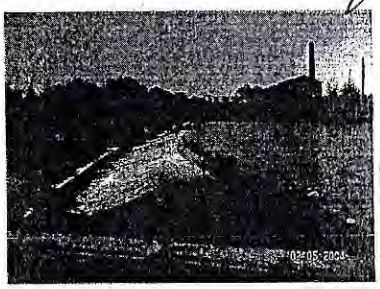
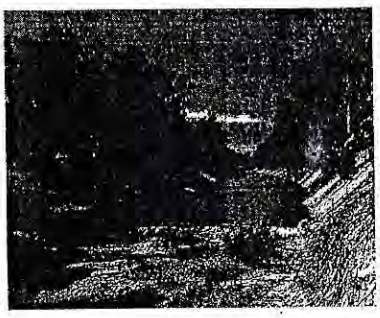
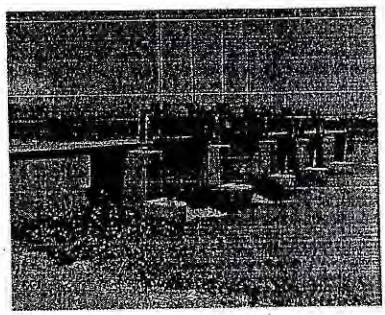
NEW 23/12/011 O/C

GOVERNMENT OF BALOCHISTAN
IRRIGATION & POWER DEPARTMENT







REVISED PC-I

SIX (6) FLOOD DISPERSAL STRUCTURES ON NARI RIVER

Estimated Cost Rs - 4,912.386 Million

Dec, 2011

PROJECT DIRECTOR, SIX (6) FLOOD DISPERSAL STRUCTURES ON NARI RIVER

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LIST OF ANNEXES

GOVERNMENT OF PAKISTAN
PLANNING COMMISSION

1. NAME OF THE PROJECT

Revised PC-I of Six (6) Dispersal Structures on Nari River.

2. LOCATION

The proposed sites for the six dispersal structures are located across Nari River at Mithri, Erri, Haji Sheher, Tuk, Ghazi and Khokar in Kachhi district. The distance between these structures vary on an average between 6 to 15 kms. The Mithri weir and five dispersal sites can be located on SOP topographic sheet number 34-O (scale 1:250,000). Figure 1 gives the location map of the Project area.

3. AUTHORITIES RESPONSIBLE FOR

i)	Sponsoring	Ministry of Water and Power, Government of Pakistan
ii)	Execution	Irrigation and Power Department, Government of Balochistan
iii)	Operation & Maintenance	Irrigation and Power Department, Government of Balochistan

4. PLAN PROVISION

1.	If the project is included in the medium term five year plan, specify actual allocation.	The project is included in the current Five Year Plan and is reflected in the Federal Public Sector Development Programme (PSDP) 2011-12 at S.No. 36 under Water Sector.
2.	If the project is not included in the current plan, what warrants its inclusion and how is it now proposed to be accommodated.	Not Applicable.
3.	Programme / Provision in the current year PSDP / ADP.	An amount of Rs. 800 million have been allocated in the PSDP for the year 2011-12.

5. PROJECT OBJECTIVES

The Integrated Water Resources Management (IWRM) Policy recently approved by the Government of Balochistan specifically recognizes the fact that potential for development lies in surface water to meet growing needs of various sub-sectors of water use and to enhance groundwater recharge of depleted aquifers. The Policy assigns highest priority to Sailaba farming, construction of storages (storage dams) for development of surface waters to expand the command area and to

recharge the groundwater. As agriculture places heaviest demand on the resource, the government strategy is to develop a clear vision for the future of irrigated agriculture in the province for the next 5 to 25 years.

The Project after implementation will assist in conserving 287 MCM (232,596 Acre ft) of flood water for irrigating about 36,854 hectares (91,030 acres) of fertile culturable land.

6. DESCRIPTION AND JUSTIFICATION OF PROJECT

6.1 INTRODUCTION AND BACKGROUND

The Irrigation and Power Department acquired the services of M/S Cameos Consultants to study the feasibility and design of six Dispersal Structures on Nari River. The sites were identified by the Irrigation and Power Department. The purpose of the Project is to disperse flood water for irrigating a vast tract of land located on the left and right banks of Nari river. The feasibility study and design of the Project was carried out under the technical, economic, social and environmental constraints and found feasible. Subsequently the PC-I, amounting to Rs. 3318.17 million was prepared and submitted to Federal Government for approval and arrangement of funds.

The scope of work as per original PC-I is as follows.

1. Construction of Dispersal Structure at Erri
   - Construction of 120 m wide gated weir (12 bays/ gates);
   - Construction of 7.3 m wide road bridge with 11 piers and abutments (maximum height 9 m);
   - Construction of 6 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides and 40 m wide stone apron, 0.6 m thick, on the inner side.
   - Construction of Type IV stilling basin, 120 m wide and 21.5 m long.

2. Construction of Dispersal Structure at Haji Shaher
   - Construction of 110 m wide gated weir (11 bays/ gates);
   - Construction of 7.3 m wide road bridge with 10 piers and two abutments (maximum height 9 m);
   - Construction of 6 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 34 m stone apron, 0.6 m thick, on the inner side.
   - Construction of Type IV stilling basin 120 m wide and 20.50 m long.

3. Construction of Dispersal Structure at Tuk
   - Construction of 60 m wide gated weir (7 bays/ gates);
   - Construction of 7.3 m wide road bridge with 6 piers and two abutments (maximum height 9.3 m);
   - Construction of 8 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 26 m stone apron on the inner side.
   - Construction of Type IV stilling basin 60 m wide and 22 m long.

4. Construction of Dispersal Structure at Ghazi
   - Construction of 65 m wide gated weir (8 bays/ gates);

- Construction of 7.3 m wide road bridge with 7 piers and two abutments (Maximum height 8.5 m);
- Construction of 9 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 27 m wide stone apron, 0.5 m thick, on the inner side.
- Construction of Type IV stilling basin 65 m wide and 20 m long.

5. Construction of Dispersal Structure at Khokar
   - Construction of 65 m wide gated weir;
   - Construction of 7.3 m wide road bridge with 7 piers and two abutments;
   - Construction of 7 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 27 m wide stone apron on the inner side;
   - Construction of Type IV stilling basin 65 m wide and 20 m long.

6. Rehabilitation of Mithri Weir and Conveyance System
   - Remodeling/ rehabilitation of Mithri weir including weir structure, construction of upstream concrete apron, left and right side sluices and head regulators to discharge 56.64 cumec (2,000 cusec) to the conveyance system.
   - Construction of right side main channel 56.64 cumec (2,000 cusec) in a length of 5 kms, and branch channels (left side and right side) in a total length of 9.332 kms.
   - Construction of left side main channel of 56.64 cumec (2,000 cusec) capacity in a length of 2.6 kms;
   - Strengthening of existing upstream river training bund, jungle clearance, and widening of upstream approach section in a length of 1.8 kms.
   - Construction of black top road from the main Quetta D.M Jamali Road to Mithri weir in a total length of 1.85 kms including cross drainage works/ culverts (1 No.).

7. Construction of Residential Colonies
   - Residential colonies at the six dispersal structure sites will be constructed. These will include 4 quarters, site offices, generator rooms and residences for Sub Engineers at each location.
   - Protection embankment for offices and residential colonies.
   - Provision of diesel generating units at the six locations.
   -

8. Laying of 11 KVA electric line to the Project Sites in a total length of 15 kms

6.2 REASONS FOR REVISION

Due to financial constraints, the Project was approved by ECNEC at a rationalized/ reduced cost of Rs. 2000.167 million (60% of original PC-I cost) on December 9, 2010, by deleting Khokar dispersal structure altogether and reduction in the scope of major works of Mithri Weir and other structures. As a result of reduction of work the envisaged benefits of the scheme could not be realized. Annexure A gives the details of the original and revised scope of work.

Later the Project was divided into two packages with Package I comprising of Mithri, Haji Sheher and Erri and Package II of Tuk and Haji Sheher and subsequently tendered. The following table gives the comparison of the original, rationalized/ revised PC-Is and awarded costs.

(Rs. In Million)

S.No	Description	Original PC-I	Rationalized PC-I	Awarded Cost
1	Mithri Weir System	769.938	330.997	149.823
2	Eari Dispersal Structure	590.655	489.904	644.747
3	Haji Shahar Dispersal Structure	505.362	407.724	547.102
4	Touk Dispersal Structure	338.236	282.529	365.573
5	Ghazi Dispersal Structure	370.212	309.2	396.097
6	Khokar Dispersal Structure	274.811		
6	Residential & Infrastructure Facilities	149.691	30.36	31.043
7	Diversion & Care of Water			30
8	General Requirements & Facilities for Employer and Engineer			37.76
	Total:	**2998.905**	**1850.714**	**2202.145**
10	Rebate already Offered in bid 1.56 % (-)			34.353
	Total:			**2167.791**
11	Further Rebate 3.4 % (-)			74.12
	Total:		1850.714	2093.671
12	Establishment of PIU	73.479	54.207	53.31
13	Physical and Financial Contingencies	153.619	38.098	21.67
14	Construction Supervision and Administration Cost	92.171	57.148	56.07
	Grand Total	**3318.174**	**2000.167**	**2224.721**

The work on the two components is in progress.

The major limitations of reducing the scope of work, however, are as follows.

- Due to reduction in the original scope of work the culturable command area to benefit has reduced from 91,000 acres to only about 60,600 acres (Reduction of 33%);
- The beneficiaries of Mithri and Khokar are showing great resentment and there might be serious social/ political repercussions. The beneficiaries of these structures are pressing hard for the inclusion of these components;
- Due to omission of roads and other allied infrastructure the linkage of the Project sites from the rest of the Province could not be ensured during floods and there would be no access to the Project components which might prove detrimental to the safety of the structures and the downstream communities in case of any catastrophe.

The revised PC-I is, therefore, framed to include most of the components of the original PC-I and accommodating the requirements of protection bund upstream of the dispersal structures as identified by the beneficiaries and considered important for the safety of the structures during floods in Nari River during operation. Annexure A gives the details of the components included in the revised PC-I.

6.3 OVERVIEW OF PROJECT AREA

6.3.1 Area and Population

The project area is one of the multi cultural and multi lingual areas of the province. Although the Beghami community in each of the five Gunda do not have any share in the flood water diverted by the Ganda's made in the Nari River by the Ghami community, but they must be considered as indirect beneficiaries of the proposed development due to their dependency on the surplus flood water, which remain unconsumed by the Ghami farmers. Therefore, the data regarding population have been taken from the villages of both Ghami and Be Ghami communities in order to know about the maximum impact of the project.

The pattern of settlement is scattered in many small and big clusters situated mostly on right bank of the Nari River. However, Ghazi and Khokar Ganda's have their lands on both right and left banks of the river. The total population of the whole project area including Be Ghami farmers is 2,901 households and 35,027 beneficiaries.

There is no evidence of migration in the project area from other part of the province or country. The area being least facilitated with respect to basic necessities of life has resulted in migration of several households to nearest towns like Sibi, Bhag, and Jocobabad. However, some of the beneficiaries also have lands in Mastung, Mangocher and Kalat and have migrated to said places for cultivation of their lands. Seasonal migration to other places in the Province is very common due to extreme hot temperatures in summers. Usually family members of each household related to agricultural activities remain in their village, while other family members visit those relatives living in relatively cooler areas of the province during this season. Beside agriculture, livestock keeping is an additional source of income for most of the residents.

The tribal structure of the project area consists of about 86 different sub tribes of Saraiki, Sindhi, Brahvi, Baloch and Punjabi. However, the most dominant tribes or clans are Abro, Bangulzai, Hambi, Gor and Lehri having 493, 257, 164, 119 and 104 households respectively in different villages in whole project area. There are many households of Punjabi tribes and few households of Kakar and Yousafzai Pathan settled in the area from the time of their forefathers. The most frequently spoken languages are Sariaki, Sindhi, Brahvi and Balochi respectively while Urdu is understood by most of the residents. According to the survey there are many households who do not have any land in the project area. Most of these landless beneficiaries are also dependant on agriculture as their major source for income generation. About 34.2 % households depend on tenancy as their major source of income. The other sources for income generation for these residents are working as skilled workers, laborers. Some have gone abroad or other parts of the country and work as unskilled labor mostly.

6.3.2 Socio Economic Status

Due to the unpredictability of the present system of rain fed agriculture the agricultural incomes are usually slightly above subsistence levels. Therefore, most of the farmers supplement their income from livestock keeping, tenancy and labor. All houses are made of adobe and the average number of rooms in all Gandas range from 3 to 5 per house. The houses generally do not have boundary walls. Since there is no electricity in about 25 % of the villages in the project area, therefore only few of the household own electric appliances. The low income of the community is apparent from the wealth indicator survey conducted by interviewing 25% of the total households. The list of items owned by average household is given in Table 6.1.

Table 6.1 List of Items Owned (Average/ Household in All Gandas)

Name of Item	Erri	Haji Shaher	Tuk	Ghazi	Khokar
	Average per Household				
Family Size	8.68	17.2	12.01	12.31	12.9
Rooms	3.55	9.7	4.8	3.99	4.6
Windows	2.73	5.3	3.44	3.1	3
Radio	0.42	1	0.57	0.48	0.7
Television	0.02	0.1	0.09	0.09	0.2
Electric Fan	0.13	0.4	0.47	0.51	1.6
Fridge	0.00	0.1	0.01	0.02	0.1
Bike	0.51	0.9	0.64	0.53	0.6
Motor Bike	0.12	0.4	0.16	0.17	0.1
Tractor	0.00	0.00	0.00	0.01	0.03
Truck	0.00	0.00	0.00	0.03	0.00
Car	0.00	0.00	0.00	0.02	0.00

Name of Item	Erri	Haji Shaher	Tuk	Ghazi	Khokar
	Average per Household				
Camel	0.41	0.7	0.53	0.75	0.5
Donkey	0.6	1.2	0.89	0.88	0.9
Goat	13.75	22.8	11.15	8.66	8.4
Sheep	2.3	2.9	1.32	0.24	0.4
Cows	0.88	1.2	1.52	1.66	1.3
Bullocks	0.62	0.7	0.91	0.8	0.7

It is uncommon to take credits from Agricultural Development Bank or from other banks. However, internally the community takes interest free loans from relatives, traders and shopkeepers and repay at the time of harvest. The Hindu traders in the area usually take 10% interest on the loans extended to the farmers. Most of the farmers do plowing of their land on credit from tractor owners of the area. Only fuel and oil cost are given at the time of plowing and the rent of the tractor is paid to the owner at the time of harvest. On weddings, births and deaths, friends and relatives offer cash and gifts based on reciprocity.

The main economic activity of the entire project area is agriculture with labor and keeping livestock, as a secondary sources of income. Tenancy is common in the area and in Tuk and Ghazi Gandas the main source of income of more than 50% of the resident households is tenancy. In whole of the project area about 34.2 % of the households have tenancy as their primary source of income. However, tenants are also dependant on agricultural activities in the area for income generation. The primary sources of income and their percentages are listed in the Table 6.2.

Table 6.2 Percentage of Primary Source of Income

PRIMARY SOURCE OF INCOME	Erri Gunda		Haji Shaher Gunda		Tuk Gunda		Ghazi Gunda		Khokar Gunda	
	H.H	% age	H.H	% age	H.H	% age	H.H	% age	H.H	% age
Agriculture	350	84.33	456	80	88	26.7	357	42.48	529	70.72
Tenant	53	12.77	99	17.37	219	66.36	461	55	160	21.4
Labor	2	0.48	5	0.88	16	4.8	18	2.16	44	5.88
Government Job	9	2.16	4	0.7	4	1.2	2	0.24	8	1.07
Livestock	--	--	1	0.17	--	--	--	--	5	0.67
Shopkeeper	1	0.24	5	0.87	3	0.9	--	--	2	0.26
Grand Total	**415**	**100**	**570**	**100**	**330**	**100**	**838**	**100**	**748**	**100**

6.3.3 Village Amenities

The area is very poorly provided with social amenities and lacks most of the basic facilities. There is no electricity in the project area except some big villages. It is not common to install tube wells and dug wells in the whole project area as the quality of groundwater is not adequate for drinking and irrigation purposes. There are only five primary and two middle schools for girls and the nearest high school is in Bhag. The education of most of the boys is also restricted upto middle as there are only two high schools in the entire project area located at Haji Shaher and Khokar Gandas. Only a very limited number boys get higher education. There are four civil dispensaries, four BHU and one RHU for the whole project area, which usually lack costly medicines and equipments. The nearest health facilities of value are at Sibi and Quetta and the residents have problems in taking their patients to the hospitals during emergencies. Although keeping livestock is common in the area but there is no animal dispensary or hospital in the whole project area and the nearest husbandry hospital is in Bhag.

Drinking water is the major problem for the whole project area as rain and flood water stored in earthen ponds is used for drinking purposes. The water stored in such ponds are also used by animals and usually gets contaminated. There is no public water supply scheme in the entire project area. A water supply scheme was constructed by PHE Department for Bhag town with its source at Sanni/ Shoran but the scheme never functioned. There are only four private PCO's located in Mithri, Erri and Haji Shaher Gandas. There are about 90 shops containing goods for domestic use and agricultural inputs, mostly in large villages. There is no banking facility in the area and the nearest bank is at Bhag and Sibi.

The roads towards the five gandas takeoff from the main National Highway connecting Quetta from Dera Murad Jamali at different locations between Sibi and Bakhtiarabad. All the Gandas are approachable with black topped road up to the left bank of Nari River. There is no bridge for crossing Nari river. Most of the command area becomes inaccessible during floods of Nari river.

For local transportation most of the villagers use pickups for going to Bhag and Sibi. Motorbikes are also used as a means of transport. The nearest market places of value where people can buy things for domestic use and agricultural inputs are Bhag and Sibi Bazaar. The agricultural products usually find markets in Bhag, Jacobabad, Sukkur, Sibi and Quetta. To approach the main markets at Jacobabad, Sukkur and Quetta, the farmers usually hire trucks and sometimes pickups. However, for local market at Bhag and Sibi mostly pickups and tractors are used. Communal transportation of agricultural product is also common.

6.3.4 Land Rights

6.3.4.1 Introduction

The lands under cultivation are registered under individual titles whereas the communal land is registered under shamilat. The process of registering and changing land titles is time consuming and usually the concerned staff demand extra money for the purpose, usually 1000 rupees are paid per Jerib of land. The land in the project area is inherited to the male heirs of the family and females are not given any share. However, widows can get houses of their deceased husbands and also get share in land if she has sons. The land and water rights in the project area are owned by sub tribes of Sindhi, Brahvi, Baloch, Sariaki and Punjabi ethnic groups. There are also few households of Kakar Pathan having shares in the land. Most of the current resident communities have migrated from different areas of Sind, Balochistan and Punjab since time of their ancestors. Some adopted tenancy as their profession and started developing undeveloped land as Lutbund tenants of the owners at that time. In most of the areas of Balochistan the Lutbund tenants have legal share in the lands of their owners. However, the land owners of the Project area do not recognize any share of Lutbund tenants in their land.

Most of the shareholding households are permanently resident in the area to irrigate their lands. However, land of non resident shareholders is being cultivated mostly by tenants and relatives and their share of crop or cash is given to them. Although there is no restriction on selling of land by the residents but this practice is not common in the project area. In the light of previous transaction the cost of land is Rs. 50,000 per acre.

The total Ghami land available for cultivation is 74,578 acres and is cultivated according to the availability of flood water. About 9,273 acres of land is lying undeveloped and uncultivated, which cannot be brought under command from the Nari River due to elevation differences between the command area and the river bed. Some portion of this land is rain-fed called khushkaba. The cultivable land available in Erri, Haji Shaher, Tuk, Ghazi and Khokar Gunda's is 19,616, 3,225, 2,398, 5,091 and 44,246 acres respectively.

Although the BeGhami farmers do not have any share in the flood water diverted through the five Gandas yet they might get surplus water during high floods. The total cultivable land of BeGhami farmers in all five Gunda's is 52,833 acres. However, the cultivable land available of such farmers in each Gunda is 13,506, 10568, 5,901, 16,993 and 5,864 acres in Erri, Haji Shaher, Tuk, Ghazi and Khokar Gandas respectively.

6.3.4.2 Land Quartile

The land in the scheme area is distributed among the different sub clans and individuals of the sub clans in a certain ratio. In order to assess the impact of the project on big and small land owners of the area, Quartile distribution list has been prepared. The list shows the percentage of land held by households in upper, second, third and lower Quartiles. The results of the Quartile distribution show that the upper Quartile has more than 60% of the total land in each Ganda. The results of the Quartile Distribution have been given in Table 6.3.

Table 6.3 Land Quartile Distribution of Gandajat Flood Irrigation Scheme

LAND QUARTILE DISTRIBUTION OF GANDAJAT FLOOD IRRIGATION SCHEME										
	Erri Ganda		Haji Shaher Ganda		Tuk Ganda		Ghazi Ganda		Khokar Ganda	
Name of Quartile	Land Acre	%age	Land Acre	%age	Land Acre	%age	Land Acre	%age	Land Acre	%age
Upper Quartile	12141.72	66.37	1957.15	60.67	1638.068	68.27	3320.57	65.25	26804.3	66.98
Second Quartile	3364.10	18.39	794.78	24.63	447.15	18.63	1000.84	19.66	7381.47	18.45
Third Quartile	1671.55	9.14	317.94	9.85	211.43	8.80	516.22	10.14	3792.69	9.48
Lower Quartile	1116.49	6.10	156.37	4.85	103.42	4.30	251.87	4.959	2040.89	5.09
Grand Total	**18293.86**	**100**	**3226.24**	**100**	**2400.068**	**100**	**5089.5**	**100**	**40019.4**	**100**

6.3.5 Water Rights

The flood water from Nari River is used by the communities on upstream user's right basis where the upstream users divert as much water as they can. On an average about 20 floods come in the Nari river annually and the farmers do not recall even a single year without any flood.

Two types of beneficiaries exist in the project areas of each Gunda viz Ghami and Beghami. Ghami contribute in terms of labor and cash for the construction of diversion bund at their respective locations, desilting of distribution channels and gandas on channels. They have full rights of using flood water according to their need and their lands are located in the upstream command area of the each ganda. Beghamai do not contribute for the construction of Gunda or any other activity and have no flood water rights in the system. However, in wet seasons/ years surplus flood water is allowed to the downstream users (Beghami) to irrigate their land.

For the overall management of the said system, a management committee exists comprising representatives from Bala and Zarin Nari and is headed by Assistant commissioner of Bhag. The Committee manages the irrigation system during floods to ensure that the flood water is distributed among the different shareholders as per agreed formula.

6.3.5.1 Issues and Options on Water Rights

The shareholding or ghami communities of each Ganda have well defined rights on flood water of Nari river. The upstream users at each ganda divert the flood water till their irrigation requirements are met after which they let the water to the downstream users and this distribution pattern is repeated till the tail end of the system. Keeping in view the existing arrangement for water distribution, it is fair enough that each community should get share of flood water according to its land holdings.

6.3.5.2 Existing Maintenance Arrangements

The Mithri Weir System is being operated and maintained by the I&P Department. Ganda irrigation is one of the oldest and largest community managed flood irrigation system in the Country/ Province. According to the field survey Rs. 0.4 million are spent annually by the farmers to rebuild each Ganda in the project area. Rarely though assistance is provided to the farmers by the Agriculture Department for the construction of gandas through provision of dozer hours. The community usually deposits the cost for hiring the dozer, usually at the rate of Rs. 250 per hour, in the bank account of the concerned Department. The rate also includes the fuel cost. The rates are much cheaper compared to the market rates of dozer hiring which is usually around Rs. 1200 per hour. According to the farmers more than 300 dozer hours and about 15 days are required for the construction of fully washed away ganda. It is pertinent to mention here that sometimes the concerned MPA or MNA, on request, provides dozer hours to communities of gandas on subsidized rates.

For operation, maintenance and distribution of flood water between the shareholding communities of each ganda the farmers have agreed upon certain rules for its operation and maintenance. To effectively carry out maintenance of the system the community has divided the five gandas into Bala and Zerin Nari. The Tehsil Bala Nari includes communities from the first four gandas while the last ganda Khokar is in Zerin Nari. The same committee of Munsif's, deputed for monitoring of the water distribution and timely breaching of gandas, assess the money required on the maintenance of the damage caused to main river. The required cash is contributed equally by the farmers of Bala and Zarin Nari.

Similarly each community of the five gandas has nominated a Naib who is mainly responsible for the timely construction of breached ganda, timely collection of money from the farmers, arrangement of labor, hiring and payments of tractors and dozer. The Naib heads a team of about two to four Rais, one Rais for each main channel, who assist Naib in execution of his tasks. The Rais usually collects money from the Ghami shareholders. As a compensation for their services rendered the labor share of Naib and Rais for the construction of gandas is waived off. For the cleaning and maintenance of each main channel on each ganda the concerned community is responsible to provide labor and cash according to their land shares. The cleaning of each main channel is done annually before Rabi season in October.

6.3.5.3 Tenancy Arrangements

Tenancy is very common and one of the oldest professions of the project area since considerable number of households are related to this profession. In Tuk and Ghazi gandas more than 50 % of the households depend on tenancy as their major source of income. As a whole about 34.2 % of the resident households depend on tenancy as their primary source of income generation in the project area. There are many households who are working as Lutbund tenants and have developed the uncultivated lands of their owners. According to an agreement made, the owners cannot exonerate them from their duties with out valid reasons.

In the most common tenancy arrangement, the land owner only provides land and his share of cash required in the construction of the ganda, while the rest of the inputs are provided by the

tenants. In this type of tenancy arrangements, the tenant holds fifty percent share in the harvested crop.

6.3.6 Situation Analysis of Women

The study was conducted by taking information from 25% of the households in the Project area. The condition of women with respect to health, hygiene, education, water supply and sanitation facilities are described as under.

6.3.6.1 Gender Issues

Like in other areas of Balochistan, the women in the project area are well dominated by men. Usually women are not involved in activities outside the house and in decision making. For their marriage the females are told about the decision made by the head of household and in most cases they cannot contest/ argue the decision made. However, older women are consulted by men in case of marriages of sons and daughters. Men have control over household budget and on mobility of the women with respect to going out of the village due to illness or any other reason. The common tasks which the women are responsible for are preparation of food, looking after the children, washing clothes , taking care of livestock and fetching drinking water from the nearest reservoir. Most of the women of the tenant's family help their husbands, fathers and brothers in the field. While in spare time most of the women indulge in handicrafts, sewing clothes and doing embroidery on dresses, sheets, pillows and other things. Embroidery is done only on family dresses which are not marketed.

6.3.6.2 Health and Hygiene

The major diseases caused in the project area are diarrhea, intestinal diseases, tuberculosis, skin diseases and gynecological problems. Most of the women are aware that the crux of the problem is using stored water in earthen ponds for all purposes including drinking. The results of the survey indicate that the women know the basic reasons for the causes of such diseases such as flies, mosquito's, dirty water and food. Most of the women have also knowledge about the initial preventive measure for most of the diseases such as use of ORS, bed nets and common tablets used for fever and headache. In spite of having information about the common diseases and their prevention usually people do not pay attention to basic reasons for the cause. Bed nets are used by most of the people specially children to secure them from malarial attack. The overall sanitation conditions were found very poor as there are no proper bathrooms inside of the compounds. Animal herds were kept very close to their rooms causing different problems such as abundance of house fly, mosquitoes and cow dung. The reservoirs or ponds made near the villages for storage of drinking water are also the main cause of mosquitoes and flies in the area. The drainage conditions are also found to be very poor and spilt water is found in streets as there are no channels provided for waste water disposal.

There are not enough health facilities provided to the vast project area. There are only four BHU's, four civil dispensaries and one RHC and most of these health centers lack basic medicines and equipments. The most serious and emergency patients cannot be treated in these facilities and have to be shifted to other places for treatment.

6.3.6.3 Women in Agriculture

The findings of the study show that women are involved in harvesting and post harvesting agricultural activities such as cleaning of seeds, separating grain from Chaff. Women are also responsible for storage of grains and in case of insect attack on stored grains women clean the grain, dry it in the sun and store it again. Women do not inherit land of their father or husband.

6.3.6.4 Education

The condition of education is poor as there is no girl's high school in the whole Project area. There are very few madrassas in which female can take religious education. The nearest girl's

high school is in Bhag, but it is very uncommon for the people to send females for education in other areas of the province.

6.3.6.5 Potable Water Supply

The main source of potable water in the project area is flood water stored in the reservoirs or ponds developed by the farmers near villages. The fetching of water from these reservoirs or ponds is mostly the duty of women and children. According to women many of their health problems such as gynecological problems are related to usage of this contaminated water. The containers used to fetch water are made of goat skin some cases which are unhygienic and injurious to health. There is no practice of boiling and filtration of water fetched from different sources.

6.3.7 Cultural Values

The people of the Project area are very co-operative. They take care of each other, especially within their tribe, at different occasions such as marriages and deaths. They also assist each other in cash and kind, but there is no formal co-operative organization in the area. Co-operation here is known by different names, which are as follows:

a. "Bijar". At the time of marriage the relatives and community people contribute in terms of cash or kinds according to their financial capacity.

b. "Sargust". The second assistance is called sargust (salami). The people give money to the bridegroom and congratulate him, his parents, and the family. This ceremony is very common in the area.

c. "Purs". At the time of a person's death the people assist the grieving and share their sorrow showing sympathy with the family. They also pay cash to the affected family according to their capacity. It is known as Purs.

d. "Pory". In case of murder the tribe decides to pay a lump-sum fine to the victim's family. The murderer is also assisted by monetary contribution so that he may be able to pay the fine.

e. People also co-operate in the installation of community hand pumps and their maintenance.

People in the Project area solve their conflicts in two ways. One is through government organizations and the other is through the Jirga system. In Nari area the Jirga system is very effective. In case of conflict, people submit their request to the Jirga to resolve their disputes. The system provides justice within a short time and saves money also. People also register their cases in court but for that purpose they have to go to Sibi. The common people cannot bear the expenses and court fees. In biradari system (informal brotherhood) the minor disputes are solved through counseling and negotiation among the conflicting parties. This system is also practiced in the area.

6.4 TOPOGRAPHY

The Nari river originates near Spera Ragha and has a total length of about 400 kms (249 miles). The levels of the highest and lowest points are 2591m (8,500 ft) and 125m (410 ft). The average slope of the river is about 0.62%. The River catchment is drained by various torrents which join to form medium sized runoff streams, ultimately combining to take the shape of Nari river. In the north eastern part, Loralai river and Sehan rud join together to form Anambar which, after receiving the flows from Narechi rud, assumes the shape of Beji river, a principal tributary of Nari river. In the north-western part of the basin, three streams namely the

Loni, Sor Jhal and Loe Manda join to form Sangan river. Thus Beji from the east and the Sangan from the west meet near Babar Kach Railway Station to form the Nari River. Flowing further southward for about 4 kms, the river enters the Sibi Plain and splits into several meandering branches. Further downstream, these branches rejoin in the Kachhi Plain area where it becomes wide and shallow.

Hereafter most of the discharge of the Nari river during floods is spilled over the banks at various locations and travels in the southern direction either as sheet flow or in meandering channels to strike the Patfeeder and Kirther canals, off-taking from Gudu Barrage.

Figures 2 gives the drainage/ topography of the catchment area and its geology.

6.5 METEOROLOGY AND HYDROLOGY

6.5.1 General

The proposed sites are located on Nari river at different locations in Kachhi/ Jhal Magsi districts and can be found on 1:250,000 scale SOP topographic sheet number 34-O.

The watershed of Nari river stretches between latitudes 29° 12' & 29° 53' N and longitudes 67° 14' & 67° 43' E. Nari river is the principal stream of the watershed which drains an area of about 22,525 sq kms (8,700 sq miles).

The hydrological studies are intended to estimate the different hydrological parameters of the basin. These studies form basis for estimation of water availability and the hydraulic design of the dispersal and allied structures.

6.5.2 Climate

The climate of the area can be termed as semi arid.

6.5.2.1 Rainfall

The salient features of the different rainfall gauging stations are given as follows.

S. No	Station	Latitude		Longitude		Elev ft (amsl)	District	Period of record	No of Years (net)
		deg	min	deg	min				
1	Killa Saifullah	30	42	68	22	5080	Killa Saifullah	1901 to 1950	48
2	Murgha Kibzai	30	44	69	15	5000	Zhob	1964 to 1996	28
3	Loralai	30	24	68	36	4700	Loralai	1892 to 1969	76
4	Badenzai	30	12	69	16	1500	Zhob	1975 to 1996	20
5	Sharan Jogezai	31	02	68	32	6200	Killa Saifullah	1974 to 1996	19
6	Sinjawi	30	17	68	21	5200	Loralai	1911 to 1996	67
7	Harnai	30	06	67	56	2860	Sibi	1963 to 1996	24
8	Duki	30	11	68	34	3560	Loralai	1901 to 1996	72
9	Nana Sahib	30	04	68	55	3116	Loralai	1974 to 1996	20
10	Kohlu	29	54	69	16	3878	Kohlu	1921 to 1950	30
11	Spin Tangi	29	56	68	06	1800	Sibi	1891 to 1996	84
12	Babar Kach	29	47	67	58	800	Sibi	1981 to 1996	67
13	Khost	30	13	67	35	4130	Sibi	1892 to 1969	58
14	Shahriq	30	12	67	42	4000	Sibi	1891 to 1996	86
15	Mach	29	52	67	20	3200	Sibi	1899 to 1996	64
16	Panir	29	41	67	37	1400	Sibi	1894 to 1946	52
17	Nari	29	40	67	55	500	Sibi	1891 to 1939	48
18	Dhadar	29	28	67	39	406	Sibi	1932 to 1946	15
19	Mashkaf	29	34	67	44	465	Sibi	1894 to1946	52

6.5.2.2 Meteorological Data

Meteorological data for Babar Kach, Badenzai, Khost and Duki meteorological stations is available. The average values of the monthly evaporation rates for the stations are given as follows.

Station	Monthly Evaporation (in)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Babar Kach	3.39	4.01	8.05	11.65	15.96	16.37	14.68	12.88	10.79	8.30	5.09	3.04
Badenzai	3.63	4.70	7.69	9.94	12.54	15.10	15.43	14.88	12.52	10.01	7.03	4.82
Khost	4.05	3.72	6.84	11.15	15.04	19.79	22.06	19.62	14.40	11.63	8.75	5.61
Duki	3.40	3.61	6.88	10.74	14.35	19.82	18.97	12.88	12.65	8.62	5.72	4.08

6.5.3 Sedimentation

The sedimentation data for the Nari river at Sibi bridge is available for a period from 1962 to 1970 and therefore used to estimate the sedimentation yield of the catchment. The data has been published in the report "Sediment Appraisal of Pakistan Rivers, July 1987".

6.5.4 Water Availability

A stream gauging station at Sibi bridge is available for a considerable period of time from 1961 to 1971 and then from 1986 to 2001. Based on the above the year-wise water availability of the Nari river basin is given as follows.

Year	Available Flow (MCM)	Year	Available Flow (MCM)
1961	815.18	1986	172
1962	761.55	1987	255
1963	308.35	1988	671.60
1964	1,053.44	1989	613.98
1965	381.22	1990	955.60
1966	862.53	1991	882.43
1967	661.57	1992	1,909.27
1968	112.09	1993	485.30
1969	167.97	1994	1,312.36
1970	544.88	1995	1,778.43
1971	313.44	1996	665.74
--	--	1997	2,050.50
--	--	1998	1,968.65
--	--	1999	1,064.84
--	--	2000	407.93
--	--	2001	1,554.73

Year	Available Flow (MCM)	Year	Available Flow (MCM)
--	--	2002	702.07
--	--	2003	269.70

Based on the above the wet (25%), average (50%) and dry year (75%) water availabilities have been estimated as 1029, 668 and 330.40 MCM respectively. The analysis of monthly data reveals that 82% of the flow will be available in Kharif season whereas the remaining 18% will be available during Rabi season.

6.5.5 Sedimentation

The sediment yield of the catchment as per "Sediment Appraisal of Pakistan Rivers, July 1987", compiled by WAPDA for the period of record is as follows.

S.No	Year	Sedimentation	
		Million Short Ton	10^3 Acre ft
1	1962	11.5	10.4
2	1963	30.3	27.8
3	1964	34.2	30.8
4	1965	26.7	24
5	1967	55.4	49.9
6	1968	2.4	2.2
7	1969	5.7	5.1
8	1970	24.9	22.4

The annual average sediment yield can also be expressed as 1,176 m^3 (2.47 Acre ft) per square kms of the drainage area. The average sediment concentration is 3.5% (by weight) or 35,000 ppm. The minimum observed concentration was 30 ppm and the maximum observed concentration was 73,900 ppm. The average discharge of suspended sediment consists of about 5% sand, 52% silt and 43% clay. The bed load is about 10% of the total sediment load. The unit weight of the fresh deposits is about 51 lbs/ cft.

6.5.6 Crop Water Requirements

The crop water requirement of the proposed cropping pattern (total area of about 36,854 ha - 91,030 acres) has been worked out to be about 287 MCM (232,596 Acre ft) annually. In the light of operation studies carried out based, on the availability and demand, the water requirement will be met at reliability levels of more than 70%. Two irrigations per crop (0.92m to 1.12m total depth) has been used for estimation of crop water requirements.

6.6 FLOOD STUDIES FOR DESIGN

6.6.1 Design Flood

The design flood adopted for the different project components are as follows.

- the weir and stilling basin has been designed to pass a 1 in 50 year flood, with a two to three foot freeboard to the top of the abutments;

- the weir has been checked for a 1 in 100 year flood. The peak flow has been allowed to encroach on the freeboard, but not overtop the abutments.
- Minor upstream and downstream guide bunds and channel protection bunds have been designed for a 1 in 25 year flood event where overtopping and failure of the bunds will not result in catastrophic failure of the weir.

SMADA 6.0 software has been used to carry out the detailed flood and rainfall frequency studies and the maximum one day data of the years of record have been fitted to the different distributions like normal, 2 parameter log normal, 3 parameter log normal, log Pearson type III and Gumbel Extreme Value Type I. As a result of analysis the best fit distribution system has been assessed to be the Gumbel Extreme Value Type I. As mentioned in the preceding section flow data is available for the river at Sibi Bridge. The total duration of the data used is about 30 years which is sufficient for the purpose.

The design floods corresponding to the different return periods are summarized as follows:

S.No	Return Period	Design Flood	
		Cumec	Cusec
1	200 Years	6422.10	226790.00
2	100 Years	5933.60	209539.00
3	50 Years	5177.18	182827.00
4	25 Years	4416.38	155960.00
5	10 Years	3420.51	120792.00
6	5 Years	2677.30	94546.00
5	2.33 Years	1524.89	53850.00

It is pertinent to mention here that the above discharge has been analyzed based on the data of flood flows on Sibi river. As the river flows downstream it gets spilled from the left and right banks and also collected by the channel network in the command area and as such decreases in intensity from Mithri to Khokar gandas. Two parallel rivers running along the left and right sides of the command area namely Nari Nallah and Dingra Nallah respectively drain the surplus flow from the channel network. Nari and Dingra nallahs merge and dispose off the collected flow into Bolan and Sharkal rivers. It is supported by the fact that the river section decreases from Mithri to Khokar indicating decrease in the discharge carrying capacity of the river from head to tail.

6.7 GEOLOGY, ENGINEERING GEOLOGY AND TECTONIC SETUP

6.7.1 General

The site of the five dispersal structures is covered in Survey of Pakistan topographic sheet No. 34-O . The sites have easy approach from Quetta - D.M Jamali Road.

6.7.2 Scope of Work

Following scope of work was specified for the Project;

a. Drilling of drill Holes by Rotary method to a maximum of 100ft (30m).
b. Collection of soil and rock samples.
c. Carrying out various laboratory tests on soil and rock samples.
d. Evaluation of the data and presentation of a technical report.

6.7.2.1 Previous Works and Available Data

The geologic literature for the Project is quite scarce. The only available literature is " The Reconnaissance Geology of Part of West Pakistan" in the form of a geological map on 1:253,440 scale published under Colombo Plan Cooperative Project for Government of Pakistan by Government of Canada which provides a generalized appraisal of the regional geology of the area. This map along with a litho-stratigraphic map of Pakistan published in 1993 by Geological Survey of Pakistan were studied. Geology of India and Pakistan by D. N. Wadia (1960) was also consulted which described in few lines the Flysch nature of Oligo and Miocene age in the area.

6.7.3 Physiography and Drainage

The Basin consists of mountains of Central Brahui Range, Suleman Range, plateau and the valleys running along the various ranges. The hills bordering the Kachhi Plain consist of conglomerates, sandstone and bright colored gypsiferrous clay of Siwalik age.

The Nari river originates near Spera Ragha and has a total length of about 400 kms (249 miles). The River catchment is drained by various torrents which join to form medium sized runoff streams, ultimately combining to take the shape of Nari river. In the north eastern part, Loralai river and Sehan rud join together to form Anambar which, after receiving the flows from Narechi rud, assumes the shape of Beji river, a principal tributary of Nari river. In the north-western part of the basin, three streams namely the Loni, Sor Jhal and Loe Manda join to form Sangan river. Thus Beji from the east and the Sangan from the west meet near Babar Kach Railway Station to form the Nari River. Flowing further southward for about 4 kms, the river enters the Sibi Plain and splits into several meandering branches. Further downstream, these branches rejoin in the Kachhi Plain area where it becomes wide and shallow.

Hereafter most of the discharge of the Nari river during floods is spills over the banks at various locations and travels in the southern direction either as sheet flow or in meandering channels to strike the Patfeeder and Kirther canals, off-taking from Gudu Barrage.

6.7.4 Regional Geology Setup

The geological formation can be categorized into three groups according to their characteristics.

1. The Pliocene upper Mancher formation of shale is dominant aquitard.
2. Miocene Sibi group of sandstone and shale and Pliocene lower Mancher formation of sandstone.
3. Pleistocene Dada conglomerates are dominates in the basin.

The stratigraphic succession of the area is as under.

Era	Epoch	Age	begin – end (Millions Years)	Formation
Cenozoic:	Holocene		0.0118 -	Recent to Sub-recent
	Pleistocene	Late	0.126 - 0.0118	DADA CONGLOMERATES
		Middle	0.781 - 0.126	
		Early	1.81 - 0.781	
	Pliocene	Late	2.59 - 1.81	UPPER MANCHER FORMATION
		Middle	3.60 - 2.59	
		Early	5.33 - 3.60	LOWER MANCHER FORMATION
	Miocene	Late	11.6-533	SIBI GROUP
		Middle	16.0-11.6	
		Early	23.0-16.0	

6.7.4.1 Pliocene Upper Mancher Formation
Mancher formation is chiefly sandstone and shale with subordinate conglomerate. Sandstone and shale are inter-bedded as strata 1-25 feet thick and sandstone is predominates in the lower half, and shale predominates in the upper half.

The shale of the lower half is soft, earthy and clayey. For the most part of its color are spectacular vivid, ferruginous hues of orange, yellow, brown, brick-red, and yellow-buff displayed in alternating beds or members.

6.7.4.2 Pliocene Lower Mancher Formation
In lower half of this formation the sandstone is gritty, soft, crumbly and cross-bedded. On fresh surface it is green or greenish grey.

6.7.4.3 Miocene Sibi Group
The rocks of this group are mainly inter-bedded sandstone and shale, but include pebbles conglomerate and a minor quantity of limestone. The shale is soft weathering, earthy, clayey, or sandy and displays colors of Khaki, green, and maroon. The sandstone is harder then the shale but is poorly cemented and crumbly, where exposed to weathering. Most of it is poorly sorted, coarse grained, gritty, pebbly and porous, and could be classed as a "salt and pepper" subgrey wakes. Cross-bedding is common in this rock. The sandstone and shale are intercalated in beds up to 20 feet thick and proportion of shale generally exceeds that of sandstone in the approximate ratio of 3 to 2.

