Polavaram Project

Why An Alternative Design For Head Works

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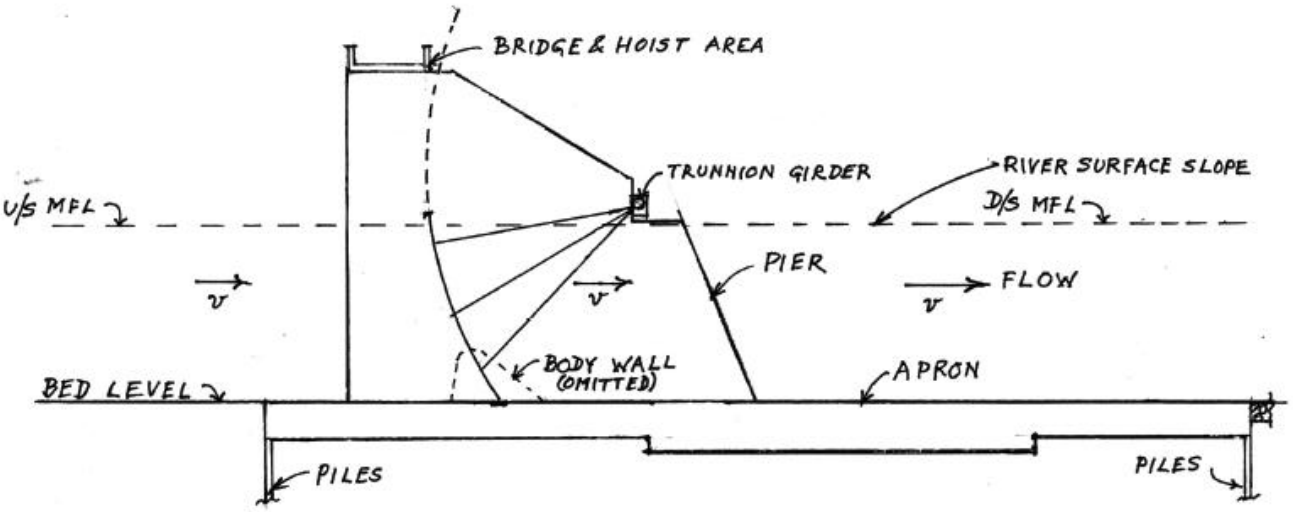
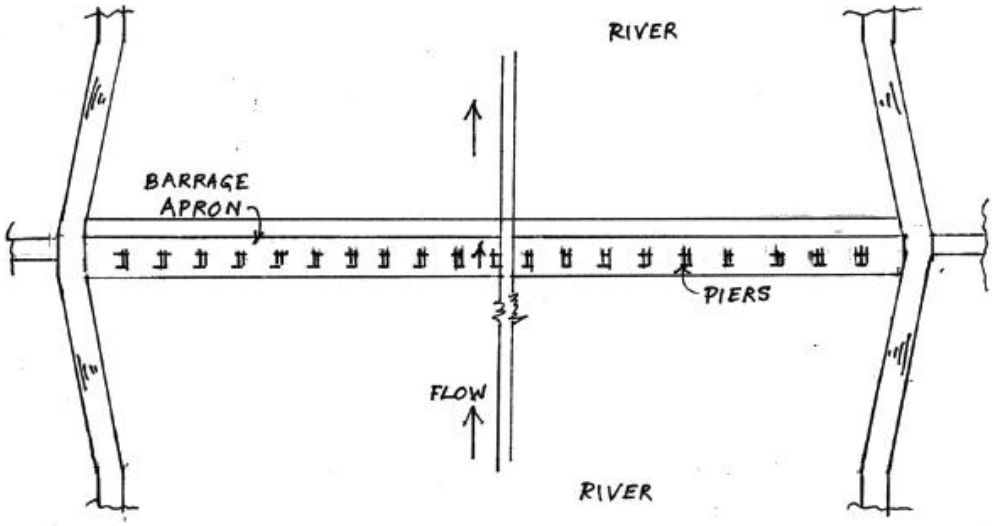


SCHEMATIC CROSS SECTION OF BARRAGE



SCHEMATIC PLAN OF BARRAGE

DESIGN FEATURES :-

1. Body wall is omitted (shown dotted). Radial gates rest on apron.
2. Aprons will be @ Bed Level. All vents of barrage behave like scouring sluices. Vents near flanks also will have aprons @ deep bed level.
3. There is no obstruction to river bed load and other sedimentation transport. Hence there will be no siltation. River 'regime' is not altered.
4. Vent ways of barrage will be equal to river flow cross section area. Where necessary length of barrage can be increased to facilitate this, and smooth transitions provided at sides as well as at bed (near flanks)
5. There will be no 'afflux' as velocity of flow (v) in river and vents will be the same. The river surface profile is not altered. As such there will be no 'Back Water Curve Effect'.

T V Rao 12-5-2010

(T. HANUMANTHA RAO)

Patent Applied

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Secunderabad

POLAVARAM PROJECT - WHY AN ALTERNATIVE DESIGN FOR HEAD WORKS

By Er. T. Hanumantha Rao, Former Engineer -in- Chief, Government of Andhra Pradesh

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Knowledge In Civil Society (KICS)

Knowledge In Civil Society (KICS) provides a platform for activists from diverse sectors in civil society and the academics to engage with the often neglected aspects of science and democracy through a process of dialogues, common exploration and joint work. Started in 2005 as a network to connect, share and discuss science, technology and society (STS) topics, KICS has been registered as a Public Trust in 2010.

KICS seeks to develop and strengthen networks of civil society organizations and enhance their knowledge and capacities in STS through collaborative work. It encourages these networks with other associates from the academic world and the government, in initiating and strengthening work based on knowledge. KICS works in cooperation with other national and international institutions by carrying out research, training, documentation and pilot projects in the areas relevant to its objectives.

Introduction

A small group of sceptic social workers was unimpressed by the idea of Polavaram Dam when it was first mooted decades back, and has been pressing for a serious rethink on it ever since. I have the honour of writing these few words as a member of that group, which was particularly agitated about the tribal population that would be adversely affected by the project in several ways. At that time, the group brought out a report on the basis of a field visit to the would be project area, during which consultations were held with the area's population. That modest report triggered discussions at that time and later on.

Several questions were involved, apart from the most important anxiety about the negative impact of the project on the tribal population: putting the Godavari waters to the best uses - for irrigation, drinking water and power; the dam's capacity to withstand floods ; a fair distribution of the benefits of the dam among the regions of Andhra Pradesh ; and so on.

Obviously, the answers to these have a weighty technical component that needed to be addressed by technical experts. It was in that context our group turned to Er. T. Hanumantha Rao, Retired Engineer-in-Chief of Andhra Pradesh, and an internationally acknowledged expert on irrigation, known to have been studying the Polavaram Project intensely. Two booklets on his ideas have been earlier brought out by Centre for World Solidarity (CWS) and others who banded in this. This latest booklet is an update by Er. Hanumantha Rao, who makes a reasoned case for an alternative to what was originally visualized.

Er. Hanumantha Rao, the quintessential engineers' engineer, shows admirable sensitivity to all other relevant aspects of

irrigation — submergence problems, particularly of tribal habitats and lands ; safeguarding forest wealth and environment ; anxieties of neighbouring states, Orissa and Chhattisgarh ; and intra-regional equity in Andhra Pradesh. The present position regarding Polavaram project is that much investment has gone into the project work and there have been heightened anxieties about maximum flood possibilities on River Godavari. Luckily, since progress is not there at all on the headworks as envisaged in the original project, there seems to be potential for achieving a win-win situation through an alternative design presented by Er. Hanumantha Rao here, in which barrages come in the place of a dam and reservoir.

