2.3. Planned and On-Going Projects/Programs

(1) Water resources and flood control

The Regional Development Council of Region XI has established a series of flood control programs including drainage and shore protection as shown in Table 12.

Table 12 Proposed Water Resources and Flood Control Development Program by Province

Sub-sector Project/Program	Target	Location	Implementing Agency	Implemeting period (up to)	Project Cost up to 1998 (1000P)
1. Small water impounding management project (SWIP)					
a. Florida SWIP	1 project	Davao Province	DPWH	1996	2,000
b. San Nicolas SWIP	1 project	Davao del Sur	DPWH	1996	3,200
2. Upper Agusan flood control projects	1 project	Davao Province	DPWH	1998	101,569
3. Locally funded flood control drainage/ shore protection mini/sabo dams	149 projects	Regionwide	DPWH	1998	203,345
				Total	310,114

Source : "Updated regional Development Investment Program (RDIP) 1996 - 1998", the Regional Development Council.

They aim:

1) To prioritize the implementation of major river basin projects as identified by the National Water Resources Board,
2) To construct/rehabilitate and strengthen river/flood control systems,
3) To dredge constructed river mouths,
4) To implement the Small Water Impounding Management (SWIM) and mini-dam projects to serve as the first line of defense against floods as well as to provide water supply for irrigation and hydropower, and
5) To undertake non-structural methods of mitigating flood damages such as flood plain zoning, development regulations, flood forecasting and warning and reforestation.

The Small Water Impounding Project (SWIP), listed in the table above, is a component of other development projects by the Central Government.

The Davao City Water District (DCWD) now intends to alter the water sources from groundwater to surface water with the construction of dams. In its plan, the dam site along the Davao river have been identified as suitable locations for dam construction.

"The Master Plan Study on Flood Control and related Water Use Development in Davao Area" by DPWH is envisaged under foreign technical assistance. Major components of this study are:

1) Upper Agusan River Basin Development for flood control, watershed management, irrigation, multi-purpose dam and hydropower and water quality management,
2) Libuganon River Basin Development for flood control, irrigation, multi-purpose dam and hydropower, and
3) Davao City Development for urban flood control and river mouth improvement.

In addition, the City/Provincial Development Councils have proposed a number of river flooding control, urban drainage and seashore protection works as shown in Table 13.

Table 13 Proposed Flood Control Development Project by City/Province

Project/Program Category	Location	Implementation Period	Remarks
1. Davao Orental			Total fund
- Gabion, river bank revetment	Sumlog River, San	1997 - 2002	P 261 million
- Earth open channel	Panikian, Banaybanay, San Isidro, etc.	1997 - 2002	
- Concrete revetment for bank protection	Banaybanay, San Isidro, etc.	1997 - 2002	
- Extension of concrete revetment, etc.	Casuman, Manay, etc.	1997 -2000	
2. Davao Province			
- Rechanneling of Tag-ugama, Monkayo-Agusan River	Monkayo	1999	Total fund P 17 million
- Construction of San Miguel spur dike	Sto. Tomas	1998 - 2002	
- Construction of flap gate	Carmen	1998 - 2002	
3. Davao City			
- Improvement of Talomo River		1998 - 2001	
- Improvement of Matina River		1998 - 2001	
- Improvement of Davao River		1998 - 2001	
- Drainage of Lanang		1998 - 2001	
- Improvement of Mamay Creek		1998 - 2001	
4. Davao del Sur			
- River control works of Malalag, Sulop, Pongpong, Kinanga, Lebana River, etc.	Sta. Cruz, Digos, Malalag, Sulop, Malita, Hagonoy, Bansalan, Sta, Maria, Don Marcelino, etc.	1996 - 1998 1996 - 1998	Total fund P 203.9 million including the works after 1998
- Shore protection works	Sta. Cruz, Malita, Malalag		

Source : "City/Provincial Framework Plan", by City/Provincial PPDO.

The National Power Council (NPC), in the Power Development Program 1996, has proposed the hydropower projects in the DIDP Area as shown in Table 14, based on a long-term power demand forecast.

Table 14 Proposed Hydroelectric Project by NPC

Location/Name of River	Type of Development	Water Withdrawal (LPS)	Project Cost (million USD)	Installed Capacity (MW)	Status
Davao Oriental/Cateel River	Run-of-river	11,400	36.6	17.7	Feasibility study
Suwawan/Suwawan River	Run-of-river	8,100	18.3	18.3	Feasibility study
Tamugan/Tamugan River	Run-of-river	5,800		18.9	Feasibility study

Sources : NPC Development Plan

(2) Water supply

In the water supply sub-sector, a number of facility development projects ranging from Level I to Level III are on-going or proposed. The main development thrust is oriented to the service coverage expansion by the establishment of Level III in urban areas and by Level I in rural areas.

The Regional Development Council of Region XI has established the "Regional Development Investment Program (RDIP) in Region XI, 1994 - 1998". Along with its strategies for safe water development in rural areas, a number of Level I system construction projects are underway regionwide, with total fund of some ₱ 41,000 for about 2,000 units, as summarized in Table 15.

Also the City/Provincial Development Council have proposed diverse development plans including water source exploitation, distribution network expansion, etc. in urban and rural areas, as shown in Table 16.

Table 15 Proposed Water Supply Development Program by Province

Sub-sector Project/Program	Target	Location	Implementing Agency	Implemeting period (up to)	Project Cost up to 1998 (1000P)
1. Small water impounding management project (SWIP)					
a. Florida SWIP	1 project	Davao Province	DPWH	1996	2,000
b. San Nicolas SWIP	1 project	Davao del Sur	DPWH	1996	3,200
2. Upper Agusan flood control projects	1 project	Davao Province	DPWH	1998	101,569
3. Locally funded flood control drainage/ shore protection mini/sabo dams	149 projects	Regionwide	DPWH	1998	203,345
				Total	310,114

Source : "Updated regional Development Investment Program (RDIP) 1996 - 1998", the Regional Development Council.

Table 16 Proposed Water Supply Development Projects by City/Province

Project/Program Category	Location	Implementation Period	Remarks
1. Davao Oriental			Total fund P 18
- Level III gravity water supply area	Boston	1996 - 2002	million
- Level III pressure pumped water supply area	Banaybanay, Cateel, Tarragona	1996 - 2002	
- Level III water supply sources including reservoir			
- Level III water trunk pipeline			
2. Davao Province			
- Level III gravity fed water supply area	Mainit, Nabunturan, Kaputian,	1997 - 2002	Total fund P 47.5
- Level III pressure pumped water supply area	Nino, Asuncion, Tagum, Datu Abdul	1997 - 2002	million
- Level III water supply sources	Laak	1997 - 2002	
- Level III water supply trunk pipeline	Asuncion,Mawab, Sto. Tomas	1999 - 1999	
3. Davao City			
- Water supply system construction	Cabantian, Bunawan, Mandug	1996 - 2000	
- Water supply improvement	Toril	1996 - 2000	
- Watershed development program	Lipadas, Malagos, Mt.Apo national park	1996 - 2000	
- Surface water source development and protection	Lipadas, Baguio	1996 - 2000	
4. Davao del Sur			Total fund P 5.8
- Level III water supply construction and improvement	Sulop, Matanao	1996 - 1997	million
- Level II Waterworks	Bansalan	1997	
- Other water system	New Argo, Inawanan, Pangian, etc	1997 - 1998	
- Artesian Wells development	Malabang, Tanwalang, Kidalapong, Molopolo, etc.		
- Shallow wells	Provincewide	1996 - 1998	

Source : "City/Provincial Framework Plan", by City/Provincial PPDO.

(3) Sewerage

At present, there are neither specific on-going nor proposed development plan of sewerage system equipped with a wastewater treatment plant, except a limited number of facilities as urban storm water drainage. The development direction of water resources in the DIDP Area is presently oriented to the development of flood control and water supply without much consideration for urban environment betterment yet.

Chapter 3 Potentials and Constraints

3.1. Water Resources Potential

Given the climatic, hydrological, topographical and other natural conditions prevailing, the DIDP Area faces both opportunities with huge potentials and constraints to the regional development. The relatively even rainfall throughout the year and the steep slope of river basins tend to present high possibilities in such water utilization as irrigation for agricultural land and hydroelectric power generation with relatively modest investment for hydraulic facilities. On the other hand, they are likely to cause frequent and disastrous calamities by flash flood.

The total water resources potential is regarded as a sum of surface water and groundwater potentials. As understood before, the precise assessment of water resources potentials is difficult due to the deficiency of climatic and hydrological data and information. This implies that more integrated, intensive and consistent systems should be arranged to monitor the natural conditions in the DIDP Area. At the moment, it is important for this study to determine water resources potentials by using existing data and information, even with some assumptions.

Surface water

Of the total rainfall, the portion excluding evaporated and infiltrated water can be regarded to represent surface water potential. The mean annual rainfall in the DIDP Area has been determined by location based on the isohyet map in Figure 2. Runoff coefficients, theoretically, can be calculated using mean annual rainfall and observed discharge by each river. In the Study, a plausible value of the run-off coefficient is tentatively assumed based on previous studies. The results of the study undertaken by JICA previously in the Philippines show that the run-off coefficients are distributed in the range of 0.51 to 0.84 (Central Luzon Development Program, 1995). Thus, the run-off coefficient is assumed 0.6 in all water basins constantly in this study.

Groundwater

Of the total rainfall, the portion of water recharged into underground is accounted as groundwater potentials. In this study, 10% of the annual rainfall is applied based on the "Rapid Assessment of Water Supply Sources" by NWRC.

With respect to the water potentials in the likely drought year, the following ratios of that in normal year were derived for the five year return period, i.e. 80% probability (5 - year probability drought), based on the analysis of the rainfall records in past years.

- Davao Oriental : 76% (of the rainfall in the normal year),
- Davao Province : 81%,
- Davao City : 86%, and
- Davao del Sur : 86%.

Total potential

From the above, the overall water resources potential in the DIDP Area was identified to be annually some 30,000 million m^3 as detailed in Table 17. Of the total water resources potential in the DIDP Area, Davao Province accounts for 46%,

and Davao Oriental, Davao City and Davao del Sur account for 29%, 12% and 13%, respectively.

3.2. Development Constraints

The DIDP Area is characterized by relatively ample water resource endowments on the one hand, and modest provision of facilities for various water uses and water-related disaster prevention on the other. Despite the endowments, water availability is not high in peninsular or coastal areas, while lowland areas suffer from flooding. Water-related constraints facing the people in the DIDP Area have been identified through data analysis, site surveys and discussions, consisting of fundamental constraints and those specific to sub-sectors.

(1) Water resources policy, institutions and plans

There is no established policy nor a comprehensive plan for development and management of water resources in the DIDP Area. The National Water Master Plan, prepared by the JICA technical cooperation, covered four major river basins in the DIDP Area, accounting only for smaller than 50% of the entire DIDP land area. The Visayas-Mindanao Water Supply, Sewerage and Sanitation Master Plan also by JICA does not cover all the areas in the DIDP Areas and mainly specializing in rural development. An idea to establish an authority to oversee all the water-related activities in the Davao Gulf area seems logical as proposed, but none exists.

(2) Water resources and flood control

Water resources development

Water resources in the DIDP Area are generally under-developed. This is represented by low irrigation coverage of potentially irrigable area at 39% as of 1996. No sizable dam exists even in the major river basins except small schemes under the Small Water Impoundment Management (SWIM) Project.

Watershed management

Watershed areas in the DIDP Area have been degrading rapidly. Woodland area decreased from 8,630 km^2 in early 1980's to 5,012 km^2 in 1994. Various initiatives have been taken to increase the area under forests such as CBFM or IFMA, but no program covers the entire basin of any river. Degrading watershed increases sediment loads which affect downstream and coastal area.

Flood control

Habitual flooding affects productive agricultural land and urban areas along the mid- to lower reaches of major rivers. A number of flood mitigation measures have been taken in the Upper Agusan, the Tagum-Libuganon, the Davao, and the Padada rivers, but plain areas in these river basins still suffer from periodic flooding. Almost all areas along the large rivers are affected by flash floods due to narrow water basins, steep slopes, devastation of forest land, and inadequate agricultural land use and management in highland/hilly land area.

Urban drainage

Urban areas are expanding as population increases, and urban drainage is left under substandard conditions. This causes serious inundation with relatively small rainfalls in urban centers, especially in densely populated urban centers.

Table 17 Water Resources Potential in the DIDP Area

Province /Municipality	Total Land Area (km^2)	Rainfall (mm/y)	Surface Water in Normal Year (MCM/y)	Ground Water in Normal Year (MCM/y)	Total Water in Normal Year (MCM/y)
Davao Oriental					
Baganga	1,177.10	3,000	2,119	353	2,472
Banaybanay	419.30	1,700	428	71	499
Boston	337.30	3,300	668	111	779
Caraga	553.75	2,700	897	150	1,047
Cateel	467.12	3,250	911	152	1,063
Gov. Genereso	302.95	1,400	254	42	297
Lupon	227.22	2,000	273	45	318
Manay	479.64	2,400	691	115	806
Mati	681.80	1,500	614	102	716
San Isdro	205.20	1,400	172	29	201
Tarragona	312.88	2,000	375	63	438
Total	**5,164.26**		**7,402**	**1,234**	**8,635**
Davao Province					
Asuncion	187.12	2,500	281	47	327
Babak	73.40	1,700	75	12	87
Carmen	307.50	1,900	351	58	409
Compostela	187.50	2,900	326	54	381
Kapalong	1,112.77	2,600	1,736	289	2,025
Kaputian	117.50	2,400	169	28	197
Mabini	412.25	1,900	470	78	548
Maco	244.40	2,000	293	49	342
Mawab	159.52	2,750	263	44	307
Monkayo	692.89	2,800	1,164	194	1,358
Montevista	265.00	2,700	429	72	501
Nabunturan	235.39	2,500	353	59	412
New Bataan	678.60	2,700	1,099	183	1,283
New Corella	321.48	2,300	444	74	518
Panabo	282.18	1,900	322	54	375
Pantukan	420.13	1,800	454	76	529
Samal	89.60	1,700	91	15	107
Santo Tomas	320.41	2,000	384	64	449
Tagum	195.80	2,000	235	39	274
Maragusan	384.29	2,250	519	86	605
San Vicente	987.06	2,750	1,629	271	1,900
Talaingod	454.96	2,500	682	114	796
Total	**8,129.75**		**11,769**	**1,962**	**13,731**
Davao City					
District I	120.68		127	21	148
Poblacion	10.28	1,750	11	2	13
Talomo	110.40	1,750	116	19	135
District II	814.070		879	147	1,026
Agdao	4.89	1,800	5	1	6
Buhangin	87.33	1,800	94	16	110
Bunawan	65.50	1,800	71	12	83
Paquibato	656.35	1,800	709	118	827
District III	1,505.25		1,987	331	2,318
Baguio	75.31	2,200	99	17	116
Calinan	223.60	2,200	295	49	344
Marilog	752.04	2,200	993	165	1,158
Toril	131.30	2,200	173	29	202
Tugbok	323.00	2,200	426	71	497
Total	**2,440.00**		**2,993**	**499**	**3,492**
Davao del Sur					
Bansalan	157.75	2,300	218	36	254
Digos	267.87	2,000	321	54	375
Don Marcelino	407.30	1,600	391	65	456
Hagonoy	116.64	1,900	133	22	155
Jose Abad Santos	734.45	1,700	749	125	
Kiblawan	390.07	2,200	515	86	601
Magsaysay	169.87	2,300	234	39	273
Malalag	186.12	2,000	223	37	261
Malita	512.59	1,700	523	87	610
Matanao	202.40	2,200	267	45	312
Padada	45.03	1,900	51	9	60
Sta. Cruz	277.72	1,900	317	53	369
Sta. Maria	204.78	1,700	209	35	244
Sarangani	106.18	1,750	111	19	130
Sulop	155.26	2,000	186	31	217
Total	**3,934.03**		**4,450**	**742**	**4,317**
DIDP Total	**19,668.04**		**26,613**	**4,436**	**30,175**

Source : DIDP JICA Study Team

(3) Water supply

Domestic water supply

The main thrust of water supply is the service coverage expansion by establishment of Level III systems in urban areas and Level I in rural areas. The Government has set targets for population-based water service coverage at 95% in urban areas and 93% in rural areas by the year 2000. In the DIDP Area, the present service coverage is still remaining between 47% and 86% for different systems. Existing water supply sources are becoming inadequate in some urban areas due to limited quantity or degrading quality of groundwater sources.

