

Chapter - 1

Introduction

1.1 General

This report contains revised feasibility studies of Par-Tapi-Narmada Link project. This Link in the western part of India is planned to transfer water from the water surplus regions of Western Ghats to the water deficit regions of Saurashtra and Kutch. The link project includes seven reservoirs proposed in north Maharashtra and south Gujarat. The water from the seven proposed reservoirs would be taken through a 395 km long canal including the 33km length of the feeder canals to take over a part of the command of the on-going Sardar Sarovar Project, while irrigating small enroute areas. This would save Sardar Sarovar water which will be used to extend irrigation in Saurashtra and Kutch region.

1.1.1 Need for planning

The rainfall in the country is mostly confined to monsoon season and is unevenly distributed with respect to both space and time. As a result, some parts of the country are affected by frequent droughts, whereas other parts are affected by floods. Nearly one third of the country is drought prone. Water will become scarce resource in the near future, due to increasing thrust of population and increasing demands of water for various uses. Therefore, it needs no emphasis that water needs to be harnessed in a scientific and efficient manner for its optimum utilisation.

The monsoon flood waters need to be conserved and utilised during the period of its scarcity for drinking & industrial use, irrigation, power generation etc. The water availability and requirements in the various river basins should be assessed realistically and the requirements be met appropriately. The surplus water, if any, should be transferred to the needy areas. The National Water Policy evolved by Govt. of India in 1987 and revised in April 2002 lays emphasis on inter-basin transfer of water.

1.1.2 National perspective for water resources development

The erstwhile Union Ministry of Irrigation and the Central Water Commission formulated in the year 1980, National perspective proposal for water resources development which comprises two components viz. the Himalayan rivers development and the Peninsular rivers development. The distinct feature of the National perspective proposals is that the transfer of water from surplus basin to deficit basin would essentially be by gravity and only in small reaches it would be by lifts not exceeding 120 metres.

One of the purposes of Peninsular River Development is to construct storages and to interlink the small rivers flowing along the west coast north of Mumbai and south of the Tapi for transfer of surplus waters to the needy areas of Saurashtra and Kutch regions. Another scheme provides water supply to the metropolitan areas of Mumbai and also provides irrigation to the coastal areas in Maharashtra. Present link is part of this component of NPP.

1.1.3 Present report

As envisaged in the National perspective Plan, the water balance studies have been carried out for the west flowing river basins covered between north of Mumbai and south of the Tapi. From the studies it is revealed that considerable surplus water is available in the four basins namely Par, Auranga, Ambica and Purna, which can be transferred towards north to Narmada canal system to meet the demands of the deficit areas. Seven diversion points have been identified across the rivers in the above basins to facilitate transfer of water besides providing for enroute irrigation.

The topo sheet and pre-feasibility studies were carried out for the Par-Tapi and Par-Tapi-Narmada link project respectively. These reports were discussed and accepted by the TAC of NWDA. Thereafter, feasibility studies were carried out & report prepared and circulated on 14.8.1995. As per this FR, in addition to the divertible quantity of 1350 Mm³ from the proposed 7 reservoirs, it was also proposed to transfer 1554 Mm³ of water assumed to be surplus at Ukai reservoir.

However, as per the detailed water balance study of Tapi basin upto Ukai carried out as per TAC guidelines, by NWDA in the year 2002 it was revealed that Tapi basin is not water surplus at Ukai dam. Hence, the transfer of 1554 Mm³ of water of Tapi basin from Ukai reservoir will not be available for diversion through Par-Tapi-Narmada link. Govt. of Gujarat vide their letter dated 01.02.1996 had also indicated that there is no likelihood of surplus water in Tapi basin at Ukai and suggested to carry out feasibility study of Par – Tapi – Narmada link without considering augmentation of water from Tapi.

In view of the above, the FR of Par-Tapi-Narmada link (circulated in the year 1995) has now been revised considering only the surplus water of 1350 Mm³ available from the proposed 7 reservoirs. As per this revised study, it is found that Par-Tapi portion of the link canal will remain unchanged and in the Tapi-Narmada portion of the link canal, the length of the canal will be reduced to 190 km from earlier 225 km and the link canal will now terminate at Miyagam Branch Canal instead of Vadodara Branch Canal of Narmada Main Canal.

