BIBLIOGRAPHIC DATA SHEET	1. CONTROL NUMBER PN-AAK-216	2. SUBJECT CLASSIFICATION (695) AP10-0000-G792

3. TITLE AND SUBTITLE (240) Water supply: Misamis Occidental Water District; feasibility study, technical final report; volume I (text)

4. PERSONAL AUTHORS (100)

5. CORPORATE AUTHORS (101)

Camp Dresser & McKee Intl., Inc.

6. DOCUMENT DATE (110) 1976	7. NUMBER OF PAGES (120) 193p.	8. ARC NUMBER (170)

9. REFERENCE ORGANIZATION (130) CDM

10. SUPPLEMENTARY NOTES (500)

(Volume II appendices, 217 p.: PN-AAK-217, Summary Final Report, 45p.: PN-AAK-218)

11. ABSTRACT (950)

public utilities
[redacted] engineering

12. DESCRIPTORS (920)
Philippines
water resources
water supply
water management
feasibility
economic aspects
design criteria
financing
cost analysis

13. PROJECT NUMBER (150) 492026400

14. CONTRACT NO.(140) unknown

15. CONTRACT TYPE (140)

16. TYPE OF DOCUMENT (160)

AID 590-7 (10-79)

PN-AAK-216

LOCAL
WATER
UTILITIES
ADMINISTRATION
REPUBLIC OF THE PHILIPPINES

FEASIBILITY STUDY
TECHNICAL FINAL REPORT

VOLUME I (TEXT)

WATER SUPPLY

MISAMIS OCCIDENTAL WATER DISTRICT

JANUARY 1976

CAMP DRESSER & McKEE INTERNATIONAL INC.
CONSULTING ENVIRONMENTAL ENGINEERS

FOREWORD

The Final Report as submitted herein is a refinement of the Interim Report and the Addendum to the Interim Report.

The Interim Report dated 16 June 1975 was to provide for early review by LWUA, the Water District and the Asian Development Bank, of the findings and early action guidelines to upgrade the water supply and service to the District consumers. The Interim Report covered the first 9 Chapters and included a description of the (tentatively) Selected Plan. It did not include the Economic and Financial Feasibility Studies.

On September 16, 1975, the Addendum to the Interim Report was submitted. This had substantial revisions to Chapters 4 and 6, reflecting additional field data collected and written up between June 1975 and September 1975. The Addendum also included refinements to the Interim Plan and the cost minimization studies; economic and financial feasibility analyses. Unit prices that were used in Chapters 7 and 8 of the Interim Report vary slightly from those unit prices that were used in Chapter 9 of the Addendum. The variation was caused by an abrupt increase in pipe material during the intervening 2-3 month period. Nevertheless, the relative rankings of the identified Alternatives in Chapters 7 and 8 should not change, even if the unit prices therein were made consistent with those of the Addendum.

The Final Technical Report is supported partly by the two Volumes of the Methodology Manual on Water Supply Feasibility Studies published in August 1975.

Field appraisals by Asian Development Bank personnel were conducted in August and October 1975. Between June and November 1975 the Interim Report, the Addendum and Methodology Manuals were reviewed by AID, LWUA, the CDM Technical Review Committee and the MOWD. The Final Report reflects most of the relevant criticisms, comments and suggestions by these parties.

The following have contributed significantly to the development of this Final Report :

A. Ulvi Gulbey, Chief Engineer
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Eugene Rumph, Hydrologist
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The team work of the CDM/DCCD/LWUA project staff is to be commended and is certainly one of the key factors for the timely completion of these studies.

LIST OF ABBREVIATIONS

Agencies

BCWD	Butuan City Water District
CDM	Camp Dresser and McKee International Inc.
CNWD	Camarines Norte Water District
DCCD	Design Consultation Construction and Development Engineering Corporation
EDF	Economic Development Foundation
LWUA	Local Water Utilities Administration
MCWD	Metropolitan Cebu Water District
MOWD	Misamis Occidental Water District
MWSS	Metropolitan Waterworks and Sewerage System (formerly National Waterworks and Sewerage Authority or NWASA)
NEDA	National Economic Development Authority
NIA	National Irrigation Administration
NWRC	National Water Resources Council
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration (formerly Weather Bureau)
ZCWD	Zamboanga City Water District

Units

AC	asbestos cement
CCI	centrifugal cast iron
CI	cast iron
CLCI	cement-lined cast iron
cm	centimeter
cum	cubic meter
cumd	cubic meter per day
cumd/m	cubic meter per day per meter
cumd/ha	cubic meter per day per hectare
cum/hr/sqkm	cubic meter per hour per square kilometer
cum/mo	cubic meter per month
cum/sqkm/yr	cubic meter per square kilometer per year
FEC	foreign exchange component
GI	galvanized iron
GS	galvanized steel
ha	hectare
HGL	hydraulic grade line
hr	hour
kg	kilogram
km	kilometer
lpcd	liter per capita per day
lpd	liter per day
lps	liter per second

lps/m	liter per second per meter
m	meter
mg/l	milligram per liter
mm	millimeter
mm/yr	millimeter per year
mo	month
m/sec	meter per second
%	per cent
P	Philippine peso
pH	logarithm (base 10) of the reciprocal of the hydrogen ion concentration in water, moles per liter
PVC	polyvinyl chloride
RU	revenue unit
sqkm	square kilometer
sqmd	square meter per day
$	United States dollar
yr	year

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CHAPTER I FINDINGS AND RECOMMENDATIONS

Existing Situation

The Misamis Occidental Water District (MOWD) was formed on July 13, 1973 to include originally three cities and nine municipalities of Misamis Occidental. With its creation, the MOWD acquired the ownership and management of the public water supply systems from the provincial government in accordance with Presidential Decree No. 198. Upon advice of the Local Water Utilities Administration, however, the Provincial Board reduced the MOWD membership to two cities and four municipalities. This number was further reduced when two municipalities withdrew their membership. On July 17, 1974, the provincial board passed Resolution No. 120 finally naming Ozamiz City, Oroquieta City, Clarin and Calamba as official MOWD members. The MOWD has given priority to Ozamiz and Clarin in the water supply feasibility studies.

The study area (4,245 ha) which covers Ozamiz and Clarin is located 3 m above mean sea level. Based on the 1970 Population Census, the combined population of the two areas was about 82,400, with 64,600 in Ozamiz and 17,800 in Clarin. About 61,000 comprised the study area population in 1970, of which 23 per cent in Ozamiz were actually served by the MOWD.

Ozamiz and Clarin are primarily dependent on agriculture. Eighty three per cent (83%) of the cultivated area in Ozamiz is used for crop production. Major crops are rice, corn, coconut, bananas and fruits. Besides developing into a trade center in the northern Mindanao region, Ozamiz is a potential major tourist spot. The city has a number of historical places and scenic attractions.

The Ozamiz City water system was constructed in 1941. (Clarin has no public water system.) At present, Ozamiz has two sources of supply, namely, Talibaksan Spring and Cocok Spring. The Catadman well, which was drilled in 1967, was taken out of service in 1971 and its pump was transferred to Cocok Spring. Transmission facilities include two main pipelines extending from the two sources to the distribution system. Water from both sources is disinfected by injecting chlorine gas directly into the transmission lines. The distribution system consists of 12.8 km of pipes.

The basic water system is more than 25 years old. The total supply from the two sources is insufficient to meet present demands. Water is rationed overnight to conserve water in the storage tank. The Talibaksan transmission line has insufficient capacity to supply the demand at adequate system pressures. Chlorination equipment cannot be adjusted to regulate chlorine dosage. Low system pressures reduce the fire-fighting potential of the water system and increase the possibility of contamination from polluted drainage waters. Leakage and wastage represent about one-half of water production. Accounted for-water is about 37 per cent of current production. Despite these operational deficiencies the MOWD collects sufficient revenues to cover operating expenses. This has been achieved through management emphasis on metering consumption and eliminating illegal and non-paying concessionaires.

Hydrogeologic studies show that the MOWD is located on a narrow coastal plain at the foot of a volcanic peak, Mount Malindang, which is prolific in large springs. The measured and estimated flows from these major springs appear to be sufficient to supply the entire Ozamiz City-Clarin portion of MOWD until about the year 2000. The spring water appears to be of good quality. However, the coastal area does not appear favorable for development of sufficient groundwater supply from wells for MOWD requirements.

Projections

The study area population is projected to increase from 60,710 in 1970 to 154,000 in the year 2000. Served population will increase from 14,100 in 1970 to 53,000 in 1990 and 93,000 by the year 2000.

Projections show that the total per capita average daily water supply requirements will increase from the 1975 level of 194 lpcd to 210 lpcd in the year 2000. The domestic portion of the total per capita water requirement will increase from 65 lpcd in 1975 to about 150 lpcd in 2000. Average daily demand is expected to go up from 3,400 cumd in 1975 to 19,500 cumd in the year 2000, a six-fold increase.

Technical Findings

Several alternatives have been analyzed relative to source development, transmission routes, storage siting and extent of distribution facilities. The least-cost and recommended scheme consists of:

(1) improvements to the existing Talibaksan Spring facilities;

(2) development of Cocok, Regina, Bitoon and Dalingap Springs;

(3) reinforcement and expansion of the transmission and distribution facilities, including pipelines, valves, hydraulic (pressure) control chambers, chlorination stations and storage facilities;

(4) expansion of the distribution system and installation of new metered service connections.

The cost estimate for the early action program is about ₱683,000, of which $44,000 would be in foreign exchange. The total project cost of all improvements up to the year 2000 (based on July 1976 prices), excluding early action program, is about ₱79 million. Table I-1 is a project cost breakdown by stage. The escalated Phase I-A costs are listed in Table I-2. Annual operating and maintenance costs are estimated to increase from ₱223,000 in 1974 to ₱727,000 in 1980 and ₱946,000 in 1990.

TABLE I-1

COST BREAKDOWN (₱ x 10^3)

	Stage I-A	Stage I-B	Stage I-C	Stage II-A	Stage II-B	Total
Construction Period	1977-82	1982-86	1986-90	1984-95	1992-2000	
Source Development	2,192			704 1/		2,896
Transmission	7,675		2,656	5,874	6,574	22,779
Distribution & Storage Tanks	2,481	1,498	2,081	4,785	2,073	12,918
Administration Building	634					634
Internal Network	2,418	2,418	1,930	1,946	2,196	10,908
Service Connection	832	869	905	1,834	1,569	6,009
Total Construction Cost	16,232	4,785	7,752	15,143	12,412	56,144
Total Project Cost	23,006	6,522	10,591	21,401	17,464	78,984
Foreign Exchange $ x 10^3	774	180	416	773	548	2,691

1/ Tentative schedule indicates Lower Balingap Spring to be developed in 1984-86.

TABLE I-2

COST SUMMARY OF CONSTRUCTION
STAGE I PHASE A (1977-82)
(ESCALATED FROM JULY 1976 PRICES)
P x 1000 or $ x 1000

Item	Construction Period	1977 Construction Cost (P)	1977 FEC($)	1978 Construction Cost (P)	1978 FEC($)	1979 Construction Cost (P)	1979 FEC($)	1980 Construction Cost (P)	1980 FEC($)	1981 Construction Cost (P)	1981 FEC($)	1982 Construction Cost (P)	1982 FEC($)	Total Construction Cost (P)	Total FEC ($)
Source Development															
Coook and Regina Springs	1977-78	905	62	1,010	69									1,915	131
Talibaksan Spring	1978-79			20		24								44	
Bitoon Spring	1979-80					379		427						806	
Transmission Lines															
Coook to Ozamis City	1977-78	764	25	853	28									1,617	53
Talibaksan Spring	1978-79			931	35	1,044	39							1,975	74
Bitoon Spring	1979-80					671	25	752	28					1,423	53
Storage Tank to Clarin	1978-79			698	25	781	28							1,479	53
Storage Tank to Ozamis City	1980-81							2,156	81	2,375	89			4,531	170
Storage Tank	1978-79			581		651								1,232	
Distribution Mains	1978-82			243	8	543	18	609	20	671	22	367	12	2,433	80
Internal Network	1978-82			378	10	847	23	950	26	1,047	29	572	16	3,794	104
Service Connections	1978-82			130	4	291	8	326	9	360	10	198	6	1,305	37
Administration Building	1977-78	170		190										360	
Meter Repair Facilities	1977-78	94	11	105	13									199	24
Laboratory Equipment	1977-78	91	11	101	12									192	23
Sub-total		2,024	109	5,240	204	5,231	141	5,220	164	4,453	150	1,137	34	23,305	802
Contingencies		304	16	735	29	671	18	655	21	527	19	94	3	2,986	106
Construction Cost		2,328	125	5,975	234	5,902	159	5,875	185	4,980	169	1,231	37	26,901	908
Engineering, Administration, Legal Services and Interest during Construction		591	27	1,522	50	1,510	35	1,505	50	1,279	37	320	8	6,727	197
Total		2,919	152	7,497	284	7,412	184	7,380	225	6,259	206	1,551	45	33,018	1,105

Economic and Financial Analyses

The economic feasibility studies show that the quantifiable economic benefits resulting from an improved, upgraded and expanded water supply system exceed the economic costs associated in the development and operation of such system. Among the quantifiable benefits considered are the increase in land value, health, personal satisfaction, employment generation (short-term and long-term), and reduction in fire damages and insurance rates. The unquantifiable benefits are the project's multiplier effect on economic growth, aesthetics and social uplift. Economic costs took into account capital expenditure costs, annual operating costs, depreciation expense and certain economic adjustments associated with foreign exchange component and unskilled labor.

The calculated benefit-cost ratio for Ozamiz and Clarin is 1.16:1. The project, therefore, is economically feasible. It should be noted, however, that the actual benefits will be greater than what the ratio represents because the non-quantifiable benefits are not included in the economic analysis.

The financial feasibility studies establish a detailed set of guidelines that the water district management may use in making crucial decisions during the next few years. The financial plan indicates the manner and the time funds will be used to operate and maintain the system, implement the program, establish reserve funds and retire the indebtedness. Capital funds for the recommended plan will be acquired by borrowing from international lending agencies and LWUA.

Water rates have been established on the basis that the system will be financially self-supporting. The rates that have been developed appear to be within the "ability to pay" of the average householder in the Misamis Occidental Water District. The proposed average water rates are:

1976 - 1978	₱1.00/cum
1979 - 1981	₱1.90/cum
1982 - 1984	₱2.50/cum
1985 - 1987	₱3.20/cum
1988 - 1990	₱4.50/cum

In terms of constant 1975 pesos the average rates listed above do not exceed ₱1.20/cum from 1979 to 1990.

CHAPTER II INTRODUCTION

A. SCOPE OF WORK

This feasibility study has been undertaken by Camp Dresser and McKee International Inc. for the Local Water Utilities Administration (LWUA) as part of its effort to develop basic water supply plans for ten provincial urban areas of the Philippines. It contains technical, economic and financial studies for the improvement of the water system in the Ozamiz-Clarin portion of the Misamis Occidental Water District.

The feasibility studies have been financed from proceeds of a loan to the Government of the Republic of the Philippines from the United States of America through the Agency for International Development. The duration of the studies is 19 months from 9 December 1974, the starting date of the LWUA-CDM contract. The project staff consisted of six US engineers and 35 Filipino personnel. Some assistance was also provided by the personnel of respective water districts during the course of the studies.

The project consists of four parts:

1. Preparing water supply master plans and feasibility studies for ten urban (provincial) areas of the Philippines, initially: Cebu, Zamboanga, Butuan, Ozamiz, and Daet;

2. Developing a methodology of conducting these studies through training seminars for LWUA engineers (a Methodology Manual for Water Supply Feasibility Studies has been printed for this purpose);

3. Applying the training methodology by employing LWUA trainees in the preparation of master plans and feasibility studies for the Second Five Cities, namely: Tarlac, Cabanatuan, San Fernando - La Union, Lucena and Lipa; and

4. Assisting LWUA in long-range planning by developing selection criteria, applying these criteria to 100 cities/municipalities and conducting pre-feasibility studies on 20-60 of the 100 cities/municipalities.

Training is an important element of the project - training counterpart LWUA and local consulting engineering (DCCD Engineering Corporation) personnel in the conduct of such studies.

B. MISAMIS OCCIDENTAL WATER DISTRICT

The study area is located in the Province of Misamis Occidental in the northwestern part of the Island of Mindanao, Republic of the Philippines (Figure II-1). The study area covers the Ozamis City - Clarin portion of the Misamis Occidental Water District.

C. LOCAL WATER UTILITIES ADMINISTRATION

The Local Water Utilities Administration was established by Presidential Decree No. 198 issued on May 25, 1973. The decree seeks to establish, operate, maintain and develop reliable, adequate and economically viable municipal water supply and wastewater disposal systems. LWUA potentially covers urban areas throughout the country except Metropolitan Manila which is served by the Metropolitan Waterworks and Sewerage System (MWSS).

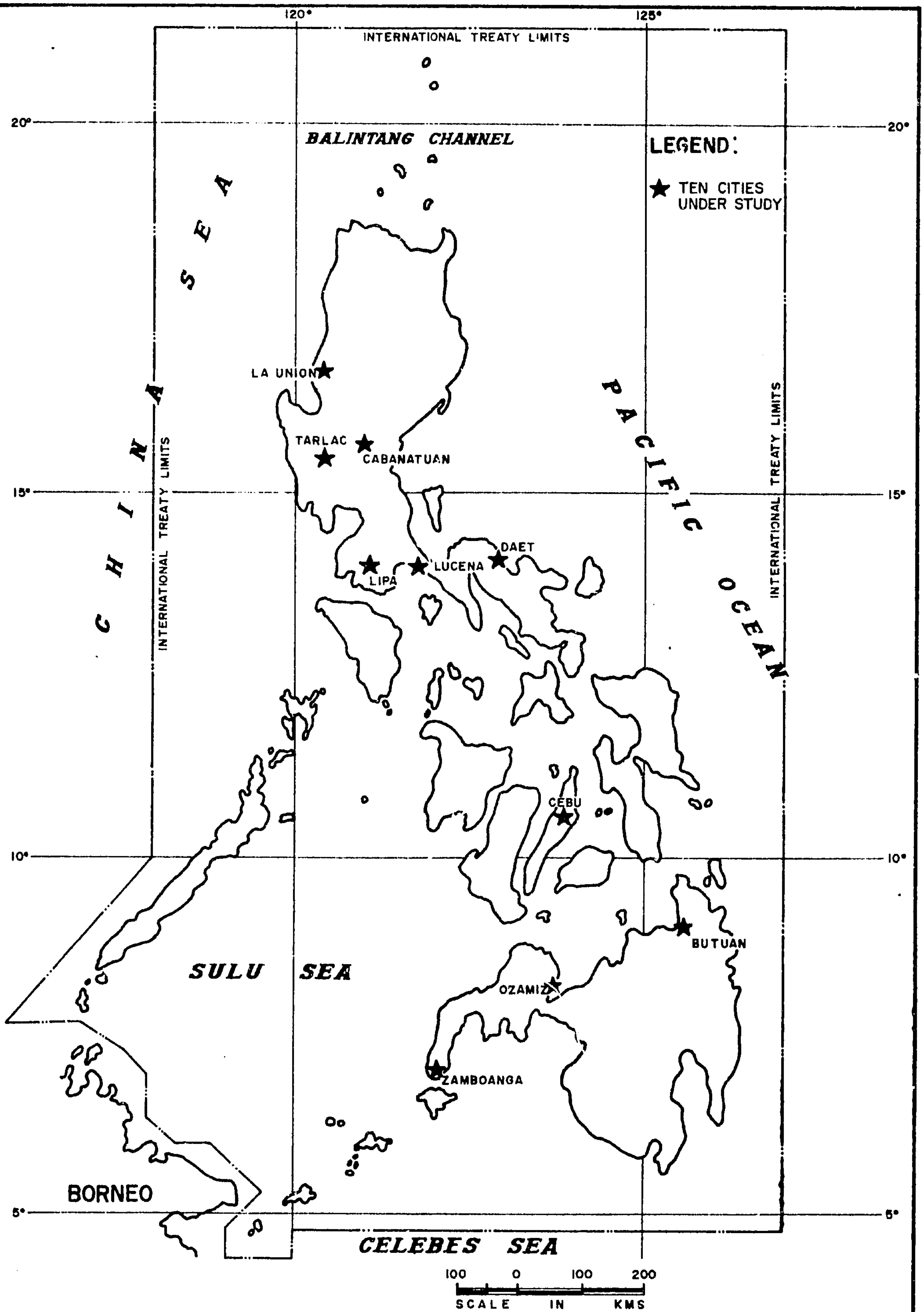
In recognition of the vital role of water supply in national development, LWUA was organized on September 18, 1973 under the National Economic Development Authority, the highest economic planning body of the country. When Presidential Decree No. 768 was issued on August 15, 1975, LWUA was placed directly under the Office of the President. This new decree amends other salient provisions of Presidential Decree No. 198. On December 11, 1975, LWUA was transferred from the Office of the President to the Department of Public Works, Transportation and Communication by virtue of Letter of Implementation No. 31.

One of the LWUA's primary activities is to encourage the formation of independent, locally controlled public water districts in provincial urban areas. This is a step designed to ensure safe and sufficient potable water supply by the district and its operation on a businesslike basis.

Primarily, LWUA renders assistance to local water districts in financial, training and technical matters. It also establishes standards for water quality and service, operations, management and administration including accounting practices. In addition, it prescribes activities necessary to ensure conformance with such standards.

Organizational Set-Up

At present LWUA is directed by a three-man Board of Trustees through a General Manager. The Board formulates policies on all the business affairs of LWUA and the General Manager is responsible for the implementation of such policies. Under Presidential Decree



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS

CDM-LWUA

FIGURE II-1
LOCATION MAP

No. 768, the Trustees are to be appointed by the President of the Philippines, for an individual term of five years.

To carry out its functions, LWUA maintains five operating divisions, each headed by a director.

The Loans and Program Division administers LWUA's revolving fund and relending program. It develops loan application criteria and covenants and processes loan applications of duly constituted local water districts. It also negotiates domestic and international loans.

The Technical Services Division provides technical assistance to water districts and develops design, construction and operational standards.

The Regulatory Division monitors the performance and operations of water districts. It also processes and administers LWUA's certification program for water districts.

The Management and Training Division conducts seminars among the board of directors of water districts, their general managers and other key personnel and technicians. Such seminars aim to strengthen the institutional structure of water districts.

Finally, the Administrative Division provides the necessary staff support to LWUA in terms of personnel recruitment, records management, general services and related functions.

Only duly organized water districts which have been issued a Conditional Certificate of Conformance can avail themselves of financial assistance from LWUA.

Funding

Under Presidential Decree No. 768, LWUA's funding and borrowing capacity was increased significantly. From an original revolving fund of ₱20 million, the authorized loans from local sources were increased from ₱500 million to ₱1 billion; loans from foreign sources were increased from $100 million to $500 million.

Accomplishments

As of October 1975, LWUA had issued Conditional Certificates of Conformance (CCC) to 19 out of 27 water districts with resolutions of organization officially filed with LWUA. A CCC is issued to a water district once it has taken significant steps towards the improvement of the public water supply according to certain criteria prescribed by LWUA.

LWUA has planned the following projects for early implementation:

1. The design and construction of improved waterworks systems in the cities of Bacolod, San Pablo, Cagayan de Oro, Davao and Tacloban;

2. The feasibility study, design and construction of waterworks systems in Marawi City and Batangas City;

3. The water resources evaluation study for Baguio City;

4. The water supply feasibility studies of 10 provincial areas, which includes this report; and

5. The water supply pre-feasibility studies of 100 cities throughout the country.

As part of its training program, LWUA has conducted seminars among key personnel of water districts. It has also developed the concept for long-range planning survey and interim demonstration program. Such plan is aimed at setting up a data bank for water needs and subsequently, undertaking immediate high-impact improvements on existing waterworks systems throughout the country.

D. HISTORICAL BACKGROUND
MISAMIS OCCIDENTAL WATER DISTRICT

The Misamis Occidental Water District (MOWD) was formed on July 13, 1973 but its jurisdiction was finally defined on July 17, 1974. MOWD was established by Resolution No. 105-A of the Provincial Board of Misamis Occidental. Under this resolution, ownership and management of the public water systems would be transferred from the Provincial Government to the MOWD in accordance with Presidential Decree No. 198.

The jurisdiction of the MOWD originally included three cities and nine municipalities of Misamis Occidental. LWUA, however, noted that too large an area for a single water district might create problems in management and administration, not conducive to an efficient and economical operation. LWUA further cited provisions in Presidential Decree No. 198 that a municipality of at least 30,000 people could organize a water district and that municipalities where population centers are closely situated may be covered by one district.

On October 15, 1973, Ozamiz City created its own water district. LWUA, however, remarked that such district was unnecessary since the Ozamiz water system formerly owned by the provincial government had already been turned over to the MOWD. If the city would proceed with its plan, LWUA indicated that it might require a merger between the MOWD and the Ozamiz City Water District.

The Provincial Board eventually passed Resolution No. 154 on December 10, 1973 reducing the MOWD membership to two cities and four municipalities. These were: Ozamiz City, Oroquieta City, Clarin which did not have a water system, Calamba, Jimenez and Lopez Jaena. The membership was further reduced when Jimenez and Lopez Jaena withdrew from the MOWD in protest over what they claimed excessive water rate increases by the District.

On July 17, 1974, the Provincial Board approved Resolution No. 120 finally naming Ozamiz City, Oroquieta City, Clarin and Calamba as official MOWD members. In separate resolutions, their local governments concurred with the organization of the MOWD. The MOWD has given priority to Ozamiz and Clarin in the water supply feasibility studies.

Resolution No. 120 was officially filed with LWUA on August 2, 1974. On August 26, 1974, LWUA awarded the Conditional Certificate of Conformance to MOWD in recognition of its efforts and commitment to improve the public water service. The CCC entitles the MOWD to all rights and privileges authorized under Presidential Decree No. 198.

Function and Operation

The MOWD is a government corporation with proprietary functions and is politically independent from the local government. As constituted, the water district is subject to the provisions of Presidential Decree No. 198 and the rules and regulations of LWUA. The MOWD can promulgate its own operational laws through a five-member board of directors appointed by the provincial governor. The district can only be dissolved through the act of this board.

The MOWD was established for the purposes of acquiring, installing, improving, maintaining and operating the water supply and distribution facilities as well as the wastewater collection, treatment and disposal facilities. To realize these objectives, financial and technical assistance may be granted to the Water District through LWUA. Presidential Decree No. 198 provides that the Water District shall operate on a financially self-sufficient basis.

The estimated income of MOWD for fiscal year 1974-75, including that of Oroquieta City and Calamba, totalled to ₱487,100. Of this amount, about 62 per cent was shared by Ozamiz City.

The MOWD maintains 23 regular employees. Administrative expenditures represented 43.5 per cent of the 1974-75 budget. Expenditures for maintenance and operation of the water system accounted for the remaining 56.5 per cent.

CHAPTER III DESCRIPTION OF THE STUDY AREA

A. PHYSICAL DESCRIPTION

Location and Extent

The province of Misamis Occidental (land area: 1,939 sqkm) is located on the northwestern part of the Island of Mindanao, Republic of the Philippines. It is separated from its twin province, Misamis Oriental, on the east by Iligan Bay. The other boundaries of the province are: Zamboanga del Sur and Zamboanga del Norte on the west; Mindanao Sea on the north; Panguil Bay and Zamboanga del Sur on the south.

The study area[1] (Figure III-1), approximately 4,245 ha, is situated southwest of Misamis Occidental. It includes portions of Ozamiz City and the municipality of Clarin, two of the four areas comprising the Misamis Occidental Water District. Ozamiz City is one of three cities of the province. Clarin is located about 6 km north of Ozamiz.

The study area is divided into the present service area[2] (165 ha) and the projected study area[3] through the year 2000. The present service area covers the Poblacion[4] of Ozamiz and the surrounding

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[1]The study area encompasses the area which has been considered in the projections of gross population and land use pattern. Study area limits have been determined after a careful review of development or zoning plans, physical limits and public facility projects in the region.

[2]The service area represents sections of the study area, which are currently served or intended to be served by the municipal water system. The served population projections in Chapter VI relate to the service area.

The MOWD present service area is aggregately called core city. This includes the poblacion and the urbanized communities (barrios) clustered around the poblacion. Areas currently served by a municipal water system are, in general, located within the core city.

[3]Refer to Chapter VI.

[4]The poblacion also known as city or town proper is defined by pre-established political boundaries. It is determined by the location of the city or municipal hall. Ordinarily, the poblacion consists of the plaza or public square (which forms the central part), public market, schools, churches, commercial and residential blooks.

barrios[5] of Baybay Triumpo, Baybay Sta. Cruz, Baybay San Roque, Labo and Tinago. At present, Clarin is not served by a public water system.

Topography

Misamis Occidental has a largely hilly and rolling terrain, with a coastal plain on the east and a mountainous belt on the west. The study area lies in the narrow coastal plain along Panguil Bay and Iligan Bay, at an elevation of 3 m above mean sea level. It is located at the foot of a volcanic peak, Mount Malindang.

The two largest rivers in the study area are Clarin and Labo, both originating from the west and emptying eastward into Iligan Bay. These rivers have several tributaries. The other streams draining the study area are Tudela River, Malaubang River and Tinago Creek. Tudela River traverses part of Clarin and winds northward into Iligan Bay. Malaubang River and Tinago Creek flow southeastward into Panguil Bay.

Prolific springs abound in the Mount Malindang area. The most important of these springs are Bitoon, Dalingap and Talibaksan, which is an existing water supply source. Among the coastal springs found in the water district are Regina and Cocok, another existing supply source.

Geology

The exposed geologic section in the study area is of Pliocene and Quaternary Age. It consists of andesitic volcanic rocks to the west and marine and terrestial coastal plain sediments to the east.

Soils

There are three types of soil in the study area: Bantog clay, Jasaan clay loam and hydrosol. The Bantog clay overlays the coastal areas of Ozamiz and Clarin. This dark reddish brown soil has developed from recent alluvial deposits. It is considered very productive to rice and is planted as well to coconut, peanuts and other crops.

Jasaan clay loam which is found in Ozamiz originated from igneous rocks, mostly basalt and andesite. Its surface soil is reddish brown, slightly sticky and granular in structure. It is planted mostly to coconut, corn and rice.

Hydrosol, a poor agricultural soil, is found in the waterlogged and marshy areas along the coast of the study area. Mangrove and nipa palms grow well in this type of soil.

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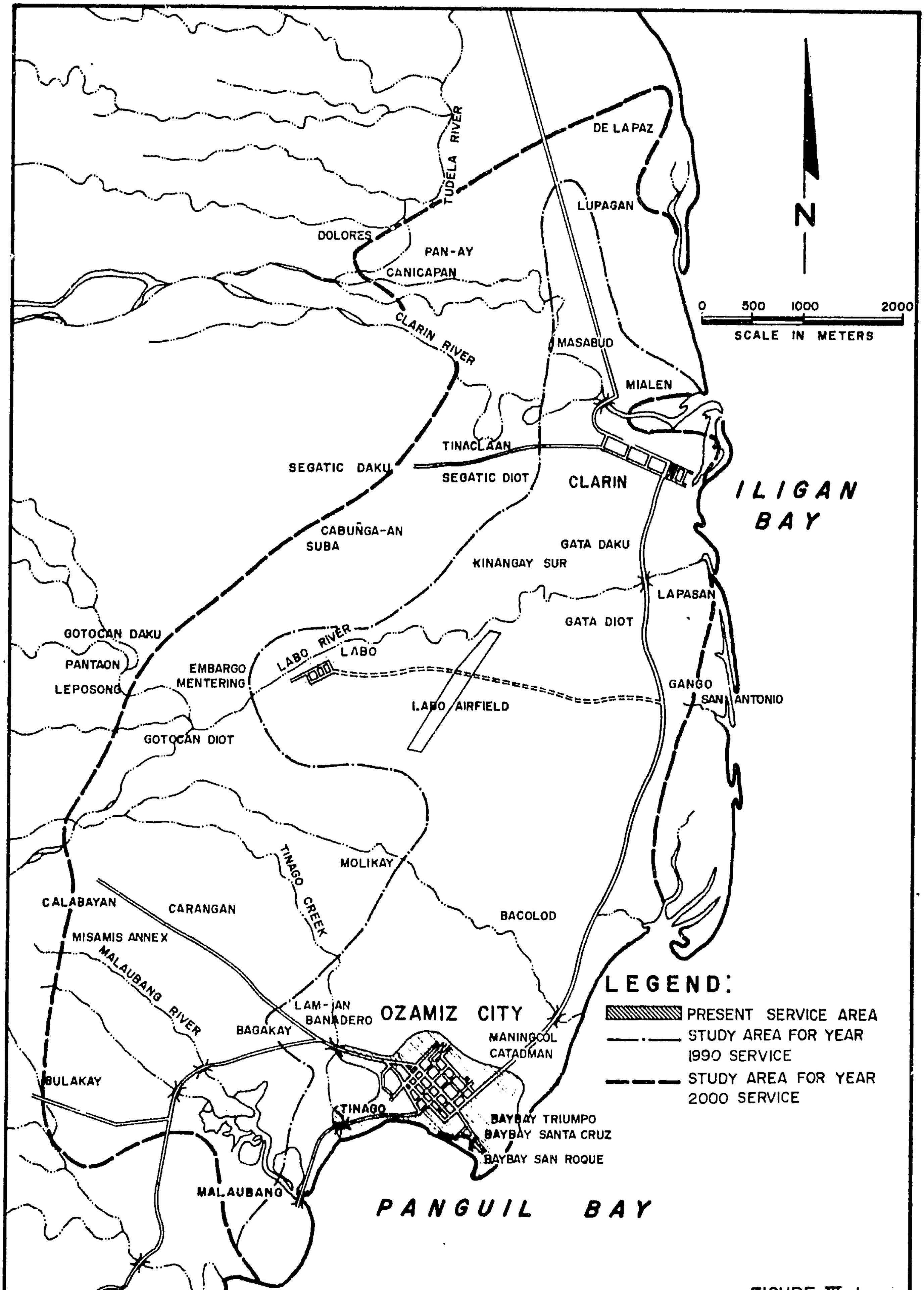
[5] A barrio is a political division of a city or municipality.



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS

CDM-LWUA

FIGURE III-1
STUDY AREA MAP

Climate

The Philippines has four climatic types (Figure III-2) based on rainfall. The climate that prevails in the province and the study area is the fourth type characterized by the absence of a pronounced rainy season and a dry season. The average monthly rainfall varies from 159 mm in April to a maximum of 686 mm in November. Based on a 20-year record from 1951 to 1970, the average annual rainfall was 4,372 mm. Normal mean temperature over the same period varied from 26.9°C in January to 28.5°C in April. Humidity, averaging about 83 per cent, was highest from June to January. The climatological data are listed in Table III-1.

TABLE III-1

CLIMATOLOGICAL DATA

	Normal Rainfall (mm) 1951-1970	Normal Mean Temperature (°C) 1951-1970	Normal Relative Humidity (%)	Normal Number of Rainy Days 1951-1970
January	421.2	26.9	84	10
February	201.8	27.1	83	8
March	243.6	27.1	81	7
April	158.9	28.5	79	12
May	250.8	28.4	82	14
June	388.8	28.0	84	14
July	316.6	27.6	84	13
August	334.3	27.7	84	12
September	336.1	27.7	84	12
October	417.8	27.7	84	12
November	685.8	27.6	85	12
December	616.1	27.2	85	10
Annual	4,372.0			136
Average		27.2	83	

B. POPULATION[6]

According to the 1970 Census on Population and Housing, Misamis Occidental had a population of 319,855 with an annual growth rate of 2.51 per cent and a density of 165 persons per square kilometer. The 1970 population represented a 29 per cent increase over the 1960 population. Ozamiz and Clarin had a combined population of 82,400 in 1970.

The study area population in 1970 was 60,710. The annual growth rate between 1960 and 1970 was 3.3 per cent; population density was 16.6 persons per hectare. Study area population estimates through the year 2000 are listed in Chapter VI.

Population Characteristics

In both Ozamiz and Clarin, the females outnumbered the males by 2 per cent in 1970. The population was relatively young, with 67 per cent below 25 years old.

The 1970 Census indicated that 79 per cent of those 6 years and above (numbering 66,022) were considered literate. Of the population 25 years and above, more than 50 per cent attended elementary school; 18 per cent, high school; and 18 per cent, college. (Educational facilities available in the study area are: 60 public schools which include 49 elementary, nine high schools, one vocational and one trade schools; and four private institutions.)

Twenty-six per cent of the population in 1970 comprised the labor force in Ozamiz and Clarin. About 35 per cent of this workforce were engaged in agriculture; 26 per cent in services; 10 per cent in manufacturing; and 10 per cent in commerce. The remaining 19 per cent were employed in construction, public utilities and minor industries.

C. LIVING CONDITIONS[7]

The standard of living in the study area may be measured by physical indicators like dwelling units, household facilities and utilities.

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[6] As of 1970, the Philippines (area: 300,000 sqkm) had a population of 36.7 million with a growth rate of 3 per cent per year, density of 122/sqkm and a median age of 17.4 years. As such, the country ranked seventh and sixteenth in population in Asia and in the world, respectively.

[7] Source: National Census and Statistics Office.

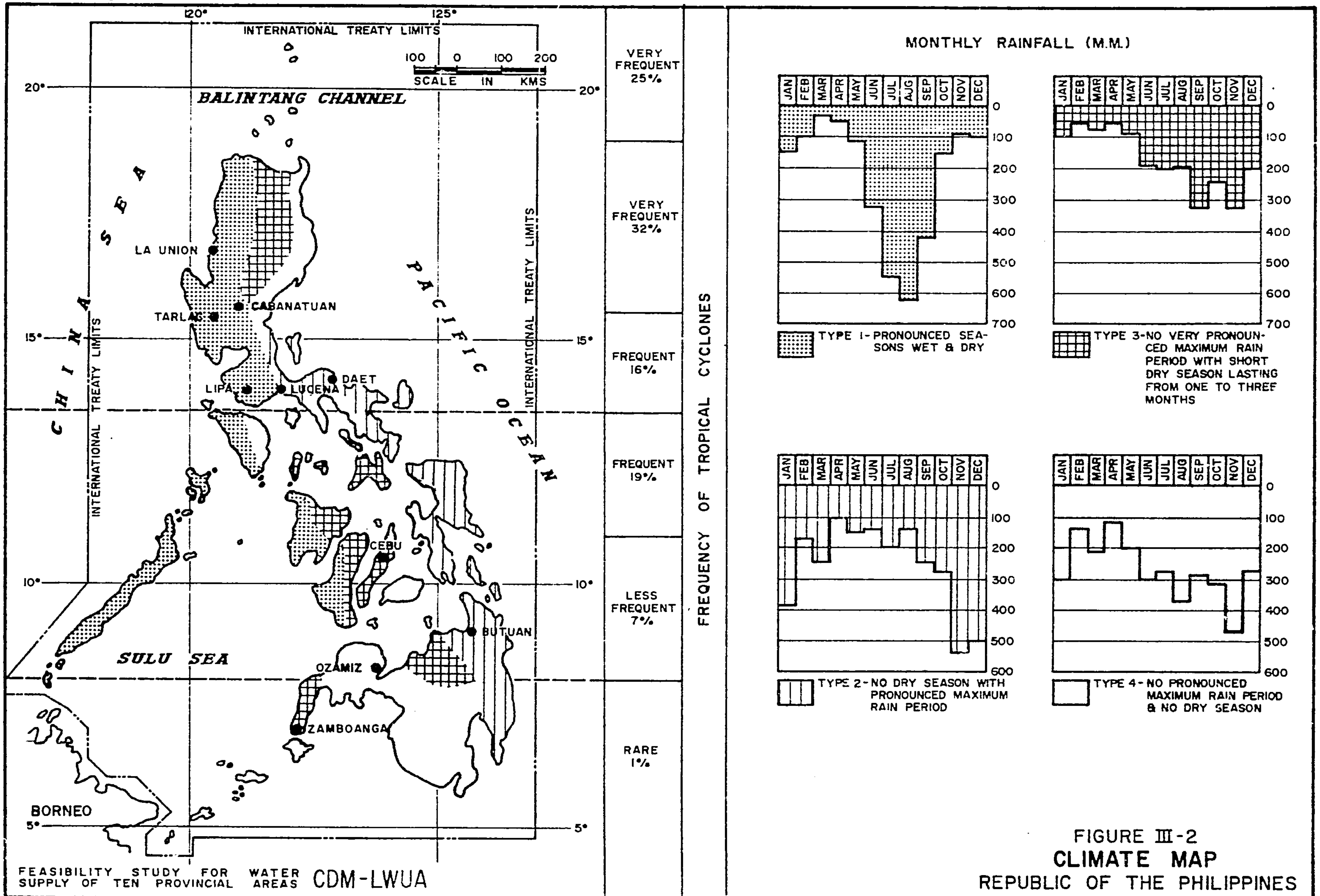

FIGURE III-2
CLIMATE MAP
REPUBLIC OF THE PHILIPPINES

In 1970, there were 13,240 dwelling units in Ozamiz and Clarin, 90 per cent of which were of the single-type. The remaining 10 per cent consisted of duplex, apartment/accesoria (low-class apartment), barong-barong (makeshift houses), commercial and industrial establishments.

Approximately 72 per cent of the total 13,027 households depended on groundwater for water supply. Twenty-seven per cent, all in Ozamiz, claimed to have been served piped water (Clarin has no piped water system). Only 1 per cent used surface water sources, including rainwater. (Technical details of the existing water supply follow in Chapter IV.)

Nineteen per cent of the 1970 households utilized the flush/water-sealed type toilet. About 29 per cent used the closed pit type and 17.7 per cent, open pit. Households without toilet facilities included 29 per cent.

Kerosene, the most common lighting source, was used by three-fourths of the total households in 1970; electricity was used by less than 25 per cent. Wood as cooking fuel was used by 80 per cent of the households. The rest depended on liquefied petroleum gas, charcoal and electricity for fuel.

Health. Water-borne diseases occur particularly in the more densely populated sections of the study area. The lack of safe water supply, sanitary and sewerage facilities contributed to the occurrence of diseases such as cholera, gastro-enteritis and dysentery. Table III-2 shows the number of cases and deaths due to water-borne diseases in Ozamiz.

The health needs of the study area are served by one emergency hospital in Ozamiz and several barrio health centers.

TABLE III-2

REPORTED CASES AND DEATHS
DUE TO WATER-BORNE DISEASES[8] (1973)
OZAMIZ CITY

	Cases		Deaths	
Diseases	Number	Rate[9]	Number	Rate[9]
Cholera El Tor	3	4.1	3	4.1
Typhoid and Paratyphoid	3	4.1	3	4.1
Gastro-enteritis	66.8	917	42	57.7
Dysentery	19	26.1	1	1.4

[8] Source: Disease Intelligence Center, Department of Health.

[9] Per 100,000 population.

D. ECONOMY

National Economy

Since the declaration of martial law in 1972, the Philippine economic structure has been undergoing various reforms. Concrete results were achieved in 1973 when all economic indicators of the country reached unprecedented levels.

In 1974, however, inflationary and recessionary developments and domestic food shortages disturbed the improving economy. As a result, the growth rate of the gross national product (GNP) declined from 9.9 per cent in 1973 to 5.9 per cent in 1974. However, the country managed to realize a modest balance of payments (BOP) amounting to $90 million despite the price decreases of some main export products, notably copper and wood products. In addition, the international reserves stood at a comfortable level of $1.16 billion at the end of the year.

Traditionally, the country has been heavily dependent on agriculture. Statistics for 1974 showed that agriculture, forestry and fishing accounted for 29.2 per cent of the GNP. The services sector contributed a share of 17.2 per cent for the same year. The construction industry posted the highest growth rate, 18.5 per cent.

Study Area Economy

Income Profile[10]. In 1971, the Province of Misamis Occidental was estimated to include 53,900 families, 14 per cent classified as urban and 86 per cent, rural. Their combined annual income amounted to ₱119.252 million, with an average of ₱2,212. This was lower than the country's average family income of ₱3,740. About 46 per cent of the total families comprised the low-income group (with annual earnings ranging from less than ₱500 to ₱3,000). The middle income (₱3,000–₱6,000) level included 26 per cent; the remaining 28 per cent received annual income of ₱6,000 and above.

Agriculture. Like the rest of the country, Ozamiz and Clarin are primarily dependent on agriculture. Eighty-three per cent of the cultivated area of Ozamiz is used for crop production. The major crops are rice, corn, coconut, bananas and other fruits.

The principal fishing ground for Ozamiz as well as the province is Iligan Bay. It provides different kinds of fish and minor sea

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[10]Source: National Census and Statistics Office.

products as shrimps, crabs and sea shells. Panguil Bay also provides a significant supply of fish resources to the study area. Tiger shrimps are found particularly in this bay.

Forests comprise 11 per cent of Ozamiz City. They abound in timber and minor forest products as firewood, rattan, almaciga resin and nipa shingles.

Ozamiz may be considered self-sufficient in poultry and livestock requirements. In addition to commercial piggeries and livestock farms, backyard raising is also a common activity.

Commerce and Industry. There are about 400 business establishments in Ozamiz City, mostly located in the poblacion. Industry is limited to cottage industries, among which are blacksmithing, ceramics, charcoal making and weaving.

Transportation and Communication. Travel by land, sea and air is available in the study area. The development of transportation system has been associated with Ozamiz being the trade center in northern Mindanao.

Communication facilities include one weekly newspaper, three radio stations, three telephone services and nine telecommunication services.

Tourism. Ozamiz is a potential tourist area. Among the historical places and resorts most visited in the city are: Fort Santiago, Bucagan Hill, Catadman Beach, Regina Resort and Nazareno Dam which was built in 1780 for irrigation.

CHAPTER IV EXISTING WATER SUPPLY FACILITIES

A. GENERAL

Based on studies of the cities of Cebu, Zamboanga, Ozamiz and Butuan and the municipality of Daet, the following problems have been found common to their water supply systems in varying degrees: water shortage; system age; water unaccountability; inadequate disinfection; and unreliable service.

The existing waterworks facilities generally require repair and renovation. Field tests show that most distribution systems have small pipes with inadequate carrying capacity, resulting in low pressures and marginal fire-fighting capabilities. Operational personnel are mostly untrained and inadequately compensated. Widespread wastage of water is evident through leakage from old, corroded GS services and careless use by the average householder.

The water shortage affects the system pressures, fire-fighting potential, and consumption patterns. Because water must be rationed, pressures fluctuate and often become negative. The negative pressures increase the possibility of contaminated water entering the distribution system. Many water district customers get water only during night-time hours. Such service strains any goodwill developed between consumers and the water district. Unserved households are, in the best of circumstances, sub-users obtaining their water from dwellings connected to the distribution system. These unserved households pay water vendors rates much greater than water district rates.

In a typical provincial urban area, the studies on water accountability indicate that (1) leakage and waste are roughly one-half of the water production; (2) accounted-for-water or billed water is about one-third of water production, and (3) the remaining one-sixth consists of unauthorized (illegal) use, meter under-registration and underestimated flat rate. Unaccounted-for-water is due mostly to leakage and unmetered connections. House connections without meters or with non-functioning meters are billed with flat-rate accounts - a situation which encourages the wasting of water. There has been no prior leakage survey conducted in any of the water districts, except during this study. Water accountability for the first five study areas is presented in Figure IV-1.

Often, delivered water is unsafe bacteriologically because of inadequate chlorination facilities. The water supply system generally includes opportunities for cross-connections with polluted water from drains/sewers.

Because of good management the MOWD revenues are sufficient to cover operating expenses. The MOWD water rates discourage extravagant use. Management emphasis on enforcing penalties has reduced non-payment of bills and illegal connections.

B. WATERWORKS FACILITIES

History of the Water System

The Ozamiz City waterworks system, initially owned and operated by the provincial government of Misamis Occidental, was constructed in 1941. At that time, the system included a groundwater spring source, a storage tank, a hypochlorinator, transmission and distribution piping. In later years, minor improvements were made to the main supply intake and transmission piping. Small additions were also made to the distribution piping grid. In 1973, ownership and management of the system were transferred to the Misamis Occidental Water District (MOWD).

A schematic diagram of the existing Ozamiz water system is shown in Figure IV-2.

