Republic of the Philippines
Cagayan de Oro City
Water District (COWD)

Special Assistance for Project Sustainability (SAPS) (for Cagayan de Oro City Water District) for Provincial Cities Water Supply Project Phase III

Final Report

November 2014

Japan International Cooperation Agency (JICA)
Yokohama Water Co., Ltd.

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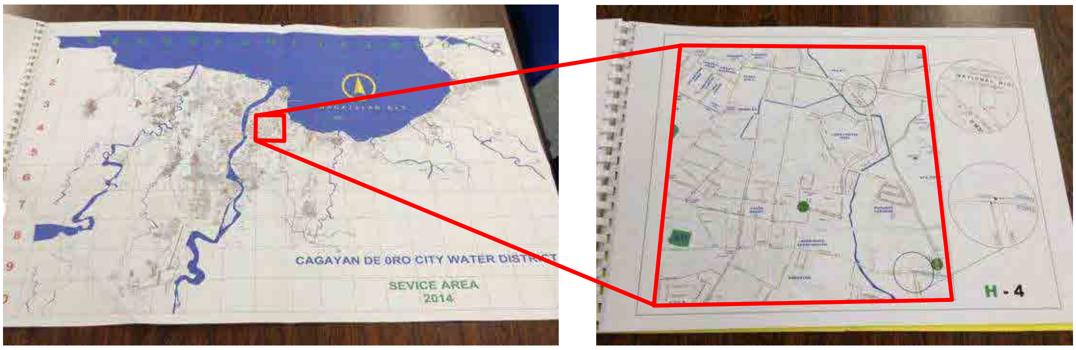

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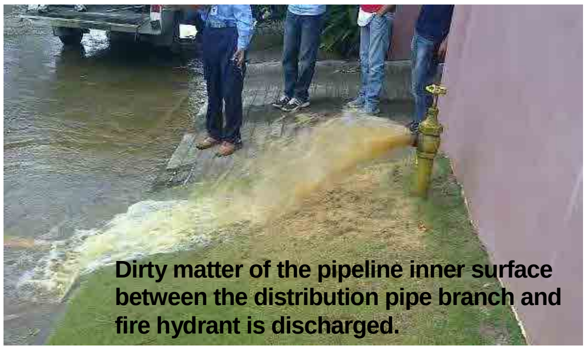

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Abbreviation (Alphabetical order)

ACP: Asbestos Cement Pipe
CAD: Computer Aided Design
CDO: Cagayan de Oro City
COWD: Cagayan de Oro City Water District
DBP: Development Bank of the Philippines
DIP: Ductile Iron Pipe
DMA: District Metered Area
DN: Diamètre Nominal
JICA: Japan International Cooperation Agency
LCC: Life Cycle Cost
LWUA: Local Water Utilities Administration
MCWD: Metropolitan Cebu Water District
NAWASA: National Waterworks And Sewage Agency
NRW: Non-Revenue Water
PE: Polyethylene (pipe)
PSI: Pound per Square Inch
PVC: Poly-vinyl Chloride (pipe)

RVWC: Rio Verde Water Consortium
SCADA: Supervisory Control And Data Acquisition
SP: Steel Pipe
uPVC: Unplasticized Poly-vinyl Chloride (pipe)
WD: Water District
YWC: Yokohama Water Co., Ltd.
YWWB: Yokohama Waterworks Bureau

Technical Terms (Alphabetical order)

DMA: This stands for "District Metered Area", and refers to water supply areas divided off to measure and manage water supply volume using a water service meter. The area is divided with a slice valve, and water flows in from one or multiple spots and is consumed within the area. By subtracting the sum total of water use as recorded on the meters installed at each house (revenue water) from the water volume from the parent meter on the inflow side (water supply volume), the NRW within the area (= water supply volume – revenue water volume) can be calculated.

Hourly factor: Hourly factor is a parameter showing the ratio of the maximum hourly supply to the mean hourly supply (max. divided by average) in a distribution system (water supply district). In a piping design, time constant is determined based on track record in the water distribution system and data in similar areas and is used to calculate the design maximum daily supply from the design maximum hourly supply.

Hourly factor differs depending on the size of the distribution system and water use. The value is usually small in a system that supply a large amount of water and in commercial districts (about 1.1 to 1.4) and is large in residential districts (about 1.5 to 2.0).

Water supply block system: This system divides the water supply area, centered on the water supply basin and water supply pump, into several water supply areas, which were then further divided; water volume and water pressure is managed for each block. In setting the water supply area, the form of demand, geographical conditions and topographical conditions are taken into account; when the vertical drop is particularly pronounced, the area is divided into the pumping water supply area and gravity flow water supply area. The main water supply pipe in the water supply area should form a pipe network. The water supply block should be divided into areas of appropriate width, taking geography and topography into account, and water should be supplied to individual users through the water supply branch pipe network, but booster pumps and decompression valves can be installed as necessary. Moreover, in order to minimize the extent of the impact on water supply in the event of abnormalities, reciprocal accommodation between adjacent water supply areas and water supply blocks should also be possible.

Unit Conversion Table

Pressure	MPa (N/mm^2)	bar ($Mdyn/cm^2$)	PSI (lbf/in^2)	atm (Standard Atmosphere)
MPa (N/mm^2)	1	10	145.04	9.869
bar ($Mdyn/cm^2$)	0.1	1	14.504	0.9869
PSI (lbf/in^2)	0.006895	0.06895	1	0.06805
atm (Standard Atmosphere)	0.101325	1.01325	14.696	1

Exchange Rate Conversions (October 2014)

1 PHP (Philippines Peso) = 2.433 JPY (Japanese Yen)

1 USD (US Dollar) = 109.45 JPY (Japanese Yen)

0 Summary

0.1 Outline and Objective of Project

Tropical storm "Sendong (known internationally as Washi)" (hereinafter referred to as "Sendong") struck the northern Mindanao region of the Philippines in December 2011, causing 1,250 deaths and affecting 1.17 million people. Cagayan de Oro (hereinafter referred to as "CDO") City with a population of 600,000 people is located downstream of the Cagayan de Oro River that flows through the northern Mindanao region. CDO is one of the cities heavily damaged by Sendong. Improvement and rehabilitation of the water supply system of Cagayan de Oro City Water District (hereinafter referred to as "COWD") was carried out through the Provincial Cities Water Supply Project Phase III funded through a Japanese ODA Loan. Sendong severely damaged these water supply facilities. Hence, COWD requested assistance from the Japan International Cooperation Agency (hereinafter referred to as "JICA") for the rehabilitation of its water supply system on May 22, 2012.

To date, COWD's water supply system serves a population of 580,000; has a water supply capacity of 163,000m^3/day; and has a Non-Revenue Water (hereinafter referred to as "NRW") rate of 56%. The total length of COWD's distribution pipeline is 510km, and about 54% of their pipelines are PVC pipes and 30% of their existing pipelines are more than 30 years old. These factors are major causes of the high NRW rate. Thus, replacing the old and weak pipelines is essential for COWD to decrease the rate of NRW.

Unfortunately, COWD does not have sufficient knowhow to prepare a reliable NRW reduction program. In order to design an effective NRW reduction program, COWD needs to develop a comprehensive pipeline replacement plan that considers cost-effectiveness and sustainability aspects. Hence, COWD requested JICA to provide assistance to its NRW reduction program.

Utilizing the recommendations that will be obtained from this study of SAPS (Special Assistance for Project Sustainability), COWD will implement a NRW reduction program. To finance such program, COWD shall access funding assistance through the "Environmental Development Project" another JICA-assisted project.

The objectives of this project are: (1) to confirm the current state of NRW of COWD; (2) to investigate the technical, institutional arrangement and financial situation of COWD's current NRW reduction activities; (3) to identify problems and challenges of current activities; and (4) to formulate recommendations and appropriate measures to address each issue.

0.2 Project Contents and Schedule

Project contents are an investigation on water projects of COWD and a proposal associated with the analysis of the investigation results. This proposal advises that COWD will continue to develop medium and long-term plans to build sustainable, strategic, and long-term perspectives.

The implementation period of the local project work was up to mid-October of 2014 from the end of April of the same year.

The JICA Study Team conducted local project work three times, and carried out advance preparation and domestic work before/after the local project work.

The 1st local project work:	From April 29 to June 3, 2014	36 days
The 2nd local project work:	From July 31 to August 20, 2014	21 days
The 3rd local project work:	From October 12 to 23, 2014	12 days

0.3 Investigation Item and Proposal

Through local project works, the JICA Study Team investigated the following items and submitted a proposal on these items. The investigation is described in Chapter 2, and the proposal in Chapter 3.

0.3.1 Survey of Activities for Reducing NRW and Proposals

The leak detection team formed in 2009 consisted of a total of 6 members including the section chief responsible for maintenance as the leader and 5 staff members. When our work started, 5 more staff members were added to form 2 teams (5 members each) under one leader for a total of 11 persons.

Until now, leak detection of about 10km of distribution pipes per year was executed and planned, and leak detection of 180km of transmission and distribution pipe over the five month period of the project (23 weeks) was executed. Until now, the leaks confirmed were mainly above ground leaks, but leak detections focused on the discovery of underground leaks were executed.

The JICA Study Team proposed that COWD draft a long-term annual plan (dividing the city into regions and selecting appropriate tools) and short-term weekly plans that specify the districts to survey during the week and determine detailed daily schedules. As short-term detection, the JICA Study Team recommended a careful study by the entire team of a plan stipulating that before the detection survey, (1) prepare a map of the detection survey area, (2) select a route, (3) check fire hydrants and valves, (4) take measures to ensure the safety of traffic and the surrounding region, and (5) determine personnel roles and rotations. The leak detection team immediately introduced and carried out these five steps.

0.3.2 Proposals on Various Activities for Reducing NRW

0.3.2.1 Method of Collecting Data on the NRW Rate and Breakdown Data

At COWD, the NRW rate is calculated by assuming that the NRW volume is the water volume obtained by subtracting the water for which the water rate is collected, which is the revenue water, from the total volume of Water Distributed, and making it dimensionless with the total water quantity distributed. The NRW is recorded as the total of (1) Leakage water, (2) Illegal connection (Stolen water), (3) Water meter insensitive (error) volume, (4) Water volume for business use in the Water District, and (5) Uncollectible account water amount, but at COWD, only (4) Water volume for business use is recorded as the rest are recorded as "other volumes of water". Originally, COWD did not categorize NRW volume, so this breakdown was analyzed for the first time by the survey.

(1) Leakage water

Setting DMA to simplify the control of water pressure and water quantity in supply areas, permits leaks in each DMA to be calculated based on the measured minimum night flow.

A District Metered Area (DMA) is an area controlled by a water meter. The amount [A] of water that flows into an independent DMA, which is separated from the other areas with valves and pipe end plugs, is measured with a flow meter. In a DMA, water is supplied to individual homes after passing flow water meters and is used [B]. The amount of NRW is calculated as the "Total amount of inflow [A] – sum of all meter values [ΣB] = amount of NRW".

Of the NRW in a DMA, the value that is almost the actual water leakage can be estimated by monitoring the minimum night flow. Water use decreases in the middle of the night. If there is a time at which no person in the DMA uses water, the flow is "0" if there is no leakage. However, if a certain degree of flow is measured, the flow is calculated as water leakage.

Although it is not accurate to estimate the value for the entire COWD from data at existing DMAs, the leakage is estimated to be about 40%.

(2) Illegal Connection (Stolen water)

COWD has not determined either the amount or places of illegal connection (stolen water). COWD has reported that in 2013 it discovered 166 cases of illegal connections. However, because there are many surface pipelines, which are PVC pipes, and water pressure is low, it is easy to access a water pipe and install an illegal connection and Stub-Outs by using simple tools. It is assumed that far more water is actually stolen. In the future, measures such as creating a more effective illegal connection (stolen water) monitoring system must be taken.

Because illegal connection mainly occurs in exposed pipes, as a countermeasure, it is necessary to understand the location of the exposed pipes and to note it on the pipe drawing. In addition, there is a need to develop an implementation guideline which defines that the staff, which work in the water supply area everyday as well as the water leakage survey team, such as meter reading staff, meter reading research staff and maintenance staff, check the illegal connection. It is difficult to determine the actual amount of illegal connection. Because the extent of illegal connections and the amount stolen are unknown, stolen water is usually combined with leakage water. After DMAs are fully constructed and the minimum night flow is measured for the entire and all water supply areas, it will be possible to calculate the basic leakage and estimate the amount of illegal connection.

(3) Water Meter Insensitive (Error) Volume

COWD replaces the customer's water meter only when it breaks. COWD has a laboratory to test water meters, is testing newly purchased meters and meters requested for testing by customers, and is assessing whether the meters show "satisfactory" values or not. As meters insensitive to water volume have not been counted in NRW investigation, we tested meter errors in COWD's laboratory by using a method that can quickly estimate the volume.

In order to determine the meter insensitive volume, COWD collected 5 water meters that are used over time every year from the first year to the tenth year of use for a total of 50 water meters, tested instrumental errors of the water meters in the COWD water meter laboratory to calculate the instrumental error of each water meter, and then calculated the water meter insensitive volume for the entire water supply system. Water velocities of 30L/h, 60L/h, 120L/h and 800L/h were tested; whose rated flows were 10, 20, 40 and 100L, respectively. Water was supplied from a tester tank. The water meter counts were compared with the rated flows, and the errors were calculated for each velocity.

The test on 50 specimens showed trends of insensitivity at all velocities from the slowest to fastest velocities. At a slow velocity of 30L/h, the error was -17%, and the error at 60L/h was -10%. At slow velocities, the actual volumetric flows are small, and the effect of the errors is not large. The errors were -4.3% and -3.9% at a middle velocity of 120L/h and a fast velocity of 800L/h, respectively. Showers, laundries, toilet flushing, and watering at homes are performed at fast velocities. For all velocities combined, the error of the water meters was -4.6%. The count failures suggest that COWD must always include an NRW ratio of 4.6%.

The specimens include five water meters that are extremely insensitive. There was one meter that did not count almost any value at all (an error of almost -100%). Of the 50 water meters tested, 5 were malfunctioning, which accounted for 10%. For the 87,000 water meters possessed by COWD, 8,700 water meters are possibly malfunctioning. It is highly recommended to test and check the performance of any meter that is suspected to be malfunctioning when the water meter is read instead of waiting for a report mentioning that it is broken.

By replacing the malfunctioning meters with new meters, COWD can improve the NRW ratio from 4.6% to Revenue Water ratio side 0.7%. This will improve the fraction in the NRW by water meter errors by 5.3 points (4.6 - (-0.7)).

There was little difference in the water meters by country of manufacture or manufacturer.

(4) Water Volume for Business Use in the Water District

Regarding the water volume for business use in the Water District, COWD already calculates this volume every year, so we will use that.

(5) Uncollectable Account

For the unpaid water volume, the percentage of uncollectable account stated in the Annual Report of the previous year to the water service income is to be calculated.

(6) Total Distributed Amount

In water distribution analysis, the amount of NRW is calculated by setting the total distributed amount as 100% and subtracting the amount of revenue water, which is easy to determine, from the total amount. The ratio of NRW consists of the aforementioned items, of which the water volume for business use and unpaid water volume can be determined by calculation. The meter insensitive water volume can be estimated from experimental data. By subtracting these and the calculated amount of leakage and stolen water from the amount of NRW, the ratio of leakage can be estimated from the minimum night flow measurement.

It is most important here that the total distributed amount is correct. The amount of revenue water is almost correct because it is calculated from water charges. The correctness of the total distributed amount determines the ratio of revenue water, which is calculated as described below.

The ratio of revenue water is calculated by dividing the amount of revenue water by the total distributed amount and multiplying by 100. The calculated ratio varies depending on the correctness of the total distributed amount, which is the denominator, as does the ratio of NRW. COWD cannot be said to adequately maintain its flow meters installed on the deep wells that are its own water source, and a comparison beteween the electro-magnetic flow meters and ultra-sonic flow meters that it has installed show deflection of measured values from 88% to 163%.

The measurement error at the bulk water receiving station (RVWC) was 163%. If the measurement by the ultrasonic flow meter was correct, of the reported amount of 40,000m^3/day, only 24,500m^3/day was actually pumped. The total distributed amount by COWD was reported to be 157,000m^3/day, but it could actually have been only 141,500m^3/day. The flow meters at 3 deep wells (11% of all wells) showed a measurement error of 113%, suggesting a measurement error of 13,500m^3/day for all wells combined. By considering an error of 3,500m^3/day (25%), the actual total distributed amount is calculated to be 138,000m^3/day.

The distributed amount by COWD for year 2013 - before and after the analysis is shown in the table.

Table Changes in the water distribution water volume analysis
according to the practice of investigation and analysis

			Before	After
Distributed Water 100% 157,000m^3/day → 138,000m^3/day	Revenue Water 44.4→50.5%	Water Charge	44.4%	50.5%
		Other	+0.0%	+0.0%
	Non-Revenue Water 55.6→49.5%	Leakage	N/D	42.1%
		Illegal Water	N/D	
		Water Meter Error	N/D	4.6%
		Unpaid Water Charge	N/D	0.4%
		Use by COWD	1.5%	1.7%
		Other	54.1%	--

↓

Distributed Water	Before Analysis	After Analysis
COWD Deep Well	117,000	117,000 / 1.13 = 103,500 → In contrast to a differential of 13,500 from before analsysis, an error is defined as 25% of the wells; not all the deep wells → 103,500 + 13,500 × (1 - 0.25) = 113,600
RVWC Bulk Water	40,000	40,000 / 1.63 = 24,500
Total (m^3/day)	157,000	138,000

0.3.2.2 Water Supply Design and Service Pipe Connections

According to the Stub-Out ledger of COWD, there is a Stub-Out to which 96 water meters are connected. From the water meters, the water was supplied to each home through a DN13mm PVC pipe or hose extending over 10m or sometimes over 100m. Water leak was observed from such pipes and hoses at more than a dozen points. Because the service pipes were exposed and not protected even on roads, the pipes were being damaged by passing bicycles and pedestrians.

The water supply rules of COWD approve the installation of a water meter to a Stub-Out only when (1) the supply water pressure at the Stub-Out is at least 10PSI, (2) the pipe from the Stub-Out to the home is not longer than 20m, and (3) there will be no more than 20 water meters installed to the Stub-Out after the said installation. However, there are 218 Stub-Outs that do not meet the criteria, which account for 17% of all Stub-Outs in the water supply district. Such Stub-Outs are located in districts where customers frequently complain that water is not sufficiently supplied. The JICA Study Team proposed an action for quickly solving the problem.

Keeping the water supply rules of COWD in mind, the number of water meters connected to a Stub-Out is to be reduced by installing new Stub-Outs on the distribution pipe line near the Stub-Outs to which a number of meters over the specified numbers are connected. The new Stub-Outs should be installed at appropriate locations so that the service pipes to homes do not exceed 20m. The rules approve up to 20 water meters per Stub-Out, but the number should be reduced to 16 when the meters are divided. This will allow the installation of several new water meters for new customers. If the nearest Stub-Out to a new customer already has 20 meters connected, the water meter of the new customer must be installed at a far Stub-Out. By having four “empty” connections at each Stub-Out, it will be possible to continue observing the water supply rules as it provides time until a new Stub-Out is installed.

The costs for constructing the necessary new Stub-Outs and moving the water meters service pipes are estimated to be about 35,000PHP per existing Stub-Out. It will require 11.2 million PHP (321 Stub-Outs × 35,000PHP) to improve all Stub-Outs. The divisions were estimated to improve water supply to 2,677 connected customers and increase revenue water by 1,387m^3/day by allowing the water that is otherwise not consumed to be used.

This amount of revenue water corresponds to 2.0% of the mean daily supply of the current revenue water. Because 1% of the revenue water in COWD was about 7 million PHP in 2013, a 2% increase of revenue water will exceed the costs for renewing the Stub-Outs in a year. By improving the Stub-Outs only once, COWD will gain the increased revenue by the improvement for many years. Thus it is recommended to take early action.

0.3.3 Proposals on DMA Construction and Distribution Network Calculation

The JICA Study Team and COWD discovered 18 districts (8 in the eastern area and 10 in the western area) in which DMA can be constructed within the water supply district of COWD. In these DMA candidates, the water supply systems are branched from the distribution main to supply water to their water supply districts and are basically separated from their adjacent distribution networks. Therefore, DMAs can be completed just by constructing flow meter chambers and installing flow meters. The JICA

Study Team determined the piping network so that it can build DMA at about 30 other loctions, but because sluice valves are required to divide the network, it will be necessary to peform detailed piping network calculations to perform a detailed survey to clarify if it can be divided.

0.3.4 Measures for Reducing NRW Involving Organization and/or Personnel Resource, Publicity, Customer Services

0.3.4.1 Organizational Reform

A structural reform of the COWD organization is scheduled to be carried out in January 2015. The NRW Reduction Team now includes employees of multiple sections, but the structural reform will establish a new department related to maintenance with sections concerned with leak countermeasure and with maintenance formed under this department. This will establish a chain of command and division of duties, probably permitting requests and instructions etc. to be smoothly exchanged between sections.

0.3.4.2 Improvement of Water Service

Understanding how customers feel about COWD's water supply and making improvements in response to their dissatisfactions and desires help improve water supply services. Every year, COWD conducts a questionnaire survey of 300 customers, but attribute analysis of the residence area of the respondents has not been performed, so the survey cannot clarify what people desire in which regions. The JICA Study Team has recommended that they have the respondents also enter the region where they live and their ages (decade of birth) so they can specify regions that should be improved and their demands that differ according to the taste and mindset of each age group.

0.3.4.3 Incentive Mechanism

COWD has not employed any special systematic action that involves an incentive mechanism (bounty system) for reducing NRW. In interviews with COWD employees, they mentioned overtime allowances paid for working on days off and overtime work for repairing leaking pipes and preparing conference materials, but they are a mere extension of ordinary works and do not constitute an incentive mechanism.

The JICA Study Team proposed the following systematic incentive mechanisms for reducing NRW to COWD. The list also includes those for activating the organization besides those for reducing NRW.

These evaluations can be combined with the merit rating system of COWD. A system should be established to make evaluations, and the funds need to be budgeted if a bonus is to be paid in the bounty system.

0.3.4.4 Outsourcing

In Japan, the wages of public servants are decided based on the personnel expenses of private companies. The wages are calculated based on the data of medium-sized to large-size private companies and determined at their average value. In Japan, this average value is higher than the personnel expenses of most small private companies. Many governmental organizations outsource administrative service works to private companies to not only improve efficiency but also to incorporate the know-how of the private companies and reduce personnel expenses.

On the other hand, in the Philippines the personnel expenses of public servants are lower than in private companies. Outsourcing of works may improve the efficiency but would adversely affect business management due to increased personnel expenses. COWD has employees under various types of employment contract, including cheap temporary and seasonal employees, to execute its works.

The JICA Study Team conducted an interview on outsourcing for improving work efficiency. Today, COWD outsources only security services; and all other works including reading meters, examining leakage and repairing leaking pipes (sudden works) are performed by its employees. COWD does not outsource the design of water works and also executes water works by itself except for large-scale projects.

It is likely too early to introduce the concept of outsourcing in Japan, where personnel expense is high, into the Philippines, where labor cost is cheap.

0.3.5 Drafting Leak Detection Plans and Field Training Using New Leak Detection Equipment

The leak detection team is headquartered at the Macasandig branch office at the Macasandig booster pumping station in the east distribution district. For this project, new instruments and equipment (1 unit of correlative leak detector AQUASCAN, 1 unit of a sound collector for a correlative leak detector HydroPhone, 1 unit of areal correlative leak detector ZONESCAN, 2 units of leak detector for resin pipe D305 and 2 units of general type of leak detector Pocket Phone, All Rental) were introduced, that has greatly enhanced its material capabilities.

As field training, leak detection has been conducted as on-the-job training in the field on the transmission pipe starting at the Macasandig government branch office and extending to the Camaman-an distribution reservoir, on the transmission pipe along the eastern harbor shoreline, and at the existing 2

DMAs, other Sub Divisions, and commercial districts. It is necessary to replace the policy of performing leak detection only in response to the discovery of a leak in the field with systematic organized leak detection, so the JICA Study Team proposed this improvement and conducted field on-the-job training according to this proposed improvement.

Leak detection is divided into office planning, field detection, and detection reporting (including requests for repair of leaks). At the office planning stage, all team members spread out and check the distribution network map covering that day's detection range, then they all discuss the selection of the leak detectors to be used and assignment of the personnel (their roles), check the detection route and locations of pipelines, valves and fire hydrants, and the road traffic conditions and surrounding environment as known at that time, and through this process, create an image of the detection work to be performed. The field leak detection is performed on the planned detection route, but it is recommended that to prioritize efficiency of detection, cleaning the valve chambers in advance be positioned as part of organized maintenance.

After first field work, we requested that COWD submit a leak detection report every Monday, and until now carefully completed reports have been sent from COWD every week. At this time, detection surveys are performed by trial and error based on leak detection plans prepared by the JICA Study Team and by the COWD leak detection teams. They conducted a water leakage survey from mid-May and during the 5 months (23 weeks) until mid-October, completed the water leakage survey of 180.3km already (10.1km/week) and found 36 leakage points.

0.3.6 Fiscal Outlook of COWD

COWD is planning water supply improvement projects by obtaining a loan from the Development Bank of the Philippines (DBP). The sum has already been settled between COWD and DBP, and the financing limit was set at 458 million PHP. The JICA Study Team proposed a project plan using the loan, and DBP and COWD both agreed.

The projects will involve (1) renewing asbestos cement pipes (ACPs) with ductile iron pipes (DIP), (2) improving Stub-Outs, (3) burying exposed pipes on roads, and (4) renovating the pipes installed in Phase I.

Aiming to start the DBP projects in 2015, various designs are to be created in a year and a half. The financial plan for executing the projects in 5 years starting in 2016, during which two or more projects may be executed simultaneously, was investigated.

The major purpose of this project is the reduction of the NRW rate, but later a follow-up project on the 250 million PHP scale to expand the water supply area will be studied, and it is predicted that it will be funded by the DBP and private banks in the Philippines.

It is assumed that the improvement of the NRW rate by the above setting (about 50% to 25%) will be a fall of the NRW rate of about 3% to 4% per year during the five year exection period achieved by the concentrated improvement and upgrading of water system facilities by a new DBP project (458 million PHP) and that before this, recommendations by this survey project can reduce it by about 1 to 2% per year. The JICA Study Team hypothesizes that it can achieve an NRW rate of about 25% at COWD in 2025.

In addition, COWD is assumed to be financed by an ODA two-step loan of the Environment Development Projects (EDP) by JICA.

0.4 Toward Formulation of Medium- to Long-Term Plans

If the distribution system matures, the distribution piping network and the NRW rate will be controlled in greater detail by the DMA or distribution blocks, and it will beome necessary for SCADA to manage the remote control and data. This road naturally will require further improvement of the 24 hour water supply that is already the foundation of efficient water operation. The contents proposed will be steadily and continually implemented by COWD in the medium to long term, and this is counted to sharply cut the NRW rate.

0.5 Achieving Priorities

In this project, the project team discussed problems in the COWD water business and the future tasks with COWD personnel from the same side and from the same points of view as compared to the YWWB water business.

Some matters of operation and maintenance that should be implemented in Japan are not implemented by COWD. Referring to the problem gives them a clue to recognizing the situation. It is important for them to understand the background that they experienced in Japan and recognize the necessity of introducing our proposals. It is not certain whether or not all matters implemented in Japan are effective in the Philippines due to the differences in laws, customs, and climate. However, if COWD personnel have learned, seen, or heard possible solutions to solve problems, it is worth giving advice to them.

Maturity of the water supply business starts with maintaining an adequate water supply volume, and once 24-hour water supply is achieved, an interest in water quality grows. Water quality should be maintained in accordance with the water quality standards in the country and must not exceed those standards. Good water sources are desired for maintaining safe water quality. Then development of sewage systems is enhanced so that pollution of the water supply by sewage water is prevented. Water service starts with maintaining an adequate water supply volume. Full realization of a 24-hour water supply is an absolute requirement. Safe water quality cannot be expected with an intermittent water supply. Without a constant monitoring of water quality (water volume, water pressure) by SCADA, it cannot be confidently said that safe water is being supplied.

We strongly hope that a safe and secure water environment. will be established in CDO City, that is a large Philippine city and a center of technology and industry

We also expect that our activities in this project will give Water Districts besides COWD suggestions for improvement of their water business and links to improvement of the water environment in the countries of Southeast Asia.

1 Introduction

1.1 Outline of Project

1.1.1 Background of Project

Tropical storm "Sendong (known internationally as Washi)" (hereinafter referred to as "Sendong") struck the northern Mindanao region of the Philippines in December 2011, causing 1,250 deaths and affecting 1.17 million people. Cagayan de Oro (hereinafter referred to as "CDO") City with a population of 600,000 people is located downstream of the Cagayan de Oro River that flows through the northern Mindanao region. CDO is one of the cities heavily damaged by Sendong. Improvement and rehabilitation of the water supply system of Cagayan de Oro City Water District (hereinafter referred to as "COWD") was carried out through the Provincial Cities Water Supply Project Phase III (hereinafter referred to as "PCWSP III") funded through a Japanese ODA Loan. Sendong severely damaged these water supply facilities. Hence, COWD requested assistance from the Japan International Cooperation Agency (hereinafter referred to as "JICA") for the rehabilitation of its water supply system on May 22, 2012.

In August 2012, JICA, COWD and the Local Water Utilities Administration (hereinafter referred to as "LWUA") signed a Memorandum of Understanding (MOU) for the implementation of the "Rehabilitation Project for COWD's Facilities Damaged by Typhoon Sendong". As a result of this project, rehabilitation of the water supply system in Macasandig and Balulang districts, areas previously financed under PCWSP III, was completed in October 2013.

To date, COWD's water supply system serves a population of 580,000; has a water supply capacity of 163,000m^3/day; and has a Non-Revenue Water (hereinafter referred to as "NRW") rate of 56%. The total length of COWD's distribution pipeline is 510km, and about 54% of their pipelines are PVC pipes and 30% of their existing pipelines are more than 30 years old. These factors are major causes of the high NRW rate. Thus, replacing the old and weak pipelines is essential for COWD to decrease the rate of NRW.

Unfortunately, COWD does not have sufficient knowhow to prepare a reliable NRW reduction program. In order to design an effective NRW reduction program, COWD needs to develop a comprehensive pipeline replacement plan that considers cost-effectiveness and sustainability aspects. Hence, COWD requested JICA to provide assistance to its NRW reduction program.

Utilizing the recommendations that will be obtained from this study of SAPS (Special Assistance for Project Sustainability), COWD will implement a NRW reduction program. To finance such program, COWD shall access funding assistance through the "Environmental Development Project," another JICA-assisted project.

1.1.2 Objectives of Project

The objectives of this project are: (1) to confirm the current state of NRW of COWD; (2) to investigate the technical, institutional arrangement and financial situation of COWD's current NRW reduction activities; (3) to identify problems and challenges of current activities; and (4) to formulate recommendations and appropriate measures to address each issue.

1.2 Scope of Works

1.2.1 Subject Area of Project

The project area is CDO City (Capital of Province of Misamis Oriental) and COWD's water supply area. The province of Misamisu Oriental is situated in the northern part of Mindanao Island located in the southern Philippines.

1.2.2 Contents of Project

Project contents are an investigation on water projects of COWD and a proposal associated with the analysis of the investigation results. This proposal advises that COWD will continue to develop medium and long-term plans to build sustainable, strategic, and long-term perspectives.

1.2.2.1 Plan for Local Project Work

The implementation period of the local project work was up to mid-October of 2014 from the end of April of the same year.

The JICA Study Team conducted local project work three times, and carried out advance preparation and domestic work before/after the local project work.

The 1st local project work:	From April 29 to June 3, 2014	36 days
The 2nd local project work:	From July 31 to August 20, 2014	21 days
The 3rd local project work:	From October 12 to 23, 2014	12 days

1.2.2.2 Investigation Item

Through local project works, the JICA Study Team investigated the following items and submitted a proposal on these items. The investigation is described in Chapter 2, and the proposal in Chapter 3.

(1) Understanding COWD's NRW Reduction Program and Proposals for Improvements

Investigation Item: 1) Confirmation of functions of the NRW reduction measures team and its activities
2) Efforts to achieve NRW reduction measures
3) Business flow of on-desk and on-site
4) Understanding of the current system
5) Identify issues and problems, and measures and correspondence for the damage

(2) Proposals on Various Activities Related to NRW Reduction Measures

(2-1) Current state of pipe network map, confirmation of accuracy and pipe network diagram information

Investigation Item: 1) Management conditions on attribute contents, frequency and flow of updating of pipeline ledger and schematic diagrams
2) Accuracy of map diagram and check on-site
3) Number of installations and their intervals with fire hydrant and valve
4) Information on opening and closing and inspection status of valves

(2-2) Confirmation of situation analysis of current NRW and recommended actions

Investigation Item: 1) Current water volume data underlying the NRW
2) Method and frequency of data collection
3) Flow of NRW rate determination

(2-3) Fact-finding survey and proposals on how to proceed with water supply business including customer data, water meter management ledger, water billing data management (meter reading), and database required for NRW measures (RMS: Revenue Management System)

Investigation Item: 1) Database input item of RMS
2) Context of the relevant ledger
3) Registration process of new customers
4) Flow from meter reading to billing
5) Process flow of unbilled revenues
6) Review of customer service (Previous year comparison display of usage)
7) Data analysis on water use

(2-4) Proposals on results of review of surface and underground water leakages in each region and data on water pressure

Investigation Item: 1) Comparison of causes of water leakage by various dimensions (by surface and groundwater, by location, by meter size, by pipe material, by year when pipes were laid, by road category)

2) Correlation between water pressure and water leakage

(2-5) Confirmation on whether COWD's calculation of transmission pipe network flow is appropriate and recommendations for improvement

Investigation Item: 1) Data necessary for the calculation of transmission pipe network (water volume at node branch, pipe diameter, pipe length, ground elevation, etc.)

(2-6) Check status of current water supply design and the water supply pipe connection and proposals for improvement

Investigation Item: 1) Current water supply design guidelines

2) Number of water meters at water supply pipe branch (Stub-Out)

(3) Confirmation of Status of Pipe Network Calculation and DMA Installation and Proposals for Improvement

(3-1) Confirmation of existing pipe network calculation and construction of DMA

Investigation Item: 1) Confirmation/Hearing of pipe network calculation

2) Confirmation of DMA candidate site

(3-2) Proposals in relation to the requirements in establishing DMAs and the number of DMAs that can be set up against total water supply coverage

Investigation Item: 1) How to set up DMAs

2) Elevation of water supply area

3) Intake and booster pump performance

4) Barangay population (number of households) data

5) Data on volume of water supply

(3-3) Analysis of pipe network calculation results and current situation on the DMA water distribution and proposals on pipe network development

Investigation Item: 1) Pipe network improvements based on pipe network calculation results for defective water pressure areas (increase in pipe diameter and division of water supply zones)

(3-4) Proposals in accordance with the priorities of the pipe network development

Investigation Item: 1) Pipe network improvement target based on pipe network calculation results

2) Analysis of surrounding environment of target pipeline

(4) Survey of NRW and Strategic Proposals on NRW Reduction Measures and Implementation Plan

(4-1) Current state of COWD (in terms of financial resources, human resources and organization, DMA establishment, public relations of water information, customer service)

(4-2) Survey results (pipe network system, distribution water volume analysis, revenue management system, DMA water volume, monitoring of water pressure and flow rate)

(5) Preparation of water leakage survey plan and OJT (On the Job Training) on Usage Water Leakage Survey Equipment

(6) Status of NRW Survey and Proposed Strategies on NRW Reduction Measures and Implementation Plan

(6-1) Short-term Measures (Improvements in the conduct of ordinary business operations)

(6-1-1) Improvement of short-term NRW measures except water leakage (water meter error, illegal connection, non-paying customers, unbilled revenues, incorrect meter reading)

Investigation Item: 1) Sensitivity of water meter (water meter error)
2) Location of illegal connection place
3) Measures to address non-paying customers
4) Water meter reading
5) Recording of meter reading
6) Meter reading route
7) Training of staff for meter reading
8) Consignment of meter reading

(6-1-2) Short-term improvements to reduce water loss

(6-2) Medium-term Measures

(6-2-1) Analysis and recommendations on DMA setting to accurately measure volume of water distribution and water consumption, installation of main pipeline flow meter and SCADA introduction

(6-2-2) Proposals on deployment and operation of accurate Revenue Management System

(6-2-3) Proposals on water supply equipment maintenance (placement of Stub-Out with optimal number of water faucets, appropriate water supply connection work, and others)

Investigation Item: 1) Forecast of revenue water due to placement of appropriate Stub-Outs

(6-2-4) Proposals on adjustment of distribution of water pressure (management of water pressure distribution, optimization of water pressure at nighttime)

Investigation Item: 1) Minimum night flow measurement in existing DMAs (In the first project period in COWD, conducts confirmation of gate valve and water inlet point)

(6-2-5) Water distribution facility development (replacement plan for old pipes, development of mapping system, appropriate construction management)

(6-2-6) Regarding NRW Reduction Measures based on the core vision/mission of COWD and the basic concept of medium- long term policy, the JICA Study Team and COWD will formulate appropriate proposals.

(7) Financial Analysis that Takes into Account the Life Cycle Costs in NRW Reduction Measures and Proposals on Initiatives to Improve Water Services

(7-1) Analysis of financial condition and proposing an appropriate water charge

Investigation Item: 1) Water rate revision simulation

(7-2) Understanding water consumption pattern of customers, confirmation of current billing method, and proposals for improvements

(7-3) Options on extending or replacement of pipes over the medium-long term, leakage point identification (rapid leak repairing and pipeline rehabilitation plan), and comparison of cost-effectiveness measures to reduce NRW

(7-4) Study of incentive mechanism to promote NRW reduction measures

Investigation Item: 1) Review of COWD incentive mechanism and comparison with other companies

(7-5) Study of outsourcing business in the implementation of NRW measures (comparison with Japan)

(7-6) Information dissemination to customers to maintain water services and conduct of a Customer Satisfaction survey

Investigation Item: 1) Preparation of questionnaire for customer satisfaction survey

(8) Review of Usage and Applicability of Water Leakage Survey Equipment

1.2.3 Flow of Implementation Work

Y	M	Project Step	Outline	Report
2014	4	[a] Preparation of Inception Report (ICP/R), Preparatory work [b] Rental of equipment	[a1/b1] Meeting with JICA [a2] Continue to make ICP/R [b2] Order of rental machines [a3] Approval of ICP/R by JICA	Inception Report (ICP/R)
	5	[c] The 1st Project period in COWD	[b3] Bringing of machines [c1] Description and discussion of ICP/R to COWD [c2] Current status and condition survey of NRW reduction [c3] Training in equipment usage [c4] Making leakage survey plan	
	6		[c5] Leakage survey (~ Oct.) [c6] Recommendations on measures to reduce NRW, agenda-setting and reporting to COWD [c7] Report to JICA PHL	
	7	[d] The 1st Project period in Japan, Preparation of Interim Report (ITM/R)	[d1] Meeting with JICA [d2] Making ITM/R (e-mail) [d3] Approval of ITM/R by JICA [d4] Contact with COWD	Interim Report (ITM/R)
	8	[e] The 2nd Project period in COWD	[e1] Description and discussion of ITM/R to COWD [e2] Implementation plan and strategy for NRW reduction measures, Research on water services and financial analysis that takes into account LCC [e3] Proposal of [e2], Assignment to COWD, Report to COWD [e7] Report to JICA PHL	
	9	[f] The 2nd Project period in Japan, Preparation of Draft Final Report (DF/R)	[f1] Meeting with JICA [f2] Making DF/R (e-mail) [f3] Approval of DF/R by JICA [f4] Contact with COWD	
	10	[g] The 3rd Project period in COWD	[g1] Description and discussion of DF/R [g3] Review of leakage machines [g2] Review of NRW reduction activities of COWD [g4] Pullback of machines [g5] Final Report to COWD [g6] Report to JICA PHL	Draft Final Report (DF/R)
	11	[h] Finalization of Final Report (F/R)	[h1] Meeting with JICA [h9] Return of machines [h2] Making F/R, Check by COWD [h4] Bookbinding, F/R Submission to JICA [h3] Approval of F/R by JICA	Final Report (F/R)

Fig-1.2.1 Project work flow

2 Investigation of Region Conditions

2.1 Basic Information

2.1.1 Natural Conditions

2.1.1.1 Investigation Location

The Philippines comprises approximately 7,000 islands of varying sizes, that can be broadly divided into the three regions of Luzon in the north (where the capital, Manila, is located), the Visayas Islands in the central part of the country, and Mindanao in the south. Mindanao Island, where CDO City is located, is the second largest island in the country after Luzon. CDO City is situated in the northern part of this island.

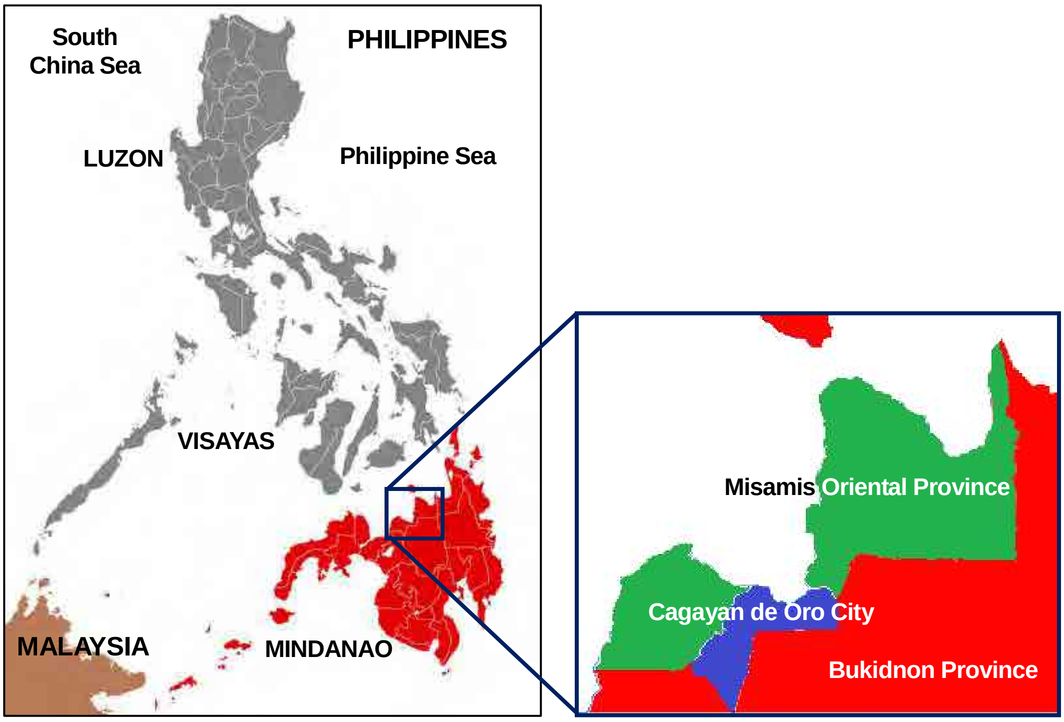


Fig-2.1.1 Location of CDO City

2.1.1.2 Geographical Features

COD City is the capital of Misamis Oriental Province and located on the central seacoast of Northern Mindanao. The Cagayan de Oro River passes through the center of the city and flows into Macajalar Bay, which connects to the Bohol Sea. COD City is bordered by the Municipality of Opol to the west and the Municipality of Tagoloan to the north, both of which belong to the same province, and is also bordered by the Province of Bukidnon to the south.

COD City occupies 14% of its province with an area of 488.86 km^2, and extends from a latitude of

8° 14′ N to 8° 31′ 5″ N and a longitude of 124° 27′ E to 124° 49′ E.

The city includes flat land along its narrow coastline on Macajalar Bay as well as high ground connected by sheer slopes. The lowland areas are characterized by relatively flat land and lie at an elevation of 10 m or less above sea level. In contrast, the highland areas, which extend to east and west starting from the south part of the city, include basins, terraced paddy fields, and canyons and gorges.

Rivers and streams inside the city limits drain into Macajalar Bay (see Fig-2.1.2). The primary rivers are the Cagayan de Oro River, Iponan River, Bigaan River, Cugman River, Umalag River, Agusan River and Alae River.

Of the total municipal area, 28% is occupied by flat land along the seacoast and the gently sloping land (slope of less than 8%) of the Cagayan de Oro River and Iponan River basins. Most of the city's land use is in these areas, which are also the sites of periodic flooding. The remaining 72% of the municipal area is covered in steep slopes (8% or more), which make land development difficult.

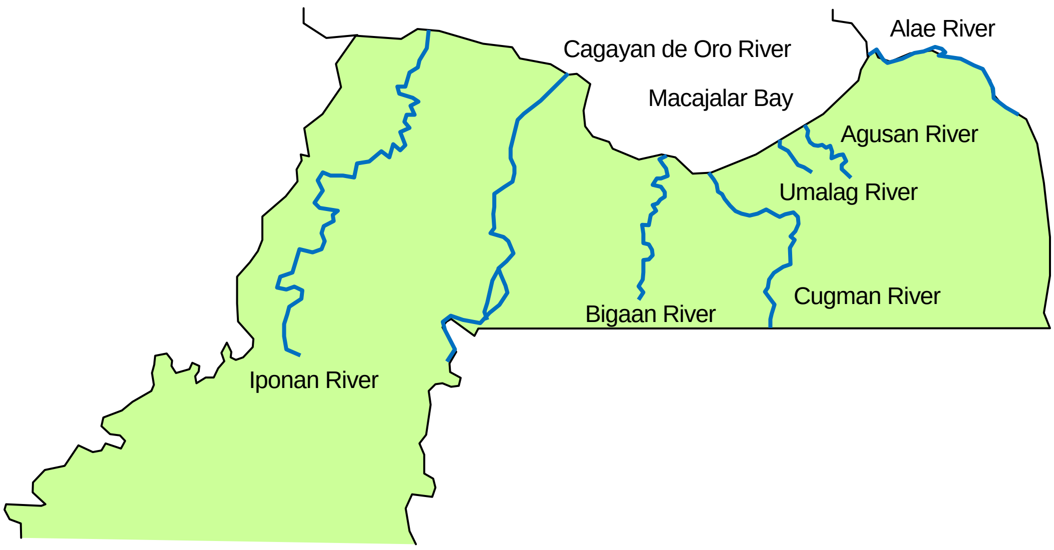


Fig-2.1.2 Main rivers of CDO City

2.1.1.3 Climate Conditions

According to the Köppen climate classification system, this area is classified as a tropical monsoon climate (Am), meaning that it has a tropical rainforest climate with a weak dry season. The average annual temperature of 28°C is high compared with that of Japan, and a maximum temperature of 39.0°C was recorded in June 1998. COD City experiences both a dry season (December to May) and a wet season (June to November), and the midsummer season (March to April) is characterized by dry weather. In contrast to Japan's wet season, this area's wet season—which starts around June—is characterized by short bursts of extremely heavy rain from the early evening onward. In addition, sunlight hours decrease during this time of year, making COD City seem less like the southern, tropical city one might imagine. Furthermore, usually, COD City is spared the direct effects of typhoons due to the influence of low pressure zones within the Intertropical Convergence Zone (ITCZ).

