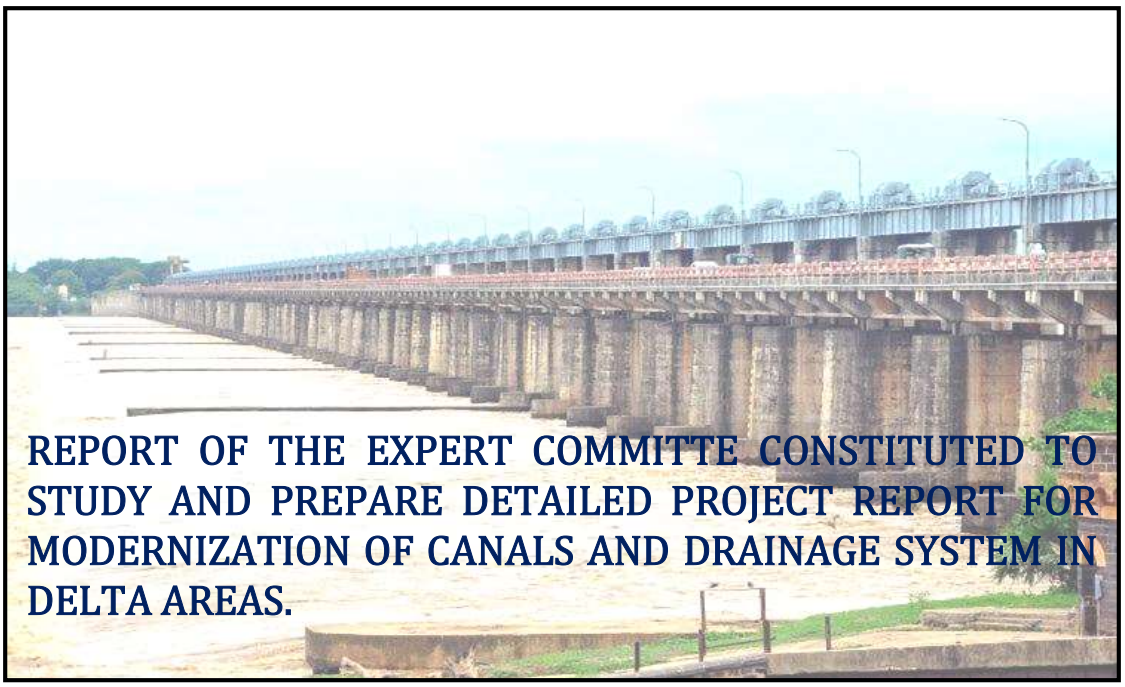
GOVERNMENT OF ANDHRA PRADESH

IRRIGATION & CAD DEPARTMENT



REPORT OF THE EXPERT COMMITTE CONSTITUTED TO STUDY AND PREPARE DETAILED PROJECT REPORT FOR MODERNIZATION OF CANALS AND DRAINAGE SYSTEM IN DELTA AREAS.

HYDERABAD

ANDHRA PRADESH

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1. PREAMBLE

1.1 Constitution of Expert Committee:

The rich coastal areas of Andhra Pradesh in the Districts of Krishna, Guntur and Prakasham are prone to cyclones frequency. Vast stretches of area have been affected recently due to 'Ogni' cyclonic rains from 29.10.2006 to 04.11.2006. The intensity of rainfall in Krishna Delta is as high as about 500mm in a single day observed at Gudiwada of Krishna District, inundating vast extents of paddy fields and habitations. The existing network of drainage system was not capable of relieving the drainage congestion to the desired level. It could also be due to poor & inadequate maintenance of existing drains that the problem has further aggravated.

In a review meeting held by Hon'ble Chief Minister on 04-11-2006, it was decided to constitute an Expert Committee to study and prepare Detailed Project Report for modernization of canals and drainage system in delta areas. The Government of Andhra Pradesh in G.O. Rt. No. 784 I & CAD (P.W.Maj. Irr.VII) Department, Dated 20-11-2006 (Annexure-I), constituted an Experts Committee with the following Engineers to make a detailed study the problems and to come up with suitable suggestions, so that a detailed project report for modernization of canals and drainage system of Krishna & Godavari Delta areas can be prepared and implemented.

1. Sri B. Rosaiah, Engineer-in-Chief (Retired) — Chairman
2. Sri B.P. Venkateswarlu, Engineer-in-Chief (Retired) — Member
3. Sri P. Sambasiva Rao, Engineer-in-Chief (Retired) — Member
4. Sri J.L. Murthy, Chief Engineer (Retired) — Member
5. Sri A.S. Suryanarayana Murthy, Chief Engineer (Rtd) — Member
6. Engineer-in-Chief (I) & Drainage Unit — Member Convener

1.2 TERMS OF REFERENCE:

The terms of reference for the committee are:-

i) To study the existing Delta System (Irrigation and Drainage Systems) as to how it is responding to the severe cyclonic storms and floods, which occurred in the past and to come up with suggestions for permanent solution and to suggest modernization of the systems.

ii) To study the innovative ideas proposed by the Farmers about linking of Budameru and other drains to Krishna River wherever feasible.

iii) To explore and identify the need for more straight cut to drains in Prakasham District.

iv) The Expert Committee shall complete the study within a period of two months and shall prepare the detailed project report.

1.3 Field Visits:

The Committee inspected the irrigation and drainage system in Godavari Delta from 18-01-2007 to 21-01-2007. The Committee interacted with the public during the inspection and held discussions with the public representatives and others at Kakinada on 19-01-2007 and at Eluru 21-01-2007

The suggestions made by the public representatives on providing better irrigation and drainage facilities are noted the proposals are studied and included in the report.

2.00 GODAVARI DELTA IRRIGATION SYSTEM

2.1. Preamble:

The river Godavari is the second largest river in the Indian Union and the largest in South India. It rises near Nasik in Maharashtra State and flows generally in a South Easterly direction for about 1500 KM and falls into Bay of Bengal. The main tributaries of the Godavari are the Manjhira, the Pranahita, the Indravathi and the Sabari. The river bifurcates into Gowthami river and Vasista river. The river Gowthami bifurcates into Gowthami and Vrudha Gowthami and Vasista into Vasista and Vynatheyam. The catchment area of the river Godavari at Dowlaiswaram is 3,14,685 Sq.KM and the maximum flood discharge recorded at Sir Arthur Cotton Barrage, Dowlaiswaram is 33,50,000 cusecs during the year 1986. The river receives a large portion of its run off during South West Monsoon (June to September).

2.2. Godavari Delta – History:

In coastal Andhra, Godavari Delta consists of West Godavari and East Godavari Districts. This delta lies between latitude 16º - 30" to 17º - 0" and longitude 81º - 15" to 82º - 30". The Godavari Delta area lies in the belt of tropical semi arid to sub humid climate. The mean annual precipitation varies from 1076 MM. to over 1153 MM. and is mostly confined to the period from June to November. The mean annual temperature varies from 32º C to 45º C. The area is mostly alluvial in nature with patches of light black cotton soils.

2.3. Godavari Anicut – History:

The Godavari Districts were suffering from floods and famine conditions frequently. The decreasing population and dwindling revenue forced the British Government to take up the Godavari Delta Anicut Scheme.

A masonry diversion weir with rough stone aprons was built by the famous British Engineer Sir Arthur Cotton across the mighty river Godavari near Dowlaiswaram with a network of canals utilizing purely indigenous material and labour in order to divert water to spread over the surface of this Delta for irrigating large extents of lands, which were subject to chronic famine conditions. The construction of this anicut was undertaken in the year 1846 and completed by 1852 at a cost of Rs. 15.08 lakhs

The original scheme consists of anicuts on four arms of river Godavari near Dowlaiswaram with a crest level of +36.00 ft. and the irrigation potential originally envisaged in the year 1852 was 6.12 lakh acres. During 1862 to 1867, the crest of the anicut was raised to +38.00 ft. but the ayacut brought under cultivation by then was 4.36 lakh acres only. 2.00 ft. falling shutters were installed raising the crest level to +38.75 ft. in 1898 increasing the Ayacut to 6.40 lakh acres. Even this level was found inadequate to meet the rapid expansion of irrigation and during 1936 the Ayacut increased to 9.81 lakh acres with introduction of 3.00 ft. falling shutters.

2.3.1 Salient features of Godavari Anciut:

Length of Old Anicut:-

1. Dowlaiswaram Arm	- 1474.80 Mt	Across Gowthami
2. Ralli Arm	- 871.30 Mt	River
3. Madduru Arm	- 472.40 Mt	Across Vasista
4. Vizzeswaram Arm	- 792.80 Mt	River
	3611.30 Mt	

Crest of Anicut : +11.81 M (+ 38'.75")

Top of Anicut Shutters: +12.72 M (+ 41'.75")

Height of Shutters: 0.91M (3' 0")

No. of Shutters: 1103 Nos of each 3.0 M long

Catchment area of Godavari: 3, 14,685 Sq Km
at Anicut site (1,19,700 Sq. Miles)

Length of River: 1465 Km (894 Miles)

M.F.D: 31,20,000 Cusecs
Observed on 15-8-53

HEAD SLUICES

1) Eastern Delta Main Canal at Dowlaiswaram

No. of Vents:	14 Nos
F.S.L Rear:	+ 12.50 M (+ 41' 0")
Sill Level:	+ 9.75 M (+ 32' 0")
Bed Width of Main Canal:	50.90 M (167 ft)
F.S. Depth:	2.74 M (9 ft)
Ayacut:	2,57,000 acres (1,40,049 Ha)
Observed Discharging capacity:	3,000 Cusecs

2) Central Delta Main Canal at Bobberlanka

No. of Vents:	15 Nos
F.S.L Rear:	+ 12.58 M (+ 41.30')
Sill Level:	+ 9.69 M (+ 31.8')
Bed Width of Main Canal:	32.61 M (107 ft)
F.S. Depth:	2.90 M (9.50 ft)
Ayacut:	2,08,000 Acres (84,390 Ha)
Observed Discharging capacity:	2,500 Cusecs

3) Western Delta Main Canal at Vijjeswaram

No. of Vents:	8 Nos
F.S.L Rear:	+ 12.71 M (+ 41.70')
Sill Level:	+ 9.62 M (+ 31.55')
Bed Width of Main Canal:	51.82 M (170 ft)
F.S. Depth:	2.80 M (9.15 ft)
Ayacut:	5,16,000 Acres (2,08,907 Ha)
Observed Discharging Capacity:	6,000 cusecs

2.4. <u>Sir Arthur Cotton Barrage – History:</u>

Due to higher potential of water ponded by the anicut and due to passage of time, the soundness of structure deteriorated. Extensive damages were caused near the left end of Ralli anicut during the floods of 1963. Geophysical investigations were conducted and they revealed that the anicuts are in precarious condition due to undermining of foundations. Due to dilapidated condition of the old anicut, SAC Barrage was constructed during 1970 –1984.

The pond level of Barrage is +13.64 M. The raise in pond level will increase the impounding capacity to about 4.00 TMC. The Godavari Barrage Project includes construction of new head sluices for all the three main canals with silt elimination measures in canals and a floating bulk head for repairs to the gates.

Salient features of Godavari Barrage (Sir Arthur Cotton Barrage) :

I. Length of Barrage

S. No	Name of arm	Length	No of vents
1	Dowlaiswaram	1437.92 Mts	70
2	Ralli	884.45 Mts	43
3	Madduru	469.66 Mts	23
4	Vijjeswaram	800.64 Mts	39
	Total:	3592.67 Mts	175

II.	Pond Level	:	+13.64 mt
	Sill Level of Spillway	:	+10.67 mt
	Top of Shutters	:	+14.01 mt
	Size of Shutters	:	3.34 x 18.29 mt
	Top of Road way	:	+22.21 mt
	Width of the Road way	:	7.50 mt
	Width of Piers	:	2.13 mt
	Hoist Platform level	:	+26.62mt

III. Details of Head Sluices:

a) Godavari Eastern Delta Head Sluice

No. of Vents	:	4 Nos
Size of each vent	:	12.195 mt x 3.89 mt
Discharging Capacity	:	6000 Cusecs
Sill Level	:	+ 9.760 Mts.
Designed Discharge	:	6,000 C/s

b) Godavari Central Delta Head Sluice

No. of Vents	:	3 Nos
Size of each vent	:	12.195 mt x 3.90 mt
Discharging Capacity	:	4260 Cusecs
Sill Level	:	+ 9.69 mt
Designed Discharge	:	4,260 C/s

c) **Godavari Western Delta Head Sluice**

No. of Vents	:	5 Nos
Size of each vent	:	12.195 mt x 3.90 mt
Discharging Capacity	:	9,937 Cusecs
Sill Level	:	+ 9.62 mt
Designed Discharge	:	9,000 C/s

2.5. **<u>Modernisation of Delta System</u>**:

There are several problems coming in the way of achieving optimum utilization of irrigation water in Godavari Delta System. As on today, the Ayacut that is irrigated under Godavari Delta System is 10,23,708 acres. No major improvements have been made to the age-old canals and distributary system to cope up with the needs of the present Ayacut and the present carrying capacities are found inadequate to supply water to the entire Ayacut in time. The existing irrigation canals are unlined resulting in considerable conveyance losses, specially in sandy soils. Most of the old structures in Godavari Delta System are showing signs of distress and such structures are to be repaired / reconstructed immediately to avoid further damages. Some of the cross drainage works across the canals do not adequate discharging capacities. Most of the lock weirs have to be redesigned and reconstructed to meet the peak demand. There are no proper regulating arrangements to the irrigation sluices resulting in considerable wastage of water in distribution. It is therefore imperative that the project for modernization of Godavari Delta System is taken up for implementation to help achieve significant improvement in overall irrigation efficiency and thereby increasing crop production. It also results in considerable economy in water use apart from reduction in water logging and soil salinity problems.

There are large extents of suitably prepared command areas in the Delta with readily available infrastructure like head works and conveyance systems. If modernized in accordance with the latest concept of irrigation, higher agricultural yields can be achieved than at present, there by offering immediate results for the money invested on modernisation.

The proposals for Modernization of Godavari Delta System were earlier submitted by I & CAD Department for Rs. 226.00 crores to Central Water Commission, New Delhi during the year 1991 and the C.W.C made certain observations. The proposals were modified by the department duly taking note of the observations and the cost estimates have also been updated with S.S.R. of 2005-06. The proposals of Modernization of Godavari Delta System

mainly aimed at remodeling and improvements to canals and distributary system to suit the designed discharge, lining of branch canals and distributaries wherever necessary, construction/remodeling of existing structures, improvements to flood banks upstream and down stream of Godavari Barrage, improvements to protection works down stream of Barrage and improvements to tidal banks in East and West Godavari Districts.

The Modernization proposals need to deal with the following issues mainly.

2.5.1 <u>Sir Arthur Cotton Barrage (Head works)</u>:- Improvements required to the head works have to be taken up to ensure safety of the structures. It is understood that the Panel of Experts of dam safety cell have inspected the Head works and suggested certain measures. All the measures suggested have to be implemented.

It is observed that the C.C. blocks and other protection works down stream of Barrage have been disturbed and Special Dam Safety Team have pointed out to take up necessary works for down stream aprons and also for the Barrage gates and hoist mechanism in letter dt: 23-06-2005 (copy enclosed). Necessary provisions are to be included in the Modernization proposals for Barrage as no provision for Modernization of Barrage has been included in the proposals earlier prepared.

A total number of 175 spillway crest gates are installed for the Barrage. Further there are 12 gates for the three irrigation sluices and 10 gates for scour sluices.

All the gates, embedded parts and hoists may be got inspected by a team of competent Engineers from the department, Central Water Commission, and reputed Organisations who are in the field of design, manufacture and erection of hydraulic gates, to verify the condition of gates, as the gates were installed more than two decades back. It is suggested that the department may take necessary action to repair/replace gates as may be

recommended by that team of Engineers. Remote control operation of the gates of spillway is recommended.

2.5.2 Maintenance of gates: The departmental workshops available at Dowlaiswaram may be strengthened and entrusted with the responsibility of thorough maintenance of gates which are vital for the irrigation in the delta, on which the economy of two districts mainly depend.

It is understood that painting to the gates is being done subject to availability of funds. It is recommended that the gates may be got painted with suitable epoxy paints having a life of at least three years. It would be convenient both budgetary requirement-wise as well as the time required for painting the gates, to paint 1/3rd of the gates every year, so that every gate gets painted once in three years on rotation.

2.5.3 <u>Canals</u>: The command areas of three deltas comprise Eastern, Central Deltas in East Godavari District and Western Delta in West Godavari District. The water drawn from the river through main canals taking off from the respective head sluices is distributed through net work of branch canals and distributaries. The delta-wise Ayacut that is under irrigation are as follows:

1. Godavari Eastern Delta		2,91,850 acres
2. Godavari Central Delta		2,01,896 acres
3. Godavari Western Delta		5,29,962 acres

	Total:	10,23,708 acres

2.5.4 Godavari Eastern Delta:

The Godavari Eastern Main Canal after running for a length of 6.72 KM bifurcates into Samalkota Canal and Kakinada Canal. The Bank Canal takes off from Godavari Eastern Main Canal at Km 1.30. The canal wise details are

1. **G.E. Main canal**	(Direct Ayacut)		2,986 acres
2. **Bank canal**			
a) Direct Ayacut		59,159 acres	
b) Coringa canal		36,333 acres	
c) Injaram canal		18,013 acres	
	Total:	1,13,505 acres	1,13,505 acres
3. **Samalkota canal:**			
a) Direct Ayacut		37,189 acres	
b) Pithapuram Branch Canal:		35,970 acres	
	Total:	73,159 acres	73,159 acres
4. **Kakinada canal**			
a) Direct Ayacut		60,047 acres	
b) Mandapeta canal		36,234 acres	
c) K.M.J. canal		5,919 acres	
	Total:	1,02,200 acres	1,02,200 acres
		Total:	2,91,850 acres

a) G.E. Main Canal: The Godavari Eastern Main Canal runs from the head sluice of Barrage for a length of 6.72 KMs. It will cater to the demand of bank canal, Kakinada canal, Samalkota canal and the Ayacut of 2,986 acres direct under main canal.

The discharge requirement of main canal excluding rush supplies is

1. Bank canal	1722 cusecs
2. Kakinada canal	1530 cusecs
3. Samalkota canal	1440 cusecs
4. Direct Ayacut under main canal	49 cusecs
Total:	4741 cusecs

The discharge of the main canal may be considered as 4,741 cusecs including conveyance losses assuming that the rush supplies will be accommodated in the free board.

b) Samalkota canal: The Samalkota canal takes off from KM 6.720 of Godavari Eastern Delta Main Canal. This canal is to serve originally an Ayacut of 37,180 acres. Subsequently Pithapuram Branch Canal serving an Ayacut of 35,970 acres is tagged on to Samalkota canal, consequent to construction of Yeleru Reservoir Project. As of now, this canal has to serve a total Ayacut of 73,159 acres. This canal is also to cater to the drinking water needs of Kakinada Town, Samalkota and enroute villages. Several industries like N.F.C.L., G.F.C.L., Spectrum Power, Samalkota Sugars, G.V.K., Gowthami Power, Reliance Power, RAK ceramics etc. are also drawing their requirements from this canal. The areas in and around Peddapuram, Samalkota, Kakinada are poised for a spectacular growth of industries in the near future. The demand on the industrial needs and drinking water needs are likely to increase enormously from the existing drawal of 150 cusecs.

The Samalkota canal has been remodeled to carry 1,440 cusecs discharge at head subsequent to tagging on the ayacut under the Pithapuram Branch Canal. But the canal was not improved to the designed side slopes of 1½: 1. Therefore the present carrying capacity of the canal at head is only 1100 cusecs as against the projected demand of 1,488 cusecs and much difficulty is being felt in water regulation for pushing the required discharge at the proper time to the tail end areas of Pithapuram Branch Canal as the demands have far outstripped the existing carrying capacity.

In view of the rapid growth of industries, it is imperative to improve the canal to 1,440 cusecs discharge at head including 300 cusecs for existing and future requirements for industrial and drinking water purpose, against the requirement of 1,488 cusecs assuming that the rush supplies will be accommodated in free board.

c) Kakinada canal: The Kakinada canal takes off from KM 6.72 of G.E Main Canal to serve an Ayacut of 1,02,200 acres. Besides it has to cater to drinking water requirements to Kakinada Town partly and enroute villages. There are no major industries depending on this canal for their requirements. The Kakinada Canal is now to be remodeled for a head discharge of 1,530 cusecs including 21 cusecs, which the Municipal Corporation, Kakinada is already drawing and 4 cusecs for future requirement for drinking water assuming that the rush supplies required can be accommodated in free board.

d). **Bank canal:** The Bank Canal takes off from KM 1.30 of Godavari Eastern Main Canal .and the Ayacut served by this canal is 1,13,505 acres. The demands towards drinking water and industries are on the increase side from year to year. In addition to the drinking water and industrial needs at 20 cusecs, the demand of union territory of Pondichery for Yanam area at 30 cusecs is also to be met from this bank canal. The existing carrying capacity of this canal in the head reach is 1,575 cusecs only against the peak demand of 1,884 cusecs worked out including the rush supplies at 10%. Much difficulty is being felt in pushing the required supplies at the required time to the tailend areas.

The Bank Canal is now required to be remodeled for a head discharge of 1,722 cusecs with an average duty of 70 acres per cusec considering the industrial and drinking water needs as 50 cusecs which includes supplies to Yanam area as per the demands of the union territory of Pondichery. The rush supplies may be accommodated in the free board.

e) Eastern Delta head sluice: The Godavari Eastern Delta head sluice is designed for a discharge of 6,000 cusecs. This discharging capacity is adequate for carrying discharge through the Godavari Eastern Main Canal after implementation of Modernization.

f) Structures on Godavari Eastern Delta: Due to inadequate number of cross regulators across the irrigation canals and channels, much difficulty is experienced in maintaining levels. Some of the cross drainage works across the canals are not having adequate drainage discharging capacities. Some of the old structures on Godavari Delta System are showing signs of deterioration, as they are century old. Such structures are to be repaired or reconstructed as the case may be. There are altogether 334 Nos. of structures on main canals and branch canals which require remodeling / replacement as per the requirement and their present condition.

g) Distributories : A net work of distributories and sub distributories takes off from main canals, branch canals etc. for providing irrigation supplies to the ayacut through field channels. The ayacut of 2,91,.850 acres of Godavari Eastern Delta is served by a number of distributories running for a total length of 1082.50 KMs. These distributories were earlier designed for a duty of 56 acres per cusec and it is now proposed to continue the same procedure in the modernization of the system. The sill levels and size of pipes etc. have been reportedly changed (unauthorisedly) from those designed, which led to difficulties in water regulation and untimely supplies to the tail end ayacut under many distributaries. It is recommended to fix sill levels and size of pipes strictly duly providing the pipes of size as required on design consideration and all the sluices have to be fixed with screw gearing shutters or stem type shutters with good sealing and locking arrangements.

Measuring flumes have to be constructed at the head of each distributory and sub distributory for maintaining the releases. A thorough record of the releases sub distributory-wise has to be maintained, and on line transmission of data has to be ensured up to the level of Executive Engineer and Superintending Engineer, so that necessary interventions can be ordered and given effect to.

h) Lining: The Godavari deltaic canals run for short lengths in sandy soils and conveyance losses are very high in such reaches. Much difficulty is

being experienced in meeting the irrigation supplies because of wastage of water due to heavy seepage losses. It is therefore felt necessary to line the main canals and branch canals either with cement concrete or brick-on-edge and for distributaries in selected reaches. Growth of Tape grass is observed in most of the lengthin Samalkota Canal.

2.5.5 Godavari Central Delta:

The main canal of the Godavari Central Delta after running for a length of 13.20 KM bifurcates at Lolla lock into 3 branch canals to irrigate an ayacut of 2,01,896 acres. The canal wise details are :

	Length	**Ayacut**
1, Main canal	13.20 KM	14,486 acres
2. Gannavaram canal	59.10 KM	55,451 acres
3. Amalapuram canal	50.80 KM	63,729 acres
4. Bank canal	62.233 KM	68,230 acres
Total:	185.333 KM	2,01,896 acres

An additional Ayacut of 10,765 acres is now contemplated under proposed schemes viz. Gogullanka lift irrigation scheme (3,500 acres), Appanapalli lift irrigation scheme (4,045 acres) and Gudapalli No. 2 extension channel (3,220 acres) in Godavari Central Delta, in addition to the existing Ayacut of 2,01,896 acres. I.D. crops are grown in 9,139 acres out of the existing Ayacut of 2,01,896 acres. I.D. crops are proposed in an extent of 5,008 acres out of 10,765 acres now contemplated under new schemes. The canal wise existing and additional Ayacut are detailed below:

S.No.	Name of canal	Existing ayacut		Addl. ayacut		Total Ayacut		Total ayacut
		Wet	Dry	Wet	Dry	Wet	Dry	
1	G.C.Main canal	5347	9139	--	--	5347	9139	14486

2	Gannavaram canal	55451	--	2257	5008	57708	5008	62716
3	Amalapuram canal	63729	--	--	--	63729	--	63729
4	Bank canal	68230	--	3500	--	71730	--	71730
	Total:	192757	9139	5757	5008	198514	14147	212661

a) Main canal: The Godavari Central Delta Main Canal runs from the head sluice of Barrage for a length of 13.20 KMs. It will cater to the demands of bank canal, Gannavaram canal, Amalapuram canal and the Ayacut of 14,486 acres direct under main canal. The discharge requirement of main canal considering 70 duty for wet Ayacut and 140 duty for I.D. crops and excluding rush supplies is

1. Gannavaram canal 937 cusecs
2. Amalapuram canal 989 cusecs
3. Bank canal 1107 cusecs
4. Direct Ayacut under main canal 147 cusecs

Total: 3180 cusecs

The main canal is now to be remodeled for a designed discharge of 3,180 cusecs including conveyance losses, with the rush supplies accommodated in the free board.

b) Gannavaram canal: The Gannavaram canal takes off from KM 13.200 of Godavari Central Main Canal to serve the existing Ayacut of 55,451 acres plus the additional ayacut of 7,265 acres contemplated under proposed schemes viz. Appanapalli Lift Irrigation Scheme (4,045 acres) and Gudapalli No. 2 extension channel (3,220 acres). Besides it has to cater to the drinking water requirement enoute the villages. There are no major industries depending on this canal for their requirement. The Gannavaram canal now to be remodeled for a head discharge of 937 cusecs including 22 cusecs presently drawn for rural water supply and 28 cusecs for future requirement for drinking water, with the rush supplies required to be accommodated in the free board. The duty adopted in working out the required discharge is 70 for wet ayacut and 140 for I.D. crops.

c) Amalapuram canal: The Amalapuram canal takes off from KM 13.200 of Godavari Central Main Canal to serve the existing Ayacut of 63,729 acres. Besides it has to cater to drinking water requirement to Amalapuram Town and enroute the villages. The present carrying capacity of the canal at head is only 850 cusecs as against a projected demand of 1,080 cusecs. Much difficulty is being felt in water regulation for pushing the required discharge at the proper time to the tailend areas as the demands have far outstripped the existing carrying capacity. In view of the rapid growth of industries like Konaseema Power Plant and also the increase in demands for drinking water from year to year, it is necessary to improve the canal to 989 cusecs discharge at head reach including drawl at 11.40 cusecs existing and 38.60 cusecs for future requirement for drinking and industrial needs.

d) Bank canal: The bank canal takes off from KM 13.200 of Godavari Central Main Canal to serve the existing Ayacut of 68,230 acres including an additional Ayacut of 3,500 acres under proposed Gogullanka Lift Irrigation Scheme. Besides it has to cater to the needs of drinking water requirement enroute the villages. There are no major industries depending on the canal for their requirement. The existing carrying capacity of the canal in the head reach is 946 cusecs only as against the peak demand of 1,210 cusecs worked out including rush supplies at 10%. Much difficulty is being felt in pushing the required supplies at the required time to the tail ends. The bank canal is to be remodeled for a head discharge of 1,107 cusecs with an average duty of 70 acres per cusec considering projected demand of 50 cusecs for drinking purposes. The rush supplies at 10% required may be accommodated in the free board.

e) Godavari Central Delta Head Sluice: The Godavari Central Delta head sluice is designed for a discharge of 4,260 cusecs. This discharging capacity is adequate for carrying discharge through the Godavari Central Main Canal after implementation of Modernization.

f) Structures on Godavari Central Delta: Due to inadequate number of cross regulators across the irrigation canals and channels, much difficulty is

experienced in maintaining levels. Some of the cross drainage works across the canals are not having adequate drainage discharging capacities. Some of the old structures on Godavari Delta System are showing signs of deterioration as they are more than century old. Such structures are to be repaired or reconstructed as the case may be. There are 467 Nos. of structures on main canals and branch canals which requires remodeling / replacement as per the requirement and their present condition.

The Kummara Calva Aqueduct on Amalapuram Canal was constructed in the year 1902. There are heavy leakages in the trough portion of Aqueduct, and is endangerous during heavy floods and cyclonic periods. It is inevitable to construct a New Aqueduct. Site survey plans are reported to be under submission to Spl. Designs Circle, Hyderabad. The Committee has recommended for taking up immediate repairs and replaced subsequently.

g) Distributories: A net work of distributories and sub distributories takes off from main canals, branch canals etc. for providing irrigation supplies to the ayacut through field channels. The ayacut of 2,01,896 acres of Godavari Central Delta is served by a number of distributories running in a total length of 1021.278 KMs. These distributories were earlier designed for a duty of 56 acres per cusec and it is now proposed to continue the same procedure in the modernization of the system. The sill levels and size of pipes etc. have reportedly been changed (unauthorized) from those designed, which led to difficulties in water regulation and untimely supplies to the tailend ayacut under many distributories. It may be ensured that correct sill levels and size of pipes duly providing the pipes of size as required on design consideration are provided and all the sluices have to be fixed with screw gearing shutters or stem type shutters with good sealing and locking arrangements.

Measuring flumes are also to be constructed at the head of each distributory and sub distributory for maintaining the releases. A thorough record of the releases sub distributory-wise has to be maintained, and on line transmission of data has to be ensured up to the level of Executive Engineer

and Superintending Engineer, so that necessary interventions can be ordered and given effect to.

h) Lining: The Godavari deltaic canals run for short lengths in sandy soils. Conveyance losses are very high in these reaches. Much difficulty is being experienced in meeting the irrigation supplies because wastage of water due to high seepage losses. It is therefore felt necessary to line the main canals and branch canals either with cement concrete or brick-on-edge and distributaries in sandy reaches. The lining is proposed with M 15 concrete over CNS soils as most of the soils in the delta are black cotton.

2.5.6 Godavari Western Delta :

The Godavari Western Delta is intended to serve an ayacut of 5,29,962 Acres + 11000 Acres (Supplementation of K.E. Delta Tail end ayacut) through 11 branch Canals. The total length of these branch canals is 350 Kms.

The canal wise ayacut in Godavari Western delta is given hereunder:

Sl No.	Name of the Canal	Length of Canal in Km	Ayacut in Acres
1	Godavari Western Main Canal	9.555	12998
2	Kakaraparru Canal	16.250	23481
3	Gostanadi & Velpur Canal	54.032	68369
4	Godavari Western Bank Canal	37.100	46617
5	Narasapuram Canal	48.611	91105
6	Eluru Canal	64.446	61977
7	Attili Canal	28.300	50756
8	Junction Canal	7.500	25339
9	Venkayya & Weyyeru Canal	51.200	59749
10	Old Weyyeru Canal	8.000	8083
11	Undi Canal	32.200	81488
	TOTAL	**357.194**	**529962**

1. G.W.Main Canal :
   (Direct Ayacut including PP Scheme) 12998 Acres

2. Kakaraparru Canal
   a) Direct Ayacut 23481 Acres
   b) G&V Canal 68369 Acres
   c) Bank Canal 46617 Acres
   d) Narasapuram Canal 91105 Acres
   Total 229572 Acres 229572 Acres

3. Eluru Canal
   a) Direct Ayacut + 61977 Acres
   Supplementation of K.E. Delta 11000 Acres
   b) Attili Canal 50756 Acres
   c) Junction Canal 25339 Acres
   Total 138072+11000 Acres 138072 Acres
   (+)11000 Acres

4) V&W Canal

a) Direct Ayacut		59749 Acres	
b) Undi Canal		81488 Acres	
c) O.W. Canal		8083 Acres	
	Total	149320 Acres	149320 Acres
		Total	529962 Acres
			(+) 11000 Acres

A) Godavari Western Main Canal :

The Godavari Western Main Canal takes off from Vijjeswaram Head Sluice. This canal has to cater to the irrigation needs of the entire ayacut of 5,29,962 acres in G.W. Delta, besides supplementing irrigation flows required for11,000 acres of tail end ayacut of Krishna Eastern delta under Krishna Eluru canal. The G.W. Main canal runs for a length of 9.555 Km.

Three main / branch canals take off from this main canal in the name of (i) Kakarparru Canal, (ii) Eluru canal and (iii) V&W canal. The G.W. main canal has to serve a direct ayacut of 12,998 acres.

The discharge requirements of the three main/branch canals, at head, at a duty of 70 acres/cusec and providing for the industrial and drinking water needs, excluding 10% rush supplies are given hereunder:

i) Kakaraparru Canal	3502 C/s
ii) Eluru Canal	4540 C/s
iii) Ayacut under main canal	196 C/s

Thus the required discharge at head of G.W. Main canal is 8238 cusecs including conveyance losses at 3% and industrial and drinking water needs. As informed by the departmental officials, the present carrying capacity is 7,600 cusecs only. The canal may be remodeled to suit the required discharge, after getting the carrying capacity confirmed by conducting gaugings, by APERL.

B) Kakaraparru Canal: The Kakaraparru Canal takes off at Km. 9.555 of Godavari Western Main Canal. This canal after running for a length of km 2.15 kms bifurcates into G&V Canal & Kakaraparru canal at G&V lock.

The ayacut under G&V canal is 68,369 acres. The Kakaraparru canal further runs for a length of 14.167 Km upto Peravali lock, where from it

branches off into Narsapur canal & Bank canal. The ayacut under Narsapur canal is 91,105 acres and the ayacut under Bank canal is 46617 acres. The ayacut directly served by the Kakaraparru canal upto Peravali lock is 23481 acres.

This canal also has to cater to the industrial & drinking needs under all canals described above, the discharge requirement for Kakaraparru canal, G&V canal, Narsapur canal & Bank canal are appended. The discharge requirement at the head of Kakaraparru canal is 3502 cusecs considering irrigation requirements at a duty of 70 acres/cusec duly providing for the industrial & drinking water needs as projected by the department & conveyance losses @ 3%. The canal may be remodelled for this head discharge duly obtaining approval to reach wise HPs from Chief Engineer, CDO. The rush supplies required may be accommodated in the free board. Gaugings may be got conducted by APERL for assessing the present carrying capacities of the canal in various reaches.

i) G & V Canal : The Gostanadi & Velpur Canal takes off Kakaraparru Canal at km 11.645 at Gostanadi lock. This canal serves an ayacut of 68,369 acres.

The G & V canal is a drain cum canal from km 11.645 to 33.300 i.e. from Gostanadi lock to Velpur surplus weir, 8 no. of minor drains are in falling into this canal and the canal discharges the drain water during rainy season through Velpur surplus weir (for a designed discharge of 190 c/s). The G&V canal upto km 33.00 was reportedly improved by the CERP organization to discharge the in-falling drain water. The canal has to cater to the drinking water needs of Bhimavaram, Tanuku towns and enroute villages and Industries like Andhra sugars, Delta paper mills etc.,

The discharge requirement at the head of G&V canal is 1058 cusecs including irrigation requirements at a duty of 70 acres/cusec, provision for the industrial & drinking water needs as projected by the department & conveyance losses @ 3%. The rush supplies required may be accommodated in the free board. The canal may be remodeled duly obtained approval of the

CE/CDO reach wise and duly establishing the existing carrying capacity by getting gaugings conducted by APERL.

ii) **Bank Canal** : The Bank Canal takes off at Km. 23.325 of Kakaraparru canal Left Bank and runs upto Lakshmipalem Lock in a length of 40.20 kms and serves an ayacut of 46617 acres.

The discharge requirement at the head of Bank canal is 712 cusecs with irrigation needs at a duty of 70 acres/cusec and making provision for the industrial & drinking water needs as projected by the department & conveyance losses @ 3%. The rush supplies required may be accommodated in the free board.

iii) **Narasapuram Canal** : This canal takes off at Peravali lock i.e., at Km. 25.805 of Kakaraparru Canal and runs upto Mogalthuru Lock in a length of 48.611 km. This canal serves an ayacut of 91105 acres.

The discharge requirement at the head of Narsapuram canal is 1382 cusecs with irrigation requirements at a duty of 70 acres/cusec and making provision for the industrial & drinking water needs as projected by the department & conveyance losses @ 3%. The rush supplies required may be accommodated in the free board.

