Chapter 7

WATER SOURCE DEVELOPMENT

7. WATER SOURCE DEVELOPMENT

7.1 General

The study on water source development covers the entire province in order to come up with water source potential exploitable mainly domestic water supply. Emphasis is placed on the groundwater availability due to its prevalent use and comparatively conservative development through the future in the jurisdiction of the provincial government. It is also advantageous to utilize groundwater for domestic water supply because of better quality and economical use. Nevertheless, surface water potential of major rivers was studied in terms of quantity (return period flow rate) and quality to provide information for LGU's future use.

A "Groundwater Availability Map" was prepared, which identifies the areas with available potable water sources. The study has two major components: (1) interpretation of existing geological and groundwater conditions and (2) preparation of Groundwater Availability Map to show groundwater potential areas under three categorized areas. Furthermore, standard well specifications by municipality were also established to reflect in the medium-term sector development plan.

The major data used in the study were obtained from concerned agencies (NAMRIA, BMGS, NWRB, LWUA, DPWH and PPDO) and supplemented by the information gathered through questionnaires from relevant local offices in the field (including spring inventories with verifications). The field information directly collected by the Study Team was also used to increase the accuracy of the Map. Among the information, the Geologic Map published by BMGS, the Water Resource Investigation Report and the Well Inventory Database of NWRB are essential for the analysis of geological characteristics, projection of high yielding area and possible area with salt water intrusion, and classification of groundwater potential areas, respectively.

The Groundwater Availability Map may be used for provincial level master plan and feasibility study at present. However, recommendations on the required investigations were presented for specific areas with scope of survey, as reference for LGUs, to conduct these prior to D/D and construction work. Aside from the requirements, updating the map is a requisite to gain more information on prevailing groundwater conditions using the questionnaires prepared for the study. An annual review and updating of the database will enable the LGUs to implement water source development on a project site basis.

The overview on current groundwater use with the conditions is summarized in Table 7.1.1 (well data collected from each municipality are presented in Table 7.1.1, Water Source Information, Data Report). There are 2,532 shallow wells, 1,195 deep wells and 806 developed springs in the province (functional sources). Majorities of the wells are shallow wells. About 29% of these water sources are public facilities. Of the total existing wells, 86% remains functional at present. In addition to the above sources, 108 untapped springs are accounted.

Table 7.1.1 Existing Groundwater Sources in the Province

Category and Classification	Shallow Well	Deep Well	Spring	Total
1. Water source being availed				
a. Public sources	468	171	669	1,308
b. Privately owned sources	2,064	1,024	137	3,225
c. Number of water sources	2,532	1,195	806	4,533
d. Profile of different sources	56%	26%	18%	100%
2. Water sources with problems and non-functional wells				
a. Water quality problems*	1,266	0	0	1,266
b. Non-functional	220	406	63	689
3. Spring source information				
a. Undeveloped	-	-	0	0
b. Untapped	-	-	108	108

Note. 1: Number of water sources being availed at present including those with water quality problems.
2: Number of existing water sources with problems: being used, but with water quality problem/abandoned wells.
3: Number of springs availed, but not adequately protected; and those as candidate sources to be developed.
*: Assumed number of sources (unsafe category) based on the study on existing water supply facilities in Chapter 4.

7.2 Geology

Most part of the Bukidnon Plateau is underlain by volcanic mudflows (lahar) mainly caused by the two volcanoes. The rest of the provincial area is underlain by igneous materials. In a limited local area, metamorphic rock units such as slate, schist, etc. are found. Likewise, Plio-Pleistocene deposits (quite limited area) made of reef limestone underlain by minor sandstone, shale and conglomerate are seen in the area of Manolo Fortich to Maluko. In the southeastern part of the province, younger sedimentary and volcanic rocks overlay along the Pulangi River.

The present configuration of the province is controlled by several faults, folds and other lineaments. The northeastern part is dominated by major thrust faults that trend either N-S or NW-SE.

For the purpose of preparing the Groundwater Availability Map of the province, only rock units significant to groundwater storage and permeability are described briefly. The rock units in the province are classified into three (3) main groups based on the geologic ages. There are, in order to oldest to youngest, the Miocene and Older Systems, the Plio-Pleistocene Series and Recent Deposits. The grouping of rock units is related to their potential as groundwater sources. The younger rocks are considered the most important to groundwater because of their porosity and permeability relative to the older rocks. The distribution of these rock groups is shown in Figure 7.2.1, Geological Map of the province and their geological features are described as below.

(1) Miocene and Older Systems

Upper Miocene to Pliocene sediments includes both the sedimentary and pyroclastic rocks. Members of this formation consist of conglomerate, pebbly sandstone, agglomerate, tuffaceous sandstone and tuff. These are well bedded and slightly folded. Lower to Middle Miocene limestone consists mostly of fine grained, dense, hard coralline limestone locally interbedded with limy shales and arkoses. It is typically milky white with some tuff and gray varieties. It is characterized by sinkhole and solution channels. This formation has a limited permeability.

Rock units of Miocene and older systems have impermeability. Most of them are classified as aquicludes. Oligocene to Miocene sediments consist of well-compacted, poorly sorted generally gray basaltic conglomerate, sandstone, shale and thin lenses of impure limestone and intercalated with basalt flows. Neogene rock units are generally in a north trending direction discordantly intruding the Cretaceous-Paleogene volcanics. It is composed mainly of diorite with a porphyritic andesite phase. Cretaceous to Paleogene metavolcanics are generally grayish, dense, crystalline, meta-andesite, meta-basalt and meta-diabase. Thin lenses of schistose tremolite occur within them. The meta-diabase occurs as dikes and sills in the older rocks. Cretaceous to Paleogene ultramafic complex is generally thrust over older rock formation consists essentially of serpentinite, peridotite, pyroxenite and dunite. Smaller bodies that vary in size and shape occur at different places within the province. The brecciated and intensely granulated serpentinites are usually observed along thrust zones. Pre-Jurassic basement complex known rock unit which is generally greenish gray included amphibolite, plagioclase-talc chlorite, actinolite and other low-grade assemblages. They occur along thrust zones of serpentinite. Isolated smaller bodies occur as erosive windows in Bukidnon Formation.

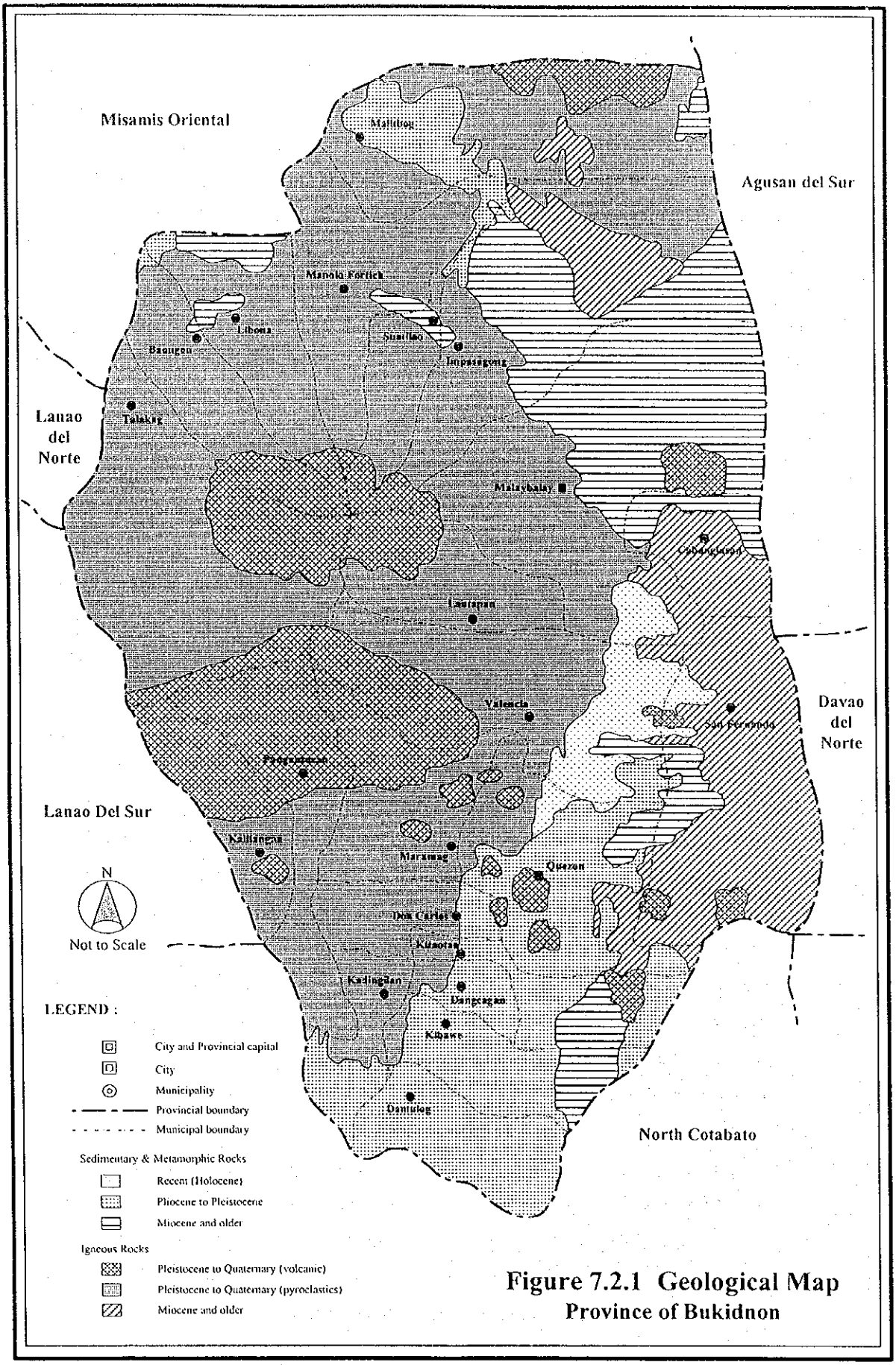

Figure 7.2.1 Geological Map
Province of Bukidnon

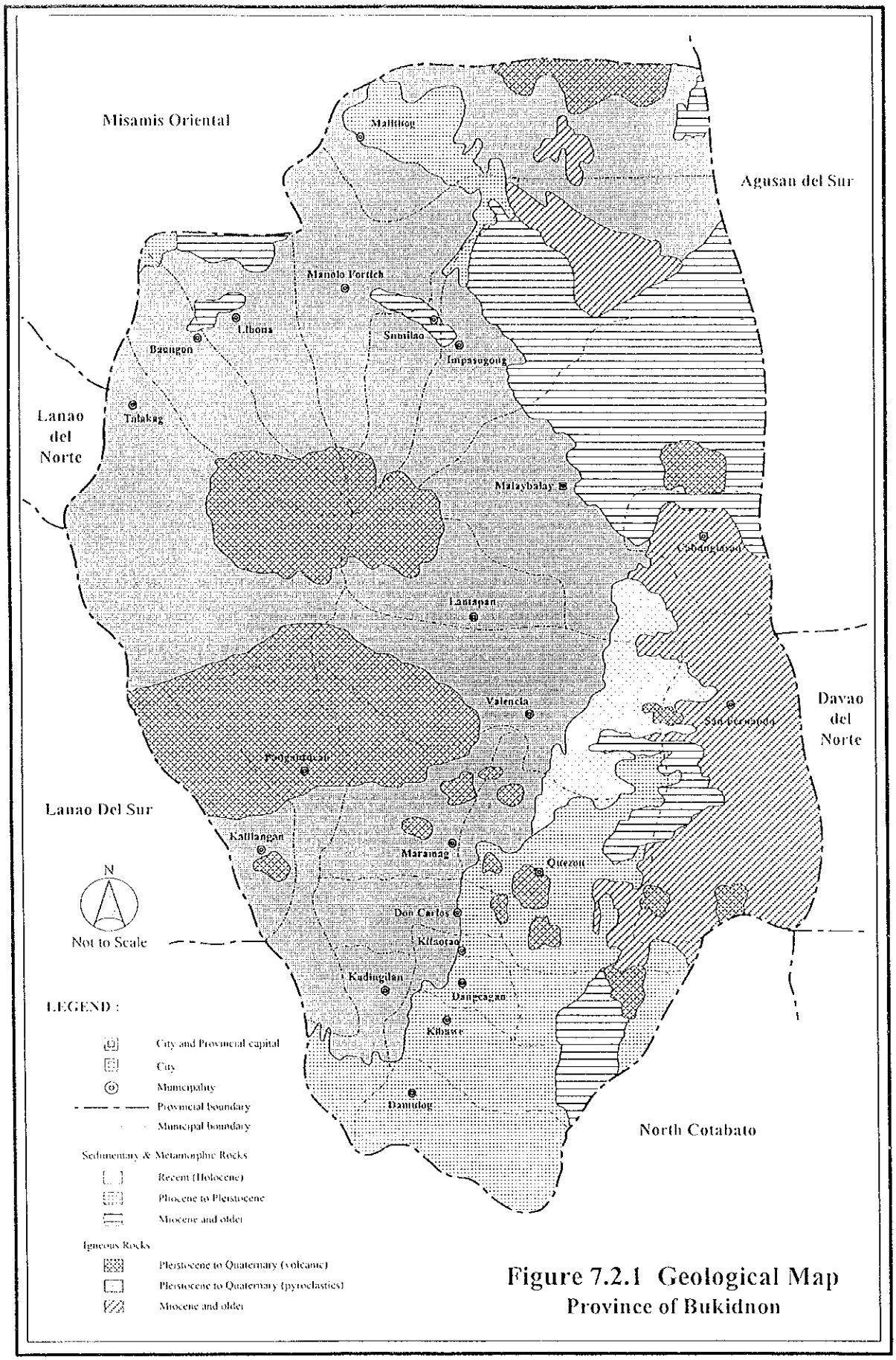

Figure 7.2.1 Geological Map
Province of Bukidnon

(2) Plio-Pleistocene Series

Sedimentary rocks of this series have various range of the permeability. Pliocene to Quaternary volcanics are composed of basalt and andesite. These are commonly extruded through the Miocene formations. Plio-Pleistocene sediments consist of conglomerate, sandstone and shale. The conglomerate facie consist of rounded to sub-rounded pebble and boulders of volcanic, igneous and metamorphic rocks derived from other formations. Plio-Pleistocene limestone is coralline and can be considered as good aquifers. It is distributed in widely separated areas and forms thin veneer on the hills mostly in southern part of the province.

