



राष्ट्रीय जल विकास अभिकरण

(भारत सरकार जल मंत्रालय के अधिनस्त सोसाइटी)

NATIONAL WATER DEVELOPMENT AGENCY

(A Society under Ministry of Water Resource, Govt. of India)

**PROPOSED BEDTI-VARADA RIVER LINK PROJECT TO
PROVIDE IRRIGATION FACILITES FOR WATER DEFICIT
AREAS OF TUNGABHADRA LEFT BANK CANAL,
RAICHUR DISTRICT, KARNATAKA**

PRELIMINARY FEASIBILITY REPORT

BANGALORE, JULY 1995

Executive Summary

The peninsular rivers development Component of the National Perspective envisages interalia diversion of surplus waters of west Flowing Rivers of Kerala and Karnataka to drought hit regions on the eastern side of the western Ghats. In pursuance to this, the present proposal of the Bedti-Varada link is aimed at diverting 242 mm of surplus waters of Bedti basin to water short Tungabhadra sub-basin to be utilised under Tungabhadra Project command.

The proposal comprises two dams viz., Pattanadahalla on Pattanadahalla stream and Shalamalahalla on Shalamalahalla stream reservoirs are proposed to be connected by an 8.5 km long conveyance system including 2.2 km long tunnel. The water diverted from pattanadahalla reservoir will be let into a stream at the exit of the conveyance system. Leading to Shalamalahalla reservoir. The combined surpluses of Pattanadahalla and Shalamalahalla are proposed to be diverted from Shalamalahalla reservoir and let into a stream leading to Varada River at the end of 14.83 km long conveyance system which includes 6.8 km long tunnel. The diverted water will be lifted by 123.7 m in three stages before letting into Varada River. The requirement of power for lifting the water works out to 61.10 MW.

The annual irrigation proposed under the link is 60,200 ha under left bank canal command of Tungabhadra irrigation project in the drought prone Raichur district of Karnataka.

The diversion through the link is proposed in a period of 214 days from June to December. The canal is designed for carrying peak demands in the month of August.

Two power houses with an installed capacity of 1.8 MW each are proposed at the toe of Pattanadahalla and Shalamalahalla dams. These power houses utilise the water released towards downstream requirement during the period from June to October for power generation.

The total cost of the project has been estimated under three units viz., i) Head works of Pattanadahalla and Shalamalahalla dams and the inter linking system between them. ii) Canal system and iii) lifting arrangements and power house complex. The cost of unit-I works out to Rs.92.51 Crores. while the cost of unit-II is Rs. 30.34 Crores. The cost of unit-III comes to Rs.96.76 Crores. The total cost of the project including establishment and tools and plants works out to Rs.240.27 Crores.

The link project is scheduled to be completed in a span of 7 years. The project will benefit the drought prone Raichur district providing assured supply for irrigation. The constructional activities would provide more employment opportunities resulting in the improved income of the people residing in the project vicinity and their socio-economic development. The benefit cost ratio is calculated based on annual cost and annual benefits which work out to 1.66. The internal rate of return of the project will be 15.30%.

As of now, no adverse effects expected from the implementation of the project.

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Salient Features

1.1	Name of the project	Bedti-Varada Link		
1.2	General			
1.2.1	River basin			
	Name of a) river b) Located in i) state	Bedti and Tungabhadra (sub-basin of Krishna basin) Karnataka		
1.2.2	Name of a) river	Bedti		
	b) Tributary	Pattanadahalla	Shalamalahalla	
	c) State	Karnataka	Karnataka	
	d) District	North canara	North canara	
	i) Reservoir	Sirsi	Sirsi	
	ii) Head works	Sirsi	Sirsi	
	f) village near head works	Siralabail	Hulgol	
1.2.3.1	Location of			
	Head works:			
	a) longitude	74°41'40"E	74°48'32"E	
	b) latitude	14°40'5"N	14°42'48"N	
1.2.3.2	a) Degree sheets	48 J/10	48 J/14	
1.2.4	Access to the project: (distance from project site)			
a	Airport	Dobolim	165 km	185 km
b	Rail head	Talguppa	90 km	70 km
c	River head	Sirsi	30 km	10km
d	Sea port	Ankola	65 km	85 km
E	Sea port	Karwar	100 km	120 km
1.2.5	Estimated life of project : 100 years			
1.3	Type of project	Irrigation project		
1.3.1	Irrigation(ha)			
	Area under (irrigation breakup)	60200		
	Kharif	-		
	Rabi	-		
	Hot weather	-		
	Two seasonal	-		
	Perennial	-		
	Total irrigated area	60200		
	Intensity of irrigation (percent)	80.8		
	b) Cost per hectare of gross area irrigated (at capital cost)	39,912		
	c) Cost per 1000 cum of gross/live storage (at capital cost)	Rs 24517/- for gross storage	Rs.28102/- for live storage	
1.3.2	Power			
	Installed capacity(Mw)	1.8		1.8
	Annual energy			
	i) firm	4.55 M.units		
	ii) secondary	1.80 M.units		
	iii) total	6.35 M.units		
1.3.3	Project performance		Period of simulation	No.of failure
	irrigation		16 years	4 years

1.4	Hydrology			
1.4.1	Catchment			
1.4.1.1	Catchment area at head work site (sq.km)		Pattanadahalla	Shalamalahalla
	gross		52.8	173.5
	intercepted			
	by existing projects		-	-
	By on-going projects		-	-
	By contemplated projects		-	30
	Un-intercepted		52.8	143.75
1.4.1.2	Catchment area (Sq.km)			
	Rain fed		52.8	173.75
	Snow fed		-	-
1.4.2	Precipitation			
1.4.2.1	Catchment	Period of record 1970-71 to 1985-86 rainfall (weighted 'mm')		
		Pattanadahalla		Shalamalahalla
		Annual	Monsoon (June to Oct)	Annual Monsoon (June to Oct.)
	Average	2926	2889	2688 2589
	Maximum	4869	4832	3765 3678
	Minimum	2041	1995	1982 1917
1.4.3	Annual gross yield calculated at the proposed site (Mcum) period of record 1970-71 to 1985-86			
		Pattanadahalla		Shalamalahalla
	Maximum	298		460
	Minimum	112		257
	Average	170		341
	Dependable (%)			
		Annual	Monsoon (June to Oct)	Annual Monsoon (June to Oct.)
	50%	166	164	337 330
	ii) 75%	134	132	287 281
	iii)90%	120	118	266 260
1.4.3.1	Design flood (cumec)	824		1533
1.4.4	Climatic data			
1.4.4.1	Command-Honnavar IMD observatory and period of record 1931 to 1960			
		Normal	Maximum	Minimum
	Air temperature	26.9	32.7	20
	Humidity	76.9	91	61
	Wind (km/hr)	5.4	7.2	4.2
1.4.5	Utilization within the state (Mcum)		242	
1.4.5.2	Committed utilisation		Pattanadahalla	Shalamalahalla
	Upstream projects			
	Projects completed		-	-
	Projects under construction		-	-
	Future projects		-	76
	Any other		-	-
	Down stream projects			
	Project completed		-	-
	Projects under construction		-	-
	Future projects		53 (Pattanadahalla)	41 (Sonda H.E)

		H.E Project)	project)
	Any other	-	-
1.4.5.3	Proposed utilization by the project		
	Kharif	242 Mm ³	
	Rabi	-	
	Total	242 Mm ³	
1.5	Reservoir	Pattanadahalla	Shalamalahalla
1.5.1	Water levels (El-m)		
	Maximum water level	-	-
	Full reservoir level	512.75	480.4
	Minimum draw down level	502.5	464.50
	Dead storage level	502.00	464.00
1.5.2	Free board (m)	3	3
1.5.3	Wave height (m)	-	-
1.5.4	Live storage (M cum)	13	72.5
1.5.5	Capacity at (Mcum)		
	Maximum water level	-	-
	Full reservoir level	18	80
	Minimum draw down level	5	7.5
	Dead storage level	4	7
1.5.6	Sedimentation after (Mcum)	Pattanadahalla in years	Shalamalahalla
		50 100	50 100
	Above MDDL	Not studied	
	Below MDDL	1 2	3.5 7
1.6	Reservoir submergence (ha)	Pattanadahalla	Shalamalahalla
		185	820
1.7	Head works		
1.7.1	Dam		
1.7.1.1	Masonry and concrete dam: (non overflow section)	pattanadahalla	Shalamalahalla
	Type of dam	Concrete gravity	Concrete gravity
	EL of top (m)	515.75	483.4
	EL of deepest foundation (m)	479.5	450.4
	Length at top (m)	720	670
	Length at river bed (m)	25	75
	Width at top (m)	6	6
	Width at deepest bed level (m)	27.6	25
	Maximum height above deepest foundation level m)	36.25	33
1.7.1.2	Spillway (overflow section)		
	Type of spillway	Ogee	Ogee
	Full reservoir level (E1-m)	512.75	480.4
	Maximum water level (E1-m)	-	-
	Length (m)	50	90
	Maximum height above the deepest foundation level (m)	28.5	24.8
	Crest level (E1-m)	507.55	475.20
	No of gates	10	18
	Type of gates	vertical	Vertical

	Size of gate (m)	3.65x5.2	3.58x5.2
	Maximum discharging capacity at FRL (cumec)	901	1609
1.8	Bedti-Varada link canal	Interlinking canal from pattanadahalla to Shalamalahalla reservoir	Link canal from Shalamalahalla to Varada river
	i) Designed discharge at head (cumecs)	12.98	38.13
	ii) Bed width at off-take (m)	3.10	4.75
	iii) Full supply depth at the off-take (m)	2.1	3.15
	iv) bed slope of canal	1:6500	1:6500
	Length of the canal (including tunnel) (km)	8.50	14.83
	Length of tunnel (km)	2.20	6.80
	Diameter of tunnel (m)	3.30	4.9
	Bed slope of tunnel	1:1000	1:1000
	Off-take level of the link canal (m)	501.50(FSL)	502.30(FSL)
	FSL at tail of the link canal (m)	497.08 (FSL)	565.00(FSL)
	Type of canal	Lined canal trapezoidal section with round corners	
	Side slopes	1.5H:1V	1.5H:1V
	Type of tunnel	Modified horse shoe section	
1.9	Total cost of the project	Rs.24024 lakhs	
1.10	Annual benefit	Rs.7075 lakhs	
1.11	Annual cost	Rs.4254 lakhs	
1.11	Benefit cost ratio at 10% interest on capital outlay	1.66	
1.12	Benefit cost ratio with a social rate of discharge of 10%	1.55	
1.13	Internal rate of return	15.30%	
1.14	Annual cost per hectare (Rs)	7066	

Chapter-1 Introduction

1.1 General

Water is the most precious gift of nature, the most crucial for sustaining life and is required in almost all the activities of man, for drinking and municipal uses, for irrigation to meet the growing food and fibre needs, for industries, power generation, navigation and recreation. The development, conservation and use of water, therefore forms one of the main elements in the country's development planning. The water resources in the country are however, limited considering the future demands. Moreover, the rainfall is mostly confined to the monsoon season and is unevenly distributed both in space and time even during the monsoon season. As a result, the country is drought prone, by the turn of the century, water will be scarce resource and therefore, needs to be harnessed in a most scientific and efficient manner.

The erstwhile union Ministry of irrigation and the central water commission formulated in the year 1980, a National Perspective for water resource development which comprises two components viz., the Himalayan rivers development and the peninsular rivers development. The distinctive feature of the National Perspective proposal is that the transfer of water would essentially be by gravity and only in some reaches it would be by lifts not exceeding 120 meters. The proposals are considered technically viable.

The Ministry held discussions with the concerned state Governments in the year 1980 in which initiative taken by the government of India in preparing the National Perspective benefiting various regions was welcomed by the states. The general consensus was that monsoon flood water which otherwise runs waste into the sea should be conserved in various storage reservoirs, big and small and the water conserved should be utilised for irrigation, power generation etc. It was felt that the water availability and requirements of the various river basins should be assessed realistically and the requirements should be met adequately. It was agreed that central government, on its own, will take up studies regarding possibilities of development within the basins as well as outside in order to firm up the quantum of water, if any, available for transfer outside. Agreements regarding allocation of water to the different areas would have to be reached at the political level at the appropriate time within broad framework of national policy for development and use of water. The national water development agency (NWDA) was thus set up in July, 1982, as a registered society, to give concrete shape to the peninsular water resources development.

The peninsular rivers development component envisages, as its first part, the diversion of the surplus flows of the Mahanadi to the Godavari system to the water short Krishna, Pennar and Cauvery basins.

This would benefit the drought prone areas of Andhra Pradesh, Karnataka, Maharashtra, Orissa and Tamil Nadu. The second part is to construct storages and to interlink the small rivers flowing along the west coast, north of Bombay and south of the Tapi for additional water supplies to the Bombay city and partial release of water from Tapi and Narmada to Saurashtra and Kutch areas. The third part envisages interlinking of the southern tributaries of the Yamuna and a dam on the Ken at Greater Ganga and another dam on Yamuna at Panchanad besides construction of small storages in the system to benefit the Ujjain and Indore areas of Madhya Pradesh and the Bundelkhand region of the Uttar Pradesh. The fourth part of the proposal is to divert a part of the waters of the west flowing rivers of Kerala and Karnataka to the east for benefiting the drought prone areas east of the Western Ghats part from bringing new areas on the western side under irrigation. The proposal of the peninsular rivers development

component of the national perspective envisages additional irrigation benefits of 13 million hectares in Andhra Pradesh , Gujarat, Karnataka . Kerala , Madhya pradesh, Maharashtra , Orissa , tamil nadu and uttar Pradesh besides generation of power.

1.2 Diversion from west flowing rivers of Kerala and Karnataka and proposals by other organizations

Due to copious rainfall, the west flowing rivers originating in western ghats carry abundant discharges during monsoon months. Due to steep slope and short lengths of the river, the topography of the region does not permit the utilization of entire waters. This leads to a paradoxical situation in the peninsular Indian region; abundant water and no land to utilise them and vast means of arable land and no water to irrigate them. The areas situated on the eastern side of western ghats receive scanty rainfall being situated in the rain shadow area and are chronically drought affected. The unutilized waters of west flowing rivers if harnessed at suitable locations could be transferred to deficit areas in the east.

Recognising this fact, the committee for assessment of water resources of rivers flowing into Arabian sea and their utilization, proposed three links for diversion of surplus waters of west flowing rivers of Kerala and Karnataka. Bedti-Dharma link for diversion of surplus waters of Bedti basin to Dharma river was one among them.

1.2.1 Bedti-Dharma link

The Bedti-Dharma link proposed by the committee comprises a dam on Bedti river near Kalghatgi village in Dharwad district with a storage capacity of 442 at FRL 564 m. the proposal envisages diversion of 334 Mm³ of Bedti river water into Dharna river, a tributary of Varada river in Tunga-bhadra sub-basin

The govt of Karnataka has proposed a hydro power project down-stream of the dam site proposed by the committee for assessment of water resources of rivers flowing into the Arabian sea and their utilization. The studies carried out by the NWDA at the site propose by govt of Karnataka indicate that no surplus water will be available for diversion at this site after meeting the upstream utilizations and down stream commitments

1.2.2 Proposal by WRDO, Govt of Karnataka:

The water resources development organization (WRDO) of the govt. of Karnataka identified a storage dam on Shalamalahalla stream at Nilkani. This site is a little upstream of the shalamalahalla reservoir proposed by the NWDA. The proposal of WRDO involves diversion of 75.6 Mm³ of water into Varada River, a tributary of Tungabhadra. The requirement of this dam has been taken into account while computing surplus at shalamalahalla dam.

1.3 The Report

This report deals with pre-feasibility study of Bedti-Varada link which form part of peninsular rivers development component of national perspectives. The water balance studies carried out by NWDA indicate that while the Bedti basin is surplus to the order 2428 Mm at 75% dependability (Revised water balance study of bedti sub-basin T.S.No.37), the Tungabhadra basin is deficit to the tune of 303Mm at 75% dependability (revised water balance study of Tungabhadra sub-basin and at Tungabhadra dam site T.S.No.65). The intensity of Irrigation is very less in the left bank canal command of Tungabhadra project presumably due to insufficient water . Keeping in view the objectives of national perspective and in the light of the proposals made by the other organizations for transfer of surplus water of Bedti River could be diverted to Tungabhadra sub-basin. The Pattanadahalla stream and Shalamalahalla stream were

identified as possible storage sites for transfer of surplus waters from Bedti river . The diverted water will be carried through Varada river to Tungabhadra for use in left bank canal command. The proposal involves diversion of surpluswaters from pattanadahalla to Shalamalahalla reservoir through a 8.5 km long conveyance system that includes 2.2 km tunnel from where the combined surpluses of Pattanadahalla and Shalamalahalla will be diverted to Varada river by 14.30 km long Conveyance system including 6.8 km tunnel.

Detailed studies of the alignment of the proposed Badti-Varada link have been carried out on topo sheets to the scale of 1:50,000 based on this alignment , a Toposheet study report of Bedti-Varada link was prepared and circulated to all the concerned during December , 1991. The preliminary feasibility studies are now carried out for this alignment. Plate-1 shows the index map of Bedti-Varada link and plate-2 Vicinity map.

1.4 Link proposals

The bedti-Varada link comprises of the following components :

1. A storage cum diversion dam across pattanadahalla with FRL-512.75m and gross and live storage capacities of 18 Mm³ and 13 Mm³ respectively.
2. A 8.50 km long conveyance system (including 2.2 km long tunnel) connecting pattanadahalla reservoir and shalamalahalla reservoir. The link canal takes off at an elevation of 501.50 m (FSL) and outfall at 497.08 m (FSL) into a stream leading to Shalamalahalla reservoir. The quantum of diversion from pattanadahalla reservoir into shalamalahalla reservoir during the monsoon season varies annually based on the storage and demand position of shalamalahalla reservoir.
3. A storage cum diversion dam across shalamalahalla rive rwith FRL of 480.4m and gross and live storage capacities of 80 Mm³ and 72.5Mm³ respectively.
4. lifting arrangements in three stages for lifting the waters from MDDL of 464.5m of the Shalamalahalla reservoirs into Varada river for further transfer. The total lift involved in three stages is 123.7m.the required discharging capacity of pumps is 33.3 cumecs.
5. A 14.83 km long conveyance system (including 6.8km tunnel) connecting the shalamalahalla reservoir and Varada river. The canal takes off at an elevation of 520.30 m FSL) from the delivery cistern (after an initial lift of 57.80 m from MDDL of Shalamalahalla Reservoir) and discharges into an Varada river at an elevation of 565.0 m (FSL).
6. Two power houses with installed capacity of 1.8 MW each at the toe of pattanadahalla and shalamalahalla dams to utilise the water releases for downstream requirements for power generation

Chapter-2 Hydrology

2.1 General

This chapter deals with the assessment of water balance at shalamalahalla and pattanadahalla damsites in Bedti basin. The NWDA has already prepared a preliminary water balances study of Bedti basin upto pattanadahalla and Shalamalahalla damsites (Technical study no. 133). A brief of relevant details are presented in the following paragraphs :

2.2 Bedti basin

The bedti river (also called as Gangavali in lower reaches) is one of the principal west flowing rivers in the karnataka state. The Bedti basin lies between east longitudes of $74^{\circ}17'$ and $75^{\circ}12'$ and north latitudes of $14^{\circ}32'$ and $15^{\circ}27'$. the catchment area of the basin is 3902 km^2 which lies in Dharwad and North Kanara districts of Karnataka.

The streams Shalamalahalla and Bedti halla join near Kalghatgi town and form the bedti river. Bedti halla and shalamalahalla streams rises from the range of hills in the west and south of Dharwad district of Karnataka at an elevation of 700 m above the MSL. The total length of the river from source to its outfall into sea near Gokarna is about 152 Km. Sonda is tributary of the Bedti river and below its confluence with Bedti the Bedti popularly known as Gangavali River

2.3 Bedti basin upto the pattanadahalla and shalamalahalla damsites:

The catchment area of the Bedti basin upto Pattanadahalla damsite is 52.80 km^2 and that upto shalamalahalla damsite is 173.75 km^2 and lies between latitudes $14^{\circ}35'N$ to $14^{\circ}43'N$ and longitude $74^{\circ}37'E$ to $74^{\circ}53'E$. The entire catchment area upto these damsites is 5.8%of the total area of bedti basin and entirely lies in the Sirsi taluk of North Kanara district.

2.3.1 Water balance study at pattanadahalla and shalamalahalla damsites by NWDA

The detailed computation of water balance upto Pattanadahalla and Shalamalahalla damsites are given in the preliminary water balance study at the above two damsites (NWDA tech.study No.133). The location of Pattanadahalla damsite is shifted upstream by about 4.5 km as from the location indicated in the preliminary water balance study . therefore the yield and requirement have been worked out on prorata basis with reference to the catchment areas. The surface water balance at 75% dependability , at the pattanadahalla damsite & Shalamalahalla damsites after considering import,export, water needs and regeneration by 2025 AD are assessed to be 80 Mm^3 and 167 Mm^3 respectively. The cumulative surface water balance upto shalamalahalla at 75 % dependability is 247 Mm^3 (excluding reservoir evaporation losses) and out of which 242 Mm^3 is proposed to be diverted to varada rivere in Tungabhadra sub-basin. The details of surface water balance are furnished in table 2.1. the yield series upto Pattanadahalla and Shalamalahalla damsite are given in Annexures 2.1 & 2.2 respectively.

Table 2.1 Surface water balance at pattanadahalla and Shalamalahalla

		Pattanadahalla damsite (Mm3)	Shalamalahalla Damsite (Mm3)
i)	Gross annual yield at 75% dependability	134	287
ii)	Surface water : Import (+) Export (-)	Nil Nil	Nil 76
iii)	Overall availability	134	211
iv)	Surface water requirement for : Irrigation domestic use Industrial use Hydro-power generation (downstream release) SUB TOTAL Say	.82 .45 .64 53 54.91 55	2.68 1.48 2.11 41.00 47.27 47
v)	Regeneration from (+) Irrigation Domestic Industrial use SUB TOTAL Say	NIL 0.36 0.51 0.87 1	
vi)	Surface water balance at 75% dependability	80	167

Note: * The requirement for hydropower generation show against Pattanadahalla dam is different from that indicated in preliminary water balance study at Shalamahalla and Pattanadahalla dam sites (Page 42). The Pattanadahalla dam site has been shifted by 4.5 km upstream from the earlier location increasing the free catchment between the damsites proposed by NWDA and that of KPC which result in higher yields from the free catchment. As such there is a reduction in the committed release downstream of Pattanadahalla dam site.

2.4 Tungabhadra sub-basin

The river Tungabhadra is formed by the confluence of Tunga and Bhadra rivers. The river Tunga and Bhadra rises in the western ghats in the Varaha Bravata hills at Gangamula at an elevation of about 1198 m above MSL. The total length of river Tungabhadra river is 531km. The catchment area lies between latitudes 13°08' and 16°17'N and 74°50' and 78°20'E. The catchment area of the sub-basin is 47827 km² out of which 38790 km² lies in Karnataka and 9037 km² lies in Andhra Pradesh. Varada and Hagani are the two important tributaries of Tungabhadra river.

Chapter-3 Head works

3.1 General

The head works of this project consists of two dams viz., pattanadahalla dam on pattanadahalla stream and shalamalahalla dam on shalamalahalla stream and interlinking system between these two reservoirs. The FRL of the pattanadahalla dam is proposed at 512.75 m and that of Shalamalahalla dam at 480.4 m. The locations of the dams and interlinking systems are shown in plate 3 and 4.

The head works are located in the reserve forests of the western Ghats. In view of the uncertainty about the availability of suitable materials at reasonable lead for the construction of earth/rockfill dams. Construction of concrete dams is preferred. Brief details of the head works of the project are given in the following paragraphs.

3.2 Pattanadahalla dam:

3.2.1 Location of head works:

The proposed damsite is located at latitude 14° 40' 05" N and longitude 74° 41' 40"E near Siralabail village in Sirsi taluk of North Kanara district of Karnataka.

3.2.2 Topography, Physiography and geology of the project area:

The area at the project site is hilly and covered with thick forest. The left bank of damsite is steeper than the right bank. As per the geological and mineral map of Karnataka and Goa published by Geological Survey of India in August 1981, the most prominent rock formation at the Pattanadahalla dam site are granites, metabasalt, greywacke- argillite and ultramafics. Field verification or surveys have however not been undertaken by the N.W.D.A.

3.2.3 Hydraulic and structural aspects of dam

The head works at pattanadahalla dam includes :

50 m long spill way in river portion

Non-over-flow section of 670 m on both sides of the spillway.

3.2.3.1 Spillway

The spillway with crest level at 507.55 m is proposed across river course to dispose of the maximum flood discharge of 901 cumecs through 10 gates of 3.65(m)*5.2 (m). Details of spillway calculations are given in Annexure 3.1.

3.2.3.2 Non-overflow dam

The non-overflow concrete dam is 36.25 m high above deepest foundation level. A road way of 6m wide is provided at the top of the dam. The upstream face of the dam is vertical from EL +479.5 m to EL 485.0 m and from EL 495.0 m to EL 515.75 m to EL 505.25m and from EL 505.25 to foundation level the slope is 0.8H to 1 V. The base width at deepest foundation level is 27.60 m. The typical section of the dam is given in plate-5.

3.3 Shalamalahalla dam

3.3.1 Location of head works:

The proposed dam site is located at latitude 14°42'48" and longitude 74°48'32"E about 0.5 km from Hulgol village in sirsi taluk of North Kanara district of Karnataka. The Hulgol is situated on fair weather metalled road connecting Sirsi and Hulgol via Sonda.

3.3.2 Topography, Physiography and geology of the project area

The area of the project site is hilly and is covered by thick forest. The left bank of the river at the dam site is much steeper compared to the right bank. As per the geological and mineral map of Karnataka and Goa published by the Geological Survey of India in August 1981, the most prominent rock formations at the Shalamalahalla dam site are dolerite, amphibolite, dykes and geywack, argillite. Field investigations or surveys have however not been carried out by the NWDA.

3.3.3 Hydraulic and structural aspects of dam

The head works at Shalamalahalla dam includes :

90 m long spillway in river portion.

Non-overflow section of 580 m on both sides of spillway.

3.3.4 Spillway:

The spillway with crest level at 475.20 m is proposed across the river course to dispose of the maximum flood discharge of 1609 cumecs. through 18 gates of 3.58 m x 5.2 m. Details of spillway are given in Annexure 3.2.

3.3.3.2 Non overflow dam

The non-overflow concrete dam is 33 m high above deepest foundation level. A roadway of 6 m wide is provided at the top of the dam. The upstream face of the dam is vertical from EL 483.4 m to EL 465.0 m and from EL 455 m to EL 450.4 m and has a slope of 1:10 from EL 483.4 m to EL 472.9 m and from EL 472.9 to deepest foundation level the slope is 0.8 H: 1V. The base width at deepest foundation level is 25 m. The typical section of the plan is given in plate-5.

