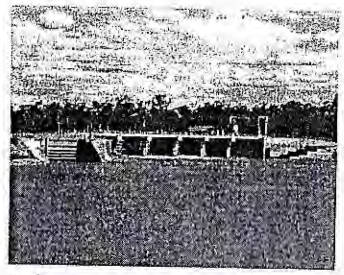
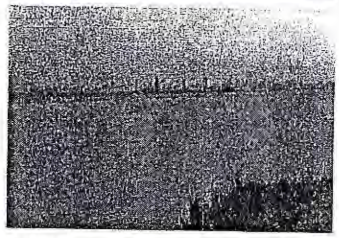
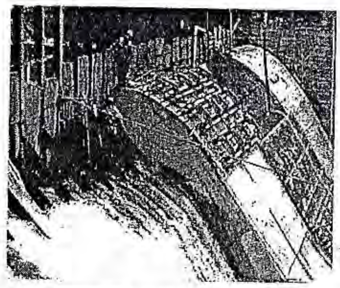
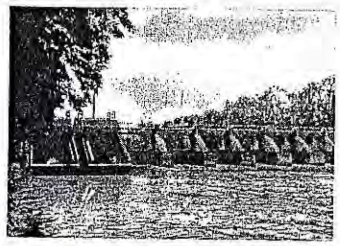
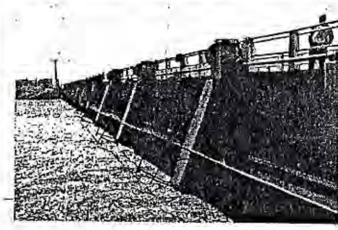
GOVERNMENT OF BALOCHISTAN
IRRIGATION DEPARTMENT

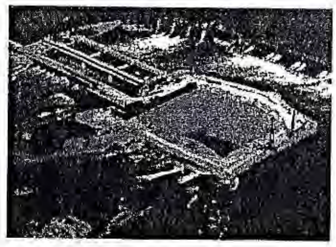












PREFEASIBILITY STUDY FOR CONSTRUCTION OF DISPERSAL STRUCTURE'S ON ZHOB RIVER

MAIN REPORT
VOLUME-I

October, 2012

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VOLUME I MAIN REPORT

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PROJECT AT A GLANCE

1. **Name of the Project:** Construction of Flood Dispersal Structures on Zhob River.

2. **Location:** The proposed sites are located across Zhob River near Muslim Bagh, Killa Saifullah, Wulgai/ Khulgai, Gowal, Shinkai and Humayun Killi with the location coordinates as follows.

S. No	Description	Location	
		Latitude	Longitude
1	Muslim Bagh Dispersal Structure	30°50'30.33"	67°55'16.37"
2	Killa Saifullah Dispersal Structure	30°45'48.80"	68°25'36.74"
3	Wulgai/ Khulgai Dispersal Structure	30°42'58.75"	68°33'30.59"
4	Gowal Dispersal Structure	30°43'12.77"	68°38'26.71"
5	Shinkai Dispersal Structure	30°45'30.48"	68°53'23.26"
6	Humayun Killi Dispersal Structure	30°56'56.28"	69°07'32.29"

Figure 1 gives the location map of the project sites.

3. **Estimated Cost** Rs. 10,340.35 Million

S.No	Description	Amount (Million Rs)
1	Muslim Bagh Dispersal Structure	1,420.99
2	Killa Saifullah Dispersal Structure	1,237.50
3	Wulgai/ Khulgai Dispersal Structure	1,456.92
4	Gowal Dispersal Structure	1,480.48
~~5~~	~~Shinkai dispersal Structure~~	~~1,681.97~~
6	Humayun Killi Dispersal Structure	1,863.02
	TOTAL	**9,140.88**
7	2% Contingencies Cost	182.82
8	3% Detailed Design, Supervision, Engineering and Administration Cost	274.23
9	6.50% Price Escalation	594.16
10	PIU Cost	84.81
11	Environmental Monitoring/ Mitigation Cost	63.46
	GRAND TOTAL	**10,340.35**

4. Project Components

Dispersal Structure		Muslim Bagh	Killa Saifullah	Wulgai / Khulgai	Gowal	Shinkai	Humayun Killi
Weir							
Type		Broad Crested	Broad Crested	Broad Crested	Broad Crested	Broad Crested	Broad Crested
Natural Surface Level (NSL), m		1677.88	1529.48	1511.83	1503.28	1482.48	1447.25
Weir Crest Level, m		1679.80	1531.30	1514.46	1506.50	1483.71	1449.30
Width of Weir, m		214	200	200	200	215	225
Legth of Stilling Basin, m		27.59	38.75	40.60	46.38	38.60	49.60
Design Discharge (Q), cumec		1666.28	3871.91	3942.51	4766.11	4980.44	5280.32
Abutment Level, m		1683.80	1537.34	1521.10	1512.60	1490.22	1456.00
Free Board, m		1.00	1.00	1.00	1.00	1.00	1.00
Sluice							
Crest Level, m		1678.30	1529.77	1513.48	1505.30	1482.20	1447.80
Width of Sluice, m		13.80	13.80	13.80	13.80	13.80	13.80
Legth of Stilling Basin, m		23.17	37.15	36.44	36.44	42.82	47.03
No. of Gates		4	4	4	4	4	4
Head Regulator							
Crest Level, m		1678.90	1530.38	1513.99	1505.90	1482.80	1448.35
Width of Sluice, m		13.80	13.80	13.80	13.80	13.80	13.80
Legth of Stilling Basin, m		23.17	20.72	21.18	21.18	21.18	21.18
No. of Gates		4	4	4	4	4	4
Discharge Capacity, cumec		56.63	56.63	70.78	70.78	70.78	70.78
Upstream River Training Works							
Type		Earthen	Earthen	Earthen	Earthen	Earthen	Earthen
Top Width, m		3.50	3.50	3.50	3.50	3.50	3.50
Side Slope		2: 1	2: 1	2: 1	2: 1	2: 1	2: 1
Length, m		586	551	3565	5530	1317	2655
Top Level, m		1683.80	1537.34	1521.10	1512.60	1490.22	1456.00
Irrigation System							
Cultivable Command Area (CCA), Ha		1,724	2,443	2,638	2,885	3,287	4,178
Main Canal							
Design Discharge, cumec		56.63	56.63	70.78	70.78	70.78	70.78
Total Length, m		6350	6200	8400	6000	11000	11500
Bottom Width, m		29.55	29.55	33.33	33.33	33.33	33.33
Bed Slope, %		0.012	0.012	0.012	0.012	0.012	0.012
Side Slopes	Internal	1: 1	1: 1	1: 1	1: 1	1: 1	1: 1
	External	2: 1	2: 1	2: 1	2: 1	2: 1	2: 1

Dispersal Structure	Muslim Bagh	Killa Saifullah	Wulgai / Khulgai	Gowal	Shinkai	Humayun Killi
Left Side Embankment						
Top Width, m	7.30	7.30	7.30	7.30	7.30	7.30
Side Slops	2: 1	2: 1	2: 1	2: 1	2: 1	2: 1
No. of Cross Regulators	4	4	5	5	5	6
Distributaries						
No. of Distributaries	4	4	5	5	5	6
Total Length, m	10415	12000	18192	14789	15220	16027
No. of Fall Structures	32	11	11	8	8	23
Cross Drainage Works (Culverts)						
Total Number	13	3	2	2	6	2
Storage Tanks						
Total No. of Tanks	2	2	2	1	1	1
Bottom Length, m	700	700	700	700	700	700
Bottom Width, m	500	500	500	500	500	500
Top Width, m	7	7	7	7	7	7
Intake Tower	1	2	2	2	2	2
Type	Vertical Circular	Vertical Circular	Vertical Circular	Vertical Circular	Vertical Circular	Vertical Circular
Diameter / Size (D), m	3.00	3.00	3.00	3.00	3.00	3.00
Size of Conduit / Pipe (D), m	0.45	0.45	0.45	0.45	0.45	0.45
Maximum Capacity (MCM)	1.48	1.48	1.48	1.48	1.48	1.48

5. Project Benefits

Total Water Available	10,826 Ha-m (87,729 Acre ft)
Area to Benefit	17,154 Hectares (42,371 Acres)
EIRR	14.87%

SECTION 1
INTRODUCTION

1.1 BACKGROUND AND STUDY RATIONALE

As a result of frequent droughts, Balochistan is facing acute shortage of drinking and irrigation water. Groundwater resources are quite limited and depleting at a faster rate due to over pumping.

Water availability is decreasing with time due to climatic changes (causing low precipitation) and enhanced demand for ever increasing population and agriculture. The entire focus has been on the development of the resources and no consideration has been given to the management of the available resources which has resulted in the lowering of water table and mining of groundwater in the mostly northern river basins. The groundwater development and/or demand in the southern basins, however, have not increased as much to exert stresses on the available resources and therefore the situation is not very critical. Yet there is an urgent need of management of this scarce resource on the basis of experiences gained from the over-drawn northern basins.

It is pertinent to mention here that the Governments of Pakistan and Balochistan are jointly providing subsidy of around Rs. 7 billion (for the year 2004-05) to the electric tube well owners, numbering around 7000 in the Province. This is based on the actual number of tube wells in operation and assuming that, on an average, a farmer owns two tube wells. The Project Preparation Technical Assistance studies for the Balochistan Resource Management Programme revealed that there are farmers who even own over 12 tube wells, whereas large proportion of farmers own two or more tube wells. It is important to mention that the electric tube well owners represent around 3% of the total farms of Balochistan (around 243,000 farms) – a fractional segment of the total farming community. This has also contributed to the mining of groundwater resources.

Interventions to improve recharge of groundwater have been implemented in the province during the last few decades, including construction of delay action dams and watershed management. The impacts of such interventions are varied in terms of improving the recharge due to technical, social and political constraints. As a result there has been criticism from various quarters/ circles on the effectiveness of recharge interventions in fulfilling the desired objectives. Unfortunately the basic flaw in these projects is the limited coverage and that the development interventions were mostly isolated with no consideration for planning and management at river basin level. Balochistan covers about half of the country's area and development initiatives need tremendous financial resources to have sizable development.

The analysis of water demand and supply has, therefore, become crucial for future planning and management of water resources (surface and groundwater). Integrated Water Resources Management (IWRM) is gaining priority at the policy levels, which requires data regarding availability and use of water resources in the province to initiate useful planning process in the context of IWRM framework.

Currently, the surface water resources of the province constitute 96% of the total water resources available per annum, whereas the rest 4% is available from groundwater resources. The major part of the fresh groundwater resources has already been exploited; therefore, the potential for future development lies in the development of the available surface water resources, mainly flood water.

There is, therefore, an emergent need for the planning, development and management of surface water resources which offers great potential.

1.2 PROJECT AREA

The Zhob River Basin (ZRB) lies between latitudes 30^0 30' and 32^0 10'N and longitudes $67^0$29' and $69^0$45'E in the North Eastern part of Balochistan covering districts of Muslim Bagh, Killa Saifullah and Zhob. The proposed dispersal structures are located along the Zhob River at different feasible locations.

The Zhob River is the principal stream of the basin and flows west to east in the beginning and then curves to north in the remaining stretch. Some of the larger streams are perennial in short stretches. These include the Faqirzai Rud in the Murgha Faqirzai sub-basin, the Kano River in the Muslim Bagh sub-basin and the Sawar Rud and Toiwar (Kandil) Rud in the Qila Saifullah sub-basin.

The Zhob River itself is perennial in two stretches, from just north of Qila Saifullah (Qila Taimur) for approximately 54 km eastward, and from the confluence of the Kandil Rud for 72 km eastward, through the Qila Saifullah sub-basin outlet and to the basin outlet north east of Zhob.

