CHAPTER 1

INTRODUCTION

1.1 Aim of the Project and Description of Works

The Lower Penganga project is a joint project between the states of **Maharashtra and Andhra Pradesh** on Penganga river. An understanding was reached between the states of Maharashtra and Andhra Pradesh on 6th October 1975 to take up Lower Penganga Project as an inter-state joint project. As per the agreement dated 7-8-1978 reached between the states of Maharashtra and Andhra Pradesh, the state of Maharashtra can use all the waters of Penganga river up to Lower Penganga project site near ChikalWardha village subject to the condition that the Lower Penganga Project is taken up as a joint project. Joint meetings were held during 1978-84 to clear techno-economical issues and sharing of costs of common portion of works. Maharashtra Government prepared a Detailed Project Report for the joint project and submitted the same to Central Water Commission for clearance. The net annual 75% dependable flows at Lower Penganga dam are assessed as 42.67 TMC to be shared in the ratio of 88:12 between Maharashtra and Andhra Pradesh, which implies that the share of Maharashtra is 37.55 TMC and that of Andhra Pradesh is 5.12 TMC. The Andhra Pradesh share of water is proposed to be utilised for irrigation purpose in the backward tribal areas of Adilabad district. As per the DPR prepared by Maharashtra Government for the joint project, the project creates an irrigation potential of 199962 Ha in Maharashtra and 29757 Ha in Adilabad district of Andhra Pradesh.

Maharashtra Government submitted the Detailed Project Report for the joint project i**ncluding the portion of Andhra Pradesh** to Central Water Commission for clearance.

This Detailed Project Report pertains to the Andhra Pradesh portion of the joint project from the Andhra Pradesh link canal offtaking at 11.91 km of Left Bank Canal of Lower Penganga Project . The report is prepared based on reliable data, adequate investigations and after comprehensive studies on various techno-economic aspects as per the latest guidelines of Central Water

Commission for the preparation of Detailed Project Reports of Irrigation and Multipurpose Projects, 2010;.

1.1.1 Description of works

The Lower Penganga Project envisages construction of a dam across Penganga river with central gated concrete spillway from RD 870 to RD 1245 m with 25 nos of radial gates of size 12 m X 8 m and earth dam on both flanks of concrete dam across Penganga river and canals on left and right flanks. The total length of dam including spillway is 1988m.

The total catchment area up to the dam site is 17983 km ^{2}. The gross storage of the reservoir is 1045.37 Mcum at FRL of +261.5 m. The water spread area at FRL is about 162 km$^{2.}$

As per the DPR prepared by Maharashtra Government for the joint project, the project will irrigate 175760 Ha (CCA) of land as detailed below.

Description	GCA (ha)	CCA (ha)	ICA (ha)	Total (ha)
By gravity canal				
RBC upto 72km	56449	55159	41095	74546
LBC upto 96km	19531	15625	14219	
A.P upto 54km*	24700	21017	19233	
(* *The scope of A.P portion (Length of main canal and ayacut) is since changed as per the DPR now being prepared by A.P)*				
By Lift				
Parwa LIS	55013	44010	40050	85504
Kali LIS	54881	43905	39954	
Mukutban LIS	7555	6044	5500	
Total	218129	175760	160050	

The command is in Yavatmal district of Maharashtra through left bank canal and three lift irrigation schemes up to 96km. Further 41095 Ha of land will be irrigated in Chandrapur district through right bank canal off taking at tail end of LBC and crossing the river by an aqueduct. Another 19233 Ha of land will be irrigated in Adilabad district of Andhra Pradesh.

The Andhra Pradesh link right bank canal takes off at CH.11.91 km of LBC. The Andhra Pradesh canal will be of 1925m length up to the left bank of river Penganga. An aqueduct will be constructed across Penganga river. Maharashtra Government will take up the Andhra link canal works upto the right bank of Penganga river including the aqueduct. The gravity canal in Andhra portion will be **89.09** km long from the off take point.

Salient features of the joint Lower Penganga Project as per the Detailed Project Report prepared by Maharashtra are given below.

Salient Features of Lower Penganga Project.

A	**Location**	
	Latitude	19 ^{o} - 54` - 30" N
	Longitude	78 ^{o} - 12` - 30" E
	Toposheet No	56-I/1
	District	Yavatmal
	Tahsil	Ghatanji
	Village	Tadsaoli
B	**Watershed**	
	River	Penganga
	Catchment area upto Dam	17983 km^2
	Free catchment area	7843 km^2
	75% dependable gross yield at project including regeneration	1565.85Mm^3 or 55.33 TMC
	Net 75% dependable yield at dam site	1208.28Mm^3 or 42.67 TMC
C	**Dam**	
	Type	Earthen Dam
	Total Length including spillway	1998m
	Maximum height	35.63m
	Free board (a)above FRL and (b)above MWL	(a) 4.5m and (b) 2.5m
D	**Spillway**	
	Type	Ogee
	Length	405m (CH.855m to 1260m

	Max.height From foundation	27.630m
	Crest level	253.50m
	Design flood	25160.38 cumec
	No. and size of gates	27 radial gates of 12m x 8m
E	**Reservoir**	
	FRL	261.5m
	MWL	263.5m
	TBL	266.00m
	MDDL	252.00m
	Dead storage level	249.00m
	River bed level	230.37m
F	**Submergence**	
	Area under submergence at FRL + 0.50m	15951.1ha.
	Private land (cultivable)	14657.49ha
	Forest land	746.67ha
	Govt.land	546.94ha
	Total villages affected	46 nos
	Fully affected	32 nos
	Partially affectd	14 nos
	Total population affected	36809 SC.....5764 ST.....11076 OBC.....7358 Others.12611
	Total Buildings / Houses affected	8136 SC:1274; ST: 2448; OBC: 2787; OC: 866; Others: 761
G	**Storage at FRL**	
	Gross	1045.37Mm^3
	Live	864.80Mm^3
	Dead	180.57Mm^3

As per the detailed surveys and investigation carried out now, the scope of Andhra Pradesh Portion of the joint project is finalised. The salient features are given below.

Salient Features of Lower Penganga Project.(*Andhra Pradesh Portion*)

A	**Canal**	
	Off take point	CH.11.91 km of LBC
	Length	89.09km
	Discharge at off take	18.15 cumec
	Bed width	5.2m / 2.75m
	Side slopes	1 ½ : 1
	Bed fall	1 in 10000 to 1 in 9000
	Off take level (CBL)	245.31
	FSL	247.91
	No. of reaches	5
	No of distributaries	26
	No. of structures	172
	Forest land	8.78 ha
	Private land	258.22
	Govt. land	
B	**Command**	
	GCA	29757 ha
	CCA	19233 Ha.
	GIA	31733 ha
	Number of Mandals benefited	4
	Number of Villages benefited	89
	Total population benefited	76000
C	**Water allotment**	
	Total annual allotment to AP	5.12 TMC
	For Irrigation	4.923 TMC
	For Drinking water supply	0.197 TMC

1.2 Location Of Project Area

The Lower Penganga Dam is located on Penganga river near Tadsoli village in Ghatanji Tahsil of Yavatmal district in Maharashtra at the following coordinates.

Longitude : 78° 12' 30" E

Latitude : 19° 54' 30" N

The benefits from the project accrue in Yavatmal and Chandrapur districts of Maharashtra and Adilabad district in Andhra Pradesh.

The Andhra Pradesh Link canal takes off from chainage 11.91 km of the Left Bank Main Canal of Lower Penganga Project to serve new command in Adilabad district of Andhra Pradesh.

Index map showing the location of the dam and project area is given as Plate-1

1.3 Access By Air/Rail/Road

By Road

The proposed dam site is approachable by road from Pandharkawda, taluq head quarter situated on N.H 7 at a distance of 145 km from Nagpur. The distance from Pandharkawda to Dam site is 45 km. To approach the dam site, one has to travel from Pandharkawada in a south-west direction by NH-7 for about 2 km and then follow metalled O.D.R 30 km upto Chikalwardha village and then travel 13 km of metalled O.D.R upto site.

The dam site can also be approached by road from Yavatmal which is 83 km away and is approachable in all seasons. The route is as follows.

- Yavatmal to Ghatanji road. 35 km by state highway No.237 & 235.
- Ghatanji to Patapangara 35 km by metalled MDR
- Patapangara to dam site 13 km by metalled ODR.

By Air

The nearest airport is Nagapur.(180km)

By Rail

The nearest rail head is Kinwat (50km) in Nanded district of Maharashtra

1.4 General Climatic Conditions of the State and the Project Area in Particular

Three distinct seasons prevail over the Penganga sub-basin: the rainy season from mid June to mid October, winter from mid October to February and summer from March to mid June. The precipitation of the catchment area is mainly due to south-west monsoon and is from June to October. There are occasional post monsoon showers in December. There are frequent dry spells of a fortnight or more even during monsoon period. In early October, heavy showers are some times experienced. The average rainfall in the river valley is 1016 mm out of which 762 mm occurs in monsoon. The rainfall increases from west to east in the river valley.

The climate of the area is dry with large temperature variations. The maximum and minimum temperature in the valley so far recorded are 44.4 ^{0} C and 15.6^{0} C respectively.

Climate of Adilabad district (Project area)

The climate of the district is characterised by a hot summer and is generally dry except during the southwest monsoon season. The year may be divided into four seasons. The cold season from December to February; summer from March to May. The period from June to September constitutes the south-west monsoon season; while October and November form the post monsoon season.

1.5 General Description of Topography, Physiography and Geology of the Area.

The river Penganga originates near village Madha in Buldhana district at an altitude of 685.70m. The river flows mainly in south-eastern direction up to the upper Penganga dam site. From here it flows in southern direction for a short distance and again flows in south-eastern direction up to the Sahastrakunda fall from where it flows in a northern direction for some distance. From the point of confluence of its tributary Pus river, it flows in eastern direction up to Lower Penganga Dam site. The total length of river Penganga is 668.8km.

The Penganga catchment is feather shaped with length about twice the average width. Upper reaches of the basin lie on the plateau and is covered by forest in lower reaches.

The types of rocks that are found in the Penganga sub-basin are the Deccan trap, Gondwanas & Puranas. The ground water occurs in the soil cover, weathered mantle and in the highly jointed fractured zones of the hard rock. In the alluvium, the ground water is found in the basal portion containing gravel and coarse sand. The depth of ground water varies from 4.5m to 16.0m.

Topography Physiography and Geology of Adilabad district.

The Sahayadri parvat or Satnala range traverses the district from the north-west to the south-east for about 281km. In this range, the Mahbubghat is the highest peak. In the eastern portion of the district some hills and hillocks of minor importance are found.

In the geological history of the Peninsular India, the district of Adilabad has special significance in some of the areas. The Indian stratigraphy occurs in this district in addition to various types of geological formations. Important deposits of coal, limestone, iron ore and clays are also found besides several other minerals in the district.

1.6 Population

Maharashtra

The entire submergence area of 15951 ha due to the reservoir is in Maharashtra. The area lies in Mahur and Kinwat taluks of Nanded district; and Mahagaon, Arni and Ghatanji taluks of Yavatmal district. A total of 46 villages are affected out of which 32 are fully affected 14 are partially affected. Total affected population is 36809 (2001 census).

Andhra Pradesh

About 5.12 TMC of water is proposed to be utilized for irrigation of 29757 Ha (GCA) of land and drinking water requirements of several villages en-route the WCS, in the district of Adilabad with a total population of 25 Lakhs (2001 census). Most of the

population in the district is engaged in agriculture. Data on Mandal-wise, village-wise population of 4 mandals in the command area of the gravity canal are collected from the Mandal Revenue Officers concerned. These particulars are given in Statements-1

The canal runs through 4 mandals covering 89 villages. The total population of the villages is 76000 as per 2001 census. The particulars are given in Annexure 1.6/1.

The details of population affected and benefited are covered separately in the EIA and EMP studies.

1.7 Natural Resources

The present project is on Penganga River. Penganga is an inter-state river and is a tributary of river Wardha in Godavari river basin. Its catchment area lies mostly in Maharashtra (93.5%) and part in Andhra Pradesh (6.5%).

The catchment of river Penganga is feather shaped with length being about twice the width. Upper reaches of the basin lie on the plateau and the lower reaches are covered by forest. The types of rock found in the basin are Deccan trap, Gondwanas & Puranas. Ground water occurs in the soil cover, weathered mantle and in the highly jointed fractured zones of the hard rock. The depth of ground water varies from 4.5 m to 16 m.

Andhra Pradesh has drawn up sub-basin wise master plan for the use of Godavari water resources as per the GWDT tribunal award. The present planned utilisations are as per the agreement between Maharashtra and Andhra Pradesh in accordance with the GWDT award.

1.7.1 The planned utilisations of Andhra Pradesh.

The planned utilisations of Andhra Pradesh in Penganga sub-basin are as follows (Unit: TMC)

	Name of the project	Existing	Ongoing	Future
Major	Lower Penganga			5.120
Medium	Satnala	2.048		
	Mathadivagu		0.905	
Minor		2.020	0.237	0.233

Sub-Total		4.068	1.142	5.352
Total				10.562

1.7.2. Present Level of Utilisation of Land & Water Resources

At present the utilisations from the existing projects in Penganga sub-basin are as above irrigating an ayacut of 11457ha.

1.7.3. System Efficiency

Specific data in this regard from the existing projects in Adilabad district is not available. However the efficiency rates for the nearby Jaikwadi project on Godavari river are as follows.

- Conveyance efficiency 65%
- Field Efficiency 60%

1.8 Land Use and Socio Economic Aspects Including Tribal, Backward and Drought Areas etc.

Adilabad district is economically backward. The percentage of tribal population in the district is 16.74% of the total population and that of schedule castes is 18.54%. The rural population in the district is 73.47% consisting of mainly illiterate working class. The literacy rate of the district is 44.7%. The main occupation and source of livelihood of the people of Adilabad is agriculture. Even though the lands are fertile, the farmers depend on ill distributed and erratic rainfall with no dependable assured irrigation at all. Thus full benefit of the natural resources are not realised by the people so far.

The total geographical area of the district is 1610500 Ha, out of which forest area is 43%, barren and uncultivated land is 3 %, land put to non agricultural uses is 4%, Current fallows is 7 %, Permanent pastures and other grazing lands is 1%, Other fallow land is 4% , net area sown is 37% and land under miscellaneous tree crops & groves not included in net area sown is 1%.

1.9 History (Earlier Proposals)

The States of Maharashtra and Andhra Pradesh entered into an agreement on 7-8-1978 for this joint project. GWDT made the allocation of waters to these states as per this agreement.

