

## CHAPTER 6 GROUNDWATER RESOURCES DEVELOPMENT PLAN

### 6.1 SCOPE OF THE GROUNDWATER RESOURCES DEVELOPMENT PLAN

Groundwater resources development plan was formulated based on the results of the evaluation of groundwater potential and the results of projection of the future water demand. The plan for the whole study area will cover the development potential estimated by macro hydrogeological evaluation. On the other hand, groundwater development plan for each Pilot GND consists of the following components:

#### (1) Demand Estimates

Water demand for domestic use and non-domestic use are estimated based on socio-economic conditions of each GND.

#### (2) Water Supply Scheme

Water supply scheme for the Pilot GNDs was proposed for a standard water supply level. The water supply level is to be selected from the following three levels, based on groundwater development potential and socio-economic conditions of the Pilot GNDs:

Level 1 :Water distribution through a single public hydrant with hand-pump

Level 2 :Water distribution through several public hydrants. Water is pumped up by powered pumps to an elevated water tank and sent to the hydrants.

Level 3 :Water distribution through hydrants for each house. Water is pumped up by powered pumps to an elevated water tank and sent to the hydrants through distribution pipelines.

Regarding a standard of water supply level of Level 2, NWSDB has intention to change “Stand Post” to “Yard Tap” which is a hydrant with installed at the land of each house. Since the water supply amount of Yard Tap is regulated under the standard consumption rate of 45 liter/capita/day that is same unit consumption rate with the Stand Post, same design criteria of Level II can be applied. In this report therefore, a term of Yard Tap is adopted for the Level 2 water supply scheme.

#### (3) Groundwater Resources Monitoring Plan

Existing shallow wells and the test wells provided in the Study shall be utilised for groundwater level observation. Monitoring methods are proposed as a management plan.

#### (4) Organization and Management Plan

To ensure sustainable operation of the groundwater utilisation, organization and management plan is proposed.

#### (5) Operation and Maintenance Plan

Operation and maintenance plan for the water supply scheme is proposed for the water supply levels.

## 6.2 PLANNING BASIS

In this Study, the highest priority of the allocation of the water use is for domestic water use. Therefore, the planning basis needs to be consistent with the design criteria, coverage plan and water supply system plan made by the National Water Supply Board (NWSDB), the responsible organization for the planning, design construction and operation of both urban and rural water supply schemes in Sri Lanka.

For the formulation of groundwater resources development plan, the following are the determined planning criteria to be taken into consideration.

### (1) Scope of area

- 15 pilot GNDs.
- Development plan for the entire study area (Hambantota and Monaragala) will be recommended based on the results of groundwater potential evaluation.

### (2) Target Year

- The target year of 2010 shall be adopted in accordance with the concept of Vision 2010 planned by National Planning Department.

### (3) Population Projection

- Use of the data of Census (1992, 2001) and the results of water demand study by NWSDB.

### (4) Domestic Water Use

- Highest priority shall be placed on domestic water use.

### (5) Non-domestic Water Use

- Non-domestic use and non-revenue water (NRW) shall be estimated and included in the total water demand, in accordance the plan made by NWSDB.

### (6) Unit Water Consumption

- The Design Guide made by NWSDB (1989) shall be adopted.

### (7) Coverage Ratio of Population

- In the plan made by NWSDB for the estimation of future water demand, there are GNDs with coverage ratio of less than 100% of population, since NWSDB are utilizing the increasing coverage ratio until the year of 2025. In this Study, on the other hand, the coverage ratios of 100% for the all GNDs were adopted, to corresponds the national goal that is to provide access to safe drinking water to all by the year of 2010 (NPD, 2002).

For the unit water consumption, the Design Guide (NWSDB 1989) states the criteria shown in *Table 6.1*. Since the Pilot GNDs of the Study area can be categorized as the level of “Medium Rural”, the unit consumption rates of 140 litre/capita/day for the direct connection and 45 litre/capita/day for the yard tap shall be adopted. The unit consumption rate for the hand pump is

not specified by the guideline; however, the same rate of the yard tap (45 litre/capita/day) is normally adopted for the existing plan.

**Table 6.1 Unit Water Consumption**

	Community		Direct Connection		Yard Tap	
	Category	Population	% Population	Rate lpcd	% Population	Rate lpcd
1	Medium Rural	1,000 – 1,500	10 - 20	140	80 - 90	45
2	Large Rural	1,500 – 5,000	20 - 40	140	60 - 80	45
3	Small Urban	5,000 – 10,000	30 - 50	185	50 - 70	45
4	Medium Urban	10,000 – 20,000	30 - 60	185	40 - 70	45
5	Large Urban	over 20,000	Assess value individually			

Source: NWSDB (1989), Design Guid

## 6.3 PROJECTION OF FUTURE WATER DEMAND

### 6.3.1 CONDITIONS FOR THE ESTIMATION

Future water demand of the Study area was estimated based on the population and related socio-economic conditions data. The estimation was carried out by GNDs in two districts. The basic criteria for the water demand projection provided by the Planning and Design Division of National Water Supply and Drainage Board (NWSDB) were adopted for the estimation. The following items are the considerations for water demand estimation, which agreed upon among the WRB, NWSDB and the Study Team, through the course of discussions during 3<sup>rd</sup> Study in Sri Lanka.

#### (1) Target Year

Vision 2010 (National Planning Department, 2001) indicates that the national goal is to provide access to safe drinking water to all by the year 2010. The target year of 2010, for the development plan that will be formulated by this project, is adopted in accordance with the concept of Vision 2010.

#### (2) Projection of Population

The populations of each GND in the year of 2010 were estimated by the projected population of 2005 and 2015 by NWSDB. The populations both of present (2001) and target year (2010) are presented.

#### (3) Water Supply Coverage Ratio

The coverage ratio, both by existing water supply scheme and future plan, were estimated to obtain the actual demand to be covered by groundwater resources development plan by this project. The amount of the water supply coverage by existing scheme and future plan shall be deducted from the "Total Demand" of the target year of 2010.

#### (4) Coverage Plan

For domestic water use, water supply scheme is to be selected from the 3 (three) levels: Level 1 (hand pump), Level 2 (yard tap) and Level 3 (direct connection) based on groundwater development potential and socio-economic conditions of the project area.

The demarcation of such levels in the GNDs by the criteria of NWSDB is summarized as follows.

- Level 1 (Hand Pump):

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The water supply by the hand pumps is not planned by NWSDB. Therefore, coverage plan of the Level 1 is not be made.

- Level 2 (Yard Tap) and Level 3 (House Connection):

The designed percentage of the coverage plan of Level 2 and Level 3 is allocated as follows:

	GND that is covered by Scheme	GND has existing scheme partly	GND has no existing scheme
Level 2	0 %	10 %	20 %
Level 3	100 %	90 %	80 %

### (5) Consumption Rate

The consumption rates for the levels are defined by the design criteria of NWSDB. The consumption rates for each level are described as follows:

Level 1 (Hand Pump) : Not applicable

Level 2 (Yard Tap) : 45 litre/capita/day, which is defined by the design criteria of NWSDB.

Level 3 (Direct Connection) : 140 litre/capita/day, which is defined by NWSDB, as the consumption rate for the large rural community with population of 1,500 to 5,000

### (6) Non Domestic Demand

The percentages of non domestic demand are allocated as follows:

- GND that is partly or fully covered by the existing water supply scheme shall be 30% of “Total Domestic Demand”.
- GND that is not covered by existing water supply scheme shall be 25% in Monaragala and 20% in Hambantota of “Total Domestic Demand”.

