# Executive Summary

## 1.0 General

In the year 1980, the erstwhile Union Ministry of Irrigation and Central Water Commission (CWC), formulated National Perspective Plan (NPP) for Water Resources Development in the country which comprises two Components: (i) Himalayan Rivers Development Component; and (ii) Peninsular Rivers Development Component. The National Water Development Agency (NWDA) was set up by the Government of India as an Autonomous Society under the Ministry of Water Resources on 17th July, 1982 to study the feasibility of the proposals of links under Peninsular Component of National Perspective Plan and give concrete shape to these proposals. Subsequently in 1990, NWDA Society resolved to take up the studies of the Himalayan Component also. Further, on 28th June, 2006, preparation of Detailed Project Reports (DPRs) of link projects and pre-feasibility / feasibility reports of Intra-state links as proposed by States were also included in the functions of NWDA. Accordingly, MoWR vide Resolution No.2/18/2005-BM dated 30th November, 2006 has modified the functions of NWDA Society. The functions of NWDA were further modified vide MoWR Resolution dated 19th May, 2011 to undertake the works of preparation of DPRs of Intra-state links. The Gazette notification of the enhanced mandate of NWDA was issued on 11th June, 2011.

On the basis of its enhanced mandate, NWDA requested all the State Governments to identify the intrastate link proposals in their States and send details to NWDA for their prefeasibility / feasibility studies. In response, Govt. of Tamil Nadu proposed the 'Ponnaiyar - Palar Intra-state link project' vide their ltr. No. 175 dated 24.08.2009 to assess the feasibility of diverting the flood water from the Ponnaiyar river to the water deficit Palar basin.

Accordingly, NWDA has prepared the PFR of Ponnaiyar (Krishnagiri) - Palar Intra-state link and circulated the same to Govt. of Tamil Nadu on 30th March, 2011 for their observations/comments if any. In response, Govt. of Tamil Nadu has communicated their observations on 19th July, 2011. Further, Govt. of Tamil Nadu vide letter dated 2nd November, 2011 communicated their consent for preparation of DPR of Ponnaiyar (Krishnagiri) - Palar link after taking into consideration of their comments.

As a part of optimisation of the proposal, further studies have been carried out by NWDA on toposheets and after reconnaissance survey an alternative proposal of link canal

off-taking from existing Nedungal Anicut which is located 16 km downstream of Krishnagiri dam has been proposed, instead of from Krishnagiri dam, since the initial reach of the Ponnaiyar (Krishnagiri) - Palar link passes through developed areas. In addition to this, the proposed tunnel (200 m long) at off-take point and 6-lane NH-46 crossing at outfall point can be avoided and a number of CD/CM structures proposed enroute the canal can be reduced considerably, besides reduction of length in canal.

The alternative proposal of 'Ponnaiyar (Nedungal) - Palar link Project' has been sent to the Govt. of Tamil Nadu on 10th July, 2012 for their consent for preparation of Detailed Project Report (DPR) of Ponnaiyar (Nedungal) - Palar link Project'. The Govt. of Tamil Nadu vide letter dated 7th Jan, 2013 has conveyed consent for preparation of DPR of the modified proposal of 'Ponnaiyar (Nedungal) - Palar link'.

Accordingly, NWDA has prepared the DPR of Ponnaiyar (Nedungal)- Palar link project based on detailed Surveys & Investigations and considering suggestions/views along with active support and co-operation of PWD, WRO, Govt. of Tamil Nadu and other reputed organisations like Central Soil & Materials Research Station (CSMRS), New Delhi; Geological Survey of India (GSI), Chennai; CSIR - National Geophysical Research Institute (NGRI), Hyderabad.

## 2.0 Aim and Justification of the Project

The Ponnaiyar is a major Inter-State river amongst the streams between Palar and Cauvery which rises in the Hills of Nandidurg in Kolar district of Karnataka at an elevation of about 900 m above MSL. The total catchment area of Ponnaiyar and Gadilam rivers lies in Karnataka, Andhra Pradesh, Tamil Nadu and Union Territory of Puducherry. It mainly flows through Karnataka and Tamil Nadu States and confluence into Bay of Bengal at Cuddalore.

The Palar river is also an Inter-State river originates in Kolar district of Karnataka state near Kaivara village at an altitude of 900 m. The catchment area of the basin lies in Karnataka, Andhra Pradesh and Tamil Nadu.

Presently, the main source of irrigation in the proposed command area under the Ponnaiyar (Nedungal) - Palar Link Project is only groundwater through tube wells/bore wells and open wells. Tank/Pond irrigation practices by harvesting rainwater are also available to some extent. The open wells account for more than 90% of the area being irrigated in the vicinity of the proposed link project. Besides irrigation use, groundwater is the only source

for domestic use in Krishnagiri and Vellore districts of Tamil Nadu in the vicinity of Ponnaiyar (Nedungal) - Palar link Project. Also, the groundwater assessment made by Central Ground Water Board (CGWB) indicates that the groundwater usage increased above 100% in Krishnagiri and Vellore districts and to an extent between 142% and 201% in all the blocks lying especially in Vaniyambadi taluka of Vellore district. The same have been categorized as over-exploited for future groundwater development. Groundwater exploitation is almost twice the annual replenishable groundwater. Also, it has been observed that during monsoon periods, the Ponnaiyar river is in spate while the Palar river remains dry.

