2.2 Historic Development of Minor Irrigation

Tubewell irrigation in Bangladesh started in the mid 1960's with the introduction of 385 deep tubewells in Thakurgaon District. During the 1970's tubewell development was mainly controlled by BADC. The use of shallow tubewells become widespread in the 1980's and a rapid expansion occurred when controls on STW development were lifted in 1986.

The development of minor irrigation in the NW region is shown below for the period from 1985 to 1991. The information was derived from a variety of sources, including the MPO and AST/CIDA.

Table - 1 Development of Minor Irrigation in NW Region

Mode Number of operating minor irrigation units

	1985	1986	1987	1988	1989	1991
DTW	7038	-	6958	-	8561	7360
STW	79227	76368	83616	94211	115871	136652
LLP		4671	4879	4754	5178	4877

The data clearly indicate that the increase in minor irrigation development relates mainly to the rapid increase in the number of STW since 1986 (79% increase).

Table 2 shows the development of minor irrigation for the period from 1986 to 1991 for the 70 thanas which were subjected to re-assessment of groundwater resource potential. Data on shallow tubewells (STW) and low lift pumps (LLP) were derived from the Agricultural Sector Team data (AST/CIDA), while deep tubewell (DTW) data was based on BADC data for 1987 and 1989, on AST/CIDA data for 1991.

In some thanas a marked decline in the number of DTW can be observed between 1989 and 1991. The reasons for this decline are not clear, but may in part relate to the fuel crisis faced during the Gulf war in 1991. A marked increase in STW can be observed from the table, with a total for the 70 thanas of 58 163 in 1986 and 96 886 in 1991 (an increase of about 66%). The growth in the number of STW is, however, not evenly spread throughout the region. The most rapid expansion has occurred in Bogra District (83%), parts of Natore District (101%) and Sirajganj District (138%). A decline of STW numbers can be observed in Nawabganj District and parts of Rajshahi District where aquifer conditions are clearly unfavourable for STW development. Both the DTW and the LLP statistics indicate that their number have remained approximately constant over the past 5 years.

Table 3 shows an extract from the 1988/1989 AST census data for STW. The 1989 dry season extended well into May and irrigation requirements were high. The additional decline in groundwater levels required the conversion of many of the STW into deep set STW (DSSTW), particularly in parts of Naogaon, Pabna and Rajshahi Districts. For all 70 thanas an average of 11.5% of STW were deep set in 1989. The 1991 data shows a significant reduction in the number of DSSTW (only 3% of total).

Low lift pump irrigation is generally of minor importance in the studied thanas. The extent of surface water irrigation in 1991 (including traditional irrigation) is shown in Table 4. The average extent of surface water irrigation for all 70 thanas was only 3% of net cultivable area, while this was 30.8%

for groundwater irrigation. In two thanas the area irrigated by surface water exceeds 10% of net cultivable area. These are thanas Gomastapur in Nawabganj (11.8%) and Manda in Naogaon (12.6%).

Table 5 shows an extract from the 1991 AST/CIDA census. The area irrigated by suction mode units (STW and DSSTW) represents 74% of total irrigated area. The area irrigated by DSSTW represent 2.9% of the area served by suction mode units. In 1989 this was about 11.5%. The 1991 census also gives information on command areas for the different types of minor irrigation equipment. Command areas for DTW show a very large range from 4.9 to 35.9 ha with a mean for all DTW of 20.5 ha. For STW the range is from 1.5 to 6.0 ha with a mean of 4.1 ha.

Figure 1 shows the thanas for which analysis was carried out together with percentage of the NCA covered by minor irrigation in 1991. Irrigation coverage is over 50% on the northern part of the Lower Atrai, reducing to less than 25% in the Mohananda and parts of the Teesta.

3. Groundwater Resource Development Potential

3.1 Previous Estimates

National Water Plan Phase I

The first comprehensive national/regional assessment of groundwater resources in Bangladesh was undertaken within the first phase of the National Water Plan. The optimum development of groundwater was derived by the Master Plan Organisation (MPO) with the use of a variety of simulation models. These models have a number of built-in constraints, which are:

- **Recharge**

  Potential recharge, defined as the maximum possible rate of recharge to an infinite sub-surface reservoir was taken as the upper limit of resource potential. The recharge was related only to natural sources such as rainfall and flooding and did not take account of the recharge from surface water irrigation return flow.

  The potential recharge is sensitive to a number of key parameters. These include the deep percolation characteristics of the sub-soil, the rainfall during the pre-monsoon and monsoon season, and the extent and depth of flooding. The extent of flooding is closely associated with the flood phase distribution.

  Within the analysis procedures of the MPO different recharge types are defined, viz. usable recharge and available recharge. Usable recharge was taken as 75% of the estimated mean potential recharge, this reduction to allow for prediction uncertainties. Available recharge is an areal modification of the usable recharge values to account for development constraints such as groundwater salinity, topography, etc.

- **Pump and Well Technology**

  The main constraint for suction mode technology such as used by shallow tubewells (STW) and deepset shallow tubewells (DSSTW) is the maximum allowable or operational depth to pumping level. The depth was set at 7.0 m for STW and 9.0 m for DSSTW, assuming a 2.0 m deep pit. It should be borne in mind that this is an

average setting value and should probably be seen in the context of F2 or F3 land. Deeper settings (pits) are known to exist in various parts of the Atrai basin. Deeper pits are common in other countries (Pakistan/India). Assuming a setting of 4.0 m below ground level makes a considerable impact on the available resource. The deeper pits, which will require lining, should perhaps be viewed in the context of the higher lands.

For DTW no suction lift constraint exists but limits were based on the general setting of the pump intake at 20 m below ground surface. This is common for many existing wells, there is, however, generally no reason to exclude greater depth settings for the pump intake. The implication would mean higher development costs and the possibility of new wells affecting existing wells which had the 20m setting.

- **Hydraulic Constraints of the Aquifer System**

Low aquifer transmissivity will cause excessive draw-down in the tubewell if high abstraction rates are used. The use of low capacity pumps may be possible under these conditions, although economic viability may become a constraint.

A high hydraulic resistance of the clay layers, which overly the aquifer in most of the country, can constrain the vertical downward leakage (recharge) to the aquifer to the extent that it is less than the rate of potential recharge (see above). In the majority of the country this forms no serious constraint for force mode units.

The hydraulic resistance, if high, can cause important hydraulic head differences between the water table and the piezometric level in the aquifer, which adds to the depth to the pumping level in the wells.

- **Groundwater Salinity**

Groundwater salinity forms no constraint in the Northwest Region.

- **Additional Constraints Imposed by the MPO**

The MPO have introduced additional planning constraints, which reduce the resource potential, yielding the available recharge as defined above. These include:

- adverse soil conditions, such as saline soils and peat soils;
- difficult terrain such as deep flooded and hilly areas;
- surface water irrigation projects;

Some of these constraints should be reconsidered since they are inappropriate or unnecessary in a regionally continuous aquifer, particularly those related to terrain and to surface water irrigation projects. Terrain irregularities are not always grouped in one large contiguous area and groundwater development may well be possible in close proximity to such classified lands. Likewise, in existing irrigated areas, there is probably scope for using groundwater to irrigate areas which are out of command of the surface water system or difficult to command. Surface water irrigation in effect enhances the groundwater resource availability.

Deep flooded areas, although not always suitable for tubewell irrigation, especially by fixed force mode units, do contribute to recharge which could be used in (and pumped from) immediately adjacent areas.

Other factors considered include:

- higher priority groundwater users(e.g. potable supplies), and
- financial and economic viability of tubewells and groundwater development, i.e. it may be inadvisable to proceed beyond the potential of suction mode units where the incremental benefits of force mode technology are small.

National Water Plan Phase II

During the National Water Plan Phase II a re-assessment of resource potential took place using additional data which had been collected from special study areas and the feedback from the significant groundwater development which had since taken place since the completion of Phase I. The potential recharge and resource potential without planning constraints were re-evaluated on a thana basis. In the assessment, account was taken of the effect of local relief differences (flood phases) on the available modes of pumping.

Table 6 gives a comparison between estimated net groundwater use in 1989/90 and the unconstrained resource potential as prepared by the MPO. For a significant number of thanas (those shown shaded in Table 6) the present groundwater use exceeds the MPO limits of DSSTW resource potential, this despite the fact that large numbers of STW are in operation in the study area. There are several factors to be considered in this context, but primarily the main questions relate to the actual abstraction characteristics of the groundwater abstraction units, depending on:

- rainfall characteristics;
- crops grown;
- working efficiency of the units;
- availability of fuel/power, and
- deep percolation characteristics of the soils;
- the integrity of the 25% reduction in estimated values between potential and usable recharge.

In the comparison it was assumed that one suction mode units irrigates 4.05 ha (10 acres) while a force mode units irrigates 19 ha (47 acres). The command areas were derived from the 1991 census data, and are the approximate average for the 70 thanas for which a re-assessment of resource potential was made.

The cause of the difference between present groundwater use and MPO's estimate of suction mode potential is attributed to the rather conservative estimates of a number of key parameters that dictate the results of the various groundwater models. The parameters related to the groundwater models are associated with the:

- estimation of effective rainfall;
- thickness of the upper clays;
- depth dependent specific yield values, which are likely to be underestimated;
- transmissivity values;
- hydraulic resistance of the upper clays, which appears to be generally over-estimated.

3.2 Revised Estimates of Resource Development Potential

3.2.1 General

The groundwater resource potential was re-evaluated during NWRS using similar modelling techniques as those developed by the MPO.

The assessment of the resource potential without planning constraints has taken account of existing surface water irrigation. The impact of different degrees of flood control on the potential recharge and thus the upper limit of the resource availability was also assessed.

3.2.2 Effect of Flood Control on Potential Recharge

The implication of flood control on potential recharge was evaluated with a recharge model which simulates recharge from natural sources.

In the recharge model, which is similar to the MPO model described in detail in Technical Report Volume 5 of the National Water Plan Phase I, synthesised flood hydrographs were used to represent three basic conditions; no flood control, full FCD and partial protection. Each hydrograph, shown in Figure 2 was kept constant for each of the 17 years which cover the simulation period. Rainfall was allowed to vary and was based on rainfall records for the historical period from 1972 to 1988.

The results of the model simulation are shown in Table 7. The difference between no flood control and full FCD is very marked particularly for thanas which have a large proportion of F1 land, which, under full FCD is assumed to be fully protected from flooding. The difference between no flood control and partial protection is only minor.

The reduction in potential recharge, although dramatic, should, however, not be directly related to a reduction in groundwater resource potential, since other factors such as land availability and well technology often control the limits on resource development, as will be shown in Section 3.2.3.

Another effect of full FCD will be the increased sub-surface drainage from high land to low land areas. Particularly in the northern part of the region, where soils are permeable and the water transmitting properties of the aquifer are very good, this enhanced drainage may significantly increase the requirement for irrigation of HYV T Aman.

3.2.3 Assessment of Groundwater Potential for Different Flood Control Options

The groundwater development potential was re-evaluated for 70 thanas using the following procedure:

- If 1989 development levels were less than the development limits defined by the MPO, the MPO data was used without change.

- If 1989 development levels were found to be in excess of the MPO limits, a revised limit for Mode 1 development (ie suction mode possible on all land) was calculated as follows:

RSML = NGWU + (MPODSSTW-MPOSTW) * (1 - %DSSTW*0.01)

where

RSML	-	revised suction mode limit for F0 land
NGWU	-	net groundwater use in 1989
MPODSSTW	-	MPO development limit at which DSSTW can no longer operate on F0 land
MPOSTW	-	MPO development limit at which STW can no longer operate on F0 land
%DSSTW	-	proportion of total suction mode units which are deep set {the value is variable since it depends to a large extent on the amount of water which manages to recharge the aquifer in the previous monsoon season}.

- The development limits for the additional flood phases were derived from the revised suction mode limit for F0 land by adding the incremental development potential as derived by the MPO.

The results of the analysis are shown in Tables 8 and 9 for conditions with and without flood control.

Table 8 shows the upper limits of groundwater resource development potential for no flood control and partial protection. The maximum development level is expressed as a percentage of the area available for irrigation. For full irrigation coverage this percentage is thus 100. For partial development the constraint to full development is indicated by shading. Constraints can relate to usable recharge, to pumping limits for force mode units or to water table limits for village hand tubewells fitted with Tara pumps.

Table 9 shows the upper limits for full FCD conditions. The thanas for which the upper limit of resource potential is reduced are marked in the table. The maximum development level is compared with the case of no flood control. The reduction in resource potential is in all cases caused by the reduction in usable recharge.

The maximum development limits are further shown in Figures 3 and 4. Figure 5 marks those thanas that will be affected by full FCD. It should be noted that the low development limit of Nandigram is related to non-availability of data to define the potential recharge. It is likely that development limits are as high as the adjacent thanas.

The development limits that can be reached by suction mode development are generally unaffected by the flood control measures since their upper limit is below that of force mode units.

Analysis of the behaviour of groundwater levels under different flood conditions, has led to the following main observations:

- Groundwater levels are a close reflection of flood levels during the monsoon season when so-called 'aquifer full' conditions occur. With flood control and consequent reduction in flood levels, the groundwater levels will also show a reduction in level

similar to that of the flood levels.

- During the early part of the dry season (October to January) groundwater tables recede to levels in January which are nearly identical.

- In the latter part of the dry season, which coincides with the main irrigation season, virtually no difference in groundwater levels are observed for no flood control or full FCD conditions and pumping costs are thus not affected.

Figure 6 illustrates the generalised behaviour of the groundwater table under natural and full FCD conditions.

4. Groundwater Development in Project Areas

4.1 Introduction

The future development of minor irrigation was assessed for the 21 project areas listed in Table 10. The growth of minor irrigation was determined as follows:

- Future growth rates were based on an extrapolation of the historic growth rates for STW, available for individual thanas. It was also assumed that the number of DTW and LLP will not change.

- Limits of suction mode development were derived from the re-assessment of groundwater resource potential for the 70 selected thanas.

- Upper limits of groundwater development potential were also derived from the re-assessment of potential, for no flood control and full FCD conditions.

- The baseline conditions for the analysis were the 1989 estimates of the number of tubewells, and the 1991 estimates of command areas and existing surface water irrigation. Data were allocated from thanas to project areas on a straight proportional basis.

- It was assumed that there is no change in the area irrigated from surface water. The main surface water irrigation projects within the study area include the Pabna Irrigation Project, the Kurigram Irrigation Project and the Buri Teesta scheme. The Kurigram Project (north and south units) already has significant small scale irrigation coverage which is likely to expand. The proposed surface water developments through either major river pumping stations or a barrage will take time to be implemented; in the meantime small scale irrigation development is likely to continue within the Project's FCD area. Small scale irrigation is also likely to continue within the protected Pabna FCD area for the land areas not commanded by the Phase I pumping station at Bera.

  When the Teesta Irrigation Project comes on stream and the large areas come under irrigation from the barrage a transition to surface water supplies will need to be allowed for. Since the scheme is predominantly one for supplementary irrigation the potential for conjunctive use will need to be fully explored. In the meantime, continued small scale irrigation development can be assumed necessary, particularly

with the use of STW units whose effective life is only 5 to 7 years.

4.2 Estimated Growth Rates

Table 11 shows the historical growth rates for STW for 70 upazilas and the projected rates used in the assessment of future growth of minor irrigation in the project areas. The projection to the year 2007 (15 year planning period) is complicated by the following factors:

- In a large number of thanas the upper limit of resource development potential can only be reached with the use of force mode technology. This implies that when the development levels reach the cut-off level for suction mode technology, a large scale replacement of suction mode units by force mode units will be required. The cost implications to the private sector are enormous considering that the cost, per unit abstraction of water, of low capacity force mode tubewells is, at 1992 prices, more than 6 times higher than suction mode tubewells. The implications on growth rates once development levels go beyond the limit of suction mode technology is uncertain.

- The use of lined pits for STW may allow for deep setting to a depth of 4 to 5 m. It is likely that this option will be favoured for cost reasons since the increase in the price of such STW is only some Taka 10 000.

- In the northern part of the region boro irrigation is constrained by the occurrence of highly permeable soils. In these areas soils cannot be easily puddled and consequently irrigation efficiencies are low to the extent that STW irrigation is uneconomical. The relatively low historic growth of STW irrigation, despite the very high groundwater resource availability, may bear witness to these constraints. Low growth rates for STW of 5% relative to 1989 development levels were used.

- In the Mohananda basin a decline in the number of shallow tubewells has occurred, which is mainly attributable to the poor aquifer conditions in the area. A near zero growth rate of suction mode technology was therefore assumed for this area.

4.3 Projection of Development

Figures 7 to 14 and Table 12 show the projected minor irrigation development in the 21 project areas. The graphs show projections based on historic growth rates for the planning period upto year 2007. Also indicated are the estimated limits with regard to the use of suction mode technology and the maximum limits of resource development potential for no flood control and full FCD conditions. For partial flood protection conditions closely approximate those for no flood control.

4.3.1 Growth in Small Scale Irrigation Development from Present to 2007

The growth in small scale irrigation basically relies on the perceived needs of the private sector. Their take up of irrigation equipment is dependent upon many factors which includes:

- the price of irrigated crops, principally rice;
- the cost of irrigation equipment;
- availability of water resource;

- availability of suitable land for irrigated agriculture;
- alternative sources of earnings open to farmers.

Each of these factors in itself is a complex topic which is governed by many other controlling influences e.g.

- subsidy levels particularly of irrigation equipment;
- fuel costs, and the costs of other agricultural inputs;
- agricultural performance in the monsoon season;
- groundwater zoning restrictions;
- conflict of interest for the same water resource.

For most development modes there is an initial slow start to development. This then quickens as the concept of the mode of development is understood and the market developed and efficient sale and servicing culture. Prices of equipment fall and operation and maintenance becomes a common and reasonably efficient system. This growth rate can be increased by the application of subsidies or reduced by the application of taxes or zoning restrictions.

It becomes apparent that future predictions become a complex and difficult exercise. Irrigation in the past has been dominated by the small scale irrigation sector, particularly in the north west region of the country. In the last few years shallow tubewells have been the most popular source for irrigation water showing very high growth rates. This has been primarily due to the fact that the units are cheaper, easier to operate and maintain than DTWs and are more convenient and, on a per unit, cheaper than LLPs. It is unlikely that these conditions will continue through to 2007 since the scope for suction mode units is more limited than DTWs whilst in the future it is proposed that subsidies will be removed from DTWs making them a more expensive investment per unit area commanded.

Ideally every thana should be considered separately for the likely development scenarios assuming different marketing and pricing policies which might come into play in the future. An approximate approach is to assume that in the near future farmers are likely to continue with the development of STW based irrigation as long as the water resource is available. With the advent of the National Minor Irrigation Development Project and the policy of the Government to remove subsidies on DTWs (force mode units) it is likely that STWs will be an even more popular option. As tubewell development progresses, the natural baseflows in the river system is unlikely to increase, hence LLP development must be seen in most of the region to be at a development limit. The preference of farmers for STW rather than LLPs further strengthens this assumption.

Because of the preference of farmers for small manageable units and the lower financial implications, STWs must be assumed to be the main development mode in the near future, perhaps until after the turn of the century. STW development will rely more and more on deep-setting techniques both to enable STW development in marginally suited territory and to enable the units to cope with adversely dry years when resources are limited; this will normally follow a dry monsoon year such as 1992.

In most of the area STW deployment growth rates have been relatively high in the last few years because of the advent of the cheaper chinese equipment which has entered the market place. It is taken to be a valid assumption that in most parts of the region that irrigation development in the near future will continue to be dominated by further fielding of STWs. Hence, the development in each area will be dictated by the groundwater resource potential more than any other factor. If the groundwater resource estimated to be available is sufficient to enable STW to continue at the current growth rate to the year 2007, then this is likely to be a realistic prognosis. If resources are inadequate, then it is likely that irrigation development in such areas will slow down and tend to stagnate at the suction

mode limit (normal DSSTW limits, say 2m pits) unless heavy subsidies are re-introduced for force mode units.

5. Gaibandah Improvement Project

Transmissivity values are generally very high ranging from 2000 m^2/d in the northwest of the project area to over 4000 m^2/d along the edge of the River Jamuna.

The physiography is dominated by two physiographic units, the Lower Teesta Flood Plain with medium to medium-fine textured soils and the Old Teesta Flood Plain with medium textured soils. The latter unit occurs mainly adjacent to the River Teesta.

Groundwater resource development potential is excellent due to the potential recharge, excellent aquifer transmissivities and storage properties. The MPO (WRPO) resource assessment studies have indicated that large scale groundwater development in the area is possible with suction mode technology.

The historic growth of groudwater irrigation has however not been as high as in the Atrai Basin and most parts of the Bogra District. The 1989 minor irrigation statistics indicate that only about 25% of NCA is irrigated from groundwater. Development growth rates of STW based irrigation have been about 5 to 7% per annum over the past 5 years. The relatively slow rate of expansion of minor irrigation is probably attributable to high infiltration rates and permeabilities of many of the soils of the area giving rise to low irrigation efficiencies and hence poor financial returns to the farmers.

The projection of future minor irrigation development in the area has been based on historic growth rates. This has resulted in a growth from about 14,000 ha in 1989 to 24,000 ha in 2007. The increase can be totally supported by suction mode tubewell technology (i.e STWs).

The implications of flood control on net groundwater resource availabilities is negligible since total availability exceeds the net requirement for all the irrigable area.

A major point of concern, an issue already discussed in section 3.2.2, is the enhanced drainage from high land to low land during the monsoon season in the situation where FCD is introduced. Given the high permeability of the sub-soil, and hence potentially high deep percolation flows, and the excellent water transmitting properties of the aquifer, irrigation of extensive areas of t. aman may be required. Wherever irrigation of a t.aman crop is undertaken, then there is the likelihood that the dry season irrigation resource will be reduced thereby affecting the extent of HYV boro irrigation which is possible. This impact may be to some extent mitigated by the option of compartmentalisation for the Gaibandha project.

