Paper No. 515

A FEASIBLE INLAND NAVIGATION ROUTE FROM KALABAGH TO PORT QASIM

BY

MOHIUDDIN KHAN

A FEASIBLE INLAND NAVIGATION ROUTE FROM KALABAGH TO PORT QASIM

BY

MOHIUDDIN KHAN*

Abstract

Inland Navigation was practiced in the Indus River system from the days of Mohenjodaro 2500 B.C. The British introduced steam powered Craft in 1823. The Indus flotilla was operated from Kotri to Kalabagh. It was discontinued in 1871 when through railway service was introduced. Experience of developed countries has shown that it was a mistake to neglect inland navigation USA Canada & Europe have not only developed new navigation canals but improved the old systems. Gigantic projects like St. Lawrence seaway and the excellent waterways connecting land locked Moscow to inland seas of Baltic, white, cspian, Black and Azov are good examples. It is a tragedy of developing countries that they cannot recognise transport's strategic role in providing intersectoral linkages of the economy. A country's ability to transport effeciently is equivalent to its ability to prospor.

Some proposals for water transport in different reaches of Indus other rivers and canals were under consideration in the early fiftees but the first proposal for connecting Kalabagh to sea at Karachi was put up by the author of this paper in 1963 Engineering Congress. The proposal served as a base for further studies as any inland navigation project without connection to sea had limited uses. This 1963 proposal made use of Indus from Kalabagh to Sukker, Nara Canals a new link to Kotri from Jamroa, the Kalri Baghar feeder upper, Kalri lake and a new navigation link to Karachi. The reaches of river Indus from Sukker to Kotri was not recommended as it did not have enough water before Tarbela Dam, Mangla Dam and other storages. Variants of the link from Naraa to Kotri was also suggested by the irrigation deptt, NESPAK, and Deplaix. Rohri canal was also considered but given up. The consensus of a majority of parties including the development workshop consultants was to use Nara Canal and a link from Sukker to Kotri. The consensus was also for using Kalri Baghar feeder, Kalri like lake kui Ghero drain land ghero creeek for the portion from Kotri to Port Qasim.

Development workshop consultants came up with the arrangement that as the Indus downstream of Sukker to Kotri had a discharge of over 15,000 cusecs for 150 days in a year this reach should be accepted as a suitable navigation route as even in Europe navigation remains suspended during the

*Engr. Mohiuddin Khan

winters. This author of the paper carried out water studies for the years 1975 to 1985 as the studies by Development Workshop Consultants were for 70-71 to 80-81. These studies showed that river had supplies above 15,000 cusecs for 7 1/2 months. But the most important factors in switching over by the author to the Indus alternative instead of the Nara Alternative for the reach Sukker to Kotri is the future proposal for Sehwan Barrage which would very much enhance the discharge of the Indus from Sukker to Sehwan a distance of over 200 miles being a distance of about 90 miles up to Kotri only. Even this reach would have higher supplies than at present from future storages upstream particularly Mancher. There are a number of attractive features for the rout as it is not only economical but has less number locks and quicker time of transport inspite of larger distance. Larger size of harges than in the canal alternative are possible.

In part-II of the paper now presented the pros and cons of the reach Kotri to Port Qasim have been examined in depth in addition to the alternative of Kalri Baghar feeder, Kalri lake, Gharo creek alingment four alternatives were suggested for using the Indus instead of Baghar and Kalri lake. The first by Mr.Deplaix of ESCAP to have a weir at Hajipur 20 miles downstream of Kotri with a new barrage at Sujawal bridge site but because of the longer route and the high cost he himself did not recommend it. A proposal by Mr. Houton UN expert for an inflatable barrage near Thatta on Indus and connecting the Indus to Garo Creek was also considered unfeasible. The US trade and development programme technical mission also suggested the use of Indus from Kotri to opposite cross over canal from Gharo creek as one of the alternative for detailed feasibility study but they proposed new canals from between Gharo, Creek, Kalri lake and between Kalri Lake and Kotri pondage for appraisal concept plan.

The author in this paper suggests using the Hajipur weir with a multipurpose canal from the weir to Gharo Creek for water supply of Karachi and other areas on the right banks of Indus. The canal shall have a capacity of about 4000 cusecs for bulk water and navigation etc. The Hajipur weir shall also be multipurpose as it helps in acting as a subordinary weir for Kotri which is incapable of being operated to its full head due to leakage of about 3000 cusecs in winter. Not only this loss would be saved but Baran Nai water would be tapped and the Kotri barrage restored to its discharged head. The cost is most economical as it is shared by various sectors.

The cost of water transport is a fraction of the road rail and pipeline transport. Water transport is ideal for bulk cargo. It is interesting to note that railway share of the total domestic freight traffic (in terms of tonne - Kms) was 30.3 percent of in 1980-81 reaching substantial decrease from nearly 50 percent in 1971-72. Road transport has taken over most of this traffic with disastrous consequences. According to JICA study 1983 structural overloading together with inadequate maintenance is causing complete failure of major highway systems. The situation reached a point of break down in 1978-79 when NLC introduced 1250 large truck trailor units, High speed diesel oil vehicle is mostly

used by trucks has the highest share of 43 percent of P.O.L. according to oil company. This gives an interesting analysis of the net saving that could be expected by inland water transport. They have worked out that the capital expenditure on I W T I can be recovered in 4 years and a foreign exchange of US $ 125 million can be saved every year. According to Development Workshop Consultants, the annual saving is Rs. 360 million to Rs. 1250 million depending on extent of traffic that can be diverted to the water ways. An immediate engineering feasibility study for the reach Kotri to Port Qasim as indicated in the paper with locks at Sukker and a hydrographic study of Indus for navigation from Kotri Kalabagh is essential.

Port Qasim at present serves Afghanistan. It could also serve Western part of China and Tibet through the Karakoram highway. The new development of transport of cargo particularly by containers has a great future for this port. Containers could be transferred from the sea vessels direct to inland barges when an inland waterway from Port Qasim to Kalabagh is ready. Thus an inland port at Kalabagh would considerably reduce the bulk loads on road and railways. The distance from Kashgar in China to Port Qasim is planned as Kalabagh is midway. At present containers to western China have to sail thousands of miles East of Karachi and Port Qasim through the straits of Mullacca to reach the eastern coast of China and then transport across the whole width of China to reach Western China. Apart from there international benefits a vital national benefit is the national integration that would result by opening up Indus route to port Qasim between all the provinces. The mighty Indus already serves them for irrigation and hydroelectric power it could also be a channel for trade and commerce.

Paper No.515

A FEASIBLE INLAND NAVIGATION ROUTE FROM KALABAGH TO PORT QASIM

BY

MOHIUDDIN KHAN

INTRODUCTION

It is a great pleasure to contribute a paper for Engineering Congress for the forgotten topic of Inland Navigation. It may be recalled that the author of this paper presented a paper in the golden Jubilee Session of the Engineering Congress in 1963 on the subject and in these 25 years lot of work was done by various organisations and experts on Inland Navigation. The subject has continued to engage our attention all along, the author contributed two other papers on the subject for other forums, the last paper was presented in the seminar arranged by the Chartered Institute of Transport at Karachi in March 1987. The subject of the paper was also on "a Feasible Inland Navigation Route from Kalabagh to Port Qasim". This is enclosed as Appendix-T. With the present paper I feel we are in a position to start feasibility studies which would make this proposal a practical proposition. It has become essential to implement this as road and rail communications on trunk routes for bulk cargo have become saturated. Perusal of Part-I would show that the most difficult portion of the route is Port Qasim to Kotri. This paper examines in depth various alternatives for this reach and a new multipurpose alternative has been suggested which is independent of structures on the previous alternatives and is simple and economical.

II. Previous Alternative Routes Considered for the Reach Kotri to Port Qasim.

i) For various desk studies in the past the Kalri Baghar Upper Canal, Kalri Lake (total 68 miles) from Kotri formed a major part of the route to Port Qasim as this is the only large waterway available as Indus below Kotri barrage is practically dry most of the year. The canal and the lake have some difficult features, the canal is non-perennial and runs through deep cut in the tail reach to command the lake instead of an easier alignment along the river. There is a drop of 20 Ft. at the end of the lake into Kalri Baghar Canal lower (fig.1 and 2). Another most difficult structure is the crossing of Baran Nai which has a structure almost as large as the Ravi syphon on BRBD link near Lahore. In fact this difficult alignment for the canal was selected by Sir Thomas Foy, a very eminent engineer with the aim of storage of extra water in Kalri lake and to generate hydroelectric power at the tail end of the lake. The power project did not materialise as it generates mostly secondary power as the canal is non-perennail. The availability of Sui Gas for power generation and the high cost of civil works for hydel projects acted as a disincentive for such hydroelectric projects.

The lake storage has been useful but it created the following problems.

a) Silt free water in the Kalri Baghar Canal lower taking off from the lake created problems for the farmers. To overcome this a new canal from tail of Baghar Canal Upper to the head of Baghar Canal lower had to be constructed at great cost.

b) The heavy weed growth in the vast shallow lake has reduced the life and capacity of the lake.

c) The perennial supplies passing through the lake have losses and the water gets polluted by the weeds and is not palatable for drinking inspite of treatment at the Karachi water works.

ii) To over-come the difficulties and also to avoid the expensive remodelling of Kalri Baghar Feeder for inland Navigation the following alternatives were suggested by various experts:-

a) In 1981 Mr. Deplaix ESCAP expert on navigation proposed construction of a weir at Hajipur 20 miles downstream of Kotri barrage (fig.3) The main purpose of this was to avoid the heavy cost of Baran river crossing, raising of three bridges and a lock. He felt that the cost of the weir would be cheaper than remodelling the works on Kalri Baghar feeder and the river reach between Kotri and Hajipur would be a better alternative alingment. He proposed the pond level of Hajipur weir at R.L. 43 with 13 ft. head across the weir giving 10 to 9 ft. depth of water in the river even in low supplies for navigation. The downstream floor of the navigation bay at Kotri barrage is at R.L. 35. He also suggested the weir to be gated for passing floods and flow regulation. A 3 mile long canal was proposed to reach the river from K.B. feeder.

b) Another idea proposed by him was much more drastic change in the concept to build a barrage across the Indus under the Thatta bridge using a new damming technique which requires no piers and can be adjusted even to existing bridges. The retention level of this barrage would be R.L.33 and the pondage effect was assumed to be over 35 miles long. This level would be maintained only when the discharge downstream of Kotri is nil. This level is stated to be lower than highest water level recorded at Thatta which could involve no raising of bunds and only a drain at the foot of the bunds. The pondage effect was supposed to extend upto another proposed weir which could be located either near Hajipur as in the previous para or near Jherruck, 10 miles downstream where a combined barrage with bridge was suggested. For the Jherruck site the level of the Thatta Barrage could be lower at R.L.28.He stated that though this is an expensive proposal it would avoid K.B. feeder altogether,. Mr.Deplaix concluded that as this route would be longer, too far from the Chul Coal Mine and probably more costly than the other solutions specially in maintenance, he did not recommend it finally.

iii) Mr. Houton U.N. expert proposed an inflatable barrage on the Indus near about Thatta in 1986 to make available navigation depths in the Indus upto Kotri. He suggested connecting this point to Gharo Creek along the alingment already studied by various experts. This proposal was considered by the expert Committee of Ministry of Water and Power and was rejected. So was the proposal for dredging the Indus in this reach and following the alignment to Gharo Creek as already discussed. It was felt that the dredged river would not have enough water for navigation.

iv) The United States trade and development programme technical mission visited Pakistan in 1986 studied all the navigable sites in Pakistan and had discussions with the various Pakistani authorities, suggested the following alternatives in 1987.