In light of the above scenario and due to non-availability of canal irrigation facilities in the existing command area in the vicinity of the proposed project, where the farmers mainly depend on rainfall and groundwater for irrigation and domestic uses, the Ponnaiyar (Nedungal) - Palar Link Project is planned on priority to recharge the groundwater. Total length of the link canal is about 54.150 km and traverses through Krishnagiri and Vellore districts of Tamil Nadu. The link canal will finally outfall into Godd Ar with an FSL of 419.676 m near village Makhanpur in Natrampalli Taluka of Vellore district. The stream Godd Ar joins Kal Ar, a major tributary of Palar River, after traversing a distance of 7.400 km from canal outfall. The Kal Ar runs for a distance of about 8.600 km further and confluences with the river Palar. Thus, the Godd Ar and Kal Ar will form part of the link canal and lead the diverted water into Palar river for use in water deficit existing command area of 7950 ha, presently being irrigated under tanks, tube wells/bore wells and open wells/dug wells in Vaniyambadi taluka of Vellore district by diverting the flood water spilling down the existing Krishnagiri dam. Further, the existing enroute command area to an extent of 1900 ha identified under the link project which lies in Krishnagiri and Pochampalli talukas of Krishnagiri district and Tirupattur taluka of Vellore district will be stabilised by feeding the enroute existing system tanks (Eris), besides 3.882 $Mm^3$ of drinking water supply to enroute villages for about 1.52 lakh rural human population.

This Link Project brings economic prosperity to the acute water short drought-prone command area lying in the vicinity, since the existing command area gets stabilised due to additional water to be made available through this project. Hence the Project is fully justified.

## 3.0 Methodology Adopted

The Pre-feasibility Report of Ponnaiyar (Krishnagiri) - Palar Link Project prepared by NWDA in March, 2011, formed the basis for proceeding further for preparation of DPR,

based on detailed Survey & Investigations, updated hydrological studies, irrigation planning and command area development, designs of structures and other related studies. DPR of this project has been prepared by NWDA involving various Government Departments/ Organisations viz., CSMRS-New Delhi, GSI-Chennai and NGRI-Hyderabad. Detailed topographical surveys of the link canal alignment, CD/CM structures, River surveys and survey for connection of GTS BMs and establishing Permanent Bench Marks etc, and studies like Hydrological and Water Availability Study, Irrigation Planning and Command Area Development (CAD), Design Aspects and Detailed Estimates including Construction Programme - Management and Plant Planning etc. have been carried out Departmentally. The field investigation works viz., Construction Materials Investigations, Geological Investigations, Geotechnical Investigations inclusive of Borrow areas, Geophysical Investigations have been carried out by various Government Organisations viz., CSMRS, GSI and NGRI. The Comprehensive Environmental Impact Assessment (CEIA) and Socio-economic studies will be taken up later separately after obtaining the necessary approval from State Environmental Impact Assessment Authorities (SEIAA), Govt. of Tamil Nadu which is presently under process.

### 3.1 Data Collection

The data required for preparation of DPR of Ponnaiyar (Nedungal) - Palar link canal project have been collected from various Government Departments / Organisation of Karnataka, Tamil Nadu and Andhra Pradesh States viz., Department of Economic and Statistics; PWD, WRO, Govt. of Tamil Nadu; Census of India-2011; Departments of Agriculture, Govt. of Karnataka, Tamil Nadu and Andhra Pradesh; IMD Pune; Hydrological Atlas of Tamil Nadu prepared by CGWB etc. Also the data / information required has been collected during the course of field Surveys & Investigations.

### 3.2 Surveys and Investigations Carried out Departmentally

On receipt of consent from Government of Tamil Nadu, the work for preparation of Detailed Project Report of Ponnaiyar (Nedungal) - Palar Link Project has been taken up by National Water Development Agency during September, 2012.

The Survey & Investigation works and preparation of Detailed Project Report of Ponnaiyar (Nedungal) - Palar Link Project was taken up by Investigation Division, National Water Development Agency, Bengaluru under the administrative control of the Superintending Engineer, Investigation Circle, National Water Development Agency,

Hyderabad under the jurisdiction of the Chief Engineer (South), National Water Development Agency, Hyderabad.

NWDA has adopted two pronged strategy for preparation of DPR of Ponnaiyar (Nedungal) - Palar Link Project. All detailed field surveys & investigations for which in-house facilities are available have been carried out by NWDA departmentally. Other specialized Survey & Investigations were outsourced on consultancy services as per the MoUs with other Govt. departments/specialized concerned reputed agencies.

The following field Survey & Investigations were carried out by NWDA, departmentally.

### 3.2.1 Survey for Transferring the GTS Bench Mark

The GTS Bench Mark which is a primary protected Bench marks of Geodetic & Research Centre of Survey of India (SOI) located at Permanent Way Inspector (PWI) Office at Tirupattur Railway Station in Vellore district has been connected to the Permanent Bench Mark (PBM) and Bench Mark levels at various locations in the vicinity of the proposed project by conducting Double Tertiary Leveling (DTL) over a length of about 75 km. Adequate number of PBMs and TBMs as per the specified guidelines have been established along the link canal and at various locations in the vicinity of the project area.