Table 2 Development of Minor Irrigation

Code	Thana	District	DTW			Shallow Tubewell Numbers					Low Lift Pump Numbers				
			BADC		AST	Agricultural Sector Team					Agricultural Sector Team				
			'87	'89	'91	'86	'87	'88	'89	'91	'86	'87	'88	'89	'91
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
2	Adamdighi	Bogra	92	96	94	1132	1222	1370	1479	1796	0	0	0	0	0
85	Bogra	Bogra	103	110	110	2441	2670	2639	2931	3891	15	15	30	33	6
142	Dhunot	Bogra	4	13	1	2353	2394	2488	2630	3733	54	55	58	71	93
149	Dupchachia	Bogra	142	147	157	681	788	923	1179	1445	14	14	14	14	0
167	Gabtali	Bogra	84	82	142	1805	1913	2239	2304	2899	6	12	13	19	24
227	Kahalu	Bogra	207	215	246	455	558	823	984	1274	0	0	0	0	0
355	Nandigram	Bogra	118	120	98	1169	1389	2053	2582	3134	19	19	0	0	0
439	Shariakandi	Bogra	13	17	10	968	1039	1226	1324	1622	6	5	63	71	36
452	Sherpur	Bogra	6	8	4	1520	1669	2146	2551	3501	117	123	108	110	130
455	Shibganj	Bogra	272	274	264	1407	1429	578	958	2571	27	29	6	5	1
466	Sonatola	Bogra	18	28	25	950	1018	1493	1602	1419	12	14	11	23	4
169	Gaibandha	Gaibandha	88	93	81	1478	1641	1563	1690	1710	48	56	63	67	61
177	Gabindaganj	Gaibandha	163	172	57	1917	1960	1990	2341	2880	67	72	75	86	33
380	Palasbari	Gaibandha	68	68	65	798	844	782	885	1281	23	21	19	18	20
428	Sadullapur	Gaibandha	75	71	61	828	890	951	1022	1130	22	31	26	22	24
429	Shaghata	Gaibandha	47	50	33	1296	1378	1557	1493	1696	73	64	61	54	34
475	Sandarganj	Gaibandha	55	59	57	1301	1441	1345	1481	1522	24	27	23	27	5
7	Akkelpur	Joypurhat	88	82	90	476	427	719	915	1066	11	12	1	1	0
107	Chilmari	Kurigram	21	28	19	369	341	290	314	321	0	0	1	1	0
283	Kurigram	Kurigram	32	32	40	410	432	466	515	550	15	21	9	13	11
408	Rajarhat	Kurigram	21	32	42	396	438	444	537	630	1	1	3	4	1
497	Ulipur	Kurigram	52	67	64	764	869	875	1001	994	4	3	4	6	4
3	Aditmari	Lalmonirhat	20	24	27	343	391	436	481	592	34	33	34	41	31
202	Hatibandha	Lalmonirhat	11	15	14	143	151	204	239	285	5	5	3	2	1
240	Kaliganj	Lalmonirhat	11	20	25	337	345	305	311	302	5	5	3	2	1
291	Lalmonirhat	Lalmonirhat	25	36	45	363	414	453	537	635	31	34	45	49	67
19	Atrai	Naogaon	0	1	1	1540	1778	2110	2490	2916	246	284	494	528	379
22	Badalgachi	Naogaon	54	123	96	438	488	858	979	1068	8	13	35	32	12
307	Manda	Naogaon	63	187	117	1039	1078	1123	1000	901	151	175	218	233	218
324	Mohadebpur	Naogaon	124	263	104	916	871	1076	1075	1399	23	26	20	25	23
357	Naogaon	Naogaon	36	47	53	1572	1676	1726	2012	1874	65	74	73	64	53
369	Niamatpur	Naogaon	13	0	32	466	558	504	540	400	19	26	40	41	16
400	Porsha	Naogaon	8	79	26	159	153	130	127	193	154	129	171	150	219
419	Raninagar	Naogaon	94	97	94	1895	1758	2020	2468	2765	87	86	104	119	68
24	Bagatipara	Natore	22	31	37	116	99	127	143	112	15	12	9	15	7
48	Baraigram	Natore	65	67	4	798	871	874	935	622	6	6	15	16	1
192	Gurudaspur	Natore	8	15	8	522	587	1143	1229	1380	121	137	40	21	19
363	Natore	Natore	81	34	96	869	1131	1923	2460	2306	173	136	97	65	93
462	Singra	Natore	27	34	23	3645	4336	4918	5758	6489	83	96	123	137	54

Table 2 Development of Minor Irrigation (Continued)

Code	Thana	District	DTW			Shallow Tubewell Numbers					Low Lift Pump Numbers				
			BADC		AST	Agricultural Sector Team					Agricultural Sector Team				
			'87	'89	'91	'86	'87	'88	'89	'91	'86	'87	'88	'89	'91
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
72	Bholahat	Nawabganj	32	128	10	214	186	111	67	145	14	8	6	9	12
181	Gomastapur	Nawabganj	21	114	19	576	582	438	455	300	221	229	213	283	320
346	Nachole	Nawabganj	8	87	7	191	191	73	85	66	50	52	52	54	69
366	Nawabganj	Nawabganj	40	128	34	310	284	310	383	273	87	98	123	140	122
456	Shibganj	Nawabganj	80	232	66	363	453	578	958	530	61	77	29	21	16
144	Dimla	Nilphamari	3	5	8	524	541	444	551	691	35	39	5	18	38
212	Jaldhaka	Nilphamari	7	14	7	384	420	257	299	274	11	7	2	0	0
266	Kishoreganj	Nilphamari	7	15	7	432	449	310	310	499	11	11	7	4	0
45	Bhangura	Pabna	2	3	51	618	756	991	935	978	4	9	15	15	9
103	Chatmohar	Pabna	10	20	33	825	1091	1363	1772	1058	18	18	13	13	12
156	Faridpur	Pabna	2	2	2	686	750	912	1147	921	87	75	119	136	79
29	Bagmara	Rajshahi	44	53	44	775	940	1267	1713	1452	428	489	616	653	451
153	Durgapur	Rajshahi	1	8	12	342	402	783	1114	1178	87	88	58	84	80
178	Godagari	Rajshahi	58	184	50	398	385	445	470	507	43	40	45	47	27
328	Mohanpur	Rajshahi	34	38	41	266	304	320	391	321	27	28	35	53	78
373	Paba	Rajshahi	30	39	26	383	389	438	578	660	42	51	43	59	178
402	Puthia	Rajshahi	80	220	37	363	453	518	838	765	61	77	132	124	114
481	Tanor	Rajshahi	40	175	85	618	598	1079	1166	274	49	48	22	22	18
182	Gangachara	Rangpur	22	30	23	480	475	446	457	520	8	8	3	3	3
254	Kaunia	Rangpur	42	43	44	426	494	468	544	628	19	22	15	13	3
277	Rangpur	Rangpur	98	133	148	818	824	893	962	1187	46	39	41	42	46
397	Pirgacha	Rangpur	136	141	138	1000	1046	1054	1181	1354	69	68	58	43	34
399	Pirganj	Rangpur	104	126	133	544	580	630	865	1387	34	40	29	29	20
61	Belkuchi	Sirajganj	1	2	2	366	479	624	959	958	3	6	3	6	5
243	Kamarkanda	Sirajganj	8	11	6	207	230	364	658	849	1	2	0	0	0
255	Kazipur	Sirajganj	134	139	39	467	469	757	1177	1748	3	3	5	6	4
403	Raiganj	Sirajganj	175	180	86	720	850	997	1505	2010	77	89	110	143	115
430	Shahjadpur	Sirajganj	24	30	13	1763	2217	2539	2998	2980	46	48	40	47	27
463	Sirajganj	Sirajganj	178	191	147	283	395	605	931	1349	11	15	16	17	8
484	Taras	Sirajganj	5	6	2	1491	1710	1979	2521	2816	7	7	0	0	0
498	Ullapara	Sirajganj	291	197	170	1255	1469	2165	2761	2904	24	32	62	64	36
	Totals		4148	5631	4052	58163	63847	73048	86253	96886	3468	3694	4029	4333	3673

Table 3 Number of Suction Mode Units 1988/89

MPO Code	Thana Name	District	Area km²	Suction Mode Units			
				Normal	Deep set	Total	% Deep set
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2	Adamdighi	Bogra	171	1125	354	1479	23.9
85	Bogra	Bogra	407	2708	223	2931	7.6
142	Dhunat	Bogra	246	2553	77	2630	2.9
149	Dubchachia	Bogra	163	1179	0	1179	0.0
167	Gabtali	Bogra	241	2341	0	2341	0.0
227	Kahaloo	Bogra	241	983	1	984	0.1
355	Nandigram	Bogra	266	2578	4	2582	0.2
439	Sariakandi	Bogra	468	1324	0	1324	0.0
452	Sherpur	Bogra	298	2198	353	2551	13.8
455	Shibganj	Bogra	315	1600	2	1602	0.1
463	Sonatali	Bogra	101	931	0	931	0.0
169	Gaibandha	Gaibandha	321	1690	0	1690	0.0
177	Gobindaganj	Gaibandha	463	2302	2	2304	0.1
380	Palasbari	Gaibandha	194	885	0	885	0.0
428	Sadullapur	Gaibandha	233	1022	0	1022	0.0
429	Shaghata	Gaibandha	225	1493	0	1493	0.0
466	Sundarganj	Gaibandha	419	1166	0	1166	0.0
7	Akkelpur	Joypurhat	140	771	144	915	15.7
107	Chilmara	Kurigram	91	314	0	314	0.0
283	Kurigram	Kurigram	277	515	0	515	0.0
408	Rajarhat	Kurigram	181	537	0	537	0.0
484	Ulipur	Kurigram	455	2498	23	2521	0.9
3	Aditmari	Lalmonirhat	194	481	0	481	0.0
202	Hatibandha	Lalmonirhat	290	239	0	239	0.0
240	Kaliganj	Lalmonirhat	238	311	0	311	0.0
291	Lalmonirhat	Lalmonirhat	256	514	23	537	4.3
19	Atrai	Naogaon	261	2321	169	2490	6.8
22	Badalgachi	Naogaon	214	847	132	979	13.5
307	Manda	Naogaon	411	397	603	1000	60.3
324	Mohadevpur	Naogaon	393	905	170	1075	15.8
357	Naogaon	Naogaon	274	564	1448	2012	72.0
369	Niamatpur	Naogaon	448	487	53	540	9.8
400	Porsha	Naogaon	259	127	0	127	0.0
419	Raninagar	Naogaon	246	2298	170	2468	6.9
24	Bagatipara	Natore	139	129	14	143	9.8
48	Baraigram	Natore	406	795	393	1188	33.1
192	Gurudaspur	Natore	202	801	428	1229	34.8
363	Natore	Natore	404	1531	929	2460	37.8
456	Singra	Natore	528	897	61	958	6.4

Table 3 Number of Suction Mode Units 1988/89 (Continued)

Upazila Code	Upazila Name	District	Area km²	Suction Mode Units			
				Normal	Deep set	Total	% Deep set
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
72	Bholahat	Nawabganj	130	47	20	67	29.9
181	Gomastapur	Nawabganj	318	455	0	455	0.0
346	Nachole	Nawabganj	279	54	31	85	36.5
366	Nawabganj	Nawabganj	481	309	74	383	19.3
455	Shibganj	Nawabganj	525	897	61	958	6.4
144	Dimla	Nilphamari	328	551	0	551	0.0
212	Jaldhaka	Nilphamari	328	299	0	299	0.0
266	Kishoreganj	Nilphamari	264	310	0	310	0.0
45	Bhangura	Pabna	121	407	528	935	56.5
103	Chatmohar	Pabna	321	671	1101	1772	62.1
156	Faridpur	Pabna	142	1058	89	1147	7.8
29	Bagmara	Rajshahi	383	674	1039	1713	60.7
153	Durgapur	Rajshahi	196	1088	26	1114	2.3
178	Godagari	Rajshahi	448	385	85	470	18.1
328	Mohanpur	Rajshahi	164	257	134	391	34.3
373	Paba	Rajshahi	261	543	35	578	6.1
402	Puthia	Rajshahi	194	770	68	838	8.1
475	Tanore	Rajshahi	295	1481	0	1481	0.0
182	Gangachara	Rangpur	214	321	136	457	29.8
254	Kaunia	Rangpur	150	544	0	544	0.0
277	Rangpur	Rangpur	318	962	0	962	0.0
397	Pirgacha	Rangpur	266	1168	13	1181	1.1
399	Pirganj	Rangpur	414	863	2	865	0.2
61	Belkuchi	Sirajganj	155	959	0	959	0.0
243	Kamarkanda	Sirajganj	93	658	0	658	0.0
255	Kazipur	Sirajganj	370	1177	0	1177	0.0
403	Raiganj	Sirajganj	267	1505	0	1505	0.0
430	Sahjadpur	Sirajganj	349	2916	82	2998	2.7
462	Sirajganj	Sirajganj	326	5273	485	5758	8.4
481	Tarash	Sirajganj	300	333	19	352	5.4
497	Ullapara	Sirajganj	414	991	10	1001	1.0
498	Ullapara	Sirajganj	414	2541	220	2761	8.0
	Totals		20307	76824	10034	86858	11.6

Table 4 1991 Irrigated Areas

MPO Code	Thana Name	District	Area km²	NCA km²	Ratio %	Irrigated Area									
						Total				Surface			Groundwater		
						(ha)	of g	% of nca	% of nia	(ha)	of g	% of nca	(ha)	% of ga	% of nca
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
2	Adamdighi	Bogra	171	156	92	12806	74.9	81.8	100.0	66	0.4	0.4	12740	74.5	81.4
85	Bogra	Bogra	407	366	90	20874	51.3	57.0	71.2	290	0.7	0.8	20585	50.6	56.2
142	Dhunat	Bogra	246	218	89	15325	62.3	70.4	88.0	879	3.6	4.0	14446	58.7	66.4
149	Dubchachia	Bogra	163	149	91	12149	74.5	81.6	100.0	2	0.0	0.0	12147	74.5	81.6
167	Gabtali	Bogra	241	221	92	17063	70.8	77.2	96.5	257	1.1	1.2	16806	69.7	76.0
227	Kahaloo	Bogra	241	218	91	14589	60.5	66.8	83.5	49	0.2	0.2	14540	60.3	66.6
355	Nandigram	Bogra	266	244	92	16925	63.6	69.4	86.7	4	0.0	0.0	16920	63.6	69.4
439	Sariakandi	Bogra	468	345	74	8662	18.5	25.1	31.3	540	1.2	1.6	8122	17.4	23.5
452	Sherpur	Bogra	298	262	88	16956	56.9	64.7	80.9	1206	4.0	4.6	15750	52.9	60.1
455	Shibganj	Bogra	315	287	91	18597	59.0	64.8	81.0	16	0.1	0.1	18581	59.0	64.7
466	Sonatali	Bogra	101	90	89	7162	70.9	79.9	99.9	142	1.4	1.6	7020	69.5	78.4
169	Gaibandha	Gaibandha	321	273	85	8295	25.8	30.4	38.0	482	1.5	1.8	7813	24.3	28.6
177	Gabindaganj	Gaibandha	463	423	91	14288	30.9	33.8	42.3	399	0.9	0.9	13889	30.0	32.9
380	Palasbari	Gaibandha	194	174	90	6682	34.4	38.4	48.1	227	1.2	1.3	6455	33.3	37.1
428	Sadullapur	Gaibandha	233	209	90	6505	27.9	31.1	38.9	461	2.0	2.2	6044	25.9	28.9
429	Shaghata	Gaibandha	225	192	85	7510	33.4	39.1	48.9	317	1.4	1.7	7192	32.0	37.4
475	Sundarganj	Gaibandha	419	344	82	6334	15.1	18.4	23.0	210	0.5	0.6	6125	14.6	17.8
7	Akkelpur	Joypurhat	140	129	92	5633	40.2	43.8	54.7	25	0.2	0.2	5608	40.1	43.6
107	Chilmara	Kurigram	91	65	72	2174	23.9	33.4	41.7	389	4.3	6.0	1785	19.6	27.4
283	Kurigram	Kurigram	277	215	78	3790	13.7	17.7	22.1	786	2.8	3.7	3003	10.8	14.0
408	Rajarhat	Kurigram	181	163	90	4564	25.2	28.0	35.1	491	2.7	3.0	4073	22.5	25.0
497	Ulipur	Kurigram	455	354	78	6064	13.3	17.2	21.4	406	0.9	1.1	5657	12.4	16.0
3	Aditmari	Lalmonirhat	194	178	92	3304	17.0	18.6	23.2	542	2.8	3.0	2762	14.2	15.5
202	Hatibandha	Lalmonirhat	290	261	90	1797	6.2	6.9	8.6	556	1.9	2.1	1241	4.3	4.7
240	Kaliganj	Lalmonirhat	238	203	85	2692	11.3	13.3	16.6	817	3.4	4.0	1875	7.9	9.2
291	Lalmonirhat	Lalmonirhat	256	209	82	4952	19.3	23.7	29.7	1330	5.2	6.4	3622	14.1	17.4
19	Atrai	Naogaon	261	247	95	13183	50.5	53.3	66.6	2021	7.7	8.2	11162	42.8	45.1
22	Badalgachi	Naogaon	214	195	91	5769	27.0	29.5	36.9	222	1.0	1.1	5547	25.9	28.4
307	Manda	Naogaon	411	384	94	9136	22.2	23.8	29.7	4838	11.8	12.6	4298	10.5	11.2
324	Mohadevpur	Naogaon	393	360	92	5805	14.8	16.1	20.2	471	1.2	1.3	5334	13.6	14.8
357	Naogaon	Naogaon	274	253	92	11091	40.5	43.9	54.8	2193	8.0	8.7	8898	32.5	35.2
369	Niamatpur	Naogaon	448	411	92	1336	3.0	3.2	4.1	212	0.5	0.5	1123	2.5	2.7
400	Porsha	Naogaon	259	232	90	2080	8.0	9.0	11.2	1113	4.3	4.8	967	3.7	4.2
419	Raninagar	Naogaon	246	225	91	13225	53.8	58.8	73.5	1729	7.0	7.7	11496	46.7	51.1
24	Bagatipara	Natore	139	128	92	1193	8.6	9.3	11.6	104	0.8	0.8	1088	7.8	8.5
48	Baraigram	Natore	406	379	93	7245	17.8	19.1	23.9	110	0.3	0.3	7135	17.6	18.8
192	Gurudaspur	Natore	202	182	90	4677	23.2	25.7	32.1	207	1.0	1.1	4470	22.1	24.5
363	Natore	Natore	404	366	91	11635	28.8	31.8	39.7	578	1.4	1.6	11057	27.4	30.2
462	Singra	Natore	528	493	93	24565	46.5	49.9	62.3	950	1.8	1.9	23615	44.7	47.9

Table 4 1991 Irrigated Areas (Continued)

MPO Code	Thana Name	District	Area km²	NCA km²	Ratio %	Irrigated Area									
						Total				Surface			Groundwater		
						(ha)	of g	% of nca	% of nia	(ha)	of g	% of nca	(ha)	% of ga	% of nca
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
72	Bholahat	Nawabganj	130	117	90	1085	8.3	9.3	11.6	667	5.1	5.7	418	3.2	3.6
181	Gomastapur	Nawabganj	318	279	88	4695	14.8	16.8	21.0	3287	10.3	11.8	1407	4.4	5.0
346	Nachole	Nawabganj	279	263	94	1691	6.1	6.4	8.1	1455	5.2	5.5	236	0.8	0.9
366	Nawabganj	Nawabganj	481	404	84	2522	5.2	6.2	7.8	1506	3.1	3.7	1016	2.1	2.5
456	Shibganj	Nawabganj	525	473	90	2798	5.3	5.9	7.4	708	1.3	1.5	2089	4.0	4.4
144	Dimla	Nilphamari	328	292	89	2983	9.1	10.2	12.8	1467	4.5	5.0	1516	4.6	5.2
212	Jaldhaka	Nilphamari	328	301	92	2274	6.9	7.6	9.4	948	2.9	3.1	1326	4.0	4.4
266	Kishoreganj	Nilphamari	264	234	89	2971	11.3	12.7	15.9	1151	4.4	4.9	1820	6.9	7.8
45	Bhangura	Pabna	121	100	ERR	3561	ERR	ERR	ERR	237	ERR	ERR	3325	ERR	ERR
103	Chatmohar	Pabna	321	270	ERR	6589	ERR	ERR	ERR	336	ERR	ERR	6253	ERR	ERR
156	Faridpur	Pabna	142	105	ERR	5092	ERR	ERR	ERR	889	ERR	ERR	4203	ERR	ERR
29	Bagmara	Rajshahi	383	351	ERR	8633	ERR	ERR	ERR	2092	ERR	ERR	6541	ERR	ERR
153	Durgapur	Rajshahi	196	182	ERR	6248	ERR	ERR	ERR	1915	ERR	ERR	4333	ERR	ERR
178	Godagari	Rajshahi	448	417	93	1992	4.4	4.8	6.0	593	1.3	1.4	1399	3.1	3.4
328	Mohanpur	Rajshahi	164	148	90	2715	16.6	18.4	23.0	1219	7.4	8.3	1496	9.1	10.1
373	Paba	Rajshahi	261	205	79	5081	19.5	24.7	30.9	1539	5.9	7.5	3542	13.6	17.2
402	Puthia	Rajshahi	194	180	93	2610	13.5	14.5	18.1	112	0.6	0.6	2498	12.9	13.9
481	Tanore	Rajshahi	295	269	91	1847	6.3	6.9	8.6	357	1.2	1.3	1491	5.1	5.5
182	Gangachara	Rangpur	214	175	82	2757	12.9	15.7	19.7	157	0.7	0.9	2599	12.1	14.8
254	Kaunia	Rangpur	150	127	85	4767	31.8	37.5	46.9	188	1.3	1.5	4579	30.5	36.0
277	Rangpur	Rangpur	318	279	88	6050	19.0	21.7	27.1	418	1.3	1.5	5632	17.7	20.2
397	Pirgacha	Rangpur	266	245	92	8499	32.0	34.7	43.4	408	1.5	1.7	8091	30.4	33.0
399	Pirganj	Rangpur	414	380	92	13328	32.2	35.0	43.8	2374	5.7	6.2	10954	26.5	28.8
61	Belkuchi	Sirajganj	155	122	79	3487	22.5	28.5	35.6	134	0.9	1.1	3353	21.6	27.4
243	Kamarkanda	Sirajganj	93	82	89	3784	40.7	45.9	57.4	95	1.0	1.1	3689	39.7	44.8
255	Kazipur	Sirajganj	370	303	82	8859	23.9	29.2	36.5	361	1.0	1.2	8498	23.0	28.0
403	Raiganj	Sirajganj	267	240	90	13368	50.1	55.6	69.5	1467	5.5	6.1	11901	44.6	49.5
430	Sahjadpur	Sirajganj	349	285	82	11238	32.2	39.5	49.3	358	1.0	1.3	10880	31.2	38.2
463	Sirajganj	Sirajganj	326	235	72	11270	34.6	48.0	60.0	110	0.3	0.5	11160	34.2	47.5
484	Tarash	Sirajganj	300	266	89	11654	38.8	43.8	54.7	103	0.3	0.4	11551	38.5	43.4
498	Ullapara	Sirajganj	414	364	88	18392	44.4	50.5	63.1	554	1.3	1.5	17837	43.1	49.0
		Totals	14432	12754	88	312585	21.7	24.5	30.6	45606	3.2	3.6	266979	18.5	20.9

ga - gross area
nca - net cultivable area
nig - net irrigable area (80 % of nca)