This alternative deserves notice with immediacy so that its feasibility is not impaired by any rush to push unacceptable earlier ideas. Time is of essence as considerable work needs to be done by way of preparatory studies regarding the alternative which is *prima facie* extremely impressive, on which, we hope fervently, responses would be forthcoming quickly.

The possibility of minimizing risk due to high floods ; opportunity to take on board the neighbouring states by obviating submergence there as also of tribal habitats and lands in Telangana ; navigation potential, exploiting which would open up allround growth prospects in the entire basin area because of cheaper transport; possibility of the revised project gathering implementation pace without being hampered by objections from neighbouring states; and putting investment made so far to good use even in the alternative — all these make the Er. Hanumantha Rao alternative impressive and, immediate consideration to it, imperative. Thus in effect, this alternative design would facilitate construction of the project (wihtout stopping) and at the same time give all the benefits envisaged in the high dam proposal.

Is someone, and everyone, listening?

Acknowledgments , Apologies & Disclaimers
Er. Hanumantha Rao has been at the Polavaram Project idea for years, and is thorough in incorporating, and responding to, newer

facts and ideas as they emerged while coming up with this alternative. We have not been able to keep pace with him, but he has been patient with us.

One thought was that we will get all the alternatives (including this one) to Polavaram as visualized initially assessed, by an independent team of experts. The following three distinguished persons readily agreed to do so through a field visit:

1) Sri Jagdish Mohan, former Chief Engineer (Irrigation), Uttar Pradesh

2) Sri C.P. Sinha, formerly Director, Central Water Commission

3) Prof. M.S. Bhatt, Professor of Environmental Economics, Jamia Millia Islamia, New Delhi.

Unfortunately the idea could not be proceeded with as we were not able to raise the necessary resources for this. Our profound apologies to these experts. We are going ahead with publishing this particular alternative from Er. Hanumantha Rao with the hope that it generates quick public inputs from the above three eminent persons, as also others, and that the government would initiate the preparatory work that would be necessary for the alternative getting ahead.

The publication of this booklet by Er. Hanumantha Rao on this subject has been possible due to the efforts of the following, who have been part of the original group that expressed reservations of a serious nature on the construction of a high dam for Polavaram project, almost a quarter century back:

1) Dr. P. Venkat Rao (founder of Centre for Environment Concerns, now in Australia)

2) Sri R. Murali (of MARI, Warangal)

3) Sri M. Bharath Bhushan, (now Consultant in Rural Development)

Dr. P. Venkat Rao was instrumental in organizing a recent national conference, with participation of civil society representatives from Orissa and Chhattisgarh, on the alternatives to the Polavaram project ; this has kept discussion on the matter going. Sri Bharath Bhushan should be credited with having done all that was necessary to ensure that the booklet was readied in print expeditiously.

Centre for World Solidarity (CWS) continues to show their interest on Polavaram. The new group, Knowledge In Civil Society (KICS), made an initial modest grant for this publication, to which Sri Murali's group added a more substantial amount.

The views in the booklet on Polavaram are those of Er. T. Hanumantha Rao, who is the author and the leader of a discourse that he did not allow to be forgotten.

July 2012

M.V. SASTRI
Honorary Convenor, CWS
and Trustee KICS

Polavaram Project
Why An Alternative Design For Head Works

Er. T. Hanumantha Rao

Section I : Summary and Rationale for Alternative Design

1.1. Need for the alternative design for Head Works

On 19th December, 2007, NEAA, National Environmental Appellate Authority (now National Green Tribunal) had quashed the Environmental clearance given for Polavaram dam by the Ministry of Environment and Forests (MOEF) in 2005. The main reason for this quashing is due to "not conducting public hearings in the affected areas of Orissa and Chhattisgarh states" which is in "violation of natural justice". The governments of Orissa and Chhattisgarh also had opposed the project vehemently from the very beginning (2004) and had gone on appeal to the Supreme Court to stop the project as it submerges lands in their states. An important major project in Andhra Pradesh, which benefits the Coastal Andhra with irrigation of 7.2 lakh acres and Hydro Power of 960 M.W., additional usage of 45 Thousand Million Cubic feet of Krishna water, in Telangana and Rayalaseema, 23 TMC industrial & drinking water to Visakhapatnam area, 80 TMC to Krishna Delta and second crop water to Godavari Delta, had to be stopped due to quashing by the Appellate Authority.

There was no possibility for conducting Grama Sabhas and public hearings for obtaining the consent of the villagers in the submergible areas of Orissa and Chhattisgarh since this will have

to be conducted by these two governments and they are vehemently opposing the project. Even for constructing protection dykes (costing about Rs. 700 Crores) the consent of villagers through Grama Sabhas will have to be obtained.

A "Catch-20" situation developed in 2007 : unless Public Hearings are conducted environmental clearance cannot be given ; the two governments were opposing the project and hence Public Hearings cannot be conducted. The Orissa government has stalled the Vamsadhara Stage II and Jhanjhavathi projects for the past 25 years for the reason that these projects will submerge villages (which are even much smaller in number than under Polavaram dam). In the light of this experience, it would be reckless on anybody's part to try to go ahead with Polavaram dam and spend thousands of Crores of rupees without the consent of the two upstream states. The Andhra Pradesh government had already spent hundreds of Crores of rupees on the two stalled projects which are lying waste, as full benefits of the same could not be obtained so far. When clearance from Orissa government for these projects is so difficult, one cannot be so sure of Polavaram project clearances from the two state governments concerned.

In order to continue the Polavaram project, a need was felt then to explore a technical solution for the Head Works (Dam) of the project which would not submerge villages in the upper two states and at the same time give all the benefits of the project as briefly stated above (without any reduction). Fortunately such a solution was found possible as explored by the author, and this solution was published in the media (January 2008) and later passed on to A.P. State Government. This design is only an alternative to the Head Works (Dam) which is not yet started and there would be no changes in the design of canals now under construction. Instead of storing the required live storage in one big dam, it would be stored at three places through low barrages. Details of the same are covered in the paras of the Section II that follows.

1.2. Present situation

Andhra Pradesh government is now continuing with the construction of the project canals (started in 2005), after obtaining stay orders from the Andhra Pradesh High Court on the quashing orders issued by the Appellate Authority (NEAA). Tendering process is now going on for the construction of the Head Works (Dam and Component works). The State Government had rejected the alternative design for the dam on the grounds that it is not technically feasible and higher cost averments; these were proved wrong, partly by their own submissions later on in the meeting of some M.Ps. with the Chief Minister on 24th June, 2010. The case for the alternative design was also strongly substantiated by the author subsequently (noted in the following paras). Initially the State Government said that the alternative proposal would cost Rs. 19.108.53 Crores (costlier than the Dam proposal), submerge 345 villages (more than 276 under the Dam), store only less than 21 TMC (as against 75 TMC under the Dam). But later on in the Chief Minister's Conference on 24th June, 2010, it was conceded by the government that the alternative proposal would cost only Rs. 12,106. 71 Crores (as against the earlier argued Rs. 19,108.53 Crores), submerge only 130 villages (earlier 345 villages) and store 59.017 T.M.C. (as against the earlier less than 21 TMC). With a better appreciation of the author's concept, the figures are working out nearer to what was suggested in the alternative proposal. It is felt that with such better appreciation of the alternative design concept and improved investigation on field and design, under the guidance of the author, it would certainly lead to the figures given in the alternative proposal. Even for argument's sake, if this alternative design is not feasible, it would be better for the government to accept the concept in principle and explore ways and means to make it feasible, instead of rejecting it altogether. Such an attempt would be in the interests of all the beneficiaries and facilitate early completion of the project instead of being abandoned or stopped midway or endlessly delayed like the Vamsadhara Stage II and Jhanjhavathi projects. This would lead to a situation of considering the alternative design as a boon to the people, who are now facing the risk of the project being abandoned after the incurring of an expenditure more than Rs.