C. Eluru Canal : The Eluru Canal takes off from Godavari Western Main Canal at Km 9.555 and runs for a length of 64.901 Kms ie., upto Eluru Lock (Krishna Eastern Canal lock). This canal serves direct ayacut of 61977 acres and 11000 acres in the tail reach of Krishna Delta System. The Attili Canal and the Junction Canal branches off from this Eluru canal. The ayacut under Attili canal is 50756 acres. The ayacut under Junction canal is 25339 acres.

Waters required for V&W canal will be released over Settipeta Weir, just down stream of Km. 9.555 of Eluru canal which flows into Errakalva/ Yanamaduru drain near Nandamuru Aqueduct. The V&W canal draws water from Yanamaduru drain at Duvva head sluice and branches off further into

V&W canal, Undi canal and O.W canal. The total ayacut under these three canals is 149,320 acres .

The Eluru canal at head has therefore to be designed to serve a total ayacut of (287,392+11000) 2,98,392 acres.

Therefore, the discharge requirement at the head of Eluru canal is 4540 cusecs with irrigation requirements at a duty of 70 acres/cusec and making provision for the industrial & drinking water needs as projected by the department & conveyance losses @ 3%. The canal may be remodeled to carry 4540 cusecs at head, if necessary, after establishing the existing carrying capacity duly getting gaugings conducted by APERL. The hydraulic particulars reach wise may be got approved by CE/CEO.

i) **Eluru Canal**: The canal takes off from Godavari Western Main Canal ie., at Km 9.555 and runs upto Eluru Canal Lock. The Eluru canal serves a direct ayacut of 61977+11000 acres (11000 acres in originally Krishna Eluru Canal of Krishna Eastern Delta ayacut) besides feeding Attili canal and Junction canal. The Eluru canal is being improved for drawing additional discharge 110C/s for supplementation to the tail end ayacut under the Krishna Eluru Canal of Krishna Eastern Delta and for Drinking water purpose to the Eluru Municipal Corporation. After completion of the above improvement works, the canal has to accommodate the future requirement of 2271 cusecs in the reach from Km 9.827 to Km 10.862 to cater to the drinking water needs of enroute villages and industries ie., Foods Fats and Fertilizers, Andhra Sugars Unit-III including 3% conveyance losses. The rush supplies at 10% may be accommodated in the free board.

ii) Attili Canal: Attili Canal takes off from Eluru Canal off takes at Km. 10.724 and runs for a length of 26 Kms and intended to serve an ayacut of 50,756 acres. The discharge requirement at the head of Attili canal is 773 cusecs with irrigation requirements at a duty of 70 acres/cusec and providing for the industrial & drinking water needs as projected by the department & conveyance losses @ 3%. The rush supplies required may be accommodated in the free board.

iii) Junction Canal: This canal takes off at Km. 15.600 of Eluru canal left bank of Muddapuram Lock and runs for a length of 4.500 Kms and serves an ayacut of 25339 acres . This Canal connects Eluru Canal and V&W canal through Muddapuram Lock for navigation purpose. The discharge requirement at the head for this canal is 383 cusecs with irrigation requirements at a duty of 70 acres/cusec and providing for the industrial & drinking water needs as projected by the department & conveyance losses @ 3%. The rush supplies required may be accommodated in the free board.

D) V&W Canal: The V&W Canal take off from Yanamaduru drain through Duvva head sluice. The canal which receives supplies released over Settipeta Weir besides Yanamaduru drain flows serves an ayacut of 149320 acres and the canal runs fro a length of Km. 52Kms.This canal branches off into three canals ie., i) V&W Canal, ii)Undi Canal and iii) OW Canal. The canal has to be remodeled to suit the requirements projected at 2269 cusecs excluding 10% rush supplies, but including industrial and drinking water needs and conveyance losses at 3%.

i) **V&W Canal**: The Canal runs Duvva Head Sluice up to Yelurupadu Lock. This canal serves a direct ayacut of 59749 acres . In addition to the irrigation requirements, this canal has to cater to the drinking water needs of several villages near around Kolleru lake. The requirements are reported to be 20 cusecs.

A proposal for separating the drain flows from irrigation flows and is reported to be under examination at Government level, as the canal is functioning as drain cum irrigation canal. A statement showing water requirements reach wise is appended.

ii) Undi Canal: This Canal takes off at Chilkampadu lock ie., at Km. 31.986 of V&W Canal and runs for a length of 44 Kms and serves an ayacut of 81488 acres. The discharge requirement at the head of Undi canal is 1235 cusecs with irrigation requirements at a duty of 70 acres/cusec and provision

for the industrial & drinking water needs as projected by the department & conveyance losses @ 3%. The rush supplies required may be accommodated in the free board.

iii) Old Weyyeru Canal: This Canal takes off from V&W Canal at Chinakapavram Lock i.e., at Km. 56.818 and runs for a length of 8Kms and serves an ayacut of 8083 acres. The discharge requirement at the head of this canal is 129 cusecs with irrigation requirements at a duty of 70 acres/cusec and provision for the industrial & drinking water needs as projected by the department & conveyance losses @ 3%. The rush supplies required may be accommodated in the free board.

E) Structures on Godavari Western Delta: Due to inadequate umber of cross regulators across the irrigation canals and channels in the Delta, especially on Eluru Canal, it is reported that difficulty is experienced in maintaining required water levels. Some of the cross drainage works across the canal system are not adequate and the discharging capacities most of the Lock Weirs are inadequate to meet the peak demand. Some of the old structures on Godavari Western Delta are showing signs of deterioration as they are century old. Out of the 24 locks and weirs and major structures, only two locks, 4 Escapeas, 10 UTs and two Weirs and Nandamuru aqueduct were reconstructed recently. All the remaining major and Minor structures are to be reconstructed to cater to the future demands.

Construction /Reconstruction of locks or cross regulators on canals proposed for I.W.T. may be taken up to suit the I.W.T. needs.

F) Distributories: A net work of distributories and sub distributories takes off from main canals, branch canals etc. for providing irrigation supplies to the ayacut through field channels. The ayacut of 5,29,962 acres of Godavari Western Delta is served by a number of distributories running for a total length of 1719.00 KMs. These distributories were earlier designed for a duty

of 56 acres per cusec and the same procedure may be continued while taking the modernization of the system.

The sill levels and size of pipes etc. have been reportedly changed unauthorisedly from those designed, which led to difficulties in water regulation and untimely supplies to the tail end ayacut under many distributories. Correct sill levels and size of pipes duly providing the pipes of size as required on design consideration may be ensured and all the sluices have to be fixed with screw gearing shutters or stem type shutters with good sealing arrangements.

Measuring flumes are also to be constructed at the head of each distributory and sub distributory for monitoring the releases. A thorough record of the releases sub distributory-wise has to be maintained, and on line transmission of data has to be ensured up to the level of Executive Engineer and Superintending Engineer, so that necessary interventions can be ordered and given effect to.

G) LINING: It is reported by the department officials, that seepage of water is very high in these reaches and it is necessary to line the main canals and branch canals to control seepage and thereby minimize the wastage and for distributaries in selected reaches.

Brick-on-edge or C.C. lining as feasible may be considered for lining.

2.6. Crop water requirement:- As per the Polavaram reports from 1995 onwards the utilizations of Godavari delta are shown as 266.30 TMC.(said to before modernization figure) Even in the recent crop water requirement of Polavaram the utilization of Godavari Delta has been shown as 266.30 TMC and after ground water use, the net surface water utilisation is of the order of 224.30 TMC.

Demand table for the above water requirement for Godavari Delta System:

Sl.No	Months	Surface Water (TMC)	Ground Water (TMC)	Total (TMC)
1.	June	6.03	12.00	18.03
2	July	34.61	0.00	34.61
3.	Aug	34.60	0.00	34.60
4.	Sep	31.03	0.00	31.03
5	Oct	30.30	0.00	30.30
6	Nov	11.03	12.00	23.03
7	Dec	10.00	10.00	20.00
8	Jan	13.90	8.00	21.90
9.	Feb	18.60	0.00	18.60
10	March	16.10	0.00	16.10
11	April	13.50	0.00	13.50
12	May	4.60	0.00	4.60
Total		**224.30**	**42.00**	**266.30**

2.7. GROUND WATER:

The crop requirement of Godavari Delta irrigation system has a deficit of 42.00 TMC as per the proposed cropping pattern under Modernization scheme of the Godavari Delta System and ground water exploration is also proposed to be made by conjunctive use.

2.8. RECYCLING OF DRAINAGE WATER.

The coastal region of the delta area is nearly 3 lakh acres. This area is classified as Zone I which is low lying and liable for submersion. It is also proposed to transplant this area early in June so that the crop grow to such an extent as to with stand the submersion during the months of August and September. The canals and channels in this area are also proposed for lining as the transmission losses in this region are noticed to be high. These being tailed lands, they always suffer either with excessive water or deficiency of water.

With a view to supplement this area from drains, the following major drains which re perennial are selected for supplementation. The drain water is proposed to be diverted into canals in June and January to February. The selected drains are (1) Tulyabhaga drain (2) Teki drain (3) Biccavole drain in Eastern Delta, (1) Kunavaram drain, Vasalathippa drain in Central Delta, (1) Yenamadurru drain (2) Nakala drain (3) Bondada drain in Western Delta.
As per the gauging conducted, a minimum flow of 700 C/s is found dependable.

S.No.	Name of the drain;	Minimum dependable Discharge in C/s.
1.	Tulyabhaga drain 4 cum/sec	140
2.	Teki drain 3 cum/ sec.	100
3.	Biccavole drain 0.3 4 cum/sec	10
4.	Kunvaram drain 2.25 cum/sec.	80
5.	Vasalathippa drain 2 cum/sec	70
6.	Yanamadurru drain 7.05 cum/sec	250
7.	Nakkala drain 0.7 cum/sec	25
8.	Bondada drain 0.7 cum/sec	25
		700

The above drains are tidal in the reaches selected for supplementation. The drain water has been chemically examined and found to be suitably for reuse as irrigation water upto February.

It is proposed to construct regulators on these drains at the point of utilization and stop tidal insertion and divert the water into the Delta canals by link channels. The regulators will not have any higher sills than their bed levels so that high floods in drains can be passed without any terrors effects and to scour away the little silting in non-flood seasons when the drain water is raised and stored for supplementing canal water. Thus, in order to augment canal supplies during the periods of scarcity it is now proposed to construct regulators across the drains, so that the drainage water which is at present going waste, can be reused. If necessary low lift pumping may also be adopted for supplementing the canal flows in the lean months. A provision is made in project estimate for the construction of regulators and also for providing low lift pumps wherever feasible.

The Godavari Delta System is an age old established Irrigation system having well defined water courses, field Channels and filed Drains which does not require any improvements to field Channels and field drains. The entire ayacut under the modernization Scheme is already under plough. As such the land leveling and land shaping are not required.

2.9.0 RIVER CONSERVANCY:

In order to protect the irrigated area and the population living on either side of the River from damages due to the floods in Godavari River, flood banks have been constructed along the margins of the river on both sides, above and below the Dowlaiswaram anicuts. The high floods in Godavari do not last more than a few days. All the flood banks of the river were raised by 3 to 4M. after the floods occurred in 1959. Due to the unprecedented floods occurred in 1986, the flood banks on the both sides of the river on the up-stream of Barrage have been raised and strengthened sufficiently.

2.9.1 Flood banks: Godavari River ranks 3rd in the river system of India after Ganga and Sindhu. It rises near Nasik and travels in all 1465 Kms and its tributaries travels through the states of Maharastra, Andhra Pradesh, Madhya Pradesh, Orrisa and to a little extent through Karnataka. The major tributaries are Manjira Indiravathi, Pranahita, Sabari and Maneir. The catchment area of Godavari is 3,15,685 Sq. Kms. The river is known as Akhanda Godavari up to Dowlaiswaram Barrage . The river bifurcates into two main branches namely Gowthami Godavari, Vasista Godavari below the S.A.C. Barrage and finally joins Bay of Bengal after traversing nearly 90 Kms. The Gowthami and Vrudha Gowthami Rivers where as Vasista Godavari bifurcates into Vasista and Vynatheyam river before the confluence with sea.

The river Godavari is conserved with flood banks on both sides with lower reaches from Polavaram in West Godavari District and from Purshothampatnam in East Godavari District upto confluence of Bay of Bengal. The total length of flood banks of Godavari river in East and West Godavari Districts are about 535 Kms (East Godavari 404.46 Kms + West Godavari 130.40 Kms a total of 534.86 (or) 535 Kms).

The Details of the bank of different branches of the river are as follows:

East Godavari District:-

1.Angaluru Flood Bank	1.93 Km.
2. Akhanda Godavari left bank	41.73 Km.
3. Gowthami Right Flood bank	85.10 Km.
4. Gowthami Left Flood bank	63.40 Km
5. Vasista left Flood bank	90.60 Km.
6. Vynatheyam Left Flood bank	28.50 Km.
7. Vynatheyam Right Flood bank	28.20 Km.
8. Polavaram Island Flood bank	40.60 Km.
9. Abandoned bankfrom Nadipudi lock to Km13.4. of Vy.L..B	8.80 Km.
10. Coringa island flood bank (Yanam to Girijanpeta)	9.80 Km.
11. Coringa island flood bank (Yanam to Tallarevu)	5.80 Km.
SUB TOTAL	**404.46 Km.**

West Godavari District:-

1. Akhanda Godavari Right bank		40.20 Km.
2. Vasista Right Flood bank		90.20 Km.
SUB TOTAL		130.40 Km.
TOTAL (East & West Godavari)		**534.86 Km**.
	Say	**535.00 Km.**

Out of which 129.50 Km length of flood banks i.e above barrage and Polavaram Island Project were raised by 2.00m over the observed maximum flood level of 1986 floods and remaining flood banks are formed to O.M.F.L. of 1953 floods, with a free board of 0.9 to 1.5m with top width of 5.5m & side slopes 1.5:1 to 2:1 where the peak discharges recorded was 27 lakhs cusecs at Dowlaiswaram Barrage.

There has been a disastrous flood on 16.8.86 which surpassed all the previous records with a peak discharge of 35.12 lakh cusecs at Dowlaiswaram and the depth of flow over the anicut crest reached nearly 24.6 ft. Consequent to this, extensive breaches have occurred to the flood banks, there by inundating vast areas in all the three sections of the deltas. On account of the above unprecedented floods, many breaches to the flood banks have occurred with a huge loss of population, cattle and crops.

During the floods 2nd to 4th August 2006 which surpassed the 1953 floods have caused breaches to the flood banks of Godavari river causing disasters to mankind.

With experience of the present floods it was proposed to raise the flood banks below barrage by 2.00m over the OMFL of 1986 flood standards for the balance length of 405.50 Kms. The banks are proposed with top width of 6.5m and side slopes of 1:5:1 on river side and 2:1 on land side, and dowel bank 0.3m above TBL. Government in G.O.Ms No. 4 Dt 3.1.07 accorded Administrative Approval for Rs 548.32 crores for raising & widening of flood banks to 1986 standards along with repairs to structure, construction of new structure, formation of ramps & groynes in respective breaches.

As improvements to the flood banks for full length are being taken up under a separate programme, there is no necessity to deal with this issue under modernization project.

Maximum flood levels recorded at Sir Arthur Cotton Barrage:

S.No.	Date	Flood level (in ft)	Maximum discharge in cusecs
1	16-08-1986	24.55	35,12,768
2	25-08-1990	22.73	27,90,628
3	08-09-1994	19.84	22,67,510
4	31-08-2000	17.78	19,89,026
5	21-09-2005	19.30	22,08,973
6	07-08-2006	22.80	28,50,664

2.9.2. **Tidal Banks in East and West Godavari Districts.** The total length of existing tidal banks in Godavari Eastern, Godavari Central and Godavari Western Deltas is 87.60 KMs and details are

1. Godavari Central Delta:

i) Between Gowthami flood bank and Kunavaram drain in Katrenikona and Uppalaguptham Mandals. 25.00 Kms.

ii) Between Kunavaram drain and Vasalatippa drain in Uppalaguptham Mandal 10.00 Kms.

iii) Between Vasalatippa drain to Vynatheyam flood bank in Allavaram Mandal 10.00 Kms

2. **Godavari Eastern Delta:**

i) From Girijanapeta outfall sluice to Yanam flood bank in Tallarevu Mandal: 13.00 Kms.

3. **Godavari Western Delta**: 37.30 Kms.

Total: 95.30 Kms

Tidal bank standards: The maximum high tide level ever recorded is +2.10 M. as per the observations made by the Kakinada Port authorities. It is necessary to revise the standards of the tidal bank providing for a free

board of 1.50 M. above the maximum high tide level so far recorded. The top of bank level is proposed at +3.60 M. The outfall sluices on the tidal banks have to be reconstructed to suit these standards. Single lane road in W.B.M. is proposed over the tidal bank with suitable turn tables at an interval of ½ KM.

i) <u>TIDAL BANKS IN GODAVARI CENTRAL DELTA</u>: The Ayacut of about 50,000 acres in Allavaram, Uppalaguptham and Katrenikona Mandals is being badly affected especially during high tides, as the existing tidal banks are not to standards.

The public representatives are representing for taking up necessary improvements to this existing Tidal Banks as the back waters of the sea are affecting the regular drinking water facilities also. In order to protect the interest of the public and Ayacutdars it is now proposed to improve the existing Tidal Banks.

There by it is proposed to improve the existing Tidal Banks in a total length of 45 K.Ms to avoid crop damages in an extent of 50,000 Acres, as will as drinking water facilities. The high tide level as ascertained from Kakinada Port authorities is +2.10 M. As such it is now proposed to improve the existing tidal banks keeping top level as +3.60 M. considering 1.50 M. free board. There are 22 Nos. of existing structures on the tidal banks. They have to be reconstructed as they are age-old structures. List of structures and typical cross section of the Tidal Bank as proposed now are appended.

ii) <u>TIDAL BANKS IN GODAVARI EASTERN DELTA :</u>

Tidal banks were formed in Coringa Island Project area at tail end of Godavari Eastern Delta in Tallarevu Mandal to protect the surrounding ayacut in an extent of 11,403 acres in P. Mallavaram, Polekurru, Corangi and Gadimoga villages in Tallarevu Mandal from tidal waves of Bay of Bengal. These banks were formed in the year 1954-55 for a length of 13.00 KMs. from Girijanapeta outfall sluice ie. incontinuation of flood bank from Yanam

to Girijanapeta. The tidal bank from KM 0.000 to KM 7.250 ie. Girijanapeta outfall sluice to Pedavalasala outfall sluice was handed over to R & B Department and they have already restored to the standards and remaining balance length from KM 7.250 to 13.000 is to be improved to the proposed standards. The following structures on tidal banks have to be improved or reconstructed as they are age old.

1. Outfall sluice at Gadimoga village limits
2. Outfall sluice at Pedavalasala village limits
3. Outfall sluice at Pedaboddu Venkatapayapalem village limits

iii) <u>TIDAL BANKS IN GODAVARI WESTERN DELTA :</u>

The Godavri Western Delta having tidal banks to a length of 37.30 Kms in coastal belt of the delta to safe guard the tail end ayacut and the detaisl are as follows.

i) South Tidal Bank	7.80 Kms
ii) West Tidal Bank	7.40 kms
iii) East Tidal Bank	2.80 km
iv) Biypputippa Tidal Bank	1.20 kms
v) Old Yanamadurru Drain to Bandala chadu Drain	2.50 kms
vi) Bandalachadu Drain to Polimarathippa Drain	3.50 kms
vii) Yanamadurru Drain to Polimarathipa Drain	1.70 kms
viii) Gunupudi South Tidal Bank	6.90 kms
vii) Gonteru Tital Bank	<u>3.50 Kms</u>
Total	**<u>37.30 Kms</u>**

The above tidal banks are also to be brought to the standards.

2.10. Dedicated drain for disposal of effluents from industries: During the visit of the Committee to East Godavari District, the Hon'ble M.L.As. and other public representatives requested to suggest a dedicated

drain for disposal of effluents from industries directly into sea, as they are causing pollution in the deltaic areas with the effluents led into deltaic canals and drains. There are about 140 large and medium scale industries operating in the district. In future several more industries are likely to come up. At present the discharge of treated / untreated industrial effluents and municipal sewage led into the canals / drains is causing pollution problems.

It is reported that earlier the Andhra Pradesh Industrial Infrastructure Corporation considered a proposal for a dedicated drain for disposal of industrial effluents. The A.P.I.I.C. has entrusted the studies to M/s. Kirloskar Company Limited, for preparation of project report on collection, conveyance and disposal of industrial and municipal effluents. The consultants submitted the detailed project report in 1991 and the following dedicated drains are suggested.

- One drain starts from Hukumpet, Rajahmundry and discharges into Bay of Bengal near Avulamanda village near Uppada. The total length of this proposed drain is 93 KMs.

- Another drain starts from Maredubaka village and discharge into Coringa river near Tallarevu village. The total length of this proposed drain is 38 KMs.

The total cost of the project was estimated as Rs. 34.76 crores as per the S.S.R. in the year 1990-91. It may cost around Rs. 100.00 crores at the present rates. The land required for the proposed drain is approximately 175 acres as per the report submitted by the Consultants. The total power requirement would be approximately 3,500 K.W / day for pumping the effluents at three stages. The operational and maintenance cost would be around Rs. 3.20 crores as per the estimates in the year 1990-91. The project cost and O & M are to be revaluated.

The project was designed for carrying the effluents of capacity 163 KLD, The effluents from the industries would be approximately 83 KLD and from the local bodies would be about 80 KLD.

It is understood that the above project was not pursued further, owning to high project cost and operation & maintenance cost etc.

It is proposed to take up the dedicated drains keeping in view the hazards caused to public health and environment due to contamination of canals / drains with industrial effluents. The Government of Andhra Pradesh may consider levying suitable charges for the operation & maintenance of the dedicated drains from the industries, which are releasing effluents.

2.11. Construction of aqueduct in place of existing syphon for crossing Coringa River near Tallarevu (v).

The Coringa Island main channel is crossing Coringa River at KM 0.573 where there is existing syphon for crossing Coringa River. The ayacutdars have made a request before the Committee during visit to East Godavari District to construct an aqueduct as the existing siphon is not functioning well and causing problems to supply of water to the ayacut down stream of the syphon. The proposals have been studied in depth and observed that the levels of canal and drain does not permit the construction of aqueduct. Further construction of aqueduct is not feasible as the Coringa River is presently navigable. However all the existing structures are now proposed for remodeled or reconstructed to the designed standards in the Modernization of Delta System.

2.12. Diversion of Kovvadakalva flood flows into Godavari river

The Kovvada Kalva is a hill stream originating in Papi Hills in West Godavari District. The Kovvada Kalva runs for a total length of 72.425 KMs before in falling into Rallamadugu near Nidadavolu. Another hill stream by

name Pedralla Kalva joins the Kovvada Kalva below the point of crossing of Indira Sagar Right Main Canal.

The Kovvada Kalva and the Pedralla Kalva cross the Indira Sagar Right Main Canal closely.

A small reservoir with a gross storage capacity of 0.42 TMC is constructed across Kovvada Kalva near L N D Peta in West Godavari District. The spillway of the reservoir is designed for a maximum flood discharge of 22,000 c/s. There is no provision for flood moderation at this project site. The maximum flood discharge of Pedralla Kalva which joins the Kovvada Kalva, is 20,000 c/s. Thus, the total maximum flood discharge of both these streams put together is 42,000 c/s.

During the floods, the Kovvada Kalva flood banks are getting breached at a large number of locations, almost every year, causing huge damages to crops in the neighboring villages.

The Kovvada Kalva after the confluence with Pedralla Kalva runs parallel to Akhanda Godavari Right Flood Bank near Pata Pattisam village.

There are proposals with the Department for diverting about 35,000 c/s of flood waters into the Godavari river by constructing a cross regulator across Kovvada Kalva and an outfall regulator near Pata Pattisam Village, to provide relief from floods to the areas below Patha Pattisam (V) up to Rallamadugu.

The departmental officials have informed that they have approached the Government for according Administrative Approval for the proposed diversion.

The committee recommends this proposal to avert large number of breaches occurring to the Kovvada Kalva flood banks, almost yearly, inundating large areas where crops are grown and flood waters are entering certain villages rendering the inhabitants vulnerable.

It is pertinent to note that this proposal of diversion does not address the problem of flood damages in the areas upstream of Patha Pattisam (V).

It is, therefore, absolutely essential to form flood banks to Kovvada Kalva upstream of Patha Pattisam (V) leaving enough waterway between the flood banks to accommodate the maximum flood discharge of 42,000 c/s. The flood banks may be formed duly consolidated with power roller and following I.S. standards.

2.13.0 Navigation:

All the main canals and branch canals in the delta are navigable. The designers of this old irrigation system therefore though of combining irrigation with navigation so that a cheap transport facility become available for the movement of men and material. Due to development of road transport in recent times, A minimum requirement of flow of 18 T.M.C. is needed for navigation purpose. But the availability in the months from March to May is less than this. This short fall in the river for meeting the navigation requirement be made good after completion of Polavaram Project as the said Project is a multi – purpose project and there will be tail race water. Further the canals will be closed during April and May for taking up repairs in the irrigation system during which time there will be no navigation in the canals.

In the past, the river ways were the principal means of communication and till the advent of Roads and Railways; important trade centers were generally situated on the waterfront. In India also, water transport was developed much earlier than other modes of transport. Country boats of varying sizes have been plying on our waterways from time immemorial.

With the diversion of water from rivers for meeting the ever-increasing needs of Irrigation, deforestation of the catchments area leading to erosion and accumulation of silt in the rivers and lack of proper maintenance, the navigability of waterways gradually declined. With the introduction of trains, trucks and aeroplanes, it has to face serious competition. In spite of this, the Inland Water Transport has not only survived but continues to play an important role in many advanced countries of the world like U.S.A., Germany, France, Russia etc., even though other modes of transport such as rail and road are far more developed in those countries than India. This is because of its inherent advantage of being the cheapest mode of transport.

It is recognized all over the world that Inland Water Transport is the cheapest mode of transport particularly for certain type of cargo both over long and short distances. It is also established fact that it requires less power to move an equivalent tonnage on waterway.

The cost of ratio between water, Rail and Road Transports is 1: 3: 5. As such the cost per tonne-kilometre is the lowest in the case of Inland Water Transport.

Inter model comparison:

Sl. No.	Item	Mode of Transport		
		Road	Rail	I.W.T.
1.	Energy Consumption (Litres of HSD per 1000 T. Km.	40	11	5.60
2.	One Horse Power can move on (Kg.)	150	500	4000
3.	Operate Cost indices	312	138	100

All modes of transport viz., Air, Road, Rail, Water have equal importance and each of these is to be considered as part of an integrated transport system. One of the main advantages in favour of Inland Water Transport is that most of the waterways are gift of nature and can be used for navigation with relatively minimum investment. Even the cost of maintenance of waterways is much lower compared to the maintenance of road and railways.

2.13.1 INLAND WATER TRANSPORT IN ANDHRA PRADESH

There are a number of rivers in Andhra Pradesh. Of these the important ones are the Godavari and Krishna. In addition to these rivers, there is a network of canals in the Krishna – Godavari Delta and the Buckingham Canal.

The following Canals have been considered for the Inland Water Transport by the Government of India.

LENGTH OF CANAL SYSTEM AND RIVER STRTCHES IN A. P.CANALS:

1. Kakinada Canal (Kakinada – Rajahmundry) .. 50 Km.

2. Eluru Canal (Rajahmundry – Vijayawada via Eluru 139 Km.
3. Commamuru Canal (Vijayawada–Pedaganjam).. 113 Km.
4. Buckingham Canal (Pedaganjam– Mercaunam). 443 Km.

RIVERS:

1. River Krishna (Wazirabad – Vijayawada).. 157 Km.
2. River Godavari (Bhadrachalam – Rajahmundry) 171 Km.

Total **1073 Km**

Water will be available in the Kakinada Canal and Eluru Canal (Godavari Delta) for about 270 days (9 Months). In Commamuru Canal (Krishna Delta) water will be available for 150 days (5 Months). In Buckingham Canal water will be available through out the year due to high tides of the sea as the canal is running parallel to the seacoast. Water will be available for 9 Months in the River course of River Godavari in the stretch from Bhadrachalam to Rajahmundry.

After construction of Indira Saghar Project across Godavari River near Polavaram village, the stretch from Bhadrachalam to Rajahmundry would become navigable through out the year.

In the stretch from Wazirabad to Vijayawada in the Krishna River, water will be available during Khariff crop period (ie.) from July to November (150 days). But at present there is no navigation in the above stretch of river due to topography of river course.

CORRIDOR WIDTH:

Present corridor width in canal system is lying from 15 M to 40 M and Depth 3.5 M to 1.5 M. The required corridor width and depth for Navigation purpose are 50 M and 1.8 M respectively. Additional width required for increasing cargo-road facility on top of Bank will be about 25 M.

The Committee Recommendations:

1. The Kakinada Canal in Godavari Eastern Delta, Godavari-Eluru Canal, Krishna – Eluru Canal, Krishna Western Delta Main Canal and Commamuru Canal have to be remodelled to suit the I.W.T. standards, while taking up Modernization Works.
2. All other Canals, which had earlier navigation facilities may be continued accordingly, so that they would be useful in future for I.W.T., based on future needs. It is necessary to ensure that I.W.T. standards are strictly adhered to by providing adequate clearance in construction of Bridges or other structures.
3. It is understood that the canals shall have as high as 50 M corridor width. The canals identified for I.W.T will have higher carrying capacities with this required corridor width for the F.S.D with which the canals operated even as unlined or lined canals. When the water is to be released to these canals based on the crop water requirement supply levels could drastically fall affecting the commandability. The existing infrastructure would not be adequate to maintain the supply levels. It may therefore, require construction of additional regulators/locks. This aspect may be looked into in finalizing designs.

2.13.2 IMPROVEMENTS TO YENAMADURRU DRAIN FROM KM 0.000 TO 60.330

The Yenamadurru Drain is a major drain in Godavari Western Delta having a catchment area of 900 Sq.miles of Deltaic Area.

The Yenamadurru Drain starts from Nandamuru acqueduct and runs to length of K.M. 60.33 and finally empties into Upputeru near Pathapadu village.

It receives frequent intensive floods and causes a lot havoc and loss of crop by inundation of adjoining valuable wet lands in the Mandals of Tadepalligudem, Tanuku, Attili, Pentapadu, Ganapavaram, Palakoderu, Bhimavaram and Mogaltur.

The maximum flood level recorded at Nandamuru acqueduct on 5-10-1983 was +42.91 ft. and at Duvva regulator on 6-10-1983 was + 33.20 Ft. the maximum flood discharge received at Duvva Regulator is 20250 Cusecs as against the flood discharge of 16,600 Cusecs. Newly, Nandamuru acquiduct is constructed with a designed discharge carrying capacity of 20000 cusecs of Yerra Kalva. The Yenamadurru Drain at present having carrying capacity of 16,600 Cusecs at KM 10.000 (below Duvva regulator) and 23000 Cusecs at confluence point into Upputeru river near Pathapadu Village limits

For remodeling of Yenamadurru Drain for improvements to Yednamadurru Drain the present Hydraulic Particulars are approved by Chief Engineer, C.D.O., Hyderabad, vide Lr. No.CE/CDO/EE/C1/ DEE3/ 48/2006 Dt. 22-06-06 taken into consideration meanwhile preparing this estimate.

Now it is proposed to improve the Yenamadurru Drain from KM 0.000 to 60.330 with the bed widths and banks as per revised Hydraulic particulars. Dredging is proposed from Km. 36.000 to Km. 60.330 and suitable provision is made for the land proposed to be procured.

The existing Duvva regulator at KM 9.600 is originally designed to 16600 Cusecs and the maximum flood discharge received at Duvva regulator is 20250 Cusecs. To remodel the Yenamadurru Drain from KM 0.000 to 60.330, the existing Duvva regulator is to be improved to carry the design discharge of 23000 Cusecs as per the present Hydraulic particulars.

The estimate is prepared based on the current schedule rates 2006-07 and the amount is worked out to Rs. 46.14 crores.

2.14.0 Research farms on conjunctive utilizations of Brackish water and Sweet Water:

The water in drains is got examined chemically for their fitness for irrigation. The water is not directly useful for irrigation after February. The sub-surface water Zone I area is also brackish. Hence , such saline water has

to be mixed with the Canal water and used for irrigation. The proportion in which both canal and surface drainage water to be mixed is to be experimented in the proposed demonstration farms under the scheme. After studying various mixing, the most economical water proportion is to be arrived at, for conjunctive utilization of brackish water is to be arrived at, for conjunctive utilization of brackish water and sweet water. These experiments are not undertaken so far.

For examining the feasibility of conjunctive utilization of brankish water and canal water, it is proposed to study the after effects of such utilization on small farms in coastal areas. It is proposed to have 3 farms of 4 acres block in each of the three deltas for conducting the above study (Three on drains water and 3 on sub-surface water).

2.15.0 Meteorological Stations :

There are no Meteorological stations in the Project area except the two at Kakinada and Nidadavole. Even these stations are out side the delta area and are under the control of I.M.D. No reliable data on evaporation, temperature humidity is available for the delta area. Studies may be got done by establishing necessary weather stations at the sub-divisional head quarters viz., Ramachandrapuram, Kakinada and Kotipalli in Eastern Delta, Amalapuram and Gannavaram in Central Delta, Tadepalligudem, Tanuku, Undi and Narasapuram in Western Delta.

2.16.0 Provision of Other Services:

As this is an old system, the field channels were excavated owned and maintained by the farmers below 150 acre limit. Such practice in water regulation is developed over decades. It may not be advisable or necessary to meddle with the local practices followed rigorously by the farmers. New methods of water management and regulation are of immediate necessity and the farmers participation is already in vogue.

3. GODAVARI DELTA DRAINAGE SYSTEM

3.1 Locations:

The State of Andhra Pradesh is situated on the Eastern side of the Indian Peninsula between longitudes 76^0 – 50'E and 84^0 - 50 E and latitudes 12^0 -14'N and 19'-54'. The State has an area of 2,75,005 Sq. Km (1,06,094 thousand square miles) and a population of about 75.73 Million (2001 Census). Andhra Pradesh is the fifth largest in area and the fourth most populous state in the Indian Union.

3.2 Topography:

Geographically, the State can be divided into three natural regions.

a) The Coastal Plains
b) The Eastern Ghats
c) The Peneplains.

3.2.1 The Coastal Plains:

The Andhra Pradesh Coast has a long coast line popularly known as the COROMANDAL COAST, extending from Pulicat lake in the South on the boRBer of Tamilnadu State upto Rushikulya in the North at the border of Orissa State. The area, for a considerable distance inland, comprises chiefly of mangroves, swamps and sand dunes. The two deltas formed by the mighty Krishna and Godavari Rivers both flowing into the Bay of Bengal cutting across Eastern Ghats, lie in between the swamps and upland areas.

The Krishna Delta starts from below Vijayawada, where the River Krishna cuts a gap through a gneissic ridge. The land in the Krishna Delta is very fertile and predominantly irrigated paddy crop grown over an extent of nearly 5.30 Lac hectares. The slope of the country is varying from 1 in 4200 at the head of the delta to 1 in 7500 in its lower part and this flat gradient of land is mainly responsible for its poor drainage characteristics.

The Godavari Delta starts from below Dowlaiswaram where the river divides into two branches like wise Krishna Delta the land of Godavari Delta is very fertile with 4.09 lakh belongs of irrigated ayacut.

3.2.2 The Eastern Ghats:

This is a range of scattered hills running more or less parallel to the coastline at a distance of about 130 Km. away from it in the interior. This forms the boundary between the peneplained Deccan Plantean area and coastal plains. Some of the hills in this range reach an elevation of (+) 910 Meters to (+) 1520 Meters above M.S.L. A number of medium size coastal rivers such as Budameru, Thammileru, Yerracalva, Thandava, Varaha etc., originate from these hills and flow Eastward and join the Bay of Bengal, either through the Kolleru lake or directly. The three major rivers of the state (i.e.,) Krishna, Godavari and Pennar make their way into Bay of Bengal cutting wide gaps through this hill range.

The Godavari River is the largest river in the region. It has its origin in the Western Ghats near Nasik, only 80.5 Km (50 Miles) from the Arabian Sea. The river enters Andhra Pradesh about 8 Miles East of Bilohi Town. After flowing nearly for 1360 Kms (845 Miles) across Deccan Platean, it enters the plains at Polavaram and drops into the Bay of Bengal after traveling for about 105 Km (65 Miles) from Polavaram. The main tributaries of this river are the Purna, the Manjira, the Pranahitha, the Indravathi and the Sabari. The later three together account for about 70 percent of the total flow of the river. At its exit from the Eastern Ghats, the river flows through a 2 Mile long narrow gorge with a width of 183 Meters (200 Yards) to 275 Meters (300 Yards) only. Further down, at Dowlaiswaram the river is about 4 miles wide. Below this town it divides into two branches, the Gowthami and the Vasista. The River is navigable for most part of the year for a distance of 386 Kms (240 Miles) from its mouth. The catchment area of the River at Dowlaiswaram is 3,14,401 Sq. Km (1,21,500 Sq. Miles). The maximum ever occurred flood discharge during August, 1986, is of the oRBer of 36 lakh

cusecs which is more than that of Ganga though the later has a catchment area more than thrice that of Godavari.

