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DPHE

## STUDY TO FORECAST DECLINING GROUNDWATER LEVEL IN BANGLADESH

FINAL REPORT  
EXECUTIVE SUMMARY

**EPC ENGINEERING AND PLANNING CONSULTANTS LTD., BANGLADESH**  
*in association with*  
**Mott MacDonald Ltd., U.K.**

JUNE, 1994

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## EXECUTIVE SUMMARY

### PROJECT

The Department of Public Health Engineering (DPHE) is responsible for supplying potable water to the rural people of Bangladesh. United Nations Children's Fund (UNICEF) has been assisting DPHE in its endeavor since 1972. Since 1970's and particularly after 1980's the growth of minor irrigation was rapid. Due to large scale abstraction of groundwater for irrigation use, the groundwater levels have lowered in many areas rendering many tubewells fitted with suction mode hand pumps inoperable particularly during dry months. To sustain the continued water supply to the rural people installation of Tara (deepset) pumps are required.

The Engineering and Planning Consultants Ltd. in association with M/s. Mott MacDonald have been assigned by DPHE/UNICEF to identify the areas for phasewise requirement and installation of Tara pumps. The work started from 20th December, 1993 and ended on 20th June, 1994.

The areas under study covered all of Bangladesh excepting the coastal areas, greater Chittagong, Chittagong Hill Tracts and part of greater Sylhet district. The main reason for exclusion of these areas is inadequate database. The total number of studied thanas are 349 and listed in Table 1.2.

A wide range of models and programs were used, and developed as required to form an integrated package for predicting the impact of irrigated development on rural water supplies. According to the local hydrogeological conditions, these models can be equated with single or multiple layered aquifer conditions as applicable according to the aquifer conditions. All the areas are modelled as single cell models, where the basic grid cell is equivalent to a thana. Both the single and multiple layer aquifer conditions are modelled through the integration of a suite of new and existing models and data sets. The elements of the modelling approaches are :

- Definition of potential recharge as the ultimate limit to groundwater development
- Definition of depth-storage profiles to determine the relationship between the net groundwater abstraction and depth to water
- Analysis of historical minor irrigation data to predict future growth of irrigation by mode

- Compilation and analysis of historical irrigation statistics and demographic data in order to estimate groundwater abstraction
- Compilation of groundwater level data to define the existing conditions for hand pump tubewell operation
- Calibration of depth-storage curves against historical water level and abstraction data
- Prediction of future water levels

For single layer aquifer conditions, the following steps have been defined for prediction of future water levels (and are further illustrated by Figures 1.1 to 1.3).

In total 349 thanas of Bangladesh were studied and the thanawise final output of the model results are given as Data Report in four volumes. A sample of the output of Adamdighi thana is given in Figure 1.4.

The final calibration of Adamdighi thana in Bogra district is given as a case study. Hydrographs and model output for Adamdighi are shown in Figure 1.5 to 1.9.

Figure 1.7 shows the basic depth-storage calibration. The water level and abstraction cross-plot is calibrated with the medium depth-storage plot. No increase or decrease of the specific yield values were required. The abstraction in 1991 exceeded the Master Plan Organisation's (MPO) estimated usable recharge but according to figures 1.5 and 1.6 the recharge capacity of the aquifer has not been exceeded and justifies a modest increase in the usable recharge factor of 20 percent. Figure 1.8 shows the rapid growth of irrigation since irrigation shallow tubewells became easily available and that there is infact, little irrigable land left for further development. Based on this rate of growth the figure 1.9 shows the net abstraction and the resultant water levels would be expected in 1995, and it will remain static till full development. Please note that in cases where irrigation growth stops in the near future due to exhaustion of recharge, subsequently the irrigated areas will decrease due to increase in demand of drinking water supply for increased population.

The study results predicted the hand pump tubewells requirement for the years 1995, 2000, 2010 and in full development of the resources and is given in Table 1.2.

Hydrogeological parameters and use of land and water resources were worked out and are shown in Table 1.3.

## CONCLUSION AND RECOMMENDATION

- a) UNICEF may prepare a schedule for phasewise replacement of No. 6 pumps by Tara pumps in the predicted areas as "Marginal Tara areas" and "Tara areas" as shown in Table 1.2. A summary in tabular form indicated the phasewise coverage of thanas by hand tubewell requirements is shown in Table 1.1 and another summary predicting the population to be served by the different hand pump system is shown in Table 1.1A.
- b) In order to improve the studies more accurate monitoring of groundwater development will be needed in terms of nationwide network of groundwater levels, numbers of operating units and actual abstraction.
- c) The studies have indicated that groundwater development may be constrained in areas of the eastern hills of Sylhet and the Sylhet basin due to difficult aquifer conditions and use of LLP for surface water availability.
- d) Uncertainty over the privatization of DTWs specially in time. With the increase of population the irrigation demand may be higher and to meet up the demand the privatization of DTW will come up.
- e) In the study the deep percolation (DP) values of the MPO DP3 (medium value) is used. In some cases the abstraction is far below the DP3 condition but in areas like Bogra district for higher abstraction, DP4 (medium high) values were considered. So, care should be taken to use the DP values.
- f) Groundwater recharge conditions in Bangladesh is advantageous with rainfall and with much of the country flooded during the monsoon.
- g) In the terms of reference there is no provision for hardware or software handover, training or production support. Some training is always necessary and there may be some provision for pertaining training to the users. Moreover, we believe the programs which we have developed for this project have an application in DPHE and UNICEF that go beyond the specific objectives of this project.

**TABLE 1.1**  
**Summary of Hand Tubewell Requirements**

Hand Pump Technology	1995		2000		2010		Full Development	
	Nrs. of thana covered	%	Nrs. of thana covered	%	Nrs. of thana covered	%	Nrs. of thana covered	%
Nr. 6	197	56.44	160	45.86	132	37.82	114	32.66
Marginal Tara	60	17.20	58	16.61	49	14.04	36	10.32
Tara	92	26.36	128	36.67	161	46.13	178	51.00
Marginal Super Tara	0	0	3	0.86	5	1.44	14	4.01
Super Tara	0	0	0	0	2	0.57	7	2.01

**TABLE 1.1A**

**Summary of Predicted Population to be Served by Different Hand Pump System:**

	1995	2000	2010	F. Dev.
Population under Nr. 6	48,532,153 42%	42,721,984 33%	42,954,119 42%	51,198,190 23%
Population under Marginal Tara	14,364,087 12%	15,170,195 12%	17,073,078 11%	17,993,789 8%
Population under Tara	23,198,103 20%	37,447,596 29%	56,652,766 35%	87,205,995 39%
Population under Mrg. S. Tara	642,013 1%	1,366,725 1%	2,560,423 2%	5,398,370 2%
Population under Super Tara	0	0	976,250	4,823,991
<b>Sub-total:</b>	<b>86,736,356</b> 75%	<b>96,706,500</b> 75%	<b>120,216,636</b> 75%	<b>166,620,335</b> 75%
Populn. outside DGL Study Area	29,247,647 25%	32,609,592 25%	40,537,269 25%	56,184,683 25%
<b>Total :</b>	<b>115,984,003</b>	<b>129,316,092</b>	<b>160,753,905</b>	<b>222,805,018</b>

**Number of Thanas to be covered :**

	1995	2000	2010	F. Dev.
Nr. 6	196	159	131	113
Marginal Tara	59	58	49	40
Tara	92	128	161	178
Marg. S. Tara	1	3	5	10
Super Tara	0	0	2	7
<b>Sub-Total:</b>	<b>348</b>	<b>348</b>	<b>348</b>	<b>348</b>
<b>Outside DGL :</b>	<b>138</b>	<b>138</b>	<b>138</b>	<b>138</b>
<b>Total Thana :</b>	<b>486</b>	<b>486</b>	<b>486</b>	<b>486</b>

Note: Criteria for different Hand Pumps:

- a) No.6 (upto 6m)
- b) Marginal Tara (6-8m)
- c) Tara (8-15m)
- d) Mrg. Super-Tara(15-16m)
- e) Super Tara (>16m)