4,000 Crores on canals and other works. This is because several issues on this project are now pending judgments in the Supreme Court and Andhra Pradesh High Court and nobody can predict what the judgments would be, especially in the light of quashing orders of the environmental clearance given by the "Appellate Authority" (now National Green Tribunal).

It is a pity that an alternative design intended to help quickly complete the project without any hindrances emanating from the two upstream states and the Court cases, and to give immediate benefits to coastal Andhra Pradesh, is considered as anti-project due to perhaps a lack of appreciation of technical details of this alternative. The purpose of the present effort is to focus on perspectives of this alternative design for the benefit of the public.

Other important issues to be considered in the present context are the problems associated with submersion of villages and displacement of people if the dam is constructed. It would submerge 276 villages in Andhra Pradesh and about 30 villages in the two upstream states, with a live storage of only 75 TMC. As a comparison, the Nagarjuna Sagar Dam submerged only 52 villages whereas its live storage is 302 TMC (above sea level of sluice). Thus the Polavaram dam submerges nearly six times more number of villages than the Nagarjuna Sagar dam with only one fourth of its live storage, whereas the alternative to Polavaram dam (being proposed here), which submerges about 70 villages would be more attractive than the earlier 'dam' proposal. Another important aspect is with regard to displacement of nearly two lakh people (mostly tribals) if dam has to be constructed.

Such a proposal could have been implemented some fifty years back (e.g. Nagarjuna Sagar dam) when several Acts (e.g. Forest Conservation Act, Wildlife Protection Act, Tribal Consent Act, Forest Rights Act, etc.) were not there. At present, even when the displacement is limited to only a few thousand persons, several mining projects, Thermal power plants etc. are facing major hurdles and some proposals are even being abandoned. It is in this background one has to view, whether it is possible to displace

a few lakhs of persons now. Thus any alternative proposal which envisages displacement of much lesser number of persons should be welcome. This is the first main advantage of the alternative design.

The other additional advantages of this design are listed below and are elaborated in Section II. The alternative design provides for:

1) Navigation of sea going vessels (as in St. Lawrence River in U.S.) is possible and the same is not possible in the "Dam" design, which has the navigation path through a small Tunnel.

2) Apart from saving 1 lakh acres of agricultural lands belonging to tribals from submersion (that will be caused in the dam proposal), they can be given irrigational facilities through gravity flow canals taking off from the barrages proposed in the alternative design. This will benefit the Telangana backward tribal areas immensely.

3) Even if any flood exceeding the designed PMF (Possible Maximum Flood) of 50 lakh Cusecs) occurs due to any future climate changes, such a flood can safely pass through the low barrages proposed in the alternative design, as an unobstructed flow. In the case of a dam, it would result in a breach causing surge flows (Tsunami like) of stored reservoir water. If such an event occurs during nights, 50 lakh people living on the downstream side will have a watery grave before they rise up in the morning, according to "Dam Break Analysis" conducted by the National Institute of Hydrology and other studies. Even in the case of a breach of the low barrage (proposed now), there will be no such surge flows, as the barrage does not store any water above the incoming flood flow level. Such natural peak flood flows would occur gradually over a period of days (and not suddenly like in a dam break) and people will have time to vacate and go to higher grounds earmarked for them.

4) The alternative design can be executed in less than half the time required for the high dam at a much lesser cost (about Rs. 6000 Crores cheaper).

5) It is easier to get all the clearances required from the Ministries of Government of India for the alternative design, as the submersions are less than one fourth of dam design. Simultaneously all the pending cases in the High Court and Supreme Court would automatically get cleared as there would be no submersions in the two upstream states.

6) There is no need to abandon the three major lift irrigation projects now under completion (constructed at huge costs) as provided in the dam design, thus saving public money.

7) This alternative design saves 206 villages (276- 70) in Telangana area from submersion, apart from not causing any submersion in Orissa and Chhattisgarh states, which aspect is presently stalling the construction of the project.

8) Industrial development and economic growth in the Godavari basin (mostly in Telangana), is possible through navigation of sea going ships, which is possible only in this alternative design (and not possible in the earlier high dam design).

SECTION II : Details Of Alternative Design For Dam

Brief details of the alternative design are given below. A more detailed technical review of the author is also available and will have to be referred to.

2.1 Alternative Design Proposals

In the alternative design of the head works, all the benefits of the earlier proposal are fully retained without any reduction. They relate to diversion of 80 TMC water to Krishna Basin, irrigation facilities to Polavaram Ayacut (7.2 lakh acres) first and second crops under Godavari and Krishna Deltas, Industrial & Drinking Water Supply to Visakhapatnam area (23 TMC), Hydro Power Generation (960 MW), etc.

The required live storage of 75 TMC, instead of being stored at one place at Polavaram High Dam, would be stored at three places (downstream of Bhadrachalam across Godavari, Sabari and at Polavaram) shown as (A), (B) and (C) in the map enclosed through low barrages, similar to the one existing at Dowleshwaram, with water levels not exceeding the Maximum Flood Levels (MFL) which are much lower than the full reservoir Levels of the dam proposed. Due to this, more than 230 tribal villages (with about 2 lakh population) would be saved from submersion (which would be resulting in the earlier 'Dam' proposal). Also there would be no submersion at all of any villages in Chhattisgarh and Orissa States, and hence their earlier objection to the project would get automatically cleared.

Since the bottom level of barrage gates would be at average deep river bed level, all the gates would function as scour vents and hence there would be no siltation on the upstream side of the barrages.

About 1 lakh acres belonging to Girijan farmers, which would be submerged under the old proposals, can be given irrigation facilities, (without affecting the Polavaram Project), through gravity flow canals taking off from the two upstream barrages of the alternative proposal.

In the alternative proposal, there is a facility for sea going vessels to navigate from Bay of Bengal to Sriramsagar Dam (700 Km), which would in turn lead to commercial and industrial development, giving employment to the rural poor, all the year round, similar to St. Lawrence Sea Way (America) constructed in the mid 20th century. There is no such facility in the earlier proposal, as the navigation canal will have to go through a tunnel about 1 km long. Maps showing navigation of sea going vessels in Mississippi and Tennessee rivers are appended.

The alternative proposal can be constructed at a lower cost (about Rs. 6,500 Crores cheaper) than the high dam, and can be completed in lesser time than the Dam.

Another very important concern is of dam safety. Even if the earlier proposed high earth – cum – rock filled dam is to be constructed to withstand the Possible Maximum Flood (PMF) of 50 Lakh Cusecs, "there is every possibility for this to breach, called "Dam Break" as explained in the subsequent paras. Earthen dams are breaching all over the world and also in India. It is therefore not a rare phenomenon. In Andhra Pradesh there were several cases of breaches of earthen dams. For example the Kadem earthen dam (Adilabad District) had breached, whereas the adjacent cement based dam was intact. It has to be therefore considered as a catastrophe in waiting. Also the track record of quality of construction of earthen dams under the Jalayagnam programme of Andhra Pradesh is not bright. Both the earthen dams started and completed during Jalayagnam had breached, causing immense damages downstream. One earthen dam (Gundlavagu) breached before the water level reached the Full Reservoir Level (FRL). Another earthen dam (Palemvagu) breached twice after receiving floods.