Conglomerate and pebble rich sandstone contain well-rounded to sub-angular fragments up to an inch diameter, consisting of chart, limestone and sandstone.

6.7.4.4 Pleistocene Dada Conglomerates
The formation consists essentially of coarse boulders and pebbles conglomerate subordinate, coarse cross-bedded sandstone. The conglomerate is thick-bedded and composed of poorly sorted cobbles, boulders, and pebbles in a calcareous, sandy matrix.

A high proportion of the boulders are limestone and marl derived from the tertiary and older rocks of nearby high ranges.

The Dada conglomerate is sufficient well cemented and resistant.

6.7.4.5 River Deposits
It lies in the central part of the valley, and unconsolidated fill of recent and sub-recent deposits formed by the deposition of disintegrated sediments of surrounding mountains in the structural depression by Nari River. These deposits are mainly composed of clay, silt, sand and gravel.

6.7.5 Mithri / Dispersal Structure Geology
The sites are lying in the synclinorium basin and covered with recent alluvium from the country rocks, consisting of mainly clay and sand underlain by Dada Conglomerates. The depth of this alluvium is estimated more the 610 m (2000 feet). The clay is earthy brown in color and silty and soft to stiff in nature. Sand is brown in color, poor sorted and well rounded, strong to very strong, and having the size from 0.1 to 1.0mm.

6.7.6 Field Investigations
6.7.6.1 Surface Geological Mapping
After reconnaissance of the proposed structure sites, more specific surface geological mapping of projects areas was taken up and a geological map was prepared. The Geological map is shown in Figure 3.

6.7.6.2 Subsurface Investigations

On the basis of initial reconnaissance and surface geological mapping a detailed soil/ geological investigation program was firmed up for the drilling to investigate the sub-surface soil condition. Accordingly four boreholes were drilled in the river bed, one at Haji Shahar and 3 boreholes at Erri Village, by percussion methods to determine the depth of rock and other design parameters. To evaluate the allowable bearing capacity of the soil standard penetration test was carried out along the depth of the borehole. Detailed logging of the boreholes was carried out.

6.7.6.3 Sub-surface Lithology

The sub-surface Lithology encountered near Haji Shahar Village (BH #1) is as follows.

0 to 3m	Silty sand (medium dense)
3 to 27m	very soft clayey silt
27 to 30m	dense silty sand

The 2nd hole was drilled up to 15m near Erri Village in Nari bed. The Lithology encountered is as follows.

0 to 1.5m	silty sand
1.5 to 3m	clayey silt
3 to 4.5m	silty sand
4.5 to 6m	clayey silty
7.5 to 15m	sandy silt

The 3rd hole was drilled near Erri Village, Left Bank of Nari River upto a depth of 15 m. The sub-surface Lithology encountered is as follows.

0 to 1.5 m	soft silty sand
1.5 to 3m	very soft clayey silt
3 to 4.5m	medium dense sandy silt
4.5 to 7.5m	silty sand
7.5 to 9m	clayey silt
9 to 10.5m	sandy silt layer
10.5 to 23.5m	silty sand
23.5 to 25m	very soft clayey silt.

The 4th hole was drilled near Erri Village, Right Bank of Nari River, upto a total depth of 15 m. The sub-surface Lithology is as follows.

0 to 1.5m	silty sand
1.5 to 3m	clayey silt
3 to 6m	Medium to very soft sandy silt
6 to 9m	clayey silt
9 to 13.5m	sandy silt
13.5 to 15m	very soft clayey silt was encountered.

Table 6.4 Consistency of Clay and Approximate Correlation to the SPT (N)

STANDARD PENETRATION, NUMBER (N)	CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH, qu (KN/Sq M)
0-2	Very Soft	0-25
3-5	Soft	25-50
6-10	Medium Stiff	50-100
11-20	Stiff	100-200
21-30	Very Stiff	200-400
>30	Hard	>400

Table 6.5 Relation between N-Values, Relative Density , Angle of Friction for Granular Soils

STANDARD PENETRATION NUMBER (N)	PACKING OF MATERIAL	APPROXIMATE RELATIVE DENSITY, Dr %	APPROXIMATE ANGLE OF FRICTION OF SOIL (deg)
0-4	Very Loose	0-5	26-30
5-10	Loose	5-30	28-35
11-30	Medium Dense	30-60	35-42
30-50	Dense	60-95	38-46
>50	Very Dense		

Detail of standard penetration test results are shown in the composite soil profiles.

In addition soil samples were collected from the Nari River near Mithri Weir and existing canal system for gradation and shear strength analyses.

6.7.7 Laboratory Tests

The tests were performed on dried soils samples by using sieves and hydrometer and determined the distribution of grain sizes within the soil sample. Four undisturbed samples, in which the condition of the soil in the samples was, closed enough to the conditions of the soil in-situ to allow tests of structural properties of the soil to be used to approximate the properties of the soil.

6.7.7.1 Density

The density is defined as mass per unit volume. The density of five soil samples have been determined by measuring the weight of soil samples of known volume. The values of density determined in the laboratory (Table 6.6) have been used to evaluate overburden pressure and for calculation of pile load/Soil bearing capacities.

6.7.7.2 Specific Gravity

Specific Gravity tests were performed on five soil samples from various horizons in accordance with ASTM designation D 854-83. The results of this show that the variation in value from 2.68 to 2.71.The values have been presented in Table 6.6.

6.7.7.3 Unconfined Compression Strength

Unconfined Compression tests were performed on soil samples. These are used to determine the unconfined Compressive Strength of soil. The values ranging from 0.85 to 1.65 `Kg/sq cm. The values have been presented in Borehole Logs.

Table 6.6a. The results of the tests performed for the four boreholes are presented as follows.

Borehole No	Depth (m.)	Initial Moisture (%)	Bulk Density gm/cc	Dry Density gm/cc	Specific Gravity	Cc
BH-1	9.0	12.1	1.65	1.48	2.7	0.17
BH-1	18.3	10.2	1.66	1.51	2.69	0.18
BH-3	7.5	7.6	1.75	1.63	2.68	0.21
BH-3	12	8.8	1.84	1.69	2.7	0.19

The soil classification and shear strength of Mithri are given in Table 6.6b.

S.No	Sample Location	Classification	Name	Shear Strength	
				c (kg-cm^{-1})	φ (°)
1	Weir downstream	SP	Poorly graded sand	0.015	30.3
2	Canal RD 0+500	SM	Well graded sand	--	--
3	Canal RD 1+000	CL-ML	Lean clay silt	--	--
4	Commad Area	CL-ML	Lean clay silt	--	--

6.7.8 Bearing Capacity from SPT Numbers

One of most commonly method for determining allowable soil bearing capacity is from standard penetration test (SPT) numbers. It is simply because SPT numbers are readily available from soil boring. The equations that are commonly used were proposed by Meryerhof based on one inches of foundation settlement. Bowles revised Meyerhof's equations because he believed that Meyerhof's equation might be conservative.

Meyerhof's equations

For footing width, 4 feet or less:

$$Q_a = (N/4) / K \quad \text{..... [1]}$$

For footing width, greater than 4 ft:

$$Q_a = (N/6)[(B+1)/B]^2 / K \quad \text{.....[2]}$$

Bowles' equations

For footing width, 4 feet or less:

$$Q_a = (N/2.5) / K \quad \text{.....[3]}$$

For footing width, greater than 4 ft:

$$Qa = (N/4)[(B+1)/B]^2 / K \quad \text{.....[4]}$$

Where:

Q_a	=	Allowable soil bearing capacity, in kips/ft^2.
N	=	SPT numbers below the footing.
B	=	Footing width, in feet
K	=	$1 + 0.33\ (D/B) \leq 1.33$
D	=	Depth from ground level to the bottom of footing, in feet

The SPT, Bearing Capacity, Strain and Stress are given in the Composite soil Profiles (Figures 4 to 7).

The bearing capacity of soil at Mithri weir was found from the shear strength parameters and design configuration to be between 120 KPa (2,500 psf) to 144 KPa (3,000 psf).

6.7.9 Seismicity Studies

6.7.9.1 General

Earthquakes are generally caused by the release of stresses in the earth's crust. The stresses are built up due to crust deformation resulting from the movement of tectonic plates and are released by movement along faults causing rupture of the rocks in the crust. The occurrence of earthquakes is not merely a random phenomenon but is governed mainly by definite elastic and tectonic processes.

6.7.9.2 Seismic Activities

The dispersal structures lie in the active seismic belt which has experienced several destructive earthquakes. Three such earthquakes are i) Kachhi Plain earthquake of October 21 1909 (magnitude 7.2) with epicenter between Bhag and Shahpur destroying the villages of Bhag, Shahpur and Belpat, ii) Earthquake of August 25 1931 (magnitude 6) with an epicenter near Shahrig sustaining damages to property and infrastructure of Sanni and Bhag and iii) Mach earthquake of August 27 1931 (magnitude 7.4) and sustaining damages to Mach, Kirta, Dhadar, Mushkaf, Sanni, Gandava and Kotra etc.

6.7.9.3 Seismic Zone

The actual maximum felt intensities for all the earthquakes which occurred in this region range between magnitude 7 and 8. The acceleration corresponding to these intensities computed from different empirical relationships range from 0.16g to 0.24g with an average value of 0.2g. A horizontal acceleration of 0.2g has been taken for the design of different structural components.

6.7.10 Construction Materials

6.7.10.1 Fill for Embankment

A homogeneous type embankment has been proposed to be constructed with an up stream and downstream slopes of 2 :1. The fill will be impervious Silty Clay to be used as embankment.

In order to evaluate the suitability of the required excavation materials as embankment fill, sample were collected from borrow area.

The selected borrow areas are located in the immediate vicinity of the dispersal structures. Large Silty Clay/ Clayey Silt alluvial deposits are available.

6.7.10.2 Boulders and Stones

Boulders and pitching stone required for the protection of embankment slopes and gabion floors are required to be hard, durable and massive. Reconnaissance survey was carried out to find a good quality source of rip-rap near to the project sites. According to which acceptable quality stone available nearest to the dam site is found in Bibi Nani nalla about 75 kms North West of the Project sites along Sibi-Quetta road.

The samples were collected and tested in laboratory. The following test were conducted on the selected samples.

1. Specific Gravity
2. Water absorption
3. Loss Angeles abrasion test
4. Sodium Sulphate soundness test

6.7.10.3 Fine Aggregates

The only natural deposits of sand close to the project area is located near Mushkaf about 55 km north-east of dam site in the Kumbri nullah bed along Quetta-Sibi road. This source is

already being exploited for construction work in Dhadar and Sibi. The deposits are spread over large area and the source will be sufficient to meet the project requirements.

Representative samples from sand source were collected and tested to evaluate the characteristics which are as under:

a) Gradation
The particle size distribution of sand shows that sand is predominantly fine grained. Fineness modulus of the sand measured is very low, compared to the ASTM minimum acceptable limit of 2.4. Sand will, however, need washing to remove silt and clay particles.

b) Organic Impurities
The tests carried out on the sand indicate that sand does not contain organic impurities.

c) Soundness
The soundness of the test was determined by sodium sulphate soundness test.

6.7.10.4 Coarse Aggregate (Gravel)
Large quantities of crushed stone can be obtained near Bolan weir on Sibi Quetta road about 60 to 80 kms from the Project area. The coarse aggregate from this source meets the chemical and physical requirements.

6.7.10.5 Cement
Most of concreting will be done in the spillway area, which will include the crest structure, chute and the flip bucket. A sample of coarse aggregates was sent to CMTL Lahore for "petrographic analysis". The petrographic studies show that the sample is deleterious. It has Alkali Silica Reaction (ASR) potential. Therefore the selected aggregates may be used with Sulphate Resistant / Slag Cement instead of Ordinary Portland Cement. The required type of cement can be transported from D. G. Khan which is the nearest location, if available.

6.7.10.6 Steel
For the construction of the weir and other works and other structure it is proposed to have reinforcing steel consisting of deformed bars complying with ASTM A 615 Grades 40 and 60, which has to be transported from Karachi and Quetta.

6.7.10.7 Water
The water required for the manufacture and curing of concrete and for the compaction of earth works can be drawn from Nari River. This seems to be generally of good quality. Keeping in view the requirements water storage tanks have to be constructed in the immediate vicinity of 5 dispersal structure sites. Water sample from the river collected and sent to the laboratory for testing. The testing results show pH value of 7 and conductivity value of 520 us/cm. The result shows that values are within permissible limits. Therefore the water available can be used for manufacturing and curing of concrete.

6.8 ENVIRONMENTAL IMPACT DURING CONSTRUCTION STAGE

6.8.1 General

This section covers the possible impact by the construction of the Project on air, water, land and also on socio economic matters/ issues. The possible impacts include resettlements, Agriculture, water quality, aquatic life, watershed erosion and sediment siltation, downstream erosion and water borne diseases. Regarding socio economic impacts due to the Project implementation, increase in per capita income and other opportunities and general uplift of the area are expected.

6.8.2 Land Related Impacts

The study findings regarding land related impacts are as under.

6.8.2.1 Development of Borrow land

Considerable quantities of construction materials are required for the construction of dispersal and associated structures which would be borrowed from the surrounding areas. No major effect on the borrow area is anticipated since these would be carefully selected.

6.8.2.2 Reclamation of land

The study shows that no reclamation of land issues are envisaged during the construction stage.

6.8.2.3 Development of Roads

For the transportation of construction material, equipments and heavy machinery to the Project site, the highway from Quetta to Karachi would be used. The roads are black topped, in good condition and could bear heavy vehicular movements. The Project sites are also linked to the main highway through black top roads and therefore accessible in all weathers.

6.8.2.4 Land use changes

The probable landuse changes are contractor's camps and residential units and dispersal structures which are described as follows.

a) Contractors Camps and Residential Colony

During the construction of the Project, considerable number of technical staff, workers, contractors and officials would stay near the sites and would need land for their accommodation such as contractor camp, staff residences etc. These temporary residential areas would be used by the local people once the construction is completed. These facilities will be located at appropriate places since large vacant land is available. No negative impact is foreseen due to the location of such camps. The wastewater discharged from the camps will be drained into the river after proper treatment or will be absorbed in the soil.

b) Mithri Weir and Dispersal Structures

No resettlement of households and submergence of agriculture land is involved.

6.8.2.5 Wildlife

The construction phase of the Project will have no impact on the wildlife of the area. A few animals, small reptiles and some birds might lose their dwellings temporarily but no substantial effect is foreseen on their breeding and multiplication, since large number of similar locations exist in the nearby area where this wildlife can shift for eventual reversal to their improved environment after construction.

6.8.2.6 Water Supply and Sanitation

The Project beneficiaries are currently getting water supply for drinking and washing purposes from Nari river source which is extremely unhygienic and unreliable. The construction activity will not disturb the source.

6.8.3 Water Related Impacts

Following are the water related impacts due to the construction of dispersal structures.

6.8.3.1 Water Quality

During the construction stage different type of activities such as cuttings, earth works and cement works may result in deteriorating the water quality. There might be slightly temporary

adverse affects.

6.8.3.2 Aquatic and terrestrial life
As there is no major population of plants, animal habitats, fish fauna and reptile animals in the reservoir area so there would no major effect on them. Similarly the biodiversity including plants and animals in the command area and lower riparian during the construction period would not be affected.

6.8.4 Agricultural Land
During the construction of the structures, no agriculture land will be submerged and/or affected.

6.8.5 Watershed Erosion and Sedimentation
No construction activity is proposed in the catchment area, therefore no effect is anticipated.

6.8.6 Downstream Erosion and Siltation
The flow down the dispersal structures will not be effected and therefore no adverse impacts are anticipated. Some construction materials may mix with the flood flows which negative impacts are negligible.

6.8.7 Water Borne Diseases
The surface water of Nari river contains considerable quantity of silt and suspended dissolved solids. However the local communities use the stored water behind the gandas and river ponds for drinking and domestic purposes. At times when the surface water dries people dig up ditches and shallow wells to tap sub surface flow. During construction the wastewater from the temporary residential areas for the works/staff may be the source of water borne diseases. Proper precautions may, therefore, be required to treat the wastewater prior to disposal into the river.

6.8.8 Waste Water Discharge
Wastewater from the contractor camp and residential area for Project staff may pollute the river. Proper wastewater disposal techniques will be required to be employed during the construction stage for the minimization of these adverse impacts.

6.8.9 Air Related Impacts
During the course of construction following minor issue may arise;

6.8.9.1 Air Quality
Since no industry is located in the vicinity of the structures the existing atmosphere is quite clear. This, however, will be temporarily adversely affected during construction due to cutting, vehicular movement and other activities.

6.8.9.2 Dust
The large quantities of dust particles will get into the air, and adjoining areas of the site, while fine particles will disperse and remain suspended in the air causing pollution in the surrounding areas. Although the problem will be temporary, special precautions are required to be taken to minimize the adverse affect on air quality and keep the nuisance localized.

6.8.9.3 Smoke
Smoke emission from the vehicular movement and heavy machinery would slightly cause smoke problems. The effect will be felt more at the dispersal structure sites.

6.8.9.4 Noise
Noise at a particular site will vary both spatially and temporally. No hospital or other noise sensitive establishment exist in the area. The noise problem will be localized and of short

duration.

6.8.10 Socio Economic Impacts

The socio economic impacts may comprise increase in per capita income and would create direct and indirect opportunities of jobs. Following impacts are expected during construction stage.

6.8.10.1 Population and Settlement Pattern

Considerable job opportunities will be created, both skilled and unskilled, and there would be influx of local people from within the district and adjoining areas and other parts of the Province and/or country. These people would reside in construction camps and, therefore, there would be temporary increase in the visitor population.

6.8.10.2 Human Resource Development

Skill development of the local population is anticipated as they would get opportunities to work with the skilled staff which would benefit them in future. The local labor would enhance their skills in the fields of concreting, masonry and other construction techniques.

6.8.10.3 Life Style and Culture

During the construction of the dam, people from different parts of the country would visit/ stay in the area. This would provide an excellent opportunity for the local and visitor population to get familiar with each others cultures, traditions and norms.

6.8.10.4 Socio economic uplift

During the construction of the dam and associated structures, the local people would get jobs which would result in economic uplift of the local population.

6.8.11 Land Compensation and Facilities

6.8.11.1 Land Compensation

No land compensation issue is involved during the construction stage.

6.8.11.2 Housing

During the construction stage hiring of houses for the staff other than the camps area would be required. This would result in creating economic opportunities to the local population.

6.8.11.3 Telephone

Telephone facilities are available in most of the villages of the area.

8.4.11.4 Water and Sanitation

During the construction period a small sewage treatment plant will be required to be installed at the site. The treated wastewater can then be disposed of in the river. Similarly the solid waste will have to be dumped at landfill sites to be established under the Contract.

6.8.11.5 Transportation

The situation of transport facilities is very meager in the whole Project area. The Project will have to use its own transportation facilities. The construction will have no negative impact on the transport facilities, rather it will have a positive impact.

6.9 ENVIRONMENTAL IMPACT DURING OPERATIONAL STAGE

6.9.1 Land Related Impacts

Land related impacts during operational stage are as under :

6.9.1.1 Reclamation of land

During the operational stage no water logging, salinity and erosion problems are anticipated,

so, no reclamation of the land is required at this stage.

6.9.1.2 Landuse changes
As mentioned earlier the dispersal structures will simulate the existing ganda system in diverting flood water to the fields for irrigation. No negative landuse impacts are therefore foreseen.

6.9.1.3 Wildlife
During the operational stage, the wildlife migrated during the construction stage may return thereby providing a natural balance. The command area will attract diverse wildlife including migratory birds.

6.9.2 Water Related Impacts
Following impacts are anticipated during operational stage;

6.9.2.1 Water Quantity and Quality
The farmer's would get reliable water for irrigation, drinking and washing purposes. There would be no negative impact on the downstream and/or command area water quality.

Major recharge of the groundwater will be effected as a result of the application of irrigation water to the fields and according to an estimate about 99.80 MCM (80,910 Acre-ft) will be added to the groundwater reservoir and could be tapped by the command area farmers and those of lower riparian through the installations of shallow tubewells and open surface wells for irrigation purposes.

No water logging and salinity problems are envisaged as a result of the implementation of the Project.

6.9.2.2 Aquatic and Terrestrial Life
Impact on aquatic terrestrial life during the operational stage is as under.

a) Command Area
The command area would directly benefit from the implementation of the Project. A total of about 36,842 hectares (91,000 acres) of fertile culturable land would be supplied with dependable irrigation water for creating new cropped lands besides increasing the yield of the existing crops. A positive impact on plants, animal habitats and reptile animals in the area are, therefore, anticipated.

b) Lower riparian
The lower riparian area is a vast flood plain and fed from Nari, Lehri, Bolan and other small rivers. The river flow spreads in the form of sheet flow and hit right side flood protection embankment of Kirther canal system. On an average the average annual water availability from the Nari river for the lower riparian would decrease by about 40%. There would, therefore, be no significant impact on the downstream aquatic and terrestrial habitats.

6.9.3 Agriculture
The farming communities would get reliable flood flows at more than 70% reliability for irrigation and will grow cash crops and vegetables etc. According to an estimate the total average annual cropped area would increase from the present level of 6,558 hectares (16,200 acres) to 36,854 hectares (91,030 acres) increasing the crop intensity from 12.70% to 60%.

This may result in the use of agro-chemicals for the control of insect pest for better crop production. The use of agro chemicals will raise the risk of chemical contamination. However, with the provision of agricultural research and extension services which includes farmer training on the safe use, storage and disposal of chemicals would minimize the risks of chemical

contamination.

The Project interventions would significantly improve the socio economic conditions of the command area population. Chapter 11 gives the details of the agriculture benefits.

6.9.4 Watershed Erosion and Sedimentation

As there would be no intervention in the watershed area, therefore no erosion is expected.

6.9.5 Downstream Erosion and Siltation

The Project would not alter the hydraulics of the Nari river and therefore the downstream erosion and siltation problems would be minimal. Similarly no negative impact on the cropland and infrastructure is foreseen in the Project area.

6.9.6 Water Borne Diseases

No adverse affect on human health is expected except the existing diseases like malaria, diarrhea which are the main diseases due to the use of river water for drinking purposes. The malaria hazard may increase due to increase in water availability and vegetative cover and for which proper monitoring will be required.

6.9.7 Wastewater Discharge

Domestic wastewater from the colonies will be collected and properly treated to meet the standards of discharge of wastewater in the water bodies, prior to its disposal into the river in order to avoid deteriorating the water quality. Therefore no adverse impact is foreseen in the area.

6.9.8 Air Related Impacts

During the operational stage there would be a positive impact on air related issue such as dust and noise. The air quality will rather improve due to more vegetation in the command.

6.9.8.1 Dust

During operational stage, the area would be dust free as there would be no construction activities and heavy vehicular movement.

6.9.8.2 Noise

No noise issue is anticipated during operational stage as there would be no heavy machinery movement and other noise related activities.

6.9.9 Socio Economic Impacts

During operational stage, both Ghami and Beghami communities of targeted command area would get reliable flood flows. Presently, however, only ghamai communities are entitled to get diverted water from the gandas. This would result in change of cropping pattern and the farming communities will grow cash crops instead of their traditional and uncertain field crops due to unreliable flood flow. Employment, health, life style and cultural uplift are the direct benefits in this stage. For more details refer to section 11 on "Economic and Financial Analyses".

6.9.9.1 Population and Settlements Pattern

Currently the local population go to nearby cities for jobs and labor work due to the existing poor economic conditions and having no alternate and reliable opportunities in their own area. During operational stage almost all the farming communities would be involved in agriculture sector and even may attract the lower riparian communities for jobs in the targeted area. This would result in population growth and up to some extent congestion in housing and traffic.

6.9.9.2 Human Resource Development
The skills of the farming communities would improve in agricultural sector such as basics in crop raising, storage, marketing and other relevant sectors.

6.9.9.3 Life Style and Culture
With the uplift of economic condition of the communities, they would send their children to schools and would be economically able to provide basic health facilities. Due to increase in social activities in the area, the social amenities such as roads, BHU, water supply, community centers etc will raise the living standards of the people.

6.9.9.4 Socio economic uplift
Skills of the communities will further develop resulting in local technical self sufficiency. All the job opportunities related to the construction, maintenance and agriculture will ultimately be directed towards increasing the per capita income of the population in the area.

6.10 IMPACT OF DISPERSAL STRUCTURES ON LOWER RIPARIANS

The targeted communities are located between Erri and Bhag. After Bhag the flood water of Nari river scatters into a vast flood plain. The lower riparian area also drains other big and small rivers like Bolan, Lehri, Chatter etc. The Project will suffice the irrigation water requirements of the entire command area upto Bhag town. After implementation of the Project therefore there will be no adverse affects in respect of water availability in lower riparian.

6.10.1 Water Availability for Use by Lower Riparians

In the light of operation studies for comparison under the with and without project scenarios have been carried out. According to the studies the average annual water availability for the lower riparian area would reduce from 668 MCM to 381.10 MCM (541,550 Acre ft to 308,954 Acre ft).

6.10.2 Effects of Water Availability

The major effects of the construction of dam are as under.

6.10.2.1 Effect on Traditional Flood Plain Cultivation
As mentioned earlier most of the villages in the command area and the lower riparian divert flood water by constructing bunds across the river to divert the water to their fields. After construction of dispersal structures the command area beneficiaries (Ghamai and Beghami) would get reliable annual flood flows of 287 MCM (232,596 Acre ft) . After the availability of which the farmers would be able to grow cash crops, vegetables and orchards on 36,854 ha (91,030 acres) of fertile culturable land in the entire command area.

6.10.2.2 Ground Water Level Changes
After implementation of the Project, the groundwater of the command and lower riparian areas will mainly be supplemented through increased irrigation in the command area and according to an estimate about 99.80 MCM (80,910 Acre-ft) water will be contributed to the groundwater.

6.10.2.3 Conflicting Demands for Water Use
The traditional rights over water usage are well defined in the command in which the upstream user has the right to divert as much water as he needs and/or can divert and allow the remaining to the downstream users and so on. This system of water distribution pattern is also followed at branch and field level system. After the Project construction, the target area would get reliable flood flows and follow the existing arrangement of water distribution.

6.11 ENVIRONMENTAL MITIGATION PLAN

6.11.1 General

During the construction and operation stages, ameliorating measures will be undertaken for the

mitigation of possible adverse environmental impacts. Mitigation plan during construction and operation of dam are discussed in detail in the following subsections.

6.11.2 Construction Stage

6.11.2.1 Land Related Mitigation

As there is no houses/population to be affected by Project interventions, therefore, no resettlement is required.

6.11.2.2 Water Related Mitigation

The impact on the environment due to the excessive use of water for construction and other purposes will be mitigated by adopting the following measures:

1. Proper collection and disposal of water used for construction (to be contractor's responsibility).
2. Sewage treatment facilities to be provided to treat the wastewater from the construction camps and other sanitary appliances (to be contractor's responsibility).
3. Sludge collected from the sewage treatment plant should be disposed of in the drying beds, where brine from the Reverse Osmosis plants will be stored. Solid waste of the Project area should be disposed of properly through landfill methods.
4. Diesel, oil and lubricants should be properly stored in accordance with the petroleum regulations. This will be the responsibility of the contractor.

6.11.2.3 Air Related Mitigation

The air related mitigation is discussed as follows.

i) Air pollution

During the construction phase of the Project, some adverse impacts on the environment by suspended dust are foreseen. These will be effectively mitigated by adopting the following preventive measures:

- Constant sprinkling of water on the service roads and dirt tracks.
- Controlling the vehicle speed by imposing speed limits.
- Planting rapidly growing trees, shrubs and grasses in the Project Area.
- Control on emissions of exhaust gases of vehicles to be used for construction.

ii) Noise

Due to the involvement of heavy machinery for construction purposes, the following measures would be enforced to mitigate the effects of high sound level.

- All the vehicles will be equipped with effective mufflers.
- The speed of the vehicle used for transportation of construction machinery and material will be limited.
- Noise level of machines to be used during the construction will be controlled as far as possible and the workers will be provided ear muffs, where necessary.

6.11.2.5 Socio- Economic Related Mitigation

i) Employment

The Project will create job opportunities for the people living in the surrounding area during both the stages of the Project. It is expected that a large number of people will be employed, particularly in the category of laborers and semi-skilled workers. This will, therefore, be a positive impact.

ii) Traffic

The Project Area will be heavily loaded with traffic due to the construction of the proposed dam. Paved access roads will be provided in the Project area. The following preventive measures will be undertaken to control the traffic pollution and the potential of accidents.

- There will be a frequent check on the exhaust smoke of the vehicles.
- Sufficient number of security and safety guards will be provided at the check posts.
- Traffic signs and symbols will also be installed at appropriate locations in order to avoid accidents.

6.11.3 Operation Stage

6.11.3.1 Land Related Mitigation

As mentioned earlier the dispersal structures will simply simulate the gandas presently being constructed at the five locations for spate/ flood irrigation. As such no land mitigation would be required.

6.11.3.2 Agricultural Extension Services

After the implementation of the Project, agriculture in the command area will be boosted. The farmers will need technical as well as financial assistance to adopt the modern agricultural practices. This will be provided by the agricultural extension services unit of Agriculture Department.

6.11.3.3 Infra structural facilities for lower riparian

Infrastructural facilities such as schools, dispensaries, water supply schemes, roads, community centers etc. should be provided to the lower riparian.

6.11.3.4 Afforestation/Plantation

Afforestation of suitable species carried out in the catchment area shall not only reduce the soil erosion, but will also improve the environment.

Plenty of water supplies in the command area would increase the density of vegetation, resulting in improvement of the environment and landscape of the area.

6.11.3.5 Water Related Mitigation

i) Downstream Water Mitigation

As mentioned earlier the lower riparian would not be adversely affected.

ii) Water pollution

The occurrence of water pollution is likely to occur in the Project Area due to the sanitary discharge of the residential colony, which in turn will affect the downstream population. Oil, grease and other lubricants may pollute the river water. The problem can be avoided by taking the following measures:

- Treatment facilities to be provided for sanitary discharge.
- Oil, grease and lubricants to be properly disposed of.
- Quality of water of Nari river to be monitored.

iii) Irrigation System

The irrigation system will be maintained and managed by the communities themselves as is being presently practiced.

6.11.3.6 Air Related Mitigation

i) Air Pollution

The Project is environmentally air friendly. It is anticipated that the air quality of the Project Area will further improve with the creation of a water reservoir. The traffic load will increase by the increased number of visitors due to better infrastructure resulting in increased air pollution. This can be controlled by taking the following measures:

- Plantation to be carried out in the Project Area.
- Air quality to be monitored.

ii) Noise

Special Mitigation measures for abatement of high noise effects are not foreseen. The treatment plant and pumping station should be designed in such a way that noise levels should not exceed the following levels:

▸ At a distance of 1 m from the noise source	85db (A)
▸ At the boundary of the plant & near the human settlement	60 db (A) day time 55 db (A) night time

It is expected that the above noise level limits will be achieved without any difficulty.

6.11.3.7 Socio-Economic Related Mitigation

i) Education

The Project will be instrumental in raising the living standard of community and also economic level. The community will send their children to schools instead involving them in other economic activities. New schools will be constructed in the Project area and this will result in increase in the level of literacy.

ii) Fire Protection

Fire fighting equipment at the proposed damsite and staff colony will be provided as per requirements, which may consist of the following:

- Underground fire services main with valves in the chambers.
- Hydrants and fire hoses in the cabinets.
- Fire extinguishers (CO_2, dry gas, foam etc).
- Sufficient sets of breathing apparatus.
- One fire fighting truck equipped with complete mobile fire fighting system.
- Fire protection walls should also be constructed around the main transformers.

iii) Occupational Health and Safety

Procedures for the safe and efficient operation and maintenance of the health facility will be prepared for implementation during the operation and maintenance stage of the Project.

6.11.3.8 Emergency Procedure and Contingency Plan

Emergency procedure and contingency plan for the operation and maintenance of the Project will be developed for its safe running.

6.11.4 Cost of Mitigation Measures

No mitigation measures are envisaged as a result of the Project. No mitigation cost has therefore been included in the Project cost.

6.12 INSTITUTIONAL REQUIREMENTS AND ENVIRONMENTAL MONITORING

6.12.1 General

It is evident from the other sections of the report that environmental control and its monitoring carry much importance during construction as well as the operation stage of the Project. An institutional framework such as an environmental cell is required at the Project for the proper implementation and monitoring of environmental control system and procedure. The organizational set-up and monitoring required during the construction and operation stages is described in the following subsections.

6.12.2 Organizational Set-up

An organizational set-up for ensuring compliance of health, safety and environment (HSE) requirements should be established. This set-up will be headed by an HSE specialist and will comprise, inter alia, environmentalist, inspector and laboratory technicians and a laboratory. The cell will be reporting directly to the Project Management.

6.12.3 Environmental Monitoring

In order to adhere to the environmental regulations, periodic monitoring through sampling and testing of various parameters is necessary. The environmental monitoring cell will regularly monitor requisite parameters during construction and operation stages, flood warning, landslides, seismology, sediments etc. The various monitoring requirements are discussed in the following subsection;

6.12.4 Construction Stage

It is necessary that the monitoring staff be deputed for strict monitoring of different activities during the construction stage to avoid any environmental hazards or inconvenience to the local people. The following parameters will require special attention.

- During the excavation and equipment movement, dust and noise should not increase to undesirable limits;
- It should be carefully monitored that traffic hazards do not occur due to the movement of heavy machinery;
- Since the work force will come from the other parts of the country, it should be monitored that no ethnic, religious, cultural or other law and order conflicts arise;
- It should be ensured that the contractor will provide proper medical, sanitary and residential facilities to his workers. Proper safety measures should also be provided and maintained by him;
- Local people should be hired as far as possible during all the construction activities.

6.12.5 Operation Stage

The following parameters will be monitored regularly during the operation stage;

- Noise of treatment plant and pumping machinery;
- Sanitation of residential colony;
- Fire protection system;
- Water quality and availability of Nari river in downstream areas;
- Water quality in reservoir;
- Continuous public relation with local people.

It should be ensured by the means of above monitoring that necessary permissible limits of noise, soil and water pollution, health and safety, and water rights of lower riparian are achieved through the environmental mitigation measures spelled out in section 6.10.

6.12.6 Flood Warning

The existing stream gauging station at Sibi Bridge should be strengthened. The manual gauge

should be replaced with automatic gauging equipment fitted with data logger. Similarly river gauging stations are also required to be installed at Nari Gorge. The gauge discharge relation should be monitored regularly.

6.12.7 Landslides

The unstable slopes and activities on such lands should be monitored for potential landslides and any unstable slope should be stabilized prior to its likely sliding and blockage of access to any Project.

6.12.8 Seismology

Since the area is seismic-prone, a seismograph needs to be installed at a suitable point near dam. During and after construction, seismic records should be maintained. After every major tectonic movement, all the Project components need to be examined for safety and integrity.

6.12.9 Sediment

The sediment flow into the reservoir should be monitored along with the discharge and samples taken using D49 Samplers for the integrated samples. The bed load samples should be used for heavy particles, which may settle at the reservoir entry and cannot be removed through the conventional methods. The downstream flow should also be monitored and sediment sampling taken.

6.13 SOILS

6.13.1 Introduction

6.13.1.1 General

This chapter describes in detail the agricultural potential of soils under irrigation is undertaken here to assess soil-crop-water relationship.

6.13.1.2 Summary

Total reported Gandajaat study area is 128,457 acres (52,007 hectares). Each Ganda has its specific soil area according to its physiographic feasibility for flood irrigation. Consequently five land units distinguish 'Gandas' irrigation command areas. Topography of the area is flat. Excluding a small proportion, the extensive area comprises land having high to very high agricultural potential under irrigation. Presently, the traditionally controlled river water does not meet water requirements of land and a plenty of land area, comprising good agricultural land, remains fallow or even abandoned.

6.13.2 Previous Studies

Fortunately sufficient material is available from previous studies made by the Soil Survey of Pakistan. The 'Gandajaat commands' is a part of *Kachhi Area* soil survey report. It was surveyed in 1980. The information given here is derived from that report except local deviations due to the change of the river course seen during field review work and requisite interpretations for the Gundajaat area.

6.13.3 Climate

The climate of study area is classified as arid sub-tropical continental characterized by low rainfall and high evaporation. Summers are hot and winters are mild. The mean annual temperature is 35.6°C. The mean summer (May to September) temperature is 38.2 °C and mean winter (December to February) temperature is 15.3 °C. The mean annual rainfall is 142 mm.

As regards **soil climate**, the temperature regime is 'hyperthermic' and moisture regime is 'aridic' in major soils area or aridic that borders 'ustic' in some soils subject to flooding in summer each year. In view of aridic moisture regime, the irrigation is necessary for crop production in the vast good agricultural land area.

6.13.4 Geology and Parent Material

The sedimentary rocks, comprising mainly shale and sandstone, make up the geology concerning surrounding hills of the study area. It comprises Sibi formation (Oligocene-Pliocene age). The soil parent material originated from these rocks. The Gandajaat area, a part of Kachhi plain, has a general elevation ranging between 55 and 170 meters. The slope of the plain is generally less than one percent. It is a Piedmont plain formed in alluvium derived from the aforementioned rocks. It came into being as a result of erosional and depositonal cycles. Following the erosional cycle, a widespread accretion of clayey material took place forming perceptibly flat, featureless land plain, here the Gandajaat area.

6.13.5 Physiography and Landforms

Physiographically, the relief of area is almost a dead level barren surface of <1% slope in uncultivated parts except locally it may be intercepted by rills and shallow gullies. However, the extensive 'Gandajaat' cultivated area gives a look of flat land having an alveolar pattern of field plots.

Major landform is 'Piedmont plain'. For the soils of study area it can be subdivided into two sub-landforms namely; the late Pleistocene/ Subrecent Piedmont plain and the Recent Piedmont plain. This subdivision is based on land elevation and degree of development of soils. The late Pleistocene/ Subrecent Piedmont plain occupies 124,991 acres (50,604 ha) and the Recent Piedmont plain covers 3,465 acres (1,403 ha).

6.13.6 Natural Vegetation and Land Use

Being mainly barren, the natural vegetation in uncultivated area is only local and sparse. At places it is 'Capparis aphylla (Karir), Panicum antidotale (gam), Suaeda fruticosa (lani), Haloxylon sp. (lana), and Tamarix aphylla (gaz or lai) etc. However, in cultivated fields, there are also tree species of 'Prosopis spicegera (kandi) and Acacia sp. (kikar).

In 'Gandajaat' area, the vast land is cultivated to grow mainly 'wheat' in winter and 'sorghum' in summer. Other crops are oil seeds and pulses. The agricultural management is traditional, so the yields of crops are low. Due to shortage of irrigation water, a considerable land area remains fallow. Moreover, as the area comprises mainly somewhat fine to fine textured soils, so the water requirements of land are also high, meaning by that it needs more irrigation water to bring it to field capacity and it also holds more water at wilting coefficient when the general crop plants cease to grow.

6.13.7 Method of Study

6.13.7.1 Field Studies

A general review of soils in the study area was made during February 2005 to update possible significant changes in map units. It was particularly due to the diversion in river course during the past about 20 years. Landsat 7 imageries (scale 1:100,000) along with available soil maps (originally scale 1:250,000) diverged at the same scale were used. At specific sites auger holes were made to examine soil to a depth of 3.94 ft (1.2 meters) and shallow pits were dug especially for the detailed study of subsoil. The fact being that it was the over wash material added from the fresh river alluvium to already existing soil profile. So the substratum material was the original soil that was buried.

The Gandajaat command area was marked from coordinates of villages taken by Social Survey Staff. It was also checked from drainage pattern studies from satellite imageries.

6.13.7.2 Laboratory Studies

Six soil samples were collected from the specific sites of changed river course for analysis in the laboratory. The nature of analyses are as below:

* Particle-size distribution, EC, organic matter, calcium carbonate, pH value, SAR, soluble ions and micronutrients (Fe and Zn).

The soil samples were analyzed in Soil Survey of Pakistan Laboratory, Lahore. The analytical results are provided in Tables 6.15 and 6.16.

6.13.8 Description of Representative Soil Profiles

Four kinds of soils were recognized in the study area; Kachhi, Luni, Bolan and Katohar. Taxonomically these soils are designated 'soil series' as per definition given in USDA Handbook 18, the Soil Survey Manual. The profile description of these soil series is taken from Soil Survey report of Kachhi Area of Soil Survey of Pakistan except for Katohar series described in section 6.13.8.4.

6.13.8.1 Kachhi series

The Kachhi series is moderately deep and deep, well drained, strongly calcareous, moderately fine textured soil developed in Subrecent Piedmont alluvium derived mainly from shales and sandstones.

The description of its representative profile is given below:

Horizon	Depth (cm)	Description
A1	0-15	Light yellowish brown (10YR6/4) dry and dark yellowish brown (10YR4/4)moist; silt loam; massive; strongly calcareous; few medium and fine roots; moderately alkaline
B21	15-45	Very pale brown (10YR7/4)dry, yellowish brown (10YR5/4) moist; silty clay loam; weak subangular blocky and weak platy in patches; strongly calcareous; few medium and common fine roots; moderately alkaline.
B22	45-72	Very pale brown (10YR7/4) dry, yellowish brown(10YR5/4)moist; Bands of faint brown and yellowish brown, silty clay loam; weak subangular blocky and few inped laminations; strongly calcareous; few medium and common fine roots; moderately alkaline.
C	72-95cm	Light brown(7.5YR6/4)dry, brown(7.5YR5/4)moist, bands of dark grayish brown(2.5Y4/2); silty clay loam; massive to weak platy; strongly calcareous; few fine roots; mildly alkaline.
B2b	95-150	Brown(10YR5/3)dry, dark brown(10YR3/3) in patches (10YR4/3)moist; silty clay; weak subangular blocky; strongly calcareous; mildly alkaline.

6.13.8.2 Luni series

The Luni series is moderately deep and deep, well drained, strongly calcareous, medium textured soil developed in Subrecent Piedmont alluvium derived mainly from shales and sandstones of Sibi formation.

The description of its representative profile is given below:

Horizon	Depth (cm)	Description
Ap	0-12	Pale brown(10YR6/3)dry, brown(10YR5/3)moist; silt loam; massive; Strongly calcareous; common fine and medium roots; moderately alkaline; clear smooth boundary.
B21	12-37	Pale brown(10YR6/3)dry, brown(10YR5/3)moist; silt loam; weak coarse subangular blocky; strongly calcareous; few fine and medium roots; moderately alkaline.
B22	37-77	Pale brown(10YR6/3)dry, brown(10YR5/3)moist; silt loam; weak

		coarse subangular blocky, few inped laminations; strongly calcareous; few fine and medium roots; moderately alkaline.
C1	77-100	Pale brown(10YR6/3)dry, brown(10YR5/3)moist, few distinct strong brown mottles(7.5YR5/8); silt loam; laminated; strongly calcareous; common fine and few medium roots; moderately alkaline.
IIC2	100-114	Pale brown(10YR6/3)dry, brown(10YR5/3)moist; loamy sand; massive; Strongly calcareous; few fine roots; moderately alkaline.abrupt smooth boundary.
IIIC3	114-150	Pale brown(10YR6/3)dry, variegated brown and strong brown(10YR5/3, 7.5YR5/8) moist; silt loam; laminated; strongly calcareous; few medium decayed roots; moderately alkaline.

6.13.8.3 Bolan Series

The Bolan series is deep very deep, well drained, calcareous, medium textured soil formed in Recent Piedmont river alluvium. It has no B horizon.