1.2 Aims of the project and its description

The main aim of Par-Tapi-Narmada link is to transfer the surplus waters of Par, Auranga, Ambica and Purna river basins to take over part of Narmada Canal command (Miyagam branch) after providing enroute irrigation. Water thus saved in Sardar Sarovar Project, as a result of this transfer, could be taken further northwards to benefit water scarce areas of Saurashtra and Kutch regions in Gujarat. This link mainly envisages construction of seven dams, three diversion weirs, two tunnels (5.0 km & 0.5 km of length), 395 km long canal (205 km in Par-Tapi portion including the length of feeder canals and 190 km in Tapi-Narmada portion), 6 power houses and a number of cross-drainage works. Besides providing irrigation benefits to the enroute command and Narmada command, the link will generate hydropower of the order of 93.00 Mkw through the power houses installed at four dam sites viz. Jheri, Paikhed, Chasmandva and Chikkar and in two feeder canals taking off from Dabdar and Kelwan dams. The reservoirs will also provide flood relief to the people residing in downstream areas.

The seven dams proposed in the scheme are Jheri, Mohankavchali, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan. The Jheri and Mohankavchali dams are proposed to be constructed across Par river, one below the other while the Paikhed dam is proposed across Nar river, a tributary of the Par. Chasmandva dam is proposed across Tan river which is a tributary of Auranga, Chikkar dam is proposed across river Ambica, Dabdar is proposed across Kapri which is Ambica's tributary and Kelwan dam is proposed across river Purna. Three diversion weirs are proposed downstream of Paikhed, Chasmandva and Chikkar dams as the hilly terrain does not permit the link canal to take off from the dam sites.

The Jheri water after power generation will reach Mohankavchali through river course. The water from Mohankavchali reservoir will flow through a 5 km long tunnel to reach the Paikhed weir. The first part of the link canal viz Par-Tapi reach will take off from the right bank of the Paikhed weir and after inter-connecting the remaining four reservoirs viz Chasmandva, Chikkar, Dabdar and Kelwan will finally terminate at the left flank of existing Ukai reservoir on Tapi river. The second part of the link canal viz. Tapi-Narmada reach will take off from the right bank of Ukai reservoir and after crossing the Narmada river in the downstream of Sardar Sarovar reservoir will finally terminate at RD 62.90 km of Miyagam Branch Canal of Narmada Main Canal of Sardar Sarovar Project.

A number of aqueducts are proposed for the link canal where it crosses major rivers/streams. Various cross drainage works such as cross regulators, road bridges etc. are also provided at suitable locations wherever necessary.

1.3 Location of project area and approach to various sites

The project of Par-Tapi-Narmada link generally falls in the state of Gujarat except Jheri reservoir which falls in Maharashtra state. Jheri dam is located in Nasik district of Maharashtra, while remaining dams viz. Mohankavchali, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan dams are located in Valsad and Dang districts of Gujarat. Par-Tapi reach of canal passes through Valsad, Navsari, Dang and Surat districts of South Gujarat whereas Tapi-Narmada reach of canal passes through Surat, Bharuch and Vadodara districts of Gujarat. Thus, the project area is mainly spread in the districts of South Gujarat except for Jheri dam and reservoir. However, the irrigation benefits of this scheme would ultimately reach Saurashtra and Kutch regions of Gujarat after providing enroute irrigation in the specified commands in Par-Tapi and Tapi-Narmada reaches of the link.

The Jheri dam site is approachable from Nasik via Peint town, the distance being 75 km. This dam site is also approachable from Dharampur, a taluka of Valsad district, the distance being 76 km. Mohankavchali, Paikhed and Chasmandva dam sites are accessible from Dharampur, the distances being 30 km, 38 km and 25 km respectively. Chikkar dam site is about 12 km from Waghahi which is a railway station and a town as well. Dabdar dam site can be approached from Waghahi railway station which is 8 km away. The Kelwan dam site is lying at a distance of 28 km from Vyara and 30 km from Waghahi. The Paikhed and Chasmandva weir sites are easily accessible from Dharampur while the Chikkar weir site is very nearer to Waghahi railway station.