(3) Recent Deposits (Holocene Series)

This includes river and lake deposits. These are mostly flood plains, areas along the mouths of major drainage deposits of loose gravel, sand, silt, clay and mud, which are being transported by rivers. This formation is seen only along the Pulangi River in the eastern part of Valencia.

7.3 Groundwater Sources

7.3.1 Classification of Groundwater Availability

For planning purpose, the provincial area is divided into the following sub-areas in terms of groundwater availability.

(1) Shallow well area

Shallow well area is defined in this study as an area where solo shallow well is available. These areas have water bearing rock formations extending not more than 20 m in depth from the ground surface. Shallow well areas are usually located in alluvial and coastal plains, where recent unconsolidated materials overlie impervious rocks at shallow depth. The extent of completely shallow well area is limited, because most of the recent formations are thick or deposited on the Late Plio-Pleistocene series that usually have multiple aquifers located at greater depths.

(2) Deep well area

In deep well areas, the lower aquifers are located more than 20 m from the ground level. These areas could be found in portions underlain by the Plio-Pleistocene series and Recent formations. Most of these areas have more than one aquifer occurring at various depths. Areas where both shallow and deep wells could be developed are categorized as deep well areas.

(3) Difficult area

These are areas not suitable for well development. The areas under this category largely consist of rock formations older than Miocene epoch. The groundwater availability in the aforesaid rocks is very low and usually released in the opened rock fractures. Springs are the common sources of water supply in these areas.

In addition to the above classification, potential areas to have high yielding deep aquifers are also presented based on NWRB's geo-resistivity survey.

7.3.2 Groundwater Availability in the Province

The Groundwater Availability Map is presented in Figure 7.3.1. The major databases used in the preparation of the map were obtained from BMGS and NWRB. The methodology and study procedures with respective outputs are discussed in 7.3.2, Supporting Report.

Technical information on the wells by municipality is also shown in the Data Report. The groundwater development potential areas in the province through the future are summarized below.

(1) Shallow well area

The province has no solo shallow well area. The development of shallow wells is, however, possible in the "Deep Well Area" (recent alluvium and beach deposits), where shallow aquifers usually occur. The shallow wells in the province are driven to an average depth of 17.8m (15.7m to 19.2m). These wells have average static water level of 3.0 mbgs (1.0m to 6.0m) and average specific capacity of 0.3 lpsm (0.2 lpsm to 0.5 lpsm).

(2) Deep well Area

The deep well area covers approximately 55% of the province, widely distributed in the central volcanic area and the Pulangi River basin. The deep well area is composed of the alluvial plain and the piedmont made of pyroclastics of Plio-Pleistocene epoch. The former is composed of recent deposits of clay, silt, sand, and gravel, which forms a groundwater storage basin for some aquifers. While, the pyroclastics piedmont mainly consists of mudflows (lahars) caused by two volcanoes.

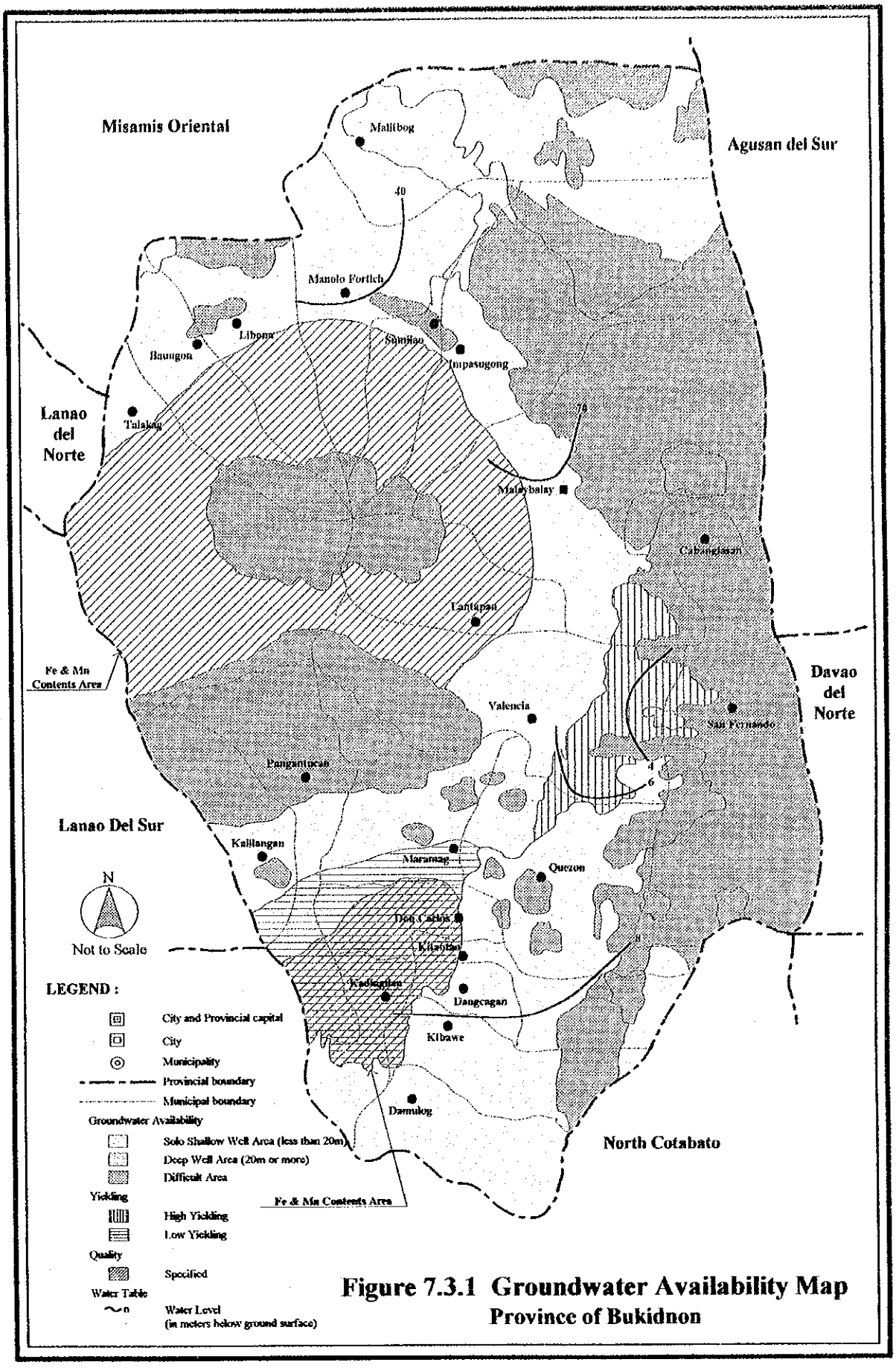

Figure 7.3.1 Groundwater Availability Map
Province of Bukidnon

Considering the geological formations, the alluvial plain is categorized as a high potential area for deep well development, while the volcanic sediments of Plio-Pleistocene epoch are classified as a low to medium yielding area for deep well development. In alluvial plain, the average depth of the existing deep wells is 38.9 m with average water level of 5.2 mbgs, and the average specific capacity is about 3.2 lpsm.

In the volcanic sediment area composed of Plio-Pleistocene series, the average depth of the existing deep wells is 48.5 m with an average water level of 13.2 mbgs, and a specific capacity of 0.9 lpsm.

(3) Difficult area

About 45% of the provincial area is classified as a difficult area to exploit groundwater. Such areas are characterized by volcanoes and the Central Mindanao Cordillera, which are located in the central and eastern sides of the province.

The geology is made up of 1) volcanic rocks of Oligocene to Miocene epoch, 2) well-compacted sediments of Oligocene to Miocene epoch including sandstone, siltstone and conglomerate, 3) igneous rocks of Cretaceous period to Paleocene epoch,. These rocks and formations are in dense, massive and consolidated conditions and have impervious characteristics. The groundwater occurs only in fissures or fault fracture zones.

7.3.3 Groundwater Quality

There is water quality problem in both shallow and deep wells in pyroclastic piedmont areas of the two volcanoes. Major water quality problems are high Fe and Mn contents. The results of water resources investigation for the province conducted by NWRB and general information from DPWH-DEO and PPDO revealed the problem areas as shown in the Groundwater Availability Map in Figure 7.3.1.

Among the water quality problem of the province, groundwater characteristics with high Fe and Mn contents are the most serious with a high percentage of affected existing wells. The problem is extended to most of the piedmont areas with higher elevation in many municipalities around Mt. Kitanglad and Mt. Kalatungan.

7.4 Spring Sources

Spring is a natural outlet of groundwater at the ground surface. It occurs when water table intersects the ground surface, usually along the contacts of pervious and impervious rock formation and through rock features. Because of the intense fracturing, particularly older formation, and the presence of large solution openings in limestone, secondary permeability is induced to the rocks that favors spring development.

For the study, springs are categorized into developed, undeveloped and untapped springs. A developed spring is utilized in provision of sanitary protection, otherwise it is classified as undeveloped spring, which is considered as unsafe water source. An untapped spring, as the name implies, is unutilized and flowing in its natural state.

Based on the inventory of water sources prepared during the study, the province has 806 developed springs currently serving the province, which come out from high volcanic mountain areas in the central and eastern parts of the province. Of these springs, 736 have discharges of less than 2.8 lps, while 70 yield with 2.8 lps or more. Most of these springs are not dried up during the drought year with yields varying from 0.1 lps to 47.2 lps. The technical information of springs in each municipality is presented in Table 7.4.1 Existing Spring Sources, Supporting Report.

7.5 Surface Water Sources

The major surface water sources in the province are Tagoloan, Cagayan and Pulangi Rivers. Sawaga, Pulangi and Muleta streams are tributaries of the Mindanao River. There are five (5) stream gauging stations in the province.

Surface water use in the province totaled 86.0 m^3/sec according to the NWRB's water rights registration database, as of March 1997. Of this usage, 98% of the water rights were registered for irrigation. The large-scale flumes are operated by the NIA. The diversions of major flume are located in Sumilao at the Tagoloan River, in Talakag at the Cagayan River, in Lantapan and Valencia at the Sawaga River, and in Valencia and Maramag at the Pulangi River, respectively. Other surface water rights are lodged to waterworks and private companies for domestic and industrial users. For domestic water supply, the Malaybalay WD had registered 0.07m^3/sec intake amount at the Sawaga River in the year 1990.

Data on river flow together with maintenance flow and water use of the major rivers/streams were obtained from available runoff records at the gauging stations (refer to Table 7.5.1, Supporting Report). The inflow to and the outflow from the respective municipalities are estimated as the exploitable potential of the major rivers in the province as shown in Table 7.5.2, Supporting Report.

Water quality analyses at selected streams were conducted through this study. The examined water quality at each stream meets the Class "A" limitation of "DENR Fresh Water Quality Criteria". However, high Fe and Mn contents were observed at all streams due to the existence of mineral rich rocks of the volcanoes. It is noted that mining activities on chromite, copper and gold are prevalent at the Tagoloan stream watershed in the municipalities of Malaybalay, Impasugong and Libona. These operations have caused contamination of the surface water by heavy metals such as mercury solution. The agricultural fertilizers are used for the pineapple plantation in piedmont of the central volcanic area, which may be a potential pollution source.

7.6 Future Development Potential of Water Sources

(1) Groundwater

Based on the study of existing water sources, groundwater is considered as a safe and more economical source for future water supply requirements of the province.

Shallow wells are the possible source for Level I service. Considering the existing wells in the province, the potential aquifers for shallow wells occur between 3 to 18 mbgs. One disadvantage of shallow wells is the lowering of water level during dry season that reduces the discharge of the wells. Another disadvantage is the usual high susceptibility of shallow aquifers to direct infiltration of surface pollutants.

In general, deep wells have better water quality and invariable yields when developed with appropriate technology. This depends that the wells tap to comparatively deeper aquifer. It reduces the hazards of groundwater pollution. In addition, lowering of groundwater level does not affect the discharge, since usual confinement of deep aquifer rises water level above the aquifers. In Recent deposits and Plio-Pleistocene series, good aquifers apparently occur from 30 m to 160 m in depth.

Additional wells can still be developed to meet the future water supply demand of the province. For future planning purpose, the Groundwater Availability Map includes basic

information for municipal groundwater development with the following data: well type, well yield, static water level and water quality. Aquifer formations are described in Table 7.6.2, Supporting Report. The groundwater development potential in the province is shown in Table 7.6.1.