3.3 Climate:

There are three seasons in Andhra Pradesh, the hot summer followed by tropical monsoon from July to November with winter from December to February. The maximum temperature varies from 38^0 C to 49^0 C, May being the hottest month.

3.4 Important Rivers Of Andhra Pradesh

40 Rivers big and small flow through the State. Out of the total 40 rivers, 12 rivers are Inter-State Rivers. The most important of these are Krishna, Godavari and Pennar. Andhra Pradesh is the lowest riparian state and these inter-state rivers, after flowing through the state, empty into Bay of Bengal. The other 28 rivers are not inter-state and flow within the State boundaries.

3.5 Rainfall

The average rainfall of Andhra Pradesh is about 890 mm (35 inches). Normally, higher precipitations of 1524 mm to 1778 mm (60 to 70 inches) are recorded in the Eastern Ghats. There are two monsoons, viz., the South West and North East. The South West monsoon starts in the middle of June and continues up to the end of September and North East monsoon begins at the end of September and continues till December.

3.6 Delta Areas:

The word 'Delta' is very loosely used. A delta is caused due to settlement of sediments brought in by the river. The process of such deposition goes on for ages and results in building up of the delta. Krishna and Godavari Deltas, though popular as deltas, do not fit into this definition.

The areas commanded by the Commamur canal in Guntur and Prakasam Districts and like wise, considerable part of the ayacut under Krishna Eluru Canal, Godavari Eluru Canal do not constitute a part of delta. The areas covered by sand dunes and some areas close to the sea also can

not be defined as delta areas. However, customarily even from the days of British Engineers all the areas have been grouped into one category "Delta".

The Deltaic area is spread over in the following Districts.

1. East Godavari
2. West Godavari
3. Krishna
4. Guntur
5. Prakasham

3.6.1 Godavari Delta:

Godavari Delta lies in East Godavari and West Godavari Districts.

A statement showing District Wise details of ayacut, and drainage net work are at *Annexure-XV*.

a) Godavari Eastern Delta:

The irrigated ayacut in Godavari Eastern Delta is 1.18 Lakh Ha (2.92 lakhs acres). It receives part of upland drainage from Yeleru into Biccavolu Basin and with the completion of Yeleru Reservoir Project @ Yeleswaram the impact of upland drainage is reduced considerably. This delta is drained by Biccavolu, the Tulyabhaga and the Teki (Atreya) drains. All theses drains infall into the Sea directly.

b) Godavari Central Delta:

The irrigated ayacut in Godavari Central Delta is 0.82 lakh ha (2.02 lakh acres). It is absolutely free from any external drainage, but yet this delta suffers from inundation frequently. This is because of serious error committed in the layout of the network of irrigation channels. The drains infalling into Vasistha and the Gouthami Rivers which receives in floods often do not allow free drainage and cause damage to crops. In most cases, the drains flow against the rising slope of the country. Large areas are low lying pockets without any facility for the out flow of drainage.

c) Godavari Western Delta:

The total ayacut irrigated in Godavari Western Delta is 2.14 L Ha (5.30 lakh acres). The external catchments from which the drainage is received is much more than the delta area itself. The principal sources of upland drainage are the Kovvada Calva, the Yerra Calva. The Yerra Calva is called the river of sorrow of West Godavari District. Unlike East Godavari, the delta i.e., terrain of West Godavari consists of spurs and valleys at closure intervals and therefore there are mostly individual basins with no or a few other drains joining the mainstream. It is convenient to group these drains as (i) Drains joining Kolleru Lake (ii) Drains joining Upputeru, the only outlet of Kolleru and (iii) Drains joining Vasista branch of Godavari. Heavy floods from upland catchment and also due to inadequate carrying capacity of Upputeru, ayacut situated in periphery of Kolleru Lake are frequently inundated. The intensity of the problem could however be reduced to some extent after demolition of fish tanks in Kolleru Lake bed upto 5.0 ft. contour.

Details of drainage network in Godavari Delta are at *Annexure-XVI.*

3.7 STORMS & DEPRESSIONS:

The storms and depressions that develop in Bay of Bengal during monsoon season move across the coastal areas of Andhra Pradesh, causing heavy to very heavy rains. Andhra Pradesh has 1050 Km length of coastal line. This coast line, being the most cyclone prone zone in India was hit by about 90 cyclones since 1900 AD. According to one study, tropical storms originating from Bay of Bengal strike the densely populated parts of the Coast causing serious floods, causing misery to the inhabitants of the area, besides loss of life and loss to public and private properties.

The storms and depressions on the East Coast of India are very frequent and severe in nature. They vary in size from 60 Kms to 240 Kms in diameter and have different intensities and core wind velocities some times reaching upto 325 Kmph. Nealry, 50 % of the storms on East Coast occur along the Andhra Coast causing very severe storm tides in the rich Krishna and Godavari Deltas.

In the North Coast Andhra Pradesh, most of the storms occur in the month of October and November.

The devastation caused by the Killer tidal wave that hit coastal Andhra Pradesh in 1977 is an unforgettable catastrophic event.

The details of storms and depressions occurred since 1977 together with loss sustained are at *Annexure –XVII..*

The details of the storms and depressions in Bay of Bengal (Month wise) since 1892 to 1991 are at *Annexure-XVIII.*

3.8 IRRIGATION:

3.8.1 Water Resources:

Andhra Pradesh State is blessed with 3 Major Rivers, the Godavari, the Krishna and the Pennar, with a total drainage (catchments) area of 70 % of the state's land area. In addition, there are 12 Inter State Rivers and 28 Other Minor Rivers.

It is assessed that the water potential is 7.77 Million Ha. Even, the major rivers are highly seasonal, more than 90 % of the total flows occur between June to December. Rainfall varies greatly from month to month and year to year. Therefore, irrigation is necessary for sustenance of people. The infrastructure needed for providing irrigation calls for huge investment for the construction of storage dams. Ground water aquifers are normally low yielding and costly to develop, since the Deccan Plateau underlain by crystalline rocks.

Andhra Pradesh has a heritage of irrigation dating back to several centuries. In the past, during the periods of Eastern Chalukyas (7^{th} to 13^{th} Century) Kakatiyas (13^{th} to 14^{th} Century) and Vijayanagara Kings (14 to 17^{th} Century), several tanks and diversion systems were constructed and the wells dug at that time are still popular and productive. Godavari Delta System, Krishna Delta System, Pennar Delta System and K.C. Canal System were constructed in 19^{th} Century. Similarly the Hyderabad State Rulers had constructed Khanapur Canal System, Mahaboobnagar System, Pocharam Project and Nizamsagar Project.

After independence, high priority was given for irrigation development and some major projects like Tungabhadra Project, Prakasham Barrage, Sir Arthur Cotton Barrage, remodeling of K.C. Canal, Nagarjuna Sagar Project, TBP.HLC Stage-I & II, RDS, SRSP Stage-I, Vamsadhara Stage-I, Somasila Project, Yeleru Reservoir Project, Jurala, Srisailam Project, Telugu Ganga were taken up. In addition, several Medium Schemes all over the State were taken up which have contributed to the steady growth of irrigated area.

In a span of 40 years i.e., 1951-52 to 1990-91, an additional irrigation potential of 2.6 Million Ha (6.42 Million Acres) has been created, of which major and medium irrigation projects alone contributed about 1.84 Million Ha (4.55 Million Acres) (70.8 %).

Under the major projects, which are almost completed and nearing completion, the land development is lagging behind. The State Government is aware of the inadequacy of the current land development operations and hence initiated Command Area Development (CAD) Programme duly forming CAD Authorities in 1977 in three major projects, Nagarjuna Sagar, Sri Ramasagar and Tungabhadra System.

The Government of Andhra Pradesh has taken up a pioneering step as a first move to ensure effective CAD work by enacting the Andhra Pradesh Irrigation & CAD Act, 1984. This is a comprehensive legislation which provides for systematic land development, optimum utilization of water and conjunctive use of surface and ground water.

3.8.2 Cropping Pattern:

The State can be divided into seven agro climative zones based on topography and distribution of rain fall pattern, irrigation soil characteristics etc. The cropping pattern associated with these zones is:

1. Krishna Godavari Zone.
2. North Coastal Zone.
3. Southern Zone.
4. Northern Telangana Zone.

5. Southern Telangana Zone.
6. Scarce rainzone of Rayalaseema and
7. High Altitude and Tribal areas.

In Krishna-Godavari Zone, the principal cropping system is paddy. The other major crops grown are cotton, black gram, green gram, groundnut, fodder, tobacco, sugarcane, chillies, coconut and seacem.

3.8.3 Drainage Problems – Description:

The irrigated area in Krishna and Godavari Deltas is served by a number of major, medium and minor drains for disposal of the surplus water from fields, that accumulate especially during the monsoon, when the area is subjected to incidence of heavy rain & wide spread rainfall. Rapid disposal of surplus water is the prime purpose for which the drains are intended to serve. The objective is not effectively achieved, owing to congestion of drains due to several reasons. The problem of "drainage congestion" in delta occurs generally between the elevation (+) 10.00 m and the sea level. It is more acute, since the terrain is very flat in vast extent of tracts.

3.8.3.1 Causes of drainage congestion:

1. Increase in the irrigated areas in the upland catchments, as in the case of Nagarjuna Sagar Right Canal Command and lack of commensurate improvements to Drainage net work.
2. Constriction of flood flow areas, due to formation of drain banks along major, medium and minor drains.
3. Increase of irrigated area in deltas without commensurate improvements to drainage network.
4. Cultivation of flood plains depriving the natural facility of flood moderation.
5. Use of some drains as irrigation channels.
6. Formation of roads without a proper appreciation of the consequent drainage problems.
7. Inadequate water way in cross drainage and cross masonry works.

8. Simultaneous floods in rivers and drain joining them.
9. Heavy rainfall in three consecutive days exceeding 387.50mm which is the norm to compute the MFD in designing drains.
10. Obstruction to flow of drain due to formations of sand bars at their confluence with the Sea.
11. Obstructions caused by heavy embankment and roadways.
12. Max flood level of the drainage channel at or below the sea high tide level.

3.8.3.2 Effects due to drainage congestion:

Paddy is the main crop grown in deltas. Different varieties of paddy have different sustenance capacities to withstand submersion and most of the crops sustain for about 3 to 4 days. Submersion for a period longer than their withstanding capacity results in an acute deficiency in the yield. Water logging, increase in the salinity of soils and health hazards are some more effects that increase with the drainage congestion.

3.8.3.3 Tail end Farmers:

The tail end farmers are liable to suffer most due to inadequacies both in the irrigation and drainage systems. The problems in the net work of irrigation channels deprive the tail end lands from receiving the required supplies timely. Defective function of outfall sluices result sometimes in entry of river waters and sea waters into the command. The tail end areas are prone to inundation frequently due to inadequate carrying capacity of drains, whenever heavy rains lash the command

3.8.3.4 Salinity:

Major types of soils in the deltas are very deep black clays, coastal sands and soils with stratified layers. The presence of high ground water table and low permeability might be responsible for the salinity problems in these areas. The salinity gets reduced by leaching and providing effective drainage facilities.

3.8.3.5 Water logging:

During rainfall or irrigation application, the pores of top soils in the fields get saturated. When the saturation reaches optimum level, water starts accumulating on ground surface causing water logging. Retention of land/field under water for a considerable period causes severe damage or total crop loss. The National Commission on Agriculture had therefore defined an area as water logged when the water table rises to an extent that the soil pores in the route zone of a crop becomes saturated resulting in restriction of normal circulation of air, decline in level of oxygen and increase in the level of carbon dioxide. The ill-effects of water logging are more manifesting in the areas having saline soils. The best remedy is a proper drainage system.

3.8.3.6 Leaching of Nutrients:

Leaching of nutrients is another hazard due to continuous submergence of fields. During normal irrigation applications, the salinity of soil profile will be reduced due to dissolution of excess salts, whereby salt balance is maintained in irrigated soils, such that crops do not suffer. But due to continuous submergence of fields, some of the essential minerals and other nutrients needed to protect plant life would also get dissolved and flow away from the soil, either by seepage into under ground water table or by percolation into nearby drain. Hence, quick disposal of surplus water by creating proper drainage network is the intervention required to outcome the problem of leaching of nutrients due to continuous submergence.

3.8.3.7 Factors influencing Drainage:

Topographical factors: These are of prime importance in drainage. Where surface slope is sufficiently steep, the waters received due to excess precipitation will flow away rapidly from the area thus resulting in diminishing percolation. Since, the deltaic areas are with flat slopes, a well designed and maintained drainage system is needed for providing quick relief to the ayacut from inundation due to heavy rain fall.

3.8.3.8 Water and climatic factors:

The common sources of water logging causing major concern in drainage problem area are (1) Precipitation (2) Irrigation and (3) Seepage. If excess is due to precipitation, better surface drainage could be the remedial measure. If due to canal seepage, seepage interception is required.

3.8.4 Historical Review of the drainage problems in Andhra Pradesh:

Irrigation through large tanks and open head channels was well developed in Andhra Pradesh long back. The 'drainage' aspect was not thought of then, as it was not a problem in view of limited extent of agriculture. Only during the latter part of 19th Century, when irrigation was taken up by harnessing Krishna & Godavari waters on a large scale, it was realized then that providing 'drainage' facility is a necessity.

The first known 'drainage scheme' is learnt to have been taken up in Krishna District, in the year 1929, when the "Pedalanka Drain" infalling into Upputeru was diverted to Bay of Bengal through a straight cut. "Repalle main drain straight cut (K.W.Delta) to Bay of Bengal and "Nallamada Drain" joining Bay of Bengal through a straight cut called "Nallamada Diversion" followed later. The Romperu drain in Prakasam District taken up during 2nd World War period to provide employment for demobilized army personal proved highly beneficial, relieving vast extents from submersion besides bringing thousands of acres of waste land under cultivation.

3.8.4.1: Drainage Cess Act 1955:

Proposals for levy of special drainage cess for attending to the drainage problems of deltas of Krishna and Godavari was first mooted in 1950 and again in 1955. The Andhra Pradesh Irrigation (Levy of Betterment Contribution) Act was enacted in 1955, but does not appear to have been implemented. The situation arising in the wake of the unprecedented and disastrous floods in this region between 27.09.1964 and 01.10.1964 drew the attention for an immediate solution to the recurring problem.

3.8.4.2 Constitution of an Expert Committee:

The Government of India, Ministry of Irrigation and power vide Resolution No.V.501 (4)/64, Dated 09-10-1964 constituted an "Expert Committee" under the Chairmanship of Sri A.C. Mitra, Engineer-in-Chief of Uttar Pradesh to study the flood and drainage problems in the Krishna and Godavari Deltas for suggesting a comphrensive plan for controlling the same. The Expert Committee popularly known as "MITRA COMMITTEE" submitted report on 06-01-1966 to Government of India. A number of recommendations were made, out of which a few notable ones implemented are at *Annexure – XIX..*

3.8.4.3 Drainage Cess Act 1968:

The Krishna, Godavari Drainage Cess Act was enacted in 1968 to raise necessary funds to implement a comphrensive drainage plan based on the recommendations of the Mithra Committee. The Krishna and Godavari Delta Drainage Board was formed on 09-11-1969 for formulating the programmes and review the progress in execution of works. The State Government accoRBed Administrative Approval in G.O. Ms. No.1599 PWD, Dated 21-11-1969 for Rs.13.39 Crores to implement those schemes that were of immediate importance. The Drainage Cess was collected upto 1979 and improvements to the drains on a limited scale were carried out, with the available funds.

3.8.4.4 Drainage Act 1985:

For pooling up of resources, the Government of Andhra Pradesh once again enacted the Krishna Godavari and Pennar Delta Drainage Act, 1985 (Act No.26 of 1985) and A.P. Non Delta Drainage Cess Act, 1986 (Act No.20 of 1986). Each Act was for duration of five years initially. No substantial work could be taken up as the funds raised were found to be meagre due to some concessions by way of remissions granted by the Government. The rates of drainage cess collected until introduction of W.U.As (1997) and rates proposed are at *Annexure – XX.*

3.8.4.5 Report of Dr. K. Sreerama Krishnaiah:

In the wake of severe floods in 1986, Government of Andhra Pradesh appointed Dr. K. Sreerama Krishnaiah, Officer on Special Duty, Telugu Ganga Project to prepare a "Comphrensive Report" of Drainage Schemes of Krishna, Godavari and Pennar Irrigation Systems. The report was submitted during 1987; but the recommendations made were implemented partly, due to budgetary constraints.

3.8.4.6 Cyclone Emergency Reconstruction Project (CERP):

The irrigation and drainage system received a severe battening due to the devastatiner cyclone of May, 1990. Colossal damage to the infrastructure in several sectors in all the nine coastal Districts of Andhra Pradesh was caused. The estimated damage to the drainage and irrigation sector was of the order of Rs.172.00 Crores. Assistance to an extent of Rs.211 Crores was received from the World Bank in a big way for "Cyclone Emergency Reconstruction Project" (CERP) for improvements to the infrastructure indicated below.

a) Improvements to Major and Medium Drains.
b) Improvements to Irrigation Canals.
c) Strengthening/Reconstruction of Structures.

However, reconstruction of structures to the revised standaRBs of drains could not be taken up due to various reasons.

The District-wise details of drains, flood and tidal banks taken up for improvements in the six coastal districts are at *Annexure –XXI*.

3.8.4.7 Andhra Pradesh Hazard Mitigation and Emergency Cyclone Recovery Project (APHM & ECRP):

The State of Andhra Pradesh had been affected by series of cyclones and floods during 1996. On account of theses cyclones and floods, the State suffered heavy damage to public and private properties. Loss of life also resulted due to the cyclonic winds and rains.The cyclones struck the state as many as 4 times between June, 1996 and the middle of November, 1996. The important factor that caused to the inundation of fields for long time in that year was the drainage congestion in minor drains, which were not improved earlier. Hence, Minor drains, leftover works of CERP and flood banks were proposed under World Bank Aided Project APHM & ECRP.

The District-wise details of minor drains other works and flood banks taken up under APHM & ECRP are at *Annexure –XXII.*

3.8.4.8 Andhra Pradesh Economic and Restructuring Project (APERP):

During the period 1998 to 2005, Rehabilitation of some of the canal and drainage network of Krishna and Godavari deltas was taken up under World Bank Aided Project APERP. An amount of Rs.104.00 Crores and Rs.79.00 Crores was spent in Krishna Delta and Godavari Delta respectively towaRBs minimum rehabilitation of Canal and Drainage network.

3.8.4.9 Sri M.S. Chalapathi Rao Committee Report on Krishna & W.G. Districts:

Heavy rains that lashed Krishna and West Godavari Districts in August, 2000, causing serious damages to the crops, Government of Andhra Pradesh constituted a Committee under the Chairmanship of Sri M.S. Chalapathi Rao during 9/2000 with the following terms of reference.

i. To study the drainage problems of Yerracalva, Yanamadurru drain in West Godavari District, Budameru and Gunderu in Krishna District.

ii. To study the inundation aspects of Kolleru Lake and the effective disposal of the waters of the Kolleru Lake.

iii. To identify the works that are required either by increasing the cross sectional areas or diversion of waters from one drain to the another or by excavation of link drains to give relief or by any suitable method that is economical and viable so that there will not be any submersion.

iv. To study the possibility of dredging near Perantalakanuma and Upputeru for better discharges in Upputeru, which is the only outlet of Kolleru lake and there by to prevent submersion.

The Committee submitted its report during May, 2001.

The status on implementation of the Committee's recommendations is at *Annexure – XXIII.*

3.9 Tidal Effect:

3.9.1 Tides: Tides are generated in the Bay of Bengal by the forces of attraction on Sun and Moon on the rotation of the Earth. The effect of tide is noticeable in a regular alternation of rise and fall of water level in the Sea, the estuarine channels and creeks. The rising of tide is called the "High tide while receding of tide is called the "Ebb tide" and the difference between the highest tidal level and lowest tidal level is called the "Tidal Range".

The tidal phenomenon in Bay of Bengal was subjected to a detailed study and the tidal level on any day are predicted and published by Calcutta Port Trust. The tidal range at any location follows steadily and gradually the movement of Moon. The tidal range at the time of full moon and new moon is found to be maximum. This phase is called the "Spring tide". The tidal range starts diminishing till the occurrence of "Neap Tide".

3.9.2 H.T.L & L.T.L :

Most of the drains join the Bay of Bengal directly or through the backwaters. These drains are therefore subjected to tidal action for some length. The length in which the tidal action is noticed varies even in a day. The current practice is to consider about 12 to 15 Km. as the tidal reach on adhoc basis. The tidal range i.e., difference between high tide level and low tide level is known to vary from "Zero" at Kanyakumari, where as the current practice in Andhra Pradesh for fixing the maximum flood level takes into consideration average tide level of 1.07 M (3.25 Feet) in Prakasham and Guntur Districts and 0.92 M (3.00 Feet) in Godavari District. This practice does not seem to be based on any scientific studies. When the difference i.e., tidal range, increase from South to North, what is being adopted now is the reverse of the same. The relevance of these levels is

a) The high tides determine the standards of the tidal banks.
b) Low tides to locate the sill and standards of the outfall sluices and hence there is a great need to study the aspect to considerable detail, revise the present norms on a rational basis rather than adhoc.

Once this is not certain, when floods coincide during the four months period of monsoon and also when the occurrence of floods coincide with the full moon/new moon periods, it becomes necessary that some compromise may have to be made in deciding the HTL & LTL to be considered for purpose of drain designs. One possible course of action in the study may be that one has to take the average of the highest HTL and the lowest LTL during the four months monsoon period.

3.10 Maintenance of drains

The improvements carried out earlier to the drainage system have given considerable relief from stagnation of water in the irrigated deltaic areas of Godavari Districts in normal times. However, when heavy cyclone rains occur, the same is not the case. Hence, the drainage system needed to be further improved and maintained and nourished. Inadequate maintenance

will choke up the drains with weeds, silt and shoals, the banks erode with gully formations and ultimately breach. Settlement of banks and slips do occur. Therefore to keep up the drains in a good condition, and to retain the benefit over longer periods, the following works are to be carried out yearly and regularly.

1. Removal of weeds.
2. Removal of unauthorized fish stakes and small cross bunds formed by the fishermen.
3. Protection of bunds either by revetment or by turfing at locations of meanderings and other vulnerable reaches.
4. Restoration of drain sections as and when gullies, slips, erosions and settlements take place.
5. Removal of silt and shoals in the drain bed.
6. Maintenance of cross masonry works on the drains and removal of obstructions.
7. Maintenance of Sea mouths/ Mogas in regime conditions by dredging.
8. Evicting the encroachments, unauthorized plantation and irrigation in the boundaries of the drain.
9. Gauging the drains to assess the flood levels and flows for statistical data. Above all, periodical supervision by supporting staff is an absolute necessity.

Whatever may be the reasons, the maintenance of the drains was never considered as a priority and important work. The drains were being improved on and off to meet the urgent need without any specific productivity matching the need. Some of the drains are disowned, Vegetables, pulses, etc., in the drain beds and on banks are grone. Water is pumped in such a way that it damages the banks. Lack of supervision makes it an unclaimed system.

The meagre funds provided, to remove the weed in the drains and pay salaries of the staff mostly will not serve any purpose. After realizing the importance of the maintenance of the drainage system, the Government of Andhra Pradesh has introduced a method with farmers' participation by way

of collecting the drainage cess from them, to provide grant for maintaining the drainage system. If drainage cess of half a bag as per the market rate is collected, perhaps sufficient funds will be available for the maintenance. Otherwise, whatever benefits are derived by the improvements will be lost and the water logging and stagnation prevalent prior to improvements will continue to have its way in a few years.

3.11 Kolleru Lake and its problems:

Kolleru Lake: Splendid, enchanting and impressive was the shallow lake Kolleru. It derives its name from the abundant and bountiful source of water. Its shape is artistic. It is a close replica of dark shade we find in the moon. It is covered by ridges and vallies. The coast line of Baltic Sea comes to the mind while studying the map of Kolleru. It occupies an area about 260 Square miles. This was the history prior to formation of illegal fish tanks (i.e.,) prior to 1975.

The lake lies between longitudes 81^0 – 10' and 81^0 – 20' E and latitude 16^0 – 41' and 16^0 – 45' N. The lake is located partly in Krishna District and partly in West Godavari District. The Kolleru lake area was once named "Island of Konala" (600 AD) at the time it was written as "Co lair" or "Co-lleru". It is now being written as "Kolleru". It is situated 32.2 Km away from Bay of Bengal and is connected by a narrow water way called Upputeru. The area of the lake at an elevation of + 3.05 M (+ 10 Feet) is about 901 Sq. Km. The lake receives drainage from a catchment of 4700 Sq. Km. Out of which, 3,340 Sq. Km is upland and 1360 Sq. Km is deltaic. Four main rivers viz., Budameru, Ramileru, Thammileru and Gunderu besides a number of small streams and drains join the Lake.

3.11.1 Present Status:

To connect the area with other parts of the District, roads have been formed cutting across the lake with top levels more than ten feet. The roads formed obstructing the flows of water into Kolleru Lake. The inadequate vent ways provided to cause flow from one compartment to other compartment and compartmentalizing the Lake. **The Committee recommends to form necessary bridges on the road with required vent ways to maintain uniform level of Lake.**

A number of accretions (shoals and mounds) and exuberant wild growth of water hyacinth and Kikkisa (local name) obstruct the flows of water in Kolleru Lake and Upputeru River.

The Kolleru Lake waters do not maintain a single level to be called as lake level, but different levels are maintained at different times. The first crop is raised above EL. + 5 feet (1.53m) though the area below EL + 7 Feet (2.135 m) suffers frequently due to flooding during monsoon. The lake level rises above EL + 5 Feet (1.53 m) almost every year. The capacity of lake between the elevation (+) 5' Feet (1.53 m) and + 10 Feet (+3.05 m) is 12.684 TMC. An average area of 78 Sq. Km. (30 Sq. Miles) gets submerged for every one foot (0.3m) rise in the lake level. Maximum lake level attained during the period from 1916 to 2000 (85 years) was + 10.70 Feet (+3.26 M) on 11-10-1964.

The Kolleru Lake being an International wet land is the only fresh water lake of such magnitude in our Country. It is also unique and that it does not get affected by sea tides.

The only outlet from the Kolleru lake is the Upputeru river. Two natural courses the Juvvikanuma and the Perantlakanuma lead the water from the lake into the Upputeru. In the channelisation scheme, partly executed, the main pilot channel is connected to the Perantalakanuma. These Kanumas have been the foci of attention right from the pre independence times. In spite of the unambiguous policy followed till early 1980 to keep the kanumas in good state they present a forlorn appearance now. Juvvikanuma is practically defunct as it is fully infested with Kikkisa

grass. Perantalakanuma is barely 10 M wide now for boats to ply. Launches can not enter it and through it into the lake due to the wooden bridge erected across it at Penchikalamarru (Km.1.6 of Upputeru). However, it is reported that R & B authorities are planning to construct a high level bridge in place of wooden bridge.

As recommended by the Mithra Committee, the section of Upputeru has been partly increased to pass 20,000 cusecs (566 Cumecs) in between road and railway bridges (i.e., from Km.9.950 to Km.10.450) and additional vents of Railway bridge were cleared to pass 20,000 Cusecs during last season.

A straight cut from Upputeru at Km.47/0 (M 29/0) to sea formed during 1983 as per the recommendation of the Mithra Committee has been functioning well.

Over the years, a number of roads have been formed across the lake, the most important among them being the Eluru – Kaikalur Road, Siddhantam – Padayedlagadi road and Eluru – Pathicodulanka – Gundugolanu Road constructed after 1969. While designing bridges on these roads the lake levels do not appear to have been considered with the result that some of them get submerged when the lake water level rises above EL + 7 Feet (+2.1 m). They also obstruct the free flow of the land drainage into the Upputeru.

The following Rivers/Drains contribute flood water of more than one lakh cusecs during peak flow into Kolleru:

Sl. No.	Name of River/Drain	Maximum peak Flow in Cusecs
1	Budameru	42,281
2	Ramileru	12,673
3	Thammileru	28,330
4	Gunderu	16,804
5	Minor Streams	3,744
6	Kaikaluru Swamp Drain No.1	269
7	Kaikaluru Swamp Drain No.2	427

8	Motur Channel Drain	632
9	Chandraiah Drain	1,146
10	Pedapadu Drain	378
11	Vatluru Drain	427
12	Mondicodu Drain	854
13	Pandicodu Drain	1,264
14	Siddapuram Drain	427
15	C.W. Drain	1,264
	Total	**1,10,920**

Capacities of Kolleru Lake at various levels are here under

Lake level In feet	Area		Capacity in M.Cft.
	Acres	Square Miles	
+ 3.00	86,400	135	--
+ 4.00	1,02,300	160	3,375
+ 5.00	1,21,600	190	8,994
+ 6.00	1,47,200	230	14,848
+ 7.00	1,66,400	260	21,678
+ 8.00	1,82,400	286	29,273
+ 9.00	2,01,620	315	37,637
+ 10.00	2,20,800	345	46,617

3.11.2 Inevitable Submersion of Ayacut Under Kolleru Infalling Drains

Kolleru Lake is a natural fresh water lake formed in between two alluvial plains of Godavari and Krishna Rivers. It is located partly in West Godavari District and partly in Krishna District. The lake is connected to Sea by a narrow way called Upputeru which runs for a distance of 39 Miles 6 furlongs (64 Kms.). The total water spread area at + 10 Ft. level is 345 Sq. Miles. The lake receives drainage from a catchment of nearly 4700 Sq. Km. having a peak inflow of 1,10,920 Cusecs through a number of streams/drains emptying into the lake. Due to reduction in capacity of Kolleru Lake as well as, inadequate discharging capacity of Upputeru (11,000 Cusecs), the lake level is rising fast, submerging valuable irrigated land around the lake. During heavy rains and peak floods, the lake level is rising

alarmingly upto 10 Feet. The lake levels since 1916 to 2006 are given below:

KOLLERU LAKE MAXIMUM WATER LEVELS FROM 1916 TO 2006
(*OBSERVED AT KOLLETIKOTA*)

Water levels arranged in ascending oRBer

Sl.No.	Year	Lake level in feet (+)	Sl.No.	Year	Lake level in feet (+)
1	1918	3.20	47	1924	7.00
2	1937	3.20	48	1950	7.00
3	1920	3.60	49	1930	7.10
4	2002	3.77	50	1947	7.10
5	2003	3.94	51	1972	7.10
6	2004	4.10	52	1917	7.30
7	1922	4.40	53	1938	7.30
8	1952	4.50	54	1943	7.30
9	1926	4.60	55	1990	7.48
10	1987	4.69	56	1954	7.50
11	1929	4.80	57	1974	7.50
12	1993	4.99	58	1940	7.60
13	1999	5.02	59	1941	7.60
14	1934	5.10	60	1933	7.70
15	1984	5.20	61	1970	7.70
16	1979	5.30	62	1931	7.80
17	1967	5.40	63	2005	7.84
18	1981	5.40	64	1925	7.90
19	1985	5.50	65	1961	7.90
20	1997	5.58	66	1955	8.00
21	1927	5.60	67	1998	8.01
22	1992	5.77	68	1948	8.10
23	1919	5.80	69	1956	8.10
24	1982	5.80	70	1960	8.10
25	1942	6.00	71	2000	8.10
26	1945	6.00	72	1958	8.30
27	1965	6.10	73	1976	8.30
28	1946	6.20	74	1977	8.30
29	1953	6.30	75	1991	8.37
30	2001	6.30	76	1995	8.46
31	1935	6.40	77	1975	8.60
32	1971	6.40	78	1932	8.70
33	1928	6.40	79	1969	8.80
34	1936	6.50	80	1957	8.90

35	1968	6.50	81	1963	9.00
36	2006	6.53	82	1986	9.00
37	1923	6.60	83	1983	9.30
38	1996	6.69	84	1949	9.40
39	1948	6.70	85	1962	9.50
40	1966	6.70	86	1939	9.60
41	1980	6.70	87	1959	9.90
42	1973	6.80	88	1989	9.97
43	1988	6.89	89	1978	10.00
44	1994	6.89	90	1916	10.40
45	1921	6.90	91	1964	10.70
46	1951	6.90			

It can be seen from the above statistics, that Kolleru often attained level of 7 Feet in most years. Hence, the ayacut below 7 Feet contour will be under submersion during even moderate floods.

All the Major and Medium Drains in falling into Kolleru Lake are designed with their M.F.L at confluence above + 7' contour (2.12 M). Hence, they do not cause any submersion in normal floods.

However, the following 14 Nos. of Minor Drains in falling into Kolleru are designed with M.F.Ls at confluence below + 7' (2.12 M) contour.

Sl. No.	Name of the Drain	MFL at Confluence In Meters	Ayacut in Hectares
1	Nidamarru Drain	+ 1.98	77.7
2	Kolletiroad Punta Codu	+ 1.98	155.4
3	Thummacodu Drain	+ 2.01	476.3
4	Pedayedlagadi Drain	+ 1.70	310.9
5	Pedacodu Drain of Chataparru	+ 1.80	--
6	Gongarala Codu Drain	+ 2.00	155.4
7	Gangadevi Codu Drain	+ 2.08	492.1
8	Kothacodu Drain of Adavikolanu	+ 1.64	349.7
9	Venkatapuram Drain	+ 1.98	77.7
10	Vissa Codu Minor Drain	+1.91	455.7
11	Tavvacodu Minor Drain	+ 2.02	388.5
12	Appalaswamy Banda Codu Minor Drain	+ 1.60	178.9
13	Polimeracodu drain of K.Durgapuram	+ 1.60	90.7
14	Rayaleti Calva Drain	+ 1.45	255.0
	Total		**3464.0**

As, the lake level rises frequently upto + 7 (2.12 M) contour even for normal floods, the ayacut served by these minor drains would suffer from inundation. As the topography of the country dictates the fixation of M.F.L, it is better if the ayacut served by these minor drains is not irrigated during Khariff season; else loss of crops has to be faced eventually.

Upputeru is proposed to be improved to discharge 15,000 Cusecs at +7' Kolleru Lake level. Kolleru is already declared as Wild Life Sanctuary up to + 5' (1.50 M) contour. The quantum of water in between elevations + 7' (2.12 M) contour and + 5' (1.50 M) contour is 12,684 Mcft (12.68 TMC). Hence, there will be submersion of ayacut under the above 14 Nos. of Minor Drains ayacut between + 5' (1.50 M) contour and + 7' (2.12 M) contour to an extent of 3464 Ha (Part). This is inevitable as this ayacut i.e., 3464 Ha (Part) has to suffer for inundation during Kolleru submersion.

4. DRAINS OF EAST GODAVARI DISTRICT

4.1 THE EAST GODAVARI DISTRICT:

The Godavari District, from which the East Godavari District carves, was for a long time not a homogeneous unit and its component parts were ruled before it was administered by British by various dynasties at different periods of time. In 1766, the Nawab of Nizam has given these parts to British and since then it is ruled by the Chief and Council and by Collectors. When Madras Presidency was formed in A.D. 1859, the East Godavari District has become one of the Districts of the Presidency. Subsequently, several changes took place, and now the East Godavari District lies between 16^0 – 30' and 18^0 – 20' of Northern Latitude, and 81^0 – 30' and 80^0 – 36' of the Eastern Longitude. The District is bounded on the North, the Visakhapatnam District and the State of Orissa under East with Bay of Bengal on the South and on the West by West Godavari and Khammam Districts.

The East Godavari District can be broadly classified into three natural zones – the Delta, the Upland Area and the Agency tracts. It has an area of 27,990 Square Kilo Meters. The District Head Quarters is Kakinada, which is a seaport town. Rajahmundry is a large town situated on the left bank of the Godavari.

Besides the mighty river Godavari forming the Western boundary to the District, many of the small rivers are draining the area. Seethapally vagu, Burada Kalva and Torrigedda are the rivers from the Northern boundary and join the Godavari. Yeleru, Pumpa and Thandava are the East flowing rivers directly joining the Sea.

The East Godavari District, in general is characterized by humid climate with oppressive summers and seasonal rainfall. The mean and minimum daily temperature during the summer is 39.9^0 C. The normal rainfall of the District is 1137 Millimeters and more than half of the annual rainfall is brought by the South-West monsoon, while the large portion of the rest occurs in November. Storms and depressions originate in the Bay of

Bengal generally during the post monsoon period, cross the coast, causing widespread heavy rains and strong winds.

The main soils in the District are alluvial soils in Delta area, sandy clayee soils at tail end portion of Godavari, and red loamy soils in Upland area and in agency tracts. The general elevation of the district varies from a fraction of a meter near the Sea to 450 meters in the hills of the Agency. The highest peak is "Papikonda" or Bison hill which is 1280 meters high.

The District has a net irrigated area of 6,84,000 acres. The Godavari irrigation System irrigates all the Mandals in Delta Region. The Yeleru Irrigation Channels, the Thandava and Pumpa River Channels, and a few other rain fed tanks irrigates parts of the Upland areas. Of late, a good number of tube wells were sunk to supplement the ground water irrigation. Pushkara Lift Irrigation Scheme along with Indira Sagar Left Main Canal are under execution to provide irrigation facilities in the upland areas.