**TABLE 1.2**  
**Predicted Hand Tubewell Requirements**

Zila	Thana	1995	2000	2010	Full Development
Brahmanbaria	Akhaura	Nr. 6	Marginal Tara	Marginal Tara	Marginal Tara
Brahmanbaria	Bancharampur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Brahmanbaria	Brahmanbaria	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Brahmanbaria	Kasba	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Brahmanbaria	Nabinagar	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Brahmanbaria	Nasirnagar	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Brahmanbaria	Serail	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Chandpur	Chandpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Chandpur	Feridganj	Nr. 6	Nr. 6		Nr. 6
Chandpur	Haimchar	Nr. 6	Nr. 6		Nr. 6
Chandpur	Hajiganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Chandpur	Kachua	Nr. 6	Tara	Tara	Tara
Chandpur	Matlab	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Chandpur	Shahrasti	Nr. 6	Marginal Tara	Tara	Marginal Tara
Comilla	Barura	Nr. 6	Marginal Tara	Tara	Tara
Comilla	Brahmanpara	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Comilla	Burichang	Tara	Tara	Tara	Tara
Comilla	Chandina	Nr. 6	Marginal Tara	Tara	Tara
Comilla	Chauddagram	Nr. 6	Marginal Tara	Marginal Tara	Marginal Tara
Comilla	Daudkandi	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Comilla	Debidwar	Nr. 6	Tara	Tara	Mrg. S. Tara
Comilla	Homna	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Comilla	Comilla	Tara	Tara	Tara	Tara
Comilla	Laksam	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Comilla	Muradnagar	Nr. 6	Marginal Tara	Marginal Tara	Tara
Comilla	Nangalkot	Nr. 6	Marginal Tara	Tara	Tara
Feni	Daganbhuiya	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Habiganj	Ajmiriganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Habiganj	Bahubal	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Habiganj	Baniyachang	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Habiganj	Chunarughat	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Habiganj	Habiganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Habiganj	Lakhal	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Habiganj	Madhabpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Habiganj	Nabiganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Laksmipur	Raipur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Laksmipur	Ramganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Moulvi Bazar	Baralekha	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Moulvi Bazar	Kameiganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Moulvi Bazar	Kulaura	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Moulvi Bazar	Moulvibazar	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Moulvi Bazar	Rajnagar	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Moulvi Bazar	Srimangal	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Noakhali	Chatkhil	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Noakhali	Senbag	Nr. 6	Nr. 6	Tara	Tara
Sunamganj	Bishambarpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sunamganj	Chatak	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sunamganj	Dirai	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sunamganj	Dhermapasha	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sunamganj	Dwarabazar	Nr. 6	Nr. 6	Nr. 6	Nr. 6

cont... 2



**TABLE 1.2**  
**Predicted Hand Tubewell Requirements**

Zila	Thana	1995	2000	2010	Full Development
Sunamganj	Jagannathpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sunamganj	Jamalganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sunamganj	Sulla	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sunamganj	Sunamganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sunamganj	Tahirpur	Nr. 6	Nr. 6		Nr. 6
Sylhet	Balaganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sylhet	Beani bezar	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sylhet	Biswanath	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sylhet	Companiganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sylhet	Fenchuganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sylhet	Gotappanj	Nr. 6	Nr. 6	Nr. 6	Tara
Sylhet	Gowainghat	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sylhet	Jaintapur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sylhet	Kanainghat	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sylhet	Sylhet	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sylhet	Zakiganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Dhaka	Dhamrai	Marginal Tara	Marginal Tara	Tara	Tara
Dhaka	Dohar	Marginal Tara	Tara	Tara	Tara
Dhaka	Keraniganj	Tara	Tara	Tara	Tara
Dhaka	Nawabganj	Tara	Tara	Tara	Tara
Dhaka	Savar	Tara	Tara	Tara	Tara
Faridpur	Alfadanga	Marginal Tara	Marginal Tara	Marginal Tara	Marginal Tara
Faridpur	Bhanga	Nr. 6	Nr. 6	Marginal Tara	Marginal Tara
Faridpur	Boalmari	Tara	Tara	Tara	Tara
Faridpur	Char bhadrasan	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Faridpur	Faridpur	Marginal Tara	Marginal Tara	Marginal Tara	Tara
Faridpur	Madhukhali	Tara	Tara	Tara	Tara
Faridpur	Nagarkanda	Marginal Tara	Tara	Tara	Tara
Faridpur	Sadarpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Gazipur	Gazipur	Mrg. S. Tara	Mrg. S. Tara	Mrg. S. Tara	Super-Tara
Gazipur	Kaliakoir	Tara	Tara	Mrg. S. Tara	Super-Tara
Gazipur	Kaliganj	Tara	Tara	Tara	Tara
Gazipur	Kaspasia	Tara	Tara	Tara	Tara
Gazipur	Sreepur	Tara	Tara	Tara	Tara
Rajbari	Baliakandi	Tara	Tara	Tara	Tara
Rajbari	Goalundo	Marginal Tara	Marginal Tara	Tara	Tara
Rajbari	Pangsa	Tara	Tara	Tara	Tara
Rajbari	Rajbari	Marginal Tara	Marginal Tara	Tara	Tara
Gopalganj	Gopalganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Gopalganj	Kasiani	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Gopalganj	Kotalipara	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Gopalganj	Muksudpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Jamalpur	Bakshiganj	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Jamalpur	Dewanganj	Marginal Tara	Tara	Tara	Tara
Jamalpur	Islampur	Nr. 6	Marginal Tara	Marginal Tara	Tara
Jamalpur	Jamalpur	Tara	Tara	Tara	Tara
Jamalpur	Madarganj	Marginal Tara	Tara	Tara	Tara
Jamalpur	Melandaaha	Marginal Tara	Marginal Tara	Marginal Tara	Marginal Tara
Jamalpur	Sharishabari	Tara	Tara	Tara	Tara
Kishorganj	Astogram	Nr. 6	Nr. 6	Nr. 6	Nr. 6

cont... 3

TABLE 1.2  
Predicted Hand Tubewell Requirements

Zila	Thana	1995	2000	2010	Full Development
Kishorganj	Bajitpur	Nr. 6	Tara	Tara	Tara
Kishorganj	Bhairab	Nr. 6	Nr. 6	Marginal Tara	Marginal Tara
Kishorganj	Hossainpur	Marginal Tara	Tara	Tara	Mrg. S. Tara
Kishorganj	Itna	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Kishorganj	Karimganj	Nr. 6	Nr. 6	Nr. 6	Tara
Kishorganj	Katladi	Nr. 6	Marginal Tara	Tara	Tara
Kishorganj	Kishorganj	Nr. 6	Tara	Tara	Tara
Kishorganj	Kuliarcher	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Kishorganj	Mithamoin	Nr. 6	Nr. 6		Nr. 6
Kishorganj	Nikli	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Kishorganj	Pakundia	Marginal Tara	Tara	Tara	Tara
Kishorganj	Tarail	Nr. 6	Marginal Tara	Marginal Tara	Tara
Madaripur	Kalkini	Nr. 6	Nr. 6		Nr. 6
Madaripur	Madaripur	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Madaripur	Rajoir	Marginal Tara	Marginal Tara	Tara	Tara
Madaripur	Sibchar	Nr. 6	Nr. 6	Marginal Tara	Marginal Tara
Manikganj	Daulatpur	Marginal Tara	Marginal Tara	Tara	Tara
Manikganj	Ghior	Marginal Tara	Marginal Tara	Marginal Tara	Tara
Manikganj	Harirampur	Marginal Tara	Marginal Tara	Tara	Tara
Manikganj	Manikganj	Tara	Tara	Tara	Tara
Manikganj	Saturia	Tara	Tara	Tara	Tara
Manikganj	Shivalaya	Nr. 6	Nr. 6	Marginal Tara	Tara
Manikganj	Singair	Marginal Tara	Marginal Tara	Tara	Tara
Munshiganj	Gazaria	Nr. 6	Nr. 6		Nr. 6
Munshiganj	Lohajang	Tara	Tara	Tara	Mrg. S. Tara
Munshiganj	Munshiganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Munshiganj	Serajdikhan	Nr. 6	Tara	Tara	Mrg. S. Tara
Munshiganj	Sreenagar	Tara	Tara	Tara	Tara
Munshiganj	Tangibari	Nr. 6	Marginal Tara	Tara	Tara
Mymensingh	Bhaluka	Tara	Tara	Tara	Tara
Mymensingh	Fulbaria	Tara	Tara	Tara	Tara
Mymensingh	Gaffargaon	Tara	Tara	Tara	Tara
Mymensingh	Gouripur	Nr. 6	Nr. 6	Tara	Tara
Mymensingh	Haluaghat	Marginal Tara	Tara	Tara	Tara
Mymensingh	Ishwarganj	Nr. 6	Nr. 6	Nr. 6	Tara
Mymensingh	Mymensingh	Nr. 6	Tara	Tara	Tara
Mymensingh	Muktagacha	Tara	Mrg. S. Tara	Mrg. S. Tara	Mrg. S. Tara
Mymensingh	Nandail	Nr. 6	Tara	Tara	Mrg. S. Tara
Mymensingh	Phulpur	Nr. 6	Nr. 6	Marginal Tara	Tara
Mymensingh	Trishal	Tara	Tara	Mrg. S. Tara	Super-Tara
Narayanganj	Araihazar	Nr. 6	Nr. 6	Marginal Tara	Marginal Tara
Narayanganj	Sonargaon	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Narayanganj	Narayanganj	Nr. 6	Nr. 6		Nr. 6
Narayanganj	Rupganj	Tara	Tara		Tara
Narsingdi	Belabo	Marginal Tara	Marginal Tara	Tara	Tara
Narsingdi	Monohardi	Nr. 6	Nr. 6	Marginal Tara	Tara
Narsingdi	Narsinghdi	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Narsingdi	Palash	Marginal Tara	Marginal Tara	Marginal Tara	Marginal Tara
Narsingdi	Raipura	Nr. 6	Nr. 6	Marginal Tara	Marginal Tara
Narsingdi	Shibpur	Nr. 6	Nr. 6	Nr. 6	Marginal Tara