The description of its representative profile is given below:

Horizon	Depth (cm)	Description
Ap	0-13	Light yellowish brown(10YR6/4)dry, yellowish brown (10YR5/4) moist; silt loam; massive; strongly calcareous; few fine roots; moderately alkaline; clear smooth boundary.
C1	13-28	Pale brown(10YR6/3)dry, brown(10YR5/3)moist; fine sandy loam; massive and laminated; strongly calcareous; common fine roots; moderately alkaline; abrupt smooth boundary.
C2	28-51	Light yellowish brown(10YR6/4)dry, yellowish brown(10YR5/4)moist; silt loam; laminated with thin lenses of silty clay; strongly calcareous; common fine roots; moderately alkaline; abrupt smooth boundary.
C3	51-58	Pale brown(10YR6/3)dry, brown(10YR5/3)moist; silt loam; massive; strongly calcareous; few fine roots; moderately alkaline; abrupt smooth boundary.
C4	58-74	Light yellowish brown(10YR6/4)dry, yellowish brown(10YR5/4)moist; silt loam; laminated; strongly calcareous; few fine roots; moderately alkaline; abrupt smooth boundary.
C5	74-84	Light brown (7.5YR6/4)dry, brown/dark brown(7.5YR4/4); silty clay loam; massive; strongly calcareous; few fine roots; moderately alkaline.
IIC6	84-92	Pale brown(10YR6/3)dry, brown(10YR5/3)moist; loamy fine sand; massive; strongly calcareous; few very fine roots; moderately alkaline; abrupt smooth boundary.
IIIC7	92-104	Light brown (7.5YR6/4)dry, brown/dark brown(7.5YR4/4); silty clay loam; massive; strongly calcareous; few very fine roots; moderately alkaline;
IVC8	104-155	Light yellowish brown(10YR6/4)dry, yellowish brown(10YR5/4)moist; silt loam; massive; strongly calcareous; few very fine roots; moderately

alkaline.

6.13.8.4 Katohar Series

The Katohar series is deep very deep, well drained, calcareous, fine textured soil formed in Recent Piedmont river alluvium. It has no B horizon. Its moderately deep phase was also recognized in case of overwash material.

The following profile* (Katohar moderately deep) was described in the study area near village Abro downstream of Erri Ganda showing surface crackings. The soil was formed as a result of redeposition of alluvium on abandoned river course which becomes clear from buried soil encountered in the soil profile. Katohar moderately deep phase occurs on the margins of abandoned river course. Location of pit is shown on the soil map.

Horizon	Depth (cm)	Description
A	0-12	Brown (10YR5/3)dry, brown/dark brown (10YR4/3)moist; silty clay loam; massive; violently effervescent; rare very fine roots; pH 8.2; clear wavy boundary.
C1	12-70	Brown (10YR5/3)dry, brown/dark brown (10YR4/3)moist;, thin distinct brown(7.5YR4/3) laminations; silty clay; weak platy; moderately to violently effervescent; pH 8.3; abrupt smooth boundary.
$2Ap_b$	77-88	Yellowish brown(10YR5/4)dry, dark yellowish brown (10YR4/4); clay loam; massive; violently effervescent; common white fibres ; pH 8.3; clear smooth boundary.
$2B_b$	88-150	Brown(10YR5/3)dry, brown to dark yellowish brown (10YR4/3.5)moist; silt loam; weakly structured/partially homogenized; violently effervescent; pH 8.3.

6.13.8.5 Inclusions

Besides the soil series described above in profiles, there may be minor inclusions of other soil series. These are Bhag, Belpat, Kundi and Chatter series.

- Bhag series is similar to Kachhi series, but its texture is silty clay.
- Belpat series is also similar to Kachhi series, but it contains salt specks.
- Kundi series is similar to Bhag series, but it contains salt specks.
- Chattar series is similar to Bolan series, but it is coarse textured (loamy sand, loamy fine sand).

Analytical results of the soil profile described above are provided in table 6.16.

6.13.9 Soil Characteristics

6.13.9.1 General

The soils of the study area are broadly categorized as Piedmont alluvial soils. Characteristically such soils differ within limited extents depending upon nature of local alluvium. However, as the study area is already not wide spread, the soils of this area have origin of their parent material exclusive from shales and sandstones. So the differentiating criteria among soils are characteristics resultant from other soil genesis factors. The geological age of soils plays a pivotal role for differentiation among these. Here it is late Pleistocene/ Subrecent Piedmont plain and Recent Piedmont plain. The soils of these landforms are developed having a B horizon and undeveloped having no B horizon respectively.

The soils are level to nearly level. The colors of soils range between 10 yr and 7.5 yr hues. The texture of soils is medium to moderately fine or fine. All the soils are strongly calcareous. The

pH ranges between 7.9 and 8.4. except locally these may be saline-sodic at the surface with a bit high pH value. All the soils are deficient in organic matter.

6.13.9.2 Soil Map Units

Five kinds of map units were established in the study area. Three in late Pleistocene/ Subrecent Piedmont plain and two in Recent Piedmont plain. The names of these map units are: Kachhi association, Luni-Kachhi association, Luni-Bolan association, Bolan association and Katohar association. Apart from these, the 'river bed' is a miscellaneous area.

i) Kachhi association

This soil association occurs in late Pleistocene/ Subrecent Piedmont plain. Its total area is 29,618 acres - 11,991 ha (23.1%). It occurs in three locations namely the Haji Shaher, Ghazi and Khokar.

Its components are Kachhi (55%), Luni (20%), Bhag (10%). The remaining 15% are inclusions comprising Belpat, Kundi series and gullies, channel beds.

The Kachhi series occupies nearly level surfaces, luni occurs on nearly level levee positions and Bhag genesis on slightly concave basins and channel infills.

Kachhi is weakly structured silty clay loam, Luni is weakly structured silt loams and loams, whereas Bhag is weakly structured silty clays.

ii) Luni-Kachhi association

This soil association also occurs in late Subrecent Piedmont plain. It is very extensive and its total area is 34,486 ha (66.3%).

Its components are: Luni (60 %), Kachhi (25%) and inclusions (15%). The inclusions are Bhag series, Belpat series and gullied land.

The Luni series occupies a bit higher nearly level physiographic position than Kachhi series.

Luni is weakly structured silt loams and loams. Kachhi is weakly structured silty clay loam, whereas Bhag is weakly structured silty clays. The Belpat is also weakly structured silty clay loam, but it contains salt specks.

iii) Luni-Bolan association

This soil map unit occurs in late Subrecent dissected Piedmont plain. Its total area is 4,027 ha (7.7%). It occurs in two gandas, the Erri and Haji Sheher.

Its components are: Luni (50%), Bolan (20%), Kachhi (10%) and inclusions (20%). The inclusions may be Bhag series, Kundi series and channel beds etc. The Bhag and Kundi series are silty clays, but the latter also contains salt specks.

The Luni series occurs on nearly level levees, Bolan series occupies nearly level channel margins and Kachhi series has its physiographic position on level to nearly level back slopes.

Luni series is weakly structured silt loams and loams, but Kachhi series is weakly structured silty clay loams. The Bolan series is stratified silt loams and very fine sandy loams.

iv) Bolan association

This soil association occurs on dissected Recent Piedmont plain. Its total area is 1,213 ha (2.3%). It occurs in three Gandas, the Haji Sheher, Ghazi and Khokar.

Its components are; Bolan (50%), Chattar (20%), Bolan shallow over sand (10%) and inclusions (20%). The inclusions may be torrent beds and gulliesand phases of Bolan and Chattar series. The Luni series is weakly structured silt loams and loams and Chattar series is stratified/massive sands and loamy sands.

v) Katohar association

This soil association occurs in Recent Piedmont plain. Its total area is 197 ha (0.4%). It was only mapped in Erri Ganda.

Its components are; Katohar (50%), Bolan (20%), Chattar (10%), Kachhi (5%) and inclusions (15%). The inclusions may be different depth phases of Katohar series, and channel beds etc. Katohar moderately fine texture soil variant was also recognized.

The Katohar series is stratified silty clays. The Bolan series is stratified silt loams and very fine sandy loams. Kachhi series is weakly structured silty clay loams. Chattar series is stratified/massive sands and loamy sands.

vi) Miscellaneous Area

The miscellaneous areas are river and channel beds or small gullies. However, there was no sizable area available for mapping scale except a portion of Nari river bed was identified for this purpose. Other such areas, being in minor proportions, were taken in inclusions with different map units. The miscellaneous area occupies 230 acres - 93 ha (0.2%) in the study area.

6.13.9.3 Extent of Map Units in Gundajaat

Total area is 128,457 acres (52,007 ha). Extents of map units in different Gandajaat are summarized in table 6.7.

Table 6.7: Gandajaat map units areas

Gundajaat		Map units area (hectares)						Total area (ha)
S.No	Name	Kachhi association	Luni-Kachhi association	Luni-Bolan association	Bolan association	Katohar association	Misc.area	
1	Erri	-	5019.3	885.7	-	197.3	93.0	6195.3
2	Haji Sheher	1523.6	8566.2	419.3	635.6	-	-	11144.7
3	Tuk(a)*	-	1430.0	-	-	-	-	4135.5
	(b)		2705.5	-	-	-	-	
4	Ghazi	2244.8	8934.8	-	92.9	-	-	11272.5
5	Khokar	8222.1	4460.0	-	484.5	-	-	13166.6
6	Mithri	--	3370.0	2722.0	--	--	--	6092.0
Total		**11990.5**	**34486.8**	**4027.0**	**1213.0**	**197.3**	**93.0**	**52007.0**

* This part of Tuk command area is under dispute.

6.13.9.4 Soil Taxonomy

i) Introduction

Taxonomic grouping of soils is very important for a great variety of purposes particularly for agricultural and engineering uses. This system of classification is based on soil properties that reflect similarities and differences among soils. By virtue of this the pedologists are able to use experience on soils in a known area to predict behavior of similar soils in other areas.

Soil Taxonomy has well defined taxa based on soil characteristics studied in the field and laboratory data of soil samples. The grouping of soils in this system has been successfully used for transfer of soil technology particularly at family level in many countries of the world.

The soil family differentiae, particle-size distribution has its peculiar importance for its compromise between pedologic and engineering classification. Thus the Soil Taxonomy has a wide practical utility for classifying soils in this modern system.

ii) Taxonomic Classification

U.S. Soil Taxonomy (1999) has been used for categorizing soil taxa and subsequent soil classification.

The surface horizon is 'Ochric epipedon'. The diagnostic sub-surface horizon in Kachhi, Luni and Bhag series was identified as ' Cambic B' due to alterations in the original rock material and development of a weak soil structure.

In the light of available climatic and laboratory data , a tentative soil classification has been made. In the absence of complete laboratory data, the best available estimates for soil properties were used.

The taxonomic grouping and classification of soils mapped in the area is given in Table 6.8.

Table 6.8: Soils Taxonomic Classification

Soil Name	Taxa				
	Order	*Suborder*	*Great Group*	*Subgroup*	*Family* [1/]
Kachhi	Aridisols	Cambids	Haplocambids	Vertic Haplocambids	Fine silty,
Luni	-do-	-do-	-do-	Fluventic Haplocambids	Fine loamy
Bolan	Entisols	Fluvents	Ustifluvents	Aridic Ustifluvents	Coarse loamy
Katohar	Entisols	Fluvents	Torrifluvents	Ustertic Torrifluvents	Clayey
Bhag	Aridisols	Cambids	Haplocambids	Ustertic Haplocambids	-do-

1/ Family differentiae for particle-size distribution have been given. Other important differentiae for mineralogy and temperature regime are; mixed, hyperthermic.

6.13.10 Land Capability Classification

6.13.10.1 General

According to Soil Conservation Service USDA, the land capability classification is a method of grouping such soils together that have similar potential for crop production, grazing or forestry. According to the system, the land capability classes are eight and are designated by Roman numerals (I to VIII), while sub-classes , representing hazards, are shown by small letters as suffix with the class numerals.

Four classes, class I to class IV are arable lands with decreasing agricultural development potential. Similarly class V through VII are for grazing or forestry with decreasing range/forestry potential. The class VIII is agriculturally unproductive, because it does not meet minimum requirements of a cultivable land.

6.13.10.2 Land Capability Classes/sub-classes

Land capability classification of the study area has been carried out for determining their capability for overall agricultural production and the degree as well as extent to which a land is capable of giving returns under irrigated agriculture.

The prefix 'ir' has been added to especially refer of a land area under irrigation.

Like soil map units, the area has also been designated into land capability associations due to small map scale resolution.

Four land capability classes/associations have been recognized on the basis of limitations.

Suffix for subclasses are 's', and 'w'. The 's' represents limitation due to soil factor; here it represents very clayey or very sandy soil.. The 'w' shows flooding hazard.

Thus the land capability classes/sub-classes of different soil areas mapped are given below:

Soil series	*Land capability class/subclass*
Kachhi	irIIs
Luni	irI
Bolan	irIIw
Katohar	irIIs
Bhag	irIIs
Chattar	irIIIs
River bed	VIIIw

The land capability associations (LCA).including classes/subclasses are shown on land capability map and described in succeeding sub-sections. Four land capability associations were recognized in a descending order of very good agricultural land to agriculturally unproductive land with the total study area being 128,457 acres (52,007 hectares). Here a *good agricultural land* is similar to a *land having high agricultural potential under irrigation.*

i) Class I-II Very Good and Some Good Agricultural Land
irI-irIIs

This class is very extensive in the study area. It covers 95,127 acres - 38,513 ha (74.1%). Its major land area is very suitable for irrigated agriculture with reference to general cropping. These crops are wheat, maize, sorghum, oilseeds, and fodders etc. It comprises level to nearly level mainly deep, medium to moderately fine textured, non-saline, non-sodic soils. However it has some soils having somewhat high shrink-swell clays and a little area (<1%) susceptible to flooding during heavy floods. Most of its area has no major problem for growing general crops provided sufficient irrigation water is available under modern agricultural management practices.

ii) Class II-I Good and Some Very Good Agricultural Land
irIIs-irI

This land class occupies 11,991 ha(23.1%). The land area comprises nearly level, deep to very deep, moderately fine textured approaching fine textured soil with some area of medium textured soil. It has no major limitation for cropping except difficult workability due to somewhat clay approaching clay soil. The land area is highly suitable for general crops, both *Rabi and kharif.* Careful seed bed preparation is necessary along with care for ploughing at proper moisture contents so as not to allow clods formation.

iii) Class II Good Agricultural Land
irIIw-irIIs

This class covers 3,482 acres - 1,410 ha (2.7%) in the study area. The land area comprises mainly nearly level, deep, medium and some fine textured soils. It also has a little proportionate (<0,1%) of coarse textured soil (irIIIs). Its limitation is susceptibility

to flooding during heavy rains. Some area has high shrink-swell clays that pose problem of difficult workability. However, the major area is highly suitable for general crops especially *Rabi* crops.

iv) Class VIII Agriculturally Unproductive Land
VIIIw

A minor extent of 230 acres - 93 ha (0.2%) is occupied by agriculturally unproductive land. It comprises broadened Nari river bed. It has scattered Tamarix bushes towards its margins. Sand bars and minor marsh or water basins appear when the river becomes dry.

6.13.10.3 Land Capability Area in Gandajaat
Extent of land capability area is summarized in Table 6.9.

Table 6.9: Land capability area, Gandajaat

Gundajaat		Land capability associations area (ha)				Total area (ha)
S.No	Name	I-II	II-I	II-II	VIII	
1	Erri	5905.0	-	197.3	93.0	6195.3
2	Haji Sheher	8985.5	1523.6	635.6	-	11144.7
3	Tuk (a)*	1430.0	-	-	-	4135.5
	(b)	2705.5	-	-	-	
4	Ghazi	8934.8	2244.8	92.9	-	11272.5
5	Khokar	4460.0	8222.1	484.5	-	13166.6
6	Mithri	6092	--	--	--	6092
	Total area	**38513**	**11990.5**	**1410.3**	**93.0**	**52007**

* Tuk (a) command area is under dispute

6.13.11 Water Quality

A water sample from Nari river near Tuk Ganda was collected for analysis. Its purpose is to know present basic water quality.

The water sample was analyzed by Quetta Chemicobacteriological Laboratory. The analytical results are given below:

pH	7.0
Qualitative presence of carbonates	Nil
Electrical conductivity (*u*S/cm)	520

No sodicity/salinity hazard is anticipated from these results. Carbonates are also absent. The water falls within the limit of ECw 750 *uS*/cm for safe irrigation water..

The pH value is also normal, indicative of no salinity/sodicity hazard. Now, for maximum crop yields, availability of sufficient irrigation water is necessary.

Excluding rainy season, presently there is a limited flow of the river water. The flood water or the mammoth water reservoir from rains after the construction of flood dispersal structures is expected to have much better quality of water.

6.13.12 Crop Suitability Ratings

The crop suitability ratings of the area have been appraised in two parts; general and specific. In case of latter, an environmentally befitted study of the area was undertaken for the suitable

selected crops as advised by the Head, Agriculture and Soils of the project.

6.13.12.1 General

Crop Suitability Ratings of Soils is an assessment of their relative suitability for sustained production of specified crops. These are based on two factors; soil characteristics and climate of the area. These range from 1 for the most suitable soils to class 4 for the least or not suitable soils.

Crop Suitability classes are given below:

Suitability Class 1	:	Well suited
Suitability Class 2	:	Moderately suited
Suitability Class 3	:	Poor/marginally suited
Suitability Class 4	:	Not suited

The ratings are similar to land capability classes with two important differences. Firstly crop suitability class is a rating for an individual crop, whereas land capability class is a rating for overall production. Secondly, crop suitability rating takes into account only the most favorable season of the year for the soil-crop combination under consideration, while land capability classification is based on the limitation of a soil for crop production throughout the year.

Soils are rated according to their ultimate development conditions, when irrigation and drainage are provided and improved crop varieties and cultural practices are introduced.

Crops considered are: wheat, oilseeds, berseem, cotton, rice, maize, sorghum, sugarcane, moong and mash among field crops; carrot, melons, turnips, and onion among vegetables; citrus, guava and date-palm among fruit crops.

Moderately deep to deep, moderately fine to medium textured soils (Kachhi, Luni and Bolan) are suitable for all crops. However, the deep to moderately deep, fine textured soils (Katohar and Bhag) are more suitable for rice and maize.

Crop suitability ratings are given in Table-6.11. The basis for this rating is the ***Land Capability*** approach in this table.

Extent of area under different soils in map units was calculated on the basis of percentage of the soil as mentioned in sections 6.13.9.2.

Specific crop suitability ratings are given in Table 6.12 and extent of area under different soils is given in Table-6.13.Here the basis for this rating is ***Land Evaluation*** approach. This is a modern approach for land classification and ultimate crop rating.

6.13.12.2 Specific Crop Suitability Study

Some environmentally suitable crops were selected for the study area as given below:

Kharif crops	**Rabi crops**
Cotton	Wheat
Moong, mash	Barley
Fodder (berseem, guara)	Lentil
Maize	Gram
Rice	Onion
Sorghum	Turnips
Guava	Carrot
Date-palm	Melons

Potato	Oilseeds (sarson, rape seed.)
Tomato	Radish
Coriander	Cumin

The suitability of these crops was studied in the light of land qualities of different soils. .These include: effective soil depth, water holding capacity, salinity-sodicity, plant nutrients supply capacity and oxygen availability in the root zone.

A qualitative relative assessment of relevant land qualities among soils is given in table 6.10.

Table 6.10:Land qualities among soils relevant to plant growth.

Soil	*Effective soil depth*	*Available water capacity*	*Salinity-sodicity hazard*	*Plant nutrients supply*	*Oxygen availability in root zone*	*Erosion* & flooding hazard*
Kachhi	moderately deep to deep	high	non	high	moderate	non
Luni	moderately deep to deep	moderate	non	moderate	moderate	non
Bolan	deep to very deep	moderate	Non	moderate	moderate	moderate
Katohar	deep to very deep	high	Non	high	low	slight
Bhag	moderately deep	high	Non	high	low	slight

Only in case of perennial orchards, the more susceptibility to flooding (Bolan series) has been considered for final assessment given in table 3.5.

As regards crop characteristics, the selected parameters are assessed in the table 6.11.

Table 6.11:Crop characteristics relevant to soil properties.

Kharif crops				**Rabi crops**			
Crop	*Rooting depth*	*Water requirements*	*Salinity tolerance*	***Crop***	*Rooting depth*	*Water requirement*	*Salinity tolerance*
Cotton	deep	moderate	moderate	Wheat	moderate	moderate	slight
Moong, mash	moderate	low	moderate	Barley	moderate	low	moderate
Fodders	deep	high	Low	Lentil	moderate	moderate	low
Potato	shallow	moderate	Low	Cumin	moderate	moderate	low
Tomato	deep	moderate	Low	Onion	shallow	moderate	low
Coriander	shallow	moderate	Low	Melons	deep	moderate	low
Maize/Sorghum	v. deep	moderate	Low	Carrot	deep	moderate	low
Guava	moderate	moderate	Low	Turnips	deep	moderate	Low
Date-palm	v. deep	moderate	High	Radish	moderate	moderate	Non
Rice	shallow	high	High	Oilseeds	moderate	moderate	low
Sugarcane	deep	high	moderate	Gram	deep	low	moderate

The crop suitabilities of different soils after matching crop characteristics and land qualities are given in the series of table 6.11.

The crop suitabilities S/S/S/S/S resulted from matching against land qualities: effective soil depth/available water capacity/salinity hazard/plant nutrient supply/oxygen availability in the root zone.. It is assumed that all crops considered here require sufficient plant nutrient supply as well as oxygen availability in the root zone.

Table 6.11 (a): Crop suitabilities in Kachhi series

Kharif crops		**Rabi crops**	
Crop	**Suitabilities**	**Crop**	**Suitabilities**
Cotton	S1/S1/S1/S1/S2	Wheat	S1/S1/S1/S1/S1
Moong, mash	S1/S1/S1/S1/S1	Barley	S1/S1/S1/S1/S2

Kharif crops		Rabi crops	
Crop	**Suitabilities**	**Crop**	**Suitabilities**
Fodders	S1/S1/S1/S1/S1	Lentil	S1/S1/S1/S1/S1
Potato	S1/S1/S1/S1/S1	Cumin	S1/S1/S1/S1/S1
Tomato	S1/S1/S1/S1/S1	Onion	S1/S1/S1/S1/S1
Coriander	S1/S1/S1/S1/S1	Melons	S1/S1/S1/S1/S2
Maize/Sorghum	S2/S1/S1/S1/S1	Carrot	S2/S1/S1/S1/S1
Guava	S1/S1/S1/S1/S1	Turnips	S1/S1/S1/S1/S1
Date-palm	S2/S1/S1/S1/S1	Radish	S1/S1/S2/S1/S1
Rice	S1/S1/S1/S1/S1	Oilseeds	S1/S1/S1/S1/S1
Sugarcane	S1/S1/S1/S1/S1	Gram	S1/S1/S1/S1/S2

Table 6.11 (b): Crop suitabilities in Luni series

Kharif crops		Rabi crops	
Crop	**Suitabilities**	**Crop**	**Suitabilities**
Cotton	S1/S1/S1/S1/S2	Wheat	S1/S1/S1/S1/S1
Moong, mash	S1/S1/S1/S1/S1	Barley	S1/S1/S1/S1/S2
Fodders	S2/S2/S1/S1/S1	Lentil	S1/S1/S1/S1/S1
Potato	S1/S1/S1/S1/S1	Cumin	S1/S1/S1/S1/S1
Tomato	S1/S1/S1/S1/S1	Onion	S1/S1/S1/S1/S1
Coriander	S1/S1/S1/S1/S1	Melons	S1/S1/S1/S1/S2
Maize/Sorghum	S2/S1/S1/S2/S1	Carrot	S2/S1/S1/S1/S1
Guava	S1/S1/S1/S1/S2	Turnips	S1/S1/S1/S1/S1
Date-palm	S2/S1/S1/S1/S2	Radish	S1/S1/S2/S1/S1
Rice	S1/S2/S1/S1/S1	Oilseeds	S1/S1/S1/S1/S1
Sugarcane	S2/S2/S1/S1/S1	Gram	S1/S1/S1/S1/S2

Table 6.11 (c): Crop suitabilities in Bolan series

Kharif crops		Rabi crops	
Crop	**Suitabilities**	**Crop**	**Suitabilities**
Cotton	S1/S1/S1/S1/S2	Wheat	S1/S1/S1/S1/S1
Moong, mash	S1/S1/S1/S1/S1	Barley	S1/S1/S1/S1/S2
Fodders	S2/S2/S1/S1/S1	Lentil	S1/S1/S1/S1/S1
Potato	S1/S1/S1/S1/S1	Cumin	S1/S1/S1/S1/S1
Tomato	S1/S1/S1/S1/S1	Onion	S1/S1/S1/S1/S1
Coriander	S1/S1/S1/S1/S1	Melons	S1/S1/S1/S1/S2
Maize/Sorghum	S2/S1/S1/S2/S1	Carrot	S2/S1/S1/S1/S1
Guava	S1/S1/S1/S1/S3*	Turnips	S1/S1/S1/S1/S1
Date-palm	S2/S1/S1/S1/S3*	Radish	S1/S1/S2/S1/S1
Rice	S1/S2/S1/S1/S1	Oilseeds	S1/S1/S1/S1/S1
Sugarcane	S2/S2/S1/S1/S1	Gram	S1/S1/S1/S1/S2

* Susceptibility to flooding

Table 6.11 (d): Crop suitabilities in Katohar series

Kharif crops		Rabi crops	
Crop	**Suitabilities**	**Crop**	**Suitabilities**
Cotton	S1/S1/S1/S1/S2	Wheat	S1/S1/S1/S1/S2
Moong, mash	S1/S1/S1/S1/S2	Barley	S1/S1/S1/S1/S2
Fodders	S1/S1/S1/S1/S2	Lentil	S1/S1/S1/S1/S2
Potato	S1/S1/S1/S1/S2	Cumin	S1/S1/S1/S1/S2
Tomato	S1/S1/S1/S1/S2	Onion	S1/S1/S1/S1/S2
Coriander	S1/S1/S1/S1/S2	Melons	S1/S1/S1/S1/S2
Maize/Sorghum	S1/S1/S1/S1/S2	Carrot	S1/S1/S1/S1/S2
Guava	S1/S1/S1/S1/S2	Turnips	S1/S1/S1/S1/S2

Kharif crops		Rabi crops	
Crop	**Suitabilities**	**Crop**	**Suitabilities**
Date-palm	S1/S1/S1/S1/S2	Radish	S1/S1/S1/S1/S2
Rice	S1/S1/S1/S1/S1	Oilseeds	S1/S1/S1/S1/S2
Sugarcane	S1/S1/S1/S1/S2	Gram	S1/S1/S1/S1/S2

Table 6.11 (e): Crop suitabilities in Bhag series

Kharif crops		Rabi crops	
Crop	**Suitabilities**	**Crop**	**Suitabilities**
Cotton	S2/S1/S1/S1/S2	Wheat	S2/S1/S1/S1/S2
Moong, mash	S1/S1/S1/S1/S2	Barley	S2/S1/S1/S1/S2
Fodders	S2/S1/S1/S1/S2	Lentil	S2/S1/S1/S1/S2
Potato	S1/S1/S1/S1/S2	Cumin	S1/S1/S1/S1/S2
Tomato	S2/S1/S1/S1/S2	Onion	S1/S1/S1/S1/S2
Coriander	S1/S1/S1/S1/S2	Melons	S2/S1/S1/S1/S2
Maize/Sorghum	S2/S1/S1/S1/S2	Carrot	S2/S1/S1/S1/S2
Guava	S2/S1/S1/S1/S2	Turnips	S2/S1/S1/S1/S2
Date-palm	S2/S1/S1/S1/S2	Radish	S2/S1/S1/S1/S2
Rice	S1/S1/S1/S1/S1	Oilseeds	S2/S1/S1/S1/S2
Sugarcane	S2/S1/S1/S1/S2	Gram	S12/S1/S1/S1/S2

The final crop suitability for each soil is reported from the least suitability assessed as a result of matching land qualities in each soil against crop characteristic requirements as given in the tables above.

Table 6.12 Specific crop suitability ratings in different soils.

Crops	**Soil Map Symbol**				
	Kachhi	**Luni**	**Bolan***	**Katohar**	**Bhag**
Cotton	S2	S2	S2	S2	S4
Moong, mash	S1	S1	S1	S2	S2
Fodders	S1	S2	S2	S2	S2
Potato	S1	S1	S1	S2	S2
Tomato	S1	S1	S1	S2	S2
Coriander	S!	S1	S1	S2	S2
Maize/Sorghum	S2	S2	S2	S2	S2
Guava	S1	S2	S3	S2	S2
Date-palm	S2	S2	S3	S2	S2
Rice	S1	S2	S2	S1	S1
Sugarcane	S1	S2	S2	S2	S2
Wheat	S1	S1	S1	S2	S2
Barley	S2	S2	S2	S2	S2
Lentil	S1	S1	S1	S2	S2
Cumin	S1	S1	S1	S2	S2
Melons	S2	S2	S2	S2	S2
Carrot	S2	S2	S2	S2	S2
Turnips	S1	S1	S1	S2	S2
Radish	S2	S2	S2	S2	S2
Oilseeds	S1	S1	S1	S2	S2
Gram	S2	S2	S2	S2	S2

* Due to more susceptibility to flooding in this soil, the suitability to perennial orchards is downgraded.

Total area covered by each soil is given in Table 6.13. It has been calculated on the basis of proportionate components in various map units mentioned in sec. 6.13.9.2.

Table 6.13: Extent of area under different soils*

Soil	Kachhi	Luni	Bolan	Katohar	Bhag	Chattar	Inclusions	Misc.
Area (ha)	15804 (30.4%)	23705 (45.60%)	1028 (2.0%)	99 (0.2%)	1199 (2.3%)	262 (0.5%)	9777 (18.8%)	93 (0.20)

More details given in table 3.8 (B)

Total reported irrigable soil area = 128,227 acres (51,914 ha)
Non-irrigable area = 230 acres (93 ha)
Total reported area = 128,457 acres (52,007 ha)

6.13.13 Soil Constraints and Data Interpretations

The soil constraints discovered as a result of field investigations as well as laboratory analysis of soil samples are discussed here.

6.13.13.1 General field Observations

Based on field observations, the following general deficiencies were encountered in the study area:

- Agricultural potential of good agricultural land in an extensive fallow or abandoned area remains hidden due to continuous unavailability or insufficiency of irrigation water.
- Traditional soil management; poor soil tillage resulting in clods formation , lack of fertilizer use and no or limited use of pesticides and weedicides results in low yields of crops.
- Uneven distribution of water particularly due to improper leveling of field plots as well as cultivation from insufficient residual moisture becomes source of patchy crop growth..

Apart from permanent limitations due to unfavorable soil characteristics, the above mentioned deficiencies account for decreased crop yields. These can, however, be overcome through adopting modern agricultural practices as may be advised by the Agriculture Department.

6.13.13.2 Specific Interpretations from Field and Laboratory Data

In the succeeding paragraphs, the soil constraints identified as a result of field studies have been described.

i) Inadequate Soil Depth

Extensive area of about 38,811 acres (15,713 ha) or nearly one/third of the gross command area comprises shallow to moderately deep soils (Kachhi and Bhag). This depth constraint affects choice of suitable crops to get maximum yields. Naturally these crops could be shallow or moderately deep rooted crops. So an important part of command area is not very highly fit for such crops as leguminous fodder, maize, sugarcane and orchards. It does not mean that it is not suitable for these crops, but the very high yield potential is not attainable. However, high yields of even deep rooted crops are possible with modern agricultural management. The shallow to moderately deep rooted crops will remain very highly suitable in these soils.

ii) Soils with High Swell-Shrink Ratio

An extensive area of 39,056 acres (15,812 ha) is occupied by clayey to somewhat clayey soils (Katohar, Bhag and Kachhi series) having high shrink-swell potential. Upon drying, hexagonal crackings appear on the surface of these soils. These soils are not very suitable for general crops except special crop such as rice. Workability remains problem in these soils. Ploughing in wet conditions results into clods formation. These soils demand careful seed bed preparation and inclusion of very deep rooted crops such

as fodder crops for propagation of soil structure in deeper layers.

iii) Highly Calcareous Soils

All the soils in the study area are violently are effervescent as determined from field tests. The laboratory revealed very high calcium carbonate contents in these soils. These usually range between 15 to 50 %. Naturally some problems arise from these high values. The problems are chemically due to fixation of phosphorus and physically from crust formation at the surface soil. These problems result into low yields of crops and low seed germination unless proper measures are taken to overcome these factors especially propagation of organic matter in these soils. The Agriculture Department can further guide suitable practices in this respect.

iv) Deficiency of Micronutrients

Laboratory data revealed deficiency of micronutrients with regard to Ferrous and Zinc. The 'Fe' ranges between 1.40 to 5.68 $mgkg^{-1}$ and 'Zn' ranges between 0.35 to 0.84 $mgkg^{-1}$ as given in Table 6.16. It is generally being < 5 $mgkg^{-1}$, the Fe is deficient. The Zn, being < 1 $mgkg^{-1}$, is acutely deficient. For maximum crop productions, it is advisable to seek guidance from crop specialists of Agriculture Department to meet crop requirements of micronutrients.

Table 6.14

6.14 (A) Crop Suitability Ratings of Soils Under Ultimate Development Conditions
Nari River 'Gandajaat'

S.No	Soil	L.C. class	Crops											
			Wheat	berseem	Maize/ sorghum	Mash/ moong	sugarcane	Fodder	Potatoes	onion	turnips	citrus	guava	Date-palm
1	Kachhi	IrI	1	1	1	1	1	1	1	1	2	1	1	1
2	Luni	IrI	1	1	1	1	1	1	1	1	1	1	1	1
3	Bolan	IrIIw	1	2	2	2	2	2	2	1	1	3	3	3
4	Katohar	IrIIs	2	2	2	2	2	2	2	2	3	3	3	3
5	Bhag	IrIIs	2	2	3	2	2	2	2	2	3	3	3	3
6	M.A.[1/]	Not applicable												

1. Miscellaneous area (Rv).

6.14.(B) Extent of area under different soils

S.No	*Soil*	*Constituent map unit (cmu)*	*Net area/ cmu (ha)*	*Total soil area (ha)*	*Percentage of CCA*
1	Kachhi	a.Kachhi association b.Luni-Kachhi association c. Others(Lu-Bo, Kt)	a.6595 b. 9069 c.140	15804	31,6
2	Luni	a. Luni-Kachhi association b. Luni-Bolan association c. Others (Ki)	a.20655 b. 652 c. 2398	23705	47.3
3	Bolan	a. Luni-Bolan association b. Bolan association c. Others (Kt)	a. 261 b. 728 c, 39	1028	2.3
4	Katohar	a. Katohar association	a. 99	99	0.2
5	Bhag & Chattar	a. Kachhi association b. Kachhi & Katohar association	a. 1199 b. 262	1461	3.2
6	Inclusions & Misc.	a.Minor areas of soils in different *cmu* b. River bed	a. 7000 b. 93	7093	15.4

Gross Command Area = 52007 ha
Net Command Area (CCA) = 51914 ha
Unirrigable Area = 93 ha

Table 6.15
LABORATORY ANALYTICAL DATA **
Nari River 'Gandajaat'

S.No	Soil series	Horizon/ layer	Depth (cm)	Sand %	Silt %	Clay %	*Tex.Class.	$CaCO_3$ %	Org. matter %	pH	ECe x10^3	Soluble ions meq/l					
												CO_3	HCO_3	Cl	SO_4	Ca + Mg	Na
1	Kachhi	A1	0-15	19.5	56	24.5	SiL	24.0	0.44	8.1	3.6	A	2.6	20.7	12.7	7.2	3.88
2		B21	15-45	7	64	29	SiCL	24	0.38	8.1	1.3	A	2.6	6.8	3.6	4.8	9.0
3		B22	45-72	2	59	39	SiCL	25	0.48	8,1	2.3	A	2.4	4.9	15.7	10.0	12.85
4		C	72-95	3	59	38	SiCL	24	0.48	7.7	7.5	A	2.4	30.7	41.9	54.8	20.0
5		$B2_b$	95-150	3	42	55	SiC	20	0.69	7.7	8.5	A	2.2	46.4	36.4	63.6	20.1
6	Luni	Ap	0-12	19	63	18	SiL	28.5	2.54	7.85	1.1	A	4.8	2.5	3.7	5.6	6.0
7		B21	12-37	14	72	14	SiL	29.5	1.24	8.05	0.5	A	2.8	1.3	0.9	2.8	2.1
8		B22	37-77	10	70	20	SiL	27.5	0.65	8.2	0.6	A	3.0	1.2	1.8	2.0	3.58
9		C1	77-100	18	70	12	SiL	31.0	0.48	8.2	1.65	A	3.0	2.7	10.8	4.0	10.5
10		IIC2	100-114	56	39	5	SL	34.0	0.20	8.35	1.3	A	2.6	2.5	7.9	2.8	10.0
11		IIIC3	114-140	18	70	12	SiL	30.0	0.24	8.10	4.5	A	2.6	12.7	29.7	13.2	30.1
12	Bolan	Ap	0-13	36	38	26	L	25.0	0.29	8.1	5.00	A	1.1	1.2	T	NA	NA
13		C1	13-28	58	30	12	SL	26.0	0.25	8.2	0.50	A	0.9	0.5	T	"	"
14		C2	28-51	23	59	18	SiL	29.0	0.21	8.2	0.95	A	0.9	0.6	T	"	"
15		C3	51-58	24	61	15	SiL	29.0	0.21	8.2	1.00	A	1.0	0.6	T	"	"
16		C4	58-74	36	48	16	L	28.0	0.19	8.3	0.80	A	1.0	0.55	A	"	"
17		C5	74-84	18	52	30	SiCL	26.5	0.25	8.0	2.00	A	1.1	0.65	P	"	"
18		IIC6	84-92	66	26	8	SL	25.5	0.10	8.4	0.90	A	0.9	0.60	P	"	"
19		IIIC7	92-104	14	56	30	SiCL	24.0	0.25	8.1	1.65	A	1.0	0.70	P	"	"
20		IVC8	104-155	15	68	17	SiL	24.0	0.29	8.1	2.20	A	1.1	0.75	P	"	"
21	Katohar	A1	0-8	21	51	28	SiCL	28.0	0.24	7.8	1.0	A	1.1	0.8	P	"	"
22		C1	8-58	12	48	40	SiC	25.5	0.24	7.8	2.0	A	0.9	1.0	P	"	"
23		C2	58-97	20	39	41	SiC	23.5	0.25	8.0	1.5	A	0.9	0.9	P	"	"
24		B1b	97-127	8	50	42	SiC	23.0	0.31	8.0	3.2	A	1.3	1.3	P	"	"
26		B2b	127-158	8	41	52	SiC	20.5	0.30	8.0	1.6	A	0.9	0.9	P	"	"

* SiCL (silty clay loam), L (loam), SL (sandy loam), SiL (silt loam), CL (clay loam), SL(sandy loam), LS(loamy sand).T (traces), A (absent), P (present).

** (Results adopted from Soil Survey Report, 'KACHHI Area').

Table. 6.16**

Analytical Results from Soils Occurring along Recently Abandoned Course of Nari River

S.No	Soil series	Horizon/ layer	Depth (cm)	Sand %	Silt %	Clay %	*Tex.Class.	Ca-CO_3 %	Org. matter %	pH	ECe x10^3	Micro.n		Soluble ions meq/l					
												Fe 1/	Zn 2/	CO_3	HCO_3	Cl	SO_4	Ca + Mg	Na
27	Katohar	A	0-12	19	18	33	SiCL	26.5	-	7.52	2.20	5.68	0.65	A	1.9	4.0	13.1	11.6	10.4
28		C1	12-70	18	42	40	SiC	25.0	-	7.55	1.81	4.05	0.45	A	3.0	4.9	10.2	10.0	8.1
29		$2Ap_b$	70-88	23	40	37	CL	21.0	-	7.52	4.36	4.10	0.84	A	3.0	8.5	32.1	33.0	10.6
30		$2B_b$	88-150	20	61	19	SiL	27.0	0.38	7.66	3.84	3.35	0.60	A	3.50	4.5	30.4	25.4	13.0
31	Katohar*	Ap	0-12	41	51	8	SiL	22.5	0.38	7.59	1.67	2.10	0.40	A	3.20	4.1	9.4	9.80	6.9
32		C	12-45	19	53	28	SiCL	29.0	0.35	7.57	2.53	1.40	0.35	A	2.10	6.8	16.1	16.8	8.5

1/, 2/ $mgkg^{-1}$

* Katohar moderately fine variant

** Analysis were performed in Soil Survey of Pakistan laboratory Lahore.

6.14 DESIGN OF STRUCTURES

6.14.1 General

Spate irrigation on Nari river is one of the oldest and largest spate irrigation system in Balochistan. Under the system the farmers construct gandas on Nari river to divert flood water to the fields. Presently about five gandas are being constructed across Nari river at Erri, Haji Shaher, Tuk, Ghazi and Khokhar. The bunds are generally made in such a way that they break in case of high floods. This works as a safety valve. It avoids substantial damage to the channel network, as very large floods are passed down the river rather than playing havoc with the flood channels/ fields.

At present, from 10 May to 15 August, the land owners of the upper Nari are allowed to make gandas (earthen bunds) in the Nari River while after 15 August they are not allowed to do so. The average land irrigated by them is 6,560 hectares (16,200 Acres).

As a general rule when the land served by one ganda in Upper Nari is fully irrigated, the management committee would allow breaching of the Ganda so that the command area of the next ganda receives the flood water for irrigation and so on.

After 15 August the land owners of lower Nari are allowed to make gandas in the Nari River and during this period the land owners in upper Nari are not allowed to irrigate their land.

Water is not allowed to go waste to the low lying areas east and west of the Nari River. Guide bunds prevent water flowing to these areas - all landowners contribute towards these bunds, with farmer in lower Nari paying twice the amount per hectare in case bunds on the upper Nari were broken

If any dispute arises the Management Committee would inspect the area and would be authorized to decide and allow a downstream party to break the ganda at a proper time or instruct repair to a guide bund to take effect within 5 -10 days. In case repairs to guide bunds are not made the main bund of the area concerned may be broken.

The other scenario could be that the flood is intense enough, beyond the sustaining capacity of the bund, to over top and subsequently breach it.

Under the Project, detailed design of the five dispersal structures along with ancillary works has been carried out and being presented in the following sections. Attached figures give the details of the different Project components.

6.14.2 Mithri Flood Irrigation System

The scheme was constructed in the year 1975 by the Irrigation and Power Department, Government of Balochistan and is located at a distance of about 9.7 kms west of Mithri Railway station on Nari River. The scheme comprises of the following components.

a) Main weir, 285m (935ft) in length;
b) Canal head regulator of 56.63 cumec (2,000 cusec) discharge capacity;
c) left and right sides earthen guide bunds;
d) Flood canal 1,524 m (5,000 ft) long of 56.63 cumec (2,000 cusec) capacity

During the initial year the scheme was damaged by an extreme flood event and subsequently restored in 1980. However the scheme could not function properly due to the improper location of the headworks and non existence of silt extrusion facility. The initial reach of the canal and

headworks, therefore, got silted up and therefore was quite ineffective in diverting the flood discharge.

6.14.2 Project Components

Two different alternatives have been considered viz. i) construction of a Barrage at Erri and ii) construction five dispersal structures at the locations of the existing gandas. Alternative I comprises of construction of a Barrage at Erri, construction of left and right guide bunds from Mithri to Erri in a length of about 7 kms and conveyance channel from Erri to Khokar in a length of 28 kms. The alternative is marred with considerable social, technical and economic repercussions as follows.