Along with the West Godavari and Krishna Districts, this District also shares the distinction of being the rice granary of Andhra Pradesh. This District stands first for the cultivation of coconut and bananas. It is estimated that 7.53 lakhs tones of food grains valued at Rs.450 Crores are produced annually.

4.2 THE EXISTING DRAINAGE SYSTEM AND NECESSITY FOR IMPROVEMENTS:

For the plant growth and good yield, the air, the water and the salts have to be in proper proportion. A proper drainage is therefore a necessity and a complementary to the Irrigation and without proper drainage no irrigation is permanent. Submersion of plants and crops for prolonged periods ruins the plants and the crops.

Lack of proper drainage develops water logging in many cases and in the cases of certain soils make the land unfit for cultivation by increasing the salinity of the soil.

The removal of excess water, than what is needed and required for the roots of the plants to absorb is called the drainage. Thus, while irrigation is

the application of water to soil for ensuring plant growth, drainage is the removal of excess water for the survival of the plant.

Drainage is generally easily ensured where the land has a steep slope or the subsoil is porous. On the upland tracts, the drainage problem occurs but seldom. In the deltaic areas, where the land is flat it is prone to water logging and hence drainage is a serious problem. Drainage also becomes important when water is applied on large-scale irrigation.

Drainage can be ensured either by natural or by artificial drains or by a suitable combination of both.

The general topography of the Delta of East Godavari District is flatter and low lying. The drainage finds its way to Sea with great difficulty, and therefore the drainage is a serious problem and is essential in these deltaic areas.

When the irrigation system was first established in 1852 by Sir Arthur Cotton, the drainage system was also formulated with the branches of Godavari and the available rivulets. Since, then these natural valleys are called as drains.

These drains are classified as Major, Medium and Minor depending upon the catchment it serves. Those that serve an area below 12.95 Square Kilometres are called as Minor ones, while those that drain a catchment area above 51.80 Square Kilometres are known as Major drains. The drains that fall between 12.95 to 51.80 Square Kilometers are medium drains.

In the delta of the East Godavari District, there are 19 Major drains, 42 Medium Drains and 262 Minor Drains.

The drains in these deltas are of two types – drains join the Sea direct, and drains join one branch or the other of the river Godavari. The Lower Kowsika, Vasalatippa, Kunavarm in the Central Delta, Tulyabhaga and Biccavolu drains in the Eastern Godavari Delta are some important drains that join the Sea. These drains are subjected to the tidal action and their mouths often affected by the littoral drifts of sand.

The other types of drains are those that join the Sea through one of the arms of the River Godavari. The Kuttunga, Gorinkala, Shankaraguptam

and Panchanadi drains join the Vynatheyam, arm of Vasista Godavari, the Teki joins the Coringa branch of the Godavari.

Whenever the river Godavari is in high floods, the floodwaters back up into these drains and cause inundation over the low lying marginal areas. The drainage congestion in these drains are at its worst when the local rains and the floods in the rivers are experienced simultaneously. The period of floods over the marginal rains some times extends to 30 to 40 days. The outfall sluices constructed at the mouth of these drains will function and will prevent the waters when there is flood in the river.

The drainage system was first formulated for an extent of about 1,80,000 acres. The extent of irrigated area in the East Godavari District has now increased enormously with two to three crops in an year and absolutely there is no increase of the drainage commensurate with the growth of Irrigation. Added to this, the inadequate maintenance, the unauthorized plantation, the cultivation extended nearer to the bed of the drains, the growth of the water hyacinth, the continuous silting of the drains and the damages caused due to frequent floods and cyclones, had made the drainage most ineffective.

Barring, throwing a spade of earth here and there, there was no maintenance worth mention to these drains. The improvements contemplated since early seventies are inadequate. The few straight cuts and maintenance of the section to the observed flood leveling selected drains had only extended the life of the drainage at discreet locations by few years.

Improvements were carried out extensively to all major and medium drains by CERP Organization and minor drains were improved under APHM & ECRP Organization during 1991-95 and 1997-2002 respectively.

4.3 DRAINS IN GODAVARI EASTERN DELTA:

The Godavari Eastern Delta is covered by three basins – Biccavolu, Tulyabhaga and Teki. There are seven major drains, twenty two medium drains, one hundred twenty minor drains and 324 revenue and private drains, in this area, serving the entire ayacut of 2.58 Lakhs Acres. The total length of the major drains is 176 Kilometers and that of medium drains

183.08 Kilometers. The minor drains both Government, revenue and private cover a length of 773 Kilometers. A brief description of the drains basin-wise is detailed below:

4.3.1 BICCAVOLU BASIN:

The Biccavolu basin is drained by three major drains namely Biccavolu, Vetlapalem and West Yeleru, five medium drains – New Voolapally, Kankanala Codu, Tooteru, Gaderu and East Yeleru. In addition to this, there are fourteen minor drains in the basin.

Biccavolu is the principal drain. The two major drains West Yeleru and Vetlapalem and the five other medium drains joint it. The Biccavolu basin is bounded by Samalkota Canal, on the Northern side and Kakinanda canal on the Southern side and drains a total area of 543.59 Square Kilometers which is partly deltaic and partly upland. It receives drainage from an ayacut of 57,327 acres. The shape of the basin is triangular having almost negligible width at its Western boundary and widens by 10 Kilometers at its base. Being the catchment having a shape of that of a pan type it receives floods faster than other drains.

4.3.1.1 BICCAVOLU DRAIN:

The Biccavolu drain is a natural course and one of the major drains in the Eastern delta. The drain starts from Biccavolu surplus escape of right bank of Samalkota Canl at its 30.30 Kilometer in the village limits of Biccavolu. After running for a length of 23 Kilometers in the Eastern direction, it bifurcates with left arm carrying seventy five percent of the total discharge. Both the arms further run a distance of 4 Kilometers before they empty into the Bay of Bengal through the salt creek of length of 7 Kilometers at Kakinada Town.

The drain receives the drainage water from an ayacut of 57,327 acres lying in between Samalkot Canal and Kakinada Canal in Biccavolu, Pedapudi, Karapa and Kakinada Mandals.

The drain is narrow and deep at its upper reaches. It is after the confluence of West Yeleru drain, which brings vast current of floods from

upland areas, the drain becomes more inadequate to cater the needs of the drainage.

The improvements are carried out by CERP Organization.

The maximum flood level of the drain is fixed based on the mean tidal level of the Sea which is + 0.10 M and also there will not be any submersion of the ayacut at half flood level condition.

The Committee visited Biccavolu drain where West Yeleru major drain joins at Km.6.20 L.B near Achutapuram (V) limits on 19-01-2007. At this location sufficient margins are available both for Biccavolu and West Yeleru Drains. The Field Engineers informed that the functioning of drain is satisfactory.

4.3.1.2 VETLAPALEM DRAIN:

Vetlapalem drain is also a major drain joining Biccavolu. It starts from surplus of Samalkot canal at Km.43.50 of right bank in the village limits of Vetlapalem. It runs for a length of 4.39 Kilometers and joins Biccavolu drain at Km.11.650 on left side. There are no in falling drains into this drain. It receives drainage from Samalkota canal ayacut of 1333 acres.

Improvements were carried out by CERP Organization to discharge max flood of 42.87 Cumecs.

West Yeleru is an upland drain starts from the surplus of Burugupudi tank. It runs along the town limits of Samalkota before crosses Samalkota canal and enters delta area and runs for a length of 10.70 Kilometres before joining Biccavolu near Atchutapuram village limits. The drain receives drainage from upland catchment of 307.07 Square Kilometers. It is proposed to divert about 425 cumecs as surplus water of Yeleru Reservoir scheme from Dabbakalva into this drain. Thus, the total discharge to be disposed off through the drain including the drainage from self-catchment of 7000 acres is 623 cumecs. But the existing aqueduct vent capacity through which the drain passes is only 326 cumecs and hence the drain is improved to a discharge capacity of 326 cumecs and banks are raised with a free board of two meters so as to accommodate the excess discharge if any over the designed one in the free board. It is found not desirable to design a drain for such a huge

capacity for the flood anticipated at a later date. The improvements were carried out by CERP Organization. The maximum flood level is fixed based on the Biccavolu drain at the confluence with West Yeleru.

4.3.1.3 MEDIUM DRAINS OF THE BICCAVOLU BASIN:

New Voolapally, Kankanalacodu, East Yeleru, Gaderu and Tooteru are the medium drains that join Biccavolu.

4.3.1.3.1 NEW VOOLAPALLY:

New Voolapally drain is another medium drain that joins Biccavolu of Godavari Eastern Delta. The drain starts in the village limits of Anaparthy and runs through the villages Koppaaram, Komaripalem, Tossipudi, Balabhadrapuram, Pandalapaka, Biccavolu, Voolapalli for a length of 8.33 Kilometers and finally joins into Biccavolu major drain at its 24.07 K.M on the right side. The drain receives its drain water from an ayacut of 4,198 acres of Tossipudi north side channel No.3, Pandalapaka Mondi Channel and Nakkla Channel. It drains a total area of 16.99 square kilometers.

There is one minor drain infalling into New Voolapalli drain at Km.2.53 on left side. The drain is improved by CERP Organization to allow a discharge of 11.40 cumecs. The carrying capacity of the drain is increased from 40% to 200%.

4.3.1.3.2 KANKANALA CODU:

Kankanala Codu is the longest medium drain in Biccavolu basin. This drain infalls into Biccavolu major drain at Km.8.05 on right side. Kankanala codu drain receives drainage from the ayacut bounded by Kamarapriyam gazam channel. Kaikavolu channel, Pagadi channel, Pedapudi channel, Bonuthumuru channel etc., and drains a total area of 20.875 Sq. Kilometers. It caters drainage from an ayacut of 5,160 acres.

The drain starts in the village limits of Gollala Mamidada, Peddada, Kumarapriyam, Pedapudi, Kaikavolu, Domada and Karakuduru for a length of 11.00 Kilometers and fainnaly empties into Biccavolu major drain. The drain receives the drainage water from an ayacut of 5,160 acres lying in between Kumarapriyam gazam channel, Kaikavolu Channel, Pagadi Channel, Pedapudi

Channel and Bonthumuru Channel in Pedapudi Mandal. There is one minor drain i.e., Gandredu punta infalling into Kankanala codu drain. The improvement works carried by CERP Organization. The carrying capacity of the drain is increased by 35% to 160 % to discharge 13.09 cumecs.

4.3.1.3.3 EAST YELERU:

East Yeleru is the upland medium drain in Eastern Delta in the Biccavolu basin. This drain infalls into Salt creek near Kakinada town. The drain receives drainage from the ayacut bounded by Narayanakhandi drain surplus drain, Sarpavaram drain (Yeletikalva drain) and Gaderu medium drain and drains a total area of 55.25 square Kilometers.

The drain starts in the village limits of Venkatakrishnarayapuram and runs in the village limits of Madhavapatnam, Bhavanarayanapuram and Kakinada town limits for a length of 6.230 Kilometers and finally empties into Salt creek. The drain receives the drainage water from an ayacut of 12,666 acres lying in between Sarpavarm drain (Yeletikalva) and Gaderu medium drain in Kakinada Mandal. The improvements to the drain are carried out by CERP. The carrying capacity of the drain is increased by 40 % to 200 % to discharge now 86.56 cumecs.

4.3.1.3.4 GADERU:

Gaderu is medium drain that infalls into East Yeleru medium drain at 1.845 K.M on left side. Gaderu drain receives drainage from the ayacut of Navarayeru system. This drain is having a catchment area of 34.08 Square Kilometers. It caters drainage from an ayacut of 8,422 Acres.

The drain starts in the village limits of Navara Village in Samalkot Mandal and runs in the village limits of Gonechala, Atchampeta, Panasapadu, Sarpavaram, Ramanayyapeta and Suryaropeta for a length of 12.00 Kilometers and finally empties into East Yeleru medium drain. There is one minor drain i.e., Petakalva infalling into Gaderu drain. The improvement to the drain is carried out by CERP. The carrying capacity of the drain is increased by 40 % to 200 % to discharge 52.13 cumecs.

4.3.1.3.5 THOOTERU:

Thooteru medium drain is one of the important medium drains in Biccavolu basin and originates from Navarayeru system of Yeleru in the village limits of Venkata Krishna Rayapuram and empties into Biccavolu major drain at Km.10.115 from left side. The drain runs through the villages of V.K. Rayapuram, Jaggammavari Peta, Vetlapalem, Domada. This drain serves a deltaic catchment of 18.64 square kilometers and also drains an ayacut of 4600 acres in the villages of Samalkot and Pedapudi Mandals.

There are 3 local minor drains infalling into this drain. The improvements of drain were taken up by CERP.

4.3.2 THULYABHAGA BASIN:

The Tulyabhaga basin is drained by Tulyabhaga major drain and nine medium drains – Lolla, Anapalamma, Chodavaram, Kandregula, Yendamuru, Kurada, Raju, Shahapuram and Patharlagedda. There are a total number of 22 minor drains also in the basin.

Tulyabhaga is bounded by Kakinada canal on the Northern side, Mandapeta and Coringa Canals on the Southern side and drains a total area of 282.86 square kilometers. It caters drainage from an ayacut of 75,000 acres. The shape of the basin is triangular having negligible width at its Western boundary and widens by 1 Kilometer at its base. Being the catchment having a shape of a pan type, it receives floods faster than other drains. This Tulyabhaga basin is abutted in between Teki and Biccavolu basins.

4.3.2.1 THULYABHAGA DRAIN:

Tulyabhaga, one of the seven branches of Godavari is known as KASYAPA GODAVARI. Tulyabhaga means "equivalent share" as a dip in this natural course is considered as a dip in the Holy Ganges. When the drainage system was established, a small part of it was converted into Kakinada canal and the rest as a drain.

The drain now starts from the surplus at Km.11.66 right bank of Kakinada canal in Velegathodu Village limits and empties into Bay of Bengal

about 3 Kilometers East of Matlapalem Village after running for a length of 47.58 Kilometers.

The drains receive drainage from 75,000 acres lying between Kakinada canal, Mandapeta and Coringa canals in Rayavaram, Ramachandrapuram, Karapa and Kakinada Mandals. There are nine medium drains infalling into Tulyabhaga drain namely, Lolla, Anapalamma, Chodavaram, Kandregula, Yendamuru, Kurada, Raju and Shahapuram.

Improvements are carried out by CERP Organization. The maximum flood level of the drain is fixed based on the mean tidal level of the Sea which is + 0.10 M and also there will not be any submersion of ayacut at half the maximum discharge condition.

Worst slips were noticed during the execution and also after, in this drain. This is mostly due to poor type of soils and due to excavation in dry conditions.

4.3.2.2 MEDIUM DRAINS OF THULYABHAGA:

Lolla, Anapalamma, Chodavaram, Kandregula, Kurada, Raju, Shahapuram, Yendamuru and Tadepalli Medium drains are joining Tulyabhaga Drain.

4.3.2.2.1 LOLLA:

Lolla Drain is one of the medium drains in Tulyabhaga basin. This drain infalls into Tulyabhaga major drain at Km.25.640. Lolla drain receives drainage from the ayacut bounded by Vedurupaka Channel, and Nadurupaka Channel etc., and drains a total area of 18.39 square kilometers.

The drain starts in the village limits of Arthamuru and runs thorugh the villages of Ramavaram, Mahendrawada, Rayavaram and Vedurupaka for a length of 8.54 Kilometers and finally empties into Tulyabhaga major drain. The drian receives the drainage water from an ayacut of 5,160 acres lying in between Vedurupaka channel and Nadurupaka channel in Anaparthi and Rayavaram Mandals. The improvement works are carried out during the year 1991-92. The carrying capacity of the drain is increased by 40 % to 200 % to discharge 12.03 cumecs.

4.3.2.2.2. ANAPALAMMA:

Anapalamma drain is another medium drain in Tulyabhaga basin. It originates in the village limits of Kutukuluru village and runs through Someswaram, Pasalapudi, Vedurupaka, Nadurubada village limits for a length of 7.33 Kilometers and finally empties into Tulyabhaga drain at Km.24.53. The catchment area of the drain is 40.20 Square Kilometers.

It is bounded by Chodavaram canal, Someswaram channel and Vedurupaka Channels. The minor drains infalling into this drain are Godavari Badava drain and old Anapalamma drain. This drain caters the drainage needs of villages in Anaparthy and Rayavaram Mandals for an extent of 9900 acres. This drain is improved by CERP Organization. The carrying capacity of this drain is increased by 45 % to 200 % after improvements to discharge 20.26 Cumecs.

4.3.2.2.3 CHODAVARAM:

Chodavaram drain is another medium drain in Tulyabhaga basin. It is bounded by Chodavaram old and new channels and Narsapurapupeta channel. It serves an ayacut of 22.25 square kilometers and receives drainage from 5504 acres of land. It originates in Chodavaram village and after running a total length of 7.85 Kilometers, the drain finally empties into Tulyabhaga drain at Km.15.394 on its right side. It caters to the needs of the ayacutdars of Yenamadala, Oduru, Narasapurapupeta and Velangi Villages of Ramachandrapuram & Karapa Mandals. There are no infalling drains joining into this drain. Improvements were carried out by CERP. The carrying capacity of the drain is increased by 40 % to 200 % to discharge 13.67 cumecs.

4.3.2.2.4 KANDREGULA:

Kandregula drain is another medium drain in Tulyabhaga basin and serves an ayacut of 18.10 square kilometers. It receives drainage from 4474 acres of land, and originates in the village limits of Kandregula. After running a length of 6.76 Kilometers, it finally empties into Tulyabhaga drain from left side. It caters the needs of the ayacutdars of Kurada,

Chinamamidada village for a total extent of 4474 acres. There are no infalling drains for this drain. Improvements were carried out by CERP Organization. The carrying capacity of the drain is increaded by 40 % to 200 % after improvements to discharge 11.90 Cumecs.

4.3.2.2.5 KURADA:

Kurada drain is another medium drain in Tulyabhaga basin. The drain starts in the village limits of Kurada Village and runs through the villages of Aryavattam, Gollapalem, Selapaka, Old Manjera and Tanukuvada for a length of 10.25 KM, before it joins the Tulyabhaga drain. This drain has a deltaic catchment of 17.10 square kilometers and receives drainage from 4200 acres of ayacut in Karapa and Kajuluru Mandals. One minor drain, Ava drain is infalling into this drain. The improvements to this drain are carried out by CERP Organization. The carrying capacity of the drain is increased by 35 % to 110 % at various sections to discharge 19.14 cumecs.

4.3.2.2.6 RAJU:

Raju drain is a medium drain in Tulyabhaga basin. It starts in the village limits of Muthukumulli and runs for a length of 6.95 kilometers through the villages of Aryavattam, Peddapurapupadu and finally empties into Tulyabhaga drain.

The Catchment area of the drain is 30.91 square kilometers and the drain receives drainage from an extent of 5107 acres of ayacut. The drain is improved by CERP Organization. The volume of earthwork executed is 0.52 lakhs cubic meters. The carrying capacity of the drain is increased by 40 % to 200 % to discharge 17.01 cumecs,

4.3.2.2.7 SHAHAPURAM:

Shahapuram drain is a medium drians Tulyabhaga basin. The drain originates in the Village limits of Shahapuram, it runs through the Villages of Kandregula, Karapa, Vemulavada, Vakada, Kongodu and Gorripudi for a length of 8.25 Kilometers and finally empties into Tulyabhaga drain.

The drain is having a deltaic catchment of 25.9 Square Kilometers. The drain receives drainage from an ayacut of 6400 acres. Improvements

were carried out by CERP. The carrying capacity of the drain is increased by 40 % to 200 % to discharge 15.12 Cumecs.

4.3.2.2.8 YENDAMURU:

Yendamuru drain is a medium drain and originates in the Village limits of Yendamuru and runs for a length of 4.8 Kilometers through the villages of Yendamuru Peddapurapupadu and finally infalls into Raju medium drain. The catchment area of this drain is 16.63 Square Kilometers and receives drainage from 4100 Acres.

The drain is bounded by Coringa canal and its channels. The minor drain infalling into this drain is Venkateswrlu drain. The villages benefited by this drain are spread over in Kajuluru and Karapa Mandals. This drain has been improved by CERP Organization. The carrying capacity of this drain has been increased by 30 % to 110 % to discharge 11.25 cumecs.

4.3.2.2.9 TADEPALLI:

Tadepalli is one of the medium drains in Tulyabhaga basin. The drain starts from the Village limits of Tadepalli, runs for a length of 6.74 Kilometers and joins the Tulyabhaga major drain near Velangi village. Its catchment area is bounded by Enamadala west side bodi on Eastern side, Velangi channel on North side, Vella North Side channel on Southern side and Kapavaram channel, on Western side. The drain flows through the villages of Tadepalli, Vella, Siripuram, Chodavaram and Velangi. It receives drainage from an area of 14.24 Square Kilometers. Ragu Bodhi, minor drain is the only infalling drain into it.

This medium drain caters the drainage needs of about 9780 acres ayacut situated in the catchment. Improvements to this drain are carried by CERP, to receive safely a maximum discharge of 11.59 cumecs.

4.3.3 TEKI BASIN:

Teki is the biggest basin in the Eastern Delta drained by three major drains namely Teki, Nalluru and Andrangi and five medium drains viz., Kaleru, Machara, Venturu Surplus, Gummileru and Narsipudi. In addition to this, there are 50 minor drains in the basin.

Teki is the principal drain in the basin with two major drains Nalluru and Andrangi and other three medium drains Kaleru Machara and Venturu surplus joining it. The Teki basin is bounded by Mandapeta and Coringa canals on the North Bank canal on the West and South and Coringa river on the East. It drains a total area of 482 Square Kilometers which is purely deltaic. It is catering the drainage requirement of 1,05,000 acres.

The shape of the basin is fern leaf type. The lateral width of the basin is only about 11 Kilometers, while the length is about 45 Kilometers. Because of its shape, even though, the peak flood intensity is reduced on account of the flood peaks of the tributaries reaching the main drain at different times, the discharge in the main drain will be distributed over a long period of time causing drainage congestion and inundation of fields for long periods, damaging the crops. Further, the terrain of the catchment is very flat and consequently the flow is sluggish, causing drainage congestion.

The flow conditions in the Teki drain are affected both by the floods in the river Godavari and by tidal effects, in addition to the inadequate cross sections of the drains in the basin.

Teki, the principal drain of the basin, had its infall into Coringa river which is a branch of the Gowthami-Godavari river. It is a common experience that the flood level of Godavari would attain the peak during the months of July and August. Consequently the flood level of Coringa river would also touch the maximum during these months, directly affecting the discharging capacity of the Teki drain. The Coringa flood waters even back up to into the Teki drain and devastate what is before it. The damage caused to the tender paddy plants during this period is enormous. It is estimated that an extent of 40,000 acres will be affected by these floods.

Again in the months of September and October during the North-East monsoon and due to the cyclonic storms, the Teki drain would be in floods. But its discharging capacity is affected, even though the river Godavari is not in floods, due to the severe tidal action to which Coringa river is subjected to during this part of the year. This results in stagnation of water in the paddy fields at the time of harvesting and thereby loss of food grains.

Therefore, for effective functiong of the drain.

i) The Flood waters of Godavari have to be prevented from entering the Teki through Coringa river.
ii) The tidal effect has to circumvented, and
iii) The carrying capacity of the drains are to be increased.

The flood waters of Godavari, entering Teki drain, through Coringa river are regulated by the construction of a Regulator on Coringa river near Yanam Town.

The tidal effect on the Teki drain in discharging the flood water is circumvented by diverting part of the maximum flood of Teki drain from its upper reaches into the river Godavari, where it is permitted. A diversion is taken up, to relieve 50 % of the maximum discharge of Teki at Km.20.34 near Gangavaram Village to join the waters in Godavari near Kota Village.

Teki and its medium drains were improved for increased capacities.

4.3.3.1 TEKI DRAIN:

Teki is one of the major drains in the Eastern Delta having a catchment area of 482 Square Kilometers. The drain starts from Teki Surplus Weir above Alamuru lock at Km.22.600 of Right bank of Coringa canal in the village limits of Alamuru. After running for a length of 39.10 Kilometers, the drain bifurcates into two equal branches and runs for another 1.5 Kilometers (both left and right arms) before it empties into Coringa River near Tallarevu lock. The Coringa river runs for a further length of about 12 Kilometers from the confluence of Teki drain and joins "Bay of Bengal". Thus the Teki drain flows for a total length of 40.6 Kilometers. The drainage water from an ayacut of 1,05,000 acres, bounded by Mandapeta canal, Coringa canal in the North, bank canal in the West and South and Coring river in the East will be served by the drain. The drain passes through Pamarru, Kajuluru and Tallarevu Mandals. There are two major drains namely Nalluru and Andrangi, three medium drains – Kaleru, Machara and Venturu surplus and seven minor drains that join the drain during its course to give relief from the drainage congestion. The drain is improved to discharge 161.52 cumecs by CERP Organization.

The maximum flood level of Teki drain at the confluence with Coringa river is fixed at +0.75 Mts., based on the 1st warning flood level of Godavari which is taken as +1.20 Mts.

4.3.3.2 NALLURU DRAIN:

Nalluru major drain is the second largest drain in the Teki basin. It collects drainage through two medium drains namely Gummileru and Narsipudi and one minor drain Yedida. The Nalluru drain serves an irrigated area of 33,200 acres lying between Bank and Mandapeta Canals to the north of Coringa canal. The catchment area of the drain is about 135 Square Kilometers wihich is purely deltaic. The drain starts from the right bank of Mandapeta in Jegurupadu Village limits just below the bifurcation of Mandapeta canal with Kakinada Canal. It runs for a length of 22.60 Kilometers and empties into Teki drain at its 32.250 KM near Teki Village, to give relief from the drainage congestion, the Nalluru drain is improved by CERP Organization to receive a maximum discharge of 45.37 cumecs.

4.3.3.3 ANDRANGI DRAIN:

This is another major drain in the Teki basin that infalls into Teki drain. There are five minor drains namely Draksharama, Hasanbhada, Bhimakrosupalem, Addampalli and Penumalla that joins this drain. The catchment area of this drain is bounded by Coringa canal on North, Injaram canal on South and West and Teki drain on the East. It drains a total area of 57 Square Kilometers which is purely deltaic. It receives drainage from an ayacut of 15,200 acres. The drain starts from North of Ramachandrapuram – Draksharama road near Draksharama. It runs for a length of 18.575 Kilometers in Draksharama and kajuluru Mandals and finally empties into Teki drain at Km.3.10. To give relief from the drainage in an ayacut of 15,200 acres lying between Coringa canal and Injaram, the drain is improved to allow a maximum discharge of 25.5 Cumecs by CERP Organization.

4.3.3.4 CORINGA REGULATOR:

Coringa river is a branch of Gowthami Godavari and originates at the outskirts of Yanam town. After running for a length of 1.5 Kilometers, in Pondicherry Territory, it enters Andhra Pradesh near Nelapalli Villlage. In olden days, the river is popularly known as "Atri Godavari" and is believed to be one of the seven branches on Godavari river.

The Coringa river drains an area of 565 square kilometers apart from the waters it receives from its own catchment, during the months of July and August when Godavari is in floods. These flood waters enter the Coringa river, inundate vast areas and damages the tender paddy fields. The loss is estimated to be enormously high.

It is estimated that about 40,000 acres of ayacut in Tallarevu, Kajuluru and Pamarru Mandals will be under submersion some times partial and some times fully, due to these floods and 40,000 tonnes of food grains valued at Rs.1000 lakhs are lost annually. The river is known for its navigation from the times immemorial. The French people used to transport both the military and commercial cargo from the Sea to the Yanam town through this river. As time passed on and with the development of quick land transport, barring conveyance of river sand, conconuts, and other commodities, the navigation in the Coringa river is not much preferred but it did not die down.

A regulator was constructed 560 M upstream of the confluence of the river with Godavari to regulate the entry of Godavari water into Coringa. When the Godavari is in floods, the gates of the regulator will be closed to prevent the flood waters entering the river and during other periods free flow will be allowed to facilitate navigation.

The Regulator is 21.2 Mts. Long, consists of two vents each of the size 10x7.27 M. It is capable of discharge 34 cumecs at high tide level of +1.28 M. There has been sufficient draft in the river and required head room is provided in the regulator to facilitate navigation. Stoplog type gates, are proposed to operate, as the operation is mostly for a period of one or two months when Godavari is in floods. A single lane bridge of 4.25 M wide between the kerbs is also provided to connect the banks, so that it can be used as a diversion road from Yanam to Kakinada.

The committee visited the structure on 19.01.2007. It is recommended to attend all necessary repair works for proper functioning.

4.3.3.5 TEKI DIVRSION:

In the months of September and October during the onset of North-East monsoon, the Teki drain is in floods but its discharging capacity is retaRBed due to the severe tidal action to which the Coringa river is subjected to. During this part of the year, level of Coringa river rises quickly on account of tidal effect and the flood waters of Teki will not be effectively discharged resulting in stagnation of flood water in paddy fields at the time of harvest.

With regards to tidal action there may not be a feasible remedy for lowering the tidal effect on Coringa river. Alternatively a part of flood water has to be diverted from its upper reaches into river Godavari whose water level will be lower at this period.

The Teki drain runs almost parallel to Gowthami Godavari for its entire length and approaches very near that is 4.4 Kilometers to the left flood bank in between Gangavaram and Dangeru Village. There is already an existing minor drain called Gangavaram in between the villages and joins the Teki drain near Km.20.46. Therefore, the Teki waters from this point are diverted through this Gangavaram drain duly shaping the drain to divert 50 % of Teki water by providing reverse slope.

The computed maximum flood at Km.20.47 of Teki from 278.98 square kilometers is 120.56 cumecs. The Gangavaram drain was remodeled to take 60.28 cumecs (that is 50 % of the discharge) with bed fall of 1 in 7000 by CERP Organization.

Further, to dispose off the water safely into Godavari and to prevent the waters of Godavari entering the Teki diversion at the time of floods, an outfall sluice is also constructed, at Km.46.7 of Gowthami Godavari flood bank near Kota Village.

The committee visited the outfall sluice on 19.01.2007 which is in good condition. Field engineers reported that the functioning of structures is satisfactory.

4.3.3.6 MEDIUM DRAINS IN TEKI BASIN:

Kaleru, Gummileru, Venturu Surplus Weir, Machara, Narsipudi and Seela medium drain join in Teki Drain.

4.3.3.6.1 KALERU:

Kaleru is the lengthiest medium drain in Teki basin. The kaleru drain is bounded by Mandapeta canal on left side and Nidasanameta channel, kurmapuram channel right and drains a total area of 50.09 square kilometers which is completely deltaic.

The drain starts from the village limits of Tapeswaram and runs for a length of 16.15 kilometers through the villages of Mandapeta, Maredubaka, Pulugurtha, Chelluru, Kaleru and Yendagandi and finally infalls into Teki major drain at Km.30.025. In addition to the deltaic drainage area of 12,340 acres of ayacut the above villages, this drain receives effluent from Maredubaka paper mill and Chelluru Sugar Factory. There are no infalling minor drains in this drain. The ayacut of this drain falls in Mandapeta, Anaparthy, Rayavaram and Pamarru Mandals. This drain has been improved by CERP. The carrying capacity of the drain is increased by 45 % to 200 % in various reaches to discharge 23.46 Cumecs.

4.3.3.6.2 GUMMILERU:

Gummileru drain is a medium in Godavari Eastern Delta and originates from Gummileru Village. There are two feeder drains, one Penikeru drain at 2.615 KM and the other at KM 3.49 are infalling into it. The drain receives its drainage from an ayacut of 8,576 acres lying in between Choppella channel on North, Gummileru and Nalluru drains on East, Jonnada channel on South and Bank canal on West.

The drain after running for a length of 3.49 Kilometers from its origin joins the Nalluru major drain at its Km.6.30 on right side. The drain is improved by CERP Organization. The carrying capacity of the drain has increased from 40 % to 200 % to discharge 18.37 cumecs.

4.3.3.6.3 VENTURU SURPLUS WEIR:

Venturu surplus drain is another medium drain in Teki basin. It originates from Venturu surplus weir situated at Km.38.604 on right bank of Injaram Canal. It is bounded by Injaram canal and Kurmapuram channels and after running a total length of 4.80 Kilometers, it finally empties into Teki drain at Km.25.690 on its left side. It receives drainage from 19.42 Square Kilometers and caters to the needs of ayacutdars of Jagannayakula palem, Venturu and Kurakalla Palli Villages. The entire catchment is deltaic only.

There is one minor drain infalling into this drain namely – Kurakallapalli minor. Ventur drain is improved by CERP Organization. The carrying capacity of the drain is increased by 35 % to 200 % to discharge 19.28 cumecs.

4.3.3.6.4 MACHARA:

Machara drain is a medium drain of Teki basin. It starts from the Macharametla Village limits and runs through the villages of Machara, Vakatippa, Amuzuru and finally infalls into Teki drain at its Km.27.00 on right side. The total length of the drain is 11.05 Kilometers. The drain receives its drainage from an ayacut of 4,205 acres of the above villages.

There is only one minor infalling drain joining Machara at KM. 2.700. Improvements were carried out by CERP Organization. The carrying capacity of the drain is increased by 40 % to 200 % after its improvement to discharge 13.03 Cumecs.

4.3.3.6.5 NARSIPUDI:

Narsipudi is a medium drain, originating from a local tank in R.S. No.65 of Dulla Village and passes through the village limits of Narsipudi, Yedida, Modukuru, and Mandapeta and runs for a length of 7.235 Kilometers and empties into Nalluru drain at Km.10.19. The drain receives its drainage from its ayacut of 5,107 acres.

There is one feeder drain, draining an extent of 20.66 Square Kilometers infalling at the head of Narsipudi drain. The drain is improved by

CERP Organization and the carrying capacity of the drain is increased by 40 % to 200 % to discharge 13.01 Cumecs.

4.3.3.6.6 SEELA:

Seela drain is a medium drain in Godavari Eastern Delta. The drain starts the village limits of Kajuluru just above Kajauluru No.1 Channel, and empties into Coringa canal after running for a length of 10.50 Kilometers. The drain receives drainage from an ayacut of 3,763 acres in Kajuluru, Cheduvada, Seela and Manjeru drainages. This drain is bounded by the Coringa canal on North, Vella south side channel, Kajuluru No.1 Channel on the Eastern side.

There are no infalling drains to this drain. The drain is improved by CERP Organization. The carrying capacity of the drain is increased by 40 % to 200 % to discharge 10.61 cumecs.

4.3.4 OTHER MEDIUM DRAINS IN GODAVARI EASTERN DELTA:

Mandarava and Patharlagedda are other medium drains that directly join in Bay of Bengal.

4.3.4.1 MANDARAVA:

Mandarava drain is a medium drain that joins direct the Bay of Bengal. It starts from Polikurrupunta i.e., the road connecting Mallavaram and Gadimoga Villages in the Villages limits of Mallavaram. It runs for a length of 8.2 Kilometers in Coringa island and joins sea through Salt creek through an outfall sluice in Pedagodimoga Village limits. It drains an area of 20.71 Square Kilometers from the ayacut of Mallavaram and Polikurru ayacut bounded on left side of Gadimoga channel right side Neelapalli channel, Talluru North Channel and South Channel.

There are six infalling minor drains for the drain, as the existing section of the drain is inadequate through out its length to discharge 15.48 cumecs. The drain is improved to the required standards with a bed slope of 1 in 4800 by CERP Organization.

4.3.4.2 PATHARLA GEDDA:

Patharlagedda drain is one of the medium drains in Godavari Eastern Delata that joins the Sea directly. It starts in the village limits of Patharlagedda and after running a length of 8.65 Kilometers through the Villages of Penuguduru, Gurjanapalli and Nadakuduru, finally joins the sea near chollangi Village. The catchment area of the drain is 24.70 Kilometers.

Improvements were carried out to this drain by CERP Organization. The carrying capacity of the drain was increased from 40 % to 200 % due to the repairs.

4.4 DRAINS OF GODAVARI CENTRAL DELTA:

The Godavari Central Delta comprises of three islands the main Bobbarlanka, Nagaram and Polavaram.

Bobbarlanka is the delta in between the main branches of Vasista and Gowthami Godavari and extends upto Bay of Bengal. This island is served by number of major drains. Nagaram Island is in between Vasista and Vynatheyam branches and extends upto Bay of Bengal. This Island is served by a number of Medium Drains, while Polavaram Island is a small one with a few medium drains.

There are altogether ten major drains, twenty one medium drains and 1 minor drain in these Islands.

Since this delta is more flatter, there are almost equal number of basins that of drains. Also more number of medium drains having independent status join in one or the other branches of the Godavari or the Sea. The total length of major drains is 185.91 Kilometers and that of medium drains is 175.04 Kilometers and minor drains cover a length of 411.00 Kilometers.