cont... 4

**TABLE 1.2**  
**Predicted Hand Tubewell Requirements**

Zila	Thana	1995	2000	2010	Full Development
Netrakona	Atpara	Nr. 6	Marginal Tara	Marginal Tara	Tara
Netrakona	Barhatta	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Netrakona	Dhubaura	Tara	Tara	Tara	Tara
Netrakona	Durgapur	Nr. 6	Tara	Tara	Tara
Netrakona	Khaliajuri	Nr. 6	Nr. 6		Nr. 6
Netrakona	Kalmakanda	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Netrakona	Kendua	Nr. 6	Marginal Tara	Tara	Tara
Netrakona	Modan	Nr. 6	Nr. 6		Nr. 6
Netrakona	Mohanganj	Nr. 6	Marginal Tara	Marginal Tara	Tara
Netrakona	Netrakona	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Netrakona	Purbadhala	Nr. 6	Nr. 6	Nr. 6	Tara
Shariyatpur	Bhedarganj	Nr. 6	Nr. 6		Nr. 6
Shariyatpur	Damudya	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Shariyatpur	Goshairhat	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Shariyatpur	Naria	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Shariyatpur	Shariyatpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Shariyatpur	Janjira	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sherpur	Jhinaigati	Tara	Tara	Tara	Marginal Super-Tara
Sherpur	Nakla	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sherpur	Nalitabir	Marginal Tara	Tara	Tara	Tara
Sherpur	Sherpur	Nr. 6	Tara	Tara	Tara
Sherpur	Sribardi	Nr. 6	Nr. 6	Tara	Tara
Tangail	Basail	Marginal Tara	Tara	Tara	Tara
Tangail	Bhuapur	Nr. 6	Marginal Tara	Marginal Tara	Tara
Tangail	Delduar	Marginal Tara	Marginal Tara	Tara	Tara
Tangail	Ghatall	Tara	Tara	Tara	Tara
Tangail	Gopalpur	Marginal Tara	Marginal Tara	Tara	Tara
Tangail	Kalihati	Marginal Tara	Tara	Tara	Tara
Tangail	Madhupur	Marginal Tara	Tara	Tara	Tara
Tangail	Mirzapur	Tara	Tara	Tara	Tara
Tangail	Nagarpur	Marginal Tara	Tara	Tara	Tara
Tangail	Shakhipur	Tara	Tara	Tara	Marginal Super-Tara
Tangail	Tangail	Marginal Tara	Marginal Tara	Tara	Tara
Bagerhat	Bagerhat	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Bagerhat	Chitalmari	Nr. 6	Nr. 6		Nr. 6
Bagerhat	Fakirhat	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Bagerhat	Mollahat	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Chuadanga	Alamdanga	Nr. 6	Marginal Tara	Marginal Tara	Marginal Tara
Chuadanga	Chuadanga	Nr. 6	Marginal Tara	Marginal Tara	Marginal Tara
Chuadanga	Damurhuda	Marginal Tara	Tara	Tara	Tara
Chuadanga	Jiban nagar	Nr. 6	Marginal Tara	Marginal Tara	Marginal Tara
Jessore	Abhaynagar	Tara	Tara	Tara	Super-Tara
Jessore	Bagherpara	Marginal Tara	Tara	Tara	Tara
Jessore	Chaugacha				
Jessore	Jhikargacha	Nr. 6	Nr. 6	Marginal Tara	Marginal Tara
Jessore	Keshabpur	Tara	Tara	Tara	Tara
Jessore		Marginal Tara	Tara	Tara	Tara
Jessore	Manirampur	Nr. 6	Marginal Tara	Tara	Tara
Jessore	Sarsa	Marginal Tara	Marginal Tara	Marginal Tara	Marginal Tara
Jhenaidah	Harinakundu	Nr. 6	Nr. 6	Nr. 6	Tara

cont... 5

**TABLE 1.2**  
**Predicted Hand Tubewell Requirements**

Zila	Thana	1995	2000	2010	Full Development
Jhenaidah	Jhenaidah	Marginal Tara	Tara	Tara	Tara
Jhenaidah	Kaliganj	Marginal Tara	Tara	Tara	Tara
Jhenaidah	Kotchandpur	Marginal Tara	Tara	Tara	Tara
Jhenaidah	Maheshpur	Marginal Tara	Tara	Tara	Tara
Jhenaidah	Sailkupa	Tara	Tara	Tara	Super-Tara
Khulna	Phultala	Nr. 6	Nr. 6	Tara	Tara
Khulna	Terakhada	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Kushtia	Bheramara	Tara	Tara	Tara	Tara
Kushtia	Daulatpur	Marginal Tara	Marginal Tara	Marginal Tara	Marginal Tara
Kushtia	Khoksa	Tara	Tara	Tara	Marginal Super-Tara
Kushtia	Kumarkhali	Tara	Tara	Tara	Marginal Super-Tara
Kushtia	Kushtia	Nr. 6	Nr. 6	Nr. 6	Tara
Kushtia	Mirpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Magura	Magura	Nr. 6	Marginal Tara	Tara	Tara
Magura	Mohammadpur	Marginal Tara	Marginal Tara	Tara	Tara
Magura	Salikha	Tara	Tara	Tara	Tara
Magura	Sripur	Marginal Tara	Marginal Tara	Marginal Tara	Tara
Meherpur	Gangni	Nr. 6	Nr. 6	Marginal Tara	Tara
Meherpur	Meherpur	Nr. 6	Nr. 6	Marginal Tara	Marginal Tara
Narail	Kalia	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Narail	Lohagara	Nr. 6	Nr. 6	Tara	Tara
Narail	Narail	Nr. 6	Nr. 6	Marginal Tara	Tara
Satkhira	Kalaroa	Tara	Tara	Tara	Tara
Satkhira	Satkhira	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Satkhira	Tala	Nr. 6	Tara	Tara	Tara
Bogra	Adamdighi	Tara	Tara	Tara	Tara
Bogra	Bogra	Tara	Tara	Tara	Tara
Bogra	Dhunot	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Bogra	Dupchachia	Tara	Tara	Tara	Tara
Bogra	Gabtal	Marginal Tara	Marginal Tara	Marginal Tara	Marginal Tara
Bogra	Kahalu	Tara	Tara	Tara	Tara
Bogra	Nandigram	Tara	Tara	Tara	Tara
Bogra	Shariakandi	Nr. 6	Nr. 6	Marginal Tara	Tara
Bogra	Sherpur	Tara	Tara	Tara	Tara
Bogra	Shibganj	Tara	Tara	Tara	Tara
Bogra	Sonatola	Marginal Tara	Marginal Tara	Marginal Tara	Marginal Tara
Dinajpur	Birampur	Marginal Tara	Marginal Tara	Tara	Tara
Dinajpur	Birganj	Nr. 6	Marginal Tara	Tara	Tara
Dinajpur	Biral	Marginal Tara	Tara	Tara	Tara
Dinajpur	Bochaganj	Nr. 6	Nr. 6	Marginal Tara	Tara
Dinajpur	Chirirbandar	Nr. 6	Nr. 6	Marginal Tara	Tara
Dinajpur	Fulbari	Marginal Tara	Marginal Tara	Tara	Tara
Dinajpur	Ghoraghat	Tara	Tara	Tara	Tara
Dinajpur	Hakimpur	Nr. 6	Nr. 6	Marginal Tara	Tara
Dinajpur	Kaharol	Marginal Tara	Marginal Tara	Tara	Tara
Dinajpur	Khansama	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Dinajpur	Dinajpur	Nr. 6	Nr. 6	Marginal Tara	Tara
Dinajpur	Nawabganj	Nr. 6	Nr. 6	Marginal Tara	Marginal Tara
Dinajpur	Parbatipur	Tara	Tara	Tara	Tara
Gaibandha	Fulchari	Nr. 6	Nr. 6	Nr. 6	Marginal Tara

cont... 6

**TABLE 1.2**  
**Predicted Hand Tubewell Requirements**

Zila	Thana	1995	2000	2010	Full Development
Gaibandha	Gaibandha	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Gaibandha	Gabindaganj	Marginal Tara	Tara	Tara	Tara
Gaibandha	Palasbari	Marginal Tara	Marginal Tara	Marginal Tara	Marginal Tara
Gaibandha	Sadullapur	Nr. 6	Marginal Tara	Marginal Tara	Tara
Gaibandha	Shaghata	Nr. 6	Marginal Tara	Marginal Tara	Marginal Tara
Gaibandha	Sandarganj	Nr. 6	Marginal Tara	Tara	Tara
Jaipurhat	Akkelpur	Tara	Tara	Tara	Tara
Jaipurhat	Jaipurhat	Tara	Tara	Tara	Tara
Jaipurhat	Kalai	Tara	Tara	Tara	Tara
Jaipurhat	Khettal	Tara	Tara	Tara	Tara
Jaipurhat	Panchbibi	Tara	Tara	Tara	Tara
Kurigram	Bhurungamari	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Kurigram	Razibpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Kurigram	Chilbari	Marginal Tara	Marginal Tara	Tara	Tara
Kurigram	Fulbari	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Kurigram	Kurigram	Nr. 6	Nr. 6	Marginal Tara	Tara
Kurigram	Nageswari	Nr. 6	Tara	Tara	Tara
Kurigram	Razarhat	Nr. 6	Marginal Tara	Tara	Tara
Kurigram	Rahumari	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Kurigram	Ulipur	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Lalmonirhat	Aditmari	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Lalmonirhat	Hatibanda	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Lalmonirhat	Kaliganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Lalmonirhat	Lalmonirhat	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Lalmonirhat	Patgram	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Naogaon	Atrai	Tara	Tara	Tara	Tara
Naogaon	Badalgachhi	Tara	Tara	Tara	Tara
Naogaon	Dhamoirhat	Tara	Tara	Tara	Tara
Naogaon	Manda	Tara	Tara	Tara	Tara
Naogaon	Mohadebpur	Tara	Tara	Tara	Mrg. S. Tara
Naogaon	Naogaon	Tara	Tara	Tara	Mrg. S. Tara
Naogaon	Niamatpur	Tara	Tara	Tara	Tara
Naogaon	Patnitala	Tara	Tara	Tara	Tara
Naogaon	Porsha	Tara	Tara	Tara	Tara
Naogaon	Reninagar	Tara	Tara	Tara	Tara
Naogaon	Shapahar	Tara	Tara	Tara	Tara
Natore	Bagatipara	Tara	Tara	Tara	Tara
Natore	Baraigram	Tara	Tara	Tara	Tara
Natore	Gurudaspur	Tara	Tara	Tara	Tara
Natore	Lalpur	Tara	Tara	Tara	Tara
Natore	Nator	Tara	Tara	Tara	Tara
Natore	Singra	Tara	Tara	Tara	Tara
Nawabganj	Bholahat	Tara	Tara	Tara	Tara
Nawabganj	Gomestapur	Tara	Tara	Tara	Tara
Nawabganj	Nachol	Tara	Tara	Tara	Tara
Nawabganj	Nawabganj	Tara	Tara	Tara	Tara
Nawabganj	Shibganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Nilphamari	Dimla	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Nilphamari	Domar	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Nilphamari	Jaldhaka	Nr. 6	Nr. 6	Nr. 6	Nr. 6

