Chapter 6
Designs and Layout

6.1 Structure, Layout and Design Features of the Head Works

6.1.1 Location of the Head Works

The link canal proposes to connect the existing Somasila reservoir on Pennar River in Andhra Pradesh and Grand Anicut across Cauvery River in Tamil Nadu. As such, the Somasila dam is at its head and the Grand Anicut is at its tail end.

6.1.1.1 Somasila Dam

The Somasila dam is proposed to be utilized for diversion of water from Pennar River to Cauvery. A new head regulator is proposed just right side of the existing head regulator of Kandaleru Flood Flow Canal. The components of the proposed head regulator are as follows:

(i) Providing a head regulator with design discharge of 603.33 cumec.
(ii) All other related works.

The existing south feeder canal and the Kandaleru flood flow canal take-off from a common head regulator on the right flank of dam. Considering the size, FSL and slope of these existing canals, it may not be suitable for the purpose of this proposal without extensive remodeling works and so it is advantageous to have an independent off-take for the proposed canal.

The Pennar (Somasila) – Palar – Cauvery (Grand Anicut) link canal is proposed to take off from the right flank of the Somasila dam. The required discharging capacity of the link canal has been worked out to be 603.33 cumec. Hence, it is proposed that the canal could have a head regulator with 5 bays of 3.0 m x 7.50 m (to pass a discharge of 603.33 cumec into the link canal) located by the side of the off-take point of Kandaleru flood flow canal.

6.1.1.2 Tail end at Grand Anicut

The link canal terminates at the Grand Anicut across Cauvery River at RD 529.19 km near Tohur village of Thanjavur taluk of Thanjavur district.

The NSL of left bank area of Cauvery River is 63.395 m and the FSL of the link canal is 60.859 m.

6.2 Design Features of Pennar (Somasila) – Palar – Cauvery (Grand Anicut) link canal

6.2.1 Description of the Canal System

As already mentioned, the proposed link canal takes-off from the right flank of the Somasila dam through a canal head regulator. The general topography of the area through which the Pennar (Somasila) – Palar – Cauvery (Grand Anicut) link canal traverses is mostly plain except with a few hillocks in the initial reaches viz., 0.000 km to 35.000 km and 123.00 km to 153.00 km, where it runs very close to the hilly areas of Rapur Velikonda hills and Ramapuram Reserved Forest respectively. The canal runs almost in a southernly direction except for intermittent shiftings to south-eastern and south-western directions in very small reaches, till joins at Grand Anicut on Cauvery. The alignment of link canal runs mostly in partial filling and cutting. Maximum height of filling in the entire reach of the canal is 26 m and maximum depth of cutting is 46 m.

A uniform bed slope of 1 in 20000 is adopted for the entire alignment. The canal is designed as a trapezoidal section with bottom corners rounded and is proposed to be lined. The velocity at the head and tail end of the link canal are 1.183 m/s and 1.123 m/s respectively. The full supply depth is 6.0 m throughout the length of canal. Sections of the canal at head and tail end are 72.40 m x 6.0 m and 39.55 m x 6.0 m respectively. The designed discharge at head and tail end of the link canal are to be 603.33 cumec and 351.02 cumec respectively. The canal has been designed for 1.1 times the peak discharge. A free board of 1.0 m is provided throughout the length of the link canal.

6.2.2 Utilisation of water potential from the streams crossed by the canal

Almost all the rivers, streams and rivulets crossed by the Pennar (Somasila) - Palar - Cauvery (Grand Anicut) link canal are not perennial. The yields are undependable and most of the streams are not prone to flash floods in general. The possibility of providing additional storage on these streams is remote because of the nature of the topography and likely submersion of large tracts of cultivable lands. In view of the above, utilisation of water from these enroute streams may not be feasible.

6.2.3 Description of soil profile along the canal alignment

The details of sub-surface strata for the link alignment have been taken from the results furnished by the University of Mysore, Mysore. With the help of these details, the sub-surface profile of the link canal was derived for working out the earthwork quantities.

6.2.4 Evaluation of the properties of soil samples collected enroute

The canal alignment generally runs in filling except in initial reaches where it runs in cutting. In some of the reaches the canal runs in partly cutting and filling. The soils as available from cutting and adjoining identified borrow areas are considered to be generally suitable for embankment purposes.