1.10 Choice of Project

Three alternative sites for the location of the dam were studied in detail and investigations were carried out at all the three locations. These alternative sites are:

1. Chanaka (on Hattighat) 32 miles on the down stream of the final proposed site at Tadsaoli.
2. Dhanora 13 miles on the upstream side of the final proposed site at Tadsaoli.
3. Tadsaoli (Chikhalwardha)

Finally the site near Tadsaoli is selected for the Dam for obvious advantages.

1.11 Stages of Development of the Project

Maharashtra

As per the DPR for the joint project prepared by Maharashtra, the construction period is 8 years. It will take 2 more years to create full irrigation potential for the project as a whole. The construction is proposed in one stage only.

Andhra Pradesh

It is contemplated to draw 42.67 TMC of water from Penganga river out of which 5.12 TMC of water will be utilised by Andhra Pradesh for irrigation and drinking water purposes in Adilabad district. Andhra Pradesh will draw the water from the off take point at 11.91 km of the LBC near **Kurli village** in Maharashtra. The actual commissioning of the project for AP use is linked to the completion of the head works and Left Bank canal by Maharashtra.

As per the Maharashtra planning, the completion of the LPP works will take at least 8 years from the commencement of work, which is yet to take place. Andhra Pradesh wants to derive the benefits of the scheme as early as possible. For this purpose, Andhra Pradesh plans to complete its portion of the project namely the gravity canal

system in Adilabad district from the off take point at ch.11.91km of Left Bank Canal in Maharashtra, within 3 years period of time. In the meantime, till the LPP is completed, water will be lifted from Penganga into the gravity canal from the proposed barrage cum aqueduct on Penganga at CH. 1925m of the gravity canal.

Barrage cum Aqueduct on Penganga

Independent of the Lower Penganga Joint Project, Maharashtra Government is planning to construct 4 (four) barrages on Penganga river on the down stream of LPP. The first of them is near Rajapet village close to the proposed aqueduct on Penganga for the Andhra link canal. It is now proposed to combine these two structures into barrage cum aqueduct. Maharashtra has invited Andhra Pradesh to make use of these four barrages for lifting the allocated water to AP. Independent of LPP (5.12TMC), Andhra Pradesh is planning to lift water from the first barrage at Rajapet for irrigation purpose of left over ayacut in Adilabad district.

The construction of LPP by Maharashtra is likely to take longer time. In the meantime, Andhrapradesh wants to take advantage of the first barrage cum aqueduct near Rajapet village, for deriving early benefit of irrigation by lifting 5.12 TMC of water annually in to the gravity canal for irrigating the proposed ayacut under LPP, till the LPP system is completed. Once the LPP Canal system is completed and water is drawn from the reservoir by gravity, the pumping system at the first barrage will continue to serve its purpose of drawing water for the separate ayacut proposed under the barrages below LPP (independent of LPP).

1.12 Fitment of the Scheme in Overall Development of the River Basin

The proposed utilizations under the project will be within the frame work of GWDT award. The utilisations by Andhra Pradesh are within the allocated waters to it and fit into the master plan for the over all development of sub-basin wise water resources in Godavari basin.

1.13 Intimation to the other development authorities regarding this scheme.

The development authorities concerned are aware of the scheme.

1.14 Public announcement and Public hearing

As the development authorities concerned are aware of the scheme, public hearing is not considered necessary in the present case.

1.15 Interlinking of the scheme with neighboring schemes.

The other schemes on Penganga river adjacent to the present scheme are Upper Penganga project on the upstream of the present dam.

The other significant schemes of Andhra Pradesh in Penganga basin are Satnala project and Mathadivagu project, both in Adilabad district. The present scheme excludes the command of these projects. However, some of the existing minor schemes will be integrated into the present scheme.

1.16 Interstate / International aspects

This project is a joint project of Maharashtra and Andhra Pradesh, as per the agreement reached between these States on interstate river Penganga and as per the GWDT award.

No international aspects are involved.

1.17 Cost and Benefit of the Scheme

The B.C ratio for the joint project is 1.61 as per the DPR for the joint project prepared by Maharashtra Government.

1.18 Public cooperation and participation

(a) Maharashtra:-The relevant portion from the DPR for the joint project is reproduced below**.**

"*The land coming under the submergence is fertile land. Main occupation of the people is agriculture and therefore, it was obvious that the people affected from the project are against the project. These people have formed "Dharan Virodhi Sangharsh Samiti" which has organized agitations in the past.*

But most of the local population is supporting the project. This fact has been underlined during public hearing carried out for the project. "Nimna Penganga Dharan Nirman & Punarvasan Kalyankari Sanstha" has been formed to speed up the project. Though the lands are fertile, erratic monsoon and lack of assured irrigation facilities has caused distress to the farmers. Continuous rise in the cost of seeds,

pesticides, fertilizers, labour has added to the misery of farmers. Socio-economic development is very low. Therefore, people are looking for alternate employment opportunities and tool to raise farm return.

At present the people are very supportive to the project and voluntarily coming forward to offer their lands. 345ha of land for dam sheet & quarry have been purchased directly by private negotiations. Co-operation of the people and participation is necessary to sacrifice the land for betterment of the adjoining area. Nearly 46 villages require rehabilitation."

b) Andhra Pradesh

Public cooperation and participation is envisaged by allotting part of work on the infrastructure of the project in the ayacut to Water Users Associations in the command area.

1.19 Provision for domestic and industrial power supply

Provision of 5.546 M cum (0.197TMC) of water is made for the drinking water supply for the en-route villages. No provision is made for industrial power supply.

CHAPTER 2

PHYSICAL FEATURES

2.1 Geographical Disposition

The Dam site is located on Penganga river near Tadsoli village in Ghatanji Tahsil of Yavatmal district in Maharashtra at the following coordinates.

Longitude : 78° 12' 30" E

Latitude : 19° 54' 30" N

The gross catchment area upto the project site is 17983 km^2.

The Andhra Pradesh portion of the works lie in the Adilabad distrct area.

2.2 Topography of the Basin, Reservoir and Command Area.

Basin

The Penganga catchment is feather shaped with length about twice the average width. Upper reaches of the basin lie on the plateau and is covered by forest in lower reaches. The terrain of the basin is a rolling terrain with natural slope of the ground and rock outcrops.

Command area

Adilabad district is situated between East longitudes 77° 47 ` to 80° 0¨ and North latitudes 18° 40` to 19° 56`. Andhra Pradesh portion of the command lies entirely in Adilabad district. The command area is rolling and undulating. The Sahayadri parvat or Satnala range traverses the district from the north-west to the south-east for about 281km. In this range, the Mahbubghat is the highest peak. In the eastern portion of the district some hills and hillocks of minor importance are found.

2.3 Geology of the Basin, Reservoir and Command Area

Basin

The types of rocks that are found in the Penganga sub-basin are the Deccan trap, Gondwanas & Puranas. The ground water occurs in the soil cover, weathered mantle and in the highly jointed fractured zones of the hard rock. In the alluvium, the ground water is found in the basal portion containing gravel and coarse sand. The depth of ground water varies from 4.5m to 16.0m.

Dam site

The area of the dam site is governed by dark clay fine grained Deccan trap comprising closely jointed basalt. In the river bed the rock is exposed at places and also on the right bank for about 100m from the river bank and on left bank from R.D 770m to 800m. The left flank is entirely covered with black and yellowish soil with kankar pieces. On the right flank closely joined basalt is exposed over a length of about 100m from the river bank.

In the spillway section, on riverbed two massive basalt flows separated by a thin weathered layer exist. The top flow is about 8.8m thick.

Command Area

In the geological history of the peninsular India, the district of Adilabad has special significance. The Indian stratigraphy occurs in this district in addition to various types of geological formations. Important deposits of coal, limestone, Manganese, iron ore and clays are also found besides several other minerals in the district.

CHAPTER 3

INTER STATE / INTERNATIONAL ASPECTS

3.1 State / Countries traversed by the river

Penganga is an inter-state river and is a tributary of river Wardha in Godavari river basin. Its catchment area lies mostly in Maharashtra (93.5%) and remaining in Andhra Pradesh (6.5%). The Penganga sub basin lies between latitudes 19 ° 17' N to 20 ° 32'N and 75 ° 57 ' E to 79 ° 12 ' E.

3.2 Distribution of catchment in States

District wise breakup of the catchment area of Penganga sub basin is given in the following table.

State	District	Sub basin area (km^2)	% of the area of sub basin
Maharashtra	Akola	3060	12.83
	Buldana	2216	9.29
	Chanda	668	2.80
	Nanded	3124	13.10
	Parbhani	2952	12.38
	Yavatmal	10280	43.10
Andhra Pradesh	Adilabad	1554	6.50
Total		23854	100

93.5% of the catchment of Penganga river lies in the State of Maharashtra. As per the hydrological studies of Godavari basin carried out by WAPCOS considering data from 1941-42 to 1994-95, the 75% dependable annual yield of Penganga sub-basin is 3841

Mcum (135.64TMC). On catchment area proportion basis, the yields generated from catchment of each state are:

Maharashtra: 126.8 TMC

Andhra Pradesh 8.84 TMC

3.3 Effect of the following on project & of the project on the following.

3.3.a *Interstate agreement*

The Lower Penganga project is a joint project between the states of Maharashtra and Andhra Pradesh on Penganga river. An understanding was reached between the states of Maharashtra and Andhra Pradesh on 6th October 1975 to take up Lower Penganga Project as an inter-state joint project. As per the agreement dated 7-8-1978 reached between the states of Maharashtra and Andhra Pradesh, the state of Maharashtra can use all the waters upto Lower Penganga project site near Chikal Wardha subject to the condition that the Lower Penganga Project is taken up as a joint project. Joint meetings were held during 1978-84 to clear techno-economical issues and sharing of costs of common portion of works. Maharashtra Government prepared a Detailed Project Report for the joint project and submitted the same to Central Water Commission for clearance. The net annual 75% dependable flows at Lower Penganga dam are assessed as 42.67 TMC to be shared in the ratio of 88:12 between Maharashtra and Andhra Pradesh, which implies that the share of Maharashtra is 37.55 TMC and that of Andhra Pradesh is 5.12 TMC. The cost of the project will be borne by the States of Maharashtra and Andhra Pradesh in the ratio of 88:12, proportionately to the utilisation of water by each state. The area under submergence including land for dam and colony is 16063ha, which lies entirely in Maharashtra.

The Andhra Pradesh part involves only a gravity canal and no submergence is involved.

Copy of the draft agreement between the States of Maharashtra and Andhra Pradesh is appended as Annexure 3.3.1

3.3.b *Interstate adjudication*

Godavari Water Dispute Tribunal (GWDT) made the following allocation of water to the basin states at 75 % dependability.

State	Allocation (annually at 75 % dependability)
Maharashtra	A. The state of Maharashtra can use all the waters upto : Lower Penganga project site near ChikalWardha subject to the condition that the Lower Penganga Project is taken up as a joint project. Waghadi Project Dam site on the Waghadi river near village Yelbara. Saikheda Dam on Khuni river near village Lingti.
	B. In addition to the use of all the waters up to the point as specified above, the state of Maharashtra can use from the waters of the rest of Penganga sub-basin 9 TMC.(255 M cum) for its existing, under construction and proposed schemes / projects each of which individually will not exceed an annual use of I.5 TMC.
Andhra Pradesh	The State of Andhra Pradesh can use all the remaining waters of the Penganga Sub-basin.

3.3.c *Interstate aspect submergence.*

An area of 16063ha will be under submergence including land for dam and colony. All this area lies in Maharashtra. This area consists of 2254.41ha of Govt. land, 746 ha of forest land and 13585 ha of private land. A total of 46 villages will be affected ; 32 villages fully submerged and 4 villages partially. Total number of houses affected are 836. The total number of population affected is 36809.

In Andhra Pradesh, no submergence is involved. The area of land required for the gravity canal and distributaries is 509.26ha. The land acquisition, ousters rehabilitation and compensation from both the States will be dealt by the respective States.

3.3.d Any other aspects of the project involving Inter-state problems.

A draft agreement in respect of the joint Lower Penganga Project between the States of Maharashtra and Andhra Pradesh is prepared and is likely to be signed very soon. This agreement deals with all the aspects likely to be emerged during construction and Operation of the project.

3.3.e *Existing and sanctioned projects*.

Particulars of the existing and sanctioned projects pertaining to Andhra Pradesh in Penganga basin are given in the following table.

	Name of the project	Existing	Ongoing	Future
Major	Lower Penganga			5.120
Medium	Satnala	2.048		
	Mathadivagu		0.905	
Minor		2.020	0.237	0.233
Sub-Total		**4.068**	**1.142**	**5.352**
Total				**10.562**
In addition to the above, feasibility of lift schemes for lifting water from the proposed barrages by Maharashtra on Penganga river below Lower Penganga Project for the purpose of drinking water supply to Adilabad town and irrigation of leftover ayacut in Adilabad district, is under study				

3.4 Existing riparian use, quantum of water presently utilised, commitments for ongoing projects, plans for future development, balance share of the state/country and proposed utilisation by this project.

As given above under Para 3.3.d

3.5 Whether operation and regulation of the project conform to the 'stipulation made in the Tribunal award/agreement and also the mechanism for such operation.

Yes. Operation and regulation of this project will be as per the stipulation made in the GWDT award and as per the agreement between the states of Andhra Pradesh and Maharashtra.

3.6 In case of addition/alterations for existing project involving submergence in other states and additional utilisation of water, concurrence 'of the concerned states is to be included.

Not applicable as of now.

3.7 Details regarding consumptive use of water in case of Hydro electric or Thermal Power Projects

Not applicable

CHAPTER 4

SURVEYS AND INVESTIGATIONS

The detailed project report for the joint project has been prepared by Maharashtra Government and submitted to Central Water Commission. The details of surveys conducted for the river, reservoir, head works, canals etc. are given in that report.

This report covers the Andhra Pradesh portion involving the Andhra Pradesh Link Canal taking off from the Left Bank Main Canal of Lower Penganga Project, Gravity canal and command in Adilabad district.

4.1 Topographical Surveys

4.1.1 River

Not Applicable

4.1.2 Reservoir

Not Applicable

4.1.3 Head works (Dams including Dykes, Barrages, weirs etc.)

Not Applicable

4.1.4 Plant and Colony layout

Not Applicable

4.1.5 Canal and Water Conductor System and Canal Structures.

The Andhra Pradesh Link Canal for carrying Andhra Pradesh share of 5.12 TMC of water takes off from ch.11.91 km of the Left Bank Main Canal. The aim of the survey is to finalise the alignment of the gravity canal covering maximum possible command in Adilabad district

within the permissible limits of hydraulic parameters and avoiding forest land to the maximum possible extent.

