

Chapter 1

Introduction

1.1 General

Water is the most essential natural resource next to air, required for sustaining life on the earth. It is required for drinking and industrial uses, for irrigation to meet the growing food and fiber needs, for power generation, navigation and recreation. The development, use and conservation of water, therefore, play a vital role in the country's development planning. The water resources in the country are, however, limited considering the future demands. 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. In the very near future, water will become a scarce resource due to increasing thrust of population and increasing demands for various uses. Therefore, it need not be emphasised that water should be harnessed in the most scientific and efficient manner.

The monsoon flood waters should be conserved to the maximum extent possible to meet the demands for irrigation, power generation, domestic and other uses. The water availability and requirements in the various river basins need to be assessed realistically. The reasonable basin requirements should be provided for and the surplus water, if any, should be transferred to the needy areas. The National Water Policy adopted by the Government of India in September, 1987 emphasizes that water should be made available to water short areas by transfer from other areas including transfers from one river basin to another, based on a national perspective.

1.2 National Perspective Plan for Water Resources Development

The erstwhile Union Ministry of Irrigation (now Ministry of Water Resources) and the Central Water Commission in the year 1980 formulated the National Perspectives for Water Resources Development, which comprises two main components, viz. Himalayan Rivers Development and Peninsular Rivers Development. Himalayan Rivers Development envisages construction of storage reservoirs on the main

Ganga and the Brahmaputra and their principal tributaries in India and Nepal alongwith inter-linking canal systems to transfer surplus flows of the eastern tributaries of the Ganga to the West apart from linking of the main Brahmaputra with the Ganga. Peninsular Rivers Development of the National Perspectives Plan includes interlinking of major rivers flowing in the Peninsular India including the southern tributaries of Yamuna. The major parts of this components are (i) interlinking of Mahanadi-Godavari-Krishna-Pennar-Cauvery, (ii) interlinking of west flowing rivers, north of Bombay and south of Tapi, (iii) interlinking of Ken with Chambal and (iv) diversion of west flowing rivers. The interlinking of these rivers will envisage construction of storage reservoirs at potential sites and canal systems for transferring the waters from surplus to deficit basins/areas. The canals will also include tunnels and lifts, wherever necessary.

1.3 Krishna (Nagarjunasagar) – Pennar (Somasila) Link Project

This report deals with the feasibility of Krishna (Nagarjunasagar) – Pennar (Somasila) Link Project. The Project comprises of the following components:

- i) The existing storage reservoir at Nagarjunasagar across the Krishna with FRL 179.83 m, gross storage capacity of 11560 Mm³, live storage capacity of 5733 Mm³ and minimum draw down level of 155.45 m;
- ii) The existing 202.75 km long Nagarjunasagar Right Bank Canal (NSRBC);
- iii) The proposed 393.02 km long link canal taking off from the Nagarjunasagar reservoir which runs parallel and adjacent to the existing NSRBC on its right side to a distance of 202.75 km.
- iv) Existing Nagarjunasagar Right Bank Canal head regulator, power block and power house of installed capacity 3x30 MW.
- v) Proposed head regulator, power block and powerhouse of installed capacity 3x30 MW and one standby unit (30MW) for the link canal.

- vi) The existing Somasila reservoir across the Pennar river with FRL of 100.58 m, gross storage capacity of 2208 Mm³ and live storage capacity of 1994 Mm³. The MDDL of the reservoir is 82.30 m.

It is proposed to divert a quantity of 12146 Mm³ from Nagarjunasagar reservoir through the proposed link canal and the existing NSRBC. The link canal will divert a quantity of 8167 Mm³ and the remaining 3979 Mm³ (12146 - 8167) will be diverted through NSRBC.

The total requirement of NSRBC is 3979 Mm³, out of which part requirement of 1623 Mm³ will be provided through the proposed Pulichintala Right Bank Canal which is proposed to be brought through Godavari (Inchampalli) – Krishna (Pulichintala) link canal. The balance requirement of 2356 Mm³ (3979 - 1623) will be met from the diverted water through NSRBC.