Although the surface water from precipitation and the runoff is quite sufficient in the basin, especially in north east and north west part of the basin that meets the needs of a successful Sailaba farming for the most part, yet most areas of the Zhob River Basin(ZRB) are classified as the range lands.

The ZRB is one of the major river basins of the Balochistan province with the mean annual rainfall of 210 mm. There is a great potential for the development and management of surface water through the construction of suitable structures for the development and management of the resource.

The Government of Balochistan is quite conscious of the situation and has embarked on the study for the formulation of the project for the development and management of surface water resources of Zhob river basin. The project will go a long way in the agriculture development and socio economic uplift of the population of the basin.

~~The proposed flood dispersal sites are located on Nari River at the following locations.~~

i. Muslim Bagh Dispersal Structure is proposed to be located about 18 kms East of Muslim Bagh Town having coordinates of N 30° 50' 30.33" and E 67° 55' 16.37".

ii. Killa Saifullah Dispersal Structure is proposed to be located about 18 kms North East of Killa Saifullah Town having coordinates of N 30° 45' 48.88" and E 68° 25' 36.74".

iii. Wulgai/ Khulgai Dispersal Structure is proposed to be located about 28 kms North East of Killa Saifullah Town having coordinates of N 30° 42' 58.75" and E 68° 33' 30.59".

iv. Gowal Dispersal Structure is proposed to be located about 34 kms North East of Killa Saifullah Town having coordinates of N 30° 43' 12.77" and E 68° 38' 26.71".

v. Shinkai Dispersal Structure is proposed to be located about 58 kms East of Killa Saifullah Town having coordinates of N 30° 45' 30.48" and E 68° 53' 23.26".

vi. Hamayun Dispersal Structure is proposed to be located about 91 kms North East of Killa Saifullah Town having coordinates of N 30° 56' 56.28" and E 69° 07' 32.29".

Figure 1 gives the location map of the Project sites.

1.3 OBJECTIVES AND PURPOSE OF THE STUDY

The objective is to carry-out a pre-feasibility level study for the construction of 6 dispersal structures across Zhob River at different feasible locations and to assess the availability of water at the proposed structure sites through comprehensive water balance studies.

These structures are located on extremely potential sites and optimized under technical, social and environmental constraints and will go a long way in sufficing the irrigation and drinking water requirements of the area through conservation of flood flows.

1.4 TOR AND SCOPE OF THE STUDY

The different components of the Prefeasibility Study are summarized as follows.

- Engineering Surveys and Investigations;
- Layout optimization;
- Hydrological and hydraulic studies to estimate the yield and design of different components like weir/spillways, stilling basins, sluicing arrangements and headworks;
- Identification of command area and design of conveyance system;
- Socio economic and environmental studies;
- Pre-feasibility level design and cost estimates;
- Preparation of Pre feasibility Study Reports and PC-I.

SECTION 2
SOCIO ECONOMICS STUDIES

2.1 DATA COLLECTION METHODOLOGY

The data regarding the sociological studies for the Project area was collected through field observations, questionnaire survey regarding wealth indicators, historical profiles, village amenities, land and water rights and tenancy arrangements. Different PRA tools such as group discussion, ranking, walkover survey and semi structured interviews were carried out for the collection of the required data.

The assessment methodology of the socio-economic profile relied exclusively on focused group discussions (FGD)/ meetings and direct observation. Therefore, statistical data provided is based on estimates of the communities who participated in the group discussions/ meetings, who were consistently prompted to make estimates as accurate as possible. The selection of FGD participants aimed at representation of the relevant socio-economic strata, castes, lineage groups and targeted villages to benefit from the project development. Prior to the conduction of FGD, the community was briefed about the purpose of the team visit. The meetings were represented by all groups of stakeholders.

The studies incorporate existing socio-economic conditions of target groups. The main theme includes a description of the project population, indigenous groups or minorities, their key problems and development priorities, dimensions of land and water use. Individual interviews with key informants on specific topics, to gain in-depth insights and confidence, were also carried out.

Community consultation meeting at Killa Saifullah dispersal structure

Stakeholder consultations were done to get their perception and seek their views and subsequently to incorporate their feedback. The key stakeholders with whom consultation and FGD were held also included Irrigation Department officials, community members including big and small farmers, sharecroppers, and tenants.

2.2 POPULATION AND COMMUNITY STRUCTURE

The beneficiaries are settled on right and left banks of the Zhob River and the mode of settlement is in the form of set of clusters and scattered households. Houses are mainly constructed of impermanent materials, typically mud or sub-baked bricks fused with baked mud strengthened with chopped straw. These materials make poorer households susceptible to invasion of vermin and need reconstruction/ repair after each rainy season. The boundary walls of the houses are usually made of bushes. The language spoken is Pashto and a small number of the people could speak and understand Urdu also.

As mentioned the beneficiaries are settled downstream of the proposed sites on the banks of Zhob River in districts Killa Saifullah. The beneficiaries belong to Pashtun tribe. The project area comprises of 39 villages. The names of villages with population are summarized in the following table.

Table 2.1 Population and Community Structure

S. No	Name of Weir	Village Name	House holds	Population
1	Muslim Bagh Dispersal Structure	Shana Khara	150	2150
2	Killa Saifullah Dispersal Structure	Khusa killi	150	2100
		Zeraki	100	1400
		Wachalora	50	700
		Killi Torkha Doulatzai	60	840
		Spinki shah	50	700
		Sur Tangi	50	700
		Ghuzlona	60	840
		Braz	25	350
		Ghabzai	30	420
3	Wulgai/Khulgai Dispersal Structure	Molvi Ghulam Mohd	200	2400
		Ali Khail	300	3600
		Ali Tarzai	200	2400
4	Gowal Dispersal Structure	Surnar	60	720
		Dohara	15	220
		Dargha Killi	20	320
		Babokarzai	15	300
		China Killi	10	210
		Killi Srakandian	30	450
		Shanabaha	80	960
		Sur Shinki	180	2000
		Hamya Killi	60	700
5	Shinkai Dispersal Structure	Nali Pie	500	6000
		Nalimian	20	242
		Landi Shah	34	408
		Spinki Shah	18	216
		Gurach	21	252
		Zara shah	14	168
		Kandil Killi	20	240
6	Humayun Killi Dispersal Structure	Kazhbon	20	300
		Tora Shah	17	170
		Shakhan	30	400
		Abdul Razique Kazha	9	164
		Ragha Killi	9	220
		Pavar Killi	100	900
	Total		**3,057**	**39,060**

As can be seen an estimated 3,057 households are settled in the command area having a total population of about 39,060 souls. Reportedly the communities are settled in the area for a long time. The average family size is about 12.78 persons per household.

2.3 SOCIO ECONOMIC STATUS

The rain fed and flood based agriculture, though unsustainable, is the main source of income for the majority of the farmers.

The other major sources of income for the communities are government jobs, small businesses, transport, skilled/ unskilled labor and livestock.

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 villages having more population have shops mostly of goods for domestic use only.

2.4 LIVESTOCK IN THE AREA

The livestock rearing is common in the project area and is their primary source of income. The livestock potency and pattern is summarized in the table below.

Table 2.2 Livestock Pattern and Potency at Household (HH) level in Project Area

S. No	Description	Average Per Household
1	Horse	0
2	Donkey	3.9
3	Goat / Sheep	114.49
4	Cows	28.13
5	Buffalos	0

2.5 LAND & WATER RIGHTS

The land and flood water are owned by the tribes. The land is distributed among the beneficiaries. The settlement or the cadastral record is registered at tehsil and district levels with Revenue Department and is available for analysis. Water and land share selling is uncommon in the area. The units under which the farmers measure their land are *Jareeb* and *block*. Two *Jareebs* are equal to one acre and four *Jareebs* make a *block*.

The exact size of the command area could not be ascertain which requires obtaining cadastral record from the Revenue Department and further requirement to update on individual land titles, which is highly time consuming process. The record updating by the department is not properly undertaken after the establishment of settlement record.

The farmers have no time bound water distribution system on Zhob river floods as they are practicing rain harvesting by boundary irrigation methods and flood irrigation practices in which the flash floods overtop the river banks and as a result irrigate the adjacent land.

Lower riparian issues are not foreseen as a result of the construction of the dispersal structures. The communities residing on the banks of the river expect to irrigation their agriculture land on sustainable basis after the Project implementation.

2.6 EXISTING MAINTENANCE ARRANGEMENTS

Presently the maintenance of *kacha* channel is the collective responsibility of beneficiaries, whereas the field maintenance is the sole responsibility of land owner or tenant.

2.7 EXISTING WATER RESOURCES IN THE AREA

As mentioned rains and floods are the major sources of irrigation. Intermittently the flood water of the Zhob River overtops the banks which is diverted by farmers to irrigate their lands. The overtopped flood water is the cheapest source for irrigating their *Khushkaba* land.

The communities have also installed about 6 tubewells in the command area mainly for drinking purposes. However, irrigation from this source was only done marginally due to the low discharge of these wells. In addition since these tubewells are operated by diesel operated engines the operation and maintenance cost is also very high.

Table 2.3 Existing Situation of Ground Water & Number of Tube wells in the Area

Average Depth of borehole (m)	Discharge pipe in mm	Quality of water	No. of Tube wells
122	150	Sweet	6

2.8 WATER DISTRIBUTION MECHANISM AFTER SCHEME COMPLETION

There is no existing flood water distribution system in the area. The communities are of the view that the water distribution mechanism would be devised by the farmer committee headed by their tribal chief.

According to survey, the beneficiaries assured that water distribution would not be an issue. According to them the water distribution could be time based depending upon the size of landholding from head to tail of the command area. The survey team also met with chief tribesman and he was also of the same opinion.

2.9 VILLAGE AMENITIES

2.9.1 Educational Facilities

District Killa Saifullah has a better literacy rate compared to other districts of Balochistan. District headquarter has a college, high, middle and primary schools providing quality education in the district and suburbs/ villages. Almost every child has equal educational opportunity which is a positive sign. According to the survey, in the villages there are thirty one primary schools for boys and three for girls, three middle schools for boys and two for girls, and two high schools only for boys (Hamayun Killi and Khulgai Ali Khel Killi). Sending the children to Madrassas for religious education is also common. The following table gives the details of the educational facilities in the Project areas.

Table 2.4 Educational Facilities in the project area

S. No	Name of Scheme	Primary		Middle		High		College	
		Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1	Muslim Bagh	3	1	1	1	-	-	-	-
2	Killa Saifullah:	7	-	-	-	-	-	-	-
3	Wulgai/Khulgai	2	-	-	-	1	-	-	-
4	Gowal	7	1	1	-	-	-	-	-
5	Shinkai	5			-	-	-	-	-
6	Humayun Killi	7	1	1	1	1	-	-	-
	Total	**31**	**3**	**3**	**2**	**2**	-	-	-

2.9.2 Communication and Transportation Facilities

All surveyed villages are well connected with the main roads through secondary and tertiary road network, developed in the last 8 to 12 years. Private transport system exists in the area. Mobile networks have full spatial coverage. People travel to nearest city by bus and pick-ups. Transport to main city is also mostly available in the areas. The inter village communication is mostly done by motor cycles.

2.9.3 Electricity

There is no electricity in the project area except some large villages. It is not common to install tubewells and dugwells in the whole project area due to high cost of installation and subsequent operation and maintenance.

2.9.4 Housing Structure

Houses are mainly constructed of bricks fused with baked mud and strengthened with chopped straw. These materials make poor households susceptible to invasion of vermin and are also seasonally unstable, needing reconstruction after each rainy season. The rural areas are comparatively backward.

