GOVERNMENT OF PAKISTAN
PLANNING COMMISSION
NATIONAL TRANSPORT RESEARCH CENTRE
ISLAMABAD

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INLAND WATER TRANSPORT
CANAL RECONNAISSANCE

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NTRC-117

APRIL, 1989

ACKNOWLEDEMENT

I appreciate the advice and help provided to me during this reconnaissance of canals by Mr. Muzzammil Hussain Qureshi, Secretary, Irrigation and Power Department, Government of Sind; Mr. Muhammad Idris Rajput, Additional Secretary, Irrigation and Power Department, Government of Sind, Karachi; Chief Engineer Irrigation Sukkur; Chief Engineer Irrigation Kotri and the officers of the Irrigation Department who accompanied me during the said tour. My special thanks go to Mr. Sardar Jang, Junior Hydrographic Officer, Port Qasim Authority, who accompanied me as a representative of Port Qasim/Ports and Shipping and whose hard work and contribution during the said reconn-aissance was very useful.

Table of Contents

SUMMARY

The use of the Indus River and its canals for navigation has been the subject of extensive discussion and study in the past. Although, presently there is no worth-while inland water transport in existance in the country, this was not always like that. River Indus and its tributaries had been functioning as conduit for transport since time immemorial. Record on navigation in the past indicates that water transport flourished in Indus River up to the end of the last century.

In the past, a number of efforts have been made to determine the navigational potential especially of Indus River but proved fruitless due to divergent views concerning the most critical issue i.e. quantum of draft available below Sukkur during winter months. Unfortunately most of the studies carried out in the past were desk studies. The National Transport Research Centre (NTRC) always felt that given a great advantage of economics of transportation by Inland Water Transport (IWT) and the vast net work, the feasible, development of IWT should be one of the major initiatives in the future. Subsequently an Indus River Expedition was arranged by NTRC in December 1987 - January 1988 from the junction of Kabul River (Attock) to the mouth of Indus at the Arabian Sea. With one of the objectives of determining the depth of the water available in the main channel of the Indus during dry winter season. This Expedition confirmed that the River downstream of Sukkur was not navigable during the winter months.

Hence, the idea of finding an alternate IWT route between Sea and Sukkur came to the mind of those interested in exploring the possibility of an inland water system in the country.

With a view to further explor the possibilities of Inland water Transport in Pakistan, a reccee survey was organized by the National Transport Research Centre from 10th February to 13th February 1989 along the existing

canals between Port Qasim and Sukkur. The survey team was headed Dr. M. Tahir Masood of the Centre and included representative from Port Qasim/D.G. Ports and Shipping and the concerned officiers of the Sind Irrigation Department. Salient findings of the survey are as follows:-

(1) All the previous studies and Indus River Expedition 1987/88 sponsored by NTRC have already established that the River Indus is navigable upstream of Sukkur upto Kalabagh practically during the whole year.

(2) The team inspected K.B. Feeder (Lower), Kinjar Lake, K.B. Feeder (Upper), Jam Rao Canal, Nara Canal and Rohri Canal.

(3) All these canals are perennial and run at full-depth except for a few days when annual maintenance is done.

(4) The canals provide sufficient depth of water (more than 9') and width (more than 50') required for the crafts normally used for IWT system.

(5) The bridges and regulators along these canals however do not have adequate head-room to allow free passage of the crafts.

(6) Rohri Canal has maximum number of structures (29 bridges and 19 regulators), followed by Jam Rao Canal (16 bridges and 14 regulators). Nara Canal has only 1 structure between Sukkur and Jam Rao Canal off-take.

(7) The most promising route appears to be Port Qasim - K.B. Feeder(Lower) - Kinjar Lake By-pass - K.B. Feeder (Upper) - Kotri barrage - Berani (New Channel) - Jam Rao Canal - Nara Canal - Sukkur Barrage.

(8) The development of a water-way along the above alignment will involve the following:-

(a) Stillwater Basin at Port Qasim linking the Port, via Gharo, with lower K.B. Feeder near Thatta.

(b) Navigational link of the stillwater basin with K.B. Feeder (Lower).

(c) Improvement/reconstruction of 1 bridge and 3 regulators along K.B. Feeder (Lower).

(d) Navigational link between K.B. Feeder(Lower) and Kinjar Lake by-pass.

(e) Improvement/reconstruction of 3 bridges and 5 regulators along the Kinjer Lake by-pass.

(f) Navigational link of Kinjer Lake by-pass with K.B. Feeder (Upper).

(g) Improvement/reconstruction of 1 Syphon, 6 bridges and 1 regulator along K.B. Feeder (Upper).

(h) Navigational link of K.B. Feeder(Upper) with the River Indus above Kotri Barrage.

(i) Another navigational link on the other side of the river above Kotri Barrage.

(j) Construction of New Channel between Kotri and Berani linking Kotri Barrage with Jam Rao Canal. This will also involve the crossing of Rohri Canal.

(k) Improvement/reconstruction of 10 bridges and 4 regulators along Jam Rao Canal.

(l) Provision of navigational link with Nara Canal at Head Works of Jam Rao Canal.

(m) Improvement/reconstruction of 5 bridges along Nara Canal.

(n) Provision of navigational link between Nara and the Indus River above Sukkur Barrage.

(o) General improvement of all the existing canals — their banks, desilting and removing of weeds, and improving/reconstruction of existing structures (bridges and regulators) falling along the proposed route.

The preliminary ground reconnaissance indicates that inland navigation from the Sea to Sukkur along the proposed route is technically a viable project. According to very rough estimate, the cost of improving the water-way route is Rs.1500 million for alternative-1 and Rs.1700 million for alternative-2, but exact indication of cost and economic viability is not available at this stage. The requisite information can only be obtained through a detailed Techno-economic Study, for which negotiation are underway with USAID.

INTRODUCTION

There is no inland water transport system in the country except for about 2,000 country boats operating in the private sector between Sukkur and Kalabagh with the biggest concentration in the 152 Km reach between Sukkur and Guddu. The Indus River is the main river of Pakistan and in terms of the extent of dependent agriculture, it is one of the most important rivers of the world. The principal rivers of the Indus system are of perennial nature but the flow in each varies enormously during the year. So the flow in Indus River is at minimum during the five months of winter (December to April), with maximum flow occurring during July-September moon-soon season.

Pakistan has one of the largest irrigation networks in the world and some of the canals are even larger than the largest rivers in Europe. Whereas each small canal in Europe is navigable in some way, no real benefit has been derived from this great national resource so far in Pakistan. In the past, a number of efforts have been made to determine the navigational potential especially of Indus River but proved fruitless due to divergent views concerning the most critical issue i.e. the quantum of draft available below Sukkur during winter months. Those favouring the idea believe that not only sufficient draft is available to allow navigation by modern flat-bottomed crafts but alternate links to sea can also be used to serve the purpose. Those opposing the proposition remain un-convinced. Since almost all these were desk studies, unfortunately, neither side has any incortrovertibel facts to present and hence the impass.

The National Transport Research Centre however feel that given the great advantage of economics of transportation by Inland Water Transport (IWT) and the vast network, the feasible, development of IWT should be one of the major initiatives in the future.

Since the entire issue seemed to be dependent on the question of draft below Sukkur, the Centre had been making efforts to find ways and means to obtain the answer. This obviously could only be done by actually measuring the available draft during the minimum flow period all along the river but especially below Sukkur.

NTRC sponsored an Indus River Expedition in December 1987/January 1988 which explored the Indus River from Attock to Port Qasim. The recommendations given by the said expedition are :-

(a) The team strongly recommends that further study be made of the entire channel system. It is necessary to complete extensive cross-sectional analysis of the inland navigation. Simply having adequate depths in the channel is not sufficient to permit practical navigation. Radius of channel curves, width to permit two way traffic with suitable safety margin, and stability of the bottom materials in regard to shifting bars and shallows needs to be evaluated.

(b) Consideration must be given to the minimal channelization operations necessary to sustain an uninterrupted commercial season. Also the impact of the summer flooding and consequent channel alterations must be taken into consideration. Development of navigation markers and a suitable maintenance and updating procedure must be pursued.

(c) The team recommends that a study be undertaken to determine the most desirable configuration for bulk commercial vessels and driving system that would be compatable with the unique characteristics of the Indus and it's attendant canals. Simply modeling on the European or American transport systems might not be in the best interests of Pakistan. Utilizing smaller, shallower draft vessels that could navigate the Indus during the dry season and accommodate the narrow channels, and at the sme time be compatable with the restrictions of the existing canal system might be advisable. The unique qualities of the Indus preclude simply adopting equipment designed for rivers of more consistent flow rates and uniformly deeper and straighter channels.

(d) If commercial traffic seems practical, it is recommended that a serious effort be made to utilize the expertise of local fishermen, hunting guides and ferrymen as pilots, and to help establish and maintain navigational markers. These people are acquainted with the unique characteristics of each section of the river and would be invaluable resources in establishing a successful navigational system.

(e) Although several of the Barrages have boat locks, not all appear to be in suitable condition to accommodate regular traffic. It might be necessary to either modify the locks to accept new vessel designs (see C above) or develop vessels compatable with the existing lock configurations.

(f) The team recommends a survey of the existing canal system with the objective of incorporating them into a unified inland water transport system in conjunction with the Indus channel. The extensive canal system presents obvious possibilities of utilization for transportation.

The obvious problems include the need to modify existing bridges over many of the canals to permit passage of commercial sized vessels and the potential damage to canal channels by boat wakes and propeller wash. It is apparent that not all canals would lend themselves to this utilization, nor would the necessary modifications be economically feasable in some cases. It might be possible to consider a long term programme of up-grading as bridges need major repair or expansion as a consequence of the continuing increase in vehicular traffic.

(g) It is recommended that the waterways connecting Port Qasim to Hyderabad, either via the Indus or creeks, canals and the Indus, be investigated with the objective of initiating commercial traffic to the interior. The increasing vehicular traffic could be alleviated if a significant portion of bulk goods could be transported by water.

(h) The existing ferry traffic and local barge traffic should be studied to determine the actual amount of material being transported seasonaly and to ascertain which sections of the river both support significant amounts of traffic and have the potential for further expansion. There are regions where there was very little evidence of existing traffic and other regions where apparently a thriving barge traffic exists. Much of this traffic may be local commodities but some might be adaptable to other materials and further alleviate the vehicular congestion.