Detailed surveys.

Detailed topographical surveys were conducted along the canal alignment as per the guidelines of Central Water Commission and as per the TOR of the tender document. The survey was conducted using modern equipments like DGPS, Total Stations, Auto levels.

Particulars of GTS BM connected during the survey are given below.

Value	Description
+247.48m	On Concrete Pillar behind Primary School Building at Savargaon village

Control points (Bench marks) duly connected to GTS BM by conducting double check leveling (DCBM) are established through out the length of the alignment at 1km interval.

Gravity Canal

Longitudinal section of the canal is prepared with levels at 25m interval. The longitudinal section plan is prepared to the horizontal scale 1 in 2000 and vertical scale of 1 in 100 giving the soil profile and locations of geo-technical investigation locations.

Cross sections of the canal alignment are taken @ 50m interval extending 100 m on either side of the center line of the alignment for preparing the strip contour plan. Cross sections are plotted to the horizontal scale 1 in 2000 and vertical scale of 1 in 100 giving the following details.

- Bed width
- Side slopes and nature of soil
- Full supply depth and free board
- Width of berms and ledges
- Profiles of banks.
- Details of inspection and non-inspection paths
- Drain arrangements
- Details of lining and under drainage arrangements.

The Longitudinal Section plots and Cross Section plots are presented in drawing volume vide drawing nos. AA/IRR/1079/DPR/LS/DWG NO. 1 TO 89

Canal Structures.

Block leveling of the area of the structure on 5m grid basis is carried out. Grid plan of the site with contours at 1m interval to cover an area up to 300m on either side of the center line of the canal- 100m down stream of the point of exit of water and 100m upstream of the point of water inlet.

L.S and cross sections at 25m interval along the river and road crossings up to a length of 500m upstream and down stream are taken.

- Particulars of the cross drainage structures are given in para 7.5 below.
- Particulars of the cross masonry structures are given in para 7.5 below.
- The design details of the CM & CD works are given in the design volume.
- Contour plans of the area of the structures are given in the drawing volume.

4.1.6 Power house switch-yard, surge-shaft, Tail race etc.

Not Applicable

4.1.7 Tunnel, Audits and Penstocks

Not Applicable

4.1.8 Command Area

The Gross command area is 29757ha. 10% of the GCA is selected for taking up detailed command area survey as approved by the Department. The particulars of the selected area for detailed survey are given below..

Slno.	Distributary no	Area surveyed (ha)	Remarks
1	D10	631.5	
2	D15	1818.7	
3	D23	524.8	

Block leveling of the selected area at 15m grid basis is carried out. The OFD works are planned to convey water up to field channels. Contour plan of the area to the scale 1 in 10000 with contours at 0.5 m interval is prepared.

The command area plan is given in drawing volume.

4.1.9 Catchment area/water shed survey. Identification of inter-se priorities of water sheds for soil conservation.

Nil

4.1.10 Any Other

Nil

4.2 Other Surveys

4.2.1 Archaeological survey in the reservoir area.

This subject was covered in the DPR for the joint project prepared by Maharashtra. There are no centrally protected monument / Archaeological site located in the proposed submergence area of the joint project or encountered along the canal alignment of Andhra Pradesh` portion.

4.2.2 Mineral Survey

The major and minor mineral resources in the four mandals falling in the command are given below.

Sl.no	Mandal	Major mineral	Minor mineral
1	Tamsi	Manganese	Road metal
2	Adilabad	Manganese, Lime stone	
3	Jainad	Manganese	
4	Bela	Lime stone	
Source-: Handbook of statistics – Adilabad district - 2009			

The A.P. Portion involves construction of only a gravity canal. No reservoirs or any storage tanks are planned. As such these mineral resources are not affected by the project.

4.2.3 Right of way surveys for the reservoirs

Not applicable to this report. This subject was covered in the DPR for the joint project prepared by Maharashtra.

4.2.4 Communication Surveys

The length of the canal is 89.09km. The canal bank will have a jeepable inspection path. The existing communication network in the command area is adequate. No additional communication network, other than the inspection path on one of the canal banks is proposed.

4.2.5 Drainage Survey

The net 75 % dependable waters at the dam site are assessed as 42.67 TMC after accounting for all the upstream utilisations. The share of Andhra Pradesh is 5.12 TMC to be delivered at the head of Andhra link canal taking off at ch.11.91 km of the Left Main Canal of Lower Penganga Project. This water will be utilised for Irrigation purpose in Adilabad district and drinking water supply to enroute villages.

The topography of the command is slopy and can offer sufficient drainage. The cropping pattern is ID. Water logging of the command is not anticipated.

4.2.6 Soil Surveys

The detailed soil survey of the command of Lower Penganga project including the command in Adilabad district was carried out by Maharashtra for the joint Lower Penganga Project.

4.3 Geology Geo-technical Features and Seismicity.

These features pertaining to the project area and vicinity are covered in detail in the DPR for the joint Lower Penganga Project prepared by Maharashtra. The following report pertains to the Andhra Pradesh portion from the off take point of the Andhra link canal covering the gravity canal and command in Adilabad district.

4.3.1 Geology Geo-technical Features

(a) REGIONAL GEOLOGY:

The project area is located partly in Deccan Trap province and partly in Precambrain terrain.

The main Rock types of the area, belong to Peninsular Gnessic Complex (PGC) of Archean era Pakhal super group, Penganga and Sullavai group (Proterozoic), Gondwana sediments (Upper carboniferous to lower creataceous) and Deccan traps (Cretaceous to Paleocene). Peninsular Gnessic Complex (PGC) is represented by granite and granite gneiss, intruded by basic dykes and quartz veins. Older metamorphics like banded iron quartzite occurs within PGC. These are exposed around Adilabad and south of Utnur. Pakhal Super Group comprises a sequence of Dolomite, Limestone, Quartizites, Arkose and Shale. Penganga group comprises mainly of limestone, shales and sandstones.

These meso and Neo proterozoic sediments having general trend of NW-SE direction unconfirmly overly the PGC or shows faulted contact. They are wide spread south of Penganga extending towards east. Some of the manganise deposits are located in the Penganga group.

The Gondwana Super Group in the region are represented by Talchir, Barakar,, Barren measures, Kamthi, Maleri/Yerapalli/Bhimaram/Dharamaram, Kota and Gangapur/Chikiyala formations. These sediments are deposited in the Godavari Graben which extends from Asifabad east in the south direction and comprises of repeated cycles of conglomerate, Sandstone, Shale and Clay. These Gondwana Super Group of rocks have general trend of NW - SE direction. The Barakar formation in the region is host of Coal Seams. Regionally Deccan Traps also wide spread lying over Archaeans – Proterozoic and Gondwana rocks and represented by thick Amygdoloidal to massive Basalts flows with thin intertrapeans. They extend from Asifabad and Nirmal towards NW direction. NW-SE, N60E – S60W faults occur NW of Adilabad in

penganga group. Enechelon faults are common in Gondwanda.NW-SE trending kadam fault is a major fault of the area running close to Boath village and cutting across Godavari river.

(b) LOCAL GEOLOGY:

The gravity canal alignment runs in the northern part of Adilabad district extended from west to east. The area is characterised by contrast geomorphologic setup with high flat topped hill ranges, which are characteristic land forms of Deccan trap terrain exposed in the western part (Photo-1) and undulatory terrain, soil covered, with occasional rock out crops covering almost entire eastern sector. This pediplain terrain is developed over flat bedded rock types. Denudational hill ranges made up of metamorphic are conspicous in the south eastern end portion of the canal. The canal area is located in penganga river basin and drained by Satnala and other tributaries of penganga. Radial drainage has developed over flat toped hill ranges in the western part and northely trending drainage system and denritic drainage pattern in remaining area. The canal crosses Satnala at ch 58.850km (Photo-2). Bad land topography has developed around Satnala, at ch 70kms and in between ch 80-83kms.

The canal in the initial of 28kms runs along the foot hill portion of Arli hill ranges. All along the reach basalts belonging to Deccan traps are exposed. They are near horizontally disposed. In all, 5 flows have been identified. They are made up of alternate sequence of compact and amygdoloidal basalts. Their contact is sharp. They are traversed predominantly by 1. N-S, 2 NW-SE and 3 N60 E-S60W trending joints. At some places columnar joints are also observed. Between 9.00 and 10.00kms the canal crosses valley portion occupied by scree material mixed with clay.

Along the reach ch 28 to 89.09 kms limestones belonging to penganga group are the rock types which are exposed at places (Photo-3). The general trending of bedding is

along NW-SE with sub horizontal beds 4° to 15° dipping towards NE. The limestone is pink to Grey and flaggy in nature. Bedding joints are the persistent joints.

(c) GEOPHYSICAL INVESTIGATIONS:

Geophysical surveys make use of differences in the physical properties like electrical conductivity and elastic moduli, density and magnetic susceptibility of geological formations in the area of study to delineate different soil / lithological units. These methods may be employed to get preliminary information on stratigraphy or complement the boring program by correlation of stratigraphy between widely spaced boreholes. Of the four methods of geophysical surveys, namely seismic, electrical, magnetic and gravity surveys, only seismic refraction and electrical resistivity surveys are widely used in civil engineering projects. Magnetic methods are ocasionally used for detecting buried channels, dykes, ridges and intrusions in the subsurface rocks. (IS:1892-1979).

Electrical Resistivity Method:

Electrical Resistivity Method makes use of the physical properties of earth material. Amongst all physical properties, it is electrical resistivity that changes significantly from hard compact formations to soft formations. Hence, Electrical Resistivity Method is widely used to study sub-surface lithology. As electrical resistivity method has ability to delineate sub-surface lithology at low cost and easy operation, it plays a significant role in the geo-technical problems.

The resistivity methods can be employed successfully to estimate the thickness and electrical nature of the formations, which in turn provides useful information regarding the nature of the sub-surface lithology. The success of resistivity method increases with the additional information on geological characteristics of the formations studied in field and their relation (empirical) with electrical properties.

For establishing such relationship between electrical and geological characteristics, it is necessary to compare the resistivity results with the borehole data and rocks exposed in the existing wells road cuts, slopes etc. The relationship thus derived between the resistivity and geological characteristics of the formation will be of immense use in interpreting the resistivity results. The success of the resistivity methods depends how best this relationship is established in a given region.

Methodology:

The resistivity of the subsurface formations is generally measured with four electrodes, two for current and other two for potential measurements. The instruments used for the resistivity surveys are (a) Power source (DC or low frequency AC), (b) Meter to measure current and potential, (c) Electrodes and cable.

There are two popular Electrical Resistivity Methods in vogue. They are (1) Wenner configuration and (2) Schlumberger configuration. Wenner array is generally used when the ground surface is level and without much lateral variations. The spacing between successive electrodes is equal.

Schlumberger array is commonly used in a terrain having level variations. This method eliminates the surface irregularities. In Schlumberger array, the center point is fixed and the measurements are made by increasing the distance between the current electrodes so as to take the probe to depths required.

Apparent resistivities are calculated for each electrode separation. These apparent resistivity values are used to estimate true resistivity and thickness of formations. The apparent resistivity values are plotted on log-log graph sheet against electrode separation and field curve is obtained.

The field curves thus obtained are interpreted by using Master Curves to estimate the true thickness and resistivity.

Based on nature of formation and degree of weathering four types of curves are generally obtained. 1) A type, 2) H type, 3) K type, and 4) Q type.

In A type of Curves Rho2 is greater than Rho1, Rho3 is greater than Rho2

In H type of Curves Rho 1 and Rho3 are greater than Rho 2

In K type of Curves Rho 2 is greater than Rho1 and Rho 3

In Q type of Curves Rho 1 is greater than Rho 2 and Rho2 is greater than Rho3

Beside the conventional method of curve matching, several empirical methods were invented because of the lack of calculated sets of master curves and for easy handling of the data (Moores, 1945). One among such methods is inverse slope method suggested by Mr.Shankeranarayana and Ramanujachary (1967). This inverse slope method is tested widely in India, using it in different geological situations and it is found to give good results, correlating well with the borehole data.

This method is simple and direct and gives resistivities and thickness of the different layers directly from the plot of the field data on a linear graph. In practice, in inverse slope method, the inverse value of the resistance (R) obtained in Schlumberger configuration is plotted against the electrode separation on a linear graph paper and the plotted points are fitted to straight line segments. The number of straight line segments obtained indicates the number of layers present, while the reciprocals of slopes of each segment give resistivity of the corresponding layer and the intersected points on the abscissa give the depth to the interface.

Ranges of Resistivity for Rocks & Minerals

The electrical resistivity of rocks varies due to

- Mineral composition
- Texture and structure
- Presence of pores or cracks and filling material like secondary crystallization, liquid and gas.
- Temperature

The relationship between resistivity, age and lithology has been established by Keller and Frishknecht (1966) in general way, which is given in the following table.

TABLE - 1

Relationship of Resistivity with Lithology

Age	Marine Sedimentary	Terrestrial Sedimentary	Extrusive rocks (basalt, rhyolite)	Intrusive rocks (granite, gabbro)	Chemical precipitate (limestones, salt)
Quaternary and Tertiary age	1-10	1-10	10-200	500-2000	50-5000
Mesozoic	5-20	25-100	20-500	500-2000	100-10,000
Carboniferous Paleozoic	10-40	50-300	50-1000	1000-5000	200-100,000
Early Precambrian	40-200	100-500	100-2000	1000-5000	10,000-100,000
Precambrain	10-2000	300-5000	200-5000	5000-20,000	10,000-100,000

Note: All figures are in ohm.m

Average values of resistivity for various rocks and minerals (IS:1892-1979) are given below

Material	Mean Resistivity Ohm.m
Limestone (marble)	10^{12}
Quartz	10^{10}
Rock salt	10^{6} - 10^{7}
Granite	5000 - 10^{6}
Sandstone	35 - 4000
Moraines	8 - 4000
Limestones	120 - 400
Clays	1 - 120

GEOPHYSICAL INTERPRETATION

In the present study, Schlumberger array of electrical resistivity method is used and the results are interpreted by inverse slope method.

