Proceedings of the Third Philippine Water Congress

Theme: Government and Private Partnership in Water Supply

31 July - 1 August 1989
Makati, Philippines

Francisco A. Arellano
Editor

SAMAHAN SA PAGAWAING TUBIG-INUMIN NG PILIPINAS

PHILIPPINE WATER WORKS ASSOCIATION, INC.

PROCEEDINGS OF THE THIRD PHILIPPINE WATER CONGRESS

Theme: Government and Private Partnership in Water Supply

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Philippine Waterworks Association, Inc.
Quezon City, Philippines
1989

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FOREWORD

The Philippine Water Works Association, Inc. (PWWA) holds a yearly congress and exhibition for the Philippine Water Industry. The congress provides the vital forum for exchanging ideas and experiences in waterworks development. This year the organizing committee has adopted for its theme: Government and Private Partnership in Water Supply. This is a very timely topic considering that the nation is now on a threshold of massive economic development with an ultimate goal of turning into a newly industrialized country (NIC) by year 2000. Apparently, to achieve this, the very basic necessity of providing the essential quality and quantity of water must first be fully addressed. The PWWA has long recognized this goal and the importance of the sector which it represents. By serving as the pivotal point of all entities dealing with the development of water resources for the production and delivery of community water supply it has continuously pursued programs in support of this national development plan.

For the Third Philippine Water Congress, sectorial representatives from the government, well drillers, consultants, contractors and manufacturers have been invited to act as resource persons. Important issues such as; the programs of the government in water supply, monitoring of water quality and protection of our water reusorces, products and procedures applicable to the sector, problems encountered by water districts have been discussed under the technical sessions.

The need to document the proceedings of the technical sessions gave rise to the publication of this material. This is not only for the participants but also for all concerned practitioners in the field of waterworks who may find the papers informative and valuable. This is already the third PWWA course proceedings. The contributors have shared their expertise and knowledge, and without their valuable inputs this publication would not have seen its birth.

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Full - Lenght Papers

THE ANGAT WATER SUPPLY OPTIMIZATION PROJECT: A GEM OF AN IDEA

by Luis V.Z. Sison

INTRODUCTION

Necessity is the mother of invention. So they say; so it is, even with the Metropolitan Waterworks and Sewerage System (MWSS). From a need was born the Angat Water Supply Optimization Project (AWSOP) which, as the project name banners, aims to optimize the use of the water coming from the Angat River. In layman's terms, it means that the water is lost to Manila Bay to bathe the sharks will now be diverted and processed to slake the thirst of millions of our kababayans.

Through the years since the inception of the Manila Water Supply System in 1882, water demand has always exceeded water supply. It seems more and more people need more and more water for various purposes as the years roll on.

Even today, based on the volume of water supply and the volume of consumer demand, the MWSS meets only 86 percent of the consumption requirements of 8.28 million people in its service area in Metro Manila and its environs.

In 1970, the First Manila Water Supply Project was completed. This increased the delivery of water to 1,137 million liters per day (MLD) in the system capacity. But still, this was not adequate to satisfy the increasing demand for water.

The second Manila Water Supply Project, started in 1975, was completed in 1987 and brought in 1,100 MLD. But studies recommended a new source that must be developed so that no serious supply-to-demand gap would occur beyond 1986.

The third Manila Water Supply Project was then conceived to provide long-term public water supply to meet the water requirements of Metro Manila and Rizal up to the early part of the next century. Estimated to cost =P12.4 billion, this will harness the Laiban Dam in Tanay, Rizal as the next source or water supply, after Angat. the project was started in 1982 but had to be deferred because of the large financing needed.

The lack of sufficient funds coupled with the urgent need for adequate water services pushed the MWSS to search for an alternative that shall cost less and is more readily implementable than MWSS III. The search for an interim water supply project that will involve low investment cost and make the project operational within a short period (three years) ended where the water story began - in Angat.

ANGAT RIVER

The Angat River in Norzagaray, Bulacan was conceived as a major source for Manila in 1903. But the initial development of the Angat was done only during the 1920's.

Since 1939, Angat River has been the main source of domestic water supply for Metro Manila. After the construction of the Angat Dam and Reservoir in 1968, the water supply drawn from the Reservoir increased progressively from 13 cubic meters per second (CMS) in 1975 to the present average allocation of 22 CMS.

The average Angat river flow of 61 CMS is first used totally by the National Power Corporation (NPC) to generate electric power. Since this use is not consumptive, the water can be used for the second time. For the second use, the MWSS uses one-third (22 CMS) for water supply. About one-fourth (14 CMS) is used by the National Irrigation Administration. (NIA) for irrigation. The remaining two-fifth (25 CMS) is lost to Manila Bay. It is from this lost portion of 25 CMS that the MWSS will harness or divert 15 CMS as an additional source of water.

This idea crossed my mind when I barely warmed my seat as MWSS Administrator. At the first Water Crisis Committee meeting in March 1987, we were informed that: (1) domestic water has the highest priority in the use of water and (2) MWSS uses only one-third of the second use of the Angat River flow or one-sixth of Angat's multiple-use. So I wondered whether the water not utilized for irrigation for second

use, could be harnessed, and brought to the faucets of millions of Metro Manilans still in constant need of life's most precious commodity - drinking water. That idea germinated and later blossomed into what is now known as AWSOP. Here is the rest of the story.

FEASIBILITY STUDY

To undertake a feasibility study that would lead up to detailed engineering, if found viable, the MWSS chose the joint venture of DCCD Engineering Corporation and the Engineering and Development Corporation of the Philippines (EDCOP) as principal consultants. The others were NIA-Consult, Inc., for irrigation and river basin management, and the UP-National Hydraulic Center, for reservoir operations and underground water technology.

The consultants started in October 1987 a three (3) stage study of the Angat River, namely;

1. First Stage - to determine the additional water that could be drawn from Angat River after satisfying the irrigation requirement of National Irrigation Administration; completed on December 31 1987;

2. Second Stage - to prepare a Feasibility Study that should establish the viability of the proposed project and determine the scheme of development that shall be capable of withdrawing the additional 15 CMS of water allocation from Angat Reservoir to be diverted towards Metro Manila' completed on May 31, 1988;

3. Third Stage - to prepare the preliminary designs of the Intake, Tunnel, Aqueduct and the Additional Treatment Plant to accommodate the additional water yield; completed July 30, 1988.

The First Stage Study was basically the determination of the additional allocation from Angat Reservoir and this study was presented to the National Water Resources Board which approved in January 1988 an additional water rights for MWSS of 15 CMS.

PROJECT BENEFITS

The AWSOP will increase the current water supply by 1,300 million liters per day enough to serve an additional 440,000 connections or some 3.6 million people. Additional water supply is expected to be received by 1992 and the whole project completed in 1994.

PROJECT COMPONENTS

The AWSOP has three major components: (1) Headworks (2) Treatment Plant and (3) Distribution System.

1. HEADWORKS

The headworks comprise all structures and facilities described as follows:

a. A 2.45 meters diameter x 74 meters long penstock (with 24 CMS capacity) to be connected to the existing 3 meter diameter penstock branch upstream of the inlet valve of Main Turbine Unit #1. The 2.45 meter diameter penstock shall be constructed vertically thence laterally through the existing Auxillary Plant thence into a new Auxiliary Powerhouse.

b. One (1) Turbine-Generator set plus Electro-Mechanical equipment for the new Auxiliary Hydro-Power Plant with an installed capacity of 26.7 MW for 24 CMS.

c. A new powerhouse superstructure set apart from the existing plants to house the Turbine-Generator Set.

d. Modification of the extreme left bay of the Ipo Dam Spillway to serve as the approach

to the New Intake.

e. Intake Structure and Gates.

f. A 3.3 meter diameter x 6.4 kilometer tunnel (with a 24 CMS capacity) from the Intake to the Bicti Outlet Portal.

g. A 3.8 meter diameter x 16 kilometers aqueduct (with a 24 CMS capacity) from Bicti to La Mesa. This component of the Project comprise tunnel segments and pipelines in cut and cover sections.

An international public bidding for the construction of the tunnel and aqueduct, above-cited items 1.f and 1.g., respectively, was held on January 26, 1989.

The winning bidders were:

1. The joint venture of AG & P/Hydro Resources Corp./Marubeni Corp./Tekken which took the contract for Tunnel No. 3 with a bid price of =P307,661,338.30;

2. Capitol Industrial Construction Group, Inc., which won Contract No. AQ-5A, consisting of one section of Angat's Aqueduct No. 5, with winning bid price of =P224,208,897.00;

3. D.M. Consunji, Inc., which won contract No. AQ-5B with a =P203,020,465.00 bid price for the second section of the aqueduct; and

4. F.F. Cruz and Co., Inc., which won Contract No. AQ-5C, the third section of the aqueduct, with a total bid price of =P221,892,966.00.

2. TREATMENT PLANT

The new treatment plant shall comprise the following operational plant units:

a. Rapid mixing
b. Flocculation
c. Sedimentation
d. Rapid Filtration
e. Disinfection

Plant units shall be arranged to allow direct filtration operation when such is desired or as condition permit.

At present, mainly because of limited supply of raw water, the design capacity of the existing La Mesa Treatment Plant is under utilized. The design capacity of La Mesa Treatment Plant is 1,500 MLD but has been generally operated in the range of 900 to 1,100 MLD.

The AWSOP shall maximize the La Mesa Treatment Plant design capacity but will require the construction of an additional Treatment Plant with a capacity range about 900-1,000 MLD.

3. DISTRIBUTION SYSTEM

The water distribution component of the Project shall cover the existing Central Distribution System and shall extend farther to areas presently classified as Fringe Area. Extending the Central Distribution System to the Fringe Areas will increase the percentage of population served while in-filling of the existing Central Distribution System shall densify the dispersal of

service connections within the MWSS service area particularly those in Las Piñas, Parañaque, Marikina, Taguig, Valenzuela and Quezon City.

Important features of the Water Distribution System are as follow:

a. Replacement of old mains, reinforcement of existing lines and addition of new lines for a total of about 520 kilometers.

b. Construction of the Capitol Reservoir at Quezon City and puts tandem Pumping Station to serve the National Government Center and other elevated areas in the north sector.

c. Installation of booster pump stations in other selected areas in Las Piñas, Cavite, Pasay and Quezon City.

COST AND INVESTMENT REQUIREMENTS

After the feasibility study established the technical, economic and financial viability of AWSOP, we submitted the same to the National Economic and Development Authority (NEDA) for approval.

The Investment Coordination Committee (ICC) reviewed and evaluated the project with an economic internal rate of return (EIRR) of 21.45% and a financial internal rate of return (FIRR) of 19.61%. Based on this evaluation, the NEDA approved the implementation of the project under Board Resolution No. 66, series of 1988.

The AWSOP was originally estimated to cost =P6.7 billion of which 30 percent or =2.0 billion is government equity; =P2.3 billion peso (MWSS Angat) bonds, and the balance, foreign loans.

We decided to avail of more local funds for AWSOP to avoid too much foreign exchange risk exposure and for economic reasons since it was foolhardly to use foreigh funds for local costs, especially since all revenues are in pesos.

The AWSOP easily attracted willing financiers for the project. The Philippine National Bank (PNB) and the Union Bank of the Philippines (UBP) offered a bond flotation for the entire =P2.3 billion and made a firm commitment of =P1.2 billion; the Asian Development Bank (ADB) first offered $100 million then increased this to $130 million; and the World Bank likewise offered $40 million as its participation in the project.

When the AWSOP was presented to the Department of Budget and Management, Secretary Guillermo N. Carague threw his full support behind the project. The first annual allocation of =P291.12 million was included in the CY 1989 National Budget which was subsequently approved by Congress and President Corazon C. Aquino.

One of the conditions of the bond flotation offered by the PNB and UBP was the guarantee of the Republic of the Philippines as to the principal and interest. Since the National Government does not normally guarantee long term local borrowings we resorted to local bond flotation because MWSS bonds were eligible for Government guarantee under the MWSS charter.

We then requested authority to float bonds amounting to =P2.3 billion from the President of the Philippines through the Secretary of Finance, the Government Corporate Monitoring and Coordinating Committee (GCMCC) and the Central Bank Monetary Board.

On May 4, 1989, the President approved what is now considered the biggest single government peso bond flotation in history.

Based on this approval, the Memorandum of Agreement (MOA) by and between the MWSS and PNB and UBP specifying the banks' commitment to buy bonds was signed on May 17, 1989.

MWSS Angat Bonds

Term : (10) years, inclusive of three (3) years grace period on principal.

Interest : Floating based on the average 182-day T-bill rate as reported by the Central Bank within the seven-day period before the start of each interest rate setting date plus a spread of 1.5% per annum; payable semi-annually in arrears.

Tranching : In ten (10) uniform sized issues approximately =P230 million per tranche.

Redemption

Period : In fourteen (14) equal installments commencing at the end of the seventh (7th) semester from respective issue dates and semi-annually thereafter.

Denomination : =P100,000; =P500,000 =P1,000.000; =P5,000,000; =P10,000,00

Type : Serial; MWSS Angat Bonds

Form : Registered or Bearer at the option of the investor

Issue Price : At par

Manner of Sale : Negotiated

Issue Dates : Commencing on July 3, 1989 and quarterly thereafter up to October 1, 1991

Security : Fully and unconditionally guaranteed by the Republic of the Philippines as to principal and interest.

Sinking Fund

Provision : A sinking fund for the retirement of the obligation at maturity shall be established under the custody and the management of the Central Bank of the Philippines.

Call Feature : Callable at the option of the Issuer subject to a mutually agreed upon early redemption schedule

Arrangement Fee : One-time fee equivalent to 3/8% of the face value of the bond flotation payable on issue dates.

Others Features : Eligible as security on any transaction with the Philippine Government for which such security is required.

The first series of the MWSS Angat Bonds flotation is expected to be issued in July 1989.

Meanwhile, the IBRD and the ADB conducted a parallel appraisal of the project from April 11 to 21, 1989 by IBRD and from April 11 to May 12, 1989 by ADB. This joint appraisal culminated in an Aide Memory dated April 21, 1984 from IBRD, and a Memorandum of Understanding (MOU) dated June 29, 1989 with ADB. As earlier stated, ADB and IBRD committed a $130 million and $40 million loan package, respectively.

Loan negotiations are scheduled this month (July 1989) with ADB and in August 1989 with IBRD.

As an additional source of funding, the National Government included the project for financing in the 16th Yen Loan Package under Japan's Overseas Economic Cooperation Fund (OECF). A project appraisal by Japan OECF representatives was conducted on June 19-30, 1989. The amount of $80 million was allocated for AWSOP.

To minimize cost of capital and maintain the financial internal rate of return of the project, the MWSS will receive the OECF proceeds as National Government equity upon approval of Congress and the President. This will ensure total availability of financing for the project.

URBAN AND RURAL WATER SUPPLY IN THE PHILIPPINES: A PERSONAL VISION

by Ricardo T. Quebral

INTRODUCTION

The urban and rural water supply sector of our country has undergone a massive transformation during the last 4 years in terms of political, structural, policy and financial dimensions. This is a result of a vision of the national government - a vision of what the country's future must be. The leaders of the American Independence, the French Revolution, the Katipunan society as well as the EDSA revolution all had one thing in common - each of them had a vision. Without that vision -- all these movements would not have succeeded. The vision provides guidance as well as a source inspiration to those who have to live by it.

I am not a stranger to PWWA. Neither can I be considered a balikbayan. Let's just say that I have merely returned from a leave of absence. And now that I am again with you, let me now pose this question before you: -- what is PWWA's vision? If there is one, is that vision based on a vivid understanding of future conditions?

Rather than expound on what programs my office or the government have, let me share with you my own vision of urban and rural water supply in the Philippines. After expounding on my vision, I shall then try to bridge the gap between the present situation and that vision by discussing measures that should be taken to effect the shift.

VISION VS REALITY

1. In the future, all urban and rural areas will be adequately covered by Level I water services for the far flung areas and with a combination of Levels II and III for all others. Who will run these systems? I believe that only those firms that are committed, structurally trim and action oriented will succeed in the long run. Because of this belief, I'd place my money on the water districts. They will ultimately manage all water systems regardless of service levels within their territorial jurisdiction. By implication, MWSS will be the biggest of those water districts.

Right now, there are water districts, RWSA's, BWSAs, local government and private enterprises managing water systems. If one considers the varying organizational concepts, tariff philosophies, political concerns, quality standards as well as financing policies, the ultimate result is confusion. A sure way of developing a migraine.

2. Since it will only be the WDs that will be left, they will be institutionally and financially capable of managing all facilities within their area of concern. The district in my vision will be able to: (a) replace deteriorated assets using internally generated funds; (b) organize the required institutions in rural areas and service them on a continuing basis. Hopefully, I envision the WDs going to LWUA for assistance only as a last resource.

At present most WDs, like adolescents, are experiencing growing pains. They feel awkward in facing their public. They would like to be independent but cannot. They would like to explore new areas but find their internal sources limited.

3. In the future WDs will again socio-political acceptance on a national level. Right now you still read news that some political leaders are not too keen about the existence of the WD. That attitude will change. Right now you still read news that some political leaders are not too keen about the existence of the Wd. That

attitude will change. Right new some WDs are still known as NAWASAs or LWUA branch by their populace. That picture will change as is already happening in our progressive districts.

4. In the future, all water districts will be given grant funds for their source development. This will enable WDs to be on equal footing with one another. No longer will WDs be penalized with higher tariffs just because the water source is 50 km too far and needs the whole treatment apparatus of MWSS to make it drinkable. Cross-subsidy among water districts will also be possible on a national scale. A regional limit on water rates will be enforced. To some extent progressive communities will subsidize lesser developed areas.

Right now, the cross subsidy is being applied among connections within a WD only. Some steps however, have already been taken by the government with respect to the provision of grant funds for source development.