Source: AST 1991 survey

Table 5 Extract from AST 1991 Census

MPO Code	Thana	District	Irrigated Area			Minor Irrigation Facilities											Command Areas (ha)				
			Total (ha)	SW (ha)	GW (ha)	STW Nr	STW (ha)	SST Nr	SST (ha)	DTW all Nr	DTW all (ha)	LP all Nr	LP all (ha)	Manual Nr	Manual (ha)	radition (ha)	DTW	STW	SST	LP all	Manual
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
2	Adamdighi	Bogra	12806	66	12740	1428	7540	368	2391	94	2809	0	0	0	0	66	29.9	5.3	6.5	0.0	0.0
85	Bogra	Bogra	20874	290	20585	3658	16461	233	1282	110	2830	6	0	50	12	264	25.7	4.5	5.5	0.0	0.2
142	Dhunat	Bogra	15325	879	14446	3599	14154	134	245	1	35	93	688	67	12	191	35.2	3.9	1.8	7.4	0.2
149	Dubchachia	Bogra	12149	2	12147	1411	7154	34	240	157	4753	0	0	0	0	2	30.3	5.1	7.1	0.0	0.0
167	Gabtali	Bogra	17063	257	16806	2880	15650	0	0	57	1151	24	0	14	6	55	20.2	5.4	0.0	0.0	0.4
227	Kahaloo	Bogra	14589	49	14540	1269	6045	5	34	246	8461	0	0	0	0	49	34.4	4.8	6.7	0.0	0.0
355	Nandigram	Bogra	16925	4	16920	3134	14023	0	0	98	2892	0	0	38	6	4	29.5	4.5	0.0	0.0	0.1
439	Sariakandi	Bogra	8662	540	8122	1622	7899	0	0	10	178	36	277	270	45	263	17.8	4.9	0.0	7.7	0.2
452	Sherpur	Bogra	16956	1206	15750	3052	13982	449	1715	4	53	130	1204	0	0	2	13.4	4.6	3.8	9.3	0.0
455	Shibganj	Bogra	18597	16	18581	2571	12014	0	0	264	6566	1	0	6	1	8	24.9	4.7	0.0	0.0	0.1
466	Sonatali	Bogra	7162	142	7020	1419	6487	0	0	25	480	4	71	245	53	114	19.2	4.6	0.0	17.7	0.2
169	Gaibandha	Gaibandha	8295	482	7813	1710	6678	0	0	81	1111	61	408	227	24	73	13.7	3.9	0.0	6.7	0.1
177	Gabindaganj	Gaibandha	14288	399	13889	2899	11874	0	0	142	2009	33	0	38	6	128	14.1	4.1	0.0	0.0	0.2
380	Palasbari	Gaibandha	6682	227	6455	1281	5543	0	0	65	889	20	0	133	23	9	13.7	4.3	0.0	0.0	0.2
428	Sadullapur	Gaibandha	6505	461	6044	1130	5075	0	0	61	949	23	0	161	20	219	15.6	4.5	0.0	0.0	0.1
429	Shaghata	Gaibandha	7510	317	7192	1696	6716	0	0	33	473	34	0	29	4	80	14.3	4.0	0.0	0.0	0.1
475	Sundarganj	Gaibandha	6334	210	6125	1522	5274	0	0	57	800	5	51	371	50	158	14.0	3.5	0.0	10.3	0.1
7	Akkelpur	Joypurhat	5633	25	5608	935	2974	131	523	90	2111	0	0	6	0	25	23.5	3.2	4.0	0.0	0.1
107	Chilmara	Kurigram	2174	389	1785	321	1380	0	0	19	370	0	0	262	34	389	19.5	4.3	0.0	0.0	0.1
283	Kurigram	Kurigram	3790	786	3003	550	2290	0	0	40	628	11	125	472	85	661	15.7	4.2	0.0	11.4	0.2
408	Rajarhat	Kurigram	4564	491	4073	630	3177	0	0	42	842	1	12	266	54	479	20.1	5.0	0.0	12.1	0.2
497	Ulipur	Kurigram	6064	406	5657	994	4290	0	0	64	1222	4	37	1013	145	369	19.1	4.3	0.0	9.3	0.1
3	Aditmari	Lalmonirhat	3304	542	2762	592	1915	0	0	27	410	31	0	3180	437	315	15.2	3.2	0.0	0.0	0.1
202	Hatibandha	Lalmonirhat	1797	556	1241	285	957	0	0	14	166	1	10				11.9	3.4	0.0	10.0	0.0
240	Kaliganj	Lalmonirhat	2692	817	1875	302	913	0	0	25	277	1	0	2093	686	813	11.1	3.0	0.0	0.0	0.3
291	Lalmonirhat	Lalmonirhat	4952	1330	3622	635	2695	0	0	45	741	67	1	1266	185	552	16.5	4.2	0.0	0.0	0.1
19	Atrai	Naogaon	13183	2021	11162	2915	11129	1	4	1	28	379	1537	0	0	484	28.3	3.8	4.0	4.1	0.0
22	Badalgachi	Naogaon	5769	222	5547	1062	3425	6	25	96	2058	12	114	85	38	108	21.4	3.2	4.2	9.5	0.4
307	Manda	Naogaon	9136	4838	4298	866	2289	35	98	117	1910	218	3035	4	2	1803	16.3	2.6	2.8	13.9	0.4
324	Mohadevpur	Naogaon	5805	471	5334	1393	3825	6	20	104	1483	23	144	32	6	327	14.3	2.7	3.4	6.2	0.2
357	Naogaon	Naogaon	11091	2193	8898	1143	4489	731	3125	53	1267	53	1012	83	17	1181	23.9	3.9	4.3	19.1	0.2
369	Niamatpur	Naogaon	1336	212	1123	385	782	15	39	32	302	16	0	0	0	121	9.4	2.0	2.6	0.0	0.0
400	Porsha	Naogaon	2080	1113	967	193	643	0	0	26	324	224	998	0	0	114	12.5	3.3	0.0	4.5	0.0
419	Raninagar	Naogaon	13225	1729	11496	2560	9356	205	814	94	1325	68	1161	2	0	567	14.1	3.7	4.0	17.1	0.0
24	Bagatipara	Natore	1193	104	1088	110	358	2	6	37	716	7	0	16	8	62	19.4	3.3	3.0	0.0	0.5
48	Baraigram	Natore	7245	110	7135	978	5599	0	0	51	1435	1	0	110	102	59	28.1	5.7	0.0	0.2	0.9
192	Gurudaspur	Natore	4677	207	4470	1380	4367	0	0	8	103	19	176	1	0	31	12.9	3.2	0.0	9.3	0.0
363	Natore	Natore	11635	578	11057	2301	8441	5	20	96	1941	93	255	1098	654	323	20.2	3.7	4.0	2.7	0.6
462	Singra	Natore	24565	950	23615	6487	22972	2	8	23	619	56	709	37	15	241	26.9	3.5	4.0	12.7	0.4

Table 5 Extract from AST 1991 Census (Continued)

MPO Code	Thana	District	Irrigated Area			Minor Irrigation Facilities															
			Total (ha)	SW (ha)	GW (ha)	STW Nr	STW (ha)	SST Nr	SST (ha)	DTW all Nr	DTW all (ha)	LP all Nr	LP all (ha)	Manual Nr	Manual (ha)	radition (ha)	Command Areas (ha)				
																	DTW	STW	SST	LP all	Manual
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
72	Bholahat	Nawabganj	1085	667	418	145	344	0	0	10	74	12	51	0	0	617	7.4	2.4	0.0	4.2	0.0
181	Gomastapur	Nawabganj	4695	3287	1407	287	1201	13	38	19	167	320	2420	3	1	867	8.8	1.9	7.6	0.0	0.4
346	Nachole	Nawabganj	1691	1455	236	54	144	31	75	7	45	69	690				6.4	1.5	10.0	0.0	0.0
366	Nawabganj	Nawabganj	2522	1506	1016	255	682	18	69	34	249	130	1175	86	16	331	7.3	2.7	3.8	9.0	0.2
456	Shibganj	Nawabganj	2798	708	2089	530	1330	0	0	66	558	16	128	716	202	580	8.4	2.5	0.0	8.0	0.3
144	Dimla	Nilphamari	2983	1467	1516	691	1398	0	0	8	99	38	380				12.4	2.0	0.0	10.0	0.0
212	Jaldhaka	Nilphamari	2274	948	1326	274	1127	0	0	7	91	0	0	397	107	948	13.0	4.1	0.0	0.0	0.3
266	Kishoreganj	Nilphamari	2971	1151	1820	499	1327	0	0	7	34	0	0	3348	459	1151	4.9	2.7	0.0	0.0	0.1
45	Bhangura	Pabna	3561	237	3325	543	2803	79	408	4	113	9	0	0	0	98	28.3	5.2	5.2	0.0	0.0
103	Chatmohar	Pabna	6589	336	6253	1043	4955	15	110	33	1184	12	0	5	4	125	35.9	4.8	7.3	0.0	0.8
156	Faridpur	Pabna	5092	889	4203	918	4165	3	12	2	26	79	0	0	0	219	13.2	4.5	3.9	0.0	0.0
29	Bagmara	Rajshahi	8633	2092	6541	1429	5258	23	84	44	1199	451	1097	0	0	995	27.3	3.7	3.6	2.4	0.0
153	Durgapur	Rajshahi	6248	1915	4333	1178	4120	0	0	12	212	364	0	0	0	675	17.7	3.5	0.0	0.0	0.0
178	Godagari	Rajshahi	1992	593	1399	489	922	18	63	50	412	30	112	7	2	482	8.2	1.9	3.5	3.7	0.3
328	Mohanpur	Rajshahi	2715	1219	1496	321	795	0	0	41	701	78	0	0	0	913	17.1	2.5	0.0	0.0	0.0
373	Paba	Rajshahi	5081	1539	3542	643	2802	17	127	26	605	178	0	13	7	614	23.3	4.4	7.5	0.0	0.6
402	Puthia	Rajshahi	2610	112	2498	765	1915	0	0	37	582	114	0	3	0	43	15.7	2.5	0.0	0.0	0.1
481	Tanore	Rajshahi	1847	357	1491	273	752	1	0	85	738	18	229	0	0	264	8.7	2.8	0.4	12.7	0.0
182	Gangachara	Rangpur	2757	157	2599	520	2173	0	0	23	330	3	34	584	96	123	14.3	4.2	0.0	11.5	0.2
254	Kaunia	Rangpur	4767	188	4579	628	3687	0	0	44	802	3	28	102	89	159	18.2	5.9	0.0	9.4	0.9
277	Rangpur	Rangpur	6050	418	5632	1187	3315	0	0	148	2282	46	460				15.4	2.8	0.0	10.0	0.0
397	Pirgacha	Rangpur	8499	408	8091	1354	5508	0	0	138	2580	34	253	23	3	155	18.7	4.1	0.0	7.4	0.1
399	Pirganj	Rangpur	13328	2374	10954	1387	6339	0	0	133	3540	19	0	7897	1074	2267	26.6	4.6	0.0	0.0	0.1
61	Belkuchi	Sirajganj	3487	134	3353	958	3327	0	0	2	24	5	29	9	2	105	12.1	3.5	0.0	5.8	0.2
243	Kamarkanda	Sirajganj	3784	95	3689	849	3594	0	0	6	89	0	0	21	6	95	14.8	4.2	0.0	0.0	0.3
255	Kazipur	Sirajganj	8859	361	8498	1748	7937	0	0	39	556	4	26	14	6	335	14.2	4.5	0.0	6.6	0.4
403	Raiganj	Sirajganj	13368	1467	11901	2008	9653	2	7	86	2240	115	1326	5	1	140	26.0	4.8	3.6	11.5	0.2
430	Sahjadpur	Sirajganj	11238	358	10880	2979	10652	1	5	13	223	27	202	2	0	156	17.1	3.6	4.9	7.5	0.2
463	Sirajganj	Sirajganj	11270	110	11160	1349	8108	0	0	147	3037	8	81	33	15	29	20.7	6.0	0.0	10.1	0.4
484	Tarash	Sirajganj	11654	103	11551	2816	11508	0	0	2	40	0	0	9	3	103	20.2	4.1	0.0	0.0	0.3
498	Ullapara	Sirajganj	18392	554	17837	2903	14165	1	4	170	3665	37	271	6	3	284	21.6	4.9	4.0	7.3	0.5
		Totals	539468	52844	486624	94321	386844	2584	11594	4052	83217	3974	21022	24958	4826	23583	20.5	4.1	4.5	5.3	0.2

Table 6 Comparison of Actual (1989/90) Groundwater Resource Utilisation Versus MPO Estimates

MPO Code	Thana Name	District	Area km²	NCA km²	Ratio %	1989 GW irr. (N		1989 GW use (Mm3)	MPO GW Potential (Mm3)			
						Force Mode	Suction Mode		Mode 1	Mode 2	Mode 3	Mode 4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
2	Adamdighi	Bogra	171	156	92	96	1479	48.8	51.7	57.7	57.7	57.7
85	Bogra	Bogra	407	366	90	110	2931	87.3	76.9	106.1	137.4	137.4
142	Dhunat	Bogra	246	218	89	13	2630	68.1	71.9	92.2	92.2	92.2
149	Dubchachia	Bogra	163	149	91	147	1179	47.3	28.6	39.7	55.0	55.0
167	Gabtali	Bogra	241	221	92	172	2341	79.7	78.2	81.3	81.3	81.3
227	Kahaloo	Bogra	241	218	91	215	984	50.4	43.7	61.5	72.3	72.3
355	Nandigram	Bogra	266	244	92	120	2582	79.6	82.0	89.8	89.8	89.8
439	Sariakandi	Bogra	468	345	74	17	1324	35.5	79.2	110.2	175.5	175.5
452	Sherpur	Bogra	298	262	88	8	2551	65.5	70.7	78.2	78.2	78.2
455	Shibganj	Bogra	315	287	91	274	958	56.8	78.6	106.3	106.3	106.3
466	Sonatali	Bogra	101	90	89	28	1602	43.9	38.3	47.0	53.0	53.0
169	Gaibandha	Gaibandha	321	273	85	93	1690	53.8	86.6	108.3	108.3	108.3
177	Gabindaganj	Gaibandha	463	423	91	82	2304	68.1	149.1	156.3	156.3	156.3
380	Palasbari	Gaibandha	194	174	90	68	885	30.5	69.1	80.0	80.0	80.0
428	Sadullapur	Gaibandha	233	209	90	71	1022	34.3	87.3	87.3	87.3	87.3
429	Shaghata	Gaibandha	225	192	85	50	1493	43.7	75.9	75.9	75.9	75.9
475	Sundarganj	Gaibandha	419	344	82	59	1481	44.5	125.5	157.1	157.1	157.1
7	Akkelpur	Joypurhat	140	129	92	82	915	32.9	25.6	41.4	42.0	42.0
107	Chilmara	Kurigram	91	65	72	28	314	11.3	22.2	29.1	34.1	34.1
283	Kurigram	Kurigram	277	215	78	32	515	16.8	62.6	80.5	124.6	124.6
408	Rajarhat	Kurigram	181	163	90	32	537	17.4	60.2	73.8	81.4	81.4
497	Ulipur	Kurigram	455	354	78	67	1001	33.3	163.1	170.6	170.6	170.6
3	Aditmari	Lalmonirhat	194	178	92	24	481	15.0	94.6	94.6	94.6	94.6
202	Hatibandha	Lalmonirhat	290	261	90	15	239	7.8	152.2	152.2	152.2	152.2
240	Kaliganj	Lalmonirhat	238	203	85	20	311	10.2	53.1	66.1	116.0	116.0
291	Lalmonirhat	Lalmonirhat	256	209	82	36	537	17.9	97.7	105.6	105.6	105.6
19	Atrai	Naogaon	261	247	95	1	2490	63.1	44.2	57.1	97.9	97.9
22	Badalgachi	Naogaon	214	195	91	123	979	39.4	44.0	52.2	52.2	52.2
307	Manda	Naogaon	411	384	94	187	1000	47.5	31.1	42.6	92.5	92.5
324	Mohadevpur	Naogaon	393	360	92	263	1075	58.4	30.3	44.1	117.9	117.9
357	Naogaon	Naogaon	274	253	92	47	2012	56.5	50.8	67.2	77.1	77.1
369	Niamatpur	Naogaon	448	411	92	0	540	13.7	0.0	0.0	36.5	84.0
400	Porsha	Naogaon	259	232	90	79	127	12.6	0.0	0.0	12.9	37.6
419	Raninagar	Naogaon	246	225	91	97	2468	74.0	8.5	36.6	92.2	92.2
24	Bagatipara	Natore	139	128	92	31	143	7.3	15.3	20.3	36.5	36.5
48	Baraigram	Natore	406	379	93	3	1188	30.4	38.7	48.8	139.4	153.7
192	Gurudaspur	Natore	202	182	90	30	1229	34.7	28.0	38.1	68.2	68.2
363	Natore	Natore	404	366	91	34	2460	66.3	68.8	83.4	121.2	121.2
462	Singra	Natore	528	493	93	34	5758	149.8	78.6	99.7	178.2	178.2

Table 6 Comparison of Actual (1989/90) Groundwater Resource Utilisation Versus MPO Estimates (Continued)

MPO Code	Thana Name	District	Area km²	NCA km²	Ratio %	1989 GW irr. (N Force Mode	1989 GW irr. (N Suction Mode	1989 GW use (Mm3)	MPO GW Potential (Mm3) Mode 1	Mode 2	Mode 3	Mode 4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
72	Bholahat	Nawabganj	130	117	90	128	67	16.9	5.2	9.6	39.0	39.0
181	Gomastapur	Nawabganj	318	279	88	114	455	25.1	0.0	2.1	33.4	65.5
346	Nachole	Nawabganj	279	263	94	87	85	12.5	0	0	0	10.1
366	Nawabganj	Nawabganj	481	404	84	128	383	24.9	38.6	67.7	144.3	144.3
456	Shibganj	Nawabganj	525	473	90	232	958	51.8	70.1	98.8	137.8	137.8
144	Dimla	Nilphamari	328	292	89	5	551	14.5	136.0	206.0	288.0	288.0
212	Jaldhaka	Nilphamari	328	301	92	14	299	9.2	109.1	140.7	147.6	147.6
266	Kishoreganj	Nilphamari	264	234	89	15	310	9.6	81.5	115.2	118.8	118.8
45	Bhangura	Pabna	121	100	83	67	935	31.6	17.9	23.3	54.4	54.4
103	Chatmohar	Pabna	321	270	84	20	1772	47.2	40.2	52.3	120.4	120.4
156	Faridpur	Pabna	142	105	74	2	1147	29.3	39.7	50.2	58.6	58.6
29	Bagmara	Rajshahi	383	351	92	53	1713	49.7	23.1	37.1	114.9	129.3
153	Durgapur	Rajshahi	196	182	93	8	1114	29.1	36.9	48.6	74.0	74.0
178	Godagari	Rajshahi	448	417	93	184	470	33.7	0.0	0.0	46.1	80.4
328	Mohanpur	Rajshahi	164	148	90	38	391		13.4	17.3	43.0	43.0
373	Paba	Rajshahi	261	205	79	39	578		12.7	21.7	48.9	48.9
402	Puthia	Rajshahi	194	180	93	220	838	47.3	14.5	22.3	50.9	50.9
481	Tanore	Rajshahi	295	269	91	175	1166	50.3	22.5	34.6	55.3	55.3
182	Gangachara	Rangpur	214	175	82	15	457	13.3	112.3	112.3	112.3	112.3
254	Kaunia	Rangpur	150	127	85	43	544	18.9	69.7	78.7	78.7	78.7
277	Rangpur	Rangpur	318	279	88	133	962	40.1	131.2	131.2	131.2	131.2
397	Pirgacha	Rangpur	266	245	92	141	1181	46.6	100.6	119.7	119.7	119.7
399	Pirganj	Rangpur	414	380	92	126	865	36.9	91.1	127.3	155.2	155.2
61	Belkuchi	Sirajganj	155	122	79	2	959	24.5	16.7	22.6	52.3	52.3
243	Kamarkanda	Sirajganj	93	82	89	11	658	18.0	16.6	22.6	33.1	33.1
255	Kazipur	Sirajganj	370	303	82	139	1177	46.3	57.3	79.0	138.7	138.7
403	Raiganj	Sirajganj	267	240	90	180	1505	59.5	51.0	73.7	80.1	80.1
430	Sahjadpur	Sirajganj	349	285	82	30	2998	79.4	60.0	94.9	130.9	130.9
463	Sirajganj	Sirajganj	326	235	72	191	931	46.2	76.4	105.1	146.7	146.7
484	Tarash	Sirajganj	300	266	89	6	2521	64.5	66.2	85.3	112.5	112.5
498	Ullapara	Sirajganj	414	364	88	197	2761	93.3	106.9	132.0	132.0	132.0

19 ha per DTW
4.05 ha per STW
625 mm net irrigation demand

Mode 1 Maximum total potential at which suction mode (DSSTW) can operate on all land
Mode 2 Maximum total potential at which force mode is used on F0 and F1 land, suction mode on F2 and F3 land
Mode 3 Maximum total potential for 2 cusec force mode units (DTW) on all land
Mode 4 Maximum total potential for 1 cusec force mode units (DTW) on all land