2.10 HUMAN AND ECONOMIC RESOURCES

Skilled labour is not available in the area, whereas the unskilled labour on daily wages is abundant. There is need of vocational training centers to train skilled labour on need basis in the area.

2.11 SITUATION ANALYSIS OF WOMEN

The study was conducted by random sampling, covering 25% of the households in the Project area. The condition of women with respect to health, hygiene, education, water supply and sanitation facilities is very poor. Literacy rate is low in women due to strict tribal system. Women are mostly ignored in decision making.

2.12 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 usually responsible for preparation of food, looking after the children, washing clothes, taking care of livestock and fetching drinking water from the nearest reservoirs. 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.

2.13 PERCEPTION & WILLINGNESS OF THE COMMUNITY

There is no ongoing major conflict/ dispute among the villages and within the village and no court cases on land and water distribution. There are therefore no barriers to project development process.

Community is fully willing and supportive for the construction of the dispersal structures. Community members and tribal elders ensured that they would provide their land for storage tanks and conveyance system free of cost and that the affectees would be compensated by all tribes.

During the Socio Economic assessment survey the objectives of scheme were discussed in detail with the beneficiaries and their feedback was sought/ obtained. The problems and the benefits perceived by the beneficiaries after the construction of project interventions include:

- Mostly the flood flow is abundant but the farmers are financially unable to divert it through conventional methods. By the construction of dispersal structures the flood flows will be sustainably diverted for irrigating their lands which will considerably improve the socio economic conditions of the population of the area.
- Flood flow is available for a very short time and might not occur at its usual time or according to its familiar routine. Therefore, by the provision of storage through off shore storage tanks would induce reliability of water availability. The stored water could be used throughout the year both in Kharif and Rabi seasons as and when required.
- There would be expansion in command area, increased crop yield and improved cropping pattern;
- There would be reduction in crop failure (mostly happening due to unavailability of water during critical stages of crops);
- There would be improvement in the socio-economic conditions of the population of the area;
- Water would be available for human beings and livestock;
- The groundwater would be recharged.

SECTION 3
HYDROLOGY / WATER AVAILABILITY

3.1 GENERAL

The hydrological studies are intended to estimate the different hydrological parameters of the sub-projects. These studies form basis for estimation of water availability and the hydraulic design of weir, conveyance system and other appurtenant structures. The watershed characteristics of the 6 Sub- Basins are as follows.

Table 3.1 Characteristics of Sub Basin

S. No	Name of Dam	Catchment Area (Sq Km)	Length of Longest Stream (m)	Height Difference "H" (m)	Slope (m/m)
1	Sub Basin 1	1,249.50	50,002	1,329.00	0.0266
2	Sub Basin 2	2,761.00	120,136	1,090.00	0.0091
3	Sub Basin 3	246.00	33,136	474.00	0.0143
4	Sub Basin 4	402.00	44,748	1,077.00	0.0241
5	Sub Basin 5	1,054.00	56,456	451.00	0.0080
6	Sub Basin 6	3,416.00	150,604	1,329.00	0.0088
	TOTAL	9,128.50	455,082	958.33	0.0151

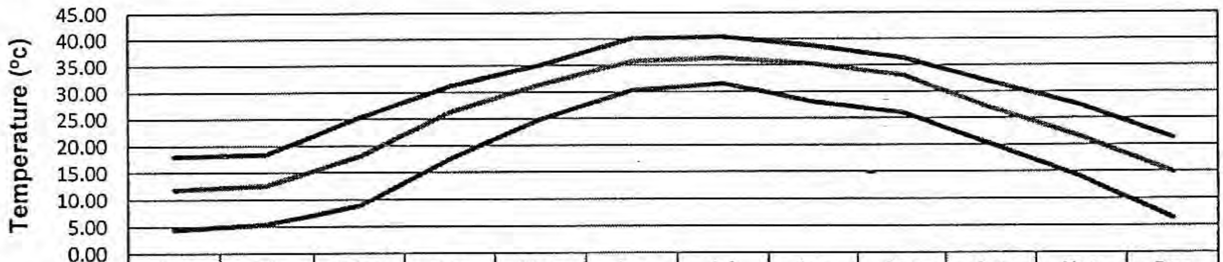
Figure 2 gives the catchment area of the sub basins.

3.2 CLIMATE

The climate of the Zhob basin, generally elevated at 1,500-2,200 meters above sea level, is semi-arid (steppe) *kalt* (cold) – BSk.[1] It can be placed in "warm summer and cool winter" temperature region. The summer is warm with mean temperatures ranging from 21°C to 32°C. June is the hottest month when mean maximum temperatures exceed 32°C but do not rise above 38°C, however, the mean temperature, even in the hottest month, remains below 32°C. The winter is cool and longer than summer. It lasts for about 7 months (October-April). In winter the mean temperature is below 10°C and in the coolest month (January) the mean monthly temperature drops below 10°C. Frost is common and the low temperature is caused by high elevation. Kan Mehterzai is at a height of 2,170 meters above sea level and remains snow-clad in January and February when mercury remains below freezing point during the cold spells. Nights are chilly in Killa Saifullah district and cold katabatic winds can confine the inhabitants to their homes.

[1] Fazale Karim Khan, *A Geography of Pakistan: Environment, People, and Economy* (Karachi: Oxford University Press, 1993), p. 42.

TEMPERATURES RECORDED AT MUSLIM BAGH °C



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	4.41	5.39	8.81	17.48	24.82	30.36	31.54	28.12	26.03	20.16	14.02	6.41
Max	18.01	18.40	25.25	31.16	35.04	40.09	40.35	38.66	36.34	31.88	27.41	21.27
Ave	11.84	12.61	18.00	26.24	31.37	35.78	36.32	35.26	33.08	26.93	21.53	14.91

Source: Pakistan Meteorological Department, Karachi

The mean annual rainfall ranges between 125 and 500 mm, most of which comes in winter from the western depressions.[2] A considerable part of winter precipitation comes as snowfall. The area is characterized as semi-arid with rainfall less than potential evapo-transpiration. According to the Pakistan Meteorological Department, the total annual precipitation in 1995 was 279.1 mm at Zhob. By the extent of vegetation in Killa Saifullah it can be assumed that the level of precipitation here is more than that in Zhob.

3.2.1 Rainfall

There are seven gauging stations for which daily rainfall data is available namely Muslim Bagh, Killa Saifullah, Loralai, Murgha Kibzai, Sharan Jogezai, Bundat Jungle and Sanzala. The daily rainfall data for the gauging stations has been procured from Water Resources Planning, Development and Monitoring Directorate (WRPDMD) of Irrigation Department, Government of Balochistan.

Table 3.2 Rainfall Data in mm

S. No	Month	Gauge Station Rainfall in mm						
		Loralai	Sanzal	Sharan Jogezai	Bandat Jungle	Murga Kibzai	Killa Saifullah	Muslim Bagh
1	January	19.54	56.59	15.90	42.67	40.49	12.45	35.47
2	February	22.11	54.85	14.71	46.73	28.18	24.39	32.03
3	March	29.16	47.18	30.09	52.07	60.52	37.41	33.99
4	April	22.22	28.03	13.63	15.07	58.19	18.02	14.74
5	May	14.43	1.93	10.61	4.40	18.89	18.49	8.67
6	June	8.74	0.38	8.19	1.78	33.48	5.50	2.83
7	July	39.86	1.98	21.06	20.07	183.33	28.47	15.11
8	August	30.99	0.71	15.94	16.26	52.80	18.40	9.47
9	September	3.73	0.00	4.45	1.35	18.59	4.26	1.46
10	October	2.47	1.55	4.22	0.76	2.80	2.99	1.37
11	November	4.40	7.34	3.03	4.83	2.88	3.74	2.87

[2] Government of Pakistan, *Atlas of Pakistan* (Rawalpindi: Survey of Pakistan, GoP, 1990), p. 55.

S. No	Month	Gauge Station Rainfall in mm						
		Loralai	Sanzal	Sharan Jogezai	Bandat Jungle	Murga Kibzai	Killa Saifullah	Muslim Bagh
12	December	12.50	32.60	9.02	19.02	7.41	7.70	19.56
	TOTAL	**210.14**	**233.12**	**150.87**	**225.00**	**507.57**	**181.82**	**177.57**

Thiessen Polygons have been drawn with respect to the seven gauging stations to determine the aerial coverage of the stations and subsequently to estimate the aerial rainfall of the catchments. Based on it the monthly average rainfall data for the different sub catchments is given as follows.

Table 3.3 Rainfall Data for different sub catchments

S. No	Month	Dispersal Structures					
		Muslim Bagh	Killa Saifullah	Wulgai/ Khulgai	Gowal	Shinkai	Humayun Killi
1	Jan	35.47	37.24	32.81	29.43	29.43	31.27
2	Feb	32.03	41.99	37.02	32.56	32.56	31.83
3	Mar	33.99	45.55	41.45	39.18	39.18	42.74
4	Apr	14.74	20.37	20.83	19.39	19.39	25.86
5	May	8.67	8.28	9.81	9.97	9.97	11.46
6	Jun	2.83	2.55	4.10	4.92	4.92	9.68
7	Jul	15.11	16.84	22.59	22.29	22.29	49.13
8	Aug	9.47	11.79	16.59	16.46	16.46	22.51
9	Sep	1.46	1.87	2.33	2.76	2.76	5.40
10	Oct	1.37	1.77	1.94	2.40	2.40	2.47
11	Nov	2.87	5.30	5.08	4.67	4.67	4.37
12	Dec	19.56	19.77	17.95	16.17	16.17	14.71
	TOTAL	**177.57**	**213.31**	**212.52**	**200.19**	**200.19**	**251.42**

Figure 5 gives the location map of the rain gauge stations and Thiessen Polygon.

3.2.2 Evaporation

There are only two climatological stations viz. Badenzai and Muslim Bagh for which limited climatological data exist. The following table gives the evaporation and other meteorological data for the two stations.

Table 3.4 Meteorological Parameters

Station	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Badenzai	Evaporation (mm)	84	108	183	241	310	371	375	362	313	250	168	110
Muslim Bagh	Mean Relative Humidity (%)	64.5	59	52.5	48	45.5	44.5	49	46.5	43	43.5	46	52.5
	Mean Daily Temperature °C	5.8	8.4	13.6	19.1	23.8	27.7	30	28.9	25.3	19.1	13.5	8.6
	Mean Wind Speed (m/s)	2.7	3	3.4	3	3.3	3	2.8	2.7	2.7	3.1	3	3

3.3 WATER AVAILABILITY

3.3.1 General

The available surface water for the Project has been assessed on the basis of data of 2 stream gauging stations, namely Sherik and Badenzai weirs, compiled by the WRPDMD. It is pertinent to mention here that under Supporting Public Resource Management (SPRM) Project, sponsored by Asian Development Bank (ADB) comprehensive studies were carried out for the assessment of surface water resources of 18 basins of Balochistan including the Zhob River Basin (ZRB) using the daily discharge data of the two gauging stations.

Similarly to improve the daily time resolution to hours the volume of the water available at the sites has also been estimated from daily weighted aerial rainfall data of the catchment using the data of rain gauging stations mentioned in Section 3.2.1 and SCS rainfall-runoff relationship. The SCS model has been used to establish the rainfall runoff relationship. It takes into account various factors affecting runoff from watersheds like type of soil, soil cover and antecedent moisture contents etc. The method divides soil into four hydrological soil groups A, B, C and D corresponding to low, moderate, high and very high runoff generation rates respectively. Similarly vegetal cover has been classified into various categories like cultivated land, rangeland, meadow, wooded forest etc. Antecedent moisture conditions (AMC) are classified as AMC I, II and III. This classification depends upon 5 day antecedent rainfall prior to the day for which runoff is being considered. The formula for computation of rainfall is given as follows:

$$P_s = \frac{(P - 0.2S)^2}{P + 0.8S}$$

Where,

P_s = Runoff (in)
P = Total precipitation (in)
S = Potential maximum retention (in)

The land-use of the catchment area of the sub basins is mainly categorized as pasture or rangeland with Group B and C soil types. Group C soils have considerably slow infiltration rates when thoroughly wetted. They comprise of shallow soils over impervious material. Similarly Group B soils have a moderate infiltration rate when thoroughly wetted. They chiefly are moderately deep to deep, moderately drained to well drained soils that have moderately fine to moderately coarse textures with moderate rate of water transmission. Antecedent moisture conditions AMC I, II and III have been used for the synthesis of the long term operation studies. The Curve Numbers have also been adjusted for slope. The sub basin wise curve number details are as follows.