(i) Any development of the river for navigation will necessitate the cooperation of existing irrigation and electrical generating programmes with a developing water transportation division. Although the objectives of the different divisions might seem to be at odds, in reality they have the same goal, that of the most efficient utilization of the Indus waters. The inland transportation does not "use up" the water, but indeed, it does have specific requirements. Studies would determine the minimal water levels necessary for navigation that were compatable with the maintenance of adequate flow for the irrigation canal system. It might be determined that specific sections of the river could not meet all of the volume demands during particular drought periods. This could be integrated into an overall plan to make the best use of the available water in those sections of the "Maintenance" of the channel.

PAST NAVIGATION STUDIES

The use of the interconnection network of rivers and canals of Pakistan for navigation has been the subject of extensive discussion and study. Interest in the subject was generated when large inter-river link canals were being planned following the Indus Waters Treaty of 1960. In 1959, the President of Pakistan directed that possible use for navigation of the Indus River from Kalabagh to the Sea and of the canals be examined. This and a later directive in 1966, led to studies by individuals and government agencies during the sixties. Later, in the wake of the international oil price rise and the overloading of Pakistan's rail and road systems, interest in the subject was renewed and in 1974 the federal government commissioned two studies to examine the possibility of using the Indus from Kalabagh to Sukkur and connecting Sukkur to the new Port Qasim. In early 1981 UNDP provided the services of Mr. J. M. Deplaix, IWT Expert to assess the possibility of development of inland waterways in Pakistan. In March 1984, a comprehensive desk study was completed by the Irrigation Drainage and Flood Control Council of Pakistan. In October 1984, Mr. Leonard E. Van Houten, UNDTCD Adviser on Inland Waterways visited Pakistan to investigate the potential for inland water transport. More recently in January 1987, US Department of State (Department of Army for TDP of the IDCA) arranged the visit of Specialists to Pakistan for the appraisal of prospects for Inland navigation (report dated May 1987). Subsequently, an Indus River Expedition was arranged by the NTRC in December 1987 - January 1988 from the junction of the Kabul river to the mouth of the Indus on the Arabian Sea with one of the objectives of determining the depth of water available in the main channel of the Indus during dry winter season. The JICA Study Team in their Final Report on the Pakistan National Transport Plan Study (March 1988) have recommended that a detailed techno-economic study be carried out to assess the feasibility of the inland water transport system. It may thus be seen that most of the efforts so far made are in the form of 'Desk Studies'.

U.S. TECHNICAL MISSION REPORT

The team, after careful examination of technical and economic/financial aspects with regard to viability of a prospective navigation project, found that :-

(a) Essentially no use is currently being made of the Indus River and associated irrigation canals for the transport of commercial products. On the other hand, the existing railways and highways cannot provide economical transportation for bulk commodities as will be needed to sustain a growing economy.

(b) pakistan's current inland freight transportation systems are relatively inefficient with disproportionately large share (75 percent) moving by railway.

(c) Highway and railway systems are in poor condition with overloaded trucks causing accelerated highway deterioration and absolete rolling stock and priority emphasis on passenger service greatly limiting railway freight capacity.

(d) Existing transportation deficiencies result in unsatisfied demand, high transportation cost and constrained development of mineral resources such as coal and iron ore.

(e) Demand for freight transportation is projected to grow from current levels of 60 million tons per year to about 210 million tons in the year 2000, to about 700 million tons in the year 2020.

(f) Administrative actions, to achieve more cost effective organization of the transportation system; and massive capital investment will be required to satisfy projected demand.

(g) pakistan's extensive system of rivers and large water supply canals provide a rational starting point for development of a comprehensive inland navigation system.

Consequently, the team focussed their attention mainly on identifying a conceptual plan for development of an inland navigation system in Pakistan which could be technically feasible, exhibiting reasonable prospects for economic justification and cost benefits. The team's Study results envisaged that :-

(a) First phase of inland navigation system would consist of an efficient high capacity trunk-line from Karachi area (Port Qasim) to inland centres of agriculture, commerce, mining and manufacturing in the Lahore, Rawalpindi and Peshawar areas.

(b) Initial development of a basic trunkline navigation system would entail about 1,400 miles of rivers and canals; at least 10 locks; extensive dredging and river training works; substantial relocations of railway, highway and canal crossings; inland ports and operating facilities and equipment at an initial start-up cost well in excess of $ 1,000,000,000; with cumulative development costs in excess of $ 3,000,000,000 during the first twenty years of project life.

(c) Upfront costs could be minimized by time phased expansion of trunkline capacity from about 15 million tons annually in year 2000 to over 45 million tons annually in year 2020.

(d) Initially, an inland navigation trunkline will divert inefficient energy intensive bulk commodity shipments from the highways.

(e) Ultimately, the navigation trunkline could complement the bulk commodity capability of a modern railway system for long haul-low cost movement of such bulk commodities as grains, cotton, coal and iron ore.

(f) On an average annual basis, direct navigation system benefits for the least favourable conditions considered by the team could be expected to exceed costs for all discount rates below 8 percent. Under the most favourable conditions benefits would exceed costs for all rates upto 12 percent.

(g) Significant indirect benefits would include greater competitiveness with foreign imports; reduction of fuel consumption; promotion of expanded utilization of coal for electric power generation and industrial production.

(h) Decision level analysis of the viability of an inland navigation project was dependent upon concurrent and comparable analysis of railway and highway modernization and expansion of alternatives as well as alternatives for satisfying future water supply requirements in the lower Indus basin.

The Team concluded that, subject to the provision of strong support and active participation by the Government of Pakistan, a feasibility level study of a Pakistani inland navigation system was clearly warranted. Essential Govt. of Pakistan participation would include collection of basic data and concurrent development of long range plans for transportation and water project development.

In July, 1987, the US Technical Mission furnished a report to Economic Affairs Division, through the US Embassy, recommending a feasibility study costing about 1.5 million US dollor. However, the US Government offered through the TDP, funds upto US $ 500,000 for the said study.

NATIONAL TRANSPORT RESEARCH CENTRE VIEW

We in NTRC/Planning Commission agreed with the Ministry of Communications approach that a full scale, indepth, comprehensive and a decision-oriented feasibility study based on actual field investigation/surveys is required on a section by section basis starting from Port Qasim side upwards towards the North comprising technical, economic, financial and managerial (construction, operational). The work programme for the study can include: (1) analysis of Indus River fleet requirement; (2) identification of transport needs; (3) hydrology assessment; (4) navigation review; (5) management review; (6) dredging requirement; (7) port evaluation; (8) cost/benefit analysis; and (9) recommendations for phased development. But, we do not agree with undertaking the said study as a whole i.e. the most important thing is, to first, establish a water way. It is better to spend time and effort on considering all the aspects mentioned under the work programme above but under a phased programme. Most important thing is to consider the section from the Arabian Sea to Sukkur and carry out a reconnaissance to establish a suitable water-way alignments. So, there is a need for a test study for the said section (Sea to Sukkur) which may consist of air and/or ground reconnaissance of the river and the canal systems in the area.

GROUND RECONNAISSANCE

Accordingly, the Senior Chief NTRC ordered a ground reconnaissance which was undertaken by Dr. M. Tahir Masood, Consultant NTRC and Mr. Sardar Jang, Junior Hydrographic Officer, Port Qasim Authority, Karachi. An Officer(XEN/AXEN) of Irrigation Dept. joined the team for his respective area. Transport and local hospitality was provided by the Chief Engineer Irrigation, Kotri and the Chief Engineer Irrigation, Sukkur Barrage under the kind instructions of the Secretary Irrigation, Govt. of Sind, Karachi.

On 9th February 1989 the team visited the office of the Additional Secretary Irrigation, Karachi who provided useful information and a map of Sind showing irrigation and drainage systems. The team also met Mr. Baluch, retired Chief Engineer Irrigation who also provided some very useful information about the canals in the area. From the above map and the information, it became clear that the team should reconnoitre the following canals :-

(a) K.B. Feeder (Lower)
(b) Link Canal and Khinger Lake
(c) K.B. Feeder (Upper)
(d) Jam Rao Canal
(e) Nara Canal; and
(f) Rohri Canal.

All these canals are parennial and during the Summer months and sowing season they run at full-depth. Except Nara, all these canals are designed and dug while Nara Canal is dug for only 8 miles (starting from Sukkur Barrage), and the it flows in the old river bed. Over the passage of time bunds were constructed to channelize and stop erosion which gave shape to the banks of Nara Canal.

The team started on the morning of 10 February 1989 from Port Qasim and travelled on the inspection path along K.B. Feeder(Lower), Khinger Lake, Link Canal and K.B. Feeder (Upper). On 11-12 February 1989 the team travelled on the inspection path along Jam Rao Canal, Nara Canal, and Rohri Canal. The team collected data on velocity of current, discharge, width of channel and water depth and quite a few places along the canals. They also collected data on various bridges, sluice valves, regulators and head works at Kotri and Sukkur. The said information was verified by the Team and was supplemented by the information and blue prints provided by the Irrigation Department Officers who accompanied the team during the said reconnaissance.

The inspection path runs along the bank of all the canals except Nara where it runs at a distance of 500 to 1500 feet from the water channel at quite a few places.

The brief information & sketches on these canals is given at Annex-I, while the detailed information is given in the tables at Annexure-II. The map showing the said canals and reconnaissance route is at Annexure-III.

PROPOSED STANDARDS

US Department of State Report of May 1987 suggests the following standards:-

(1) Pusher-boat (power unit) as standardized unit about 100 ft long and 25 ft wide with a loaded draft of 6 ft.

(2) Barge, single-skinning, all the open hopper type, to carry bulk-cargoes. The barges are 25 ft wide and about 150 ft long with a capacity of about 100 tons per foot of draft. The maximum loaded draft will be 9 ft with a capability for initial operation at 6 ft draft.

(3) Lock — each lock shape sized of pass the standard two configuration of barges and pusher-boat in a single lockage. The three respective conditions suggested are :-

(a) 15 million tons - 6 ft draft;
(b) 30 million tons - 7.5 ft draft;
(c) 45 million tons - 9 ft draft.

SUITABILITY OF CANALS

As seen from the data collected on the canals reconnoitred by the team provide sufficient depth of water and width required as per proposed standards mentioned above. Minimum width and depth available along the route studied are 79 feet and 11.3 ft. respectively. The structures (bridges and regulators, etc) along these canals have been designed and constructed without keeping the navigational aspect in mind. Hence, the overhead clearance above the water level ranges from 2-3 ft. on the averate. Rohri Canal has maximum number of structures (29 bridges and 19 regulators), whereas Nara Canal has very few structures (only 5) over their entire lengths.