A) Gharo Creek (9 miles) Dredge Ghari Creek (7 miles) upgrade existing drain from Gharo Creek to Kotri lake (21 miles) Kalri lake (31 miles) and upgrade K.B. feeder canal from Kalri lake upto Kotri pondage (35 miles) Indus river and follow the Indus river to Kotri barrage.

B)Some as allignment (a) exept new cannals between gharo crack, kalu lake and between kalri and Kotri pondage for a total of 103 miles

(c) Dredge gharo creek new aoss over cannal from gharo creek to the indes river and follow the indus river to kotri barrage

The Mission stated that Port Qasim to Kotri alignment (a) best reflects desk study concepts. However, alignment (b) appears to be the most compatible with anticipated watr availability and water supply needs and was therefore adopted for the appraisal concept plan. Alignment (c) would warrant consideration during feasibility studies.

The construction of a new channel of 103 miles (b) above would no doubt overcome the difficulties of K.B. feeder but shall also have major works like the crossing of Baran Nai locks and road and rail bridges. Apparently a still water channel is proposed at a lower level due to limitations of water supply availability. It is no doubt a simpler solution.

III)SUGGESTED ALTERNATIVE ALIGNMENT:

It would be seen from the previous paras that each alignment has some good and bad points. The first part of Mr. Depalix proposal at (ii) (a) for Hajipur weir has the potential of becoming economical if the weir can serve more than one purpose and the river Indus is avoided downstream a channel along the river bank could connect the channel from Gharo Creek (fig.1 marked in red dotted line). instead of the river position. The following are some of the multipurpose uses of Hajipur weir:-

i) As there is 3000 cusecs leakage under the Kotri barrage due to gaps between the sheet plies and substrata the head across the barrage has been restricted due to which the barrage cannot be operated to feed the canals to their capacity in winter when there is low depth in the river downstream. This problem is quite old and serious thought was being given to construct a subsidiary weir downstream of the barrage with the Hajipur weir this purpose is fully served.

II) The water supply for Karachi at present passed through K.B. feeder, Kalri lake and Jam branch of K.B. feeder lower which has all the handicaps discussed in para II. If these requirements of Karachi and the 3000 cusecs going waste are passed downstream of Kotri barrage for the Hajipur weir, a multipurpose channel would be available from Hajipur weir to Gharo for navigation and water supply to Karachi. The channel would have the necessary flexibility to take care of the rising needs of Karachi water supply which are estimated to be 1000 million gallons per day by the year 2000 AD. Besides there are large areas in Mirpur Sakro Tehsil right upto Ket Bander which have no source of fresh water supply for drinking. Not only the wastage of water downstream of Kotri could

be stopped at Hajipur but the water of Baran Nai could also be tapped which at present is going waste to sea.

III) Some of the other advantages of this alingments are as below:-

a) The existing locks in Kotri barrage are fully utilized nnot only for passage to Port Qasim but also the sea to Keti Bander when supplies are ample. The navigation channel from Kotri to Gharo shall have only 3 locks as compared with 8 locks in the K.B. feeder alternative thus increasing the speed of transport. As railway bridges exist on the river between Kotri and Hajipur with a road bridge at Kotri all these are avoided on this alignment as compared with K.B. feeder alternative.

b) A redeeming feature about Hajipur weir is that its cost would be low as the head across is only 13 ft. against 32 ft. for high Sehwan barrage and 23 ft. for the low Sehwan barrage. Simple gates could be erected on the weir. The site has some inbuilt advantages such as a large rock out crop on the left bank, an island in the middle of the river which could be used for construction of the weir. Another good feature is that Jherruck stone quarry is only a few miles downstream which makes availability of stone and aggregate at economical cost as there is a road in addition to the river for transportation.

c) The size of the multipurpose channel for navigation and water supply in the first phase need not be more than 95ft. wide and 9 ft. deep as this is the minimum requirement for the type of barges as discussed in next par. The channel from Hajipur weir to Gharo would be for about 4000 cusecs with a bed width of 150 ft. and depth of 9 ft. The cost of the channel could be shared between the three parties as such it would be the most economical alternative as compared with any other alignment. The cost of Hajipur weir also could be shared. The canalisation of Gharo Creek is entirely charged to navigation.

IV) Parameters considered essential for viable inland navigations:

The criteria for selecting a vessel should be its ability and flexibility to ply all the waterways on its route and to negotiate the locks, bridges and other structures on the way. The vessel should suit the waterway not vice versa. The vessel should suit the existing conditions and their upgrading should accompany upgrading of the waterway. A common mistake made by someof the consultants and foreign experts is to assume dimensions of vessels being followed in other countries which do not suit Pakistan conditions.

Vessel Type:

The type of vessels for inland waterway in Pakistan needs careful consideration. NESPAK in its report of 1975 have suggested a self-propelled vessel.240 ft. long, 28 ft. wide draft 6 ft. and depth of vessel 8 ft. capacity 800 tons. Mr. L.E.Van Houton UN expert in his report of Feb 1986 discusses the economic advantages of push towing to self-propelled vessels, and suggests a push boat of 90' x 26' x 8' draft 6 ft and barges 150 x 24 x 8 ft with draft 6 ft. He also suggests use of two small self-propelled

vessels of sizes 40' x 10' x 4' draft 3 ft capacity 18 tons and 60' x 15' x 6 draft 4.5 ft. Development Workshop consultants suggest a 'design vessel 1.4m (4.67 ft) x 7.6m (25 ft) x 2.1m (6.9 ft) of 1.4m (4.67 ft) draft and capacity 250 tonnes like Indian type. They also indicate that on Indus main route self-propelled barges could be used but pushed tow of 2 to 4 barges would be more flexible. There can be no two opinions that for Pakistan, inland navigation we should go in for pushed tow boats, pushing a flotilla of barges. Mr. Deplaix, UN expert mentions the possible example of 12 barges with a tow boat passing the Kotri lock, giving a total capacity of 25000 tons. The days of self-propelled vessels are over now.

Size of the vessel:

The width of the vessel suggested by NESPAK, Mr. Houten and Development Workshop Consultants varying from 24 ft to 28 ft in the previous para is not feasible for Pakistani conditions as the locks in the upper Indus barrages have a width of 20 ft except Kotri barrage lock which is 270' x 60'. Mr. Deplaix rightly suggests that we should not have barges wider than 19ft to pass all the structures. He also feels that the pushing technique permits the use of small barges united into a beig tow which passes the big locks as a unit and Another great advantage of this lesser width is that it would involve less cost in the remodelling of bridges. Wider barge section generates greater resistance and retards, the speed. The largest country boat in Indus also has a width of about 19 ft which is significant.

The length of the vessel also has to be limited to fit in with the size of the locks as the upper Indus barrage locks are slightly larger than 60 ft, a vessel of 60 ft is the correct size. Thus a size of 19' x 60' automatically follows unless we think of wholesale remodelling of upper Indus barrages which will be not justified in the first stage.

Size:

The next important factor is the draft of the vessel. NESPAK suggest a draft of 6 ft. Houten suggests different drafts from 3 ft to 6 ft and Development Workshop suggest 4.5 ft in the first stage but higher drafts in the reach Sukker to Kalabagh. Mr.Depalaix suggests a draft of 8 ft even with a channel depth of 9 ft leaving only one foot for under keel clearance whereas NESPAK assumes an under keel clearance of 3 ft and Houten assumes from 1' to 3 ft. Development Workshop Consultants suggest a clearance of 0.3 m to 0.6 m i.e. 0.99 ft to 1.98 ft. It can be said without hesitation that 3 ft clearance is definitely on the high side. Mr.Deplaix mentions that in Russia 6" clearance is provided and in Thailand 8". Another very important point indicated both by Deplaix and D.W.Consultants is that when there is less draft available, the vessel need not be loaded fully. Mr.Deplaix states that in Thailand recently barges were designed for 4.6 ft draft but nevertheless a draft of 10 ft is reached 150 days in a year as such the design provides for a draft of 9 ft. For Pakistan, he suggests that a draft of 8 ft is feasible. There is some weight in this

argument.Mr.Deplaix design of vessel of 60 x 19 and a draft of 8 ft could be considered as a conceptual design for further detailed surveys and studies for the following reasons:-

(1) As the river Indus alternative is being recommended for the reach Sukker to Kotri against the canal alternative larger depths are available after Sehwan barrage. Till Sehwan barrage is ready we have enough supplies in this reach of the river for navigation in 7 to 8 months which is good enough for a start.

(2) Lesser keel clearance means smaller air clearance thus easing the bridges on the tail portion of the system to Port Qasim.

(3) The larger draft would help bigger vessels and the size suggested by Mr. Depalix has a carrying capacity of 200 tons.

Dimensions of Navigation Channel:

Dimensions of the navigation channel is another important parameter in making inland navigation viable. As discussed in the previous section. The depth of the channel has a relationship with the draft. A depth of 9 ft is the minimum required for a draft of 8 ft. As far as Indus river upstream of Sukker is concerned, it has this depth in all months except the closure months of December to January and low flow month of February to March i.e. a period of about 9 months. Below Sukker this depth is available about 6-7 months before Sehwan barrage completion and for 9 months after Sehwan barrage. Downstream of Kotri water is available all the year with Hajipur weir and release of supplies for Karachi.