Table-2.1.1 shows the average weather conditions in CDO City over the last 20 years. Additionally, Fig-2.1.3 shows temperatures in the city and Fig-2.1.4 shows rainfall and hours of sunlight.

Table-2.1.1 Average weather of the past 20 years of CDO City

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Record of Highest Temperature	37	38	38	38	38	39	37	37	36	37	38	37	39
Average Highest Temperature	30	30	31	32	32	32	31	32	31	31	31	30	31
Average Temperature	27	27	27	28	29	28	28	28	28	28	27	27	28
Average Lowest Temperature	23	23	23	25	25	25	24	24	24	24	24	23	24
Record of Lowest Temperature	17	17	18	20	22	18	17	21	22	18	20	18	17
Precipitation	116	69	52	41	97	208	207	208	226	176	138	90	1,628
Rain days	10	7	6	6	8	13	14	14	15	15	11	11	130
Average Daylight hours	7.7	9.3	10.7	11.3	11.2	4.0	9.6	6.9	6.7	8.6	5.3	3.5	7.9

Unit: Temperature / Degree C, Precipitation / mm, Rain days / day, Daylight hours / hour

Reference: Historical Weather for Cagayan de Oro, Philippines / www.weatherbase.com

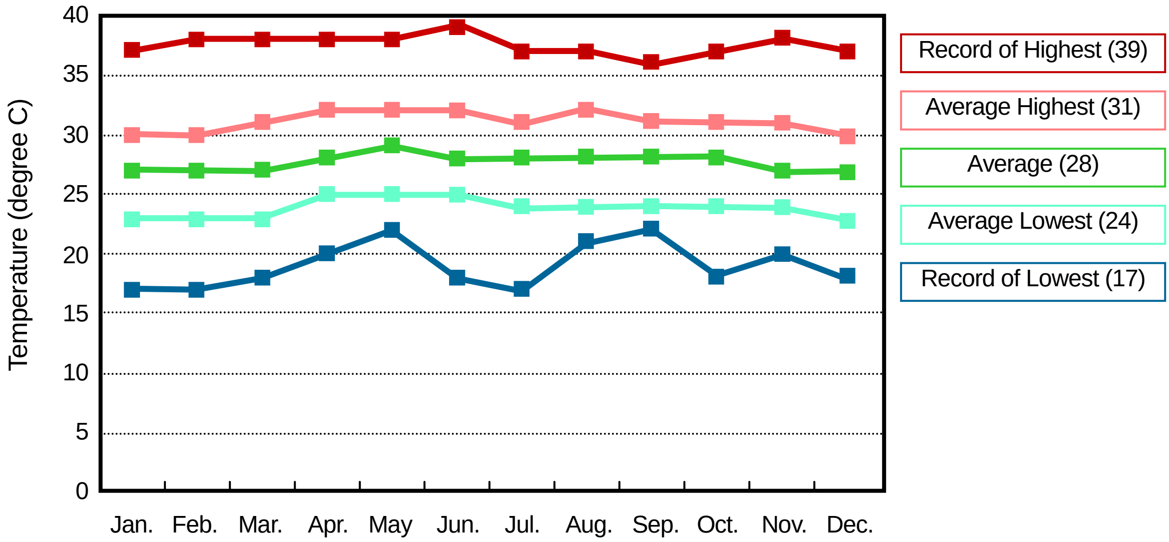


Fig-2.1.3 Monthly temperature of CDO City

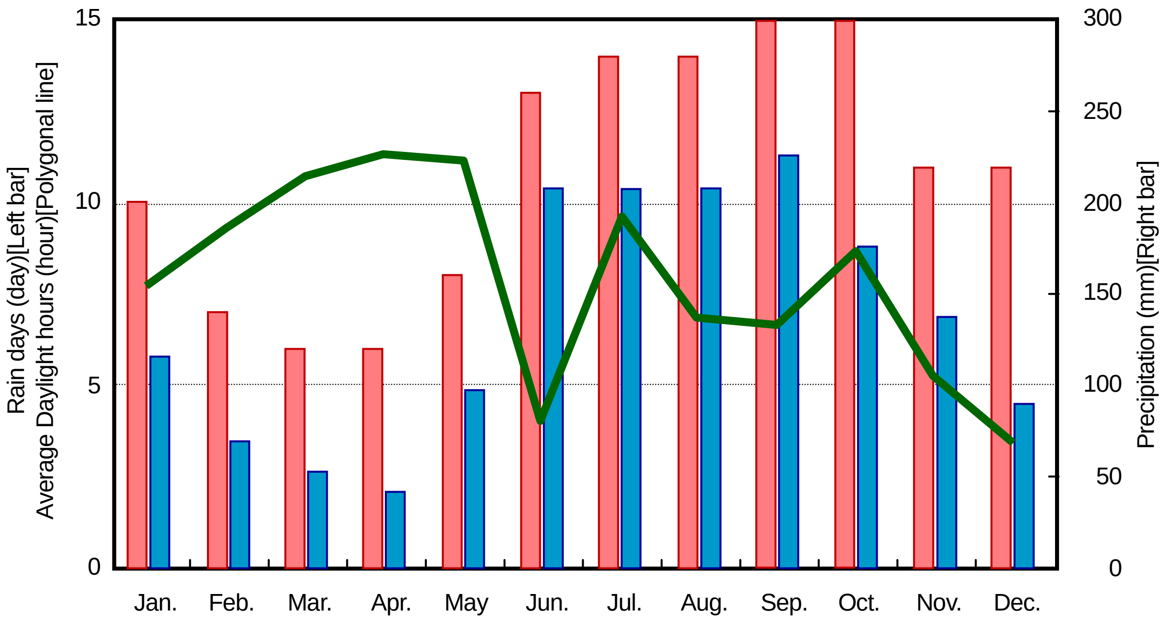


Fig-2.1.4 Precipitation and Daylight hours of CDO City

2.1.1.4 Geological Features and Soil Characteristics

Geologically speaking, CDO can be divided into three types of land: low-lying land, flat highlands, and hills and mountains.

The lowlands comprise sandbars, tidal flats, coastal alluvial plains, broad alluvial plains and river floodplains; the flat highlands in the southeast part of the city comprise terraced paddy fields, plateaus, piedmonts, and canyons and gorges; and the hilly and mountainous areas comprise escarpments, conglomerate hills, limestone hills, shale hills and mountains.

The primary soil type in CDO is clayey soil, with other soil types including sand, salic silt, loam and clayey loam. In contrast to this region's San Manuel loam and Bantog clay layers, which enable very high agricultural productivity, the Matima clay and Umingan clayey loam layers severely reduce such productivity.

The lowland plains have a gravelly soil underlayer in which wide-stretching confined aquifers exist. Deep wells have been drilled throughout the COWD — 26 such wells are utilized as city-owned water resources. Although we believe groundwater supplies will persist and not become depleted in the future, population increases are expected to greatly increase the water demand. For this reason, treatment of water taken from the Cagayan de Oro River — an abundant water resource — alongside use of existing sources during the dry seasons is being considered in the COWD.

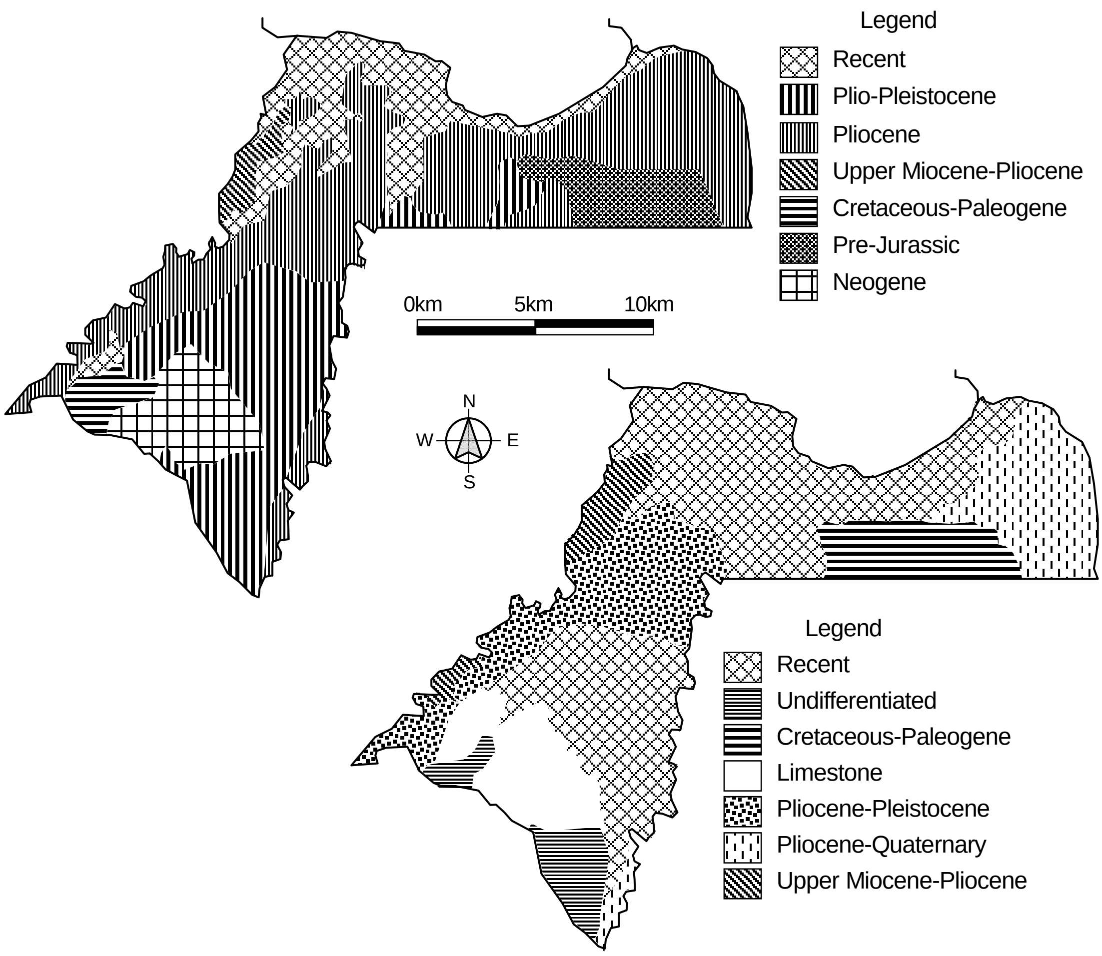


Fig-2.1.5 Geological map of CDO City
(Upper left: Surficial geology, Lower right: Subsurface geology)

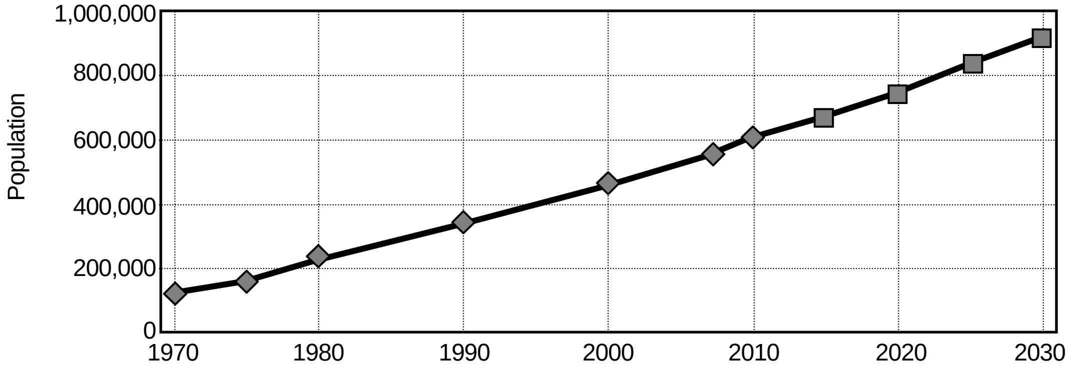
2.1.2 Society and Economy

Vast amounts of farmland, forests and other natural areas remain in the plentiful hills and mountains of CDO. In contrast, urban development is also progressing steadily, leading to the construction of numerous key educational and research institutions. The economy continues to grow thanks to great numbers of tourists visiting the city from other parts of the Philippines and abroad, and the local market presents increasing opportunities for investment. Furthermore, the population growth rate is high, with CDO representing the fastest-growing municipality on Mindanao Island, and COWD analysis projects a continuation of this fast-paced growth into the future.

2.1.2.1 Population

The National Statistics Office (NSO) conducts censuses in the Philippines, and CDO's population is 602,088 according to the 2010 census. The first census of the city, which was conducted in 1903, listed a population of 10,937.

From the 1990s onward, CDO was home to 12,000–16,000 births and 2,000–5,000 deaths per year, leading to continuous growth of about 10,000 persons annually.



Year	1970	1975	1980	1990	2000	2007	2010	2015	2020	2025	2030
Population	128,319	165,220	227,312	339,598	461,877	553,966	602,088	671,000	748,000	828,000	910,000
Annual rate	----	+5.19%	+6.59%	+4.10%	+3.12%	+2.63%	+2.82%	+2.4%	+2.2%	+2.0%	+1.9%

Reference: National Statistics Office (NSO), Census of Population and Housing of the Philippines

Fig-2.1.6 Population and its growth rate of CDO City since 1970 (Real value◆, Predicted value■)

CDO is part of northern Mindanao, which is known as Region X (the tenth region). The population growth rate of CDO is recorded as being just under twice that of Region X as a whole.

Fig-2.1.6 shows data from 1970 onward (◆ symbols represent NSO statistical data). Regardless of slowing growth rates since the start of the current century, an average annual rate of approximately 3%

can be observed. Predicted population values up until the year 2030, which were calculated using regression analysis, are shown from midway through the graph (represented by ■ symbols).

2.1.2.2 Industry and Economy

(1) Industry and Trade

According to the Bureau of Customs, imported items in the CDO foreign trade market (listed in order of highest import quantities) include wheat, food product ingredients, petroleum gas, wheat flour, chemicals, mineral products, coffee and cream, fertilizers, milk and cream, and steel slabs. Most items are imported from Brazil, Japan, Australia, Canada and other such countries. Exports from CDO (listed in order of highest export quantities) include canned pineapple, coconut powder, cement, powdered milk, coconut oil, clinker, pineapples, coconut shell charcoal, wood products and bananas. Most of these are exported to the United States, Japan, China, South Korea, European countries and so forth.

There are currently about 17,000 production-related businesses operating in CDO with an approximate 1% rate of increase annually according to the Bureau of Finance. A majority of these operate in the wholesale and retail industries.

(2) Economy

In 2012, the National Competitiveness Council (NCC) named CDO as the most competitive city in the Philippines. The NCC evaluated cities according to the three categories of "Economic dynamism", "Government efficiency", and "Infrastructure" and cities were ranked as follows (starting from the highest-ranked): CDO, Iloilo (Iloilo Province), San Fernando (Pampanga Province), Butuan (Agusan del Norte Province) and Bacolod (Negros Occidental Province). CDO came in third in terms of economic dynamism, seventh in government efficiency and third again in infrastructure.

In recent years, the city has built and developed large-scale supermarkets, hotels and subdivisions in the city center, cultivating an overall atmosphere that is brimming with energy. Furthermore, CDO has received much praise for its logistics bases within the city limits, which serve as distribution points for agricultural goods, industrial products and so forth, as well as for the new airport and connecting transportation network that is currently under development. CDO received a somewhat lower ranking in the government efficiency category: although the city's small-scale government may appear to be less efficient than large-scale governments when examined on a category-by-category basis, larger governments are less maneuverable in certain areas, and CDO's smaller governmental structure enables it to offer a variety of unique, beneficial services.

2.1.2.3 Social Infrastructure

(1) Roads

From the perspective of places such as Manila and Cebu, CDO City serves as an important gateway to Mindanao Island. It is possible to travel overland by road from CDO to Manila via Surigao City in 40 hours, and also to travel by road to Davao City in the southern part of Mindanao Island in 6 hours. The road network of CDO City extends for a total of 630.8 km (392.0 miles). Among its primary routes, the bus company offers regularly scheduled buses to the Manila metropolitan area, Davao City, Butuan City, the Province of Bukidnon, Iligan City and Zambpanga City. Numerous taxi companies provide transportation services in CDO, and a great number of jeepneys also form a transport grid throughout the city.

(2) Airports and Seaports

Laguindingan International Airport was opened in June 2013 as a replacement for Lumbia Airport, which is located about 46km (29 miles) northwest of the CDO city center. Many domestic passengers as well as foreign visitors transferring at Manila and Cebu use Laguindingan International Airport to come to CDO and nearby municipalities. Multiple flights operated daily by Philippine Airlines, the low-cost carrier (LCC) Cebu Pacific Air and other airlines connect CDO with Manila's Ninoy Aquino International Airport (NAIA) in 1 hour and 20 minutes and with Cebu's Mactan Cebu International Airport in 1 hour and 10 minutes.

As for sea routes, a number of regularly scheduled passenger and freight liners travel from the Port of CDO to various parts of Mindanao Island as well as Manila (Luzon Island), Cebu Island, Negros Island, Bohol Island, Panay Island and other parts of the Philippines. The oversea route to the Port of Manila takes about 30 hours. According to CDO municipal data, the Port of CDO handled 2.15 million passengers and 4.11 million tons of cargo in 2012.

(3) Urban Development and Land Use

According to the CDO City Socioeconomic Report (2007), land use within the city limits consists of 36% agricultural, 12% residential, 2% industrial, 33% unoccupied, and others.

Many new subdivisions are being built in the city. These expansive complexes cover areas ranging from several thousand square meters to two million square meters, with large-scale projects including 2,600 land use subdivisions.

Large-scale shopping malls, hotels, commercial complexes and other facilities are being constructed in central CDO. In addition, a large shopping mall is being built in the suburban area near

Lumbia Airport (far from the city center) in order to attract more shoppers.

(4) Rivers and rainwater drainage

Various large rivers in CDO empty into Macajalar Bay (see Fig-2.1.2). The local river basin centering on the Cagayan de Oro River encompasses eight rivers including tributaries, streams and so forth: the Cagayan de Oro River (266km/165miles), Tumalaong River / Samalang River (158km/98 miles), Kalawaig River / Tsutopon River / Minontai River (194km/121miles), Biranan River / Sangaya River / Cagayan River (263km/163miles), and others. The Cagayan de Oro River Basin extends across seven administrative districts, covering a total area of 137,934 hectares (340,842 acres).

In December 2011, Tropical Storm Sendong (known internationally as Tropical Storm Washi) struck CDO, and the resulting heavy rains caused damage and casualties as water drained from across the large river basin into the bay. Although typhoons are not known to pass directly through CDO City, Sendong brought extremely heavy rains that caused widespread damage. During the tropical storm, 470mm (18.5inches) of rainfall was measured in upstream areas, which is much more than the typical daily rainfall of 181mm (7.1inches); a month's worth of rain (as measured during the wet season) was observed in a single day.

Cagayan de Oro River Basin features a gradual downward slope starting in the highland forested areas to the south and leading out toward the lowlands in the north where water drains into the bay. When rain falls, rainwater temporarily collects in the lower sections of road, leading to road flooding in many cases. In terms of social infrastructure, rainwater drainage construction has not managed to keep up with urban development in CDO City: throughout the city, large-diameter reinforced concrete drainage pipes used in drainpipe construction projects are lined up along the roadsides even on major arterial roads, waiting for construction work to begin.

(5) Sewerage

Presidential Decree (PD) 198 requires the treatment of sludge and wastewater as part of sewerage works operations. Although CDO City is responsible for fulfilling these duties in the COWD and Local Government Unit, there is currently no wastewater treatment system installed. Individual wastewater treatment facilities are installed in each building in the city to fulfill treatment obligations, but night soil is usually released directly into rivers, where it accumulates and emits a foul odor during seasons with low rainfall. Furthermore, night soil is discharged into small rivers and streams in certain areas, and this combined with the discharge and disposal of household waste into the rivers leads to putrid odors that greatly detract from the quality of residents' living environments in many locations.

CDO City has a standard design for individual wastewater treatment facilities under the Building Standard Law. CDO has not enacted individual wastewater treatment facility management standards, but it has aready started to discuss this issue.

In the Philippines, the lack of sufficient water supply infrastructure prevents directing of public funds into sewerage infrastructure improvements. The order of priority for water-related (water and sewerage) services is (1) secure sufficient water supplies for waterworks, (2) stabilize water quality and (3) construct wastewater systems.

(6) Electric Power and Energy

Mindanao Island's primary source of electricity is hydroelectric power generation. However, the first half of 2014 was characterized by unusually low rainfall due to the influence of El Niño, leading to insufficient water levels for power generation. In response, scheduled power outages were conducted for four hours per day in a rotating fashion among three districts. Although normal power supply was restored during the second half of the year following rainfall during the wet season (starting from around June), conditions at power companies remain dire. Despite the use of propane gas in some households to provide heat sources for cooking, bath and shower water, and so forth, the majority of houses rely on electric power to meet such needs.

2.1.2.4 Education

Education in the Philippines consists of preschool education (age 5), primary education (6 years starting at age 6), secondary education (6 years) and tertiary education (4–5 years). Starting in June 2012, secondary education was increased by two years (senior years) for a total of six years. Tertiary education is similar to the four years of university education seen in Japan, with engineering students engaging in five years of tertiary education. Although not part of compulsory education, schooling is free at public schools up until the completion of secondary education. The academic year starts in June and ends in March of the following year.

Education was positioned as a top priority in the national budget in the revised 1987 Constitution, and wages for educators were set a high level in order to help secure sufficient education personnel. Teacher, engineer and healthcare worker are popular occupations in the Philippines.

Table-2-1-2 Education system of the Philippines

	Years of schooling	Remarks	Ratio of number of schools of public and private schools	Ratio of number of students of public and private schools
Preschool (Kindergarten school)	1 year (5-year-olds)	Free of charge		
Elementary (Elementary school)	6 years (From 6-year-old)	Free of charge	Public: 90% Private: 10%	Public: 93% Private: 7%
Secondary (High school & Senior)	6 years	Free of charge	Public: 60% Private: 40%	Public: 80% Private: 20%
Tertiary (University/College)	4 years (Engineering: 5 years)		Public: 10% Private: 90%	

Table-2.1.3 Education-related indicators in the public (private) schools of CDO City

	Preschool	Elementary	Secondary	Tertiary	Reference
Attending school rate	27.89% (3.14%)	84.21% (13.48%)	72.16% (21.92%)	11.34% (63.31%)	CHED, Department of Education, 2013
Number of students	11,838 (1,333)	78,852 (12,624)	39,378 (11,962)	8,332 (46,508)	CHED, Department of Education, 2013
Number of schools		70 (101)	39 (49)	2 (16)	CHED, Department of Education, 2013
Number of teachers		1,812	1,103		CHED, Department of Education, 2013

2.1.2.5 Income Levels and Poverty

Low income levels and poverty are long-standing, major problems in the Philippines. Relevant indicators for Region X (the tenth region, known as Northern Mindanao), where CDO is located, are shown in Table-2.1.4. Although Region X falls somewhat below average levels nationwide, CDO City boasts the highest levels in the region.

Average annual household income is 190,000PHP, but the population of the poor, whose annual household income is less than 9.604PHP, which is quivalent to one-twentieth of the average, accounted for 43.1%. This suggests that the gap between the rich and the poor is very large.

Table-2.1.4 Situation of income and poverty of Region X (10), including CDO City

Item	Indicator	Reference
Average family income	190,000PHP	NSO(2012)
	165,000PHP	NSO(2010)
Average family expenditure	143,000PHP	NSO(2012)
	139,000PHP	NSO(2010)
Average family savings	47,000PHP	NSO(2012)
	26,000PHP	NSO(2010)
Poverty threshold	9,604PHP	NSCB(2012)
Poverty incidence among families	35.6%	NSCB(2012)
Poverty incidence among population	43.1%	NSCB(2012)
Simple literacy rate	93.9%	NSO(2008)
	91.8%	NSO(2003)
Functional literacy rate	85.9%	NSO(2008)
	83.7%	NSO(2003)
Employment rate	94.7%	NSCB(2014)
	94.4%	NSCB(2013)
Unemployment rate	5.3%	NSCB(2014)
	5.6%	NSCB(2013)
Underemployment rate	20.7%	NSCB(2014)
	24.6%	NSCB(2013)

2.1.3 Administrative Organ

2.1.3.1 Cagayan de Oro City Hall

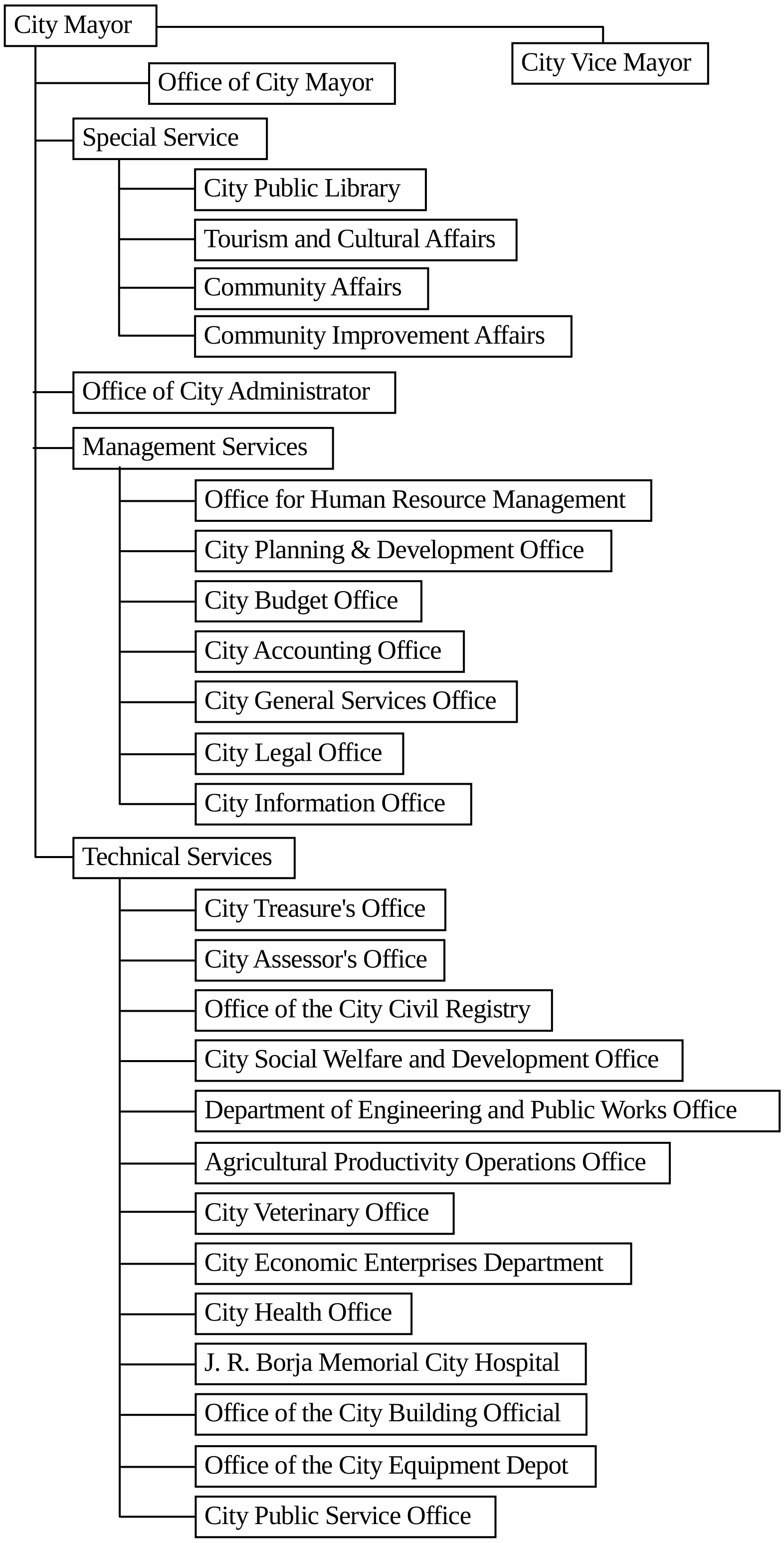


Fig-2.1.7 Organization chart of CDO City Hall

2.1.3.2 Government Agencies Related to Water Supply

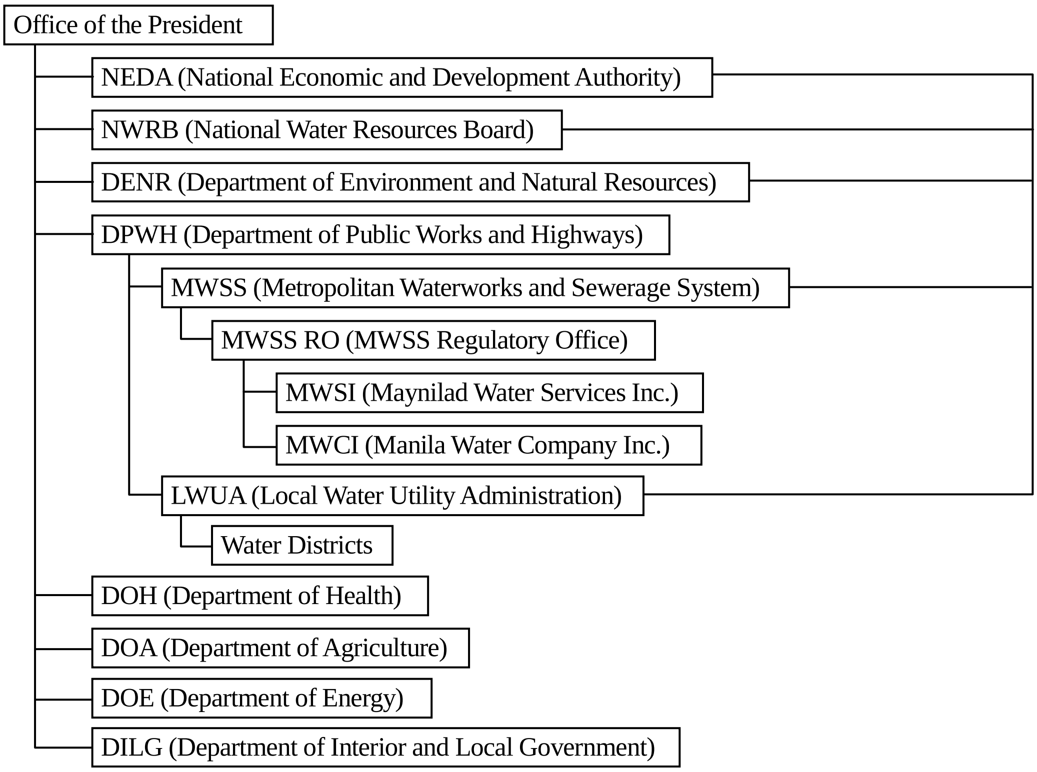


Fig-2.1.8 Government agencies diagram related to water supply

2.1.3.3 Government Agencies Related to Wastewater / Septage management

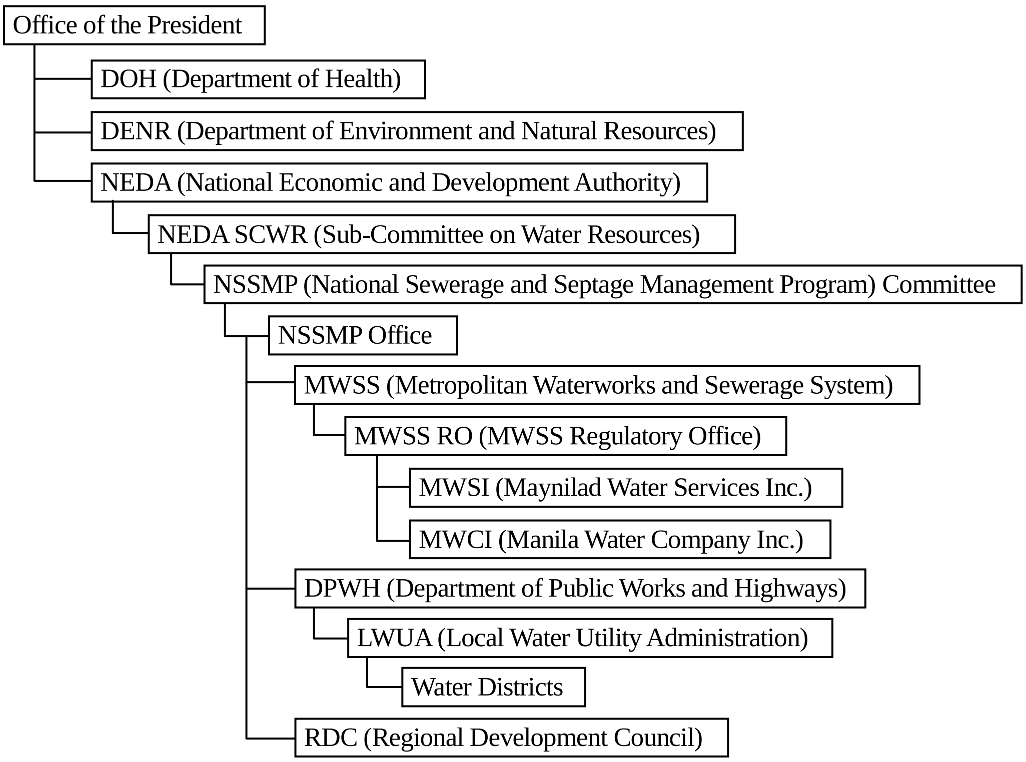


Fig-2.1.9 Government agencies diagram related to wastewater / septage management

2.2 Cagayan de Oro City Water District (COWD)

2.2.1 Organization of the Water District

2.2.1.1 History of the COWD

On August 1, 1973, COWD was established as the first water district in the Philippines, and on January 4 of the following year, it began operating as a financially independent quasi-public enterprise under the 1973 State Water Supply Business Law that was Presidential Directive (PD) No. 198 under the first application of the Conditional Certificate Conformance (CCC) from the LWUA. The COWD has succeeded in improving its capabilities, efficiency and reliability to build its organization as a water supply business system under the strong leadership of its first General Manager.

The water supply business of the COWD took over the management of the National Waterworks and Sewage Agency (NAWASA) that was abandoned in 1973 and the business of the former CDO city water supply system. At that time, it supplied 3,500 water taps with a daily average distributed water volume of 12,200m^3/day through only 39km of transmission and distribution pipes, and transmitted water only to the center of the city, which then included about 15% of the total number of 25,000 households in the city at that time. During the 40 years since the establishment of the COWD, the number of water taps it supplies has increased about 23 times, the quantity of water distributed and total length of pipelines have expanded both about 13 times, and the water supply district has grown to include the urban region and neighboring town of Opol.

After taking over pipes managed by NAWASA, beginning in 1975, COWD laid 55.8km of steel pipe and 15.8km of plastic pipe during its First Expansion Work, Phase 1 (1975 – 1977), then laid 23.5km of steel pipe and 16.3km of plastic pipe during its Phase 2 (1990), and 64.9km of steel pipe and 12.1km of plastic pipe during its Phase 3 (2003 – 2007), expanding the water supply region in order to satisfy growing demand accompanying the rising population.

In March 1992, the operation of the COWD as a water utility was recognized to be sound and it became a GOCC (Government Owned and Controlled Corporation). The COWD's water utility has earned nationwide admiration, and was selected as the Number One Water District in the Philippines in 1986, 1987, and 1999. And in January 28, 2000, the LWUA gave the COWD its highest honor: membership in the LWUA-WD Hall of Fame.

COWD was the first Water District to introduce a Bulk Water Supply Project (BWSP) contract in the Philippines. COWD and the service water supplier, Rio Verde Water Consortium (RVWC) entered into a service water supply agreement for 25 years beginning July 2007, and the first completed section began to transmit a daily maximum quantity of water equal to 50,000m^3 (average 40,000m^3) water to the Western part of the COWD region. Under the initial plan, water purification systems with capacity to supply an average of 40,000m^3 each would be constructed during the Second Stage Construction in 2011 and Third Stage Construction in 2017, ultimately establishing a 120,000m^3/day water supply system, but legal problems with both parties remain unresolved, so beginning with the Second Stage, the project has been delayed.

Since it was selected as the Philippines number one water supply district, in 2005 when about 30 years had passed since its establishment, leaking from deteriorated water supply systems, mainly from water supply pipes that have deteriorated over time began on the COWD system, but water theft on provisional distribution pipes on roads, which are not adequately maintained or inspected is ignored, and defective water meters are not replaced, so it is considered that the steady annual increase of these types of NRW will create an abnormal situation such as a future NRW rate of more than 50%.

2.2.1.2 Division of Duties

COWD will carry out a structural reform in January 2015. The members of the leak detection team, that is the C/P of this case are now gathered from three engineering divisions and the chain of command is divided and unclear, so the Production Department and Maintenance Department will be reorganized to form a department that will control NRW elimination countermeasures and control of leakage, and divisions in charge of NRW countermeasures in parts to the East and West of the Cagayan de Oro river will be established.

(1) Organizational Chart

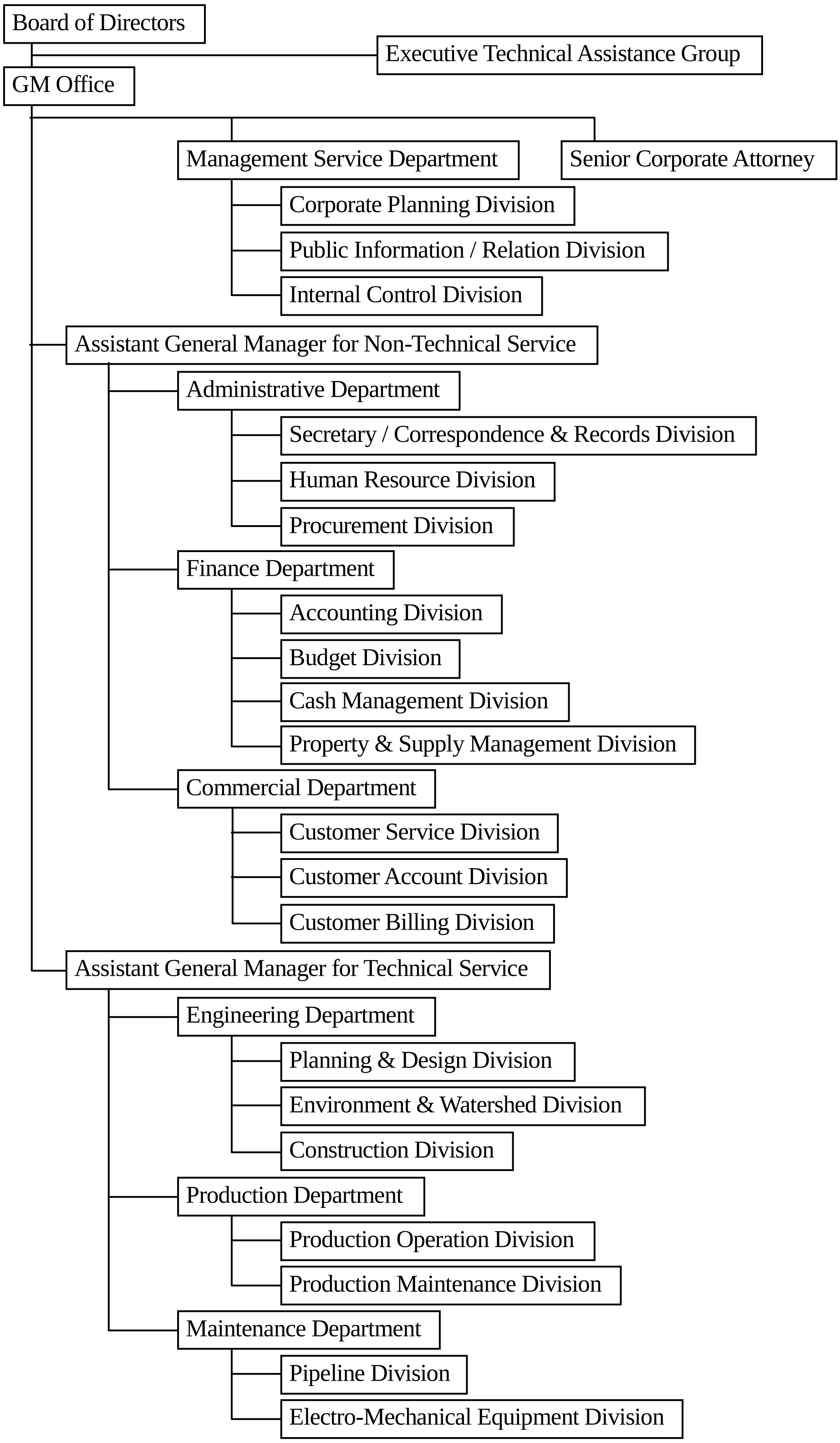


Fig-2.2.1 Organization chart of COWD

(2) Division of Duties

Table-2.2.1 Department / Division name and Division of duties

Name of Dept./Div.	Division of duties
I Board of Directors	Enacts laws to steer, guide and direct the operation of the District toward achieving the utility goals and objectives. It sees to it that policies are properly implemented as intended.
Ia Executive Technical Assistance Group	Consolidates and directs all the activities per instructions of the Office of the Board of Directors and the Office of the General Manager. Manages the documentation and compilations of Policies & Resolutions upon approval of the Office of the Board of Directors.
II Office of General Manager	Directs the basic efforts of all departments and offices towards achieving utility goals and objectives within established policies.
IIa Senior Corporate Attorney	Conducts consulting work related to the law.
IIb Management Service Department	Provides support to the office of the General Manager. It is responsible for establishing an effective feedback mechanism in order to provide comprehensive information about the general operation of the District.
Corporate Planning Division	Directs the integration of department reports and information to realize clear pictures of the COWD's operations. Supervises the research works related to the general operation of COWD. Spearheads the consolidation of programs and plans necessary in the formulation of a Corporate Framework.
	Computer Software Development Section
Public Information / Relation Division	Directs the activities in public relation programs in the community, print and broadcast media, and general public. Supervises the activities in the implementation of COWD's Scholarship Program.
Internal Control Division	Directs the activities in the implementation of COWD's financial management, auditing function and operation. Supervises the control of procurement / disposal / inventory of COWD's material and supply requirements.
III Assistant General Manager for Non-Technical Service	Directs the basic efforts of all departments under the Admin / Finance / Commercial Services group towards achieving utility goals and objectives within established policies.
IIIa Administrative Department	Provides services to departments and divisions that are responsible for accomplishing the primary objectives of the COWD. Oversees the procurement activities of COWD. Directs the implementation of CSC (Civil Service Commission) rules and regulations as well as COWD Personnel Policies. Administers the general services of the COWD.
Secretary / Correspondence & Records Division	Directs the activity in the recording of in and out communication of COWD. Filing and adequate maintenance of records, personnel properties and other documents related to COWD's operations. Prepares official documents and communications.
Human Resource Division	Implements CSC Rules and Regulations as well as COWD Personnel Policies that cater to the training needs of COWD's employees.
General Service Division	Responsible for the janitorial, security, and healthcare services of COWD.
Procurement Division	Responsible for the procurement activities of COWD.
IIIb Finance Department	Directs the activities in utility functions involving financial management and control, and cash, property and supply management.
Accounting Division	Responsible for the preparation of monthly financial statements, disbursement vouchers on capital, operating & maintenance expenditures, budget allocation for expenditures and preparation of annual budget.
	General Accounting Section Financial Records Section
Budget Division	Responsible for the preparation of Annual Budget, monitors actual expense against budget. Prepares monthly O&M and CAPEX.

Name of Dept./Div.	Division of duties
Cash Management Division	Responsible for the control & management of cash, safeguarding and custodial funding. Collection Section Cash & Disbursement Section
Property & Supply Management Division	Responsibility in the planning, acquisition custodianship, issuance & utilization, accounting & disposal of COWD's properties and supplies. Processing Section Receiving / Releasing Section
IIIc Commercial Department	Directs the operation related to customer services, billing and maintains customer accounts and records.
Customer Service Division	Directs the processing of customers' applications, complaints & inquiries. Installs service pipelines, inspects and investigates new and existing accounts and service lines of customers. Customer Processing & Assistance Section Service Connection Section
Customer Account Division	Directs the operation of Bugo Sub-Office related to customer services, billing, complaints & inquiry. Maintains & assesses customer accounts and records, pipeline network within a specific area of coverage. Accounts Assessment Section Bugo Operation Section
Customer Billing Division	Directs the operation of meter reading and preparation of customer billing and delivery of the same. Maintains customer billing records and posts corresponding customer payments. Billing Section Meter-Reading / Delivery Section
IV Assistant General Manager for Technical Service	Directs the basic efforts of all departments under the Technical Services group towards achieving utility goals and objectives within established policies.
IVa Engineering Department	Directs the monitoring and evaluation of the environment and watershed, to safeguard the fresh water quality, availability, and sustainability; Directs the identification, evaluation, planning & design for a viable water supply project; Directs the implementation of COWD approved water supply improvement/expansion projects.
Planning & Design Division	Directs the planning and design of all water supply system facilities. Evaluates existing water supply system and proposed development. Civil Works Section Architectural Design Section Water Resource Section Electro-Mechanical Section
Environment & Watershed Division	Directs the monitoring of the environment and the watershed and evaluates its effect on the fresh water resource quality, quantity and sustainability. Environmental Management Section Watershed Management Section
Construction Division	Directs and implements the construction of all water supply system projects and maintenance of all utility buildings. Construction Section Meter Stub-Out Installation Section Electro-Mechanical & Sanitary Installation Section
IVb Production Department	Directs the operation and preventive maintenance of production facilities, transmission & distribution pipelines and its appurtenances.
Production Operation Division	Directs the activities in the operation of its production facilities. Central Station Water Resources Facilities Operation Section West Station Water Resources Facilities Operation Section East Station Water Resources Facilities Operation Section

Name of Dept./Div.	Division of duties
Production Maintenance Division	Directs the activities in the preventive maintenance of production wells and their equipment. Operates the distribution and transmission pipelines and its appurtenances and maintains the quality of water.
	Preventive Maintenance Section Transmission / Distribution Section Quality Control Assurance Section
IVc Maintenance Department	Schedules, coordinates and supervises the repair and maintenance of all utility transmission & support facilities.
Pipeline Division	Responsible for the repair of mainline and service connection leakages. Schedules, supervises the maintenance of record of activities and material usage necessary in the repair & maintenance of the system.
	Pipeline Repair Section Pipeline Rehabilitation Section Water Meter Section
Electro - Mechanical Equipment Division	Schedules, supervises repair of the water production facilities, repair and preventive maintenance of vehicles and equipment. Schedules operation of vehicles & equipment. Responsible for the fabrication of fittings required in the repair and installation of pipelines.
	Vehicle / Equipment Section Production Facilities & Fabrication Section

(3) Number of Staff

417 staff members are working in COWD. About one quarter of that are period workers, such as temporary staff and casual staff. They are engaged in the business of meter reading, driving and plumbing, etc.