WATER-WAY ALTERNATIVES

As a result of the said reconnaissance following alternative water-ways are suggested (Sketch at Annex-III & IV):-

(1) Port Qasim (Phitti Creek) should be connected by Khui Gharo drain. There after develop a new channel (60 km) to join K.B. Feeder (Lower) near its Tail i.e. Head Works of Oderolall Branch. From there follow K.B. Feeder (Lower) (19 Km) - Link Canal (40 Km) - K.B. Feeder (Upper) (56 Km) to Kotri Barrage. From Kotri Barrage develop a channel (80 Km) to join Jam Rao Canal in the general area of Mirpurkhas or in general area of Tando-Adam. Then follow Jam Rao Canal (96 Km) to its Head Works and then along Nara Canal (146 Km) right upto Upstream of Sukkur Barrage. Approximate distances are shown in the table on the next below:-

Table
Approximate Distances

S. No.	Name (Leg)	Distance (Km) Alt-1	Alt-2	By Road (N.Hwy.)	By Rail	By River	Remarks
1	2	3	4	5	6	7	8
1.	Port Qasim to Kotri	175	175	165	167	170	-
2.	Kotri to Sukkur	322	311	316	298	470	-
3.	Total (Port Qasim to Sukkur)	497	486	481	465	640	River does not flow close to P.Q.Barges will have to travel quite a distance in sea to reach P.Q.

(2) Follow the same suggested route as alternative (1) upto Fazlani and then along Rohri Canal right upto upstream of Sukkur Barrage. The total length of water-way is approximately 486 Km.

In both alternatives the proposed leg from Port Qasim (P.Q) to Kotri Barrage is the same. From Kotri to Sukkur the water-way length along Rohri is a little shorter i.e. by 11 Km but due to presence of lot many structures along Rohri Canal it may not be cost effective. The route along Jam Rao - Nara Canal faces same problem along Jam Rao Canal i.e. quite a few structures but it is cost effective along the length of the water-way through Nara Canal. Similarly some engineering works would be required to Kotri and Sukkur Barrages to achieve entry from K.B. Feeder (Upper) and Rohri/Nara Canal respectively.

An Irrigation Officer suggested the consideration of Nara Canal for IWT system, all the way through its length and then developing a water-way along Thar Escape and Doro Puran joining the Arabian Sea near Mithi/Khinger Kota. How suitable is the coast line here is a debatable point.

COST ESTIMATES

a) Alternative I .... Rs. 1,500 million

b) Alternative II .... Rs. 1,700 million

These guess estimates are based on the following works:-

(1) Development works at Sea/Port Qasim/canal ports enroute.

(2) Construction of new channel from the Sea to the existing canal (stillwater basin).

(3) Improvement of existing canals along the suggested route.

(4) Re-construction/improvement of existing structures (bridges, regulators, etc)along the canals upto Kotri.

(5) Engineering works required to develop an entry into the River from K.B. Feeder Upper and exit from Indus River upstream of Kotri Barrage

(6) Construction of a new channel from Kotri to Rohri/ Jam Rao Canal

(7) Reconstruction/improvement of existing structures along Rohri/Jam Rao - Nara Canals

(8) Engineering works involved in development of entry into the River upstream of Sukkur Barrage.

USE OF DRAINS

Some time we hear people talking about the use of Left Bank Outfall Drain (LBOD) and other drains to be developed for use as a channel for inland water transport system. I personally do not agree with this because such drains have been constructed with a specific purpose of curtailing the menace of water-lodging and also providing an escape for the flood water in the area. During winter months i.e. non-flood season there is hardly any water available. In case some one suggests to develop these drains in such a way so as to provide adequate water from the existing canals or from Kotri/Sukkur Barrages, even then that is not a practical solution because no additional water is available for this purpose. Kotri and Sukkur Barrages have been designed to meet specific irrigation needs of the area. In fact vast area in Sind is still barren due to lack of water for irrigation, for example Therparker. The Irrigation Department has many plans for future to construct additional canals/branches to irrigate the vast tract of land. One such development is the construction of 49 mile long canal to run parallel to Jam rao Canal starting from Jam Rao Head-works.

NEW CHANNELS

The water through the IWT channels will flow into Sea which will be a waste. Hence, we may consider to have a stillwater basin.

Under the above mentioned circumstances we will have to design the inter-connecting new channels in such a way that either they have stagnent water or fit in the existing canal system to irrigate the lands to meet the requirement of water to run IWT system. We need to worry about the critical five months from December to April when there is not enough draft available in the River downstream of Sukkur and there is overall shortage of water in the canal system of the area and also the canals are closed for desilting. Under these circumstances, one may suggest a few development works so as to store enough water during the summer months and flood season. The water, thus, stored in the shape of big lakes can be released as and when required to meet the demands of IWT water-way. Once the proposal is adopted, the IWT system has to be very closely linked with the irrigation system. In case a stage comes when a decision is made to create a water-way along the selected route, the planning, design and construction of the system must be closely linked with the improvement and expansion projects of the Irrigation Department.

In addition to development works concerning bridges, regulators and barrages, there will be a requirement of adequately raising and strengthening of the canal banks to cope with the turbulance created as a result of traffic in the canals. As mentioned earlier, the River from Sukkur to Attock is quite suitable for navigational use as enough water is available throughout the year. There is a proposal to construct a Dam at Kalabagh which will definitely influence the river flow/quantity of water between Kalabagh and Sukkur. If this Dam is constructed, then the proposal to plan IWT system may need to be reviewed again. Fishing nets pose a problem to navigation in the river.

CONCLUSION

The priliminarily reccee done by me indicates that the prospects of constructing a water-way between Arabian Sea and Sukkur for navigational use, are quite promising. Now, a comprehensive study including a detailed reconnaissance of the area is recommended. This study of the water-way from the Sea to Sukkur Barrage should be taken as the Phase-I of the overall study as mentioned above in this report. There is a requirement to prepare a detailed estimates for various alternatives discussed above.

Once the water-way has been established, engineering effort is known and the cost estimates prepared then one can proceed with the Phase-II of the study which includes other items of work programme mentioned on page 9. We suggest this because it is very important to first establish the water-way, know quantum of work involved and the cost estimates so that the cost benefits prove the viability of the project and also Government accepts the project vis-a-vis its cost in principal. Once the project, as a result of Phase-I, is found viable and accepted in principal, then we should go ahead to design the complete IWT system from the Arabian Sea to Attock/Kalabagh.

Here we would like to mention that we should also consider the use of road transport and railway i.e. we may like to know the cost of developing a second highway from Sea to Sukkur and/or develop additional railway facilities between these two points. May be the cost of putting the

IWT system between the Sea and Sukkur is too high as compared to the development of the other two modes i.e. road and rail. In other words, I am suggesting the consideration of another alternative whereby we have IWT system from Attock/Kalabagh to Sukkur or Multan to Sukkur and use road/rail from Sukkur to Sea.

At the end let me say a few words about the IWT system in USA and other countries of the world. We feel that most of such systems have not been designed basically for irrigation only. These have been designed and constructed/improved, basically, for generation of power and navigation.

The initial cost of putting the IWT system in place may be closal which can only be met through a consortium of international agencies. But, in the long run the project may yield a good benefit - cost ratio making it a viable project. One horsepower is known to move an average 150 Kg on road, 500 Kg on rail and 4000 Kg on water. It is estimated that in USA the average cost of carriage by IWT is one-tenth that of rest.

Annexure - I

- Brief Canal Data
- Information Notes

BRIEF CANAL DATA

Sl. No.	Name	K.B. FEEDER LOWER			LINK CANAL			K.B. FEEDER UPPER			NARA CANAL			ROHRI CANAL			JAM RAO CANAL		
		Head	Middle	Tail	Head	Middle	Tail	Head	Middle	Tail	Head	Middle	Tail	Head	Middle	Tail	Head	Middle	Tail
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.	Width (ft.)	165	133	79	175/140	136	136	192	191	-	346/370	400	270	237	137.0	39.5/22	165	85	23
2.	Depth (feet)	13.3	11.4	11.3	13.9	-	13.9	13	-	15	14.6	17.4	18.04	12.0	12	5.5	-	-	-
3.	Dis-charge (cusecs)	6854.8	4329.48	3000	8154/7106	6822/6922	6854	8980.59	8771.87	8153.92	13649/12325	12300	12280	10465.0	5638	513/265.8	3400	1250	41
4.	Velocity (ft/sec.)	2.88	2.8	2.67	3.36	-	3.36	3.11	3.09	3.92	3.32/2.27	2.27	2.27	3.5	3.14	2.05	3.78/2.51	2.45/2.36	2.05/0.92

Note:

K.B. FEEDER LOWER: The tail of the canal at RD 103 which is at a distance of 104 Kms from Port Qasim. At RD 103 is the Head Works of Sakro Branch which has a discharge of 2501 cusecs.

K.B. FEEDER UPPER: At RD 190 is the head of link canal and tail of K.B. Feeder Upper. At this point there is a village bridge which has 5 spans and 15 feet roadway. This canal has inlets as well as intake for rain water from the surrounding areas and irrigation is by lift pumps. At RD 151 is a road bridge of 15 spans, each 22 feet. This canal is approximately 30 miles long.

contd.../-

NARA CANAL: The length of Nara Canal from Sukkur to Jam Rao head is 115 miles and width ranges from 400' to 500' and the depth is from 15' to 25'. From RD 505 Nara Canal has a natural flow and from RD 00-2505 irrigation is done by pumps that is lift irrigation. The inspection path is close to the canal at RDs 478, 465, 451, 438, 423, 418, 412, 407, 391, 367, 381, 371, 364, 352, 343, 338, 334, 325, 324 and 320, otherwise the inspection path is quite far from the water channel and is not accessible by vehicle. There is Irrigation Rest House at Tajjal, RD 373. At RDs 320, 316, 313, there are small villages which have small markets mechanical maintenance shops then there is a Rest House at Kathore, RD 294. There is a Boat Bridge at RD 275. There is another Rest House and a road bridge at Saidu.