3.4 Inter linking system from pattanadahalla to shalamalahalla

An interlinking system of 8.5 km length comprising of 2.2 km modified horse shoe tunnel and a trapezoidal open canal 6.3 km, length will divert the water from pattanadahalla to shalamalahalla. The link canal will take off at FSL 501.5 m and discharges at EL 497.8 m into a stream leading to shalamalahalla reservoir. The salient features of Shalamalahalla and pattanadahalla reservoirs are given in Annexure- 3.3.

3.5 Fixation of Storage capacities

3.5.1 Dead storage

The catchment area upto the two dam sites viz., the Shalamalahalla and the pattanadahalla are mostly covered by thick forest and by rocks at fringes. As such, the silt load is expected to be small in comparison to other basins entirely with open catchment. In the absence of any observed silt load data at the proposed dam sites, a sediment inflow rate of 398.61 m³/km²/year of the catchment as proposed by the Karnataka Power Corporation in their projects envisaged in the Bedti basin has been assumed for working out the silt load. Based on the expected silt accumulation in the two reservoirs after 100 years. The dead storages and dead storage levels have been fixed for the reservoirs using the area capacity curves.

Sl.No	Reservoirs	Catchment area (km ²)	Silt accumulation in 100 years (Mm ³)
1.	Shalamalahalla	173.75	7
2.	Pattanadahalla	52.8	2

Though silt accumulation for pattanadahalla reservoirs over 100 years is 2Mm³ for fixing dead storage level, dead storage capacity is taken as 4 Mm³ and levels are fixed

accordingly. The dead storage levels are 464.00 m for shalamalahalla and 502.00 m for pattanadahalla.

3.5.2 Live storage

The live storage required at the two reservoirs have been worked out keeping in view the surplus water available for diversion at these two reservoirs after meeting the upstream uses and committed downstream requirement for the Hydel power projects of the Karnataka power corporation. In the integrated operations of the two reservoirs considered, the water of pattanadahalla reservoir is diverted to shalamalahalla reservoir to the extent so as to meet the shortage after taking into consideration of the storage available at shalamalahalla reservoir, inflow into reservoir, demands for down stream requirement and monthly diversion required for crop water requirement in the command of LBC of Tungabhadra project from Shalamalahalla. As 95% of the rainfall occurs in monsoon period, it is proposed to store and divert water to the maximum quantity as may be possible in every monsoon month, the full reservoir levels (FRLS) have been fixed for the two reservoirs using respective area capacity curves. The proposed live and gross storages and their FRLS for the two reservoirs are as follows:

Sl.No	Reservoir	Live storage (Mm ³)	Gross storage (Mm ³)	FRL (m)
1	Shalamalahalla	72.5	80	480.4
2	Pattanadahalla	3	18	512.75

3.6 Working tables of Bedti varada link

3.6.1 Simulation Study

The simulation study of pattanadahalla and shalamalahalla reservoirs has been carried out with following assumptions:

1. Evaporation losses of the reservoirs are treated as Nil, as the total evaporation losses are less than 1Mm³ for each project
2. The initial storage of pattanadahalla and shalamalahalla reservoirs are taken as dead storage ½ of the live storage.
3. Operation policy:

a) Shalamalahalla reservoir:

The continuity equation adopted at this reservoir is

$$S_{t+1} = S_t + I_t + R_t - D_t - Q_t$$

Where

S_{t+1} = Storage at the end of the tth period

S_t = Storage at the beginning of the tth period

I_t = Inflows during the 't' th period

R_t = diverted flows from pattanadahalla reservoir during the tth period

D_t = committed requirements both upstream and downstream during the tth period.

Q_t = quantity diverted to varada river during the tth period.

The operation policy at shalamalahalla is to accord priority to committed downstream releases. The Karnataka Govt has proposed a hydropower project namely Sona Hydro electric project downstream of Shalamalahalla. The balance quantum of water required for power generation due to interception of the catchment by the proposal of NWDA is met by committed downstream releases. Deficits, if any in meeting

the irrigation requirements/downstream requirements at shalamalahalla reservoir will be met from storages of pattanadahalla reservoir.

b) Pattanadalla reservoir :

The continuity equation adopted at this reservoir is

$$S_{t+1}=S_t + I_t + R_t -D_t -Q_t$$

Where

S_{t+1} =Storage at the end of the tth period

S_t =Storage at the beginning of the tth period

I_t = Inflows during the 't' th period

R_t = diverted flows from pattanadahalla reservoir during the tth period

D_t = committed requirements both upstream and downstream during the tth period.

Q_t =quantity diverted to varada river during the tth period.

The operation policy at Pattanadahalla is such that the downstream requirements get the priority. The Government of Karnataka has proposed a hydro-electric project namely Pattanadahalla Hydro-electric project downstream of NWDA's proposal. The reduction in the quantum of water available for power generation due to interception of the catchment by the proposal of NWDA is met by committed downstream releases, Deficits, if any in meeting the irrigation requirements/ downstream requirements at Shalamalahalla reservoir will be met from storages of Pattanadahalla reservoir.

The integrated working tables of pattanadahalla and shalamalahalla reservoirs have been prepared for the period 1970-71 to 1985-86. The monthly working tables are given in Annexures 3.4.1 to 3.4.8. the working tables indicate that the link is able to meet the requirements in 12 out of 16 years.

The criteria adopted to restrict the height of the dams is as follows:

1. The waters are to be transferred only during june to December
2. No provision is made to transfer the water during rabi season. By doing so , constructions of large storages, which may become uneconomical due to topographical restrictions have been avoided.
3. Up stream and down stream commitments are taken into account.
4. On the basis of the above criteria, gross storage capacities of 18 Mm³ and 80 Mm³ are provided in the pattanadahalla and shalamalahalla reservoirs respectively.

The Tungabhadra project is already under operation. However, the data on actual utilizations by left bank canal during kharif season were not available. The area to be benefited by the diverted water from shalamalahalla of the bedti basin has been arrived on the basis of average delta worked out with suitable cropping pattern under left bank canal by climatological method with the assumption that 75% success of the project is assured.

Chapter - 4 Conveyance system

4.1 General

The alignment of the proposed Bedti-varada link canal has been marked on toposheets to the scale of 1:50,000. The conveyance system of proposed link has two components 1) Interlinking of pattanadahalla and shalamalahalla reservoirs and 2) Link canal/tunnel from shalamalahalla reservoir to tributary of varada river. The inter linking system of pattanadahalla and shalamalahalla reservoir is 8.5 km long including 2.2 km long tunnel. The conveyance system from shalamalahalla reservoir to varada river is 14.83 km long including 6.8 km long tunnel. The canal off takes from shalamalahalla reservoir at FSL 520.3m after an initial lift of 57.8 m and outfalls into a stream leading to varada river FSL 565.0 m with another lift of 65.90 m in two stages of 25.78 , and 40.12m. plates 3 and 4 show the alignment of link canal. Palte-6 shows the L-section of link canal/tunnel from pattanadahalla to shalamalahalla reservoir, and plate-7 shows the L-section of link canal/tunnel from shalamalahalla to the stream leading to varada river. The reach wise description of the alignment is given in the following paragraphs.

4.2 Description of alignment

4.2.1 Interlinking system between pattanadahalla and shalamalahalla reservoirs

An open canal taking off from the pattanadahalla reservoir at FSL 501.5 m will deliver the water into a tunnel proposed to negotiate hill ranges after traversing a distance of 1.7 km. The tunnel has a length of 2.2 km and discharges the diverted water into an open canal at its exit. The open canal taking off from the exit of tunnel at FSL 497.79 m will discharge the water into a stream leading to shalamalahalla reservoir after flowing for 4.6 km at FSL 497.08 m .The total length of interlinking system is 8.5 km comprising 2.2 km long tunnel.

The design of canal are given in Annexure 4.1 and the cross section details of canal/tunnel are shown in plate-8. The canal will have dimensions of 3.1 m x 2.1 m and the modified horse shoe tunnel has a diameter of 3.3 m.

4.2.1.1 Reach from R.D 0.00 km to 1.70 Km

An open Trapezoidal canal, takes off at FSL 501.50 m from pattanadahalla reservoir to carry the diverted water. It passes through a dense forest upto 1.7 km. The canal will discharge water into a tunnel at R.D 1.70 km. The FSL of the canal at the end of the reach is +501.24 m.

4.2.1.2 Reach from R.D 1.70km to 3.9 Km

In this reach a modified horse shoe type lined tunnel of dia 3.3 m with bed slope of 1:1000 is proposed to cross the ridge. The tunnel discharges water into an open canal at R.D. 3.9 km.

4.2.1.3 Reach from R.D 3.90 km to 8.5 km

An open canal is proposed to carry the diverted water from the exit of the tunnel with an FSL of 479.79 m. the canal outfalls into a stream, leading to shalamalahalla reservoir at FSL 497.08m. The canal outfalls into a stream, leading to Shalamalahalla reservoir at FSL 497.08 m. The canal crosses two roads at R.D. 7.95 km and to R.D. 8.30 km, where road bridges are proposed.

4.2.2 conveyance system from Shalamalahalla reservoir to the tributary of Varada river

The combined surpluses of the pattanadahalla and shalamalahalla reservoirs are proposed to be lifted into the delivery cistern situated at an elevation of 522.3 m. An open canal takes off from this delivery cistern and runs for 6.72 km before discharging into tunnel with lifts in two stages at RD 2.7 km and at RD 5.55 km. Two balancing reservoirs are proposed to facilitate lifting. A tunnel of length 0.48 km discharges water into an open canal which again discharges water into another tunnel. This tunnel runs up to RD 13.03 km before discharging into open canal which runs the water to the stream leading to varada river. The total length of conveyance system is 14.83 km including 6.8 km tunnel. Plate -8 shows the cross section of canal/tunnel. The detailed computations of the design of canal/tunnel are given at annexure 4.2. the reachwise description of link is given below:

4.2.2.1 Reach from RD 0 km to RD 2.7 km

The FRL and MDDL of shalamalahalla reservoir are fixed at 480.4m and 464.5 m respectively. The diverted waters from shalamalahalla reservoir will be lifted by 57.80 m by means of 11 pumps and discharged into a delivery cistern located at an elevation of 522.3 m. the power requirement for this lift will be around 26.6 MW

A contour open canal of trapezoidal shape takes off from delivery cistern at FSL 520.3m and it passes through forest area in this reach and discharges into a balancing reservoir at RD 2.7 km. the FSL at the end of the reach is 519.77 m.

4.2.2.2 Reach from RD 2.7 km to 5.55 km

The diverted water received at the balancing reservoir is proposed to be lifted by 25.78 m by means of 11 pumps by consuming 13.09 MW of power. The pumped water will be delivered into a delivery cistern located at an elevation of 542.66 m.

An open canal takes off at an elevation of + 540.66 m (FSL) from the delivery cistern and runs upto R.D.5.55 km. In this reach, the canal crosses one road at R.D. 2.90 km a valley from 4.10 km to 4.60 km and a small nalla at 5.23 km requiring construction of a road bridge, an aquaduct and an under tunnel at these locations respectivel. The canal discharges the water into a balancing reservoir at R.D. 5.55 km. The FSL at the end of the reach is 539.86 m.

4.2.2.3 Reach from RD 5.55 km to 5.75 km

The water received at the balancing reservoir is proposed to be lifted by 40.12 m by means of 11 pumps consuming 21.41 MW of power. The lifted waters will be dischraged into a delivery cistern at the elevation of + 576.98 m.

A open canal takes off from delivery cistern at + 574.98 m (FSL) and runs upto R.D. 5.75 km before discharging water into a tunnel at RD 5.75 km at + 574.95 m (FSL).

4.2.2.4 Reach from R.D 5.75 km to 6.23 km

In this reach, modified horse shoe type tunnel of 4.9 diameter will carry the water through the hills and dischrages into a open canal at RD 6.23 km at + 573.22 m (FSL).

4.2.2.5 Reach from RD 6.23 to 6.71 km

In this reachof the open canal, the canal crosses a stream at R.D.6.48 km where an aquaduct is proposed. The canal then discharge the water into a tunnel at RD 6.71 km at + 572.85 m (FSL).

4.2.2.6 Reach from R.D 6.71 km to 13.03 km

A modified horse shoe type tunnel is proposed to carry the water in this reach to cross the mountain range. The diameter of the tunnel is proposed at 4.9 m. The tunnel will discharge water into a open canal at RD 12.64 km at 565.28 m (FSL).

4.2.2.7 Reach from R.D 13.03 km to 14.83 km

In this reach an open canal carries the waters upto its outfall into a stream at 565 m (FSL), which ultimately leads to the Varada river.

Chapter-5 Canal Structure

5.1 General

The link canal is aligned as a contour canal, wherever feasible and wherever the canal comes across streams roads etc., cross drainage and cross masonry works have been proposed. Since the system has to cross Western Ghats, most of its length has to be designed as tunnel. Due to limitations in the availability of sufficient data and for want of field investigations and surveys, no detailed design of cross drainage works have been made in this report.

5.2 Details of cross drainage works

5.2.1 Interlinking system from pattanadahalla to Shalamalahalla:

In this entire run of 8.5 km (including 2.2 km long tunnel) the canal has been provided with two road bridges as the canal crosses two roads at RD 7.95 km and RD 8.30 km.

5.2.2 Link from shalamalahalla reservoir to Varada river

In the entire run of 14.83 km (including 6.8 km long tunnel) the canal has been provided with one road bridge, two aqueducts and one under tunnel, as the canal crosses road a RD 2.9 km streams at R.D 4.1 km , RD 6.48km and RD 5.23 km respectively.

5.3 Aqueducts

Aqueducts have been proposed for the link canal at the crossing of the streams where the bed level of the canal is above the high flood level of the stream. A head loss of 0.3 m has been assumed at each aqueduct . The location of aqueducts are shown in the longitudinal section of the link canal (plate -7).

5.4 under tunnels

Under tunnels have been proposed for the link canal at the crossing of small drain. A head loss of 0.03 m has been assumed at the under tunnel. The location is shown in longitudinal section of the link canal. (plate-7)

5.5 cross masonry works

The requirement of bridge across the canal has been ascertained from the details of existing roads and cart tracks crossing the alignment. The location of road bridges are shown in longitudinal sections of link canal (plate-6 and 7).

5.6 Outfall structure

A notch type outfall structure is proposed at R.D 8.5 km at the end of conveyance system between pattanadahalla and shalamalahalla reservoirs and at R.D 14.83 km of conveyance system from Shalamalahalla reservoir to Varada river.

Chapter – 6 Environmental aspects

Environmental aspects:

6.1 General

To provide food shelter and fibre to mankind, development of water resources is essential and consequently interference with the environment is unavoidable. The environment is degraded by inappropriate planning. In respect of disturbance of environment there are two schools of thoughts. One school holds that ecological systems are fragile and highly unstable. It is implicit therefore, that environment should be left as much as possible, in its natural state and that its diversity should be preserved at any cost. Modification for the purpose of development should be minimal and confined to the range of tolerance limits of elements of ecological system. The second school of thought assures that environment is globally stable and there is large element of built-in resilience in ecological system. In any case it is essential to understand and analyse the impact on environment while undertaking water resources development project. A brief account of environmental aspects of creating storages at Shalamahalla and Pattanadahalla dam sites are given in this chapter.

6.2 Reservoir submergence

6.2.1 Pattanadahalla reservoir

Based on the studies on toposheets of 1:50,000 scale it is observed that, at FRL 512.75 m, about 185 ha of area is in Sirsi taluk of North Kanara district would come under submergence of which, 154 ha is forest land, 24 ha is cultivable land, and 16 ha is under non-agricultural use. No important historical monuments and archaeological structures will be coming under submergence. No roads/railway lines will be submerged. Provision for compensatory afforestation on account of submergence of forests up to FRL of Deam has been made in the cost estimates.

6.2.2 Shalamahalla reservoir

Based on the studies on toposheets of 1:50,000 scale it is observed that at FRL 480.4 m, an area of about 820 ha would come under submergence of which 642 ha is forest land, 106 ha is cultivable land and 72 hectares is non-agricultural land. No important historical monuments and archaeological structures are coming under submergence. Provision for compensatory afforestation on account of submergence of forest land up to FRL has been made in the cost estimates.

6.3 Rehabilitation

Due to construction of proposed two dams, one village i.e., Hulgol with a population of 967 in the Sirsi taluk of North Kanara district of Karnataka will be submerged. This displaced person will have to be resettled at a suitable place and cultivable land will have to be provided to them. In addition to this some permanent huts are also getting affected. These permanent huts are generally used by the labourers. These labourers are to be rehabilitated at suitable places. It is preferable to rehabilitate these persons where comparatively more amenities are available with respect to the facilities available at their original settlements.

6.4 Flora and Fauna

The copious rainfall and topography of the catchments provide ideal conditions for rich growth of varied flora in the catchment. The flora can generally be classified as trees, shrubs and creepers. A variety of dominant and codominant species of trees and shrubs and creepers exist in the evergreen, semi-green moist deciduous forest and green

land. The important species of trees available are teak wood, Bamboo, palmyra, Eucalyptus etc. The shrubs include coffee and tea. A variety of rich fauna is found in the catchment. The Mammalian fauna commonly found in the forest are cat, tiger, jackal, fox, sambar, spotted deer, Nilgai, rabbit, pig, monkey etc. Reptilian fauna found in the catchment are great monitor, lizard, python and cobra. Fishes of many kinds are also found in the river. Besides, birds such as jungle fowls, Quails, king crow, horn bills, pigeons etc., are also found in the catchment.

Chapter -7 Command area

Command area:

7.1 General

The Tungabhadra project is an interstate project between Karnataka and Andhra Pradesh constructed on Tungabhadra river, which is tributary of river Krishna. The water from this project is to be utilized by the two states as per the Krishna Water Dispute Tribunal award. It is proposed to utilize the waters of Bedti under left bank canal of Tungabhadra project during Kharif season which lies entirely in Karnataka portion. The water will extend the irrigation facilities to additional areas in the drought prone Raichur district which are not covered at present under the left bank canal command. The status of the irrigation in Tungabhadra sub-basin of the Krishna basin is discussed below.

The revised water balance study report of Tungabhadra sub-basin (Technical study No.65) prepared by the National Water Development Agency indicates that, the sub-basin had a maximum culturable area of 3365134 ha in the year 1978-79. The ultimate annual irrigation from existing, ongoing and future identified major, medium and minor projects 2025 A.D is assessed as 1009540 ha i.e (30% of the culturable area), from existing projects , 38483 ha (1.1 % of culturable area) from ongoing projects and 196334 ha (5.8 % of culturable area) from future identified projects. The entire Tungabhadra sub basin has been assessed as deficit to the order of 833 Mm³ and at Tungabhadra damsite, magnitude of deficit is of the order of 1735 Mm³ at 75% dependability after considering all inbasin requirements for domestic, irrigation and industries. The return flows has been considered as 10% of net surface water utilization from major and medium projects with utilisation of 85Mm³ or more and 80% of the surface water utilization for domestic and industrial purposes. The intensity of the irrigation of various projects in the sub basin varies between 35% and 160%. The main crops grown in the sub basin are paddy, wheat, jowar, Bajra , Ragi , maize, grams, pulses, sugarcane, chillies, ground nut, sesamum and cotton. Being deficit the irrigation intensity is less under Tungabhadra project which covers mostly drought areas. The diverted water from the bedti basin is proposed to be used in the command area of the left bank canal of the Tungabhadra project for irrigation of an additional area of 60200 ha annually in the Kharif season with a delta of 0.402 m. palte-9 shows the command area of Tungabhadra left bank canal.

7.2 Soils

Based on the information provided by the state soil survey agencies of Karnataka and Andhrapradesh, the soils in the command of Tungabhadra irrigation project can be broadly identified as Red sandy soil, Medium black soil, mixed red and black soil and deep black soil in Bellary and Raichur districts of Karnataka and red earth and black cotton soil in Kurnool districts of Andhra Pradesh. The irrigation is being already in practice under LBC of Tungabhadra project, it is assumed that the soils in the command area for which diverted waters are to be utilized are suitable for irrigation.

7.3 Cropping pattern

The Cropping pattern of Tungabhadra project as supplied by the project authorities and furnished in the Revised water balance report (Tech. study No.65) of Tungabhadra sub-basin is given in table 7.1. the designed weighted average delta of Tungabhadra project for left bank canal, right bank low level canal and right bank high level canal are 1.07 m (Karnataka) and 1.39 m for Andhra Pradesh and 0.61 m for Karnataka respectively.

Table 7.1 Cropping pattern of Tungabhadra project

Sl.no	Name of the crops	Left bank canal	Right bank low level canal	Right bank high level canal
I	Perennials:			
i)	Sugarcane	3.5	16.6	-
ii)	Garden crops	2.6	-	-
II)	Kharif:			
i)	Paddy	8.7	20.2	-
ii)	Semi dry crops	36.6	-	100
iii)	Cotton	12.2	-	-
III	Rabi:			
	Semi dry crops	36.4	63.2	-
Total		100	100	100

Since the diverted water is expensive , a suitable cropping pattern with predominantly less water consuming crops and with 90% cropping with available water. The water requirements of the crops proposed have been computed by climatological approach. The weighted average delta for the proposed cropping pattern and the cropwise gross irrigation requirements are furnished in Annexure 7.1.

Chapter-8 Cost estimates

Cost estimates:

8.1 General

The surplus water diverted from Bedti is to be utilized for irrigation in Tungabhadra project under left bank canal. The project proposals of diversion schemes are detailed para 1.4. The cost of project is divided under three heads i.e., unit-I, unit—II and unit –III. Unit-I includes cost of head works and its appurtenant works of pattanadahalla and shalamalahalla dams and cost of interlinking system between the two reservoirs including the proposed road bridges. Unit-II covers cost of link canal/tunnel from shalamalahalla reservoir to the stream leading to the Varada river. Unit –III covers the cost of lifting arrangements. In the absence of detailed field investigations and surveys, the estimate relating to the cost of the project has been worked out on the basis of the cost of similar works of existing/ongoing/proposed projects in the basins. The abstract of cost of the link project is given in the Annexure 8.1. The cost at the current prices (1992) has been arrived at by considering an escalation of 10% per year compounded annually. The total cost of link project works out to Rs.24027 lakhs

8.2 Unit-I-Head works

The cost of the head works and appurtenant works at Shalamalahalla and Pattanadahalla including interlinking system and cross drainage works out to Rs.9251 lakhs. The abstract of cost of works under this head is given at Annexure 8.2. The cost under various sub-heads is detailed below:

- **Preliminary**

The provision under this sub-head has been made at 3% of the cost of C-works out to Rs.222 lakhs.

- **Land**

The provision under this sub-head has been made at 4.7% of the cost of C-works based on the provisions kept in the proposed Mahadayi hydro-electric project in Mahadayi basin by Karnataka power corporation (KPC), Government of Karnataka. The cost works out to Rs.347 Lakhs.

- **Works**

This head covers the cost of various components under the head work such as dams, spillway, intake structures, river diversion works, inter linking system of the reservoirs etc. the cost of these items except canal are worked out on unit rate basis, based on the cost of Mahadayi hydro-electric project. The cost of the canal is worked out on the basis of the rates adopted for earth work and lining work of canal For Irukkanakudi reservoir tamilnadu (year 1987) for similar work. The cost works out to be Rs.7384 lakhs. The details of the cost abstract are given in Annexure 8.5.

- **Buildings**

The cost of this item is taken as 3% of the cost of C-works which works out to be Rs.222 lakhs.

- **Plantation**

Provision for this head is made at 0.5% of cost of C-works. The cost works out to Rs.37 lakhs.

- **Miscellaneous**

A provision of Rs.295 lakhs is made under this sub-head at 4% of the cost of C-works.

- **Maintenance**

The provision under this item is made at 1% of the cost of I-Works, less cost of A, b and Q. this rate is as per the guidelines for preparation of project estimates for major irrigation and multipurpose projects. The amount works out to Rs.33 lakhs.

- **Special T&P**

The provision under this sub-head is made at 4% of the cost of C-works, as provided in Mahadayi hydro-electric project report of Karnataka power corporation (May 1987). The amount works out to Rs.295 lakhs.

- **Communication**

A provision of Rs 345 lakhs is made under this sub-head at 4.67% of C-works as per Mahadayi Hydro-electric project report of Karnataka power corporation (may 1987).

- **Losses on stock and unforeseen items**

The cost of this item is taken as 0.25 % of I-works less the cost of A, B & Q. This is as per the guidelines for preparation of project estimates for major irrigation and multipurpose projects. The amount comes to Rs.21 lakhs.

8.3 Unit-II-Link Canal Systems

The total cost of link canal system from shalamalahalla reservoir to the stream leading to Varada river including the cost of tunnel works out to Rs.3034 lakhs. The cost under various sub-heads is as detailed below and the abstract of cost of Unit-II is presented in Annexure 8.3.

- **Preliminary**

Under this sub-head a lumpsum provision of Rs 25 lakhs is made.

- **Land**

Provision made under this sub-head covers the cost of land acquisition along the link canal alignment. The land width and area of land to be acquired have been worked out and the rates of the land as adopted in the mahadayi hydro-electric project report have been considered. Provision is also made for rehabilitation. The amount works out to Rs57 laks. The details of the estimate are given in Annexure 8.6.

- **Regulators**

The provision made under this sub-head covers the cost of outfall structures. Notch type outfall structures have been proposed at the end of the conveyance system. A lumpsum provision of Rs 10 lakhs has been made in the estimate.

- **Cross drainage works**

The cross drainage works were proposed wherever the canals cross the streams, nalahs, etc. Provisions for aqueducts etc., are made under this sub-head. The cost of aqueducts is based on cost curves prepared by Irrigation department, Govt of Andhra Pradesh Ichampally project. The amount comes to Rs.57 lakhs. Details are given in Annexure 8.8 and 8.9. plate -10 shows the cost curves of aqueduct and under tunnel.

- **Bridges**

A lump sum provision of Rs.15.00 lakhs for bridges has been made under this sub-head.

- **Buildings**

Lump sum provision of Rs. 60 lakhs has been made under this head.

- **Rock excavation and canal lining**

The rates under this item are as per the rate adopted for Irukkankudi reservoir scheme in Tamil nadu. The quantity to be excavated in the canal and tunnel, including lining is taken into this head. The cost of canal has been worked out and the rates adopted in Irukkanakundi project in Tamil nadu and the cost of the tunnel is based on the rates adopted in Mahadayi hydro-electric project of Karnataka. The amount comes to Rs.2652 lakhs. Details are given in Annexure 8.7.

- **Plantation**

The rate adopted for this item is Rs.0.251 lakhs/running kilometer of canal based on Irukkanakudi reservoir scheme in Tamil nadu. The cost works out to Rs.2 lakhs.

- **Miscellaneous**

Lump sum provision of Rs.25 lakhs has been made under this Sub-head.

- **Maintenance**

Provision under this sub-head is made at 1% of the I-work less cost of A, B and Q which works out to Rs28 lakhs

- **Special T&P**

Provision made under this head is 4% of the cost of canal/tunnel the amount works out to RS.106 lakhs.

- **Communication**

Lumpsum provision of Rs.20 lakhs has been made under this sub-head.

- **Losses on stock and unforeseen items**

The provision made under this sub-head is at 0.25% of the I-works less cost of A, B and Q.