The well design with gravel placement is required for additional well development. However, the natural gravel packed well for Level-I water supply is also adaptable within limited areas in the province. The percentages of the natural gravel packed wells in the expected municipality area are assumed in the Supporting Report. The construction ratio of natural gravel packed well to the total requirements in the province is probably summed at a few percent.

(2) Spring

A total of 108 untapped spring sources for future development are listed in Table 7.6.4 Untapped Spring Source Identification, Supporting Report. The list includes detailed data on barangay name, owner, discharge rate in dry season, transmission line length and elevation difference between spring source and served area.

Such springs are mainly located in the mountainous municipalities, which are belonging to the volcanic areas and the Central Mindanao Cordillera. Other municipalities have a few untapped springs. Discharge rates of the springs are ranging from 2.0 lps to 500 lps. The spring development potential in the province is shown in Table 7.6.1.

(3) Surface Water

The potential surface water volume exploitable at major rivers for the use of domestic water supply was estimated by municipality. It was arranged in this calculation to ensure maintenance flow of the rivers under the draught flow in the 10-year return period with due consideration of the present water rights.

The calculation results are shown in Table 7.5.2, Supporting Report. In particular, municipalities situated in the Tagoloan, Cagayan main and Pulangi River basins are privileged to use larger amount of river water.

Table 7.6.1 Groundwater Development Potential in the Province

Area	Groundwater Development Potential	Water Quality	Area Feature
Central-West Volcanic Mountains	The springs are major water sources for drinking water supply in this area. Most of these spring fields are located on a hillside belt of Mt. Kitanglad and Mt. Kalatungan, where altitude is about 1,000 m. It is found in northern side of Mt Kitanglad and southern piedmont area of Mt. Kalatungan that the discharge rates of some springs are more than 500 lps. Generally, the springs in piedmont area of Mt. Kalatungan are richer than other area in terms of discharge. The deep well source is also available in the area of pyroclastics sedimentary formations with limited well yields which are estimated about 100 m^3/day to 500 m^3/day. The depths of the deep wells are ranging from 30 m to 180 m. However, the deep well fields with very limited yielding at the southern hillside of Mt. Kalatungan are observed.	The water quality of spring source is generally potable. But the influence by the fertilizer has not yet examined. The groundwater quality is examined high Fe and Mn contents in hillside of Mt. Kitanglad & southern hillside of Mt. Kalatungan.	This area covers sixteen (16) municipalities and occupies about 43% of the province. The boundary of this area is located along the national highway from Cagayan de Oro City to Kidapawan. The area has volcanic Feature represented by Mt. Kitanglad and Mt. Kalatungan with elevations of 2,838 m and 2,824 m, respectively.
North Valley & Volcanic Mountains	Groundwater sources are very limited at the Tagoloan River Valley. Deep wells with depths of 30 m to 80 mbgs may be constructed for limited water use for Level-I service. In this regard, the potential area of deep wells is located at the southern hillside of Mt. Sinalagas. In the other mountainous areas, the spring is a potential source.	The groundwater (both wells and springs) is potable.	This area covers three municipalities and one city, which are located northern part of the province. This area is symbolic of deep valley along the Tagoloan River.
Southeast Alluvial Plain & Volcanic Hills	Deep well development is possible in alluvial plain area along the Pulangi River. Some deep wells located downstream of the Pulangi River are designed to take water from limestone sediments which are underlain by the alluvial deposits. The production amounts of deep wells with depths of 40 m to 120 m in alluvial plain or limestone area are estimated at 1,000 m^3/day to 3,000 m^3/day. The groundwater level in this area is generally shallow within 5 mbgs. Major water sources to be used in other mountainous areas are springs with potable quality. However, the water extracted from deep wells may also be available where sedimentary formations mainly limestone or sandstone overlay.	The groundwater, developed as wells and springs, is potable.	This area covers municipalities in southeastern part of the provincial area. Municipalities of Cabanglasan and San Fernando are belonging to the mountainous area, while other municipalities are located along the alluvial plain formed by the Pulangi River.

7.7 Water Source Development for Medium-Term Development Plan

For the preparation of the medium-term development plan in terms of water source development, standard specifications of wells by municipality were prepared. The parameters such as proportion of well type, well depth, static water level and specific capacity are shown in Table 7.7.1, which were established using well information from NWRB and the province (detailed data base is included in Table 7.1.1, Data Report), and hydrogeological assessment presented in Table 7.6.2, Supporting Report.

The water sources availability (ratio between wells to springs) by municipality is attached to the Table 7.7.1 that was assumed based on water sources study with consideration of limited information such as geology, topography, water sources inventory, etc. These ratios indicate the general profile of different types of groundwater source available in the municipalities. Therefore, figures of ratio have no projected meaning of future development values of each groundwater source. With consideration of present water sources utilization, the percentages of spring development compared with well development for future demand in the entire province are studied in Chapter-8 as planning section.

Table 7.7.1 Standard Specification of Wells by Municipality

Municipalities with Classification		Type	Proportion (%)	Standard Specification			Ratio (%) well:spring
				Depth Range (m)	SWL (m)	Sp. Cap. (lpsm)	
Baungon	Rural	SW	-	- <D< -	-	-	40:60
		DW	70	50 <D< 100	40	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	90	90 <D< 150	40	1.0	
Cabanglasan	Rural	SW	-	- <D< -	-	-	20:80
		DW	20	30 <D< 60	10	0.2	
	Urban	SW	-	- <D< -	-	-	
		DW	0	- <D< -	-	-	
Damulog	Rural	SW	-	- <D< -	-	-	100:0
		DW	100	20 <D< 90	10	1.0	
	Urban	SW	-	- <D< -	-	-	
		DW	100	60 <D< 150	10	2.0	
Dangcagan	Rural	SW	-	- <D< -	-	-	80:20
		DW	70	20 <D< 90	10	1.0	
	Urban	SW	-	- <D< -	-	-	
		DW	100	60 <D< 150	10	2.0	
Don Carlos	Rural	SW	-	- <D< -	-	-	30:70
		DW	100	20 <D< 90	8	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	100	60 <D< 150	8	1.0	
Impasugong	Rural	SW	-	- <D< -	-	-	40:60
		DW	40	60 <D< 90	50	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	100	100 <D< 150	50	1.0	

Table 7.7.1 Standard Specification of Wells by Municipality (continued)

Municipalities with Classification		Type	Proportion (%)	Standard Specification			Ratio (%) well:spring
				Depth Range (m)	SWL (m)	Sp. Cap. (lpsm)	
Kadingilan	Rural	SW	-	- <D< -	-	-	50:50
		DW	100	20 <D< 90	10	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	100	60 <D< 150	10	1.0	
Kalilangan	Rural	SW	-	- <D< -	-	-	50:50
		DW	20	60 <D< 90	50	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	30	100 <D< 150	50	1.0	
Kibawe	Rural	SW	-	- <D< -	-	-	80:20
		DW	80	20 <D< 90	10	0.5	
	Urban	SW	-	- <D< -	-	-	
		DW	100	60 <D< 150	10	2.0	
Kitaotao	Rural	SW	-	- <D< -	-	-	60:40
		DW	50	20 <D< 70	7	0.5	
	Urban	SW	-	- <D< -	-	-	
		DW	100	60 <D< 150	7	2.0	
Lantapan	Rural	SW	-	- <D< -	-	-	40:60
		DW	70	60 <D< 90	50	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	100	100 <D< 150	50	1.0	
Libona	Rural	SW	-	- <D< -	-	-	40:60
		DW	80	50 <D< 90	40	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	60	90 <D< 150	40	1.0	
Malaybalay	Rural	SW	-	- <D< -	-	-	40:60
		DW	30	80 <D< 120	70	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	70	120 <D< 180	70	1.0	
Malitbog	Rural	SW	-	- <D< -	-	-	50:50
		DW	80	50 <D< 90	40	0.5	
	Urban	SW	-	- <D< -	-	-	
		DW	100	90 <D< 150	40	1.0	
Manolo Fortich	Rural	SW	-	- <D< -	-	-	40:60
		DW	90	50 <D< 90	40	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	100	90 <D< 150	40	1.0	
Maramag	Rural	SW	-	- <D< -	-	-	50:50
		DW	60	40 <D< 80	30	0.5	
	Urban	SW	-	- <D< -	-	-	
		DW	100	80 <D< 150	30	1.0	
Pangantucan	Rural	SW	-	- <D< -	-	-	40:60
		DW	30	50 <D< 90	40	0.5	
	Urban	SW	-	- <D< -	-	-	
		DW	40	90 <D< 150	40	1.0	
Quezon	Rural	SW	-	- <D< -	-	-	70:30
		DW	60	20 <D< 70	7	0.5	
	Urban	SW	-	- <D< -	-	-	
		DW	50	60 <D< 120	7	1.0	
San Fernando	Rural	SW	-	- <D< -	-	-	30:70
		DW	0	- <D< -	-	-	
	Urban	SW	-	- <D< -	-	-	
		DW	10	60 <D< 120	5	1.0	

Table 7.7.1 Standard Specification of Wells by Municipality (continued)

Municipalities with Classification		Type	Proportion (%)	Standard Specification: Depth Range (m)	SWL (m)	Sp. Cap. (lpsm)	Ratio (%) well:spring
Sumilao	Rural	SW	-	- <D< -	-	-	40:60
		DW	90	60 <D< 90	50	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	60	100 <D< 150	50	1.0	
Talakag	Rural	SW	-	- <D< -	-	-	40:60
		DW	80	60 <D< 90	50	0.3	
	Urban	SW	-	- <D< -	-	-	
		DW	100	100 <D< 150	50	1.0	
Valencia	Rural	SW	-	- <D< -	-	-	100:0
		DW	80	20 <D< 40	5	0.5	
	Urban	SW	-	- <D< -	-	-	
		DW	100	60 <D< 100	5	2.0	

Shallow wells are currently used in some municipalities. The municipal areas are categorized into deep well and shallow well areas considering the on-going practices. The proportions (%) of shallow and deep wells are determined with reference to groundwater development potential in the Groundwater Availability Map. Furthermore, the well locations are assumed in terms of rural and urban areas by municipality referring to the classification of rural and urban barangays.

For the municipalities without any well data, the well parameters are appropriated using those in adjoining towns, provided they have similar hydrogeologic features.

For the furtherance in collecting accurate information to design the concrete specifications of the planned wells, the following recommendations are made (details are referred to Chapter 7.7.1, Supporting Report). Prior to the detailed design or pre-construction stage, additional detailed groundwater investigations entailing the construction of test wells shall be conducted. The municipalities that fall on this group are Manolo Fortich, Lantapan, Maramag, Don Carlos and Dangcagan. Additionally, the investigation on alternative water source available for the Malaybalay WD shall be conducted within hillside of Mt. Kitanglad or Mt. Tago. Table 7.7.2 summarizes the requirements.

The groundwater development for water supply in urban areas (Level II and III systems) may require the construction of deep wells with a larger casing diameter of 6 inches or more to ensure larger production rates. In these cases, short spacing intervals between the adjacent wells often cause the well interference due to the large lowering of pumping water level when the adjacent wells are operated simultaneously in a longer period. As the remedy of the problem on pump-operation with excess electric consumption and deterioration of deep well life may

be obliged. Thus, appropriate spacing interval and number of wells to be constructed per km^2 shall be considered. Table 7.7.1, Supporting Report presents reference information on spacing arrangements for planned wells.

Table 7.7.2 Detailed Groundwater Investigation Required

Municipality	Area	Investigation Activities and Specifications
Manolo Fortich & Lantapan	Urban Area	Test Wells; One deep well by municipality depth of 150 m, diameter of 250 mm and well screen of 40m target aquifers: pyroclastics Installation of Test; Pumping Test & Water Quality Examination Time Draw-down with maximum discharge of 1,500m^3/day Recovery Test Water Quality Examination to include of Fe and Mn
Maramag & Don Carlos	Urban Area	Test Wells; One deep well by municipality depth of 150 m, diameter of 200 mm and well screen of 30m target aquifers: pyroclastics Installation of Test; Pumping Test & Water Quality Examination Time Draw-down with maximum discharge of 1,000m^3/day Recovery Test Water Quality Examination to include of Fe and Mn
Dangcagan	Urban Area	Test Wells; One deep wells depth of 180 m, diameter of 300 mm and well screen of 50m target aquifers: limestone sediments Installation of Test; Pumping Test & Water Quality Examination Time Draw-down with maximum discharge of 2,500m^3/day Recovery Test Water Quality Examination to include of Ca, Mg, Fe and Mn

The groundwater development for water supply in urban areas (Level II and III systems) may require the construction of deep wells with a larger casing diameter of 6 inches or more to ensure larger production rates. In these cases, short spacing intervals between the adjacent wells often cause the well interference due to the large lowering of pumping water level when the adjacent wells are operated simultaneously in a longer period. As the remedy of the problem on pump-operation with excess electric consumption and deterioration of deep well life may be obliged. Thus, appropriate spacing interval and number of wells to be constructed per km^2 shall be considered. Table 7.7.1, Supporting Report presents reference information on spacing arrangements for planned wells.

Spring sources, proposed by barangay level, for future development are shown in Table 7.6.4, Supporting Report. Further investigation shall be conducted for these springs, prior to the implementation to confirm on the following items: (1) location and type of spring sources, (2) fluctuation of discharge rates through the year, (3) distance from spring sources and proposed served areas and (4) elevation differences between the two points.