### 3.2.2 River Surveys

#### (i) Ponnaiyar River

River survey was carried out along the fair weather deep channel of the Ponnaiyar river at the existing Nedungal Anicut/Weir, from where the proposed link canal off-takes. The L-section along the river has been surveyed for 1.050 km u/s upto MWL+3m and 0.500 km d/s of the Anicut, with levels at 50 m interval. Cross-sectional survey was conducted by Single Tertiary Leveling for the reach of the river at 50 m interval upto the length of L-section carried out. Each cross-section has been extended upto 2.40 km (i.e MWL + 3m) covering the area beyond the firm bank with levels at 50 m grid basis. In addition, five more cross-sections were taken along the Axis of the Anicut, Toe and Heel of the dam including two cross-sections at 10 m away from Toe and Heel of the Anicut.

#### (ii) Godd-Ar and Kal Ar (A Tributary of Palar River)

The L-section along Godd Ar for a length of 7.400 km and along Kal Ar for a length of 8.600 km upto the confluence with Palar river was carried out by Double Tertiary Leveling

(DTL) at 50m interval. 35 cross-sections of 500 m length of each at 50 m interval were taken along the above rivers at 500 m interval by Single Tertiary Leveling (STL).

Based on the L-Sections and average cross-sectional areas of the Godd Ar and Kal Ar, the average carrying capacity is computed as 60 cumec and 87 cumec respectively.

### 3.2.3 Canal and Water conductor System

The Canal alignment has been fixed for a length of 54.150 km, duly taking into account the actual site conditions and minimal deep cutting for its optimization, by Double Tertiary Leveling (DTL) with levels at 50 m interval. Cross-sections of the link canal were taken at 50 m interval by Single Tertiary Leveling (STL) upto RD 41.700 km and 250 m interval upto outfall point at RD. 54.150 km. Cross section levels were taken at every 50 m upto 150 m on either side of the canal alignment. R.C.C pillars of size 0.15 x 0.15 x 0.75 m along the main canal alignment were fixed at 200 m interval. R.C.C TBMs of size 0.40 x 0.40 x 1.10 m were also erected at every 2 km along the canal including at Turning Points (TPs) and CD/CM crossings. All the above Pillars were painted red and chainage with project name written with white paint.

### 3.2.4 Grid Surveys of Canal Structures

The link canal on its way crosses a total 61 Nos. of small rivers, streams/ rivulets/Nallas, State/district/village Roads. In addition, one Head regulator at off take and one outfall structure at outfall point of the link canal is also proposed. Out of the above structures Grid surveys have been carried out for 8 Nos. of identified typical representative major CD/CM structures.

## 3.3 Specialised Survey & Investigations carried out by Consultants

The following special Surveys & Investigations for the project have been completed by outside agencies on consultancy services:

### 3.3.1 Archaeological Survey along the Link Canal Alignment

Archaeological field explorations have been carried out for the entire link canal project by the Archaeological Survey of India (ASI), Chennai during August, 2014 and declared that no Archeological remains were identified.

The State Department of Archeology, Chennai, Govt. of Tamil Nadu also communicated during July, 2014 that no sites/temples/monuments or any remains of archaeological, historical and cultural importance are hindrance to the Proposed Project.

### 3.3.2 Mineral Surveys along the Canal Alignment

The engineering Geology Division, Geological Survey of India (GSI), Chennai communicated that no major deposits of economic importance gets affected or falling within the proposed project area.

### 3.3.3 Geological Investigations

Geological Survey of India (GSI), Chennai carried out the Geological and Geo-technical investigations of the proposed link project. Geological mapping and Geotechnical investigations along the link canal and identification of bore-hole points for carrying out sub-surface explorations by drilling have been completed. Geotechnical assessment and logging rock cores recovered from of 15 Nos. of borehole drilled was carried out to interpret the nature of overburden and bed rock, to infer the fresh rock depth and to assess the rock mass characteristics. GSI submitted the lithology of the exploratory bore holes drilled along the link canal in Krishnagiri and Vellore districts of Tamil Nadu.

### 3.3.4 Geo-physical Investigations

Geo-physical Investigations have been carried out by the NGRI-National Geo-physical Research Institute (Council of Scientific & Industrial Research), Hyderabad during December, 2014, using the latest technology 'Electrical Resistivity Tomography (ERT) imaging'.

NGRI conducted the investigations all along the link canal of 54.150 km length at 500 m interval and at 8 Nos. of identified major CD/CM structures. A report with details of Geo-physical investigations showing different sub-surface conditions/features encountered was prepared by NGRI.

### 3.3.5 Construction Materials Investigation

The CSMRS, New Delhi carried out the field investigations in respect of Coarse and Fine aggregates in the vicinity of the project area and carried out Laboratory investigations for assessing their suitability to use in concrete during construction of the project.

#### (i) Rock and Coarse Aggregates

Out of the Rock Quarry Sites inspected and identified by CSMRS Team, Rock samples were collected from two Rock Quarries i.e., Sulamalai village rock quarry near Anchur in Krishnagiri district (RQS) and Gundalaguttai village rock quarry near Bargur in Krishnagiri district (RQG). Based on various physical tests including Petrographic examinations on the representative samples from the above quarry sites CSMRS reported that the coarse

aggregates from the above two quarry sites are suitable for concrete in project construction works.

**(ii) Sand**

CSMRS after detailed laboratory testing reported that the natural sand from the Palar river near Madanur village in Vellore district and the crushed sand from Sulamalai village rock quarry are suitable for use as fine aggregate in concrete for the proposed project.