Vertical air clearance:

This is the clearance required over the vessel for passage below bridges. NESPAK in their study recommended an air clearance of 12 ft for vessels. Development Workshop recommends 3 meters and even suggest water ballasting for the barges so that they could negotiate a bridge in a loaded low air clearance condition. They also state that the large country boat called Bagoacher requires a clearance of 4 meters (13.2 ft) to pass under the bridge with masts down. Mr. Houten UN expert recommends 15 ft clearance. Mr.Deplaix feels that a 13.5 ft clearance is good enough even for accommodating containers. This should be good enough as a 15 ft would be too much.

Mr. Houten suggest that the clear span of the bridges should be equal to width of the tow plus 10 to 20 ft i.e. say 19+20=39 ft. Mr.Deplaix suggests a span of 70 ft appararently this is for two-way traffic. As slowing down at bridges is not desirable with bridges at close intervals, the span of 70 ft for the bridges seems suitable. This new span could be accommodated in the centre of the channel alongwith the remodelling required for raising of the bridge to provide the necessary 13.5 ft air clearance.As far a bridges on rivers and bridges are concerned they have to be also examined from this point of view.

V.EXAMPLES OF OTHER COUNTRIES IN INLAND NAVIGATION:

Both NESPAK, Deplaix and Development Workshop Constultants have quoted the experience of various countries in inland navigation in their reports but have not mentioned the future plans of

those countries which could be of great use to us. This may be because it is difficult to get information on future plans from other countries. I have been fortunate in obtaining a book which gives useful information on the future plans of India. India has gigantic plans for water resources and inland navigation. A plan from the 1975 book "India's Water Wealth" by Dr. K.L.Roa former, federal ministr for irrigation and power who is an eminent engineer is enclosed. This unique proposal under serious condition is to divert surplus Ganges water to Cauvery in South India with series of dams. Through the heart of India from North to South. This is a scheme of astronamical proportions and could rank as one of the largest water resource development projects in the world. The idea is not only to augment water resources but to provide navigation. As stated by Dr. K.L.Roa this report of a man made river spanning the entire length of Indian subcontinent is to be a symbol of the unity of India. Should Pakistan lag behind though it has the mighty river Indus which serves all the provinces for irrigation and hydroelectric power ? With inland water transport on the Indus from Port Qasim to Kalabagh and beyond, it could no doubt serve as the symbol of unity of Pakistan and a step towards national integration.

VI) PROPOSED ACTION PLAN:

As indicated in this paper a quarter century of desk studies prefeasibility studies and surveys have evolved a feasible proposal for Inland navigation from Kalabagh to Port Qasim. The following steps are urgently needed to firm up the proposal:-

(i) An Engineering feasibility study for Inland navigation from Kotri to Port Qasim.

(ii) Construction of a navigation lock in Sukker barrage which is the only bottle-neck between Kalabagh and sea as all other barrages have locks.The lock could be constructed in one of the closed bays. This opportunity could be used to construct a fish ladder which has caused considerable damage to the breeding of fish on this mighty river.

(iii) A Hydrographic study may be carried out for navigation of Indus from Kalabagh to the sea to ascertain the exact period and the drafts available in different reaches and periods of the year. This can be undertaken by DG Ports and Shipping and ACOP of WAPDA.

(iv) Aftr the construction of a lock in Sukker Barrage which may be completed in a year or two pilot run of fhotillas of barages with a tow boat could be tried from Kalabagh to sea in the wet months when there is enough supply. The route in a Keti Bander may be longer to Port Qasim but it could demonstrate the cheap transport of Cargo as compared with road and rail and encourage the private sector.

VII) REFERENCES:

1- Paper by Mohiuddin Khan on "Inland Navigation in West Pakistan-a few proposals of 1963 Engineering Congress Goldern Jubilee Session.

2- NESPAK report 1975 Inland Water route Port Qasim to Sukker.

3- Bulk loads on Inland waterways 1979 by Mohiuddin Khan for the Seminar on fuel economy.

4- Mr. Deplaix ESCAP expert on Navigation 1981.

5- Report on prospects of Inland Navigation in Pakistan by Development Workshop Consultants 1984.

6- Report by Mr. Houten UN Expert on Navigation 1986.

CHATERED INSTITUTE OF TRANSPORT PAKISTAN

APPENDIX-1

Seminar on Inland Water Transport with
Special reference to Pakistan March 1987
paper by Mohiuddin Khan
on
"A feasible inland navigation route from Kalabagh to Port Qasim"

I. History of Inland Water Transport in Pakistan and a few examples from developed countries:

Navigation was practiced in the Indus river system from the days of Mohenjo Daro 2500 B.C. Alexander crossed West Pakistan from river Jhelum to Indus upto Kotri in 330 B.C. Muslim rulers of the subcontinent developed Inland navigation on all the major rivers. Remanants of the famous project of Feroz Shah connecting Ganges to Indus via Jumna Saraswati and Sutlej constructed in the fourteenth century still exist.

The British introduced steam powered craft in 1823. They operated in Indus and Punjab flotillas between Kotri to Sukker and Sukker to Kalabagh, respectively. Operation of the flotillas was discontinued in 1871 when through railway service was introduced.

Experience of developed countries has shown that it was a mistake to neglect Inland navigation. These countries continued not only with improvement of existing Inland waterways but added a number of new waterways inspite of the development of railways. USA had developed TVA and other projects as multipurpose. The gigantic St. Lawrence Seaway which makes Chicago in the interior of USA accessible to occean vessels is another example. Moscow is connected to the five rivers of Baltic, White, Caspian, Black and Azov. Smaller European countries have also not lagged behind. Holland has over 4800 miles of navigable canals which is 48 times the average width of the country.

II. Recent Developments in Pakistan

The Central Engineering Authority(CEA) had a navigation directorate after the creation of Pakistan. It mostly dealt with the then East Pakistan and carried out some preliminary desk studies on the Indus. In 1959, the President of Pakistan issued a directive that a study should be carried out to make river Indus navigable from Kalabagh to sea and also to study the feasibility of converting existing canals into navigation canals. As a result of this a study was carried out by

foreign consultants of WAPDA for making the Indus basin inter river link canals navigable in 1961. As federal government was not prepared to pay the extra cost required for making these link canals navigable, the proposal was given up. Studies for making river Indus and some of the irrigation canals were carried out by West Pakistan Irrigation and Power Department and some Pakistani consultants. The author of this paper contributed a paper on 'Inland Navigation in West Pakistan - A few proposals' for the Engineering Congress Golden Jubilee Convention which was also the centenary of PWD Irrigation Department in 1963. This paper suggested using river Indus from Kalabagh to Sukker which had ample water round the year for navigation.Downstream of Sukker as the water in the Indus in winter was too low the Nara Canal on the left of Indus upto Jamroa weir for 106 miles with a new connecting irrigation-cum-navigation link of 70 miles from Jamroa to a point on Indus upstream of Kotri was suggested. From Kotri the Kalri Baghar feeder, Kalri lake and a new connecting navigation channel along Kui-gharo drain upto Gharo creek was suggested. The Gharo creek was proposed to be connected to Karachi port as at that time Port Qasim site was not even discovered. Another alternative from Kotri was to make use of the Pinyari canal upto Thatta and then the river Indus upto Keti Bander which was also being considered as an alternative port to Karachi. The navigation directorate of the office of Central Engineering Authority preferred the first alternative though the irrigation department West Pakistan preferred the second alternative. Lot of water has flowed down the Indus since 1963 and since then the Mangla Dam, the Tarbela dam, Chashma barrage and the Inter river link canals have been completed. The West Pakistan Irrigation Department, WAPDA, some consultants and others have carried out studies for some of the portions todate. This paper shall discuss pros and cons of those studies and suggests the most feasible alternative for inland navigation route from Kalabagh to Port Qasim.

III. Principle parameters for inland navigation

Principle parameters and variables concerning inland navigation are generally the following:

1. Discharge with minimum maximum water levels.
2. Flow velocity
3. Width and depth of navigation channel
4. Free span and clearance of structures
5. Lock dimensions.

For purposes of navigation in all the previous studies a draft of 6 ft has been generally assumed. Allowing for the free board and other factors this requires a minimum depth of 9 ft in the channel. For purposes of bed width the width of the largest country boat on the system

could decide the dimention. This is almost 20 ft, allowing for two traffic lanes up and down and clearance for manoeuvring lane a width of 100 ft is required. These boats require an overhead clearance of 12 ft with masts down. The velocity in canals is generally 2 to 3 ft/sec and in deeper ones it may be higher. In rivers also the velocities are within these limits in normal flow but in floods they are much higher. These velocities are suitable for navigation except in floods. Lock dimensions particularly in barrages are important. It may be mentioned that in Kalabagh a width of only 12 ft. has been provided whereas in Sukker there is no lock at all. It is necessary that locks should have a width of at least 60 ft which is the normal barrage span. Overhead clearance at locks needs to be 12 ft. This is available in most of them but the bridges on canals have less than 3 ft. clearance.

Please see enclosed plan which shows the alignment of various alternatives. (please se Plan III-1)

IV. Navigation from Kalabagh to Sukker on Indus

WAPDA prepared a report in 1976 for navigation of Indus from Sukker to Kalabagh. The total stretch of the river was split into portions between barrages. Cross sections of the river were taken at 10 mile interval and a long section of the deep channel of the river was also observed based on judgement and knowledge of the local boatmen. Boat traffic data and number of country boats available between Sukkur and Kalabagh was also surveyed. Existing capacity of the country boats varied from 200 maunds to 2500 maunds. Upstream of Taunsa the boat size was between 200 to 500 maunds. Cargo for planned navigation was expected to be wheat, soya bean oil and iron products from Karachi upto Kalabagh and stone aggregate, cement and fertilizer on the way down.

The study found no major obstruction to navigation. The Indus river was considered navigable all the year from Sukker to Kalabagh for 4.5 ft draft boats proposed to be used. Larger craft could ply for more than 9 months in a year when river had higher flows.

Inland Ports

Development Workshop Consultants have proposed four main ports in this reach viz Sukker, Ghazighat, Dera Ismail Khan and Kalabagh and six intermediate ports viz Ghotki, Guddu, Mithankot, Taunsa, Leiah and Chashma.