### (7) Non Revenue Water (NRW)

The percentages of NRW are allocated as follows:

- GND that is covered by existing water supply scheme shall be adopted for the actual percentage of each scheme. However, if there is a GND where the actual NRW exceeds 40%, the ratio of 30% shall be adopted.
- GND that is not covered by existing water supply scheme shall be 30 %.

### (8) Total Demand

Total demand is obtained as the sum of “Total Domestic”, “Non Domestic” and “Non Revenue Water”.

### (9) Water Demand to be Examined Under the Project

This demand will be calculated by the subtraction of “Served Amount” from “Total Demand”.

### 6.3.2 FUTURE WATER DEMAND OF THE STUDY AREA

The projected future water demand of each GND of Hambantota and Monaragala is presented in Appendix D of the supporting report, and summarized in the *Table 6.2* by DS division.

**Table 6.2 Future Water Demand in 2010 (DS Division)**

DS Division	Entire Water Demand		Water Demand to be Covered by the Study	
	Population	Demand (m <sup>3</sup> /day)	Population	Demand (m <sup>3</sup> /day)
<b>Monaragala District</b>				
Badalkumbura	44,134	9,717	41,894	9,403
Bibile	40,225	8,901	32,063	7,758
Buttala	52,577	12,412	44,304	11,253
Kataragama	18,054	3,828	9,661	2,653
Madulla	32,817	7,138	32,535	7,099
Medagama	38,048	8,032	27,189	6,511
Monaragala	48,671	10,987	41,410	9,971
Siyambanduwa	57,298	12,475	54,521	12,086
Sevanagala	47,565	10,709	39,022	9,513
Tanamalwila	29,630	6,506	26,688	6,093
Wellawaya	62,478	13,748	56,620	12,928
<b>Subtotal</b>	<b>471,497</b>	<b>104,453</b>	<b>405,907</b>	<b>95,268</b>
<b>Hambantota District</b>				
Weeraketiya	67,621	14,126	65,281	13,799
Beliatta	64,087	13,577	57,729	12,687
Katuwana	76,099	16,352	52,687	13,074
Angunakolapellessa	51,133	10,676	49,302	10,420
Okuwela	22,618	4,692	22,618	4,692
Tissamaharama	73,898	18,565	46,247	14,694
Ambalantota	76,616	17,923	34,848	12,075
Hambantota	57,268	14,761	11,797	8,395
Lunugamvehera	31,375	8,571	9,331	5,485
Tangalle	77,771	16,913	45,472	12,392
Suriyawewa	43,472	9,361	29,965	7,470
<b>Subtotal</b>	<b>641,958</b>	<b>145,517</b>	<b>425,277</b>	<b>115,183</b>
<b>Total</b>	<b>1,113,455</b>	<b>249,970</b>	<b>831,184</b>	<b>210,451</b>

The total population of two districts is estimated as 1,113,500. The distribution of population and population density by GND of the target year of 2010 are shown in the *Figure 6.1* and *6.2* respectively. The total water demand is estimated as 249,970 m<sup>3</sup>/day. On the other hand, some areas have already been supplied water by existing water supply schemes and can be expected to be supplied water in the year 2010. Such population in these areas should be excluded from the target of the formulation of groundwater resources development plan by the Study. Distribution of actual population to be supply the water under the project is shown in *Figure 6.3*.

Therefore, the actual population estimated to be covered under the Study was estimated as 831,184 for the two districts. Consequently, the actual water demand to be covered by the Study is estimated as 95,268 m<sup>3</sup>/day in Monaragala, 115,183 m<sup>3</sup>/day in Hambantota (i.e., total 210,451

m<sup>3</sup>/day for the two districts). The distribution of the water demand of 2010 is shown in *Figure 6.4*.

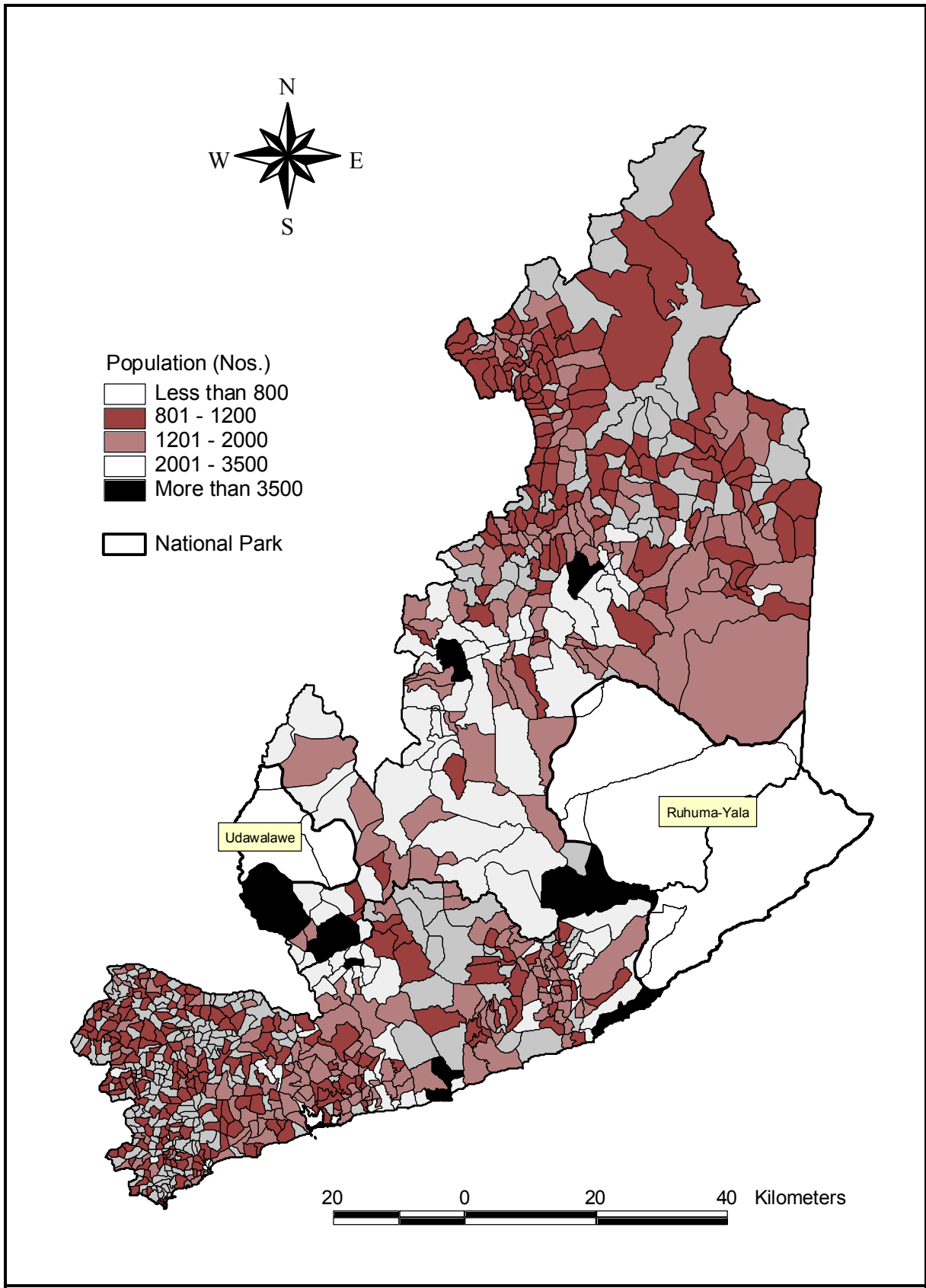
### 6.3.3 FUTURE WATER DEMAND OF THE PILOT GNDs

The projected future water demand of each Pilot GND is summarized in the *Table 6.3*.