5. In the future, I see the existence of a technical school giving regular accredited programs to WD operators/technicians as well as well drillers and pump mechanics. No one will be employed on a technician level without the necessary diploma or certificate of competence. Anybody here interested in becoming the Dean of such a school?

Right now our training programs are focused on serving current employment levels rather than on future sector requirements. Even our training institutions are fragmented, result -- always a dearth of qualified people. Also, I've noticed that no standards or proficiency have been established on levels of competence in so far as the operator/technician levels are concerned.

That is my vision of how our urban and rural water supply program will eventually shape up. In order to transform this vision into reality, there are a lot of things to be planned and things to be done. Let me share some of them with you.

Let's start with my own organization - LWUA.

1. My office is presently undergoing the mixed pain and joy of reorganization. The process will take some time but we have agreed to limit our number of personnel to meet certain government requirements and some physical constraints. We must then develop the private sector capacity to implement our crash programs. And by crash I mean bidding of projects everyday if we have to. The private sector must rise to this challenge for all of us to succeed. Some weeks ago I received a memo form the Construction Industry urging us to adopt measures which would eliminate so called "unfair competition" from foreign firms with respect to projects funded by multilateral sources. The next day I read about the National Confederation of Constructors Association of the Philippines (NACAP) and PCA discussing details of possible national work stoppage in government offices to protest the slow payment of their construction services. I get confused thinking about it.

To the consultants, contractors, suppliers and manufacturers here is a piece of information that will gladden your heart. Within the next 3 to 5 years, there will be a massive implementation of water supply projects and your resources, I'm sure, will be taxed to the limit. I hope that when you rise to the challenge you do so by lifting yourself and not by putting others down.

2. LWUA must look for access to grant funds which it can pass on the WDs. To some extent we are currently succeeding but only on a piecemeal basis. There must be a national policy on providing the source facilities regardless of service levels on a grant basis. Corollary to his, the tariff structures must be reviewed to really achieve true-cross subsidy and to generate funds. An Asset Management Plan must be placed into effect.

3. LWUA must strengthen the WD to enable it move past the adolescent stage and become a mature organization which can accomplish its mission. Institutional development is a dynamic word. All products or organizations that do not rapidly move forward will fall rapidly behind.

4. For LWUA to succeed, we must decentralize, we must be customer oriented, and we must learn to move faster. If in the process we encounter some failures, at least let us learn our lessons faster.

As far as the water districts are concerns:

1. The emphasis being placed on Operation and Maintenance must equal the devotion and tender loving care they bestow on new projects. If we are to move forward, we must not repeat not repeat our past projects and infinitum.

2. They must take a more active role in water resources monitoring as well as in watershed management. Let's face it. Without water, there is no water district; there is only a district.

3. To gain socio-political acceptance, a massive information drive is not enough; the district's water service must improve and keep on improving. As the saying goes, "actions speak louder than words."

LASTLY, for all of us, in PWWA, we must take heed of the following:

1. Our country will have a difficult time developing without the necessary value transformations. Instead of the "remedyo" mentality, we must all learn to do things right the first time. Instead of considering only short term profits, we must learn to accept long-term implications. We must all strive to be "models" in our industry rather than be a "lone ranger" with a lone cause.

2. The PWWA can take more active role in further shaping this vision. While I realize the contraints faced by a conglomeration of private and public firms, if the PWWA can initiate adoption of national standards by its members, monitor performance of its members, and propose policy statements for government to consider, it will have truly achieved what it set out to do in the first place.

I have presented to you a vision of our future that neither I nor LWUA can achieve alone. Neither can the WDs do it alone. Neither can PWWA. But if everyone here lives with conviction or even passionately some part of the vision, this vision will flourish. KAYA KO, KAYA MO, KAYA NATING LAHAT.

Thank you very much for letting me share my vision with you.

Contingency Plans For Calamity Stricken Water Districts

by Arturo G. Villasan

INTRODUCTION

Typhoons are the most common of the calamities that hit our country year after year. Yet despite the anticipated yearly occurrence a genuine and workable constigency program in relation to the responses of the water districts during and after this phenomena remain much to be desired.

The Philippines lies along the so called typhoon belt in our part of the globe. In particular, the area starting at Leyte Island down to Batanes lies along the path of at least, ninety five percent of typhoons paths.

Typhoon season in the Philippines starts the month of June and lasts up to October and at times even to December. The intensities become stronger in direct proportion to the chronology of the months.

From June to September the weaker typhoons come and their path is usually North West . This means they approach the country from the East or the Pacific Ocean and as they approach the land they continue to swerve northward usually crossing the Philippine archipelago at extreme northern Luzon or Batanes.

Starting October, the super typhoons come. At about this time high pressure brought about by a cold front starts to gather North of the Philippines. This high pressure pushes back the typhoons and so the typhoons go Northwest or further South. Thus, during the months of October November and December, we experience real strong typhoon. This usually hits Nueva Ecija, Tarlac and Pangasinan and the Ilocos.

In a single year, typhoons, named by the letters of the alphabet usually run through all the letters or at times, even go through the first new letters again.

It is not unusual for typhoons of 300 kilometers per hour to hit Nueva Ecija dimishing in power as it traverse land and exiting on Dagupan with center winds of 200km/hr.. The destruction wrought by this meteorological phenomenon is tremendous. Still, as mentioned earlier we have not developed the preparatory measures for contigencies in case such as this.

For instance, a year after the Cabanatuan City Water District took over the operations of the water system, a heavy typhoon directly hit Cabanatuan City. Immediately after, we were visited by LWUA fieldmen. Their arrival assuaged our feeling of despair. They listed down the damages we suffered. That was as far as it got. This listing is procedural. And that was we got.

WHAT HAPPENS TO A WATER DISTRICT AFTER A TYPHOON?

The reason perhaps, why there is very little concern for Water Districts when affected by typhoon is that it suffers very minimal physical damages. This is expected because most water facilities are underground. Elevated tanks are usually made of solid monolithic concrete.

Most often, what the damages are for vertical structures like buildings which are not essential to the actual operation of the water system.

Thus in the aftermath of typhoons, when government and other relief agencies start a rehabilitation program, water districts are not included. This is so because the damages to a water district become pronounced only after the typhoon .

The first facility to be affected when strong winds hit a community facility is the power line. This leads

to power interruption for a time resulting in a standstill in water production. In the rural areas, crops are usually lost to floods. Buildings and houses of light materials are not spared and the economy of the community is seriously derailed.

Now the problem starts for the water districts. In the aftermaths of the severe typhoons that cross Central Luzon after skirting the eastern coasts of Leyte. Samar and the Bicol region, restoration of power can take months. Except for few water districts like San Pablo City that get water from springs, Water Districts without any standy by diesel powered pumps or generations has simply to stop operation. People normally take remedial measures. This involve the reactivation of their shallow wells operated by hand pumps.

Weeks or even months later, when power is restored the Water Districts resume operations. It is at this point that the district is back to square one, so to speak. They are out to win back the concessionaires' confidence before they would get their patronage back. San Antonio Water District in Nueva Ecija was not so lucky. It never recovered after a typhoon in October 1985, Guimba, Nueva Ecija Water District closed for four years after the same typhoon, is still trying to start up.

Some water districts have been provided with standby generating sets to tide them over during power failures. But this is not for an extended period of time. It has been reasoned out that the failure to provide this constigency measure can be attributed to foreign consultants and designers who are not familiar with Philippine meteorological conditions and they have failed to forsee these problems at the onset of the planning works.

Even when a water district is able to somehow operate through other altemative sources of power, there are other problems which they must face.

This next problem is collection. People whose properties have been suffered damaged would place higher priority for house repairs. A water district, if it wants to maintain good will, would be well advised to relax in their collection policies.

From the low income group there will be request for partial payment of bills. This is more warranted than no payment at all. This is in consideration that Water Districts could not disconnect water services anyway after a calamity.

A Water District though fortunate enough to have auxilliary sources of power, suffers just the same. While it spends more producing water with the use of diesel fuel, its collection goes way down. In addition, a Water District situated in a community that has been hit by a typhoon definitely cannot raise its rates for at least a year. This will require them to reposition its financial goals.

RECOMMENDATIONS

Now that LWUA has definitely decided to engage the services of Filipino technical people for feasibility studies and engineering designs, our local engineers being more familiar with Philippine climate could hopefully, make the necessary provisions and contigences for typhoons in operating the facilities of the water districts.

There ought to be an auxilliary source of power for all water production facilities. This is a must.

Whenever possible when the source of water is ground water, the use of submersibles must be avoided. Submersibles cannot be coupled with a diesel engine when electric power fails. A generating set would be necessary and this is very expensive to operate. On the other hand, a conventional shafted turbine pump could be easily coupled with a diesel engine. It has been shown in Olongapo City Water District that this method is less expensive to operate compared to using electric power, if not cheaper.

Water rates of Water Districts located along the typhoon belt should make the necessary provisions in their water collection to build up reserves for operation during and after calamities.

The feasibility of setting up a generating set pool that could be farmed out to water districts when the need arises needs serious study. This could lessen the capital investment of small water districts.

Finally, in planning for a water system that will be located along the so-called typhoon belt, the feasibility study must contend with Murphy's Law.

If a typhoon hits an area, it would hit that area. Most likely, at the worst possible time.

A PRACTICAL MAINTENANCE APPROACH FOR HANDPUMPS AND HANDPUMPED WELLS IN THE PHILIPPINES

by Lamberto L. Abrecea and Antonio V. Molano Jr.

INTRODUCTION

Precipitation (rainfall) is highly unpredictable because distribution varies widely with time and place due to archipelagic nature of the country's geography, and local topographic arrangement which influence its climate conditions.

Precepitation is an important source both for rainfed and irrigated crops. In many areas in the Philippines, it is the direct source of domestic water supply. It also feeds rivers, lakes and recharge reservoir and aquifers.

EFFECTS OF DIRTY ENVIRONMENT

Poor sanitation affects water quality. The most probable path linking sources of pollution and infection to diseases can be related to the pollution of water from excreta, refuse, pesticides, bad water sources and improper storage. From these polluted sources, water is used for washing, cleaning, drinking, cooking, bathing and food production. This results in de\diseases from polluted water, lack of sanitation and personal hygiene.

WATER-BORNE DISEASES

The different water-related diseases are as follows:

water-borne	- cholera, typhoid, hepatitis
water-washed	- scabies, trachoma
water-based	- schistosomiasis
water-related-vectors	- malaria sleeping sickness

TYPES OF WELLS

Dug Well - is a manually excavated open hole, usually circular in shape and line with concrete pipe, brick. The diameter of the well varies from 1.0 to 1.5 meters and it has a depth of not more than 6 meters.

Driven Well - is a drilled hole into the ground and into the water bearing formation. Water enters into the well through the strainer and the pipe diameter ranges from 32mm to 50mm with a usual depth of 12 meters.

Cased Well - is an open hole normally constructed by getting or drilling using either rotary or percussion drilling equipment. Its wall is provided with the casing which is either PVC of Iron Pipe to prevent the side of borehole from collapsing. At a depth where water is available, well screen is provided to permit entry of water into the well.

Gravel Pack Well -a borehole to accomodate casing/screen sorrounded by gravel is constructed by either percussion, rotary of jetting method. Gravel placed around the screen/cassing helps collect all available groundwater into the well to maximize its yield and prevent clogging of screen by fine sand materials. A sand trap at the bottom of the well collects fine sand materials that enter the screen.

VARIOUS TYPES OF HANDPUMP

A. Deep Well Handpump
   1. Magsaysay Pump
   2. Malawi Pump
B. Shallow Well Handpump
   1. Jetmatic Pump

RESULTS OF IMPROPER OPERATION AND MAINTENANCE OF SHALLOW WELL (JETMATIC)

No Water
Limited Discharge
Noisy and Shaky Parts
Worn-out Parts

THE DO'S AND DON'T FOR USING SHALLOW WELL (JETMATIC)

A. DO'S
   1. Up and down stroke
   2. Pump slowly
   3. Long stroke

B. DON'TS
   1. Left and right stroke
   2. Impact and pumpling
   3. Short stroke

RESULTS OF IMPROPER OPERATION AND MAINTENANCE FOR USING DEEP WELL (MAGSAYSAY TYPE)

No Water
Limited Discharge
Not Functioning or abandoned
Noisy and shaky parts
Worn-out parts

THE DO'S AND DON'T FOR USING DEEP WELL (MAGSAYSAY TYPE)

A. DO'S
   1. Up and down stroke
   2. Pump slowly
   3. Long stroke

B. DON'TS
   1. Left and right stroke
   2. Impact in pumping
   3. Short stroke

RESULTS OF IMPROPER OPERATION AND MAINTENANCE FOR USING DEEP WELL (IMPROVED TYPE)

No water
Limited Discharge
Not functioning or abandoned

Noisy and shaky parts
Worn-out parts

THE DO'S AND DON'TS FOR USING DEEP WELL (IMPROVED TYPE)

A. DO'S
1. Up and down stroke
2. Pump slowly
3. Long stroke

B. DON'TS
1. Left and right stroke
2. Impact in pumping
3. Short stroke

TROUBLE SHOOTING

A. Shallow Well Handpump

Common Causes of Troubles and Their Remedies

INDICATION	CAUSES	REMEDIES
1 Pump Handle works	1. Worn out rubber cup	1. Replace the rubber cup
	2. Worn out plunger valve	2. Replace plunger valve
	3. Worn out propet valve	3. Replace propet valve
	4. Worn out plunger	4. Replace the plunger
	5. Worn out valve cage	5. Replace the valve cage
	6. Disconnected piston rod	6. Reconnect piston rod
	7. Leak at cylinder joints	7. Retighten nuts of cylinder joints and/or apply epoxy paste
	8. Water level gone down below perforation or screen level	8. Re-develop the well by using air com pressor
2 Noisy and Shaky	1. Worn out head handly during operation	1. Replace worn out and pivot handle or pivot shaft pin
	2. Loose handle head shaft or pivot shaft pin set screw	2. Retighten handle head or pivot shaft pin set screw

B. Deep Well Handpump

Common Causes of Troubles and Their Remedies

INDICATION	CAUSES	REMEDIES
1. Pump handle works easily but delivers no water	1. Damaged drop pipe or drop pipe disconnected 2. Water level gone down much below the cylinder assembly 3. Worn out cylinder leather cups 4. Connecting rod joint disconnected 5. Worn out working or standing valve 6. Pump cylinder cracked	1. Replace damaged or connected disconnected drop pipe 2. Add more drop pipes and sucker rods 3. Overhaul the cylinder and replace the leather cups 4. Pull out the pump & join the connecting rod 5 Replace worn out worling or standing valve 6. Replace cylinder
2. Delayed flow or small flow	1. Leakage in cylinder working or standing valve assembly 2. Leakage in drop pipe assembly	1. Overhaul cylinder, clean or replace valve assembly 2. Replace defective drop pipe
3. Noise during operation	1. Bent sucker rod 2 Defective yoke & main shaft bushing 3. Loose bolts' nuts at pump head assembly	1. Straigthen the defective rod 2. Replace/lubricate defective bushing 3 Tighten loose nuts at pump head assembly
4. Shaky Handle	1. Loose foundation bolts' nut 2. Worn out main shaft bushing 3. Loose steel plate	1. Tighten foundation bolts' nuts 2. Replace/lubricate worn out bushing 3. Tighten or replace handle woodscrews

C. IMPROVED DEEP WELL HANDPUMP

Common Causes of Troubles and Their Remedies

INDICATION	CAUSES	REMEDIES
1. Pump handle works easily but delivers no water	1. Damage drop pipe or drop pipe disconnected	1. Replace damaged or connect disconnected drop pipe
	2. Water level gone down much below	2. Add more drop pipes and sucker robs the cylinder assembly
	3. Worn out cylinder leather cup	3. Overhaul the cylinder and replace the leather cup
	4. Connecting rod joint disconnected the connecting rod	4. Dismantle the handle & reservoir and join
	5. Worn out working and standing valve	5. Replace worn out working or standing valve
	6. Pump cylinder 33B	6. Replace cylinder cracked
2. Delayed flow or small flow valve assembly	1. Leakage in cylinder working or standing standing	1. Overhaul cylinder, clean or replace working and valve assembly
	2. Leakage in drop pipe assembly	2. Replace defective drop pipes
3. Noisy or shaky	1. Bent sucker rod handle	1. Straighten the defective rod operation
	2. Loose rank plate pivot screw or handle pivot pin	2. Retighten loose nuts or crank and handle picot pin
	3. Defective crank plate or handle	3. Replace defective bearing bearing
	4. Loose reservoir flange bolt's nuts	4. Retighten loose bolts' nuts at flange or reservoir

WATER QUALITY MANAGEMENT THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

by Beta P. Balagot

INTRODUCTION

The use of water is a requirement of all organisms in our biosphere. Whether the organisms are protozoans living in the lake, a worm in the soil, a tree in the forest, a businessman concerned about his profits, a farmer, or you and me - these diverse organisms functioning in different ways all require water. Water, therefore, is our most valuable single natural resource. It is the basis of our existence and as such, must be so preserved and used judiciously.

To date, we have been very careless with our use of water. As our way of life has become more sophisticated, we find that we use greater quantities of water. It has been estimated that the requirements of a human being have increased about eight times since the turn of the century. In addition, rapid population growth and increase in industrial activities have resulted in the deterioration of the quality of our water resources.

The management of water resources incompasses two major concerns: 1) the provision of an adequate supply of water to meet various need; and 2) the protection of the quality of water to meet both present and future needs. The Peper today is involved with the second concern, i.e., water quality management.

