CHAPER III WATER SUPPLY IMPROVEMENT PLAN IN THE CENTRAL DRY ZONE

3.1 Geography

The Central Dry Zone In Myanmar covers three Divisions of Sagain, Magway and Mandalay, which are situated between lat. 19 ° to 23 ° N. and long. 94 ° to 96.5 ° E. with a total area of 77,000 km^2 expanding maximum 560 km long and 270 km wide. The zone is located in the basin lies between Chine Hills on the west and Shan Plateau on the east. The ground elevation ranges between 45m and 70 m above mean sea level. As the average annual rainfall is from 500 mm to 1000 mm, and the evaporation generally reaches over 1500 mm a year, the zone is categorized to the hottest and driest area in Myanmar. There are 85 Townships and 15,802 villages in the three Divisions and 10,8 million populations are estimated in 2000. The Central Dry Zone, where shares more than 20% of the total population of the Union of Myanmar, is characterized as typical agricultural zone in Myanmar and less developed area in social infrastructure.

The study area covers 11 Townships which belong to two Divisions of Mandalay and Magway. The total study area is 16,500 km^2 and has 3.2 million populations whose 80 % live in rural area.

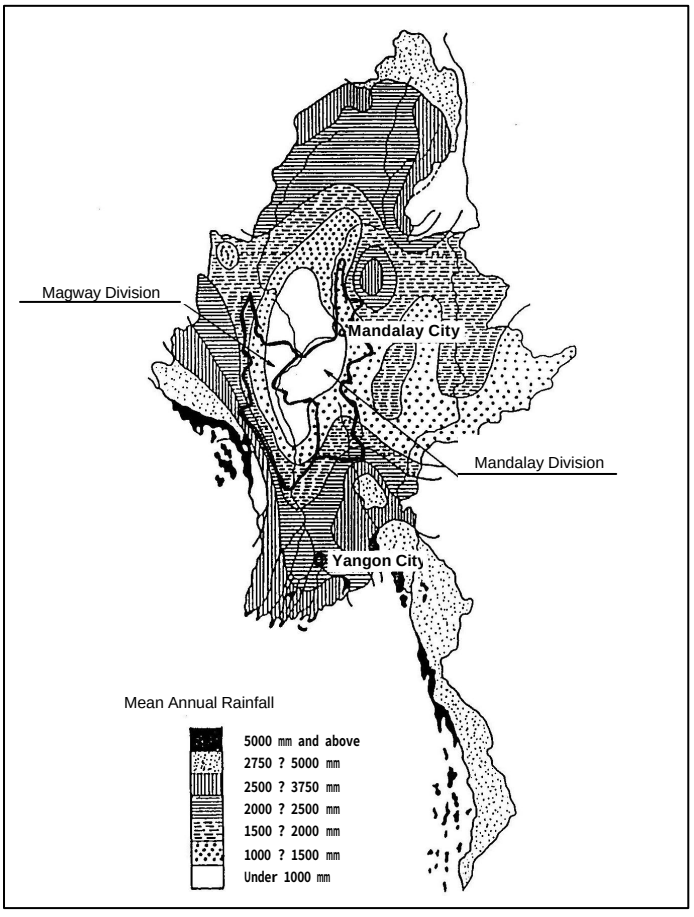

Table 3.1.1 Study Area and the Central Dry Zone

3.2 Hydrogeological Situation

(1) Hydrogeological Structure

Myanmar is situated in an area of complex plate tectonic setting. As a result of plate tectonic evolution, the country has been divided from west to east into four major geotectonic units, the Arakan Coastal Zone, Indo-Burma Ranges, Inner-Burman Basin and Sonop-Burman Ranges, forming the north-south elongated structures. The Central Dry Zone is covered by the Inner-Burman Basin (or Inner-Burman Tertiary Basin).

Inner-Burman Tertiary Basin consists of two major north-south oriented sedimentary troughs separated by a central line of volcanic rocks. The troughs are subdivided into an umber of S-N or SW-NE oriented sub-basins up to 600 km and 200 km wide. The sub-basins contain up to 10,000 m of Tertiary and Quaternary deposits. Depending on the width of the basin, the deposits were deformed by more or less extensive compression folding which locally led to overthrusting in the range of 1,000 m. The Tertiary rocks that are developed exclusively in marine facies in southern Myanmar indicate a continental influence, becoming increasingly intense towards the N and NE, on depositional environment. They are mostly argillaceous and fine sandy.