### 3.3.6 Soil Surveys Including Borrow area Surveys

CSMRS Team completed the field investigations and collected the representative samples along the alignment and from Borrow areas during October, 2014. The undisturbed soil samples in Shelby tubes and SPT samples were also collected during sub-surface exploratory drilling works in February, 2015. CSMRS prepared and submitted the report incorporating laboratory test results of all the samples collected.

### 3.3.7 Sub-Surface Explorations/Drilling Works

The sub-surface explorations as identified/recommended by GSI, Chennai along the link canal and at the selected proposed CD/CM Structures have been completed at 15 Nos. of boreholes by diamond drilling by a private Agency. The Geological Survey of India, Chennai consequently logged and assessed the above rock cores retrieved from 15 Nos. of boreholes for Laboratory testing. The drilling works were completed in February, 2015.

### 3.3.8 Geo-technical Investigations

The representative rock core samples have been selected by CSMRS and the test report of rock core samples has been prepared.

### 3.3.9 Comprehensive Environmental impact Assessment (EIA) and Environmental Management Plan (EMP) Including Socio-economic Survey and R-R Plan.

These studies will be taken up later by the specialists on consultancy services separately. The ToRs for carrying out EIA studies have been submitted to the State Environmental Impact Assessment Authority (SEIAA), Govt. of Tamil Nadu for approval. Using these ToRs, EIA studies will be carried out through a reputed agency.

## 4.0 Climate

The climate of the proposed Command area under the link canal which comprises areas in Krishnagiri and Vellore districts is characterized as following:

The annual normal rainfall of Krishnagiri area is 802 mm and during monsoon it is about 637 mm. The average monthly maximum and minimum rainfall of Krishnagiri station is 183 mm and 29 mm during September and December respectively. The climate of Krishnagiri district is comparatively more pleasant than that of the surrounding districts. Summer season prevails in April and May months and January to March, it is dry season. The maximum temperature during summer season is about $37^0$C and the minimum temperature is about $17.2^0$ C. Maximum relative humidity of about 78% occurs during November and December months where as the minimum of about 31% during March and April months.

The annual normal rainfall of Vellore district is about 1023 mm and during monsoon it is about 893 mm. The mean annual rainfall of Vaniyambadi station is about 800 mm, of which monsoon rainfall is about 668 mm. Monthly maximum and minimum rainfall is 157 mm and 33 mm during September and December respectively. Mean annual rainfall of Tirupattur is about 878 mm, of which 724 mm is during monsoon. Vellore district has a tropical climate. The highest temperature is recorded during May and June. Vaniyambadi is hot in summer with highest day temperature in the range of $31^0$C to $41^0$C. The relative humidity ranges from 37% to 86% in Vellore district.

The monthly mean potential evapo-transpiration ($ET_O$) in the command area varies from 18.4 cm to 9.98 cm and the average annual potential evapotranspiration is about 168.60 cm.

## 5.0 Topography, Physiography and Geology

The Link Canal passes through Krishnagiri and Vellore districts for a total length of 54.150 km. The project area is dominated by isolated hilltops and hillocks and continuous hill ranges in small stretches with bushes at some places. The proposed canal alignment mostly passes through undulating plains with mango and coconut plantation. Recent Alluvium, weathered and fractured gneissic rocks, granite and charnockites are the predominant geological formations in the vicinity of the project area in Krishnagiri and Vellore districts. The rock types of charnockites, granite gneiss/grey migmatite, pink migmatite, epidote hornblende gneiss, Pyroxenites, quartz veins and Pegmatite are observed along the proposed Ponnaiyar (Nedungal) - Palar Link canal alignment.

The Ponnaiyar and Palar are two major rivers draining in the vicinity of the Project area. The entire command area under the link canal is drained by major tributaries like

Bargur Ar and Mattur Ar and many other streams/rivulets and Nallas of Ponnaiyar river. The project area is densely covered with tanks (Eris)/dug wells/bore-wells and check dams constructed on natural streams. At tail end command in Vaniyambadi, the Palar with major tributaries viz., Godd Ar/ Kal Ar, Cheyyar forms main natural drainage. All these streams in the command are ephemeral in nature and structurally controlled. The river Palar is dry for major part of the year leading to critical drought-prone condition.

## 6.0 Population

The command area spreads over two talukas of Krishnagiri district and two talukas in Vellore district with maximum area lying in Vaniyambadi taluka of Vellore district itself. The population is predominantly rural as per the 2011 census.

According to 2011 census Krishnagiri district had a population of 1879809, out of which 960232 (51.08%) were male and 919577 (48.92%) were female. A total of 217323 were under the age of six, constituting 112832 males and 104491 females. Scheduled castes and scheduled tribes accounted for 14.22% and 1.19% of the population respectively. The district had a total of 448053 households.

According to 2011 census, Vellore district had a population of 3936331 out of which 1961688 (49.84%) were male and 1974643 (50.16%) were female. A total of 432550 were under the age of six, constituting 222460 males and 210090 females. Scheduled castes and scheduled tribes accounted for 21.85 % and 1.85% of the population respectively. The district had a total of 929281, households.

## 7.0 Seismic Study

No new dams/reservoirs are proposed in the present study, since the existing Krishnagiri dam ad Nedungal Anicut are planned as Head works of the link project. Therefore, seismic studies are not conducted in this study. However, the Krishnagiri dam and reservoir falls under seismic Zone - II.