Chapter 8

FUTURE REQUIREMENTS IN WATER SUPPLY AND SANITATION IMPROVEMENT

8. FUTURE REQUIREMENTS IN WATER SUPPLY AND SANITATION IMPROVEMENT

8.1 General

Phased investments for provincial sector development are planned in almost the same manner as adopted in the 1998 Philippine National Development Plan (PNDP) and the National Sector Master Plan (NSMP), Medium-Term Investment covering the years 1999 to 2003 and Long-Term Development covering the period 2004 to 2010.

Targets of provincial service coverage for the two phases are established as percentages of beneficiaries or utilities to be served by sub-sector. Service coverage in the base year (1997) and national sector targets indicated in the National Sector Master Plan (NSMP) and the updated Medium-Term Philippine Development Plan, 1996 - 1998 (MTPDP) are the bases of the study. Sector targets which are not prescribed in the national plan: school and public toilets as well as sewerage are assumed based on the current conditions. In addition, preliminary discussions on solid waste management are included as a vital component of sanitation sector.

Projection of frame values by municipality is undertaken for respective sub-sectors; future population by urban and rural area, the number of student enrollment to public schools and the number of public utilities. Reference base figures for the study of framework are the 1995 Census of Population and Housing, the statistical data of the province and the information from relevant agencies. Provincial population by target year and the base year (1997) is estimated with reference to NSO population census results (1980, 1990 and 1995), 1995 Census-based National and Regional Population projection prepared by NSO and Provincial Physical Framework Plan/Comprehensive Provincial Land Use Plan. While, the population distribution to urban and rural areas prepared by NSO in 1995 is modified to meet actual conditions in the classification of the areas.

Types of required facilities and their implementation criteria according to service level standards are referred to the NSMP and the NEDA Board Resolution No. 12 (s. 1995). Some planning conditions and assumptions not prescribed in the national plan are conferred to the relevant standards of sector agencies and provincial government. For sewerage requirements, the deficit in sanitation must first be addressed. Partial upgrading of on-site disposal to a sewerage system (off-site disposal) is envisaged in the final target year.

In estimating future requirements by municipality, additional population (or number of students/public utilities) to be served by sub-sector is first calculated as a shortfall at target years in comparison between each target and its base year service coverage. In this regard, planned/on-going projects to be completed by respective base years are considered as part of existing services for each target year. Required number of facilities by sector component is then estimated corresponding to the said additional population (or number of students/public utilities) to be served. Rehabilitation work for Level I facilities limited to new deep wells to be constructed under PW4SP is taken into account. Generally, rehabilitation of deep wells and shallow wells constructed by means of conventional method is difficult.

Logistic support is considered as a minimum requirement of LGUs for community development and training, and other relevant activities along with the implementation of PW4SP. The types and number of well drilling/rehabilitation equipment and supporting vehicle for Level I facilities are also suggested as reference information. Also, minimum requirements for setting up a provincial laboratory to support drinking water quality surveillance and monitoring are described. This will include building, instrument/equipment and reagent/chemical requirements. The 1993 Philippine National Standards for Drinking Water (PNSDW) requires that initial examinations of water from newly constructed sources should first be undertaken before operation for public use and henceforth periodic examinations of these water supply sources/facilities.

Project priority for medium-term development is discussed entailing general criteria to identify specific projects. However, at the provincial level master plan, it is suggested that municipal priority ranking be used for allocation of provincial fund.

8.2 Targets of Provincial Sector Plan

Provincial sector targets for the years 2003 and 2010 are determined as the provincial average of the desirable minimum level for each sub-sector. Table 8.2.1 summarizes the target percentages to be served by sub-sector. Details by sub-sector are discussed in this sub-section.

(1) Water supply

The base year (1997) service coverage was calculated as a total of 1997 figures and expected by planned/on-going projects scheduled to be completed by 1998. Table 8.2.2 shows service coverage for the planning purpose (details are referred to Supporting Report).

Table 8.2.1 Provincial Sector Targets

Sub-sector	Existing Service Coverage	Phase I (1999-2003)		Phase II (2004-2010)	
Water Supply	Population Coverage (%)	Population Coverage (%)	Additional Population to be Served	Population Coverage (%)	Additional Population to be Served
Urban Area	74	80	53,763	95	301,317
Rural Area	80	85	137,085	93	115,281
Sanitation	Household Coverage (%)	Household Coverage (%)	Additional Households to be Served	Household Coverage (%)	Additional Households to be Served
Household Toilet					
Urban Area	87	93	23,999	98	55,184
Flush	22	35	13,296	50	36,403
Pour Flush	63	55	7,846	50	18,781
VIP	15	10	2,857	0	0
Rural Area	59	75	48,355	93	81,374
Flush	8	10	3,636	20	13,064
Pour Flush	69	75	37,926	80	68,310
VIP	23	15	6,793	0	0
School Toilet	Public School Student Coverage (%)	Public School Student Coverage (%)	Additional Public School Students to be Served	Public School Student Coverage (%)	Additional Public School Students to be Served
	34	60	74,654	90	120,404
Public Toilet	Public Utilities Coverage (%)	Public Utilities Coverage (%)	Additional Public Utilities with Sanitary Toilets	Public Utilities Coverage (%)	Additional Public Utilities with Sanitary Toilets
	97	100	3	100	0
Sewerage	Urban Population Coverage (%)	Not Applicable		Urban Population Coverage (%)	Urban Population to be Served
	0			50	215,359
Solid Waste	Urban Household Coverage (%)	Urban Household Coverage (%)	Additional Urban Households to be Served	Not Applicable	
	75	90	21,513		

Table 8.2.2 Estimation of Base Year Service Coverage of Water Supply

Municipality/ City	Area	Population (1997)	Population Served by 1997 Facilities				
			Level III	Level II	Level I	Total	Percentage Coverage
Baungon	Urban	4,960	1,032	210	2,702	3,944	80
	Rural	18,906		1,368	14,075	15,443	82
	Total	23,866	1,032	1,578	16,777	19,387	81
Cabanglasan	Urban	4,013		390	2,881	3,271	82
	Rural	26,540		3,876	21,174	25,050	94
	Total	30,553		4,266	24,055	28,321	93
Damulog	Urban	3,870		175	2,401	2,576	67
	Rural	11,746		1,315	9,839	11,154	95
	Total	15,616		1,490	12,240	13,730	88
Dangcagan	Urban	4,548	867	612	2,551	4,030	89
	Rural	12,909		200	2,486	2,686	21
	Total	17,457	867	812	5,037	6,716	38
Don Carlos	Urban	23,145	2,133	972	10,722	13,827	60
	Rural	30,211	1,503	912	16,462	18,877	62
	Total	53,356	3,636	1,884	27,184	32,704	61
Impasugong	Urban	5,475	2,329		2,162	4,491	82
	Rural	21,110	728	1,604	17,622	19,954	95
	Total	26,585	3,057	1,604	19,784	24,445	92
Kadingilan	Urban	4,794		1,620	1,236	2,856	60
	Rural	22,227		1,040	13,094	14,134	64
	Total	27,021		2,660	14,330	16,990	63
Kalilangan	Urban	17,250	1,156	540	11,445	13,141	76
	Rural	11,049	193	897	4,415	5,505	50
	Total	28,299	1,349	1,437	15,860	18,646	66
Kibawe	Urban	4,347	2,772	52		2,824	65
	Rural	27,352	369		23,848	24,217	89
	Total	31,699	3,141	52	23,848	27,041	85
Kitaotao	Urban	9,891		1,008	5,801	6,809	69
	Rural	30,209			22,285	22,285	74
	Total	40,100		1,008	28,086	29,094	73
Lantapan	Urban	14,761	1,015	197	11,159	12,371	84
	Rural	23,619	667	5,325	15,056	21,048	89
	Total	38,380	1,682	5,522	26,215	33,419	87
Libona	Urban	2,317	935		335	1,270	55
	Rural	30,525	4,584	5,145	9,648	19,377	63
	Total	32,842	5,519	5,145	9,983	20,647	63
Malaybalay (Capital)	Urban	28,759	25,261			25,261	88
	Rural	91,419	4,072	8,058	39,523	51,653	57
	Total	120,178	29,333	8,058	39,523	76,914	64
Malitbog	Urban	2,704		112	2,160	2,272	84
	Rural	14,342		1,518	11,716	13,234	92
	Total	17,046		1,630	13,876	15,506	91

Table 8.2.2 Estimation of Base Year Service Coverage of Water Supply (contd)

Municipality/ City	Area	Population (1997)	Population Served by 1997 Facilities				
			Level III	Level II	Level I	Total	Percentage Coverage
Manolo Fortich	Urban	5,512	4,281		701	4,982	90
	Rural	64,481	19,635	4,926	36,484	61,045	95
	Total	69,993	23,916	4,926	37,185	66,027	94
Maramag	Urban	52,948	5,879	11,583	3,357	20,819	39
	Rural	12,898	558	5,130	587	6,275	49
	Total	65,846	6,437	16,713	3,944	27,094	41
Pangantucan	Urban	23,078	1,200	2,181	15,734	19,115	83
	Rural	16,450		1,532	9,903	11,435	70
	Total	39,528	1,200	3,713	25,637	30,550	77
Quezon	Urban	14,458	7,639		5,930	13,569	94
	Rural	61,163	1,889	1,909	54,592	58,390	95
	Total	75,621	9,528	1,909	60,522	71,959	95
San Fernando	Urban	13,130		360	10,162	10,522	80
	Rural	23,524		432	19,564	19,996	85
	Total	36,654		792	29,726	30,518	83
Sumilao	Urban	10,880	3,881	3,224	3,559	10,664	98
	Rural	5,711		1,568	3,473	5,041	88
	Total	16,591	3,881	4,792	7,032	15,705	95
Talakag	Urban	5,663	4,800	252		5,052	89
	Rural	35,438		450	29,653	30,103	85
	Total	41,101	4,800	702	29,653	35,155	86
Valencia	Urban	36,445	20,552		13,883	34,435	94
	Rural	97,553	11,053	5,984	78,256	95,293	98
	Total	133,998	31,605	5,984	92,139	129,728	97
Provincial Total	Urban	292,948	85,732	23,488	108,881	218,101	74
	Rural	689,382	45,251	53,189	453,755	552,195	80
	Total	982,330	130,983	76,677	562,636	770,296	78

The base year service coverage in urban area (74%) is higher than the updated MTPDP sector target (69%) for the year 1998, while rural area (80%) is almost same as the sector target of 79%. As identified in Chapter 4, both in urban and rural area, the province achieved the targets of the MTPDP.

For Phase I development, targets of service coverage for water supply by urban and rural are establishes in consideration of about 5% increase from the base year. 80% and 85% is adopted for urban and rural area, respectively. Phase II targets are planned to increase urban and rural water supply coverage to 95% and 93%, respectively, as envisaged in the NSMP.

(2) Sanitation

1) Household toilets

As with water supply, the base year service coverage is calculated as shown in Table 8.2.3 reflecting any planned or on-going projects scheduled to be completed by 1998 (details are referred to Supporting Report).

The province has base year service coverage of 67%, which is slightly higher than the current national average coverage of 60%. Urban area registers a level of 87% that is well above the national average coverage. Rural area however, has only 59% owing to the presence of numerous unsanitary facilities. By type of sanitary toilet facility, the existing percentage composition to total households is as follows:

Type	Urban (%)	Rural (%)
Flush	22	8
Pour-flush	63	69
VIP latrine	15	23

To attain sufficiency and equitable access to basic services, provincial target of Phase I for urban household toilets is planned at 93%, while, for rural household toilets, 75% is projected. A higher percentage increase was assigned to the rural area than the urban area in order to lessen the gap of the coverage between these 2 areas and to achieve a more balanced distribution of this basic facility as embodied in the PNDP. For Phase II, 98% is arranged for urban households, while, 93% as set by the NSMP is adopted for rural household toilets.

The existing composition of the 3 facility types serves as an indicator in the distribution for Phase I, while for Phase II, VIP and sanitary pit privy/latrine (dry-type) is phased-out.