Table 3.5 Curve Number detail of Sub-Basin

S. No	Description	Curve No.
1	Sub Basin 1	83.48
2	Sub Basin 2	84.58
3	Sub Basin 3	82.33
4	Sub Basin 4	83.30
5	Sub Basin 5	83.66
6	Sub Basin 6	84.24

3.3.2 Water Availability Based on Stream flow Data

Under the SPRM studies the rate of average and wet years water availability has been estimated as 0.0163 MCM/ Sq kms and 0.0335 MCM/ Sq kms (34 Ac-ft/ Sq miles and 70 Ac-ft/

Sq miles) respectively. Based on it the water availability for each dispersal structure has been assessed as follows.

Table 3.6 Water Availability

S. No	Description	Catchment Area (Sq km)	Water Availability			
			Wet Year		Average Year	
			MCM	Acre ft	MCM	Acre ft
1	Muslim Bagh Dispersal Structure	1249.50	41.86	33934.39	20.37	16511.36
2	Killa Saifullah Dispersal Structure	4010.50	134.35	108918.68	65.37	52996.25
3	Wulgai/ Khulgai Dispersal Structure	4256.50	142.59	115599.64	69.38	56246.99
4	Gowal Dispersal Structure	4658.50	156.06	126517.31	75.93	61559.17
5	Shinkai dispersal Structure	5712.50	191.37	155142.24	93.11	75487.12
6	Humayun Killi Dispersal Structure	9128.50	305.80	247915.26	148.79	120627.43

3.3.3 Water Availability Based on Rainfall Data

Detailed analysis of the available daily rainfall data of the seven rainfall gauging stations was made to assess the daily frequency of the different intensity rainfalls. The analysis yielded the following result.

Table 3.7 Water Availability Analysis

Rainfall Intensity (in) Classes	0.4-0.5	0.5-1.0	1.0-2.5
Average Annual Frequency of Occurrence	8.06	3.62	2.2

The SCS Triangular Unit Hydrograph technique has been employed for the estimation of the hourly flood hydrograph at the structures for the above classes of rainfall.

The 24 hours time distribution of rainfall recommended by Wirasatullah Khan for Balochistan has been used. The relationship is given as follows.

$$P_t = (t / 24)^{0.2} \times P_{Ta\text{-}24}$$

Where,

t = time in hours;

$P_{Ta\text{-}24}$ = total 24 Hour design rainfall.

Based on the analysis the annual water availability has been assessed as follows.

Table 3.8 Available Water

S. No	Name of Structure	Available Water	
		MCM	Acre ft
1	Muslim Bagh Dispersal Structure	16.26	13,180
2	Killa Saifullah Dispersal Structure	62.18	50,410
3	Wulgai/ Khulgai Dispersal Structure	63.85	51,764
4	Gowal Dispersal Structure	68.28	55,352
5	Shinkai Dispersal Structure	81.42	66,008
6	Humayun Killi Dispersal Structure	129.88	105,293

Based on the headwork and canal capacity the entire flow could not be diverted to the command area.

3.4 WATER DEMAND AND BALANCE

The monthly irrigation water requirements (IWR) for the crops included in the proposed cropping pattern have been derived by applying the Crop Coefficients K_c for the different growth stages to the peak daily evapo-transpiration ET_o and adjusted to take into account the effective rainfall.

The crop coefficients are based on the values quoted in FAO Publications 24 and 33 modified to reflect mid season and staggered planting and harvesting.

The cropping pattern has been determined in the light of available water, crop water requirements and diversion capacity.

Based on above the crop water requirements of the dispersal structures is as follows.

Table 3.9 Crop Water Requirements

S. No	Name of Structure	Command Area (Ha)	Water Demand	
			MCM	Acre ft
1	Muslim Bagh Dispersal Structure	1,724.29	10.65	8633
2	Killa Saifullah Dispersal Structure	2,442.51	16.40	13299
3	Wulgai/ Khulgai Dispersal Structure	2,638.46	17.14	13899
4	Gowal Dispersal Structure	2,884.62	18.01	14600
5	Shinkai Dispersal Structure	3,286.64	19.12	15502
6	Humayun Killi Dispersal Structure	4,177.73	26.88	21795

Based on the water availability and demand the results of the water balance studies have been reproduced as follows.

Table 3.10 Water Balance

S. No	Name of Structure	Water Available		Water Demand		Balance	
		MCM	Acre ft	MCM	Acre ft	MCM	Acre ft
1	Muslim Bagh Dispersal Structure	16.26	13,180	10.65	8633	5.61	4,547
2	Killa Saifullah Dispersal Structure	62.18	50,410	16.40	13299	35.13	28,477
3	Wulgai/ Khulgai Dispersal Structure	63.85	51,764	17.14	13899	19.65	15,931
4	Gowal Dispersal Structure	68.28	55,352	18.01	14600	6.07	4,919
5	Shinkai Dispersal Structure	81.42	66,008	19.12	15502	0.09	75
6	Humayun Killi Dispersal Structure	129.88	105,293	26.88	21795	21.67	17,565

3.5 FLOOD STUDIES FOR DESIGN OF SPILLWAY

3.5.1 Design Flood

The weir has been designed to withstand a flood with a return period of 100 years. The river training works have been designed for a 1 in 50 year flood event.

a. **Rainfall Frequencies**

SMADA 6.0 software has been used to carry out the detailed rainfall frequency studies and the maximum one day data of Muslim Bagh, Killa Saifullah, Sharan Jogezai, Loralai, Sanzala and Murgha Kibzai has been fitted to the different distribution systems 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.

The rainfalls (in mm) of different return periods are given as follows:

Table 3.11 Rainfall Frequencies

S. No	Description	Rainfall in mm for Different Return Periods (Years)					
		2	3	10	50	100	200
1	Sub Basin 1	33	50	61	86	96	106
2	Sub Basin 2	37	53	64	91	102	110
3	Sub Basin 3	32	49	59	84	95	107
4	Sub Basin 4	31	47	58	82	92	109
5	Sub Basin 5	33	51	62	85	96	111
6	Sub Basin 6	36	53	63	79	93	104

3.5.2 Flood Studies

The section discusses in detail the approach adopted for estimation of the rainfall runoff relationship, generation of flood hydrograph and routing the same through the dispersal structures.

a. **Estimation of Flood Peak / Flood Hydrograph**

Keeping in view the size of the catchment SCS Triangular Unit Hydrograph technique has been employed for the estimation of the design flood. The different parameters estimated for the purpose are discussed in the following sections.

HEC HMS model was used to determine the inflow and outflow hydrographs.

b. **Time of Concentration**

The catchment area was marked on 1:50,000 scale toposheets. Similarly 90 m resolution DEM was used to find the catchment limits and stream pattern. The catchment DEM was super imposed on the scanned SOP sheets and the catchment area and other design parameters computed from the two were found to be in close conformity. The time of concentration (T_c) has been calculated from Kirpich's formula as given below:

$$T_c = \left[\frac{11.9L^3}{H}\right]^{0.385}$$

Where,
L = Length of the longest stream in km / miles and
H = Difference in altitude of the stream at start and point of interest in meters / feet.

c. Time Distribution of excess rainfall

The 24 hours time distribution of rainfall recommended by Wirasatullah Khan for Balochistan has been used. The relationship is given as follows.

$$P_t = (t / 24)^{0.2} \times P_{T\,a\text{-}24}$$

Where,

t = time in hours;

$P_{T\,a\text{-}24}$ = total 24 Hour design rainfall.

d. Inflow Hydrographs

As mentioned the SCS Unit Hydrograph technique has been used for the estimation of flood peak, time to peak etc using the information derived in the preceding sections.

Hydrologic Modelling System (HEC-HMS) software prepared by US Army Corps of Engineers (HEC) has been used for the simulation of rainfall runoff / inflow flood hydrographs. Similarly detailed reservoir routing has been carried out with the help of the same models using the Modified Puls method.The peak inflow floods of different return periods at the dispersal structures are calculated and summarized as follows.

Table 3.12 The peak inflow floods of different return periods

S. No	Name of dispersal Structure	Catchment Area (Sq km)	Discharge in Cumec at Different Return Periods					
			2	3	10	50	100	200
1	Muslim Bagh	1,249	165	471	728	1,413	1,732	2,053
2	Killa Saifullah	4,010	376	1,043	1,473	2,618	3,127	3,556
3	Wulgai/ Khulgai	4,256	393	1,079	1,531	2,734	3,273	3,741
4	Gowal	4,658	416	1,144	1,636	2,944	3,543	4,107
5	Shinkai	5,712	503	1,408	2,048	3,743	4,523	5,386
6	Humayun Killi	9,128	831	2,117	2,990	5,009	6,178	7,226

Similar hydrological studies were carried out for the cross drainage works along the conveyance system. The details are as follows.

Table 3.13 Hydrological Studies Results

Weir	Culvert No.	RD (m)	Catchment Area (km^2)	Stream Length (m)	Height Differnce (m)	Discharge (cumec)	
						50 Year	100 Year
Muslim Bagh	1	0+536	0.28	515	26.22	5.20	7.60
	2	1+898	0.76	1807	35.2	4.90	7.40
	3	2+000	0.763	515	47.69	9.50	11.00
	4	2+397	1.955	1807	41.23	4.30	5.60
	5	3+081	1.44	3192	42.59	4.30	5.30
	6	3+654	0.148	2894	45.61	2.10	3.30
	7	4+388	0.982	145	25	2.30	3.50
	8	4+554	0.255	1649	35.2	1.30	2.46
	9	5+046	0.604	527	41.23	1.90	3.92
	10	5+400	0.196	1170	15.3	0.99	2.00

Weir	Culvert No.	RD (m)	Catchment Area (km^2)	Stream Length (m)	Height Differnce (m)	Discharge (cumec)	
						50 Year	100 Year
	11	5+750	7.692	7320	156.23	8.30	11.24
	12	6+000	7.692	7320	156.23	9.20	13.66
	13	0+945*	7.692	7320	156.23	11.65	15.50
Killa Saifullah	1	3+394	0.97	2174	9.8	1.61	2.12
	2	4+825	4.13	3530	26.2	6.37	8.30
	3	6+120	3.78	2349	120.3	7.47	9.85
Wulgai/ Khulgai	1	1+022	9.4	4379	142.60	12.17	15.71
	2	5+295	11.4	5702	352.20	13.93	17.92
Gowal	1	2+180	27	10887	82.3	24.43	30.12
	2	5+216	2.3	3532	19.7	3.54	4.45
Shinkai	1	0+774	0.5	742	6.6	1.98	2.83
	2	3+172	1.19	1342	29.5	4.59	6.51
	3	3+567	1.82	1441	16.4	5.95	8.38
	4	5+275	4.4	3821	29.5	8.89	12.15
	5	6+958	8.6	6512	45.9	12.63	17.02
	6	8+800	8	6021	23.0	11.33	15.29
Hamayun	1	1+168	1.6	2251	16	196.00	273.00
	2	3+456	59.5	22970	2894	108.10	131.48
	3	11+490	33.1	14043	2343	84.43	103.14

Detailed hydrological data & analysis is attached in Annexure-A.