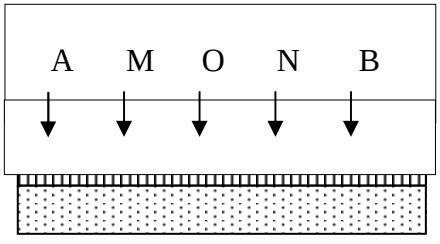

Fig. 1 Schlumberger Electrode Array

In order to establish relationship between the electrical resistivity and geological characteristics of different group of rock in the present study area, resistivity surveys have been conducted near existing open wells and borewells, where the sub-surface geological data is known. These resistivity values are considered to clarify subsurface lithology in the present study area.

The Civil Engineers use a five fold classification for the soils and rock encountered during the excavation in the project. These are

1. All Soils.
2. Soft Disintegrated Rock (SDR)
3. Hard Disintegrated Rock (HDR)
4. Fissured (semi weathered) and Fractured Rock (F & FR) and
5. Hard Rock (HR)

The different formations met with are described in the following paras.

- Top Soils: This formation is composed of end product of weathering process and transported material. It is generally unconsolidated.
- Weathered Rock: This formation is developed because of weathering of bed rock and it is further differentiated into highly weathered rock and moderately weathered rock depending on the degree of weathering.

- Fissured and Fractured rock: This formation predominantly consists of close to moderately spaced fractures and joints. The nature of this rock formation is relatively hard which requires partial blasting during canal and other excavation works.
- Hard rock with Joints : This formation is predominantly Hard with widely spaced joints. Hence, it requires blasting during canal and other excavation works.
- Hard rock: Under this formation, the bed rock is fresh and hard and occurs relatively at deeper depths (exposed hard rocks are exception), traversed by a

few joints or devoid of joints and fractures and requires blasting during excavation of canals and other excavation works.

Along canal alignment Vertical Electrical Soundings (VES) have been taken at an interval of 100m with probing depth extending upto 30m. The resistivity data has been analysed by inverse slope method to infer subsurface geological profile. Geological logs have been prepared for individual VES locations and presented in Appendix-I. From surface and subsurface geological data, geological sections along canal alignment is prepared depicting successive sub-surface geological profiles as follows:

1) Soil cover, 2) Highly weathered rock, 3) Moderately weathered rock and 4) Jointed/fractured and fissured to hard rock.

The entire canal alignment has been divided into 4 reaches depending on terrain conditions for geophysical interpretation.

- Reach-I : Ch 0.00 to 30.00 Km
- Reach-II : Ch 30.00 to 52.00 Km
- Reach-III : Ch 52.00 to 71.00 Km
- Reach-IV : Ch 71.00 to 89.09 Km

The nature of sub-surface profile in these reaches is summarised below followed a brief description.

S.No.	Reach	Thickness of overburden soils	Nature of overburden soils	Depth to hard rock	Type of rock	Remarks
I	0.00-30.00	Nil to 2.00 m	Clayey soils +scree	Either exposed or occurs below 2.00m depth	Basalt Ch.0.00 -19.00km ch.19.52 – 20.00km limestone Ch.19.00 – 19.50Km Ch. 28.00 – 30.00Km	
II	30.00-52.00	2.00 to 3.00 m	Clayey soils	2.00 – 3.00 m	Flaggy limestone	
III	0.52-71.00	0.5 to 2.00 m	Clayey, sandy clays	2.00 – 8.00 m	Thin to thick bedded limestone	
IV	71.00 – 89.090	0.5 to 2.00m	Clayey, sandy clays	0.5 – 6.00 m	Thin to thick bedded limestone	

Reach between Ch: 0.00 Km to Ch: 30.00 km

In this reach proposed canal runs along slopes of hill ranges with intermittent valleys. The area is occupied by Basalts upto Ch: 28.00Km, except in the valley portion in between ch19.00 and 19.50km, wherein underlying limestones of penganga group are expected to occur. And in the remaining stretch also i.e. from ch 28.00 – 30.00km flaggy limestones are the rock types. Since the canal runs through a hilly terrain hard rock is expected to occur under thin veneer of soil and scree cover, whose thickness ranges from 0.50 to 2.0m.

Reach between Ch: 30.00 Km to Ch: 52.00 Km

Canal alignment predominantly passes through moderately elevated, undulatory terrain. Along this reach hard rock, Limestone is expected to occur below 2.0 to 3.00m depth, overlain by compact weathered rock with thin soil cover.

Reach between Ch: 52.00 and 71.00 km

The area between Ch: 52.00 and 71.0 km is a flat and gently sloping terrain occupied by 0.50 – 2.00m thick soil cover. Hard limestone is expected to occur from 2.00m to 8.00m depth.

Reach between Ch: 71.00 to 89.09 Km

It is also an elevated, undulatory terrain with thin to 2.0m thick soil cover area. Hard flaggy limestone to thick bedded limestone occurs at from depths varying between 0.50m to 6.0m.

Lithologs along canal alignment, based on Results of Electrical Resistivity Surveys and Geological studies are shown as Appendix-1 in part I and Geological sections are shown as Plate-1 - 18 in part-II.

4.3.2 Seismicity

According to revised IS-1843/2002, the gravity canal falls within the **zone-2** of the Seismic Zone Map of India (Plate-5) which means that the area has very low damage risk. Although the proposed area falls under low damage risk one without potential threat to the structures, precautions have been taken for earth quake resistant design of major structures like aqueducts, Super passages, bridges etc. Considering an important factor of 3, the horizontal seismic coefficient is taken as 0.05g and vertical seismic coefficients as 0.10g

4.4 Foundation Investigation

4.4.1 Earth and rock fill dam/barrage/weir etc.

Not Applicable

4.4.2 Masonry/concrete dam/weirs etc.

Not Applicable

4.4.3 Canal

The soil profile along the canal alignment is investigated by conducting ERT at every 100m interval. The soil profile in different reaches is given in the following table.

S. No.	Reach	Thickness of overburden soils	Nature of overburden soils	Depth to hard rock	Type of rock
I	0.00-30.00	Nil to 2.00 m	Clayey soils +scree	Either exposed or occurs below 2.00m depth	Basalt Ch.0.00 -19.00km ch.19.52 - 20.00km limestone Ch.19.00 - 19.50Km Ch. 28.00 - 30.00Km
II	30.00-52.00	2.00 to 3.00 m	Clayey soils	2.00 - 3.00 m	Flaggy limestone
III	52.00-71.00	0.5 to 2.00 m	Clayey, sandy clays	2.00 - 8.00 m	Thin to thick bedded limestone
IV	71.00 - 89.090	0.5 to 2.00m	Clayey, sandy clays	0.5 - 6.00 m	Thin to thick bedded limestone

The longitudinal section of the soil profile along the canal alignment is given at drawing no.AA/IRR/1079/DPR/GEO-LS

4.4.4 Power house tunnels, de-silting chamber, surge tanks, transformer cavern etc. and canal structures

Not Applicable

4.5 Construction Material Investigation

Various construction materials like sand, aggregate, stone, borrow area soils, cement and steel are proposed to be obtained from the designated quarries. The samples of these materials will be got tested before doing detailed designs of the structures. For preliminary designs random samples are tested and values taken.

4.6 Hydrological and Meteorological Investigations

The water availability studies were made by Maharashtra for the joint Lower Penganga Project.

Maharashtra used the following data for the water availability studies.

- Rainfall data from 20 stations falling in the catchment area of Penganga upstream of the dam site for the period 1967 to 2008
- Gauge and discharge data of P.G. Bridge site of CWC for the period 1970 to 2007
- Upstream utilisations for the period 1970 to 2007

Using the concurrent rainfall and runoff data, Rainfall – Runoff relations were built in the form of regression equations. Using these equations, annual yield series were generated for the period 1967 to 2008 based on the average weighted rainfall over the catchment up to the project site.

CHAPTER 5

HYDROLOGY

The hydrology for the Lower Penganga Joint Project has been finalised by Maharashtra as a component of the DPR for the combined project covering all the issues as per the guidelines issued by Central Water Commission.

The present report pertains to Andhra Pradesh portion of the project covering the gravity canal and command in Adilabad district. No additional hydrological studies are needed in this report as far as the joint project is concerned. In this context hydrology involved in this report pertains to the gravity canal and its command. Even though the detailed para wise discussion of hydrology of the joint project is redundant, appropriate paragraphs under hydrology are included as per the CWC guidelines.

5.1 Hydrological inputs to the project planning.

As per the hydrological studies carried out for the joint project and as per the agreement between, Maharashtra and Andhra Pradesh , Andhra Pradesh share of 75% annual dependable yield is 5.12 TMC (including evaporation losses and conveyance losses) from the Lower Penganga Project. This will be delivered to Andhra Pradesh through the Andhra Link Canal taking off at ch.11.91 km of the Left Bank Canal of Lower Penganga Project. The entire quantity of 5.12 TMC of water will be utilised for **irrigation and drinking water purpose in Adilabad district, through a gravity canal.**

No conjunctive use of ground water is planned. The regulated supply of water as per the requirement of Andhra Pradesh will be ensured at the offtake point of Andhra link canal at ch.11.91 km of LBC of the joint project. No storage / balancing

reservoirs are proposed along the gravity canal. As such there will not be any evaporation losses and sedimentation problems.

Therefore the only hydro meteorological inputs involved are the evapo-transpiration values, conveyance losses and field losses. These are considered in the crop water requirement studies.

5.2 Simulation and Performance testing of alternative plans.

All these studies pertaining to the Lower Penganga Project are covered in the hydrology report for the joint project. The present report covers the gravity canal and its command for which water supply will be regulated at the off take point at 11.91km of LBC of Joint Lower Penganga Project. As such simulation and performance testing of alternative plans does not arise.

5.3 Hydrologic studies for design flood design flood levels etc.

5.3.1 *Design flood for safety of structure*

The design flood studies for the Lower Penganga joint project have been made by Maharashtra for the DPR of the joint project. The catchment area of Penganga up to Lower Penganga Dam is 19783sqkm. Probable Maximum Flood (PMF) for the dam has been worked out as 25160.38 cumecs. The Standard Project Storm (SPS) values have been provided by India Meteorological Department (IMD). Maximum Moisture Factor (MMF of 15% has been adopted for working out the Probable Maximum Storm (PMS).

However, for the present report of Andhra Pradesh, the design flood studies are required for cross drainage works only. As per the finalised alignment of the gravity canal, there are several stream crossings. Aqueducts/Under Tunnels/Super passages are proposed at these crossings depend upon the levels. The design floods for these structures are assessed using empirical formula (Dickens).

STATEMENT SHOWING THE DETAILS OF CROSS DRAINAGE WORKS												
			Particulars of Drain			Particulars of Canal						
Sl. No.	Name of CD work	Chainage in km	Ground Level (m)	Catchment Area Sq.Kms	MFD Cumecs (CA3/4)	Bed width (m) Cutting /Banking	FSD (m)	CBL (m)	FSL (m)	TBL (m)	Loss of Head in (m)	Remarks
1	AQUEDUCT	1925	219.680	210.760	807.596	5.200	2.600	244.818	247.418	248.318	0.300	
2	AQUEDUCT	3886	235.944	0.402	9.845	5.200	2.600	244.521	247.121	248.021	0.1	
3	UT	4375	244.276	0.342	8.721	5.200	2.600	244.473	247.073	247.973		
4	AQUEDUCT	5063	235.889	1.192	22.252	5.200	2.600	244.254	246.854	247.754	0.15	
5	AQUEDUCT	5475	239.239	0.603	13.342	5.200	2.600	244.113	246.713	247.613	0.1	
6	AQUEDUCT	5950	237.680	0.079	2.908	5.200	2.600	243.965	246.565	247.465	0.1	
7	SP	6225	249.788	0.068	2.597	5.200	2.600	243.938	246.538	247.438		
8	UT	6625	242.272	0.068	2.607	5.200	2.600	243.898	246.498	247.398		
9	AQUEDUCT	7000	236.375	0.867	17.513	5.200	2.600	243.760	246.360	247.260	0.1	
10	UT	7300	242.788	0.143	4.542	5.200	2.600	243.730	246.330	247.230		
11	AQUEDUCT	7925	240.957	0.213	6.116	5.200	2.600	243.618	246.218	247.118	0.05	
12	AQUEDUCT	8825	239.733	100.815	464.512	5.200	2.600	243.328	245.928	246.828	0.2	
13	UT	9530	245.663	0.632	13.823	5.200	2.600	243.257	245.857	246.757		
14	UT	10040	243.794	0.412	10.031	5.200	2.600	243.206	245.806	246.706		
15	UT	10979	241.393	2.551	33.712	5.200	2.600	243.112	245.712	246.612		
16	UT	11815	243.030	0.344	8.761	5.200	2.600	243.029	245.629	246.529		
17	AQUEDUCT	12300	238.520	0.091	3.219	5.200	2.600	242.930	245.530	246.430	0.05	
18	UT	13625	244.489	0.565	12.709	5.200	2.600	242.798	245.398	246.298		
19	UT	14075	245.002	0.574	12.862	5.200	2.600	242.753	245.353	246.253		
20	SP	15000	248.434	0.162	4.986	5.200	2.600	242.660	245.260	246.160		
21	UT	15425	244.307	0.405	9.906	5.200	2.600	242.618	245.218	246.118		
22	SP	16838	245.179	1.091	20.812	5.200	2.600	242.476	245.076	245.976		
23	UT	18350	242.688	0.133	4.289	5.200	2.600	242.325	244.925	245.825		
24	UT	18600	239.869	0.200	5.842	5.200	2.600	242.300	244.900	245.800		
25	AQUEDUCT	18900	238.837	0.910	18.166	5.200	2.600	242.170	244.770	245.670	0.1	
26	UT	19575	243.700	0.544	12.354	5.200	2.600	242.103	244.703	245.603		
27	SP	19750	245.366	0.544	12.354	5.200	2.600	242.085	244.685	245.585		
28	UT	20015	243.260	1.456	25.848	5.200	2.600	242.059	244.659	245.559		

