After the detailed designs of the Water System have been finished, preparation of Pre-qualification Documents will commence. A 4-month schedule is proposed for the Pre-construction stage. This includes Publication, Pre-bid Conference, Bid Evaluation, and Awarding of Winning Bidders.

The construction will start after the Notice to Proceed (NTP) is given to the winning bidders. It is projected to be completed in one year or at the end of 1997. The construction of the system will be divided into two phases, Phase I covers year 1998 to 2001 while Phase II includes up to year 2005. Except for the town of Mendez and Tagaytay City, which have relatively small system and one source development, the Stage I development works will be implemented. Phase II implementation will be completed by the end of year 2001.

**Fig. 10.1-1** presents the proposed implementation schedule for the Water Supply Development Project.

## 10.2 WATER SUPPLY PLAN FOR G.M.A.

### 10.2.1 Existing Water Supply System Facilities

The Gen. Mariano Alvarez Water District (G.M.A.-WD) is operating the water system in the Municipality of G.M.A. which covers 21 barangays, and 2 other separate systems. The facilities include eight (8) deepwells in addition to the pumping and storage facilities and pipelines as indicated in **Figs. 10.2-1A to 1C.**

(1) Source

The existing G.M.A. Water District Supply Facilities has eight (8) wells located at the Poblacion area and adjacent barangays. Originally, there were six (6) wells constructed in 1972 by the National Housing Authority to serve its twenty one (21) barangays. In 1992 operation of the Water Systems of Teacher's Village and Mandarin Homes were transferred to the G.M.A.Water District.

Based on the monthly data sheet officially submitted to LWUA, the total average production of these wells is 84,720 $m^3$. (2,824 $m^3/d$)

(2) Pumping Facilities

Pump Statistical Data of existing facilities is shown in **Table 10.2-1**.

(3) Storage Facilities

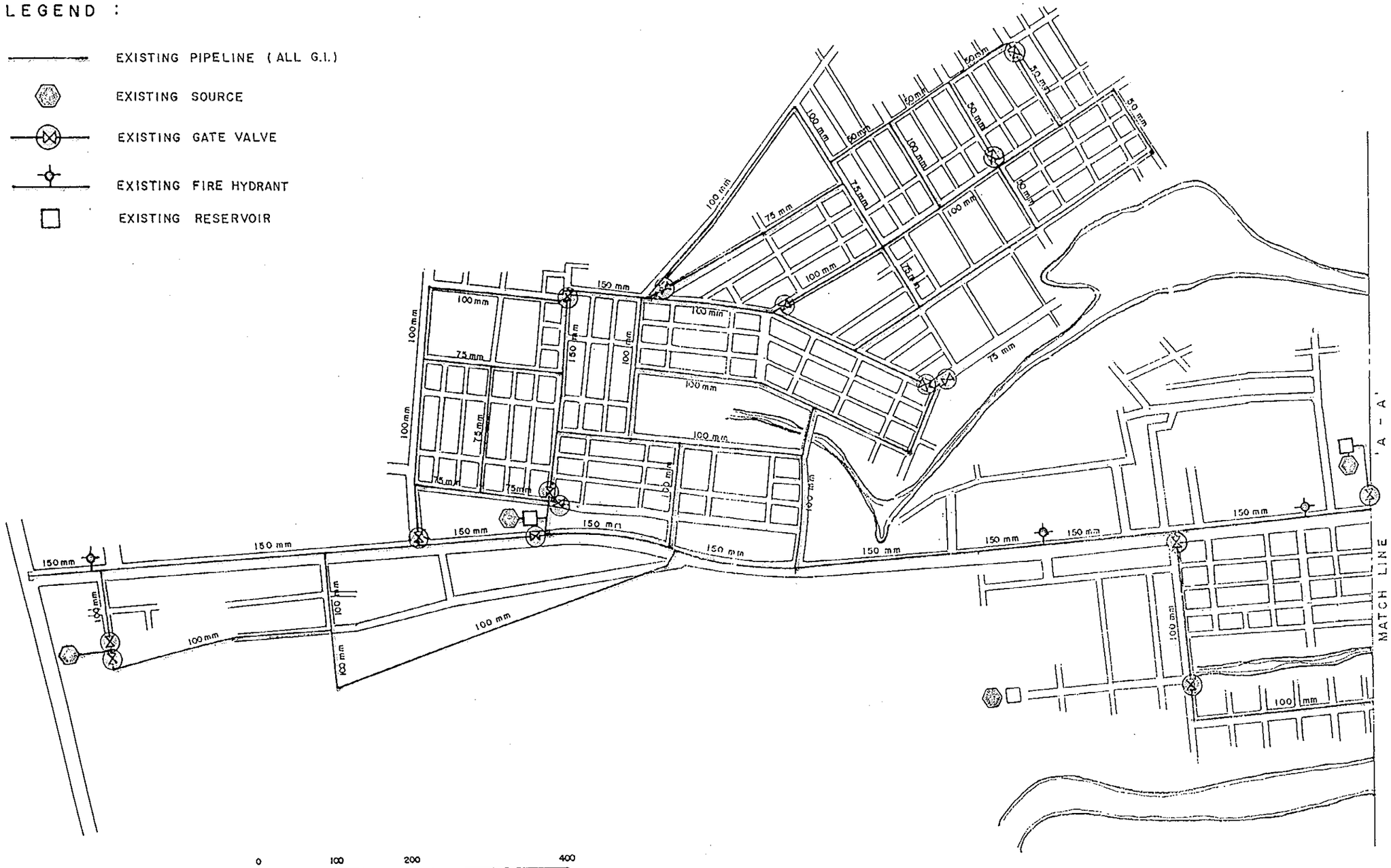
To date, the G.M.A.-WD has five (5) existing steel reservoirs serving the 21 barangays. Four (4) of which are elevated tanks with a capacity of 227 $m^3$ and one (1) ground reservoir which

**Fig. 10.1-1 PROPOSED IMPLEMENTATION SCHEDULE**

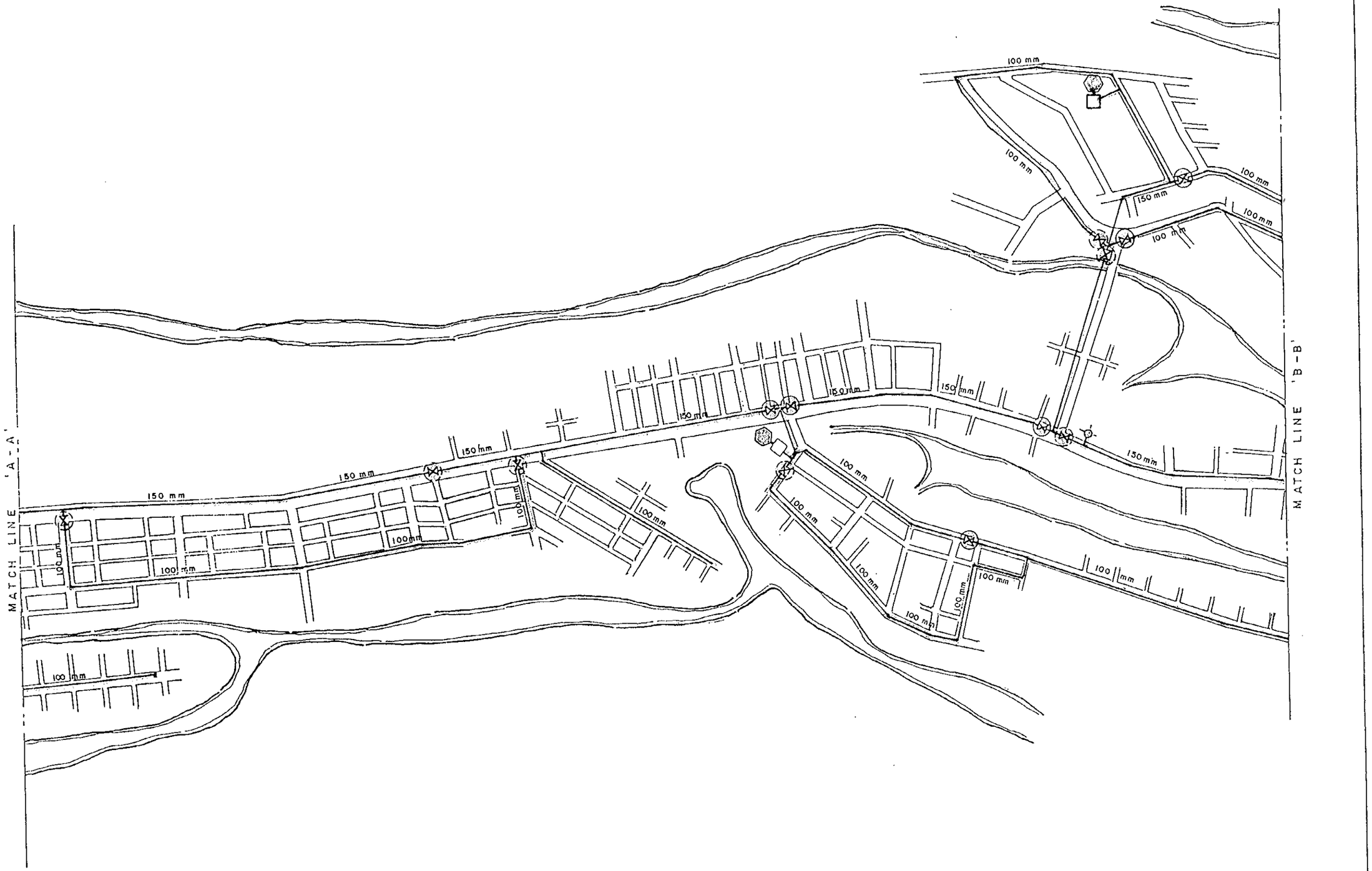
| NAME OF WD | ITEM | 1996 | | | | 1997 | | | | 1998 | | | | 1999 | | | | 2000 | | | | 2001 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| GMA-WD | Detailed Engineering Design<br>Pre-Construction<br>Construction | | | | | | | | | | | | | | | | | | | | | | | | |
| MWD | Detailed Engineering Design<br>Pre-Construction<br>Construction | | | | | | | | | | | | | | | | | | | | | | | | |
| NWD | Detailed Engineering Design<br>Pre-Construction<br>Construction | | | | | | | | | | | | | | | | | | | | | | | | |
| TC-WD | Detailed Engineering Design<br>Pre-Construction<br>Construction | | | | | | | | | | | | | | | | | | | | | | | | |
| TAN-WD | Detailed Engineering Design<br>Pre-Construction<br>Construction | | | | | | | | | | | | | | | | | | | | | | | | |

LEGEND :

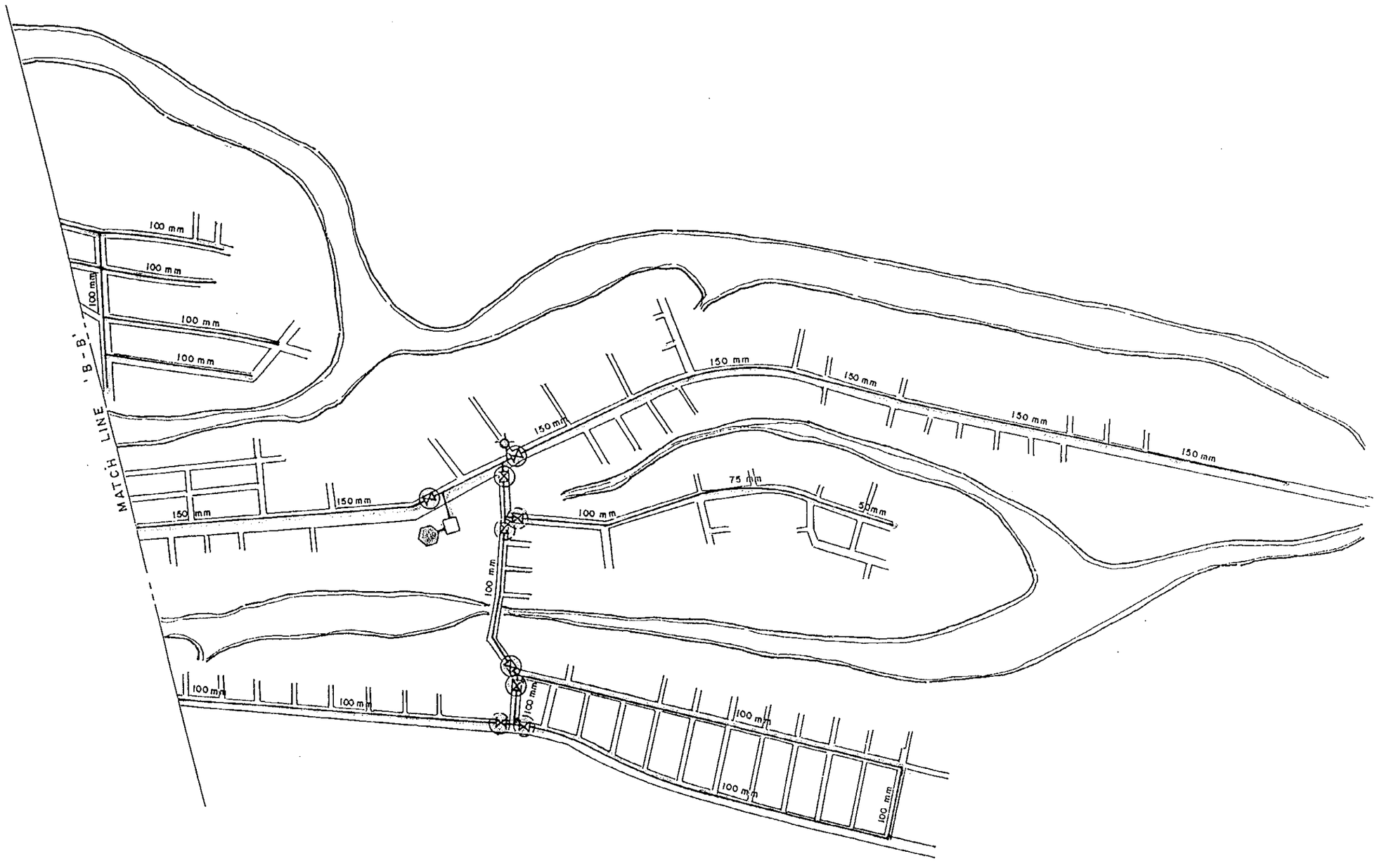
- EXISTING PIPELINE ( ALL G.I.)
- EXISTING SOURCE
- EXISTING GATE VALVE
- EXISTING FIRE HYDRANT
- EXISTING RESERVOIR




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.2-1A<br>EXISTING WATER SUPPLY SYSTEM<br>GMA WATER DISTRICT<br>G M A , CAVITE |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.2-1B<br>EXISTING WATER SUPPLY SYSTEM<br>GMA WATER DISTRICT<br>G M A , CAVITE |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.2-1C |
| JAPAN INTERNATIONAL COOPERATION AGENCY | EXISTING WATER SUPPLY SYSTEM<br>GMA WATER DISTRICT<br>G M A, CAVITE |

Table 10 2-1
PUMP STATISTICAL DATA
GMA WATER DISTRICT

| Pumping Station | Location | Date Installed | Casing Diameter (mm) | Well Depth (m) | Type of Pump and Capacity | Discharge Rate (Lps) | Operating Time | Status |
|---|---|---|---|---|---|---|---|---|
| 1 | San Gabriel | 1972 | 200/150 | 183 | submersible pump 25 Hp | 7.90 | 18 hrs | operational |
| 2 | Maderan | 1972 | 200/150 | 183 | submersible pump 25 Hp | 6.60 | 17 hrs. | w/ elev tank operational |
| 3 | Teachers Village | 1990 | 200/150 | 183 | submersible pump 15 Hp | 9.64 | 17 hrs. | w/ elev tank operational |
| 4 | NHA Compound | 1972 | 150/100 | 138 | submersible pump 5 Hp | 1.72 | 19 hrs. | w/ elev tank but limited discharge operational |
| 5 | Memije | 1972 | 200 | 138 | submersible pump 20 Hp | 8.60 | 18 hrs. | w/ elev. tank operational |
| 6 | Olaes | 1972 | 200 | 138 | submersible pump 30 Hp | 14.40 | 18 hrs. | w/ ground reservoir operational |
| 7 | Elises | 1972 | 200/150 | 123 | submersible pump 25 Hp | 6.00 | 15 hrs. | w/ elev. tank |
| 8 | Mandarin Homes | 1992 | --- | --- | submersible pump 15 Hp | 12.00 | 18 hrs. | w/ elev. tank |

Source: Pumping Test Data 1993 (Water District)

has a capacity of 757 $m^3$. These tanks are being operated on a fill and draw basis. A typical plan of the existing reservoir is shown in **S/R**.

The first elevated tank is located in barangay Maderan with an overflow elevation of 168.75 masl.

The second elevated tank is located in the NHA Project office compound and has an overflow elevation of 138 masl.

The third elevated tank is located in barangay Memije and has an overflow elevation of 106.92 masl

The fourth elevated tank is located in barangay Elises and has an overflow elevation of 92.73 masl

The ground reservoir is located near pumping station no. 6 in Area F with a ground elevation of 86 masl and an overflow elevation of 90.8 masl.

At Teachers Village, the elevated steel tank has a capacity of 230 $m^3$ and an overflow elevation of 128 masl.

The elevated tank at Mandarin Homes has a capacity of 114 $m^3$ and an overflow elevation of 58 masl.

Except for Teachers Village and Mandarin Homes, all steel reservoirs are in a deteriorated state and would require major rehabilitation work.

(4) Disinfection facilities

The G.M.A.-WD has no disinfection facilities.

(5) Transmission/Distribution Facilities

The original transmission/distribution pipelines, which were constructed in 1972, have a total length of approximately 17,800 linear meters of GI and PVC pipes with sizes ranging from 50 to 150 mm in diameter.

To date, an additional 2,224 linear meters of PVC piping (50 to 150mm diameter) have been laid to cover the present service area composed of 21 barangays.

Teachers Village and Mandarin Homes, which were recently turned over to the water district, have their own distribution pipeline network. Mandarin Homes is not within the vicinity of the present service area. It is approximately 3 km east of barangay Calimag. Layout of the transmission/distribution is presented in **Fig. 10.2-1A to 10.2-1C.**

(6) Valves and Hydrants

There are 37 known valves in the distribution network with sizes of 50, 75, 100, 150 mm in diameter, 16 of which were installed in 1972 (8 units are not functioning) and 21 newly installed.

There are five (5) existing fire hydrants located along the length of the main distribution line.

(7) Service Connections

Records of the G.M.A.-WD shows that as of August 1994, there were about 3,744 service connections covering the 21 barangays and 2 subdivisions.

These service connections are divided by consumer category into 3,648 domestic 70 commercial and 26 institutional.

Of the 3,744 connections, 3,667 ( 98%) are metered.

(8) Operation and Maintenance

The G.M.A.-WD presently operates and maintains the original water system serving the 21 barangays (composed of 5 pressure zones) and 2 other separate systems serving the subdivisions of Teachers Village and Mandarin Homes, respectively.

The G.M.A.-WD presently employs 23 personnel headed by the General Manager.

The schedule of water rates as of September are as follows:

| Area | Minimum charge (0 - 5 $m^3$) | Commodity charge (6$m^3$ and above) |
|---|---|---|
| Residential | P 40.00 | P 8.00/$m^3$ |
| Commercial | P 80.00 | P16.00/$m^3$ |
| Mandarin Homes | | |
| Residential | P 40.00 | P 5.00/$m^3$ |

### 10.2.2 Deficiencies of the Existing System

(1) Insufficient Source Capacity

With the present actual production of 2,824 $m^3/d$, the existing source facilities cannot meet the maximum day requirement of 4,318 $m^3/d$.

(2) Low Pump and Motor Efficiency

Low efficiency rating based on the pump test record.

(3) High unaccounted-for water.

(4) Deteriorated/Defective Steel Reservoirs

- Reservoir piping connections need replacement
- Restoration/Repainting of steel reservoirs

(5) No Treatment Facility

Disinfection facility (Hypochlorinator) should be installed on all existing well source.

### 10.2.3 Water Use Profile

(1) Population Served

As of September 1994, service area population of the G.M.A.was approximately 53,404. It is estimated that about 20,504 persons are entirely dependent on the G.M.A. W.D. for water supply from its 3,728 service connections. These figures indicate that for every connection, an average of 5.5 persons are being served by the system.

(2) Water Consumption

Water consumption of the G.M.A.-WD, as recorded for the month ending September 1994, was 45,440 $m^3$. The average consumption per capita for domestic connection is estimated at 73.87 lpcd. The low water consumption figures may be attributed to an insufficient water supply.

(3) Accounted for Water

The total accounted for water for the month of September is 45,440 $m^3$.

The accounted-for water represents 58% of the total monthly production of 78,216 $m^3$.

(4) Unaccounted for Water

The total unaccounted-for water in the G.M.A.-WD is 32,776 $m^3$/month (1,092 $m^3$/d) which is 42% of the total monthly production.

(5) Present Water Demand

The present water demand of the G.M.A.-WD, according to the latest record (September 1994), is 2,607.2 $m^3$/d. This includes the unaccounted for water during average day demand.

### 10.2.4 Population and Water Demand Projection

(1) Population Projection

The future population of the municipality of the G.M.A. and the barangays in the existing service area were adopted from the Engineering Study of Water District, 1992. The historical population data were gathered from the National Census and Statistics Office (NCSO). A growth rate of 3.76% is adopted in this study up to the design year (2005). Thus, in the year 2005 the municipal population may reach 114,774.

The present service area includes twenty one (21) barangays and two (2) subdivisions. The 1994 served population of these barangays totals 20,504 which is 26.8% of the total municipal population.

The proposed improvement and expansion of service area will increase the served population to 49.6% of the total projected municipal population in the year 2005. **Table 10.2-2, 10.2-3A** and **10.2-3B** show the population projection, served population and water demand projection. **Fig. 10.2-2** shows service area delineation.

(2) Water Demand Projections

Water demand figures were projected based on the assumptions adopted from previous studies and the LWUA Methodology Manual. Some of these includes;

- Domestic unit consumption is estimated at 0.120 $m^3$/d in proposed implementation year (1998) and 0.130 $m^3$/d for the design year (2005). The number of person per household is 5.5 (Water District Data).
- Commercial unit consumption is at 1.0 $m^3$/connection/d.
- Institutional unit water consumption is estimated at 3.0 $m^3$/connection/d.
- unaccounted for water is assumed to be 20% after project implementation.

TABLE 10.2-2

POPULATION PROJECTION
GMA WATER DISTRICT

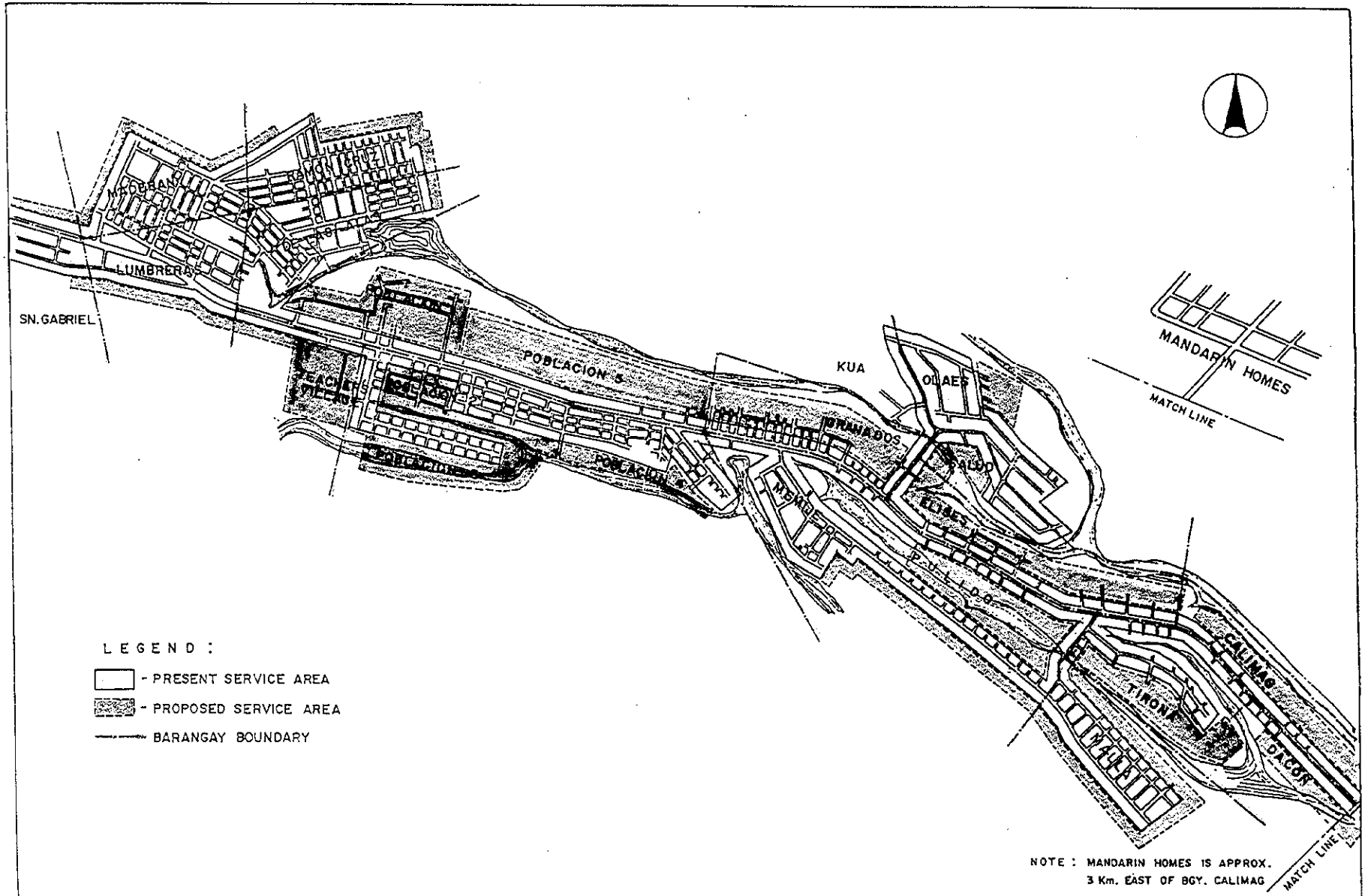
| | Municipality/ Bgy. in the Service Area | Historical Population | | | Historical Growth Rates | | Projected Growth Rates | | Projected Population | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1975 | 1980 | 1990 | 1975-80 | 1980-90 | 1990-2000 | 2000-2005 | 1994 | 1998 | 2002 | 2005 |
| | GMA | 37,942 | 48,376 | 65,977 | N/A | N/A | 3.76 | 3.76 | 76,474 | 88,640 | 102,743 | 114,774 |
| 1 | San Gabriel | 685 | 873 | 1,996 | N/A | N/A | 3.76 | 3.76 | 2,314 | 2,681 | 3,108 | 3,472 |
| 2 | Maderan | 1,145 | 1,460 | 2,163 | N/A | N/A | 3.76 | 3.76 | 2,507 | 2,905 | 3,368 | 3,763 |
| 3 | Lumbreras | 1,897 | 2,419 | 2,782 | N/A | N/A | 3.76 | 3.76 | 3,225 | 3,737 | 4,332 | 4,840 |
| 4 | Cruz | 2,204 | 2,811 | 2,525 | N/A | N/A | 3.76 | 3.76 | 2,927 | 3,392 | 3,932 | 4,392 |
| 5 | De Las Alas | 2,012 | 2,567 | 2,913 | N/A | N/A | 3.76 | 3.76 | 3,376 | 3,914 | 4,536 | 5,067 |
| 6 | Poblacion 2 | 1,878 | 2,393 | 2,763 | N/A | N/A | 3.76 | 3.76 | 3,203 | 3,712 | 4,303 | 4,807 |
| 7 | Poblacion 3 | 775 | 988 | 1,210 | N/A | N/A | 3.76 | 3.76 | 1,403 | 1,624 | 1,884 | 2,105 |
| 8 | Poblacion 1 | 511 | 651 | 1,903 | N/A | N/A | 3.76 | 3.76 | 2,206 | 2,556 | 2,963 | 3,310 |
| 9 | Memije | 1,627 | 2,075 | 3,063 | N/A | N/A | 3.76 | 3.76 | 3,550 | 4,115 | 4,770 | 5,328 |
| 10 | Pulido | 1,644 | 2,095 | 2,695 | N/A | N/A | 3.76 | 3.76 | 3,124 | 3,621 | 4,197 | 4,688 |
| 11 | Malia | 1,237 | 1,576 | 1,990 | N/A | N/A | 3.76 | 3.76 | 2,307 | 2,672 | 3,099 | 3,462 |
| 12 | Tirona | 838 | 1,068 | 1,513 | N/A | N/A | 3.76 | 3.76 | 1,754 | 2,032 | 2,356 | 2,632 |
| 13 | Dacon | 1,512 | 1,929 | 2,269 | N/A | N/A | 3.76 | 3.76 | 2,630 | 3,048 | 3,533 | 3,947 |
| 14 | Granados | 1,768 | 2,255 | 2,508 | N/A | N/A | 3.76 | 3.76 | 2,907 | 3,369 | 3,906 | 4,363 |
| 15 | Poblacion 4 | 1,531 | 1,952 | 2,593 | N/A | N/A | 3.76 | 3.76 | 3,006 | 3,483 | 4,038 | 4,511 |
| 16 | Poblacion 5 | 1,007 | 1,283 | 2,369 | N/A | N/A | 3.76 | 3.76 | 2,746 | 3,181 | 3,689 | 4,121 |
| 17 | KVA | 1,230 | 1,568 | 1,601 | N/A | N/A | 3.76 | 3.76 | 1,856 | 2,150 | 2,493 | 2,785 |
| 18 | Olaes | 1,080 | 1,388 | 1,500 | N/A | N/A | 3.76 | 3.76 | 1,739 | 2,015 | 2,336 | 2,609 |
| 19 | Elises | 1,321 | 1,684 | 2,646 | N/A | N/A | 3.76 | 3.76 | 3,067 | 3,554 | 4,120 | 4,603 |
| 20 | Salud | 862 | 1,099 | 2,335 | N/A | N/A | 3.76 | 3.76 | 2,706 | 3,136 | 3,636 | 4,062 |
| 21 | Calimag | 910 | 1,161 | 1,582 | N/A | N/A | 3.76 | 3.76 | 1,834 | 2,125 | 2,464 | 2,752 |
| 22 | Teachers Village | - | - | - | N/A | N/A | 3.76 | 3.76 | 2,398 | 2,778 | 3,220 | 3,560 |
| 23 | Mandarin Homes | - | - | - | N/A | N/A | 3.76 | 3.76 | 2,563 | 2,970 | 3,442 | 3,846 |
| | Total | 27,674 | 35,295 | 46,919 | | | | | 59,348 | 68,770 | 79,725 | 89,025 |

TABLE 10.2-3A
1998 SERVED POPULATION AND WATER DEMAND PROJECTIONS
GMA WATER DISTRICT

| BARANGAY | BARANGAY POPULATION | SERVICE AREA POPULATION | DOMESTIC | | | COMMERCIAL | | | INSTITUTIONAL | | TOTAL | | | UNACCOUNTED-FOR WATER (cum/d) | AVERAGE DAY DEMAND (cum/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Water Demand | No. of Conn. | Served Pop. | Water Demand | | |
| 1 San Gabriel | 2,681 | 2,413 | 306 | 1,681 | 201.7 | 6 | 33 | 6 | 1 | 3.0 | 313 | 1,714 | 210.7 | 52.3 | 263 |
| 2 Maderan | 2,905 | 2,614 | 331 | 1,822 | 218.6 | 6 | 33 | 6 | 1 | 3.0 | 338 | 1,855 | 227.6 | 56.4 | 284 |
| 3 Lumbreras | 3,737 | 3,363 | 426 | 2,344 | 281.2 | 8 | 44 | 8 | 2 | 6.0 | 436 | 2,388 | 295.2 | 73.8 | 369 |
| 4 Cruz | 3,392 | 3,052 | 386 | 2,127 | 255.2 | 7 | 39 | 7 | 1 | 3.0 | 394 | 2,166 | 265.2 | 66.8 | 332 |
| 5 De Las Alas | 3,914 | 3,522 | 446 | 2,454 | 294.4 | 9 | 50 | 9 | 2 | 6.0 | 457 | 2,504 | 309.4 | 76.6 | 386 |
| 6 Poblacion 2 | 3,712 | 3,340 | 423 | 2,328 | 279.4 | 8 | 44 | 8 | 2 | 6.0 | 433 | 2,372 | 293.4 | 72.6 | 366 |
| 7 Poblacion 3 | 1,624 | 1,462 | 185 | 1,019 | 122.2 | 4 | 22 | 4 | 1 | 3.0 | 190 | 1,041 | 129.2 | 32.8 | 162 |
| 8 Poblacion 1 | 2,556 | 2,300 | 291 | 1,603 | 192.4 | 5 | 28 | 5 | 1 | 3.0 | 297 | 1,631 | 200.4 | 49.6 | 250 |
| 9 Memije | 4,115 | 3,704 | 469 | 2,582 | 309.8 | 9 | 50 | 9 | 2 | 6.0 | 480 | 2,632 | 324.8 | 81.2 | 406 |
| 10 Pulido | 3,621 | 3,258 | 412 | 2,270 | 272.4 | 8 | 44 | 8 | 2 | 6.0 | 422 | 2,314 | 286.4 | 71.6 | 358 |
| 11 Malia | 2,672 | 2,404 | 304 | 1,676 | 201.1 | 6 | 33 | 6 | 1 | 3.0 | 311 | 1,709 | 210.1 | 51.9 | 262 |
| 12 Tirona | 2,032 | 1,828 | 232 | 1,274 | 152.8 | 5 | 28 | 5 | 1 | 3.0 | 238 | 1,302 | 160.8 | 40.2 | 201 |
| 13 Dacon | 3,048 | 2,743 | 348 | 1,912 | 229.4 | 7 | 39 | 7 | 1 | 3.0 | 356 | 1,951 | 239.4 | 59.6 | 299 |
| 14 Granados | 3,369 | 3,032 | 384 | 2,113 | 253.6 | 7 | 39 | 7 | 1 | 3.0 | 392 | 2,152 | 263.6 | 66.4 | 330 |
| 15 Poblacion 4 | 3,463 | 3,134 | 397 | 2,184 | 262.0 | 8 | 44 | 8 | 2 | 6.0 | 407 | 2,228 | 276.0 | 69.0 | 345 |
| 16 Poblacion 5 | 3,181 | 2,862 | 362 | 1,994 | 239.2 | 7 | 39 | 7 | 1 | 3.0 | 370 | 2,033 | 249.2 | 62.8 | 312 |
| 17 Kua | 2,151 | 1,936 | 245 | 1,349 | 161.8 | 5 | 28 | 5 | 1 | 3.0 | 251 | 1,377 | 169.8 | 42.2 | 212 |
| 18 Olaes | 2,015 | 1,814 | 230 | 1,264 | 151.6 | 4 | 22 | 4 | 1 | 3.0 | 235 | 1,286 | 158.4 | 39.4 | 198 |
| 19 Elises | 3,554 | 3,198 | 405 | 2,229 | 267.4 | 8 | 44 | 8 | 2 | 6.0 | 415 | 2,273 | 281.6 | 70.6 | 352 |
| 20 Salud | 3,136 | 2,822 | 357 | 1,966 | 235.9 | 7 | 39 | 7 | 1 | 3.0 | 365 | 2,005 | 245.9 | 61.1 | 307 |
| 21 Calimag | 2,125 | 1,912 | 242 | 1,332 | 159.8 | 5 | 28 | 5 | 1 | 3.0 | 248 | 1,360 | 167.8 | 42.2 | 210 |
| 22 Teachers Village | 2,778 | 2,778 | 505 | 2,778 | 332.8 | 10 | 55 | 10 | 1 | 3.0 | 516 | 2,833 | 345.8 | 86.2 | 432 |
| 23 Mandarin Homes | 2,970 | 2,970 | 540 | 2,970 | 356.4 | 10 | 55 | 10 | 1 | 3.0 | 551 | 3,025 | 369.4 | 92.6 | 462 |
| Total | 68,771 | 62,461 | 8,226 | 45,271 | 5,431.1 | 159.0 | 880.0 | 159.0 | 30.0 | 90.0 | 8,415.0 | 46,151.0 | 5,680.1 | 1,417.9 | 7,098.0 |

TABLE 10.2-3B
2005 SERVED POPULATION AND WATER DEMAND PROJECTIONS
GMA WATER DISTRICT

| BARANGAY | BARANGAY POPULATION | SERVICE AREA POPULATION | DOMESTIC | | | COMMERCIAL | | | INSTITUTIONAL | | TOTAL | | | UNACCOUNTED-FOR WATER (cum/d) | AVERAGE DAY DEMAND (cum/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Water Demand | No. of Conn. | Served Pop. | Water Demand | | |
| 1 San Gabriel | 3,472 | 3,124 | 396 | 2,177 | 283.0 | 8 | 44 | 8.0 | 2 | 6.0 | 406 | 2,221 | 297.0 | 74.0 | 371.0 |
| 2 Maderan | 3,762 | 3,386 | 429 | 2,360 | 306.8 | 8 | 44 | 8.0 | 2 | 6.0 | 439 | 2,404 | 320.8 | 80.2 | 401.0 |
| 3 Lumbreras | 4,840 | 4,356 | 552 | 3,036 | 394.7 | 10 | 55 | 10.0 | 2 | 6.0 | 564 | 3,091 | 410.7 | 102.4 | 513.0 |
| 4 Cruz | 4,392 | 3,952 | 500 | 2,754 | 358.0 | 10 | 55 | 10.0 | 2 | 6.0 | 512 | 2,809 | 374.0 | 94.0 | 468.0 |
| 5 De Las Alas | 5,068 | 4,556 | 577 | 3,176 | 412.9 | 11 | 60 | 11.0 | 2 | 6.0 | 590 | 3,236 | 429.9 | 107.2 | 537.0 |
| 6 Poblacion 2 | 4,807 | 4,326 | 548 | 3,015 | 392.0 | 10 | 55 | 10.0 | 2 | 6.0 | 560 | 3,070 | 408.0 | 102.0 | 510.0 |
| 7 Poblacion 3 | 2,104 | 1,894 | 240 | 1,320 | 171.6 | 4 | 22 | 4.0 | 1 | 3.0 | 245 | 1,342 | 178.6 | 44.4 | 223.0 |
| 8 Poblacion 1 | 3,310 | 2,979 | 377 | 2,076 | 269.9 | 7 | 38 | 7.0 | 1 | 3.0 | 385 | 2,114 | 279.9 | 70.0 | 350.0 |
| 9 Memije | 5,329 | 4,788 | 606 | 3,337 | 433.8 | 12 | 66 | 12.0 | 2 | 6.0 | 620 | 3,403 | 451.8 | 113.0 | 565.0 |
| 10 Putido | 4,688 | 4,219 | 534 | 2,940 | 382.2 | 10 | 55 | 10.0 | 2 | 6.0 | 546 | 2,995 | 398.2 | 99.8 | 498.0 |
| 11 Malla | 3,461 | 3,114 | 394 | 2,170 | 282.1 | 8 | 44 | 8.0 | 2 | 6.0 | 404 | 2,214 | 296.1 | 73.9 | 370.0 |
| 12 Tirona | 2,632 | 2,368 | 300 | 1,650 | 214.5 | 6 | 33 | 6.0 | 1 | 3.0 | 307 | 1,683 | 223.5 | 55.5 | 279.0 |
| 13 Dacon | 3,947 | 3,552 | 450 | 2,476 | 322.0 | 8 | 44 | 8.0 | 2 | 6.0 | 460 | 2,520 | 336.0 | 84.0 | 420.0 |
| 14 Granados | 4,363 | 3,926 | 497 | 2,736 | 356.0 | 10 | 55 | 10.0 | 2 | 6.0 | 509 | 2,791 | 372.0 | 93.0 | 465.0 |
| 15 Poblacion 4 | 4,511 | 4,060 | 514 | 2,830 | 368.0 | 10 | 55 | 10.0 | 2 | 6.0 | 526 | 2,885 | 384.0 | 96.0 | 480.0 |
| 16 Poblacion 5 | 4,122 | 3,710 | 470 | 2,586 | 336.2 | 9 | 50 | 9.0 | 2 | 6.0 | 481 | 2,636 | 351.2 | 86.8 | 438.0 |
| 17 Kua | 2,785 | 2,506 | 317 | 1,746 | 227.0 | 6 | 33 | 6.0 | 1 | 3.0 | 324 | 1,779 | 236.0 | 59.0 | 295.0 |
| 18 Olaes | 2,610 | 2,349 | 298 | 1,637 | 212.8 | 6 | 33 | 6.0 | 1 | 3.0 | 305 | 1,670 | 221.8 | 56.2 | 278.0 |
| 19 Elises | 4,602 | 4,142 | 524 | 2,886 | 375.2 | 10 | 55 | 10.0 | 2 | 6.0 | 536 | 2,941 | 391.2 | 96.8 | 488.0 |
| 20 Salud | 4,062 | 3,656 | 463 | 2,548 | 331.2 | 9 | 50 | 9.0 | 2 | 6.0 | 474 | 2,598 | 346.2 | 85.8 | 432.0 |
| 21 Calimag | 2,752 | 2,476 | 314 | 1,726 | 224.4 | 6 | 33 | 6.0 | 1 | 3.0 | 321 | 1,759 | 233.4 | 57.6 | 291.0 |
| 22 Teachers Village | 3,560 | 3,204 | 406 | 2,233 | 290.3 | 8 | 44 | 8.0 | 2 | 6.0 | 416 | 2,277 | 304.3 | 75.8 | 380.0 |
| 23 Mandarin Homes | 3,846 | 3,461 | 438 | 2,412 | 313.6 | 8 | 44 | 8.0 | 2 | 6.0 | 448 | 2,456 | 327.6 | 82.4 | 410.0 |
| Total | 89,025 | 80,104 | 10,144 | 55,827 | 7,258.2 | 194 | 1,067 | 194.0 | 40 | 120.0 | 10,378 | 56,894 | 7,572.2 | 1,889.8 | 9,462.0 |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.2-2 |
| JAPAN INTERNATIONAL COOPERATION AGENCY | SERVICE AREA DELINEATION<br>GMA WATER DISTRICT<br>GMA, CAVITE |

Domestic connections are projected to reach 10,144 in 2005, while commercial and institutional connections are projected to reach 194 and 40 respectively. **Table 10.2-3B** shows the number of connections for each category.