The Central Dry Zone is covered with Tertiary sedimentary rocks, which may be grouped under three broad unit, namely, in ascending order, the Eocene rocks, Pegu Group (Oligo-Miocene) and Irrawaddy Formation (Pliocene to Pleistocene). The study area is covered, particularly with the last two and Quaternary unconsolidated sediments (Middle Pleistocene to Holocene, Alluvium).

The Pegu Group in the study area is mostly the Miocene rocks and occupies mainly a broad area of Pegu Yoma Anticlinolium. The sediments are generally continental in the north and marine in the south. The Irrawaddians are characteristically composed of medium to coarse, ferruginous sandstones with abundant quartz pebbles and silicified fossil wood. Clay lenses occur rarely within the arenaceous sequence. There are two volcanic areas on the Central (Inner) Volcanic Line, the Mt. Popa and a part of the Lower Chindwin volcanic area. Both of them are composed of andesites, tuff, rhyolite and basalts.

The Quaternary sediments of Middle Pleistocene to Holocene age occur along the Ayeyarwaddy River, associated watercourses and piedmont plains. The overlaying younger alluvial sediments are found in significant amount in the valleys of the rivers such as the Ayeyarwaddy, Chindwin, and Mu. The Holocene fluviatile alluvium is also confined to the larger watercourses. Generally the width of the recent unconsolidated alluvium is less than 1.6 km and it has a thickness of less than 60 m. The deposits are heterogeneous being

composed of gravel, sand, silt, and clay.

Geological Map in the study area is shown in Fig. 3.2.1. In this figure, Quaternary unconsolidated sediments (Q_2) is shown in faded yellow color, Irrawaddy Formation (Tm-Tp)in thick yellow color, and of Pegu Group (Tm, Tφ)in Orange color respectively.

(2) Groundwater Potential in the Central Dry Zone

There are three major aquifers of Pegu Group aquifer (Pegu aquifer), Irrawaddy Formation aquifer (Irrawaddy aquifer), and Quaternary unconsolidated sediments aquifer (Alluvial aquifer) in the study area. In the first two aquifers, groundwater is mainly fissure water in rocks and the last is stratum water. The potential and quality of groundwater are varied depending on aquifers which groundwater originates. And groundwater levels are also varies due to undulation of the ground level. Characteristics and typical water quality of these aquifers are shown in Table 3.2.1 and 3.2.2 respectively.

Table 3.2.1 The Major Aquifers in the Central Dry Zone

Name of Aquifer	Major Rock Unit	Area of Occurrences	Remarks
Alluvium Aquifer	Sand, Gravels and mud.	Major river basins and its tributaries, base of mountains and ranges	Fresh GW, seasonal water table changes
Irrawaddy Aquifer	Mainly Sand, sandstones with gravels, grits, siltstones	Central Lowland and Rakhine Costal Plain	Thick aquifer fresh GW with high iron content
Pegu Aquifer	Sandstone, siltstones and shales	Central Lowland and Rakhine Costal Plain	Mostly saline & brackish water, some fresh water in recharged area

Table 3.2.2 Typical Groundwater Quality in the Major Aquifers

Division	Aquifer	EC mS/cm	T.D.S *1) mg/l	pH	Total Hardness mg/l	Na+ mg/l	Cl- mg/l	SO_4^{2-} mg/l
Magway	Alluvial	0.8	507	8.37	255	178.48	112.18	95.52
	Irrawaddy	1.0	666	8.41	254	135.01	147.32	87.84
	Pegu	3.5	2,368	8.44	485	365.47	235.01	173.28
Mandalay	Alluvial	1.5	935	8.26	257	330.51	200.22	136.8
	Irrawaddy	2.0	1,283	8.52	268	430.79	237.14	195.36
	Pegu	3.4	2,247	8.84	330	504.62	298.91	198.72
NDWQS*2)		1.5	1,000	6.5-9.2	500	200	200-600	400

*1) Total Dissolved Solid
*2) National Drinking Water Quality Standard

Pegu aquifer is generally not so suitable for drinking due to its saline taste. Irrawaddy aquifer contains normally allowable T.D.S level, however, some are not drinkable due to a high mineral contents. Alluvial aquifer is generally confined to large watercourses,