2) School toilets

The base year service coverage of public school students is shown in Table 8.2.4 counting expected coverage of any planned or on-going projects scheduled to be completed by 1998 (details are referred to Supporting Report)

Table 8.2.3 Base Year Service Coverage of Household Toilets

Municipality/ City	Area	1997		Households and Population Using Sanitary Toilets								
				Number of Households					Service Coverage (%)			
		Population	HHs	Flush	Pour Flush	VIP/Dry	Total	Population	Flush	Pour Flush	VIP/Dry	Total
Baungon	Urban	4,960	919	172	634		806	4,365	19	69		88
	Rural	18,906	3,560	1,032			1,032	5,483	29			29
	Total	23,866	4,479	1,204	634		1,838	9,848	27	14		41
Cabanglasan	Urban	4,013	712		315		315	1,766		44		44
	Rural	26,540	4,861	12	45	2,441	2,498	13,536		1	50	51
	Total	30,553	5,573	12	360	2,441	2,813	15,302		6	44	50
Damulog	Urban	3,870	774		30	352	382	1,897		4	45	49
	Rural	11,746	2,290			1,025	1,025	5,286			45	45
	Total	15,616	3,064		30	1,377	1,407	7,183		1	45	46
Dangcagan	Urban	4,548	839	24	718		742	4,003	3	86		88
	Rural	12,909	2,360		1,625	106	1,731	9,424		69	4	73
	Total	17,457	3,199	24	2,343	106	2,473	13,427	1	73	3	77
Don Carlos	Urban	23,145	4,417	520	1,879	800	3,199	16,665	12	43	18	72
	Rural	30,211	5,689		1,000	1,045	2,045	10,876		18	18	36
	Total	53,356	10,106	520	2,879	1,845	5,244	27,541	5	28	18	52
Impasugong	Urban	5,475	952	35	415	340	790	4,545	4	44	36	83
	Rural	21,110	3,770		1,510	121	1,631	9,078		40	3	43
	Total	26,585	4,722	35	1,925	461	2,421	13,623	1	41	10	51
Kadingilan	Urban	4,794	951		951		951	4,794		100		100
	Rural	22,227	4,242		600	1,792	2,392	12,448		14	42	56
	Total	27,021	5,193		1,551	1,792	3,343	17,242		30	35	64
Kalilangan	Urban	17,250	3,194	522	1,800	594	2,916	15,698	16	56	19	91
	Rural	11,049	2,065		1,200	265	1,465	7,845		58	13	71
	Total	28,299	5,259	522	3,000	859	4,381	23,543	10	57	16	83
Kibawe	Urban	4,347	836	579	257		836	4,347	69	31		100
	Rural	27,352	5,342		2,000	456	2,456	12,582		37	9	46
	Total	31,699	6,178	579	2,257	456	3,292	16,929	9	37	7	53
Kitaotao	Urban	9,891	2,039		2,039		2,039	9,891		100		100
	Rural	30,209	5,843		1,728	1,971	3,699	19,032		30	34	63
	Total	40,100	7,882		3,767	1,971	5,738	28,923		48	25	73
Lantapan	Urban	14,761	2,617	150	2,467		2,617	14,761	6	94		100
	Rural	23,619	4,287		1,000		1,000	5,433		23		23
	Total	38,380	6,904	150	3,467		3,617	20,194	2	50		52
Libona	Urban	2,317	434	75	359		434	2,317	17	83		100
	Rural	30,525	5,520	28	4,792	172	4,992	27,473	1	87	3	90
	Total	32,842	5,954	103	5,151	172	5,426	29,790	2	87	3	91
Malaybalay (Capital)	Urban	28,759	5,277	4,168	1,018		5,186	28,184	79	19		98
	Rural	91,419	16,682	1,190	3,061	755	5,006	27,426	7	18	5	30
	Total	120,178	21,959	5,358	4,079	755	10,192	55,610	24	19	3	46

Table 8.2.3 Base Year Service Coverage of Household Toilets (contd)

Municipality City	Area	1997		Households and Population Using Sanitary Toilets								
				Number of Households				Population	Service Coverage (%)			
		Popula-tion	HHs	Flush	Pour Flush	VIP/Dry	Total		Flush	Pour Flush	VIP/Dry	Total
Malitbog	Urban	2,704	528	10	455		465	2,380	2	86		88
	Rural	14,342	2,691		1,524	439	1,963	10,470		57	16	73
	Total	17,046	3,219	10	1,979	439	2,428	12,850		61	14	75
Manolo Fortich	Urban	5,512	1,058	1,005	53		1,058	5,512	95	5		100
	Rural	64,481	11,597	2,938	2,150	708	5,796	32,241	25	19	6	50
	Total	69,993	12,655	3,943	2,203	708	6,854	37,753	31	17	6	54
Maramag	Urban	52,948	9,934	1,208	4,259	3,259	8,726	46,595	12	43	33	88
	Rural	12,898	2,429	105	1,264	211	1,580	8,384	4	52	9	65
	Total	65,846	12,363	1,313	5,523	3,470	10,306	54,979	11	45	28	83
Pangantucan	Urban	23,078	4,211	219	2,000	992	3,211	17,540	5	47	24	76
	Rural	16,450	3,046		1,600		1,600	8,719		53		53
	Total	39,528	7,257	219	3,600	992	4,811	26,259	3	50	14	66
Quezon	Urban	14,458	2,728	1,440	881		2,321	12,290	53	32		85
	Rural	61,163	11,432	353	9,470		9,823	52,601	3	83		86
	Total	75,621	14,160	1,793	10,351		12,144	64,891	13	73		86
San Fernando	Urban	13,130	2,540	27	2,513		2,540	13,130	1	99		100
	Rural	23,524	4,389		1,809	1,385	3,194	17,173		41	32	73
	Total	36,654	6,929	27	4,322	1,385	5,734	30,303		62	20	83
Sumilao	Urban	10,880	1,953	60	422	420	902	5,005	3	22	22	46
	Rural	5,711	1,036		318		318	1,771		31		31
	Total	16,591	2,989	60	740	420	1,220	6,776	2	25	14	41
Talakag	Urban	5,663	1,075	75	1,000		1,075	5,663	7	93		100
	Rural	35,438	6,575		2,282	2,500	4,782	25,870		35	38	73
	Total	41,101	7,650	75	3,282	2,500	5,857	31,533	1	43	33	77
Valencia	Urban	36,445	6,889	320	5,753	287	6,360	33,530	5	84	4	92
	Rural	97,553	18,476	101	13,223	2,305	15,629	82,921	1	72	12	85
	Total	133,998	25,365	421	18,976	2,592	21,989	116,451	2	75	10	87
Provincial Total	Urban	292,948	54,877	10,609	30,218	7,044	47,871	254,878	19	55	13	87
	Rural	689,382	128,182	5,759	52,201	17,697	75,657	406,072	4	41	14	59
	Total	982,330	183,059	16,368	82,419	24,741	123,528	660,950	9	45	14	67

Base year service coverage is 34% applying the standard number of public school students to be served by one (1) unit of toilet facility. The low level is due to a large number of unsanitary or absence of facilities.

In the absence of national targets for school toilets, the existing level of service coverage is the base in setting up the targets. It is expected that all new construction of school-buildings will entail sanitary toilets enabling the coverage to increase on a high level. For Phase I and II, 60% and 90% are set, respectively.

Table 8.2.4 Base Year Service Coverage of Public School Toilets and Public Toilets

Municipality City	Public School Toilets			Public Toilets		
	Total Number of Public-School Students (1997)	Std. No. of Public School Student that can be Served by Sanitary Toilets in Base Year (1997)	Service Coverage (%)	Number of Public Utilities with Toilets in 1997	Number of Public Utility with Sanitary Toilets in Base Year (1997)	Service Coverage (%)
Baungon	4,362	880	20	4	4	100
Cabanglasan	6,813	3,520	52	2	2	100
Damulog	4,391	1,440	33	4	4	100
Dangcagan	4,256	1,920	45	4	4	100
Don Carlos	13,095	3,800	29	8	8	100
Impasugong	7,236	1,680	23			
Kadingilan	5,392	2,880	53	2	2	100
Kalilangan	7,543	840	11	3	2	67
Kibawe	6,672	5,560	83	9	9	100
Kitaotao	8,127	4,240	52	2	2	100
Lantapan	7,792	4,200	54	10	8	80
Libona	7,765	1,200	15			
Malaybalay	27,325	10,120	37	4	4	100
Malitbog	4,210	1,680	40	2	2	100
Manolo Fortich	16,883	9,280	55	7	7	100
Maramag	16,515	920	6	8	8	100
Pangantucan	8,395	960	11	3	3	100
Quezon	16,587	9,160	55	4	4	100
San Fernando	8,264	1,440	17			
Sumilao	3,615	80	2	1	1	100
Talakag	9,565	3,600	38	2	2	100
Valencia	29,229	5,840	20	10	10	100
Provincial Total	224,032	75,240	34	89	86	97

3) Public toilets

The base year service coverage considering expected additional coverage by 1998 is shown in Table 8.2.4 (details are referred to Supporting Report).

Of the 89 existing public utilities, 86 are served with at least one sanitary toilet giving a 97% coverage. Only 3 public utilities (mostly public markets) are not provided with sanitary toilet facilities.

Without national targets as of now, the indicator in setting up provincial targets would be the existing level of coverage. Accordingly, 100% coverage for both Phase I and Phase II are assumed.

(3) Sewerage

Given the non-existence of sewerage systems in any municipality at the present time, this plan does not consider the service during Phase I. For Phase II, a target of 50% coverage was applied to urban population of municipalities with more than 10,000 urban population provided by Level III water supply systems.

(4) Solid waste

The municipal level data in 1997 on the number of households served by the municipal refuse collection revealed that the current practice is concentrated to urban areas. The base year service coverage for urban area by municipality is reflected in Table 8.2.5.

Table 8.2.5 Base Year Service Coverage of Municipal Solid Waste System in 1997

Municipality/City	Total No. of Households	No. of Urban Households	No. of Households Served	Coverage of Total Number of Households (%)	Coverage of Urban Households (%)
Baungon	4,479	919	98	2	11
Cabanglasan	5,573	712			
Damulog	3,064	774	548	18	71
Dangcagan	3,199	839	801	25	95
Don Carlos	10,106	4,417	1,050	10	24
Impasugong	4,722	952			
Kadingilan	5,193	951	1,258	24	100
Kalilangan	5,259	3,194	3,320	63	100
Kibawe	6,178	836	396	6	47
Kitaotao	7,882	2,039	4,033	51	100
Lantapan	6,904	2,617			
Libona	5,954	434			
Malaybalay (Capital)	21,959	5,277	10,000	46	100
Malitbog	3,219	528			
Manolo Fortich	12,655	1,058	450	4	43
Maramag	12,363	9,934	3,208	26	32
Pangantucan	7,257	4,211	1,305	18	31
Quezon	14,160	2,728	1,114	8	41
San Fernando	6,929	2,540	1,477	21	58
Sumilao	2,989	1,953			
Talakag	7,650	1,075	3,500	46	100
Valencia	25,365	6,889	8,410	33	100
Provincial Total	183,059	54,877	40,968	22	75

About 22% of the total households in the province relied on municipal refuse collection using trucks or a 75% urban household coverage. These municipalities have a total of 22 units of collection truck.

No national targets have yet been set. However, considering the present level of coverage, a 90% urban household coverage is applied for the medium-term period (1999-2003).

8.3 Projection of Frame Values

8.3.1 Population Projection

Future population for all municipalities by urban and rural area was projected for the target years 2003 and 2010 together with the present population in 1997 as the planning base year.

The regional population in the future is published by the NSO, while the projection at the provincial and municipal levels were not available during the time of this study. The future population of LGUs was therefore projected (details are included in the Supporting Report). Available information for the study at present is as follows:

- NSO population census results in 1980, 1990 and 1995
- 1995 Census-based National and Regional Population Projection prepared by the NSO
- Provincial Physical Framework Plan/Comprehensive Provincial Land Use Plan (1993-2002)

(1) 1995 Census-Based National and Regional Population Projections: NSO

The NSO projected the regional population for the period 1995-2020. The assumptions take into account future trends in the demographic processes of fertility, mortality and migration required by the cohort-component method for projecting population. The 1995 Population Census was used as the basis for the projection.

In the regional population projection, Region X and XI are classified as medium-sized regions. The following are the result of the projection for the two regions in 2000, 2005 and 2010.

Table 8.3.1 Regional Population Projection

Year		1980	1990	1995	2000	2005	2010
Region X	Population	2,758,985	3,509,753	3,938,252	4,441,739	4,955,545	5,465,272
	Growth Rate	-	2.44 %	2.33 %	2.44 %	2.21 %	1.98 %
Region X (Revised)	Population	1,765,120	2,197,554	2,472,947	2,737,148	NA	NA
	Growth Rate	-	2.22 %	2.39 %	2.05 %	NA	NA
Region XI	Population	3,346,803	4,458,829	5,052,730	5,749,821	6,456,464	7,146,889
	Growth Rate	-	2.91 %	2.53 %	2.62 %	2.35 %	2.05 %

Notes: Region X revised is excluding CARAGA Region NA: Not Available
Growth rates of Region X and revised Region X from 1990 to 2000 are projected at 2.38% and 2.22%, respectively.

The growth rates from 1980-1995 between Region X (previous composition of the provinces used by the NSO) and the recently arranged Region X (excluding CARAGA Region) are almost the same. The growth rate (2.22%) of the revised Region X adopted

from 1990 to 2000 is the same as that experienced from 1980 to 1990 (10 years). However, the growth rates between 1990 and 1995, and 1995 and 2000 become 2.39% and 2.05% respectively as a result of the 1995 census.

(2) Provincial Physical Framework Plan/Comprehensive Provincial Land Use Plan:
Planning period 1993-2002

The provincial population for the year 2002 was projected with 1990 as the base year. The provincial growth rate experienced between 1980 and 1990 was adopted for the projection. However, the growth rate used in the Land Use Plan was revised in this study from 3.09% to 2.94% based on updated census results. Meanwhile, the recorded/ projected growth rate of Region X (excluding CARAGA Region) from 1980 to 1990 and from 1990 to 2000 is 2.22 %

The population projection on the provincial total and the component municipalities was made with 1990 as the base year. The population for the year 2002 was projected using a uniform growth rate between 1990 and 2002 referring to the experience from 1980 to 1990 (census years).

Comparing the census and the projected population in 1995, the provincial population based on the census is about 4% lower than the projected. On the other hand, the growth rate from 1990 to 1995 was reduced from the previous 2.94% to 2.19%. Thus, it is recommended to use the recently experienced growth rate for the medium-term projection. Regarding the municipal population in 1995, about 60% of the municipalities decreased their population from 1990. Although the differences between actual and projected population are within ±10%, the municipal growth rates experienced between 1990 and 1995 may be applied for the medium-term plan to reflect the current trends.

(3) Population Projection of the Province

The following conditions are considered/assumed in the population projection.

Provincial Population

1) Regional population (Region X including CARAGA Region at present) projected by the NSO for the year 2010 is referred to, as the fixed frame value of the Region. The following are the population ratios of the province to the Region from 1980 to 1995 and for the year 2003 (projected with 1995 as base year and with the growth rate from 1990 to 1995).