6.2.5 Lining

100 mm thick CC (1:3:6) lining is proposed for both bed and sides throughout the length of the canal.

6.2.6 Transmission losses

The transmission losses are assumed as 0.60 cumec per million m^2 of wetted area as per Bureau of Indian Standard Code IS: 10430 – 1982.

6.2.7 Design calculations for adequacy of canal section

a) Formulae used

The canal sections for various reaches are designed using Manning's formula for velocity,

$V = (1/n) R^{2/3} S^{1/2}$

where

V = Velocity
n = Rugosity co – efficient
S = Bed slope
R = Hydraulic mean depth (A/P)
A = Area of cross section = $bd + d^2 (\theta + \cot \theta)$
P = Wetted perimeter = $b + 2d (\theta + \cot \theta)$
b = bed width

d = depth of water
θ = Angle of the side slope

The formula adopted for critical velocity is $Vo = 0.55\ d^{0.64}$

The Rugosity co-efficient for the lined canal is taken as 0.018. Side slope of 1.5H : 1V is adopted except for deep cutting in hard rock where the slope adopted is 0.25H : 1V. A uniform bed slope of 1 in 20000 is adopted for the entire canal alignment.

b) Design of canal sections in various reaches

The Pennar (Somasila) - Palar - Cauvery (Grand Anicut) link canal is planned to divert annually a total quantity of 8565 Mm^3. The maximum diversion proposed is 1468 Mm3 during the month of August based on simulation studies and the peak discharge works out to 548.09 cumec.

The canal sections are designed for the above peak discharge increased by a capacity factor of 1.1 to take care of any future eventualities. The designed discharge at the head works out to 603.33 cumec for the link canal. The canal is designed for this discharge as a trapezoidal section with rounded corners and to be lined for its entire length. The hydraulic design is done as per Manning's formula with values of co-efficient of rugosity as 0.018. The typical section of the canal as given in IS 10430-1982 "Criteria for design of lined canals and guidelines for selection of type of lining" is adopted.

As the canal advances from the Somasila dam, the discharge in the canal gets reduced at every off-take point due to drawal of water into the branch canals/ direct sluices to meet the requirement of enroute command, resulting in scope for reduction in the canal section. Hence the canal is broadly divided into suitable hydraulic reaches depending on the reduction in the discharge and the sections have been designed accordingly.

The entire canal along its length is divided into 10 reaches for designing the canal section, considering the following.

1) Taking-off a major branch canal,
2) Discharge of canal falling by 10%,
3) Canal running in full cutting in hard rock.

Salient features of the link canal at its head are given in Table 6.1.

Table 6.1
Salient features of the link canal at head

Type of canal	Lined (Trapezoidal with rounded corners)
Design discharge	603.33 cumec
Bed width	72.40 m
Full supply depth	6.0 m
Velocity	1.183 m/s
Bed slope	1 in 20000
Side slope	1.5 H to 1 V
Manning's 'n'	0.018

c) Head Loss at Different Structures

Head losses due to various CD works have been worked out using the formulae given in I.S. Codes and textbooks. The total head loss due to structures worked out to be 8.099 m.

6.3 Canal structures

6.3.1 General

The link is aligned as a contour canal and it crosses a number of major, medium and minor rivers / streams enroute. It crosses several roads as it passes through fairly developed and densely populated areas. It also crosses six railway tracks of the South-Central / Southern Railway. The type of cross drainage work is decided based upon the physical features of the stream such as its catchment area, bed level with reference to the bed and full supply levels of the link canal at the crossing.

Based on field survey, the locations of the cross drainage works and cross masonry works have been identified. In general, aqueducts, syphon aqueducts and canal syphons proposed across major rivers / streams and under tunnels across all other small rivers/drains. Super passages have been provided where the drains are to be taken over the canal. Cross regulators have been proposed at the major off-take points of the branch canals and the points of change in the section of the canal to facilitate negotiation of variation in the bed width and levels.

6.3.2 Cross drainage works

In its entire run of 529.190 km, the link canal has been provided with 229 cross drainage works, of which 21 are aqueducts, 9 are siphon aqueducts, 9 are canal syphons, 6 are super passages and the rest 183 are under tunnels.