Mithankot port needs to be upgraded to a main port for the following reasons:-

(a) It may be desirable to have a railway spur from Rajanpur to Mithankot so that Chachran on the opposite bank of the Indus is accessible. A ferry for railway wagons would make available a crossing. There is no railway crosing in 250 miles between

Sukker and Taunsa barrages. Unfortunately, no railway bridge exists at Guddu barrage.

(b) This railway ferry is essential for defence purposes as the railway track between Sukker and Rahimyar Khan is nearest to the border and could be cut off by enemy action. Mithankot - Chachran will provide a staging point for our defence equipment.

(c) Mithankot is also important as it is a junction of the Indus and Panjnad rivers and is on the navigation route to Lahore.

At present, there is little boat traffic upstream of Kalabagh and none whatsoever in the gorge between Kalabagh Dam site and Attock. With the construction of Kalabagh Dam navigation is possible upstream of the dam and mechanical means for shifting of the barges is suggested as system of locks at the dam would be too expensive and passage through it time consuming.

V. Navigation from Sukker to Kotri

For this reach the following seven proposals were suggested by Mohiuddin Khan, Irrigation and Power Department, Government of Sindh, NESPAK and Mr. Deplaix:-

1. Feeder cum navigation channel from Sukkur to GM barrage via Nara Canal	Mohiuddin Khan
2. Navigation along Nara Canal-cum-new link upto Hala	Irrigation & Power Department, Sindh
3. Navigation along Rohri Canal-cum new link upto Hala	-do-
4. Navigation along Rohri Canal	-do-
5. Navigation through river Indus	-do-
6. Navigation from Sukkur to GM Barrage via Nara Canal, Jamrao Canal	NESPAK
7. Feeder-cum-navigation canal for Sukker to GM Barrage via Nara Canal, and a new link upto Sakrand	Mr. Deplaix, ESCAP Expert

It would be seen from the above list that between the first alternative proposed in 1963 and the last one proposed in 1982 Nara Canal forms a common component of alternative 1, 2, 6 and 7 because Nara Canal has such redeeming features which make it attractive for navigation. The

following are some of these features:-

(1) Nara Canal runs in the old bed of eastern Nara mostly in cutting.

(2) This is the only canal where extensive navigation is practiced even now.

(3) It is a perennial canal with a minimum bed width of 170 ft and depth 10 ft.

(4) It has possibilities of increase in discharge by future remodelling.

(5) There are practically no bridges and no regulator or fall in the 106 miles length upto Jamroa head.

Unlike this, the Rohri canal runs in half cut and fill and has a large number of falls, regulators and bridges. The raising of bridges involved in this case is much higher for navigation as the full supply of Rohri is above ground level. Besides, there is a proposal to split up the canal into two portions, the upper portion to be fed from Sukker barrage and the lower portion from the future Sehwan barrage. Thus the alternatives 3 and 4 which use this canal are inferior to the Nara alternatives.

The alternative 5 using river Indus from Sukker to Kotri has some inherent advantages as there is no structure in this reach except the newly constructed Dadu Moro bridge which has enough clearances. The main factor which has discouraged use or this is the lack of sufficient discharge in winter. However, this shall be discussed in detail later in depth.

(i) Feeder-cum-navigation channel from Sukker to GM Barrage via Nara Canal:

In 1963, Mr. Mohiuddin Khan in a paper in the Engineering Congress made a suggestion that Nara Canal in a total length of 106 miles with a new link from Jamroa head to a point upstream of GM barrage and another 70 miles should be examined for inland navigation from Sukker to Kotri. An important feature of this channel was that it should act as a feeder for transfer of supplies from Sukker to GM barrage through a shorter and regular canal instead of the existing route of the river which was longer and caused considerable losses of water due to the wide meandering channel in low flow months. The project is thus multi-purpose. A long section of the proposed channel is enclosed (Fig.V.1). In the first phase which was to be a pilot phase, only 50 ft wide channel 8 ft deep was proposed to be enlarged later.

The proposal was examined by NESPAK in their study in 1975. They objected to the alignment of the channel from head Jamroa to river Indus stating that it runs in heavy filling which is not correct as they have assumed an alignment to the east as agianst the one proposed in the paper by mistake and have come to the conclusion that the link canal runs in heavy filling with consequent requirement of raising some of the ;bridges to 20 ft. It can be seen from the long section enclosed that the link canal is in cutting where the bridges are located. In fact it is clearly mentioned in the paper at page 179 that "Jamroa Kotri link passes near Nawabshah and is mostly in cutting so that it may facilitate suitable free board at the bridges without undue raising".

Another objection raised by NESPAK is that the section at 60 ft by 8 ft is too small. They have missed the point that it is the first phase pilot section. A very important point which has been misunderstood by NESPAK is that extra supplies would be required to run the link from Jamrao to Kotri. The concept of the paper envisages rerouting the available irrigation supplies required for Kotri via Nara Canal and through this new link instead of passing through the river to save losses. No extra supplies are required and infact water will be saved for the system. It would be seen that the objections of NESPAK are based on improper understanding of the proposal. The project is feasible and the fact that variants of this proposal have been considered by Irrigation and Power Department Sind. Mr.Deplaix and NESPAK itself shows good points about this alignment.

Unlike the studies by NESPAK which were of reconnaisance level a detailed feasibility study after survey was carried out by National Development Consultants in early eighties for channel connecting Nara Canal at Jamroa with Rohri Canal as a Feeder. This more or less follows the alignment suggested by Mr. Khan.

(2) Navigation along Nara Canal-cum-new link upto Hala:

This proposal was suggested by Sind Irrigation Department. It suggests using 106 miles of Nara Canal with a new still water channel upto river Indus. Two alternatives were considered for the still water channel one with a length of 64 miles and another with a length of 65.25 miles. The second one was recommended. The size of the channel is 8 ft deep and 125 ft wide and water requirement of 326 cusecs has been also worked out for this channel.

NESPAK has examined this proposal and feels that the proposal is not economically feasible due to the raising of the bridges and requirement of more than ten locks. The channel also passes through water-logged area. There is some weight; in the objections of NESPAK, it is not understood why we should go for a still water channel when a multi purpose link would not only save water but be a great asset as in the previous proposal. Development Workshop Consultants supported this proposal initially.

3) Navigation along Rohri Canal cum new link upto Hala:

This proposal was also advanced by Sind Irrigation Department and envisages the utilization of 49 miles of the Rohri Canal and excavation of 113 miles long new link channel. Rohri canal has a discharge of 16, 150 cusecs a bed width of 247 ft and depth 16 ft. The new link channel dimensions are 128 ft wide with a depth of 9 ft (as modified by NESPAK) and a total loss of water of 565 cusecs. There are 17 structures in the Rohri canal to be remodelled and in addition 16 structures have to be provided on the new 113 miles of channel. 6 lock structures have to be provided in Rohri canal and another 6 in the new channel.

NESPAK has commented that one of the advantages of the alignment is that there is no railway crossing on the whole channel and another advantage is that the new channel runs in

cutting and as such avoids water-logging. Among the demerits are the high cost, large acquisition of land which is fertile and developed, loss of 565 cusecs and a total number of 12 locks which makes passage through the channel slow.

Some important points missed by NESPAK in their comments is that Rohri canal itself runs in balanced depth i.e. its full supply level is above ground which is already causing severe water-logging. There is a scheme to split the command of Rohri canal into two, the head reach to be fed by Sukker barrage and the lower portion to be fed by new Sehwan barrage. This would need changes in the discharge of the canal. Thus Rohri alternative is inferior to the Nara alternative.

(4) Navigation along Rohri Canal:

This proposal was made by Sind Irrigation Department and consists of making use of Rohri Canal upto 123 miles from head and constructing a new channel of only 33 miles. Rohri canal has a bed width of 130 ft and a F S depth of 12 ft upto 125 miles. The 33 miles still water channel proposed has a width of 128 ft and depth of 9 ft as in the previous alternative but the losses in this are 165 cusecs due to lesser length. A total of 41 structures in the Rohri Canal need remedelling. In addition, five new strucutres on the still water channel are required. A large number of locks are required.

NESPAK states that the proposal has merits of smaller new channel and lesser losses but suffers from heavy cost due to remodelling a large number of structures on Rohri. Remodelling Rohri which is a perennial canal would not be easy, great delays would be incurred in passing through locks. Other additional points mentioned in the last sentence of the previous proposal also apply to this.

(5) Navigation through river Indus:

Irrigation Department Sind examined this proposal in some detail though the reach of river Indus from Sukker to Kotri for navigation was suggested by many in the past. It is stated by the Irrigation Department that it could be used for irrigation during Kharif when enough supplies are available from 15th April to 30th September. To make this feasible, marking of the active navigable channel and provision for the thing facilities of the inland ports, arrangements for loading and unloading are necessary.

NESPAK considers that the proposal is practicable, however, they state that a definite recommendation can be made after detailed survey of the river. Some of the merits of the proposal are that no extra water is required, no cross structures are to be constructed or remodelled except the lock at Sukker barrage. No question of acquisition of expensive land and heavy cost of remodelling rail and road bridges. Navigation will be beneficial as all the important and fast growing industrial towns are located along the Indus.

Merits and demerits of river Indus as a Navigation route from Kotri to Sukkur:

One of the greatest demerits of using Indus river for navigation is that supplies downstream of Sukkur are not available all the year round. NESPAK estimates that supplies are available from 15th April to 30th September.

This has been based on supplies from 1977-1973 which is before Tarbela Dam and as such cannot be realistic. Development Workshop assumes that discharges above 15,000 cusecs are available for over 150 days and they accept this as suitable to start navigation as even in Europe navigation remains suspended during winter. The author has carried out some water studies for the years 1971-1985 as the studies by Development Workshop are for years 1970-71 to 1980-81. These studies show that the river has supplies above 15,000 cusecs for 7 1/2 months downstream of Sukker (please see Table V-I). The supplies upstream of Kotri (please see Table V-2) are also more or less for the same period though losses are heavy in early Kharif and gains are high in Rabi. there should be thus no difficulty in using the Indus for 7-8 months in the first instance.

There are possibilities of improvement of supplies in the near future by the construction of new Sehwan barrage. The details of this project was indicated by Lower Indus Project Consultants. (please see Fig V-2 and Table V-3).