As the existing NSRBC was designed to carry 3979 Mm³ of water annually, it is proposed to divert 3979 Mm³ through this canal as against the balance requirement of 2356 Mm³ under this canal. After meeting the balance requirement of 2356 Mm³ under NSRBC, it is proposed to transfer the remaining quantity of 1623 Mm³ (3979 - 2356) to the link canal at the tail end of NSRBC at RD 202.75 km. Thereafter, the Krishna (Nagarjunasagar) - Pennar (Somasila) link canal will carry 9790 Mm³ (8167 + 1623) from RD 202.75 km and will tail off into Somasila reservoir at RD 393.02 km with FSL 101.102 m. It is envisaged that enroute, the Nagarjunasagar – Somasila link canal will provide irrigation to a culturable command area of 168017 ha utilizing 908 Mm³ of water besides providing 124 Mm³ of water for meeting domestic and industrial requirements.

The link canal powerhouse with an installed capacity of 90 MW will generate 377 million units of power annually on the average.

1.4 Description of the project area

1.4.1 Location

Nagarjunasagar project

Krishna (Nagarjunasagar) - Pennar (Somasila) link project lies entirely in the State of Andhra Pradesh. The Nagarjunasagar reservoir, from which the link canal off-takes, was constructed by the Govt. of Andhra Pradesh near the historical Nagarjuna Konda in Nalgonda district for

harnessing the waters of Krishna river for irrigation and power generation. It is situated at about 100 km downstream of the Srisaillam Hydro Electric Project and at a distance of about 150 km upstream of the Prakasam Barrage on the river Krishna. Maximum height of the dam above the deepest foundation level is 124.66 m. Water spread area of the reservoir is 285 km². The dam is accessible by road from Hyderabad, Guntur and Macherla, the road distances being approximately 145 km, 150 km and 24 km respectively from the dam. Macherla is the nearest railway station located on Macherla-Guntur Metre Gauge line.

The Nagarjunasagar Right Bank Canal named as "Jawahar Canal" runs for a length of 202.75 km. It serves an ayacut of 4.75 lakh ha in Guntur and Prakasam districts. It was designed as a contour canal for a head discharge of 311.50 cumec. The head regulator was designed to discharge 594.65 cumec of water.

The Right Canal powerhouse is situated to the left of the NSRBC at the toe of the right flank non-over flow dam. Installed capacity of the powerhouse is 3x30 MW. Water is drawn through 4.6m x 11.6m (15'x38') power sluices and then through 6.1m (20') dia steel penstocks. After power generation, the water flows into the NSRBC through the tailrace channel.

All along, the NSRBC is well connected by wide network of roads. Service roads are laid on either banks of the canal to facilitate inspection and quick repairs to the canal as and when needed and also for use by the people living in the nearby villages. The Guntur - Macherla Metre Gauge and Guntur - Nandyal Broad Gauge railway lines are crossing the NSRBC at RD 19.87 km and 201.00 km respectively.

Krishna (Nagarjunasagar) - Pennar (Somasila) link canal

Krishna (Nagarjunasagar) - Pennar (Somasila) link canal (N-S link) taking off from the Nagarjunasagar reservoir is proposed as a contour canal running for a total length of 393.02 km before it tails into the Somasila reservoir on the Pennar river. It is proposed to run parallel and adjacent to the existing NSRBC on its right for the initial 202.75 km, at the end of which the NSRBC is proposed to amalgamate into the link canal. Thereafter the link canal runs as a single canal upto the Somasila reservoir. The proposed link canal is designed to discharge 488 cumec at head, 565 cumec at RD 202.75 km and 498 cumec at the tail end.

Beyond RD 202.75 km till it reaches the Somasila reservoir, the link canal is criss-crossed by a number of state highways and district roads. The roads connecting Ongole - Kurnool, Kanigiri - Kurnool, Kavali - Badvel and Nellore - Badvel are crossing the link canal alignment at RD 246.30 km, 265.61 km, 341.92 km and 367.45 km respectively.