29	UT	20675	244.636	0.173	5.240	5.200	2.600	241.993	244.593	245.493		
30	AQUEDUCT	21337	233.948	14.717	125.484	5.200	2.600	241.816	244.416	245.316	0.11	
31	UT	21700	240.650	0.295	7.814	5.200	2.600	241.780	244.380	245.280		
32	SP	22050	246.082	0.064	2.467	5.200	2.600	241.745	244.345	245.245		
33	AQUEDUCT	22560	236.742	0.129	4.186	5.200	2.450	241.644	244.094	244.994	0.05	
34	AQUEDUCT	22875	239.122	0.171	5.186	5.200	2.450	241.563	244.013	244.913	0.05	
35	SP	23725	244.880	0.155	4.821	5.200	2.450	241.478	243.928	244.828		
36	AQUEDUCT	24300	238.070	0.526	12.038	5.200	2.450	241.320	243.770	244.670	0.1	
37	AQUEDUCT	25175	238.028	0.085	3.071	5.200	2.450	241.183	243.633	244.533	0.05	
38	DUCT	25325	247.061			5.200	2.450	241.168	243.618	244.518		
39	UT	26325	243.336	0.290	7.701	5.200	2.450	241.068	243.518	244.418		
40	SP	26650	245.221	0.191	5.640	5.200	2.450	241.035	243.485	244.385		
41	SP	26950	246.675	0.209	6.017	5.200	2.450	241.005	243.455	244.355		
42	SP	27300	244.755	0.238	6.635	5.200	2.450	240.970	243.420	244.320		
43	UT	27756	241.900	4.625	52.672	5.200	2.450	240.924	243.374	244.274		
44	SP	28600	245.993	2.139	34.490	5.200	2.450	240.840	243.290	244.190		
45	SP	29050	248.045	0.369	9.223	5.200	2.450	240.795	243.245	244.145		
46	AQUEDUCT	29700	231.602	0.941	18.636	5.200	2.450	240.630	243.080	243.980	0.1	
47	AQUEDUCT	30050	232.523	45.606	293.080	5.200	2.450	240.445	242.895	243.795	0.15	
48	SP	31750	243.381	2.655	34.734	5.200	2.450	240.275	242.725	243.625		
49	UT	32218	241.719	2.047	33.372	5.200	2.450	240.228	242.678	243.578		
50	UT	32600	242.264	0.325	8.384	5.200	2.450	240.190	242.640	243.540		
51	UT	33625	240.632	4.518	51.751	5.200	2.450	240.088	242.538	243.438		
52	SP	34050	243.226	0.572	12.831	5.200	2.450	240.045	242.495	243.395		
53	UT	35129	241.923	1.305	23.807	5.200	2.450	239.937	242.387	243.287		
54	SP	36150	243.820	0.096	3.370	5.200	2.450	239.835	242.285	243.185		
55	UT	36850	242.473	0.116	3.880	5.200	2.450	239.765	242.215	243.115		
56	SP	38525	244.801	0.838	17.078	5.200	2.450	239.598	242.048	242.948		
57	FLUMED SECTION	39400	249.208	0.084	3.042	5.200	2.450	239.510	241.960	242.860		
58	AQUEDUCT	40061	224.433	4.491	51.524	5.200	2.450	239.294	241.744	242.644	0.15	
59	UT	40550	240.052	0.131	4.241	5.200	2.450	239.245	241.695	242.595		
60	AQUEDUCT	41580	229.850	1.193	22.260	5.200	2.450	238.992	241.442	242.342	0.15	
61	SP	41975	244.927	0.125	4.092	5.200	2.450	238.953	241.403	242.303		
62	AQUEDUCT	42500	231.752	4.317	50.016	5.200	2.450	238.800	241.250	242.150	0.1	
63	SP	44425	242.111	5.018	55.993	5.200	2.450	238.608	241.058	241.958		
64	SP	45625	241.619	0.879	17.703	5.200	2.450	238.488	240.938	241.838		

65	UT	46500	241.265	0.727	15.352	5.200	2.450	238.400	240.850	241.750		
66	AQUEDUCT	47344	230.848	1.880	31.308	4.600	2.250	238.216	240.466	241.366	0.1	
67	SP	48150	241.502	0.980	19.207	4.600	2.250	238.135	240.385	241.285		
68	SP	50025	242.939	0.951	18.773	4.600	2.250	237.948	240.198	241.098		
69	SP	50350	242.055	0.399	9.796	4.600	2.250	237.915	240.165	241.065		
70	SP	51200	242.194	0.618	13.595	4.600	2.250	237.830	240.080	240.980		
71	UT	52378	236.210	1.165	21.870	4.600	2.250	237.712	239.962	240.862		
72	UT	53860	239.606	1.165	21.873	4.600	2.250	237.564	239.814	240.714		
73	AQUEDUCT	54543	232.265	53.317	329.509	4.600	2.250	237.396	239.646	240.546	0.1	
74	VIADUCT	58850	216.055	849.935	2298.222	4.600	2.250	236.965	239.215	240.115	0.75	
75	SP	61275	240.499	0.087	3.116	4.600	2.250	235.973	238.223	239.123		
76	BOX	62175	243.955			4.600	2.250	235.883	238.133	239.033		
77	BOX	65213	248.506			4.600	2.250	235.548	237.348	238.098		
78	AQUEDUCT	67635	231.625	26.386	194.422	3.500	1.800	235.159	236.959	237.709	0.12	
79	BOX	68375	239.251			3.500	1.800	235.077	236.877	237.627		
80	BOX	69285	240.805			3.500	1.800	234.976	236.776	237.526		
81	SP	70330	237.875		0.500	3.500	1.800	234.860	236.660	237.410		
82	BOX	70725	241.810	0.415	10.091	3.500	1.800	234.816	236.616	237.366		
83	UT	71400	232.725	0.302	7.948	3.500	1.800	234.741	236.541	237.291		
84	AQUEDUCT	71854	232.405	0.675	14.515	3.500	1.800	234.641	236.441	237.191	0.05	
85	BOX	73300	239.081	0.244	6.778	3.500	1.800	234.480	236.280	237.030		
86	SP	73396	237.699	0.244	6.778	3.500	1.800	234.469	236.269	237.019		
87	SP	73725	238.567	0.235	6.581	3.500	1.800	234.433	236.233	236.983		
88	BOX	74850	237.395	0.471	11.080	3.500	1.800	234.308	236.108	236.858		
89	UT	75795	233.758	2.334	36.820	3.500	1.800	234.203	236.003	236.753		
90	UT	76275	233.640	13.516	117.718	3.500	1.800	234.149	235.949	236.699		
91	SP	79127	236.075	1.026	19.885	3.500	1.800	233.832	235.632	236.382		
92	UT	79493	234.524	0.639	13.936	3.500	1.800	233.792	235.592	236.342		
93	SP	80225	235.631	0.112	3.779	3.500	1.800	233.710	235.510	236.260		
94	SP	81100	236.354	0.604	13.356	2.750	1.100	233.613	234.713	235.463		
95	AQUEDUCT	81500	227.161	19.097	152.561	2.750	1.100	233.519	234.619	235.369	0.05	
96	AQUEDUCT	82700	231.117	5.019	55.999	2.750	1.100	233.335	234.435	235.185	0.05	
97	UT	83936	234.045	0.272	7.338	2.750	1.100	233.198	234.298	235.048		
98	UT	84250	231.132	2.772	35.879	2.750	1.100	233.163	234.263	235.013		
99	UT	84800	231.049	7.091	72.567	2.750	1.100	233.102	234.202	234.952		
100	UT	85425	231.466	11.938	107.255	2.750	1.100	233.033	234.133	234.883		

101	UT	86150	233.568	0.778	16.148	2.750	1.100	232.952	234.052	234.802		
102	UT	86847	232.415	2.733	35.500	2.750	1.100	232.875	233.975	234.725		
103	UT	87425	234.013	3.041	38.456	2.750	1.100	232.810	233.910	234.660		
104	UT	87775	231.227	4.690	53.220	2.750	1.100	232.772	233.872	234.622		
105	UT	89075	230.278	17.618	143.608	2.750	1.100	232.627	233.727	234.477		

5.3.2 *Design flood for Flood Control Component*

There is no flood control component in the scheme.

5.3.3 *Hydrologic design of surface drainage*

The gravity canal and its command are in the uplands of Penganga river. Only Satnala stream is passing through the command in addition to the main Penganga river.

The important structures are aqueducts and Super passages. The criteria for CM & CD works as per BIS code IS 7784-1993 is 50 year return flood. There is no recorded history of floods in the area. The design floods at the stream crossings are assessed using the generally accepted empirical formulae in vogue. The corresponding water levels (Flood levels) at the stream crossings are within the banks suggesting that there will not be any threat of inundation of the command area due to floods.

5.3.4 *Design flood for planning construction and diversion arrangement.*

No cofferdam or diversion arrangement of the streams is needed for the system covered under this report. Only aqueducts across minor streams are planned, which do not require elaborate diversion arrangements.

5.3.5 *Determination of flood levels for structure on river banks.*

The system covered by this report does not involve any structure on river banks.

5.3.6 *Determination of outlet levels.*

These issues pertain to Dam and reservoir which are covered in the DPR for the joint project. The present report is only for the gravity canal and its command in Andhra Pradesh and does not involve the above issues.

5.3.7 *Tail water rating curves.*

Tail water rating curves pertaining to Spillway of the Lower Penganga project are covered in the DPR for the joint project.

This report dealing with canal and command, does not require any tail water studies.

5.4 Effect of project development on hydrologic regime.

(a) ***Impact on existing projects in the down stream of planned project.***

The utilisations under this project are as per the GWDT allotment and in accordance with the master plan of Andhra Pradesh for the utilisation of Godavari basin water resources. As such the development under this project will not have any adverse effect on the down stream existing projects.

(b) ***Low flows***

Water for this scheme will be drawn from the Lower Penganga reservoir as per the working table prepared for the reservoir. As such the proposed utilisations will not affect the low flows.

(c) ***Flood hydrology***

The annual utilisations are only 5.12 TMC to be drawn from reservoir of Lower Penganga reservoir. These utilisations are meagre and will not have any effect on the flood hydrology.

(d) ***Total runoff***

The utilisations are 5.12 TMC at 75% dependability. The total runoff at down stream of the project will be affected by this much volume.

(e) *River hydraulics.*

The effect of lower Penganga dam on river hydraulics of Penganga river is covered in the DPR of the joint project.

The river hydraulics of the streams in the command area will not be affected, as the gravity canal crosses them through aqueducts without interfering with the stream flows.

(f) *Sediment yields, Sediment carrying capacities and aggredations and degradation at various locations.*

These issues pertain to reservoir and Penganga river and are discussed in the DPR for the Lower Penganga Joint Project. The utilisations of 5.12 TMC, which are to be drawn from the reservoir, will not change the status of these issues.

(g) *Water quality*

This is dealt in Main DPR for joint project.

(h) *Water demand*

The utilisations are as per the master plan of Andhra Pradesh for the utilisations of Godavari basin water resources. As such there will not be any additional stress on the water demand.

CHAPTER 6

HYDRO-GEOLOGY

The project draws 5.12 TMC of water from the Left Main Canal of Lower Penganga Project to meet all the irrigation demands of the command and drinking water needs of the en route villages. No ground water is proposed to be utilized. Hence no studies on Hydro-geology are made for the Andhra portion of this project. **Hence there is no material / studies for the following paras.**

6.1 Hydro-Geological setup

6.2 Ground water resource availability

6.3 Ground water development process

6.4 Anticipated behavior of ground water on down stream after creation of the reservoir

6.5 Quality of Ground Water

6.6 Identification of areas of rising / declining water tables and explore the feasibility of conjunctive use of surface and ground water.

6.7 Proposal for conjunctive use of surface and ground water.

CHAPTER 7

DESIGN FEATURES AND CRETERIA FOR DIFFERENT RIVER VALLEY STRUCTURES

7.1 Structure and Layout

The project components pertaining to this report include:

- Gravity Canal of 89.09km length
- Canal Lining
- Command (GCA 29757ha)
- Cross Masonry and Cross drainage works
- Bridges
- Aqueducts
- Under tunnels
- Regulators (With gates)
- Canal structures

The structural and hydraulic design calculations and drawings are given in a separate volume as Volume III

Summary of the design report is given below.

7.1.1 General-Brief

The layout of the canal alignment is given in drawing no. AA/IRR/1079/DPR/INDEX MAP

7.1.2 Geology, Seismicity and foundation - Brief

The details of the Geology, foundation, Seismology are given in the geology section, Para 4.3 above.

7.1.3 Alternative studies carried out for selection of site

(a) Dam

This item is dealt in main DPR of Maharashtra Govt.

(b) Gravity Canal

The location of the off take point of Andhra Link canal for the gravity canal is fixed.

The alignment of the gravity canal was finalised after detailed study of Topo sheets, field reconnaissance and detailed topographical surveys. The best possible alignment was decided considering the following objectives.

- Off take **level from Left Main Canal of LPP at 11.91 km is fixed as +245.31m**.
- Design bed fall of 1 in 10000 for the canal.
- Covering of maximum ayacut by gravity.
- Avoiding reserved forest, wild life sanctuary etc.; in the alignment.
- Minimising cut and fill for canal construction

7.1.4 Choice of final layout of all major components of the project and reason-Details

This report for Andhra Pradesh portion of the joint project, deals with the gravity canal, CM & CD works and command. The gravity canal alignment is finalised according to the contour to cover maximum ayacut. The layout of the cross drainage works is decided based on the topography of the terrain and drain near the crossing.

7.1.5 Design flood and Sediment studies

(a) Design Flood

The catchment area of Penganga up to Lower Penganga Dam is 19783 Sq km. **PMF for the dam has been worked out as 25160.18 cumec.** The SPS values have been provided by IMD. MMF of 15% has been adopted for working out the PMS.

However for the present report of Andhra Pradesh, the design flood studies are required for cross drainage works only. As per the finalised alignment of the gravity canal, there are several stream crossings. Aqueducts / Superpassages/Under Tunnels are proposed at these crossings. The design floods for these aqueducts / Superpassages/Under Tunnels are assessed using empirical formulae. The particulars of the structures and the design flood details are given in the preceding Para 5.3.1 above.

(b) Sediment Studies

The sedimentation studies for the main reservoir are covered in the DPR for the joint project. There are no reservoirs in the present study area of Andhra Pradesh portion. As such no sedimentation studies are needed.

7.1.6 Free Board

Not applicable to the present study. There are no reservoirs in the present study area of Andhra Pradesh portion

7.1.7 River diversion arrangements

No cofferdam or diversion arrangement of the streams is needed for the system covered under this report. The proposed CD works across minor streams do not require large scale diversion arrangements.

7.1.8 Construction materials - Brief

The detailed information on the construction materials, borrow areas, leads are given in the Estimates volume. The tested quarries that are being used by the department for construction of similar works in the area will be used for this project. Accordingly, the data has been worked out for framing the estimate of the project.

7.1.9 Details of model studies for important structures.

The scope of work in the present report involves only gravity canal and CD works. As such no model studies were taken up.

