SAN JOSE WATER

SAN JOSE DEL MONTE CITY
WATER DISTRICT

Water Safety Plan

DECEMBER, 2015 - VERSION 1

Table of Contents

List of Figures

List of Tables

Abstract

The City of San Jose Del Monte is located at the northeast portion of Manila characterized by topography of rolling plains. The City is approximately 42 kilometres away from Manila. Due to its proximity to Metro Manila, the city earned its appellation as the "Balcony of the Metropolis". The city is largely a resettlement area of the government, thus, the rapid growth in population. At present, the city is divided into two political districts; District 1 – the part of the city which is outside Sapang Palay Resettlement Project (SPRP) and District 2 which comprises SPRP. It has a total number of 59 barangays.

Sixty percent (60%) of the city's water supply comes from San Jose Del Monte City Water District. San Jose del Monte City Water District (San Jose Water) is a government owned-and controlled corporation established on July 22, 1980 by virtue of PD 198, as amended, otherwise known as the Provincial Water Utilities Act of 1973. It belongs to Category A of water districts.

San Jose Water gets its source from surface water and ground water. It has a total length of pipelines laid of 591, 677.7 linear meters, traversing the slopes of the city. San Jose Water divided its service area into two parts – "Area", which is within Sapang Palay Resettlement Project (SPRP) and "Non-Area" which is outside SPRP. Non-Area is composed of barangays outside SPRP and numerous private subdivisions - some of which had their water systems turned over to San Jose Water.

It is mandated to provide safe and potable water and sanitation to the residents of the City of San Jose Del Monte, Bulacan. San Jose Water serves all 59 barangays in the city. It has 92, 945 total number of service connections translating to approximately a population of 521, 515; it is the fourth largest water district in the country.

San Jose Water has a total raw water allocation of 80,000 cmd from Metropolitan Waterworks and Sewerage System (MWSS). The allocated raw water supply comes from Angat Dam, which is a multi-purpose dam and is intended for power, irrigation and water supply. To date, San Jose Water gets close to 50,000 cmd raw water from MWSS Aqueduct No. 6 which passes adjacent to the Water Treatment Plant Compound of San Jose Water.

Aside from the allocated raw water from MWSS, San Jose Water also gets treated water from Angat Bulk Water Supply System Project (ABWSP). San Jose Water also makes

use of 11 deep well stations located outside SPRP Area. These deep wells have rated capacity of 25 to 190 gpm.

To ensure safe and potable water is being delivered to the residents of the city, San Jose Water conducts hourly collection of samples from randomly selected concessionaires for turbidity and chlorine residual testing. Its treatment plants have an online chlorine residual monitoring system.

Once a month, water samples are submitted to DOH-accredited laboratories for bacteriological testing. Water sample is collected at source twice a year for physical and chemical analysis. San Jose Water also guarantees that the water it serves conforms to the standards prescribed by the Philippine National Standards for Drinking Water.

To further improve water quality, San Jose Water signed an agreement with the Korean Water Resources Corporation for a one-year twinning partnership in 2011. The partnership resulted to efficient coagulation with the revision on coagulant dosing line at raw water intake facility, improved sludge treatment system, improved manganese removal capability and stricter water quality monitoring by inclusion of additional parameters such as manganese, alkalinity, color, iron and trihalomethanes.

Last April 1, 2015, San Jose Water implemented Septage Management Project for the City of San Jose Del Monte. The city government passed Ordinance No. 2012-48-11 requiring all owners of residential, commercial, and industrial structures in the city to desludge their septic tanks every five years. This will ensure that septage will be properly collected, treated and disposed in accordance with the environmental standards. This project will reduce the occurrence of contamination of water ways such as creeks, rivers and ground water.

The Water Safety Plan focuses on monitoring the safety of drinking-water supply from its catchment to San Jose Water's concessionaires. This WSP comprises the protection of the water sources, water treatment plants, pumps and reservoirs from risks that will endanger the quality of water being delivered.

The plan covers San Jose Water's water supply and distribution systems in Water Treatment Plants No. 1 and 2, the eleven (11) deep well (ground water) stations and the Angat Bulk Water Supply System.

Introduction

The City of San Jose Del Monte covers 10,553 hectares, according to the Land Management Bureau. However, the Local Government Unit (LGU) claims an actual territorial area of 31,294 hectares; this includes the disputed areas with adjacent municipalities. The Angat Watershed Reservation, which has a land area of 18,000 hectares, is partly within the City.

Commercial, residential, and light industrial areas, are found all over the City. Currently, it has more than a hundred private subdivisions located in various barangays. There are also at least six resettlement projects of the National Housing Authority within the City. The biggest of which is the 752 hectares SPRP in Sapang Palay. In between the built-up clusters are pockets of agricultural lands, which are continuously converted into urban uses.

The city is divided into two political districts; District 1 which comprises the 23 barangays outside SPRP and District 2 which comprises the remaining 36 barangays in SPRP.

Based on the city's demographic profile, the City of San Jose del Monte experienced a 3.64% population growth, or an additional population of 138,746 persons from the year 2000. Should the city observe the same growth trends, in 30 years, the city's population would increase by roughly 1.9 million.

The San Jose del Monte City Water District (San Jose Water) is a government owned-and controlled corporation established on July 22, 1980 by virtue of PD 198, as amended, otherwise known as the Provincial Water Utilities Act of 1973. It belongs to Category A of water districts.

San Jose Water started with only 200 service connections carried over from the old municipal waterworks system it replaced. To reach out to the communities not yet served by regular distribution lines of San Jose Water due to financial and technical limitations at that time, it implemented the Tawid Uhaw Project (TUP) in the early 90's. TUPs are structures made up of two communal metered faucets funded by the local government and civic organizations.

In 1995, San Jose Water was able to secure approval for the implementation of the Comprehensive Water Supply Improvement Project Phase I funded by the French and Philippine governments. In 1997, the P154-milion modern Water Treatment Plant was completed and inaugurated at Bgy. Minuyan. This treatment plant serves mostly the Sapang Palay Resettlement Project Area and processes 20,000 cubic meters of raw water per day from the Angat River.

Early in 2006, San Jose Water started operating its second water treatment plant under the Comprehensive Water Supply Improvement Project Phase II. The Project, amounting to P547 Million is funded by the Japan Bank for International Cooperation (JBIC) through the Local Water Utilities Administration (LWUA). The additional 30,000 cmd of safe drinking water benefited 30,000 households. Included in the project is the construction of another Water Treatment Plant at the WTP Complex at Brgy. Minuyan, Sapang Palay, City of SJDM. Raw water is sourced from the Angat River.

San Jose Water began implementing Angat Bulk Water Supply System Project in 2014 to augment the water requirement of the concessionaires in SPRP area and in Brgy. Muzon – the most populous barangay in the city. A 1,000 cum steel bolted tank, expandable to 2,000 cum was installed at Bgy. Muzon.

Still part of its mandate of providing water and sanitation to the city, San Jose Water established its Septage Management Project for the city. City Ordinance No. 2012-48-11 establishing a septage management program for the city was signed by Mayor Reynaldo S. San Pedro last December 4, 2012. The passage of the ordinance is in compliance with the requirement of Clean Water Act which requires LGUs to provide an enabling environment for septage management to preserve the integrity of our water resources, ensure water quality and promote public health. The ordinance authorizes San Jose Water to collect and haul septage from domestic, commercial and industrial establishments in the city. A 60 cmd septage treatment facility was constructed to treat and dispose the effluents according to prevailing environmental standards.

With quality and adequacy of its water supply taken cared of, San Jose Water is now the largest water district in Central and Northern Luzon and the fourth largest in the country. At present, San Jose Water is a Category A Water District. It currently serves all 59 barangays in the city. It has 92, 945 service connections translating to approximately a population of 521,515. The 98.48% of San Jose Water's service connections are classified as residential while 1.52% belongs to commercial classification.

San Jose Water has a total number of 260 employees or a ratio of 1:356 per service connection.

Our Vision

Safe and potable water flowing twenty four hours a day from the tap of every home in the City of San Jose del Monte.

Our Mission

To serve all residents of the City of San Jose del Monte with equitable, reliable and immediate access to safe and potable water twenty four hours a day at the least possible cost.

As mandated by the Department of Health's Administrative Order 2014-0027 which declares the development and implementation of Water Safety Plan (WSP) by all drinking-water service providers and as required by the Local Water Utilities Administration Memorandum Circular No. 010.14, the management of San Jose Water issued a Memorandum Circular dated December 16, 2015 directing a ___-man team who are experts in water quality monitoring to create and develop a Water Safety Plan. The newly assembled WSP Team mostly come from the Operations and Technical Services Groups. The team underwent rigorous training, workshops, and walkthroughs to identify and assess the hazards and risks that may jeopardize the quality of water being delivered to concessionaires.

The WSP Team conducted periodic meetings and consultations which helped them developed an appropriate Water Safety Plan. Control measures were considered for each identified hazards. The effectiveness of these control measures was validated and was included in the improvement plan.

San Jose Water's WSP is in conjunction with its Crisis Management Plan created in 2013. This crisis management plan of San Jose Water aims to ensure, in emergency and disaster situations, the least possible impact on water supply and San Jose Water's public image through an effective response that contributes to preserving the health and life of the population.

The WSP on the other hand, focuses on monitoring the safety of water from its source to San Jose Water's concessionaires. This WSP comprises the protection of the water sources, water treatment plants, pumps and reservoirs from risks that will endanger the quality of water being delivered to the concessionaires.

Specifically, this plan aims to:

a) Ensure the safe quality of supplied water from its catchment to the tap of every home in the City of San Jose Del Monte.
b) Prevent contamination of water by identifying potential risks and addressing these risks quickly and effectively with appropriate control measures
c) Provide policies and procedures to maintain quantity and quality of service even during adverse conditions
d) Facilitate decision-making on critical issues in a potentially stressful environment and define responsibilities and roles during emergency situation
e) Provide procedures for using the lessons gained following every emergency or unforeseen event to guarantee that every hazard and issues are covered and will not recur in the future.

The plan integrates existing operational crisis response plans managed by individual Departments of San Jose Water. It is considered as a risk management strategy or umbrella which will influence San Jose Water's tasks of working towards the continuing supply of safe water. Further, the plan is intended to facilitate organized decision-making in times of crisis and is designed to be used in conjunction with the normal decision-making hierarchy of San Jose Water and does not supplant that decision-making process.

I. THE WATER SAFETY PLAN TEAM

To secure the technical expertise needed to develop this Water Safety Plan, San Jose Water assembled a team of experts in water quality monitoring coming from Operations and Technical Services Groups. These individuals have vast experience in understanding the quality of raw water, its treatment and distribution.

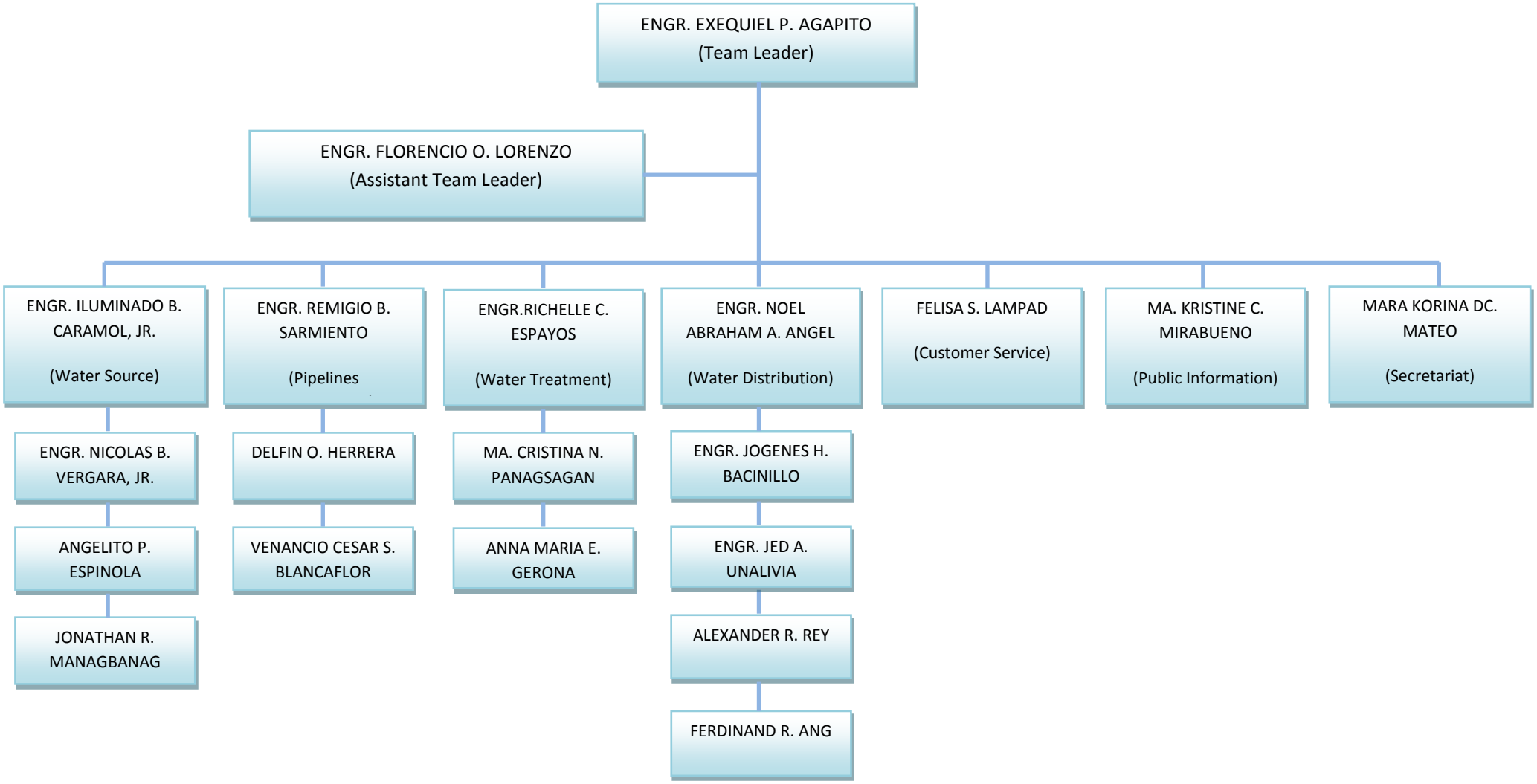


Figure 1 - The San Jose Del Monte City Water District Water Safety Plan Team

NAME	DEPARTMENT/ DIVISION	OFFICIAL DESIGNATION	WSP TEAM RESPONSIBILITY	TASK DESCRIPTION IN THE WSP TEAM
Engr. Exequiel P. Agapito	Production Dept.	Manager	WSP Team Leader	Over sees the following: ➢ Production, quality control/monitoring, storage and distribution of safe and potable water to consumers ➢ Operation, safeguarding and maintenance of production, treatment and storage facilities/appurtenances of San Jose Water.
Engr. Florencio O. Lorenzo	Water Treatment Plant Division	Manager	Assistant Team Leader	Oversees the: ➢ Operation, safeguarding and maintenance of Water treatment Plant equipment, structures and grounds ➢ Application of chemicals on all stages of the treatment process and assists in the implementation of other water quality management programs ➢ Initiates the evaluation of existing systems and research on new treatment methods or chemicals and submits recommendation
Engr. Iluminado B. Caramol, Jr.	Bulk Water Supply and Pumping Station Division	Manager	Water Source	Oversees the: ➢ Operation, safeguarding and maintenance of equipment, appurtenances, structures and grounds on all Deepwell Pumping Stations, lift/booster stations and reservoir stations. ➢ Maintenance of adequate supply of safe and potable water at the distribution system ➢ Application of chemicals at deep well sources and assists in the implementation of other water quality management programs ➢ Initiates the evaluation of existing systems and submits recommendation

Engr. Remigio B. Sarmiento	Service Connection and Water Meter Maintenance Division	Manager	Pipelines Maintenance	➢ Plans for, recommends and implements all corrective and preventive maintenance works on San Jose Water transmission and distribution mains, line appurtenances and service connection meters ➢ Plans for, recommends and implements all preventive and corrective maintenance works on San Jose Water reservoirs and tanks ➢ Implements existing San Jose Water policies, Standard Operating Procedures (SOPs), safety practices regarding maintenance works; reviews said policies, SOPs, safety practices and recommends changes as deemed necessary. ➢ Coordinates with local government officials and other non-government officials in the implementation of maintenance works to ensure understanding and smooth facilitation of the works required
Engr. Richelle C. Espayos	Water Treatment Plant Division	Sr. Engineer A	Water Treatment	➢ Implements, supervises and updates various water quality management programs of Water Quality Management Section based on PNSDW and other recognized standards on drinking water quality ➢ Assists the operation and monitoring of all electromechanical equipment of Water Treatment Plant No. 1 and No. 2 based on water demand of the system and water quality requirement at the water source ➢ Ensures protection, cleanliness and security of the WTP laboratory equipment, tools and various units of chemical handling and feeding system ➢ Coordinates the maintenance requirements of WTP laboratory equipment, tools and all electromechanical equipment of chemical handling and feeding system