- The conveyance channel will be aligned along the right bank of the Nari river with a high left embankment to protect the channel from the floods of Nari river thereby blocking the existing arrangement of diverting flood water. It is pertinent to mention here that the section of Nari river decreases from head to tail which indicates that in high floods the area behaves as a flood plain after spilling from both the banks with the flood flows decreasing in the respective order. The existing spate irrigation arrangement which is effected by flooding of the command area will therefore be disrupted;

- To confine the floods upstream of the barrage guide bunds will have to be constructed upto Mithri weir which will be prone to disrupting the existing spate irrigation system and restricting the flood way;

- The system will be capable to divert only a limited quantity of flood 56.63 cumec (2,000 cusec) while a large proportion of the flood will be passed downstream, un-attenuated, varying the flood regime and exposing the downstream areas to higher risks of flooding and damages to the irrigation system;

- During the survey the communities were reluctant to allow procurement of land for the conveyance system through their land. The lower command area communities were apprehensive of tampering of the flood flows by the upper command communities thereby hindering equitable distribution of food water.

The main features of the Alternative II, construction of five dispersal structures at the locations of the exiting five gandas, are;

- The gated dispersal structures will simulate the functioning of the existing gandas raising the pond level to the same level as that in the existing gandas;

- The dispersal structures will divert the flood to the fields through conveyance channels constructed by the farmers. The farmers will be able to construct secondary gandas on the channels to divert water to their fields as per their existing water rights. During the field surveys the farmers specifically recommended construction of only a gated weir structure with no other intervention in the existing irrigation system.

Based on the above the construction of five separate dispersal structures have been recommended at the five ganda locations. The existing channels are in cutting below the command and the farmers construct gandas to raise the water to command the irrigated land. This necessitates raising the channel level which will subsequently raise the required level of the dispersal structures which is unacceptable due to technical reasons. The flood water will

be conveyed to the field through the existing conveyance system which will be maintained by the communities through their own resources as is presently being practiced.

Similarly the Project also comprises of remodeling/ rehabilitation of Mithri Weir.

Where the weir is located on the bend of a river, as is the case in Mithri weir, the offtake must be located on the outside of the bend. When water flowing in a river or in an open channel passes round a bend, the water level on the outside of the bend will be higher than that on the inside of the bend. Near the bed of the channel, the velocity of flow is low and the head difference between the outside and the inside of the bend, causes the water to move along the channel bed from the outside of the bend to the inside. This sets up a spiral flow in the river, with the bed flow picking up sediment from the river bed and transporting it to the inner side of the bend. At the inside of the bend the water rises and then flows outwards along the surface. As the water rises, it dumps its sediment load on the inner side of the bend.

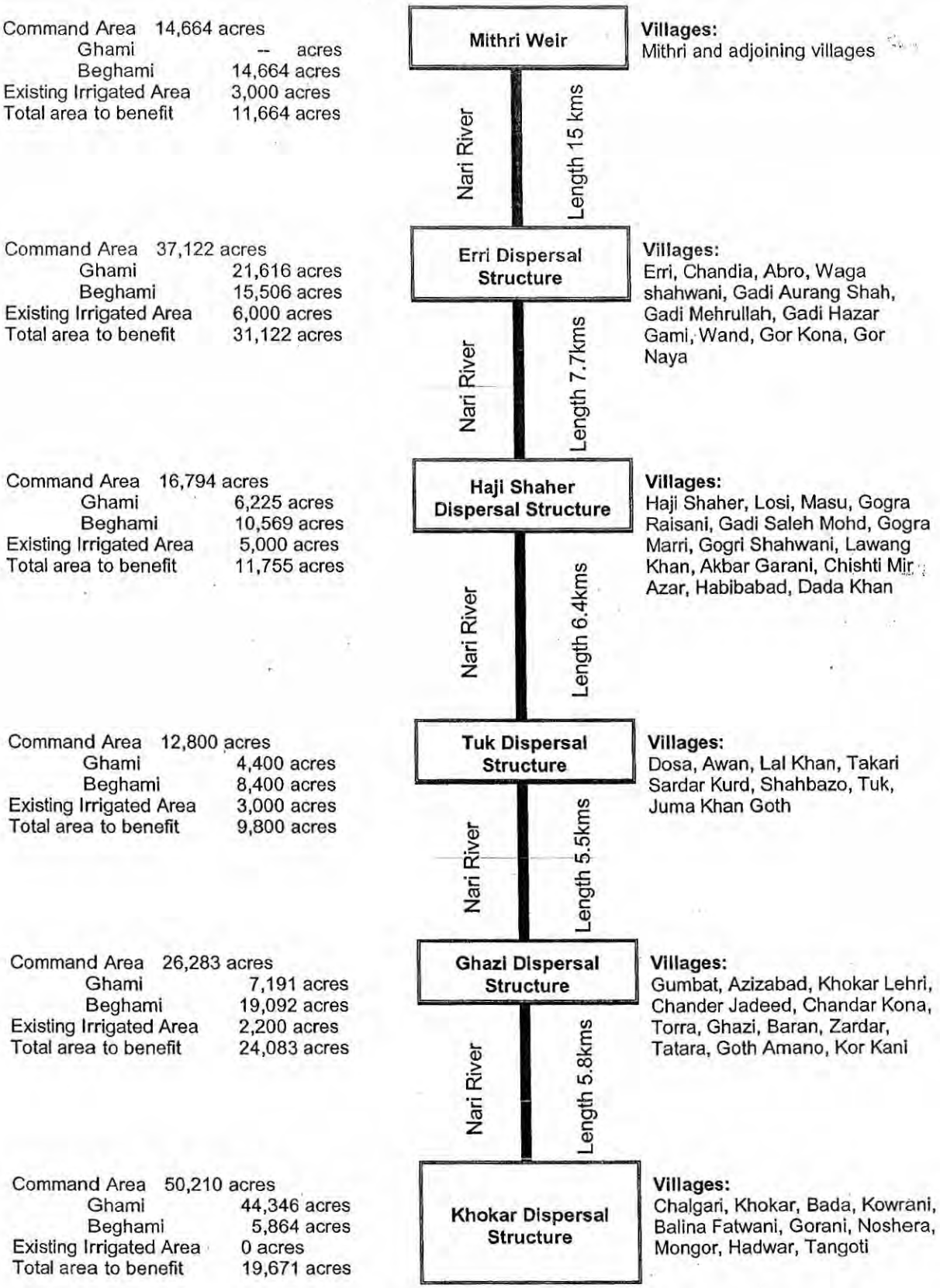
Thus offtakes set on the outside of bends tend to remain clear, whilst those sited on the inside of bends tend to silt up. As in the case of existing Mithri weir, where the intake is located on the inside of a sharp bend and therefore completely submerged by silt.

Under the proposed rehabilitation scenario, therefore, the approach to the weir has been proposed to be straightened. Two head regulators of 56.63 cumec (2,000 cusec) have been proposed to irrigate the command areas on the left and right sides of the river.

A scour sluice has been provided near the head regulator to minimize entry of silt into the conveyance system. A suitable layout adopted and which has been model tested comprises of a curved scour sluice channel, incorporating a skimming weir which feeds the offtake channel. The scour sluice is gated. The sluice channel is curved with an offtake skimming weir on the outside of the bend in the sluice. The width of the curved sluice channel gradually reduces. The bed load moves to the inside of the bend thus reducing the bed load in the vicinity of the skimming weir. The smooth geometry of the curved sluice channel means that the bottom flow in the sluice channel passes through the sluice whilst the upper layers of flow, containing less and finer sediment, are skimmed off and past into the offtake channel. With this system, model tests have shown that it is possible to remove up to 75% of the sediment entering the excluder. The scour sluice has been designed to take 5 percent of the design flood flow

The scour sluice channel bed level is 0.6m (2ft) below the level of the skimming weir and/or head regulator crest level.

The Project components are given in section 6.2. The following figure gives the schematic plan of the interventions.


Command Area 14,664 acres
Ghami -- acres
Beghami 14,664 acres
Existing Irrigated Area 3,000 acres
Total area to benefit 11,664 acres
Mithri Weir
Villages:
Mithri and adjoining villages
Nari River
Length 15 kms
Command Area 37,122 acres
Ghami 21,616 acres
Beghami 15,506 acres
Existing Irrigated Area 6,000 acres
Total area to benefit 31,122 acres
Erri Dispersal Structure
Villages:
Erri, Chandia, Abro, Waga shahwani, Gadi Aurang Shah, Gadi Mehrullah, Gadi Hazar Gami, Wand, Gor Kona, Gor Naya
Nari River
Length 7.7kms
Command Area 16,794 acres
Ghami 6,225 acres
Beghami 10,569 acres
Existing Irrigated Area 5,000 acres
Total area to benefit 11,755 acres
Haji Shaher Dispersal Structure
Villages:
Haji Shaher, Losi, Masu, Gogra Raisani, Gadi Saleh Mohd, Gogra Marri, Gogri Shahwani, Lawang Khan, Akbar Garani, Chishti Mir Azar, Habibabad, Dada Khan
Nari River
Length 6.4kms
Command Area 12,800 acres
Ghami 4,400 acres
Beghami 8,400 acres
Existing Irrigated Area 3,000 acres
Total area to benefit 9,800 acres
Tuk Dispersal Structure
Villages:
Dosa, Awan, Lal Khan, Takari Sardar Kurd, Shahbazo, Tuk, Juma Khan Goth
Nari River
Length 5.5kms
Command Area 26,283 acres
Ghami 7,191 acres
Beghami 19,092 acres
Existing Irrigated Area 2,200 acres
Total area to benefit 24,083 acres
Ghazi Dispersal Structure
Villages:
Gumbat, Azizabad, Khokar Lehri, Chander Jadeed, Chandar Kona, Torra, Ghazi, Baran, Zardar, Tatara, Goth Amano, Kor Kani
Nari River
Length 5.8kms
Command Area 50,210 acres
Ghami 44,346 acres
Beghami 5,864 acres
Existing Irrigated Area 0 acres
Total area to benefit 19,671 acres
Khokar Dispersal Structure
Villages:
Chalgari, Khokar, Bada, Kowrani, Balina Fatwani, Gorani, Noshera, Mongor, Hadwar, Tangoti

6.14.3 Design and Drawings of Works

Detailed design and drawings of the different components of works have been prepared on the basis of topographic surveys, hydrological studies and geo-technical investigation.

6.14.4 Design Criteria

According to the hydraulics of the existing ganda system the water level of Nari river is raised and flow is diverted through an off-take channel to the command area. In the off take channel gandas are also constructed by farmers along its length. The operation of these gandas follow the same rules as of the main gandas.

Keeping in view the requirements of the system and the demand of the communities a gated weir with Bell shaped guide bunds on both sides of the weir have been proposed to be constructed at the five locations. Both upstream and downstream ends of the banks are curved gently to lead the flow along smooth parallel lines. A typical dispersal structure comprises of the following components:

i. Weir with automatic lift radial gates;
ii. Upstream curved head;
iii. Downstream curved head;
iv. Straight portion which joins two curved heads/ ends.

The arrangement will raise the pond water of the river to the desired level above the command area levels. If the discharge in the main river increases the gates will be proportionately opened so that the desired water level is maintained and surplus water is released to the downstream dispersal structure. Under the proposed scheme, therefore, the entire command area of all the five gandas could be irrigated simultaneously.

6.14.5 Design of Weir and Appurtenant Structures

The weir will usually be designed to withstand a flood with a return period of 100 years.

A broad crested weir with the crest level almost at the level of the river bed has been proposed to be constructed to avoid building a solid obstruction across the river. The raising of the water level is effected by the gates alone. During floods the gates are raised to pass the excess flow underneath the gates maintaining the required afflux level. During low floods the gates will be lowered fully to divert the flood flows to the command while maintaining the required water level. The structure is, therefore, efficient in discharging silt load downstream and will effect better control over the levels.

As water flows across a weir, static head is converted to velocity head with negligible energy loss. The resulting high velocities can cause scour downstream. To safely dissipate this kinetic energy a common method is to form a hydraulic jump immediately downstream of the weir. Stilling basins are structures that ensure that the hydraulic jump occurs just downstream of the weir for the expected range of flows over the weir, and that the turbulent flow within a jump does not damage the weir structure.

For the purpose USBR Type 4 basin has been proposed. The stilling basin type recommended, through comparatively expensive, is the easiest to construct and effective in dissipating energy. However the stilling basin of the head regulator of the Mithri canal has been designed as USBR Type III due to hydraulic requirements.

The selection of the height of the canal embankments have been adopted based on the design flood level and necessary free board as require. The top with of the embankment has been fixed as 6.10m (20 ft).

The conveyance system of the Mithri weir irrigation system has been designed on the basis of Lacey and manning equation. The design parameters in respect of left and right side conveyance system are as follows.

Design Capacity	56.64 cumec (2,000 cusec)
Bottom width	26.8 m (88 ft)
Longitudinal Slope	1:4,300
Sideslope	2H:1V

6.14.5.1 Scour Depth, Seepage and Uplift

6.14.5.1.1 General

The foundations of a weir have to be designed to counter the effects of scour in the river bed and seepage under the structure itself. The cutoffs have to be extend to at least the expected scour depths, both upstream and downstream of the structure. If sub-surface flow is to be intercepted, they are likely to extend much deeper.

In addition, the cutoffs have to be sufficiently deep to maintain a seepage gradient under the structure that is sufficiently low so that fines will not be washed from under the structure. This may be done by checking the exit gradient is safe for the maximum design differential head. In addition, the structure seepage path length is checked using Lane's weighted creep method. Either the cutoffs depths or the length of the structure may be increased to satisfy this criteria; it is usually more economical to deepen the cutoff depths.

Finally, the overall weir structure has to be checked for safety against uplift pressures from the water seeping underneath. Increasing the depth of the upstream cutoff is effective in reducing the uplift pressure under the structure.

6.14.5.1.3 Seepage and Exit Gradient

When the upward thrust of the seepage flow passing beneath a structure is greater than the submerged weight of the soil resisting the upward thrust on the downstream side of the end cut off wall, piping will occur and the material will be washed upwards and into the river flow. This may occur for any structure across which there is a head loss.

Since the proposed structure is gated and provided with stop logs, the head difference across the structure is usually taken as the expected maximum water level upstream and the bed level downstream.

To design the structures against piping, Khosla's and Lane's Weighted Creep Theory have been used.

Khosla's Method

The exit gradient at the downstream end of a structure may be determined by using Khosla's method. Khosla's equation is:

$$G_e = H / (\Pi\, d\, F^{0.5})$$

$$F = 1+\sqrt{(1+(b/d))/2}$$

Where:

Ge	=	1/2.5
H	=	the head difference across the structure ft [m]
d	=	the depth of the downstream cutoff below any downstream protection and filter ft [m]
b	=	the length of the structure ft [m]

Khosla's equation does not consider the reduction of exit gradient that occurs if an upstream cut off is provided to the structure, and application of the equation often leads to deep downstream cutoffs and a consequent increase in uplift pressure under the structure. This would then result in thick floors.

Lane's Weighted Creep Theory

Bligh postulated that percolating water follows the outline of the base and foundations of a structure (ie water creeps along the bottom structural contour), and that the path followed by the percolating water, called the creep length, was proportional to the head loss across the structure. Lane modified this theory, after analyzing the foundations of 200 dams world wide, and stipulated that in computing the creep length, a weighting factor of one third should be applied to the horizontal creep as it is less effective in reducing uplift or differential head. Thus to ensure safety against piping:

The sum of the vertical creep lengths (vertical faces and surfaces at 45° and more), plus one third the sum of the horizontal creep lengths (horizontal faces and faces 45° and less), must be greater than the differential head across the structure times Lane's creep coefficient © of 1.6.

6.14.5.2 Uplift Pressures and Floor Thickness

Where seepage occurs beneath a hydraulic structure, the head causing that seepage will also cause uplift on the structure. Where the uplift pressure is greater than the sum of the weight of the structure plus the weight of the water above the structure, the structure can be forced upwards and may break up.

Since the proposed structure is a comprises of concrete the thickness is designed based on direct gravitational stability.

The factor of safety for uplift has been given as follows.

$$\text{Factor of Safety} = \frac{\text{Weight of "concrete" and water on the weir}}{\text{Upward pressure from the seepage water}}$$

$$F\ of\ S = \frac{d_c t + d_w H_2}{[H_1 - (H_1 - H_3) g_r] d_w}$$

Where:

d_c	=	unit weight of concrete [2,400 kg/m^3 or 150 lb/ft^3]
d_w	=	unit weight of water [1,000kg/m^3 or 62 lb/ft^3]
t	=	thickness of stilling basin at the point of interest, [m or ft]

g_r = the gradient of the equipotential lines (ie the number of equipotential lines upstream of the point of interest divided by the total number of equipotential lines).

The thickness of the base slab is usually adjusted to give a factor of safety against uplift of between 1.1 and 1.3 depending on the degree of accuracy to which the soil and other parameters are known.

6.14.5.3 Radial Gates

Radial gates have been proposed to be constructed/ installed at the five dispersal structures which will be instrumental in raising the water level to command the irrigated area. The gates will be equipped with both automatically and manually controlled mechanisms. Water level sensors would be provided which will allow opening and closing of the gates automatically to maintain a required water level. To operate the system the power requirements will be fulfilled by getting a connection from the nearest WAPDA transmission line/ grid. However, provision of diesel generating units has also been proposed as standby power source.

6.14.6 Training Works

A heavily built bell mouth on both sides of the river has been proposed. The design is based on the following design considerations.

i. The width of the weir has been proposed to be equivalent to 5 √Q.
ii. Length of the upstream bund = 1.25 to 1.5 times width of weir
iii. Length of downstream guide bank = 0.25 times width of weir
iv. The upstream curvature of the bund is 145°
v. The downstream curvature of the bund is 60°

6.14.7 Structural Design

The following design criteria, parameters, coefficients and constants, design codes, material strength, unit loads, weight and stability criterial shall be applicable to the design of structures.

6.14.7.1 Reinforced Concrete and Plain Concrete

All the concrete and reinforcement drawings and details have been prepared in accordance with the following standards and instructions.

The plain cement concrete shall conform to the provisions of ACI 318-02 and commentary (ACI 318R-02). "Building Code Requirements for Structural Plain Concrete" whereas mass concrete shall conform to ACI 207.1R-96.

The design of reinforced concrete is based on the strength design method set out in "Building Code Requirements for Reinforced Concrete" (ACI 318-02) and Commentary (ACI 318R-02) of the American Concrete Institute (ACI) using load and strength reduction factors. The structures in contact with water shall take into account the certain provisions of "Code Requirements for Environmental Engineering Concrete Structures (ACI 350-01) and Commentary (ACI 350R-01). Case in place reinforced concrete shall also have a minimum crushing cylindrical strength of 3,000 psi at 28 days after casting.

The structural steel shall conform to the requirements of the applicable provisions of the latest edition of:

- "Specification for the Design, Fabrication and Erection of Structural Steel for

Buildings" of the Manual of Steel Construction of the American Steel Construction (AISC).

- "Standard Specifications for Highway Bridges" of the American Association of State Highway and Transportation Officials (AASHTO).
- Design of structural steel shall based on the use of high strength structural steel meeting the requirements of ASTM Designation A-242 or standard strength meeting the requirements of ASTM Designation A-7 or A-36 as applicable.

All reinforcement steel shall be grade 40 (A615) or 60 (A615) deformed bars and shall conform to American Society of Testing Material (ASTM) standards.

6.14.7.2 Joints

The following four types of joints are recommended. Quite often one joint may be a combination of two or more of these types.

i) Construction Joints

These joints are usually provided where necessary for the practical placement of concrete. They should usually, but not necessarily, be vertical or approximately horizontal. The reinforcement steel shall be continued across the joint and the concrete face shall be prepared to give continuity. Where required to ensure water tightness in construction joints, a water stop shall be provided. Construction joints may be used to avoid corner cracks due to settlement of fresh concrete at the sides of wall openings or at junctions of walls and slabs.

ii) Contraction Joints

These shall be used to relieve tensile stresses in the concrete by shrinkage. They differ from construction joints wherein means are used to prevent bond between the joint faces and the reinforcement does not cross the joint. Concrete on one side of the joint is cast first, and after the form is removed from the face, the joint is painted with bituminous material to prevent bond with the concrete placed against it. Water stops shall be installed, where water tightness is necessary. Contraction joints may also serve as construction joints.

iii) Expansion Joints

These are used to eliminate or reduce compressive stresses that would otherwise result from thermal expansion, creep, or settlement of concrete. Expansion joints are either 25 mm or 19 mm and the space is filled with elastic joint filler. Water stops shall be placed in expansion joints where necessary to provide water tightness. Expansion joints may also be used as contraction joints and to take up rotation and displacement. Expansion joints shall be provided between concrete and brick/ stone masonry.

iv) Control Joints

These joints consist of weakened places where cracks, if any, will occur and are provided in concrete walls to prevent unsightly random cracking. Control joints are positioned at points to reduce shear and bending moment. Reinforcement running perpendicular to the joint will be reduced by 50% at the joint, subject to stress requirements. A crack will be induced by forming a rebate 19 mm wide by 12.5 mm deep on each exposed face and the rebate will be sealed with sealant.

v) Water Stops

All water stops in joints shall be of poly vinyl chloride (PVC) of type and sizes manufactured by the approved concerns.

6.14.7.3 Design of Gates

The structural components of the gates have been designed based on load and resistance factor design (LRFD) principles. LRFD is a method of proportioning structures such that no applicable limit state is exceeded when the structure is subjected to all appropriate design load combinations.

Structural Analysis and Design

SAP 2000 software has been used for the analysis and design of the different structural gate components.

7.0 CAPITAL COST ESTIMATES

The cost of the different components of the Project has been computed as follows.

S.No	Description	Amount (Rs.)
1	Rehabilitation of Mithri Weir System	1173.056
2	Construction of Dispersal Structure at Erri	764.588
3	Construction of Dispersal Structure at Haji Sheher	837.565
4	Construction of Dispersal Structure at Tuk	481.917
5	Construction of Dispersal Structure at Ghazi	500.182
6	Construction of Dispersal Structure at Khokhar	473.503
7	Provision of Residential and other Infrastructure Facilities	55.377
8	General Requirements and Facilities for Employer and Engineer	78.320
9	Establishment of Project Implementation Unit (PIU)	83.279
	Sub Total	**4447.787**
10	Physical and Financial Contingencies (2%)	88.956
11	Construction Supervision Cost (3%)	133.434
12	Price Escalation During Construction	242.210
	Grand Total	**4912.386**

7.1 BASIS OF COST ESTIMATE

The cost estimates have been based on the prevailing market rates. The details are as follows:

- The cost of the major project components awarded are based on the approved rates of M/S Agha Construction Company.
- For new items/ components included extensive survey was carried out for the collection of prevailing market rates of construction materials, labor and construction machinery. In addition the recently awarded tenders and estimates of works of similar nature were also studied. Detailed rate analysis of the related scheduled items were also carried out for the estimation.
- Provision for the detailed design, engineering and administrative costs has been provided in the project cost at the rate of 3% of the project cost each. It is mandatory to engage the consultants for the detailed design, contract documentation, evaluation of bids and supervision of works.
- The estimate presented in this report is the feasibility level cost estimate and is subject to 5 % to 15% change. Physical contingencies have been provided at the rate of 1% of the total cost to allow for the design changes, delays, logistical changes keeping in mind the site specific conditions. Similarly financial contingencies have also been considered at the rate of 1% of the project cost.

- Price escalation has been adopted as 6% per annum.

7.2 DATE ON WHICH COST ESTIMATE ARE MADE

November, 2011

7.3 ANNUAL PHASING OF EXPENDITURE

The component wise cost is as follows.

S.No	Description	Amount (Rs.)			
		Total	2010-11	2011-12	2012-13
1	Rehabilitation of Mithri Weir System	1173.056	210.07	481.49	481.49
2	Construction of Dispersal Structure at Erri	764.588	--	382.29	382.29
3	Construction of Dispersal Structure at Haji Sheher	837.565	141.38	348.09	348.09
4	Construction of Dispersal Structure at Tuk	481.917	--	240.96	240.96
5	Construction of Dispersal Structure at Ghazi	500.182	--	250.09	250.09
6	Construction of Dispersal Structure at Khokhar	473.503	--	236.75	236.75
7	Provision of Residential and other Infrastructure Facilities	55.377	5.54	24.92	24.92
8	General Requirements and Facilities for Employer and Engineer	78.320	7.83	35.24	35.24
9	Establishment of Project Implementation Unit (PIU)	83.279	23.62	29.83	29.83
	Total	**4447.787**	**388.44**	**2029.68**	**2029.68**
10	Physical and Financial Contingencies (2%)	88.956	2.19	43.38	43.38
11	Construction Supervision Cost (3%)	133.434	20.93	56.25	56.25
12	Price Escalation During Construction	242.210	--	121.11	121.11
	Grand Total	**4912.386**	**411.55**	**2250.42**	**2250.42**

7.4 HISTORY OF PROJECT APPROVAL, YEAR-WISE PSDP ALLOCATION, RELEASES AND EXPENDITURE

The Project was approved by ECNEC at a rationalized/ reduced cost of Rs. 2000.167 million (60% of original PC-I cost) on December 9, 2010, by deleting Khokar dispersal structure altogether and significant reduction in the scope of major works of Mithri Weir and other structures. Implementation on the Project started in the second quarter of the year 2011 and is scheduled to be completed on or before 30 June 2013 subject to annual release of funds as per provision kept in the PC-I. The details of the year-wise allocation/ releases and expenditure are as follows.

(Rs. In Million)

S.No	Year	Allocation	Release	Expenditure
1	2010-11	411.56	411.55	411.55
2	2011-12	800.00	160.00	160.00
	Total	**1211.56**	**571.55**	**571.55**

7.5 ITEM-WISE, YEAR-WISE ACTUAL EXPENDITURE AND PHYSICAL PROGRESS

The following table gives the item-wise expenditure and physical progress.

S.No	Description	Amount (Million Rs.)	Expenditure (Million Rs)	Physical Progress (%)
1	Rehabilitation of Mithri Weir System	1173.056	364.823	10%
2	Construction of Dispersal Structure at Erri	764.588		
3	Construction of Dispersal Structure at Haji Sheher	837.565		
4	Construction of Dispersal Structure at Tuk	481.917		
5	Construction of Dispersal Structure at Ghazi	500.182		
6	Construction of Dispersal Structure at Khokhar	473.503		
7	Provision of Residential and other Infrastructure Facilities	55.377		
8	General Requirements and Facilities for Employer and Engineer	78.320		
9	Establishment of Project Implementation Unit (PIU)	83.279	23.615	--
	Sub Total	**4447.787**	**388.438**	--
10	Physical and Financial Contingencies (2%)	88.956	2.189	--
11	Construction Supervision Cost (3%)	133.434	20.928	--
12	Price Escalation During construction	242.210	--	
	Grand Total	**4912.386**	**411.555**	--

7.6 ITEM-WISE COMPARISON OF REVISED COST WITH THE APPROVED COST AND GIVE REASONS FOR VARIATION

(Rs. in Million)

S.No	Description	Approved Cost	Revised Cost	% Increase(+)/ Decrease(-)	Remarks
1	Rehabilitation of Mithri Weir System	330.997	1173.056	254	In the approved PC-I the scope of work for the component was reduced drastically. The increase in the cost of the component is therefore due to higher contractor rates and inclusion of the components as per the scope of work in the original PC-I.
2	Construction of Dispersal Structure at Erri	489.904	764.588	56	The increase in the cost of the component is mainly due to higher rates quoted by the contractor, revision in the design of some components and addition of the items deducted during rationalization of PC-I which otherwise were required under the Project.
3	Construction of Dispersal Structure at Haji Sheher	407.724	837.565	105	–do--
4	Construction of Dispersal Structure at Tuk	282.529	481.917	71	–do--
5	Construction of Dispersal Structure at Ghazi	309.20	500.182	62	–do--

S.No	Description	Approved Cost	Revised Cost	% Increase(+)/ Decrease(-)	Remarks
6	Construction of Dispersal Structure at Khokhar	--	473.503	100	The component was deducted altogether. However the beneficiaries and elected representatives of the area are pressing hard for its inclusion. The component is, therefore, again included in the revised PC-I.
7	Provision of Residential and other Infrastructure Facilities	30.360	55.377	82	The increase is due to increased rates quoted by the Contractor.
8	General Requirements and Facilities for Employer and Engineer	19.049	78.320	311	The increase is due to the increased rates quoted by the Contractor and accommodation of some important items like establishment of laboratory, provision of facilities for the employer and the engineer at the site and at Sibi specifically taking into account the socio political condition of the area.
9	Project Implementation Unit (PIU)	54.207	83.279	54	The increase in cost is due to accommodation of some support staff and project allowance as per details given in section 13.
	Sub Total	**1923.97**	**4447.787**		--
10	Physical and Financial Contingencies (2%)	19.049	88.956		--
11	Construction Supervision Cost (3%)	57.148	133.434		In the light of increased scope of work additional resources including staff, equipments and vehicles etc., will be required to be accommodated so that the supervision of the works are effectively carried out as per the design specifications.
12	Price Escalation During Construction	--	242.210	100	In the light of present level of inflation a price escalation of about 6% of the construction cost has been adopted.
	Grand Total	**2000.167**	**4912.386**		

7.7 UNIT COSTS

a) Facilities e.g. per tubewell

Not applicable.

b) Output e.g. per acre foot of water

Cost of work	:	Rs. 4912.386 Million
C.C.A. benefitted	:	36,854 hectares (91,030 Acres)
Cost per acre of	:	Rs. 133,293/ hectare
C.C.A benefitted		Rs. 53,964/ acres.

8. ANNUAL OPERATING COST

The annual operation and maintenance cost of the Project has been estimated as Rs. 24.56

million which is equivalent to 0.5% of the capital cost of civil works. A team comprising of a Sub Divisional Officer, two Sub Engineers, 20 mechanical and civil operators and other support staff will be employed during the operation and maintenance of the scheme.

9. DEMAND AND SUPPLY ANALYSIS

Natural resources and particularly water resources within Balochistan may at best be described as critical particularly with the increasing scarcity of water and severity of the recent drought. Despite 96% of the province's water coming from surface flows, the emphasis to date has been on developing limited (4%) groundwater resources. This has led to critical conditions in the almost all the basins of the Province. In the absence of water metering, regulatory enforcement and perhaps most detrimentally, the introduction of a heavily subsidized flat rate electricity fee for use of groundwater for agricultural purposes, the value of water as a resource has been overlooked. The situation is further aggravated by increasing population and urban migration, particularly in response to the recent prolonged drought.

It is therefore mandatory that the emphasis be shifted from exploitation of groundwater resources to conservation of flood water resources through construction of small and large dams at potential sites throughout the Province.

The projected demand for water is presented in the following table.

No.	Particular	Water (billion m^3)	Water (million acre feet)
Available Water Resources			
1	Surface Water (Indus River perennial)	4.76	3.87
2	Surface Water (Indus River non-perennial)	5.68	4.62
3	Surface Water (floods and runoff)	15.69	12.76
4	Groundwater	1.07	0.87
5	Total Available Water	27.2	22.12
Water Use			
6	Surface Water (Indus River perennial)	3.75	3.05
7	Surface Water (Indus River non-perennial)	-	-
8	Surface Water (floods and runoff)	3.69	3.00
9	Groundwater	0.60	0.49
10	Total Water Use	8.04	6.54
Balance Available			
11	Surface Water (Indus River perennial)	1.01	0.82
12	Surface Water (Indus River non-perennial)	5.68	4.62
13	Surface Water (floods and runoff)	12.00	9.76
14	Groundwater	0.47	0.38
15	Total Balance Left	19.16	15.58

Source: Irrigation and Power Department, 2004, Balochistan and BCS (2001).

The construction of the Five Dispersal Structures on Nari river would be an effort to conserve flood flows and utilize it for irrigation. The Project on implementation will conserve an average of about 333 MCM (270,000 Acre ft) of flood flow for subsequent utilization for agriculture purposes.

10. FINANCIAL PLAN

10.1 SOURCES OF FINANCING

(a) Equity: The project is to be fully financed (100%) by

Federal Government as grant.

b) Debt: Not Applicable.
c) Grants along with sources: Same as 10.1 (a) above.
d) Weighted cost of capital: Not Applicable.

11. BENEFITS OF THE PROJECT AND ANALYSIS

11.1 CONVERSION FACTORS

11.1.1 Construction Conversion Factor

A Construction Conversion Factor (CCF) was estimated as a part of the Feasibility Study. The calculations were based on breaking down each element and a CCF, of 80% has been estimated for Dispersal Structures on Nari River scheme based on a break down of the components of construction costs, materials, labor, machinery & transport and others. The value of 79.5% is obtained from the calculations and rounded value of 80% is used in this analysis.

The calculations of economic rates for steel and cement are shown as per Annexure D, p.6. A value of 85% is calculated for Steel and 72% for Cement.

Table 11.1 Derivation of Construction Correction Factor

Item	% of Total Cost	Conversion Rate (%)
Steel	3.6	85
Cement	4.4	72
Unskilled labor	17.6	80
Skilled labor	12.5	100
Machinery & Transport	18.5	55
Others	43.6	90
Total	**100**	**80**

11.1.2 Labor

Economic prices for labor are estimated from the shadow wage rate which reflects the opportunity cost of labor in the economy.

The opportunity cost of the skilled labor is estimated to be 100% as the skilled labor is scarce in the economy and able to find the jobs almost at the prevailing equal wage rates.

Unskilled labor is always in surplus in the economy and there are no restrictions on the mobility of it. The shadow wage rate for unskilled labor is also determined by the opportunity cost. The prevailing wage rate for unskilled labor was found to be Rs 300 per day in the scheme area for the common masonry work and Rs. 350 per day in the nearest town like Sibi. So the shadow wage rate / conversion rate is valued at 75% of the financial cost

11.1.3 Machinery and Transport

The calculation of economic prices for machinery and transport are shown as per Annexure D, p.7. The Import prices (CIF) are taken and taxes are added to these. The conversion rate for both is calculated as 55%.

11.1.4 Standard Conversion Factor

The SCF is calculated from national statistics of imports, exports and rates of duties, taxes and subsidies to produce an overall estimate of the net distortion in the economy as a whole compared to an open market. This is applied to any items that do not have an individual economic price estimate. The derivation of SCF has been shown in Annexure C, p 8.

$$SCF = \frac{M+X}{(M+T_m)+(X-T_x)}$$

Where:
M is the CIF values of imports
X is the FOB values of exports
T_m is the net value of taxed/ subsidies on import
T_x is the net value of taxes/ subsidies on export.

The SCF has been calculated for four years 2007-11. It has a value of between 88% and 94% for each year with the average of 92%. The value of 90% is used in the analysis.

11.2 PROJECT COSTS

11.2.1 Scheme Construction Costs

Scheme construction cost is estimated to be Rs 4912.386 million including 3% of consultancy, engineering and administration cost and 2% for physical and financial contingencies.

It is assumed that the Project will be implemented in a period of three years and the financial phasing of 8%, 46% and 46% in the first, second and third years respectively. Economic development costs are estimated by converting at the CCF.

11.2.2 Residual Values

The Residual values are omitted from the analysis as it contributes insignificantly in the financial and economic IRRs considering the project life of 30 years and more. The discounting factor reduces the present values to almost making no effects in the over all returns in the 30th year.

11.2.3 Scheme O&M costs

Scheme annual O&M costs have been taken at the rate of 0.5% of the capital cost, equivalent to Rs. 24.56 million.

11.2.4 Land Development

No land development costs are included in the analysis. Land is not a limiting factor and the command area soils are suited to irrigated agriculture and therefore land development costs are negligible.

11.2.5 Command Area Development

Command area development costs are excluded from the analysis and irrigated area estimates are based on predicted water conveyance efficiencies. Command area development will only be undertaken if schemes benefits increase and cover the costs involved.

11.3 SCHEME BENEFITS

11.3.1 Agriculture

The improvement in the irrigation system will have direct benefits on the agriculture of the scheme area, and the benefits generated from the intervention are given as per Annexure C & C.

11.3.2 Poverty Alleviation

Gross value of production of crops will increase from Rs. 172.196 million to Rs. 2170.220 million in without and with project situations respectively. This is equivalent of additional 5,240 full time jobs in the scheme area.

As mentioned earlier there are 2,901 shareholders in the command area. With the implementation of the Project the area per shareholder will increase from 8.1 acres to 36.615 acres with the economic returns increasing from Rs. 5243 to Rs. 15,922 respectively (Refer **Annexure C)**

11.4 DEVELOPMENT OF PRODUCTION MODELS

11.4.1 General

A standard set of crop production models are developed in Farmod. Prices are applied to these quantities within the financial and economic models. The units used are generally kg and acres etc, which is local practice.

The models reflect local conditions and current practices on scheme. Altitude has a major effect on crop yields and the cropping pattern and calendar. Crop production models are built to identify the assumptions as to the expected outputs, levels of inputs and crop management practices that will be achieved.

11.4.2 Outputs

Crop production depends upon the inputs used. The farmers in flood schemes are reluctant to change their cropping pattern and risks of crop failure are involved, so the farmers in the scheme grow only those crops whose IWR is less. Thus the limited or no use of fertilizers is evident. So to say their practices are risks aversion.

It is assumed that with the reliable supply of irrigation water the farmers will not only apply more inputs like fertilizers, chemicals, and labor but they will make change in their cropping pattern. In general it is to say that the crop production will increase as a result of scheme development.

11.4.4 Crop Inputs

Crop models developed for this scheme has the facility of adding the inputs like seed, fertilizers, chemicals, mechanized operations and labor requirements. These inputs are used for the calculation of crop budgets. The detail of these has been provided for each crop in the analysis.

11.4.5 Traded Goods

Economic Prices for traded item as net imports or exports for Pakistan are based on border prices have been used in the economic analysis which is subject to short term fluctuation.

11.4.6 Dealing with Price Inflation

The analysis has been carried out at constant prices based on current prices at the time of the study. The use of five years average prices is based on current prices in the month of analysis.

Data on current cropping practices, output and farm gate prices were collected from group interviews with leaders and farmers in the scheme.

11.4.7 Crop Area Assumptions

Crop area assumptions are shown in Table 11.2. below. Existing crops are expanded to make use of increased water. The cropping pattern is rather simple as compare to perennial irrigated schemes. Barley, sorghum, corriander, guar and melon crops are developed in with project situation.

Table 11.2. Crop Area Assumptions

Crop	Current		At Full Development	
	Hectare	Acre	Hectare	Acre
Rabi Crops				
Wheat	2024	5000	2733	6750
Barley	0	0	2077	5129
Guar	0	0	3047	7525
Kharif Crops				
Bajra	2105	5200	3036	7500
Sorghum	0	0	8441	20580
Mash	1619	4000	8300	20500
Corriander	0	0	2753	6800
Melons	810	2000	3845	9496
Musk Melon	0	0	2733	6750
	6559	16200	36964	91030

11.4.8 Crop Yield Assumptions

Yield rate assumptions are shown in Table 11.3. The present yield is low, which are based on existing practice with no use of chemicals for spraying and chemical fertilizers as is usually characteristic of flood irrigated areas in Balochistan. Yield projections in the with Project scenario have been made after due consideration of the existing yields of progressive farmers and the yield potential of the area. In addition, it is anticipated that a project input of extension advice will have a significant impact on the production system by the Agriculture Department.

Table 11.3. Crop Yield Assumptions

Crop	Initial Production		Full Development Production	
	Hectare	Acre	Hectare	Acre
Rabi Crops				
Wheat	162	400	314	775
Barley	182	450	273	675
Guar	81	200	162	400
Kharif Crops				
Maize	141	350	226	560
Sorghum	182	450	304	750
Mash	81	200	117	290
Corriander	0	0	161	400
Melons	607	1500	2429	6000
Musk Melon	607	1500	2328	5750

11.4.9 Labor Assumptions

Nominal labor budgets were developed for each crop. Labor requirements for fertilizer applications and harvesting are based on the pattern of use of inputs and yields, other activities are based on the number of operations undertaken. Details of labor requirements are included

in the production models.

11.4.10 Price Assumptions - Outputs

Prices used in the analysis are shown in the Annexure C (Financial Analysis) and Annexure D (Economic Analysis). Constant prices are assumed over the project lifetime except the price of seed where improved varieties are adopted.

Farmgate prices are not available in Pakistan and prices collected at scheme level during feasibility studies show wide seasonal and inter farmer variation. Published prices are collected at crop auction in major wholesale markets which are used to estimate farmgate prices by allowing for handling, transport, taxes and Commission Agents fees. For Nari, prices are based on Sakkar market averaged over 2003 to 2008 and adjusted by the Consumer Price Index (CPI). Substantial increase in production of other crops is unlikely to bring any change in the prices and therefore harvest month prices were used. The price in each harvest month was calculated and an average seasonal price estimated based on the proportion of the harvest in each month. Wheat, barley, Bajra, and sorghum prices are taken as the rate obtained for sale in the village, which is above the official wheat support price, reflecting the local scarcity. All prices include the cost of taxes and transport to market.

11.4.11 Price Assumptions - Inputs

Standard prices for inputs are assumed with an allowance for transport to the Project. Pesticide prices are variable so an average treatment cost per acre is calculated as shown in Annexure D. Seed prices for local seed rate are assumed at 10% above output prices to allow for selection, improved seeds are based on retail prices. Farm labor and mechanized operations are prices at rates reported by scheme farmers. Wage rate has been adopted as Rs. 300/day.

11.4.12 Economic Prices

Economic output prices are based on border prices for traded crops, for Nari using import parity prices for wheat. For the price of sorghum SCF prices are used. Economic price calculations are included in Annexure D.

Fruit and vegetable crops are not generally traded. Economic prices are, therefore, estimated on financial prices adjusted by Standard Conversion Factor (SCF).

The economic price for urea is taken at import parity, delivered at the scheme. Likewise other fertilizers are imported and the economic price is taken at import parity. Other crop inputs are freely traded and are valued at financial prices adjusted by the SCF. Labor is valued at the local financial price adjusted by the SCF.

11.4.13 Model Development

Scheme benefits are estimated over 30 years following a three year construction period. Costs/Benefits from tubewells are included in the analysis.

The production models were developed using Farmod, based on a standard layout. Similarly Farmod has been used to estimate hired labor requirements based on labor budgets on a monthly basis.

11.4.14 Marketing

Existing marketing arrangements are adequate for the proposed increase in production and no changes are required.

Incremental production at full development is shown in Table 11.3, above. The increased production in the critical seasons is also too small to adversely affect the market as Nari has only a small proportion of the total country supply, however the model uses lower prices a s a whole, which are likely to be substantial.

11.5 ESTIMATING FIRR AND EIRR

The IRR is estimated by entering the costs streams and benefits streams in columns of a spreadsheet, calculating the net cashflow and using the @ IRR function to calculate the IRR. Two sets of scheme benefits data are used and calculated at financial and economic prices, these are output by Farmod.

The scheme benefits start in the year following construction so the complete IRR model is over 50 years. It is assumed that the scheme continues at current production in the construction period and these benefits and costs are excluded from the IRR estimate as they balance.

The FIRR is estimated at 16.50% and the EIRR at 18.14% as shown in Annexure C and Annexure D respectively.

The sensitivities of the IRR were tested to reduced and delayed benefits and increased costs and are shown in Table 11.4. The scheme is not unduly sensitive to departures from the design.

Table 11.4. Sensitivity of FIRR and EIRR

Assumption	FIRR	EIRR
Base Model	16.50	18.14
Benefits delayed 3 years	12.90	14.09
Incremental benefits reduced by 20%	14.38	15.90
Construction costs increased by 20%	14.80	16.35
Benefits reduced and costs increased by 20%	12.80	14.38

The Net Present Value at different discount rates have been calculated as follows.

Discount Rate (%)	10	15	18
Net Present Value	2490	616	(474)
Benefit Cost Ratio	1.62	1.08	0.89

The detailed financial and economic analyses are given in Annexure C and D respectively.