It is proposed to accommodate the head regulator and the power block of the link canal power house in the right earthen dam of the Nagarjunasagar project, beside the existing NSRBC head regulator. The above powerhouse of installed capacity of 3x30 MW will be built in the space available between NSRBC and the link canal. After generation of power, the water will be let into the link canal.

Somasila project

Somasila project is an ongoing multi-purpose project constructed across river Pennar near Somasila village in Nellore district of Andhra Pradesh. The catchment area upto the dam site is 50492.5 km². Total length of the dam is 760.7 m with a maximum height of 38 m from the deepest foundation level.

The Somasila dam is located on the border of Cuddapah and Nellore districts. It is approachable from Nellore town through roads from either of the banks. From left bank, the dam is 89 km away from Nellore while from right bank it is 77 km away.

1.4.2 Climatic Conditions

The climate of Coastal Andhra Pradesh, in which the Nagarjunasagar - Somasila link traverses is mostly Tropical Rainy. The western portions of Prakasam and adjoining parts of Guntur and Nellore districts belong to the Hot Steppe type of climate.

The mean maximum temperature in the command area ranges from 27 to 30°C in January and 34 to 41°C in May, which is the hottest month. Mean minimum temperature varies widely from 17 to 20°C in December, which is the coolest month, to 27°C and 28°C in May and June.

The annual rainfall in the command area varies from 700 to 1500 mm. The Nellore district receives 50 to 60 percent of its rain from north-

east monsoon in October and November. The rest of the area receives 60 percent of its rain during the south-west monsoon.

The Guntur, Prakasam and Nellore districts have hot climate. The summer season starts by about March and continues till May. Thereafter, the south-west monsoon season follows and extends upto September. North-east monsoon sets in by mid-October. During the north-east monsoon period, the coastal belt is particularly prone to damages due to cyclonic storms. The cold weather period from December to February is a season of generally fine weather.

1.4.3 Topography, physiography and geology of the area

The link canal is aligned along the Eastern Ghats, skirting the Vinukonda, Markapur and Velikonda ranges. The canal mostly runs in plain area except at the crossings of basin ridges between various rivers, enroute. Major soil types encountered along the alignment are black cotton and red sandy soils.

Geologically, the northern part of the region along the canal alignment is characterised by Cuddapah and Kurnool formations upto Kurichedu. Thereafter and upto the Somasila reservoir, the link canal passes through Dharwars, which comprises of slates, phyllites, schists, gneisses, marbles, gneissic complex and associated basic and ultrabasic intrusives.

1.4.4 Human Population

Since the off-take reservoir Nagarjunasagar and the tail end reservoir Somasila are existing reservoirs and no additional storages are contemplated enroute the link alignment, no resettlement and rehabilitation problems are contemplated.

People living in the enroute command area are mostly dependent on agriculture and extending irrigation facilities to an extent of 1.68 lakh ha will not only increase agricultural production but also create around prosperity.

The scheme is intended (i) to provide irrigation facilities to enroute areas lying in the districts of Prakasam and Nellore where the existing irrigation facilities are not adequate and occurrence of frequent droughts is common, and (ii) to divert remaining surplus water further south beyond

Pennar upto Gundar river where the water shortage is much more severe.

Out of the total workforce in the Prakasam district, 48% are agricultural labourers, 25% are cultivators, 3% are workers of house hold industry, 5% are marginal workers and 19% are other workers. Similarly, the people living in the districts situated further south, which will be benefited by the diverted water, are mainly dependent upon agriculture.

1.4.5 Natural resources

The major minerals available in Guntur, Prakasam and Nellore districts, in which the link is aligned, are quartz, kyanite, barytes and slates. Bamboo, cashew, beedi leaves and timber are the minor forest produce in the region.