Engr. Nicolas B. Vergara, Jr.	Bulk Water Supply and Pumping Station Division	Sr. Water Utilities Management Officer	Pipelines Maintenance	➢ Directs the operation and safeguarding of deep well sources, lift, booster stations, reservoir stations and other distribution system appurtenances ➢ Coordinates with the Maintenance and support Services Group regarding the maintenance of equipment, facilities and appurtenances ➢ Coordinates with Water Quality Management Group regarding the operation of chlorination equipment at deep well sources ➢ Assists in the evaluation of existing systems and submits recommendations
Engr. Noel Abraham A. Angel	Bulk Water Supply and Pumping Station Division	Engineer A	Water Distribution	➢ Monitors water supply in the entire service area of San Jose Water ➢ Supervises and monitors corrective and preventive maintenance on all production facilities ➢ Inspects all production and storage facilities of San Jose Water ➢ Updates maps and data base for the improvement of water supply ➢ Ensures the security of San Jose Water's structures
Ma. Kristine C. Mirabueno	Corporate Affairs Division	Information Officer B	Public Information	➢ Compiles and writes press releases, news items, captions and feature articles of the water district for publication at local and national newspaper and for broadcast at the radio and television. ➢ Establishes and maintains cordial relations with the media and other civic oriented groups ➢ In charge of the newsletter, brochures, information aides and the annual report of the water district ➢ Files clippings and articles regarding water district and its activities ➢ Recommends to management solutions to public relation problems

				➢ Monitor all systems operations of the water district so as to be aware on pertinent facts and data whenever queries are raised by media group, etc. ➢ Promotes and designs programs that shall establish the role of the water district in the community in which it is dedicated to the advancement of the public interest/to gain the confidence of the public in the water district's capacity to render good if not excellent service and to provide safe and potable water ➢ Performs any public relations related works as been tasked by the General Manager. ➢ Performs other related duties that may be assigned from time to time by the General Manager.
Mara Korina DC Mateo	Production Dept.	Clerk Processor B	Secretariat	➢ Performs clerical job ➢ Type letters, reports memorandums and other needed documents ➢ Files and maintains records of all correspondence and reports. ➢ Prepares and dispatches request of the team needed for the operation ➢ Performs other function that maybe assigned from time to time
Engr. Jogenes H. Bacinillo	Bulk Water Supply and Pumping Station Division	Sr. Water Utilities Management Officer	Water Distribution	➢ Directs the planning, implementation and monitoring of all preventive, predictive and corrective maintenance activities on all WTP equipment, appurtenances, structures and grounds in coordination with the Operations Section ➢ Evaluates existing maintenance system and

				recommends improvement to meet the required efficiency and safety ➢ Submits report and communications to superiors regarding the monthly accomplishment activities and other concerns of the Section
Engr. Jed Uñaliva	Bulk Water Supply and Pumping Station Division	Engineer A	Water Distribution	➢ Supervises and assists in the following activities of the Section: a. leak detection, b. day and night time flow measurement ➢ Prepares and implements programs in reducing non-revenue water ➢ Prepares and implements project related in reducing non-revenue water ➢ Records data gathered on the field and interprets data for further actions ➢ Submits reports and communications regarding the activities and accomplishments of the group.
Felisa S. Lampad	Customer Service	Customer Service Officer B	Customer Service	➢ Assists in supervising and monitoring service application aspect of the Marketing and Service Application Section ➢ Approves processed New Connection (NC) applications, Maintenance Orders (MO) for Inspection and Estimate, Reconnection Disconnection, Mainline Disconnection and Service Requests. ➢ Disseminates Water District programs and policies ➢ Entertains complaints/reports from WD concessionaires and concerned citizens ➢ Verifies adjustment to receivables and prepares notice to concessionaires.

				➢ Prepares adjustment memo based on complaints
Delfin O. Herrera	Service Connection and Water Meter Maintenance Division	Water Maintenance Foreman	Pipelines	➢ Supervises and assists in the ff activities of the Section: a. implementation of project, b. interconnection work, c. preparation of program works ➢ Prepares and updates program of works ➢ -Submits reports and communications to superiors regarding the status and accomplishment of the project. ➢ Maintains availability and orderliness of materials and equipment for the project
Venancio Cesar S. Blancaflor	Service Connection and Water Meter Maintenance Division	Sr. Water Maintenance Man A	Pipelines	➢ Inspects and estimates all applicants for New Connections, Mainline Disconnection and Mainline Reconnection ➢ Prepares and submits all construction and related documentations ➢ Supervises the restoration of all damage roads, pavement and other facilities affected by the implementation of all WD utility projects and repairs ➢ Monitors and submits reports on the status of the actual construction of the water supply system of subdivisions turned-over to the WD
Ma. Cristina N. Panagsagan	Water Treatment Plant Division	Chemist A	Water Treatment	➢ Conducts bacteriological and physical/chemical analysis of water samples from all sources and at the distribution system including samples from other agencies/institutions ➢ Conducts research and testing on new treatment chemicals to keep up with the trend of modern

				technology. ➢ Determines and recommends proper dosages of coagulants and disinfection chemicals ➢ Monitors monthly consumption of treatment chemicals and other consumables to maintain adequate stock at all times ➢ Prepares and maintains complete records of all laboratory test and activities ➢ Cleans, maintains and calibrates laboratory apparatus and equipment
Anna Maria E. Gerona	Water Treatment Plant Division	Medical Technologist I	Water Treatment	➢ Conducts the ff laboratory activities: a. Bacteriological examination of drinking water collected at source and distribution system. b. Preparation of culture media used for bacteriological examination. c. Sterilization of glassware to be used for conduct of bacteriological examination d. Calibration and cleaning of equipment/apparatus used for bacteriological examination. ➢ Collects water sample at source and distribution system for daily water quality monitoring ➢ Conducts regular inventory of culture media and other materials needed for bacteriological examination ➢ Prepares monthly report on individual results of bacteriological examination of drinking water. ➢ Maintains cleanliness and orderliness of the laboratory

Angelito P. Espinola	Bulk Water Supply and Pumping Station Division	Plant Equipment Operator C	Water Source	➢ Operates and controls all electromechanical equipment and appurtenances of the WTP in coordination with laboratory personnel and adjacent lift/booster stations. ➢ Computes and records production, chemical usage, power usage and other similar data during tour of duty ➢ Assists in the implementation of urgent maintenance activities of the WTP
Jonathan R. Managbanag	Bulk Water Supply and Pumping Station Division	Sr. Water Resources Facilities Technician	Water Source	➢ Operates and controls all electromechanical equipment and appurtenances of the WTP in coordination with laboratory personnel and adjacent lift/booster stations. ➢ Computes and records production, chemical usage, power usage and other similar data during tour of duty ➢ Assists in the implementation of urgent maintenance activities of the WTP
Alexander R. Rey	Bulk Water Supply and Pumping Station Division	Sr. Water Resources Facilities Technician	Water Distribution	➢ Operates and controls all electromechanical equipment and appurtenances of the WTP in coordination with laboratory personnel and adjacent lift/booster stations. ➢ Computes and records production, chemical usage, power usage and other similar data during tour of duty. ➢ Assists in the implementation of urgent maintenance activities of the WTP

Ferdinand R. Ang	Bulk Water Supply and Pumping Station Division	Sr. Water Resources Facilities Operator A	Water Distribution	➢ Operates pumping units and water treatment equipments within jurisdiction to maintain adequacy and safety of water supply. ➢ - Monitors, checks and records all meter readings and other related data and accomplishes daily operation records. ➢ Manipulates distribution valves to meet water supply schedule and to faciltate mainline leak repair. ➢ Conducts routine chlorine residual monitoring and checks water supply schedule on selected points of the distribution system. ➢ Logs important events/abnormalities during tour of duty and informs superiors if necessary. ➢ Attends to customer complaints/requests

II. THE WATER SUPPLY SYSTEM

San Jose Water gets its source from surface water and ground water. It has a total length of pipelines laid of 591, 677.7 linear meters, traversing the slopes of the city. San Jose Water divided its service area into two parts – “Area”, which is within Sapang Palay Resettlement Project (SPRP) and “Non-Area” which is outside SPRP. Non-Area is composed of barangays outside SPRP and numerous private subdivisions - some of which had their water systems turned over to San Jose Water.

The City of San Jose Del Monte is largely a resettlement area of the government. Month by month, families from nearby Metro Manila’s depressed areas come in droves to settle in government low-cost housing units. These relocated families comprise 43% of San Jose Water’s service area, while the remaining 57% of the served population is from private subdivisions which water systems have been turned over to San Jose Water, two bulk water supply concessionaires and erstwhile residents of the city.

San Jose Water serves more than 90,000 residences and establishments within the city twenty-four hours a day, seven days a week. Service connections are classified as 98.48% residential which comprises the majority of the served population, 1.52% commercial, and a marginal percentage for backyard farming, agriculture and livestock.

Residential class is intended for domestic consumption. Commercial class is intended for business purposes. Because of the city’s rapid growth in population, San Jose Water has to cope with the city’s increasing demand for fresh and potable water.

San Jose Water’s water quality conforms to standards set by the Philippine National Standards for Drinking Water to guarantee that the water supplied to consumers is of the highest quality, potable and safe for general domestic use and consumption.

The water supplied to concessionaires averages 0.5 mg/L chlorine residual with no objectionable color, odor and taste. It has chemical constituents that are within the limits and free from indicator organism (Coliform, E. Coli).

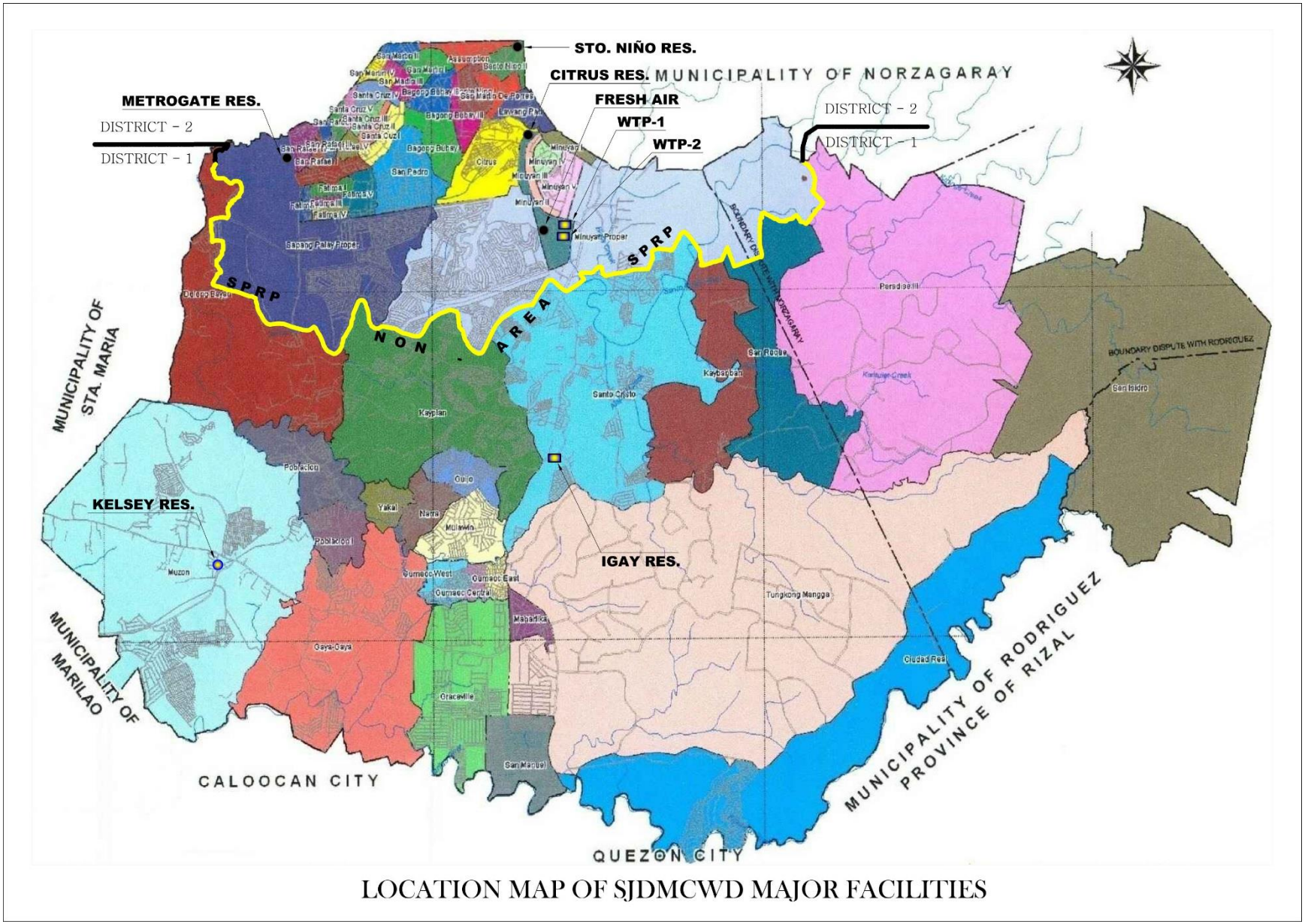


Figure 1 – Location Map of San Jose Water's Major Facilities

A. Water Sources

Surface Water

MWSS Raw Water Allocation

San Jose Water has a total raw water allocation of 80,000 cmd from Metropolitan Waterworks and Sewerage System (MWSS). The allocated raw water supply comes from the Umiray- Angat-Ipo system in Norzagaray, Bulacan. The heart of the system is the Angat Dam, which is a multi-purpose dam and is intended for power, irrigation and water supply. To date, San Jose Water gets close to 50,000 cm of raw water per day through MWSS' Aqueduct No. 6 which passes adjacent to the Water Treatment Plant Compound of San Jose Water.

The Angat Bulk Water Supply Project (ABWSP)

The Angat Bulk Water Supply Project (ABWSP) produces 15,000 cmd treated water that augments the water requirement for Brgy. Muzon and some portions of Sapang Palay Resettlement Area. Brgy. Muzon is the city's biggest and most populous barangay and also the farthest from San Jose Water's Water Treatment Plants. Water from ABWSP undergoes regular chemical, bacteriological, and physical analysis.

Groundwater

Most of San Jose Water's ground water stations are located within the residential area of the city. The management have to purchase the lot where the ground water will be extracted, some were preexisting and were donated by private subdivisions which water systems were turned over to San Jose Water.

At present, San Jose Water makes use of 11 deep well stations located in Non-Area. These deep wells have rated capacity of 25 to 190 gpm. The treatment for ground water involves the use of Liquid Chlorine Dioxide and Liquid Calcium Hypochlorite.

B. Water Treatment

Water Treatment Plant No. 1

San Jose Water uses the standard coagulation-flocculation-clarification-, rapid gravity media filtration and chlorine gas disinfection. WTP1 use the coagulation-flocculation process but employs the pulsator clarifier for turbidity removal. It undergoes single media filtration and final disinfection by chlorination. The system have capability for preliminary, intermediate and post- chlorination. The system also employs back-up use of liquid calcium hypochlorite if chlorine gas is not available. The water treatment plant uses Poly Aluminum Chloride for the coagulation, as well as provision for use of additives such as Polymer.

The first step of the process involves proper mixing of raw water with PAC (Poly Aluminum Chloride) with 10% minimum alumina content as coagulant with contact time of less than 1 min. Chlorine is also added for preliminary disinfection to eliminate the existing microorganism (algae, bacteria) that is likely to grow in the structures and sludge blanket.

Water contains colloidal suspended solid which must be gathered into heavy floc to allow settling which takes place into two steps: coagulation that involves destabilizing the colloid to precipitate and flocculation process that intends to increase the cohesion of the floc formed by coagulation.

Following this process is settling that is allowing the particles in suspension in the water to settle by gravity to improve water quality. Each Pulsator clarifier is designed to treat half of the entire flow. Clarified water is evenly collected over the whole surface by perforated troughs and flows into a canal feeding four filters. Sludge formed from the clarifier flows by gravity in the WTP 2 sludge lagoon for disposal.

Filtration is designed to remove particles suspended in water. The filters provide a 1.2m water depth above the filter media. The sand layer allows intensive washing with air and water without any grain size degrading or mud ball formation. Filter backwashing

is carried out by air and water together with surface sweeping using clarified water. The wash water from the filter backwashing goes into the wash water recycling tank and let to stand for 1 hour before recovery and pumped into the flash mixer. The filtered water flows by gravity from the filtered water channel outlet into a covered storage tank.

The final process involves injecting chlorinated water into the filtered water tank to disinfect any remaining contaminant in the water that may be dangerous to the health, as well as to meet the standard set in residual chlorine by the PNSDW to assure safe drinking water. Chlorinated water then flows into the Treated Water tank with capacity of 1,100 m^3, which goes to the distribution system.