POLICY FRAMEWORK

Figure 1 sets out the "rational" policy framework in evolving a water quality management program. The principal elements in the decision-making process are the following:

1. Examination of the water resources and public health requirements
2. Establishing pollution control goals
3. Development of alternative pollution control strategies and associated administrative institutional mechanisms designed to meet requirements
4. Preparation and implementation of plans
5. Information system

In practice, there may be few opportunities to follow. Through these stages and a prepared plan; a series of decisions to must be taken befor the formal planning process. Nevertheless, that process of defining the main objectives and examining alternative ways of attaining the objectives and implications before arriving at a decision still applies. This decision-making process does not by itself provide "the" answer: different strategies have different costs and benefits and the selection will often rest on political priorities. However, its importance lies in the information presented to the decision-maker through this process allowing him to understand the options and the implications of his decisions.

OBJECTIVES OF WATER QUALITY MANAGEMENT

Based on the assessment of existing pollution problems, the following objectives have been defined for our present programs related to Water Quality Management:

Physical:

1. Improve stream quality by reducing pollutions discharges to some administratively determined levels of river quality;
2. Stop accidental pollution and illegal operations; and
3. Minimize adverse environmental change.

Institutional/Technical:

1. Improve monitoring; and
2. Improve the process of adjudicating pollution cases.

Socio-Political:

1. Equity ensure "fair" treatment; and
2. Minimize political intervention.

ADMINISTRATIVE STRUCTURE

The Department of Environment and Natural Resources (DENR) is the government entity which has responsible in protecting the quality of our water resources. Figure 2 shows the organizational structure of the DENR. Water quality management functions of the DENR are carried out by the Environmental Management Bureau and the Environmental Management Sector of the Regional Offices. Figure 3 and Annex 1 present the organization structure and functions of the Environmental Management Bureau. Administratively, our water pollution control objectives require controls, and the monitoring of the receiving waters to ensure that the objectives are being achieved. The present system of water pollution control administration consists of controls exercised on industries that discharge directly to rivers, lakes or coastal water. Discharges are controlled through a system of permits which define the conditions under which the discharged is permitted to discharge. The conditions of the permits may include quantities of effluents that may be discharged, maximum allowable concentrations, temperature, color, etc. are based on a uniform set of water quality criteria.

WATER QUALITY STANDARDS/CRITERIA

The DENR is currently enforcing water quality standards/criteria promulgated in 1978 for stream standards and effluent standards promulgated in 1982. However, in response to advances in technology and changes in economic conditions, these water quality criteria/ standards are in the process of being revised. A Technical Committee was formed by DENR in April 1988, to undertake the revision of the standards. Annex 2 presents the draft of the revised standards/criteria. The following guidelines were adopted by the committee for the review and promulgation of the new standards:

1. Any environmental standard to be promulgated must satisfy the following:
   a. It is capable of precise definition;
   b. Reliable method(s) of, and/or equipment for, analysis must be available for determining whether the test samples meet the standards. It is preferable that the method of analysis chosen be as simple as possible and does not need the use of sophisticated equipment;
   c. The standard is for the purpose of maintaining gradual progress in improving the environment in the light of the local circumstances and needs. The standard should neither be too lax nor too stringent since in the former case some degree of pollution of the river or waterway is most likely to occur and in the latter case unnecessary expenditures may be incurred by the discharger; and
   d. The standard should be practicable, i.e., capable of being attained or enforced technically, economically, financially, politically and socially.

2. Considering that most Philippine rivers are relatively short, the principle of "self-purification of

stream'' should be rarely, if at all, used.

3. Standards for certain parameters which cannot be immediately enforced because of inadequacy, of absence of appropriate equipment, expertise, of funds for analysis, or not being practicable at the present time, should be in the meantime (within five to ten years) be considered initially as guidelines of provisional standards.

4. The use of a national uniform effluent standard by industry type should be looked into if there are adequate data to base a realistic and separate industry-type effluent standards. If his is not possible, the Committee should consider the use of the existing format of graduated uniform standards for all types of industries in terms of maximum concentration levels of applicable parameter, depending on the use or classification of the receiving body of water. For certain pollutants and/or conditions or waterways (such as the ratio of the volumes of the receiving waterways and the effluent as well as the water use or classification), the present format may be modified by regulating the maximum concentration of specific pollutants in the effluent.

5. Effluent standards should be equitable so that one discharger may not gain undue advantage over another belonging to the same industry type.

6. For the effective implementation of effluent standards, consideration should be given to the statistical nature and expected fluctuations in effluent quality, personal error in sampling and/or analysis, etc., by using appropriate statistical methods. Actions/decisions should not be taken on the basis of one grab sample alone.

7. In setting up standards for effluents to be discharged into inland waterways, the main objective is to ensure the maintenance of good stream conditions if the waterway is presently reasonably clean; and to improve the quality of waterway if, through misuse, they have become polluted.

8. A distinction on the allowable limits for effluents should be made between existing and new or planned industries such that initially and for a reasonable period of time (e.g. not more than ten years), existing industries must comply with less stringent standards as compared with new or planned industries. The former must comply with the long-term ultimate standards on or before the lapse of the period.

In the promulgation of standards, the following water quality management policies and/or practices are presumed to be in force and implemented by concerned agencies (Item I), or if not, are recommended by the DENR (Item II).

Item I

1. The goal of water pollution abatement, which is to protect and enhance the capacity of water resources to serve the widest possible range of human needs must be emphasized and that this goal is best attained by keeping water as clean as possible as determined by appropriate standards.

2. A pollution control policy of using the best practicable technology currently available (BPTCA) be pursued in the planning, design and construction of wastewater treatment plants or water pollution control systems.

3. In consonance with the DENR Riverine Revival Program, no river or waterway should be exploited as a waste carrier.

4. Existing monitoring of pollutants will be continued and extended as required.

Item II

5. The Metro Manila Area and other highly urbanized centers of population that are now in serious state of pollution should be relieved of additional pollution loads. In fact, the proposal to ban industries within a 50-km radius from Manila several years back should be revived and enforced.

6. No new and expansion projects that are considered pollutive and environmentally-critical in nature (as defined under Presidential Proclamation No. 2146) are to be entitled to incentive under Executive Order No. 226.

7. Strict control will be exercised over the location of new plants or factories relative to their pollutive potential. Pollutive, highly pollutive hazardous and extremely hazardous industries should be encouraged to locate or relocate outside of built-up and/or polluted areas, preferably near open coastal waters not classified or used for recreational or communal fishing purposes or higher classification such as Class SA and SB waters.

8. The reuse and recovery of essential nutrients and carbonaceous matters from wastewaters should be encouraged and/or promoted.

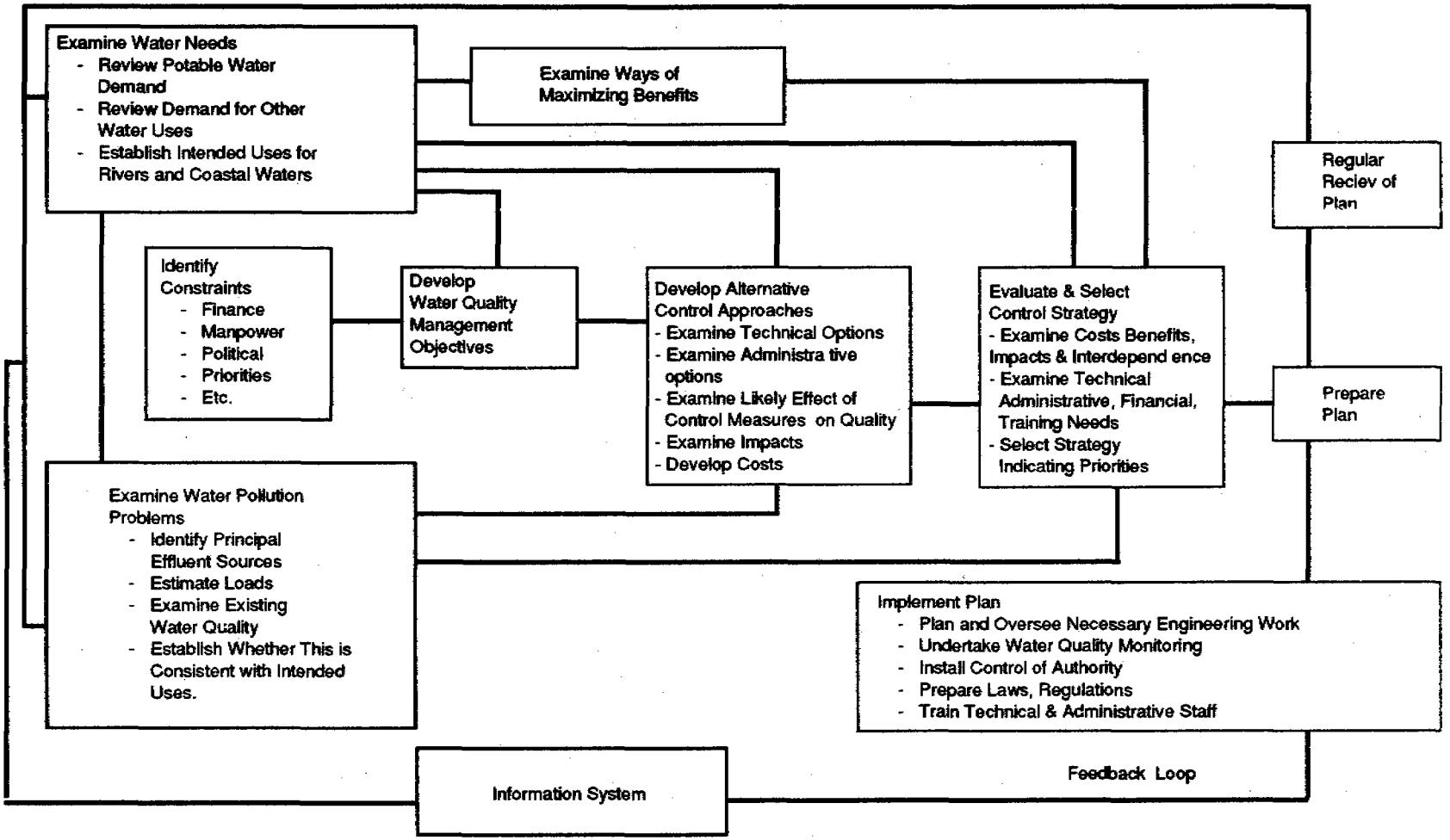
9. All domestic sewage should be suitably treated before being discharged into the environment. Housing and subdivision projects should be required to initially install centralized; primary conventional sewage treatment plants with provision for dis-infection by chlorination before discharging effluents into any body of water. First class housing and subdivision projects as defined by appropriate government agencies should, however, be required to install centralized primary and secondary sewage treatment plants.

10. A policy should be promulgated to require industrial zones or estates to allow the establishment of highly pollutive industries, in these areas, hence, the same must be provided with appropriate and adequate centralized wastewater treatment systems..

11. There should be more effective coordination between local planning authorities and environmental regulatory agency.

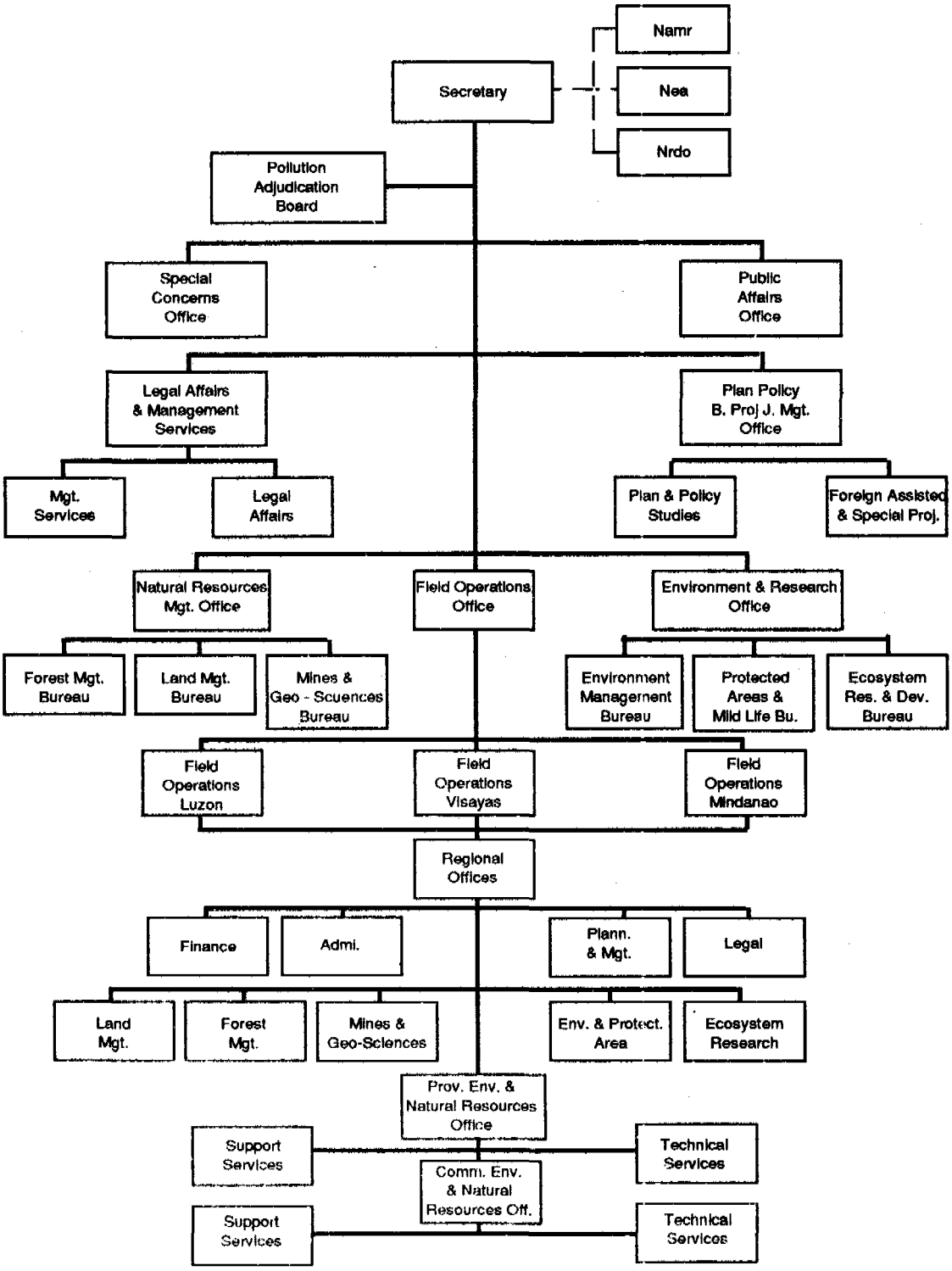
12. In cases where management programs have been set up for rehabilitation of certain water bodies, the implementing agencies may formulate their own standards provided that these are at least as strict as the National Effluent Standards.

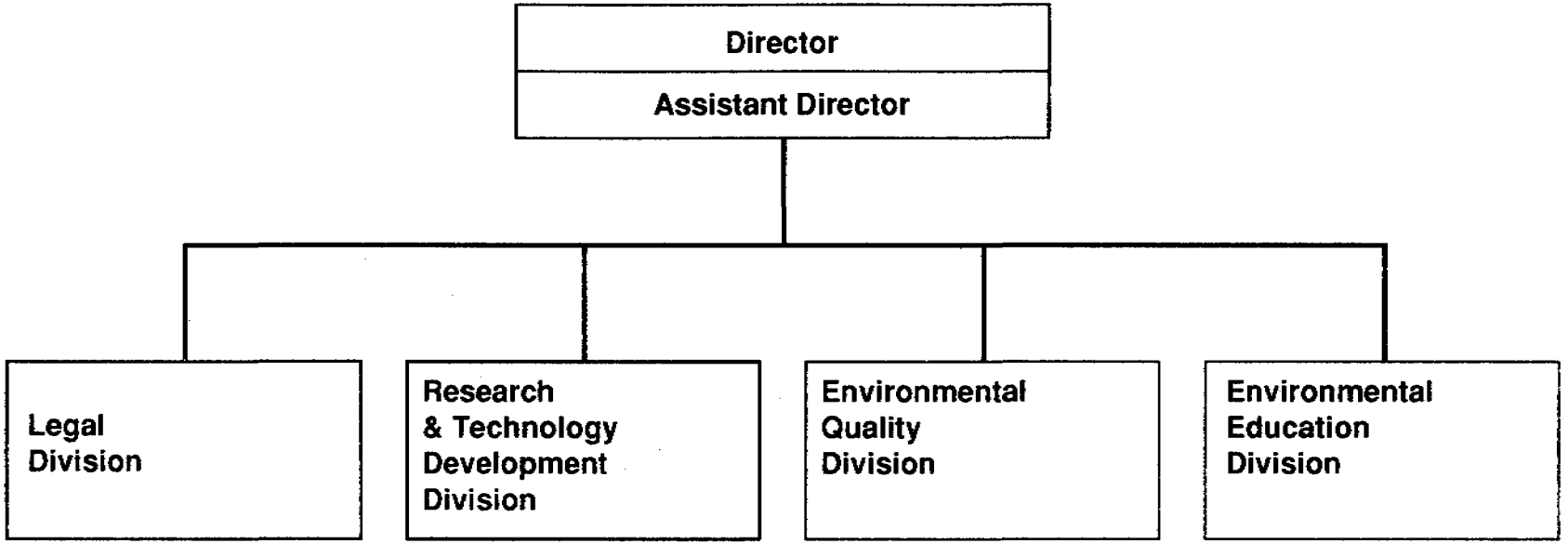
Figure 1. POLICY FRAMEWORK IN THE EVOLUTION OF A WATER QUALITY MANAGEMENT PROGRAM



DENR ORGANIZATIONAL CHART

Figure 2.





ENVIRONMENTAL MANAGEMENT BUREAU
Organizational Chart

Figure 3 .