7.2 Dam

Not applicable to this report. Detailed report on Dam is available in the DPR for the joint project report prepared by Maharashtra.

7.3 Barrage / Weir and Head regulator

Not applicable.

7.4 Canals

7.4.1 Description of Canal system

The Andhra Link Canal takes off from ch.11.91 km of the Left Main Canal of Lower Penganga Project .The off take point is located in Maharashtra territory. Maharashtra Government has finalised the alignment of the off take channel for Andhra Pradesh for a length of 2100m from the off take point to the crossing point of Penganga river up to right bank (Starting of Andhra territory) comprising of 1925 m of gravity canal up to left bank of penganga river and 600m length of aqueduct across Penganga river.

The canal alignment beyond the Penganga river crossing has been finalised after detailed topographical survey and considering the following aspects.

- Off take level from Left Main Canal of LPP at 11.91 km is fixed as +245.31m.
- Design bed fall of 1 in 10000 for the canal.
- Covering of maximum ayacut by gravity.
- Avoiding reserved forest, wild life sanctuary etc.; in the alignment.
- Minimising cut and fill of canals.

The features of this alignment are given below.

Length of the canal	89.09	km	From off take point
Ayacut covered by gravity			
GCA	29757	Ha	
CCA	19233	Ha	
Mandals	4	nos	
Villages	89	nos	
Length of canal passing through Forest area	1375	metre	From ch 24.825 to 26.200.
Length of canal running along Forest boundary	1550	metre	From chainage km: 9.500 to 10.500, 10.750 to 16.000 24.800 to 27.200
Forest area in the command	8.78	Ha	
Major streams enroute	11	nos	
Road crossings	1	NH 7	At ch. 56.225
Railway track crossing	1		At ch. 55.500
Major structures	6	nos	
No. of distributories	26	nos	

The canal alignment passes through forest area for a length of 1375m between chainage 24.825km to 26.200km. This could not be avoided. Taking the alignment in a detour along the forest border involves increase in length of the canal, high embankment as the level along the forest boundary is low due to steep fall of the forest terrain. Further the land to be acquired will increase due to increased length of canal and high embankments.

Generally all the left over ayacut below gravity canal alignment (contour level 245m to 240m) in Adilabad district is covered by this gravity canal. However this gravity canal overlaps a part of the command of the existing Satnala project. This overlapped command is excluded from the command of the present gravity canal of Lower Penganga project.

The distributory system with provision for field channels serving upto 8 Ha in a block of about 40 ha is marked on the ayacut map. 26 distributories are planned along the ridges of the watershed.

Villages with their boundaries are also marked on the ayacut map. Detaiils of village wise and mandal wise ayacut are worked out. The total ayacut identified is 29757 Ha (GCA) and 19233 Ha (CCA). The gravity canal is divided into 5 reaches. Details of these reaches are given in the ensuing chapter on Canal capacity.

The following statements / drawings are enclosed

1	Map showing alignment of main gravity canal with distributors	Plate 2
2	Ayacut map with Mandals and village boundaries.	Plate 3
3	Statement showing distributory wise and reach wise Ayacut and discharge particulars	Given in para 7.4.7 below

The gravity canal crosses four streams, including Satnala. Satnala project command is excluded from the command of lower Penganga project. The other streams are minor streams. They are not integrated with the canal network of LPP. The gravity canal crosses these streams through aqueducts . No storage, Tail tanks are provided.

7.4.3 Description of the soil profile along the canal system

The soil profile along the canal alignment is investigated using Electrical Resistivity Test (ERT) technique. Report on the ERT and the soil profile is given in the Geology volume.

7.4.4 Evaluation of the design parameter based on the samples collected along with canal alignment, borrow area and suggested treatment for problematic reaches.

Casing Soils: Type SC

Description	Density	C Value	Φ value
OMC	2080 Kg/cm	1000 Kg/sq.m	30°
SMC	2190 Kg/cm	1000 kg/sq.m	25°

Hearting Soils: Type CI

Description	Density	C Value	Φ value
OMC	2100 Kg/cm	2500 Kg/sq.m	18°
SMC	2110 Kg/cm	2000 kg/sq.m	14°

Foundation Soils : Type SC

Description	Density	C Value	Φ value
OMC	1920 Kg/cm		
SMC	2070 Kg/cm	1000 kg/sq.m	25°

7.4.5 Details of lining provided.

PCC (M-15) lining of the entire section upto TBL is provided. Reach-wise particulars of the lining is given in the following table.

Sl.no	Reach	Chainage		Discharge (Designed) Cumec	Type of lining		Remarks
		From Km	To Km		Mix	Thickness mm	
1	I	0	22.194	18.147	M15	75	
2	II	22.194	47.068	16.177	M15	75	
3	III	47.068	62.492	12.543	M15	75	
4	IV	62.492	80.817	7.042	M15	60	
5	V	80.817	89.090	2.280	M15	60	

7.4.6 Transmission losses assumed for lined / unlined channel with justification for

Sl.no	Channel	Efficiency	Justification
A	**CANAL EFFICIENCY**		
	Gravity canal	65.00%	The efficiency rates are adopted as per the observed and approved efficiency rates for the Jaikwadi project.
	Distributories	65.00%	
B	**FIELD EFFICIENCY**		
	Minors and sub-minors	60.00%	
	Field channel	60.00%	
C	**Overall efficiency of the system (A * B)**	**39.00%**	

7.4.7 Cutoff statement showing the detail of the discharge required from tail to the head considering the irrigation requirement and transmission losses in the off taking channel

DISTRIBUTORY WISE AND REACH WISE AYACUT AND DISCHARGE PARTICULARS

Chainage(km)	Distributory	GCA in Ha	Commandable Area(CCA) 65% (Ha)	Reach wise Ayacut (Ha)	Discharge required (Cumecs)	Cumulative Discharge (Cumecs)	Reach wise Discharge (Cumecs)	Remarks
3.310	D1	240.94	155.72	2102	0.133	16.482	16.482	Reach I
5.268	D2	126.20	81.57		0.070	16.348		
7.491	D3	76.19	49.24		0.042	16.278		
8.792	D4	104.79	67.72		0.058	16.236		
12.727	D5	322.39	208.36		0.179	16.178		
14.200	D6	865.76	559.54		0.480	15.999		
17.810	D7	634.13	409.84		0.351	15.519		
22.194	D8	882.13	570.12		0.489	15.168		
28.194	D9	551.03	356.13	3769	0.305	14.680	14.680	Reach II
31.000	D10	631.50	408.14		0.350	14.375		
34.485	D11	546.29	353.07		0.303	14.025		
43.166	D12	331.24	214.08		0.183	13.722		
45.750	D13	166.10	107.35		0.092	13.539		
47.068	D14	3606.21	2330.69		1.997	13.447		
55.394	D15	1818.71	1175.43	5451	1.007	11.449	11.449	Reach III
56.717	D16	1323.26	855.22		0.733	10.442		
62.492	D17	5292.51	3420.55		2.931	9.709		
77.594	D18	2126.63	1374.44	5471	1.178	6.778	6.778	Reach IV
79.000	D19	4534.26	2930.49		2.511	5.600		
80.817	D20	1803.89	1165.85		0.999	3.089		
84.925	D21	367.13	237.28	2438	0.203	2.090	2.090	Reach V
85.914	D22	314.61	203.34		0.174	1.886		
86.640	D23	524.80	339.18		0.291	1.712		
87.567	D24	1012.79	654.57		0.561	1.421		
88.780	D25	820.66	530.39		0.455	0.860		
89.090	D26	732.91	473.68		0.406	0.406		
	Total	**29757.08**	**19233.00**	**19233**				

7.4.8 Design calculation for adequacy of canal sections adopted.

REACH WISE HYDRAULIC PARTICULARS

S.No	Description	Units	Reach - I : Km 0 - 22.194	Reach - II: Km 22.194 - 47.068	Reach -III: Km 47.068 - 62.492	Reach -IV: Km 62.492 - 80.817	Reach -V: Km 80.817 - 89.09
1	Total Ayacut proposed		19233	17130	13360	7909	2438
2	Reach Ayacut	Ha	2102	3769	5451	5471	2438
3	a) Discharge Required	Cumecs	16.48	14.68	11.45	6.78	2.09
	b) Discharge designed	Cumecs	18.15	16.18	12.54	7.04	2.28
4	Bed width	m	5.20	5.20	4.60	3.50	2.75
5	Full supply depth	m	2.60	2.45	2.25	1.80	1.10
6	Canal side slopes (in/out)	-	1.5:1/2:1	1.5:1 / 2:1	1.5:1 / 2:1	1.5:1 / 2:1	1.5:1 / 2:1
7	Bed fall	-	1/10000	1/10000	1/10000	1/9000	1/9000
8	Value of Rugosity	-	0.018	0.018	0.018	0.018	0.018
9	Free board(upto TBL)	m	0.90	0.90	0.90	0.75	0.75
10	Velocity	m/sec	0.77	0.74	0.70	0.63	0.47
11	Critical Velocity Ratio		1.16	1.16	1.14	1.17	1.14
12	Top width of banks I/NI	m	7.0/4.0	7.0/4.0	7.0/4.0	6.0/2.5	4.0/2.0
13	Thickness of lining	mm	75	75	75	60	60
14	Lining Free Board	m	0.75	0.75	0.75	0.60	0.60

7.4.9 Design discharge data for each distributary

As given in para 7.4.7

7.4.10 Canal operation and criteria for fixing the level of outlets / off-taking channels

The off-taking points of the distributaries are located at the ridge points along the length of the gravity canal. Accordingly the sill level of the outlet for the distributary

is fixed depending upon the canal bed level at the off take point. The FSL of the distributary is fixed based on the discharge required and average water level of the canal.

7.5 Canal structures / Gates etc,

(a) List of canal structures

CD Structures

The particulars of the structures and the design flood details are given in the preceding Para 5.3.1 above.

CM Structures

STATEMENT SHOWING THE DETAILS OF CROSS MASONRY WORKS											
Sl. No.	Description	Name of cross Masonry work	Chainage in (km)	Existing Road Level (m)	Road Width (m)	Bed Width in m	FSD in m	Hydraulic Particulars of Canal			Remarks
								CBL	FSL	TBL	
1	Cart track crossing	SLRB	700	242.889	4.250	5.200	2.600	245.240	247.840	248.740	
2	WBM Crossing	DLRB	3085	253.952	4.250	5.200	2.600	244.702	247.302	248.202	
3	Cart track crossing	SLRB	5255	255.020	4.250	5.200	2.600	244.235	246.835	247.735	
4	Cart track crossing	SLRB	6175	254.765	4.250	5.200	2.600	243.943	246.543	247.443	
5	Cart track crossing	SLRB	6700	254.445	4.250	5.200	2.600	243.890	246.490	247.390	
6	Cart track crossing	SLRB	7440	249.752	4.250	5.200	2.600	243.716	246.316	247.216	
7	Cart track crossing	SLRB	8640	241.972	4.250	5.200	2.600	243.546	246.146	247.046	
8	Cart track crossing	SLRB	9375	246.345	4.250	5.200	2.600	243.273	245.873	246.773	
9	BT road Crossing	DLRB	10535	248.382	7.500	5.200	2.600	243.157	245.757	246.657	
10	BT road Crossing	DLRB	12105	244.002	7.500	5.200	2.600	243.000	245.600	246.500	
11	BT road Crossing	DLRB	12600	245.781	4.250	5.200	2.600	242.900	245.500	246.400	
12	Cart track crossing	SLRB	14635	254.429	4.250	5.200	2.600	242.697	245.297	246.197	
13	Cart track crossing	SLRB	15400	245.239	4.250	5.200	2.600	242.620	245.220	246.120	

14	Cart track crossing	SLRB	16410	247.954	4.250	5.200	2.600	242.519	245.119	246.019	
15	Cart track crossing	SLRB	17062	248.082	4.250	5.200	2.600	242.454	245.054	245.954	
16	Cart track crossing	SLRB	19060	240.510	4.250	5.200	2.600	242.154	244.754	245.654	
17	Cart track crossing	SLRB	19600	245.669	4.250	5.200	2.600	242.100	244.700	245.600	
18	Cart track crossing	SLRB	19915	248.143	4.250	5.200	2.600	242.069	244.669	245.569	
19	Cart track crossing	SLRB	21630	242.160	4.250	5.200	2.600	241.787	244.387	245.287	
20	Cart track crossing	SLRB	23200	253.518	4.250	5.200	2.450	241.530	243.980	244.880	
21	WBM Crossing	DLRB	28275	248.769	4.250	5.200	2.450	240.873	243.323	244.223	
22	BT road Crossing	DLRB	30700	246.961	7.500	5.200	2.450	240.380	242.830	243.730	
23	Cart track crossing	SLRB	31350	246.477	4.250	5.200	2.450	240.315	242.765	243.665	
24	BT road Crossing	DLRB	33175	247.464	7.500	5.200	2.450	240.133	242.583	243.483	
25	BT road Crossing	DLRB	34350	247.038	7.500	5.200	2.450	240.015	242.465	243.365	
26	Cart track crossing	SLRB	36400	249.059	4.250	5.200	2.450	239.810	242.260	243.160	
27	Cart track crossing	SLRB	37950	242.385	4.250	5.200	2.450	239.655	242.105	243.005	
28	Cart track crossing	SLRB	41450	246.808	4.250	5.200	2.450	239.155	241.605	242.505	
29	Cart track crossing	SLRB	41810	250.959	4.250	5.200	2.450	238.969	241.419	242.319	
30	BT road Crossing	DLRB	43075	246.220	7.500	5.200	2.450	238.743	241.193	242.093	
31	Cart track crossing	SLRB	49750	243.749	4.250	4.600	2.250	237.975	240.225	241.125	
32	Cart track crossing	SLRB	50300	243.720	4.250	4.600	2.250	237.920	240.170	241.070	
33	WBM crossing	DLRB	51375	244.707	4.250	4.600	2.250	237.813	240.063	240.963	
34	Cart track crossing	SLRB	52175	237.250	4.250	4.600	2.250	237.733	239.983	240.883	
35	Cart track crossing	SLRB	53850	241.009	4.250	4.600	2.250	237.565	239.815	240.715	
36	Railway track crossing		55500	243.318	4.250	4.600	2.250	237.300	239.550	240.450	
37	NH Crossing	DLRB	56225	243.104	7.500	4.600	2.250	237.228	239.478	240.378	
38	WBM Crossing	DLRB	57635	238.240	4.250	4.600	2.250	237.087	239.337	240.237	