The growth rates by municipality for the years 1995 and 2002 are revised using the updated population records.

Year	1980	1990	1995	2003
Province	631,634	843,891	940,403	1,118,358
Region	2,758,985	3,509,753	3,938,252	4,742,782
P/R	22.9%	24.0%	23.9%	23.6%

The provincial ratio to the Region is stable with a range of 23% to 24%. The population share of the province to the regional total in the long-term period is assumed to be represented by that of 2003.

The growth rate (2.19 % is adjusted to 2.20% and 2.22 % for the years 1997 and 2003, respectively as the sum of the municipal population) experienced during the period 1990 to 1995 is basically applied for the medium-term (1995-2003) projection with 1995 as the base year. For the long-term projection, from 2004 to 2010, the provincial average growth rate of 2.03 % was estimated by applying the aforementioned manner of projection. The projected population for the years 1997, 2003 and 2010 are as follows:

Year	Population	Growth rate
1995	940,403	Census result
1997	982,331	2.20 % (initial assumption 2.19 %)
2003	1,120,854	2.22 % (initial assumption 2.19 %)
2010	1,289,804	2.03 % (estimated from projected population in 2010)

Municipal population

The municipal population for the medium-term target years is estimated using the recorded growth rates between 1990 and 1995. Table 8.3.2 shows the projected population with growth rates by municipality.

For the year 2010 in the long-term, it is assumed that the trend of population growth of the respective municipalities between 1990 and 2002, which is considered in the Land Use Plan, will be realized in line with the land use plan of the province. Thus, the projected growth rate for the year 2002 by municipality in the Land Use Plan is first applied to project the 2010 population from the year 2003. Then, the municipal population estimated initially is adjusted in proportion to the population size of each municipality to the total provincial population, to meet the above mentioned provincial population fixed for the year 2010 (1,289,804 persons).

Table 8.3.2 Municipal Population Projection and Growth Rates

Municipality/ City	Annual Growth Rate (%)				Population		
	'80-'90	Land UsePlan	'90-'95	Adopted	1995	1997	2003
Baungon	0.77	0.74	2.72	2.72	22,617	23,866	28,040
Cabanglasan	4.58	4.58	2.14	2.14	29,288	30,553	34,683
Damulog	0.77	0.76	2.00	2.00	15,010	15,616	17,587
Dangcagan	0.83	0.83	2.36	2.36	16,660	17,457	20,084
Don Carlos	2.72	2.71	2.20	2.20	51,083	53,356	60,800
Impasugong	4.34	4.33	2.33	2.33	25,389	26,585	30,522
Kadingilan	1.48	1.46	1.76	1.76	26,093	27,021	30,006
Kalilangan	2.71	2.70	2.43	2.43	26,973	28,299	32,682
Kibawe	0.60	0.60	1.48	1.48	30,783	31,699	34,612
Kitaotao	1.57	1.55	2.18	2.18	38,404	40,100	45,649
Lantapan	4.00	4.00	1.93	1.93	36,943	38,380	43,036
Libona	3.40	3.39	1.47	1.47	31,897	32,842	35,848
Malaybalay	4.54	4.50	3.46	3.46	112,277	120,178	147,379
Malitbog	0.95	0.95	1.91	1.91	16,414	17,046	19,093
Manolo Fortich	3.74	3.71	1.91	1.91	67,400	69,993	78,388
Maramag	4.19	4.17	2.50	2.50	62,673	65,846	76,361
Pangantucan	2.10	2.10.	1.43	1.43	38,418	39,528	43,055
Quezon	1.67	1.62	0.99	0.99	74,141	75,621	80,242
San Fernando	2.33	2.33	3.38	3.38	34,299	36,654	44,735
Sumilao	4.57	4.56	3.00	3.00	15,640	16,591	19,806
Talakag	3.51	3.49	2.16	2.16	39,378	41,101	46,738
Valencia	3.56	3.53	2.07	2.07	128,623	133,998	151,509
Province	2.94	3.09	2.19	2.19	940,403	982,331	1,120,854

Note: 1995 population is census results.

In this adjustment, the growth rates of Baungon, Damulog, Dangcagan, Kibawe and Malitbog are fixed (rates used in the Land Use Plan) to avoid negative growth rates (less than –0.5%). Table 8.3.3 shows the study process results and the projected population by municipality for the year 2010 as well as the adjusted growth rates

Population by urban and rural area

In the Land Use Plan, urban/rural population by municipality for the year 2002 is projected with 1990 as the base year. The annual growth rate of the rural population for the year 2002 by municipality is estimated referring to the experience from 1980 to 1990 and the future land use plan. The provincial average growth rate is set at 1.15%, which is modified from the experienced 0.77 % between 1980 and 1990. Furthermore, the growth rates for 4 municipalities, of the total 21 municipalities, are modified with a uniform rate of 0.77 %. The urban population by municipality is estimated as the balance between the

total population and the rural population. The average growth rate of the urban area of the province is estimated at 6.3 %.

Table 8.3.3 Municipal Population for the Year 2010

Municipality/City	Population Projection Using G.R in Land Use Plan			2010 Population Projection					
	2003 Pop.	GR. (%)	2010 Pop.	[1] Adjusted Pop.	[2] GR. (%)	[3] Modified Pop.	[4] GR. (%)	[5] Modified Pop.	[6] GR. (%)
Baungon	28,040	0.74	29,525	27,433	-0.31	29,525	N.A	29,525	0.74
Cabanglasan	34,683	4.58	47,452	44,090	3.49	44,090	3.8	43,755	3.38
Damulog	17,587	0.76	18,544	17,230	-0.29	18,544	N.A	18,544	0.76
Dangcagan	20,084	0.83	21,281	19,773	-0.22	21,281	N.A	21,281	0.83
Don Carlos	60,800	2.71	73,315	68,121	1.64	68,121	5.8	67,603	1.53
Impasugong	30,522	4.33	41,066	38,156	3.24	38,156	3.3	37,866	3.13
Kadingilan	30,006	1.46	33,210	30,857	0.40	30,857	2.6	30,622	0.29
Kalilangan	32,682	2.70	39,383	36,592	1.63	36,592	3.1	36,314	1.52
Kibawe	34,612	0.60	36,092	33,535	-0.45	36,092	N.A	36,092	0.60
Kitaotao	45,649	1.55	50,838	47,236	0.49	47,236	4.0	46,877	0.38
Lantapan	43,036	4.00	56,633	52,620	2.91	52,620	4.5	52,220	2.80
Libona	35,848	3.39	45,270	42,063	2.31	42,063	3.6	41,743	2.20
Malaybalay	147,379	4.50	200,562	186,352	3.41	186,352	15.9	184,935	3.30
Malitbog	19,093	0.95	20,400	18,954	-0.10	20,400	N.A	20,400	0.95
Manolo Fortich	78,388	3.71	101,157	93,989	2.63	93,989	8.0	93,275	2.52
Maramag	76,361	4.17	101,641	94,439	3.08	94,439	8.1	93,721	2.97
Pangantucan	43,055	2.10	49,797	46,269	1.03	46,269	3.9	45,917	0.92
Quezon	80,242	1.62	89,795	83,433	0.56	83,433	7.1	82,799	0.45
San Fernando	44,735	2.33	52,562	48,838	1.26	48,838	4.2	48,466	1.15
Sumilao	19,806	4.56	27,061	25,144	3.47	25,144	2.1	24,953	3.36
Talakag	46,738	3.49	59,423	55,213	2.41	55,213	4.7	54,793	2.30
Valencia	151,509	3.53	193,153	179,467	2.45	179,467	15.3	178,103	2.34
Province	1,120,854	3.09	1,388,160	1,289,804	2.03	1,298,720	100	1,289,804	2.03

Note: G.R.: Annual Growth Rate N.A.: Not Applicable

1) Adjusted in proportion to municipal population (provincial total of 1,388,160) to meet the fixed figure (1,289,804)
2) Estimated growth rates of municipalities between 2003 and 2010 using adjusted population [1].
3) Modified population from adjusted population [1] for Baungon, Damulog, Dangcagan, Kibawe and Malitbog (figures in Land Use Plan are used) to avoid negative growth rates. The population of the remaining municipalities is that of adjusted [1].
4) Proportion of the municipal population (excluding above five municipalities) to total population of 1,172,879.
5) Municipal population: modified for the five municipalities [3] and rearranged for the other municipalities to meet the population of 1,172,879 using the shares {above item 4)}.
6) Estimated growth rates of municipalities between 2003 and 2010 applying finally adjusted population [5]

Urban and rural population by municipality was studied considering the 1995 census results and the estimated figures in the Land Use Plan.

1) Past population development

With regard to the rural population of the province to the total population, the provincial averages in 1980, 1990 and 1995 were 84.7 %, 68.5 % and 70.2 %, respectively. The provincial averages of the rural population in the past 15 years were within the range of 70-85 %. While, the growth rates of Don Carlos, Kalilangan, Kitaotao, Lantapan, Maramag, Pangantucan and Sumilao from 1990 to 1995 showed

negative trends. Likewise, the share of the urban population of the province has been about 20%-30 % during the census period, although the growth rate from 1990 to 1995 was as high as 6.30 %.

2) Projection of urban and rural population for the years 1997, 2003 and 2010

The rural population by municipality for the target years was first projected and the urban population was calculated to meet the aforementioned municipal total population by smoothing the rural population.

In the projection of municipal rural population, the following are assumed by short/medium-term and long-term purposes.

- Short/Medium-term target: 1997 and 2003
- Updated census results in 1995 are applied in terms of the share of rural population to total population by municipality.
- Long-term target: 2010

The growth rate of the rural population by municipality, which is used for the projection in the year 2002 in the Land Use Plan, is basically employed with 2003 as base year. It is anticipated that the share between urban and rural population will be regulated to meet the land use plan in the long-term period.

The urban population of 5 municipalities: Kadingilan, Kibawe, Kitaotao, Libona and Talakag for the year 2010 by applying the above-mentioned method revealed lesser population than that of 2003. Therefore, the rural and urban population of these municipalities was revised to keep the urban population in 2003 for that of year 2010.

Under the above assumptions and modifications, the provincial average share of rural population for the year 2010 was arrived at 64%, about 6% lower than that of 1995 (70.2%) and much lower than in 1980 and 1990 (about 84.7% and 68.5%, respectively).

Table 8.3.4 presents the projected urban and rural population by municipality with assumed/estimated growth rates.