Their wages are low compared to the regular employment worker. However, from the business results, they can extend the employment period or be appointed to regular employment. Period employment is also contributing to the business efficiency of COWD.

Of the regular employment staff, in the non-technical side such as the Management Service Department, Administrative Department and Finance Department, female staff outnumber the males. On the other hand, in the technical side, males outnumber the females. The male to female ratio is approximately 2:1.

Table-2.2.2 Number of staff of the Department

	GM/AGM	Dept. Mngr.	Div. Mngr.	Supervisor	Permanent	Temporary	Casual	Total
MSD	1 F1	1 F1	3 F3	4 F3/M1	16 F10/M6		6 F3/M3	31 F21/M10
AD			2 F2	5 F3/M2	19 F11/M8		4 M4	30 F16/M14
FD		1 F1	4 F4	3 F3	30 F26/M4		7 F4/M3	45 F38/M7
CD		1 F1	3 F3	3 F1/M2	64 F14/M50		38 F3/M35	109 F22/M87
ED	1 M1	1 M1	2 F2	4 F1/M3	18 F3/M15	4 M4	10 F2/M8	40 F8/M32
PD		1 M1	2 M2	6 F1/M5	26 F2/M24	14 M14	11 F1/M10	60 F4/M56
MD		1 F1	2 M2	4 M4	73 F2/M71	1 M1	21 M21	102 F3/M99
Total	2 F1/M1	6 F4/M2	18 F14/M4	29 F12/M17	240 F68/M178	19 M19	97 F13/M84	417 F112/M305

Remarks: F / Female, M / Male
Temporary staff / Staff to be hired on a project-by-project basis (Up to 2 years, updatable)
Casual staff / Staff to be employed in six month units (Up to 2 years, updatable)

2.2.2 Management and Finances

COWD prepares an annual report for every fiscal year (January to December), clarifying the outline of COWD's business during that fiscal year.

The financial report that is attached to this document presents major financial statements — a balance sheet (see Table-2.2.5), income statement (see Table-2.2.6), cash flow statement (see Table-2.2.7) and fund flow statement (see Table-2.2.8) — prepared according to LWUA Guidelines.

2.2.2.1 Management

The population of the North Mindanao region that includes CDO City is continuing to grow, and an annual rate of increase of about 2% is predicted (see Fig-2.1.6). In response to population growth, COWD is increasing the number of customers supplied and the quantity of revenue water, and it is predicted that the revenue water will continue to increase steadily in the future.

Its NRW rate on the other hand exceeds 50%, and the situation has tended to worsen in the past few years. The water resources now owned by COWD are 160,000m^3/day (city-owned water resources: approx. 120,000m^3/day, service water received: approx. 40,000m^3/day), and this can be converted to 58,400,000m^3 per year, but the quantity supplied in 2013 already exceeded 57,100,000m^3. This fact suggests that not only will the NWR be improved rapidly, but that the amount of water supply will exceed the present retained water resources in a few more years, further suggesting that it is essential to immediately sharply increase the quantity of water received at a unit price higher than its own water resources, or to develop new water resources at great cost.

Table-2.2.3 Water supply basic information of COWD

	Unit	2010	2011	2012	2013
Population of CDO City	Person	582,465	612,430	671,216	710,020
Number of connections	Number	76,351	78,722	80,619	83,016
Service rate	%	78.7	82.0	84.1	81.8
Water supply volume	1,000m^3/year	53,617	53,490	53,844	57,156
Revenue water volume	1,000m^3/year	23,917	23,726	24,100	25,363
NRW rate	%	55	56	54	55
Daily average supply per capita	L/person	109	104	104	122

Remarks: For 2011 and 2012, the influence of Sendon of December 2011 can be seen.

Table-2.2.4 Water supply cost and Unit price of water supply of COWD (2013)

Indicator	Calculation formula	Estimated value
Water supply cost	Ordinary expenses(PHP) / Revenue water volume (m^3)	25.6 PHP/m^3
Unit price of water supply	Water Sales (PHP) / Revenue water volume (m^3)	26.4 PHP/m^3

2.2.2.2 Financial Statements

(1) Balance Sheet

The balance sheet of COWD presented in Table-2.2.5 below has been prepared by adding the percentage of each item to total assets, etc.

Quick ratio[1] (= Quick assets / Current liabilities × 100), which is an indicator of a company's ability to meet short-term obligations, stood at 110% (calculated based on the assumption that quick assets for 2013 equaled Cash + Special deposits). As the ratio exceeded 100%, it is deemed that COWD has sufficient quick assets to meet its short-term obligations.

On the other hand, of the balance of Accounts Receivables Customers that constitute more than 60% of current assets, approximately 60% are Net disconnected accounts, most of which are considered to be uncollectible, are to be written off. To correctly understand the financial condition of COWD, it is necessary to properly account for the uncollectible portion of these accounts receivable,

[1] Quick ratio is a measurement of a company's ability to meet its short-term obligations. Quick assets refer to highly liquid current assets such as cash and deposits. Compared with the current ratio (calculated as Current assets / Current liabilities × 100), the quick ratio is a stricter indicator. In general, if the quick ratio exceeds 100%, it is deemed that the company has sufficient quick assets to pay for current assets.

by reducing the existing allowance for bad debts for write-off and recording the amount in excess of the bad debt allowance as expense, for example.

The balance of Loans Payable equals nearly 80% of the book value of the utility plants. Thus it is assumed that construction of the utility plants of COWD is financed mostly by loans. But, compared with the scale of the rate of revenue, this is not such a high percentage so increasing loans to construct facilities is considered possible.

(2) Income Statement

At COWD, each department compiles its expense items and reflects them in the income statement. However, it has failed to classify them into large categories such as “Labor expense” and “Power expense” to enable comparison of expenses of each department or outline the current situation of all the water districts that will be used in business analysis. Therefore, we suggested it classify the expense items into large categories by taking into consideration the initiatives of other cities of the Philippines. The Income Statement compiled based on the above is as shown in Table-2.2.6.

For COWD, approximately 20% of the Operating Income margin and more than 5% of the Ordinary Income margin on water rate revenue is derived, which is considered satisfactory in terms of profitability at the moment. However, while revenue is expected to increase with approximately 2% growth in the water supplied population each year, the high inflation rate of nearly 4% p.a. is predicted to continue in the interim. Even if the costs are controlled at the current level, it will be difficult to maintain the current profit on a long-term basis unless revenue increases even further through implementation of streamlining of operations and revision of water rates, etc.

Turning to expenses, the maintenance expense of general plants is extremely low at approximately 2%. Considering the fixed assets currently held by COWD, there is a possibility that it has not properly maintained and managed its plants on a regular basis.

In addition, depreciation expenses account for only 10% of the water rate revenue. This means COWD is unable to gain sufficient cash to finance future renewals of plants just by recovering the costs of the existing plants through depreciation expense. Low depreciation expense means that many of its plants are aging (the years of service either exceed or approximate the useful life). It is considered necessary for COWD to renew its plants.

The expense incurred for purchased water that constitutes a quarter of the total amount of water supply accounts for nearly one-third of total operating expense. This indicates that the cost of purchased water is higher than that of city-owned water resources. It is desirable to improve the NRW rate to increase the revenue water in future and to control the growth of purchased water in the long run.

(3) Cash Flow Statement, Fund Flow Statement

The amount of water rates received by COWD almost equals the amount of revenue on water supply shown on its income statement. It is estimated that water rates have been successfully collected at a certain level in recent years, and as a result, a large portion of the accounts receivable is the balance for prior years. Also, considering the fact that cash flow from investing activities is not very active, it is presumed that very few plants have been newly constructed or renewed in the past (see Table-2.2.7 and 2.2.8).

The Fund Flow Statement shows a balance of the working capitals for each year, but because the balance of it from the previous year is not accumulated in the next year's working capitals, the amount of working capitals that can be used in a specific year is not clearly known. In order to systematically construct or renew the necessary facilities, it is essential to enact medium to long term funding plans utilizing long-term loans, but to enact plans to clarify working capitals now on hand and to predict future working capitals, project operation is extremely important.

Table-2.2.5 Balance sheet (Price unit: 1,000PHP)

Assets	2011	2012	2013	Ratio
Utility Plant	1,122,107	1,108,241	1,151,030	74.2%
Utility Plant in Service	1,784,604	1,828,550	1,925,905	(124.1%)
Construction Work in Progress	5,996	8,482	17,734	(1.1%)
Utility Plant held for Future Use	739	3,103	2,987	(0.2%)
Unclassified Utility Plant		6,717	12,147	(0.8%)
Accumulated Depreciation and Amortization	-669,232	-738,611	-807,743	(-52.1%)
Investments and Fund Accounts	2,608	2,608	2,608	0.2%
Other Physical Property	2,608	2,608	2,608	(0.2%)
Current Assets	308,516	367,879	374,635	24.1%
Cash	64,412	124,704	90,723	(5.8%)
Special Deposits	34,655	39,194	48,193	(3.1%)
Working Funds	203	213	208	(0.0%)
Temporary Investments	4,008	0	22,584	(1.5%)
Accounts Receivable Customers	251,051	245,647	246,875	(15.9%)
Cash Advances to Officers and Employees	272	0	42	(0.0%)
Accounts Receivable Others	1,055	1,045	1,059	(0.1%)
Allowance for Bad Debts-Credit	-75,407	-77,917	-80,817	(-5.2%)
Materials and Supplies Inventory	27,797	34,537	45,175	(2.9%)
Prepayments	470	456	593	(0.0%)
Others	13,406	14,810	23,489	1.5%
Other Deferred Debits	13,406	14,810	23,489	(1.5%)
Total Assets	1,446,637	1,493,538	1,551,762	100.0%

Liabilities and Capital	2011	2012	2013	Ratio
Capital	474,234	511,104	596,592	38.4%
Capital Contribution - Government	867	867	867	(0.1%)
Other Paid-in Capital	47,207	58,356	101,592	(6.5%)
Retained Earnings-Unappropriated	397,751	423,472	465,724	(30.0%)
Retained Earnings-Appropriated	144	144	144	(0.0%)
Appraisal Capital	28,265	28,265	28,265	(1.8%)
Long Term Debts	884,250	842,959	777,871	50.1%
Loans Payable	875,590	838,017	777,871	(50.1%)
Other Long Term Debts	7,413	4,942	0	(0.0%)
Retentions on Contracts	1,247	0		(0.0%)
Current and Accrued Liabilities	81,273	86,929	126,808	8.2%
Current Portion on Long Term Debts	34,109	38,944	60,031	(3.9%)
GSIS/SSS/COWD Accounts Payable	2,658	2,566	9,326	(0.6%)
Customers' Deposits	10,748	9,057	9,057	(0.6%)
Medicare Payable	166	170	176	(0.0%)
Interest Payable	0	0		(0.0%)
Withholding Tax Payable	9,233	3,506	5,157	(0.3%)
Other Current and Accrued Liabilities	24,359	32,686	43,061	(2.8%)
Deferred Credits	3,709	49,375	47,320	3.0%
Other Deferred Credits	3,709	49,375	47,320	(3.0%)
Operating Reserves	3,171	3,171	3,171	0.2%
Other Operating Reserves	3,171	3,171	3,171	(0.2%)
Total Liabilities and Capital	1,446,637	1,493,538	1,551,762	100.0%

Table-2.2.6 Profit and Loss statement (Price unit: 1,000PHP)

	2011	2012	2013	Ratio
Operating Revenue				
(1) Water Sales	638,371	640,300	668,895	94.3%
(2)Other Revenue	38,221	32,459	35,902	5.1%
Penalty Charges	30,592	25,014	28,111	(4.0%)
Miscellaneous Service Revenues	7,042	7,029	7,173	(1.0%)
Installation Fee / Meter Stand			(4,643)	
Reconnection Fee			(1,931)	
Others			(0,599)	
Other Water Revenues	587	416	618	(0.1%)
Total Operating Revenue	676,592	672,759	704,797	99.4%
Operating Expenses				
(3)Operation Cost	419,856	456,069	482,700	68.1%
Source of Supply		147,923	151,820	(21.4%)
Pumping		95,714	101,966	(14.4%)
Administrative Salaries and Wages		79,066	80,316	(11.3%)
Employees' Pensions and Benefits		48,422	57,954	(8.2%)
Tax and Licenses		14,000	15,278	(2.2%)
GSIS, Philhealth and HDMF Contributions		12,357	12,757	(1.8%)
Security Services		5,854	6,870	(1.0%)
Office Supplies		4,222	4,114	(0.6%)
Light and Power		3,387	3,551	(0.5%)
Water Treatment		2,915	3,547	(0.5%)
Light, Power and Water		3,096	3,401	(0.5%)
Miscellaneous Expenses		39,113	41,127	(5.8%)
(4)Depreciation	63,520	66,593	69,137	9.7%
(5)Maintenance	46,294	12,754	12,869	(1.8%)
Transmission and Distribution		6,870	7,485	(1.1%)
General Plant		3,849	3,653	(0.5%)
Sources of Supply		2,035	1,731	(0.2%)
Total Operating Expenses	529,670	535,416	564,706	79.6%
Operating Income	146,922	137,343	140,091	19.8%

	2011	2012	2013	Ratio
Non-Operating Revenue				
(6)Other Income	3,198	2,992	4,487	0.6%
Non-Operating Expenses				
(7)Interest of Long-Term Debts	105,430	101,812	85,590	12.1%

	2011	2012	2013	Ratio
Net Total Income	679,790	675,751	709,284	100.0%
Net Total Expenses	635,100	637,228	650,296	91.7%
Ordinary Income	44,690	38,523	58,988	8.3%

Table-2.2.7 Cash flow statement (Price unit: 1,000PHP)

	2011	2012	2013
Receipts			
Collection of Water Bill: Current	376,767	378,308	385,838
Collection of Water Bill: Arrears	280,154	294,417	308,122
Other Sales or Services	612	1,082	983
Miscellaneous Service Revenues	7,226	7,082	7,375
Other Water Revenues	583	416	617
Refunds of Employees Cash Advances	207	553	252
Refunds/Payments of Accounts Receivable and Others	7,846	278	621
Interest Revenues	307	540	290
Miscellaneous Non-Operating Revenues	1,444	5,219	5,774
LWUA Grant: Sendong	0	53,791	0
Cash Donations: Sendong	0	2,824	0
Other Receipts/Adjustments	-3,809	4,262	9,278
Sub-Total	671,337	748,772	719,150
Disbursements			
Payment of Vouchers Payable	341,485	368,409	401,126
Payroll	87,124	95,866	101,414
Advances to Officers and Employees	4,769	1,230	3,015
Payment of Phase II-A Production Wells	535	498	461
Payment of Phase II-B Schedules A,B,C	12,373	12,373	11,732
Payment of Phase III 520,128 million PHP	28,446	28,446	13,551
LWUA 200 million Loan - Lateral Project	28,122	28,122	11,718
LWUA 5 million Loan Youngsville	908	988	988
DBP Refinancing Loan	65,310	65,494	93,689
John-dort Ventures	0	1,235	3,706
Franchise Tax	25,271	17,392	11,752
Capital Improvements	37,536	68,427	68,369
Reserve and Contingency	0	0	10,695
Sendong Rehabilitation -53 million PHP	0	0	20,915
Disbursements Related to Previous Years	24,299	0	0
Sub-Total	656,178	688,480	753,131
Net Receipts / Disbursements	15,159	60,292	-33,981
Cash Balance: Beginning	49,253	64,412	124,704
Cash Balance: End	64,412	124,704	90,723

Table-2.2.8 Fund flow statement (Price unit: 1,000PHP)

	2011	2012	2013
Sources of Working Capital			
Operations	26,560	25,721	42,252
Net Income: Net of Re-adjustment	(26,560)	(25,721)	(42,252)
Expenses Not Using Working Capital	59,917	69,379	69,132
Depreciation and Amortization of Fixed Assets	(59,917)	(69,379)	(69,132)
Income Not Providing Working Capital	0	0	0
Gain on Sales of Fixed Assets	(0)	(0)	(0)
Sub-Total	86,477	95,100	111,384
Other Paid-in-Capital	0	11,149	43,236
Additional Loans Payable	-34,165	-37,708	-60,146
Other Long Term Debts	7,413	-2,336	-4,942
Retentions on Contract Payments	129	-1,247	
Other Deferred Credits	-110	45,666	-2,055
Sub-Total	-26,733	15,524	-23,907
Total Sources of Working Capital	59,744	110,624	87,477
Uses of Working Capital			
Additions to Utility Plant	45,758	55,513	111,921
Total of Uses of Working Capital	45,758	55,513	111,921
Net Increase / Decrease in Working Capital	13,986	55,111	-24,444

2.2.2.3 Revenue Management System (RMS)

COWD has developed and operates its own customer control database. This system uses MySQL that is the Oracle® Relational Database Management System (RDBMS), uses a Linux server, and its front end is operated to control the customers' water supply system volume, and the payment and collection of water supply system fees.

This system (1) prepares water fee invoices based on meter reading quantities, (2) calculates penalty charges for unpaid fees, (3) helps customers pay through negotiations with the cashier, (4) controls customer information and master files, (5) prepares water supply cut-off notices, (6) controls and revises customer records and (7) prepares payment status tables etc.

Operators receive payments from customers at a system terminal. Payments are made with cash or bank checks. Customers' payments are made at 13 banks in addition to the COWD, headquarters and three branch offices. At its headquarters, payments from customers are accepted throughout the morning on Saturdays.

(1) Items entered into the RMS (Revenue Management System) database

Customer number, contract signer name, address, telephone number, water meter size, water meter number, Stub-Outs used, contract date, monthly water volume used, payment amount, payment date, delayed payment situation are entered.

(2) Relationship of database with ledger

Among the above types of information, customer number, contract signer name, address, water meter size, water meter number, and the ID number of the Stub-Out installed are entered in the ledger.

(3) Work of registering new customers

Customers who wish to receive water supplied by COWD can obtain a supply by attending a seminar held by COWD every Wednesday and Saturday and by submitting an application, contract oath, seminar attendance certificate, new connection fee payment certificate (DN13mm: 1,000PHP) and schematic diagram and specification of water supply. After passing examination, the customer is registered and water begins to flow to the new customer approximately 2 or 3 weeks after the application.

2.2.2.4 Water Rate

The COWD's water rate system is the gradual increase by the purpose of use rate system: a rate system based on a basic fee up to 10m^3/month and a surplus rate. The purposes of use are home use, government use, and commerce and industry use.

Forty years have passed since the founding of the COWD so the number of its facilities reaching their replacement period will increase in the future and the rising population is causing soaring demand. COWD has, therefore, continued taking management actions to deal with these circumstances, but in response to soaring personnel costs, fuel costs, and resource costs etc. caused by economic growth that has steadily occurred since 2007, it has carried out staged revision to replace its established water rate system with new rates at a revision rate of +30% to May 2014 (approved by the LWUA in June 2011 and implemented in May 2014). The staged rate revision will be revisions of 10% in November 2013 and February 2014 and a final revision of 10% in May 2014. This revision hypothesizes that during the period beginning in 2014, COWD will increase its current profits by an extremely large amount equivalent to 200 million PHP every year (2013 water sales were 670 million), and COWD will, in the future, make investments to be able to carry out project operations that sustain these profits, and will consider the necessary important litmus test to predict these profits.

The spreading construction of medium and large-scale new subdivisions in the suburbs of CDO city requires the extension of new distribution pipelines, and many of the new subdivisions are constructed on high elevation plateaus, requiring pump pressurization equipment. Therefore, in order for its customers to bear a part of this expense, the COWD is adding 2.00PHP/m^3 (commerce and industry use: 4.00PHP/m^3) to the basic rate and surplus rate in such special districts. This is now done in only one district, but presumably such special districts will be expanded according to the state of future urban development.

Water rates for commerce and industry use will be set at amounts double the rates set for home use and government use.

(1) Residential / Government use (Revision: May, 2014)

Table-2.2.9 Water tariff (Residential / Government use)

Water Meter Diameter	Minimum charge (PHP/10m^3)		Excess charge (PHP/m^3) [Old rate → New rate]			
	Old rate	New rate	11-20m^3	21-30m^3	31-40m^3	41m^3-
13mm (1/2")	168.00	218.40	23.50 → 30.55	24.50 → 31.85	25.50 → 33.65	26.50 → 36.00
20mm (3/4")	268.80	349.40				
25mm (1")	537.60	698.85				
40mm (1.5")	1,344.00	1,747.20				
50mm (2")	3,360.00	4,368.00				
75mm (3")	6,048.00	7,257.60				
100mm (4")	12,096.00	15,724.80				
250mm (10")	63,840.00	60,278.40				

(2) Commercial / Industrial use (Revision: May, 2014)

Table-2.2.10 Water tariff (Commercial / Industrial use)

Water Meter Diameter	Minimum charge (PHP/10m^3)		Excess charge (PHP/m^3) [Old rate → New rate]			
	Old rate	New rate	11-20m^3	21-30m^3	31-40m^3	41m^3-
13mm (1/2")	336.00	436.80	47.00 → 61.10	49.00 → 63.70	51.00 → 67.30	53.00 → 72.00
20mm (3/4")	537.60	698.80				
25mm (1")	1,075.20	1,397.80				
40mm (1.5")	2,688.00	3,494.40				
50mm (2")	6,720.00	8,736.00				
75mm (3")	12,096.00	15,724.80				
100mm (4")	24,192.00	31,449.60				
250mm (10")	127,680.00	120,556.80				

Under the LWUA's "Manual on Water Rates and Related Practices", water rates are set at amounts that ensure recovery of the cost of operating the water system services plus costs including all maintenance costs considering the rate of inflation, and it is considered that they must be set at proper rational levels reflecting public services. It covers everyone from high volume users to low-income earner, but it is necessary to set water rates that ensure fairness considering low-income earners (at minimum water meter diameter supply connections of 13mm, it must not exceed 5% of the income of low income group inside the water supply district). When the rates are changed, it is essential to hold a public hearing.

2.2.3 Water Distribution Analysis

2.2.3.1 Water Distribution Analysis Table

Analysis of COWD's water distribution prior to this project subtracts the revenue water quantity as shown by the water rate income from the total distribution water quantity to obtain the NRW quantity. The revenue water quantity is calculated based on the quantity of water read from customers' water meters. The breakdown of NRW quantity only clarifies the water volume for business use in the water supply district.

Table-2.2.11 Water distribution volume analysis table

Distributed Water 100%	Revenue Water 44.4%	Water Charge	44.4%
		Other	0.0%
	Non-Revenue Water 55.6%	Water Meter Error	N/D
		Illegal Water	N/D
		Unpaid Water Charge	N/D
		Leakage	N/D
		Use by COWD	1.5%
		Unknown Water	N/D
		Other	54.1%

2.2.3.2 History of NRW

COWD took over the water utility from NAWASA in 1973, but the NRW rate at that time appears to be far higher than it is now. This means that the water meters that measure the quantity of water used might not be accurate. In the late 1970s, the NRW rate fell dramatically, and it can be hypothesized that this was a result of the replacement of old pipelines laid in the NAWASA period with new pipelines, reducing leaking, and of an increase in the number of water meters installed and the quantity of revenue water as a result of the rising population.

Such dramatic declines are generally caused by a rise in the quantity of water transmitted and distributed (denominator representing the NRW rate) by operating new water purification plants, but in the case of COWD, it can also be hypothesized that it was caused by the installation of new water meters that simply measure water used, and lowering the leakage rate by replacing pipelines, reducing the NRW quantity that is the numerator.

In the 1980s, the rise of the leakage rate over the passage of time was offset by the increase in the number of supply water taps (number of customers) and rising demand caused by population increase, maintaining the NRW rate at a level above 10%.

In the 1990s, as a consequence of the remarkable worsening of traffic conditions accompanying economic growth in CDO City, the shock of heavy trucks traveling on roads above the pipelines replaced when COWD was established more than 20 years earlier caused concern that these pipelines would leak easily under the impact of this shock where the soil cover is shallow (depth of the pipelines). It can be stated that in this period, leaking started to occur as a result of the laying of many new pipelines to meet the rising number of customers rather than because of pipeline replacement.

It is assumed that until the first half of the 2000s, the NRW rate was held down by an increase in revenue water quantity achieved by laying new pipelines to meet the continued increase in new customers without an increase of the total water distribution quantity. Later, the NRW rate steadily worsened, presumably because only laying new pipelines without replacing any old ones increased leakage from pipelines that were more than 30 years old.

COWD did not have an organization to perform leak detection until 2009 so it repaired leaks as they appeared above ground. Under the present circumstances that include a high NRW rate, it is necessary to not only continue to repair leaks when they appear above ground, but to assign workers to quickly discover and repair leaks underground.

And customers' water meters that were installed are used until they fail instead of being periodically replaced. Water meters tend to become less accurate over time, and in Japan, it is legally required that they be replaced every 8 years, but COWD does not follow such a rule. In addition, the accuracy based on number of years of use has not been surveyed, so it is possible that a major cause of the NRW rate is the insensitivity of water system meters.

Table-2.2.12 Trends in number of service connections, water volume, pipeline length and NRW rate

Year	Connec-tion	Distributed volume		Revenue Water Volume		Pipe length (m)	NRW rate (%)
		(m^3/year)	(m^3/day)	(m^3/year)	(m^3/day)		
1976	3,962	4,546,716	12,423	806,736	2,204	39,670	82.26
1977	4,507	4,515,966	12,373	1,836,597	5,032	39,670	59.33
1978	6,627	4,818,389	13,201	2,050,539	5,618	84,350	57.44
1979	10,118	5,999,908	16,438	3,690,032	10,110	111,980	38.50
1980	13,479	5,758,818	15,734	4,379,673	11,966	118,000	23.95
1981	16,415	7,025,665	19,248	5,768,259	15,803	123,870	17.90
1982	19,056	9,507,575	26,048	7,076,189	19,387	128,490	25.57
1983	21,177	10,150,124	27,809	8,457,897	23,172	136,940	16.67
1984	23,500	10,158,501	27,755	8,757,652	23,928	144,180	13.79
1985	24,825	10,856,481	29,744	9,062,674	24,829	151,940	16.52
1986	26,412	11,745,295	32,179	9,731,961	26,663	154,380	17.14
1987	28,081	12,594,909	34,507	10,567,833	28,953	158,000	16.09
1988	30,511	14,423,194	39,408	11,620,192	31,749	164,190	19.43
1989	32,805	14,776,658	40,484	12,560,090	34,411	167,180	15.00
1990	34,620	18,691,903	51,211	13,697,712	37,528	201,040	26.72
1991	37,698	20,601,725	56,443	14,412,007	39,485	219,918	30.04
1992	39,823	21,742,375	59,405	16,694,166	45,612	233,057	23.22
1993	41,432	23,700,801	64,934	16,484,800	45,164	249,602	30.45
1994	43,734	26,386,936	72,293	18,276,563	50,073	263,442	30.74
1995	46,232	26,419,821	72,383	19,266,022	52,784	281,956	27.08
1996	47,958	28,369,248	77,512	20,317,946	55,514	292,387	28.38
1997	50,127	30,380,383	83,234	21,676,187	59,387	308,758	28.65
1998	52,153	30,003,696	82,202	21,710,275	59,480	325,371	27.64
1999	54,343	28,198,382	77,256	21,366,680	58,539	339,992	24.23
2000	55,470	27,342,239	74,706	20,384,885	55,696	341,384	25.45
2001	55,425	28,803,751	78,914	20,470,217	56,083	349,229	28.93
2002	58,194	28,377,625	77,747	19,901,310	54,524	357,664	29.87
2003	60,327	31,785,978	87,085	21,592,997	59,159	376,833	32.07
2004	62,087	35,116,160	95,946	22,230,808	60,740	384,317	36.69
2005	64,284	40,782,458	111,733	23,031,094	63,099	421,661	43.53
2006	66,168	42,708,791	117,010	22,983,821	62,969	435,424	46.18
2007	68,421	48,692,815	133,405	23,016,135	63,058	456,419	52.73
2008	70,944	48,346,968	132,096	22,497,424	61,468	467,351	53.47
2009	74,020	53,045,855	145,331	23,266,261	63,743	481,114	56.14
2010	76,351	53,616,511	146,895	23,916,766	65,525	504,754	55.39
2011	78,722	53,488,946	146,545	23,726,357	65,004	528,593	55.64
2012	80,619	53,843,895	147,114	24,100,044	65,847	543,444	55.24
2013	83,016	56,974,426	156,094	25,362,677	69,487	562,056	55.48

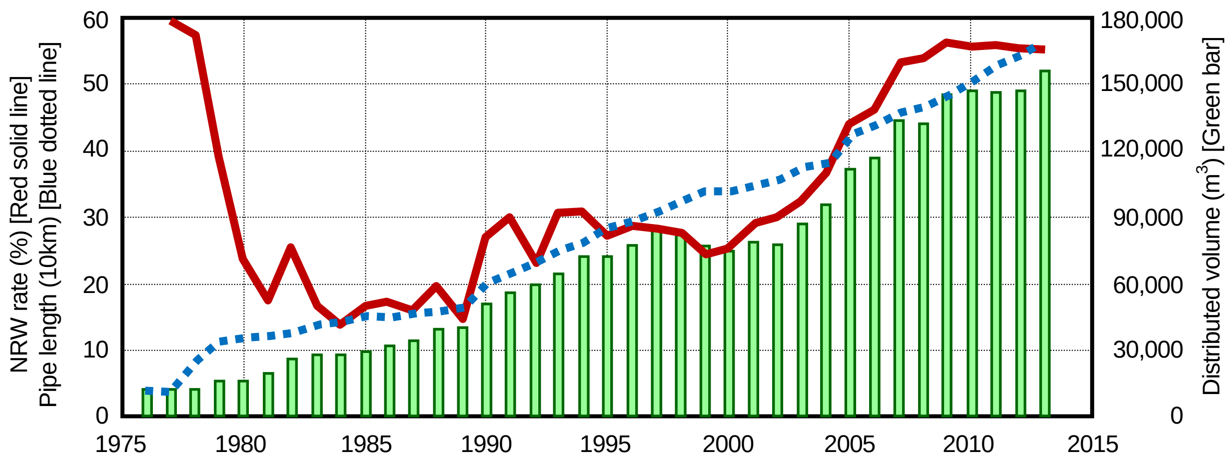


Fig-2.2.2 Transmission and distribution water volume, Pipeline extension and Transition of NRW rate

2.2.3.3 Water Meter Insensitivity

Water meters installed in homes in Japan must, in compliance with the Measurement Act, be used only for 8 years. When a meter that has passed this 8-year time limit has been read, the water utility with responsibility for controlling the meter is penalized with a sentence of penal servitude not greater than six months, or a fine not greater than 500,000JPY. This means that water utilities must replace meters with new ones or perform recalibration before elapse of the 8-year deadline.

In the Philippines, no administrative agency has clear control of measurements, and measuring instruments used for commercial transactions include only weigh scales, range finders, and volumeters, with water meters not included among major measuring instruments regulated by legal metrology.

COWD's only water meter replacement policy is to replace water meters after they have failed, but COWD has water quantity readers that are periodically calibrated and it independently calibrates its water meters.

However, this calibration is done by passing specified quantities defined as small, medium, and large quantities through the water meter to be calibrated, then judging it to be appropriate if it is within a margin of error in the total test flow rate zone and not appropriate if it is above the allowed error.

Table-2.2.13 Water meter appropriate examination of COWD

Flow rate	Small	Moderate	Large
	60L/h	120L/h	1,500L/h
Test volume	10L	10L	100L
Error accuracy	+/- 5%	+/- 2%	+/- 2%
Appropriate range	9.5~10.5L	9.8~10.2L	98.0~102.0L
Judgment of results	Usable if appropriate range at all flow rates above		

Generally, water meters count the water flow poorly at low flow rates (fail to operate, low precision), but provide high precision and few errors when the flow rate is large. For example, in the case where the meter error is defined as -2%, in the Water District, supply was 100L, but in the case where a water meter only counted 98L, the missing 2L would not be included in the water rate calculation, so this is defined as NRW (2%) that is a loss for the water district. This adds to water meter insensitivity.

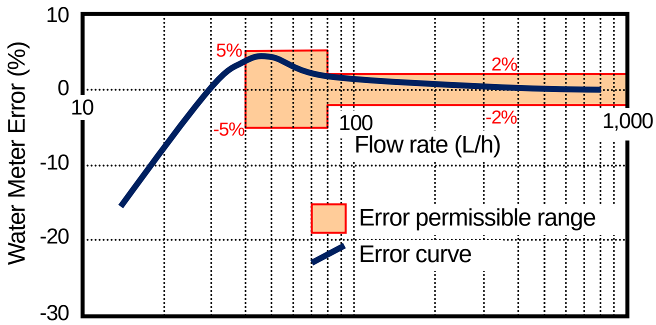


Fig-2.2.3 Instrumental error curve of water meter

COWD has, until now, only judged the appropriateness/inappropriateness of water meters. This survey applied a method of numerically evaluating the degree of accuracy of the object water meters.

2.2.3.4 Unpayable Fees

Water fees in arrears are fees not paid by the deadline stipulated in an invoice that COWD sends to each home after it reads their meters, but although delayed, in many cases, the customers pay the fee to COWD along with a penalty and a reconnection fee. In this way, water fees in arrears are almost all paid throughout the year, and incorporated in water system fees as revenue water.

But there are also cases of customers who move without paying unpaid fees. It is often impossible to trace their whereabouts, and in such cases the unpaid fees remain unrecoverable. These unpaid fees are a loss for COWD and are included in NRW. In 2013, COWD was unable to collect about 2.9 million PHP against total water income of 669 million PHP.

2.2.3.5 Leakage

COWD recruited employees from three technology divisions in 2009 to form a five-member leak detection team. Until now, the leak detection team has detected leaks on about 10km of pipeline each year. This is the distance that a Yokohama City Waterworks team inspects within one week. Until a JICA Study Team arrived, it seemed that leak detection had been carried out haphazardly, but systematic leak detection was not performed.

Leak detection related instruments that COWD now owns include 2 leak detectors, 1 areal correlative leak detector (8 loggers), and 1 portable ultrasonic flowmeter with the leak detectors used most often.

Past leak detection by COWD has consisted mainly of confirming the leaking point at a place where leaking water has appeared on the ground surface. When a puddle forms continually during clear weather, it can be concluded that a leak has occurred at the location. The leak detection team confirms the leaking point then the leak repair team takes over to perform the repair work. Both the leak detection team and the leak repair team prepare repair ledgers concerning the leaking point to keep a history of their work.

2.2.3.6 Illegal Connection

In cases where it is necessary to move distribution pipes already laid under a road because of road widening or the construction of a building, on rare occasions an above-road pipe is laid for a short period of time as a temporary distribution pipeline. On the COWD system, such a temporary distribution pipe at a road widening site may remain in use above the road for several years at the longest, but the number of such places is unknown and their length has not been clarified. Many of the above-road pipes are PVC pipelines with a diameter between 50mm and 75mm. These water pipelines are easily processed and it is possible to easily connect a branch pipe to them without using any particular special tools. And their low distribution water pressure also simplifies such work. For such reasons, people perform illegal actions such as connecting branch pipes to the above-road pipelines at night and other times when there are few passers-by.

And close to Stub-Outs, if a branch pipe from a distribution pipe is laid towards a Stub-Out under shallow earth cover, it is easier to connect to this pipe than to a distribution pipe. Therefore, it is undeniable that in a case where traces of an excavation are seen on the road surface near a Stub-Out, it is possible that an illegal connection has been made.

COWD must reassess and take countermeasures to control above-road pipelines that have been left in place for many years.

2.2.4 Transmission / Distribution System

2.2.4.1 Total Water Distribution Quantity

COWD’s transmission and distribution systems are managed separately in two areas divided by the Cagayan de Oro River that flows through central CDO City with the area on the left bank managed as the West District and the area on the right bank as the East District. The West District receives its service water supply from its city-owned water resources, and since 2007, from the Rio Verde Water Consortium (RVWC).

In response to the damage caused by Sendong in 2012, COWD implemented a restoration project as a grant aid project, installed home electrical generators at every intake well in the district as a flood countermeasure, and raised the related electric generators to a level where they would be safe from the impact of floods.

Table-2.2.14 Design maximum water distribution volume obtained from the rated pumping amount of water intake pump

	West part	East part	Total
Own source	31,493m^3/day	89,656m^3/day	121,149m^3/day
Bulk water	43,997m^3/day	0m^3/day	43,997m^3/day
Total	75,490m^3/day	89,656m^3/day	165,146m^3/day
Number of own wells	11	17	28

The RVWC service water supply project initially stipulated the construction of a water purification plant with an average daily capacity of 40,000m^3 as Second Stage Work in 2011 and another with a daily average of 40,000m^3 as Third Stage Construction in 2017, but because of legal problems between the COWD and RVWC, the project has been temporarily delayed beginning with Second Stage Construction. But the project is not suspended, and COWD, aware that this project is indispensable for both parties, is preparing for an increase in demand in the East District expected to occur in the near future (starting 2020) by continuing discussions to resolve problems.

2.2.4.2 Transmission / Distribution System

Fig-2.2.4 shows the locations of the present transmission / distribution facilities operated by COWD, and Fig-2.2.5 is a map of the transmission / distribution system pipelines.

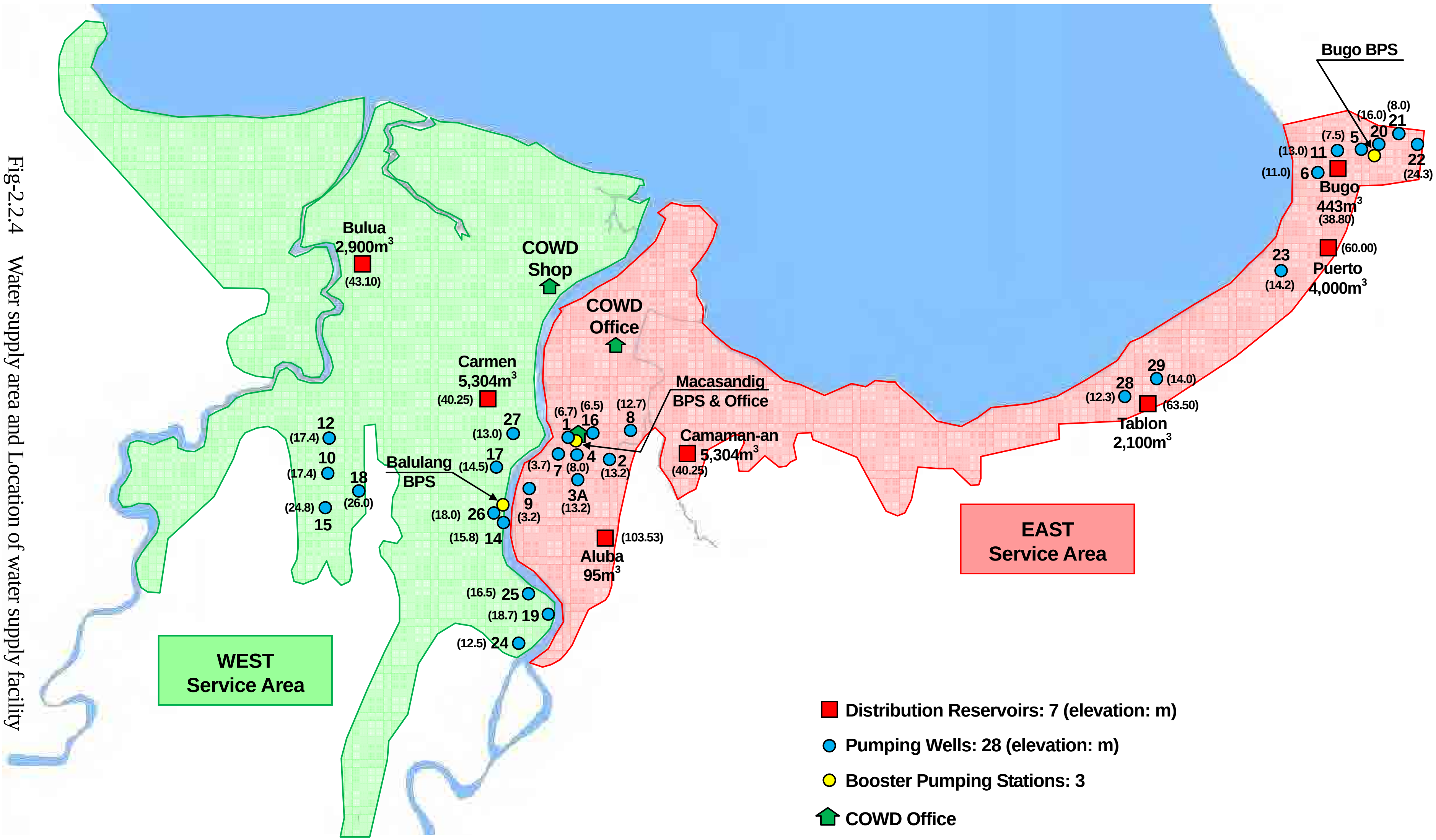


Fig-2.2.4 Water supply area and Location of water supply facility

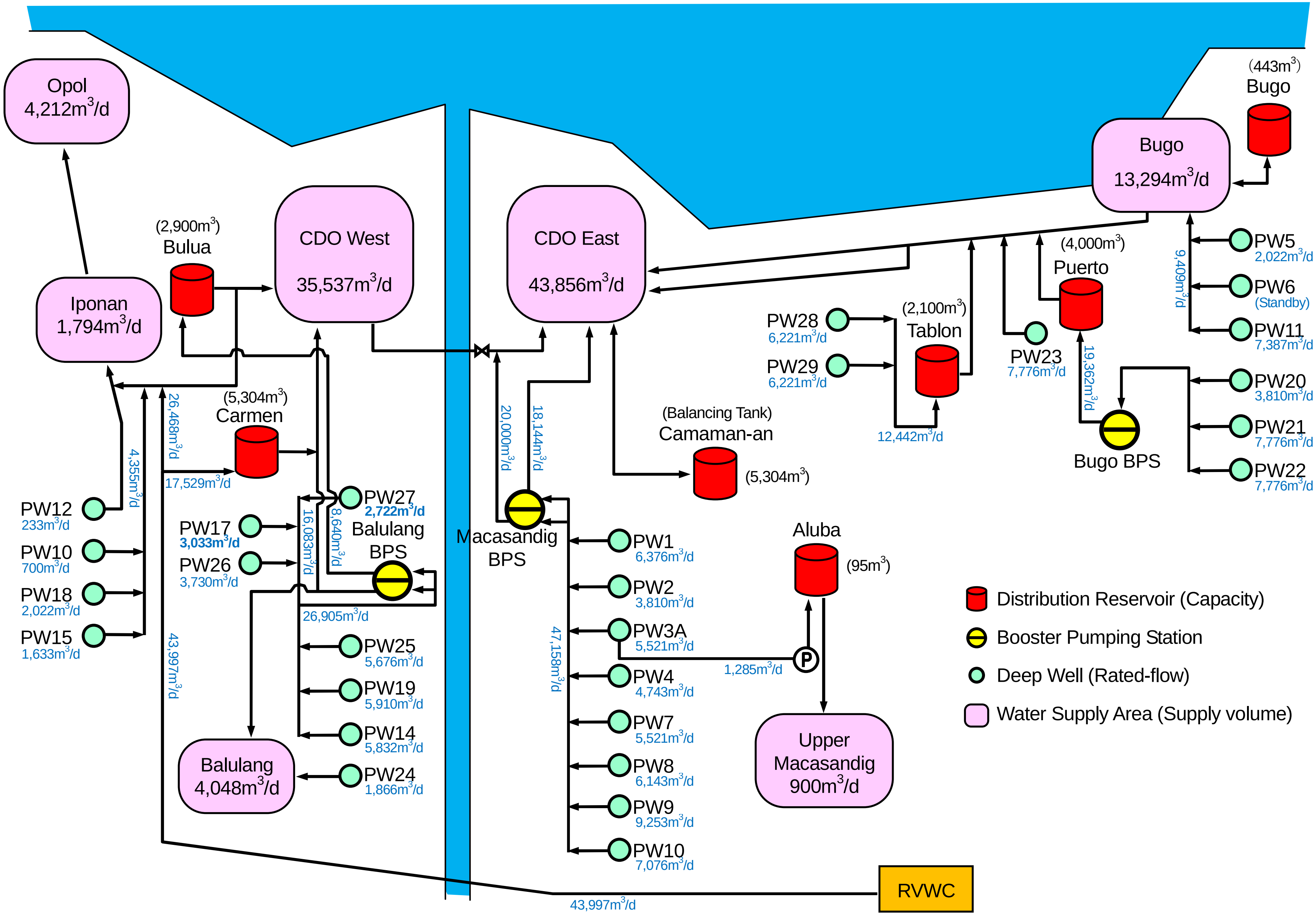


Fig-2.2.5 System diagram of water supply facility

2.2.4.3 Distribution Reservoir

Table-2.2.15 shows the distribution reservoirs now operated by COWD. It has a total of 7 distribution reservoirs in CDO City: 2 in the Western District and 5 in the Eastern District. The total reservoir capacity is 20,136m^3, which is a storage rate equal to 12.2% of the total planned water distribution quantity, and when full, they hold water for 2.9 hours.