(3) Water Demand Variations

Presented below is the year 2005 water demand variation.

| | |
|---|---|
| Average-day demand | 9,462 $m^3$/d (109.5 lps) |
| Maximum-day demand | 12,300 $m^3$/d (142.4 lps) |
| Peak-hour demand | 18,924 $m^3$/d (219.0 lps) |

**Table 10.2-4A** shows the annual water demand per type of connection and **Table 10.2-4B** shows the annual water demand variation.

### 10.2.5 Analysis and Evaluation of Alternatives

(1) Considerations

The existing facilities that will be considered and incorporated in the recommended plan of the water supply system in the year 2005 are as follows;

1) Existing Water Supply System Facilities

Existing water supply system facilities of the G.M.A.-WD is presently serving twenty one (21) barangays and two (2) subdivisions.

Between June 1993 and June 1994, there was a sudden increase in service connections exceeding the 1992 LWUA Engineering Study projection by at least 800.

The preliminary study shows that the present service area is rapidly expanding and that the existing source facilities will not be adequate to meet future water needs for the design year (2005).

2) Additional Water Source

The G.M.A.-WD has been using groundwater from wells in the service area since 1970. The water resources study indicates that ground water from deepwells in the G.M.A. service area is the only practical and economical water source that the G.M.A.-WD and its consumers can afford; all other sources, such as surface water, are much more expensive.

For the design year (2005), utilization of JICA test well no. 1 plus three (3) additional sources will be required to meet the projected maximum day demand of 142 lps.

TABLE 10.2-4A
ANNUAL WATER DEMAND AND NUMBER OF CONNECTIONS
GMA WATER DISTRICT

| YEAR | DOMESTIC | | COMMERCIAL | | INSTITUTIONAL | | TOTAL | | UNACCOUNTED-FOR WATER (cumd) | AVERAGE DA DEMAND (cumd) |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | | |
| 1994 | 3,648 | 2,407.7 | 70 | 70.0 | 26 | 78.0 | 3,744 | 2,555.7 | 766.7 | 3,194.0 |
| 1995 | 4,214 | 2,781.0 | 81 | 81.0 | 26 | 78.0 | 4,321 | 2,940.0 | 884.0 | 3,675.0 |
| 1996 | 4,868 | 3,212.0 | 94 | 94.0 | 27 | 81.0 | 4,989 | 3,387.0 | 1,016.0 | 4,234.0 |
| 1997 | 5,622 | 3,710.5 | 108 | 108.0 | 27 | 81.0 | 5,757 | 3,899.5 | 1,169.0 | 4,874.0 |
| 1998 | 8,226 | 5,429.2 | 159 | 159.0 | 30 | 90.0 | 8,415 | 5,680.1 | 1,417.9 | 7,098.0 |
| 1999 | 8,610 | 5,682.6 | 167 | 167.0 | 32 | 96.0 | 8,809 | 5,945.6 | 1,486.0 | 7,432.0 |
| 2000 | 8,993 | 5,935.4 | 171 | 171.0 | 34 | 102.0 | 9,198 | 6,208.4 | 1,552.0 | 7,760.0 |
| 2001 | 9,376 | 6,188.2 | 175 | 175.0 | 36 | 108.0 | 9,587 | 6,471.2 | 1,617.0 | 8,088.0 |
| 2002 | 9,568 | 6,314.8 | 179 | 179.0 | 37 | 111.0 | 9,784 | 6,604.8 | 1,651.0 | 8,256.0 |
| 2003 | 9,760 | 6,441.6 | 184 | 184.0 | 38 | 114.0 | 9,982 | 6,739.6 | 1,684.0 | 8,424.0 |
| 2004 | 9,952 | 6,568.3 | 189 | 189.0 | 39 | 117.0 | 10,180 | 6,874.3 | 1,718.0 | 8,592.0 |
| 2005 | 10,144 | 7,258.2 | 194 | 194.0 | 40 | 120.0 | 10,378 | 7,572.2 | 1,892.0 | 9,462.0 |

TABLE 10.2-4B

WATER DEMAND VARIATIONS
GMA WATER DISTRICT

| YEAR | Average Day Demand (cumd) | Average Day Demand (L/s) | Maximum Day Demand (cumd) | Maximum Day Demand (L/s) | Peak-Hour Demand (cumd) | Peak-Hour Demand (L/s) |
|---|---|---|---|---|---|---|
| 1994 | 3,194 | 36.9 | 4,152 | 48 | 6,388 | 73.9 |
| 1995 | 3,675 | 42.5 | 4,778 | 55.3 | 7,650 | 88.5 |
| 1996 | 4,234 | 49.0 | 5,504 | 64.0 | 8,468 | 98.0 |
| 1997 | 4,874 | 56.4 | 6,336 | 73.3 | 9,748 | 112.8 |
| 1998 | 7,098 | 82.2 | 9,227 | 106.8 | 14,276 | 165.2 |
| 1999 | 7,432 | 86.0 | 9,662 | 111.8 | 14,864 | 172.0 |
| 2000 | 7,760 | 89.8 | 10,088 | 116.8 | 15,520 | 179.0 |
| 2001 | 8,088 | 93.6 | 10,514 | 121.6 | 16,176 | 187.2 |
| 2002 | 8,256 | 96.0 | 10,732 | 124.2 | 16,512 | 191.1 |
| 2003 | 8,424 | 97.5 | 10,951 | 126.2 | 16,848 | 195.0 |
| 2004 | 8,592 | 99.4 | 11,170 | 129.2 | 17,184 | 198.9 |
| 2005 | 9,462 | 109.5 | 12,300 | 142.4 | 18,924 | 219.0 |

3) Pressure Zone

The ground elevation within the service area ranges from a high of 150 m in Brgy. San Gabriel to a low of 40 m in Brgy. Calimag. An area with such a high variation in ground elevation cannot be served by one pressure zone. Because of this topography and the location of existing sources and reservoirs, the system will be operated in five (5) pressure zones.

4) Storage Location

Location of storage is influenced by the demand in the service area. A preliminary analysis showed that the existing location of the storage tank cannot adequately meet the requirements of the water system. An additional reservoir site shall be chosen to effectively balance the supply particularly during peak hour conditions.

5) Design Criteria

- Well Parameters for Additional Sources

The following well parameters were established for purposes of cost analysis of schemes requiring additional sources.

| | | |
|---|---|---|
| Depth | : | 200 – 300 m |
| Borehole Diameter | : | 350 – 400 mm |
| Casing Diameter | : | 200 mm(0–200m) |
| | | 150 mm(200–300m) |
| Screens | : | 200/150 mm stainless steel |
| Expected Yield | : | 16.6–25 lps |
| Expected SWL | : | 30 – 50 m |
| Expected PWL | : | 90– 100 m |

- Distribution System

Parallel pipes will augment portions of existing pipelines and new pipes will be laid to cover the expansion area while the pipe size configuration is designed at peak hour condition.

- Demand Ratios

The projected water demand of the G.M.A.–WD for the design year (2005) are 12,300 $m^3/d$ for maximum day and 18,924 $m^3/d$ for peak hour demand.

- Storage Requirement

During peak-hour water demand conditions and whenever the production capacity of the sources is less than the demand of the system, an additional water supply will be provided by the reservoir. Generally the volume of storage must be sufficient to meet the operational, emergency and firefighting reserved requirements. **Table 10.2-5** shows the storage capacity requirement of the system up to the year 2005.

The reservoir will be constructed at an elevation such that the required minimum pressure in the distribution system is satisfied.

- System Pressure

The minimum pressure head to be adopted in the system is 7 m while the maximum is 70 m. The system pipe network is designed to conform with the pressure requirement even during peak hour conditions.

- Fire Protection

Full fire protection will be provided to the entire service area.

- Flow Velocity

Flow Velocity in the Distribution System is limited to a maximum of 3 m/s at all times and minimum of 0.3 m/s. However, in order to obtain good pressure throughout the distribution system, it is necessary to allow the velocity flow less than the minimum.

- Computer Analysis

Pipe sizes were designed for peak-hour condition and only pipes with a diameter of 50 mm and above were included in the analysis.

- Common Items

To simplify the evaluation of alternatives, items common to the alternatives considered such as reservoir, distribution lines, valves, hydrants, service connections and other appurtenances were not included in the analysis.

(2) Development of Alternatives

Groundwater through well were considered as capable of meeting the increasing demand in the service area. Additional wells are expected to meet the supply requirement of the system by the year 2005.

Table 10-2-5
STORAGE REQUIREMENT
GMA WATER DISTRICT

| YEAR | Max Day Demand (cumd) | Served Population | Emergency Storage Requirement (cum) | Operational Storage Requirement | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Max-day (cum) | ID-1.33 (cum) | ID-1.2 (cum) | ID-1.10 (cum) | PKD (cum) |
| 1997 | 6,336.0 | 44,792 | 528 | 984 | 347 | 374 | 781 | 171 |
| 1998 | 9,227.0 | 46,151 | 768 | 1428 | 501 | 539 | 1133 | 244 |
| 1999 | 10,088.0 | 47,552 | 805 | 1556 | 543 | 584 | 1233 | 263 |
| 2000 | 10,960.1 | 48,995 | 840 | 1684 | 584 | 629 | 1334 | 281 |
| 2001 | 10,514.0 | 50,482 | 876 | 1610 | 556 | 598 | 1274 | 265 |
| 2002 | 10,732.0 | 52,014 | 894 | 1638 | 562 | 605 | 1295 | 266 |
| 2003 | 10,951.0 | 53,592 | 912 | 1665 | 569 | 611 | 1316 | 266 |
| 2004 | 11,170.0 | 55,218 | 930 | 1693 | 575 | 618 | 1336 | 267 |
| 2005 | 12,300.0 | 56,894 | 1025 | 1857 | 627 | 674 | 1465 | 288 |

Operational Storage Requirement

| Supply rate | Storage Volume | Pump Hours |
|---|---|---|
| MD | (0.224 - (0.0416 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 24 |
| ID-1.33 | (0.114 - (0.0359 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 18 |
| ID-1.20 | (0.125 - (0.0400 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 20 |
| ID-1.10 | (0.190 - (0.0404 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 22 |
| PKH | (0.082 - (0.0336 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 16 |

Emergency Storage Requirement :

2 hours of Max day demand

In consideration of limited source capacity and well location, two possible alternatives were developed. The following will give insight to each proposal for the improvement of the water system.

1) Alternative 1 - Max. day demand with maximum storage

This alternative proposes the commissioning of the JICA test well in the NHA compound into a production well and the construction of 3 additional wells located at Poblacion 4, Poblacion 5 and barangay Calimag. The wells will be equipped with a 25 Hp pump for the NHA compound and a 60 Hp pump each for the 3 additional sources.

An additional reservoir volume of 876 $m^3$ will be constructed.

**Table 10.2-6** and **Fig. 10.2-3A** presents the detail of this alternative.

2) Alternative 2 - 1.1 MDD with Intermediate storage

This alternative proposes the commissioning of the JICA well in the NHA compound into production well and poblacion 4, Poblacion 5, barangay Calimag and barangay R. Cruz. The wells will be equipped with a 25 Hp pump for NHA compound and a 60 Hp pump each for the 4 additional sources.

An additional reservoir volume of 484 $m^3$ will be constructed.

**Table 10.2-6** and **Fig. 10.2-3B** presents the details of this Alternatives.

(3) Evaluation of Alternatives

Each of the alternative was evaluated based on the construction cost at 1994 price levels.

The following table summarizes the cost of each alternative

| | Cost (P) |
|---|---|
| Alternative 1 | 23,466,407.00 |
| Alternative 2 | 22,290,269.00 |

Alternative 1 is higher by P1.18 million in construction cost than Alternative 2. Due to the small difference in project cost, operation and maintenance expenses were considered. In Alternative 2, energy cost is higher by about 1.18 million than Alternative 1 per annum. With this annual difference in energy cost, Alternative 1 is adapted as the recommended plan for the improvement of water supply system of G.M.A.-WD.

TABLE 10.2-6
Cost Comparison of Alternatives
GMA Water District

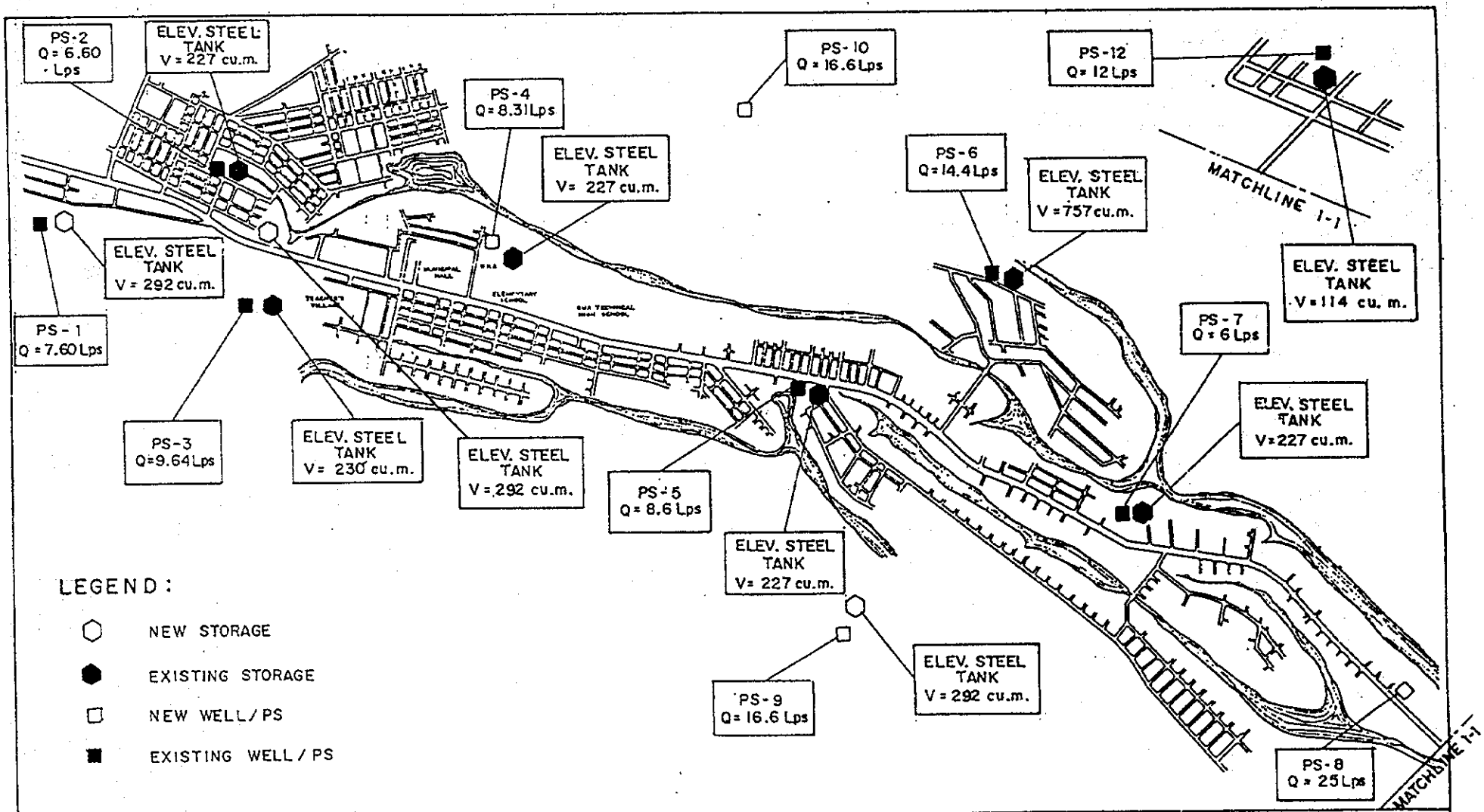
Alternative 1 - MDD Supply with maximum Storage

| Facilities | | Construction Cost (P) | |
|---|---|---|---|
| Storage Tank V = | 876 cum | | 11,388,000.00 |
| 2 units Deepwell (300 m) | | | 6,000,000.00 |
| 1 unit Deepwell (200 m) | | | 2,000,000.00 |
| 3 sets 60 HP Pump and Motor | | | 2,159,586.00 |
| 1 set 25 HP Pump and Motor | | | 478,821.00 |
| Power Connections (900 m) | | | 1,440,000.00 |
| | | P | 23,466,407.00 |
| **Power Cost** | | | |
| 360 HP | 4,290.28 KWH/D | P | 7,085,200.00 |

Alternative 2 - 1.1 MDD Supply with Intermediate Storage

| Facilities | | Construction Cost (P) | |
|---|---|---|---|
| Storage Tank V= | 484 cum | | 6,292,000.00 |
| 3 units Deepwell (300 m) | | | 9,000,000.00 |
| 1 unit Deepwell (200 m) | | | 2,000,000.00 |
| 4 sets 60 HP Pump and Motor | | | 2,879,448.00 |
| 1 set 25 HP Pump and Motor | | | 478,821.00 |
| Power Connections (920 m) | | | 1,640,000.00 |
| | | P | 22,290,269.00 |
| **Power Cost** | | | |
| 420 HP | 5,740.33 KWH/D | P | 8,266,100.00 |

Note: Alternative 1 has lower energy cost than Alternative 2 by 1.18 million.



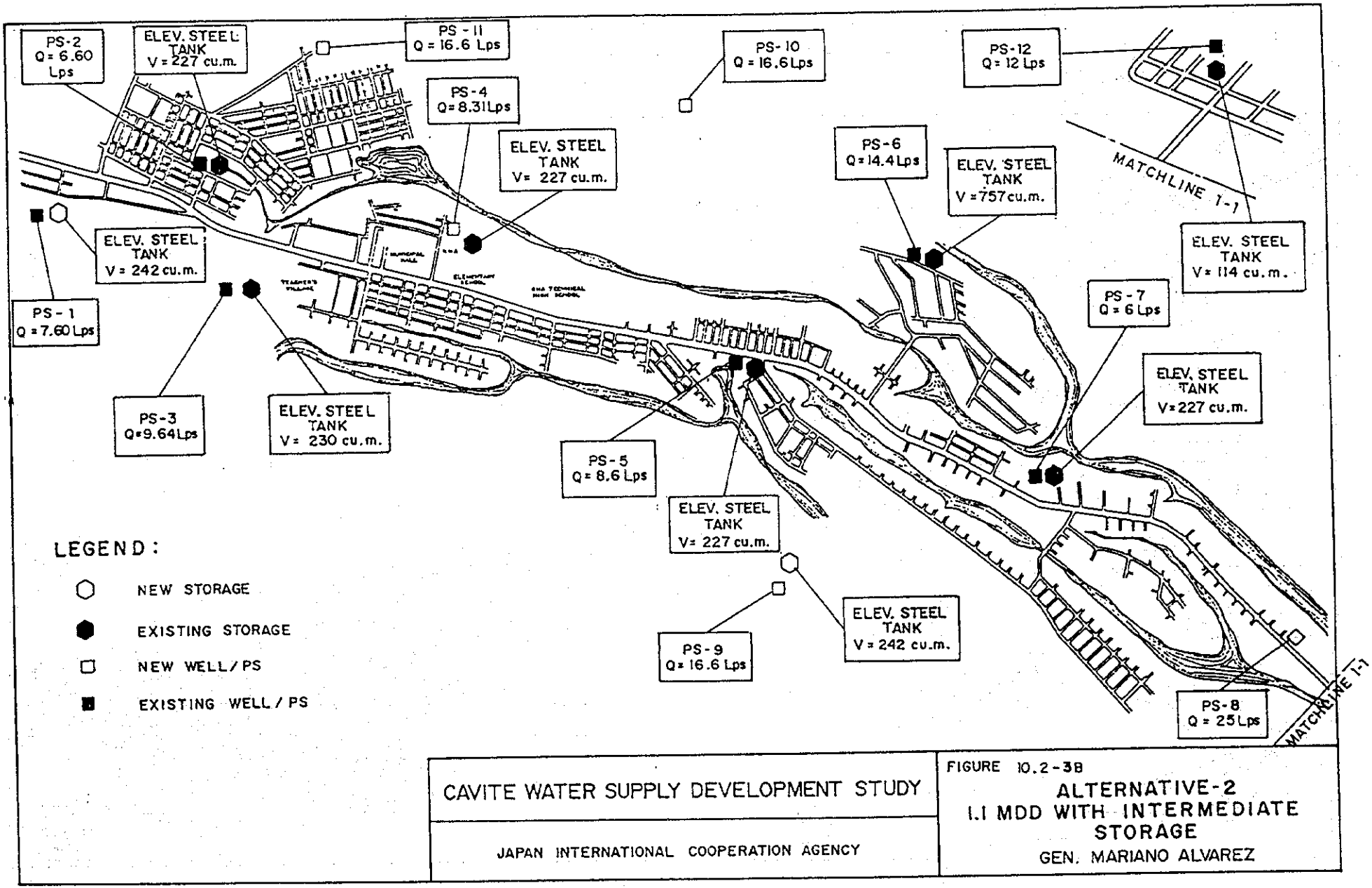

CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE: 10.2-3A

ALTERNATIVE-1
MAXIMUM DAY DEMAND
WITH MAXIMUM STORAGE

GEN. MARIANO ALVAREZ




CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 10.2-3B

ALTERNATIVE-2
1.1 MDD WITH INTERMEDIATE STORAGE
GEN. MARIANO ALVAREZ

### 10.2.6 Recommended Plan

(1) Description of the Scheme

The recommended scheme for the proposed improvement of water supply system of the G.M.A.-WD is to be implemented in two phases.

Phase I expansion will cover zone 2,3 and 5 and would include construction of 3 additional sources located at brgy. Calimag, Poblacion 4 and Poblacion 5, utilization of the JICA test well in the NHA compound in zone 2; construction of an elevated steel tank at brgy. Memije in zone 3.

Phase II expansions will cover zone 1 and 4 and would include construction of 2 elevated steel tanks at brgys San Gabriel and Lumbreras..

**Fig. 10.2-4** shows the relationship between water supply and demand when the recommended plan shall be implemented.

The proposed water supply system for the G.M.A.-WD is shown in **Fig. 10.2-5A, 10.2-5B** and **10.2-5C**. The computer print out of the hydraulic analysis of the system and the schematic nodal diagram of the distribution system are presented in the supporting document.

(2) Proposed Facilities

The recommended plan for the G.M.A.-WD water supply system is scheduled to be implemented in 2 stages. Phase I (zones 2, 3 and 5) and Phase II (zones 1 and 4).

The proposed facilities of Phase I improvement are as follows:

1) Laying 6.078 km of distribution line.

2) Construction of 3 deepwells, 2 with 16.6 lps (No. 9 and 10) capacity and 1-25 lps (No. 8) capacity. Preliminary well design for proposed wells are shown in **Fig. 10.2-6A** and **10.2-6B**.

3) Provision of electro-mechanical facilities and housing for the 3 proposed well sources and 1 JICA test well. Pump setting diameters are shown in the **S/R**.

4) Construction of a 292 $m^3$ capacity elevated steel tank.

5) Installation of 2,756 service connections.

6) Installation of 10 units of hypochlorinators.

7) Installation of 17 units additional gate valves and 7 units of fire hydrants.

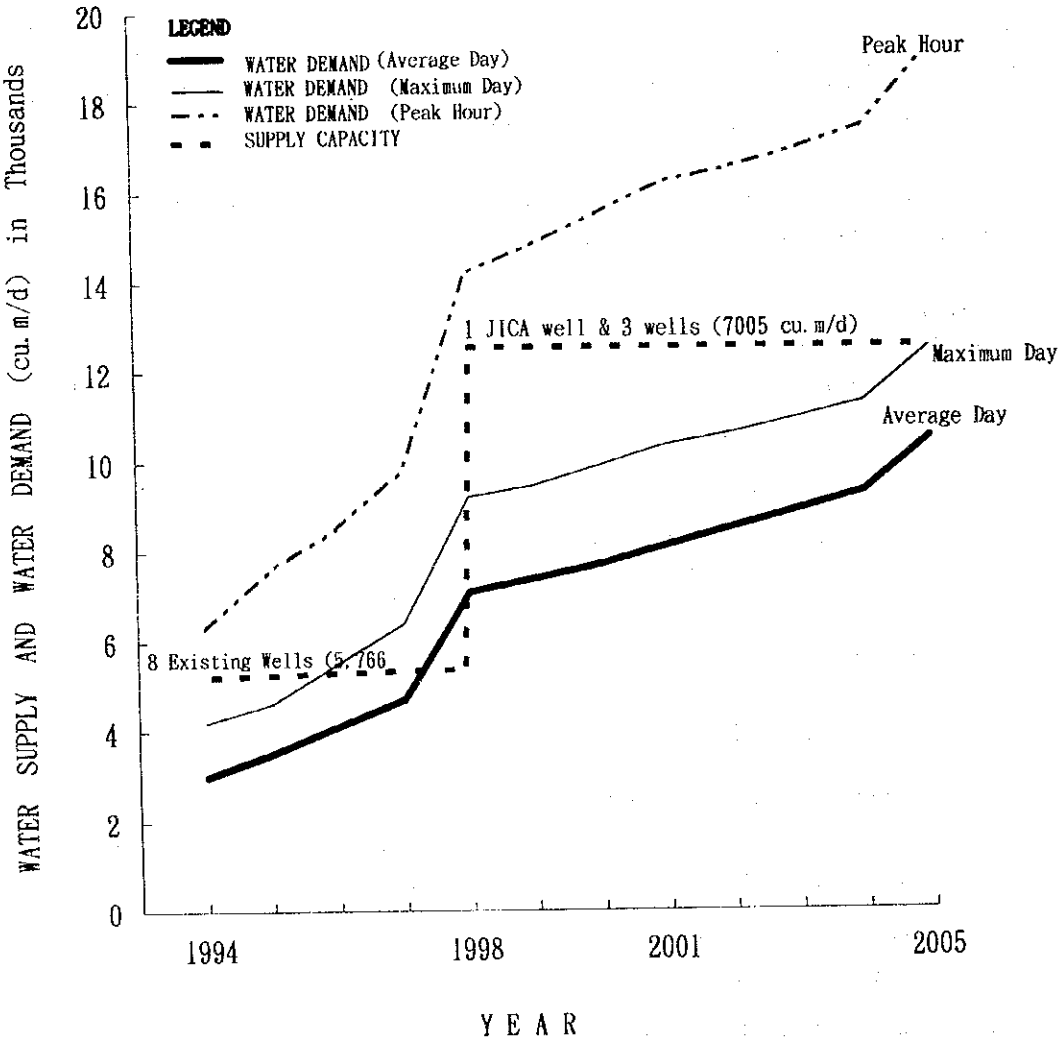
8) Rehabilitation of 3 existing elevated steel tanks.

9) Land acquisition (1000 $m^2$)

Fig. 10.2-4

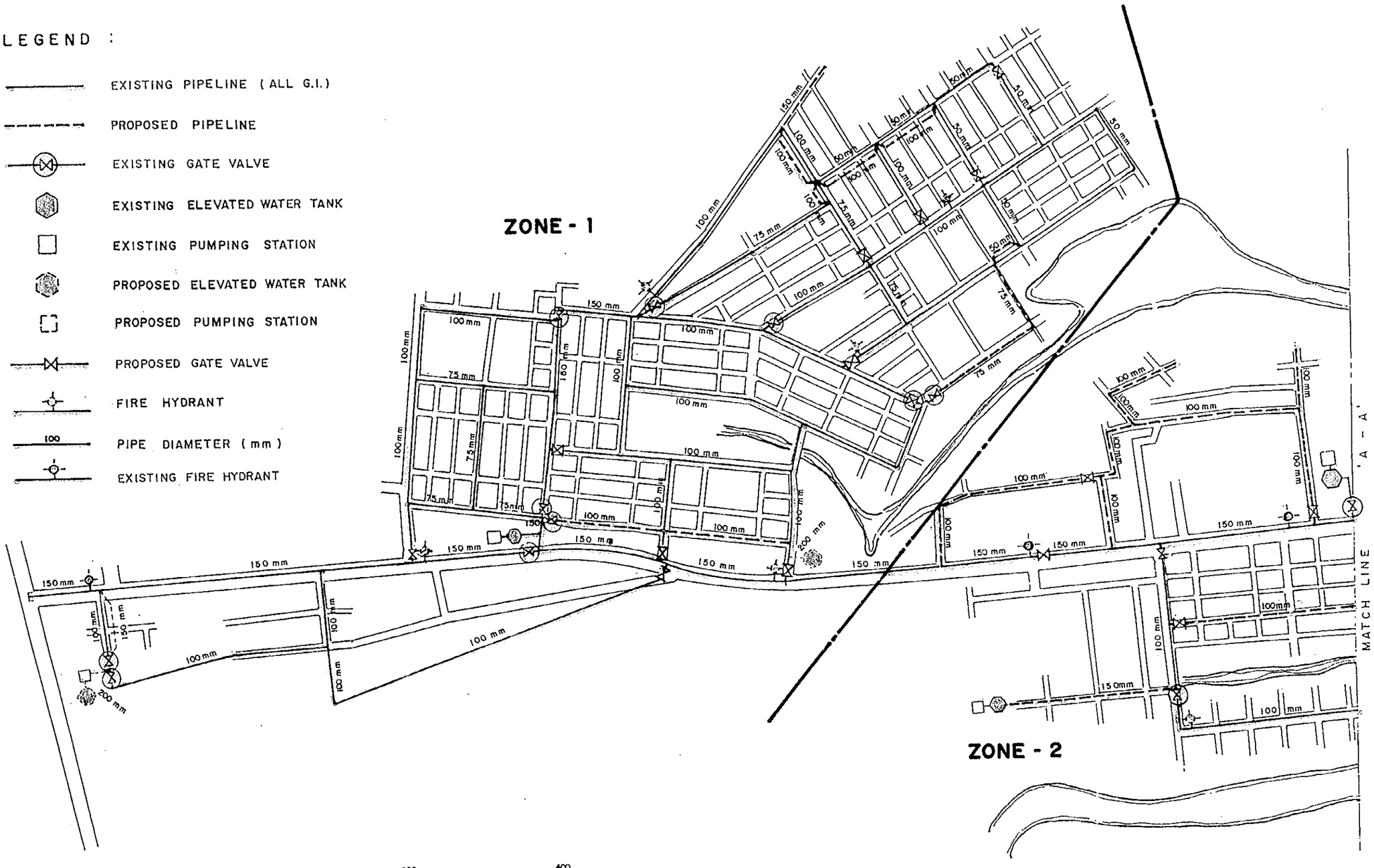
WATER SUPPLY VS DEMAND CURVE OF RECOMMENDED PLAN

GMA

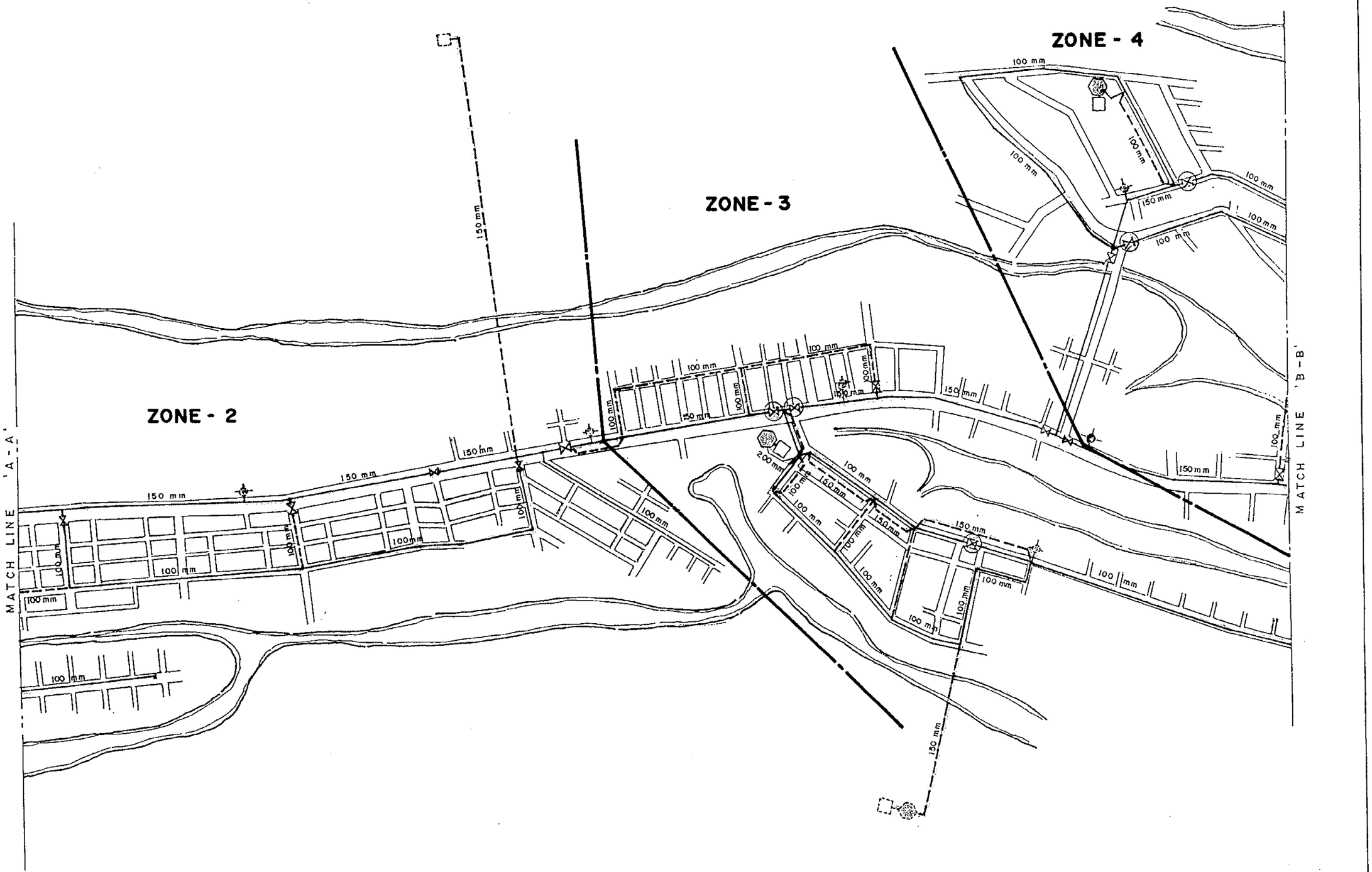


LEGEND :

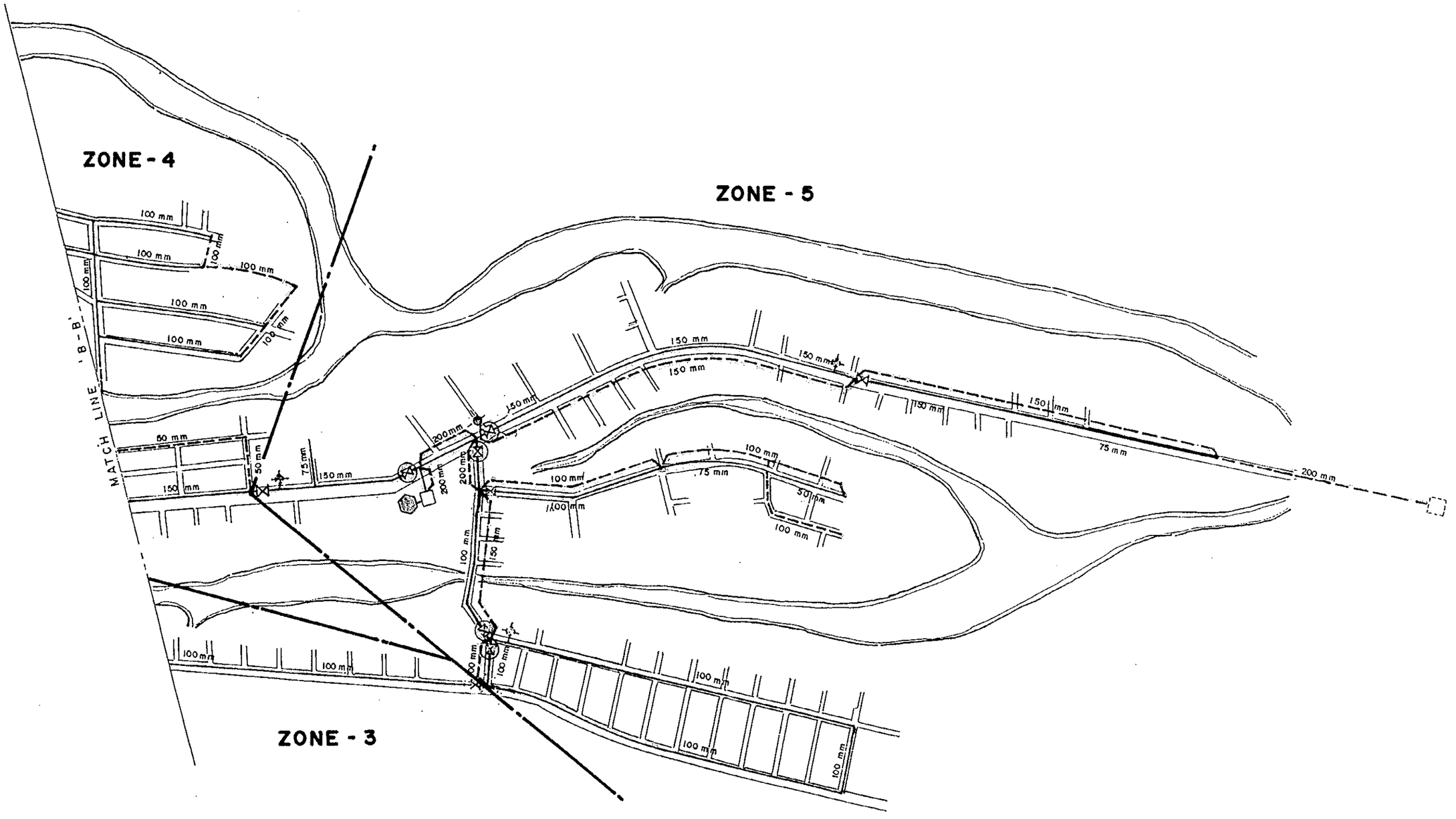
- EXISTING PIPELINE ( ALL G.I.)
- PROPOSED PIPELINE
- EXISTING GATE VALVE
- EXISTING ELEVATED WATER TANK
- EXISTING PUMPING STATION
- PROPOSED ELEVATED WATER TANK
- PROPOSED PUMPING STATION
- PROPOSED GATE VALVE
- FIRE HYDRANT
- 100 PIPE DIAMETER ( mm )
- EXISTING FIRE HYDRANT