Table 8.3.4 Population Projection by Urban and Rural Area

	Municipalty/ City	1997			2003			2010						
								Population Projection Using Growth Rate Used in Land Use				Adjusted [1]		
		Total	Urban/ Rural	Share (%)	Total	Urban/ Rural	Share (%)	Total	Urban/ Rural	G.R. (%)	Share (%)	Urban/ Rural	G.R. (%)	Share (%)
Rural Area	Baungon	23,866	18,906	79.2	28,040	22,213	79.2	29,525	18,983	-2.22	64.3	18,983	-2.22	64.3
	Cabanglasan	30,553	26,539	86.9	34,683	30,127	86.9	43,755	31,789	0.77	72.7	31,789	0.77	72.7
	Damulog	15,616	11,746	75.2	17,587	13,228	75.2	18,544	13,958	0.77	75.3	13,958	0.77	75.3
	Dangcagan	17,457	12,909	73.9	20,084	14,852	73.9	21,281	15,241	0.37	71.6	15,241	0.37	71.6
	Don Carlos	53,356	30,211	56.6	60,800	34,426	56.6	67,603	36,376	0.79	53.8	36,376	0.79	53.8
	Impasugong	26,585	21,110	79.4	30,522	24,236	79.4	37,866	25,272	0.60	66.7	25,272	0.60	66.7
	Kadingilan	27,021	22,227	82.3	30,006	24,683	82.3	30,622	26,044	0.77	85.0	25,299	0.35	82.6
	Kalilangan	28,299	11,049	39.0	32,682	12,760	39.0	36,314	14,870	2.21	40.9	14,870	2.21	40.9
	Kibawe	31,699	27,352	86.3	34,612	29,866	86.3	36,092	31,514	0.77	87.3	31,346	0.69	86.9
	Kitaotao	40,100	30,208	75.3	45,649	34,389	75.3	46,877	35,960	0.64	76.7	35,617	0.50	76.0
	Lantapan	38,380	23,619	61.5	43,036	26,485	61.5	52,220	35,087	4.10	67.2	35,087	4.10	67.2
	Libona	32,842	30,525	92.9	35,848	33,319	92.9	41,743	42,077	3.39	100.8	39,214	2.35	93.9
	Malaybalay	120,178	91,420	76.1	147,379	112,11	76.1	184,935	141,962	3.43	76.8	141,96	3.43	76.8
	Malitbog	17,046	14,342	84.1	19,093	16,064	84.1	20,400	16,763	0.61	82.2	16,763	0.61	82.2
	Manolo Fortich	69,993	64,481	92.1	78,388	72,215	92.1	93,275	78,939	1.28	84.6	78,939	1.28	84.6
	Maramag	65,846	12,897	19.6	76,361	14,957	19.6	93,721	15,020	0.06	16.0	15,020	0.06	16.0
	Pangantucan	39,528	16,450	41.6	43,055	17,918	41.6	45,917	17,619	-0.24	38.4	17,619	-0.24	38.4
	Quezon	75,621	61,163	80.9	80,242	64,900	80.9	82,799	60,406	-1.02	73.0	60,406	-1.02	73.0
	San Fernando	36,654	23,525	64.2	44,735	28,711	64.2	48,466	31,602	1.38	65.2	31,602	1.38	65.2
	Sumilao	16,591	5,711	34.4	19,806	6,818	34.4	24,953	6,555	-0.56	26.3	6,555	-0.56	26.3
	Talakag	41,101	35,438	86.2	46,738	40,298	86.2	54,793	51,200	3.48	93.4	48,353	2.64	88.2
	Valencia	133,998	97,553	72.8	151,509	110,30	72.8	178,103	85,519	-3.57	48.0	85,519	-3.57	48.0
	Province	982,331	689,383	70.2	1,120,854	784,87	70.0	1,289,804	832,756	0.85	64.6	825,79	0.73	64.0
Urban Area	Baungon	23,866	4,959	20.8	28,040	5,827	20.8	29,525	10,542	8.84	35.7	10,542	8.84	35.7
	Cabanglasan	30,553	4,013	13.1	34,683	4,556	13.1	43,755	11,966	14.79	27.3	11,966	14.79	27.3
	Damulog	15,616	3,870	24.8	17,587	4,359	24.8	18,544	4,586	0.73	24.7	4,586	0.73	24.7
	Dangcagan	17,457	4,548	26.1	20,084	5,232	26.1	21,281	6,039	2.07	28.4	6,039	2.07	28.4
	Don Carlos	53,356	23,145	43.4	60,800	26,374	43.4	67,603	31,227	2.44	46.2	31,227	2.44	46.2
	Impasugong	26,585	5,475	20.6	30,522	6,286	20.6	37,866	12,594	10.44	33.3	12,594	10.44	33.3
	Kadingilan	27,021	4,794	17.7	30,006	5,323	17.7	30,622	4,578	-2.13	15.0	5,323	0.00	17.4
	Kalilangan	28,299	17,250	61.0	32,682	19,922	61.0	36,314	21,444	1.06	59.1	21,444	1.06	59.1
	Kibawe	31,699	4,347	13.7	34,612	4,746	13.7	36,092	4,579	-0.51	12.7	4,746	0.00	13.1
	Kitaotao	40,100	9,891	24.7	45,649	11,260	24.7	46,877	10,918	-0.44	23.3	11,260	0.00	24.0
	Lantapan	38,380	14,761	38.5	43,036	16,551	38.5	52,220	17,133	0.49	32.8	17,133	0.49	32.8
	Libona	32,842	2,317	7.1	35,848	2,529	7.1	41,743	-334	-174	-0.8	2,529	0.00	6.1
	Malaybalay	120,178	28,759	23.9	147,379	35,268	23.9	184,935	42,973	2.86	23.2	42,973	2.86	23.2
	Malitbog	17,046	2,704	15.9	19,093	3,029	15.9	20,400	3,637	2.65	17.8	3,637	2.65	17.8
	Manolo Fortich	69,993	5,512	7.9	78,388	6,173	7.9	93,275	14,336	12.79	15.4	14,336	12.79	15.4
	Maramag	65,846	52,948	80.4	76,361	61,403	80.4	93,721	78,701	3.61	84.0	78,701	3.61	84.0
	Pangantucan	39,528	23,078	58.4	43,055	25,137	58.4	45,917	28,298	1.71	61.6	28,298	1.71	61.6
	Quezon	75,621	14,458	19.1	80,242	15,341	19.1	82,799	22,393	5.55	27.0	22,393	5.55	27.0
	San Fernando	36,654	13,130	35.8	44,735	16,024	35.8	48,466	16,864	0.73	34.8	16,864	0.73	34.8
	Sumilao	16,591	10,880	65.6	19,806	12,988	65.6	24,953	18,398	5.10	73.7	18,398	5.10	73.7
	Talakag	41,101	5,663	13.8	46,738	6,440	13.8	54,793	3,593	-8.00	6.6	6,440	0.00	11.8
	Valencia	133,998	36,445	27.2	151,509	41,207	27.2	178,103	92,583	12.26	52.0	92,583	12.26	52.0
	Province	982,331	292,948	29.8	1,120,854	335,97	30.0	1,289,804	457,048	4.49	35.4	464,01	4.72	36.0

Note: Adjusted population by municipality is estimated according the following procedure.

- Urban population of the 5 municipalities in 2003 was employed for the year 2010 (since estimated urban population in 2010 is less than that of 2003).
- Accordingly, rural population for the 5 municipalities estimated using the growth rates in the Land Use Plan was revised to meet respective municipal population fixing urban population in 2010.
- Rural population of the other municipalities is estimated in application of respective growth rates in the Land Use Plan, and that for urban population is calculated as the balance with municipal total population.

8.3.2 School Enrollment Projection

From the 1995 total population of the province, the number of children who would be enrolling in elementary and high school levels for all municipalities is derived.

School age population is extrapolated from the NSO age group classification of 5-9, 10-14 and 15-19 years old bracket by municipality. The age group for the elementary level is from 6 to 13 years, while that for the high school level is from 14 to 17 years. The percentages of school age population for the target years are based on the existing composition or structure of the 1995 population.

From the school age population, the number of children who would attend either private or public school, by target year is computed using the projected participation rate. The participation rate by target year varies depending on the socio-economic condition of the province. Generally, an improved economy will result to a higher participation rate. For the province, a decreasing participation rate in both private and public schools is foreseen by year 2010.

The number of public school students by target year is then derived from the projected number of children who will attend school. A participation rate for public school enrollment is established based on the existing participation rate of public school students to the total school age population. Based on the projection, a decrease of 3% from the 1997 rate is foreseen in 2003 and an increase 4% from the 2003 rate in 2010 (details are referred to Table 8.3.6, Supporting Report). It should be noted that the participation rate in 1997 was almost 100%, an indication that a number of school enrollees are over-aged.

Table 8.3.5 shows the projected number of public school students by municipality, by target year. About 247,600 and 298,900 public school students are estimated to enroll for years 2003 and 2010, respectively.

8.3.3 Projection of the Number of Public Utilities

The number of public utilities (limited to public markets and bus/jeepney terminals) by target year is projected in urban areas for all municipalities. The provincial physical framework plan and the provincial comprehensive development plan serve as references in the projection. Bus or jeepney terminals are considered in major transport routes of the province.

A total of 3 public markets, bus/jeepney terminals and parks/playgrounds are planned for construction by year 2003 and no construction has yet been set for the year 2010. Refer to Table 8.3.5 for the number of public utilities by municipality by target year (details are referred to Supporting Report).

Table 8.3.5 Projected Public School Enrollment and Number of Public Utilities by Municipality

Municipality/City	Number of Public School Student			Number of Public Utilities		
	1997	2003	2010	1997	2003	2010
Baungon	4,362	5,478	6,153	4		
Cabanglasan	6,813	8,160	10,295	2		
Damulog	4,391	4,186	4,181	4		
Dangcagan	4,256	4,199	4,711	4		
Don Carlos	13,095	13,041	15,353	8		
Impasugong	7,236	7,394	9,173			
Kadingilan	5,392	6,542	7,069	2		
Kalilangan	7,543	7,857	8,271	3	1	
Kibawe	6,672	7,072	8,296	9		
Kitaotao	8,127	9,817	10,674	2		
Lantapan	7,792	9,383	12,056	10	2	
Libona	7,765	8,698	10,690			
Malaybalay (Capital)	27,325	31,873	42,348	4		
Malitbog	4,210	4,615	4,931	2		
Manolo Fortich	16,883	18,132	22,845	7		
Maramag	16,515	17,004	22,098	8		
Pangantucan	8,395	9,636	10,882	3		
Quezon	16,587	17,939	19,600	4		
San Fernando	8,264	10,621	11,507			
Sumilao	3,615	4,723	6,281	1		
Talakag	9,565	10,246	12,718	2		
Valencia	29,229	31,012	38,734	10		
Provincial Total	224,032	247,628	298,866	89	3	

8.3.4 Planning Area and its Projected Population for Sewerage

Urban areas with more than 10,000 population provided by Level III water supply systems in 2010 serve as the planning area. Population in the area is considered as the potential population to be served.

Fifteen (15) municipalities with a total urban population of about 430,712 are considered (refer to Table 8.5.5).

8.3.5 Number of Households to be Served by Municipal Solid Waste Collection System

The number of urban households in 2003 is the potential households for the planning (refer to Table 8.3.5, Supporting Report).

8.4 Types of Facilities and Implementation Criteria

In principle, types of facilities and their implementation criteria as prescribed in the NSMP and the NEDA Board Resolution No. 12 (s. 1995) are adopted to this PW4SP.

8.4.1 Water Supply

The following are major conditions and assumptions applied to urban and rural water supply, which are intended as a guide for the implementation of sector projects.

(1) Urban water supply

Prevailing situation of urban water supply in each municipality was first reviewed mainly focusing on existing water sources and magnitude of service coverage. Planned/on-going projects for concerned municipalities were also studied and reflected in the plan, with due attention to merging of municipalities into an integrated water supply system. Potential water source for future development was then evaluated based on the study results in Chapter 7, taking into account the possibility to utilize untapped spring sources. Recommendations arising from these studies were also incorporated as overall development strategy.

Aforementioned studies were carried out by the following sequence:

- Review of existing water supply systems and water sources;
- Review of planned/on-going projects;
- Establishment of planning conditions covering service level, utilization of existing facilities, water sources, and number of systems; and
- Recommendations for overall development strategy.

Table 8.4.1 presents a summary of the study results by municipality.

1) Review of existing water supply systems and water sources

Majority of the existing Level III systems in urban areas is utilizing spring sources. The municipalities/city of Don Carlos, Kibawe, Malaybalay, Maramag and Valencia

Table 8.4.1 Summary of Urban Water Supply by Municipality

Municipality	Existing Condition	Future Requirements	Water Source Availability	On-going/Planned Project
Baungon	One Level III managed by municipality exists. Served population is 1,000 (21% of urban population). Water source (estimated supply amount of 100 cu.m/day) is a combination of spring and deep well. The project to augment transmission line and expansion of distribution system is under way waiting for the fund from ADB-urban and LGU-urban water supply projects.	System expansion is required. Part of rural barangays will be covered, since the transmission line passes these areas.	The spring source identified is sufficient for the proposed project.	Under way waiting for the fund from ADB-urban and LGU-urban water supply project.
Cabanglasan	There is no Level III system at present. They use Level I with deep wells in poblacion area (4,000 persons). There is an on-going Level II project using spring source (however, supplementary spring source is necessary; Iba spring, about 20km away from the service area-costly requiring river crossing).	Individual Level III system shall be developed.	Investigations on both springs and wells shall be proceeded.	None
Damulog	There is no Level III system. They use Level I and II. The water source is deep well. Grade up from Level II to Level III was made at some systems, but it is so called spaghetti connection.	Individual Level III system shall be developed. Proper plan and design for the grade-up from Level II system to Level III is required. Urban population to be served is less than 4,000.	Deep well (fair potential)	None
Dangcagan	There is one Level III system entailing Level II service (combined sources; spring and deep well are used) managed by municipal government. About 20% of urban population (urban population is only 4,500) is served by the system.	Expansion of the system is required. Study on the expansion with reference to the source shall be conducted considering the services to the barangays where transmission line will pass.	There is a good spring source, 8km away from the service area (pumping system is required).	None
Don Carlos	There is one WD covering about 2,100 population (9% of urban population). Water sources are lake water and deep well. The promotion of the users to join the WD is under way. Currently, they use shallow wells (more than 1,000 in number).	System expansion with sufficient information dissemination to beneficiaries is required.	Deep well	The WD is planning to expand the system.
Impasug-Ong	One Level III system exists operated by RWSA (2,300 persons are served, 43% of urban population). Water source is a spring (deep well is stand-by).	Expansion shall be done using spring with emphasis on distribution line.	Priority shall be given to spring source.	LGU-urban water supply, but financial arrangment must be sought.
Kadingilan	There is no Level III system at present. Urban population is 4,800 and about 34 % is covered by the Level II systems using deep wells.	Individual Level III system shall be developed. The plan using deep wells shall be studied.	Deep well (but, low yealding and possibility of high iron/manganese content)	None

Table 8.4.1 Summary of Urban Water Supply by Municipality (Cont'd.)