Tabl 7 Impact of Flood Control on Potential Recharge

MPO Code	Thana Name	District	Area km²	No Flood Control		Full Flood Control			Controlled Flooding		
				Mean (mm)	STD (mm)	Mean (mm)	STD (mm)	% change	Mean (mm)	STD (mm)	% change
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2	Adamdighi	Bogra	171	698	77	450	119	36	680	85	3
85	Bogra	Bogra	407	791	79	486	128	39	768	85	3
142	Dhunat	Bogra	246	977	105	614	145	37	949	109	3
149	Dubchachia	Bogra	163	545	60	373	107	32	530	65	3
167	Gabtali	Bogra	241	629	75	442	119	30	610	80	3
227	Kahaloo	Bogra	241	719	79	460	128	36	700	86	3
355	Nandigram	Bogra	266	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
439	Sariakandi	Bogra	468	1413	107	941	155	33	1364	116	3
452	Sherpur	Bogra	298	815	74	547	118	33	794	81	3
455	Shibganj	Bogra	315	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
466	Sonatali	Bogra	101	1269	207	910	253	28	1258	214	1
169	Gaibandha	Gaibandha	321	1465	133	723	224	51	1397	150	5
177	Gabindaganj	Gaibandha	463	661	129	465	188	30	650	134	2
380	Palasbari	Gaibandha	194	502	72	363	112	28	491	77	2
428	Sadullapur	Gaibandha	233	649	122	500	166	23	533	81	18
429	Shaghata	Gaibandha	225	1431	142	773	215	46	1322	139	8
475	Sundarganj	Gaibandha	419	1402	165	815	270	42	1353	181	3
7	Akkelpur	Joypurhat	140	683	74	463	114	32	670	82	2
107	Chilmara	Kurigram	91	1586	113	974	213	39	1521	126	4
283	Kurigram	Kurigram	277	1507	155	1058	252	30	1470	163	2
408	Rajarhat	Kurigram	181	1511	300	1189	412	21	1526	299	0
497	Ulipur	Kurigram	455	1474	164	919	258	38	1431	185	3
3	Aditmari	Lalmonirhat	194	1496	344	1254	425	16	1516	340	0
202	Hatibandha	Lalmonirhat	290	979	137	700	217	28	959	143	2
240	Kaliganj	Lalmonirhat	238	1088	170	808	235	26	1060	176	3
291	Lalmonirhat	Lalmonirhat	256	976	153	737	206	24	958	156	2
19	Atrai	Naogaon	261	927	36	605	68	35	856	50	8
22	Badalgachi	Naogaon	214	517	109	401	135	22	507	114	2
307	Manda	Naogaon	411	880	94	645	126	27	847	108	4
324	Mohadevpur	Naogaon	393	530	112	445	121	16	521	115	2
357	Naogaon	Naogaon	274	668	79	456	107	32	638	90	4
369	Niamatpur	Naogaon	448	359	124	352	125	2	357	125	1
400	Porsha	Naogaon	259	465	108	420	113	10	453	110	3
419	Raninagar	Naogaon	246	822	80	607	105	26	781	92	5
24	Bagatipara	Natore	139	409	66	259	85	37	392	69	4
48	Baraigram	Natore	406	731	122	554	155	24	712	129	3
192	Gurudaspur	Natore	202	684	100	509	132	26	660	104	4
363	Natore	Natore	404	675	73	442	94	35	640	78	5
462	Singra	Natore	528	800	68	620	95	23	768	77	4

Table 7 Impact of Flood Control on Potential Recharge (Continued)

MPO Code	Thana Name	District	Area km²	No Flood Control		Full Flood Control			Controlled Flooding		
				Mean (mm)	STD (mm)	Mean (mm)	STD (mm)	% change	Mean (mm)	STD (mm)	% change
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
72	Bholahat	Nawabganj	130	573	123	483	161	16	561	129	2
181	Gomastapur	Nawabganj	318	578	87	483	105	16	559	94	3
346	Nachole	Nawabganj	279	324	113	294	117	9	321	114	1
366	Nawabganj	Nawabganj	481	998	76	600	96	40	945	81	5
456	Shibganj	Nawabganj	525	430	107	282	139	34	413	112	4
144	Dimla	Nilphamari	328	1171	138	863	219	26	1152	144	2
212	Jaldhaka	Nilphamari	328	1057	152	798	234	25	1044	159	1
266	Kishoreganj	Nilphamari	264	1026	157	758	228	26	1007	161	2
45	Bhangura	Pabna	121	1035	140	873	190	16	1031	165	0
103	Chatmohar	Pabna	321	871	131	561	172	36	842	134	3
156	Faridpur	Pabna	142	903	63	649	94	28	855	83	5
29	Bagmara	Rajshahi	383	758	72	533	96	30	722	81	5
153	Durgapur	Rajshahi	196	509	89	354	111	30	492	94	3
178	Godagari	Rajshahi	448	438	89	371	99	15	429	92	2
328	Mohanpur	Rajshahi	164	626	64	451	90	28	603	73	4
373	Paba	Rajshahi	261	440	82	301	103	32	426	87	3
402	Puthia	Rajshahi	194	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
481	Tanore	Rajshahi	295	362	92	336	94	7	359	90	1
182	Gangachara	Rangpur	214	1233	163	936	223	24	1217	168	1
254	Kaunia	Rangpur	150	1196	165	886	233	26	1172	169	2
277	Rangpur	Rangpur	318	486	77	372	111	23	478	80	2
397	Pirgacha	Rangpur	266	1031	157	662	257	36	1004	167	3
399	Pirganj	Rangpur	414	600	139	501	169	17	595	142	1
61	Belkuchi	Sirajganj	155	1001	135	594	181	41	967	140	3
243	Kamarkanda	Sirajganj	93	714	108	482	148	32	690	113	3
255	Kazipur	Sirajganj	370	1708	106	1176	165	31	1621	134	5
403	Raiganj	Sirajganj	267	766	80	460	133	40	739	89	4
430	Sahjadpur	Sirajganj	349	1091	97	678	146	38	1034	104	5
463	Sirajganj	Sirajganj	326	1194	94	831	138	30	1142	107	4
484	Tarash	Sirajganj	300	917	43	648	88	29	871	63	5
498	Ullapara	Sirajganj	414	854	97	547	136	36	821	102	4
		Mean		931		651		30	901		3

Table 8 Upper Limit of Groundwater Resource Development for No Flood Control (NFC) or Partial Protection

MPO Code	Thana Name	District	Area km²	NCA km²	SW of ga)	NWD GW (Mm3)	NWD GW (mm)	NFC UR (mm)	NFC UR (Mm3)	Dev. Limits DTW2 (Mm3)	Dev. Limits HTW (Mm3)	Max Dev % of nia	Constraint
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
2	Adamdighi	Bogra	171	156	0.4	78	455	524	89.5	89.5	89.5	100	None
85	Bogra	Bogra	407	366	0.7	181	446	593	241.5	241.5	241.5	100	None
142	Dhunat	Bogra	246	218	3.6	103	420	733	180.3	180.3	180,3	100	None
149	Dubchachia	Bogra	163	149	0.0	74	456	409	66.6	66.6	66.6	90	UR
167	Gabtali	Bogra	241	221	1.1	109	452	472	113.7	113.7	113.7	100	None
227	Kahaloo	Bogra	241	218	0.2	109	452	539	130.0	130.0	130.0	100	None
355	Nandigram	Bogra	266	244	0.0	122	458	337	89.7	89.7	89.7	74	UR
439	Sariakandi	Bogra	468	345	1.2	169	362	1060	496.0	320.7	246.6	100	None
452	Sherpur	Bogra	298	262	4.0	123	414	611	182.2	182.2	182.2	100	None
455	Shibganj	Bogra	315	287	0.1	143	455	538	169.6	169.6	169.6	100	None
466	Sonatali	Bogra	101	90	1.4	44	435	952	96.1	96.1	87.1	100	None
169	Gaibandha	Gaibandha	321	273	1.5	134	416	1099	352.7	303.8	228.8	100	None
177	Gabindaganj	Gaibandha	463	423	0.9	209	451	496	229.5	229.5	229.5	100	None
380	Palasbari	Gaibandha	194	174	1.2	85	441	377	73.0	73.0	73.0	85	UR
428	Sadullapur	Gaibandha	233	209	2.0	102	436	487	113.4	113.4	113.4	100	None
429	Shaghata	Gaibandha	225	192	1.4	94	418	1073	241.5	241.5	202.2	100	None
475	Sundarganj	Gaibandha	419	344	0.5	171	407	1052	440.6	440.6	352.6	100	None
7	Akkelpur	Joypurhat	140	129	0.2	64	458	512	71.7	71.7	71.7	100	None
107	Chilmara	Kurigram	91	65	4.3	30	331	1190	108.2	106.2	67.6	100	None
283	Kurigram	Kurigram	277	215	2.8	102	370	1130	313.1	243.5	169.2	100	None
408	Rajarhat	Kurigram	181	163	2.7	78	433	1133	205.1	205.1	147.8	100	None
497	Ulipur	Kurigram	455	354	0.9	174	383	1106	503.0	503.0	433.1	100	None
3	Aditmari	Lalmonirhat	194	178	2.8	86	442	1122	217.7	217.7	217.7	100	None
202	Hatibandha	Lalmonirhat	290	261	1.9	127	439	734	212.9	212.9	212.9	100	None
240	Kaliganj	Lalmonirhat	238	203	3.4	96	405	816	194.2	194.2	160.1	100	None
291	Lalmonirhat	Lalmonirhat	256	209	5.2	96	375	732	187.4	187.4	187.4	100	None
19	Atrai	Naogaon	261	247	7.7	111	426	695	181.5	145.6	114.0	100	None
22	Badalgachi	Naogaon	214	195	1.0	96	450	388	83.0	83.0	83.0	86	UR
307	Manda	Naogaon	411	384	11.8	162	394	660	271.3	139.0	145.2	86	DTW2
324	Mohadevpur	Naogaon	393	360	1.2	177	451	398	156.2	139.6	147.7	79	DTW2
357	Naogaon	Naogaon	274	253	8.0	113	411	501	137.3	137.3	137.3	100	None
369	Niamatpur	Naogaon	448	411	0.5	204	456	269	120.6	36.9	120.6	18	DTW2
400	Porsha	Naogaon	259	232	4.3	109	421	349	90.3	26.5	45.7	24	DTW2
419	Raninagar	Naogaon	246	225	7.0	102	413	617	151.7	151.7	151.7	100	None
24	Bagatipara	Natore	139	128	0.8	63	457	307	42.6	42.6	42.6	67	UR
48	Baraigram	Natore	406	379	0.3	189	465	548	222.6	139.7	98.2	52	HTW
192	Gurudaspur	Natore	202	182	1.0	90	445	513	103.6	103.6	84.2	94	HTW
363	Natore	Natore	404	366	1.4	179	444	506	204.5	204.5	157.6	88	HTW
462	Singra	Natore	528	493	1.8	240	455	600	316.8	315.5	232.7	97	HTW

Table 8 Upper Limit of Groundwater Resource Development for No Flood Control (NFC) or Partial Protection (Continued)

MPO Code	Thana Name	District	Area km²	NCA km²	SW of ga)	NWD GW (Mm3)	NWD GW (mm)	NFC UR (mm)	NFC UR (Mm3)	Dev. Limits DTW2 (Mm3)	Dev. Limits HTW (Mm3)	Max Dev % of nia	Constraint
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
72	Bholahat	Nawabganj	130	117	5.1	54	417	430	55.9	55.9	47.9	88	HTW
181	Gomastapur	Nawabganj	318	279	10.3	119	374	434	137.9	52.0	64.4	44	DTW2
346	Nachole	Nawabganj	279	263	5.2	122	438	243	67.8	0.0	0.0	0	TW2/HT
366	Nawabganj	Nawabganj	481	404	3.1	192	400	749	360.0	246.3	193.1	100	None
456	Shibganj	Nawabganj	525	473	1.3	232	442	323	169.3	169.3	169.3	73	UR
144	Dimla	Nilphamari	328	292	4.5	137	417	878	288.0	288.0	288.0	100	None
212	Jaldhaka	Nilphamari	328	301	2.9	145	441	793	260.0	260.0	260.0	100	None
266	Kishoreganj	Nilphamari	264	234	4.4	110	416	770	203.1	203.1	203.1	100	None
45	Bhangura	Pabna	121	100	2.0	49	402	776	93.9	70.9	50.3	100	None
103	Chatmohar	Pabna	321	270	1.0	133	413	653	209.7	191.2	121.6	92	DTW2
156	Faridpur	Pabna	142	105	6.3	47	330	677	96.2	96.2	91.0	100	None
29	Bagmara	Rajshahi	383	351	5.5	163	424	569	217.7	140.7	146.7	87	DTW2
153	Durgapur	Rajshahi	199	182	9.8	79	396	382	76.0	76.0	76.0	96	UR
178	Godagari	Rajshahi	448	417	1.3	205	457	329	147.2	98.0	101.9	48	DTW2
328	Mohanpur	Rajshahi	164	148	7.4	66	404	470	77.0	51.8	42.9	65	HTW
373	Paba	Rajshahi	261	205	5.9	93	357	330	86.1	83.7	68.9	74	HTW
402	Puthia	Rajshahi	194	180	0.6	89	460	382	74.1	56.5	59.3	63	DTW2
481	Tanore	Rajshahi	295	269	1.2	132	449	272	80.1	80.1	80.1	60	UR
182	Gangachara	Rangpur	214	175	0.7	87	404	925	197.9	197.9	197.9	100	None
254	Kaunia	Rangpur	150	127	1.3	62	416	897	134.6	134.6	134.6	100	None
277	Rangpur	Rangpur	318	279	1.3	137	431	365	115.9	115.9	115.9	85	UR
397	Pirgacha	Rangpur	266	245	1.5	120	451	773	205.7	205.7	205.7	100	None
399	Pirganj	Rangpur	414	380	5.7	175	424	450	186.3	186.3	186.3	100	None
61	Belkuchi	Sirajganj	155	122	0.9	60	390	751	116.4	62.9	45.9	76	HTW
243	Kamarkanda	Sirajganj	93	82	1.0	41	437	536	49.8	49.8	49.8	100	None
255	Kazipur	Sirajganj	370	303	1.0	149	403	1281	474.0	263.1	169.7	100	None
403	Raiganj	Sirajganj	267	240	5.5	111	416	575	153.4	153.4	153.4	100	None
430	Sahjadpur	Sirajganj	349	285	1.0	140	402	818	285.6	266.7	247.3	100	None
463	Sirajganj	Sirajganj	326	235	0.3	117	358	896	291.9	291.9	217.2	100	None
484	Tarash	Sirajganj	300	266	0.3	132	441	688	206.3	206.3	179.5	100	None
498	Ullapara	Sirajganj	414	364	1.3	179	432	641	265.2	265.2	265.2	100	None

Table 9 Upper Limit of Groundwater Resource Development for Full FCD

MPO Code	Thana Name	District	Area km²	NCA km²	SW of ga)	NWD GW (Mm3)	NWD GW (mm)	FFC UR (mm)	FFC UR (Mm3)	Dev. Limits DTW2 (Mm3)	Dev. Limits HTW (Mm3)	Max Dev % of nia	Constraint	Max Dev % of nia NFC	Effect of FFC
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
2	Adamdighi	Bogra	171	156	0.4	78	455	338	57.7	57.7	57.7	74	UR	100	Yes
85	Bogra	Bogra	407	366	0.7	181	446	365	148.4	148.4	148.4	82	UR	100	Yes
142	Dhunat	Bogra	246	218	3.6	103	420	461	113.3	113.3	113.3	100	None	100	No
149	Dubchachia	Bogra	163	149	0.0	74	456	280	45.6	45.6	45.6	61	UR	90	Yes
167	Gabtali	Bogra	241	221	1.1	109	452	332	79.9	79.9	79.9	73	UR	100	Yes
227	Kahaloo	Bogra	241	218	0.2	109	452	345	83.1	83.1	83.1	76	UR	100	Yes
355	Nandigram	Bogra	266	244	0.0	122	458	337	89.7	89.7	89.7	74	UR	74	No
439	Sariakandi	Bogra	468	345	1.2	169	362	706	330.3	320.7	246.6	100	None	100	No
452	Sherpur	Bogra	298	262	4.0	123	414	410	122.3	122.3	122.3	99	UR	100	Yes
455	Shibganj	Bogra	315	287	0.1	143	455	538	108.7	108.7	108.7	76	UR	100	Yes
466	Sonatali	Bogra	101	90	1.4	44	435	683	68.9	68.9	68.9	100	None	100	No
169	Gaibandha	Gaibandha	321	273	1.5	134	416	542	174.1	174.1	174.1	100	None	100	No
177	Gabindaganj	Gaibandha	463	423	0.9	209	451	349	161.5	161.5	161.5	77	UR	100	Yes
380	Palasbari	Gaibandha	194	174	1.2	85	441	272	52.8	52.8	52.8	62	UR	85	Yes
428	Sadullapur	Gaibandha	233	209	2.0	102	436	375	87.4	87.4	87.4	86	UR	100	Yes
429	Shaghata	Gaibandha	225	192	1.4	94	418	580	130.4	130.4	130.4	100	None	100	No
475	Sundarganj	Gaibandha	419	344	0.5	171	407	611	256.1	256.1	256.1	100	None	100	No
7	Akkelpur	Joypurhat	140	129	0.2	64	458	347	48.6	48.6	48.6	76	UR	100	Yes
107	Chilmara	Kurigram	91	65	4.3	30	331	731	66.5	66.5	66.5	100	None	100	No
283	Kurigram	Kurigram	277	215	2.8	102	370	794	219.8	219.8	169.2	100	None	100	No
408	Rajarhat	Kurigram	181	163	2.7	78	433	892	161.4	161.4	147.8	100	None	100	No
497	Ulipur	Kurigram	455	354	0.9	174	383	689	313.6	313.6	313.6	100	None	100	No
3	Aditmari	Lalmonirhat	194	178	2.8	86	442	941	182.5	182.5	182.5	100	None	100	No
202	Hatibandha	Lalmonirhat	290	261	1.9	127	439	525	152.3	152.3	152.3	100	None	100	No
240	Kaliganj	Lalmonirhat	238	203	3.4	96	405	606	144.2	144.2	144.2	100	None	100	No
291	Lalmonirhat	Lalmonirhat	256	209	5.2	96	375	553	141.5	141.5	141.5	100	None	100	No
19	Atrai	Naogaon	261	247	7.7	111	426	454	118.4	118.4	114.0	100	None	100	No
22	Badalgachi	Naogaon	214	195	1.0	96	450	301	64.4	64.4	64.4	67	UR	86	Yes
307	Manda	Naogaon	411	384	11.8	162	394	484	198.8	139.0	145.2	86	DTW2	86	No
324	Mohadevpur	Naogaon	393	360	1.2	177	451	334	131.2	131.2	131.2	74	DTW2	79	Yes
357	Naogaon	Naogaon	274	253	8.0	113	411	342	93.7	93.7	93.7	83	UR	100	Yes
369	Niamatpur	Naogaon	448	411	0.5	204	456	264	118.3	36.9	118.3	18	DTW2	18	No
400	Porsha	Naogaon	259	232	4.3	109	421	315	81.6	26.5	45.7	24	DTW2	24	No
419	Raninagar	Naogaon	246	225	7.0	102	413	455	112.0	112.0	112.0	100	None	100	No
24	Bagatipara	Natore	139	128	0.8	63	457	194	27.0	27.0	27.0	43	UR	67	Yes
48	Baraigram	Natore	406	379	0.3	189	465	416	168.7	139.7	98.2	52	HTW	52	No
192	Gurudaspur	Natore	202	182	1.0	90	445	382	77.1	77.1	77.1	86	HTW	94	Yes
363	Natore	Natore	404	366	1.4	179	444	332	133.9	133.9	133.9	75	HTW	88	Yes
462	Singra	Natore	528	493	1.8	240	455	465	245.5	245.5	232.7	97	HTW	97	No

Table 9 Upper Limit of Groundwater Resource Development for Full FCD (Continued)

MPO Code	Thana Name	District	Area km²	NCA km²	SW of ga)	NWD GW (Mm3)	NWD GW (mm)	FFC UR (mm)	NFC UR (Mm3)	Dev. Limits DTW2 (Mm3)	Dev. Limits HTW (Mm3)	Max Dev % of nia	Constraint	Max Dev % of nia NFC	Effect of FFC
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
72	Bholahat	Nawabganj	130	117	5.1	54	417	362	47.1	47.1	47.1	87	HTW	88	Yes
181	Gomastapur	Nawabganj	318	279	10.3	119	374	362	115.2	52.0	64.4	44	DTW2	44	No
346	Nachole	Nawabganj	279	263	5.2	122	438	221	61.5	0.0	0.0	0	TW2/HT	0	No
366	Nawabganj	Nawabganj	481	404	3.1	192	400	450	216.5	216.5	193.1	100	None	100	No
456	Shibganj	Nawabganj	525	473	1.3	232	442	212	111.0	111.0	111.0	48	UR	73	Yes
144	Dimla	Nilphamari	328	292	4.5	137	417	647	212.3	212.3	212.3	100	None	100	No
212	Jaldhaka	Nilphamari	328	301	2.9	145	441	599	196.3	196.3	196.3	100	None	100	No
266	Kishoreganj	Nilphamari	264	234	4.4	110	416	569	150.1	150.1	150.1	100	None	100	No
45	Bhangura	Pabna	121	100	2.0	49	402	655	79.2	70.9	50.3	100	None	100	No
103	Chatmohar	Pabna	321	270	1.0	133	413	421	135.1	135.1	121.6	92	DTW2	92	No
156	Faridpur	Pabna	142	105	6.3	47	330	487	69.1	69.1	69.1	100	None	100	No
29	Bagmara	Rajshahi	383	351	5.5	163	424	400	153.1	140.7	146.7	87	DTW2	87	No
153	Durgapur	Rajshahi	199	182	9.8	79	396	266	52.8	52.8	52.8	67	UR	96	Yes
178	Godagari	Rajshahi	448	417	1.3	205	457	278	124.7	98.0	101.9	48	DTW2	48	No
328	Mohanpur	Rajshahi	164	148	7.4	66	404	338	55.5	51.8	42.9	65	HTW	65	No
373	Paba	Rajshahi	261	205	5.9	93	357	226	58.9	58.9	58.9	63	HTW	74	Yes
402	Puthia	Rajshahi	194	180	0.6	89	460	382	51.5	51.5	51.5	58	DTW2	63	Yes
481	Tanore	Rajshahi	295	269	1.2	132	449	252	74.3	74.3	74.3	56	UR	60	Yes
182	Gangachara	Rangpur	214	175	0.7	87	404	702	150.2	150.2	150.2	100	None	100	No
254	Kaunia	Rangpur	150	127	1.3	62	416	665	99.7	99.7	99.7	100	None	100	No
277	Rangpur	Rangpur	318	279	1.3	137	431	279	88.7	88.7	88.7	65	UR	85	Yes
397	Pirgacha	Rangpur	266	245	1.5	120	451	497	132.1	132.1	132.1	100	None	100	No
399	Pirganj	Rangpur	414	380	5.7	175	424	376	155.6	155.6	155.6	89	UR	100	Yes
61	Belkuchi	Sirajganj	155	122	0.9	60	390	446	69.1	62.9	45.9	76	HTW	76	No
243	Kamarkanda	Sirajganj	93	82	1.0	41	437	362	33.6	33.6	33.6	83	UR	100	Yes
255	Kazipur	Sirajganj	370	303	1.0	149	403	882	326.3	263.1	169.7	100	None	100	No
403	Raiganj	Sirajganj	267	240	5.5	111	416	345	92.1	92.1	92.1	83	UR	100	Yes
430	Sahjadpur	Sirajganj	349	285	1.0	140	402	509	177.5	177.5	177.5	100	None	100	No
463	Sirajganj	Sirajganj	326	235	0.3	117	358	623	203.2	203.2	203.2	100	None	100	No
484	Tarash	Sirajganj	300	266	0.3	132	441	486	145.8	145.8	145.8	100	None	100	No
498	Ullapara	Sirajganj	414	364	1.3	179	432	410	169.8	169.8	169.8	95	UR	100	Yes