Rural water supply and sanitation

Sanitation constitutes an important part of the minimum basic needs. This is not adequately satisfied in many rural communities deprived of safe drinking water, including indigenous cultural communities.

(4) Sewerage

Water pollution

Increasing concern in the DIDP Area is water pollution caused by improper land use and management, inappropriate mining activities, discharge of industrial and domestic wastewater, and dumping of solid wastes. The surface water of large rivers in the area is still suitable for both agricultural and domestic uses, except high turbidity due to severe erosion. However, the streams and canals flowing in urban centers have already contaminated by the discharge of domestic and commercial wastewater

Groundwater in some coastal areas suffer from salt water intrusion caused by over-exploitation. Groundwater in Davao City and Davao Province are increasingly contaminated by agro-chemicals and leachate from solid waste dumping sites.

Sewerage development

There exist no sewerage facilities with a treatment plant in the DIDP Area. Existing systems consist of quite limited extent of piped sewers or open ditches for storm water discharges. Domestic wastewater goes to septic tanks or directly to storm drains, canals, rivers and other natural disposal areas without treatment.

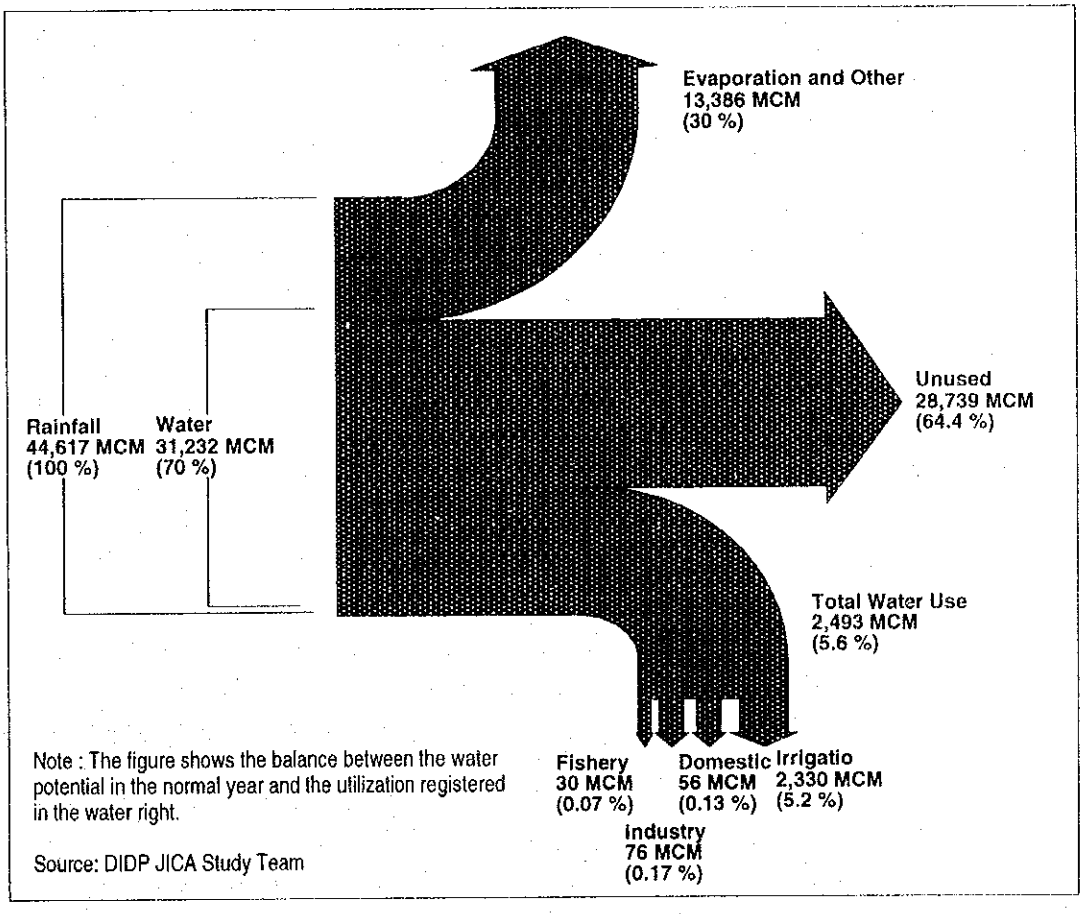
Chapter 4 Water Balance Analysis

4.1. Hydrological Balance Model

The total water resources potential in the DIDP Area is estimated at some 30,000 MCM/year in the normal year. Some 30% of the total rainfall in the DIDP Area is lost by evaporation and other reasons. Based on the registration records of water rights in NWRB, out of the total water potential, about 2,500 MCM/year (nearly 8%), excluding the hydropower generation uses, is presently utilized as water for a various socioeconomic activities, and the remaining 92% water is discharged into the sea through rivers without the utilization, as shown in Figure 7.

According to the registration records of water rights in NWRB, irrigation is by far the largest water consumer accounting for 93% of the total water use. This is followed by industrial uses (3.0%), domestic uses (2.2%), and fishery and other uses (1.8%).

Figure 7 Present Hydrological Water Balance Model



4.2. Water Demand Projection

Irrigation water

Based on the proposed DIDP development frameworks, the agriculture in the DIDP Area is envisioned to develop with the average GRDP growth at 2.9% annually toward 2016. The water demand for irrigation uses is conceived to increase as the

results of irrigation area expansion and intensified irrigation ratio. The irrigation water demand for paddy field and irrigated banana field, excluding rain-fed banana field, are presented in Table 18. These demand were computed based on the projected irrigation area, using the required unit rates as shown below.

- The required unit rate of rice : 2,600 mm/year, and
- The required unit rate of banana : 188 mm/year in Davao Oriental and Davao Province,
  250 mm/year in Davao City,
  313 mm/year in Davao del Sur.

Domestic water

Based on the proposed DIDP development frameworks, the population in the DIDP Area is envisioned to increase with the average 2.08% annually toward 2016 and the urbanization ratio is deemed to increase from 41.6% at present to 57.1% in 2016. The water demand for domestic uses by households, commerce, institutions, services and others is conceived to increase toward 2016 due to the rise of total and urban population. The domestic water demand, which contains the water for commerce, services and institutions in urban and rural areas are tabulated in Table 19. These demands were computed based on the population number, the water service ratios and other conditions, which are detailed in Section 6.2.

Industrial water

Based on the proposed DIDP development frameworks, the industry in the DIDP Area is envisioned to develop with the average GRDP growth at 8.5% annually toward 2016. The water demand for industrial uses is conceived to increase, keeping pace with industrial growth. The industrial water demand, including the water for livestock and fisheries, is shown in Table 19. Industrial water demand was computed based on the employment number estimated by the industry sector, the required unit rates ranging from 0.25 to 6.0 m^3/day/worker depending on the industry sub-sectors. The water demand for livestock and fisheries was estimated in proportion to maximum plausible GRDP growth rate at 6.0% annually.

4.3. Transition of Water Demand

The water demand projection indicates that the water demand in 2016 for irrigation, domestic and industrial uses will reach 1.5 times, 3.4 times and 1.8 times as much as the present, respectively. In the whole of the DIDP Area, as shown in Table 20, the water potential is far beyond the total water demand at the time of 2016, indicating that the water utilization ratio in 2016 stays up to 10% even in a drought year.

Davao Province, as shown in Figure 8, will continue to be by far the largest water consumer toward 2016, because it is endowed with vast agricultural lands around the Tagum-Libuganon River and the Upper Agusan River. Unlike the other provinces in the DIDP Area, Davao City will have a predominant portion (some 84% of the total demand) of domestic and industrial water demand. This reflects that Davao City accommodates a large-scale urban centers with huge population and major industrial zones.

Table 18 Irrigation Water Demand

Province /Municipality	Irrigation Area (ha)				Required Unit Rate (mm/year)		Water Demand (MCM/year)	
	Rice		Banana					
	1998	2016	1998	2016	Rice	Banana	1998	2016
Davao Oriental								
Baganga	310	650	-	-	2,600	188	8.1	16.9
Banaybanay	2,288	2,413	-	-	2,600	188	59.5	62.7
Boston	-	70	-	-	2,600	188	0.0	1.8
Caraga	170	435	-	-	2,600	188	4.4	11.3
Cateel	515	2,070	-	-	2,600	188	13.4	53.8
Governor Generoso	200	338	-	-	2,600	188	5.2	8.8
Lupon	75	721	-	-	2,600	188	2.0	18.7
Manay	-	265	-	-	2,600	188	0.0	6.9
Mati	-	520	-	-	2,600	188	0.0	13.5
San Isidro	-	-	-	-	2,600	188	0.0	0.0
Tarragona	-	40	-	-	2,600	188	0.0	1.0
Total	**3,558**	**7,522**	**-**	**-**			**92.5**	**195.6**
Davao Province								
Asuncion	4,156	4,506	-	-	2,600	188	108.1	117.2
Babak	-	50	-	-	2,600	188	0.0	1.3
Carmen	6,510	6,510	2,473	2,473	2,600	188	173.9	173.9
Compostela	3,659	3,659	-	-	2,600	188	95.1	95.1
Kapalong	609	839	-	-	2,600	188	15.8	21.8
Kaputian	-	150	-	-	2,600	188	0.0	3.9
Mabini	-	20	-	-	2,600	188	0.0	0.5
Maco	24	44	-	-	2,600	188	0.6	1.1
Mawab	308	394	-	-	2,600	188	8.0	10.2
Monkayo	439	811	-	-	2,600	188	11.4	21.1
Montevista	88	918	-	-	2,600	188	2.3	23.9
Nabunturan	-	100	-	-	2,600	188	0.0	2.6
New Bataan	170	270	-	-	2,600	188	4.4	7.0
New Corella	344	8,434	-	-	2,600	188	8.9	219.3
Panabo	60	115	6,014	6,014	2,600	188	12.8	14.3
Pantukan	115	235	-	-	2,600	188	3.0	6.1
Samal	-	-	-	-	2,600	188	0.0	0.0
Santo Tomas	9,730	10,280	2,470	2,470	2,600	188	257.6	271.9
Tagum	15	15	2,082	2,082	2,600	188	4.3	4.3
Maragusan	400	1,330	-	-	2,600	188	10.4	34.6
San Vicente	-	550	-	-	2,600	188	0.0	14.3
Talaingod	27	27	-	-	2,600	188	0.7	0.7
Total	**26,654**	**39,257**	**13,039**	**13,039**			**717.5**	**1,045.1**
Davao City								
Poblacion	0	0	-	-	2,600	250	0.0	0.0
Talomo	0	120	-	-	2,600	250	0.0	3.1
Agdao	0	0	-	-	2,600	250	0.0	0.0
Buhangin	0	0	-	-	2,600	250	0.0	0.0
Bunawan	0	0	-	-	2,600	250	0.0	0.0
Paquibato	10	10	-	-	2,600	250	0.3	0.3
Baguio	0	0	-	-	2,600	250	0.0	0.0
Calinan	25	155	1,449	1,449	2,600	250	4.3	7.7
Marilog	5	5	-	-	2,600	250	0.1	0.1
Toril	0	120	1,833	1,833	2,600	250	4.6	7.7
Tugbok	5	5	1,455	1,455	2,600	250	3.8	3.8
Total	**45**	**415**	**4,737**	**4,737**			**13.0**	**22.6**
Davao del Sur								
Bansalan	1,420	2,347	-	-	2,600	313	36.9	61.0
Digos	774	1,164	-	-	2,600	313	20.1	30.3
Don Marcelino	-	100	-	-	2,600	313	0.0	2.6
Hagonoy	3,585	3,585	900	900	2,600	313	96.0	96.0
J.A. Santos	-	-	-	-	2,600	313	0.0	0.0
Kiblawan	114	346	-	-	2,600	313	3.0	9.0
Magsaysay	3,577	4,337	-	-	2,600	313	93.0	112.8
Malalag	65	65	-	-	2,600	313	1.7	1.7
Malita	-	220	-	-	2,600	313	0.0	5.7
Matanao	3,432	4,574	-	-	2,600	313	89.2	118.9
Padada	-	160	-	-	2,600	313	0.0	4.2
Santa Cruz	-	-	-	-	2,600	313	0.0	0.0
Santa Maria	90	118	-	-	2,600	313	2.3	3.1
Sarangani	-	-	-	-	2,600	313	0.0	0.0
Sulop	-	100	-	-	2,600	313	0.0	2.6
Total	**13,057**	**17,116**	**900**	**900**			**342.3**	**447.8**
The Whole DIDP Area	**43,314**	**64,310**	**18,676**	**18,676**			**1,165.3**	**1,711.2**

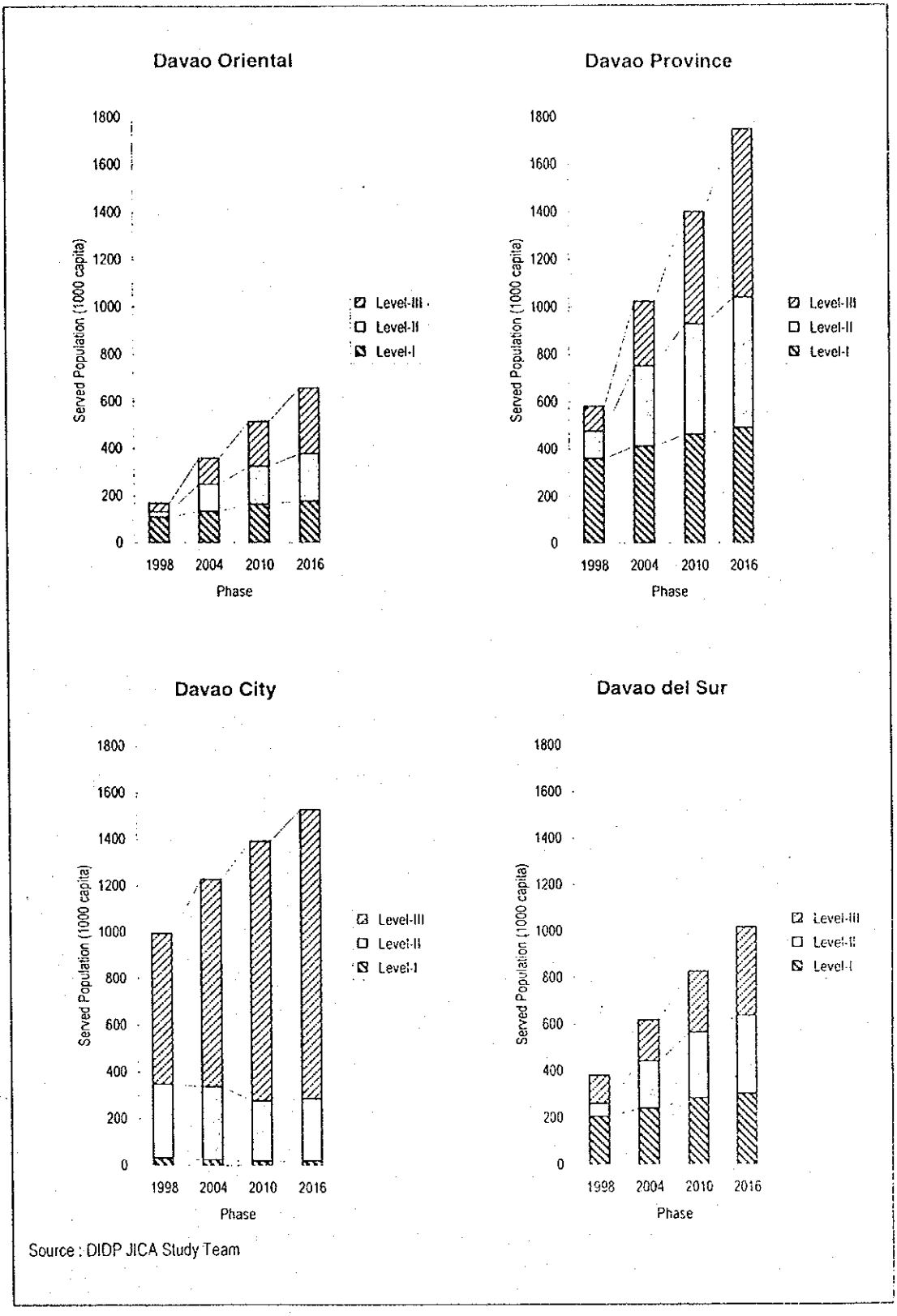
Note : The irrigation area of banana by rain fed is uncounted.
Source : DIDP JICA Study Team