1.4.6 Land use and socio-economic aspects

The land use pattern falling in the new proposed command area in the Guntur, Prakasam and Nellore districts through which the link canal passes, is considered. The land use pattern in the proposed new command area enroute the link canal comprises, the gross command area of 394514 ha and the total cropped area of 205697 ha (52.14%), of which 55298 ha is cultivated during both Kharif and Rabi seasons (double cropped areas). Out of the remaining area, 143151 ha is exclusively cultivated during Kharif season, 7248 ha exclusively in Rabi season. The above estimate of crop land includes area under various tree plantations. Apart from the above, fallow land is estimated to be 25111 ha and forest land area (notified) is 19890 ha, of which open forest is 6759 ha and degraded forest is 13131 ha.

More than 70% of the population in the command area are dependent on agriculture. The literacy rate is less than 50%. More than 75% of the agricultural land holdings are small.

1.5 Choice of the project

The water balance studies of the Krishna basin upto the Nagarjunasagar dam site and the Pennar basin upto the Somasila dam site, carried out by NWDA, reveal that after full development by 2025 AD, there will be surface water deficit to an extent of 1525 Mm³ and 3820 Mm³ respectively at 75% dependability, in these basins. The river basins

located further south including Cauvery and Vaigai, are also established to be much more deficient in water resources. In contrast to the water resource situation in the Krishna and other southern river basins as above, the Mahanadi and Godavari basins were found to be substantially surplus in the water resources as per the water balance studies of NWDA, even after ultimate water resources development in these basins. Hence, the only option available to meet the deficits of Krishna and other southern basins is by diverting surplus Mahanadi and Godavari waters to Krishna and from there to Pennar and further south. The Nagarjunasagar - Somasila link, which connects Krishna to Pennar, is a vital "Link" in the overall peninsular rivers link proposal from Mahanadi to Vaigai.

For the Nagarjunasagar - Somasila link, two proposals viz. i) extending the NSRBC upto the Somasila reservoir after making suitable modifications to widen the existing NSRBC to carry more discharge, and ii) having independent canal from Nagarjunasagar to Somasila running parallel to the existing NSRBC were considered. Of these two proposals, the second proposal was preferred for the following reasons.

i) The existing NSRBC is designed to carry a quantity of 3979 Mm³ annually, whereas the quantity proposed to be carried by the link canal is 12146 Mm³ annually which is more than 3 times that of NSRBC. ii) The remodeling of the existing NSRBC and the existing CD / CM works on it suitably, to carry this huge increase in the quantum of water, is rather impossible. And even if possible, the existing system of irrigation supplies to already developed command area, gets disturbed during the period of remodeling, which may run for several years.

Considering the above difficulties involved in widening and remodeling the existing NSRBC and the CD/CM works on it, the second proposal of having independent canal from Nagarjunasagar to Somasila was finally adopted.

1.6 Stages of development of the project

As mentioned above, the Nagarjunasagar - Somasila link is an integral part of the Peninsular rivers development component under the NPP. As such, the link project has to be constructed and brought into operation together with its connected links from Mahanadi to Godavari and from Godavari to Krishna. The construction work of the link project is proposed to be completed in eight years. It is proposed to complete all the preliminary works such as additional surveys, design studies,

laboratory tests, construction of approach roads etc. in the first three years. The process of land acquisition and thereafter rehabilitation and resettlement, procurement of machinery and T&P are proposed to be taken-up from the first year itself and can be completed by the end of third year. Construction of colonies and approach roads for the same and laying of electric lines shall also be commenced from first year onwards. The construction of power block, power house, head regulator and tunnel are to start with excavation from the fourth year and would be completed by the end of seventh year. The excavation of canals is to commence from third year and construction of the cross drainage and cross masonry (CD and CM) works are proposed to be completed by the end of eighth year. The lining work of the entire length of canal will be started in fourth year and the same will be completed by the end of eighth year. The distributory system as well as drainage including command area development are programmed to be taken-up simultaneously in the third year and can be completed by eighth year. The proposed diversion to Somasila reservoir will be started by the end of eighth year.