cont... 7

**TABLE 1.2**  
**Predicted Hand Tubewell Requirements**

Zila	Thana	1995	2000	2010	Full Development
Nilphamari	Kishorganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Nilphamari	Nilphamari	Nr. 6	Nr. 6	Marginal Tara	Tara
Nilphamari	Saidpur	Nr. 6	Nr. 6	Marginal Tara	Tara
Pabna	Atgharia	Tara	Tara	Tara	Tara
Pabna	Bera	Marginal Tara	Marginal Tara	Tara	Tara
Pabna	Bhangura	Tara	Tara	Tara	Tara
Pabna	Chatmohar	Tara	Tara	Tara	Tara
Pabna	Faridpur	Tara	Tara	Tara	Tara
Pabna	Ishardi	Tara	Tara	Tara	Tara
Pabna	Pabna	Tara	Tara	Super-Tara	Super-Tara
Pabna	Santhia	Marginal Tara	Tara	Tara	Tara
Pabna	Sujanagar	Tara	Tara	Super-Tara	Super-Tara
Panchagar	Atwari	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Panchagar	Boda	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Panchagar	Debiganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Panchagar	Panchagar	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Panchagar	Tetulia	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Rajshahi	Bagha	Marginal Tara	Marginal Tara	Tara	Tara
Rajshahi	Bagmara	Tara	Tara	Tara	Mrg. S. Tara
Rajshahi	Boalia	Marginal Tara	Marginal Tara	Marginal Tara	Tara
Rajshahi	Charghat	Tara	Tara	Tara	Tara
Rajshahi	Dugapur	Marginal Tara	Tara	Tara	Tara
Rajshahi	Dogajari	Tara	Tara	Tara	Tara
Rajshahi	Mohanpur	Tara	Tara	Tara	Tara
Rajshahi	Paba	Tara	Mrg. S. Tara	Mrg. S. Tara	Mrg. S. Tara
Rajshahi	Puthia	Tara	Tara	Tara	Tara
Rajshahi	Tanor	Tara	Tara	Tara	Tara
Rangpur	Badarganj	Marginal Tara	Tara	Tara	Tara
Rangpur	Gangachara	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Rangpur	Kaunia	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Rangpur	Rangpur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Rangpur	Mithapukur	Nr. 6	Nr. 6	Marginal Tara	Tara
Rangpur	Pirgachha	Nr. 6	Nr. 6	Nr. 6	Marginal Tara
Rangpur	Pirganj	Marginal Tara	Marginal Tara	Tara	Tara
Rangpur	Taraganj	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Sirajganj	Belkuchi	Marginal Tara	Tara	Tara	Tara
Sirajganj	Chauhali	Marginal Tara	Marginal Tara	Marginal Tara	Marginal Tara
Sirajganj	Kamarkhanda	Tara	Tara	Tara	Tara
Sirajganj	Kazipur	Marginal Tara	Tara	Tara	Tara
Sirajganj	Raiganj	Tara	Tara	Tara	Tara
Sirajganj	Shahzadpur	Tara	Tara	Tara	Tara
Sirajganj	Sirajganj	Marginal Tara	Tara	Tara	Tara
Sirajganj	Taras	Tara	Tara	Tara	Tara
Sirajganj	Ullapara	Tara	Tara	Tara	Tara
Thakurgaon	Baliadangi	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Thakurgaon	Haripur	Nr. 6	Nr. 6	Nr. 6	Nr. 6
Thakurgaon	Pirganj	Nr. 6	Nr. 6	Marginal Tara	Tara
Thakurgaon	Ranisonkail	Nr. 6	Marginal Tara	Tara	Tara
Thakurgaon	Thakurgaon	Nr. 6	Nr. 6	Nr. 6	Nr. 6