Table-2.2.15 Distribution reservoir specification table

Reservoir name	Capacity	Ground Level	Distribution area, Others
Bulua	2,900 m^3	43.10 m	Downstream basin of left bank of the Cagayan de Oro River
Carmen	5,304 m^3	40.25 m	Downstream basin of left bank of the Cagayan de Oro River
Aluba	95 m^3	105.53 m	Upper Macasandig area
Camaman-an	5,304 m^3	40.25 m	Right bank of the Cagayan de Oro River (Central part of the city), Balancing tank
Tablon	2,100 m^3	63.50 m	Right bank of the Cagayan de Oro River (Central part of the city)
Puerto	4,000 m^3	60.00 m	Right bank of the Cagayan de Oro River (Central part of the city) by transmission pipe
Bugo	433 m^3	38.80 m	Bugo area, Balancing tank
Total	20,136 m^3		

2.2.4.4 Groundwater Pump and Booster Pump

Table-2.2.16 shows the specifications of intake pumps and capacities of home electrical generators at COWD's present pumping stations, while Table-2.2.17 shows the specifications of booster pumps.

Groundwater is purified by COWD simply by disinfection using liquid chlorine. The liquid chlorine is made by liquefying chlorine gas which is then injected into chlorine containers (gas cylinders). The injection is done by using a sampling pipe to first extract groundwater pumped up but not yet supplied to a transmission pipe, using an injector to mix the water from the sampling pipe with the liquid chlorine from the chlorine injection apparatus installed on the gas cylinder, then pumping the chlorinated water into the transmission pipeline. Later the chlorine is fully mixed in during transmission.

The liquid chlorine is qualitatively stable, but its toxicity is high so the process must be controlled to prevent it accidentally escaping outside the system. COWD solidly fixes the system to a wall with chains to prevent it from overturning.

But the chlorine must be constantly injected, and that which is consumed must be regularly replaced. Judging from past chlorine consumption trends, a gas tank replacement period standard must be established to procure it systematically, and at the same time, it is necessary to budget an amount necessary to purchase it in annual purchasing budgets.

Table-2.2.16 Intake pump specification table

Pumping well name	Location	Rated pumping volume	Pump lifting height	Standby generator
PW 1	Macasandig	408.8 m^3/h	45.5 m	438kVA
PW 2	Macasandig	288.0 m^3/h	32.1 m	250 HP
PW 3A	Macasandig	68.1 m^3/h	99.9 m	219kVA
PW 4	Macasandig	181.7 m^3/h	45.5 m	219kVA
PW 5	Bugo	136.3 m^3/h	43.6 m	75kVA
PW 6	Bugo	(Standby)		
PW 7	Macasandig	181.7 m^3/h	45.5 m	219kVA
PW 8	Macasandig	227.1 m^3/h	45.5 m	250kVA
PW 9	Macasandig	408.8 m^3/h	45.5 m	218kVA
PW 10	Calaanan	56.8 m^3/h	79.4 m	75kVA
PW 11	Bugo	408.8 m^3/h	45.5 m	288kVA
PW 12	Calaanan	(Standby)		
PW 14	Balulang	227.1 m^3/h	45.5 m	219kVA
PW 15	Calaanan	90.8 m^3/h	79.4 m	132kVA
PW 16	Tomas Saco	227.1 m^3/h	36.4 m	175kVA
PW 17	Balulang	136.3 m^3/h	14.8 m	167kVA
PW 18	Pueblo	83.6 m^3/h	79.4 m	219kVA
PW 19	Balulang	227.1 m^3/h	45.5 m	165kVA
PW 20	Bugo	180.1 m^3/h	15.9 m	500kVA
PW 21	Bugo	360.0 m^3/h	21.8 m	156kVA
PW 22	Bugo	360.0 m^3/h	21.8 m	156kVA
PW 23	Agusan	360.0 m^3/h	71.5 m	313kVA
PW 24	Balulang	68.1 m^3/h	54.5 m	---
PW 25	Balulang	181.7 m^3/h	58.8 m	165kVA
PW 26	Balulang	136.3 m^3/h	67.0 m	165kVA
PW 27	Balulang	204.4 m^3/h	54.5 m	132kVA
PW 28	Tablon	288.0 m^3/h	71.5 m	250kVA
PW 29	Tablon	288.0 m^3/h	71.5 m	250kVA

Table-2.2.17 Booster pump specification table

Pumping well name	Location	Rated pumping volume	Pump lifting height	Standby generator
BP 1 MAC	Macasandig	370.9 m^3/h	71.5 m	438kVA
BP 2 MAC	Macasandig	363.4 m^3/h	46.1 m	
BP 3 MAC	Macasandig	499.6 m^3/h	65.4 m	
BP 4 MAC	Macasandig	363.4 m^3/h	46.1 m	600kVA
BP 5 MAC	Macasandig	370.9 m^3/h	71.5 m	
BP 6 MAC	Macasandig	499.6 m^3/h	65.4 m	
BP 1 MAC-NEW	Macasandig	370.9 m^3/h	71.5 m	
BP 2 MAC-NEW	Macasandig	370.9 m^3/h	71.5 m	
BP 3 MAC-NEW	Macasandig	370.9 m^3/h	71.5 m	
BP 4 MAC-NEW	Macasandig	370.9 m^3/h	71.5 m	688kVA
BP 5 MAC-NEW	Macasandig	370.9 m^3/h	71.5 m	
BP 1 BUG	Bugo	378.1 m^3/h	62.7 m	500kVA
BP 2 BUG	Bugo	378.1 m^3/h	62.7 m	
BP 3 BUG	Bugo	378.1 m^3/h	62.7 m	
BP 1 BAL	Balulang	360.0 m^3/h	91.0 m	688kVA
BP 2 BAL	Balulang	360.0 m^3/h	91.0 m	
BP 3 BAL	Balulang	360.0 m^3/h	91.0 m	
BP 4 BAL	Balulang	338.0 m^3/h	50.0 m	313kVA
BP 5 BAL	Balulang	338.0 m^3/h	50.0 m	
BP 6 BAL	Balulang	338.0 m^3/h	50.0 m	
ILBP 1	Aluba	64.0 m^3/h	76.3 m	
ILBP 2	Aluba	64.0 m^3/h	76.3 m	

2.2.5 Service Facilities

Most service water supply facilities in Japan are service pipes branching from distribution pipes and extended to a covered meter box underground on the customer’s building lot, and a meter installed in the box. This means that in many cases, one water meter is installed at every home.

In contrast, in the Philippines, water meters installed formerly on individual houses are gathered into single locations, pipes branching from the distribution pipe emerge above ground level and are linked to stands on which about 20 water meters called Stub-Outs can be installed together to perform central control of water meters (see Fig-2.2.6). The range of responsibility for service water supply in the water district extends to each water meter, with the customers required to control the service pipe from the water meters to their homes. For this reason, even when a leak has occurred beyond the water meter, the water district does not detect it, and because the customer's water meter is also counting the leaked water, all customers must constantly maintain their own water meters and service pipes. This is explained as an important matter at the new connection seminars that new users are obligated to attend before they apply for a service water connection.

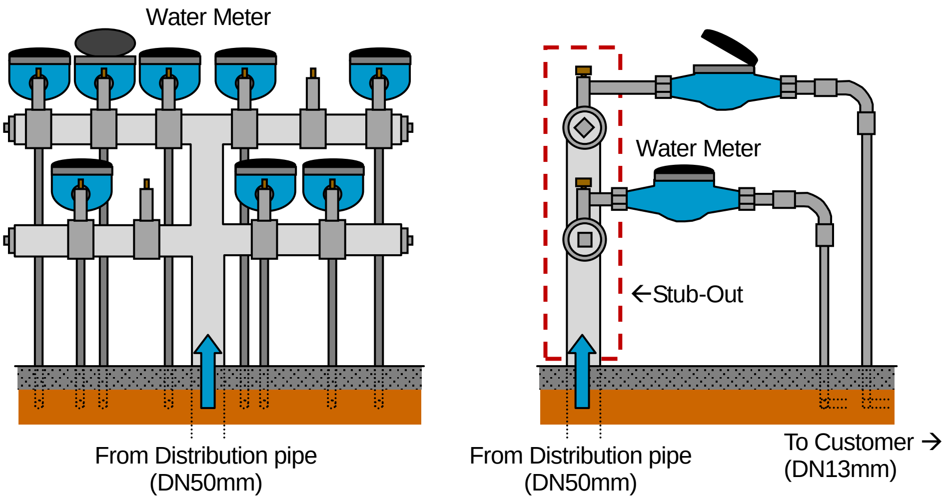


Fig-2.2.6 Schematic diagram of Stub-Out structure

COWD has set regulations governing service pipe connections. Under normal conditions, a case where the length of a service pipe from a Stub-Out to a house is less than 20m at a location where the service water pressure is more than 10PSI (0.07MPa, 0.7kgf/cm^2), it is possible to install up to 20 water meters (DN13mm) at a Stub-Out at 1 location. At a location where the water pressure is 10PSI or higher, installing more than this number of water meters is allowed.

But under the present conditions at COWD, there are many places where the service water pressure does not reach 10PSI, and there are many Stub-Outs where the number of water meters installed greatly exceeds 20. In a certain district that is a candidate DMA district, the service water pressure is slightly lower than 10PSI, and there were Stub-Outs where 82 water meters were installed. As expected, many complaints of the failure of the water supply are received. Stub-Outs that do not satisfy such a standard account for 17% of all Stub-Outs in the city. There are Stub-Outs at 1,289 locations throughout the city, and comparing these with the regulations shows that improvement is necessary at 218 locations. There are 5 Stub-Outs on which more than 65 water meters are installed and the maximum is 96 water meters on one Stub-Out. And here, the service pipes are laid from the Stub-Out over the road to each home like a person's hair bound up in a bun. When these cross streets, pedestrians or motorcycles pass above them, hastening the deterioration of the service pipes (mainly PVC pipe or water supply use vinyl hose), causing leaks.

Incidentally, at the MCWD, service water regulations limit the number that can be installed on one Stub-Out to only 16, and up to 32 can be installed where adequate service water pressure is ensured.

Table -2.2.18 Number of Stub-Outs that do not meet the installation criteria

Number of water meters / Stub-Outs		Standard	Without standard					Total
		~20	21~32	33~48	49~64	65~80	81~96	
Number of Stub-Outs	Number of places	1,071	140	61	12	2	3	1,289
	Ratio	83.1%	16.9% (218 Places)					

Pict-2.2.1 Example of Stub-Out installation: 82 water meters on one Stub-Out

2.2.6 Existing District Metered Areas (DMA)

COWD's distribution network is divided into two water supply districts on the Western side and the Eastern side of the Cagayan de Oro River, but the Eastern and Western Districts have not been further subdivided into small water supply districts. In 2012, in a joint technology project with Manila Water Company, DOWD established DMA at three locations ([1] to [3] in Fig-2.2.7, Table-2.2.19) and measured the minimum flow rate during the night. From the result, the leakage rate (= leak quantity/distribution quantity × 100%) was calculated as shown in Table-2.2.19.

Table-2.2.19 Minimum night flow measurement at DMAs (2012)

DMA name	Inlet volume (m^3/h)		Leakage rate	Remarks
	Average	Night Min.		
[1] RER Sub-Division P1	16.84	7.20	42.8%	Quiet residential area
[2] San Lazaro	33.39	12.00	35.9%	Slum where underclasses live
[3] Limketkai	10.44	5.64	54.0%	Large-scale shopping mall

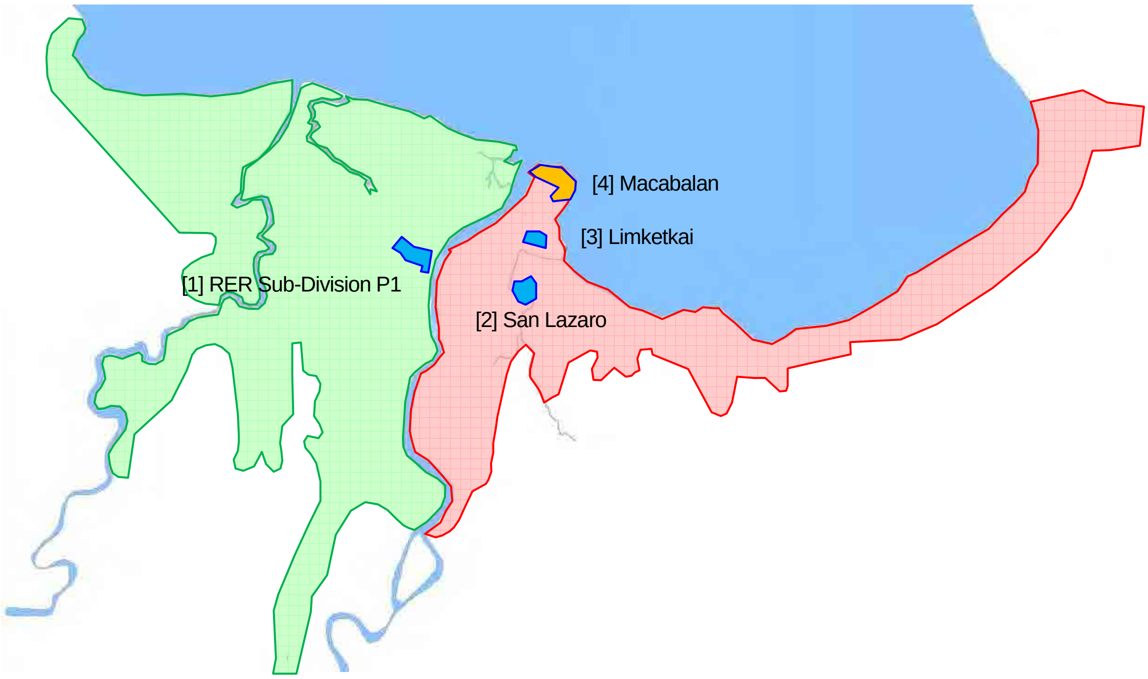


Fig-2.2.7 Existing DMA places and Pilot area

COWD has set [4] the Macabalan district on the right bank at the mouth of the Cagayan de Oro River as a pilot district. In this district, a branched distribution pipeline network branching off from the main distribution pipelines is laid. Because inlet flow meters are not installed, it is impossible to form DMA.

[3] Limketkai above is a large shopping mall. Other districts are residential neighborhoods where, late at night when minimum nighttime flow rate measurement is performed, most of the residents are asleep, and the times when they use the water supply is extremely limited. But in a large-scale commercial business district, stores such as supermarkets that sell fresh food products must use water for 24 hours every day, and COWD has to clarify water supply use late at night by conducting interviews. Before and after the measurements, the personnel read the water meter and if it showed water usage, they had to subtract it. The leakage rate revealed by the investigation might be calculated at slightly too high a rate.

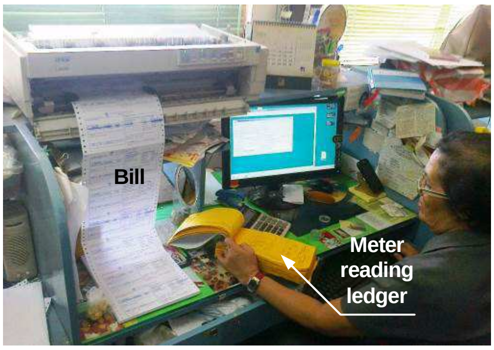
Despite the small number of samples, it is estimated that the leakage rate in 2012 was approximately slightly lower than 40%. Even in residential districts, the water supply could be used late at night similarly in stores or factories, so it is necessary to clarify such a residential environment and deduct the quantity of water used.

2.2.7 Water Meter Reading, Billing and Payments in Arrears

2.2.7.1 Water Meter Reading and Billing

In COWD, a water meter reader reads the water meters every month. They (32 persons) are in charge of water meter reading zones formed by dividing the COWD water supply region into 24 zones (each zone divided into between 7 and 8 districts). Meter reading is done according to a monthly water meter reading schedule set by the Billing Section. Water meter reading is carried out except when the weather is extremely bad. On the day of water meter reading, the readers bring water meter reading ledgers from the Meter Reading Section and read water meters riding motorcycles or bicycles owned by COWD. After the water meter reading, the outliers of water consumption are checked in the office, and normally, the day after the water meter reading, the Billing Section staff enter the volumes from the meter reading ledgers and immediately prepare billings. Here, the volumes of water read according to the readings are checked for anomalous values. The water meter reading staff delivers the billings to the customers between two days after the water meter reading and 10 days before the payment date.

When an anomalous value is seen as a volume of water used, an investigation group in the Commercial Department re-inspects the concerned customer's water meter. If the volume of water used is remarkably high so they suspect that water has leaked, they notify the customer and when leakage has been clarified, prepare a billing by applying water volume data for the past 3 months as settled water consumption.



Pict-2.2.2 Meter reading (Left), Meter reading data input and Printing of bill (Right)

Meter reading routes are prepared as maps (sketches) for each division by the meter readers. Temporary employees can be sent into the field immediately to back up the meter readers. Stub-Outs that are on meter reading routes are divided, with the right side and left side of one Stub-Out read by different meter readers. To perform meter reading more efficiently, the divisions of one Stub-Out must be changed so it can be read by one meter reader.

2.2.7.2 Procedure for Dealing with Customers Who Fail to Pay the Water Fee and Supply Cutoff

The customers who have not paid their water fee after the payment deadline are charged a 10% penalty that is imposed only once. Later, if the payment is not made for two months, a Disconnection notice is sent. If there is no payment within a further 48 hours, the water supply line is disconnected.

Once the payment deadline has passed, the customer can come to a COWD office and negotiate installment payments or set an expected payment date, but if the disconnection take place, water supply will not begin if all unpaid accounts and the reconnection fee (300PHP) are not paid. During this period, the investigation group carries out the payment invoicing procedure using a triplicate demand notification and quietly undertakes disconnection measures as stated in the contract. In addition, if there is no payment or no reconnection even after one month from disconnection, the current contract is aborted. Thereafter when using the water supply, as a new customer, he/she has to pay connection fees and attend the seminar course.

Interviews with customers whose supply had been cut off revealed that during the cutoff period, they purchased water from neighbors for a fee (5PHP/20L). This is 250PHP when converted based on $1m^3$. This is an extremely high rate as shown by a comparison with COWD's water rate table (Table-2.2.9). Even the amount paid in a surcharge district is about $30PHP/m^3$, so including the reconnection fee, having the water supply cut off imposes a heavy economic burden on the household.

It is reported that the underclasses include households so poor they cannot pay water rates, but when we accompanied COWD employees sent out to shut off people's water, we saw that they have refrigerators and TVs and were talking on cell phones. This is a customer service matter, but it is necessary to simulate the costs people bear when their water supply is cut off to inform customers of the cost burden for comparison purposes.

Pict-2.2.3 Disconnection work (Left 2 pictures) / Reconnection work (Right 2 pictures)

2.2.7.3 New Customer Seminar

Customers who will begin to receive water supplied by COWD must attend new customer seminars that are held every Wednesday and every Saturday. At the seminar, the national anthem is sung, then over a period of about 2.5 hours, COWD's utility business is introduced and the contract, management of water meters and service pipes, notifications of a cutoff for COWD's reasons, payment of fees, and handling of unpaid fees are all explained. Because this seminar is an activity contracted with customers, COWD gives the explanations with great care, and after the explanations, sets aside one hour for questions that it answers in detail.

For a new customer to apply for a supply of water by the system, each customer must submit a written application, water supply plan (design document), a contract oath, seminar participation confirmation seal, and a new connection fee (1,000PHP).

Pict-2.2.4　New connection seminar

3 Activities and Proposals

3.1 Survey of Activities for Reducing NRW and Proposals

3.1.1 Functions and Activities of the Team for Reducing NRW

The leak detection team formed in 2009 consisted of a total of 6 members including the section chief responsible for maintenance as the leader and 5 staff members (COWD employees selected from various departments and sections). The leak detection equipment is a set including one general purpose type (steel pipe use) leak detector, one correlative leak detection device, and one zone scan leak detector. When our work started, 5 more staff members were added to form 2 teams (5 members each) under one leader for a total of 11 persons.

The COWD enacts leak detection plans for single years and conducts leak detection. The 2013 plan called for leak detection on about 10km of large diameter transmission pipe (DN400mm, 600mm, and 800mm). Leak detection of about 7.5km was performed, resulting in a judgment that there were no leaks. For 2014, leak detection of about 9.9km of a 300mm diameter distribution pipe is planned and this leak detection is now continually in progress. However in the future, not only annual single year leak detection plans, but a long-term leak detection plan to efficiently and effectively detect leaks in all pipes within the COWD service region should also be prepared.

As for the state of leak repair activities, if leak repair of service pipes (DN13mm~20mm) is included, every month, approximately 530 leaks are repaired (based on data for January 2011 to April 2014). However, leak repair of distribution pipes is far rarer than that of service pipes at fewer than 10 per month. But almost all are leaks discovered on the surface, and there are almost no reports of detection of underground leaks.

COWD actively evaluates the number of days until leaks are repaired. The leak detection team's goals for 2014 are to repair leaks in transmission and distribution pipes within 24 hours, to conduct leak detection within 6 working days, and to repair leaks in service pipes within 2 working days. But the locations of leaks are not entered on maps after they are repaired and the causes of the leaks are not analyzed. In the future, it will be necessary to study leak reduction countermeasures by clarifying frequent leak locations and analyzing the causes of the leaks. The JICA Study Team has recommended analyzing the causes by recording them on a map based on mesh management.

Pict-3.1.1 Surface water leakage occurrence location (Left) /
Survey of underground water leakage (Center, Right)

In COD City, puddles are occasionally seen on roads, but leak detection is not performed. The water in the puddles must be sampled to determine if it is or is not water leaked from the water supply system, and if it is, it must be immediately excavated to repair the leak.

Pict-3.1.2 Situation of water puddle occurrence location in CDO city

3.1.2 Actions of COWD for Reducing NRW

Presently (April 2014) the NRW rate of the COWD is 55%. In 2013, COWD enacted a management guideline setting a target NRW rate reduction of about 2% per year, and achievement of a NRW rate of 45% by 2017. But it only enacted numerical targets without clarifying specific policies for this reduction. This is a result of the fact that specific policies cannot be enacted because of a lack of understanding of what should be done and how it should be done to undertake reduction measures.

The JICA Study Team acquired understanding and cooperation from the executives of COWD on surveying the current ratio of NRW, extracting concrete topics for individual items constituting the NRW, and proposing measures and their priorities. The activities are described below.

3.1.3 Execution of Measures for Reducing NRW Procedures both at the Office and on Site

COWD has surveyed underground water leakage only for a very short period of about 10 km a year, and the survey has in many cases failed to detect water leakage. The water leak detection team has always consisted of only 5 persons. Their activities have been insufficiently planned and involved only responding to reports of leakage. The JICA Study Team proposed that COWD draft a long-term annual plan (dividing the city into regions and selecting appropriate tools) and short-term weekly plans that specify the districts to survey during the week and determine detailed daily schedules.

As short-term detection, the JICA Study Team recommended a careful study by the entire team of a plan stipulating that before the detection survey, (1) prepare a map of the detection survey area, (2) select a route, (3) check fire hydrants and valves, (4) take measures to ensure the safety of traffic and the surrounding region, and (5) determine personnel roles and rotations. The leak detection team immediately introduced and carried out these five steps.


Pict-3.1.3 Survey location status check in the office (Left) /
Division of roles and Image training (Right)

3.1.4 Clarifying the Current System, Extracting Problems and Issues, and Measures and Responses Against the Hazard

In the current COWD system, the leak detection team visits the site where a citizen has found a pool of leaking water on the ground and reported it to COWD. The team specifies the point of water leakage on the water pipe, and transmits the information to the team in charge of repairing the leaking pipe.

However, when this happens, the error that is the distance from the indicated leak point to the actual leak occurrence point is incorporated into the evaluation criteria and it is assumed that this error is less than 68cm (average record in 2013). So when a leak has already occurred, it takes a long time for the leak detection team to perform the confirmation work, preventing the start of leak repair. This is considered to be a result of the fact that because distribution pipes are PVC pipes (plastic pipes) and the water pressure is low, it is difficult for the vibration sound to travel and it is also difficult to make a judgment using ordinary leak detectors.

In Japan, in principle, excavation and repair work is performed whenever a surface leak has been discovered, but COWD must evaluate the leak point error, so it cannot do this. The JICA Study Team immediately recommended to the leak detection team that they replace the present system with a system such that, in principle, in the case of a surface leak, excavation and leak repair work can be started immediately without the need for leak detection.

In CDO City roads are managed by the Department of Engineering and Public Works Office and excavation request procedures are time consuming, preventing prompt repair of leaks. It is necessary to organize the way leaks are repaired on a city-wide scale by, for example, simplifying excavation requests in the case of leaks. In the case of a surface leak, it is necessary to consult with the road administrator to obtain excavation authorization on the same day.

3.2 Proposals on Various Activities for Reducing NRW

3.2.1 Current States of Pipeline Mapping, Checking the Precision, and Proposals on Pipeline Mapping System

3.2.1.1 State of Control of Pipeline Ledgers and Pipeline Maps, Attribute Contents, Update Frequency, and Replacement Flow

In COWD, a pipeline ledger is prepared using a spreadsheet program to enter (1) pipeline diameter, (2) pipeline type, (3) pipeline length (distance from start to end of pipeline), (4) pipeline location (addresses of start point and end point), and (5) year placed, at the time of pipeline work (newly placed, replaced). Data for (4) pipeline location is often missing, and in fact, many locations of many pipelines cannot be specified. Pipeline maps and pipeline ledgers are not in one-to-one correspondence, so it is not easy to match pipeline ledger information with map information.

Because control maps that are daily used are copies of precise CAD maps, the maps are difficult to share among staff members. When the JICA Study Team recommended that the COWD perform mesh management (X-Y coordinate) to control its pipeline ledgers and maps, the leak detection team immediately adopted this recommendation and prepared mesh management maps (1.5km intervals, sub-mesh: 0.5km or 0.75km intervals). Although the maps still need correcting, improving, adding information and updating, the control maps will be shared among all persons involved as they will be displayed and controlled with mesh numbers.

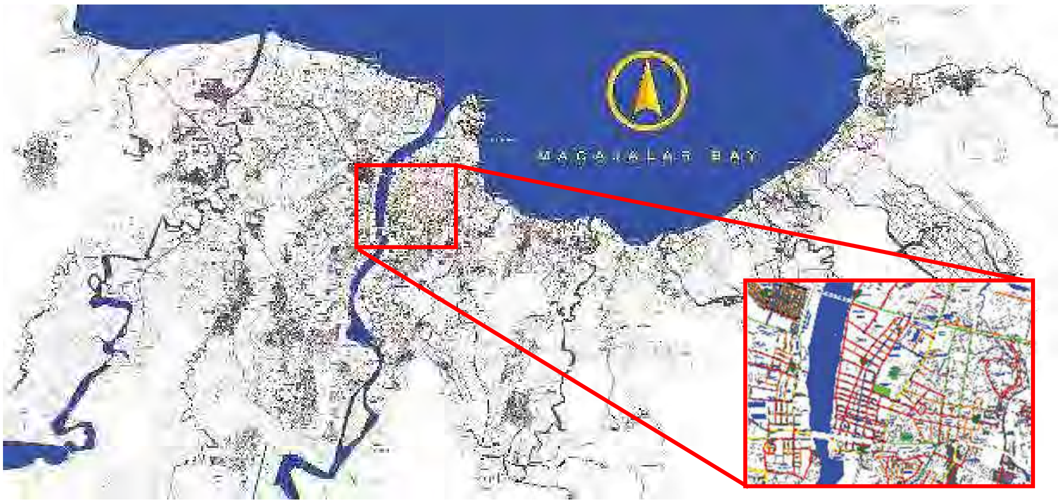
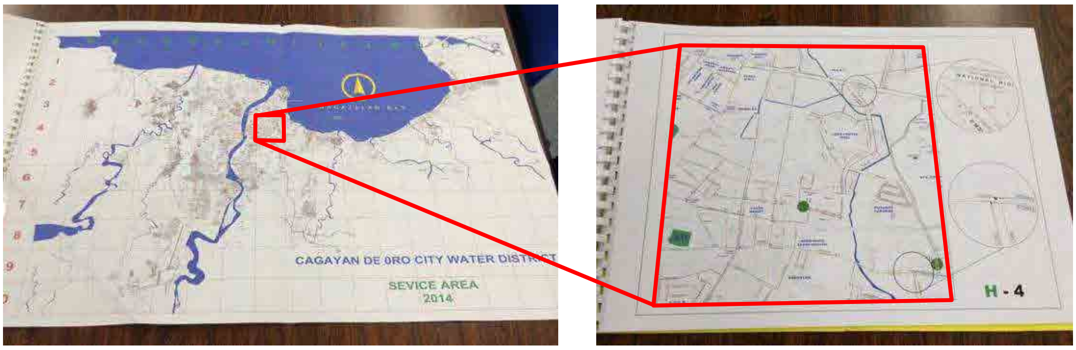


Fig-3.2.1 COWD Pipeline diagrams (Mapping)



Pict-3.2.1 Mesh management diagram made by COWD

Pipeline maps for distribution and transmission pipes in the entire COWD area are prepared using a CAD program, are stored on the server, and are updated whenever a section submits a document. The maps show Barangay names and important water supply facilities as well as pipelines in different colors depending on their meter size. Valves, fire hydrants or Stub-Outs are entered as basic information. They also present water quality test sampling points. But, for Stub-Outs, there is no data for the time before the start of map preparation, and entries concerning locations of branches from distribution pipes are often missing. They do not present information about water meters or service pipes. To date, these maps have been viewed only on a PC display and were not bound. In response to a recommendation by the JICA Study Team, COWD has decided to construct a system of binding them and retaining them in each section in conjunction with the introduction of meshes.

3.2.1.2 Precision of Maps

At COWD, GIS information concerning the urban region's topography and road information is represented by CAD software based on a map information web service, and the ground elevation of water supply facilities is also displayed. This accurately establishes consistency of the actual locations pipelines are buried (road sections) with the maps.

For pipelines pipeline type is added along with color categorization of diameter size. COWD has been working to improve the precision of pipeline representation every year, and the display accuracy is higher than it was when YWC visited in June, 2013.

However, urbanization is rapidly advancing in CDO City. Streets are replanned each time a new building is built, and there are districts where road division changes entirely in half a year. Pipeline maps remain unchanged unless they are altered by new construction of water pipes, and the original GIS information may not follow such changes. This would result in the distribution pipe, which should be on the pedestrian path side of the road, to be located in the middle of the road. It is necessary to always adjust GIS information by communicating with the road administrator and asking him/her to inform COWD about road division changes every time streets are replanned.

3.2.1.3 Confirming Precision in the Field

On COWD's pipeline maps, there is a scattered lack of conformity regarding valves, fire hydrants, and Stub-Outs entered on the maps; they do not actually exist in the field for example. COWD deals with this problem by adding information such as "Not Found" on its maps, but it does not enter all information on the maps.

The JICA Study Team recommended that when a comparison of the actual site and the pipeline maps during leak detection finds a discrepancy, or at locations where pipelines are complexly placed so that it is difficult to specify the pipelines, specifying locations by simple offsets to reflect them on the maps be added to their roles during leak detection.

Because the mesh maps that were prepared in this project employed square meshes, their printouts on oblong A3 sheets of paper have a margin on one side. For complicated piping, it was decided that enlarged maps were to be pasted in the margin as shown in Pict-3.2.1.

3.2.1.4 Number and Spacing of Valves and Fire Hydrants

COWD buries valves underground just as we do in Japan, and its fire hydrants and air valves are on the surface, but it installs far fewer valves or fire hydrants than we do in Japan. We think that one reason for this is the lack of clear installation criteria for valves or fire hydrants. In particular, fire hydrants are installed in response to the wishes of residents. This can be said about South East Asia in general, but it is often assumed that water supply facilities will be used for a very long time once they are placed as pipelines. However, water supply pipelines leak as years pass and under the effect of the road environment, and leaks must be repaired when they occur. When repairs are performed, a valve in front of or behind the leak location must be operated to shut off the flow in the pipeline, and after repair work is completed, a fire hydrant must be used to wash the inside of the pipeline. However, valves or fire hydrants, which are auxiliary facilities, are not seen nearby, so it is necessary to search for between 0.5 and 1 km in the vicinity. In Japan, valves and fire hydrants are installed every 100 to 200m, and measures are taken so that short-term and efficient small scale cutoff can be done by operating the valve when cutting off water and by using a fire hydrant when restoring and cleaning the site.

And because the leak detectors - the correlative leak detector and zone scan leak detector - that have been introduced use the valves and hydrants as sensor installation locations, it is difficult to set sensor installation locations when preparing the leak detection plan.

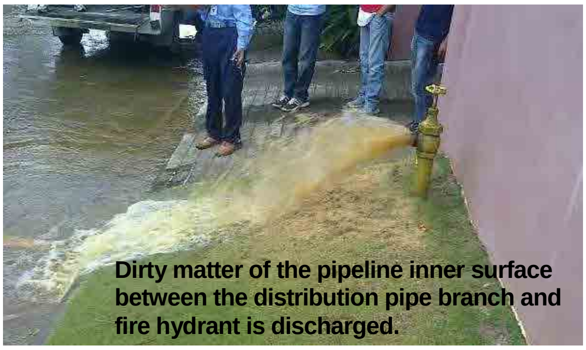
To add a valve, it is necessary to purchase materials and execute earthworks and installation works, so it cannot be easily installed, requiring aggressive action to set installation guidelines for pipeline replacement works. To construct a new DMA, valves need to be installed at its boundaries. The pipes can be plugged at the boundaries, but valves are effective as they are helpful for future reconstruction of DMA and for providing a backup connection during an emergency.

3.2.1.5 Valve Opening / Closing Information and Inspections

During field work, we inspected COWD’s distribution areas, but few valve chambers are equipped with manholes permitting entry by workers, and hand holes that ensure space to insert a rotating key (T-shaped handle) necessary for valve operation are installed. On many of the hand holes, the structures of the hatch and the hatch rest are not sealed, so rainwater or dirt gets inside, requiring that the interior of the hole be cleaned out and washed to install sensors, interfering with efficient leak detection. In Japan, to maintain valves, the valve chambers are maintained and the hatches are checked to make sure they open and close correctly and are not loose. The JICA Study Team recommended that the interior of the valve chambers be inspected and cleaned every month.

The staff of COWD’s Maintenance Department who clean the interior of valve chambers immediately open and close them on the spot to check the open/closed status of the valves. In a valve that has not been operated for many years, dirt adheres to the valve and inside of the pipeline, and when it is operated, this dirt peels off and travels inside the pipeline (causing red water or turbidity), so the valve should be washed as it is operated. Considering that this is a public water supply service, in order to avoid supplying red water or turbid water, an operating manual must be provided.

Pict-3.2.2 The inside of the hand hole that has not been maintained



Pict-3.2.3 Surface type fire hydrant (Right: water distributed from a fire hydrant.)

3.2.2 Analysis of the Amount of NRW

3.2.2.1 Method of Collecting Data on the NRW Rate and Breakdown Data

At COWD, the NRW rate is calculated by assuming that the NRW volume is the water volume obtained by subtracting the water for which the water rate is collected, which is the revenue water, from the total volume of Water Distributed, and making it dimensionless with the total water quantity distributed. The NRW is recorded as the total of (1) Leakage water, (2) Illegal connection (Stolen water), (3) Water meter insensitive (error) volume, (4) Water volume for business use in the Water District, and (5) Uncollectible account water amount, but at COWD, only (4) Water volume for business use is recorded as the rest are recorded as “other volumes of water”. Originally, COWD did not categorize NRW volume, so this breakdown was analyzed for the first time by the survey.

(1) Leakage Water

Concerning leakage water, as part of a water distribution improvement project conducted jointly with Manila Water Company Inc. (MWCI) in 2012, model DMAs were located at three locations

(RER Sub Division P1 district, San Lazaro district, and Limketkai district) and the minimum night flow rate was measured.



Pict-3.2.4 Existing DMA ([1]RER Sub Division P1, [2]San Lazaro, [3]Limketkai, from left)

This time, minimum night flow was first planned to be similarly monitored, but two of the mother meters that were installed in 2012 were already not working. Therefore, the flow was measured only at [1] RER Sub Division P1. In [2] San Lazaro, the flow was measured by using a portable ultrasonic flow meter.

A District Metered Area (DMA) is an area controlled by a water meter. The amount [A] of water that flows into an independent DMA, which is separated from the other areas with valves and pipe end plugs, is measured with a flow meter. In a DMA, water is supplied to individual homes after passing flow water meters and is used [B]. The amount of NRW is calculated as the “Total amount of inflow [A] – sum of all meter values [ΣB] = amount of NRW”.

Of the NRW in a DMA, the value that is almost the actual water leakage can be estimated by monitoring the minimum night flow. Water use decreases in the middle of the night. If there is a time at which no person in the DMA uses water, the flow is “0” if there is no leakage. However, if a certain degree of flow is measured, the flow is calculated as water leakage.

Although it is not accurate to estimate the value for the entire COWD from data at existing DMAs, the leakage is estimated to be about 40%.

Incidentally, for the water leakage downstream of the water meter, when leakage is found, the water tariff is reduced by the deduced consumption through settlement. However, COWD does not summarize this deduced consumption as the NRW amount. In the water supply area of COWD, it is often observed that the water supply pipe from a water meter to each home is lying on the street for several tens of meters, which is a remarkable feature of the Stub-Out system. In such site, the visual leakage can be confirmed in no small part. Because of the water leakage downstream of the water meter, COWD staffs are not involved in these leak repairs. However, through reduced tariff by leakage, these leakages may have affected the revenue.

By summarizing the deduced consumption, it is necessary to understand the actual situation. In addition, in order to reduce the deduced consumption, measures to reduce the downstream water leakage are needed such as announcing to customers that downstream water leakage should be repaired when it is found. By summarizing the deduced consumption, it is necessary to understand the actual situation. In addition, in order to reduce the deduced consumption by settlement caused by water leakage, efforts are required such as calling customers to repair the downstream water leakage as soon as it is found.

Table-3.2.1 Minimum night flow measurement in residential DMA (Top: 2012, Lower: 2014)

DMA name	Average flow rate	Minimum flow rate	Maximum flow rate	Leakage rate	Hourly factor
[1]RER Sub Division P1	16.84m^3/h	7.20m^3/h	25.20m^3/h	42.8%	1.50
	24.12m^3/h	15.60m^3/h	36.00m^3/h	64.7%	1.49
[2]San Lazaro	33.39m^3/h	12.00m^3/h	49.20m^3/h	35.9%	1.47
	40.26m^3/h	31.54m^3/h	56.09m^3/h	78.3%	1.39

But, minimum night flow measurements made in [2] San Lazaro on October 2014 feature a unique trend so we describe it in detail below.

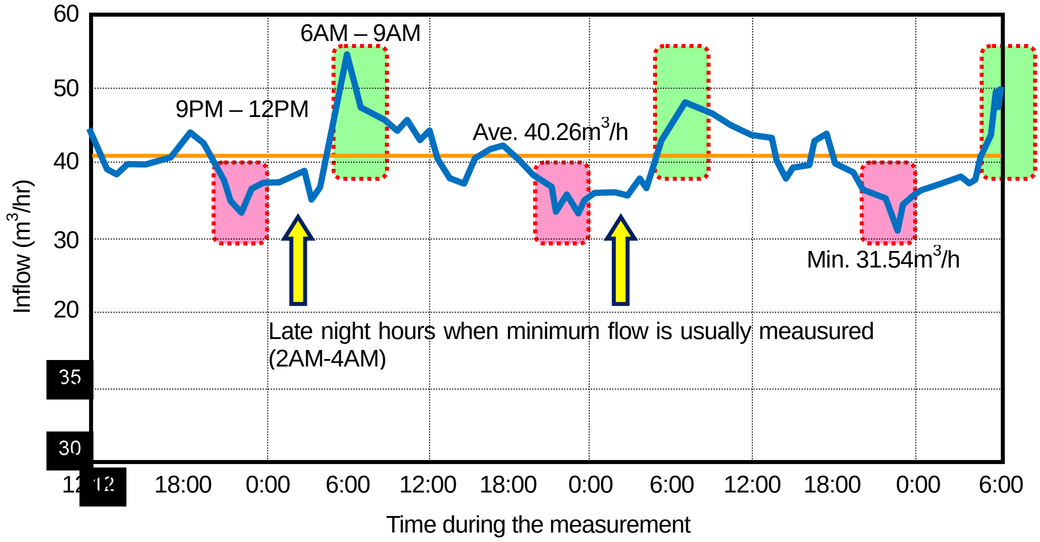


Fig-3.2.2 Inlet volume to DMA San Lazaro

From 6:00 a.m. to 9:00 a.m., the inlet volume to San Lazaro increases. This is because it is the time when people get up in the morning to start their day's activities, and it is a general trend. But in San Lazaro, the time when the flow rate is at its minimum level is from 9:00 p.m. to 12 p.m., later the flow rate increases gradually during the night. Normally, in a residential neighborhood, the minimum flow rate occurs between 2:00 a.m. and 4:00 a.m, but in San Larazo, such a trend is not seen. This is assumed to be a result of the following. 1) It is possible that customers use large quantities of water at night. And because the entire city uses water at the same time at dawn, customers might accumulate water at night in prospect of the water supply being unsatisfactory. 2) It is presumed that there are people who steal water at night. It is occasionally reported that people open taps at night to steal water because during the daytime, this would effect the supply of other customers. In the COWD district, fire hydrants are above ground, so that anyone with tools can open them.

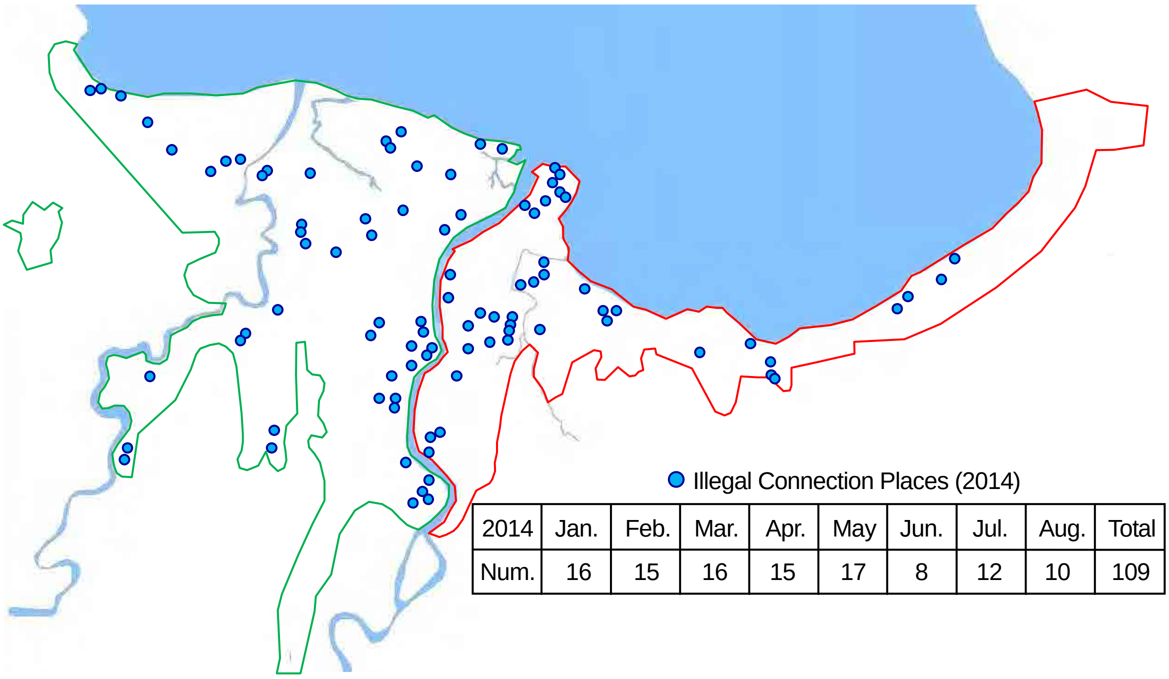
Flow rate measurements now done using ultrasonic flow rate gauges calculate an extremely high leakage rate of 78.3% for San Lazaro, so in the future a more detailed survey will be required. It is necessary to continue long-term minimum nighttime flow rate measurements at the same time as the San Lazaro customers are interviewed about their water use actions and loggers are installed on their water meters, to clarify the customers' daily water use actions. It will also be necessary to further subdivide the San Lazaro DMA.

(2) Illegal Connection (Stolen Water)

COWD has not determined either the amount or places of illegal connection (stolen water). COWD has reported that in 2013 it discovered 166 cases of illegal connections. However, because there are many surface pipelines, which are PVC pipes, and water pressure is low, it is easy to access a water pipe and install an illegal connection and Stub-Outs by using simple tools. It is assumed that far more water is actually stolen. In the future, measures such as creating a more effective illegal connection (stolen water) monitoring system must be taken.

Because illegal connection mainly occurs in exposed pipes, as a countermeasure, it is necessary to understand the location of the exposed pipes and to note it on the pipe drawing. In addition, there is a need to develop an implementation guideline which defines that the staff, which work in the water supply area every day as well as the water leakage survey team, such as meter reading staff, meter reading research staff and maintenance staff, check the illegal connection.

Pict-3.2.5 Illegal connection point (Left) / Exposed PVC pipes that are laid above ground (Right)



2014	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
Num.	16	15	16	15	17	8	12	10	109

Fig-3.2.3 Illegal connection places

It is difficult to determine the actual amount of illegal connection. Because the extent of illegal connections and the amount stolen are unknown, stolen water is usually combined with leakage water. After DMAs are fully constructed and the minimum night flow is measured for the entire and all water supply areas, it will be possible to calculate the basic leakage and estimate the amount of illegal connection.