This is as per the guidelines of preparation of project estimates for major irrigation and multipurpose projects. The amount comes to Rs.7 lakhs.

8.4 Unit –III Lifting arrangements and power house complex

The total cost of lifting the water from Shalamalahalla reservoir into the link canal in three stages works out to Rs.9209 lakhs. The details of cost estimate are furnished in Annexure 8.4.1 and Annexur 8.10. The computation of requirement for power are given in Annexure 8.12. The cost of power consumption for lifting water is given in Annexure 8.13. The cost of balancing reservoirs is given in Annexure 8.14.

Two power houses with an installed capacity of 1.8 MW each are proposed at the toe of pattanadahalla dam and shalamalahalla dam.these power houses utilizes the water released towards downstream requirement during the period from June to October for power generation. The cost of power house complex works out to Rs.467 lakhs. The details of cost estimate are given in Annexure 8.4.2 and 8.11.

Chapter –9 Time Schedule

9.1 General

The entire work of link project` is tentatively proposed to be completed in a period of 7 Years including construction of dams, excavation of tunnels and other major and minor canal structures.

9.2 Phasing of time schedule

The time schedule for the construction of Bedti-Varada link will spread over a period of 7 years. It is expected that pre-construction and investigation surveys, design of civil works, acquisition of land. Procurement of construction material and equipments, tunneling equipments, construction of building and laying of communication network will be completed in the 1st and 2nd year. The canal and tunnel excavation are proposed to be started in the 3rd year and will be completed by end of 7th year. The formation of canal embankments and lining of canal/tunnel will be carried out simultaneously with the canal/tunnel excavation and will be completed by the end of 7th year. The pumping installments will start in the 5th year and will be completed by 7th year. Erection of gates and other miscellaneous work will be completed during 7th year. The construction schedule in the form of bar chart is given at plate-11.

9.3 Financial programme

The annual financial out lay will depend upon the quantity of works scheduled to be completed in a year. Accordingly a tentative financial programme has been framed for the project. The financial outlay in the form of bar chart is given at plate-12.

Table 9.1 Yearly Financial outlay

Yearly financial outlay	
Year	Financial outlay Rs in lakhs
I Year	1200
II year	3627
III year	5000
IV year	5000
V year	5300
VI year	2100
VII year	1800
Total	24027

Chapter -10 Economic Analysis

10.1 General

The Bedti-varada link canal is envisaged for transfer of 242 Mm³ of surplus water from Bedti river to Varada river in Tungabhadra sub-basin. The diverted water of 242Mm³ will irrigate an area of 60200 ha. In Kharif season under Left Bank canal command of Tungabhadra project increasing its irrigation intensity from 62.2% to 80.3%.

10.2 Direct benefits

10.2.1 Benefits from Irrigation

The cropping intensity under Left bank canal of Tungabhadra project will be as under after implementing the proposal.

Intensity of irrigation

Sl no		Before link proposal		After link proposal	
		Area in ha	% C.C.A	Area in ha	%C.C.A
I	Perennial:				
1.	Sugarcane	7053	2.2	7053	2.2
2.	Garden crops	5239	1.6	3239	1.6
II	Kharif Crops:				
1.	Paddy	17532	5.4	24221	7.5
2.	Semidry crops	73754	22.8	113887	35.2
3.	Cotton	24585	7.6	37963	11.7
III	Rabi:				
	Semidry crops	73351	22.6	73351	22.8
	Total	201514	62.2	261714	80.8

In the absence of data on produce/ha of various crops grown under all canals of Tungabhadra project before and after introduction of irrigation, it is not possible to calculate B.C ratio on the whole of system of Tungabhadra project. However, on the assumption that the area of 60200 ha which is proposed to be irrigated by the diverted waters would otherwise have been irrigated by the rainfall only, the B.C ratio calculations have been restricted to the additional area of 60200 ha only. The cost of distribution system has also not been taken into account since, the existing system itself is presumed to be sufficient to cater the needs of extra area. The abstract showing direct benefits from the project is given in Annexur 10.1.

Before introduction of irrigation in the proposed command, only 47326 tonnes of food grains valued at Rs.3085 lakhs were produced. The net income after meeting expenditure on seeds, manure, labour, depreciation on implements and land revenue would be around Rs.1426 lakhs. After introduction of irrigation the food production will increase to 114715 tonnes. There will be a net increase of production of 66889 tonnes over the existing production. The total value of produce after canal irrigation is 122333 lakhs. The net value of produce after meeting expenditure on Seeds, manure, labour, depreciation on implements and land revenue etc will be an extra production of 66889 tonnes of food grains valued at Rs.7011 lakhs annually. The details are given in Annexure 10.1, 10.2.1 and 10.2.2.

10.2.2 Benefits from power

Two power houses with an installed capacity of 1.8 MW each are proposed for power generation, once at the toe of pattanadahalla dam and the second at the toe of Shalamalahalla dam. These power houses utilizes the water released to meet the

downstream requirements during the period from June to October for power generation.

The reservoir operation tables are prepared for 16 years from 1970-71 to 1985-86 are given in Annexure 3.4.

The monthwise/yearwise power generated from both Pattanadahalla and Shalamalahalla reservoirs have been prepared for 16 years from (1970-71 to 1985-86) and are given in Annexure 3.41 to 3.48 average power generated in a year comes to 6.35 M.units and considering a rate of Rs.1/- per unit the annual revenue from power generation comes to Rs.63.50 lakhs. Details are shown in Annexure 10.3.3.

10.3 Indirect benefits

The secondary and incidental benefits that will account by the commissioning of this scheme are of immense value to the people of the area. The ground water will get supplemented by the regenerated flows and will add to rise in the water table. The scarcity of drinking water in these areas will be solved to a considerable extent. Increase in employment opportunities during construction and after, is also an indirect benefit of the scheme. The cropping pattern adopted in this case is the same as that existing under command area of Left Bank Canal of Tungabhadara irrigation project. This will result in better income to the farmers and bring them at par with those of the affluent parts. The socio-economic conditions of the population in these drought areas will improve and the development activities will usher in.

10.4 Benefit cost ratio

The benefit cost ratio at 10% interest on the estimated cost of the project works out to 1.66. The details of B.C ratio calculation are given in the table 10.1.

Table 10.1 Computation of B.C Ratio

Sl.no	Particulars	Before irrigation (Rs. in lakhs) (X)	After irrigation (Rs. In lakhs) (Y)
I	Gross receipts		
1.	Gross value of the farm produce	3085	12383
2.	Dung receipts at 30% of fodder expenses	139	557
	Total	3224	12940
II	Total Expenses		
1.	Expenditure on seeds	269	460
2.	Expenditure on manure	413	482
3	Expenditure on chemicals	216	556
4	Expenditure on labour	136	188
5	Expenditure on fodder @ 15% of gross value of produce	463	1857
6	Depreciation on implement at 2.75% of gross value of produce	85	341
7	Share and cash rent at 5% of gross value of produce before irrigation and at 3% of gross value of produce after irrigation.	154	371
8	Land revenue at 2% of gross value of produce	62	248
	Total expenses	1798	4503

	Net value of produce(I-II)	1426	8437
III	i)Net annual benefit from irrigation(Y-X)		7011
	ii)Annual benefit from power generation		64
	Total		7075
A	Net annual benefit from irrigation and power generation		7075
B	Total cost of the project (capital)		24027
C	Annual cost		
1	Interest on capital investment at 10%		2403
2	Depreciation on civil works at 1% of the capital cost (less of raising main, pump, power house complex and electrical installations etc) assume life of the project as 100 years. [24027-(1055066+2822.84+3927)]		198
3	Depreciation of the pumping system (2822.84) @ 8.33% of the estimated cost of the pumping system(assuming life 12 years).		235
4	Depreciation of the raising mains @ 3.33% of the estimated cost (1055.66) assuming life 30 years.		35
5	Depreciation at 90% of the estimated cost of power house complex and its all electrical installations (392) assuming a life of 30 years.		12
6	Charges of the power for lifting water for irrigation to 60200 ha @ Rs.1/-per unit		1234
7	Annual operation and maintenance cost at Rs100/ha for 60200 ha		60
8	Maintenance of the head works at 1% of its cost of 7384 lakhs		74
9	Maintenance cost of power house complex and its electrical installations @ 1% of its cost of 392 lakhs		4
Total annual cost			4255
B.C.ratio=7075/4225=2.56			

The B.C ratio has also been worked out using discounted cash flow method. By this method the B.Cratio works out to be 1.55 with a discounting rate of 10%. The details are given in Annexure 10.4

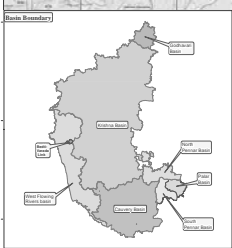
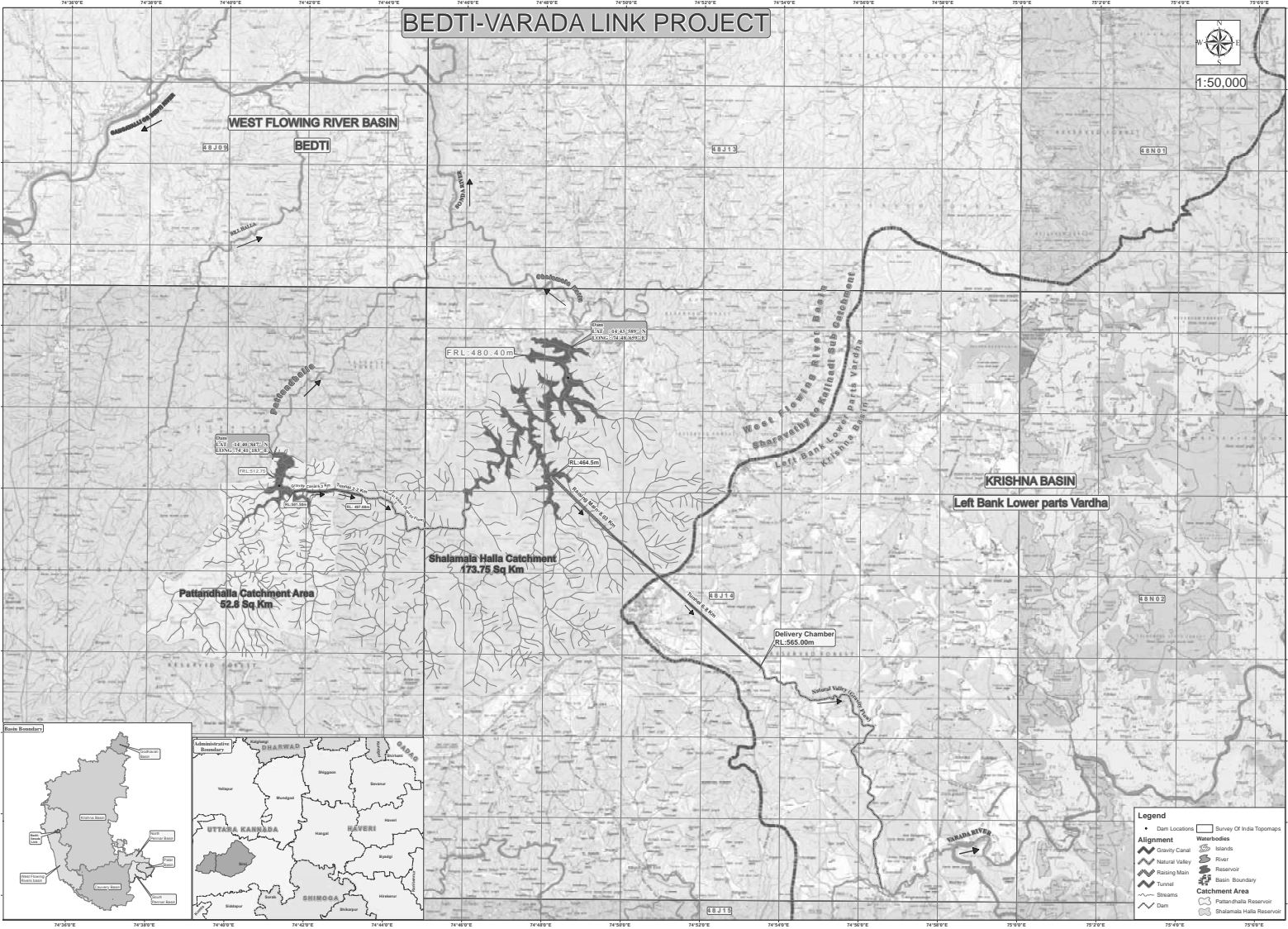
10.5 Internal rate of return

The interest rate of return of the project will be 15.3% without considering distributional and employment effects. Details are given in Annexure 10.5.

10.6 Value of water

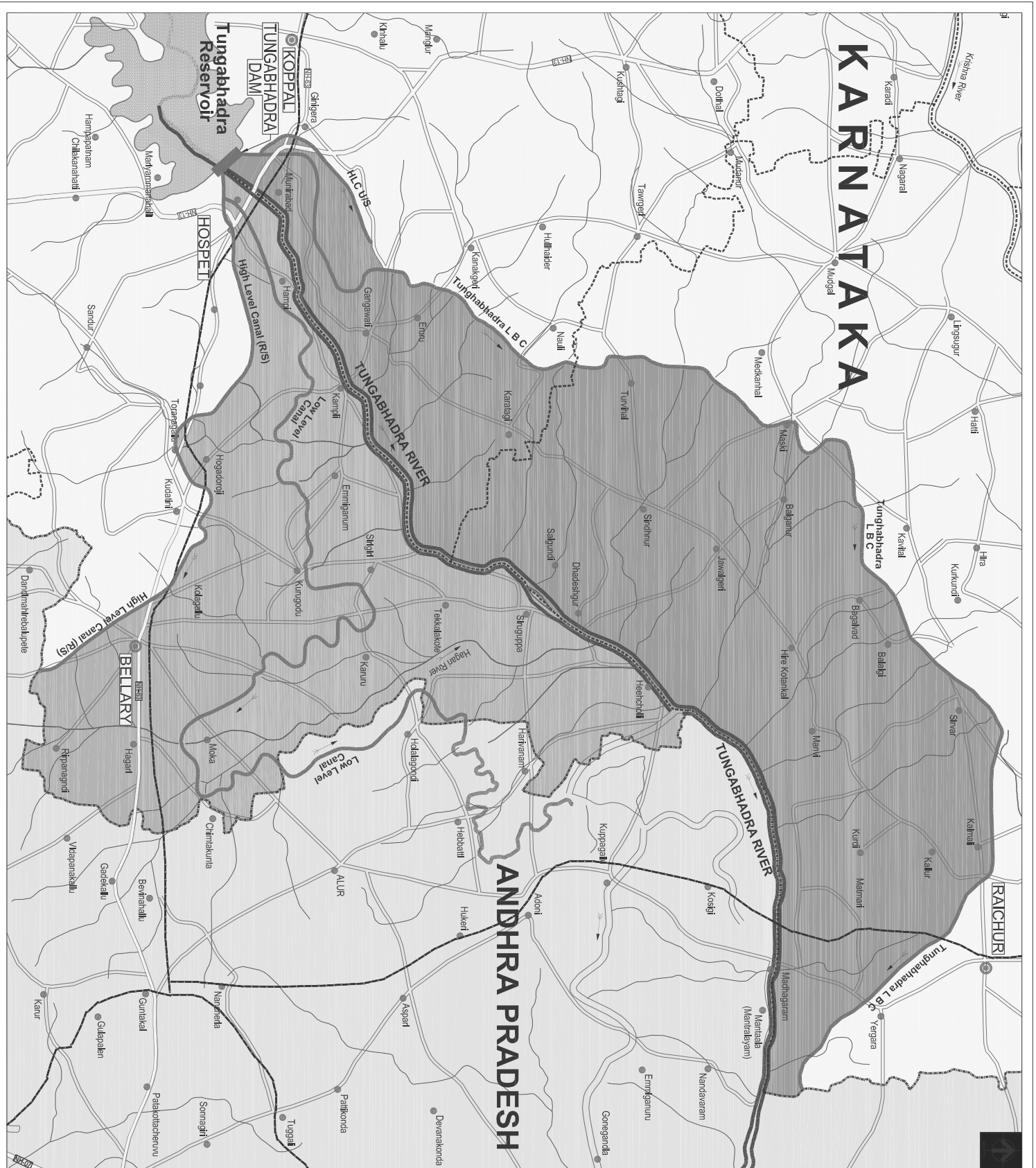
The value of water per unit volume considering the annual cost will be about Rs.1.76 per cubic metre of water diverted through link canal. The same when considered on capital cost of the link project would be Rs.9.93 per cubic metre of water diverted through link canal.

BEDTI-VARADA LINK PROJECT



Legend

•	Dam Locations	□	Survey Of India Topomaps
—	Alignment	▭	Waterbodies
~	Grassy Canal	○	Islands
~	Natural Valley	—	River
~	Raising Main	—	Reservoir
~	Tunnel	—	Basin Boundary
~	Streams	—	Catchment Area
~	Dam	—	Pattandhalla Reservoir
~		—	Shalamais Hills Reservoir



LEGEND

National Highways	Highways	State Highways	Other Roads
State Highways	Other Roads	Canals	Other
Canals	Other	Other	Other
Other	Other	Other	Other

Reference

Main Canal
Karnataka Ayacut Under Left Bank Canal
Karnataka Ayacut Under Low Level Canal
Karnataka Ayacut Under High Level Canal

0	FOR APPROVAL	26.09.13	SK	SN	NR
Rev.	Description	Date	Dwn	Desg	Chk, App.

CLIENT
KARNATAKA NEEPAVARU INGAM LIMITED
 (A GOVT. OF KARNATAKA UNDERTAKING)
 BANGALORE - 560 001

PROJECT TITLE
MODERNISATION OF CANAL SYSTEM OF
TUNGABHADRA PROJECT

DRAWING TITLE
INDEX MAP SHOWING CANAL SYSTEM OF
TUNGABHADRA PROJECT

Date: 26/09/2013
 Drawing No: KNNL-TP-IND-001

Dwg.	Chk.	App.	Scale	Drawing Status
SK	SN	NR	1:5,00,000	FOR APPROVAL
Project No.	Drawing No.	Sheet No.	Rev.	01 of 01
0	01	01	0	

Supervising Engineer
 Tungabhadra Project Circle
 Mulbagal

Supervising Engineer
 Tungabhadra
 Yerranahalli Camp

Chief Engineer
 Inga Var Zone
 Mulbagal

REPORTABLE

**IN THE SUPREME COURT OF INDIA
CIVIL ORIGINAL JURISDICTION
WRIT PETITION (CIVIL) NO. 512 OF 2002**

“IN RE : NETWORKING OF RIVERS”

WITH

WRIT PETITION (CIVIL) NO. 668 OF 2002

J U D G M E N T

Swatanter Kumar, J.

1. Nearly ten years back, the petitioner in Writ Petition (Civil) No. 668 of 2002, a practicing advocate, instituted the petition based on some study that there was a need to conserve water and properly utilize the available resources. Thus, the present petition has been instituted with the following prayers:-

“a. Issue an appropriate writ order or direction, more particularly a writ in the nature of Mandamus directing the respondent no. 1 to take appropriate

steps/action to nationalize all the rivers in the country.

b. Issue an appropriate writ order or direction, more particularly a writ in the nature of Mandamus, directing the respondent No. 1 to take appropriate steps/action to inter link the rivers in the southern peninsula namely, Ganga, Kaveri, Vaigai and Tambaravani.

c. Issue an appropriate writ order or direction in the nature of mandamus directing the respondents to formulate a scheme whereby the water from the west flowing rivers could be channelized and equitably distributed.”

2. The above directions were sought by the petitioner against the Central Government as well as against various State Governments, for effective management of the water resources in the country by nationalization and inter-linking of rivers from Ganga - Cauveri, Vaigai-Tambaravarmi up to Cape Kumari. According to him, as early as in 1834, Sir Arthur Cotton, who had constructed the Godavari and Krishna dams, suggested a plan called the ‘Arthur Cotton

Scheme' to link the Ganga and Cauveri rivers. In 1930, Sir C.P. Ramaswamy Aiyar also suggested and supported such

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a scheme. Thereafter, various political leaders of the country have supported the cause; but no such schemes have actually been implemented. It is the case of the petitioner that the Inter-State Water Disputes Act, 1956 (for short 'the Act') and the River Boards Act, 1956 were enacted by the Parliament under Article 262 read with Entry 56 of List-I of the Seventh Schedule to the Constitution of India, 1950 (hereafter, 'the Constitution'). Due to reluctance of water-rich States, the National Water Development Agency (hereafter, 'NWDA') has not been allowed to undertake detailed survey and it is argued that only by nationalization of the rivers, by the Government of India, this problem can be resolved to some extent. The petitioner had filed a writ before the High Court of Judicature at Madras, being Writ Petition No. 6207 of 1983, praying for various reliefs. This Writ Petition was disposed of without any effective orders by the High Court. Persisting with his effort, the petitioner

earlier filed writ petitions before this Court, being Writ Petition (C) No. 75 of 1998 and Writ Petition (C) No. 15 of - 1999, praying *inter alia* for nationalized navigation and inter-linking of all the rivers in the country.

3. We must notice, to put the records straight, that on 29th September, 1994, a Bench of this Court took *suo motu* notice of a write-up that had appeared in the Hindustan Times newspaper, dated 18th July, 1994, titled “*And quiet flows the maili Yamuna*”. Notice was issued to the Central Pollution Control Board, Municipal Corporation of Delhi, Irrigation and Flood Department of the Government of India, National Capital Territory of Delhi and the Delhi Administration. Since then, the writ petition is being continuously monitored by this Court, till date. During the pendency of this writ petition, I.A. No. 27 came to be filed, wherein the learned *Amicus Curiae* in that case referred to the address of Dr. A.P.J. Abdul Kalam, the then President of India, on the eve of the Independence Day. This, *inter alia*, related to creating a network between various rivers in the

country, with a view to deal with the paradoxical situation of floods in one part of the country and droughts in other parts. In other words, it related to the inter-linking of rivers

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and taking of other water management measures. On 16th September, 2002, this Court, while considering the said I.A., directed that the application be treated as an independent writ petition and issued notice to the various State Governments as well as the Attorney General for India and passed the following order:-

“Based on the speech of the President on the Independence Day Eve relating to the need of networking of the rivers because of the paradoxical phenomenon of flood in one part of the country while some other parts face drought at the same time, the present application is filed. It will be more appropriate to treat to treat it as independent Public Interest Litigation with the cause title “IN RE : NETWORKING OF RIVERS -- v. ---” Amended cause title be filed within a week.

Issue notice returnable on 30th September, 2002 to the respondents as well as to the Attorney General.

Serve notice on the standing counsel of the respective States.

Dasti service, in addition, is permitted.”

4. This is how I.A. No. 27 in Writ Petition (Civil) No. 725 of 1994 was converted into Writ Petition (Civil) No. 512 of -

2002. The Writ Petition (Civil) No. 512 of 2002 was taken up for hearing and notice was issued to all the States, inviting affidavits regarding their stance on the issue of networking of rivers.

5. In view of the above order, the petitioner in Writ Petition (Civil) No. 668 of 2002 withdrew Writ Petition (C) No. 75 of 1998 as well as Writ Petition (C) 15 of 1999, which leave was granted by this Court.

6. As already discussed above, the petitioner had filed Writ Petition (Civil) No. 668 of 2002 with somewhat similar prayers as contained in I.A. No. 27. In that writ petition, the petitioner has averred that no prayer with regard to inter linking of rivers covering the southern part of the

Peninsular Region had been claimed and it was also his contention that the southern part was most drought prone and had been witnessing more inter-state water disputes.

Thus, he had filed Writ Petition (Civil) No. 668 of 2002 and prayers made therein were liable to be allowed.

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7. In the present case, we are concerned with Writ Petition (C) No.668 of 2002, Writ Petition (C) No. 512 of 2002 as well as the I.A.s and the contempt petitions filed in these two petitions. Accordingly, this order shall dispose of all these matters but we make it clear that presently, we are not dealing with Writ Petition (C) No. 725 of 1994.

8. It has also been averred by the petitioners and the intervenors in these petitions that the need to conserve water resources and assuring their optimum consumption can be seen from the steps taken in this regard, not only by the developed countries but also by developing and under-developed countries. The Government of India has always shown considerable concern regarding the management of

water resources in the country and had framed, for this purpose, the National Water Policy which is being updated on a yearly basis. The National Water Policy seeks to make available water supply to those areas which face shortages. This aspect of the matter could be effectively dealt with, only if the various rivers in the country are linked and are nationalized. This has been a matter of public debate and - discussion for a considerable time and still continues to be so, without showing any reflection of ground reality.

9. The Ministry of Irrigation, along with the Central Water Commission, had formulated in the year 1980 a National Perspective Plan (NPP) for optimum utilization of water resources in the country which envisaged inter-basin transfer of water from water-surplus to water-deficit areas. Apart from diverting water from rivers which are surplus, to deficit areas, the river linking plan in its ultimate stage of development will also enable flood moderation. It was comprised of two components: Peninsular Rivers Development and Himalayan Rivers Development. The first

involved major inter-linking of the river systems and the latter envisaged the construction of storage reservoirs on the principal tributaries of rivers Ganga and Brahmaputra in India, Bhutan and Nepal. This was to help transfer surplus flows of the eastern tributaries of the Ganga to the West, apart from linking the main Brahmaputra and its tributaries with the Ganga and Mahanadi rivers. The scheme is divided into four major parts:

- i) -
- ii) Interlinking of Mahanadi-Godavari-Krishna-Cauvery rivers and building storages at potential sites in these basins.
- iii) Interlinking of West flowing rivers north of Bombay and south of Tapi.
- iv) Interlinking of rivers Ken & Chambal.
- v) Diversion of other west flowing rivers from Kerala.

10. The petitioners have also made several suggestions which have been appreciated by the competent authorities on consideration. It is emphasized that the cost is negligible when compared to the potential benefits which may be bestowed on the nation. The petitioners rely upon Article 262 of the Constitution, read along with Entry 17, List II and Entry 56 of List I of the Seventh Schedule to the Constitution to substantiate their submissions. Finally, the petitioners submit that the preservation of water resources is a part of the right to life and livelihood, enshrined in Article 21 of the Constitution and that the Central Government should take immediate and urgent steps to nationalize the rivers, so that equitable and proper -

distribution of water can be ensured for the betterment of the population. According to them, the Central Government should also adopt all necessary measures, both scientifically and naturally, to increase the usable water resources and to preserve whatever resources the Union of India has already been naturally gifted with.

11. As a result and because of the inaction on the part of the Central Government and the State Governments, it is submitted that grant of the reliefs as prayed for in the writ petition would be in consonance with the constitutional spirit and in the larger public interest.

12. The learned *Amicus Curiae*, who had been pursuing this public cause for a number of years, in furtherance to the request of this Court, has also submitted a detailed note with regard to the background and summary of the proceedings in these petitions.