This is for the high Sehwan barrage and it has now been decided to construct low Sehwan barrage as high Sehwan is considered unfeasible on many counts but the areas to be commanded remain the same only the storage at the barrage is omitted with considerable saving in cost. The updated cost for the low Sehwan barrage is Rs. 1,478.94 million against Rs. 542 million and that of the feeder is Rs. 1,322 million against the original Rs. 233 million. The main idea of this project is to split up the command of Rohri and Nara Canals into two portions, Sukkur barrage to command the northern part and Shewan to command the southern part. The period of construction of this project is 1995-2002 as per the new consultants. This may depend on the availability of funds.

One redeeming feature of the area is that recently the Dadu Moro road bridge has been constructed and advantage could be taken of this structure to shift the Sehwan barrage site slightly upstream so that the training works of the bridge could serve the barrage. In the cost of a new barrage training works and the diversion of river form a substantial part of cost. This would also improve the command level for the Mancher lake. One very important point regarding Sehwan barrage is that it will make available an active river portion for navigation upto Sehwan as lot of water has to be passed downstream of Sukkur to feed the Southern command of Rohri and Nara canals in addition to requirements of Kotri barrage. The releases from Mancher storage also shall be added to the supplies for Kotri. Out of a total length of 298 miles between Sukker and Kotri only about 90 miles below Sehwan/Dadu barrage would have lesser supplies as indicated in previous para. Even these would be more than the present and would increase due to extra demands of

Karachi, etc. Training of the river for navigation in this small reach would be quite easy for even large barges. As such this alternative route of the river is much superior to the navigation route through Nara and Rohri Canals. The river alternative has the following other merits:-

(a) This is the cheapest alternative as compared with all the canal alternative.

(b) Though the distance is more along this route the time of travel would be less as there is only one lock at Sehwan in all this distance between Sukkur to Kotri.

(c) As major towns are located close to the river this route will help industrialization of the areas along the river and also the development of reverine area. This route will facilitate transport of Chachali ore to the Steel Mills and the Lakhra Coal to other areas.

(d) The route is away from the border and is more secure as compared with Nara Canal alternative.

(e) Much larger barges can be operated along the river as compared with the canal alternative. Protection of the bank also is not required as in the canals.

(f) As a lock shall be constructed at Sukker barrage immediately, it could be combined with a fish ladder to improve river ecology.

(g) Navigation without waiting for any major expensive constructions as in the canal route.

(h) This route has the further advantage that when Sehwan/Dadu barrage and Sehwan feeder are ready, large towns of Nawabshah and Sanghar would also be connected to the river through the Sehwan feeder and also the Nara Canal on which navigation already exists on a small scale. With a lock at the head of Nara canal access to the river would be possible.

(i) Needless to say the supply position in this reach of the river would considerably improve after completion of Kalabagh Dam in the early ninties. Even if it is delayed the Sehwan barrage would make the rivver navigable in a major part of the length from Sukker to Kotri.

(j) The active length of the river with greater supplies between sukker and Kotri would be over 66% leaving only 33% as low flow reach. The losses would be considerably reduced as in the present position the entire reach between Sukker and Kotri has low flows.

(6) Navigation from Sukker to GM Barrage via Nara Canal, Jamroa Canal:

This proposal was put up by NESPAK in their reconnaisance study of 1975. This consists of using the Nara Canal as in alternatives one and two above, and then using 3,983 cusecs Jamroa Canal (width 140 ft wide and 8 ft deep) upto mile 42 and then a new still water link of 30

miles ending in the river 15 miles upstream of GM Barrage (128 ft wide and 9 ft deep). The losses of water in the still water channel would be of the order of 150 cusecs. Remodelling of 9 structures on the Jamroa Canal and construction of 11 new structures on the still water channel would be required in addition to eleven locks. NESPAK considers this the best alternative though they recognise that cost of structures would be high. It is also stated that while the alignment of the channel is considered to be vulnerable to enemy attack and increases the possibility of smuggling it can on the other hand prove to be a quick line of communication for defence purposes and control of smuggling.

It would be seen that this proposal makes use of Nara Canal and also Jamroa Canal to reduce the length of the new channel. NESPAK has missed the point that Jamroa Canal is one of the worst canals in Pakistan from the point of silt movement. Research on this serious problem has been going on for the last 60 years with no proper remedy so far. The silt movements in this canal are such that dunes as high as 5 ft are created in the channel in a depth of channel of 8-9 ft only. Another important feature of this canal is that Jamroa is a small canal of a FS depth of only 8 ft. NESPAK has suggested some remodelling of this canal. As it is a parennial canal, remodelling is not easy and dredging has not been much of a success either. With dunes in bed, effective depth in places reduces to only 3 ft thus making navigation impossible. This would also not provide enough flexibility for future use of bigger vessels with uneven bed and sides would considerably reduce the two way traffic of larger vessels. Jamroa canal would thus be a bottleneck in the whole alingment and if at all a still water channel has to be adopted for the lower portion it has to start from tail Nara Canal avoiding Jamroa Canal altogether. This was the proposal of the Irrigation Department, Sind. It has already been stated that a still water channel has its own problems like loss of water and maintenance of regime and as such a multi purpose channel for both irrigation and navigation link alternative one has a better hydraulic regime and there is no question of losses in that alternative. In fact the NESPAK alternative has new problems more serious than the previous alternatives. The eleven locks and the difficult Jamroa canal make transport slow and expensive.

(7) Feeder cum navigation canal from Sukker to GM Barrage via Nara Canal and a new Link upto Sakrand:

Mr. Deplaix ESCAP expert suggested an alternative in 1982. This consists of using Nara Canal upto tail at 116 mile and taking off a channel in deep cutting from there upto Sakrand and then out fall into Indus.The idea of making a deep channel was to avoid raising of structures and also prevent water logging. He did not give any dimensions and details of this project. The heavy cut would require excavation of large earth work and acquisition of land for spoil banks. The cost would be higher. In fact as the alternative it has one particular advantage that it avoids as in some alternatives of NESPAK and Irrigation and Power Department, Sind the still channel with losses

and the Jamroa and Rohri Canal which have their own problems. It is in fact a modification of alternative one of Mr. Khan.

Recommendations:

It would be seen from the previous pages that the alternatives using Nara Canal have definite advantage over those using Rohri Canal or Jamroa Canal. The still water portions connecting the canals to the river suffer from some disadvantages such as losses whereas a multi purpose link for irrigation and navigation does not have this defect, however, the most suitable alternative, keeping in account future projects and for larger vessels is the Indus river itself.

VI. Kotri to Port Qasim

Port Qasim to Kotri is the most important section of all the inland navigation proposals as without connection to the sea inland navigation would not be productive. A reconnaisance study for this was carried out by NESPAK and report prepared in 1975. Development Workshop Consultants, 1984 also reviewed this proposal and agreed with NESPAK and updated the cost. This important section was examined by a Committee of experts under the Chairmanship of the Federal Secretary, Ministry of Water and Power on 23rd January 1986. This Committee decided that the proposals for this reach were conceptually unsound and on the basis of available information it was not possible to recommend any other route from the sea inland for which the development of a pilot project could be recommended As this decision denies the direct access to the sea, it takes away the main advantage of inland navigation. The objections raised by the Committee needs to be examined in depth as this is the most important component of the trunk route connecting Indus upto Kalabagh/Peshawar and other rivers to Lahore.

The first member of the expert committee to speak in the meeting was General Manager Planning, WAPDA who stated tht the previous studies were only partial pre-feasibility studies and no consideration was paid to commodities that could be moved and economic aspects of navigation. This statement seems to have been made as the officer has not studied the reports prepared thoroughly. The NESPAK study has gone into some detail and has even worked out the cost of the Port Qasim Kotri alignment as Rs. 180 million. There is a section in their report on traffic projections and economic benefits and another section on comparison of different transportation systems. This aspect cannot certainly be called a partial pre-feasibility report. Similarly, the report of development workshop has updated the cost of NESPAK to Rs. 450 million. Their report has a chapter on freight transport which deals with all commodities and their economics, transport sector plans, a section on institutional aspects and economic experience of other countries on inland navigation. There is a report by the Director General, Ports and Shipping of April 1985, which deals with transport of commodities for inland navigation, socio-economic impact, etc. Secretary Irrigation and Power Department, Government of Sind and his Chief Engineer made the following

engineering points:

Kalri Baghar Feeder

Kalri Baghar feeder has a length of 37 miles and a full supply discharge of 9,000 cusecs but being a non perenial canal, it runs with fluctuating supplies with very low flows in winter months. Required depth for navigation is available for about six months. The velocity in the canal has a range of 3 ft/sec to 4.5 ft/sec which is within the limits for navigation.

The bed width of the channel varies from 192 ft in the head reach to as low as 83 ft in the lower reaches with depths of 14.2 ft to 20 ft. respectively. This width is enough for navigation.

There are nine bridges on the canal, with spans varying from 60 ft to 22 ft. each. The overhead clearance of the bridges also varies from 1.9 ft to 6.49 ft and these bridges need to be remodelled for a clearance of 12 ft for navigation which has been considered by NESPAK

The objection that Kalri Baghar Feeder runs only in Kharif and as such still water channels have to be created in months when it does not have flow supplies is very valid. NESPAK have missed this point and designed the works assuming it as perennial. They have provided 4 locks in this 37 mile channel which could, however, help in creating still water channels if one more cross regulator across the K8 feeder & one lock are also provided. There should be no difficulty in creating those still water channels. The redeeming feature about KB feeder is that it has 14 ft depth and 192 ft top width in the first 30 miles and 20 ft depth and lesser width in the last 7 miles. It is easy to get still water channels for 6 ft. draft vessels even with small flows. Another very useful feature of KB feeder is that it has its sides lined which will prevent erosion by movement of heavy barges.

The crossing of Baran Nai is no doubt not easy. NESPAK have made use of the downstream cistern and stone apron of the Baran super passage by converting it into a weir by erecting gates. This is not a desirable design particularly as the setting of the bed of the weir is the same as the bed of the cistern i.e. RL 51.4 against the bed level of KB feeder of R.L. 45.12. The full supply level at the KB feeder at the entrance to Baran Nai is 61.16 leaving no margin for lower levels which will be attained. This level is too high when the KB feeder is made to run as a still water channel with very small supplies. the right solution for this is to shift the alignment of the level crossing some distance downstream to get the levels in the bed of Baran Nai corresponding to bed of KB feeder if it is made to run as a still water channel with very small supplies.