(3) Water Meter Insensitive (Error) Volume

COWD replaces the customer's water meter only when it breaks. COWD has a laboratory to test water meters, tests newly purchased meters and meters requested for testing by customers, and assesses whether the meters show "satisfactory" values or not. As meters insensitive to water volume have not been counted in the NRW investigation, we tested meter errors in COWD's laboratory by using a method that can quickly estimate the volume.

In order to determine the meter insensitive volume, COWD collected 5 water meters that are used over time every year from the first year to the tenth year of use for a total of 50 water meters, tested instrumental errors of the water meters in the COWD water meter laboratory to calculate the instrumental error of each water meter, and then calculated the water meter insensitive volume for the entire water supply system. In this test, 50 meters were tested, accounting for only 0.06% of all water meters of COWD. The test was conducted as a pilot trial to help COWD perform the test by themselves.

COWD is using water meters manufactured mainly in Israel, Thailand, China, Korea and Germany. The specimens were sampled from DN13mm water meters so as to be evenly distributed throughout all districts, manufacturers and age.

Pict-3.2.6 Water meter test laboratory: Before installation (Left), During measurement (Center, Right)

Water velocities of 30L/h, 60L/h, 120L/h and 800L/h were tested; whose rated flows were 10, 20, 40 and 100L, respectively. Water was supplied from a tester tank. The water meter counts were compared with the rated flows, and the errors were calculated for each velocity.

Of the 50 specimens tested, the errors of the first 10 are shown in Table-3.2.2. Error curves of the meters (values highlighted in green in “2. Meter Error” of the table) are plotted on the left graph of Fig-3.2.4, and the error ratios of the meters (values highlighted in pink in “6. Error Ratio” of the table) are plotted on the right figure. The data for all meters tested are attached at the end of this document.

The error curves were determined from the results of the meter test. On the other hand, the error ratio of each meter should be determined by estimating how frequent each velocity is actually used at home, converting the velocity into volumetric flow, and calculating the error at the volumetric flow. Because the actual data of water use was not available in this short project period and there was no means to monitor, experimental data from a city in Japan were used for the actual data.

The test on 50 specimens showed trends of insensitivity at all velocities from the slowest to fastest velocities.

At a slow velocity of 30L/h, the error was -17% (for a discharge of 100L, the meter counted only 83L), and the error at 60L/h was -10%. At slow velocities, the actual volumetric flows are small, and the effect of the errors is not large. The errors were -4.3% and -3.9% at a middle velocity of 120L/h and a fast velocity of 800L/h, respectively. Showers, laundries, toilet flushing, and watering at homes are performed at fast velocities. For all velocities combined, the error of the water meters was -4.6% (for a discharge of 100L, the meters counted 95.4L). The count failures suggest that COWD must always include an NRW ratio of 4.6%.

The five red squares on the lower part of the right figure of Fig-3.2.4 are meters that were particularly insensitive. There was one meter that did not count almost any value at all (an error of almost -100%). Of the 50 water meters tested, 5 were malfunctioning, which accounted for 10%. For the 87,000 water meters possessed by COWD, 8,700 water meters are possibly malfunctioning. It is highly recommended to test and check the performance of any meter that is suspected to be malfunctioning when the water meter is read instead of waiting for a report mentioning that it is broken.

Table-3.2.2 Water meter error test table (Data from 1 to 10, in total 50 water meters)

Customer ID			101	102	103	104	105	106	107	108	109	110
Installed Date			2014/03	2013/11	2007/01	2007/01	2007/02	2012/03	2006/01	2006/01	2005/01	2008/01
Passage Year			0.3	0.7	7.6	7.5	7.4	2.3	8.6	8.5	9.5	6.5
Meter DN (mm)			13	13	13	13	13	13	13	13	13	13
Meter Number			1321389	1317576	235995	236246	236290	236105	867505	1071005	471040644	842805
Meter Company			Arad	Arad	Actaris	Actaris	Actaris	Actaris	Asahi	Asahi	Asahi	Asahi
Installed Area			Tablon	Iponan	Macabalan	Nazareth	Bonbon	Lapasan	Nazareth	Bonbon	Puntod	Macabalan
1. Meter Count (800-120-60-30)	L/h	L	L	L	L	L	L	L	L	L	L	L
	30	10	670.5	361.4	865.1	1011.0	990.9	186.3	526.7	340.8	1153.6	1053.9
	60	20	660.6	351.7	858.7	1011.0	981.0	176.5	518.1	330.3	1145.3	1044.7
	120	40	640.6	331.8	840.3	1011.0	960.8	156.3	499.9	310.5	1125.8	1024.7
	800	100	600.6	291.8	800.9	973.4	920.4	115.8	459.0	271.8	1084.9	983.9
	Initial		500.6	192.1	701.0	867.3	819.9	15.4	359.1	171.6	983.4	883.4
2. Meter Error	L/h	L	%	%	%	%	%	%	%	%	%	%
	30	-16.9	-1.0	-3.0	-36.0	-100.0	-1.0	-2.0	-14.0	5.0	-17.0	-8.0
	60	-10.2	0.0	-0.5	-8.0	-100.0	1.0	1.0	-9.0	-1.0	-2.5	0.0
	120	-4.3	0.0	0.0	-1.5	-6.0	1.0	1.3	2.2	-3.3	2.2	2.0
	800	-3.9	0.0	-0.3	-0.1	6.1	0.5	0.4	-0.1	0.2	1.5	0.5
3. Range Count (Japan experience)	L/h		%	%	%	%	%	%	%	%	%	%
	V<42		22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
	42<V<85		14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
	85<V<310		31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
	310<V		33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
	Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
4. Consumption (Field meter test)	L/h		L	L	L	L	L	L	L	L	L	L
	V<42		52.6	52.6	52.6	52.6	52.6	52.6	52.6	52.6	52.6	52.6
	42<V<85		154.5	154.5	154.5	154.5	154.5	154.5	154.5	154.5	154.5	154.5
	85<V<310		1486.0	1486.0	1486.0	1486.0	1486.0	1486.0	1486.0	1486.0	1486.0	1486.0
	310<V		3306.9	3306.9	3306.9	3306.9	3306.9	3306.9	3306.9	3306.9	3306.9	3306.9
	Total		5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0
5. Consumption Ratio	L/h		%	%	%	%	%	%	%	%	%	%
	V<42		1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	42<V<85		3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
	85<V<310		29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
	310<V		66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1
	Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
6. Error Ratio	L/h		%	%	%	%	%	%	%	%	%	%
	V<42		-0.01	-0.03	-0.38	-1.05	-0.01	-0.02	-0.15	0.05	-0.18	-0.08
	42<V<85		0.00	-0.02	-0.25	-3.09	0.03	0.03	-0.28	-0.03	-0.08	0.00
	85<V<310		0.00	0.00	-0.45	-1.78	0.30	0.37	0.67	-0.97	0.67	0.59
	310<V		0.00	-0.20	-0.07	4.03	0.33	0.26	-0.07	0.13	0.99	0.33
	Total		-0.01	-0.25	-1.14	-1.89	0.65	0.65	0.18	-0.81	1.40	0.84

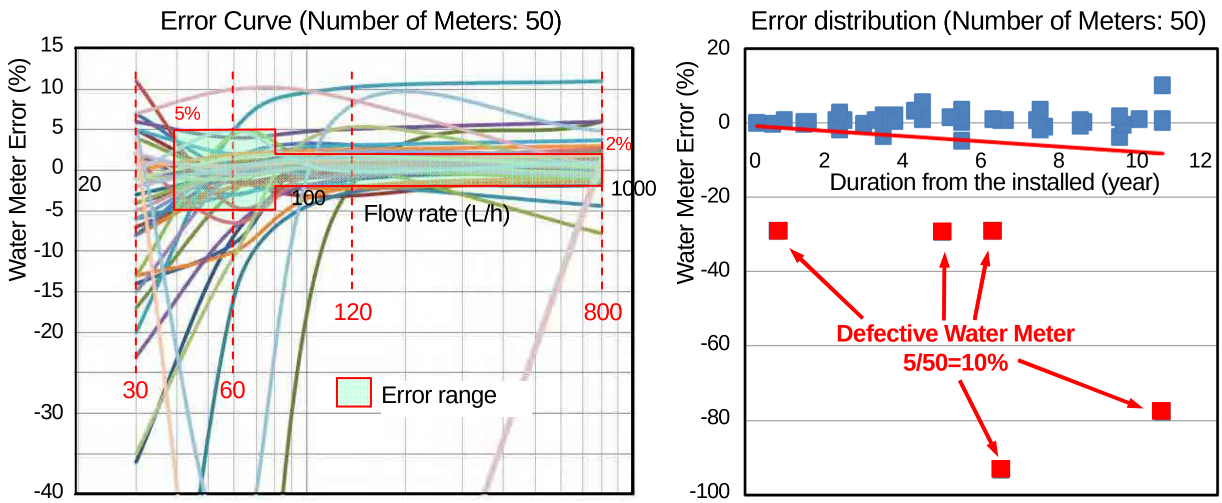


Fig-3.2.4 Instrumental error curve (Left) and error distribution (Right) of water meter

Replacing the malfunctioning meters with new meters changed the NRW rate of 4.6% to a revenue earning water rate of 0.7%. This will improve the fraction in the NRW of water meter errors by 5.3 points (4.6-(-0.7)). Fig-3.2.5 shows a trend after removing the malfunctioning meters in Fig-3.2.4 (right).

The water meters did not much differ by country of manufacture or manufacturer.

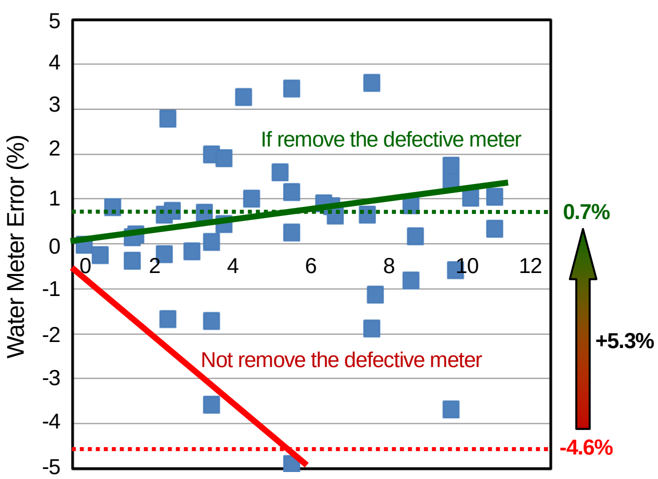


Fig-3.2.5 Improvement of NRW rate by replacement of defective water meters

There are many Water Districts in the Philippines that do not have a device for testing water meters (standard tank for testing water volume). A simple standard tank that can be easily manufactured is described below.

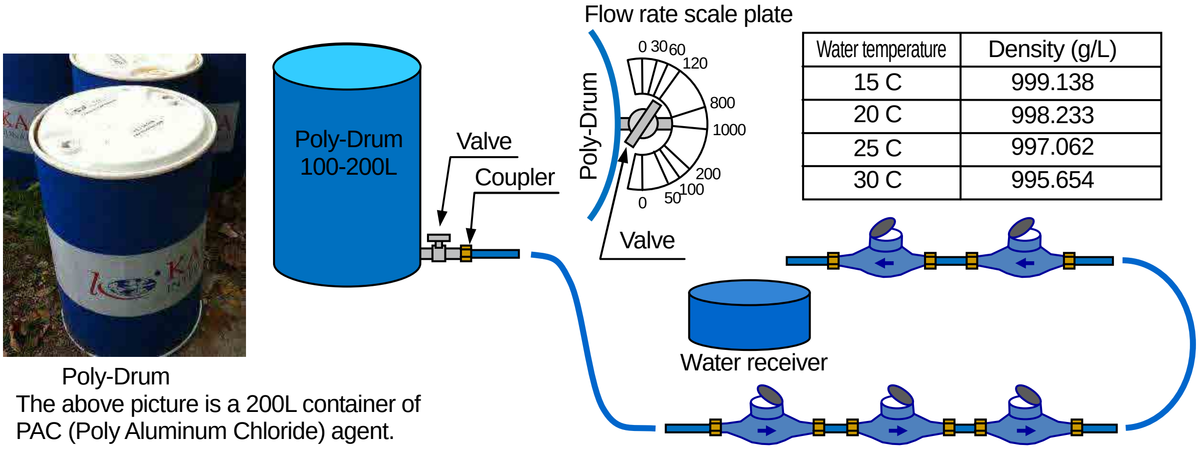
A simple standard tank for testing water meters can be prepared by using a Poly drum (with a capacity of 100 ~ 200L). Install a valve at the bottom of the drum, connect the valve and a disconnected water meter with a hose, correctly measure the amount of water to pour into the drum, discharge water to the water meter by regulating the flow by adjusting the height of the Poly drum and the aperture of the valve, and calculate the error of the meter from the difference between the amount of water discharged and the count. Then the insensitive ratio of the meter can be determined from the meter error (meter insensitive to water volume).

The amount of water to be poured into the Poly drum should be correctly measured. By using a bottled water case, etc. and measuring the water by weight (consider the density of water), the examiner should pour an amount of water with which a test can be completed in 10 to 20 minutes when the water is discharged at predetermined test velocities. The amount does not need to be a simple value (such as 10L and 50L) as long as it is correctly measured. Because water is to be poured from bottles, care should be taken not to spill the water outside the drum. It is also acceptable to measure the amount of water only roughly when it is poured into the drum but precisely and accurately after the test by collecting the water in the drain receptacle.

Before pouring water, open the valve and check that no water flows out. Close the valve, and pour water. Open the valve to start the test. When the flow of water stops, the test is completed.

Because the velocity is controlled by the aperture of the valve, a preliminary test on volumetric flow is required. Measure the time required for discharging a correct amount of water several times. Check the apertures for giving slow to fast volumetric flows, and prepare a scale showing the correct apertures that give predetermined flows.

Fig-3.2.6 depicts a water meter testing system that uses a simple standard tank.



Water temperature	Density (g/L)
15 C	999.138
20 C	998.233
25 C	997.062
30 C	995.654

Fig-3.2.6 System of instrumental error testing of water meter by simple standard testing water tank

(4) Water Volume for Business Use in the Water District

Regarding water volume for business use in the Water District, COWD already calculates this volume every year, so we will use that.

(5) Uncollectable Account

For the unpaid water volume, the percentage of uncollectable account stated in the Annual Report of the previous year to the water service income is to be calculated.

(6) Total Distributed Amount

In water distribution analysis, the amount of NRW is calculated by setting the total distributed amount as 100% and subtracting the amount of revenue water, which is easy to determine, from the total amount. The ratio of NRW consists of the aforementioned items, of which the water volume for business use and unpaid water volume can be determined by calculation. The meter insensitive water volume can be estimated from experimental data. By subtracting these and the calculated amount of leakage and stolen water from the amount of NRW, the ratio of leakage can be estimated from the minimum night flow measurement.

It is most important here that the total distributed amount is correct. The amount of revenue water is almost correct because it is calculated from water charges. The correctness of the total distributed amount determines the ratio of revenue water, which is calculated as described below.

The ratio of revenue water is calculated by dividing the amount of revenue water by the total distributed amount and multiplying by 100. The calculated ratio varies depending on the correctness of the total distributed amount, which is the denominator, as does the ratio of NRW. The flow meters of COWD at deep wells, which are their water sources, are not sufficiently maintained, and the values monitored by magnetic flow meters differed from ultrasonic flow meter measurements as shown in Table-3.2.3 and Fig-3.2.7.

Table-3.2.3 Measurement comparison with existing electromagnetic and ultrasonic flow meter

Pump location	Installed Month/Year	Diameter	Electromagnetic flow [A]	Ultrasonic flow [B] (X axis)	Flow Ratio [A/B] (Y axis)
PW11 (Intake P)	Apr. 2008	250mm	386m^3/h	298m^3/h	130%
PW23 (Intake P)	Mar. 2008	250mm	289m^3/h	292m^3/h	99%
PW29 (Intake P)	Mar. 2008	250mm	200m^3/h	180m^3/h	111%
BP 1 MAC (Booster P)	Nov. 2008	600mm	726m^3/h	758m^3/h	96%
BP 2 MAC (Booster P)	Dec. 2008	500mm	754m^3/h	851m^3/h	89%
BP 1 BAL (Booster P)	Apr. 2010	300mm	474m^3/h	361m^3/h	131%
BP 2 BAL (Booster P)	Apr. 2010	350mm	764m^3/h	751m^3/h	102%
BP 1 BUG (Booster P)	Dec. 2008	400mm	611m^3/h	698m^3/h	88%
RVWC (Bulk Receive)	Jun. 2006	900mm	1,669m^3/h	1,027m^3/h	163%

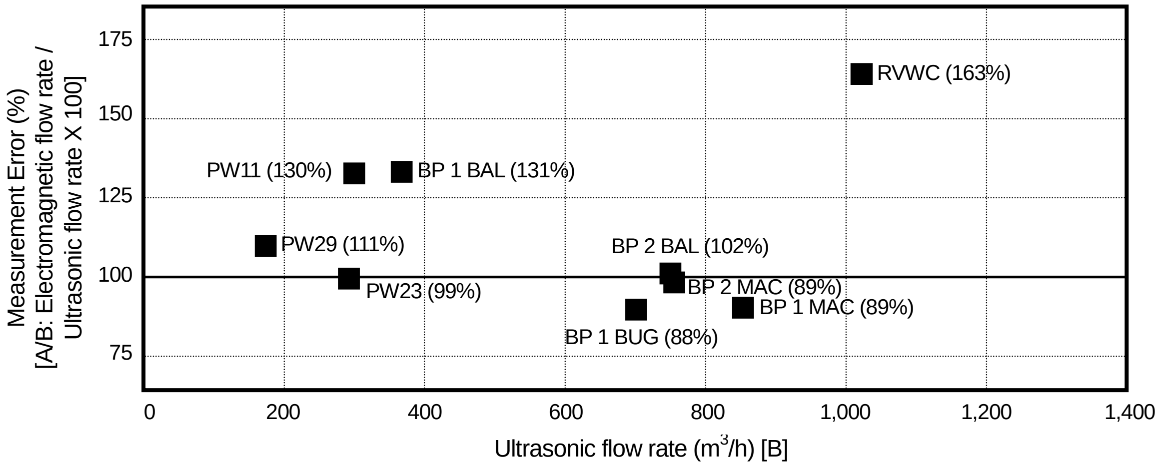


Fig-3.2.7 Measurement comparison with existing electromagnetic flow meter and ultrasonic flow meter

In general, magnetic flow meters are more accurate than ultrasonic flow meters. The amount of water conveyed was checked at 9 points including 3 intake pumps, 5 booster pumps and a transmission pump at RVWC where water is received. A magnetic flow meter is installed to each pump. An ultrasonic flow meter was mounted from the outside. Based on measurements at the same time zone, the percentages between the measurements by the magnetic flow meters and ultrasonic flow meter were calculated by setting the measurements of the existing magnetic flow meters as the numerator and the measurements of the ultrasonic flow meter as the denominator. The results are shown in Table-3.2.3 and Fig-3.2.7. Measurement errors were within the range of about 10% (mean 97.5%) at 6 out of the 9 pumps. However, the flow meters at PW11 (intake pump), BP 1 BAL (booster pump) and RVWC (water receiving) showed measurements that were larger than those of the ultrasonic flow meter by 30% to 60%. If the measurements by the ultrasonic meter were correct, values larger than the actual volumetric flows have been reported.

The conditions were: 1) the ultrasonic flow meter was new and accurate, 2) the thickness of the pipe inputted to the ultrasonic flow meter was the thickness of an ordinary pipe because the actual thickness was not stated in the completion diagrams of the deep wells, 3) measurements by an ultrasonic flow meter fluctuate by the contamination on the inner surface of the pipe, and 4) the existing magnetic meters were not inspected after installation.

The accuracy of the flow meters at intake pumps and water receiving station is very important in determining the total distributed amount. Because the values are used to analyze water distribution, flow meters need to be periodically inspected.

The measurement error at the water receiving station (RVWC) was 163%. If the measurement by the ultrasonic flow meter was correct, of the reported amount of 40,000m^3/day, only 24,500m^3/day was actually pumped. The total distributed amount by COWD was reported to be 157,000m^3/day, but it could actually have been only 141,500m^3/day. The flow meters at 3 deep wells (11% of all wells) showed a measurement error of 113%, suggesting a measurement error of 13,500m^3/day for all wells combined. By considering an error of 3,500m^3/day (25%), the actual total distributed amount is calculated to be 138,000m^3/day.

The distributed amount by COWD for year 2013 - before and after the analysis is shown in Table-3.2.4.

Table-3.2.4 Changes in the water distribution volume analysis according to the practice of investigation and analysis

			Before	After
Distributed Water 100% 157,000m^3/day → 138,000m^3/day	Revenue Water 44.4→50.5%	Water Charge	44.4%	50.5%
		Other	+0.0%	+0.0%
	Non-Revenue Water 55.6→49.5%	Leakage	N/D	42.1%
		Illegal Water	N/D	
		Water Meter Error	N/D	4.6%
		Unpaid Water Charge	N/D	0.4%
		Use by COWD	1.5%	1.7%
		Other	54.1%	--

Distributed Water	Before	After
COWD PWs	117,000	Divided by 113% = 103,500 → in contrast to the differential of 13,5000 from the left, only 25% of the wells are defined as in error, not all the deep wells. → 103,500＋13,500×(1-0.25)＝113,600
RVWC (Bulk Receive)	40,000	Divided by 163% = 24,500
Total (m^3/day)	157,000	138,000

3.2.2.2 NRW Rate Determination Procedure

The water volume obtained by subtracting the water supply system volume determined from customers' water meters, which is the revenue water, from the total volume of water distributed is defined as the NRW and calculated monthly.

The water intake volume that is the foundation of the total distribution volume is measured by flow meters at pumping stations and booster pumping stations in the case of ground water, and by flow meters at the points of entry in the case of receiving service water. But distribution water is measured once a month, so data in daily or hourly units is not collected and the average service water supply is calculated based on monthly data. Thus, it is impossible to calculate the daily planned service water supply. And time constants etc. cannot be calculated.

Regarding the volume of groundwater pumped up, while there are places where flow meters are installed, for places where flow meters are not installed, the flow rate is calculated based on pump performance and pump operation time.

Until now, COWD has not confirmed the precision of flow meters at these pumping stations and those operated by service water suppliers, so the JICA Study Team recommended regular confirmation of the precision of flow meters.

Revenue water is found by having water meter readers read and record water meters installed at homes every month. Reading water meters at individual homes is stipulated by water meter reading schedules as once a month at fixed intervals of about one month, but because water meter reading days vary because of holidays or weather conditions, according to the month, the interval between readings might be shorter or longer than one month. This means that the NRW may be larger or smaller in volume than it was the previous month.

3.2.2.3 Analysis of Data Concerning Volume of Water Used

COWD has not analyzed data on the amount of water other than calculating the ratio of NRW. In Japan, the amount of water used per person is in principle analyzed as the supply unit to plan water supply. However, such an activity has not been performed by COWD. Analysis requires time and labor, but is a necessary work and is thus described below.

(1) Amount of water used per person per day

The mean daily amount of water used by a person is easy to calculate and is determined by dividing the amount of water supplied (in the Water District) by the population served.

(2) Quantity of water used, rate income, number of customers by use and by quantity of water used stage

The Quantity of Water Used Table by use and by quantity of water used stage is data needed to clarify the major customers of COWD and to study management strategies such as water rate revisions. It analyzes the water use zone that categorizes revenue earning water, water rate revenues, and number of customers in each meter month by quantity of water used to categorize (within the basic water supplied; $10m^3$ or less, $20m^3$ or less, $30m^3$ or less, $40m^3$ or less and $41m^3$ or more), and analyze and represent them as percentages. At COWD it can be prepared using meter data.

(3) Supply unit (for Residential)

The supply unit (for Residential) is determined by totalizing the meter readings of revenue water for housework that passed through water meters and dividing by the population served. The supply unit is an important factor for calculating water demand and is a key index for planning water supply. The population served needs to be correctly understood. However, in many Water Districts, only the number of customers (the number of homes connected to water meters) is known, and the population served is estimated by multiplying the mean number of persons per home by the number of customers.

In Japan, the supply unit for domestic use is generally 200 to 240L/person/day, and the amount is increased depending on people's lifestyle in the area.

(4) Prediction of water demand

Water demand can be predicted by classifying water for housework (population served × supply unit), commerce (shops, offices, schools, etc.) and industry, and totalizing the meter readings for each class.

The sum of the values is the mean amount of revenue water. Dividing the sum by the ratio of revenue water gives the mean amount of water supply. The maximum amount of water supply can be calculated by dividing the mean amount of water supply by the load ratio (the percentage of the daily mean water supply to the daily maximum water supply) (See Fig-3.2.8).

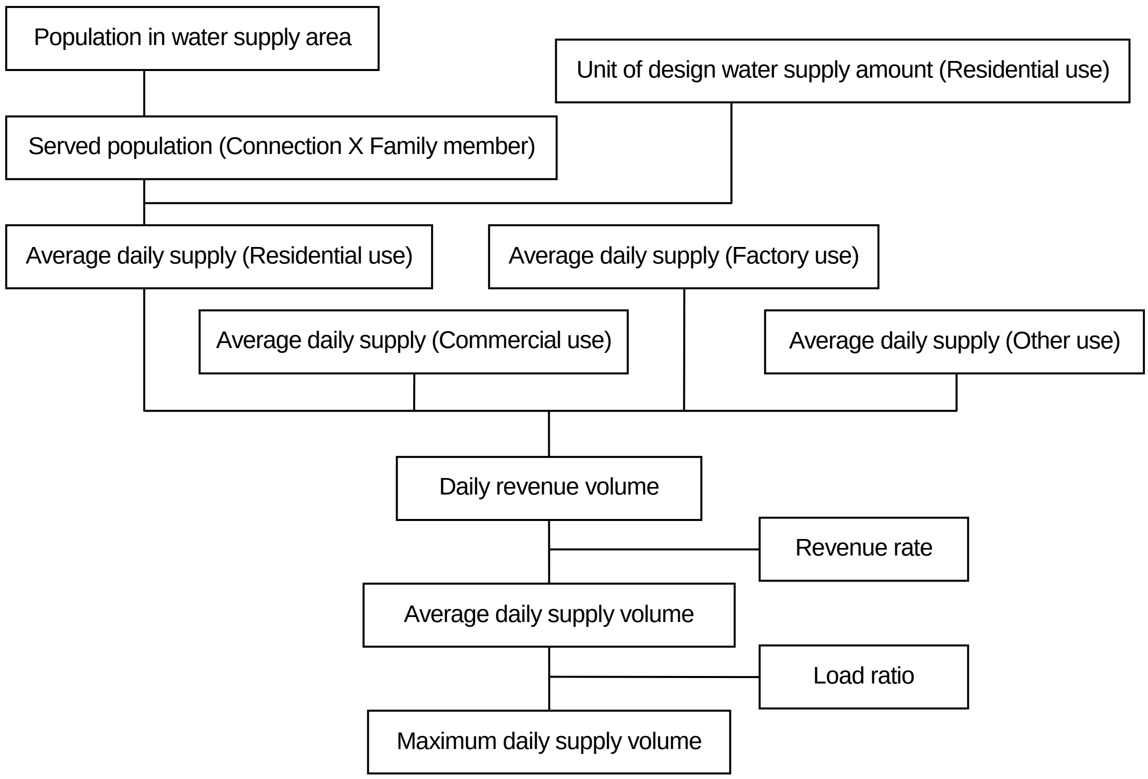


Fig-3.2.8 Procedure for calculating the water demand prediction

3.2.3 Circumstances of Discovering Surface and Underground Water Leaks, Leaks in each Region, and State of Water Pressure

3.2.3.1 Comparison of Leak Numbers by Various Factors Involved

COWD repairs approximately 530 water leaks every month, but almost all of these are in service pipes, with fewer than 10 leaks per month on transmission pipes and distribution pipes. COWD has not performed detailed analysis of the causes of leaks, but does organize data by surface/underground, by meter size, and by pipe material.

When detections performed in response to requests for leak detection are analyzed by surface/underground, visual leak detections occur about 10 times a month and leak detection using acoustic leak detectors is performed about 13 times a month, both very low frequency and almost all done on service pipes. The meter size of the pipes that leaked is lower than 300mm in more than 98% of cases, with the most frequent size 100mm in 37% of cases. When analyzed by pipe material, 90% are PE pipes, and leakage from PVC pipes, DIPs, and SPs is rare. But, there are few samples, so COWD has been informed that it will be necessary to scrutinize the data.

COWD does not collect detailed data related to water leakage occurrence location, such as installed year or location, so at this time, these cannot be analyzed, but introducing mesh management is counted on to permit future analysis of the causes of leaks based on year placed, location, etc.

3.2.3.2 Relationship between Water Leaks and Water Pressure

The types of pipes used as distribution pipes by COWD are mainly plastic pipes: PVC pipes and PE pipes. Aged plastic pipes leak as a result of pipe body deterioration or damage caused by the load of vehicles passing above, or of defective execution. If high pressure water flows through these locations, conspicuous leaks appear. In the COWD distribution pipe network, high pressure is observed on water distributed from some low land sections and from booster pumping stations, but large diameter steel pipes are laid from booster pumping stations and leakage detection surveys have not found any leaks on these. In the future, distribution pipe networks partially at low ground level should be surveyed, their relationship with leaks revealed, and measures to prevent leaks on the pipe networks will be taken.

Water pressure in a water supply district can be effectively controlled by constructing DMAs. Without DMAs, water pressure is difficult to control when there is lowland (high-pressure area) near the water supply facility and highland (low-pressure area) behind the lowland. The problem of uneven water pressure that is presently confronted by COWD can be solved by dividing the water supply district into DMAs.

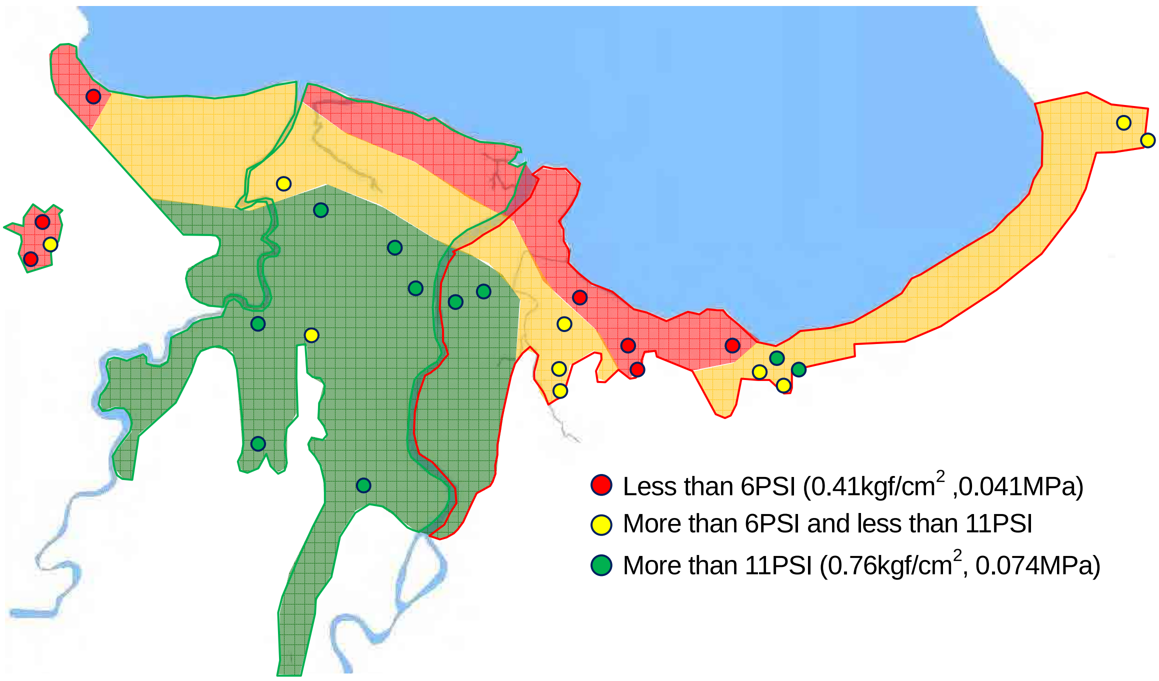


Fig-3.2.9 Water pressure distribution of the water-supply area

This time, the JICA Study Team and COWD prepared a water pressure distribution map. Over the western area, the water supply pressure is relatively high with at least 11PSI (0.76kgf/cm^2, 0.074MPa) due to the installation of booster pumps and water reception from RVWC. At the northwestern end of the Water District, the water pressure is 6PSI (0.41kgf/cm^2, 0.041MPa) or lower. The first action to take should be to check the number of Stub-Out water meters, and take necessary measures to improve the Stub-Outs as described in Section 3.2.5. If the measures are insufficient, it will be necessary to install booster pumps as a short-term measure, and replace the pipes to increase their diameter as a medium-term measure.

In the eastern area, the water pressure is low in coastal regions that are far from booster pumps. Measures similar to those to be implemented in the western area need to be taken.

We started water pressure monitoring from the western area and expanded to the eastern part because we started checking leakage in the western area.

3.2.4 Distribution Network Calculations for the Entire COWD Network and at the Transmission Pipe Level

3.2.4.1 Distribution Network Calculation at the Transmission Pipe Level

The COWD distribution network calculations are performed using EPANET, which is software developed by the USEPA (US Environmental Protection Agency). Their calculations include a range from large diameter transmission pipes to small diameter pipes with 50mm that are defined as distribution pipes.

According to the hydraulic analysis data by COWD, analysis data was submitted, but did not provide results showing that an appropriate distribution network was constructed. All it shows is that the entire distribution pipe network is analyzed over a wide range and a satisfactory water supply is not possible under present circumstances, and it is not used to simulate the building of an appropriate distribution network. It is necessary to perform analysis and simulations to determine how water is operated to transmit water in stages to distribution reservoirs through transmission pipes and major distribution pipes, and next, if water distribution in each region through branches from transmission pipes is satisfactory.

Of the various entry data, node branch water volume should be reconsidered, but in addition, in order to obtain adequate precision as data, the way nodes were set and branch water volume was analyzed to simulate the distribution networks in each district.

The amount of water supply at each node used was the average amount of water supply, but by considering the time factor, conditions that maximize the quantity of water used inside the COWD's water service sysem were studied. In Japan, the time factor is generally a standard of 2.0 in small cities, 1.5 in medium cities, and 1.3 in large cities and industrial cities. A stated above, COWD does not clarify the time factor, so in this simulation, for convenience, the time factor was set as 2.0.

The results of the simulation on the east side suggest the result is low water pressure (6.5 psi) around Macabalan. But because the pipeline network calculation cannot evaluate leakage and other NRW, and if the NRW rate that is now high in COWD is considered, the actual water pressure is even lower than the pipeline network calculation results, so in these regions, in the morning time period when water demand is concentrated, the system may be unable to supply enough water. Lowering the NRW rate will ensure sufficient water supply to meet the demand throughout the entire east side, but it is necessary to take drastic measures, such as increase of the diameter of the pipe line as it transmits water to Macabalan, revision of lifting ranges of pumps in the Macasandig booster pumping station, and installation of small booster pumps, etc.

The results of this simulation suggest that even if the east side is further divided into east and west side, it will be possible to supply water.

On the west side on the other hand, the supply pressure is not high enough at Opol or Igit at the north-east end. As on the east side, calculation shows that lowering the NRW rate will ensure a supply of water sufficient to meet overall demand of the west side, but in the west side case, even if the NRW is reduced for example, the present pipeline network will be unable to transmit enough water to the region in the future, during early morning hours when water demand is concentrated. This is caused by small pipeline diameter used to transfer water to these regions. Distribution pipelines with diameter of 200m and 250mm in Iponan, will be replaced by pipelines with diameter of 300mm, and pipelines with diameter of 150mm in Bulua will be replaced with larger pipes with diameter of 400mm, ending water supply problems.

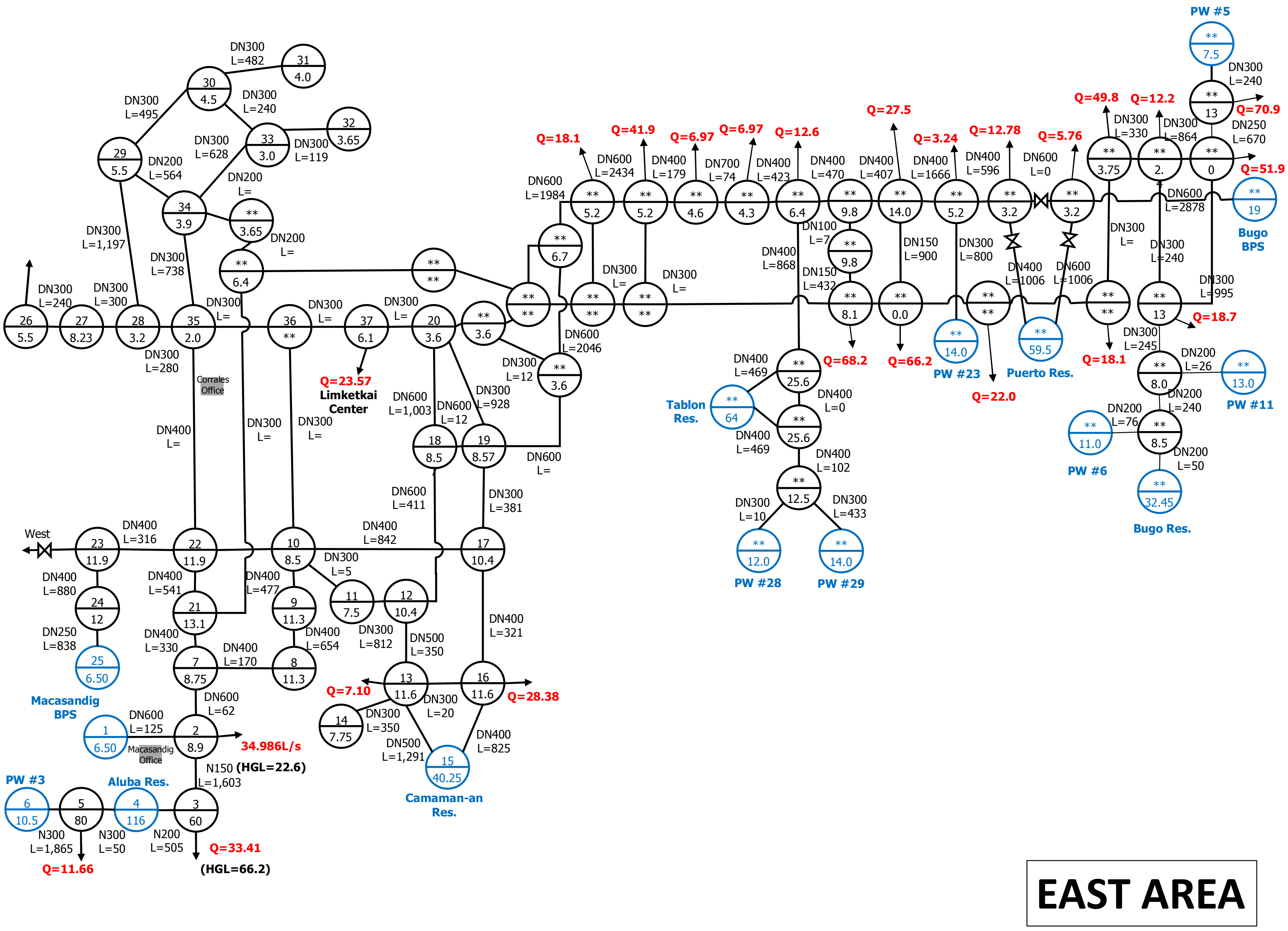


Fig-3.2.10 Pipe network analysis in the East water supply area (Current Condition)

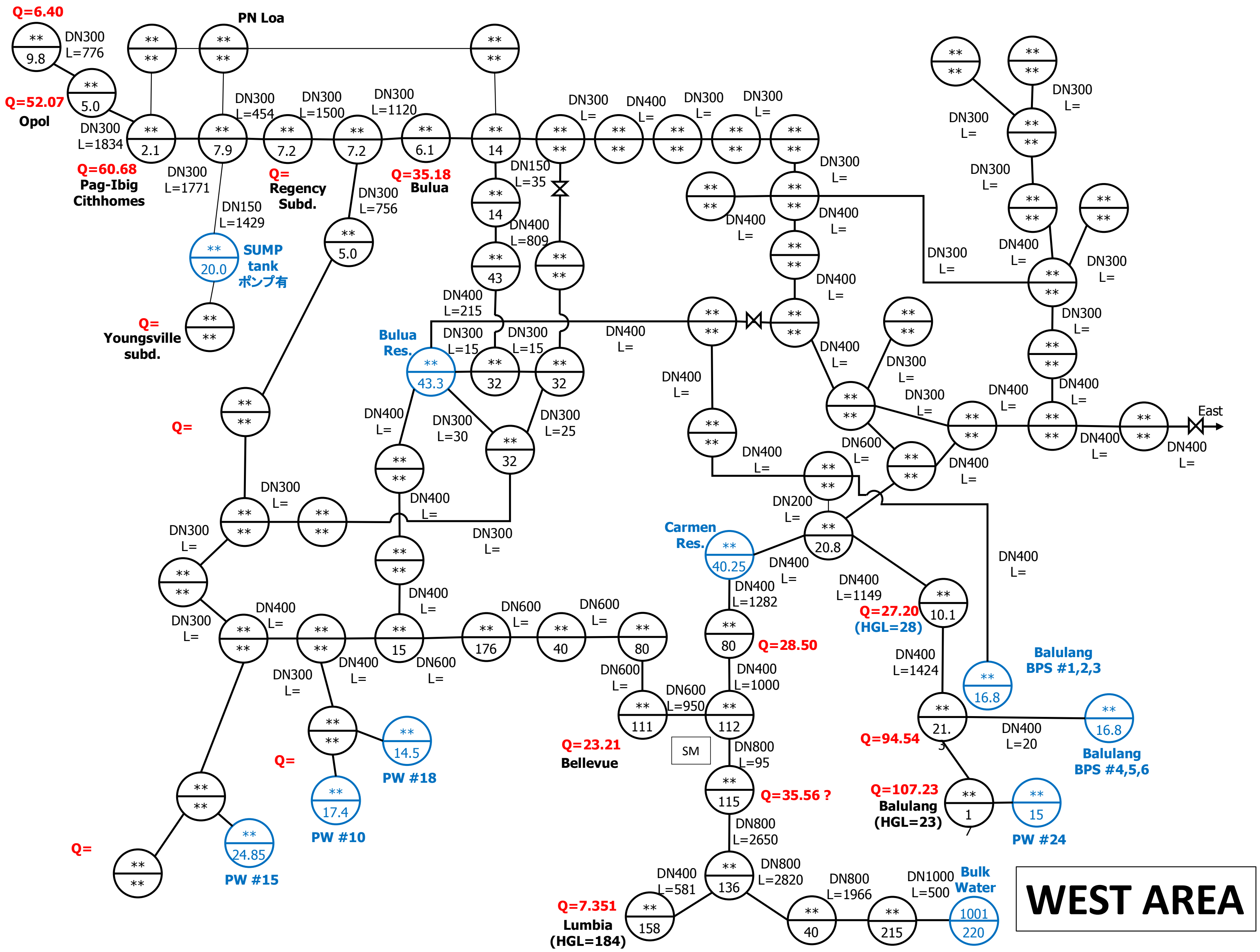


Fig-3.2.11 Pipe network analysis in the West water supply area (Current Condition)

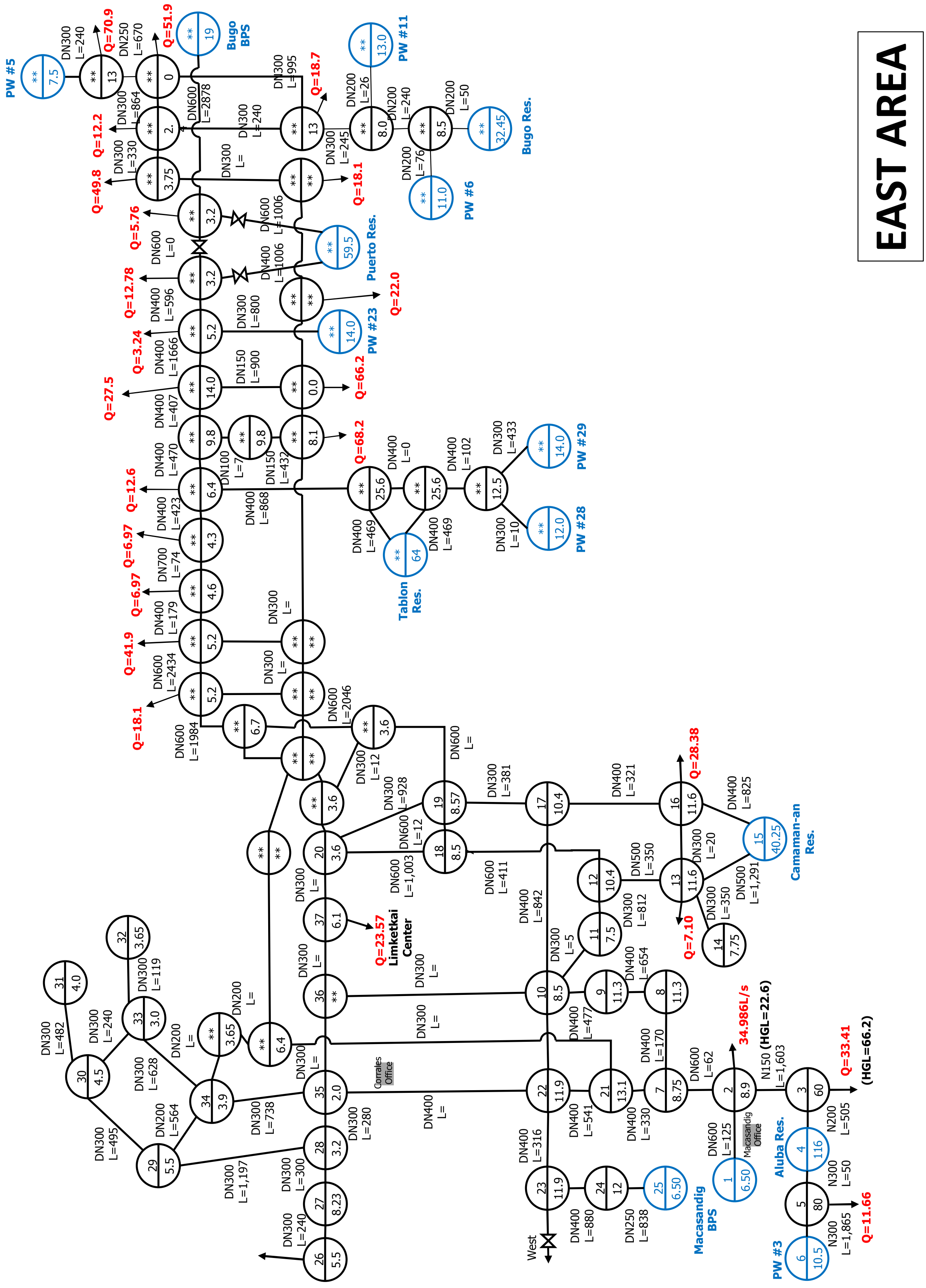


Fig-3.2.12 Pipe network analysis in the East water supply area (In the case of dividing the East into two)

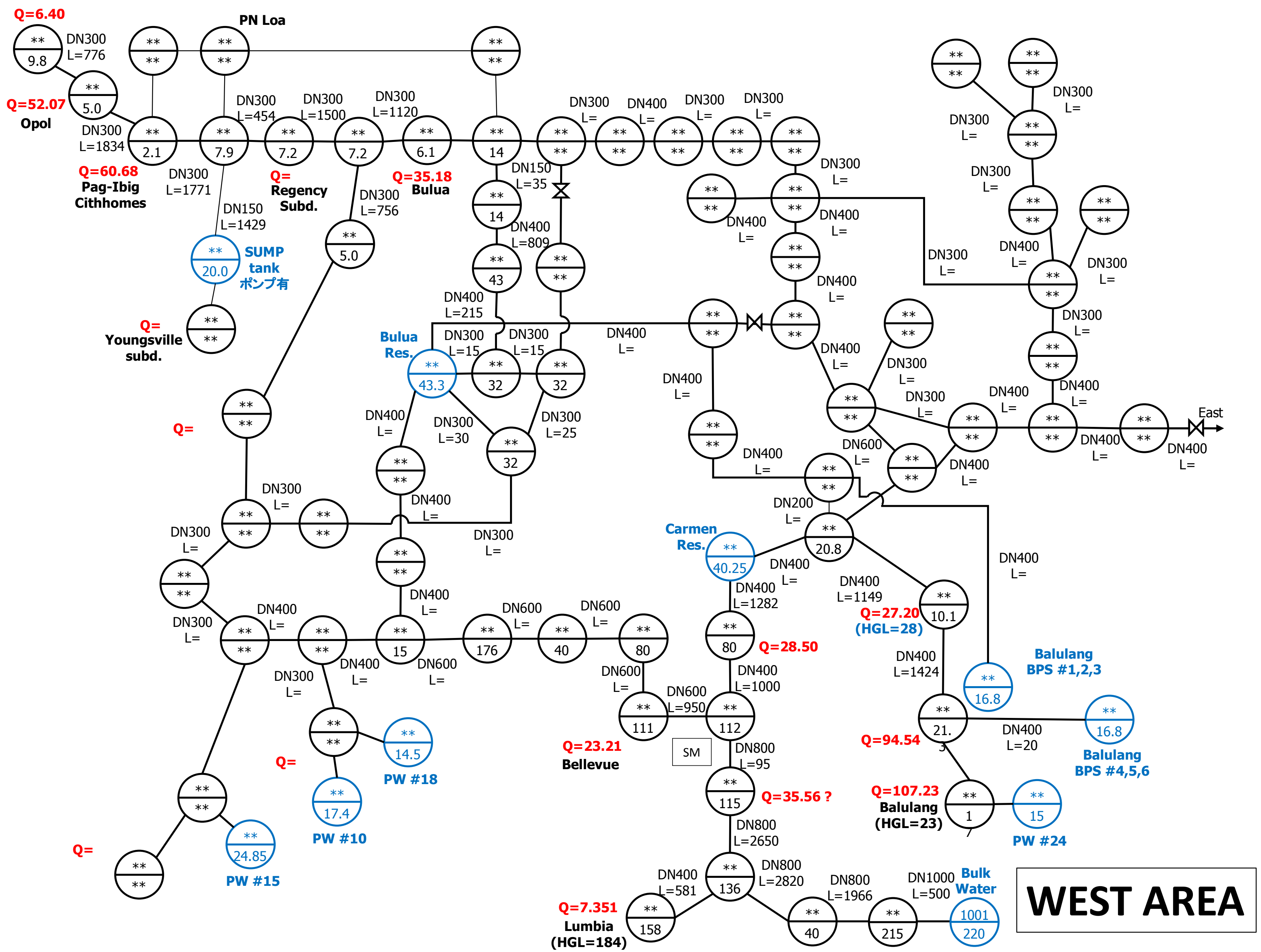


Fig-3.2.13 Pipe network analysis in the West water supply area (In the case of pipe improvement)

3.2.5 Water Supply Design and Service Pipe Connections

3.2.5.1 Number of Water Taps on a Service Pipe Branch (Stub-Out)

According to the Stub-Out ledger of COWD, there is a Stub-Out to which 96 water meters are connected. The JICA Study Team observed a Stub-Out that was connected to 82 water meters. From the meters, the water was supplied to each home through a DN13mm PVC pipe or hose extending over 10m or sometimes over 100m. Water leak was observed from such pipes and hoses at more than a dozen points. Because the service pipes were exposed and not protected even on roads, the pipes were being damaged by passing bicycles and pedestrians. The pipes after water meters are not in the scope of COWD's responsibility, but in terms of customer service, it is likely necessary to take some kind of action.