13. As per the learned *Amicus Curiae*, on 14th August, 2002, the then President of India, Dr. APJ Abdul Kalam, in his address to the nation on the eve of Independence Day, - had observed that the need of the hour was the creation of a Water Mission which, *inter alia*, would look into the question of networking of rivers with a view to deal with the paradoxical situation of floods in one part of the country and drought in the other. Based on this and as afore-recorded, a notice was issued, on 16th September, 2002, to

the States and the Attorney General for India as respondents. In response to the said notice, none of the States or Union Territories, except the State of Tamil Nadu, had filed affidavits supporting/opposing the prayers made in the writ petition. The time for filing of affidavits was again extended up to 30th September, 2002, but no further affidavits were received by that time.

14. The learned then Attorney General for India, on behalf of the Union of India, stated that the Government had accepted the concept of interlinking of rivers and a High Powered Task Force would be formed. Therefore, this Court, vide Order dated 31st October, 2002, recorded that there is in-principle consensus amongst all States to go ahead with the project of interlinking of rivers.

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15. Vide Order dated 30th August, 2004, it was noticed by this Court that, though there had been a change in the Government, the then Solicitor General, appearing for the

Government, informed this Court that a decision had been taken, in principle, to continue with interlinking of rivers.

16. A high level Task Force was set up. However, vide order dated 5th May, 2003, this Court observed that inputs from other experts, in many fields, were necessary and that the Task Force was to give due consideration to such inputs. Feasibility Reports (hereafter, 'FR') were prepared for the intended links. Subsequently, vide its order dated 8th April, 2005, this Court made it absolutely clear that the orders of the Court in these respects have to be complied with in letter and spirit. The FR of all links were to be put on the website after their completion. This Court had also made observations that the prior consent of any State Government was not necessary for placing the FRs on the website and directed them to be so placed. With great persuasion and efforts, the FRs of 16 links had been placed on the website. At the request of the *Amicus*, the website -

was ordered to be made interactive so that people could submit their response thereto.

17. The status report filed on behalf of the Government of India also showed that a committee of environmentalists, social activists and other experts would be constituted to be involved in the consultative process of formulation and execution of the entire project.

18. The status reports filed, from time to time, have been considered by this Court.

19. Now, we may deal with the response of various States, as they appear from the record before us. The response affidavits have been filed on behalf of ten States. However, the remaining States have not responded, despite the grant of repeated opportunities to do so. While the States of Rajasthan, Gujarat and Tamil Nadu have supported the concept of inter-linking of rivers, the State of Madhya Pradesh had stated that networking of rivers is a subject falling under the jurisdiction of the Central Government and the Central Government should consider the matter. The -

States of Karnataka, Bihar, Punjab, Assam and Sikkim have given their approval to the concept in-principle, but with definite reservations, i.e., a kind of qualified approval, arguing that the matters with regard to the environmental and financial implications, socio-economic and international aspects, such as inter-basin water transfer, need to be properly examined at the appropriate levels of the Government. For example, all the rivers in Bihar originate from Nepal and it may be necessary or desirable to take consent of neighbouring countries, is a matter which would require consideration of the appropriate authority in the Central Government. According to the State of Punjab, inter-linking of rivers should be started only from water-surplus States to States facing water deficit. The States of Assam, Sikkim and Kerala had raised their protests on the grounds that they should have exclusive right to use their water resources and that such transfer should not affect any rights of these States. The State of Sikkim was concerned with particular reference to tapping of the hydro

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power potential in the State and the State of Kerala entirely objected to long distance, inter-basin, water transfer.

20. The Union of India filed three different affidavits dated 25th October, 2002, 5th May, 2003 and 24th December, 2003. From these affidavits, the stand of the Union of India appears to be that networking of rivers had been considered with great seriousness even after the 1972 Rao Committee Report. Surveys and studies were underway. The 1980 National Perspective Plan of the erstwhile Ministry of Irrigation, presently the Ministry for Water Resources, envisaged inter-basin transfer from water-surplus to deficit areas. It would have direct benefits, like the irrigation of 35 million hectares (Mha), full exploitation of existing irrigation projects of 140 Mha, power generation of 34 million Kilowatt (KW); besides the indirect benefits like flood control, navigation, water supply, fisheries, pollution control, recreation facilities, employment generation, infrastructure and socio-economic development etc. With regard to the approvals required, it is submitted that the Ministry of Environment and Forests, Union of India had given some -

clearances, while refusing the same in other cases. The consent of some of the States had not been received. The expected financial implication as far back as in 2002 was Rs.5,60,000 crores.

21. However, the Union of India has submitted that there is no necessity for formation of a high-powered committee as prayed for in the petitions. The high-level task force is to be set up for considering the modalities of state-wise consensus. The NWDA was set up as autonomous registered society under the aegis of Ministry of Water Resources, in New Delhi in 1992, for the purposes of preparation of FRs, conduct of water-balance and other scientific studies, etc. for Peninsular Region rivers (and for Himalayan Region rivers also, since 1990) and is headed by the Union Minister of Water Resources. The Chief Ministers and/or the Ministers and the Secretaries as their nominees for Water Resources/Irrigation of the State governments are its members. The pre-feasibility reports of all 30 identified links had been completed by the NWDA.

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22. The Union of India and some states have shown their concerns and their apprehensions about these projects, including questioning the reliability of water supply from distant sources, distribution of water given the existing tribunal awards and the continued availability of existing water surpluses.

23. In another affidavit, the Union of India referred to the Terms of Reference to the Task Force and the appointment of its Members. Action Plan I was prepared, which was expected to be implemented by 2016. Out of the independent links to be pursued for discussion, the first were the links in the States of Gujarat, Maharashtra, Chattisgarh; secondly, the States of Karnataka, Madhya Pradesh, Uttar Pradesh and Rajasthan were to be included in discussions and thirdly, the States of Andhra Pradesh, Tamil Nadu and Orissa were to be invited for discussion. The Detailed Project Reports (hereafter, 'DPR') were expected to be completed by December, 2006. However, from the

record, it appears that these DPRs have not been completed even till today. The scheme of inter-linking of -

rivers/preparation of DPRs is stated to be under review by different groups and authorities.

24. The Union of India also intended that these project reports should encompass water sector schemes, rainwater harvesting schemes etc., as these cannot be implemented independent of the inter-linking scheme. The last of the affidavits filed on behalf of the Union of India was in December, 2003. This affidavit gives details of the States, with which a dialogue was to be held as also the details of constitution of sub-committees. The Terms of Reference of the Task Force included the approval of all links. With the intention to arrive at a general consensus, before entering into agreements, the Union of India has discussed details with Maharashtra and Gujarat and preliminary discussion has taken place with the States of Andhra Pradesh, Chattisgarh, Karnataka, Orissa, Tamil Nadu and Pondicherry. According to the Union of India, invoking the

matter internationally, at this stage, was not advisable as the matter was premature. The NWDA was to begin the DPR for the first link, i.e., the Ken-Betwa project, which itself - was expected to take 30 months time. In this, the DPR has now been prepared; however, the implementation is yet to begin. We must notice that in all other links even the DPRs are not ready, as of now. The draft Memorandum of Understanding (hereafter, 'MoU') had been circulated for conduct of DPR of three more Peninsular links. The Standing Committee of the Parliament on Water Resources, (hereafter, 'the Standing Committee'), in its report for the year 2004-05 has commented that for the purpose of preparation of DPRs for the Ken-Betwa link and the Parbati-Kalisindh-Chambal link projects, a sum of Rs.14 crores had been earmarked, out of the total Rs.35 crores allocated for NWDA. However, the Standing Committee had been constrained to observe that, though the FR of the Ken-Betwa link was completed in November, 1996, the project was still at a nascent stage. At the time of the report in 2004-05, the basic MoU between the Governments of Uttar

Pradesh and Madhya Pradesh, for preparation of DPR, still remained to be signed, on the ground that the State of Uttar Pradesh required more water to be allocated to it. They - further observed that, if the Ministry of Water Resources, Government of India had set a time frame for finalization of issues like this, the precious time of eight years would not have been lost. The matter still rests at that stage. Today, though DPR has been prepared for this link alone, no link project has reached the implementation stage.

25. The report of the Standing Committee which, *inter alia*, had examined the river inter-linking proposal was presented to the Parliament of India on 23rd August, 2004. It was strongly recommended that the Government should take firm steps and fix a definite time frame to lay down the guidelines for completion of FRs, preparation of DPRs and completion of projects so that they may be completed and the benefits accrued within reasonable time and costs. It was the opinion of the Standing Committee that the inter-linking of Himalayan and Southern region rivers, if done

within a definite schedule, would save the nation from the devastating ravages of chronic droughts and floods. The recommendations of the Standing Committee deal primarily with two kinds of States; the States having water shortage - and the States having surplus water. Still, there would be a third category of States, which would be comprised of those States which have just sufficient water and therefore, do not fall in either the flood-affected or the drought-affected categories of States. The role of such States may not be very project-related; but, their consent/concurrence is needed for complete implementation of the programme. Their role is relevant as some canal projects, linking different rivers, may pass through such States. But as already noticed, except one, no other DPR has so far been finalized and in fact, none put into implementation. Thus, this question would remain open and has to be examined at the appropriate stage by the competent forum.

Projection of Status Reports : -

26. Different Status Reports have been filed in this case. The last of the Status Reports have been filed by the Union of India on 18th March, 2011. It has been pointed out that the NWDA, which was to complete the task relating to preparation of FRs and DPRs of link projects, has completed

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208 preliminary water-balance study of basins, sub-basins and diversion points, 74 toposheets and storage capacity studies of reservoirs, 37 toposheet studies of link alignments and 32 pre-feasibility reports of links, towards the implementation of inter-linking of rivers in the country. Based on these studies, this agency identified 30 links (16 under the peninsular river development component and 14 under the Himalayan river development component) for preparation of FRs. The process of consensus building is on-going, in regard to the feasibility of implementing other interlinking projects. These reports have shown that a significant effort and attempts have been made and the unquestionable benefits that would accrue on the

implementation of the interlinking projects will be to benefit the country at large. One aspect that needs to be noticed is that, till today, no minor or major project has been actually implemented at the ground level despite the fact that this case has been pending before this Court for more than ten years. Only the DPR of the Ken-Betwa link has been prepared and its implementation is awaiting the approval of

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the State Governments as well as the allocation of funds, even to begin the work. This does not speak well of the desire on the part of any of the concerned Governments to implement these projects, despite the fact that there is unanimity of views among all that this project is in the national interest.

27. The Committee of Environmentalists, Social Scientists and other Experts on inter-linking of rivers, had met after the submission of the Status Report dated 5th March, 2010. They discussed various aspects of different projects. In the Himalayan region, FRs of two remaining

links were completed, i.e., the Sarada-Yamuna link and Ghagra-Yamuna Link. The field survey and investigation for Sone Dam on the southern tributaries of the Ganga link, was still in progress. The Ministry of Environment and Forests had refused permission for survey and investigation of the Manas-Sankosh-Tista-Ganga link, but the toposheet study for the alternative Jogigopa-Tista-Farakka link has been completed. In the Peninsular region, the projects relating to Bedti-Varada and Netravati-Hemavati-Tapi are awaiting -

Karnataka Government's consent. In Netravati-Hemvati-Tapi link, the Karnataka Government has refused to consent even to the preparation of FR until decision of related cases, pending in the Courts.

28. In the Dhadun dam, relating to the Ken-Betwa link, two power houses and a link canal will be taken up in Phase I and the Betwa basin will be completed in Phase-II. Upper Betwa Sub-Basin will receive priority completion and minor projects are proposed to be completed first. Phase-II will be

commenced after survey and investigation. However, this project is still at the survey and planning stage and even comprehensive clearances, from the Uttar Pradesh Government, have not been received. The State of Rajasthan refuses to consider the MoU for another priority link, Parbati-Kalisindh-Chambal, until the updation of its hydrology project.

29. Similarly, there are other projects where public hindrances are caused against carrying out of survey and investigation. In the Par-Tapi-Narmada and Damanganga--Pinjal links, residents have shown concern about the extent of land to be submerged on the construction of the proposed dam. In response, the State Governments of Gujarat and Maharashtra have set up Committees to take up the matters with the *panchayats* and to commence the projects.

30. The NWDA had also, in the course of framing of its policies, proposed intra-state links. Except for six States and four Union Territories, all other States and Union Territories have interest in these intra-State links. There

are eight inter-linking projects which are under review by different State authorities. However, the details of the divergence between the State Governments are not clearly spelt out, even as of now.

31. An additional study was undertaken by the National Council for Applied Economic Research (hereafter, 'NCAER') and the revised final report, published in April 2008, assessed the economic impact of the rivers interlinking program and suggested an investment roll out plan, i.e., a practical implementation schedule, for the same. A copy of -
this report was submitted in the year 2011, before this Court.

32. As already noticed, the Task Force was constituted by the Central Government for interlinking of river projects in December 2002. It submitted its Action Plans I and II for implementation of the project and also finalized the terms of reference for the purposes of the DPRs. Action Plan I,

submitted in April 2003, envisages completion of 30 FRs by the authorities by December 2005.

33. Action Plan II, submitted in April 2004, mainly envisaged the appraisal of individual projects, in respect of their economic viability, socio-economic and environmental impacts, preparation of resettlement plans and reaching speedy consensus among States. The reports have been submitted to the Central Government and are under consideration. With this completion of work, the Task Force had completed its object and stood dissolved. After winding up of the Task Force, a Special Cell on interlinking of rivers was created under the Ministry of Water Resources. -

However, what happened to the two Action Plan reports submitted by the Task Force is a matter left to the imagination of anyone.

34. From the above, it is not difficult to visualize the difficulties in preparation, execution, financing and consensus building, still, it is the need of the hour to carry

out these projects more effectively and with greater sensitivity.

Economic Aspect :

35. As per the report of the Standing Committee for the year 2004-05, which was presented to the Parliament of India, the planned budgetary allocation was made under NWDA as follows :

36. Actual allocation for 2002-03 was Rs.15.30 crores, the budget estimate for 2003-04 was 20 crores, the revised estimate for the same year was Rs.21.95 crores and for 2004-05, the budget estimate was Rs.35 crores.

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37. The *Amicus Curiae*, in his report, has noted that the new aggregated cost of the entire program varies between Rs. 4,44,331.20 crores, at 2003-04 prices, and Rs.4,34,657.13 crores, at 2003-04 prices, depending on the implementation of the proposed Manas-Sankosh-Tista-Ganga link or the Jogigopa-Tista-Farakka link respectively.

38. As already noticed, the NCAER had been assigned the work of assessing the economic impact of river interlinking programmes, which in turn, suggested an investment roll-out plan for the same. The report of the NCAER was prepared in April, 2008. This report considers various financial aspects and the impact of various river interlinking projects in India. They point out that after independence, irrigation was viewed as infrastructure for agricultural development rather than as a commercial enterprise. In 1983, the Nitin Desai Committee forwarded the idea of Internal Rate of Return (hereinafter referred to as 'IRR'), suggesting that projects should normally earn a minimum IRR of 9 per cent. However, for drought-prone and hilly areas and in areas with only 75 per cent of dependable flows -

in the basin, a lower IRR of 7 per cent was recommended. Successive Finance Commissions also stressed on recovery of a certain percentage of the capital investment apart from working expenses. The Eleventh Finance Commission has recognized that this would have to be done in a gradual

manner. Receipts should cover not only maintenance expenditure but also leave some surplus as return on the capital invested.

39. This NCAER report, with some significance, noticed that until 2003-04, it was only in four years that the economy grew at more than 8 per cent per annum. Each of these years coincided with very high rate of growth in the agricultural sector. In contrast, industry and services sectors have, at best, pulled up the Gross Domestic Product (GDP) growth to 7.3 per cent per annum when there was no significant contribution from the agricultural sector. The report clearly opines that interlinking of river projects will prove fruitful for the nation as a whole and would serve a greater purpose by allowing higher returns from the agricultural sector for the benefit of the entire economy. -

This would also result in providing of varied benefits like control of floods, providing water to drought-prone States, providing water to a larger part of agricultural land and even power generation. Besides annuring to the benefit of

the country, it will also help the countries like Nepal etc., thus uplifting India's international role. Importantly, they also point out to a very important facet of interlinking of rivers, i.e., it may result in reduction of some diseases due to the supply of safe drinking water and thus serve a greater purpose for humanity.

40. The Bhakra dam has also been cited as an example in this report as having enabled the States of Punjab and Haryana to register faster growth as compared to the rest of the country. This project provided an additional irrigated area to the extent of 6.8 million hectares over 35 years. Increased irrigation intensity led to increased usage of High Yielding Variety (HYV) seeds which at present constitute more than 90 per cent of the area under wheat and 80 per cent of area under paddy cultivation. The region uses some of the most advanced agricultural technologies in India. -

NCAER, while depicting the poverty ratio vis-à-vis these States and the other States all over India, has provided the following tables:

States	Rural		Urban		All India	
	1973-74	1999-00	1973-74	1999-00	1973-74	1999-00
Punjab	28.21	6.35	27.96	5.75	28.15	6.16
Haryana	34.23	8.27	40.18	10.00	35.36	8.74
All India	56.44	27.09	49.01	23.62	54.88	26.10

41. Thus, they conclude that the Bhakra Dam was instrumental in helping India achieve food security, in reducing volatility of food grain prices and declining the incidence of poverty in those regions.

42. Besides pointing out the benefits of Bhakra Dam, the NCAER Report also states that the link canals have both short and long term impacts on the economy. Short term impact of link canals is in the form of increased employment

opportunities and the growth of the services sector. In the medium to long term, the major impact of link canals is through increased and assured irrigation. Although the major and direct gainers from the interlinking of rivers (ILR) programme will be agriculture and agriculture-dependant households, the entire economy will benefit because of increased agricultural production and other benefits.

43. The Report of the NCAER has pointed out various benefits of rivers interlinking programme at the State and National levels. However, when coming to the financial aspect of the programme, two concepts are of great relevance: firstly, the investment strain and secondly, the scope of financial investment and its recoupment. Primarily, it is clear from the records before us that this is a programme/project on which the nation and the States should have a rational but liberal approach for financial investment. Referring to the financial strain, the NCAER Report projects two sets of investment rollout plan. At the start of the programme, investment would be small, but

would increase gradually peaking in the year 2011-2012. It

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will then start falling. Investment rollout from the year 2008-2009 to 2014-2015 will have considerable strain on the Central Government finances, especially after the passage of Fiscal Responsibility and Budget Management Rules (FRBMR). The Government is now committed to reducing fiscal deficit by 0.3 percentage points of GDP every year and was to reduce the fiscal deficit down to 3 per cent of GDP by the fiscal year 2007-2008. The FRBMR also put a restriction on Government borrowings. In each subsequent financial year, the limit on borrowings of 9 per cent of GDP was to progressively reduced by at least 1 percentage point of GDP, a commitment which is to be adhered to by all Governments. The investment plan prepared by the NCAER was intended to help in clearing doubts in the minds of the people and opponents of the programme that investment is not going to take place in a single or couple of years, but over a period of at least ten years. Since the impact analysis undertaken by the

NCAER assumes that the Interlinking of Rivers (ILR) programme is entirely financed by the Central Government,

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a longer rollout plan would also help in reducing the impact on public finances.

44. The NCAER has also suggested changes which are necessary for the effective implementation of the river networking programme. *Inter alia*, it includes the pricing of irrigation benefits and improvement in the quality of service. It will be useful to notice at this stage, these suggested changes termed as 'Changes necessary' which are as under:

“A revision of water rates is necessary in the interest of efficiency. However, it should go hand in hand with improvement in the quality of service (Government of India 1992). Specific recommendations were made by the Committee on Pricing of Irrigation Water (Government of India, 1992) with regards to pricing:

1. Water rates are a form of user charges, and not a tax. Users of public irrigation must

meet the cost of the irrigation service.

2. As irrigation is one of the key inputs similar to seeds and fertilizer, its pricing should be addressed in the first step.

3. Under-pricing of irrigation is mainly responsible for the -

4. deteriorating quality of irrigation services. A revision of water rates is necessary in the interest of efficiency. However, it should go hand in hand with improvement in the quality of service.

5. Rates for non-agricultural users (domestic and industrial) should also be revised so that full cost is recovered.

6. Rates should be based on O&M norms and capital charges (interest and depreciation).

7. Averaging of rates by region and/or categories of projects is desirable. Categorisation could be:

- major and medium storage system,
- major and medium projects based exclusively on barrages/diversion works,
- minor surface irrigation works,
- lift irrigation canals, and
- lift irrigation from groundwater.

8. Distinction of rates in terms of tail and head reaches of a system, soil quality, and other criteria for rate determination should be approached with caution due to complexities involved with it.

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10. Water rates should be applied on two-part tariff. All lands in

command area should pay a flat annual fee on a per hectare basis for membership of the system and a variable fee linked to the actual extent of service (volume or area) used by each member.

11. The move to full-fledged volumetric pricing cannot be introduced immediately. The proposed rationalization of water pricing will have to be accomplished in three phases.

12. In the first phase, rationalization and simplification of the existing system of assessment (based on crop-wise irrigated area on an individual basis) to a system of season-specific areas rates should be taken up. The level of cost recovery to be aimed during the first phase

should at least cover O&M costs and 1 per cent interest on capital employed. The irrigated area under a crop which spreads over to more than one season should be charged at the rates applicable to different seasons. However, in each season, distinction should be made -

13. between paddy, sugarcane, and perennial crops.

14. In the second phase, the aim should be on volumetric measure for irrigation water charging.

15. In third phase, the focus should be on people participation for improving water use and, thus, productivity.

The recommendations of the Committee on Pricing of Irrigation (also known as the Vaidynathan Committee Report) were further studied by the Group of Officers formed by the Planning Commission in

October, 1992. It recommended that the irrigation water rates should cover the full annual O & M cost in phases in the next five years. These recommendations and the Vaidyanathan Committee Report were, in February 1995, sent to all the States/union territories that had started taking action with several states revising water rates upwards.”

To sum up the short comings and their analysis, the report states as under :

“One shortcoming of the above analysis is that it has not considered the issue of cost of resettlement of displaced people due to ILR Project. A draft National Rehabilitation Policy was prepared with the objective of minimizing development induced displacement of people by -

promoting non-displacing or least displacing alternatives for meeting development objectives. The draft policy is yet to be finalized by the National Advisory Council (NAC). The NAC intends to finalise a rehabilitation package that includes, inter alia, providing land for all agricultural families, implementing special employment guarantee programmes, providing homesteads and dwelling houses, bearing transportation cost, providing training and other support services, instituting a rehabilitation grant in order to compensate loss of income/livelihood. The ILR project has to consider displacement costs on the basis of norms stipulated in the national

Rehabilitation Policy as and when it gets finalized.”

45. Besides making the above observations and recommendations, the NCAER also suggests that after completion of the linking of rivers programme, the different river links should be maintained by separate river basin organizations, which would all be functioning under the direct control of the Central Water Commission or such other appropriate central body.

46. In the summing up of its Report, the NCAER has stated that water is essential for production of food, - economic growth, health and support to environment. Its main contribution to economic well-being is through its use of agriculture to improve food security. Water is essential to increase agricultural productivity under modern technology. Nearly 64 per cent of the population in rural area and 4 per cent in urban area depends on agriculture as their principal source of income. The analysis carried out in the State shows that the ILR programme has the potential to increase the growth rate of agriculture, which declined from 4.4 per

cent in 1980s to 3.0 per cent in 1990s and which is still susceptible to the vagaries of rainfall. In order to put our economy on the high growth path and improve the quality for life of people in the rural areas, a mixed policy of both increased availability of irrigation and increasing non-farm activity is required.

Principles Applied:

47. From the above narrated facts, stated recommendations and principles, it is clear that primarily there is unanimity between all concerned authorities - including the Centre and a majority of the State Governments, with the exception of one or two, that implementation of river linking will be very beneficial. In fact, the expert opinions convincingly dispel all other impressions. There shall be greater growth in agricultural and allied sectors, prosperity and stimulus to the economy potentially causing increase in per capita income, in addition to the short and long term benefits likely to accrue by such implementation. These would accrue if the expert

recommendations are implemented properly and within a timeframe. Then there shall be hardly any financial strain on the economy. On the contrary, such implementation would help advancement of India's GDP and bring greater wealth and prosperity to the nation as a whole. Besides actual benefits accruing to the common man, the Governments also benefit from the definite possibility of saving the States from drought on the one hand and floods on the other. This project, when it becomes a reality, will provide immeasurable benefits. We see no reason as to why the Governments should not take appropriate and timely - interest in the execution of this project, particularly when, in the various affidavits filed by the Central and the State Governments, it has been affirmed that the governments are very keen to implement this project with great sincerity and effectiveness.

48. The States of Rajasthan, Gujarat, Tamil Nadu have fully supported the concept. Madhya Pradesh has also supported the Scheme, but believes that it must be

implemented by the Central Government. The States of Karnataka, Bihar, Punjab and Sikkim have given some qualified approvals. Their main concern is, with regard to inter basin transfer, which must involve *quid pro quo*, as with any other resources inter-linking must be from water surplus to water deficit States and in regard to environmental and financial implications. Some of the other States are not connected with these projects as they have no participation in inter-linking of rivers. The State of Kerala has protested to some extent, to the long distance inter basin water transfer on the basis that the State needs -

water to supply their intricate network of natural and man-made channels.

49. It is also the case of the State of Kerala that their rivers are monsoon-fed and not perennial in nature, therefore, Kerala experiences severe water scarcity during summer or off-monsoon months.

50. The stand taken by the respective States, as noticed above, shows that, by and large, there is unanimity in accepting interlinking of rivers but the reservations of these States can also not be ignored, being relatable to their particular economic, geographical and socio-economic needs. These are matters which squarely fall within the domain of general consensus and thus, require a framework to be formulated by the competent Government or the Legislature, as the case may be, prior to its execution.

51. The National Commission for Review of the Working of the Constitution (NCRWC) 2002 in its Report also dealt with another important facet of river interlinking i.e. sharing of river waters. Explaining the doctrines of river sharing, it

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described Doctrine of Riparian Rights, Doctrine of Prior Appropriation, Territorial Integrity Theory, Doctrine of Territorial Sovereignty, English Common Law Principle of Riparian Right, Doctrine of Community Interest, Doctrine of Equitable Apportionment. It also explained that when

determining what a reasonable and equitable share is, the factors which should be taken into consideration. In that behalf, it specifically referred to agreements, judicial decisions, awards and customs that already are in place. Furthermore, relative economic and social needs of interested states, volume of stream and its uses, land not watered were other relevant considerations. Thus, it will be for the expert bodies alone to examine on such issues and their impact on the project.

52. Be that as it may, we have no hesitation in observing that the national interest must take precedence over the interest of the individual States. The State Governments are expected to view national problems with a greater objectivity, rationality and spirit of service to the nation and -

ill-founded objections may result in greater harm, not only to the neighbouring States but also to the nation at large.

53. Now, we may refer to certain constitutional provisions which have bearing on the matters in issue before us. Under the constitutional scheme, there is a clear demarcation of fields of operation and jurisdiction between the Legislature, Judiciary and the Executive. The Legislature may save unto itself the power to make certain specific legislations not only governing a field of its legislative competence as provided in the Seventh Schedule of the Constitution, but also regarding a particular dispute referable to one of the Articles itself. Article 262 of the Constitution is one of such powers. Under this Article, the Parliament, by law, can provide for the adjudication of any dispute or complaint with respect to the use, distribution and control of water of any inter-state river or river valley.