This would no doubt increase the length of the bye-pass channel and the cost of construction of a new level crossing but this has the following advantages:-

(a) An entirely new crossing of Baran Nai is available without fouling the existing super passage structure and creating silting problems.

(b) Baran Nai supplies could also be used through the level crossing for use of downstream canals as at present it is being wasted to the sea, thus making it is a multi-purpose structure. Darwat dam on Baran Nai upstream would further control the floods & benefit navigation.

The Committee of experts has decided that the alignment is unfeasible without considering the possible improvements in design. The two major changes now suggested make the KB feeder suitable for navigation even in non-flow season by still water sections in the feeder. the new level crossing makes passage through Baran Nai feasible and also taps the water of this river which is going waste to sea. The committee also considered an alternative of canalising Indus downstream of Kotri and gave it up as unfeasible due to low flows. Also a proposal for an inflatable downstream barrage on Indus by Mr. Van Houten UN expert was also considered unfeasible.

Kinjhar Lake:

The expert committee has reaised some objections about navigation of Kinjhar lake. It is stated that the upper inlet portion of the lake is silted and the lower end has rock in bed. The silt and rock has to be cleared if navigation is to be provided. An important point about silt in the upper portion is that this is going to dis-appear in the future as new Kalri Baghar canal has been constructed to carry all the silt instead of it passing through the lake.

Gharo Creek

It is stated that no hydrographic survey had been carried out in this Creek and the tidal levels had not been analysed to study the range of the tidal fluctuations and the back water effect. It has to be understood that Gharo Creek branches off from the Phitti Creek and thus enjoys the significance of being naturally connected to Port Qasim in its head reaches. All information about the Phitti Creek is available regarding tidal fluctuations, etc. The requirements for dredging could be easily worked out as all information is available with the Port Qasim authorities. In fact Port Qasim could take up this work. The level of the creek has been kept at RL 10 which is quite low for the outfall of the drain and connection to the creek. No regulator is required at the mouth as the mouth is Port Qasim itself.

Khui Ghari Drain Section:

The objections that the Khui Gharo drain is above ground level could be easily remedied if we lower the levels between the locks. In fact the lock at mile ten from Khinjar lake could be eliminated to lower the drain level below ground. i.e. from RL30 to RL20 and also save time in passing of craft through an extra lock.

The alternative of making use Pinyari canal upto Thatta and the Indus upto Keti Bander which was supported by the former Irrigation & Power Department West Pakistan in 1963 was given up as Keti Bandar was no longer the alternative port for Karachi after the discovery of

Port Qasim and also due to the other problems of low supplies in Indus and non-perenial nature of pinyari canal

VII. Freight projections and economic aspects

One very important point to be kept in mind is that water transport is the cheapest method of transport as compared with railway, road and even pipeline. The following table indicates the economics of water transport.

Typical Horse Power - Per-Net-Ton Ratios

Carrier type	Horse Power per Net ton	Statistical average Hosepower Per Net Ton
1. Rail road (freight)	3.5 - 1.0	2.64
2. Highway Trucks and semi trailers	11.33 - 2.13	7.0
3. River Tows	0.20 - 0.14	0.18
4. Bulk cargo ships	0.35 - 0.22	0.25
5. Pipelines	2.0 - 3.00	2.50

COST PER TON MILE

Transport type	Cost per ton mile (U.S. Cents)
1. Roads	2.86
2. Railways	1.061
3. Pipelines	0.236
4. Waterway Barges	0.092

Latest freight projections from JICA studies and NTRC are indicated in Table VII-1 which gives commodity tonnage & traffic projections by commodity and mode (Rail and Road) are indicated in Table VII-2. The Consultants state that long haul bulk cargo. Particularly of low value is well suited for water transport. This consists of foodgrains. cotton, coal & coke, rock salt, rock phosphate minerals and ores, iron and steel, cement, fertilizers, sugar edible oil, stone, stone ballast sand and gravel, dry cargo containers and P.O.L. They have also stated that water transport can provide in future 9900 million tonne-kms of cargo carriage which is 25% of the total cargo.

It is interesting to note that railway share of the total domestic freight traffic (in terms of tonne-kms) was 30.3% in 1980-81 recording substantial decrease from nearly 50% in 1971/72. Road transport has taken over most of this traffic with disastrous consequences. According to JICA study 1983, structural overloading together with inadequate maintenance is causing

complete failure on major highways. This sometimes results in loss of whole sections of highway system. For example, increase of axle load from 8 to 10 tons doubles the destructive effect. The situation reached a point of virtual break down in 1978-79 when National Logistics Cell (NLC) introduced 1,250 large truck/trailer units. NTRC special survey of NLC vehicles in 1982 recorded axle loadings as high as 10.8 - 13.23 tonnes.

The import of crude petroleum products cost Pakistan US $ 1.691 million in 1981-82 which is 30% of the total import or 69% of export earnings. High speed diesel oil which is mostly used by trucks and transporters has the highest share of 43% of POL consumption according to oil company advisory committee.

A report by D.G., Ports and Shipping gives an interesting analysis of the net saving that could be expected by inland water transport. They have worked out that the capital expenditure on IWT can be recovered in 4 years and a foreign exchange of US $ 125 million can be saved every year in future. According to Development Workshop Consultants, the annual fuel saving in cost is Rs. 350 million to Rs. 1250 million depending on the extent of traffic that can be diverted to the waterways. According to them the cost of making Indus navigable upto Kalabagh and connecting Indus to Lahore is Rs. 840 million. The cost works to one tenth of the cost of road per mile.

VIII. International benefits of Inland navigation waterway from Kalabagh to Port Qasim.

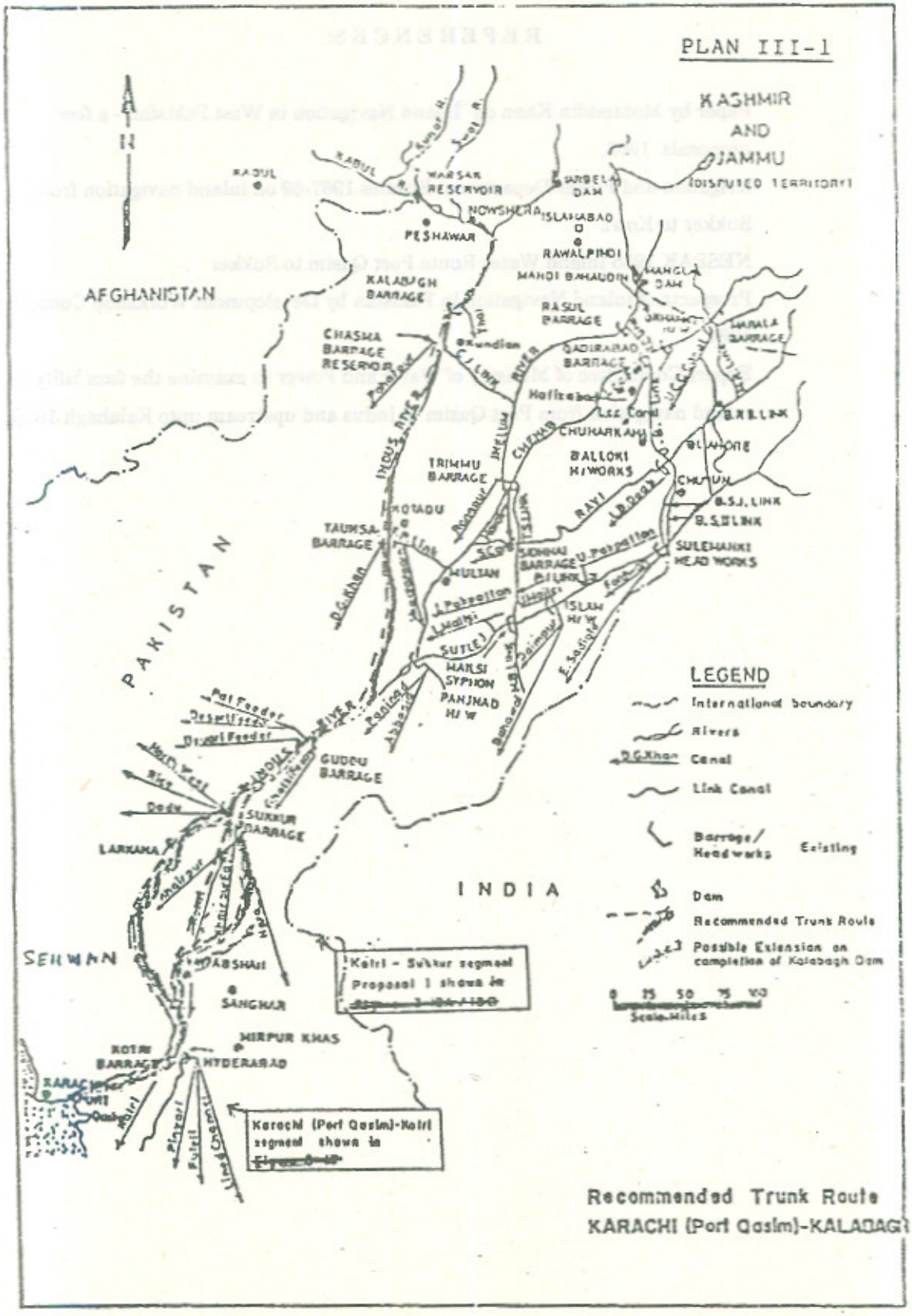
America Europe are giving considerable importance to inland navigation, even India is planning gigantic multipurpose canal from Ganges in the North to Cauvery in south India which will be a navigation canal. In Pakistan, we have not made any serious attempt to even revive the navigation that existed on the Indus from Kalabagh to Kotri. This has been mainly due to un-imaginative planning of our transport network by bureacrats who have no conception of modern inland navigation.

The author of this paper suggests that we should develop Port Qasim also as a port of transhipment of cargo particularly containers that could be transported from sea vessels to inland barges directly to save time and also reduce the pressure on railways and roads. The reduction of road traffic would result in great savings as discussed in the previous section. It is to be understood that new development of container transport has made this all the more necessary. A modern container ship costs US $ 50,000 daily. The barges could be unloaded up-country to rail and road vehicles on inland ports on Indus. An international inland port could be established for China and

even Afghanistan at Kalabagh. China could be a great beneficiary for its SINKIANG- and UIGHUR regions and western Tibet as the distance from Kashgar to Karachi would be cut to half at Kalabagh. Thousands of miles of haulage through sea could be saved by this route as the alternative route for China for western China would be through thousands of miles of sea route through straits of Malacca, Pacific and then by land across the whole of China to the West. As China has helped us in the construction of Karakorrum highway, they may be interested in developing the Inland waterway in Pakistan as a joint venture.