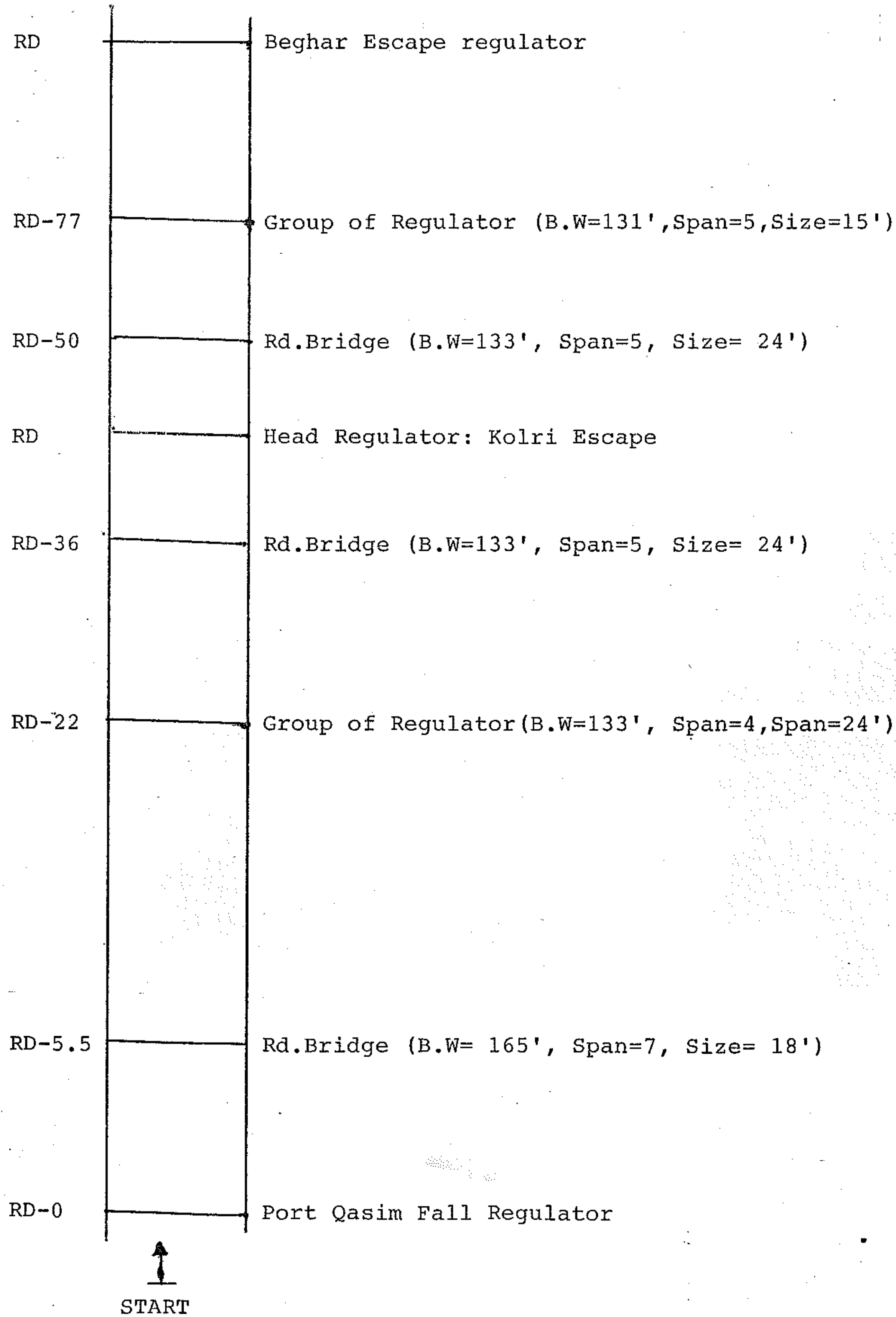
JAM RAO CANAL:- Village Dalore is situated at mile 49. The total length of Jam Rao Canal is 124 miles. The tail of Jam Rao Canal is at Jaddo at mile 124. At mile 43 the canal crosses LBOD through a syphen which also has a bridge of 4 spans named Landhi Bridge.

LAKE KHINGER:- Khinger Lake has total area of 50 sq. miles and its was constructed in 1957. Its storage capacity is .508 million acre feet and useable capacity 38 mg feet, the average depth of the lake is 25 feet and the maximum depth is 54 feet. Deposition of silt per year is 4,335 acre feet. The design and life of lake is 102 years but after opening of link canal the designed life has increased to 192 years. The link canal was opened in 1976. The cross regulator at link canal has 5 spans, 20 feet each. The average depth of link canal is approximately 14 feet.

Annexure - II (One RD = 1000 feet)

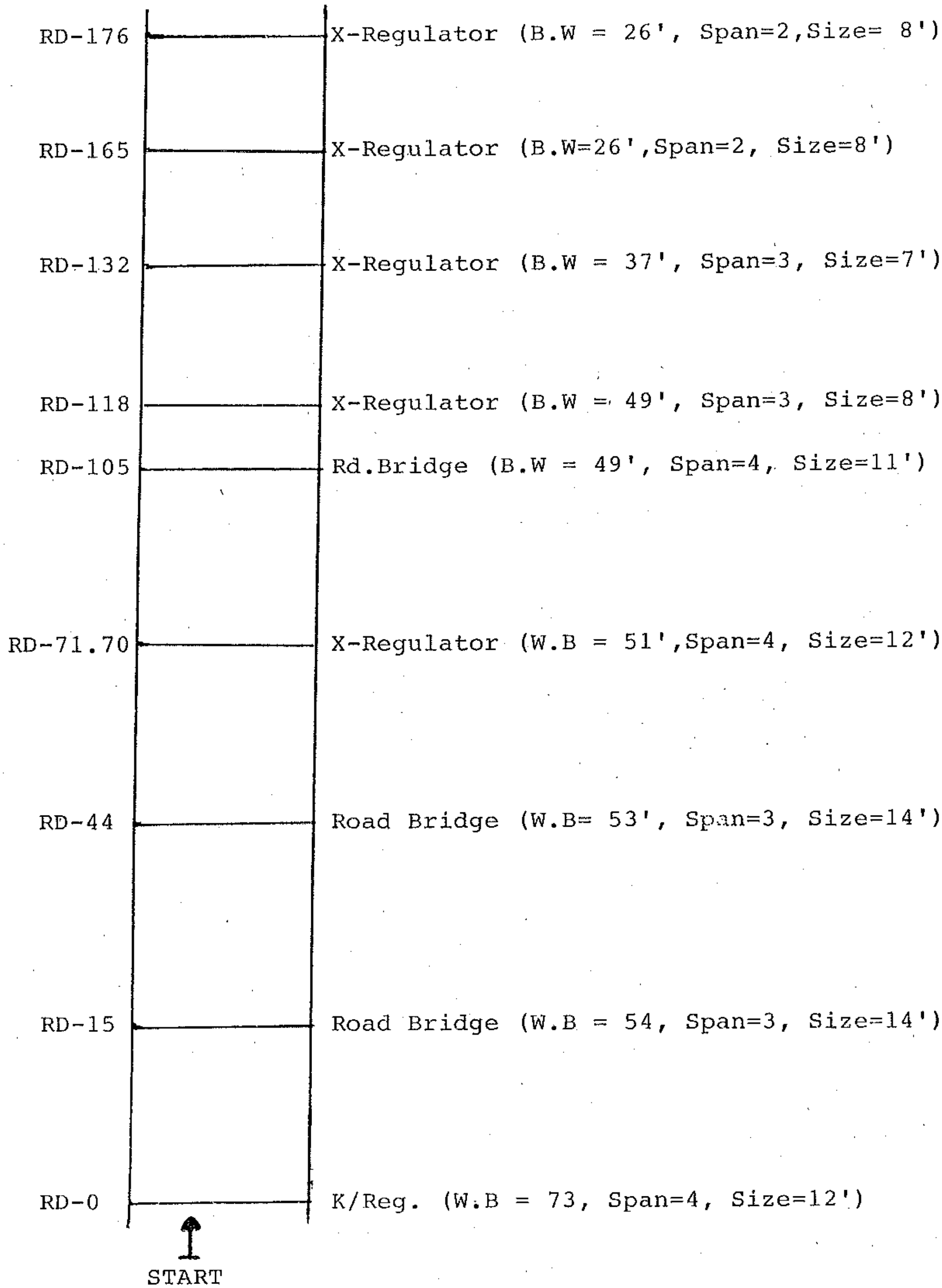
- Detailed Information on the Canals (Sketches)
- Detailed Information on the Canals (Tables)

K.P. FEEDER (LOWER)



Not to Scale

ODEROLALL BRANCH



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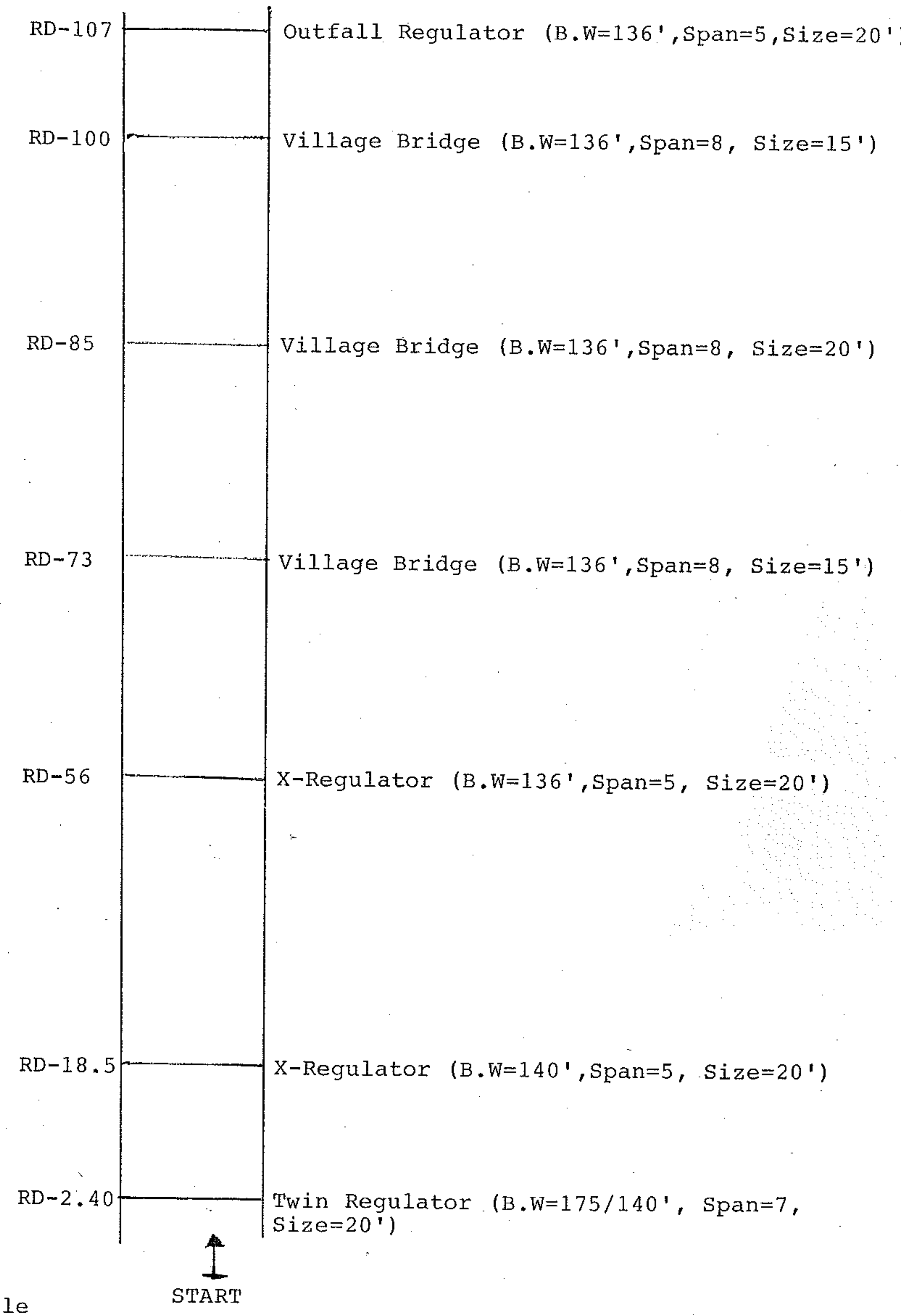
M.R.B. LINK CANAL