The water supply rules of COWD approve the installation of a water meter (DN13mm) to a Stub-Out only when (1) the supply water pressure at the Stub-Out is at least 10PSI, (2) the pipe from the Stub-Out to the home is not longer than 20m, and (3) there will be no more than 20 water meters installed to the Stub-Out after the said installation. However, as shown in Table-2.2.18, there are 218 Stub-Outs that do not meet the criteria, which account for 17% of all Stub-Outs in the water supply district. Such Stub-Outs are located in districts where customers frequently complain that water is not sufficiently supplied. The JICA Study Team proposed an action for quickly solving the problem.

Keeping the water supply rules of COWD in mind, the number of water meters connected to a Stub-Out is to be reduced by installing new Stub-Outs on the distribution pipe line near the Stub-Outs to which a number of meters over the specified numbers are connected. The new Stub-Outs should be installed at appropriate locations so that the service pipes to homes do not exceed 20m. The rules approve up to 20 water meters per Stub-Out, but the number should be reduced to 16 when the meters are divided. This will allow installation of several new water meters for new customers. If the nearest Stub-Out to a new customer already has 20 meters connected, the water meter of the new customer must be installed at a far Stub-Out. By having four "empty" connections at each Stub-Out, it will be possible to continue observing the water supply rules as it provides time until a new Stub-Out is installed. The number of divisions of illegal Stub-Outs and the number of new Stub-Outs to be installed are shown in Table-3.2.5.

Table-3.2.5 Division of Stub-Outs that do not meet the installation criteria

Number of water meters on one Stub-Out	Standard	Without standard					Total
	~20	21~32	33~48	49~64	65~80	81~96	
Number of Stub-Outs	1,071	140	61	12	2	3	1,289
Number of divisions	--	2	3	4	5	6	--
Number of new Stub-Outs	--	140	122	36	8	15	321

The costs for constructing the necessary new Stub-Outs shown in Table-3.2.5 and moving the water meters' service pipes are estimated to be about 35,000PHP per existing Stub-Out. It will require 11.2 million PHP (321 Stub-Outs × 35,000PHP) to improve all Stub-Outs. The divisions were estimated to improve water supply to 2,677 connected customers and increase revenue water by 1,387m^3/day by allowing the water that is otherwise not consumed to be used.

This amount of revenue water corresponds to 2.0% of the mean daily supply of the current revenue water. Because 1% of the revenue water in COWD was about 7 million PHP in 2013, a 2% increase of revenue water will exceed the costs for renewing the Stub-Outs in a year. By improving the Stub-Outs only once, COWD will gain the increased revenue by the improvement for many years. Thus it is recommended to take early action.

Let us investigate improving the Stub-Out in Pict-2.2.1, to which 82 water meters are connected. From this Stub-Out, let us assume that 20 customers can always fully use the mean water consumption and the remaining 62 customers can only use the minimum volume of water. The daily water consumption from this Stub-Out is 37.5m^3/day (0.85m^3/day [mean water consumption] × 20 customers + 0.33m^3/day [minimum volume of water] × 62 customers). If the improvement of the Stub-Out results in all customers being able to use the mean water consumption or 69.7m^3/day (0.85m^3/day [mean water consumption] × 82 customers), the revenue water will increase by 32.2m^3/day. If the customers who could only use the minimum volume of water can now use up to an amount of water that requires excess charge, the revenue will increase by 983.7PHP/day (32.2m^3/day × 30.55PHP/m^3 [excess charge]), which is an increase of 359,000PHP a year. Because this Stub-Out needs to be divided into six, five new Stub-Outs need to be installed, requiring costs of 175,000PHP (35,000PHP/Stub-Out × 5 Stub-Outs). The estimation shows that the costs can be recovered in half a year, and COWD will gain profits over many subsequent years.

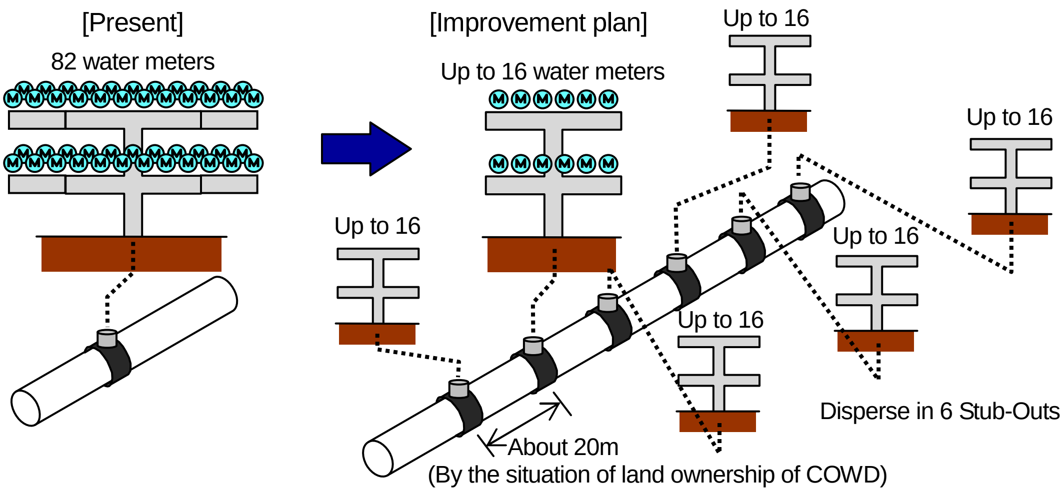


Fig-3.2.14 Example of division of Stub-Out

3.3 Proposals on DMA Construction and Distribution Network Calculation

3.3.1 DMA Construction

3.3.1.1 Setting DMA Candidates

The same is true throughout the Philippines, but in CDO city, developers have developed many Sub Divisions (new estates). In these Sub Divisions, there are many cases of independent water supply systems, so the COWD service region has an environment permitting relatively easy formation of DMA.

This survey was able to study the PN Loa district, Sta Barbara district and others as DMA candidate sites because in these and many other areas, the systems are independent. And a Sub Division called Tuscania, is not positioned as a DMA by the COWD, but inflow meters (master meters) are already installed, and if they are defined as DMA, operation can be started immediately.

Inflow meters are installed on such independent distribution systems, and are defined as DMA, and clarifying the state of NRW will make a major contribution to reducing the NRW rate. It was recommended that the COWD needs to select candidate districts and install inflow meters to form multiple DMA, and to clarify the state of NRW.

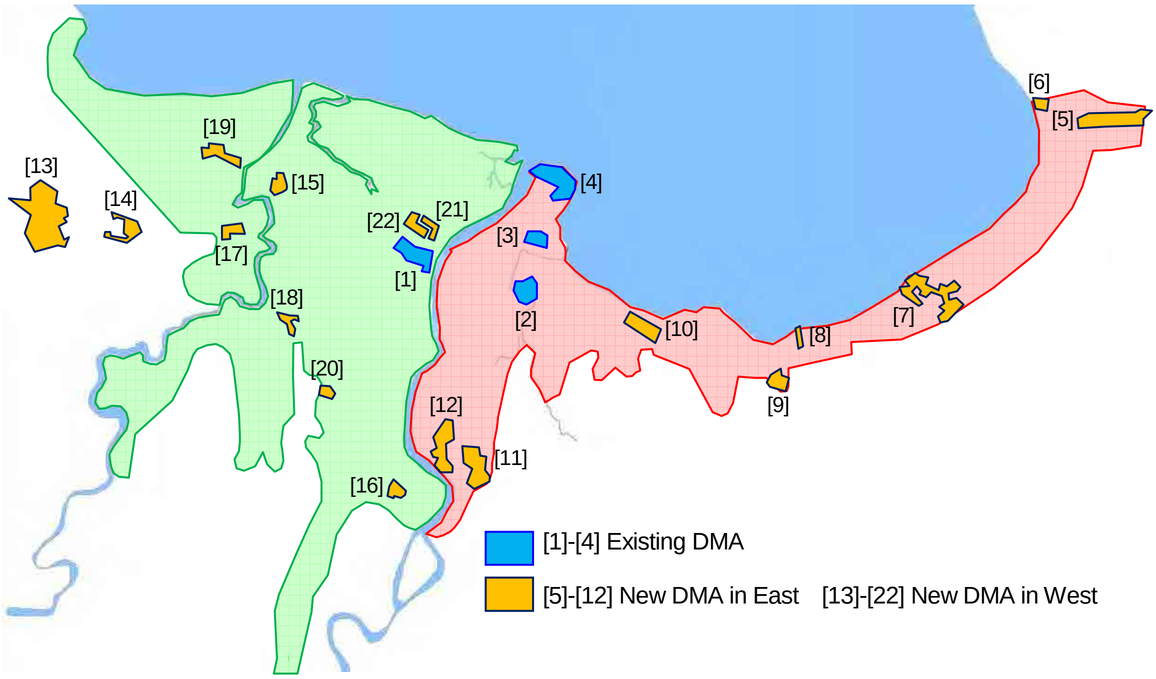


Fig-3.3.1 Extraction and selection of DMA location

(Numbers in the figure represent the location in Table-3.3.1 and 3.3.2)

This time, the JICA Study Team and COWD searched for water supply systems in which DMA can be constructed. COWD has already found that a DMA can be constructed in [4] Macabalan just by building a flow meter chamber and installing a flow meter. In late August 2014, after the Phase II field works, the room was built and a flow meter was installed, enabling flow to be measured.

The JICA Study Team discovered 18 districts (8 in the eastern area and 10 in the western area) in which DMA can be constructed within the water supply district of COWD. In these DMA candidates, the water supply systems are branched from the distribution main to supply water to their water supply districts and are basically separated from their adjacent distribution networks. Therefore, DMAs can be completed just by constructing flow meter chambers and installing flow meters.

Table-3.3.1 Minimum night flow measurements at DMA

DMA name	Inlet volume (m^3/h)		Leakage rate	Remarks
	Average	Night Min.		
[1] RER Sub-Division P1	24.12	15.60	64.7%	Quiet residential area
[2] San Lazaro	40.26	31.54	78.3%	Slum where underclasses live
[3] Limketkai	–	–	–	Large-scale shopping mall
[4] Macabalan	138.77	92.64	66.8%	Slum where underclasses live

Remark: See Page 3-10 for Measurements in [2] San Lazaro. [4] Similar phenomena also occur in Macbalan.

Table-3.3.2 Areas that can be built by DMA

DMA name	Mesh Number	Inlet pipe diameter	Ground level (m)	Inlet flow volume
[5] Vila Trinitas	P2-4	150mm	14.0-30.0	1,700 m^3/h
[6] San Agustin	O2-5	200mm	0.0- 3.5	1,300 m^3/h
[7] Tablon	M4-3	150mm	2.8-14.0	600 m^3/h
[8] Kimwa Compound	L5-1	150mm	3.5- 5.8	450 m^3/h
[9] Vila Flora Sub-Division	L5-4	150mm	0.0-46.0	1,900 m^3/h
[10] Capistrano Complex	J4-7	150mm	6.1-12.5	400 m^3/h
[11] Southview	G6-3	150mm	46.0-66.2	1,400 m^3/h
[12] Tibasak St.	G5-8	100mm	9.1-22.6	1,800 m^3/h
[13] Pag-Ibig Cithihomes	B3-4	200mm	8.8-12.5	1,200 m^3/h
[14] Youngth Ville	C3-2	150mm	15.5-53.0	500 m^3/h
[15] Villa Candida Sub- Division	E2-8	200mm	5.2-18.3	800 m^3/h
[16] Lourdes Ville	G7-1	100mm	13.0-23.0	1,100 m^3/h
[17] Cambridge/Villamar	D3-6	150mm	5.2- 9.2	1,200 m^3/h
[18] Siver Creek P1	E4-8	100mm	5.8- 9.5	500 m^3/h
[19] Vamenta Sub- Division	D2-9	200mm	5.2- 7.8	1,000 m^3/h
[20] Bellevue Homes	F5-7	150mm	93.0- 107	500 m^3/h
[21] Tuscania	G3-4	100mm	5.8- 5.8	400 m^3/h
[22] Sta. Barbara	G3-4	150mm	5.8- 5.8	400 m^3/h

3.3.1.2 Methods Used to Set Existing DMAs

COWD's first distribution pipe network distributed water in districts formed by dividing the entire water supply system into Western and Eastern parts. Through a water distribution system improvement project carried out jointly with the Manila Water Company Inc. (MWCI) in 2012, valves installed so that a DMA could be built were used to install DMA in three residential districts. They were installed because the DMA inlet pipes do not have flow meters, but low priced foreign made products stop functioning after 2 years.

Since a detailed survey was carried out in 2012, COWD has not installed boundary use valves to build DMA. They have found that a DMA can only be constructed in [4] Macabala. The district is located at the end of the water supply, and it was easy to find. They understood that a DMA can be constructed by installing a flow meter at the branch pipe from the distribution main but had not installed it until the JICA Study Team promoted the installation, by which flow measurement became possible.

3.3.1.3 Population Data and Water Supply Volume Data by Barangay

The COWD and the JICA Study Team will place data obtained by the 2010 Census of the Philippines on the COWD water supply map and perform calculations to reflect this data in water volumes used at nodes used for distribution network calculation. In large barangays, because the allocation of water supply spans a plurality of nodes, it was necessary to allocate the water supply with reference to the variation of housing based on the air map information.

Data was assembled to be used to distribute the water supply volume among nodes according to the number of households supplied to calculate distribution.

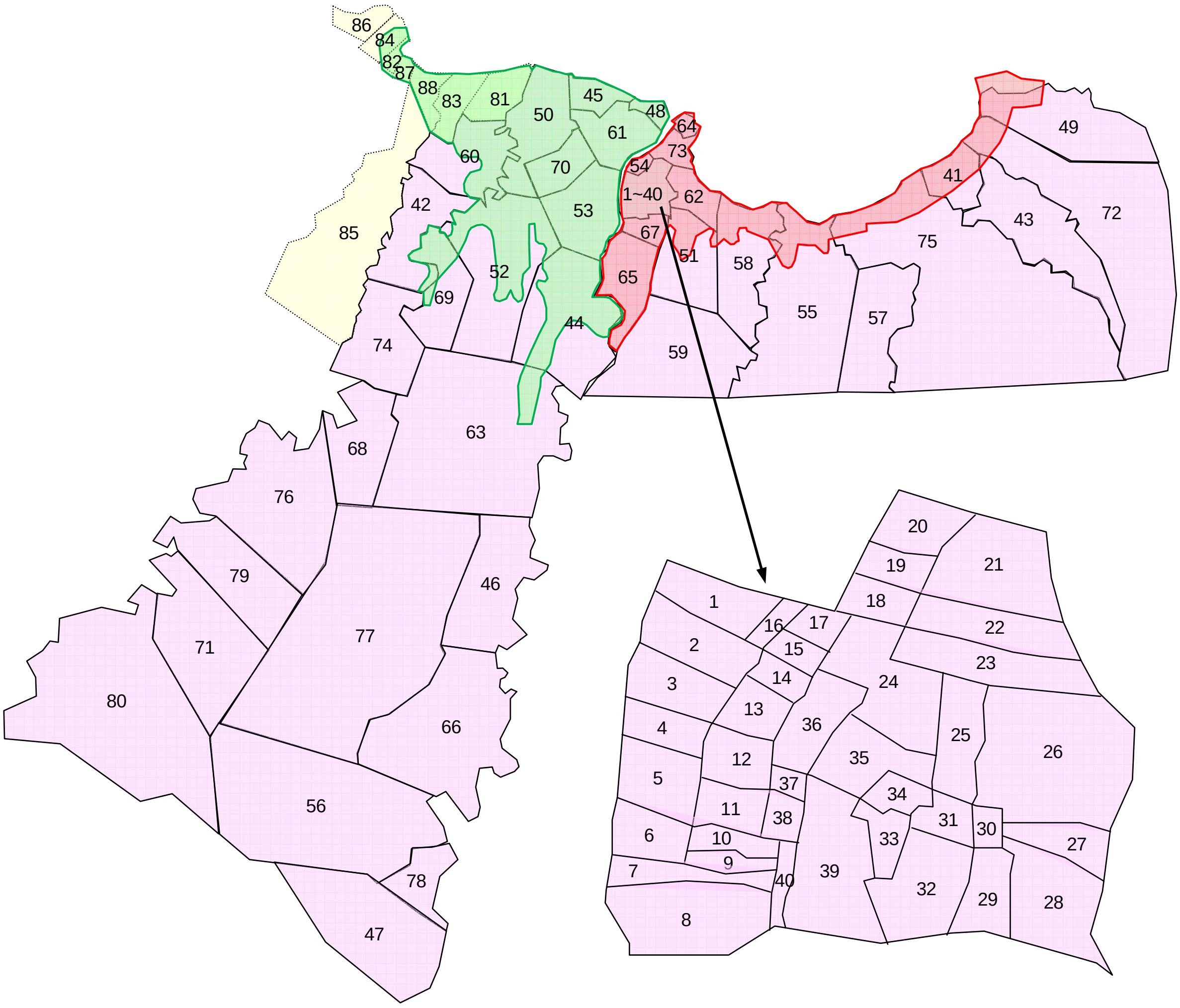


Fig-3.3.2 COWD water supply area and Barangays

(Numbers in the figure represent the location in Table-3.3.3)

Table-3.3.3 Barangay population

No.	Name	Population	No.	Name	Population	No.	Name	Population
1	Barangay 01	453	31	Barangay 31	1,506	61	Kauswagan	34,541
2	Barangay 02	84	32	Barangay 32	1,410	62	Lapasan	41,903
3	Barangay 03	177	33	Barangay 33	86	63	Lumbia	14,079
4	Barangay 04	108	34	Barangay 34	621	64	Macabalan	20,303
5	Barangay 05	83	35	Barangay 35	2,395	65	Macasandig	23,310
6	Barangay 06	212	36	Barangay 36	791	66	Mambuaya	2,490
7	Barangay 07	542	37	Barangay 37	77	67	Nazareth	10,658
8	Barangay 08	157	38	Barangay 38	94	68	Pagalungan	1,806
9	Barangay 09	132	39	Barangay 39	46	69	Pagatpat	5,178
10	Barangay 10	616	40	Barangay 40	830	70	Patag	17,219
11	Barangay 11	342	41	Agusan	14,812	71	Pigsag-an	1,256
12	Barangay 12	469	42	Baikingon	2,342	72	Puerto	11,475
13	Barangay 13	2,330	43	Balubal	2,893	73	Puntod	18,399
14	Barangay 14	479	44	Balulang	32,531	74	San Simon	1,346
15	Barangay 15	2,966	45	Bayabas	12,999	75	Tablon	18,608
16	Barangay 16	143	46	Bayanga	2,769	76	Taglimao	1,418
17	Barangay 17	2,342	47	Besigan	1,404	77	Tagpangi	2,684
18	Barangay 18	1,496	48	Bonbon	9,195	78	Tignapoloan	4,514
19	Barangay 19	419	49	Bugo	27,122	79	Tuburan	1,395
20	Barangay 20	121	50	Bulua	31,345	80	Tumpagon	2,232
21	Barangay 21	254	51	Camaman-an	24,651	In CDO City		602,088
22	Barangay 22	1,944	52	Canito-an	15,069	81	Barra	14,334
23	Barangay 23	916	53	Carmen	67,583	82	Bonbon	2,698
24	Barangay 24	929	54	Consolacion	9,919	83	Igpit	10,123
25	Barangay 25	1,295	55	Cugman	20,531	84	Luyongbonbon	3,491
26	Barangay 26	2,383	56	Dansolihon	4,811	85	Malanang	3,593
27	Barangay 27	1,380	57	F.S. Catanico	1,710	86	Molugan	9,575
28	Barangay 28	541	58	Gusa	26,117	87	Poblacion	3,690
29	Barangay 29	485	59	Indahag	6,235	88	Taboc	2,918
30	Barangay 30	875	60	Iponan	20,707	Out of CDO City		50,422

Remark: Shaded portions are not a COWD water supply area.

3.3.2 Proposals on Distribution Network Improvement based on Distribution Network Calculation

3.3.2.1 Improvement of the Distribution Networks of Insufficient Water Supply based on the Results of Distribution Network Calculation

COWD performed renovation works of Phases 1 to 3 when the system was transferred from NAWASA to COWD. Recent population inflow into CDO City is conspicuously large, but pipeline rehabilitation works have not been executed to cope with the population growth. The aforementioned distribution network calculation showed that there will be pipelines in which the supply water pressure (amount of water supply) will be insufficient at nodes of the distribution network. Appropriate pipe sizes and appropriate water pressures from booster pumps should be investigated from the upstream of the distribution network, and lines that need improvement should be extracted.

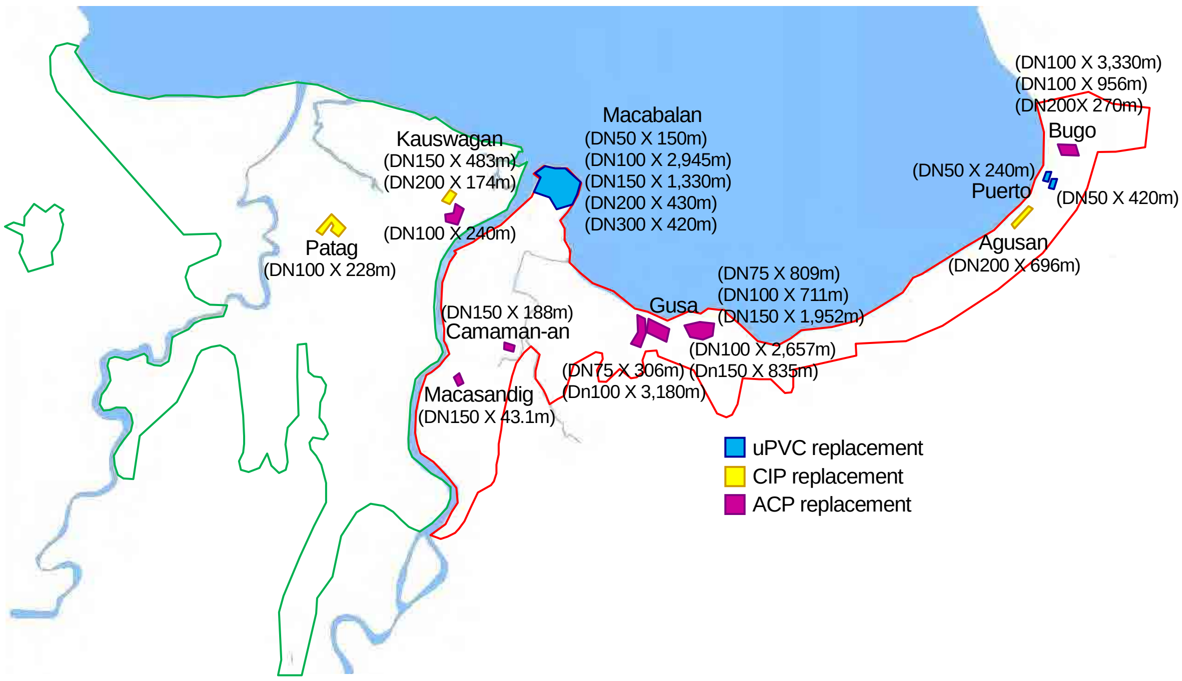


Fig-3.3.3 Necessary route of the pipeline replacement

Table-3.3.4 Draft of pipeline replacement route

	Location	Place name	Pipe diameter (mm)
Asbestos Cement Pipe	Camaman-an	Ramonal Village	DN150: 188m → 170m
	Kauswagan	Sitio Pasil Road - Kauswagan Road	DN100: 240m → DN150
	Macasandig	Booster Station	DN150: 43m
	Bugo	Zone 1	DN200: 270m → DN150
		Reyes SD	DN100: 3,330m → DN150
		Graymar Village	DN100: 956m → DN150
	Gusa	Sta. Cecilla SD	DN75: 306m → DN100: 450m
			DN100: 3180m → DN150: 570m
		Capistrano SD	DN100: 2,657m → 450m
			DN150: 835m → 570m
		Villa Ernesto SD	DN75: 809m & DN100: 711m → 1,440m
			DN150: 1,635m → 1,170m
Cast Iron Pipe	Kauswagan	Portion of Kauswagan Road from Corner Bayabas-Kauswagan Road	DN150: 483m
			DN200: 174m
	Patag	IV MA Camp Evangelista Road	DN100: 228m
	Agusan	National Highway from BOV	DN200: 696m
Unplasticized PVC Pipe	Puerto	Baybay	DN50: 240m
		Puerto area	DN50: 420m
	Macabalan	Macabalan	DN50: 150m
			DN100: 2,945m
			DN150: 1,330m
			DN200: 430m
			DN300: 420m

3.3.3.2 Environment Surrounding the Target Pipelines

In CDO City, many large supermarkets, malls, hotels, commercial buildings, and Sub Divisions are being constructed not only in the city center but throughout the city. The JICA Study Team has heard that many more construction works are now planned. As pipeline replacement, objects of the improvement of the present distribution network are shown, but the development of these large-scale facilities requires an even larger water supply. The degree of increase in the volume of water used caused by development is a matter that should be considered by distribution network calculation, but a study will be conducted to decide whether to consider the increase of development at replacement time or to introduce new pipelines as a burden on the developer during development. COWD was informed of the importance of pipeline planning based on such medium and long-term plans and on urban development plans.

3.4 Measures for Reducing NRW Involving Organization and/or Personnel Resource, Publicity, Customer Services

3.4.1 Organizational Reform

A structural reform of the COWD organization is scheduled to be carried out in January 2015. The NRW Reduction Team now includes employees of multiple sections, but the structural reform will establish a new department related to maintenance with sections concerned with leak countermeasures and with maintenance formed under this department. This will establish a chain of command and division of duties, probably permitting requests and instructions etc. to be smoothly exchanged between sections.

3.4.2 Publicity

To publicize water supply information, COWD is disseminating water outage information to customer’s followers through Facebook®. And COWD also receives notifications of the discovery of surface leaks from customers and residents through Facebook®. When an event is held in the city, the COWD Free Water Booth is exhibited to publicize the activities and social contribution of COWD among the city’s residents. Many of these activities clearly show off the hospitable spirit of the people of the Philippines, especially Mindanao islanders.

3.4.3 Improvement of Water Service

Understanding how customers feel about COWD’s water supply and making improvements in response to their dissatisfactions and desires help improve water supply services. Every year, COWD conducts a questionnaire survey of 300 customers, but attribute analysis of the residence area of the respondent has not been performed, so the survey cannot clarify what people desire in which regions. The JICA Study Team has recommended that they have the respondents also enter the region where they live and their ages (decade of birth) so they can specify regions that should be improved and their demands that differ according to the taste and mindset of each age group.

Table-3.3.5 Customer satisfaction survey results (Population: 300)

Questionnaire	Number that answered "YES" (Percentage)			
	2010	2011	2012	2013
Do you have 24-hour water service?	259 (86%)	238 (79%)	163 (54%)	209 (70%)
Is water pressure adequate?	254 (85%)	230 (77%)	224 (75%)	206 (69%)
Does the water taste good?	272 (91%)	226 (75%)	211 (70%)	231 (77%)
Are you confident that water is safe?	266 (89%)	135 (45%)	174 (58%)	231 (77%)
Are you satisfied with COWD water service?	269 (90%)	215 (72%)	182 (61%)	231 (77%)

3.4.4 Incentive Mechanism

COWD has not employed any special systematic action that involves an incentive mechanism (bounty system) for reducing NRW. In interviews with COWD employees, they mentioned overtime allowances paid for working on days off and overtime work for repairing leaking pipes and preparing conference materials, but they are a mere extension of ordinary works and do not constitute an incentive mechanism.

The JICA Study Team proposed the following systematic incentive mechanisms for reducing NRW to COWD. The list also includes those for activating the organization besides those for reducing NRW.

Provide an opportunity of a pay increase or promotion or pay a bonus to the following employees:

The first employee who finds an illegal connection or who makes the thief subscribe to COWD,

Employee who submits a proposal(s) of improvement to COWD,

Employee whose research paper (or oral presentation or poster) is accepted at an international congress (not only the speaker but also coauthors),

Employee who receives a training program of at least one week in an overseas advanced nation, submits a report to COWD and shares the training materials with other employees, or

Employee who reports a dishonest act of a COWD employee(s) (whistle blowing).

These evaluations can be combined with the merit rating system of COWD. A system should be established to make evaluations, and the funds need to be budgeted if a bonus is to be paid in the bounty system.

3.4.5 Outsourcing

In Japan, the wages of public servants are decided based on the personnel expenses of private companies. The wages are calculated based on the data of medium-sized to large-size private companies and determined at their average value. In Japan, this average value is higher than the personnel expenses of most small private companies. Many governmental organizations outsource administrative service works to private companies to not only improve efficiency but also to incorporate the know-how of the private companies and reduce personnel expenses.

On the other hand, in the Philippines the personnel expenses of public servants are lower than in private companies. Outsourcing of works may improve the efficiency but would adversely affect business management due to increased personnel expenses. COWD has employees under various kinds of employment contract, including cheap temporary and seasonal employees, to execute its works.

The JICA Study Team conducted an interview on outsourcing for improving work efficiency. Today, COWD outsources only security services; and all other works including reading meters, examining leakage and repairing leaking pipes (sudden works) are performed by its employees. COWD does not outsource the design of water works and also executes water works by itself except for large-scale projects.

It is likely too early to introduce the concept of outsourcing in Japan, where personnel expense is high, into the Philippines, where labor cost is cheap.

3.5 Drafting Leak Detection Plans and Field Training Using New Leak Detection Equipment

3.5.1 Training on Site

The leak detection team is headquartered at the Macasandig branch office at the Macasandig booster pumping station in the east distribution district. It has used its equipment, which consists of one acoustic leak detector purchased in 1997 and one acoustic leak detector and one correlative leak detector purchased in 2010, to detect leaks.

But for this project, new instruments and equipment (1 unit of correlative leak detector AQUASCAN, 1 unit of a sound collector for a correlative leak detector HydroPhone, 1 unit of areal correlative leak detector ZONESCAN, 2 units of leak detector for resin pipe D305 and 2 units of general type of leak detector Pocket Phone) were leased, that has greatly enhanced its material capabilities.

As field training, leak detection has been conducted as on-the-job training in the field on the transmission pipe starting at the Macasandig government branch office and extending to the Camaman-an distribution reservoir, on the transmission pipe along the eastern harbor shoreline, and at the existing 2 DMAs, other Sub Divisions, and commercial districts. It is necessary to replace the policy of performing leak detection only in response to the discovery of a leak in the field with systematic organized leak detection, so the JICA Study Team proposed this improvement and conducted field on-the-job training according to this proposed improvement.

Leak detection is divided into office planning, field detection, and detection reporting (including requests for repair of leaks). At the office planning stage, all team members spread out and check the distribution network map covering that day's detection range, then they all discuss the selection of the leak detectors to be used and assignment of the personnel (their roles), check the detection route and locations of pipelines, valves and fire hydrants, and the road traffic conditions and surrounding environment as known at that time, and through this process, create an image of the detection work to be performed. The field leak detection is performed on the planned detection route, but it is recommended that to prioritize efficiency of detection, cleaning the valve chambers in advance be positioned as part of organized maintenance.

It is calculated that if each team performs leak detection at a rate of about 3km per day, excluding holidays and days of bad weather, it can detect leaks in distribution pipelines in an entire water district in about six months. The standard for this calculation is using leak detectors and correlative leak detectors that linearly survey pipelines, but when detection surveying is performed as an areal survey using the areal correlative leak detector ZONESCAN, it is possible to calculate the length of overall distribution networks on which sensors are installed, so in districts with a high density distribution network, performing areal detection surveys, then performing point source detection using leak detectors at places where a leak is suspected permits efficient detection surveying.

After the first field work, we requested that COWD submit a leak detection report every Monday, and until now carefully completed reports have been sent from COWD every week. At this time, detection surveys are performed by trial and error based on leak detection plans prepared by the JICA Study Team and by the COWD leak detection teams. They conducted a water leakage survey from mid-May and during the 5 months (23 weeks) until mid-October, completed the water leakage survey of 180.3km already (10.1km/week, 36 leak points were found). Details of the water leakage survey are shown in Fig-3.5.1.

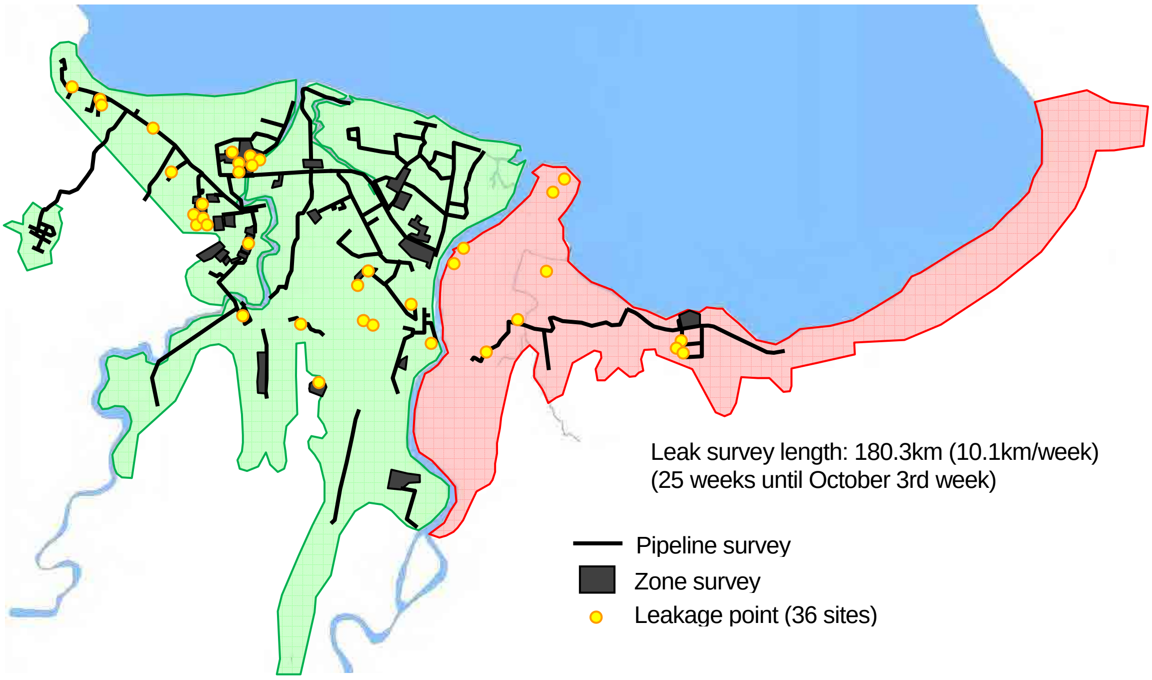


Fig-3.5.1 Water leakage survey results

In half a year, we could not complete surveying the entire transmission and distribution pipe system (elongation: 510 km), which was our initial goal. This was because it rained little during the dry season but started to rain for a much longer time during the daytime then the norm in June and throughout the subsequent rainy season, impeding continuous surveys for detecting leakage. Also in August 2014, COWD reshuffled part of its personnel, and several new members were appointed to the leakage detection team, resulting in a decelerated survey. However, such climatic conditions and personnel reshuffle are repeated every year, and thus a system that can cope with such climatic conditions and personnel reshuffle needs to be established. For example, the leakage detection team should prepare manuals for operating devices so it can deal quickly with member changes. Because it is impossible to avoid rain during the rainy season, works to be done on rainy days should be decided in advance separately from works be done on sunny days; and activities should be investigated in advance to prevent stagnation of the activities of the team due to rain.

3.5.2 Results of OJT

3.5.2.1 Correlative Leak Detector [AQUASCAN 610]

Leaks in large diameter steel pipes can be fully detected with AQUASCAN. However in the COWD system, there are many service pipe branches from large diameter transmission pipes that are normally used, and in many cases, these supply branches are not shown on the maps. And because the valves are not thoroughly maintained, installing sensors is time-consuming.

When there are many water supply branches from transmission pipes, it has been impossible to clearly discover leaks on PVC pipes. It is necessary to study measures to improve future leak detection by doing this at night, which is a time period when customers do not use water. In addition, thoroughly maintaining valves permits efficient use of AQUASCAN. Cooperation of the leak survey team and maintenance department is very important.

The analyzer sometimes requires more than 30 minutes to detect leakage for a transmission pipe from which supply pipes branch. It takes 5 to 10 minutes to measure the distance between two points, install the sensors and input data into the analyzer. We recommend postponing the survey of such a pipeline, which requires more than 10 minutes for analysis, and continue surveying other pipes. The transmission pipes with supply branches should be surveyed all at once at night, and this enables efficient leak detection using this equipment.

Pict-3.5.1　Water leakage survey by AQUASCAN 610

3.5.2.2　Zone Correlative Leak Detector [ZONESCAN 820]

In the RER Sub Division P1 area, which is a DMA, ZONESCAN 820 has discovered clear leaks. COWD also evaluated this as extremely high precision discovery of leaks.

Pict-3.5.2　Water leakage survey by ZONESCAN 820

However, in Japan it is easy to install a logger (sensor) on top of a valve or fire hydrant under a manhole, but in the COWD service region, there are few valves and maintenance is not performed thoroughly, so sensors are often installed on covers at surface fire hydrants and water taps. In this case, there is a danger of theft, so it is necessary to post somebody to constantly watch them, obstructing efficient detection. It is necessary to clearly set valve installation criteria, and in order to be able to install valves at appropriate locations, it is also necessary to improve and to thoroughly maintain the distribution network, and to make improvements permitting loggers to be installed on valves whenever possible.

3.5.2.3 Leak Detector for Resin Pipe [D305]

The JICA Study Team identifies the leak points from resin pipelines using D305 in each place. The leak detection team of COWD also identify the leak points using D305 following a similar process. By using D305, even an inexperienced member can detect leaks quickly. Its performance is also much higher compared to other detectors.

Pict-3.5.3 Water leakage survey by D305

However, because COWD introduced the Stub-Out system, service pipes tend to be long. When a service pipe runs parallel to a water main line, the T-shaped sensor of D305 picks up electromagnetic waves flowing not in the main pipe but in the service pipe which is connected to the main pipe, obstructing leak detection. Any service branch not shown on maps during leakage investigation cannot be identified as to whether it is a branch or a leakage, and interferes with the investigation, requiring improvement of both the leakage detector and detection method.

3.5.3 Effectiveness of the Detectors

We interviewed the COWD leak detection team on the detectors that were brought from Japan and used by the team over a period of about 5 months and asked about their impressions of using the detectors and points that can be improved and/or requests on the equipment bodies and analytical systems as a user review. The configuration was investigated by also considering the price (labeled price) of the detectors.

3.5.3.1 Evaluating Leakage Survey Equipment and Materials by COWD

Leak survey equipment, Portable Ultrasonic Flow Meters brought by the JICA Study Team and acoustic bars manufactured in the region were evaluated as follows by COWD.

Table-3.5.1 Evaluations of leakage survey equipment and materials (High 5 to Low 1)

Name of the equipment	Accuracy	Performance
Correlative leak detector [AQUASCAN 610]	3	4
Zone correlative leak detector [ZONESCAN 820]	5	5
Leak detector for resin pipe [D305]	3	4
General type leak detector [Pocket Phone]	5	5
Portable ultrasonic flow meter [ULTRA FLUX]	5	5
(Acoustic Rod)	4	4

Remark: Accuracy means that if there is a small difference between the leaking location specified by the leak inspection and an actual leak location, it is highly accurate. Performance means its operability is high if the materials are easy to operate and can be operated skifully.

3.5.3.2 User Reviews and Discussions

(1) Correlative Leak Detector [AQUASCAN 610]

The following are COWD users' reviews of AQUASCAN.

Analysis results are displayed immediately on the screen, so it can be used to perform leakage inspections rapidly.
In a channel where the inspector does not know if there is or is not a leak, if there is no leakage, it displays the fact.
If the leakage quantity is small, it is difficult to interpret the analysis result on the analyzer
It is extremely good at confirming leakage locations at night in particular.

According to the evaluation table, COWD's evaluation of AQUASCAN is not as high as expected. This is thought to be a result of COWD forming many service pipe branches from large-diameter transmission pipes and distribution pipes, resulting in these pipes not being reflected in drawings. It is assumed that this low evaluation is a result of these devices being incapable of quickly distinguishing between these service pipe branches that are thought to be quasi-leaks, and real leaks with high accuracy in a short period of time.

But, this device made a big contribution to the great improvement in leak inspection length since the previous year, showing that it has been very successful in supporting more efficient leak inspections.