39	Cart track crossing	SLRB	60940	238.659	4.250	4.600	2.250	236.006	238.256	239.156	
40	Cart track crossing	SLRB	61850	243.765	4.250	4.600	2.250	235.915	238.165	239.065	
41	BT Road Crossing	DLRB	63350	240.868	7.500	3.500	1.800	235.755	237.555	238.305	
42	Cart track crossing	SLRB	64725	243.665	4.250	3.500	1.800	235.603	237.403	238.153	
43	Cart track crossing	SLRB	65213	248.506	4.250	3.500	1.800	235.548	237.348	238.098	
44	Cart track crossing	SLRB	66823	241.645	4.250	3.500	1.800	235.370	237.170	237.920	
45	Cart track crossing	SLRB	67296	236.886	4.250	3.500	1.800	235.317	237.117	237.867	
46	Cart track crossing	SLRB	68275	237.797	4.250	3.500	1.800	235.088	236.888	237.638	
47	WBM Crossing	DLRB	68760	242.844	4.250	3.500	1.800	235.034	236.834	237.584	
48	Cart track crossing	SLRB	69856	240.285	4.250	3.500	1.800	234.913	236.713	237.463	
49	BT Road Crossing	DLRB	70512	240.347	7.500	3.500	1.800	234.840	236.640	237.390	
50	Cart track crossing	SLRB	71850	233.489	4.250	3.500	1.800	234.691	236.491	237.241	
51	Cart track crossing	SLRB	72425	238.191	4.250	3.500	1.800	234.577	236.377	237.127	
52	Cart track crossing	SLRB	73270	239.590	4.250	3.500	1.800	234.483	236.283	237.033	
53	Cart track crossing	SLRB	74250	238.457	4.250	3.500	1.800	234.374	236.174	236.924	
54	Cart track crossing	SLRB	75358	238.144	4.250	3.500	1.800	234.251	236.051	236.801	
55	Cart track crossing	SLRB	76875	237.848	4.250	3.500	1.800	234.083	235.883	236.633	
56	Cart track crossing	SLRB	77175	239.384	4.250	3.500	1.800	234.049	235.849	236.599	
57	Cart track crossing	SLRB	78070	239.661	4.250	3.500	1.800	233.950	235.750	236.500	
58	Cart track crossing	SLRB	78850	240.373	4.250	3.500	1.800	233.863	235.663	236.413	
59	Cart track crossing	SLRB	79682	237.382	4.250	3.500	1.800	233.771	235.571	236.321	
60	Cart track crossing	SLRB	80595	238.548	4.250	3.500	1.800	233.669	235.469	236.219	
61	BT Road Crossing	DLRB	81300	233.649	7.500	2.750	1.100	233.591	234.691	235.441	
62	Cart track crossing	SLRB	83160	237.381	4.250	2.750	1.100	233.284	234.384	235.134	
63	WBM	DLRB	84335	233.652	4.250	2.750	1.100	233.154	234.254	235.004	

	Crossing										
64	Cart track crossing	SLRB	85165	236.861	4.250	2.750	1.100	233.062	234.162	234.912	
65	BT Road Crossing	DLRB	85793	238.236	7.500	2.750	1.100	232.992	234.092	234.842	
66	Cart track crossing	SLRB	86591	237.260	4.250	2.750	1.100	232.903	234.003	234.753	
67	BT Road Crossing	DLRB	88200	236.970	7.500	2.750	1.100	232.724	233.824	234.574	

(b) Layout of the proposed structure

Refer drawing volume Part-II

(c) Testpit / bore-hole data for deciding the nature of the foundation

(d) Bed level, FSL & Capacity of the canal at the point of entry of the structure

The particulars of the Bed level, FSL and the design flood details are given in the preceding Para 5.3.1 above.

(e) Transition in canal section and head losses

The particulars of the head losses are given in the preceding Para 5.3.1 above.

(f) Stresses allowed

(g) Cross drainage

The design criteria is as per BIS code

(h) Regulators-cross regulators-basic design criteria

The design criteria is as per BIS code

(I) Escapes, falls, road bridges, standing wave flumes-basic design criteria

The design criteria is as per BIS code

(j) Conditions assumed to check the stability of the structure.

The design criteria is as per BIS code

7.6 Power House

Not applicable

7.7 Instrumentation

Not applicable to this report. Instrumentation particulars for the Dam are given in the DPR for the joint project prepared by Maharashtra.

CHAPTER 8

RESERVOIR

There are no storage / balancing reservoirs in the scope of the present report for Andhra Pradesh portion. DPR for the joint project prepared by Maharashtra contains the details about reservoir of the Lower Penganga Joint Project.

CHAPTER 9

IRRIGATION PLANNING

An extent of GCA 29757 Ha (CCA 19233Ha) is identified in Adilabad district for irrigation by gravity by utilising 5.12 TMC of waters allotted to Andhra Pradesh.

9.1 Existing Irrigation facilities in the proposed project command area

Details of the existing irrigation facilities in the proposed project command area are given in the following table.

Source in the project command		GCA (Ha)	CCA (Ha)
a	Canals Satnala Project	24000	14000
b	Tanks		150
c	River lift	Nil	

9.2 Existing Cropping Pattern

The existing cropping pattern in the command for each Mandal as on 24-6-2010 has been collected from the Assistant Director of Agriculture, Adilabad. Statement showing Mandal wise Normal areas and area sown particulars during Kharif 2010 in Adilabad district for the following mandals as collected from the Agriculture department is given in Statement -2

1. Adilabad
2. Tamsi

3. Talamadugu
4. Jainad
5. Bela

9.4 Agro-climatic conditions

9.4.1 Monthly Normal Rainfall

Mandal wise monthly Normal rainfall data in the command area is given below.

Mandal	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Tamsi	9.7	3.7	5.6	8.9	12.1	177.1	323.6	289.5	114	117.4	10.4	7.2	1079.2
Adilabad	12.1	5.1	15.5	13	33.3	206.1	334.1	318.4	134.7	114.5	11.6	8	1206.4
Jainad	18.4	5	7.4	15.3	25.9	219.6	340	346	132.8	94	8.4	6.4	1219.2
Bela	11.8	3.4	14.5	10	32.4	194.5	342	339.7	144.3	105.7	11.7	7.5	1217.5

Source.: Hand book of statistics Adilabad District 2009.

9.4.2 Monthly Climate data

The monthly maximum and Minimum normal temperatures for Adilabad district are given below.

Month	Normal Temperature (Centigrade)	
	Max	Min
January	26.8	10.1
February	29.6	12.8
March	32.6	17.0
April	36.2	22.4
May	37.4	25.2
June	35.1	23.7
July	31.6	22.2
August	30.2	21.9
September	31.5	21.7
October	32.3	18.4
November	27.7	12.2
December	26.4	9.4

Source.: Hand book of statistics Adilabad District 2009.

9.5 Proposed Cropping Pattern

Maharashtra Government approved the cropping pattern for the joint project and the same was adopted in the DPR prepared by the Maharashtra Government.

The approved cropping pattern is given below.

Approved Crop pattern as per Govt. of Maharashtra				
	Season	**Crop Name**	**%**	**Remarks**
A)	Perennial	Sugar cane	-	
		other	-	
B)	Tow seasonal	Cotton (Medium Staple)	20	
		Chillies	4	
		Termeric	3	
			27	
C)	Kharif Season irrigated	Hy.Jowar	20	
		Ground Nut	15	
		Sunflower	5	
		Vegetables	10	
			50	
D)	Kharif Season Unirrigated	Pulses & fodder (Tur)	**23**	
			100	
E)	Rabi Season	Wheat	5	
		Jowar	10	
		Gram	10	
		Sunflower	15	
		Saf flower	15	
		Vegetable	10	
			65	
	Total cropping intensity		**165**	

The actual cropping pattern proposed for this project will be as per the approved cropping pattern by Maharashtra as adopted in the combined DPR.

9.6 Crop Water Requirement

The crop water requirement is worked out as per modified Penman`s method as per the procedure given in FAO publication 24 and WMD, Ministry of Agriculture Technical Series No. 2 1971. The annual demand for irrigation is 139.4 Mcum or 4.923TMC.

The inputs for calculating the crop water requirement, namely, crop coefficient, ETO and rainfall values are adopted as per the values considered in the DPR for the joint project prepared by Maharashtra Government. Also seepage loss rate of 0.61 cumec per million Sq.m of wetted area is considered.

The detailed computations of crop water requirement are given in Annexure 9.6/1

9.7 Water Planning

The total available water for Andhra Pradesh from Lower Penganga project is 5.12 TMC annually. This water is to be fully utilised for irrigation and drinking water purposes of enroute villages in Adilabad district.

As per the National Water Policy and existing guidelines of CWC, irrigation and multipurpose projects should invariably include a drinking water component, whenever there is no alternative source of drinking water. Drinking water needs of human beings and animals should be the first charge on any available water. In this regard guidelines are available in the following.

- Guidelines on Provision for Drinking Water Supply Systems in Multipurpose and Irrigation Projects – issued by Central Water Commission.
- Manual on Water supply and Treatment – brought out by Ministry of Urban Development.

9.7.1 Drinking Water Requirement

The drinking water requirement is for the towns and villages enroute the canal alignment in the project area. The quantity of water required for drinking purpose is assessed based on the population projected over the next 50 years after completion of the project.

Data on the population statistics of Adilabad district is collected from the census of 1901 to 2001 from the Handbook of statistics, Adilabad district 2009, published by the Chief Planning Officer, Adilabad.

Population projections are made for the year 2064 (50 years from 2014, the year when the project is expected to be commissioned).

The total population of the 89 villages in the command as per the 2001 census is 76000. The average decade growth rate of population of Adilabad district as per the census records from 1901 to 2001 is 18.82%. By applying arithmetical progression method, the projected population after 50 years in 2064 would be 1,65,380.

The per capita demand per day in case of rural areas is between 40 to 70 liters as per the CPHEEO guide lines. However, the per capita demand for this project is considered as 70 liters per day per person. Considering filtration and other losses as 25% and assuming 5% as industrial demand, the total requirement towards drinking water is assessed as 5.546 Mcum (0.197TMC).

The detailed calculations are presented in Annexure 9.7/1.

This requirement will be added to the peak requirement for irrigation including provision for rush irrigation for designing the canal capacity at the head.

9.7.2 Irrigation purpose

The total quantity of water required for irrigation purpose is 4.395 TMC excluding seepage losses. The requirement on fortnightly basis assessed as per the working table is given below.

Month /Fortnight		Qty (Mcum)	Flow rate (cumec)
June	1	1.016	0.784
	II	1.908	1.472
July	1	1.005	0.727
	II	1.072	0.827
August	1	1.005	0.727
	II	1.072	0.827
September	1	4.978	3.841
	II	6.725	5.189
October	1	8.777	6.349
	II	12.318	9.504
November	1	13.057	10.075
	II	16.851	13.002
December	1	20.733	14.998
	II	18.544	14.309
January	1	13.667	9.894
	II	11.930	9.206
February	1	6.605	4.778
	II	1.483	1.320
March	1	1.005	0.727
	II	1.072	0.827

9.7.3 Availability of Water (Surface)

Detailed water availability studies for the joint project have been carried out by Maharashtra Water Resource Department. Working tables were also prepared and the success of the project was established.

The proposed utilisation by Andhra Pradesh under this project is 5.12 TMC annually.

9.7.4 Canal Capacity

The demand at the canal head is arrived at considering all the requirements for peak irrigation, drinking water and seepage losses. The total length of canal is divided into 5 reaches as given below.

Reach no	Chainage		Reachwise discharge
	From	To	cumec
I	0.000	22.194	16.48
II	22.194	47.068	14.68
III	47.068	62.492	11.45
IV	62.492	80.817	6.78
V	80.817	89.09	2.09

The canal section for each reach is designed as per the procedure given in the relevant BIS code.

9.8 Command Area Drainage

9.8.1 Review of existing drainage system

(a) The maximum intensity of rainfall over the command (SPS value)is given below.

1 day 410mm

2 day 560mm

3 day 592mm

(Source: Generalised PMP Atlas for Godavari published by CWC)

(b) Assessment of water logging, soil salinity and alkalinity

From the local inquiry and field inspection, it is gathered that these problems do not exist in the command.

(c) Identification of areas needing drainage

No water logging problem is anticipated.

9.8.2 Type of drainage needed with proposals

Does not arise.

9.9 Water course / Field channels

Provision for water courses / field channels has been made at the rate of Rs.15000/- per acre on the basis of sub estimate of a representative sample area surveyed.

9.10 Water Management

9.10.1 Review and evaluation of existing system of operation and distribution

At present Water User Associations manage the water distribution at field level. The system is functioning satisfactorily.

9.10.2 Proposal for Participatory Irrigation Management

Participatory Irrigation Management is already in vogue through WUAs.

9.10.3 Scope of introduction of modern technology like sprinklers; drip irrigation etc. (generally for lift schemes)

Not contemplated in this report as irrigation in the present project is planned through gravity canal.

9.10.4 Existing practice of Dept. of Agriculture for popularising micro irrigation

Micro irrigation system is popularised through seminars, publicity and workshops. However at present the area irrigated in Adilabad by lift irrigation is virtually nil.

9.10.5 Facilities for Training the Operation and Maintenance-personnel at-different levels of management & farmers

Departmental infrastructure is available for this purpose. Govt. of A.P invested large amounts under Neeru-Meeru program towards water conservation and water management program.

9.10.6 Existing extension activity & proposals for its improvement be described.

Does not arise.

9.11 Agricultural support services

Existing :- Does not arise.

Proposed :- Does not arise.

CHAPTER 10

COMMAND AREA

10.1 Command Area

10.1.1 Command Area Details

(a) Location

Area covering 4 mandals of Adilabad district, Andhra Pradesh.

(b) Classification of Land

Culturable, Waste Barren.

(c) Gross Command Area, Culturable command area (ha)

Sl.no	Name of Mandal	GCA	CCA
1	Tamsi	5434	2934
2	Adilabad	886	479
3	Jainad	19485	10522
4	Bela	9811	5298

d) Size of Land Holding

Most of the land is held by small and medium farmers.