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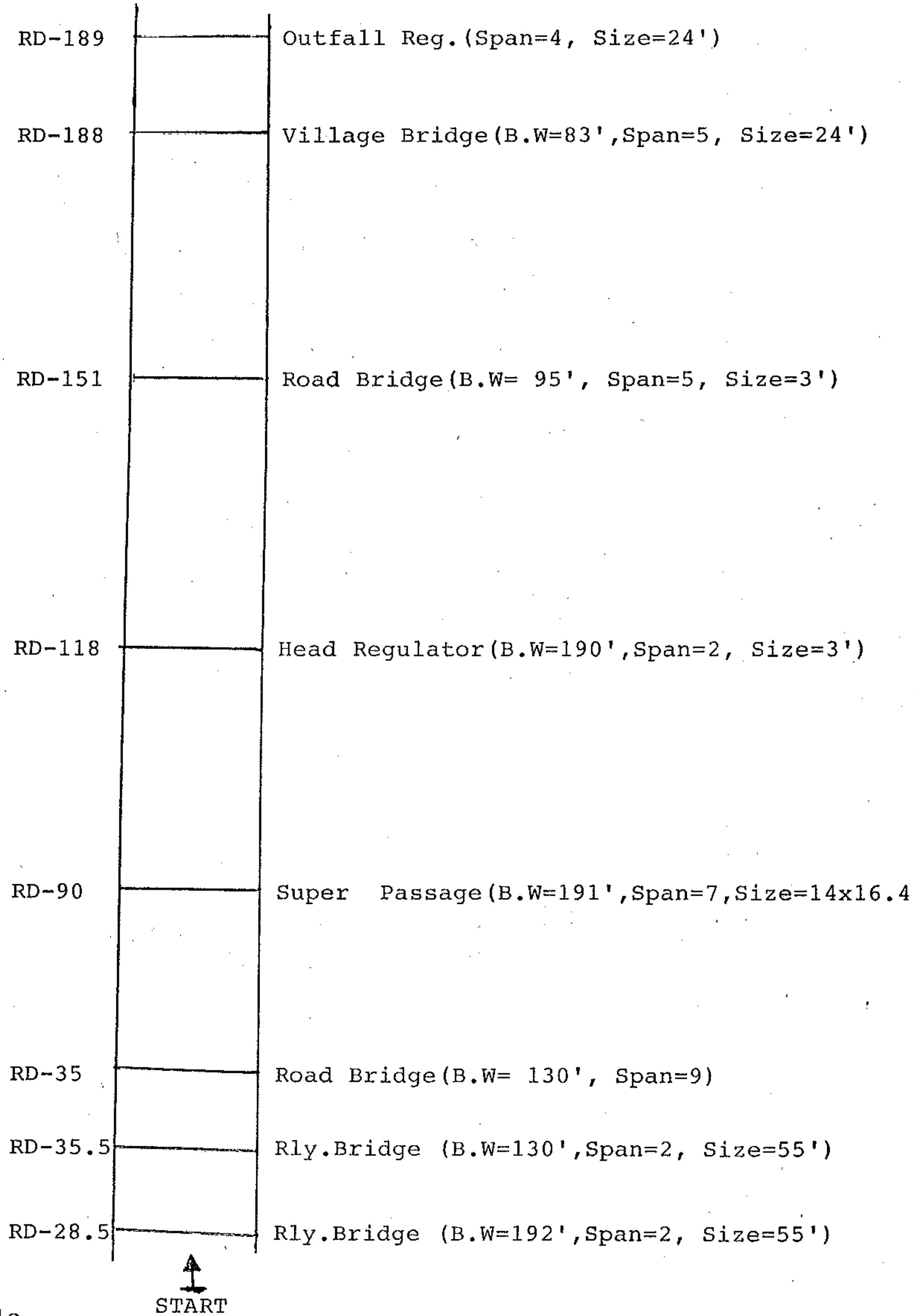
K.B. FEEDER (UPPER)



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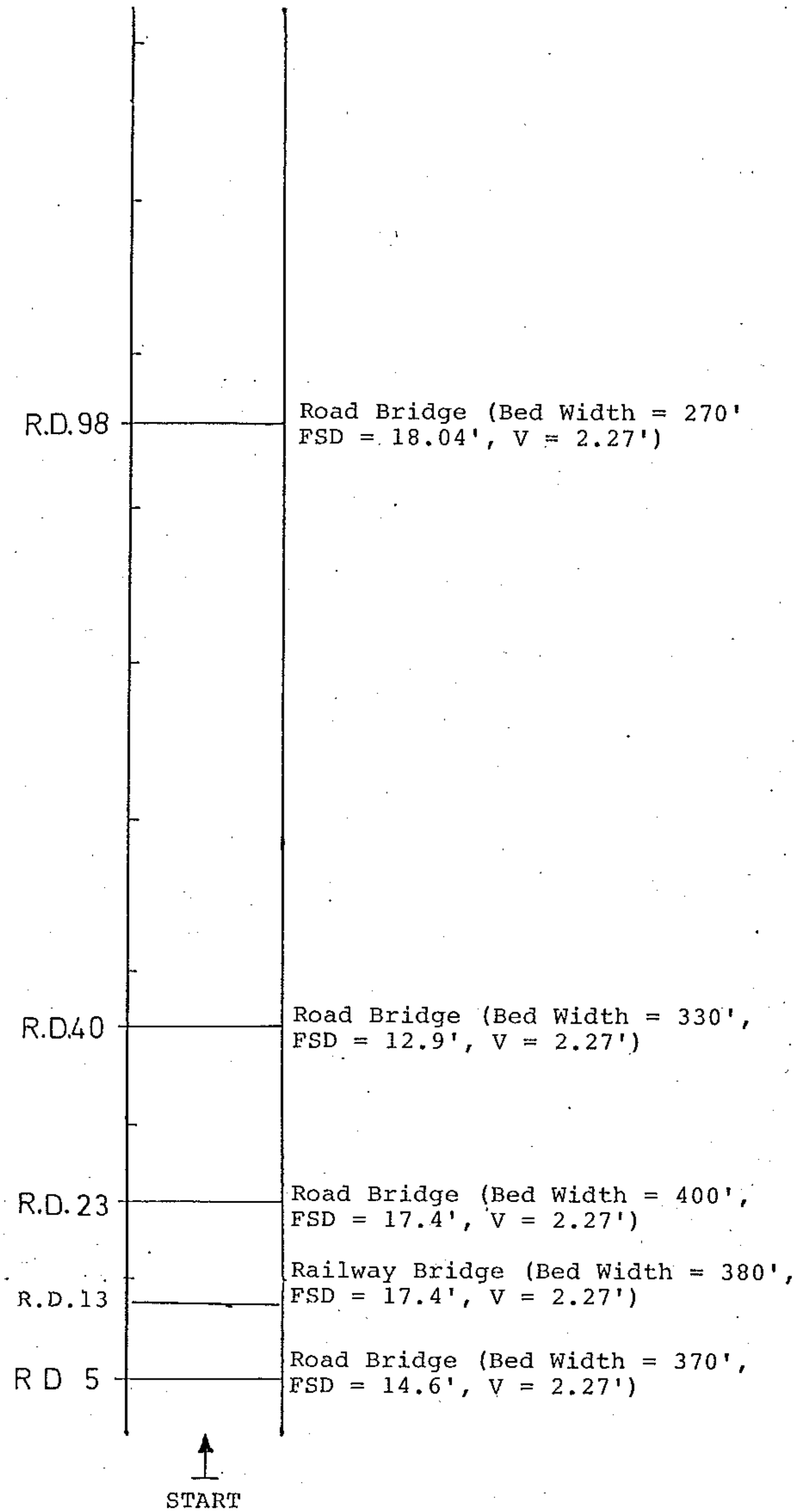
JAM RAO CANAL

Miles	
124	Head Regulator,W=23,Span=2,Size= Nil.
120	X Regulator W= 23, Span=2, Size= Nil.
116	X Regulator W= 33, Span=2, Size= 15
111	X Regulator W= 38, Span= 2, Size=17.5
103	Road Bridge
101	X Regulator W= 35, Span= 3, Size= 10'
97	Road Bridge
92	Road Bridge
89	Cross Regulator(B.W=48,Span=4,Size=10')
82	X Regulator/Road Bridge, W=60,Span=5, Size=11'.
79	Road Bridge.
77	X Regulator(B.W=65,Span=5,Size=9').
74	Road Bridge.
69	X Regulator W= 85,Span=5, Size= 11'.
62	Road Bridge.
59	X Regulator(B.W=85',Span=6,Size=10').
53	Road Bridge.
49	X Regulator/Road Bridge(B.W=9,Span=8, Size= 10').
44	Road Bridge.
41	Road Bridge
38	Road Bridge
32	X Regulator(B.W=9, Span=9, Size=10')
29	Road Bridge
24	Railway Bridge.
21	Road Bridge.
17	X.Regulator (B.W=150',Span=10,Size=10').
07	Road Bridge.
	Jam Rao Head Regulator.