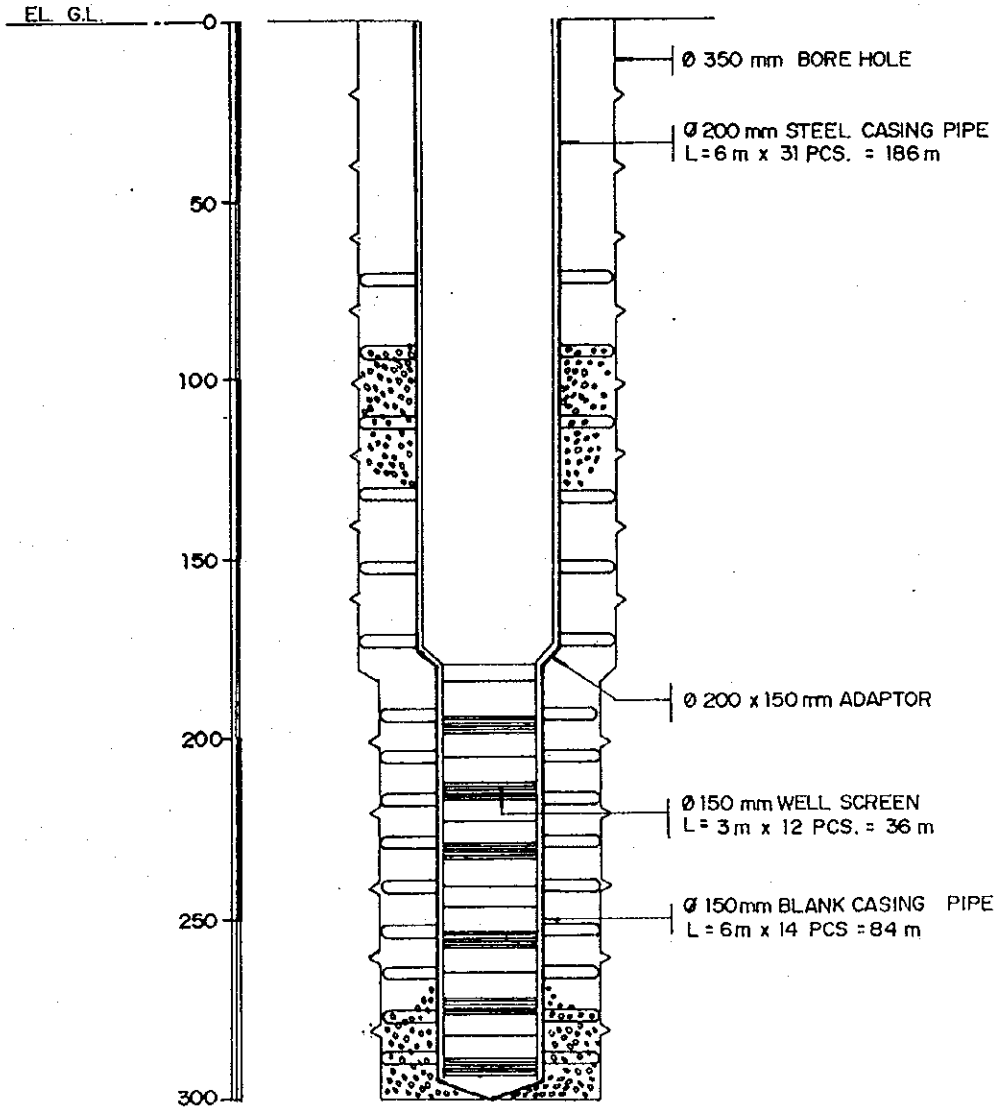

| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | Fig. 10.2-5A<br>RECOMMENDED WATER SUPPLY SYSTEM<br>GMA WATER DISTRICT<br>G M A , CAVITE |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | Fig. 10.2-5B<br>RECOMMENDED WATER SUPPLY SYSTEM |
| JAPAN INTERNATIONAL COOPERATION AGENCY | GMA WATER DISTRICT<br>G M A , CAVITE |

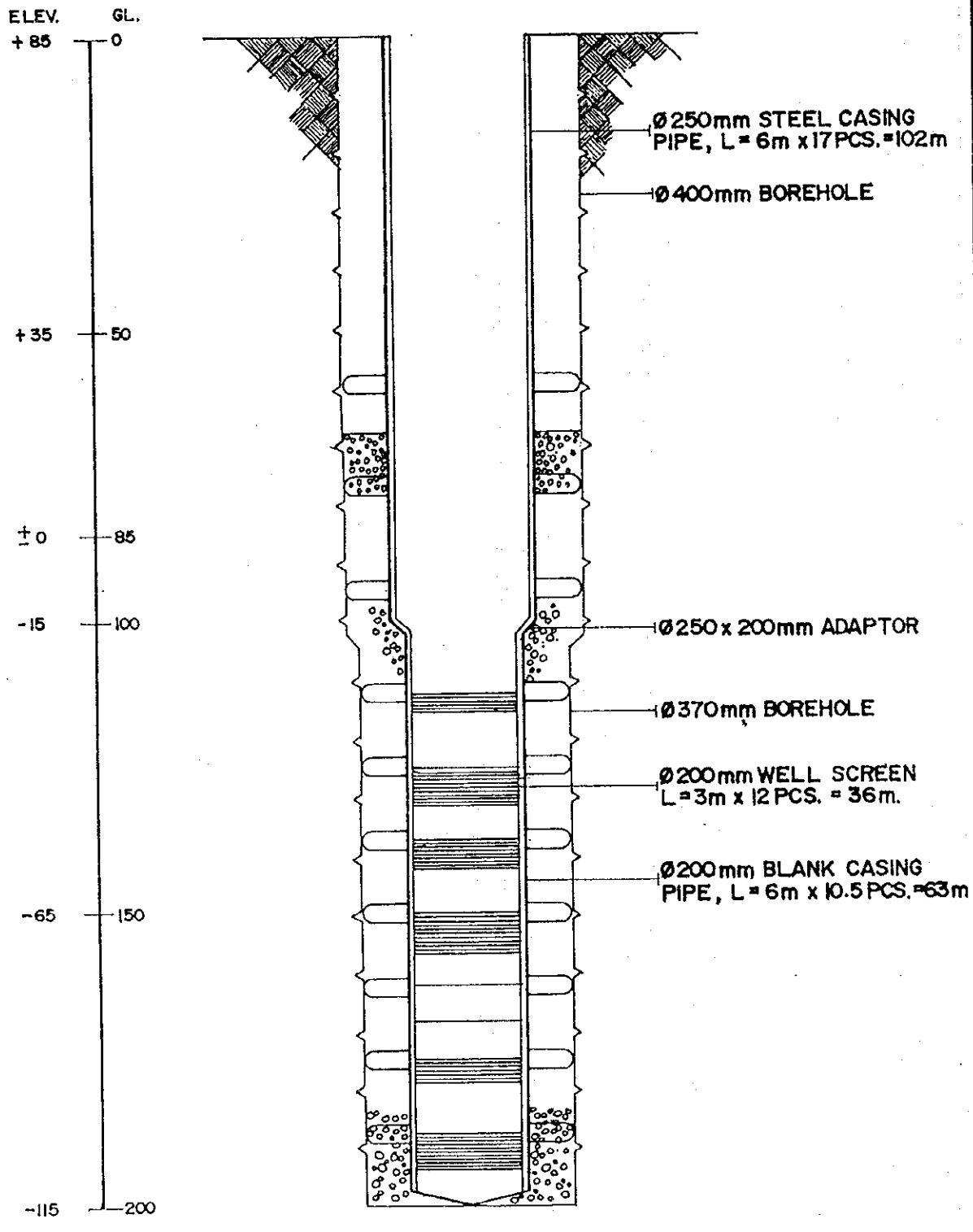



| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | Fig. 10.2-5C<br>RECOMMENDED WATER SUPPLY SYSTEM |
| JAPAN INTERNATIONAL COOPERATION AGENCY | GMA WATER DISTRICT<br>G M A , CAVITE |




SCALE 1: 2000 M.

| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | Fig. 10.2-6A |
| JAPAN INTERNATIONAL COOPERATION AGENCY | PRELIMINARY WELL DESIGN PROPOSED WELL No. 9,10 GMA |




SCALE 1: 1000 M.

| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | Fig. 10.2-6B<br>PRELIMINARY WELL DESIGN<br>PROPOSED WELL No. 8 |
| JAPAN INTERNATIONAL COOPERATION AGENCY | GMA |

The proposed facilities for Phase II improvement are as follows:

1) Laying 3.510 km of distribution line.

2) Construction of 2 units of 292 $m^3$ capacity elevated steel tank

3) Installation of 791 service connections.

4) Installation of 11 units additional gate valves and 7 units of fire hydrants.

5) Rehabilitation of 2 existing elevated steel tanks.

6) Land acquisition. (600 $m^2$)

(3) Operation and Maintenance

Zone 1 will utilize the existing well source and the elevated reservoir located in brgy. Maderan, another existing well and the proposed reservoir in brgy. San Gabriel and a proposed reservoir at brgy. Lumbreras.

Zone 2 will utilize the existing elevated reservoir and JICA test well No. 1 in the NHA compound, the existing well source and the elevated reservoir in Teachers Village and a proposed deepwell located approximately 400 m north of Poblacion No. 5

The existing NHA well and 5 Hp pump will serve as a standby source.

The zone service area will cover poblacion 1 to 4, Teachers Village and portions of Poblacion No. 5.

Zone 3 will utilize the existing deepwell source and the steel reservoir in brgy. Memije and a proposed well and reservoir located approximately 400 m south of poblacion No. 4.

The zone service area are portions of poblacion 4 and 5, brgys. Memije, Pulido and portion of brgy. Granados.

Zone 4 will utilize existing deepwell source and ground steel reservoir located at brgy. Olaes. This zone will serve the water need of brgys. Olaes, Kua, Salud and portion of Granadas.

Zone 5 will utilize the existing deepwell source and steel reservoir in brgy. Elises and a proposed deepwell located near the existing municipal road east of brgy. Calimag. This zone will serve the water needs of brgys. Calimag, Tirona, Elises, Dacon and Malla.

Water from the sources will be treated by chlorine using hypochlorinators. Fire hydrants will be installed in densely populated areas while valves will be installed for necessary zoning and emergency purposes. The water systems is designed to operate 24 hours daily.

## 10.3 WATER SUPPLY PLAN FOR MENDEZ

### 10.3.1 Existing Water Supply System Facilities

The Mendez Water District (MWD) is operating the water system in the municipality of Mendez which covers nine Bgys. The facilities include a deepwell, pumping and storage facilities, disinfection facility and pipelines as indicated in **Fig. 10.3-1.**

(1) Source Facilities

The MWD derives its water supply source from a well located in Bgy. Galicia. It was constructed in 1993 with a total depth of 243 mbgl. The well has 200 mm diameter casing from ground level to 152 mbgl, 150 mm from 152 mbgl to 189 mbgl and openhole up to the entire depth.

(2) Pumping Facilities

Pumping Station No. 1 is located in Bgy. Galicia, some one (1) km northwest of the Poblacion. It is equipped with a 25 Hp submersible pump/motor and a 52 KVA generator set which serves as standby-power during power outages. The average discharge of the pump is 10 lps. It operates eight (8) hours daily. The plan of existing pumping stations is presented in the **S/R**.

(3) Storage Facilities

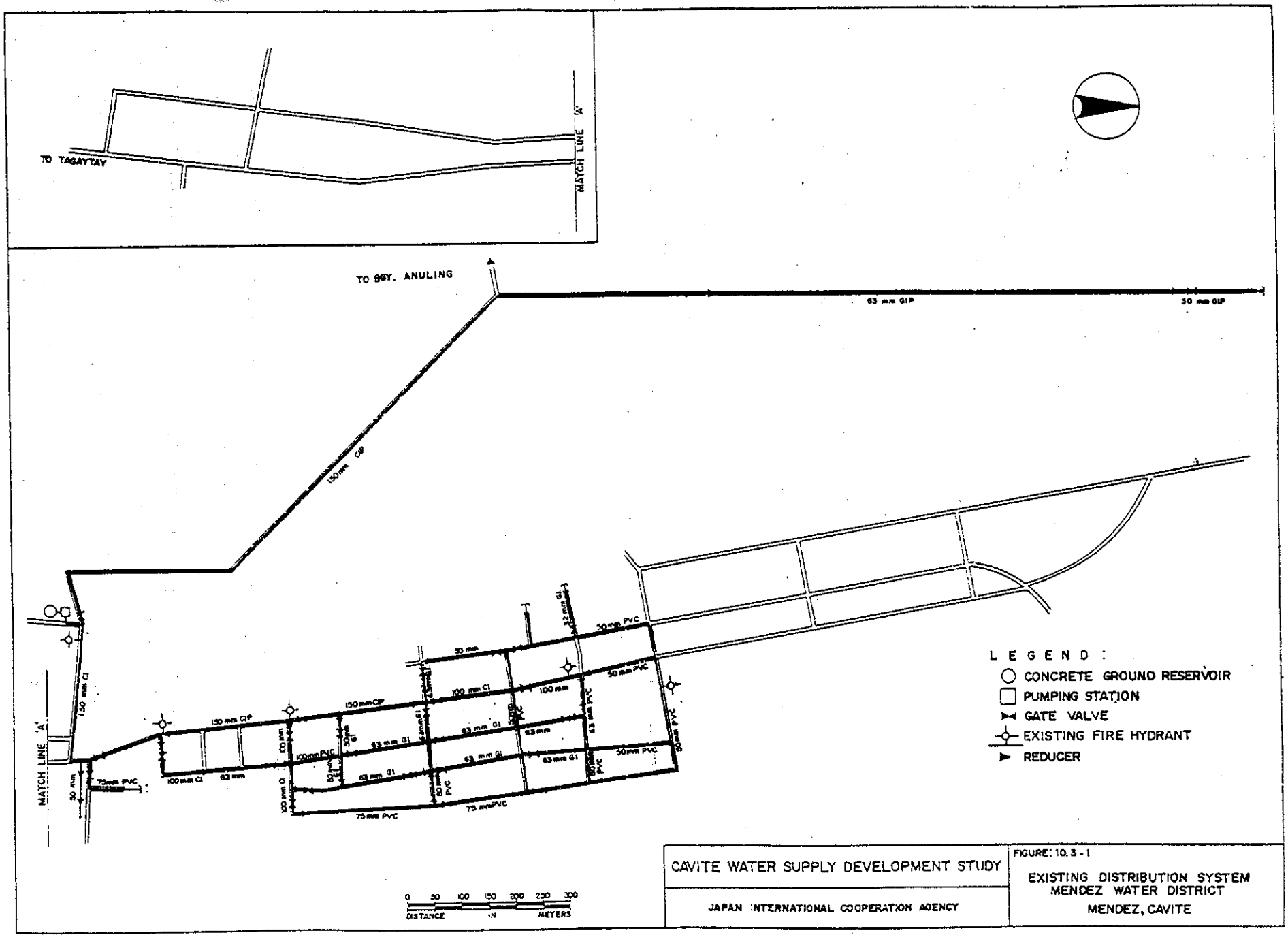
At present, the Water District is utilizing a 212 $m^3$ concrete ground reservoir constructed in 1962 by the National Waterworks and Sewerage Authority. It is located in Bgy. Galicia near Pumping Station No. 1 at an elevation of 100.57 masl. The overflow elevation is 7.5 m above ground level. The plan of existing reservoir is shown in the **S/R**.

(4) Disinfection Facilities

Pumping Station No. 1 is provided with a hypochlorinator to assure water users of safe and potable water. It was reported that 45 kg of chlorine granules are consumed every 2 1/2 months. This is equivalent roughly to a dosage of 3.7 ppm.

(5) Transmission/Distribution Facilities

The transmission/distribution lines consist of CI, GI and PVC pipes with sizes ranging from 50 mm to 150 mm. The total length is about 6.8 km.


TO TAGAYTAY
MATCH LINE "A"
TO BGY. ANULING
63 mm GIP
50 mm GIP
150mm CIP
150 mm CI
150 mm GIP
100 mm CI
63 mm
50 mm
63 mm GI
50mm PVC
100 mm
63 mm PVC
100mm PVC
75mm PVC
MATCH LINE 'A'
LEGEND :
CONCRETE GROUND RESERVOIR
PUMPING STATION
GATE VALVE
EXISTING FIRE HYDRANT
REDUCER
0 50 100 150 200 250 300
DISTANCE IN METERS
CAVITE WATER SUPPLY DEVELOPMENT STUDY
JAPAN INTERNATIONAL COOPERATION AGENCY
FIGURE: 10.3-1
EXISTING DISTRIBUTION SYSTEM
MENDEZ WATER DISTRICT
MENDEZ, CAVITE

(6) Valves and Hydrants

There are 31 CI gate valves in the distribution system. These gate valves were installed in 1994 and are all operational. The sizes range from 50 to 150 mm in diameter.

There are 4 fire hydrants and 1 blow-off valve for fire protection. These were also newly installed (1994) and in good condition. The sizes of the fire-hydrants and the blow-off is 100 mm and 50 mm, respectively.

(7) Service Connection

As of September 1994, the MWD had a total of 801 service connections of which 783 are domestic, 10 commercial and 8 institutional. Of the total number of connections 20 are unmetered.

(8) Operation & Maintenance

The Mendez water district has a total of 10 personnel headed by the general manager. Number of personnel and corresponding position is presented below:

| Position | Number |
|---|---|
| Treasurer | 1 |
| Bill Collector | 1 |
| Posting Clerk | 1 |
| Billing Clerk | 1 |
| Pump Operator | 2 |
| Meter Reader | 1 |
| Pipe Fitter | 1 |
| Water Pump Tech. | 1 |
| Utility | 1 |
| Total | 10 |

Pumping Station No. 1 operates from 10:00 pm to 6:00 pm on a fill-and-draw scheme. The Water District service is from 6:00 am - 5:00 pm daily.

The MWD is charging its consumers P 8.00/$m^3$ and P16.00/$m^3$ for residential and commercial connections, respectively.

### 10.3.2 Deficiencies of the Existing System

The noted deficiencies of the existing system during the field investigations conducted in September to October 1994 are as follows:

- Insufficient source capacity
- Unmetered connections.
- Lack of plumbing tools and office equipment.

### 10.3.3 Water Use Profile

(1) Population Served

As surveyed, the average persons per household in the service area is 5.2. At present (1994) the service area population and the total served population is 7,638 and 4,121, respectively.

(2) Water Consumption

The water consumption of the MWD as recorded for the month ending September, 1994 was 15,400 $m^3$. The average consumption per capita for domestic connections is 99.30 lpcd while 0.546 $m^3$/connection/day for commercial. Low water demand figures may be attributed to insufficient water supply.

(3) Accounted-for Water

The total accounted-for water for the month of September 1994 is 13,104 $m^3$. The total accounted-for water represents 71% of the total monthly production of 18,478 $m^3$.

(4) Unaccounted-for Water

The total unaccounted-for water in the MWD is 179 $m^3$/d which is 29% of the total monthly production.

(5) Present Water Demand

The present water demand of the MWD according to the latest (September 1994) record of the Water District is 603 $m^3$/d. This includes the unaccounted-for water during average day demand.

### 10.3.4 Population and Water Demand Projection

(1) Population Projection

Future population of the municipality of Mendez and the barangays in the existing service area were projected by the ratio method using historical population data gathered from the National Statistics Office (NSO). A growth rate of 1.61% is adopted in this study up to design year (2005). Thus, the year 2005 municipal population may reach 22,431.

The present service area includes nine (9) barangays namely: Bgys. 1–7, Galicia and Panungyan. The 1994 served population of these barangays totals 4,121 which is 22% of the total municipal population. The proposed improvement and expansion of service area to Bgy. Asis will increase the served population to 62% of the total projected municipal population in the year 2005. **Table 10.3–1, 10.3–2A,** and **10.3–2B** show the population projection, served population and water demand projection, respectively. **Fig. 10.3–2** shows the service area delineation.

The service area population in the design year (2005) is projected to reach 15,474 while the served population is expected to reach 13,848. The design–year (2005) served population and water demand projection is shown in **Table 10.3–2B.**

(2) Water Demand Projections

- Domestic unit water consumption is estimated at 0.120 $m^3/d$ in the proposed implementation year (1997) and 0.130 $m^3/d$ for the design year (2005) per person and number of person per household of 5.2 (NSO data).
- Commercial unit water consumption is estimated at 1.0 $m^3/d$.
- Institutional unit water consumption is estimated at 3.0 $m^3$/connection/d.
- unaccounted–for water is assumed to be 20% of the total water demand after project implementation.

Domestic connections are projected to reach 2,639 in 2005 while commercial and institutional connections are projected to reach 25 and 28 connections, respectively. **Table 10.3–2B** shows the number of connections for each category.

(3) Water Demand Variation

| | |
|---|---|
| Average–day demand | 2,336 $m^3/d$ (27.0 lps) |
| Maximum–day demand | 3,037 $m^3/d$ (35.2 lps) |
| Peak–hour demand | 4,672 $m^3/d$ (54.1 lps) |

TABLE 10.3-1

POPULATION PROJECTION
MENDEZ WATER DISTRICT

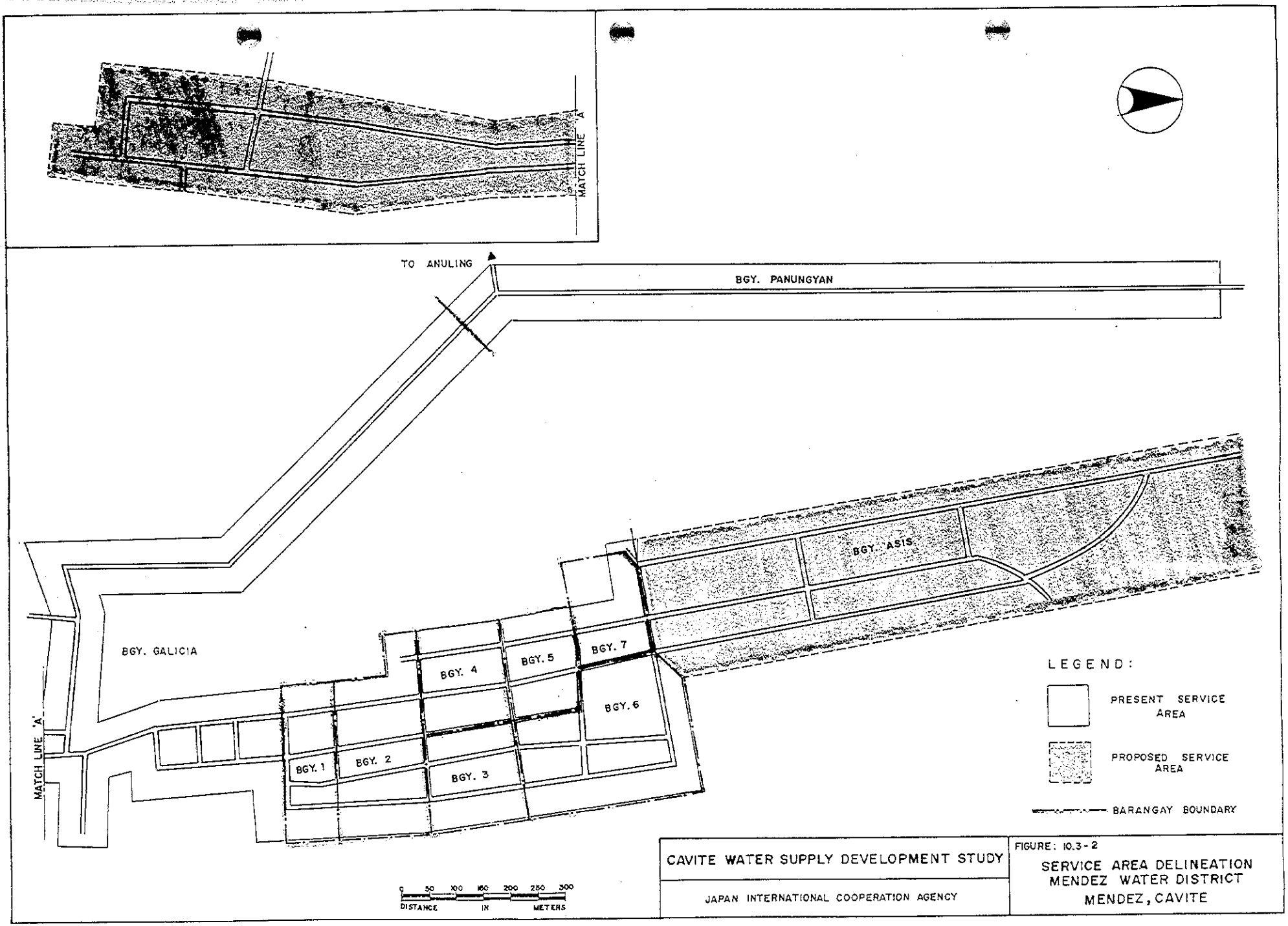
| Municipality/ Bgy. in the Service Area | Historical Population 1975 | 1980 | 1990 | Historical Growth Rates 1975-80 | 1980-90 | Projected Growth Rates 1990-2000 | 2000-2005 | Projected Population 1994 | 1998 | 2002 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MENDEZ | 13,844 | 15,044 | 17,652 | 1.68 | 1.61 | 1.61 | 1.61 | 18,817 | 20,058 | 21,381 | 22,431 |
| 1 Barangay 1 | 554 | 524 | 578 | -1.11 | 0.99 | 1.35 | 1.21 | 610 | 643 | 677 | 702 |
| 2 Barangay 2 | 801 | 871 | 813 | 1.69 | -0.69 | 1.29 | 1.14 | 856 | 901 | 945 | 978 |
| 3 Barangay 3 | 1,078 | 1,194 | 1,186 | 2.07 | -0.07 | 1.40 | 1.30 | 1,254 | 1,326 | 1,399 | 1,454 |
| 4 Barangay 4 | 561 | 581 | 565 | 0.70 | -0.28 | 1.19 | 1.05 | 592 | 621 | 649 | 670 |
| 5 Barangay 5 | 727 | 811 | 844 | 2.21 | 0.40 | 1.47 | 1.43 | 895 | 949 | 1,005 | 1,049 |
| 6 Barangay 6 | 1,056 | 1,076 | 1,258 | 0.38 | 1.58 | 1.60 | 1.58 | 1,340 | 1,428 | 1,521 | 1,594 |
| 7 Barangay 7 | 694 | 721 | 663 | 0.77 | -0.84 | 1.23 | 1.05 | 696 | 731 | 765 | 789 |
| 8 Asis | 2,267 | 2,500 | 3,157 | 1.98 | 2.36 | 1.74 | 1.79 | 3,382 | 3,623 | 3,886 | 4,098 |
| 9 Galicia | 2,081 | 2,401 | 3,245 | 2.90 | 3.06 | 2.13 | 2.34 | 3,530 | 3,841 | 4,196 | 4,498 |
| 10 Panungyan | 1,251 | 1,068 | 1,626 | -3.11 | 4.29 | 1.64 | 1.65 | 1,735 | 1,852 | 1,977 | 2,076 |
| Total | 11,070 | 11,747 | 13,935 | | | | | 14,891 | 15,914 | 17,020 | 17,908 |

TABLE 10.3-2A
1998 SERVED POPULATION AND WATER DEMAND PROJECTIONS
MENDEZ WATER DISTRICT

| | BARANGAY | BARANGAY POPULATION | SERVICE AREA POPULATION | DOMESTIC | | | COMMERCIAL | | | INSTITUTIONAL | | TOTAL | | | UNACCOUNTED-FOR WATER (cum/d) | AVERAGE DAY DEMAND (cum/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Water Demand | No. of Conn. | Served Pop. | Water Demand | | |
| 1 | Barangay 1 | 643 | 483 | 54 | 280 | 33.6 | 2 | 10 | 2.0 | 2 | 6.0 | 58 | 290 | 41.6 | 10.4 | 52.0 |
| 2 | Barangay 2 | 901 | 675 | 77 | 400 | 48.0 | 1 | 5 | 1.0 | 1 | 3.0 | 79 | 405 | 52.0 | 13.0 | 65.0 |
| 3 | Barangay 3 | 1,326 | 994 | 114 | 591 | 70.9 | 1 | 5 | 1.0 | 1 | 3.0 | 116 | 596 | 74.9 | 19.1 | 94.0 |
| 4 | Barangay 4 | 621 | 466 | 53 | 275 | 33.0 | 1 | 5 | 1.0 | 1 | 3.0 | 55 | 280 | 37.0 | 9.0 | 46.0 |
| 5 | Barangay 5 | 949 | 759 | 79 | 412 | 49.4 | 1 | 5 | 1.0 | 1 | 3.0 | 81 | 417 | 53.4 | 13.6 | 67.0 |
| 6 | Barangay 6 | 1,428 | 1,142 | 109 | 566 | 67.9 | 1 | 5 | 1.0 | 1 | 3.0 | 111 | 571 | 71.9 | 18.1 | 90.0 |
| 7 | Barangay 7 | 731 | 585 | 55 | 288 | 34.6 | 1 | 5 | 1.0 | 1 | 3.0 | 57 | 293 | 38.6 | 9.4 | 48.0 |
| 8 | Asis | 3,623 | 2,174 | 207 | 1,077 | 129.2 | 2 | 10 | 2.0 | 1 | 3.0 | 210 | 1,087 | 134.2 | 33.8 | 168.0 |
| 9 | Galicia | 3,841 | 2,496 | 238 | 1,238 | 148.6 | 2 | 10 | 2.0 | 1 | 3.0 | 241 | 1,248 | 153.6 | 38.4 | 192.0 |
| 10 | Panungyan | 1,852 | 1,296 | 124 | 643 | 77.2 | 1 | 5 | 1.0 | 1 | 3.0 | 126 | 648 | 81.2 | 20.8 | 102.0 |
| | Total | 15,914 | 11,070 | 1,110 | 5,770 | 692.4 | 13 | 65 | 13.0 | 11 | 33.0 | 1,134 | 5,835 | 738.4 | 185.6 | 924.0 |

TABLE 10.3-2B
2005 SERVED POPULATION AND WATER DEMAND PROJECTIONS
MENDEZ WATER DISTRICT

| | BARANGAY | BARANGAY POPULATION | SERVICE AREA POPULATION | DOMESTIC | | | COMMERCIAL | | | INSTITUTIONAL | | TOTAL | | | UNACCOUNTED-FOR WATER (cum/d) | AVERAGE DAY DEMAND (cum/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Water Demand | No. of Conn. | Served Pop. | Water Demand | | |
| 1 | Barangay 1 | 702 | 667 | 113 | 590 | 76.7 | 2 | 10 | 2.0 | 2 | 6.0 | 117 | 600 | 84.7 | 21.3 | 106.0 |
| 2 | Barangay 2 | 978 | 929 | 159 | 826 | 107.4 | 2 | 10 | 2.0 | 2 | 6.0 | 163 | 836 | 115.4 | 28.6 | 144.0 |
| 3 | Barangay 3 | 1,454 | 1,381 | 237 | 1,233 | 160.3 | 2 | 10 | 2.0 | 2 | 6.0 | 241 | 1,243 | 168.3 | 41.7 | 210.0 |
| 4 | Barangay 4 | 670 | 637 | 108 | 563 | 73.2 | 2 | 10 | 2.0 | 2 | 6.0 | 112 | 573 | 81.2 | 20.8 | 102.0 |
| 5 | Barangay 5 | 1,049 | 997 | 171 | 887 | 115.3 | 2 | 10 | 2.0 | 2 | 6.0 | 175 | 897 | 123.3 | 30.7 | 154.0 |
| 6 | Barangay 6 | 1,594 | 1,514 | 258 | 1,342 | 174.5 | 4 | 21 | 4.0 | 2 | 6.0 | 264 | 1,363 | 184.5 | 46.5 | 231.0 |
| 7 | Barangay 7 | 789 | 750 | 128 | 665 | 86.5 | 2 | 10 | 2.0 | 2 | 6.0 | 132 | 675 | 94.5 | 23.5 | 118.0 |
| 8 | Asis | 4,098 | 3,893 | 670 | 3,483 | 452.8 | 4 | 21 | 4.0 | 2 | 6.0 | 676 | 3,504 | 462.8 | 116.2 | 579.0 |
| 9 | Galicia | 4,498 | 3,149 | 542 | 2,818 | 366.3 | 3 | 16 | 3.0 | 2 | 6.0 | 547 | 2,834 | 375.3 | 93.7 | 469.0 |
| 10 | Panungyan | 2,076 | 1,557 | 253 | 1,313 | 170.7 | 2 | 10 | 2.0 | 2 | 6.0 | 257 | 1,323 | 178.7 | 44.3 | 223.0 |
| | Total | 17,908 | 15,474 | 2,639 | 13,720 | 1,783.7 | 25 | 128 | 25.0 | 20 | 60.0 | 2,684 | 13,848 | 1,868.7 | 467.3 | 2,336.0 |




CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE: 10.3-2

SERVICE AREA DELINEATION
MENDEZ WATER DISTRICT
MENDEZ, CAVITE

**Table 10.3-3** shows the annual water demand per type of connection and **Table 10.3-4** shows the annual water demand variation.

### 10.3.5 Analysis and Evaluation of Alternatives

(1) Considerations

The alternatives presented were considered to be implemented in one stage and take into account the water requirements of the system up to the design year (2005).

1) Existing Water Supply System Facilities

The MWD presently serves nine (9) barangays with PS1 located in Bgy. Galicia as its source. In 1993, extensive improvement was done to the system through a loan from LWUA. The majority of the pipelines, gate valves, fire hydrants were replaced and in good condition. However, a preliminary analysis showed that the existing source and storage facility is not adequate to meet the design year (2005) requirement of the system.

2) Additional Water Sources

Groundwater through wells is considered a possible water source for the MWD. The existing source is a deepwell located in Bgy. Galicia with a 10 lps capacity. Another groundwater source being considered is the test/production well constructed in barangay Galicia as part of this Feasibility Study (FS). The discharge is 27 lps.

3) Pressure Zone

A single pressure zone is considered in the whole service area.

4) Storage Location

Location of storage is influenced by the demand in the service area. Preliminary analysis showed that the existing location of the storage tank cannot adequately meet the requirements of the water system. An additional reservoir site shall be chosen to effectively balance the supply particularly during peak hour conditions.

5) Design Criteria

- Well Parameters for Additional Sources

The following well parameters were established for purposes of cost analysis of schemes requiring additional sources.

TABLE 10.3-3
ANNUAL WATER DEMAND AND NUMBER OF CONNECTIONS
MENDEZ WATER DISTRICT

| YEAR | DOMESTIC | | COMMERCIAL | | INSTITUTIONAL | | TOTAL | | UNACCOUNTED-FOR WATER (cumd) | AVERAGE DAY DEMAND (cumd) |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | | |
| 1994 | 783 | 488.0 | 10 | 10.0 | 8 | 33.0 | 801 | 531.0 | 185.6 | 708.0 |
| 1995 | 843 | 528.0 | 11 | 11.0 | 9 | 35.0 | 863 | 574.0 | 191.0 | 765.0 |
| 1996 | 907 | 571.0 | 12 | 12.0 | 10 | 37.0 | 929 | 620.0 | 206.0 | 826.0 |
| 1997 | 976 | 617.8 | 12 | 12.0 | 10 | 38.9 | 998 | 668.7 | 222.9 | 891.6 |
| 1998 | 1,110 | 692.4 | 13 | 13.0 | 11 | 33.0 | 1,134 | 738.4 | 185.6 | 924.0 |
| 1999 | 1,256 | 793.0 | 14 | 14.0 | 12 | 36.0 | 1,282 | 843.0 | 212.0 | 1,055.0 |
| 2000 | 1,421 | 908.0 | 15 | 15.0 | 13 | 39.0 | 1,449 | 962.0 | 242.0 | 1,204.0 |
| 2001 | 1,608 | 1,039.0 | 16 | 16.0 | 14 | 42.0 | 1,638 | 1,097.0 | 278.0 | 1,375.0 |
| 2002 | 1,820 | 1,189.0 | 18 | 18.0 | 15 | 46.0 | 1,853 | 1,253.0 | 317.0 | 1,570.0 |
| 2003 | 2,060 | 1,361.0 | 20 | 20.0 | 16 | 50.0 | 2,096 | 1,431.0 | 361.0 | 1,792.0 |
| 2004 | 2,331 | 1,558.0 | 22 | 22.0 | 17 | 54.0 | 2,370 | 1,634.0 | 412.0 | 2,046.0 |
| 2005 | 2,639 | 1,783.7 | 25 | 25.0 | 20 | 60.0 | 2,684 | 1,868.7 | 467.3 | 2,336.0 |

TABLE 10.3-4

WATER DEMAND VARIATIONS
MENDEZ WATER DISTRICT

| YEAR | Average Day Demand (cumd) | Average Day Demand (L/s) | Maximum Day Demand (cumd) | Maximum Day Demand (L/s) | Peak-Hour Demand (cumd) | Peak-Hour Demand (L/s) |
|---|---|---|---|---|---|---|
| 1994 | 708 | 8.2 | 920 | 10.6 | 1,416 | 16.4 |
| 1995 | 765 | 8.9 | 995 | 11.5 | 1,530 | 17.7 |
| 1996 | 826 | 9.6 | 1,074 | 12.4 | 1,652 | 19.1 |
| 1997 | 892 | 10.3 | 1,159 | 13.4 | 1,783 | 20.6 |
| 1998 | 924 | 10.7 | 1,201 | 13.9 | 1,848 | 21.4 |
| 1999 | 1,055 | 12.2 | 1,372 | 15.9 | 2,110 | 24.4 |
| 2000 | 1,204 | 13.9 | 1,565 | 18.1 | 2,408 | 27.9 |
| 2001 | 1,375 | 15.9 | 1,788 | 20.7 | 2,750 | 31.8 |
| 2002 | 1,570 | 18.2 | 2,041 | 23.6 | 3,140 | 36.3 |
| 2003 | 1,792 | 20.7 | 2,330 | 27.0 | 3,584 | 41.5 |
| 2004 | 2,046 | 23.7 | 2,660 | 30.8 | 4,092 | 47.4 |
| 2005 | 2,336 | 27.0 | 3,037 | 35.2 | 4,672 | 54.1 |

| | | |
|---|---|---|
| Depth | : | 300 m |
| Borehole Diameter | : | 350 mm |
| Casing Diameter | : | 200 mm |
| Screens | : | 150 mm Stainless Steel |
| Expected Yield | : | 20–25 lps |
| Expected SWL | : | 110 mbgl |
| Expected PWL | : | 150 mbgl |

- Distribution System

No pipelines will be replaced and the concentration of this study is the expansion area. The pipelines will be laid along the National Highway and in the streets of the municipality. The pipe network layout is generally influenced by the existing roadways and the area to be served while the pipe size configuration is designed at peak hour condition.

- Demand Ratios

The projected water demands of Mendez for the design year 2005 are 3,037 $m^3/d$ for maximum-day and 4,672 $m^3/d$ for peak-hour demand.

- Storage Requirement

During peak-hour water demand conditions and whenever the production capacity of the sources is less than the demand of the system, additional water supply will be provided by the reservoir. Generally, the volume of storage must be sufficient to meet the operational, emergency and fire firefighting reserve requirements. **Table 10.3-5** shows the storage capacity requirement of the system up to the year 2005.

The reservoir will be constructed at an elevation such that the required minimum pressure in the distribution system is satisfied.

- System Pressure

The minimum pressure head to be adopted in the system is 7 m while the maximum is 70 m. The system pipe network is designed to conform with the pressure requirement even during peak-hour conditions.

- Fire Protection

Full fire protection will be provided to the entire service area.

- Flow Velocity in the Distribution System

Table 10.3-5

STORAGE REQUIREMENT

MENDEZ WATER DISTRICT

| YEAR | Max Day Demand (cumd) | Served Population | Emergency Storage Requirement (cum) | Operational Storage Requirement | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Max-day (cum) | ID-1.33 (cum) | ID-1.2 (cum) | ID-1.10 (cum) | PKD (cum) |
| 1997 | 1,183.0 | 5,741 | 99 | 228 | 103 | 112 | 188 | 67 |
| 1998 | 1,331.0 | 6,409 | 111 | 253 | 113 | 123 | 210 | 73 |
| 1999 | 1,497.5 | 7,155 | 125 | 282 | 125 | 136 | 233 | 80 |
| 2000 | 1,684.8 | 7,987 | 140 | 314 | 137 | 150 | 259 | 87 |
| 2001 | 1,895.5 | 8,916 | 158 | 350 | 151 | 165 | 287 | 95 |
| 2002 | 2,132.6 | 9,953 | 178 | 389 | 167 | 181 | 319 | 104 |
| 2003 | 2,399.3 | 11,111 | 200 | 433 | 183 | 200 | 355 | 113 |
| 2004 | 2,699.4 | 12,404 | 225 | 482 | 202 | 219 | 394 | 123 |
| 2005 | 3,037.0 | 13,848 | 253 | 536 | 222 | 241 | 437 | 133 |

Operational Storage Requirement

| Supply rate | Storage Volume | Pump Hours |
|---|---|---|
| MD | (0.224 - (0.0416 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 24 |
| ID-1.33 | (0.114 - (0.0359 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 18 |
| ID-1.20 | (0.125 - (0.0400 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 20 |
| ID-1.10 | (0.190 - (0.0406 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 22 |
| PKH | (0.082 - (0.0336 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 16 |

The flow velocity in the distribution system is limited to a maximum of 3 m/s at all times and a minimum of 0.3 m/s. However, in order to obtain a good pressure in all parts of the distribution system, it was necessary to allow a velocity flow less than this minimum.

- Computer Analysis

  Pipe sizes were designed for peak-hour demand condition and only pipes with a diameter of 50 mm and above were included in the analyses.

- Common Items

  To simplify the evaluation of alternatives, items common to each scheme such as valves, hydrants, service connections and some pipelines were not included in the analyses.

  The operation and maintenance cost of the alternatives were also not considered because of their minimal effects in the result of the evaluation.

(2) Development of Alternatives

Groundwater through wells were considered as capable of meeting the increasing water demand in the service area. Additional wells are expected to meet the supply requirement of the system by the year 2005.

Optimization of source versus storage analysis is necessary to determine the most economical system for the MWD. The following alternatives will give insight to each proposal for the improvement of the main system.

1) Alternative 1 – MDD Supply with Maximum Storage

This alternative proposes the commissioning of the test well in Bgy. Galicia into a production well with a discharge of 25 lps. The well will be equipped with a 75 Hp submersible pump and an electric motor drive. No transmission pipelines will be needed in this scheme because the well is situated in the service area.

An additional elevated steel tank volume of 577 $m^3$ shall be constructed.