Water Supply (Source) Facilities

At present, the MOWD has two water supply sources, namely: the Talibaksan Spring and the Cocok Spring. (Source facilities are shown in Figure IV-3.) The Talibaksan facilities consist of a spring outlet box with a 150 mm CCI and a 150 mm AC pipes and a single open top storage tank. Spring flow at this source is measured at 3,100 cumd.

The Catadman well, which was drilled in 1967, was taken out of service in 1971 and its pump was transferred to Cocok Spring. Its open casing was still flowing as of February 1975. The Cocok facility consists of a vertical turbine pump mounted on a casing on top of the spring source. Pump output and spring flow measurements were found to be 300 cumd at 11 m discharge pressure and 3,100 cumd, respectively. In 1971 Cocok Spring was connected to the distribution system through a transmission line from the spring pump station. Talibaksan Spring and Cocok pump station produce 3,400 cumd which serves an estimated 17,500 population.

Water Transmission Lines

The water transmission lines of the Ozamiz waterworks consist of two main trunk pipelines: one from Talibaksan Spring and the other from Cocok Spring. Water from Talibaksan Spring flows by

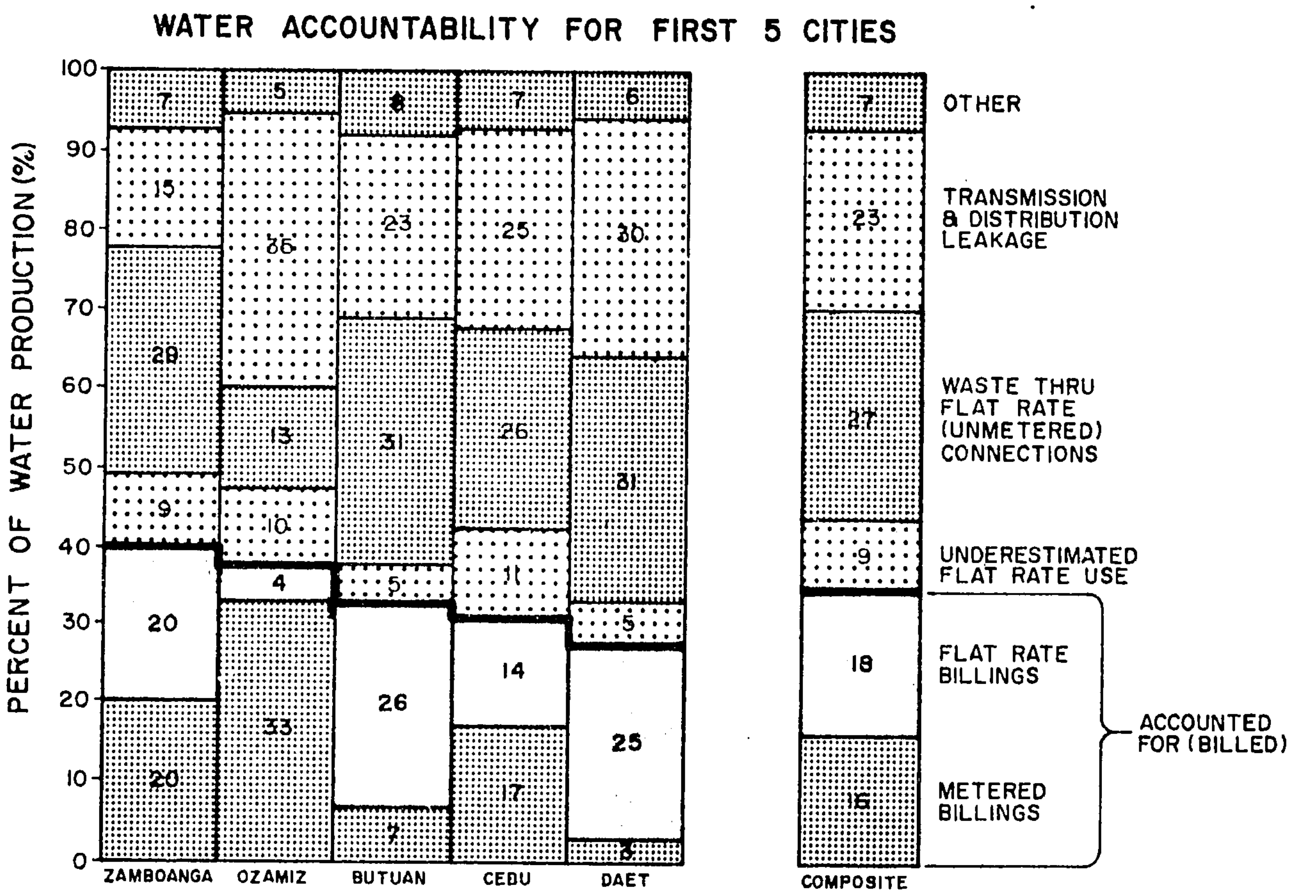


FIGURE IV-1
WATER ACCOUNTABILITY

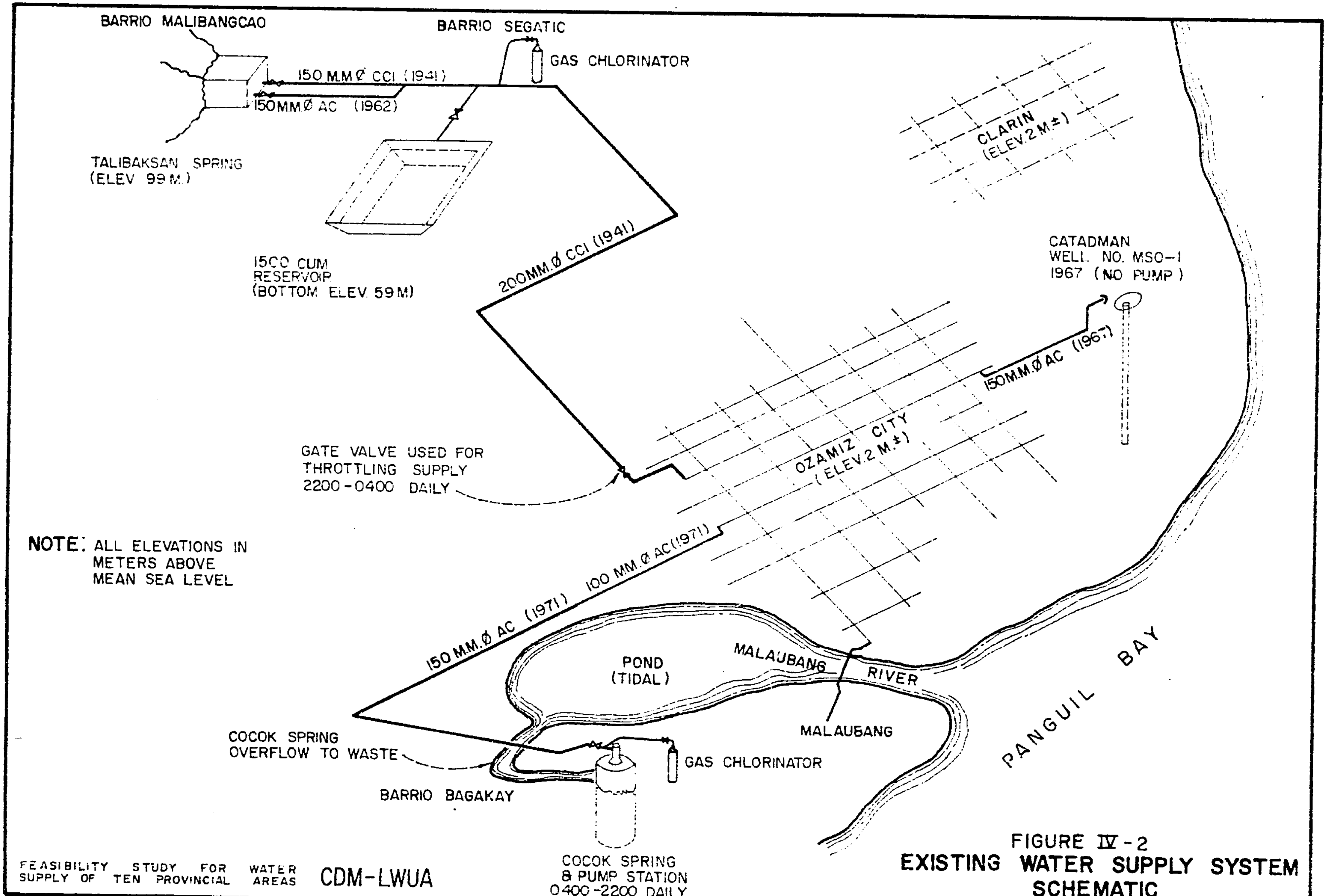
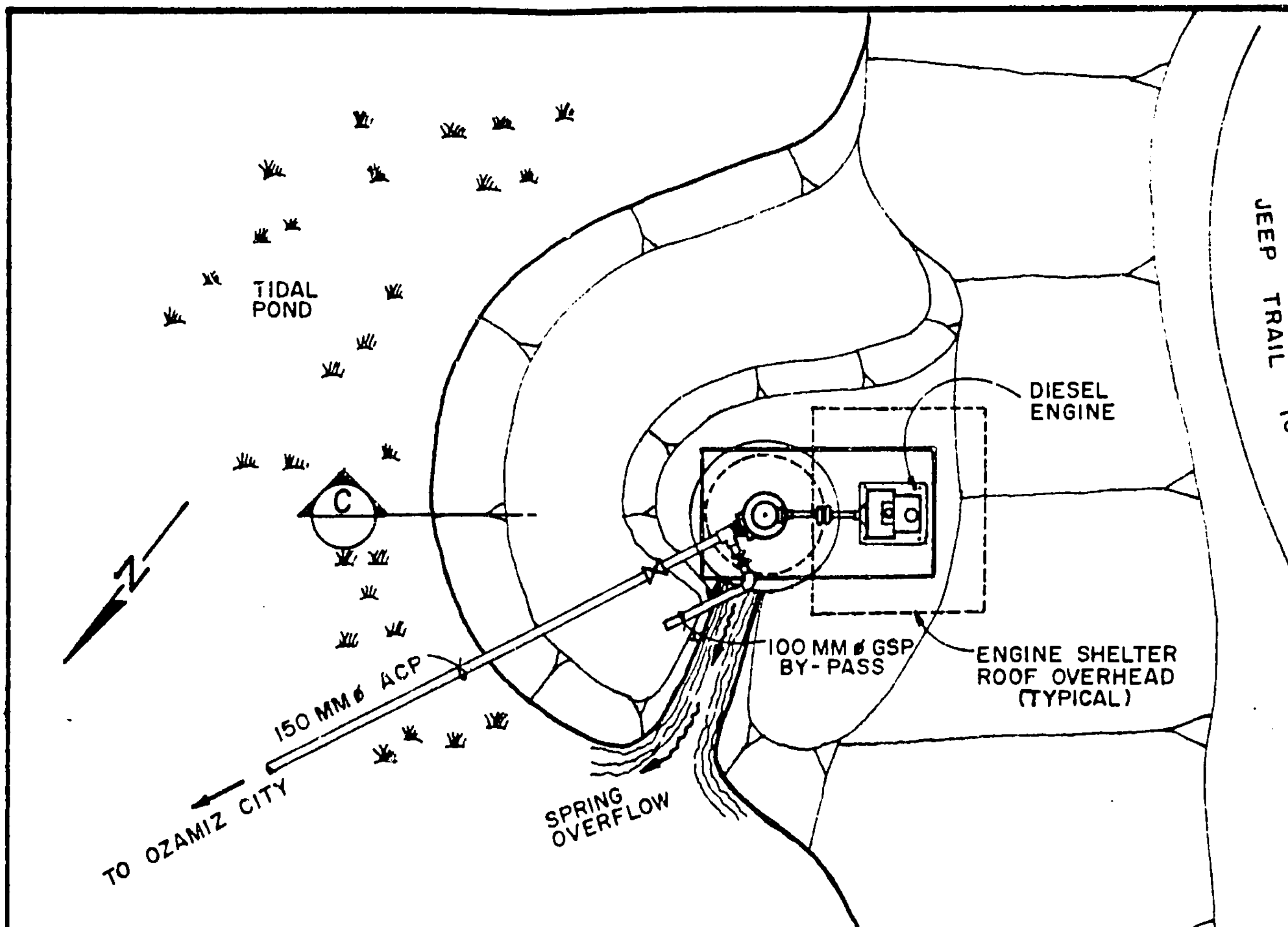
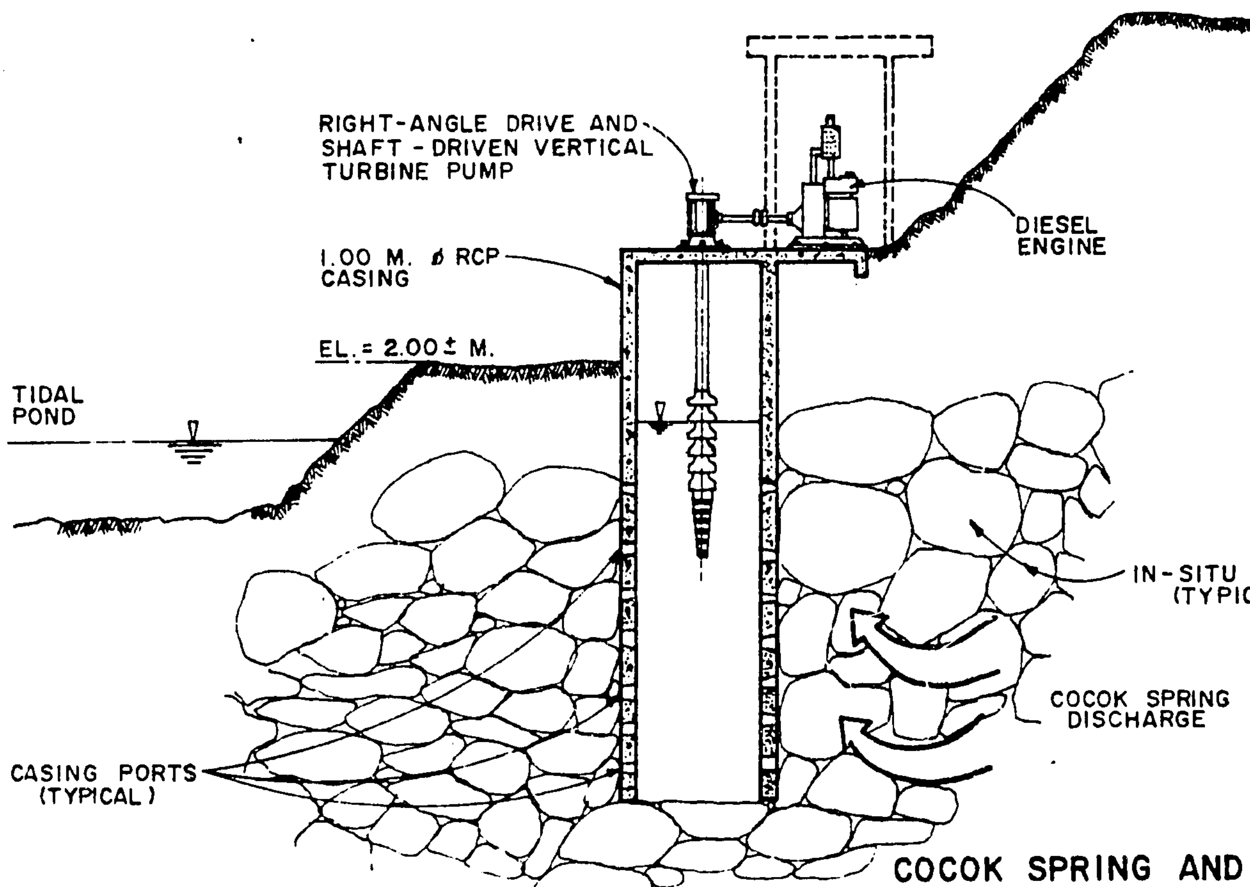


FIGURE IV-2
EXISTING WATER SUPPLY SYSTEM SCHEMATIC



SECTIONAL PLAN

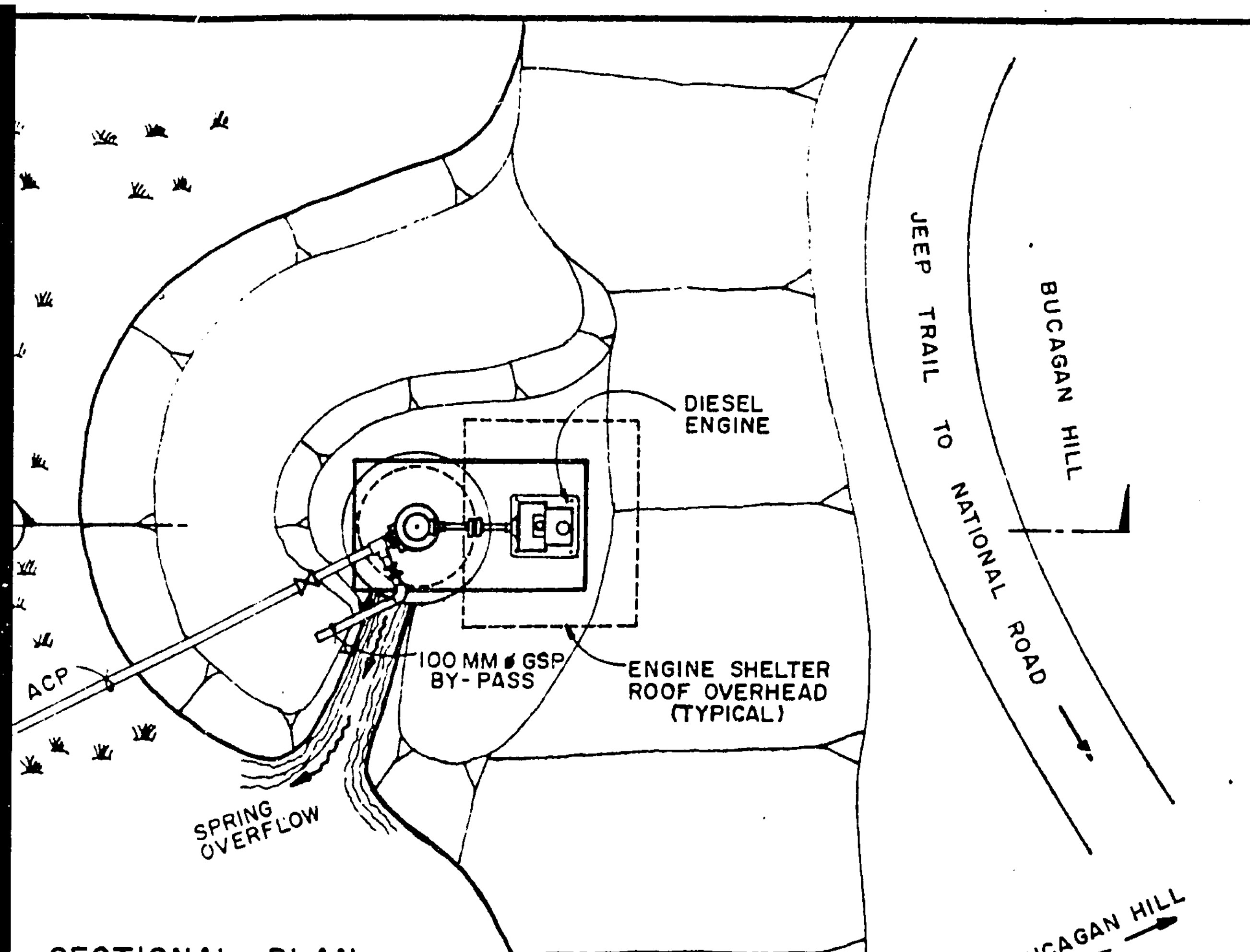


SECTION THRU -"C"

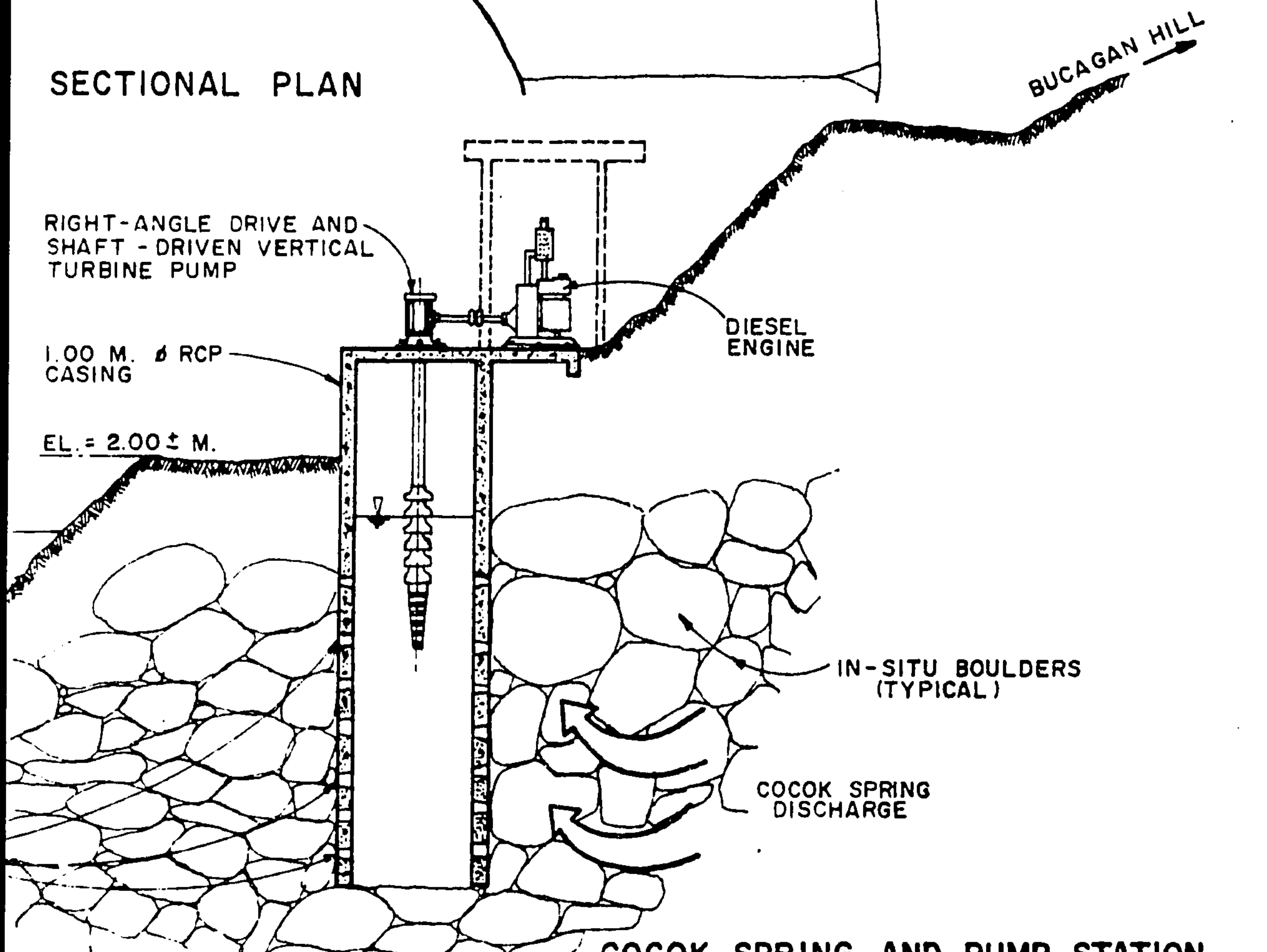
COCOK SPRING AND

BARRIO BAGAKAY,

FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS CDM - LWUA



SECTIONAL PLAN



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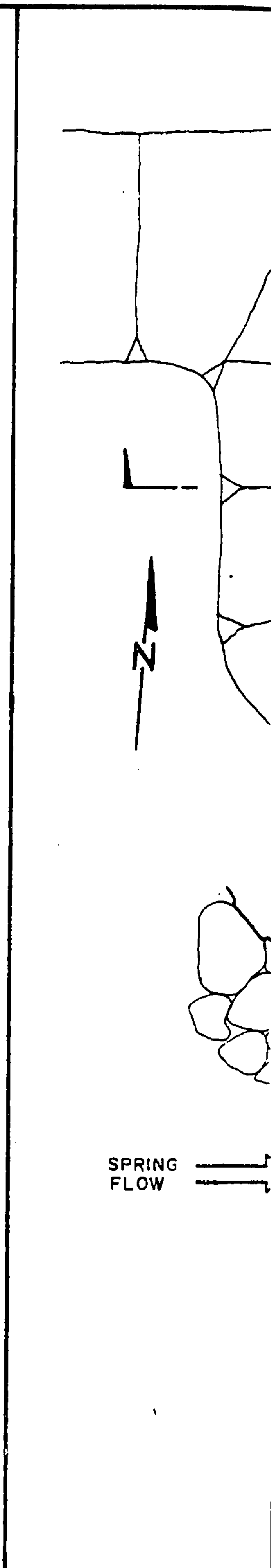
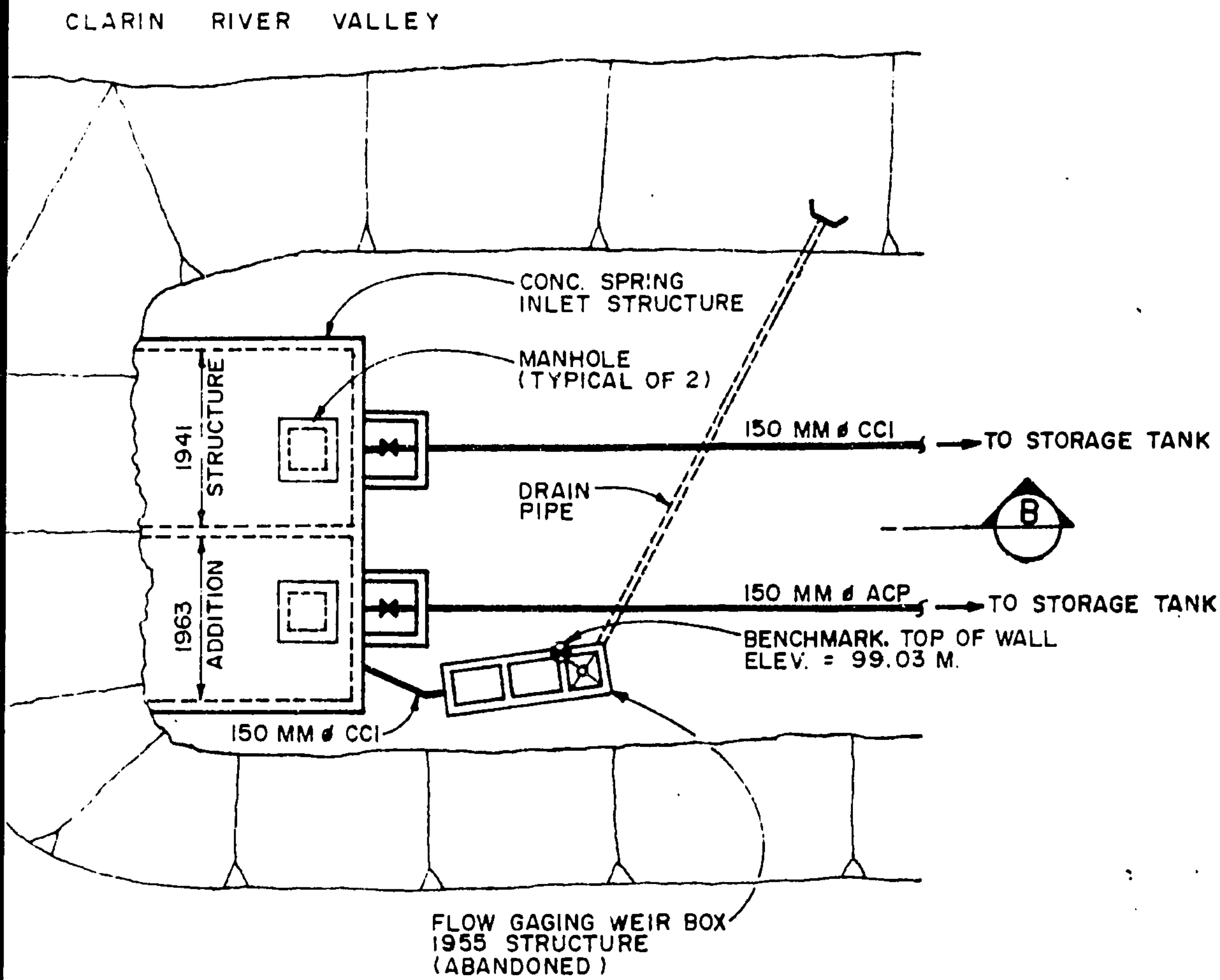


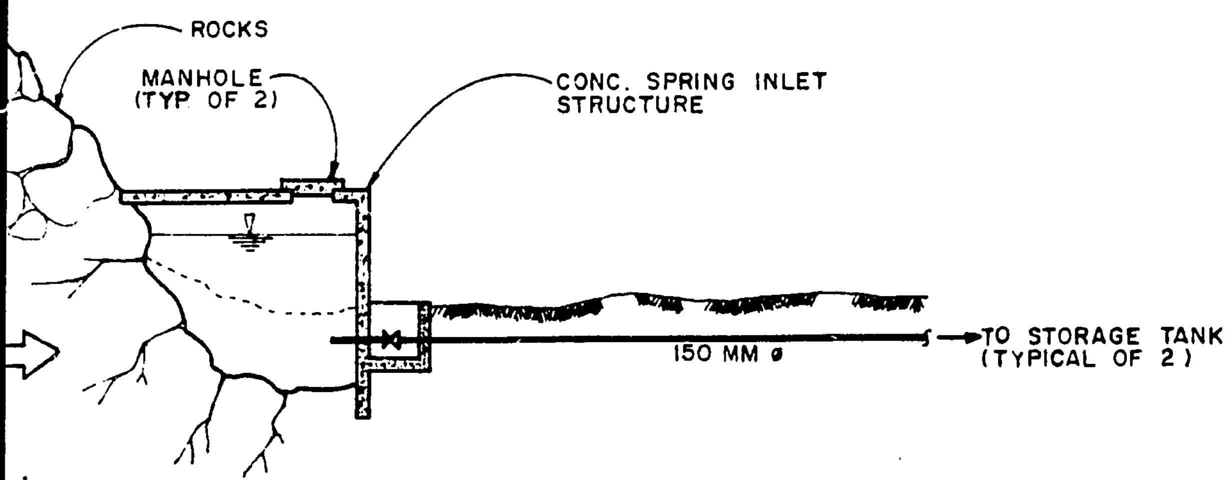
COCOK SPRING AND PUMP STATION
BARRIO BAGAKAY, OZAMIZ CITY

ATER AREAS CDM - LWUA

b

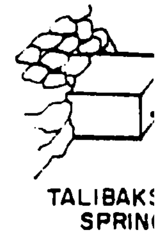


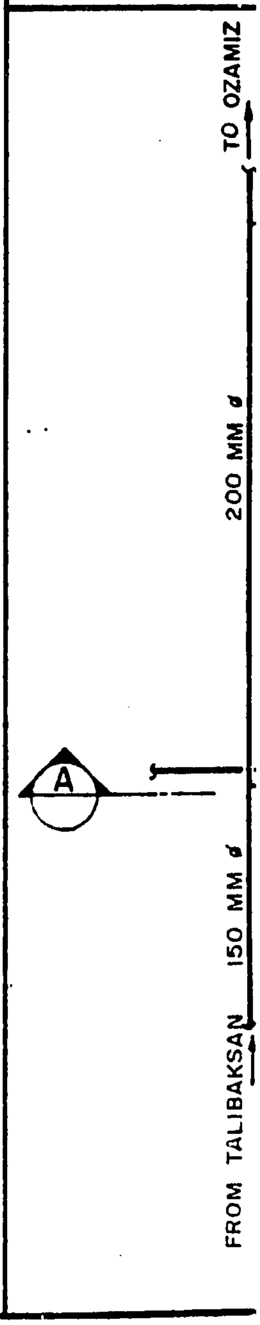
PLAN



SECTION THRU -"B"

TALIBAKSAN SPRING INLET STRUCTURE
BARRIO MALIBANGCAO, CLARIN





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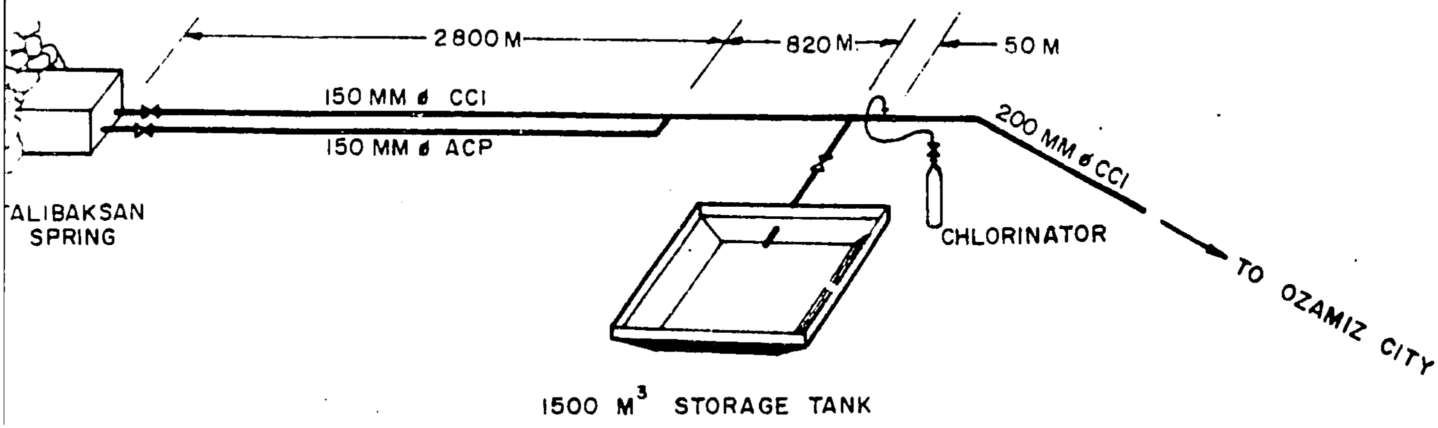
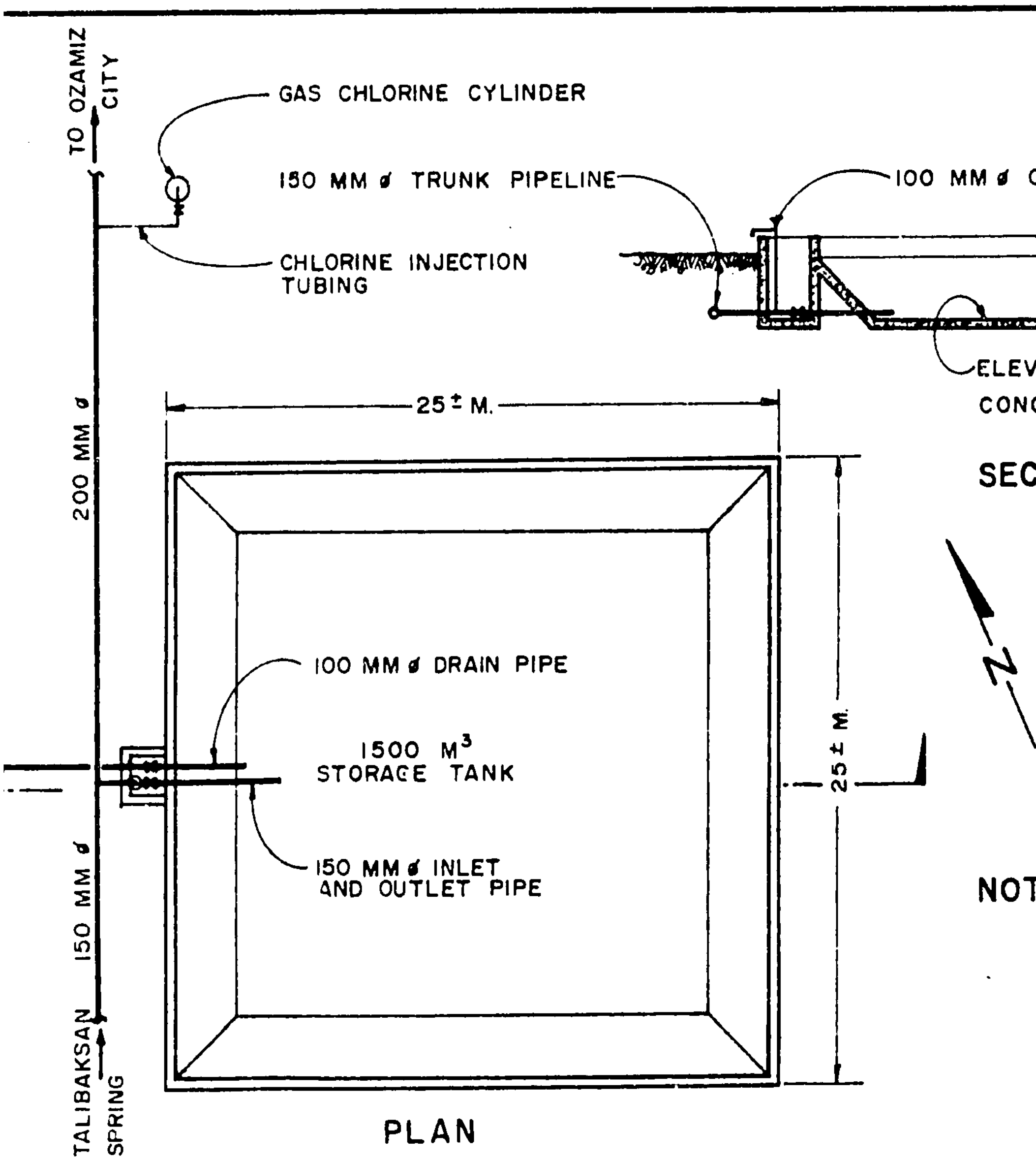
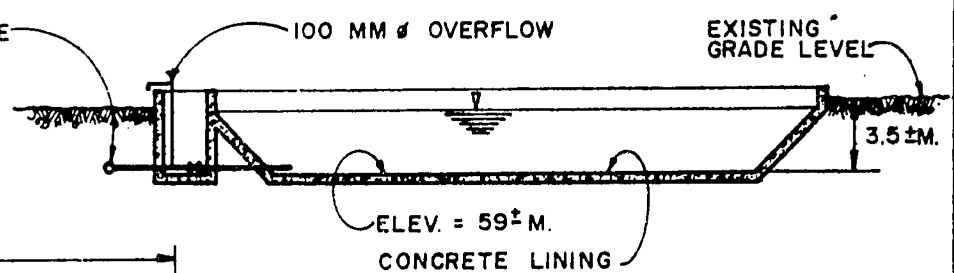


SCHEMATIC PIPING DIAGRAM
TALIBAKSAN SPRING TO STORAGE TANK



PLAN



SECTION THRU - "A"

NOTE: DIMENSIONS ARE APPROXIMATE ONLY. CONTOUR LINES ARE TYPICAL.

1500 CUBIC METER STORAGE TANK
BARRIO SEGATIC, CLARIN

FIGURE IV-3
EXISTING WATER SOURCES AND STORAGE FACILITIES
SCHEMATIC PLANS & SECTIONS
OZAMIZ CITY

d

gravity through two parallel lines, each 150 mm in diameter and 2.8 km long. At this point, they converge into a single 150 mm diameter CCI line that leads to the storage tank. Water from the tank flows by gravity through a 200 mm diameter CCI line that extends 6.7 km to the point where it enters the poblacion distribution grid. Water delivered to the city was measured at 3,000 cumd. This main trunk was observed to be in good condition, with no significant leakage. The second transmission system conveys water from Cocok Spring through a 150 mm diameter AC pipe. This line connects the pump at the spring with the nearest extremity of the poblacion distribution network, a distance of 2.5 km to the northeast.

Water Treatment Facilities

Water is chlorinated at the two sources. Chlorine gas is injected directly, without regulation, into the main transmission line of Talibaksan and into the Cocok discharge line.

Distribution System

The city's distribution system was first constructed in 1941 when the transmission line from Talibaksan Spring was connected to a network of 100 mm and 150 mm CCI pipes in the poblacion area. The system has been expanded during several construction periods in the 1950's, 1960's and 1970's.

The schematic plan of the distribution system is shown in Figure IV-4. In the schematic plan, nodes represent the junction points of pipelines which, in turn, connect the nodes. Both nodes and pipelines are assigned unique numbers. The diameter of the pipeline is also indicated. Schematic plans facilitate computer studies of water distribution system.[1] A subsequent section presents the results of computer studies of the existing system.

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[1] Refer to Methodology Manual on Water Supply Feasibility Studies.

<u>Pipe Size and Length</u>. The total system piping excluding transmission lines is 12.8 km. The length of pipe by size, type and age is listed in Table IV-1. From the table it may be seen that the original distribution system was adequately designed since it consisted almost entirely of 100 mm and 150 mm diameter pipes. Subsequent improvements to the system largely consisted of 75 mm and smaller-size pipes. Today, 27 % of the piping is 75 mm or smaller in diameter.

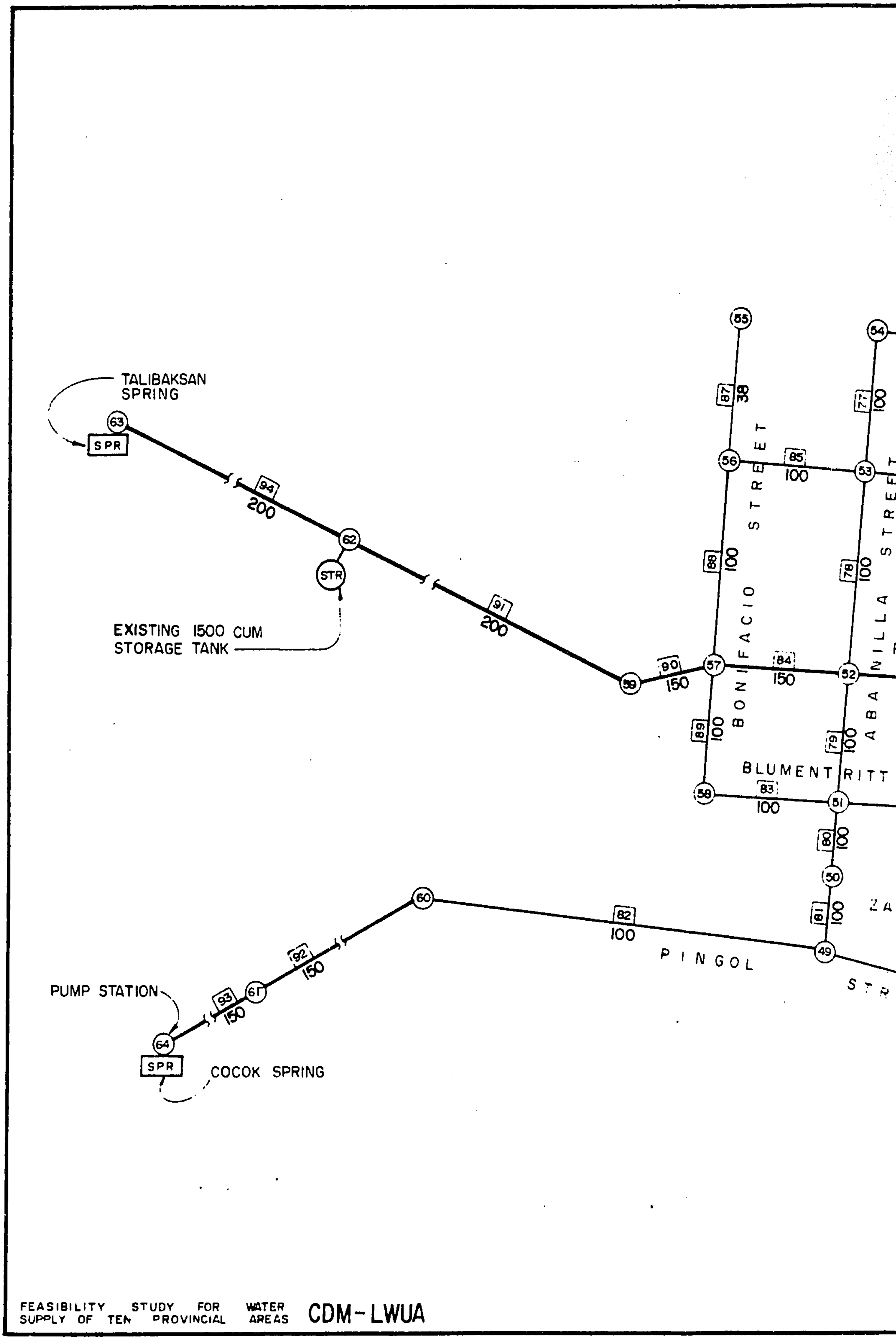
TABLE IV-1

SIZE AND LENGTH OF EXISTING PIPES

Pipe Diameter (mm)	Pipe Material	Length of Pipe (m) and Period Installed 1940	1954-57	1962-67	1971-74	Total Length (m)	Total by Diameter (m)
37	GS	150	1,440	870	50	2,510	2,510
50	GS		460	90	180	730	730
75	GS		60	110		170	170
100	CI	6,170	100			6,270	
100	AC				700	700	6,970
150	CI	1,340				1,340	
150	AC			470		470	
150	S		610			610	2,420
Total		7,660	2,670	1,540	930	12,800	12,800

<u>Present Carrying Capacity</u>. Hydraulic tests made on the transmission lines indicate that the cast iron pipe laid in 1941 still retains 100 per cent of the original carrying capacity. From limited observations of the distribution piping, it is believed that the same condition prevails in the internal network and that all 100 mm and 150 mm pipes (73 per cent of the piping) are in good condition.

<u>System Pressures</u>. The pressures in the distribution system are low, ranging from 0 to 6 m. Several 24-hour pressure recordings and spot pressure gagings were made within the distribution system. These measurements are summarized in Table IV-2. Each pressure reading record is referred to a node number in Figure IV-4. Daytime pressures are lowest along Don Mariano Marcos Avenue near the City Hall and highest in the vicinity of Rizal Avenue near Bonifacio Street.