1.7 Fitment of the scheme in overall development of the region

The Mahanadi - Godavari - Krishna - Pennar - Cauvery – Vaigai - Gundar link proposal will be a boon to the entire peninsular region covering the states of Orissa, Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Pondicherry. The main aim of the project is to divert the waters from surplus basins to the deficit basins, for the overall development of the region. For its part, the Nagarjunasagar – Somasila link is proposed to serve as one of the carriers from Krishna to Pennar to divert the surplus waters of Mahanadi and Godavari besides taking over part command of Nagarjunasagar and irrigating new areas enroute the link. Thus, the Nagarjunasagar - Somasila link project forms an essential integral part of the whole Peninsular rivers development component. And the enroute irrigation component of the link would enhance the overall development of the regions.

1.8 Integrating the scheme with neighbouring basin schemes

The Nagarjunasagar - Somasila link proposes inter-connecting of the existing Nagarjunasagar reservoir on Krishna with the existing Somasila reservoir on Pennar. As the required water for diversion through the link

is actually proposed to be brought to Nagarjunasagar from the Godavari, unforeseen/occasional short-falls, if any, in the natural inflows into these reservoirs could be made up from the water transferred through the link canals. Further, the scheme is linked up with NSRBC to supplement its requirement. Also, the scheme proposes to bring about 168017 ha under irrigation in the basin area covered by the streams between Gundlakamma and Pennar and about 8426 Mm³ will be diverted into the Somasila reservoir. These waters are proposed for further transfer to the basins viz. basin area covered by the streams between Pennar and Palar, Palar, basin area covered by the streams between Palar and Cauvery, Cauvery and Vaigai. By providing outlets in the shape of escapes in the link canal at all the other river crossings in between Krishna and Pennar, the short-falls in the flows of these rivers for downstream utilisation could also be made up. Similarly, the needs of the water supply schemes enroute the canal could also be taken care of.

1.9 Inter-state Aspects

The Nagarjunasagar - Somasila link project lies entirely in the Andhra Pradesh State. However, this link is an integral part of the main Mahanadi - Godavari - Krishna - Pennar - Cauvery - Vaigai - Gundar link, which envisages transfer of surplus Mahanadi and Godavari waters that would be brought into the Krishna river to Pennar and from there to Palar, Cauvery, Vaigai etc. Hence, a broad consensus amongst the states of Orissa, Maharashtra, Madhya Pradesh, Karnataka, Andhra Pradesh, Tamil Nadu and Pondicherry has to be reached before taking up the project. More details about interstate aspects are given in Chapter on "Inter-state aspects".

1.10 Cost and benefits of the Scheme

The Nagarjunasagar - Somasila link is an integral part of the Peninsular rivers development component under the National Perspective Plan proposals. The surplus flows of the Mahanadi and Godavari, to be received through the Inchampalli - Nagarjunasagar link are proposed to be diverted from Nagarjunasagar reservoir to the water-short Pennar, Cauvery, Vaigai and Gundar basins. As such, it will be more appropriate to assess the benefits of Nagarjunasagar - Somasila link only after the overall economics of the entire inter-linking proposal under peninsular rivers development i.e., Mahanadi - Godavari - Krishna - Pennar - Cauvery - Vaigai - Gundar link is finalised, since the benefits from this link project will be realised not only in Krishna basin but also in the

basins of Pennar, Cauvery, Vaigai, Gundar and few other intermediate small basins. However, to reflect a broad general idea of the economic viability of the scheme, the B.C. ratio of this link has been estimated on the basis of benefits that accrue due to irrigation and water supply for domestic and industrial uses contemplated under the link.

While working out the total cost, cost of head works, link canal, power component and cost of command area development are considered. The total cost is estimated to be Rs. 6321 crores based on 1998-99 schedule of rates. The net annual benefits from enroute irrigation for a CCA of 168017 ha have been worked out to be Rs. 105 crores and that of water supply for domestic and industrial uses to be Rs. 80 crores.

Thus, the B.C. ratio works out to be 1.90. Details of benefit-cost analysis are given in Chapter on "Benefit – Cost ratio".