**Table 6.3 Future Water Demand in Pilot GNDs (2010)**

GN Division Name	Plan (by NWSDB)						Project Water Demand 2010	
	Population 2010		Covered No.	Total Demand m <sup>3</sup> /day	level 2 (Y.T.) %	level 3 (D.C.) %	Population No.	Demand m <sup>3</sup> /day
	No.	Density Nos/km <sup>2</sup>						
MONARAGALA								
<b>M1 Hambegamuwa</b>	2,170	13.7	0	469	20	80	2,170	<b>469</b>
<b>M2 Bodagama</b>	1,801	86.0	0	389	20	80	1,801	<b>389</b>
<b>M3 Hulandawa L</b>	2,270	312.9	0	491	20	80	2,270	<b>491</b>
<b>M4 Unawatuna</b>	2,427	285.4	503	633	10	90	1,924	<b>563</b>
<b>M5 Yalabowa</b>	1,980	412.4	1,194	480	10	90	786	<b>313</b>
<b>M6 Badalkumbura</b>	1,380	709.7	1,119	334	10	90	261	<b>178</b>
<b>M7 Sevanagala</b>	6,085	368.3	0	1,315	20	80	6,085	<b>1,315</b>
HAMBANTOTA								
<b>H1 Keliyapura</b>	668	26.6	1,070	160	0	100	(402)	<b>11</b>
<b>H2 Vitarandeniya</b>	1,633	249.7	2,240	380	10	90	(607)	<b>66</b>
<b>H3 Talunna</b>	1,224	276.2	485	274	10	90	739	<b>206</b>
<b>H4 Wediwewa</b>	1,699	84.7	0	352	20	80	1,699	<b>352</b>
<b>H5 Tammennawewa</b>	1,754	88.3	2,132	523	0	100	(377)	<b>225</b>
<b>H6 Pahala Mattala</b>	424	36.9	241	118	10	90	183	<b>84</b>
<b>H7 Siyambalagasvila N</b>	1,049	576.5	1,180	252	0	100	(131)	<b>87</b>
<b>H8 Ranna West</b>	1,792	643.5	790	395	10	90	1,001	<b>284</b>

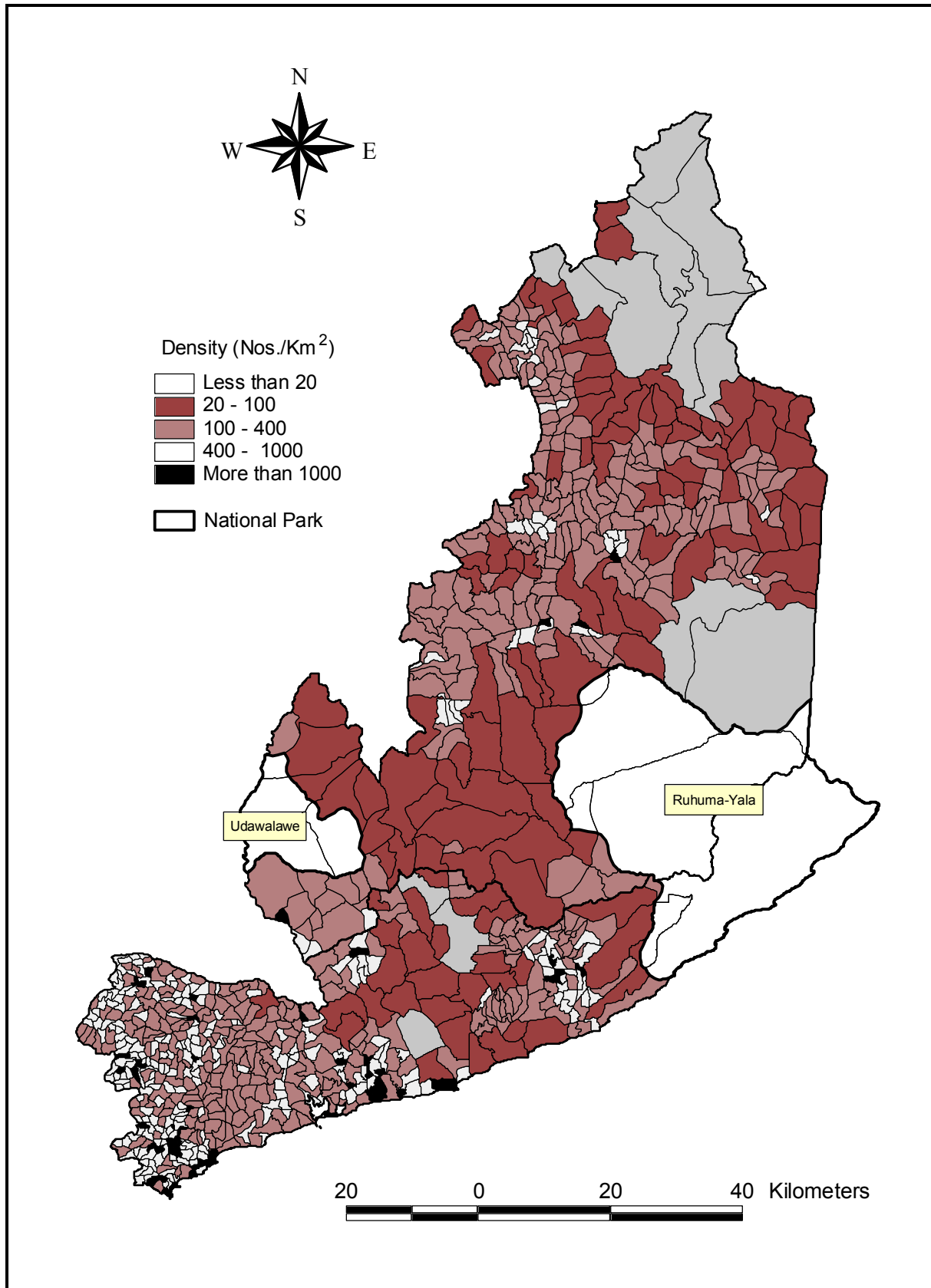
The Pilot GNDs of Keliyapura, Vitarandeniya, Tammennawewa and Siyambalagasvila North have the future water supply plans, to be constructed before the target year of 2010. The estimation of water demand of such existing plans was made by only direct connection's (Level 3) domestic consumption rates of 140 litre/capita/day; the demands of non-domestic and non-revenue water (NRW) are not estimated. Therefore, the project demand generated is a slight amount, although the demand shows negative value. The Pilot GND of Unawatuna, Yalabowa and Badalkumbura have existing water supply schemes. Therefore, the estimated project demand is the demand of the stranded area in the GND.