12. IMPLEMENTATION SCHEDULE

The Project implementation period has been estimated to be 36 months. The detailed implementation Schedule is attached as Annexure E.

13. MANAGEMENT STRUCTURE AND MANPOWER REQUIREMENTS

In order to successfully implement the project, a range of technical assistance and other support services are required to assist government and local communities. These are particularly relevant when considering the multi disciplinary approach for undertaking a range of activities relating to water resources management, a participative community focused development process. There will also be a need to assist the Project Implementation Unit (PIU) headed by a Project Director with the design of civil works, for top supervision, on farm development, financial management, auditing, monitoring of the Project. The project, therefore,

requires the assistance of specialist staff and support services for improved subproject management, capacity building, technical support and quality control.

In addition, supervisory consultants comprising mainly of specialist design and supervision staff will be required to assist the PIU in the timely implementation of the Project strictly in accordance with the design specifications. Their key role will be to assist in planning, supervision/ monitoring and implementation of project components.

A breakdown of PIU staffing requirements is given as follows.

Sr.No.	Designation	Grade	Numbers
1	Project Director	19	1
2	Executive Engineer/ DPD	18	1
3	Sub Divisional Officer (SDO)	17	2
4	Sub Engineers	11/16	3
5	Community Agriculture Advisor	17	1
6	Computer Programmer	17	1
7	Accounts Officer	17	1
8	Administration Officer	17	1
9	Assistant	14	1
10	Messenger	4	4
11	Driver	4	5
12	Levies Man	5	6
13	Security Guard	1	4
14	Chowkidar	1	2
15	Part time Sweeper	1	1

The details of equipments and other items are as follows.

S.No.	Description	Units	Quantity
1	Vehicle (Double Cabin Hilux Pickup) - Fully Loaded	Nos.	2
2	Vehicle (Double Cabin Hilux Pickup) - Standard	Nos.	5
3	Motor Cycle for Sub Engineer	Nos.	3
4	Computer (P-IV)	Nos.	6
5	Laptop	Nos.	6
6	Printer (HP LaserJet)	Nos.	6
7	Fax Machine	Nos.	1
8	Total Station survey equipment complete	Nos.	1
9	Level Including Staff and Other Items	Nos.	2
10	Telephone Exchange Unit	Nos.	1
11	Digital Photocopier	Nos.	1
12	UPS	Nos.	3
13	Generator	Nos.	1
14	Stabilizers	Nos	3

14. ADDITIONAL PROJECTS/ DECISIONS REQUIRED

Not Applicable.

15. CERTIFICATE

The PC-I has been prepared as per guidelines issued by the Planning Commission for the preparation of PC-I for Infrastructure Sector Projects.

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Additional Chief Secretary
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ANNEXURE-A

Annexure A

SIX DISPERSAL STRUCTURES ON NARI RIVER
COMPARISON OF ORIGINAL SCOPE OF WORK AS PER APPROVED PC-I AND PROPOSED REVISED SCOPE OF WORK

S.No	Scope As per Revised PC-I	Scope as per Approved PC-I
1	**Construction of Dispersal Structure at Erri**	**Construction of Dispersal Structure at Erri**
	Construction of 120 m wide gated weir (12 bays/ gates);	Construction of 120 m wide gated weir (12 bays/ gates);
	Construction of 7.3 m wide road bridge with 11 piers and abutments (maximum height 9 m);	Construction of 7.3 m wide road bridge with 11 piers and abutments (maximum height 9 m);
	Construction of 6 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides and 40 m wide stone apron, 0.6 m thick, on the inner side.	Construction of 6 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides and 40 m wide stone apron, 0.6 m thick, on the inner side.
	Construction of Type IV stilling basin, 120 m wide and 21.5 m long.	Construction of Type IV stilling basin, 120 m wide and 21.5 m long.
2	**Construction of Dispersal Structure at Haji Shaher**	**Construction of Dispersal Structure at Haji Shaher**
	Construction of 110 m wide gated weir (11 bays/ gates);	Construction of 110 m wide gated weir (11 bays/ gates);
	Construction of 7.3 m wide road bridge with 10 piers and two abutments (maximum height 9 m);	Construction of 7.3 m wide road bridge with 10 piers and two abutments (maximum height 9 m);
	Construction of 6 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 34 m stone apron, 0.6 m thick, on the inner side.	Construction of 6 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 34 m stone apron, 0.6 m thick, on the inner side.
	Construction of Type IV stilling basin 120 m wide and 20.50 m long.	Construction of Type IV stilling basin 120 m wide and 20.50 m long.
3	**Rehabilitation of Mithri Weir and Conveyance System**	**Rehabilitation of Mithri Weir and Conveyance System**
	Remodeling/ rehabilitation of Mithri weir including weir structure, construction of upstream concrete apron, sluice and head regulator to discharge 56.64 cumec (2,000 cusec) to the conveyance system.	Remodeling/ rehabilitation of Mithri weir including weir structure, construction of upstream concrete apron, sluice and head regulator to discharge 56.64 cumec (2,000 cusec) to the conveyance system.
	Construction of main channel (5 kms), and branch channels (left side and right side) in a total length of 9.332 kms.	**Scope of work reduced to only construction of main channel (1.2 kms).**
	Strengthening of existing upstream river training bund, jungle clearance, and widening of upstream approach section in a length of 1.8 kms.	**Deleted.**
	Construction of black top road from the main Quetta D.M Jamali Road to Mithri weir in a total length of 1.85 kms including cross drainage works/ culverts (1 No.).	**Deleted.**

Annexure A

SIX DISPERSAL STRUCTURES ON NARI RIVER
COMPARISON OF ORIGINAL SCOPE OF WORK AS PER APPROVED PC-I AND PROPOSED REVISED SCOPE OF WORK

S.No	Scope As per Revised PC-I	Scope as per Approved PC-I
4	**Construction of Dispersal Structure at Tuk**	**Construction of Dispersal Structure at Tuk**
	Construction of 60 m wide gated weir (7 bays/ gates);	Construction of 60 m wide gated weir (7 bays/ gates);
	Construction of 7.3 m wide road bridge with 6 piers and two abutments (maximum height 9.3 m);	Construction of 7.3 m wide road bridge with 6 piers and two abutments (maximum height 9.3 m);
	Construction of 8 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 26 m stone apron on the inner side.	Construction of 8 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 26 m stone apron on the inner side.
	Construction of Type IV stilling basin 60 m wide and 22 m long.	Construction of Type IV stilling basin 60 m wide and 22 m long.
5	**Construction of Dispersal Structure at Ghazi**	**Construction of Dispersal Structure at Ghazi**
	Construction of 65 m wide gated weir (8 bays/ gates);	Construction of 65 m wide gated weir (8 bays/ gates);
	Construction of 7.3 m wide road bridge with 7 piers and two abutments (Maximum height 8.5 m);	Construction of 7.3 m wide road bridge with 7 piers and two abutments (Maximum height 8.5 m);
	Construction of 9 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 27 m wide stone apron, 0.5 m thick, on the inner side.	Construction of 9 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 27 m wide stone apron, 0.5 m thick, on the inner side.
	Construction of Type IV stilling basin 65 m wide and 20 m long.	Construction of Type IV stilling basin 65 m wide and 20 m long.
6	**Construction of Dispersal Structure at Khokar**	**Construction of Dispersal Structure at Khokar**
	Construction of 65 m wide gated weir;	**The component deleted altogether.**
	Construction of 7.3 m wide road bridge with 7 piers and two abutments;	
	Construction of 7 m high hockey shaped earthen guide embankment with stone pitching on upstream and downstream sides with 27 m wide stone apron on the inner side;	
	Construction of Type IV stilling basin 65 m wide and 20 m long.	
7	**Construction of Residential Colonies**	**Construction of Residential Colonies**
	The revised scope of work will comprise of 6 quarters, 6 control rooms and 6 generator rooms one at each location.	The approved scope of work includes 4 quarters and generator rooms one at each location.
	Protection embankment for offices and residential colonies.	Component deleted.
	Provision of diesel generating units at the six locations.	Provision of diesel generating units at the six locations.

FIGURE NO.	MAPS TITLE
1	LOCATION MAP OF PROJECT AREA
2	CATCHMENT BOUNDARY MAP
3	GEOLOGICAL FORMATION
4	COMMAND AREA AND DISTRIBUTION SYSTEM
5	COMMAND AREA MAP
6	PROPOSED ACCESS ROADS MAP
7	LAND CAPABILITY MAP
	MITHRI WEIR SYSTEM
8	GENERAL LAYOUT PLAN
9	LAYOUT PLAN OF HEAD RAGULATOR AND SLUCE
10	HEAD RAGULATOR PLAN AND SECTION
11	SLUICE PLAN & SECTION
12	MAIN CHANNEL CROSS SECTION
13	PLAN & PROFILE OF MAIN CHANNEL RIGHT (SHEET 1 OF 4)
13.1	PLAN & PROFILE OF MAIN CHANNEL RIGHT (SHEET 2 OF 4)
13.2	PLAN & PROFILE OF MAIN CHANNEL RIGHT (SHEET 3 OF 4)
13.3	PLAN & PROFILE OF MAIN CHANNEL RIGHT (SHEET 4 OF 4)
	ERRI DISPERSAL STRUCTURE
14	GENERAL LAYOUT PLAN
15	PLAN OF EARI DISPERSAL STRUCTURE
16	BARRAGE SECTION AND DETAILS
	HAJI SHAHER DISPERSAL STRUCTURE
17	GENERAL LAYOUT PLAN
18	PLAN OF DISPERSAL STRUCTURE
19	BARRAGE SECTION AND DETAILS
	TOUK DISPERSAL STRUCTURE
20	GENERAL LAYOUT PLAN
21	PLAN OF DISPERSAL STUCTURE
22	BARRAGE SECTION A-A AND DETAILS
	GHAZI DISPERSAL STRUCTURE
23	GENERAL LAYOUT PLAN
24	PLAN OF DISPERSAL STRUCTURE
25	BARRAGE SECTION A-A AND DETAIL
	MISCELLANIES DRAWINGS
26	TYPICAL CROSS SECTIONS OF DISPERSAL
27	TYPICAL CROSS SECTIONS OF DISPERSAL
28	TYPICAL CROSS SECTIONS OF GUIDE BUND
29	TYPICAL RADIAL GATE PLAN, FRONT, SIDE ELEVATIONS AND DETAILS
30	TYPICAL BRIDGE DETAILS

CLIENT:
IRRIGATION AND POWER DEPARTMENT OF BALOCHISTAN

CONSULTANTS:
CAMEOS CONSULTANTS
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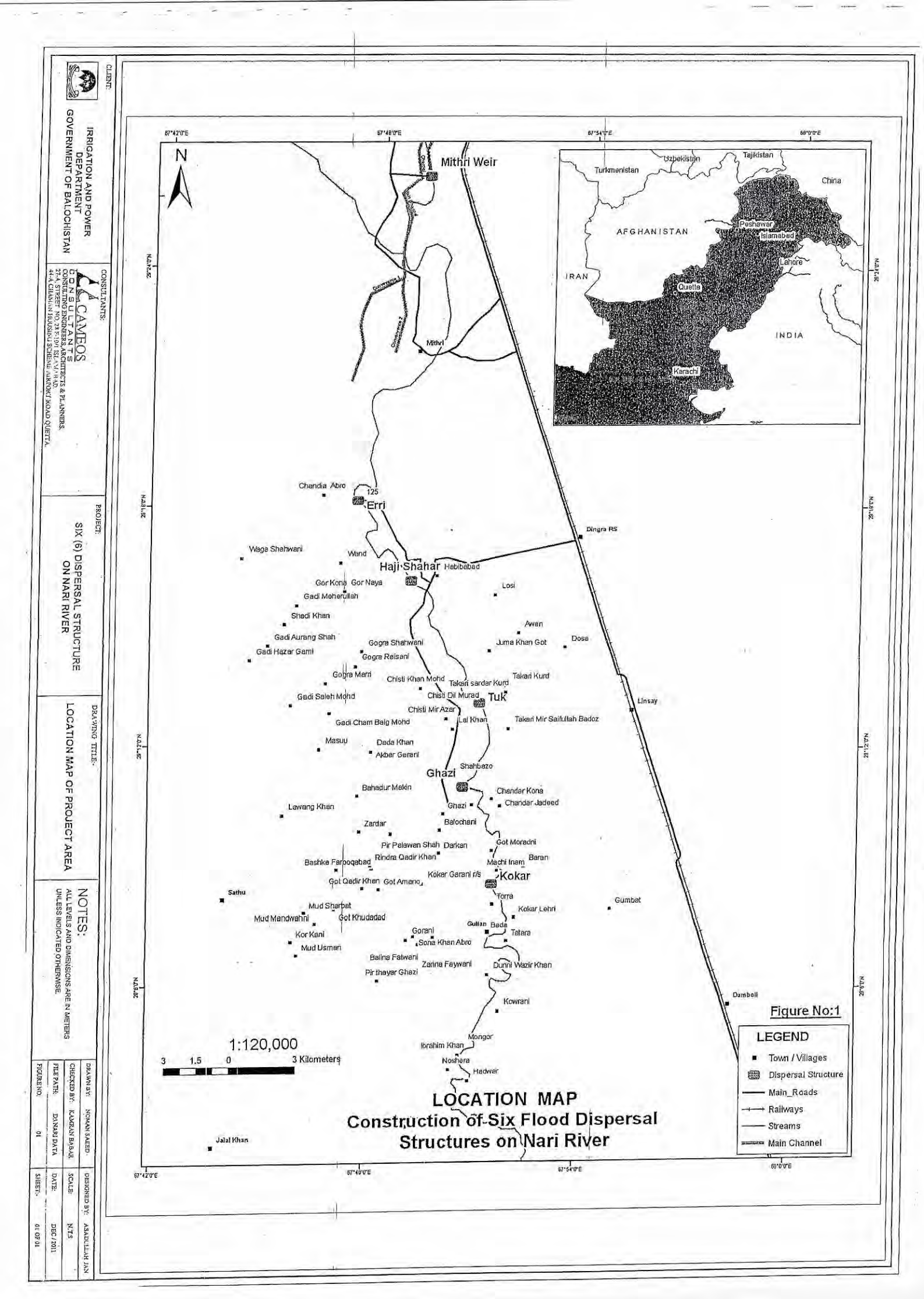
27-A, ST. NO. 28 F-6/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

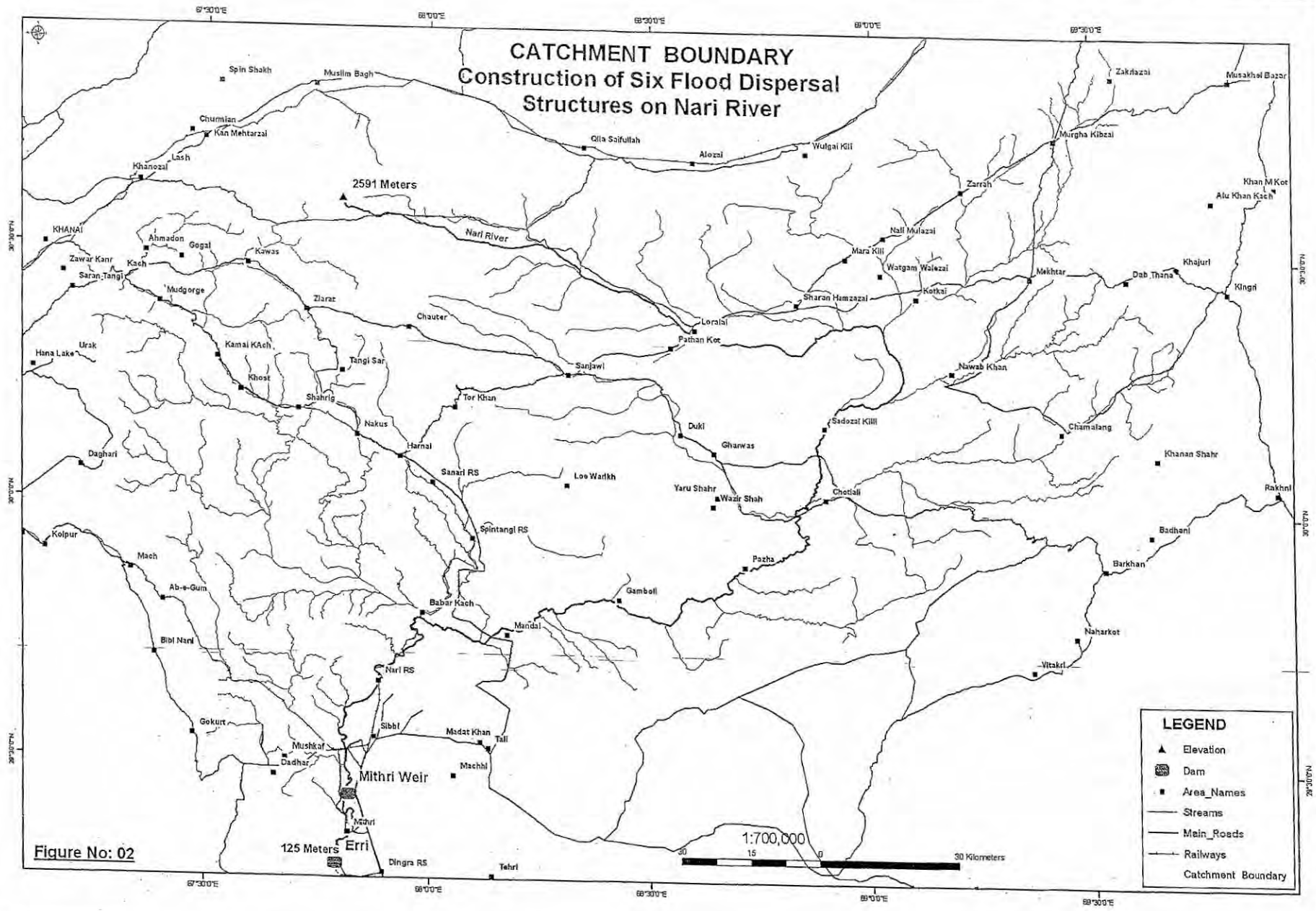
PROJECT:
SIX (6) DISPERSAL STRUCTURE ON NARI RIVER

DRAWING TITLE:-
FIGURES INDEX

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	AS SHOWN
FILE PATH:	DA NARI DATA	DATE:	DEC / 2011
FIGURE NO.	0	SHEET:-	1 OF 01


CLIENT:
IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN
CONSULTANTS:
CAMEOS CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
PROJECT:
SIX (6) DISPERSAL STRUCTURE ON NARI RIVER
DRAWING TITLE:-
LOCATION MAP OF PROJECT AREA
NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.
DRAWN BY: NOMAN SAEED
CHECKED BY: KAMRAN BABAR
DESIGNED BY: ASADULLAH JAN
FILE PATH: D:\NARI\DATA
SCALE: N.T.S
DATE: DEC / 2011
FIGURE NO: 01
SHEET:- 01 OF 01
N
Mithri Weir
Mithri
Chandia Abro
125
Erri
Dingra RS
Waga Shahwani
Wand
Haji Shahar
Habibabad
Gor Kona
Gor Naya
Losi
Gadi Mehrullah
Shadi Khan
Awan
Gadi Aurang Shah
Gogra Shahwani
Juma Khan Got
Dosa
Gadi Hazar Gami
Gogra Reisani
Gogra Marri
Chisti Khan Mohd
Takari sardar Kurd
Takari Kurd
Gadi Saleh Mohd
Chisti Dil Murad
Tuk
Linsay
Chisti Mir Azar
Lal Khan
Takari Mir Saifullah Badoz
Gadi Cham Baig Mohd
Masuu
Dada Khan
Akbar Gerani
Ghazi
Shahbezo
Bahadur Mekin
Chandar Kona
Chandar Jadeed
Lawang Khan
Ghazi
Zardar
Balocharii
Pir Palawan Shah
Darkan
Got Moradni
Bashke Farooqabad
Rindra Qadir Khan
Machi Inam
Baran
Got Qadir Khan
Got Amano
Kokar Garani r/s
Kokar
Sathu
Torra
Gumbat
Mud Sharbat
Kokar Lehri
Mud Mandwahni
Got Khudadad
Gullan
Bada
Tatara
Kor Kani
Gorani
Sona Khan Abro
Mud Usman
Balna Fatwani
Zarina Faywani
Dunni Wazir Khan
Pir thayar Ghazi
Kowrani
Damboli
Mongor
Ibrahim Khan
Noshera
Hadwar
Jalal Khan
1:120,000
3 1.5 0 3 Kilometers
LOCATION MAP
Construction of Six Flood Dispersal Structures on Nari River
Figure No:1
LEGEND
Town / Villages
Dispersal Structure
Main_Roads
Railways
Streams
Main Channel
Uzbekistan
Tajikistan
Turkmenistan
China
AFGHANISTAN
Peshawar
Islamabad
Lahore
IRAN
Quetta
INDIA
Karachi
67°42'0"E
67°48'0"E
67°54'0"E
68°0'0"E
29°24'0"N
29°18'0"N
29°12'0"N
29°6'0"N



CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET. NO. 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER	DRAWING TITLE:- CATCHMENT BOUNDARY MAP

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	NOMAN SAEED	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	N.T.S
FILE PATH:	DA\NARI DATA	DATE:	DEC / 2011
FIGURE NO.	02	SHEET:	01 OF 01

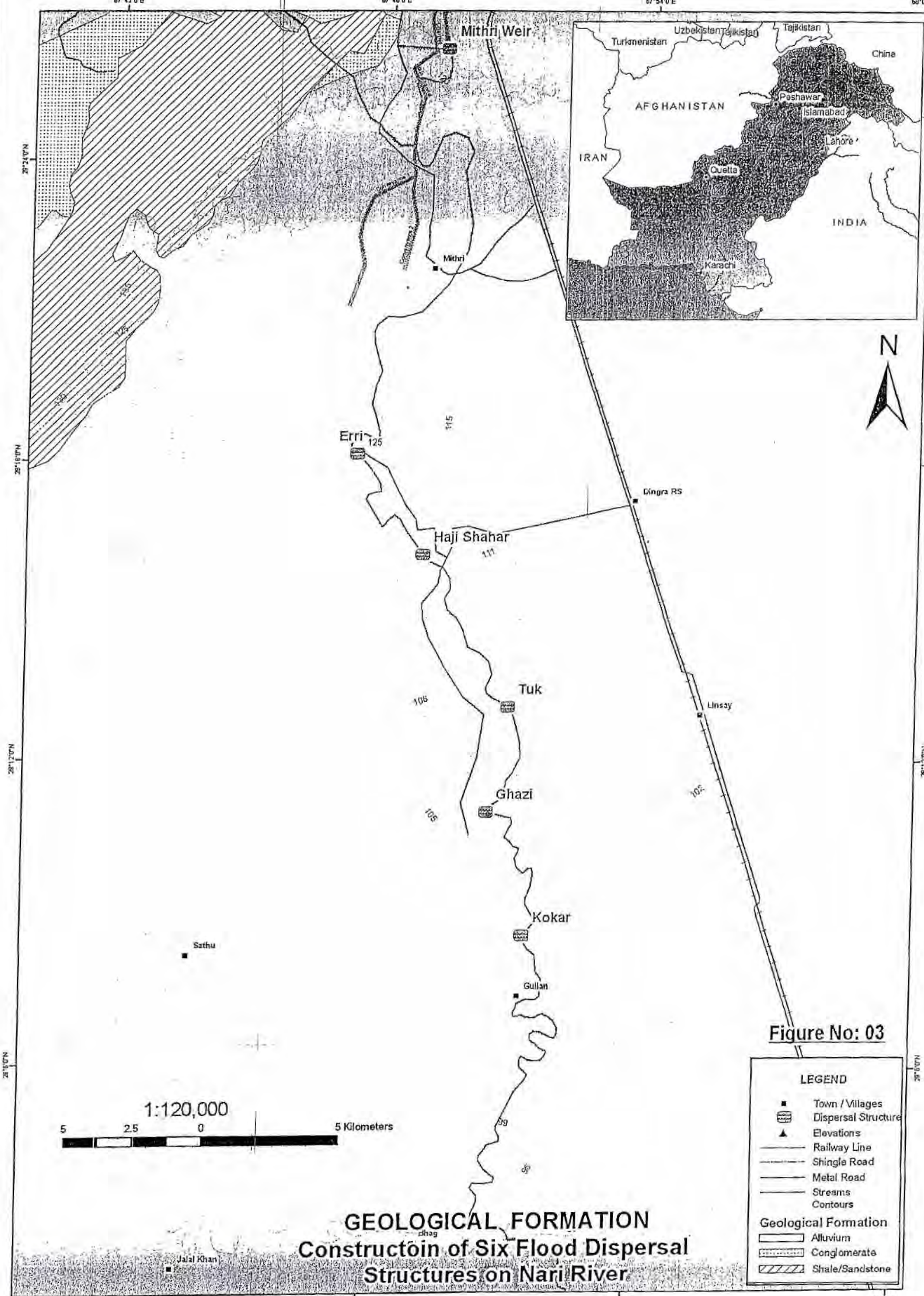


Figure No: 03

GEOLOGICAL FORMATION
Constructoin of Six Flood Dispersal Structures on Nari River

CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN

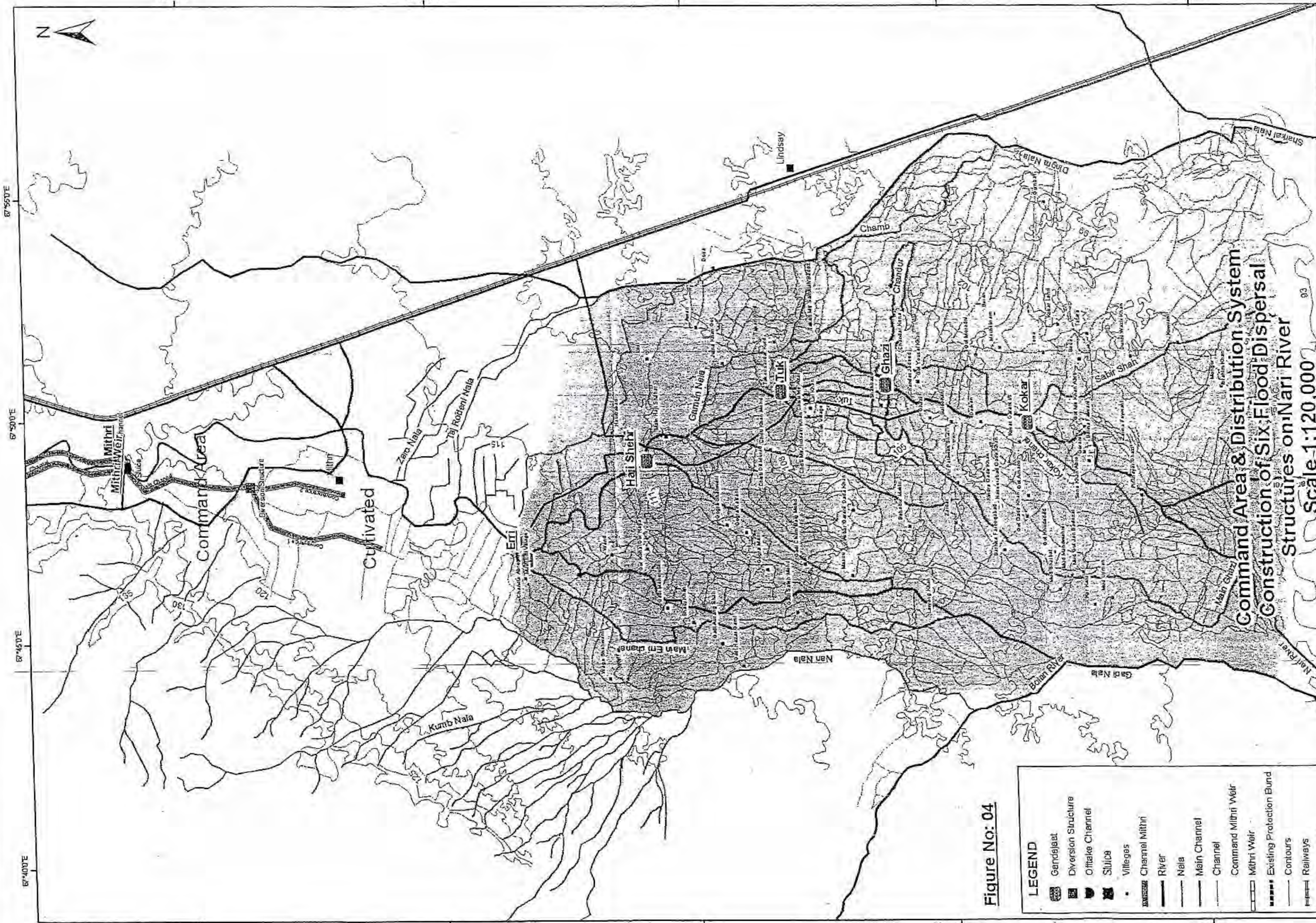
CONSULTANTS: CAMEOS CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER

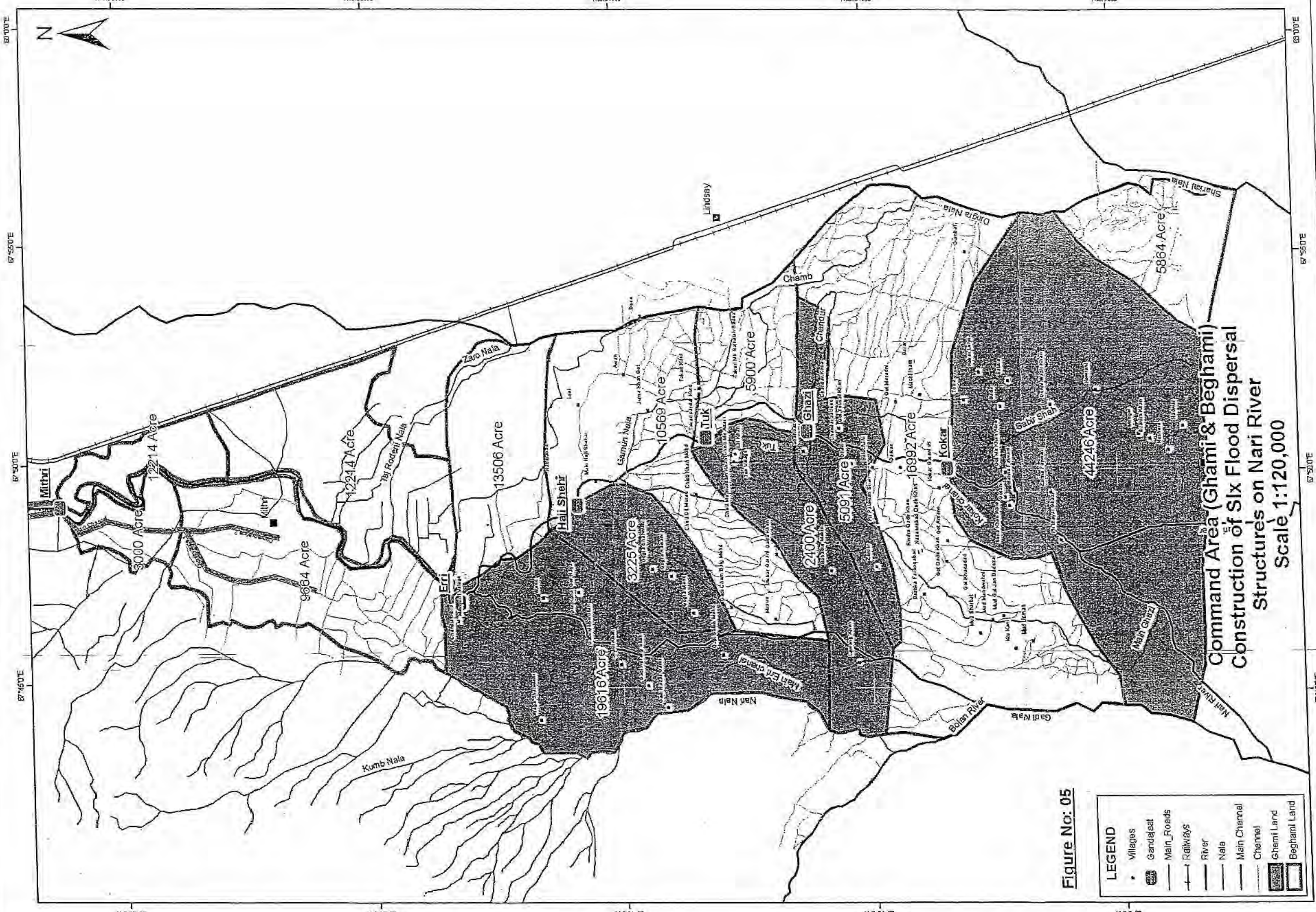
DRAWING TITLE: GEOLOGICAL FORMATION MAP

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

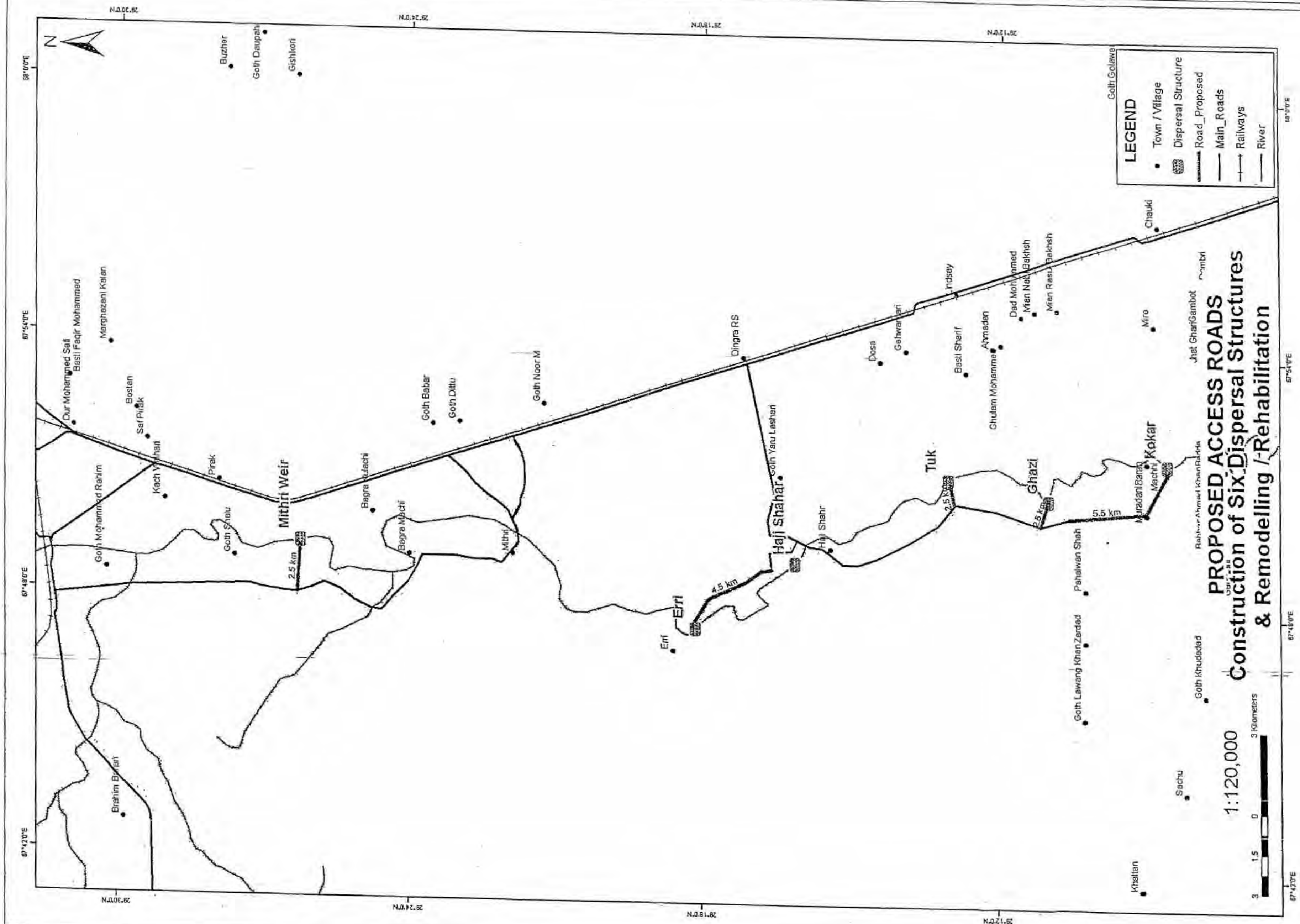
DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	N.T.S
FILE PATH:	D:\NARI DATA	DATE:	DEC / 2011
FIGURE NO.	03	SHEET:-	01 OF 01



CLIENT:	CONSULTANTS:	PROJECT:	DRAWING TITLE:-	NOTES:		
IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET, NO. 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	SIX (6) DISPERSAL STRUCTURE ON NARI RIVER	COMMAND AREA AND DISTRIBUTION SYSTEM	ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: NOMAN SAEED CHECKED BY: KAMRAN BABAR FILE PATH: D:\NARI DATA FIGURE NO.:	DESIGNED BY: ASADULLAH JAN SCALE: N.T.S DATE: DEC / 2011 SHEET:- 01 OF 01

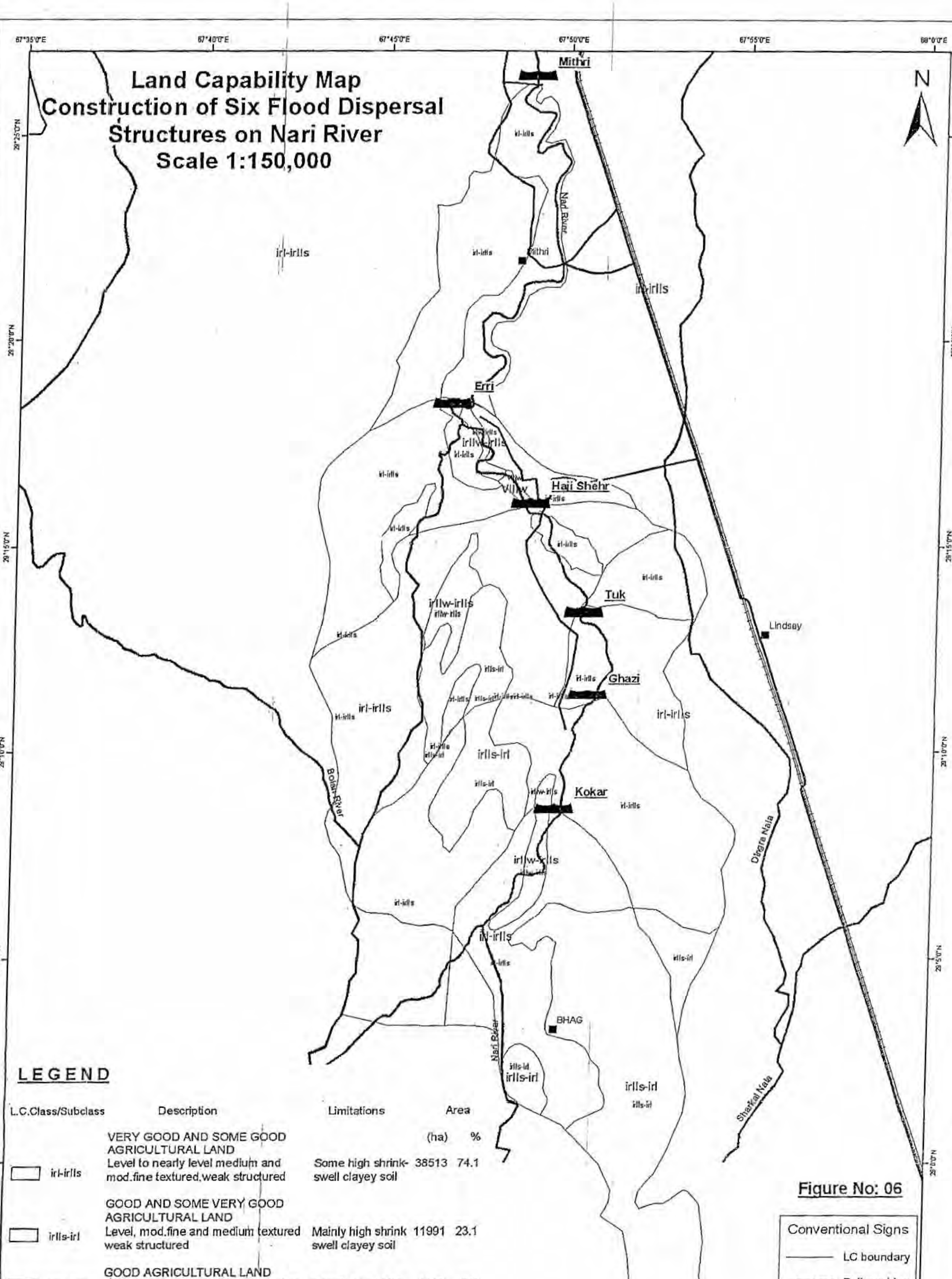


CLIENT:	CONSULTANTS:	PROJECT:	DRAWING TITLE:-	NOTES:		
IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET, NO. 28 F-10/1 ISLAMABAD. 43-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	SIX (6) DISPERSAL STRUCTURE ON NARI RIVER	COMMAND AREA MAP	ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: NOMAN SAEED CHECKED BY: KAMRAN BABAR FILE PATH: D\NARI DATA FIGURE NO. 05	DESIGNED BY: ASADULLAH JAN SCALE: N.T.S DATE: DEC / 2011 SHEET:- 01 OF 01



CLIENT:	CONSULTANTS:	PROJECT:	DRAWING TITLE:-	NOTES:		
IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET NO. 28 F-10/1 ISLAMABAD 41-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA	SIX (6) DISPERSAL STRUCTURE ON NARI RIVER	PROPOSED ACCESS ROADS MAP	ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.		