WOMEN IN WATER SUPPLY AND SANITATION

by Ana Marie L. Avendano & Lily C. Hidalgo

INTRODUCTION

Who are the main users of water for domestic purposes and house sanitation units? No doubt, the answer would be women and and young children. For this reason alone, women should be given special attention during planning of water supply and sanitation projects. They should be allowed to play an active role during community and household decision making, so that the facilities are planned with full awareness of their perceptions and needs. Experience in many countries have shown that the seemingly small aspects of design can make all the difference between the use and non-use of a water or sanitation facility. A check with the women would enlighten planners about the suitability of technology and design features to their needs; as well as to their young children.

No longer are the women considered mere household fixtures without due consideration for their preferences in running the house. Proof of this is the increasing awareness on the role they can play on the successful implementation of projects for the health and hygiene. Women's participation is encouraged in the implementation of the International Drinking Water Supply and Sanitation Decade through the UNDP project - Promotion and Support of Women's Participation in the International Drinking Water Supply and Sanitation Decade. This project collaborates with water supply and sanitation projects executed by United Nations system agencies, non-governmental organizations and bilateral assistance programs to demonstrate how active involvement of women can enhance the effectiveness of the projects and increase the well being of the women and their families.

WOMEN AND WATER

Of the basic needs of man, water has always been given top priority. In most households, it is usually the women's responsibility to provide adequate and safe water for the family. As the main users of water, women find the use of water other than for drinking in domestic activities like washing clothes, washing dishes, cleaning floors, bathing and in cooking. It has been observed that more than half of the women in Asia alone have to carry water by as much as 50 meters or more to their houses.

As water carriers for household, they make decision as to how much water they have to consume and thus achieve health effects to the volume of water available in their homes. Also, women determine the quality of water they bring home from water sources they have selected and in terms of the cleanliness of the transport and storage containers.

Thus if water supply improvements are being considered, it is logical that the first person to consult would be the women who would greatly benefit above all.

The Asian Development Bank seeing the potential in women's participation has embarked on a UNDP-financed project Regional Study on Domestic Shallow Well Water Supplies. Main project objective is to assess the demand in Asia for family-owned shallow wells with handpumps given access to credit and implementation by village women. The project is presently being undertaken in five countries which include: the Philippines, Bangladesh, Indonesia, Pakistan and Thailand.

Benefits that can be derived by women from this project include:

a) Increased dignity at the idea of no longer having to act like a beast of burden for carting water;

b) Time and energy saved from carting water will enhance women's other existing roles such as child care and provide the potential for more productive pursuits or even leisure;

c) Enhanced role in community through responsibility for organization, construction, maintenance and credit repayments for the project;

d) Better privacy in washing and bathing;

e) It may minimize permanent physical disfigurement and miscarriages which result from carting water when pregnant; as well as result in better health from more water used;

f) Financial independence potential through cultivation of garden plots to grow vegetable for sale or family consumption;

g) Time saved for caring of sick family members;

h) Greater convenience on water related activities; and,

i) Self reliance could be attained through maintenance training and related activities such as health and hygiene education.

Initial results show an overwhelming response to the project concept. Water supply has the highest priority for women who is most concerned on the aspects of quantity, reliability and convenience. Quality of water was found to be given less importance as long as it is found tolerable specially if no other source is available. While questions on monetary matters are generally referred to the husband by some, most of the women respondents have been very vocal of the problems they have encountered in providing safe and adequate water supply and have expressed their preference as to what type of installation would suit their needs. Overwhelming support is attached to the ability of women to manage the project through the structure of women's organization or groups. It is through these organizational structures where they may be able to assert their combined influence in cases where women per se may not be successful project implementors/promoters.

WOMEN AND SANITATION

Unlike water, sanitation tends to be viewed as urgent only after the water supply is satisfactory. As such, women's potential contribution to sanitation projects is so little recognized.

It cannot be assumed that women's and men's interests in sanitation are necessarily alike. Unlike water usage which is universal, differences also may exist in defecation practices of women and men as well as related habits. There is some evidence to suggest that in many situations women are more interested than men in improving sanitation, at least in part, because of better privacy offered.

While it is a common fact that women are the ones who clean the sanitation units making sure that all the materials needed by household members (such as water for flushing and washing) are present, their role in the promotion of health and hygiene has often been overlooked. Aside from being the most frequent users of household toilet units, it is women who encourage (or discourage), teach and supervise young children's use of the units. In terms of sanitation awareness, properly educated/oriented women can influence the behavior of family members not only with regard to the proper use of the toilet but in other sanitary practices such as handwashing and advise the family members of the danger of excreta , unclean hand, uncovered food and water, and flies.

Thus to make sure that the proposed facilities will suit women and be usable to their children and other members of the family, women should participate with men at household and community levels in making

decisions between technology options and such design features as height of pedestal and type of seat, type and size of the enclosure, lighting, doors, location and orientation details, among others. From the view point of the project and its implementors and funders, women are therefore critical to the health impact of the project, since this impact depends on the regular use of fully operating and clean units.

WHY WOMEN

Women play a vital role in enhancing awareness for water supply and sanitation at home and in communities and thus promote health and hygiene.

As motivators within the family and the community, women may be helpful in convincing men to undertake the construction and/or rehabilitation of water supply sources and latrines. Women's informal groups and communication networks can serve to create community awareness of the need of the facilities.

In the community, women can serve as managers of water and sanitation facilities, particularly on proper use and maintenance. They can be trained in surveillance for defects of the system such as leaks. They can keep stock of spare parts and undertake maintenance and minor repairs.

Thus, there are basically two ways for water supply and sanitation projects to consider women:

a) by including information on women in the project area on the data to be collected, and using it in planning; and,

b) by assisting women to play an active role in the project, through data collection, in decision making about the technology and design aspects and its accompanying education activities.

EXTENT OF WOMEN'S PARTICIPATION

In some societies, the social rules governing women's public and private roles are fairly rigid. They may be allowed to express what they want and like in the privacy of the home, or in women's club or informal gatherings of female relatives and neighbors, but not in public meetings or even in their own homes when male visitors are present. This situation becomes very obvious when a community meeting is called and the husbands take it upon themselves to attend contending that the women have better things to do at home.

One way to define the extent of women's participation in any water supply and sanitation project should be in terms of three indicators:

a) Duration of Participation - which refers to the amount of time contributed over a specified period;

b) Level of Participation - refers to whether the women who take part are representing themselves only by expressing a personal preference, their families, other women, or the community as a whole; and,

c) Associated Power - a complex concept representing a range from no power at all to extensive or authoritarian power.

CONCLUSION

Planning of women s active participation, whether alone or together with men, should be based on understanding of: the socially and culturally accepted water supply and sanitation - related roles for women; the kinds of social situations and organizational arrangements through which women can best play an active

role; and the extent of women's participation which can be expected in a given situation.

Grass-roots organizations and groups can facilitate and legitimize women's participation. These mechanisms need not be limited to organizations with only women members, although it would be more advantageous.

While it is true that project planners and implementors have now realized how women's participation can make the difference on the success of water supply and sanitation projects, no argument is made for planning separate women's components or for separating women's activities from those of men. Any attempt, therefore, to encourage participation among women or men should take place within the context of their complementary roles.

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Figures 1 and 2. Women as water carriers for house hold

Field Jointing of Water Pipelines

by Jonathan Lean

INTRODUCTION

There has been a need for water pipelines in one form or another for centuries using all manner of different materials. Throughout that time there was been a need to join those pipes by effective and economic means, using either integral joints or specialist types available separately. Whatever the method of jointing, there has always been the need to keep the cost to a minimum, either in the initial purchasing price or by means of a reduction in the installations times. The important thing is that the total installed cost of the pipeline is kept as low as possible, both at time of installation and throughout its life.

Today there is an enormous variety of pipeline materials for the engineer to choose from, each one giving particular benefits for certain conditions but, equally, having limiting factors which must be recognized during the design stage of any scheme. Similarly, the types of joint available have their own advantages and disadvantages which must be considered during the design stages, with the normal operation and maintenance of the system being important factors in the thoughts of the design engineer.

In recent years there have been important developments in new pipeline materials and, while the basic jointing concepts have changed relatively, a great deal of development work has taken place to make the most of these improvements in pipe design.

The concept of integral corrosion protection of pipes and pipe joint has become prevalent most recently, rather than the older concept of protection after the pipe was installed; it has been necessary, therefore, for pipe and joint manufacturers to develop methods of coating their products at point of manufacture rather than to expect the contractor to make a totally effective job of protection under frequently difficult conditions on site.

PIPE MATERIALS

The range of pipe materials varies according to local experience, availability and conditions. These materials range from old favorities such as steel, ductile, iron and asbestos cement, through to the more recent ones such as UPVC, GRP and polyethylene.

We are all familiar with the various different methods of pipe jointing available such as flanging, welding, screwing etc. Most of these methods require expensive and accurate pipe-end preparation prior to jointing. The exceptions to these are the integral joint and the mechanical coupling.

Mechanical couplings, which in their various forms can be used on all of these material, sometimes with modifications or with special design, bring the pipe designer a wider range of possibilities than is available to him using the integral joints supplied by the pipe maker. Virtually all rigid or semi-rigid pipe materials can be effectively joined using mechanical joints and the imagination of the pipe designer is really the limiting factor.

The rigid pipe materials such as steel, iron, asbestos cement and concrete, have been the ones most frequently used with mechanical couplings. There is no problem of long term pipe deformation under the influence of the coupling loading and the inherent strength of the pipe materials means that less severe control is required over the installation of the pipeline. Mechanical couplings are frequently used because increased flexibility is required and adequate pipe strength is therefore needed to take advantage of this flexibility. The plastics materials such as UPVC, GRP and PE need closer attention to their installation due to their lower inherent structural strength and their natural flexibility. In some cases couplings of special design are required to give sound connection in these materials. The rigid pipe materials, steel, ductile iron, asbestos cement and concrete, can all be regarded in much the same way from the design and installation point of view; they are all structurally strong (to varying degrees) and they can all use the same basis type of mechanical coupling. The

difference comes in the material cost of the pipe, the available jointing methods, their corrosion resistance and availability local manufacture, etc. Ductile iron and concrete normally come with integral joints which sufficient angularity for most purposes.

In certain sizes mechanical couplings may offer greater angularity than is available with integral socket-type joints and the designer may require the extra ability that this type of coupling provides. Iron and concrete pipes come in standard lengths and whenever these pipes are cut for closing lengths or for pipework in pumping stations etc., then the excess pipe length removed cannot easily be utilized except with the aid of mechanical couplings.

Where it may be necessary to remove pipes in the future for maintenance or modification, the push-fit type of joint normally needs to be replaced by couplings as they permit removal of any single pipe without disturbing its neighbours.

Many pipe designers and end users continue to keep rigidly to the concept that a ductile iron system should contain ductile iron and nothing else, and therefore incorporate larger quantities of ductile iron change pieces, double collars and flanged sockets in order to connect to other materials, make us of cut lenghts and to connect to valves and other flanged equipment. These items are heavy and expensive and, in virtually every cased, there is some form of mechanical coupling which can replace these products at lower cost and with greater ease of installation.

Asbestos cement is normally supplied with separate type joints which provide an economic method of joining similar pipes together. However, when asbestos cement must be connected to pipes of other materials, it becomes necessary to use mechanical stepped couplings which an available in an extremely wide range of sizes and combination of sizes, to meet almost any set of pipes types and diameters. All the above pipe types use form of elasometic seal for their normal joining method. However, steel can be jointed either by welding or by means of a flexible seal. Economics and installation conditions will decide which is the correct method to use. Welding will give full structural strengthen in bending and tension but will eliminate any flexibility and expansion capability, making it necessary to incorporate expansion compensators or loops into the line. It will also make removal of pipe sections for maintenance or for modifications in the future impossible without cutting the pipe. While the raw-material cost for the pipe will be a minimum if it is welded, the installation time can be very much extended compared to that when couplings are used. In addition, couplings will permit angularity between successive pipes, both at time of installation and in service due to ground settlement, thus eliminating to a large extent the need for special setting pieces or flexible sections. When steel pipes are being welded it is necessary to keep them accurately in position during the welding process, which can be extremely difficult in uneven terrain. This problem is greatly eased when mechanical couplings are used. Mechanical couplings can be supplied to meet virtually any size and pressure requirement encountered in the water pipe pipeline field.

If steel pipes are to be coated with plastics coating, such as epoxy, then the coating must be stopped short of the pipe end if the pipes are to be welded together. The coating must then be made good in-sity. However, if couplings are to be used for the pipe connection, 'stop-back' is necessary and the full degree of pipe protection can be maintained right to the end of the pipe.

The plastics materials, UPVC, GRP and PE, need to be treated differently by the designer. For most purposes UPVC can be regarded as a rigid pipe material and the standard couplings used for the rigid materials mentioned above can be used. However, it should never be forgotten that UPVC does not have the structural strength of these materials and that it is a semi-flexible pipe which, if too much load is applied, will deform, possible leading to leakage.

Glass Reinforced Plastics pipe (GRP) is supplied with a wall thickness quite adequate to support the internal pressure loading, but the arrangement of winding may be insufficient to support the relatively high local loadings imposed by the sealing rings of mechanical couplings. In order to overcome this potential problem, one of several possible alternatives can be used:

1) Use specially couplings with low gasket pressure.
2) Use thickened-up pipe ends which can resist standard coupling loadings.
3) Assemble standard couplings using lower bolt torques than standard.

Practical testing has established that by reducing bolt torques to approximately 40% of standard recommendations, no damage results to pipes from a number of manufacturers, even when the standard wall thickness is used, and this is by far the simplest solution as standard products can be purchased. Specially designed couplings can be easily mistaken for standard items and unnecessary damage and confusion could result. Thickened-end pipe, while being a feasible solution, means that pipes of pre-determined length must be supplied to site, limiting flexibility of installation, or thick-wall pipe must be purchased for cutting lengths.

Polyethylene (PE) is probably the most flexible type of pipe commonly jointed using mechanical couplings, and most certainly will deflect under the load imposed by the sealing rings of virtual any type of coupling.

It is therefore necessary to support the bore of the pipe for all but the most rigid forms of this material. One of the features of PE pipe is that when it is pressurized it will tend to shrink length wise and in addition it has to high coefficient of expansion. It is for these and economic reasons that this material is most commonly connected by butt fusion welding or electro-fusion welding, to produce long lengths of pipe which are totally integral with each other. However, when pipes in this material have to be connected under difficult circumstances, or they are modified, it is frequently impossible to use the fusion techniques due to inaccessibility or damp conditions. It is here that mechanical coupling comes into its own but must retain the longitudinal load-bearing capability of the parent pipe. Various ways have been found to achieve this, but al rely on some form of gripping teeth which bite into the pipe either on the inside or outside. If the coupling has been designed properly, the resulting grip should be at least equal to the minimum strength of the pipe in tension.

USES OF MECHANICAL COUPLINGS

Mechanical couplings have been widely regarded as suitable only for miscellaneous pipe connections around pumping stations, valve chambers and treatment plant. However, there are numerous instances where all the economic and construction factors have combined to make mechanical couplings the principle method of pipe connection for trunk pipelines, particularly for steel pipe.

The more common areas of usage for mechanical couplings are given below, with some of the typical benefits:

1. Flexible joints should be provided adjacent to buried structures to give allowances for ground settlement. Failure to provide adequate flexibility can result in pipe or structure failure.

2. Pipes are normally supplied in standard lengths. Pipes are inevitably cut when they run up to pumping stations, valve chamber, bridges etc, and the coupling provides a ready method of making effective use of the maximum possible amount of the pipe lengths delivered to site. With full pipe lengths costing many times the cost of a coupling, this economy cannot be ignored by today cost conscious engineer.

3. Obstructions, both below and above ground, can be avoided by the use of angular defletion capability of couplings. Long radius bends can be negotiated without the need for purpose-made bends and setting pieces, thus considering reducing the installation costs.

4. Pipes laid above ground are typically supported on piers, with pier tops specially shaped to form sadles for better pipe location. The use of anchored couplings, ie couplings with integral feet for bolting down to the pier tops, eliminates this unneccessary expense and permits the whole weight of the pipeline to be taken on the couplings without the need for the shaped pier top or pipe straps. Anchored couplings have the added advantage of providing the best possible flexibility should

there be any ground settlement.

5. Flange adaptors are made up from half of a standard coupling welded to a flange, (or the equivalent is provided as a casting), the drilling of which will depend on the flange standards in use. These items permit ready connection of valves, pumps and other flanged items to plain-ended pipework, while retaining flexibility and expansion capability. They permit the simple removal of valves etc, for maintenance purposes and are invaluable for the compact design of plant rooms and pumping stations.

These better known benefits of mechanical couplings can be used to good effect when couplings are used as main line joints in a pipeline. However, in this case the speed of installation becomes of much greater importance. As explained under 'Pipe-Materials' most materials come with integral joints for normal pipe connection. However, as steel pipe does not normally fall into this category it is necessary for the pipeline designer to make careful cost comparisons based on material costs, installation times, availability of suitable labour and the required standard of testing of the completed pipeline. The nature of the terrain, including accessibility of plant and materials, together with the required deadlines on the scheme, should be considered carefully according to their relative merits. Further consideration of this subject is found 'Cost of Ownership!.

Equipment manufactures are increasingly appreciating the need for quick and reliable connection of their equipment to the finished pipework. Machinery such as pumps, valves and chillers increasingly are incorporating pipe connections designed specifically for mechanical couplings, rather than for the longer-established pipe-connection methods such as flanging and threading. This trend reflects increased confidence in the reliability of couplings and particularly of their sealing rings.

This is especially the case where elevated or fluctuating temperatures are encountered during the normal operation of the equipment. Natural rubber rings have been in continuous use for anything up to 60 years on ambient-temperature systems, but when an elastomeric seal is used at, say, 90C then special formulation of the seal material is required for long term leak-tight performance.

The normal type of coupling used on water services is the sleeve type, and this gives the best overall combination of properties for the majority of water use situations, ie, it gives good angularity, cutting length adjustment and expansion allowance, but it does not normally grip the pipe sufficiently to give and-load restraint against internal pressure thrusts.