Table 10 Project Areas

Project 1 – Naogaon

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Atrai	25600	1149	4.5	1089	94.8
Manda	41700	12272	29.4	11467	93.4
Mohadebpur	39100	10061	25.7	9217	91.6
Naogaon	28500	16949	59.5	15664	92.4
Raninagar	25600	2551	10.0	2333	91.5
Total		42982		39770	92.5

Project 2 – Bogra Polder 2

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Adamdighi	17100	11623	68.0	10643	91.6
Atrai	25600	13430	52.5	12731	94.8
Dubchachia	16300	4645	28.5	4243	91.3
Naogaon	28500	2912	10.2	2691	92.4
Raninagar	25600	22085	86.3	20197	91.5
Singra	52800	1474	2.8	1378	93.5
Total		56169		51883	92.4

Project 3 – Bogra Polder 3

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Adamdighi	17100	528	3.1	484	91.7
Bogra	40700	9306	22.9	8383	90.1
Kahaloo	24100	16297	67.6	14756	90.5
Nandigram	26600	20558	77.3	18849	91.7
Raninagar	25600	679	2.7	621	91.5
Singra	52800	13185	25.0	12316	93.4
Total		60553		55409	91.5

Project 4 – Chalan Beel Polder A

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Baraigram	40900	9488	23.2	8848	93.3
Chatmohar	32100	5897	18.4	5075	86.1
Gurudaspur	20200	14500	71.8	13068	90.1
Total		29885		26991	90.3

Project 5 - Chalan Beel Polder B

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Bagatipara	13900	4588	33.0	4237	92.3
Baraigram	40900	452	1.1	421	93.1
Gurudaspur	20200	2347	11.6	2115	90.1
Natore	40400	17004	42.1	15407	90.6
Singra	52800	9169	17.4	8564	93.4
Total		33560		30744	91.6

Project 6 - Chalan Beel Polder C

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Manda	41700	2448	5.9	2287	93.4
Raninagar	25600	313	1.2	286	91.4
Atrai	25600	10975	42.9	10405	94.8
Natore	40400	10665	26.4	9664	90.6
Singra	52800	5354	10.1	5000	93.4
Bagmara	38300	16188	42.3	14831	91.6
Total		45943		42473	92.4

Project 7 - Chalan Beel Polder D

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Bagmara	38300	18403	48.0	16861	91.6
Manda	41700	21467	51.5	20059	93.4
Mohonpur	16400	16066	98.0	14451	89.9
Paba	26100	898	3.4	707	78.7
Tanore	29500	498	1.7	455	91.4
Total		57332		52533	91.6

Project 8 - Gaibandha

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Gaibandha	32100	14438	45.0	12426	86.1
Kaunia	15000	3405	22.7	2883	84.7
Pirgacha	26600	13885	52.2	12792	92.1
Sadullapur	23300	6424	27.6	5760	89.7
Sundarganj	41900	33222	79.3	27305	82.2
Ulipur	45500	1600	3.5	1085	67.8
Total		72974		62251	85.3

Project 9 - Hurasagar

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Sahjadpur	34900	12150	34.8	10036	82.6
Total		12150		10036	

Project 10 - SIRDP

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Bhangura	12100	7271	60.1	6431	88.4
Chatmohar	32100	3116	9.7	2681	86.0
Faridpur	14200	1815	12.8	1666	91.8
Raiganj	26700	7765	29.1	6986	90.0
Sahjadpur	34900	9460	27.1	7889	83.4
Tarash	30000	7899	26.3	7142	90.4
Ullapara	41400	35607	86.0	31460	88.4
Total		72933		64255	88.1

Project 11 - Teesta Right Embankment

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Dimla	32800	32372	98.7	28771	88.9
Gangachara	21400	15864	74.1	12966	81.7
Hatibandha	29000	9060	31.2	8165	90.1
Jaldhaka	32800	3095	9.4	2839	91.7
Kaliganj	23800	4613	19.4	3932	85.2
Kaunia	15000	9916	66.1	8394	84.7
Kishoreganj	26400	3460	13.1	3070	88.7
Lalmonirhat	25600	875	3.4	711	81.3
Pirgacha	26600	11652	43.8	10735	92.1
Rangpur	31800	17065	53.7	14964	87.7
Sundarganj	41900	1301	3.1	1069	82.2
Total		109273		95616	87.5

Project 12 - Teesta Left Embankment

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Aditmari	19400	18000	92.8	16515	91.8
Hatibandha	29000	12200	42.1	10992	90.1
Kaliganj	23800	19500	81.9	16614	85.2
Lalmonirhat	25600	8700	34.0	7073	81.3
Total		58400		51195	

Project 13 - Mohananda Basin

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Bholahat	12400	1428	11.5	1290	90.3
Godagari	45300	1042	2.3	968	92.9
Gomastapur	31800	1197	3.8	1098	91.8
Nachole	29000	1576	5.4	1486	94.3
Nawabganj	48400	4411	9.1	3700	83.9
Shibganj	53600	5844	10.9	5266	90.1
Total		15498		13808	

Project 14 - Middle Bangali Project Area

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Bogra	40700	22940	56.4	20629	89.9
Dhunat	24600	24609	100.0	21808	88.6
Gabtali	24100	24116	100.1	22115	91.7
Gobindaganj	46300	492	1.1	449	91.4
Kamarkanda	9300	1295	13.9	1142	88.2
Kazipur	37000	28785	77.8	23573	81.9
Raiganj	26700	10092	37.8	9071	89.9
Sariakandi	46800	20413	43.6	15048	73.7
Sherpur	29800	11891	39.9	10455	87.9
Shibganj	31500	9963	31.6	9077	91.1
Sirajganj	32600	18976	58.2	13679	72.1
Sonatala	10100	9558	94.6	8517	89.1
Total		183130		155563	84.9

Project 15 - Upper Karatoya Basin - Unit 1

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Palashbari	19400	2655	13.7	2382	89.7
Pirganj	41400	8892	21.5	8163	91.8
Total		11547		10544	

Project 16 - Upper Karatoya Basin - Unit 2

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Gobindaganj	46300	2801	6.0	2559	91.4
Palashbari	19400	1441	7.4	1293	89.7
Total		4242		3852	

Project 17 - Upper Karatoya Basin - Unit 3

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Gobindaganj	46300	9331	20.2	8525	91.4
Palashbari	19400	4419	22.8	3964	89.7
Total		13750		12489	

Project 18 - Upper Karatoya Basin - Unit 4

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Gaibandha	32100	2161	6.7	1861	86.1
Gobindaganj	46300	4747	10.3	4337	91.4
Palashbari	19400	5143	26.5	4613	89.7
Shaghata	22500	5387	23.9	4595	85.3
Total		17438		15406	

Project 19 - Upper Karatoya Basin - Unit 5

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Gaibandha	32100	1957	6.1	1685	86.1
Shaghata	22500	15235	67.7	12995	85.3
Sonatala	10100	1160	11.5	1034	89.1
Total		18352		15714	

Project 20 - Upper Karatoya Basin - Unit 6

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Sariakandi	46800	1307	2.8	963	73.7
Sonatala	10100	1810	17.9	1613	89.1
Total		3117		2576	

Project 21 - Upper Karatoya Basin - Unit 7

Thana	Thana Area (ha)	Gross Area (ha)	Gross Area (%)	NCA (ha)	NCA (%)
Gobindaganj	46300	16880	36.5	15422	91.4
Sariakandi	46800	1307	2.8	963	73.7
Sonatala	10100	2970	29.4	2647	89.1
Total		21157		19032	

Table 11 Historic Growth Rates of STW

Code	Thana	District	Growth Rate (Units/yr		Adopted Growth	Code	Thana	District	Growth Rate (Units/yr		Adopted Growth
			86-91	86-89	(%)				86-91	86-89	(%)
(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
2	Adamdighi	Bogra	133	86	9	72	Bholahat	Nawabganj	-14	-40	0
85	Bogra	Bogra	290	87	7	181	Gomastapur	Nawabganj	-55	-42	0
142	Dhunot	Bogra	276	79	10	346	Nachole	Nawabganj	-25	-35	0
149	Dupchachia	Bogra	153	130	10	366	Nawabganj	Nawabganj	-7	33	0
167	Gabtali	Bogra	219	130	7	456	Shibganj	Nawabganj	33	168	5
227	Kahalu	Bogra	164	142	10	144	Dimla	Nilphamari	33	3	5
355	Nandigram	Bogra	393	398	10	212	Jaldhaka	Nilphamari	-22	-40	5
439	Shariakandi	Bogra	131	95	10	266	Kishoreganj	Nilphamari	13	-46	5
452	Sherpur	Bogra	396	294	15	45	Bhangura	Pabna	72	60	7
455	Shibganj	Bogra	233	-157	10	103	Chatmohar	Pabna	47	227	10
466	Sonatola	Bogra	94	195	7	156	Faridpur	Pabna	47	132	10
169	Gaibandha	Gaibandha	46	16	5	29	Bagmara	Rajshahi	135	258	8
177	Gabindaganj	Gaibandha	193	127	7	153	Durgapur	Rajshahi	167	237	
380	Palasbari	Gaibandha	97	14	7	178	Godagari	Rajshahi	22	28	0
428	Sadullapur	Gaibandha	60	44	5	328	Mohanpur	Rajshahi	11	29	5
429	Shaghata	Gaibandha	80	38	5	373	Paba	Rajshahi	55	63	10
475	Sandarganj	Gaibandha	44	13	5	402	Puthia	Rajshahi	80	128	
7	Akkelpur	Joypurhat	118	163		481	Tanor	Rajshahi	-69	189	10
107	Chilmari	Kurigram	-10	-9		182	Gangachara	Rangpur	8	-6	5
283	Kurigram	Kurigram	28	28		254	Kaunia	Rangpur	40	17	7
408	Rajarhat	Kurigram	47	33		277	Rangpur	Rangpur	74	46	8
497	Ulipur	Kurigram	46	44		397	Pirgacha	Rangpur	71	45	6
3	Aditmari	Lalmonirhat	50	30	5	399	Pirganj	Rangpur	169	95	11
202	Hatibandha	Lalmonirhat	28	29	10	61	Belkuchi	Sirajganj	118	160	
240	Kaliganj	Lalmonirhat	-7	-11	5	243	Kamarkanda	Sirajganj	128	143	15
291	Lalmonirhat	Lalmonirhat	54	41	5	255	Kazipur	Sirajganj	256	236	15
19	Atrai	Naogaon	275	237	10	403	Raiganj	Sirajganj	258	218	10
22	Badalgachi	Naogaon	126	164		430	Shahjadpur	Sirajganj	243	260	8
307	Manda	Naogaon	-28	-26	3	463	Sirajganj	Sirajganj	213	179	15
324	Mohadebpur	Naogaon	97	68	9	484	Taras	Sirajganj	265	270	10
357	Naogaon	Naogaon	60	112	3	498	Ullapara	Sirajganj	330	431	10
369	Niamatpur	Naogaon	-13	-6							
400	Porsha	Naogaon	7	-9							
419	Raninagar	Naogaon	174	237	7						
24	Bagatipara	Natore	-1	15	7						
48	Baraigram	Natore	-35	21	5						
192	Gurudaspur	Natore	172	214	10						
363	Natore	Natore	287	443	10						
462	Singra	Natore	569	474	10						

Table 12 Development Projections

	Project	Area (ha)	NCA (ha)	NIA (ha)	Irrigation Development Levels(ha)					
					1989	007 (NFC)	2007 (FFC)	Max (NFC)	Max (FFC)	Max (SM)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	Naogaon	42982	39770	31816	13335	19401	19401	31755	31217	15135
2	Bogra Polder 2	56395	52089	41671	30273	41671	41671	41671	41671	37440
3	Bogra Polder 3	60737	55578	44462	29963	44462	44462	44462	44462	35765
4	Chalan Beel Polder A	30214	27290	21832	7154	16892	15922	17799	15922	9109
5	Chalan Beel Polder B	33562	30746	24597	7547	18689	18689	21989	19918	9370
6	Chalan Beel Polder C	45970	42498	33998	13563	30879	30879	33998	33561	16480
7	Chalan Beel Polder D	57460	52650	42120	14054	20606	20606	39934	37976	15660
8	Gaibandha	73048	62306	49845	15574	26986	26986	49845	49845	>26986
9	Hurasagar	12150	10036	8029	4028	8029	8029	8029	8029	6109
10	SIRDP	72955	64275	51420	30521	51420	51420	51420	51420	44379
11	Teesta Right Embankment	110090	96364	77091	14881	25141	25141	77091	77091	>25141
12	Teesta Left Embankment	58400	51195	40956	5576	8510	8510	40956	40956	>8510
13	Mohananda Basin	15497	13808	11046	1484	1718	1718	8318	7286	>1718
14	Middle Bangali Project	183716	155563	124450	69946	124450	124450	124450	124450	104331
15	Upper Karatoya Basin – Unit	11547	10544	8435	3141	5967	5967	8436	7890	5198
16	Upper Karatoya Basin – Unit	4242	3852	3082	1309	2623	2450	3081	2450	2205
17	Upper Karatoya Basin – Unit	13750	12489	9991	4210	8458	7972	9991	7972	7102
18	Upper Karatoya Basin – Unit	17438	15406	12325	4909	9427	9427	12325	12325	8130
19	Upper Karatoya Basin – Unit	18352	15714	12571	4096	7192	7192	12571	12571	6665
20	Upper Karatoya Basin – Unit	3117	2576	2061	1088	2061	2061	2061	2061	1723
21	Upper Karatoya Basin – Unit	21157	19032	15226	6129	12465	12465	15225	15028	10389

Figure : 1

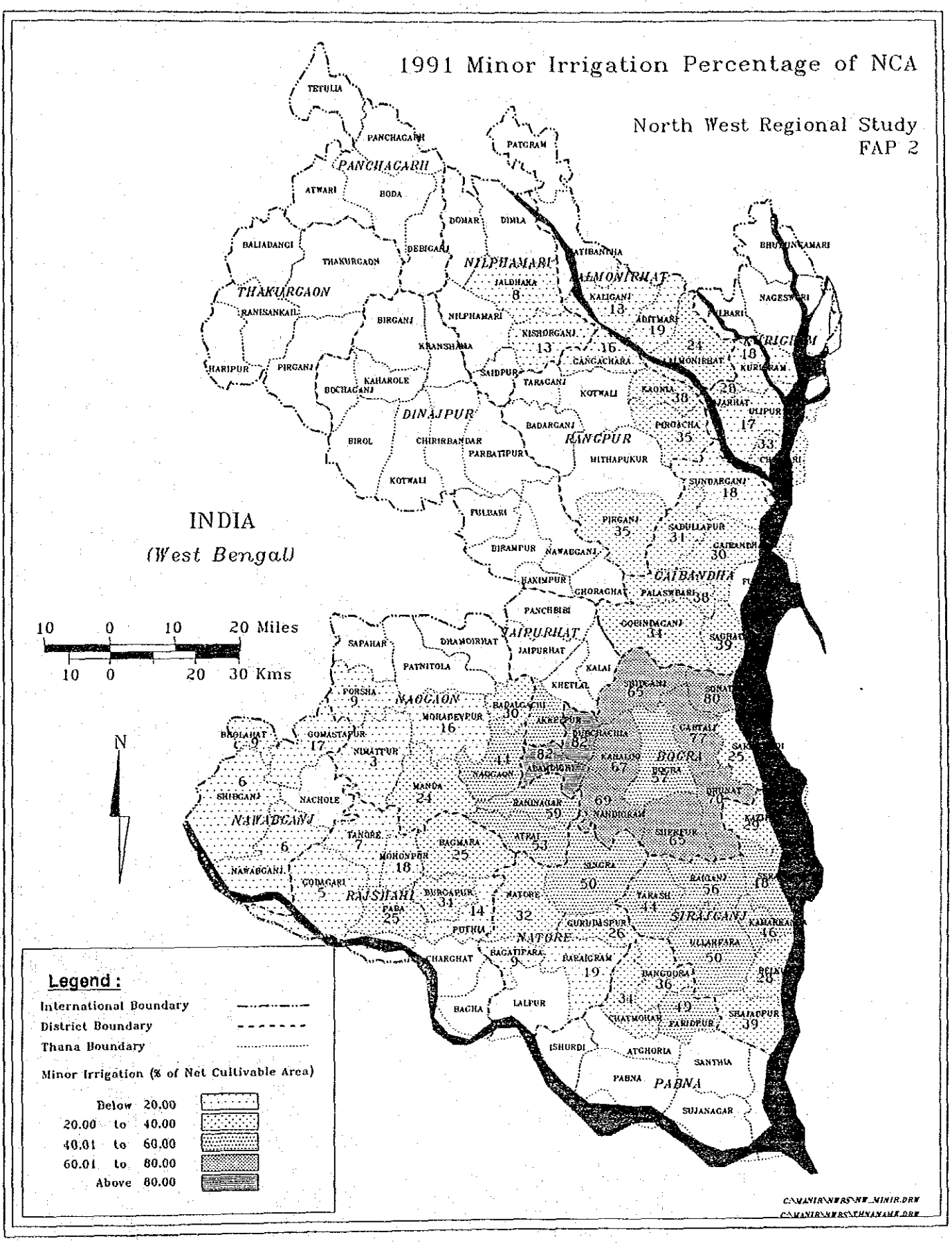
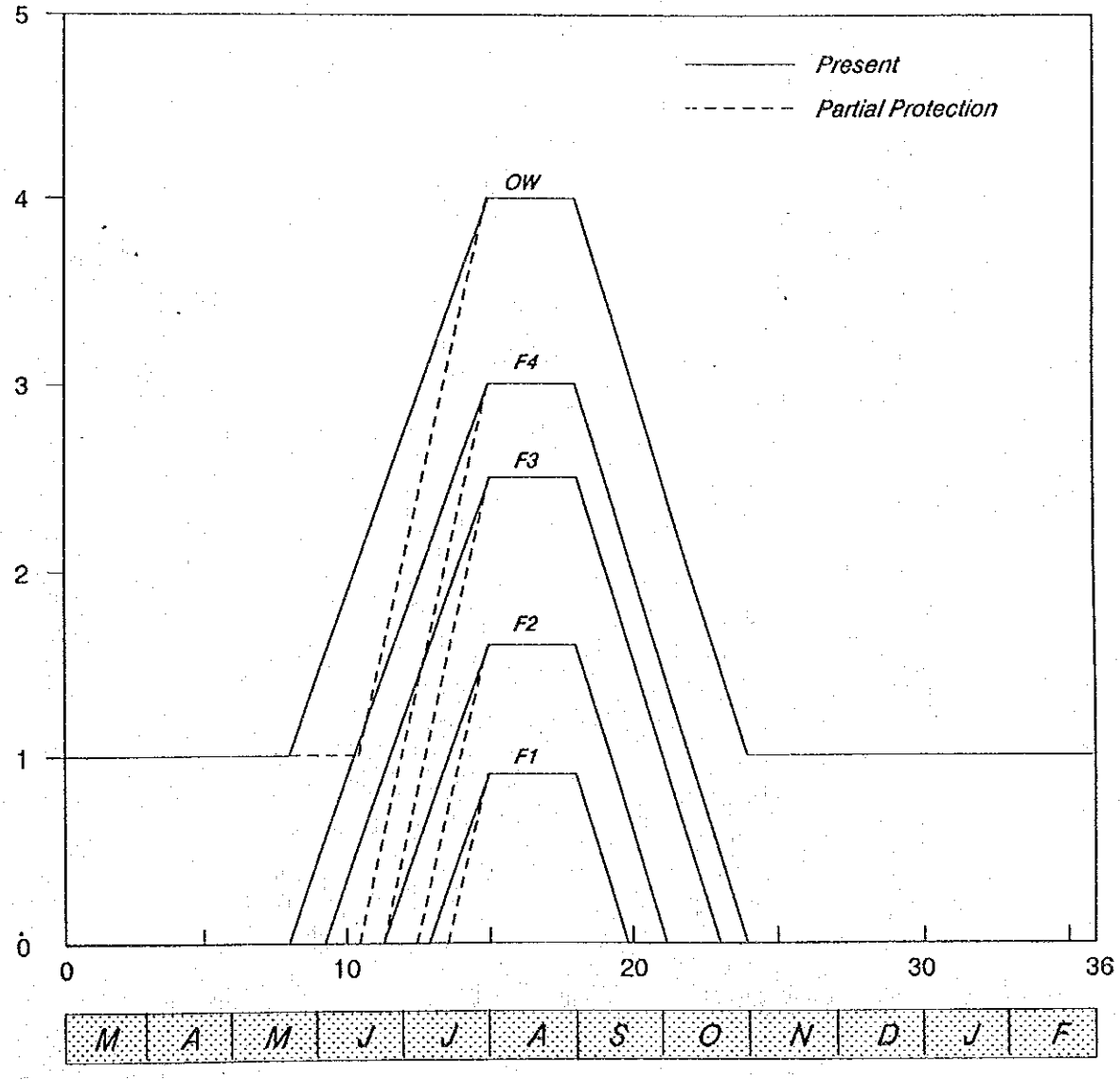