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS CDM-LWUA

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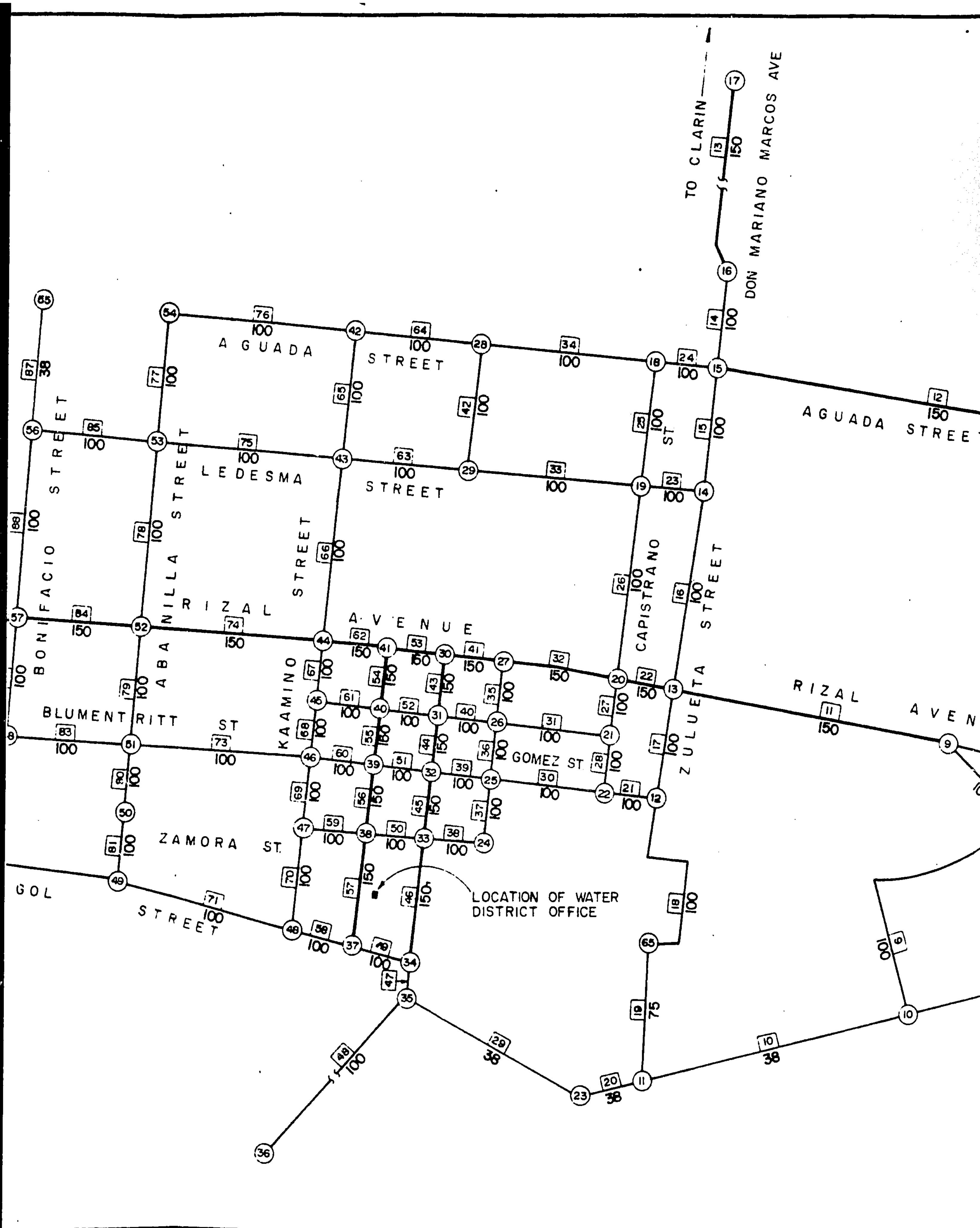
TO CLARIN
DON MARIANO MARCOS AVE
AGUADA STREET
LEDESMA STREET
RIZAL AVENUE
BONIFACIO STREET
ABANILLA STREET
KAAMINO STREET
CAPISTRANO ST
ZULUETA STREET
BLUMENTRITT ST
GOMEZ ST
ZAMORA ST.
GOL STREET
LOCATION OF WATER DISTRICT OFFICE

b

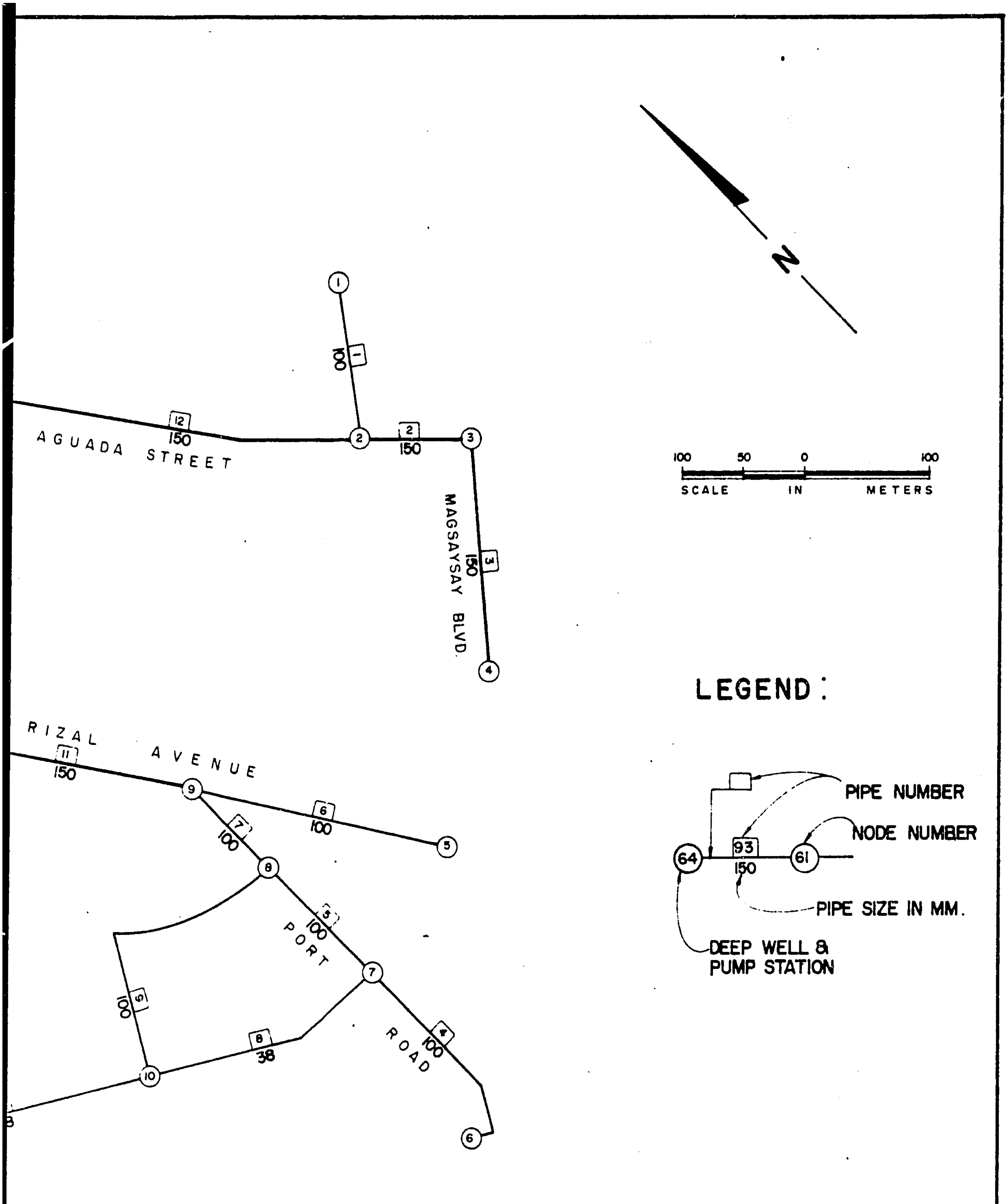

FIGURE IV-4
EXISTING WATER DISTRIBUTION SYSTEM
SCHEMATIC PLAN

TABLE IV-2

SUMMARY OF PRESSURE MEASUREMENTS
(July 1975)

Location Node Number	Type of Measurement	Date of Measurement	Pressure Range (m) During Time Interval 0000-0400	0400-1200	1200-1800	1800-2400
59	24-hr recording	24 July - 25 July	3	2-6	3-5	3-6
38	24-hr recording	7 Feb - 8 Feb	2	1.5-5	1.5-3	2-5
3	24-hr recording	27 July - 23 July	5	1-5	1-3	3-5
55	Spot reading	22 July			1	
44	Spot reading	23 July		1		
17	Spot reading	23 July		0		

<u>Valves and Hydrants</u>. There are 31 valves and 26 hydrants in the distribution system. These are listed below according to size of the main.

Main Size (mm)	Number of Valves	Number of Hydrants
100	25	20
150	5	6
200	1	

The fire hydrants are connected to the distribution piping by a 75 mm GS riser with a tee. At one end of the tee is a gate valve with a 62 mm threaded outlet; at the other end is a plug. The hydrants in the poblacion are installed at 150 m intervals; however, due to the low pressures in the system, the hydrants are only marginally useful for fire-fighting purposes.

<u>Storage</u>. Ozamiz City has no distribution storage. However, an existing 1,500 cum open-top facility on the transmission line from Talibaksan Spring is used to store water during night hours. Water

from the storage tank increases the daytime supply to the city. (Unlike in some urban areas of the Philippines, residents in the service area do not construct home storage facilities.)

Service Connections. At present, the Water District has a total of 1,624[2/] service connections in Ozamiz City, 1,452 of which are metered. Of the metered connections, 256 have non-functioning meters. The service connections and metered connections are listed by consumer category in Table IV-3. Typical service connections are of Schedule 20 GS piping. The experience with this type of connection indicates that Schedule 20 GS is too light and that the GS piping has a limited useful life of 15-20 years.

The Water District is using 10 different manufactured brands of water meters. This causes difficulty in obtaining spare parts and maintaining serviceable meters. Approximately 60 per cent of the meters installed are manufactured locally.

TABLE VI-3

SERVICE CONNECTIONS BY CONSUMER CATEGORY

Consumer Category	Number of Metered Connections[3]	Number of Unmetered Connections	Total Number of Connections
Domestic	848	165	1,013
Commercial	577	6	583
Institutional	9		9
Industrial	17	1	18
Bulk	1		1
Hydrants	—	26	26
Total	1,452	198	1,650

[2/] Excludes 26 fire hydrants.

[3] According to the MOWD, 256 metered connections have non-functioning meters. For purposes of billing, these are considered flat rate connections.

Operation and Maintenance

The MOWD operates and maintains the Ozamiz City water sources, supply lines and distribution system. Present staffing for maintenance includes a main foreman, a service foreman, one pipefitter, three laborers and two plumbers.

At 10:00 p.m. each day the Water District reduces the water supply to the city by shutting off the Cocok Spring pump station and partially closing a valve on the lower end of the Talibaksan transmission line. The Cocok pump station is shut off to conserve fuel during the period of low demand. The gate valve on the 200 mm line is partially closed to allow the reservoir along the Talibaksan line to fill overnight. At 4:00 a.m. the Cocok pump station is restarted and the valve on the Talibaksan line is fully opened.

The maintenance program consists of repairing main breaks, repairing service connections, and repairing and replacing non-functioning meters. Main and service connection breaks are repaired when surface ponding indicates leakage or when detected by geophone survey. Unfortunately, the City of Ozamiz is constructed on granular fill overlaying a former swamp; therefore, leakages often do not surface, making visual detection difficult. The MOWD has recently instituted a geophone program for detection of main and service line breaks.

In the case of service line repairs, the most deteriorated section of the line is often the only portion replaced. Because the entire service line is not replaced when it begins to deteriorate, several stop-gap repairs with Schedule 20 GS are made instead of 100 per cent replacement. Because of the poor serviceability of Schedule 20 GS pipe and the inadequate service line repairs, it is believed that significant leakage occurs in the service lines. This problem is discussed in a subsequent section on leakage.

Every month, the Water District repairs about 100 water meters. Spare parts in stock are only of local brand. Meters of other brands are dismantled and usable parts are interchanged or repaired until no further maintenance can be achieved. At this point, the meter or brand is phased out. The repaired meters were approximately categorized by the District according to defect as follows:

Willful Damage	20%
Stopped by rust & sand (Displacement type meter)	30%
Defective	50%

Based on reports from the District, the local meters have so far proven unsatisfactory accordingly due to the poor quality, short useful life and the high cost of spare parts. As a consequence, the Water District has ordered 900 displacement meters with magnetic drive to increase the metered connections and reduce the maintenance problems.

C. WATER QUALITY

Samples for analysis were taken from three sources: Talibaksan Spring, Cocok Spring and Catadman Well which used to be operational. Results of the analysis are shown in Table IV-4.

The analysis indicated that iron in water from two sources was marginally high. Water from Talibaksan Spring was slightly alkaline, with moderate hardness and dissolved solids. It was also mildly corrosive. Water from Cocok Spring was very similar to that of Talibaksan. However, its iron content of 0.55 mg/l was slightly higher than the desired level of 0.30 mg/l, as recommended in the Philippine National Standards for Drinking Water. Water from Catadman well was harder than the water of the two springs.

TABLE IV-4

WATER QUALITY TESTS RESULTS-EXISTING SOURCES

Test/Units		Allowable Limits[4]	Catadman Well[5] 24-Jan-75	Coook Spring 23-Jan-75	Talibaksan Spring 23-Jan-75
Physical					
Color	(unit)	15			
Taste	"	3			
Odor	"				
Turbidity	"	5	0	0	0
Solids					
a. TDS	(mg/l)	500	296	214	214
b. Suspended	(mg/l)		8	9	14
Conductivity (micromhos/cm)					
Chemical					
pH		7-8.5	7.6	7.2	7.2
Alkalinity	(mg/l as $CaCO_3$)				
a. Total	"		198	118	108
b. Phenolpthalein	"		0	0	0
Total Hardness	"		138	92	98
Calcium	(mg/l)	75	19.5	16.5	15.5
Magnesium	"	50	18.4	9.9	9.7
Iron	"	0.3	0.85[6]	0.55[6]	0.30
Fluoride	"	1.5	0.30	0.30	0.32
Chloride	"	200	12	12	10
Sulfate	(mg/l)	200	4.1	1.4	2.0
Nitrate	"				
Manganese	"	0.1	.005	.002	.001
Copper	"	1.0	.002	.002	nil
Zinc	"	5	.010	.010	.002

[4] Philippine National Standard.
[5] Not operated.
[6] Exceeds allowable limits.

D. WATER USE PROFILE

General

The current water demands of Ozamiz City have been analyzed to project the future water requirements. Data on metered connections and revenue-producing water were obtained from the water district. Other data were taken from field measurements on water production and leakage and interviews with concessionaires. These data have been used to establish the present water use profile.

Population Served

According to the 1970 Census on Population and Housing, 14,100 people received piped water in Ozamiz City while in the same year, the number of service connections was 1,560. These figures indicate that for every connection, an average of nine persons were served, representing slightly more than one household. (A household in 1970 had an average of 6.5 members.) Because of a growing population, a small increase in the number of service connections and a relatively stable supply of water since 1971, the Water District today serves more people per connection than in 1970. Interviews with concessionaires, however, showed that an average of 10.8 persons were served per connection. As of May 1975, the water district had 1,624 connections to concessionaires in the service area. Thus, approximately 17,500 (1,624 x 10.8) people in Ozamiz City are currently served by the MOWD.

Domestic Consumption

A study of six metered connections in Ozamiz showed a wide range of domestic per capita consumption. The data collected in the study are summarized below:

	Number of Consumers	Three-Month Average Consumption	Average Per Capita Consumption
Without Auxiliary Supply	29	75 cum	83 lpcd
With Auxiliary Supply	22	32 cum	47 lpcd
Total	51	107 cum	68 lpcd

From the data above, those concessionaires having an auxiliary source of water consume less water from the Water District than those without an auxiliary source. Many concessionaires resort to auxiliary water supply because of the water shortage. It is probable that an increase in system pressures and supply may result in an increase in domestic per capita consumption. Data from another water district which has system pressures ranging from 5-15 m indicate domestic consumption of 115 lpcd. (The difference of 115 lpcd and 68 lpcd may be inferred as "unsatisfied demand".)

Commercial, Institutional and Industrial Consumption

Commercial consumption is the water use associated with business operation, hotels, restaurants, markets, and family commercial establishments. It is difficult to estimate commercial consumption because a significant portion of it is actually domestic consumption. In most commercial establishments, the owner or operator lives in the premises with his family, and in some cases, with the employees.

To separate the commercial use from the domestic use when both are supplied from the same service connection is difficult, if not practically impossible. A comparison of consumption from domestic connections with that from commercial connections shows the same range of per capita consumption - domestic, 38-180 lpcd and commercial, 70-165 lpcd. Because of the difficulty of separating the commercial demand, it can be assumed as a percentage of the domestic demand. In the case of Ozamiz, this percentage is assumed to be 5-8 per cent of the domestic demand or 4-6 lpcd.

Water consumed by hospitals, schools, universities and governmental buildings is considered institutional consumption. The MOWD has nine institutional concessionaires that consume about 11 cumd. This consumption corresponds to 1 lpcd.

Industrial water consumption is associated with the manufacture of goods. Like commercial consumption, the actual industrial consumption is difficult to determine because it also includes domestic consumption. There are 18 industrial concessionaires in Ozamiz that consume about 12 cumd. Even assuming that 100 per cent of the consumption is industrial demand, the per capita consumption would be 1 lpcd. A low industrial demand is expected because of the absence of any water-intensive industry in Ozamiz. In part, this can be attributed to the water supply shortage which discourages industrial growth.

In summary, commercial, institutional, and industrial demands are altogether difficult to estimate because of coincident domestic consumption. Based on the assumption of commercial demand being 5-8% of the domestic demand, the combined commercial, institutional and industrial water consumption is estimated as follows:

Commercial	4 - 6 lpod
Institutional	1 lpod
Industrial	1 lpcd
Total	6 - 8 lpod

Accounted-for-Water

Accounted-for-water is the sum of metered water consumption plus the inferred water consumption at flat rate connections. The accounted-for-water is revenue-producing water for the water district. For Ozamiz City, metered water consumption in May 1975 was 37,447 cum and the inferred flat rate consumption was 1,680 cum. Therefore, the total accounted-for-water was 39,127 cum, which corresponded to 37 per cent of the total production (39,127 cum = 1,262 cumd; 1,262 ÷ 3,400 = .37).

Unaccounted-for-Water

Unaccounted-for-water or unbilled water does not generate revenue for the water district. The unaccounted-for-water can be divided into several categories: underestimated flat rate use, wastage at flat rate connections, leakage, and other uses.

Underestimated Flat Rate Use. Experience with flat rate charges indicates that these are less than charges for metered consumption, assuming the same amount of water is used. In Ozamiz, the average flat rate is based on a consumption of 8 cum per month. However, the average metered consumption is 30 cum per month. Thus, it is likely that the average underestimated flat rate use would be 22 cum per month per flat rate connection. This amounts to approximately 9 per cent of the total production and indicates potential revenue if flat rates are to be increased.

Wastage at Flat Rate Connections. Because flat rate connections are unmetered, the concessionaire has a tendency to waste water by leaving faucets running and by not repairing leaks. This wastage is estimated to be 100 per cent of the actual consumption, or 30 cum per month per flat rate connection. The flat rate wastage is 410 cumd or 13 per cent of the total production. Of the 454 connections billed with flat rates, 256 have non-functioning meters and 198 have no meters. Replacing the non-functioning meters with good meters and converting the 198 non-metered connections to metered connections will reduce the 410 cumd wastage. This may help raise system pressure or make more water available for existing or new concessionaires.

Leakage. Water is also lost due to leaks in the transmission mains, distribution mains, and service connections. In geophone surveys conducted by the MOWD in Ozamiz City, no major leaks were found in the distribution mains. Tests of transmission lines showed 350 cumd loss due to leakage. A 24-hour measurement of the water delivered to the distribution system showed the minimum night-time demand was 86 per cent of the average demand, indicating significant leakage in the distribution system. The greater portion of the leakage is probably in the service connections. The service lines are of Schedule 20 GS, which is too light (thin) for water service connections and is observed to deteriorate significantly in 15-20 years. Leakage estimates are summarized below:

System Component	Estimated Leakage (cumd)	Acceptable Leakage[7] (cumd)
Transmission Mains:		
Talibaksan	250	150
Cocok	100	20
Distribution System (including service connections)	850	150
Total	1,200	320

A program to eliminate leakage in the distribution system could significantly increase the water available for consumption. The program should be directed toward replacement of existing GS service connections with more serviceable plastic pipes.

Other Uses. Water for public use (fire-fighting, main flushing, and street cleaning), by meter under-registration, and by unauthorized use represents other uses. Other uses are estimated to represent 6 per cent of the total production.

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[7] Estimated at 11 cumd per kilometer of pipe.

Summary

A summary of water consumption and production is presented in Table IV-5. The accounted-for-water based on the May 1975 billing is 37 per cent of production which corresponds to 72 lpcd. The accounted-for-water is the sum of metered water use plus estimated use at non-metered (flat rate) connections. The unaccounted-for-water is 63% of production. Some of the unaccounted-for-water can be considered as consumed water, namely, underestimated flat rate use and other uses which include meter under-registration, public use and theft. This part of the unaccounted-for-water is defined as unrecorded consumption. Thus the total consumed water in Ozamiz is broken down as follows:

Accounted-for-water	
Metered use	65 lpcd
Flat rate use	7 lpcd
Unrecorded Consumption	
Underestimated flat rate use	17 lpcd
Other uses (assuming 2 lpcd public use)	11 lpcd
Total Consumed Water	100 lpcd

The equivalent per capita consumption in the category other use (Table IV-5) is approximately divided into public use (2 lpcd) and meter under-registration plus unauthorized use (11 lpcd). Public use includes water which has no revenue potential and which is not actually consumed by concessionaires. For this reason it is subtracted from the aggregate of other uses and is not included in the total consumed water.

TABLE IV-5

SUMMARY OF WATER PRODUCTION AND CONSUMPTION

Production/Consumption Category	Amount of Water cum/mo	cumd	lpcd	Per cent of Production
1. Accounted-for-water				
a. Metered consumption at 1,196 connections	35,400	1,140	65	33
b. Non-metered consumption at 428 connections	3,800	120	7	4
c. Sub-Total	39,200	1,260	72	37
2. Unaccounted-for-water				
a. Leakage	37,000	1,200	69	35
b. Underestimated flat rate use at 428 connections	8,900	290	17	9
c. Wastage at 428 flat rate connections	12,700	410	23	13
d. Other uses	7,200	230	13	6
e. Sub-Total	65,800	2,130	122	63
3. Total Production	105,000	3,400 8/	194	100

8/Rounded off

E. COMPUTER STUDIES

General

The Ozamiz City distribution system has been analyzed with the use of a computer program in an attempt to verify field observations. The computer program is explained in the Methodology Manual on Water Supply Feasibility Studies under Water Distribution Analyses.

Field Measurements

Flow measurements were made of the water delivered to the distribution system. Water from Talibaksan Spring was measured at 3,000 cumd and that from Cocok Spring at 200 cumd.

The total area served by the distribution system was determined as 72 hectares. The area served by each node was estimated and the water was allocated to the nodes on an areal basis.

The C-value analysis of existing transmission lines showed that no carrying capacity has been lost. It was assumed that the pipes in the distribution system also would have near original carrying capacity. Therefore, C-value = 100 was assumed for 100 mm and 150 mm CI pipes, and C-value = 110 was assumed for 100 mm and 110 mm AC pipes. Pipes of diameter less than 100 mm were assigned C-value = 80 or 90, depending on the age of the pipe.

Computer Analyses

In the following discussion, the location of nodes and pipes is shown in Figure IV-4. The points of known HGL are at Node 59, along the transmission line from Talibaksan Spring, and at Node 64, the Cocok Spring pump station. The pressure at Node 59 was measured to be 5.93 m and that at Node 64 was 11.26 m. Given the demands at the nodes in the distribution system and the HGL at Nodes 59 and 64 (the source nodes for this analysis), the computer determined the HGL in the distribution system. The system data for this study are shown in Appendix Table IV-E-1.

The pipe data are listed in Appendix Table IV-E-2. The data indicate that low velocities prevail in the distribution system and several pipes have very low head losses. The flows in the pipes are also small - the major reason for low velocities and low head losses. Pipes No. 84 and 90 have high head losses. The total available head is only 11.26 m and almost one-third is lost due to friction in Pipes 84 and 90 (1.62 + 2.04).

Appendix Table IV-E-3 contains the node data. A check of the source nodes, (59 and 64), indicates that the total flow supplied to the distribution system is 36.53 lps or 3,156 cumd. This is almost equal to the supplied amount of 3,200 cumd - the discrepancy being in the accuracy of areas served by the nodes. The Talibaksan source represented by Node 59 supplies 32 lps. The Cocok Spring source, Node 59, contributes 4.45 lps. Though the source nodes do not supply the exact amounts measured in the field, the computer run approximates field conditions reasonably well.

The pressures as shown in Appendix Table IV-E-3 are less than the recommended minimum pressure, 14 m. The lowest pressure is .22 m at Node 17. The pressure data listed in Table IV-E-3 show good agreement with the field data listed in Table IV-2. Thus the computer run also agrees with the pressure readings and verifies the field observations that pressures are quite low in the core city service area.[9]

F. DEFICIENCIES OF THE EXISTING WATER SYSTEM

The effective yield from the system's water sources is inadequate to satisfy present system demand. The transmission main from Talibaksan Spring has insufficient capacity to deliver the full spring yield to the distribution system at adequate pressure. The Cocok pump station is of temporary construction, and of inadequate capacity to fully utilize the existing spring source and transmission main. Operation of the pump is intermittent.

There are no laboratory facilities for water quality testing and control. Existing chlorinating equipment and practices are rudimentary. Potential cross-connections which can cause pollution

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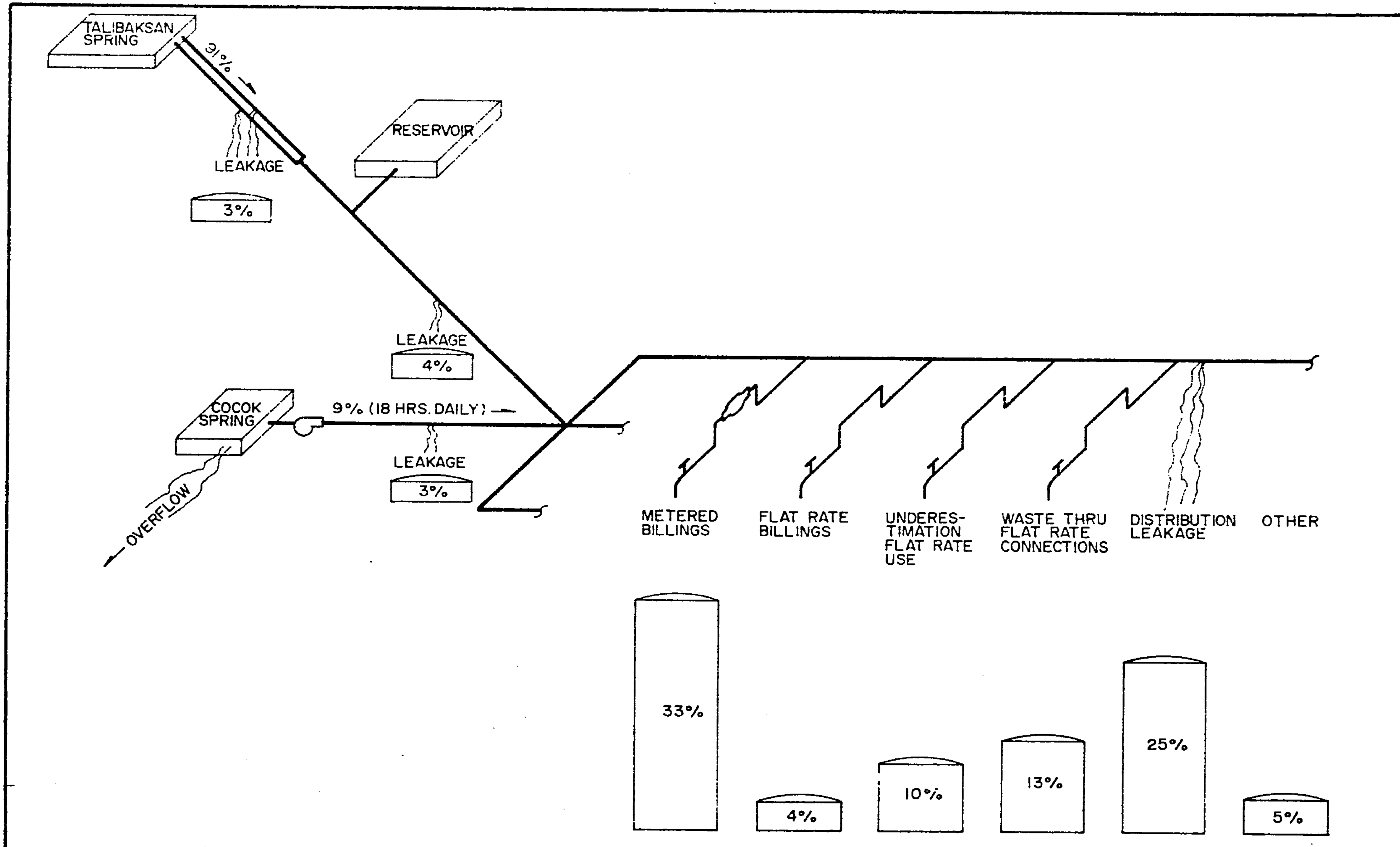
[9] In the course of obtaining additional field data, it was discovered that several minor changes should be made in the computer input data to reflect the actual pipe sizes and locations. The computer printout lists Pipe No. 72 between Nodes 54 and 47 on Zamora Street and Pipe No. 86 between Nodes 55 and 54 on Aguada Street. Neither of these pipes exists and each has subsequently been deleted from the schematic diagram in Figure IV-3. Pipes No. 54, 55, 56 and 57 should be 150 mm instead of 100 mm as listed in the computer printout. The impact of these changes would not significantly alter the computer analysis.

of the water in the distribution system are numerous. The reservoir has an open top, permitting pollution of stored water.

Water lost to underground leakage and wastage (Figure IV-5) is approximately one-half of total water production. Twenty-eight per cent of the connections have no working meters and are billed on flat rate basis. The flat rate consumption on which billing is based is underestimated.

The present level of service of the Misamis Occidental Water District is inadequate. Water pressures are low throughout the poblacion. Some concessionaires have requested to be disconnected because water is no longer available to serve them. Water must be rationed during night hours to keep reserve water in the reservoir. Fire-fighting capabilities are severely limited.

Meter and plumbing shops are inadequately equipped. Plumbing materials and repairs are substandard. Valves and hydrants are not properly maintained. Mains of inadequate capacity are used for distribution extensions. Distribution records are inadequate.



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS CDM - LWUA

FIGURE IV-5
SCHEMATIC WATER AUDIT

CHAPTER V FEASIBILITY STUDY CRITERIA

A. GENERAL

The planning, design and economic criteria used in the feasibility studies have been derived from studies of local conditions, accepted practices, standards and methods here and abroad. These criteria, together with a developed basis of cost estimates, have been utilized to evaluate and compare the various alternatives identified in the course of the study.

In the alternative analysis and evaluation, feasibility study criteria need not be as refined as those used for the detail development of the recommended scheme. The key point, however, must be consistency. As long as each alternative to be analyzed is subjected to similar criteria (or rules), the screening would be accomplished in a fair and consistent manner.

B. PLANNING CRITERIA

This water supply feasibility study has been guided by the following planning criteria (not in order of importance):

1. Regional Approach: Planning of facilities was made on a regional basis, taking into account the short-term district boundaries and the long-term logical service areas beyond present district or political boundaries.

2. Source of Water: Groundwater and surface water were given equal emphasis as potential sources of water.

3. Self-Sufficiency: The recommended plan was based on a system which would provide the highest quality of water service within the "ability to pay" of the consumers.

4. Conservation: Selection of alternative plans considered water, power, chemicals and foreign exchange as a valuable resource which must be conserved to the greatest extent possible.

5. Staged Development: The long-range implementation program would be implemented in construction stages to satisfy projected requirements of a specific design year:

Stage	Construction Implementation	Target Design Year
First Stage	1977–81	1990
Second Stage	1988–90	2000

6. Alternative Plan Screening and Selection: From an array of identified plan alternatives, the recommended plan was selected on the basis of least (present worth) cost and other non-economic parameters. The selected plan has been tested for economic/financial feasibility.

7. Skilled Manpower Shortage: The recommended plan recognizes, in the short-term, the apparent shortage in skilled, technical and managerial expertise. Emphasis was given on the need for district personnel training and certification.

8. Water Quality: The feasibility study identifies present and future water quality problems and includes recommendations towards providing water supply that is safe, healthful and wholesome. It develops conceptually long-range water quality management plans to conserve the integrity of this valuable resource.

C. DESIGN CRITERIA[1]

Unit Water Demands

Average per capita domestic water consumption has been estimated for the study area with the use of field data and available records of past and present water use as well as those from similar cities. For the analysis of existing conditions, actual metered (or connected) customers and "borrowers" were considered separately. However, for short and long-range planning, it has been assumed that "borrowers" would eventually become metered consumers. Per capita domestic use has been increased each year to account for economic growth within the community. (Chapter VI includes detailed unit water demands.)

Commercial and institutional water demands have been estimated as percentage of domestic demand. Where no reliable records were available, a unit flow of 5 cum/day/ha (gross) was used.

There are currently few or almost no heavy and/or "wet" industries in the study area. Land zoning plans, where available show those areas designated for future industrial development. Where no records are available, a unit flow of 10 cum/day/ha has been used in the water demand estimates.

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[1]Refer to Appendix A.

Demand Variation

Maximum daily and peak hourly demands have been estimated from field data and available records. For basic analysis of the water supply facilities, the following ratios have been used:

- maximum day to average day ratio = 1.2
- peak hour to average day ratio = 1.5 - 2.0

Unaccountable Water

Review of the available records and consumption patterns indicate present unaccountable water to be in the order of 65 per cent or more of the total water production. The "composite" accountability of water in the first five urban areas (Zamboanga, Cebu, Ozamiz, Daet and Butuan) includes the following:

Metered billings	16%
Flat rate billings	18
Non-billed use through flat rate connections	9
Non-billed waste through flat rate connections	27
Leakage	23
Other (unauthorized use, public use, meter under-registration)	7
Total	100%

For preliminary design purposes, it has been assumed that:

- unaccountable water would be reduced gradually as positive improvements are added to the system.
- by 1990, unaccountable water would be about 25-30 per cent of the total water production.
- by 2000, unaccountable water would be reduced to 20-25 per cent.

D. ECONOMIC CRITERIA

Discount Rate

The opportunity cost of capital or discount rate used in this feasibility study is 12 per cent. The discount rate was used for economic screening of the technically viable alternatives. (For justification, refer to Chapter 9, Methodology on Water Supply Feasibility Studies.)

Inflationary Trends

Over the two decades preceding 1970, the Philippines had enjoyed quite a reasonable degree of price stability, marred only by a brief period of inflation resulting from the 1960-62 devaluation. From 1959 to 1969, the Philippines experienced an average inflation rate of 5 per cent per annum.

However, the pace of inflation from 1969 to the present has been at least double that of the inflationary period 1962-69. Political unrest, extraordinary monetary expansion in 1969, typhoons, plant diseases, floods and a second devaluation early in 1970, and lately the oil crisis and worldwide inflation explain the greater severity of the recent inflation. Price control policies failed to suppress the spiralling prices.

While it is difficult to separate clearly the effects of domestic and external factors in the price level, in most recent years before 1973, external factors apparently played a relatively small role in the price increases.

By contrast, the large price increases in 1973 were attributable mainly to external factors, i.e., the oil crisis. The sharp increases in the price of crude oil, coupled with massive price increases in essential imports and raw material shortage, and the usual reinforcing inflation psychology, have triggered off the almost 40 per cent in the country.

NEDA foresees that the government can effectively combat inflationary tendencies in the economy so much so that inflation rate could be brought down to about 12 to 18 per cent for fiscal year 1975. A 12 to 18 per cent rate of inflation per year may sound optimistic given recent experiences, but it is possible this can be achieved. The rate of inflation in industrial countries is expected to decline from 15 to 10 per cent. Commodity prices after posting substantial increases are expected to drop.

The NWASA Water Supply Study for Greater Manila in 1969 assumed a 5 per cent inflation rate based on 1965 prices. The LWUA water supply feasibility studies undertaken in 1972 assumed the same inflation rate based on mid-1972 prices. Recent developments such as the large increases in import bills due to oil crisis signify that the 5 per cent inflation rate would be too low.

Projections made in this feasibility study indicate a general price escalation rate of 12 per cent for the period 1976 through 1980; 10 per cent for the period 1981-85; and 8 per cent for the period 1986-90. These are subject to the following conditions:

- o no major changes in the structure and stability of international political relations;
- o no significant changes in production technology as to reduce dependence on oil;
- o no dramatic increases in the price of energy originating from the cartel countries;
- o the government will not retrench (i.e., fight inflation at the price of the recession that goes with it) as forecasted;
- o no significant oil discoveries in the country; and
- o no internal political upheavals of significant proportions.

E. BASIS FOR COST ESTIMATES[2]

For the purpose of cost estimating, a construction cost index (CCI) for water supply projects has been developed, with 1965 as the base year (CCI=100). Unit costs for the water supply feasibility studies have been projected to July 1976 price levels (CCI=384). Construction cost curves have been developed for in-place costs of pipelines, deep wells, water treatment plant, pump stations, and storage reservoirs and used for estimating the relative cost magnitudes of alternative water supply plans. Escalation factors used in calculating the capital cost of recommended improvements are tabulated as follows:

Year	Escalation Factor
1976	1.00
1977	1.12
1978	1.25
1979	1.40
1980	1.57
1981	1.73
1982	1.90

[2]Details of cost estimates are presented in Appendix B.

F. IMPLEMENTATION SCHEDULE

The recommended water supply improvements and facilities may be implemented in increments or stages. The following is the proposed schedule for implementation of the Early Action and Phase I-A improvements:

Final Report Submission	January	1976
LWUA/ADB-Loan Negotiation	December	1975
Select Design Engineer	May	1976
Start Final Design	July	1976
Complete Early Action Works	December	1976
Complete Final Design: Prequalify Contractor	December	1977
Open Bids	March	1978
Complete Phase I-A Works:		
Source Development		1979
Transmission Facilities		1979
Administration Building		1979
Distribution Mains		1981
Internal Network		1981
Service Connections		1981

CHAPTER VI POPULATION AND WATER DEMAND PROJECTIONS

A. GENERAL

One of the early steps in developing the preliminary design of a water system is the projection of future population and water demands for the delineated service area. These projections have a significant impact on facility layouts and sizes, construction staging and cost of the project.

B. POPULATION PROJECTIONS

Population projections took into account past population trends in Ozamiz and Clarin; land use or development plan; physical limits of the urban areas; current and proposed public facilities.

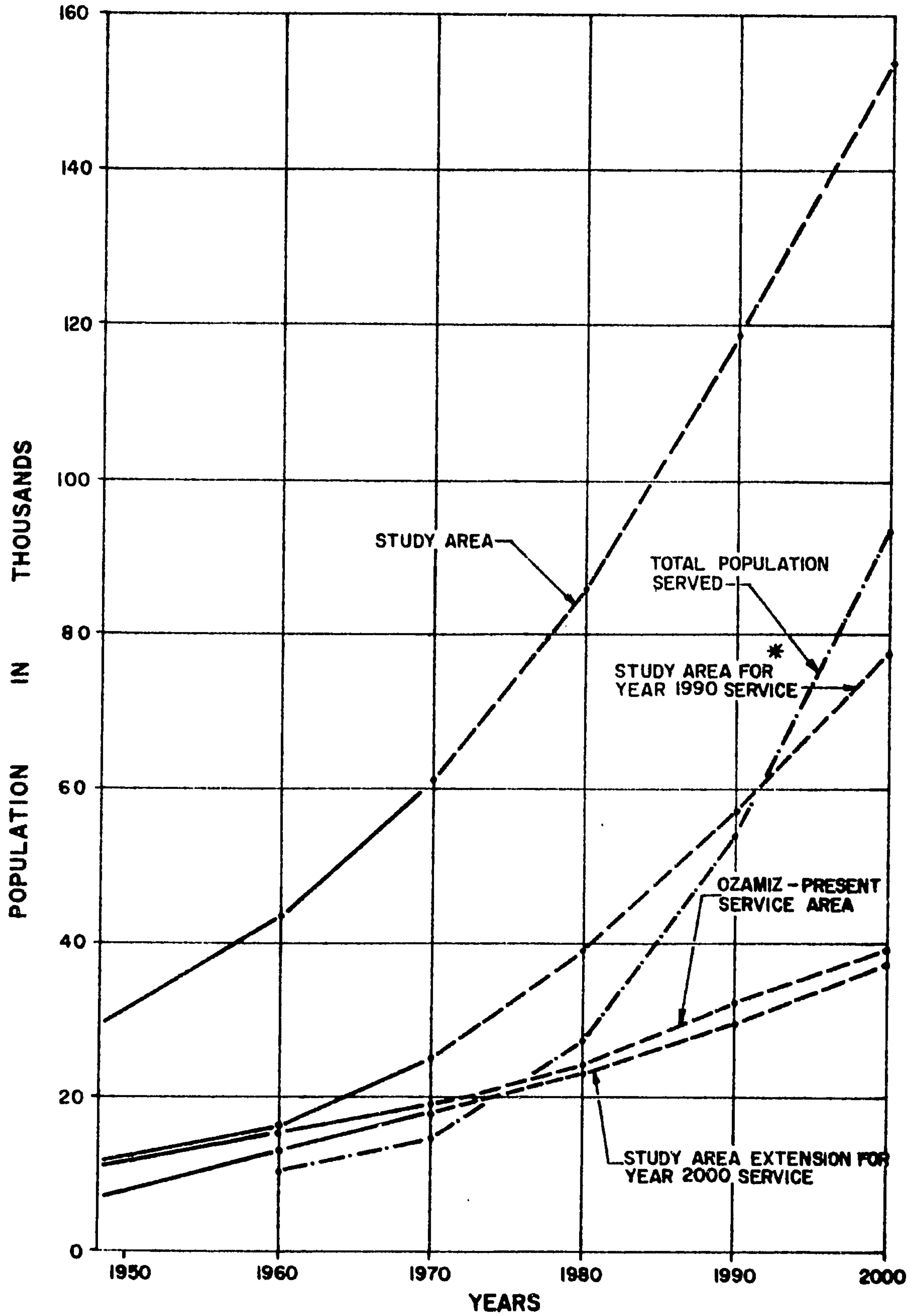
Population trends indicate that in the study area, population would increase approximately from 60,710 in 1970 to 154,000 in the year 2000 (Figure VI-1, Tables VI-1 and VI-2). The annual growth rate from 1970 to 1980 is projected to be 3.5 per cent. This is expected to decrease to 3.3 per cent in 1980-90 and to 2.7 per cent from 1990 to 2000. Population density will increase from 14 persons per hectare in 1970 to 36 persons per hectare in 2000.

The served population (Tables VI-3 and VI-4) which was 23 per cent of the study area population in 1970 is projected to be 45 per cent in 1990 and 60 per cent in 2000. Hence, the served population would increase from 14,100 in 1970 to 53,000 in 1990 and 93,000 in 2000. This represents more than six-fold increase in 30 years.

TABLE VI-1

PAST POPULATION TRENDS
MISAMIS OCCIDENTAL WATER DISTRICT
(OZAMIZ AND CLARIN)

		1948	1960	1970
A.	Present Service Area: (165 ha)			
	Ozamiz City			
	Poblacion (Core City)	9,688	8,664	7,523
	Baybay Triumpo			1,971
	Baybay Sta. Cruz			1,135
	Baybay San Roque		2,410	1,665
	Labo	1,064	1,326	1,403
	Tinago		2,658	4,952
	Sub-Total (A)	10,752	15,058	18,649
B.	Additional Study Area for 1990 (1,980 ha)			
	Ozamiz City			
	San Antonio	-	-	1,464
	Gango	1,135	2,716	2,329
	Bacolod	-	-	491
	Maningcol	1,908	1,606	1,990
	Catadman	-	2,059	4,798
	Banadero	-	1,018	1,644
	Lam-an	-	543	1,476
	Malaubang	1,147	1,461	2,279
	Sub-Total (Ozamiz)	4,190	9,403	16,471
	Clarin			
	Poblacion	3,152	2,185	3,391
	Lupangan	1,005	397	551
	Masabud	-	406	520
	Mialen	-	824	1,007
	Gata Daku	1,453	656	853
	Lapasan	-	1,089	798
	Gata Diot	-	198	261
	Kinangay Sur	1,674	810	961
	Sub-Total (Clarin)	7,248	6,565	8,342
	Sub-Total (B)	11,438	15,968	24,813



* EXCLUDING PRESENT SERVICE AREA

FIGURE VI - I
MISAMIS OCCIDENTAL WATER DISTRICT
POPULATION PROJECTIONS

C. Additional Study Area for 2000 (2,100 ha)	1948	1960	1970
Ozamiz City			
Gotocan Dacu	-	234	335
Pantaon	-	400	492
Leposong	-	373	445
Embargo	921	388	550
Mentering	-	283	170
Molikay	-	444	1,053
Gotocan Diot	-	264	382
Calabayan	1,237	1,257	1,380
Carangan	1,608	-	880
Misamis Annex	-	3,367	4,945
Bagakay	-	1,107	1,405
Sub-Total (Ozamiz)	3,766	8,117	12,037
Clarin			
De la Paz	-	628	626
Pan-ay	989	1,006	1,216
Dolores	573	522	620
Canicapan	520	531	532
Tinacla-an	-	623	498
Segatic Diot	-	521	396
Segatic Daku	-	285	529
Cabunga-an	-	102	282
Suba	997	306	514
Sub-Total (Clarin)	3,079	4,524	5,213
Sub-Total (C)	6,845	12,641	17,250
Grand Total (A + B + C):	29,035	43,667	60,712

TABLE VI-2

POPULATION - PAST TRENDS AND PROJECTIONS
MISAMIS OCCIDENTAL WATER DISTRICT

Year	Present Service Area A = 165 ha			1990 Study Area Extension A = 1,980 ha			2000 Study Area Extension A = 2,100 ha			Total Population
	Pop.	Density (P/ha)	Growth (%)	Pop.	Density (P/ha)	Growth (%)	Pop.	Density (P/ha)	Growth (%)	
1948	10,750	65.2		11,440	5.8		6,845	3.3		29,035
			2.8			2.8			5.2	
1960	15,060	91.2		15,970	8.1		12,640	6.0		43,670
			2.3			4.5			3.2	
1970	18,650	113		24,810	12.5		17,250	8.2		60,710
			2.5			4.5			3.0	
1980	24,000	145		38,500	19.4		23,000	11.0		85,500
			3.0			4.0			2.5	
1990	32,000	134		57,000	28.8		29,400	14.0		118,400
			2.0			3.3			2.5	
2000	39,000	236		77,400	39.0		37,600	18.0		154,000

TABLE VI-3

ESTIMATES OF POPULATION SERVED
MISAMIS OCCIDENTAL WATER DISTRICT

	Present Service Area			1990 Study Area Extension			2000 Study Area Extension		
Year	Pop. Trend and Projection	Pop. Served	%	Pop. Trend and Projection	Pop. Served	%	Pop. Trend and Projection	Pop. Served	%
1948	10,750	-	-	11,440	-	-	6,845	-	-
1960	15,060	10,050	67.0	15,970	-	-	12,640	-	-
1970	18,650	14,100	75.6	24,810	-	-	17,250	-	-
1980[1]	24,000	19,200	80.0	38,500	7,700	20	23,000	-	-
1990	32,000	27,200	85.0	57,000	22,800	40	29,400	3,000	10
2000	39,000	35,100	90.0	77,400	46,500	60	37,600	11,300	30

TABLE VI-4

SUMMARY OF POPULATION SERVED ESTIMATES
MISAMIS OCCIDENTAL WATER DISTRICT
(OZAMIZ AND CLARIN)

Year	Total Study Area Population	Population Served	% Served
1960	43,700	10,050	23
1970	60,710	14,100	23
1980[1]	85,500	26,900	31
1990	118,400	53,000	45
2000	154,000	93,000	60

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[1] Population estimated to be served in 1980 may not be realized as Construction Phase I-A would still be underway.

C. DEMAND PROJECTIONS

Water supply projections have been made for domestic, commercial, institutional and industrial demands and for unaccounted-for-water. Inherent in making projections are assumptions about future conditions. These assumptions are discussed in this section for each category of water use.

Domestic Demand

The projected demands for domestic water have been based on a unit per capita consumption and the projection of served population. In Chapter IV, the present total consumption of water in Ozamiz City was estimated to be 100 lpcd which could be apportioned as follows:

Accounted-for-Water Use	72 lpcd
Unrecorded Use	28 lpcd
Total	100 lpcd

These figures are based on the present situation of inadequate service, low pressure, and rationed night-time supply. It is possible that present domestic consumption would approach 115 lpcd if adequate pressure and supply are provided. This assumption appears reasonable as data indicate the suppressed domestic consumption is 83-85 lpcd for concessionaires having no supplemental water supply. For purposes of projections, it is assumed that the rate of increase of domestic demand will be in the order 1% compounded annually. By applying these assumptions, the projected domestic per capita consumption is:

Year	Projected Domestic Consumption (lpcd)
1980	120
1990	133
2000	150

The above projection assumes an increasing economic growth rate for the population in the study area concurrent with a pricing policy and public relations program of the Water District to discourage wasteful and extravagant water use.