**FIGURE 6.1 DISTRIBUTION OF POPULATION BY GND (2010)**

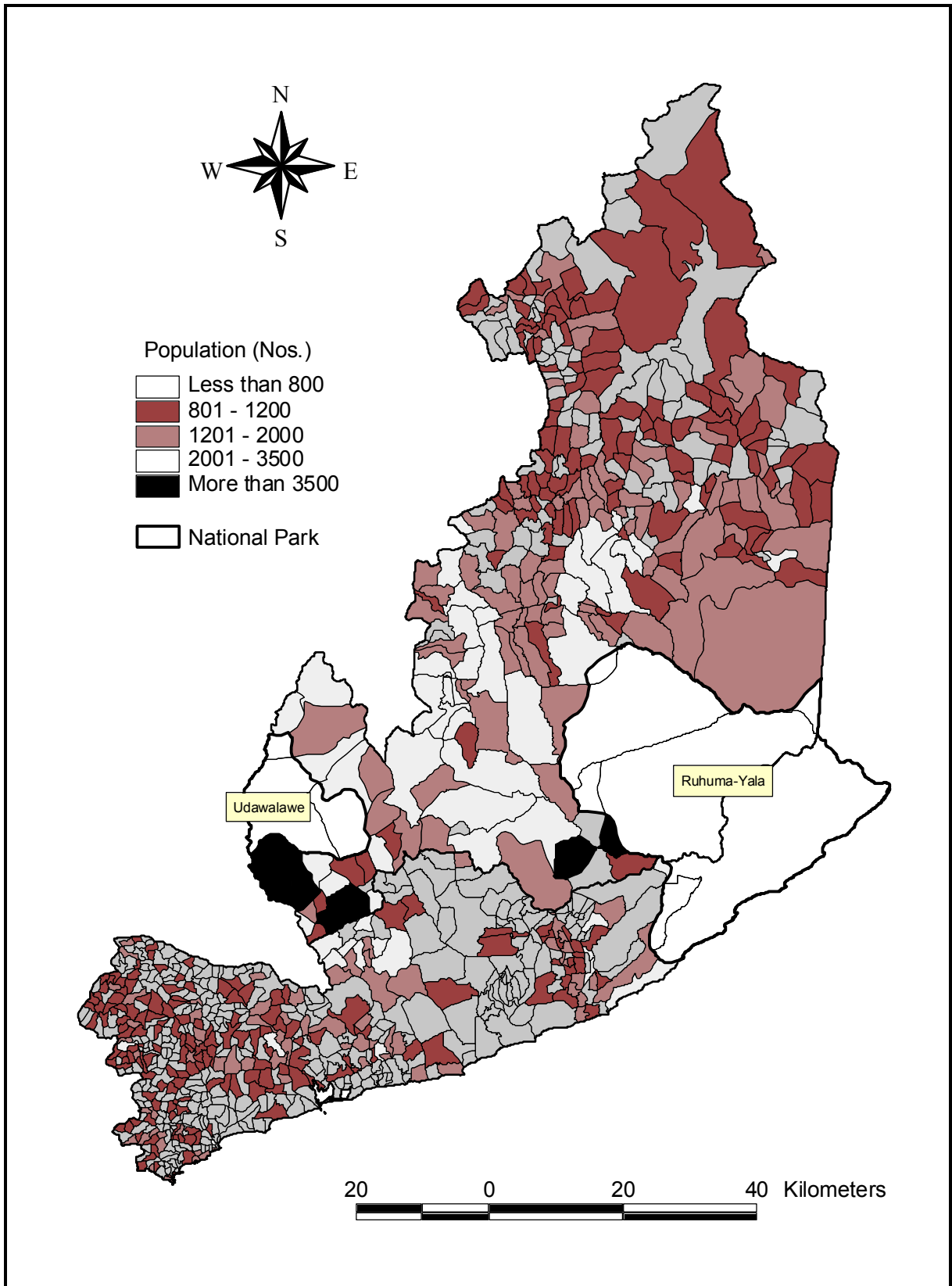
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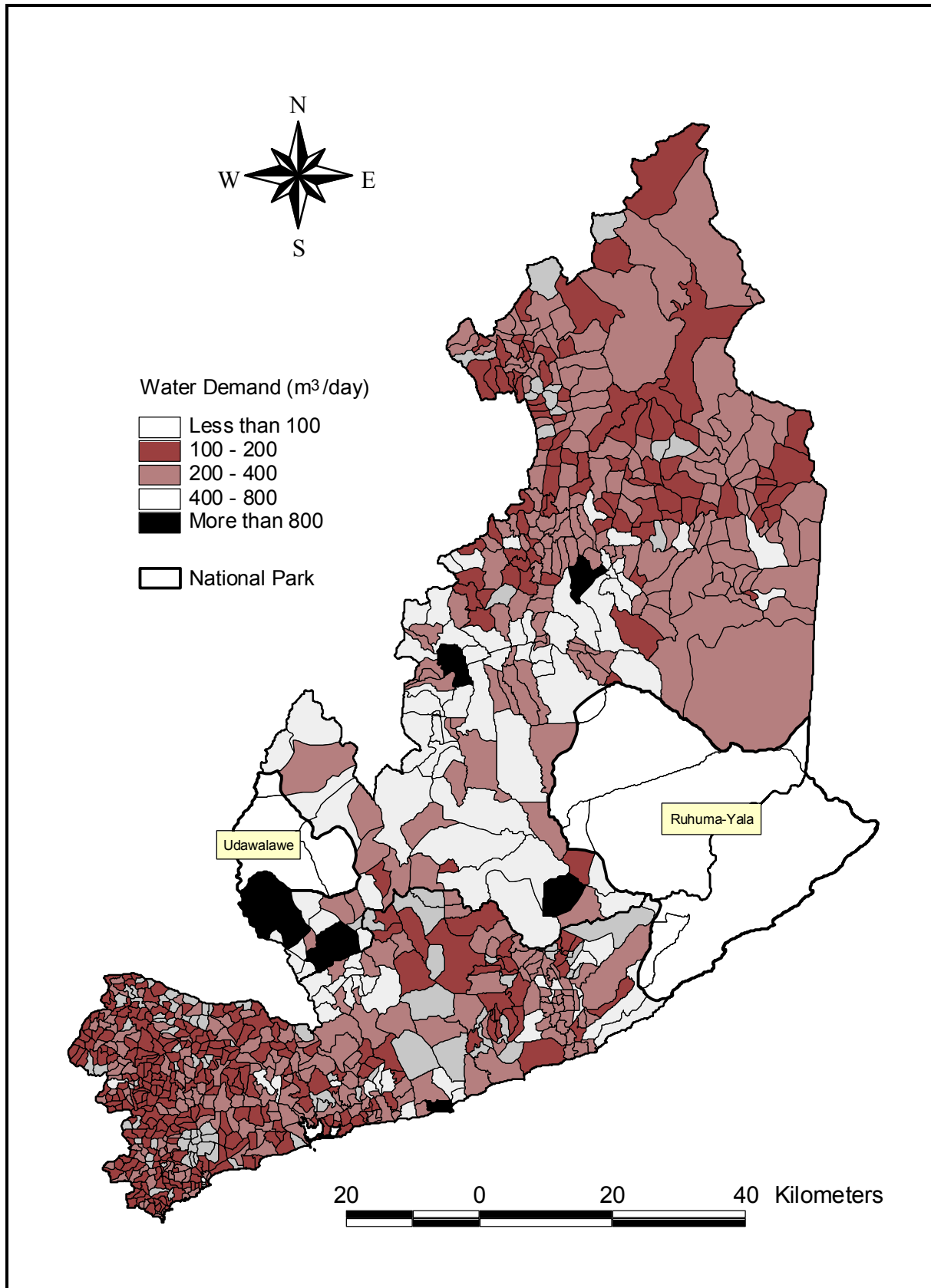


**FIGURE 6.2 DISTRIBUTION OF POPULATION DENSITY BY GND (2010)**





**FIGURE 6.3 DISTRIBUTION OF POPULATION TO BE SUPPLY THE WATER BY THE PROJECT (2010)**



**FIGURE 6.4 DISTRIBUTION WATER DEMAND (2010)**

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## 6.4 GROUNDWATER RESOURCES DEVELOPMENT PLAN