The proposed reservoirs, weirs, link canal including feeder canals in the area are shown in the index map.

1.4 Climate

The project area falls mostly in Gujarat State which is situated on the west coast of India, is surrounded by the Arabian Sea on the west, and the states of Rajasthan, M.P. and Maharashtra on north, east and southern sides respectively. The eastern side of project area is flanked by western ghats and Satpura range of hills. Thus, the climate of the area is influenced by Arabian Sea and the hill range in South Gujarat. The coastal area along the sea has humid climate whereas area away from the coast has dry climate. Most of the project area falls in the average temperature zone of 25.°- 27.5 ° c. The rainfall in the project area including Narmada command varies from a low of 400 mm or even less in Kutch region to a high of 3100 mm in hilly reaches of Valsad district in southern part. Dharampur, Valsad, Pardi, Gandevi and

Chikhali talukas in the project area receive average annual rainfall of more than 2000 mm, whereas Navsari, Vansda, Umargaon, Vyara, Songadh, Valod, Bardoli, Surat, Mandvi, Olpad, Kamraj, Rajpipla, Dediapada, Sagbara, Mangrol and Palsana talukas receive average annual rainfall between 1000 and 2000 mm. Hence project area under these talukas falls under humid climate zone.

1.5 General description of area

Out of the total area of 196 lakh hectares in Gujarat, the net area sown is 97 lakh hectares and irrigated area is 22 lakh hectares. As such percentage of irrigated area with respect to sown area is 22.3%. Further as per 2001 census, the density of population in Gujarat was 258 per sqkm which is more or less equal to average density of population of the country as a whole. However, there is wide variation in the density of population within the state ranging from almost nil in certain places like Rann of Kutch area to the maximum in places like Surat and Vadodara in south Gujarat which are industrially developed. The population of districts of north Gujarat and Kutch which are thinly populated will increase if assured irrigation is provided and areas under cultivation are extended. The topography of Southern part of project area is steep along hills of the western ghats and satpura ranges and the ground level reduces as we go westwards towards Arabian Sea.

1.6 Physiography

The project area falls under the 'West Coast Plain' region. The West coast plains are wider in northern Gujarat comprising Kutch, Kathiawar peninsula and Gujarat plains. Some part of the project area also falls in Peninsular plateaus and Central highlands. Peninsular plateau region is triangular in shape and bounded by eastern ghats in the east and Sahyadri (Western ghats) in the west. Central highlands are a wide belt of hilly country bordered on the west by Aravalli range and Vindhyan range and Narmada valley on the south.

1.7 Forests

Valsad and Dang districts of South Gujarat in which six, out of seven reservoirs of the present scheme fall, are having good forests. According to the revised survey of forest types carried out by Champion and Seth. These forests fall under "Sub Group 3-B South Indian Moist Deciduous Forests" in which Teak (*Tectona grandis*) and Sadad (*Terminalia crehulata*) form main species. The salient details of the forest in the basin and the submergence are given in Table - 1.1.

Table - 1.1
Forest submergence in reservoirs

Sr. No.	Basin	Basin area (ha)	Forest area (ha)	%age of forest area	Forest area submerged by proposed reservoirs (ha)	%age of forest area submerged w.r.t forest area of the basin
1.	Par	164800	69733	42.3	1468	2.1
2.	Auranga	74800	28031	37.5	300	1.1
3.	Ambica	268500	83688	31.2	914	1.1
4.	Purna	219300	76245	34.8	890	1.2
	Total	727400	257697	35.4	3572	1.4

1.8 Water resources

1.8.1 Surface water

Surface water balance studies for various river basins at the proposed diversion points have been dealt in detail in the Chapter No.- 5 (Hydrology). As per these studies, surface water balance at all 7 diversion points after considering the future requirements upto 2025 AD works out to be 1170 Mm³ and 1765 Mm³ at 75% and 50% dependabilities respectively .

For deciding the capacity of the reservoirs and the corresponding availability of water from reservoir at the specific reliability, simulation studies were carried out to derive yield-capacity relationship of each of the reservoirs. The divertable yields likely to be available from the reservoirs is 1350 Mm³ . The details of these studies are also given in Chapter-5 (Hydrology).