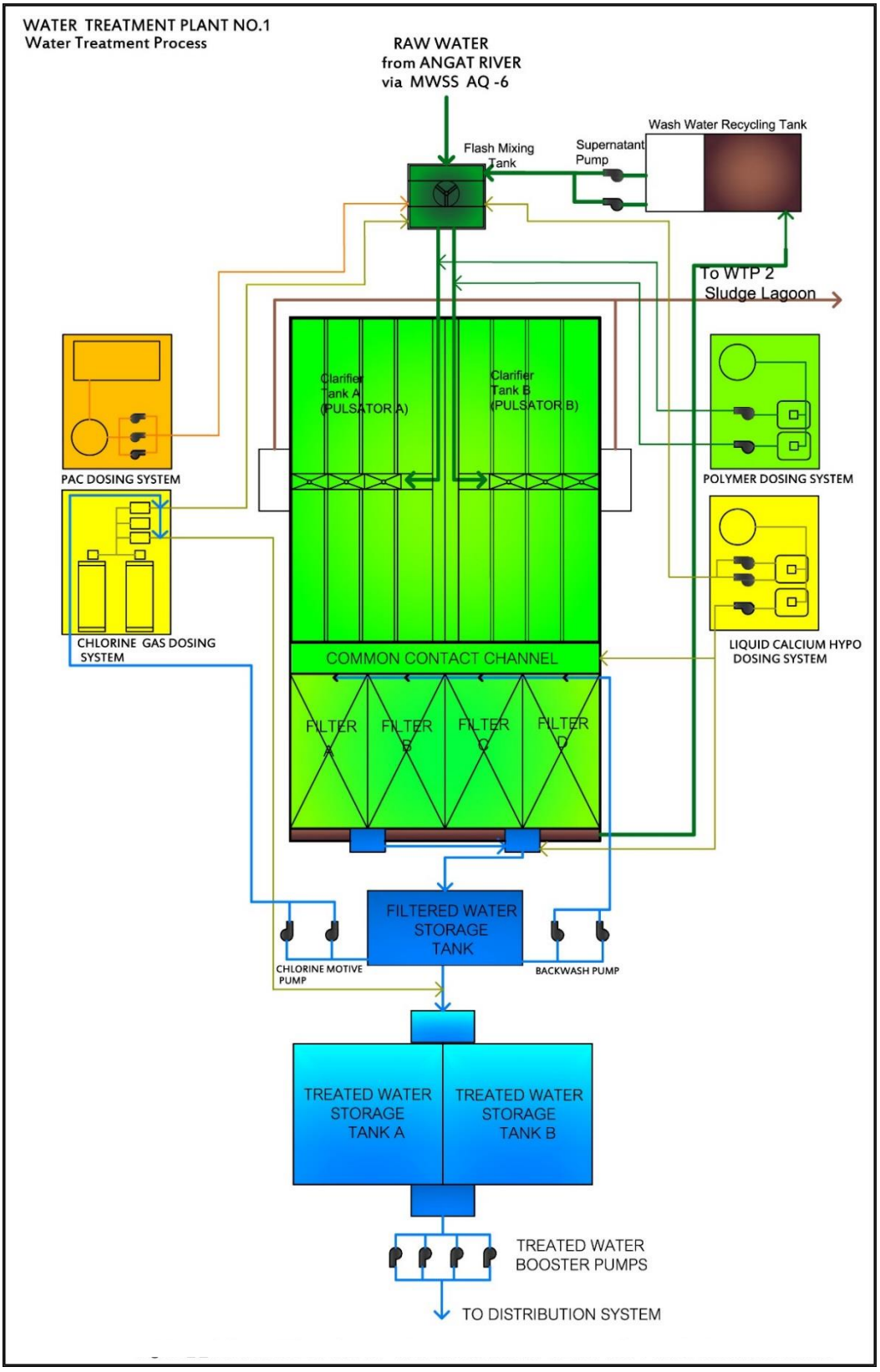


Figure 2 - Schematic Diagram of WTP No. 1 Water Treatment Process

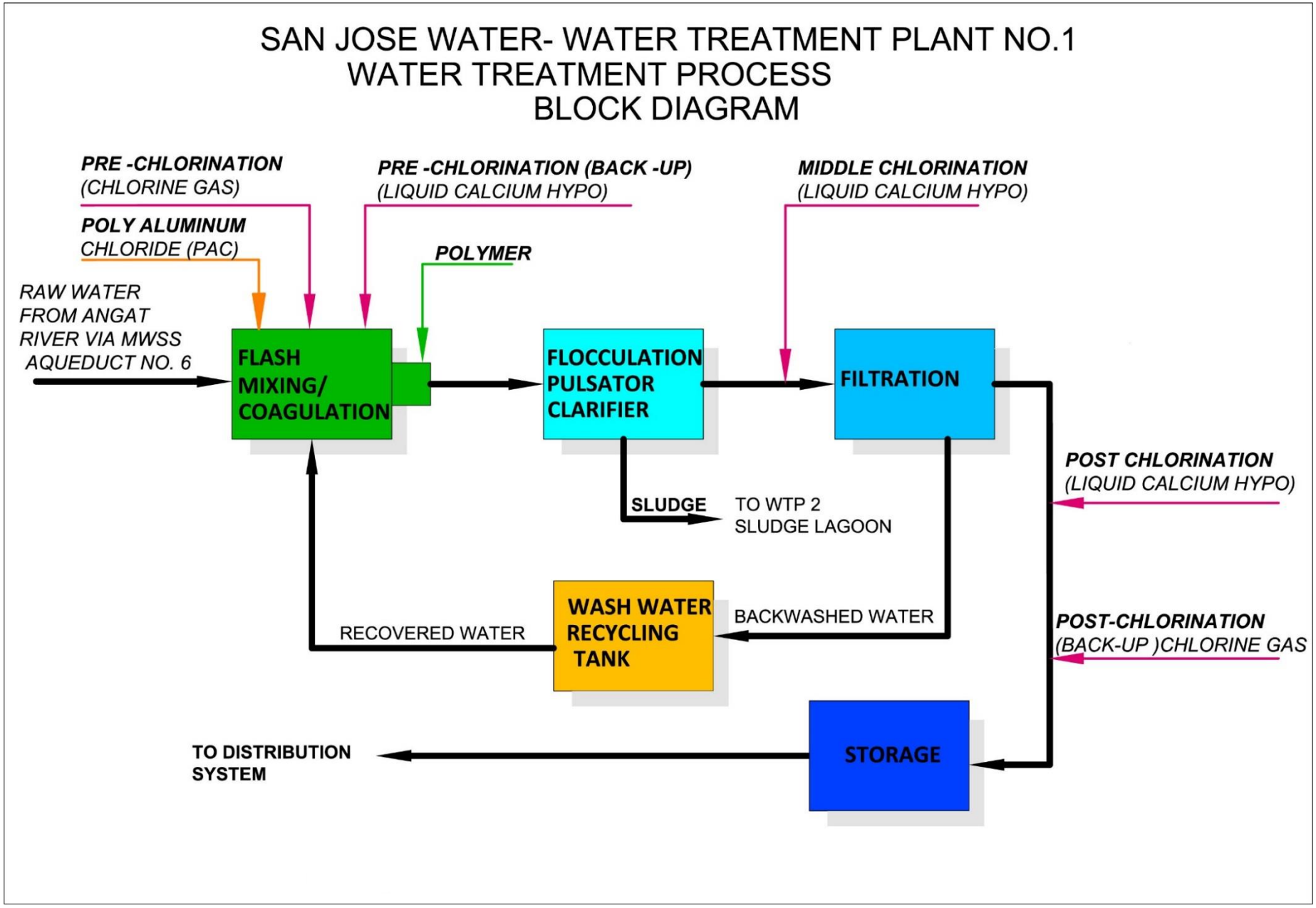


Figure 3 - Block Diagram of WTP No. 1 Water Treatment Process

Water Treatment Plant No. 2

Raw water flows to WTP2 under pressure from aqueduct via a 600mm diameter pipework. This raw water is then pre-treated in the form of screening and grit removal before flowing into the raw water tank to assist in equalizing any peaks of high turbidity and some minor setting. The 30mld flow then proceeds to the succeeding treatment process within WTP 2.

PAC together with Chlorine Gas is added and mixed uniformly with raw water by two installed paddle mixers. The system have back-up use of liquid calcium hypochlorite for chlorination like the WTP1 and also provision for polymer addition. Right after is the first stage of Pre-Treatment which is screening. Two screens will prevent large solids from further entering the WTP process. The automatic screen cleaning mechanisms and screening conveyor are activated by the measurement of differential level across the screen or after a preset time. The screenings collected are discharged into a discharge chute and then to a screening bin located at ground level adjacent to the raw water inlet structure.

A grit separation system is utilized after the screens to remove sand and grit particles form the raw water supply. In the aerated grit chamber, grit is removed by causing the raw water to flow in a spiral pattern. Air is introduced to the grit chamber via blowers and air diffusers along one side causing a perpendicular spiral velocity pattern to flow through the tank.

In the grit removal system, baffled walls are installed to facilitate coagulation and are facilitated by flocculation process which is slow mixing of coagulated raw water that allows particles to gather to form larger, heavier particles called "floc" which will be settled in the raw water tank. In the raw water tank, the training walls facilitate long detention time in order to allow proper settling time for the heavier flocs to form as sludge at the bottom of the tank. A small inlet pipe inside the raw water tank supplies the Amiad Microfiber Filter with flow of 2,500 m¬³ each.

Water then flows into the two flocculation tanks and flows again by gravity into the common inlet channel. From the inlet channel the water flow is divided into six (6) filter units for filtration of water. Dirty wash water from the filter units gravitates to one of two Sludge Separation Tanks. The sludge from the SST gravitates in the sludge lagoon and supernatant is pumped back to the inlet chamber of WTP2.

The filtered water from the filter units and Amiad microfiber filter enters the Contact Channel where it is dosed with chlorine prior to entering the Clear water Tanks. The chlorinated clear water is then pumped into the Distribution system.

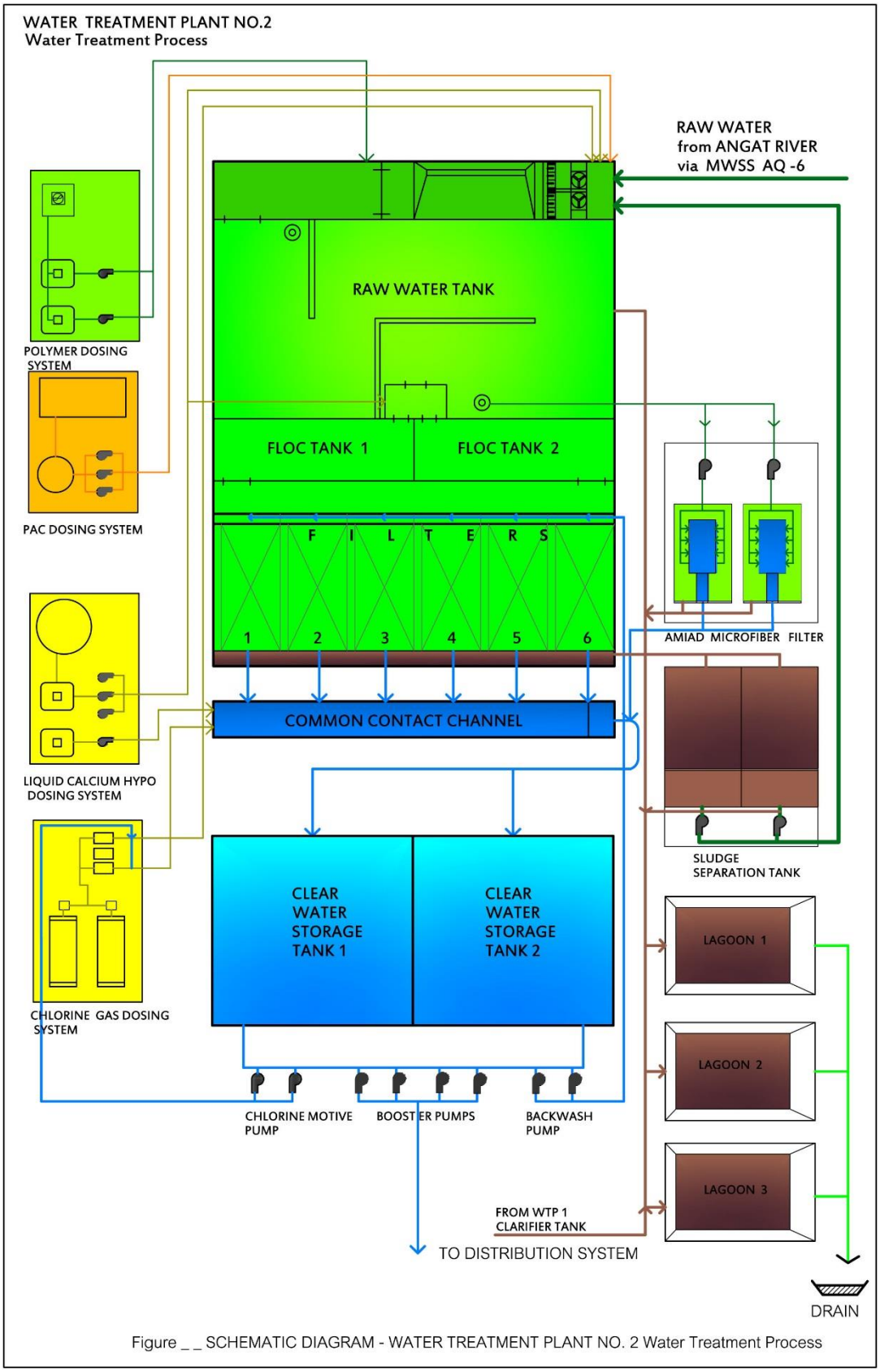


Figure 4 - Schematic Diagram of WTP No. 2 Water Treatment Process

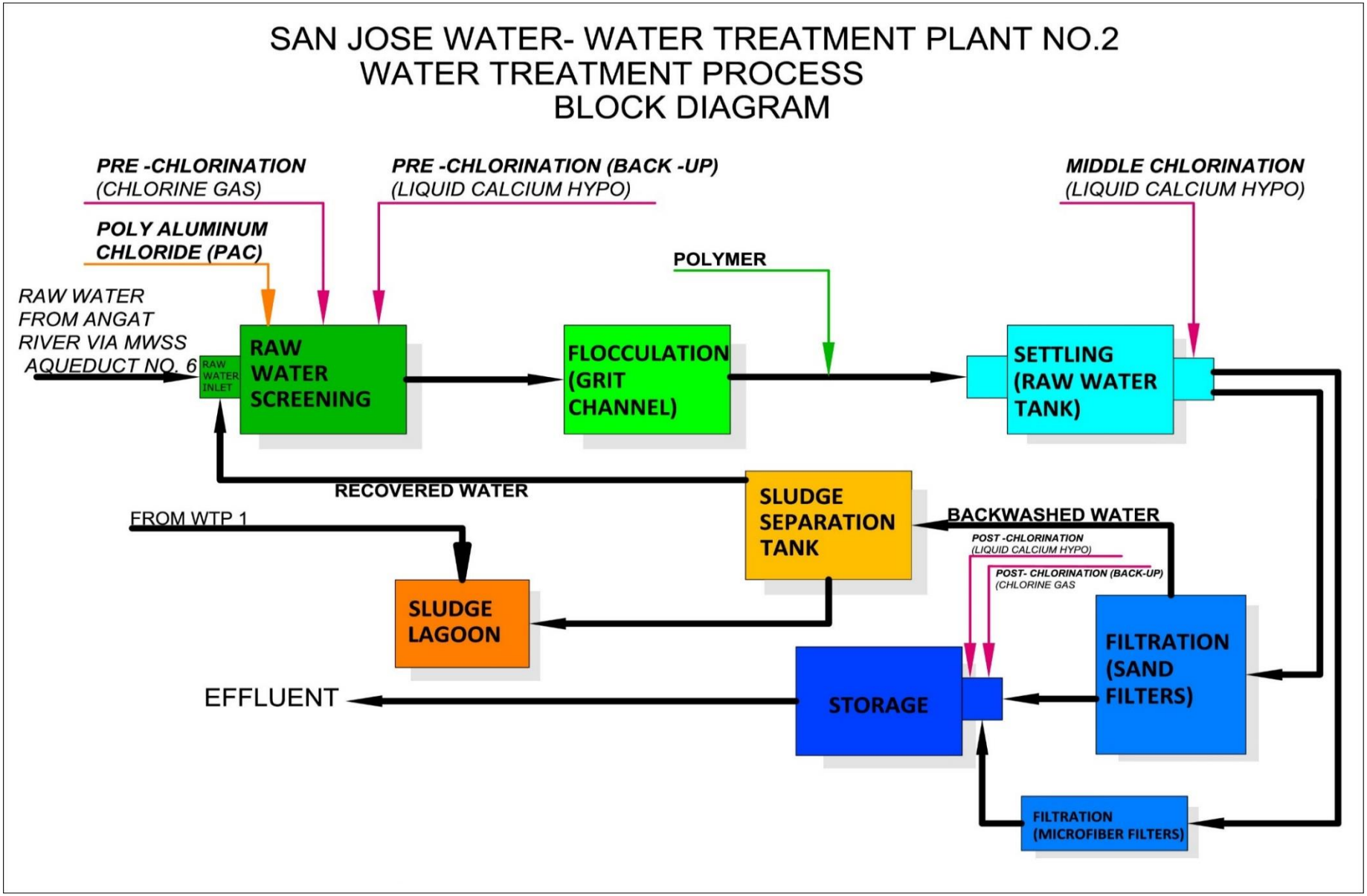


Figure 5 - Block Diagram of WTP No. 2 Water Treatment Process

Groundwater

San Jose Water's existing deep well facilities in Non-Area include 11 deep well stations, network of pipelines, elevated water tanks and reservoirs. These deep wells have rated capacity of 136 to 1,036 cmd. The treatment for ground water involves the use of Liquid Chlorine Dioxide and Liquid Calcium Hypochlorite.