Table 19 Domestic and Industrial Water Demand

Province / Municipality	Domestic Water Demand (MCM/year)				Industrial Water Demand (MCM/year)			
	1998	2004	2010	2016	1998	2004	2010	2016
Davao Oriental								
Baganga	0.4	1.1	1.8	2.6	0.0	0.1	0.4	0.6
Banaybanay	0.4	1.0	1.8	2.6	0.0	0.1	0.1	0.1
Boston	0.1	0.2	0.4	0.5	0.0	0.0	0.0	0.0
Caraga	0.3	0.7	1.2	1.7	0.0	0.0	0.0	0.0
Cateel	0.2	0.6	0.9	1.3	0.0	0.0	0.0	0.0
Gov. Genereso	0.3	0.7	1.1	1.6	0.0	0.0	0.0	0.0
Lupon	0.5	1.5	2.8	4.2	0.3	0.4	0.6	0.6
Manay	0.3	0.9	1.6	2.2	0.0	0.0	0.0	0.0
Mati	1.0	2.9	5.3	8.3	0.2	0.7	1.7	2.4
San Isdro	0.3	0.7	1.1	1.6	0.0	0.0	0.0	0.0
Tarragona	0.1	0.4	0.6	0.9	0.0	0.0	0.0	0.0
Total	**3.9**	**10.9**	**18.8**	**27.6**	**0.5**	**1.3**	**2.7**	**3.7**
Davao Province								
Asuncion	0.5	1.0	1.6	2.2	0.0	0.0	0.0	0.0
Babak	0.3	0.7	1.2	1.6	0.0	0.0	0.0	0.0
Carmen	0.5	1.1	1.9	2.8	0.0	0.0	0.0	0.0
Compostela	0.6	1.3	2.0	2.7	0.2	0.3	0.4	0.4
Kapalong	0.6	1.3	2.0	2.8	0.0	0.1	0.1	0.1
Kaputian	0.2	0.5	0.8	1.1	0.0	0.0	0.0	0.0
Mabini	0.3	0.7	1.2	1.8	0.0	0.0	0.0	0.0
Maco	0.5	1.1	1.8	2.5	0.0	0.0	0.0	0.0
Mawab	0.4	0.8	1.2	1.7	0.0	0.0	0.0	0.0
Monkayo	0.6	1.4	2.2	2.9	0.1	0.1	0.2	0.2
Montevista	0.3	0.7	1.1	1.4	0.0	0.0	0.0	0.0
Nabunturan	0.6	1.2	2.0	2.8	0.0	0.3	0.3	0.5
New Bataan	0.4	1.0	1.6	2.3	18.9	18.9	18.9	18.9
New Corella	0.4	1.0	1.6	2.3	0.0	0.0	0.0	0.0
Panabo	1.7	3.9	7.2	11.0	0.0	1.1	2.7	4.3
Pantukan	0.6	1.3	2.1	2.7	20.5	20.5	20.5	20.5
Samal	0.2	0.5	0.7	1.0	0.0	0.0	0.0	0.0
Santo Tomas	1.0	2.1	3.7	5.3	0.4	0.6	0.8	0.8
Tagum	2.5	5.7	10.7	16.4	2.7	4.5	6.9	8.4
Maragusan	0.4	0.8	1.3	1.8	0.0	0.0	0.0	0.0
San Vicente	0.4	1.0	1.5	2.0	0.0	0.0	0.0	0.0
Talaingod	0.2	0.4	0.6	0.8	0.0	0.0	0.0	0.0
Total	**13.4**	**29.5**	**50.0**	**72.0**	**43.0**	**46.3**	**50.8**	**53.9**
Davao City								
Poblacion	6.4	7.6	8.2	8.0	0.0	0.0	0.0	0.0
Talomo	11.6	16.7	22.1	25.8	4.5	6.2	8.6	8.6
Agdao	4.1	5.5	6.8	7.4	0.0	0.0	0.0	0.0
Buhangin	8.2	12.8	17.4	20.7	0.0	2.8	6.3	8.9
Bunawan	3.7	5.3	7.2	9.5	0.8	1.1	1.5	1.5
Paquibato	0.4	0.6	1.0	1.2	0.0	0.0	0.0	0.0
Baguio	0.2	0.5	1.1	1.2	0.0	0.0	0.0	0.0
Calinan	1.4	2.1	3.3	4.2	0.0	0.0	0.0	0.0
Marilog	0.4	0.6	0.9	1.3	0.0	0.0	0.0	0.0
Toril	2.8	4.6	7.5	9.0	19.6	28.2	40.1	41.2
Tugbok	1.2	2.0	3.3	4.3	1.0	1.4	1.9	1.9
Total	**40.3**	**58.3**	**78.9**	**92.6**	**25.8**	**39.6**	**58.4**	**62.0**
Davao del Sur								
Bansalan	0.8	1.4	2.1	2.8	0.0	0.0	0.0	0.0
Digos	2.1	3.7	6.2	9.1	0.0	0.0	1.2	1.9
Don Marcelino	0.2	0.6	1.1	1.7	0.0	0.0	0.0	0.0
Hagonoy	0.7	1.2	1.9	2.7	0.0	0.0	0.1	0.1
Jose Abad Santos	0.5	0.9	1.4	1.9	0.0	0.0	0.0	0.0
Kiblawan	0.4	0.8	1.1	1.5	0.0	0.0	0.0	0.0
Magsaysay	0.5	0.9	1.4	1.8	0.0	0.0	0.0	0.0
Malalag	0.4	0.7	1.1	1.6	0.0	0.0	0.4	0.4
Malita	1.0	1.9	2.9	4.1	0.1	0.1	0.1	0.1
Matanao	0.4	0.8	1.2	1.6	0.0	0.0	0.0	0.0
Padada	0.3	0.5	0.8	1.1	0.0	0.0	0.0	0.0
Sta. Cruz	1.6	2.7	4.4	6.6	2.4	4.5	7.0	8.2
Sta. Maria	0.5	0.9	1.4	1.9	0.0	0.0	0.0	0.0
Sarangani	0.2	0.4	0.6	0.9	0.0	0.0	0.0	0.0
Sulop	0.4	0.6	0.9	1.3	0.0	0.0	0.0	0.0
Total	**10.0**	**18.0**	**28.5**	**40.4**	**2.6**	**4.7**	**8.8**	**10.6**
DIDP Total	**67.7**	**116.7**	**176.2**	**232.6**	**71.9**	**91.8**	**120.7**	**130.2**

Note : The Industrial water demand of household-size industries is included in the domestic water.
Source : DIDP JICA Study Team

Figure 8 Water Demand Transition by City/Province



Source : DIDP JICA Study Team

Table 20 Water Balance in the DIDP Area

(Unit : MCM/year)

Item		City/Province				Total DIDP Area
		Davao Oriental	Davao Province	Davao City	Davao del Sur	
Water Potential						
Surface Water		7,402	11,769	2,993	4,450	26,614
Groundwater		1,234	1,962	497	742	4,435
Total Potential (Normal Year)	①	8,635	13,731	3,492	5,191	31,049
Total Potential (5-Year Drought)	②	6,563	11,122	3,003	4,464	25,152
Water Demand at Present (in 1998)						
Irrigation		92.5	717.0	13.0	342.3	1,165.0
Domestic		3.9	13.4	40.3	10.1	67.6
Industry		0.5	43.0	25.8	2.6	71.9
Total	③	96.9	773.4	79.1	354.9	1,304.3
Water Demand in 2016						
Irrigation		195.6	1,045.1	22.6	447.8	1,711.1
Domestic		27.6	72.0	92.6	40.4	232.6
Industry		3.7	53.9	62.0	11.0	130.6
Total	④	226.9	1,171.0	177.2	499.2	2,074.3
Water Utilization Ratio (%)						
In 1998 (Normal Year)	= ③ / ①	1.1	5.6	2.3	6.8	4.2
In 1998 (Drought Year)	= ③ / ②	1.5	7.0	2.6	8.0	5.2
In 2016 (Normal Year)	= ④ / ①	2.6	8.5	5.1	9.6	6.7
In 2016 (Drought Year)	= ④ / ②	3.5	10.5	5.9	11.2	8.2

Source: JICA Study Team

4.4. Results of Water Balance Analysis

The ratio of the water demand to the water potential is defined as the water utilization ratio. At present, surface water is used mainly for irrigation, while groundwater is main water sources for domestic and industries, except a few places or cases. Incorporating such water uses by water sources to examine the balance between the water demand and the water potential, the water utilization of surface water to irrigation water and groundwater to domestic and industrial water is shown in Table 21 and Table 22 respectively.

Surface water

From the comparison between the irrigation water demand and the surface water potential, at the time of 2016, the following municipalities are found to have higher utilization ratio than 20%.

- Davao Oriental : Banaybanay,
- Davao Province : Compostela, Asuncion, Carmen, New Corella, Santo Tomas, and
- Davao del Sur : Bansalan, Hagonoy, Magsaysay, Matanao.

Of these municipalities, the highest utilization is conceivable in Asuncion, Carmen, New Corella and Santo Tomas which belong to the Tagum-Libuganon River basin, indicating that the water balance in these areas will become quite tight. Considering the fluctuation in both the water potential and seasonal variation of water demand, it is necessary to prepare proper countermeasures for possible water deficits such as water impounding in these areas, water diversion within the basin, etc. Likewise,

Bansalan, Hagonoy, Magsaysay and Matanao lying in the Padada River basin should also be prepared for possible water shortages in the future.

Groundwater

From the comparison between the domestic and industrial water demand, and the groundwater potential, at the time of 2016, the following municipalities are found to have higher utilization ratio than 20%.

- Davao Province : Panabo, Tagum,
- Davao City : Poblacion, Talomo, Agdao, Buhangin, Bunawan, Toril, Tugbok, and
- Davao del Sur : Digos, Sta. Cruz.

These areas are core urban centers in the DIDP Area, belonging to a provincial center or a PAIC center. Massive water demand for households, industries, etc. is attributable to such tightness in the water balance. In these areas, drying up of groundwater, ground subsiding, and, in case of coastal areas, sea water intrusion, are likely to occur in the future.

Especially in District I and District II in Davao City, consisting of Poblacion, Agdao, Talomo, etc., the water demand has been already far beyond the groundwater potential in its own area at present. Almost all the current water sources in the Davao City Water District (DCWD) are relying on the groundwater within its area and the vicinity without cautious monitoring. Such impediments as ground subsiding and contamination may arise in the near future. Therefore, in the long-run, it will become crucial to convert water sources from groundwater to surface water.

From the above water balance for both surface water and groundwater, it is justified that the areas with future water tightness have to be prepared for: i) adequate and strategic management and conservation of water basin to improve the capacity of water retarding and water recharging into underground, and ii) proper quantitatively and qualitatively monitoring for hydrological conditions such as rainfall, surface water and groundwater.

These results based on the analysis by municipality should be further followed up by the examination by water basin with more precise and geographic data and information.