54. Article 262(2) of the Constitution opens with a *non-obstante* expression, that 'notwithstanding anything contained in the Constitution, Parliament may by law - provide that neither the Supreme Court nor any other Court shall exercise jurisdiction in respect of any dispute or complaint as referred to in Article 262(1)'. In other words,

the Parliament can reserve to itself, the power to oust the jurisdiction of the courts, including the highest Court of the land, in relation to a water dispute as stated under this Article. The jurisdiction of the Court will be ousted only with regard to the adjudication of the dispute and not all matters incidental thereto. For example, the Supreme Court can certainly direct the Central Government to fulfill its statutory obligation under Section 4 of the Act, which is mandatory, without deciding any water dispute between the States. [See : *Tamil Nadu Cauvery Neerppasana Vilaiporulgal Vivasayigal Nala Urimai Padhugappu Sangam v. Union of India & Ors.*, AIR 1990 SC 1316].

55. One of the possible views taken with regard to Article 262 is that the use of expression 'may' in the Constitution does not indicate a clear legislative intent, thus, it may be possible that Section 11 of the Act could refer only to such disputes as are already referred to a

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Tribunal and which are outside the purview of the courts. Once a specific adjudicatory mechanism is created, that machinery comes into operation with the creation of the Tribunal and probably, then alone will the Court's jurisdiction be ousted.

56. The Seventh Schedule to the Constitution spells out different fields of legislation under the Union List (List I), State List (List II) and Concurrent List (List III). Entry 56 of List I empowers the Union Parliament to enact laws in relation to the regulation and development of inter-state rivers and river valleys, to the extent that such regulation and development is declared by the Parliament, by law, to be expedient in the public interest. Entry 57 deals with fishing and fisheries beyond territorial waters. Entry 97 is a residual entry, which confers those legislative fields upon the Union Parliament which are not specifically provided for under List II and/or List III. Entry 17 relates to water, that is to say, water supplies, irrigation and canals, drainage and embankments, water storage and water power, subject to the provisions of Entry 56 of List I. -

Agriculture is again a State subject. The Concurrent List (List III) does not contain any entry in regard to water and agriculture, as such.

57. Entry 42 of List III is the law relating to acquisition and requisition of property by the Union and the State Parliaments. The result is that, in relation to acquisition, the Centre and the State, both, have power to legislate. Entry 20 of List III deals with economic and social planning. Thus, with the aid of the residual powers under Entry 97, List I, the Union Parliament gets a very wide field of legislation, relatable to various subjects.

58. The River Boards Act, 1956 was enacted by the Parliament under Entry 56 of List I. The Inter-State Water Disputes Act was also enacted with reference to the same Entry. Whereas the mandate of the latter is to provide a machinery for the settlement of disputes, the former is an Act to establish Boards for the regulation and development of inter-State river basins, through advice and coordination,

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and thereby to reduce the friction amongst the concerned States.

59. It is this kind of coordination which is required to be generated at all levels to implement the inter-linking of rivers program, as proposed. Huge amounts of public money have been spent, at the planning stage itself and it will be travesty of good governance and the epitome of harm to public interest, if these projects are not carried forward with a sense of sincerity and a desire for its completion.

60. In a more recent judgment of this Court in the case of *State of Karnataka v. State of Andhra Pradesh & Ors.* [(2000) 9 SCC 572], a Constitution Bench of this Court took the view that in Section 11 of the Act, the expression 'use, distribution and control of water in any river' are the key words in determination of the scope of power conferred on a Tribunal constituted under Section 3 of the Act. If a matter fell outside the scope of these three crucial words, the power of Section 11 in ousting the jurisdiction of the courts in respect of any water dispute, which is otherwise to be -

referred to Tribunal, would not have any manner of application. The test of maintainability of a legal action initiated by a State in a Court would thus be, whether the issues raised therein are referable to a Tribunal for adjudication of the manner of use, distribution and control of water.

61. Further, this Court while declining to issue a *mandamus* directing the States of Karnataka, Andhra Pradesh and Maharashtra to constitute a common Tribunal, held:

“168.It is settled law that such a direction cannot possibly be granted so as to compel an authority to exercise a power which has a substantial element of discretion. In any event the *mandamus* to exercise a power which is legislative in character cannot be issued and I am in full agreement with the submission of Mr. Solicitor General on this score as well. At best it would only be an issue of good governance but that by itself would not mean and imply that the Union Government has executive power even to force a settlement upon the State.”

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62. The above stated principles clearly show that a greater element of mutuality and consensus needs to be built between the States and the Centre on the one hand, and the States *inter se* on the other. It will be very difficult for the Courts to undertake such an exercise within the limited scope of its power of judicial review and even on the basis of expanded principles of Public Interest Litigation. A Public Interest Litigation before this Court has to fall within the contours of constitutional law, as no jurisdiction is wider than this Court's constitutional jurisdiction under Article 32 of the Constitution. The Court can hardly take unto itself tasks of making of a policy decision or planning for the country or determining economic factors or other crucial aspects like need for acquisition and construction of river linking channels under that program. The Court is not equipped to take such expert decisions and they essentially should be left for the Central Government and the concerned State. Such an attempt by the Court may amount to the Court sitting in judgment over the opinions of the experts in the respective fields, without any tools and -

expertise at its disposal. The requirements in the present case have different dimensions. The planning, acquisition, financing, pricing, civil construction, environmental issues involved are policy decisions affecting the legislative competence and would squarely fall in the domain of the Government of States and Centre. We certainly should not be understood to even imply that the proposed projects of inter-linking of rivers should not be completed.

63. We would recommend, with all the judicial authority at our command, that these projects are in the national interest, as is the unanimous view of all experts, most State Governments and particularly, the Central Government. But this Court may not be a very appropriate forum for planning and implementation of such a programme having wide national dimensions and ramifications. It will not only be desirable, but also inevitable that an appropriate body should be created to plan, construct and implement this inter linking of rivers program for the benefit of the nation as a whole.

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64. Realizing our limitations, we would finally dispose of this Public Interest Litigation with the following directions:-

(I) We direct the Union of India and particularly the Ministry of Water Resources, Government of India, to forthwith constitute a Committee to be called a 'Special Committee for Inter-linking of Rivers' (hereinafter referred as 'the Committee') of which, the following shall be the Members:-

- (a) The Hon'ble Minister for Water Resources.
- (b) Secretary, Ministry for Water Resources.
- (c) Secretary, Ministry of Environment and Forests.
- (d) Chairman, Central Water Commission.
- (e) Member-Secretary, National Water Development Authority.
- (f) Four experts to be nominated, one each from the following Ministries/bodies:
 - (i) One Expert from the Ministry of Water Resources
 - (ii) One Expert from the Ministry of Finance

(iii) One Expert from the Planning Commission

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(iv) One Expert from the Ministry of Environment
& Forests.

(g) Minister for Water and/or Irrigation from each of the concurring States, with the Principal Secretary of the concerned Department of the same State.

(h) The Chief Secretary or his nominee not below the rank of the Principal Secretary of the concerned Department in case of any other State involved directly or indirectly in the water linking river project.

(i) Two social activists to be nominated by each of the concerned Ministries.

(j) Mr. Ranjit Kumar (*Amicus Curiae*).

(II) The Committee shall meet, at least, once in two months and shall maintain records of its discussion and the Minutes.

(III) In the absence of any person from such meeting, irrespective of his/her status, the meeting shall not be adjourned. If the Hon'ble Minister for Water Resources

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is not available, the Secretary, Ministry of Water Resources, Government of India, shall preside over the Meeting.

(IV) The Committee would be entitled to constitute such sub-committees, as it may deem necessary for the purposes of carrying on the objects of the Inter-Linking of River Program, on such terms and conditions as it may deem proper.

(V) The Committee shall submit a bi-annual report to the Cabinet of the Government of India placing before it the status-cum-progress report as well as all the decisions required to be taken in relation to all matters communicated therewith. The Cabinet shall take all final and appropriate decisions, in the interest of the countries as expeditiously as possible and preferably within thirty days from the date the matters are first placed before it for consideration.

(VI) All the reports of the expert bodies as well as the status reports filed before this Court during the pendency of this petition, shall be placed before the Committee for

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its consideration. Upon due analysis of the Reports and expert opinions, the Committee shall prepare its plans for implementation of the project.

(VII) The plans so prepared shall have different phases, directly relatable to the planning, implementation, construction, execution and completion of the project.

(VIII) We are informed that large sums have been spent on preparation of initial and detailed project reports of the project 'Ken-Betwa Project'. The DPR is now ready. The States of Madhya Pradesh and Uttar Pradesh and also the Central Government had already given their approval and consent. The clarifications sought will be discussed by the Committee. We would direct the Committee to take up this project for implementation at the first instance itself.

(IX) Keeping in view the expert reports, we have no hesitation in observing and directing that time is a very material factor in the effective execution of the Interlinking of Rivers project. As pointed out in the Report by NCAER and by the Standing Committee, the

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delay has adversely affected the financial benefits that could have accrued to the concerned parties and the people at large and is in fact now putting a financial strain on all concerned.

(X) It is directed that the Committee shall take firm steps and fix a definite timeframe to lay down the guidelines for completion of feasibility reports or other reports and shall ensure the completion of projects so that the benefits accrue within reasonable time and cost.

(XI) At the initial stages, this program may not involve those States which have sufficient water and are not substantially involved in any inter-linking of river programme and the projects can be completed without their effective participation.

(XII) However, the Committee may involve any State for effective completion of the programme at any subsequent stage.

(XIII) There are projects where the paper work has been going for the last ten years and at substantial cost to the public exchequer. Therefore, we direct the Central

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and the State Governments to participate in the program and render all financial, administrative and executive help to complete these projects more effectively.

(XIV) It is evident from the record that the Reports submitted by the Task Force have not been acted upon. Thus, the entire effort put in by the Task Force has practically been of no use to the concerned governments, much less the public. The Task Force has now been wound up. Let the reports of the Task Force also be placed before the Committee which shall, without fail, take due note of the suggestions made therein and take decisions as to how the same are to be implemented for the benefit of the public at large.

(XV) The Committee constituted under this order shall be responsible for carrying out the inter-linking program. Its decisions shall take precedence over all administrative bodies created under the orders of this Court or otherwise.

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(XVI) We grant liberty to the learned *Amicus Curiae* to file contempt petition in this Court, in the event of default or non-compliance of the directions contained in this order.

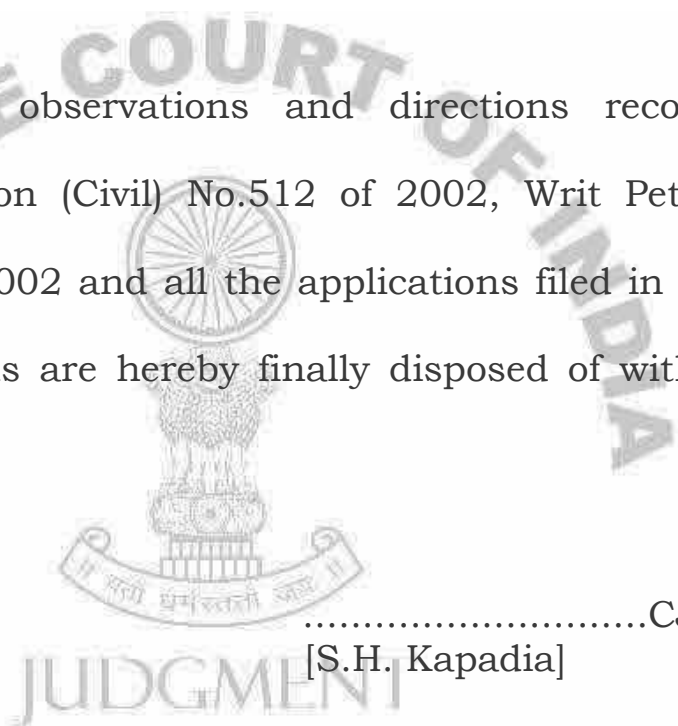
65. We would fail in our duty if we do not place on record the appreciation for the valuable and able assistance rendered by the learned *Amicus Curiae* and all other senior counsel and assisting counsel appearing in the present PIL.

66. We not only express a pious hope of speedy implementation but also do hereby issue a *mandamus* to the Central and the State Governments concerned to comply with the directions contained in this judgment effectively and expeditiously and without default. This is a matter of national benefit and progress. We see no reason why any

State should lag behind in contributing its bit to bring the Inter-linking River Program to a success, thus saving the people living in drought-prone zones from hunger and people living in flood-prone areas from the destruction caused by floods.

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67. With the observations and directions recorded supra, Writ Petition (Civil) No.512 of 2002, Writ Petition (Civil) No.668 of 2002 and all the applications filed in both these writ petitions are hereby finally disposed of with no order as to costs.



.....CJI.
[S.H. Kapadia]

.....,J.
[A.K. Patnaik]

.....,J.
[Swatanter Kumar]

New Delhi;
February 27, 2012

SUPREME COURT OF INDIA



JUDGMENT

Bedti-Varada link project
 Computation of annual dependable yield
 At pattanadahalla reservoir site for the
 Catchment area: 52.8 Sq.km Period from 1970-71 to 1985-86

Annexure: 2.1
 unit: Mm³

Sl no	Year	Jun	Jul	Aug	Sep	Oct	Monsoon total	Annual yield (mon.total x1.0137)	Yields arranged in descending order
1	1970-71	15	75	61	13	5	169	171	298
2	1971-72	36	53	18	11	4	122	124	218
3	1972-73	14	65	22	3	6	110	112	210
4	1973-74	29	61	47	8	6	151	153	199
5	1974-75	5	101	66	15	9	196	199	189
6	1975-76	94	76	78	36	10	294	298	180
7	1976-77	1	72	31	16	2	122	124	171
8	1977-78	22	62	29	26	5	144	146	170
9	1978-79	52	68	50	10	6	186	189	161
10	1979-80	15	43	53	13	4	128	130	153
11	1980-81	62	69	61	12	3	207	210	146
12	1981-82	22	54	72	16	4	168	170	145
13	1982-83	27	77	98	6	7	215	218	130
14	1983-84	34	59	57	24	4	178	180	124
15	1984-85	41	65	95	9	9	159	161	124
16	1985-86	42	39	46	6	10	143	145	112

50 % dependable yield= 165.50 say: 166 Mm³

75% dependable yield =133.75 say:134 Mm³

Note:-

Annual yield has been obtained by adding non-monsoon yield at 1.37% of monsoon yield based on the average percentage of non-monsoon yield to the monsoon yield.

Monthly yields have been worked out on prorata basis from the yield series at pattanadahalla reservoir given in the technical study No.PWBS/133/91, preliminary water balance study of Shalamalahalla and pattanadahalla dam by about 4.5 km upstream from the location indicated in the preliminary water balance study report.

Source:-

Preliminary water balance study at Shalamalahalla and pattanadahalla dam site in the Bedti basin (T.S. No.PWBS/133/191).

Toposheet study of Bedti-Varada link (T.S.No.LS-13)

Bedti-Varada link project

Annexure: 2.2

Computation of annual dependable yield unit: Mm³

at Shalamalahalla reservoir site for the Catchment area: 173.75 Sq.km

Period from 1970-71 to 1985-86

Sl No	Year	Jun	Jul	Aug	Sep	Oct	Monsoon total	Annual yield (mon.total x1.0137)	Yields arranged in descending order
1	1970-71	21	123	127	34	27	332	339	460
2	1971-72	36	125	48	28	15	252	257	446
3	1972-73	23	162	47	14	18	264	270	386
4	1973-74	49	146	96	11	16	318	325	385
5	1974-75	9	178	99	28	63	377	385	379
6	1975-76	75	133	93	50	20	371	379	361
7	1976-77	9	153	66	34	2	264	270	354
8	1977-78	25	128	60	56	22	291	297	339
9	1978-79	72	160	99	23	24	378	386	335
10	1979-80	28	108	126	27	9	298	304	325
11	1980-81	105	170	121	36	19	451	460	304
12	1981-82	22	126	160	34	12	354	361	297
13	1982-83	36	180	194	10	17	437	446	283
14	1983-84	63	103	122	51	8	347	354	270
15	1984-85	54	151	68	25	30	328	335	270
16	1985-86	50	97	91	9	31	278	283	257

50 % dependable yield= 337 say: 337 Mm³

75% dependable yield =286.5 say: 287 Mm³

Note:-

Annual yield has been obtained by adding non-monsoon yield at 2% of monsoon yield based on the average percentage of non-monsoon yield to the monsoon yield.

Source:-

Preliminary water balance study at Shalamalahalla and pattanadahalla dam site in the Bedti basin (T.S. No.PWBS/133/191).

Toposheet study of Bedti-Varada link (T.S.No.LS-13)

Design of spillway of Pattanadahalla dam

I Design of spillway length:

The spillway length of dam has been worked out on the basis of flood discharge computed using Inglis formula and safe discharge through spillway.

a) Computation of maximum flood discharge :

$$Q = \frac{124 A}{\sqrt{A+10.4}} \text{ m}^3/\text{sec}$$

Where A= catchment area in Sq.km

Q=maximum flood discharges in m³/sec

Catchment area of pattanadahalla dam site = 52.8 Sq.km

Max.discharge = 124x52.8

$$\frac{\text{-----m}^3/\text{sec}}{\sqrt{(52.8+10.4)}}$$

b) Design capacity of spill way :

$$Q=cd le (H)^{3/2}$$

Where cd= co-efficient of discharge assumed as 2.2

Le= effective length of crest

Assumed overall length of spillway=50m

Assumed number of gates = 10 gates of size 3.65 mx5.2 m each

Assumed thickness of pier=1.5m

Net length of spillway= 50-1.5x9=36.5 m

Effective spillway length=i.e., = L-2 (NK_p + K_a) H

Where L= net length of the spill way= 36.5 m

N= no of piers= 9

K_p= pier contraction co-efficient (assumed) = 0.01

K_a= Abutment contraction coefficient (assumed)=0.1

H= height of gate assumed = 5.2 m

$$Le = 36.5-2(9x0.01+0.1)5.2=36.5-1.976=34.52 \text{ m}$$

$$Q = C_d l e H^{3/2} = 2.2 \times 34.52 \times (5.2)^{3/2}$$
$$= 900.53 \text{ m}^3/\text{sec}$$

Say = 901 m³/sec

The designed capacity of spillway 901 m³/sec as computed in (b) is more than maximum flood discharge of 824 m³/sec as computed in (a). hence spillway provided is sufficient to pass the maximum flood discharge available from the catchment area intercepted by pattanadahalladam.

I Design of spillway length

The spillway length of dam has been worked out on the basis of flood discharge computed using Inglis formula and safe discharge through the spillway.

a) Computation of maximum flood discharge

$$Q = 124 A \sqrt{A+10.4}$$

-----m³/sec

Max.discharge = 124x173.75

-----m³/sec

$\sqrt{(173.75+10.4)}$

Say = 1588 m³/sec

b) design capacity of spillway :

$$Q = C_d l_e (H)^{3/2}$$

Where C_d = co-efficient of discharge assumed as 2.2

l_e = effective length

Assumed overall length of spillway = 90 m

Assumed number of gates = 18 nos. of 3.58 m x 5.2 m each

Assumed thickness of pier = 1.5 m

Net length of spillway = 90 - (1.5x17) = 64.5 m

Effective spillway length $l_e = L - 2(NK_p + K_a)H$

K_p = pier contraction coefficient (assumed) = 0.01

K_a = Abutment concentration co-efficient assumed = 0.1

Height of gate assumed = 5.2 m

$l_e = 64.5 - 2.81 = 61.69$ m

$$Q = C_d l_e (H)^{3/2}$$

$$= 2.2 \times 61.69 \times 5.2^{3/2} = 1609.32 \text{ m}^3/\text{sec}$$

The designed capacity of spillway is 1609 m³/sec (b) which is more than the computed flood discharge i.e.,588 m³/sec (a) Hence spillway provided is sufficient to safely pass the maximum flood discharge drained in the catchment area intercepted by Shalamalahaala dam.

Bedti-Varada link project
Salient features of the Bedti- Varada link proposal.

Annexure: 3.3

A. Salient features of Pattanada halla and Shalamalahalla reservoirs

Sl. No.	Description	Pattanadahalla dam	Shalamalahalla dam
1.	Location :		
	i) State	Karnataka	Karnataka
	ii) District	North Kanara	North Kanara
	iii) Latitude	140 40' 05'N	140 42' 48'N
	iv) Longitude	740 41' 40'E	740 48' 32'E
	v) River	Pattanadahalla	Shalamalahalla
	vi) Nearby village	Siralabail	Hulgol
2.	Hydrology :		
	i) Catchment area (Sq. km)	52.80	173.75
	ii) Mean annual rainfall (mm)	2725- 4047	1807-2725
	iii) Design flood (Cumecs)	824	1588
3.	Yield at dams site at:		
	i) 50% dependability (Mm3)	166	337
	ii) 75% dependability (Mm3)	134	287
4.	Total upstream utilization (Mm3)	2	6
5.	Dam/ Reservoir data:		
	i) Type of dam	Gravity	Gravity
	ii) Top level of dam (m)	515.75	483.4
	iii) Full reservoir level (m)	512.75	480.4
	iv) Minimum draw down level (m)	502.50	464.5
	v) Dead storage level (m)	502.50	464.0
	vi) River bed level (m)	485.00	455.0
	vii) Height of dam from RBL (m)	30.75	28.4
	viii) Water spread area at FRL (sq. km)	1.85	8.2
	ix) Live storage capacity at FRL (Mm3)	13.0	72.5
	x) Dead storage capacity at MDDL (Mm3)	5.0	7.5
	xi) Length of the dam at TBL (m)	720	670
6.	Spillway dam:		
	i) Length (m)	50	90
	ii) Nos and size of gate	10 gates (3.65x5.2m)	18 gates (3.65x5.2m)
	iii) Design flood discharge at FRL (Cumecs)	901	1609
7.	Submergence data:		
	i) Tehsil in which submergence area located	Sirsi	Sirsi
	ii) Total submergence area (ha)	185	820
	iii) No. Of villages affected	Nil	1
	iv) Forest area (ha)	145	642
	v) Roads (Km)	Nil	0.65
	vi) Population affected	Nil	967

B. Salient features of the link canal/ tunnel:

Sl. No.	Perticulars	Interlinking canal from Pattanadahalla to Shalamalahalla reservoir	Interlinking canal from Shalamalahalla reservoir to Varada river
1.	Total length of link road canal including tunnel (km)	8.50	14.83
2.	Bed width of canal (m)	3.10	4.75
3.	Full supply depth of canal (m)	2.1	3.15
4.	Designed capacity of the canal at head (Cumec)	12.98	38.13
5.	Off- take level of the link canal (m)	501.50 (FSL)	520.30 (FSL)
6.	Total lift involved (m)	Nil	123.70 (3 stages)
7.	Out- fall level of link canal (m)	497.08 (FSL)	565.00 (FSL)
8.	Length of canal (km)	6.30	8.03
9.	Length of tunnel (km)	2.20	6.80
10.	Bed slope of (a) Canal (b) Tunnel	1:6500 1:1000	1:6500 1:1000
11.	Diameter of tunnel (m)	3.30	4.90
12.	Pumping capacity (Cumec)	Not required	33.30

Bediti - Varada Link Project

Annexure : 3.4

Yearly working table

Unit: Mm^3

Year	Pattanada Halla Reservoir						Shalamalahalla Reservoir								
	Inflow	D/s requirement		Diversion to		Spills	Inflows	Div from Pattanada halla	U/s and D/S Req			Diversion			Spills
Demand	Met	Deficit	Shalsamala	Shalsamala	Demand				Met	Deficit	Demand	Met	Deficit		
1970	169.8	53.0	53.0	0.0	68.2	42.1	335.6	68.2	117.0	117.0	0.0	242.0	242.0	0.0	24.0
1971	122.8	53.0	53.0	0.0	46.0	36.8	255.6	46.0	117.0	117.0	0.0	242.0	242.0	0.0	17.3
1972	110.8	53.0	46.0	7.0	55.9	8.9	266.6	55.9	117.0	103.4	13.6	242.0	197.5	44.5	21.6
1973	151.8	53.0	53.0	0.0	68.0	17.8	321.6	68.0	117.0	117.0	0.0	242.0	242.0	0.0	6.7
1974	197.8	53.0	50.0	3.0	44.3	103.5	381.6	44.3	117.0	113.3	3.7	242.0	230.1	11.9	47.3
1975	296.8	53.0	53.0	0.0	57.6	186.2	375.6	57.6	117.0	117.0	0.0	242.0	242.0	0.0	73.2
1976	122.8	53.0	46.0	7.0	38.6	42.8	266.6	38.6	117.0	117.0	0.0	242.0	242.0	0.0	6.3
1977	144.8	53.0	53.0	0.0	81.3	5.9	293.6	81.3	117.0	114.8	2.2	242.0	230.1	11.9	0.0
1978	197.8	53.0	53.0	0.0	71.0	63.8	382.6	71.0	117.0	117.0	0.0	242.0	242.0	0.0	76.7
1979	123.8	53.0	53.0	0.0	64.9	10.9	300.6	64.9	117.0	117.0	0.0	242.0	242.0	0.0	19.5
1980	208.8	53.0	53.0	0.0	43.1	112.7	458.6	43.1	117.0	117.0	0.0	242.0	242.0	0.0	119.7
1981	168.8	53.0	53.0	0.0	48.1	67.7	357.6	48.1	117.0	117.0	0.0	242.0	242.0	0.0	53.7
1982	216.8	53.0	53.0	0.0	20.2	143.6	412.6	20.2	117.0	117.0	0.0	242.0	242.0	0.0	96.8
1983	178.8	53.0	53.0	0.0	95.0	30.8	350.6	95.0	117.0	117.0	0.0	242.0	242.0	0.0	62.3
1984	159.8	53.0	53.0	0.0	58.0	48.8	331.6	58.0	117.0	117.0	0.0	242.0	242.0	0.0	59.4
1985	143.8	53.0	53.0	0.0	86.9	3.9	279.6	86.9	117.0	117.0	0.0	242.0	242.0	0.0	0.0