Commercial, Institutional, and Industrial Demand

In Chapter IV, the sum of the commercial, institutional, and industrial demand was estimated to be 6-8 lpcd (or about 10 per cent of the domestic demand). For projection purposes, the aggregate of these demands was estimated to be 12 per cent of the future domestic demand. Since the unit consumption for domestic demand was assumed to increase gradually, the aggregate of commercial, institutional, and industrial demands would also increase. The projection is summarized below:

Year	Projected Domestic Consumption (lpcd)	Projected Commercial, Institutional and Industrial Consumption (lpcd)
1980	120	14
1990	133	16
2000	150	18

If it is assumed that all connections will be metered, these projections will be equivalent to the accounted-for-water in these categories. The current accounted-for-water (72 lpcd) can be separated to estimate the domestic consumption and commercial institutional and industrial consumption. If the commercial, institutional and industrial consumption is assumed to be 10% of the domestic consumption, the present domestic consumption is 65 lpcd and the commercial, institutional, and industrial consumption is 7 lpcd. The sum of the two categories is 72 lpcd (the current accounted-for-water). These figures are used in Table VI-5 which shows 1975 unit consumption figures.

Unaccounted-for-Water

The present unaccounted-for-water is 63 per cent of the water production. Field studies indicate that 55 per cent of the unaccounted-for-water is estimated to be caused by leakage and the remainder is unrecorded consumption. A program for reducing unaccounted-for-water should be implemented by the Water District. The program will consist of metering flat rate connections, replacing non-functioning meters, and leakage detection surveys. Such program for the existing system is expected to reduce the unaccounted-for-water to 35 per cent with leakage still being the major portion of the losses. However, when the improvements begin in 1977-78, it is possible that the unaccounted-for-water in the existing system will increase. This will be caused by increased leakage in the existing system (mostly in the service lines) due to the increased pressure. Thus, the MOWD will probably have to replace existing service connection lines in order to reduce the leakage in these lines. It is assumed that by year 2000 the MOWD will have replaced all of the existing service lines and will have maintained the new improvements so that the unaccounted-for-water will eventually be 20% of production. Between 1980 and year 2000 the unaccounted-for-water is assumed to be reduced as follows:

Year	Unaccounted-for-Water (%)	Equivalent in lpcd	Leakage (lpcd)	Unrecorded Use (lpcd)
1980	40	89	62	27
1990	30	64	44	20
2000	20	42	25	17

The leakage and the unrecorded usage are expected to decrease as shown. The unrecorded use will be mostly public use (because of improved fire-fighting potential) and partly meter under-registration. By year 2000 the leakage is expected to stabilize at 12 per cent of the production and the unrecorded usage, 8 per cent. This is believed to be a reasonable goal which the Water District can achieve through an effective metering program, periodic leakage surveys and good management practices. To the extent the Water District can improve upon these projections, it will be able to reduce total water demand and thereby postpone future source development.[2]

Summary

The projected unit consumption and supply requirements are listed in Table VI-5, together with the present water use profile as determined in Chapter IV. The projected average daily demand and supply requirements are listed in Table VI-6. In both tables the figures for 1975 represent the May 1975 accounted-for-water and unaccounted-for-water. The projected domestic demand and the combined commercial, institutional and industrial demand are assumed equivalent to the accounted-for-water in these categories. The total average water demand is projected to increase from the current 3,400 cumd to 19,500 cumd by year 2000.

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[2]This applies to the real economic advantage of postponing the development of Dalingap Springs (see Chapter IX).

TABLE VI-5

AVERAGE UNIT CONSUMPTION AND SUPPLY REQUIREMENT
MISAMIS OCCIDENTAL WATER DISTRICT

Item/Year	1975	1980[3]	1990	2000
Domestic, lpcd	65	120	133	150
Commercial/Institutional/Industrial				
(% of Domestic)	(10)	(12)	(12)	(12)
Equivalent lpcd	7	14	16	18
Sub-total, lpcd	72	134	149	168
Unaccounted-For-Water				
(% Production)	63	40	30	20
Equivalent, lpcd	122	89	64	42
Leakage, lpcd[4]	69	62	44	25
Unrecorded Use, lpcd	53	27	20	17
Total Unit Supply Requirement	194	223	213	210

TABLE VI-6

AVERAGE DAILY WATER DEMAND
AND SUPPLY REQUIREMENT PROJECTIONS (cumd)

Item/Year	1975	1980[3]	1990	2000
Domestic	1,140	3,230	7,050	13,900
Commercial/Institutional/Industrial	120	390	850	1,700
Sub-Total	1,260	3,620	7,900	15,600
Unaccounted-for-Water	2,140	2,380	3,400	3,900
Total	3,400	6,000	11,300	19,500

[3] 1980 figures do not have any practical meaning as Construction Phase I-A would still be underway.

[4] Unrecorded usage represents additional consumption in the study area. For 1975, the unrecorded use includes underestimated flat rate use, wastage at flat rate connections and other uses. The projected unrecorded use consists of other uses - public use, meter under-registration, and unauthorized use.

The total average demand projections listed in Table VI-6 are used to calculate the maximum daily demand and peak-hour demand listed in Table VI-7. The source development program discussed in subsequent chapters is scheduled on the basis of the maximum daily demand projections. The transmission and distribution mains which convey the water to major demand centers are designed for peak-hour requirements.

TABLE VI-7

MAXIMUM DAY AND PEAK-HOUR DEMANDS

Year	Average Daily Demand (cumd)	Maximum Daily Demand[5] (cumd)	Peak-Hour Demand[6] (cumd)
1980	6,000	7,200	9,000
1990	11,300	13,600	17,000
2000	19,500	23,400	29,000

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[5]Maximum daily demand is the maximum demand occurring on any day during the design year. The maximum daily demand is assumed to be 20 per cent more than the average daily demand.

[6]Peak-hour demand is the highest demand for any one hour period during the design year. The peak-hour demand is assumed to be 50 per cent more than the average daily demand.

CHAPTER VII WATER RESOURCES

A. GROUNDWATER

The MOWD is located on a narrow coastal plain at the foot of a volcanic peak, Mount Malindang. The flank of Mount Malindang is prolific in large springs. One of these springs and one of several coastal springs provide the MOWD supply to Ozamis City.

The measured and estimated minimum spring flows from the Mount Malindang area are sufficient to supply the entire Ozamis City - Clarin portion of the Misamis Occidental Water District beyond the year 2000. The coastal area appears favorable for development of a moderate groundwater supply from wells. However, it seems that development of a municipal well supply is neither necessary nor economically advantageous when compared with the planned spring development.

<u>Geology</u>. A study of the regional geology of the area indicates a simple sequence under and near the MOWD (from bottom to top layers). It consists of: andesitic rocks forming the core of the volcano Mount Malindang; pyroclastics and volcanic debris forming the flanks of the volcanic mountains; and marine and terrestial sediments interfingering with the volcanics. These formations date from Pliocene to Quaternary Age.

<u>Aquifers</u>. The known and potentially good aquifers in the MOWD area are the pyroclastics and volcanic debris units on the mountain flanks where they feed the high springs, and the sand and gravel of the Pliocene and Quaternary sediments in the plains which supply most of the well production and the coastal springs.

The volcanic aquifer appears to be very productive in the springs on the east flank of Mount Malindang but no tests have been conducted to determine aquifer parameters and no significant records on long term spring water production have been kept.

The Pliocene to Quaternary sedimentary aquifer system has been explored in its upper levels (to about 50 m) by many wells and considerable data on this system are available.

Appendix Table VII-A-1 is a summary of available data on 28 selected wells. Appendix Figures VII-A-1, VII-A-2 and VII-A-3 are stratigraphic logs of typical wells. Appendix Figures VII-A-4, VII-A-5 and VII-A-6 are well location maps and geologic cross-sections of the MOWD area. Figure VIII-1 shows the location of the springs in relation to Ozamis City and Clarin.

From an examination of the geologic cross-sections and well logs and from the widespread occurrence of flowing artesian wells, it is apparent that the major stratigraphic units are continuous enough to be generally subdivided into three layers. These are an upper sand water table aquifer about 10 to 30 m thick, a clay aquaclude of greatly varying thickness, and a lower sand and gravel artesian aquifer. For flowing artesian conditions, it is necessary to have a relatively impermeable continuous bed, the aquaclude, overlying the aquifer to prevent excessive loss of water and hydrostatic pressure. In addition, the aquifer must be hydraulically continuous all the way back to a recharge area elevated above the ground level in the discharge area. The clay aquaclude is not logged by the local drillers in all wells that are free flowing but the aquaclude must exist (and have been missed in logging) for the hydrostatic pressure necessary to flowing wells to be conserved in the aquifer.

Few wells are drilled into the water table aquifer because water is reported to contain hydrogen sulfide.

Numerous wells are drilled into the artesian aquifer both to obtain flowing yield and to obtain better quality water. No comprehensive pump tests are recorded from wells in MOWD. Yield tests and associated drawdowns, however, indicate the following specific capacities and the approximate aquifer transmissivities inferred from the specific capacities:

Well	Specific Capacity (lps/m)	Approximate Transmissivity cumd/m
MSO-1	0.8	95
MSO-5	0.8	95
MSO-6	0.4	48
MSO-7	0.2	24
MSO-8	1.3	155
MSO-21	0.5	60

Although these figures mainly are derived from small diameter wells (100 mm) with only limited penetration of the aquifer, they indicate that large capacity production wells are unlikely to be constructed in this aquifer. Three wells were drilled to depths ranging from 67 to 117 m without encountering a better aquifer zone but no deeper tests are known.

Springs. Springs occur whenever an aquifer intersects the land surface or whenever a natural conduit extends to the land surface from an aquifer with enough hydraulic head to force the water out. Springs are common in areas of high water table, either from a fully saturated section or "perched" as a result of an underlying impervious bed, where erosion incises the land surface. Thus, they tend to occur in gulleys or canyons.

The rate of flow from a spring depends on several factors: the head of water against which the spring is discharging, the local surface and subsurface obstructions to flow of water at the spring opening, the transmissivity of the aquifer, and the water table elevation (or the piezometric head) within the aquifer. It can be seen that there may be several ways to increase spring flow: by lowering the discharge level by pumping or by lowering the surface level of the discharge channel; by reducing the obstruction to flow at the spring opening by cleaning or developing the area; or by installing a well-screen intake pipe in the spring opening. Normally nothing can be done about improving aquifer transmissivity or about artificially raising the water table except in rare cases where some of the artificial recharge may be practical. Any artificial increase in spring flow may be temporary in that the flow will then tend to regress and eventually stabilize somewhere between the original flow rate and the initial increased rates.

Alternatively, the rate of flow of a spring (which of course fluctuates naturally with changes in water table resulting from variations in recharge) can be reduced by various events: (1) by allowing the discharge water level to increase; (2) by allowing the spring opening to become dirty or otherwise obstructed; and; (3) by reducing the water table generally. This can occur as a result of: pumping water from wells in the recharge area of the spring (or even down gradient from the spring); artificially reducing recharge by diverting water from the recharge area to other uses; or lower infiltration in the recharge area due to deforestation.

In practice, the long-term potential of springs is generally easier to determine than that of wells. The general procedure is to install gaging devices on the springs (weirs are normally most convenient and applicable) and monitor the flow for an extended period of time which should preferably cover a number of wet and dry seasons. It must extend through at least one complete cycle because spring flow normally will fluctuate with the seasonal rainfall changes as the water table fluctuates with the associated recharge. It should be noted that there will be a time lag in the cyclic rainfall change, water table change and spring flow change pattern. Seasonal low flow will not necessarily correspond with low rainfall but may lag considerably. The spring flow record can be correlated with the rainfall record for the same period and extrapolated on the basis of long-term rainfall records to develop reliable figures for minimum, maximum and average spring flows.

Specifically in the MOWD area, many large springs occur in the pyroclastic deposits incised by the Clarin River on the east flank of Mount Malindang. The aquifer that supplies these springs is obviously the pyroclastic unit. The springs appear to be localized where the deeply cut trough of the Clarin River intersects the water table. The recharge area for these springs is of considerable interest. Normally, recharge to the pyroclastics would be considered to occur directly by infiltration and the andesitic volcanic core would be relatively impervious. However, there appears to be only a small recharge area of pyroclastics above Dalingap and Bitoon Springs and below the andesite. The measured flow of the springs is over 11 million cum a year which implies a recharge of much more than 1 m per year over the pyroclastics area. Since this is considered unlikely, it is assumed that the andesitic core is porous and permeable and is contributing to the recharge as reported true in several instances in Camarines Sur and Albay.[1]

Other springs currently used for MOWD and private water supplies are probably typical coastal springs which occur where the low coastal land surface falls below the higher water table and some of the seaward draining groundwater appears at the surface. In this case, the recharge area is large (the entire expanse of volcanics and coastal sediments to the west) and should continue to supply these springs indefinitely as long as the water table is not lowered by local pumping withdrawals.

If the springs remain the prime water source, these should be equipped with permanent (concrete) measuring weirs instead of the temporary ones currently installed. A continuous program of spring flow monitoring and analysis of spring flow and rainfall records should also be undertaken. This will determine any variations in performance; a need for maintenance of the spring or watershed; or may alter long-term plans if it indicates a lesser reliable flow than shown by analysis of short-term records.

In the case of any springs used for municipal water supply, the Water District must control the recharge area to prevent water diversion or practices leading to lowered infiltration rates just as the watershed of a reservoir must be controlled. In the case of springs, it is also essential that the Water District control pumping of well water in the general area to prevent lowering of the water table and consequent reduction in or complete loss of spring flow.

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[1] Groundwater Geology of the Bicol Region; P. T. Dumapit, Bureau of Mines.

Springs are relatively common in the foothills of mountains along the coastal areas of Misamis Occidental. However, their occurrence and general size vary appreciably along the westerly shores of Panguil Bay and Iligan Bay in the area of interest in this project. A few springs emerge in low-altitude near-shore settings, as those in the vicinity of Cocok Spring. More typically, however, they appear as hillside seepages at altitude in excess of 50-100 m, 10 km away from the shoreline. Talibaksan Spring is an example of the latter type.

The undeveloped springs closest to Ozamiz City are the series emerging near the base of Bucagan Hill, of which Cocok Spring is the largest. Elevation of all these springs is about 1 m above sea level.

Cocok Spring. The single existing MOWD pump at Cocok Spring is much too small to capture the full yield of the Spring. Spring yield which does not enter the pump intake overflows to waste in a fresh-water tidal pond lying immediately to the north of the spring, from which it drains to the sea via the Malaubang River. When the pump is not being operated, the entire spring discharge drains to waste. Flow of the spring was determined by installing a temporary gaging weir in the waste drainage channel and briefly stopping the pump at times of flow observation. Experiments indicated that the flow over the weir stabilized within a few minutes that the pump was being started or stopped. It was judged that the very small difference in head on the spring due to pump operation was not a significant influence on the spring yield. With this arrangement, the Cocok Spring yield was measured on 116 days between 4 February (start of the dry season) and 31 July (by the wet season) 1975. Summary of this series of instantaneous measurements is as follows:

Month 1975	Number of Days Observation	Discharge (cumd) Maximum	Minimum	Average
February	12	3,160	3,160	3,160
March	26	3,760	3,000	3,410
April	23	3,570	3,160	3,410
May	28	3,410	3,410	3,410
June	23	3,410	3,410	3,410
July	4	3,410	3,410	3,410

The pump discharge on 8 February 1975 was measured by pitotmeter at 5.3 lps (455 cumd). It is thus apparent that the present pump is capable of capturing only about 15 per cent of the spring flow recorded during this period. Pump operators stationed at the spring reported that the water level in the spring inlet structure was sensitive to extreme high tides which caused the water level in the pond to rise.

From the preceding tabulation, the spring yield is almost constant.

When Cocok Spring was developed by MOWD, there were reportedly two prominent outlets, located about 4 m apart. The easterly outlet was intentionally closed with fill material to facilitate access to the caisson and the pump installed in the other outlet. According to the MOWD, the caisson was sunk entirely through large boulders, some of a size requiring a truck-crane to lift. It is thus considered that the aquifer permeability in the immediate vicinity of the currently developed outlet is likely high, and that these two original outlets are hydraulically connected.

There are several other small seepages emerging around the perimeter of the site which are not captured by the inlet structure. These are all very small relative to the main outlet discharge, but would warrant being captured if the Cocok Spring were to be developed to its full capacity for system supply. This spring is, in most respects, an excellent potential source of water, although due to its low elevation, all water from this source must be pumped. If Cocok Spring is selected for full development, design should include measures to insure that pumping water level in the spring never falls below the water level in the adjacent pond, to prevent the pond water from seeping into the inlet structure.

Regina Pool Spring. Other springs emerging along the periphery of the pond and around the base of Buoagan Hill were investigated. Four springs were inspected, reportedly the largest seepages in the area other than Cocok. All are in the Barrio Kalusaran area, between Cocok Spring and Ozamiz City. The largest spring is currently developed and supplies the (public) Regina Swimming Pool. A second spring, locally known as Boom Ba Spring, was developed by NWASA in 1963 to supply a small system serving about 50 houses on the hill overlooking the spring. The spring is lower than the piping system to which water is delivered by means of a 100 mm x 38 mm hydraulic ram. (This system is not a part of MOWD.) Two other unnamed and undeveloped springs are located on the margins of the ponded area, both with yields judged lower than that of the Regina Pool Spring. Nevertheless, they are practical for development with a series of small outlet structures and pumping facilities.

The Regina Pool Spring was selected for measurement as it appears the largest of this group and more suited to convenient measurement than the other springs.

The Regina Pool was constructed by excavating a basin and building a stone masonry-lined pool around the spring outlet. The pool is operated in flow-through fashion, the overflow (and leakage) being approximately equal to the pool influent from the spring. The pool overflow all drains to waste in the same ponded area receiving from the other springs in the area. There are numerous small leaks in the pool walls, the total of which was visually estimated to be on the order of 6.5 lps, or 550 cumd. A gaging weir was installed in the pool overflow, and total spring yield was roughly estimated by adding 6.5 lps to the overflow measurements. Results of the observations of the Regina Pool Springs made over a 3-month period are shown in the following table:

Month 1975	Number of Days Observation	Total (cumd)
February	1	1,680
March	4	1,040
April	5	1,040

The weir has been reported destroyed at this site and no further measurements were taken.

By allowing about 5 per cent for swimming pool use, the minimum available flow from this spring will be about 990 cumd.

Talibaksan Spring. Talibaksan Spring yields about 3,060 cumd, a flow which essentially equals that shown on drawings dating from its original development in 1941. This spring is typical of several known to occur in the hillsides of the valley of the Clarin River. Field reconnaisance and other investigation indicated that springs of significant size are generally confined to the deeply entrenched river valleys. These valleys cut into the alluvial fan members at the base of the mountains forming the western limits of the coastal sedimentary plain. The major river valley closest to the study area is that of the Clarin River. Spring reconnaisance was concentrated in the length of the river valley several kilometers upstream and downstream of the existing Talibaksan source. No springs of any significant size were located downstream of Talibaksan. The nearest important springs located upstream appeared to be in Barrios Bitoon and Dalingap in Clarin. Locations shown have been estimated from field inspection and measurement of approximate altitude with an altimeter and correlation with available 1:50,000 scale topographic mapping. Locations shown are only approximate since the entire area is devoid of landmarks or other mapped features which would permit better definition of locations. However, locations shown are believed to be conservative with respect to distance from Talibaksan (and hence pipeline length and cost).

Bitoon Spring. The closest significant potential spring source in the valley, Bitoon Spring, is located on the south bank of the main Clarin River channel. The spring emerges about 20 m above the river and cascades waterfall-fashion down a very steep and rocky bluff to the river. There are three channels draining this spring. The principal one is the most westerly and is fed from three outlets about 20 m above the river. Two other smaller streams are fed by a series of small outlets located 30-40 m east of the main outlets, and at a somewhat lower altitude. Elevation of the lowest outlet is about 180 m above mean sea level. These two subsidiary streams are roughly of the same size. Each is considerably smaller than the main spring outlet collected in the principal drainage channel to the west. On 15 April 1975, flow gaging weirs were installed on the three channels draining this spring. Total spring yield was estimated by summing the discharge measured in these three weirs:

Month 1975	Number of Days Observation	Discharge (cumd) Maximum	Minimum	Average
April	5	3,490	3,350	3,460
May	3	4,380	4,300	4,330
June	3	4,300	4,300	4,300
July	3	6,840	4,300	5,920

The entire exposed face of the bluff from which this spring emerges consists of massive boulders and rock debris in which dense vegetation has been established. Capturing the full yield appears practical, though several inlet structures will be necessary.

The Bitoon Spring is reported to be on private land. It drains into the Clarin River, which is dammed for irrigation by NIA at Barrio Tinacla-an. Therefore, development of this spring for MOWD use would result in a reduction in flow of the river at Bitoon equal to the amount intercepted by MOWD.

Lower Dalingap Spring. This spring is located on the north bank of the Clarin River channel about 1 km northwest of Bitoon Spring (and about 6 km west of Talibaksan). The spring emerges in a dense thicket within about 100 m of the river; the discharge stream reaches the river quickly through dense underbush. It reportedly lies on private land. This spring emerges in a series of five or six outlets in sandy terrain on a gentle slope of the flood plain on the bank of the river. The several outlets are scattered along about 20-25 m of channel. Capturing the flow would be practical, though a series of small inlet structures would be required. Altitude is approximately 190 meters.

To measure the spring discharge, a temporary weir was installed in the channel between the spring outlets and the river. The following are summarized observations of the flow after the weir installation on 17 April 1975

Month 1975	Number of Days Observation	Discharge (cumd) Maximum	Minimum	Average
April	5	12,980	12,980	12,980
May	5	13,380	13,380	13,380
June	3	14,910	14,910	14,910
July	3	16,080	15,780	15,860

A resident who has lived in the area for 60 years, reported that the discharge is perennial, with no visually discernible variation in discharge with the seasons or over a longer term.

Capture of the full discharge would require a single main structure and several subsidiary inlet boxes, exact layout and dimensioning of which must await topographic surveying of the site. Salient features of the facilities required are shown in Figure VII-1.

Upper Dalingap Spring. Located about 300 m northwest of Lower Dalingap Spring is another major spring known as Upper Dalingap. Its setting is similar to Lower Dalingap, consisting of a series of seven or eight recognizable outlets in sandy alluvium at the base of the hill ridge forming the north bank of the river. It is at an altitude of about 200 m above sea level. From its setting and proximity to the lower spring, it appears that the same basic aquifer system very likely sustains both springs. Upper Dalingap Spring is on private land.

A gaging weir was installed on the outlet channel on 7 February 1975. Flow was observed on 33 occasions between that date and 31 July:

Month 1975	Number of Days Observation	Discharge (cumd) Maximum	Minimum	Average
February	5	15,210	15,210	15,210
March	8	15,210	15,210	15,210
April	9	15,600	15,600	15,600
May	5	16,730	16,730	16,730
June	5	17,170	16,730	16,870
July	3	19,080	18,320	18,700

It is obvious that the discharge, within limits of accuracy in field flow measurements, remained constant throughout the 1975 dry season period and increased in the wet season.

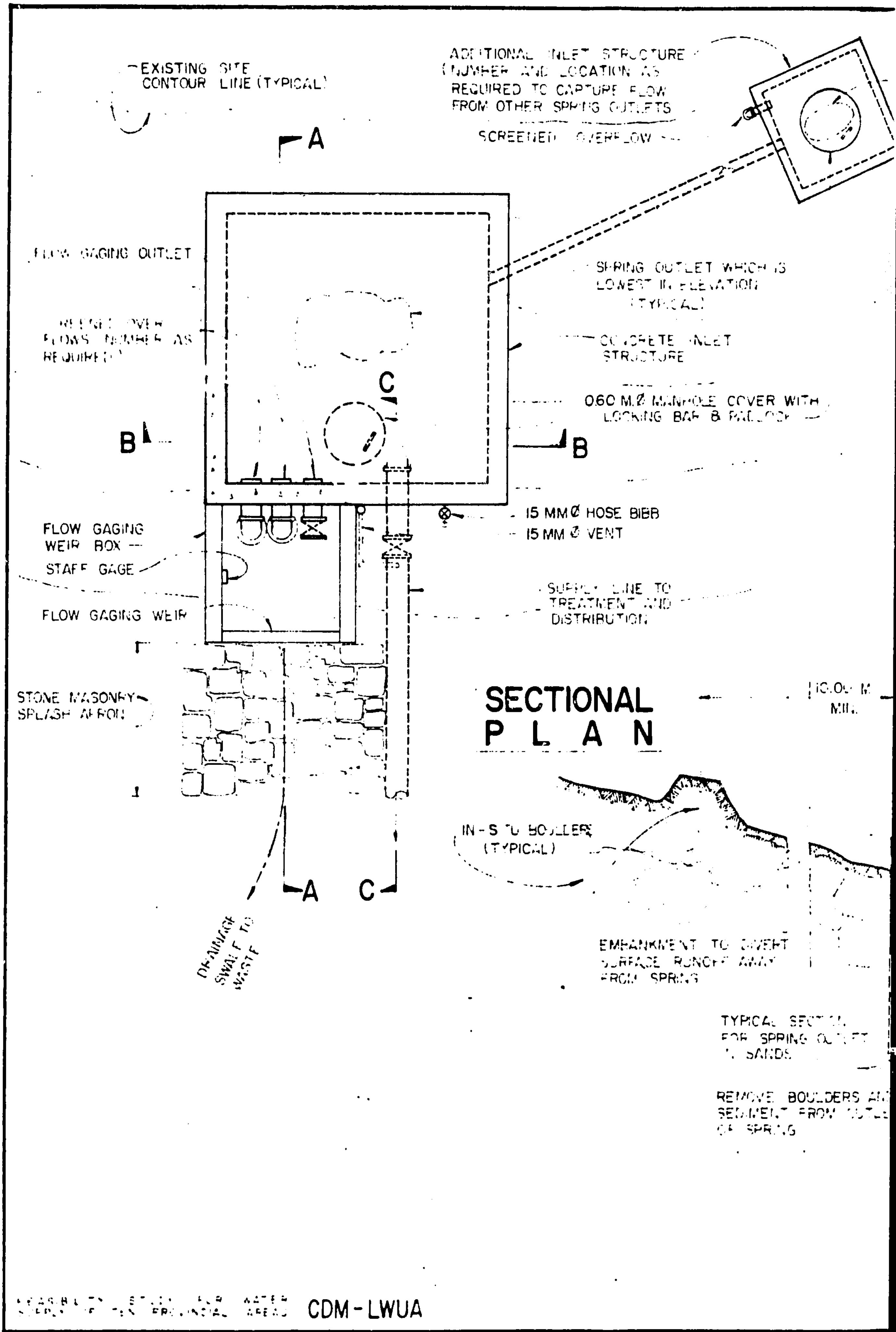
Long-time residents reported that this spring flow has always appeared constant over the years. However, they related that prior to 1970, this spring had a single prominent outlet at the base of the hill. In 1970, there occurred a rain storm of unusual intensity which precipitated a landslide on the hillside just above the spring. This slide choked the single outlet, and the spring promptly reappeared from the debris in the form of the existing several outlets. These outlets are all of about the same size, and are scattered along the winding channel through a dense thicket. Distance between the first and the last outlets is approximately 50 meters. Capturing the aggregate discharge in a series of small interconnected inlet boxes would be practical.

Summary of Spring Flows

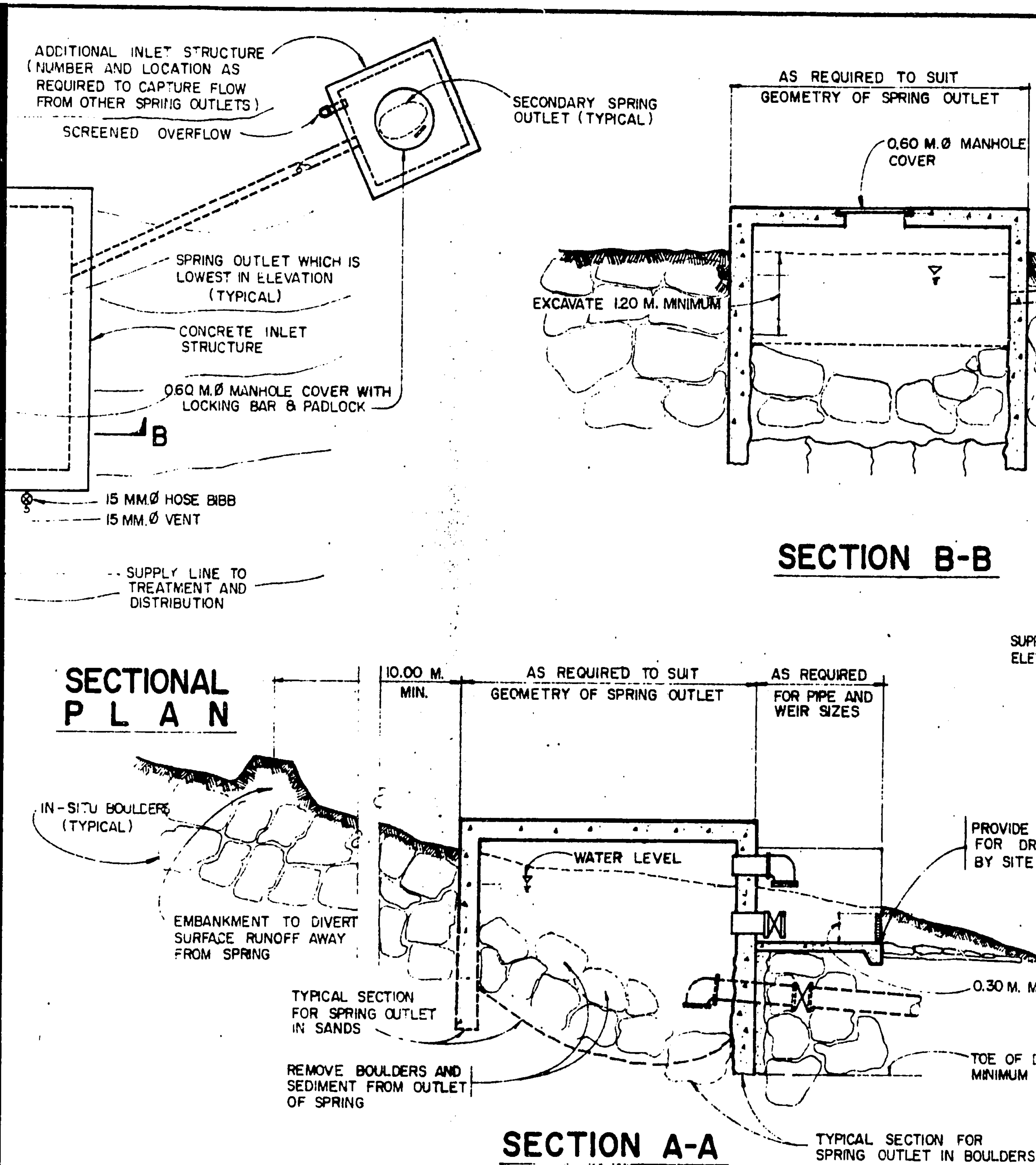
These measured spring flows must be considered as tentative.

For purposes of this study, it is proposed to use the minimum flows recorded in this period of observation. On this basis, the yields from springs in the two identified areas closest to the study area are:

Location	Spring	Provisional Design Flow (cumd)
Bucagan Hill area	Cocok	3,000
	Regina Pool	990
Clarin River Valley	T..ibaksan	3,060
	Bitoon	3,350
	Lower Dalingap	12,980
	Upper Dalingap	15,210
	Sub-Total	38,590


EXISTING SITE CONTOUR LINE (TYPICAL)
ADDITIONAL INLET STRUCTURE (NUMBER AND LOCATION AS REQUIRED TO CAPTURE FLOW FROM OTHER SPRING OUTLETS
SCREENED OVERFLOW
A
FLOW GAGING OUTLET
SPRING OUTLET WHICH IS LOWEST IN ELEVATION (TYPICAL)
FLOWS NUMBER AS REQUIRED
CONCRETE INLET STRUCTURE
C
0.60 M.Ø MANHOLE COVER WITH LOCKING BAR & PADLOCK
B
B
15 MM Ø HOSE BIBB
15 MM Ø VENT
FLOW GAGING WEIR BOX
STAFF GAGE
SUPPLY LINE TO TREATMENT AND DISTRIBUTION
FLOW GAGING WEIR
STONE MASONRY SPLASH APRON
SECTIONAL PLAN
10.00 M MIN.
IN-SITU BOULDERS (TYPICAL)
A
C
DRAINAGE SWALE TO WASTE
EMBANKMENT TO DIVERT SURFACE RUNOFF AWAY FROM SPRING
TYPICAL SECTION FOR SPRING OUTLET IN SANDS
REMOVE BOULDERS AN
SEDIMENT FROM
OF SPRING
CDM-LWUA

a



SECTIONAL PLAN

SECTION B-B

SECTION A-A

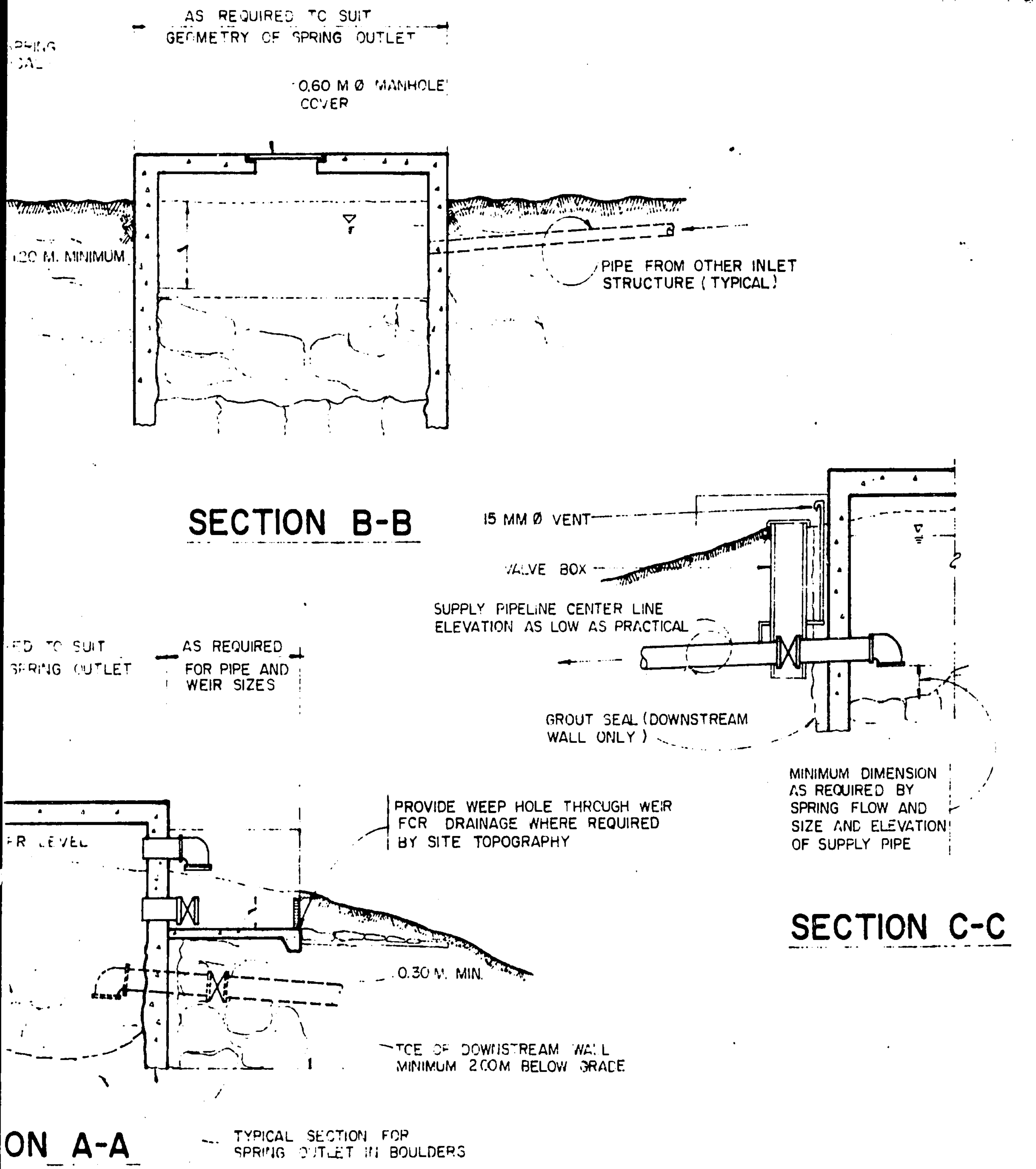


FIGURE VII-1
TYPICAL SPRING INLET STRUCTURES
NOT TO SCALE

It is evident that several combinations of these sources would satisfy the projected 23,400 cumd maximum-day demand for the year 2000.

Wells. Few wells are produced from the water table aquifer because of inferior water quality and necessity to pump water derived from the zone. However, many wells are produced from the artesian aquifer that occurs throughout most of the Ozamiz City-Clarin area.

Small diameter (25 to 50 m) cased wells have been successfully jetted into the sand beds in the area for many years. Most residences and commercial structures not connected to the MOWD system utilize such wells for local or domestic supply. Though there has been no detailed inventory in Ozamiz City, there are many such wells in the city, approximately 100 or more. These private wells are supplemented by several 100 mm diameter wells drilled for public use by NWASA. Some of these wells in the Ozamiz City area are of flowing artesian type, with yields typically 0.1 to 0.2 lps at elevations of about 30 to 40 cm above the ground surface.

There is evidence that the hydraulic gradient in the confined aquifer has declined over the years as may be seen from the following typical examples:

Well Number	When Drilled Q (lps)	Artesian Head (m above grade)	When Drilled	February March 1975 Q (lps)	Artesian Head (m above grade)
MSO-1	0.38	1.20	1967	0.20	0.30
MSO-3	0.50	2.10	1961	0.13	0.40
MSO-10	1.13	1.20	1971	0.13	0.50

The above data show that yields are rapidly declining. This is caused by the overpumping of the aquifer through the uncontrolled proliferation of wells. While the rate of installation of new wells in the poblacion will likely be reduced as soon as the level of MOWD service is improved, the availability of a fresh water artesian aquifer at modest depth will encourage continued use of such wells by consumers who for some reason do not want to obtain MOWD service.

From Ozamiz City northward along the coast to Clarin, small diameter flowing artesian wells are common. Yields and piezometric surface elevations in general tend to be higher near Clarin than Ozamiz City, probably a reflection of the greater density of wells in the latter area. The best such well is reported to be in Barrio Lupasan (Well No. MSO-2). When drilled in 1954, this 150 mm-cased well was flowing at 1.58 lps. By February 1975, this had declined to 0.65 lps. This well is approximtely 1 km south of Clarin Poblacion. Other low yield wells of this type are found throughout the Gango and Labo areas in the projected 1990 MOWD service area.

The core city area of Clarin derives all its present water from five public jetted wells (several of which equipped with hand pumps) and a number of similar private wells. As in the coastal area to the south, yields of the wells have likewise declined over the years.

The continuing decline in piezometric head in the artesian aquifer is a very undesirable situation since pumping becomes necessary where free flowing wells were previously common. A combination of low piezometric head and pumping can lead to saline water intrusion and deteriorated water quality.

Although spring water is clearly the preferable choice for Ozamiz City municipal supply, an interim well water supply would be considered for Clarin, 6 km north of Ozamiz City. This would postpone the construction of the connecting pipeline and consequently defer capital cost. A gravity spring water supply for Clarin, integrated with the Ozamiz City supply, is obviously preferable from all viewpoints (ease of maintenance, cost of operation, reliability of water quality and quantity) except that of initial capital cost. It was necessary to investigate this factor.

The estimated maximum-day demand for Clarin in 1980 is about 1,000 cumd (12 lps) rising to 2,420 cumd (28 lps) in the year 1990. From the aquifer and existing well data (Table VII-A-1), it appears that these demands could be met. However, it would require a minimum of three wells to produce the 1980 maximum-day demand and six wells for 1990 demand. These wells would be 150 mm in diameter and about 60 m deep.

B. SURFACE WATER

Surface Water Resources

There are only two perennial watercourses of significant size passing through or near the Ozamiz City-Clarin service area: the Labo River and the Clarin River. The other small streams mapped as braiding through the coastal plain in this area are either ephemeral or, as in the case of those within the Ozamiz City Poblacion, are sluggish waterways grossly polluted with wastewater. Both the Clarin and Labo Rivers have been developed for irrigation by the National Irrigation Administration, through the construction of low diversion structures. At present there is no appreciable storage impoundment upstream of the control works on either rivers.

Labo River. The Labo River, a major stream, drains from the east flank of Mount Malindang to the north and west of Ozamis. The stream emerges from the hills about 5 km northwest of the city, and then flows northeastward passing through the small poblacion of Labo near the airport and emptying into Iligan Bay at Lapasan. In March 1952, the Department of Public Works established a gaging station at Barrio Kalabayan, Ozamiz City, near the NIA diversion dam. The watershed is 55 sqkm at this point.

Since the establishment of the gaging station, discontinuous fragmentary records have been compiled (for example, the 1952-66 period includes only 4 complete years of record; 1955-57 is continuous). In this 3-year period of continuous observation, summary flows recorded are the following:

	Month with Lowest Total Discharge (lps)			
Year	Month	Minimum	Mean	Annual Mean
1955	March	1,000	1,380	3,140
1956	March	900	1,230	3,330
1957	December	380	450	1,060

The regional NIA office (in Molave, Zamboanga del Sur) reported minimum and maximum Labo River discharges at 640 and 1,080 lps, respectively. The present area irrigated is 600 ha, implying a nominal desired diversion flow of 900 lps. NIA notes that present Labo River flow is seasonally insufficient for the present service area. Its irrigation system could be potentially extended to irrigate an additional 400 ha, if adequate water were available. There is an NIA proposal to consider supplementing the Labo River with water diverted from the Clarin River. Apparently, the full potential of the Labo River is being utilized by NIA in the driest critical months. Thus substantial storage would be required if both existing NIA and proposed MOWD supplies were to be sustained by this source for the year 2000 demand.

Clarin River. The Clarin River is the principal stream flowing through the study area. Throughout its length the Clarin River is a meandering, swiftly-flowing series of channels. Near its mouth, the river divides into three distributaries, known as the Paco, Tudela and Clarin Rivers, all of which are developed for irrigation supply in NIA systems. These three distributaries have a common watershed of

138 sqkm. The most southerly channel, the C[illegible]r, passes adjacent to the Poblacion of Clarin, and is [illegible] NIA in Barrio Tinacla-an (Canicapan).

A Bureau of Public Works flow gag[illegible] as established in late 1951 immediately upstream of t[illegible] diversion structure. The observation period, since that date, [illegible] not been continuous. Full years of record were compiled only during 1952-53, 1960-61 and 1964-65. In these 6 years, the following were observed:

Month with Lowest Total Discharge

Year	Month	Minimum (lps)	Mean (lps)	Annual Mean (lps)
1952	August	2,010	2,630	3,000
1953	July	1,270	2,050	2,550
1960	May	650	1,400	2,050
1961	May	620	1,270	2,360
1964	January	2,780	3,010	3,960
1965	February	3,020	3,420	6,010

The Clarin Communal Irrigation System irrigates 750 ha, the nominal design diversion flow to this area being about 1,125 lps. The regional NIA office notes minimum and maximum river flows at the dam of 1,500 lps and 4,000 lps, respectively.

Several major springs considered for eventual MOWD supply drain into the Clarin River 5 to 10 km upstream of the Clarin Dam. While some of this spring drainage flows into the Paco and Tudela distributaries, a portion drains through the Clarin River outlet. Thus, interception of the spring discharge at its source will result in a corresponding decline in river flow at the downstream irrigation headworks. The magnitude of this reduction may be developed, based on the following assumptions:

(1) Irrigation flow demands on the Paco and Tudela distributaries are, in general, about the same percentage of mean flow in those channels as in the case of the Tinacla-an Dam on the Clarin channel.

(2) The Clarin River distributary conveys about 50 per cent of the total discharge from the basin as a whole (in 1964,

which was selected as a typical year, the proportion of mean annual discharge carried by the Clarin, Paco and Tudela distributaries was 52, 38 and 10 per cent, respectively).

(3) Water from Bitoon, Lower Dalingap and Upper Dalingap Springs heading toward the Clarin River Valley, flows through the three distributaries in roughly the same proportions as the corresponding division of total runoff from the valley.

(4) The aquifer recharges the river (rather than being recharged by the river) for the full length of the river valley between the springs and the dam. (In other words, any spring flow intercepted represents a downstream surface water flow reduction of exactly the same amount.)

From the foregoing it is postulated that, were the full 235 lps net demand in the year 2000 intercepted from springs draining into this valley, only about 130 lps would appear as the decrease in effective river discharge at the Tinaola-an Dam on the Clarin River distributary.

For preliminary appraisal, the NIA demand of 1,125 lps (1.5 lps/ha) was considered. To this may be added the estimated 130 lps flow effectively withdrawn by MOWD in the year 2000, for a theoretical total of 1,255 lps river flow required to sustain both demands simultaneously. Review of the available 6 years of full-year records showed the following:

Year	Number of Days When River Flow Was Less Than 1,255 lps
1952	0
1953	2
1960	34
1961	52
1964	0
1965	0

The above short-term records imply that both the NIA and ultimate MOWD demands could not be fully satisfied simultaneously, in scattered periods totalling several days to a month or more, in years when the mean annual river flow at the Tinacla-an Dam falls below about 2,500 lps. During the dry year 1960-61, the year 2000 MOWD demand would have amounted to approximately 10 per cent of the mean flow of the river in the driest month, with the mean flow just sufficient to satisfy the NIA demand alone. Thus a water rights conflict may arise in the distant future.

The 130 lps MOWD demand from the surface water would represent about 48 per cent of the total MOWD demand projected for the year 2000. This amount would represent (assuming no further increase in the NIA demand) about 12 per cent of the nominal irrigation requirements.

It is considered that MOWD will likely obtain water rights to this small fraction of the river resource for the following reasons:

(1) There are no other springs of suitable size and elevation for public supply as those identified in the Clarin Valley upstream of the NIA headworks.

(2) Available (fragmentary) stream flow data imply that occurrence of such conflicts will be relatively infrequent and of relatively brief duration.

(3) The critical volume, for which there is a potential conflict, appears (from river flow data to date) to be a very modest percentage of irrigation needs but a very great percentage of the projected water supply demand.

(4) Should developments over the next 15 years or so suggest that more of the river flow should properly be allocated to irrigation, there are other resources (springs such as Cocok, etc.) outside the Clarin Valley which can be developed for MOWD supply. In other words, options are retained for future adjustment of the funding and construction planning, if required.

(5) According to the national policy enunciated by the National Water Resources Council, the body adjudicating water rights in the country, public water supply has a higher priority (other considerations being equal) than irrigation.

C. WATER QUALITY OF POTENTIAL SOURCES

Samples were taken from the Catadman well, two public and private wells, the Dalingap Spring (located west of C rin) and one surface water source, the Clarin River. Results of analysis are shown in Table VII-1.

Surface Water

Water sample from the Clarin River was of good quality. However, turbidity and color may be a problem during the rainy season.

Surface water would normally require provision of complete treatment facilities, regardless of frequency of rainy periods. When water does not contain a high degree of color and turbidity, direct filtration followed by disinfection may be practiced.

Groundwater

Water quality parameters of Dalingap Spring at Clarin were within acceptable limits. Two wells were tested for chlorides and results were within acceptable limits. Hydrogen sulfide was reportedly present in wells shallower than 25-30 meters. However, deeper wells (45$\pm$) produced better quality water.

Analysis of water samples taken from the proposed spring sources indicates that all the physical and chemical quality parameters are within the acceptable limits.

Findings

Springs and wells produce good quality water. Surface water, if to be utilized, would most likely require some form of treatment particularly in handling seasonal color and turbidity problems.

TABLE VII-1

WATER QUALITY TEST RESULTS

Test/Units		Allowable Limits[2]	Upper Dalingap Spring 23-Jan-75	Lower Dalingap Spring 14-Apr-75	Bitoon Spring 14-Apr-75	Ozamis MSO-3 14-Apr-75
Physical						
Color	(unit)	15		10	10	10
Taste	"	3				
Odor	"					
Turbidity	"	5	0	1	1	1
Solids						
a. TDS	(mg/l)	500	183	153	164	281
b. Suspended	(mg/l)		12	26	12	9
Conductivity	(micromhos/cm)					
Chemical						
pH		7-8.5	7.3	7.8	8.1	8.5
Alkalinity	(mg/l as $CaCO_3$)					
a. Total	"		82	53	46	106
b. Phenolpthalein	"		0	0	0	5
Total Hardness	"		88	42	40	46
Calcium	(mg/l)	75	11.0	11.3	11.2	10.4
Magnesium	"	50	5.0	10.3	10.1	10.5
Iron	"	0.3	0.15	nil	0.02	0.03
Fluoride	"	1.5	0.34	0.03	0.04	0.21
Chloride	"	200	10	14	14	14
Sulfate	(mg/l)	200	3.0	nil	nil	5.3
Nitrate	"					
Manganese	"	0.1	0.008	nil	nil	0.006
Copper	"	1.0	0.002	nil	nil	0.001
Zinc	"	5	0.005	.004	.01	0.009

[2] Philippine National Standard.