SECTION 4
SOIL STUDIES

4.1 INTRODUCTION

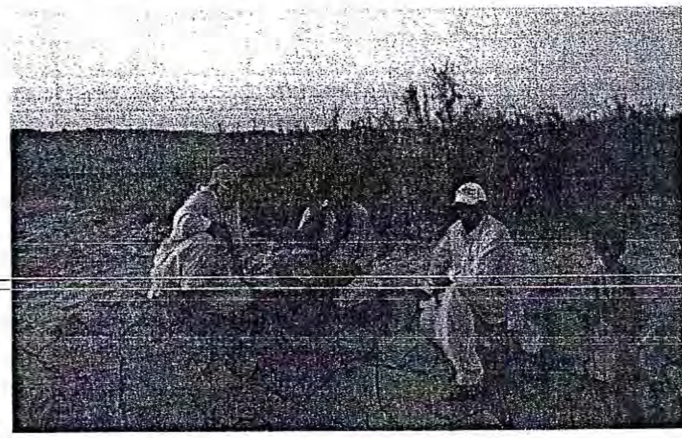
The Project area of the dispersal structures is scattered along the banks of Zhob River. The present study relates to soils of command areas of the six dispersal structures. Zhob Valley is a high land area with mainly semi arid climate. The topography and nature of parent material, the composition and type of minerals, play pivotal role in soil genesis. The soils of the command area are identified and mapped. The total command area of Structures surveyed is about 17,154 hectares (42,371 acres).

Previously, soil studies of the project area have not been carried out by any department or agency.

4.2 METHOD OF STUDY

4.2.1 Field Studies

The project area was surveyed on reconnaissance level. Auger holes were drilled to examine soils to a depth of 1.2 meter or to gravel / retarding layer at shallower depth. Augering was done at suitable intervals depending upon complexity of soils. A study of different recognized soils was carried out in specially excavated pits or excavations / cuts to 1.2 meters depth. The soils were differentiated on such characteristics as texture, color, thickness of horizon / layer and pH value according to Soil Survey Manual (USDA Handbook 18, revised 1993) and instructions as given in FAO Guidelines for Soil Description. Texture in the field was determined by 'Feel Method' and pH by thymol blue indicator. Color notations were based on Munsell Soil Color Charts.



4.2.2 Laboratory Studies

Soil samples were collected for analysis in the laboratory for particle-size distribution, EC, soluble cations, anions and calcium carbonate. The soil samples were subsequently analyzed in CAMEOS Soil Testing Laboratory, Quetta.

4.3 SOIL CHARACTERISTICS

4.3.1 General

The soil of the Project area is formed in piedmont alluvium. The slope class is level to very gently sloping. The texture of the soil is mainly medium, but moderately coarse textured soils also occur. The colour is brown to dark brown, but slightly redder in between 10YR and 7.5YR hues. The pH value ranges between 7.6 and 8.4.

All the soils are deficient in organic matter, strongly calcareous and in the substrata these may have stratified layers of different texture or a clay layer.

As a result of field and laboratory studies the main characteristics of soils mapped in command areas of dispersal sites are given in the following table.

Table 4.1 main characteristics of soils mapped in command areas of Weir sites

S. No	Name of Dispersal Structure	Important characteristics of soils occurring in command area				
		Texture	Structure	Color	Calcareousness	pH
1	Muslim Bagh Dispersal Structure	Gravely sandy Loam A-2-4	Massive / Moderately effervescent	Light brownish grey 2.5Y6/2	Moderately calcareous	7.6
2	Killa Saifullah Dispersal Structure	Silty sandy Loam A-3	Massive strongly effervescent	Brown 7.5YR4/2	Moderately to strongly calcareous	8.4
3	Wulgai/Khulgai Dispersal Structure	Loamy sand A-4	Massive	Brown 10YR4/3	Moderately calcareous	8.1
4	Gowal Dispersal Structure	Clay loam	Massive/weakly homogenized	Brown 2.5Y/10YR4/3	Non to slightly calcareous	8.1
5	Shinkai Dispersal Structure	Clay loam A-6	Massive/weakly homogenized	Brown 2.5Y/10YR4/3	Non to slightly calcareous	7.8
6	Humayun Dispersal Structure	Loamy sand A-6	Massive Moderately effervescent	Pale Brown 10YR5.5/3	Moderately calcareous	7.8

4.4 LAND CAPABILITY CLASSIFICATION

4.4.1 General

According to Soil Conservation Service USDA Agriculture Handbook No.210, 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, there are eight land capability classes, 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 is 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.

4.4.2 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 following table gives the land classification of each dispersal structure command area.

Table 4.2 Land classification of each individual weir site command area

Name of Dispersal Structure	I Very Good Agriculture Land %	II Good Agriculture Land %	III Moderate Agriculture Land %	IV Poor Agriculture Land %	VII Marginal Forest Land %	VIII Agriculturally Unproductive Land %
Muslim Bagh Dispersal Structure	19.32	80.68	---	---	---	---
Killa Saifullah Dispersal Structure	42.39	57.61	---	---	---	---
Wulgai/Khulgai Dispersal Structure	16.17	79.86	3.97	---	---	---
Gowal Dispersal Structure	13.26	83.42	2.32	---	---	---
Shinkai Dispersal Structure	26.27	46.89	26.84	---	---	---
Humayun Dispersal Structure	18.63	81.37	---	---	---	---

Figure 22-27 shows the soil map of dispersal structures command area.

SECTION 5
AGRICULTURAL STUDIES

5.1 SUMMARY

The high risk of crop failure associated with flood irrigation and consequent risk mitigation strategies adopted by farmers do not leave much space for the classical improvements in agricultural practices that are justified in intensive agriculture. There are, however, some niches of possible production gains that can be obtained through carefully designed changes in cropping practices.

Farmers in proposed scheme have developed various cropping strategies to cope with the risks inherent in flood irrigation. These include:

- Growing local varieties that are adapted to the local agro climatic conditions and have a high tolerance to drought.
- Growing crops that produce some fodder even if the floods fail and grains cannot be grown.
- Practicing intercropping, so that, in bad years, one of the planted crops can be harvested.
- Selecting crops in relation to the timing and volume of the first irrigation and, where possible, of subsequent irrigations.
- Selecting crops in relation to the soil moisture available after irrigation.

Sorghum, wheat and maize are the main subsistence crops in proposed scheme areas. The selection of the crop and varieties that are grown in the areas depends on a number of factors:

- Location of the field within the system
- Timing and volume of irrigation water that is likely to be received
- Resistance to drought, pests and disease
- Alternative use in drought periods when grains cannot be grown, e.g. as fodder
- Suitability for storage
- Possibility of rationing
- Market and, where relevant, support prices.

The yields of most flood irrigated crops are highly variable. In bad years, parts of the scheme may not produce any crop, while the crops on other fields may only receive enough irrigation to produce some fodder. The wide ranges in yields observed in scheme can be attributed to:

- The unreliability of irrigation
- The degree of control that farmers can exercise over flood flows.
- The farming skills in soil moisture conservation practices.
- The priority that farmers give to flood irrigation, considering that many of them work in other sectors because of the low return to labour.

In most project area, there is minimal use of chemical or organic fertilizers such as manure. While yields could be increased through a combination of greater investment in fertilizers, pest control and labour, it is important to note that the traditional cultivars used in most schemes do not always respond well to increased use of fertilizers. Other factors that contribute to the limited use of chemical fertilizers are the cost and extent of availability of chemical fertilizers, access to credit, the lack of information on the use of fertilizers, and the high level of risk that fertilizers will be washed off by uncontrolled irrigation.

Research suggests that there is scope for production increases with relatively simple adjustments to farming practices, such as early planting, mulching and deep ploughing, well targeted use of fertilizer, etc. Areas for improvement include:

- The introduction of an integrated farming systems approach, including livestock and agro forestry
- the use of improved seed varieties for instance, by more exchange of varieties between areas
- a better understanding of the balance of nutrients, including those brought by floods, and better guidance on fertilizer application
- cultivating more minor crops and wild plants such as vegetables
- a better control of post-harvest losses, which can be reduced by simple improvements in storage.

Although there is considerable scope for crop productivity improvement through extension and research, these services are usually poor and ill-adapted to the specific concerns of project areas, and the bulk of investment in agricultural research usually goes into perennial irrigated agriculture.

Yet research into a wide range of topics is needed to address specifically the needs of flood irrigation agriculture. Research needs to be systematically carried out in consultation with farmers through farmer-led trials and experiments and through farmer-to-farmer extension activities.

5.2 INTRODUCTION

Flood irrigation generally supports a low-input, risk-averse type of farming owing to the recurrent uncertainties in the timing, number and size of floods that occur and the potential damage to crops and irrigation infrastructure caused by large floods. At some locations, in any one year, few if any significant floods occur, this makes cropping impossible.

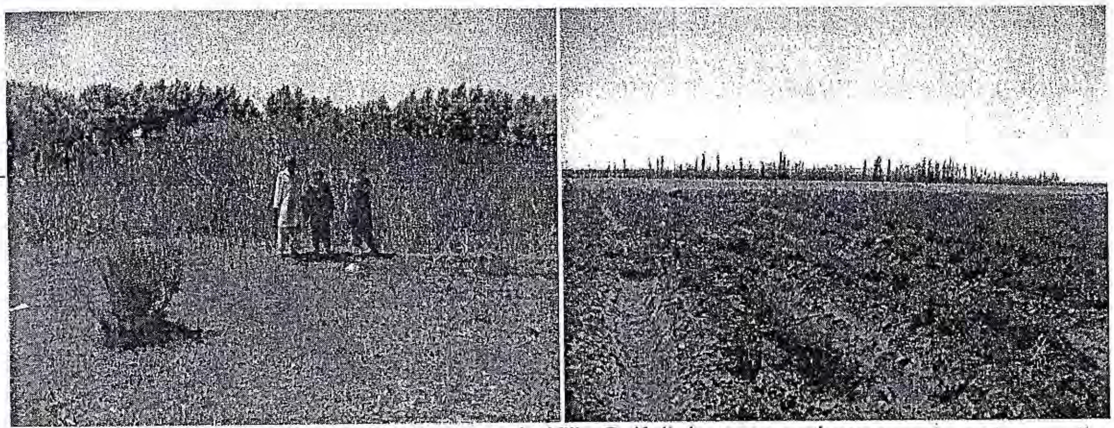
While the risks of crop failure in flood irrigated are quite high, the probability of receiving irrigation is not equally distributed throughout the command areas. Drought-resistant crops such as sorghum, wheat and maize dominate the cropping patterns. The production of fodder is also a priority in most of project areas in order to support livestock. Livestock provide traction for ploughing and bund building, and act as a form of saving, as animals can be sold to generate cash in bad years. In addition, farmyard manure can be an important source of income.

5.3 CROPS GROWN IN PROJECT AREA

Farmers have developed various cropping strategies to cope with the precarious circumstances that are part of flood irrigation:

- They generally grow local varieties that are adapted to the local agro climatic conditions and have a high tolerance to drought.
- They grow crops that produce some fodder even if the floods fail and grains cannot be grown.

- They may practice intercropping, whereby two or three different crops with different water requirements and harvesting times are planted in the same field, so that, in bad years, one of the planted crops can be harvested
- At some locations, their crop choice is determined by the timing and volume of the first irrigation and, where possible, subsequent irrigations. For example, sorghum is grown in fields with early irrigations, oilseeds and pulses are irrigated later and the last summer floods are reserved for the cultivation of wheat during the winter months
- On other location their selection of crops depends on the soil moisture that is available after irrigation.