10.1.2 Climate of Command Area.

(a) Average annual Rainfall... 1157mm

(b) Seasonal distribution

Monsoon 984mm

Non-monsoon 173mm

(c) Coefficient of variation

The coefficient of variation of rainfall over the sub-basin is generally of the order :

- June 60%.
- July 40-50%

- August 50%
- September 70 to 80%
- October >100%

(d)Temperature

Maximum	41.1 ^{o} c
Minimum	9.4 ^{o} c
Average	25.3 ^{o} c

Evapo-Transpiration (ETO) – annual **1577mm**

10.1.3 Irrigation

(a) Prresent source of irrigation in the command is Rainfall

(b) Methods of irrigation followed are Minor tanks and bore wells

(c) Status of land development for Irrigated Areas

(I) Condition of Channels..... unlined

(ii) Longitudinal slopes in the fields.. Natural ground

(iii) Status of Field channels and drains. Unlined

(d) Assumed field application efficiency... 60%

(e) Record of water logging, Salinity and Flooding

No records are available. However, from the local inquiry and field inspection, it is gathered that these problems do not exist in the command.

10.1.4 Socio-Economic Aspect

(a) Population major occupation(s) income etc.

The major occupation of the population is farming and agricultural labour. About 74 % of the population live in rural areas. The per capita income is very low. However the average daily earning of coal worker is Rs.750/-

(b) Classification of farmers (marginal-small-medium-big)

Majority of the farmers are marginal and small.

(c) Land tenure

Small formers own 1 – 2 acres per person.

(d) Annual Income-average (Rs)

Category	from farm	subsidiary sources	Total
Land less	nil	20000 (labour)	20000
Marginal farmers (upto 2 acres)	25000	10000 (labour)	35000
Medium farmers (5 acres)	70000		70000
Big farmers (10 acres)	150000		150000

(e) Availability of agriculture labour and wages

About 74% of the people in Adilabad district live in rural areas. They are mostly agriculture workers. The average daily wage of agricultural worker is Rs. 200.

10.1.5 Infrastructure facilities

(a) Railways and roads (villages, district etc.)

Railways

There are 16 no of railway stations in Adilabad district with a track length of 219km in the district.

Highways

Length of roads in the district is given below.

I. National Highway 110km

II. R&B

- State Highways 340km
- Major district roads 844km
- Other district roads 764km

III Zilla parishad 7355km

(all roads including district and village roads)

(b) Marketing facilities

There are a number of agriculture market committees in the district. There are 60 godowns with a storage capacity of 33180 MT.

(c) Agro-industries

The Horticulture department has implemented several schemes (Mango, Coconut, Oilpalm etc.)

(d) Banks; credit societies etc.

There are a total of 22 banks functioning in Adilabad district. The average population per Bank branch is 5829000. The details of the banks is given below

Nationalised banks	9
Rural banks	4
Cooperative banks	1
Other banks	8

10.2 Topography and Soils

10.2.1 Topography and Relief

The terrain is generally undulating with a large forest cover. There are some hill ranges notable among them being Sahayadri.

10.2.2 Land Slopes

The land is generally undulating with gentle slopes from west to east.

10.3 Drainage – Density of natural drainage (km per sqkm of command area.)

The most important river that drains the district is the river Godavari. The Penganga, Wardha and Pranahita are the other important rivers. Kadam river and Peddavagu river also drain the district. Besides these major rivers, small rivers like the Satnala, the Swarna vagu and the Sudha vagu also drain the district. Thus, the natural drainage network of the district is very dense.

10.4 Agriculture

10.4.1 Present land use

Adilabad district is economically backward. The percentage of tribal population in the district is 16.74% of the total population and that of schedule castes is 18.54%. The rural population in the district is 73.47% consisting of mainly illiterate working class. The literacy rate of the district is 44.7%. The main occupation and source of livelihood of the people of Adilabad is agriculture. Even though the lands are fertile, the farmers depend on ill distributed and erratic rainfall with no dependable assured irrigation at all. Thus, full benefit of the natural resources are not realised by the people so far.

The total geographical area of the district is 1610500 Ha, out of which forest area is 43%, barren and uncultivated land is 3 % , land put to non agricultural uses is 4%, Current fallows is 7 %, Permanent pastures and other grazing lands is 1%, Other fallow land is 4% , net area sown is 37% and land under miscellaneous tree crops & groves not included in net area sown is 1%.

10.4.2 Cropping pattern followed.

Season	Irrigated		Rainfed		Remarks
	% area	Yield (T/ha)	% area	Yield (T/ha)	
Kharif		2.72		1.329	
Rabi		2.867			

10.4.3 Agriculture practices adopted-use of

(a) Improved implements and seeds

(b) Fertilizers, insecticides, pesticides, etc.

(c) Extension services.

Conventional type of farming is in practice.

10.4.4 Farmers' attitude towards improved agricultural practices and willingness for payment of water rates to meet O&M expenses.

Generally willing to implement improved agriculture practices and willing to make payment of water rates to meet O&M expenses.

10.4.5 Preparedness by State Irrigation/Agriculture Departments/WUAs/ Cooperatives to adopt improved farming system.

Generally prepared to adopt improved agriculture practices and forming system.

10.4.6 Identification of problems in command area

10.5.1 Physical problems (including hazards)

(a) Land slopes
(b) Soil depth
(c) Salinity/alkalinity
(d) Soil erosion
(e) Water logging
(f) Drainage
(g) Any other

Not expected to face any such problems.

10.5.2 Financial problems

(a) Socio-economic conditions

The farmers in the command are poor with small and marginal land holdings. They need financial support for seeds and manures.

(b) Availability of improved implements/machines and other inputs.

Only conventional type of implements are being used.

(c) Credit facilities - Existing Cooperative structures/Number of primary agricultural societies in the area

Public sector banks and co-operative banks are existing in the area.

(d) Infrastructure facilities

Seed supply centers, Agriculture marketing yards are established in the area.

(e) Department of Agriculture and Soil Conservation's Plan for agricultural development with details of financial sharing.

10.6 Proposed Cropping pattern with justification based on land Irrigibility classification, agro-climatic conditions, developed irrigated cropping pattern in the adjoining projects/areas etc.

As per Para. 9.5 above.

10.7 Land Development Works (proposals)

10.7.1 Area involved

(a) Land leveling/shaping

(b) Field channels

(c) Field drainage

(d)Implementation of warabandi

(e) Reclamation of water logged areas.

(f) Farm roads

No specific land development plans are proposed other than the canal system.

10.7.2 Measures proposed

No specific land development plans are proposed other than the canal system.

10.7.3 Agency responsible for survey planning and execution of land' development works. Availability of experienced agencies/contractors and their willingness to employ local population especially displaced persons.

No specific land development plans are proposed other than the canal system.

10.7.4 Cost estimates and cost per ha for land development.

No specific land development plans are proposed other than the canal system.

10.7.5 Financing arrangement for execution of works

No specific land development plans are proposed other than the canal system.

10.7.6 Schedule for completion of land development

No specific land development plans are proposed other than the canal system.

10.7.7 Status of existing extension services, credit agencies, TCD 'farms etc. and location of inputs like seeds fertilizers, insecticides.

Many nationalised banks and other banks totaling 22 in number are functioning in the district.

10.7.8 Conducting adaptive trials and demonstration on farmers field.

10.7..9 Action Research Programme

10.7.10 Participatory Irrigation Management

Being implemented through WUAs

10.7.11 Training of

(a) Senior Level Officers

(b) Middle level officers

(c) Farmers

Necessary training will be imparted as per requirement.

10.8 Ayacut roads

The existing road network is adequate. No provision is made for new roads except inspection path along the bank of the main gravity canal.

CHAPTER 11

FLOOD CONTROL

Not applicable.

CHAPTER 12

DRAINAGE

No drainage congestion / water logging / Salinity is anticipated.

12.1 Basin Characteristics

(a) Geological history/geology

(b) Physiography

(c) Existing Drainage lines

(d) Farm drainage

(e) Rainfall, its distribution over space and time (give 1, 2 and 3 days rainfall of 5 years frequency)

The above information is given in detail in chapter 4.3.1 (geology) and chapter 5 (Hydrology) above.

12.2 Investigation--Brief

(a) Water-table investigation and Artesian conditions, if any

Not warranted

(b) Soil surveys-texture and permeability

Not warranted

12.3 Cultivation practices

(a) Existing cultivation practices

Conventional practices only.

(b) Proposed cultivation practices

Modern practices can be gradually introduced.

12.4 Existing Drainage

Natural drainage system.

12.5 Drainage deficiencies

No deficiency.

12.6 Drainage requirements including alternative layout of drains, their capacities

Not required and hence not proposed.

CHAPTER 13

POWER

Not applicable.

CHAPTER 14

NAVIGATION

Not applicable.

CHAPTER 15

CONSTRUCTION PROGRAMME AND MAN POWER AND PLANT PLANNING

15.1 Construction Programme

Work Program in the form of bar chart enclosed vide Annexure 15/1

15.2 Key materials Planning

15.2.1 Special Materials

(a) Cement

(b) Steel

(i) Structurals

(ii) Plates

(iii) Bars & rounds

(iv) Special Steels, if any

(c) Explosives

(i) Gelatin

(ii) Detonators

(iii) Fuse coil

(iv) Explosives-Ammonia Nitrate

.

(d) Oils and Lubricants

(i) H.S.D. Oil

(ii) Petrol

(iii)Lubricants

Work is likely to be carried out through contractors. Hence, no planning of material is required at this stage.

15.2.2 Materials - Data

Material	Source	Mode of transportation	Distance from nearest Rly.stn to work site	Mode of handling
Cement	Manufacturers	Rail / Road		Trucks
Steel	SAIL	Rail / Road		
Explosives				
Oils and Lubricants	Oil Companieas			

15.3 Construction power requirement & proposed supply arrangement

Power requirement for the construction is insignificant and will be drawn from the local power grid.

15.4 Plant/Equipment Planning

Work is likely to be taken up through EPC procedure.

15.5 Man Power Planning

Work is likely to be taken up through EPC procedure. Required professional and Technical staff will be provided. The work is likely to be attached to a division of I&CAD department, under the control of a circle.

CHAPTER 16

FOREIGN EXCHANE ELEMENT

No foreign exchange is involved.

CHAPTER 17

ENVIRONMENT, ECOLOGY AND FOREST ASPECTS OF THE PROJECT

EIA aspects are covered separately in the EIA study report.

CHAPTER 18

ESTIMATE

18.1 The estimates are prepared as per the CWC publication "Guidelines for preparation of estimate for river valley projects". The Andhra Pradesh Schedule of Rates for the year 2012-13 are followed.

18.2 Classification of Units

The project works are grouped into the following units:

Unit-I Head-Works including main dam and auxiliary dam, dykes spillway, outlet works, energy dissipation devices, barrages, weirs regulators including intake structures and diversion works.

Unit-II - Main canals, branches., and distribution system inclusive of all pucca works.

18.3 Accounts Heads

18.3.1 Minor Heads:

(i) Direct Charges

(I) Works

(II) Establishment

(III) Tools and Plant

(IV) Suspense.

(V) Receipts and recoveries on capital account

(ii) Indirect Charges:

a) Capitalized value of abatement of land revenue, and

b) Audit and account charges.

18.3.2 Detailed Sub-Heads under I-Works

A- Preliminary

B- Land

i) Acquisition & Compensation

ii) Rehabilitation and resettlement

C- Works

D- Regulators and measuring devices (for canals only)

E- Falls (for canals only) .

F- Cross drainage works (for canals only).

G- Bridges (for canals only)

H- Escapes (for canals only)

1- Navigation works

J- Power Plant Civil Works

K- Buildings

L- i) Earthwork;

ii) Lining and

iii) Service Road

M- Plantation

N- Tanks and reservoirs

0- Miscellaneous

P- Maintenance

Q- Special T&P

R- Communications.

S- Power Plant and Electrical Mechanical system

T- Water Supply Works

U- Distributaries minors and sub-minors.

V- Water courses

W- Drainage (to be clubbed with Environment and ecology)

X- Environment and ecology

Y- Losses on stock

18.4 Abstract of cost

18.4.1 Detailed Abstract of Cost

The cost of various units are compiled in a tabular form according to the various accounts heads as below.

18.4.2 General Abstract of Cost

On the basis of the detailed abstract of cost as in Para 18.4.1 .a general abstract of cost for the whole project is compiled by minor and detailed heads in the following table.

18.5 Preparation of estimates

18.6 Detailed estimate of costs – 1 Works

Above items 18.1 to 18.6 are presented in the detailed estimates volume.

The classified abstract of cost for 1-works is given below

GENERAL ABSTRACT		
LOWER PENGANGA INTER STATE PROJECT		
Sno	**Description of Item**	**As per SSR 2011-12 Amount Rs. in Crores**
1	**Construction of Gravity Canal**	
i.	Earth work	155.30
ii.	Lining	87.25
iii.	Cross Masonry works	24.55
iv.	Cross Drainage works	136.93
v.	Offtakes	1.84
vi.	Cross Regulators	2.06
vii.	Distributory network @ 15000/- acre	
	Total acres = 19233 Ha = 47525 acres	71.29
viii.	Office Buildings and Quarter at Nirmal and Adilabad	8.25
		487.48
	Sub-Total	**487.48**
	L.S Provisions	
1	Provisions for Land Acquisition and R&R (5%) of Rs.487.48 Crores	24.37
2	Provision towards VAT @ 5% on Rs. 487.48 Crores	24.37
3	Provision towards Service tax @ 4.12% on Engineering works Rs. 4.875 Crores	0.20
4	Price Variation provision @ 5% on 487.48	24.37
5	For Contingencies 0.5% on 487.48	2.44
	Provisions for Labour cess (1%) of Rs.487.48 Crores	4.87
	Provisions for Detailed investigation and design (1%) of Rs.487.48 Crores	4.87

	Sub-Total	**85.51**
	GRAND TOTAL	**573.00**

18.7 II-Establishment

The work is likely to be taken up on EPC contract basis which reduces the involvement of department to considerable extent. Accordingly a provision of 2 % of (1-works-B land) is considered in the estimate.

18.8 III – Tools & Plants

As the work is likely to be taken up on EPC basis, no separate provision is made under this head.

18.9 IV - Suspense

Nil

18.10 V – Receipts and Recoveries on capital account

Permanent office and residential buildings will be constructed, which will remain with the department even after construction of the building. No special T& P are required for the project, as the project will be constructed through EPC contract. As such there will not be any receipts or recoveries which will constitute revenue to the Government. As such the provision under this head is Nil.

18.11 Indirect charges

A provision of 0.5 % of 1 works is provided under this head.

CHAPTER 19
BENEFIT - COST RATIO

B.C. RATIO

The B.C. Ratio for the joint project is 1.61 as worked out by Maharashtra.

ECONOMIC RATE OF RETURN (IRR)

The IRR for the joint project is 12.27% as worked out by Maharashtra