The deep well facilities augment water pressure in the high portions and far end of the pipelines of the service areas.

The water quality of the groundwater is compatible with the PNSDW and thus, do not require any treatment except for preventive disinfection using Liquid Calcium Hypochlorite. The water sample taken from the distribution line 100 meters away from the well source should have a minimum 0.30-ppm of residual chlorine. Based on the result of field monitoring, the dosing of chlorine at pumping stations will be adjusted accordingly.

Deep well stations operated by San Jose Water as of September, 2015 including their addresses, operating schedules and capacities.

Source No.	Pumping Station No.	Location	Operating Schedule	Capacity m^3/day
1	13	Blk 7 Lot 19 Phase 2A Ciudad Real Subd., CSJDM, Bulacan	24 hrs. a day	136
2	20	Morning Glory Subd. Brgy. Dulong Bayan CSJDM, Bulacan	5am – 7 pm	709
3	22	Blk 10, Evergreen Heights Subd. CSJDM, Bulacan	7am – 1 pm	627
4	25	Phase 2, Pabahay 2000 CSJDM, Bulacan	24 hrs. a day	872
5	26	Phase E2, Francisco Homes Subd. CSJDM, Bulacan	24 hrs. a day	600
6	27	Phase I, Pabahay 2000 CSJDM, Bulacan	24 hrs. a day	1,036
7	28	Blk 5, Sarmiento Homes Subd. CSJDM, Bulacan	5am – 8pm	927
8	29	Blk 8, Phase 2A, Ciudad Real Subd. CSJDM, Bulacan	24 hrs. a day	247
9	40	Aurea Ville, Daang Barrio, Brgy. Gaya-gaya CSJDM, Bulacan	24 hrs. a day	545
10	53	Verde Heights / Scottsdale Subd. CSJDM, Bulacan	8am – 1pm	818
11	54	Blk 13, Francisco Homes 2 Subd. CSJDM, Bulacan	7am – 7pm	545

Table 2 - Active Deep Well Stations

Table 3 - San Jose Water's Transmission and Distribution Line

Diameter	Materials Type	Length (m)
600 mmØ	CL-CTEC Steel Pipe	3,851.0
400 mmØ	HDPE Pipe	24,029.3
400 mmØ	CL-CTEC Steel Pipe	11,597.6
300 mmØ	CL-CTEC / PVC Pipes	2,980.9
250 mmØ	CL-CTEC / PVC Pipes	8,280.7
200 mmØ	PVC / HDPE / ACP	27,989.9
150 mmØ	PVC/ CL-CTEC / CIP / GI Pipes	113,494.8
100 mmØ	PVC / HDPE / ACP / CIP / BIP / GI Pipes	127,701.0
75 mmØ	PVC / HDPE Pipes	96,407.9
63 mmØ	HDPE Pipes	5,672.4
62 mmØ	HDPE Pipes	250.0
50 mmØ	PVC / GIP / HDPE Pipes	164,403.6
38 mmØ	PVC Pipes	3,003.6
32 mmØ	HDPE Pipes	1,500.0
25 mmØ	HDPE Pipes	515.0
	TOTAL	**591,677.7 m**

TRANSMISSION LINE = 192,224.1

DISTRIBUTION LINE = 399,453.6

TOTAL LENGTH OF PIPE LINES AS OF DECEMBER 15, 2015 591,677.7 L.M.

C. Distribution

Water that are distributed by the San Jose Water comes from different sources. These water sources come from the following: a) two water treatment plants, b) bulk water supply, and c) deep wells.

A. Water Treatment Plant No. 1 Distribution System

The two (2) water treatment plants are tapped to the aqueduct of the MWSS. They are both situated in one compound at Barangay Minuyan Proper.

WTP 1 became operational last 1997 wherein the component of the water supply system project is the installation of transmission going to the five (5) reservoirs, three (3) of them are ground concrete reservoir and two ground steel tank. The project was called Comprehensive Water Supply System Project Phase 1 (CWSSP 1). WTP 1 supplies water to SPRP Area.

The water from WTP No. 1, at 56m elevation, is being pumped to ground reservoir in Fresh Air Booster Station (FABS), at 116m elevation, through 400mmØ steel transmission line. There are two reservoirs in FABS, the rectangular settling basin with 950 cum capacity and the ground round reservoir with 455 cum capacity.

There are distribution lines tapped on said reservoir. 250mmØ PVC transmission line was tapped on the rectangular reservoir to supply the Towerville Subdivsion in Brgy. Sto. Cristo and Brgy. Minuyan Proper. The transmission line convey water to three (3) booster stations in Towerville Subdivision. Booster Station 1 has a ground settling basin with capacity of 60 cum. Aligned on settling basin are pumps to two (2) elevated steel tanks. Booster Station No. 2 has ground steel tank pumping water to other elevated steel tanks of the said subdivision.

Another 200mmØ distribution line is tapped on the ground round reservoir that serves water to the lowest part of Brgy. Minuyan by gravity.

Other water from Fresh Air Booster Station is being pumped to Citrus Booster Station, at 146.68m elevation through a 400mmØ steel transmission line. Citrus Booster Station has two ground reservoirs: settling basin with 950 cum capacity and underground reservoir with 303cum. In rectangular settling basin there are two distributions interconnected from it. First, there are 200mmØ and 300mmØ transmission lines going to the elevated steel tank in Area E (Res. No. 4) and at Sampol Area in Area B respectively. Second, an abandoned 150mmØ transmission line from Minuyan to Citrus was converted into distribution line. Instead of conveying water from Minuyan directly to Citrus (as used in the water system before), the converted distribution line (that was interconnected to the distribution lines of Minuyan) is now augmenting the needs of the residents in some part of Brgy. Minuyan and Quarry Area.

Another 150mmØ line was interconnected to underground reservoir. From the underground reservoir there are lines tapped on it: the 1.) 100mmØ distribution line supplying the upper parts of Brgy. Minuyan by gravity, 2.) The 150mmØ transmission line being boosted to Brgy. Sto. Nino II Ground Steel Reservoir, and 3) 75mmØ line going to the elevated steel tank inside CBS. The water is being pumped to the elevated tank to supply upper portion of Brgy. Citrus

Sto Niño II steel ground reservoir and Reservoir No. 4 collects water and distribute it by gravity. Sto Niño II reservoir, with 157.86m elevation and Res. No. 4 has the same fill-and-draw system.

The distribution lines under the WTP No. 1 water system ranges from 50mmØ to 200mmØ of PVC and PE pipes. The system was interconnected to the system developed by the National Housing Authority way back late 60's. The NHA water system are comprises of different types of pipes such as PVC, GI pipe, steel pipe, and Asbestos Cement Pipe (ACP).

The CWWSP 1 is also interconnected to Bulk Water Supply Project which will be tackled later.

B. Water Treatment Plant No. 2 Distribution System

WTP 2 was activated last 2006. It supplies water to the Non-Area operation with 3,900lm 600mmØ steel transmission line going to Igay Reservoir, with 153.62m elevation, at Brgy. Sto Cristo. The reservoir has a 1,400cum capacity.

Water from Igay Reservoir is delivered by gravity to the barangays of Tungkong Mangga, San Manuel, Maharlika, Graceville, Gaya-gaya, Kaypian, Poblacion, Poblacion 1, Muzon, Mulawin, Guijo, Narra, Yakal, Dulong Bayan, and some portions of Sto Cristo.

Other barangays such as Kaybanban, San Roque, Brgy. Paradise III and San Isidro get their water from Igay Reservoir through another booster stations in Brgy. San Roque, Brgy. Paradise and Brgy Isidro. Elevated steel tanks were erected in Brgy Paradise and San Isidro to reach the highest portions of the service areas.

Like WTP 1 the WTP 2 also has pipeline component when it was constructed. It was named Comprehensive Water Supply Sytem Project Phase 2. The distribution that started in Igay Reservoir started from 400mmØ PVC, 300mmØ PVC, 250mmØ PVC, 200mmØ PVC, and 150mmØ PVC. There are portions wherein 100mmØ and 50mmØ parallel distribution lines were also laid.

C. Angat Bulk Water Supply System

The Angat Bulk Water Supply System Project (ABWSSP) was completed last 2014 with a total length of 16,553.28m-400mmØ transmission line from Brgy. Donacion, Angat, Bulacan to Metrogate San Jose Subdivision, Sapang Palay Proper in San Jose Del Monte.

The water that being supplied is coming from a private company selling water to the water district. The owner has seven (7) deep wells in Brgy. Donacion, Angat, Bulacan. The company treated water through chlorination.

The water from Brgy Donacion is being pumped to the booster station in Brgy. Encanto, Angat, Bulacan with 48.20m elevation. Encanto Booster Station (EBS) has ground steel reservoir and four (4) booster pumps. The water in Encanto will then be pumped to another booster station in Brgy. Pulong Yantok, Angat. The same with booster station in Brgy. Encanto the Pulong Yantok Booster Station (PYBS) has also

ground steel reservoir and four (4) booster pumps. It will then pumped to ground steel reservoir in Metrogate San Jose Subdivision in Sapang Palay Proper, City of San Jose del Monte.

Metrogate Booster Station (MBS) has also four (4) booster pumps. The Metrogate Booster Station is also interconnected to Res. No. 4 and Res. No. 5 which augment the water requirement of the concessionaires in Sapang Palay areas. The interconnection of MBS to the water system of Sapang Palay make it BWSSP interconnected to CWSSP No. 1.

MBS also pumps water to Kelsey Hills reservoir in Brgy. Muzon through the 7,888lm 400mmØ transmission line. Before reaching Kelsey Hills Subd., other subdivision water systems has been interconnected to the Metrogate-Kelsey Hills transmission line. Sarmiento Homes Subd. is already interconnected while new NHA low cost housing San Jose del Monte Heights Subdivision is scheduled for interconnection.

D. Distribution through Deep Wells

There are eleven (11) active deep wells use in the operation. These deep wells have discharge line interconnected to the nearest distribution line. Basically the water is treated through chlorination prior to distribution. To date the Ciudad Real Subdivision is the only service area being served solely by deep wells.

Other areas augmented by existing deep wells are:

1. Sarmiento Homes
2. Pabahay 2000
3. Francisco Homes 2
4. Dulong Bayan
5. Evergreen Heights
6. Verde Heights (Brgy. Kaypian)

Water from Angat Dam which passes through MWSS' Aqueduct No. 6 is being treated at San Jose Water's two Water Treatment Plants.

Water from WTP No. 1 is being pumped to ground reservoir in Fresh Air Booster Station (FABS). It will be collected and stored at Sto Niño II steel ground reservoir and Reservoir No. 4 and distribute it to the concessionaires of SPRP Area by gravity.

WTP 2 supplies water to Non-Area. The treated water is transmitted and stored at Igay Reservoir. Water from Igay Reservoir is delivered by gravity to the barangays of Tungkong Mangga, San Manuel, Maharlika, Graceville, Gaya-gaya, Kaypian, Poblacion, Poblacion 1, Muzon, Mulawin, Guijo, Narra, Yakal, Dulong Bayan, and some portions of Sto Cristo.

Other barangays such as Kaybanban, San Roque, Brgy. Paradise III and San Isidro get their water from Igay Reservoir through another booster stations in Brgy. San Roque, Brgy. Paradise and Brgy Isidro. Elevated steel tanks were erected in Brgy Paradise and San Isidro to reach the highest portions of the service areas.

Treated water from ABWSSP passes through transmission lines from Brgy. Donacion, Angat, Bulacan to Metrogate San Jose Subdivision, Sapang Palay Proper in San Jose Del Monte. The water that being supplied is coming from a private company selling water to the water district. Water that is supplied by ABWSSP augments the water requirement of the concessionaires in Brgy. Muzon and some areas in SPRP.

The diagram on the next page illustrates the description of San Jose Del Monte City Water District Water Supply System.

Figure 6 - Description of San Jose Del Monte City Water District Water Supply System

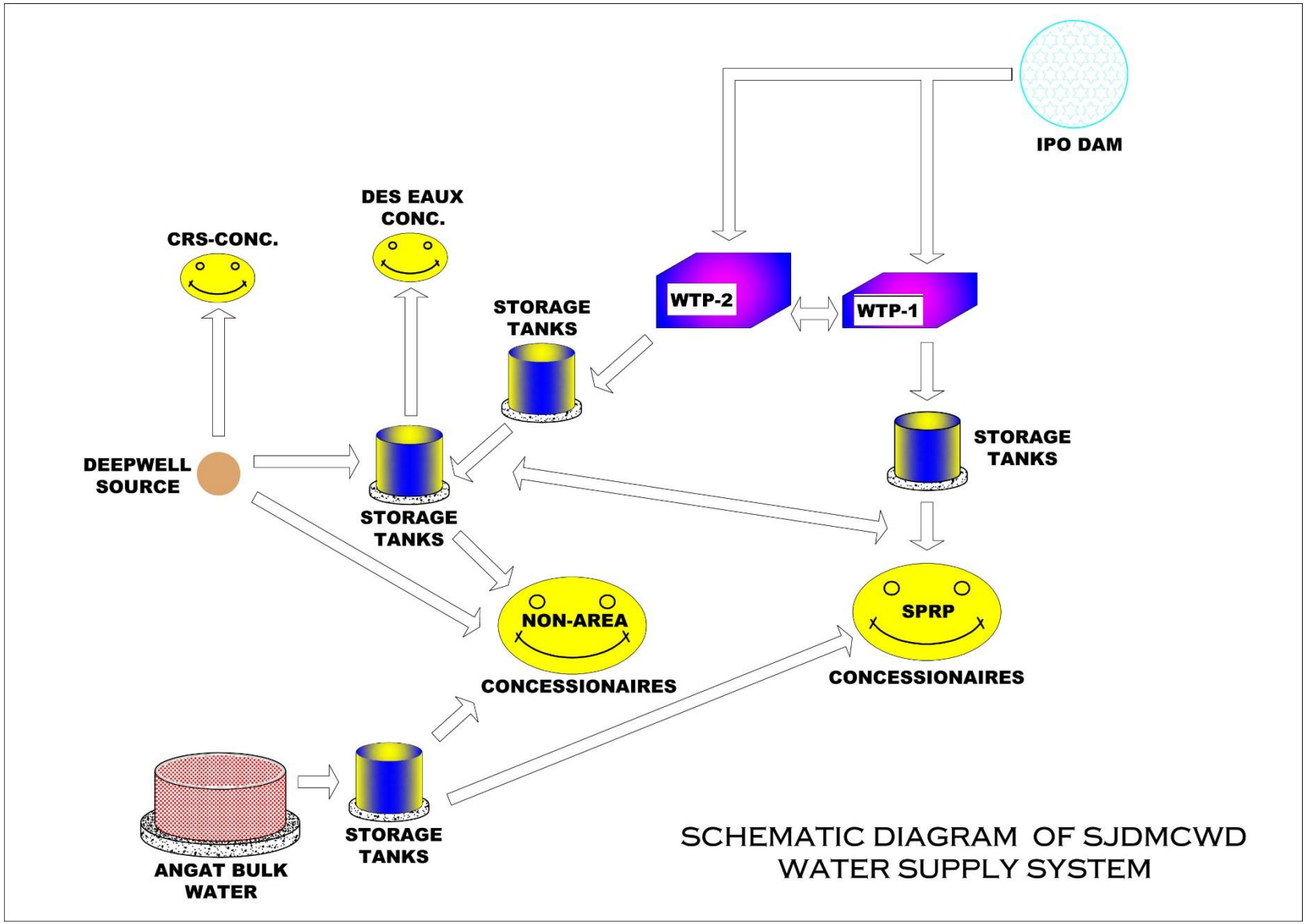


Figure 7 - Process Flow of WTP No. 1 and 2

A. WATER TREATMENT PLANT 1 AND 2

Process Step	Symbol		Responsible Department/Section
	WTP1	WTP2	
Raw Water Supply from Angat River via MWSS Aqueduct No.6			WTP-WQMS
Receiving Raw Water in Inlet Chamber where Flow is regulated via positioner Butterfly Valve			WTP-WQMS
Prechlorination using Gas (with LCH as back up)			WTP-WQMS
Coagulation and Flash Mixing where PAC is applied as coagulant			WTP-WQMS
Raw Water Screening for WTP2			WTP-WQMS
Flocculation where polymer is added	Recovery	Recovery	WTP-WQMS
Sedimentation (Sludge Blanket Clarifier Pulsator for WTP1 and Conventional Sedimentation for WTP2)			WTP-WQMS
Sludge Extraction, draw off into the Lagoon			WTP-WQMS
Middle chlorination			WTP-WQMS
Filtration			WTP-WQMS
Backwash Water to Wash Water Recycling Tank for WTP1 and Sludge Separation Tank for WTP2			WTP-WQMS
Sludge Detention into the Lagoon			WTP-WQMS
Post-chlorination using LCH (with Gas as back up)			WTP-WQMS
Storage			WTP-WQMS
Transport to Highest Reservoir	B	A	Water Distribution Section
Storage			Water Distribution Section
Distribution			Water Distribution Section
Concessionaire			Water Distribution Section