TABLE VII-1 (continued)

Test/Units		Allowable Limits[2]	Ozamis MSO-19 13-Apr-75	Clarin MSO-21 13-Apr-75	Clarin MSO-22 13-Apr-75
Physical					
Color	(unit)	15	10	10	30
Taste	"	3			
Odor	"				
Turbidity	"	5	1	1	2
Solids					
a. TDS	(mg/l)	500	312	221	
b. Suspended	(mg/l)		8	94	
Conductivity (micromhos/cm)					
Chemical					
pH		7-8.5	8.2	8.3	8.8
Alkalinity	(mg/l as $CaCO_3$)				
a. Total	"		105	112	216
b. Phenolpthalein	"		3	5	24
Total Hardness	"		13	94	88
Calcium	(mg/l)	75	2.4	5.1	12.7
Magnesium	"	50	2.1	22.6	31.4
Iron	"	0.3	0.02	0.02	0.60
Fluoride	"	1.5	0.07	0.02	0.36
Chloride	"	200	14	12	12
Sulfate	(mg/l)	200	4.7	nil	nil
Nitrate	"				
Manganese	"	0.1	0.001	0.008	0.08
Copper	"	1.0	0.001	nil	0.04
Zinc	"	5	0.010	0.006	0.005

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[2]Philippine National Standard.

CHAPTER VIII ANALYSIS AND EVALUATION OF ALTERNATIVES

A. GENERAL

This chapter identifies the alternatives for the source development, transmission, treatment, storage and distribution systems. The analysis and evaluation presented herein are based largely on economic present worth cost studies. However, selection of the recommended plan may be influenced by non-economic parameters especially if the "best" or "second best" alternatives fall within the degree of cost estimating accuracy.

It is assumed that the engineering design of the first-stage works will start in 1977 and construction phase will be completed in 1980-81. Construction cost estimates of the proposed improvements are based on the projected July 1976 unit prices. All estimates on the imported items are based on an exchange rate of 7 pesos to 1 US dollar. It is assumed that no customs duty will be charged on items imported for this public water supply project.

Preliminary unit costs were developed for estimating construction costs of the proposed facilities (Appendix B).

Total project cost includes construction cost, engineering and contingencies, land cost, administrative and legal fees and interest during construction. Present worth of capital costs is calculated backward from completion time of construction.

Annual costs include labor, power, chemicals and maintenance costs, where applicable. These estimates are carried out for 1975, 1981 (the year when the first stage of proposed improvements is completed), 1990 and 2000. Present worth of annual expenditures is based on uniform and gradient series (where applicable) at 12 per cent interest rate. Cost of any facility to be replaced during the design period (1977-2000) is included under capital costs for that year.[1]

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[1]Service life of facilities:

a) Structures and pipelines	:	50 years
b) Mechanical equipment	:	25 years
c) Land	:	infinite

During economic analysis, no escalation factor is applied to July 1976 unit prices as it is assumed that all the alternatives will be affected approximately with the same rate.

Economic comparison of the alternative schemes is based on present worth of net disbursements during the period of 1977-2000. Annual maintenance cost estimates are based on construction costs of the facilities: for structures and pipelines, 0.5 per cent; and for equipment such as pump and motor, 2.0 per cent of the estimated construction cost is used. Total annual power cost can be estimated with the following formula (where applicable, diesel fuel cost of ₱1.00 per liter is used):

$$M = H \times 0.065 \times 3.78 \times 1.0 \times 8760 \; ^{2/}$$

Personnel and maintenance costs may increase as more facilities are put to operation. Power cost at the pump station will increase gradually in relation to the daily pumpage of water.

Salvage values of the facilities at the end of the design period are important in the computation of net present worth of the total expenditures. With this, comparison of the alternatives can be made at the same economic base. It is assumed that the salvage value of a facility would depreciate by linear method throughout its service life. Therefore, a facility with longer service life will depreciate less than a facility with shorter service life during the same study period. Also, a facility constructed at a later stage will have higher salvage value than a similar one constructed at an earlier date.

The difference between the total present worth cost capital and annual expenditures, and the present worth of salvage values would give the net present worth cost of the alternative.

2/ M = Annual power cost in pesos
H = Horsepower utilized
0.065 = Diesel fuel requirement in gallons per horsepower per hour
3.78 = Conversion factor from gallon to liter
1.0 = Unit diesel fuel cost, in pesos per liter
8,760 = Number of hours in one year

B. SOURCE AND TRANSMISSION ALTERNATIVES

Surface Water Sources

Diversion of surface water flow from the Clarin and Labo Rivers for water supply to the study area may create a potential conflict with the existing NIA irrigation projects on these rivers. Since the minimum flows of these rivers are more or less used up by the irrigation projects, additional and substantial amounts of supply can only be obtained by an impoundment reservoir. This means a high capital cost initially for a dam and appurtenances, raw water intake and transmission line, water treatment plant, booster pump stations and treated water transmission line. Annual maintenance and operating costs would also be relatively high because of the number and complexity of facilities involved. Therefore, at least for the design period, no further consideration is given to the surface water sources.

Groundwater Sources - Wells

Investigation shows that the groundwater potential of the area is not significant. In the past, with the existing private wells operating, piezometric level of the groundwater has continuously declined. This indicates that discharge from the aquifer is more than recharge. Further lowering the water table with additional wells could cause saline water intrusion and possibly reduce the existing spring yields. Therefore, long term reliance on groundwater wells neither appears technically feasible nor practical. In spite of this, however, economy of groundwater supply for the Clarin area was studied because at present there is no public water system in this municipality. The new system, if connected to the springs or to the Ozamiz system for gravity supply, would require relatively long transmission lines. The present worth cost comparison between the local well field development and the gravity system, including capital and annual costs for the period of 1977 to 2000, shows that the supply scheme by gravity is about ₱1.0 million cheaper. Therefore, no further consideration is given to groundwater well supply for the study area.

Groundwater Sources - Springs

As a potential water source to MOWD, the springs have several distinct advantages over deep wells or surface sources. Majority of the springs can serve the study area by gravity flow. The source development is simple, and operation and maintenance costs are relatively low. As the water in general has a good quality, no treatment (other than disinfection) will be required at the source.

Construction works at the springs would include one or several collection chambers, depending on the number and spacing of the spring outlets, and necessary piping for supply connection, overflow and drainage. The Cocok and Regina Springs are 1-2 meters above sea level; therefore, spring water in the collection chamber will have to be pumped into the transmission - distribution system. All the other existing and proposed springs are located at elevations varying from 100 m to 200 m above mean sea level - sufficiently high for gravity supply.

Source Development Alternatives

Locations and estimated safe yields of the springs which are being considered as sources of supply for MCWD are discussed in Chapter VII. With different combinations of these springs, three alternatives are developed and studied in detail.

Regardless of the alternative under study, certain improvements are to be made to the existing facilities at Talibaksan Spring. These improvements will include a 3 km access road to the spring, shut-off valves and flow meters for the existing and proposed piping and miscellaneous structural and site work. These works are scheduled for completion between mid-1977 to mid-1978. The proposed alternative combinations for the future spring developments are discussed below and summarized in Table VIII-1.

Alternative S-1. In this alternative, it is assumed that the Bitoon Spring will be developed first, during the period from 1978 to 1980. The Cocok Spring will be phased out as soon as Bitoon is put into operation. The proposed works at Bitoon will include two collection chambers, necessary piping flow meter and valves, general site improvements and a 3 km long access road. The total estimated yield from Talibaksan and Bitoon is about 6,400 cumd, which is adequate for the area until the year 1982. The Lower Dalingap Spring will have to be developed around 1980-82. The spring has several outlets within about 20-25 m length of a sandy terrain on the north bank of the Clarin River. The required facilities would include a spring collection chamber, necessary piping, valves and flow meter, general site improvements and extension of the access road by about 1 km. A single transmission line will convey the flows from the Bitoon and Lower Dalingap Springs to the service area.

At a later stage, around the year 1995, the Upper Dalingap Spring flows will have to be tapped and transmitted to the distribution system through another pipeline.

TABLE VIII- 1

SUMMARY – SOURCE ALTERNATIVES

Alternative	Spring Development	Construction Period	Cumulative Safe Yield (cumd)	Year When Safe Yield of Springs Needs Augmenting	Remarks
S-1	Talibaksan	1977-78	3,060	-	
	Bitoon	1978-80	6,460	1980	
	Lower Dalingap	1980-82	19,460	1982	
	Upper Dalingap	1995-97	23,460	1997	Only 5,000 cumd out of 15,200 cumd safe yield is included for comparison purposes
S-2	Talibaksan	1977-78	3,060	-	
	Cocok/Regina	1978-80	7,060	1980	
	Bitoon	1981-83	10,460	1983	
	Lower Dalingap	1987-89	23,460	1989	
S-3	Talibaksan	1977-78	3,060	-	
	Lower Dalingap	1978-80	16,060	1980	
	Upper Dalingap	1992-94	23,460	1994	Only 7,400 cumd out of 15,200 cumd safe yield is included for comparison purposes.

Alternative S-2. Following the improvements to the existing Talibaksan Spring facilities, the Coook and Regina Springs under this alternative will be developed to their full capacities. Each of these springs would need construction of a collection chamber, piping including valves and flow metering device, and a pump station. These works are scheduled for completion during the period from 1978 to 1980. Development of the Bitoon Spring will follow that of the Coook and Regina Springs in 1983. Around the year 1989, the Lower Dalingap Spring will increase the total supply to 23,460 cumd - the necessary supply for the year 2000.

Alternative S-3. For this alternative, it is assumed that development of the Lower Dalingap Spring will follow the improvements to the Talibaksan Spring. As soon as the Lower Dalingap Spring is under operation, which is tentatively scheduled for 1980, the Coook Spring will be phased out. The Upper Dalingap Spring will be developed and tied into the system around 1994, during the second stage of construction.

Transmission Alternatives

The basic transmission alternatives are related to the proposed spring development. Therefore, the three alternatives discussed for the source development are also applicable to the transmission lines.

The Talibaksan, Bitoon and Dalingap Springs can be tied into the distribution system either with a single pipeline or with two or more pipes in staged construction.

In order to have a uniform hydraulic grade line in the system, all the excess pressures in the transmission lines are to be dissipated at the hydraulic control chambers, located at about elevation 70 m. The hydraulic control chambers are to be provided at the junction of the transmission lines coming from different spring sources and elevations. This is intended to prevent possible hydraulic interference of flow from one source to another.

Alternative TRN-1. To meet the 1990 water demands of the project area, the Bitoon and Lower Dalingap Springs must be developed during the initial stage of construction. The existing 2 - 150 mm transmission lines from the Talibaksan Spring do not have adequate capacity to carry the required flow and at the same time maintain residual pressure in the distribution system. With consideration given to the future service area limits, a hydraulic grade line (HGL) of 70 m is established for the distribution system. This HGL elevation can easily be achieved since the proposed spring sources are at elevations 100 m or higher. The elevation differences of the proposed springs served by a common transmission line may cause hydraulic interferences and affect the spring flows unless some form of hydraulic control is provided at the junction points. To accomplish this hydraulic control, excess hydraulic energy from one of the sources would be dissipated within the hydraulic control chamber and a new HGL would be established relative to the ground elevation at the location of the control chamber.

A general layout of the existing and proposed transmission facilities are shown in Figure VIII-1. As shown in this figure, the Talibaksan supply line has to be reinforced by a 350 mm diameter pipe from the spring to hydraulic control chamber No. 1. This line plus two existing 150 mm diameter lines will be able to carry the combined flows from the Talibaksan, Bitoon and Lower Dalingap Springs. Sometime in 1980, when Bitoon Spring is developed, a 250 mm diameter pipe will connect it to the Talibaksan transmission line through hydraulic control chamber No. 2. Future (1982) extension of the same transmission line to the Lower Dalingap Spring will be accomplished by a 300 mm diameter pipeline. The Upper Dalingap Spring will be required around 1995 and the supply from this spring will be conveyed to the distribution system by a 200 mm diameter pipe line. (For purposes of comparing alternatives, this transmission line size was computed only for the differential flow of 4,000 cumd which is required from the Upper Dalingap Spring to meet the year 2000 demands).

Additional transmission lines will be needed for connecting major demand centers and the proposed storage tanks to the source. Locations and sizes of these pipes in construction stages 1 and 2 are shown in Figure VIII-1. For this alternative, the storage tank for the Ozamiz area will be located at Bucagan Hill.

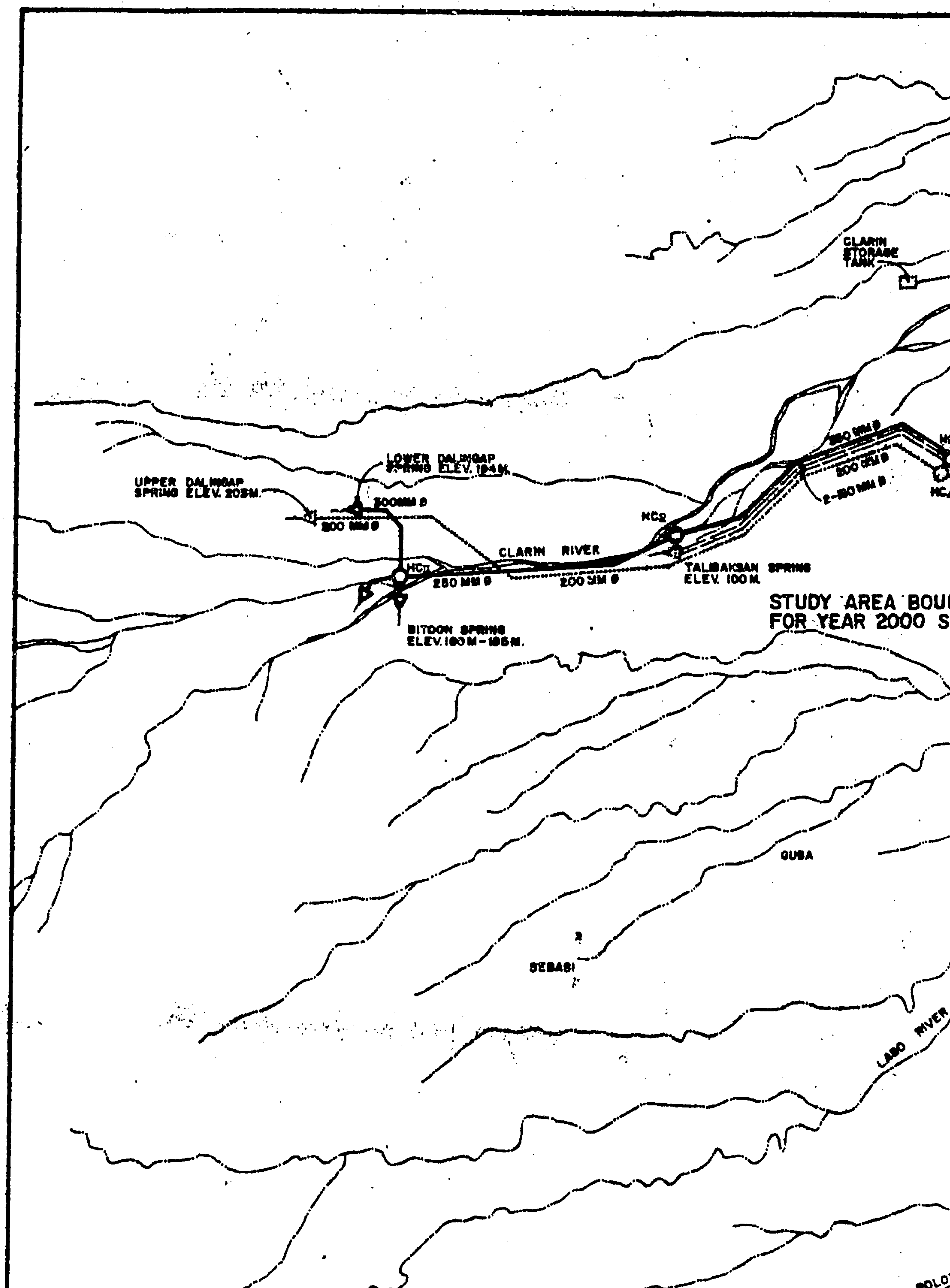
Alternative TRN-2. For Alternative TRN-2, it is assumed that the Cocok and Regina Springs will be developed right after or at the same time with the improvements to the Talibaksan spring. Pump stations at these sources will be needed to boost the HGL to elevation 70 m, as required by the system operation. A 200 mm transmission line will be sufficient to carry the flows from the springs to the Ozamiz distribution system. The proposed pipeline locations from the sources to the demand centers and the storage tank sites, are shown in Figure VIII-2. The storage tank site for this alternative will be on a hill to the west of Ozamiz. (A storage tank adjacent to the pump station at Bucagan Hill may not function properly.) During the initial stage of construction, a 250 mm diameter pipe from Talibaksan to hydraulic control chamber No. 1 and a 150 mm diameter pipe from the Bitoon Spring to the Talibaksan Spring will be constructed. When the Lower Dalingap flows are needed (about 1989), a 300 mm diameter pipe will connect this spring to the transmission and distribution systems.

Alternative TRM-3. Layout of the transmission facilities in this alternative is similar to Alternative TRM-1 except for Bitoon which is not included for development during the design period (1977-2000). The Lower Dalingap Spring will be directly connected to the proposed Talibaksan transmission line in 1980. Pipe sizes required from the Talibaksan Spring to hydraulic control chamber No. 1 and from the Lower Dalingap Spring to Talibaksan are 300 mm and 250 mm, respectively. Around the year 1994, another 250 mm diameter transmission line will convey the water from the Upper Dalingap Spring to the water supply system.

Project Costs

A breakdown of the capital costs for the three alternatives is shown in the following table:

ITEM	Construction Cost (P)	Total Project Cost (P)	Foreign Exchange Components ($)
ALTERNATIVE S1/TRM-1			
STAGE 1 (1977-82)			
Source Development	1,930,000	2,780,000	14,000
Transmission Facilities	21,200,000	30,500,000	1,430,000
Total:	23,130,000	33,280,000	1,444,000
STAGE 2 (1988-97)			
Source Development	185,000	290,000	3,300
Transmission Facilities	16,800,000	24,400,000	1,081,700
Total:	16,985,000	24,690,000	1,085,000
ALTERNATIVE S2/TRM-2			
STAGE 1 (1977-83)			
Source Development	3,550,000	5,140,000	188,500
Transmission Facilities	14,250,000	20,830,000	987,500
Total:	17,800,000	25,970,000	1,176,000
STAGE 2 (1986-90)			
Source Development	340,000	510,000	3,500
Transmission Facilities	14,950,000	21,770,000	815,500
Total:	15,290,000	22,280,000	819,000



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS **CDM-LWUA**

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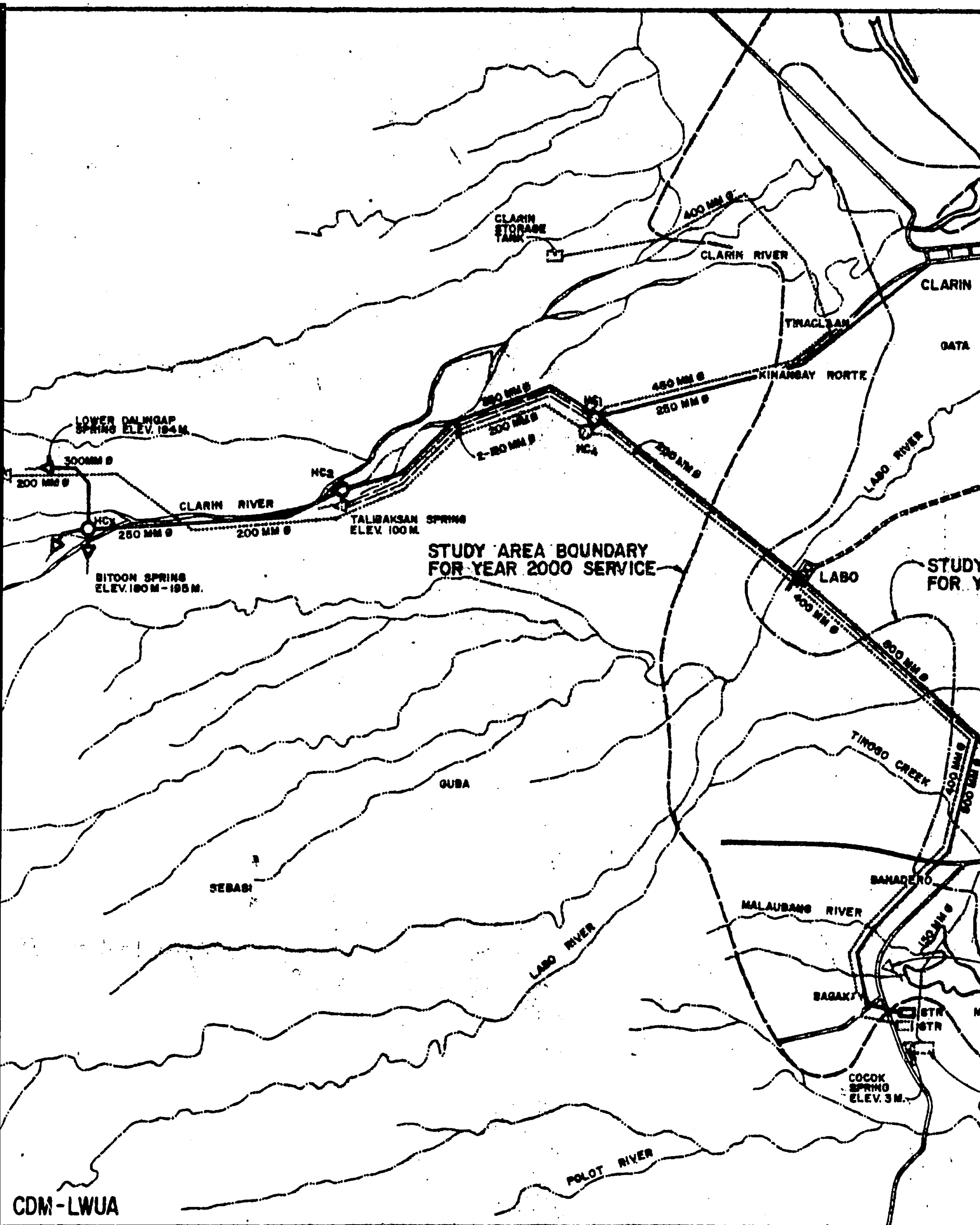

CLARIN STORAGE TANK
400 MM Ø
CLARIN RIVER
CLARIN
TINACLIPAN
GATA
KINANGAY NORTE
450 MM Ø
250 MM Ø
HC1
HC4
250 MM Ø
200 MM Ø
2-150 MM Ø
200 MM Ø
LABO RIVER
LOWER DALINGAP SPRING ELEV. 184 M.
300MM Ø
200 MM Ø
HC2
CLARIN RIVER
HC3
250 MM Ø
200 MM Ø
TALIBAKSAN SPRING ELEV. 100 M.
STUDY AREA BOUNDARY FOR YEAR 2000 SERVICE
BITOON SPRING ELEV. 180 M - 195 M.
LABO
400 MM Ø
STUDY
FOR Y
500 MM Ø
TINOGO CREEK
400 MM Ø
500 MM Ø
GUBA
SEBASI
SANADERO
MALAUBANG RIVER
150 MM Ø
LABO RIVER
SAGAKI
STR
STR
COCOK SPRING ELEV. 3 M.
POLOT RIVER
CDM - LWUA

b

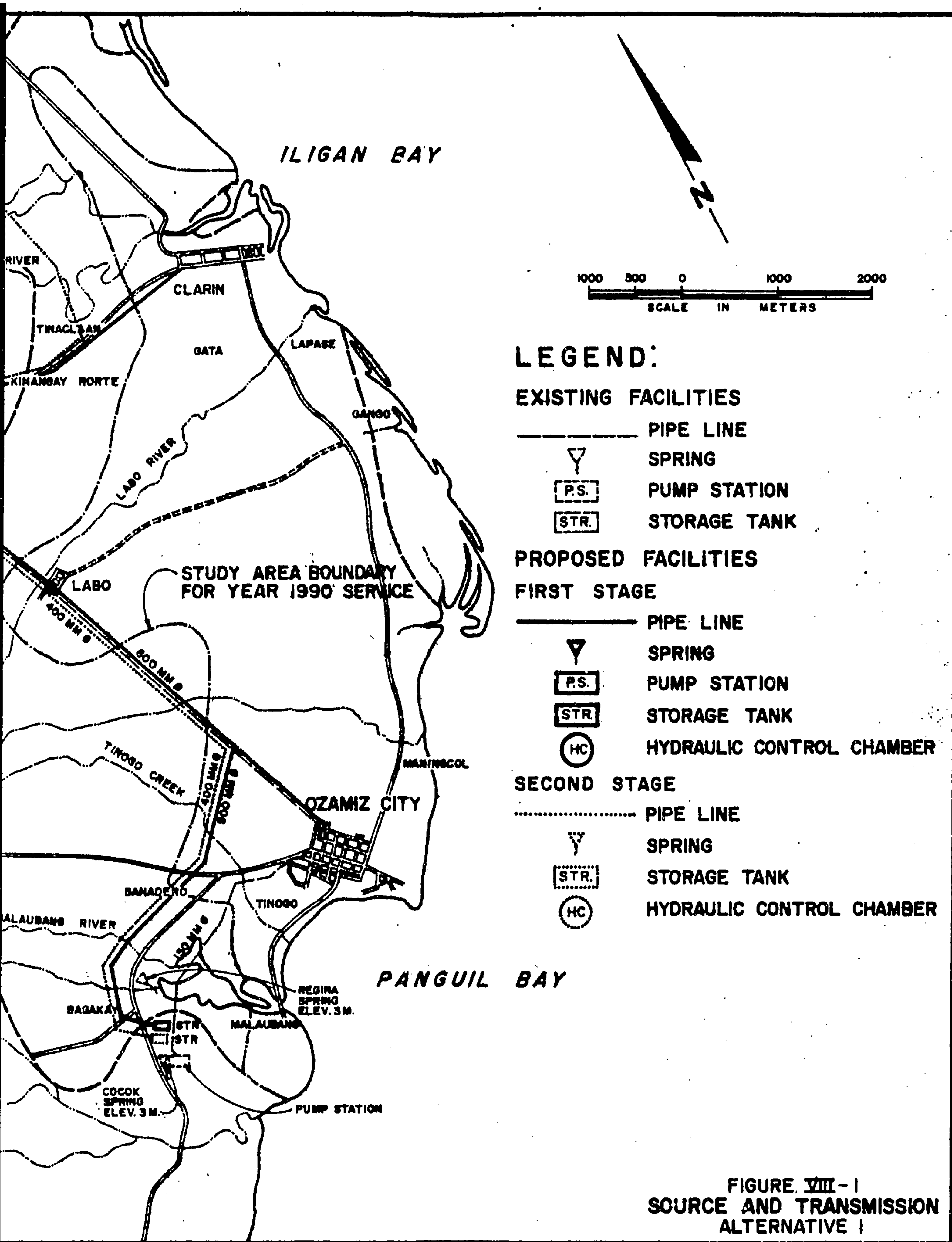
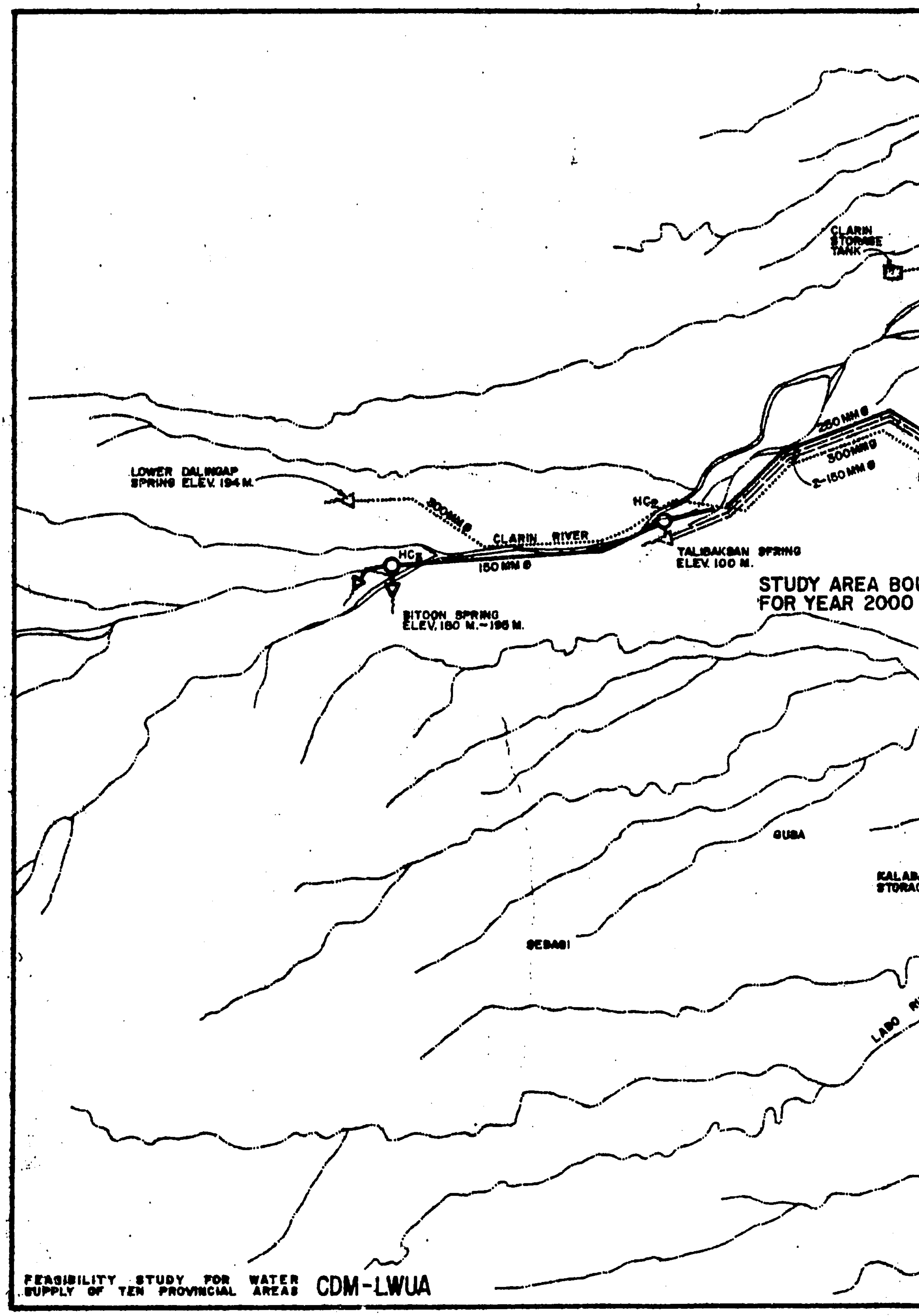
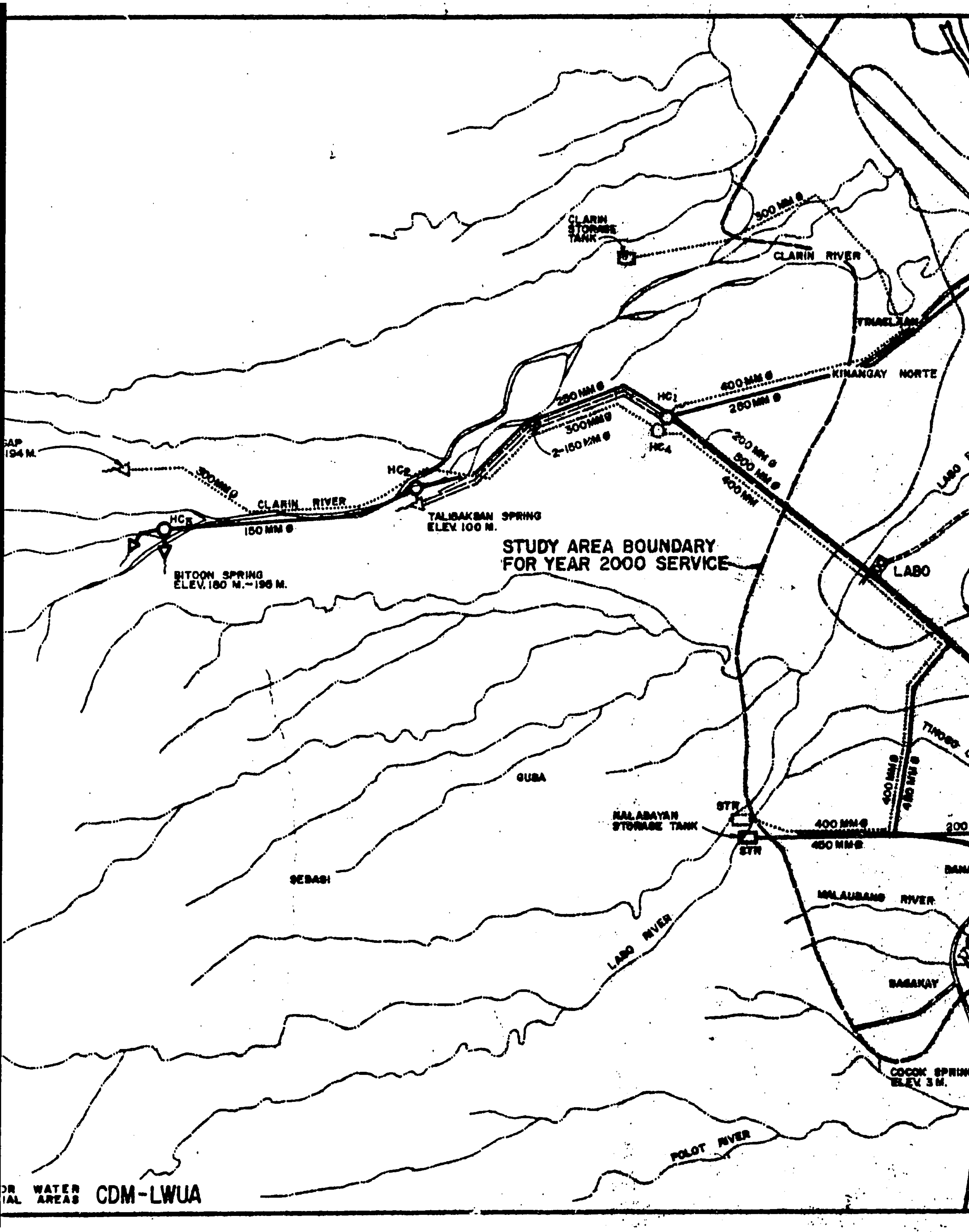


FIGURE VIII-1
SOURCE AND TRANSMISSION
ALTERNATIVE I


CLARIN STORAGE TANK
250 MM Ø
300 MM Ø
2-150 MM Ø
LOWER DALINGAP SPRING ELEV. 194 M.
300 MM Ø
CLARIN RIVER
HC2
150 MM Ø
TALIBAKSAN SPRING ELEV. 100 M.
STUDY AREA BOU
FOR YEAR 2000
BITOON SPRING ELEV. 180 M.-195 M.
GUBA
SEBAGI
LABO RIV
FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS
CDM-LWUA



CLARIN STORAGE TANK
300 MM Ø
CLARIN RIVER
KINANGAY NORTE
400 MM Ø
280 MM Ø
250 MM Ø
300 MM Ø
2-150 MM Ø
HC1
HC4
HC2
200 MM Ø
500 MM Ø
400 MM
194 M.
300 MM Ø
CLARIN RIVER
HC3
150 MM Ø
TALIBAKSAN SPRING
ELEV. 100 M.
BITOON SPRING
ELEV. 180 M.–196 M.
STUDY AREA BOUNDARY
FOR YEAR 2000 SERVICE
LABO
GUBA
MALABAYAN
STORAGE TANK
STR
400 MM Ø
450 MM Ø
SEBASI
MALAUBANG RIVER
LABO RIVER
BAGAKAY
COCOK SPRING
ELEV. 3 M.
POLOT RIVER
WATER
AREAS
CDM-LWUA

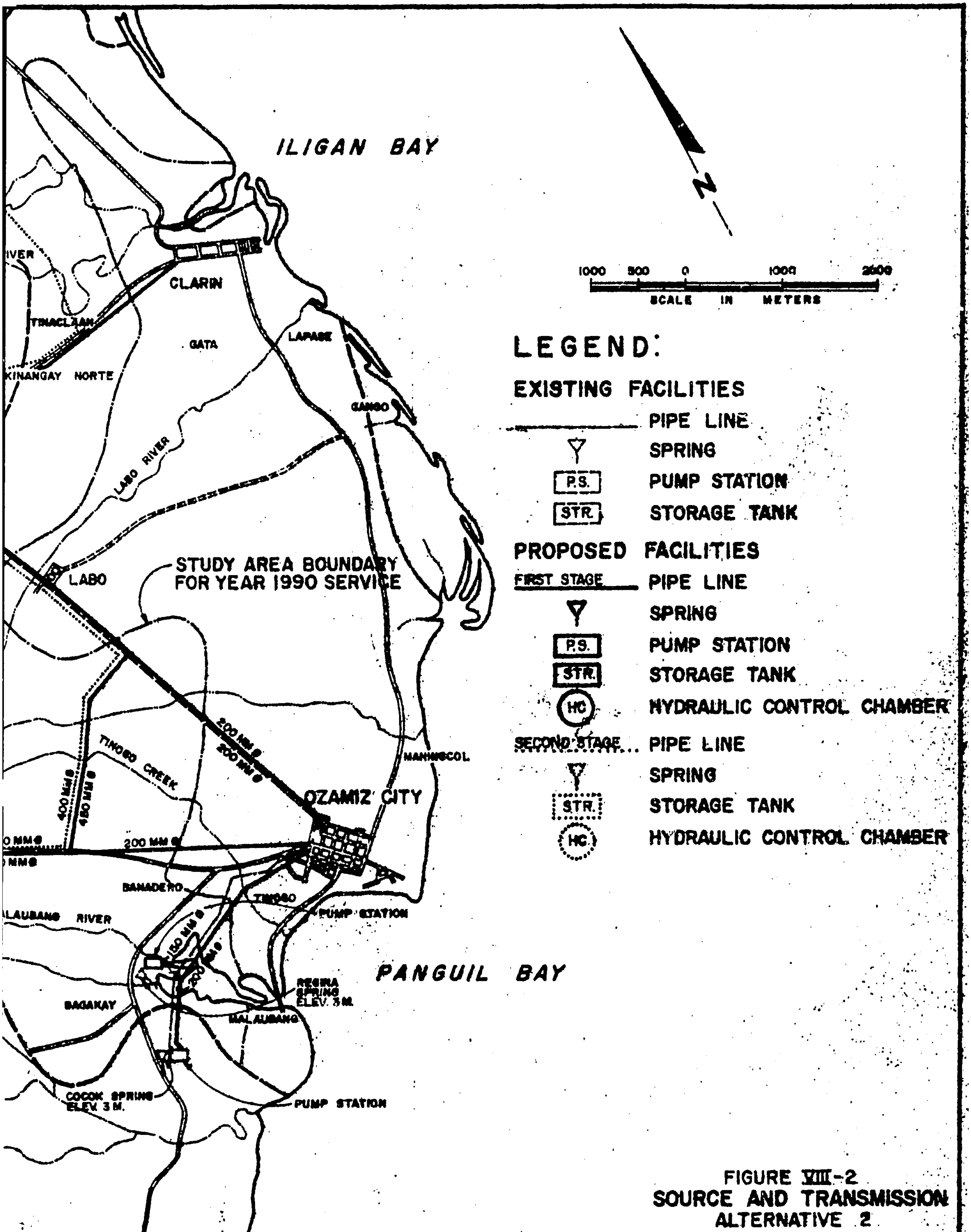


FIGURE VIII-2
SOURCE AND TRANSMISSION
ALTERNATIVE 2

ALTERNATIVE S3/TRN-3

STAGE 1 (1977-81)

Source Development	1,560,000	2,220,000	6,600
Transmission Facilities	20,600,000	29,930,000	1,436,400
Total:	22,160,000	32,150,000	1,443,000

STAGE 2 (1986-94)

Source Development	190,000	300,000	3,500
Transmission Facilities	17,990,000	20,145,000	1,090,500
Total:	18,180,000	20,445,000	1,094,000

Annual Costs

The estimated annual costs of the facilities which are included in the comparison of the alternative spring development and transmission schemes are shown in the following table:

Alternative	Operational Period	Personnel	Maintenance	Power	Total
S1/TRN-1	1978-80	10,000	11,000	-	21,000
	1980-81	10,000	81,000	-	91,000
	1981-82	10,000	119,000	-	129,000
	1982-90	10,000	124,000	-	134,000
	1990-97	20,000	199,000	-	219,000
	1997-2000	20,000	210,000	-	230,000
S2/TRN-2	1978-80	10,000	11,000		21,000
	1980-81	45,000	57,000	88,000	190,000
	1981-82	45,000	66,000	95,000	206,000
	1982-83	45,000	130,000	100,000	275,000
	1983-84	45,000	135,000	105,000	285,000
	1984-89	45,000	138,000	110,000	293,000
	1989-90	45,000	141,000	122,000	308,000
	1990-2000	55,000	228,000	122,000	405,000
S3/TRN-3	1978-80	10,000	11,000	-	21,000
	1980-81	10,000	80,000	-	90,000
	1981-90	10,000	118,000	-	128,000
	1990-94	20,000	193,000	-	213,000
	1994-2000	20,000	210,000	-	230,000

Salvage Values

Estimated salvage values of the alternative schemes for the year 2000 are shown by construction stage in the following table:

Alternative	Construction Stage	Construction Cost (P)	Salvage Value In Year 2000 (P)
S1/TRM-1	1	23,100,000	13,600,000
	2	17,000,000	13,870,000
S2/TRM-2	1	17,740,000	11,100,000
	2	16,294,000	11,660,000
S3/TRM-3	1	22,170,000	13,730,000
	2	18,200,000	14,600,000

Net Present Worth Cost

The net present worth cost of each alternative scheme is shown in Table VIII-2. As indicated in this table, Alternative S2/TRM-2 is the least-cost scheme. Alternatives S1/TRM-1 and S3/TRM-3 are practically equal. The initial project cost of Alternative S2/TRM-2 is about P6.0 million less than the other alternatives.

In Alternative S2/TRM-2, it is assumed that the Cosok and Regina Springs will be developed at about the same time with the improvements to the Talibaksan Spring supply and transmission facilities. Because of proximity of the Cosok and Regina Springs to the service area, initial investments for the transmission lines in Alternative S2/TRM-2 would be greatly reduced and large sums of investments for the other transmission lines would be delayed. Another advantage in Alternative S2/TRM-2 is having water supply coming from two opposite directions. Such condition would increase the reliability of supply and improve operational pressure during peak-hour demands.

TABLE VIII-2

SOURCE DEVELOPMENT AND TRANSMISSION ALTERNATIVES
PRESENT WORTH COST COMPARISONS

Alternative	Stage	Construction Period	Total Project Cost (P)	Annual Costs (P) 1980	Annual Costs (P) 1990	Annual Costs (P) 2000	Present Worth Costs (P) Capital	Present Worth Costs (P) Annual	Present Worth Costs (P) Total	Present Worth of Salvage Value in Year 2000	Present Worth of Net Disbursements 1977–2000
1	1	1977–82	33,280,000								
	2	1988–97	24,690,000								
				21,000	134,000	230,000	25,160,000	660,000	25,810,000	1,810,000	24,000,000
2	1	1977–83	25,970,000								
	2	1986–90	22,280,000								
				21,000	308,000	405,000	19,315,000	1,463,000	20,778,000	1,510,000	19,278,000
3	1	1977–81	32,150,000								
	2	1986–94	20,445,000								
				21,000	128,000	230,000	24,990,000	660,000	25,650,000	1,870,000	23,780,000

C. TREATMENT ALTERNATIVES

All of the spring sources yield good quality water with the exception of Coook Spring which contains 0.55 mg/l iron. This amount of iron in a public water supply is slightly above the desirable limit (0.3 mg/l). Iron in the groundwater can be precipitated by aeration or chlorination and then removed by sedimentation. Considering the small amount of excess iron and its public acceptance in the past, provision of iron treatment facilities at Coook may not be economically justified. The springs at the source are basically free of any man-made pollution. However, to preserve its natural potability in the distribution system, chlorine application at suitable points of the system would be recommended. A residual chlorine in the amount of 0.2 mg/l will provide adequate protection against potential contamination in the distribution system. Effective treatment with chlorine can be accomplished if sufficient detention time (about 15 minutes) is provided. In the proposed system, the most effective point for chlorine application would be at the downstream portion of the hydraulic control chambers. Other water treatment alternatives are discussed in Appendix VIII-C.

D. DISTRIBUTION ALTERNATIVES

The distribution alternatives in the MOWD are distribution main staging; storage location and staging; and the provision of fire flow requirements within the internal distribution network. Evaluation of these distribution system components and their alternatives is presented in this section. The distribution system components and alternatives are discussed in Appendix VIII-D.

Each component of the distribution system is designed to meet certain conditions of flow - - peak-hour flow, maximum daily flow, and fire flows - - or certain pressure requirements for the flow conditions. The peak-hour and maximum daily flow requirements are listed in Table VI-7.

Distribution Mains

As discussed in Appendix VIII-D the minimum size for distribution mains is generally 200 mm and, under some circumstances, 150 mm. Since these are minimum acceptable sizes, it is not recommended that these sizes be staged. However, where possible, all distribution mains which could be constructed in two construction phases have been so designated in the recommended plan.

The location of the future distribution mains has been planned along existing planned street rights-of-way where possible. Distribution main spacing is maintained at approximately 1,000 m intervals. To avoid dead ends in the system, the distribution main network is looped as much as possible.

Storage Facilities

Storage facilities are designed to provide 15 per cent of the maximum daily flow requirements. For 1990 the storage requirement is 2,000 cum and for year 2000, 3,500 cum. By establishing the hydraulic grade lines at the source and distribution storage at an elevation of 70 m, it is possible for the MOWD to provide service to areas up to an elevation of 50 m. This will enable the MOWD to serve ultimately an area of 4,200 ha without having to install booster pump stations. The location of storage is limited to a site having an elevation between 63 m and 68 m, allowing for a 7 m operational range. In the Ozamiz-Clarin area, three sites meet the desired criteria. These are located as follows:

Site 1 - Near Barrio Kalabayan northwest of Ozamiz and 4.8 km from the core city of Ozamiz.

Site 2 - On the Bucagan Hill southwest of Ozamiz and 2.8 km from the core city of Ozamiz.

Site 3 - Near Barrio Loocson northwest of Clarin and 5.6 km from the poblacion of Clarin.

For source alternatives S1 and S3, Sites 2 and 3 were used as the distribution storage sites. However, for source alternative S2, storage located at Bucagan Hill is too close to the Cocok and Regina Springs pump stations to contribute the proper flow during peak hour conditions. Therefore, Sites 1 and 3 were used for alternative S2. For the source/transmission alternatives, the following storage volumes were used:

	Construction Stage	Storage Volume (cum) for Alternative S1/TRN-1	S2/TRN-2	S3/TRN-3
Site 1	1978-1980	1900		1900
	1988-1990	900		900
Site 2	1978-1980		1900	
	1988-1990		900	
Site 3	1988-1990	700	700	700

The storage locations and transmission lines connecting the storage to the distribution system are shown in Figures VIII-1 and VIII-2. Storage for Clarin is postponed to 1990 because of its proximity to the hydraulic control chamber and the longer distance to Site 3. The required storage volumes at Sites 1 and 2 were staged by installing 2,000 cum in 1980 and another 800 cum in 1990. Staged construction is discussed in Appendix VIII-D. The storage tanks will be located approximately on-grade and will permit an HGL range of 7 m from 63 m at the outlet elevation to 70 m at the overflow elevation. The structures will be of reinforced concrete and covered.