In the alternative design, there is no dam, and the issue of dam break does not arise. The low barrage will be with a vent way slightly more than the river cross section area. As such the regime of the river is not affected. This means that the river flows down the barrage, without any obstruction irrespective of the extent of

the flood and there will be no 'afflux' (i.e. level difference between upstream and downstream of the barrage).

Government of Andhra Pradesh is contending that there will not be any submersions of villages in the two upstream states as these villages would be protected by constructing dykes and thus there is no need to conduct Gram Sabhas in these villages and elicit public opinion. The upstream states are not accepting this arrangement and are objecting for the construction of 43 kms length of dykes within their state boundaries. Environmental Impact Assessment (EIA), approval of Gram Sabhas, clearance of pollution control boards in their states and other formalities for the construction of these dykes costing about Rs 700 Crores are still required and hence have to be complied with. There is no hope of completing these tasks by conducting Gram Sabha meetings and obtaining environmental Stage II clearances, as these states are not agreeing to the proposal of constructing dykes. They contend that these dykes cannot prevent submersions, especially where local storm rainfall – run off cannot be fully drained when the river is in high floods. They also quote examples of how these dykes had failed in Andhra Pradesh, elsewhere in India and all over the world to prove their point. In this context, it is relevant to note that the National Environmental Appellate Authority (NEAA) in December 2007 had struck down the Environmental clearance (stage 1) given by the DOEF (Department of Environment and Forests). Also emergency Action Plan as per the guidelines issued in 2006, disaster management plans, inundation maps (dam break) are not yet prepared for clearance.

The State Government had worked out details and estimates without a full appreciation of the concept of the alternative design, and this resulted in erroneous figures. The manner, how these figures were wrong and the details of the correct figures which give rise to the above said major advantages are explained below:

2.2 Comparison with old proposals

The following picture would emerge from the concept of the alternative proposal:

- Cost of the alternative proposal works out to Rs. 7,143 Crores and this is cheaper than the old proposal by Rs. 6,000 Crores, if realistic costs are considered for the old proposal. This old proposal would cost more due to cost of construction of dykes 43 Km. long in each of the two neighbouring states, installing gates and pump sets within the dykes, cost of NPV of forests, connectivity works, realistic R & R costs for greater submersion of villages, revised IBM value for works etc. The State Government initially estimated the cost of alternative proposal as Rs. 19,108.53 Crores and later modified it to 12,106.71 Crores and, during the meeting of some MPs with the Chief Minister on 24-06-2010, it was mentioned (as reported in the press) that both the proposals cost the same. Thus it can be seen that as the concept is being understood gradually, the correct picture of the alternative proposal is emerging. This is also reflected in the other details noted below.

- The alternative concept contemplates a live storage of 79 TMC i.e. not less than the 75 TMC live storage, provided in the old proposal. All the benefits of the project contemplated originally using 75 TMC live storage are possible through the alternative proposals also. These relate to irrigating 7,20,000 acres ayacut and not 2.5 Lakh acres as stated by State Government, supply to Godavari delta, diversion of 80 TMC to Krishna delta, supply of 23 TMC water for drinking and industrial purposes. All these benefits are possible because the total live storages being provided at three places in the alternative proposal is not less than the 75 TMC of the old proposal. Though 2.5 Lakh acres was mentioned in the alternative proposal as the remaining area to be irrigated, actually the entire area of 7.2 Lakhs acres can be irrigated if it is so desired, since there is no reduction in the useful storage. The State Government has initially stated that the live storage under the three barrages would be very

low and later during the meeting of some MPs with the Chief Minister of Andhra Pradesh on 24-06-2010, it was stated that this storage would be 59.017 TMC. As the understanding of the concept is getting improved, a better picture of the alternative was emerging out. Actually field surveys will have to be done, and investigated, such that optimum locations for the barrages and their water levels are determined, so as to reduce village submergence and at the same time get the required storage. It is then likely to get the required 75 TMC live storage, as against the 59.017 TMC worked out by the State Government. In such a case, all the benefits of the old proposal can be achieved through the alternative barrages, without any reduction whatsoever. An innovative design showing the schematic drawing of the silt free barrage is enclosed.

- **Submersion of Villages**: The report of the State Government on the Alternative proposal indicated initially that 345 villages would be submerged. This was later modified and drastically reduced to 130 villages, as informed to the MPs in the Chief Minister's meeting on 24-06-2010. This was possible with a better understanding of the concept of the alternative proposal. It would further get reduced to 70 villages when properly investigated as mentioned above.

- **Hydro-Power Generation**: During the MPs meeting with the Chief Minister on 24-06-2010, it was mentioned by the State Government that the hydro power generation for the alternative proposal would be hardly 172 MW. When an upstream barrage on Godavari at Dummugudem (presently under construction) can produce 340 MW of hydro power, the proposed three barrages would be able to produce not less than 960 MW of power, if operated optimally as indicated in the Author's detailed alternative proposals and as per the calculations attached to it.

- Andhra Pradesh Government had agreed to spend Rs. 600 Crores for constructing dykes to prevent submersion. Due

to this, it was felt that the objections from the two upstream states were cleared. This is not correct, as explained in Para 2.1 above.

- Since the alternative proposal is costing less than the old proposal and the benefits are the same as the earlier proposal, the benefit cost analysis would work out favourably for the alternative proposal. Actually the benefits of alternative proposal are many more than the old proposal as explained in paras 1.2 and 2.1 above.

- There will be no difficulty in adopting the alternative design for the head works of the project, since there is hardly any progress on the construction of the dam, from 2005 till 2012. The canals already under construction can be utilized, with a lift of about 11 m. from the proposed Polavaram low barrage pond, using about 54 MW of hydropower out of 1038 MW power generated. All these are given in the author's detailed report. For a comparison, this lift of 11m. is insignificant when compared to the lift of about 300 m, in the case of the Godavari, Devadula major project (located on the upstream of Bhadrachalam), intended to irrigate nearly the same extent as that of Polavaram. Since the canals were already excavated, at higher levels, this lift of 11 m is found necessary. If this was not done, it would have been possible to construct gravity flow canals taking off from the low barrage (without any lift whatsoever).

- Other very important issues are related to the two major lift irrigation projects (Pushkara & Thatipudi) and another major gravity flow irrigation project Yeleru ayacut which are all contemplated to be tagged on to the Polavaram Project as per the old proposal. These are discussed in great detail under Para 2.5 below. It was conclusively proved that there is no need to abandon these two major lift irrigation projects recently completed, and tag on their ayacut of 3,75,166 acres to the Polavaram Project command, as it would involve in wastage of hundreds of Crores of Rupees of tax payers

money recently spent on civil works of the Lift Irrigation projects (such as intake, suction wells, approaches, pump houses, pumping mains including structures on them, other immovable structures, cisterns, etc.). It would be necessary to reexamine this proposal of the State Government, since the same ayacut served by recently completed major projects, should not be proposed to be served by another major project, yet to be started. Also since this would involve wastage of tax payer's money, there would be a need for the Ministry of Finance and the Planning Commission to have a second look and review the situation. However, for purposes of comparison of the alternative proposal, storage as well as ayacut of 7.2 Lakh acres as envisaged in the old proposal were kept intact without any reduction.

2.3 The following two main issues will have to be addressed and solved, first before undertaking any discussions on technical alternative suggested. Any such technical discussion would only be futile, since the alternative is suggested only to solve the problems faced and not as an end in itself. Again this alternative should be considered as a solution to the existing problems noted below and not a problem by itself. The need for this alternative design will be further reinforced when the following two issues are considered.