1.8.2 Ground water

The utilisable Ground water Resources for irrigation in Gujarat is 1.9169 M ha m/year whereas net draft is only 0.6411 M ha m/year. Thus leaving 1.2758 M ha m/year as available potential for future development. Similarly utilisable Ground Water resources in Maharashtra is 3.4810 M ha m where as net draft is only 0.6854 M ha m/year, thus leaving 2.7956 M ha m/year as available potential for future development. In this way, it is seen that only 33.44% and 19.69% of Utilisable resources have been exploited in Gujarat and Maharashtra respectively and abundant ground water potential is still available for development in these two states.

1.9 Soils

The southern parts of the project area are dominated by deep black, shallow black, brown and alluvial soils, whereas the northern parts of the state are dominated by sandy loams. All along the coast, alluvial soils are found. However, a small strip of coastal area remains uncultivated due to increase of tidal waters and salinity problem. Gujarat has 1600 km long coast. An area of 3 lakh hectares remains submerged during monsoon and in the remaining periods it is affected by tidal water, with the result that no vegetation can grow. As such, Govt. of Gujarat has set up a Kharland development board which undertakes the reclamation of such areas under the provisions of the Kharland Act 1963. However, other areas which constitute major portion of the state are, in general, fit for irrigated agriculture.

The soils of the hill ranges in the east are shallow, fine loamy to fine clayey and non-calcareous. The soils have originated from basalt and other rocks. Due to severe to very severe erosion, weathered materials as well as rocks are exposed at places resulting in poor growth of vegetation on the slopes of the hills.

1.10 Land use and socio-economic aspects

The particulars of land used in the command area of the link canal are given below:

a)	Gross command area	2,69,163 ha
b)	Culturable command area	1,88,414 ha
c)	Annual irrigation	1,69,339 ha

Agriculture is the main occupation of the people in the command area.

1.11 Agriculture

Like other part of India, the economy of the project area is dominated by agriculture which accounts for more than one-third of the income. More than 60% of the working population depend on agriculture. Agro industries account for more than 50% compared to other industries. Agricultural production largely depends upon climatic conditions which vary from one region to the other. Variation in rainfall in different areas and limited irrigation facilities have made the area susceptible to drought and famine. Severe food shortages due to drought have been experienced at least 25 times since 1900 AD. In view of scanty and erratic rains in the area, irrigation project is a dire necessity for increasing agricultural productivity and economic betterment.

1.12 Past studies

A broad study was carried out by Gujarat Govt. in 1973 with particular reference to meeting the needs of the drought prone areas of the state. The study contained proposals to inter-link the river of the state with the object of better utilisation of water resources in the state. This study was submitted to the Govt. of India.

Thereafter, the Govt. of India requested Gujarat to furnish a master plan, incorporating studies regarding the availability of water, its committed and projected utilisation and proposals for diversion of surplus waters to the needy areas. Accordingly, a report titled " National Perspectives for Water Resources Development – Master plan of Gujarat for utilisation of surplus water of west flowing rivers south of Tapi" was prepared by Irrigation Deptt., Govt. of Gujarat in 1981.

The proposal envisaged a link canal inter-connecting the Damanganga, the Tapi and the Narmada rivers. This link canal proposed transfer of surplus waters from the west flowing rivers, south of Tapi Viz, Damanganga, Par, Auranga, Ambica and Purna, to the Ukai left bank canal, thereby releasing 2580 Mm³ (2.09 MAF) of waters for utilisation in the needy areas of both Tapi and Narmada basins releasing in turn an equal quantity of water as an exchange from Ukai reservoir. Out of this quantity, about 380 Mm³ (0.31 MAF) of water was proposed to be utilised for irrigating C.C.A. of about 50000 hectares between the proposed link canal and Ukai Right Bank Main Canal which does not have any other sources of irrigation . Culturable command area of about 25,000 hectares to the right of the canal was proposed to be brought under lift irrigation utilising about 190 Mm³ (0.15 MAF) of water. The remaining quantity of 2010 Mm³ (1.63 MAF) was proposed to be transferred further north for extension of irrigation in the Saurashtra and Kutch areas through the Narmada high level canal.