4.4.1 GORINKALA BASIN:

The Gorinkala basin is drained by three major drains Gorinkala, Upper Kowsika and Sakurru and two medium drains namely Ryali Surplus Weir and Sankyanadi. There are four minor drains in the basin. Gorinkala is the principal drain. The two major drains Upper Kowsika and Sakurru and the

two other medium drains join in it. The Gorinkala drain is bounded by Gannavaram and Amalapuram canals and drains a total area of 190.54 square kilometers. It caters drainage from an ayacut of 50,000 acres. The shape of the basin is that of a sharp knife having almost negligible width at head and widens by 9.00 Kilometers at its base. Being the catchment area is of knife shape, it receives drainage slowly.

4.4.1.1 GORINKALA DRAIN:

The Gorinkala drain originates at Ryali Surplus Weir on right bank of Amalapuram canal between 18.00 and 19.00 K.M and flows for a total length of 23.415 Kilometers in between Gannavaram and Amalapuram Canals and joins Vtynatheyam branch of Godavari at Munjavarapukottu through an outfall sluice. It collects drainage from the two major drains Upper Kowsika and Sakurru, two medium drains – Ryali Surplus Weir drain and Sankyandi and four other minor drains. It runs in the Gannavaram, Palivela and Ambajipeta Mandals and receives drainage from the ayacut of 47,000 acres lying between Gannavaram and Amalapuram Canals. The drain is deep and narrow and inadequate to cater to the needs of the drainage. There are about nine meanderings at its trail reaches.

The improvements are carried out by CERP Organization.

4.4.1.2 SAKURRU DRAIN:

Sakurru drain is a major drain in Godavari Central Delta of East Godavari District. The drain commences from the confluence on left and right arms of Upper Kowsika near Sakurru Village and is bounded by Vynatheyam River and Ambajipeta Gannavaram Road. The drain is having a catchment of 61.62 square kilometers at confluence and caters the drainage from an ayacut of 15,200 acres.

The drain passes through the villages of Gannepalli, Nandampudi, Munjavarampukottu and after running for a length of 4.0 Kilometers, joins Gorinkala drain from left side very near to the outfall sluice of Gorinkala drain.

Improvements were carried out by CERP Organization to accommodate a maximum discharge of 49.79 cumecs.

4.4.1.3 UPPER KOWSIKA DRAIN:

Upper Kowsika is one of the important major drains in Central Delta. It is named after the saint "Kowsika" and is believed to be one of the seven branches of Godavari and separated from the parent river after the formation of flood banks as a part of construction of anicut by Sir Arthur Cotton. The local people still performs the rituals on the bank of Upper Kowsika drain treating it as "Holy Godavari".

The Upper Kowsika major drain is bounded by Amalapuram canal and Gannavaram canal on either side and drains a total area of 49.29 Square Kilometers which is deltaic. The drain starts from Mukkamala Village limits. It runs for length of 24.00 Kilometers and infalls into Sakurru major drain which in turn empties into Gorrinkala and then into Vynatheyam Godavari through outfall sluices. A medium drain from left known as left arm joins the drain from the confluence of left and till it joins Gorinkala drain, the drain is called "Sakurru". The drain receives drainage water from an ayacut of 12,186 acres of Mukkamala, Irusumanda Pulletikurru, Chiratapudi, Isukapudi, Matchavaram, K.Pedapudi, Gangalakurru, Mosallapalli and Bandarulanka villages of Kothapeta and Ambajipeta Mandals. The drain was improved by CERP Organization. The carrying capacity of the drain is increased by 200 % at various sections to discharge 34.98 cumecs.

4.4.1.4 MEDIUM DRAINS OF GORINKALA BASIN:

Ryali Surplus Weir and Sankyanadi are the medium drains of Gorinkala. Sankyanadi, as it is found to be adequate and no improvements were found necessary by CERP organization.

4.4.1.4.1 RYALI SURPLUS WEIR:

Ryali Surplus Weir drain is one of the medium drains in the Gorinkala basin in Godavari Central Delta. This drain starts from Ryali Surplus Weri on Amalapuram Canal at Km.18.680 on right bank and runs for a total length of

6.80 Kilometers and infalls into Gorinkala major drain at its starting point. One minor drain namely Ramachandrapuram Surplus Weir drain which is a minor drain joins the medium drain. The entire catchment of 16.83 Square Kilometers lying between Gannavaram Canal and Amalapuram Canl which is purely deltaic is drained by this Ryali Surplus Weir drain. The drain runs though Atreyapuram Mandal and Ravulapalem Mandal receiving drainage from an ayacut of 3,200 acres.

The improvements to the Ryali drain were carried out by CERP Organization to accommodate the maximum flood discharge of 36.92 cumecs arrived based on revised design standards.

4.4.1.4.2 SANKYANADI DRAIN:

Sankyanadi is one of the medium drains in Gorinkala sub basin of Vynatheyam basin in Godavari Central Delta. The drain starts between Ambajipeta channel and Narendrapuram channel in Narendrapuram Village limits and runs for a length of 11.30 Kilometers through the villages Narendrapuram, Munganda and Mungandapalem and empties into Gorinkala drain at Km.0.605. The catchment area of the Sankyanadi drain is 16.4 Square Kilometers which is purely deltaic.

The committee visited the drain in above said village limits. It is noticed that the garbage has been dumped in the drain resulting in reduction of carrying capacity in addition to unhygienic situation. The committee recommends that the drain running through habitation is to be run in closed conduit in order to maintain public hygiene.

4.4.2 KUMMARAKALVA – DESICODU – VASALATIPPA SYSTEM:

Kummarakalva is a Godavari joining drain while Vaslatippa is a Sea joining one. Desicodu is a minor infalling drain into Kummarakalva. An attempt is made for an inter basin diversion ultimately into sea from Kummarakalva to Vasalatippa through the Desicodu.

4.4.2.1 KUMMARA KALVA DRAIN:

The Kummarakalva drain is in Vynatheyam Godavari basin. The drain is drained by three minor drains. The Kummarakalva drain is bounded on

left side by Mukteswaram to Amalapuram road and on right side by Amalapuram and Benda canals and drains a total area of 69.90 Square Kilometers, which is a deltaic catchment and it caters drainage from an ayacut of 17,300 acres.

The Kummarakalva drain starts in Vakkalanka Village limits and runs through Ambajipeta, Inavilli, Amalapuram and Allavaram Mandals and after running for a length of 24 Kilometers, it empties into Vynatheyam Godavari through an outfall sluice. The outfall sluice will be kept closed during floods in Godavari river to avoid entry of flood waters into the drain. As a result, the entire ayacut used to be under submersion. To relieve the above drainage congestion, the drain is improved for its full discharge capacity. To relieve the ayacut from submersion when Godavari is in floods and the out fall sluice of the drain is closed, a provision is made to divert fifty percent of its discharge direct into sea, through Desicodu and Vasalatippa drains.

Improvements to this drain were carriedout by CERP Organization. The committee visited the drains in the town limits of Amalapuram on 18.01.2007 and observations are appended separately in the Chapter No.7.1.1 (i.e.) suggestions received from public and views of committee.

4.4.2.2 VASALATIPPA DRAIN:

Vasalatippa is a major drain with eight minor drains joining into it. It is bounded by Amalapuram Canal, Amalapuram Channel and Samanthakurru channel and drains a total area of 56.44 Square Kilometers which is a deltaic catchment. It receives the drainage from the ayacut of 13,950 acres.

Vasalatippa drain is one of the major drains in Godavari Central Delta. The drain starts from Km.53.10 of right bank of Amalapuram canal in Amalapuram town limits and runs for a length of 20.00 Kilometers through the villages of Amalapuram, Chinthadavaruvu, Peruru, Thandavapalli, Vanne-Chinthalapudi, Gopavaram, Gudala, Samanasa, Bheemanapalli, Tadikona, Devaguptam, Challapalli and Samanthakurru. This drain joins the Salt Creek near Rameswaram Village through combined course of Vasalatippa and Lower Kowsika drains for a length of 0.60 Kilometers and runs in Salt Creek for a

length of 2.28 Kilometers and finally joins in Bay of Bengal through Moga at a distance of 2.5 Kilometers to Rameswaram Village in South West direction. The drain receives 50 % discharge of Kummarakalva drain through Desicodu drain to give quick relief to Kummarakalva when Godavari is in floods, tail end reach of the drain near the sea mouth is also improved by dredging.

Improvements were carried out by CERP Organization to make the drain to allow a flow of 57.26 Cumecs.

4.4.2.3 DESICODU:

Desicodu is a minor drain, having a catchment of 11.65 Square Kilometers. It originates near the Village limits of Allavaram and after running for a length of 6.49 Kilometers, joins Kummara Kalva. This drain was widened to accommodate a maximum discharge of 26.89 Cumecs and the slope reversed and connected to Vasalatippa drain. It thus accommodates in addition to its discharge from self catchment, fifty percent of water of Kummara Kalva, when the entry of the waters of the later in to Godavari are permitted and joins them into Vasalatippa, a Sea joining drain.

4.4.3 LOWER KOWSIKA DRAIN:

The basin is drained by the Lower Kowsika major drain and its four minor drains namely Allavaram drain, Srigetlapalli drain, Devaguptam drain and Samanthakurru drain. Lower Kowsika basin is bounded by Benda North Channel. Allavaram Channel and Samanthakurru channel and drains a total area of 36.24 Square Kilometers, which is deltaic. It receives the drainage from the ayacut of 13,500 acres.

Lower Kowsika drain is one of the major drains in Godavari Central Delta. The drain starts from Allavaram Village limits and runs for a length of 16.40 Kilometers touching the Villages Allavaram, Godi, Godilanka, Mogalamuru, Turupulanka, Relluguda, Devaguptam, Samanthakurru and Komarigiripatnam. The drain joins the Salt Creek near Rameswaram Village and runs through the combined course of Lower Kowsika and Vasalatippa drain for a length of 0.60 Kilometers in a South West direction into Bay of

Bengal through a Moga at a distance of 2.5 Kilometers from Remeswaram Village.

Improvements were carried out allow a maximum discharge 24.21 Cumecs by CERP Organization.

4.4.4 KUNVARAM BASIN:

The basin is drained by the Kunavaram major drain and its two medium drains Rangarajucodu right arm and Old Inapuram and three minor drains Old Samanasa, Goraganamudi and North South Peekilmeru drains. The total catchment area of the basin is 90.48 Square Kilometers and receives drainage from an ayacut of 22,000 acres. The basin is bounded by Amalapuram canal below Samanasa lock on left side and Bank canal on right side below N.K. Palli channel.

4.4.4.1 KUNAVARAM DRAIN:

Kunavaram major Drain is one of the major drains in Godavari Central Delta. This Drain starts from the confluence of Rangarajucodu and Old Samanasa drains near Kunavaram Village and runs for a length of 9.00 Kilometers through Villages of Kunavaram, Uppalaguptam, N. Kothapalli, S. Yanam and Katrenikona. This drain joins Gowthami-Godavari after traversing a length of 18 Kilometers along old course from its tail end through swamp.

Rangaraju Codu Right Arm and Old Inapuram Medium drains join Kunavaram drain. The improvements to the Kunavaram drain are of two fold – (i) Improvements to the drain course and (ii) effective joining of the drain into sea as the existing course near the sea, over a length of 20 Kilometers is almost blocked.

The improvements to the drain are carried out for a maximum flood discharge of 44.76 cumecs by CERP organization.

The reach of 20 Kilometers near the Sea, known as Old Course was now chocked up and became inoperative. Therefore the Kunavaram drain has no exit. In the year 1988, a straight cut of length 1,236 meters was excavated to give way to the drain into Bay of Bengal. This straight cut had

hardly functioned for two months, and the entire area was sand casted. Therefore, the matter was referred to the Central Water and Power Research Station, Pune and finally an alignment of 600 meters length was recommended and massive groynes are proposed. Formation of Groyne however was not materialized so far.

The committee visited the straight cut on 18.01.2007. The field engineers reported that the Sea mouth of the straight cut was opened twice i.e., 1994 (CERP) and 2001 but the same was closed due to littoral drift within no time. It is observed that the entire area was sand casted.

The committee recommends for opening of straight cut again and to maintain the Sea mouth continuously by deploying dredger for better functioning of drain.

4.4.4.1.1 RANGARAJU CODU:

Rangaraju Codu is a medium drain in Godavari Central Delta. It starts from the ridge located near Nangavaram Village limits and runs for a length of 6.20 Kilometers before it infalls into Kunavaram major drain. The total catchment area of the drain is 13.20 Square Kilometers. It receives the drainage from 3250 acres of land in the Villages of Uppalaguptam Mandal.

The only one minor drain infalling into this drain is New Samanasa Drain. This drain has been improved during 1991-92 by CERP Organization. The carrying capacity of the drain is increased by 20 % to 80 % to discharge 9.65 Cumecs.

4.4.4.1.2 OLD INAPURAM:

Old Inapuram is a medium drain in Godavari Central Delta connecting Kunavaram with Godavari. It starts in N. Kothapalli Village limits and runs through a length of 12.60 Kilometers. The total catchment area of the drain is 43.38 Square Kilometers. It receives the drainage water from the ayacut of N.Kothapalli, Vanapallipalem, Pedagadavalli, Chinagadavali, Uppalaguptam, Vetlapalem, Katrenikona, Uppudi, Inapuram, Kundaleswaram and Kunchenapalli Villages and finally empties into river Godavari through an

outfall sluice near Kunchanapalli Village limits. It receives the drainage from about 10,000 acres.

This drain was improved by CERP Organization. The carrying capacity is increased by 30% to 100 % to discharge 21.29 cumecs.

4.4.5 VRUDHA GOWTHAMI BASIN:

The Vrudha Gowthami basin is bounded by Anathavaram Channel on the right and Bank canal on the left and drains a total area of 72.85 Square Kilometers which is deltaic area. It receives drainage from an ayacut of 17,000 acres.

The Vrudha Gowthami is the principal drain and three medium drains Mummidivaram, Somidevarapalem and Bondacodu drains joins it. In addition to this, there are three minor drains.

4.4.5.1 VRUDHA GOWTHAMI DRAIN:

Vrudha Gowthami drain is one of the major drains in Godavari Centrla Delta. The drain starts at Mukteswaram Village limits and after running for a length of about 19.90 Kilometers through Villages of Mukteswaram, Saripalli, Totharamudi, K.Jagannadhapuram, Magram, Krapachintalapudi, Mummidivaram, Kothalanka and Inapuram Villages finally empties into Gowthami Godavari River through an out fall sluice at Kothalanka Village.

The Outfall sluice will be kept closed during floods in Godavari to prevent entry of flood water of Godavri into the drain. When there are floods in the drain simultaneously the waters will not have any outlet and the entire ayacut will be in submersion. To prevent the submersion, improvements were carried out to the drain and also proposed to excavate link drain connecting Vrudha Gowthami, Amalapuram and Old Inapuram drains through Kandikuppa drain to divert these waters into Salt Creek and finally into Bay of Bengal.

Improvements to Vrudha Gowthami drain were carried out for a maximum discharge of 30.13 cumeces by CERP Organization.

4.4.5.2 MEDIUM DRAINS OF VRUDHA GOWTHAMI:

Mummidivaram, Bondacodu and Somidevarapalem are the three medium drains that join Vrudha Gowthami drain.

4.4.5.2.1 MUMMIDIVARAM:

Mummidivaram drain is a medium drain in Godavari Central Delta. The drain starts from S.No. 645 of Mummidivaram Village limits and runs for a length of 6.20 Kilometers in Mummidivaram Village limits and finally empties into Vrudha Gowthami drain through open head. The drain has got a deltaic catchment area of 20.81 Square Kilometers. The drain receives drainage water from the ayacut of Rajupalem channel, pallipalem south side channel and Kothalanka channels of Bank Canal. There are two feeder drains infalling into this drain namely Godilanka drain and Chintavari codu drain.

This drain is improved by CERP Organization. The carrying capacity of the drain is increased by 40 % to 200 % with a discharge of 13.07 Cumecs.

4.4.5.2.2 BONDACODU:

Bondacodu drain is a medium drain that joints Vrudha Gowthami. It starts in Ananthavaram Village limits and runs for a length of 8.00 Kilometers and crosses Magham Channel through an under tunnel. Below the under tunnel, it runs for another 2.34 Kilometers before joining the Vrudha Gowthami drain at Km.2.50. The drain below the under is named as Somi Devara Palem drain. Thus, the total length of the drain is 10.34 Kilometers. The entire catchment is deltaic with an area of 16.83 Square Kilometers. It receives the drainage from the villages of Magham, Ananthavaram, Pothukurru, Karpa, Chippalapalem, Mallayyapalem, Mummidivaram and Somidevara Palem Villages and and finally joins into Vrudha Gowthami drain at Km.2.50 and serves the drainage in an extent of 6500 acres. The only minor drain infall into this drain is Karapa. This drain has been improved by CERP Organization. The carrying capacity of the drain is increased by 45% to 180 % at various sections to discharge 15.96 cumecs.

4.4.6 THE AMALAPURAM DRAIN:

The Amapalapuram drain is drained by five minor drains namely Vemavaram, Bhatnavilli, Vilasavilli, Gunnepalli and Rangarajucodu left arm. Amalapuram drain is one of the major drains bounded by Vilasavilli channel, Anathavaram, Reddipalli channel, Vadaparru Channel and drains a total area of 56.18 Square Kilometers which is deltaic catchment. It receives the drainage from the ayacut of 13,900 acres.

Amalapuram drain starts from Km.53.10 left side of Amalapuram canal in Amalapuram limits and runs for a length of 15.40 Kilometers in the villages of Amalapuram, Bhatnavilli, Reddipalli, Bheemanapalli, Ananthavaram, Gunnepalli, Cheyyeru, Somidevarapaalem, Inapuram and Kundaleswaram. The drain empties into Gowthami Godavri river through an outfall sluice. The outfall sluice will be kept closed during floods in Godavari river to avoid entry of flood water into the drain. As a result, the entire ayacut will be in submersion when there are floods in the drain simultaneously. To relieve the above drainage congestion and to relieve the ayacut from submersion, the improvements were carried out and also proposed to excavate link drain connecting Amalapuram, Vrudha Gowthami, Old Inapuram drains through Kandikuppa drain to Saltcreek which joins into Sea.

The improvements to the drain are carried out to discharge a maximum flood of 21.70 cumecs by CERP Organization.

4.4.7 LINK DRAIN (Proposed by CERP Organization):

The Link drain commences from Vrudha Gowthami 1.00 Km. upstream of the outfall sluice and runs for a length of 15.300 Kilometers through the villages of Ainapuram, Kundaleswaram, Nadavapalli, Dontikurru, Pallamkurru and kandikuppa. The drain during its run collects the drainage from Vrudha Gowthami, Amalapuram and old Ainapuram drains and finally runs through Kandikuppa drain at Km.9.120 before it joins Bay of Bengal through the Salt Creek.

The link drain is basically the diversion of waters from different basins, hitherto joining Godavari, to Bay of Bengal; and is intended to give relief

from submersion to an ayact of 43,000 acres in the basins of Vrudha Gowthami, Amalapuram and old Ainapuram.

Vrudha Gowthami and Amalapuram major drains and old Ainapuram medium drain are the drains joining Gowthami Branch of Godavari direct. There are outfall sluices to these drains at their joining with the Gowthami Branch to prevent Godavari waters backing up into the drain when Godavari is in floods. When Godavari is in floods and when there are floods in these drains simultaneously, the waters in the drains have no outlet and therefore they breach the bunds and submerge vast areas under these basins.

To avert this, the flood waters from Vrudha Gowthami, Amalapuram and Old Ainapuram are linked and diverted to Sea through Kandikuppa drain. The excavation from linking to diversion into Sea is called Link Drain and consists of open excavation over a length of 6.18 Kilometers and the rest is deepening and widening of the Kandikuppa drain for a length of 9.12 Kilometers. This diversion is necessary when Godavari is in floods and in most of the other times, the waters from the said drains reach Godavari, through the existing outfall sluices. In view of that, the diversion is designed for fifty percent of the maximum discharge from the total catchment of the basins which works out to 34.86 Cumecs.

The link drain will give relief not only to the upper reaches in the basins of the above drains but the lower reaches of the area will also derive the advantage. Since well defined Banks are proposed on the either side of the drain than what it was, the tidal waters of Kandikuppa are confined within the banks only.

The maximum water level of the drains is + 1.90 M, just at the maximum level of the Vrudha Gowthami drain at its commencement and falls down to +1.0 M, at the Salt Creek. However, this could not be taken by CERP due to Land Acquisition problem.

4.4.8 MEDIUM DRAINS IN POLAVARAM ISLAND:

Two medium drains, namely Perumalla Raju Codu and North Addlakalva, drain the Polavaram Island and join the Gowthami branch of Godavari.

4.4.8.1 PERUMALLA RAJU CODU:

Perumalla Raju Codu is a medium drian and take its origin from Survey No.403 of Kesanakurru Village in Polavaram Island and runs for a length of 6.00 Kilometers through the villages of Kesanakurru and Tillakuppa. This drain joins Gowthami Godavari in Kesanakurru Village limits through an outfall sluice. The total catchment area is 21.86 Square Kilometers. There are four minor drains in falling into this medium drain. This drain is improved by CERP Organization. The carrying capacity of the drain is increased by 40 % to 200 % to discharge 13.500 cumecs.

4.4.8.2 NORTH ADDALA KALVA:

North Addalakalva drain is another medium drain in Polavaram Island of Godavri Central Delta. It starts in the village limits of Komaragiri and runs through Komaragiri, Kothapalli, Yedurulanka and Guthenadeevi Villages. The minor infalls are P.W.D. Minor Drain No.7, Drain No.6, Drain No.10, Drain No.8, Drain No.9, Drain No.11, Drain No.12, Drain No.14, Drain No.15, Drain No.16 and Drain No.19. North Addalakalva drain infalls into Gowthami Godavari River.

The length of the drain is 8.633 Kilometers and the catchment area is 28.11 square kilometers. It serves the drainage of 6800 acres in the above named villages. Improvements are carried out by CERP Organization. The carrying capacity of the drain is increased by 35 % to 180 % to discharge 15.98 Cumecs.

4.4.9 DRAINS IN NAGARAM ISLAND:

Nagaram Island in the Central Delta is drained by Sankaraguptam major drain and nine medium drains – Kunavaram, Namanapalem, Vadabodi, Vadrevulapalli, Kadali, Vepachettu, Rameswaram and Panchanadi and good number of minor drains also drain the area.

4.4.9.1 SANKARAGUPTAM DRAIN:

Sankaraguptam is one of the important drains of the Nagaram Island of the Central Delta. The drain starts near Kattimanda Village in Malikipuram

Mandal and flows parallel to the coastal line for a total length of 22.3 Kilometers, collecting drainage from the fields of Kattimanda, Kunavaram, Chintapalli, Mogali Kuduru, Gudapalli, Ponnamanda, Katrenipadu and B-Savaran Villages before it falls into Vynatheyam arm of Vasista Godavari river. The drain must have been a branch of Godavari in olden days like Coringa river in Eastern Delta and joins Bay of Bengal.

The drain collects drainage through a number of medium and minor drains joining it along the course. Of these, the Kunavaram drain which in turn collects its drainage through Chintapalli No.1, Mogalikuduru which infalls through Namanapalem medium drain and Gudapalli minor drains, is the most important tributary. The other minor drains that join Sankaraguptam drain are kattimanda, Ponnamanda No.1 and Ponnamanda No.2 drains. The drain has a total catchment area of 93.4 square kilometers and a total length of about 22.3 kilometers.

Like some of the typical medium drains in Nagaram Island, the highest bed level of the drain is not at its end, but it is at its 8.4 Kilometrage. The flow of the river is thus, from K.M 8.40 to Km.0.00 towards the Bay of Bengal while from Km.8.40 to Km. 22.9, it is towaRBs the Vynatheyam river of Godavari.

An outfall sluice at the Sea and the straight cut excavated from Km.0.00 of the drain into the sea has become ineffective due to sand casting of the area. There was no possibility for the drain waters to join the Sea. Thus, the waters in the drain Sankaraguptam from Km.0.00 to Km.8.40 have to be stagnated or flow towards the Vynatheyam river when surface levels permit.

At the confluence of the Sankaraguptam drain with Vyanatheyam river of Godavari, the maximum flood level of the river during the floods is +1.55 M and the maximum flood level of the drain is (-) 0.40 M. Therefore, the river waters back up into the drain for its entire length of 22.3 Kilometers causing drainage congestion. As a result of this, the marginal lands along the drain are subjected to submersion for more than a week and above 30 Cm. draining crops.

During summer, due to high tides in the Bay of Bengal, the peak tide level will be of the oRBer of +1.23 M. The water level being low in the drain during the period, the tidal waters back up into the drain over its entire length. As a result of this, the marginal lands along the drain are submerged, reducing the crop yield. It is estimated that about 6,400 acres of paddy fields and 1100 acres of coconut gardens on either side of the drain are getting submerged directly.

The improvements to the Sankaraguptam were taken up along with the other drains during 1990-91 and certain repairs were carried out. Since the farmers have represented that their coconut gardens require water from Sankaraguptam drain by inundation and there is uncertainty even after improvements to the relief for the paddy fields, no improvements have been carried out for the Sankaraguptam drain.

The committee visited the Sankaraguptam drain on 18.01.07. It is reported by the field engineers that the Hydraulic standards are revised duly allowing entire water into Vynatheyam River for entire length of 22.90 Km. It is also informed that a portion of head reach i.e., from Km.16.00 to Km. 22.90 was only taken up under World Bank aided APERP leaving tail end reaches. Series of fish nets are seen converting the drain into fish ponds. These are to be removed immediately and full pledged improvements are to be taken up for the entire length instead of piecemeal improvements at head reach in order to reap full benefits.

4.4.9.2 KUNAVARAM MEDIUM DRAIN:

Kunavaram drain is a medium drain infalling into Sankaraguptam. This drain is in the sub basin of Vynatheyam Godavari basin of Razolu Mandal in Godavari Central Delta. It starts in the village limits of Chintalapalli and runs for a length of 5.70 Kilometers and infalls into Sankaraguptam drain at its Km.17.51. The drain receives its drainage water from its ayacut of 9652 acres of Gannavaram canal.

There is one minor drain, Gudapalli drain infalling at Km.2.661 and one medium drain Namanapalem drain joins this drain. The drain is improved by

CERP Organization. The carrying capacity of the drain was increased from 40% to 250% to discharge 19.88 cumecs.

4.4.9.3 NAMANAPALEM:

Namanapalem drain is a medium drain joining Kunavaram. It originates at Tatipaka Village limits and runs for a length of 9.634 Kilometers through the Villages of Tatipaka, Palagummi, Kadali, Chintapalli and Kunavaram. The drain has a deltaic catchment of 20.43 Square Kilometers and infalls into Kunavaram medium drain which inturn infalls into Sankaraguptam major drain.

Namanapalem drain receives the drainage water from an ayacut of 5000 acres. The minor drains infalling into this drain are Mogalikuduru drain and Chintapalli No.I. This drain caters the needs of the ayacutdars in Razole Mandalam. This drain has been improved by CERP Organization. The carrying capacity of the drain was increased from 35 % to 100 % to discharge 13.93 cumecs.

4.4.9.4 VADABODHI:

Vadabodhi is a medium drain in Godavari Central Delta. This drain infalls into Vynatheyam Godavari river. Vadabodhi drain receives drainage from the ayacut of Vadrevulapalli medium drain which infalls at K.M 2.540 on right bank and drains a total area of 32.57 square kilometers. It caters drainage from an ayacut of 8,000 acres.

The drain starts in the village limits of Pasarlapudi and runs through the villages of Pasarlapudi lanka and Lutukurru for a length of 5.46 Kilometers and finally empties into Vynatheyam Godavari river. The drain is joined by another medium drain called Vadrevulapalli drain at Km.2.54.

The drain gives drainage relief to an ayacut of 8000 acres in the above villages. The improvements are carried out by CERP Organization. The carrying capacity of the drain is increased by 35 % to 180 % to discharge 17.61 cumecs.

4.4.9.5 VADREVULAPALLI:

Vadrevulapalli drain is a medium drain infalling from left side into Vadabodhi drain at K.2.540. The drain receives drainage from a catchment area of 20.93 Square Kilometers and caters drainage from an ayacut of 5171 acres.

The drain starts in the Village limits of Vadrevula and runs through the Village Manepalli, Nagaram, Mamidikuduru and Pasarlapudi for a length of 10.288 Kilometers and finally empties into Vadabodhi medium drain. The improvements were carried by CERP Organization. The carrying capacity of the drain is increased by 40 % to 110 % to discharge 13.11 cumecs of flow.

4.4.9.6 KADALI:

Kadali drain is a medium drain and takes its origin from Kunavaram Village limits and runs for a length of 10.014 Kilometers through the villages of Mulukipalli, Ponnamanda, Gogannamatham and joins river Vynatheyam Godavari through an outfall sluice. The entire ayacut is deltaic. This drain has a catchment of 28.48 Square Kilometers. It receives the drainage from 7000 acres. The minor drains infalling into this drain are Mullukalva, Allukalva and Adurru drains.

This drain was improved by CERP Organization. The carrying capacity of the drain was increased by 34 % to 123 % at various sections to discharge 16.11 cumecs.

4.4.9.7 VEPACHETTU:

Vepachettu drain is another medium drain that infalls into Vasista Godavari at Km.72.60 left bank. Vepachettu drain receives drainage from the ayacut bounded by Chintapalli channel and Gannavaram canal. Three minor drains, sompalli, Mogumaiah drain No.2 and 3 join the drain. Vepachettu has a total catchment area of 31.65 Square Kilometers and caters drainage from an ayacut of 7,821 acres.

The drain starts in the village limits of Sivakodu at the tail end of Sompalli drain and runs through the Villages Sivakodu, Mattaparru, Lakkavaram, Viswesarayapuram, Gudimallanka and Malkipuram for a length

of 9.10 Kilometers and finally empties into Vasista Godavari. The improvement works were carried out by CERP Organization. The carrying capacity of the drain was increased by 40 % to 200 % to discharge 17.28 cumecs.

4.4.9.8 RAMESWARAM:

Rameswaram drain is another medium drain that infalls into Vasista Godavari through an outfall sluice at Km.87.60 of Vasista left bank. Rameswaram drain receives drainage from the ayacut bounded by Sakhinetipalli channel, Gannavaram channel, Mamidithota channel and Gondi channel etc. and drains a total area of 23.83 Square Kilometers.

The drain starts in the village limits of Sakhinetipalli and runs through the Villages of Sakhinetipalli, Remeswaram, Gudimulalanka and Anthervedi etc., for a length of 7.10 Kilometers and finally empties into Vasista Godavari. The drain receives the drainage water from an ayacut of 5,888 acres lying in between Sakhinetipalli channel, Gannavaram Channel, Mamidithota channel and Gondi Channel in Sakhinetipalli Mandal. The improvements were carried out by CERP Organization. The carrying capacity of the drain was increased by 40 % to 180 % to discharge 14.30 Cumecs.

4.4.9.9 PANCHANADI:

Panchanadi drain is another medium drain that starts in the Village limits of Komaragiripatnam Village. It passes through Komaragiripatnam and Bendamurulanka Villages in Allavaram Mandal and after running for a length of 7.8 Kilometers, the drain infalls in to Vynatheyam branch of Godavari. The catchment area of the drain is 18.64 Square Kilometers. Chunchula minor drain is infalling into this drain. The drain receives drainage from 4608 acres of ayacut. Improvements were carried out to this drain by CERP Organization. The carrying capacity of the drain is increased by 40 % to 200 % to discharge 12.14 Cumecs.

4.4.10 OTHER MEDIUM DRAINS:

Kattunga and Palivela are two medium drains that runs almost parallel to Gorinkala, in the upper parts of Godavari Central Delta.

4.4.10.1 KATTUNGA:

Kattunga medium drain commences from the Village limits of Rajavaram near Km.2.81 of Central Delta Main Canal. It runs adjacent to the right bank of Central Delta Main Canal in the head reaches upto Lolla Village and from there parallel to Ganapavaram Main Canal and after running for a length of 17.70 Kilometers, it finally empties into Vasista Godavari river at Km.22.605 through an outfall sluice. The drains has completely Deltaic catchment of 17.58 Square Kilometers and receives drainage from 4350 acres.

For a length of 11 Kilometers, this drain runs through Rajavaram, Vasanthavada, Tadipudi, Kattunga and Ankampalem Villages. There are no infalling minor drains into this drain. The drain was improved by CERP Organization. The carrying capacity of the drain was increased by 40 % to 140 % after improvements to discharge 12.54 Cumecs.

4.4.10.2 PALIVELA:

Palivela drain is another medium drain in Central Delta. The unique feature of this drains is that it originates 1.6 KM below Lolla high channel and infalls into Amalapuram Canal after running for a length of 17.68 Kilometers. It is bounded by Lolla High level channel and Amalapuram canal. This drain is having completely deltaic catchment of 18.23 Square Kilometers. It runs through the Villages of Lolla, Ankampalem, Merlapalem, Ravulapadu, Lakshmipolavaram, Ravulapalem, Vedereswaram, Devarapalli, Kothapeta and Palivela receiving the drainage from 4500 acres of ayacut from the above villages.

The drain was improved by CERP Organization. The carrying capacity of the drain was increased by 30 % to 200 % at various sections to discharge 10.54 cumecs.

5 DRAINS OF WEST GODAVARI DISTRICT

5.1 THE DISTRICT:

West Godavari District, known as the rice bowl of Andhra Pradesh, was carved out of Krishna District and was for a long time, not **a** homogeneous unit. Its component parts were ruled, before it was administered by British by various dynasties at different periods of time. In 1776, the Nawab of Nizam handed over these parts to British for governance and was ruled by the Chief Councils and by Collectors with Machilipatnam as headquarters. The Madras Province was formed in A.D.1859, with Godavari and Krishna Districts as parts of the Presidency. Subsequently several changes took place and on 15th April 1925, West Godavari District was formed initially with Machilipatnam as its headquarters. The District headquarters was later shifted to Eluru town.

The territory constituting West Godavari District in contrast with many other Districts of Andhra Region does not abound in prehistoric sites. West Godavari District now lies between 16^0 – 15' and 17^0 – 30' of Northern latitude and 80^0 – 50' and 81^0 – 55' of the Eastern longitude. The District is bounded on the North by Khammam District, on the South by Krishna District and the Bay of Bengal, on the East by the River Godavari and on the West by Krishna District.

The District consists of three very dissimilar natural diversions – the Delta, the Upland and the Agency tracts. The Delta area is fertile, low lying and water logged. The Upland area is undulating plain, broken by low ranges. The agency area is traversed by the Eastern Ghats broken by the Papikonda hill range. The area is covered by scattered hills and spurs rising from the lower uplands. The highest peak in the District is Pedda Konda of the Papikonda hill range which rises to an elevation of 1,364 meters above the mean sea level.

Main soils of the District are composed of red sandy loams, sandy clay loams, clay alluvial, delta alluviums and areanactous. Alluvial and Delta alluvium soils are found along side of the river Godavari. Deep clays are

found in the Delta, while arenacious soil is found along the Sea coast. Red sandy loams and sandy clay loams are found in the Upland areas. The general elevation of the delta portion in the District varies from fraction of a meter near the Sea to 11 meters near the hills of the agency.

The District has got net irrigated area of 5.3 lakhs acres. Oflate Tadipudi Lift Irrigation Scheme along with Indira Sagar Right Main Canal are under execution to aprovide irrigation facilities in the upland of West Godavari District.

The District is spread over an area of 7,780 square kilometers. The District is divided into three Revenue Divisions and 46 Mandals for Administrative purpose. The headquarters of the District is Eluru. Other important towns in the District are Bhimavaram, Narasapuram, Tanuku and Tadepalligudem.

Besides the mighty river Godavari forming the Eastern boundary to the District, many small rivers drain the area. Yerrakalva also called Yenamadurru drain in its lower reaches from Northern boundary joins the Bay of Bengal through Upputeru. Thammileru and Ramileru from the Northern boundary join the Kolleru lake. Kolleru lake is an extensive shallow natural depression created by a gradual rise on either side by alluvial deposits from the Godavari and Krishna Rivers. It receives very large volume of drain water from the surrounding deltaic country. The surpluses of Kolleru lake escape into the Bay of Bengal through a narrow outlet called Upputeru.

West Godavari District climatically is characterized in general by aggressive summer season and good seasonal rainfall. The day temperature during the summer months exceeds 43^0 C. The mean maximum temperature during the summer months is 38.4^0 C, while the mean minimum temperature during winter months is about 18^0 C. The average annual rainfall in the District is 1076.2 mm. More than half of the annual rainfall is brought by the South-West monsoon, while a large portion of the balance rainfall occurs in the month of November.

Storms and depressions originating from the Bay of Bengal generally in the post monsoon period cross the coast, causing widespread heavy rains and strong surface winds.