After selection of source/transmission alternative 2 as the recommended scheme, additional storage alternatives were considered. These alternatives and the final storage recommendations are described in Appendix VIII-D.

Internal Network

The existing internal network in MOWD will be incorporated into the long-term improvement program by connections at several points to new distribution mains and by reinforcement of the existing network. Field studies indicate that the carrying capacity of existing 100 mm and 150 mm pipes has not deteriorated and, therefore, can be kept in service. However, new, larger fire hydrants should be installed; pipes in sizes less than 100 mm should be replaced; dead-end pipes should be looped; new valves should be installed; and streets without service should be extended service. A 22 ha area of the core city was examined to determine the approximate costs of reinforcing the internal network. The estimated costs and number of pipes and valves are listed in Table VIII-3.

Table VIII-3 also includes the construction costs for the service area extension to new areas. The costs estimates are based on recommendations discussed in Appendix VIII-D. For MOWD an average of 100m/ha of pipe is assumed to be installed in the service area extension. The minimum pipe diameter recommended is 100 mm.

Hand Pump Wells

Hand pump well for urban areas is discussed in Appendix VIII-D. In summary the hand pump well is not preferable to a piped water system because of the lower level of service and the marginal cost advantage. However, in rural areas not likely to be near the piped water system, the hand pump well is more economically favorable.

TABLE VIII-3

INTERNAL NETWORK COST

	Description of Area	Internal Network Component	Average Requirement per Hectare Served	Construction Cost (P/ha)	Foreign Exchange Component (US$/ha)
A.	Reinforcement of Existing Network	Pipes			
		100 mm	30m/ha	4,350	135
		150 mm	40m/ha	9,800	312
		Valves			
		100 mm	.80/ha	1,632	
		150 mm	.30/ha	840	
			Total (Rounded)	16,600	440
B.	Service Area	Pipes			
		100 mm	80m/ha	11,600	360
		150 mm	20m/ha	4,900	156
		Valves			
		100 mm	.40/ha	816	
		150 mm	.10/ha	280	
			Total (Rounded)	17,700	520
C.	Fire Protection Service				
	High-Value Area	150 mm Hydrant	.57/ha	5,000	
	Residential Area	100 mm Hydrant	.20/ha	1,600	

E. OTHER ALTERNATIVES ON WATER CONSERVATION AND AUGMENTATION

In areas where water is a soarce resource there are several alternative measures of conserving water. These alternatives depend on sophisticated technology in the case of water reuse and desalting or governmental policy in the case of land management. Appendix VIII-E is a discussion of these conservation and augmentation alternatives.

CHAPTER IX DESCRIPTION AND COST OF THE RECOMMENDED PLAN

A. GENERAL

Deficiencies of the existing water supply system can only be eliminated by upgrading the quality and increasing the quantity of water delivered the service area. This will require undertaking an extensive construction program including source development, treatment, transmission and distribution facilities.

This chapter describes the early action program required; the first and second stage construction programs; their capital and annual costs; other ongoing considerations; sewerage and drainage concepts; monitoring of water quality and flows; updating the water supply master plan; and the environmental statement. (Appendices A, B, C and D are discussions of the Design Criteria, Basis of Cost Estimates, Construction Materials and Methods and Outline Specifications.)

B. EARLY ACTION GUIDELINES

While the findings and recommendations of the final report are being discussed, pending their approval by the Water District, LWUA and financial agencies, certain steps may be taken to facilitate "early action" in the MOWD water supply system. These early action guidelines are as follows (costs are shown in Table IX-1):

General Planning and Administration

1. Continue the publicity and promotional campaign concerning the water supply feasibility studies so that Water District customers are kept fully aware of the impending improvements and prepare them for the anticipated water rate increases.

2. Discuss in detail within the Water District ideas relative to raising the implementation funds (both peso and foreign exchange components).

3. Strengthen the legal basis for development of new water sources, and prepare for the implementation and enforcement of policies involved.

4. Conduct a physical inventory and survey of the existing water supply and sewerage systems, and all connections to private premises. An inventory of all private wells, septic tanks, and private and public drainage systems should be included.

5. Initiate a sewerage/drainage feasibility study after the planning of water supply facilities is completed. In connection with this study, conduct an oceanographic survey of the Iligan and Panguil Bays.

6. With consultation, adopt a flexible and enforceable plumbing code in anticipation of the proposed water supply facility improvements and future sewerage/drainage schemes. The use of thin-wall Schedule 20 steel pipe for water service connections should be discontinued. It is recommended that PVC pipe be used for service connections.

7. Initiate improvements to the management, engineering and maintenance procedures of the Water District in accordance with the established LWUA guidelines, in anticipation of future requirements that may be imposed by lending agencies.

8. Purchase calculators, typewriters, addressograph and validating machines, miscellaneous items of office equipment/furniture, and appropriate technical books for a basic Water District Library.

Land Acquisition and Data Collection

9. Acquire the land to cover proposed water sources, storage tank sites, administration, laboratory and shop facilities, as well as rights-of-way for proposed transmission pipelines. Conduct detailed topographic surveys of all these proposed sites for future facilities.

10. Initiate a routine hydrologic and meteorological data collection program by establishing rainfall and evaporation gaging stations in the Water District. Also initiate a continuous program to monitor flows from the existing and proposed spring sources. (According to the National Water Resources Council, it has available funds for the purchase of such monitoring equipment.)

Operational Improvements

11. Meter all existing flat rate service connections. Purchase and install the required water meters. (There are approximately 450 connections with non-functioning meters and no meters in MOWD.)

14. Continue with leakage surveys of the existing water supply system, identifying actual and potential cross-connections between the water supply system and pollution sources. Perform the necessary pipeline repairs and valve repairs/replacements discovered during the surveys.

15. Purchase three additional vehicles (one $\frac{1}{2}$ or $\frac{3}{4}$ ton pick-up truck and two jeep-type, four-wheel drive vehicles for use by the Water District staff).

16. Purchase three complete sets of pipe drilling/tapping machines for the installation of customer services on distribution pipes.

17. Purchase and install on the Talibaksan/Ozamis transmission pipeline four automatic vacuum/air release valves.

18. Make minor repairs, pipe interconnections, etc., to existing pipes to ensure maximum service to existing customers.

TABLE IX-1

COST ESTIMATES FOR EARLY ACTION WORKS

Item	Estimated Construction Cost (₱)	Estimated Foreign Exchange Component (US $)
1. Land		
Sources (acquire 3 ha)	60,000	
Transmission Line (Rights-of-Way)	6,000	
Storage Tank (2 x 2 ha)	80,000	
Adm. Building (0.25 ha)	125,000	
	271,000	
2. Water Analysis Equipment		
Chlorine Residual Sets	4,000	500
	4,000	500
3. Disinfection Equipment		
Coook Spring	20,000	2,500
Storage Tank Site	20,000	2,500
	40,000	5,000
4. Hydrologic, Meteorological & Spring Data Collection		
a. Spring gaging 4 sites @ ₱1,000, 1 site @ ₱2,000	6,000	
b. Meteorological stations	15,000	1,500
	21,000	1,500
5. Leakage Surveys, etc.		
a. 4 Geophones	5,600	800
b. Valve maintenance/replacement	23,000	
	29,000	800
6. Drilling/Tapping Machines		
3 sets	23,000	3,000
	23,000	3,000

TABLE IX-1 (Continued)

COST ESTIMATES FOR EARLY ACTION WORKS

Item	Estimated Construction Cost (₱)	Estimated Foreign Exchange Component (US $)
7. Vacuum/Air Release Valves		
4 each	3,000	400
	3,000	400
8. Miscellaneous Repairs, Interconnections, etc.	7,000	
	7,000	
9. Vehicles		
2 Jeeps	100,000	14,000
1 Pick-Up Truck	50,000	7,000
	150,000	21,000
10. Office Equipment		
2 Calculators	2,100	300
2 Typewriters	6,000	860
1 Addressograph	25,000	3,400
1 Validating Machine	10,000	1,300
3 Filing Cabinets	3,000	
	46,000	5,900
Sub-Total	594,000	38,000
15% Contingencies	89,000	5,700
Total Project Cost	₱683,000	$ 44,000

C. FIRST STAGE OF LONG-TERM RECOMMENDED PROGRAM

As a result of the alternative studies which were described in Chapter VIII, Alternative 2 has been selected as the recommended scheme for source development and transmission facility construction. Certain modifications have been made to the selected alternative for purposes of construction phasing and cost minimization. The construction of treatment facilities, distribution system piping and internal distribution system network will proceed simultaneously to provide a balanced source/transmission/distribution construction program.

The first stage of the proposed program will be implemented in three construction steps and the second stage in two construction steps. Each construction step or phase would be about 4 to 5-year period The major exception to this is Stage II Phase A which begins in 1984 and ends in 1995, since the development of Lower Dalingap Spring must be implemented in 1984-86 (refer to water supply-demand chart, Figure IX-1). Because this additional source will provide enough water supply to the MOWD (Ozamiz and Clarin) to satisfy demands until year 2000, the cost of the development of this source has been included in the Stage II program.

Construction Phase I-A (1977-82)

Source Development. The Cocok and Regina Springs will be developed first and tied into the existing distribution system. There are several springs emerging around the Regina swimming pool. These springs which have a total minimum yield of approximately 1,000 cumd will be collected and pumped into the Ozamiz system. The existing facilities at Cocok Spring produce approximately 15 per cent of the total estimated minimum spring yield. The proposed new collection facilities and pump station at Cocok will fully utilize the expected spring yield (estimated to be approximately 3,000 cumd). The distance between the Cocok and Regina Springs is approximately 500 m, and they are located such that they can be connected to a common transmission line to supply the Ozamiz area. All necessary appurtenances such as valves, flow meters and recording devices will be incorporated into the pumping facilities.

During this construction phase, certain improvements will be made to the existing facilities located at Talibaksan Spring. These improvements will not substantially interfere with water supply to the service area and will include general site and structural improvements, installation of valves on the existing transmission lines and provision of flow metering devices.

Along with the above works on the Cocok, Regina and Talibaksan Springs, it is proposed that the Bitoon Spring site be developed during this construction phase. Bitoon Spring has several outlets

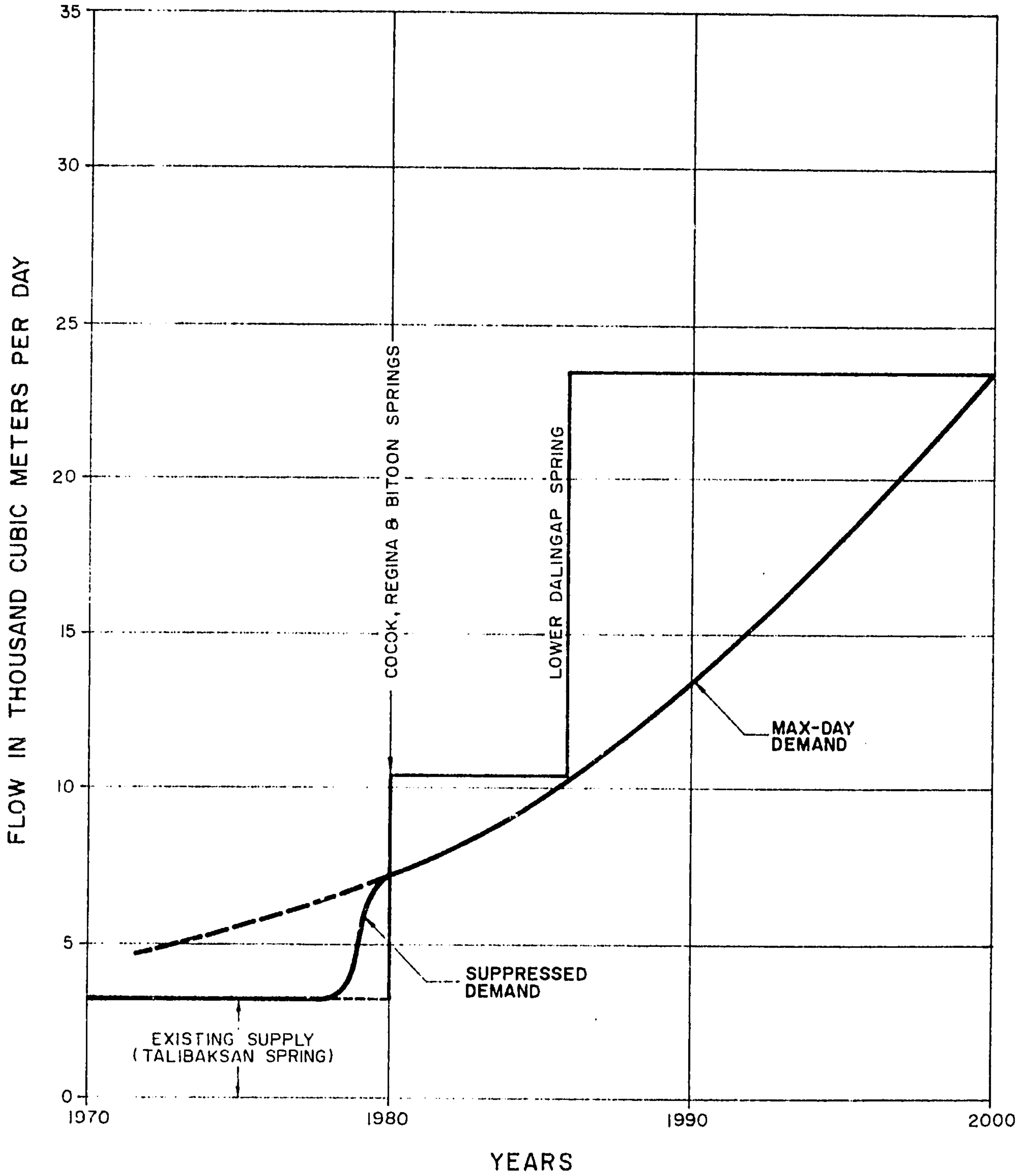


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FIGURE IX-1
WATER SUPPLY-DEMAND CHART

which will be tapped separately and brought together at a collection chamber constructed at the location of the spring outlet of lowest elevation. It will be necessary to construct a 3-km access road to this site. All appurtenances such as valves, flow metering devices, overflows and drain pipes will be included.

The proposed works at Cocok, Regina, Talibaksan and Bitoon Springs scheduled for the period 1977-80, will provide an estimated minimum total spring yield of approximately 10,400 cumd. This amount of source capacity will be adequate to satisfy the projected demand of the Water District until 1986 (Figure IX-1).

Transmission Facilities. The first line to be installed will be the line from Cocok and Regina Springs. A 150 mm line from Cocok will parallel the National Road and will be connected to a 200 mm line at the junction of the National Road and the road to Barrio Kalabayan. Regina Spring water will be pumped through a 150 mm line which will be connected to the existing 150 mm Cocok transmission line. The present section of 100-m pipe which joins the existing Cocok transmission line to the distribution system will be reinforced with a 150 mm line. (See Figure IX-2, appended and Appendix Figure IX-C-1.)

The existing two 150 mm transmission pipelines from Talibaksan Spring are adequate for the Talibaksan Spring flow, but will have to be reinforced with a 3,120 m long, 250 mm pipeline in order to carry additional flow from Bitoon Spring. The Bitoon Spring flows will be transmitted from the Spring to the hydraulic control chamber located near the Talibaksan Spring site via a 2,600 long, 200 mm pipeline.

Talibaksan Spring is located at an elevation of 100 m. The existing parallel 150-mm pipelines will remain essentially unchanged and will discharge into the new storage tank to be located at an elevation of 70 m. A valved connection between the existing 150-mm pipelines and the hydraulic control chamber located on the Bitoon Spring pipeline will be provided to permit flow diversion if required for the existing pipes.

Because Bitoon Spring is located at such a relatively high elevation (180 m), a hydraulic control chamber will be required in its delivery pipeline to ensure that the maximum static pressure encountered is maintained at a reasonable level. The hydraulic control chamber to be employed is a small concrete structure with a vertically hanging baffle facing the inflow from the source. Energy dissipation is accomplished by the impact of the incoming jet of water on the vertical baffle, and by the eddies or turbulence created by the directional change of the jet after it strikes the baffle. This type of hydraulic control chamber is illustrated in Appendix Figure IX-C-2. A similar energy dissipation structure will be incorporated in the inlet portion of the storage tank to be located at the junction of the Bitoon and Talibaksan pipelines (near Barrio Segatic). The existing uncovered storage tank located along the existing pipeline from Talibaksan Spring will have to be abandoned because its location and elevation are not compatible with the effective operation of the new system.

Profile of the proposed pipeline from the springs to the proposed source storage tank is shown in Appendix Figure IX-C-3.

A transmission line from the proposed source storage tank will be extended to Clarin. The completion of this line should coincide with the development of Cocok and Regina Springs. A 200 mm line will be installed from the source storage tank in Barrio Segatic to Barrio Kinangay Norte, where it will be reduced to 150 mm pipe extending to the Poblacion of Clarin.

A 250 mm line will be installed from the source storage to a point about 3 km from Ozamiz City. At this point, the line will be reduced to a 250 mm pipe and will extend to Ozamiz City.

Phase I-A transmission lines are listed in Table IX-2.

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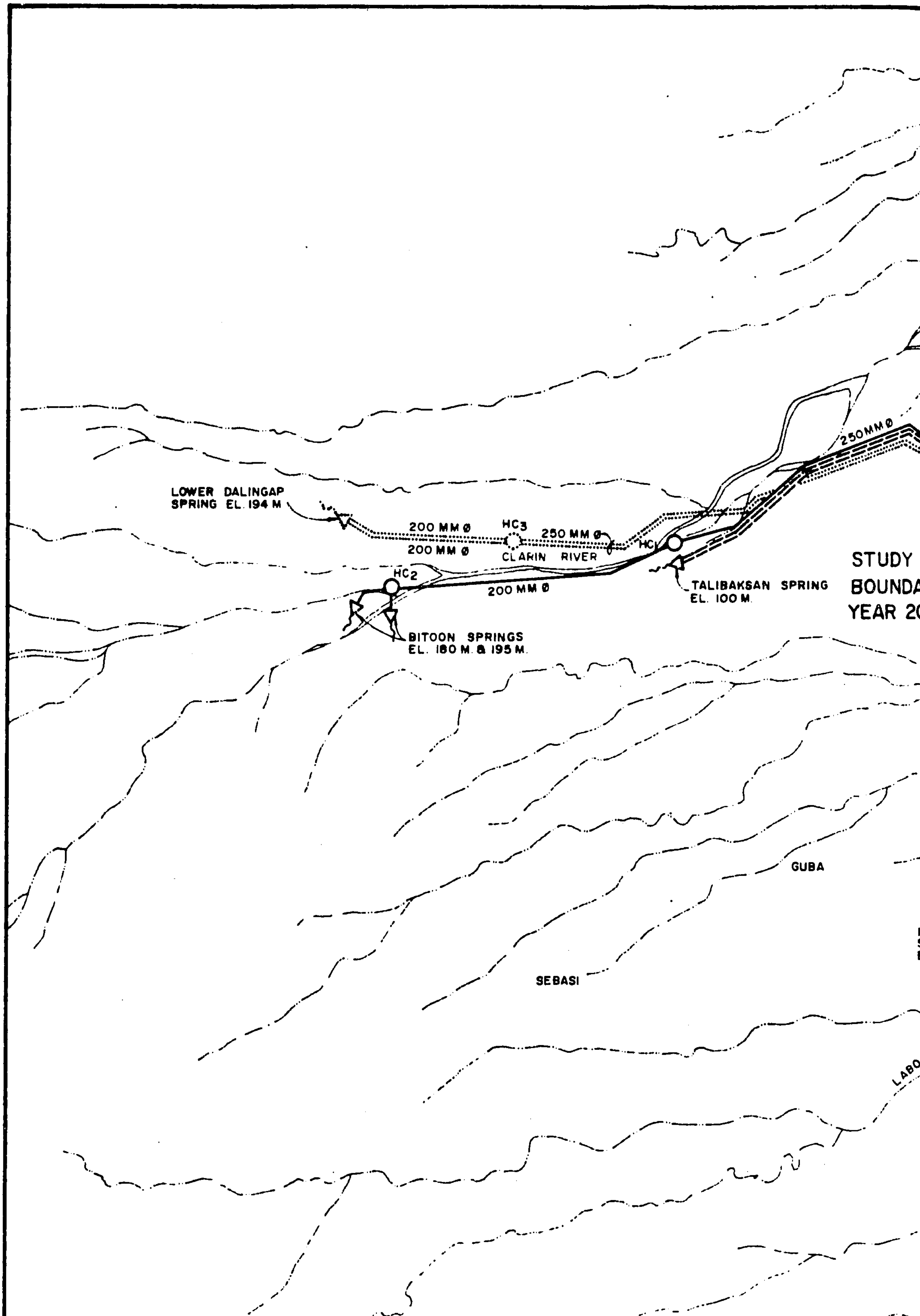
TABLE IX-2

FIRST STAGE PHASE A TRANSMISSION LINES

Location	Construction Period	Pipe Size (mm)	Pipe Length (m)
Cocok Spring to Ozamiz City	1977-78	150 200	2,870 900
Regina Spring to National Road	1977-78	150	1,220
Talibaksan Spring to the Source Storage Tank	1978-79	250	3,120
Bitoon Spring to Talibaksan	1979-80	200	2,600
Source Storage Tank to Clarin	1978-79	200 150	2,150 1,350
Source Storage Tank to Ozamiz		250 200	3,550 2,850



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS
CDM-LWUA

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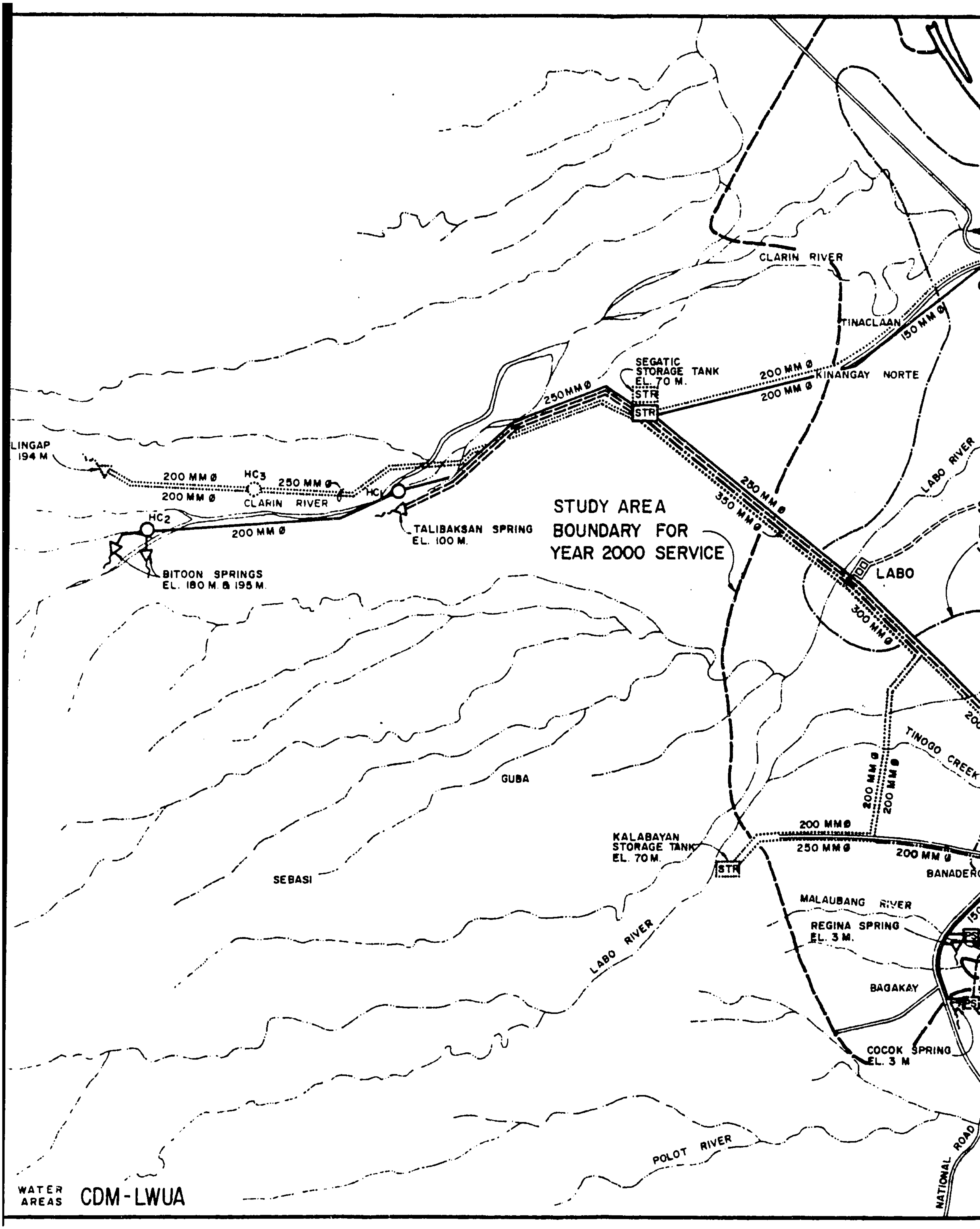
CLARIN RIVER
TINACLAAN
150 MM Ø
SEGATIC STORAGE TANK EL. 70 M.
STR
200 MM Ø
KINANGAY NORTE
200 MM Ø
250 MM Ø
LINGAP 194 M
200 MM Ø
HC3
250 MM Ø
200 MM Ø
CLARIN RIVER
HC1
HC2
200 MM Ø
TALIBAKSAN SPRING EL. 100 M.
BITOON SPRINGS EL. 180 M. & 195 M.
STUDY AREA BOUNDARY FOR YEAR 2000 SERVICE
250 MM Ø
350 MM Ø
LABO RIVER
LABO
300 MM Ø
TINOGO CREEK
200 MM Ø
200 MM Ø
GUBA
200 MM Ø
KALABAYAN STORAGE TANK EL. 70 M.
STR
250 MM Ø
200 MM Ø
BANADERO
SEBASI
MALAUBANG RIVER
REGINA SPRING EL. 3 M.
LABO RIVER
BAGAKAY
COCOK SPRING EL. 3 M
POLOT RIVER
NATIONAL ROAD
WATER AREAS
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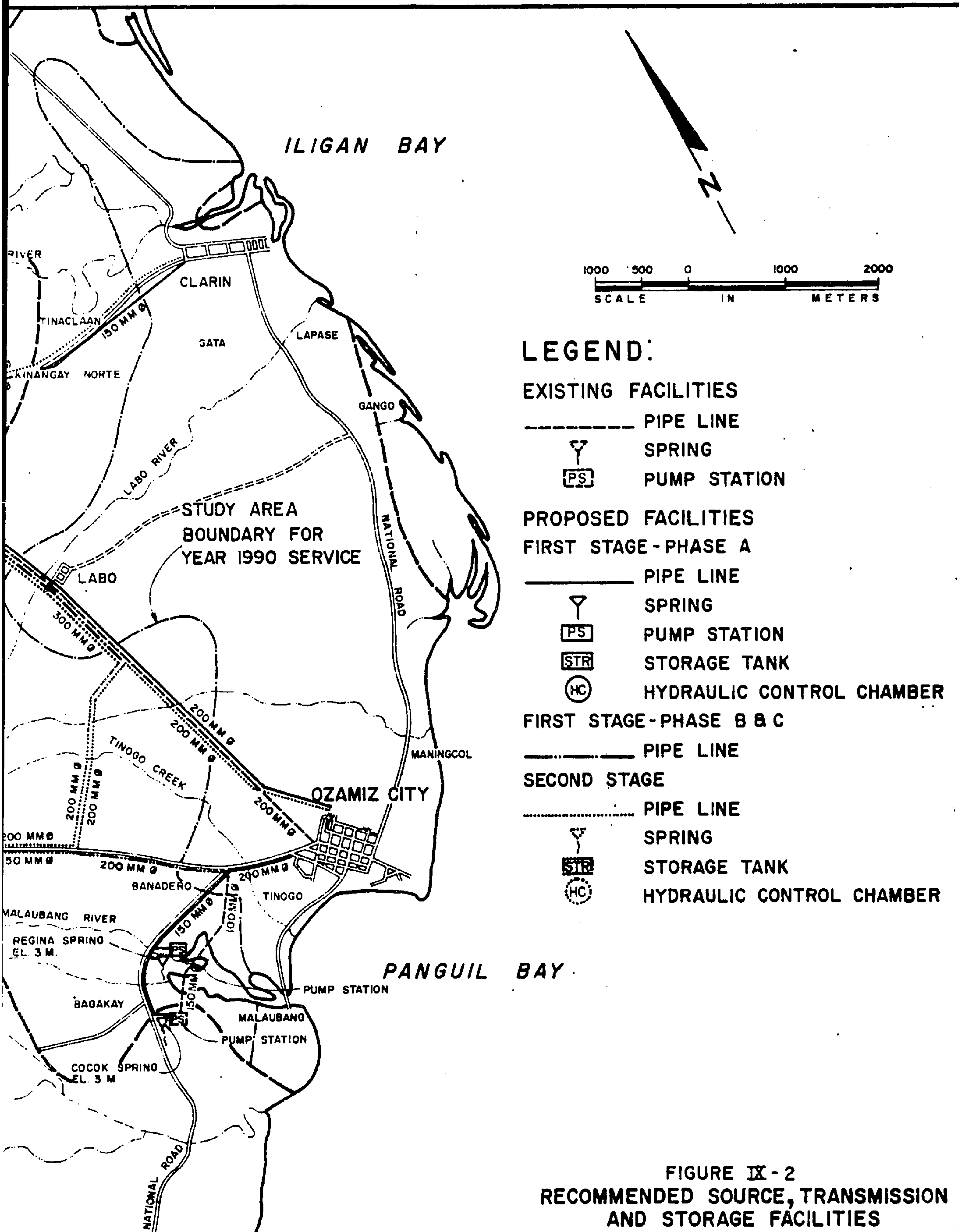

FIGURE IX - 2
RECOMMENDED SOURCE, TRANSMISSION
AND STORAGE FACILITIES

C

The transmission lines will be equipped with adequate number of shut-off valves. Cost estimates for the valves are based on their sizes reduced one nominal size lower than the diameter of the corresponding transmission line.

The number of valves and sizes required for the transmission lines is as follows:

Size (mm)	Number
100	2
150	24
200	8

Storage Tank. Concurrent with the construction of the Talibaksan Spring transmission line, a 1,900 cum ground storage facility will be constructed in Barrio Segatic at a ground elevation of about 67 meters. The tank will have a 3 m operational range and will control the system HGL between 67 and 70 m. Water leaving the storage tank will be measured and chlorinated.

Treatment Facilities. Treatment required for the existing and proposed spring sources is disinfection by chlorination. For the Cocok and Regina Springs it is proposed that the chlorination facilities, provided in the Early Action Program, be initially installed at the Cocok Spring pump station and subsequently moved to the Regina Spring pump station upon its completion. Two units will be provided and will be located in a separate room adjacent to the pump station. For the Talibaksan and Bitoon sources, effective chlorination can be accomplished by provision of chlorinators adjacent to the transmission pipelines just downstream of the storage tank near Barrio Segatic. It is suggested that all chlorinators be of the same type, to the greatest extent possible, to facilitate repair and replacement.

Distribution Mains. The recommended schedule for installation of distribution mains is listed in Table IX-3 and locations are shown schematically in Figure IX-3.

TABLE IX-3

FIRST STAGE PHASE A DISTRIBUTION MAINS

Construction Period	Description	Pipe Number	Node From	Node To	Pipe Size (mm)	Pipe Length (m)
1978-79	Ozamiz City	21	2	3	150	200
" "		23	2	1	200	370
" "		24	1	4	150	590
" "		25[1/]	1	21	150	500
1980-81		20	3	5	150	750
" "		19	5	6	200	650
" "		7	6	4	200	920
1978-79	Clarin City	13	11	12	150	700
		14	12	14	150	500

In Ozamiz City the following lines will be installed: a 150 mm main along Bonifacio Street between Pingol and Rizal Streets; a 200 mm main on Pingol Street from Burgos Street to Bonifacio Street; a 150 mm main along Pingol Street from Burgos to Zulueta Street, thence, along Zulueta Street to Rizal Street; and a 150 mm line along the Malaubang Road from Pingol Street and to be connected to the existing 150 mm line which is out of service at this time.

In Clarin a 150 mm line will be installed along Rizal Street beginning at the National Road and extending to the point of connection with the Clarin transmission line along the Clarin-Tinacla-an Provincial Road.

In the latter part of Phase I-A, additional distribution mains will be installed in Ozamiz City when the new transmission line from the storage tank in Barrio Segatic is completed. Three mains will be installed: a 150 mm line some 750 m along Bonifacio Street from Rizal Street to the point of connection with the new transmission line; a 200 mm line from the new transmission line to the National Road at Prospera Park; and a 200 mm line from Prospera Park along

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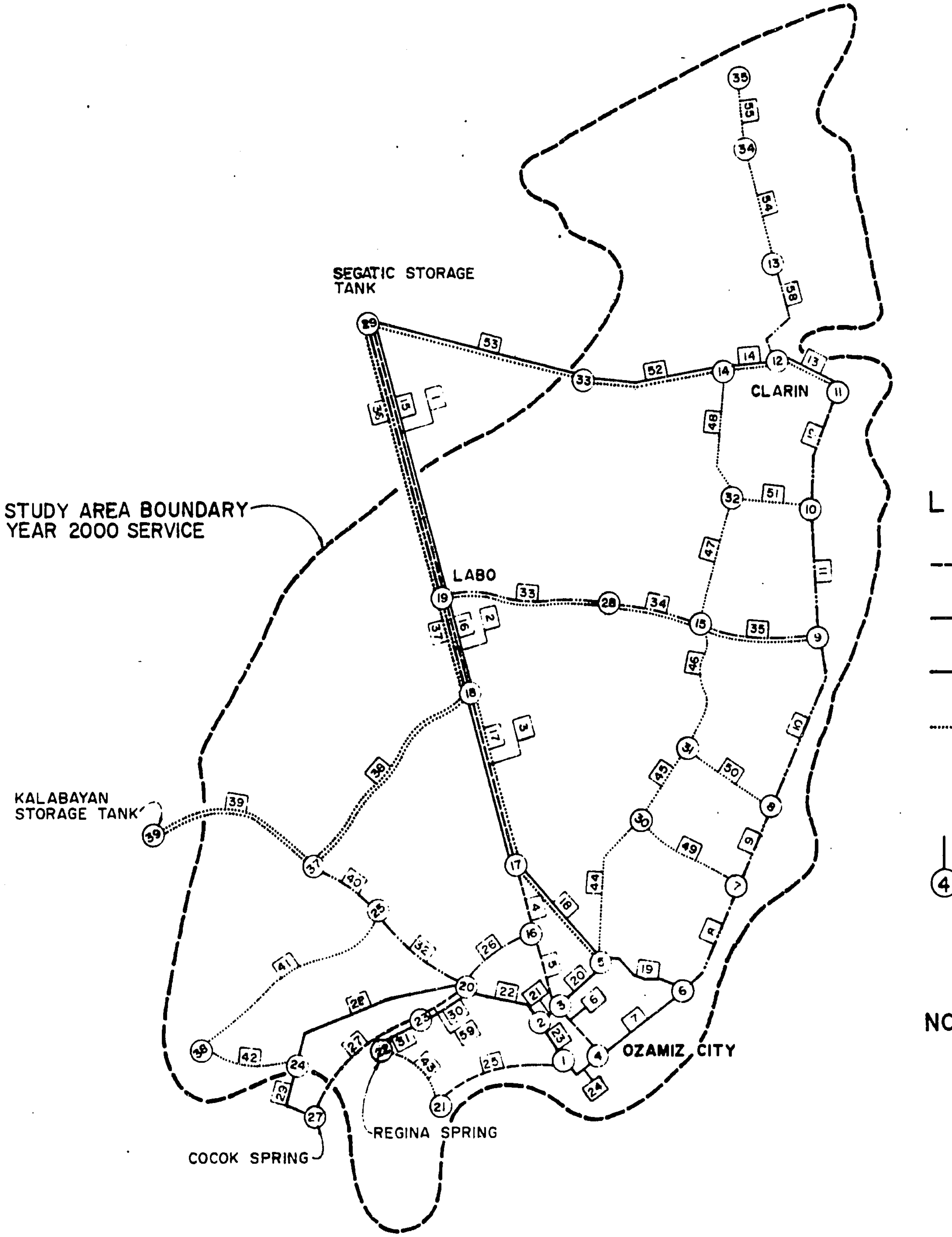
[1/] Only one part of pipe number 25 as explained in the text.



FUTURE TRA

FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS CDM - LWUA

a

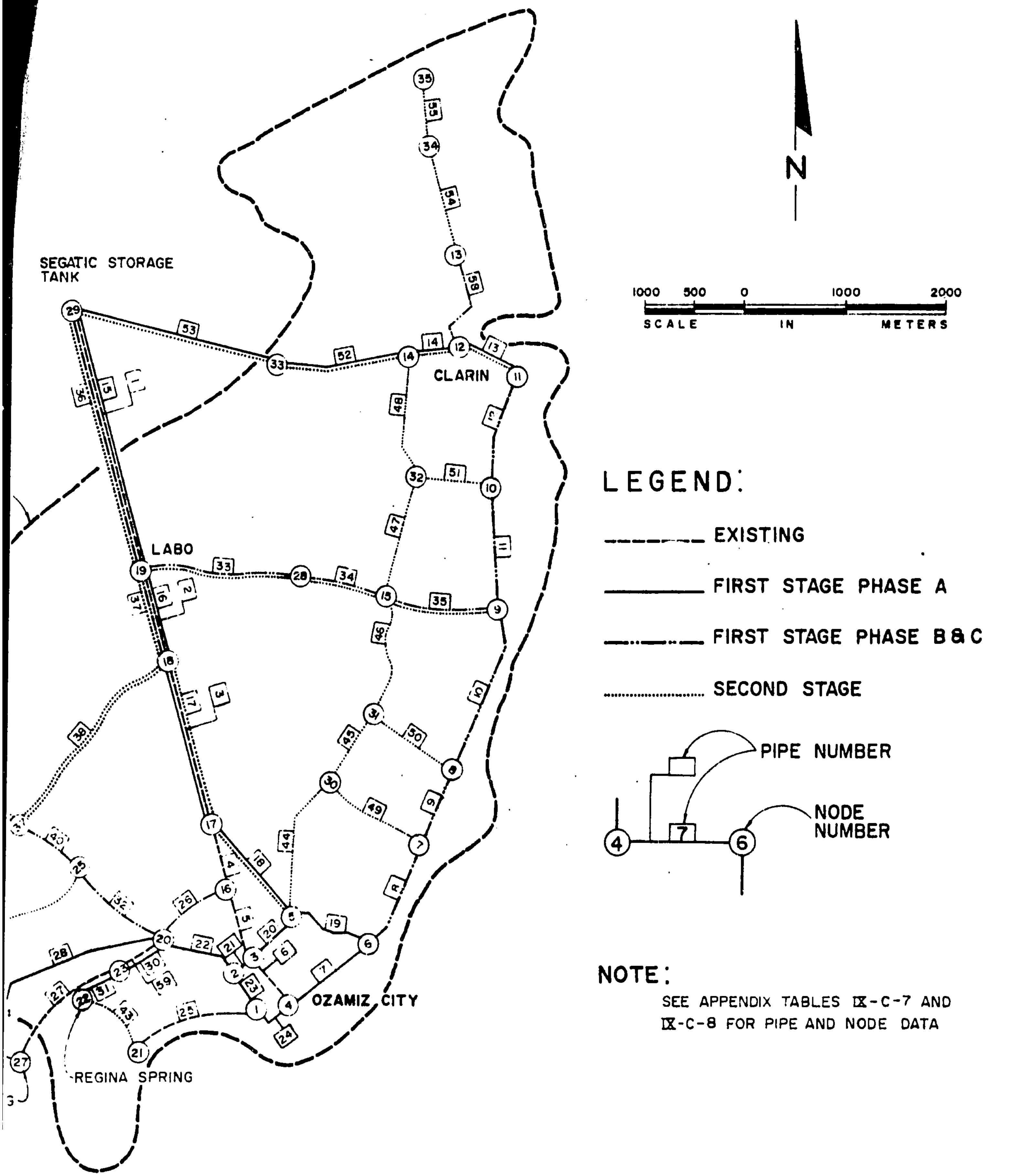


FIGURE IX-3
FUTURE TRANSMISSION LINES & FEEDER MAINS
SCHEMATIC PLAN

)M-LWUA

b

the National Road to Rizal Street. The last three lines will complete a loop of 150 mm and 200 mm mains which will significantly improve the distribution of water and peak-hour pressures in the poblacion of Ozamiz City.

The details of distribution mains to be installed in Phase I-A are as follows:

Pipe Diameter (mm)	Total Length (m)	Number of Valves
150	3,240	18
200	1,940	-

A 100-mm fire hydrant will be installed at the end of the 150-mm distribution main in Malaubang for occasional flushing of the main.

Internal Network. The construction program for the internal network is discussed in Appendix IX-C. During Phase I-A, 30 ha of the existing service area in the poblacion of Ozamiz City will be reinforced with 100 mm and 150 mm lines and 150 mm fire hydrants will be installed in the same area. In addition, 100 ha of the area will receive internal network piping. Approximately 85 ha will be served in and around the Ozamiz City poblacion; about 50 ha between Magsaysay Boulevard and the National Road; and another 35 ha in the vicinity of the Misamis College. Some 15 ha in the poblacion of Clarin will also receive an internal network system.

Service Connections. The recommended program for installation of service connection is described in Appendix IX-C. During Phase I-A 1,500 new connections will be installed and 200 existing connections will be replaced.

Administrative Building. The existing offices of the Water District provide an overcrowded working environment for the existing staff and do not allow proper functioning of the facilities located within them. These offices are located in a rented building without adequate space for expansion.

In order to provide adequate facilities for billing, collection, customer service, record keeping, general administration, water meter repair, laboratory analyses and general storage, it is recommended that a new administrative building be constructed. The cost for this building has been estimated on the assumption that approximately 30, 60, 60 and 150 sqm of floor space will be allocated for laboratory, water meter repair, general storage and administration facilities, respectively.

All required items such as land, building construction, paved parking area, furnishings and office equipment, are also included in the cost.

Meter Repair Facilities. The Water District performs metering of service connections and meter maintenance under very difficult circumstances. The Water District has no proper meter repair facilities, adequate space, tools or equipment, with which to properly repair and test water meters.

It is recommended that a new water meter repair/test facility including necessary test benches, work benches, tools, sinks, carts, tools, furnishings, etc., be provided. The space required for these facilities has been included in the proposed administrative building.

Laboratory Equipment. At present the Water District has no facilities for determining the quality of the water supplied to consumers or entering the transmission and distribution pipelines from existing sources. It is absolutely necessary that these facilities be provided to monitor the quality of sourcewaters and to detect as early as possible the sources of polluted water within the service area of the system.

To ensure monitoring and managing the water quality by the Water District, it is recommended that complete laboratory equipment be procured for physical, chemical and bacteriological analyses of drinking water. The space required for these facilities has been included in the proposed administrative building.

Cost Summary - Phase I-A. The cost summary of Construction Phase I-A is presented in Table IX-4. Based on 1976 price levels, the total project cost of this phase is ₱23.0 million, of which about $774,000 is in foreign exchange.

TABLE IX-4

COST SUMMARY OF CONSTRUCTION
STAGE I PHASE A (1977-82)

Item	Construction Period[2]	Construction Cost (₱)	Foreign Exchange Component (U.S.$)[3]
Source Development			
Cocok & Regina Springs	1977-78	1,616,000	100,000
Talibaksan Spring	1978-79	33,000	
Bitoon Spring	1979-80	543,000	
Transmission Lines[4]			
Cocok to Ozamiz City	1977-78	1,364,000	44,300
Talibaksan Spring	1978-79	1,491,000	56,000
Bitoon Spring	1979-80	958,000	36,000
Storage Tank to Clarin	1978-79	1,116,000	40,200
Storage Tank to Ozamiz City	1980-81	2,746,000	102,900
Storage Tank	1978-79	930,000	
Distribution Mains	1978-82	1,551,000	52,000
Internal Network[5]	1978-82	2,418,000	66,000
Service Connections[5]	1978-82	832,000	24,000
Administration Building	1977-78	304,000	
Meter Repair Facilities	1977-78	168,000	20,000
Laboratory Equipment	1977-78	162,000	19,000
Sub-Total		₱16,232,000	$560,400
Engineering & Contingencies			
25%		3,247,000	118,000
15%		488,000	14,000
Sub-Total		₱19,967,000	$692,000
Land[6]			
Administrative & Legal Fees at 3%		599,000	
Sub-Total		₱20,566,000	$692,000
Interest during Construction at 12%		2,440,000	82,000
Total		₱23,006,000	$774,000

[2] From mid-year to mid-year.
[3] Based on ₱7.00 to $1.00.
[4] Includes hydraulic control chambers.
[5] Engineering and contingencies computed at 15%.
[6] Included in Early Action Works.

Construction Phase I-B (1982-86)

The construction in Phase I-B is limited to distribution mains, extension of internal network, and installation of service connections.

Distribution Mains. The construction program for distribution mains will be implemented mainly to connect the City of Ozamiz with the Municipality of Clarin by installing a 150 mm line along the National Road. Concessionaires along the roadside will be served by direct connection to this line. This line will be 6,000 m long and will require 10-150 mm gate valves. The recommended mains are listed in Table IX-5.

TABLE IX-5

FIRST STAGE PHASE B TRANSMISSION AND DISTRIBUTION MAINS

Year	Description	Pipe Number	Node From	Node To	Pipe Size (mm)	Pipe Length (m)
1982-86	Distribution Mains					
	National Road	8	6	7	150	1,100
	Ozamiz City	9	7	8	150	800
	to Clarin	10	8	9	150	1,700
		11	9	10	150	1,200
		12	10	11	150	1,200

Internal Network. An additional 30 ha of the existing system in the poblacion of Ozamiz City will be reinforced and serviced by fire hydrants. Some 100 ha in the fringe areas of Ozamiz City and Clarin will be extended service by installation of internal network. In Ozamiz City, it is anticipated that 40 ha of this area will be between the City Hall site and the proposed market site. Another 20-30 ha will be northeast and in the immediate vicinity of the proposed market. Approximately 20 ha will be served between the National Road and the road to Malaubang. Some 10-20 ha will be provided service in Clarin.

Service Connections. Another 1,500 new service connections will be installed and 300 existing service connections will be replaced.

Cost Summary - Phase I-B

The cost summary for Phase I-B is given in Table IX-6. Based on 1976 price levels, the total project cost of this phase is ₱6.5 million, of which about $180,000 is in foreign exchange.

TABLE IX-6

COST SUMMARY OF CONSTRUCTION
STAGE I PHASE B (1982-86)

Item	Construction Period[7]	Construction Cost (₱)	Foreign Exchange Component (US$)[8]
Distribution Mains	1982-86	1,498,000	46,800
Internal Network[9]	1982-86	2,418,000	65,500
Service Connections[9]	1982-86	869,000	24,000
Sub-Total		₱4,785,000	$136,000
Engineering & Contingencies			
25%		375,000	12,000
15%		493,000	13,000
Sub-Total		5,653,000	$161,000
Land Costs[10]			
Administrative & Legal Fees 3%		170,000	
Sub-Total		5,823,000	161,000
Interest during Construction 12%		699,000	19,000
		₱6,522,000	$180,000

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7 From mid-year to mid-year.
8 Based on ₱7.00 to $1.00.
9 Engineering and contingencies are computed at 15 per cent.
10 Included in Early Action Phase.

Construction Phase I-C (1986-90)

Transmission Lines. During Phase I-C a second transmission line will be installed from the storage tank in Barrio Segatic to Ozamiz City. Computer analysis of Phase I-A and I-B transmission lines and distribution mains indicates reinforcement will be required to maintain adequate peak-hour pressures in Ozamiz City. For this purpose, a 350 mm line will be laid beginning at the storage tank and extending 3,550 m to a point 3 km from Ozamiz. The line initially will have excess capacity, but will be fully utilized to fill storage when the Kalabayan storage tank is constructed in 1989.