REFERENCES:

1. Paper by Mohiuddin Khan on 'Inland Navigation in West Pakistan - a few proposals' 1963.
2. Irrigation and Power Department Studies 1967-69 on inland navigation from Sukker to Kotri.
3. NESPAK 1975 Inland Water Route Port Qasim to Sukker
4. Prospects of Inland Navigation in Pakistan by Development Workshop Consultants 1984.
5. Expert Committee of Ministry of Water and Power to examine the feasibility of inland navigation from Port Qasim to Indus and upstream upto Kalabagh 1986.


PLAN III-1
KASHMIR AND JAMMU
(DISPUTED TERRITORY)
AFGHANISTAN
PAKISTAN
INDIA
KABUL
WARSAK RESERVOIR
NOWSHERA
PESHAWAR
ISLAMABAD
RAWALPINDI
TARBELA DAM
MANGLA DAM
MANDI BAHAUDIN
KALABUGH BARRAGE
RASUL BARRAGE
CHASHMA BARRAGE RESERVOIR
QADIRABAD BARRAGE
TRIMMU BARRAGE
MULTAN
TAUNSA BARRAGE
SULEMANKI HEAD WORKS
GUDDU BARRAGE
SUKKUR BARRAGE
LARKANA
SEHWAN
SANGHAR
MIRPUR KHAS
KOTRI BARRAGE
HYDERABAD
KARACHI
LEGEND
International boundary
Rivers
Canal
Link Canal
Barrage/ Headworks
Existing
Dam
Recommended Trunk Route
Possible Extension on completion of Kalabagh Dam
Scale-Miles
Kotri - Sukkur segment Proposal I shown in
Karachi (Port Qasim)-Kotri segment shown in
Recommended Trunk Route
KARACHI (Port Qasim)-KALABAGH

LONGITUDINAL SECTION

JAMRAO - KARACHI NAVIGATION CHANNEL

FIGURE. V-1

VERT. SCALE = 1 INCH = 100 FEET

HOR. SCALE = 1 INCH = 10 MILES

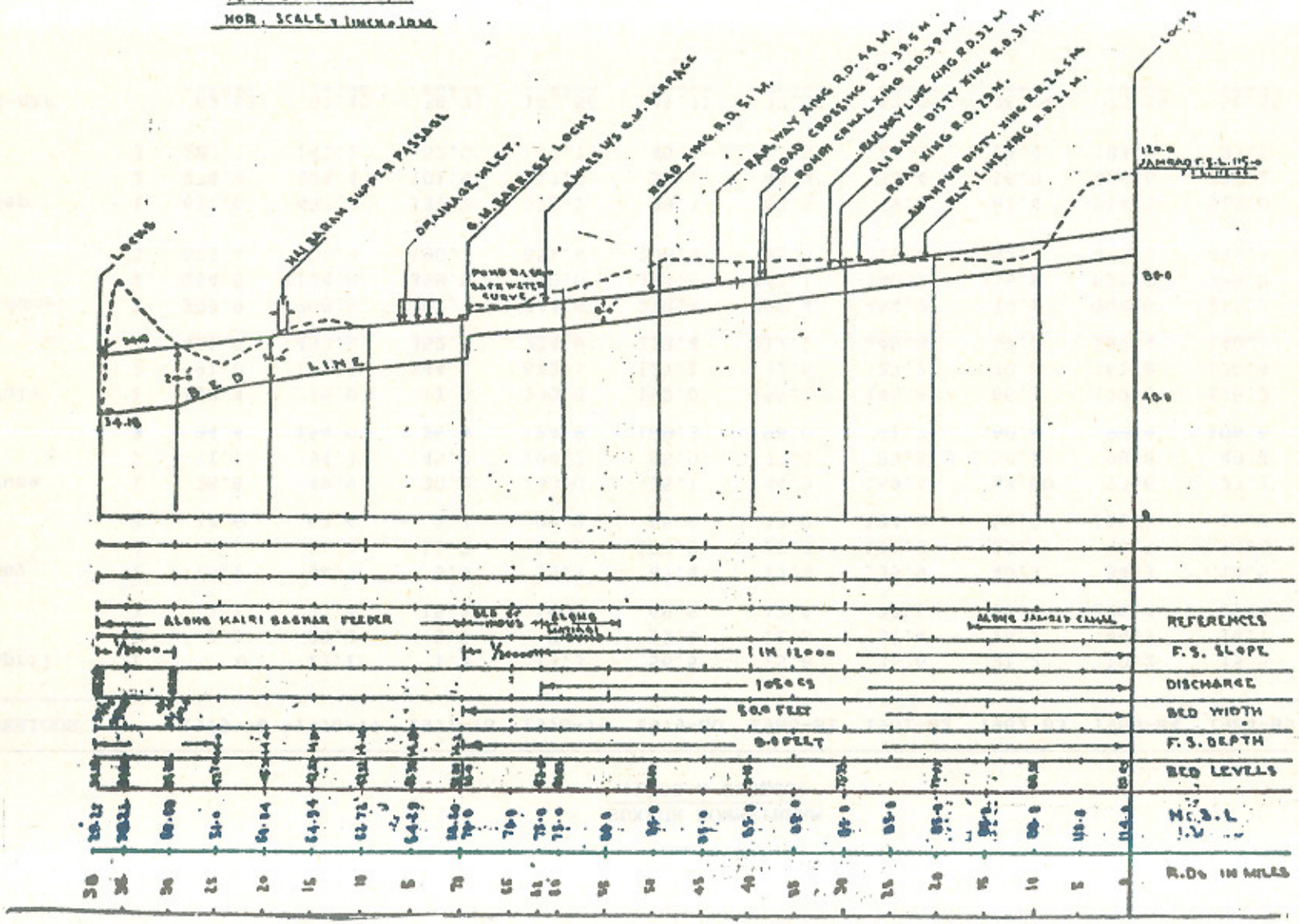


Table V-1

SUKKUR DOWNSTREAM

(1000 x CUSECS)

PERIODS		1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	Average
April	1	0	27.1	1.3	13.3	56.5	15.6	35.6	21.2	10.2	15.5	20.0
	2	5.3	29.4	5.5	8.4	55.0	12.0	31.4	26.2	44.3	14.7	23.0
	3	3.1	27.4	15.3	18.9	69.8	17.5	33.5	25.1	146.4	15.4	57.2
May	1	15.2	54.7	5.9	35.5	67.4	17.3	135.9	40.3	84.3	14.5	47.1
	2	4.1	61.2	11.2	66.3	100.9	20.3	101.6	63.4	46.7	14.0	55.0
	3.	14.6	67.4	2.7	99.8	65.0	32.8	194.2	50.0	111.1	15.9	63.4
June	1	28.6	49.9	30.9	133.0	25.1	44.9	169.5	43.00	93.6	27.3	66.6
	2	71.7	94.3	45.7	194.2	55.9	73.6	89.8	50.1	98.8	49.4	82.4
	3	94.4	154.0	26.4	124.8	109.3	98.0	41.7	60.8	99.4	106.6	89.7
July	1	108.4	39.0	11.5	230.0	192.0	158.1	145.8	66.3	129.5	126.9	120.8
	2	91.0	171.0	144.1	642.1	127.1	132.8	127.2	70.8	161.8	120.4	178.8
	3	421.7	430.3	352.4	724.9	233.4	212.1	249.8	57.0	127.4	140.1	294.9
August	1	209.9	708.6	307.7	744.8	273.3	292.4	454.2	70.1	204.0	211.2	347.6
	2.	264.5	1124.8	358.9	920.0	304.8	447.1	340.2	235.8	621.2	289.0	490.6
	3	603.4	707.9	190.7	651.4	208.5	85.9	218.4	292.1	478.0	439.3	387.6
Sep:	1	657.0	497.7	132.7	276.2	39.3	80.9	79.0	82.4	554.3	512.0	291.1
	2	274.8	424.4	101.9	117.0	25.1	44.4	53.4	16.0	426.6	278.1	176.2
	3	180.7	141.2	52.0	72.7	45.8	51.8	27.3	34.4	183.0	97.5	88.6
K-MAF		62.53	97.40	38.71	103.56	41.71	37.06	53.05	26.24	73.39	50.55	58.42

Table V-1 (Contd.)

SUKKUR DOWNSTREAM

(1000 x CUSECS)

PERIOD		1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	Average
Oct.	1	34.9	30.9	29.7	27.5	31.4	30.5	10.6	36.2	30.6	23.0	37.2
	2	4.3	11.6	33.0	25.9	14.5	32.0	15.3	36.6	36.4	15.6	22.5
	3	1.8	6.6	29.7	23.0	12.8	16.2	8.5	24.8	15.4	10.6	14.7
Nov.	1	0.6	8.6	3.7	10.6	8.3	13.1	6.9	13.0	8.0	8.5	3.1
	2	0	7.0	2.8	4.6	4.9	5.9	4.4	5.5	10.7	5.5	5.1
	3	0	6.9	8.3	7.2	5.1	2.2	2.5	0.2	3.4	5.1	4.5
Dec.	1	0	4.7	8.7	7.6	2.1	4.2	5.0	0	7.9	4.9	4.3
	2	0	0.9	0.5	1.9	4.9	5.8	2.3	4.6	11.1	3.0	5.8
	3	5.7	0.3	0	2.1	5.9	6.2	0	35.4	6.4	1.0	6.3
Jan:	1	9.9	22.2	12.8	7.7	12.7	11.7	10.9	20.2	14.5	8.8	15.1
	2	14.7	16.0	11.8	13.6	23.0	22.9	22.3	1.4	26.8	16.1	10.9
	3	3.3	20.1	1.2	9.2	10.0	26.3	18.8	5.1	38.2	13.7	14.6
Feb:	1	0.2	18.4	1.6	1.5	0.3	24.7	2.0	4.6	14.3	0.2	6.8
	2	0	2.1	6.1	5.9	0	12.2	0.8	9.3	1.8	0.6	3.9
	3	0	0	4.1	21.2	0	6.5	6.1	2.2	0.3	1.7	4.2
Mar:	1	0.9	1.2	2.9	47.9	1.8	1.5	9.6	0	1.2	2.8	7.0
	2	4.2	3.6	8.0	91.0	2.4	5.3	8.8	0	8.8	0.5	13.5
	3	19.8	2.3	27.9	35.7	4.8	15.5	6.2	2.5	14.9	0.9	13.0
R-MAF		2.45	3.30	3.92	6.88	2.94	4.92	2.96	4.12	6.33	2.44	4.03
A-TOTAL:		64.98	100.70	42.63	110.44	44.65	41.98	56.01	30.36	79.72	52.97	62.45