Figure 1.1

### Single layer Aquifer Conditions : Calibration of the Resource Potential Model

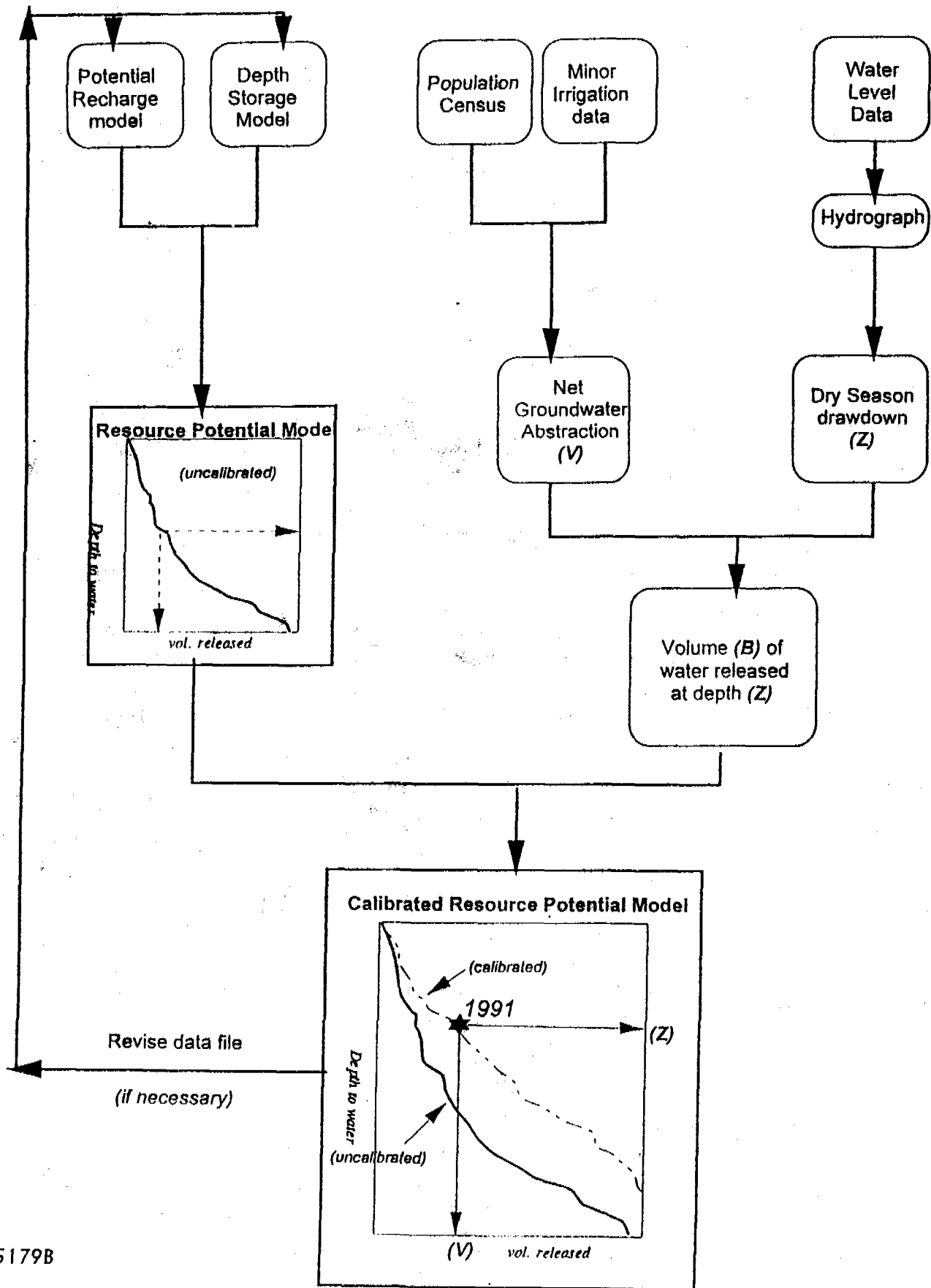


Figure 1.2

### Predicting Water Levels in 1995 and 2000

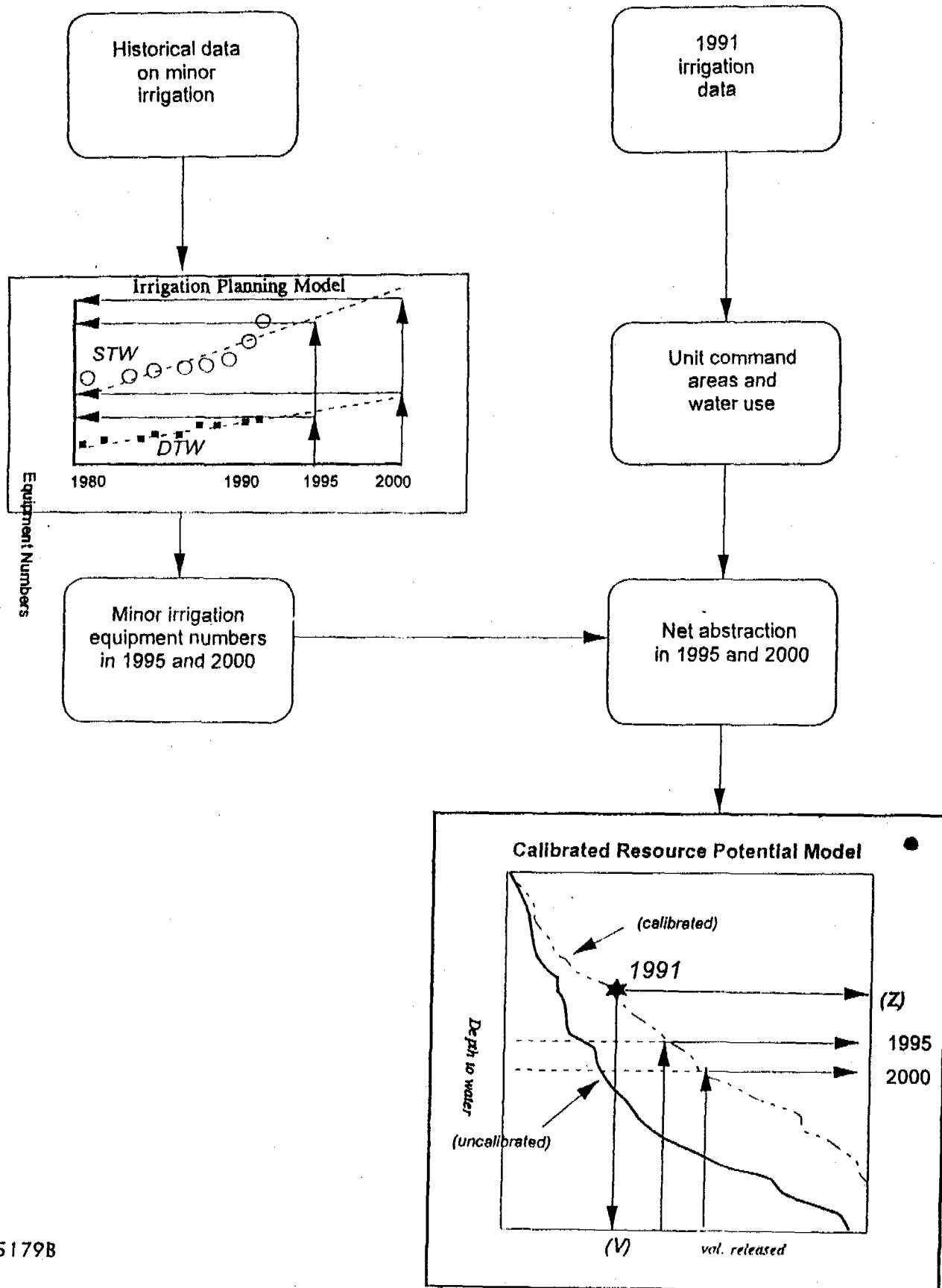




Figure 1.3

### Predicting Water levels at Full Irrigation Development

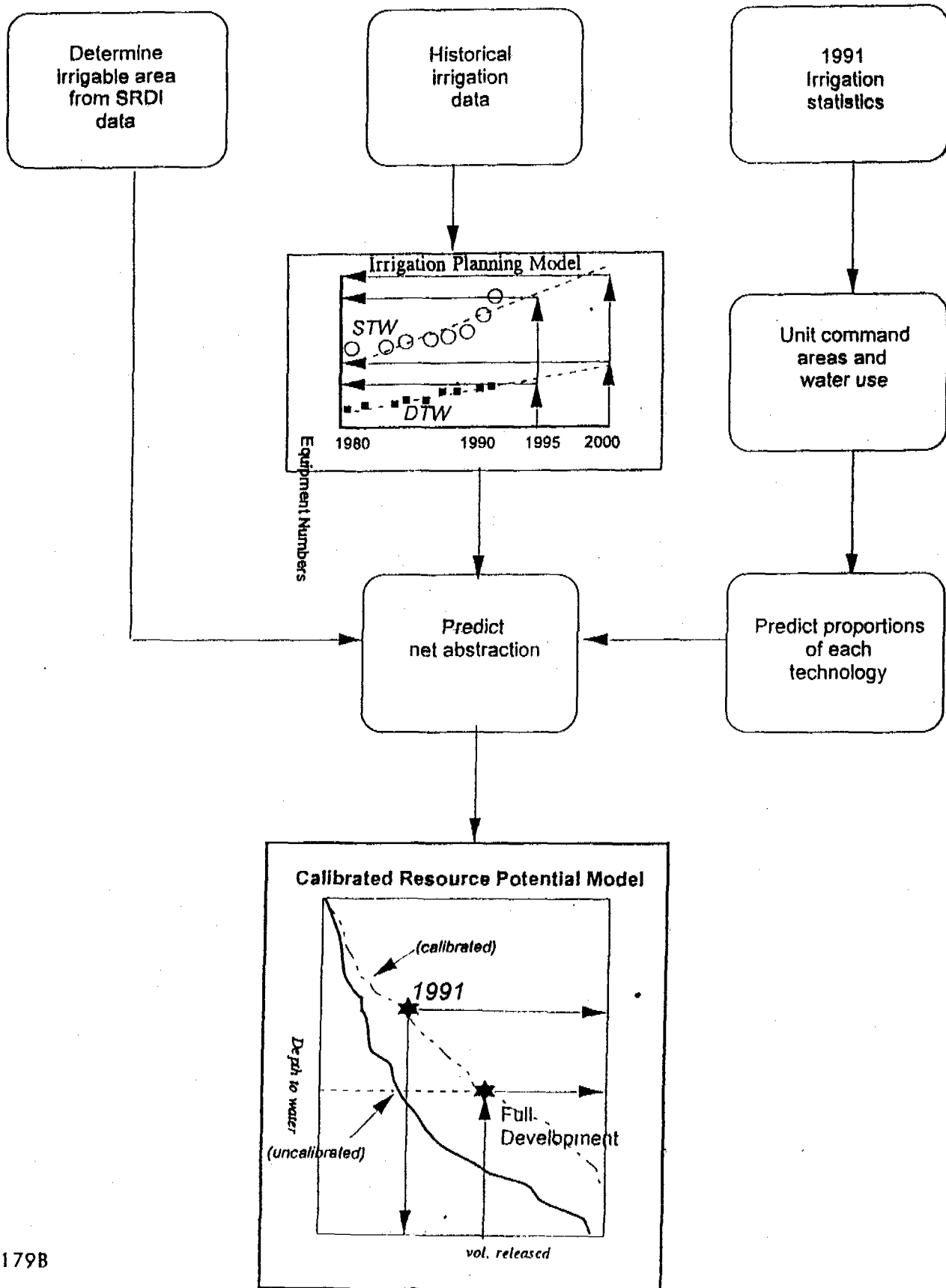


Figure 1.4

Geocode: 51006 Dist: Bogra

Thana: ADAMDIGHI

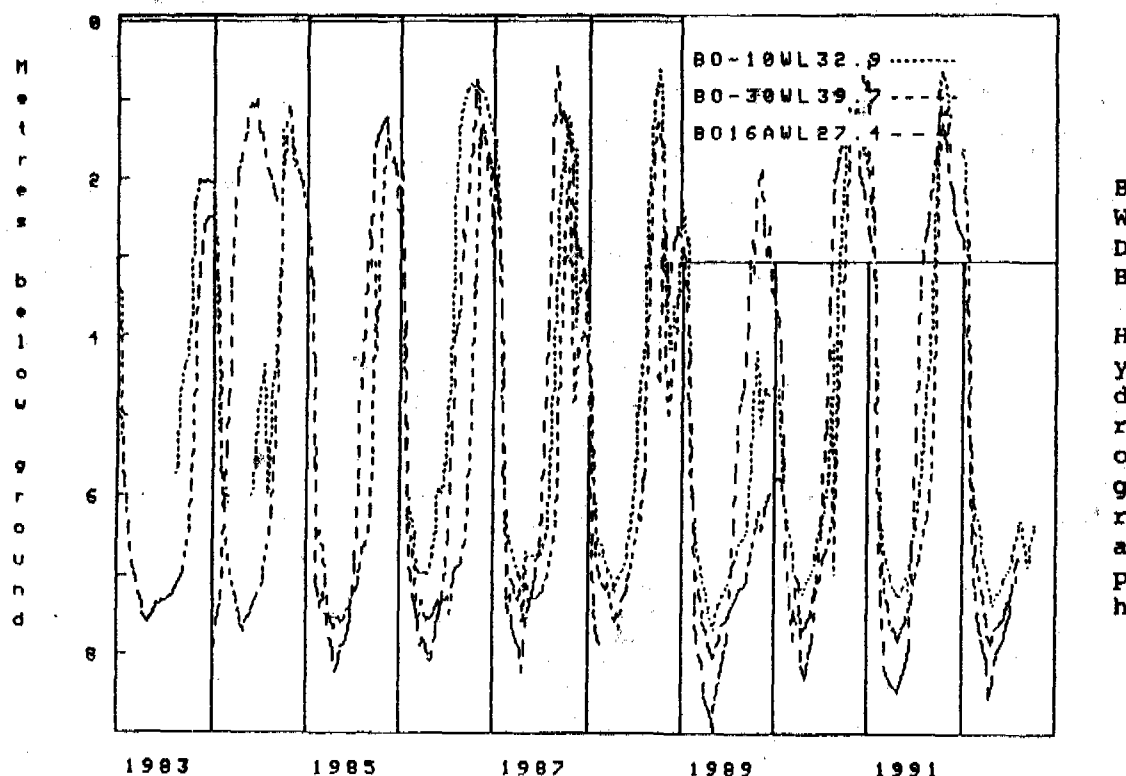
1 of 2

Gross area :17,092ha Population(1981) :132,690 Transmissivity :2500m<sup>2</sup>/d  
 Irrigable area :14,086ha Usable recharge : 327mm Surface clay : 9 m  
 F0: 65.2 F1: 8.5 Net irrigation reqt.: 440mm Aquifer type :SINGLE  
 F2: 17.9 F3: 0.0 Deep percolation : 2.5mm/d

Union	Popln. (1981)	Hand Pumps '92			Depth Water (m)
		Nr 6	Tara	Deep	
Adamdighi	19,050	164	28	0	8.5
Champapur	17,245	148	28	0	8.8