Municipality	Existing Condition	Future Requirements	Water Source Availability	On-going/Planned Project
Kaliangan	One Level III managed by the municipality exists. The system covers 1,200 population (7% of urban population, 17,000, is covered) The spring source is used. Majority of the people uses free flowing Level I (sufficient water available).	System expansion	Spring source (sufficient quantity)	LGU - Urban WSP
Kibawe	One WD exists. Served population is 2,800 (64% service coverage of urban population). Water sources are deep wells. Expansion of the system is planned by the WD using deep wells.	System expansion with augmentation of water source	Deep well (but, possibility of high iron content)	The WD is planning to expand the system. Financial support is sought to LWUA.
Kitaotao	No Level III system exists at present. They use Level I and II systems. Level II service covers only 1,000 persons (10% of urban population, 10,000 people). Water source is deep well. Water quality (iron and manganese) problem is prevalent.	Individual Level III system shall be developed. A simple treatment facilities for iron/manganese shall be considered.	Deep well (but, possibility of high iron/manganese content)	None
Lantapan	One Level III operated by the municipality exists . The system serves 1,000 persons (7% of urban population; 4 urban barangays exist). Water source is spring. This municipality is one of recipient of LGU-urban water supply.	System expansion	Untapped springs shall be used.	LGU - Urban WSP
Libona	One Level III is operated by RWSA. Service population is 940 (40% of the urban population). Water source is deep well. Expansion of the system to cover 11 barangays (including 10 rural BRYs) is being planned using surface water. Financial support from ADB is sought.	System expansion	Spring/Deep well (fair potential, but possibility of high iron/manganese content) Utlization of surface water is under planning for system expansion.	Expansion of the system is being planned using surface water. Financial support from ADB is sought.
Malaybalay	There is one WD. Service population is 25,000 (88% of urban population) Deep well and surface water are utilized. Insufficient water source and limited capacity of treatment plant are current problems. The WD requested LWUA financial assistance for the improvement needs.	System expansion with augmentation of water source and improvement of water treatment plant are required. Further study shall be conducted.	River water may be used for augmentation of water source, but intake facility shall be constructed at the upstream of existing one.	Under preparation of system expansion with assistance from LWUA
Malitobog	No Level III system exists at present. Majority of people uses Level I facilities and supplemented by limited Level II. Water source is spring.	Individual Level III system shall be developed. The plan shall be prepared in consultation with people.	Untapped springs shall be used.	None
Manolo Fortich	One Level III operated by municipal government exists . Served population is 4,300 persons (78% of urban population). Water sources are combined ones (spring and deep well). The area is covered by ADB assisted project. Expansion of the system in use of spring shall be sought.	System expansion with augmentation of water source.	Spring source may be utilized.	ADB project

Table 8.4.1 Summary of Urban Water Supply by Municipality (Cont'd.)

Municipality	Existing Condition	Future Requirements	Water Source Availability	On-going/Planned Project
Maramag	There is one WD. Water source is spring. There are 12 urban barangays. WD serves for 5,900 persons (11% of urban population). Many Level II systems also serve urban barangays.	System expansion. The upgrading from existing Level II to Level III is a requisite in the future.	Priority shall be given to spring source.	None
Pangantucan	One Level III exists operated by RWSA. Service population is 1,200 in 8 urban barangays (5% of urban population). Water source is spring. Majority of the urban barangays is served by Level II systems.	System expansion shall be required. Upgrading of Level II systems to Level III is also a requisite in use of spring sources.	Untapped springs shall be used.	None
Quezon	One Level III operated by the municipality exists . 7,600 persons are served by the system (53% of urban population). Water source is spring in application of pumping system. Water source is sufficient, but costly in use of pumping measures.	Expansion shall be planned to increase service coverage using a spring (17 km away from urban areas) by gravity system.	Untapped springs shall be used.	None
San Fernando	No Level III system exists at present. They are served by Level I (majority) and Level II. Water sources are spring and deep well.	Individual Level III system shall be developed.	Priority shall be given to deep well (since untapped spring sources have insufficient quantity or located in the remote area)	None
Sumilao	One Level III managed by the municipality exists. The system serves for 3,900 persons (36% of urban population). Water source is spring. Expansion / construction of Level III shall be implemented by the municipality in use of spring sources. The municipality is eager to expand the system, but facing financial problem.	System expansion	Untapped springs shall be used.	None
Talakag	There is one Level III together with Level II operated by RWSA. Service population is 5,000 (90% of urban population). Water source is spring in application of pumping system. This municipality is one of the recipient of ADB project. A supplemental spring source identified shall be used for the extension of the system.	System expansion	Untapped springs shall be used.	ADB project
Valencia	One WD and one Level III system managed by RWSA exist. Water source is a combination of spring and deep well. Served population by these two systems is 20,600 (56% of urban population). The deep well may be the supplemental water source.	System expansion	Deep well (good potential, but possibility of high iron/manganese content)	The WD has a plan to expand the system covering one each of rural and urban barangay with financial support from Land Bank.

are served by WDs. While the municipalities of Baungon, Dangcagan, Impasugong, Kalilangan, Lantapan, Libona, Manolo Fortich, Pangantucan, Quezon, Sumilao and Talakag are served by Level III systems operated either by the municipal government or local community.

Currently, 5 out of the total 22 municipalities/city, namely: Cabanglasan, Damulog, Kadingilan, Kitaotao and San Fernando have no Level III system in their urban areas and are presently served by Level II systems and/or Level I facilities.

Population served by Level III systems range from about 900 persons in Dangcagan to 25,300 persons in Malaybalay. The average size of served population is about 5,000 persons.

Preference is made to utilize spring sources owing to less O&M activities and cost compared to deep well with electric motor pump.

2) Review of planned/on-going projects

At present, there are planned/on-going projects such as ADB-assisted/LGU urban water supply project coordinated by the DILG. The recipient municipalities/city are Baungon, Impasug-ong, Lantapan, Libona, Manolo Fortich and Talakag. In addition to this, the WDs of Don Carlos, Kibawe, Malaybalay and Valencia are planning to expand their systems. However, details of respective project have not been clarified during the preparation of this PW4SP.

3) Establishment of planning conditions

a. Service level

It shall be noted that a national policy for urban water supply is a Level III system, in general, as the most suitable measure. Therefore, for the investment needs of the sector development, it is assumed in this PW4SP that underserved or unserved urban population at present and in the future will be provided with individual house connections. However, it does not intend to exclude from being implemented Level I and II facilities in urban area as individual cases in the future

b. Utilization of existing facilities

The existing Level I and II facilities are considered to be utilized during the

Phase I period. However, the population served by these facilities is assumed to be absorbed by Level III service in Phase II.

c. Water sources

Possibility/availability to utilize surface water and groundwater (spring and deep well) is evaluated as potential water sources for water supply development.

From the viewpoints of cost effectiveness and easy O&M of water supply system, utilization of spring sources is given due priority in the course of urban water supply planning. Application of deep wells for water source is regarded as the second priority in principle. Surface water is, on the other hand, not adopted at this moment, because of large capital investment requirements and complexity of surface water treatment.

Water source development study revealed that some of the municipalities in the planning area have high potential for spring development. Among various untapped spring sources identified during the course of PW4SP preparation, the untapped sources located in the municipalities of Cabanglasan, Dangcagan, Malitbog and Quezon are considered to have favorable conditions for use in Level III services.

d. Number of systems

In principle, one (1) Level III system is considered for urban area of every municipality. In the municipalities with an existing Level III system/s, the expansion of the system was first considered. In case of no existence of Level III system/s, a new system was recommended. Existing plan/s on the development of Level III/WD are also taken into account to determine respective systems of the municipalities.

- Possibility and necessity to merge service area of some neighboring municipalities to an urban water supply system were also studied from the view points of:
- water source constraints, and
- economical development/scale merit of water supply system by cost reduction of water source development and other common facilities as well as O&M cost/minimized number of technical staff.

Any rural barangay/s being served by an existing urban Level III system are considered to continue throughout the future.

e. Rehabilitation

Rehabilitation of existing and future facilities is assumed to be undertaken by the operating bodies.

4) Overall development strategy

Expansion of the existing system/s was planned for those with WD/Level III, while creation of the system is considered for those without systems at present.

Merging of municipal systems (physical arrangement) in the long-term is considered. Integrated management systems shall also be sought. Conditions to be studied include; water source availability, willingness by concerned municipalities and technical study on cost recovery/economic construction.

The following municipalities may be studied for integration both in the physical and in the management systems.

- Kitaotao and Dangcagan

Integration of small Level III systems for operation and management shall be sought, although these systems are currently managed individually.

Some municipalities have high potential for spring development as a result of a number of untapped spring sources favorable for urban water supply that were identified during the course of PW4SP preparation. However, a detailed survey to ensure appropriate developments of spring sources shall be conducted in the implementation of the projects.

(2) Rural water supply

1) Service level

Level I systems (deep well/shallow well/developed spring) are generally planned for rural areas where houses are scattered. In the PW4SP, public investment for Level I facilities covers 10% of the total number of required facilities, considering the existing share of population served between public (25%) and private facilities (75%).

Level II systems are considered where houses are clustered and suitable untapped spring is available.

Service level standards are set forth as 15 households per source for Level I and 5 households per communal faucet for Level II, as defined in the national plan.

Application of Level III systems in rural areas may be considered in a case to case basis during actual implementation.

2) Utilization of existing facilities

The existing facilities/systems in all service levels are considered to be utilized throughout the future.

3) Water source

For Level I facilities, deep well construction is given priority wherever applicable considering safety against possible contamination and stable water supply. Standard specifications of shallow and deep wells are summarized in Table 8.4.3 based on the water source evaluation results presented in Chapter 7. Conventional construction method (driven well) may be employed under favorable substrata or hydrogeological conditions. The standard structure of wells in application of "open-hole drilling and gravel pack" is presented in Figure 8.4.1, Supporting Report. In addition to this, for deep well with high iron content, application of iron removal facility is recommended. The standard structure of iron removal facility is presented in Figures 8.4.2 (a) and (b), Supporting Report.

Table 8.4.2 Standard Specifications of Level I Wells

Specification	Shallow Well	Deep Well
Construction Method	Open-hole drilling and gravel pack	
Casing Diameter	50mm	100mm
Borehole Diameter	150mm	200mm
Ranges of Well Depth	Standard Depth	
0 - 20m	20m	Not Applicable
21 - 50m	Not Applicable	40m
51 - 100m	Not Applicable	80m
101 - 150m	Not Applicable	120m

Spring development is also included in Level I planning adopting its share of 30%. This takes into account the existing percentage of developed springs (46%) among public Level I facilities as safe water sources.

Profile between gravel packed well and natural gravel packed well for Level I water supply:

The open-hole drilling method is employed for the well construction to ensure yielding ground water from adequate aquifer in provision of proper screen location and specifications. The conventional "cased-hole driven well" shall be used only in cases where well specifications are established in the specified area with sufficient information on the hydrogeological condition including existence of natural gravel at the expected aquifer.

It is important to study on the potential area to adopt natural gravel method, which can perform the same level of function as gravel-packed wells. Such areas are usually limited to the upper stream of larger rivers in alluvial fans and alluvial plains. The arial proportion between those in application of gravel-packed and natural gravel pack wells will be worked out referring to the condition of the province.

Modification needs of riser pipe diameter according to the water level of deep wells:

The standard specification of deep well hand pump is set with a diameter of 2-1/2 inch in the plan. However, the water level of the deep wells may range between 20 m and around 40m, depending on the aquifer conditions.

Although, the Malawi type deep well pump with a cylinder, currently used in the Philippines, has an operation experience up to 40m in pumping water level, the diameter of riser pipe shall be adjusted between 1" to 2-1/2" to mitigate required power at the pump handle (calculating required power under the specific pumping water level).

For Level II systems, only untapped springs suitable for water supply purpose are considered. Identified untapped springs are presented in Table 7.4.1, Supporting Report.

4) Number of systems/facilities

The number of Level I wells and spring development is estimated based on the service level standard; while the number of Level II systems coincides with the number of untapped springs.

5) Rehabilitation

Rehabilitation of existing Level I wells is not considered, since most of the existing wells constructed by driving method is not suitable for rehabilitation to recover their functions. However, minor repair work for hand pump and concrete apron is a requisite.

8.4.2 Sanitation

The conditions and assumptions are established for the different sanitation components to serve as guides in the implementation of projects.

(1) Household toilets

Three types of sanitary toilet facilities for individual houses are considered for Phase I; flush, pour-flush and VIP/sanitary pit privy (dry-type). While for Phase II, flush and pour-flush are planned considering the improvement of living standard.

The type of toilet facilities is dependent on the existing or planned service level of water supply in the community. In urban and rural areas with Level I or II water supply facilities, only pour-flush and/or VIP are considered, while in urban areas with Level III water supply systems, flush type toilets requiring a piped water connection are included. Isolated rural areas where there is dearth of water supply, sanitary pit privy (dry type) is considered.

(2) School toilets

Standard service level currently used by DECS (40 students per unit facility) is employed for both phases.

The standard toilet facility (1 building) with 5 units of toilet bowl to serve for 200 students is adopted for the planning purpose, which is modified from FW4SP design to provide a shallow well as a water source.

(3) Public toilets

As a minimum requirement, at least 1 sanitary toilet facility is assumed to be provided for respective utilities: public market and bus/jeepney terminal.

The FW4SP standard design with 6-units of toilet bowl for the market is adopted. In this design, it is assumed that water supply will be tapped from the existing system, hence an elevated water tank is provided.

8.4.3 Urban Sewerage

The commencement of staged implementation of the sewerage program is planned in Phase II for the limited urban area (50% of urban population served by Level III system for the municipalities with urban population of more than 10,000). It is practical to start the program fully using the existing facilities to allow for lower initial investment cost than starting at once a conventional sewerage system (refer to Figure 8.4.2 Staged Improvement in Sewage Collection Method, Supporting Report).

Low cost off-site technologies such as small-bore sewer for collection of effluent from septic tank are to be adopted. Improvement of sewage collection method may be gradually achieved from combined sewer to separate sewerage system.

Sewage treatment facilities may range from community scale septic tank or Imhoff tank to aerated lagoon systems and to a more advanced treatment process such as oxidation ditch. For this PW4SP, aerated lagoons are assumed as a representative treatment facility for planning purpose. Daily average wastewater quantity is assumed to be 100L per capita per day.

8.4.4 Solid Waste

In terms of facility requirements, this PW4SP only studied the number of refuse collection trucks required for the year 2003. A rated capacity of 5 cu.m truck/vehicle is considered for calculation of required units of truck. Disposal of solid waste shall be studied in detail through investigations, F/S and D/D. Unit solid waste generation for urban area is assumed to be 0.418 kg. per capita per day.