Distribution Mains. The major construction of distribution mains will be the installation of a 150-mm line from Labo to the National Road. This will significantly improve peak-hour pressures to concessionaires along the National Road. The line will pass the Labo Airfield and will serve commercial and light industrial concessionaires in the vicinity of the airport and between the airport and the National Road.

Additional distribution mains will be installed along the National Road from Clarin toward Tudela and along the road to Barrio Kalabayan beginning at the National Road. Another distribution main will be installed between Nodes 20 and 16. This line will connect the existing 200 mm transmission main to the new Cocok transmission main.

The recommended transmission and distribution mains are listed in Table IX-7.

TABLE IX-7

FIRST STAGE PHASE C TRANSMISSION AND DISTRIBUTION MAINS

Year	Description	Pipe Number	Node From	Node To	Pipe Size (mm)	Pipe Length (m)
1986-90	Transmission Line					
	Segatic Storage to	15	29	19	350	2,650
	Node 18	16	19	18	350	900
	Distribution Mains					
	Labo to	33	19	28	150	1,600
	National Road	34	28	15	150	900
		35	15	9	150	1,150
	Kalabayan Road	32	20	25	200	1,100
		40	25	37	200	750
	Ozamiz City	26	20	16	150	800
	Clarin	58	12	13	150	1,100

The details of the required piping and valves for both transmission and distribution mains are listed below:

Pipe Size (mm)	Length of Pipe (m)	Number of Valves
150	5,550	12
200	1,850	
300		4
350	3,550	

Two hydrants will be required for occasional main flushing. One will be instalied at the end of the pipeline extending toward Tudela ; the other at the end of the line on the Kalabayan Road.

Internal Network. The internal network service area will be extended to 100 hectares. It is likely that this extension will be concentrated along the fringe areas of the Ozamis City and Clarin service areas. The 100 ha, which would receive internal network in Phase I-A, will have fire protection service by the installation of hydrants.

Service Connections. New service connections will total 1,500. The Water District will replace 400 existing service lines as part of the program to gradually phase out the existing Schedule 20 GS service lines.

Cost Summary - Phase I-C

The cost summary of Construction Phase I-C is presented in Table IX-8. Based on 1976 price levels, the total project cost of this phase is ₱10.6 million, of which $416,000 is in foreign exchange.

TABLE IX-8

COST SUMMARY OF CONSTRUCTION
STAGE I PHASE C (1986-1990)

Item	Construction Period[11]	Construction Cost (₱)	Foreign Exchange Component (US$)[12]
Transmission Lines	1986-87	2,656,000	158,000
Distribution Mains	1986-90	2,081,000	69,000
Internal Network[13]	1986-90	1,930,000	52,000
Service Connections[13]	1986-90	905,000	24,000
Sub-Total		₱7,572,000	$303,000
Engineering & Contingencies			
25%		1,184,000	57,000
15%		425,000	11,000
Sub-Total		₱9,181,000	$371,000
Land Costs[14]			
Administrative and Legal Fees 3%		275,000	———
Sub-Total		₱9,456,000	$371,000
Interest during Construction 12%		1,135,000	45,000
Total Project Cost		₱ 10,591,000	$416,000

[11]From mid-year to mid-year.
[12]Based on ₱7.00 to $1.00.
[13]Engineering and contingencies are computed at 15 per cent.
[14]Included in Early Action Phase.

D. SECOND STAGE OF LONG-TERM RECOMMENDED PROGRAM

The second stage of the recommended program will include the development of the Lower Dalingap Spring, source transmission pipeline, storage tank, transmission pipelines, distribution mains, internal distribution network and service connections. These works will be implemented in two phases.

Construction Phase II-A (1984-95)

Source Development. At the time when water demand approaches the yield from Coook, Regina, Talibaksan and Bitoon Springs, further increases in demand will be met by water supplied from the Lower Dalingap Spring. This spring emerges in a series of five or six outlets which can be tapped with several relatively small collection chambers and conducted to a larger chamber located at the spring outlet of lowest elevation. All necessary piping, valves and flow measuring and recording devices will be provided at this downstream chamber. It is proposed that development of the Lower Dalingap Spring be completed by 1986, subject to the previous comments made concerning the timing of construction of these facilities. It is expected that this source will be adequate to meet total water demand at least until the year 2000.

Transmission Facilities. The transmission pipelines from Lower Dalingap Spring to the hydraulic control chamber and from the control chamber to the Barrio Segatio storage tank will be a 1,300 m long, 200 mm diameter pipeline and a 5,150 m long, 250 mm diameter pipeline respectively (Appendix Figure IX-D-1). The capacity of these source pipelines will be adequate to meet system water demands until the year 1994.

The transmission lines conveying water into the distribution system will also be reinforced as shown in Table IX-9 and Figure IX-2, appended. Within these works, the proposed storage tank at Barrio Kalabayan will be connected to the system by constructing 250 mm main from the storage tank along the Kalabayan Road to the 200 mm line installed in Phase I-C. Another 200 mm line will be installed which will connect the main from Kalabayan storage to the transmission lines from Segatio Storage Tank.

A second transmission line, 200 mm pipe from Segatio Storage to Clarin, must be installed to maintain peak-hour pressures in Clarin and vicinity.

TABLE IX -9

SECOND STAGE PHASE A TRANSMISSION LINES

Location	Construction Period	Pipe Size (mm)	Pipe Length (m)
Lower Dalingap to HC	1984-86	200	1,300
HC to Segatic Tank	1984-86	250	5,150
Lines to Kalabayan Tank	1989-90	250	1,850
		200	2,-50
Line to Clarin	1993-94	200	3,500

Storage Tank. Beginning in 1989 the MOWD (Ozamiz and Clarin) will construct the first storage facility in the distribution system. A 700 cum ground level storage tank will be built in Barrio Kalabayan at a ground elevation of 63 meters. The tank will have a 7 m operational range with the overflow elevation at 70 m. The tank will supply peak-flow demand in Ozamiz and help maintain more uniform pressures in the fringe areas of the distribution system near Ozamiz City.

Treatment Facilities. No additional treatment facilities will be provided during this phase, other than the minor piping required to supply chlorine solution to the new source transmission pipeline from the existing chlorination facilities located downstream from the Barrio Segatic storage tank.

Distribution Mains. Several distribution mains installed in the Stage I program must be reinforced in Phase II-A by installing a parallel line. Such lines are in the poblacion of Clarin, along the road from Labo to the National Road, and along the transmission line from Segatic storage to Ozamiz City. New distribution mains are proposed to be installed in new service areas along the National Road from Coook Spring to just north of Barrio Maningcol. Also, new service will be extended 1,800 m from Clarin northward toward Tudela. The distribution main construction schedule for Phase II-A is shown in Table IX-10.

TABLE IX -10

SECOND STAGE PHASE A DISTRIBUTION MAINS

Construction Period	Description	Pipe Number	Node From	Node To	Pipe Size (mm)	Pipe Length (m)
1990-95	Distribution Mains Reinforcement					
	Clarin	13	11	12	150	700
		14	12	14	150	500
	Ozamiz	17	18	17	200	1,650
		18	17	5	200	1,200
	Labo to National Road	33	19	28	150	1,600
		34	28	15	150	900
		35	15	9	150	1,150
	New Service Area					
	Ozamiz	41	25	38	150	2,150
		42	38	24	150	1,000
		43	22	21	150	900
		44	5	30	150	1,500
		49	30	7	150	1,150
	Clarin	54	13	34	150	1,100
		55	34	35	150	700

Internal Network. Internal network service will be extended to 95 ha. The area is projected to be in new service areas along the National Road. Fire hydrants will be installed in 165 ha of internal network to be laid in Phases I-B and I-C.

Service Connections. The program to replace the existing service lines is scheduled for completion in Phase II-A. To complete the program will require that 724 service lines be replaced. Also, during Phase II-A, 3,100 new service connections are projected to be made.

Cost Summary-Phase II-A. The cost summary of Phase II-A is presented in Table IX-11. Based on 1976 price levels, the total project cost of this phase is ₱21.4 million, of which $773,000 is in foreign exchange.

TABLE IX - 11

COST SUMMARY OF CONSTRUCTION
STAGE II PHASE A (1984-95)

Item	Construction Period[15]	Construction Cost (₱)	Foreign Exchange Component (US$)[16]
Source Development[17]	1984-86	704,000	
Transmission Lines[17]	1984-86	2,950,000	110,000
	1989-90	2,924,000	206,000
Storage Tank	1989-90	410,000	
Distribution Mains	1990-95	4,375,000	144,000
Internal Network [18]	1990-95	1,946,000	50,000
Service Connections[18]	1990-95	1,834,000	50,000
Sub-total		15,143,000	560,000
Engineering & Contingencies			
25%		2,841,000	115,000
15%		567,000	15,000
Sub-total		18,551,000	690,000
Land Costs[19]			
Administrative & Legal Fees 3%		557,000	
Sub-total		19,108,000	690,000
Interest during construction 12%		2,293,000	83,000
Total Project Cost		₱21,401,000	$773,000

[15] From mid-year to mid-year.
[16] Based on ₱7.00 to $1.00.
[17] Lower Dalingap Spring development and transmission lines are tentatively included under Stage II.
[18] Engineering and contingencies are computed at 15%.
[19] Included in Early Action Phase.

Construction Phase II-B (1992-2000)

No additional works will be required during this construction phase for expansion of source or treatment facilities.

Transmission Facilities. The existing pipelines from Lower Dalingap Spring to the hydraulic control chamber and from the control chamber to the Barrio Segatio storage tank will be reinforced with a 1,300 m long, 200 mm pipeline and a 5,150 m long, 250 mm pipeline, respectively. A 300 mm transmission line will be installed from the Segatio Storage tank to Node 18. A 200 mm line will continue from Node 18 to the Kalabayan Storage tank. The installation of these two lines will complete the transmission facilities required for the design year 2000.

The characteristics of these lines are summarized in the following table:

SECOND STAGE PHASE B TRANSMISSION LINES

Location	Construction Period	Pipe Size (mm)	Pipe Length (m)
Lower Dalingap to HC	1992-94	200	1300
HC to Segatio Tank	1992-94	250	5150
Segatio Tank to Node 18	1994-95	300	3550
Node 18 to Kalabayan Tank	1994-95	200	4100

Storage Tank. An additional 900 cum storage tank should be constructed in Phase II-B. As tentatively scheduled the tank will be built at the Segatic site where the First Stage storage tank would be constructed. If future demand centers would indicate that distribution storage should be provided in Ozamis or Clarin, it is possible for the Water District to locate the storage at another site. If this is done, the District must install additional transmission lines to connect the tank to the distribution system and ensure that it fills properly.

Distribution Mains. The Phase II-B distribution mains will be installed in new service areas about 1 km from the National Road and parallel to it. These lines are listed in the following table.

SECOND STAGE PHASE B DISTRIBUTION MAINS

Construction Period	Description	Pipe Number	Node From	Node To	Pipe Size (mm)	Pipe Length (m)
1995-2000	Along National Road	45	30	31	150	800
		46	31	15	150	1,200
		47	15	32	150	1,200
		48	32	14	150	1,250
		50	31	8	150	1,000
		51	32	10	150	800

Also included is a 100 mm fire hydrant to be installed at the end of the pipeline extending from Clarin toward Tudela.

Internal Network. Approximately 95 ha of new area will be served by internal network. Some 35 ha of the newly served area will be provided with fire hydrants as well as the 105 ha from earlier phases. The district will have at this point only 60 ha of internal network which will require fire hydrant service. It is anticipated that 50 ha of area provided with fire hydrants in Stage I will be upgraded from residential to commercial, high-value classification.

Service Connections. The number of new service connections is projected to be 3,100 during Phase II-B. By year 2000 the MOWD (Ozamiz and Clarin) will have an estimated 12,550 concessionaires.

Cost Summary-Phase II-B. The cost summary for Construction Phase II-B is presented in Table IX-12. Based on 1976 price levels, the total project cost for this phase is P17.4 million, of which $548,000 is in foreign exchange.

TABLE IX – 12

COST SUMMARY OF CONSTRUCTION
STAGE II PHASE B (1992–2000)

Item	Construction Period[20]	Construction Cost (₱)	Foreign Exchange Component (US$)[21]
Transmission Lines	1992–94	2,934,000	110,000
	1994–95	3,640,000	140,000
Storage	1994–95	500,000	
Distribution Mains[22]	1995–2000	1,573,000	49,000
Internal Network[22]	1995–2000	2,196,000	50,000
Service Connections[22]	1995–2000	1,569,000	50,000
Sub-total		12,412,000	399,000
Engineering & Contingencies	25%	2,162,000	75,000
	15%	565,000	15,000
Sub-total		15,139,000	489,000
Land Cost[23]			
Administrative and Legal Fees	3%	454,000	
Sub-total		15,593,000	489,000
Interest during construction		1,871,000	59,000
Total Project Cost		17,464,000	$548,000

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[20] From mid-year to mid-year.
[21] Based on ₱7.00 to $1.00.
[22] Engineering and contingencies are computed at 15 per cent.
[23] Included in Early Action Phase.

E. CAPITAL COST SUMMARY

The capital costs of each phase of construction including "Early Action Works" are summarized in Table IX-13. Land costs for Stage I and II facilities are included in the "Early Action Program". Construction cost estimates of the improvement program are based on projected July 1976 unit prices. The project cost listed in Table IX-13, in general, includes the estimated construction costs, engineering fees and allowance for contingencies, land and easement purchase, administrative and legal fees, and interest during construction. Also listed is the estimated foreign exchange component of the project cost which includes cost of direct and/or indirect import items.

The water supply and demand chart in Figure IX-1 indicates the timing of the construction phases for the source development in relation to the maximum daily water demand projection for the study area. The proposed source and transmission improvements are shown in Figure IX-2 appended.

TABLE IX - 13

CAPITAL COST SUMMARY

Construction Stage/Phase	Period	Construction Cost (₱)	Total Project Cost (₱)	Foreign Exchange Component (US$)
Early Action	1976-78	594,000	683,000	44,000
I-A	1977-82	16,232,000	23,006,000	774,000
B	1982-86	4,785,000	6,522,000	180,000
C	1986-90	7,572,000	10,591,000	416,000
II-A	1984-95	15,143,000	21,401,000	773,000
B	1992-2000	12,412,000	17,464,000	548,000
Total		56,738,000	79,667,000	2,735,000

F. ANNUAL OPERATION AND MAINTENANCE COSTS

Annual costs include personnel, power, chemicals, maintenance, rentals, repayments of loans accrued in the past, and other miscellaneous expenses which are necessary to run the overall water system. The total annual cost of the existing system in 1974 was ₱223,000. Following implementation of the recommended improvements, the present annual cost will increase due to additional personnel, power, chemicals and maintenance costs. The annual costs listed below do not include the annual repayment of the loan for construction of the new facilities.

The annual operation and maintenance costs are listed in Table IX-14. The costs for Items 1, 2 and 3 include cost of maintenance, power and chemicals. The water district (Ozamiz and Clarin) personnel and administrative costs are included in Item 4.

TABLE IX - 14

ANNUAL OPERATION AND MAINTENANCE COSTS[24]

ITEM	Annual Costs (₱) 1980	1990	2000
1. Source Facilities	283,000	304,000	319,000
2. Water Treatment	18,000	34,000	58,000
3. Storage Transmission and Distribution	73,000	167,000	253,000
4. Water District Personnel and Administration	308,000	354,000	442,000
5. Miscellaneous	45,000	87,000	123,000
Total	727,000	946,000	1,195,000

[24]Do not include annual payments on capital loan which are to be made for proposed improvements. Above costs are based on 1976 price levels.

G. SEWERAGE/DRAINAGE CONCEPTS

Existing Sewerage/Drainage Facilities

Drainage in the poblaciones of both Ozamiz City and Clarin is poor. This is especially so in Ozamiz where much of the present commercial area is built on land reclaimed from the bay.

Existing facilities in Ozamiz City for handling storm runoff consist of ditches at the edges of the streets, draining into larger open channels which empty into Panguil Bay. Flow in these ditches is very sluggish due to the absence of hydraulic gradient, especially during high tide. The ditches contain large amounts of organic and putrescible waste material, resulting from the discharge of sanitary sewage to the ditches. There is a storm drainage system serving a few hectares in the vicinity of the public market and central commercial district. No drawings of this piped system are available.

Ozamiz City suffers from serious flooding during the rainy season, particularly when heavy rains coincide with periods of unusually high tides.

Clarin likewise has no adequate drainage system in the poblacion. Open ditches meander through the community, carrying runoff to the Clarin River and Iligan Bay.

There is no central sanitary sewage collection or disposal system in either Ozamiz or Clarin. In both communities, septic tanks are used in the larger houses. Under such a system, the effluent wastes are piped from the tanks to leaching pits or overflow to the nearest drainage ditch. Consequently, these ditches are visibly grossly polluted and are aesthetically offensive. Volume of sanitary wastes discharged to these open ditches is such that much of them is flowing all through the dry season, during which periods, virtually the entire flow is raw sewage or septic tank effluent.

Relationships with Infrastructure and Other Economic Factors

The provision of sewerage in Ozamiz and Clarin has a significant impact on water supply, drainage and surface runoff facilities. On the other hand, economics (i.e., "ability to pay") and public health affect the feasibility of providing sewerage, either on a separate or a combined basis.

Because of its location, any system of public sewerage in the

MOWD will include some form of discharge, treated or otherwise, into the Panguil Bay.

As stated before, alternatives for water supply sources in the MOWD area include groundwater sources such as springs, deep wells and infiltration galleries. Therefore, the provision of sewerage with discharge into the Panguil Bay will have little potential pollutional effect on the above alternative sources of water supply.

In view of the drainage problems now being experienced in the MOWD area, it appears that surface runoff facilities warrant being close to the top of the district's infrastructure priority list. Before the decision is made on the provision for an implementation of drainage facilities, it must be determined whether drainage/sewerage should be designed as a separate or a combined system.

The 1970 Census indicated that in Ozamiz City and Clarin, only 19 per cent and 18 per cent, respectively, of the households were provided with water-borne (flush) toilets. It is unlikely that such a low percentage of modern toilets would justify economically an immediate or early sewering program.

The rationale for the provision of wastewater collection facilities has been historically based on aesthetics and public health benefits. At present, there is a water supply shortage in MOWD. As the water supply problem is resolved, wastewater volumes will increase. Related public health and aesthetic problems will correspondingly increase. In short, solving the water supply problem will, in turn, compound and aggravate the wastewater problem.

Taking into account the area's "ability to pay" and its needs, implementation of infrastructure facilities appears to be as follows:

(1) water supply, firstly

(2) drainage/surface runoff, next

(3) wastewater, lastly

Projected Wastewater Volumes

For MOWD, it was estimated that wastewater flows would be approximately as follows:

Year	Wastewater Flows cumd	mgd	% Sewered[25]
1990	800	0.21	17
2005	240	0.75	37
2025	6,950	1.8	53

Alternatives Available

The economic costs of providing sewerage/drainage facilities will be significant. Since Ozamiz City and Clarin are flat and near sea level, underground construction will need to contend with groundwater. Pumping will be required. The provision of a financially self-sufficient sewerage system is seldom achieved even in developed countries. It is likely that communities in the MOWD are no exceptions to that rule.

Feasible alternatives for sewerage in the MOWD area appear to be as follows:

(1) individual (septic tanks) or public (collection) system

(2) combined or separate system

(3) centralized treatment (various degrees)

(4) disposal system (sea outfalls or land treatment)

Private individual wastewater systems (based on the septic tank concept) are not practical in the MOWD area except in places where sufficient lot size is available for a well-designed leach or tile field. Predominant soil conditions in Ozamiz and Clarin consist of finely textured organic clays. Septic tanks are not viable in the core city area not only because land use and population densities are intense, but also due to tight soil conditions. For the core city area and where densities exceed 35-50 persons/ha, a public sewer system may be economically justifiable.

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[25]Per cent of study area population that will be connected to the sewer system.

The question of whether the MOWD study should go for a <u>combined</u> or a <u>separate</u> sewerage/drainage system depends to a certain extent on economic priorities. As stated above, after the water supply improvements are implemented, the drainage problems will have to be addressed also. As has been the case historically in cities throughout the world, drainage systems (in spite of all good intentions) are converted into combined systems in a short time. Taking into account the geographical setting of Ozamiz and Clarin the large volume of dilutional waters - the Panguil Bay and the low projected future wastewater flows to be generated, it is likely that a well-operated combined system with efficient wastewater interception facilities may be economical solution at least for the near-term sewerage/drainage requirements of the study area.

An alternative to the combined system which must be investigated in detail in the sewerage feasibility study is the provision of open canals (peripheral drains) and separate underground wastewater sewers.

Alternative treatment and disposal methods of intercepted (or separate) wastewater may consist of:

(1) Screening of gross solids; grit removal prior to discharge into the Panguil Bay, using multiport diffusers; or

(2) Screening of gross solids; high rate lagoons and effluent discharge into the Panguil Bay, using simple sea outfalls; or

(3) Primary treatment and land application of effluent and/or discharge into the Panguil Bay.

<u>Recommendations</u>

As soon as the first phase water supply program is underway, a comprehensive sewerage/drainage feasibility study should be undertaken. This study must address the issue of combined vs. separate sewers. It should incorporate oceanographic studies relative to marine disposal of wastewaters into the Panguil Bay. It should also update the population and water demand projections of this water supply study.

Once the decision has been made to use either the combined or separate system, the Water District must embark as promptly as possible, in a street sewering[26] and house connection program.

A plumbing code should be developed by the MOWD to coordinate plumbing requirements for water, wastewater and surface runoff facilities. This code becomes very important and meaningful particularly when a separate system of sewers is adopted.

In the meantime, a house-to-house survey should be conducted to inventory existing wastewater and toilet facilities. As-built drawings of storm drains and peripheral canals must be compiled and accurately recorded in preparation for the sewerage/drainage feasibility study.

For residences and establishments that currently lack waste disposal facilities and are financially unable to provide the modern flush toilet with septic tank, the Department of Health (Division of Environmental Sanitation) has developed an inexpensive water seal squat type toilet.

H. MONITORING OF WATER QUALITY AND FLOWS

Water quality and flow data must be gathered from Talibaksan, Cocok, Regina, Bitoon and Dalingap Springs. Flow data from these water supply sources may be taken once monthly, except during the dry weather months when flow data should be taken twice monthly. Water quality analysis consisting of the parameters indicated in Chapter IV should be done on a bi-monthly basis.

The node-path network shown in Figure IX-4 illustrates the development and transmission of water quality monitoring and flow gaging data from the stream to the level of management decisions.

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[26] The rate of sewering is influenced by the following factors:

1. the limited rate local street sewers can physically be constructed by available forces with acceptable traffic dislocation;
2. the administrative and social constraints on the rate at which premises can actually be connected to the sewer system;
3. the availability of funds.

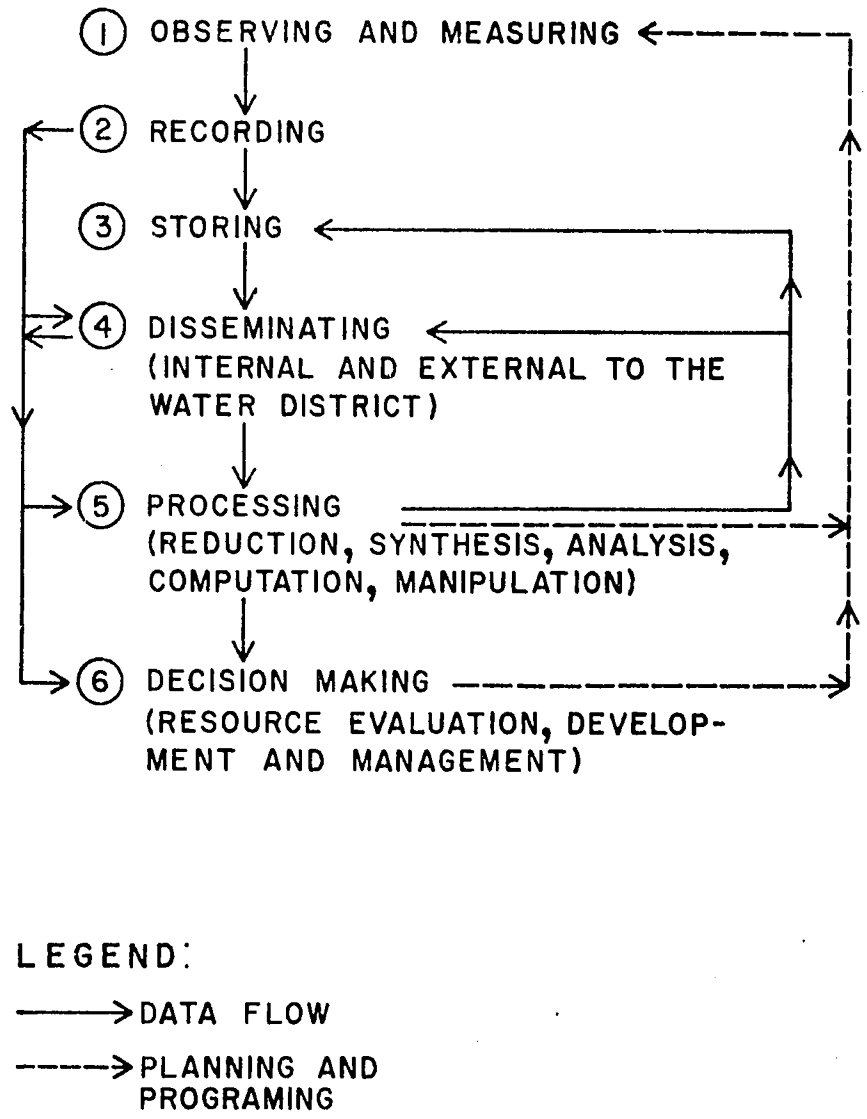

FIGURE IX-4
WATER DATA COLLECTION
STORAGE AND RETRIEVAL

Nodes 1 and 2 represent functions to be performed by the water district. These two functions involve the actual field sampling and laboratory analysis and the recording of data in field and laboratory notebooks and eventually computer input file forms. Node 3 represents the storage function. Data may be stored directly as field and laboratory notes, then published in monthly reports and copies sent to LWUA and the National Water Resources Council. One of the future plans of NWRC is to computerize its data system.

The disseminating node, represented as 4, involves the retrieval from the NWRC computer file, or copies of field and laboratory notes, annual, monthly, or other periodic reports and summaries. The processing node, 5, represents data summary by technical personnel and consultants for derivation of water quality-quantity relationships, for the definition of long term trends, problem areas, and derivation of alternative solutions to water quality-quantity problems. This leads to the decision-making step, 6, wherein planning decisions are made based on sound water quality/quantity knowledge.

Updating and review of the sampling program should be performed by the water districts and their consultants as the goals and needs of the area change. These agencies should be responsible for maintaining communication among all the involved agencies. All data and information should be routed through LWUA and NWRC.

I. UPDATING THE WATER SUPPLY MASTER PLAN

After the water supply master plan has been adopted and initially implemented, it will be necessary to undertake a program for continuously updating and keeping the plan current. Plan updating should take place at least once every 5 years, or sooner if significant changes occur. Updating is required to assess the effectiveness of the current plan, the benefits gained, the actual costs, the problems encountered, and to provide overall review, refinement, and direction for the future.

In time, certain aspects of the plan may change. These aspects directly involve or are related to the following areas: technological changes, social goal changes, land use concept changes, and population projection changes.

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Chapter VII should contain additional water service data such as new flow gaging, groundwater information, etc.

Chapter VIII should contain a re-evaluation of alternative systems. Where significant changes in projections of future conditions have taken place, it will be necessary to re-evaluate the economic comparison of the alternatives.

Chapter IX should explain in detail the updated plan. In the area of economic and financial feasibility analysis re-evaluation of the benefit/cost ratios, as well as the rate structures should be made.

J. ENVIRONMENTAL STATEMENT

The recommended plan will enhance public health; improve the quality of life in the study area and guide the area's long-term growth and productivity. These benefits are discussed in detail in Chapter X.

A long-term adverse effect of the water supply project is the unavoidable increase in wastewater. As the available water supply increases, so will wastewater increase. Because of the current water shortages, water-borne wastes are also minimal. However, water-flush toilets are expected to increase in use as local economy progresses. It is, therefore, essential that sewerage studies be conducted as expediently as possible after the initial phase of water supply implementation is underway.

The peso costs and the short-term adverse effects are offset by the long-term benefits. When compared to the general benefits, particularly that of the health aspects and social uplift, the amount of upset is relatively minor. The commitment of resources is small compared with the anticipated benefits.

A short-term adverse impact will result from soil erosion and dust during construction of transmission and the distribution pipelines. The eroded soil from construction sites will eventually settle in the bottom of the stream beds. These conditions can cause damage to aquatic biota through suffocation and burial. However, this problem can be minimized by the inclusion of strict erosion and dust control criteria in the contract specifications.

During the construction period, noise associated with heavy equipment and traffic will occur near the construction sites. This temporary disruption will have only a moderate impact.

The design of the physical facilities (such as the pump station, the storage tanks, hydraulic control chambers and spring collection chambers must be done unobtrusively and in harmony with the environment.

The primary impact of the recommended plan on natural resources is the use of chlorine, power and fuel during the operating phase, and the use of materials, foreign exchange, etc., during the construction phase. The labor time for construction and operation is also a natural resource. However, in view of current unemployment in the area, the use of this resource has a beneficial impact.

Secondary resource commitment occurs as a consequence of new development encouraged by expansion of the water supply system. As the study area population continues to increase, areas of land will be irreversibly committed to residential, commercial and industrial uses. Well developed and successful land use planning will minimize the loss of open space and associated natural biota.

Resource use is necessary in the construction and operation of water supply systems, but the benefit/cost ratio shows the overwhelming advantage of carrying on with the project.

CHAPTER X ECONOMIC FEASIBILITY ANALYSIS

A. WATER AND THE ECONOMY

Introduction

Water is a basic requirement in any country's economic development and no economic activity can take place without it. However, this basic function diminishes in relative importance as a higher level of economic development is attained by a country. In most instances, the availability of water alone will not spur economic growth for there are other significant factors that influence development, such as peace and order, political stability, rate of taxation and availability of infrastructure facilities. Hence, a water supply project must be considered as only one part of a regional development program. It must be viewed within the context of the overall government program.

In a developing country like the Philippines, water supply plays a fairly important role in the national or regional economy. Traditionally, water has been made available to the consuming public at very nominal rates. There is a tendency for the consumers to use water wastefully. As a consequence, the regard given to it is far below its true importance.

Economic Value

Economic value is measured by market prices in a competitive economy. The market pricing mechanism reveals the value that people are willing to pay for goods and services. The particular case of water, however, is different because of the absence of a competitive market. Due to its socio-political implications, as well as, its capital intensive nature, it has to be a monopoly. Hence, the interaction that characterizes a free market does not occur, a situation that makes estimation of the true economic value of water difficult.

Even though market prices are not readily available, the economic value of water can be estimated. In cases where water has been conveyed for some distance; treated to improve its quality; stored for a period of time; and metered out to individual users; payment for such services could indicate fairly the economic value of water. This is so because a consumer's willingness to pay for such service somehow reflects the desirability, usefulness and importance of water to him.

It must be pointed out that generally, a consumer's willingness to pay declines as the most essential needs for water are satisfied. The level of essential needs, however, may vary in different communities. Generally, water used for drinking and cooking commands high degree of willingness to pay. Water used in flushing toilets, bathing and watering of lawns may be essential in some communities but secondary to others. At any rate, for a quantity beyond the level of essential needs, willingness to pay and value can decline considerably.

Perspective. This refers to the attitude of an individual in viewing the value of water to him, as well as, to the community. Differences in perspective account for the varying estimation in the valuation of water. To the water consumer, the value of water is measured by its contribution to his personal satisfaction or his net revenues. His perspective is thus confined to a narrow spectrum that includes only himself and perhaps his household. A regional perspective, on the other hand, would take into account all the revenues and benefits accruing to the entire region. These may include employment generation and health benefits. The third is the national perspective which would consider the overall effects of the project to the country. This is the view taken by national planning agencies.

Major Uses of Water Supply

Domestic. Water for domestic use is given top priority because drinking water is essential to life. However, in comparing the volume of total water used for domestic purposes (washing clothes, dishes, bathing, etc.), the volume of drinking water is very insignificant. In the case of drinking water, the value of water derives from the essentiality of use, but only in a limited quantity. In the case of secondary uses, the value of water derives from the volume of use, and assumes a lesser value. Estimation of the value of water for domestic purposes is an extremely difficult task to achieve with a high degree of accuracy. This is due to the variations in use and quantity. However, if value were to be equated with costs, this could be arrived at by computing for the rates at which the households are being charged for the use of water.

Industrial Use. Water is used by industry primarily for industrial operations. Some water goes into the production process as an input such as soft drinks, etc. Since most of the water used for industrial purposes goes back to the streams, this affects water quality rather than water supply. The most appropriate method of determining the value of water used by industry is to analyze the cost of alternative processes that will produce the same product while using less water. The primary alternative is internal recycling which, studies show, is relatively low in costs when used for cooling purposes. Where water is used to wash or carry dissolved materials, recycling is generally more expensive. In this case, costs will vary with the nature and extent of quality degradation of the water which occurs during the process.

Other Uses. Crop irrigation is one of the major uses of water. It has been observed that one-half of the water diverted for irrigation is consumed through evaporation and transpiration and hence is not available for subsequent use. The value of water used for irrigation purposes depends upon environmental conditions, the type of crops grown, the stage of growth of the crop and the efficiency of water utilization on the farm. Bodies of water are also used extensively to assimilate and transport waste materials, in relation with domestic and industrial uses. In this case, the value of water could be estimated by examining the alternative cost of providing treatment for the effluent.

Another important use is hydropower generation. Water used for this purpose may be valued by comparison with the lowest-cost alternative of providing electric power. Lastly, bodies of water serve a basic role in many recreational activities. Ordinarily, water quality is not adversely affected by recreational use. Water value in this case depends on a number of factors such as accessibility, setting, beauty and quality.

All this estimation of the value of water for the major uses would be helpful in a better allocation of water use and a more efficient design of facilities. This is because economic values provide the best general indication of the basic worth of water itself. The fundamental thing is to view water use within the framework of the whole system, not confined to specific uses.

In the Philippines, the National Water Resources Council establishes the water priorities, in pursuance of the policies laid down by its charter, Presidential Decree No. 424. In general, the system of priorities for the development, conservation and utilization of the country's water resources reflects the current usage of water and is responsive to the changing demands for water. Another presidential decree (Presidential Decree No. 198) provides the creation, operation, maintenance and expansion of water supply and wastewater disposal systems are a national policy of high priority.

B. BENEFIT-COST ANALYSIS

One approach in determining the economic feasibility of the water supply project involves the following steps:

1. The identification of the economic benefits and costs that can be attributed to the establishment, operation and maintenance of an improved water supply system;

2. The determination of the possible bases for quantifying these benefits and costs; and

3. The comparison of the present value of the benefits likely to be generated and the present value of the costs.

The results of the economic analysis are then expressed as a single rate called the benefit-cost ratio. The project is considered feasible if the ratio is equal to or greater than one.

A second approach in determining the economic feasibility of the project involves a comparison of the benefits and costs of the recommended system and those of the next best system. In this method, the capital expenditure costs and the operating and maintenance costs for both alternative systems are transformed to an equivalent annual cost basis during the projection period. The comparison will show which of the alternative systems will generate the same level of benefits at less cost.

The first approach was adopted in this study because it is the most widely accepted method in water resource projects. Moreover, in this case, a recommended program has already been selected from various alternatives (as discussed in Chapters VII, VIII and IX) on the basis of technical criteria. Hence, adopting the second method in the benefit-cost analysis may not be appropriate.

In the analysis, benefits as well as costs were projected up to 1990. While it is recognized that benefits are expected to extend beyond 1990, projection was cut off in that year so that benefits and costs would have the same periods for comparative purposes. However, computations of most of the benefits started in 1978 since those benefits are expected to accrue only from that year when the first phase of Stage I will commence. All costs, on the other hand, were considered from 1976.

C. ECONOMIC BENEFITS

General

The economic benefits that will be derived from the proposed improvement of the water supply system may be classified into quantifiable and non-quantifiable. Quantifiable benefits are those which can be expressed in monetary terms. On the other hand, non-quantifiable benefits are intangible but real, and are extremely difficult to express in monetary terms.

Quantifiable Benefits

Quantifiable benefits may either be primary or secondary. Primary benefits are the immediate products or services resulting from the measures for which project and associated costs have been incurred. Secondary benefits are all the other benefits attributable to the project.

The specific forms in which benefits appear, however, are not always obvious and quantification can be exceedingly difficult. Much of the valuation herein was based on a set of assumptions formed from the best available data within the study time frame. The quantifiable benefits that are discussed in the succeeding pages are: increase in land value; health; personal satisfaction; employment generation; fire protection; and reduction of insurance costs.

Increase in Land Values. The completion of a water supply project in Ozamiz and Clarin will result in an increase in the land values of the study area. However, it must be pointed out that the increase in land value cannot be attributed solely to the water supply project. Any difference between the acquisition cost and the present market value of a piece of land evolves from a series of market and public forces which exist whether or not the water supply project is undertaken. Such forces include the general pace of industrialization, construction activity, inflation, land speculation, taxation, public land acquisition and selling. More particularly, such a difference could be the result of a general estimation of productivity due to infrastructure investments which include a water supply project.

Discussions on the Ozamiz area indicate that land values have conservatively gone up by at least 15 per cent annually in the last few years. This is parallel to the experience in Zamboanga City where land values have increased by 16.4 per cent per year over the last ten years. For purposes of analysis, the value of 15 per cent per annum will be used as the natural increase associated with inflation and economic growth.

The increase in land value due to the provision of an improved public water supply system was estimated in the household survey in Lipa City (May 1975) to be about 22.6 per cent. It is reasonable to assume that this figure represents the incremental value on land without access to water supply. In a specific instance, a residential lot about 400 sqm has the following market values:

Without Water	400 sqm x ₱50 = ₱20,000
With Water	400 sqm x ₱65 = ₱26,000
	Ratio = 1.3

In this particular case, the incremental cost of ₱6,000 closely represents the market value of a private dug well to serve the premises.

On the basis of this information, it may be conservative to assume that land served by the distribution system will incur a 20 per cent increase in value during the year that water service is extended to such premises.

In the case of Ozamiz, benefits due to land increase were estimated to amount to ₱40.8 million. Appendix Table X-C-1 shows the computations of this benefit, together with the assumptions.

Health Benefits. The establishment of a water supply system in a community will necessarily bring about health benefits to the population. Undoubtedly, the provision of safe, potable water to the population is a prerequisite for the maintenance of minimum health standards. These health benefits are ordinarily manifested in the following:

1. A significant reduction in the incidence of water-borne diseases such as cholera, dysentery, gastro-enteritis, and typhoid/paratyphoid. As a result, there will be a decrease in the amount of time lost by income earners who are afflicted with such diseases.

2. A subsequent reduction in premature deaths due to the lower incidence of water-borne diseases.

3. A corresponding reduction in medical expenses due to the same reason.

In order to determine the amount of benefit arising from the reduction of income lost by those afflicted with water-borne diseases, pertinent statistics on morbidity and mortality rates were gathered from the Department of Health. From 1963 to 1973, an average of 1,057.1 out of every 100,000 population in Ozamiz were afflicted with primary water-borne diseases every year, regardless of age, sex and income class. This morbidity rate was assumed to remain constant during the 13-year projection period.

Since not all of those afflicted with said diseases were wage-earners, an adjustment was made accordingly. Based on the 1970 Census on Population and Housing of the National Census and Statistics Office, 27 per cent of Ozamiz's total population were economically active.[1] Using the same percentage, it was assumed, therefore, that only 27 per cent of the 1,057.1 per 100,000 who were afflicted with water-borne diseases were economically active. Hence, this is the only segment of the population who would suffer a reduction in income due to said diseases. Furthermore, these afflicted wage-earners were assumed to be earning ₱8 a day and unable to work for 15 days on the average because of their illness. The final figure corresponding to the economic cost of time lost due to water-borne diseases was thereby arrived at by multiplying the number of wage-earners afflicted with water-borne diseases in a year by ₱8 a day and then by 15 days.

Another health benefit that could be associated with the establishment of a safe public water supply system is the reduction of the economic cost of the premature death of those afflicted with water-borne diseases in the project area. Obviously, the reduction of the life span of the population caused by said diseases is an economic loss to the community.

This economic loss due to premature death was determined by multiplying the number of wage-earners who die because of water-borne diseases (assuming that a water supply system were not established) by the given monetary value for each death. The projected number of such deaths was based on the average of the 11-year mortality rate figures on primary water-borne diseases in Ozamiz from 1963 to 1973, as gathered from the Department of Health. These figures indicated that 76.6 persons died, of the 1,057.1 per 100,000 population who were afflicted with water-borne diseases. As in the case of the determination of the economic cost of time lost due to illness, a similar adjustment was made in the economic loss due to premature death. Only 27 per cent of the 76.6 deaths were assumed to be income earners. This mortality rate was assumed to

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[1] Economically active population includes those who are 10 years and over, whether employed or unemployed, excluding retired persons, students and housewives.

be constant over the projection period. The monetary value, on the other hand, was based on the estimated income earned by the average wage earner over a period of five years discounted at 12 per cent plus 20 per cent associated economic costs such as funeral expenses and burial plot (summation of ₱200 a month x 12 months x discount factor + 20 per cent associated costs).

The third health benefit that can be derived from the improvement of the water supply in Ozamiz is the reduction of the medical expenses of persons afflicted with water-borne diseases. According to the Lipa City pilot survey on "Ability to Pay",[2] an afflicted person spends ₱113.00 on the average for medical expenses, which include hospitalization, medicine and doctors' fees. Based on this finding, the total medical expenses incurred due to water-borne diseases were arrived at by multiplying ₱113.00 by the number of people afflicted by such diseases in the study area. The average morbidity rate for the past 11 years was assumed to be constant during the projection period, which is 1,057.1 out of every 100,000 population.

The sum of all three health benefits had to undergo three final adjustments to arrive at more meaningful figures. First, the sum of health benefits was escalated by 10 per cent every year on account of inflationary trends. Second, the sum was reduced by 40 per cent because it is believed that not all water-borne diseases are caused by a poor water system. It may also be due to less than ideal personal hygiene or lack of sewerage facilities. Third, the sum was discounted at 12 per cent in order to obtain its present day value. Appendix Table X-2 shows the calculations associated with health benefits for Ozamiz City. Hence, the total present value of health benefits due to the proposed water supply project in Ozamiz City after adjustments amounts to about ₱2.8 million.

<u>Personal Satisfaction Benefits</u>. Obviously, personal satisfaction among the consumers will arise from the convenience of having safe and adequate water piped into the place of consumption. Since water is essential to life, all members of the population presumably would be willing to obtain it in sufficient quantities at some given price. Hence, the personal satisfaction benefits of a water supply project may be measured by the amount which the consumers are able (and willing) to pay for the convenience of the service.

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[2] Refer to Methodolgy Manual on Water Supply Feasibility Studies, Chapter 20.

The results of the household survey in Lipa City were taken as indicative of the level of 'willingness to pay' of the cities included in this Ten-City Feasibility Study.[3] Although it is recognized that there are certain differences between the statistical characteristics of Lipa and Ozamiz (such as income level, population, service area, etc.), the Lipa survey results still provide a reasonable basis for the quantification of this benefit.

The Lipa survey indicated that the average households may be expected to pay no more than ₱25.00 per month for an improved and upgraded water supply system. Currently, average householders in the 16 water districts associated with LWUA are paying between ₱8-₱16 per month for inadequate and insufficient water supply. Taking these data as background and allowing for the condition where health benefits have already been quantified (and are really part of personal satisfaction benefits), it is probable that personal satisfaction benefits should not exceed about ₱10/ month.

This specific benefit may also be roughly quantified by the labor associated with fetching water from a "free" faucet. For example, about 1 hour per day may be used up just for this effort; therefore, the economic value of this effort is at least:

$$1/8 \times ₱8/\text{day} \times 30 = ₱30/\text{month}.$$

The conservative value of ₱10.00 a month was adopted in this study to represent "the willingness to pay" level escalated by 6 per cent every year due to inflation. This figure is considered the fair value of the convenience, personal satisfaction and aesthetics associated with dependable water supply after health benefits have been deducted therefrom. Appendix Table X-C-3 shows the computation of this benefit. Hence, over the 13-year projection period, the present day value of total personal satisfaction benefits (discounted at 12 per cent) amount to ₱5.5 million.

Employment Generation Benefits. The employment benefits to be generated by the project were estimated from the cost of labor employed in the project. Short-term employment benefits will result from the expenditures for skilled and unskilled labor recruited from the study area during the construction period. In a developing economy, it is reasonable to expect unemployment of unskilled labor and the scarcity of skilled labor. In this study, it was assumed that all unskilled labor hired in the project were previously unemployed. Moreover, it was assumed that all skilled labor were previously

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[3]Refer to Methodology Manual on Water Supply Feasibility Studies, Chapter 20.

employed, otherwise they would have migrated elsewhere in search for employment and/or better wages. Therefore, the economic benefit was evaluated on the basis of 100 per cent of the wages paid to unskilled laborers who would otherwise be unemployed and the increase in wages of skilled laborers who would receive higher wages than in their previous employment. For the construction period of Stage I, which will extend from 1977 to 1990, the proposed project is estimated to provide economic benefits resulting from short-term employment amounting to ₱2.9 million (based on July 1976 prices). Only 10 per cent of the cost of skilled labor per year was assumed to represent the increase in wages. Appendix Table X-C-4a shows the short-term labor requirements and payroll of the project in Ozamiz City.

Long-term employment will be provided to those who will be retained by the Water District for the maintenance and operation of the project. Based on the proposed staffing plan in Chapter XI, the total number of permanent positions to be filled for the first five years is 45. By 1981, this number is expected to increase to 47 and by 1984, to 55. At present, the Water District employs more people than the proposed staffing plan but with lower salary scales, taken individually and collectively. The proposed staffing plan places emphasis on the competence and quality of the required personnel, rather than on the number. On the whole, therefore, the total payroll in the proposed staffing plan is higher than the existing one, after both were adjusted upwards by 10 per cent due to inflation.

Appendix Table X-C-4b presents the computations of the long-term employment benefits, amounting to ₱1.6 million. As shown, the total annual salaries paid under the present and proposed staffing arrangements were projected over a 13-year period. Only the yearly differences in salaries of the two plans were considered as benefits, discounted at 12 per cent to obtain their present values.

Taken together, the short-term and long-term employment benefits from the proposed water supply project in Ozamiz and Clarin amount to ₱4.5 million.

Fire Protection Benefits. With the installation of suitable type of fire hydrants especially in the high-value districts as part of the proposed project, savings due to reduced fire damages will result from the availability of an adequate amount of water for fire-fighting purposes.

Based on the records of the city's fire department and other assumptions explained in detail in Appendix Table X-C-5, the average annual loss to fire in Ozamiz and Clarin was estimated to be ₱1.709 million It is reasonable to expect that in time, as urbanization of the study area develops, further increases in fire incidence will be experienced. However, the amount of damages per year will decrease considerably due to a combination of factors, including the presence of water supply. Other factors are fire prevention consciousness, adherence of households, and commercial, industrial and institutional establishments to fire prevention regulations and the zoning schemes in the project.

In the computation of the fire protection benefit, the following factors were considered: proposed fire hydrant schedule, projected increase of service area, inflationary trend and discount factor. Appendix Table X-C-5 shows the fire protection benefits in Ozamiz arising from the improvement of the water supply system amounting to about ₱1.4 million.

No attempt was made to quantify the inconvenience to the people rendered homeless due to fire.

Reduction of Fire Insurance Costs. Associated with the availability of an adequate amount of water for fire-fighting purposes, it is reasonable to expect that the present level of insurance costs would be reduced significantly. This is because the cost of fire insurance normally reflects the extent of risks due to fire. With improved fire protection, the burden of insurance expenses of households and commercial, industrial and institutional establishments would be reduced.