1991 Minor Irrigation Percentage of NCA
North West Regional Study
FAP 2
INDIA
(West Bengal)
10 0 10 20 Miles
10 0 20 30 Kms
N
PANCHAGARH
THAKURGAON
NILPHAMARI
LALMONIRHAT
DINAJPUR
RANGPUR
KURIGRAM
GAIBANDHA
JAIPURHAT
NAOGAON
NAWABGANJ
RAJSHAHI
BOGRA
NATORE
SIRAJGANJ
PABNA
Legend :
International Boundary
District Boundary
Thana Boundary
Minor Irrigation (% of Net Cultivable Area)
Below 20.00
20.00 to 40.00
40.01 to 60.00
60.01 to 80.00
Above 80.00

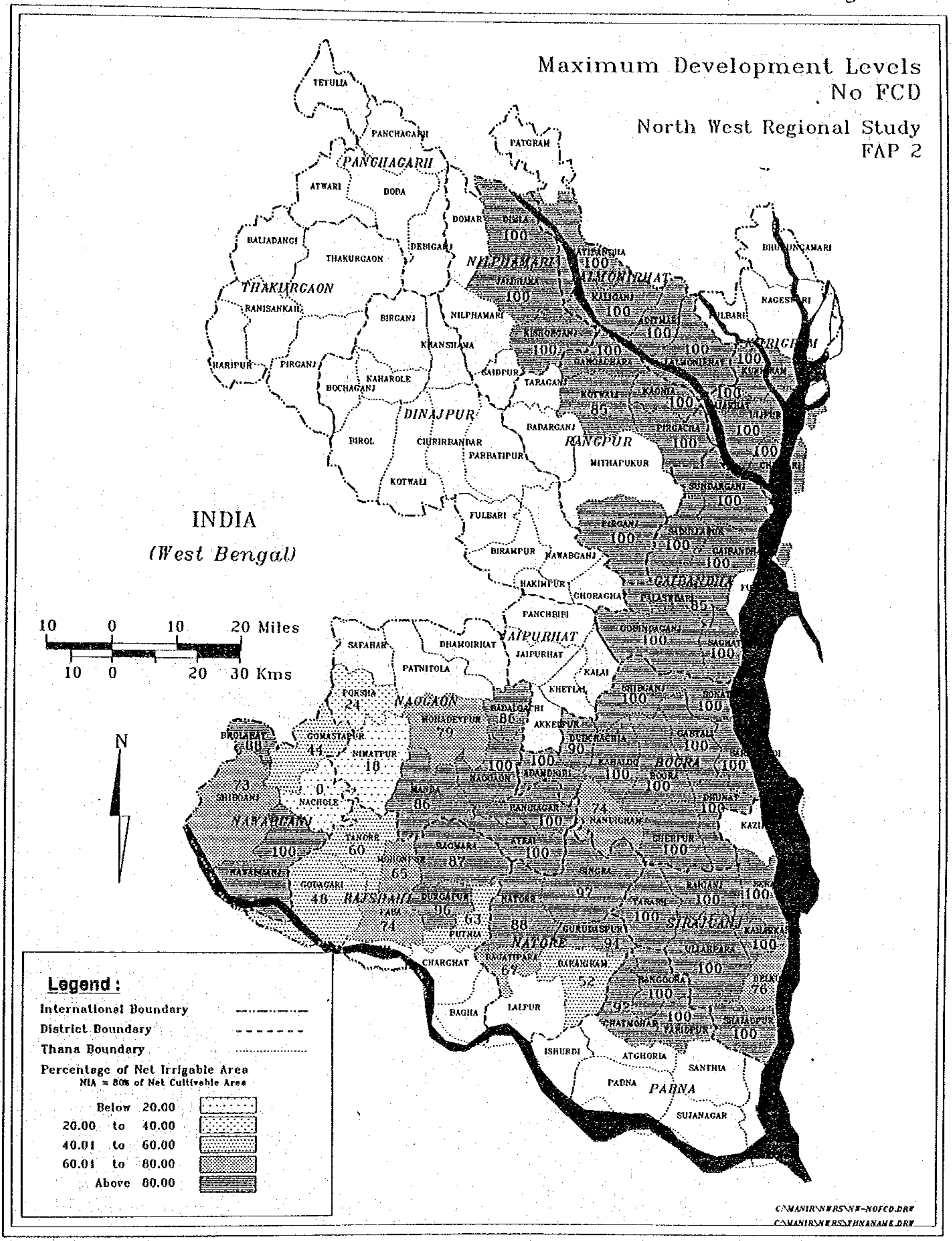
Figure 2

FLOOD HYDROGRAPHS

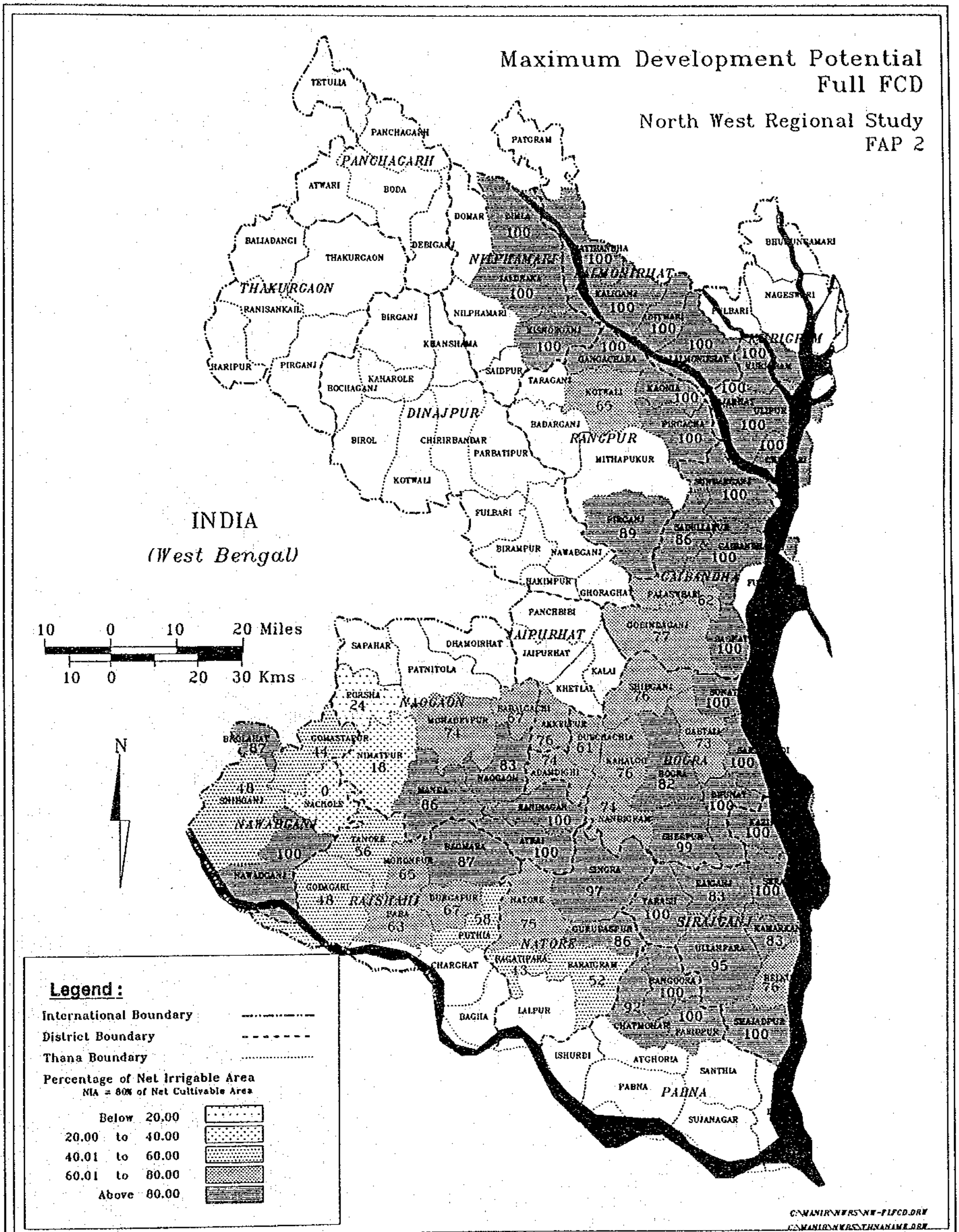


NOTE : Full FCD shows a drop of 1m in water levels, but 1m remains in open water

Figure : 3



Maximum Development Levels
No FCD
North West Regional Study
FAP 2
INDIA
(West Bengal)
10 0 10 20 Miles
10 0 20 30 Kms
N
PANCHAGARH
THAKURGAON
DINAJPUR
NILPHAMARI
LALMONIRHAT
KURIGRAM
RANGPUR
GAIBANDHA
JAIPURHAT
NAOGAON
NAWABGANJ
BOGRA
RAJSHAHI
NATORE
SIRAJGANJ
PABNA
Legend :
International Boundary
District Boundary
Thana Boundary
Percentage of Net Irrigable Area
NIA = 80% of Net Cultivable Area
Below 20.00
20.00 to 40.00
40.01 to 60.00
60.01 to 80.00
Above 80.00


Maximum Development Potential
Full FCD
North West Regional Study
FAP 2
INDIA
(West Bengal)
10 0 10 20 Miles
10 0 20 30 Kms
N
PANCHAGARH
THAKURGAON
DINAJPUR
NILPHAMARI
LALMONIRHAT
RANGPUR
GAIBANDHA
JAIPURHAT
NAOGAON
BOGRA
NAWABGANJ
RAJSHAHI
NATORE
SIRAJGANJ
PABNA
Legend :
International Boundary
District Boundary
Thana Boundary
Percentage of Net Irrigable Area
NIA = 80% of Net Cultivable Area
Below 20.00
20.00 to 40.00
40.01 to 60.00
60.01 to 80.00
Above 80.00

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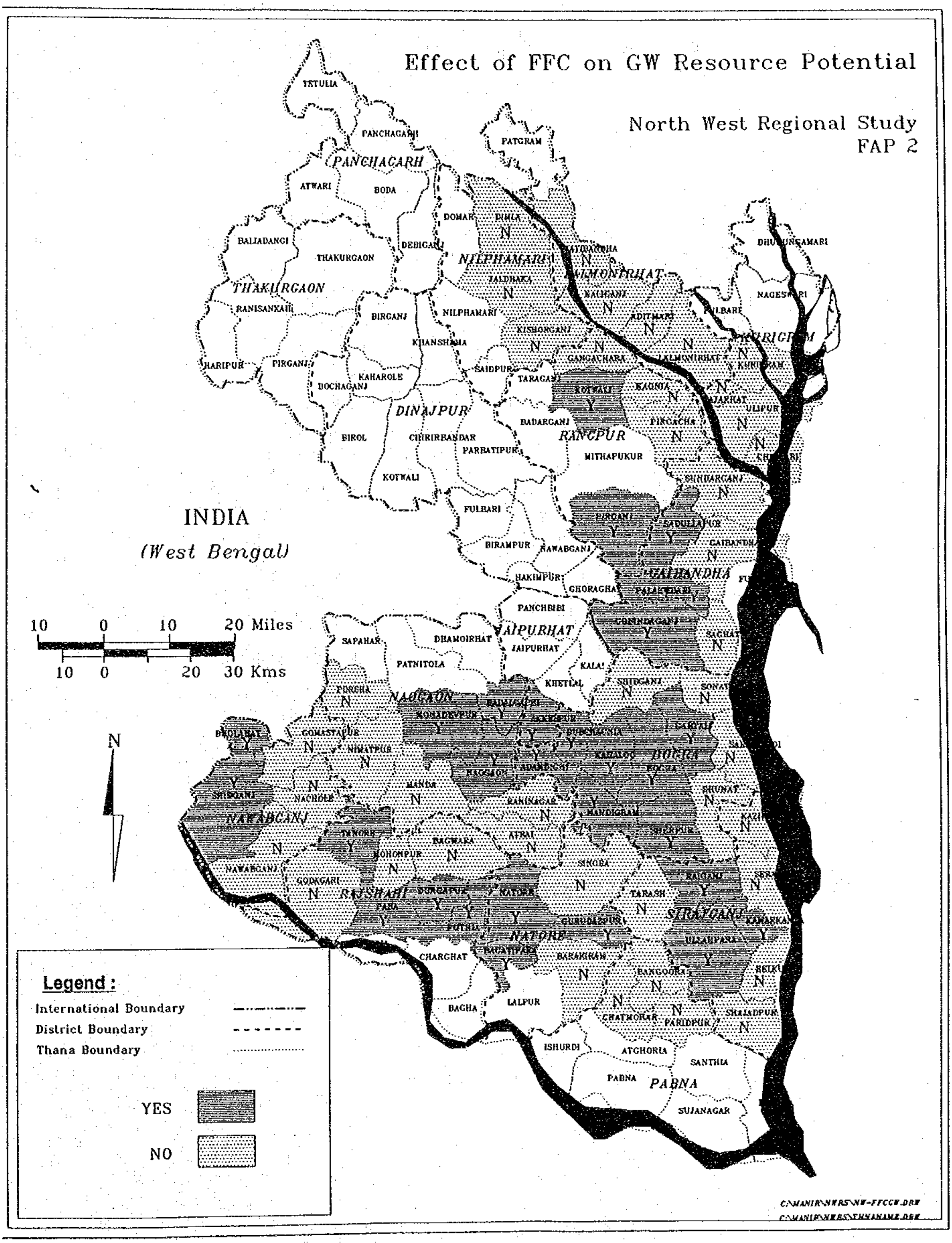


Effect of FFC on GW Resource Potential
North West Regional Study
FAP 2
INDIA
(West Bengal)
10 0 10 20 Miles
10 0 20 30 Kms
N
Legend :
International Boundary
District Boundary
Thana Boundary
YES
NO
PANCHAGARH
THAKURGAON
DINAJPUR
NILPHAMARI
LALMONIRHAT
KURIGRAM
RANGPUR
GAIBANDHA
JAIPURHAT
NAOGAON
BOGRA
NAWABGANJ
RAJSHAHI
NATORE
SIRAJGANJ
PABNA

Figure : 6

Effect of Flood Control on Groundwater Levels

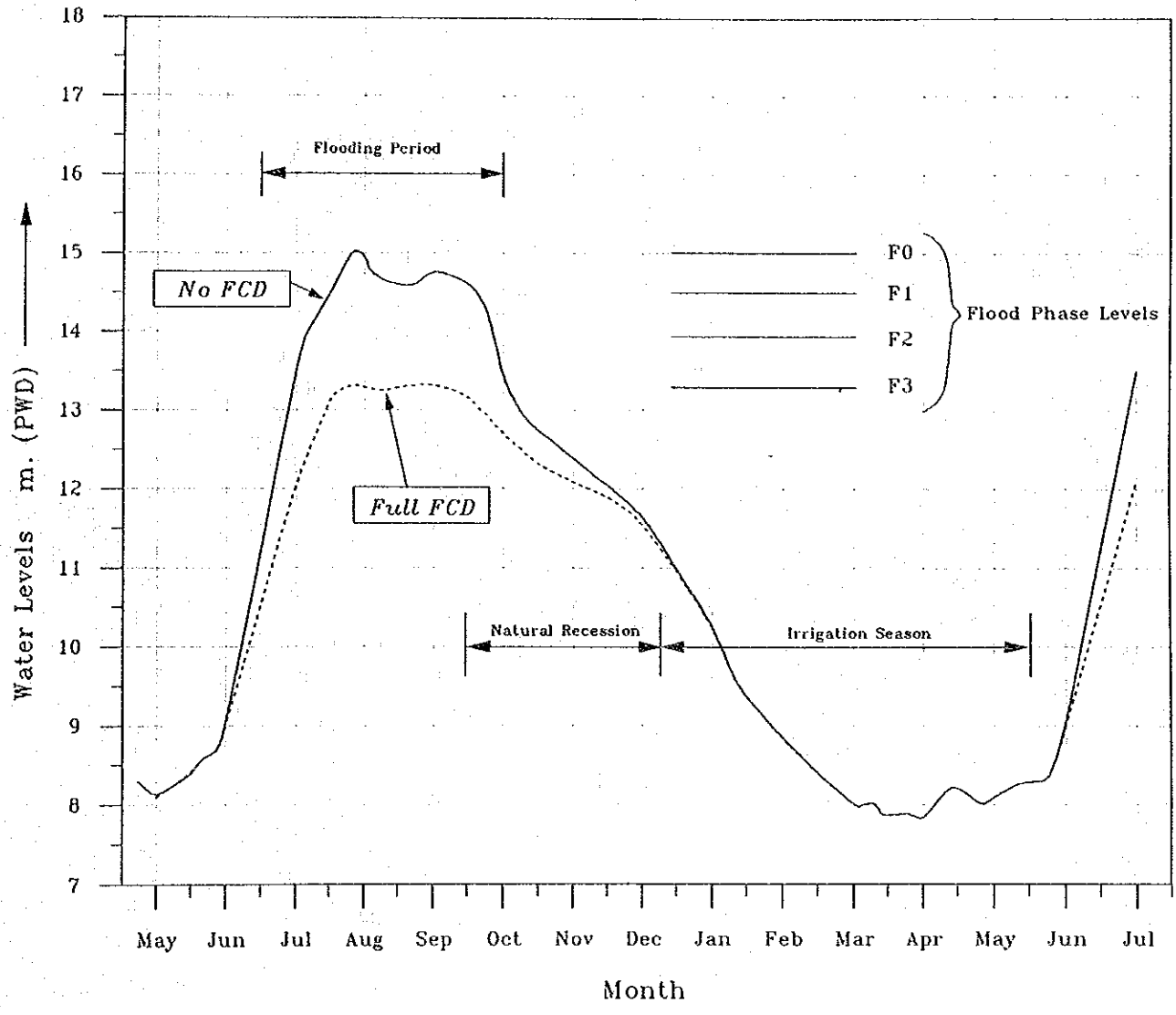
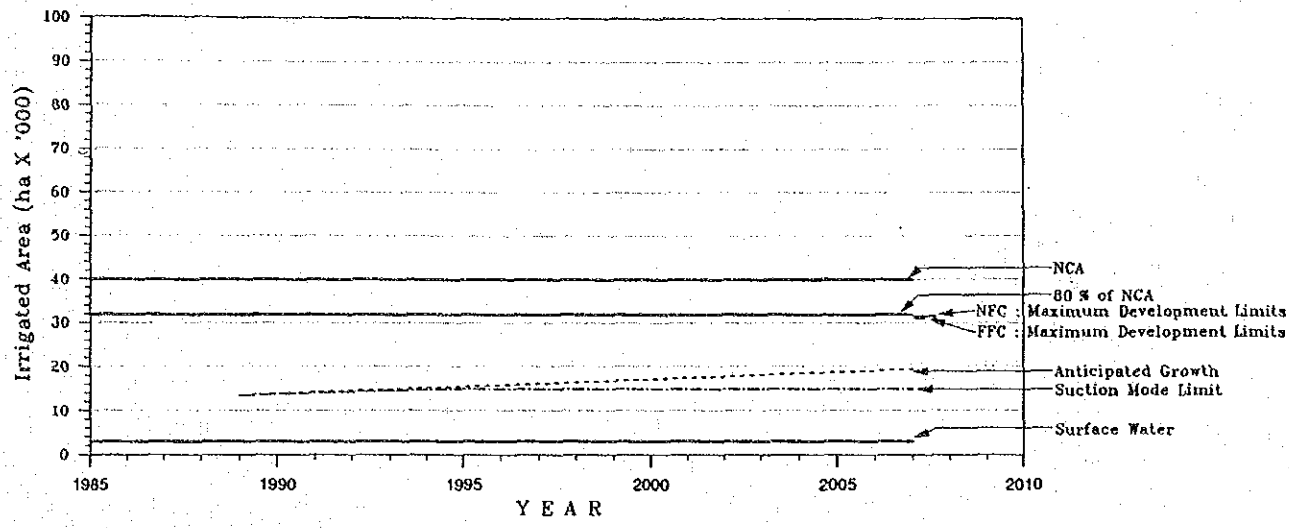