5.2 DRAINAGE SCENARIO:

Sir Arthur Cotton, while formulating the irrigation system for the command area, also conceived the drainage problems associated with it and simultaneously formulated drainage facilities for the command area by utilizing the existing rivers, rivulets and streams as conveyors to take the excess water into Sea. Since then, these rivers, rivulets and streams are known as drains. There are about 514 drains of various categories in the West Godavari District. These drains are broadly classified as Major, Medium and Minor based on the considerations of the area it drains. Those that serve an area below 12.95 square kilometers (5 Square Miles) are called as Minor ones, while those that drain a catchment area above 51.80 Square Kilometers (20 Square Miles) are known as Major drains. The drains that fall between 12.95 Square Kilometers (5 Square Miles) to 51.80 Square Kilometers (20 Square Miles) are medium drains. The category wise and the total lengths of these drains are detailed as below.

Sl. No.	Type of Drain	Nos.	Length in K.Ms
1	Major Drains	22	452.00
2	Medium Drains	61	424.00
3	Minor Drains	431	2047.00
	TOTAL	**514**	**2923.00**

The drains in the West Godavari District are of two types drains join the Kolleru lake and its outlet Upputeru and drains join Vasista branch of Godavari.

Kolleru lake is a natural depression of land between Godavari and Krishna Rivers and is nearly 32.2 Kilometers (20 Miles) away from the Sea. It has a total water spread area of 901 Square Kilometers at an elevation of +3.05 Mts (10.0 Feet). The Lake receives the drainage from a catchment of

nearly 4,760 Square Kilometers (1,839 Square Miles). Out of which, 3,400 Square Kilometers (1,314 Square Miles) is upland and 1,360 Square Kilometers (525 Square Miles) is deltaic. Many rivers and drains empty into this lake.

As assessed from Ryvs formula, the maximum inflows into Kolleru lake can be of the oRBer of 3,130 cumecs (1,10,920 cusecs). A notable feature of the Kolleru lake is, that it is not affected by the tides and therefore the Northern lands of Kolleru lake are not affected by the Sea water.

Upputeru is the only outlet to Kolleru lake. It takes off from the lake into two arms known as Perantala Kanuma, Juvvi Kanuma. These arms after flowing for a length of 6.4 Kilometers (4 Miles) join each other near Dumpagadapa Village of Akiveedu Mandal, whereafter this is known as "Upputeru River".

From West Godavari, Ramileru, Pedapadu, Vatluru, Thammileru, Kovvali, Thokapalli, Pandicodu are main drains that join Kolleru Lake direct.

Addala Creek, old Yanamadurru, New Yanamadurru, Gunupudi South, Gontheru and Mogalturu join the Upputeru.

Nakkala and Kaza drains join the Vasista branch of Godavari. The drains that join the Sea and nearer to are subjected to the tidal action and their mouths are often affected by the littoral drifts of the sand.

When the river Godavari is in high floods, the flood waters back up into the drains that join the Vasista branch of Godavari and cause inundation of low lying marginal areas. The drainage conditions in these drains are worst, when the local rains and floods in the river are experienced simultaneously. The period of floods over the marginal areas some times extends to 30 to 40 days. The outfall sluices constructed at the mouth of these drains will function and will prevent the waters of their worth backing up only when there is no flood in the drains.

The Drainage system in West Godavari District was first formulated for an extent of 2,20,000 Acres. The extent of the irrigated area in this District has now increased enormously with two to three crops in a year and absolutely there is no increase of the drainage commensurate with the growth of irrigation. Added to this, the inadequate maintenance, the

unauthorized plantation, the cultivation extended near to the bed of the drain, the growth of the water hyacinth, the continuous silting of the drains and the damages caused due to frequent floods and cyclones made the drainage most ineffective. The floods of 1983, 1984 and 1986 and the cyclonic storm of May, 1990 has completely ruined the drainage system. Barring throwing a spade of earth, here and there, there was no maintenance worth mention to these drains. The improvements contemplated since early seventies are inadequate. With increased and continuous irrigation and with the drains unable to discharge the drainage water, even a small precipitation of rain results in submersion of the areas and the consequent poor yields or total loss of the crop.

5.3 HISTORICAL REVIEW:

The irrigation through large tanks and open-head channels was well developed in Andhra Pradesh from times immemorial. The drainage was never thought of then, nor was it a problem in view of the limited extent of agriculture. It was only during the last century, when irrigation on large scale was taken up by harnessing the Krishna and Godavari waters to irrigate over two million acres, it was realized that drainage is a necessity and complementary function of irrigation and that without good drainage, no irrigation will be permanent.

The first known drainage scheme taken up was in Krishna District in 1929 where the waters of "Pedalanka Drain" falling into Upputeru were diverted to Bay of Bengal. This is followed by Repalle main drain straight cut and Nallamada straight cut in Guntur District.

The havoc caused by the cyclone of November, 1938 forced the then Revenue Minister Sri Tanguturi Prakasam Panthulu to rush to the areas under Kunavaram drain in Central Delta of East Godavari District to suggest remedial measures.

The Romperu Drainage Scheme taken up during the Post Second World War Period to provide employment for demobilized army personnel proved highly beneficial in not only relieving vast extents of submersion but also brought about ten thousand acres of waste land under cultivation.

The proposals for the levy of a special drainage cess for attending to the drainage problem of the deltas of Krishna and Godavari were first mooted in 1950 and then in1955. The Andhra Pradesh Irrigation (Levy of betterment contribution) Act was formed in 1955. But the provisions of this act were never implemented seriously for some reason or the other.

The unprecedented and disastrous floods in this area during 1964 once again highlighted the need for immediate action for solving these recurring problems. The Ministry of Irrigation and Power, Government of India therefore constituted in November 1964, an Expert Committee of Engineers to study the flood and drainage problems in the Delta and adjoining upland areas and suggest a comprehensive plan for controlling the same. The Expert Committee popularly known as "Mitra Committee" submitted its report in January, 1966.

The Krishna-Godavri Drainage Cess Act was enacted in 1968 to raise necessary funds to implement the comprehensive drainage plan. The Krishna and Godavari Delta Drainage Board was formed on 06-11-1969. The State Government had accorded Administrative Approval in G.O. Ms. No.1599 P.W., Dated 21-11-1969 for Rs.13.39 Crores to implement those schemes that are of immediate importance.

The Drainage Cess was collected upto 1979 and the improvements to the drains that were possible with the available funds were carried out.

As lack of resources has affected the drainage system badly, the Government of Andhra Pradesh has again enacted the Krishna-Godavari-Pennar Delta Drainage Act (1985) to raise funds. The collected drainage cess was found to be meager due to granting of remission of land revenue or drainage/water cess by Government and no substantial work could be taken up.

After seeing the severity of flood destruction during the floods of 1986, Government appointed Sri K. Sri Rama Krishnaiah as office on Special Duty to prepare a comprehensive plan on drainage problems in Krishna Godavari-Delta. The report was submitted during 1987 and it could not be implemented.

The floods of 1988 and 1989 further damaged the Drainage System.

When this was the position of maintenance of drainage system in the Krishna-Godavari Deltas, the Cyclone that occurred in May, 1990 caused clossal damage to the infrastructure in several sectors in the nine Coastal Districts of Andhra Pradesh, which in total was estimated at Rs.2,200 Crores. The estimated damage to the Drainage and Irrigation sectors alone is Rs.172.00 Crores. (Drainage sector Rs.78.00 Crores and Irrigation Sector Rs.94.00 Crores). The Government of Andhra Pradesh prepared a programme of Rs.2,800 Crores for the consideration of World Bank. The World Bank Team inspected the deltas for on the spot study of extent of damages in June, 1990. After field assessment, the Bank came forwaRB to extend a liberal loan of Rs.713.60 Crores (US $ 368 Million) to implement the Andhra Pradesh Cyclone Emergency Reconstruction Project. Out of this, an amount of Rs.211.00 Crores was earmarked for Drainage and Major Irrigation sectors. A special Cyclone Emergency Reconstruction Project Unit of Chief Engineer with headquarters at Dowlaiswaram was formed for implementing the programme pertaining to Drainage and irrigation sectors.

5.4 Status after CERP:

After CERP, no substantial improvements to major and medium drains in large scale have been taken up.

5.5 DRAINS IN WEST GODAVARI DISTRICT:

Unlike East Godavari, the Delta terrain of West Godavari consists of spurs and valleys at closer intervals and therefore there are mostly individual basins with no or a few other drains joining the main stream.

It is therefore convenient to group these drains as

1. Drains joining Kolleru Lake
2. Drains joining Upputeru, the only outlet of Kolleru; and
3. Drains joining Vasista branch of Godavari.

5.5.1 DRAINS JOINING KOLLERU LAKE (KOLLERU BASIN):

Kolleru, a natural lake situated in between the Godavari and Krishna Delta, has a water spread are of 901 Sq. KMs. Water from a catchment area of 4760 Sq. Kms drains into this lake.

In West Godavari alone, eleven Major drains, eleven Medium drains and ninety eight minor drains join the lake. The following Major and Medium drains that join the Kolleru lake are improved.

MAJOR DRAINS:

1) Ramileru
2) Pedapadu
3) Vatluru
4) Thammileru
5) Gunderu
6) Kovvali (No.9 U.T)
7) No.7 U.T. Drain
8) Thokalapalli
9) No.6 U.T. Drain
10) Pandicodu
11) Buckleys

MEDIUM DRAINS:

1) Loyeru
2) Jalipudi
3) Mondicodu
4) No.10 U.T. Drain
5) No.8 U.T. Drain
6) Ajarala
7) No.1 Escape
8) No.3 U.T. Drain
9) No.4 U.T. Drain
10) No.2 Escape
11) No.5 U.T. Drain

5.5.1.1 LOYERU:

Loyeru is a medium drain and takes its origin from the siphon at 7.4 KM of Gogunta main drain. After traversing a length of 8.2 Kms the drain empties into Kolleru Lake near Koniki and Satyavolu Villages. Three Minor drains, Kothathandu, Dovvalacodu and Jalagala codu join the drain during its course. The drain has a deltaic catchment of 28.88 Sq. Kms. It collects water from about 5.120 acres of the ayacut. The drain was improved by CERP Organization. The discharge carrying capacity of the drain was

increased to 17.53 cumecs, which works out to 12 to 20 % increase after improvements.

5.5.1.2 RAMILERU:

Ramileru is one of the Major drains of the District emptying into Kolleru. The drain originates near Dalagatta Village of West Godavri and enters the Krishna District after traveling 48.27 Kms in the upland areas crossing Krishna-Eluru Canal at 47.98 Kms through an under tunnel. Thereafter the drain runs for a further length of 10.1 Kms in the Krishna Delta before joining the Kolleru lake. The drain has a catchment of 308.09 Sq. Kms out of which 266.67 Sq. Kms. lie in upland areas while 41.42. Sq. Kms lie in the delta. The drain collects water from about 9600 acres of the ayacut in the villages of Vasanthawada, Rajampeta, Satyavolu and Pedapadu of the Delta. The discharge carrying capacity of the drain was improved to 303.84 cumecs by CERP Organization. The discharge capacity of the drain was increased from 2 to 5 % after improvements.

The Committee visited Ramileru U.T on Krishna Eluru Canal on 21-01-2007 and findings are appended separately in Chapter 6.1.5 i.e., suggestions received from public and views of the Committee.

5.5.1.3 PEDAPADU:

Pedapadu is one of the Major drains in the Krishna Delta. It originates at Bhogapuram Village in West Godavari District and enters into the Krishna Eastern Delta after traveling 5 Kilometers. It crosses Vijayawada-Eluru canal at 53.90 Km and empties into the Kolleru lake after running for a further length of 11.4 Kms. Two minor drains, Kalaparru and Pedapadu join the drain during its course. The drain has a total catchment of 86.85 Sq. Kms (82.85 Sq. Kms in upland area and 4.00 Sq. Kms in Delta area). The drain also collects water from the delta ayacut of 6,150 acres of the Villages pedapadu, Mupparru and Punukollu. The discharge carrying capacity of the drain was increased from 5 to 9 % to accommodate a maximum discharge of 94.43 Cumecs by CERP Organization.

5.5.1.4 VATLURU:

This is a major drain originating from the surplus of Gannavaram Tank in the West Godavari District. After traveling a distance of 3.5 Kms, the drain enters into the Krishna Eastern Delta, crossing Krishna-Eluru Canal at Km.58.50 through an under tunnel. From there onwaRBs the drain runs for a further length of 12.7 Kms in the delta before joining Kolleru. The drain has a total catchment area of 91.91 Sq. Kms of which 75.08 Sq. Kms is in the upland area and 16.83 Sq. Kms. is in the Delta area. The drain also collects water from about 4000 acres of the ayacut from the Villages of Kothuru and Mupparru. The drain was improved by CERP Organization. The carrying capacity of the drain was increased to 5 % to discharge 52.07 Cumecs.

5.5.1.5 THAMMILERU:

Thammileru is one of the major drains in the West Godavari District. It takes its origin near Pothanavarigudem Village in Khammam District, about 86 Kms North of Eluru town and flows down to South collecting on its way, water from two important tributaries Gonalavagu and Chatrayavagu. After running in Southern direction for a total length of about 88.50 Kms the river bifurcates itself into East Thammileru and West Thammileru branches and flows around Eluru town. These two branches cross the National High Way – 5 Road and Eluru canal and run across the Krishna Eastern Delta before both the branches empty into Kolleru lake.

The East Thammileru branch starts from the Eastern Regulator (also called as Escape) on the Eluru Canal and after traveling 4.97 Kms from the regulator it cuts across the Krishna Eastern Delta. This branch of the drain joins the Mondicodu drain at R.B. 4.83 Km which ultimately empties into Kolleru Lake.

The West Thammileru branch commences from the Western Regulator (also known as Escape) on the Eluru Canal and after traveling 11.8 Kms from the Regulator across the Delta, empties directly into Kolleru.

The Committee visited the two escapes on 21-01-2007 and the functioning of the same are satisfactory as reported by field engineers.

5.5.1.6 JALIPUDI DRAIN:

Jalipudi is a medium drain in the Kolleru basin in the Krishna Eastern Deltaand runs in between the Western and Eastern branches of Thammileru. The drain commences from Eluru town and runs in the out-skirts of the town for a length of 1.36 Km collecting the drainage of Eluru town and crosses the Vijayawada-Eluru canal through an under tunnel at Km.63.93. It runs for a further distance of 11.4 Km in the Delta area before it empties into Kolleru. The drain has different names at different reaches. The drain in its first 3.8 Kms that is upto Medepalli village is called as Tapillacodu. Below Medepalli Village, it is called as Katlampudi vagu.

Jalipudi drain has a total catchment are of 12.69 Sq. Kms. Improvements to this drain are carried out for a total length of 12.76 Kms of which 1.36 Kms length is in the Eluru town and the balance in the delta. The carrying capacity of the drain was increased by about 12 % to accommodate a maximum discharge of 20.27 Cumecs by CERP Organization.

5.5.1.7 MONDICODU DRAIN:

Mondicodu is a medium drain in the Kolleru basin. It starts from No.4 Escape of the Eluru canal at Km.73.813. After running 10.7 Kms through Malkapuram and Kovvali Villages, it branches off into two medium drains namely Kokkirayalanka Codu and Seshaiah Codu. These two branches of the drain finally empty into the Kolleru Lake.

No.10 U.T. Drain from 1.8 Km and East Thammileru from 4.970 KM join the Mondicodu at R.B 3.0 KM and 4.8 KM respectively. The drain collects water from about 3365 acres of ayacut of the Godavari Western Delta. The Mondicodu drain in the upper reaches was improved by CERP Organization. Improvement works to the two branches of the Mondicodu i.e., Kokkirayalanka Codu and Seshaiah Codu were also executed by CERP Orgainztion.

5.5.1.7.1 NO.10 U.T.DRAIN:

No. 10 U.T. Drain is a medium drain which starts from Km.70.152 of Godavari-Eluru Canal in the Village limits of Denduluru and Kovvali. It runs for a length of 1.800 Kms and empties into Mondicodu drain @ Km.3.000. The catchment area of this drain is 12.95 Sq. Kms entirely in upland. The maximum flood discharge of the drain is 30.98 Cumecs at its confluence with Mondicodu drain. This was not taken up by CERP Organization as existing section was found to be adequate.

5.5.1.8 GUNDERU AND KOVVALI (NO.9 U.T) DRAINS:

Gunderu and Kovvali are one and the same. The portion of the drain in the upland area, that is above the Eluru canal is known as Gunderu. In the delta area after it crosses the Eluru canal through an under tunnel, the drain is called as Kovvali or No.9 U.T. Drain.

Gunderu is a small hill stream having its origin in the hill ranges of Badamcherla Reserve Forest of Chintalapudi mandal of West Godavari District. The Gunderu basin lies in between the catchments of Thammileru and Yerracalva. The drain flows in South-Eastern direction for about 40.23 Kms till it crosses the South-Central Railway line through Bridge No.126, near Denduluru Railway Station and runs further in Southern direction for about 5.34 Kms till it comes to National Highway 5 and runs parallel to the road for about 1.765 KM. It then crosses the Eluru canal through an under tunnel at Km.67.760 of Eluru canal and from there it is called as Kovvali or No.9 U.T drain. The catchment area of the drain is 427.2 Sq. Kms (upland) and 20.45 Sq. Kms (Delta).

Improvements to Gunderu drain were taken up from the downstream of Railway bridge No.126 to its end that is No.9 U.T which is about 5.34 Kms. by CERP Organization to accommodate 97.00 Cumecs.

Kovvali drain is one of the major drains in the Godavari Western Delta in the Kolleru basin. It receives water from a total catchment of 437.54 Sq. Kms. of which 427.19 Sq. Kms is on the upland area and 70.36 Sq. Kms. in the delta area. This drain is a part of the Gunderu river, traversing 8.7 Kms in Kovvali Village limits. The Kovvali drain was improved under CERP.

The Committee visited Gunderu Drain and No.9 U.T and views of the Committee are appended separately in Chapter 7.1.5 i.e., suggestions received from public and views of the Committee.

5.5.1.9 No.7 U.T. DRAIN:

No.7 U.T. Drain is a major drain and traverses a length of 5.6 Kms through Surappagudem, Gundugolanu and Agadallanka before entering into Kolleru Lake. No.8 U.T medium drains joins at Km.2.6. The drain has got a catchment area of 73.97 Sq. Kms. of which 53.77 Sq. Kms. lies in the upland area and 20.19 Sq. Kms. in the delta area. The discharge carrying capacity of the drain was increased by 22.5 % to discharge 69.38 cumecs by CERP Orhganization.

5.5.1.9.1 NO.8 U.T. DRAIN:

This is a medium drain, which starts from U.T. No.8 at RB 59.86 Kms of Godavari-Eluru canal. After running for a length of 5.6 Kms through Surappagudem, Gundugolanu and Ratnapuram Villages, it joins at 2.6 KM RB of No.7 U.T. Drain. This drain has a catchment area of 8.39 Sq. Kms. in the Delta area. This drain was improved under CERP Organization.

5.5.1.10 THOKALAPALLI DRAIN:

Thokalapalli is one of the major drains in the Godavari Western Delta. The drain originates from Badampudi Village and crosses the Eluru-Godavari Canal through No.1 and No.2 U.Ts. After running for a total length of 24.2 Kms through Villages Badampudi, Upplapadu, Bommidi, Kagupadu, Ravlaparru, Apparaopeta, China Nindra Kolanu, Benapalli and Thokalapalli, this drain empties into Kolleru Lake.

The drain has a total catchment area of 315.39 Sq. Kms, out of which 236.63 Sq. Kms. lie in the upland area and 78.76 Sq. Kms. in the Delta area. Two regulators one at its 5.8 KM and the other at 8.0 KM are constructed to utilize the drain water. The regulator at 5.8 KM serves Ravulapadu canal whih feeds an ayacut of 609 acres. The regulator at 8.00 KM feeds China Nindra Kolanu canal which serves an ayacut of 6118 acres.

Four medium drains – Ajarala, No.1 Escape, 3 U.T. Drains and No.6 U.T. Major Drain also empty into Thokalapalli. Another 4 minor drains are also infalling into Thokalapalli drain. Thokalapalli drain was improved by CERP Organization. The discharging capacity of the drain was increased by 35 to 89.5 % excess, to discharge 113.26 Cumecs.

5.5.1.10.1 AJARALA DRAIN:

Ajarala drain is a medium drain that joins Thokalapalli drain through No.1 U.T. It originates from the bridge at KM 63.15 of Narsapuram-Aswaropeta high way. It travels a length of 3.3 Kms through Peda Tadepalli Village before emptying into Thokalapalli. The drain has a catchment area of 24.70 Sq. Kms, totally in the upland area. The drain was improved under CERP Organization. The discharge carrying capacity of the drain was increased by 43 to 55 % excess, to discharge 11.72 Cumecs.

5.5.1.10.2 NO.1 ESCAPE DRAIN:

No.1 Escape drain is a medium drain that joins Thokalapalli drain and commences from the Escape at Km.34.393 of the Godavari-Eluru Canal, before joining the Thokalapalli at RB 20.20 KM, it runs for a length of 2.0 KMs through Badampudi and Bommidi Villages. Improvements to the drain were carried out under CERP, to discharge 21.80 cumecs.

5.5.1.10.3 NO.3 U.T. DRAIN:

This is a medium drain that empties into the Thokalapalli drain at RB 17.00 KM. The drain originates at 37.829 KM of Godavari-Eluru canal and after running 2.70 Kms on the boundary of Unguturu Village, it joins Thokalapalli. This drain has a total catchment of 28.92 Sq. Kms of which 26.40 Sq. Kms lies in the upland while 2.51 Sq. Kms is in the Delta area. The drain improved by CERP Organization. The discharge carrying capacity of the drain was increased by 40 % excess, to discharge 20.3 Cumecs.

5.5.1.10.4 NO.4 U.T. DRAIN:

This is a medium drain that empties into the Thokalapalli drain at RB 15.00 KM. No.4 U.T. Drain emanates from Godavari-Eluru canal at 40.32

KM. Before joining Thokalapalli drain, it travels for a length of 2.67 Kms on the boundary of Unguturu Village. The drain receives water from a total catchment of 23.82 Sq. Kms of which 20.71 Sq. Kms. is in the upland area and 3.11 Sq. Kms is in Delta area. The discharge carrying capacity of the drain was increased from 38.16 to 40 % excess, to carry 18.21 Cumecs by CERP Organization.

5.5.1.10.5 NO. 6 U.T. DRAIN:

This is a major drain empties into the Thokalapalli at RB 4.7 Kms. This drain originates from No.6 U.T of the Godavari-Eluru Canal and after traversing 6.11 Kms through Kaikaram and Somayyapalem Villages, it finally joins the Thokalapalli drain. Two medium drains, No.2 Escape and 5 U.T drain, join the 6 U.T drain at RB 4.31 Km and at RB 8.5 KM. No.6 U.T. Drain receives water from a total catchment area of 61.64 Sq. Kms of which 53.22 Sq. KMs is in upland area and 8.36 Sq. KMs is in Delta area. The discharge carrying capacity of the drain was increased by 24 % excess to carry 38.09 Cumecs by CERP Organization.

5.5.1.10.6 NO.2 ESCAPE DRAIN:

No.2 Escape Drain is a medium drain that joins No.6 U.T Drain which ultimately empties into Kolleru through Thokalapalli drain. It starts from the Escape at Km.46.762 of Kaikaram Village of Godavari-Eluru Canal. After traveling for a length of 1.69 Kms, the drain joins the No.6 U.T. Drain at RB 4.31 Kms. It collects water from a catchment area of 19.99 Sq. Kms in the upland area and 3.107 Sq. Kms in the delta area. The No.5 U.T drain which has a catchment area of 19.94 Sq. Kms in upland area joins this drain at RB 0.85 KM. Improvements to the No.2 Escape drain were carried out under CERP Organization. The discharge carrying capacity of the drain was increased from 2 to 42 % to carry a discharge of 21.65 Cumecs.

5.5.1.10.7 NO.5 U.T. DRAIN:

No.5 U.T. Drain joins the No.2 Escape drain at RB 0.85 KM. It originates from the UT at Km.47.073 of Godavari-Eluru Canal. The drain

after traveling for a distance of 1.08 Kms on the boundary of Kaikaram Village joins the No.2 Escape Drain. The discharge carrying capacity of the drain was increased to 14.27 Cumecs by CERP Organization.

5.5.1.11 PANDICODU DRAIN:

Pandicodu is a major drain that joins Kolleru. The drain originates from Ranaparru Village and travels parallel to Peda Nindra Kolanu Branch Canal. After traveling 12.0 Kms on the out-skirts of Nidamarru, Narasimhapuram, Peda Nindra Kolanu, B. Gopalavaram and Agadallanka Villages, joins Kolleru. Buckleys drain which is a major drain of the basin joins Pandicodu at R.B. 12.00 Km. Another two minor drains Murugu codu and Pandicodu minor are also joining Pandicodu drain. It has a total catchment of 35.60 Sq. Kms. The discharge carrying capacity of the drian was increased from 30 % to 94 % excess, to discharge 66.6 Cumecs by CERP Organization.

5.5.1.11.1 BUCKLEYS DRAIN:

Buckleys is a major drain and it originates from the downstream of the Jattipalem Escape at Km.34.390 of Madhyamatta Canal. The drain joins the Pandicodu drain, after traveling a distance of 7.33 Kms on the boundary of Narasimhapuram, Apparaopuram Agraharam, West Pipparru and and Ganaparru Villages. The drain collects water from a catchment of about 56.26 Sq. Kms and also from the Jattipalem Escape which has a discharge of 9.51 Cumecs. The drain was improved under CERP Organization. Five minor drains are infalling into Buckleys Drain. The carrying capacity of the drain was increased from 40 to 72 % excess, to carry a discharge of 47.18 Cumecs.

5.5.2 DRAINS JOINING UPPUTERU (UPPUTERU BASIN):

Upputeru basin is bounded by Narsapur canal on the Eastern side, Venkaiah-Weyyeru canal on North-Western side and Bay of Bengal on the Southern side. About fifty percent of the Delta area of West Godavari is covered by this basin. The Upputeru basin consists of three main sub basins – New and Old Yanamadurru basins and Gontheru, besides a number of minor basins. In total, eleven major drains, thirty five medium drains and ninety eight minor drains flow in the area and join the Upputeru.

5.5.2.1 UPPUTERU:

Upputeru is a narrow and the only water way connecting Kolleru Lake and Bay of Bengal. It takes off from the Lake in two arms known as Perantala Kanuma and Juvvi Kanuma. These two arms, after flowing for a length of 6.4 KM join each other near Dumpagadapa Village, whereafter it is known as Upputeru. The drain travels in Southern direction crossing Gudivada-Bhimavaram Railway line at its 9.65 KM (6^{th} Mile) and after reaching Kalidindi Village at its 22.526 KM (14^{th} Mile), the drain takes South-West direction. It joins the Sea near Chinagollapalem Village after traveling a total distance of 60.150 Kilometers. The drain almost loops into an acute serpentine bend before it joins the Sea.

A number of drains both from West Godavari and Krishna Districts join the Kolleru Lake of which Buckleys, Pandicodu, Thokalapally, No.6 U.T, No.7 U.T, Kovvali, Gunderu, Thammileru, Vatluru, Pedapadu and Ramileru from West Godavari side and Budameru, Chandraiah and Polaraj from Krishna side are important ones. The total catchment area of all these drains put together works out to 5.235 Sq. Kms (3,788 Sq. Kms. Upland and 1,447 Sq. Kms. Delta) and the estimated inflows into the lake is about 3,141 Cumecs (1,10,920 Cusecs).

Upputeru receives drainage from an ayacut of 3,55,000 acres. Improvements were carried out for all the major drains infalling into Kolleru Lake. Out of the estimated inflows of 3,141 Cumecs (1,10,920 Cusecs) into Kolleru Lake a discharge of 424.7 Cumecs (15,000 Cusecs) is proposed to be diverted into Krishna River through Budameru divrsion channel, thus

reducing the inflows into the Kolleru Lake to 2,715.6 Cumecs (95,900 Cusecs).

In addition to the waters surplussing from Kolleru Lake, Chinakapavaram, Venkaiah-Weyyeru canal, Old and New Yanamadurru drains, Addala Creek, Gunupudi South, Gonteru, Dharbarevu and West Kukkaleru from West Godavari side and Pullava drain, Polaraj canal, Peda Kommileru drain, Lavala drain, Campbell canal and Bantumilli canal from Krishna District also join the Upputeru during its run.

Very often, it so happens that the drains join Upputeru are in peak flood when Kolleru Lake level is at its maximum. In such cases, the flow in the Upputeru river from the Kolleru Lake is hampered. The extent and period of submersion of cultivable lands bordering Kolleru Lake along the inflowing rivers and the Upputeru is increased. The high water level in Kolleru Lake backs up and reduces the discharging capacity of the deltaic drains flowing into Kolleru Lake or into the Upputeru and this results in submersion of crops along these drains as well.

The discharge carrying capacity of Upputeru at + 3.05 M. Lake level is only 398 Cumecs (11,250 Cusecs) as assessed by MITRA Committee. Since the discharge carrying capacity of the Upputeru is inadequate, a straight cut was excavated during 1977 at 46.660 KM (M.29/0) just upstream of confluence of New Yanamadurru drain with Upputeru for a length of 4.340 KM., to divert initially 424.7 Cumecs (15,000 Cusecs) of waters of Upputeru into Bay of Bengal. This straight cut which is known as "First Straight Cut" is functioning very well and is now estimated to discharge more than 566.3 Cumecs (20,000 Cumecs).

New Yanamadurru drain which joins Upputeru just downstream of this straight cut during its floods, the waters of the drain instead of going downstream, forces its way into this straight cut and join the Sea, thereby waters of Upputeru coming from the Upper reaches are being obstructed by these waters of Yanamadurru. In other words, the straight cut at present is better utilized by the New Yanamadurru drain to join the waters into Sea than that of Upputeru waters coming from Kolleru. Therefore, it has become a necessity to make Upputeru waters coming from Kolleru to utilize the

straight cut for joining the Sea and to prevent waters of New Yanamadurru join the Straight cut, but to flow downstream of Upputeru.

The New Yanamadurru drain was shaped by streamlining the mouth of the drain at the confluence region with Upputeru, so that the Yanamadurru waters comfortably go down and flow into the downstream course of Upputeru and the waters of Kolleru Lake coming from Upper reaches utilize the straight cut. Necessary regime stabilizing arrangements are also planned so that in no case the Yanamadurru waters force its way, as it is the case now, into the straight cut.

The Upputeru drain at the vicinity of the Sea mouth has a serpentine bend near Chinagollapalem Village. It is said that at this meandering reach, i.e., is at Km.59.700 part of Upputeru waters join the Sea but the area is now sand cast and absolutely there is no course existing. The Central Water Power Research Station, Pune has favoured to reopen the area at this Km.59.700 which will be more favourable site to permit the waters of Upputeru coming from upper reaches to join the Sea waters.

To discharge the waters of Kolleru and those of infalling drains of Upputeru into the Sea, to the maximum extent possible, the Upputeru is improved from Km.47.800 to Km.60.150 to accommodate a maximum discharge of 852 Cumecs (30,100 Cusecs). As it is not possible and as it is costlier to take up the improvements by deepening and widening of Upputeru under dry bed conditions, dredging was resorted under CERP.

The improvements to Upputeru comprise of :

1. Streaming of New Yanamadurru drain, so as to allow the waters of the drain to join the Upputeru and flow in the downward direction without obstructing to the flows of upstream waters by dredging.
2. To provide a new entry into the Sea at Km.59.700 of Upputeru by dredging and
3. Widening and deepening the Upputeru from Km.47.800 to Km.60.150 to accommodate a discharge of 852 cumecs (30,100 cusecs) by dredging.

The new Sea mouth opened at Km.59.700 is observed for one season and it was behaving satisfactory, except drifting of erosion and silting at the

confluence, the carrying capacity of the mouth was found to be quite adequate. After one season the course was sand casted due to insufficient flow for flush of the river. The Committee suggest for opening the course and for continuous maintenance dreding.

5.5.3 GONTHERU BASIN:

The Gontheru basin is drained by four Major drains viz – Baggeswaram, Mogalturu, Gontheru and Basavarajucodu and five Medium drains viz. Palacodu, Kakileru Polamuru, Thokkodu and Devaracodu. In addition to this, there are thirty one minor drains in the basin. The Gontheru is the principal drain. The three major drains Mogalturu, Baggeswaram and Basavarajucodu and six medium drains join during its course. The Gontheru basin is bounded by Narsapur canal on the Eastern side and Gostanadi – Velpuru canal on the Western side and drains a total catchment area of 438.2 Sq. Kms. Which is entirely deltaic. It also receives drainage from an ayacut of 1,00,800 acres.

5.5.3.1 GONTHERU: Gontheru originates from the under tunnel at Km.4.626 of Bhupayya minor irrigation canal near Pervali Village. After traveling in Southern direction for a distance of 50.68 Km. through a number of villages, it empties into Upputeru through Salt Creek. Basavarajucodu from right at Km.30.70, Baggeswaram at Km.36.80 and Mogalturu at Km.47.60 from left join the course. The medium drains – Palacodu at Km.0.00, Kakileru at Km.14.78, Thokkodu at Km.41.60 and Devaracodu at Km.44.00 also join the drain.

The drain has a total catchment of 438.24 Sq. Km. and receives drainage from an ayacut of 14,335 Hectares (35,474 Acres). The drain is improved to carry a maximum discharge of 109.10 cumecs which is about 22% excess over the present capacity. Near the Sea mouth, the soils to be excavated are slushy clays and it is difficult to carry out the improvements under dry bed conditions and therefore the drain is improved under dry bed conditions from Km.0.00 to Km.38.60 and by dredging from Km.38.60 to the end i.e., Km.50.70 under CERP Organization.

5.5.3.1.1 PALACODU DRAIN:

Palacodu is a medium drain which originates from the boundaries of Tadiparru Village. After running for a length of 7.20 Km. through Ajjaram and Tanuku Villages, it joins Gontheru major drain. It has a catchment area of 24.98 Sq. Km. and receives drainage from an ayacut of 2680 Hectares (6624 Acres). The drain was reconstructed to carry a maximum discharge of 15.79 cumecs which is 13.41 % excess over its original capacity. Three minor drains – Malacodu, Azzaram No.1 drain, and Azzaram No.2 drain are infalling into Palacodu drain.

5.5.3.1.2 KAKILERU DRAIN:

Kakileru Drain originates from Ogidi Village and after running for a length of 5.84 Kms. Through Ogidi, Inaparru, Kakileru, Kayitipadu and Alamuru Villages, it joins Gontheru major drain. Alibanda, a minor drain joins the Kakileru drian. It collects drain water from a catchment area of 15.22 Sq. Kms and serves an ayacut of 1295 Hectares (3,200 Acres). The drain is improved to carry a maximum discharge of 10.66 cumecs which is 30 % excess over its original capacity under CERP Organization.

5.5.3.1.3 BASAVARAJU CODU DRAIN:

Basavaraju Codu, a major drain in the basin takes its origin from 56.552 KM of the left bank of Gostanadi-Velpuru canal near Vendra Village. It joins Gontheru, the principal drain of the basin at RB 30.7 KM after traveling a distance of 10.40 KM. Polamuru, a medium drain and two other minor drains are infalling into Basavarajucodu. The drain has a catchment of 57.09 Sq. Kms. and serves an ayacut of 2830 Hectares (7,000 Acres) and was designed to carry 25.61 Cumecs, which is 47 % more than the original capacity under CERP Organization.

5.5.3.1.3.1 POLAMURU DRAIN:

Polamuru drain starts from Polamuru Village and passes through Polamuru, Nowduru and Toleru Villages. It joins the Basavarajucodu major

drain, after traveling a distance of 9.15 KMs. Navuduru No.I minor drain is the only minor drain infalling into Polamuru drain. It receives drain water from a catchment area of 18.90 Sq. KMs and also serves an ayacut of 1.890 Hectares (4,672 Acres). The drain was designed for a maximum discharge of 12.54 cumecs and the carrying capacity was increased by 32 %.

5.5.3.1.4 BAGGESWARAM DRAIN:

Baggeswaram, a major drain of Gontheru basin commences from the culvert at Km.10.00 of Penugonda-Kanteru road in the Village limits of Kakileru and after traversing a distance of 25.20 Kms. Through Kakileru, Satyavaram, Alamuru, Kommuchikkala, Valamarru, Chintaparru, Bhaggeswaram, Lankalacoderu, Volivela, Thillapudi, Mallavaram, Kavitam and Kapavaram Villages, it joins Gontheru at its R.B. 6.80 KM. Penugonda, Velagaluru, Dumpacodu and Dagguluru minor drains are also infalling into this drain. It receives water from a catchment of 73.01 Sq. Kms. and serves an ayacut of 5,880 Hectares (14,530 Acres). The drain is improved to carry a maximum discharge of 30.20 Cumecs under CERP Organization. The carrying capacity was increased by 40 %.

5.5.3.1.5 THOKKODU DRAIN:

Thokkodu drain is a medium drain infalls into Gontheru. The drain originates from the fields of Srungavruksham Village and receives drainage from an ayacut of 967.75 Hectares (2,400 Acres). It runs in the Southern direction through the villages of Machipuri and Kamsali Bethapudi for a length of 8.100 KMs and finally empties into Gontheru drain at Km.41.620 of Right Bank. The drain has a catchment of 19.42 Sq. KMs and is desiged for a maximum flood discharge of 12.48 Cumecs. Only one local minor drain with catchment area of 1.35 Sq. KMs. is infalling into Thokkodu drain at Km.4.120. The carrying capacity of the drain is improved by 49 % over its original carrying capacity under CERP Organization.