Existing crops grown in Killa Saifullah command area

5.3.1 Varieties

The selection of the crops and varieties that are grown in scheme areas is affected by a number of factors, amongst which are the: (a) location within the system (b) timing and volume of irrigation water that is likely to be received (b) resistance to drought, pests and disease (c) alternative use in drought periods when grains cannot be grown, e.g. as fodder; (e) suitability for storage (d) possibility of ratooning (e) market and where relevant, support prices

5.3.2 Yields

The yields of most crops in project area are highly variable. In bad years, parts of the scheme may not produce any crop, while the crops on other fields may only receive enough irrigation to produce some fodder.

The wide ranges in yields observed in project area are variously attributed to the unpredictability of water supply, degree of control that farmers can exercise over flood flows, farming skills and soil moisture practices and the priority that farmers give to flood irrigation, considering that many of them work in other sectors because of the low return to labour in flood irrigation area.

Yields also vary substantially from one year to another. Yields also vary reflecting the adequacy of irrigation and the effort made by farmers in moisture conservation and husbandry.

5.3.3 Crop

In several areas, there is a decline in the cultivation of traditional flood irrigated crops.

Rising standards of living and changing habits can reduce the market for traditional grains, such as sorghum, allowing wheat and other cereals to take their place.

Furthermore, research, extension and credit services have been directed to high-value crops, at the expense of traditional flood irrigated crops, and promoting the use of groundwater for irrigation.

Mixed crop of sorghum, and Kharif fodder moth bean (sown after summer rains in July, August and September). Spring plantings of sorghum whenever possible. Wheat only sown when there are late floods, particularly in late August and September. Main crop of sorghum sown as soon as possible after first summer floods. Rare for these crops to receive a second watering; farmers prefer to expand acreage with subsequent storm water.

Cropping patterns in project areas are strongly influenced by the priority given to subsistence crops, the need to grow forage to support livestock and the strategies that farmers adopt if there is insufficient water. In scheme, farmers at the head of the system, who normally receive a more reliable supply, can follow a cropping pattern of mixed sorghum, mung beans and wheat. As water becomes less reliable at the middle and tail-end sections of the system, the cropping pattern changes. If the flood season arrives late, moisture is stored in the soil and wheat is grown. If the flood season is early, sorghum is grown and later floods are used for oilseed.

5.4 OPTIONS TO IMPROVE AGRICULTURAL PRACTICES

The high risk of crop failure associated with flood irrigation does not leave much space for the classical improvements that are justified in intensive agriculture. There is, however, a possibility that production gains can be obtained through carefully designed changes in agricultural practices.

5.4.1 Traditional versus improved varieties

Farmers mainly use local varieties. Local cultivars are well adapted to their environment, having developed over long periods. Where water supply is limited, a local cultivar can produce both grain and fodder and, if additional rainfall or floodwater becomes available, the yield increases.
In traditional systems, seed is normally retained from one year to the next. The practice of using self-produced seed, however, can lead to diseases. Yet there are very few substitutes for the traditional varieties as agricultural research in most countries has been concentrated on improving the yields of perennially irrigated crops. Seed may be purchased in some instances when self-produced seed becomes liable to disease and the use of improved seed varieties should be considered more systematically.

Finally, although the main focus of research is often on improving crop yield per unit area, the availability and sustainability of a variety is also crucial. Local cultivars still fare well in terms of drought resistance; labour inputs, market values, food values and storage, and these factors need to be given more consideration in research.

5.4.2 Cropping intensities

Agriculture is not confined only to raising of fruit, field, vegetable and fodder crops as commonly understood, but it is an integrated farming system comprising of raising livestock, small ruminants, forestry and range management. Agriculture is the main occupation of 60-70% of population which contributes 56-60 % to the provincial GDP and employs about 66.5 % labor force. The vast rangelands, large number of livestock particularly small ruminants and high value deciduous fruit play a major role in the economy of Province especially where irrigation is available for agriculture.

The present cropping intensity of the project command area is only 5.66 percent which is very low due to most of the culture able area lying uncultivated due to inadequate water supply. The present agriculture is low by all standards and below subsistence level mainly due to constraint of irrigation and its dependence on scanty rains and sporadic floods.

The prominent crops are sorghum, maize (fodder purpose) and wheat. Targeted intensity of 94.34 percent will be achieved after 5th year of the project commencement while ultimate production will be achieved after seven years of project commencement.
The proposed scheme is located in Up Lands agro- ecological zones of the Province. As there is shortage of water during critical stages of crop, therefore, no high value crops like fruits and vegetables are grown.

5.4.3 Existing Cropping Pattern and Cropping Intensity

Based on survey of Zhob River dispersal structures sites and information collected from the community, currently, 2,400 acres (972 hectares) of land are under crops in both seasons (Rabi and Kharif) out of 42,371 acres (17,154 hectares) of total command area with cropping intensities in percentage is as follows.

Table 5.1 Existing Cropping Pattern and Cropping Intensity

S. No	Name of Crop	Cropped Area (Acres)	Cropped area (%)	Uncultivated Land (hectares)	Total Land (hectares)
1	Sorghum	546	56.25	16,182	17,154
2	Maize	202	20.83		
3	Kharif Fodder	162	16.67		
4	Wheat	61	6.25		
	Total	972	100		

Existing crops dependents on rain or flood water during monsoon season. Only two tubewell are installed at the depth of 400 ft and cost about Rs. 700,000/- to Rs. 800,000/- which is beyond the financial capacity of small and poor farmers. Main problem is prolonged power shutdown due to load shedding which cause major problems during critical stages of crops.

5.4.4 Planting Density

The amount of water that plants use depends on the quantity of soil moisture that is available, the root growth rate and the extent of root development. The farmer can influence the relationship between these factors by adjusting the planting density on the plot of land according to whether or not further rain or floodwater in the growing season is likely to occur.

A very dense plant population creates a high competition among the plants for moisture, nutrients and light. As a result of this competition, plants, especially sorghum, grow very thin and tall and the yield is low. Young crop stands of high plant density are more affected by drought than equal stands of lower density. It is suggests that, in order to use water more efficiently, it may be more suitable to grow cultivars that yield more grain per plant and grow them at a lower plant density. In flood irrigation systems, planting at high density may be preferred by farmers for the following reasons:

- densely grown crop can be thinned and used to feed their animals, which do not have any other source of feed

Water logging and infestations of insects such as locusts and heavy attacks by birds can kill young plants. These problems reduce the plant population as well as the yield. To cope with such problems high-density planting is preferred; and densely grown plants suppress weeds and the majority of the farmers do not practice weeding.

5.4.5 Fertilizers

In most of project area, there is minimal use of chemical fertilizers, or organic fertilizers such as manure. Farmyard manure is used in some areas where soils are sandy and recognized as being relatively infertile.

Incorporating crop residues in the soil is also generally not practiced, as they are often used as fodder.

It is usually taken for granted that yields could be increased with greater investment in fertilizers, combined with improved cultural practices and adequate irrigation.

Most of farmers believe that their soils are naturally fertilized by the fine sediments that are deposited during flood irrigation. Floods often carry around 10 percent in weight of fine silts that are deposited on the fields. However, the origin of floodwater affects its nutrient value. There are, however, other factors that contribute to the limited use of chemical fertilizers. These are

- The cost, as the use of chemical fertilizers depends on the availability of credit to farmers
- The lack of experience of farmers in the use of fertilizers and pesticides
- the availability of chemical fertilizers
- The high level of risks that fertilizers will be washed off by uncontrolled irrigation.

5.4.6 Pest and Disease Control

As the cropping pattern in the project area is dominated by monocultures and large areas are planted at the same time, the impact of pests and diseases can be dramatic. The use of pesticides and insecticides is rare as most farmers lack the financial resources to apply these products.

The traditional cropping system is designed to be flexible enough to cope to certain extent with inevitable crop failures induced by pests and diseases. At the beginning of a cropping season, a late-maturing, high-yielding crop is planted. If this crop fails because of over-flooding or shortage of water or pest and insect attack, it is replaced by an early maturing and drought, pest and disease tolerant variety, which is usually low-yield variety.

5.4.7 Grain Storage

In Project area it was found that grain storage losses averaged 7 percent for a several reasons as under.

- The work of insects and pests
- The storing of grains before they were completely dried and the high moisture in storage spaces.

Grains were typically stored in earthen containers that were usually not tightly closed. Storage spaces were in most cases multi-functional and shared with residential or animal husbandry functions. A number of low-cost changes were introduced that brought down storage losses to less than 1 percent:

- Cleaning of grain prior to storage;
- construction of special storage place;
- fumigation of seeds affected by pests and diseases;
- improved storage containers.

5.5 THE ROLE OF LIVESTOCK

Livestock is an integral and important component of the livelihoods of households in most of project area, main source of animal feed is usually crop residues and rainfed grazing lands. A second source is the cultivation of flood irrigated fodder crops, such as maize (green).

5.6 AGROFORESTRY

An important element in flood irrigated agriculture is agro forestry. Flood irrigated trees are often planted on field bunds and in outwash areas. In project area this approach is limited. Farmers are dependent on only flood and rain which is being utilized for crops.

5.7 AGRICULTURAL EXTENSION, TRAINING AND RESEARCH

No coordination among various agencies working in the Project areas on institutional basis particularly between Agriculture, Livestock and Forest Department

5.8 PROPOSED WATER EFFICIENT CROPPING PATTERN

Proposed cropping pattern is based on water availability and local market requirements/ consumption. Surplus crops will be sold in the nearest markets which are, on an average, located at a distance of 40-50 km from the proposed sites. The main markets near project site are Zhob city and Kila Saifullah.

Based on the above criteria, water efficient cropping pattern is proposed with stored water irrigation and with flood water irrigation. The summary is as under.

Table 5.2 Crop Water Requirement Detail of Zhob River Dispersal Structures

S. No	Name of weir / Dispersal Structure	Water available (hec-m)	With Stored water irrigation		With Flood Irrigation		Total	
			Demand (hec-m)	Area (hec)	Demand (hec-m)	Area (hec)	Demand (hec-m)	Area (hec)
1	Muslim Bagh	1,626	592	864	473	860	1,065	1,724
2	Killa Saifullah	6,221	592	813	1,049	1,630	1,641	2,443
3	Wulgai/Khulgai	6,388	592	679	1,123	1,960	1,715	2,638
4	Gowal	6,830	592	748	1,209	2,136	1,802	2,885
5	Shinki	8,145	592	748	1,321	2,538	1,913	3,287
6	Humayun	12,993	592	691	2,097	3,487	2,690	4,178
	Total	**12,993**	**3,554**	**4,543**	**7,272**	**12,611**	**10,826**	**17,154**

Total water available in six dispersal structure after scheme completion is 12,993 ha-m (105,293 acre-ft) and total water demand for 17,154 ha (42,371 acres) is 10,826 ha-m (87,728 acre-ft). The water demand for storage is 3,554 ha-m(28,797 acre-ft) for 4,543 ha(11,221 acres) and flood water demand is 7,272 ha-m(58,931 acre-ft) for 12,611 ha(31,150 acres). By stored water irrigation and flood irrigation cropping intensity will increase by 124% through cropping rotation both in Rabi ad kharif season. The potential land will be utilized for both seasons.