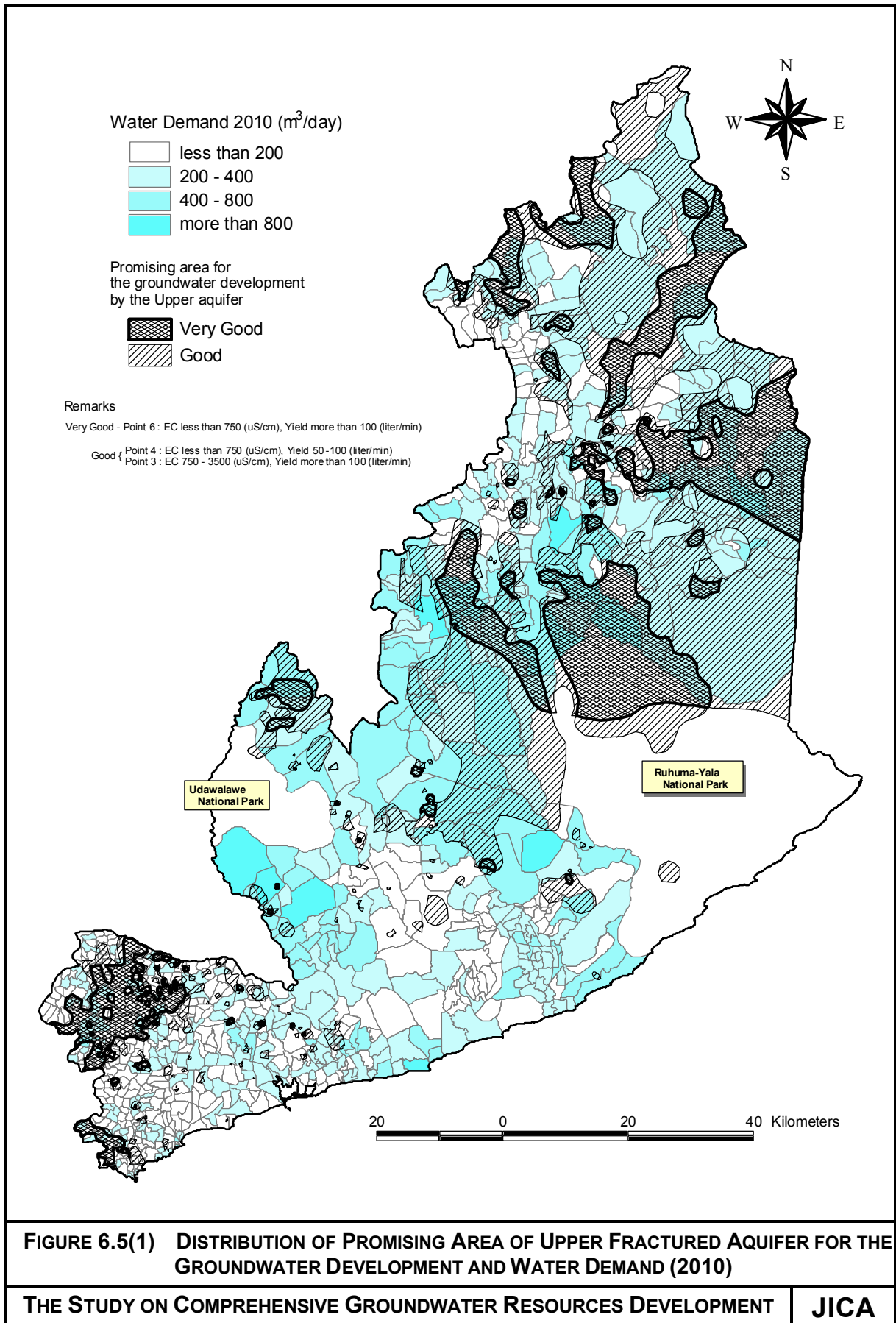
### 6.4.1 DEVELOPMENT PLAN IN THE STUDY AREA

#### (1) Promising Areas for Groundwater Development

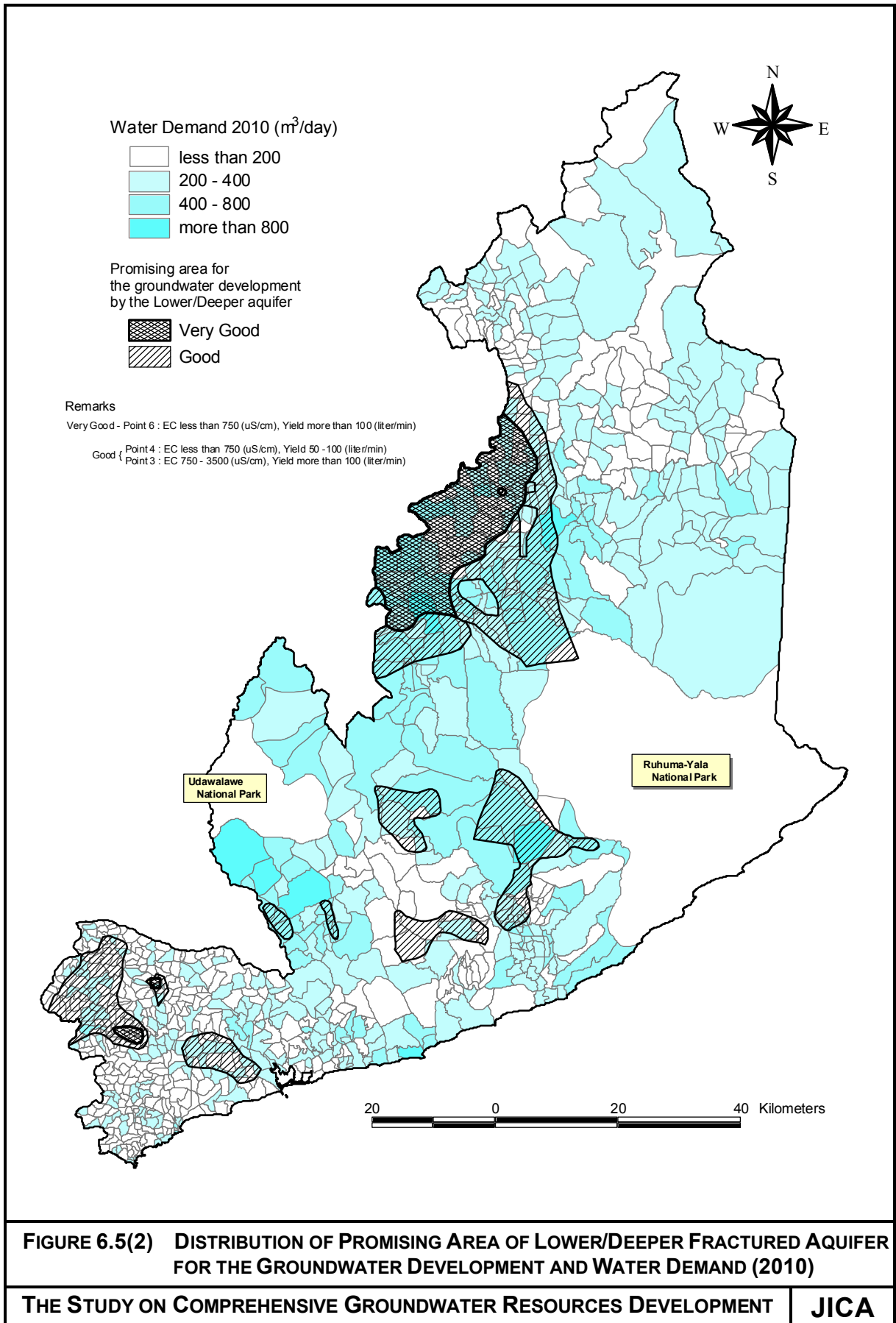
The promising area for the groundwater resources development in Hambantota and Monaragala district was determined by the groundwater evaluation as described in Chapter 5. *Figure 6.5* shows the promising area for the groundwater resources development and the distribution of water demand (2010) in the Study area. The map presents the two promising areas by the aquifer type of “Upper Aquifer” and “Lower/Deeper Aquifer”. The area categorized as “good” is the promising area where the groundwater yield expected is 50 to 100 liter/min with groundwater quality EC less than 750  $\mu$  s/cm, or the groundwater yield expected is more than 100 liter/min with groundwater quality EC 750 to 3,500  $\mu$  s/cm. The other area categorized as “very good” is the promising area where the groundwater yield expected is more than 100 liter/min with groundwater quality of EC less than 750  $\mu$  s/cm.