**Table 10.3-6** and **Fig.10.3-3A** presents the details of this alternative.

2) Alternative 2 – 1.33 MDD Supply with Intermediate Storage

This alternative proposes the commissioning of the test well in Bgy. Galicia into a production well and the construction of an additional well in Bgy. Asis to meet the future water demand of the system. The wells will be equipped with two (2) 50 Hp

TABLE 10.3.6
Cost Comparison of Alternatives
Mendez Water [illegible]t

Alternative 1 - MDD Supply with Intermediate Storage

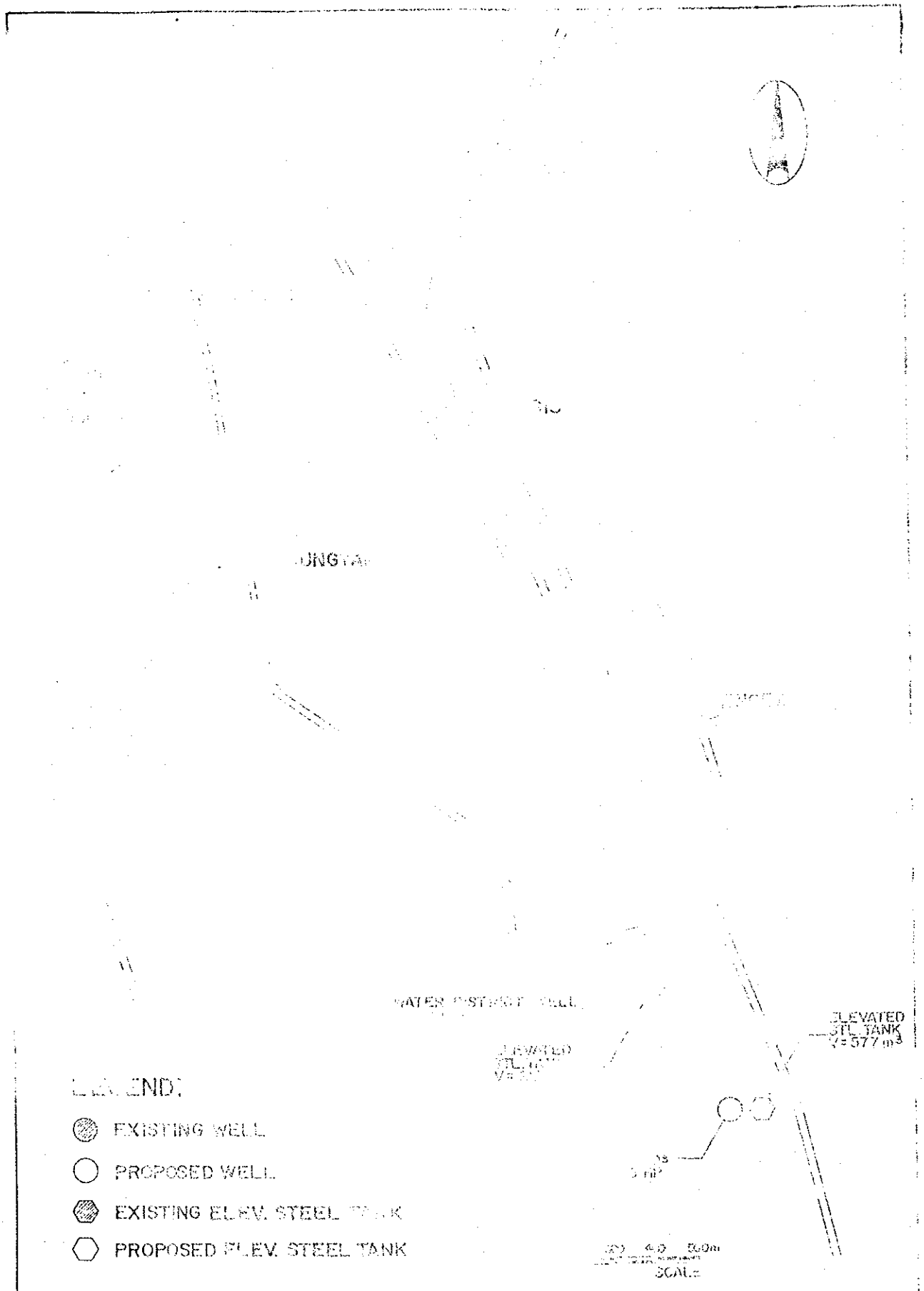
| Facilities | | Construction Cost (P) |
|---|---|---|
| Storage Tank | V = 577 cum | 7,501,000.00 |
| PS2 | 75HP | 1,019,564.00 |
| Power Connections | | 775,000.00 |
| | P | 9,295,564.00 |

Alternative 2 - 1.33 MDD Supply with Intermediate Storage

| Facilities | | Construction Cost (P) |
|---|---|---|
| Elevated Tank | V = 236 | 1,000.00 |
| PS2 | | 623,700.00 |
| Power Connections | | 700,000.00 |
| PS3 | | 623,700.00 |
| Power Connections | | 2,700,000.00 |
| Transmission | 50 [illegible] mm | 387,428.00 |
| Deep Well (1 @ P3,000,000.00) | | 3,000,000.00 |
| | P | 9,839,828.00 |

Alternative 3 - Minimum Storage/Maximum Supply

| Facilities | | Construction Cost (P) |
|---|---|---|
| Elevated Tank | V = 41 cum | 733,000.00 |
| PS2 | 75HP | 1,019,564.00 |
| Power Connections | | 775,000.00 |
| PS3 | 75HP | 1,019,564.00 |
| Power Connections | | 2,775,000.00 |
| Transmission - 750 m x 150 mm | | 390,000.00 |
| Deep well (1 @ P3,000,000.00) | | 3,000,000.00 |
| | P | 9,512,128.00 |




CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

ALTERNATIVE - I
MOD SUPPLY WITH MINIMUM STORAGE
MENDEZ WATER DISTRICT
MENDEZ

submersible pumps and electric motor drives with a combined capacity of 63.5 lps. A total of 750 m of 100 mm diameter pipelines shall be needed to connect the proposed well in Bgy. Asis to the system.

An additional elevated steel tank with a volume of 263 $m^3$ shall be constructed.

**Table 10.3-6** and **Fig. 10.3-3B** presents the details of this alternative.

3) Alternative 3 – Minimum Storage/Maximum Supply

This alternative proposes the commissioning of the test well in Bgy. Galicia into a production well and the construction of an additional well in Bgy. Asis. The wells will be equipped with two (2) 75 Hp submersible pumps and electric motor drives with combined capacity of 44 lps. A total of 750 m of 150 mm diameter pipeline shall be needed to connect the proposed well to the system.

An additional elevated steel tank with a volume of 41 $m^3$ shall be constructed.

**Table 10.3-6** and **Fig. 10.3-3C** presents the details of this alternative.

(3) Evaluation of Alternatives

Each of the alternatives was evaluated based on the construction cost at 1994 price level.

The following table summarizes the cost of each alternative.

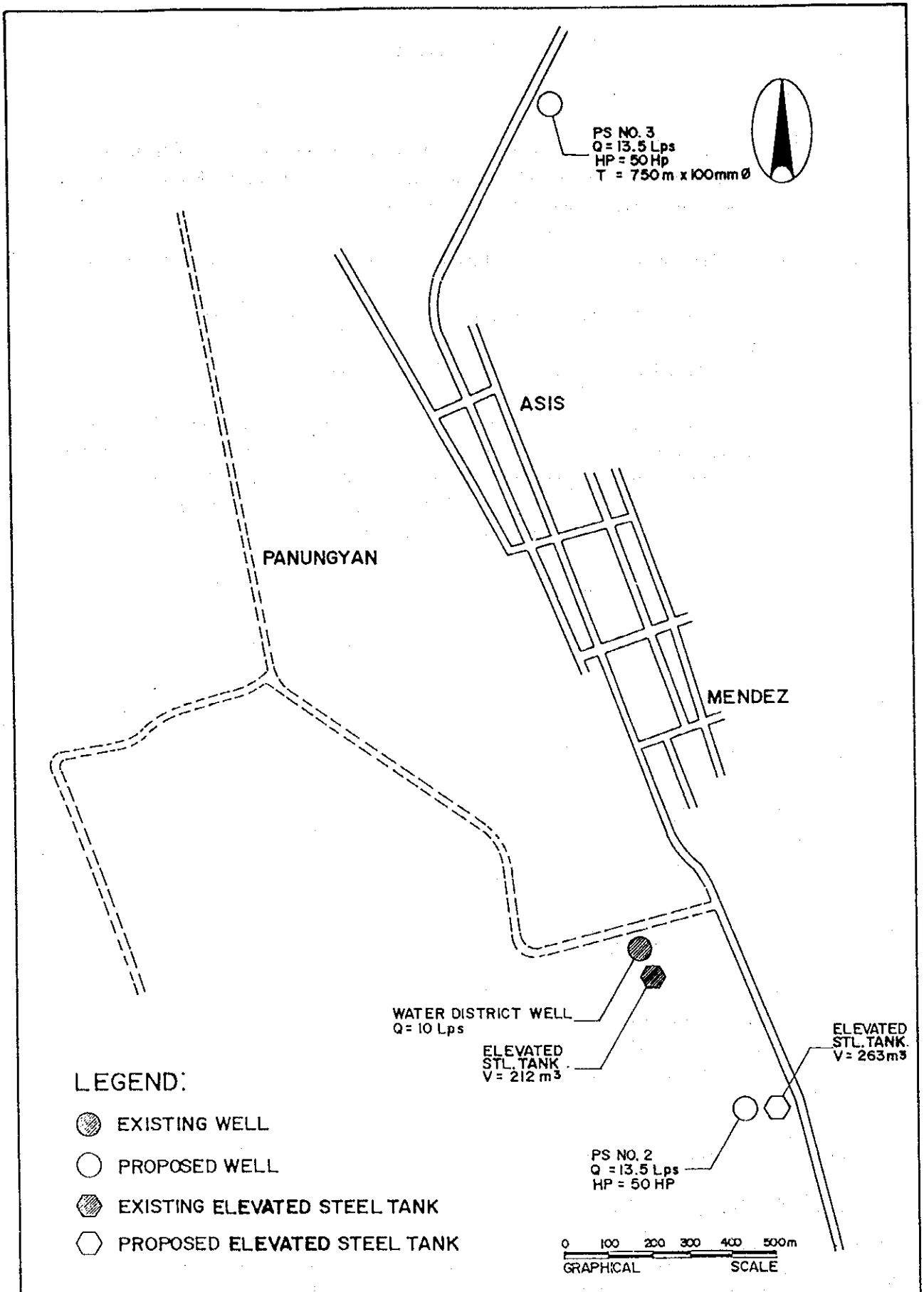
| | Cost (P) |
|---|---|
| Alternative 1 | 9,295,564.00 |
| Alternative 2 | 11,298,900.00 |
| Alternative 3 | 9,512,128.00 |

Evaluating the energy cost of the alternatives shows that the power requirement of Alternative 1 is much less than the two (2) alternatives thereby resulting in less energy cost. Alternative 1, being the least cost alternative, is recommended for the improvement of the MWD water supply system.

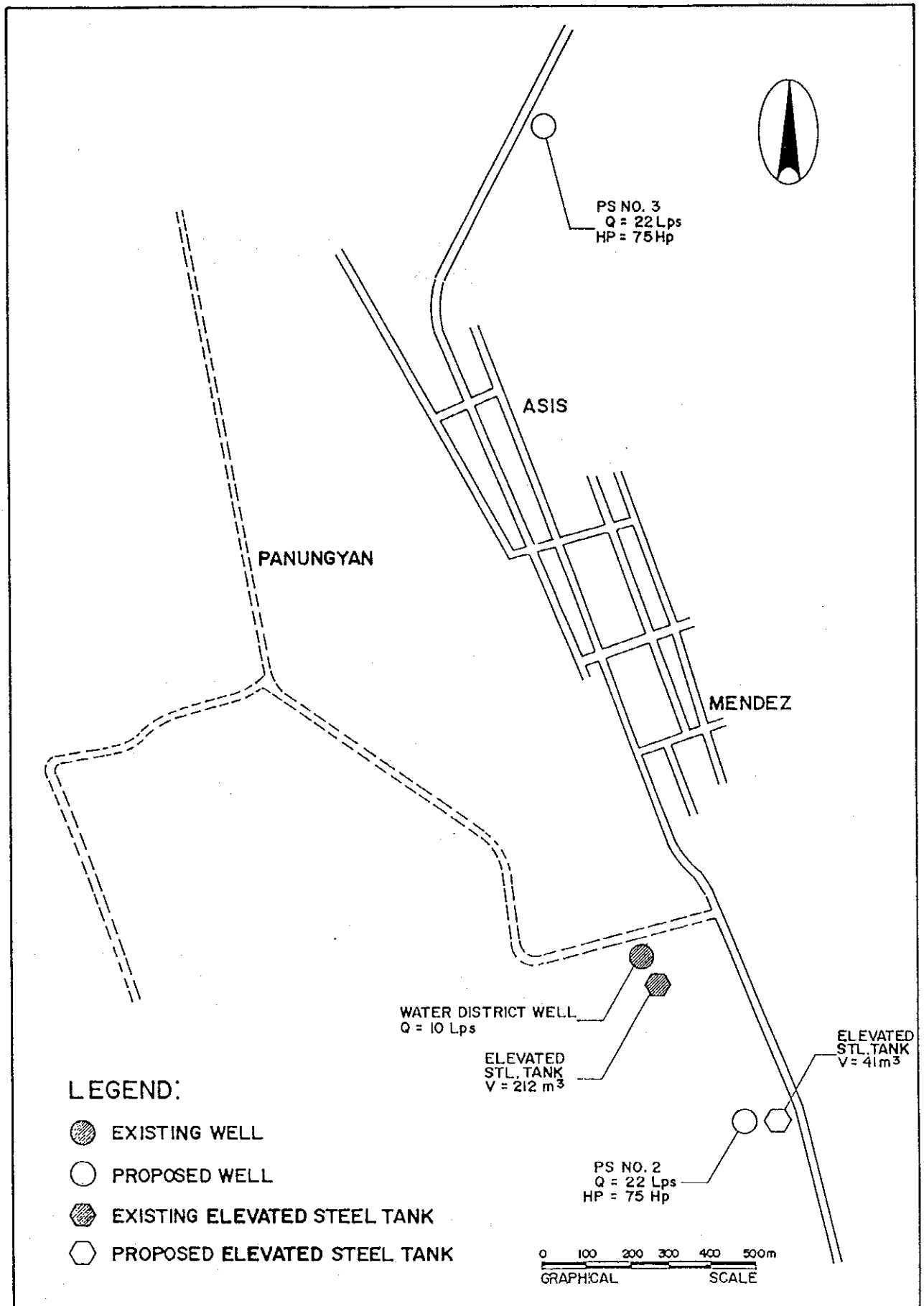
### 10.3.6 Recommended Plan

(1) Description of the Scheme

The main objective of the recommended plan for the Mendez Water District is to improve the existing facilities and to provide an adequate water supply in the year 2005. The existing reservoir in PS1 will be used for emergency purposes while the proposed 577 $m^3$ reservoir



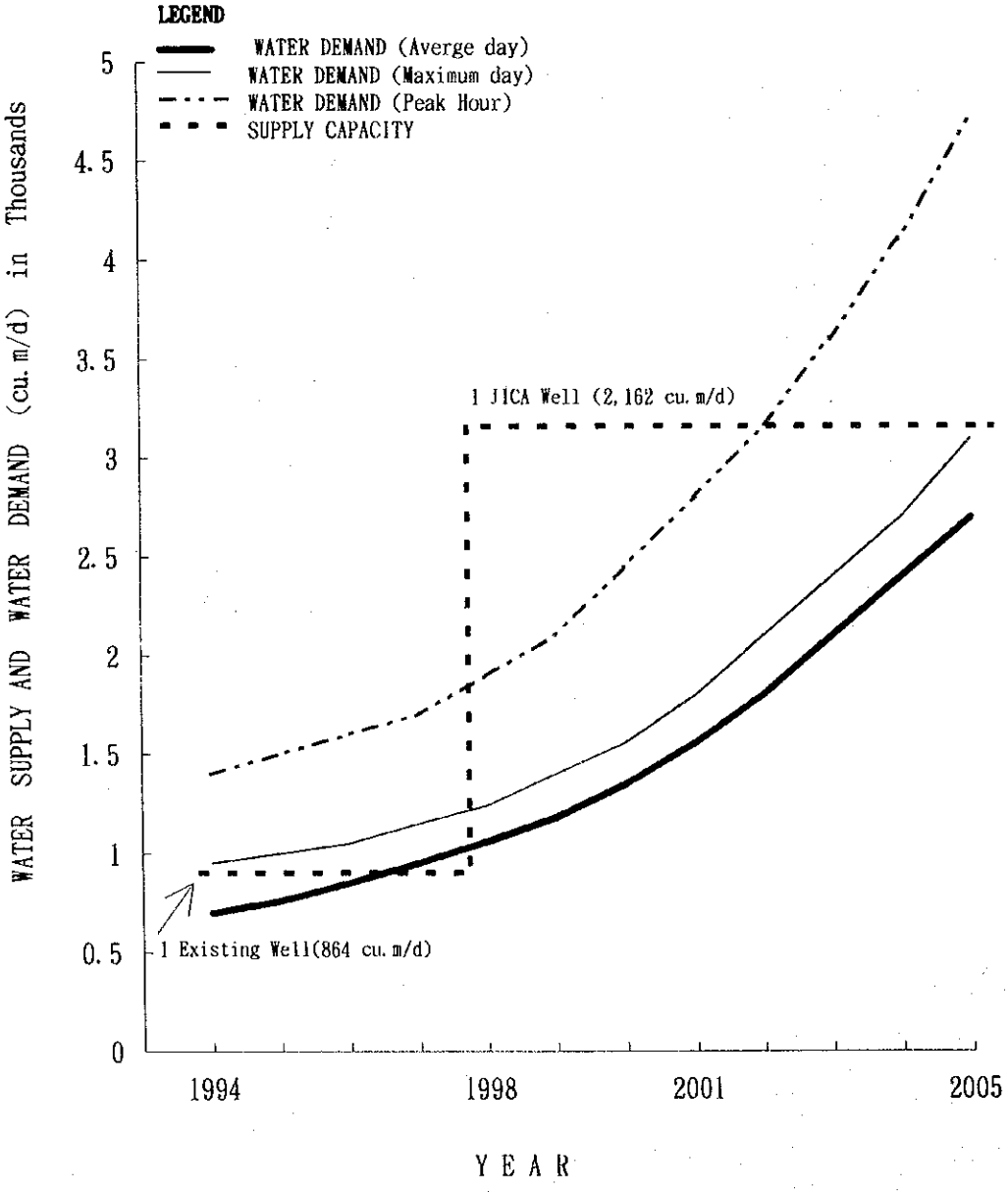

| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE 10.3 - 3B<br>ALTERNATIVE - 2<br>1.33 MDD SUPPLY WITH INTERMEDIATE STORAGE<br>MENDEZ WATER DISTRICT<br>MENDEZ |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE 10.3-3C<br>ALTERNATIVE - 3<br>PEAK HOUR SUPPLY MINIMUM STORAGE<br>MENDEZ WATER DISTRICT<br>MENDEZ |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

Fig. 10.3-4

WATER SUPPLY VS DEMAND CURVE OF RECOMMENDED PLAN
MENDES



adjacent to the JICA test well (Q=25 lps) will be utilized on a fill and draw basis. PS1 will be feeding the system directly.

The service area includes the whole Poblacion and will be extended up to Bgy. Asis. A hypo-chlorinator is also provided to disinfect the water from the test/production well. The proposed gate valves will be used to segregate areas during repairs and the tapping of new connections. Hydrants and blow-off valves will be utilized for fire protection purposes and regular flushing of the distribution system.

**Fig. 10.3-4** shows the relationship between water supply and demand when the recommended plan shall be implemented.

The proposed water system for the MWD is shown in **Fig. 10.3-5**. The computer print-out of the hydraulic analysis of the system and the schematic diagram of the distribution system are presented in the supporting document.

(2) Proposed Facilities

The proposed water system for the MWD water supply system is to be implemented in one stage.

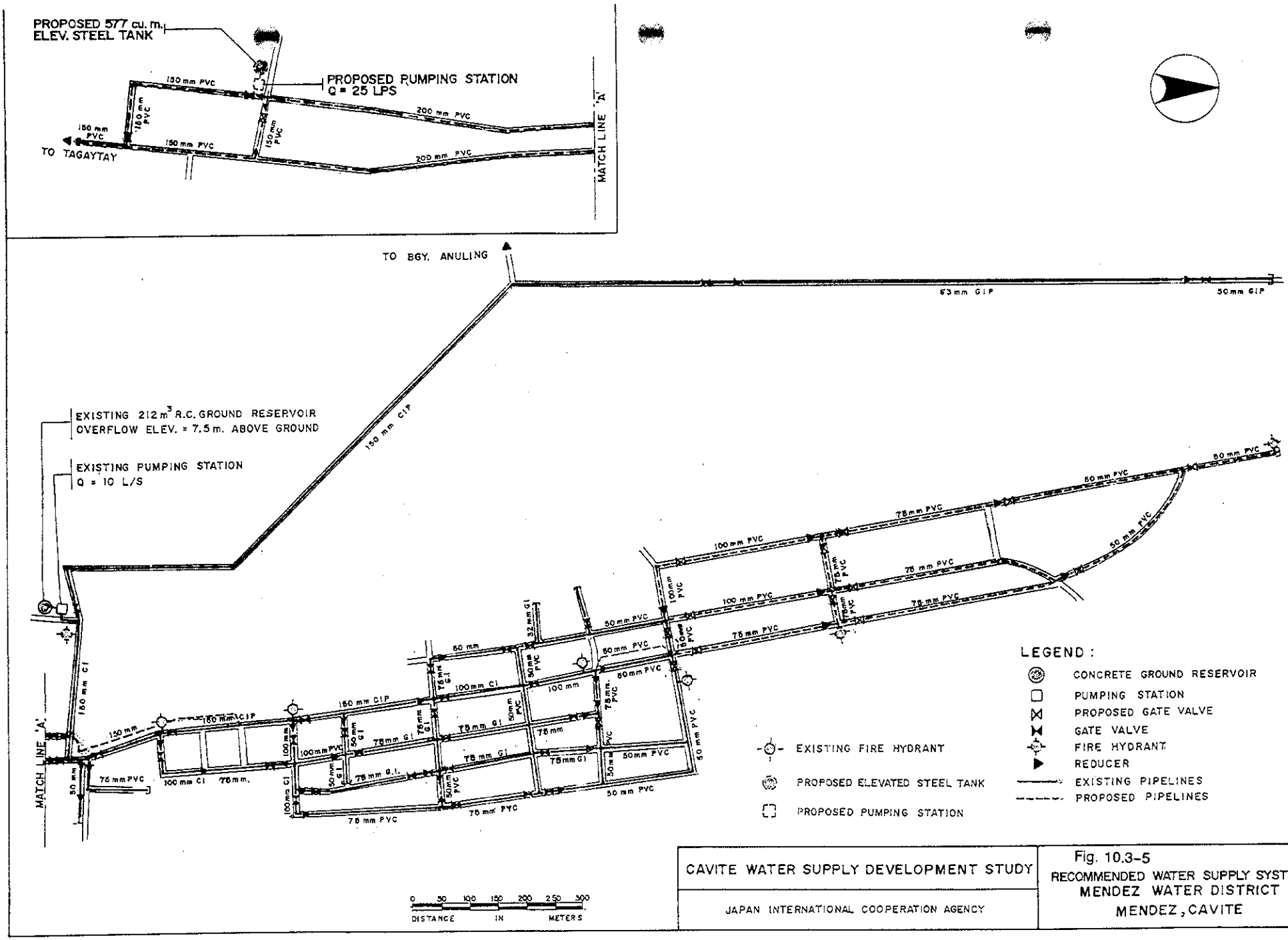
The proposed facilities for the improvement of the MWD are as follows:

1) Laying 5.378 km of distribution lines.
2) Installation of 10 additional gate valves, 1 unit of fire hydrant and 1 unit of blow-off valve.
3) Construction of a 577 $m^3$ elevated steel reservoir.
4) Provision of electro-mechanical facilities and a pump house for the test/production well.
5) Installation of 350 service connections.
6) Installation of a hypochlorinator in the test/production well.
7) Provision of plumbing tools and office equipment
8) Land acquisition (400 $m^2$).

(3) Operation and Maintenance

PS1 will operate on a direct pumping scheme while the proposed test/production well will operate on a fill and draw basis using the proposed 577 $m^3$ elevated steel tank. Water from the two deepwells will be treated with chlorine using the hypo-chlorinators.

The pipelines were designed for peak-hour operations.




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | Fig. 10.3-5<br>RECOMMENDED WATER SUPPLY SYSTEM<br>MENDEZ WATER DISTRICT<br>MENDEZ, CAVITE |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

## 10.4 WATER SUPPLY PLAN FOR NAIC

### 10.4.1 Existing Water Supply System Facility

The Naic Water District (NWD) is operating the water system in the Municipality of Naic which covers Bgys. Halang, Calubcob, San Roque, Malainen Bago. The facilities include a spring source with intake box and pipeline as indicated in **Fig. 10.4-1**

(1) Source Facility

The NWD utilize Banyo Spring as their source of water. The spring is located 7.0 km east of the Poblacion. The spring has an elevation of 57.4 mamsl and has a reported discharge of 4.3 lps. The spring intake box has a dimension of 2.63 m x 6.41 m x 1.66 m with a 200 mm GI pipes that conveys water by gravity to the distribution system. The spring intake structure is shown in the **S/R**.

(2) Pumping Station

The NWD has no pumping station.

(3) Storage Facility

The NWD has no storage facility.

(4) Disinfection Facility

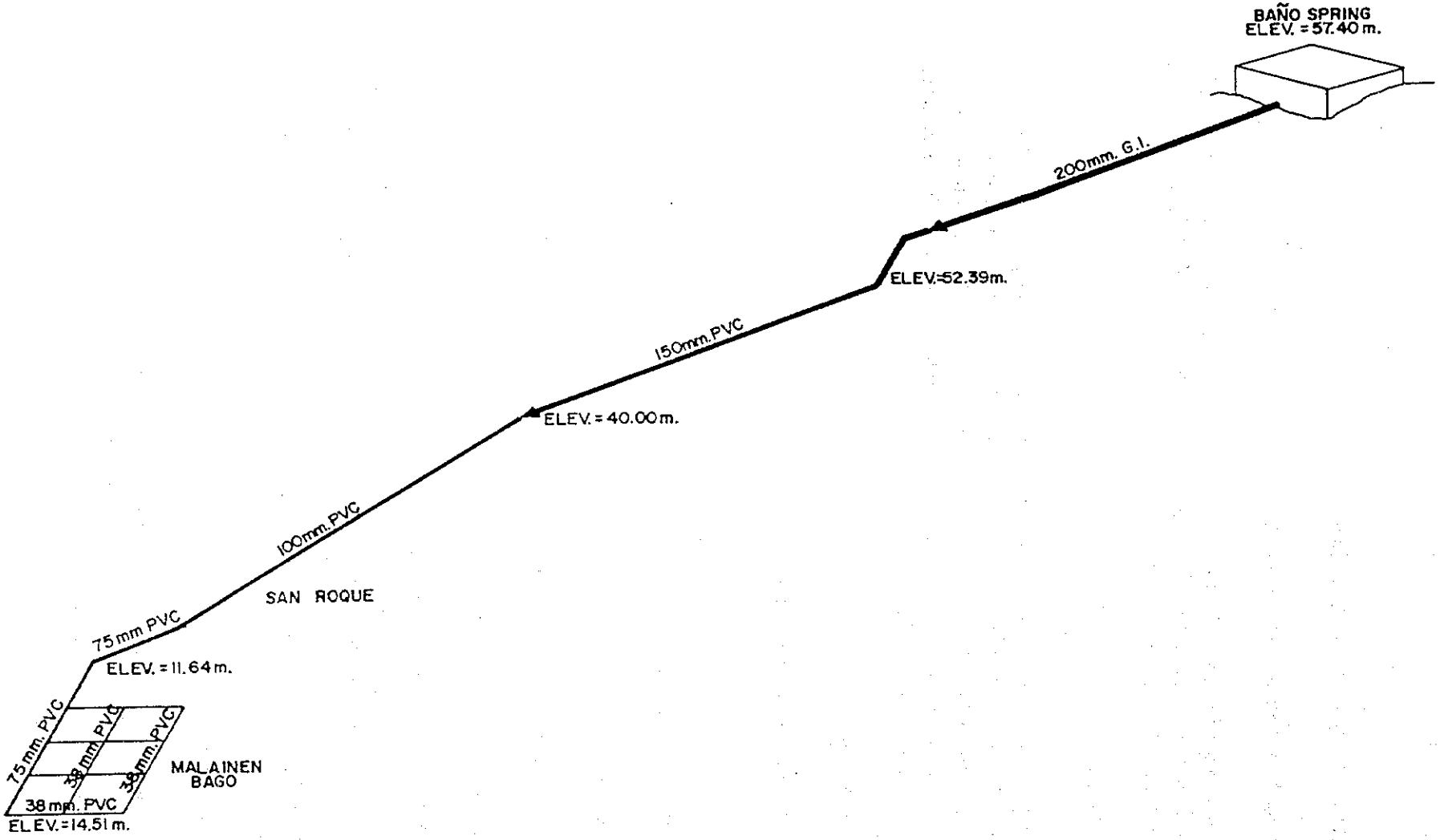
The Water District has no disinfection facility.

(5) Transmission/Distribution Facilities

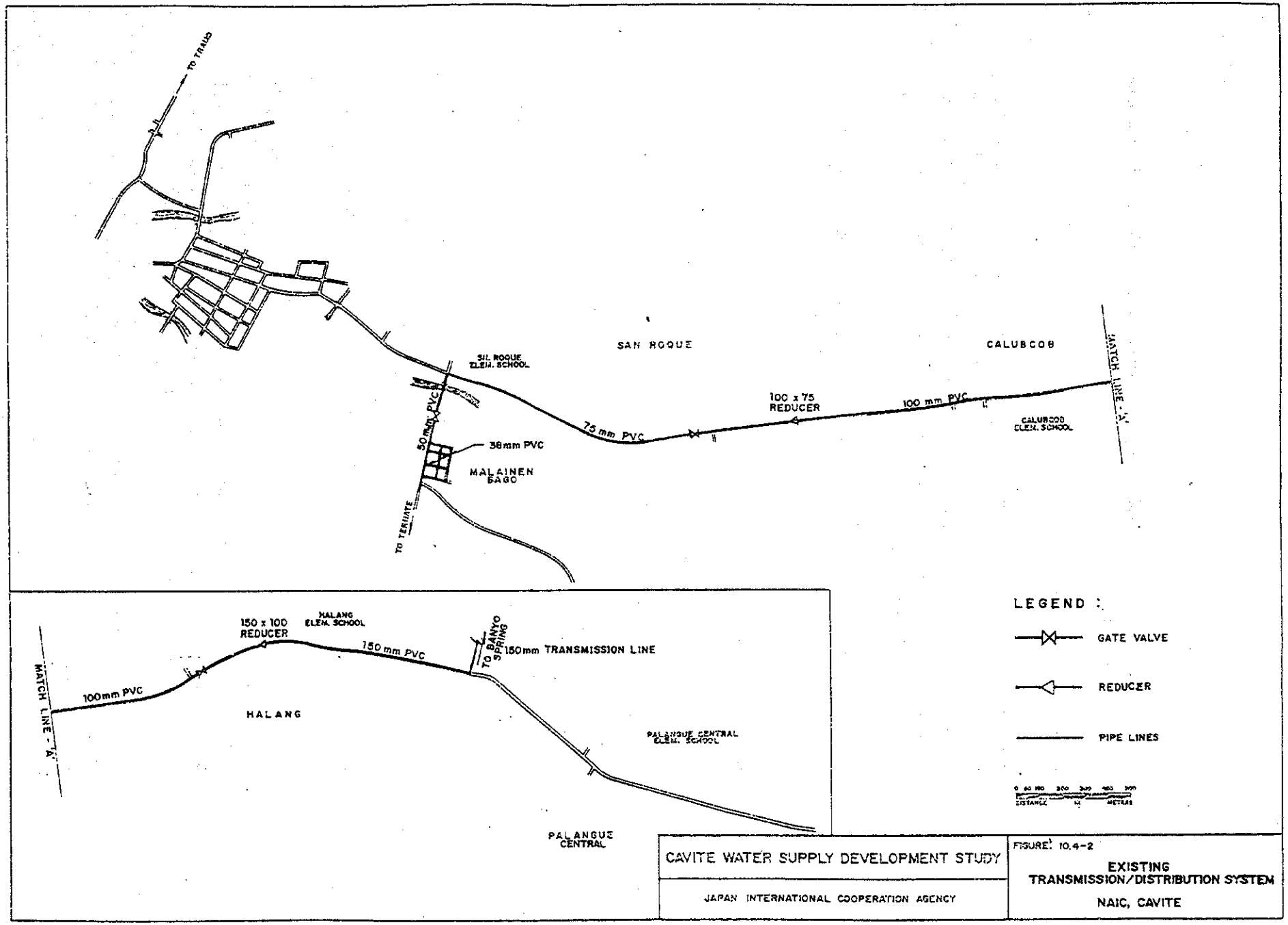
The NWD has a total of 8.53 km of transmission/distribution lines with a diameter ranging from 38 mm to 200 mm PVC, and GI pipes. The said pipes were installed in 1988 and were found to be still in good operational condition except for a few leaks along the 200 mm transmission lines. The main distribution lines of the Water District stretches from Bgy. Halang to Bgy. Malainen Bago. **Fig. 10.4-2** shows existing transmission /distribution system.

(6) Valves and Hydrants

There are three identified gate valves installed in the water system of the NWD. The valves are placed so that the water can be rationed to the different part of the service area. Location of valves are presented in **Fig. 10.4-2**.




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.4 - 1 |
| JAPAN INTERNATIONAL COOPERATION AGENCY | SCHEMATIC DIAGRAM<br>EXISTING WATER SUPPLY SYSTEM<br>NAIC WATER DISTRICT<br>NAIC, CAVITE |




CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 10.4-2

EXISTING TRANSMISSION/DISTRIBUTION SYSTEM

NAIC, CAVITE

(7) Service Connection

As of October 1994, the NWD had a total of 558 unmetered connections. All connections are considered residential.

(8) Operation and Maintenance

The Naic Water District operates the water system by the rationing method. Bgy. Halang is served from 8:01 a.m. to 11:00 a.m. and then water is diverted to Bgys. Calubcob, Bgy. San Roque and Bgy. Malainen Bago from 11:01 a.m up to 8:00 a.m. the next day. No water treatment is being employed at the water source. The water rates being charged is P30.00 per month on a flat rate basis.

The Water District is composed of 10 employees, the general manager, a secretary, one billing clerk, two bill collectors, four plumbers, and one gate tender.

### 10.4.2 Deficiencies of the Existing System

During the field investigation conducted last October 1994, several deficiencies in the existing system were noted. These deficiencies were as follows:

- Insufficient source capacity
- No disinfection facility
- No storage facility
- Unmetered connections
- Inefficient valving scheme
- Lack of plumbing tools and office equipment
- Leakages along the 200 mm transmission lines

### 10.4.3 Water Use Profile

Water consumption in the NWD cannot be quantified because they have no records on water production and water usage (unmetered connections).

In the absence of water accountability analysis, the present per capita consumption (0.120 $m^3/d$) that will be adopted will be based on the previous LWUA study of the adjacent Water District. Likewise, the accounted-for water and unaccounted-for water cannot be computed. However, the unaccounted-for water is believed to be high due to leakage in the transmission lines, and due to unmetered connections.

Judging from the NSO records, the average persons per household in the service area is 5.2. The present service area population of domestic connections is 6,910 while the population served is 2,950.

The present water demand of the NWD using the above assumptions is estimated at 472 $m^3/d$.

### 10.4.4 Population and Water Demand Projection

(1) Population Projection

The future population of the municipality of Naic and the barangays in the existing service area were projected by ratio method using historical population gathered from the National Statistics Office (NSO). An average growth rate of 3.04% is adopted in this study up to design year (2005). Thus, the year 2005 municipal population may reach 80,906.

The present service area includes four (4) barangays. The 1994 served population of these barangays total 2,950, which is 5.7% of the total municipal population. **Table 10.4-1**, **10.4-2A**, and **10.4-2B** show the population projection, served population and water demand projection.

The service area population in the design year (2005) is projected to reach 28,354 while the served population is expected to reach 23,003. The design-year (2005) served population and water demand projection is presented in **Table 10.4-2B**. **Fig. 10.4-3** shows the service area delineation.

(2) Water Demand Projection

- Domestic unit water consumption is estimated at 0.120 $m^3/d$ in proposed implementation year (1997) and 0.140 $m^3/d$ for the design year (2005) per person and an average of 5.2 person per household (NSO data).

- Commercial unit water consumption is estimated at 1.3 $m^3/d$ increasing to 1.5 $m^3/d$ in design year.

- Institutional unit water consumption is estimated at 3.0 $m^3$/connection/d to 5 m/connection/d in design year.

- unaccounted-for water is assumed to be 25% of the total water demand after project implementation.

Domestic connections are projected to reach 3,807 in 2005 while commercial and institutional connections are projected to reach 375 and 28 connections, respectively. **Table 10.4-2B** shows the number of connections for each category.