Table V-2

KOTRI UPSTREAM
(1000 x CUSECS)

PERIOD		1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	Average
April	1	0.9	12.7	11.6	20.1	19.5	6.1	10.1	1.7	3.9	10.3	13.9
	2	0.7	13.8	10.5	5.5	48.2	11.4	37.1	14.9	15.6	11.3	16.8
	3	1.1	15.5	16.3	6.2	35.4	9.6	17.7	19.6	95.5	13.8	25.1
May	1	3.3	27.3	19.7	14.1	54.8	11.9	70.7	17.2	61.3	12.1	29.2
	2	13.0	45.6	10.4	18.6	79.3	11.0	134.1	44.3	55.3	14.0	42.6
	3	10.3	53.5	12.7	70.2	78.4	18.6	155.5	40.3	70.5	9.9	52.0
June	1	16.5	56.0	9.7	105.5	40.7	27.9	159.1	20.9	78.0	8.5	52.3
	2.	58.4	54.7	44.2	128.1	19.0	57.6	107.0	27.5	109.3	24.5	61.0
	3	66.5	124.4	34.9	126.7	62.7	61.7	24.7	35.8	76.4	54.2	71.0
July	1	93.9	48.4	58.7	146.1	160.5	125.5	86.5	39.5	93.2	85.4	93.8
	2.	77.5	87.9	122.2	293.6	120.8	98.2	117.0	39.8	148.8	101.2	120.7
	3	196.2	232.2	237.0	426.8	174.7	135.4	132.2	59.2	99.2	107.0	178.0
August	1	199.5	330.9	276.6	570.7	242.8	196.3	226.8	34.6	125.4	158.9	236.3
	2	198.9	488.7	329.0	620.8	290.6	251.8	282.5	91.9	207.9	205.6	296.8
	3	339.8	728.2	204.4	676.2	175.2	143.8	251.4	217.5	335.3	256.3	332.8
Sep.	1	440.1	418.4	158.7	478.0	84.7	52.5	97.7	115.8	331.1	339.1	251.6
	2	314.4	467.7	107.6	149.6	19.3	66.5	42.6	17.0	448.6	281.8	191.6
	3	164.5	241.9	52.1	101.5	31.4	38.5	31.2	15.3	187.6	70.6	93.5
K-MAF		44.63	70.40	34.94	80.84	36.72	26.86	40.54	17.23	51.44	35.75	43.93

Table V-2 (Contd.)

KOTRI UPSTREAM
(1000 x CUSECS)

PERIOD		1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	Average
Oct.	1	79.0	75.9	51.8	47.9	55.1	26.3	17.7	23.7	35.0	32.1	42.3
	2	25.2	46.3	22.3	46.0	19.2	20.6	13.1	16.0	20.9	15.2	21.0
	3	7.8	26.5	24.6	34.1	16.9	14.8	10.6	14.0	12.4	15.6	17.0
Nov.	1	7.0	22.6	17.5	25.6	9.3	8.6	9.3	14.0	12.3	12.1	15.8
	2.	3.2	19.2	9.5	15.9	8.6	7.1	6.1	4.6	10.9	10.7	10.0
	3	3.1	15.5	6.8	9.0	7.0	3.9	4.8	2.0	10.4	3.4	7.3
Dec.	1	4.5	16.4	7.6	8.7	6.8	2.6	3.4	1.3	7.1	6.0	0.7
	2	3.1	15.8	6.6	7.6	4.9	4.5	5.1	1.2	9.1	6.9	6.5
	3	1.1	10.4	3.1	6.0	3.7	6.3	3.9	14.4	12.4	5.8	6.7
Jan:	1	10.0	17.3	3.9	4.1	2.8	4.7	3.4	17.7	9.1	2.7	7.6
	2	9.6	24.1	14.6	7.6	16.9	17.6	14.0	8.4	23.2	15.9	14.9
	3	6.3	19.6	7.7	12.2	15.6	27.3	16.1	2.3	35.4	16.0	15.9
Feb:	1	4.7	25.4	3.5	8.0	9.0	27.8	11.7	6.3	26.8	6.5	13.0
	2	3.9	18.3	3.2	6.7	2.6	20.0	2.2	6.2	10.5	5.7	7.7
	3	3.0	7.0	4.5	8.3	1.8	14.2	1.3	7.7	2.9	3.0	5.4
Mar:	1	2.4	5.4	4.0	57.0	1.2	6.4	3.5	3.3	2.3	3.3	6.9
	2	2.8	6.9	3.8	85.9	2.0	3.4	6.6	1.4	2.0	1.7	11.7
	3	5.0	10.7	14.1	46.0	2.8	6.0	4.9	1.0	4.4	1.0	9.6
R-MAF		3.68	7.71	4.21	8.42	3.20	4.46	2.84	2.98	5.02	5.43	4.60
A-TOTAL		48.31	78.11	39.15	89.26	39.92	31.32	43.38	20.21	56.46	59.18	48.53

SEHWAN BARRAGE FEEDER
AND STORAGE WORKS
N
PROPOSED
SEHWAN BARRAGE
MANCHAR
LAKE
SEHWAN
SL4
SL5
S1
S2a
S3a
S4a
NAWABSHAH
SEHWAN
FEEDER
CHOTIARI
RESERVOIR
LEGEND
Development Unit
Boundary

Fig. V-2

Table V-3

Sehwan Barrage Statistics

Item	Statistic
Area commended	3,568,000 acres present CCA
	2,964,000 acres development CCA
Length,	3,500 feet
Maximum headpond level	R.L. 123.0
Maximum holding level to command feeder	R.L. 110.0
Minimum downstream water level	R.L. 93.0
Total headpond storage capacity	1.0 MAF
Effective storage	0.8 MAF
Half-life of headpond	40 years
Head levels	R.L. 128.0
Head Regular Capacity	
Aral Manchar	20,000 cusecs
Sehwan Feeder	35,800 cusecs
Foreign exchange cost	Rs. 325 million
Local currency cost	Rs. 217 million
Total Cost	Rs. 542 million

Sehwan Feeder Statistics

Item	Statistic
Area commanded	3,568,000 acres present CCA
	2,964,000 acres development CCA
Length	74 miles
Head discharge	35,800 cusecs
Tail discharge	10,500 cusecs
Principal offtakes	
Rohri South Canal	18,000 cusecs
Jamroo Canal	9,000 cusecs
Mithrao Canal	5,800 cusecs
Khipro Canal	4,700 cusecs
Foreign exchange cost	Rs. 140 million
Local currency cost	Rs. 93 million
Total Cost	Rs. 233 million

Table VII-1

FREIGHT PROJECTIONS 1980/81-1999/2000
(by commodity tonnage)

thousand tonnes

Commodity	1980/81	1999/2000
Wheat	2014	4702
Rice	2884	6780
Cotton	749	3076
Edible oil	617	1857
Cement	2585	10917
Fertilizer	2702	8138
Iron and Steel	781	4000
Mining	10851	43280
Coal and Coke	2872	18154
Petroleum	4608	7936
Firewood	1013	3233
Agricultural commodities*	5064	13468
Others	16446	15166
Total	53988	182707

(Inter/district movement excluding localised intra-zonal road traffic)

*Agricultural commodities include sugarcane, fruit, vegetables and livestock

Table VII-2

FREIGHT TRAFFIC PROJECTIONS 1999/2000
(by commodity and mode)

Commodity	Mode	PROJECTIONS			
		Thousand tone (%)		Million tonne-kms (%)	
		Case A	Case B	Case A	Case B
Wheat	Road	2,760(58.7)	3,731(71.0)	746(39.6)	888(47.2)
	Rail	1,942(41.3)	1,523(29.0)	1,138(60.4)	991(52.8)
Rice	Road	5,506(81.2)	6,913(77.7)	3,187(71.9)	2,367(52.2)
	Rail	1,274(18.8)	1,989(22.3)	1,245(28.1)	2,170(47.8)
Cotton	Road	2,900(94.3)	2,942(91.8)	1,101(88.5)	998(78.2)
	Rail	175(5.7)	264(8.2)	143(11.5)	278(21.8)
Edible Oil	Road	1,571(84.6)	1,392(74.2)	620(67.4)	412(45.0)
	Rail	286(15.4)	484(25.8)	300(32.6)	505(55.0)
Sugar	Road	1,336(92.8)	1,415(92.1)	460(86.4)	411(75.8)
	Rail	104(7.2)	121(7.9)	73(13.6)	131(24.2)
Cement	Road	9,086(83.2)	9,328(81.5)	3,242(70.4)	2,106(45.6)
	Rail	1,831(16.8)	2,116(18.5)	1,365(29.6)	2,510(54.4)
Fertilizer	Road	5,351(65.7)	5,885(61.4)	2,388(53.2)	1,396(30.4)
	Rail	2,788(34.3)	3,695(38.6)	2,103(46.8)	3,197(69.6)
Iron and Steel	Road	3,875(96.9)	2,876(67..4)	2,062(92.6)	662(29.6)
	Rail	125(8.1)	1,392(32.6)	164(7.4)	1,572(70.4)
Mining	Road	41,889(86.8)	42,380(95.8)	8,536(93.5)	7,471(81.6)
	Rail	1,391(8.2)	1,842(4.2)	594(6.5)	1,681(18.4)
Coal and Coke	Road	15,803(87.0)	16,753(71.3)	11,360(82.1)	7,442(52.9)
	Rail	2,351(13.0)	6,753(28.7)	2,481(17.9)	6,636(47.1)
Petroleum	Road	6,808(85.8)	6,850(82.2)	1,961(76.7)	1,615(62.8)
	Rail	1,128(14.2)	1,508(18.0)	596(23.3)	958(37.2)
Other Dry Cargo	Road	47,318(86.1)	48,164(80.9)	23,578(77.6)	17,625(57.4)
	Rail	7,644(13.9)	11,364(19.1)	6,829(22.5)	13,088(42.6)

JICA (1982c) Table 3-1-6 page 165

A - Present Pattern
B - Sixth Plan