START

Not to scale.

NARA CANAL


R.D.98
Road Bridge (Bed Width = 270'
FSD = 18.04', V = 2.27')
R.D.40
Road Bridge (Bed Width = 330',
FSD = 12.9', V = 2.27')
R.D. 23
Road Bridge (Bed Width = 400',
FSD = 17.4', V = 2.27')
R.D.13
Railway Bridge (Bed Width = 380',
FSD = 17.4', V = 2.27')
R D 5
Road Bridge (Bed Width = 370',
FSD = 14.6', V = 2.27')
START

ROHRI CANAL

RD 588	Fallwith V.R.B,(B.W =142.5',Span=6,Size=10')
RD 578	X Regulator with M.R.B. (B.W=147/142)
RD 549	V.Rd.Bridge (B.W= 148,Span=8, Size 6 of 24'-3", 2 of 23'-3"
RD 532	V.Rd.Bridge (B.W=148, Span= 8, Size 6 of 24'-3", 2 of 23'-3".
RD 523	Fallwith V.R.B. (B.W= 149, Span= 5,Size=10)
RD 495	X Regulator with V.R.B.(B.W= 160, Span=6, Size= 10)
RD 481	Steel V.R.B. (B.W= 160,Span= 9, Size= 7 of 24'-3", 2 of 23'-3").
RD 464	Steel V.R.B. (B.W= 160.5, Span= 9, Size= 7 of 24'-3", 2 of 23'-3").
RD 442	Fall Regulator with V.R.B (B.W= 161.5, Span= 6, Size = 10).
RD 424	X Reg. with M.R.B.(B.W= 175/162, Span=8, Size= 10).
RD 412	Steel V.R.B.(B.W= 175, Span= 10, Size= 8 of 22, 2 of 20).
RD 379	Steel V.R.B.(B.W= 176, Span= 10, Size= 8 of 24-3", 2 of 23-3")
RD 355	Steel V.R.B.(B.W= 179, Span= 10, Size= 8 of 24-3", 2 of 23-3").
RD 328	X Reg.with M.R.B.(B.W= 229/181),Span= 8, Size= 10).
RD 320	Steel M.R.B. (B.W= 229, Span= 12, Size= 10 of 24-25, 2 of 23-25").
RD 294	Steel M.R.B. (B.W= 230, Span = 12, Size= 10 of 24-25", 2 of 23-25").
RD 278	Steel M.R.B. (B.W= 231, Span= 12, Size= 10 of 24-25", 2 of 23-25").
RD 265	X Reg. with M.R.B.(B.W= 241/232, Span= 13, Size= 10)
RD 235	V.Road Bridge (B.W= 268, Span= 5, Size= 65'-9").
RD 222	Steel M.R.B. (B.W= 243, Span= 12, Size= 10 of 24-25", 2 of 23-25").
RD 205	X Reg. with M.R.B.(B.W= 236/244,Span= 10, Size= 10)
RD 191.2	Steel M.R.B. (B.W= 237, Span= 12, Size= 10 of 24-25", 2 of 23-25").

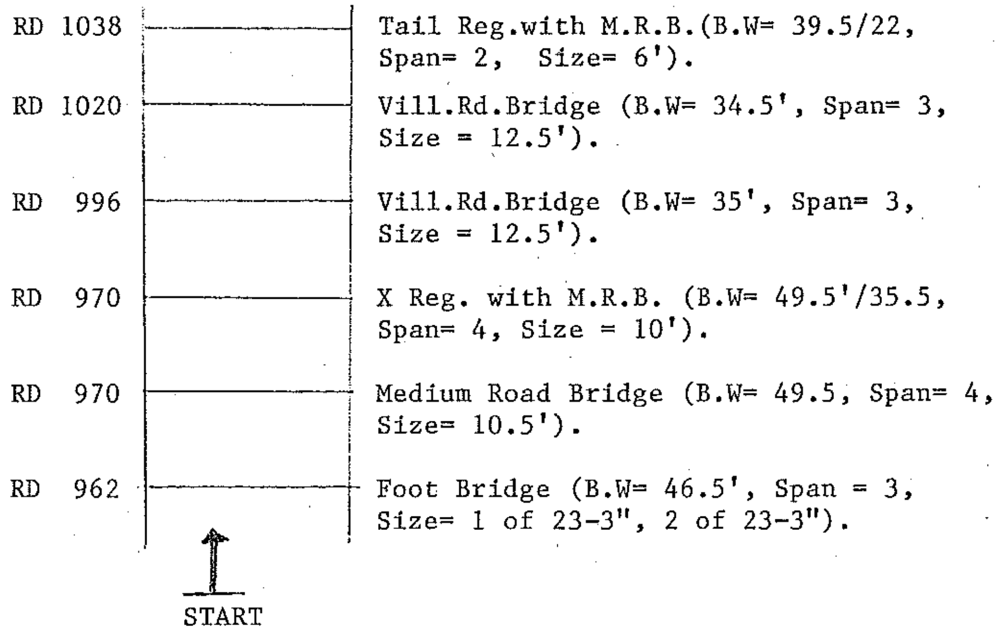
START

ROHRI CANAL

RD 948	V.Rd.Bridge (B.W= 46.5, Span=3, Size= 15).
RD 929	X Reg.with M.R.B.(B.W= 47.5, Span= 3, Size = 10')
RD 911	X Reg. with V.R.B. (B.W= 41.5, Span= 6, Size=5').
RD 891	X Reg. with M.R.B. (B.W= 120/42, Span= 3, Size= 10').
RD 871	Steel M.R.B. (B.W= 94.5, Span= 6, Size= 4 of 24-3", 2 of 23-3").
RD 851	Steel M.R.B. (B.W= 95, Span= 6, Size= 4 of 24-3", 2 of 23-3").
RD 833	Steel V.R.B. (B.W= 96, Span= 6, Size= 4 of 24-3", 2 of 23-3").
RD 819	Steel V.R.B. (B.W= 97, Span= 6, Size= 4 of 24-3", 2 of 23-3").
RD 807	X Reg.with R.B. (B.W.=116/97, Span= 6, Size= 10').
RD 786	Steel V.R.B. (B.W.= 116, Span= 6, Size= 4 of 24-3", 2 of 23-2").
RD 765	Fallwith V.R.B. (B.W= 117/116.5, Span= 7, Size= 10').
RD 738	Steel V.R.B. (B.W= 117, Span = 6, Size= 4 of 24-3", 2 of 23-3").
RD 722	Steel V.R.B. (B.W= 119, Span=6, Size= 4 of 24-3", 2 of 23-3").
RD 705	X Reg. with M.R.B. (B.W= 130.5/119, Span= 4, Size= 10').
RD 693	Steel M.R.B. (B.W= 131, Span= 8, Size= [illegible] of 24-3", 2 of 23-3").
RD 680	Steel M.R.B. (B.W= 132, Span= 8, Size= [illegible] of 24-3", 2 of 23-3").
RD 660	Steel M.R.B. (B.W= 132, Span = 8, Size= 6 of 24-3", 2 of 23-3").
RD 646	X Reg.with M.R.B.(B.W= 136.5/132.5, Span= 5, Size= 10').
RD 636	Steel V.R.B. (B.W= 137, Span= 8, Size= 6 of 24-3", 2 of 23-3").
RD 617	X Regulator with M.R.B. (B.W= 141.5/137.5, Span= 8, Size= 10').

START

ROHRI CANAL



Not to Scale

DESIGNED DATA OF K.B.F.(LOWER) CANAL AND ODEROLALL BRANCH

Sl. No.	Name of Structure	Bed Width U/S	Bed Width D/S	Designed bed level U/S	Designed bed level D/S	Designed F.S level U/S	Designed F.S level D/S	Pav.or Cill level	Zero of Guage U/S	Zero of Guage D/S	No. of Span	Size of Span	Designed discharge	Cutt off	Road-way of bridge	Velocity V/M	Velocity V/D
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	K.B.F.(LOWER)																
1.	P.Q. Fall Regulator	165	-	-	23	-	37	37	37	24	7	15'	6855	-	-	2.88	-
2.	Road Bridge RD-5.5	165	-	23	23	36	36	24	-	-	7	18'	6850	0.10	-	-	-
3.	X-Regulator RD-22	133	-	22	24	35	27	27	25	25	7	24'	4849	0.21	-	-	-
4.	Head Regulator Jam Br.	80	-	22	-	35	-	28	27	24	4	10'	2292	0.10	-	-	-
5.	Road Bridge RD-36	133	-	24	24	35	35	24	24	24	5	24'	4329	0.10	-	-	-
6.	Head Reg.Kolri Escape	71	-	26	26	35	35	26	26	26	5	10'	2000	0.21	-	-	-
7.	Road Bridge RD-50	133	-	22	22	33	33	24	-	-	4	24'	-	0.10	-	-	-
8.	X-Regulator RD-77	131	-	20	20	31	31	22	22	20	5	15'	4173	0.10	-	-	2.97
9.	Beghar Escape Reg.	79	-	20	16	31	27	20	-	20	5	25'	3000	-	-	-	2.67
	ODEROLALL BRANCH																
10.	Oderolall Br. K/Reg.	73	54	18	20	29	29	13	20	21	4	12'	1235	0.33	16	2.67	
11.	Road Bridge RD-15	54	-	19	19	28	28	19	-	-	3	15'	1235	6.10	16	2.29	ft/Sec.
12.	Road Bridge RD-49	53	-	17	17	25	25	25	-	-	3	14'	1193	-	22	2.28	"
13.	X-Reg. RD-71.70 O/Lall Branch	51	49	15	15	24	23	15	15	15	4	12'	1159/1067	0.24	16	2.28	"
14.	Rd.Bridge; RD-105 O/Lall Br.	49	49	12	12	21	20	12	12	12	4	11'	1046/1046	0.10	20	2.28	"
15.	X-Reg; RD-118 O/Lall Br.	49	37	11	12	19	19	11	11	12	3	8'	1028/660	0.20	16	2.02	"
16.	X-Reg; RD-132 O/Lall Br.	37	32	11	12	18	18	12	11	12	3	7'	648/481	0.70	16	1.92	"
17.	X-Reg; RD-165 O/Lall Br.	26	32	9	9	15	14	9	19	9	2	8'	346/285	0.38	16	1.80	"
18.	X-Reg; RD-176 O/Lall Br.	26	33	9	9	15	14	9	9	9	2	8'	346/236	0.10	16	1.80	"