Table 21 Comparison between Surface Water Potential and Demand

Province / Municipality	Irrigation Water Demand (MCM/year)				Surface Water Utilization Ratio (%) in Normal Year				Surface Water Utilization Ratio (%) in 5-year drought			
	1998	2004	2010	2016	1998	2004	2010	2016	1998	2004	2010	2016
Davao Oriental												
Baganga	8.1	11.0	14.0	16.9	0.4	0.5	0.7	0.8	0.5	0.7	0.9	1.0
Banaybanay	59.5	60.6	61.7	62.7	13.9	14.2	14.4	14.7	18.3	18.6	19.0	19.3
Boston	0.0	0.6	1.2	1.8	0.0	0.1	0.2	0.3	0.0	0.1	0.2	0.4
Caraga	4.4	6.7	9.0	11.3	0.5	0.7	1.0	1.3	0.6	1.0	1.3	1.7
Cateel	13.4	26.9	40.3	53.8	1.5	2.9	4.4	5.9	1.9	3.9	5.8	7.8
Gov. Generoso	5.2	6.4	7.6	8.8	2.0	2.5	3.0	3.5	2.7	3.3	3.9	4.5
Lupon	2.0	7.5	13.1	18.7	0.7	2.8	4.8	6.9	0.9	3.6	6.3	9.0
Manay	0.0	2.3	4.6	6.9	0.0	0.3	0.7	1.0	0.0	0.4	0.9	1.3
Mati	0.0	4.5	9.0	13.5	0.0	0.7	1.5	2.2	0.0	1.0	1.9	2.9
San Isidro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tarragona	0.0	0.3	0.7	1.0	0.0	0.1	0.2	0.3	0.0	0.1	0.2	0.4
Total	**92.5**	**126.9**	**161.2**	**195.6**	**1.2**	**1.7**	**2.2**	**2.6**	**1.6**	**2.3**	**2.9**	**3.5**
Davao Province												
Asuncion	108.1	111.1	114.1	117.2	38.5	39.6	40.7	41.7	47.5	48.9	50.2	51.5
Babak	0.0	0.4	0.9	1.3	0.0	0.6	1.2	1.7	0.0	0.7	1.4	2.1
Carmen	173.9	173.9	173.9	173.9	49.6	49.6	49.6	49.6	61.2	61.2	61.2	61.2
Compostela	95.1	95.1	95.1	95.1	29.2	29.2	29.2	29.2	36.0	36.0	36.0	36.0
Kapalong	15.8	17.8	19.8	21.8	0.9	1.0	1.1	1.3	1.1	1.3	1.4	1.6
Kaputian	0.0	1.3	2.6	3.9	0.0	0.8	1.5	2.3	0.0	0.9	1.9	2.8
Mabini	0.0	0.2	0.3	0.5	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1
Maco	0.6	0.8	1.0	1.1	0.2	0.3	0.3	0.4	0.3	0.3	0.4	0.5
Mawab	8.0	8.8	9.5	10.2	3.0	3.3	3.6	3.9	3.8	4.1	4.5	4.8
Monkayo	11.4	14.6	17.9	21.1	1.0	1.3	1.5	1.8	1.2	1.6	1.9	2.2
Montevista	2.3	9.5	16.7	23.9	0.5	2.2	3.9	5.6	0.7	2.7	4.8	6.9
Nabunturan	0.0	0.9	1.7	2.6	0.0	0.2	0.5	0.7	0.0	0.3	0.6	0.9
New Bataan	4.4	5.3	6.2	7.0	0.4	0.5	0.6	0.6	0.5	0.6	0.7	0.8
New Corella	8.9	79.1	149.2	219.3	2.0	17.8	33.6	49.4	2.5	22.0	41.5	61.0
Panabo	12.8	13.3	13.8	14.3	4.0	4.1	4.3	4.4	4.9	5.1	5.3	5.5
Pantukan	3.0	4.0	5.1	6.1	0.7	0.9	1.1	1.3	0.8	1.1	1.4	1.7
Samal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Santo Tomas	257.6	262.4	267.1	271.9	67.0	68.2	69.5	70.7	82.7	84.2	85.8	87.3
Tagum	4.3	4.3	4.3	4.3	1.8	1.8	1.8	1.8	2.3	2.3	2.3	2.3
Maragusan	10.4	18.5	26.5	34.6	2.0	3.6	5.1	6.7	2.5	4.4	6.3	8.2
San Vicente	0.0	4.8	9.5	14.3	0.0	0.3	0.6	0.9	0.0	0.4	0.7	1.1
Talaingod	0.7	0.7	0.7	0.7	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	**717**	**827**	**936**	**1,045**	**6.1**	**7.0**	**8.0**	**8.9**	**7.5**	**8.7**	**9.8**	**11.0**
Davao City												
Poblacion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Talomo	0.0	1.0	2.1	3.1	0.0	0.9	1.8	2.7	0.0	1.0	2.1	3.1
Agdao	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buhangin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bunawan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paquibato	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Baguio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calinan	4.3	5.4	6.5	7.7	1.4	1.8	2.2	2.6	1.7	2.1	2.6	3.0
Marilog	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toril	4.6	5.6	6.7	7.7	2.6	3.2	3.8	4.4	3.1	3.8	4.5	5.2
Tugbok	3.8	3.8	3.8	3.8	3.3	3.3	3.3	3.3	3.8	3.8	3.8	3.8
Total	**13.0**	**16.2**	**19.4**	**22.6**	**0.4**	**0.5**	**0.6**	**0.7**	**0.5**	**0.6**	**0.7**	**0.9**
Davao del Sur												
Bansalan	36.9	45.0	53.0	61.0	17.0	20.6	24.3	28.0	19.7	24.0	28.3	32.6
Digos	20.1	23.5	26.9	30.3	6.3	7.3	8.4	9.4	7.3	8.5	9.7	10.9
Don Marcelino	0.0	0.9	1.7	2.6	0.0	0.2	0.4	0.7	0.0	0.3	0.5	0.8
Hagonoy	96.0	96.0	96.0	96.0	72.2	72.2	72.2	72.2	84.0	84.0	84.0	84.0
Jose Abad Santos	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kiblawan	3.0	5.0	7.0	9.0	0.6	1.0	1.4	1.7	0.7	1.1	1.6	2.0
Magsaysay	93.0	99.6	106.2	112.8	39.7	42.5	45.3	48.1	46.1	49.4	52.7	55.9
Malalag	1.7	1.7	1.7	1.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9
Malita	0.0	1.9	3.8	5.7	0.0	0.4	0.7	1.1	0.0	0.4	0.8	1.3
Matanao	89.2	99.1	109.0	118.9	33.4	37.1	40.8	44.5	38.8	43.1	47.5	51.8
Padada	0.0	1.4	2.8	4.2	0.0	2.7	5.4	8.1	0.0	3.1	6.3	9.4
Sta. Cruz	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sta. Maria	2.3	2.6	2.8	3.1	1.1	1.2	1.4	1.5	1.3	1.4	1.6	1.7
Sarangani	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sulop	0.0	0.9	1.7	2.6	0.0	0.5	0.9	1.4	0.0	0.5	1.1	1.6
Total	**342**	**377**	**413**	**448**	**7.7**	**8.5**	**9.3**	**10.1**	**8.9**	**9.9**	**10.8**	**11.7**
DIDP Total	**1,165**	**1,347**	**1,529**	**1,711**	**4.4**	**5.1**	**5.7**	**6.4**	**5.3**	**6.1**	**7.0**	**7.8**

Note : The water utilization ratio is defined as : Ratio = (water Demand)/(Water Potential) x 100 (%).

Source : DIDP JICA Study Team

Table 22 Comparison between Groundwater Potential and Demand

Province / Municipality	Domestic and industrial Water Demand (MCM/year)				Groundwater Water Utilization Ratio (%) in Normal Year				Groundwater Water Utilization Ratio (%) in 5-Year drought			
	1998	2004	2010	2016	1998	2004	2010	2016	1998	2004	2010	2016
Davao Oriental												
Baganga	0.4	1.2	2.3	3.3	0.1	0.3	0.6	0.9	0.1	0.4	0.8	1.2
Banaybanay	0.4	1.1	1.9	2.7	0.6	1.5	2.7	3.8	0.7	2.0	3.5	5.0
Boston	0.1	0.2	0.4	0.5	0.1	0.2	0.3	0.5	0.1	0.3	0.4	0.6
Caraga	0.3	0.7	1.2	1.7	0.2	0.5	0.8	1.1	0.2	0.7	1.1	1.5
Cateel	0.2	0.6	0.9	1.3	0.1	0.4	0.6	0.9	0.2	0.5	0.8	1.1
Gov. Genereso	0.3	0.7	1.1	1.6	0.7	1.7	2.7	3.8	0.9	2.2	3.5	5.0
Lupon	0.8	1.9	3.3	4.8	1.8	4.2	7.3	10.5	2.3	5.6	9.6	13.8
Manay	0.3	0.9	1.6	2.2	0.3	0.8	1.4	1.9	0.4	1.1	1.8	2.5
Mati	1.2	3.6	7.0	10.7	1.2	3.6	6.9	10.5	1.6	4.7	9.0	13.8
San Isidro	0.3	0.7	1.1	1.6	0.9	2.4	4.0	5.7	1.2	3.1	5.3	7.5
Tarragona	0.1	0.4	0.6	0.9	0.2	0.6	1.0	1.4	0.3	0.8	1.3	1.9
Total	**4.4**	**12.1**	**21.5**	**31.3**	**0.4**	**1.0**	**1.7**	**2.5**	**0.5**	**1.3**	**2.3**	**3.3**
Davao Province												
Asuncion	0.5	1.1	1.6	2.2	1.1	2.3	3.5	4.7	1.4	2.8	4.3	5.8
Babak	0.3	0.7	1.2	1.6	2.6	5.8	9.5	13.2	3.2	7.1	11.7	16.3
Carmen	0.5	1.1	1.9	2.8	0.9	2.0	3.3	4.9	1.1	2.4	4.0	6.0
Compostela	0.8	1.5	2.4	3.1	1.5	2.8	4.4	5.8	1.9	3.5	5.5	7.1
Kapalong	0.6	1.3	2.1	2.8	0.2	0.5	0.7	1.0	0.3	0.6	0.9	1.2
Kaputian	0.2	0.5	0.8	1.1	0.9	1.8	2.8	3.9	1.1	2.3	3.5	4.8
Mabini	0.3	0.7	1.2	1.8	0.4	0.9	1.6	2.3	0.5	1.1	1.9	2.8
Maco	0.5	1.1	1.8	2.6	1.1	2.3	3.7	5.3	1.4	2.9	4.6	6.5
Mawab	0.4	0.8	1.2	1.7	0.8	1.7	2.8	3.9	1.0	2.1	3.5	4.8
Monkayo	0.7	1.5	2.3	3.1	0.4	0.8	1.2	1.6	0.5	1.0	1.5	2.0
Montevista	0.3	0.7	1.1	1.4	0.5	1.0	1.5	2.0	0.6	1.2	1.8	2.5
Nabunturan	0.6	1.5	2.3	3.3	1.1	2.5	3.9	5.5	1.3	3.1	4.8	6.8
New Bataan	0.4	1.0	1.6	2.3	0.2	0.5	0.9	1.3	0.3	0.6	1.1	1.5
New Corella	0.4	1.0	1.6	2.3	0.6	1.3	2.2	3.2	0.7	1.6	2.7	3.9
Panabo	1.7	5.0	9.9	15.2	3.2	9.3	18.4	28.4	3.9	11.5	22.7	35.0
Pantukan	0.6	1.3	2.1	2.7	0.8	1.7	2.7	3.6	1.0	2.2	3.4	4.5
Samal	0.2	0.5	0.7	1.0	1.4	3.0	4.7	6.4	1.8	3.7	5.8	7.9
Santo Tomas	1.4	2.7	4.5	6.1	2.2	4.2	7.0	9.5	2.7	5.2	8.6	11.7
Tagum	5.2	10.2	17.7	24.7	13.3	26.0	45.1	63.1	16.4	32.1	55.7	78.0
Maragusan	0.4	0.8	1.3	1.8	0.5	1.0	1.5	2.1	0.6	1.2	1.9	2.6
San Vicente	0.4	1.0	1.5	2.0	0.2	0.4	0.6	0.7	0.2	0.4	0.7	0.9
Talaingod	0.2	0.4	0.6	0.8	0.2	0.3	0.6	0.7	0.2	0.4	0.7	0.9
Total	**56.5**	**75.8**	**100.8**	**125.9**	**2.9**	**3.9**	**5.1**	**6.4**	**3.6**	**4.8**	**6.3**	**7.9**
Davao City												
Poblacion	6.4	7.6	8.2	8.0	356	421	455	443	414	489	529	515
Talomo	16.0	22.9	30.7	34.4	83.0	118	159	178	97	138	185	207
Agdao	4.1	5.5	6.8	7.4	403.4	537	661	726	469	625	768	844
Buhangin	8.2	15.7	23.8	29.5	52.3	99.6	151	188	61	116	176	218
Bunawan	4.5	6.4	8.7	10.9	37.8	54.0	73.6	92.8	43.9	62.8	85.6	108
Paquibato	0.4	0.6	1.0	1.2	0.4	0.7	1.3	1.5	0.5	0.9	1.5	1.7
Baguio	0.2	0.5	1.1	1.2	0.1	0.2	0.6	0.7	0.1	0.3	0.7	0.8
Calinan	1.4	2.1	3.3	4.2	2.8	4.3	6.6	8.6	3.2	5.0	7.7	10.0
Marilog	0.4	0.6	0.9	1.3	0.4	0.6	1.0	1.4	0.5	0.7	1.1	1.6
Toril	22.4	32.7	47.7	50.2	77.4	113	165	174	90	132	192	202
Tugbok	2.2	3.4	5.2	6.2	11.3	17.6	27.0	32.0	13.1	20.4	31.4	37.3
Total	**66.1**	**97.9**	**137.3**	**154.6**	**13.0**	**19.3**	**27.1**	**30.5**	**15.2**	**22.5**	**31.5**	**35.5**
Davao del Sur												
Bansalan	0.8	1.4	2.1	2.8	2.3	3.8	5.7	7.6	2.7	4.5	6.6	8.9
Digos	2.2	3.8	7.3	11.0	4.0	7.0	13.7	20.5	4.7	8.2	15.9	23.8
Don Marcelino	0.2	0.6	1.1	1.7	0.3	0.9	1.6	2.6	0.4	1.0	1.9	3.0
Hagonoy	0.8	1.3	2.0	2.7	3.4	5.7	8.9	12.3	4.0	6.7	10.3	14.3
Jose Abad Santos	0.5	0.9	1.4	1.9	0.4	0.7	1.1	1.5	0.4	0.9	1.3	1.8
Kiblawan	0.4	0.8	1.1	1.5	0.4	0.9	1.3	1.8	0.5	1.0	1.5	2.1
Magsaysay	0.5	0.9	1.4	1.8	1.3	2.4	3.5	4.7	1.5	2.8	4.1	5.4
Malalag	0.4	0.7	1.5	2.0	1.0	1.9	4.0	5.3	1.1	2.2	4.7	6.2
Malita	1.1	2.0	3.0	4.2	1.2	2.2	3.5	4.8	1.4	2.6	4.0	5.6
Matanao	0.4	0.8	1.2	1.6	0.9	1.8	2.6	3.5	1.1	2.1	3.1	4.1
Padada	0.3	0.5	0.8	1.1	3.5	6.3	9.7	13.3	4.1	7.3	11.2	15.5
Sta. Cruz	4.0	7.2	11.5	14.7	7.6	13.6	21.8	27.9	8.9	15.8	25.3	32.5
Sta. Maria	0.5	0.9	1.4	1.9	1.4	2.6	3.9	5.3	1.7	3.1	4.6	6.2
Sarangani	0.2	0.4	0.6	0.9	1.1	2.1	3.3	4.6	1.3	2.5	3.8	5.3
Sulop	0.4	0.6	0.9	1.3	1.2	2.0	3.0	4.1	1.4	2.4	3.5	4.8
Total	**12.6**	**22.7**	**37.3**	**51.0**	**1.7**	**3.1**	**5.0**	**6.9**	**2.0**	**3.6**	**5.8**	**8.0**
DIDP Total	**139.6**	**208.5**	**296.9**	**362.8**	**3.1**	**4.7**	**6.7**	**8.2**	**3.8**	**5.7**	**8.1**	**9.9**

Note : The water utilization ratio is defined as : Ratio = (water Demand)/(Water Potential) x 100 (%).
Source : DIDP JICA Study Team

Chapter 5 Development Strategies

5.1. Sector Objectives

The overall objectives for the long-term water resources development are:

- To establish systems which utilize relatively rich water resources in the DIDP Area to the maximum extent and on the sustainable bases, and
- To restructure mitigation measures for water-related disasters and negative impacts caused by water uses.

In pursuing the long-term objectives, the following short-term concerns shall be addressed:

- To remedy urgently serious damages or problems existing at present, and
- To take first-step measures for provision of various water use facilities to be improved in view of their functions over the long-term.

5.2. Basic Strategy

In the projects/programs of sector development, the following approaches should be laid down, commonly to all the water resources sub-sectors.

Approach with integrated water basin management

Almost all water basins in the DIDP Area are observed to suffer from denudation of forest land and consequent soil erosion and silting, etc. to varying degrees. In the long-term, the integrated water basin management is the most effective and efficient approach encompassing all water resources sub-sectors: water resources development, flood control and drainage, and water supply. This approach comprised a series of measures ranging from structural measures and non-structural ones. Given the current worsening situation of watersheds in the DIDP Area, afforestation and reforestation aiming at the conservation of upper watersheds is deemed crucial. It is also important that proper land use regulation is applied to respective water basins. From the natural environmental viewpoint, this approach could contribute to conservation of the terrestrial (land and river) and marine ecosystem.

Community-participatory approach

Active and continuous community participation is essential for effective and efficient implementation of projects/programs and enhancement of demand-side awareness in all the water resources sub-sectors. Local communities shall play an important role in any stage of planning, implementation, monitoring, etc. for reforestation works in watershed management, water supply, small water impounding management (SWIM), flood forecasting and warning and so on. Naturally, close coordination between local communities together with NGO' s and government agencies would become more essential.

5.3. Specific Strategies

The three fundamental alternative strategies for the DIDP development, namely Internal Integration Strategy, Globalization Drive Strategy and High Tech – High Services Strategy share some principal development ideology into the sector strategies of the water resources.