(3) Water Demand Variation

Presented below is the year 2005 water demand variation:

TABLE 10.4-1

POPULATION PROJECTION
NAIC WATER DISTRICT

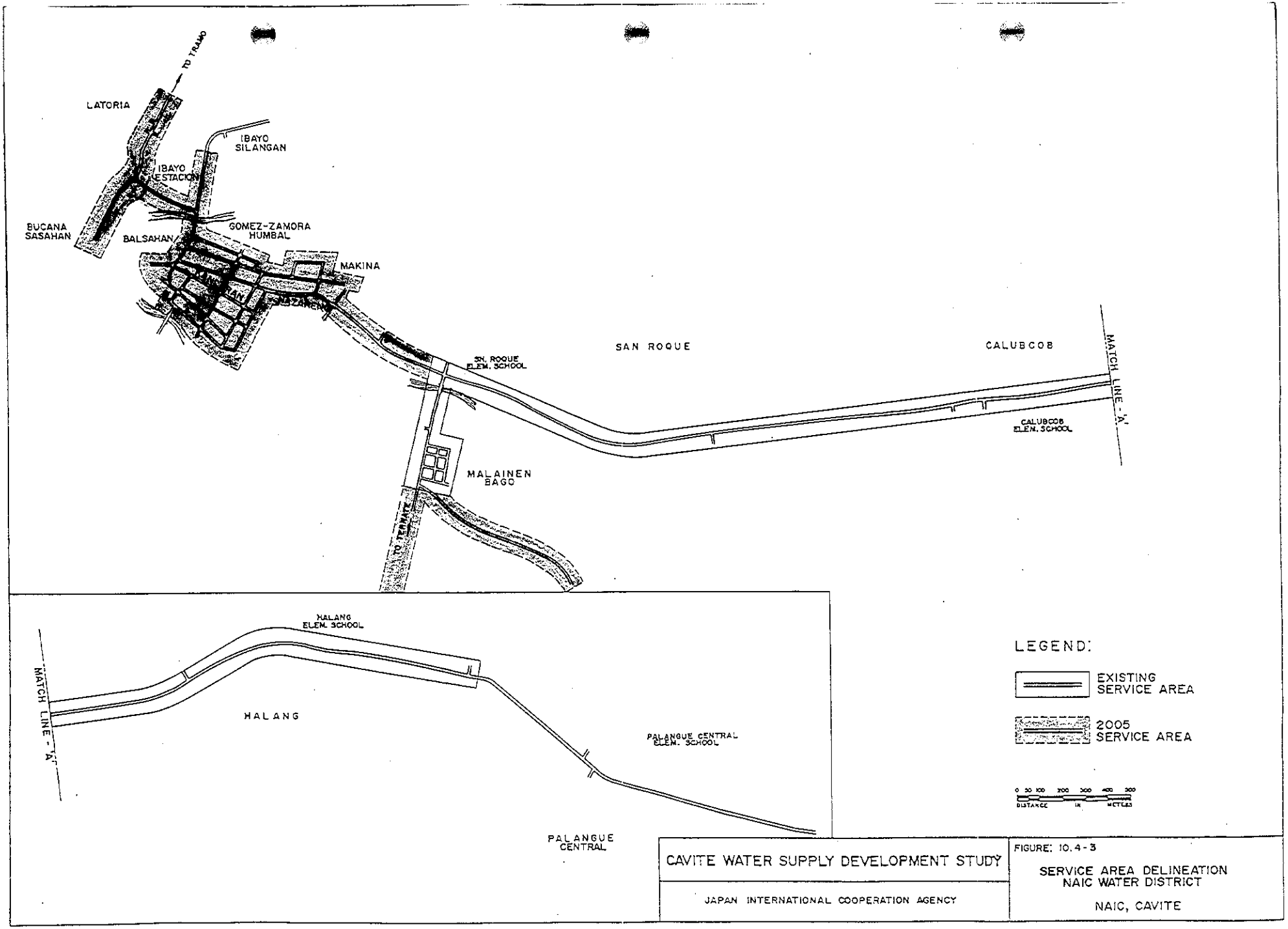
| Municipality/ Bgy. in the Service Area | Historical Population 1975 | 1980 | 1990 | Historical Growth Rates 1975-80 | 1980-90 | Projected Growth Rates 1990-2000 | 2000-2005 | Projected Population 1994 | 1998 | 2002 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NAIC | 32,130 | 38,243 | 51,629 | 3.54 | 3.05 | 3.04 | 3.04 | 58,199 | 65,606 | 73,954 | 80,906 |
| 1 BALSAHAN | 865 | 691 | 509 | -4.39 | -3.01 | 0.42 | 0.57 | 518 | 527 | 563 | 615 |
| 2 BUCANA-SASAHAN | 517 | 732 | 1,151 | 7.20 | 4.63 | 3.71 | 3.99 | 1,332 | 1,541 | 1,792 | 2,015 |
| 3 CALUBCOB | 371 | 477 | 721 | 5.15 | 4.22 | 3.54 | 3.73 | 829 | 952 | 1,099 | 1,226 |
| 4 CAPT. NAZARENO | 1,036 | 885 | 718 | -3.10 | -2.07 | 0.84 | 0.03 | 743 | 768 | 829 | 906 |
| 5 GOMEZ-ZAMORA | 954 | 1,173 | 1,024 | 4.22 | -1.35 | 2.45 | 2.23 | 1,128 | 1,243 | 1,364 | 1,457 |
| 6 HALANG | 1,294 | 1,471 | 1,901 | 2.60 | 2.60 | 2.85 | 2.77 | 2,127 | 2,380 | 2,659 | 2,886 |
| 7 HUMBAC | 597 | 591 | 847 | -0.20 | 3.66 | 2.86 | 2.78 | 948 | 1,061 | 1,186 | 1,288 |
| 8 IBAYO ESTACION | 904 | 1,162 | 1,907 | 5.15 | 5.08 | 3.72 | 4.00 | 2,207 | 2,554 | 2,971 | 3,342 |
| 9 IBAYO SILANGAN | 1,553 | 2,417 | 3,529 | 9.25 | 3.86 | 3.38 | 3.53 | 4,031 | 4,605 | 5,276 | 5,854 |
| 10 KANLURAN | 2,185 | 2,427 | 2,264 | 2.12 | -0.69 | 2.44 | 2.19 | 2,493 | 2,745 | 3,008 | 3,210 |
| 11 LATORIA | 654 | 927 | 1,345 | 7.23 | 3.79 | 3.36 | 3.49 | 1,535 | 1,751 | 2,004 | 2,221 |
| 12 MAKINA | 597 | 649 | 656 | 1.68 | 0.11 | 2.24 | 1.95 | 717 | 783 | 851 | 902 |
| 13 MALAINEN BAGO | 1,863 | 2,185 | 3,050 | 3.24 | 3.39 | 3.07 | 3.08 | 3,442 | 3,884 | 4,384 | 4,801 |
| 14 SAN ROQUE | 2,012 | 2,597 | 2,966 | 5.24 | 1.34 | 2.91 | 2.86 | 3,327 | 3,732 | 4,183 | 4,552 |
| Total | 15,402 | 18,384 | 22,588 | | | | | 25,376 | 28,527 | 32,169 | 35,275 |

TABLE 10.4-2A
1998 SERVED POPULATION AND WATER DEMAND PROJECTIONS
NAIC WATER DISTRICT

| | BARANGAY | BARANGAY POPULATION | SERVICE AREA POPULATION | DOMESTIC | | | COMMERCIAL | | | INSTITUTIONAL | | TOTAL | | | UNACCOUNTED-FOR WATER (cum/d) | AVERAGE DA DEMAND (cum/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Water Demand | No. of Conn. | Served Pop. | Water Demand | | |
| 1 | BALSAHAN | 527 | 448 | 27 | 150 | 18.0 | 5 | 29 | 6.8 | 0 | 1.3 | 33 | 179 | 26.1 | 8.9 | 35.0 |
| 2 | BUCANA-SASAHAN | 1,541 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | CALUBCOB | 952 | 762 | 87 | 481 | 57.7 | 10 | 52 | 12.4 | 1 | 2.3 | 97 | 533 | 72.4 | 24.6 | 97.0 |
| 4 | CAPT. NAZARENO | 768 | 614 | 37 | 204 | 24.5 | 8 | 42 | 10.0 | 1 | 1.8 | 45 | 246 | 36.3 | 11.7 | 48.0 |
| 5 | GOMEZ-ZAMORA | 1,243 | 995 | 60 | 330 | 39.6 | 12 | 68 | 16.2 | 1 | 3.0 | 73 | 398 | 58.8 | 19.2 | 78.0 |
| 6 | HALANG | 2,380 | 1,904 | 184 | 1,011 | 121.3 | 24 | 131 | 30.9 | 2 | 5.7 | 210 | 1,142 | 157.9 | 53.1 | 211.0 |
| 7 | HUMBAC | 1,061 | 849 | 51 | 282 | 33.8 | 11 | 58 | 13.8 | 1 | 2.5 | 62 | 340 | 50.1 | 16.9 | 67.0 |
| 8 | IBAYO ESTACION | 2,554 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 9 | IBAYO SILANGAN | 4,605 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 10 | KANLURAN | 2,745 | 2,196 | 132 | 727 | 87.2 | 27 | 151 | 35.7 | 2 | 6.6 | 162 | 878 | 129.5 | 43.5 | 173.0 |
| 11 | LATORIA | 1,751 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | MAKINA | 783 | 627 | 38 | 208 | 25.0 | 8 | 43 | 10.2 | 1 | 1.9 | 46 | 251 | 37.1 | 11.9 | 49.0 |
| 13 | MALAINEN BAGO | 3,884 | 3,107 | 187 | 1,029 | 123.5 | 39 | 214 | 50.5 | 3 | 9.3 | 229 | 1,243 | 183.3 | 60.7 | 244.0 |
| 14 | SAN ROQUE | 3,732 | 2,986 | 289 | 1,587 | 190.4 | 37 | 205 | 48.5 | 3 | 9.0 | 329 | 1,792 | 247.9 | 83.1 | 331.0 |
| | Total | 28,527 | 14,488 | 1,092 | 6,009 | 721.0 | 181 | 993 | 235.0 | 14 | 43.4 | 1,287 | 7,002 | 999.4 | 333.6 | 1,333.0 |

TABLE 10.4-2B
2005 SERVED POPULATION AND WATER DEMAND PROJECTIONS
NAIC WATER DISTRICT

| | BARANGAY | BARANGAY POPULATION | SERVICE AREA POPULATION | DOMESTIC | | | COMMERCIAL | | | INSTITUTIONAL | | TOTAL | | | UNACCOUNTED-FOR WATER (cum/d) | AVERAGE DAY DEMAND (cum/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Water Demand | No. of Conn. | Served Pop. | Water Demand | | |
| 1 | BALSAHAN | 615 | 523 | 65 | 358 | 50.1 | 6 | 34 | 8.0 | 1 | 1.6 | 72 | 392 | 59.7 | 20.3 | 80.0 |
| 2 | BUCANA-SASAHAN | 2,015 | 1,713 | 229 | 1,259 | 176.3 | 20 | 111 | 26.2 | 2 | 5.1 | 251 | 1,370 | 207.6 | 69.4 | 277.0 |
| 3 | CALUBCOB | 1,226 | 981 | 134 | 738 | 103.3 | 9 | 47 | 11.2 | 1 | 2.9 | 144 | 785 | 117.4 | 39.6 | 157.0 |
| 4 | CAPT. NAZARENO | 906 | 725 | 101 | 554 | 77.6 | 11 | 62 | 14.7 | 1 | 2.2 | 113 | 616 | 94.5 | 31.5 | 126.0 |
| 5 | GOMEZ-ZAMORA | 1,457 | 1,166 | 130 | 716 | 100.2 | 18 | 100 | 23.7 | 1 | 3.5 | 149 | 816 | 127.4 | 42.6 | 170.0 |
| 6 | HALANG | 2,886 | 2,309 | 328 | 1,804 | 252.6 | 29 | 159 | 37.5 | 2 | 6.9 | 359 | 1,963 | 297.0 | 99.0 | 396.0 |
| 7 | HUMBAC | 1,288 | 1,030 | 137 | 753 | 105.4 | 13 | 71 | 16.7 | 1 | 3.1 | 151 | 824 | 125.2 | 41.8 | 167.0 |
| 8 | IBAYO ESTACION | 3,342 | 2,674 | 396 | 2,177 | 304.8 | 42 | 230 | 54.3 | 3 | 8.0 | 440 | 2,407 | 367.1 | 121.9 | 489.0 |
| 9 | IBAYO SILANGAN | 5,854 | 4,683 | 665 | 3,659 | 512.3 | 59 | 322 | 76.1 | 5 | 14.0 | 728 | 3,981 | 602.4 | 200.6 | 803.0 |
| 10 | KANLURAN | 3,210 | 2,568 | 335 | 1,842 | 257.9 | 39 | 212 | 50.1 | 3 | 7.7 | 376 | 2,054 | 315.7 | 105.3 | 421.0 |
| 11 | LATORIA | 2,221 | 1,777 | 231 | 1,269 | 177.7 | 28 | 153 | 36.1 | 2 | 5.3 | 261 | 1,422 | 219.1 | 72.9 | 292.0 |
| 12 | MAKINA | 902 | 722 | 96 | 528 | 73.9 | 9 | 50 | 11.7 | 1 | 2.2 | 106 | 578 | 87.8 | 29.2 | 117.0 |
| 13 | MALAINEN BAGO | 4,801 | 3,841 | 476 | 2,617 | 366.4 | 48 | 264 | 62.4 | 4 | 11.5 | 528 | 2,881 | 440.3 | 146.7 | 587.0 |
| 14 | SAN ROQUE | 4,552 | 3,642 | 484 | 2,664 | 373.0 | 46 | 250 | 59.2 | 4 | 10.9 | 533 | 2,914 | 443.1 | 147.9 | 591.0 |
| | Total | 35,275 | 28,354 | 3,807 | 20,938 | 2,931.5 | 375 | 2,065 | 487.9 | 28 | 84.9 | 4,211 | 23,003 | 3,504.3 | 1,168.7 | 4,673.0 |




CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE: 10.4-3

SERVICE AREA DELINEATION
NAIC WATER DISTRICT

NAIC, CAVITE

| | |
|---|---|
| Average-day demand | 4,673 $m^3/d$ (54.1 lps) |
| Maximum-day demand | 6,075 $m^3/d$ (70.3 lps) |
| Peak-hour demand | 9,346 $m^3/d$ (108.2 lps) |

**Table 10.4-3** shows the annual water demand per type of connection and **Table 10.4-4** shows the annual water demand variations.

### 10.4.5 Analysis and Evaluation of Alternatives

(1) Considerations

The existing facilities that will be considered and incorporated in the recommended plan of the water supply system in the year 2005 are as follows;

1) Existing Water Supply System Facilities

The Naic Water District at present is being supplied by Banyo Spring. This spring will serve only Bgy. Halang in the design year (2005). Likewise, the transmission and distribution lines of this spring will be retained.

2) Additional Water Sources

The additional water sources that can be considered are surface water from the Labac and Balsahan Rivers and groundwater through deepwells.

Preliminary analysis showed that complete treatment of surface water from the two rivers would be very expensive due to the elaborate processes of treatment and the high cost of operation and maintenance needed to make the water potable. Therefore, surface water is not considered in this study.

Since only one spring (Banyo Spring) with significant discharge (4.3 lps) can be found in the area, additional water source/s through deepwell are considered in this study to meet the water requirements by the year 2005. Deepwells are considered to be the most reliable additional source of water supply for the future needs of the Naic Water District.

3) Pressure Zones

During the implementation of Phase I improvement (1997), the service area will be divided into two pressure zones. Pressure Zone I will be composed of Bgy. Halang, Bgy. Calubcob and part of Bgy. San Roque. These barangays will be serve by Banyo Spring. Pressure Zone No. II will be composed of barangays Nazareno, Makina, Humbac, Malainen Bago, Gomez-Zamora, Kanluran, and Balsahan. This will be served by Production well No. 1 and one additional well in Bgy. Malainen

TABLE 10.4-3

ANNUAL WATER DEMAND AND NUMBER OF CONNECTIONS
NAIC WATER DISTRICT

| YEAR | Domestic | | COMMERCIAL | | INSTITUTIONAL | | TOTAL | | UNACCOUNTED-FOR WATER (cumd) | AVERAGE DAY DEMAND (cumd) |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | | |
| 1994 | 558 | 354.0 | 0 | 0.0 | 0 | 0.0 | 558 | 354.0 | 118.0 | 472.0 |
| 1995 | 558 | 354.0 | 0 | 0.0 | 0 | 0.0 | 558 | 354.0 | 118.0 | 472.0 |
| 1996 | 558 | 354.0 | 0 | 0.0 | 0 | 0.0 | 558 | 354.0 | 118.0 | 472.0 |
| 1997 | 992 | 655.0 | 167 | 216.9 | 13 | 40.0 | 1172 | 911.9 | 304.1 | 1,216.0 |
| 1998 | 1,092 | 735.0 | 181 | 224.0 | 14 | 41.0 | 1287 | 1,000.0 | 333.0 | 1,333.0 |
| 1999 | 1,202 | 825.0 | 187 | 232.0 | 14 | 42.0 | 1403 | 1,099.0 | 369.0 | 1,468.0 |
| 2000 | 1,323 | 926.0 | 193 | 240.0 | 14 | 43.0 | 1530 | 1,209.0 | 408.0 | 1,617.0 |
| 2001 | 1,456 | 1,039.0 | 191 | 248.0 | 14 | 44.0 | 1661 | 1,331.0 | 460.0 | 1,791.0 |
| 2002 | 2,721 | 1,977.0 | 335 | 435.0 | 27 | 77.0 | 3083 | 2,489.0 | 871.0 | 3,360.0 |
| 2003 | 3,043 | 2,254.0 | 348 | 452.0 | 28 | 80.0 | 3419 | 2,786.0 | 965.0 | 3,751.0 |
| 2004 | 3,403 | 2,570.0 | 361 | 470.0 | 29 | 83.0 | 3793 | 3,123.0 | 1,064.0 | 4,187.0 |
| 2005 | 3,807 | 2,931.5 | 375 | 487.9 | 29 | 84.9 | 4211 | 3,504.3 | 1,168.7 | 4,673.0 |

TABLE 10.4-4

WATER DEMAND VARIATIONS
NAIC WATER DISTRICT

| YEAR | Average Day Demand (cumd | (L/s) | Maximum Day Demand (cumd) | (L/s) | Peak-Hour Demand (cumd | (L/s) |
|---|---|---|---|---|---|---|
| 1994 | 472 | 5.5 | 614 | 7.1 | 944 | 10.9 |
| 1995 | 472 | 5.5 | 614 | 7.1 | 944 | 10.9 |
| 1996 | 472 | 5.5 | 614 | 7.1 | 944 | 10.9 |
| 1997 | 1,216 | 14.1 | 1,581 | 18.3 | 2,432 | 28.1 |
| 1998 | 1,333 | 15.4 | 1,733 | 20.1 | 2,666 | 30.9 |
| 1999 | 1,468 | 17.0 | 1,908 | 22.1 | 2,936 | 34.0 |
| 2000 | 1,617 | 18.7 | 2,102 | 24.3 | 3,234 | 37.4 |
| 2001 | 1,791 | 20.7 | 2,328 | 26.9 | 3,582 | 41.5 |
| 2002 | 3,360 | 38.9 | 4,368 | 50.6 | 6,720 | 77.8 |
| 2003 | 3,751 | 43.4 | 4,876 | 56.4 | 7,502 | 86.8 |
| 2004 | 4,187 | 48.5 | 5,443 | 63.0 | 8,374 | 96.9 |
| 2005 | 4,673 | 54.1 | 6,075 | 70.3 | 9,346 | 108.2 |

Bago. In design year 2005, Pressure Zone I will be limited to Bgy. Halang alone, while Pressure Zone II will have additional barangays such as Latoria, Bucana Sasahan, Ibayo Estacion, Ibayo Silangan, Calubcob and the whole area of San Roque.

4) Storage Location

Location of storage is influenced by the demand in the service area. Preliminary analysis showed that the most ideal location of the proposed reservoir is in Bgy. Calubcob. However, to reduce the cost in Phase I Improvement, the storage requirement is divided into two. One is to be constructed in Bgy. Malainen Bago in Phase I and the other is to be constructed in Bgy. Calubcob in Phase II Improvement.

5) Design Criteria

- Parameters for Additional Sources

The following well parameters were established for purposes of cost analysis of schemes requiring additional sources.

| | | |
|---|---|---|
| Depth | : | 150 m |
| Borehole Diameter | : | 350 mm |
| Casing Diameter | : | 200/150 mm |
| Screens | : | 150 mm stainless steel |
| Expected Yield | : | 20–25 lps |
| Expected SWL | : | 10–20 mbgl |
| Expected PWL | : | 50–60 mbgl |

- Distribution System

The distribution system will be mainly laid along the National Highway and in the streets of the municipality. The pipe network layout is generally influenced by the existing roadways and the area to be served while the pipe size configuration is designed at peak–hour condition.

To minimize cost, the pipelines of the old system are considered in this study. However, some are to be provided with parallel lines to meet the hydraulic design requirements.

- Demand Ratios

The projected water demands of Naic for the design year (2005) are 6,075 $m^3/d$ and 9,346 $m^3/d$ for maximum–day and peak–hour demand, respectively.

- Storage requirements

  During peak-hour water demand conditions and whenever the production capacity of the sources is less than the demand of the system, additional water supply will be provided by the reservoir. Generally the volume of storage must be sufficient to meet the operational, emergency and firefighting reserve requirements. **Table 10.4-5** shows the storage capacity requirement of the system up to the year 2005.

  The reservoir will be constructed at an elevation such that the required minimum pressure in the distribution system is satisfied.

- System Pressure

  The minimum pressure head to be adopted in the system is 7 m while the maximum is 70 m. The systems pipe network is designed to conform with the pressure requirement even during peak-hour conditions.

- Fire Protection

  Full fire protection will be provided to the entire service area by the year 2005. Fire hydrants should be placed strategically in the distribution system. Likewise, the emergency storage requirements should also be considered.

- Flow Velocity in the Distribution System

  The flow velocity in the distribution system is limited to a maximum of 3 m/s at all times and a minimum of 0.3 m/s. However, in order to obtain a good pressure distribution system in all parts of the service area, it was necessary to allow a velocity flow less than this minimum.

- Computer Analysis

  Pipe sizes were designed for peak-hour demand conditions and only pipes with diameters 50 mm and above were included in the analyses. Likewise, pump design is based on hydraulic analysis result during maximum-day demand.

- Common Items

  To simplify the evaluation of alternatives, items common to the alternatives considered such as valves, hydrants, service connections and other appurtenances were not included in the analysis.

TABLE 10.4.5
STORAGE REQUIREMENT
NAIC WATER DISTRICT

| YEAR | Max Day Demand (cumd) | Served Population | Emergency Storage Requirement (cum) | Operational Storage Requirement | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Max-day (cum) | ID-1.33 (cum) | ID-1.2 (cum) | ID-1.10 (cum) | PKD (cum) |
| 1998 | 545.0 | 7,002 | 45 | 103 | 46 | 50 | 85 | 29 |
| 1999 | 769.1 | 8,299 | 64 | 143 | 63 | 68 | 118 | 39 |
| 2000 | 1,085.4 | 9,836 | 90 | 198 | 85 | 92 | 162 | 52 |
| 2001 | 1,531.7 | 11,658 | 127 | 275 | 116 | 125 | 225 | 69 |
| 2002 | 2,161.6 | 13,817 | 179 | 381 | 157 | 170 | 310 | 93 |
| 2003 | 3,050.5 | 16,376 | 254 | 529 | 214 | 232 | 429 | 124 |
| 2004 | 4,304.9 | 19,408 | 358 | 734 | 291 | 315 | 593 | 166 |
| 2005 | 6,075.0 | 23,003 | 506 | 1,017 | 396 | 428 | 820 | 222 |

Operational Storage Requirement

| Supply rate | Storage Volume | Pump Hours |
|---|---|---|
| MD | (0.224 - (0.0416 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 24 |
| ID-1.33 | (0.114 - (0.0359 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 18 |
| ID-1.20 | (0.125 - (0.0400 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 20 |
| ID-1.10 | (0.190 - (0.0406 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 22 |
| PKH | (0.082 - (0.0336 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 16 |

Emergency Storage Requirement :

2 hours of Max-day demand

(2) Development of Alternatives

No alternative for source evaluation was made. Likewise, Pressure Zone I will utilize Banyo Spring up to the design year. In Pressure Zone II, groundwater through additional wells were considered as capable of meeting the increasing demand in the service area. Additional wells are expected to meet the supply requirement of the system up to the year 2005. Therefore, the alternatives were concentrated in Pressure Zone II.

Optimization of source/s versus storage analysis is necessary to determine the most economical system for Naic Water District. Since all the wells are proposed to be drilled within the service area, transmission lines cost were not included in the cost estimates for each alternative. The following alternatives will give insight to each proposal for the improvement of the system.

1) Alternative 1 – Maximum Day Supply with Maximum Storage

This alternative will utilize Production well No. 1 and construction of one additional well to meet the demand in the system. The wells shall be equipped with 50 Hp turbine pumps and electric motor drives.

A 1,523 $m^3$ elevated steel tank shall be constructed.

**Table 10.4–5 and Fig. 10.4–4A** presents the details of this alternative.

2) Alternative 2 – 1.20 MDD Supply with Intermediate Storage

This alternative proposes to utilize the Production well and construction of two additional wells to meet the demand in the system. The wells will be equipped with a 50 Hp and two 40 Hp turbine pumps and motors, respectively.

A 934 $m^3$ elevated steel tank is to be constructed to meet the storage requirement of this alternative.

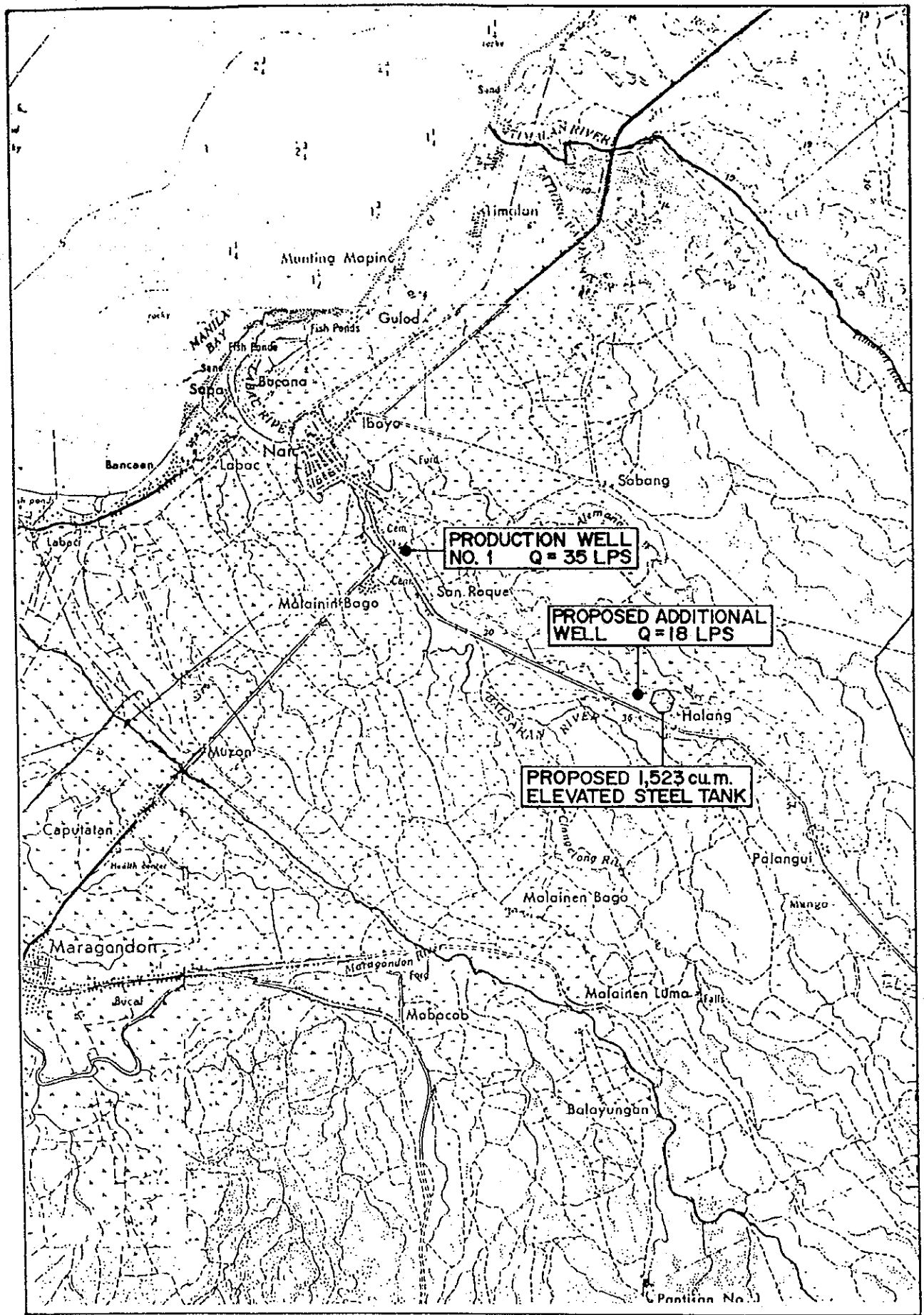
**Table 10.4–5 and Fig. 10.4–4B** presents the details of this alternative.

3) Alternative 3 – 1.33 MDD Supply with Intermediate Storage

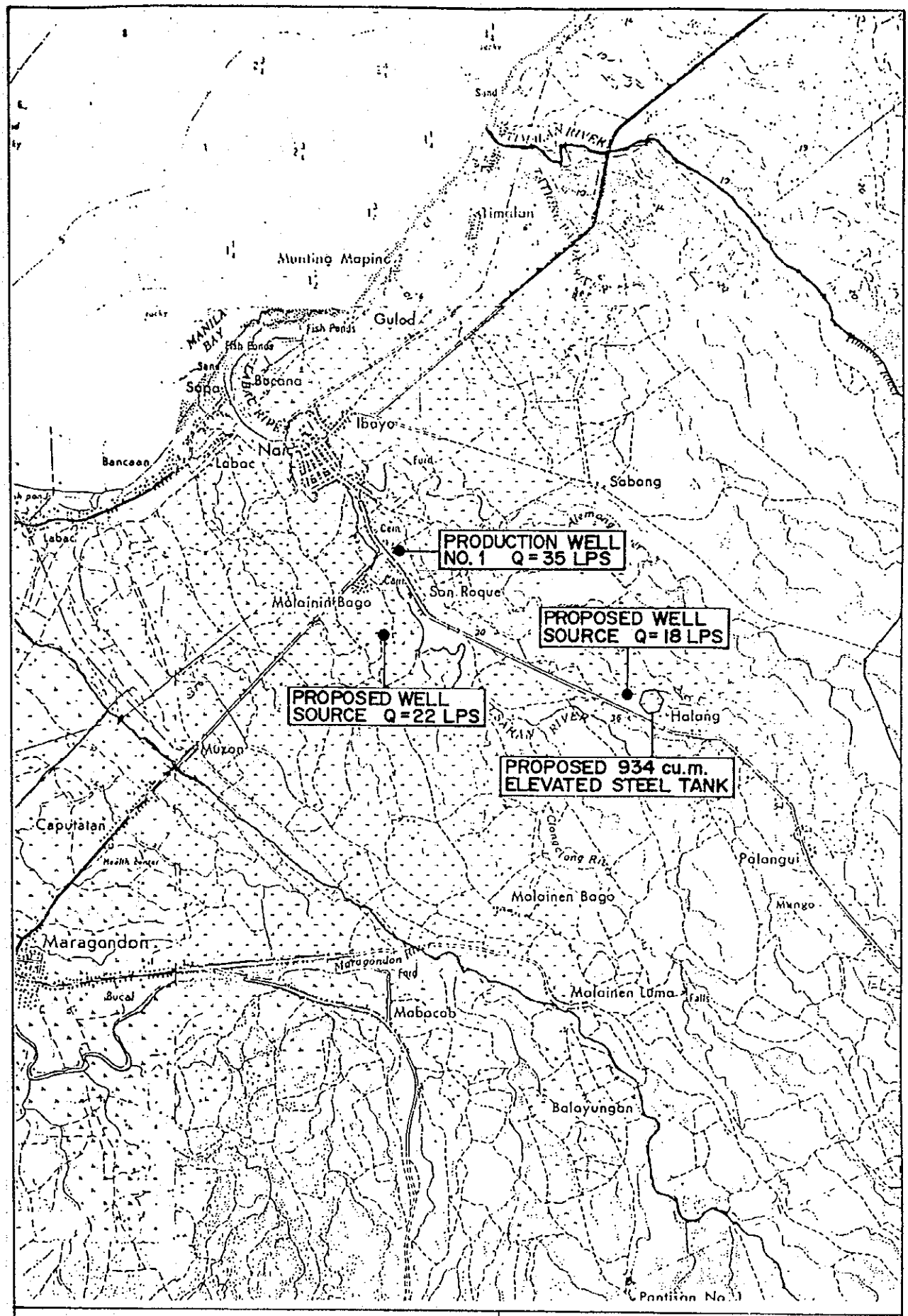
This alternative proposes the construction of two additional deepwells to meet the supply rate required. Production well No. 1 will be equipped with a 50 Hp pump and motor and the additional two wells will be equipped with 40 Hp pumps and motors each.

An elevated steel tank with a volume of 902 $m^3$ will be constructed.

**Table 10.4–5 and Fig. 10.4–4C** presents the details of this alternative.




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.4-4A<br>ALTERNATIVE - I<br>MAX-DAY SUPPLY WITH MAXIMUM STORAGE<br>NAIC |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

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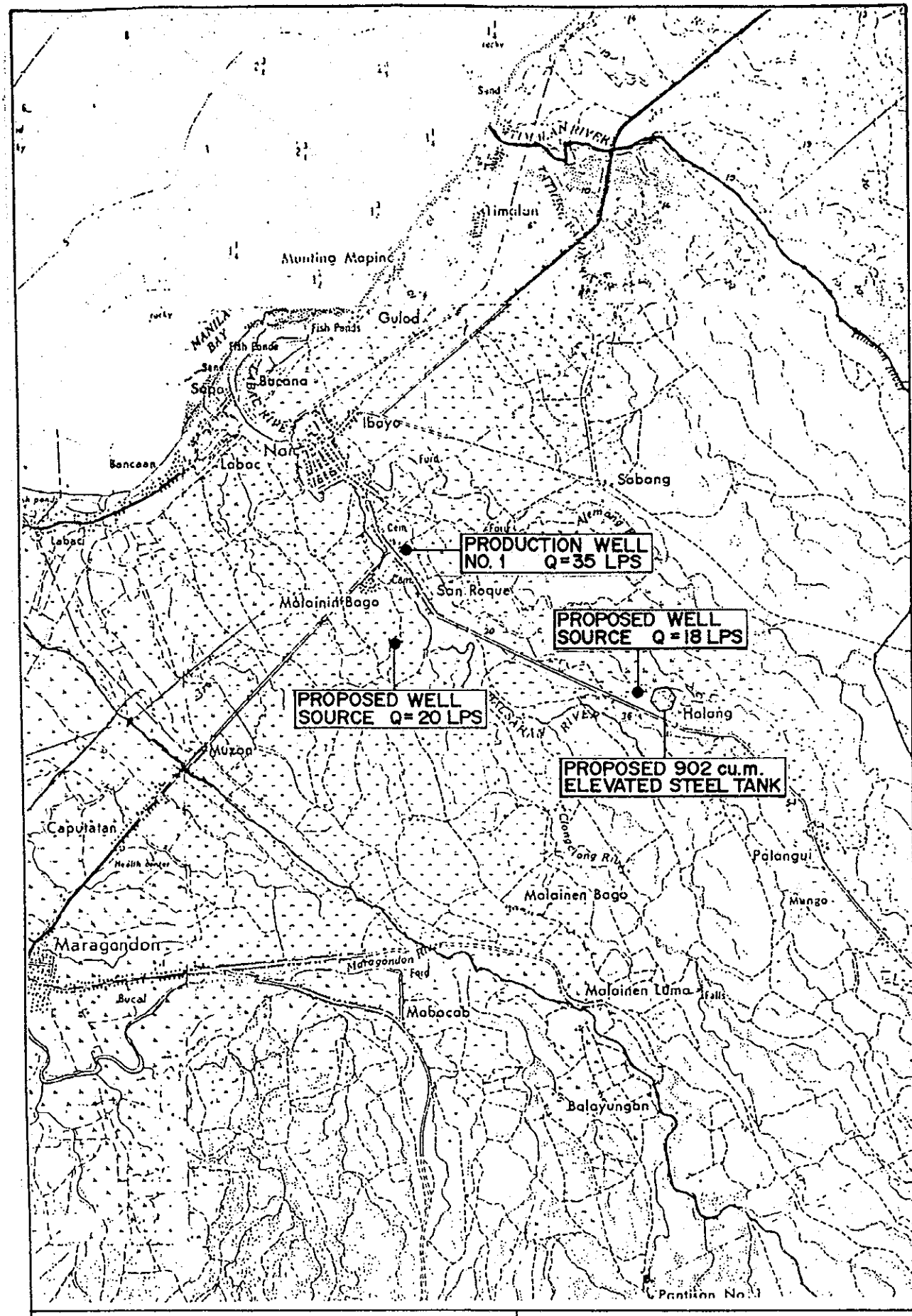
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.4 – 48<br>ALTERNATIVE - II<br>1.20 MDD SUPPLY WITH INTERMEDIATE STORAGE<br>NAIC |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.4-4C<br>ALTERNATIVE - III<br>1.33 MDD SUPPLY WITH INTERMEDIATE STORAGE<br>NAIC |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

4) Alternative 4 – Peak-Hour Supply Rate with Minimum Storage

This alternative proposes the construction of three additional wells. Production Well No. 1 will be equipped with a 50 Hp pump and motor while the three additional wells will be equipped with individual 30 Hp pumps and motors.

An elevated steel tank with a volume of 728 $m^3$ will be constructed to meet the storage requirement.

**Table 10.4-6 and Fig. 10.4-4D** presents the details of this alternative.

(3) Evaluation of Alternatives

Each of the alternatives was evaluated based on construction cost at 1994 price level.

The following table summarizes the cost of each alternative.

| | Cost (P) |
|---|---|
| Alternative 1 | 22,757,898.00 |
| Alternative 2 | 17,139,233.00 |
| Alternative 3 | 16,723,233.00 |
| Alternative 4 | 16,239,469.00 |

Evaluation of the alternatives vis-a-vis the pump capacities shows that their rating differ only by 10 Hp which when analyzed will show a very small effect in energy costs. Alternative 4 being the least-cost alternative, is recommended for the improvement of the NWD Water Supply System.

### 10.4.6 Recommended Plan

(1) Description of the Scheme

The recommended scheme for the proposed improvement on the water supply system of Naic Water District is to be implemented in two phases. Phase I is to be implemented in the year 1996-1997, while Phase II follows in the year 2000-2001.

The service area will be divided into two pressure zones. Pressure Zone I will be comprised of Bgy. Halang, Bgy. Calubcob, and half of Bgy. San Roque. This will be supplied by Banyo Spring. However, during Phase II, Pressure Zone I will serve only Bgy. Halang. Pressure Zone II will serve Bgys. Malainen Bago, Nazareno, Gomez-Zamora, Makina, Humbac, Kanluran, Balsahan and half of Bgy. San Roque. This will be served by JICA test well No. 1 and one additional well. However, during Phase II it will be expanded to cover

TABLE 10.4-6
Cost Comparison of Alternatives
Naic Water District

Alternative 1 - MDD Supply with maximum Storage

| Facilities | Construction Cost (P) |
|---|---|
| Deepwell Construction (150 m) | 1,500,000.00 |
| 2 sets 50 HP Pump and Motor | 1,458,898.00 |
| Elevated Steel Tank V= 1,523 cum | 19,799,000.00 |
| P | 22,757,898.00 |

Alternative 2 - 1.20 MDD Supply with Intermediate Storage

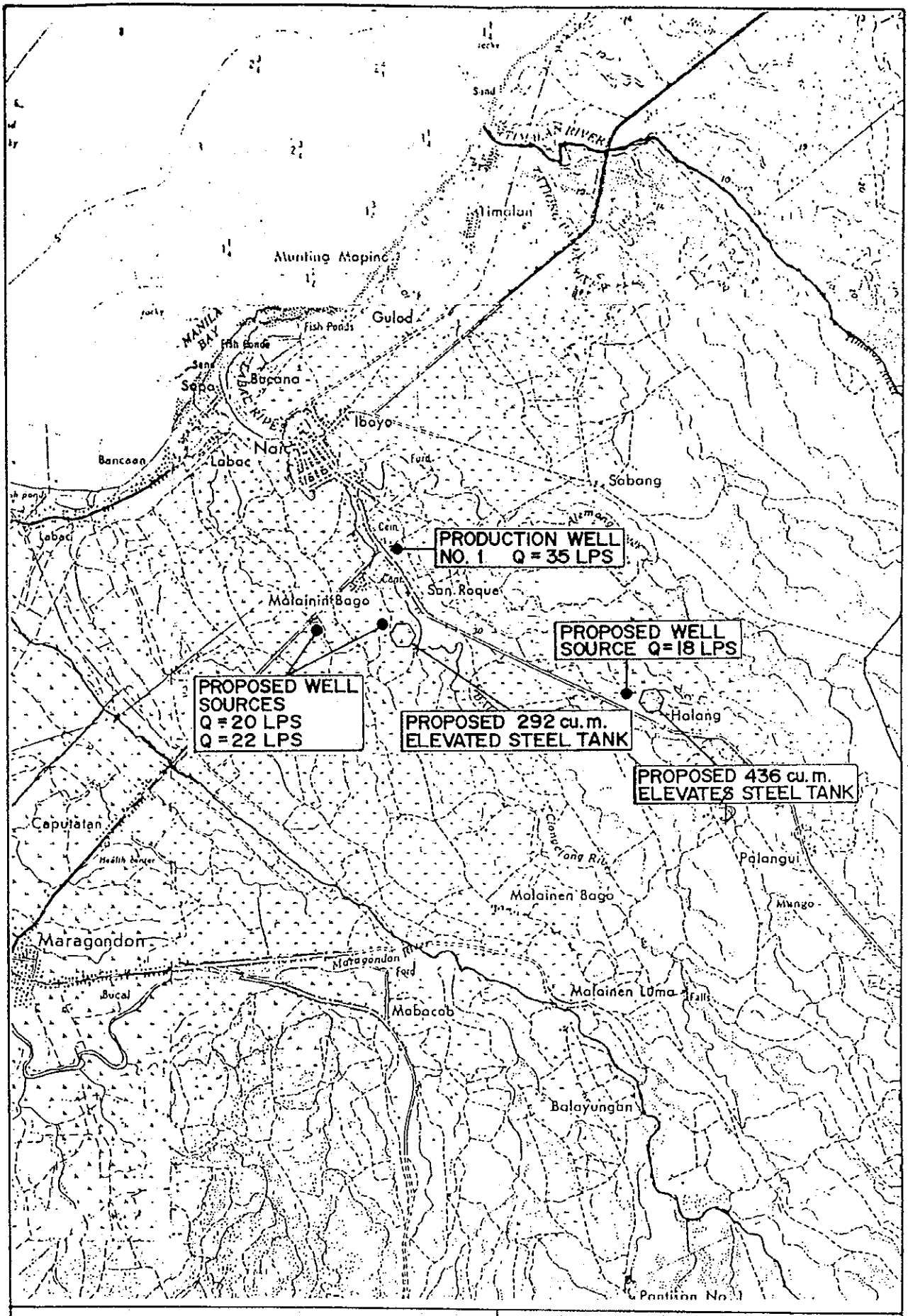
| Facilities | Construction Cost (P) |
|---|---|
| Construction of two deepwells (150 m each) | 3,000,000.00 |
| 1 set 50 HP Pump and Motor | 729,449.00 |
| 2 sets 40HP Pump and Motor | 1,267,784.00 |
| Elevated Steel Tank V= 934 cum | 12,142,000.00 |
| P | 17,139,233.00 |

Alternative 3 - 1.33 MDD Supply with Intermediate Storage

| Facilities | Construction Cost (P) |
|---|---|
| Construction of two deepwells (150 m each) | 3,000,000.00 |
| 1 set 50 HP Pump and Motor | 729,449.00 |
| 2 sets 40 HP Pump and Motor | 1,267,784.00 |
| Elevated Steel Tank V= 902 cum | 11,726,000.00 |
| P | 16,723,233.00 |

Alternative 4 - Peak Supply and Minimum Storage

| Facilities | Construction Cost (P) |
|---|---|
| Construction of three deepwells (150 m each) | 4,500,000.00 |
| 1 set 50 HP Pump and Motor | 729,449.00 |
| 3 sets 30 HP Pump and Motor | 1,546,020.00 |
| Elevated Steel Tank V= 728 cum | 9,464,000.00 |
| P | 16,239,469.00 |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.4 - 4D<br>ALTERNATIVE - IV<br>PEAK HOUR SUPPLY RATE<br>WITH MINIMUM STORAGE |
| JAPAN INTERNATIONAL COOPERATION AGENCY | NAIC |

Bgys. Latoria, Ibayo Estacion, Bucana Sasahan, Ibayo Silangan, Calubcob and the whole of Bgy. San Roque.