DESIGNED DATA OF M.R.B. LINK CANAL

Sl. No.	Name of Structure	Bed width U/S	Bed width D/S	Designed bed level U/S	Designed bed level D/S	Designed F.S level U/S	Designed F.S level D/S	Pav.or Cill level	Zero of Guage U/S	Zero of Guage D/S	No. of Span	Size of Span	Designed discharge	Cutt off	Road-way of bridge	Velocity V/M	Velocity V/D	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	15	17	18	19
1.	Twice Reg. RD-2.4 PR Link Canal.	175/140	-	40	40	54	53	41	375	39	7	20'	8154/7106	-	-	3.36	-	
2.	Twice Reg. RD-2.4 PR for Lake	175	-	40	-	-	54	41	38	-	8	20	-					
3.	Group of Reg. RD-18.5	140	-	38	31	52	45	41	28	27	5	20	8154/7078	7.2	-	-	-	
4.	X-Reg. C RD-56.0	136	-	28	28	42	42	28	26	26	5	20	6822/6922	0.20	-	-	-	
5.	Village Bridge RD-73	136	-	25	24	40	40	-	25	25	8	15	-	-	-	-	-	
6.	Village Bridge RD-85	136	-	25	25	39	39	-	24	24	5	20	-	0.10	-	-	-	
7.	Village Bridge RD-100	136	-	23	23	38	38	-	23	23	8	15	-	-	-	-	-	
8.	Outfall Regulator RD-107	136	-	23	23	37	36	25	21	19	5	20	6854	-	-	3.36	-	

DESIGNED DATA OF K.B.F.(UPPER) CANAL

Sl. No.	Name of Structure	Bed Width U/S	Bed Width D/S	Designed bed level U/S	Designed bed level D/S	Designed F.S level U/S	Designed F.S level D/S	Pav. or Cill level	Zero of Guage U/S	Zero of Guage D/S	No. of Span	Size of Span	Designed discharge	Cutt off	Road-way of bridge	Velocity V/M	Velocity V/D	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.	Railway Bridge RD-28.50	192	-	52	52	65	65	51	-	-	2	55	8981	1	-	3.11	-	
2.	Railway Bridge RD-34.50	130	-	51	51	64	64	51	-	-	2	55	8979	1	-	-	-	
3.	Road Bridge RD-35	130	-	51	51	64	64	51	-	-	9	-	8979	0.02	-	-	-	
4.	Super Passage RD-89.90	191	-	46	47	60	60	87	52	-	7	14x16.4	8772	1.0	-	-	-	
5.	Road Bridge RD-118	190	-	45	59	59	-	48	-	-	2	3	8389	-	-	-	-	
6.	Road Bridge RD-151	95	-	36	36	56	56	39	-	-	5	22	8315	-	-	-	-	
7.	Village Bridge RD-188	83	-	34	34	54	54	34	-	-	5	24	8304	-	-	-	-	
8.	Outfall Reg. RD-189	-	-	34	34	54	54	41	41	41	4	24	8154	0.22	-	3.92	-	

DESIGNED DATA OF JAMRAO CANAL

Sl. No.	Name of Structure	Bed Width U/S	Bed Width D/S	Designed bed level U/S	Designed bed level D/S	Designed F.S level U/S	Designed F.S level D/S	Pav.or Cill level	Zero of Guage U/S	Zero of Guage D/S	No. of Span	Size of Span	Designed dis-charge	Cutt off	Road-way of bridge	Velocity V/M	Velocity V/D	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.	Jamrao Head Regulator	-	165	-	95	109	103	106	-	95	6	25'	3400	5.7	13.0	3.78	2.51	
2.	7th Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	10.0	-	-	
3.	17th Mile X-Regulator	150	120	81	81	89	88	81	76	76	10	10'	2772	0.2	14.0	3.36/3.33	2.3/2.3	
4.	21st Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0	-	-	
5.	24th Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	22.0	-	-	
6.	29th Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0	-	-	
7.	32nd Mile X-Regulator	95	95	72	70	81	79	74	68	68	9	10'	2446	1.1	14.0	3.03/2.7	2.3/2.3	
8.	38th Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	15.0			
9.	41st Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	14.0	-	-	
10.	44th Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	14.0	-	-	
11.	49th X-Regulator	95	95	64	60	73	70	69	64	94	8	10'	2116	3.1	14.0	2.66/2.47	2.3/2.3	
12.	49th Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	14.0	-	-	
13.	53rd Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	14.0	-	-	
14.	59th Mile X-Regulator	85	85	58	61	68	65	56	59	59	6	10'	1250	3.08	14.0	2.45/2.36	2.3/2.04	
15.	62nd Mile R.Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	14.0	-	-	
16.	69th Mile X-Regulator	85	85	53	50	62	59	60	55	55	5	11'	1068	3.25	14.0	2.35/2.18	2.01/1.98	
17.	74th Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	14.0	-	-	
18.	77th Mile X-Regulator	65	63	48	47	56	55	47	47	47	5	9'	986	0.9	14.0	2.16/2.06	1.98/1.98	
19.	79th Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	6.0	-	-	
20.	82nd Mile X-Regulator	60	60	45	44	53	52	50	44	44	5	10'	807	1.48	10.0	2.04/1.80	1.92/1.85	
21.	82nd Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	21.0	-	-	
22.	89th Mile X-Regulator	48	48	41	41	50	47	46	41	41	4	10'	480	2.1	14.0	1.85/1.74	1.85/1.72	
23.	92nd Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	14.0	-	-	
24.	97th Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	-	-	
25.	101st Mile X-Regulator	35	35	36	36	43	42	31	36	36	3	10'	248	1.81	14.0	1.72/1.45	1.70/1.43	
26.	103rd Mile Road Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	10.0	-	-	
27.	111th Mile X-Regulator	38	38	31	31	38	38	-	31	31	2	17.50'	188	0.61	7.0	1.38/1.37	1.37/1.32	
28.	116th Mile X-Regulator	33	33	29	29	36	34	29	29	29	2	15'	136	1.54	12.0	1.36/1.31	1.32/1.27	
29.	120th Mile X-Regulator	23	23	27	27	33	32	27	27	27	2	10'	46	0.48	14.0	1.03/1.1	1.21/1.06	
30.	124th Mile Head Regulator	23	23	25	-	30	29	-	25	25	2	-	41	1.59	10.0	1.05	0.92	

DESIGNED DATA OF NARA CANAL

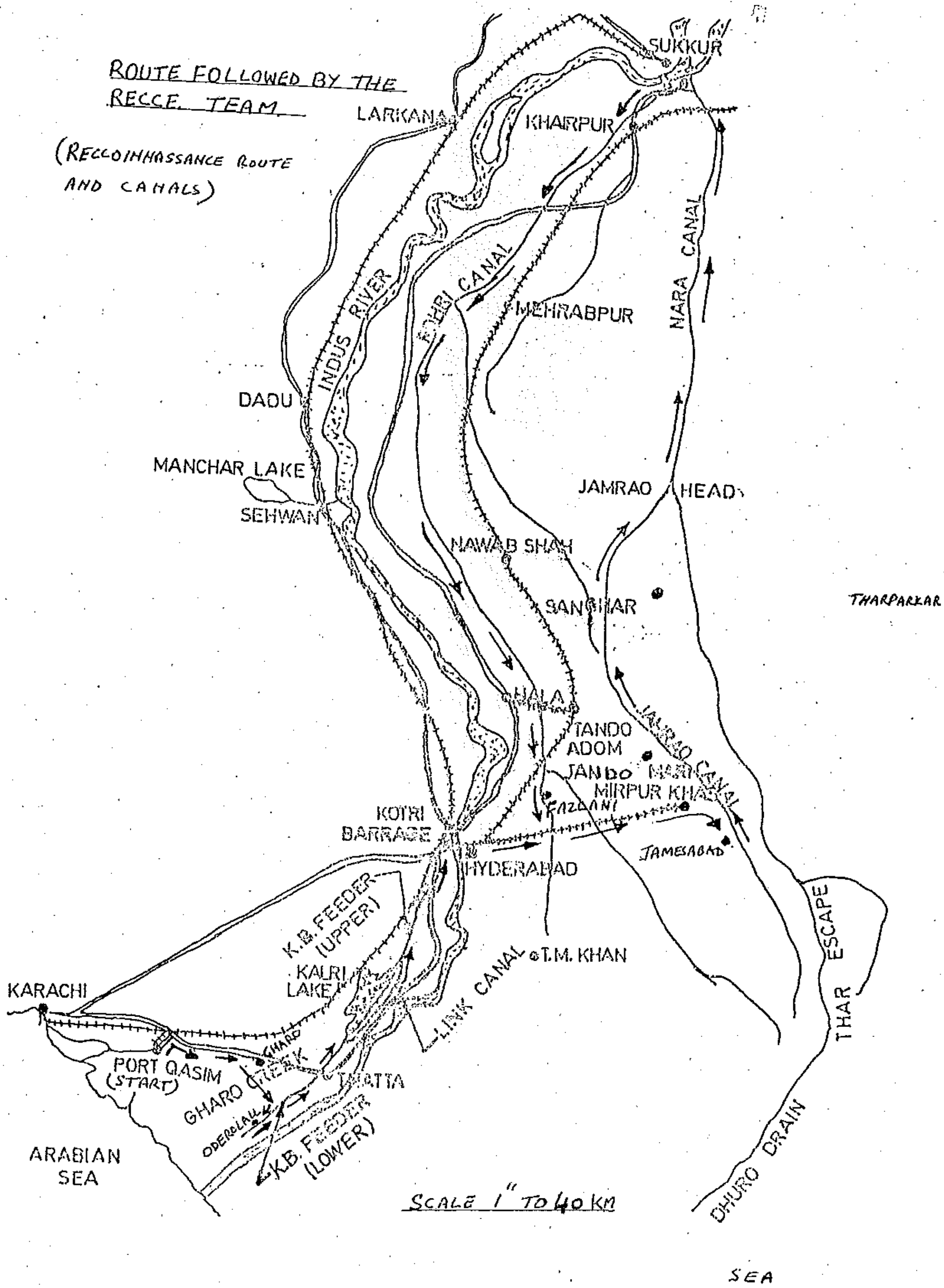
Sl. No.	Name of Structure	Bed width U/S	Bed width D/S	Designed bed level U/S	Designed bed level D/S	Designed F.S level U/S	Designed F.S level D/S	Pav.or Cill level	Zero of Guage U/S	Zero of Guage D/S	No. of Span	Size of Span	Designed discharge	Cutt off	Road-way of bridge	Velocity V/M	Velocity V/D	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.	Road Bridge RD-5	346/370				188							13649/12325			3.32/2.27		
2.	Railway Bridge RD-13	380				188							12325			2.27		
3.	Road Bridge RD-23	400				185							12300			2.27		
4.	Road Bridge RD-40	330				183							12300			2.27		
5.	Road Bridge RD-98	270				177							12280			2.27		