Watershed restoration/enhancement, multi-purpose dam plan and the assurance of access to safe water by SWIM are regarded as a essential component of the Internal Integration strategy which aims at maximum and sustainable use of indigenous resources. The development of water supply, flood control and drainage and sewerage development, and the systematic provision of water resources monitoring would support the Globalization strategy. The High Tech – High Service strategy would justify water recycling and energy recovery with sludge treatment.

These DIDP fundamental strategies are incorporated into the development direction in water resources sector presented in the following.

(1) Water resources and flood control

Water resources development

The water balance analysis identified that certain areas would likely face significant tight balance in the future due to the increasing water demand for agriculture or domestic and industrial uses. While this naturally justifies the necessity of multi-purpose dams and river water diversions in the long-term, the careful consideration should be incorporated into such water resources development related to the influences in social-economic and natural environment.

Flood control

The plain lands of major river basins coincide almost perfectly with the most active and indispensable areas for socioeconomic activities in the DIDP Area. Accordingly, it is essential for the entire DIDP Area that these areas are free from flood damages. Both urgent structural measures and comprehensive flood protection schemes should be undertaken.

In terms of flash-flood mitigation measures, urgent alleviation using structural measures should be undertaken primarily to protect built-up areas, arterial roads and main bridges. Besides, the restoration of water retarding capacity in water basins by reforestation and other suitable measures is crucial in the long-run.

Urban drainage

A long-term urban drainage development plan should be enacted in line with urban planning and flood control around rivers. On the other hand, in the large urban centers, urban drainage systems need a series of immediate rehabilitation and reinforcement in the short-term.

Water resources assessment and monitoring system

Improvement and reinforcement of a water resources assessment and monitoring system is necessary to evaluate surface water and groundwater in terms of both quantity and quality. Observed results would contribute to proper and multi-dimensional management of water resources, and lead to the independent and precise management by water basins.

SWIM scheme

The SWIM scheme shall be more extensively applied in the form of small-scale integrated watershed management/program providing water for irrigation, domestic and also mini-hydro power generation, if applicable.

(2) Water supply

In water supply for domestic use, the most important consideration is to expand service coverage by safe water, which is at some 60% at present in the population number base. In both urban and rural areas of the DIDP Area, much more efforts and investments for water supply sector are required to keep pace with the regional development.

Urban water supply

- In the short-term, all urban centers shall be served by pipe-born water supply system. Such pipe-born systems shall be developed as Level III in principle to meet the requirement of service level, except sparsely populated urban areas using existing Level II systems.
- Pipe-born water supply shall be expanded in the industrial zones newly constructed in PAICs areas and tourism centers to be created along with tourism development plans.
- Cost effectiveness, besides service coverage expansion, shall be pursued in urban water supply. Therefore, along with new construction of facilities, improvement and rehabilitation of existing water supply facilities are essential,
- In the long-term, surface water utilization may be introduced in large urban centers, like Davao City, with huge water demand to secure stable water availability and to avoid excess extraction of groundwater.

Rural water supply

- Consistent efforts to develop and expand in rural water supply should be made for currently deprived areas. Extensive and immediate provision, mainly by Level I or Level II systems, are crucial to meet the "Minimum Basic Needs (MBNs)" in rural areas.
- Community involvement shall play an important role for effective and efficient implementation of projects/programs. Communities are expected to participate in construction works such as well drilling, material transportation, installation of equipment and pipes, etc. as labor forces, as well as common participatory activities.

(3) Sewerage

Domestic wastewater

Introduction of sewerage systems equipped with domestic wastewater treatment is needed to preserve sanitary living environs and amenity in urban centers. In the short-term, the highest priority shall be accorded to core urban centers accommodating densely populated areas and tourism centers. Besides, the reclamation and reuse of treated sewage should be introduced in the long-term to save water resources and enhance water users' awareness for water saving.

Industrial wastewater

Comprehensive countermeasures for all kinds of polluted industrial wastewater are needed to meet relevant regulatory standards. Also, the monitoring activities against the industrial wastewater treatment and discharge should be reinforced. The reclamation and reuse of treated industrial wastewater should be progressively

introduced to save water resources and reduce the pollution loads to be discharged into the environment.

Chapter 6 Development Plan

6.1. Water Resources and Flood Control

6.1.1. Development direction and components

In the water resources and flood control sub-sector of the DIDP Area, a number of development needs have been identified as follows.

1) The certain areas would likely become significantly tight in the water balance by 2016 due to the increasing water demand for agriculture or domestic and industrial uses. This justifies the necessity of multi-purpose dams and river water diversions in the long-term.

2) Comprehensive flood mitigation is essential to maintain and enhance socioeconomic activities in the prime water basins. This should coordinate urgent countermeasures and integrated planning in the long-term.

3) Urgent and appropriate alleviation measures against flash floods are crucial for habitually afflicted areas throughout the entire DIDP Area.

4) Urban drainage systems are calling for immediate rehabilitation and reinforcement to modify presently incomplete structures in large urban centers. Together, these areas should be protected by comprehensive drainage networks in the long-run.

5) Establishment of a water resources assessment and monitoring system is necessary to evaluate surface water and groundwater in terms of both quantity and quality.

6) Extensive application of the SWIM scheme in isolated areas should be emphasized to provide flood mitigation as well as water supply to the areas with small water basins as a multi-purpose project.

(1) Water resources development and management

Comprehensive water resources development and flood mitigation measures are essential to enhance socioeconomic activities in the plain areas of prime water basins. The results of the water balance analysis indicates that the tight water balance is anticipated toward 2016 in the following areas.

For surface water

- Davao Oriental : Banaybanay,
- Davao Province : Compostela, Asuncion, Carmen, New Corella, Santo Tomas, and
- Davao del Sur : Bansalan, Digos, Hagonoy, Magsaysay, Matanao.

For groundwater

- Davao Province : Panabo, Tagum,
- Davao City : Poblacion, Talomo, Agdao, Buhangin, Bunawan, Toril, Tugbok, and
- Davao del Sur : Digos, Sta. Cruz.

Of these areas, the most impending problems for irrigation water have been found in Asuncion, Carmen and Santo Tomas which belong to the Tagum-Libuganon River Basin and in Compostela which belongs to the Upper Agusan River Basin. Meanwhile, the tight balance for domestic and industrial water has been revealed in the area around the urban centers of Davao City, Panabo-Tagum, Sta. Cruz-Digos.

Incorporating such anticipated future water balance in the DIDP Area, the establishment of holistic plans for water resources development and management is required particularly for the following basins:

- The Upper Agusan River Basin,
- The Tagum-Libuganon River Basin,
- The Tuganay River Basin and the Lasang River Basin,
- The Davao River Basin, and
- The Cebulan River Basin and the Padada River Basin.

(2) Flood control

Plain lands in major water basins

Up to now, a number of flood mitigation measures have been undertaken in major water basins: the Upper Agusan River, the Tagum-Libuganon River, the Davao River and the Padada River. Despite such long-term endeavors, plain lands in major water basins still suffer from periodical flooding, to greater or lesser degrees. The plain lands of these basins coincide almost perfectly with the most active and indispensable areas for socioeconomic activities in the DIDP Area.

Accordingly, it is essential for the entire DIDP Area that these areas are free from flood damages. Aside from some urgent mitigation applying conventional structural measures to be undertaken in the short-term, comprehensive flood protection schemes, as shown in Figure 9, should be undertaken more intensively on the long-term base, properly associated with land use, agriculture and urban development in respective areas.

Flash flood-prone areas

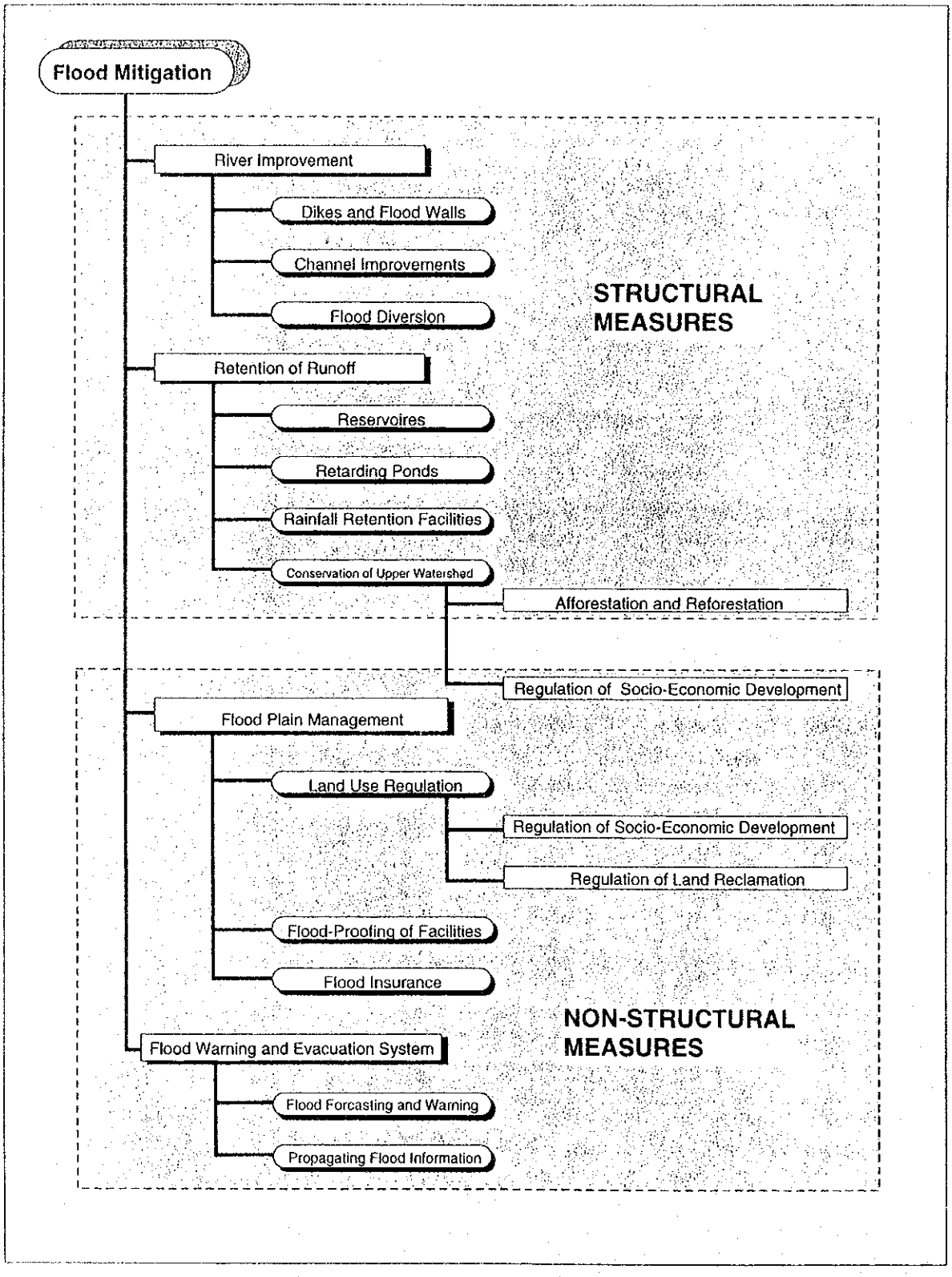
Almost all areas located along principal rivers in the DIDP Area has been affected by flash floods due to narrow water basins, steep slope, devastation of forest land, etc. This has caused habitual and painful impediments in the areas.

Flash flood prevention measures need to be taken for the following rivers, including their tributaries in some cases:

- Davao Oriental : Sumlog, Baguan, Quinaman, Baguian, Casuman, Manay, Caraga, Lanunayao, Baganga, Dapnan, Cateel,
- Davao Province : Lasang, Kingking,
- Davao City : Lim Dan, Talomo, Tagonol, and
- Davao del Sur : Margus, Tabayon, Murabatuan, Culman, Calian, Siblan.

In the short-term, urgent alleviation using structural measures should be undertaken primarily to protect built-up areas, arterial roads and main bridges. Besides, the restoration of water retarding capacity in water basins by reforestation and other suitable measures is crucial in the long-run.

Figure 9 General Flood Control Measures



(3) Urban drainage

While large urban centers in the DIDP Area have expanded their urban areas with population increase, it has been found that urban drainage in the areas has been left under substandard conditions. This is why even small rainfall may cause serious inundation here and there. Naturally, a long-term urban drainage development plan should be enacted in line with urban planning and flood control along and around rivers. On the other hand, in the large urban centers, especially in Davao City and other provincial capitals, urban drainage systems need a series of immediate rehabilitation and reinforcement in the short-term.

(4) Water resources assessment and monitoring system

Incorporating maximum and sustainable utilization of water resources in the entire DIDP Area, especially in the areas which the future tight water balance are foreseen, improvement and reinforcement of a water resources assessment and monitoring system is necessary to evaluate surface water and groundwater in terms of both quantity and quality. Necessary and proper means, depending the subject areas, should be introduced based on the short-term and long-term plans. The system to be introduced shall be selected properly from:

- Meteorological measurement (rainfall, temperature, sunshine, etc.),
- River water gauging (run-off, water stage, etc.),
- Groundwater assessment equipment employing monitoring wells,
- Water quality analysis, and
- Data processing instrument.

Observed results would contribute to proper and multi-dimensional management of water resources and lead to the independent and precise management of respective water basins.

(5) SWIM scheme

Urgent and appropriate alleviation measures against flashflood are crucial for habitually afflicted areas throughout the entire DIDP Area. A SWIM scheme shall be more extensively applied to areas located in relatively small watersheds without available groundwater sources and often suffering from flash floods, not only for irrigation water supply but also for flood-proof provision, drinking water supply, etc.

Such a SWIM scheme should become more effective and feasible in the form of small-scale integrated watershed management/program providing water for irrigation, domestic and also mini-hydropower generation, if applicable. In this scheme, community participation would play an important role through planning, implementation and operation.

NIA has already launched a series of the SWIM projects targeting mainly at irrigation water supply. The sites of the SWIM scheme proposed here will be increased and selected including candidate sites planned by NIA, incorporating the needs for flood prevention, drinking water supply, hydropower generation, etc.

6.1.2. Proposed development projects/programs

The proposed projects/programs incorporate the development components mentioned above. While some of the development components enumerated in the above are not taken up here directly, they are considered to be associated with the

proposed projects/programs or be substantiated as the result of the other initiative projects/programs concerned.

The following proposed projects/programs for water resources and flood control are detailed in Project Report:

WR - 01: Integrated Watershed Management Program (refer to Project No. EN-10 in the Project Report),

WR - 02: Comprehensive Water Resources Development Project in Tagum-Libuganon River Basin,

WR - 03: Water Resources Assessment and Monitoring System Reinforcement Program,

WR - 04: Flood Control and Drainage Reinforcement Project in Upper Agusan River,

WR - 05: Urgent Drainage Rehabilitation Project in the Urban Center of Davao City,

WR - 06: Comprehensive Flood Control and Drainage Development Project in the urban Center of Davao City,

WR - 07: Flash Flood Prevention Program in Principal Rivers, and

WR - 08: Expansive Deployment Program of Small Water Impounding Management.

6.2. Water Supply

6.2.1. Development direction

In the water supply sector, a number of development needs have been identified as follows.

1) Upgrading and expansion of pipe-born water supply by Level III systems are demanded in all urban centers including industrial and tourism centers. Surface water utilization may be introduced in urban centers with huge water demand and shortages of groundwater.