Bedti - Varada Link Project

Assurance : 3.4.1

Working table for the water year:1970

Units : cum Power kw

Month	Pittanada Halla Reservoir								Shalamahalla Reservoir																	
	Level in m	Storage	Inflow	D/s requirement		Div to Shalamala	Spills	Power	Sec pos	Level in m	Storage	In- flows	Div from Pittanada	Demand		U/s and D/S Req		Deficit		Diversion		Spills	Power	Sec pos		
				Demand	Net									Deficit	US	DS	US	DS	US	DS	Dem- and				Net	Def- icit
Jan	502.67	11.5	14.3	20.2	20.2	0.0	0.0	0.0	1.21	0.00	474.16	43.0	10.4	0.0	26.0	10.0	25.0	10.0	0.0	0.0	11.0	11.0	0.0	0.0	0.43	0.00
Feb	502.12	5.5	14.2	18.0	18.0	0.0	0.0	19.4	1.02	0.13	467.23	16.0	122.4	25.0	25.0	16.0	25.0	16.0	0.0	0.0	53.2	53.2	0.0	0.0	0.21	0.00
Aug	512.75	18.0	60.2	15.0	15.0	0.0	0.0	14.0	1.13	0.67	440.05	11.4	126.4	25.0	25.0	15.0	25.0	15.0	0.0	0.0	31.7	31.7	0.0	23.0	1.02	0.70
Sep	512.75	18.0	12.2	0.2	0.2	0.0	0.0	0.0	0.02	0.00	449.19	30.0	33.4	15.0	0.0	0.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.0	0.00	0.00
Oct	512.75	18.0	4.2	1.0	1.0	0.0	0.0	0.0	0.12	0.02	449.06	11.7	25.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	1.0	0.00	0.07
Nov	512.75	18.0	1.2	0.0	0.0	0.0	0.0	0.0	0.00	0.00	440.10	30.0	6.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	14.0	0.0	0.0	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	460.09	22.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	0.0	0.0	0.00	0.00
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.24	24.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.24	24.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.24	24.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.24	24.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.24	24.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total		169.2	53.0	53.0	0.0	68.2	42.1				335.6	60.2	76.0	11.0	76.0	11.0	0.0	0.0	0.0	112.0	112.0	0.0	24.3			

Working table for the water year:1971

Units : cum Power kw

Month	Pittanada Halla Reservoir								Shalamahalla Reservoir																	
	Level in m	Storage	Inflow	D/s requirement		Div to Shalamala	Spills	Power	Sec pos	Level in m	Storage	In- flows	Div from Pittanada	Demand		U/s and D/S Req		Deficit		Diversion		Spills	Power	Sec pos		
				Demand	Net									Deficit	US	DS	US	DS	US	DS	Dem- and				Net	Def- icit
Jun	512.75	18.0	35.3	30.3	20.3	0.0	15.0	0.0	1.22	0.20	473.14	24.2	35.4	15.0	25.0	10.0	25.0	10.0	0.0	0.0	11.3	11.3	0.0	0.0	0.27	0.00
Jul	512.75	18.0	32.3	18.0	16.0	0.0	0.0	36.3	1.21	0.39	475.27	27.1	124.1	0.0	25.0	18.0	25.0	18.0	0.0	0.0	53.2	53.2	0.0	17.1	1.09	0.71
Aug	512.75	18.0	17.3	15.0	15.0	0.0	0.0	0.0	1.13	0.00	440.00	30.0	17.1	0.0	25.0	15.0	25.0	15.0	0.0	0.0	31.7	31.7	0.0	0.0	0.00	0.00
Sep	512.75	18.0	10.2	0.2	0.2	0.0	0.0	0.0	0.01	0.00	441.21	3.5	27.4	22.5	0.0	0.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.0	0.00	0.00
Oct	502.50	5.0	3.2	1.0	1.0	0.0	0.0	0.0	0.05	0.00	464.50	1.1	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.00
Nov	504.24	7.1	1.3	0.0	0.0	0.0	0.0	0.0	0.00	0.00	474.50	1.3	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	14.0	0.0	0.0	0.00	0.00
Dec	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	464.50	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	0.0	0.0	0.00	0.00
Jan	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	464.50	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Feb	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	464.50	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Mar	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	464.50	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Apr	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	464.50	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
May	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	464.50	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total		122.8	53.0	53.0	0.0	46.0	16.2				255.6	46.0	76.0	11.0	76.0	11.0	0.0	0.0	0.0	112.0	112.0	17.6	17.1			

Bedili - Varada Link Project

Annexure : 3.4.2

Units : Ha Power MW

Working table for the water year:1972

Month	Pattandaha Reservoir										Shalamahalla Reservoir																	
	Level in m	Storage	Inflow	O/S requirement		Div to Shalamahalla	Spills	Power	Sec per	Level in m	Storage	Inflow	Div from Pattandaha	U/s and O/S Req				Deficit		Diversion		Spills	Power	Sec per				
				Demand	Net									Deficit	Demand	DS	US	Net	DS	US	DS				US	DS	US	
Jun	502.50	5.0	13.0	20.3	13.3	7.0	0.0	0.0	0.05	0.00	164.50	7.5	22.4	0.0	26.0	10.0	22.4	0.0	3.0	10.0	11.0	0.0	11.0	0.0	11.0	0.0	0.00	0.00
Jul	501.50	5.0	64.0	15.0	16.0	0.0	25.0	0.0	1.02	0.27	164.50	7.5	161.4	26.0	25.0	16.0	25.0	15.0	0.0	0.0	51.2	53.2	0.0	21.4	0.0	0.74	0.00	
Aug	512.75	18.0	21.0	15.0	15.0	0.0	6.0	0.0	1.13	0.00	163.75	11.5	12.4	15.0	0.0	0.0	0.0	0.0	0.0	0.0	54.3	33.0	21.3	0.0	0.00	0.00	0.00	
Sep	512.75	18.0	2.0	0.2	0.2	0.0	15.0	0.0	0.91	0.00	164.50	7.5	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.00	0.00	
Oct	502.50	5.0	5.0	1.0	1.0	0.0	0.0	0.0	0.05	0.00	164.50	7.5	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.3	12.3	1.5	0.0	0.00	0.00	0.00	
Nov	502.50	5.0	1.0	0.0	0.0	0.0	0.0	0.0	0.09	0.00	164.50	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	0.0	7.8	0.0	0.00	0.00	0.00	
Dec	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	164.50	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Jan	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	164.50	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Feb	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	164.50	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Mar	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	164.50	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Apr	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	164.50	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
May	502.50	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	164.50	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Total			119.0	53.0	46.0	7.0	55.0	0.0					266.5	55.0	16.0	11.0	12.4	31.0	5.6	10.0	112.0	197.3	14.5	31.0				

Units : Ha Power MW

Working table for the water year:1973

Month	Pattandaha Reservoir										Shalamahalla Reservoir															
	Level in m	Storage	Inflow	O/S requirement		Div to Shalamahalla	Spills	Power	Sec per	Level in m	Storage	Inflow	Div from Pattandaha	U/s and O/S Req				Deficit		Diversion		Spills	Power	Sec per		
				Demand	Net									Deficit	Demand	DS	US	Net	DS	US	DS				US	DS
Jun	502.50	5.0	23.0	20.3	20.3	0.0	0.0	0.0	1.34	0.30	164.50	7.5	48.4	0.0	26.0	10.0	26.0	0.0	0.0	11.0	11.0	0.0	0.0	0.00	0.00	0.00
Jul	509.67	15.0	60.0	15.0	16.0	0.0	26.0	0.0	1.14	0.46	164.50	8.0	145.4	26.0	25.0	16.0	25.0	15.0	0.0	0.0	53.2	53.2	0.0	0.0	0.00	0.00
Aug	512.75	18.0	16.0	15.0	15.0	0.0	16.0	0.0	1.13	0.27	160.40	80.0	95.4	26.0	25.0	15.0	25.0	15.0	0.0	0.0	31.7	31.7	0.0	0.0	0.00	0.00
Sep	512.75	18.0	7.0	0.2	0.2	0.0	7.0	0.0	0.92	0.00	174.35	43.7	15.4	4.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.00
Oct	512.75	18.0	1.0	0.0	0.0	0.0	1.0	0.0	0.08	0.00	175.03	46.0	6.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	0.0	0.00	0.00
Nov	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	173.26	39.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	7.3	0.0	0.0	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	171.55	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	171.55	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	171.55	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	171.55	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	171.55	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	171.55	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total			151.0	53.0	52.0	0.0	68.0	0.0					321.0	55.0	16.0	11.0	11.0	41.0	0.0	0.0	212.0	212.0	0.0	0.0		

Bodhi - Varada Link Project

Working table for the water year:1974

Month	Pattanaada Balla Reservoir										Shafanaballala Reservoir																				
	Level in m	Storage	Inflow			D/S requirement			Div to Shalamala	Spills	Power	Sec pos	Level in m	Storage	Inflow from Pattanaada			D/S Req			Deficit			Diversion			Spills	Power	Sec pos		
			in	out	net	Dem	Met	Def							Dem	Met	Def	Dem	Met	Def	Dem	Met	Def	Dem	Met	Def					
Jan	512.75	18.0	1.8	20.8	17.8	3.0	0.0	0.0	1.17	0.00	0.00	471.55	31.4	8.4	0.0	25.0	10.0	16.0	14.0	0.0	0.0	1.7	11.0	0.0	11.0	0.0	10.7	0.0	0.21	0.54	
Feb	502.50	5.0	100.8	16.0	16.0	0.0	0.0	71.8	1.00	0.78	0.78	464.50	7.5	177.4	1.0	25.0	16.0	25.0	15.0	0.0	0.0	0.0	0.0	52.1	52.1	0.0	10.7	0.0	1.03	0.25	
Mar	512.75	18.0	65.8	15.0	15.0	0.0	26.0	23.0	1.13	0.67	0.67	480.40	80.0	98.4	25.0	25.0	15.0	25.0	15.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.0	0.00	0.00	0.00	
Apr	512.75	18.0	14.8	0.2	0.2	0.0	14.6	0.0	0.02	0.00	0.00	480.40	80.0	27.4	14.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	32.0	0.00	1.80	0.00
May	512.75	18.0	5.8	1.0	1.0	0.0	0.0	1.1	0.00	0.00	0.00	479.49	67.7	62.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	0.0	0.00	0.00	0.00
Jun	512.75	18.0	2.8	0.0	0.0	0.0	1.1	0.0	0.06	0.00	0.00	480.40	80.0	7.8	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	0.0	0.0	0.00	0.00	0.00
Jul	512.75	18.0	1.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	480.40	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Aug	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Sep	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Oct	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Nov	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.25	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Total			197.8	53.0	50.0	1.0	44.3	103.5							341.6	44.3	76.0	41.0	76.0	37.3	0.3	3.7	242.0	230.1	11.9	47.3					

Working table for the water year:1975

Month	Pattanaada Balla Reservoir										Shafanaballala Reservoir																				
	Level in m	Storage	Inflow			D/S requirement			Div to Shalamala	Spills	Power	Sec pos	Level in m	Storage	Inflow from Pattanaada			D/S Req			Deficit			Diversion			Spills	Power	Sec pos		
			in	out	net	Dem	Met	Def							Dem	Met	Def	Dem	Met	Def	Dem	Met	Def								
Jun	512.75	18.0	93.8	20.8	20.8	0.0	0.0	73.0	1.62	0.18	0.18	472.25	66.6	14.4	0.0	25.0	10.0	16.0	10.0	0.0	0.0	0.0	0.0	11.3	11.3	0.0	38.3	1.10	0.70	0.00	
Jul	512.75	18.0	75.8	16.0	16.0	0.0	0.0	59.8	1.21	0.39	0.39	480.40	80.0	122.4	0.0	25.0	16.0	15.0	15.0	0.0	0.0	0.0	0.0	51.7	51.7	0.0	0.0	1.33	0.30	0.00	
Aug	512.75	18.0	77.3	15.0	15.0	0.0	26.0	35.3	1.13	0.37	0.37	480.40	80.0	92.4	26.0	25.0	15.0	15.0	15.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	19.1	0.30	1.12	0.00	
Sep	512.75	18.0	35.8	0.2	0.2	0.0	26.0	8.7	0.02	0.63	0.63	480.40	80.0	19.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.16	0.00
Oct	512.75	18.0	9.3	1.0	1.0	0.0	0.0	8.3	0.08	0.00	0.00	480.40	80.0	1.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	0.0	0.00	0.30	0.00
Nov	512.75	18.0	3.3	0.0	0.0	0.0	0.0	3.3	0.00	0.00	0.00	480.40	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	480.40	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.47	67.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.47	67.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.47	67.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.47	67.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	479.47	67.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	
Total			296.1	53.0	52.0	0.0	57.5	135.1							375.6	57.6	76.0	41.0	76.0	41.0	0.0	0.0	242.0	242.0	0.0	73.1					

Dudli - Varada Link Project

Annexure : 3.4.5

Working table for the water year:1978

Units : Mm Power KW

Month	Paltanada Halla Reservoir										Shalamalaballa Reservoir															
	Level in m	Storage	Inflow			D/s requirement			Div to Shalamala	Spills	Power	Sec pos	Level in m	Storage	Inflow			D/S Req			Diversion Dem- and Met	Spills	Power	Sec pos		
			Surf	Sub	Total	Met	Deficit	Met							Deficit	Surf	Sub	Total	Met	Deficit					Met	Deficit
Jun	512.75	18.0	51.8	10.8	10.8	0.0	26.9	4.1	1.62	0.18	472.39	37.5	71.4	25.2	26.0	10.0	26.0	10.0	0.0	0.0	11.9	11.9	0.0	7.3	0.62	0.49
Jul	512.75	18.0	67.3	16.0	16.0	0.0	0.0	51.8	1.21	0.39	480.40	80.0	159.4	3.0	25.0	16.0	25.0	16.0	0.0	0.0	53.2	53.2	0.0	55.2	1.10	0.70
Aug	512.75	18.0	49.3	15.0	15.0	0.0	26.9	7.9	1.13	0.60	480.40	80.0	98.4	25.2	25.0	15.0	25.0	15.0	0.0	0.0	81.7	81.7	0.0	3.6	1.03	0.25
Sep	512.75	18.0	9.8	0.2	0.2	0.0	9.8	0.0	0.02	0.00	480.40	80.0	22.4	9.8	0.0	0.0	9.8	0.0	0.0	0.0	54.3	54.3	0.0	0.0	0.00	0.00
Oct	512.75	18.0	5.3	1.0	1.0	0.0	4.3	0.0	0.08	0.00	477.38	57.7	23.4	4.3	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.00
Nov	512.75	18.0	2.3	0.0	0.0	0.0	2.3	0.0	0.05	0.00	473.72	62.8	7.6	2.3	0.0	0.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	0.0	0.00	0.00
Dec	512.75	18.0	0.9	0.0	0.0	0.0	0.0	0.0	0.00	0.00	478.54	62.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	7.3	0.0	0.0	0.00	0.00
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	476.39	55.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	476.39	55.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	476.39	55.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	476.39	55.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	476.39	55.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total			187.8	53.0	53.0	0.0	71.0	25.3					382.6	71.0	76.0	41.0	76.0	41.0	0.0	0.0	242.0	242.0	0.0	76.7		

Working table for the water year:1979

Units : Mm Power KW

Month	Paltanada Halla Reservoir										Shalamalaballa Reservoir															
	Level in m	Storage	Inflow			D/s requirement			Div to Shalamala	Spills	Power	Sec pos	Level in m	Storage	Inflow			D/S Req			Diversion Dem- and Met	Spills	Power	Sec pos		
			Surf	Sub	Total	Met	Deficit	Met							Deficit	Surf	Sub	Total	Met	Deficit						
Jun	512.75	18.0	14.3	20.3	20.3	0.0	0.0	3.3	1.31	0.30	476.39	55.4	27.4	0.0	25.0	10.0	26.0	10.0	0.0	0.0	11.9	11.9	0.0	0.0	0.54	0.30
Jul	509.00	12.0	42.3	16.0	16.0	0.0	20.3	3.0	1.13	0.30	472.40	21.3	107.4	20.3	25.0	16.0	25.0	16.0	0.0	0.0	53.2	53.2	0.0	0.0	0.30	0.30
Aug	512.75	18.0	52.4	15.0	15.0	0.0	26.9	19.3	1.13	0.47	479.75	62.3	125.4	25.2	25.0	15.0	25.0	15.0	0.0	0.0	81.7	81.7	0.0	19.5	1.02	0.75
Sep	512.75	18.0	12.4	0.2	0.2	0.0	12.6	0.0	0.02	0.00	480.40	80.0	26.4	12.4	0.0	0.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.0	0.00	0.00
Oct	512.75	18.0	1.4	1.0	1.0	0.0	2.3	0.0	0.08	0.00	478.56	64.7	8.4	2.3	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.00
Nov	512.75	18.0	1.8	0.0	0.0	0.0	1.3	0.0	0.00	0.00	477.61	54.8	5.6	1.3	0.0	0.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	0.0	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	475.75	59.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	7.3	0.0	0.0	0.00	0.00
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	474.07	42.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	474.07	42.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	474.07	42.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	474.07	42.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	474.07	42.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total			128.3	53.0	53.0	0.0	64.9	10.3					300.6	64.9	76.0	41.0	76.0	41.0	0.0	0.0	242.0	242.0	0.0	19.5		

Bedli - Varada Link Project

Annexure : 3.4.6

Working table for the water year:1988

Units : Ha Power KW

Month	Pattanaada Halla Reservoir								Shalamalaballa Reservoir																	
	Level in m	Storage	Inflow	D/S requirement Demand	Net Deficit	Div to Shalamalaballa	Spills	Power	Sec per	Level in m	Storage	In- flows	Div from Pattanaada	Demand DS	U/s and D/S Req DS	D/S Req DS	Net DS	Deficit US	DS	Diversion Demand	Net Deficit	Spills	Power	Sec per		
Jun	512.75	18.0	51.8	10.8	19.8	0.0	0.0	41.0	1.52	0.18	474.07	42.4	104.4	0.0	25.0	10.0	10.0	0.0	0.0	11.0	11.0	0.0	18.9	0.64	1.16	
Jul	512.75	18.0	58.8	16.0	16.0	0.0	0.0	52.8	1.21	0.39	480.40	80.0	169.4	0.0	25.0	16.0	25.0	16.0	0.0	0.0	53.2	53.2	0.0	75.2	1.10	0.70
Aug	512.75	18.0	69.8	15.0	15.0	0.0	26.9	18.9	1.15	0.67	480.40	80.0	120.4	26.9	25.0	15.0	25.0	15.0	0.0	0.0	81.7	81.7	0.0	25.6	1.03	0.77
Sep	512.75	18.0	11.8	0.2	0.2	0.0	11.6	0.0	0.02	0.00	480.40	80.0	35.4	11.6	0.0	0.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.9	0.00	0.00
Oct	512.75	18.0	2.8	1.0	1.0	0.0	1.8	0.0	0.08	0.00	480.11	72.7	18.4	1.8	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.9	0.00	0.00
Nov	512.75	18.0	2.8	0.0	0.0	0.0	2.8	0.0	0.00	0.00	478.25	75.3	8.6	2.8	0.0	0.0	0.0	0.0	0.0	0.0	16.9	16.9	0.0	0.9	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	480.04	71.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	0.0	0.0	0.00	0.00
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	478.58	63.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	478.58	63.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	478.58	63.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	478.58	63.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	478.58	63.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total			208.3	53.0	53.0	0.0	43.1	112.7					436.5	43.1	76.0	41.0	76.0	41.0	0.0	0.0	242.0	242.0	0.0	119.7		

Working table for the water year:1981

Units : Ha Power KW

Month	Pattanaada Halla Reservoir								Shalamalaballa Reservoir																	
	Level in m	Storage	Inflow	D/S requirement Demand	Net Deficit	Div to Shalamalaballa	Spills	Power	Sec per	Level in m	Storage	In- flows	Div from Pattanaada	Demand DS	U/s and D/S Req DS	D/S Req DS	Net DS	Deficit US	DS	Diversion Demand	Net Deficit	Spills	Power	Sec per		
Jun	512.75	18.0	21.3	20.3	20.3	0.0	1.0	0.0	1.52	0.00	478.58	63.4	21.4	1.0	16.0	10.0	25.0	10.0	0.0	0.0	11.0	11.0	0.0	0.0	0.00	0.00
Jul	512.75	18.0	51.3	16.0	16.0	0.0	28.3	19.3	1.21	0.39	473.08	37.9	125.4	26.3	25.0	16.0	25.0	16.0	0.0	0.0	53.2	53.2	0.0	16.0	0.17	0.82
Aug	512.75	18.0	71.3	15.0	15.0	0.0	3.0	56.3	1.13	0.67	480.40	80.0	159.4	0.0	25.0	15.0	25.0	15.0	0.0	0.0	81.7	81.7	0.0	27.7	1.33	0.77
Sep	512.75	18.0	15.3	0.2	0.2	0.0	15.1	0.0	0.02	0.00	480.40	80.0	33.4	15.3	0.0	0.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.9	0.00	0.00
Oct	512.75	18.0	3.8	1.0	1.0	0.0	2.8	0.0	0.08	0.00	480.19	74.7	11.4	2.8	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.9	0.00	0.00
Nov	512.75	18.0	1.8	0.0	0.0	0.0	1.8	0.0	0.00	0.00	480.07	71.8	8.6	1.8	0.0	0.0	0.0	0.0	0.0	0.0	16.9	16.9	0.0	0.9	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	478.75	64.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	0.0	0.0	0.00	0.00
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.10	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.10	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.10	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.10	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.10	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total			168.3	52.0	52.0	0.0	48.1	67.7					357.6	48.1	76.0	41.0	76.0	41.0	0.0	0.0	242.0	242.0	0.0	53.7		

Bedli - Farada Link Project

Working table for the water year:1992

Assurance : 3.4.T

3

Units : Mm Power MW

Month	Pattanaada Halla Reservoir									Shalamalabaila Reservoir																
	Level in m	Storage (m ³)	D/S requirement			Div to Shalamalabaila	Spills	Power	Sec pos	Level in m	Storage (m ³)	In-flows	Div from Pattanaada	U/s and D/S Req				Deficit		Diversion		Spills	Power	Sec pos		
			Demand	Met	Deficit									Demand	Met	Deficit	Met	US	DS	US	DS				US	DS
Jan	512.75	18.0	15.3	20.8	20.8	0.0	5.0	0.0	1.52	0.00	477.10	56.4	25.4	6.0	26.0	10.0	26.0	10.0	0.0	0.0	11.9	11.9	0.0	0.0	0.59	0.90
Feb	512.75	18.0	15.3	16.0	16.0	0.0	0.0	20.8	1.21	0.59	475.71	19.9	149.4	0.0	25.0	16.0	25.0	16.0	0.0	0.0	53.2	53.2	0.0	23.1	1.03	0.77
Mar	512.75	18.0	15.3	15.0	15.0	0.0	0.0	32.3	1.13	0.67	480.40	30.0	193.4	0.0	25.0	15.0	25.0	15.0	0.0	0.0	81.7	81.7	0.0	11.7	1.03	0.77
Apr	512.75	18.0	5.8	1.0	1.0	0.0	5.6	0.0	0.02	0.00	480.40	30.0	9.4	5.8	0.0	0.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.0	0.00	0.00
May	512.75	18.0	6.8	1.0	1.0	0.0	5.8	0.0	0.08	0.00	473.69	49.7	16.4	5.8	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.00
Jun	512.75	18.0	2.8	0.0	0.0	0.0	1.8	0.0	0.00	0.00	474.81	45.8	8.6	2.8	0.0	0.0	0.0	0.0	0.0	0.0	18.0	18.0	0.0	0.0	0.00	0.00
Jul	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	475.90	41.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	0.0	0.0	0.00	0.00
Aug	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.99	33.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Sep	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	475.99	33.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Oct	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.99	33.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Nov	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	473.09	33.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	473.09	33.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total		216.3	51.0	53.0	53.0	0.0	20.2	142.6			412.6	20.2	76.0	41.0	76.0	41.0	0.0	0.0	242.0	242.0	0.0	0.0	0.0	0.0	0.00	0.00

Working table for the water year:1993

Assurance : 3.4.T

3

Units : Mm Power MW

Month	Pattanaada Halla Reservoir									Shalamalabaila Reservoir																
	Level in m	Storage (m ³)	D/S requirement			Div to Shalamalabaila	Spills	Power	Sec pos	Level in m	Storage (m ³)	In-flows	Div from Pattanaada	U/s and D/S Req				Deficit		Diversion		Spills	Power	Sec pos		
			Demand	Met	Deficit									Demand	Met	Deficit	Met	US	DS	US	DS				US	DS
Jan	512.75	18.0	15.3	20.8	20.8	0.0	5.0	0.0	1.52	0.00	472.09	33.4	82.4	13.0	26.0	10.0	26.0	10.0	0.0	0.0	11.9	11.9	0.0	0.0	0.55	0.90
Feb	512.75	18.0	15.3	16.0	16.0	0.0	0.0	15.3	1.21	0.33	470.35	60.9	102.4	26.9	25.0	16.0	25.0	16.0	0.0	0.0	53.2	53.2	0.0	15.0	1.08	0.72
Mar	512.75	18.0	15.3	15.0	15.0	0.0	0.0	14.3	1.13	0.37	480.40	30.0	121.4	26.9	25.0	15.0	25.0	15.0	0.0	0.0	81.7	81.7	0.0	11.7	1.03	0.77
Apr	512.75	18.0	5.8	1.0	1.0	0.0	23.8	0.0	0.02	0.00	480.40	30.0	59.4	5.8	0.0	0.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.0	0.00	0.00
May	512.75	18.0	6.8	1.0	1.0	0.0	2.8	0.0	0.08	0.00	480.40	30.0	7.4	6.8	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.00
Jun	512.75	18.0	2.8	0.0	0.0	0.0	1.8	0.0	0.00	0.00	480.40	30.0	7.4	6.8	0.0	0.0	0.0	0.0	0.0	0.0	18.0	18.0	0.0	0.0	0.00	0.00
Jul	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	479.03	35.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	18.0	0.0	0.0	0.00	0.00
Aug	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.18	37.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	0.0	0.0	0.00	0.00
Sep	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.18	37.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Oct	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.18	37.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Nov	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.18	37.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	477.18	37.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total		173.3	51.0	53.0	53.0	0.0	95.0	30.3			350.8	25.0	76.0	41.0	76.0	41.0	0.0	0.0	242.0	242.0	0.0	0.0	0.0	0.0	0.00	0.00

Bodii - Varada Link Project

Annexure : 1.4.3

Working table for the water year:1984

Units : Cm Power MW

Month	Pattanaada Hulla Reservoir									Shalanshalaballa Reservoir																
	Level in m	Storage	Inflow	D/s requirement Demand Met Deficit	Dir to Shalanala	Spills	Power	Sec pow	Level in m	Storage	In-floos	Dir from Pattanada	Demand	U/s and D/S Req Met	Deficit	Diversion Demand Met Def-icil	Spills	Power	Sec pow							
Jan	512.75	18.0	49.8	20.3	29.3	0.0	10.0	0.0	1.62	0.00	477.38	57.7	53.4	20.0	16.0	10.0	26.0	10.0	0.0	0.0	11.9	11.9	0.0	1.2	0.29	0.12
Jul	512.75	18.0	54.8	16.0	16.0	0.0	0.0	42.3	1.21	0.39	480.40	30.0	150.4	8.0	25.0	16.0	25.0	16.0	0.0	0.0	52.2	52.2	0.0	52.2	1.10	0.70
Aug	512.75	18.0	24.8	15.0	15.0	0.0	19.3	0.0	1.13	0.00	480.40	30.0	67.4	19.3	25.0	15.0	25.0	15.0	0.0	0.0	81.7	81.7	0.0	0.0	0.24	0.00
Sep	512.75	18.0	8.2	0.2	0.2	0.0	4.5	0.0	0.02	0.00	474.75	45.5	24.4	8.1	0.0	0.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.0	0.00	0.00
Oct	512.75	18.0	8.5	1.0	1.0	0.0	7.5	0.0	0.08	0.00	469.54	24.2	29.4	7.8	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.00
Nov	512.75	18.0	1.8	0.0	0.0	0.0	1.2	0.0	0.00	0.00	474.48	44.3	6.5	1.1	0.0	0.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	0.0	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.81	36.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	470.25	26.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	0.0	0.0	0.00	0.00
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	470.35	26.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	470.35	26.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	470.35	26.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	470.35	26.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total			159.3	53.0	53.0	0.0	58.0	18.3					331.3	58.0	76.0	41.0	76.0	41.0	0.0	0.0	242.0	242.0	0.0	0.0		

Working table for the water year:1985

Units : Cm Power MW

Month	Pattanaada Hulla Reservoir									Shalanshalaballa Reservoir																
	Level in m	Storage	Inflow	D/s requirement Demand Met Deficit	Dir to Shalanala	Spills	Power	Sec pow	Level in m	Storage	In-floos	Dir from Pattanada	Demand	U/s and D/S Req Met	Deficit	Diversion Demand Met Def-icil	Spills	Power	Sec pow							
Jan	512.75	18.0	41.8	20.3	20.3	0.0	11.0	0.0	1.62	0.00	470.35	26.9	49.4	11.0	16.0	10.0	26.0	10.0	0.0	0.0	11.9	11.9	0.0	0.0	0.50	0.00
Jul	512.75	18.0	38.3	16.0	16.0	0.0	22.3	0.0	1.21	0.39	476.04	51.1	96.4	22.3	25.0	16.0	25.0	16.0	0.0	0.0	52.2	52.2	0.0	0.0	1.92	0.00
Aug	512.75	18.0	45.8	15.0	15.0	0.0	16.3	0.0	1.13	0.00	480.55	26.9	90.4	25.0	25.0	15.0	25.0	15.0	0.0	0.0	81.7	81.7	0.0	0.0	1.92	0.00
Sep	512.75	18.0	5.8	0.2	0.2	0.0	5.5	0.0	0.02	0.00	480.98	26.9	8.4	5.5	0.0	0.0	0.0	0.0	0.0	0.0	54.3	54.3	0.0	0.0	0.30	0.00
Oct	512.75	18.0	9.8	1.0	1.0	0.0	8.5	0.0	0.08	0.00	471.64	21.7	30.4	8.3	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	0.0	0.00	0.00
Nov	512.75	18.0	1.8	0.0	0.0	0.0	1.3	0.0	0.00	0.00	476.55	33.3	4.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	0.0	0.00	0.00
Dec	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	474.48	44.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Jan	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.75	26.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Feb	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.75	26.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Mar	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.75	26.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Apr	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.75	26.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
May	512.75	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	472.75	26.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
Total			143.8	53.0	53.0	0.0	60.0	3.9					279.8	66.9	76.0	41.0	76.0	41.0	0.0	0.0	242.0	242.0	0.0	0.0		

Design of linking system between Pattanadahalla and Shalamalahalla reservoir

A. Design of Canal:

Maximum monthly diversion of 26.9 Mm³ is proposed on the basis of working tablkes in June month in 30 days. The actual discharge workout to be 10.38 m³/ sec.