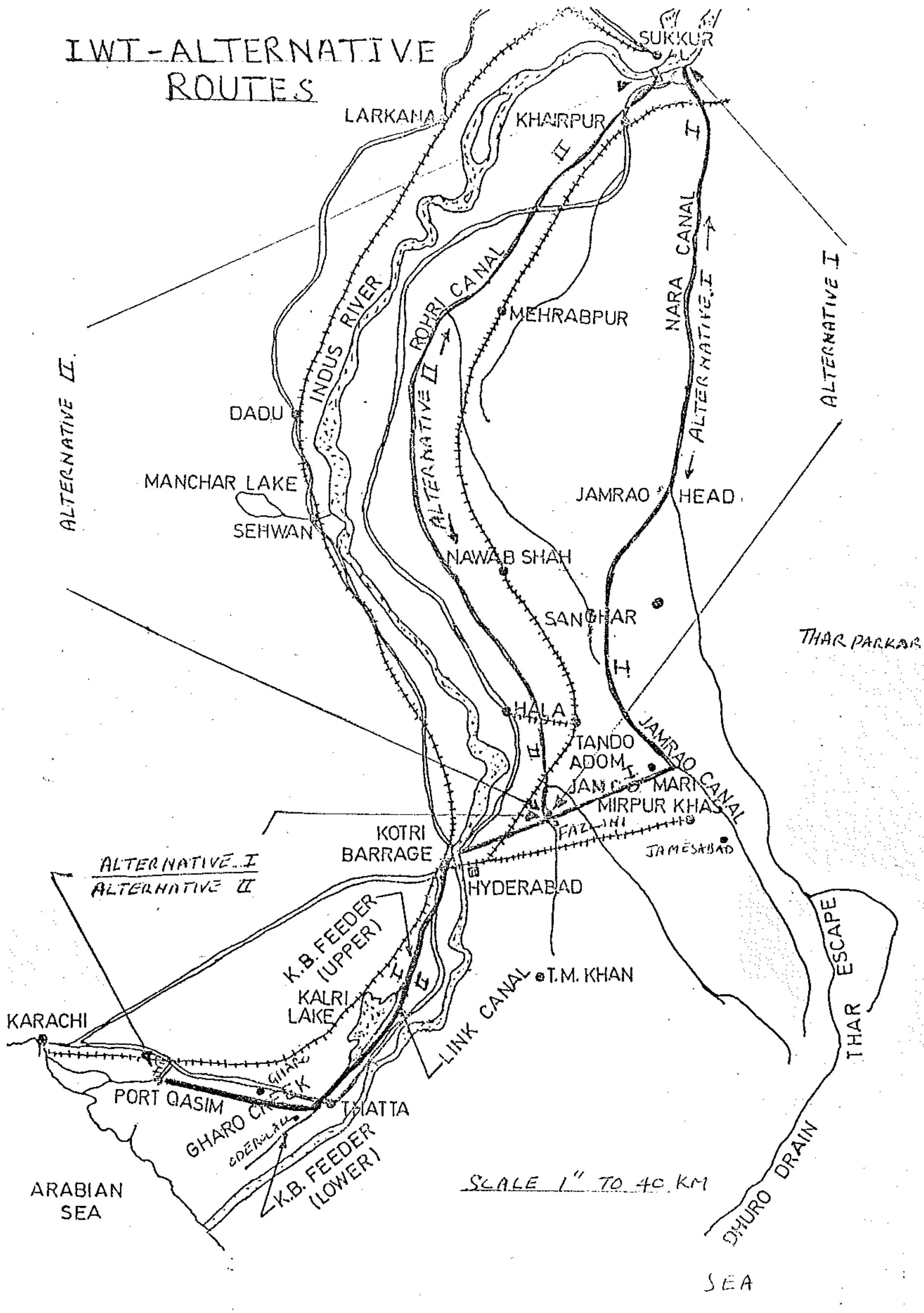
DESIGNED DATA OF ROHRI MAIN CANAL
ROHRI CANAL CIRCLE

Sl. No.	Name of Structure	Bed Width U/S	Bed Width D/S	Designed bed level U/S	Designed bed level D/S	Designed F.S level U/S	Designed F.S level D/S	Pav. or Cill level	Zero of Guage U/S	Zero of Guage D/S	No. of Span	Size of Span	Designed discharge	Cutt off	Road-way of bridge	Velocity V/M	Velocity V/D	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.	Steel Medium Rd.Bridge RD 191.2	237	237	156	156	168	168	-	-	-	10 2	24.5' 23.5'	10465	-	12'	-	-	
2.	X-Reg. with MRB RD-205	244	236	155	152	167	164	157	155	152	10	10'	10435	3.35	12'	3.50	-	
3.	Steel M. Rd. Bridge RD-222	243	150	150	162	162	162	-	-	-	10 2	24.50' 23.25'	10139	-	12'	-	-	
4.	Village R. Bridge RD-235	268	268	148	148	164	164	-	-	-	5	65'-9"	15392	-	-	-	-	
5.	X-Reg. with MRB RD-265	241	232	147	147	159	159	148	147	147	13	10'	10046	-	12'	3.31	-	
6.	Steel Medium R. Bridge RD-278	231	231	146	146	158	158	-	-	-	10 2	24.25' 23.25'	9630	-	12'	-	-	
7.	Steel Medium R. Bridge RD-294	230	230	145	145	157	157	-	-	-	10 2	24.25' 23.25'	9596	-	12'	-	-	
8.	Steel Medium R. Bridge RD-320	229	229	143	143	155	155	-	-	-	10 2	24.25' 23.25'	9542	-	12'	-	-	
9.	X-Reg.with MRB RD-320	229	181	142	140	154	152	145	142	140	8	10'	9526	2.09	12'	3.30	-	
10.	Steel VRB RD-355	172	172	139	139	151	151	-	-	-	8 2	24.3' 23.3'	7265	-	8'	-	-	
11.	Steel VRB RD-379	176	176	137	137	149	149	-	-	-	8 2	24.3' 23.3'	7215	-	8'	-	-	
12.	Steel VRB RD-412	175	175	135	135	147	147	-	-	-	8 2	22' 20'	7145	-	8'	-	-	
13.	X-Reg. with MRB RD-424	175	162	134	133	146	145	136	134	133	8	10'	7120	1.0	12'	3.18	-	
14.	Fall Reg. with VRB RD-442	161	161	131	128	143	140	133	131	128	6	10	6579	3.50	12'	3.16	-	
15.	Steel VRB RD-464	160	160	126	126	138	138	-	-	-	7 2	24.3' 23.3'	6551	-	8'	-	-	
16.	Steel VRB RD-481	160	160	125	125	137	137	-	-	-	7 2	24.3' 23.3'	6530	-	8'	-	-	
17.	X-Reg. with VRB RD-495	160	151	124	118	136	130	126	124	118	6	10'	6512	6.50	8'	-	-	
18.	Fall Reg. with VRB RD-523	149	149	116	111	128	123	117	115	111	5	10'	6069	4.50	8'	3.14	-	
19.	Steel VRB RD-532	148	148	115	115	127	127	-	-	-	6 2	24.3' 23.3'	-	-	8'	-	-	
20.	Steel VRB RD-549	148	148	109	109	121	121	-	-	-	6 2	24.3' 23.'	-	-	8'	-	-	
21.	X-Reg. with MRB RD-578	147	142	107	107	119	119	108	107	107	8	10'	5988	-	8'	3.17	-	
22.	Fall with VRB RD-588	142	142	106	102	118	114	108	106	102	6	10'	5870	4.00	12'	3.14	-	
23.	X-Reg. with MRB RD-617	141	137	101	101	113	113	102	101	101	8	10'	5825	-	8'	3.70	-	

contd..../-

Annex - III


ROUTE FOLLOWED BY THE RECCE TEAM
(RECCOINHASSANCE ROUTE AND CANALS)
SUKKUR
LARKANA
KHAIRPUR
INDUS RIVER
ROHRI CANAL
MEHRABPUR
NARA CANAL
DADU
MANCHAR LAKE
SEHWAN
JAMRAO HEAD
NAWAB SHAH
SANGHAR
THARPARKAR
HALA
TANDO ADOM
JAMRAO CANAL
JANDO
MIRPUR KHAS
FAZLANI
KOTRI BARRAGE
HYDERABAD
JAMESABAD
K.B. FEEDER (UPPER)
KALRI LAKE
LINK CANAL
T.M. KHAN
KARACHI
PORT QASIM (START)
GHARO CREEK
GHARO
THATTA
ODERO LAL
K.B. FEEDER (LOWER)
ARABIAN SEA
THAR ESCAPE
DHURO DRAIN
SCALE 1" TO 40 KM
SEA


IWT-ALTERNATIVE ROUTES
SUKKUR
LARKANA
KHAIRPUR
I
II
NARA CANAL
ROHRI CANAL
INDUS RIVER
MEHRABPUR
ALTERNATIVE I
ALTERNATIVE II
DADU
MANCHAR LAKE
SEHWAN
JAMRAO
HEAD
NAWAB SHAH
SANGHAR
THAR PARKAR
HALA
TANDO ADOM
JAMRAO CANAL
MIRPUR KHAS
KOTRI BARRAGE
JAMESABAD
ALTERNATIVE I
ALTERNATIVE II
HYDERABAD
K.B. FEEDER (UPPER)
T.M. KHAN
KALRI LAKE
LINK CANAL
KARACHI
THAR ESCAPE
PORT QASIM
THATTA
GHARO CREEK
K.B. FEEDER (LOWER)
SCALE 1" TO 40 KM
ARABIAN SEA
DHURO DRAIN
SEA

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