Most underground installations do not need special support or anchorage to prevent pipe movement, as there is normally sufficient restraint provided by the backfill loading. Normally, only anchorage in the form of thrust blocks a major changes in direction is required. However, when a pipeline is installed above ground then full restraint us required. However, when a pipeline is installed above ground then full restraint is required and here the sleeve-type coupling needs either external-thrust restraint or tie-rods to take the load.

New developments on the sleeve type coupling have been aimed at producing a coupling with most of the advantages of the conventional sleeve type, but with the addition of gripping teeth which bite into the pipe surface, either on steel or ductile-iron pipe, to give a full end-load bearing which is quick and simple to assemble.

Size range is limited because the pressure thrust in a pipe increase in proportion to the square of the diameter and there is a limitation on the number of teeth that can be incorporated. However, speed and ease of installation together with similarly to existing coupling types make this development attractive to pipework designers and installers alike.

COST OF OWNERSHIP

Mechanical couplings are considered for use in water or sewage schemes because in some way they contribute to direct or indirect financial savings. These fall into two main categories.

1) Initial installation cost savings
2) Savings in operating costs.

INSTALLATIONS COSTS

Savings in this area result from the following situations:

1. Obstacles, uneven ground, existing services, are more easily dealt with, using coupling as their ability to accomodate angular defletion means that pipes can be deviated around such obstructions without the need for special, expensive fittings, thrust blocks, etc.

2. Ground settlement and expansion can be accommodated without the need for expensive ancilliary equipment. Each mechanical coupling, other than locking couplings, can give a useful amount of expansion allowance which can be used to great effect in the reduction of stressing in pipelines, particularly above ground.

3. Mechanical couplings can be used to lay a pipeline round long radius bends, rather than using purpose made bends. The permissible angularity at each pipe without the need for thrust blocks will depend on the ground conditions and on the operating pressure in the pipeline, but major schemes such as El Arish water supply in Egypt used this concept to follow the line of a road and avoid major obstacles where necessary. This ability not only eliminates the cost of most simple bends on trunk mains, but also eliminates the need for additional excavation and concrete for thrust blocks. Additionally the pipework becomes more flexible in its usage and modifications to a scheme will be less likely to leave unwanted pipework in the stockyard.

4. Locking couplings, for polyethylene, steel and ductile iron are increasingly available and have the ability to reduce the requirements for line anchorage, particularly at bends and tees where thrusts are developed. In many cases the provision of thrust blocks is expensive or even impossible because of other services. In such cases the additional cost of locking couplings may be less than the extra excavation and concrete for thrust blocks.

Most pumping station use either steel or ductile iron pipework and unless fully flanged or welded pipework is used there is usually a need to anchor the pipework against thrusts development by internal pressure. Any pumping-station system needs to be able to be readily dismantled and at this end, flange adaptors are frequently used. Anchorage of this pipework may be difficult or impossible and it is here that the new locking coupling can be of great assistance in avoiding the need for complicated anchorage yet retaining the ease of dimantling found in the standard which is needed for simple maintenance.

5. Mechanical couplings can be installed only the most basic of equipment. This normally means just a spanner plus the normal cranage and pipe handling equipment which is requires for any other type of pipe materials. What is not needed is special jacking equipment for turning pipe ends to size, welding sets and generators, etc.

6. The equality of the connection is constant when using couplings, therefore testing of the finished pipeline is simpler and cheaper than with, say, welding which will normally be radiographed in order to guarantee the strength and standard of leak-tightness at each joint. This process is expensive and time-consuming and is quite unnecessary when couplings are used. Low experience has shown that the elastomeric seal in mechanical couplings gives extremely reliable and leak-free operation, even on first test, provided that reasonable care is taken in preparation of pipe ends.

Therefore, only a final water-pressure test normally is required to prove the soundness of the pipeline.

7. Other methods of jointing, particularly welding, require the provision of specialist operatives and labour in order to achieve a leak-tight pipeline. Mechanical couplings can be installed using unskilled labour which can be diverted elsewhere on the site when there is no coupling assembly to

be done. A minimum of training is required, normally limited to assembly of one or two couplings under supervision; this greatly increases the contractors flexibility of operation on the site and significantly reduces costs. In many territories, skilled welders at economic rates are impossible to find and a commitment to welding will almost inevitably lead to higher prices for the Client.

8. The simplicity of mechanical couplings greatly reduces pipework installation time, especially compared with welding, but also compared with some of the larger push-fit types of joints, which require the use of specialist jacking equipment if the assembly is to be carried out without damage to the pipe ends. By comparison, assembly of larger diameter mechanical couplings is very rapid and the recent El Arish pipeline in Egypt illustrated that pipes of 732.5mm o.d. could be laid, levelled and connected with mechanical couplings at the rate of 3 per hour - 4 per hour using only an excavator and a gang of four men.
   It is with these qualities of rapid and leak-tight assembly that the contractor often can reduce the total allowance significantly within the contract period for pipework installation and, consequently, will be able to shorten his total contract period to the advantage of both himself and the Client in view of the considerable cost savings which result.

9. The reduction in pipe-laying times, in addition, will give the contractor greater flexibility in his contract programme. If other methods of pipe connection are used, laying may well be the principal factor in the total time taken for the competition of the contract, with all other activities being controlled by this. Reduction of pipe-laying time may often allow other activities more flexibility on their timing.

10. All the above properties of reduced assembly time, quaranted effectiveness, use of unskileed labour, reduced specialist equipment, etc, mean that the contractor can make more accurate estimates of both his costs and time for completion of a contract with a large pipework content. This, inevitably, will enable him to keep his contract prices down as the degree of undertainty in the contract will be reduced. This will make him more competitive and have obvious benefits for the Client and his customers in turn.

Economic factors will vary considerably according to location, size of scheme, construction schedule and labour and plant costs and all these will need to be taken into consideration by the contractor during the estimation of the contract.

OPERATING COSTS

Ease and speed of maintenance, reliability and the ability to accomodate variations in operating conditions are the important factors here, and can be divided into the following categories:

1. Long life of sealing rings gives negligible maintenance costs resulting from leakage failure. Leakage through corrosion of pipes is more likely to occur than sealing-ring failure, on ambient temperature systems and there have been numerous examples where pipes have been replaced or weld systems repaired, yet the sealing rings have been in a addition such that they could be re-used. Sealing ring quality has improved steadily over the years, and the current national and international standards ensure that the rings will last at least the lifetime of the pipeline. It is recognized in many industries that elastomeric rings can cope with a very wide range of products and operating conditions without premature failure. The water cycle normally gives less arduous conditions than in some industries and the days have now gone where rubber seals are regarded as the weak link in the pipeline.

2. Servicing of valves, pumps, etc., speeded up through the rapid disassembly and re-assembly of pipework when flange adaptors are used in the system. Any fully flanges system needs to include some convenient method of dismantling so that the flange gaskets can be 'un-sandwiched'.

The flange adaptor provides the simplest, quickest method of achieving this aim. Generous use of flange, adaptors during the original installation may save many times their original cost during the life of the system with reduced maintenance time and costs, and reduced loading on pumps and other machinery, since the pipework loading will be partly isolated by means of the elastomeric seal of the adaptor. The misalignment absorbing ability of the couplings and adaptors, used in pairs, will greatly reduce the accuracy required in setting-up and re-assembling pipe sections and hence reduce the maintenance time.

3. Systems which incorporate adequate mechanical couplings are very quick and easy to modify should the function or operating method of the system change in the future. Most forms of coupling can be regarded as unions, eliminating the need to draw back either pipe longitudinally to disengage it form its neighbor.
   If new pipe sections are laid up to existing and there is some misalignment between the pipes, mechanical couplings used either in the original system or in the new work will be able to accomodate this misalignment.

4. Mechanical couplings which are supplied with high-quality works applied coatings such as nylon or epoxy, may never require painting during the life of the pipeline, if they located above ground. Below ground, they will certainly not require further attention. Provided that the pipe also is suitably protected at time of initial installation, there may be little or no subsequent maintenance of the pipes themselves.
   More than half of century of experience of couplings being used as main line joints with proper protection has shown that maintenance of such pipelines is minimal. Couplings installed with hot poured bitumen protection have been exposed in tropical conditions after several decades with no noticeable deteriotation of the protection. The modern coatings and paint protections applied in the 80's give every indication of being equally successful in maintaining the performance of the coupling and in keeping the cost of maintenance to a minimum.

5. Even when pipes themselves fail, mechanical couplings can provide the most economical solution to their repair. The standard forms of couplings already discussed can be used to drop new sections of pipe into the line, thus avoiding the need to excavate the complete length of the original pipe, which may be difficult or impossible due to other services or obstructions in the ground. The in-built tolerance of the sleeve-type coupling makes this operation simplicity itself and removes the need for accurate cutting length and squareness which would be necessary with welding or any form of push-fit joint, even if this type could be used.
   Any maintenance organization will aim to keep its stocks to a minimum and a product which can do the job of several other times is always attractive in terms of keeping transport, stock levels and labour costs as low as possible. New products now available are aimed specifically at the repair and maintenance market. The transitional coupling, with its ability to satisfy a wide range of pipe sizes within a single coupling, has great attraction in keeping down stocks.
   The standard sleeve type coupling is able to accomodate variation in pipe diameter of between 3mm and 7m according to diameter. The transitional type of coupling is designed a much heavier, harder sealing ring than the standard type which is more resistant to estrusion and is therefore tolerant of diameter ranges of more than 10mm. This means, effectively, that one coupling can replace several sizes of standard product in the maintenance organization. Where a water undertaking has several sizes of pipe close to each other in diameter, the economies of stocking this this type become obvious.

CORROSION PROTECTION

Old established methods of corrosion protection, such as hot-poured bitumen, tape wrapping or in-situ painting, are rapidly being superceded. Taking their place is a range of factory-applied coatings - nylon, epoxy etc, - which give not only a more closely controlled standard for coatings than has previously been possible, but also more complete protection and frequently at lower cost.

Pipe protections vary greatly according to the nature of the pipe material. If the pipe material is fundamentally corrosion resistant, such as UPVC, PE or asbestos cement, then no corrosion protection is required. Ductile iron is receiving increasingly more sophisticated coatings as more experience is gained with its usage under different conditions and the requirement of specifiers become more stringent. Steel, by nature probably the material most in need of protection, has been subjected to very close scrutiny over the years in order to increase its working life and to reduce the long and short term cost.

Bitumen wraps are becoming more sophisticated and thinner, or are being replaced by plastic coatings such as epoxy. The type of coating has little effect on the operation of mechanical couplings used with the pipe, except that the thicker coatings need to be cut back to allow the coupling to seat firmly on the pipe material itself.

WORKS-APPLIED COATINGS

Coatings for the protection of mechanical couplings have to meet certain criteria:

1) They must give protection to the base metal, according to conditions of use.
2) They should not interfere with the operation of the joint, particularly the sealing function of the fit.
3) They should be flexible enough to withstand the bending induced in the coupling during the assembly process, without cracking or disbonding.
4) They should be sufficiently resistant to normal handling and impact treatment, such as mechanical couplings receive on site and in transit, to maintain the full effectiveness of the coating, with minimal site repair.

There are a number of different types of coating which meet these criteria, including wet applied and powder coatings.

Cold applied, wet paint coatings normally are relatively low-cost products as raw materials, but if applied in more then one coat the labour costs add very considerably to the finished price. Materials in this category cover an enormous range of coating types, from the simple bitumen to the two-pack epoxies. Surface-preparation requirements also vary considerably from wire brushing to a full blast clean However, the common factor is that, under normal conditions, they can be repaired on site with relative ease. The range of colours available can be considered to be the widest for this catergory of coating, and for colour matching purposes this may be the deciding factor.

Powder coatings are always applied at works by fusing a powder such such as nylon or epoxy on to the metal surface of the product by one of two basic methods:

1. Fluidised-bed dipping

With the fluidised-bed method, the metal item is first heated in an oven to the required temperature and it is then dipped into a fluidised bed of the powder. On removal the powder melts onto the hot metal surface to give a uniform and constinuous plastic coating over the whole of the surface area of the product.

2. Electrostatic Spray Method

With the electrostatic spray method the product is first sprayed with electrostatically charged powder so that a uniform layer adheres to the metal surface. The item then passes through an even to fuse the powder on the metal, again producing a uniform and continuous coating.

Powder-coating methods have been found to give a very successful and reliable combination of properties during both the application and use of the coating. Both methods of application give a comparatively uniform film thickness and both give complete coverage, whereas most forms of wet spray application cannot

give total confidence in this respect without careful inspection. Elimination of any mixing of paint components and of evaporation of solvents leads to more uniform properties in the finished coating.

For most soil conditions, including saline soils, it has been found that powder nylon coatings very adequate protection to the metal components of couplings with modest cost. Nylon coatings possess a most satisfactory combination of physical properties giving good bonding to the metal surface, provided a suitable primer is used, and have excellent flexibility and scuff resistance to the normal knocks and damage received during transit and handling. Additionally they are available fully approved to water-quality standards.

Where highly-corrosive conditions exist, some engineers prefer fusion-bonded epoxy powders but these are generally somewhat harder and therefore more brittle with greater susceptibility to impact damage, although scuff-damage resistance tends to be greater than for nylon. Howevei, the finished cost of these materials is normally higher due, pruncipally, to their greater requirement for heating during the application process. These products also are available with water-quality approval.

BOLTS

It is considered by many engineers that the weakest point of mechanical couplings from the corrosion point of view is the bolting. It makes little sense to provide a high quality works coating to the coupling cody and then only to provide either black or galvanized bolts. This potential weakness has been recognized by the coupling manufacturers and two principle alternatives are available:

1. stainless-steel bolts, or
2. coated bolts

The benefits of stainless steel are well known, and various grades are available to suit a range of applications and environmental conditions.

Bolts can alternatively be coated with a variety of possible plastic products, the most common one being nylon. The bolt is first zinc plated and primed and then coated by the electrostatic powder-spray process.

It is normally accepted that the correct grade of stainless steel gives the greatest degree of resistance to corrosion when providing bolting materials in a corrosive environment. In the majority of situations, this extreme degree of corrosion resistance is unnecessary and also very expensive. In most situations coated bolts provide very adequate long-term protection at very modest cost compared with stainless steel.

In situ protections to couplings, while generally being of low material cost, have the following disadvantages:

1. They are labour intensive;
2. It is difficult to give full protection to all parts of the assembled coupling because of inaccessibility;
3. Inspection after site wrapping or painting is often difficult or impossible, and if low-quality labour is used there is no guarantee of the finished effectiveness of the protection.

In-situ protections undoubtedly have their place in today's pipelines, particularly where local labor is cheap or where it is desired to reduce the foreign currency element of materials purchased for the contract. Very large diameter pipework is difficult to handle under site conditions without some physical damage to coatings and where pipe diameters exceed about two meters, it may be considered undesirable to purchase couplings which are works protected in a material which cannot readily be made good on site. Also, if matching of colours, say inside a pumping station, is of importance, than an in-situ protection may be necessary.

The paint type in-situ protections have already been discussed above. In addition to these are the pipe wrapping materials which include mastic and tape products. Mechanical couplings, because of their constitution,

need first to have their contours smoothed out before the application of tapes for protection so that the tape will conform adequately to the surface profile and so that soil loadings will not cause failure of protection due to lack of support.

When catholic protection is required for the general protection of a steel pipeline, the couplings can be included into this system whether they are coated or not. In the case of uncoated couplings, bonding straps can be welded to the flanges and sleeve of each coupling very simply to provide full continuity. If, however, the coupling has been coated at works with a fusion bonded material such as nylon or epoxy, then any attempt to carry out them it welds on the coupling clearly will destroy the coating locally. This can be overcome by the addition of screw pillars welded to the coupling prior to coating. The pillars are kept of coating and can then be connected during assembly by means of a simple bonding strap. This method has been used on a number of occasions recently on major pipeline schemes including the Taif C3 scheme in Saudi Arabia.

SEALING RINGS

Mechanical couplings have made use of many different types of sealing rings according to pipe contacts and usage. In the past, natural rubber has been the principle ring material for water purposes as it has combined long life, satisfactory chemical resistance properties and low cost.

However, specifiers are becoming increasingly aware that some of the synthetic compounds offer significant advantages over natural rubber in certain areas, particularly chemical resistance, resistance to microbiological attact and much reduced microbiological affection potable water. It is for these reasons that the synthetic elastomers, EPDM (ethylene propylene diene monomer), NBR (nitrile butadiene rubber) and SBR (styrene butadiene rubber), are becoming more favoured for potable water applications.

Research work into the microbiological effects of non-metallic materials on potable water has been most advance in Western Europe and new standard have been introduced by several countries including the United Kingdom, West Germany, France and Italy which control the range of materials which are more capable of meeting new standards than is natural rubber. Additionally, coatings applied and coupling manufacturers alike are using approved products where customers require these.

SUMMARY

Modern water undertakings are becoming increasingly aware of the need to give a more effective services to the customer without increasing their costs. Indeed there are considerable pressures to reduce costs in every department and whether on the design, construction or maintenance side then changed methods and materials will be the key to keeping these costs to a minimum. The advent of more sophisticated pipeline materials has led to significant changes in the existing methods of pipe design and some require totally different concepts in pipe jointing in order that they can be utilized.

Increasing labor costs, tighter controls over budget and contract periods and an ever-demanding public mean that designer, contractor and public service alike cannot afford to ignore the need to change methods and attitudes. New problems, like new materials are arising all the time and the pipe designer and user are increasingly finding that the mechanical coupling, in all its diversity, can provide the solution to many of these.

ARTIFICIAL RECHARGE OF GROUND WATER SYSTEMS IN THE PHILIPPINES

by Mario P. Sandoval

INTRODUCTION

Just more than a decade ago, news of "inexhaustible water supply" in a Metro Manila subdivision triggered the large scale housing and industrial development around South Superhighway in Parañaque, Bicutan and Muntinglupa. Today, these areas suffer a critical water shortage which can be attributed to the decline in water levels and well yields. They have reached a condition of "ground water mining" where groundwater abstraction significantly exceeds the natural recharge to the water-bearing formations.