## 8.0 Hydrology and Water Assessment

As per the hydrological studies of Ponnaiyar basin upto Krishnagiri dam site (C.A 5428 $km^2$), the gross annual yield at 75% and 50% dependability has been assessed as 200 $Mm^3$ and 315 $Mm^3$. The annual water balance at Krishnagiri dam site after considering the import as regeneration from Cauvery basin to a tune of 293 $Mm^3$ (i.e., regeneration from Bengaluru water supply in Ponnaiyar basin) and after accounting for all in-basin needs has been assessed as surplus by 156 $Mm^3$ at 75% dependability and 271 $Mm^3$ at 50%

dependability. Accordingly, the 75% dependable annual yield at Tirukoilur Anicut (C.A : 12318 $Km^2$) from intercepting catchment of 6890 $km^2$ below Krishnagiri dam is worked out on prorata basis as 254 $Mm^3$. The surplus water balance at Krishnagiri dam (156 $Mm^3$) together with the above yield (254 $Mm^3$) available at Tirukoilur Anicut contributing from the intercepting catchment, totaling to an extent of 410 $Mm^3$ will cater to the needs of d/s of Krishnagiri dam. However, keeping in view the committed water utilizations from the existing projects, it is proposed to divert the flood flows during monsoon period.

From the observed spill discharge data at Krishnagiri dam site during monsoon period (June to December) for the period from 1958-59 to 2009-10, the quantum of average spills has been assessed to be as 157 $Mm^3$. Out of 157 $Mm^3$, it is proposed to regulate 86 $Mm^3$ of flood waters spilling down the Krishnagiri dam to the proposed Ponnaiyar (Nedungal) - Palar link canal through Nedungal anicut to feed enroute system tanks for irrigation and recharging the groundwater potential enroute the link canal and in Palar basin for stabilizing the existing ayacut presently being irrigated under open wells/bore wells thereby benefitting the total area of 9850 ha annually, besides, providing drinking water supply to the enroute villages.

## 9.0 Flood Control and Drainage

### (i) Flood Control

Studies for probable maximum floods for the existing Krishnagiri dam were already carried out and the design flood considered was 4234 cumec and accordingly the dam was designed and constructed during 1955-56. The spillway discharge capacity is 4061 cumec with 8 vents of 12.19 m x 6.10 m with its crest level at 477.01 m.

While the crest level of the spillway is at 477.01 m and FRL is at 483.11 m, the flood absorption upto a reservoir level of 481.56 m (1580') is created. As soon as the reservoir level reaches 1.55 m below FRL the state of extraordinary emergency of flood situation shall be declared by the Krishnagiri dam controlling officer. However storage of water in Krishnagiri reservoir and its regulated releases in d/s to the existing Barur supply channel and the proposed Ponnaiyar (Nedungal) – Palar Link Canal which off-takes from the Nedungal Anicut (16 km d/s of dam) will provide incidental benefits of flood moderation in downstream areas.

### (ii) Drainage

The entire command area is well drained by major tributaries like Bargur and Mattur and many streams and Nallas of Ponnaiyar river. It is observed that the proposed link canal crosses many streams enroute. The entire enroute command area in Krishnagiri and Vellore districts is covered densely with tanks (Eris)/Check dams constructed on natural streams, being maintained by PWD, Govt. of Tamil Nadu. At tail-end command in Vaniyambadi the Palar and its major tributaries viz., Godd Ar/Kal Ar, Cheyyar are main source of natural drainage. Most of the above streams in the command area are ephemeral in nature and are structurally controlled. The river Palar is dry for major part of the year. Hence, the natural drainage system in the proposed command area is more than adequate.

## 10.0 Reservoir

The existing Anicut at Nedungal has been proposed to be utilized for diversion of water from Ponnaiyar river to Kal Ar. The off-take regulator is proposed to be located by the side of the off take of Barur canal. 86 $Mm^3$ flood waters spills down the dam are proposed to be regulated to the link canal of the Ponnaiyar river at existing Krishnagiri reservoir through existing Nedungal Anicut.

The MWL of Krishnagiri reservoir is 484.63 m. Its FRL is 483.11 m with a corresponding storage of 68.20 $Mm^3$. The crest level of Spill way is 477.01 m.

## 11.0 Irrigation Planning and Command Area

The proposed Ponnaiyar (Nedungal) - Palar link canal envisage diversion of flood water for recharging the groundwater in the vicinity of the project area. Presently, the groundwater is over-exploited by 142% to 201% and therefore, the link canal is proposed to stabilize the existing ayacut by recharging the groundwater.

Out of 86 $Mm^3$ water proposed to be diverted, 75.141 $Mm^3$ will be utilised for stabilizing the existing irrigation of 9850 ha at 100% intensity, 3.882 $Mm^3$ for domestic water supply to the villages / areas enroute the link canal and remaining 6.977 $Mm^3$ towards transmission losses.