In general, the promising area in Monaragala for groundwater development is fairly large compared with that of Hambantota. The upper aquifer of the northeast to central eastern part and the south central part of Monaragala are expected to be highly exploitable. The lower / deeper aquifer of the central western area of Monaragala where high GND demand is concentrated is also a promising area. In addition, the evaluation map indicates that the south central area including Kataragama is another promising area of the lower aquifer. On the other hand, the southwest area seems to be a less productive area, although high GND demand exists.

In Hambantota, the coastal side of the central area was mostly evaluated as poor due to water quality. There is an area evaluated as “good” in the centre of the district, where the lower and deeper fractured aquifer is promising. The western end of the district was evaluated as “good”. This is a promising area of the upper aquifer. The lower and deeper aquifer of part of this area is also promising. There is an area around Talunna expected to have possibilities of occurrence of productive deeper fractured aquifer.



**FIGURE 6.5(1) DISTRIBUTION OF PROMISING AREA OF UPPER FRACTURED AQUIFER FOR THE GROUNDWATER DEVELOPMENT AND WATER DEMAND (2010)**



## (2) Water Demand and the Area Covered by the Groundwater Development

The GNDs distributed within the promising areas for the groundwater development were extracted to determine the amount and area of the water demand to be covered by the plan. The results are listed as Appendix A and summarized as follows:

**Table 6.4 Water Demand and the Area Covered by the Groundwater Development**

<b>Hambantota District</b>				
<b>Aquifer Type</b>		<b>Number of GNDs</b>	<b>Demand (m<sup>3</sup>/day)</b>	<b>Area (km<sup>2</sup>)</b>
Upper Aquifer	Very good	69	11,405	147.29
	good	153	27,487	616.80
Lower/Deeper Aquifer	Very good	3	436	5.75
	good	126	26,323	520.28
Subtotal		<b>351</b>	<b>65,651</b>	<b>1,290.28</b>
<b>Monaragala District</b>				
<b>Aquifer Type</b>		<b>Number of GNDs</b>	<b>Demand (m<sup>3</sup>/day)</b>	<b>Area (km<sup>2</sup>)</b>
Upper Aquifer	Very good	84	22,445	1,465.28
	good	115	32,764	1,957.11
Lower/Deeper Aquifer	Very good	42	10,767	302.18
	good	55	22,539	894.40
Subtotal		<b>296</b>	<b>88,514</b>	<b>4,618.97</b>
<b>Total of Hambantota and Monaragala</b>				
		<b>Number of GNDs</b>	<b>Demand (m<sup>3</sup>/day)</b>	<b>Area (km<sup>2</sup>)</b>
Grand Total		<b>647</b>	<b>154,165</b>	<b>5,909.25</b>

In Hambantota district, the demand amount is estimated as 65,651 m<sup>3</sup>/day for 351 GNDs with an area of 1,290 km<sup>2</sup>, while Monaragala district is estimated as 88,514 m<sup>3</sup>/day for 296 GNDs with an area of 4,618.97 km<sup>2</sup>. Therefore, the total demand amount in two districts is estimated as 154,165 m<sup>3</sup>/day. This amount covers a total of 647 GNDs with an area of 5,909 km<sup>2</sup>.

## (3) Comparison Between Present Water consumption and Production Volume by the Plan

The results of questionnaire survey reveal that average water consumption is 19 liter/day/capita in Hambantota district and 35 liter/day/capita in Monaragala district. The consumption rate for the water supply levels are defined by the design criteria of NWSDB, that is 45 liter/day/capita for Level 1 (hand pump) and Level 2 (yard tap), 45 liter/day/capita for Level 3 (direct connection). The present consumption rates therefore, are lower than any levels of design criteria of NWSDB.

On the other hand, by the development plan, following production volume is expected. In the planned area of Hambantota district, 17.28% of total population that is 46,369 peoples can be supplied 45 liter/day/capita by the yard tap, and 82.72% of population that is 221,982 peoples can be supplied 140 liter/day/capita by the direct connection. Thus, total production volume of

33,164m<sup>3</sup>/day/capita for the 268,350 peoples can be developed. In the planned area of Monaragala district, 17.98% of total population that is 68,282 peoples can be supplied 45 liter/day/capita by the yard tap, and 82.02% of population that is 311,535 peoples can be supplied 140 liter/day/capita by the direct connection. Thus, total production volume of 46,687m<sup>3</sup>/day/capita for the 379,817 peoples can be developed.

#### (4) Drilling Program for Groundwater Development

Drilling programs for the production wells is examined based on the groundwater development plan. The programs consist of different types of wells based on aquifer type (Upper Aquifer and Lower/Deeper Aquifer). A depth of 200 m or less is required for the wells to the Lower/Deeper Aquifer, while a depth of 70 m or less is required for the wells to the Upper Aquifer. Table 6.5 shows the required number of wells by aquifer type. Expected well yields of 201 and 312 m<sup>3</sup>/day were adopted for estimation of the required number of the wells for the Upper Aquifer and Lower/Deeper Aquifer respectively. As a result, a total of 468 wells for the Upper Aquifer and a total of 193 wells for the Lower/Deeper Aquifer are estimated.

**Table 6.5 Required Number of Wells by Aquifer Type**

Upper Aquifer	District	Demand (m <sup>3</sup> /day)	Number of Wells
	Hambantota	38,892	193
	Monaragala	55,209	275
	<b>Total</b>	<b>94,101 m<sup>3</sup>/day</b>	<b>468 wells</b>

Remark: Expected well yield of 201 m<sup>3</sup>/day (an average of 586 existing wells with 12 hours operation/day) was adopted

Lower/deeper Aquifer	District	Demand (m <sup>3</sup> /day)	Number of Wells
	Hambantota	26,759	86
	Monaragala	33,306	107
	<b>Total</b>	<b>60,065 m<sup>3</sup>/day</b>	<b>193 wells</b>

Remark: Expected well yield of 312 m<sup>3</sup>/day (an average of 7 test wells with 12 hours operation/day) was adopted

Based on the estimated number of the wells, the drilling programs are examined below.

##### 1) For the Upper Aquifer

To examine the drilling program of upper aquifer, the real operating rate is estimated as shown in table below. Average drilling rate is estimated as 48 wells/year by a rig. According to the actual achievement of drilling division of WRB, there is 136 days contingency period per year due to the maintenance and repair of the rigs. This period can be converted to the 18 wells per year. Therefore, the real operating rate will be estimated as 30 wells/year. Two drilling rigs with necessary equipment capable of drilling to 100 m depth with 8 inches hole diameter is necessary for drilling the production well. Therefore, using two rigs, approximately 7.8 years period will be required for drilling a total of 468 wells for the Upper Aquifer.

Drilling Rate	Contingency		Real
	Period	Nos. of well	Operating Rate
48 wells/years	136 days	18 wells	30 wells /year

At present, 7 drilling rigs are in operating condition managed by WRB and, 14 drilling rigs are

in operating condition managed by NWSDB. Considering the required depth of the wells, the rigs among these can be assigned for the program.