2) Consistent efforts are necessary to develop and expand rural water supply for currently deprived areas to meet the MBNs in rural areas.

3) Improvement and rehabilitation of existing water supply facilities are essential, since old and insufficient facilities contribute to the lower service level and the high water leakage in water distribution.

4) Active and continuous community participation is crucial for effective and efficient implementation of projects/programs and enhancement of demand-side awareness by water users.

(1) Service coverage target

In water supply for domestic use, the most important consideration is to expand service coverage by safe water, which remains at some 60% at present on the population base. In both urban and rural areas of the DIDP Area, much more efforts and investments for water supply are required to keep pace with the regional development. Considering various service coverage targets at the national level and the regional level in Southern Mindanao, service coverage targets in 2016 to be

pursued are determined to be 98% coverage for the DIDP Area as a whole, or 95% for rural population and 100% for urban population, as shown in Table 23.

Table 23 Service Coverage Target of Water Supply

Items	Service Coverage (population number base)		
	Urban Population	Rural Population	Overall Area
DIDP Target in 2016 (Proposed)	100% 8% by Level II 92% by Level III	95% 47.5% by Level I 47.5% by Level II (including negligible part of Level III)	98% 20% by Level I 25% by Level II 53% by Level III
National Target in 2000	95%	93%	94%
Target of Southern Mindanao Region in 1998	Not specified	Not specified	98%

Source : JICA Study Team

(2) Water consumption rate

The present unit water consumption (per capita daily consumption) is reported to range from 100 to 130 lit/day/cap in urban areas and 30 to 50 lit/day/cap in rural areas. The unit water consumption is foreseen to increase year by year, and 150 lit/day/cap and 60 lit/day/cap of water consumption in the target year of 2016 are proposed for urban and rural water supply, respectively, as shown Table 24.

Table 24 Water Consumption Rate

Water Supply Categories	Present (lit/day/cap)	2016 (lit/day/cap)
Urban Water Supply (Level III or Level-II)	100 to 130	150
Rural Water Supply (Level II or Level I, including negligible part of Level III)	30 to 50	60

Source : JICA Study Team

(3) Prioritization criteria of rural water supply

In rural water supply, extensive and immediate provision, mainly by Level-I or Level II systems, are crucial to meet the "MBNs" . Given the limited financial resources, the rural water supply development should be implemented according to adequate priority order.

The prioritization methodology for rural water supply, as shown in Table 25, is recommended. This methodology is established based on; i) the per capita municipal income (PCMI) and the internal revenue allotment (IRA) as a parameter representing financial status, and ii) the incidence of diarrhea and the unserved household ratio as a parameter representing sanitation conditions.

(4) Framework of service coverage expansion

In order to attain the targets mentioned above, Level I, Level II and Level III systems need the additional facilities for some 283,000 people, 838,000 people and 1,706,000 people up to 2016, respectively, as shown in Table 26. The corresponding construction cost up to 2016 is estimated roughly at some ₱ 11,000 million in total.

Water supply expansion toward 2016, therefore, should be proceeded in accordance with proper priority order in line with the DIDP Master Plan.

6.2.2. Development components

For the water supply in each City/provinces of the DIDP Area, the transitions of development toward 2016 and the served population by municipality in respective phases are shown in Figure 10 and Table 27. Municipalities are selected based on prioritization order listed in Table 28.

Davao Oriental

The incremental provision for a total of 488,000 people, consisting of 68,000 people of Level I, 178,000 people of Level II and 242,000 people of Level III, is required in Davao Oriental toward 2016.

In urban water supply development, Level III system should be developed in early stage in core urban centers in the province, such as Mati, Lupon, Baganga, Manay and Cateel. For rural water supply development mainly by Level I system, the early implementation should take place according to the proposed priority order in selected barangays of the prioritized municipalities, such as Caraga, Manay, Cateel, San Isidro, Lupon, Tarragona, Boston and Baganga.

Davao Province

The incremental provision for a total of 1,168,000 people, consisting of 131,000 people of Level-I, 435,000 people of Level-II and 602,000 people of Level-III, is required in Davao Province toward 2016.

In urban water supply development, Level III system should be developed in early stage in core urban centers in the province, such as Tagum, Nabunturan, Panabo, Island Garden City of Samal, Compostela, Monkayo, Kapalong and Maco. For rural water supply development mainly by Level I system, the early implementation should take place according to the proposed priority order in the selected barangays of the prioritized municipalities, such as Monkayo, Carmen, Kaputian, Samal and Panabo.

In water supply development of Davao Province, the utilization of surface water as a water source will become the issue in the future to prevent excessive extraction of groundwater in the area along Panabo-Tagum Conurbation Area, as detailed in Section 4.3 of this report.

Davao City

The incremental provision for a total of 636,000 people, consisting of 38,000 people of Level II and 598,000 people of Level III, is required in Davao City toward 2016. Mainly Level III is expanded in urban areas. The development of Level I and Level II systems will not be required due to high urbanization.

In urban water supply development, Level III system should be developed in early stage in the sub-districts having relatively low service coverage at present, such as Tugbok, Bunawan and Toril.

In water supply development of Davao City, the utilization of surface water as a water source will become a crucial issue in the future to prevent excessive extraction of groundwater, as detailed in Section 4.3 of this report.

Table 25 Prioritization Criteria for Rural Water Supply

The Priority for needed municipalities are examined the following formula:

Priority Score = $(X_{mi} + X_{ir})$ x 0.15 + X_{id} x 0.2 + X_{uh} x 0.5

1. **Financial resources** - total weight of 30%, broken down into:

   A. **Per Capita Municipal Income (PCMI)(X_{mi})** - equal to 1995 municipal income divided by municipal population. The lower the PCMI, the higher the score, (Weight = 15%).

   B. **Internal Revenue Allotment (IRA) (X_{ir})** - equal to 1995 municipal internal revenue allotment. The lower the IRA, the higher the score, (Weight = 15%).

2. **Incidence of diarrhea (X_{id})** - 20%. This is equal to the 1996 diarrhea cases divided by municipality' s total population times 100,000. Municipalities with high incidence of diarrhea shall be given the higher scores:

3. **Households (HHs) unserved by safe water (X_{uh})** - 50% weight. This is equal to the percentage of HHs unserved by safe water in a given barangay. The greater the proportion of HHs unserved by safe water, the higher the score.

Evaluated Items	Ranges	Score
1. Per Capita Municipal Income	Unit : Peso/month	
	0 - 200	10
	201 - 400	8
	401 - 600	5
	• 600	0
2. Internal Revenue Allotment	Unit : Peso	
	0 – 5,000,000	10
	5,000,001 - 10,000,000	8
	10,000,001 - 20,000,000	5
	> 20,000,000	0
3. Incidence of Diarrhea	Unit : Cases/capita	
	0 - 500	0
	501 - 1,000	5
	1,001 - 2,000	8
	> 2,000	10
4. Households unserved by safe water	Unit : %	
	0 - 20	0
	21 - 40	3
	41 - 60	6
	61 - 80	8
	81 - 100	10

Table 26 Framework of Domestic Water Supply Development

Province	Unit	Phase			
		1998	2004	2010	2016
Population					
Urban Population	(1000 people)	1,553	1,904	2,360	2,838
Rural Population	(1000 people)	1,963	2,132	2,184	2,218
Total	(1000 people)	3,517	4,034	4,538	5,045
Served Population Ratio					
Level-I	(%)	19.9	20.0	20.4	19.5
Level-II	(%)	14.6	24.0	25.7	26.8
Level-III	(%)	25.7	35.9	44.8	51.7
All Level	(%)	60.2	79.9	90.9	98.0
Non-Served	(%)	39.8	20.1	9.1	2.0
Served Population Number					
Level-I	(1000 people)	701	808	924	984
Level-II	(1000 people)	512	966	1,168	1,350
Level-III	(1000 people)	905	1,448	2,035	2,611
All Level	(1000 people)	2,118	3,223	4,127	4,944
Non-Served	(1000 people)	1,399	813	416	111
Required Construction Cost (accumulated)					
Level-I	(million Peso)	-	107	222	283
Level-II	(million Peso)	-	1,135	1,640	2,093
Level-III	(million Peso)	-	3,314	6,027	8,479
All Level	(million Peso)	-	4,556	7,889	10,855

Source : JICA Study Team

Davao del Sur

The incremental provision for a total of 640,000 people, consisting of 100,000 people of Level I, 277,000 people of Level II and 262,000 people of Level III, is required in Davao del Sur toward 2016. In urban water supply development, Level III system should be developed in early stage in core urban centers in the province, such as Digos, Sta. Cruz, Malalag, Malita and Bansalan. In water supply development of Davao del Sur, the utilization of surface water as a water source will become the issue in the future to prevent excessive extraction of groundwater in the area along the Sta. Cruz-Digos Urban Corridor, as detailed in Section 4.3 of this report.

For rural water supply development mainly by Level I system, the early implementation should take place according to the proposed priority order in the selected barangays of the prioritized municipalities such as Don Marcelino and Sulop.

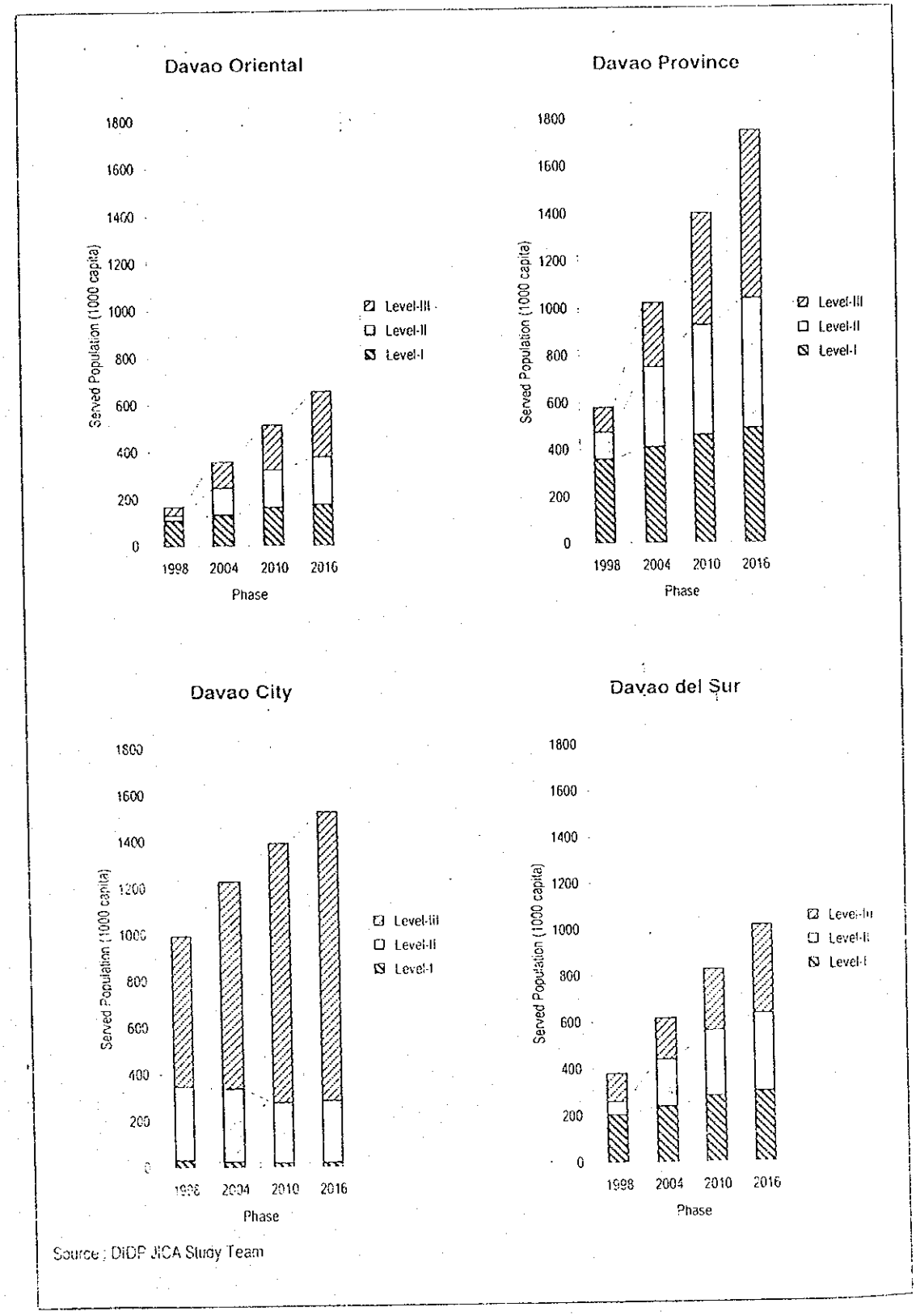
6.2.3. Proposed development projects/programs

The proposed projects/programs incorporate the development components mentioned above. While some of the development components enumerated in the above are not taken up here directly, they are considered to be associated with the proposed projects/programs or be substantiated as the result of the other initiative projects/programs concerned.

The following proposed projects/programs for water supply are detailed in Project Report:

WR - 09: Expansive Water Supply System and Surface Water Development Project in Davao Metropolitan Area,

Figure 10 Domestic Water Supply Transition by City/Province



Source : DIDP JICA Study Team

Table 27 Domestic Water Supply Development by Municipality (1/2)