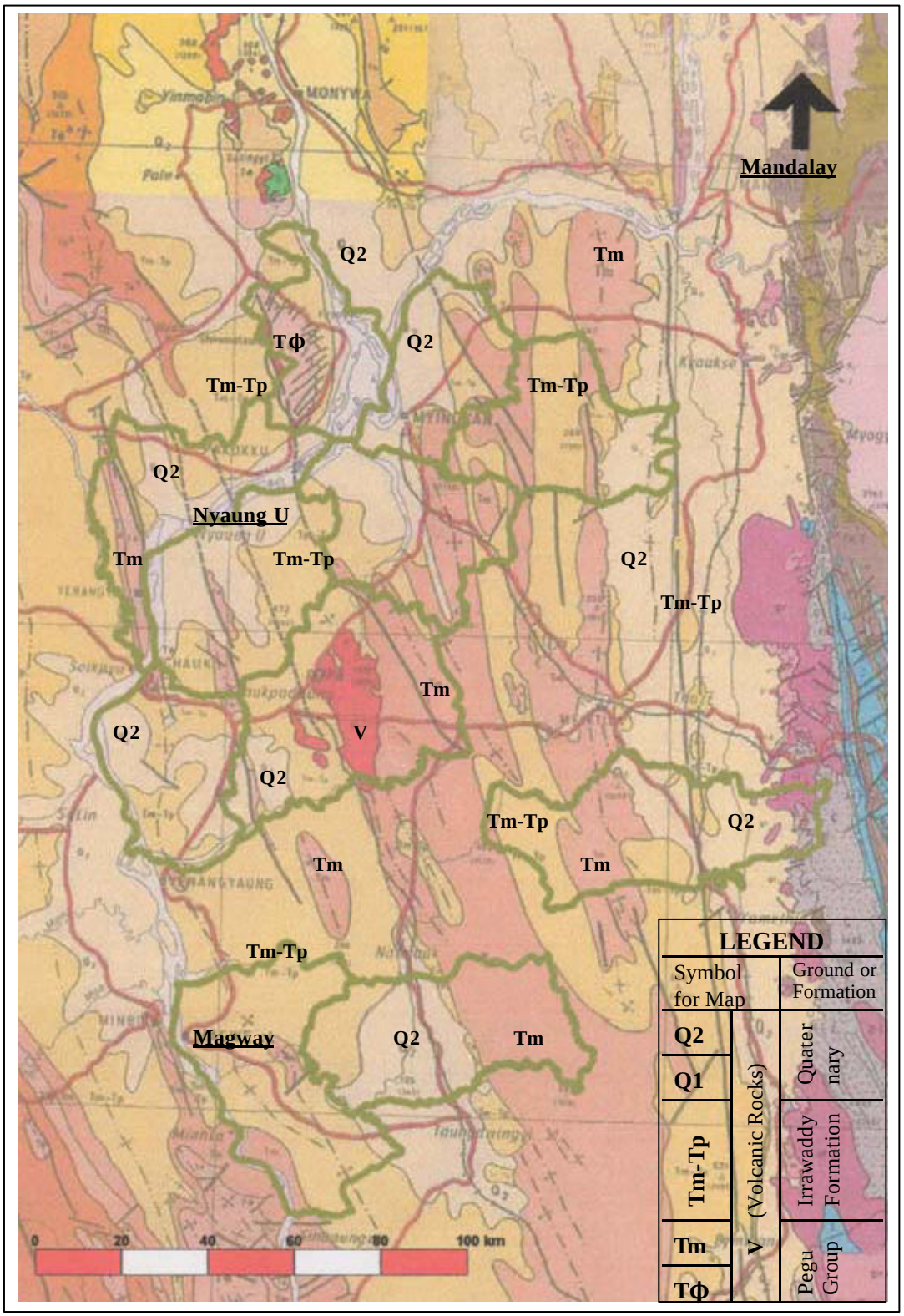

Fig. 3.2.1 Geological Map of the Study Area

(Geological symbols, see Table 1.1.3.1)

Source: "Geological Map of The Socialist Republic of The Union of Burma, 1977." Prepared under The Auspices of The Earth Sciences Research Division

valleys, or basins. Small scale alluvial deposits are found here and there and provide groundwater sources for dug wells or shallow wells of villages. In villages where are located on Pegu or Irrawaddy aquifer, shallow wells or dug wells in such small alluvial deposit can be considerable as the alternative water sources.