Issue 1: Peak flood flows and stability of earthen dam

An earth-cum-rock-fill dam (commonly called earthen dam) is proposed to be built at Polavaram, which is located almost at the end of the river, where the peak discharge of the river occurs. The maximum ever observed discharge at this place in Godavari is 24% more than the corresponding one of river Ganga, though Godavari catchment area is about one third and annual yield is about one fifth of that of Ganga (vide CWC journal *Bhagirath* January – March 2001). Other major rivers in the world which have lesser peak flood discharges than Godavari are Yangtze (biggest river in China), Mekong (biggest in South East Asia), Mississippi (biggest in US), and Volga (Russia). They do not have

earthen dams at locations where such high flood flow conditions occur. Nile, the longest river in the world, has an earthen dam, at almost at the end of the river, but the peak flood of this river at this place is less than one sixth of that of the Godavari. Though the proposed earthen dam at Polavaram may be the first of its kind in the world, viewed according to peak flood flow parameters, it does not mean that we should not construct an earthen dam at this place. We can still do it, because we have a proven technology for the same. But this confidence was shattered due to the occurrence of two major events since 2005. Firstly, two earthen dams of about the height of Polavaram dam, which were started and completed as a part of the State Government's "Jalayagnam" have breached (Gundlavagu dam once and Palemvagu twice), well before the receipt of the maximum flood, even though they were designed properly and quality control measures were followed during construction. This has shaken the confidence on earth dams, under Jalayagnam Programme. Secondly, another shock of an extraordinary flood which occurred in the river Krishna (an adjacent catchment) during October 2009 had indicated a disturbing trend.. This flood was estimated as 2.7 times more than any ever occurred during the past 100 years. If a similar flood in river Godavari occurs, at any time in the future, it would be of the magnitude of about 90 lakh cusecs. The possibility of this cannot be ruled out as we had practically witnessed such an event only a few years ago in a contiguous catchment. In this connection, it would be relevant to study the effects of global warming on the future rainfall patterns. Several international organizations, such as the United Nations, Intergovernmental Panel on Climate Change (IPCC), Princeton University, Global Water Policy Project (GWPP) etc., have done research on "Climate Models" and concluded, among several other things, that the Krishna and Godavari Basins in India would witness an increase in rainfall up to 50% more, from 2000 to 2050 (National Geographic, April 2009). Climatologists feel that the recent phenomenal increase in Krishna floods is perhaps an indication of this.

The Possible Maximum Flood (PMF) was revised by the Central Water Commission and determined as 50 lakh cusecs, a few years

back. Even though the dam spillway is now designed for this huge discharge, it still falls short of the above extraordinary flood of 90 lakh cusecs. In such an event the breach (dam break) of the earthen dam is very much real and not hypothetical. The free board of about 7.5 m above the FRL intended in the design of earth dam is just sufficient for the wave height and run up for the designed PMF. When an inflow above 50 lakh cusecs occurs, water levels would rise to facilitate discharge over the spillway and at 90 lakh cusecs, the wave will flow well above the top of dam, resulting in erosion of earth cum rock fill dam and would eventually breach the dam. If past occurrences of breaching of earthen dams in Andhra Pradesh and the world are any guide, the breach can occur suddenly without any warning even without receiving the PMF. Breaches in earth dams have occurred previously all over the world within a few hours of appearance (e.g. Teton Earthen Dam, USA). With regard to experience in the case of masonry/concrete dams, they are relatively free from such risk, since even when water overflowed over them, structures did not breach. In the case of Polavaram dam, it is not possible to build a masonry/concrete dam due to lack of rocky strata at any reasonable depth in the foundations. As such the proposed dam can only be earth-cum-rock fill dam (commonly called as earth dam).

Studies revealed that in the event of a dam break of Polavaram dam occurring in a night at about 10 P.M, 46 lakh people living in the delta, would have a watery grave before they get up in the morning. It is this real threat that frightens anybody and the need for seeking an alternative technical proposal (that would give the same benefits as the dam) would then arise. This is all the more necessary, since the proposed dam is located very close to a huge habitat area, where the density of population is the highest in the state. The technical alternative is a step in this direction and the technical details will have to be formulated/ improved, so as to make it possible, or else another alternative solution will have to be worked out to solve the issues. Since the progress on the head works is almost nil during the past 7 years, this alternative is possible. To proceed on the construction of the dam on the basis that there is no risk, would amount to gambling with the lives of 46 lakh people, and the planners would be well advised to consider

whether it is worth taking such a risk when there is a scope for exploring alternative solutions.

When there is no dam and a flood of about 90 lakh cusecs occurs, it would be gradual and it would increase over a few days. In such a situation, people would have time to vacate their habitats as per the advance flood warnings, and move to the assigned safe places. Whereas in the case of a dam break, when it occurs without any early warnings, like Teton Dam, a Tsunami like flood wave would occur suddenly, giving no scope for the people to vacate. This is the main difference between a natural calamity and a man made one. All the above details as known to the author are being furnished as a part of professional responsibility and not to create fear or panic in the minds of the public. If the government and public want the earthen dam, it would be according to their wisdom and choice, and there is no compulsion to choose any alternative design. In this connection it would be apt to recollect the words of caution of ICOLD (International Conference on Large Dams, Director of Dams, Pennsylvania and others that the worst large scale human destruction can be caused by man made activities, firstly through atomic plants and secondly through the major dams. It would also be relevant to note the Murphy's Law (followed by NASA, USA), namely that "if there is a possibility for a failure to occur, it would certainly occur sometime or the other". Thus, if there is an alternative to a major earthen dam, it can be preferred if so desired by the public and the government.

2nd Issue: Submersions in Orissa and Chhattisgarh States

The Polavaram dam would submerge 23 villages in Chhattisgarh and Orissa States (13 + 10) as stated by Andhra Pradesh and more than 35 villages as contended by the two upstream states. These two upstream State Governments were objecting during the past eight years, to the various clearances given by the Government of India, and being unsuccessful, they had taken up the issues with the High Court of Orissa and the Supreme Court. Among their several other objections, their main contention is that the

conditions prevailing at the time of issue of the Bachawat award in 1980, have since changed , and due to this, the award is not valid, and hence will have to be reopened and that the award itself made a provision for such reopening of the issues whenever conditions change. According to these states, the condition of 36 lakh cusecs flood (on which the award is based) is changed to 50 lakh cusecs flood and that due to this, more than 35 villages (as against 23 earlier) would get submerged and that they are not agreeable to the Polavaram dam on account of this. These issues are now pending with the Supreme Court and these states have requested for a stay on the construction of Polavaram dam. In this connection, it would be of interest to note how the Orissa government had stalled the construction of Vamsadhara Stage – II project and Jhanjhavathi project of Andhra Pradesh on the plea of submersion of a few villages, in that state. The expenditure incurred by Andhra Pradesh Government about 25 years back, is a dead investment all these years as the full benefits of these projects could not be realized. In the case of the Jhanjhavathi Project, no storage at dam site could be made in the absence of dam in the river portion. The maximum that was possible was to construct a temporary collapsible rubber dam and divert the river flows and irrigate a few thousand acres. The sad thing about all this is that nobody knows when these two irrigation projects can be completed, if at all they can be. If this experience is any guide, the Andhra Pradesh Government would be well advised not to proceed further with the Polavaram dam without obtaining the consent of Chhattisgarh and Orissa states. 25 years back, the wastage was in tens and hundred Crores of rupees, and if Polavaram dam is stalled, the wastage would then run into thousands of Crores of rupees, as already over Rs. 4,200 Crores, was spent on this project. Unless the long incomplete Vamsadhara Stage II and Jhanjhavathi projects are restarted now and completed, one would not be able to appreciate how difficult it would be to complete the Polavaram dam. Planners will have to note this since huge amounts of tax payers money is involved in such capital expenditures. The technical alternative proposed is exactly intended to address these serious problems and solve them. ***In this alternative proposal, there will not be any***

submersion of even a single village in Chhattisgarh and Orissa states. There will also be additional benefits of this alternative proposal as stated in para 1.2 and in the subsequent paras. All the benefits of the earlier proposal will be fully realized without any reduction in any aspect.