Table 5.3 Proposed Cropping Pattern with Stored Water Irrigation

Weir Name	Orchards	Kharif Pulses	Kharif Vegetables	Rabi Vegetables	Rabi Pulses	Wheat	Total area (hectare)
Muslim Bagh	6	0	105	247	223	283	858
Killa Saifullah	6	81	142	162	81	341	807
Wulgai/Khulgai	24	0	202	452	0	0	655
Gowal	16	0	186	303	0	243	732
Shinkai	16	0	186	303	0	243	732
Humayun	20	0	202	468	0	0	670
Total area (hectares)	**89**	**81**	**1024**	**1934**	**304**	**1111**	**4543**
Cropping Intensity (%)	**1.96**	**1.78**	**22.55**	**42.58**	**6.68**	**24.45**	**100**

Table 5.4 Proposed Cropping Pattern with Flood Irrigation

Weir Name	Kharif Pulses	Sorghum	Maize	Kharif Fodder	Wheat	Total area (hectares)
Muslim Bagh	61	476	202	121	0	860
Killa Saifullah	0	621	765	243	0	1,630
Wulgai	40	931	567	259	162	1,960
Gowal	202	1,215	517	202	0	2,136
Shinkai	202	1,579	352	202	202	2,538
Humayun	261	1,822	1,078	204	121	3,487
Total area (hectares)	**767**	**6,644**	**3,482**	**1,233**	**486**	**12,611**
Cropping intensity (%)	**6.08**	**52.68**	**27.61**	**9.78**	**3.85**	**100**

5.9 CROP WATER REQUIREMENTS OF PROPOSED CROPPING PATTERN

Total Water demand in all the proposed six dispersal structures is 108.17 MCM (87,729 acre ft), with stored water irrigation 35.71 MCM (28,797 acre ft) and flood water irrigation 72.66 MCM (58,931 acre ft). The efficient cropping pattern low delta crops along with medium delta crops has been proposed according to need and climatic condition of the area.

In Muslim Bagh dispersal structure command area soil is gravely sandy loam which is most suitable for peas, maize and small grains like wheat and barley. In Killa Saifullah dispersal structure command area soil is silty sandy loam which is suitable for all crops grown in the area/region.Wulgai/Khulgai and Humayun dispersal structure the command area soil is loamy sand which is most suitable for potato, vegetables like carrot, turnip and fruits. Whereas command area soil of Gowal and Shinki dispersal structures is clay loam which is most suitable for crops like maize, sugar beet, vegetables (Tomato, cabbage, broccoli) and fruits(Apple, cherry, pear and wall nuts).

Annual crop water requirements of water efficient cropping pattern is given in **Annexure-B.**

SECTION 6
GEOLOGY AND GEOTECHNICAL STUDIES

6.1 GENERAL

The Zhob River Sub-basin lies geologically in Axial Belt Basin, which is a long narrow sinuate-shape belt, and runs from Arabian sea through Bela, Khuzdar, Quetta, Zhob and Waziristan. Further, the belt in its northern extension covers the area of Kurram Agency, Attock-Hazara folded belt.

Oligocene-Miocene molasses covers the Project area and are largely of sedimentary origin. The sedimentary sequence is composed of calcareous rocks. Most of the sedimentary rocks stem from marine environment particularly in the project area. Rocks of igneous origin (Ophiolites) predominate in some parts of the project area.

In Project area Ophiolites are associated with pelagic sediments, which contain gabbroic and soloaritic intrusions. The part of catchment area which falls in Muslum Bagh and adjoins area has the igneous rocks and limestone from Nasai Group of Eocene age.

Geology of the Zhob River comprises of sticky clay (May be Bostan Clay) having the depth of half meter to few meters at top, underlain by sandy material from Shaigalu Group in Toiwar deposited by the Zhob river. Therefore the material found in Zhob River bed is generally Arenaceous Sand and some gravels underlain by Boistan clay and also having thin layer of clay on top at places.

Figure 3 gives the Geological Map of the Project area.

6.2 SEISMICITY OF THE AREA

The project site is located in Zone 2B as per "Seismic Provisions-2007" of Building Code of Pakistan. This zone indicates high degree of damage during the seismic loading. Keeping in view the seismo-tectonic set up of the project site and the degree of importance of the structures of the proposed project, it is recommended that the structures should be designed to withstand maximum horizontal peak ground acceleration (PGA) of 0.16 - 0.24g. This PGA has 10% probability of excedence in 50 years. **Figure 4** gives the Seismic Map of the Project area.

6.3 FIELD INVESTIGATION

6.3.1 General

The purpose of field investigations was:

- Identification of strata encountered;
- collect disturbed and undisturbed samples;
- selection of suitable location for the weir;
- carry-out field density tests.

Keeping in view the scope of the geotechnical studies, a field investigation program was developed. The investigation included the following activities;

- Excavation of test pits;
- In-situ testing;
- Soil and water sampling.

The field work was supervised by our geologist who was responsible for client liaison, field co-ordination, logging of the strata encountered and handling of the samples collected. The field work component of the investigation was carried out during July/ August, 2012.

6.3.2 Test Pit Excavation

For visual classification of foundation soils at shallow depths, twelve (12) test pits were excavated down to maximum depth of 1.8 m below the existing ground surface. In some test pits, excavation of 1.8m could not be achieved due to presence of large boulders or encountering rock. The test pits were manually excavated. Subsurface logs of all the test pits were prepared after carefully observing the strata along the cut section of the excavated pits.

6.3.3 Sampling

Disturbed and undisturbed soil samples were obtained during the field work. Disturbed soil samples were obtained from all the test pits through shallow surface sampling. These samples were placed in polythene bags and preserved in wide-mouthed plastic jars. The jars were clearly labeled to indicate the project name, test pit designation and depth of sample.

Undisturbed samples were collected by box sampling method where applicable and preserved by waxing.

All the soil samples were carefully transported for subsequent laboratory testing.

6.4 LABORATORY TESTING

For the evaluation of physical strength and chemical characteristics of the subsoil, selected disturbed and undisturbed soil samples were tested in the laboratory. The groundwater samples were tested for estimation of chemical constituents. The following laboratory tests were performed on selected soil and water samples.

- Sieve Analysis;
- Hydrometer Analysis;
- Atterberg Limits;
- Bulk Density and Insitu Moisture Content;
- Specific Gravity;
- Direct Shear;
- Constant Head Permeability Test;
- Chemical Analysis (soil and water).

Detailed summary of the laboratory test results and copy of the laboratory test reports are attached in **Annexure C**.

The samples from the river bed were analyzed at CAMEOS Laboratory in Quetta. Results of grain size analysis shows that the material is SP – Poorly graded Sand (A-3).

The UD sample from the same place was analyzed at "Soil Testing Services" Laboratory at Karachi.

6.5 EVALUATION OF FIELD AND LABORATORY TESTS

6.5.1 General

The geotechnical investigations carried out at the project site comprised field and laboratory work. The field and laboratory investigations were aimed at evaluating the engineering characteristics of the foundation soils. The conditions and engineering characteristics of the soils present at the project sites are discussed in the following sections.

6.5.2 Stratigraphy and Geotechnical Parameters

Based on the field and laboratory investigations, the site generally consist of overburden soil layers with the underlying rock (Bostan Clay). Typical subsurface profiles for each weir location are given in the following sections.

6.5.3 Muslim Bagh Dispersal Structure

The Muslim Bagh Dispersal Structure is located at about 17 kms, north-east of Muslim Bagh on Quetta Zhob Road. Water table was not encountered in any test pit. After observing nearby wells and interviewing locals it was concluded that the depth of ground water is variable. The minimum depth to water table is about 5 meter.

The impermeable strata comprising of sticky clay is estimated at about 3-4 meters of depth and is underlain by gravels, pebbles and sandy clay. The permeability of the bed is relatively low, probably due to presence of silt contents.

Results of grain size analysis show that the soil is silty-sand with gravels. Due to the presence of boulders and pebbles in formation, UDS sample was not possible and, therefore, the values from standard tables have been adopted. The results of the laboratory test results are as follows.

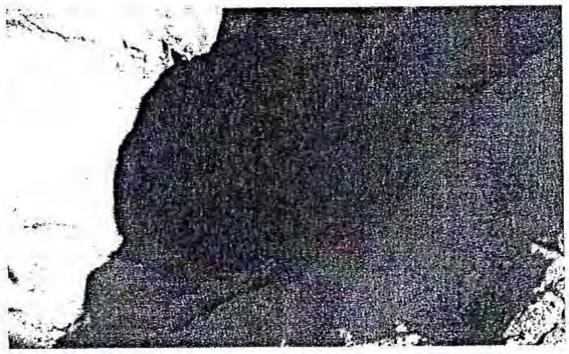
Table 6.1 Results of Lab test of Muslim Bagh Dispersal Structure

Specific Gravity			2.86
Natural Moisture Content (%)			7.81
Attenberg Limits		LL	NP
		PL	
		PI	
Coefficient of Permeability, *k* (cm/sec)			8.87E-03
Soil Classification	Weir Axis	Unified	Silty Sand with Gravels
		AASHTO	A - 3
	Command Area	Unified	Silty Sand with Gravels
		AASHTO	A – 2
Strength Parameters		Cohesion (kPa)	0
		Angle of Friction	35

The bearing capacity has been estimated to be more than 287.30 KPa (3 tons/sq ft).

6.5.4 Killa-Saifullah Dispersal Structure

The dispersal structure is located at about 10 kms north of Killa Saifullah town on Quetta-Zhob road. Water table was not encountered in test pits. However, based on the collected data of nearby wells and interviewing locals of the area the depth of water is estimated as 5m below ground level.



The estimated thickness of the sticky clay bed is about 5-6 meter which is underlain by gravel and sandy clay. The permeability of the bed / overburden is high due to the presence of well-sorted sand. The results of the laboratory test results are as follows.

Table 6.2 Results of Lab test of Killa Saifullah Dispersal Structure

Specific Gravity			2.66
Natural Moisture Content (%)			7.81
Attenberg Limits		LL	21
		PL	4
		PI	17
Coefficient of Permeability, *k* (cm/sec)			1.93E-03
Soil Classification	Weir Axis	Unified	Poorly Graded Sand
		AASHTO	A-3
	Command Area	Unified	Silty Clay
		AASHTO	A-6
Strength Parameters		Cohesion (kPa)	0
		Angle of Friction	26.4

The bearing capacity has been estimated to be more than 287.30 KPa (3 tons/sq ft).

6.5.5 Wulgai / Khulgai Dispersal Structure

The Wulgai / Khulgai dispersal structure is located at about 18 km north-east of Killa Saifullah town/ city, on Killa Saifullah - Zhob road. Water table was not encountered in test pits. However after observing nearby wells and interviewing locales the depth of water is estimated as 5m below ground level. The estimated thickness of the sticky clay bed is about 5-6 meter which is underlain by gravel and sandy clay. The permeability of the bed / overburden is Low, due to clayey silty sand. The results of the laboratory test results are as follows.

Table 6.3 Results of Lab test of Wulgai / Khulgai Dispersal Structure

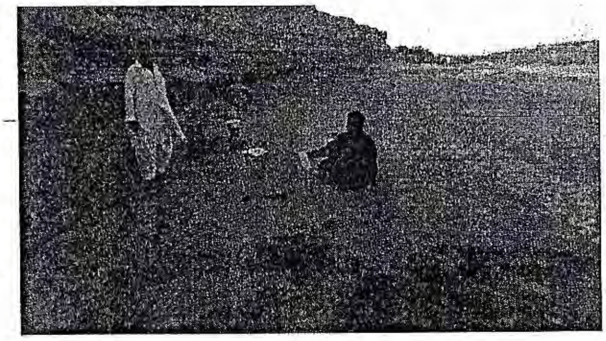
Specific Gravity		2.66
Natural Moisture Content (%)		8.64
Attenberg Limits	LL	
	PL	
	PI	NP
Coefficient of Permeability, *k* (cm/sec)		3.990E-06

Soil Classification	Weir Axis	Unified	Poorly Graded Sand
		AASHTO	A - 3
	Command Area	Unified	Silty Clay
		AASHTO	A-6
Strength Parameters		Cohesion (kPa)	0
		Angle of Friction	24.7

The bearing capacity has been estimated to be more than 287.30 KPa (3 tons/sq ft).