Chatnigram	22,197	204	29	0	8.8
Kundagram	18,413	157	28	0	7.6
Nasratpur	18,961	164	28	0	8.5
Santahar	36,824	170	32	0	9.1

Minor Irrigation in 1993

Pump Type	Number Operating	Irrigated Area (ha)
STW	1,172	6,047
DSSTW	724	3,905
DTW	125	3,499
Manual TW	0	0
LLP	0	0
Tradi'n'l	1,350	717

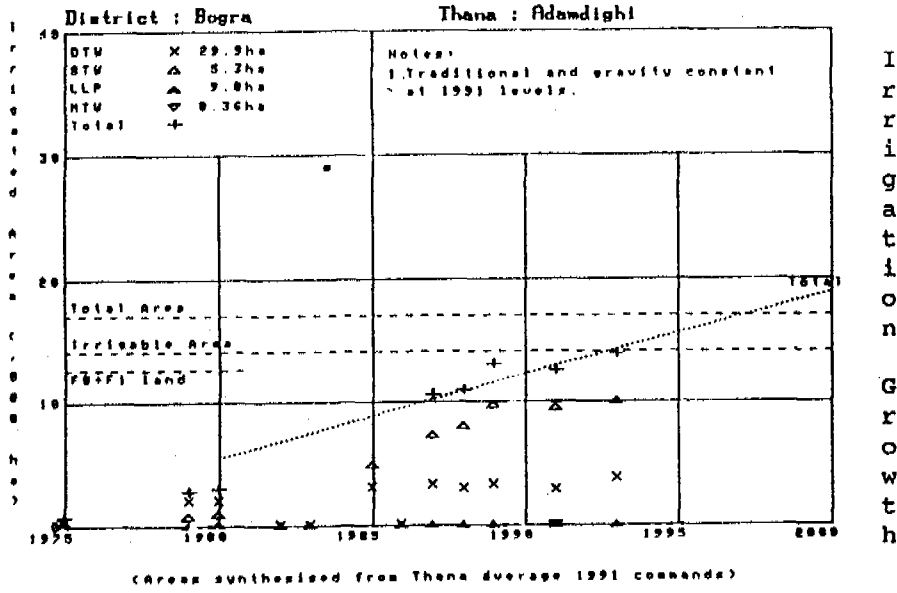


Average Depth to Water (m)

DFHE (deepest 1991): 8.9  
 BADC (deepest 1991): .  
 BWDB (deepest 1992): 8.8

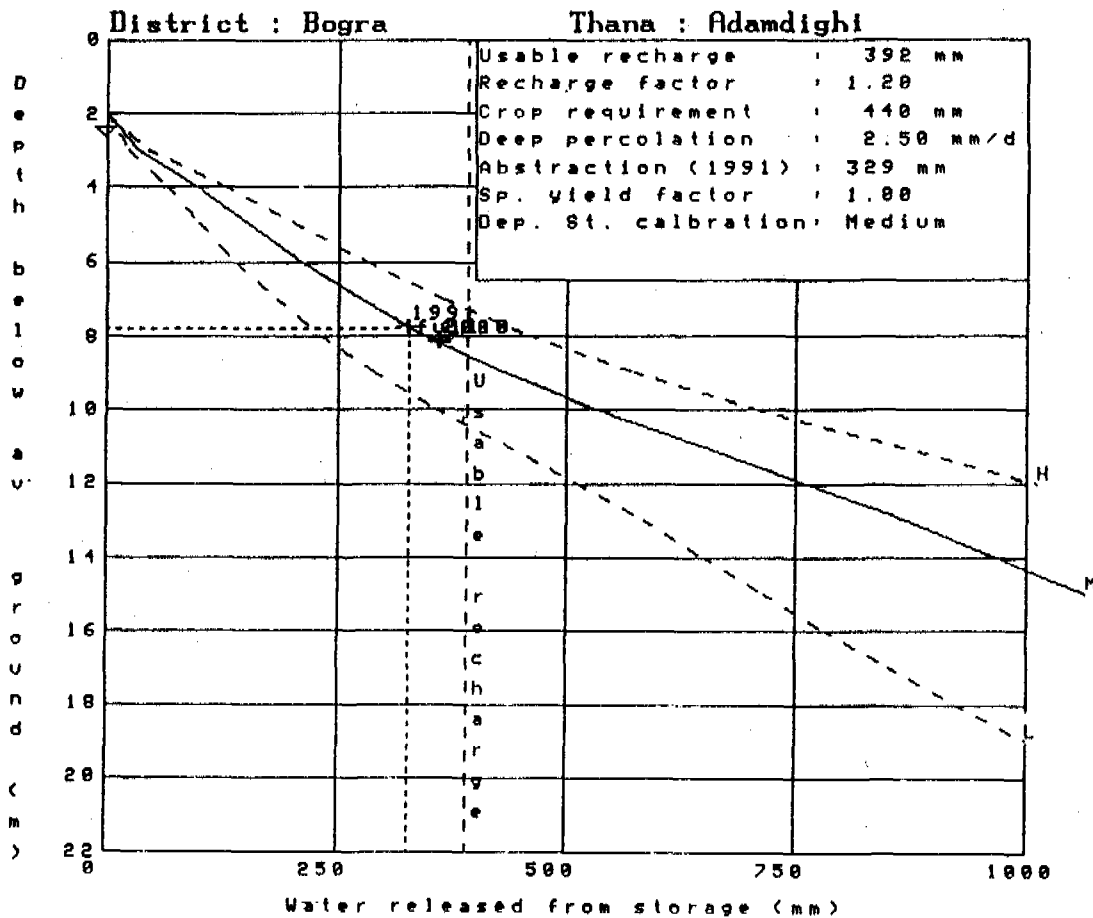
Design Depth to Water (m)

Present maximum : 9.0  
 For calibration(1991)  
 Early dry season: 2.5  
 Late dry season : 7.8



FUTURE REQUIREMENTS FOR HAND PUMP TECHNOLOGIES

Year	Depth to Water (m)	Net GW Abst. (mm)	Recommended Hand Pump Technology
Present	9.0	329	Tara
1995	8.2	363	Tara
2000	8.2	363	Tara
2010	8.2	364	Tara
Full development	8.2	363	Tara



Comment:

Ten Years Depth to Groundwater Hydrograph

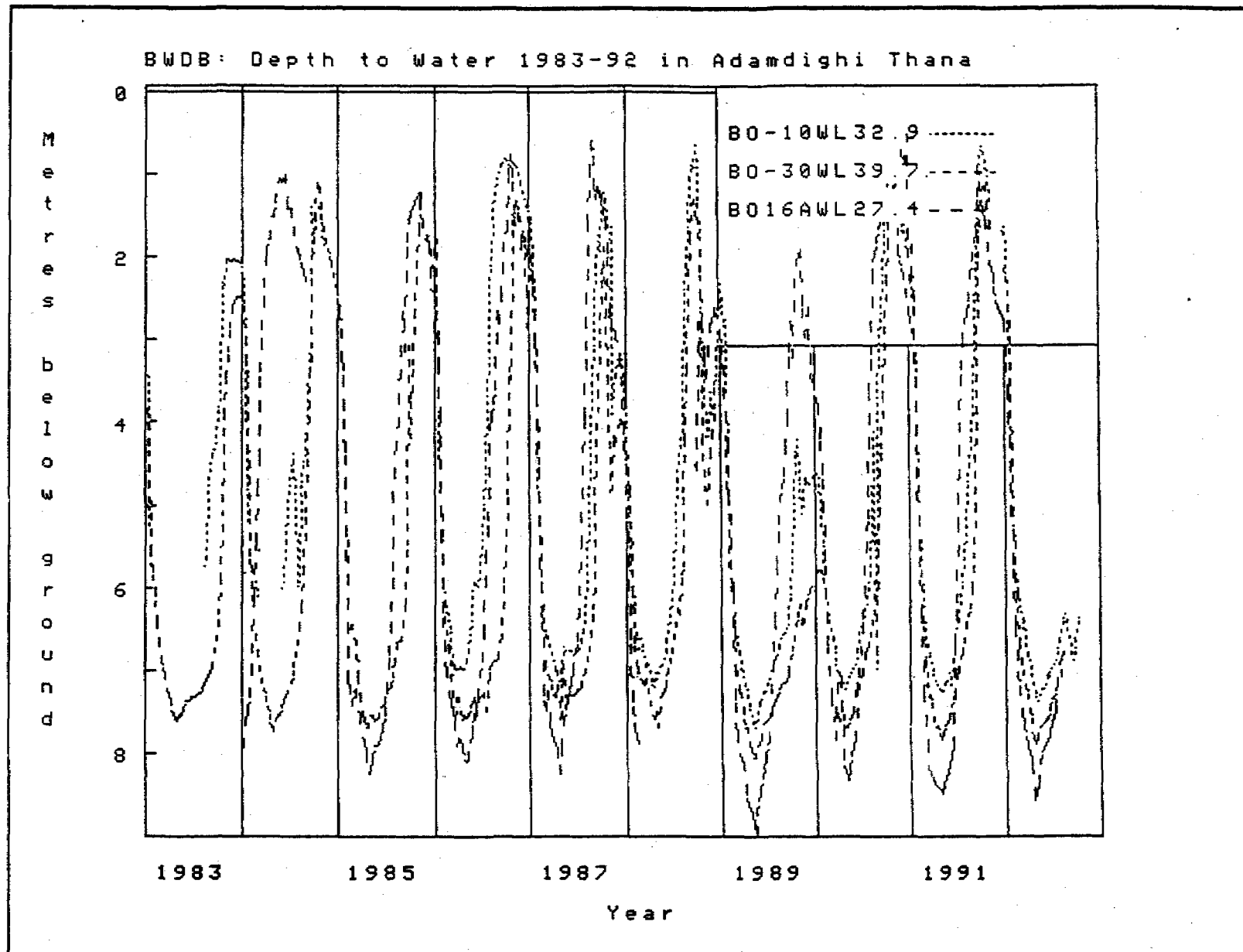


Figure 1.5

One Year Depth to Groundwater Multiple Hydrograph

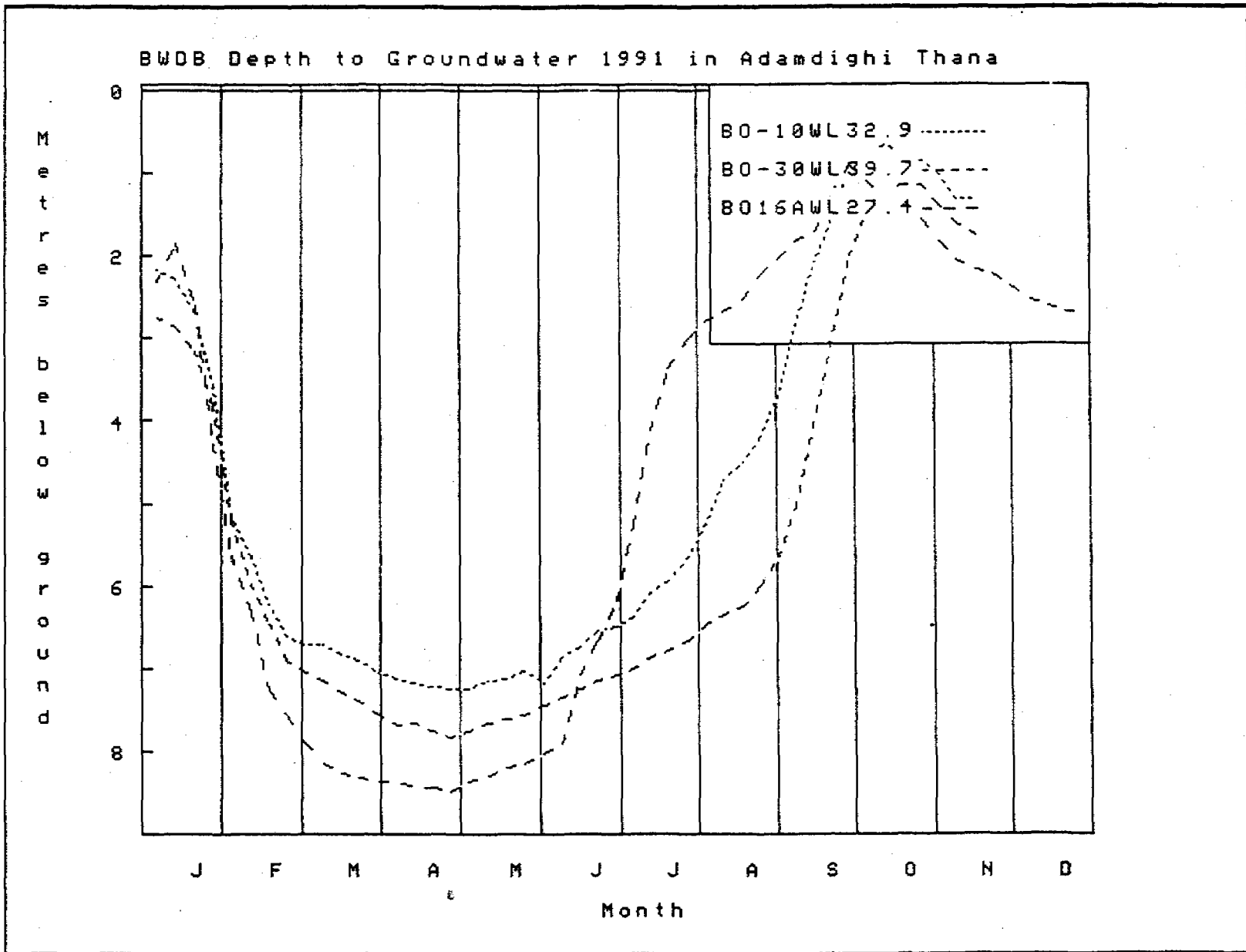


Figure 1.6

Depth/Storage Calibration

District : Bogra

Thana : Adamdighi

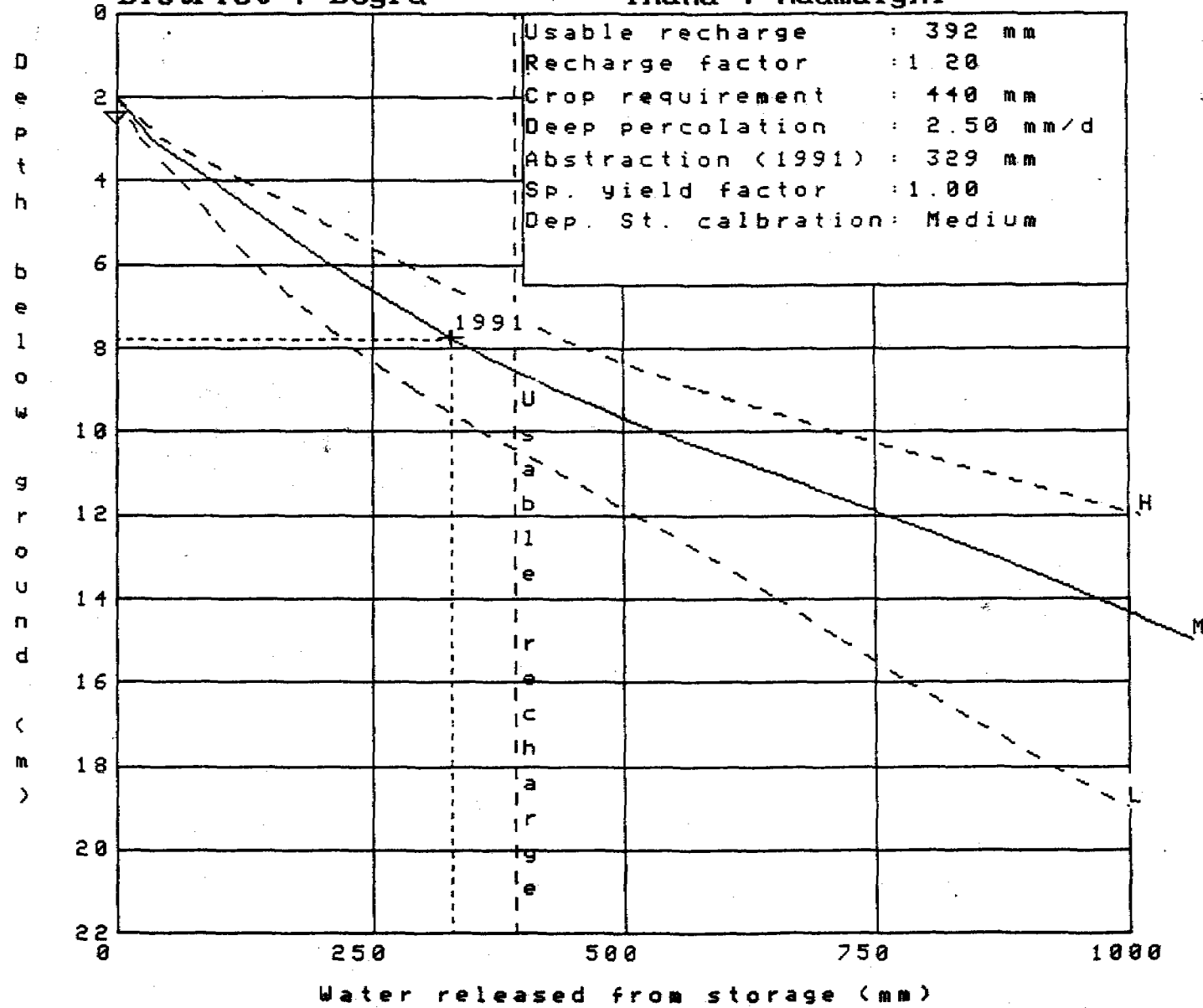