Because this work emphasized performing efficient leak inspections, the leak analysis time per location was set at 15 minutes. It is assumed that the analysis precision of AQUASCAN is, therefore, somewhat poor.

In order to perform efficient leak inspections continually in the future, it has been evaluated that every leak survey team should be provided with at least one unit (there are now two teams, so two units should be provided).

(2) Zone Correlative Leak Detector [ZONESCAN 820]

COWD user reviews of ZONESCAN are as follows.

It can specify leak locations with extremely high precision
It can specify a correct distance from the logger to the leak with high accuracy.
It can clarify whether there is or is not a leak in an inspection area.
An areal detection survey can specify leak locations, making it the best machine for discovering leaks at difficult locations.
Users want to be able to use it to specify the locations of GPS or other logger.

It takes long time to perform an inspection using ZONESCAN, because it integrates and analyzes long-term leak noise from loggers installed at multiple locations, but it was given high evaluations of its leak point discovery precision.

In COWD, the pressure inside pipes is low and many non-metallic pipes are used, so it has been very difficult to discover leaks with ordinary leak inspection equipment, but leaks can be discovered at such difficult locations using ZONESCAN. So from this evaluation, it was decided that three will be necessary.

And 10 loggers will be installed at various locations so that ZONESCAN will collect and aggregate fixed period leakage sounds. COWD's fire hydrants are above-ground type, and there are few sluice valves and fire hydrants, so loggers equipped with water meters are installed. Throughout developing countries, including the COWD area, it is feared that such loggers will be stolen. And children sometimes find COWD loggers and play with them, moving them from their installed locations. For this reason, there is a desire for improvements so that it will be possible to clarify locations with GPS.

(3) Leak Detector for Resin Pipe [D305]

COWD user reviews of D305 are as follows.

Many service pipes branching from water main lines are parallel to water main lines, so it is sometimes difficult to accurately specify a location on the water main line being inspected. # Its needle reacts strongly to drainage channels, road side ditches, barricades, electric cables, and other things not objects of the inspection, preventing skillful specifications of the locations of the water main line. # It can be used usefully as a pipe locater.

COWD operates many PVC pipes, and their water pressure is very low, so the D305 is counted on to function effectively, but it was not highly evaluated. This is, to a great degree, born by COWD's Stub-Out system. In Cagayan de Oro City, we confirmed that many service pipes run parallel to water main lines at various places, so it has been difficult to perform accurate detection simply by transmitting electromagnetic waves through the water main line. Also in the Philippines, in MCWD (metropolitan Cebu), the D305 is highly evaluated and has made a great contribution to leakage inspections, showing that its evaluation varies according to local conditions. But Stub-Outs will be improved and parallel service pipes organized, so that in the future, the D305 will be useful.

On the other hand, the D305 was evaluated as extremely useful when used as a pipe locator.

The range where COWD now uses this device is limited, but each Team for Reducing NRW will require one unit (there are now 2 teams, so a total of 2 units).

(4) General Type Leak Detector [Pocket Phone]

COWD user reviews of Pocket Phone are as follows.

It extremely precisely and dependably discovers pin point leaks. # Because along with being able to specify accurate leak locations it can handle various kinds of pipes and leak sounds, it is the best device for leak inspections. # Combining it with ZONESCAN in particular permits extremely effective leakage inspections # When the inside pipe pressure and leakage sound are low, it is difficult to make pin point specifications.

Pocket Phones are conventional acoustic leak detection devices. COWD has used these in the past, and evaluated them highly, but COWD uses AQUASCAN, ZONESCAN and other leak detectors to specify leak locations both areally and linearly, then uses the Pocket Phone to make the final leak location specification at night. They have been highly evaluated for their ability to obtain high precision when used in line with the basic usage method.

A Pocket Phone is used individually by each inspector, with specifying the final leak position as a particular useful role, so each leak insection team must have at least 2 (there are now 2 leak survey team, requiring 4 Pocket Phones).

(5) Portable Ultrasonic Flow Meter

COWD user reviews of portable ultrasonic flow meters are as follows.

If information about a pipeline is correctly known, it is possible to obtain extremely accurate flow rates.
This is a machine that permits confirmation of the precision or the capacity of flow meter or master meter.
If installed correctly, it can obtain data equal to that of other flow metters, but according the site, it may be extremely difficult to install it correctly.

A Portable Ultrasonic Flow Meter is not just a leak inspection device, but it is necessary to know accurate flow rates in order to reduce the NRW rate. It is rated highly for the precision of its measured values, but it is not easy to correctly install these devices. During secondary site work, installation was time-consuming and data could not be obtained, but during tertiary work, the user appeared to be experienced, using a level for example, and it was installed and began obtaining data in a short time.

When constructing many DMA in the future, it could be used effectively to confirm the precision of parent meters or for use as a flow meter at a location where it is difficult to install a master meter, so each leak insection team must have at least 2 (there are now 2 leak survey team, requiring 4 Portable Ultrasonic Flow Meters).

(6) Acoustic Rod

Acoustic Rods were not brought from Japan. A video showing how to make them prepared by the YWWB was brought and shown. COWD made them itelf on the scene. COWD user reviews of acoustic rods are as follows.

This is a good tool for discovering leaks and confirming the final location.
It is particularly useful way to discover the general locations of leaks in places where water meters are exposed.

Every member of leak survey teams of the YWWB carries one and uses it to check for leaks and specify the final location. Expertise is required to distinguish sounds, but it is extremely easy to make, and is in principle, a basic tool, so in the future, COWD is expected to use it.

3.5.3.3 Configuration of the Device in the Case of Purchasing

Leak survey teams are formed and the following table shows evaluations of leak inspection equipment and necessary costs of equipment required to perform the inspections. The prices include Japanese consumption taxes, but not transport costs. And right now COWD's NRW reduction teams include 2 leak survey teams. The following costs are based on prices calculated premised on two teams.

Table-3.5.2 Configuration of leak survey equipment prepared for the two leak survey teams

Name of the equipment	Price+ Tax (Top: JPY bottom: PHP)	Quantity	Total (Top: JPY Bottom: PHP)
AQUQSCAN (with Hydro Phone)	3,500,000 1,440,000	2	7,000,000 2,880,000
ZONESCAN (with 10 loggers)	2,700,000 1,110,000	3	8,100,000 3,330,000
D305	1,200,000 490,000	2	2,400,000 980,000
Pocket Phone	900,000 370,000	4	3,600,000 1,480,000
ULTRA FLUX	2,800,000 1,150,000	2	5,600,000 2,230,000
Total			26,700,000 10,820,000

Considering prices in the Philippines, these may appear to be extremely high prices. We request that medium and small water districts study ways to use these devices effectively, by carrying out joint purchasing with neighboring water districts, associations, or joint support groups, having each water district use them in turn.

3.6 Fiscal Outlook of COWD

3.6.1 Project to be Executed by New Borrowing

COWD is planning water supply improvement projects by obtaining a loan from the Development Bank of the Philippines (DBP). The sum has already been settled between COWD and DBP, and the financing limit was decided at 458 million PHP. The JICA Study Team proposed a project plan using the loan, and DBP and COWD both agreed.

The projects will involve (1) renewing asbestos cement pipes (ACPs) by ductile iron pipes (DIP), (2) improving Stub-Outs, (3) burying exposed pipes on the road, and (4) renovating the pipes installed in Phase I.

Table -3.6.1 Breakdown of DBP project expenses

Project name	Design/Construction cost
(1) Replacing asbestos cement pipes with ductile iron pipes	55,000,000 PHP
(2) Improving Stub-Outs	22,000,000 PHP
(3) Burying exposed pipes on roads	45,000,000 PHP
(4) Renovating the pipes installed in Phase 1	311,000,000 PHP
(5) Purchasing vehicles or equipment for maintenance work	25,000,000 PHP
Total	458,000,000 PHP

Regarding (1), in the water supply district of COWD, there are ACPs still remaining for about 13km. COWD is concerned about the fragility of ACP as the water supply pipes and desires to replace them at an earlier stage.

ACP was developed in Italy at the beginning of the 1900s, and mass production started in Japan in the 1920s. Aware that the pressure resistance and strength of ACP decline over time, causing frequent leaks, in Japan, many water utilities stopped installing new ACP pipes in the 1970s. Pipe materials that provide superior durability, such as DIP and PVC pipes can now be supplied for low prices, so the historical role of ACP is about to end.

ACPs, which were installed in the early phases, constitute the main pipes of COWD. Therefore, the JICA Study Team proposed COWD replace them not with resin pipes such as PVC or PE pipe but by DIPs. DIP is about 6 times more durable than resin pipes and deteriorates only slightly. The long service life of DIP suggests that using resin pipes to replace ACP would require 3 times more replacements compared to using DIP for replacing ACP. DIP is also 40 times less prone to leakage compared to resin pipes, reducing the risk of leakage. Replacement of ACP by DIP is a necessary action for COWD, which aims to reduce NRW.

DIP requires larger initial investment compared to resin pipes because the ductile iron pipes and construction costs are expensive. However, when the life cycle costs (LCC) are compared, there is very little difference between the two numbers because resin pipes require replacement 3 extra times. We explained not only the comparison of their initial expenses but also their life cycle costs, and COWD understood the effects.

Table 3.6.2 Comparison of price of placing DIP and PVC pipes

	DN75mm (length 5.4km)		DN100mm (length 6.0km)		DN150mm (length 2.3km)	
Pipe material	PVC pipe	DIP	PVC pipe	DIP	PVC pipe	DIP
Pipe material cost	230P/m	1,140P/m	340P/m	1,670P/m	600P/m	2,990P/m
Pipe installation cost	400P/m	1,200P/m	590P/m	1,760P/m	1,050P/m	3,130P/m
Cost of valves, fire hydraunts, and other materials	260P/m	520P/m	1,100P/m	2,200P/m	1,230P/m	2,470P/m
Cost of valves, fire hydraunts, and other materials, etc.	660P/m	1,320P/m	1,430P/m	2,850P/m	1,530P/m	3,050P/m
Preparatory work cost	1,550P/m	4,180P/m	3,460P/m	8,480P/m	4,410P/m	11,640P/m
Work cost per project	8.4M.P	22.6M.P	20.8M.P	50.9M.P	10.1M.P	26.8M.P
Renewal interval	30 years	90 years	30 years	90 years	30 years	90 years
Work cost per 3 projects (90÷30)	25.2M.P	---	62.4M.P	---	30.3M.P	---
Comparison of LCC work costs	25.2M.P	22.6M.P	62.4M.P	50.9M.P	30.3M.P	26.8M.P

Of the projects shown in Table-3.6.1, early execution of (2) improving Stub-Outs and (3) burying exposed pipes on roads will help increase the ratio of revenue water.

Regarding (4), the pipelines that were transferred from NAWASA to COWD were rehabilitated during Phase I. Forty years have already passed since the rehabilitation. Project (4) “Renovating the pipes installed in Phase I” was decided to focus on pipeline rehabilitation, in which COWD has not taken the initiative as the water supplier. Transmission and distribution pipes will be rehabilitated for an elongation of about 40 km. Unlike in Project (1) “Replacing asbestos cement pipes with ductile iron pipes”, the entire pipeline cannot be replaced by DIP. Therefore, the starting and ending points of main lines will be defined, priority given on the main lines, and DIP will be used for main lines of higher priority. Because the funds are limited, some main lines will be replaced by resin pipes, which will be changed into DIP 15 to 20 years later when the pipes are to be renovated again. The priority will be determined by listing and considering the need of increasing the pipe size to cope with increases in population and demand for water supply so as to improve the low water supply pressure based on distribution network calculation. In this project, distribution network calculations were conducted on transmission pipes and distribution mains to decide the pipes to be rehabilitated, which are shown in Table-3.3.4. As COWD understood the importance of setting priority also for ordinary distribution pipes, we can expect that the DBP projects will be satisfactorily propelled and carried out.

3.6.2 Fiscal Outlook of COWD by New Borrowing

Aiming to start the DBP projects in 2015, various designs are to be made in a year and a half. The financial plan for executing the projects in 5 years starting in 2016, during which two or more projects may be executed simultaneously, was investigated.

The present financial obligation states of COWD were analyzed prior to executing the DBT projects. COWD has already obtained loans from LWUA and DBP, and is deliberately repaying the principal and interest until the end of the repayment period in 2032. COWD has also already set up a schedule of revising the water rates in 2016 and 2018.

To simulate loans and repayment, the following conditions were assumed.

Table-3.6.3 Prerequisites of the simulation

Condition items	Condition	Reference
Population growth rate	2.4~1.9%	Fig-2.1.6
Inflation rate	3.5~4.0%	Bangko Sentral ng Pilipinas (BSP)
DBP loan (458MPHP) repayment	Repayment is 15 years (Equal principal repayment)	Hearing from COWD
DBP loan (250MPHP) repayment	Repayment is 10 years (Equal principal repayment)	Hearing from COWD
Interest	7.7%	Hearing from COWD
Old pipe replacement, after DBP loan (458MPHP)	Update Cycle: PVC pipes is 30 years, Steel pipes is 60 years	Table-3.6.4 to 3.6.5

COWD is assumed to be financed by an ODA two-step loan of Environment Development Projects (EDP) by JICA.

The major goal of this project is NRW reduction, but later, a 250 million PHP scale supplementary project intended to expand the water supply district will be studied, with financing presumably provided by the DBP and private banks in Philippine.

The NRW rate improvement set above (about 50% to 25%) will be possible through a 3% to 4% reduction of NRW during the five year execution period achieved by concentrated improvements and renewal of water supply facilities as a new DBP project (458 million PHP), and a 1% to 2% annual reduction achieved based on advice given during prior surveys The JICA Study Team is counting on lowering NRW to 25% in COWD in 2025.

COWD and RVWC have entered into a water wholesale contract, and during the second term work, it expects to receive about 40,000m^3/day. The unit price of this received water will be higher than its own water, so it is presumed that such large scale reception of water will impact its business income and expenditures to some degree.

Table 3.6.4 Cost of replacing COWD's deteriorated pipes (uPVC pipe and PE pipe laid since 1990)

	Unit	DN50mm	DN75mm	DN100mm	DN150mm	DN200mm	DN250mm
New pipe cost	PHP/m	92	229	335	597	1,190	1,886
Installation cost	PHP/m	434	636	1,134	2,260	36,889	42,224
Other work cost	PHP/m	421	691	1,175	2,826	30,461	35,287
Total work cost	PHP/m	947	1,556	2,644	5,143	68,540	79,397
Deteriorated pipe length	m	69,466	52,899	63,091	63,696	20,194	3,747
		273,093m (273km)					
Project cost	Mil.PHP	66	82	167	328	1,384	298
		2,324					

Table 3.6.5 Cost of pipeline renewal required by COWD

Deteriorated pipe renewal period[a]	20 years	30 years	40 years	50 years	Total
Length renewed annually (km/year)[b]	13.7	9.1	6.8	5.5	[a]×[b] 273km
Annual renewal cost (1 million PHP) [c]	116.2	77.5	58.1	46.5	[a]×[c] 2,324 Mil.PHP

Remark: When the renewal period of resin pipe is considered 30 years, the annual renewal length is 9.1km and the annual renewal cost is 77.5M.PHP. Iron pipes have a set renewal period of 60 years, and will be eligible for renewal in 2035.

Under these conditions, three simulation patterns were prepared: assuming that (1) the quantity of water received remains at its present level, (2) that quantity of water received is increased by 40,000m^3/day, and (3) the quantity of water received is increased by only half, at 20,000m^3/day.

The profit and loss statement simulation is shown in [1] to [40] of Table-3.6.6 to 3.6.8, the self-owned water resources simulation in [41] to [49] of Table-3.6.6 to 3.6.8, and the ordinary income estimation in Fig-3.6.1 to 3.6.3.

The unit of the monetary values in the following tables is 1,000PHP, the unit of quantity of source water is 1,000m^3, and the variables except for the NRW reduction target represent the change over the preceding year.

Table-3.6.6 Profit and Loss statement simulation [Maintaining present status] (Price unit: 1,000PHP)

No.	Items	Calculating Formula	2013	2014
[01]	Operating Revenue			
[02]	(1) Water Sales	2013×(a)×(b)×(c)	668,895	875,914
[03]	(2) Other Revenue	2013×(a)	35,902	36,729
[04]	Sub-Total of Operating Revenue		704,797	912,644
[05]	Operating Expenses			
[06]	(3) Operation Cost		482,700	503,865
[07]	Water Source: Purchased Water	(2017～) 2016×(d)	151,820	151,820
[08]	Pumping	2013×(a)×(d)×(e)	101,966	108,488
[09]	Administrative Salaries and Wages	2013×(a)×(d)	80,316	85,453
[10]	Employees' Pensions and Benefits	2013×(a)×(d)	57,954	61,661
[11]	Tax and Licenses	2013×(a)×(d)	15,278	16,256
[12]	GSIS, Philhealth and HDMF Contributions	2013×(a)×(d)	12,757	13,573
[13]	Security Services	2013×(a)×(d)	6,870	7,310
[14]	Office Supplies	2013×(a)×(d)	4,114	4,377
[15]	Power Cost	2013×(a)×(d)	3,551	3,778
[16]	Water Treatment	2013×(a)×(d)×(e)	3,547	3,773
[17]	Light, Power and Water	2013×(a)×(d)	3,401	3,618
[18]	Miscellaneous Expenses	2013×(a)×(d)	41,127	43,758
[19]	(4) Depreciation		69,137	70,730
[20]	Current Depreciation	2013×(a)	69,137	70,730
[21]	New Loan Depreciation	New Loan Construction Cost / 30years		0
[22]	(5) Maintenance		12,869	23,692
[23]	Transmission and Distribution	2013×(a)×(d)	7,485	7,964
[24]	Additional	YWWB Case×(a)×(d)		7,000
[25]	General Plant	2013×(a)×(d)	3,653	3,887
[26]	Additional	YWWB Case×(a)×(d)		2,000
[27]	Sources of Supply	2013×(a)×(d)	1,731	1,841
[28]	Additional	YWWB Case×(a)×(d)		1,000
[29]	Sub-Total of Operating Expenses		564,706	598,287
[30]	Operating Income		140,091	314,357
[31]	Non-Operating Revenue		2,013	2,014
[32]	(6) Other Income	2013×(a)	4,487	4,590
[33]	Non-Operating Expenses			
[34]	Interest of Current Long-term Debts		85,590	71,754
[35]	Interest of New Long-term Debts (458MP)			
[36]	Interest of New Long-term Debts (250MP)			
[37]	(7) Interest of Long-term Debts		85,590	71,754
[38]	Net Total Income		709,284	917,234
[39]	Net Total Expenses		650,296	670,041
[40]	Ordinary Income		58,988	247,193
[41]	Water Resource			
[42]	(A) Water Resource		58,400	58,400
[43]	Self-Owned Water	120,000×365days	43,800	43,800
[44]	Purchased Water	40,000×365days	14,600	14,600
[45]	(B) Water Demand		26,236	26,841
[46]	Revenue Water Volume	2013×(a)×(c)	25,363	25,947
[47]	Waterworks Usage Volume	2013×(a)	873	893
[48]	(C) Necessary Distributed Water Volume	(B)/(1-(f))	57,156	53,150
[49]	(D) Surplus Water Volume	(A)-(C)	1,244	5,250
[50]	Variable			
[51]	(a) Population Growth Rate		1.000	1.023
[52]	(b) Water Rates Revision		1.010	1.280
[53]	(c) Increase demand by Pressure Improvement		(1.000)	(1.000)
[54]	(d) Inflation Rate		1.000	1.040
[55]	(e) Deferred Effect for Expenses		(1.000)	(1.000)
[56]	(f) Prospect of NRW Ratio		55.0%	49.5%

No.	2015	2016	2017	2018	2019	2020	2021	2022	2023
[01]									
[02]	895,813	925,041	954,938	975,758	996,754	1,017,925	1,039,272	1,060,795	1,082,495
[03]	37,564	38,405	39,254	40,110	40,973	41,843	42,721	43,605	44,497
[04]	933,377	963,446	994,191	1,015,868	1,037,727	1,059,768	1,081,993	1,104,401	1,126,992
[05]									
[06]	524,464	560,071	587,347	615,879	645,724	676,939	709,585	743,726	779,429
[07]	151,820	167,002	172,847	178,897	185,158	191,639	198,346	205,288	212,473
[08]	114,836	120,303	125,992	131,912	138,073	144,481	151,147	158,080	165,290
[09]	90,453	95,716	101,256	107,084	113,217	119,669	126,455	133,591	141,095
[10]	65,269	69,066	73,063	77,269	81,695	86,350	91,246	96,396	101,811
[11]	17,207	18,208	19,262	20,371	21,537	22,765	24,055	25,413	26,840
[12]	14,367	15,203	16,083	17,009	17,983	19,008	20,085	21,219	22,411
[13]	7,738	8,188	8,662	9,160	9,685	10,237	10,817	11,428	12,070
[14]	4,633	4,903	5,186	5,485	5,799	6,129	6,477	6,843	7,227
[15]	3,999	4,232	4,477	4,735	5,006	5,291	5,591	5,907	6,238
[16]	3,994	4,184	4,382	4,588	4,802	5,025	5,257	5,498	5,749
[17]	3,830	4,053	4,287	4,534	4,794	5,067	5,354	5,657	5,974
[18]	46,318	49,013	51,850	54,834	57,975	61,278	64,753	68,408	72,250
[19]	72,337	74,324	78,859	83,507	88,169	92,845	97,534	99,238	102,623
[20]	72,337	73,958	75,592	77,240	78,902	80,578	82,268	83,971	85,689
[21]	0	367	3,267	6,267	9,267	12,267	15,267	15,267	16,933
[22]	25,078	26,537	28,073	29,689	31,389	33,178	35,059	37,038	39,119
[23]	8,430	8,920	9,436	9,979	10,551	11,152	11,785	12,450	13,149
[24]	7,410	7,841	8,294	8,772	9,274	9,803	10,359	10,943	11,558
[25]	4,114	4,354	4,606	4,871	5,150	5,443	5,752	6,076	6,418
[26]	2,117	2,240	2,370	2,506	2,650	2,801	2,960	3,127	3,302
[27]	1,949	2,063	2,182	2,308	2,440	2,579	2,725	2,879	3,041
[28]	1,059	1,120	1,185	1,253	1,325	1,400	1,480	1,563	1,651
[29]	621,879	660,933	694,279	729,075	765,282	802,961	842,179	880,003	921,170
[30]	311,498	302,513	299,913	286,793	272,445	256,807	239,814	224,398	205,822
[31]	2,015	2,016	2,017	2,018	2,019	2,020	2,021	2,022	2,023
[32]	4,695	4,800	4,906	5,013	5,121	5,230	5,339	5,450	5,561
[33]									
[34]	65,948	60,454	54,549	48,339	41,684	34,581	26,956	19,987	12,972
[35]	34,182	31,818	29,453	27,089	24,724	22,360	19,995	17,631	15,266
[36]								18,360	16,419
[37]	100,130	92,272	84,002	75,427	66,408	56,941	46,951	55,978	44,657
[38]	938,071	968,246	999,097	1,020,881	1,042,848	1,064,998	1,087,332	1,109,850	1,132,553
[39]	722,009	753,204	778,280	804,502	831,690	859,902	889,130	935,981	965,827
[40]	216,063	215,041	220,817	216,379	211,158	205,096	198,202	173,870	166,726
[41]									
[42]	58,400	58,400	58,400	58,400	58,400	58,400	58,400	58,400	58,400
[43]	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800
[44]	14,600	14,600	14,600	14,600	14,600	14,600	14,600	14,600	14,600
[45]	27,450	28,337	29,243	29,880	30,523	31,172	31,825	32,485	33,149
[46]	26,537	27,403	28,288	28,905	29,527	30,154	30,787	31,424	32,067
[47]	913	934	955	975	996	1,017	1,039	1,060	1,082
[48]	53,824	53,465	53,169	50,645	48,450	46,525	44,825	45,117	45,410
[49]	4,576	4,935	5,231	7,755	9,950	11,875	13,575	13,283	12,990
[50]									
[51]	1.023	1.022	1.022	1.022	1.022	1.021	1.021	1.021	1.020
[52]	(1.000)	1.000	(1.000)	1.000	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
[53]	(1.000)	1.010	1.010	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
[54]	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035
[55]	(1.000)	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
[56]	49.0%	47.0%	45.0%	41.0%	37.0%	33.0%	29.0%	28.0%	27.0%

No.	2024	2025	2026	2027	2028	2029	2030	2031	2032
[01]									
[02]	1,104,371	1,143,322	1,165,887	1,188,633	1,211,560	1,234,669	1,383,756	1,409,860	1,436,455
[03]	45,397	46,998	47,925	48,860	49,803	50,753	51,710	52,686	53,679
[04]	1,149,768	1,190,319	1,213,812	1,237,493	1,261,363	1,285,422	1,435,466	1,462,545	1,490,135
[05]									
[06]	816,762	865,220	908,527	953,914	1,001,478	1,051,318	1,103,541	1,158,433	1,216,133
[07]	219,910	227,607	235,573	243,818	252,352	261,184	270,325	279,787	289,579
[08]	172,787	183,291	193,450	204,127	215,347	227,135	239,520	252,579	266,351
[09]	148,985	159,638	168,486	177,785	187,557	197,824	208,610	219,984	231,979
[10]	107,504	115,190	121,575	128,285	135,336	142,745	150,528	158,735	167,390
[11]	28,341	30,368	32,051	33,820	35,679	37,632	39,684	41,848	44,129
[12]	23,664	25,356	26,761	28,239	29,791	31,421	33,135	34,941	36,846
[13]	12,745	13,656	14,413	15,208	16,044	16,922	17,845	18,818	19,844
[14]	7,631	8,177	8,630	9,106	9,607	10,133	10,685	11,268	11,882
[15]	6,587	7,058	7,449	7,860	8,293	8,746	9,223	9,726	10,257
[16]	6,010	6,375	6,729	7,100	7,490	7,900	8,331	8,785	9,264
[17]	6,308	6,759	7,134	7,528	7,942	8,376	8,833	9,315	9,822
[18]	76,290	81,745	86,276	91,038	96,042	101,299	106,822	112,647	118,789
[19]	107,688	114,104	115,890	117,691	119,506	121,335	123,179	125,057	126,971
[20]	87,421	90,504	92,290	94,091	95,906	97,735	99,579	101,457	103,371
[21]	20,267	23,600	23,600	23,600	23,600	23,600	23,600	23,600	23,600
[22]	41,306	44,259	46,713	49,291	52,000	54,847	57,837	60,991	64,316
[23]	13,884	14,877	15,702	16,568	17,479	18,436	19,441	20,501	21,619
[24]	12,204	13,077	13,802	14,564	15,364	16,205	17,089	18,020	19,003
[25]	6,776	7,261	7,663	8,086	8,531	8,998	9,488	10,006	10,551
[26]	3,487	3,736	3,943	4,161	4,390	4,630	4,882	5,149	5,429
[27]	3,211	3,440	3,631	3,831	4,042	4,263	4,495	4,741	4,999
[28]	1,743	1,868	1,972	2,081	2,195	2,315	2,441	2,574	2,715
[29]	965,755	1,023,583	1,071,130	1,120,896	1,172,983	1,227,500	1,284,557	1,344,481	1,407,421
[30]	184,013	166,736	142,682	116,597	88,379	57,922	150,909	118,064	82,714
[31]	2,024	2,025	2,026	2,027	2,028	2,029	2,030	2,031	2,032
[32]	5,674	5,874	5,990	6,107	6,224	6,343	6,463	6,585	6,709
[33]									
[34]	9,283	7,203	5,125	3,023	1,175	720	430	110	0
[35]	12,902	10,537	8,173	5,808	3,444	1,079	0		
[36]	14,478	12,536	10,595	8,654	6,712	4,771	2,830	888	0
[37]	36,662	30,276	23,892	17,485	11,331	6,571	3,260	998	0
[38]	1,155,442	1,196,193	1,219,802	1,243,600	1,267,587	1,291,765	1,441,929	1,469,130	1,496,844
[39]	1,002,418	1,053,860	1,095,023	1,138,381	1,184,314	1,234,071	1,287,817	1,345,479	1,407,421
[40]	153,024	142,333	124,779	105,218	83,273	57,694	154,112	123,651	89,423
[41]									
[42]	58,400	58,400	58,400	58,400	58,400	58,400	58,400	58,400	58,400
[43]	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800
[44]	14,600	14,600	14,600	14,600	14,600	14,600	14,600	14,600	14,600
[45]	33,819	35,012	35,703	36,399	37,101	37,809	38,522	39,249	39,989
[46]	32,715	33,869	34,537	35,211	35,890	36,575	37,265	37,968	38,684
[47]	1,104	1,143	1,165	1,188	1,211	1,234	1,257	1,281	1,305
[48]	45,701	46,682	47,604	48,532	49,468	50,412	51,363	52,332	53,319
[49]	12,699	11,718	10,796	9,868	8,932	7,988	7,037	6,068	5,081
[50]									
[51]	1.020	1.035	1.020	1.020	1.019	1.019	1.019	1.019	1.019
[52]	(1.000)	(1.000)	1.000	(1.000)	(1.000)	(1.000)	1.100	(1.000)	(1.000)
[53]	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
[54]	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035
[55]	0.990	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000
[56]	26.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%

Table-3.6.7 Profit and Loss statement simulation [Case of water supply of 40,000m^3/day] (Price unit: 1,000PHP)

No.	Items	Calculating Formula	2013	2014
[01]	Operating Revenue			
[02]	(1) Water Sales	2013×(a)×(b)×(c)	668,895	875,914
[03]	(2) Other Revenue	2013×(a)	35,902	36,729
[04]	Sub-Total of Operating Revenue		704,797	912,644
[05]	Operating Expenses			
[06]	(3) Operation Cost		482,700	503,865
[07]	Water Source: Purchased Water	(2017～) 2016×(d)	151,820	151,820
[08]	Pumping	2013×(a)×(d)×(e)	101,966	108,488
[09]	Administrative Salaries and Wages	2013×(a)×(d)	80,316	85,453
[10]	Employees' Pensions and Benefits	2013×(a)×(d)	57,954	61,661
[11]	Tax and Licenses	2013×(a)×(d)	15,278	16,256
[12]	GSIS, Philhealth and HDMF Contributions	2013×(a)×(d)	12,757	13,573
[13]	Security Services	2013×(a)×(d)	6,870	7,310
[14]	Office Supplies	2013×(a)×(d)	4,114	4,377
[15]	Power Cost	2013×(a)×(d)	3,551	3,778
[16]	Water Treatment	2013×(a)×(d)×(e)	3,547	3,773
[17]	Light, Power and Water	2013×(a)×(d)	3,401	3,618
[18]	Miscellaneous Expenses	2013×(a)×(d)	41,127	43,758
[19]	(4) Depreciation		69,137	70,730
[20]	Current Depreciation	2013×(a)	69,137	70,730
[21]	New Loan Depreciation	New Loan Construction Cost / 30years		0
[22]	(5) Maintenance		12,869	23,692
[23]	Transmission and Distribution	2013×(a)×(d)	7,485	7,964
[24]	Additional	YWWB Case×(a)×(d)		7,000
[25]	General Plant	2013×(a)×(d)	3,653	3,887
[26]	Additional	YWWB Case×(a)×(d)		2,000
[27]	Sources of Supply	2013×(a)×(d)	1,731	1,841
[28]	Additional	YWWB Case×(a)×(d)		1,000
[29]	Sub-Total of Operating Expenses		564,706	598,287
[30]	Operating Income		140,091	314,357
[31]	Non-Operating Revenue		2013	2014
[32]	(6) Other Income	2013×(a)	4,487	4,590
[33]	Non-Operating Expenses			
[34]	Interest of Current Long-term Debts		85,590	71,754
[35]	Interest of New Long-term Debts (458MP)			
[36]	Interest of New Long-term Debts (250MP)			
[37]	(7) Interest of Long-term Debts		85,590	71,754
[38]	Net Total Income		709,284	917,234
[39]	Net Total Expenses		650,296	670,041
[40]	Ordinary Income		58,988	247,193
[41]	Water Resource			
[42]	(A) Water Resource		58,400	58,400
[43]	Self-Owned Water	120,000×365days	43,800	43,800
[44]	Purchased Water	40,000×365days	14,600	14,600
[45]	(B) Water Demand		26,236	26,841
[46]	Revenue Water Volume	2013×(a)×(c)	25,363	25,947
[47]	Waterworks Usage Volume	2013×(a)	873	893
[48]	(C) Necessary Distributed Water Volume	(B)/(1-(f))	57,156	53,150
[49]	(D) Surplus Water Volume	(A)-(C)	1,244	5,250
[50]	Variable			
[51]	(a) Population Growth Rate		1.000	1.023
[52]	(b) Water Rates Revision		1.010	1.280
[53]	(c) Increase Demand by Pressure Improvement		(1.000)	(1.000)
[54]	(d) Inflation Rate		1.000	1.040
[55]	(e) Deferred Effect for Expenses		(1.000)	(1.000)
[56]	(f) Prospect of NRW Ratio		53.0%	49.5%

No.	2015	2016	2017	2018	2019	2020	2021	2022	2023
[01]									
[02]	895,813	925,041	954,938	975,758	996,754	1,017,925	1,039,272	1,166,875	1,190,744
[03]	37,564	38,405	39,254	40,110	40,973	41,843	42,721	43,605	44,497
[04]	933,377	963,446	994,191	1,015,868	1,037,727	1,059,768	1,081,993	1,210,480	1,235,242
[05]									
[06]	524,464	560,071	587,347	615,879	645,724	676,939	709,585	743,726	779,429
[07]	151,820	167,002	172,847	178,897	185,158	191,639	198,346	205,288	212,473
[08]	114,836	120,303	125,992	131,912	138,073	144,481	151,147	158,080	165,290
[09]	90,453	95,716	101,256	107,084	113,217	119,669	126,455	133,591	141,095
[10]	65,269	69,066	73,063	77,269	81,695	86,350	91,246	96,396	101,811
[11]	17,207	18,208	19,262	20,371	21,537	22,765	24,055	25,413	26,840
[12]	14,367	15,203	16,083	17,009	17,983	19,008	20,085	21,219	22,411
[13]	7,738	8,188	8,662	9,160	9,685	10,237	10,817	11,428	12,070
[14]	4,633	4,903	5,186	5,485	5,799	6,129	6,477	6,843	7,227
[15]	3,999	4,232	4,477	4,735	5,006	5,291	5,591	5,907	6,238
[16]	3,994	4,184	4,382	4,588	4,802	5,025	5,257	5,498	5,749
[17]	3,830	4,053	4,287	4,534	4,794	5,067	5,354	5,657	5,974
[18]	46,318	49,013	51,850	54,834	57,975	61,278	64,753	68,408	72,250
[19]	72,337	74,324	78,859	83,507	88,169	92,845	97,534	99,238	102,623
[20]	72,337	73,958	75,592	77,240	78,902	80,578	82,268	83,971	85,689
[21]	0	367	3,267	6,267	9,267	12,267	15,267	15,267	16,933
[22]	25,078	26,537	28,073	29,689	31,389	33,178	35,059	37,038	39,119
[23]	8,430	8,920	9,436	9,979	10,551	11,152	11,785	12,450	13,149
[24]	7,410	7,841	8,294	8,772	9,274	9,803	10,359	10,943	11,558
[25]	4,114	4,354	4,606	4,871	5,150	5,443	5,752	6,076	6,418
[26]	2,117	2,240	2,370	2,506	2,650	2,801	2,960	3,127	3,302
[27]	1,949	2,063	2,182	2,308	2,440	2,579	2,725	2,879	3,041
[28]	1,059	1,120	1,185	1,253	1,325	1,400	1,480	1,563	1,651
[29]	621,879	660,933	694,279	729,075	765,282	802,961	842,179	880,003	921,170
[30]	311,498	302,513	299,913	286,793	272,445	256,807	239,814	330,477	314,072
[31]	2015	2016	2017	2018	2019	2020	2021	2022	2023
[32]	4,695	4,800	4,906	5,013	5,121	5,230	5,339	5,450	5,561
[33]									
[34]	65,948	60,454	54,549	48,339	41,684	34,581	26,956	19,987	12,972
[35]	34,182	31,818	29,453	27,089	24,724	22,360	19,995	17,631	15,266
[36]								18,360	16,419
[37]	100,130	92,272	84,002	75,427	66,408	56,941	46,951	55,978	44,657
[38]	938,071	968,246	999,097	1,020,881	1,042,848	1,064,998	1,087,332	1,215,930	1,240,803
[39]	722,009	753,204	778,280	804,502	831,690	859,902	889,130	935,981	965,827
[40]	216,063	215,041	220,817	216,379	211,158	205,096	198,202	279,949	274,976
[41]									
[42]	58,400	58,400	58,400	58,400	58,400	58,400	58,400	58,400	58,400
[43]	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800
[44]	14,600	14,600	14,600	14,600	14,600	14,600	14,600	14,600	14,600
[45]	27,450	28,337	29,243	29,880	30,523	31,172	31,825	32,485	33,149
[46]	26,537	27,403	28,288	28,905	29,527	30,154	30,787	31,424	32,067
[47]	913	934	955	975	996	1,017	1,039	1,060	1,082
[48]	53,824	53,465	53,169	50,645	48,450	46,525	44,825	45,117	45,410
[49]	4,576	4,935	5,231	7,755	9,950	11,875	13,575	13,283	12,990
[50]									
[51]	1.023	1.022	1.022	1.022	1.022	1.021	1.021	1.021	1.020
[52]	(1.000)	1.000	(1.000)	1.000	(1.000)	(1.000)	(1.000)	1.100	(1.000)
[53]	(1.000)	1.010	1.010	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
[54]	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035
[55]	(1.000)	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
[56]	49.0%	47.0%	45.0%	41.0%	37.0%	33.0%	29.0%	28.0%	27.0%

No.	2024	2025	2026	2027	2028	2029	2030	2031	2032
[01]									
[02]	1,214,809	1,257,654	1,410,723	1,438,246	1,465,988	1,493,950	1,674,345	1,705,930	1,738,111
[03]	45,397	46,998	47,925	48,860	49,803	50,753	51,710	52,686	53,679
[04]	1,260,205	1,304,651	1,458,648	1,487,106	1,515,790	1,544,702	1,726,055	1,758,616	1,791,790
[05]									
[06]	816,762	1,092,827	1,144,100	1,197,732	1,253,829	1,312,502	1,373,867	1,438,220	1,505,713
[07]	219,910	455,214	471,146	487,636	504,703	522,368	540,651	559,574	579,159
[08]	172,787	183,291	193,450	204,127	215,347	227,135	239,520	252,579	266,351
[09]	148,985	159,638	168,486	177,785	187,557	197,824	208,610	219,984	231,979
[10]	107,504	115,190	121,575	128,285	135,336	142,745	150,528	158,735	167,390
[11]	28,341	30,368	32,051	33,820	35,679	37,632	39,684	41,848	44,129
[12]	23,664	25,356	26,761	28,239	29,791	31,421	33,135	34,941	36,846
[13]	12,745	13,656	14,413	15,208	16,044	16,922	17,845	18,818	19,844
[14]	7,631	8,177	8,630	9,106	9,607	10,133	10,685	11,268	11,882
[15]	6,587	7,058	7,449	7,860	8,293	8,746	9,223	9,726	10,257
[16]	6,010	6,375	6,729	7,100	7,490	7,900	8,331	8,785	9,264
[17]	6,308	6,759	7,134	7,528	7,942	8,376	8,833	9,315	9,822
[18]	76,290	81,745	86,276	91,038	96,042	101,299	106,822	112,647	118,789
[19]	107,688	114,104	115,890	117,691	119,506	121,335	123,179	125,057	126,971
[20]	87,421	90,504	92,290	94,091	95,906	97,735	99,579	101,457	103,371
[21]	20,267	23,600	23,600	23,600	23,600	23,600	23,600	23,600	23,600
[22]	41,306	44,259	46,713	49,291	52,000	54,847	57,837	60,991	64,316
[23]	13,884	14,877	15,702	16,568	17,479	18,436	19,441	20,501	21,619
[24]	12,204	13,077	13,802	14,564	15,364	16,205	17,089	18,020	19,003
[25]	6,776	7,261	7,663	8,086	8,531	8,998	9,488	10,006	10,551
[26]	3,487	3,736	3,943	4,161	4,390	4,630	4,882	5,149	5,429
[27]	3,211	3,440	3,631	3,831	4,042	4,263	4,495	4,741	4,999
[28]	1,743	1,868	1,972	2,081	2,195	2,315	2,441	2,574	2,715
[29]	965,755	1,251,190	1,306,703	1,364,714	1,425,335	1,488,684	1,554,882	1,624,268	1,697,000
[30]	294,450	53,461	151,945	122,392	90,455	56,018	171,172	134,348	94,790
[31]									
[32]	5,674	5,874	5,990	6,107	6,224	6,343	6,463	6,585	6,709
[33]									
[34]	9,283	7,203	5,125	3,023	1,175	720	430	110	0
[35]	12,902	10,537	8,173	5,808	3,444	1,079	0		
[36]	14,478	12,536	10,595	8,654	6,712	4,771	2,830	888	0
[37]	36,662	30,276	23,892	17,485	11,331	6,571	3,260	998	0
[38]	1,265,879	1,310,525	1,464,638	1,493,212	1,522,015	1,551,045	1,732,518	1,765,200	1,798,499
[39]	1,002,418	1,281,467	1,330,596	1,382,199	1,436,666	1,495,255	1,558,142	1,625,266	1,697,000
[40]	263,461	29,059	134,042	111,013	85,349	55,791	174,375	139,934	101,499
[41]									
[42]	58,400	73,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000
[43]	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800
[44]	14,600	29,200	29,200	29,200	29,200	29,200	29,200	29,200	29,200
[45]	33,819	35,012	35,703	36,399	37,101	37,809	38,522	39,249	39,989
[46]	32,715	33,869	34,537	35,211	35,890	36,575	37,265	37,968	38,684
[47]	1,104	1,143	1,165	1,188	1,211	1,234	1,257	1,281	1,305
[48]	45,701	43,765	44,628	45,499	46,377	47,261	48,153	49,061	49,987
[49]	12,699	29,235	28,372	27,501	26,623	25,739	24,847	23,939	23,013
[50]									
[51]	1.020	1.035	1.020	1.020	1.019	1.019	1.019	1.019	1.019
[52]	(1.000)	(1.000)	1.100	(1.000)	(1.000)	(1.000)	1.100	(1.000)	(1.000)
[53]	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
[54]	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035
[55]	0.990	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000
[56]	26.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%

Table-3.6.8 Profit and Loss statement simulation [Case of water supply of 20,000m^3/day](Price unit: 1,000PHP)

No.	Items	Calculating Formula	2013	2014
[01]	Operating Revenue			
[02]	(1) Water Sales	2013×(a)×(b)×(c)	668,895	875,914
[03]	(2) Other Revenue	2013×(a)	35,902	36,729
[04]	Sub-Total of Operating Revenue		704,797	912,644
[05]	Operating Expenses			
[06]	(3) Operation Cost		482,700	503,865
[07]	Water Source: Purchased Water	(2017～) 2016×(d)	151,820	151,820
[08]	Pumping	2013×(a)×(d)×(e)	101,966	108,488
[09]	Administrative Salaries and Wages	2013×(a)×(d)	80,316	85,453
[10]	Employees' Pensions and Benefits	2013×(a)×(d)	57,954	61,661
[11]	Tax and Licenses	2013×(a)×(d)	15,278	16,256
[12]	GSIS, Philhealth and HDMF Contributions	2013×(a)×(d)	12,757	13,573
[13]	Security Services	2013×(a)×(d)	6,870	7,310
[14]	Office Supplies	2013×(a)×(d)	4,114	4,377
[15]	Power Cost	2013×(a)×(d)	3,551	3,778
[16]	Water Treatment	2013×(a)×(d)×(e)	3,547	3,773
[17]	Light, Power and Water	2013×(a)×(d)	3,401	3,618
[18]	Miscellaneous Expenses	2013×(a)×(d)	41,127	43,758
[19]	(4) Depreciation		69,137	70,730
[20]	Current Depreciation	2013×(a)	69,137	70,730
[21]	New Loan Depreciation	New Loan Construction Cost / 30years		0
[22]	(5) Maintenance		12,869	23,692
[23]	Transmission and Distribution	2013×(a)×(d)	7,485	7,964
[24]	Additional	YWWB Case×(a)×(d)		7,000
[25]	General Plant	2013×(a)×(d)	3,653	3,887
[26]	Additional	YWWB Case×(a)×(d)		2,000
[27]	Sources of Supply	2013×(a)×(d)	1,731	1,841
[28]	Additional	YWWB Case×(a)×(d)		1,000
[29]	Sub-Total of Operating Expenses		564,706	598,287
[30]	Operating Income		140,091	314,357
[31]	Non-Operating Revenue			
[32]	(6) Other Income	2013×(a)	4,487	4,590
[33]	Non-Operating Expenses			
[34]	Interest of Current Long-term Debts		85,590	71,754
[35]	Interest of New Long-term Debts (458MP)			
[36]	Interest of New Long-term Debts (250MP)			
[37]	(7) Interest of Long-term Debts		85,590	71,754
[38]	Net Total Income		709,284	917,234
[39]	Net Total Expenses		650,296	670,041
[40]	Ordinary Income		58,988	247,193
[41]	Water Resource			
[42]	(A) Water Resource		58,400	58,400
[43]	Self-Owned Water	120,000×365days	43,800	43,800
[44]	Purchased Water	40,000×365days	14,600	14,600
[45]	(B) Water Demand		26,236	26,841
[46]	Revenue Water Volume	2013×(a)×(c)	25,363	25,947
[47]	Waterworks Usage Volume	2013×(a)	873	893
[48]	(C) Necessary Distributed Water Volume	(B)/(1-(f))	57,156	53,150
[49]	(D) Surplus Water Volume	(A)-(C)	1,244	5,250
[50]	Variable			
[51]	(a) Population Growth Rate		1.000	1.023
[52]	(b) Water Rates Revision		1.010	1.280
[53]	(c) Increase Demand by Pressure Improvement		(1.000)	(1.000)
[54]	(d) Inflation Rate		1.000	1.040
[55]	(e) Deferred Effect for Expenses		(1.000)	(1.000)
[56]	(f) Prospect of NRW Ratio		53.0%	49.5%

