Chapter 2
Physical Features

2.1 Geographical disposition

Nagarjunasagar - Somasila link canal takes off from the existing Nagarjunasagar reservoir from its right flank earth dam and runs parallel to the NSRBC to its right side, till both the canals amalgamate into one at RD 202.75 km. Beyond this point upto its out-fall into Somasila reservoir, the canal generally runs in south direction. The canal passes through the mandals of Macherla, Durgi, Karampudi, Piduguralla, Nekarikallu, Ipuru and Bollapalli of Guntur district, Pullala Cheruvu, Tripurantakam, Donakonda, Kurichedu, Konakanamitla, Podili, Kanigiri, Veligandla and Pamuru of Prakasam district and Varikuntapadu, Udayagiri, Duttalur, Marripadu and Anantasagaram mandals of Nellore district.

2.2 Topography of the basins and command area

The link project including its command area falls in the basins of the Krishna, Gundlakamma, the streams between Gundlakamma and Pennar, and Pennar. The topography of these basins is described briefly in the following sections:

2.2.1 Krishna basin

The Krishna basin is bounded on the north by the common ridge separating it from Godavari basin, on the south and east by the Eastern Ghats and on the west by Western Ghats. Except for the hills forming the watershed round the basin, the entire drainage basin of the river comprises of rolling and undulating country and a series of ridges and valleys interspersed with low hill ranges. Large flat areas of the type seen in the Indo - Gangetic plains are scarce except in the deltas.

The interior of the basin in its middle reaches is a plateau, the greater part of which is at an elevation of 300 to 600 m. Its general slope is eastwards. Great undulating plains divided from each other by flat topped ranges of hills are the chief characteristics of this plateau. The hill sides are marked by conspicuous, wide terrain except in the southern part of the plateau where the hills are frequently crowned with

great 'tors' or rounded hummocks of bare rock as a result of constant weathering.

The Krishna is the second largest river in the peninsular India flowing east and draining into the Bay of Bengal. The river rises in the Mahadev range of the Western ghats near Mahabaleshwar at an altitude of about 1337 m above mean sea level and flows through the states of Maharashtra, Karnataka and Andhra Pradesh. The total length of the river from source to its outfall into Bay of Bengal is about 1400 km of which 305 km is in Maharashtra, 483 km in Karnataka and 612 km in Andhra Pradesh. The important principal tributaries of the Krishna are the Bhima, Ghata Prabha, Mala Prabha and Tungabhadra above the Nagarjunasagar project and the Musi, Palleru and Muneru are below the project.

2.2.2 Gundlakamma basin

The upper portion of the catchment of the basin is mostly hilly with dense forests. The middle portion comprises of small groups of hillocks and the lower portion is plain.

The river Gundlakamma is the largest of the small independent east flowing rivers between the Krishna and the Pennar. The Gundlakamma rises in the surrounding area of Gundlabrahmeswar, the border area between Nandyal and Atmakur taluks of Kurnool district at an elevation of about 800 m in Nallamala hills. After reaching plains, it forms two large tanks, one at Cumbum and other at Markapur in Prakasam district and flows in north-easterly direction and enters Guntur district. Then it changes the direction towards south-east and finally joins the Bay of Bengal near Ulichi village. Chamavagu, Rallavagu, Pogullavagu, Duvvaleru, Jampaleru, Tigaleru, Koneru and Chilakaleru are the tributaries of the river Gundlakamma. The length of the river is about 220 km.

2.2.3 Basin area of the streams between Gundlakamma and Pennar

The basin area of the streams between Gundlakamma and Pennar comprises of mainly three independent east flowing rivers viz. the Musi, the Palleru and the Manneru. The three rivers in their upper reaches flow in the Velikonda hills and thereafter immediately enter into plains. To a limited extent, the upper reaches are covered with dense forests

and the remaining area with moderate to low altitude hill range. The catchment area of the basin is fan shaped and the boundaries are Gundlakamma River in the north, Pennar River in the south and west, and the Bay of Bengal in the east.