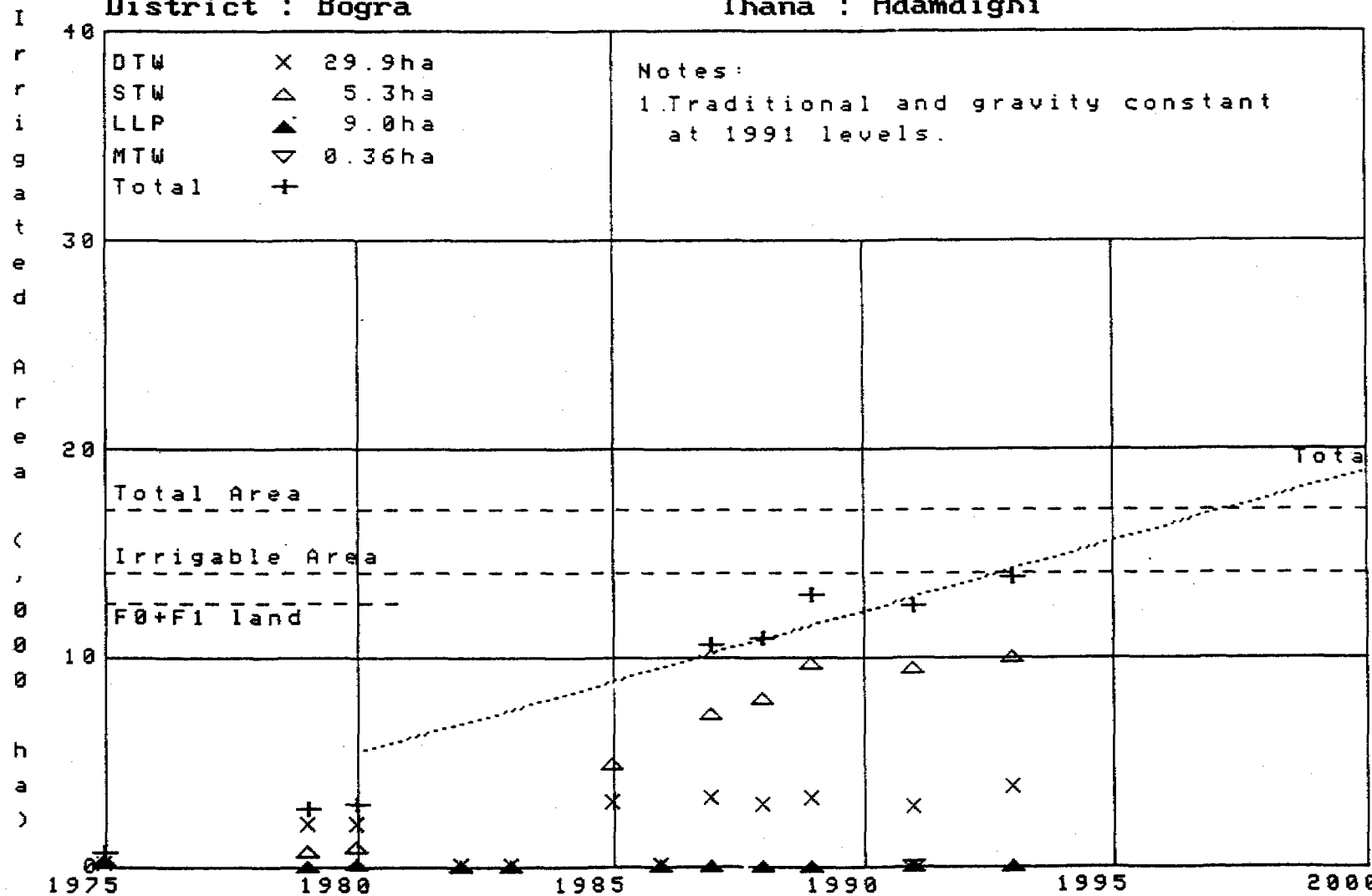


Figure 1.7

### Growth of Minor Irrigation

District : Bogra

Thana : Adamdighi



(Areas synthesised from Thana average 1991 commands)

Figure 1.8

Predicted Water Levels in Adamdighi

District : Bogra

Thana : Adamdighi

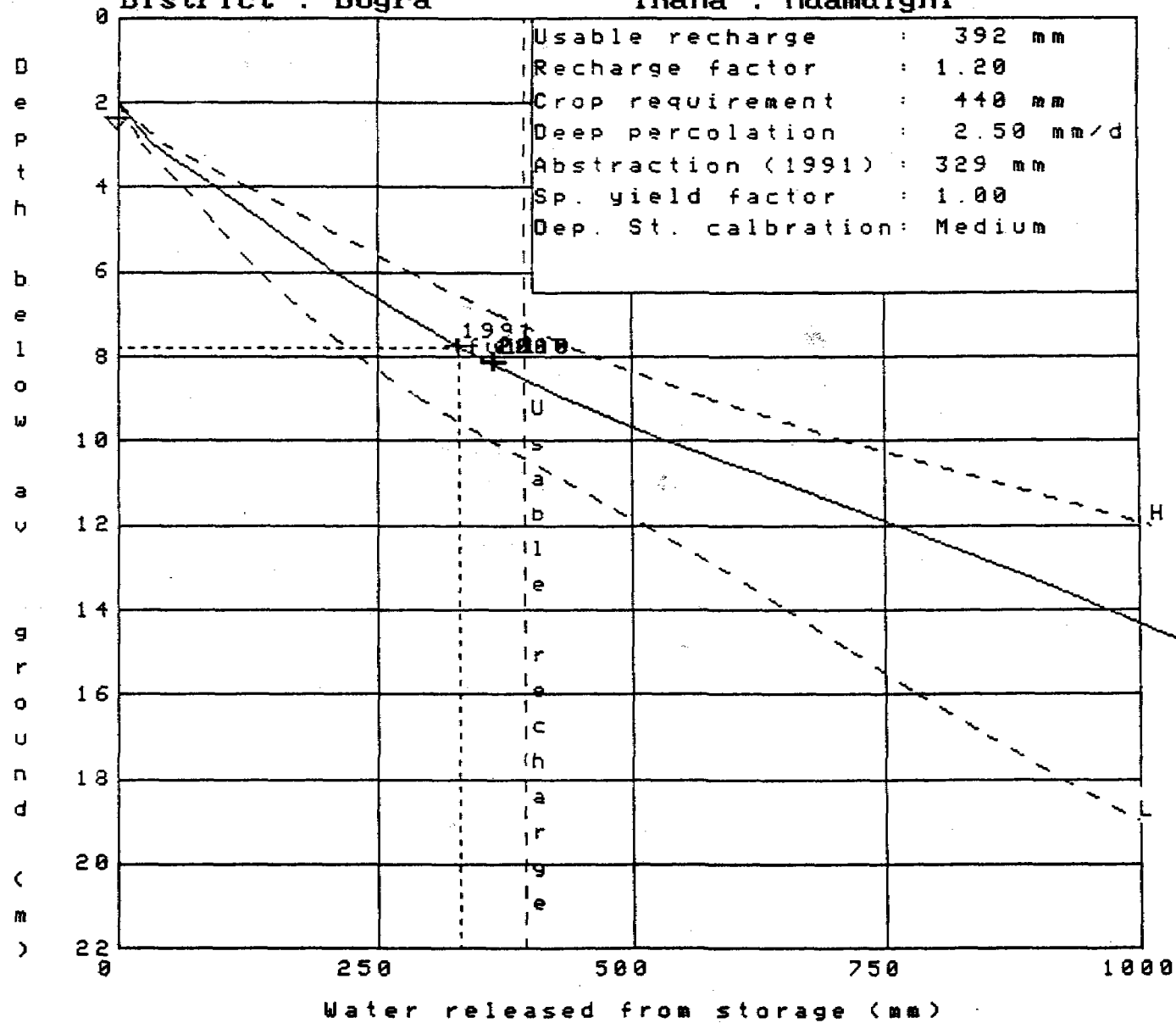


Figure: 1-9