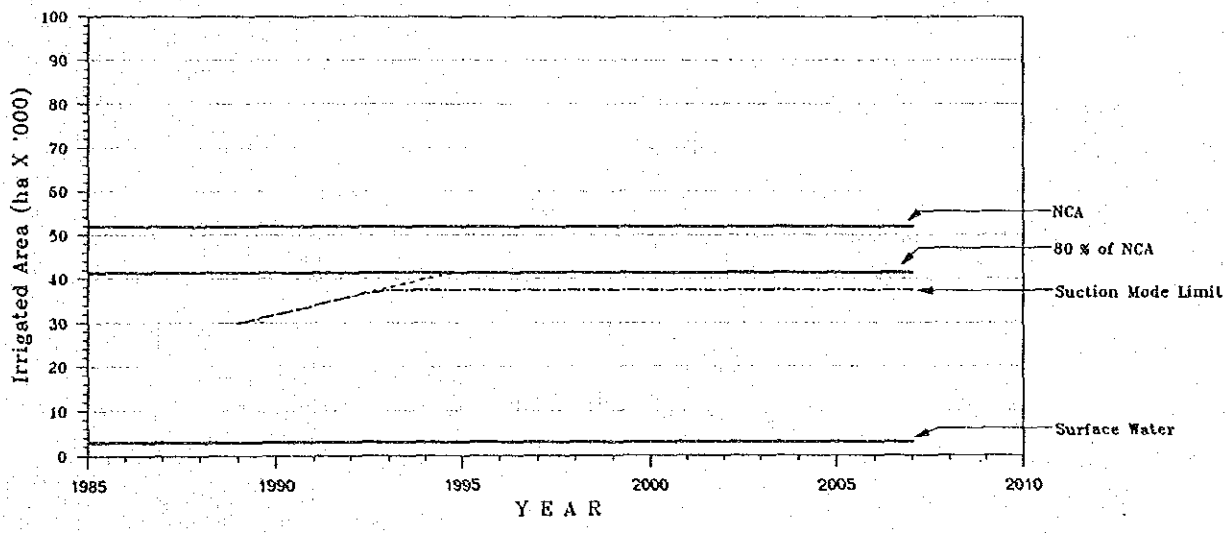
Figure : 7

Project 1 : Naogaon

Tubewell Development Projections



Project 2 : Bogra Polder 2



Project 3 : Bogra Polder 3

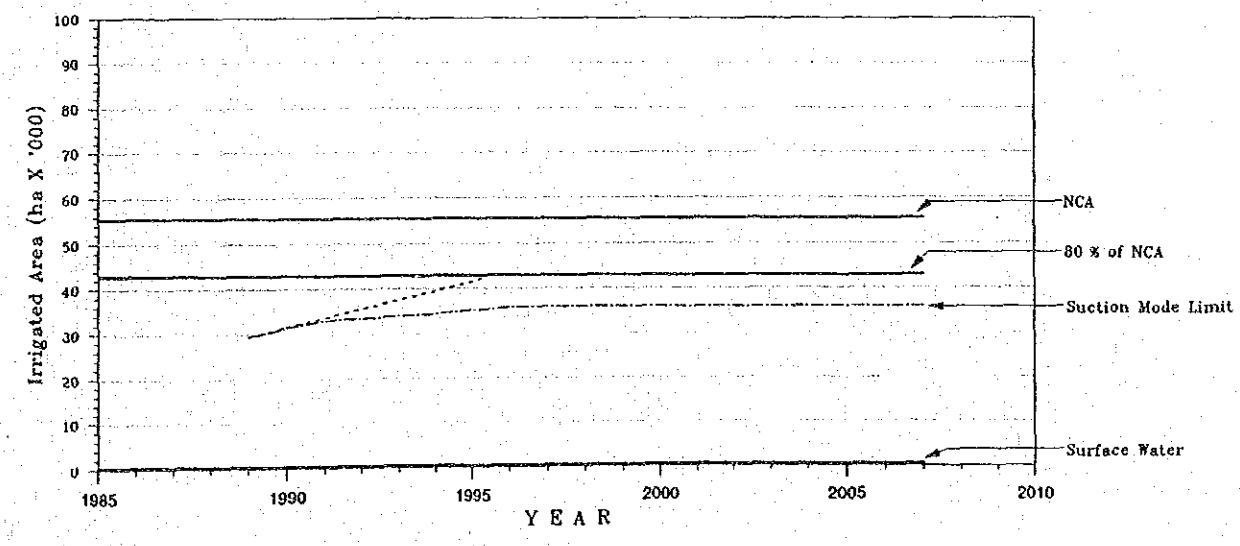


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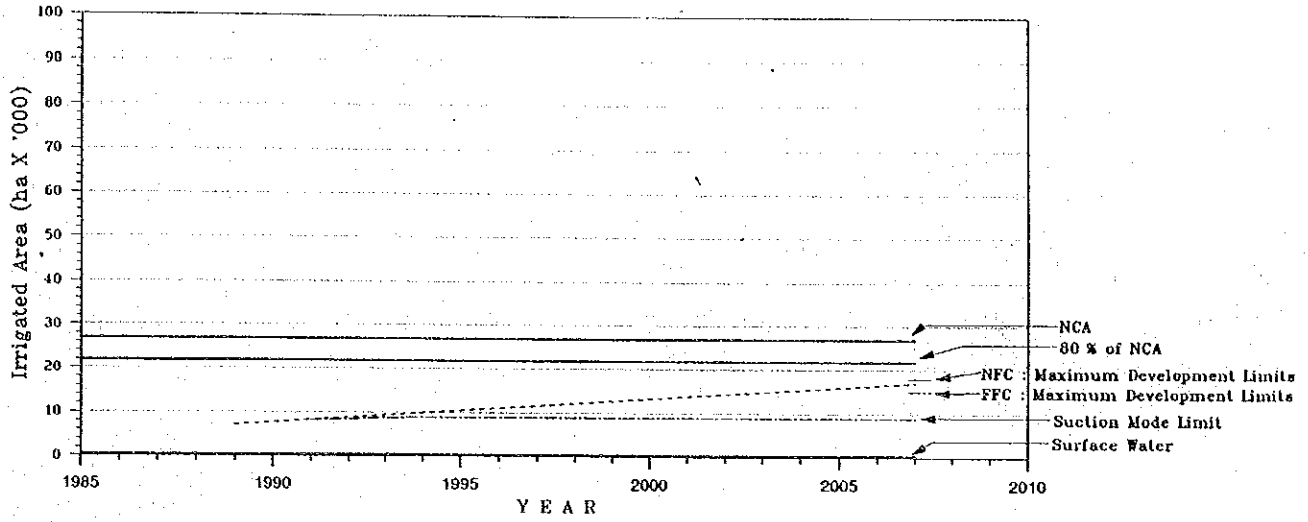
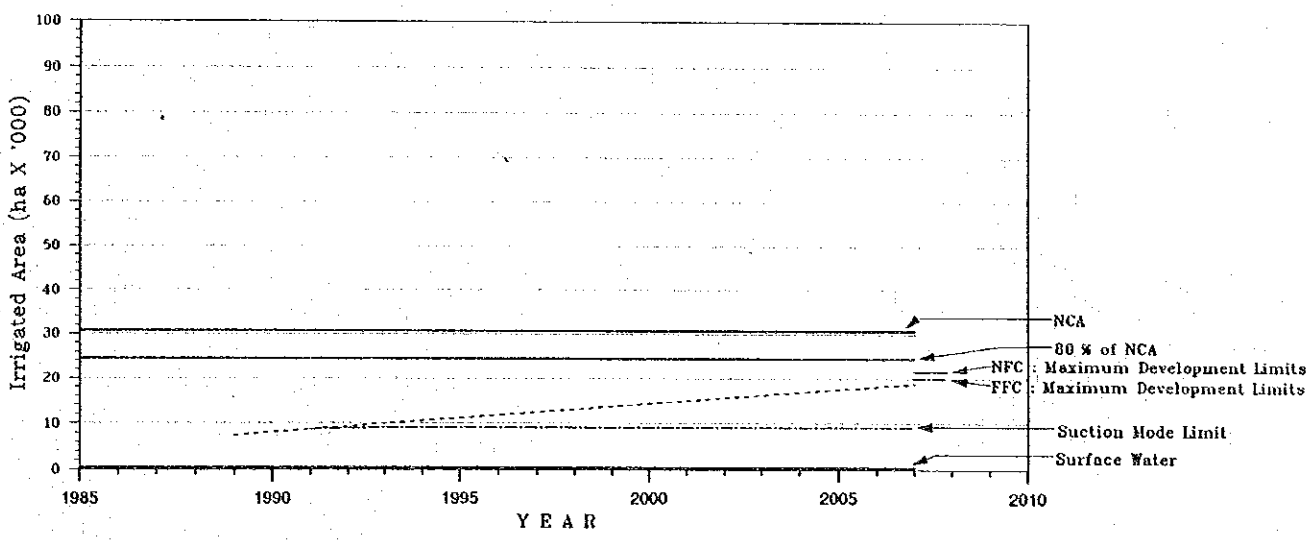
Figure : 8

Tubewell Development Projections

Project 4 : Chalan Beel Polder A



Project 5 : Chalan Beel Polder B



Project 6 : Chalan Beel Polder C

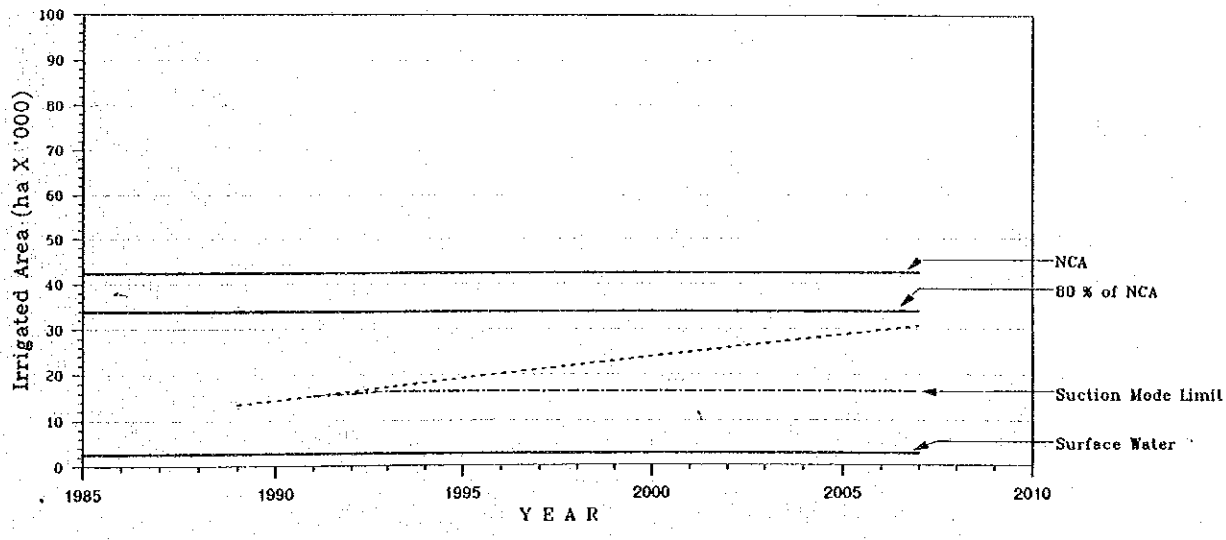


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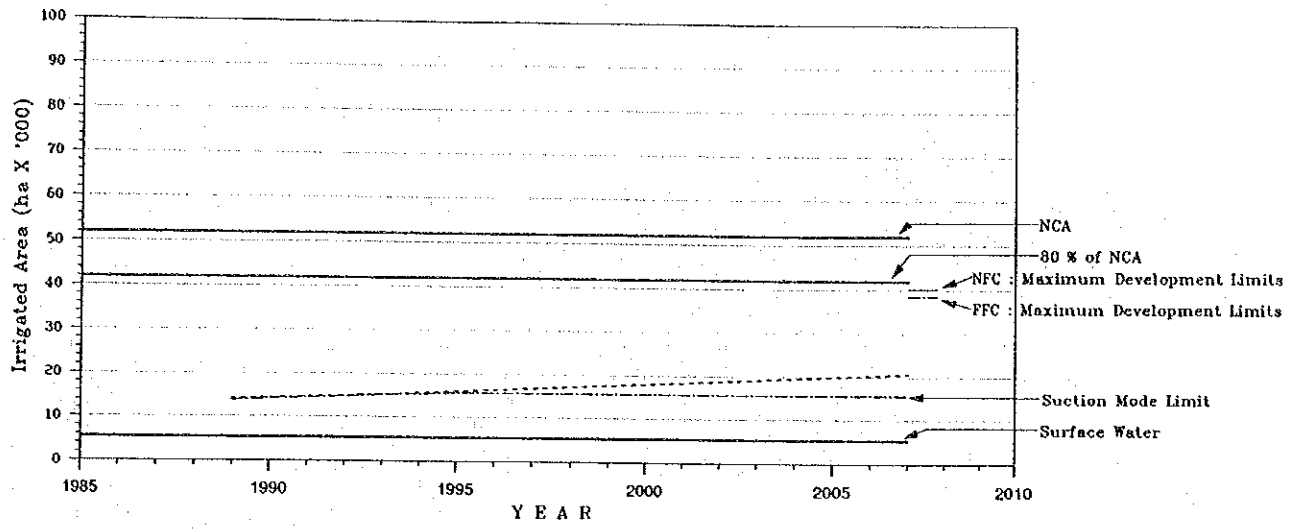
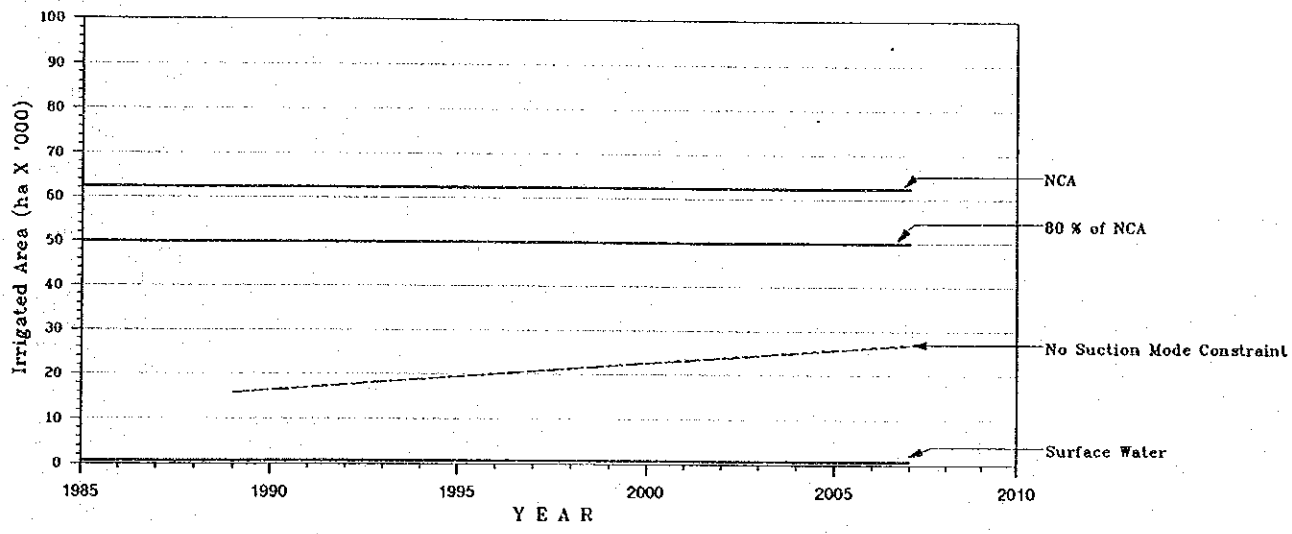
Figure : 9

Tubewell Development Projections

Project 7 : Chalan Beel Polder D



Project 8 : Gaibandha



Project 10 : SIRDP

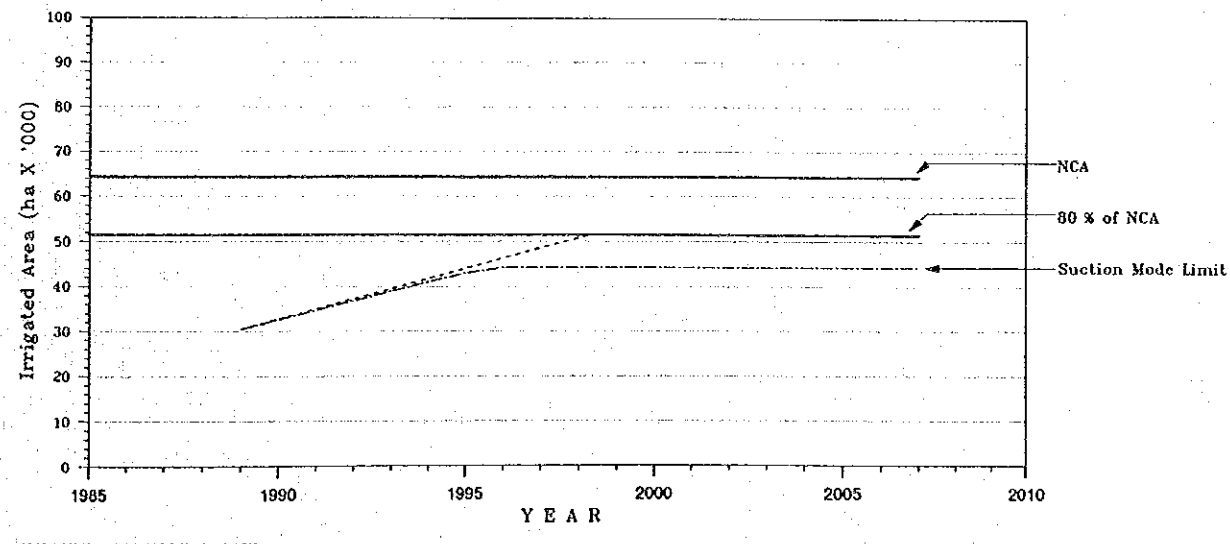


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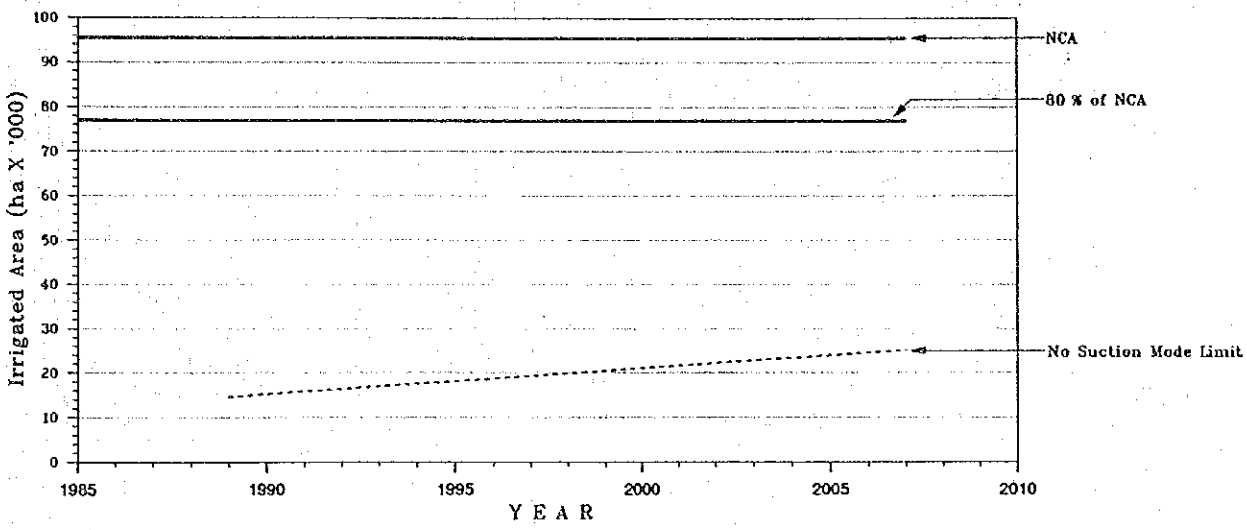
Figure : 10

Tubewell Development Projections

Project 11 : Teesta Right Embankment



Project 12 : Teesta Embankment

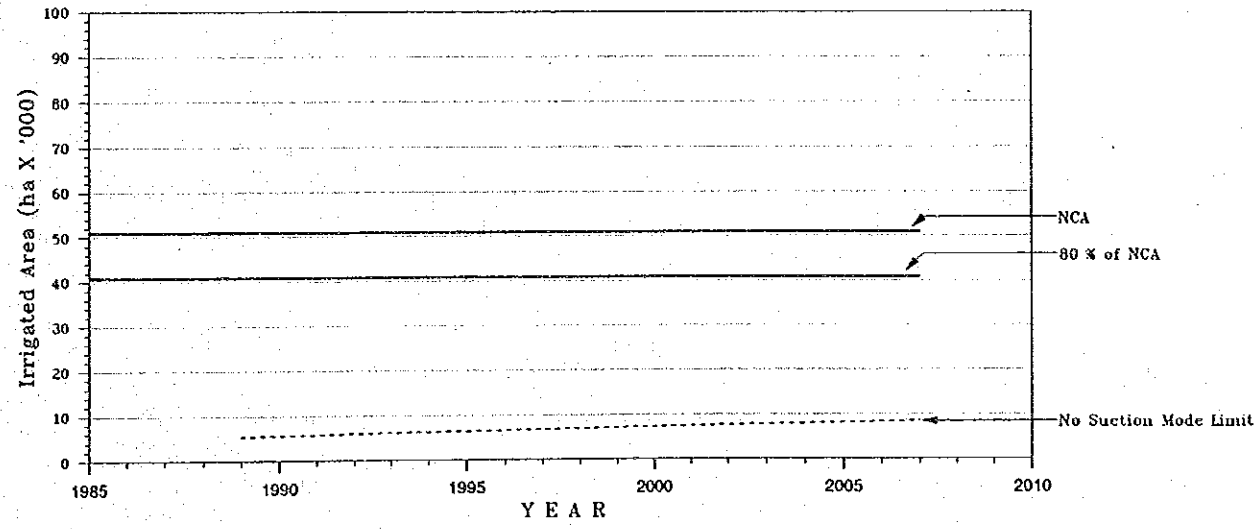


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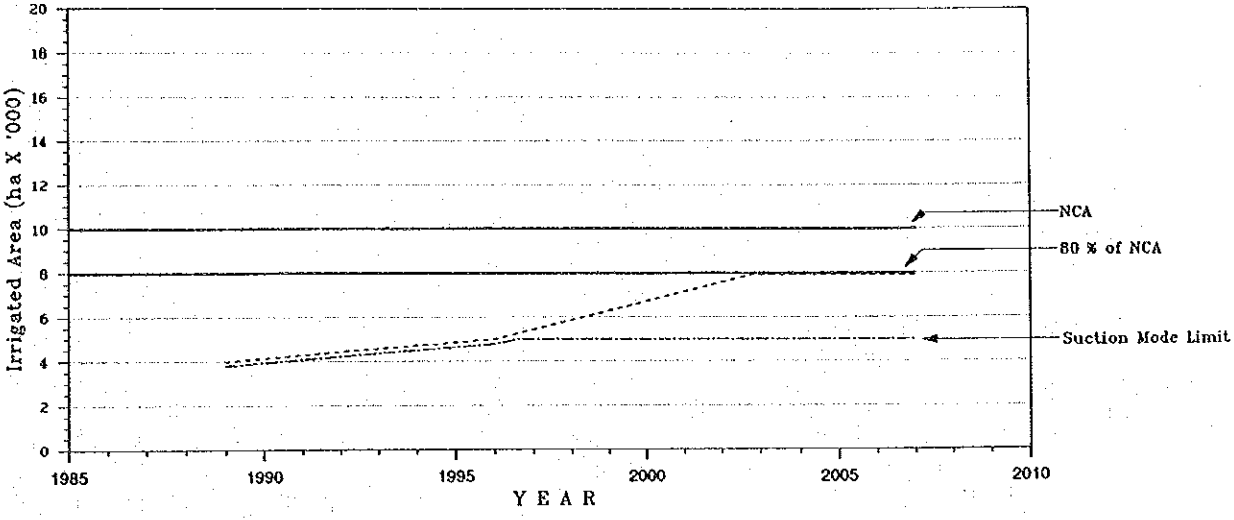
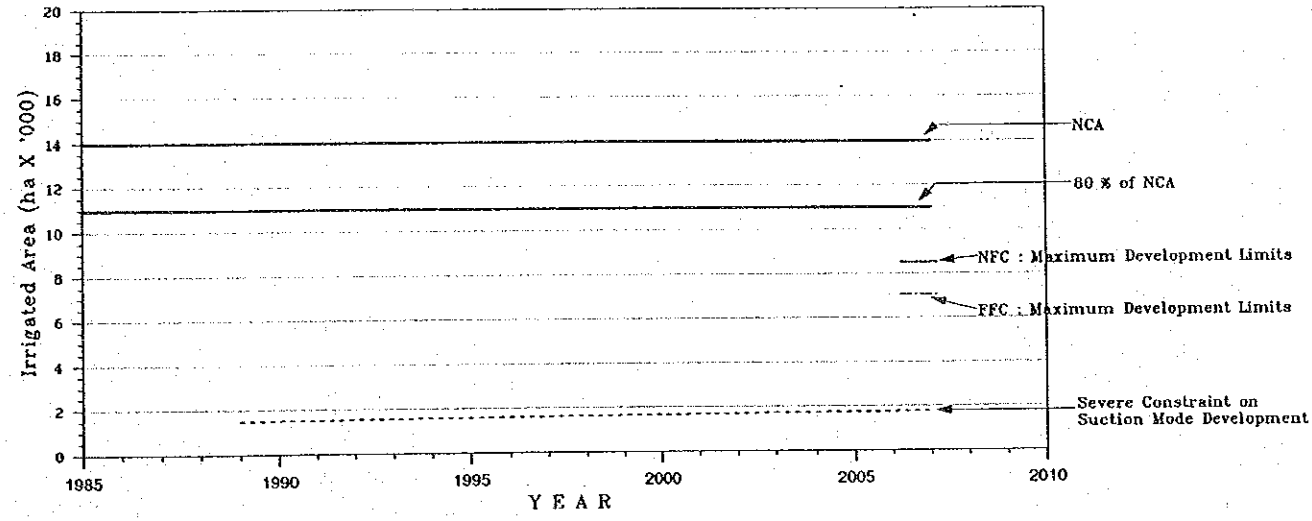
Figure : 11