From the above discussion, it can be seen that the technical alternative proposed is only intended to solve the above two main issues arising now, and also to ensure that the full benefits of the earlier proposal are achieved and the progress on the project speeded up so as to derive the benefits early and simultaneously ensure the safety of lives of millions of people living in Godavari Delta. In fact the State Government will have to work out such solutions on their own, in the interest of common good, and therefore will have to treat this alternative proposal as a helping hand in this direction.

2.4 **Irrigational facilities in Tribal Areas**: In this alternative proposal about 75% of the submergible agricultural area (nearly 1 lakh acres) of the old dam proposal will not only be saved from submersion, but also can be provided with irrigation through the proposed two barrages on the upstream side of Polavaram. This is a great advantage to the backward tribal area farmers, who face a threat of submersion as per the earlier high dam proposal. Water from these two barrages can be taken by gravity flow canals to irrigate the agricultural lands lying between the contours 46.00 m and 30.48 m. Kharif season crops can be irrigated in this area using the flood flows of river Godavari going to the sea in the rainy season. This will not adversely affect the supply of the required water to Polavaram project. Exact area to be irrigated, will have to be worked out after ground surveys during the DPR stage. Thus the alternative proposal would also benefit most of the submersion area of the old Polavaram proposal, while giving benefit to the coastal area.

2.5 Polavaram Ayacut: 75 TMC storage is essential for the purpose of irrigating 7.20 Lakh acres under Polavaram Project and 10.20 Lakh Acres under Godavari delta (Kharif and Rabi seasons) etc.

In the alternative proposals also, provision for this 75 TMC is made and there is no reduction in this. Hence this full ayacut of 7.20 lakh acres and 10.20 lakh acres can be served completely under the alternative design also. However for cost of pumping equipment and pumping charges, realistic ayacut (2.5 lakh acres) under Polavaram Project and all other demands (e.g., Krishna, Industrial, Godavari Delta etc.,) are retained without any reduction. The manner how the real new ayacut under Polavaram would be only 2.5 lakh acres and not 7.2 lakh acres will be evident from the following discussion. However for comparison, it may be stated that the alternative design provides for irrigating 7.2 lakh acres without any reduction.

There is no need to delink Yeleru ayacut of 67,600 Acres from Yeleru project and supply water to this area, from Polavaram canals, in order to utilize this extent of water for the future new ayacut of Yeleru project lying above the Polavaram geographical command. The existing system of Yeleru ayacut in Polavaram geographical command (67,600 Acres) can continue under Yeleru project, and water can be supplied to Yeleru ayacut lying above Polavaram Command by pumping water from Polavaram canals and the scheme can be designed accordingly. Polavaram left canal has adequate capacity for supplying the required additional discharge.

An ayacut of 2,77,234 Acres is shown as distributed in Visakhapatnam district (1,48,202 Acres), Krishna District (61,901 Acres) and West Godavari District (67,131 Acres). This will have to be analyzed with regard to what extent of area is already under irrigation through public lift irrigation schemes, tanks etc., where government funds were already spent. A Study has indicated that the area without any irrigation facility and where crops are raised under rainfed conditions would be less than 1.8 Lakh acres and that this much area only would need irrigation under Polavaram project. Considering that private lift irrigation systems (e.g. tube well, dug well etc.) will have to be supplied water from Polavaram project and that M.I. tanks ayacut in the command has to be deleted, this ayacut would get reduced from 2,77,234 acres to about

2.5 lakh acres. It may be noted that ayacut under M.I. Tanks was deleted from the project Commands in the cases of Nagarjuna Sagar and SRSP. The same procedure can be followed for Polavaram Project also.

With regard to the existing lift irrigation projects covering an ayacut of 3,75,166 Acres, it is mentioned by government that the "life of some of the existing L.I. Schemes is already over and the life of other schemes will be over by the time Polavaram Project is completed". It is also stated that "since they will have to be anyway abandoned, there is a need to supply this ayacut of 3,75,166 Acres under Polavaram project." Pushkara, Chagalnadu and Thatipudi L-1 Schemes comprising of 3,23,126 acres do not come under this category to be abandoned since they were also taken up for construction along with the Polavaram project at almost the same time or slightly earlier. In fact these schemes are still under construction, partly completed and about to be completed. With regard to the other four L.I. Schemes comprising of 52,040 Acres, there is no need to abandon them for the reason that their life is over and then supply water from Polavaram Project. Their life time can be extended by repairs and renewals wherever needed. Many of the present major lift irrigation projects under Jalayagnam are lift schemes and they cannot be abandoned after a life time of the pumping equipment of, say, 10 years. By appropriate renewals, whenever needed their life time can be extended and brought on par with other major gravity flow projects. The cost of renewals done later on will have to be included in the maintenance cost and would not form part of capital cost.

From the above discussion, it can be inferred that the Polavaram Project will have to Supply water to an ayacut not exceeding 2.5 Lakh Acres. With regard to Uttarandhra Sujala Sravanthi, Rudramkota irrigation and other lift irrigation projects from Polavaram Canals, the cost of pumping equipment and pumping charges for lifting Godavari water will have to be borne under the respective schemes, as they cannot be a charge on the Polavaram Project. They are not existing schemes and they would take shape only after Polavaram Project is constructed. They have

to be designed on the basis of the then available conditions in Polavaram project. Also this lift from Godavari river would be relatively minor when compared to the big lifts required to pump Polavaram water to much higher areas under these schemes. Hence these costs of new lift irrigation projects will have to be deleted for purposes of comparison. There is no need to abandon the existing L.I. Projects as discussed above. Such an action would result in wastage of public funds, since the civil works (such as pump houses, structures along pumping mains, immovable structures, cisterns etc) executed at a high cost would all go waste.

The alternate proposal gives an added advantage to the existing Krishna and Godavari deltas since the saved water from Polavaram Rabi demands (due to reduction in ayacut), can be diverted to these deltas to irrigate more areas, during the Rabi season. However for comparison purposes, it is once again reiterated that the alternative design can provide irrigation for 7.2 lakh acres as envisaged in the original proposal since there is no reduction in the live storage of 75 TMC. Also it is possible to provide water for second crop in Godavari and Krishna Deltas as envisaged in the dam design without any reduction.

2.6 Conclusion: The above technical alternative design for the Head works of the Polavaram Project are mainly intended for quickly completing the project without objections from the upstream states of Orissa and Chhattisgarh on account of submersion of villages in their states. This alternative design is technically feasible and the concept given when fully understood would lead to preparing a Detailed Project Report (DPR), after a detailed field survey and investigation. As the understanding of the concept improved, the cost of alternative proposal got reduced to less than half that thought earlier by the Government. Also the number of villages that would submerge as per the alternative proposal got reduced to 1/3rd, with a better understanding of the concept by the State Government. Similarly, the innovations made with regard to providing the spill way gates for the entire length of the barrage as scour vents, when grasped fully would lead to understanding that there would be no siltation due to the barrage.