Figure 8 - Process Flow of Angat Bulk Water Supply System Project

B.BULK WATER

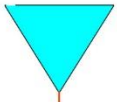
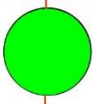
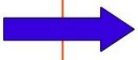
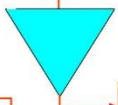
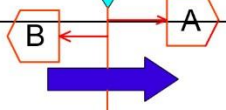
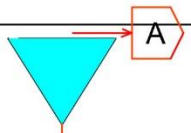
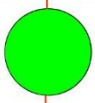
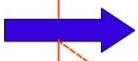
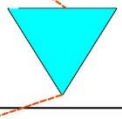
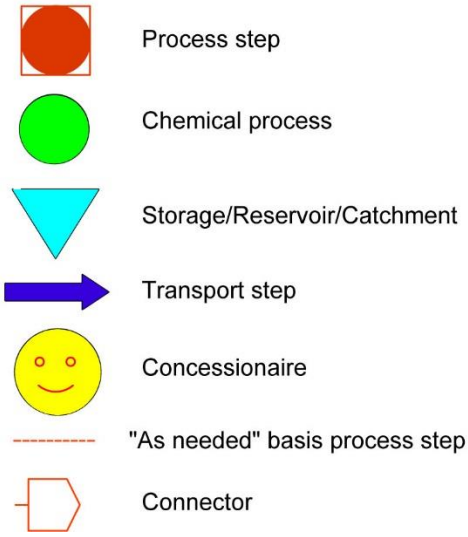
Process Step	Symbol	Responsible Department/Section
Well		Private Bulk Water Supplier
Chlorination		Private Bulk Water Supplier
Transmission to Booster Station		Private Bulk Water Supplier
Booster Station		Bulk Water Supply Division
Transmission to Reservoir		Bulk Water Supply Division
Storage		Bulk Water Supply Division
Distribution Line		Water Distribution Section
Concessionaire		Water Distribution Section

Figure 9 - Process Flow of Ground Water

Process Step	Symbol	Responsible Department/Section
Well		Water Distribution Section
Chlorination		Water Distribution Section
Distribution Line		Water Distribution Section
Reservoir		Water Distribution Section
Concessionaire		Water Distribution Section

Legend:



E. Stakeholders

It is very necessary for San Jose Water to maintain harmonious relationship and close coordination with its stakeholders. The amiable partnership will not only benefit both parties but most of all, the people they serve.

As its regulatory body, San Jose Water submits monthly water quality report to Local Water Utilities Administration.

MWSS Aqueduct No. 6 serves as a link between San Jose Water and MWSS because this is where the former gets its raw water supply. San Jose Water has a total raw water allocation of 80,000 cmd from MWSS. The allocated raw water supply comes from Angat Dam. To date, San Jose Water gets close to 50,000 cmd of raw water through MWSS Aqueduct No. 6 which passes adjacent to the Water Treatment Plant Compound of San Jose Water.

To establish conformity to environmental standards, San Jose Water reports to the Department of Environment and Natural Resources (DENR) regarding its effluent quality. San Jose Water makes sure that the environment is being conserved and protected to guarantee that adequate water supply will still be available to future generations.

San Jose Water coordinates with the City Health Office, City Engineer's Office and the Department of Public Works and Highways especially during pipe laying, maintenance works, distribution line repairs and the like. Likewise, these offices may also seek the support of San Jose Water when the need arises.

San Jose Water also established close connections with key suppliers for water treatment, MERALCO and other major suppliers to mitigate water interruption should their services fail to meet the requirements needed by San Jose Water to operate and/or their services disrupt the operation of the latter.

A stable partnership was also built between San Jose Water and the Home Owners Association (HOA), Brgy. Officials, the Philippine National Police (PNP) and the households near the facilities of San Jose Water to guarantee the security of its properties against adversaries.

Table 4 - San Jose Water's Stakeholders

Stakeholder				Interaction Mechanism	Record of Interaction
Name	Relationship to Drinking Water Supply Issues	Point of Contact with WSP Team	Issues with Drinking Water Supply		
Local Water Utilities Administration	Regulatory	Submission of WQ Report	Water Quality	Reporting	Monthly Report
Metropolitan Water Works Sewerage System	Bulk Water Supplier	MOA Signing / Meter Rdg.	Allocation and Water Rates	Meetings	Minutes of Meetings, MOA and SOA
Department of Environment and Natural Resources	Environment Protection Authority	Regulatory Monitoring	Effluent Quality	Reporting	Reports
City Health Office	Regulatory	Regulatory Monitoring	Water Quality	Reporting	Reports
City Engineer's Office	Local Regulatory	Project / Leak repair coordination	Water Quality	Meetings / Communication	Minutes of Meetings
Department of Public Works and Highways	Local Regulatory	Project / Leak repair coordination	Water Quality	Meetings / Communication	Minutes of Meetings
Meralco	Supplier (Energy)	Power interruption coordination	Water Quality / Intermittent Supply	Reporting	Reports
AMGAT	Bulk Water Supplier	MOA Signing / Meter Rdg.	Water Quality and Rates	Joint Meter Reading	SOA
Des Eaux	End Users	Meter reading	Water Quality and Rates	Joint Meter Reading	SOA
Home Owners Association	Community partner	Turn over and coordination meeting	Water Quality and Rates	Meetings / Communication	Minutes of Meetings
Brgy. Officials	Community partner	Coordination meeting	Water Quality and Rates	Meetings / Communication	Minutes of Meetings
Suppliers	Industry partner	Procurement / Delivery	Supply quality and quantity	Purchase requisitions, Purchase orders,	Delivery receipts
Household near Pump Stations	Community partner	Coordination meeting	Supply quality and quantity	Reporting	Reports
PNP	Police authority	Safety of Facility	Water Quality	Reporting	Reports

III. HAZARD IDENTIFICATION AND RISK ASSESSMENT

The WSP team took into consideration unusual events that may affect the quality of water being delivered by San Jose Water. The team identified risks that may occur in each step of the validated process flow. The hazard and hazardous event identification was conducted through existing records, historical events, local knowledge and onsite visits that can affect the safety of a water supply and establish what requires controlling the hazards in order to provide safe drinking-water. The WSP team considered all potential biological, physical and chemical hazards that could be associated with the water supply.

The hazards were ranked to establish priorities. The WSP team used a semi-quantitative risk assessment, to calculate a priority score for each identified hazard. The objective of the prioritization matrix is to rank hazardous events to provide a focus on the most significant hazards. The likelihood and severity was derived from the team's technical knowledge and expertise, historical data and relevant guidelines. The table on the next page describes the semi- quantitative risk matrix used to rate the likelihood or frequency and severity or consequence of the hazards when it occurred for calculation of the risk score. The WSP team determined a cut - off point, which is risk score of 5, above which all hazards will be retained for further consideration. There is little value in expending a great deal of effort considering very small risks.

Semi-Quantitative Risk Matrix

(From Deere et. al. 2001)

Risk Factor Matrix		Severity / Consequence				
		No Impact / Not Detectable Rating 1	Minor Compliance Impact Rating 2	Moderate Aesthetic Impact Rating 3	Major Regulatory Impact Rating 4	Catastrophic Public Health Impact Rating 5
Likelihood / Frequency	Almost certain Once a day Rating 5	5	10	15	20	25
	Likely Once a week Rating 4	4	8	12	16	20
	Moderate Once a month Rating 3	3	6	9	12	15
	Unlikely Once a Year Rating 3	2	4	6	8	10
	Rare Once every 5 years Rating 1	1	2	3	4	5
Risk Score		<6	6-9	10-15		>15
Risk Rating		Low	Medium	High		Very High

Table 5 - Semi-Quantitative Risk Matrix

Ranking	Likelihood/Frequency	Severity / Consequence
5	**Almost Certain** - Once per day	**Catastrophic** – Potentially lethal to a large population, likely to have also very significant
4	**Most Likely** - Once per week	**Major** – Potentially lethal to a small population, likely to have also significant morbidity
3	**Likely** - Once per month	**Moderate** - Potentially harmful to a large population but no mortality
2	**Unlikely** - Once per year	**Minor** - Potentially harmful to a small population but no mortality
1	**Rare** - Once every five years	**Insignificant** - Negligible impact in terms of severity of disease or numbers of people affected

A. WATER TREATMENT PLANT NO. 1 AND 2

Table 6 - Hazard Identification and Risk Assessment for Water Treatment Plants No. 1 and 2

Process Step	Hazardous Event	Hazard	Likelihood	Severity	Score	Rating
Pre-Chlorination	Failure of disinfection due to breakdown of chlorination units for chlorine gas	Microbial	5	5	25	Very High
	Failure of disinfection due to lack of chlorine gas supply	Microbial	5	5	25	Very High
Screening (WTP2)	Lack of screening process in WTP2 due to breakdown of equipment	Physical	5	3	15	High
Flash Mixing (WTP1)	Low output of coagulant due to clogged feed lines resulting to high turbidity of clarified water	Physical	5	3	15	High
	High turbidity of clarified water due to break-down of dosing pump	Physical	5	3	15	High
	No floc formation resulting to high turbidity of clarified water due to lack of coagulant supply	Physical	5	3	15	High
	Poor floc formation due to non-compliance to specification of supplied coagulant	Physical	4	3	12	High
	Contamination of open water surface (flash mixer, pulsator, filtration) due to ash fall, sabotage, bird droppings, etc.	Physical	4	3	12	High
		Chemical	4	5	20	Very High

		Microbial	4	5	20	Very High
Raw Water Tank (WTP2)	Low output of coagulant due to clogged feed lines resulting to high turbidity of raw water tank sample	Physical	5	3	15	High
	High turbidity of raw water tank sample due to break-down of dosing pump	Physical	5	3	15	High
	No floc formation resulting to high turbidity of raw water tank sample due to lack of coagulant supply	Physical	5	3	15	High
	Poor floc formation due to non-compliance to specification of supplied coagulant	Physical	4	3	12	High
	Contamination of open water surface (raw water inlet, flocculation tank, raw water tank) due to ash fall, sabotage, bird droppings, etc.	Physical	4	3	12	High
		Chemical	4	5	20	Very High
		Microbial	4	5	20	Very High
Pulsation (WTP1)	High turbidity of clarified water due to break-down of vacuum pumps and compressor	Physical	4	3	12	High

Filtration	High turbidity of filtered water due to fine flocs passing through the filter	Physical	5	3	15	High
Microfiltration (WTP2 – Amiad Filters)	High turbidity of filtered water due to fine flocs passing through the filter	Physical	5	3	15	High
Post-Chlorination	Failure of disinfection due to breakdown of chlorine dosing pumps for liquid calcium hypochlorite	Microbial	5	5	25	Very High
	Failure of disinfection due to insufficient liquid calcium hypochlorite stock	Microbial	5	5	25	Very High
	Insufficient disinfection due to low chlorine concentration of supplied liquid calcium hypochlorite.	Microbial	5	5	25	Very High
Reservoir	Intrusion of contaminants (animal entry) due to unsecured vent cover of reservoir openings	Microbial	5	5	25	Very High
	Breakdown of booster pumps resulting to low pressure to no water at service area.	Physical	5	3	15	High
		Microbial	5	5	25	Very High

B. GROUNDWATER

Table 7 - Hazard Identification and Risk Assessment for Groundwater

Process Step	Hazardous Event	Hazard	Likelihood	Severity	Score	Risk Rating
Well / Catchment	Seepage of leachate from septic tanks of nearby houses near well sources developed by San Jose Water	Physical	5	2	10	High
		Microbial	5	5	25	Very High
	Seepage of leachate from septic tanks of nearby houses near well sources turned over by developer	Physical	5	2	10	High
		Microbial	5	5	25	Very High
Disinfection	Failure of disinfection due to equipment breakdown	Microbial	5	5	25	Very High
	Shortage of Chlorine at deepwell pumping station	Microbial	5	5	25	Very High
Reservoir	Intrusion of contaminants due to exposed / unsecured vent covers of reservoir openings (animal & bird entry)	Microbial	5	5	25	Very High

C. Distribution

Table 8 - Hazard Identification and Risk Assessment for Distribution Lines

Process Step	Hazardous Event	Hazard	Likelihood	Severity	Score	Risk Rating
Storage	Intrusion of contaminants into Storage tanks due to sabotage	Chemical	5	4	20	Very High
	Yellowish water due to rusted inner surface of dilapidated storage tank	Physical	5	3	15	Very High
	Turbid water due to Pressure Fluctuations and intermittent Supply	Physical	5	2	10	High
Distribution	Turbidity of supply after repair due to pipeline breakage	Physical	5	2	10	High
	Intrusion of contaminants due to sub-standard materials and improper installation of service connection	Physical	5	3	15	Very High

	Intrusion of contaminants in supply due to illegal connections	Physical	5	3	15	Very High
	Yellowish Water due to deterioration of Steel pipes	Physical	5	3	15	Very High
Consumer Premises	Intrusion of contaminants due to substandard materials, improper installation & unsafe practice at consumer premises	Microbial	5	5	25	Very High

IV. DETERMINE AND VALIDATE CONTROL MEASURES, REASSESS AND PRIORITIZE THE RISKS

After identifying potential risks and hazards that may affect the quality of water being delivered to concessionaires, the WSP team established control measures to address the identified possible risks. Each control measures were validated to verify its efficacy based on records, data gathered and on-site assessment.

Upon validation of control measures, the risk rating for each stages of the treatment process, storage, distribution system, down to the tap of every home were reduced. The reduction in the risk rating achieved by each control is an indication of its effectiveness. The risks were prioritized in terms of their likely impact to the capacity of the system to deliver safe water. High priority risks (risk rating from medium to very high) may require system modifications or upgrade while lower priority risks (risk rating of low) can often be minimized as part of routine good practice activities.