## 2) For the Lower/Deeper Aquifer

According to the result of test wells, the promising are in Monaragala district is expected as mainly composed by the Lower Aquifer with the depth of 100m or more. On the other hand, in the Hambantota district, Deeper Aquifer with the depth up to 200m is a main aquifer. The required number of the production wells for the program is estimated as follows.

Area	Aquifer Type	Demand (m <sup>3</sup> /day)	Number of Wells
Monaragala	Lower	33,306	107
Hambantota	Deeper	26,759	86
Total		60,065 m <sup>3</sup> /day	193 wells

Based on the actual drilling rate by the test well drilling program of the Study, the drilling rates of are estimated as 48 well/year for Lower Aquifer, and 24 wells/year for Deeper Aquifer. Therefore, required period for the drilling is estimated as 2.2 years for the Lower Aquifer and 3.6 years for the Deeper Aquifer. The contingency period for the maintenance and repair of the rigs is estimated to 30% of the drilling period. Accordingly, the total period for the drilling is estimated as 2.86 years for the Lower Aquifer and 4.68 years for the Deeper Aquifer, as shown in below table.

Aquifer Type	Number of Wells	Required Period for the Program (years)		
		Estimated	Contingency	Total
Lower	107	2.2	0.66	2.86
Deeper	86	3.6	1.08	4.68
Total	193 wells	5.8	1.74	7.5 years

The drilling rig with necessary equipment capable of drilling to 200 m depth with 8 inches hole diameter will drill the production well of both Lower and Deeper Aquifer. Therefore, using one rig, approximately 7.5 years period will be required for drilling a total of 193 wells for the Lower/Deeper Aquifer.

WRB has their regional office in Monaragala district. The office includes enough yard and storehouse space to maintain a complete set of drilling equipment. Therefore, it is recommended to organize a drilling division in Monaragala regional office to complete the program.

## (4) Proposed Candidate Areas for the Development Plan

The promising area for the groundwater development is largely distributed in the Monaragala and partly in Hambantota. Moreover, there are many small promising enclave areas in the districts. Considering the distribution of each type of aquifer and regional convenience and efficiency for the drilling program, the proposed candidate areas for the development are divided into the following six blocks shown in *Figure 6.6*.



**1) Bibile-Madulla Block**

Total Area	:	1303 Km <sup>2</sup>
Population 2010	:	79,702
Demand 2010	:	15,531 m <sup>3</sup> /day
Implementation	:	By existing drilling team by WRB or NWSDB

**2) Monaragala-Siyambalanduwa Block**

Total Area	:	1722 Km <sup>2</sup>
Population 2010	:	140,139
Demand 2010	:	29,685 m <sup>3</sup> /day
Implementation	:	By existing drilling team by WRB or NWSDB

**3) Badalkumbura-Wellawaya Block**

Total Area	:	1055 Km <sup>2</sup>
Population 2010	:	157,096
Demand 2010	:	32,571m <sup>3</sup> /day
Implementation	:	Mainly by newly established drilling division in WRB Monaragala, partly by existing drilling team by WRB or NWSDB.

**4) Wellawaya- Lunugamwera Block**

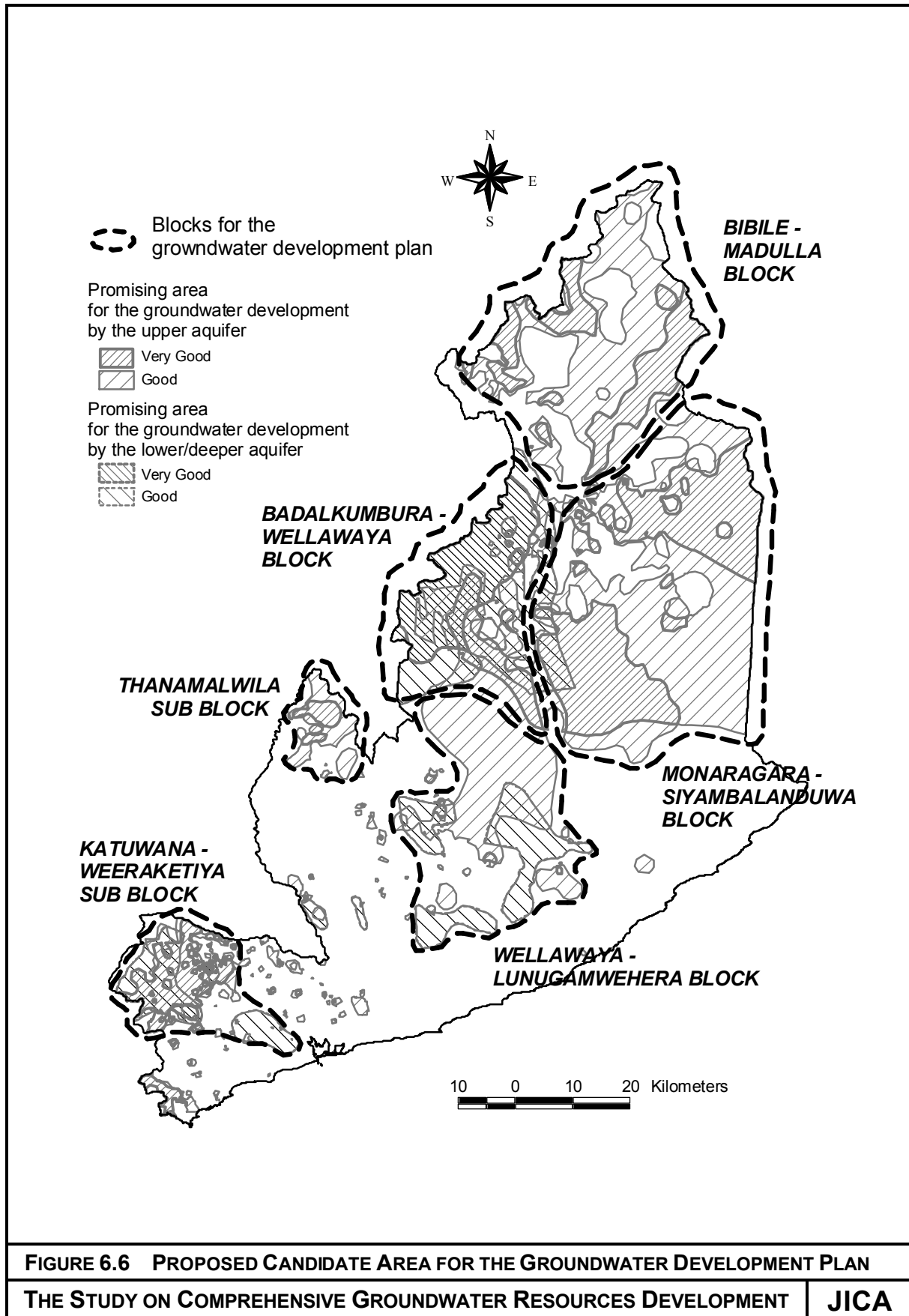
Total Area	:	1,318 Km <sup>2</sup>
Population 2010	:	108,338
Demand 2010	:	20,393 m <sup>3</sup> /day
Implementation	:	Mainly by newly established drilling division in WRB Monaragala, partly by existing drilling team by WRB or NWSDB.