Three independent east flowing rivers viz. the Musi, the Palleru and the Manneru joining the Bay of Bengal, are the major streams in the area in between the Gundlakamma and Pennar rivers. The Musi rises in Velikonda range hills near Thadivaripalli village of Podili taluk in Prakasam district. The length of this river is 122.5 km. Gajjaleru, Dondieru, Atleru and Inagaleru are the tributaries of the Musi river. The Palleru River rises in Velikonda range hills near Vedulla Cheruvu of Kanigiri taluk in Prakasam district. The length of this river is 112.5 km. Dommaleru, Narellavagu, Makeru and Gadisaleru are the tributaries of the Palleru river. The Manneru rises in the north of Pillipalli village of Kanigiri taluk in Prakasam district. The length of this river is 130 km. Dokkalavagu, Uppuvagu, Pillaperu and Upputeru are the main tributaries of the river Manneru.

2.2.4 Pennar basin

The Pennar basin is also a fan shaped basin and is bounded on the north by the Erramala hills, on the east by the Nallamala and Velikonda hills of Eastern ghats, on the south by the Nandidurg hills and on the west by the narrow ridge separating it from Vedavathi valley of the Krishna basin.

There are a number of hills and peaks of varying heights in the Pennar basin. A few notable hill ranges are the Nallamala to the east of the basin, the Erramala on the north, and the Palkonda ranges to the south of the river. The highest hill is the Horsely hill with an altitude of 1314 m. The interior of the Pennar basin has long ridges with isolated hills and small streams.

The Pennar river is one of the major rivers of the Indian peninsula flowing eastwards and draining into the Bay of Bengal. The river rises in Chennakesava hills of the Nandidurg range in Kolar district of Karnataka state. The total length of the river from the source to its out fall into the sea is 597 km, of which about 61 km is in Karnataka and the remaining 536 km is in Andhra Pradesh. The important tributaries of

the Pennar river are the Jayamangala, Chitravati, Kunderu, Papagni, Sagileru, Cheyyeru and Boggeru.

2.2.5 Command area

The new command area proposed enroute the link falls in the “Basin area covered by the streams between Gundlakamma and Pennar”. This terrain is mostly plain. The soils available in the command area are predominantly red earth, red sandy and black cotton soils.

2.3 Geology of the basins and command area

2.3.1 Krishna basin

The Krishna basin consists largely of Archaean formations, part of which are covered by Deccan trap lavas, Cuddapah and Vindhyan series and faulted blocks of Gondwanas. Hydrogeological investigations in the Krishna basin carried out by the Groundwater Departments of the respective states and the Central Ground Water Board indicate that groundwater occurs in all the geological formations and the occurence and movement of groundwater in these rocks is controlled by the nature and extent of weathering and presence of joints and fractures. In areas underlain by crystalline rocks like granites, the quality of water is unsuitable for domestic purposes due to the presence of fluorides in excess of the prescribed safe limits.

2.3.2 Gundlakamma basin

The Gundlakamma basin is underlain by various rock types of different age groups ranging from Archaean to recent. The Archaeans comprise various types of granites and charnockites occuring as intrusives in the highly folded and metamorphosed sedimentary rocks represented by khondalites, mica-schists etc. Among the Algonkians, there are metamorphosed sedimentary rocks represented by phyllites, slates, shales and quartzites belonging to the Cuddapah system of Precambrian age.

Hydro-geological investigations carried out by Central Ground Water Board indicate that in crystalline rocks the groundwater occurs under unconfined condition in shallow weathered mantle, and semi-confined to confined conditions in fractured zones. In these rocks the occurrence and movement of groundwater are controlled by depth and intensity of weathering with primary porosity and joints, fissures and other structural

features. The weathered zone is fairly thick along the valley portions where water table is shallow. The weathered zone becomes thinner at higher elevations. In these crystalline rocks the groundwater is mainly developed by open wells, dug-cum-bore wells and bore wells both for drinking and irrigation purposes.

2.3.3 Basin area of the streams between Gundlakamma and Pennar

Hydro-geological studies carried out by Central Ground Water Board in the districts falling in the basin area indicate that the geological formations in the basin area vary widely ranging from the oldest Archaeans to recent laterite and alluvium.