**Fig. 10.4-5** shows the relationship between water supply and demand when the recommended plan shall be implemented.

The proposed water supply system for Phase I and II is shown in **Fig. 10.4-6** and **10.4-7**. The computer print-out of the hydraulic analysis of the system and the schematic diagram of the distribution system are presented in the supporting document.

(2) Proposed Facilities

The recommended plan for the Naic Water District water supply system is scheduled to be implemented in two stages, Phase I and Phase II. The proposed facilities of Phase I improvement are as follows:

1) Laying 8.378 km of distribution lines.

2) Installation of 31 gate valves and 9 units of fire hydrants.

3) Construction of one additional deepwell with 20 lps capacity. The preliminary well design for the proposed well is shown in **Fig. 10.4-8.**

4) Provision of electro-mechanical facilities and housing the proposed deepwell.

5) Construction of a 292 $m^3$ elevated reservoir.

6) Installation of 1,060 service connections.

7) Installation of hypochlorinator in the two proposed sources.

8) Provision of plumbing tools and office equipment.

9) Land acquisition (500 $m^2$)

The proposed facilities for Phase II are as follows:

1) Laying 5.34 km of distribution lines.

2) Installation of 3 gate valves and 5 units of fire hydrants.

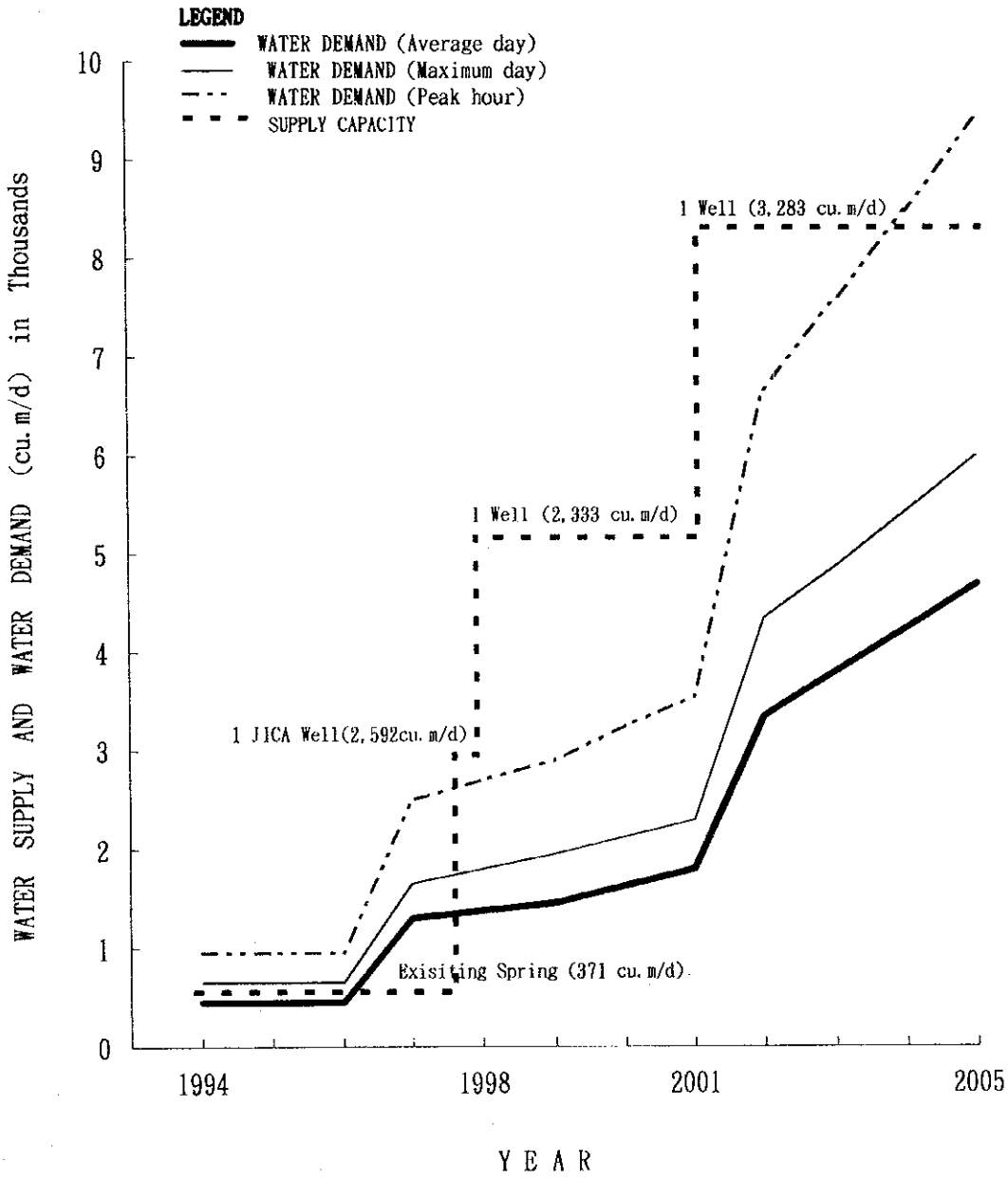
3) Construction of two additional deepwell with a 20 lps capacity. Preliminary well design for proposed well is shown in **Fig. 10.4-8**.

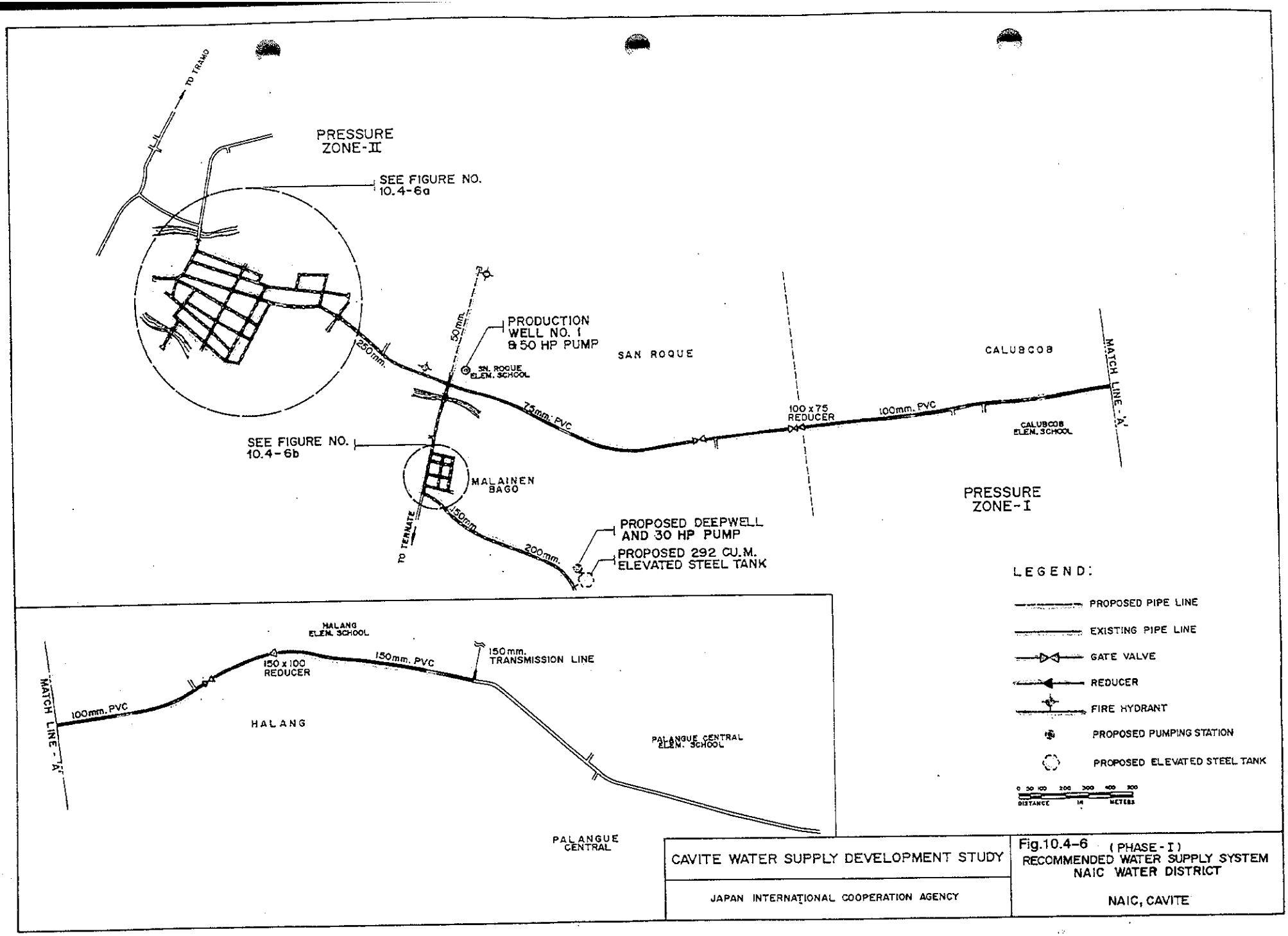
4) Provision of housing and electro-mechanical facilities in the two additional sources.

5) Construction of a 436 $m^3$ elevated steel tank.

Fig. 10.4-5

WATER SUPPLY VS DEMAND CURVE OF RECOMMENDED PLAN
NAIC






CAVITE WATER SUPPLY DEVELOPMENT STUDY

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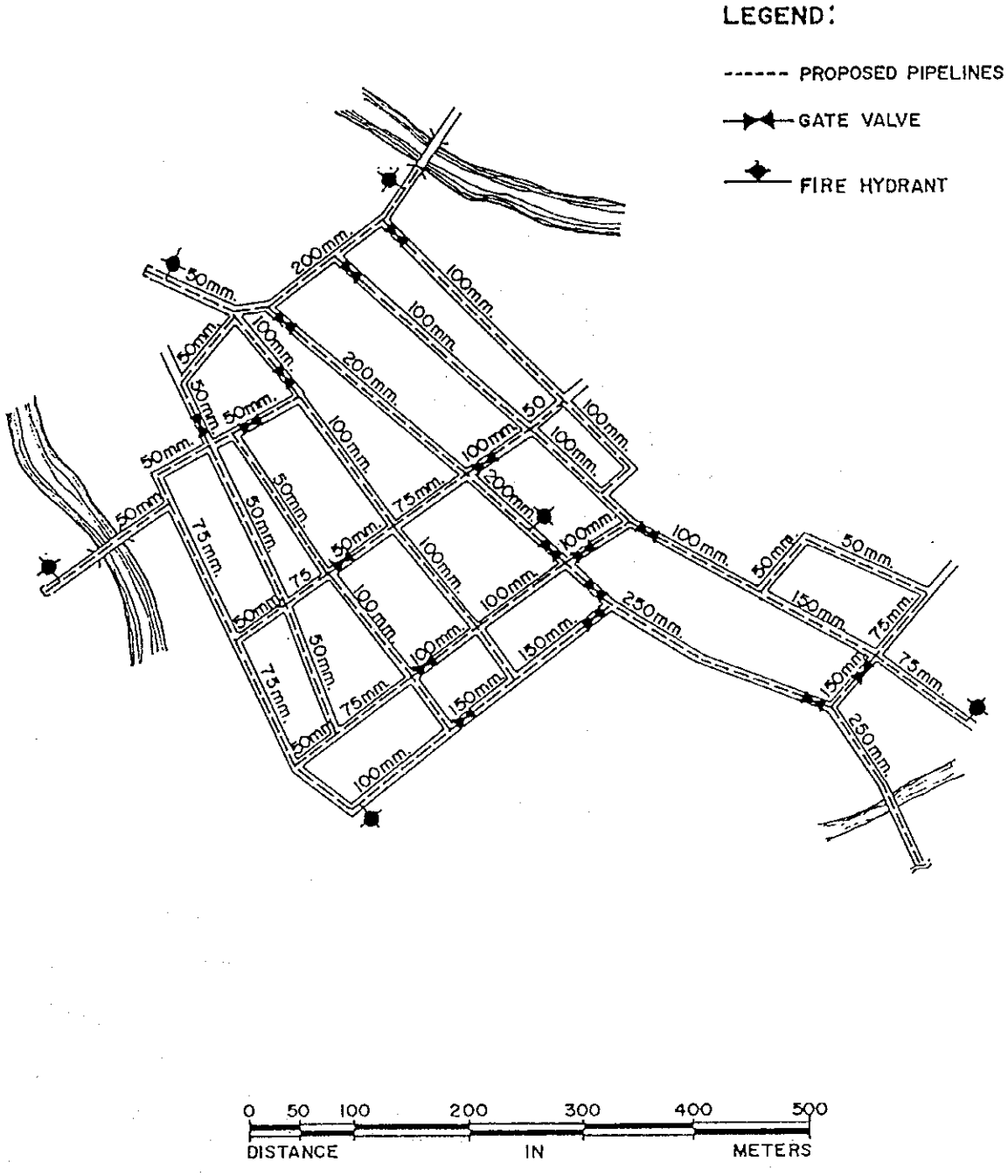
Fig.10.4-6 (PHASE-I)
RECOMMENDED WATER SUPPLY SYSTEM
NAIC WATER DISTRICT

NAIC, CAVITE




CAVITE WATER SUPPLY DEVELOPMENT STUDY

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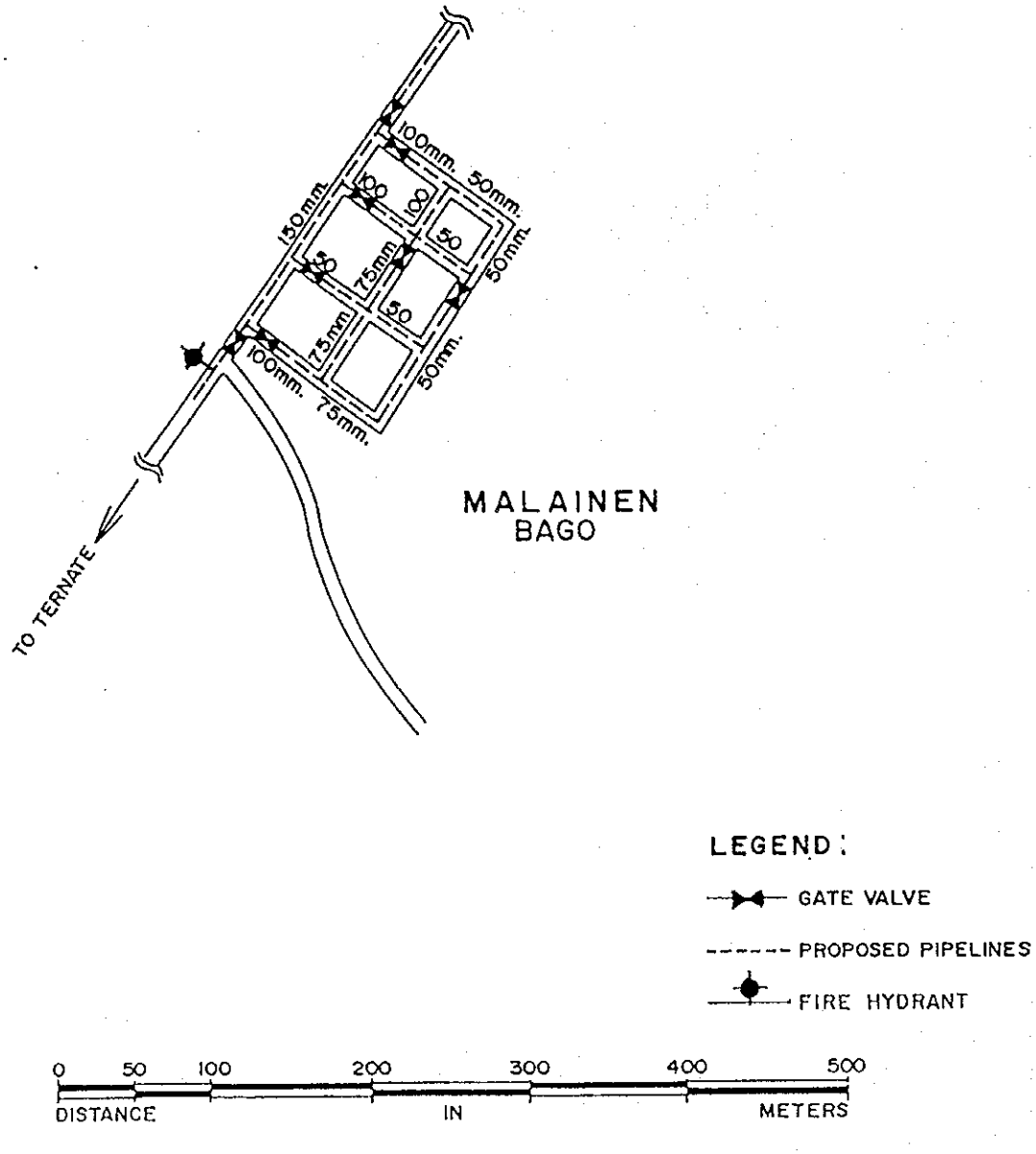
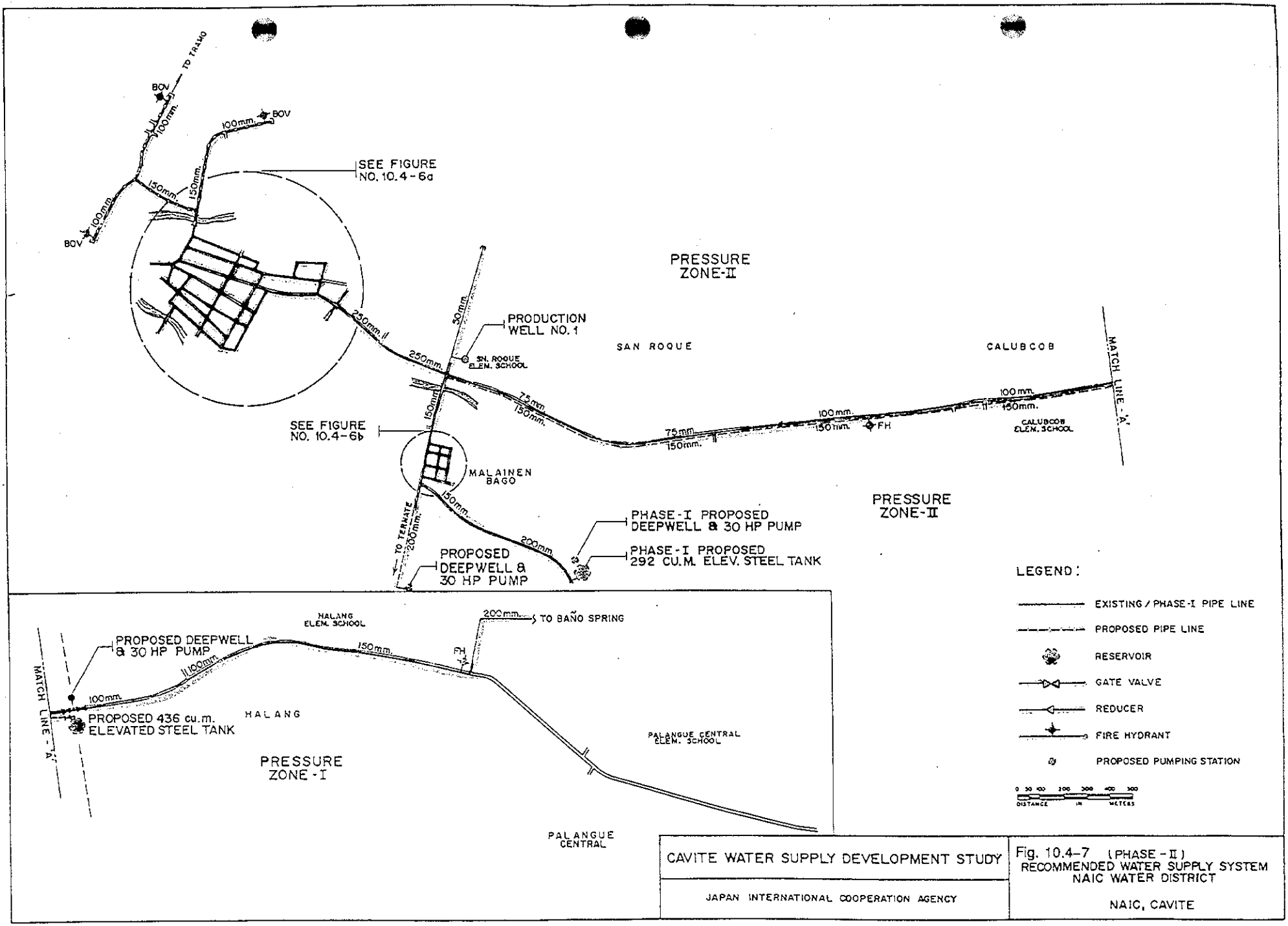
Fig. 10.4-6A
( PHASE - I )
RECOMMENDED WATER SUPPLY SYSTEM
NAIC WATER DISTRICT
NAIC, CAVITE




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | Fig. 10.4-6B (PHASE - I) RECOMMENDED WATER SUPPLY SYSTEM NAIC WATER DISTRICT |
| JAPAN INTERNATIONAL COOPERATION AGENCY | NAIC, CAVITE |

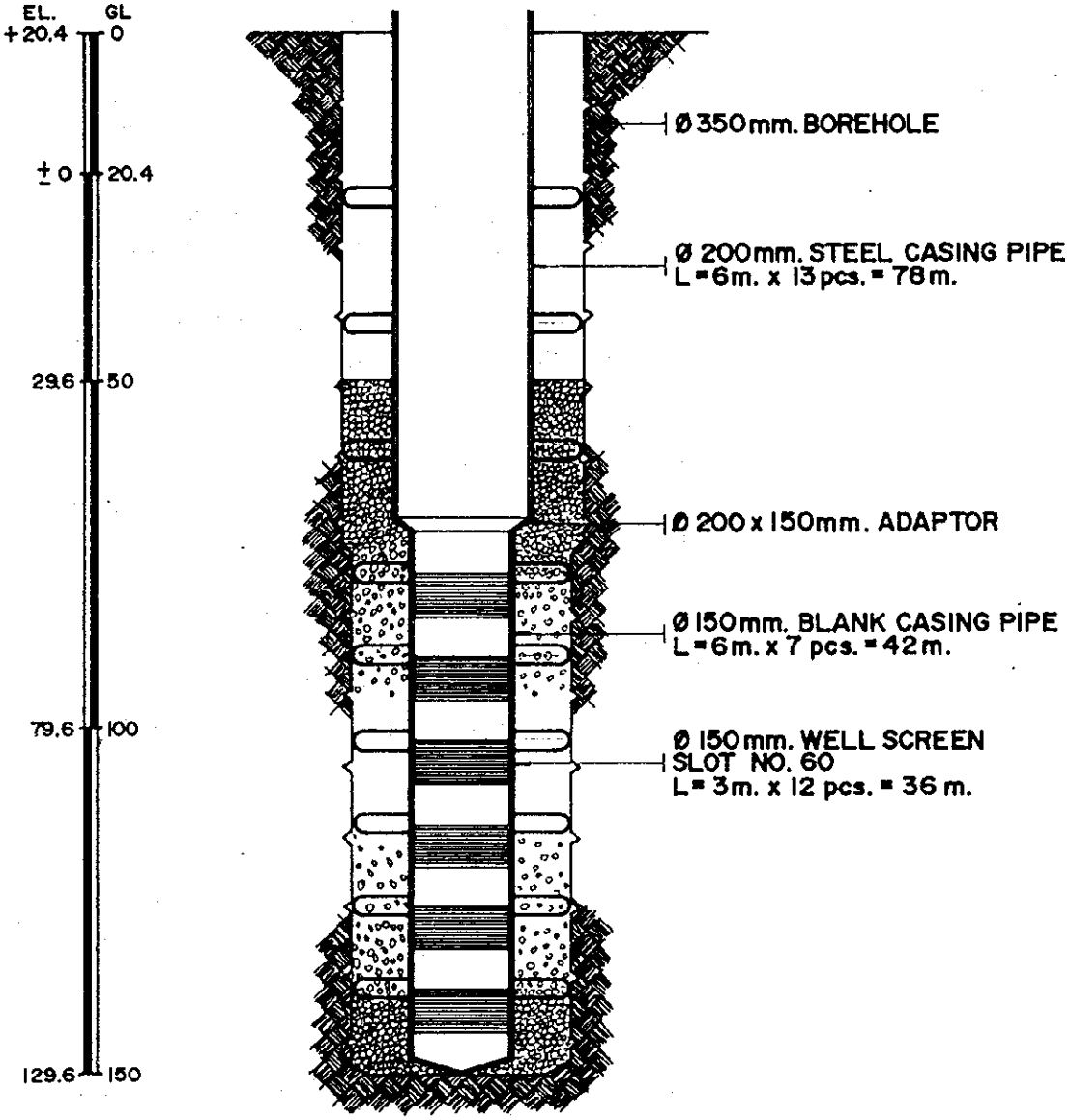



CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 10.4-7 (PHASE-II)
RECOMMENDED WATER SUPPLY SYSTEM
NAIC WATER DISTRICT

NAIC, CAVITE




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | Fig.10.4-8 |
| JAPAN INTERNATIONAL COOPERATION AGENCY | PRELIMINARY WELL DESIGN PROPOSED WELL NO. 2, 3 AND 4 NAIC |

6) Installation of 1422 service connections.

7) Installation of two hypochlorinator in the proposed additional deepwell source.

8) Land acquisition (400 $m^2$).

(3) Operation and Maintenance

In Phase I, Pressure Zone I will be served by Banyo Spring from Bgy. Halang up to half of Bgy. San Roque. Pressure Zone II will be served by Production well No. 1 and Malainen proposed well. The 292 $m^3$ reservoir will serve on a fill-and draw method using the proposed Malainen well. The water system is designed to operate on a 24 hour period daily.

Water from the two deepwells will be treated with chlorine using hypochlorinators. Blow-off valves were provided in pipeline extremities for flushing purposes.

## 10.5 WATER SUPPLY PLAN FOR TAGAYTAY CITY

### 10.5.1 Existing Water Supply System Facilities

The Tagaytay City Water District (TC-WD) is operating the water system in the city of Tagaytay, which covers fifteen (15) barangays.

The facilities include three (3) springs with intake boxes, pumping stations, storage facilities, disinfection facility and pipeline as indicated in **Fig. 10.5-1A, 10.5-1B** and **10.5-1C**.

(1) Source Facilities

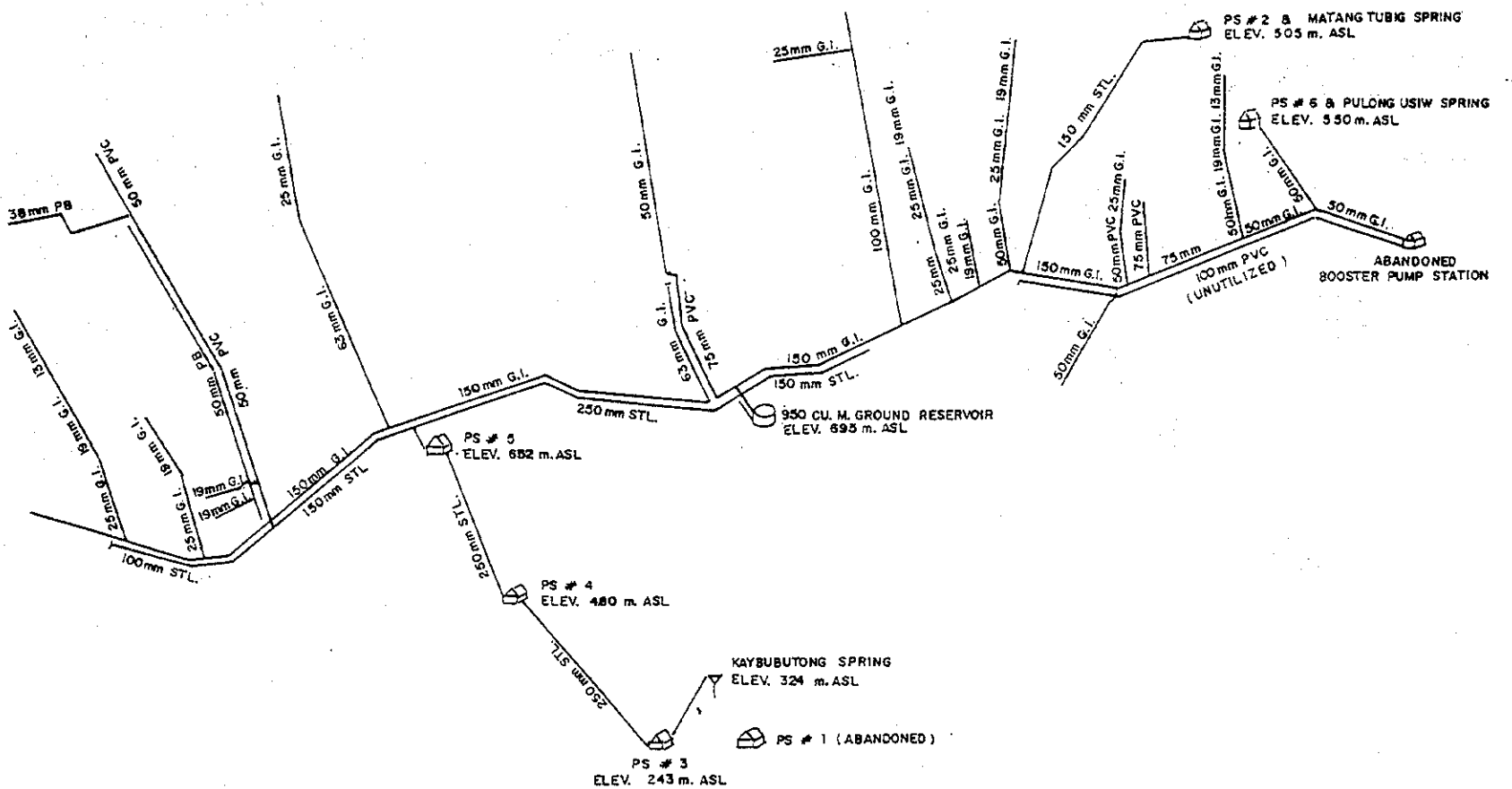
The TC-WD derives its water from three (3) spring sources which are provided with booster pumping stations. These springs are Kaybubutong, Matang Tubig and Pulong Usiw Springs.

1) Kaybubutong Spring

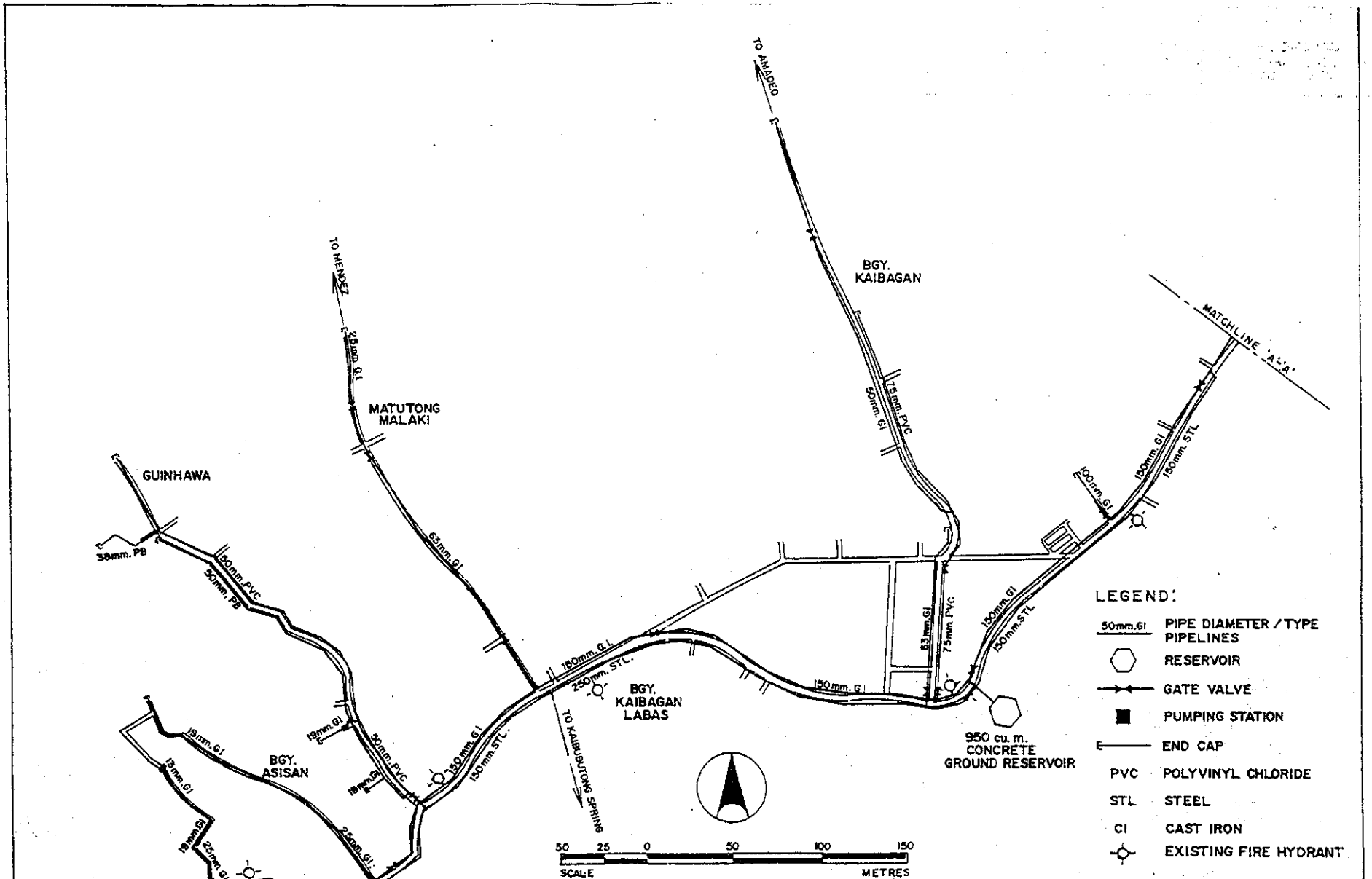
Kaybubutong Spring is located in Bgy. Sambong, approximately 1 km south of Tagaytay-Mendez crossing at an elevation of about 324 masl. This spring has a discharge of 168.4 lps. However, only 32.52 lps is being utilized due to the limited pump rated capacity. It flows by gravity to the sump tank of the first of a series of three (3) booster pumping stations (BPS) provided for this spring.

2) Matang Tubig Spring

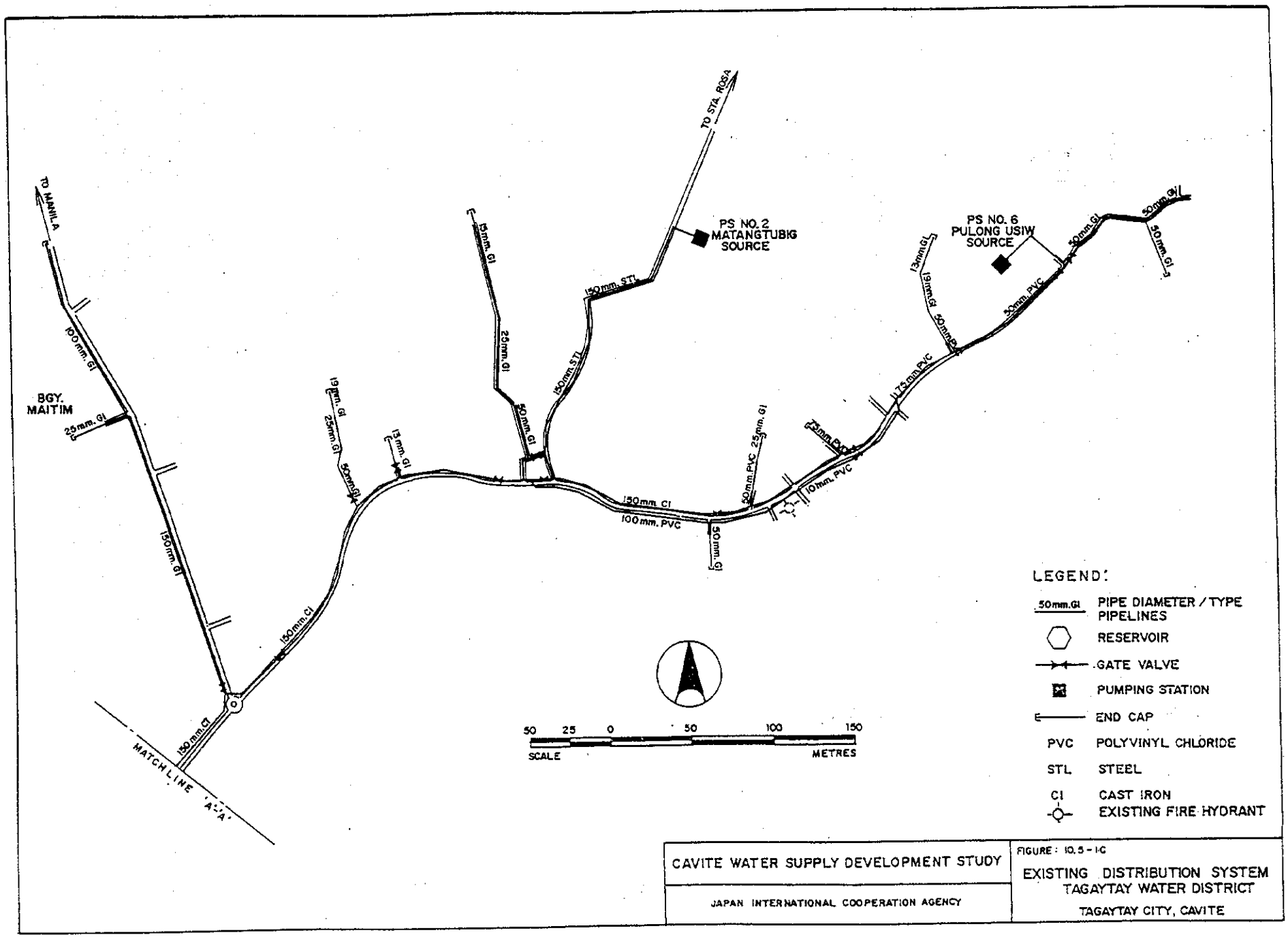
Matang Tubig Spring is located in Bgy. San Francisco, about 6.5 km northeast of Tagaytay-Mendez crossing, at an elevation of about 550 masl. The spring has a discharge of 8.16 lps.




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE : 10.5 - 1A SCHEMATIC DIAGRAM EXISTING WATER SUPPLY SYSTEM TAGAYTAY WATER DISTRICT |
| JAPAN INTERNATIONAL COOPERATION AGENCY | TAGAYTAY CITY, CAVITE |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.5-18 |
| JAPAN INTERNATIONAL COOPERATION AGENCY | EXISTING DISTRIBUTION SYSTEM TAGAYTAY WATER DISTRICT TAGAYTAY CITY, CAVITE |




CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE : 10.5 - 1C

EXISTING DISTRIBUTION SYSTEM
TAGAYTAY WATER DISTRICT

TAGAYTAY CITY, CAVITE

3) Pulong Usiw Spring

Pulong Usiw Spring is located in Bgy. Iruhin West, about 8.4 km northeast of Tagaytay–Mendez crossing, at an elevation of 550 masl. The spring has a measured discharge of 0.89 lps. Water from the spring flows to a sump tank and is pumped by BPS No. 6 directly to the distribution system.

(2) Pumping Stations

1) Booster Pumping Station (BPS) No. 2

BPS No. 2 is located adjacent to the sump tank of Matang Tubig Spring. The pumping station is equipped with a vertical turbine pump driven by a 40 Hp electric motor. Water from the spring is being pumped directly to the distribution system with an average rate of about 11.35 lps as measured in the flowmeter. The plan of existing pumping station No. 2. is shown in **Fig. 10.5–2.**

BPS No. 2 is also equipped with a 50 Hp stand–by diesel engine. It is still operable but not presently utilized even during power failures due to low efficiency.