DRAWN BY:	NOMAN SAEED	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	N.T.S
FILE PATH:	D:\NARI DATA	DATE:	DEC / 2011
FIGURE NO.	06	SHEET:-	01 OF 01



LEGEND

L.C.Class/Subclass	Description	Limitations	Area (ha)	%
	VERY GOOD AND SOME GOOD AGRICULTURAL LAND			
irl-irlls	Level to nearly level medium and mod.fine textured,weak structured	Some high shrink-swell clayey soil	38513	74.1
	GOOD AND SOME VERY GOOD AGRICULTURAL LAND			
irlls-irl	Level, mod.fine and medium textured weak structured	Mainly high shrink swell clayey soil	11991	23.1
	GOOD AGRICULTURAL LAND			
irllw-irlls	Nearly level, medium and some fine textured, stratified.	Flooding and high shrink swell clays	1410	2.7
	AGRICULTURALLY UNPRODUCTIVE LAND			
VIIlw	Miscellaneous area.	River bed	93	0.2
		Total=	52007	100

CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN

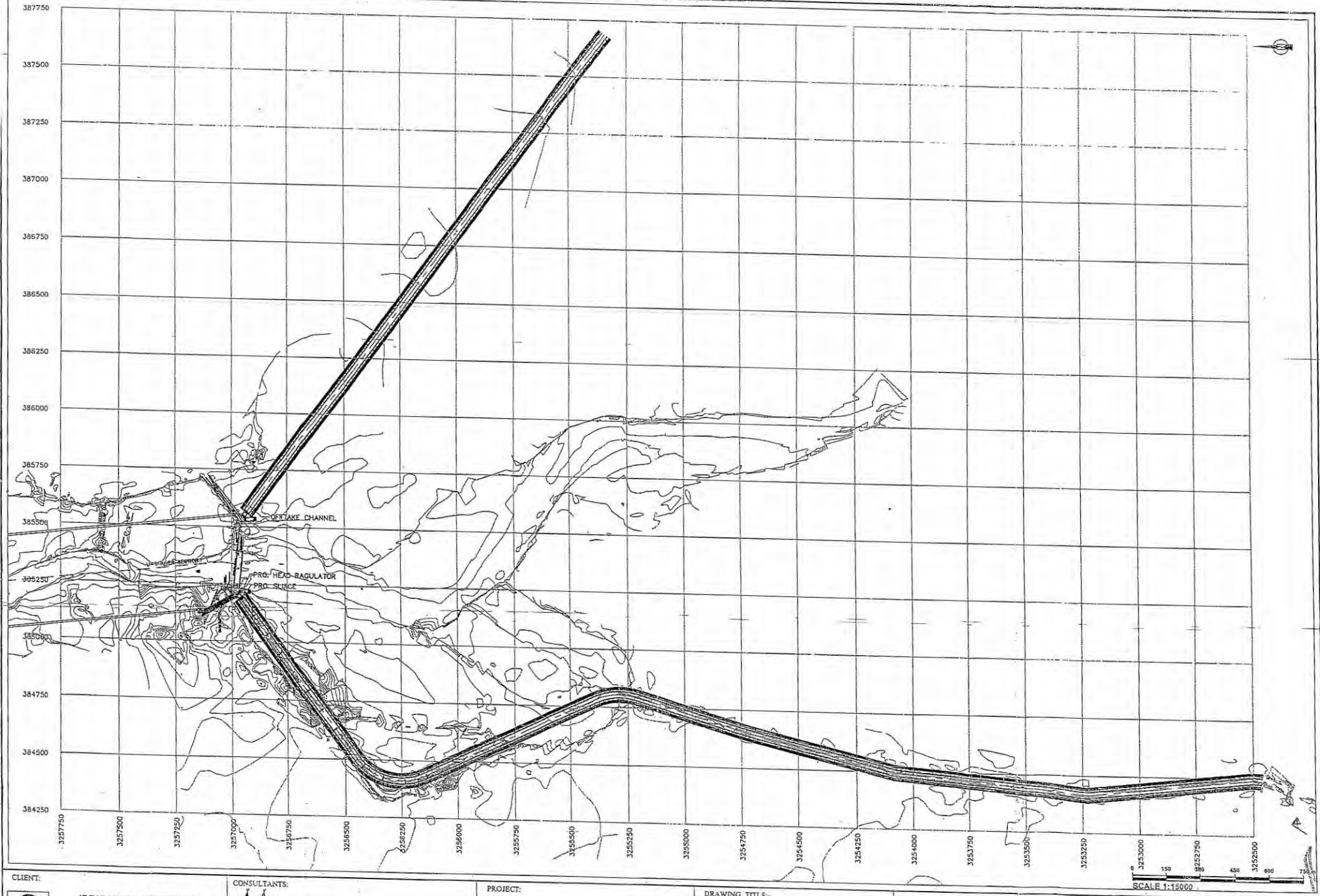
CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET. NO. 38 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER

DRAWING TITLE:- LAND CAPABILITY MAP

NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	NOMAN SAEED	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	N.T.S
FILE PATH:	D:\NARI DATA	DATE:	DEC / 2011
FIGURE NO.	07	SHEET:-	01 OF 01



CLIENT:

IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

CONSULTANTS:

CAMEOS
CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET, NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT:

SIX (6) DISPERSAL STRUCTURE
ON NARI RIVER (MITHRI WEIR SYSTEM)

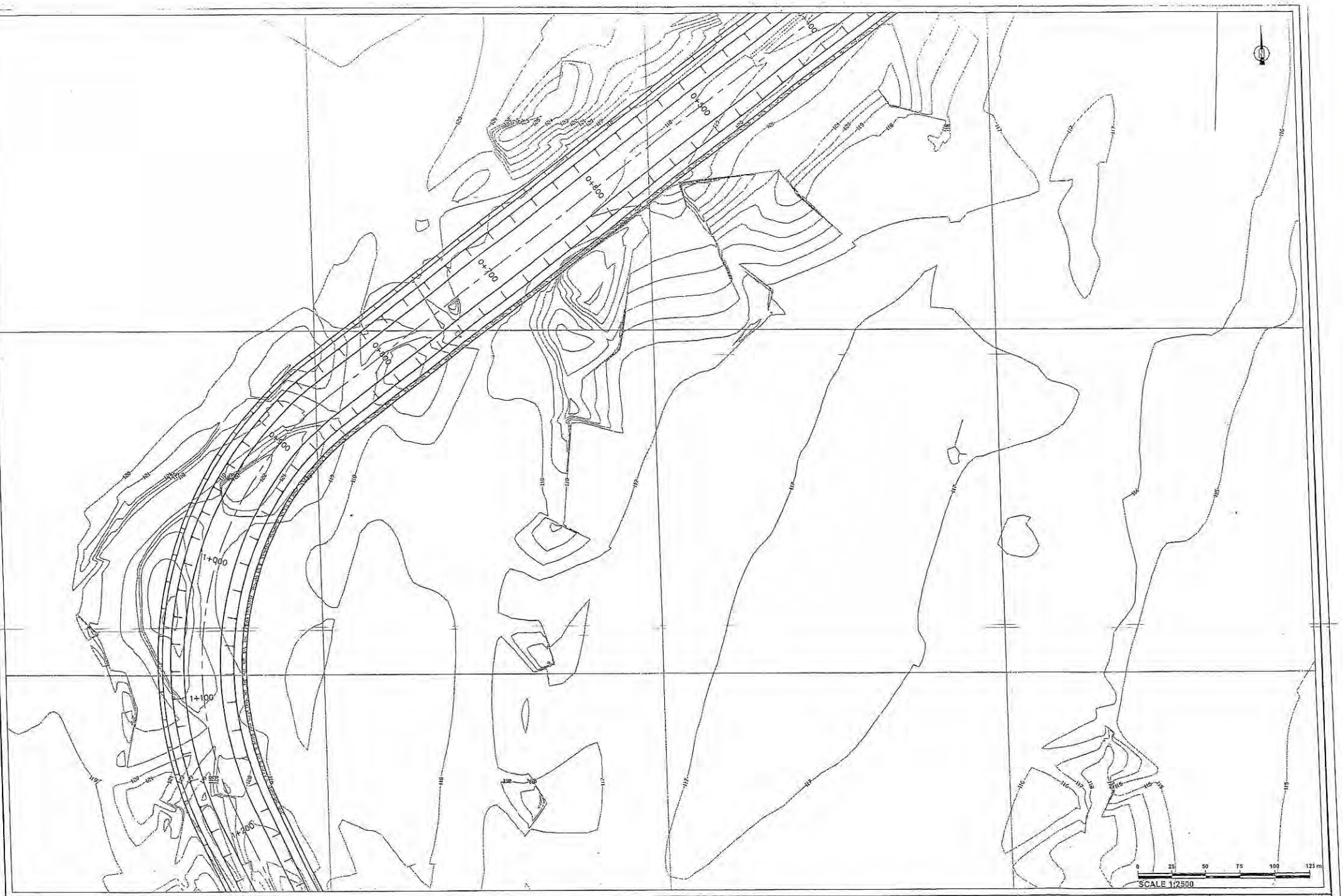
DRAWING TITLE:-

GENERAL LAYOUT PLAN

NOTES:

ALL LEVELS AND DIMENSIONS ARE IN METERS
UNLESS INDICATED OTHERWISE.

DRAWN BY:	NOMAN SAEED	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:15,000
FILE PATH:	DA\MITHRI WEIR	DATE:	DEC/2011
FIGURE NO.	08	SHEET:-	01 OF 02



CLIENT:

IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

CONSULTANTS:

CAMEOS
CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET. NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT:

SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (MITHRI WEIR SYSTEM)

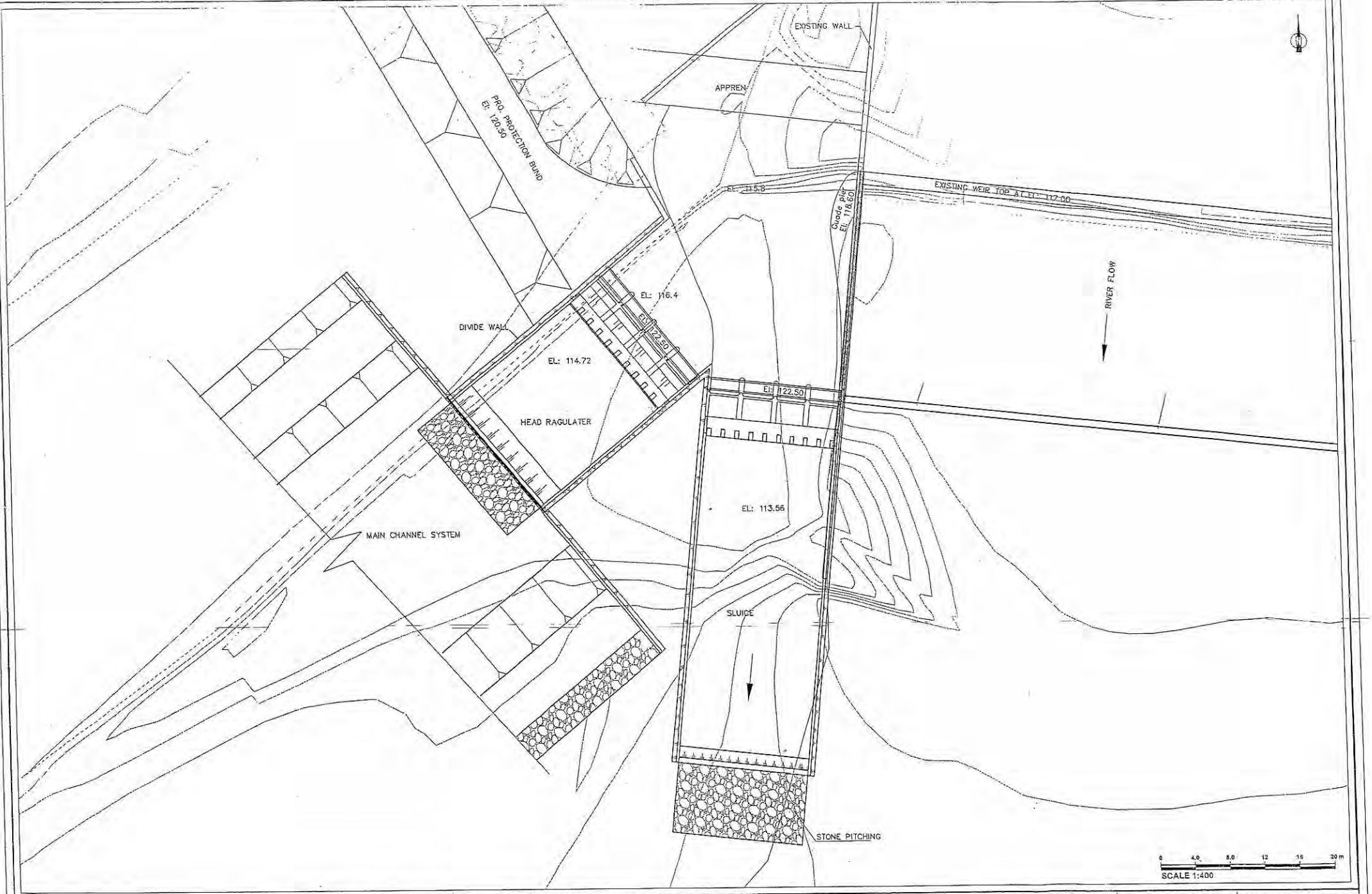
DRAWING TITLE:-

GENERAL LAYOUT PLAN

NOTES:

ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE

DRAWN BY:	NOMAN SAEED	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:2500
FILE PATH:	DA MITHRI WEIR	DATE:	DEC / 2011
FIGURE NO.	08 - A	SHEET:-	02 OF 02



CLIENT:

IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

CONSULTANTS:

CAMEOS CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT:

SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (MITHRI WEIR SYSTEM)

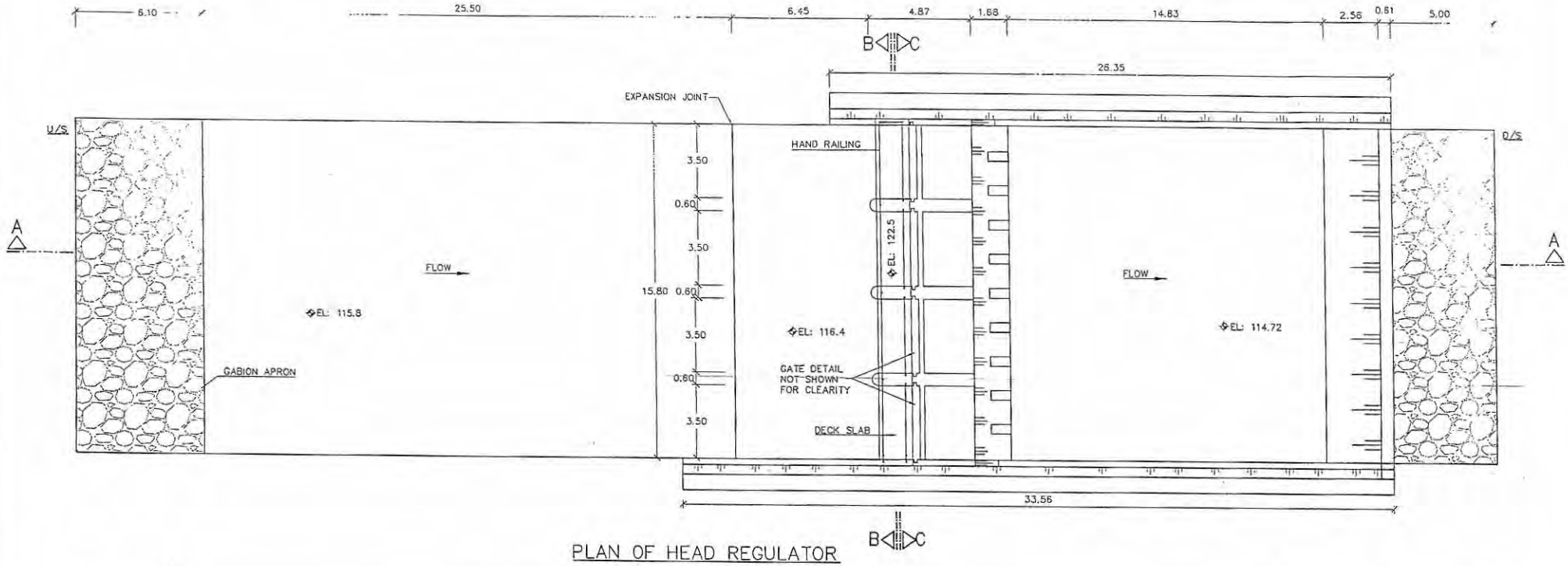
DRAWING TITLE:-

LAYOUT PLAN OF HEAD REGULATOR & SLUICE

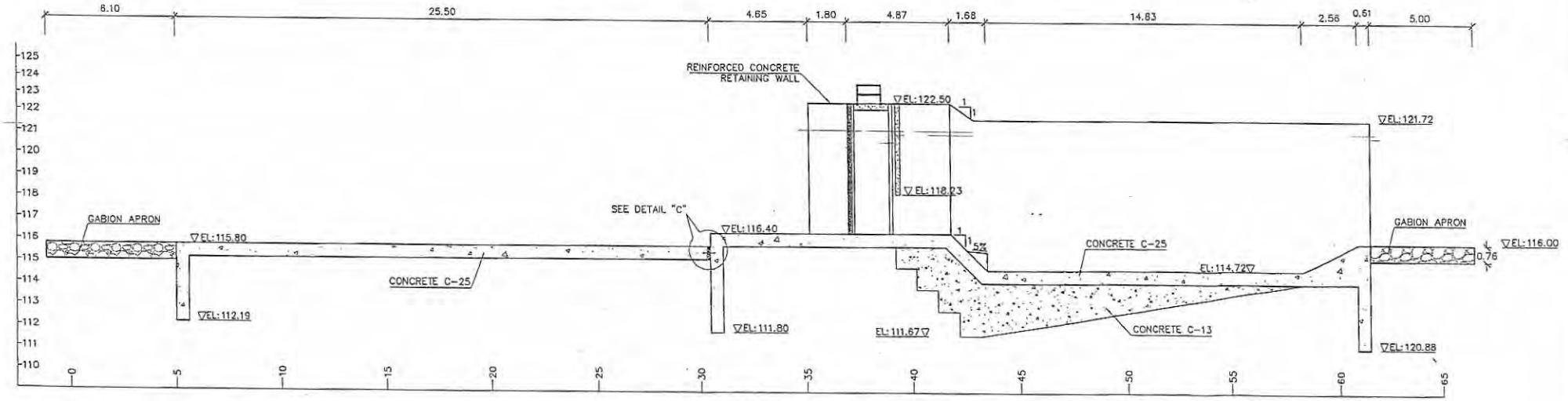
NOTES:

ALL EL:S AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	NOMAN SAEED	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:400
FILE PATH:	DA\NARI DATA	DATE:	DEC / 2011
FIGURE NO.	09	SHEET:-	01 OF 01

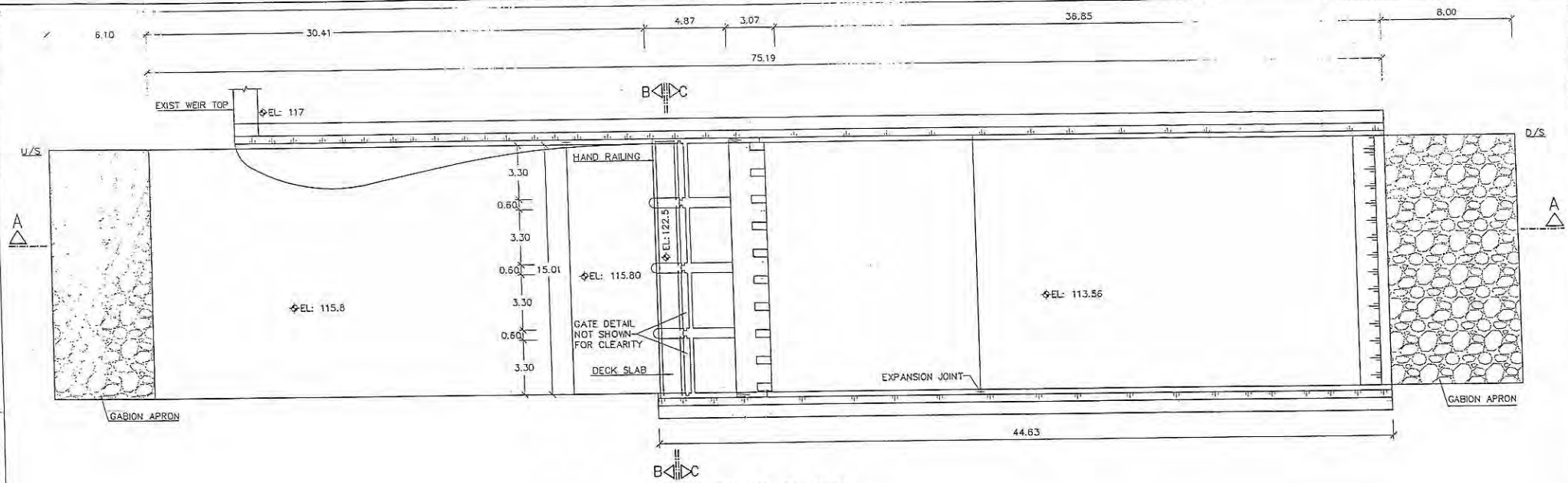


PLAN OF HEAD REGULATOR

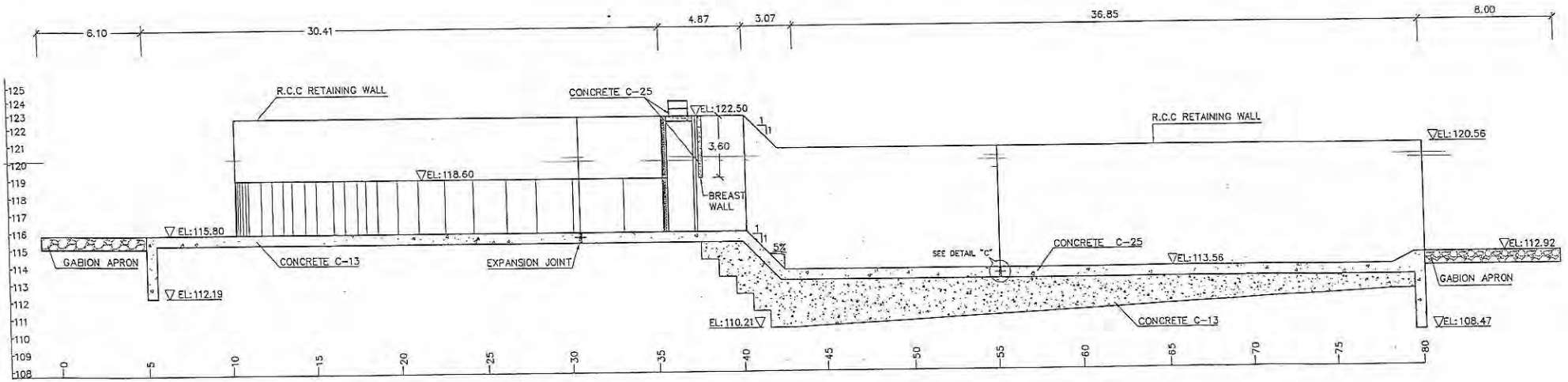


SECTION A–A

CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET, NO. 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (MITHRI WEIR SYSTEM)	DRAWING TITLE:- HEAD REGULATOR PLAN & SECTION	NOTES: ALL EL:S AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: NOMAN SAEED / DESIGNED BY: ASADULLAH JAN CHECKED BY: KAMRAN BABAR / SCALE: 1:200 FILE PATH: DA\NARI DATA / DATE: DEC / 2011 FIGURE NO. 10 / SHEET:- 01 OF 01

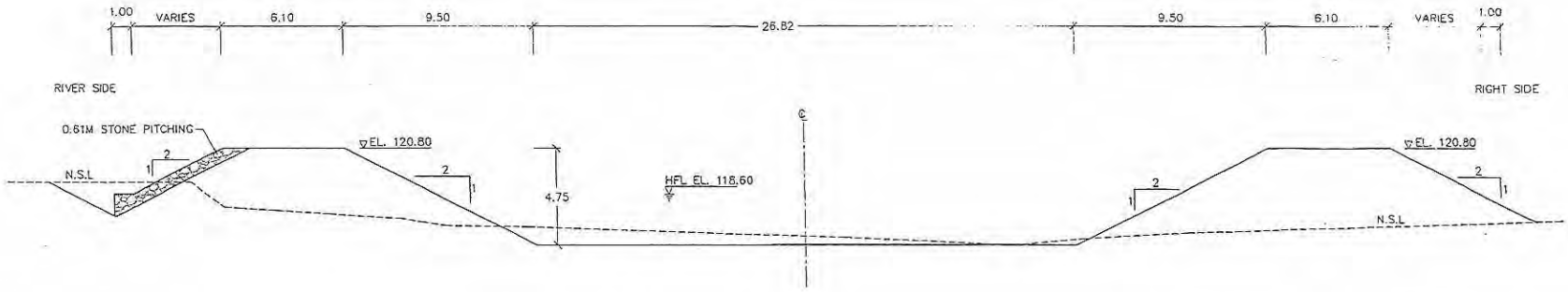


PLAN OF SLUICE

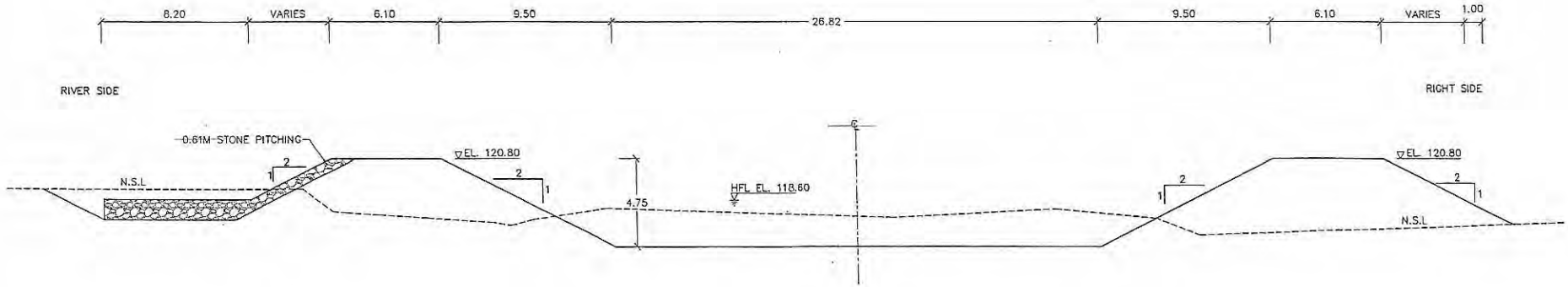


SECTION A–A

CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET. NO. 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (MITHRI WEIR SYSTEM)	DRAWING TITLE:- SLUICE PLAN & SECTION	NOTES: ALL EL:S AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: NOMAN SAEED; DESIGNED BY: ASADULLAH JAN; CHECKED BY: KAMRAN BABAR; SCALE: 1:250; FILE PATH: DA\NARI DATA; DATE: DEC/2011; FIGURE NO: 11; SHEET:- 01 OF 01



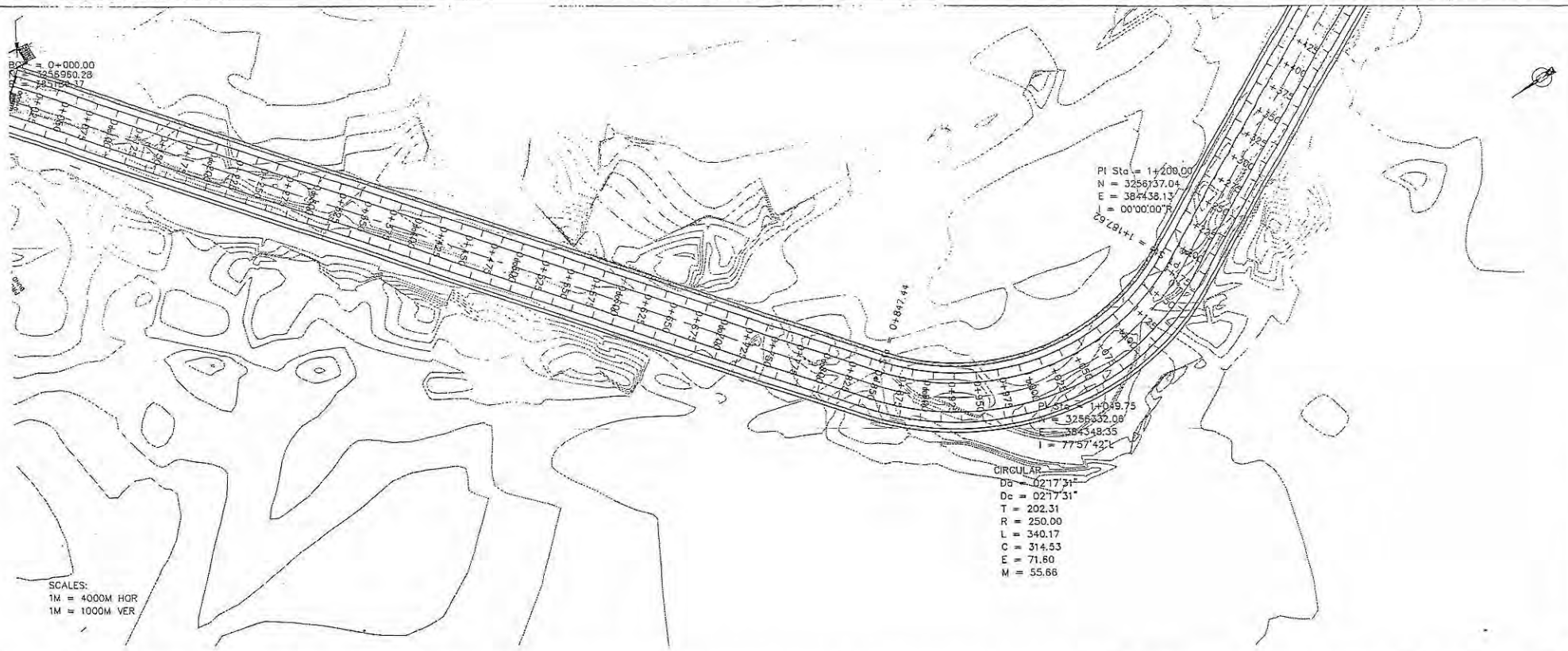
MAIN CHANNEL
RD: 0+000 TO 0+025

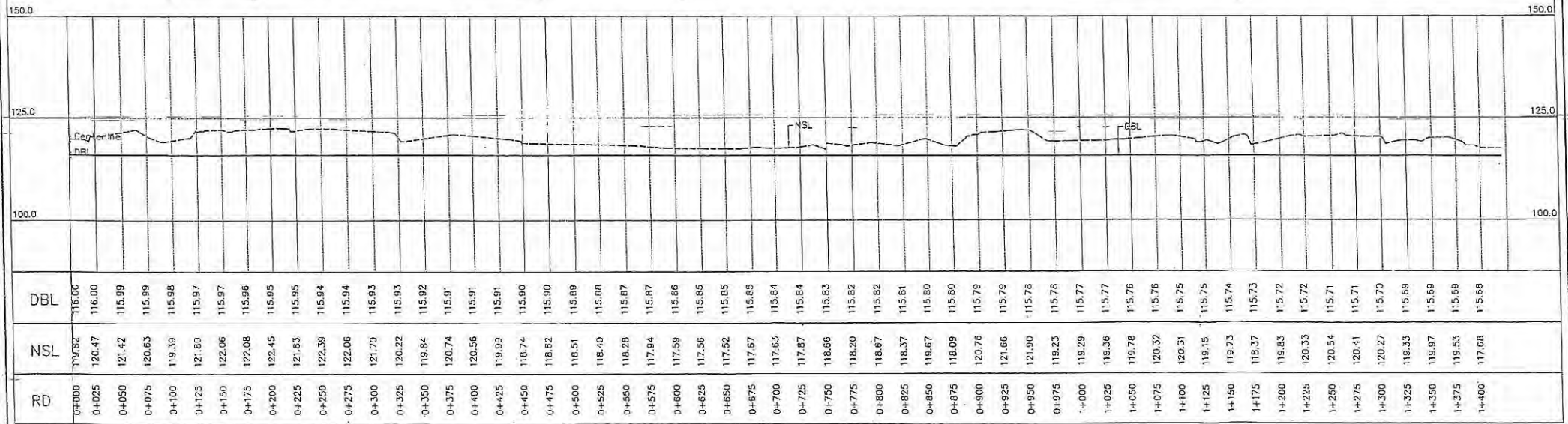


MAIN CHANNEL
RD: 0+025 TO 1+200

SCALE 1:250

CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS,ARCHITECTS & PLANNERS. 27-A, STREET, NO. 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (MITHRI WEIR SYSTEM)	DRAWING TITLE:- MAIN CHANNEL CROSS SECTION	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: NOMAN SAEED / DESIGNED BY: ASADULLAH JAN CHECKED BY: KAMRAN BABAR / SCALE: 1:250 FILE PATH: DANARI DATA / DATE: DEC / 2011 FIGURE NO 12 / SHEET:- 01 OF 01





RD	NSL	DBL
0+000	119.82	116.00
0+025	120.47	116.00
0+050	121.42	115.99
0+075	120.63	115.99
0+100	119.39	115.98
0+125	121.80	115.97
0+150	122.06	115.97
0+175	122.08	115.96
0+200	122.45	115.95
0+225	121.83	115.95
0+250	122.39	115.94
0+275	122.06	115.94
0+300	121.70	115.93
0+325	120.22	115.93
0+350	119.84	115.92
0+375	120.74	115.91
0+400	120.56	115.91
0+425	119.99	115.91
0+450	118.74	115.90
0+475	118.62	115.90
0+500	118.51	115.89
0+525	118.40	115.88
0+550	118.28	115.87
0+575	117.94	115.87
0+600	117.59	115.86
0+625	117.56	115.85
0+650	117.52	115.85
0+675	117.67	115.85
0+700	117.63	115.84
0+725	117.87	115.84
0+750	118.66	115.83
0+775	118.20	115.82
0+800	118.67	115.82
0+825	118.37	115.81
0+850	119.67	115.80
0+875	118.09	115.80
0+900	120.76	115.79
0+925	121.66	115.79
0+950	121.90	115.78
0+975	119.23	115.78
1+000	119.29	115.77
1+025	119.36	115.77
1+050	119.78	115.76
1+075	120.32	115.76
1+100	120.31	115.75
1+125	119.15	115.75
1+150	119.73	115.74
1+175	118.37	115.73
1+200	119.83	115.72
1+225	120.33	115.72
1+250	120.54	115.71
1+275	120.41	115.71
1+300	120.27	115.70
1+325	119.33	115.69
1+350	119.97	115.69
1+375	119.53	115.69
1+400	117.68	115.68

CLIENT:
IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

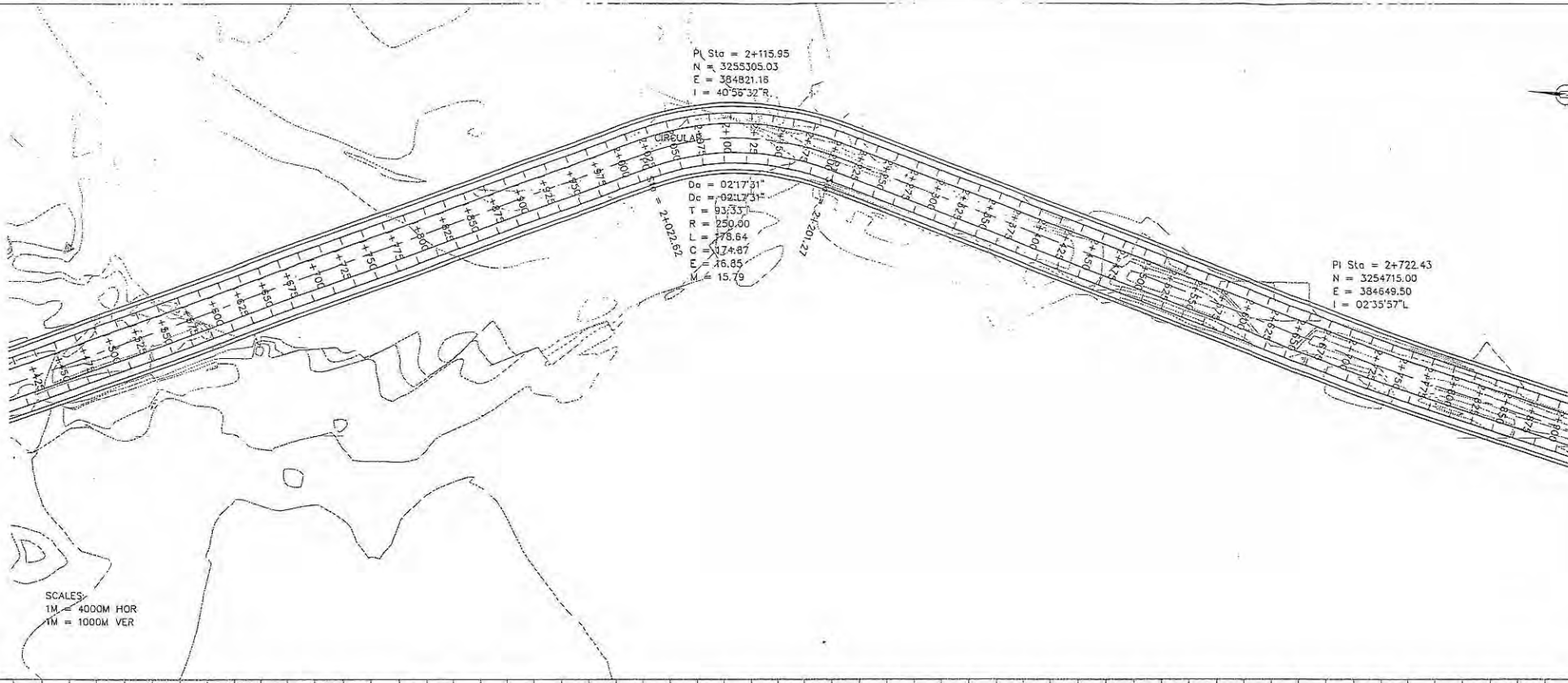
CONSULTANTS:
CAMEOS CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

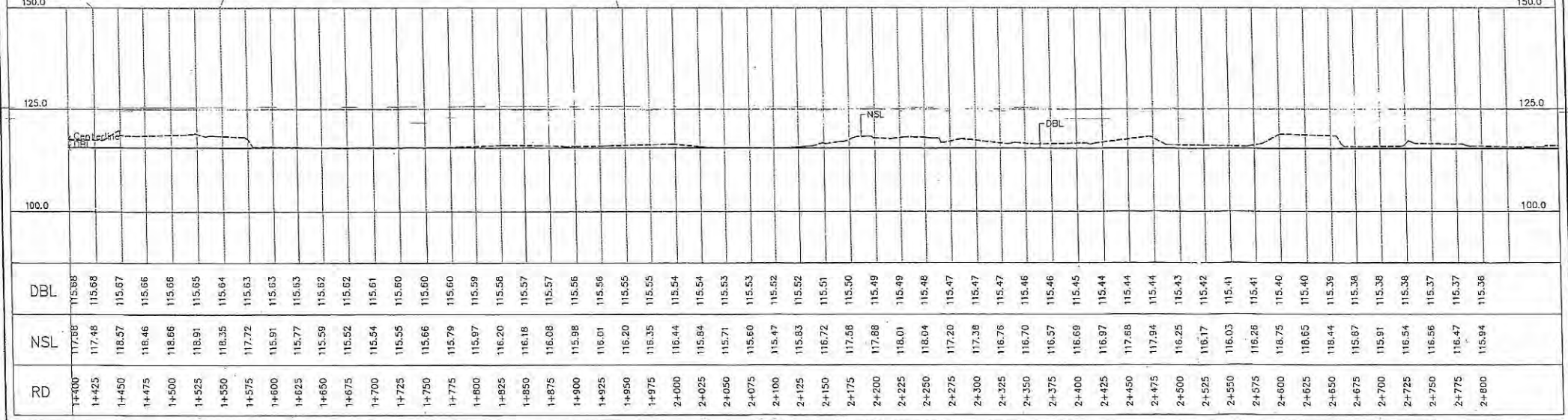
PROJECT:
SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (MITHRI WEIR SYSTEM)

DRAWING TITLE:-
PLAN AND PROFILE OF MAIN CHANNEL (RIGHT SIDE)

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	AS SHOWN
FILE PATH:	DA NARI DATA	DATE:	DEC / 2011
FIGURE NO.	13	SHEET:-	1 OF 04





RD	DBL	NSL
1+400	115.68	117.68
1+425	115.68	117.48
1+450	115.67	118.57
1+475	115.66	118.46
1+500	115.66	118.66
1+525	115.65	118.91
1+550	115.64	118.35
1+575	115.63	117.72
1+600	115.63	115.91
1+625	115.63	115.77
1+650	115.62	115.59
1+675	115.62	115.52
1+700	115.61	115.54
1+725	115.60	115.55
1+750	115.60	115.66
1+775	115.60	115.79
1+800	115.59	115.97
1+825	115.58	116.20
1+850	115.57	116.18
1+875	115.57	116.08
1+900	115.56	115.98
1+925	115.56	116.01
1+950	115.55	116.20
1+975	115.55	116.35
2+000	115.54	116.44
2+025	115.54	115.84
2+050	115.53	115.71
2+075	115.53	115.60
2+100	115.52	115.47
2+125	115.52	115.83
2+150	115.51	116.72
2+175	115.50	117.58
2+200	115.49	117.88
2+225	115.49	118.01
2+250	115.48	118.04
2+275	115.47	117.20
2+300	115.47	117.38
2+325	115.47	116.76
2+350	115.46	116.70
2+375	115.46	116.57
2+400	115.45	116.69
2+425	115.44	116.97
2+450	115.44	117.68
2+475	115.44	117.94
2+500	115.43	116.25
2+525	115.42	116.17
2+550	115.41	116.03
2+575	115.41	116.26
2+600	115.40	118.75
2+625	115.40	118.65
2+650	115.39	118.44
2+675	115.38	115.87
2+700	115.38	115.91
2+725	115.38	116.54
2+750	115.37	116.56
2+775	115.37	116.47
2+800	115.36	115.94

CLIENT:
IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

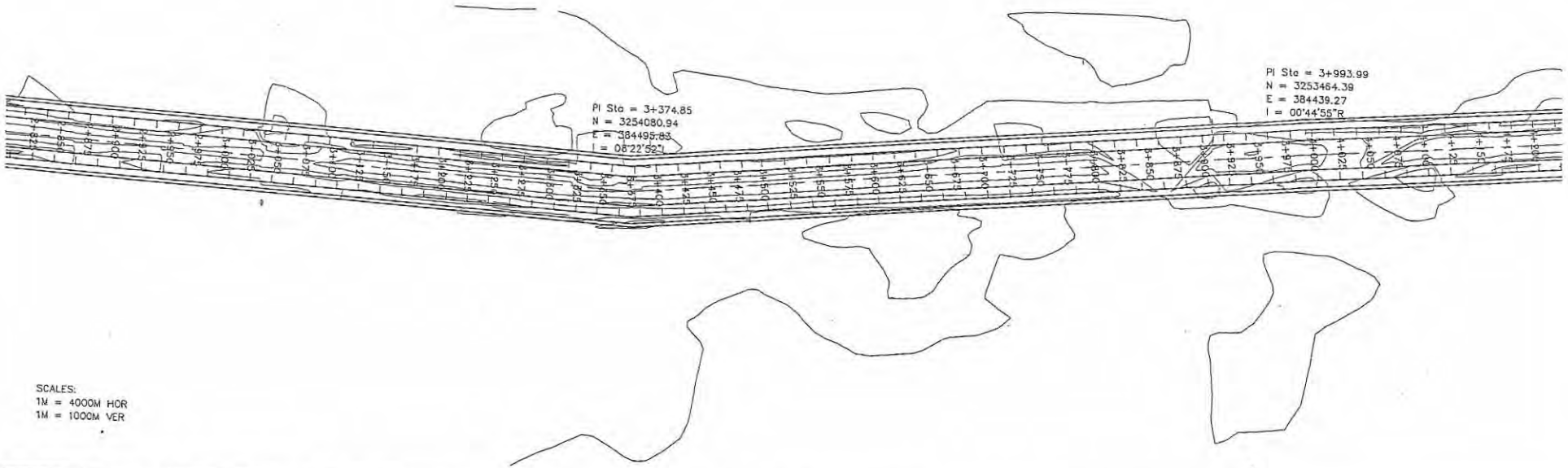
CONSULTANTS:
CAMEOS
CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS,
37-A, STREET NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT:
SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (MITHRI WEIR SYSTEM)