The total water resources of these west flowing rivers were assessed at 11,991 Mm³ (9.72 MAF), out of which the quantity of about 5,738 Mm³ (4.65 MAF) could be utilised in Gujarat.

The transfer of surplus waters from these west flowing rivers was proposed to be effected by building storage reservoirs across them and constructing a link canal of about 290 Km length from Damanganga to Karjan at a cost tentatively assessed at Rs. 480.00 crores. The contemplated link canal was to be a contour canal with its alignment roughly determined on the basis of quick topo sheet studies. Three alternative alignments as mentioned below were thought of :

- (a) **Alternative I** : The waters from the reservoirs on these rivers can be fed to the existing Ukai left bank canal system and the equivalent quantity of 720 Mm^3 (0.6 MAF) would become available at Ukai. This quantity plus 1860 Mm^3 (1.49 MAF) i.e. 2580 Mm^3 of surplus waters available in the reservoirs would be available for further transfer to the areas north of Tapi.
- (b) **Alternative II** : A parallel canal linking these reservoirs and opposite in direction to the Ukai left bank canal may be run to feed the Ukai reservoir itself.
- (c) **Alternative III** : An arterial canal carrying surplus waters from these reservoirs may be run crossing the Tapi and the Narmada on its way and emptying in Narmada command.

The approximate cost of each of the three alternatives was assessed at around Rs.480.00 crores by the Govt. of Gujarat.

Detailed feasibility studies and accurate cost estimates based on surveys and designs could only give a correct idea about the relative merits of the three alternatives. However, a transfer of 2580 Mm^3 (2.09 MAF) of water was envisaged from the storages on these rivers and this quantity of water seemed to be adequate to irrigate an area of about 3.44 lakh hectares (8.5 lakh acres) considering an overall delta of 0.76 m (2.5 ft) .

When NWDA came into existence and the study of the Damanganga to Tapi link was carried out, it was found that major portion of yield from the catchment of Damanganga in Gujarat was being developed for utilisation in Gujarat itself through Madhuban dam and very little surplus water from the Gujarat portion of catchment were left for diversion through the Damanganga – Tapi Link. With this in view, topo sheet studies and later prefeasibility studies of Par-Tapi – Narmada Link were carried out by NWDA, where the link starts from Par river instead of Damanganga river.

Prefeasibility report on “Par – Tapi – Narmada Link” (Technical study No. PFR/5/90) circulated in March 1991 envisaged diversion of 1389 Mm^3 surplus water of Par, Auranga, Ambica and Purna basins to Narmada command system besides enroute irrigation. As per this study, the link canal originates from river Par and terminates at Ukai reservoir on Tapi river. Further the proposed link canal takes off from the right side of the Ukai reservoir and terminates at Miyagam branch canal of Narmada command after crossing Narmada river.

1.13 Inter-state/international aspect

Par-Tapi –Narmada link is an inter-state scheme as all the rivers proposed to be tapped for diversion such as Par, Auranga, Ambica, and Purna are inter-state rivers involving Maharashtra and Gujarat. However, there are no international implications in this scheme.

1.14 Public co-operation and participation

While carrying out surveys and investigation, NWDA officials received public co-operation in Tapi-Narmada portion of Par-Tapi-Narmada link. However, in Par-Tapi portion NWDA officials did not get similar type of public co-operation. The people living in villages near the proposed reservoir sites were in general apprehensive of submergence of their cultural land, private house and displacement from the present places.

1.15 Cost and benefits of the scheme

The total estimated cost of the Par – Tapi – Narmada link project is Rs. 6016 crores based on 2004-05 prices. Taking rate of interest on capital cost, depreciation, maintenance of headworks and necessary O&M charges into consideration, total annual cost of the project has been worked out to be Rs.572 crores. Similarly, annual benefits, on account of increase in production and revenue from power generation has been worked out separately. The annual benefits from agricultural production and power generation works out to Rs.563 crores and Rs.55 crores respectively. Thus the total annual benefits of the entire project work out to be Rs.618 crore. Hence, the Benefit Cost Ratio of the project works out to be 1.08 which shows that the scheme is economically viable.