2) Booster Pumping Station No. 3

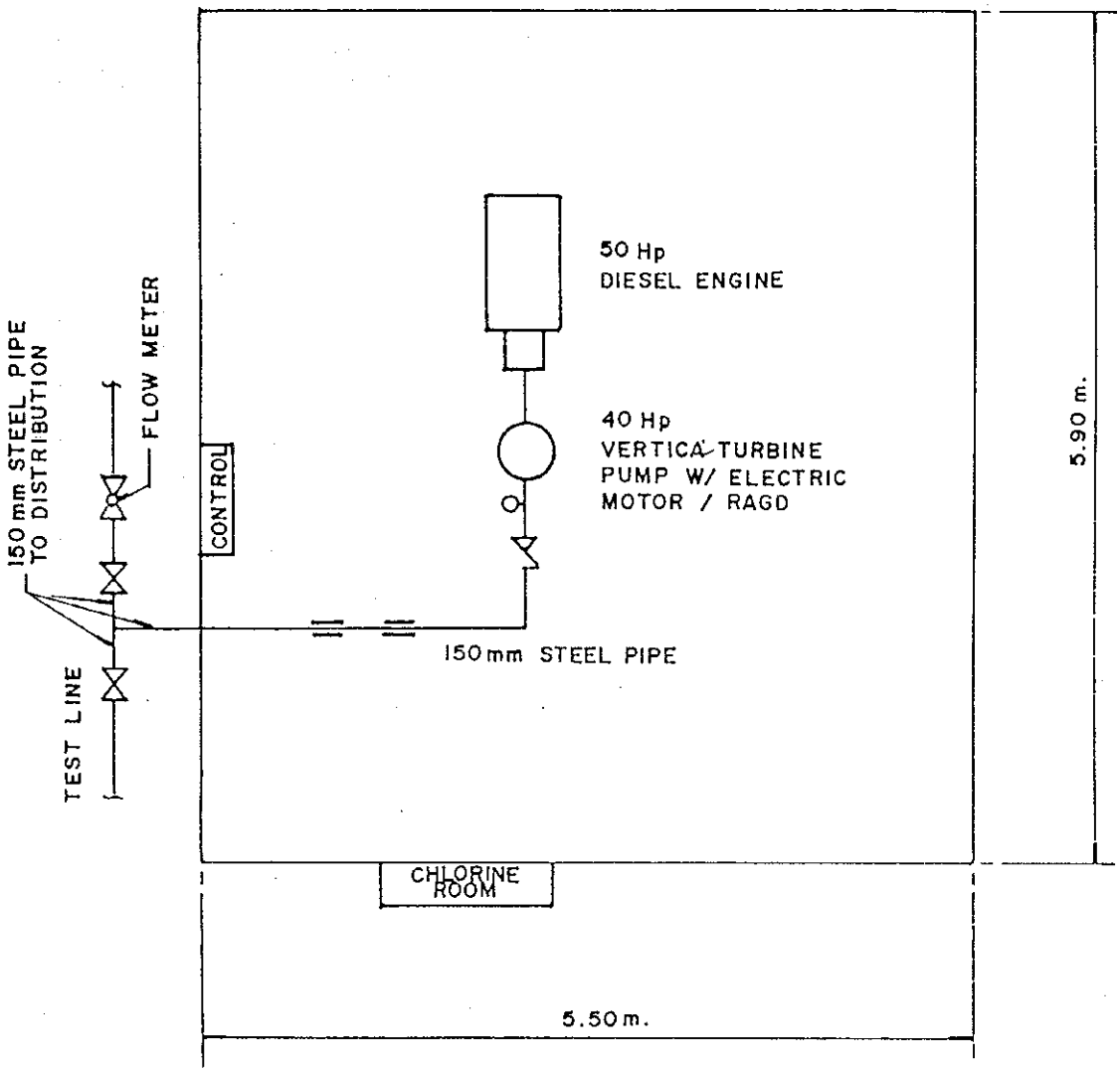
The first BPS being used for Kaybubutong Spring is BPS No. 3. It is located in Bgy. Sambong adjacent to Kaybubutong Spring with an elevation of 243 masl. The BPS is equipped with two (2) sets of multi–staged splitcase pump driven by a 100 Hp electric motor. **Fig. 10.5–3** shows the plan of existing pumping station No. 3.

3) Booster Pumping station No. 4

The second Kaybubutong Spring pumping station is BPS No. 4. It is likewise located in Bgy. Sambong about 0.5 km northwest of BPS No. 3, at an elevation of 480 masl. It also utilizes two (2) sets of multi–staged splitcase pump driven by a 100 Hp electric motor. The plan of existing pumping station No. 4 is presented in **Fig. 10.5–3**.

4) Booster Pumping Station No. 5

The third and last pumping station of Kaybubutong Spring is BPS No. 5. This BPS is located 0.34 km northwest of BPS No. 4, at an elevation of about 652 masl approximately 30 m from the National Highway in Tagaytay Mendez crossing. The station uses two (2) sets of vertical turbine pump coupled to a 40 Hp electric motor. It conveys water directly to the distribution system. **Fig. 10.5–4** shows the plan of existing pumping station No. 5.




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE : 10.5-2<br>PLAN, PUMPING STATION NO. 2<br>MATANG TUBIG SPRING<br>TAGAYTAY WATER DISTRICT |
| JAPAN INTERNATIONAL COOPERATION AGENCY | TAGAYTAY CITY |

The three BPS of Kaybubutong Spring are provided with sump tanks with a capacity of 75 $m^3$ for BPS No. 3, and 4 and 65 $m^3$ for BPS No. 5. The average pumping rate for each BPS is 32.52 lps.

5) Booster Pumping Station No. 6

BPS No. 6 is located adjacent to the sump tank of Pulong Usiw Spring. It is equipped with a 5 Hp submersible pump. Water from the 110 $m^3$ sump tank is pumped directly to the distribution system. The average pumping rate is about 1.76 lps. The plan of existing pumping station No. 6 is shown in **Fig. 10.5-5**.

(3) Storage Facility

The TC-WD has an existing two-chambered cylindrical reinforced concrete ground reservoir located about 500 m east of the TC-WD office at an elevation of 695 masl and an overflow elevation of 5 m above ground level. It has a total capacity of 950 $m^3$ with the lower chamber having a volume of 700 $m^3$ and the upper chamber having a volume of 250 $m^3$. At present, the TC-WD utilizes only the lower chamber due to leakage in the upper chamber. **Fig. 10.5-6**, shows the plan of concrete ground reservoir.

(4) Disinfection Facilities

BPS No. 5 is equipped with a gas chlorinator facility, while Pulong Usiw Spring is not provided with any disinfection facility.

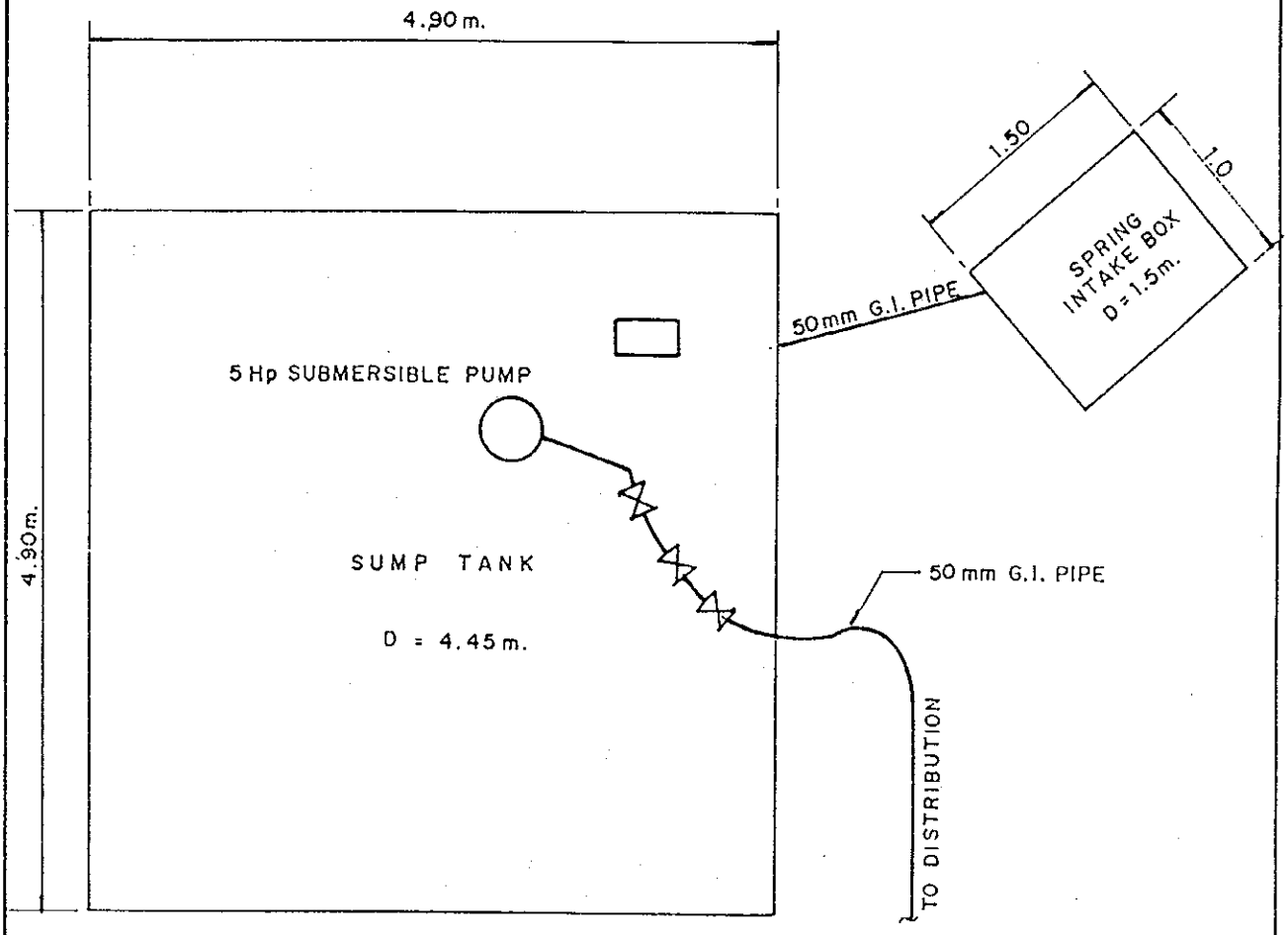
(5) Transmission/Distribution Facilities

The TC-WD has a total of 48.98 km of transmission/ distribution lines with diameter sizes ranging from 38 mm to 250 mm of PVC, CI, Steel and AC pipes. The main distribution lines of the Water District stretches from Bgy. Iruhin in the east and Bgy. Neogan in the west. **Fig. 10.5-1A, 10.5-1B** and **10.5-1C** show the existing transmission/distribution facilities.

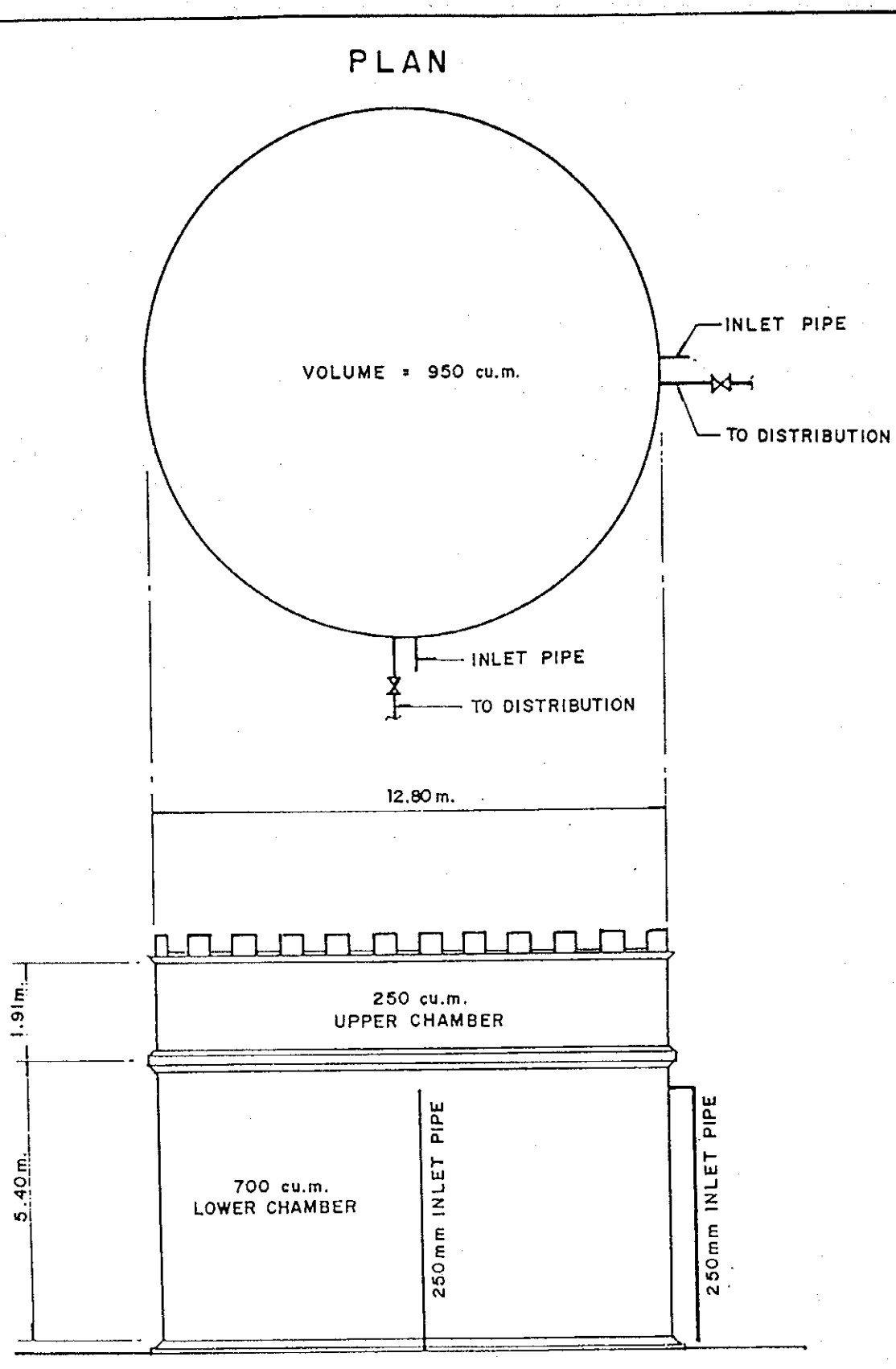
(6) Valves and Hydrants

There are several valves installed in the water system of the TC-WD. Most of these valves are placed at the junction of the pipe branching from the main distribution pipe. The breakdown of the number of valves in the system is presented below:

| | Opern'l | Inopern'l | Total |
|---|---|---|---|
| Gate Valve (100-250 mm) | 63 | 5 | 68 |
| Check Valve (150-200 mm) | 9 | 1 | 10 |
| Air Vacuum/ARV | 8 | 0 | 8 |
| Blow-Off Valve | 6 | 0 | 6 |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE : 10.5-5 |
| JAPAN INTERNATIONAL COOPERATION AGENCY | PLAN, PUMPING STATION NO. 6 PULANG USIW SPRING TAGAYTAY CITY WATER DISTRICT TAGAYTAY CITY |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE : 10. 5-6<br>950 cu.m. CONCRETE GROUND RESERVOIR<br>TAGAYTAY WATER DISTRICT<br>TAGAYTAY CITY |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

The valving scheme of the TC–WD water supply system is considered effective during maintenance, repairs and rationing operation. **Fig. 10.5–1B** and **10.5–1C** shows the valving scheme of the TC–WD water supply system.

(7) Service Connection

As of October 1994, the TC–WD had a total of 2,552 service connections which were all metered. This is broken down into three categories: 2,371 residential connections, 140 commercial connections and 41 institutional connections.

(8) Operation and Maintenance

The TC–WD provides water service 24 hours daily. However, electric power fluctuations usually occur from 6:00 p.m. to 9:00 p.m., restricting the operation to 21 hours daily.

The present operation and maintenance staff include the general manager and 46 regular and 10 casual employees.

Schedule of water rates as of October 1994 are as follows:

| Category | Minimum | Excess | |
|---|---|---|---|
| | (10 $m^3$) | 11–25 | 26–45 |
| Residential | 110.00 | 5.80 | 7.05 |
| Commercial | 220.00 | 10.60 | 14.10 |
| Institutional/Gov't | 110.00 | 5.80 | 7.05 |

### 10.5.2 Deficiencies of the Existing System

During the field investigation conducted last October 1994, several deficiencies of the existing system were noted. Such as follows:

- Under–rated pump capacity
- Low pump and motor efficiency
- Undersize distribution lines
- No chlorination at Pulong Usiw Spring
- Leakage of the upper chamber of reservoir

### 10.5.3 Water Use Profile

The present water consumption in the TC–WD was analyzed to determine water accountability. Results of the analysis are discussed below.

(1) Population Served

Based on the National Statistic Office (NSO) records, the average persons per household in the service area is 5.2. The population of the 15 barangays in the service area in 1994 is 20,695 of which 13,270 are served by the TC–WD.

(2) Water Consumption

The water consumption of the TC–WD as recorded for the month ending August, 1994 is 60,398 $m^3$. The average consumption per capita for domestic connections is 147 lpcd while 1.0 $m^3$/connection/d for commercial.

(3) Accounted–for Water

The accounted–for water is for the month of August 1994 is equal to 60,398 $m^3$.

The accounted–for water represents 79% of the total monthly production of 76,343 $m^3$.

(4) Unaccounted–for Water

The total unaccounted–for water in the TC–WD is 7,626 $m^3$ (which is 21% of the total monthly production).

(5) Present Water Demand

The present water demand according to the latest (August 1994) record of the Water District is 1,948 $m^3$/d. This includes the unaccounted–for water during average day demand.

### 10.5.4 Population and Water Demand Projection

(1) Population Projection

Future population of the municipality of Tagaytay and barangays in the existing service area were projected by the ratio method using historical population data gathered from the National Statistics Office (NSO). An average growth rate of 3.82% is adopted in this study up to design year (2005). Thus, the year 2005 municipal population may reach 41,656.

The present service area includes 15 barangays. The 1994 served population of these barangays totals 13,270, which is 48% of the total municipal population. **Table 10.5–1**, **10.5–2A**, and **10.5–2B** shows the population projection, served population and water demand projection. **Fig. 10.5–7A** and **10.5–7B** show the service area delineation.

TABLE 10.5-1

POPULATION PROJECTION
TAGAYTAY CITY WATER DISTRICT

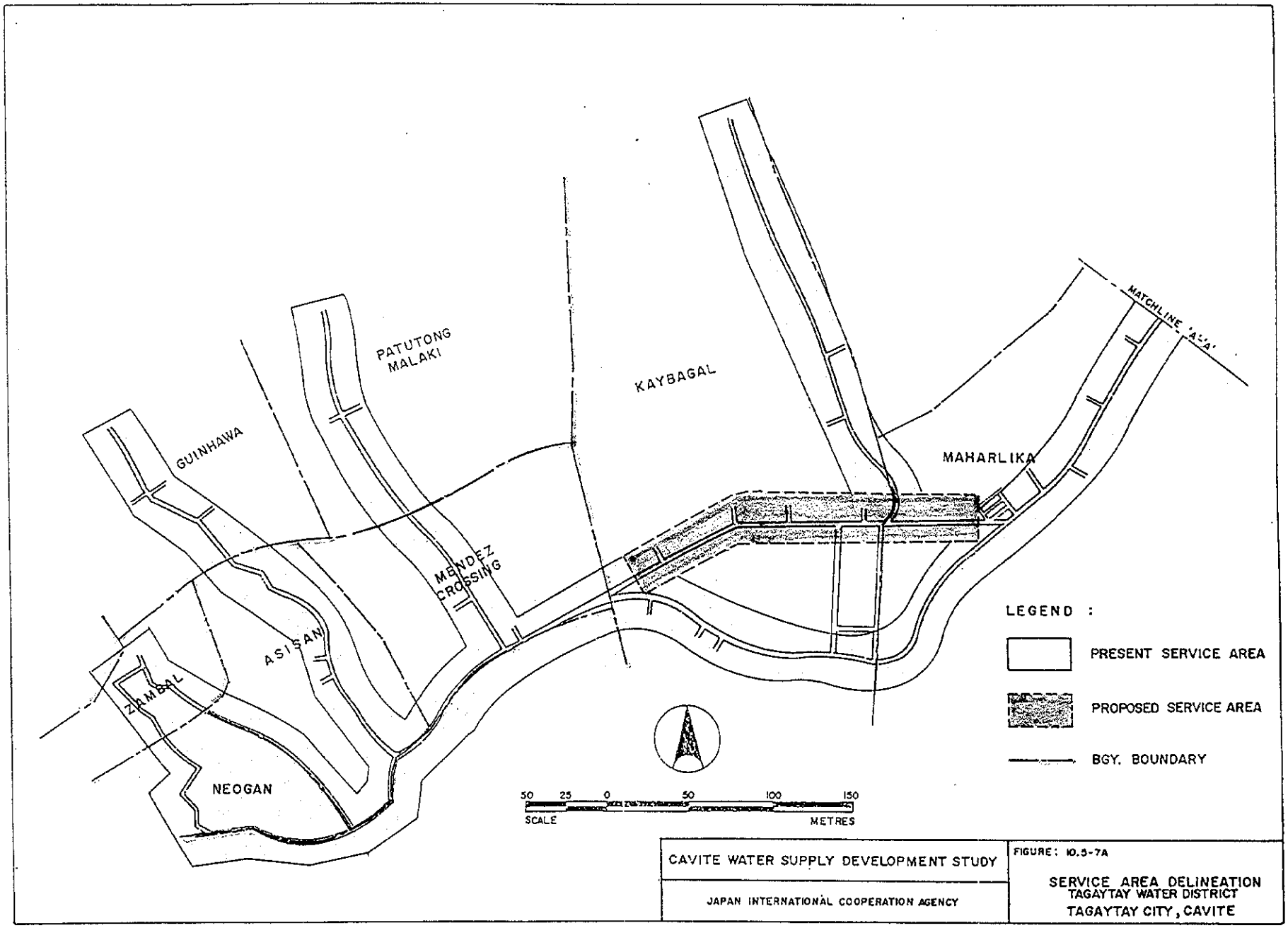
| Municipality/ Bgy. in the Service Area | Historical Population 1975 | 1980 | 1990 | Historical Growth Rates 1975-80 | 1980-90 | Projected Growth Rates 1990-2000 | 2000-2005 | 1994 | Projected Population 1998 | 2002 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TAGAYTAY CITY | 13,388 | 16,322 | 23,739 | 4.04 | 3.82 | 3.82 | 3.82 | 27,579 | 32,041 | 37,225 | 41,656 |
| 1 NEOGAN | 519 | 530 | 988 | 0.42 | 6.43 | 3.93 | 3.97 | 1,152 | 1,344 | 1,570 | 1,764 |
| 2 ZAMBAL | 151 | 201 | 280 | 5.89 | 3.37 | 3.89 | 3.92 | 326 | 380 | 443 | 497 |
| 3 ASISAN | 322 | 413 | 803 | 5.10 | 6.88 | 4.27 | 4.45 | 949 | 1,122 | 1,331 | 1,517 |
| 4 GUINHAWA | 424 | 435 | 540 | 0.51 | 2.19 | 3.13 | 2.83 | 611 | 691 | 777 | 845 |
| 5 MENDEZ CROSSING | 790 | 1,080 | 2,017 | 6.45 | 6.45 | 4.84 | 5.26 | 2,437 | 2,943 | 3,585 | 4,181 |
| 6 PATUTONG MALAKI | 567 | 785 | 1,159 | 6.72 | 3.97 | 3.89 | 3.91 | 1,350 | 1,572 | 1,832 | 2,056 |
| 7 KAYBAGAL | 2,022 | 2,598 | 3,694 | 5.14 | 3.58 | 3.86 | 3.88 | 4,299 | 5,003 | 5,824 | 6,529 |
| 8 MAHARLIKA | 682 | 755 | 1,040 | 2.05 | 3.25 | 3.58 | 3.48 | 1,197 | 1,378 | 1,583 | 1,754 |
| 9 SILANG CROSSING | 573 | 750 | 951 | 5.53 | 2.40 | 3.73 | 3.67 | 1,101 | 1,274 | 1,474 | 1,642 |
| 10 MAITIM 2ND | 940 | 1,132 | 1,582 | 3.79 | 3.40 | 3.71 | 3.66 | 1,830 | 2,118 | 2,448 | 2,727 |
| 11 SAN JOSE | 762 | 884 | 1,200 | 3.01 | 3.10 | 3.51 | 3.40 | 1,378 | 1,582 | 1,812 | 2,003 |
| 12 TOLENTINO | 812 | 927 | 1,043 | 2.68 | 1.19 | 3.24 | 3.01 | 1,185 | 1,346 | 1,523 | 1,664 |
| 13 FRANCISCO | 574 | 670 | 1,001 | 3.14 | 4.10 | 3.80 | 3.78 | 1,162 | 1,349 | 1,565 | 1,749 |
| 14 SUNGAY | 1,329 | 1,981 | 2,748 | 8.31 | 3.33 | 4.05 | 4.14 | 3,221 | 3,774 | 4,431 | 5,005 |
| 15 IRUHIN | 1,270 | 1,299 | 1,833 | 0.45 | 3.50 | 3.69 | 3.63 | 2,119 | 2,449 | 2,828 | 3,147 |
| Total | 11,737 | 14,440 | 20,879 | | | | | 24,316 | 28,326 | 33,026 | 37,080 |

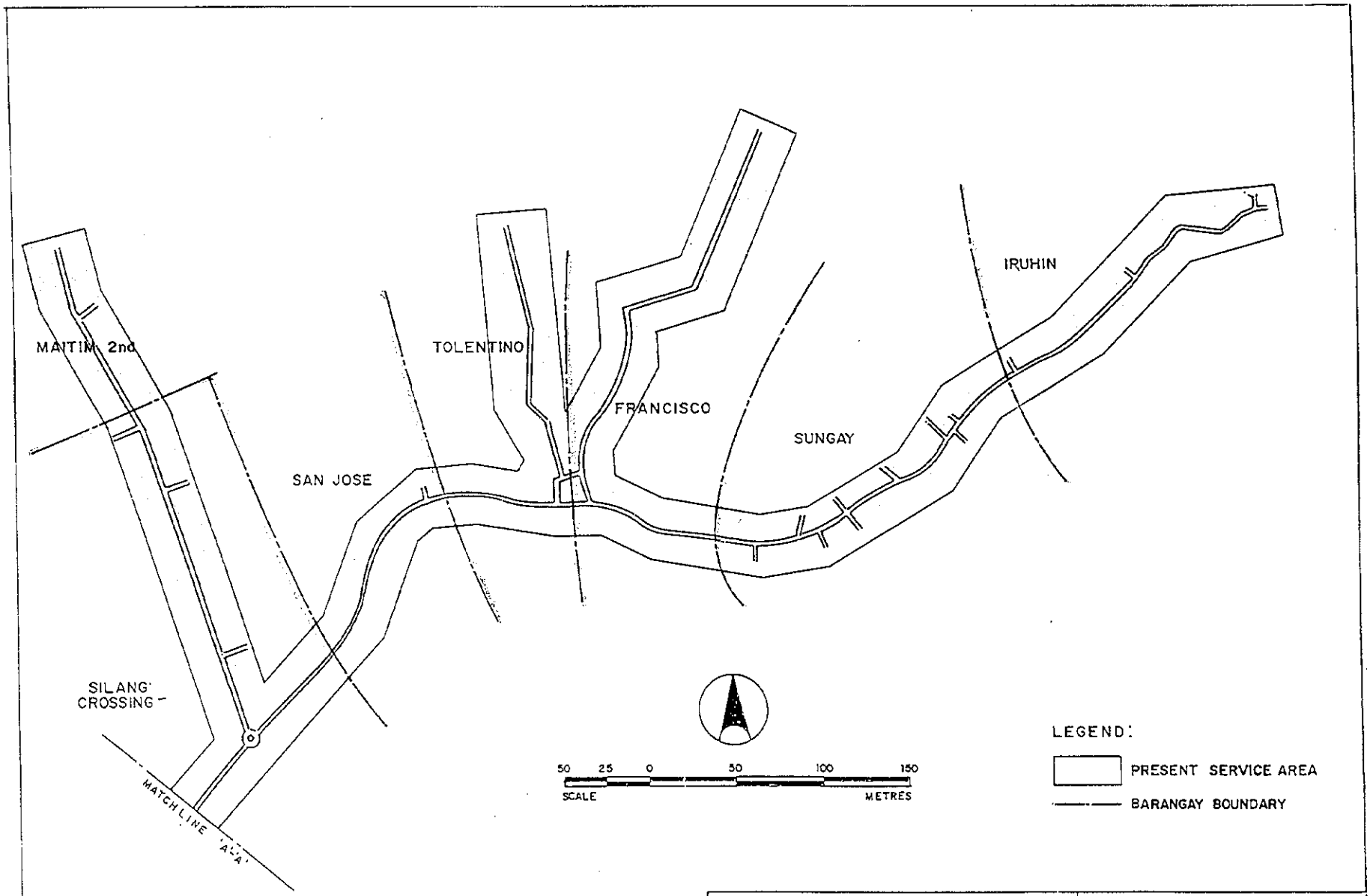
TABLE 10.5-2A
1998 SERVED POPULATION AND WATER DEMAND PROJECTIONS
TAGAYTAY WATER DISTRICT

| | BARANGAY | BARANGAY POPULATION | SERVICE AREA POPULATION | DOMESTIC | | | COMMERCIAL | | | INSTITUTIONAL | | TOTAL | | | UNACCOUNTED-FOR WATER (cum/d) | AVERAGE DAY DEMAND (cum/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Water Demand | No. of Conn. | Served Pop. | Water Demand | | |
| 1 | NEOGAN | 1,344 | 1,277 | 226 | 1,105 | 162.4 | 22 | 108 | 22.0 | 1 | 3.0 | 249 | 1,213 | 187.4 | 49.6 | 237.0 |
| 2 | ZAMBAL | 380 | 323 | 46 | 228 | 33.5 | 6 | 30 | 6.0 | 0 | 0.0 | 52 | 258 | 39.5 | 10.5 | 50.0 |
| 3 | ASISAN | 1,122 | 965 | 110 | 618 | 90.8 | 19 | 106 | 19.0 | 1 | 3.0 | 130 | 724 | 112.8 | 30.2 | 143.0 |
| 4 | GUINHAWA | 691 | 656 | 103 | 533 | 78.4 | 11 | 57 | 11.0 | 1 | 3.0 | 115 | 590 | 92.4 | 24.6 | 117.0 |
| 5 | MENDEZ CROSSING | 2,943 | 2,649 | 368 | 1,987 | 292.1 | 49 | 265 | 49.0 | 3 | 9.0 | 420 | 2,252 | 350.1 | 92.9 | 443.0 |
| 6 | PATUTONG MALAKI | 1,572 | 1,266 | 173 | 936 | 137.6 | 26 | 140 | 26.0 | 1 | 3.0 | 200 | 1,076 | 166.6 | 44.4 | 211.0 |
| 7 | KAYBAGAL | 5,003 | 4,753 | 596 | 3,337 | 490.5 | 83 | 465 | 83.0 | 5 | 15.0 | 684 | 3,802 | 588.5 | 156.5 | 745.0 |
| 8 | MAHARLIKA | 1,378 | 1,219 | 180 | 919 | 135.1 | 23 | 117 | 23.0 | 1 | 3.0 | 204 | 1,036 | 161.1 | 42.9 | 204.0 |
| 9 | SILANG CROSSING | 1,274 | 1,268 | 249 | 1,169 | 171.8 | 21 | 99 | 21.0 | 1 | 3.0 | 271 | 1,268 | 195.8 | 52.2 | 248.0 |
| 10 | MAITIM 2ND | 2,118 | 1,338 | 167 | 884 | 129.9 | 35 | 186 | 35.0 | 1 | 3.0 | 203 | 1,070 | 167.9 | 45.1 | 213.0 |
| 11 | SAN JOSE | 1,582 | 1,345 | 163 | 1,044 | 153.5 | 26 | 167 | 26.0 | 1 | 3.0 | 190 | 1,211 | 182.5 | 48.5 | 231.0 |
| 12 | TOLENTINO | 1,346 | 1,279 | 199 | 1,094 | 160.8 | 22 | 121 | 22.0 | 1 | 3.0 | 222 | 1,215 | 185.8 | 49.2 | 235.0 |
| 13 | FRANCISCO | 1,349 | 1,281 | 193 | 1,093 | 160.7 | 22 | 124 | 22.0 | 1 | 3.0 | 216 | 1,217 | 185.7 | 49.3 | 235.0 |
| 14 | SUNGAY | 3,774 | 3,397 | 419 | 2,515 | 369.7 | 62 | 372 | 62.0 | 3 | 9.0 | 484 | 2,887 | 440.7 | 147.3 | 588.0 |
| 15 | IRUHIN | 2,449 | 1,102 | 93 | 539 | 79.2 | 40 | 232 | 40.0 | 1 | 3.0 | 134 | 771 | 122.2 | 40.8 | 163.0 |
| | Total | 28,326 | 24,118 | 3,285 | 18,001 | 2,646.0 | 467 | 2,589 | 467.0 | 22 | 66.0 | 3,774 | 20,590 | 3,179.0 | 884.0 | 4,063.0 |

TABLE 10.5-2B
2005 SERVED POPULATION AND WATER DEMAND PROJECTIONS
TAGAYTAY WATER DISTRICT

| BARANGAY | BARANGAY POPULATION | SERVICE AREA POPULATION | DOMESTIC | | | COMMERCIAL | | | INSTITUTIONAL | | TOTAL | | | UNACCOUNTED-FOR WATER (cum/d) | AVERAGE DAY DEMAND (cum/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Served Pop. | Water Demand | No. of Conn. | Water Demand | No. of Conn. | Served Pop. | Water Demand | | |
| 1 NEOGAN | 1,764 | 1,764 | 310 | 1,549 | 232.4 | 26 | 127 | 26.0 | 2 | 6.0 | 338 | 1,676 | 264.4 | 70.6 | 335.0 |
| 2 ZAMBAL | 497 | 472 | 69 | 343 | 51.5 | 7 | 35 | 7.0 | 0 | 0.0 | 76 | 378 | 58.5 | 15.5 | 74.0 |
| 3 ASISAN | 1,517 | 1,441 | 190 | 952 | 142.8 | 23 | 129 | 23.0 | 1 | 3.0 | 214 | 1,081 | 168.8 | 45.2 | 214.0 |
| 4 GUINHAWA | 845 | 845 | 139 | 693 | 104.0 | 13 | 68 | 13.0 | 1 | 3.0 | 153 | 761 | 120.0 | 32.0 | 152.0 |
| 5 MENDEZ CROSSING | 4,181 | 3,972 | 304 | 3,036 | 455.4 | 63 | 340 | 63.0 | 4 | 12.0 | 371 | 3,376 | 530.4 | 140.6 | 671.0 |
| 6 PATUTONG MALAKI | 2,056 | 1,953 | 299 | 1,493 | 224.0 | 31 | 167 | 31.0 | 2 | 6.0 | 332 | 1,660 | 261.0 | 69.0 | 330.0 |
| 7 KAYBAGAL | 6,529 | 6,529 | 467 | 4,674 | 701.1 | 98 | 549 | 98.0 | 6 | 18.0 | 571 | 5,223 | 817.1 | 216.9 | 1,034.0 |
| 8 MAHARLIKA | 1,754 | 1,666 | 257 | 1,283 | 192.5 | 26 | 133 | 26.0 | 2 | 6.0 | 285 | 1,416 | 224.5 | 59.5 | 284.0 |
| 9 SILANG CROSSING | 1,642 | 1,642 | 152 | 1,524 | 228.6 | 25 | 118 | 25.0 | 2 | 6.0 | 179 | 1,642 | 259.6 | 69.4 | 329.0 |
| 10 MAITIM 2ND | 2,727 | 2,591 | 371 | 1,856 | 278.4 | 41 | 217 | 41.0 | 2 | 6.0 | 414 | 2,073 | 325.4 | 86.6 | 412.0 |
| 11 SAN JOSE | 2,003 | 1,903 | 304 | 1,520 | 228.0 | 30 | 193 | 30.0 | 2 | 6.0 | 336 | 1,713 | 264.0 | 70.0 | 334.0 |
| 12 TOLENTINO | 1,664 | 1,664 | 289 | 1,444 | 216.6 | 25 | 137 | 25.0 | 2 | 6.0 | 316 | 1,581 | 247.6 | 65.4 | 313.0 |
| 13 FRANCISCO | 1,749 | 1,749 | 303 | 1,515 | 227.3 | 26 | 147 | 26.0 | 2 | 6.0 | 331 | 1,662 | 259.3 | 68.7 | 328.0 |
| 14 SUNGAY | 5,005 | 4,755 | 718 | 3,592 | 538.8 | 75 | 450 | 75.0 | 5 | 15.0 | 798 | 4,042 | 628.8 | 209.2 | 838.0 |
| 15 IRUHIN | 3,147 | 2,990 | 228 | 1,820 | 273.0 | 47 | 273 | 47.0 | 1 | 3.0 | 276 | 2,093 | 323.0 | 108.0 | 431.0 |
| Total | 37,080 | 35,936 | 4,400 | 27,294 | 4,094.4 | 556 | 3,083 | 556.0 | 34 | 102.0 | 4,990 | 30,377 | 4,752.4 | 1,326.6 | 6,079.0 |


PATUTONG MALAKI
KAYBAGAL
GUINHAWA
MAHARLIKA
MATCHLINE 'A'-'A'
MENDEZ CROSSING
ASISAN
ZAMBAL
NEOGAN
LEGEND :
PRESENT SERVICE AREA
PROPOSED SERVICE AREA
BGY. BOUNDARY
50 25 0 50 100 150
SCALE
METRES
CAVITE WATER SUPPLY DEVELOPMENT STUDY
JAPAN INTERNATIONAL COOPERATION AGENCY
FIGURE: 10.5-7A
SERVICE AREA DELINEATION
TAGAYTAY WATER DISTRICT
TAGAYTAY CITY, CAVITE




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE : 10.5-7B |
| JAPAN INTERNATIONAL COOPERATION AGENCY | SERVICE AREA DELINEATION<br>TAGAYTAY WATER DISTRICT<br>TAGAYTAY CITY, CAVITE |

The service area population in the design year (2005) is projected to reach 35,936 while the served population is expected to reach 30,377. The design-year (2005) served population and water demand projection is presented in **Table 10.5-2B**

(2) Water Demand Projection

In the absence of reliable data on actual water consumption and other related information, water demand figures were projected based on assumptions adopted from previous studies and the LWUA methodology manual. Some of these include:

- Domestic unit water consumption is estimated at 0.147 $m^3/d$ in proposed implementation year (1997) and 0.150 $m^3/d$ for the design year (2005) per person and an average of 5.2 person per household (NSO data).

- Commercial unit water consumption is estimated at 1.0 $m^3/d$ increasing to 1.5 $m^3/d$ in design year.

- Institutional unit water consumption is estimated at 3.0 $m^3$/connection/d.

- Unaccounted-for water is assumed to be 25% of the total water demand after project implementation.

Domestic connections are projected to reach 4,400 in 2005 while commercial and institutional connections are projected to reach 556 and 34 connections, respectively. **Table 10.5-2B** shows the number of connection for each category.

(3) Water Demand Variation

Presented below is the year 2005 water demand variation:

| | |
|---|---|
| Average-day demand | 6,079 $m^3/d$ ( 70.4 lps) |
| Maximum-day demand | 7,903 $m^3/d$ ( 91.5 lps) |
| Peak-hour demand | 12,158 $m^3/d$ (140.7 lps) |

**Table 10.5-3** shows the annual water demand per type of connection and **Table 10.5-4** shows the annual water demand variations.