Tubewell Development Projections

Project 9 : Hurasagar



Project 13 : Mohananda Basin



Project 15 : Upper Karatoya Basin - Unit 1

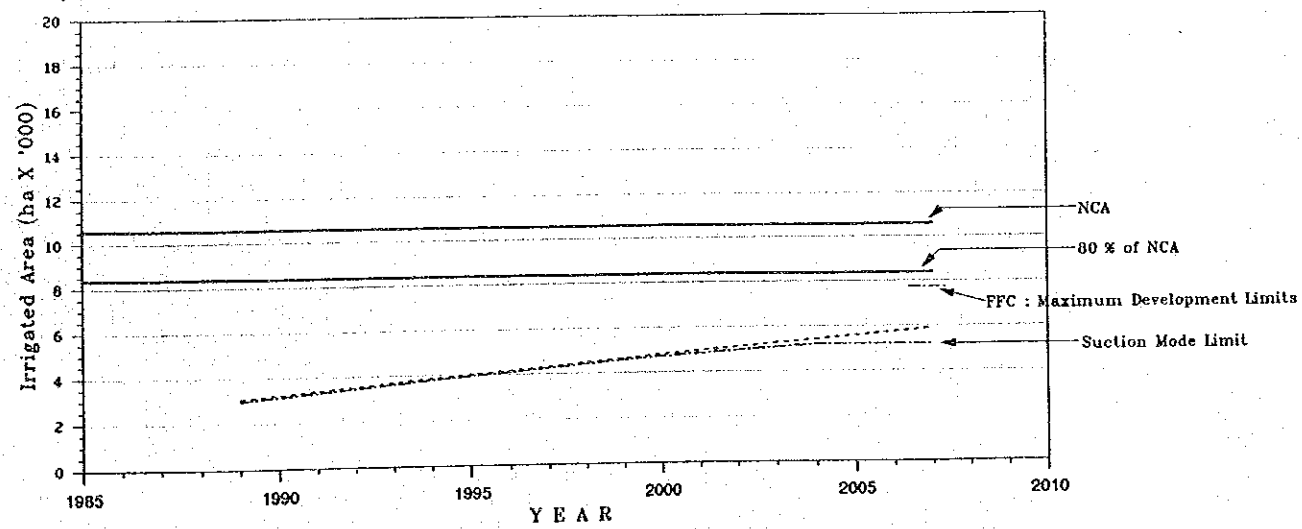


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Figure : 12

Tubewell Development Projections

Project 14 : Middle Bangali Project

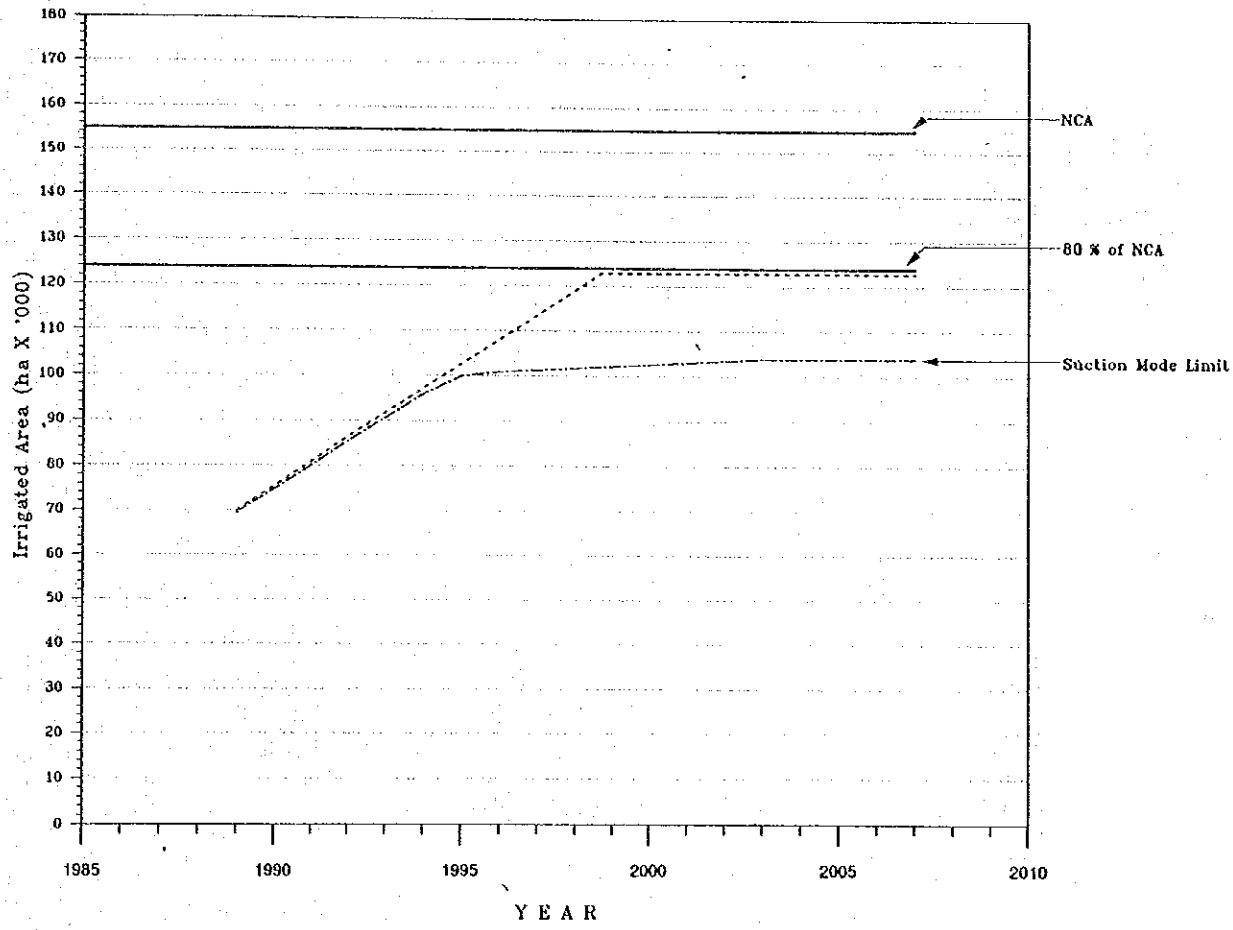

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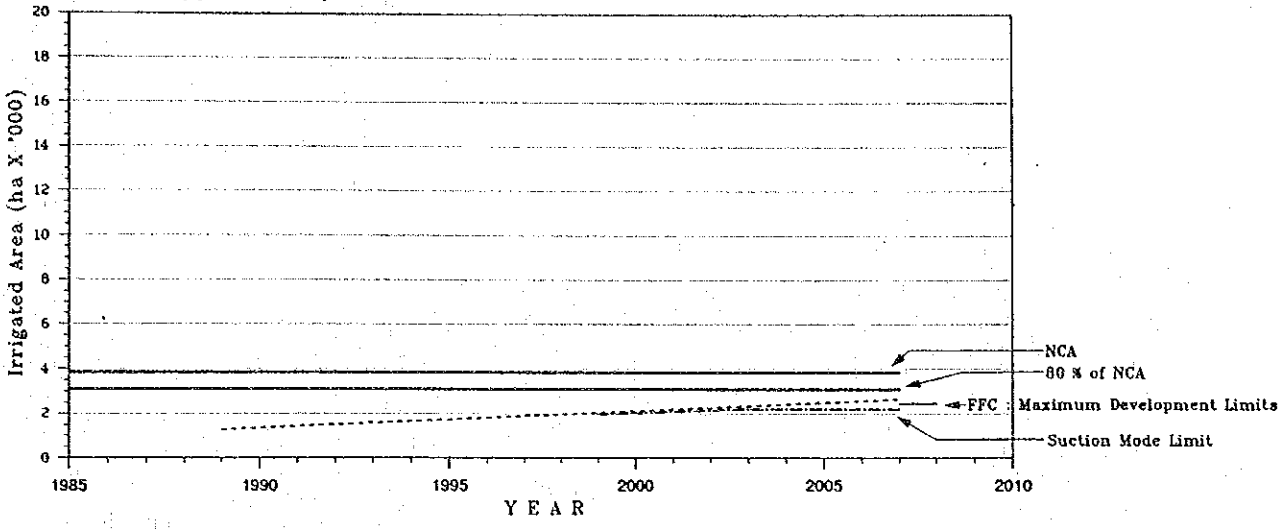
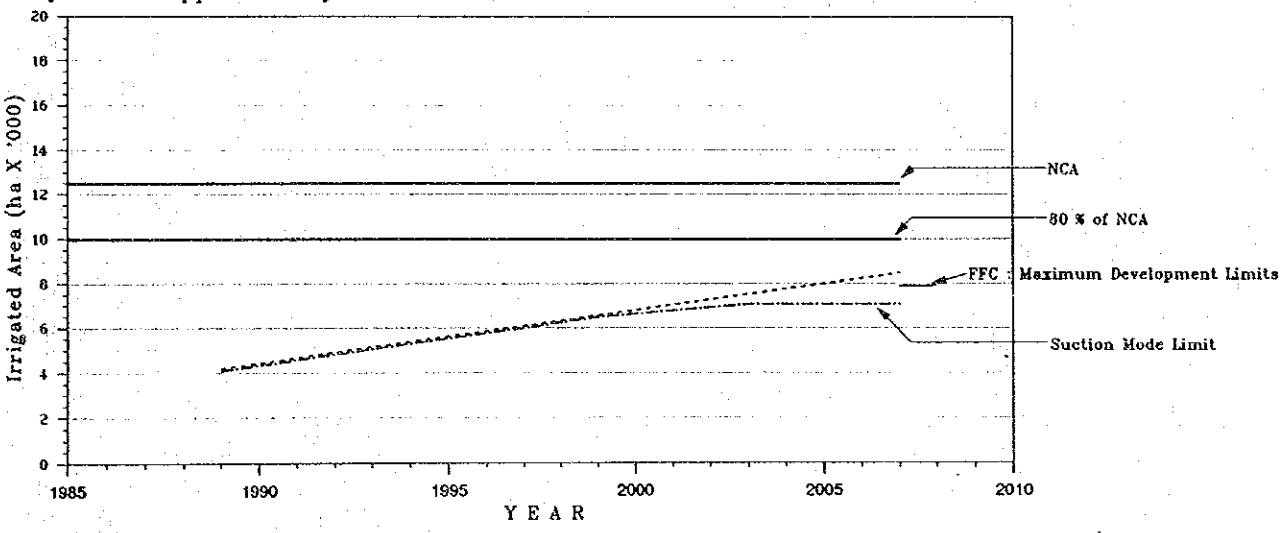
Figure : 13

Tubewell Development Projections

Project 16 : Upper Karatoya Basin - Unit 2



Project 17 : Upper Karatoya Basin - Unit 3



Project 18 : Upper Karatoya Basin - Unit 4

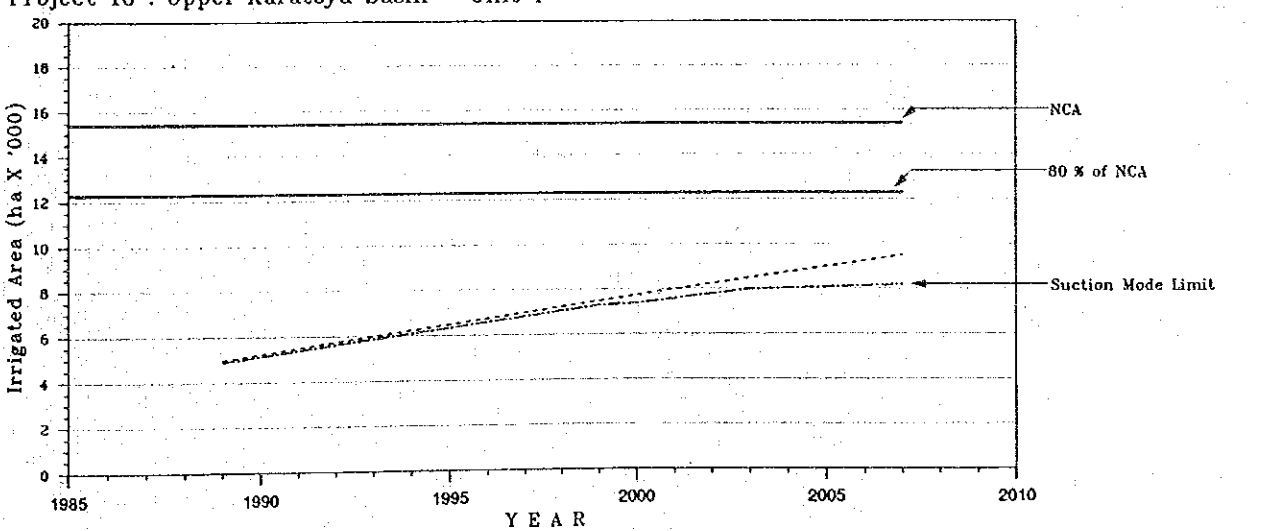


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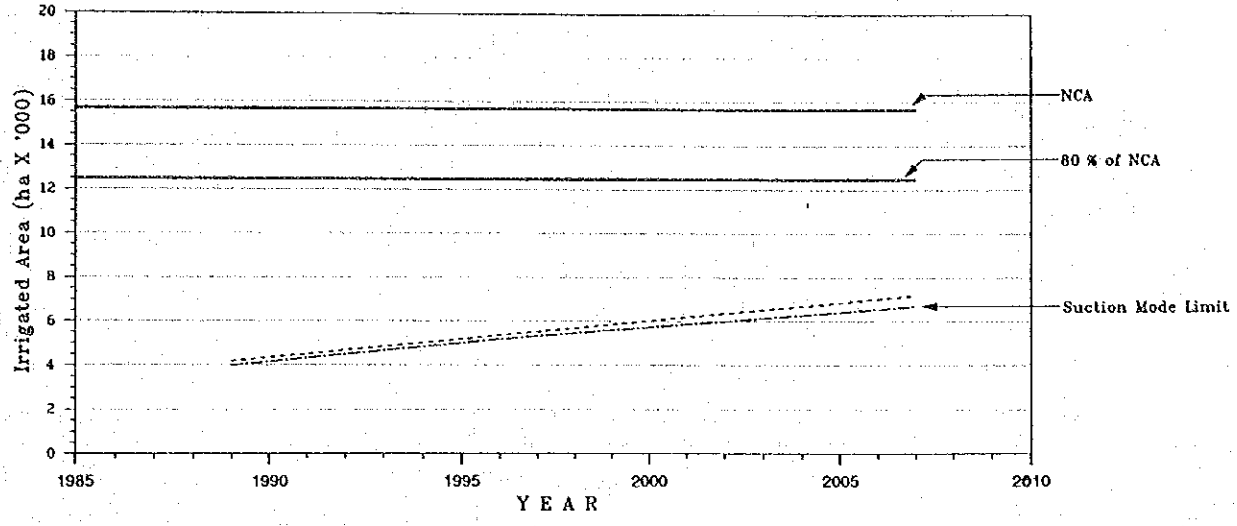
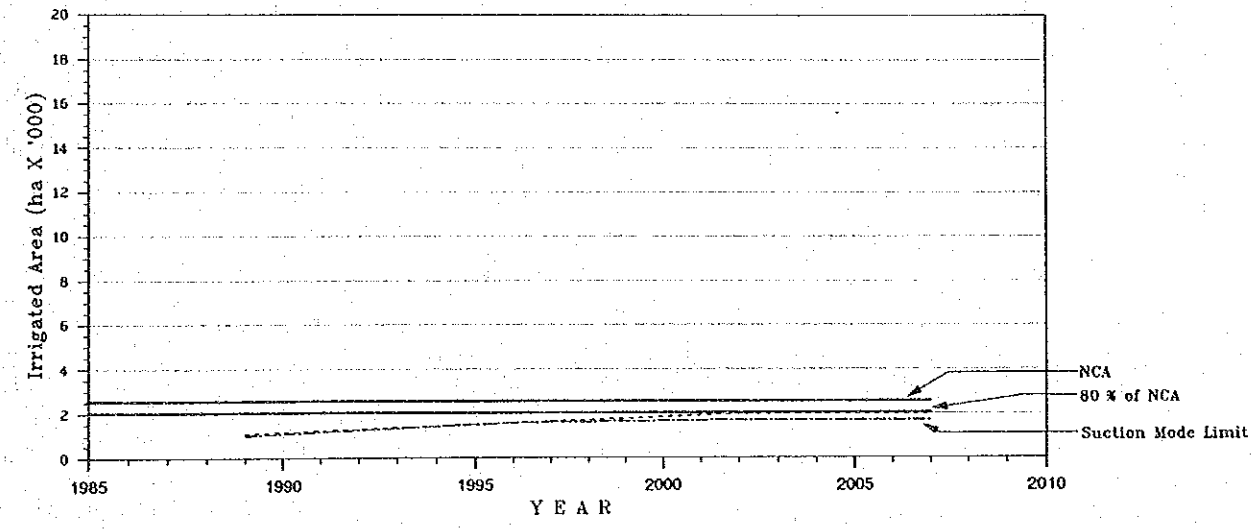
Figure : 14

Tubewell Development Projections

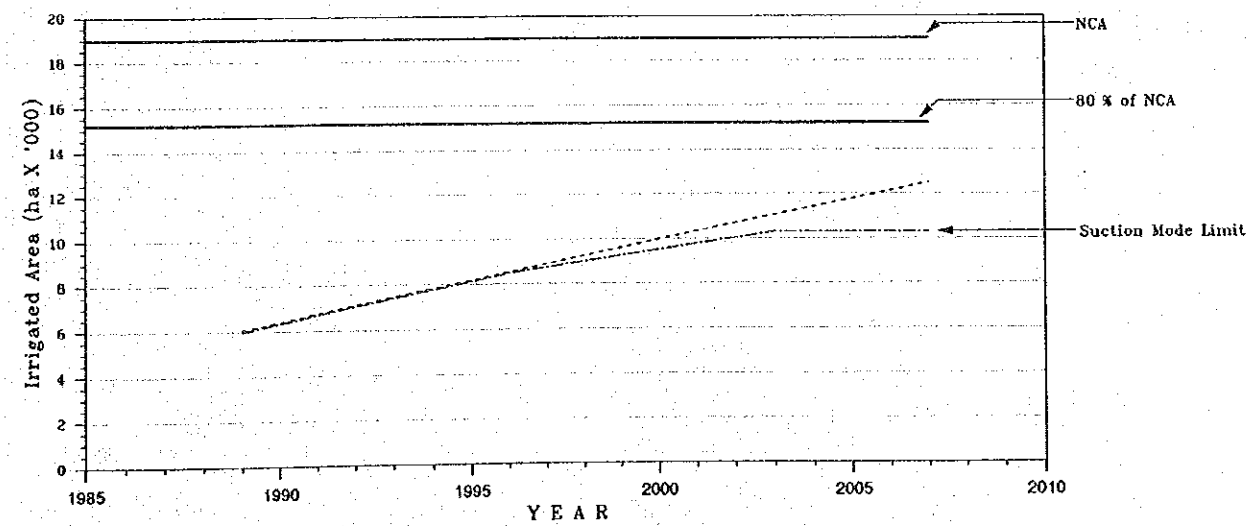
Project 19 : Upper Karatoya Basin - Unit 5



Project 20 : Upper Karatoya Basin - Unit 6



Project 21 : Upper Karatoya Basin - Unit 7



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