The details of taluka wise command area to be benefitted under the link canal are furnished in **Table - 1**:

**Table - 1**

**Benefits from the Proposed Link Project**

| Sl. No. | Particulars | Annual Irrigation (ha) | Annual utilisation ($Mm^3$) |
|---|---|---|---|
| **I** | **Irrigation Benefits** | | |
| **(a)** | **Enroute the Link Canal** | | |
| | **Krishnagiri District** | | |
| 1. | Krishnagiri<br>(Releases in to Bargur River) | 943 | 8.545 |
| 2. | Pochampalli taluka | 313 | 2.835 |
| | **Sub-total** | **1256** | **11.380** |
| | **Vellore District** | | |
| 1. | Tirupattur | 644 | 5.835 |
| | **Total** | **1900** | **17.215** |
| **(b)** | **Vellore district in Palar basin (Releases from canal out-fall)** | | |
| 1. | Vaniyambadi taluka | 7950 | 57.926 |
| | **Grand Total** | **9850** | **75.141** |
| **II** | **Drinking Water Supply**<br>(For enroute villages human population of 1.52 lakh @ 70 lit/capita/day) | | 3.882 |
| **III** | **Transmission Losses** | | 6.977 |
| | **Total diversion** | | **86.000** |

The proposed cropping pattern enroute the link canal and in Vaniyambadi taluka (tail-end command) is furnished in **Table - 2**:

**Table - 2**

**Proposed Cropping Pattern under the Link Canal**

| Sl. No. | Name of crop | Enroute | | Tail-end (Vaniyambadi taluka) | |
|---|---|---|---|---|---|
| | | % of CCA | Area (ha) | % of CCA | Area (ha) |
| | **Kharif** | | | | |
| 1. | Paddy | 35 | 665 | 35 | 2783 |
| 2. | Ragi/Jowar/Bajra | 6 | 114 | 6 | 477 |
| 3. | Groundnut | 8 | 152 | 8 | 636 |
| 4. | Cotton | 7 | 133 | 7 | 557 |
| 5. | Pulses | 6 | 114 | 6 | 477 |
| 6. | Maize | 2 | 38 | 2 | 159 |
| | | | | | |
| | **Rabi** | | | | |
| 7. | Paddy | 15 | 285 | 15 | 1190 |
| 8. | Ragi/Maize/Bajra | 5 | 95 | 5 | 398 |
| 9. | Groundnut | 1 | 19 | 1 | 80 |
| 10. | Pulses | 8 | 152 | 8 | 636 |
| | **Perennial** | | | | |
| 11. | Sugarcane | 7 | 133 | 7 | 557 |
| | **Total** | **100** | **1900** | **100** | **7950** |

As shown above, it is proposed to stabilise the existing command area of 1900 ha enroute the link canal by tank irrigation and 7950 ha in Vaniyambadi taluka of Vellore district under Palar basin by Ground water recharge.

The cropping Pattern adopted as above has been got authenticated by the Joint Director of Agriculture, Department of Agriculture, Vellore, Tamil Nadu vide letter No. E2/10557/14 dated 11.12.2014.

## 12.0 Design Aspects

The existing Krishnagiri dam on Ponnaiyar river and the existing Nedungal Anicut located 16 km d/s of the above dam are planned as water regulating structure as well as water pick up weir for diversion of water to the proposed link canal. One Head Regulator is

proposed at canal off-take about 60 m u/s of the Nedungal Anicut to regulate flows in to the Link canal.

The length of the link canal is 54.150 km with its design discharge as 68 cumec (uniform) for the entire length of the canal. The canal has been designed as a gravity canal with uniform section having bed width of 25.0 m and full supply depth of 2.45 m and bed slope 1:4500. The canal is proposed as a unlined, trapezoidal cross-section and side slopes of 1.5 : 1. A free board of 0.75 m is provided.

The canal head regulator is proposed at a distance of about 60 m u/s of the existing Barur feeder channel on the left flank of the Ponnaiyar river. The head regulator is designed with its length as 21.50 m having 5 Nos. of vents of size 3.30 x 2.00 m with fixed wheel type-vertical lift service gates. The sill level of the regulator is proposed at 433.00 m where as the pond level is considered at 435.01 m taking into account 0.30 m as normal flood level over the crest available for operating the canal during flood periods, to divert surplus spillover discharges from Krishnagiri dam. Outfall regulator coupled with single lane bridge is proposed at outfall point (RD 53.584 km) of the link canal.

A number of CD/CM structures are proposed along the canal from its off-take point to its outfall point to cross several streams/rivulets/Nallas, existing feeder channels which connect the system tanks to the fields and other roads. Altogether, as many as 62 Nos. of structures comprising 1 Head regulator; 2 cross regulators; Aqueducts and Canal Syphons of 6 Nos. each; 2 Super passages; 16 Single Lane Road Bridges and 18 Double Lane Road Bridges. Outlets and Under tunnels of 5 Nos. each and 1 elevated pipe/trough are proposed. One canal Escape is proposed along with Cross Regulator at R.D 29.550 km. Five more outlets are also coupled along with the above structures to release water to the streams enroute to cater the system tanks lying on the right side of the link canal. Typical designs of the above proposed structures were carried out by NWDA.

## 13.0 Construction Materials

The requirement of construction materials of coarse aggregates and fine aggregate (Sand) for the project can be met from nearby identified quarry sites. The quality of the materials available in these quarries have been tested by CSMRS, New Delhi and found suitable for usage in Project construction works. Further, the requirement of construction materials like cement and steel etc. can be obtained directly from the companies/factories

located in the vicinity of the Project in Krishnagiri and Vellore districts either by rail head or road head.