A. WATER TREATMENT PLANT NO. 1 AND 2

Table 9 - Identification of Hazards, Hazardous Events and Risk Assessment/Determination and Validation of Control Measures and Risk Reassessment for WTPs No. 1 and 2

Process Step	Hazardous event (source of hazard)	Hazard	Raw Risk			Existing Control Measure	Validation	Res. Risk			Proposed Control Measure
			Likelihood	Severity	Score			Likelihood	Score	Rating	
Pre-Chlorination	Failure of disinfection due to breakdown of chlorination units for chlorine gas	M	5	5	25	Regular preventive maintenance of chlorination units for chlorine gas	No incident of break-down of chlorination units for the past month.	3	15	H	Purchase of complete set spare chlorinators, regulators, ejectors, and booster pumps.
	Failure of disinfection due to lack of chlorine gas supply	M	5	5	25	Spare stock of chlorine gas good for 2 months consumption is maintained. Alternative use of liquid calcium hypochlorite for pre-chlorination is available. Maintain two supplier.	Chlorine gas inventory is available for at least two months level. Occurrence of lack of chlorine gas supply happened in the past two months in which liquid calcium hypochlorite is used in pre-chlorination.	1	5	L	

Screening (WTP2)	Lack of screening process in WTP2 due to breakdown of equipment	P	5	3	15	Regular preventive maintenance of screening equipment	No incident of screening failure for the last two years	1	3	L	
Flash Mixing (WTP1)	Low output of coagulant due to clogged feed lines resulting to high turbidity of clarified water	P	5	3	15	Regular flushing of feed lines and on-site coagulant output verification	No data recorded showing 0% reduction in raw water turbidity in the clarified water	1	3	L	
	High turbidity of clarified water due to break-down of dosing pump	P	5	3	15	Regular preventive maintenance of dosing pump units and available standby dosing pumps	No incident of break-down of dosing pump units for the past year.	1	3	L	
	No floc fomation resulting to high turbidity of clarified water due to lack of coagulant supply	P	5	3	15	Current storage tank can accommodate stock/inventory good for 2 months consumption. Level indicator is installed to measure stock level.	Chemical coagulant inventory is maintained to have available stock for at least two months as indicated by the level indicator. Two supplier is available to supply coagulant.	1	3	L	
	Poor floc formation due to non-	P	4	3	12	Certificate of analysis from chemical supplier	Two incidents of poor floc formation in the clarified water due to low quality of	3	9	M	Conduct of Alumina Testing of coagulant to ensure conformance to % Alumina of delivered sample

	compliance to specification of supplied coagulant					indicating % Alumina of delivered coagulant	coagulant happened in the past 2 years.				
	Contamination of open water surface (flash mixer, pulsator, filtration) due to ash fall, sabotage, bird droppings, etc.	P	4	3	12	Frequent monitoring of security personnel to prevent unauthorized access or dumping/throwing. Operators with visual monitoring/CCTV of open water surface.	No report of sabotage incident within the open water surface. Sabotage event can still happen since there is no installed roofing in the area.	4	12	H	Roofing of open water surface in WTP Process.
		C	4	5	20			4	20	VH	
		M	4	5	20			4	20	VH	
Raw Water Tank (WTP2)	Low output of coagulant due to clogged feed lines resulting to high turbidity of raw water tank sample	P	5	3	15	Regular flushing of feed lines and on-site coagulant pump output verification	No data recorded showing 0% reduction in raw water turbidity in the clarified water	1	3	L	
	High turbidity of raw water tank sample due to break-down of dosing pump	P	5	3	15	Regular preventive maintenance of dosing pump units and available standby dosing pumps	No incident of break-down of dosing pump units for the past year.	1	3	L	

	No floc formation resulting to high turbidity of raw water tank sample due to lack of coagulant supply	P	5	3	15	Current storage tank can accommodate stock/inventory good for 2 months consumption. Level indicator is installed to measure stock level.	Chemical coagulant inventory is maintained to have available stock for at least two months as indicated by the level indicator. Two supplier is available to supply coagulant.	1	3	L	
	Poor floc formation due to non-compliance to specification of supplied coagulant	P	4	3	12	Certificate of analysis from chemical supplier indicating % Alumina of delivered coagulant	One incident of poor floc formation in the raw water tank due to low quality of coagulant happened in the past 2 years.	3	9	M	Conduct of Alumina Testing of coagulant to ensure conformance to % Alumina of delivered sample
	Contamination of open water surface (raw water inlet, flocculation tank, raw water tank) due to ash fall, sabotage, bird droppings, etc.	P	4	3	12	Frequent monitoring of security personnel to prevent unauthorized access or dumping/throwing. Operators with visual monitoring/CCTV of open water surface.	No report of sabotage incident within the open water surface. Sabotage event can still happen since there is no installed roofing in the area.	4	12	H	Roofing of open water surface in WTP Process.
		C	4	5	20			4	20	VH	
		M	4	5	20			4	20	VH	

Pulsation (WTP1)	High turbidity of clarified water due to break-down of vacuum pumps and compressor	P	4	3	12	Regular preventive maintenance of vacuum pump & compressor	No occurrence of compressor break-down for the past 2 years.	1	3	L	
Filtration	High turbidity of filtered water due to fine flocs passing through the filter	P	5	3	15	Replenishment of filter media	High turbidity of filtered water in filtration units during period of more than 10 NTU Raw Water Turbidity	4	12	H	Complete replacement of filter media used in filtration
Microfiltration (WTP2-Amiad Filters)	High turbidity of filtered water due to fine flocs passing through the filter	P	5	3	15	Regular preventive maintenance of microfiber filter cartridge	High turbidity of filtered water in microfiltration units during period of more than 10 NTU Raw Water Turbidity	4	12	H	Complete replacement of microfiber filter cartridge used in microfiltration units
Post-Chlorination	Failure of disinfection due to breakdown of chlorine dosing pumps for liquid calcium hypochlorite	M	5	5	25	Regular preventive maintenance of chlorination units for liquid calcium hypochlorite. Maintain chlorine residual	No incident of break-down of chlorination units for the past month.	3	15	H	Purchase of complete set of dosing pump, hose and fittings.

	Failure of disinfection due to insufficient liquid calcium hypochlorite stock	M	5	5	25	Stock of liquid calcium hypochlorite for 2 weeks consumption is available in use for post-chlorination. In case of out of stock chlorine gas is use for post-chlorination.	Current storage for liquid calcium hypochlorite supply only last for two weeks consumption. Chlorine gas is use when the liquid calcium hypochlorite supply is empty.	2	10	H	Increase storage tank capacity that can accommodate liquid calcium hypochlorite consumption good for a month consumption. Maintain at least two supplier of liquid calcium hypochlorite.
	Insufficient disinfection due to low chlorine concentration of supplied liquid calcium hypochlorite.	M	5	5	25	Adjustment of chlorine dosing pump to correct setting to facilitate effective disinfection.	Once a month adjustment of chlorine dosing due to low chlorine concentration of liquid calcium hypochlorite	1	5	L	Conduct of Hypochlorite Testing to measure % Chlorine to check conformance to specification
Reservoir	Intrusion of contaminants (animal entry) due to unsecured vent cover of reservoir openings	M	5	5	25	Fencing and security personnel deployment. Padlocks and durable covers are installed.	Small animals cannot pass through vent covers; hatches are securely locked with no signs of forced entry	1	5	L	

	Breakdown of booster pumps resulting to low pressure to no water at service area.	P	5	3	15	Implement predictive, preventive and corrective maintenance program	Occurrence of corrective maintenance has been conducted 4 months ago and was immediately repaired with no interruption required.	3	9	M	Purchase of spare units and parts, set-up standby units.
		M	5	5	25			3	15	H	

B. GROUNDWATER

Table 10 - Identification of Hazards, Hazardous Events and Risk Assessment/Determination for Groundwater

Process Step	Hazardous Events / Cause of Contamination	Raw Risk				Control Measure	Validation of Control Measure	Residual Risk			Proposed Control Measure
		Hazards	Likelihood	Severity	Score			Likelihood	Score	Rating	
Well / Catchment	Seepage of leachate from septic tanks of nearby houses near well sources developed by San Jose Water	P	5	2	10	Wells have blank casings down to 40mbgl and sanitary grout down to 15mbgl	Presence of seepage from septic tanks would normally produce odor on the water; No odor reported over the last 5 years	1	2	L	
		M	5	5	25	Wells have blank casings down to 40mbgl and sanitary grout down to 15mbgl	Water analysis for the past 5 years from 11 deepwell sources does not indicate any sign of seepage of leachate from septic tanks	1	5	L	

	Seepage of leachate from septic tanks of nearby houses near well sources turned over by developer	P	5	2	10	In the absence of standard depth of blank casing and cement grout, natural ground formation serves as barrier against possible seepage of leachate	Presence of seepage from septic tanks would normally produce odor on the water; No odor reported over the last 5 years	4	8	M	Abandonment of subject sources when an alternative source of water becomes available
		M	5	5	25		Water analysis for the past 5 years from 11 deepwell sources does not indicate any sign of seepage of leachate from septic tanks	4	20	VH	
Disinfection	Failure of disinfection due to equipment breakdown	M	5	5	25	All disinfection facilities are subjected to regular preventive maintenance and calibration every month aside from the regular visual inspection by operators on duty	Two occurrences of equipment breakdown for the past year for each deepwell stations	2	10	H	Installation of standby disinfection units ready to use in case of breakdown
	Shortage of Chlorine at deepwell pumping station	M	5	5	25	Regular delivery of chlorine supply to various deep well pumping stations	No incident of chlorine shortage is reported for the past year	2	10	H	Increase storage capacity of tanks in active deep well stations

Reservoir	Intrusion of contaminants due to exposed / unsecured vent covers of reservoir openings (animal & bird entry)	M	5	5	25	Installation of vent cover screens and padlocks for hatches	Small animals cannot pass through vent covers; hatches are securely locked with no signs of forced entry	1	5	L	

C. DISTRIBUTION

Table 11 - Identification of Hazards, Hazardous Events and Risk Assessment/Determination for Distribution Lines

Process Step	Hazardous Events / Cause of Contamination	Hazards	Likelihood	Severity	Score	Control Measure	Validation of Control Measure	Likelihood	Score	Rating	Proposed Control Measures
Storage	Intrusion of contaminants into Storage tanks due to sabotage	C	5	4	20	Perimeter fencing of storage facilities;	24 storage facilities have barbed wire perimeter fences, 19 have cyclone wire fences while 10 facilities have CHB fence. There are 11 storage facilities with no perimeter fence at all	3	12	H	Fencing of storage facilities with no fence and improvement of existing perimeter fences by converting barbed and cyclone wire fencing into CHB fence

	Yellowish water due to rusted inner surface of dilapidated storage tank	P	5	3	15	Repair, Painting & Disinfection of storage tank	No reported discoloration of water caused by rusted storage tanks for the past 5 years	1	3	L	
	Turbid water due to Pressure Fluctuations and intermittent Supply	P	5	2	10			5	10	H	Develop additional source of water supply & storage facilities
	Turbidity of supply after repair due to pipeline breakage	P	5	2	10	Strict implementation of SOPs in isolation and leak repair.	Instances and reports of turbid water supply after repair are minimized in the last 2 years	4	8	M	Installation of additional blow-offs/hydrants for flushing purposes & installation of pressure reducing valves for pressure management
	Intrusion of contaminants due to sub-standard materials and improper installation of service connection	P	5	3	15	Prior to approval of service connection installation, it undergoes strict inspection to ensure compliance to Water District Standards	There are still Service Request (SR) / Maintenance Order (MO) regarding substandard service connection materials	3	9	M	Subject service connection materials to undergo strict quality control

	Intrusion of contaminants in supply due to illegal connections	P	5	3	15	Regular leak detection and Saturation Drive	Leak detection activities are regularly conducted to mitigate the adverse effect of illegal connections via backflow to the system upon low pressure; Zero incident of supply turbidity due to backflow caused by illegal connections	1	5	L	
	Yellowish Water due to deterioration of Steel pipes	P	5	3	15	Rehabilitation of old and deteriorated pipes	Minimal occurrence of iron precipitates in water supply. No reported discoloration of water caused by rusted steel pipes for the past 5 years	3	9	M	Continuous Rehabilitation of deteriorated pipelines
Consumer Premises	Intrusion of contaminants due to substandard materials, improper installation & unsafe practice at consumer premises	M	5	5	25	Information and Education campaign on standard in-house connection installation and safe water storage and handling practice	There are many Service Requests (SR) / Maintenance Orders (MO) being received due to substandard materials, improper installation & unsafe practice at consumer premises	3	15	H	Intensify Information and Education campaign on standard in-house connection installation and safe water storage and handling practice

V. IMPROVEMENT / UPGRADE PLAN

The WSP team crafted an improvement or upgrade plan for each of the identified significant risks with no known applicable controls recognized in the reassessment of risks. These improvement measures are also suitable for other less significant risks specified.

Each improvement/upgrade plan indicated is delegated to a particular officer, group or section in San Jose Water to implement the plan within the specified target date. These improvement/upgrade plans can be short, medium or long-term programs and must be monitored to ensure that improvements have been made are effective.

San Jose Water will allocate budget for these improvement plans.

A. WATER TREATMENT PLANT NO. 1 AND 2

Table 12 - Improvement and Upgrade Plan for WTP No. 1 and No. 2

Action	Arising from	Identified specific improvement plan	Accountabilities	Due	Status
Implement measures to control risks arising from sabotage and introduction of unwanted particles coming from air/environment.	Risk assessment process has indicated a high possibility of sabotage due to lack of complete protective cover for open water bearing structures. The nearby surrounding has vegetation that can conceal potential saboteur.	Install roofing for open water bearing structures.	Division Manager (WTP Division)	Last Quarter of 2017	Planning stage
Implement measures to control risks arising from breakdown of chlorination units for chlorine gas	Risk assessment process has indicated a high possibility of microbial risk due to frequent malfunction of chlorination units for chlorine gas	Purchase of complete set spare chlorinators, regulators, ejectors, and booster pumps.	Division Manager (WTP Division)	Third Quarter of 2016	For Purchase Requisition
Implement measures to control risks arising from breakdown of chlorine dosing pumps for liquid calcium hypochlorite	Risk assessment process has indicated a high possibility of microbial risk due to frequent malfunction of chlorination units for liquid calcium	Purchase of complete set of dosing pump, hose and fittings.	Division Manager (WTP Division)	Third Quarter of 2016	For Purchase Requisition

	hypochlorite				
Implement measures to control risks arising from failure of disinfection due to insufficient liquid calcium hypochlorite stock	Risk assessment process has indicated a high possibility of microbial risk due to insufficient stock of liquid calcium hypochlorite for post chlorination	Increase storage tank capacity that can accommodate liquid calcium hypochlorite consumption good for a month consumption. Maintain at least two supplier of liquid calcium hypochlorite.	Division Manager (WTP Division)	Last Quarter 2016	For Purchase Requisition
Implement measures to control risks arising from high turbidity of filtered water due to fine flocs passing through the filtration units	Risk assessment process has indicated a high possibility of turbidity due to frequent backwashing of filters caused by fine flocs passing through the filter	Complete replacement of filter media used in filtration	Division Manager (WTP Division)	Last Quarter of 2017	Budget Stage
Implement measures to control risks arising from high turbidity of filtered water due to fine flocs passing through the microfiber filter units	Risk assessment process has indicated a high possibility of turbidity due to frequent backwashing of filters caused by fine flocs passing through the microfiber filter units	Complete replacement of filter media used in filtration	Division Manager (WTP Division)	Last Quarter of 2017	Budget Stage

Implement measures to control risks arising from breakdown of old booster pumps/ units.	Risk assessment process has indicated a high possibility of turbidity due to water turbulence during filling of empty waterlines. High possiblity of microbial intrusion from uncorrected leaks on the water system.	Purchase of spare units and parts, set-up standby units.	Division Manager (WTP Division)	Last Quarter of 2016	Budget Stage
Implement measures to control risks arising from poor floc formation due to non-compliance to specification of supplied coagulant	Risk assessment process has indicated a high possibility of turbidity due to low alumina content of supplied coagulant	Conduct of Alumina Testing of coagulant to ensure conformance to % Alumina of delivered sample	Senior Engineer A (WQMS)	First Quarter of 2016	For preparation of SOP and chemicals needed to conduct test
Implement measures to control risks arising from low chlorine concentration of supplied liquid calcium hypochlorite	Risk assessment process has indicated a high possibility of microbial risk due to insufficient stock of liquid calcium hypochlorite for post chlorination	Conduct of Hypochlorite Testing to measure % Chlorine to check conformance to specification of delivered sample	Senior Engineer A (WQMS)	First Quarter of 2016	For preparation of SOP and purchase of consumable reagents needed to conduct test

B. GROUNDWATER

Table 13 - Improvement and Upgrade Plan for Ground Water Sources

Action	Arising from	Identified specific improvement plan	Accountability/ies	Due	Status
All disinfection facilities are subjected to regular preventive maintenance and calibration every month aside from the regular visual inspection by operators on duty	Risk assessment indicates that equipment breakdown can lead to failure of disinfection	Procurement of new chlorinator that will serve as stand by unit	Division Manager (BWS&PS Division)	Last quarter of 2016	For Purchase Requisition
Regular delivery of chlorine supply to various deep well pumping stations	Possibility of microbial risk due to shortage of chlorine at deepwell pumping station	Increase capacity of chlorine storage tanks in active deep well stations	Division Manager (BWS&PS Division)	Third Quarter of 2016	Preparation of Program of Works

C. DISTRIBUTION

Table 14 - Improvement and Upgrade Plan for Distribution Lines

Action	Arising from	Identified specific improvement plan	Accountability/ies	Due	Status
Perimeter fencing of storage facilities;	Risk assessment indicates the possibility of compromise of our reservoir and pumping stations (Sabotage)	Fencing of 11 storage facilities with no fences and improvement of existing perimeter fences by converting 24 barbed wire fences into CHB fences	Division Manager (BWS&PS Division), Division Manager (PDCPLC Division)	Partial Implementation for the year 2016 - 2020	Budget Stage
Develop additional source of water supply & storage facilities	Risk assessment indicates the possibility of turbidity of water supply due to Pressure Fluctuations and intermittent Supply	Construction of CWSSP – Phase III (WTP 3) Project	Manager, Engineering Department	Last Quarter of 2018	Planning Stage
		Expansion of capacity of Metrogate Reservoir Station (800cum to 1600cum)		Second Quarter of 2016	For Implementation
Regular Leak Detection and Field Apprehension	Risk assessment indicates the Intrusion of contaminants in supply due to illegal connections	Formation of DMA's at our Non Area System to identify areas with high NRW	Engineer A (NRW), Division Manager (PSDD)	Last Quarter of 2016	For Implementation
Installation of pressure reducing valves for pressure management	Turbidity of supply after repair due to pipeline breakage	Installation of Pressure Reducing Valve at Bgy. San Roque	Division Manager (PDCPLC Division)	Last Quarter of 2016	For Implementation

VI. MONITORING OF THE CONTROL MEASURES (OPERATIONAL MONITORING)

To prove that the controls continue to work, the WSP team performs operational monitoring which includes defining and validating the monitoring of the control measures and developing procedures to verify the efficacy of the control measures.