Design of canal section:

Design discharge assumed is 1.25 times of actual discharge.

Actual discharge required : 10.38 m³/ sec

Design discharge : 1.25 x 10.38
= 12.98 m³/ sec

Proposed section : Trapezoidal with round comers at base.

Assumed

Free board : 0.9 m

Side slope : 1.5: 1 (H:V)

Bed slope : 1: 6500

Mannings 'n' : 0.018

Bed width 'B' : 3.1 m

Area of cross section 'A' : $Bd + d^2 (\theta + \text{Cot } \theta)$
: $Bd + d^2 (0.59 + 1.5)$
: $Bd + d^2 2$

Wetted perimeter : P : $B + 2d (\theta + \text{Cot } \theta)$
: $B + 2d (0.59 + 1.5)$
: $B + 4.18 d$

Hydraulic mean depth 'R' = $\frac{A}{P}$: $\frac{3.1 + 2.09 d^2}{3.1 + 4.18 d}$

By trail and error method d = 2.10 m

Area of section : A = 15.73 m

Perimeter : P = 11.88 m

Hydraulic mean : R = 1.324 m

Design velocity V = 0.831 m/sec

Design discharge Q = A.V = 13.07 m³/sec

Designed discharge is more than the discharge required. Hence, bed width and depth assumed are suitable to pass the required discharge.

Proposed Section $B = 3.1 \text{ m}$, $d = 2.1 \text{ m}$

B. Design of tunnel:

Discharge required		: 10.38 m ³ / sec
Design discharge		: 1.25 times of actual discharge
		: 1.25 x 10.38 = 12.98 m ³ / sec
Type of proposed section		: Modified horse shoe
Proposed radius		: 1.65 m
Assumed 'n'		: 0.018
Slope assumed		: 1:1000
Area of cross section A		: 3.2535 r ²
	A	: 8.858 m ²
Wetted perimeter	P	: 6.4263 r
	P	: 10.603 m

Designed discharge is more than the discharge required. Hence the section is suitable to pass the required discharge.

Design of linking system between Shalamalahalla reservoir to Varada river

A. Design of Canal:

Maximum monthly diversion of 81.7 Mm³ is proposed to be diverted on the basis of working tables in August month in 31 days. The average works out to be 30.5 m³/sec.

Actual discharge required : 30.5 m³/sec
 Design discharge is 1.25 times of actual discharge
 Design discharge : 1.25 x 30.5 = 38.13 m³/sec
 Proposed section : Trapezoidal with round corners at base

Assumed

Free board : 0.9 m
 Side slope : 1.5 : 1 (H:V)
 Bed slope : 1 : 6500
 Mannings 'n' : 0.018
 Bed width 'B' : 4.75 m
 Area 'A' : $Bd + d^2 (\theta + \text{Cot } \theta)$

Wetted perimeter 'P' : $B + 2d (\theta + \text{Cot } \theta)$
 : $B + 2d (0.59 + 1.5)$
 : $B + 4.18 d$

Hydraulic mean depth 'R' = $\frac{A}{P}$
 $\frac{Bd + d^2 (0.59 + 1.5)}{B + 4.18 d}$
 $\frac{Bd + 2.09d^2}{4.75 + 4.18 d}$

$$Q = A.V = (4.75d + 2.09 d^2) \times \left[\frac{1}{0.018} \right] \left[\frac{4.75d + 2.09d^2}{4.75 + 4.18d} \right]^{\frac{2}{3}} \left[\frac{1}{6500} \right]^{\frac{1}{2}}$$

$$36.25 \times 1.451 = \frac{(4.75d + 2.09 d^2)^{\frac{5}{3}}}{(4.75 + 4.18d)^{\frac{3}{2}}}$$

By trail and error method d= 3.15 m

Area of section : A= 35.70 m²

Perimeter : P= 17.92 m

Hydraulic mean

Depth : R= 1.993 m

Design velocity V = 1.091 m/sec

Design discharge Q= A.V = 35.7 X 1.091 = 38.95 m³/ sec

Designed discharge is more than the discharge required. Hence bed width assumed are suitable to pass the required discharge.

Proposed Section B= 4.75 m, d= 3.15 m

B. Design of tunnel:

Discharge required : 30.5 m³/ sec

Design discharge : 1.25 times of actual discharge

Type of proposed section : 1.25 x 30.5 = 38.125 m³/sec

Proposed radius : 2.45 m

Assumed 'n' : 0.018

Slope assumed : 1:1000

Area of cross section A : 3.2535 r²

A : 19.529 m

Wetted perimeter P : 6.4263 r

P : 15.744 m

Hydraulic mean depth 'R' = $\frac{A}{P} = \frac{19.529}{15.744} = 1.240$ m

Velocity $V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}} = \frac{1}{0.018} (1.240)^{\frac{2}{3}} \left[\frac{1}{1000} \right]^{\frac{1}{2}} = 2.028$ m/sec

Discharge in the proposed section : A x V

= 19.520 x 2.028 = 39.60 m³/sec

Designed discharge is more than the discharge required. Hence the section is suitable to pass the required discharge

Monthly gross irrigation requirement for Kharif crops in the command of the LBC of Tungabhadra

Sl. No.	Crop	Area in ha	Gross irrigation requirement (Mm3)							Total
			Jun	July	Aug	Sept	Oct	Nov	Dec	
1.	Paddy	6689	4.53	35.35	27.32	23.84	1.94	-	-	92.98
2.	Semidry crops									
a)	Jowar	6689	1.02	2.23	7.83	3.55	0.67	-	-	15.30
b)	Groundnut	13378	2.29	4.45	14.25	3.55	1.17	-	-	25.71
c)	Cotton	13378	1.73	4.45	7.69	14.40	11.77	15.96	7.75	63.75
d)	Chillies	10033	0.82	3.34	12.86	3.50	0.49	-	-	21.10
e)	Pulses	10033	1.53	3.34	11.75	5.33	1.02	-	-	22.97
	Total	60200	11.92	53.16	81.70	54.26	17.06	15.96	7.75	241.81
	Say		11.9	53.2	81.7	54.3	17.1	16.0	7.8	242.0

Bedti-Varada link project
Abstract of cost:
Description

Annexure: 8.1

Direct charges:		
Sl. No.	Perticulars	Expenses (Rs in lakhs)
I	Works:	
	Unit-I Dam and appurtenants	9251
	Unit- II canals, tunnels, bridges and C.D works	3034
	Unit-III Power house and lifting arrangements	9676
	Sub-Total	21961
II	Establishment: (10% of I-works less B-Lands)	2127
III	Tools and Plants (1% of I-works)	220
IV	Suspenses:	Nil
V	Receipt and recoveries:	
a)	Resale value of special T & P	
	@ 75% of Rs. 484/- lakhs (-)	363
	@20 % of Rs. 207/- lakhs (-)	41
b)	Resale values of temporary buildings:	
	@15% cost of temporary buildings of Rs. 645/- lakhs (-)	97
	(-)	501
	Total	23807
Indirect charges:		
	Audit and Accounts (1% of I - Works)	220
	Grand total	24027

Unit-I

Estimation of cost of Dam and Appurtenants work

Sl. No.	Description of civil works	Expenses (Rs. In lakhs)
A	Preliminary (3% of C-works)	222
B	land (4.7% of C- works)	347
C	Works	7384
K	Buildings (3% of C-works)	222
M	Plantation (0.5% of C-works)	37
O	Miscellaneous (4% of C-works)	295
P	Maintenance during construction (1% of I-works less A, B & Q)	83
Q	Special T& P (4% of C-works)	295
R	Communication (4.67% of C-works)	345
Y	Loss on stock and unforeseen items (0.25% of I-works less A, B & Q)	21
	Total	9251 lakhs

Note: Cost of C-works of dams and tunnels of interlinking system worked out by adopting rates adopted in the project report of Mahadayi hydro-electric project of Karnataka Power Corporation for similar works. Cost of construction work of canal of interlinking system has been worked out based on the rates adopted for canal in the Irukkankudi reservoir scheme. Details are given in Annexure- 8.5.

Bedti-Varada link project
 Estimate of cost of Unit-II
 Civil works
 Canals and Tunnels:
 Description of works

Annexure: 8.3

Sl. No.	Description of civil works		Expenses (Rs. In lakhs)
A	Preliminary	1.8	25
B	land		27
C	Works		Nil
D	Regulators	1.8	10
F	Cross drainage works		57
G	Bridges	1.8	15
K	Building	1.8	60
L	Earth work and linking work of canal and tunnel		2652
M	Plantation		2
O	Miscellaneous	1.8	25
P	Maintenance (1% of I-works less A, B & Q)		28
Q	Special T& P (4% of L-Earth work & Lining)		106
R	Communication	1.8	20
Y	Losses on stock (at 0.25% of I-works less A, B & Q)		7
	Total		3034

Note: Cost of civil works of tunnel has been worked out based on the rates adopted in the project report of Mahadayi hydro-electric project of Karnataka Power Corporation for similar works. Cost of construction work of canal has been worked out based on the rates adopted for canal in the Irukkankudi reservoir scheme for similar works. Cost of cross drainage work has been estimated from the cost curves. Details are given in Annexures: 8.6, 8.7 and 8.8.

Bedti-Varada link project
Estimate of cost of Unit-III
Civil works

Annexure: 8.4.1

A) Lifting arrangements:
Description of works

Sl. No.	Description of works	Expenses (Rs. In lakhs)
A	Preliminaries (2 % of C-works)	137
B	land (4.7% of C-works)	322
C	Works	6852
K	Building (5% of C-works)	343
M	Plantation (0.5% of C-works)	34
O	Miscellaneous (4% of C-works)	274
P	Maintenance (1% of I-works less A, B and Q)	84
Q	Special T & P (4% of C-works)	274
R	Communication (4.67% of C-works)	320
S	Power plant and Electrical system 8% of C-works	548
Y	Loss on stock and unforeseen (0.25% of I-works less A, B & Q)	21
	Total	9209

Note: Cost of C-works is worked out on the lines of Sri Ram Sagar Lift Irrigation project of Andhra Pradesh, 1986 and detailes project report of Mahadayi hydro-electric project of Karnataka Power Corporation- 1990. Details are given in Annexure: 8.9 to 8.10.

Bedti-Varada link project
Estimate of cost of Unit-III

Annexure: 8.4.2

B) Power house Civil / Electrical works

Description of works

Sl. No.	Description of works	Expenses (Rs. In lakhs)
A	Preliminaries	-
B	Land	-
C	Works	392
K	Building (5% of C-works)	20
O	Miscellaneous (4% of C-works)	16
P	Maintenance (1% of I-works less A, B & Q)	4
Q	Special T & P (4% of C-works)	16
R	Communication (4.67 % of C-works)	18
Y	Loss on stock and unforeseen items (0.25% of I-works less A, B & Q)	1
	Total	467
Total cost of Unit-III = 9209+467 = 9676 lakhs (Annexure 8.4.1 and 8.4.2)		

Note:

Cost of C-works is worked out from the rates taken from the Kotni power house of Mahadayi hydro-electric project, 1987 of KPC projecting the same to 1992.

Preliminaries is already included in the rate and land is under civil works of dam, since power house is located at the toe of the dam. S-power plant and electrical system is not considered separately since they are the main item coming under works.

The computations in the case of C-works are given in Annexure 8.10.

Bedti-Varada link project
Unit-I Dam and Appurtenants works:

Annexure: 8.5

Analysis of unit rate and cost of C-works of dams and interlinking system.

In the absence of detailed data for rate analysis, the rate has been calculated on the proportionate basis of cost of construction of work of dam and appurtenant works from Mahadayi hydro-electric project report prepared by Karnataka Power Corporation in the year 1987.

The cost of C-works of Kotni dam (This include cost of care and diversion of river, preparation of foundation, dam and appurtenant works including intake structures contingencies at 3 % and work charged establishment at 2 %) = 1048.16 Lakhs

Projecting this rate to 1992, by taking 10% escalation compounded annually (Period 1987 to 1992)

$$= 1048.16 \left[1 + \frac{10}{100} \right]^5$$

$$= 1688.10 \text{ lakhs}$$

Total concrete content of Kotni dam = 79770 m³

Rate per cubic meter of concrete content = $\frac{1688.10}{79770}$ lakhs

$$= 0.02116 \text{ lakh/ m}^3$$

The National Water Development Agency has not done any field investigations of dam sites. In the absence of relevant information regarding geology of dam site, the depth of foundation has been assumed as 5.5 m for Pattanadahalla dam and 4.6 m for Shalamalahalla dam below the natural ground profile and the same has been considered for calculation of quantity of concrete contents of dam.

A. Pattanadahalla dam:

Length of dam at FRL= 685 meters

(i) Quantity of concrete upto FRL from deepest foundation level

R.D. (m)	Height of dam upto FRL 512.750 m from foundation level (m)	Area of section (sq. m)
0	5.5	33.0
38	13.5	95.40
88	23.5	245.05
138	33.25	475.23
163	33.25	475.23
213	31.25	421.63
263	29.00	365.15
313	26.75	312.78
363	24.75	269.98
413	22.50	226.13
463	20.25	186.84
513	18.25	155.74

563	18.25	155.74
613	14.75	109.53
663	8.25	49.73
685	5.50	33.0

Total quantity of concrete from foundation level at FRL

$$V = 38 \left[\frac{33.0+95.4}{2} \right] + 50 \left[\frac{95.4+475.23}{2} + 245.05 \right] = 25 (475.23) + 50 \left[\frac{475.23+49.73}{2} + 421.63 + 365.15 + 312.78 + 269.98 + 226.13 + 186.84 + 155.74 + 155.74 + 109.53 \right] + 22 \left[\frac{49.73+33.0}{2} \right]$$

$$= 2439.6 + 26518.25 + 11880.75 + 123300.00 + 910.03$$

$$= 165048.63 \text{ m}^3$$

(ii) Quantity of concrete from FRL to top of dam = $720 \times 3 \times 6 = 1296 \text{ m}^3$

(iii) Quantity of concrete for foundation for road on both sides = $2 \times 25 \times 6 \times 0.3$
 $= 90 \text{ m}^3$

Total quantity of concrete = 178100 m^3

Deductions for :

(i) Drainage gallery

(assumed size : 2m x 3m) $950 \times 2 \times 3 = 5700 \text{ m}^3$

(ii) For drain in gallery

(assumed size : 1m x 1m) $950 \times 1 \times 1 = 950 \text{ m}^3$

(iii) For spillway portion

$$36.3 \times 6 \left[\frac{5.2+7.5}{2} \right] = \frac{1390.65 \text{ m}^3}{8040.65 \text{ m}^3}$$

Say : 8040 m^3

Net quantity of concrete : $178100 - 8040 = 170060 \text{ m}^3$

Note: * Length of drainage gallery and drains are taken as the length of valley along the natural ground profile.

+ Depth of spillway portion at the d/s face is calculated from FRL to the level of a point at which vertical line and d/s slope meets i.e., $512.75 - 505.25 = 7.500 \text{ m}$

Cost of construction works of Pattanadahalla dam @ Rs. 2116 / m^3

= $170060 \times 2116 = 3598.47 \text{ lakhs}$ Say = Rs. 3598 lakhs

B. Shalamalahalla dam

Length of dam at FRL = 630 meters

(i) Quantity of concrete upto FRL from deepest foundation level

R.D. (m)	Height of dam upto FRL 480.4 m from foundation level (m)	Area of section (sq.m)	Remarks
0	4.6	27.6	--
25	12.4	84.0	--
50	18.9	166.0	--
75	25.4	285.56	--
100	30.0	392.1	Deepest foundation level
125	30.0	392.1	
150	30.0	392.1	
175	30.0	392.1	
200	27.4	329.80	
250	23.9	254.60	--
300	21.4	207.48	--
350	18.9	166.0	--
400	15.9	123.64	--
450	13.4	94.32	--
500	11.4	74.48	--
550	8.4	50.72	--
600	5.9	35.4	--
630	4.6	27.6	--

Total quantity of concrete from foundation level to FRL

$$V = 25 \left[\frac{27.6+392.1}{2} + 84 + 166 + 285.56 \right] + 75 (392.1) + 25 \left[\frac{392.1+329.8}{2} \right] + 50 \left[\frac{329.8+35.4}{2} + 254.6 + 207.48 + 166.0 + 123.64 + 94.32 + 74.48 + 50.72 \right] + 30 \left[\frac{35.4+27.6}{2} \right]$$

$$= 18635.25 + 29407.5 + 9023.75 + 945 = 115703.5 \text{ m}^3$$

Say = 115704 m³

(iii) Quantity of concrete from FRL to top of dam = 670 x 6 x 3 = 12060 m³

(iii) Quantity of concrete for foundation of road on both sides = 2 x 25 x 6 x 0.3 = 90 m³

$$\text{Total} = 115704 + 12060 + 90 = 127854 \text{ m}^3$$

Deductions:

(i) For drainage gallery (2m x 3m) = 845 x 2 x 3 = 5070 m³

(ii) For drain (assumed size 1m x 1m) = 845 x 1 x 1 = 845 m³

(iii) For spillway portion $64.5 \times 6 \left[\frac{5.2+7.5}{2} \right] = 2457.45 \text{ m}^3$
= 8372.45 m³

Say : 8373 m³

Net quantity of concrete 127854 – 8373 = 119481 m³

Cost of construction works of Shalamanahalla dam @ Rs. 2116/ m³ of concrete

$$= 119481 \times 2116 = 2528.22 \text{ lakhs}$$

Say = Rs. 2528 lakhs

C) Cost of Pattanadahalla and Shalamanahalla interlinking system

Unit rate analysis and detailed calculation for cost of work for tunnel and canala for link from Pattanadahalla and Shalamanahalla reservoir.

1. Canal:

I Calculation of unit rate of rock excavation and lining work of canal:

i) Rock excavation:

The quantity of rock excavation for canals for Irukkankudi reservoir scheme = 80557 m³

Cost of rock excavation provided in Irukkankudi reservoir report (year – 1988-89) = 47.03 lakhs

$$\begin{aligned} \text{Rate per m}^3 &= \frac{47.03 \times 10^5}{80557} \\ &= \text{Rs } 58.38 \text{ m}^3 \end{aligned}$$

Cost projected to year 1992 (assuming annual compound rate of escalation as 10%)

$$\begin{aligned} &= 58.38 \left(1 + \frac{10}{100}\right)^3 \\ &= 77.70 \text{ per m}^3 \end{aligned}$$

ii) Lining :

The quantity of lining for canals for Irukkankudi reservoir schemes = 5137 m³

Cost of lining provided as per Irukkankudi reservoir report (1988-89) = 77.45 lakhs

$$\begin{aligned} \text{Cost per m}^3 &= \frac{77.45 \times 10^5}{5137} \\ &= 1507.7 / \text{m}^3 \end{aligned}$$

$$\text{Cost projected to year 1992} = 1507.7 \left(1 + \frac{10}{100}\right)^3$$

$$= \text{Rs. } 2006.7 / \text{m}^3$$

Total cost of rock in the year 1987 : 185 lakhs

$$\begin{aligned} \text{Rate per m}^3 &: \frac{185 \times 10^5}{66600} \\ &: 277.78 \text{ per m}^3 \end{aligned}$$

Projecting this rate to year 1992 by adopting 10% annual increase : 277.78 $\left(1 + \frac{10}{100}\right)^5$

$$: 447.37 \text{ m}^3$$

ii) Lining:

Cost of lining per m³ : 1198

(as per Mahadayi hydro-electric project of K.P.C. in the year 1987)

Projecting this rate to year 1992 by adopting 10% annual increase : $1198 \left(1 + \frac{10}{100}\right)^5$
: 1929.39 per m³

II Calculation of cost of rock excavation and lining work of tunnel:

i) Rock excavation :

Cross sectional area of tunnel Radius of the tunnel including
the thickness (assumed 0.25 m) of the concrete : 1.90 m

Area of cross section : 11.75 m²

Total length of tunnel: 2200 m

Total quantity of rock excavation : $11.75 \times 2200 = 25850 \text{ m}^3$

Total cost of rock excavation : 25852×447.37

: 115.65 lakhs

: Say 116 lakhs

ii) Lining:

Area of lining : $3.2535 (1.90^2 - 1.66^2)$

: 2.887 m²

Total quantity of lining : $2200 \times 2.887 = 6351.4 \text{ m}^3$

Total cost of lining : 6351.4×1929.39

Say : Rs. 123 lakhs

Total cost of rock excavation and lining of tunnel : $116 + 123 = \text{Rs. } 239 \text{ lakhs}$

Cost of Pattanaahalla- Shalamnahalla interlinking system : $989 + 239 = \text{Rs } 1228 \text{ lakhs}$

D Cost of road bridges across Pattanadahalla- Shalamanahalla interlinking system

Two bridges have been proposed across interlinking system.

A lumpsum provision of Rs. 15/- lakhs per bridge has been provided.

Total cost of bridges = $2 \times 15 = 30 \text{ lakhs}$

Total cost of C-works for Unit-Ior Bedti- Varada link is cost of Pattanadahalla dam + Cost of Shalamalahalla dam + cost of interlinking system + cost of bridges

= $3598 + 2528 + 1228 + 30 = \text{Rs. } 7384 \text{ lakhs}$

Note:- 1) Rate for earth work and lining work of canal for Irukkankudi reservoir has been adopted which is taken from the pre- feasibility report of Pamba- Achankovil- Vaippar link report.

2) Rate for earth work and lining work of tunnel has been taken from Mahadayi hydro- electric project of Karnataka Power Corporation.

Bedti-Varada link project

Annexure: 8.6

Cost of land acquisition for Link canal from Shalamanahalla to Varada(Unit-II):

Total length of open canala	= 8030m
Bed width of canal	= 4.75 m
Formula used for calculation of canal way	= B + 80.5
Canala way	= 4.75 + 80.5 = 85.25 m
Forest land to be acquired	= 8030 x 85.25
	= 684557.5 m ²
	= 68.46 ha
	Say = 68 ha

Rate per ha of forest land as per the
report of Mahadayi hydro electric project- 1987 = 9600

Rate projecting to year 1992 by adopting annual

increase of rate by 10%
 $= 9600 \left(1 + \frac{10}{100}\right)^5$
 $= 15460.9 / \text{ha}$
Say = 15461/ ha

Cost of the land to be acquired
 $= 63 \times 15461$
 $= 1051348$
 $= 10.51 \text{ lakhs}$
Say = 11 lakhs

The cost of rehabilitation, crop compensation and acquisition of other import structures
houses etc = 16 lakhs

Total for (B) lands = 11 + 16 = Rs. 27 lakhs

Calculation of cost of works of tunnel and canal for link between Shalamalahalla and Varada river

I Quantity of rock excavation in cutting from NSL to canal bed level
Shalamalahalla to Varada

A) From top of free board to natural soil level

Reach	Length (m)	F.S.L.	N.S.S.L.	EL upto which quantity already considered under item 'B'	Height to be excavated (m)
I RD 6.52	200	574.98	580.00	575.88	4.12
RD 6.72		574.20	595.00	575.10	19.90
II RD 7.20	480-100*	573.22	590.00	574.12	15.88
	300				
RD 7.68		572.10	580.00	573.00	7.00
III RD 14.00	1800	565.28	580.00	566.18	13.82
RD 15.80		565.00	566.00	565.90	0.10

* assumed adequate length in reach II

Width of canal including spoil bank = 49.30 m

$$1) \left[\frac{49.3 \times 4.12 + 49.3 \times 19.9}{2} \right] 200 = 118418.6 \text{ m}^3$$

$$2) \left[\frac{49.3 \times 15.88 + 49.3 \times 7.0}{2} \right] 380 = 214317.0 \text{ m}^3$$

$$3) \left[\frac{49.3 \times 13.82 + 49.3 \times 0.1}{2} \right] 1800 = 617630.4 \text{ m}^3$$

$$\text{Total} = 950366.0 \text{ m}^3$$

B) Canal (Top of free board to bed level) :

Rock excavation:

Area of cross section of canal : 53.52 m²

Length of canal = Total length pf conveyance system- tunnel length – aquaduct length

: 14830 - 6800 – 500

: 7530 m

Quantity of rock excavation

: 7530 x 53.52

= 403005.6 m³

Total quantity of rock excavation (A+B)

: 950366 + 403005.6

= 1353371.6 m³

Cost of rock excavation

: 1353371.6 x 77.70

: 1051.57 lakhs

Say : Rs. 1052 lakhs

II Lining :

Wetted perimeter of canal : 21.68 m
Thickness of the lining (asumed) : 0.10 m
Quantity of lining : $21.68 \times 0.10 \times 7530$
: 16325.04 m³
Say : 16325 m³
Cost of lining : 16325×2006.7
Rs. 327.59 lakhs
Say : Rs. 328 lakhs
Total cost of rock excavation and lining of canal : $1052 + 328 =$
Rs 1380 lakhs

Details of unit rate of earth work are given in Annexure: 8.5 (C) I

2. Tunnel:

i) Rock excavation :

Area of cross section of tunnel : 3.2535 r²
Radius of tunnel including 0.25 m thickness of
tunnel lining (assumed) : 2.70 m

Area of the cross section : 23.718 m²
Length of tunnel : 6800 m
Quantity of rock excavation : 6800×23.718 m³
: 161282.4 m³
Cost of rock excavation : 161282.4×447.37
: 721.53 lakhs
Say : Rs. 722 lakhs

ii) Lining:

Area of lining : $3.2535 (2.7^2 - 2.45^2)$
: 4.189 m²
Quantity of lining : 4.189 m²
: 6800×4.189
: 28485.2 m³
Cost of lining for tunnel : 28485.2×1929.39

: Rs. 549.59 lakhs

Say : Rs. 550 lakhs

Total cost of rock excavation and lining work for tunnel : 722 + 550

: Rs. 1272 lakhs

(Details of unit rate calculation has been given in Annexure: 8.5 (C)(ii))

Note: -

- 1) Rate for earth work and lining of canal for Irukkankudi reservoir has been adopted which is taken from the pre- feasibility report of Pamba- Achankovil-Vaippar link report.
- 2) Rate for rock excavation and lining of tunnel has been taken from Mahadayi hydro-electric project of Karnataka Power Corporation.