## 14.0 Accessibility and Infra-structure

The Project area lies in Krishnagiri and Vellore districts and is well connected by National Highways/major roads and railway network. Bengaluru city is the nearest Airport (Kempegowda International Airport) to the link Project at a distance of about 100 km. Jolarpet Railway Junction is the nearest Railway station to the link canal outfall located at Natrampalli village at a distance of about 5 km. The connectivity of Railways is as following:

1. Salem - Bengaluru : Main line (Southern Railway)
2. Salem - Chennai : Main line (Southern Railway)
3. Hyderabad - Chennai : Main line (Southern Railway)

The main components of the Project i.e., Krishnagiri dam, Nedungal Anicut and the link canal are very near to the Krishnagiri district Headquarters at a distance of about 7 to 14 km.

Krishnagiri is connected by Prime Minister's Golden Quadrilateral Project executed by National Highways Authority of India (NHAI). The connectivity of Highways passing through Krishnagiri and Vellore districts is as following:

1. Kanniayakumari - Varanasi : NH - 7
2. Bengaluru - Chennai : NH - 46
3. Bengaluru - Puducherry : NH - 66

The entire project area is well connected by a developed road network and almost all the towns and villages are linked by District Highways. They are 100% electrified and connected by telephone lines/towers.

As such, no difficulty is anticipated during construction period of the project for transition of construction materials and movement of heavy machinery/construction equipment.

Various infrastructural facilities like offices, residences, stores, hospitals etc., will be provided near the project site to ensure smooth implementation, operation and maintenance of the Project.

## 15.0 Construction and Equipment Planning

The schedule of construction of the link Project is planned for a period of 4 years.

The infra-structural development, pre-construction surveys and investigations, preparation of design/ specifications and tender documents are proposed to be taken up during the 1st year and completed in the III quarter of the 1st year. In case the works are to be executed through award of contract, it is planned to award contracts for all major works by the IV quarter of 1st year. The area through which the link canal passes have good network of roads and communications system. Thus, the work on infrastructure facilities like temporary colonies, approach roads, workshop, haul roads, stores, office buildings etc. will be started during IV quarter of 1st year and completed in the I quarter of 2nd year itself. The excavation of canal in soft soil starts during the II quarter of 2nd year and is proposed to be completed by III quarter of 3rd year. The excavation of canal in murum and weathered rock starts during the III quarter of 2nd year and is proposed to be completed in III quarter of 4th year. The excavation of canal for hard rock starts during the III quarter of 2nd year and is proposed to be completed within IV quarter of 4th year. The construction of embankment portion of canal starts during the IV quarter of 2nd year and is proposed to be completed in IV quarter of 4th year.

The construction of cross masonry works shall commence during the III quarter of 2nd year and will be completed in I quarter of year 4th year. The construction of cross drainage works shall commence during the IV quarter of 3rd year and will be completed within IV quarter of year 4th year. Remoulding of Kal Ar to pass desired discharge will be carried out during IV quarter of 3rd year and completed by II quarter of 4th year.

The requirement of major construction Plant and Equipments is planned as given in **Table – 3**:

**Table – 3**

**List of Major Construction Plant and Equipments**

| Sl.No. | Description | Size/ capacity | Total |
|---|---|---|---|
| 1 | Hydraulic excavator | 2.0 $m^3$ | 28 |
| 2 | Excavator cum loader (Shoval) | 1.0 $m^3$ | 39 |
| 3 | Crawler/wagon drill | 600 | 4 |
| 4 | Jack hammer | 120 | 15 |
| 5 | Front end loader | 1.5 $m^3$ | 15 |
| 6 | Rear end dumper | 18/20t | 89 |
| 7 | Angle dozer | 90 HP | 15 |
| 8 | Vibratory compactor (pad foot) | 10t | 16 |

| Sl.No. | Description | Size/ capacity | Total |
|---|---|---|---|
| 9 | Water sprinklers | 8000 L | 44 |
| 10 | Air compressor | cfm | 14 |
| 11 | Truck | 8/10 ton | 72 |
| 12 | Water pumps | - | 20 |

Suitable provision for the above construction equipment has been kept in the estimate.

## 16.0 Environmental and Ecological Aspects of the Project

The detailed study on Environment Impact Assessment (EIA) and Environment Management Plan (EMP) including Socio-economic studies of the project will be assigned to the reputed consultancy agency by the project proponent to identify the positive and adverse environmental impacts due to the proposed link canal Project and to suggest measures to mitigate the anticipated adverse impacts on the environment, if any, together with Environment Management Plan (EMP) and Environment Monitoring Plan.

The ToRs for the EIA studies have already been submitted to SEIAA, Govt. of Tamil Nadu for which approval has been obtained.

The baseline environmental parameters viz., Air/noise environment, climate, surface and groundwater quality, land environment consists of land use/ mineral deposits/Archaeological monuments, geology and soils, public health, drinking water supply, diseases and nutrition, aquatic, terrestrial ecology, socio-economic impact etc., and likely impacts due to the project during construction and operational phases have been discussed briefly, with likely positive and adverse impacts during construction and post construction phases. Also aspects on environment management plan (EMP) have been discussed briefly. However, detailed studies will be taken up by the project proponent separately at a later date.