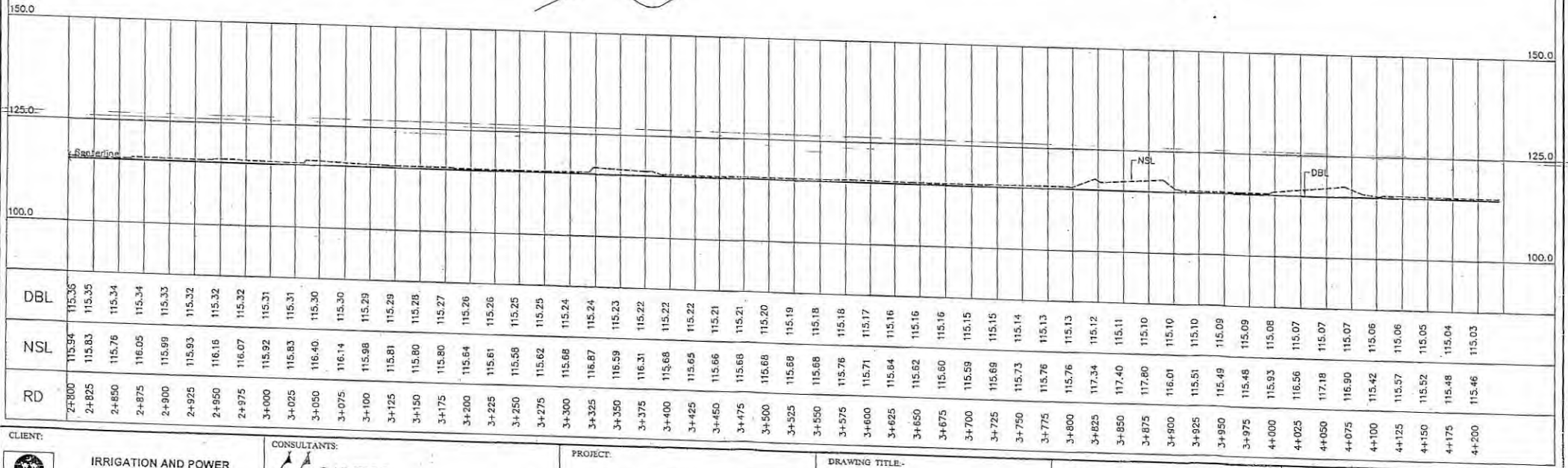
DRAWING TITLE:-
PLAN AND PROFILE OF MAIN CHANNEL (RIGHT SIDE)

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	AS SHOWN
FILE PATH:	DA NARI DATA	DATE:	DEC/2011
FIGURE NO.	13.1	SHEET:-	2 OF 04



SCALES:
1M = 4000M HOR
1M = 1000M VER



	2+800	2+825	2+850	2+875	2+900	2+925	2+950	2+975	3+000	3+025	3+050	3+075	3+100	3+125	3+150	3+175	3+200	3+225	3+250	3+275	3+300	3+325	3+350	3+375	3+400	3+425	3+450	3+475	3+500	3+525	3+550	3+575	3+600	3+625	3+650	3+675	3+700	3+725	3+750	3+775	3+800	3+825	3+850	3+875	3+900	3+925	3+950	3+975	4+000	4+025	4+050	4+075	4+100	4+125	4+150	4+175	4+200
DBL	115.36	115.35	115.34	115.34	115.33	115.32	115.32	115.32	115.31	115.31	115.30	115.30	115.29	115.29	115.28	115.27	115.26	115.26	115.25	115.25	115.24	115.24	115.23	115.22	115.22	115.22	115.21	115.21	115.20	115.19	115.18	115.18	115.17	115.16	115.16	115.16	115.15	115.15	115.14	115.13	115.13	115.12	115.11	115.10	115.10	115.10	115.09	115.09	115.08	115.07	115.07	115.07	115.06	115.06	115.05	115.04	115.03
NSL	115.94	115.83	115.76	116.05	115.99	115.93	116.16	116.07	115.92	115.83	116.40	116.14	115.98	115.81	115.80	115.80	115.64	115.61	115.58	115.62	115.68	116.87	116.59	116.31	115.68	115.65	115.66	115.68	115.68	115.68	115.68	115.76	115.71	115.64	115.62	115.60	115.59	115.69	115.73	115.76	115.76	117.34	117.40	117.80	116.01	115.51	115.49	115.48	115.93	116.56	117.18	116.90	115.42	115.57	115.52	115.48	115.46
RD																																																																			

CLIENT:
IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

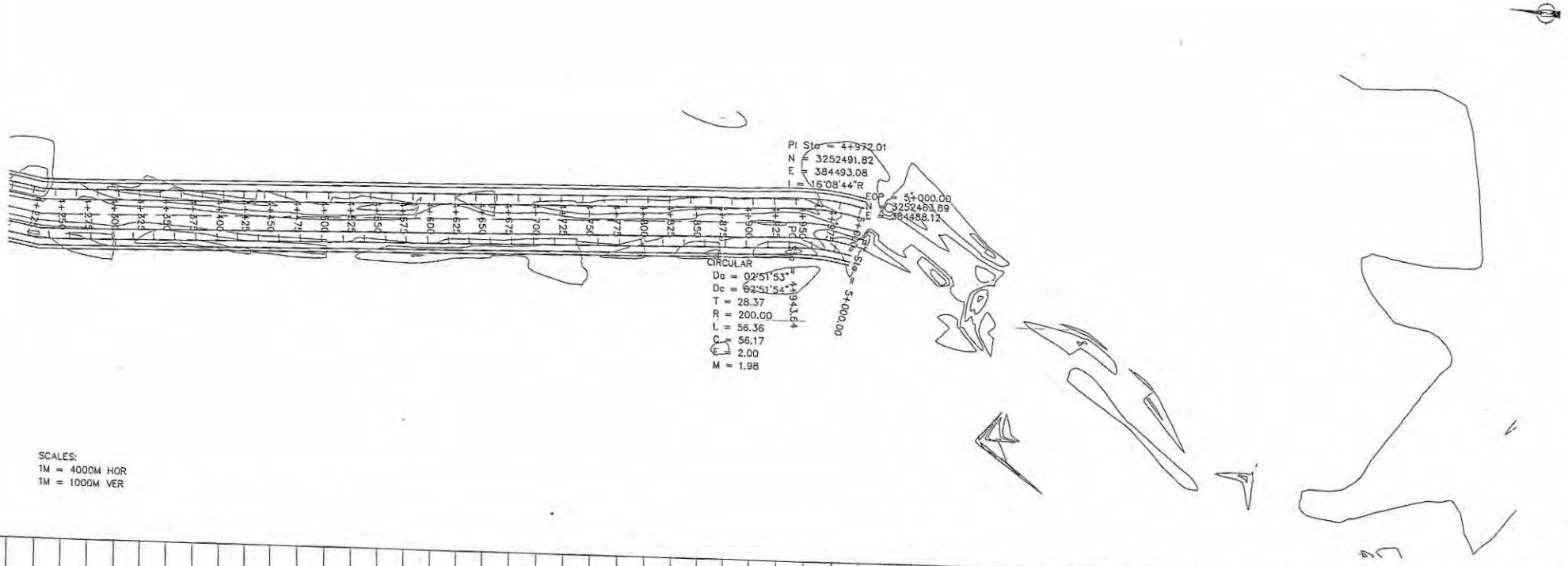
CONSULTANTS:
CAMEOS CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET, NO. 24 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT:
SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (MITHRI WEIR SYSTEM)

DRAWING TITLE:-
PLAN AND PROFILE OF MAIN CHANNEL (RIGHT SIDE)

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	AS SHOWN
FILE PATH:	D:\NARI DATA	DATE:	DEC / 2011
FIGURE NO.	13.2	SHEET:	3 OF 04



RD	DBL	NSL
4+200	115.03	115.46
4+225	115.03	115.46
4+250	115.02	115.51
4+275	115.02	115.66
4+300	115.01	115.61
4+325	115.01	115.58
4+350	115.00	115.35
4+375	115.00	115.44
4+400	114.99	115.58
4+425	114.99	115.78
4+450	114.98	116.07
4+475	114.97	116.29
4+500	114.97	116.51
4+525	114.96	116.45
4+550	114.95	116.33
4+575	114.94	116.23
4+600	114.94	115.59
4+625	114.94	115.51
4+650	114.93	115.46
4+675	114.93	115.52
4+700	114.92	115.57
4+725	114.91	115.61
4+750	114.91	115.74
4+775	114.91	115.77
4+800	114.90	115.73
4+825	114.89	115.75
4+850	114.88	115.77
4+875	114.88	115.35
4+900	114.87	115.39
4+925	114.87	115.32
4+950	114.86	115.55
4+975	114.85	115.60
5+000	114.85	115.52

CLIENT:

IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

CONSULTANTS:

CAMEOS
CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS
27-A, STREET, NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT:

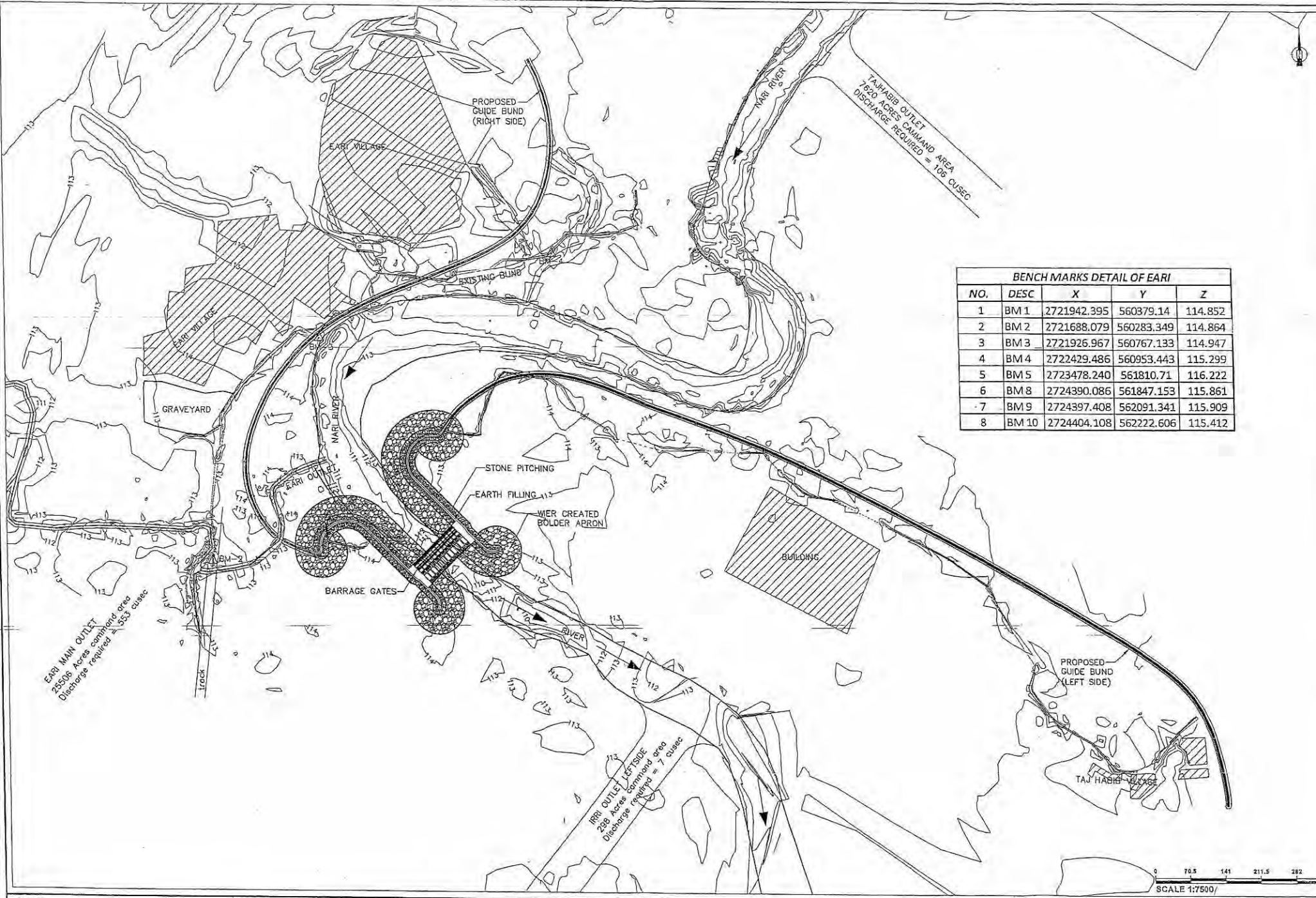
SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (MITHRI WEIR SYSTEM)

DRAWING TITLE:-

PLAN AND PROFILE OF MAIN CHANNEL (RIGHT SIDE)

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	AS SHOWN
FILE PATH:	DA\NARI DATA	DATE:	DEC / 2011
FIGURE NO.	13.3	SHEET:-	4 OF 04



BENCH MARKS DETAIL OF EARI				
NO.	DESC	X	Y	Z
1	BM 1	2721942.395	560379.14	114.852
2	BM 2	2721688.079	560283.349	114.864
3	BM 3	2721926.967	560767.133	114.947
4	BM 4	2722429.486	560953.443	115.299
5	BM 5	2723478.240	561810.71	116.222
6	BM 8	2724390.086	561847.153	115.861
7	BM 9	2724397.408	562091.341	115.909
8	BM 10	2724404.108	562222.606	115.412

CLIENT:
IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

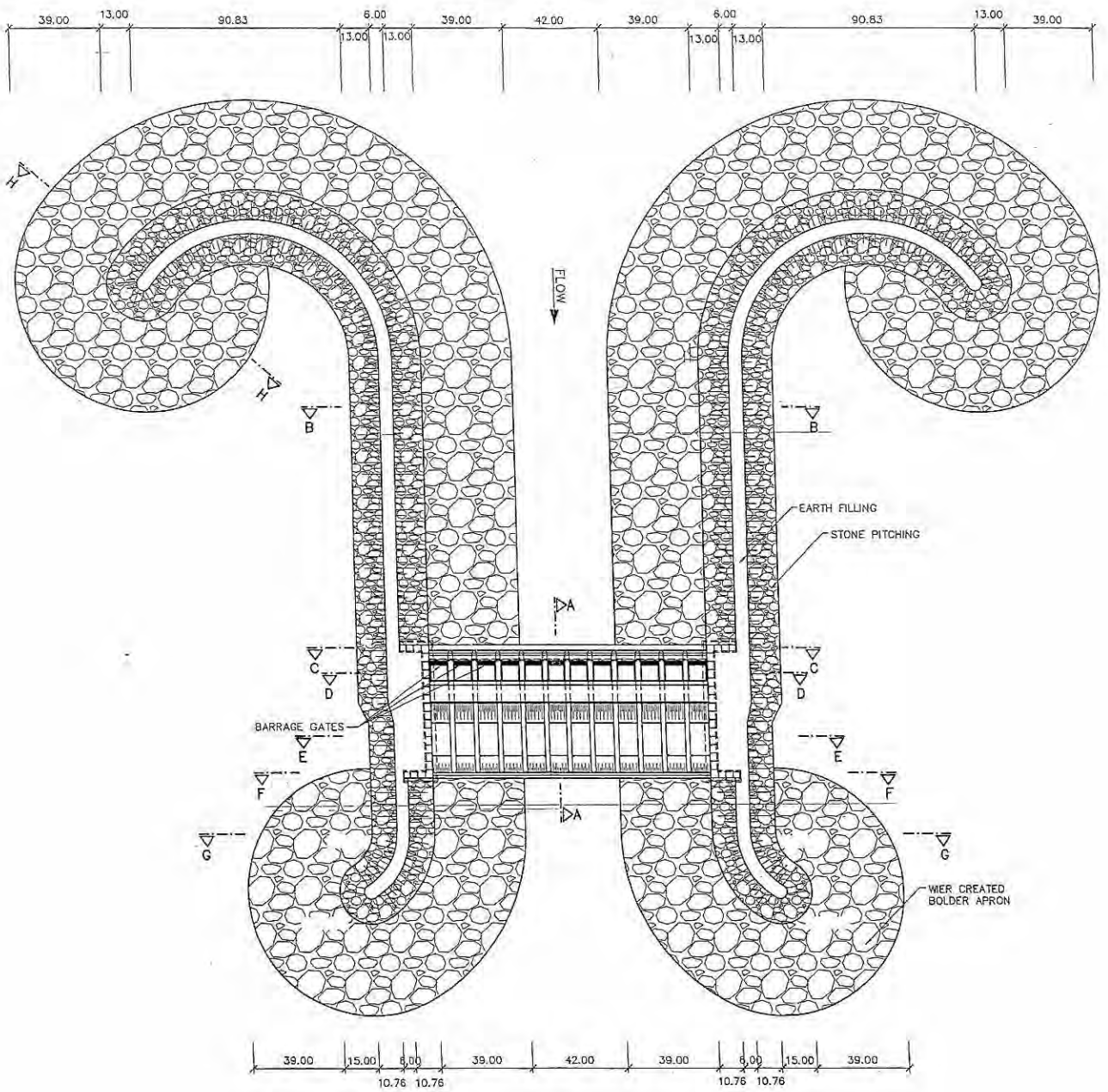
CONSULTANTS:
CAMEOS CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS
27-A, STREET, NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA

PROJECT:
SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (EARI)

DRAWING TITLE:-
GENERAL LAYOUT PLAN

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE

DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:7500
FILE PATH:	D:\NARI\DATA	DATE:	DEC / 2011
FIGURE NO.	14	SHEET:-	1 OF 01

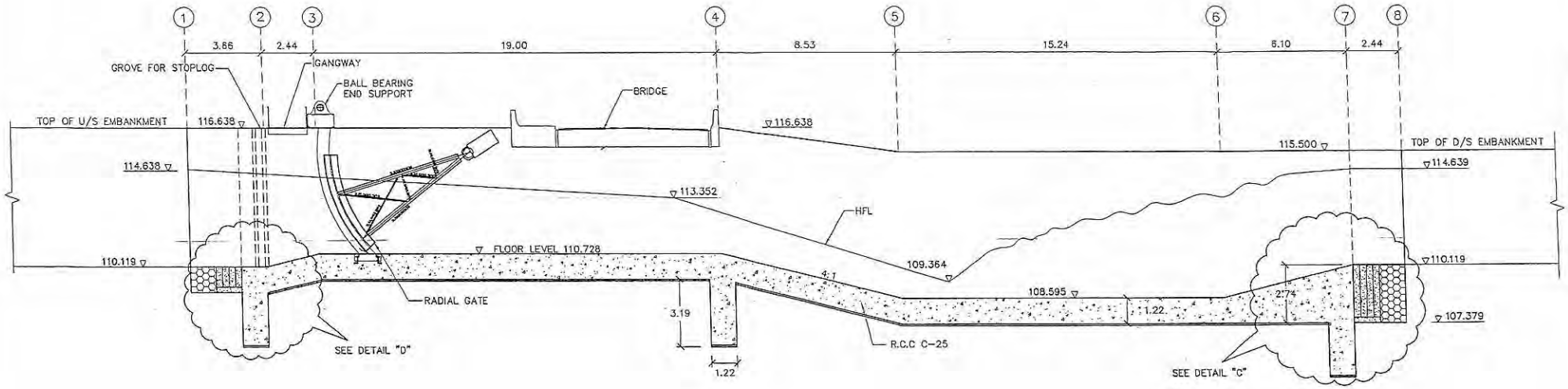


PLAN

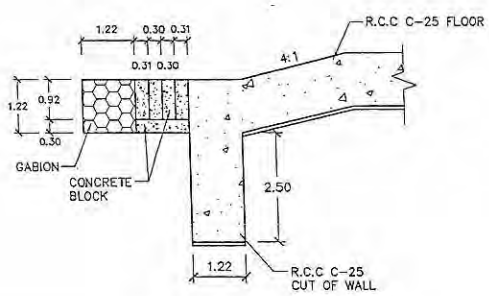
SCALE: 1:2000

SCALE 1:2000

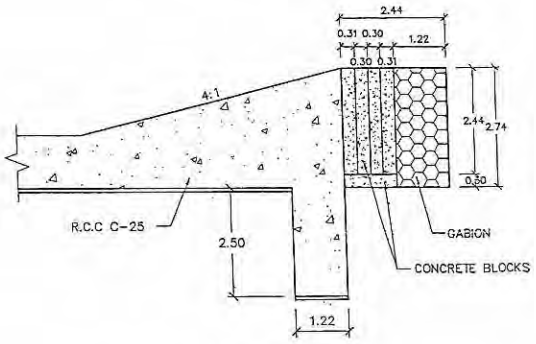
CLIENT: IRRIGATION AND POWER DEPARTMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS, CONSULTING ENGINEERS, ARCHITECTS & PLANNERS, 27-A, STREET NO. 73 F-10/1 ISLAMABAD, 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (EARI)	DRAWING TITLE:- PLAN OF EARI DISPERSAL STRUCTURE	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: MOHSIN HASSAN; DESIGNED BY: ASADULLAH JAN; CHECKED BY: KAMRAN BABAR; SCALE: 1:2000; FILE PATH: D:\NARI DATA; DATE: DEC / 2011; FIGURE NO. 15; SHEET:- 1 OF 01



SECTION A–A
SCALE: 1:200

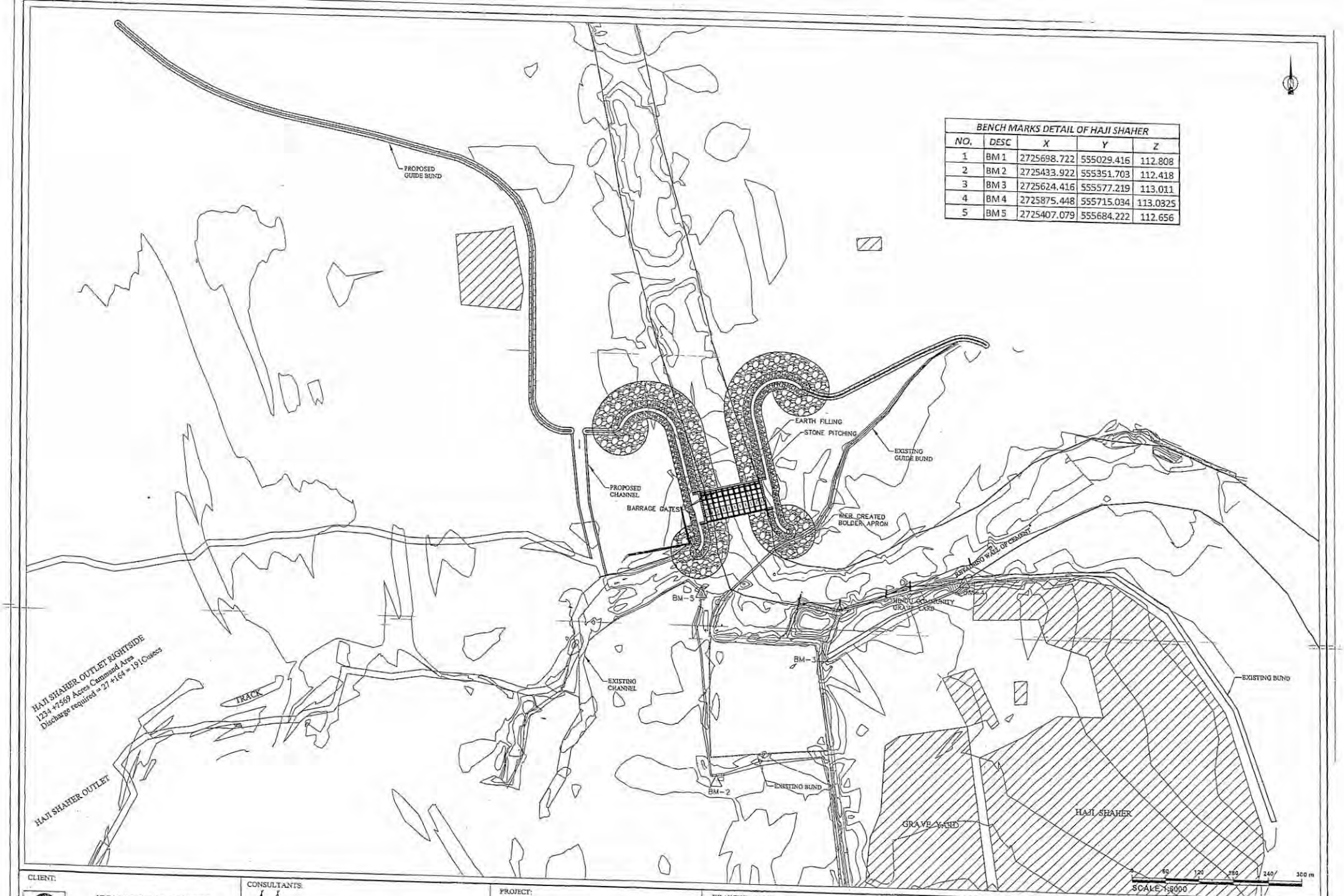


DETAIL "D"
SCALE: 1:125



DETAIL "C"
SCALE: 1:100

CLIENT: IRRIGATION AND POWER DEPARTMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS, CONSULTING ENGINEERS, ARCHITECTS & PLANNERS, 27-A, STREET, NO. 28 F-10/1 ISLAMABAD, 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (EARI)	DRAWING TITLE:- BARRAGE SECTION AND DETAILS	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: MOHSIN HASSAN; CHECKED BY: KAMRAN BABAR; FILE PATH: D:\NARI DATA; FIGURE NO. 16; DESIGNED BY: ASADULLAH JAN; SCALE: AS SHOWN; DATE: DEC / 2011; SHEET:- 1 OF 01



BENCH MARKS DETAIL OF HAJI SHAHER				
NO.	DESC	X	Y	Z
1	BM 1	2725698.722	555029.416	112.808
2	BM 2	2725433.922	555351.703	112.418
3	BM 3	2725624.416	555577.219	113.011
4	BM 4	2725875.448	555715.034	113.0325
5	BM 5	2725407.079	555684.222	112.656

CLIENT:

IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

CONSULTANTS:

CAMEOS CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET. NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA

PROJECT:

SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (HAJI SHAHER)

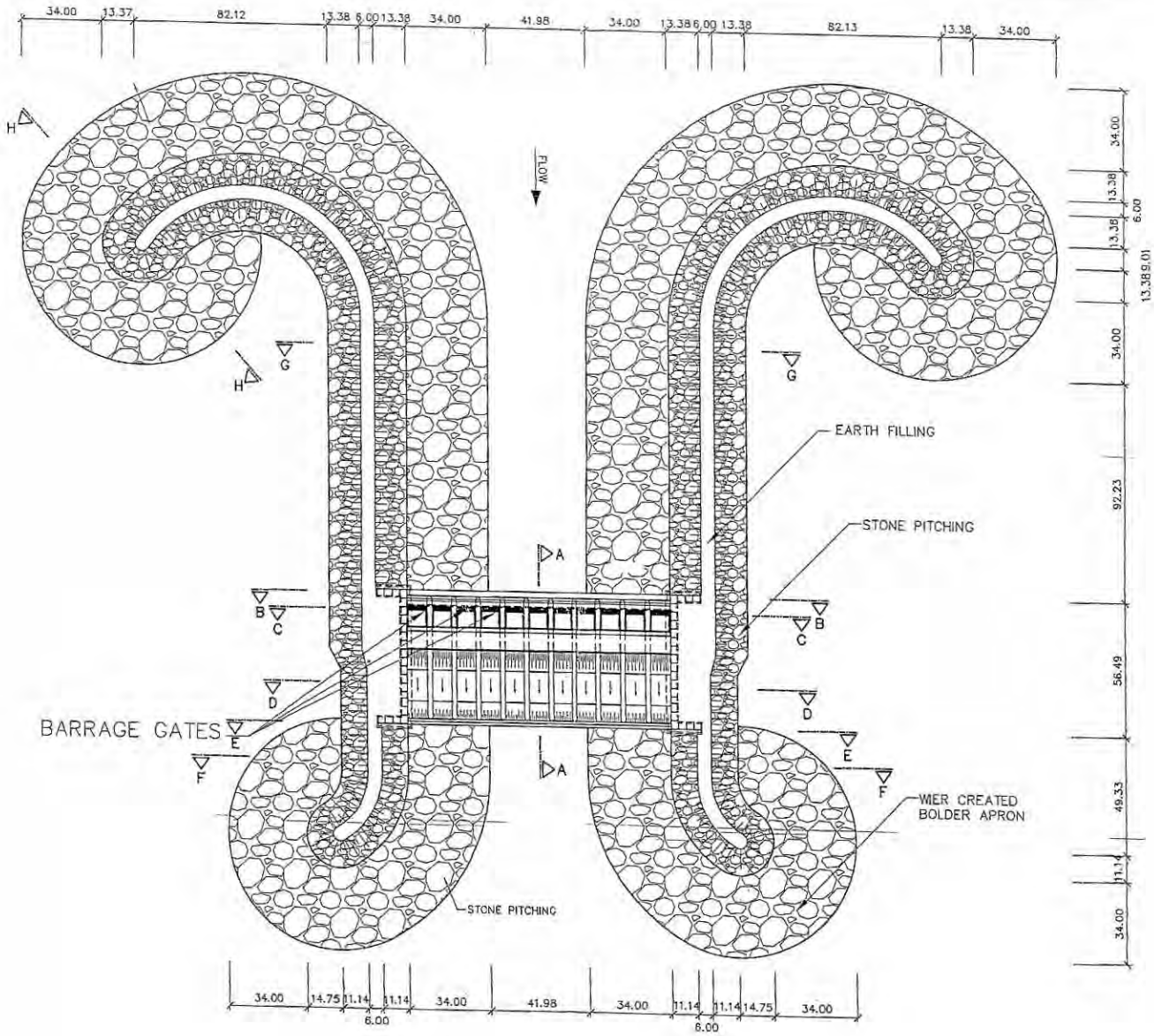
DRAWING TITLE:-

GENERAL LAYOUT PLAN

NOTES:

ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

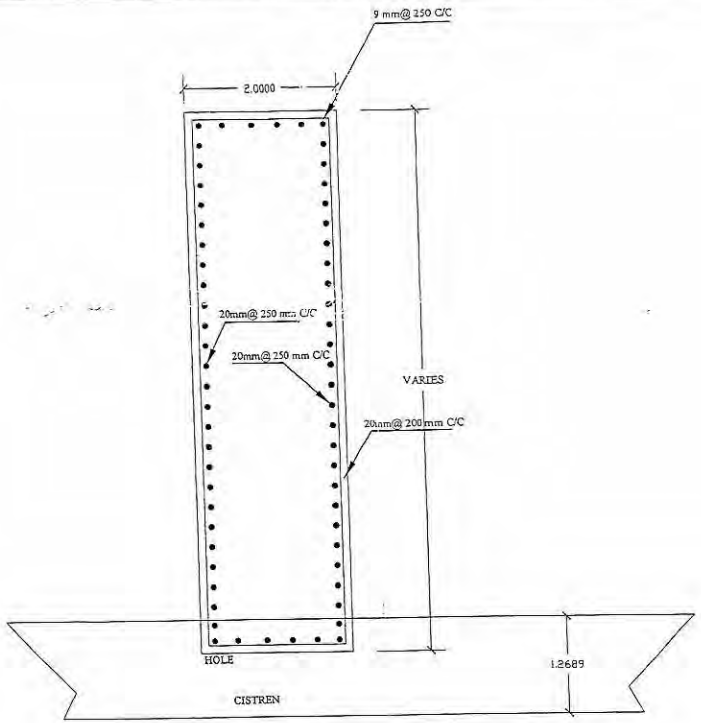
DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:6000
FILE PATH:	DANARI DATA	DATE:	DEC / 2011
FIGURE NO.	17	SHEET:-	1 OF 01

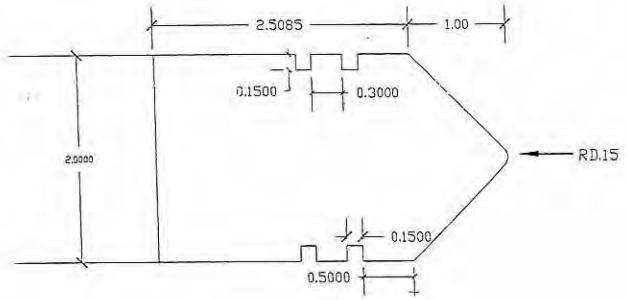


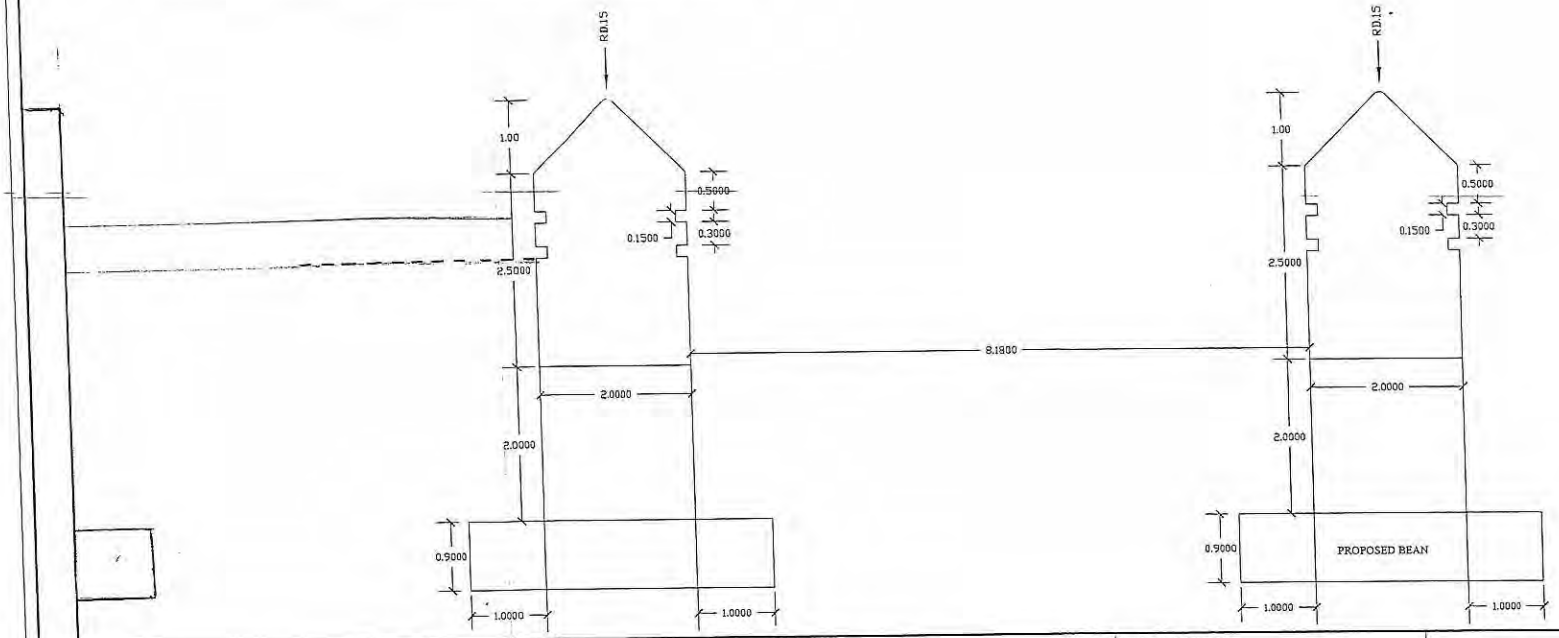
BARRAGE PLAN AT HAJI SHAHER

SCALE 1:2000

CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CONSULTANTS: CAMBOS CONSULTANTS CONSULTING ENGINEERS ARCHITECTS & PLANNERS 27-A, STREET, NO, 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURES ON NARI RIVER (HAJI SHAHER)	DRAWING TITLE:- PLAN OF DISPERSAL STRUCTURE	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: MOHSIN HASSAN; DESIGNED BY: ASADULLAH JAN; CHECKED BY: KAMRAN BABAR; SCALE: 1:2000; FILE PATH: D:\ NARI DATA; DATE: DEC / 2011; FIGURE NO. 18; SHEET:- 1 OF 01







CLIENT:

IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

CONSULTANTS:

CAMEOS CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET. NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT:

SIX (6) DISPERSAL STRUCTURE AT NARI RIVER (PAKAGE - II)

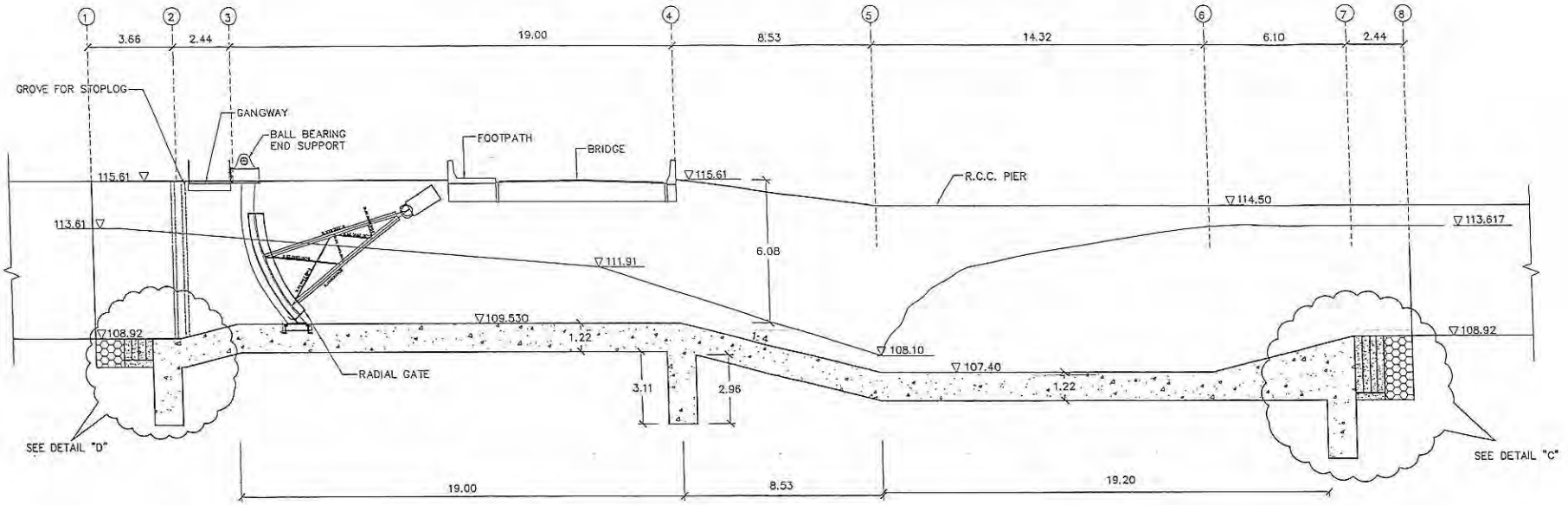
DRAWING TITLE:-

INSTALLATION OF RADIAL GATE ARRANGEMENTS

NOTES:

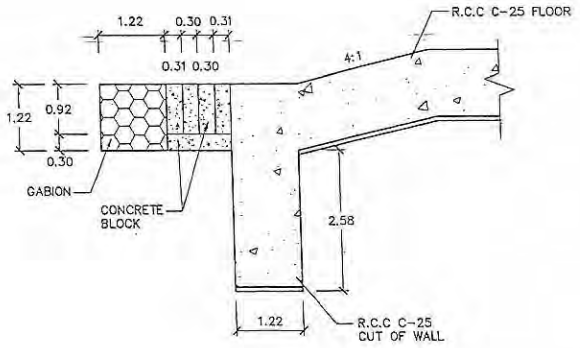
1. ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	N.T.S
FILE PATH:	D:\ SIX DISPERSAL STR.	DATE:	JAN / 2013
DRAWING NO.	00	SHEET:-	1 OF 01



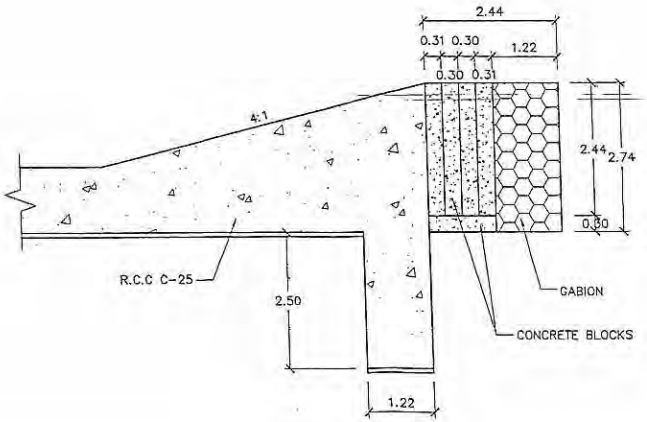
BARRAGE SECTION A–A

SCALE = 1:200



DETAIL "D"

SCALE: 1:100



DETAIL "C"

SCALE: 1:100

CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS 27-A, STREET, NO. 28 F-10/1 ISLAMABAD, 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURES ON NARI RIVER (HAJI SHAHER)	DRAWING TITLE:- BARRAGE SECTION AND DETAILS	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: MOHSIN HASSAN; DESIGNED BY: ASADULLAH JAN; CHECKED BY: KAMRAN BABAR; SCALE: AS SHOWN; FILE PATH: D:\NARI DATA; DATE: DEC / 2011; FIGURE NO. 19; SHEET:- 1 OF 01

BENCH MARKS DETAIL OF TOUK				
NO.	DESC	X	Y	Z
28	BM_1	3232988.000	388430.000	110.854
29	BM_5	3232830.000	388148.000	111.121
30	TBM_1	3232602.000	388426.000	111.609
31	TBM_2	3232525.000	388349.000	111.651
32	TBM_2	3232525.000	388349.000	111.655
33	TP	3232583.000	388401.000	111.536
34	TP	3232583.000	388401.000	111.528

CLIENT:

IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

CONSULTANTS:

CAMEOS
CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT:

SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (TOUK)

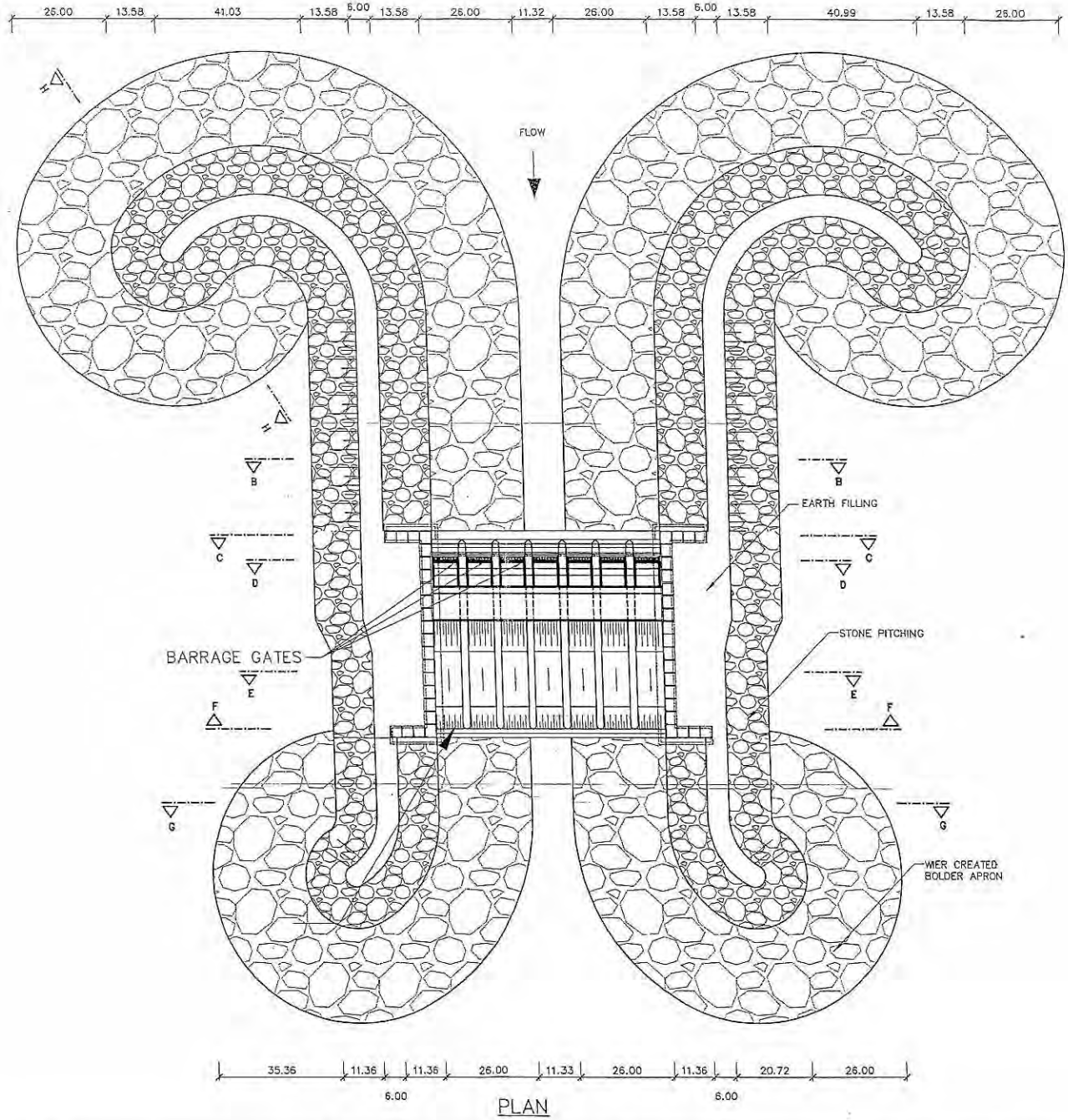
DRAWING TITLE:-

GENERAL LAYOUT PLAN

NOTES:

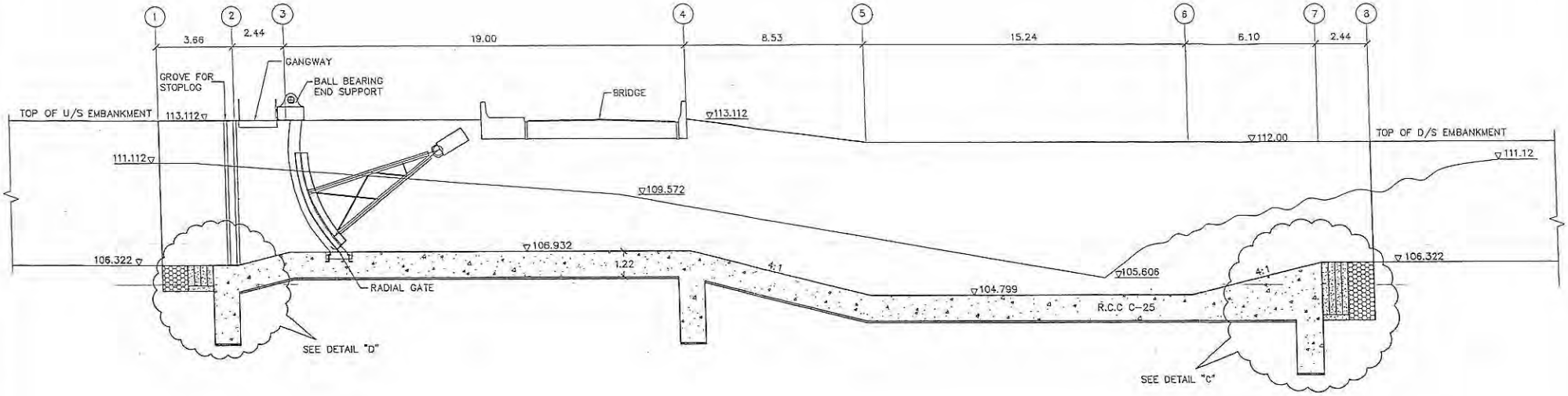
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:2500
FILE PATH:	D:\NARI DATA	DATE:	DEC / 2011
FIGURE NO.	20	SHEET:-	1 OF 01

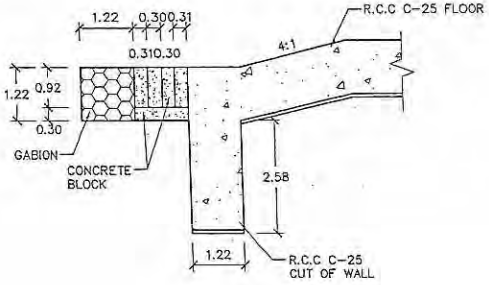


PLAN

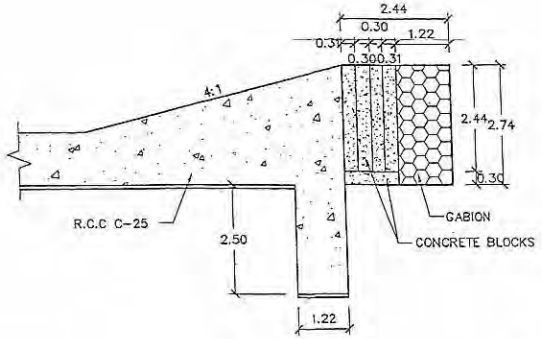
CLIENT: IRRIGATION AND POWER DEPARTMENT OF BALOCHISTAN	CONSULTANTS: CAMBOS CONSULTANTS, CONSULTING ENGINEERS, ARCHITECTS & PLANNERS, 27-A, STREET, NO. 28 F-10/1 ISLAMABAD, 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (TOUK)	DRAWING TITLE:- PLAN OF DISPERSAL STRUCTURE	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: KHALIL UR REHMAN; DESIGNED BY: ASADULLAH JAN; CHECKED BY: KAMRAN BABAR; SCALE: 1:1250; FILE PATH: D:\NARI DATA; DATE: DEC / 2011; FIGURE NO. 21; SHEET:- 1 OF 01



SECTION 1–1
SCALE=1:200



DETAIL D
SCALE: 1:125



DETAIL C
SCALE: 1:125

SCALE 1:200

SCALE 1:100

CLIENT: IRRIGATION AND POWER DEPARTMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS, CONSULTING ENGINEERS, ARCHITECTS & PLANNERS, 27-A, ST.REET. NO. 28 F-10/1 ISLAMABAD, 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (TOUK)	DRAWING TITLE:- BARRAGE SECTION A-A AND DETAILS	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: KHALIL UR REHMAN; DESIGNED BY: ASADULLAH JAN; CHECKED BY: KAMRAN BABAR; SCALE: AS SHOWN; FILE PATH: DA NARI DATA; DATE: DEC / 2011; FIGURE NO. 22; SHEET:- 1 OF 01

BENCH MARKS DETAIL OF GHAZI				
NO.	DESC	X	Y	Z
1	BM 1	2728674.041	547376.043	108.68
2	BM 2	2728648.176	547421.846	106.56
3	BM 3	2728554.026	547426.789	106.478
4	BM 4	2728524.131	547383.682	108.88

CLIENT:
IRRIGATION AND POWER DEPARTMENT
GOVERNMENT OF BALOCHISTAN

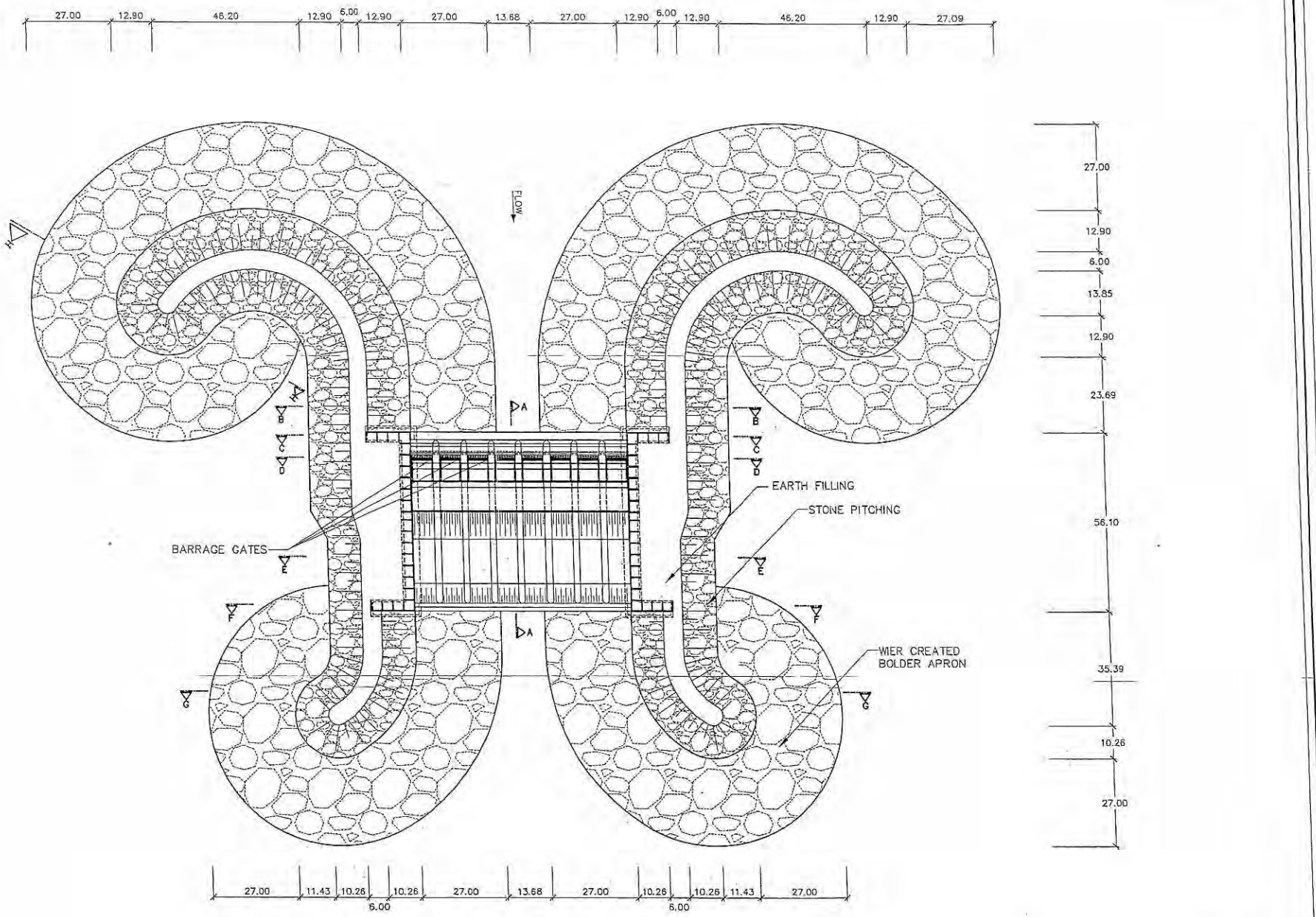
CONSULTANTS:
CAMEOS CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET NO. 28 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA

PROJECT:
SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (GHAZI)

DRAWING TITLE:-
GENERAL LAYOUT PLAN

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE

DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:4000
E-PATH:	DANARI\DATA	DATE:	1/07/2011
FIGURE NO.	23	SHEET:-	1 OF 01



BARRAGE PLAN

SCALE = 1:1250

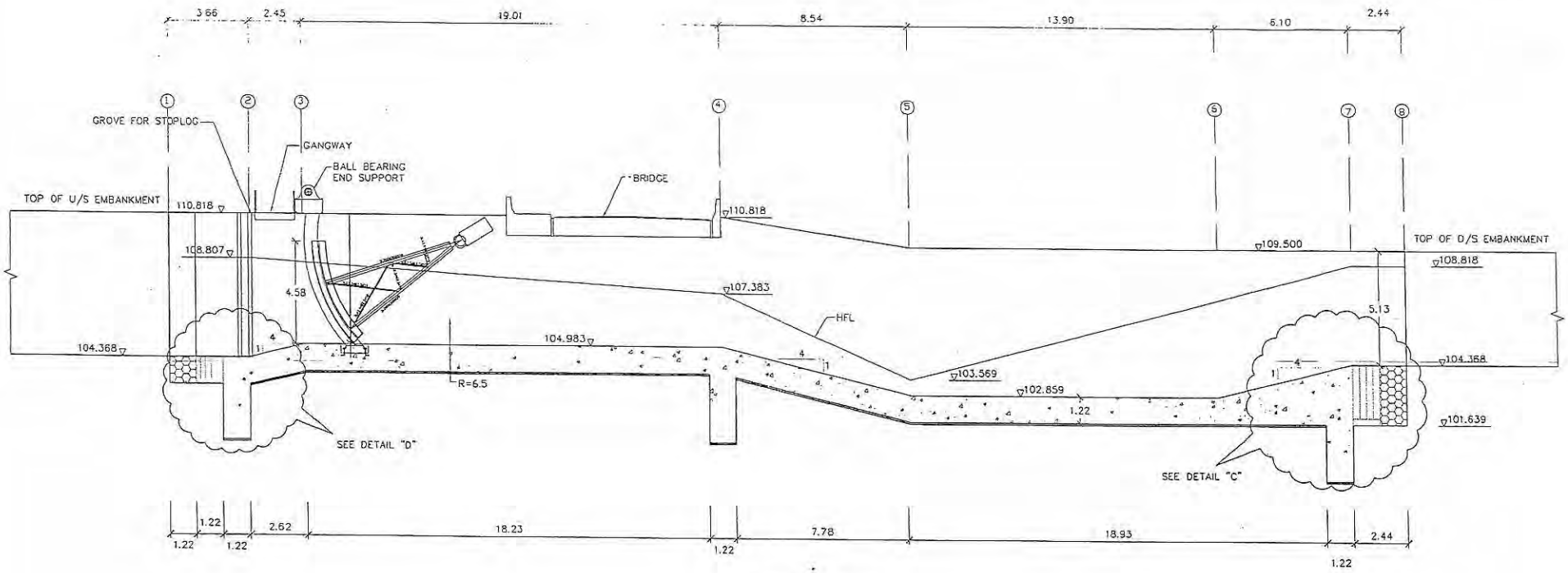
0 12.5 25 37.5 50 62.5 m

SCALE 1:1250

CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET, NO. 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (GHAZI)	DRAWING TITLE:- PLAN OF DISPERSAL STRUCTURE

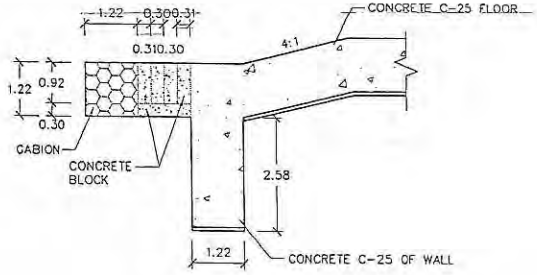
NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE

DRAWN BY:	ALLA-UD-DIN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:1250
FILE PATH:	DOMAIN DATA	DATE:	DEC / 2011
FIGURE NO.	24	SHEET:-	1 OF 01



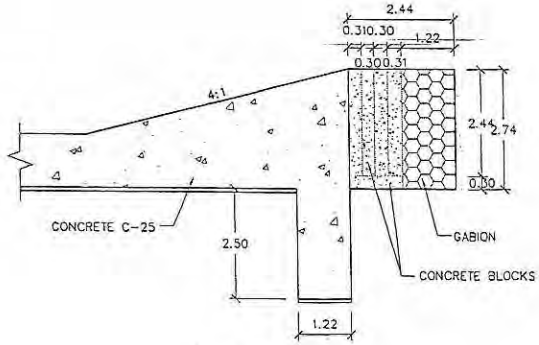
SECTION A–A

SCALE = 1:200



DETAIL–D

SCALE: 1:125



DETAIL–C

SCALE: 1:125

0 2 4 6 8 10 m

SCALE 1:200

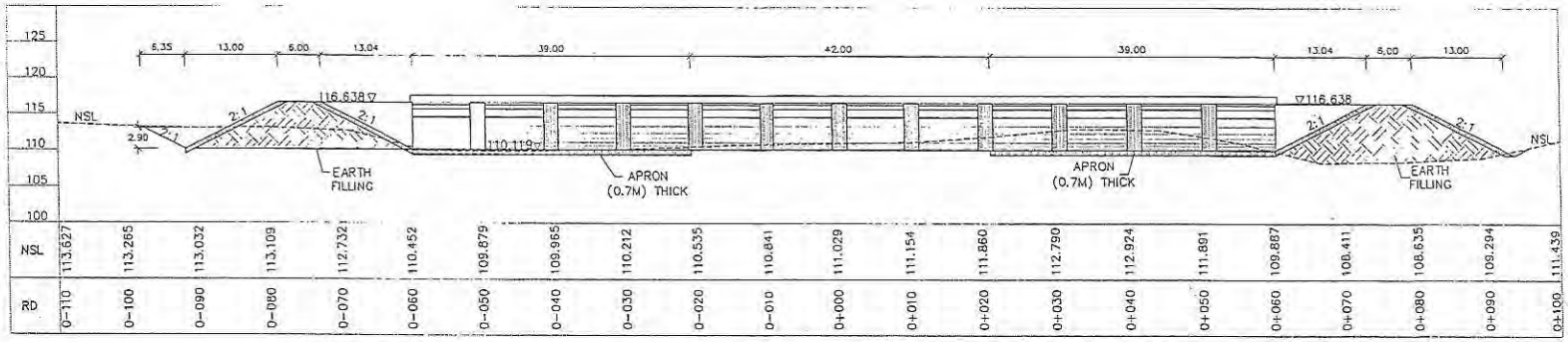
0 1.25 2.5 3.75 5 6.25 m

SCALE 1:125

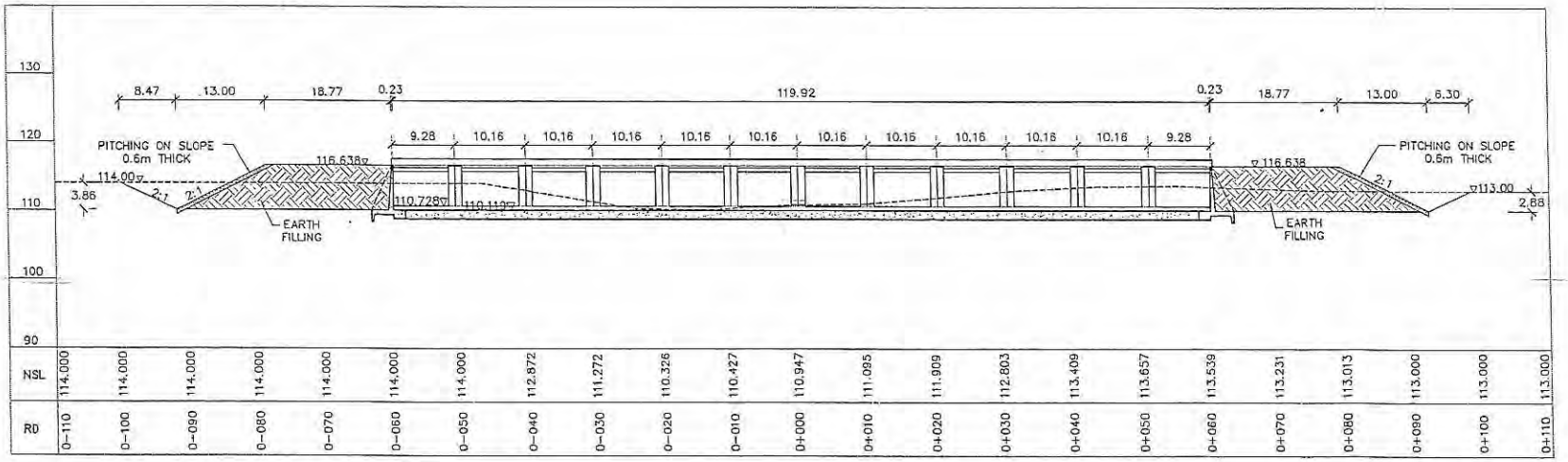
CLIENT: IRRIGATION AND POWER DEPARTMENT GOVERNMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET, NO. 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER (GHAZI)	DRAWING TITLE:- BARRAGE SECTION A-A AND DETAIL

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

DRAWN BY:	ALLA-UD-DIN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	AS SHOWN
FILE PATH:	D:\NARI DATA	DATE:	DEC / 2011
FIGURE NO.	25	SHEET:-	1 OF 01



TYPICAL CROSS SECTION

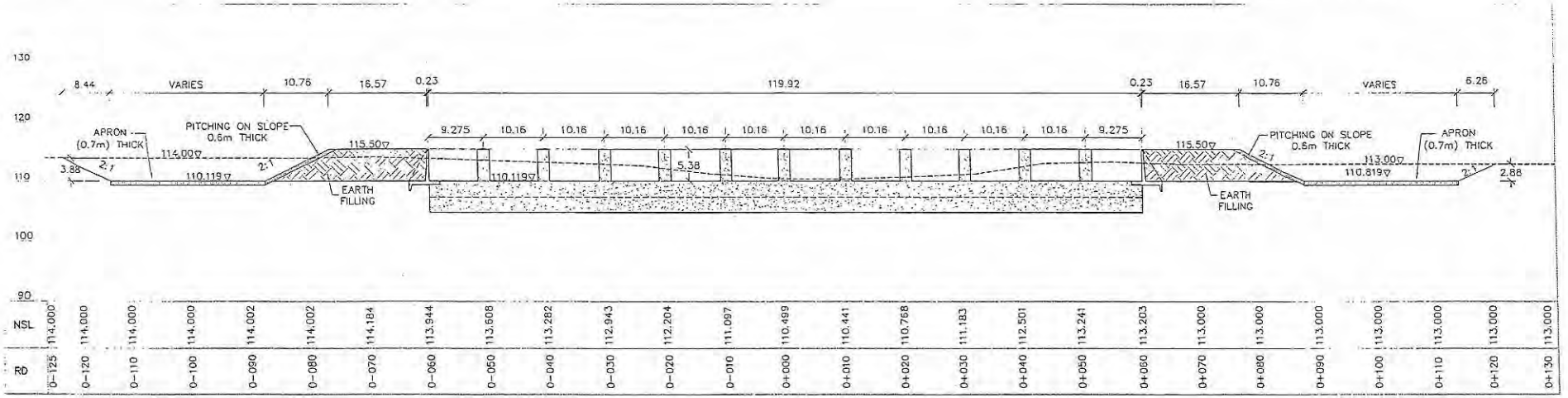


TYPICAL CROSS SECTION

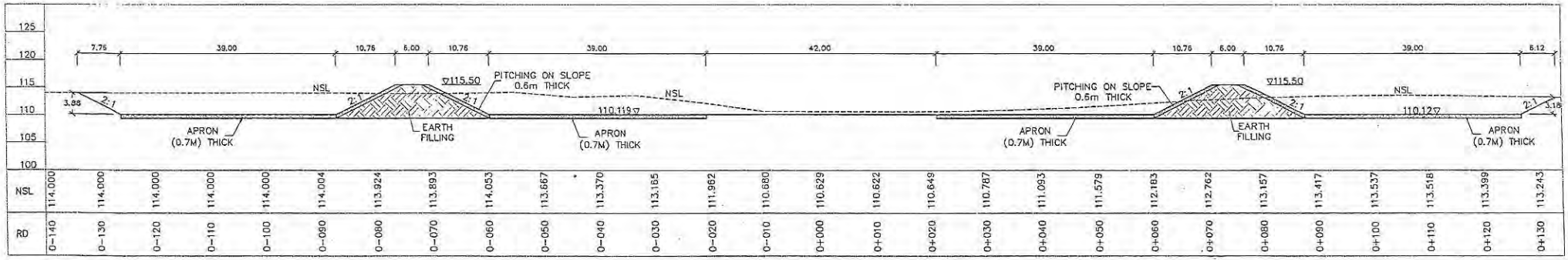
CLIENT: IRRIGATION AND POWER DEPARTMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS,ARCHITECTS & PLANNERS. 27-A, STREET NO. 25, I-8/2 (EXT.), ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER	DRAWING TITLE:- TYPICAL CROSS SECTIONS OF DISPERSAL STRUCTURE

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.

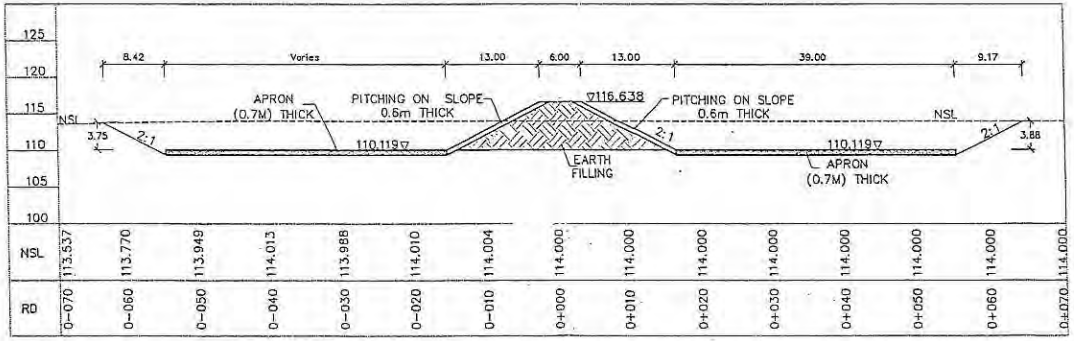
DRAWN BY:	MOHSIN HASSAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:750
FILE PATH:	DA NARI DATA	DATE:	DEC / 2011
FIGURE NO.	26	SHEET:-	1 OF 01



TYPICAL CROSS SECTION AT F–F

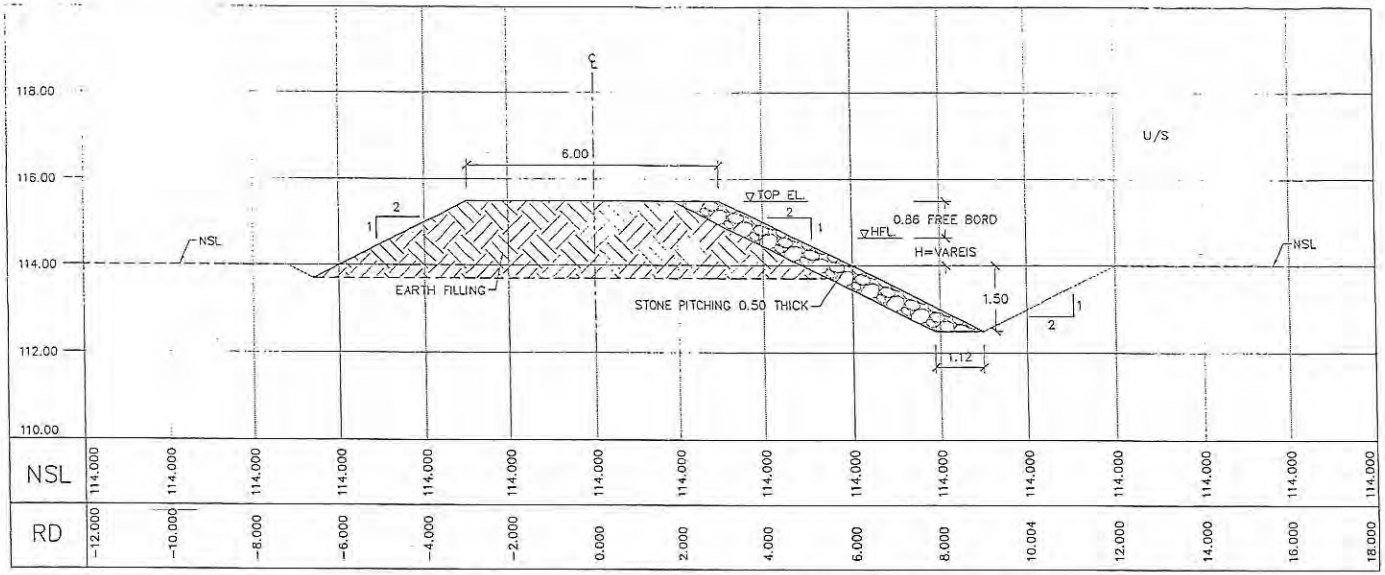


TYPICAL CROSS SECTION AT G–G

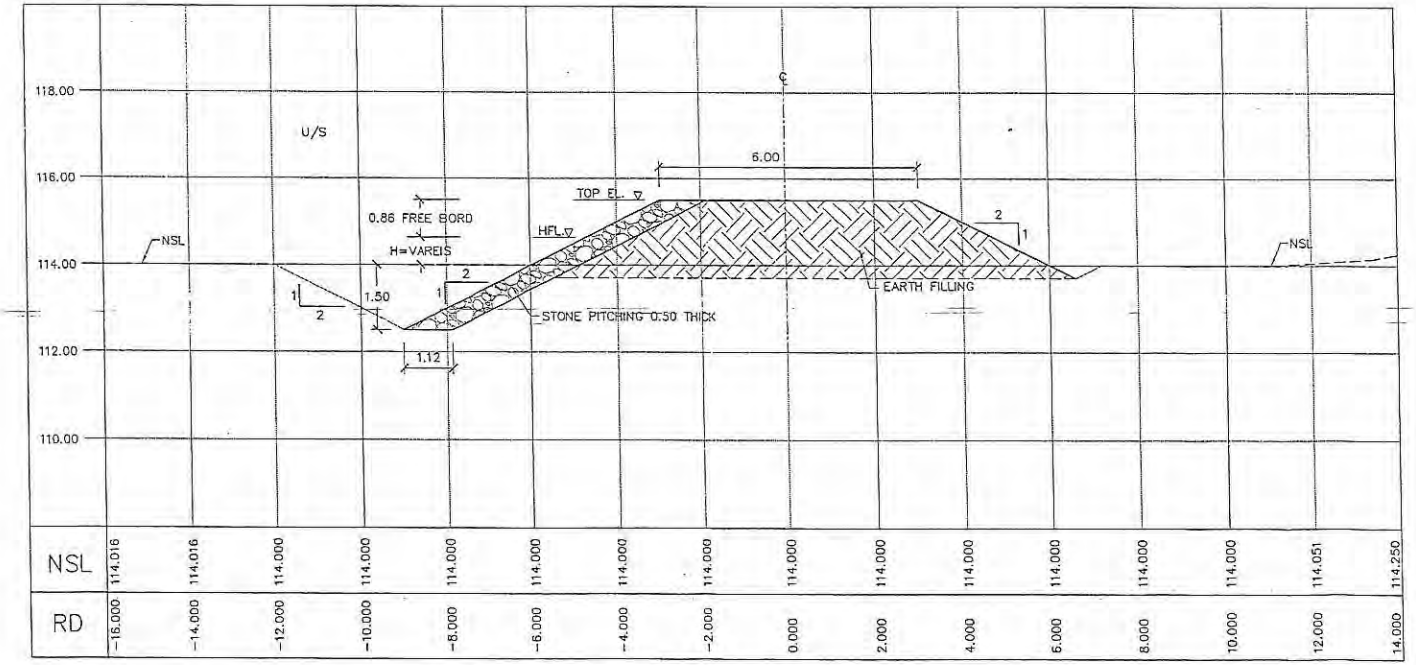


TYPICAL CROSS SECTION AT H–H

CLIENT: IRRIGATION AND POWER DEPARTMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS 27-A, 3 STREET, NO. 23 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER	DRAWING TITLE:- TYPICAL CROSS SECTIONS OF DISPERSAL	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: MOHSIN HASSAN / DESIGNED BY: ASADULLAH JAN CHECKED BY: KAMRAN BABAR / SCALE: 1:350 FILE PATH: DANARI DATA / DATE: DEC / 2011 FIGURE NO. 27 / SHEET:- 1 OF 01



CROSS SECTION OF RIGHT SIDE GUIDE BUND



CROSS SECTION OF LEFT SIDE GUIDE BUND

0 1.25 2.5 3.75 5.0 6.25 m

SCALE 1:125

CLIENT:

IRRIGATION AND POWER
DEPARTMENT OF BALOCHISTAN

CONSULTANTS:

CAMEOS
CONSULTANTS
CONSULTING ENGINEERS, ARCHITECTS & PLANNERS.
27-A, STREET NO. 25 F-10/1 ISLAMABAD.
44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.

PROJECT:

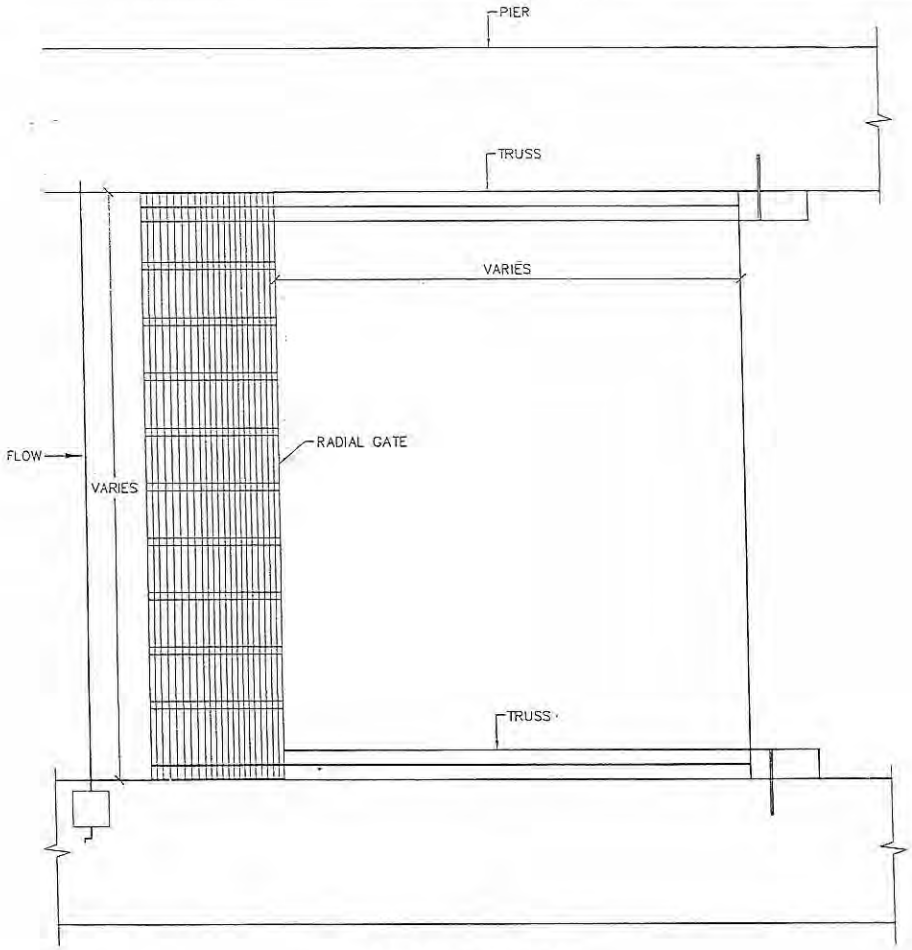
SIX (6) DISPERSAL STRUCTURE
ON NARI RIVER

DRAWING TITLE:-

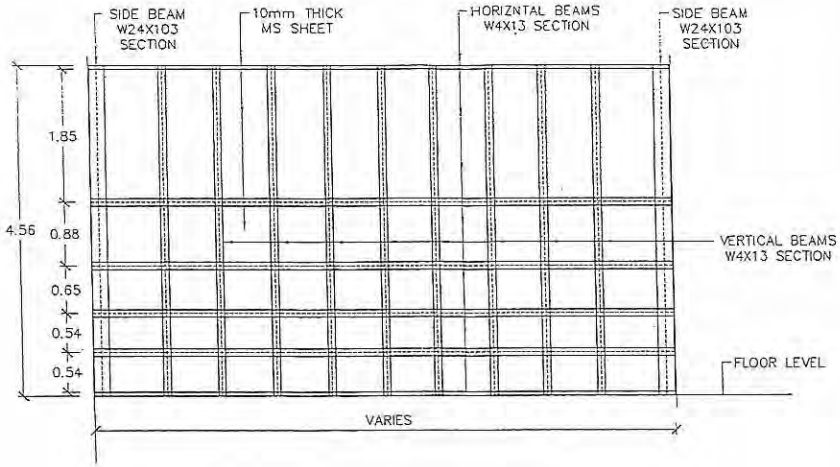
TYPICAL CROSS SECTIONS OF
GUIDE BUNDS

NOTES:
ALL LEVELS AND DIMENSIONS ARE IN METERS
UNLESS INDICATED OTHERWISE.

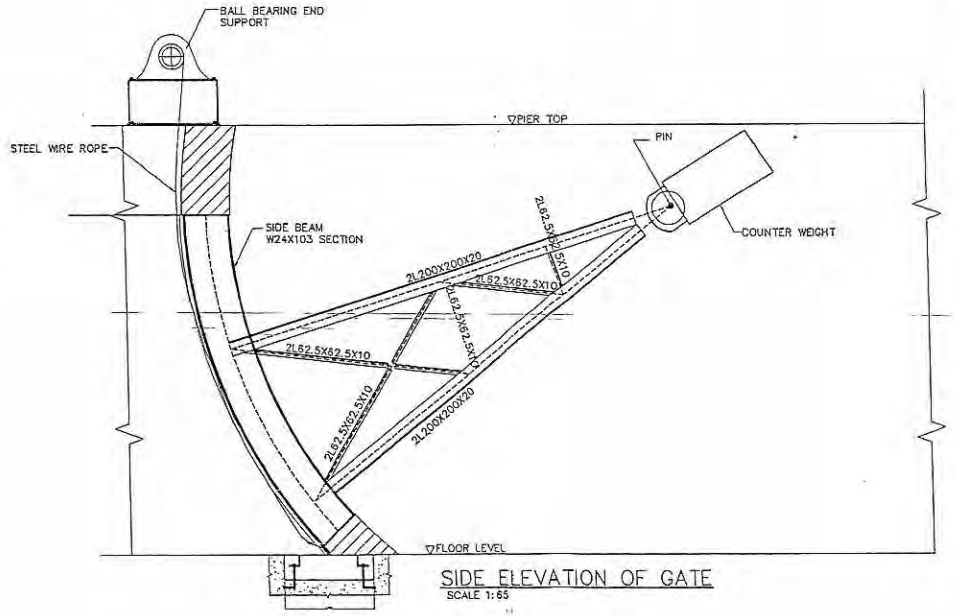
DRAWN BY:	NOMAN / KAMRAN	DESIGNED BY:	ASADULLAH JAN
CHECKED BY:	KAMRAN BABAR	SCALE:	1:125
FILE PATH:	DANARI DATA	DATE:	DEC / 2011
FIGURE NO.:	23	SHEET:	1 OF 01



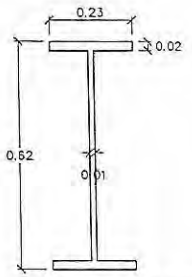
PLAN OF GATE
SCALE: 1:85



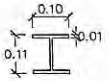
FRONT ELEVATION GATE
SCALE: 1:85



SIDE ELEVATION OF GATE
SCALE 1:65

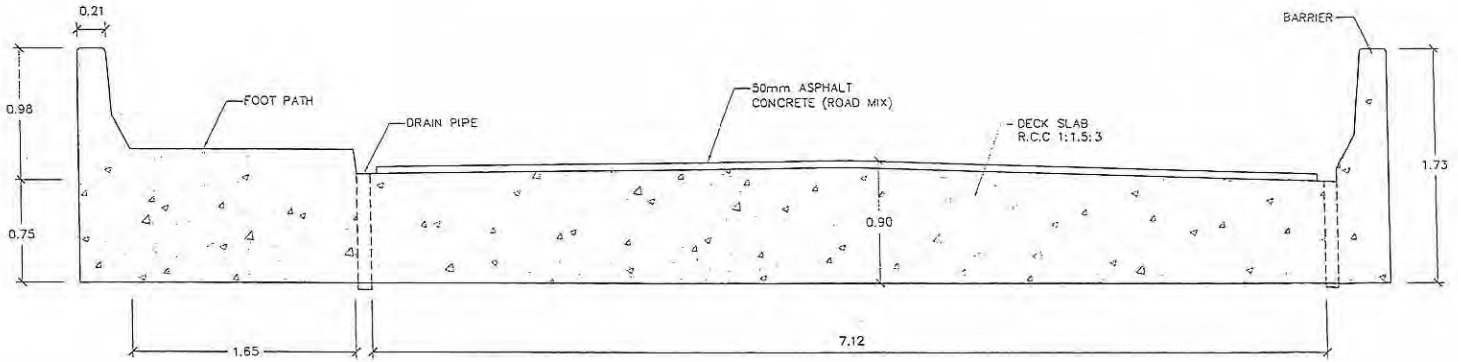


W 24 x 103 SECTION DETAIL
SCALE: 1:15

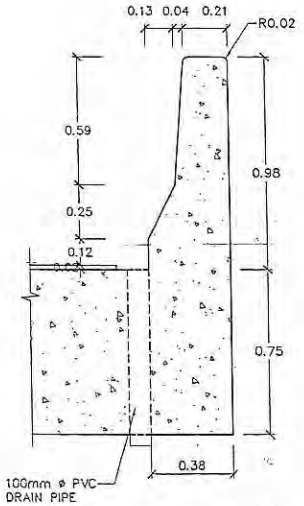


W 4 x 13 SECTION DETAIL
SCALE: 1:15

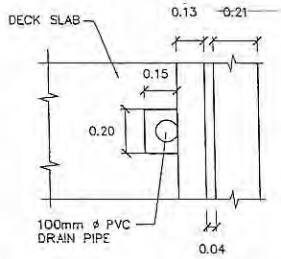
CLIENT: IRRIGATION AND POWER DEPARTMENT OF BALOCHISTAN	CONSULTANTS: CAMEOS CONSULTANTS, CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET. NO. 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER	DRAWING TITLE:- TYPICAL RADIAL GATE PLAN, FRONT, SIDE ELEVATIONS AND DETAILS	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: MOHSIN HASSAN; DESIGNED BY: ASADULLAH JAN; CHECKED BY: KAMRAN BABAR; SCALE: AS SHOWN; FILE PATH: DA NARI DATA; DATE: DEC / 2011; FIGURE NO. 29; SHEET:- 1 OF 01



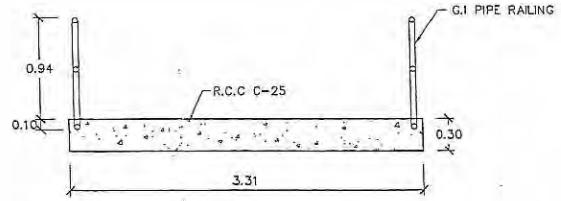
BRIDGE X-SECTION
SCALE: 1:40



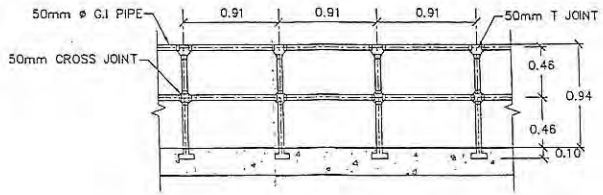
DETAIL OF BARRIER
Scale 1:25



DRAIN OUT PIPE DETAIL
SCALE: 1:25



GANGWAY SLAB DETAIL
SCALE: 1:50



DETAIL OF RAILING
FOR GANGWAY
SCALE: 1:50

CLIENT: IRRIGATION AND POWER DEPARTMENT OF BALOCHISTAN	CONSULTANTS: CAMBOS CONSULTANTS CONSULTING ENGINEERS, ARCHITECTS & PLANNERS. 27-A, STREET, NO. 28 F-10/1 ISLAMABAD. 44-A CHAMAN HOUSING SCHEME AIRPORT ROAD QUETTA.	PROJECT: SIX (6) DISPERSAL STRUCTURE ON NARI RIVER	DRAWING TITLE:- TYPICAL BRIDGE DETAILS	NOTES: ALL LEVELS AND DIMENSIONS ARE IN METERS UNLESS INDICATED OTHERWISE.	DRAWN BY: MOHSIN HASSAN / DESIGNED BY: ASADULLAH JAN CHECKED BY: KAMRAN BABAR / SCALE: AS SHOWN FILE PATH: D:\NARI DATA / DATE: DEC / 2011 FIGURE NO. 30 / SHEET:- 1 OF 01