Along the coastal areas of urban centers, a similar consequence of low water supply has been equally attained but for a different reason. Overpumping has depleted the shallow aquifers and created a condition where the sea water moves inland because of prevailing negative hydraulic gradient. Fresh water has been contaminated with sea water. It is no longer uncommon for the annular space around wells (>360 m depth) to be grouted from the surface to 240 m depth. The depth of sealing also reflects the vertical extent of saline water contamination in the coastal areas. In some areas, wells as far as 2 km from the shore have been contaminated with saline water.

The above examples show how extensive and previously unregulated ground water utilization has created a monster which the government water agencies have to fight to sustain the level of housing and industrial development in these areas.

Restrictions on the drilling of new wells has been imposed to stop the deterioration of the aquifer system. However alternative sources should be made available to supply water to affected factories and subdivisions.

The dispersal of industrial areas may reduce the stress on the aquifer system in developed areas and shift the stress to other otherwise under-developed areas. This action may likewise bring about the relocation of large population segments away from the over-crowded urban centers.

Whatever scheme is adopted to correct the situation, the demands for water by a rapidly expanding population will result in a shortfall that would require the development of new surface water sources, and the conservation and restoration of ground water.

To the second scheme, artificial recharge may be an alternative which was not viable before but is one option which may have come of age in the Philippines.

WHAT IS ARTIFICIAL RECHARGE?

Artificial recharge of aquifers is the practice of increasing by artificial means the amount of water that enters and aquifer. It is not a new concept. The East London Water Company first carried out direct recharge through wells around 1890. At present, artificial recharge installations are operating in the United States, Germany, Sweden, Israel, Australia and Holland, among others.

USES OF ARTIFICIAL RECHARGE

Artificial recharge is undertaken, to:

1. Supplement the amount of natural recharge to an aquifer. It may provide a means to increase the

yield of the aquifer if the natural recharge has been exceeded by the groundwater withdrawal.
2. Store water underground for retrieval at a later time.
3. Check or reverse saline water intrusion.

If water is injected into a coastal aquifer, a hydraulic pressure barrier may be formed between the coast and inland wells. (see Figure 1)

4. Prevent large reduction in groundwater level as a result of over-abstraction, and thus reduce the possibility of land subsidence, sea water intrusion, etc.
5. Improve the quality of some groundwater.

SOURCES OF WATER FOR ARTIFICIAL RECHARGE

An essential prerequisite of artificial recharge is the supply of water. The sources of water may be storm run-off, river or lake water, water used for cooling purposes, industrial waste or even sewage effluent. Most of these sources will require some form of treatment to avoid pollution of the aquifer and because of possible interaction between the recharged water and the natural groundwater. (see Figure 2)

METHODS OF ARTIFICIAL RECHARGE

There are several ways by which artificial recharge may be accomplished. The methods employed include:

1. Water Spreading
   a. Flooding method in which flat land is flooded by a sheet of water.
   b. Basin method in which water is released into excavated basins.
   c. Ditch or furrow method in which water is released at controlled rates into a series of flat-bottomed ditches or furrows.
   d. Natural channel method in which water is released at controlled rates into a natural stream channel. (see Figure 3)

2. Recharge pits and channels -

   This is a more refined method of water spreading and is adapted when a layer of relatively impermeable material lies close to the surface and beneath the proposed infiltration area.

3. Recharge Wells and Shafts -

   They allow direct introduction of water from the surface to an underground formation. Wells used for direct recharge are frequently multi-purpose and may also be used for pumping. Recharge wells are more frequently employed when the aquifer to be recharged is deep or confined or when there is insufficient space for a recharge basin. (see Figure 4)

ANTICIPATED PROBLEMS

Four major problems may affect the effectiveness of an artificial recharge system. They are:
1. Sediments carried by the recharge water.
2. Pollution or contamination potential.
3. Maintenance requirements.
4. Economic feasibility

1. SEDIMENTS:

Sediments consisting of clay, silt and organic materials may seal the surface through which recharge is taking place or may seal the aquifer. Settling basins and sand-gravel filters may be utilized.

2. POLLUTION:

Pollution from storm run-off and waste water is a limiting factor. Some chemical and biological compounds may be derived from pesticides and fertilizers and carried off by storm run-off.

3. MAINTENANCE REQUIREMENTS:

Maintenance requirements for all methods or artificial recharge may be costly. The cleaning of sediment build-up from recharge basins are simple but requires physical removal of materials.

Recharge wells are more easily maintained, firstly by using clean recharge water, secondly by redevelopment of the aquifers and cleaning of the well screens.

4. ECONOMIC FEASIBILITY:

The construction of an artificial recharge system must consider recovery, pumping and maintenance costs. The cost of the recharge system must also be less than the acceptable cost of the water to the user.

LOCAL APPLICATION OF ARTIFICIAL RECHARGE

While artificial recharge system may be costly, they may be used in area where the ground water level has declined to great depths and there are no other immediate alternative source of water supply. For instance, in the Sucat area, a new well may only yield less than 2.0 lps. because the shallow aquifers have already been dessaturated. Factories and subdivisions may, therefore, consider the establishment of artificial recharge system using either rainwater collector, storm run-off and waste water as recharge sources. Such system may involve modification in the design of sewer and drainage systems to accommodate the treatment plants necessary to purify the water before being recharged into the ground.

On a more ambitious scale than simply increasing the field of individual wells, artificial recharge may be considered in the control of salt water intrusion along the coastal areas. The sheer length of our shorelines dictates some large scale investments to achieve this objective. And the effect of such efforts may not be felt within a short period of time. However, to improve the quality of water in the salt water intruded areas and increase the available ground water supply in these affected areas will mean the alleviation of the critical water supply problem for a large segment of the urban population. Moreover if even 20% of the flood waters may be utilized for artificial recharge during rainy seasons, then the flood damaged to low-lying areas may be even be greatly reduced. To such areas such as Manila, Malabon and Navotas, the benefits from artificial recharge may be four-fold.

1. Improvement of the quality of ground water.
2. Increase in the available ground water.
3. Lesser drilling depth of new wells.
4. Indirect, reduction of flood levels.

The concept of artificial recharge looks simple but it still requires some detailed and sophisticated studies which must determine the source and method of treatment of recharge water, the depth and nature of the formations which can be recharged artificially and the method and design of the artificial recharge system most suitable for a particular situation.

CONCLUSION

In view of the acute shortage of water, particularly from ground water sources and the adverse effects of such shortage on industrial and housing developments, artificial recharge may provide a viable alternative towards increasing the available water supply in highly developed urban and industrial area in the country.

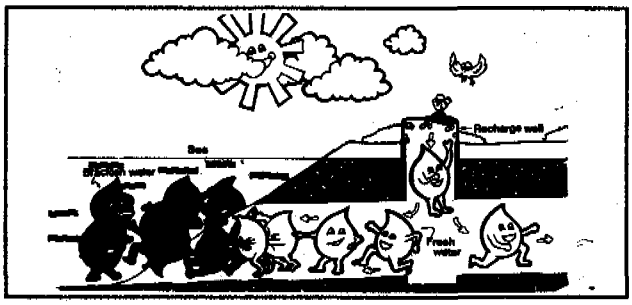

Figure 1. Pressure barrier to check or reverse saline water intrusion.

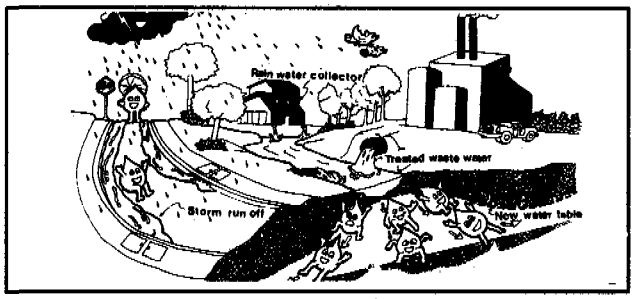

Figure 2. Sources of water recharge

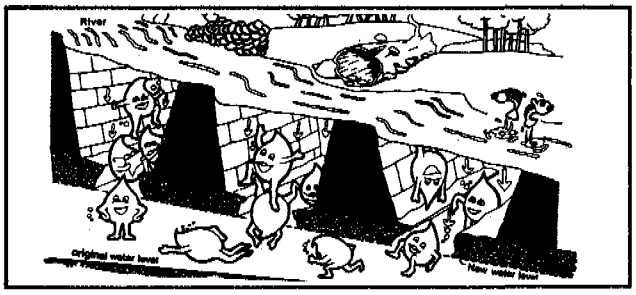

Figure 3. Natural channel method for recharge

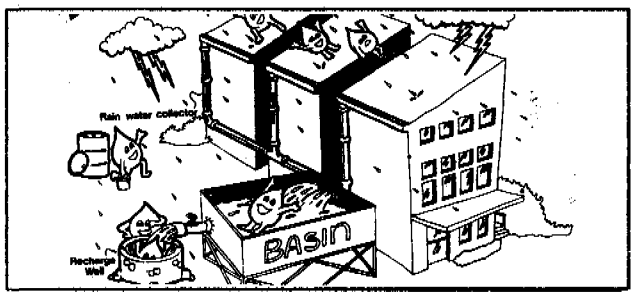

Figure 4. Recharge basin for deep or confined aquifer

WATER INDUSTRY AND THE ROLE OF CONSULTING ENGINEERS IN ITS OPERATIONS AND MANAGEMENT - THE AUSTRALIAN EXPERIENCE

by Robin L. Povey

INTRODUCTION

Australia's diverse climate, geographic and cultural conditions, combined with its political structure, has resulted in a great variety of management has been primarily the domain of Governments - particularly State (or provincial) and local Governments.

The role of the private sector has been largely as commercial of goods and services, and with some notable exceptions, has not been recognized as an equal partner in overall water sector development and management.

This paper outlines a number of the management structures, with background explanation for their development and current status. In addition, an examination is given of the role which engineering consultants can play in the management, operation and maintenance processes of water and sewerage systems. Particular emphasis is placed on the to a system for asset management, an issue which is of vital importance and relevance to many emerging Asian and Pacific water agencies.

CENTRAL MANAGEMENT STRUCTURES

Water, and particularly community sewerage or sanitation systems in Australia have been developed over a relatively short period. Initial water supply shemes for some of our larger cities commenced around 150 years ago, while the first sewerage systems only started to be installed some 100 years ago. For most of Australia's isolated small rural communities, sewerage was only possible the Second World War. In many cases, even reasonable standards of public water supply for these communities was provided only in the post-World War 2 period.

Responsibility for initiating new water supply and sewerage schemes varies throughout Australia according to Government legislation. This legislation was and still is essentially the responsibility of the State Governments. The Federal Government does not generally have any direct role in the provision of this level of infrastructure. The Federal Government does play a co-ordinating role on issues which affect resource sharing, environmental issues and planning matters between States. It may also initiate funding of particular schemes where they are deemed of national importance. State borrowings from both local and particularly international markets for water and sewerage projects projects may also be subject to control by the Federal Government through its national budgetry process.

Political history and probably to a lesser extent practical needs, have therefore shaped the system of management of water-related services currently adopted in each State.

In the Northern Territory, Western Australia and South Australia, the sparsely populated States, a single authority is responsible in each State for all aspects of water resources policy, planning, development, and management. Queensland, Tasmania and New South Wales have a system which utilities locally elected municipal, or community councils which have a broad range of responsibilities and functions, including water

services. In Queensland and Tasmania, the councils have total control over development and management of systems within policy, planning and financial constraints, and general overview of a Government agency. New South Wales on the other hand, has a Government agency which assumes direct responsibility for initial systems development and subsequent major expansion. The facilities developed by this department are handed over to the local council for operation and maintenance. In all three States, it is the responsibility of the council to collect sufficient revenue to cover loan charges and all operational and management costs. In cases where the community is not able to afford these costs, provision is made to provide load subsidies, interest assistance or grants to reduce the annual cost burden.

In Victoria, responsibility for provision of water services mainly lies with independently constituted Water Boards, although in a small number of cases, local municipal councils have the responsibility. It is probably the Victorian State's management model which is of most interest to our Asian counterparts.

While these independent Water Boards provide both water and sewerage services, their "powers and duties" are defined by legislation. Adherence to this legislation and other related legislation and regulations, e.g. environment control, soil conservation, borrowing powers etc., is monitored by a central policy setting and planning, Department of Water Resources. The typical overall structure of water sector management for Victoria is provided in Figure 1.

The Boards comprise part-time representatives from the local community. Some of these members are elected by the residents, while others may be appointed by the Government.

VICTORIA - WATER SECTOR MANAGEMENT DEVELOPMENT

Within the overall framework of water sector management in Victoria, town water supplies and sewerage services are provided by about 150 water boards and municipal undertakings. Urban reticulation systems now provide water for the entire Melbourne metropolitan area and for 345 country towns. Virtually all of the Melbourne metropolitan area is now sewered and in country Victoria, sewerage facilities are provided in 159 towns and urgan centres.

Over the past 5-8 years, economic constraints and environmental concerns have resulted in a complete reorientation of the management of the sector. Since 1983 there has been a reduction, largely by amalgamation, of the total number of urban water supply and sewerage authorities from 337 to 147.

The aim in this reduction has been to improve management efficiency and hence reduce consumer cost. Concurrently, new reporting requirements have been introduced to measure each enterprise's efficiency and effectiveness.

Overall, the management changes have meant that small boards which had part-time and poorly trained staff with high overheads have been amalgamated into larger authorities. The large authorities with their increased revenue bases are able to attract well-qualified staff, streamline accounting and technical management functions and therefore improve overall service efficiency. By combining the water and sewerage functions under the one agency control, again management efficiency improvements have been achieved. Staff and equipment which can be used effectively with regard to both functions, together with the ability to reduce the cost of revenue collection by distributing combined accounts, all contribute to the lowering of the cost of the service and advantage the consumer.

As is the case with many aspects of modern life, the democratic ideals of close community involvement and control of the provision of services such as water and sanitation, which had been promoted and carefully guarded in the early development of the water sector infrastructure, have had to be compromised in the interests of economics and in recognition of broader constraints such as environmental considerations. The key to the continuing success of the initiatives to streamline water sector management, will be the ability to retain some reasonable level of community participation in the management of the service while further reducing the number of enterprises. In Victoria, a realistic goal could be the prospect of reducing the

number of management boards to around 27 in line with the number of separate catchment basins.

ROLE OF THE PRIVATE SECTOR

Examination of the legislation governing the responsibilities and functions of water boards reveals the basis upon which individual water boards have been established. The responsibility for initiating a scheme and establishing a board usually rests with the local community. This mechanism is most commonly via the municipal (local government) council which determines the community's need for a water supply or sewerage system.

Upon identification of this need, it is necessary to have a feasibility study of the proposal and in Victoria at this stage, a private consulting engineer is usually engaged. Consulting engineers are often required for the study because of the specialist nature of the work and that the capability for this is not normally found in local government instrumentalities.

It is from these early beginnings of a scheme that a long-term involvement of a competent consultant may commerce. The initial studies of engineering and technical practicalities, combined with the need for economic pragmatism lead to detailed studies, design and cost estimates, documentation, calling of tenders and contract implementation. As indicated, for some consultants, the relationship continues into a long-term relationship with the ongoing provision of operation and maintenance advice and control.

As water boards and their incomes have grown, there has been a common trend for resident engineering staff to get engaged and gradually assume responsibility for a number of the areas that may otherwise be assigned to consultants. It is interesting to note, however, the world-wide trend back to more engagement of private consultants to assume greater responsibility for "line management" functions. This trend reversal has arisen from the identification of the potential for greater efficiency attributable to use of the private sector and a need to reduce the management "overheads" associated with resident staff.

Some water boards, particularly the larger ones, have resident engineers engaged on routine engineering management functions. The services of private consultants continue to be utilized for specialist needs or projects demanding resources not normally available within the organization. In some cases, the resident engineer function is also provided by a consultant.

The degree to which private consultants are used, and the purposes for which they are used, are often a function of the organizational structure. Some significant changes to water board management structures have taken place during the reduction of the number of these enterprises.

During the exciting development and construction period, organizations were formed on the basis of the need for investigations, design and construction of facilities. As population growth slowed, money became expensive and environmental concerns slowed or redirected development, emphasis on development changed to emphasis on more efficient and effective management of operation and maintenance.

Hence, there has been some quite dramatic (and often traumatic for those involved) organizational restructing to reflect this revised management need.

Some examples of the old and new structures of a large board, and a typical small board are provided in Figure 2,4 and 4 respectively.

At no stage in this evolution of the industry was the private sector considered seriously as anything but a service provider, whether this involvement was in an ongoing relatively permanent capacity, or in a project-by-project capacity. It is clear, however, that attitude are changing and the first signs of a tentative move to invite the private sector to participate as a partner, rather than as a servant, are beginning to emerge, Particular interest has been given to the UK and French experience and closer to home, the

privatisation moves in Malaysia are being monitored.

OPERATIONS AND MAINTENANCE

It is clear that with the water sector emphasis on capital works using cheap money and satisfying new consumer's demand for basic water and sewerage services, the predominant interest of private consultants has been the provision and development of this infrastructure. There is now however an emerging trend/need to improve operational performance at the expense of new works. This operational efficiency requirement, combined with the deleterious effects of an ageing infrastructure, have created a pressing need to improve engineering/management of the vital operations and maintenance function of the systems.

Some private firms have recognized this need and based on experience and knowledge of original design intent and construction detail, been able to develop a systematic approach to improve the system operation and maintenance.