5.5.3.1.6 DEVARACODU DRAIN:

Devaracodu drain starts from Konthalapalli village and runs for a distance of 9.20 Kilometers through Srungavruksham, Veeravasaram and Tunduru Villages before infalling into Gontheru major drain. The drain receives water from the catchment area of 13.23 Sq. KMs and serves an ayacut of 725.80 Hectares (1.800 Acres). The drain was improved under CERP Organization to carry a discharge of 10.33 Cumecs which is 52.7 % excess over its original capacity.

5.5.3.1.7 MOGALTURU DRAIN:

Mogalturu drain is a major drain which originates from culvert No.6 of Narsapuram canal. After running through the villages of Saripalli, Kopparru, Rustumbada and Mogalturu for a length of 24.5 KMs, it empties into Gontheru drain at RB 47.60 KM. Two medium drains – part of Rustumbada and Saripalli and nine other minor drains join Mogalturu during its course. The drain has a catchment area of 73.76 Sq. KMs. and serves an ayacut of 6,008 Hectares (14,846 Acres). The drain was improved to carry a discharge of 30.38 Cumecs which is 34 % more than its original capacity by CERP Organization.

5.5.3.1.7.1 SARIPALLI DRAIN:

Saripalli a medium drain infalling into Mogalturu drain takes its origin in the village limits of Likhithapudi and after traversing a distance of 13.996 KMs, it joins Mogalturu drain. The drain has a catchment of 32.67 Sq. KMs. and drains water from an ayacut of 2,240 Hectares (5,534 Acres). Two minor drains – Guruthada No.I and Guruthada No.II infall into the drain.

5.5.4 GUNUPUDI SOUTH DRAIN:

Gunupudi South Drain is one of the major drains in Upputeru basin. It originates from the U.T at RB 60.00 KM of Gostanadi-Velpuru canal just 3 KM North East of Bhimavaram town. After traveling a length of 19.3 KMs through Vissacoderu, Gunupudi, Bhimavaram, Taderu, Yanamadurru and Dirusumarru Villages, the drain empties into Upputeru through Salt Creek at

RB 8.80 KM. Korrapadu, a medium drain and many other minor drains also empty into Gunupudi South. The drain receives waters from the catchment area of 97.165 Sq. KMs and collects drainage from an ayacut of 10,117 Hectares (25,000 Acres). The drain was reconstructed to carry a maximum discharge of 36.60 Cumecs under CERP Organization. The discharge capacity of the drain was increased by 42%.

5.5.4.1 KORRAPADU DRAIN:

Korrapadu drain starts from Korrapadu Village and after running for a length of 4.185 KMs through Korrapadu and Taderu Villages, it joins Gunupudi south drain at RB 8.00 KM. The drain has a catchment area of 13.80 Sq. KMs and serves an ayacut of 1380 Hectares (3,411 Acres). After improvements, the drain carries a maximum discharge of 9.96 Cumecs which is 41.96 % excess over its original capacity. The drain was improved under CERP. Two minor drains- Addacodu and Konapadu branch drain are infalling into Korrapadu drain.

5.5.5 NEW YANAMADURRU BASIN:

The New Yanamadurru Basin consists of two parts – Deltaic part and Upland part. The deltaic part known as New Yanamadurru basin is a narrow and long horn type bounded by Gontheru basin on Eastern side and by Old Yanamadurru basin on the West.

New Yanamadurru is the principal drain of the basin. Gostanadi, a major drain and its six medium drains – Velivennu, Dammennu, Mortha, Satyavada, Pali and Byvanicodu from left and two medium drains – Kasipadu and Rayalam from right join the New Yanamadurru drain.

The upland part of the basin is known as Yerra Kalva basin which is bounded by Thammileru basin on the West and Kovvadakalva on the right.

5.5.5.1 NEW YANAMADURRU DRAIN:

New Yanamadurru drain, also called as Yerra Kalva at its upper reaches, is one of the main drains of West Godavari District. Yerra Kalva originates at an elevation of (+) 363 M. in reserve forest near Ganeshpadu and Gattugudem Villages in Kothagudem Mandal of Khammam District at a

latitude of 17^0 - 14' N and longitude of 80^0 – 55' E. It runs in Southern direction and in the first 20 KMs of its length, it enters many tanks and comes out as surplus.

Manivagu with its tributary-Jalleru joins the Yerra Kalva near Singarayapalem Village. Byneruvagu with its tributary Pulivagu joins near Manga-Pedapalem Village. The river crosses the Rajahmundry-Gundugolanu High Way near Ananthapalli Village. It crosses the Eluru canal through Nandamuru Aqueduct and the Course of the drain in the deltaic area below Nandamuru Aqueduct is known as New Yanamadurru Drain. The total length of the Yerra Kalva is 120 KM while that of New Yanamadurru drain is 61.20 KM.

A storage reservoir is constructed on Yerrakalva at Konguvarigudem Village to serve an ayacut of 9,960 Hectares (24,700 Acres) and another reservoir was constructed across Jalleru vagu, a branch of Yerrakalva near Aliveru (V) of Buttayagudem Mandal to serve an ayacut of 1700 Hectares (4,200 Acres) of Buttayagudem and Doramamidi Villages.

The New Yanamadurru drain passes through Villages Nandamuru, Muddapuram, Duvva, Meenavilleru, Pippara, Kesavaram, Yandagandi, Garagaparru, Gollalacoderu, Bhimavaram, Dirsumarru and Gollavanitippa for a total distance of 60.40 KMs and finally empties into Upputeru at Pathapadu Village. Gostandi is one of the major drains empties into this drain at 37.929 KM. Besides Gostanadi, six medium drains – Duvva at RB 17.23 KM, Kasipadu at RB 23.494 KM, Rajacodu at RB 29.46 KM, Eerlacodu at RB 32.35 KM, Rayalam at RB 51.578 KM, and Mandachedu at RB 59.847 KM, join the drain.

The drain has a total catchment of 2725.03 Sq. Kms. (23330.10 Sq. KMs. Upland and 394.93 Sq. KMs. in Delta) and serves an ayacut of 35,484 Hectares (88,000 Acres). The drain was designed for a maximum discharge of 693 Cumecs.

New Yanamadurru drain, after joining Upputeru in normal course has to go down along the waters of Upputeru. But at present, the waters of New Yenamadurru travels upstream of Upputeru for a distance of about 0.60 KMs and forces its way into the first straight cut and causing obstruction to the

flows of waters of Upputeru coming from upper reaches. In view of the floods simultaneously occurring in New Yanamadurru drain as well as in Kolleru Lake, the flow of waters from New Yanamadurru drain into first straight cut obstructs the flows of the Upputeru. This causes rise of waters in the upper reaches of Upputeru as well as Kolleru Lake and inundates large areas.

To avoid this, the New Yanamadurru drain is streamlined under CERP for a length of 1.20 KMs in such a way that the waters of New Yanamadurru after joining Upputeru goes comfortably downstream and avoid the possibility of these waters traveling upstream, utilizing first straight cut**.** However, the waters of 'Y' Drain are entering into 1st Straight Cut as per topography leaving the old course sand casted due to insufficient flushing.

The Committee explored the possibilities of diversion of Yerracalva flood waters so as to minimize the stress on delta area. It is found feasible to divert 9000 cusecs of flood flows into Tammileru Reservoir project foreshore by gravity, by constructing a cross regulator across Yerracalva in Racharla Village limits and excavating a suitable diversion channel for a length of about 8.00 Kms. This proposal provides considerable flood relief to the lower down areas and also augments water availability for Tammileru Reservoir Project. This proposal is discussed separately in Chapter 7.2.1, suggestions received from public and views of the Committee.

5.5.5.1.1 GOSTANADI DRAIN:

Gostanadi Drain is one of the major drains that infalls into New Yanamadurru. It starts from the surplus regulator at RB. 33.9 KM of Gostanadi-Velpuru canal and joins the Yanamadurru drain at RB. 37.8 KM after traveling a distance of 37.6 KM. through Velpuru, Relangi, Mamuduru, Aravilli, Vunikili, Vendra and Palacoderu Villages. Three medium drains-Velivennu, Dammennu and Mortha join the Gostanadi Velpur canal from which Gostanadi drain takes off and three other medium drains Satyavada at RB.35.6 KM, Pali at RB 14.39 KM and Byvanicodu at RB 0.8 KM join the Gostanadi drain course. It collects waters from a catchment of 12141 Hectares (30,000 Acres). The drain was improved under CERP for a

maximum discharge of 62.55 Cumecs which is 21 % excess of the original capacity.

5.5.5.1.1.1 KALAVACHARLA – BADAVA – VELIVENNU DRAINS:

Kalavacharla, Badava and Velivennu are three medium drains that run almost one after the other and receives drainage from an ayacut of 6015 hectares (14,918 Acres) i.e., in between Kanuru and Gostanadi-Velpuru canals.

Kalavacharla is a medium drain which originates near the bridge at KM.7.743 on the Kanuru main canal. After traversing a distance of 1.487 KMs, it enters the Shankara Somayajulu Tank and emerges out from the tank near Velivennu Samisragudem Road and after traveling a total distance of 4.3 KMs, it joins Badava drain. The drain receives water from a catchment area of 20.92 Sq. KMs and serves an ayacut of 2085 Hectares (5,171 Acres). Two minor drains-Purushothampalli and Nidadavolu are infalling into Kalavacharla. The drain was improved under CERP for a maximum discharge of 13.11 Cumecs.

Badava, another medium drain, commences from Kalavacharla drain just 300 Mts. Upstream of its tail end near Velivennu Village. After traveling a few meters it branches off into two arms – one on the Eastern side and the other on the Western side.

The Eastern side branch known as Eastern Badava is 1.78 KMs. long and joins Velivennu medium drain. The Western side branch known as Western Badava is 0.68 KMs long and joins Gostanadi-Velpur canal through under tunnel on Kakaraparru canal.

Badava drain receives waters from a catchment of 34.25 Sq. KMs (18.72 Sq. KMs. Eastern Badava and 15.53 Sq. Kms. Western Badava) and serves an ayacut of 1329 Hectares (3,296 Acres). Munipalli a minor drain is infalling into the drain. The Badava Drain including branches was improved under CERP for a maximum discharge of 22.93 Cumecs.

Velivennu drain commences from the tail end of Eastern branch of Badava drain in the village limits of Velivennu and after traversing 2.78 KMs, it joins Gostanadi – Velpur canal at Km.16.392. The drain has a catchment

of 6.61 Sq. KMs and receives drainage from an ayacut of 2600 Hectares (6,451 Acres). The drain was improved under CERP for a maximum discharge of 15.11 cumecs which is 15 % excess over the original capacity.

5.5.5.1.1.2 USULUMARRU AND DAMMENNU DRAINS:

Usulumarru drain originates from Velagadurru Village and travels a distance of 2.82 KMs. parallel to Kakaraparru canal before it joins Dammennu drain. It collects drain water from a catchment of 21.13 Sq. KMs. Nadipalli and Manuru are the two minor drains that infall into Usulumarru. The drain was improved under CERP to discharge 14.73 Cumecs

Dammennu drain starts at RB 0.010 KM of Usulumarru drain and joins Gostanadi-Velpuru canal, after passing 2.94 KMs through Dammennu and Mortha Villages. The drain has a catchment area of 25.03 Sq. Kms. The maximum discharge capacity of this drain is 14.88 cumecs which is 58.44 % excess over its original discharge.

Usulumarru and Dammennu combined, receives drainage from an ayacut of 2519 Hectares (6,246 Acres). Both these medium drains Usulumarru and Dammennu are improved under CERP Organization.

5.5.5.1.1.3 MORTHA DRAIN:

Mortha Drain originates at 0.60 KM of Undrajavaram Canal and passes through Mortha, Undrajavaram, Palangi, Kesavaram and Chivatam Villages and after traversing a total length of 10.4 KM joins Gostanadi –Velpur canal at Km.25.476. The drain has a catchment area of 12.95 Sq. Kms. and receives drainage from an ayacut of 1290 Hectares (3,200 Acres).

Improvements to this drain were taken up under CERP to carry a maximum discharge of 9.52 Cumecs which is 19.64 % excess over its capacity before improvements.

5.5.5.1.1.4 SATYAVADA DRAIN:

Satyavada drain takes off near Thethali Village and runs through Thethali and Mandapaka Villages before it joins Gostanadi. It collects drain water from a catchment area of 28.48 Sq. Kms. and serves an ayacut of

2839 Hectares (7040 Acres) and was improved under CERP to discharge a quantity of 16.11 cumecs which is 48 % excess over its original capacity.

5.5.5.1.1.5 PALI DRAIN:

Pali Drain originates from Relangi Village. It joins Gostanadi after traveling a distance of 4.15 KMs. It has a catchment of 19.42 Sq. KMs and drains water from an ayacut of 1942 Hectares (4,800 Acres). The drain was improved under CERP to discharge a maximum quantity of 12.17 cumecs which is 5.50 % excess over its original capacity.

5.5.5.1.1.6 BYVANI CODU AND MOGALLU DRAINS:

Mogallu, a medium drain takes off at Korukollu Village and after traversing a distance of 4.3 KMs, it joins Byvanicodu drain. It has a total catchment area of 13.98 Sq. KMs. The drain was improved under CERP to carry a maximum discharge of 10.023 Cumecs which is 113.54 % excess over its original capacity. Korukollu is the only minor drain that joins Mogallu. Byvanicodu originates from Mypa Village and after traveling a distance of 4.5 KMs it joins Gostanadi. The catchment area of Byvanicodu is 22.0 Sq. KMs. This drain was improved under CERP to carry a maximum discharge of 13.56 Cumecs which is 17.75 % excess over the original capacity. A local minor drain, in addition to Mogallu is infalling into Byvanicodu. Byvanicodu and Mogallu serve an ayacut of 2,200 Hectares (5,440 Acres).

5.5.5.1.2 DUVVA DRAIN:

Duvva Drain commences from the Regulator on Yanamadurru drain near the Tadepalligudem – Tanuku High Way, in the Village limits of Duvva. The drain travels for a distance of 8.7 KMs. through Duvva, Varigedu and Kondepadu Villages and finally empties into Yanamadurru Drain. Varigedu medium drain and Aruthlacodu are the two drains that infall into Duvva drain. The drain has a total catchment of 43.42 Sq. KMs and serves an ayacut of 4395 Hectares (10,861 Acres). The drain was improved under

CERP to carry a maximum discharge of 21.5 Cumecs which works out to 38.44 % excess over its original capacity.

5.5.5.1.2.1 VARIGEDU DRAIN:

Varigeu is a medium drain that infalls into Duvva Drain. The drain commences from Mandapaka Village and after passing through a distance of 1.74 KMs. in the Villages of Mandapaka and Varigedu, it joins Duvva drain.

The drain has a catchment of 15.33 Sq. KMs and serves an ayacut of 1533 Hectares (3,789 Acres). The drain is improved to accommodate a maximum discharge of 10.66 Cumecs under CERP Organization.

5.5.5.1.3 KASIPADU DRAIN:

Kasipadu Drain originates from the left bank of Venkaiah-Weyyerucanal. The drain traverses a distance of 8 KMs. through Chintapalli, Korumilli, Kasipadu and Pippara Villages and finally empties into Yanamadurru drain. Vissannacodu and Kothapalem drains are the two minor drains that are infalling into Kasipadu drain. The drain collects waters from a catchment of 13.37 Sq. KMs and drains waters from an ayacut of 1937 Hectares (4,787 Acres). It was improved under CERP to carry a maximum discharge of 12.45 cumecs which works out to 44.28 % excess over its original capacity.

5.5.5.1.4 RAJUCODU DRAIN:

Rajacodu originates from Komaravolu Village and after running for a length of 10.4 KMs. through Kasipadu and Pippara Villages, it empties into Yanamadurru drain. It has a total catchment of 22.82 Sq. Kms. and drains water from an ayacut of 2383 hectares (5,888 Acres). The drain was improved under CERP to carry a maximum discharge of 14.29 cumecs which is 41.9 % excess over its original capacity.

5.5.5.1.5 EARLACODU DRAIN:

Earlacodu Drain starts from Aaravilli Village and it runs for a distance of 8.90 KMs through Aaravalli, Skinarapuram and Eeduru Villages before it infalls into Yanamadurru Drain. Manchili drain and another minor drain are

infalling into this drain. The drain has a total catchment of 31.84 Sq. Kms and serves an ayacut of 3186 hectares (7872 Acres). The drain was improved under CERP to discharge 17.35 Cumecs which is about 88.3 % excess over its original capacity.

5.5.5.1.5.1 MANCHILI DRAIN:

Manchili Drain commences from the Village Kaluva Manchili and after traveling a distance of 6.8 Kms. through Manchili, Eeduru, Kanchumarru, Kondepadu villages, it joins Earlacodu drain at RB.1.40 KM. The drain has a catchment of 15.538 Sq. KMs and receives drainage from an ayacut of 1,554 Hectares (3,840 Acres). Munugucodu is the only minor drain that infalls into Manchili.

The drain was improved under CERP to carry a maximum discharge of 10.752 cumecs which works out to 126.8% excess over the original capacity.

5.5.5.1.6 RAYALAM DRAIN:

Rayalam Drain commences from the Annavaram Village limits and runs through Narasimhapuram, Bhimavaram, Rayalam, Komarada, Yanamadurru and Dirusumarru Villages for a distance of 13.7 KMs, before it joins the New Yanamadurru Drain.

Uppucodu is a medium drain connecting Old and New Yanamadurru Drains. Uppucodu commences just at the confluence of Rayalam drain with new Yanamadurru and after traveling a distance of 4.30 Kms, it joins Old Yanamadurru Drain.

The water levels of New Yanamadurru drain will normally be above the flood water levels of Rayalam drain and therefore for most of the days, the Rayalam waters have to join Old Yanamadurru drain through Uppucodu. Thus, the waters of Rayalam drain join New Yanamadurru or Old Yanamadurru drain depending upon their water levels.

The Rayalam drain was improved under CERP Organziation to accommodate a maximum discharge of 1.47 Cumecs which works out to 135 % excess over its original carrying capacity. The drain receives drainage from an ayacut of 2486 Hectares (6.144 Acres).

5.5.5.1.7 MANDACHEDU DRAIN:

Mandachedu drain originates from the village limits of Gutlapadu and the drain traverses a distance of 6.45 KMs. before it joins Yanamadurru drain. Nanditippa and Matchagada are the two minor drains that join Mandachedu drain. The drain was improved under CERP to carry a maximum discharge of 11.74 Cumecs. The drain serves an ayacut of 1295 Hectares (3,200 Acres).

5.5.6 POLIMERATIPPA DRAIN:

Polimeratippa is a minor basin in between New and Old Yanamadurru basins. The drain Polimeratippa starts from the village Gutlapadu and drains into Upputeru after traveling a distance of 5.46 KMs. The drain has a catchment of 18.61 Sq. KMs and receives drainage from an ayacut of 1,854 Hectares (4,600 Acres). The drain was improved under CERP to carry a maximum discharge of 15.23 Cumecs. Three minor drains-Badeti Calva, Tokatippa and Kothapusalamma drain are infalling into this drain.

5.5.7. OLD YANAMADURRU BASIN:

Old Yanamadurru basin lies in between Mogadindi and Polimeratippa drains. Old Yanamadurru and Bondada are the principal drains of the basin. Neelacodu, Yandagandi and Kopalle are other medium drains of the basin.

5.5.7.1 BONDADA DRAIN:

Bondada is one of the principal drains of old Yanamadurru basin and originates from the tail end of the Neelacodu medium drain at KM.53.902 of Venkaiah-Weyyeru canal. The drain after traveling a distance of 21.23 KMs empties into Old Yanamadurru drain. Three medium drains – Neelacodu at RB 0.00 KM, Yandagandi at RB.4.00 KM, and Kopalle at RB 18.5 KM, and Mahadevapatnam minor drain at RB 7.8 KM join the course. The drain has a total catchment of 157.95 Sq. KMs. and was improved under CERP to carry a maximum discharge of 56.66 Cumecs which is 36 % more than the previous discharge. The drain receives waters from an ayacut of 15,783 Hectares (39,000 Acres).

5.5.7.1.1 NEELACODU DRAIN AND JALLI KAKINADA DRAIN:

Neelacodu drain starts from Kolamuru and Aaredu Village limits. It travels through Kolamuru and Kalingatla Villages for a distance of 4.4 KMs before joining Bondada major drain. It has a catchment area of 25.89 Sq. KMs. and receives drainage from an ayacut of 647 Hectares (1,600 Acres). This Drain was improved under CERP. The drain carries 13.00 Cumecs of water which is 16.23 % excess over its original carrying capacity. This drain in its upper reaches is called as Jalli Kakinada drain and after crossing Undi-Ganapavaram road, this drain is known as Neelacodu.

Jalli Kakinada starts at the Village boundaries of Jalli Kakinada and after traveling a distance of 8.8 KMs through Villages Jalli Kakinada, Yandagandi, Arbhavaram, Penumandra and Kolamuru Villages, it joins Neelacodu drain at the later's originating point. The drain has a catchment area of 17.86 Sq. KMs. and receives drainage from an ayacut of 1781 Hectares (4,400 Acres). The drain was improved under CERP Organization. The drain carries a maximum discharge of 12.52 cumecs which is 62.32 % excess over its original capacity.

5.5.7.1.2 YANDAGANDI DRAIN:

Yandagandi drain originates in the boundaries of Yandagandi Village. It travels a distance of 9.31 KMs. before joining Bondada major drain. Its catchment area is 31.48 Sq. KMs and it serves an ayacut of 3116 Hectares (7,700 Acres). The drain was improved under CERP Organization to a maximum discharge of 17.22 Cumecs which is 18 % excess over its original discharge. Garagaparru minor drain is the only infalling minor drain.

5.5.7.1.3 KOPALLE DRAIN:

Kopalle Drain commences from the bridge in the Village limits of Peda Amiram on Bhimavaram – Juvvipalem Road and runs through the Villages Vempadu and Kopalle for a total length of 6.7 KMs. and joins Bondada major drain at RB 18.5 KM. The drain has a catchment of 31.59 Sq. KMs. and it serves an ayacut of 3160 Hectares (7,808 Acres). The drain was improved

under CERP for a maximum discharge of 17.25 Cumecs which is 41.47 % excess over its original capacity. China Amiram and Addacodu are the two minor drains that infall into this drain.

5.5.8 OLD YANAMADURRU DRAIN:

Old Yanamadurru Drain originates from the tail end of Bondada drain and after traveling a distance of 10.9 KMs. through Gollavanitippa, Gutlapadu, Kothapusalamarru and Dongapandi Villages, it joins Upputeru at RB 40.00 KM. The drain receives waters from a catchment of 245.49 Sq. KMs and serves an ayacut of 7689 Hectares (19,000 Acres) and is designed to carry a maximum discharge of 73.38 Cumecs. Uppucodu, a medium drain joins Old Yanamadurru during its course at RB 10.90 KM. This Drain was improved under CERP Organization.

5.5.8.1 UPPUCODU DRAIN:

Uppucodu drain starts from the confluence of Rayalam with Yanamadurru near Dirusumarru Village. It passes through Dirusumarru and Anacoderu Villages, and finally empties into Old Yanamadurru Drain. The drain has a catchment of 31.07 Sq. KMs. and drains an ayacut of 3108 Hectares (7,680 Acres) and was improved under CERP to carry a maximum discharge of 17.814 Cumecs, which is 14.13 % excess over its original capacity.

5.5.9 MOGADINDI DRAIN:

Mogadindi, a medium drain originates from the Village limits of Jakkaram and after traveling a distance of 9.95 KMs., it joins Addala Creek. The drain receives water from a catchment area of 49.19 Sq. KMs. and serves an ayacut of 4920 Hectares (12,160 Acres). The drain was improved under CERP for a maximum discharge capacity of 29.84 Cumecs which is 31.45 % excess over its original capacity.

5.5.10 RUDRAYACODU DRAIN:

Rudrayacodu, a major drain of Upputeru basin takes its origin at 56.315 KM of Venkaiah-Weyyeru canal and after traveling 18.75 KMs through

Villages China Kapavaram, Ajjamuru, Kalla and Kalavapudi, it joins Addala Creek at RB 3.66 KM. The drain has a catchment area of 59.55 Sq. KMs. and collects drainage from an ayacut of 8094 Hectares (20,000 Acres).

Tallicodu and Addlacodu are the two infalling minor drains. Rudrayacodu was designed to carry a maximum discharge of 27.83 Cumecs which is more than 11 % excess over its original capacity and improved under CERP Organization.

5.5.11 ADDALA CREEK DRAIN:

Addala Creek, a major drain starts from the tail end of Mogadindi drain and joins Upputeru at RB 28.5 KM after traveling a distance of 4.71 KMs. through Doddanapudi, Kallakuru, Pathalameraka and Kaluvapudi Villages. Rudrayacodu joins this drain at RB.3.66 KM. The drain collects water from a catchment of 67.31 Sq. KMs. and receives drainage from an ayacut of 5387 Hectares (13,312 Acres). The drain was designed to carry a maximum discharge capacity of 28.62 Cumecs and improved under CERP Organization.

5.5.12 CHINA KAPAVARAM DRAIN:

China Kapavaram Drain commences from the surplus flow of Venkaiah-Weyyeru canal at RB 56.20 KM. The drain passes through Villages Gummuluru, Tharatova, Kolaparru, Madivada, Akividu and Dumpagadapa Villages for a distance of 11.0 KMs. and finally empties into Upputeru at Km.14.231. During its course two minor drains namely Nakkalacodu and Avisalacodu join the drain. The drain receives surplus waters from Venkaiah-Weyyeru canal and from a catchment of 32.28 Sq. KMs. The drain also receives drainage from an ayacut of 4451 Hectares (11,000 Acres). The drain is designed to discharge 46.31 Cumecs which is 12.05 % excess over the original capacity and improved by CERP Orgainzation.

5.5.13 VENKAIAH-WEYYERU CANAL CUM DRAIN:

Venkaiah-Weyyeru Canal takes off from the upstream of Duvva Regulator on the New Yanamadurru Drain near Muddapuram Village. It serves as an irrigation canal from the off-take point to Parmella lock for a length of 22.48 KMs and supplies waters to an ayacut about 60,000 Acres.

Below Parimella lock and upto China Kapavaram flood weir, over a length of 21.8 KMs, it serves as canal cum drain. Three medium drains Old Weyyeru, Bodapadu and Palacodu join in the reach of canal cum drain. The drain has a catchment of 86.32 Sq. KMs. and receives drainage from an ayacut of 11,990 Hectares (29,630 Acres). The drain was improved under CERP to carry a maximum discharge of 14.98 Cumecs which works out to 36 % excess over the original capacity.

5.5.13.1 OLD WEYYERU DRAIN:

Old Weyyeru Drain originates from the tail end of Kasipadu minor irrigation canal and after traversing a distance of 7.25 KMs., it joins Venkaiah – Weyyeru canal at RB 34.4 KM. The drain has a catchment of 5.32 Sq. KM. and caters drainage from an ayacut of 1376 Hectares (3,400 Acres). The drian was improved under CERP to carry a maximum discharge of 9.92 Cumecs which is about 97.62 % excess over its original capacity.

5.5.13.2 BODAPADU DRAIN:

Bodapadu is a medium drain which originates at KM. 25.2 of right bank of Venkaish-Weyyeru canal in the Village limits of Ravipadu and after running parallel to the canal through Ravipadu, Bodapadu, Kasipadu, Mudunuru, Akuthigapadu, K.Pentapadu, Yanadapalli and Parimella Villages for a length of 23.70 KMs., joins back the Venkaiah-Weyyeru canal through an open cut of right bank near Parimella Village. Jammalacodu, Yenugupunta, Nilavapunta and Bilagunta are the minor drains infalling into Bodapadu.

The drain has a catchment of 24.8 Sq. KMs. and serves an ayacut of 2226 Hectares (5,500 Acres). The drain was improved under CERP to discharge 14.69 Cumecs which is 13.78 % excess over its original capacity.

5.5.13.3 PALACODU DRAIN:

Palacodu drain is a medium drain in Upputeru basin. It originates near Undi canal in the Village limits of A. Gopavaram and passes through A. Gopavaram, Muggula, Arthavaram, Aredu and Kaligotla Villages and runs for a distance of 11.160 KMs. and finally empties into Venkaiah-Weyyeru canal

at Km.44.40 with an open head. It collects drain waters from a catchment area of 26.80 Sq. KMs. and serves an ayacut of 2680 Hectares (6624 Acres). Three minor drains Valluru, Badavacodu and Corracodu infall into this drain. The drain was designed and improved under CERP to carry a discharge of 16.90 Cumecs which is 27 % excess over its original capacity.

5.5.14 VASISTA GODAVARI BASIN:

Vasista Godavari Basin is a long narrow strip of area bounded by Narsapur canal on the Western side, Vasista branch of Godavari on the Eastern side and Bay of Bengal on the South. The basin is very narrow on the Northern boundary and widens on the Southern side. The basin is spread over an area of 530.77 Sq. KMs. and about 382.14 Sq. KMs is under cultivation, with the waters supplied by the Narsapur Canal, Kakaraparru Canal and by Bank Canal. The area is flat having a slope of I in 50,000 and receives fairly good rainfall. The annual rainfall varies from 100 Cms to 130 Cms. The water-table is high and the soils are mostly black cotton type.

With area flat, with good intensity of rain, with water table high, with high intensity of cultivation, the drainage is a serious problem in this basin. Two major drains – Kaza and Nakkala, eight medium drains and forty two minor drains drain the area. When Godavari is in floods, the waters back up into the drains and inundate the areas. To prevent the Godavari Waters entering the drains, out-fall sluices are constructed at the confluence points.

5.5.14.1 NAKKALA DRAIN:

Nakkala Drain is one of the major principal drains of the Vasista Godavari Basin. It runs in between Narsapur Canal and Chinchinada Channel on Western side. It originates from the Kakaraparru new surplus escape of the right bank of Bank Canal at KM.23.833 and after traveling a distance of 40.82 KMs. through Kakaraparru, Peravali, Mukkamala, Khandavalli, Malleswaram, Pekeru, Cherukuwada, Penugonda, Seshamma Cheruvu, Poduru, Vaddiparru, Ravipadu, Penumarru, Kattukalva and Vaddilanka Villages, it empties into the Vasista Branch of Godavari through an outfall near Lakshmipalem Village at KM.59.50 Godavari Bank. During its course,

three medium drains – Kotalaparru at RB.21.65 KM, Thaderu at RB.32.62 KM and Valluru at RB.39.5 KM join the drain. Besides this, twenty two minor drains also empty into the drain. The drain has a catchment are of 218.64 Sq. KMs. and receives drainage from an ayacut of 20,639 Hectares (51,000 Acres). The drain was improved under CERP to carry a maximum discharge of 74.06 Cumecs which works out to 109 % excess over its original capacity.

5.5.14.1.1 KOTALAPARRU DRAIN:

Kotlaparru drain is one of the medium drains that joins Nakkala major drain. It originates from Siddantham Village and after running a total distance of 11.51 KMs. through Siddantham, Vadali, Tamarada, Deva, Seshamma Cheruvu and Achanta Villages, it joins Nakkala drain at RB.21.65 KM. Elaparru minor drain joins Kotalaparru at RB 6.515 KM. The drain has a catchment area of 25.63 Sq. KMs. and serves an ayacut of 2564 Hectares (6,336 Acres). The drain was improved by CERP to carry a maximum discharge of 15.012 Cumecs which will be 301.6 % excess over its original capacity.

5.5.14.1.2 THADERU DRAIN:

Thaderu Drain originates from under tunnel of Penumanchili branch canal near Mulaparru Village and after traveling through China Mallamma, Mulaarru, Kodamanchili, Penumanchili, Achanta, A-Vemavaram and Vaddiparru Villages for a total length of 12.85 KMs., it infalls into Nakkala drain at RB.32.62 KM. Kodamanchili minor drain joins Thaderu drain at RB.5.690 KM. The drain receives waters from a catchment area of 31.58 Sq. KMs. and serves an ayacut of 3,160 Hectares (7,808 Acres). The drain was improved by CERP to carry a maximum discharge of 17.25 Cumecs which is 130.90 % excess over its original capacity. About 1.16 lakh cubic meters of earth is excavated by CERP towards the improvements.

5.5.14.1.3 VALLURU DRAIN:

Valluru Drain is a medium drain which starts at Kodamanchili Village and after traveling a distance of 12.825 KMs. through Penumanchili, Kandavalli, Karugorumilli, Adiandrapalli, Valluru, Bhimalapuram, Kattukalva,

Burugupalli, Gumparru, Doddipatla and Eelaparru Villages, it joins Nakkala major drain at RB.39.80 KM. Koderu minor drain joins Valluru during its course. The drain has a catchment area of 26.93 Sq. KMs. and serves an ayacut of 2,693 Hectares (6,656 Acres). The drain was designed and improved by CERP to carry a maximum discharge of 15.52 Cumecs which works out to 51.04 % excess over its previous capacity.

5.5.14.2 KAZA DRAIN:

Kaza drain is another major drain in the Vasista Godavari basin. The drain originates at KM.43.10 of the Narsapur irrigation canal and after traveling a distance of 27.4 KMs. through Kavitam, Poduru, Mattaparru, Penumadam, Medapadu, Kaza and Gondi Villages, the drain finally infalls into Vasista river at Km.70.40 of Right bank through an outfall sluice near Navarasapuram Village. The drain receives waters from a catchment of 105.75 Sq. KMs. and receives drainage from an ayacut of 10,994 Hectares (27,166 Acres). Palakollu Ava, a medium drain and eight minor drains join the course. The drain was reconstructed by CERP Organization to carry a maximum discharge of 38.62 cumecs which is 36% excess over its original capacity.

5.5.14.2.1 PALAKOLLU AVA DRAIN:

Palakollu Ava Drain commences at KM.0.80 on left side of Diogamarru Irrigation Canal and after traveling a distance of 5.63 KMs. through Palakol, Kaza, Varidhanam and Kontheru Villages, the drain joins Kaza major drain at RB 15.20 KMs. Four minor drains join the drain during its course. The drain has a catchment of 19.44 Sq. KMs. and receives drainage from an ayacut of 1.945 Hectares (4,806 Acres). The drain was improved by CERP to carry a maximum discharge of 12.49 Cumecs which is 212.37 % excess over its original capacity.

5.5.14.3 EAST KUKKALERU DRAIN:

East Kukkaleru Drain commences from the confluence of three minor drains Viz. Marrithippa, Sarugudutippa and Vemuladivi. The drain after

running through a total length of 3.86 KMs. in the Village limits of Vemuladivi, it finally empties into Vasista branch of Godavari through an out fall sluice near Vemuladivi Village. Pallipalem minor drain joins the course during its run. The drain has a catchment of 15.66 Sq. KMs. and serves an ayacut of 1,567 Hectares (3,872 Acres). The drain was improved under CERP to carry a maximum discharge of 10.82 Cumecs.

5.5.15 BI-DIRECTONAL DRAINS:

The drains, most of them, in the Delta run from North to South and they have an independent basin or a sub-basin of their own. The course of these drains is only in one direction. There are a few other drains in the Delta that run from East to West. The flow in the drain is bi-directional; one part runs in the Western direction while the other part runs in the Eastern direction. These drains are popularly known as Bi-Directional Drains. Rustumbada, Dharbarevu and West Kukkaleru are the Bi-Directional Drains, in West Godavari District.

5.5.15.1 RUSTUMBADA DRAIN:

Rustumbada is a typical deltaic drain where a single drain runs in two opposite directions and joins two separate valleys. The drain commences from the Rustumbada Poramboku drain and runs for a total distance of 8.30 KMs. in the Village limits of Seetharampuram, Rustumbada and Narasapuram. A part of the drain known as West branch runs in the Western direction for a length of 4.13 KMs. and infalls into the Mogalturu drain at RB.18.00 KM. The other part known as Eastern branch runs in the Eastern direction for a distance of 4.17 KMs and joins Vasista Godavari.

The drain has a catchment area of 17.45 Sq. KMs. and collects drainage from an ayacut of 755 Hectares (1,866 Acres). Rustumbada Poramboku and Nattalava are the two minor drains that infall into this drain. The drain was improved under CERP Organization to carry a maximum discharge of 6.62 Cumecs.

5.5.15.2 DARBHAREVU DRAIN:

Darbharevu drain also known as Darbharevy Creek, is a medium drain of Vasista basin and a bi-directional drain by its nature. One part of the drain, known as Eastern arm flows in the Eastern direction while the other part runs in Western direction.

Both the arms take their origin from the sysphon of Ramannapalem Channel.