The granites and gneisses, granetiferous biotite gneisses etc. together with migramtites, which represent the Archaean, occupy the central part of the basin, as detached hills covering Kanigiri, Podili and Darsi taluks. Rocks having charnockite affinity have been reported to occur at places in the northern part of the basin .

Dharwars occur mainly as, two north-south elongated bands in the central part of the basin, one along the eastern margin of Cuddapah district and the other between Kanigiri and Kandukur taluks of Prakasam district. The Cuddapah formations represented by the Nallamalai and Kistna series occupy the western margin of the basin. The Upper Gondwana formations occur as isolated patches in the Kandukur taluk. Laterite occurs in parts of Kandukur and Ongole taluks of Prakasam district and Kavali taluk of Nellore district capping Gondwanas and crystallines. Alluvium occurs in the eastern portion of the basin.

In this basin, groundwater occurs in all the geological formations from oldest crystalline to recent alluvium. Groundwater occurs under the water table condition in Archaeans and lower Precambrian formations in the weathered zone and semi confined and confined conditions in joints, fissures and other weaker planes. The depth of wells in the crystallines varies from 3 to 27 m below ground level and the depth of water level ranges from 1.5 to 14.5 m below ground level. The yields of the domestic and irrigation wells observed by CGWB vary from 1 to 15 m^3 per hour. Groundwater occurs under unconfined to confined condition in Cuddapah formations. The depth of the wells varies from 5.84 to 14.5 m below ground level and depth of the water level ranges from 5 to 12 m

below land surface. The laterite occurs as discontinous patches in the Ongole and Kandukur taluks of Prakasam district and Kavali taluk of Nellore district fringing the Archaeans. As the formation is highly permeable, it is expected that the yield should be high.

2.3.4 Pennar basin

In Pennar basin, important rock formations are hard or crystalline rocks of Archaean age Dharwar super group, Cuddapah series of rocks belonging to Proterozoic age, Kurnool series comprising of Guvalacheruvu quartzites, Vempally dolomites, limestones and shales of Papagni series and Cheyyeru series. The Nallamala series comprise of Cumbum shales, which are metamorphosed to slates and phyllites.

Hydrogeological studies in the Pennar river catchment have been carried out by the Groundwater Departments and the results are similar to those observed in Krishna basin.

2.3.5 Command area

The geological and hydrological conditions in the proposed enroute command area of the link are similar to that of in the basin area of streams between Gundlakamma and Pennar.

2.4 Basin characteristics

2.4.1 Krishna basin

The Krishna basin lies in the Deccan plateau. The basin extends over an area of 258948 km^2, which is nearly 8% of total geographical area of the country. The catchment area of the river Krishna upto Nagarjunasagar dam site is 220705 km^2 and lies in the states of Maharashtra, Karnataka and Andhra Pradesh.

2.4.1.1 Rainfall

The catchment mainly experiences the south-west monsoon from mid June to mid October. The rainfall during the non-monsoon period is not significant. The annual rainfall over the catchment varies from 377 to 3048 mm.

2.4.1.2 Temperature

The climate of the catchment remains dry except in the monsoon months. The mean daily maximum temperature in the basin varies from 27.7 to 40.4^{o}C and the mean daily minimum temperature varies from 20.6 to 27.2^{o} C.

2.4.1.3 Relative humidity

The mean relative humidity is high during the monsoon period and comparatively low during the post-monsoon period. In summer the weather is dry and the humidity is low. The relative humidity in the basin ranges from 17 to 92 percent.

2.4.1.4 Wind speed

Winds are generally light with some increase in force during the later half of the summer. The catchment is influenced by winds from the south-west during the monsoon season. In the post-monsoon season, they blow from north-west to north direction. In the winter season the winds blow from north-west and south-west directions. The mean wind speed in the basin varies from 4.0 to 21.7 km/hr.

2.4.1.5 Cloud cover

Sky is generally heavily clouded during the monsoon season. During the post-monsoon months cloudiness decreases. During the rest of the year, the sky is clear or lightly clouded. The cloud cover in the basin varies from 0.8 to 8 oktas .