No.	2015	2016	2017	2018	2019	2020	2021	2022	2023
[01]									
[02]	895,813	925,041	954,938	975,758	996,754	1,017,925	1,039,272	1,060,795	1,082,495
[03]	37,564	38,405	39,254	40,110	40,973	41,843	42,721	43,605	44,497
[04]	933,377	963,446	994,191	1,015,868	1,037,727	1,059,768	1,081,993	1,104,401	1,126,992
[05]									
[06]	524,464	560,071	587,347	615,879	645,724	676,939	709,585	743,726	779,429
[07]	151,820	167,002	172,847	178,897	185,158	191,639	198,346	205,288	212,473
[08]	114,836	120,303	125,992	131,912	138,073	144,481	151,147	158,080	165,290
[09]	90,453	95,716	101,256	107,084	113,217	119,669	126,455	133,591	141,095
[10]	65,269	69,066	73,063	77,269	81,695	86,350	91,246	96,396	101,811
[11]	17,207	18,208	19,262	20,371	21,537	22,765	24,055	25,413	26,840
[12]	14,367	15,203	16,083	17,009	17,983	19,008	20,085	21,219	22,411
[13]	7,738	8,188	8,662	9,160	9,685	10,237	10,817	11,428	12,070
[14]	4,633	4,903	5,186	5,485	5,799	6,129	6,477	6,843	7,227
[15]	3,999	4,232	4,477	4,735	5,006	5,291	5,591	5,907	6,238
[16]	3,994	4,184	4,382	4,588	4,802	5,025	5,257	5,498	5,749
[17]	3,830	4,053	4,287	4,534	4,794	5,067	5,354	5,657	5,974
[18]	46,318	49,013	51,850	54,834	57,975	61,278	64,753	68,408	72,250
[19]	72,337	74,324	78,859	83,507	88,169	92,845	97,534	99,238	102,623
[20]	72,337	73,958	75,592	77,240	78,902	80,578	82,268	83,971	85,689
[21]	0	367	3,267	6,267	9,267	12,267	15,267	15,267	16,933
[22]	25,078	26,537	28,073	29,689	31,389	33,178	35,059	37,038	39,119
[23]	8,430	8,920	9,436	9,979	10,551	11,152	11,785	12,450	13,149
[24]	7,410	7,841	8,294	8,772	9,274	9,803	10,359	10,943	11,558
[25]	4,114	4,354	4,606	4,871	5,150	5,443	5,752	6,076	6,418
[26]	2,117	2,240	2,370	2,506	2,650	2,801	2,960	3,127	3,302
[27]	1,949	2,063	2,182	2,308	2,440	2,579	2,725	2,879	3,041
[28]	1,059	1,120	1,185	1,253	1,325	1,400	1,480	1,563	1,651
[29]	621,879	660,933	694,279	729,075	765,282	802,961	842,179	880,003	921,170
[30]	311,498	302,513	299,913	286,793	272,445	256,807	239,814	224,398	205,822
[31]									
[32]	4,695	4,800	4,906	5,013	5,121	5,230	5,339	5,450	5,561
[33]									
[34]	65,948	60,454	54,549	48,339	41,684	34,581	26,956	19,987	12,972
[35]	34,182	31,818	29,453	27,089	24,724	22,360	19,995	17,631	15,266
[36]								18,360	16,419
[37]	100,130	92,272	84,002	75,427	66,408	56,941	46,951	55,978	44,657
[38]	938,071	968,246	999,097	1,020,881	1,042,848	1,064,998	1,087,332	1,109,850	1,132,553
[39]	722,009	753,204	778,280	804,502	831,690	859,902	889,130	935,981	965,827
[40]	216,063	215,041	220,817	216,379	211,158	205,096	198,202	173,870	166,726
[41]									
[42]	58,400	58,400	58,400	58,400	58,400	58,400	58,400	58,400	58,400
[43]	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800
[44]	14,600	14,600	14,600	14,600	14,600	14,600	14,600	14,600	14,600
[45]	27,450	28,337	29,243	29,880	30,523	31,172	31,825	32,485	33,149
[46]	26,537	27,403	28,288	28,905	29,527	30,154	30,787	31,424	32,067
[47]	913	934	955	975	996	1,017	1,039	1,060	1,082
[48]	53,824	53,465	53,169	50,645	48,450	46,525	44,825	45,117	45,410
[49]	4,576	4,935	5,231	7,755	9,950	11,875	13,575	13,283	12,990
[50]									
[51]	1.023	1.022	1.022	1.022	1.022	1.021	1.021	1.021	1.020
[52]	(1.000)	1.000	(1.000)	1.000	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
[53]	(1.000)	1.010	1.010	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
[54]	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035
[55]	(1.000)	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
[56]	49.0%	47.0%	45.0%	41.0%	37.0%	33.0%	29.0%	28.0%	27.0%

No.	2024	2025	2026	2027	2028	2029	2030	2031	2032
[01]									
[02]	1,104,371	1,143,322	1,282,475	1,307,496	1,332,716	1,358,136	1,522,132	1,550,846	1,580,101
[03]	45,397	46,998	47,925	48,860	49,803	50,753	51,710	52,686	53,679
[04]	1,149,768	1,190,319	1,330,401	1,356,356	1,382,519	1,408,889	1,573,842	1,603,531	1,633,780
[05]									
[06]	816,762	979,023	1,026,314	1,075,823	1,127,653	1,181,910	1,238,704	1,298,327	1,360,923
[07]	219,910	341,410	353,360	365,727	378,528	391,776	405,488	419,680	434,369
[08]	172,787	183,291	193,450	204,127	215,347	227,135	239,520	252,579	266,351
[09]	148,985	159,638	168,486	177,785	187,557	197,824	208,610	219,984	231,979
[10]	107,504	115,190	121,575	128,285	135,336	142,745	150,528	158,735	167,390
[11]	28,341	30,368	32,051	33,820	35,679	37,632	39,684	41,848	44,129
[12]	23,664	25,356	26,761	28,239	29,791	31,421	33,135	34,941	36,846
[13]	12,745	13,656	14,413	15,208	16,044	16,922	17,845	18,818	19,844
[14]	7,631	8,177	8,630	9,106	9,607	10,133	10,685	11,268	11,882
[15]	6,587	7,058	7,449	7,860	8,293	8,746	9,223	9,726	10,257
[16]	6,010	6,375	6,729	7,100	7,490	7,900	8,331	8,785	9,264
[17]	6,308	6,759	7,134	7,528	7,942	8,376	8,833	9,315	9,822
[18]	76,290	81,745	86,276	91,038	96,042	101,299	106,822	112,647	118,789
[19]	107,688	114,104	115,890	117,691	119,506	121,335	123,179	125,057	126,971
[20]	87,421	90,504	92,290	94,091	95,906	97,735	99,579	101,457	103,371
[21]	20,267	23,600	23,600	23,600	23,600	23,600	23,600	23,600	23,600
[22]	41,306	44,259	46,713	49,291	52,000	54,847	57,837	60,991	64,316
[23]	13,884	14,877	15,702	16,568	17,479	18,436	19,441	20,501	21,619
[24]	12,204	13,077	13,802	14,564	15,364	16,205	17,089	18,020	19,003
[25]	6,776	7,261	7,663	8,086	8,531	8,998	9,488	10,006	10,551
[26]	3,487	3,736	3,943	4,161	4,390	4,630	4,882	5,149	5,429
[27]	3,211	3,440	3,631	3,831	4,042	4,263	4,495	4,741	4,999
[28]	1,743	1,868	1,972	2,081	2,195	2,315	2,441	2,574	2,715
[29]	965,755	1,137,387	1,188,917	1,242,805	1,299,159	1,358,092	1,419,720	1,484,374	1,552,210
[30]	184,013	52,932	141,484	113,551	83,359	50,797	154,122	119,157	81,570
[31]									
[32]	5,674	5,874	5,990	6,107	6,224	6,343	6,463	6,585	6,709
[33]									
[34]	9,283	7,203	5,125	3,023	1,175	720	430	110	0
[35]	12,902	10,537	8,173	5,808	3,444	1,079			
[36]	14,478	12,536	10,595	8,654	6,712	4,771	2,830	888	
[37]	36,662	30,276	23,892	17,485	11,331	6,571	3,260	998	0
[38]	1,155,442	1,196,193	1,336,390	1,362,463	1,388,743	1,415,232	1,580,304	1,610,116	1,640,489
[39]	1,002,418	1,167,663	1,212,809	1,260,290	1,310,490	1,364,663	1,422,980	1,485,372	1,552,210
[40]	153,024	28,530	123,581	102,173	78,253	50,569	157,325	124,743	88,279
[41]									
[42]	58,400	65,700	65,700	65,700	65,700	65,700	65,700	65,700	65,700
[43]	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800	43,800
[44]	14,600	21,900	21,900	21,900	21,900	21,900	21,900	21,900	21,900
[45]	33,819	35,012	35,703	36,399	37,101	37,809	38,522	39,249	39,989
[46]	32,715	33,869	34,537	35,211	35,890	36,575	37,265	37,968	38,684
[47]	1,104	1,143	1,165	1,188	1,211	1,234	1,257	1,281	1,305
[48]	45,701	44,887	45,773	46,666	47,566	48,473	49,388	50,319	51,268
[49]	12,699	20,813	19,927	19,034	18,134	17,227	16,312	15,381	14,432
[50]									
[51]	1.020	1.035	1.020	1.020	1.019	1.019	1.019	1.019	1.019
[52]	(1.000)	(1.000)	1.100	(1.000)	(1.000)	(1.000)	1.100	(1.000)	(1.000)
[53]	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
[54]	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035	1.035
[55]	0.990	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000
[56]	26.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%

The above simulation assumes that revenue water will increase 1.5 times in 23 years from 2014 to 2032. However, the available water source is also likely to make a 1.5 times increase by the improvement of the NRW ratio (about 50% → about 25%). Therefore, unless there is a further increase in quantity of water used (supply unit, changed under commercial and industrial standards), by the last half of the 2030s, it is assumed the present water resource reserves will be sufficient but a later shortage of water resources is foreseen. So until that time, it will be necessary to take actions to ensure water resources, such as investing in the development of new water resources or sharply increasing the quantity obtained from other organizations.

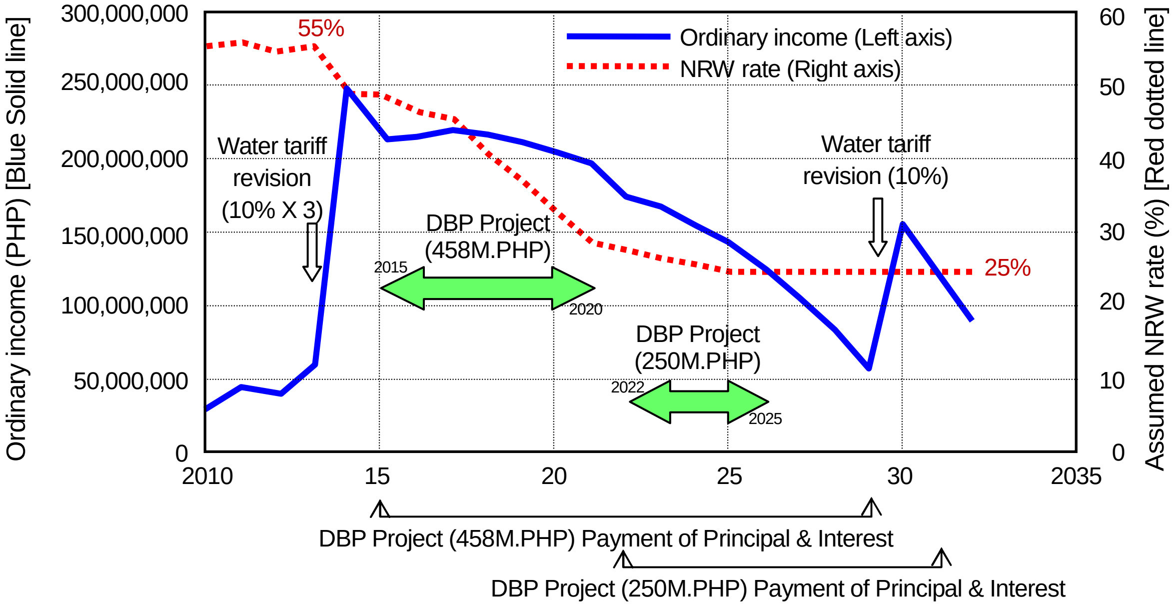


Fig-3.6.1 Ordinary income [Maintaining present status]

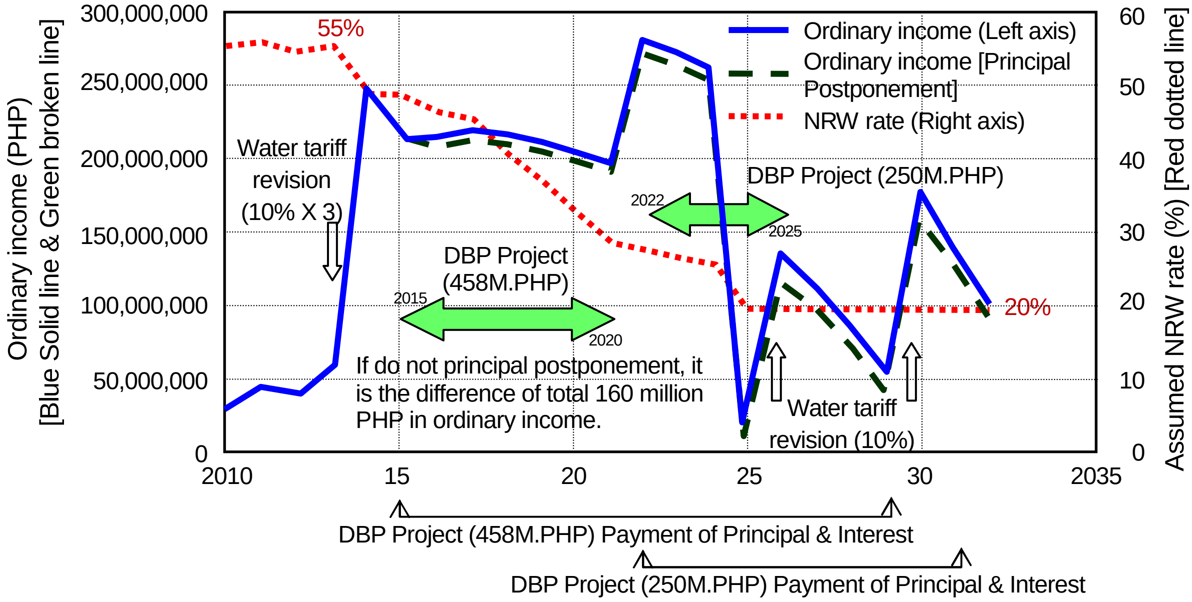


Fig-3.6.2 Ordinary income [Case of water supply of 40,000m^3/day]

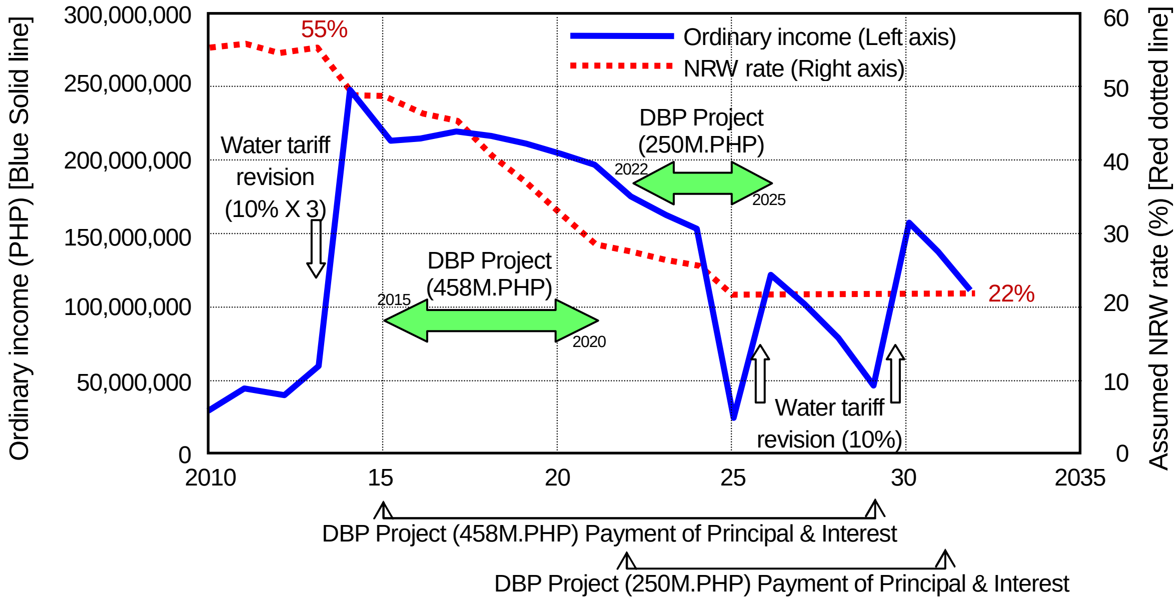


Fig-3.6.3 Ordinary income [Case of water supply of 20,000m^3/day]

As shown by the above figure, in the case where its receipts of water increased by 40,000m^3/day, it will be necessary to raise water rates to cover the new costs to prevent operating in the red, and it is predicted that water rates will increase every 3 or 4 years thereafter. Concerning the RVWC contract contents, in order to smooth the business environment, we urge efforts incorporating concern for self-owned water resources and water demand, such as receiving only 20,000m^3/day in the beginning.

COWD increased water rates by more than 30% in 2013 and 2014. Therefore, water sales are predicted to rise from 670 million PHP in 2013 to 880 million PHP in 2014, and afterwards, extremely high ordinary income of about 200 million PHP per year is anticipated. In the meantime, firmly establishing systematic renewals of facilities and at the same time making new facility investments are essential for COWD to ensure sustainable business operations.

On the other hand, the ordinary profit shows a decreasing trend throughout the period because the inflation rate (3.5 ~ 4%) is high compared to the population growth (about 2% a year) and the repayment of the interest of the new DPB loan will start in 2015. The profit level can be maintained at a good level as a whole by the water rate revisions in 2016 and 2018. To continue sound business management, it will be necessary to timely revise the water rate based on the inflation rate and socioeconomic conditions.

The water rate system should be revised so as to gradually increase the rate by also promoting economized consumption of water for effective use of available water sources and considering customers of low income and eradiation of poverty.

It is predicted that the DBP project can supply water maintaining its present NRW by reducing leaks, etc., thereby increasing the efficiency of power costs or chemical costs (water purification cost) of the pump, which is part of variable costs. COWD schedules the start of the designs for the new DBP projects in 2015 and will start the works in 2016. The schedule may have been decided based on the season for budgetary request, etc., but quick execution of the projects will lead to early improvement of the NRW ratio, and thus we propose COWD to start designing the DBP projects earlier than the schedule.

At first, COWD assumed that the Principal of Long-term Debts of the new DBP project (458 million PHP) would be deferred for 3 years. But because ordinary income equivalent to that of 2014 is predicted as stated above, the JICA Study Team asserted that a principal repayment grace period is unnecessary and COWD has begun studying the matter with a positive attitude. It is predicted that in the case where a grace period is not set for the new DBP project (458 million PHP) and a later project (250 million PHP), this will have an interest payment reduction effect equivalent to a total 160 million PHP.

In order that pipes constructed through the DBP project and existing pipes are used as long as or even longer than originally planned, appropriate management including regularly inspecting or repairing facilities is indispensable, but based on the results of observations and analysis by the JICA Study Team, it is highly possible that adequate maintenance will not be done. At this time, COWD is accelerating projects such as the leak inspections, raising both the leak discovery rate and number of repairs, so treating maintenance costs now budgeted as operating expenses as necessary costs must be studied and budgets systemetically prepared. The JICA Study Team is, based on the example of the Yokohama Waterworks Bureau, approximately doubling the amount simulated, but in the future COWD will have to carefully investigate and implement this.

Pump costs account for about 20% of the operating expenses of current COWD. This is the second largest of the cost for bulk water. If the energy of 1% is reduced, the 1 million PHP reductions are expected. Therefore, it is a very efficient way to reduce the energy consumption, such as the changing of the energy-saving pump according to the update time. And the new DBP project does not include pump renewal, but by appropriating this as maintenance costs (water resources), and performing gradual renewals, could possibly further lower costs. When this is done, it will be necessary to study the cost-benefits of new energy-saving pump introduction costs and reduceable electric power consumption costs.

In COWD, the political cost, such as welfare exemption or the cost of installation and maintenance of fire hydrants is spent from water charges income. For these project costs that are in the category of general administration, although it might be influenced by the national policy in the Philippines, the JICA Study Team recommends requesting the government for subsidy instead of using the funds from the waterworks project accounting.

Financial planning simulation that takes into account the income statement simulation is shown in Table-3.6.9 to 3.6.10.

Table-3.6.9 Financial planning simulation [Case of water supply of 40,000m^3/day, no capital grace period]

(Price unit: 1,000PHP)

No.	Items	2013	2014	2015	2016
[57]	Working Capital Income				
[58]	New DBP Project			458,000	
[59]	Other Uses of Working Capital				
[60]	Working Capital Expenses				
[61]	New DBP Project Loan			-11,000	-87,000
[62]	Principal of Long-term Debts				
[63]	Principal of Current Long-term Debts		-57,560	-61,197	-64,320
[64]	Principal of Long-term Debts (458MP)			-30,708	-30,708
[65]	Principal of Long-term Debts (250MP)				
[66]	Other				
[67]	Other Uses of Working Capital		-50,000	-50,000	-50,000
[68]	Rehabilitation Extension Costs After New DBP Project				
[69]	Sub-Total		-107,560	305,095	-232,028
[70]	Internal Reserve Funds (Compensation Possible)				
[71]	Previous Year's Working Capital		179,000	389,364	982,858
[72]	Current Year's Depreciation		70,730	72,337	74,324
[73]	(Current Years) Ordinary Profit		70,730	72,337	74,324
[74]	Estimated Cumulative Working Capital	179,000	389,364	982,858	1,040,196

*: Estimated Cumulative Working Capital in 2013 is "Current Assets (375,000)" – "Current Liabilities (127,000)" – "Net of Disconnected Accounts (150,000)" – "Allowance for Bad Debts-Credit (-81,000)"

No.	2017	2018	2019	2020	2021	2022	2023	2024
[57]								
[58]						250,000		
[59]								
[60]								
[61]	-90,000	-90,000	-90,000	-90,000		-50,000	-100,000	-100,000
[62]								
[63]	-67,354	-71,662	-76,415	-81,660	-82,184	-80,034	-69,872	-25,857
[64]	-30,708	-30,708	-30,708	-30,708	-30,708	-30,708	-30,708	-30,708
[65]						-25,000	-25,000	-25,000
[66]								
[67]	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000
[68]					-77,500	-77,500	-77,500	-77,500
[69]	-238,062	-242,370	-247,123	-252,368	-240,392	-63,242	-353,080	-309,065
[70]								
[71]	1,040,196	1,101,809	1,159,324	1,211,528	1,257,101	1,312,445	1,628,390	1,652,909
[72]	78,859	83,507	88,169	92,845	97,534	99,238	102,623	107,688
[73]	220,817	216,379	211,158	205,096	198,202	279,949	274,976	263,461
[74]	1,101,809	1,159,324	1,211,528	1,257,101	1,312,445	1,628,390	1,652,909	1,714,993

No.	2025	2026	2027	2028	2029	2030	2031	2032
[57]								
[58]								
[59]								
[60]								
[61]								
[62]								
[63]	-26,012	-26,189	-26,389	-12,218	-2,191	-2,481	-2,074	0
[64]	-30,708	-30,708	-30,708	-30,708	-28,088			
[65]	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000	
[66]								
[67]	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000
[68]	-77,500	-77,500	-77,500	-77,500	-77,500	-77,500	-77,500	-77,500
[69]	-209,220	-209,397	-209,597	-195,426	-182,779	-154,981	-154,574	-127,500
[70]								
[71]	1,714,993	1,648,935	1,689,471	1,708,578	1,718,007	1,712,354	1,854,927	1,965,345
[72]	114,104	115,890	117,691	119,506	121,335	123,179	125,057	126,971
[73]	29,059	134,042	111,013	85,349	55,791	174,375	139,934	101,499
[74]	1,648,935	1,689,471	1,708,578	1,718,007	1,712,354	1,854,927	1,965,345	2,066,315

Table-3.6.10 Financial planning simulation [Case of water supply of 40,000m^3/day, with capital grace period] (Price unit: 1,000PHP)

No.	Items	2013	2014	2015	2016
[57]	Working Capital Income			458,000	
[58]	New DBP Project				
[59]	Other Uses of Working Capital				
[60]	Working Capital Expenses				
[61]	New DBP Project Loan			-11,000	-87,000
[62]	Principal of Long-term Debts				
[63]	Principal of Current Long-term Debts		-57,560	-61,197	-64,320
[64]	Principal of Long-term Debts (458MP)			0	0
[65]	Principal of Long-term Debts (250MP)				
[66]	Other				
[67]	Other Uses of Working Capital		-50,000	-50,000	-50,000
[68]	Rehabilitation Extension Costs After New DBP Project				
[69]	Sub-Total		-107,560	335,803	-201,320
[70]	Internal Reserve Funds (Compensation Possible)				
[71]	Previous Year's Working Capital		179,000	389,364	1,012,483
[72]	Current Year's Depreciation		70,730	72,337	74,324
[73]	(Current Years) Ordinary Profit		247,193	214,979	211,593
[74]	Estimated Cumulative Working Capital	179,000	389,364	1,012,483	1,097,080

*: Estimated Cumulative Working Capital in 2013 is "Current Assets (375,000)" – "Current Liabilities (127,000)" – "Net of Disconnected Accounts (150,000)" – "Allowance for Bad Debts-Credit (-81,000)"

No.	2017	2018	2019	2020	2021	2022	2023	2024
[57]								
[58]						250,000		
[59]								
[60]								
[61]								
[62]	-90,000	-90,000	-90,000	-90,000		-50,000	-100,000	-100,000
[63]								
[64]	-67,354	-71,662	-76,415	-81,660	-82,184	-80,034	-69,872	-25,857
[65]	0	-30,708	-30,708	-30,708	-30,708	-30,708	-30,708	-30,708
[66]						0	0	0
[67]								
[68]	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000
[69]					-77,500	-77,500	-77,500	-77,500
[70]	-207,354	-242,370	-247,123	-252,368	-240,392	-38,242	-328,080	-284,065
[71]								
[72]	1,097,080	1,183,588	1,234,010	1,279,120	1,317,599	1,365,850	1,698,812	1,738,406
[73]	78,859	83,507	88,169	92,845	97,534	99,238	102,623	107,688
[74]	215,004	209,285	204,064	198,002	191,108	271,966	265,051	251,595

No.	2025	2026	2027	2028	2029	2030	2031	2032
[57]								
[58]								
[59]								
[60]								
[61]								
[62]								
[63]								
[64]	-26,012	-26,189	-26,389	-12,218	-2,191	-2,481	-2,074	0
[65]	-30,708	-30,708	-30,708	-30,708	-30,708	-30,708	-30,708	-28,088
[66]	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000
[67]								
[68]	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000	-50,000
[69]	-77,500	-77,500	-77,500	-77,500	-77,500	-77,500	-77,500	-77,500
[70]	-209,220	-209,397	-209,597	-195,426	-185,399	-185,689	-185,282	-180,588
[71]								
[72]	1,813,624	1,734,648	1,762,267	1,768,457	1,764,968	1,743,778	1,844,011	1,914,453
[73]	114,104	115,890	117,691	119,506	121,335	123,179	125,057	126,971
[74]	16,141	121,125	98,096	72,431	42,873	162,743	130,667	95,649

For the current debt status of COWD, COWD has already received several loans such as LWUA loans and DBP loans, and is repaying the principal and the interest in a planned manner. In addition, this new DBP project tries to lower the NRW rate by newly incorporating 458 million PHP from the DBP in 2015, and plans to repay the capital in 15 years. It is predicted that later projects will accept 250 million PHP from the DBP or private banks in Philippine, to expand its water supply district. Therefore, the amount of capital repayed will increase from 2015 and from 2022 (without capital grace period), but in order to repay other loans, it will tend to fall beginning in 2025. This is one data of reference when considering the new loan study period.

According to the fund flow, it can be assumed COWD has put about 50 million PHP annually into facility development (See Table-2.2.8 Fund flow statement "Additions to Utility Plant"). However, the main project is the new pipeline installation, and the existing pipeline is not rarely replaced. By this new DBP project, between 2015 to 2020, COWD is scheduled to conduct business such as the pipe replacement, to invest about 90 million PHP annually (except the first year).

After this DBP project, in order to maintain the improved NRW rate and manage the sustainable waterworks business, the pipe replacement based on planning is essential. Based on the current financial situation of COWD and the discussion above, the JICA Study Team estimated the size of the necessary pipe replacement business after the DBP project. In our estimation, by assuming that the expected life of DIP is 90 years, iron pipe is 60 years and that of resin pipe is 30 years, in the case of replacing the pipes averaging replacement demand, about 77.5 million PHP annually is required. The JICA Study Team recommends that COWD prioritizes pipe replacement and replaces pipelines steadily and continuously.

There is a need to review the fiscal balance plan and financial planning as necessary, based on the social and economic situation. It is also important to realize the pipe replacement plan steadily by reflecting it in the budget every year. For that purpose, it is required that both the financial sector and the technical sector establishes the long-term and medium-term plan based on the financial situation and implements it.

4 Toward Formulation of Medium- to Long-Term Plans

4.1 Investigation of Distribution Block System

Urbanization increases the complexity of water distribution systems, so pipeline networks are studied in order to allow backup when pipeline work or an accident occurs during the formation of a distribution network, and advanced water operation will permit customers to use the water supply without their water suspension.

In CDO City, a complex distribution pipeline network is already formed, and in broad water districts, differences between ground elevations, served populations, and periods of heavy water use etc. result in diverse characteristics of the region's distribution networks. Serving a water district with such complex distribution networks with a single water supply system results in a variety of harmful effects. Supplying a region with diverse characteristics is resolved by adopting the distribution block system.

This time, in the COWD service region, independent water supply systems have been established on the east side and west side of the Cagayan de Oro River, and these have not been further subdivided into water supply blocks. The formation of more blocks is required centered on the distribution reservoir and booster pumping station, in order to remove the causes of the high NRW rate.

COWD is currently constructing DMAs, which are the smallest unit of distribution block.

In Japan, the Design Criteria for Waterworks Facilities and the Guidelines for Waterworks Maintenance Management stipulate the installation of an appropriate number of valves on a distribution network. However, not only COWD, but water supply utilities in other countries of South-east Asia tend to install extremely few valves on boundaries to build water distribution blocks. In order to form water distribution blocks under such circumstances, medium and long-term distribution network improvement plans must stipulate not only pipeline replacement, but the installation of the appropriate number of valves required to maintain the distribution network and to control and manage the water supply system.

4.2 Efficient Water Supply Control and Management and 24-hour Water Supply

The water distribution system of COWD in principle involves pumping and distributing water using intake pumps and booster pumps except in some parts where water flows down from a distribution reservoir by gravity. To supply water, COWD highly depends on power supplied from a hydroelectric power station, and the water supply may be suspended during a power failure, particularly in areas where water is directly supplied from a pumping facility. COWD has installed independent power generators to most intake pumps and booster pumps, but the generators may be incapable of running the pumps throughout an extensive power failure. If there is an elevated tank/reservoir, water can be pumped up to the tank while power is supplied, and the water can be distributed by gravity flow during a power failure. An elevated tank can be of any size, ranging from several thousand m^3 to several m^3. The capacity of the tank should be determined based on the area of the DMA (same as Small Block) or the distribution block consisting of two or more DMAs and the population supplied (number of connections) and water demand.

For example, let us assume a DMA with 500 water taps, a water demand of 270m^3/day and an NRW ratio of 40%. The amount of water to be stored should be the amount sufficient for 6 hours of supply, and is calculated as: 270 (m^3/day) ÷ 0.6 (ratio of revenue earning water: 60%) × 6 (hours to supply water) ÷ 24 (hours/day) = 112.5m^3 → 120m^3. This amount is the present water demand, and the tank capacity can be either increased so as to cope with population growth in the future or judged sufficient for the time being (and another tank will be constructed when the population increases) depending on the land use states in the DMA , how houses are built and available funds.

Because water is distributed from an elevation tank by gravity flow, the distribution water pressure is determined by the elevation of the tank. With an elevation of about 15 m, a water pressure of at least 10PSI can be ensured at the end of the DMA, although the water pressure is also affected by the pumping pressure at the inlet and loss inside the downstream pipe (head loss). It is also possible to reduce the time of operating the pump and thus the power cost by sending water to and filling the elevation tank during hours of little water demand. Such an efficient method of water supply control and management will also lead to financial improvement and an efficient water supply system that does not depend solely on electric power.

4.3 Introduction of the SCADA System

At present, the NRW ratio in COWD is about 50%. To perform a financial simulation of the new DPB projects, the JICA Study Team set a reduction goal for NRW ratio. The JICA Study Team and COWD decided to aim at reducing the NRW ratio to 25% by 2025 and maintain the level or further reduce the ratio thereafter. The new DBP projects of COWD (renewing ACP, improving Stub-Outs, reducing illegal connections, and renovating aged pipes) as well as continuous efforts by the leak detection team, replacement of insensitive meters, and other measures will greatly contribute to reducing the NRW ratio; and thus a reduction to 25% by 2025 was judged achievable. The effects of the new DBP projects and the measures are estimated to gradually appear, and the outlook will become apparent by around 2020. The simulation also assumed that many new DMAs will be constructed and DMAs will cover almost the entire water supply district of COWD. For each DMA, the inlet meter counts and the counts of customer's water meters will be read every month and used to calculate the NRW ratio of the month in the DMA. The total ratio of NRW will then be calculated by totalizing the values of all DMAs.

Measuring the amount of inflow is fundamental for DMA and is highly important for a water supplier.

It would be even better if the inflow is continuously monitored. Continuous monitoring of the amount of inflow enables diurnal variation in the DMA to be understood and the time constant to be determined. When the NRW ratio is still high, continuous monitoring can also be used to determine the minimum night flow in the middle of the night, which helps identify DMAs where the NRW ratio is particularly high and the leak survey is to be targeted, and implement efficient and effective measures for reducing the NRW ratio.

After each and every power failure, COWD staff has to visit intake pump facilities to restart the pumps. Restarting the pumps takes time because the facilities are widely scattered. When an intake pump is suspended over a long period of time, air accumulates in the transmission pipe. Large-scale drainage work is required in such a case as the air needs to be removed via an air valve (air release valve) or a hydrant prior to restarting the pump. Shortening the suspension time until restart leads to quick and efficient restoration of the water service. The amount of revenue water will increase if water can be supplied over longer hours; and the amount of NRW will be reduced if the amount of water drained for the pump restoration work can be reduced.

The SCADA (Supervisory Control And Data Acquisition) system is a tool for solving these problems. With the remote-control and data-acquisition system, the amount of inflow can be monitored just by changing the inflow meters to those compatible with SCADA and installing data transmitters. The remote-control system can also be used to restart pumps, which leads to reduced NRW and an increased amount of revenue water as described above.

However, we recommend COWD, which is facing a high NRW ratio today, to use its funds to renew its aged pipes, continue leakage detection surveys, and implement various measures proposed for reducing NRW rather than to purchase SCADA. Only after the NRW ratio of COWD is reduced to a level approaching 25%, should COWD allot its budget for introducing SCADA and further reducing the NRW rate.

4.4 Investigation of the Surface Water Treatment System

The Cagayan de Oro River, which separates CDO City into eastern and western districts, maintains abundant water even during the dry season and empties into the Macajalar Bay. Once it rains, the clayey silt sediment on the river bed is stirred up, making the water turbid. In Southeast Asia, water treatment of highly turbid water (several hundred degrees) is believed difficult, but this is not the case if the quality of the river water is correctly understood.

Highly turbid water can be effectively purified by combining pH adjustment, coagulation sedimentation, rapid sand filtration, chlorination (pretreatment and intermediate treatment), and activated carbon treatment (powdered and granular) depending on insoluble components (Algae) and dissolved components (Color, Iron, Manganese, Taste and Odor, Ammonium Nitrogen, Trihalomethane Precursors, and Agricultural Chemicals) to be removed. More advanced purification is possible by also performing biological and ozone treatments.

After water treatment, the wastewater generated from the treatment process should be treated. Wastewater treatment by rapid filtration involves adjusting the concentration of slurry in a sludge basin, drainage basin and thickener, and dehydrating the sludge (either mechanically or by drying in the sun). The dried sludge may be effectively used as a resource or treated as industrial waste.

Since COWD plans to shift from using underground water to surface water treatment or combining both, a WTP of a daily capacity of several ten thousand m^3 will be required. An energy-saving water supply system can be created by constructing a WTP on highland on the right bank in the upper reaches of the Cagayan de Oro River, which is in the south but not far from the center of CDO city, and sending treated water to a distribution reservoir in the city by gravity flow.

According to the guideline for calculating expenses for renovating water supply facilities of the Ministry of Health, Labour and Welfare of Japan, the expenses for constructing a WTP of 30,000m^3, 50,000m^3 and 100,000m^3 in Japan are 7.5 billion JPY, 10 billion JPY and 15 billion JPY, respectively, without the land cost. By assuming that prices and labor costs in the Philippines are one-fifth of those in Japan, as comparison, the expenses for constructing a purification plant of 30,000m^3, 50,000m^3 and 100,000m^3 in the Philippines are estimated to be 0.6 billion PHP, 0.8 billion PHP and 1.2 billion PHP, respectively.

The WTP has not changed much since the modern water supply system was established. It should be noted that wastewater treatment is a part of the water treatment, and the water treatment and wastewater treatment system needs to be supported by continuous maintenance of the facility and equipment, systematic procurement of chemicals and fuels, and rapid reactions during an emergency (preparation of manuals). In many Southeast Asian countries, water suppliers lack one or some of these points and thus have not been able to purify and use surface water.

The JICA Study Team has worked with COWD for a period of half a year and found that COWD employees have always started to take improvement actions immediately every time we pointed out a problem. The JICA Study Team believes that when COWD successfully completes a WTP, the employees, who are both honest and diligent, will satisfactorily maintain and operate the plant.

Table-4.4.1 Water treatment plant construction costs

Facility	Construction unit cost			Amount	Construction cost		
Design maximum volume	30,000m^3	50,000m^3	100,000m^3		30,000m^3	50,000m^3	100,000m^3
Intake weir	192.4	230.4	325.4	1	192.4	230.4	325.4
Sand settling basin	428.6	566.6	911.6	1	428.6	566.6	911.6
Receiving well	135.7	145.7	170.7	1	135.7	145.7	170.7
Rapid mixing tank	70.6	76.6	91.6	1	70.6	76.6	91.6
Flocculation basin	208.9	302.9	537.9	1	208.9	302.9	537.9
Sedimentation basin	464.5	868.5	1,878.5	1	464.5	868.5	1,878.5
Rapid sand filter basin	825.6	1,215.6	2,190.6	1	825.6	1,215.6	2,190.6
Chlorine mixing basin	129.2	177.2	297.2	1	129.2	177.2	297.2
Pumping well	188.9	228.9	328.9	1	188.9	228.9	328.9
Trans. pump facility (in WTP)	389.6	515.6	830.6	1	389.6	515.6	830.6
Drainage basin	142.9	192.9	317.9	1	142.9	192.9	317.9
Thickener	237.0	255.0	300.0	1	237.0	255.0	300.0
Sun drying bed	48.8	60.8	90.8	1	48.8	60.8	90.8
Mechanical dewatering Facility	520.9	638.9	931.9				
Administration office	313.0	364.0	490.0	1	313.0	364.0	490.0
Chemical feeding facility	199.0	221.0	276.0	1	199.0	221.0	276.0
Central control room	499.6	783.6	1,493.6	1	499.6	783.6	1,493.6
Non-utility generation facility	226.8	293.3	458.5	1	226.8	293.3	458.5
Power receiving equipment	228.9	280.9	410.9	1	228.9	280.9	410.9
Pipeline in WTP	25.3	30.4	39.4	1	25.3	30.4	39.4
Activated carbon facility (Powder)	245.2	289.2	399.2	1	245.2	289.2	399.2
Activated carbon facility (Granular)	423.9	475.9	605.9				
RC reservoir (2,500m^3)	275.2	275.2	275.2	3	825.6	825.6	825.6
PC reservoir (2,500m^3)	315.4	315.4	315.4				
SUS reservoir (2,500m^3)	383.7	383.7	383.7				
Transmission pump facility	550.1	768.1	1,313.1	1	550.1	768.1	1,313.1
Membrane filter facility	1,052.4	1,468.4	2,508.4				
UV treatment facility	383.3	609.3	1,174.3				
Ozone treatment facility	930.7	986.7	1,126.7				
Slow sand filter basin	839.9	1,317.9	2,512.9				
Trans. pipe (DIP1000mm)	0.36	0.36	0.36	2,000	714.0	714.0	714.0
Trans. pipe (DIP 800mm)	0.23	0.23	0.23	1,000	230.0	230.0	230.0
Total (million JPY)	Prices conversion between Japan and Philippines 5：1 (1/5) 1JPY＝0.411PHP (1PHP＝2.433JPY)				7,520.2	9,636.8	14,922.0
Total (million PHP)					618.2	792.1	1,226.6

Remark: Price unit of transmission pipe is per meter.

4.5 Survey of Expansion Works in the Past

In 1973, when the former NAWASA transferred its work to COWD, COWD replaced the entire 39km distribution pipe network as its founding project (Phase 1). Since then, 40 years have passed accompanied by deterioration of pipeline materials over time, and leaks now occur frequently where they were poorly installed. Since its establishment, COWD has conducted two large-scale expansion projects (Phase 2 and 3). To build a sustainable water supply system, reliably replacing aged water supply facilities will be absolutely essential.

COWD is now preparing maps that organize these founding projects records to Phase 3 work records. This work will focus on priority areas for deteriorated pipeline replacement plans, and provide basic information for the enactment of medium and long-term plans.

4.6 Dividing the Financial Burden with the CDO City Government

Under Presidential Decree No. 198 (PD198), Water Districts in the Philippines are to be independent and do not receive any subsidy from the Government. Works for securing future water sources and controlling or mitigating damages by natural disasters such as typhoon and flood impose a huge burden on a water supplier. As the expenses are not included even in the general account of the City Government, the expenses will impose such a huge burden on the finance of COWD that may lead to bankruptcy; and thus COWD has to leave the measures intact. This may result in the citizens being burdened with serious damages. At present, not even a reasonable share by the City Government is even discussed, but the discussion is crucial for the water service district from long-term perspectives.

In Japan, the expenses for installing maintenance hydrants, which are firefighting equipment and water sources for firefighting, are paid to the Waterworks Bureau from the general account of the corresponding City Government. The responsibilities and burdens for protecting the life and property of people should not be imposed entirely on a public enterprise but be shared by the entire city administration including the Water District.

4.7 Development of Sewerage System

CDO City is the highly urbanized and capital city of the province of Misamis Oriental and serves as the entrance to the island of Mindanao. CDO City is not a tourist city but an advanced academic city where many educational and research institutes are located. Population inflow from suburbs is estimated to continue, and the population is predicted to exceed one million by about 2030. COWD is the operator in charge of water services including water supply and sewerage, which support the infrastructures in this metropolis.

As CDO City, which is expected to further develop into a sustainable city of study and research, is aiming to be an advanced hygienic city and a model of water and sewerage services, early construction of the sewerage system is anticipated. COWD has recognized its responsibility for building the sewerage system in the city, but actual actions taken have been installing septic tanks for building owners. COWD places maximum priority on securing the amount and quality of the water supply and will start the sewerage works after the goals have been achieved.

The sewerage system requires more construction costs compared to waterworks, and thus a construction plan should be formulated from long-term perspectives. Urban infrastructure is completed only after the sewerage system is constructed, and thus early completion of water supply improvement by COWD is highly anticipated.

In CDO City, prior to sewerage systems development, septage management is required. At present, it is important to ensure septage management that COWD is implementing and maintain the system for smooth sludge collection.

5 Closing Remarks

Even though NRW is shown to inhibit successful waterworks operations according to certain indicators, if abundant water resources are available then it does not represent a particularly threatening problem. However, variable costs (pump power costs, chemical costs) are undoubtedly a source of waste, and reduction of NRW can reduce these variable costs. In the COWD, increases in the population supplied with water are expected to lead to higher water demand, which makes the transformation of NRW into revenue water a vital issue.

Regarding measures for reducing NRW, there is a tendency to place too much emphasis on leak detection and repair. Because day-to-day facility maintenance, data management and other such efforts form the foundation of success in these measures, the entire administrative organization must work together as a team to steadily apply effective waterworks-field countermeasures based on a comprehensive viewpoint.

In our efforts, we made improvements to management maps based on such a viewpoint and put forth various proposals in numerous areas. There are many types of measures, including those that can be applied immediately as well as those that require a planned budget and mid- to long-term implementation approach. Whichever the case may be, we hope that everyone involved will unite as a cohesive organization in the COWD in pursuit of NRW reduction by first trying out measures that can be applied immediately, making necessary adjustments along the way, and utilizing these measures to improve waterworks operational performance.

The proposals offered by the JICA Study Team are in no way difficult to implement. The contents of these proposals represent standard operations carried out by Japanese waterworks system operators on a daily basis, and we sincerely hope that they will be proactively applied in the COWD as well.

Before the JICA Study Team began these operations, our impression of this water district, in which the ratio of NRW exceeds 50%, was a district whose management and workers had low morale, relied on others rather than taking responsibility for themselves, and conducted maintenance in a halfhearted manner. However, the passionate devotion toward making improvements by the highly experienced Chairman of the Board of Directors and young General Manager; the high motivation, capabilities and flexibility of the young workers; and the inspection system and so forth of the maintenance division impressed us deeply, with their vigorous and proactive attitudes surpassing even those of the Japanese water supplier members at times.

The JICA Study Team is deeply thankful for the kind support and cooperation of our Philippine counterparts as well as management and others while this project was being carried out, as these enabled the JICA Study Team to successfully complete onsite operations and enjoy their work.