### 10.5.5 Analysis and Evaluation of Alternatives

(1) Considerations

The existing facilities that will be considered and incorporated in the recommended plan of the water supply system in the year 2005 are as follows;

TABLE 10.5-3
ANNUAL WATER DEMAND AND NUMBER OF CONNECTIONS
TAGAYTAY WATER DISTRICT

| YEAR | DOMESTIC | | COMMERCIAL | | INSTITUTIONAL | | TOTAL | | UNACCOUNTED-FOR WATER (cumd) | AVERAGE DAY DEMAND (cumd) |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | No. of Conn. | Water Demand (cumd) | | |
| 1994 | 2,389 | 1567.0 | 441 | 441.0 | 20 | 60.0 | 2,850 | 2,068.0 | 549.7 | 2,617.7 |
| 1995 | 2,535 | 1704.0 | 444 | 444.0 | 21 | 62.0 | 3,000 | 2,210.0 | 587.5 | 2,797.5 |
| 1996 | 2,690 | 1853.0 | 447 | 447.0 | 22 | 64.0 | 3,159 | 2,364.0 | 628.4 | 2,992.4 |
| 1997 | 2,854 | 2014.9 | 449 | 449.0 | 22 | 66.0 | 3,325 | 2,529.9 | 672.5 | 3,202.4 |
| 1998 | 3,285 | 2,646.0 | 467 | 467.0 | 22 | 66.0 | 3,774 | 3,179.0 | 884.0 | 4,063.0 |
| 1999 | 3,425 | 2,816.0 | 479 | 479.0 | 23 | 70.0 | 3,927 | 3,365.0 | 938.7 | 4,303.7 |
| 2000 | 3,571 | 2,997.0 | 491 | 491.0 | 24 | 74.0 | 4,086 | 3,562.0 | 996.7 | 4,558.7 |
| 2001 | 3,723 | 3,190.0 | 503 | 503.0 | 26 | 79.0 | 4,252 | 3,772.0 | 1,056.8 | 4,828.8 |
| 2002 | 3,882 | 3,395.0 | 516 | 516.0 | 28 | 84.0 | 4,426 | 3,995.0 | 1,119.9 | 5,114.9 |
| 2003 | 4,047 | 3,613.0 | 529 | 529.0 | 30 | 89.0 | 4,606 | 4,231.0 | 1,187.0 | 5,418.0 |
| 2004 | 4,220 | 3,846.0 | 542 | 542.0 | 32 | 95.0 | 4,794 | 4,483.0 | 1,256.0 | 5,739.0 |
| 2005 | 4,400 | 4,094.4 | 556 | 556.0 | 34 | 102.0 | 4,990 | 4,752.4 | 1,326.6 | 6,079.0 |

TABLE 10.5-4

WATER DEMAND VARIATIONS
TAGAYTAY WATER DISTRICT

| YEAR | Average Day Demand | | Maximum Day Demand | | Peak-Hour Demand | |
|---|---|---|---|---|---|---|
| | (cumd) | (L/s) | (cumd) | (L/s) | (cumd) | (L/s) |
| 1994 | 2,618 | 30.3 | 3,403 | 39.4 | 5,235 | 60.6 |
| 1995 | 2,797 | 32.4 | 3,637 | 42.1 | 5,595 | 64.8 |
| 1996 | 2,992 | 34.6 | 3,890 | 45.0 | 5,985 | 69.3 |
| 1997 | 3,202 | 37.1 | 4,163 | 48.2 | 6,405 | 74.1 |
| 1998 | 4,063 | 47.0 | 5,282 | 61.1 | 8,126 | 94.1 |
| 1999 | 4,304 | 49.8 | 5,595 | 64.8 | 8,607 | 99.6 |
| 2000 | 4,559 | 52.8 | 5,926 | 68.6 | 9,117 | 105.5 |
| 2001 | 4,829 | 55.9 | 6,277 | 72.7 | 9,658 | 111.8 |
| 2002 | 5,115 | 59.2 | 6,649 | 77.0 | 10,230 | 118.4 |
| 2003 | 5,418 | 62.7 | 7,043 | 81.5 | 10,836 | 125.4 |
| 2004 | 5,739 | 66.4 | 7,461 | 86.4 | 11,478 | 132.8 |
| 2005 | 6,079 | 70.4 | 7,903 | 91.5 | 12,158 | 140.7 |

1) Existing Water Supply System Facilities

The Tagaytay City Water District is presently supplied by three spring sources (Kaybubutong, Matang Tubig, and Pulong Usiw). All these sources will continue to be used up to the design year. Likewise, the distribution system facilities, PS No. 2 and PS No. 6 , and the existing reservoir are considered to be used in this study.

2) Additional Water Sources

Additional water sources that can be considered are surface water from Taal Lake and groundwater through deepwells.

Preliminary analysis showed that complete treatment of surface water from Taal Lake would be very expensive due to the complicated processes of treatment and the high operation and maintenance expenses needed to make the water potable. Therefore, surface water is not considered in this study.

Based on the water resources evaluation, Tagaytay City area has a very limited groundwater potential through deepwells. Thus, deepwells are not considered as additional water source in this study.

The lone alternative is to increase the pumping rate capacity in Kaybubutong Spring to meet the water demand of Tagaytay City up to the design year.

3) Pressure Zones

It is more economical to divide the service area into pressure zones whenever the difference in ground level elevation is about 50 m (LWUA Methodology Manual). In this study nine pressure zones were identified.

4) Storage Location

Location of storage is influenced by the demand in the service area. In the case of Tagaytay, each pressure zone must have its individual storage tank.

5) Design Criteria

- Proposed Parameters for Additional Sources

  As recommended in water resources study, flow of the Kaybubutong Spring shall be optimized. The following parameters are to be used to increase the pumping capacity and reduce energy cost in Kaybubutong Spring;

| | | |
|---|---|---|
| Pump | : | Multi-stage turbine pump |
| Discharge | : | 42.3 lps @ 400 m TDH |
| Drive | : | Electric Motor |
| Motor Rating | : | 280 KW; 440 Volts; 3 Phase 60 Hz |
| Pipelines | : | 300 mm steel pipe Sch20 (3,077 m) |
| | : | 300 mm steel pipe Sch40 (340 m) |
| | : | 300 mm steel pipe Sch60 (592 m) |

- Distribution System

The distribution system will be mainly laid along the National Highway and in the streets of the city. The pipe network layout is generally influenced by the existing roadways and the area to be served while the pipe size configuration is designed at peak-hour condition.

To minimize cost, pipelines of the old system is considered to be retained in this study. However, some are to be provided with parallel lines to meet the hydraulic design requirements.

- Demand Ratios

The projected water demands of Tagaytay City for the design year (2005) are 7,903 $m^3/d$ and 12,158 $m^3/d$ for maximum-day and peak-hour demand, respectively.

- Storage requirements

During peak-hour water demand conditions and whenever the production capacity of the sources is less than the demand of the system, additional water supply will be provided by the reservoir. Generally the volume of storage must be sufficient to meet the operational, emergency and firefighting reserve requirements. **Table 10.5-5** shows the storage capacity requirement of the system up to the year 2005.

Each proposed reservoir will be constructed at an adequate elevation such that the required minimum pressure in the distribution system in each zone is satisfied.

- System Pressure

The minimum pressure head to be adopted in the system is 7 m while the maximum is 70 m. The systems pipe network is designed to conform with the pressure requirement even during peak-hour conditions.

TABLE 10.5-5
STORAGE REQUIREMENT
TAGAYTAY CITY WATER DISTRICT

| YEAR | Max Day Demand (cumd) | Served Population | Emergency Storage Requirement (cum) | Operational Storage Requirement | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Max-day (cum) | ID-1.33 (cum) | ID-1.2 (cum) | ID-1.10 (cum) | PKD (cum) |
| 1998 | 5,282.0 | 20,590 | 440 | 895 | 353 | 383 | 723 | 202 |
| 1999 | 5,595.0 | 21,766 | 466 | 942 | 369 | 400 | 761 | 209 |
| 2000 | 5,926.5 | 23,009 | 494 | 992 | 386 | 418 | 800 | 217 |
| 2001 | 6,277.7 | 24,323 | 523 | 1044 | 403 | 437 | 841 | 225 |
| 2002 | 6,649.7 | 25,712 | 554 | 1099 | 421 | 456 | 885 | 232 |
| 2003 | 7,043.7 | 27,181 | 587 | 1158 | 440 | 476 | 930 | 241 |
| 2004 | 7,461.0 | 28,734 | 622 | 1219 | 460 | 497 | 978 | 249 |
| 2005 | 7,903.0 | 30,377 | 659 | 1283 | 480 | 519 | 1028 | 257 |

Operational Storage Requirement

| Supply rate | Storage Volume | Pump Hours |
|---|---|---|
| MD | (0.224 - (0.0416 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 24 |
| ID-1.33 | (0.114 - (0.0359 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 18 |
| ID-1.20 | (0.125 - (0.0400 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 20 |
| ID-1.10 | (0.190 - (0.0406 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 22 |
| PKH | (0.082 - (0.0336 x @Log(SERVED POP'N/1000))) x MAX-DAY DEMAND | 16 |

Emergency Storage Requirement :

2 hours of Max-day demand

- Fire Protection

  Full fire protection will be provided to the entire service area by 2005. Fire hydrants should be placed strategically in the distribution system. Likewise, emergency storage requirements should also be considered.

- Flow Velocity in the Distribution System

  The flow velocity in the distribution system is limited to a maximum of 3 m/s at all times and a minimum of 0.3 m/s. However, in order to obtain a good pressure distribution system in all parts of the service area, it was necessary to allow a velocity flow less than this minimum.

- Computer Analysis

  Pipe sizes were designed for peak-hour demand condition and only pipes with diameters 50 mm and above were included in the analyses.

- Common Items

  To simplify the evaluation of alternatives, items common to the alternatives considered such as reservoir, distribution lines, valves, hydrants, service connections and other appurtenances were not included in the analysis.

(2) Development of Alternatives

No alternative for source evaluation was made. The proposed alternative is to maximize the use of Kaybubutong Spring by increasing the pumping rate capacity that will result to the most economical construction cost and operation and maintenance cost. Two alternatives considered for this purpose is as follows:

1) Alternative 1 - Three Booster Pumping Station Scheme.

This alternative will utilize the existing 250 mm transmission lines and the existing 100 Hp multi-stage centrifugal pump and motor will be replaced with a 125 Hp pump and motor. An additional 125 Hp pump and motor will be installed in BPS 3 and 4. Likewise, the 40 Hp turbine pump and motor in BPS 5 will be replaced with new one. This alternative can meet the water requirement in the year 2005. The old pump and motor will be used as spare in case of a pump and/or motor breakdown. **Table 10.5-6** and **Fig. 10.5-8A** presents this alternative.

2) Alternative 2 - Single Stage Booster Pumping Station Scheme

This alternative aims to reduce the pumping cost by providing a new 300 mm transmission line from Kaybubutong Spring up to the reservoir using high pressure

TABLE 10.5-6
Cost Comparison of Alternatives
Tagaytay City Water District

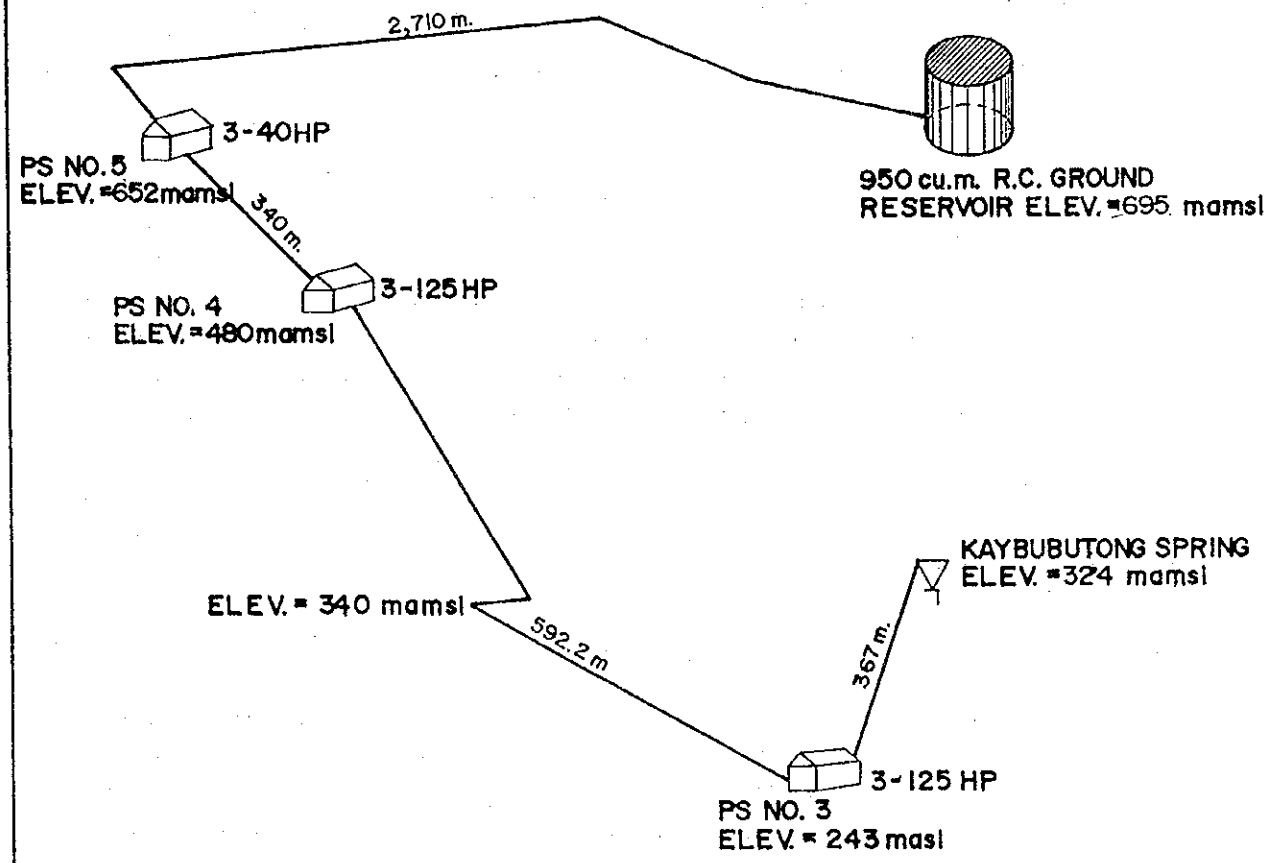
Alternative 1 - Three Booster Pumping Station Scheme

| Facilities | | Construction Cost (P) | |
|---|---|---|---|
| 6 sets Multi-stage Centrifugal Pump 125 HP | | 14,329.00/HP | 10,746,750.00 |
| 3 sets Vertical Turbine Pump 40 HP | | 14310.63/HP | 1,717,275.00 |
| | | P | 12,464,025.00 |
| **Power Cost** | | | |
| 915 HP | 9,400.55 KWH/D | P | 13,536,800.00 |

Alternative 2 - Single Stage Booster Pumping Station Scheme

| Facilities | | Construction Cost (P) | |
|---|---|---|---|
| 3 sets Multi-stage Turbine Pump 42.3 lps @ 400 m Head | | | 1,372,500.00 |
| 3 sets Electric Motor 375 HP | | | 1,297,500.00 |
| Steel pipe Sch.20 - 2,710 m | 2,218.07 /m | | 6,010,968.48 |
| Steel pipe Sch.40 - 340 m | 3,529.41/m | | 1,200,000.00 |
| Steel pipe Sch.60 - 592 m | 4,812.56/m | | 2,850,000.00 |
| Labor cost - 2710 m | 100.00/m | | 271,000.00 |
| Labor cost - 932 m | 350.00/m | | 326,270.00 |
| 11 sets Valves | Lump Sum | | 1,750,000.00 |
| 1 set Pressure Protection Device | Lump Sum | | 1,562,500.00 |
| | | P | 16,640,738.48 |
| **Power Cost** | | | |
| 795 HP | 8,167.67 KWH/D | P | 11,761,500.00 |

Note: Alternative 2 has lower energy cost than Alternative 1 by P 1.77 Million.




NOTE:
ALL PIPES 250 mm DIA. STEEL

| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.5-8A<br>ALTERNATIVE - 1<br>THREE BOOSTER PUMPING STATION SCHEME |
| JAPAN INTERNATIONAL COOPERATION AGENCY | TAGAYTAY WATER DISTRICT<br>TAGAYTAY, CAVITE |

steel pipes. It will utilize the existing sump tank in BPS No. 3 and new sets of multi-stage turbine pumps (375 Hp) will be installed. Pumped water will be directly fed to the reservoir. **Table 10.5-6** and **Fig. 10.5-8B** presents the existing and the schematic drawing of this alternative.

(3) Evaluation of Alternatives

Each of the alternatives was evaluated based on construction cost at 1994 price levels.

The following table summarizes the cost of each alternative.

| | Cost (P) |
|---|---|
| Alternative 1 | 12,464,025.00 |
| Alternative 2 | 16,640,738.00 |

Alternative 2 is higher by P4.2 Million in construction cost than Alternative 1. Due to the small difference in project cost, operation and maintenance expenses were considered. In Alternative 1, the energy cost is higher by about P1.8 Million than Alternative 2 per annum. With this annual cost difference in energy cost, Alternative 2 is adopted as the recommended plan for the improvement of water supply system of the TC-WD.

### 10.5.6 Recommended Plan

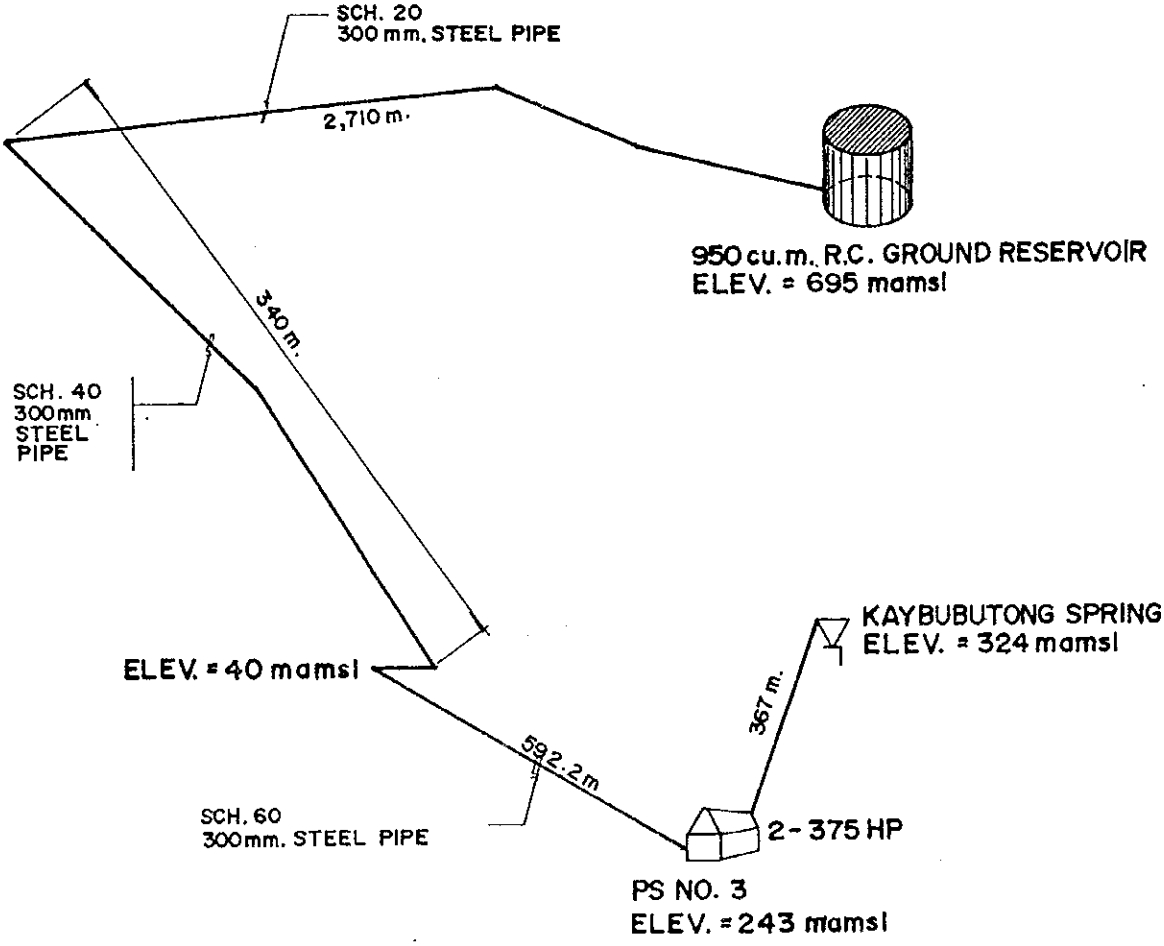
(1) Description of the Scheme

As mentioned earlier, the service area of the TC-WD is divided into nine pressure zones. Pressure Zone No. 9 (PZN-9) will be provided with a booster pump due to the high elevation of its extremities. The single stage booster pumping scheme will convey spring water from BPS No. 3 up to the existing 950 $m^3$ concrete ground reservoir and to the proposed 250 $m^3$ reservoir in PZN-2. The 950 $m^3$ reservoir of PZN-1 will feed the proposed reservoirs of PZN-5, 6, and 7. The proposed reservoir of PZN-2 will feed water to PZN-3 and 4, The reservoir of PZN-7 will feed water to the booster pump that will be installed in node 127. The booster pump of PZN-9 will feed water to the reservoir of its own zone. BPS No. 6 will supply water to the PZN-9 up to elevation 595 m only. PZN-8 will act as a separate system and will be supplied by BPS No. 2

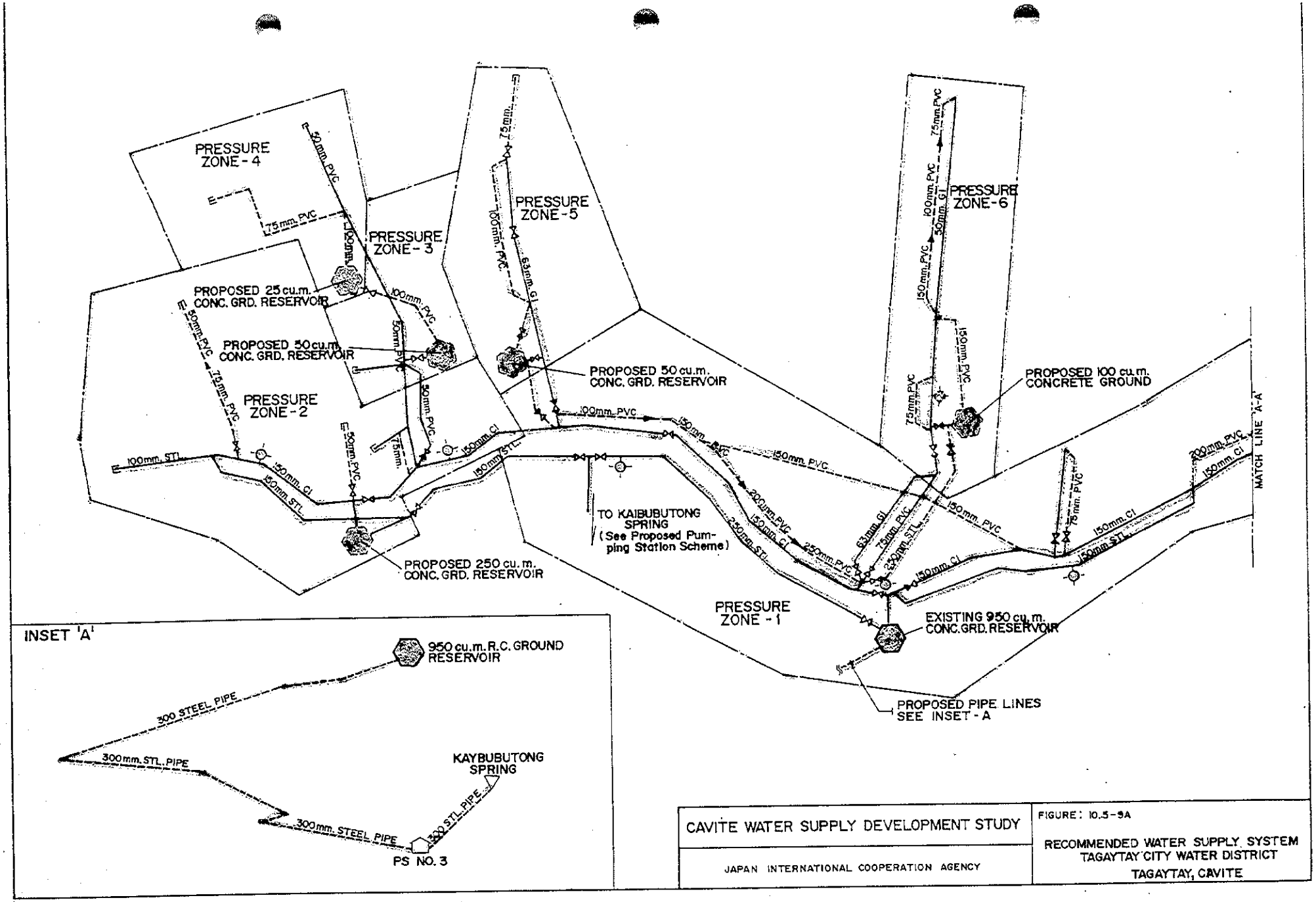
The proposed 300 mm transmission lines will be provided with high pressure valves and fittings and water hammer protection devices.

The proposed water supply system for the TC-WD is shown in **Fig. 10.5-9A** and **10.5-9B**. The computer print-out of the hydraulic analysis of the system and the schematic nodal diagram of the distribution system are presented in the supporting document.

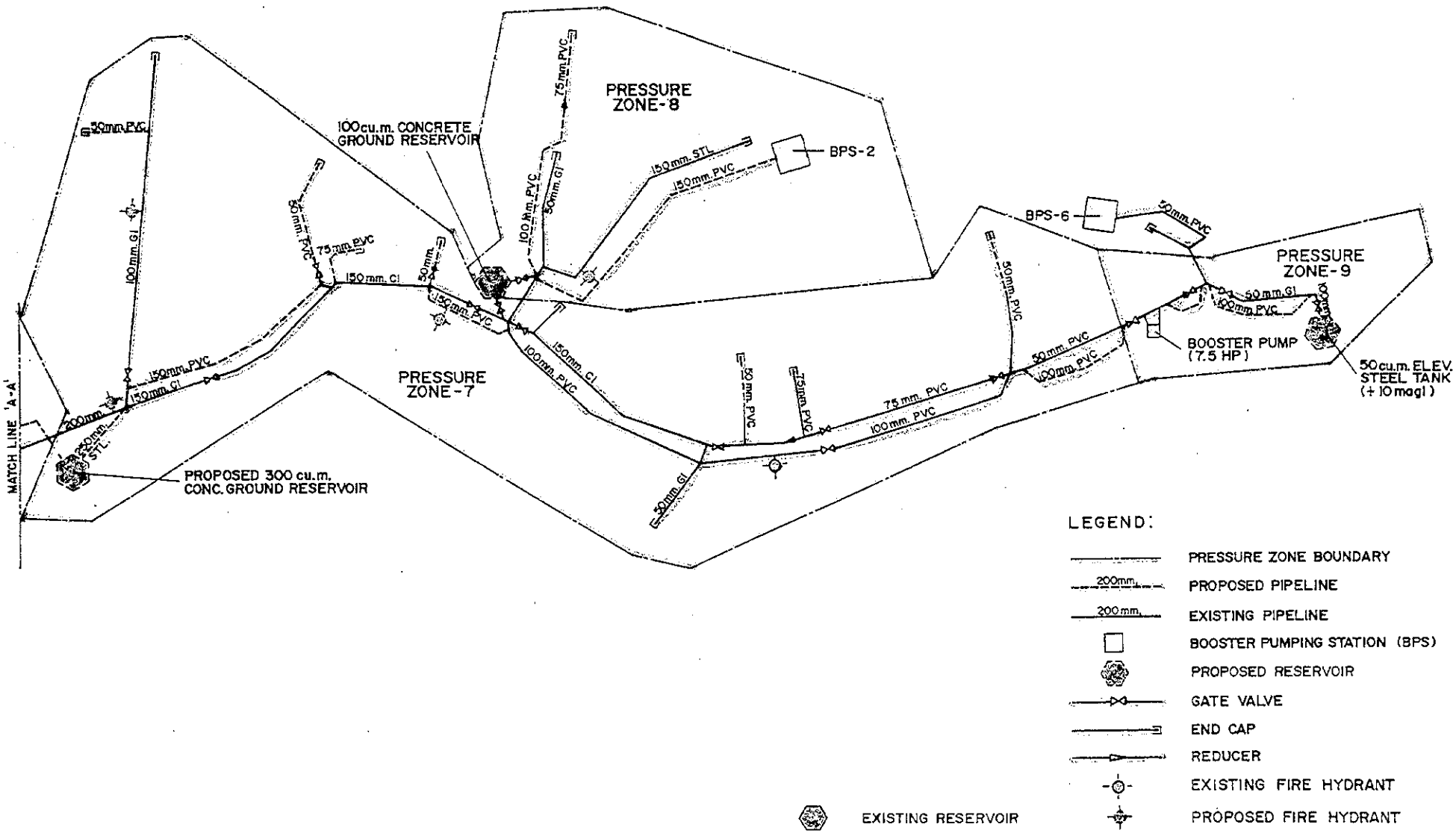
**Fig. 10.5-10** shows the relationship between water supply and demand when the recommended plan shall be implemented.




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE: 10.5 -8B<br>ALTERNATIVE - 2<br>SINGLE STEP PUMPING STATION SCHEME |
| JAPAN INTERNATIONAL COOPERATION AGENCY | TAGAYTAY WATER DISTRICT<br>TAGAYTAY, CAVITE |




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE : 10.5-9A |
| JAPAN INTERNATIONAL COOPERATION AGENCY | RECOMMENDED WATER SUPPLY SYSTEM TAGAYTAY CITY WATER DISTRICT TAGAYTAY, CAVITE |




| | |
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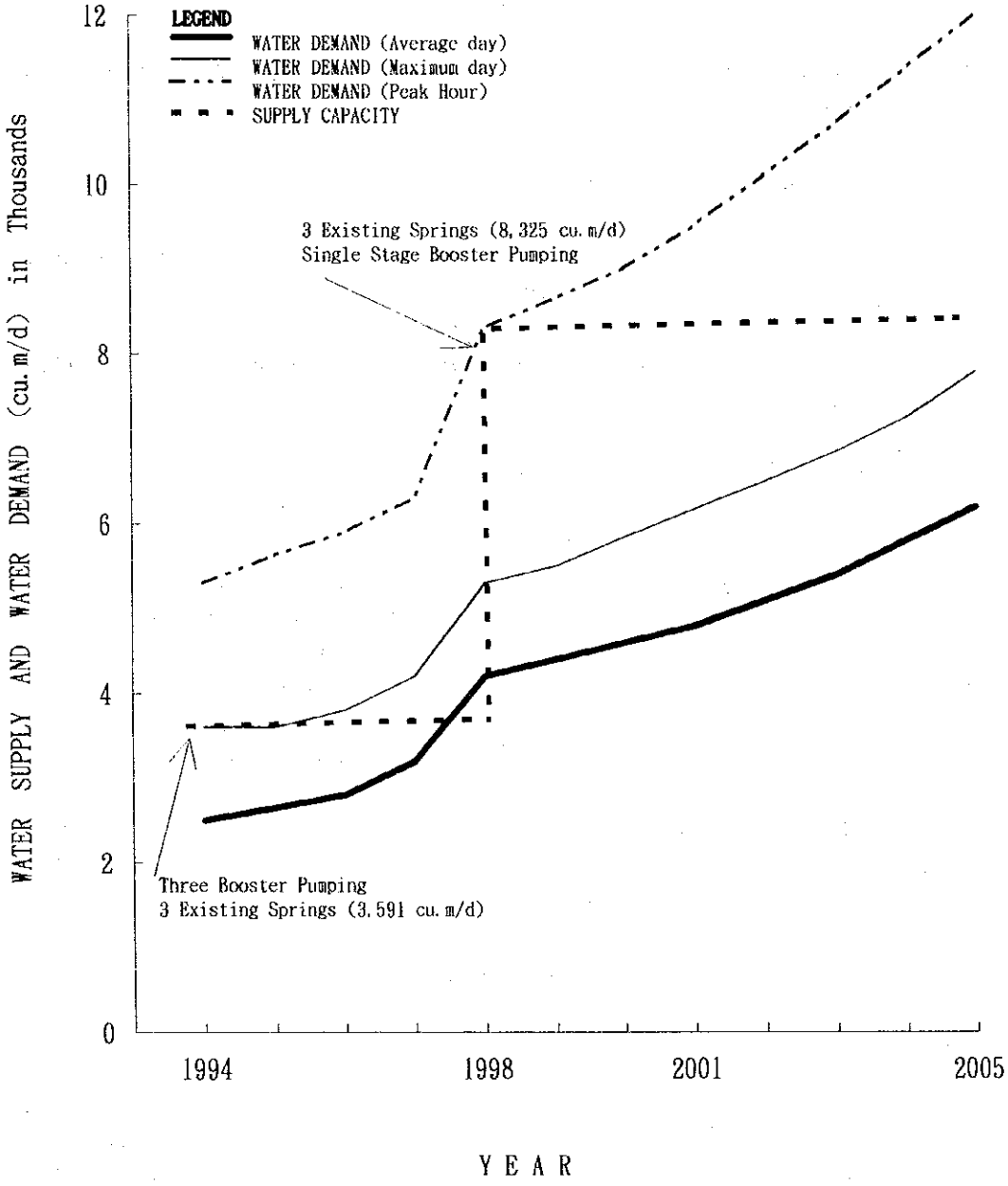
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE : 10.5-9B |
| JAPAN INTERNATIONAL COOPERATION AGENCY | RECOMMENDED WATER SUPPLY SYSTEM TAGAYTAY CITY WATER DISTRICT TAGAYTAY, CAVITE |

Fig. 10.5-10

WATER SUPPLY VS DEMAND CURVE OF RECOMMENDED PLAN
TAGAYTAY



(2) Proposed Facilities

The recommended plan for the TC-WD water supply system is to be constructed in one phase only. The proposed facilities of the recommended plan are as follows:

1) Laying 3.642 km of high pressure steel transmission lines.

2) Laying 25.425 km of distribution lines.

3) Installation of three sets of multi-stage high-head and high capacity turbine pump coupled to a 375 Hp electric motor.

4) Installation of a 7.5 Hp booster pump in node no 127.

5) Installation of water hammer protection device and high pressure valves and fittings along the 300 mm transmission lines.

6) Construction of eight (8) additional reservoirs in each zone, the capacity and type of which is shown below:

| Pressure Zone No. | Capacity ($m^3$) | Type |
|---|---|---|
| 2 | 250 | Concrete Ground Reservoir |
| 3 | 50 | Concrete Ground Reservoir |
| 4 | 25 | Concrete Ground Reservoir |
| 5 | 50 | Concrete Ground Reservoir |
| 6 | 100 | Concrete Ground Reservoir |
| 7 | 300 | Concrete Ground Reservoir |
| 8 | 100 | Concrete Ground Reservoir |
| 9 | 50 | Elevated Steel Tank |

7) Installation of 5 units of fire hydrants.

8) Installation of 449 new service connections.

9) rehabilitation of existing concrete ground reservoir.

10) Land acquisition (2000 $m^2$)

(3) Operation and Maintenance

As discussed in the previous section, the reservoir of PZN-1 and PZN-2 will supply water to all reservoir of each zone. A roving operator is needed to control the valves whenever reservoir of one zone is overflowing. A pressure switch will be installed in the booster pump of PZN-9. The pressure switch is set to shut off the pump before the water reach the overflow elevation of the proposed reservoir.

Water from the Kaybubutong Spring will be treated by the existing gas chlorinator in BPS No. 5.

Blow-off valves were provided in pipeline extremities for flushing purposes.

## 10.6 WATER SUPPLY PLAN FOR TANZA

### 10.6.1 Existing Water Supply System Facilities

The Tanza Water District (TAN-WD) is currently operating the water system in the Municipality of Tanza, which covers Bgy. Pob. 1-4. The facilities include a deepwell, pumping and storage facilities, treatment facilities and pipelines as indicated in **Fig. 10.6-1**.

(1) Source Facility

The TAN-WD utilize a deepwell which was constructed in 1990 as a source . This well is located in the municipal grounds of Tanza in Bgy Daang Amaya with a depth of 115m. The well has a 250 mm casing diameter from ground to 35 mbgl and 200 mm casing diameter from 35 m to 115 mbgl.

(2) Pumping Facilities

The pumping station is located in the municipal grounds of Tanza in Bgy Daang Amaya. This pumping station is equipped with an electric driven 40 Hp turbine pump with a rated capacity of 30 lps. Owing to the very few connection, water is pumped to the reservoir for only 1.5 hrs to 2 hrs daily. The plan of existing pumping station is shown in the **S/R**.

(3) Disinfection Facilities

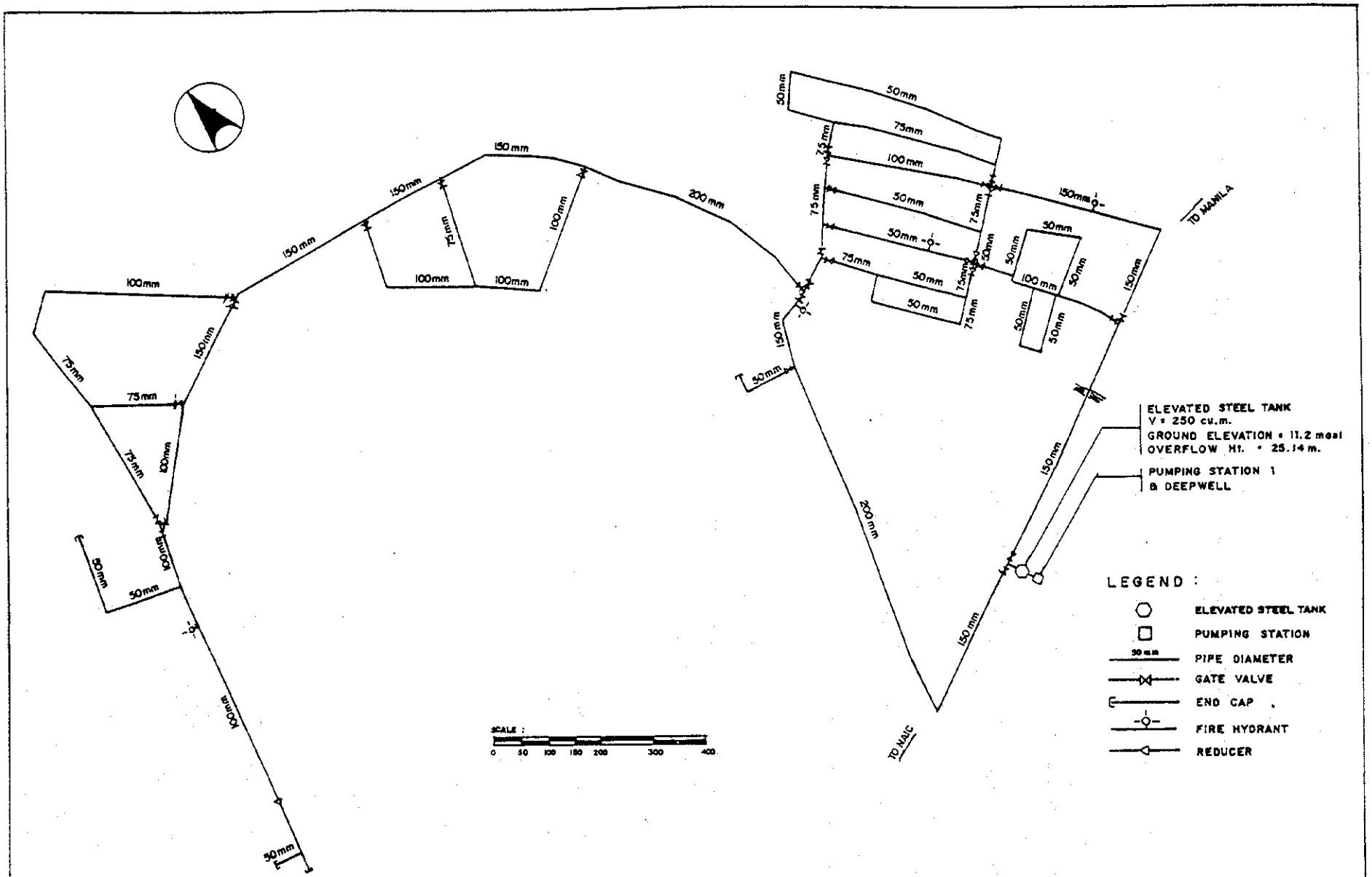
The water is treated using a hypochlorinator with a dosage of 3 ppm ensuring a free residual chlorine of 0.2 ppm along the extremities of the distribution network.

(4) Storage Facilities

TAN-WD has an elevated steel tank also located in the poblacion about 100m away from the deepwell. It has a capacity of 250 $m^3$ and an overflow height of 25.64 m (ground elevation = 11.2 masl). The plan of existing reservoir is shown in the **S/R**. The reservoir is used on a " fill -and-draw" basis.

(5) Transmission/Distribution Facilities

A total of 10,136 m of pipelines has been installed in 1993 ranging from 50 to 200 mm PVC.




| | |
|---|---|
| CAVITE WATER SUPPLY DEVELOPMENT STUDY | FIGURE : 10.6-1 |
| JAPAN INTERNATIONAL COOPERATION AGENCY | EXISTING WATER SUPPLY SYSTEM<br>TANZA WATER DISTRICT<br>TANZA , CAVITE |

(6) Valves and Hydrants

A total of 5 hydrants, 4 blow-off valves, and 30 gate valve has been installed with size ranging from 50 to 150 mm in diameter.

(7) Service Connection

As of October 1994, TAN-WD had 210 service connections (all classified as residential connections).

(8) Operation and Maintenance

The present operation and maintenance staff of TAN-WD includes the general manager and 5 personnel.

The schedule of water rates as of October 1994 are as follows:

| | 0-10 $m^3$ | 11-20 $m^3$ | 21-30 $m^3$ | over 30 $m^3$ |
|---|---|---|---|---|
| Residential/ Connection | 60.00 | 6.00/$m^3$ | 6.20/$m^3$ | 6.35/$m^3$ |

### 10.6.2 Deficiencies of the Existing System

During the field investigation conducted last October 1994, the deficiencies noted were the high color and turbidity units in their present source. Remedial measures are presently being conducted by LWUA.

### 10.6.3 Water Use Profile

The present water consumption in TAN-WD was analyzed to determine water accountability.

(1) Population Served

The average persons per household in the service area of TAN-WD is 5.2. The service area population of is 5,294 and the total population served is 1,315.

(2) Water Consumption

The water consumption of TAN-WD as recorded for the month ending August 1994 was 5,522 $m^3$. The average consumption per capita for domestic connections is 173 lpcd. The result is relatively high because the water district is only applying a residential category on all service connection.