All control measures identified as “critical” were assigned as “critical control points” and were monitored against “critical limits or operational limit” criteria. This critical/ operational limit is a criterion that will indicate whether the control measure is effective and is functioning as it was designed to be.

The WSP team created a monitoring plan for the whole water supply system indicating an acceptable critical/operational limit for each control, designated monitoring locations, and established a schedule for frequency of monitoring and assigned responsible party to conduct the monitoring.

Corrective actions are established in the event that monitoring reveals a parameter to be outside of the acceptable “limits”. The monitoring of the control measures or operational monitoring is documented from raw water inlet to the distribution system down to consumer premises.

A. WATER TREATMENT PLANT NO. 1 AND 2

Table 15 – Monitoring of the Control Measures for WTP No. 1 and No. 2

Process Step/ Control Measure	Critical limit	What	Where	When	How	Who	Corrective action
Regular preventive maintenance of chlorination units for chlorine gas	Provision of at least 1 set Spare Unit	Chlorinator	Stock Room	Monthly	Inventory	Section Chief MSSS	Request for additional Chlorinator to serve as spare unit
Spare stock of chlorine gas good for 2 months consumption is maintained	3 cylinders of 1 Ton Chlorine Gas	Chlorine Cylinder	Chlorine Storage Room	Weekly	Visual Inspection	Chemist/ Technician	Request for delivery of Chlorine
Maintain two supplier	At least 1 supplier failed to deliver/50% of requirement for 3 months (Purchase Order)	Supplier	Procurement	Monthly	Separate supplier for each WTP	Section Chief P&WS	Look for other supplier
Regular preventive maintenance of dosing pump units and available standby dosing pumps	Provision of at least 1 set Spare Unit	Dosing Pumps	Stock Room	Monthly	Inventory	Section Chief MSSS	Request for additional Dosing Pumps to serve as spare unit

Regular flushing of feed lines and on-site coagulant pump output verification	Deviation of at least 20 % Pac pump output	PAC Feedrate	PAC by-pass Line	Every shift duty (8hrs)	Conduct Volumetric Testing	Chemist	Activate standby unit and conduct corrective actions (e.g. flushing, repair of units, etc)
Current storage tank can accommodate stock/inventory good for 2 months consumption	20MT min inventory of PAC during rainy season, 10MT min inventory during dry season	PAC Inventory	Storage Tanks	Every shift duty	Chemical Inventory	Chemist	Notify supervisor if PAC is below min. standard inventory level
Adjustment of chlorine dosing pump to correct setting to facilitate effective disinfection	Residual chlorine leaving the plant must be 0.7 mg/L min. to 1.0 mg/L max.	Chlorine residual	At entry point to distribution system	On-line	Chlorine analyzer	Chemist	Activate chlorine non-compliance exceedance protocol

B. GROUNDWATER

Table 16 - Monitoring of the Control Measures for Ground Water Sources

Control Measure	Operational Range & Critical Limit	What to Monitor	Where to Monitor	When to Monitor	How to Monitor	Who will Monitor	Corrective Action
All disinfection facilities are subjected to regular preventive maintenance and calibration every month aside from the regular visual inspection by operators on duty	At least 1 Spare Unit	Chlorinator	Stockroom	Monthly	Inventory	Section Chief MSSS	Request for additional Chlorinator to serve as spare unit
Regular delivery of chlorine supply to various deep well pumping stations	At least 1 chlorine tote bin full	Level of Chlorine Tote Bin	PS # 28	Daily	Visual Inspection	Operator on Duty	Request for delivery of Chlorine

Installation of vent cover screens and padlocks for hatches	Signs of screen deterioration and damaged / missing padlock	Condition of screen and padlock	All Reservoir Stations	Monthly	Monitoring by Visual Inspection	Section Chief, MSSS	Repair or Replacement of defective screen and padlocks

C. DISTRIBUTION

Table 17 - Monitoring of the Control Measures for Distribution Lines

Control Measure	Critical Limit	What	Where	When	How	Who	Corrective Action
Perimeter fencing of storage facilities;	Signs of deformation on barbed wire fence; Missing padlocks on gates; Reported incidents of unauthorized entry from concerned citizens	Condition of perimeter fences & padlocks	All Storage tank facilities	Monthly / As needed	Monitoring by Visual Inspection	Section Chief, MSSS	Fencing of storage facilities with no fence and improvement of existing perimeter fences by converting barbed wire fencing into CHB fence
Repair, Painting & Disinfection of storage tank	Complaints regarding water quality	Water Supply	Faucet within facility / vicinity	Daily	Collection of Water Sample	Operator on Duty	Isolation of storage tank until rehabilitation is completed
Strict implementation of SOPs in isolation	Complaints regarding water quality	Water Supply	Faucet within vicinity	Daily	Collection of Water Sample	Operator on Duty	Flushing at hydrant/blow offs

and leak repair.							
Regular leak detection and Saturation Drive	Increase in Non Revenue Water per DMA (NRW > 25%)	NRW Database	DMA	Monthly	NRW Analysis	Section Chief, NRW	Continuous Formation and monitoring of DMA and intensify leak detection activities
Rehabilitation of old and deteriorated pipes	Complaints regarding water quality	Water Supply	Faucet within vicinity	Daily	Collection of Water Sample	Operator on Duty	Rehabilitation of deteriorated pipelines

VII. VERIFICATION

As a guarantee that the overall system design and operation is efficient of delivering safe and potable water to concessionaires, the WSP team performs verification which involves three activities:

1. Compliance monitoring – confirmation of compliance with water quality targets.
2. Internal and external auditing of operational activities – it can have both an assessment and a compliance checking role. The frequency of audit depends on the level of confidence required by the water utility and the regulatory body.
3. Consumer satisfaction – includes checking that consumers are satisfied with the water supplied.

A. WATER TREATMENT PLANT No. 1 AND 2

Table 18 - Verification of Control Measures for WTP No. 1 and No. 2

Verification Activity	Location of Activity	Type of Activity	Frequency of activity	Analyst	Recipient of Analysis Result*	Action on unusual/ failing result	3rd-Party Recipient of Results
Total & Fecal Coliform	Consumer's taps randomly selected per designed sampling plan	Sampling	Monthly	DOH accredited lab	Senior Engineer A, Division Manager (WTP)	For resampling of positive consumer's tap as well as before & after the sample location	LWUA, City Health Office
Heterotrophic Plate Count	Consumer's taps randomly selected per designed sampling plan	Sampling	Monthly	DOH accredited lab	Senior Engineer A, Division Manager (WTP)	For resampling of positive consumer's tap as well as before & after the sample location	LWUA, City Health Office
Residual Chlorine	WTP Treated Water, BS, Reservoir, Consumer's tap	Sampling	Daily	In-house Laboratory	Senior Engineer A, Division Manager (WTP)	For re-chlorination of non-complying residual in selected areas, adjustment of chlorine dose	LWUA
Physical & Chemical Analysis (13 Priority	WTP Raw Water Inlet, WTP Treated Water	Sampling	Semi-Annually	DOH accredited lab	Senior Engineer A, Division	For resampling	LWUA

Parameters)					Manager (WTP)		
Physical & Chemical Analysis (13 Priority Parameters)	Representative Sample of Extremities in the distribution (Consumer's tap)	Sampling	Annually	DOH accredited lab	Senior Engineer A, Division Manager (WTP)	In case of High Turbidity, Flushing of Hydrants and Blow-offs	LWUA
Physical & Chemical Analysis (13 Priority Parameters)	Deepwell Sources	Sampling	Annually	DOH accredited lab	Senior Engineer A, Division Manager (WTP)	Well rehabilitation, Shock chlorination, Adjustment of Withdrawal Rate/Pump Setting	LWUA
THM Analysis	WTP Treated Water	Sampling	Semi-Annually	DOH accredited lab	Senior Engineer A, Division Manager (WTP)	Maintain optimum chlorine dose, adjustment on chlorine dosing	LWUA

B. AUDIT OF RECORDS

Table 19 - Audit of Records

Verification Activity	Location of Activity	Type of Activity	Frequency of Activity	Analyst	Recipient of Result	Action on unusual/ failing result	3rd Party Recipients of Records
Verification of Chlorination equipment calibration	Pumping Stations	Internal audit	semi annual	WUMO(MSSS) / SWUMO	Manager (Production Department)	SOP for corrective maintenance	
Verification of deepwell history	Office Database	Internal audit	semi annual	WUMO/SWUMO/ Division Manager	Manager (Production Department)	Well Rehabilitation / Well Abandonment	
Verification of Pipeline Management	Office Database /Distribution Network	Internal audit	annual	Engineer / Field Inspector / Division Manager	Manager (Engineering Department)	Conduct investigation on status of pipeline based on the given data and make necessary recommendations for pipeline rehabilitation if necessary	

C. CUSTOMER SATISFACTION

Table 20 - Customer Satisfaction

Verification Activity	Location of Activity	Type of Activity	Frequency of Activity	Analyst	Recipient of Result	Action on unusual/ failing result	3rd Party Recipients of Records
Customer Feedback	SJW Offices/Collection Office	Survey	Daily	Corp. Affairs Div./GM	PIO/OGM/Concerned department	Service Requests/Investigation	
	SJW Offices(Frontline)	Received complaints(walk-in/hotline/e-mail)	Daily	Sr. CSO/Manager	concerned department / GM	follow-ups	

VIII. MANAGEMENT PROCEDURES

Management procedures or most commonly referred to as Standard Operating Procedures (SOPs) is a procedure specific to the operation that describes the activities necessary to complete tasks in accordance with industry regulations, laws or even just the own standards for running the business or in this case, the process of providing safe drinking water to San Jose Water's concessionaires. These procedures are documented and are periodically updated particularly in light of implementation of the improvement/upgrade plan, review of incidents, emergencies and close adversities. It also includes documentation of the system assessment, monitoring and communication plans and supporting programs.

San Jose Water has two water treatment plants (WTP-1 and WTP-2) with rated capacity of 20,000 m3/day and 30,000 m3/day, respectively. Standard Operating Procedures (SOPs) were developed for treatment procedures, maintenance of the distribution system and consumer premises to define expected and acceptable practices.

San Jose Water has a Quick Response Team that is on call for repair leaks that happen beyond office hours or during weekends and holidays. The QRT is a composite team from different operating units of San Jose Water.

San Jose Water developed a Crisis Management Plan (CMP) which aims to ensure, in emergency and disaster situations, the least possible impact on water supply and San Jose Water's public image through an effective response that contributes to preserving the health and life of the population. The Crisis Management Team and the Crisis Response Team will be activated at once the onset of a crisis situation.

To maintain San Jose Water's effectiveness and efficiency in providing safe and potable water to the city, it is important to perform regular monitoring of each process step and perform necessary corrective actions for every deviation from operational limits, incident response reports are consistently recorded and kept for future reference.

These reports are documented, updated and readily available when the need arises. These documents are written in details to provide sufficient work instructions and assurance of operational control when performed by competent and well trained operators.

Water Treatment Plants

A. COAGULANT DOSING

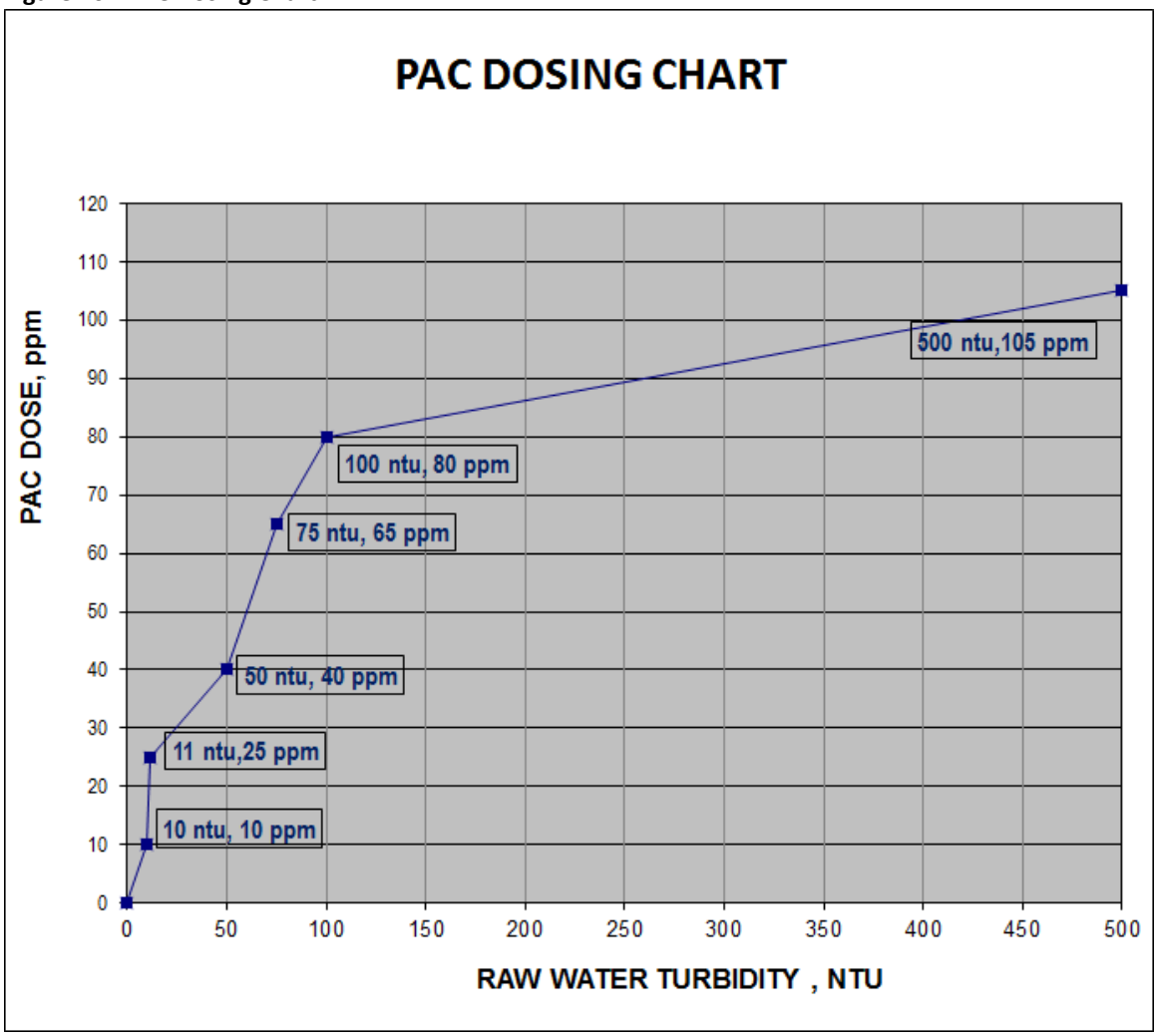
STANDARD OPERATING PROCEDURE
WATER TREATMENT PLANT 1 & 2

POLY ALUMINUM CHLORIDE DOSING

Raw water supply coming from MWSS AQ6 enters the Water Treatment Plant thru the raw water intake and applied with chemical coagulant for turbidity removal. The following procedure is followed to what amount of coagulant will be added in the treatment process.

A. Raw water turbidity is measured using the Benchtop Turbidimeter. When the raw water

Figure 10 - PAC Dosing Chart



turbidity is greater than 30 NTU, PAC is initially dosed base on the reference chart below.

Notes:

1. At any given turbidity value, the PAC DOSE shall be computed as follows:

Table 21 - Computation of PAC Dosing

No.	Turbidity Range	DOSING FORMULA, PAC Dose in ppm
1	up to 10 NTU	PAC dose = 1(TNTU)
2	*11 - 50 NTU	PAC dose = 0.95(TNTU) + 15
3	51 - 75 NTU	PAC dose = 1(TNTU) - 10
4	76 - 100 NTU	PAC dose = 0.95(TNTU) - 15
5	101 and above	PAC dose = 0.04(TNTU) + 85

The above were middle point values based on historical figures. Actual needed dose may vary depending on raw water quality. Duty Chemist should verify optimum dose from time to time through Jar Testing.

2. The **PAC Feedrate** shall be computed as follows:

PAC Feedrate, L/Hr = (PAC DOSE,ppm x Flowrate, CMH)/1,190 g/L

3. * **- Turbidity at 11 - 50NTU** should be treated initially with slightly higher dose to allow good sludge blanket formation. Fast formed sludge blanket will act like a seed' and will then be needed for efficient succeeding blanket formation necessary to prevent rapid clogging of filters that might lead to frequent backwashing/low production output.

4. The above is a quick reference chart only for Water Quality Management Section being in-charge of the chemical dosing at the plant. Duty Chemist should still verify from time to time if the above is still optimum for water treatment process.