Municipality	Served Population (1000 people)														
	1998			2004			2010			2016			Incremental from 1998 to 2016		
	Level-I	Level-II	Level-III	Level-I	Level-II	Level-III	Level-I	Level-II	Level-III	Level-I	Level-II	Level-III	Level-I	Level-II	Level-III
Davao Oriental															
Baganga	10.0	2.2	3.6	12.1	10.5	11.5	14.7	14.8	19.0	16.0	18.4	27.2	6.1	16.2	23.6
Banaybanay	7.0	2.0	4.1	9.6	8.8	12.5	12.3	12.8	20.3	13.8	16.2	28.4	6.8	14.2	24.3
Boston	3.2	0.5	0.6	3.9	3.2	1.7	4.7	4.4	2.9	5.1	5.5	4.0	1.9	5.0	3.4
Caraga	9.4	1.6	2.1	11.8	9.7	8.2	14.5	13.8	10.0	15.8	17.0	13.8	6.3	15.4	11.7
Cateel	9.0	1.3	1.2	11.2	8.9	3.7	14.2	13.2	5.9	16.2	16.9	8.4	7.1	15.6	7.2
Governor Generoso	15.4	1.7	0.7	18.3	14.0	2.3	22.1	20.0	4.5	23.5	24.2	8.3	8.1	22.5	7.6
Lupon	11.0	3.0	5.8	13.5	12.4	18.5	16.4	17.5	31.8	17.3	21.5	48.1	6.4	18.6	42.5
Manay	8.6	2.0	3.4	10.4	9.1	10.3	11.9	12.2	16.7	12.2	14.2	23.4	3.5	12.2	20.0
Mati	18.5	5.7	11.9	22.8	21.8	37.4	26.6	29.7	64.7	27.0	35.6	99.5	8.5	29.9	87.6
San Isidro	9.0	1.5	1.9	11.0	9.0	5.6	13.8	13.1	9.4	15.3	16.5	13.5	6.3	15.0	11.7
Tarragona	7.1	0.9	0.6	8.8	6.8	1.7	11.5	10.5	2.7	13.7	14.1	4.0	6.7	13.2	3.4
Sub Total	**108.2**	**22.3**	**35.9**	**133.6**	**114.1**	**111.4**	**162.5**	**162.1**	**188.0**	**175.9**	**200.1**	**278.5**	**67.7**	**177.8**	**242.6**
All Level Total			**166.4**			**359.1**			**512.6**			**654.5**			**488.1**
Davao Province															
Asuncion	20.1	4.8	2.3	21.8	16.6	5.9	24.0	22.6	10.0	26.0	27.2	14.4	5.9	22.5	12.0
Babak	9.2	2.8	2.5	11.1	9.0	6.1	13.2	13.0	9.9	14.9	16.1	14.0	5.7	13.2	11.5
Carmen	20.3	4.9	2.5	24.7	18.7	6.1	29.6	27.8	11.4	33.4	35.1	19.2	13.1	30.2	16.7
Compostela	14.5	5.2	5.4	14.9	12.8	12.8	15.7	16.5	20.6	16.3	18.8	28.4	1.8	13.5	23.0
Kapalong	21.7	5.5	3.2	24.4	18.8	8.4	26.6	25.5	14.5	27.9	29.8	21.4	6.2	24.3	18.2
Kaputian	9.7	2.3	1.1	11.0	8.3	2.8	12.6	11.8	4.6	14.1	14.7	6.6	4.4	12.4	5.5
Mabini	10.3	2.8	2.0	12.4	9.8	5.5	14.5	14.1	9.8	16.0	17.3	15.2	5.7	14.5	13.2
Maco	21.2	4.9	2.2	23.5	17.8	5.9	26.5	24.9	11.0	28.9	30.5	17.8	7.7	25.6	15.6
Mawab	6.9	3.0	3.7	7.4	6.7	8.5	7.3	8.3	13.8	7.1	8.8	19.3	0.2	5.8	15.6
Monkayo	23.3	6.0	3.6	27.8	21.3	8.6	32.3	30.4	13.8	35.8	37.4	18.9	12.4	31.5	15.3
Montevista	10.9	2.9	2.0	12.7	9.9	4.6	15.0	14.2	7.2	17.2	18.0	9.6	6.3	15.1	7.5
Nabunturan	16.2	5.1	4.5	17.0	14.0	11.3	18.0	18.4	19.0	18.7	21.1	27.6	2.5	16.0	23.1
New Bataan	14.0	4.0	3.0	15.2	12.2	7.9	15.7	15.7	14.6	14.9	16.9	23.0	0.8	12.9	20.0
New Corella	14.5	3.9	2.6	16.9	13.3	7.0	18.9	18.4	12.9	19.6	21.4	20.7	5.0	17.5	18.1
Panabo	37.8	13.9	14.6	47.0	40.2	39.8	56.6	59.4	72.9	63.7	73.6	114.4	25.8	59.7	99.9
Pantukan	17.5	5.4	4.6	22.0	17.4	10.3	26.0	25.1	15.5	29.3	31.1	20.2	11.8	25.7	15.6
Samal	7.1	1.9	1.4	8.1	6.4	3.2	9.5	9.0	5.1	10.8	11.4	7.0	3.7	9.5	5.6
Santo Tomas	20.5	8.0	8.9	23.5	20.5	22.6	26.0	28.0	38.8	27.5	32.4	57.2	6.9	24.4	48.3
Tagum	30.0	19.1	28.2	32.0	35.7	76.7	28.7	43.0	139.7	18.4	37.4	218.0	0.0	18.3	189.8
Maragusan (San Mariano)	12.1	3.6	3.0	12.4	10.1	7.3	13.0	13.0	12.1	13.3	14.8	17.0	1.3	11.2	14.0
San Vicente	19.7	4.3	1.6	24.2	17.9	3.7	29.2	26.6	5.8	33.7	34.4	7.7	14.0	30.1	6.1
Talaingod	0.8	1.5	2.7	1.2	1.8	5.8	1.4	2.3	8.3	1.6	2.5	10.2	0.7	1.0	7.5
Sub Total	**358.6**	**115.9**	**105.7**	**411.3**	**338.9**	**271.0**	**460.1**	**467.9**	**471.4**	**489.1**	**550.6**	**708.0**	**130.5**	**434.7**	**602.4**
All Level Total			**580.2**			**1,021.2**			**1,399.5**			**1,747.7**			**1,167.5**

Table 27 Domestic Water Supply Development by Municipality (2/2)

Municipality	Served Population (1000 people)												Incremental from 1998 to 2016		
	1998			2004			2010			2016					
	Level-I	Level-II	Level-III	Level-I	Level-II	Level-III	Level-I	Level-II	Level-III	Level-I	Level-II	Level-III	Level-I	Level-II	Level-III
Davao City															
Poblacion	0.0	29.5	109.2	0.0	21.6	122.4	0.0	13.3	120.1	0.0	9.7	111.5	-	-	2.4
Talomo	0.1	53.6	196.9	0.0	47.8	270.2	0.0	36.1	324.5	0.0	31.4	361.5	-	-	164.6
Agdao	0.0	19.1	70.5	0.0	15.7	89.1	0.0	11.1	99.5	0.0	9.1	104.2	-	-	33.7
Buhangin	0.5	40.1	139.4	0.1	37.1	207.3	0.0	28.4	255.9	0.0	25.2	289.3	-	-	150.0
Bunawan	0.7	19.8	61.7	0.1	15.8	85.3	0.0	11.7	105.5	0.0	11.5	132.4	-	-	70.7
Paquibato	4.3	20.4	0.0	3.9	24.8	1.4	3.0	25.0	7.2	3.1	27.1	8.1	-	6.7	8.1
Baguio	2.7	12.7	0.0	2.1	13.7	2.8	0.8	8.1	14.5	1.1	10.7	14.0	-	-	14.0
Calinan	5.2	28.7	15.8	4.4	32.2	24.7	3.7	34.2	38.1	4.2	39.5	46.9	-	10.8	31.1
Marilog	4.9	23.3	0.0	4.4	28.0	0.0	3.8	30.7	3.8	3.7	31.8	7.6	-	8.5	7.6
Toril	6.4	40.5	38.6	4.4	39.3	64.8	1.4	23.1	107.0	2.0	27.4	120.2	-	-	81.6
Tugbok	5.6	29.9	12.1	5.1	36.2	21.5	4.1	37.3	37.4	4.4	41.4	47.0	-	11.5	34.9
Sub Total	**30.3**	**317.6**	**644.1**	**24.4**	**312.2**	**889.5**	**16.9**	**258.9**	**1,113.4**	**18.4**	**264.7**	**1,242.7**	-	37.6	598.6
All Level Total			**992**			**1,226**			**1,389**			**1,526**			636.2
Davao del Sur															
Bansalan	13.1	4.3	11.2	14.6	12.9	15.6	16.2	16.6	21.5	16.0	18.5	28.9	2.9	14.2	17.7
Digos	26.2	10.2	30.8	31.1	29.2	46.5	37.2	40.3	70.5	37.3	46.3	104.0	11.1	36.1	73.2
Don Marcelino	12.1	2.1	0.0	15.0	11.4	1.4	19.3	17.6	4.8	23.0	23.8	9.4	10.9	21.7	9.4
Hagonoy	11.3	3.7	9.7	13.3	11.7	13.6	15.3	15.6	19.6	15.4	17.9	27.8	4.1	14.1	18.1
Jose Abad Santos	17.2	3.5	3.2	20.8	16.1	4.3	26.1	23.8	5.9	30.3	31.0	7.9	13.1	27.5	4.7
Kiblawan	13.4	2.8	2.8	16.8	13.1	3.8	21.0	19.2	5.0	24.2	24.8	6.7	10.8	22.0	3.9
Magsaysay	14.1	3.3	4.8	16.5	13.2	6.8	19.5	18.3	9.4	20.9	22.1	12.8	6.9	18.8	7.9
Malalag	10.5	2.4	3.4	12.8	10.3	5.0	16.0	15.0	7.6	18.3	19.3	11.4	7.8	16.9	8.0
Malita	27.3	6.5	9.8	30.8	25.0	15.0	35.6	34.0	23.1	36.8	39.8	34.9	9.5	33.3	25.1
Matanao	15.5	3.2	2.8	17.8	13.8	4.0	21.0	19.3	5.6	22.9	23.6	7.8	7.4	20.4	5.0
Padada	7.0	1.8	3.3	8.2	6.7	4.7	9.7	9.3	6.8	10.4	11.2	9.6	3.4	9.4	6.3
Santa Cruz	9.1	6.5	26.2	9.8	12.3	39.6	10.0	15.1	60.1	5.6	13.3	88.9	0.0	6.8	62.7
Santa Maria	13.7	3.2	4.9	15.7	12.6	7.0	18.5	17.5	9.9	20.0	21.1	13.7	6.3	17.9	8.8
Sarangani	5.6	1.3	2.0	6.7	5.4	3.0	8.1	7.7	4.5	9.0	9.5	6.4	3.4	8.2	4.4
Sulop	7.9	2.1	4.2	9.0	7.5	5.8	10.4	10.1	8.1	10.9	11.9	11.1	3.0	9.8	7.0
Sub Total	**204.1**	**57.0**	**119.0**	**238.8**	**201.2**	**176.2**	**284.0**	**279.3**	**262.4**	**300.9**	**334.1**	**381.2**	100.4	277.1	262.2
All Level Total			**380**			**616**			**826**			**1,016**			639.7
DIDP Total	**701.2**	**512.9**	**904.7**	**808.1**	**966.4**	**1,448.2**	**923.5**	**1,168.2**	**2,035.2**	**984.3**	**1,349.5**	**2,610.5**	**298.6**	**927.1**	**1,705.8**

Source : JICA Study Team

Table 28 Priority Order for Rural Water Supply Development

Priority Order	Province	Municipality	Per Capita Mun. Income (Peso/cap)	IRA (1000Peso)	Incidence Diarrhea (cases / 100,000 cap)	Unserved Ratio (%)	Priority Score: Per Capita Income	IRA	Incidence of Diarrhea	Unserved Ratio	Total
(First Priority)											
1	Davao Oriental	Caraga	32	23,441	2,010	71	10	-	10	8	7.5
2	Davao Oriental	Manay	42	20,459	785	88	10	-	5	10	7.5
3	Davao Province	Monkayo	594	24,852	1,690	81	5	-	8	10	7.4
4	Davao Oriental	Cateel	46	19,653	893	66	10	5	5	8	7.3
5	Davao Oriental	San Ishdro	78	16,917	746	67	10	5	5	8	7.3
6	Davao Oriental	Lupon	66	32,571	1,175	73	10	-	8	8	7.1
7	Davao Province	Carmen	397	17,788	641	75	8	5	5	8	7.0
8	Davao Oriental	Tarragona	10	14,755	1,137	52	10	5	8	6	6.9
9	Davao Oriental	Boston	38	11,635	665	60	10	5	5	6	6.3
10	Davao Province	Kaputian	455	10,148	1,555	55	5	5	8	6	6.1
11	Davao Oriental	Baganga	660	32,110	3,732	62	-	-	10	8	6.0
12	Davao Province	Samal	506	8,922	916	46	5	8	5	6	6.0
13	Davao del Sur	Don Marcelino	313	16,671	404	73	8	5	-	8	6.0
14	Davao del Sur	Sulop	272	10,146	229	69	8	5	-	8	6.0
15	Davao Province	Panabo	420	29,276	727	75	5	-	5	8	5.8
(Second Priority)											
16	Davao del Sur	Jose Abad Santos	412	23,851	889	79	5	-	5	8	5.8
17	Davao del Sur	Sarangani	125	8,025	117	53	10	8	-	6	5.7
18	Davao Province	Kapalong	820	39,283	1,298	72	-	-	8	8	5.6
19	Davao Oriental	Mati	113	42,621	444	75	10	-	-	8	5.5
20	Davao Province	Maragusan	472	16,694	573	43	5	5	5	6	5.5
21	Davao Province	Asuncion	402	19,999	744	59	5	5	5	6	5.5
22	Davao Province	Montevista	532	12,846	764	55	5	5	5	6	5.5
23	Davao Oriental	Banaybanay	106	19,266	1,617	24	10	5	8	3	5.4
24	Davao del Sur	Bansalan	377	16,068	316	42	8	5	-	6	5.0
25	Davao del Sur	Sta. Maria	292	14,671	486	47	8	5	-	6	5.0
26	Davao Province	San Vicente	455	21,926	239	75	5	-	-	8	4.8
27	Davao Province	Santo Tomas	431	20,720	899	42	5	-	5	6	4.8
28	Davao del Sur	Magsaysay	870	13,568	270	71	-	5	-	8	4.8
29	Davao del Sur	Malalag	739	15,569	740	46	0	5	5	6	4.8
30	Davao del Sur	Malita	815	37,196	1,155	46	0	0	8	6	4.6

Source : JICA Study Team

WR - 10: Expansive Water Supply System and Surface Water Development Project in Panabo-Tagum Conurbation Area,

WR - 11: Expansive Water Supply System and Surface Water Development Project in Sta. Cruz-Digos Urban Corridor Area,

WR - 12: Water Conservation and Recycling Program, and

WR - 13: Rural Water Supply and Sanitation Improvement Program.

6.3. Sewerage

6.3.1. Development direction

In the sewerage sub-sector, a number of development needs have been identified as follows.

1) Introduction of sewerage systems equipped with domestic wastewater treatment is needed to preserve sanitary conditions and amenity in urban centers.

2) Comprehensive measures for industrial wastewater discharge are needed in accordance with relevant regulations, since industrial wastewater possibly causes acute and irreversible damages to human health and natural environment.

(1) Pollution loading analysis

At present, there is no sewerage system in the DIDP Area, except a limited length of sewage pipes and channels mainly for rainwater draining. Therefore, wastewater from households, commercial and institutional housings, etc. is discharged into water bodies such as rivers, sea, streams and others without treatment. In terms of industrial wastewater, most enterprises are not prepared for wastewater treatment, though a limited number of industries are equipped with their own treatment plants.

Incorporating the above, a sewerage system equipped with sewage pipes and purification facilities will be necessary for an urban center of certain-scale in order to restore urban sanitation as well as the natural water environment, and create urban amenity like peoples' health and living environs.

The generated pollution loading in the DIDP Area, measures by biological oxygen demand (BOD), is projected using domestic and industrial water consumption computed in Section 4.2, as shown in Table 29. The DIDP Area is discharging 24,000 ton-BOD annually of pollution loading in total at present and, of that, 70% is generated in Davao City. The generated pollution loading will increase to 68,000 ton-BOD annually in 2016 almost proportional to the regional increase of the population and the industrial sector GRDP.

The generated pollution density, which is defined as the annual pollution loading per the land area, is found by far the highest in Davao City at present and in future. **Figure 11** shows the transitions of the generated pollution loading in the City/provinces toward 2016, indicating that the City/provinces will experience the increasing pollutant discharges in proportion to the growing socioeconomic activities.

(2) Thrust of water pollution control

To reduce the pollution loading discharged into the environment, both of the following countermeasures have to be taken for domestic and industrial wastewater:

- Introduction of wastewater treatment to remove the pollutants from wastewater, and
- Encouragement of water saving and water reuse to reduce discharged water volume.