5.5.15.2.1 EASTERN ARM OF DARBHAREVU DRAIN:

The Eastern Arm of Darbharevu runs for a length of 6.663 KMs. through L.B. Charla, Rajulanka and Darbharevu Villages and empties into Vasista branch of Godavari through an outfall sluice in the village limits of Darbharevu. Sattirajucodu minor drain joins at RB.0.650 KM. The arm receives water from a catchment area of 19.67 Sq. KMs. and serves an ayacut of 2,041 Hectares (5,044 Acres). The drain was improved under CERP to carry a maximum discharge of 12.59 Cumecs.

5.5.15.2.2 WESTERN ARM OF DARBHAREVU DRAIN:

The Western arm of Darbharevu runs for a length of 8.10 KMs. and passes through Mogaltur Village and empties into Salt Creek by open head near Mogaltur lock on Naraspaur Canal in the Village limits of Mogaltur. The Western arm receives water from a catchment area of 13.33 Sq. KMs. and serves an ayacut of 908 Hectares (2,245 Acres). The drain was improved under CERP to carry a maximum discharge of 12.49 Cumecs.

5.5.16 WEST KUKKALERU DRAIN:

The West Kukkaleru is a medium drain and a bi-directional drain by its nature. Both the East and West arms start at the bridge on Narsapuram – Perupalem Road in Metturevu Village limits. These two arms serve an ayacut of 681 Hectares (1,683 Acres)

5.5.16.1 EASTERN ARM OF WEST KUKKALERU DRAIN:

The Eastern arm runs for a length of 10.20 Kms. through Turuputallu, Gollapalem and Vemuladeevi Villages and finally empties into Vasista Godavari River through an outfall sluice in the Village limits of Biyyaputippa.

The Eastern arm receives water from a catchment of 23.56 Sq. KMs. The drain was improved under CERP to carry a maximum discharge of 14.19 Cumecs.

5.5.16.2 WESTERN ARM OF WEST KUKKALERU DRAIN:

The Western of Kukkaleru runs for a length of 13.10 KMs. and passes through Villages Turuputallu, Perupalem, Mutyalapalli Modi and Mytyalapalli before it empties into Salt Creek with an open head in the Village limits of Chentarevu. The Western arm receives water from a catchment area of 14.60 Sq. KMs. The drain was improved under CERP to carry a maximum discharge of 13.28 Cumecs.

6 DESIGN CRITERIA FOR DRAINS

6.1 PREAMBLE

Major Improvements were carried out to the Delta Drainage System during 1990-1995 under Cyclone Emergency Reconstruction Programme (CERP).

The Technical monitoring Committee headed by Sri M.L. Swamy, former Engineer-in-Chief has recommended the following 'C' value in Ryves formula for computation of maximum flood discharge (vide No. CERP/TMC/PMU/Irr.Dr/17-91 Dt. 19-7-1991) considering 3 day consecutive rainfall of 387.5mm (25 years return period as recommended by the Director of Hydrology, CWC) with submersion of 75mm at the end of 3rd day during tillering period (Annexure-XXIV).

S.No	Classification of Drain	Catchment Area in Square Miles.	Formula to be adopted for MFD in cusecs.
1.	Minor drains	0-5	115M
2.	Medium drains	Above 5 to 20	$115M^{2/3}$
	Major drains	Above 20	
3.	Major upland drains	Above 20	$145M^{2/3}$

6.2 Rainfall during OGNI Cyclone:

A severe cyclone christied as "OGNI" has hit the coast between Baptala and Machilipatnam bringing in unprecedented heavy rainfall of as high as 941.80 mm recorded at Machilipatnam over the period of 28.10.2006 to 1.11.2006.

The average 3 day consecutive rainfall exceeded 500 mm in 17 stations out of 28 stations in delta area of Krishna District. Even, when the very high rain fall recorded at Pamarru (826.0 mm), Gudivada (695.2 mm) and Gudlavalleru (680.0 mm) is ignored, the average 3 day consecutive rainfall in Krishna Delta worked out to be 497.6 mm or say 500 mm. The corresponding "C" value in Ryvs formula for Krishna Delta areas worked out to 156 which indicates an increase of 35.5% over the value adopted earlier (115) while carrying out major improvements to drains under CERP.

However considering the constraints of Land Acquisition, Cost etc., the committee feels that a 25% increase in 'C' value would be the minimum reasonably required for the purpose of calculating max flood discharge and hence recommended the same for Krishna Delta area.

With regard to the Godavari Delta following are the 3 day consecutive rainfall observed during "Ogni" Cyclonic rain.

District	Rain gauge Station	3 day consecutive rainfall
West Godavari	Akiveedu	290.0 mm
	Kovvur	167.6 mm
	Narasapuram	389.4 mm
	Penugonda	205.0 mm
	Poduru	222.0 mm
	Tanuku	224.2 mm
	Tadepalligudem	139.2 mm
East Godavari	Alamuru	200.2 mm
	Amalapuram	438.6 mm
	Kothapeta	277.0 mm
	Mummidivaram	481.4 mm

It is seen from the above statistics that 3 day consecutive rainfall exceeded 387.5 mm (considered for computation of max flood discharge earlier by CERP) in three rain gauge stations out of 11 stations in delta area of Godavari.

(The 3-day consecutive rain fall recorded in East and West Godavari Districts are at *Annexure XXV).*

Though the 3-day consecutive rain fall recorded during the year 2006 in the deltaic areas of Godavari Delta in East and West Godavari Districts is below 387.5 mm, for which the drainage system is designed as per the recommendations of the Technical Monitoring Committee (CERP), it is adviseable to consider the rain fall occurred in Krishna Deltaic areas in the "OGNI" Cyclonic period and redesign the drainage system in the Godavari Delta System as well adopting the same standards as recommended now for improving the major drains in Krishna Delta, considering the fact that both Krishna dnd Godavari deltaic areas are contiguous and both these deltas are exposed to severe cyclones that form in the Bay of Bengal very frequently.

Design standards recommended are at *Annexure-XXVI.*

7 SUGGESTIONS RECEIVED FROM PUBLIC REPRESENTATIVES AND OTHERS ETC., AND VIEWS OF THE COMMITTEE

Meetings are conducted at Collector's Bungalow, Kakinada on 19-01-2007 in respect of Godawari Eastern & Central Deltas and at Collectorate, Eluru on 21-01-2007 in respect of Godavari Western Delta with people representatives after field visits. During the field visits and during interaction with public representatives, several suggestions are received. The suggestions of public representatives and response of the Committee are at *Annexure XXVII & XXVIII.*

Sri T.S. Prakasha Rao, Engineer-in-Chief (Retired) and Advisor (Rayalaseema Region) putforth some valuable suggestions (*Annexure-XXIX)* before the Committee and the same are acknowledge with kind regards.

7.1 The field visits of the Committee and suggestions received from public and response of the Committee are here under.

7.1.1 Kummarakalva Drain In Amalapuram Town Limits:

The Kummara Kalva Drain is one of Major Drains in Godavari Central Delta. The length of drain is 24 Kms and the catchment area in 69.90 Sq. Km. The drain starts from Vakkalanka (V) Limits and runs through Ambajipeta, Inavilli, Amalapuram, Allavaram Mandals and finally empties into Vynatheyan Godavari through an outfall sluice. There is an extent of 17,300 Acres ayacut being served under this drain. The drain is improved to discharge 40.39 Cumecs under CERP. There is a provision to divert 50 % of the above flood discharge into the Sea by inter basin diversion through Desicodu and Vasalathippa by closing the O.F. Sluice when River Godavari is in spate.

The Committee visited the drain in the town limits of Amalapuram and noticed that habitation have been developed on the two banks of drain. The section of the drain in the said portion is reduced considerably due to dumping of garbage by the habitants resulting in unhygienic condition besides inundation of ayacut. It is reported by the field officers that the proposal for construction of retaining wall on either side of drain with a cost of Rs.2.40 Crores is under active consideration by the Government. The Committee felt that this is essential in view of development of habitations on either side of the banks and recommends for construction of retaining wall as proposed by the Department. Care may be taken to keep the drain free from dumping of any garbage by erecting wire mesh on both sides in the town limits to maintain public hygiene.

It is also noted that the existing bridges in town limits of Amalapuram are not reconstructed under CERP as per revised standards. These may be taken up immediately as they became bottlenecks for the free flow of drainage water in the drain.

The Committee also visited the U.T. constructed on Amalapuram Canal across Kummara Kalva drain in Amalapuram town limits along with Hon'ble MLA Sri K. Chittabbai on 18-01-2007. The Committee noticed that the structure is in dilapidated condition and recommended for reconstruction of U.T as per revised design criteria recommended now duly obtaining the designs from the Chief Engineer, Central Designs Organization, Hyderabad. The Committee recommends to take up protection works such as grouting etc., as a temporary measures in ordeer to supply water to the ayacut until reconstruction is initiated.

7.1.2 DIVERSION OF SEWERAGE OF RAMACHANDRAPURAM MUNCIPALITY INTO RAMACHANDRAPURAM ROAD SIDE MINOR DRAIN

The Ramachandrapuram Muncipality has excavated a Muncipal drain to carry the sullage to Muchimilli Minor drain and the Muchimilli Minor drain joins Coringa Canal.

Coringa Canal water being used as drinking water by D/S Village and Town.

This unhygienic water can not be used for drinking. Department has submitted proposals for diversion of 80 % of the sullage water to road side minor drain and from there to Tulya Bhaga Drain.

The Committee recommends this proposal and suggest that the balance 20% sullage water shall be treated and pumped into the Ramachandrapuram Road side drain only leaving Coringa water clear of the sullage.

7.1.3 IMPROVEMENTS TO REVENUE, LOCAL & PRIVATE DRAINS IN G.E & G.C DELTAS

In the meeting held in Collector's Bungalow on 19-01-2007 at Kakinada with the public representatives of East Godavari District, many issues like eviction of encroachments, deweeding in canals, drains and improvements to drainage net work etc., have been discussed. The District Collector, East Godavari District suggeted to examine improvements to Revenue, local and private drains departmentally. The District Collector opined that without improving these local, revenue and private drains along with notified drainage network, inundation problem could continue. The suggestion of District Collector is also generally endorsed by the public representatives.

The Revenue, local and private drains are not notified under delta drainage. These drains are located mostly in private lands. In most of the cases they are being maintained by the Ryots themselves as per practice in

vogue. They receive drainage from very small catchments and the discharge would also be less.

The Committee opines that the existing practice of maintenance of these drains by the farmers themselves can be continued in view of the very low discharges that these drains carry.

7.1.4 Outfall Sluice On Nakkala Drain Near Lakshmipalem

Nakkala Drain is a major drain in Vasista basin of West Godavari with a catchment area of 218.64 Sq. Kms. and empties into Vasista branch of Godavari at Km.59.50 through an outfall sluice. The drain was improved to carry a maximum flood discharge of 74.06 Cumecs. The existing outfall sluice constructed in 1886 in top tiers having 8 vents each vent of size 2.90 M x 1.37 M and bottom tier having 16 vents of two tiers each size 1.45 M x 1.55 M and is capable of discharging about 51.06 Cumecs against the improved maximum flood discharge of 74.06 Cumecs. Further, the existing structure was damaged due to floods of 1983, 1986, 1988 and 1989. As such, it was proposed to construct a new outfall sluice 70 M upstream of the existing structure by CERP Organization. The structure proposed was in two tiers each tier having six vents each vent of size 3.0 M x 2.0 M to discharge 88.42 Cumecs. Flap shutters of size 3.12 M x 2.18 M are proposed to regulate water. A 4.25 M wide single lane bridge was also provided to allow vehicular traffic.

The Committee visited the structure on 20-01-2007. It is reported by the field engineers that the structure proposed under CERP was taken up under another World Bank Aided APHM & ECRP. It is also informed that the

structure is not yet completed due to the problems encountered during execution. The field engineers reported that the R.E for the said work is under sanction by Government.

The Committee suggests that the work should be completed at the earliest as the dilapidated old out fall sluice is in alarming condition.

7.1.5 Surplus Escape operated discharges of I.S.R.M.C:

On commissioning of Indira Sagar Right Main Canal, intended to divert Godavari Waters to Krishna Delta, the surplus waters during floods will be let into any of the upland drains such as Gunderu, Ramileru, Thammileru etc., by operating surplus escapes of I.S.R.M.C. Considering the 50 % of ISRMC waters the U.Ts across Godavari Eluru Canal and Krishna Eluru Canal require improvements providing for additional discharges for accommodating the surplus discharge of ISRMC. The drains are also to be improved accordingly.

The Committee visited the Ramileru U.T at Km.47.98 of Krishna – Eluru Canal on 21-01-2007 with field staff. It is reported that the U.T is constructed to accommodate flood discharge of 10,000 Cusecs. In the event of commissioning of ISRMC having 11,255 Cusecs, the capacity of U.T is to be improved for 5,628 Cusecs in addition to its MFD. The Committee recommends improvements to U.T by way of providing additional ventage to discharge 50 % ISRMC surplus water.

7.1.6 NO.9 U.T (Gunderu & Kovvali Drains)

Gunderu and Kovvali Drains are one and the same. The position of the drain in the upland area (i.e.,) above the Eluru Canal is known as Gunderu. In Delta area, after it crosses the Eluru Canal through an under tunnel, the drain is called as Kovvali or No.9 U.T. Drain.

The Committee visited check dam on Gunderu, No.9 U.T (Km.67.760 of Eluru Canal) and Ramileru U.T (Km.47.98 of Krishna – Eluru Canal) on 21-01-2007.

7.1.7 Improvements To Drains In G.W. Delta To Suit The Ogni Cyclone On Par With The Drains Of Krishna Delta

During the meeting convened at Collectorate, Eluru on 21-01-2007, an important suggestion received from Hon'ble M.L.A., Ungutur Sri V. Vasantha Kumar requesting to considering the drains of Godavari Western Delta for improvements to suit the Ogni Cyclone standards even though heavy rainfall did not occur in the catchment of G.W. Delta. The M.L.A stated that the abundant quantity of water received from Krishna Delta will finally enter into Kolleru resulting the inundation of G.W. Delta ayacut. The M.L.A suggested that the drainage network in G.W. Delta required to be improved along with drains of Krishna Delta keeping in view of recent Ogni Cyclonic rains.

The Committee feels that though the 3-day consecutive rain fall recorded during the year 2006 in the deltaic areas of Godavari Delta in East and West Godavari Districts is below 387.5 mm, for which the drainage system is designed as per the recommendations of the Technical Monitoring Committee (CERP), it is adviseable to consider the rain fall occurred in Krishna Deltaic areas in the "OGNI" Cyclonic period and redesign the drainage system in the Godavari Delta System as well adopting the same standards as recommended now for improving the major drains in Krishna Delta, considering the fact that both Krishna dnd Godavari deltaic areas are contiguous and both these deltas are exposed to severe cyclones that form in the Bay of Bengal very frequently.

7.2 Diversion of Flood flows:

The Committee studied various proposals for diverting flood waters in order to reduce stress on delta area and the following proposal is found feasible to divert flood flows of Yerra Calva into Thammileru.

7.2.1 Diversion of Yerra Calva flood waters to Thammileru Reservoir in Racharla Village limits

The Yerra Kalva River originates at an elevation of 363.00 metres above M.S.L. from the Eastern Ghats at a latitude of 17 $^{\circ}$ – 14' North and Longitude 80 ^{O} – 51' East in the Reserved Forest near Ganesh Padu and Gattugudem Vilalge in Kothagudem Mandal of Khammam District. It flows through the center of West Godavari District for its first 20 miles. During its course it receives several tributaries namely Jalleru, Byneru and Pulivagu. The river crosses the trunk road near Ananthapalli. After flwoing for 134 KM, it crosses the Eluru Canal by an Aqueduct at Nandamuru called Nandamuru Aqueduct. Upto this portion it is called Yerra Kalva and after this Aqueduct, it is called Yenamadurru Drain.

The catchment area of the Yerra Kalva at Nandamuru Aqueduct is 223 Sq. Km giving a flood discharge of 600 M 2/3 = 46,500 cusecs.

A storage reservoir is constructed onYerra Kalva at Konguvarigudem to serve an ayacut of 24,700 acres. Another reservoir was constructed across Jalleru vagu a branch of Yerra Kalva near Aliveru (V) Buttayigudem Mandal to serve an ayacut of 4200 acres.

Even though, these two reservoirs are constructed, still submersion problem is persisting due to floods to Yerra kalva in areas specially downstream of Yerra Kalva Reservoir Project. The maximum flood discharges observed yearly at Yerra Kalva Reservoir Project site are enclosed separately.

The intensity of the floods occurring frequently and the loss of property caused thereby suggest the necessity to contain floods by diversion, as the possible flood moderation at Yerra Kalva Reservoir Project is being already given effect to.

With a view to find out the possibility of diversion of at least a part of flood flows of Yerrakalva to bring down the flood peak, the proposal is examined.

From a study of topo sheets, it is seen that an arm of the Yerra Kalva River flows close to Tammileru river course (roughly 8 KMs) near about Recharla Village in West Godavari District. There is a possibility of diverting Yerra Kalva flood flows from a point near Recharla to Tammileru Reservoir. The bed level of Yerra Kalva at this site is roughly around + 105.00 Meters. The catchment area of Yerra Kalva at this proposed point division is about 78 Sq. Miles. The maximum flood discharge would be around 11,600 C/s computed with Ryves formulae Q = CM 2/3 where C = 550.

A reservoir was constructed across Tammileru near Nagireddygudem Village in West Godavari District for a gross capacity of 3 TMC. The Reservoir is not getting filled frequently upto FRL, as the Tammileru river waters are reportedly being utilized upstream.

The FRL of the Tammileru Reservoir Project is + 108.20 M. The details of inflows into Tammileru Reservoir Project since 1980 to 2003 are appended. From this table, it is observed that the Reservoir is not filled up to FRL for 12 years out of 24 years. Thus, there is a necessity to augment the inflows to Tammileru Reservoir Project so that the irrigation interests can be protected to the ayacut envisaged.

As it is possible to divert the Yerra Kalva flood flows to Tammileru Reservoir Project foreshore by gravity, it is proposed to divert 9000 C/s flood flows by constructing a cross regulator across Yerra Kalva in Recharla Village limits and excavating a suitable diversion channel for a length of about 8.1 Kms.

The Department have prepared a Line Estimate for the proposed diversion work including provisions for the following items:

1. Excavation of diversion channel.
2. Construction of cross regulator and guide bunds.
3. Construction of two double lane bridges.
4. Construction of three single lane bridges.
5. Construction of one in fall regulator.

6. Land Acquisition for 300 Acres.

The estimated cost for the work at the present rates has come to Rs.30.50 Crores.

As this proposal provides considerable flood relief to the lower down areas, which are affected due to floods, and also augments water availability for Tammileru Reservoir Project, the Committee recommends for taking up this diversion work, after getting a detailed investigation of the scheme and designs finalized by the Central Designs Organization.

Copy of the estimate prepared by the Department along with a site plan is at *Annexure-XXX.*

7.2.2 Improvements to certain drains suggested by M/s.APSRAC.

The Engineer-in-Chief, Irrigation, Convener of the committee has informed the committee that M/S. APSRAC have recommended to take up improvements to certain drains by way of dredging, formation of strait cuts, improvements by widening the drains etc. at 9 locations. The Engineer in chief requested the committed to examine the proposals of M/S. APSRAC and make necessary recommendations.

The Committee held discussions with the officials of M/S.APSRAC on the subject on 4.6.2007. The officials of M/S.APSRAC have produced certain Satellite imageries at the locations where they recommended taking up improvements/new works. From the imageries produced, inundation of some areas adjoining the drain is seen. During discussions, they have informed that the imageries pertain to the days, when heavy rain fall is experienced. They have further said that they could not obtain imageries at the same locations 3 days/7 days of the incidence of rain fall.

In the absence of imageries 3/7 days after the incidence of the rain fall, it is not established that the inundation of the areas said to be under water on the rainy day continued for more than 3 days. Hence it cannot be conclusively said that the improvements as suggested by M/s. APSRAC are essentially required.

However, the issues on which M/s. APSRAC had given recommendations are discussed hereunder.

i) **Budameru in Krishna District:-** The Committee dealt with the issue of floods in Budameru and the future releases from Indira Sagar Project through right main canal. The committee have examined various proposals and finally recommended diverting 20,000 cusecs into Krishna River from a location upstream of Velagaleru Regulator and below the confluence of Kotulavagu with Budameru. This proposal, if implemented, would provide adequate relief to the flood problem from Budameru to Vijayawada town and the Krishna Delta lower down.

ii) **Widening of Bikkavol drain near Kakinada Town: -** The committee has inspected the Bikkavol drain at the point of confluence of west Yeleru major drain near Kakinada during the visit to East Godavari District. There are no field reports from the Engineers incharge of drainage, suggesting that large areas are getting inundated as the carrying capacity of Bikkavol drain is not adequate. There are no representations either from the public or public representatives highlighting the problem. The drain was designed to cater to the ayacut for rain fall of 387.5mm in 3 consecutive days. The drain was said to have been improved under CERP. The committee opines that the drain would cater to the stated objective, if maintained properly for the designed rain fall. The committee does not recommend any major improvements to the drain either to improved standards or by way of dredging near the in fall in to the Salt creek near about Kakinada town.

iii) **Yerrakalva near Nidadavolu Town: -** Yerrakalva crosses the Godavari western canal, by way of an aqueduct at Nandamuru village. The Nandamuru aqueduct is said to be designed to pass discharge of 20,000 cusecs of Yerrakalva. Owing to the heavy flood discharges of about one lakh cusecs as per field reports, inundation of vast stretches of land is stated to be occurring frequently.

The committee has examined the possibility of diverting a portion of flood waters of Yerrakalva from a location much above the Yerrakalva reservoir project site and recommended diversion of 9,000 cusecs of flood waters from Yerrakalva to Tammileru to serve the twin objective of flood moderation to the extent possible and also to augment water availability at Tammileru reservoir project site, which is not getting filled in almost 50% of years.

It is reported by Department official that improvements to Yerrakalva below Nandamuru Aqueduct (Yenamadurru drain) are initiated at an estimated value of about Rs 43.00 crores.

The committee understands that there are proposals to form flood banks upstream of the aqueduct on Godavari Canal along the Yerrakalva. With the limited carrying capacity of the Yanamadurru drain (Yerrakalva below Nandamuru Aqueduct), it may not be possible to contain floods within the banks, if formed continuously. This may lead to problem of breaches to the flood banks, causing inundation of adjoining areas.

iv) Out falls Sluice – Straight cut between Vetapalem and Chirala towns:

- The experience so far gained in East Godavari district in formation of straight cut for Kunavaram Drain is not encouraging to open straightcuts of small length as likely to get closed within few days of opening the mouths. When the straight cut is very long, like in the case of Upputeru Straight cut, the performance of the straight cut is good similar is the case with the straight cuts in the Krishna Western Delta. The committee opines that it is necessary that model studies are conducted to establish proper functioning of the straight cut before a decision is taken.

However the committee examined the problem of flooding in the Romperu Basin. Parchuru vagu crosses the Commamooru canal and there after the drain is called as Romperu. The Romperu was improved under hazard mitigation programme (APHM & ECRP)

The committee recommended diverting the flood flows of Parchuru vagu before entering in to the Krishna Western Delta to Gundlakamma River. The problem of flooding can be solved to a great extent, if this

diversion proposal materializes. Earlier the Nallamada Drain used to over flow its banks and enter Romperu basin areas also causing inundation of vast areas. The Nallamada Drain is being improved for a higher discharge with the "C" value at 300 to ease drainage congestion in Nallamada Basin.

The committee therefore recommends to get modal studies for opening the straight cuts done before a decision is taken. The committee also recommends continuous maintenance dredging at the existing sea mouths, to ensure free flow of drainage in to the sea.

V) OFS/ straight cut near Nizampatnam, Guntur District: - The suggestion is to have a straight cut for East Tungabhadra drain near around Nizampatnam in Guntur District. The functioning of a straight cut of short length is to be established by conducting model studies, as the experience on opening on a short straight cut for Kunavaram Drain in East Godavari District was not encouraging and the mouth opened was getting closed almost immediately.

The committee therefore recommends to getting modal studies for opening the straight cuts done before a decision is taken. The committee also recommends continuous maintenance dredging at the existing sea mouths, to ensure free flow of drainage in to the sea.

vi&ix) OFS/Straight cut near Gollapalem and Sorlapoodi, Krishna District, Opening and Maintenance of OFS near Chinnagollapalem, West Godavari District :-

The suggestion is to have a straight cut for Upputeru (Salt Creek) near around Gollapalem (v) in Krishna District. The functioning of a straight cut of short length is to be established by conducting model studies, as the experience on opening on a short straight cut for Kunavaram Drain in East Godavari District was not encouraging and the mouth opened was getting closed almost immediately.

The committee therefore recommends to get modal studies for opening the straight cuts done before a decision is taken. The committee

also recommends continuous maintenance dredging at the existing sea mouths, to ensure free flow of drainage in to the sea.

vii) Out fall sluice/ Straight cut near Hamsala Deevi, Krishna District: - The committee have inspected the out fall sluice near Hamsala Deevi. The OFS is in a dilapidated condition. This requires to be reconstructed immediately. The committee has dealt with this issue separately in the report. There is an existing course (roughly 3km long) from the sluice up to the salt creek joining the sea. Functioning of the short straight cut is doubtful.

viii) Maintenance of Out fall near Bandar, Krishna District: - Siva Ganga major drain in falls into the salt creek near Bandar. There is no out fall sluice at this location as per the field reports. There is a tidal lock on Bandar Canal. This has to be maintained properly to ensure that the Sea waters do not enter the Bandar canal.

7.3 STAFF PATTERN

The existing staff pattern to maintain the irrigation and drainage system of Krishna Delta is as follows:

Superintending Engineer, Irrigation Circle, Dowlaiswaram						
Godavari Head Works Division, Dowlai-swaram	Godavari Eastern Division, Dowlai-swaram.	Godavari Central Division, Dowlai-swaram.	Y.I. Divn., Pedda-puram.	Special M.I.Divn, Rampa-Chodavaram.	YRPC Divn., Yeleswaram.	Drainage Division, Kakinada.

Superintending Engineer Irrigation Circle, Eluru.			
Irrigation Division, Eluru.	Godavari Western Division, Settipeta, Nidadavole.	Special M.I. Division, K.R. Puram.	Drainage Division, Bhimavaram.

Krishna Delta & Godavari Delta Systems are more than century old. They are being maintained mostly with Staff sanctioned on a permanent basis.

The Committee held discussions with the Superintending Engineers, Executive Engineers and public representatives regarding the staffing pattern required. It was expressed by almost all the officers and public representatives, that the Delta System can be maintained efficiently, if the sanctioned staff strength is fully in place. They have expressed that they are finding it difficult to maintain the system, as many vacancies at the cutting edge i.e., AEE/AE are not filled up. Likewise there is an absolute necessity to employ the workers like Luscars, Maistries as per sanctions. It is recommended that the engineers (provincial) and work charged staff are continued as per sanctions.

7.4 Funding

The funds required for modernization can be from out of the State Budget or obtained through World Bank/Financial Institutions. After the works are executed, continuous maintenance is required to make them function efficiently. The Government may have to pool up huge amounts to meet the expenditure towards maintenance of canals and drains for achieving better productivity and to avoid damages due to submersion. Steps have to be taken by Government to enhance the present water rate of Rs.200/- per acre and also to impose drainage cess at suitable rates as was done previously as the present pattern of release of funds needs change for proper maintenance of the system.

At present letter of credit is stated to be issued to the extent of collection of water rate based on the certificate of Mandal Revenue Officer. Since the collection of water rate is not the responsibility of the irrigation officer, Government may take steps to release LOC without linking it up with the MRO Certificate to avoid hardship in making payments.

7.5 Mode of Execution of modernization works:

The works of modernization have to be taken up and completed in a time bound fashion. As the works involve reconstruction of structures in a big way, at least a time frame of six months would be required. This might warrant particular branch canal/distributory to be closed for a crop season, so that all the works on the distributory including reconstruction of structures is completed in one crop section.

This calls for meticulous planning right from investigation, designs and execution. For this purpose, the works have to be identified and suitably packaged preferably distributory wise and the works are to be let out to the contracting agencies, which have the expertise in the execution of works time bound, using the latest equipment. Suitable incentives for completion of work in time and heavy disincentives for non-completion of work in time and for default have to be provided for in the Agreement.

In view of huge investment required tendering the works on annuity basis could be an option.

7.6 Maintenance of Delta System:

The delta system is a complex system with many irrigation canals, distributaries, field channels and drains crisscrossing each other in the entire deltaic area. The average contour slope is very flat. As the velocities realized in the canals and drains are very low, the water courses are prone to frequent siltation and weed growth calling for constant maintenance to ensure free flow of water.

8. Conclusion and Recommendations

1. All the measures suggested by the dam safety cell for improvements to the head works, have to be implemented.

2. a) To get the barrage gates inspected by a team of Engineers and take necessary action to repair/replace gates as recommended by that team of Engineers. Remote control operation of the gates of spillway is recommended.

   b) Painting the gates of the SAC Barrage with Apoxy paints with an expected life of not less than three years. For the purpose a schedule is to be drawn and strictly adhered to in painting of 1/3rd of the total number of gates of the SAC Barrage so that the budgetary requirements are evenly phased out, while ensuring that every gate gets painted once in three years so that gates are maintained in a rust proof condition.

3. a) Weed removal in canals and drains is recommended twice in a year manually taking the basin as a unit.

   b) Removal of tape grass is recommended by deploying weed cutter. Ploughing of canal bed where tape grass is prevalent may be made in between Khariff and Rabi irrigation seasons, by closing the canals, so that the problem of tape grass is not acutely felt in Rabi Season.

   c) Silt removal at UT crossings before the onset of monsoon is recommended.

4. Flow measurement devices to be established on all important canals at salient points. Measuring flumes to be constructed at the head of all Distributaries and Sub-Distributaries and flows maintained twice a day for monitoring the releases.

5. Observed M.F.Ls to be noted at important structures after the end of each heavy flood.

6. The water supply requirement for Towns, Villages and industries enroute the canals also may be considered while the fixing the carrying capacity of canals.

7. A duty of 70 Acres/Cusec may be adopted for designing the canal system. However, in case of distributaries and pipe outlets a duty of 56 acres/cusec as per the existing practice may be continued. All the canals may be remodeled to carry the required discharge at head after establishing the existing carrying capacity duly getting gauging conducted by APERL. The hydraulic particulars reach wise may be got approved by Chief Engineer, CDO.

8. Lining of all main canals and branch canals in both the Deltas shall be taken up. Further, lining of distributaries shall be taken up after observing the performance in the system.

9. One bank of canal & major drain should be provided with B.T road and other bank should be provided with inspection path to facilitate transport of materials.

10. All the age old structures including locks should be reconstructed, except those constructed recently.

11. All the Banks are to be restored to standards duly allowing the required free board as per I.S. Code.

12. Flood banks and tidal banks along with structures are to be restored to standards.

13. Sewerage and industrial pollutants are to be treated and let into the near by drain/river. The Committee recommends that they shall not be allowed into canals even after treatment. Necessary legislation to be enacted to protect canal waters from being polluted with effluents.

14. All the Major main canals, Distributaries and Minors of the canal system and minor drains of Drainage System passing through the villages and towns shall be taken through R.C.C. Conduits for that portion passing through habitation in a phased manner, if necessary based on budgetary allocations. Alternatively construction of retaining walls revetment in the town limits and beautification of area to help improving the public hygiene may be considered.

15. During lean period, minimum flows have to be let down in to the river to maintain ecological balance.

16. Provision for construction for staff quarters, communication facilities, Computers and Telephone facilities etc., may be made upto the Section Officers level and at all locks on irrigation canals for exercising better control on water regulation.

The works of maintenance at project level can be considered to be given to a contracting agency, on tender basis, distributory wise or drain wise for maintaining them in a fit condition throughout the year, to ensure that the silt and weed is removed fully, to ensure free flow.

The funds required may be kept at the disposal of Superintending Engineer at the beginning of each quarter as per requirements, based on the value of tender.

17. The Kakinada Canal in Godavari Eastern Delta, Godavari-Eluru Canal have to be remodelled to suit the I.W.T. standards, while taking up Modernization Works.

18. To take up dedicated drains for disposal of effluents from industries and to consider levying suitable charges for the operation & maintenance of the dedicated drains from the industries, which are releasing effluents.

19. Diversion of 42,000 cusecs of Kovvada Kalva flood flows into Godavari river and to form flood banks to Kovvada Kalva upstream of Pattisam (V) is recommended.

20. Diversion of flood flows of 9,000 Cusecs of Yerracalva into Tammileru Reservoir by excavating a link channel of about 8.00 Kms long from Racharla (V) limits is recommended.

21. Aqueduct crossing Kummara Calva major drain at Km 49.497 of Amalapuram Canal is to be repaired immediately and replaced subsequently.

22. Side slopes of 1 ½: 1 in cutting and 2:1 in banking and 'n' value of 0.025 for unlined canal section is recommended.

23. The repairs to the SAC Barrage as indicated in the Irrigation Chapter may be taken up on top priority.

24. Under CERP, the drains were improved to dispose off the runoff due to cumulative rain fall of 387.55 mm in three consecutive days (25 year return period) duly allowing 75mm retention at the end of third day. The corresponding coefficient in Ryve's forumula for computing the MFD was fixed at 115 for deltaic catchment and 145 for upland catchment.

During the period from 28-10-2006 to 04-11-2007 (Ogni cyclone period) average cumulative rain fall observed in Krishna Delta is 497 mm (ignoring the heaviest rainfall observed at Gudiwada & Pamarru rain gauge stations). This Rainfall is in excess by 33% over the rain fall considered earlier for design of drains. The Committee recommends to consider an increase of 25 % over the earlier rain fall for design of drains keeping in view the land acquisition.

The coefficient of 'C' in Ryve's formula works out to 145 for deltaic catchment and 180 for upland catchment. This procedure is

recommended for arriving the MFD of Major drains considering the combined catchment in Krishna Delta only except Nallamada. The earlier criteria holds good for medium and minor drains. The revised design criteria may be adopted for Krishna Delta holds good in case of drains of Godavari Delta, as the Krishna and Godavari Deltas being contiguous experience severe cyclone frequently.

25. Side slopes of 1 ½: 1 in case of B.C. Soils and 3:1 in sandy soils and flatter slopes are recommended where excavation by dredging is necessitated.

26.Maintenance dredging at the sea mouths is recommended for proper functioning of drains entering into the Sea.

27.a) One Bank of the drain shall be provided with WBM Road while the other bank with inspection path to facilitate movement of vehicles to carry materials along major drains.

b) Provision for power roller consolidation of banks is recommended.

c) Where the works are not taken up under CERP due to various reasons, they are to be taken up under modernization scheme keeping in view the revised design criteria.

28.a) All low level cause ways may be replaced by high level bridges with adequate vent way with sill levels at or 0.3 M below bed level of the drain.

b) All the structures, where the water way is not adequate or the sill levels are higher than the drain bed levels, may be reconstructed with adequate vent way keeping sill level 0.3 M below the drain bed level.

29.The tidal lockage factor of 9/7 may be increased to 9/6 in case of drains whose MFL is below the mean tide level of Sea. The Additional discharge is to be accommodated only over the berms for better functioning of the drain during lean flows.

30.The capacity of Outfall Sluices in the tidal reach may be taken as twice the MFD of the drain to facilitate quick relief. Special rust proof steel may be used for the shutters, embedded parts and all other equipment required in respect of out fall sluices to be provided in the tidal reach. All outfall sluices on river banks may be provided with shutters to prevent backing up of water.

31.As the drains are prone to siltation and weed growth, it is not advisable to construct cross regulators across drains.

32.a) Excavation of pilot channel in Kolleru Lake is not recommended as it is prone to siltation.

b) Improvements to Perantala Kanuma and Juvvi Kanuma to the required standards is recommended.

c) The capacity of Upputeru is to be improved to carry 20000 Cusecs to provide quick relief to the ayacut facing submersion.

d) Improvements to Yenamadurru Drain below Nandamuru aqueduct to carry 23,000 Cusecs is recommended.

33. Additional Gauging stations are to be installed duly identifying locations on major drains and gauge data to be maintained upto date.

34. The size of the O.T. Sluices may be designed to draw the designed discharge at ¾ FSD condition in the head reach and ½ FSD condition in tail end reaches (Q < 20 % of main canal discharge), keeping the same earlier designed sill level to enable to prevent over drawals in the head reach.

35.Lift Schemes identified for supplementing drain water for irrigation are recommended.

36. Construction of two regulators across Upputeru to prevent entry of salt water in to the lake is being studied by another committee appointed by the Government. This Committee did not deal with this issue.

37. All Bridges on drains having insufficient carrying capacity are to be improved/reconstructed.

Sd/-
B. Rosaiah,
Engineer-in-Chief (Retired),
Chairman.

Sd/-
B.P. Venkateswrlu,
Engineer-in-Chief (Retired),
Member.

Sd/-
P. Sambasiva Rao,
Engineer-in-Chief (Retired),
Member.

Sd/-
J.L. Murthy,
Chief Engineer(Retired),
Member.

Sd/-
A.S. Suryanarayana Murthy,
Chief Engineer(Retired),
Member.

Sd/-
M.K. Rahaman,
Engineer-in-Chief (Irrigation),
Member Convener.