B. After initially dosing the incoming raw water based on the chart, amount of dose is verified thru Jar Testing Analysis in which the water treatment process is simulated by the following setting:

1. Rapid Mixing: 2 minutes @ 80 RPM
2. Slow Mixing: 20 minutes @ 40 RPM
3. Settling: 15 minutes

From the Jar Testing Result, PAC dose initially applied will be adjusted to apply the optimum dose required by the quality of the incoming raw water.

C. Water quality analysis will be performed per stage of the process to verify the effectivity of the applied optimum dose based on the Jar Testing result.

*Other Management Procedures are itemized as follows:

CATEGORY	SUB-CATEGORY	STANDARD OPERATING PROCEDURES
Operations Overview	General Information	Daily Morning Rounds
		Security on Premises
		Records Documentation
	Sampling	Sampling Procedure
Raw Water Intake	Flow Measurement	Flowmeter Accuracy/ Volumetric Testing
WTP & Deepwell Treatment Process	Dosing Procedures	Chemical Dosing @ WTP
		Chemical Dosing @ Deepwell Station
		Conduct of Jar Testing
	Flow Measurement	Flowmeter Accuracy/ Volumetric Testing
	General Information	Pump Station Operation & Monitoring
		Pumping Plant Operation & Monitoring
	Sampling	Water Sampling for Physical & Chemical Analysis
	Water Quality	Water Quality/ Treatment Process Monitoring at the plant
Treated Water Distribution	Disinfection	Disinfection of Pipeline & Reservoir
	Emergency Response	Leak Isolation
		Leak Repair
		Distribution Line Flushing
		Leak Detection
	Pipeline	Pipe Storage & Installation
	Water Quality	Water Sampling for Bacteriological Testing

Table 22 - Other Management Procedures

*Some of the mentioned SOPs are in the process of development.

Distribution System

Pipeline maintenance

SOPs on Repairs

The repair on transmission line, distribution line and on service line are being conducted by the San Jose Water personnel. There are also instances wherein the preparation is being handled by contractors and the repair is conducted by the Water District. As such the contractor shall excavate, break pavement, if any, expose and clear damaged pipeline. Once pipeline is cleared the San Jose Water maintenance personnel will conduct the repair.

When leaks happen during weekends, holidays and night time, the repair will be handled by the Quick Response Team (QRT). The QRT was established in the late 90's. It is composed of a supervisor and two teams (first team and second team). These two teams have two maintenance personnel each. Number of maintenance personnel to be utilized is depends on the extent of the activity. The first team is always the first priority to be pulled-out.

During the initial report of the leaks, the Production & Distribution Department through its roving operator shall evaluate the situation if it is needed to isolate the area. The Production & Distribution Department will decide on the following to determine if immediate interruption is needed:

1. Immediate Water Supply Interruption

    a. If the volume is too much that the leak will cause damages on roads and properties.
    b. If the location of leak is far from bodies of water containing potential contaminants.
    c. If there is few service connections in the affected water system.

2. Reduction of Water Pressure Prior to Repair

    a. If pipeline is situated in residential areas wherein there is adjacent drainage system.
    b. If there is no threat of damages to road or property.

c. If there are many service connections that will be affected. Normally the repair is scheduled at night.
d. If the pipeline is situated underneath a body of water such as creek and river.
e. If the flow is tolerable that it is somehow similar to the flow of a leaking service connection.

The SOP in the preparation for the repair are as follows:

1. Interruption will be based on the situations mentioned earlier.
2. If there are threats of entering of contaminants while preparing for the repair, excavation will be made without water supply interruption. Reduction of water pressure will be applied.
3. Total supply interruption shall only be made once water is below the level of the pipeline.

In case of leak on service lines there will be no water interruption to be made. Water interruption can only be applied on bigger sizes starting from ¾"Ø wherein pressure cannot be contained by maintenance personnel. Pressure will dictate if interruption is needed to repair the leak on service connections.

IX. SUPPORTING PROGRAMS

In 2011, San Jose Water engaged to a Water Operator Partnerships (WOPs) or "Twinning" Partnership Program. It is an approach that enables peer-to-peer exchange of knowledge and experience between two water utilities. A utility (recipient twin, in this case – the San Jose Water) that seeks to improve its performance and service delivery pairs with a stronger utility (mentor twin – K-Water) to learn from.

The Water Operator Partnership between K-Water and San Jose Water strengthened capacities to provide improved water quality. K-Water exposed its recipient twin to practical solutions, introduced new methodologies which resulted to increased customer satisfaction on San Jose Water's side.

The partnership also provided information and data for decision and policy making of San Jose Water's management. San Jose Water was able to adapt and adopt relevant best practices, solutions, approaches, assign and involve relevant staff.

As such, the WSP team with the approval of San Jose Water management formulated more supporting programs to support the delivery of safe drinking water. These programs will be coordinated and synchronized with other departments programs which seek to achieve one common goal - to serve all the residents of the City of San Jose Del Monte with equitable, reliable and immediate access to safe and potable water twenty-four hours a day at the least possible cost.

These activities do not directly affect water quality but are meant to ensure that no additional source of potential hazards will come from the operating / surrounding environment, the equipment's used and the people themselves, employees and visitors alike.

Table 23 - Supporting Programs

Program	Purpose	Specific Activity	Target Date of Implementation
Calibration	To maintain accuracy and reliability of equipment monitoring	a. Chemical Dosing Pumps	Quarterly
		b. Laboratory Instruments	Semi-annually
		c. Flowmeters	Semi-annually
Preventive Maintenance	To prevent unnecessary malfunctions in the process and maintain effectiveness of strategies implemented	a. Electro-mechanical facility wtps, deepwell stations, booster stations	Quarterly
		b. Storage/reservoir facilities	Annually
		c. Cleaning of raw and clear water tank	Annually

Hygiene and Sanitation	To prevent personnel and equipment from introducing hazard to the water	a. Sealing of stocked pipe	2nd quarter of 2016
		b. Wearing of PPEs for personnel indirect contact with clean water	2nd quarter of 2016
Training	To ensure personnel familiarity and understanding with water safety and the implications of their actions	a. Water Resources Facilities Operators' Course	1st quarter of 2016
		b. Water Quality Management	3rd quarter of 2016
		c. Understanding the Concept of Water Contamination	2nd quarter of 2016
		d. Water Supply Materials Selection and Quality Assurance	4th quarter of 2016

X. REVIEW AND AUDIT

The world's real situation is unfathomable. The existence of climate change induces weather-related disasters that could be very destructive to human life and settlement. New cases of potentially harmful viruses and bacteria cause contamination of the environment. Further, there are threats of terrorist attacks where water service could be compromised or interrupted.

With these real life situations San Jose Water is facing, it is necessary that the Water Safety Plan shall be reviewed at least once a year to ensure that new risks threatening the water sources, production and distribution of safe water are regularly assessed and addressed. An updated Water Safety Plan will ensure the employees and stakeholders confidence and support in the WSP approach. San Jose Water's water quality management system consists of a stage by stage analysis, making sure that no possible hazard could enter the system at all times.

After the implementation of the Water Safety Plan, the procedures and records should be reviewed to confirm that plan is being carried out. This is called periodic auditing. An audit-based approach places responsibility on every unit involved to provide information regarding system performance against agreed indicators. It is the collection of data to evaluate the level of conformance to the quality system as indicated in the WSP as well as the degree of compliance to regulatory requirements.

Periodic auditing also involves the completion of factual input for management decision, determines if company is at risk, identifies areas or opportunities for improvements, assesses individual performance, assists company staff training needs, improve communication and motivation of personnel.

Furthermore, there will be revisions in the WSP Team once the following changes take place:

1. Career movement
2. Resignation or retirement of members
3. Change of contact numbers
4. Expansion of the WSP Team

To guarantee the effectiveness of the audit system, the audit requires an Internal Audit procedure which will serve as an assessment of the WSP. The auditors should have no direct involvement with the auditee but are qualified enough having a technical understanding of the audit area.

Since the team is composed of water quality management experts from Operation and Technical Services Group, the WSP will be audited by representatives from the Administration Services Group.

XI. REVISE THE WSP FOLLOWING AN INCIDENT

The team will review the WSP at least once a year or as deemed necessary to ensure that occurring hazards and issues are covered. The development of the Water Safety Plan ensures decline in the number and severity of incidents affecting or would possibly affect the quality and safety of water distributed to the concessionaires. However, such incidents may still take place.

It is therefore necessary to review and/or revise the WSP following every emergency, incident or unforeseen event or near misses to guarantee that the same incident/emergency will not recur in the future and to determine whether the response was effective or needs to be improved.

Most likely, the results of a post incident review will determine the areas for improvement of the WSP whether it is a new hazard, or a revised risk for the risk assessment, a revision for an operating procedure or a training issue. It is important that the WSP must be revised so that changes may be reflected and lessons from WSP documentations and procedures are incorporated.

Acknowledgment

This WSP Manual was conceived through the efforts of each department of San Jose Del Monte City Water District. Each recorded data and information from each department has become valuable in the development of this manual. The documented accounts particularly those that occurred beyond the normalcy in the water system aided the team in identifying the risks that could endanger the quality of water being delivered to the concessionaires.

San Jose Del Monte City Water District wishes to acknowledge Maynilad Water Services Inc., which Water Safety Plan Manual served as guide for the development of San Jose Del Monte City Water District's WSP Manual. Maynilad's La Mesa Water Treatment Plant has the same water treatment technology with San Jose Del Monte City Water District's Water Treatment Plant No. 1 thus several issues and some areas in this manual was created using Maynilad's WSP Manual as one of the references. These similarities aided the WSP team to come up with its own water safety plan appropriate to the size and structure as well as the treatment procedures of San Jose Water's Water Treatment Plant No. 1.

Likewise, this manual would not have been possible without the direction from WSP Manual Guide provided by the World Health Organization and the International Water Association. Some points and ideas from the WSP manuals of Davao City Water District and Guimba Water District have also been helpful to the creation of this manual. San Jose Water is truly grateful to the substantial support the above mentioned water districts provided.

Finally, San Jose Water is in debt of gratitude to Engr. Maria Sonabel S. Anarna and Engr. Arturo B. Fernando of who unselfishly shared their wisdom and expertise in the creation of this Water Safety Plan.

List of Abbreviations

WSP	-	Water Safety Plan
K-Water	-	Korean Water Resources Corporation
DOH	-	Department of Health
SPRP	-	Sapang Palay Resettlement Project
MWSS	-	Metropolitan Waterworks and Sewerage System
ABWSSP	-	Angat Bulk Water Supply System Project
PAC	-	Polyaluminum Chloride
PNSDW	-	Philippine National Standards for Drinking Water
CWSSP	-	Comprehensive Water Supply System Project
FABS	-	Fresh Air Booster Station
ACP	-	Asbestos Cement Pipe
WTP 1	-	Water Treatment Plant Number 1
WTP 2	-	Water Treatment Plant Number 2
EBS	-	Encanto Booster Station
PYBS	-	Pulong Yantok Booster Station
MBS	-	Metrogate Booster Station
NHA	-	National Housing Authority
SOP	-	Standard Operating Procedures
DPWH	-	Department of Public Works and Highways
MERALCO	-	Manila Electric Company
CEO	-	City Engineer's Office
LGU	-	Local Government Unit
PEO	-	Provincial Engineer's Office
DMA	-	District Metering Area
NRW	-	Non-Revenue Water
IEC	-	Information, Education, Campaign
WQMS	-	Water Quality Management Section
MSSS	-	Maintenance and Support Services Section
WDS	-	Water Distribution System

WRFO	-	Water Resources Facilities Operator
SWUMO	-	Senior Water Utilities Management Officer
PPDC	-	Provincial Planning and Development Council
BWS-DD	-	Bulk Water Supply and Distribution Department
PDCPLC	-	Planning and Design / Construction & Pipeline Leakage Control
SCWMM	-	Service Connection Water Meter Maintenance
LWUA	-	Local Water Utilities Administration

Glossary of Terms

Alkalinity – the quantitative capacity of an aqueous solution to neutralize an acid. Measuring alkalinity is important in determining a stream's ability to neutralize acidic pollution from rainfall or wastewater.

Aqueduct - a conduit for water; one for carrying a large quantity of flowing water.

Backflow - flow of water in a pipe or line in a direction opposite to the normal flow; often associated with back siphonage or the flow of possibly contaminated water into a potable water system.

Backwash - the upflow or counter-current flow of water through a filter, lifting the mineral bed and flushing away to the drain the particles of foreign matter that have been filtered from the water supply during the service cycle.

Calcium Hypochlorite – a white, crystalline compound, $Ca(OCl)_2$, used as a disinfecting and bleaching agent.

Chlorine - a halogen element, a heavy, greenish-yellow, incombustible, water-soluble, poisonous gas that is highly irritating to the respiratory organs, obtained chiefly by electrolysis of sodium chloride brine: used for water purification, bleach making etc.

Chlorine Dioxide - is a chemical compound with the formula ClO_2 it is a potent and useful oxidizing agent used in water treatment and in bleaching.

Chlorine Residual – when a sufficient dosage of chlorine is applied to water, microorganisms of sanitary significance are destroyed and there is a reaction on all oxidizable matter. After all these reactions have taken place, at the end of a specified contact time there remains a certain minute quantity of chlorine in the water.

Clarification - is the final part of the process and allows the large flocs containing much of the suspended matter to sink to the bottom of a tank or basin, while the clear water overflows and is then further treated.

Coagulant – a substance that triggers formation of a soft, semisolid mass in water, to which constituent to be removed are attracted and/or trapped by adhesion; often the constituent become heavy enough to settle out.

Coagulation – is a water treatment process that promotes aggregation of small particles into larger particles that can be subsequently removed by sedimentation and/or filtration.

Colloid – a dispersion of particles larger than those in true solutions and smaller than those in true suspensions.

Contaminant – materials not normally found in water that make the water less desirable or unfit for its intended use.

Disinfection – water treatment process designed to destroy disease-causing microorganism making water safe for humans to drink normally by adding chlorine, chlorine dioxide etc.

Effluent – an outflowing of water from a natural body of water or from a sewage treatment facility.

Fecal Coliform – subgroup of coliform bacteria that has a high positive correlation with fecal contamination associated with all warm blooded animals.

Filter - a device used to clean water by removing iron, silt, taste, odor, color, etc., before it is fed into the softener or supply lines of the consumer.

Filter Media - A media filter is a type of filter that uses a bed of *sand*, peat, shredded tires, foam, crushed glass, geo-textile fabric, crushed granite or other material to filter water for drinking, swimming pools, aquaculture, irrigation, storm water management and other applications.

Floc
a flocculent mass formed in a fluid through precipitation or aggregation of suspended particle s.

Flocculation – to form flocculent masses, as a cloud or a chemical precipitate; form aggregated or compound masses of particles. Increase the cohesion of the floc formed by coagulation.

Groundwater – water that occurs below the surface of the Earth, where it occupies spaces in soils or geologic strata.

Heterotrophic Plate Count (HPC) - is a procedure used to estimate the number of live heterotrophic bacteria that are present in a water sample. A sample of water is put on a plate that contains nutrients that the bacteria need to survive and grow.

Microorganism – any organism too small to be viewed by the unaided eye, as bacteria, protozoa, and some fungi & algae.

Nephelometric Turbidity Unit (NTU) - the standard unit of measurement used to measure turbidity in water. It makes use of a light scattering effect of fine suspended particles in a light beam.

Parts Per Million (ppm) - a common basis for reporting the results of water and wastewater analysis, indicating the number of parts by weight of water or other solvent. One ppm equals one pound per million pounds of water.

Polymer – a general term for chemical composed of long chains of molecules of known electrical charge and electrical strength. These compounds aid water treatment by agglomerating (clumping together in bunches) very small particles so that they can settle out of water and/or become trapped in filters.

Precipitate - to cause a dissolved substance to form a solid particle that can be removed by settling or filtering. The term also refers to the solid thus formed.

Raw Water – water as it comes from the source (well, lake, reservoir, river) or untreated water.

Septage - the waste or sewage in a septic tank.

Total Coliform – refers to any rod-shapes, non-spore-forming gram negative bacteria capable of growth in the presence of bile sales, or other surface-active agents with similar growth-inhibiting.

Trihalomethanes (THM 's) - a group of organic chemicals to known to be carcinogenic in more than trace amounts which are produced from chlorination. They reduce the germicidal activity of chlorine in alkaline water.

Turbidity – a cloudiness or haziness of water caused by individual particles that are too small to be seen without magnification.

References

1. Philippine National Standards for Drinking Water 2007 Edition
2. City of San Jose Del Monte Ecological Profile 2014
3. Maynilad Water Safety Plan 2012
4. Water Safety Plan Manual: Step by Step Risk Management for Drinking-Water Suppliers
5. San Jose Del Monte City Water District Water Treatment Plant Operations Manual
6. San Jose Del Monte City Water District Employee's Handbook, Version 2014