**5) Thanamalwila Sub-Block**

Total Area	:	215 Km <sup>2</sup>
Population 2010	:	13,351
Demand 2010	:	2,885 m <sup>3</sup> /day
Implementation	:	By existing drilling team by WRB or NWSDB

**6) Katumana-Weeraketiya Sub-Block**

Total Area	:	445 Km <sup>2</sup>
Population 2010	:	181,637
Demand 2010	:	34,170 m <sup>3</sup> /day
Implementation	:	Mainly by existing drilling team by WRB or NWSDB, partly by newly established drilling division in WRB Monaragala



**FIGURE 6.6 PROPOSED CANDIDATE AREA FOR THE GROUNDWATER DEVELOPMENT PLAN**

**THE STUDY ON COMPREHENSIVE GROUNDWATER RESOURCES DEVELOPMENT**

**JICA**

### 6.4.2 PLANNING PROCEDURE

In this Study, the groundwater development plan for the pilot GNDs will be made mainly for domestic use. The extractable amount of groundwater depends on hydrogeological conditions of each area. The procedure used by this Study, therefore, will be basically adopted for the development planning of other GNDs. *Figure 6.7* shows the proposed planning procedure for the groundwater resources development. The proposed procedure consists of three stages: (1) Hydrogeological Investigation, (2) Master Plan and (3) Feasibility Study and Design.

#### (1) Hydrogeological Investigation

Geological investigations will be carried out for the each target GND. The investigation includes landsat imagery and aero-photo analysis for the interpretation of both geological structures and lineament. Following the geological investigations, geophysical exploration will be carried out to understand the subsurface geological structure of the target GND. The locations for test well drilling will be determined by the results of the geophysical exploration and the examination of topographical and geological conditions of the area.

The well will be drilled to determine the hydrogeological characteristics of the aquifer. Continuous pumping test will be carried out to determine the extractable yield of groundwater. The hydrogeological constants of the aquifer will also be estimated based the results of pumping test. At the same time, water quality of the groundwater can be examined by obtaining water samples.

Macro-Water balance analysis will be carried out to estimate the recharge potential of the groundwater in the planned area. The results of water balance analysis will also define the extractable yield of groundwater.

#### (2) Master Plan

The extractable yield will be estimated by the results of pumping test of a test well. Additionally, the consideration of environmental aspects and water balance will be examined to determine the pumping rate of a well. Such pumping rate will become the design capacity for the planned water supply scheme.

The determined pumping rate will be compared with the estimated water demand of each GND. If the pumping rate covers the water demand, the master plan can be formulated by using the original coverage plan that is allocated by certain ratio of level 3 and level 2 water supply scheme.

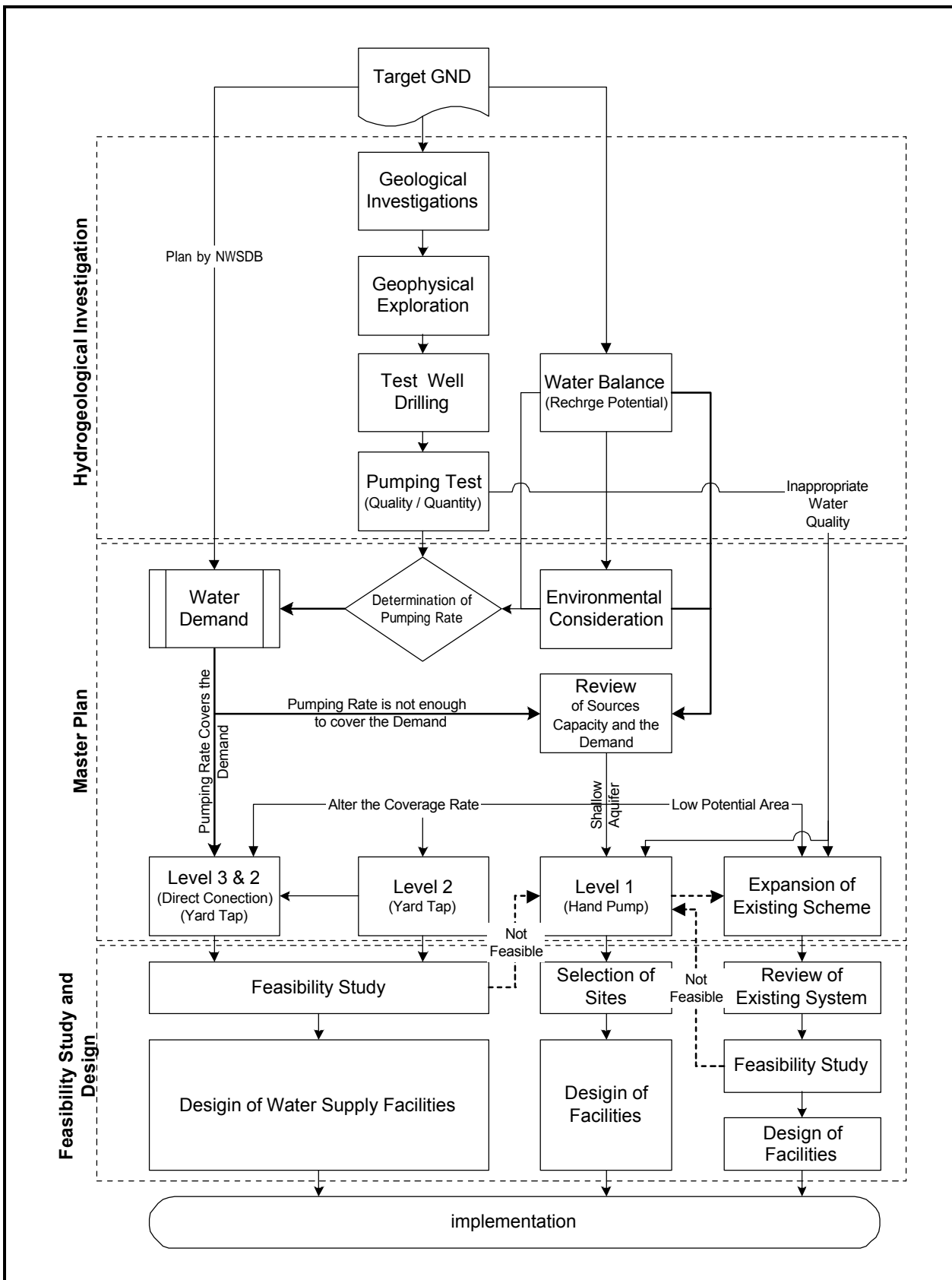


FIGURE 6.7 FLOW OF GROUNDWATER RESOURCES DEVELOPMENT

If the pumping rate does not cover the water demand, however, the source capacity and the demand will be reviewed. The review of source capacity, in concrete terms, means examining the number of wells that can be drilled in the area and/or hours of operation. This examination must be based on the consideration of the following: 1) hydrogeological characteristic of the area such as area of well influence, 2) environmental conditions and 3) water balance. Furthermore, if the reviewed source capacity does not cover the water demand, the water demand must be reviewed by altering the coverage plan of the water supply levels. For the GNDs identified as the low groundwater potential area, the master plan will be formulated either as level 1 plan or expansion of existing scheme. For the area with sufficient potential and with shallow aquifer, level 1 plan will be adopted. For the area with low groundwater, however, the plan will be shifted to expansion of an existing scheme.

### **(3) Feasibility Study and Design**

The Study covered by this project as above mentioned is: (1) Hydrogeological Investigation and (2) Master plan. The feasibility study and design stage will be carried out by Sri Lankan side according to the minutes of meeting agreed to by JICA and Government of Sri Lanka.

For the master plan formulated by the original coverage plan consisting of level 3 and 2, or altered plan with level 2, feasibility study will be required. The design for the water supply facilities will be carried out in parallel. If the plan is stated as unfeasible by the study, however, the coverage plan must be altered to level 1 system or expansion of existing system.

For the master plan formulated by level 1 of hand pump wells, the selection of the well site will be made mainly by results of hydrogeological investigation. Following this, the design will be carried out.

For GNDs with low groundwater potential and for the plan selected by the expansion of existing scheme, source capacity and system design of the scheme will be reviewed. The design will be carried out following the feasibility study.