3.3 Water Use Conditions

Villages generally product tobacco, sesames, groundnuts, coconut juice, and other crops suitable under the dry climate. This area has a less productivity of crops and the villagers are rather poor comparatively than other areas due to the hard natural conditions. Villagers consist of two categories of owner farmers and tenant farmers who earn wages for work in owner farmer's fields. Traditional water source for the villages is rainwater stored in the reservoir or pond. Women and children are mainly involved in fetching water from the rain-fed pond to their houses in the village. Villager carries water by cans or buckets hung from a pole on her shoulders several times a day. Several ceramic pots with about one meter diameter are placed beside of a house and the water is stored in these pots. In the middle of the dry season, the pond water lowers and becomes dark in color due to soil content, however, the villagers try to use the pond until it gets empty. When the pond water dries out, villagers go to tube wells or other water sources a few miles far from the village to bring back water by bullock cart in barrels.

International aid organizations and NGOs have drilled thousands of tube wells in the rural area and water shortages were solved in many villages. However, there are still hundreds of villages, which are facing difficulties in getting domestic water such as having to a long distance to the water source, high content of salinity or minerals in the well water, etc. especially in dry season. People in these villages eager to have a deep tube well in their village and use it at their convenient time, affordable price and sufficient volume.

A village, that have tube well(s), has organized a water committee by participation of villagers to operate the well pump, collect tariff, and manage other related activities. The water is drawn up from the tube well normally by an engine-drive pump or a submersible motor pump with a generator set. The water committee charges its own villagers generally Ks 10 to Ks 25 for 50 gallons of water but about the double price to the outsiders.

3.4 Present Situation of Village Water Supply

Various village water supply improving projects have been implemented from 1960's by

NGOs and international aid agencies like UNDP or UNICEF in cooperation with WRUD as the counterpart of the Myanmar side. More than 9,000 of shallow wells and 3,100 of deep wells were constructed in the country especially during the UN decade of water supply and sanitation from 1981 to 90. UNDP has been involved in community water supply and sanitation schemes utilizing shallow wells with hand pumps, rainwater roof-catchments, improved toilets, community drainages, etc. through village community oriented programs. In 1995 UNICEF also formulated "Myanmar-UNICEF Country Program of Cooperation 1996-2000". Through the program, UNICEF had implemented various sub-programs such as provision of well pumps, production of local made hand pump, opening workshops for pump repairing, well database in the country, etc. in cooperation with WRUD, the counterpart in Myanmar side. The program had obtained a lot of results and was extended to the second stage 2001-2005. On the occasion of transferring the administrative competence on rural water supply from WRUD to DDA in 2001, DDA became the sole department responsible for both urban and rural water supply in Myanmar.

BAJ, a Japanese NGO, has been operating a rural water supply scheme in Nyaung-U Township, Mandalay Division during three years from 2000. The scheme is composed of drilling 36 deep wells, rehabilitation of the existing wells, improvement water quality of rain-fed pond, technology transfer on electric resistivity prospecting and engine and well pump repairing, and operation and maintenance of facilities by community participation basis. DDA fills the role of the counterpart of this scheme and provides a well drilling equipment and a drilling team, BAJ procures materials and equipment such as well casings and screens, well pumps, raw materials, labors, etc.

DDA placed its priority on improving water supply conditions in the rural area and formulated "10 Year Project for Rural Water Supply 2000-2010", which includes three Divisions located in the Central Dry Zone. The component of the project is shown in Table 3.4.1 and 3.4.2.

Table 3.4.1 Populations of Targeted Divisions in "10 Year Project"

Division	No. of Townships	No. of Villages	No. of Household	Estimated Population in Years	
				2000	2010
Mandalay	26	5,550	789,069	3,903,805	4,666,227
Magway	25	4,792	557,119	2,977,279	3,558,748
Sagain	34	5,460	716,384	3,913,874	4,678,262
Total	85	15,802	2,062,572	10,796,958	12,905,247