Since the regime of the river is not affected and full cross section of the area of the PMF (Possible Maximum Flood) is provided as vent way, the river continues to flow as if there is no obstruction, whatever may be the magnitude of the flood. During the non-peak flood flow days (for example : one or two lakh cusecs flow) barrage gates would be opened partially to allow this flow downstream, while maintaining the water level in the pond, at near FRL of 100 feet. This is to facilitate maintaining a hydraulic head (difference of water levels on upstream and downstream) for generation of hydro power. In addition to saving about 236 tribal villages from submersion, the alternative proposal envisages about irrigating 1 lakh acres of land belonging to the tribals. This land was originally contemplated for submersion according to the earlier proposal. Apart from saving these lands from submersion, the same can be provided with irrigation facilities for one Kharif season crop through gravity flow canals from the upper two proposed barrages. The existing Polavaram canals, now under construction, where more than Rs. 4,000 Crores expenditure was incurred can be fully made use of, by pumping water from the proposed Polavaram low barrage with a pumping head of about 11 metres (54 MW power required). All the benefits of the earlier proposal namely irrigating 7.2 lakh acres of irrigation under Polavaram, irrigating Godavari and Krishna deltas, diversion of 80 TMC to Krishna basin, supply of 23 TMC for drinking and industrial purposes. Hydro power of 1038 Megawatts can be generated. Water supply to North Coastal Andhra, contemplated in the future, water supply to Khammam district areas by lift irrigation etc. can all be achieved through this alternative design also. Since the peak river flood passes through the low barrage, without any obstruction (river regime not being disturbed), dam break and risk to the lives of 46 lakh people living immediately downstream of the project, do not arise. This is a major advantage of the alternative proposal. Another major advantage of this alternative design, is that there will be no objections from the two upstream states, since there will be no submersion in their states.

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ABOUT THE AUTHOR

In addition to experience in field investigation, planning, design, research and water management in irrigation projects, the author had field experience in the construction of Rallapadu Project, Hirakud Dam (Orissa), Nagarjuna Sagar Dam, Mid Pennar Dam, Tungabhadra High Level Canal – Uravakonda Deep Cut, Kalyani Dam, Sriramsagar Dam, Telugu Ganga Project (noted in the order of his service from 1950 to 1989). His later field experience in irrigation projects till 2006 was in the African countries, during his assignments with the World Bank and in the Asian Countries during his assignments with the United Nations (OPS).

He was awarded among others:

a) Mokshagundam Visweswaraya Award (1987), jointly instituted by the Government of Andhra Pradesh and the Institution of Engineers (India), for outstanding contribution in the field of engineering.

b) Central Bard of Irrigation and Power (Government of India) Award (1989) for outstanding work in Water Resources in India

c) Visishta Seva Patram, the highest honour of Andhra Pradesh State Government (1986) for outstanding work in government service.

He has authored 86 technical papers and 4 books on innovative technologies developed by him which were later followed by government organisations and other agencies. He retired as Engineer-in-Chief (Irrigation), Government of Andhra Pradesh and later worked as Water Resources Consultant for 11 Asian and Pacific Countries (CIRDAP), The World Bank, IFAD (Rome) and United Nations (Operation Project Services).

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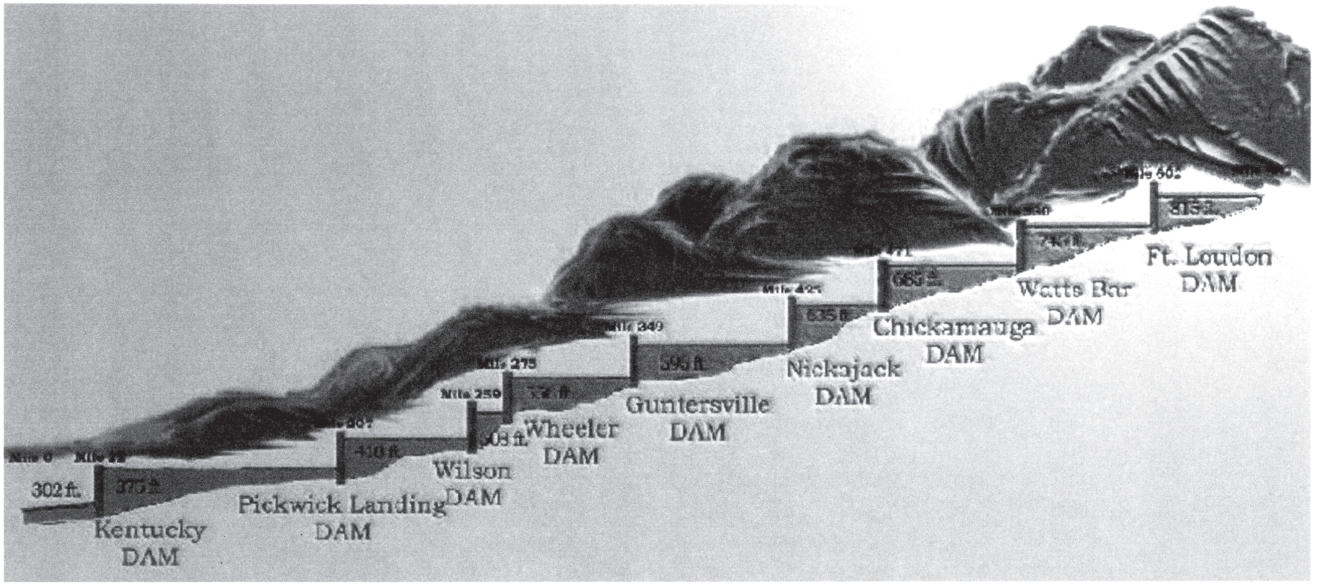
The profile of river Tennessee matches with that of river Godavari. The Profile of the river Tennessee is given below (see figure - 1).



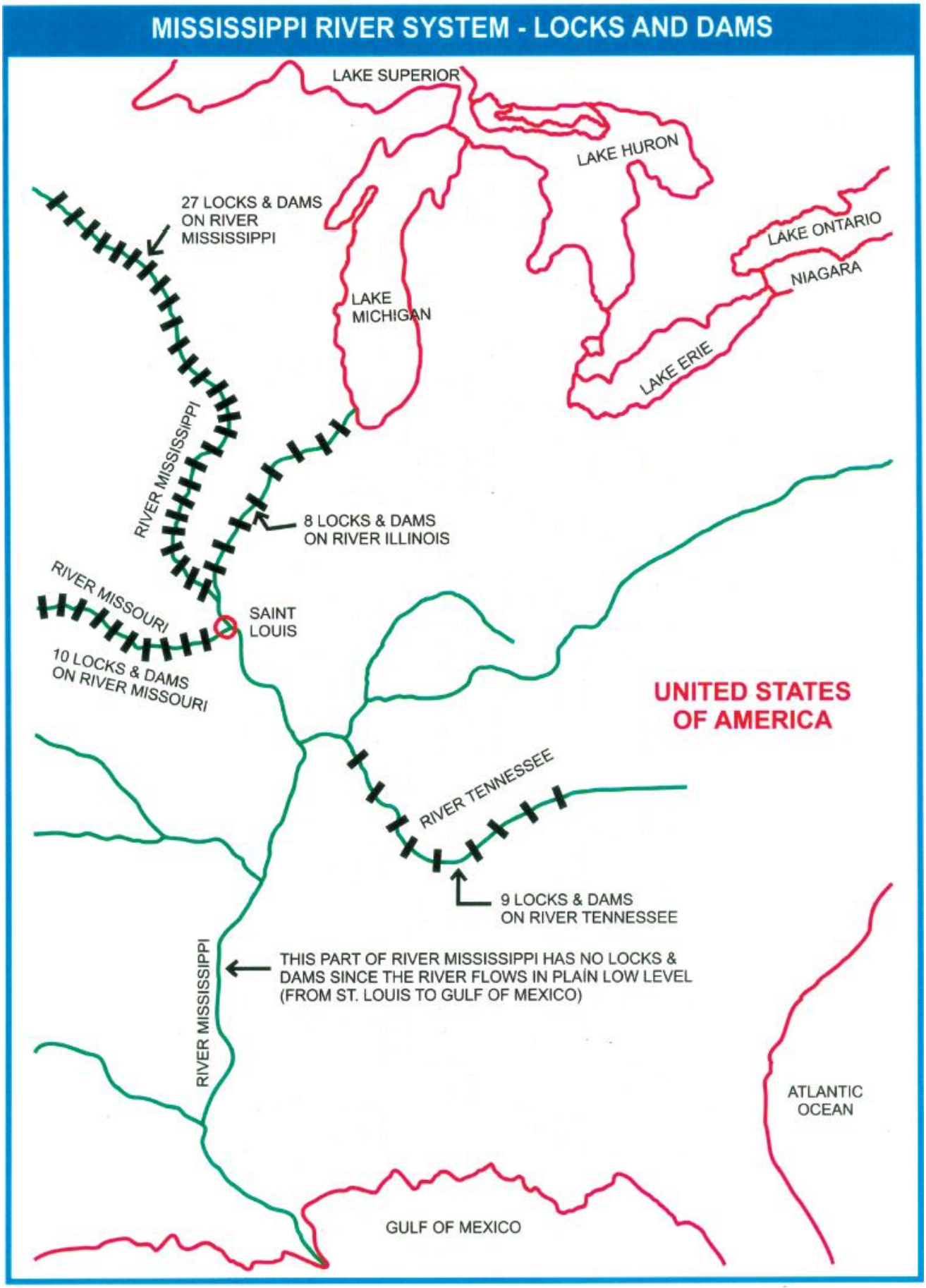
The above figure gives the following facts about Tennessee river system.