In determining the benefit arising from the reduction of fire insurance costs, a number of factors were taken into consideration. These include the number of insurable dwelling units in the project area, projected increase in dwelling units as tied up with the increase in service connections and the standard values and premium rates for buildings in provincial areas. Total fire insurance benefits, as shown in Appendix Table X-C-6, amount to ₱146,900.

Summary of Quantifiable Benefits

Table X-1 is a summary of discounted quantifiable benefits that the proposed water supply project in Ozamiz and Clarin will bring about. After all adjustments due to inflation and other factors, the final figures show that the present value of the economic quantifiable benefits amounts to ₱55.0 million.

TABLE X-1

SUMMARY OF QUANTIFIABLE BENEFITS[4]
(in million pesos)

Increase in Land Values	₱40.770
Health	2.799
Personal Satisfaction	5.477
Employment Generation	4.484
Fire Protection	1.350
Reduction in Insurance Costs	.147
	₱55.027

<u>Non-Quantifiable Benefits</u>

The non-quantifiable benefits arising from a water supply project are generally as important as the quantifiable benefits. However, they do not easily lend themselves to valuation. The approach taken herein is to acknowledge their existence and importance. No attempt has been made to quantify or include them in the benefit-cost calculations.

<u>Improved Standard of Living</u>. The most evident benefit of the project is having safe, reliable and adequate piped water supply for daily needs on an uninterrupted basis. However, the convenience of having a dependable supply of water piped into households and establishments cannot be readily expressed in monetary terms.

Physical indicators relevant to the proposed project are used as indices of the standard of living of the project area. According to the 1970 Census on Population and Housing, 35.3 per cent of the households in Ozamiz depended on piped water while Clarin had no piped water system. Only 18.8 per cent of the population of the study area used flush or water-sealed system. (Living conditions in the project area are discussed in more detail in Chapter III.) With the proposed project, a greater number of the population

[4] All discounted at 12 per cent.

shall be benefited through the availability of potable drinking water and sufficient water for water-borne disposal of wastes.

Economic Linkages. Undoubtedly, the proposed water supply project will set off a chain of events beyond its construction period. These activities include among others the inducement to industry to establish plants in the study area due to the availability of a dependable water supply. Without such supply, new industrial and commercial establishments would be forced to develop their own supply system. The overall cost of providing separate water systems is normally large and represents a deterrent to invest in the area and consequently to industrial development.

Because of the employment generated by the project, hired laborers are able to spend their wages for purchasing goods at the local stores. Hence, each peso they spend is generated back into the income stream of the local economy.

In the operation and maintenance of the project, the Water District would find it advantageous to purchase required supplies locally and engage local services.

D. ECONOMIC COSTS

General

The total cost of the proposed water supply system is the sum of all "expenditures" required to realize project objectives and benefits.

Costs have been divided into the following:

1. Capital expenditure costs
2. Annual costs
3. Depreciation costs

In general, economic costs are easier to identify and quantify than benefits. This is because costs are incurred in real, monetary terms to pay for either goods or services. Problems in valuation of economic costs arise not from the identification of costs. Rather, they stem from the technical problems associated with the planning, design and implementation of the project.

In the computation of capital expenditure costs, annual costs and depreciation costs, it was assumed that the escalation rate due to inflation will be decreasing during the projection period. From 1976 to 1980, the rate would be 12 per cent; from 1981 to 1986, 10 per cent; and from 1987 to 1990, 8 per cent.

Capital Expenditure Costs

Capital expenditure costs include construction cost of the proposed facilities and related engineering and contingencies, land cost and administrative and legal fees.

Appendix Table XI-E-4 shows the yearly (escalated) capital expenditure costs associated with the early works and Stage I of the program. The present value of the capital expenditure costs is ₱35.3 million.

Adjustments on Capital Expenditure Costs

In the determination of the costs, adjustments were made for those items which are not properly valued by the price mechanism. A price other than the market price (called the shadow price) was imputed to these items. In this way, most of the effects which could be identified, whether primary or secondary, were incorporated directly into the project analysis and imputed as direct costs to project investment. The 'shadow prices' used in this analysis are those employed by international lending institutions and the Planning and Project Development Office (PPDO) of the Department of Public Works, Transportation and Communication.

One of the items wherein 'shadow pricing' was applied is the price of unskilled labor. In a perfectly competitive market, the price of labor is determined by the marginal value of its product. In this case, therefore, the price of labor is equal to the value of the output which an extra laborer hired would produce. However, this is not applicable in an economy such as that of the Philippines where there is surplus of labor. Since there is widespread disguised unemployment in such an economy, unskilled labor is normally valued below the actual wage rate likely to be paid. In this study, the opportunity cost of unskilled labor or its potential in other employment was valued at 0.5 times its estimated cost in the project. The net effect is to reduce the cost of unskilled labor by one-half, thereby reducing also the summation of project cost.

Skilled labor, on the other hand, was valued at its going rate. It was assumed that if skilled labor were not employed in the study area, it would probably migrate elsewhere to obtain employment or better wage.

Adjustments were also made with respect to cost of project facilities which use up the limited foreign exchange reserves. Foreign exchange used to import project requirements were valued at 1.2 times their actual peso cost. This effectively increased foreign exchange cost by 20 per cent, thereby affecting project cost in a similar manner. This was done to reflect the opportunity cost or alternative value of foreign exchange. Domestic components, on the other hand, were priced at their actual cost.

Taxes, subsidies and other transfer payments were excluded in this analysis since the project will be undertaken by the government for the benefit of the community. Interest was excluded since this is considered financial instead of economic cost.

The adjusted capital expenditure costs for the period up to 1990 are estimated to have a present value of ₱35.6 million.

Annual Costs

Annual costs refer to the costs associated with the maintenance, operation and management of the project. Otherwise known as operating and maintenance costs, they include personnel, power, chemicals, and other miscellaneous maintenance expenses such as fuel and lubrication, repairs, communication needs and office rental.

Appendix Table X-D-1 presents the escalated annual recurring costs associated with running and operating the water district up to 1990. The present value of these costs is ₱8.5 million.

Depreciation Costs

Depreciation costs refer to funds which are not actually spent but are set aside in a reserve or sinking fund to cover the costs of the wear and tear and/or obsolescence of the project's capital costs.

Chapter XI, Table XI-7 presents depreciation costs of MCWD from 1976 to 1990. Depreciation costs were based on the escalated values of all depreciable equipment.

The total present worth of depreciation costs for Ozamiz City amounts to ₱3.6 million during the 15-year projection period.

Summary of Costs

Table X-2 presents a summary of the capital expenditure, annual operating and depreciation costs of the proposed water supply project for Ozamiz and Clarin. The economic costs are also presented in more detail in Appendix Table X-D-1. All costs were discounted at 12 per cent to obtain their present values.

For MOWD, the present worth of all economic costs of the project from 1976 to 1990 amounts to ₱47.6 million.

E. CONCLUSION

The summary of quantifiable benefits as well as the benefit-cost ratio, is presented in Table X-2. The benefit-cost ratio is 1.16:1.

As will be observed in the table, health benefits when put into peso values, became insignificant. The principal items on benefits are the increase in land value, personal satisfaction and employment generation, in that order.

TABLE X-2

SUMMARY OF BENEFITS AND COSTS [5]
(in million pesos)

BENEFITS		COSTS	
Increase in Land Values	₱40.770	[6]Capital Expenditures	₱35.577
Health	2.799	Annual Operating	8.464
Personal Satisfaction	5.475	Depreciation	3.565
Employment Generation	4.484		
Fire Protection	1.350		
Reduction in Insurance Costs	.147		
TOTAL	₱55.025		₱47.606
Benefit-Cost Ratio	1.16:1		

[5] All discounted at 12 per cent.
[6] Foreign exchange cost and unskilled labor cost were adjusted by 'shadow pricing'.

The preceding table shows that the quantifiable benefits exceed the project costs associated with the improvement of water supply facilities that will provide safe, dependable and adequate water supply to Ozamiz and Clarin. Under the principle of economic analysis, the project which has a benefit-cost ratio of 1.16:1 is, therefore, economically feasible. The actual benefits of the project, however, are really greater than what the ratio indicates because the unquantifiable benefits have not been incorporated into the analysis for obvious reasons.

CHAPTER XI FINANCIAL FEASIBILITY ANALYSIS

A. GENERAL

The financial feasibility analysis herein establishes a detailed set of guidelines that the water district management may use in making crucial decisions during the next few years. The technical aspects and project costs of the recommended plan have been presented in Chapter IX. Its economic justification has been shown in Chapter X. In this chapter, a plan is developed to indicate time and manner funds will be used to operate and maintain the system; implement the program; establish reserve funds and retire the indebtedness.

Water rates have been developed on the basis that the system will be financially self-supporting. Capital funds for the recommended plan will be derived by borrowing from international lending agencies and LWUA. The water rates that have been developed appear to be within the "ability to pay" of the average householder in the Misamis Occidental Water District.

B. DEVELOPMENT COSTS

The cost estimates of the facilities needed to improve and expand water services of the Misamis Occidental Water District over the development planning period have been presented in Chapter IX. Cost estimates of the facilities were based on the projected July 1976 unit prices.

Project Costs

Project costs of facilities recommended for implementation are summarized annually in Appendix Table XI-B-1. Engineering services for design and construction supervision have been broken down. It has been assumed that 70 per cent of the engineering services applies to design and 30 per cent to construction supervision. Design costs have been shown in the year preceding construction. All other items such as legal, administrative and contingencies have been distributed uniformly during the construction period. Foreign exchange component of total project cost as shown includes cost of direct and indirect import items as well as a portion of the engineering costs.

Escalation of Capital Costs

To account for the effects of inflation, capital cost estimates have been escalated. This was done year by year on an item by item basis using escalation factors computed from assumed inflationary trends and applied to the basic current cost data as shown in Appendix Table XI-B-2. The escalation factors used were based on an average annual rate of inflation of 12% per year from 1976 through 1980, 10% per year from 1981 through 1985 and 8% per year thereafter. These escalation factors have been assumed to apply equally to the local and foreign exchange cost.

Meter Replacement Schedule

Appendix Table XI-B-3 shows the meter installation and replacement schedule on the basis of the need to achieve a fully metered status.

Details such as depreciation expenses and cumulative book value, depreciation are also presented. These calculations were based on a meter service life of 15 years and initial 1976 cost of ₱190 per meter.

C. OPERATING AND MAINTENANCE COSTS

This cost category covers cash expenses required to keep the system operating and adequately maintained. It assures the continued maintenance of the water district's revenue producing capacity and protection of its investment. Included in this cost category are: personnel, power, chemicals, maintenance, rental, and other miscellaneous expenses which are necessary to run the overall water system. Most items increase in accordance with the quantity of water produced, the number of customers served and the extent to which the physical plant will be operated and maintained.

The operating cost of the existing system in 1976 was estimated at ₱315,000. The annual operating and maintenance cost will increase, following implementation of the recommended improvements due to additional personnel, electric power, fuel, chemicals and various materials and supplies.

Staff Requirements

Projections of the various types of staff required to support operations and maintenance were made at various future dates. The points in time selected coincided with the start-up of newly constructed facilities. In Misamis Occidental, the new spring development, transmission and distribution facilities are scheduled to be completed and placed in operation in 1981. Intervals therefore have been spaced so as to include Fiscal Year 1981-82 in the staff forecasting. Appendix Table XI-C-1 provides the staffing plan for the MOWD. Total salaries, wages and benefits have been based on 1976 cost levels, then escalated at 10 per cent per annum. Values for the intervening years may be obtained by interpolation.

Appendix Table XI-C-1 includes only those who will be involved in the water supply functions (even if in the future, sewerage functions are to be performed by the Water District). Personnel used for construction of distribution system extensions and new connections has been excluded since all labor costs associated with development have already been included in the development cost projections.

Other Operating and Maintenance Costs (See Chapter IX)

1. Consumable items - Projections were made on the basis of units consumed e.g., kilowatt hours of electricity, tons of chlorine, etc.

2. Services - Include insurance, legal, auditing and other general service costs.

3. Rent - Provisions have been made for equivalent rent expenses until 1980, after which rent ceases due to acquisition of the new administration building.

Service Connections

In projecting service connections, several factors related to the areas included in the study have been taken into account. The served population is expected to grow considerably during the 15-year study period. In year 1975, served population represents only 24 per cent of the total study area population. This is projected to go up to 45 per cent in the year 1990, an increase from 17,500 in 1975 to 53,000 in 1990. Appendix Table XI-C-2 shows the schedule of service connections and related data for 1975 and the projected future.

D. FINANCING POLICIES GOVERNING LOCAL WATER DISTRICT DEVELOPMENT

The following are the major potential sources of funds which can be utilized by the district:

Operating Sources

To the extent that revenues from the operations of the local water district exceed annual cash requirements for all other purposes, funds can be devoted to financing development costs. As a practical matter, it is highly desirable to finance a significant proportion of development costs in this manner in order to reduce the amounts that must be borrowed and the associated debt service costs. From the viewpoint of the individual water consumer, it is better to pay higher rates now in order to increase the proportion of development costs covered by current revenues. Thus the temporary "development surcharge" can be justified on the basis of the longer term influence toward the restraint of rate increases.

The fairness of allocating such costs among present consumers can be challenged and highly theoretical and complex considerations are involved. But by using a purely pragmatic approach, one could try to maximize the use of current revenues for development.

<u>Non-Operating Sources</u>

Non-operating sources of funds for development include three basic groups:

1. Loans - funds may be borrowed by MCWD for development. One of LWUA's primary functions is lending funds for development to water districts. From the water district's point of view, LWUA is the primary, if not the only realistic source of funds. LWUA borrows both foreign currencies and pesos at varying terms and relends needed funds to water districts according to the composite terms needed to support the blend of debt service terms LWUA itself must meet. At the present time, LWUA's terms include:

   Interest - 9% per annum to be paid monthly at ¾% per month from the year following the year of disbursement.

   Duration - 30-year loan from the date of initial disbursements.

   Principal - no principal payments due during disbursement period. Principal repayment period is 30 years less the duration of the disbursement period.

2. Charges and Assessments - consist of payments made by new customers and benefiting property owners for the costs of specific portions of the facilities being developed. Typically, such charges are made for the costs of new construction and meters and for all or a portion of the costs of new distribution system extensions. LWUA policy requires new customers to pay for connections and meters, but currently does not include an assessment for distributions system costs. These sources are referred to as "contributions in aid of construction" in accounting terminology and have the effect of reducing the amounts to be borrowed. Since many new customers will not be in a position to pay connection

fees (or benefit assessment charges) in cash, it will be necessary to provide financing assistance to those individuals requiring assistance. Present practice is to allow such payments to be made at a flat monthly rate of ₱5.00 over a period of 10 years.

3. Grants or Credits - LWUA has access to loan funds on concessionary terms and is thus able to relend funds at rates that are below market rates. This in itself is a "grant." available to the local water district borrower. In some countries, the national government makes outright grants to local water districts in recognition of the overall national benefit of having safe and reliable water systems. Another approach is for the government to advance a portion of the funds needed during the early years of development at little or no interest to assist the local utility in building its financial capacity. This is another form of "grant" as referred to above. Later, as the revenue base expands and development expenditures decline, the local utility funds such advances as permitted by its cash position. At the present time, however, the local water district is expected to undertake its development programs with no equity participation by government or assistance other than the LWUA loans.

Reserve Requirements

Since reserve requirements are tied directly to obtaining development loans from LWUA, they are considered as funds required to support capital development. After total revenue requirements are determined, it has been suggested that 10 per cent be set aside for reserve funds. Initially, a lower percentage will be used, progressively increasing to 10 per cent.

E. DETERMINATION OF FUNDS REQUIRED TO SUPPORT CAPITAL DEVELOPMENT

Once the basic data requirements have been met and the financing policies outlined, funds required to cover development costs are then determined. The most important document in this regard is the breakdown of project costs as escalated and shown in Appendix Table XI-B-2.

Depreciable Assets/Depreciation Expenses

Capital assets acquired each year become subject to depreciation in their first full year of service. Thus a pipeline completed in 1977 becomes "depreciable" in 1978. If it has a 50-year life, depreciation continues for 50 years and it is assumed to be retired in the 51st year. The cost of large facilities that require several years to construct is carried as "work in process" until completed. Forecasts of such matter had to be based on very broad assumptions.

Appendix Table XI-E-1 shows the water district's assets and depreciation forecasts, the inital purpose of which is to show the appropriate "depreciable" value for use in calculating annual depreciation expenses. At the same time, year-end book values of assets are shown as well as the value of "work-in-process".

Based on the schedule of assets, annual depreciation expenses were calculated and are shown in Appendix Table XI-E-2.

Revolving Fund for Connections

To assist new customers in financing service connecting charges, it is necessary to provide working capital for a revolving fund. It is proposed that LWUA's present policy which provides for the costs to be payable at ₱5.00/month over a 10-year period be increased to ₱5.65 to cover the increase in the cost of meters. Net inflow funds will be required over a period of 10-years to build sufficient income to support the annual costs of connections. At some future point, income exceeds annual expenditures and the revolving fund can be used to refund the earlier advances of working capital.

Appendix Table XI-E-3 indicates the working capital requirements based on preliminary data for Misamis Occidental. In this table, three key assumptions were made:

1. The monthly installment payments were based on actual costs of constructing service connections and meters; thus, the monthly payments by customers connected to the system in 1981 would be greater than by those who would be connected to the system in 1978 to account for the escalation of constructed costs.

2. Sixty per cent of all new customers would utilize the installment method of financing connection charges.

3. The amount of the charge is equal to 2/3 of the cost of piping (roughly that part of the connection lying within private property) plus the full cost of the meters (₱434).

As shown in Appendix Table XI-E-3, the annual need for additional working capital generally stops sometime in 1988 when receipts begin to exceed expenditures.

Debt Service Requirements

Most financing institutions make loans for capital development only to those entities that show some equity participation of their own. Thus, a first approximation of a financing plan should include a "pay-as-you-go" element. This must be geared to conservative estimates of the revenue-producing capacity of the water district and the manner in which it can effectively increase its revenues through improved metering, billing and collection procedures over time. The amount of funds borrowed should cover total development costs and other capital expenditures (replacement meters, vehicles, etc.).

Appendix Table XI-E-4 presents a trial financing plan and debt service requirements of Misamis Occidental. This table gives an initial indication of debt service and funds needed to support capital development. In accordance with LWUA policy, interest payments were not made on disbursed amounts during the year of disbursement and were based on the amount of outstanding debt at the beginning of each year. It can be seen that debt service increases rapidly during the early years when the annual development expenditures are very substantial. By 1982 when the annual capital expenditures are at a lower level, the debt service payments would rise to the point that the water district must still continue borrowing.

Total Cash Needs

Appendix Table XI-E-5 shows the "trial" annual cash requirements, the average cash required per cubic meter of water and the approximate proportions of the income of low income households required for water service. This information has been included to serve as a guide in developing the rate structures for subsequent use in the year-by-year revenue forecasts.

The present LWUA rate policy incorporates the use of "revenue units" in determining the basic cost per cubic meter of water to the lower income households. Commercial and industrial customers are charged twice the unit price for domestic use and wholesale water distributors are charged three times the basic price. These average unit costs provide good indicators of "revenue unit" prices that can be used for a period of several years. It is good practice for the water district to adjust prices every three years or so, instead of annually.

Revenue Unit Forecasts

Appendix Table XI-E-6 indicates the revenue unit forecast which is summarized as follows:

1975	1,398	Revenue Units
1980	4,069	"
1985	6,474	"
1990	8,879	"

Initial Rate Determination

Rates were established at five 3- year intervals:

Period	Water Rate ₱/cum
1976-1978	₱1.00
1979-1981	1.90
1982-1984	2.50
1985-1987	3.20
1988-1990	4.50

The first step of ₱1.00/cum was selected as an intermediate rate, in anticipation of the second step (₱1.90/cum) which is indicative of the required cost to make the system financially viable. Ability (and willingness) to pay indicates that ₱1.20 per cubic meter under present (1975) economic conditions would be acceptable, assuming that service improvements are realized. The rate of ₱1.90/cum in 1980 cost levels is equivalent to ₱1.18 in 1975 prices (based on 10% discount rate). Likewise ₱2.50/cum in 1983 is equal to ₱1.17 in 1975 prices.

Revenue Forecasts

Estimated future levels of income from water sales are shown in Appendix Table XI- E- 7.

Feasibility of Charges

The question of feasibility is a matter of analysing whether or not the customers of the water district are able to pay the required charges both now and in the future in order to obtain safe and reliable water services. Determination has been made for those households in the lower income groups. For present purposes, the 1976 income level of ₱440 per month was selected as a basis for analysis. It was also assumed that the consumers will limit their consumption to 20 cubic meters per month. At ₱1.00 per cubic meter, a 20 cum consumption thus represents 4.6 per cent of the customer's monthly income. For newly connected customers, the monthly cost will be ₱5.65 greater if it is assumed that the low income customer will choose the installment plan payment. Assuming the new customer also limits his consumption to 20 cubic meters or less, the monthly expenditure for water will then be 5.8% The monthly installment charge for new connections is fixed in the year of connection and remains constant throughout the 10-year payment period. Since both the water rates and the household income increase each year, the impact of the installment charge on the expenditure pattern of the household will decline over the 10-year period of payment. The estimated impact of the increased rates and connection charges on household patterns is shown below for the mid-point of each "rate block":

Item	1980	1983	1986	1989
Escalated income of household earning ₱440/mo. in 1976 (10% per year)	₱645	₱860	₱1,140	₱1,520
Expenditure for 20 cum water consumption	₱ 38	₱ 50	₱ 64	₱ 90
Income allocation to water for existing customers	5.9%	5.8%	5.6%	5.9%
Connection charge for new customers (5.65/mo in 1976)	8.87	₱11.81	₱15.48	₱19.49
Income allocation to water for new customers	7.3%	7.2%	7.0%	7.2%

Since the mid-point of the period was selected for comparison, it should be noted that the proportions shown would be slightly higher in the year preceding the mid-point and slightly lower in the succeeding year of each rate block.

In the example shown above, the proportions of the household income required for water services are considered in line with the "Ability to Pay" studies done on Lipa City where willingness among the low income group to pay for improved services fees was found to be in the vicinity of 6% of their income.

In the final analysis, if any significant improvement is to be achieved in the scope and quality of public water services and if the requirement for commercially viable and financially self-supporting water districts is to be maintained, all groups of water customers will have to pay substantially higher charges for water services than they have paid in the past.

F. FINANCIAL SUMMARY

Several "trials" have been conducted in developing the forecasts of financial statements of MOWD. These statements are based on the following major assumptions:

1. Reserve Fund: 3% of revenue requirements for 1976-80; 6% for 1981-85 and 10% for 1986-90.

2. Uncollectibles: 2% of gross revenue requirements for first year of a new rate application, and 1% for the second and third years.

3. Accounts Receivable: equivalent to 3 months of sales.

4. Accounts Payable: equivalent to 2 months of operating expenses.

External Borrowing Required

Appendix Table XI-E-8 shows the Revised Financing Plan where the "Amount Disbursed" column represents the external borrowing required. This table also presents the debt servicing necessary on a yearly basis.

Borrowing will start in 1976 and will continue until 1987. The first loan will cover the seven year period 1976-82 inclusive, and will amount to ₱31.08 million. The second loan will cover the five-year period 1983-87 inclusive and will be about ₱26.761 million.

Projections of Financial Statements

Appendix Table XI-E-9 shows the net income (loss) on a yearly basis. Net losses are forecasted in two (1980-81) of the 15 years. However, net income cumulative shows positive values all throughout.

Prior trial projections showed sustained net losses on a yearly basis when 10% reserve funds were required.

By 1990, net income cumulative will be ₱24.761 million.

Cash Flow Statements

The cash flow statement provides an indication of the adequacy of working capital. It is not generally sufficient to cover cash outlays with revenues because of the tendency of cash receipts to lag behind cash outlays. In general, an expanding organization with an active capital development program and increasing level of activities will require similarly increasing quantities of working capital.

Appendix Table XI-E-10 presents the annual "Sources of Funds" and the yearly "Application of Funds". Potential net decreases are expected in 1981 and 1988. However, net positive cumulative cash balance is achieved yearly from the very start even if "cash at the beginning of 1976" was assumed to be only ₱20,000.00.

Other Financial Statements

The "Balance Sheet" and "Rate of Return" are shown in Appendix Tables XI-E-11 and XI-E-12, respectively.

Implications of Financial Forecasts

The recommended plan for Phase I-A for MOWD is financially feasible. Borrowing for the period will be ₱31.08 million.[1]

External borrowing will still be necessary for Phase I-B.

Revenues are adequate for most years, assuming some flexibility is taken on the amount of reserve funding and depreciation expense requirements.

The cash flow analysis shows adequate working capital. Net positive cumulative cash balance is realized immediately.

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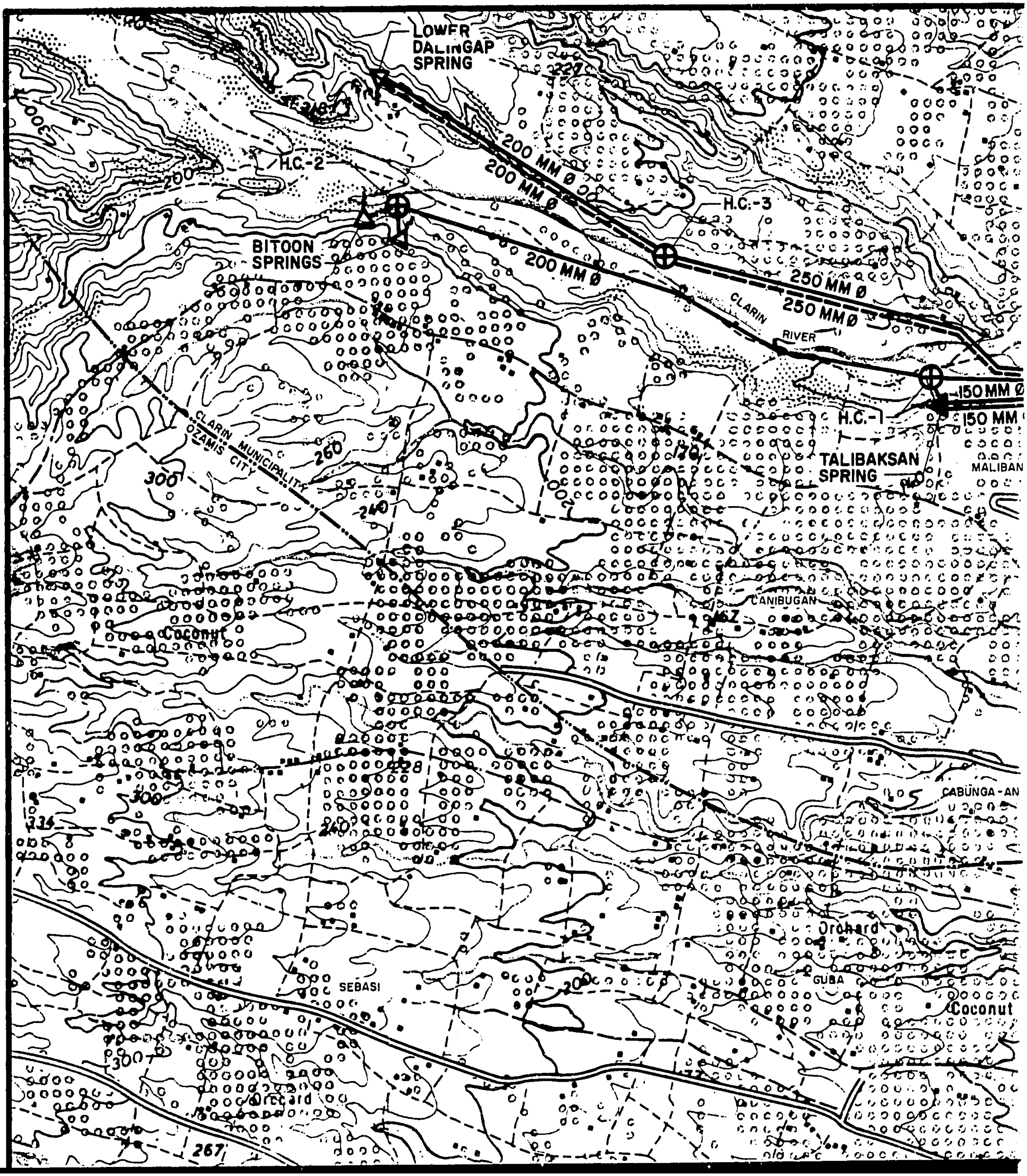
[1]On October 24, 1975, a memorandum of understanding was drawn up between the MOWD and ADB. In this memorandum, the scope of work (₱31.880 million), financial arrangements, project execution and other items were set forth (See Appendix XI-F-1).

On December 18, 1975, ADB and LWUA signed a loan agreement amounting to $16.8 million for the improvement and expansion of five provincial water districts. Of this amount, $1.749 million has been allocated to MOWD (See Appendices XI-F-2 and XI-F-3).



LOWER
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200 MM Ø
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CLARIN
RIVER
150 MM Ø
150 MM
H.C.-1
TALIBAKSAN
SPRING
MALIBAN
CLARIN MUNICIPALITY
OZAMIS CITY
300
260
240
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CANIBUGAN
Coconut
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Orchard
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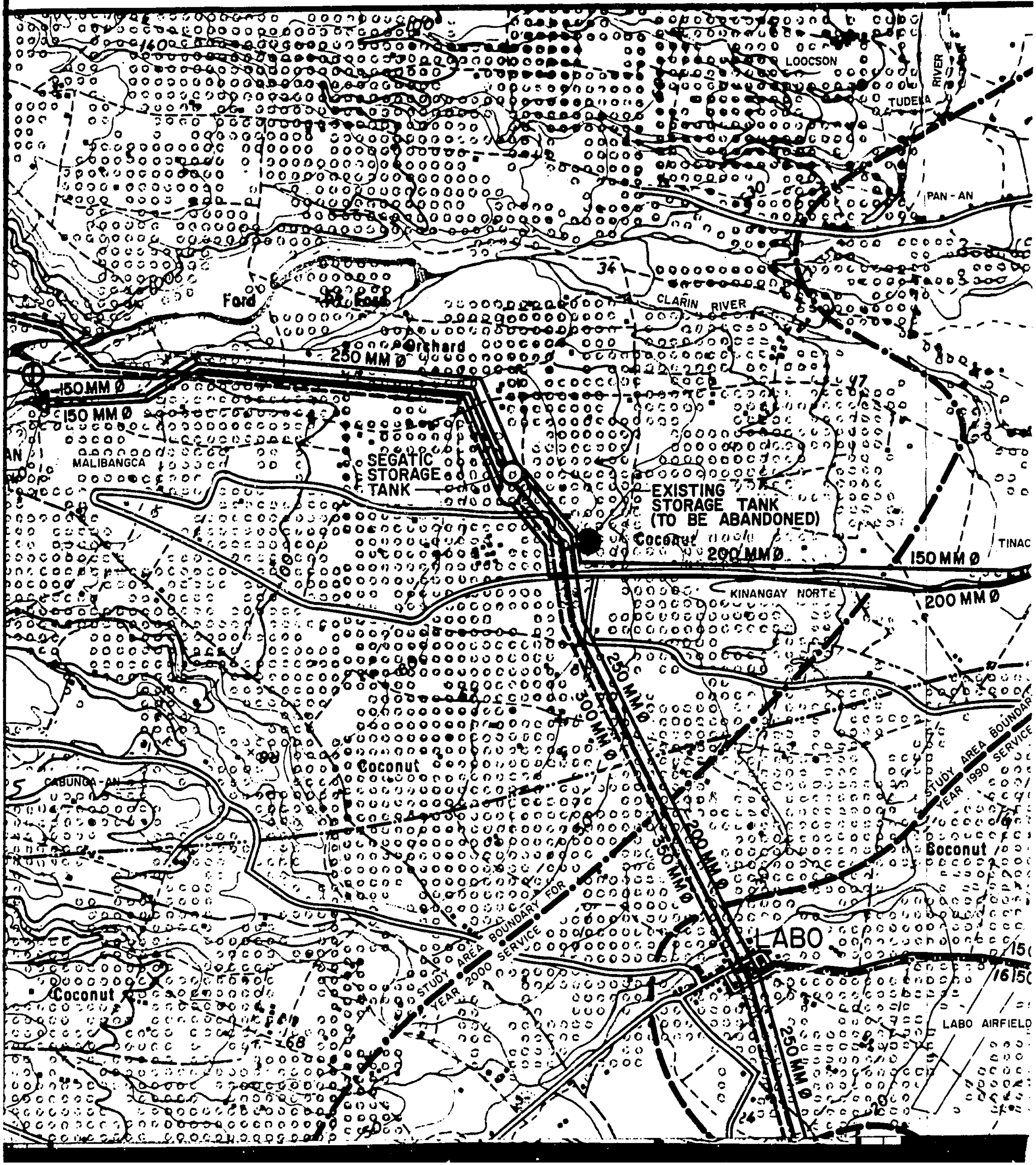

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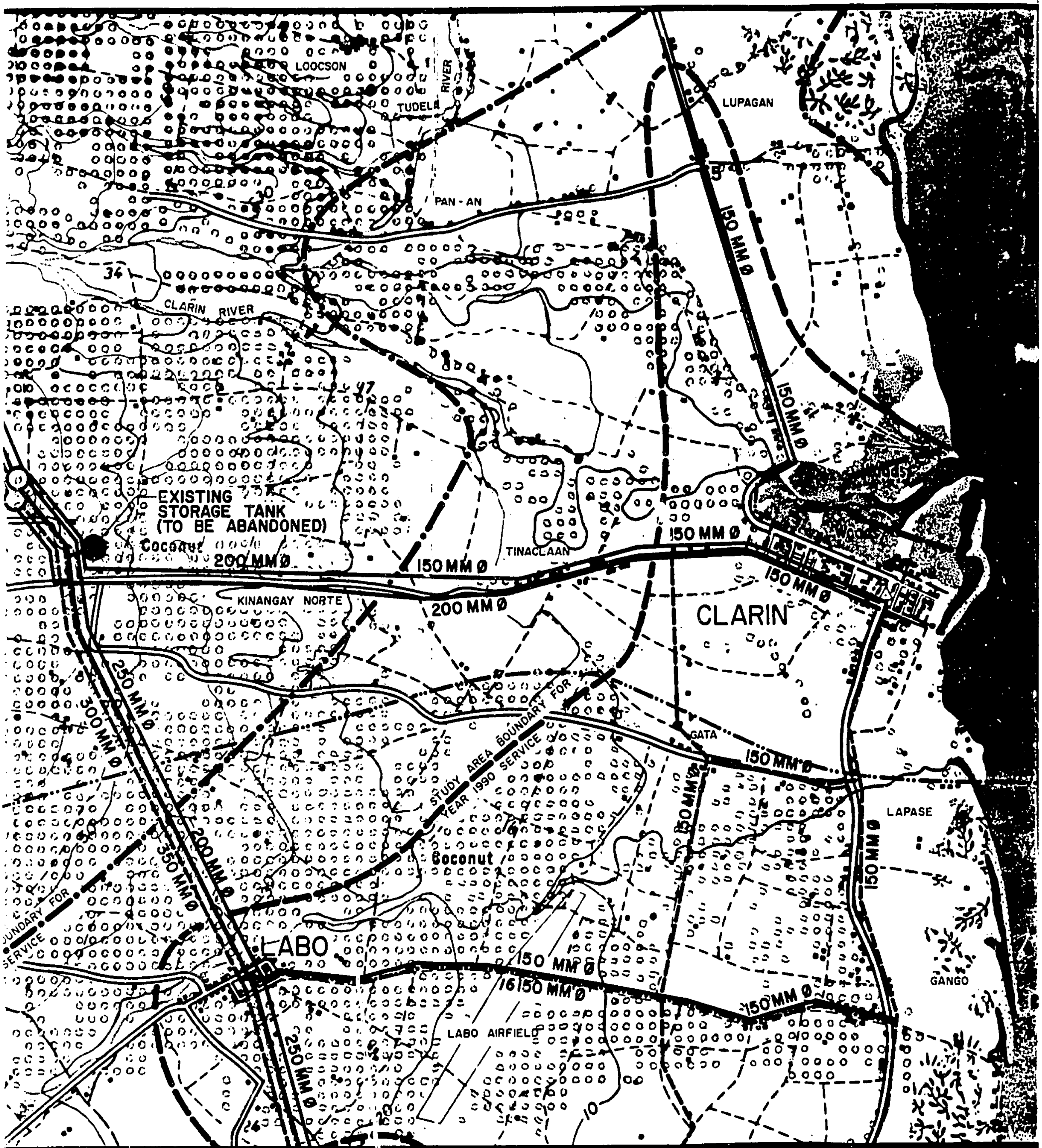
PAN - AN
34
CLARIN RIVER
Ford
Orchard
250 MM Ø
150 MM Ø
150 MM Ø
MALIBANGCA
SEGATIC
STORAGE
TANK
EXISTING
STORAGE TANK
(TO BE ABANDONED)
Coconut
200 MM Ø
150 MM Ø
TINAC
KINANGAY NORTE
200 MM Ø
250 MM Ø
300 MM Ø
Coconut
CABUNGA-AN
STUDY AREA BOUNDARY
YEAR 1990 SERVICE
350 MM Ø
200 MM Ø
Coconut
STUDY AREA BOUNDARY FOR
YEAR 2000 SERVICE
LABO
Coconut
250 MM Ø
LABO AIRFIELD


LOOCSON
TUDELA
RIVER
LUPAGAN
PAN - AN
150 MM Ø
34
CLARIN RIVER
47
150 MM Ø
EXISTING
STORAGE TANK
(TO BE ABANDONED)
Coconut
200 MM Ø
150 MM Ø
TINACLAAN
150 MM Ø
150 MM Ø
KINANGAY NORTE
200 MM Ø
CLARIN
250 MM Ø
300 MM Ø
STUDY AREA BOUNDARY FOR
YEAR 1990 SERVICE
GATA
150 MM Ø
150 MM Ø
LAPASE
150 MM Ø
200 MM Ø
350 MM Ø
Boconut
BOUNDARY FOR
SERVICE
LABO
150 MM Ø
150 MM Ø
150 MM Ø
GANGO
LABO AIRFIELD
250 MM Ø
10

LEGEND:

EXISTING SYSTEM

- ● STORAGE TANK
- ■ PUMP STATION
- ▼ SPRING
- ——— PIPELINE-150 MM OR LARGER
- - - - - PIPELINE-100 MM

PROPOSED FIRST STAGE PROJECT

PHASE I-A

- ○ STORAGE TANK
- □ PUMP STATION
- ⊕ HYDRAULIC CONTROL CHAMBER
- ▽ SPRING
- ——— PIPELINE

PHASE I-B

- - - - - PIPELINE

PHASE I-C

- -·-·-·- PIPELINE

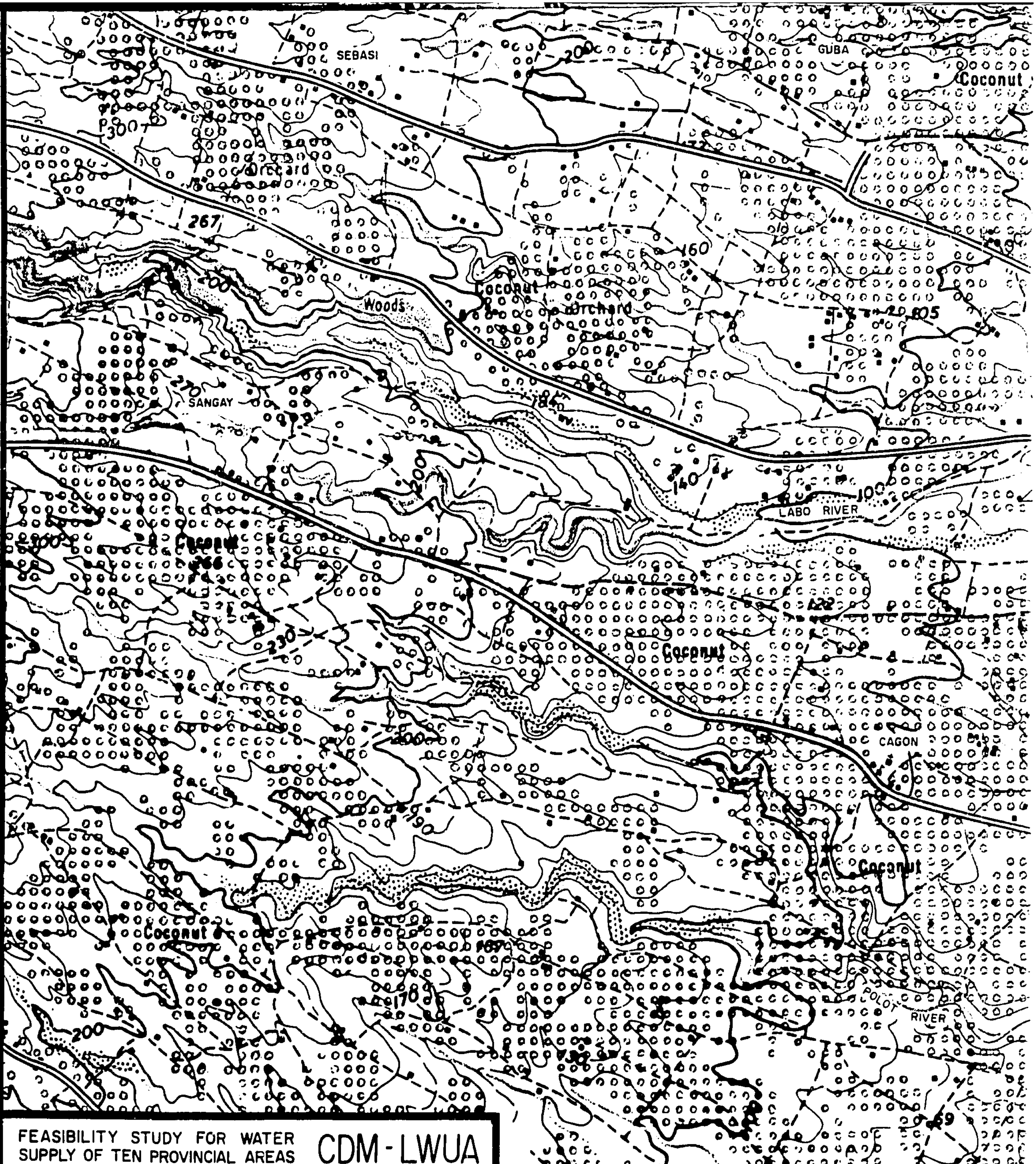
PROPOSED SECOND STAGE PROJECT

PHASE II-A

- ○ STORAGE TANK
- ⊕ HYDRAULIC CONTROL CHAMBER
- ▽ SPRING
- ——— PIPELINE

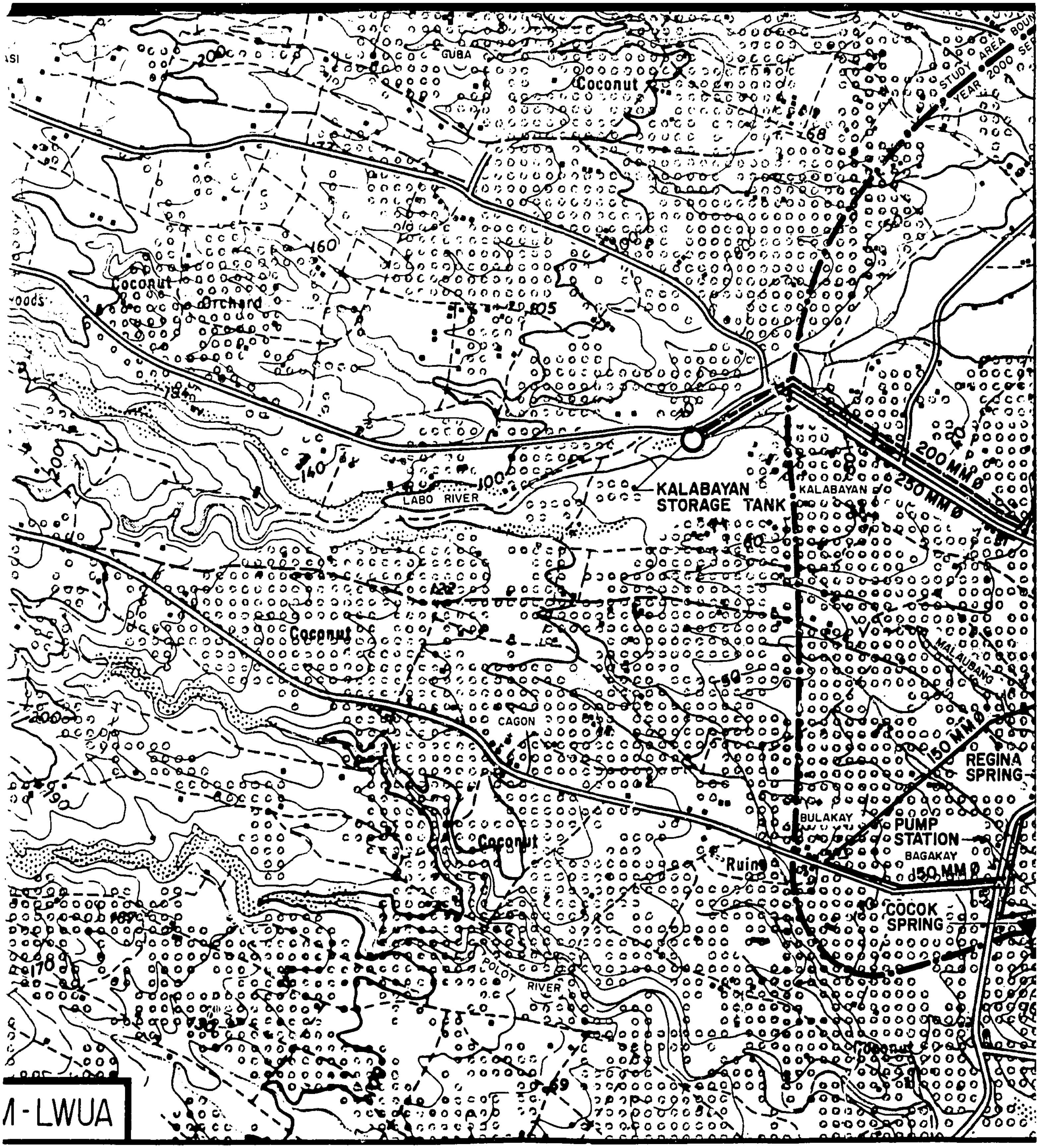
PHASE II-B

- ○ STORAGE TANK
- - - - - PIPELINE



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS

CDM - LWUA


GUBA
Coconut
STUDY AREA BOUNDARY
YEAR 2000 SER
Coconut
Orchard
160
105
134
140
100
LABO RIVER
KALABAYAN
STORAGE TANK
KALABAYAN
200 MM Ø
250 MM Ø
Coconut
MALAUBANG
CAGON
150 MM Ø
REGINA
SPRING
BULAKAY
PUMP
STATION
BAGAKAY
150 MM Ø
Coconut
Ruins
COCOK
SPRING
POLOT RIVER
Coconut
M-LWUA

LABO
STUDY AREA BOUNDARY YEAR 2000 SERVICE
150 MM Ø
16 150 MM Ø
LABO AIRFIELD
250 MM Ø
200 MM Ø
150 MM Ø
Coconut
KARANGAN
TINAGO CREEK
200 MM Ø
MALAUBANG
BANADERO
REGINA SPRING
RIVER
150 MM Ø
KALUSARAN
PUMP STATION
150 MM Ø
200 MM Ø
TINAGO
150 MM Ø
OZAMIZ CITY
200 MM Ø
MOWD OFFICE
PUMP STATION (EXPANSION)
MALAUBANG
PANGUIL

HYDRAULIC CONTROL CHAMBER

SPRING

PIPELINE

PHASE II - B

STORAGE TANK

PIPELINE

FIGURE IX-2

MISAMIS OCCIDENTAL WATER DISTRICT

WATER SUPPLY SOURCE
TRANSMISSION AND DISTRIBUTION SYSTEM
MAP SHOWING

EXISTING FACILITIES

RECOMMENDED STAGE I FACILITIES

RECOMMENDED STAGE II FACILITIES

500 0 500 1000
SCALE IN METERS

JANUARY 1978