Ageing infrastructure will become the greatest drain for capital finance, as the need to upgrade and replace these resources occurs. In Victoria, the value of this infrastructure and replace is estimated at $8.36 billion (US). Current annual capital outlays total approximately $ 315 million (US) (which is about one eight of total public sector expenditure and some 71% of which is financed by external borrowings), with annual revenue of around $609 million (US). These figures, in relative terms, ar likely to be typical of the economics of systems in many of the larger cities in South East Asian countries. It is clear that a program of effective operation and management has the potential to effect very significant savings of both capital and recurrent costs. If a system's life can be extended from say 50 years to 60 years, and annual power, chemical, and breakdown repair costs reduced, then the value of the program should be easily justifiable. Refer Figures 5 and 6.

Use of private consultants to assist with the introduction and optimization of an effective operation and management program has been found to be highly cost-efficient. Resident staff are often "buried" in the realities of day-to-day technicalities and are therefore too busy to devote sufficient time to the exercise. Further, without an intense effort to justify to management, the need of particular attention to this area, approval for diversion of resources is often not given. Despite the availability of commercial software packages, these packages often need to be tailored to the particular situation and needs. In many cases, resident staff will not have the requisite experience or skills to develop the necessary system package.

ASSET MANAGEMENT

Asset Management is the term used to define the overall management of the entire infrastructure. It integrates as components the operation and maintenance functions together with the planning, design, construction, records management, accounting and other essential functions of an efficiently managed system.

Some of the essential features associated with a system of Asset Management include:

- o System performance monitoring
- o Asset register (database)
- o Asset value
- o Asset life
- o Records of maintenance and performance
- o Forward planning.

SYSTEM PERFORMANCE MONITORING

A water board's budget uses data derived from system performance records. The consumer's of the performance of the water board is often based largely on the budget and its accuracy. The more accurate and

appropriate this data is, the better the budgeting process will be.

Many highly sophisticated data storage and telemetry systems are available. Some of this computerized support is essential to replace hard-copy in the time consuming chore of converting, recording, sorting and plotting the considerable range of hydraulic, operational and financial data that is necessary for the control and forward planning of even relatively small these days.

These information or management systems must meet three criteria:

1. Justification of the need for and cost of the system.
2. The purpose and operation of the systems must be understood by routine operations staff. A 'flashing coloured light' systems which relies for its operation and interpretation on non-operational specialists is likely to create more hazards than assistance to most non-metropolitan water boards.

   It is important to involve the actual "hands on" operations personnel in development in each part of an asset management system in order to establish their understanding and confidence in the system.

3. Each specific system must be developed to integrate with other elements of the overall management package in order to facilitate transfer of data. (See Figure 7).

To establish that an Asset Management System meets these criteria it is necessary to demonstrate:

- o the key purpose of a comprehensive Asset Register
- o current value of the assets
- o the need to accurately assess the residual life of those assets and cost of replacement - ageing assets are the 'sleeping giants' of the the water industry
- o need for accurate measurement, storage and balancing performance data, and easy and ready recovery and transfer
- o the economic benefit of optimizing utilization of key existing elements
- o relationship between maintenance and replacement costs
- o means of economically extending infrastructure life
- o effect on rates of inadequate forward planning - the need for a "Business Plan".

These factors are central to the development of an effective Asset Management system.

A COMPREHENSIVE ASSET REGISTER (THE DATA BASE)

It is essential to have accurate up-to-date "As-Constructed" plans showing the location and size (and hopefully material and age) of pipelines with service connection and valve (plus closure), fire plug and manhole positions identified, and details of installation.

Where the assets have been properly and consistently recorded in plan form it is not a large step to the completion of an Asset Register. In Victoria, this Asset Register is required to be submitted annually to DWR in any case and we have found that, with a little additional work, the Register can be expanded to include the remaining data to make it the key reference source for the operations, maintenance management and forward planning systems necessary for a total Asset Management programme.

It is not essential that this Register be computerized but, where it is, the transfer of the basic information to other segments of the integrated management program is greatly facilitated.

ASSET VALUE

The cost of replacing underground infrastructure and installing ancillary storages, pumpstations etc in well developed urban areas is invariably many times greater than even the inflated value of these assets.

The aggregate value of Australia's hydraulic infrastructure has been estimated (2) at $60 billion with 25-30% of this infrastructure now more than 60 years old.

At a micro each town and city has water and sewerage assets worth millions of dollars which it must now sensibly be planning to maintain, augment, rehabilities or replace over a on enough time span to keep future rate within reasonable limits.

Typical replacement value of water and sewage assets in a small country town of 3500 people is around $15 million. In most such towns this is the highest valued asset in the town and no one wants to be responsible for a major failure in that asset or a blow-out in rates following unplanned replacements.

Once the real value of the assets is assessed, management and ratepayers usually insist upon being kept informed of the situation, and of the proper maintenance of these assets, the development of plans for steady "modernizing" and, necessary, upgrading of the assets within a reasonable budget program.

Where original and contemporary values of a town's water and sewerage systems are recorded in a properly developed Asset Register it is simple matter to transfer this data into other segments of the Asset Management program which assists the decision-makers in development of the Forward Works Program and Business Plan.

ASSET LIFE

Some very old assets continue to perform very adequately whilst the performance of some new deteriorates very quickly. A forward works program based upon theoretical life span of assets will consequently be wasteful in many instances, inadequate in others. It is therefore not sufficient simply to keep a register of asset life.

Once the estimated effective residual age of any system component has been established by correlation between age and maintenance data, it is possible to quickly"

1. develop an Effective Age Profile (Figure 8)
2. regularly update both the Profile and associated forward programs in the light of continuing maintenance information.

Enhancing and extending the operations life of existing water mains and sewers provides not only capital but operations cost benefit for every element of the system - pumpstations, supply and rising mains, trunk mains and sewers and treatment plants.

RECORDS OF MAINTENANCE AND PERFORMANCE

Too many systems are augmented or replaced on theoretical grounds

- o theoretical demand or discharge parameters
- o assumed system capacity
- o faulty or non-existant maintenance performance and costing records because the funds for necessary record and control systems were either not sought or approved.

The important factor is that is easily recoverable. However, in earlier efforts to develop hard-copy

maintenance and performance data record systems, it always seemed that critical data was missing and that the tasks half-heartedly or abandoned them completely. Considerable success has been achieved in recovering the information promptly as needed and in a form usable for either control of essential maintenance procedures or transfer into capacity analyzes or forward works and begetting programs. These programs are adapted to low-cost PCs and menu-driven with initial data input and subsequent operation tasks done by the operations staff.

Once reliable data on performance and capacity of the existing system is available it is possible to develop a meaninfull and sustainable forward program for financially achievable rehabilitation, augmentation or replacement works. It is also possible to indicate to the ratepayers where works can be deferred or eliminated by, for instance, reduced or staggered peak demand.

RESOURCE OPTIMIZATION

Even when capital funds were readily available no Engineer worth his salt proposed augmentation or replacement works without a genuine belief, on the data available, that these works were necessary. But in the past reliable data was often scant and the equipment for accurately assessing system capacity not always available or reliable.

Ready availability of cheap capital does not mean augmentation or replacement works are carried out without assessment of the need. The data available or reliable.

It is absolutely essential that scarce capital be allocated against budget priorities determined after very careful review of available reliable data on system usage and capacity, never on the basis of assumed parameters.

The availability of this performance data, within a properly structured Asset Management system, together with the regular use of system analysis software tools and the portable flow measurement equipment and systems for examining capacity of existing system elements, makes it possible to:

- o Optimize use of existing elements as widely and for as long as their operation and maintenance, and
- o develop strategies and forward business planes in which capital funds are used to best effect and with a clear understanding of the impact on revenue through dynamic analysis of the systems.

FORWARD PLANNING

Data from the technical, operational, strategic and financial segments of an Asset Management process must finally be drawn together in a collective summary form providing the necessary information for decisions to be made on forward works and revenue programmes.

The final element in the Asset Management program is a (computerized, menu-based) Forward Business Plan (FBP) encapsulating the information needed for programme decisions. Some of the features incorporated in FBP include''

- o automatic indexation of costs with allowance for growth/variation in
- o total assessments
- o proportion of commercial/industrial/residential
- o unit demand
- o backlog connections and works programs

- o detailed presentation of recurrent expenditure including loan charges, operations costs, administra-

tion, depreciation, reserves
- o revenue by source
- o automatic inflation indexation with variation as applicable to each cost heading
- o automatic calculation of government assistance (if available)
- o option to run plan either by water or sewerage activities or both
- o designed to run five, ten or twenty year programmes
- o tabular and graphic presentation of results.

Comparisons of alternative scenarious and forward works programmes ca then be run for:

- o alternative conceptual options
- o staged developed of selected options
- o various income sources.

CONCLUSION

Current emphasis in the Philippines and other South East Asian and Pacific countries is on the development of water supply and sanitation systems.

Organizational structures at national and local levels of management reflect the need to build the infrastructure, while technical skills required for this establishment period demand design and construction expertise.

The purpose of this paper is to highlight the need to consider the management and technical requirements for the post-construction operation and maintenance mode.

The major recurrent costs of an operating relate to the asset management function. Accordingly, it is essential that even before the water and sewerage board is fully operational, consideration be given to ensuring that the organizational structure and staffing/skills availability will be flexible enough to allow for efficient and effective asset management.

Private sector involvement in the management issues is likely to continue in support and advisory roles, while in the asset management area, it is clear that particular expertise and capacity exists in this sector to streamline this functional requirement.

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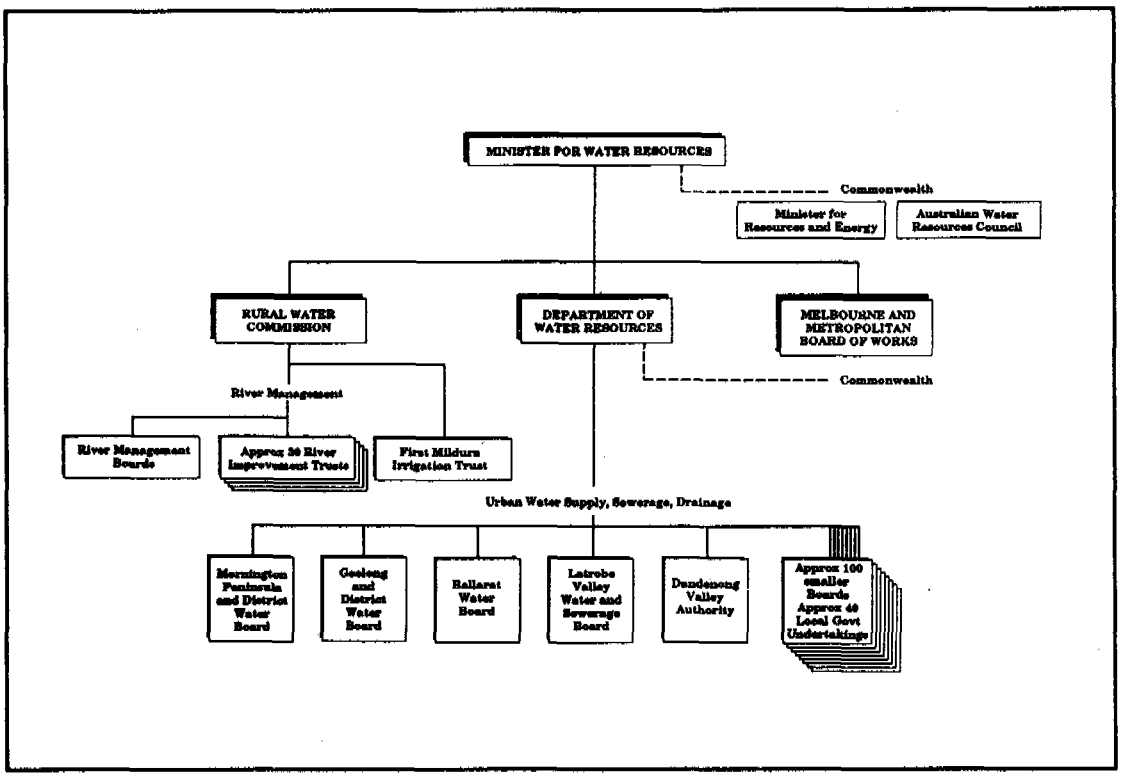

Figure 1. Victorian Water Sector Structure

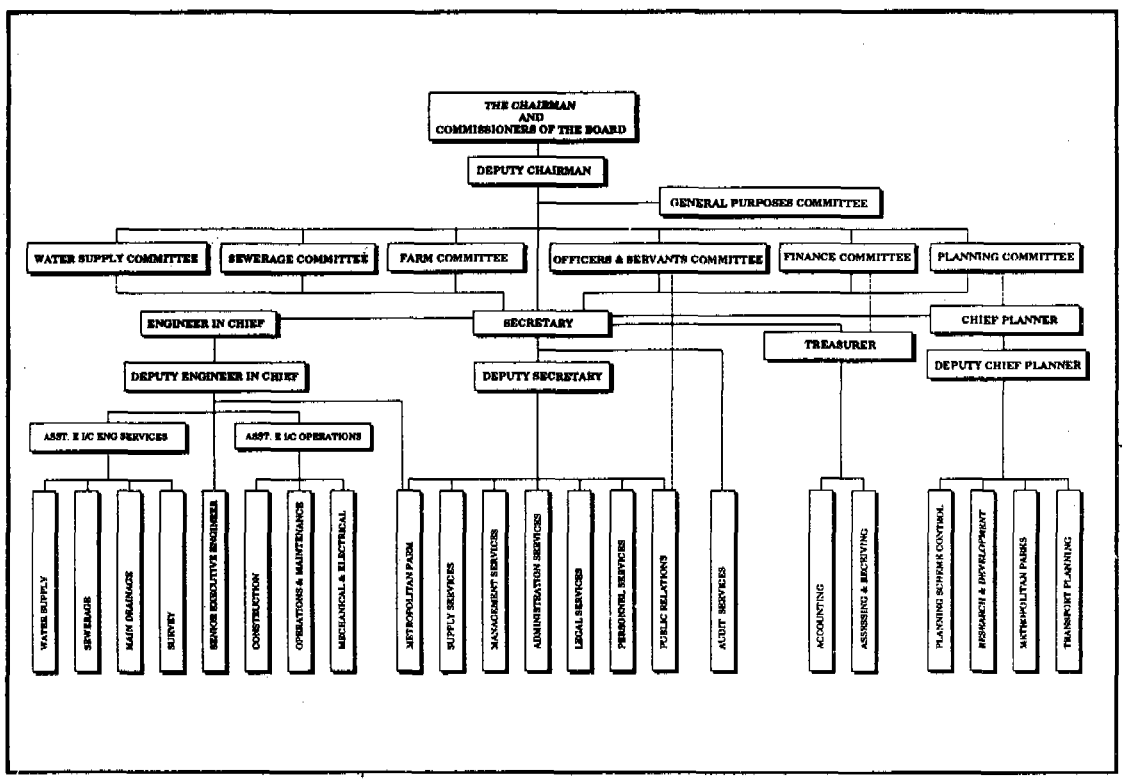

Figure 2. Organisation chart "Development Mode"

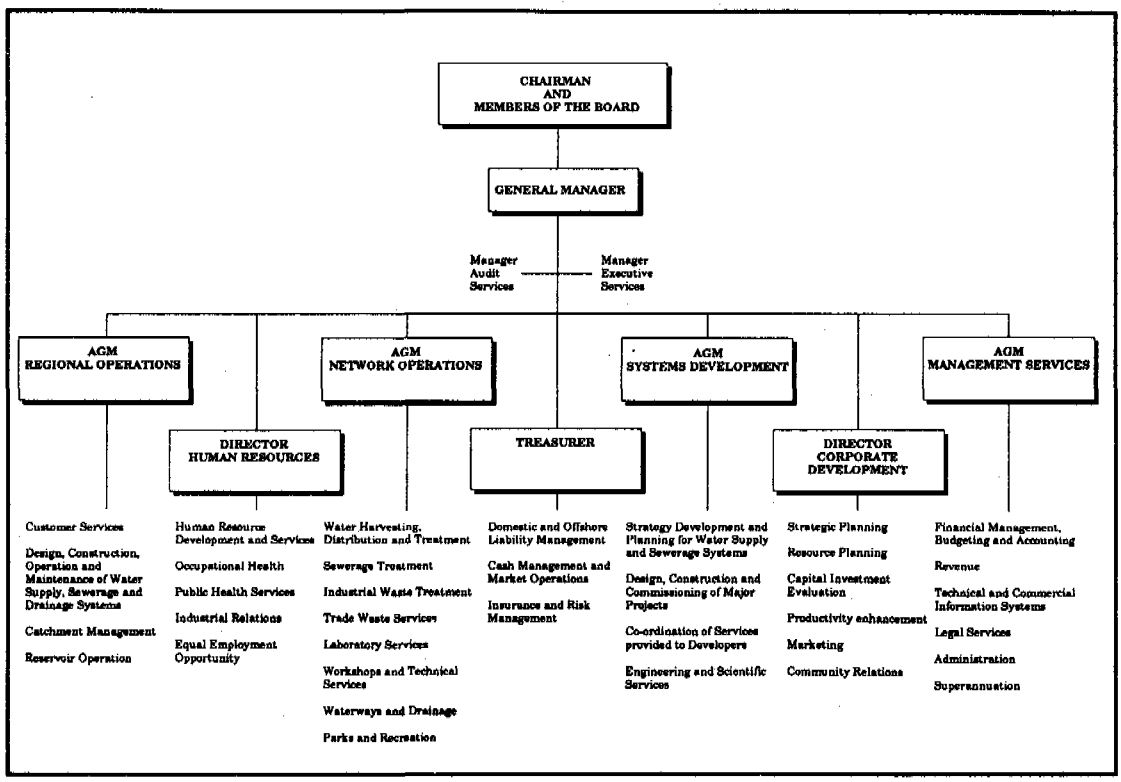

Figure 3. Organisation chart "O&M Efficiency Mode"