## 17.0 Socio-Economic Aspects and R&R Plan

No major adverse impacts are anticipated due to the link Project on Socio-economic point of view. In fact, positive impacts due to provision of assured water supply for irrigation to the fields will increase the production of crops which in turn will improve the social setup of farmers/cultivators etc, Socio-economic condition of the people living in command area as well as in the vicinity of the Project will improve in general. The district-wise details on socio-economic attributes based on secondary data are furnished in Table - 4:

**Table - 4**
**District-Wise Details on Socio-Economic Attributes Based on Secondary Data**

| Sl. No. | Item | Krishnagiri District | Vellore District |
|---|---|---|---|
| 1. | Total population | 1879809 | 3936331 |
| | Male | 960232 | 1961688 |
| | Female | 919577 | 1974643 |
| | Children upto 6 years | 217323 | 432550 |
| 2. | Population Density per sq km | 366 | 650 |
| 3. | Sex ratio(females : males) | 958:1000 | 1007:1000 |
| 4. | Literacy rate | | |
| | Male | 78.72% | 86.50% |
| | Female | 63.91% | 71.95% |
| 5. | Total Livestock population | 802352 | 542841 |
| 6. | Land holdings | Maximum Number of holdings belongs to marginal farmers owning land less than 0.50 ha | |
| 7. | Total households | 448053 | 929281 |
| 8. | Occupational distribution | | |
| | Agricultural labourers | 263328 | 391955 |
| 9. | Cultivators | 236038 | 175108 |
| 10. | Household workers | 21918 | 136415 |
| | Other workers | 356495 | 985852 |
| 11. | Sources of income | | |
| | Agricultural based activities | 100% | 100% |
| | Selling of Minor forest produce | - | - |
| 12. | Land acquisition | | |
| | i) Submergence area | - | - |
| | ii) Along link canal | 591 ha | |
| | iii) Barrow area | 149 ha | |
| | **Total** | **740 ha** | |

**Resettlement and Rehabilitation plan**

**(i) Land Acquisition**

Compensation on land acquisition for about 740 ha of land (591 ha for canal and 149 ha for borrow area) is to be acquired for construction of the link canal for which a suitable compensation needs to be provided to the owners of the land.

According to LARR bill minimum amount of compensation is to be multiple of total of ascertained market value plus a solatium. Specifically, the current version of the bill

proposes the total minimum compensation to be at least four times the market value for the land acquired in rural areas.

A total provision of Rs.227.52 crores has been kept in the cost estimate under the component B - Land towards acquisition of land.

**(ii) Rehabilitation**

No submergence area is involved as the existing Dam and Anicut are proposed to be utilised as diversion works. The link canal passes through rural areas without affecting the household/residential area and hence no person is affected. Therefore, no Resettlement and Rehabilitation (R & R) Plan is involved.

However, a lumpsum provision of Rs.50 lakhs has been kept towards economic rehabilitation measures in 'Unit – II: Canal System' under B - Land.

**(iii) Compensation to Properties**

No major properties will be under loss due to the proposed link canal. However, a lump sum provision of Rs.1 crore has been kept in the estimate under Unit – II: Canal System, B - Land for compensation of other properties, if any.

**18.0 Cost Estimates**

The estimate for the Project has been prepared based on the 'Guide lines for preparation of Detailed Project Report of Irrigation and Multi-Purpose Projects - 2010', Govt. of India, Ministry of Water Resources. The estimate has been framed at 2017-18 price-level using SOR of Govt. of Tamil Nadu. Wherever the SOR of Govt. Tamil Nadu are not available the SOR of Govt. of Karnataka have been considered. The cost of the project is estimated under three units.

**Unit – I: Cost of Head works:**

The proposed Head Regulator at canal off-take is considered under this head of account. The existing Nedungal Anicut is planned as main Head works for diversion of water to the Link canal. The cost under this head has been estimated as Rs.3.75 crores.

**Unit – II: Cost of Conveyance System:**

The cost of 54.150 km long link canal including cost of all CD/CM Structures, Regulators, Canal-escape and outlets etc. has been worked out and estimated as Rs.627.48 crores.

**Unit – III: Cost of Command Area Development**

The cost of infrastructures for digging new bore wells for recharging groundwater in the command area has been worked out and estimated as Rs.17.00 crores.

Thus, the total cost of the Project has been estimated as Rs.648.23 crores.

## 19.0 Economic and Financial Evaluation

The results of economic analysis are furnished in **Table - 5**:

**Table – 5**

**Results of Economic Analysis**

| Sl. No. | Description | Rs. lakh |
|---|---|---|
| 1. | Net return from agriculture/produce<br>-Pre project<br>-Post Project | <br>14125.50<br>28125.71 |
| | Total net benefit | 14000.21 |
| 2 | Annual cost like interest on capital depreciation, charges of operation and maintenance (O&M) for command area and Head works etc., | 7810.00 |
| 3 | Benefit - Cost Ratio (B.C.R) | 1.79 |
| 4 | Internal Rate of Return (IRR) | 13.32 % |

## 20.0 Clearances Required

Ponnaiyar (Nedungal) – Palar link Project requires the following clearances from the Agencies as indicated in **Table - 6**:

**Table - 6**

**Clearances Required from Other Departments/Agencies**

| Sl. No. | Clearance | Departments/Agencies |
|---|---|---|
| (i) | Techno-economic | Central Water Commission/TAC, MoWR, RD & GR, Govt. of India |
| (ii) | Environmental | State Level Environment Impact Assessment Authority (SEIAA), Govt. of Tamil Nadu |