2.4.2 Gundlakamma basin

The Gundlakamma basin lies in Deccan plateau. The basin is arc-shaped. The total catchment area of the basin is 8195 km^2 and lies entirely in Andhra Pradesh state. The basin covers parts of the Kurnool, Guntur and Prakasam districts.

2.4.2.1 Rainfall

The basin receives rainfall from the two monsoons viz., the south-west and the north-east. The average annual rainfall in the basin varies from 607 to 846 mm.

2.4.2.2 Temperature

The mean daily maximum temperature in the basin varies from 28.6 to 41.5^{o}C and the mean daily minimum temperature varies from 16.6 to 28.6^{o}C. Generally, day temperatures are higher by 3 to 5^{o}C in summer and night temperatures are lower by 2 to 3^{o}C in winter in the interior than in coastal parts.

2.4.2.3 Relative humidity

The coastal region is humid throughout the year, while the interior is humid during July to November. In the interior, the humidity in the afternoon becomes as low as 30 to 40 per cent during December to May.

2.4.2.4 Wind speed

Winds are generally light to moderate except in the late summer and early south-west monsoon season, when they strengthen. From November to January the winds generally blow in north and north-easterly direction. The average wind speed in the basin varies from 3.8 to 21.3 km/hr.

2.4.2.5 Cloud cover

The sky is generally heavily clouded to over cast during the south-west monsoon season. There is moderate cloudiness in the north-east monsoon season. In the rest of the year sky is mostly clear or lightly clouded.

2.4.3 Basin area of the streams between Gundlakamma and Pennar

The catchment area of the basin between Gundlakamma and Pennar is about 9886 Km^{2}. The main streams are Musi, Palleru and Manneru rivers.

2.4.3.1 Rainfall

The basin is under the influence of two monsoons viz., south-west and north-east. June to December is considered as monsoon period. The maximum, minimum and average annual rainfall of the basin are 1022, 594 and 752 mm respectively.

2.4.3.2 Temperature

The monthly average maximum and minimum temperatures for Cuddapah station are 40.3^{o}C in the month of May and 19.1^{o}C in the month of December respectively.

2.4.3.3 Relative humidity

The maximum and minimum values of relative humidity observed in the catchment are 84 and 36 per cent respectively.

2.4.3.4 Wind speed

The basin is influenced by winds from the south-west during the monsoon season. The maximum wind velocity is 11.6 km/hr in June and minimum is 4.30 km/hr in December.

2.4.3.5 Cloud cover

The sky is heavily clouded during the south-west monsoon. During the remaining part of the year, clear or lightly clouded sky prevails. The maximum cloud amount is 6.7 oktas in the month of July and minimum is 1.5 oktas in the month of January.

2.4.4 Pennar basin

The total catchment area of the Pennar basin is 55213 km^2 of which 48276 km^2 lies in Andhra Pradesh and 6937 km^2 in Karnataka. The catchment area of the Pennar river upto the Somasila dam site is 50492.5 km^2 and lies in Karnataka and Andhra Pradesh states.

2.4.4.1 Rainfall

The catchment receives rainfall both during the south-west and north-east monsoons. The rainfall during the non-monsoon period is not significant. The annual rainfall over the catchment upto Somasila project varies from 550 to 900 mm.

2.4.4.2 Temperature

The mean maximum daily temperature in the basin varies from 40.3^{o}C observed at Cuddapah to 34.7^{o}C observed at Arogyavaram and the mean minimum daily temperature varies from 20^{o}C observed at Nellore to 15.3^{o}C observed at Arogyavaram.

2.4.4.3 Relative humidity

In general, the humidity is high during the monsoon period and moderate during the non-monsoon period. The relative humidity in the catchment ranges from 21 to 84 percent.

2.4.4.4 Wind speed

Winds are generally light to moderate with some strengthening in monsoon season. The catchment is influenced by winds from south-west and north-west during May to September and from north-east and south-east during October to April. The average wind speed in the catchment varies from 4.3 to 21.3 km/hr.

2.4.4.5 Cloud cover

Sky is generally heavily clouded during the monsoon months. In the post-monsoon months cloudiness decreases. During the rest of the year, the sky is clear or lightly clouded. The cloud cover in the catchment ranges from 1.3 to 7.1 oktas.