Bedti-Varada link project

Annexure: 8.8

Abstract of cost of aquaduct for link between Shalamanahalla and tributary of Varada river:

Sl. No.	Item	RD (in Km)	CA (Sq. Miles)	Discharge of river Qd (cu.ft/ sec)	Discharge of Canal Qc (cu.ft/ sec)
1.	One aquaduct to cross the deep valley	4.10 to 4.60	3.28	4996.12	1346.55
2.	One aquaduct to cross the deep valley	6.33 to 6.48	0.20	367.36	1346.55

Note:

1. Qd (in cusecs) has been calculated by using Nawabjang Bahadur formula.

$$Qd = cA^{(a-b \log A)}$$

Where, a= 0.92, b= 1/14 and c= 1750 (assumed for Tungabhadra basin) and 'A' is in sq. Miles.

2. Cost of aquaducts has been taken from the canal curve, prepared by Andhra Pradesh Irrigation Department for Inchampally project.

Sl. No.	Item	QC (Cu sec)	QD (Cu sec)	$\frac{(QC) \times (QD)}{1000}$	Cost in lakhs (from the curve- 1987)	Cost in lakhs projected to 1992*
1.	One aquaduct to cross the deep valley	368.1	91.26	33.59	22.35	36
2.	One aquaduct to cross the deep valley	368.1	22.88	8.42	9.00	14
	Total				31.36	50

* Cost escalation compounded annually at 10 %

Bedti-Varada link project
 8.9
 Abstract of cost of under tunnel

Annexure:

Sl. No.	Item	RD in km	Catchment area (Sq. miles)	Discharge of river (Cu Secs)	Effective length L (ft)= (Canal bed widths) + (Left & right bank width) + 5.13 x (top of bank- canal bed level)	$\frac{L \times Qd}{100}$	Cost of structures	Escalated cost @ 10 % of escalation charges
1.	One under tunnel on small stream	5.23	8.20	261.43	95 + (31+31)+ 5.13 (16)	$\frac{239 \times 216.43}{100}$	4.25	7.00

Ref: Pre-feasibility report of Inchampalli-Pulichintala link

Bedti-Varada link project

Annexure: 8.10

Abstract of cost for the pumping in three stages in conveyance system from Shalamalahalla reservoir to a tributary of Varada river

Unit- III (A) C- works

Sl. No.	Description	Quantity	Rate	per	Amount (Lakhs)
1.	Vertical turbine pumps (including stand by pump capacity)	66655	4285	Kw	2822.84
2.	Specials at 20% cost of pumps	-	-	-	564.57
3.	Electrical sub-station including transformer yards	71882	691	KVA	496.70
4.	a) pumping mains of 1100 mm dia installed in 12 rows 12 x 990	11880	8886	Rm	1055.66
	b) Add for specials and water hammer devices and special values @ 12.5% of pumping main	-	-	-	131.96
5.	Cost of delivery cisterns	3	L.S.		7.50
6.	Balancing reservoir	2	785.52 each lakhs		1570.50
7.	Cost of pump house including gantry arrangements	-	-	L.S.	140.00
8.	Power lines along pumping main	-	-	L.S.	62.00
Total					6851.73

Say: 6852 lakhs

Note:- Rates adopted for item 1 is from DPR of Mahadayi Hydro-electric project 1990. For other items from the feasibility report of flood flow lift irrigation scheme- Sri Ram Sagar Project of Andhra Pradesh- 1986.

Cost of power House Complex and its Electrical Components (Unit –III-B)

In the absence of detailed data for the rate analysis. The rate has been calculated on the proportionate basis of cost of construction of Power House complex, tail race works and other electrical equipments including installation from Mahadayi Hydro-Electric project report prepared by Karnataka Power Corporation in the year – 1987.

The cost of C- works of Kotni dam Power House Complex (This includes all preliminary preparation, procurement and installation of electrical components, construction of Power House, tailrace works etc., contingencies at 3% and work charged establishment at 2%) for 20 MW installed capacity.

$$\text{Cost per MW} = \frac{1355}{20} = 67.75 \text{ LAKHS}$$

Projecting this rate to 1992 by taking 10% cost escalation compounded annually (period 1987 to 1992)

$$= 67.75 \left[1 + \frac{10}{100} \right]^5 = 100.11 \text{ lakhs}$$

Say Rs. 109 lakhs per MW of installed capacity:

Abstract cost of Power House Complex Unit –III (B)

Power House Location	Installed capacity in MW	Rate per MW	Cost in lakhs
1. Pattanadahalla	1.8	109	196
2. Shalamalahalla	1.8	109	196
Total:			392

Computation of power requirement for lifting the water at different stages in the Conveyance system:

Maximum diversion from Shalamalahalla is Varada is in August month i.e., 81.7 Mm³. Considering 31 days in August the average discharge required.

$$= \frac{81.7 \times 10^6}{31 \times 24 \times 60 \times 60} = 30.5 \text{ m}^3/\text{sec}$$

Considering 22 hours pumping in a day discharge required = $\frac{30.5 \times 24}{22} = 33.3 \text{ m}^3/\text{sec}$

Assuming 11 no. Of pumps in a row, discharge through each pump = $\frac{33.3}{11} = 3.027 \text{ m}^3/\text{sec}$

Design of pipe:

Assumed dia of pipe = 1.1 m

Area of cross section

$$\text{Velocity} = \frac{Q}{A} = \frac{3.027}{0.950} = 3.186 \text{ m/sec}$$

A) From Shalamalahalla reservoir to link canal R.D. 0 km of canal (Stage-I)

Lift involved = Top of delivery Cistern (tank height assumed as 5 m) – MDDL of Shalamalahalla reservoir

$$= 522.3 - 464.5 \text{ m} = 57.8 \text{ m}$$

Length of pipe = $\sqrt{250^2} + \sqrt{57.8^2}$

$$= 260 \text{ m (approximate)}$$

$$\text{i) Head loss in pipe line} = \frac{4 \times 0.01 \times 260 \times (3.186^2)}{2 \times 9.81 \times 1.1}$$

$$= 4.89 \text{ m}$$

$$\text{ii) Head loss in strainer} = \frac{K_s V^2}{2g} \text{ (Ks assumed as 0.95)}$$

$$= \frac{0.95 \times 3.186^2}{2 \times 9.81}$$

$$= 0.49 \text{ m}$$

$$\text{iii) Loss in foot valve} = \frac{K_s V^2}{2g} \text{ (Ks assumed as 0.8)}$$

$$= \frac{0.8 \times 3.186^2}{2 \times 9.81} = 0.41 \text{ m}$$

iv) Head loss in long sweep bend = 1m (approximate)

$$\text{v) Loss due to velocity head} = \frac{V^2}{2g} = \frac{3.186^2}{2 \times 9.81}$$

$$= 0.52 \text{ m}$$

Total loss of head = designed head

$$= 57.8 + 4.89 + 0.49 + 0.41 + 1.0 + 0.52$$

$$= 65.11 \text{ m}$$

$$\begin{aligned} \text{Power required} &= \frac{WQH}{75\eta} \text{ (assumed over all efficiency of pump as 80 \%)} \\ &= \frac{1000 \times 3.027 \times 65.11}{75 \times 0.8} = 3285 \text{ Hp} \end{aligned}$$

Each delivery main will have pumping installation having capacity of 3285 Hp. Consider one standby pump.

$$\begin{aligned} \text{Required capacity of pumps} &= (11 \times 3285 + 3285) = 39420 \text{ Hp} \\ &= 39420 \times 0.736 = 29013 \text{ KW} \end{aligned}$$

$$\text{Total KVA required} = \frac{26595}{0.85} = 31288 \text{ KVA}$$

$$\text{Total electrical power required} = \frac{26595}{1000} = 26.60 \text{ MW}$$

B) At RD 2.70 Km (Stage -II)

Lift involved = Top of delivery Cistern (link height assumed as 5 m)- Bed level or canal/ balancing reservoir at RD 2.70 km

$$= 542.66 - 516.88 = 25.78 \text{ m}$$

$$\text{Length of pipe} = \sqrt{200^2} + \sqrt{25.78^2} = 205 \text{ m (approximate)}$$

Size and No. Of pumps are same as in the stage-I

$$\begin{aligned} \text{i) Head loss in pipe line} &= \frac{4 \times 0.01 \times 205 \times 3.186^2}{2 \times 9.81 \times 1.1} \\ &= 3.86 \text{ m} \end{aligned}$$

$$\text{ii) Head loss in strainer} = \frac{0.95 \times (3.186)^2}{2 \times 9.81} = 0.49 \text{ m}$$

$$\text{iii) Loss in foot valve} = \frac{0.8 \times (3.186)^2}{2 \times 9.81} = 0.41 \text{ m}$$

iv) Head loss in long sweep bend = 1m (approximate)

$$\text{Loss due to velocity head} = \frac{(3.186)^2}{2 \times 9.81} = 0.52 \text{ m}$$

$$\begin{aligned} \text{Total loss of head} &= \text{Total designed head} \\ &= 25.78 + 3.86 + 0.49 + 0.41 + 1.0 + 0.52 \\ &= 32.06 \text{ m} \end{aligned}$$

$$\text{Power required} = \frac{WQH}{75\eta} \frac{1000 \times 3.027 \times 32.06}{75 \times 0.8} = 1617 \text{ Hp}$$

Each delivery main will have pumping installation having capacity of 1617 Hp. Consider one standby pump.

$$\begin{aligned} \text{Required capacity of pumps} &= (11 \times 1617 + 1617) = 19404 \text{ Hp} \\ &= 19404 \times 0.736 \text{ KW} = 14281 \text{ KW} \end{aligned}$$

$$\begin{aligned} \text{Power required to run 11 pumps} &= 11 \times 1617 = 17787 \text{ Hp} \\ &= 17787 \times 0.736 \text{ Kw} = 13091 \text{ KW} \end{aligned}$$

$$\text{Total KVA required} = \frac{13091}{0.85} = 15401 \text{ KVA}$$

$$\text{Total electrical power required} = \frac{13091}{1000} = 13.09 \text{ MW}$$

C) At RD 5.55 Km (Stage- III)

Lift involved = Top of delivery Cistern (tank height assumed as 5 m) – Bed level of canal balancing reservoir at RD 5.55 km.

$$= 576.98 - 536.86 = 40.12 \text{ m}$$

$$\text{Length of pipe} = \sqrt{520^2} + \sqrt{40.12^2} = 525 \text{ m (approximate)}$$

Design and No. Of pumps are as in stage-I

$$\text{i) Head loss in pipe line} = \frac{4 \times 0.01 \times 525 \times 3.186^2}{2 \times 9.81 \times 1.1}$$

$$= 9.88 \text{ m}$$

$$\text{ii) Head loss in strainer} = \frac{0.95 \times (3.186)^2}{2 \times 9.81} = 0.49 \text{ m}$$

$$\text{iii) Loss in foot valve} = \frac{0.8 \times (3.186)^2}{2 \times 9.81} = 0.41 \text{ m}$$

iv) Head loss in long sweep bend = 1m (approximate)

$$\text{v) Loss due to velocity head} = \frac{(3.186)^2}{2 \times 9.81} = 0.52 \text{ m}$$

Total loss of head = Total designed head

$$= 40.12 + 9.88 + 0.49 + 0.41 + 1.0 + 0.52$$

$$= 52.42 \text{ m}$$

$$\text{Power required} = \frac{WQH}{75\eta} \frac{1000 \times 3.027 \times 52.42}{75 \times 0.8} = 2645 \text{ Hp}$$

Each delivery main will have pumping installation having capacity of 2645 Hp. Consider one standby pump.

$$\text{Required capacity of pumps} = (11 \times 2645 + 2645) = 31740 \text{ Hp}$$

$$= 31740 \times 0.736 \text{ KW} = 23361 \text{ KW}$$

$$\text{Power required to run 11 pumps} = 11 \times 2645 = 29095 \text{ Hp}$$

$$= 29095 \times 0.736 \text{ Kw} = 21414 \text{ KW}$$

$$\text{Total KVA required} = \frac{21414}{0.85} = 25193 \text{ KVA}$$

$$\text{Total electrical power required} = \frac{21414}{1000} = 21.41 \text{ MW}$$

Total power requirement to convey the water from Shalamalahalla reservoir to a tributary of Varada river.

i.e., the power required for Stage-I, II and III lifts.

$$\text{i) Required capacity of pumps} = 29013 + 14281 + 23361 = 66655 \text{ KW}$$

$$\text{ii) Total KVA required} = 31288 + 15401 + 25193 = 71882 \text{ KVA}$$

$$\text{iii) Total electrical power required} = 26.60 + 13.09 + 21.41 = 61.1 \text{ MW}$$

$$\text{iv) Total head} = 57.8 + 25.78 + 40.12 = 123.70 \text{ m}$$

Cost of power consumption:

Total quantity to be lifted for diversion from Shalmalahalla to Varada river in a year is 242 Mm³

Pumping capacity of 11 pumps = 33.3 m³/sec

Quantity of water lifted in one hour = 33.3 x 60 x 60
= 119880 m³

Power consumed in an hour = 61.1 MW
= 61100 KW

No. of hours required for lifting 242 Mm³ of water = $\frac{242 \times 10^6}{119880}$
= 2018.69 hours

Say = 2019 hours

Power required to run pumps in one hour = 61100 KWh

1KW = 1000 watts

1 KWh = 1000 watts hour

= 1 unit

= 2019 x 61100

Total power required = 123360900 units

Total cost of power @ Rs.1/- per unit consumed = 123360900 x 1

= 123360900

= Rs. 1233.61 lakhs

Say = Rs. 1234 lakhs

Bedti-Varada link project

Annexure: 8.14

Cost of balancing reservoir (at RD 2.70 km and 5.55 km):

Proposing 2 hour storage, the required storage capacity = $33.8 \times 2 \times 60 \times 60$
= 239760 m³

Required area of reservoir considering 5 m depth = $\frac{239760}{5} = 47952$ Sq. M

Reservoir of the size = 275 x 175 x 5 m = 240625 m proposed

The estimated volume of excavation for
the reservoir (assuming 20m excavation) = $275 \times 175 \times 20 = 962500$ m³

Cost of excavation considering a rate of Rs. 77=70 for

Earth work (Irikkankudi project) = 962500×77.70
= 747.86 lakhs

Towards applying and forming revetment along the banks,
trimming side slopes and grouting holes with cement
slurry etc. @ 5% of the cost of excavation = 37.39 lakhs

Total = 785.25 lakhs

Abstract of direct benefits

Sl. NO.	Perticulars	Amount (in lakhs Rs)
A	i) Value of total agricultural produce before irrigation for 60200 ha of culturable area including dung receipts	3224
	ii) Expenditure on cost of cultivation before irrigation	1798
	iii) Net value of produce before irrigation	1426
B	i) Value of total agricultural produce after irrigation for 60200 ha of culturable area including ding receipts	12940
	ii) Expenditure on cost of cultivation after irrigation	4308
	iii) Net value of produce after irrigation	8437
	Net benefit from irrigation (B-A)	7011
C	i) Benefits from irrigation	7011
	ii) Benefits from power	64
D	Total benefits	7075

Calculation of estimated value of produce before canal irrigation

Sl. No	Crops	Area in (ha)	Produce (Qtl/ ha)	Total produce (Qtl.)	Rate per Qtl. (Rs.)	Total value of produce (Rs. In lakhs)
1.	Paddy	6689	25	167225	263	439.8
2	Semi dry crops					
(i)	Jowar	6689	11	73579	260	191.3
(ii)	Ground nut	13378	5	66890	790	528.4
(iii)	Cotton	13378	6	80268	1200	963.2
(iv)	Chillies	10033	3	30099	2022	608.5
(v)	Pulses	10033	6	60198	588	354.0
	Total	60200		478259		3085.3
					Say	3085

Sl. No	Crops	Inputs expenditure			Human labour and bullocks @ 20% of (X+Y) Rs. In lakhs
		Seeds (X) Amt. In lakhs	Manure (Y) Amt. In lakhs	Plant protection chemicals Amt in lakhs	
1.	Paddy	5.94	102.41	5.69	21.67
2	Semi dry crops				
(i)	Jowar	7.32	40.80	-	9.62
(ii)	Ground nut	167.60	34.40	0.40	40.40
(iii)	Cotton	60.40	171.40	207.40	46.38
(iv)	Chillies	19.30	51.20	1.28	14.10
(v)	Pulses	8.79	12.55	1.26	4.27
	Total	269.44	412.76	216.03	136.44
		269	413	216	136

Note:-

Crop yield and inputs for paddy has been taken from Hemavati project report (1986) and the rate of paddy is taken from Almatti- Pennar pre-feasibility report.

Details of inputs and crop yield for semi dry crops have been collected from the Directorate of Agriculture Govt. Of Karnataka and rate of produce is taken from the Almatti- Pennar pre-feasibility report.

Calculation of estimated value of produce after canal irrigation

Sl. No	Crops	Area in (ha)	Produce (Qtl/ ha)	Total produce (Qtl.)	Rate per Qtl. (Rs.)	Total value of produce (Rs. In lakhs)
1.	Paddy	6689	62	414718	395	1638.14
2	Semi dry crops					
(i)	Jowar	6689	31	207359	390	808.70
(ii)	Ground nut	13378	11	147158	1185	1743.82
(iii)	Cotton	13378	11	147158	1691	2488.44
(iv)	Chillies	10033	17	170561	3033	5173.12
(v)	Pulses	10033	6	60198	882	530.95
	Total	60200		1147152		12383.17
					Say	12383

Sl. No	Crops	Inputs expenditure			Human labour and bullocks @ 20% of (X+Y) Rs. In lakhs
		Seeds (X) Amt. In lakhs	Manure (Y) Amt. In lakhs	Plant protection chemicals Amt in lakhs	
1.	Paddy	18.00	102.41	5.69	24.08
2	Semi dry crops				
(i)	Jowar	11.86	50.50	1.51	12.47
(ii)	Ground nut	297.54	46.82	7.49	68.37
(iii)	Cotton	103.27	203.35	537.80	61.32
(iv)	Chillies	19.31	65.21	1.35	16.90
(v)	Pulses	10.40	13.87	1.73	4.85
	Total	460.38	482.16	555.57	188.49
	Say	460	482	556	188

Note:-

Crop yield and inputs for paddy has been taken from Hemavati project report (1986) and the rate of paddy is taken from Almatti- Pennar pre-feasibility report.

Details of inputs and crop yield for semi dry crops have been collected from the Directorate of Agriculture Govt. Of Karnataka and rate of produce is taken from the Almatti- Pennar pre-feasibility report.

Table showing yearly totals of energy produced. Unit: Million units

Year	Pattanadahalla reservoir	Shalamalahalla reservoir	Total
1970	3.84	2.30	6.14
1971	3.39	2.39	5.78
1972	2.53	1.92	4.45
1973	3.42	1.81	5.23
1974	4.03	3.44	7.47
1975	5.04	4.40	9.44
1976	2.91	2.03	4.94
1977	2.84	1.26	4.10
1978	4.00	3.09	7.08
1979	3.34	2.40	5.74
1980	4.05	3.98	8.03
1981	3.92	3.09	7.01
1982	3.92	3.10	7.02
1983	3.92	4.10	8.02
1984	3.42	2.70	6.12
1985	3.20	1.88	5.08
		Total	101.66
		Average	6.35

Average energy produced in a year = 6.35 M. units

Bedti-Varada link project

Annexure: 10.3.2

Table showing yearly totals of energy produced. Unit: Million units

Pattanhalla reservoir

Year	Jun	Jul	Aug	Sep	Oct	Total
1970	0.87	1.34	1.34	0.01	0.28	3.84
1971	1.17	1.34	0.84	0	0.04	3.39
1972	0.47	1.18	0.84	0	0.04	2.53
1973	0.89	1.34	1.12	0.01	0.06	3.42
1974	0.84	1.34	1.34	0.01	0.50	4.03
1975	1.30	1.34	1.34	0.51	0.55	5.04
1976	0.66	1.34	0.84	0.01	0.06	2.91
1977	0.90	1.03	0.34	0.01	0.50	2.84
1978	1.30	1.34	1.29	0.01	0.55	4.00
1979	1.09	0.84	1.34	0.01	0.06	3.34
1980	1.30	1.34	1.34	0.01	0.06	4.05
1981	1.17	1.34	1.34	0.01	0.06	3.92
1982	1.17	1.34	1.34	0.01	0.06	3.92
1983	1.17	1.34	1.34	0.01	0.06	3.92
1984	1.17	1.34	0.84	0.01	0.06	3.42
1985	1.17	0.90	1.06	0.01	0.06	3.20

Shalamalahalla reservoir

Year	Jun	Jul	Aug	Sep	Oct	Total
1970	0.31	0.60	1.34	0	0.05	2.30
1971	0.48	1.34	0.57	0	0	2.39
1972	0	1.34	0.58	0	0	1.92
1973	0.17	0.84	0.80	0	0	1.81
1974	0.15	1.00	0.95	0	1.34	3.44
1975	1.17	1.34	0.77	1.00	0.12	4.40
1976	0.40	0.95	0.68	0	0	2.03
1977	0.13	0.56	0.57	0	0	1.26
1978	0.80	1.34	0.95	0	0	0.09
1979	0.89	0.67	1.34	0	0	0.40
1980	1.30	1.34	1.34	0	0	3.98
1981	0.41	1.34	1.34	0	0	3.09
1982	0.42	1.34	1.34	0	0	3.10
1983	0.40	1.34	1.34	1.02	0	4.10
1984	0.66	1.34	1.34	0.70	0	2.70
1985	0.36	0.76	0.76	0.76	0	1.88

Bedti-Varada link project

Annexure: 10.3.3

Combined cost of power generation for both Pattanadahalla and Shalamanahalla power houses

1.	Cost of power house including civil and electrical works	392 lakhs
2.	Installed capacity = 2 x 1.8 MW	3.6 MW
3.	Average energy generated annually	6.35 M.units
4.	a) Annual cost @ 10% interest	39.2 lakhs
	b) Depreciation of system at Rs. 3.3% of cost of power house	12.94 lakhs
	c) Operation and maintenance of mechanical and electrical equipments and maintenance of civil works @ 3% of power house cost	11.76 lakhs
5.	Cost of 1 unit of energy = $\frac{63.9 \times 10^5}{6.35 \times 10^6}$	1.01
	Say	Re. 1/-

Compounding of B: C ratio by discounted cash flow method

i)	Life of the project after completion	100 years
ii)	Rate of discounting	10%
iii)	Construction period	7 years
iv)	Cost of project	Rs. 24027 lakhs
v)	Annual benefits (irrigation + power)	7075 lakhs
vi)	Maintenance cost (irrigation + power)	78 lakhs
vii)	Annual cost of ower for lifting water	1234 lakhs

Year	Costs	Benefits	Discounting factor at 10%	Present worth of costs Benefits (Rs. In lakhs)			
0	1200		1.000	1200	-		
1	3627		0.909	3297	-		
2	5000		0.826	4130	-		
3	5000		0.751	3755	-		
4	5300		0.683	3620	-		
5	2100		0.621	1304	-		
6	1800		0.564	1015	-		
7	78+1234	7075	5.639	7398	39896		
8	78+1234	7075					
9	78+1234	7075					
10	78+1234	7075					
-	-	-					
-	-	-					
-	-	-					
-	-	-					
106	78+1234	7075				25719	39896

$$B: C \text{ Ration} = \frac{39896}{25719} = 1.55$$

Bedti-Varada link project
 Calculation of IRR
 Date

Annexure: 10.5

i)	Life of the project after completion	100 years
ii)	Construction period	7 years
iii)	Cost of project	Rs. 24027 lakhs
iv)	Annual benefits (irrigation + power)	7075 lakhs
v)	Maintenance cost (irrigation + power)	78 lakhs
vi)	Annual cost of ower for lifting water	1234 lakhs

Year	Costs	Benefits	Net benefits	Discounting factor		Present worth of costs Benefits (Rs. In lakhs)	
				14%	16%	14%	16%
0	1200	-	-1200	1.000	1.000	-1200	-1200
1	3627	-	-3627	0.877	0.862	-3181	- 3126
2	5000	-	-5000	0.769	0.743	-3845	- 3715
3	5000	-	-5000	0.675	0.641	-3375	- 3205
4	5300	-	-5300	0.592	0.552	-3138	- 2926
5	2100	-	-2100	0.519	0.476	-1090	- 1000
6	1800	-	-1800	0.456	0.410	-821	- 738
7	78+1234	7075	5763	3.249	2.564	18724	14776
8	78+1234	7075	5763				
9	78+1234	7075	5763				
10	78+1234	7075	5763				
-	-	-					
-	-	-					
-	-	-					
-	-	-					
106	78+1234	7075	5763				
		TOTAL					

$$IRR = 14 + 2 \left[\frac{2074}{3208} \right] = 15.3\%$$