1) 9 step dams are constructed in a length of 580 miles.

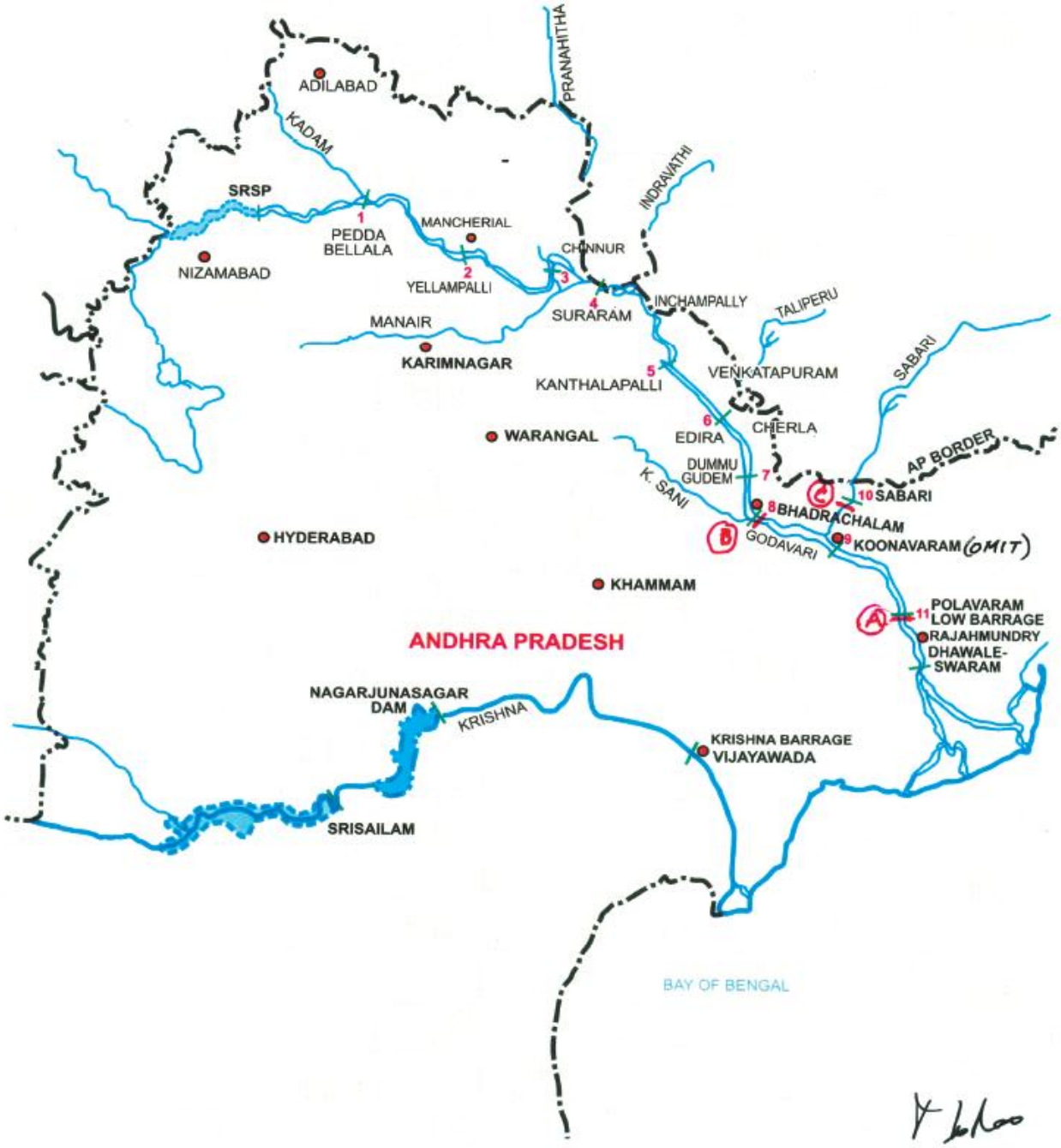
2) The total head harnessed in the 9 step dams is 513'.

3) The power generation is1567 MW.

10.10.09


MISSISSIPPI RIVER SYSTEM - LOCKS AND DAMS
LAKE SUPERIOR
LAKE HURON
LAKE ONTARIO
NIAGARA
LAKE ERIE
LAKE MICHIGAN
27 LOCKS & DAMS ON RIVER MISSISSIPPI
RIVER MISSISSIPPI
8 LOCKS & DAMS ON RIVER ILLINOIS
RIVER MISSOURI
SAINT LOUIS
10 LOCKS & DAMS ON RIVER MISSOURI
UNITED STATES OF AMERICA
RIVER TENNESSEE
9 LOCKS & DAMS ON RIVER TENNESSEE
RIVER MISSISSIPPI
THIS PART OF RIVER MISSISSIPPI HAS NO LOCKS & DAMS SINCE THE RIVER FLOWS IN PLAIN LOW LEVEL (FROM ST. LOUIS TO GULF OF MEXICO)
ATLANTIC OCEAN
GULF OF MEXICO

Polavaram Project : Alternative Design for Head Works



Notes : **LOCATIONS OF BARRAGES PROPOSED ARE INDICATIVE**

--- 3 Barrages @ Yellampalli, Kantalapalli & Dummagudem are under construction
--- 6 Barrages @ Pedda Bellala, Surarm, Edira, Bhadrachalam, Koonavaram & Sabari (1, 4, 6, 8, 9 & 10)
--- Barrage @ Chinnur (3) is optional, for navigation
--- Locks @ Barrages (including Dhawaleshwaram)
--- Sea going vessels (3000 Tonnes upto SRSP) - Inland water transport for ships
--- @ Polavaram low barrage proposed (no submersion of villages)
--- Major Dams u/s of Suraram & Kantalapalli for future, when upper states agree for submersions