Table 29 Generated Pollution Loading in the DIDP Area

Item		City/Province				Total DIDP Area
		Davao Oriental	Davao Province	Davao City	Davao del Sur	
Pollution Loading at Present (in 1998)						
Domestic Wastewater	(ton-BOD/year)	439	2,686	7,556	1,305	11,986
Industrial Wastewater	(ton-BOD/year)	151	1,093	7,747	767	9,758
Total	(ton-BOD/year)	590	3,779	15,303	2,072	21,744
Pollution Loading in 2016						
Domestic Wastewater	(ton-BOD/year)	3,977	14,397	17,750	5,445	41,569
Industrial Wastewater	(ton-BOD/year)	1,100	4,365	18,602	3,181	27,248
Total	(ton-BOD/year)	5,077	18,762	36,352	8,626	68,817
Required Treated Wastewater Ratio	(%)	100	100	72	95	86

Note : "Required Treated Wastewater" means the volume ratio of wastewater which should be treated to maintain the present pollution loading.
Source : JICA Study Team

If the future pollution loading is assumed to be kept at the present level, 81% volume of wastewater should be treated in the DIDP Area, and 69% in Davao City. Considering a huge financial investment required for the introduction of wastewater treatment, Davao City suffering from extremely high-pollution loading, as shown in Table 30, should, in the first place, start to introduce the sewerage system with wastewater treatment. Other major provincial urban centers in the DIDP Area and other urban amenity-called areas subsequently should be prepared for sewerage provision.

6.3.2. Development components

Domestic wastewater

Introduction of sewerage systems equipped with domestic wastewater treatment is needed to preserve sanitary environs and amenity in urban centers.

Urbanized areas of Davao City, discharging the major portion of pollution loading from the DIDP Area, are the subjective areas of sewerage to be implemented at the early stage. From the pollution loading analysis, they include: Poblacion, Talomo, Agdao, Buhangin, Bunawan and Toril in Davao City.

For sludge to be generated in sewage treatment, proper disposal systems should be initiated in line with sewerage development such as dehydration, composting, incineration, and/or sanitary landfilling. Besides, the reclamation and reuse of treated sewage, and energy recovery from waste sludge should be introduced in the long run to save water resources and enhance water users' awareness for water and energy saving.

Industrial wastewater

Comprehensive measures for industrial wastewater discharge are needed in line with relevant regulations. Unlike domestic wastewater, industrial wastewater possibly causes serious and irreversible damages to human health and natural

environment. Accordingly, complete control by application of wastewater purification shall be enforced to all kinds of industrial wastewater.

In terms of industrial wastewater disposal, the majority of industries have not been provided with wastewater treatment system in the DIDP Area, except a limited number of factories constructed recently. More strict enforcement of the laws and regulations is necessary. Certain institutional incentives should be considered to encourage the introduction of wastewater treatment, the rationalization of water uses and the reduction of pollution loading.

Given that factories are scattered in urban centers at present, the centralization of production firms and wastewater treatment system to industrial estates should be encouraged to ensure proper treatment and monitoring.

The reclamation and reuse of treated industrial wastewater should be progressively introduced to save water resources and reduce the pollution loads to be discharged into the environment.

6.3.3. Proposed development projects/programs

The proposed projects/programs incorporate the development components mentioned above. While some of the development components enumerated in the above are not taken up here directly, they are considered to be associated with the proposed projects/programs or be substantiated as the result of the other initiative projects/programs concerned.

The following proposed projects/programs for sewerage are detailed in Project Report:

WR - 14: Sewerage and Sanitation Development Project, and

WR - 15: Sludge Treatment and Energy Recovery Development Program.

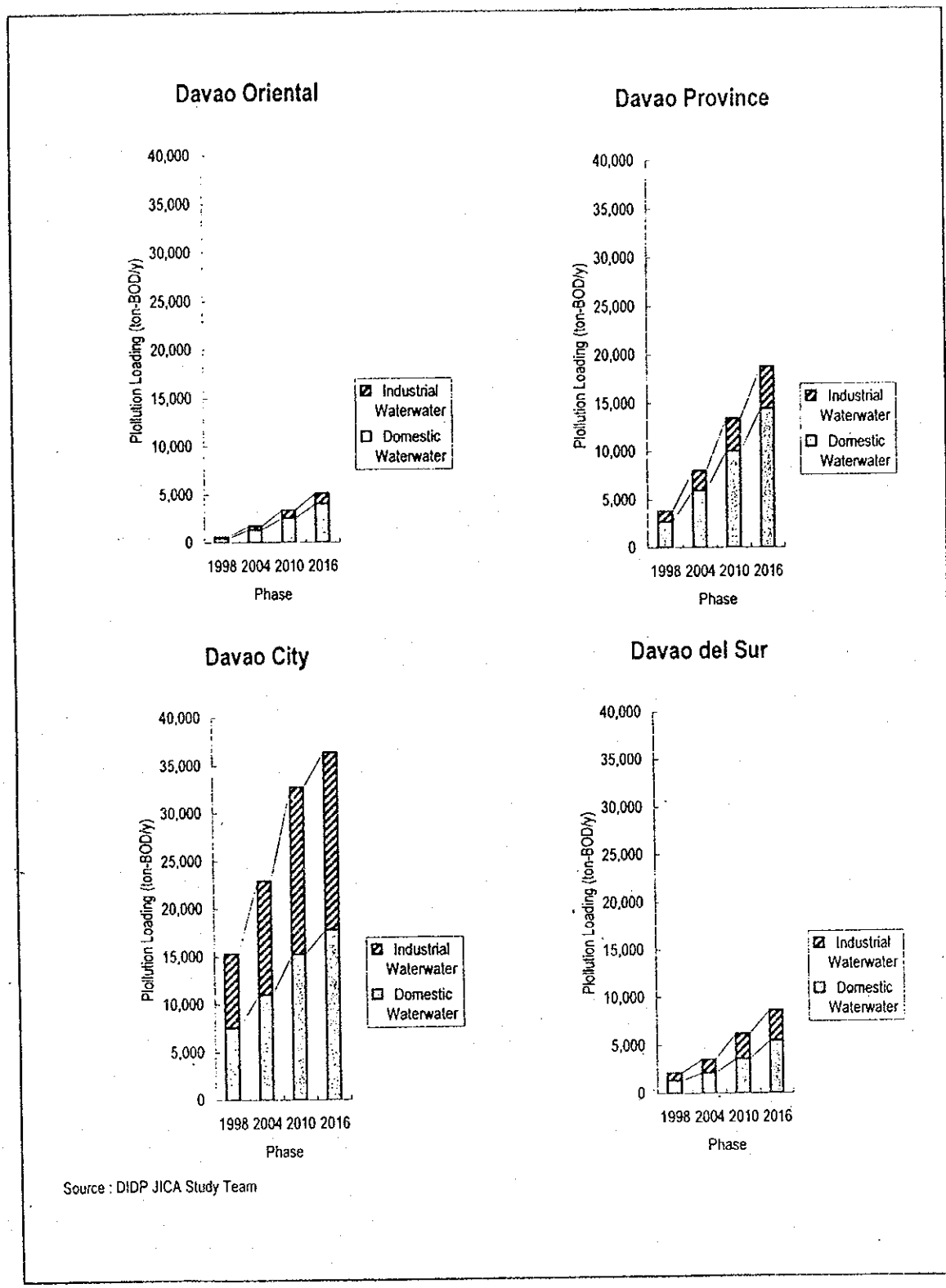
Table 30 Generated Pollution Loading by Municipality/District

Province /Municipality	Pollution Domestic Waterwater (ton-BOD/y)				Pollution Industrial Waterwater (ton-BOD/y)				Pollution Domestic and Industrial Waterwater (ton-BOD/y)				Generated Pollution Density (kg-BOD/ha/year)			
	1998	2004	2010	2016	1998	2004	2010	2016	1998	2004	2010	2016	1998	2004	2010	2016
Davao Oriental																
Baganga	45	136	255	389	-	39	130	183	45	175	386	572	0.4	1.5	3.3	4.9
Banaybanay	50	148	273	406	12	17	24	24	62	164	296	430	1.5	3.9	7.1	10.3
Boston	7	21	39	57	-	-	-	-	7	21	39	57	0.2	0.6	1.1	1.7
Caraga	25	73	134	197	-	-	-	-	25	73	134	197	0.6	1.3	2.4	3.6
Cateel	15	43	79	120	-	-	-	-	15	43	79	120	0.3	0.9	1.7	2.6
Gov. Generoso	9	28	60	118	-	-	-	-	9	28	60	118	0.3	0.9	2.0	3.9
Lupon	71	219	427	687	84	119	169	169	155	338	596	856	6.8	14.9	26.2	37.7
Manay	42	121	224	334	-	-	-	-	42	121	224	334	0.9	2.5	4.7	7.0
Mati	145	442	868	1,420	55	209	502	724	200	651	1,370	2,145	2.9	9.5	20.1	31.5
San Isidro	23	67	126	193	-	-	-	-	23	67	126	193	1.1	3.3	6.1	9.4
Tarragona	7	21	36	57	-	-	-	-	7	21	36	57	0.2	0.7	1.2	1.8
Total	**439**	**1,318**	**2,522**	**3,977**	**151**	**384**	**825**	**1,100**	**590**	**1,701**	**3,346**	**5,077**	**1.1**	**3.3**	**6.5**	**9.8**
Davao Province																
Asuncion	101	209	320	433	3	4	5	5	104	212	325	438	5.6	11.3	17.3	23.4
Babak	65	144	237	330	-	-	-	-	65	144	237	330	8.9	19.6	32.3	45.0
Carmen	105	230	382	568	-	-	-	-	105	230	382	568	3.4	7.5	12.4	18.5
Compostela	124	251	404	549	65	86	117	117	189	337	521	666	10.1	18.0	27.8	35.5
Kapalong	119	255	402	551	13	18	24	24	133	273	426	575	1.2	2.5	3.8	5.2
Kapulian	49	103	160	218	-	-	-	-	49	103	160	218	4.2	8.8	13.6	18.6
Mabini	63	145	246	357	-	-	-	-	63	145	246	357	1.5	3.5	6.0	8.7
Maco	104	220	352	508	7	10	13	13	111	229	365	521	4.5	9.4	14.9	21.3
Mawab	74	150	247	338	-	-	-	-	74	150	247	338	4.7	9.4	15.5	21.2
Monkayo	130	280	436	583	26	34	46	46	155	314	482	629	2.2	4.5	7.0	9.1
Montevista	65	136	213	287	-	-	-	-	65	136	213	287	2.5	5.1	8.0	10.8
Nabunturan	118	245	400	558	12	76	93	140	129	321	493	699	5.5	13.6	20.9	29.7
New Bataan	89	192	320	459	-	-	-	-	89	192	320	459	1.3	2.8	4.7	6.8
New Corella	85	191	321	467	-	-	-	-	85	191	321	467	2.7	5.9	10.0	14.5
Panabo	331	782	1,435	2,192	12	321	807	1,275	343	1,103	2,241	3,467	12.1	39.1	79.4	122.9
Pantukan	124	264	411	546	-	-	-	-	124	264	411	546	3.0	6.3	9.8	13.0
Samal	43	91	142	195	-	-	-	-	43	91	142	195	4.8	10.1	15.9	21.7
Santo Tomas	193	424	733	1,058	132	176	238	238	325	599	971	1,296	10.1	18.7	30.3	40.5
Tagum	490	1,141	2,145	3,276	824	1,343	2,083	2,505	1,314	2,485	4,227	5,781	67.1	126.9	215.9	295.2
Maragusan	83	167	265	360	-	-	-	-	83	167	265	360	2.2	4.4	6.9	9.4
San Vicente	90	197	301	406	-	-	-	-	90	197	301	406	0.9	2.0	3.0	4.1
Talaingod	40	79	125	160	-	-	-	-	40	79	125	160	0.9	1.7	2.8	3.5
Total	**2,686**	**5,697**	**9,994**	**14,397**	**1,093**	**2,067**	**3,426**	**4,365**	**3,779**	**7,964**	**13,420**	**18,761**	**4.6**	**9.8**	**16.5**	**23.1**
Davao City																
Poblacion	1,281	1,514	1,636	1,593	-	-	-	-	1,281	1,514	1,636	1,593	1,245	1,472	1,591	1,549
Talomo	2,310	3,342	4,422	5,163	1,344	1,850	2,568	2,568	3,654	5,192	6,991	7,731	331	470	633	700
Agdao	827	1,102	1,355	1,489	1	1	1	1	828	1,103	1,356	1,490	1,453	1,934	2,380	2,614
Buhangin	1,635	2,564	3,487	4,133	-	848	1,902	2,658	1,635	3,412	5,389	6,791	187	391	617	778
Bunawan	723	1,055	1,437	1,891	234	322	447	447	957	1,377	1,884	2,338	146	210	288	357
Paquibato	-	18	98	116	-	-	-	-	0	18	98	116	0.0	0.4	2.1	2.5
Baguio	-	35	197	200	-	-	-	-	0	35	197	200	0.0	0.4	2.4	2.4
Calinan	185	305	519	670	-	-	-	-	185	305	519	670	8.3	13.6	23.2	30.0
Marilog	-	-	52	109	-	-	-	-	0	0	52	109	0.0	0.0	1.2	2.5
Toril	453	801	1,458	1,716	5,871	8,445	12,034	12,358	6,323	9,246	13,492	14,074	482	704	1,028	1,072
Tugbok	142	266	510	671	298	410	569	569	440	676	1,079	1,240	50	77	123	142
Total	**7,556**	**11,001**	**15,172**	**17,750**	**7,747**	**11,876**	**17,522**	**18,602**	**15,303**	**22,877**	**32,693**	**36,351**	**62.7**	**93.7**	**133.9**	**148.9**
Davao del Sur																
Bansalan	123	184	290	413	-	-	-	-	123	184	290	413	10.6	11.7	18.4	26.2
Digos	337	550	953	1,485	5	7	348	570	343	557	1,301	2,055	16.1	20.8	48.6	76.7
Don Marcelino	-	16	64	134	-	-	-	-	0	16	64	134	1.0	0.4	1.6	3.3
Hagonoy	106	161	265	397	10	14	18	18	116	174	284	415	13.3	14.9	24.3	35.6
Jose Abad Santos	35	51	80	113	-	-	-	-	35	51	80	113	1.3	0.7	1.1	1.5
Kiblawan	30	44	68	96	-	-	-	-	30	44	68	96	2.0	1.1	1.7	2.5
Magsaysay	53	80	127	183	-	-	-	-	53	80	127	183	5.9	4.7	7.5	10.8
Malalag	37	60	102	163	-	-	113	112	37	60	215	275	3.9	3.2	11.6	14.8
Malita	107	178	313	498	20	26	36	36	127	204	349	534	4.3	4.0	6.8	10.4
Matanao	31	47	76	112	-	-	-	-	31	47	76	112	4.2	2.3	3.8	5.5
Padada	36	56	92	137	-	-	-	-	36	56	92	137	13.3	12.4	20.3	30.3
Sta. Cruz	287	468	813	1,269	732	1,361	2,115	2,445	1,019	1,829	2,927	3,715	37.6	65.9	105.4	133.8
Sta. Maria	54	83	134	196	-	-	-	-	54	83	134	196	4.9	4.1	6.6	9.6
Sarangani	22	36	61	92	-	-	-	-	22	36	61	92	3.9	3.4	5.7	8.7
Sulop	46	69	109	159	-	-	-	-	46	69	109	159	4.7	4.4	7.0	10.2
Total	**1,305**	**2,084**	**3,547**	**5,445**	**767**	**1,408**	**2,630**	**3,181**	**2,072**	**3,492**	**6,177**	**8,627**	**5.3**	**8.9**	**15.7**	**21.9**
DIDP Total	**11,986**	**20,300**	**31,235**	**41,569**	**9,758**	**15,735**	**24,402**	**27,248**	**21,744**	**36,035**	**55,637**	**68,817**	**11.1**	**18.3**	**28.3**	**35.0**

Note : The water from mining is exclusive from the table.

Source : JICA Study Team

Figure 11 Generated Pollution Loading Transition by City/Province



Source : DIDP JICA Study Team