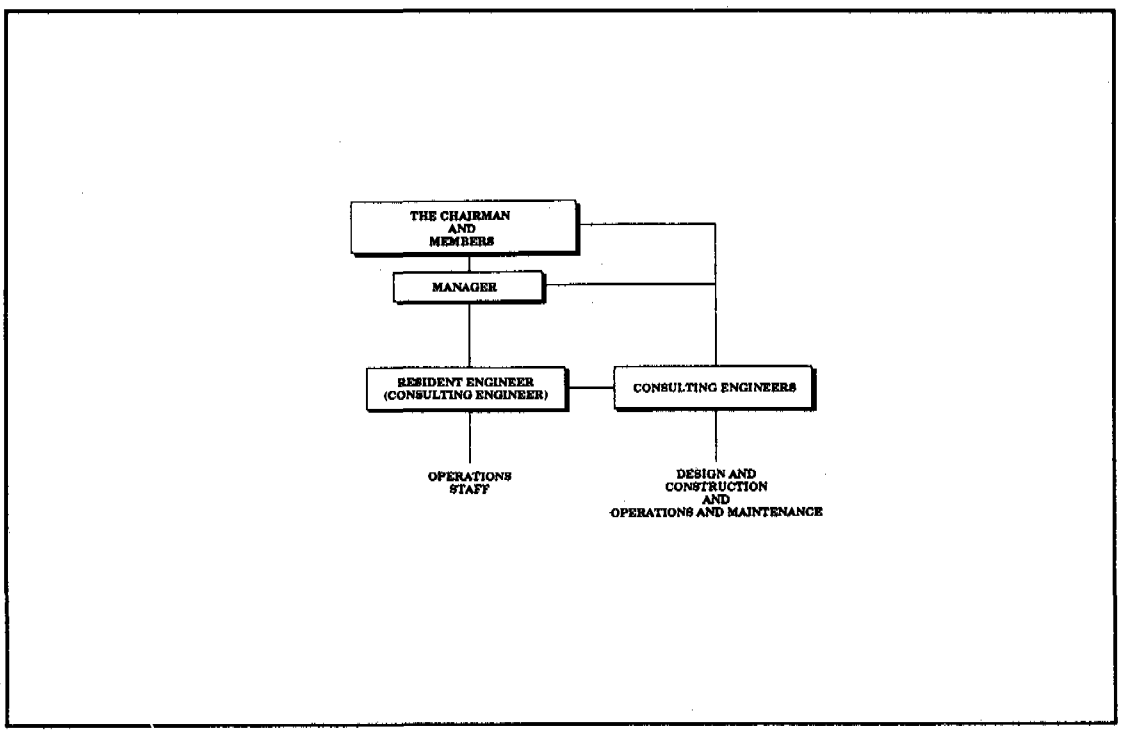

Figure 4. Local Water Board

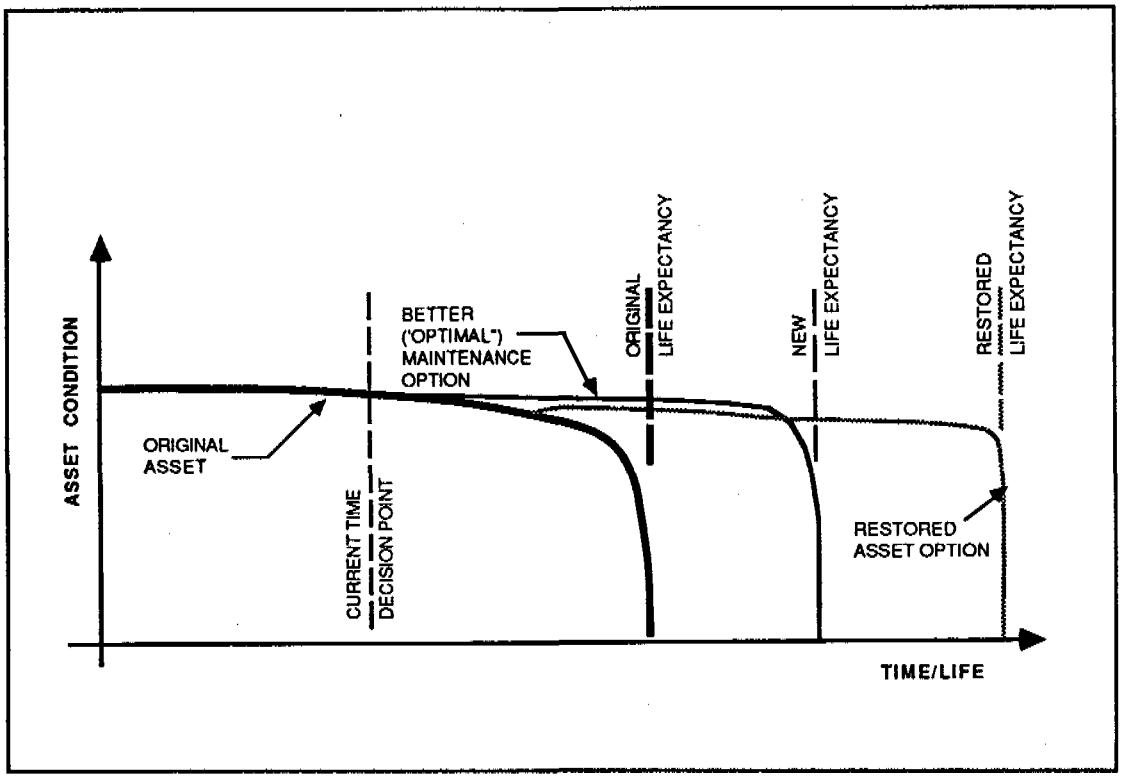

Figure 5. Life Expectancy Options

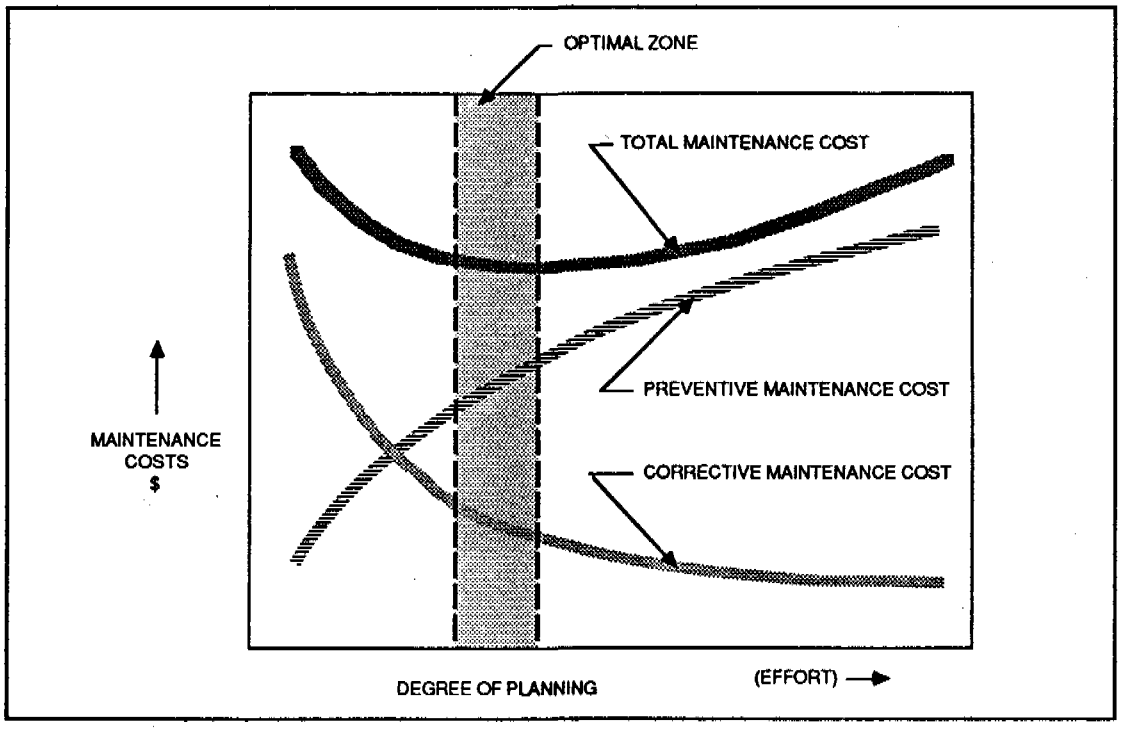

Figure 6. Optimal Maintenance Cost

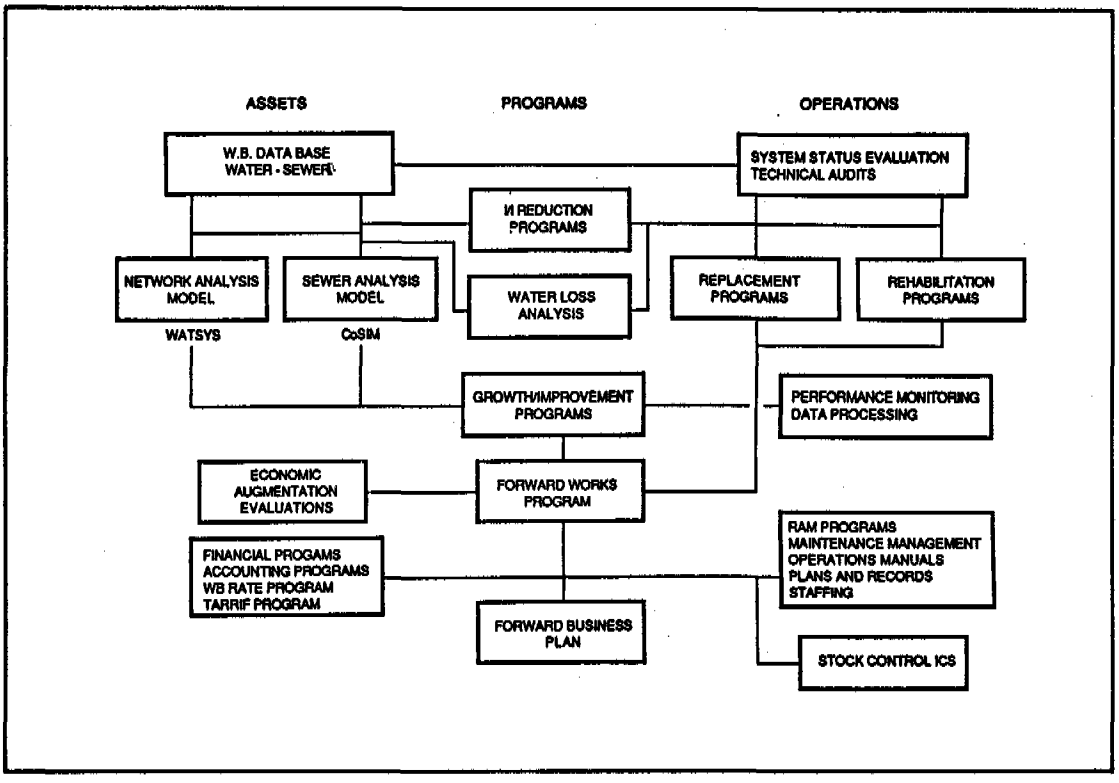

Figure 7. Integrated Computer Systems for the Australian Water Industry

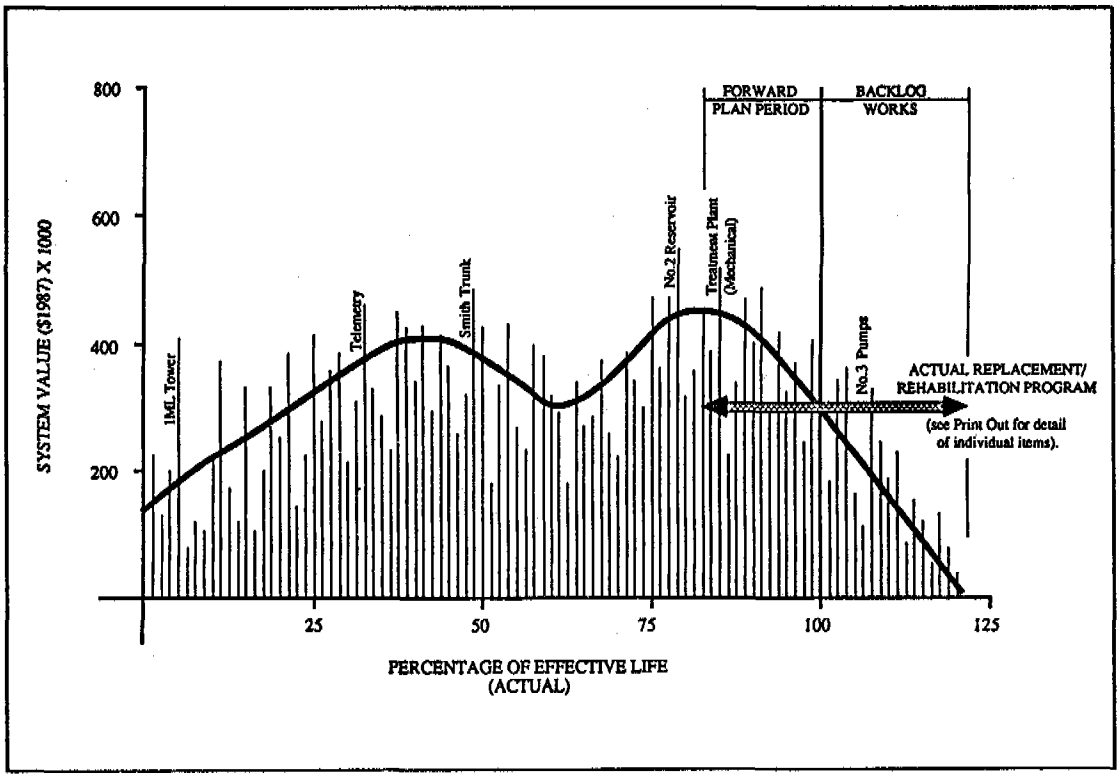

Figure 8. Age Profile After Field Assessment

PROFILE OF RESOURCE SPEAKERS

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ANA MARIE AVENDANO is a Masters of Engineering (Water Resources Management) graduate from the Asian Institute of Technology. She is a holder of B.S. Sanitary Engineering, National University and B.S. Civil Engineering, University of Sto. Tomas. A water supply engineer for DCCD and an instructor at the University of Sto. Tomas. She has undertaken numerous design works for the water supply systems of Iloilo City, Dumaguete City, La Union, Baguio City and Subic Naval Base.

BETA P. BALAGOT is the Assistant Director of the Environmental Management Bureau, DENR. She completed her B.S. Zoology (Cum Laude) and MA Economics from the University of the Philippines and MS in Ecology from the State University of New York. She has attended numerous seminars/workshops/conferences in the field of environmental management both here in the Philippines and in the countries such as USA, Thailand, France, Australia, Germany, USSR and Turkey and has presented nine technical papers on various conventions. A distinguished resource person, Ms. Balagot used to be a faculty member of the University of the Philippines and has participated in a number of committee works for environmental planning both here and abroad.

LILY C. HIDALGO is an anthropologist and human settlements and urban planning specialist. She is a graduate of the University of the Philippines (AB Anthropology) and Asian Institute of Technology (M.Sc.). She is currently the Social Advisor of the USAID Upland Access Project. She has undertaken various community development projects in the Philippines; notable of this is the UNDP-ADB Regional Study in Domestic Well Water Supplies.

JONATHAN P. M. LEAN is the Export Sales Manager of the Viking Johnson Ltd. He is based in United Kingdom and is an expert in pipe jointing for water pipelines.

ANTONIO V. MOLANO, JR. is a Civil Engineering graduate from the University of the East. He is a Chief Civil Engineer II at the Bureau of Research and Standards, Department of Public Works and Highways. He has attended numerous trainings / seminars on water supply and sanitation.

ROBIN L. POVEY is currently the Overseas Project Manager for Gutteridge Haskins and Davey Pty. Ltd, a leading engineering consultancy office in Australia. He used to be the Project Manager (Water Resources) for the Overseas Projects Corporation of Victoria. He has participated in the formulation of the guidelines in evaluating wastewater treatment plants and operators for the Australian Water Resource Council. Mr. Povey has undergone a number of overseas assignments in the field of water and wastewater engineering aside from the extensive practice in the same field in Australia.

RICARDO T. QUEBRAL is the Administrator of the Local Water Utilities Administration. He is a BS Civil Engineering graduate from the University of the Philippines and Masters of Engineering, Colorado State University. He has worked with various government agencies: MWSS. NEDA, PAEC, Bureau of Soils, NPC and UP and has undertaken overseas assignments for water supply, sewerage and sanitation projects. Aside from the numerous international seminars which he has attended in Thailand, Japan, USA, New Zealand and Korea, Mr. Quebral had extensive trainings in soil consevation, hydrology research, planning, industrial policies and finance, construction, water and wastewater treatment technologies.

MARIO P. SANDOVAL is a registered geologist and has undertaken several works in groundwater geology and water resources development both here and abroad. He is a BS Geology graduate, University of the Philippines and a Masters of Science (Ground Water Geology) holder from the University of Arizona. Currently, he is the Managing Director of Aqua Dyne Technological Services, Inc. He has undergone special training and seminars in groundwater development in the United States.

LUIS V. Z. SISON is the Administrator of the Metropolitan Waterworks and Sewerage System. He completed his AB degree (Cum Laude) and Masters in Business Administration from Ateneo de Manila and his BS Civil Engineering from the University of the Philippines. He has a distinguished career in the field of engineering and finance. He has worked with various companies and had a four year stint with ADB. Sison has attended countless courses, seminars and programs both here and abroad in various capacities. Aside from being the Chairman of the Board of PDCP, Asian Business Consultants and Northern Mindanao Corporation he also serves as board director for a number of companies.

ARTURO G. VILLASIN is the General Manager of the Cabanatuan City Water District and the President of the Philippine Association of Water Districts (PAWAD).

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