6.3.2.1 Aqueducts /Canal syphons

Aqueducts have been proposed at the crossings of the major streams where the bed level of the canal is above the high flood level of the drain. Head losses of varying from 0.026 to 0.146 m have been worked out at major aqueducts. In all, 21 aqueducts have been proposed. Wherever the FSL of the link canal is above the bed level of the drainage trough but below the HFL of the drain, canal syphons have been proposed. In all, there are 9 canal syphons and head losses varying from 0.145 to 0.550 m have been worked out at major canal syphons.

6.3.2.2 Syphon aqueduct

Syphon aqueducts have been proposed at the crossings, where the bed level of the canal is below the high flood level of the drain. Head losses varying from 0.021 to 0.175 m have been worked out at major syphon aqueduct. In all, 9 syphon aqueducts have been proposed.

6.3.2.3 Super passages

Super passages have been proposed at the crossings, wherever the bed level of the intersecting drain is well above the FSL of the link canal. There are 6 such crossings where super passages are proposed. Actual head loss has been worked out at major super passages, which varies between 0.023 m and 0.361 m.

6.3.2.4 Under tunnels

The under tunnels have been proposed along the link canal at all the crossings of small rivers/drains. No head loss has been assumed at under tunnels. A total number of 183 under tunnels have been identified. Provision has also been made in the cost estimate for small hillside drains and diversion of nalas.

6.3.2.5 Typical hydraulic designs of cross drainage works

Typical hydraulic designs of (1) Aqueduct at RD 113.536 km, (2) Super passage at RD 226.223 km (3) Canal Syphon at RD 341.800 km and (4) Syphon aqueduct at RD 242.850 km have been done.

6.3.3 Cross masonry works

6.3.3.1 Bridges

The link canal crosses National Highways, State Highways, few district roads and a number of village roads at various points. In order to facilitate free flow of traffic on these roads, four lane road bridges across National Highways and double lane bridges or single lane bridges on other roads as per their importance and type are proposed. Double lane road bridges are provided for State Highways and for some of the district roads and single lane road bridges/ cart track bridges are provided for all existing village / cart track roads crossing the canal alignment.

A total of 276 road bridges have been proposed across the link canal, of which 4 are four lane, 28 are double lane, 205 are single lane and 39 cart track bridges. The locations are shown in the longitudinal section of the link canal. No head loss has been provided for these bridges.

The link canal crosses the South-Central / Southern Railway line at six places. At RD 108.000 km near Renigunta, it crosses the railway line connecting Srikalahasthi and Renigunta towns, at RD 188.767 km near Tiruttani, it crosses the railway line connecting Arakonam and Tiruttani towns, at RD 194.813 km near Arakonam, it crosses the railway line connecting Arakonam- Katpadi towns, at RD 334.091 km near Tirukoilur, it crosses the railway line connecting Villupuram – Tirukoilur towns, at RD 386.600 km near Ulundurpettai, it crosses the railway line connecting Salem – Vridhachalam towns and at RD 429.830 km near Ariyalur, it crosses the railway line connecting Ariyalur – Tiruchchirappalli towns. Double track railway bridges are proposed at all the six crossings.

6.3.3.2 Cross / escape regulators

In all, 8 cross regulators inclusive of the tail end regulator at RD 529.190 km are proposed along the link canal. A head loss of 0.20 m has been considered for each cross regulator.

Similarly 6 escape regulators are also proposed along the canal at suitable places at RD 65.692 km, 113.486 km, 184.100 km 297.465 km, 350.853 and 483.090 km, where natural streams are available to accommodate the surplus discharges of the link canal during emergency. The discharging capacity of the escape regulator has been considered at half the discharge of the canal at that point. No head loss has been considered for escape regulator.

6.4 Alternative Proposals received from Govt. of Tamil Nadu on link alignment

Govt. of Tamil Nadu desired that a higher level canal between Pennar & Cauvery may be taken and revised alignment may be studied by NWDA for Preparation of Feasibility Report so that the irrigation and drinking water needs in upland areas could be catered and the Pennar (Somasila)-Palar-Cauvery (Grand Anicut) link should drop at Kattalai regulator instead of at Grand Anicut so that no exchange of water is there in Cauvery and the transferred water itself will be directly delivered at Cauvery (Kattalai)-Vaigai-Gundar link. Considering the suggestions of Govt. of Tamil Nadu, NWDA have already taken up the desk top studies for the alignment at higher elevation between Pennar & Cauvery and as requested FR level study on new alignment at higher elevation will be taken up by NWDA.