6.5.6 Gowal Dispersal Structure

The Gowal Dispersal Structure is located at about 34 kms north-east of Killa Saifullah town, on Quetta - Zhob road. Water table was not encountered in test pits. However, data from nearby wells and interviewing local population reveal that the depth to water table is about 5m. The estimated thickness of the sticky clay bed is about 5-6 meter which is underlain by gravel and sandy clay. The permeability of the bed / overburden is Low, due to clayey silty sand.



The results of the laboratory test results are as follows.

Table 6.4 Results of Lab test of Gowal Dispersal Structure

Specific Gravity			2.86
Natural Moisture Content (%)			8.15
Attenberg Limits		LL	
		PL	
		PI	NP
Coefficient of Permeability, *k* (cm/sec)			3.990E-06
Soil Classification	Weir Axis	Unified	Poorly Graded Sand
		AASHTO	A – 3
	Command Area	Unified	Silty Clay
		AASHTO	A-6
Strength Parameters		Cohesion (kPa)	0
		Angle of Friction	26

The bearing capacity has been estimated to be more than 287.30 KPa (3 tons/sq ft).

6.5.7 Shinkai Dispersal Structure

The Shinki Weir is located at about 50 km north-east of Killa Saifullah town, near Shinkai Killi on north of Quetta-Zhob Road. Water table was not encountered in test pits. However after observing nearby wells and interviewing locales the depth of water is estimated as 5m below ground level. The bedrock is estimated about 5-6 Meter of sticky clay underlined by the Gravel,

and sandy clay. The permeability of the bed / overburden is relative on lower side, due to clayey silty sand.
The results of the laboratory test results are as follows.

Table 6.5 Results of Lab test of Shinkai Dispersal Structure

Specific Gravity			2.68
Natural Moisture Content (%)			12.83
Attenberg Limits		LL	20
		PL	3
		PI	17
Coefficient of Permeability, *k* (cm/sec)			2.89×10^{6}
Soil Classification	Weir Axis	Unified	Silt
		AASHTO	A-4
	Command Area	Unified	Silty Clay
		AASHTO	A-6
Strength Parameters		Cohesion (kPa)	10
		Angle of Friction	14

6.5.8 Humayun Dispersal Structure

The Hamayun Killi weir is Located at 30°56'54" N and 69°07'35" E, about 77 kms East of Killa Saifullah city on Quetta - Zhob Road. The catchment area is 6,774 km^2 and at weir axis the length of the river Bed is about 309m. The depth to water table is about 0.5m. The sticky clay bed is at about 3-4 m thick which is underlain by washed sand. The permeability of the sand is considerably high. The results of the laboratory test results are as follows.

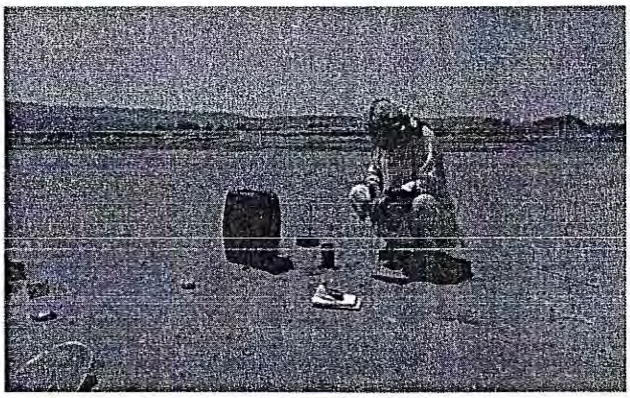


Table 6.6 Results of Lab test of Humayun Dispersal Structure

Specific Gravity			2.66
Natural Moisture Content (%)			6.86
Attenberg Limits		LL	19
		PL	3
		PI	16
Coefficient of Permeability, *k* (cm/sec)			8.125×10^{-3}
Soil Classification	Weir Axis	Unified	Poorly Graded Sand
		AASHTO	A-3
	Command Area	Unified	Silty Clay
		AASHTO	A-6
Strength Parameters		Cohesion (kPa)	0
		Angle of Friction	27.1

SECTION 7
ENGINEERING STUDIES

7.1 GENERAL

The Project comprises of construction of six (6) flood dispersal structures across Zhob river at different suitable locations to conserve and divert flood flows to irrigate the large command area located on the left and right banks of the river. In addition offshore storages have also been incorporated on the periphery of the command areas at suitable locations to store and utilize the flood flows based on the requirements. Under the scenario the flood irrigation supplies will be supplemented by stored flows inducing an element of reliability to the system.

The six dispersal structures comprise of the following main components.

- Weir, Sluice and Head Regulator;
- Upstream protection/ river training works;
- Conveyance system comprising of main canal, distributaries, X regulators etc;
- Storage Tanks, two at each structure;
- Cross drainage works to safely convey flood flows across the main canal /distributaries.

7.2 DESIGN OF WEIR AND APPURTENANT STRUCTURES

7.2.1 Weir

a. Hydrology

The weir has been designed to withstand a flood with a return period of 100 years.

b. Weir Shape

Keeping in view the ease of construction, cost and to safely pass boulders and other bed load material during floods, sloping glacis shape has been recommended.

The sloping glacis weirs have the inherent advantage of stability. On rivers subject to high velocity flows carrying boulders, weirs be made as low as possible and a shallow glacis weir would best transport boulders safely over the weir. Most of the weirs constructed by Irrigation Department are sloping glacis weirs with an upstream slope of 1V : 1H and a downstream slope of 1V : 2H or 1V : 1.5H. The structures have successfully been in operation for a number of years.

c. Stilling Basins

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.
Keeping in view the hydraulic condition USBR Type 4 stilling basin has been recommended.

d. Scour Depth, Seepage and Uplift

The foundation of the weir has been designed to counter the effects of scour in the river bed and seepage under the structure itself. The cutoffs have been extended to at least the expected scour depths, both upstream and downstream of the structure.

The Lacey empirical equation has been used to compute the depth of scour. The design scour depth below bed level (D) is given by:

Design Scour Depth (D) = XR – Y

Where:

X	=	scour factor dependent on type of reach
Y	=	design depth of flow ft [m]

$$R = 1.35 (q^2/f)^{1/3}$$

Where:

q	=	the maximum discharge per unit width ft^2/s [m^2/s]
f	=	Lacey's silt factor

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

The cutoffs have been proposed 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.

The seepage beneath a hydraulic structure usually result in 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.

The following equation has been used for estimation of the thickness of the apron at the different points of interest 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 has been 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.

e. Structural Details

The structure wise details of the weir, head regulator and sluice are as follows.

Table 7.1 Structure Detail

Dispersal Structure	Muslim Bagh	Killa Saifullah	Wulgai / Khulgai	Gowal	Shinkai	Humayun Killi
WEIR						
Type	Broad Crested	Broad Crested	Broad Crested	Broad Crested	Broad Crested	Broad Crested
Natural Surface Level (NSL), m	1677.88	1529.48	1511.83	1503.28	1482.48	1447.25
Weir Crest Level, m	1679.80	1531.30	1514.46	1506.50	1483.71	1449.30
Width of Weir, m	214	200	200	200	215	225
Legth of Stilling Basin, m	27.59	38.75	40.60	46.38	38.60	49.60
Design Discharge (Q), cumec	1666.28	3871.91	3942.51	4766.11	4980.44	5280.32
Abutment Level, m	1683.80	1537.34	1521.10	1512.60	1490.22	1456.00
Free Board, m	1.00	1.00	1.00	1.00	1.00	1.00
SLUICE						
Crest Level, m	1678.30	1529.77	1513.48	1505.30	1482.20	1447.80
Width of Sluice, m	13.80	13.80	13.80	13.80	13.80	13.80
Legth of Stilling Basin, m	23.17	37.15	36.44	36.44	42.82	47.03
No. of Gates	4	4	4	4	4	4
Discharge Capacity, cumec						
HEAD REGULATOR						
Crest Level, m	1678.90	1530.38	1513.99	1505.90	1482.80	1448.35
Width of Sluice, m	13.80	13.80	13.80	13.80	13.80	13.80
Legth of Stilling Basin, m	23.17	20.72	21.18	21.18	21.18	21.18
No. of Gates	4	4	4	4	4	4
Discharge Capacity, cumec	56.63	56.63	70.78	70.78	70.78	70.78

Figures 6 through 21 give the layout plan, plan/ profile, and typical sections of structures and canal.

7.2.2 Off-take or Head Regulator

To minimise sediment draw, the head regulator has been located to take off water at an angle (45° to 90°) to the river flow.

The head regulator is gated to regulate the entering flow properly. The maximum span of each bay of the head regulator has been adopted as 10ft (3.0 m). The head regulator has three bays so that during commissioning of the irrigation channel, bays can be shut off as required to prevent scour damage.

Breast walls are provided to the head regulator so that orifice flow occurs during large floods. This makes the flow through the regulator proportional to the square root of the flow depth (ie $\propto Q^{0.5}$), rather than proportional to the flow depth to the power 1.5 (i-e $\propto Q^{1.5}$).

The head regulator crest level has been proposed to be -0.6m below the main weir but +0.6m above the invert of the scour sluice.

7.2.3 Scour Sluice/ Sediment Exclusion

The proposed layout comprises of a weir with a curved scour sluice channel, incorporating a skimming weir which feeds the off-take channel. The layout has been model tested [3]. The scour sluice is gated to control the flow lost through the sluice channel. The width of the curved sluice channel gradually reduces. Under the arrangement 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. However, this requires only 5% to 10% of the flow for sluicing.

7.2.4 Stilling Basins

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.

Keeping in view the hydraulic condition USBR Type 4 stilling basin has been recommended.

7.2.5 River Training Works

When a weir does not extend over the width of a river, river training works are required. These comprise embankments and spurs, which may be stone protected earthen embankment or gabion structures. The embankments need to be sufficiently high and robust to channel flood flows over the weir without overtopping or failing. They should be designed for a 1 in 50 year flood and checked for 1 in 100 year flood to ensure that overtopping does not occur.

The top width of the embankment has been proposed to be 3.5m with the side slopes of 1V:2H. Stone pitching has been provided on the upstream slope and horizontal apron.
The structure wise details are as follows.

Table 7.2 Structure wise Detail of River Training Works

Dispersal Structure	Muslim Bagh	Killa Saifullah	Wulgai / Khulgai	Gowal	Shinkai	Humayun Killi
Upstream River Training Works						
Type	Earthen	Earthen	Earthen	Earthen	Earthen	Earthen
Top Width, m	3.50	3.50	3.50	3.50	3.50	3.50
Side Slope	2:,1	2:,1	2:,1	2:,1	2:,1	2:,1
Length, m	586	551	3565	5530	1317	2655

3/ Smith KVH, Hewlett RMG & Lawson JD. "Headworks for Spate Irrigation Systems." Civil Engineering Magazine, Sept 1987, and Anwar AA. "Canal Head Regulator for Spate Irrigation." IIS, University of Southampton, UK October 1995

Dispersal Structure	Muslim Bagh	Killa Saifullah	Wulgai / Khulgai	Gowal	Shinkai	Humayun Killi
Top Level, m	1683.80	1537.34	1521.10	1512.60	1490.22	1456.00

7.2.6 Conveyance System

Conveyance system including main canal, distributaries, X regulators and fall structures have been provided to convey water from the headworks to the command area.

The Lacey regime equations have been applied to hydraulically design the conveyance system. The four equations are listed below and are discussed in following sections.

Water Surface Width (W_s)

$$W_s = 4.83\ e\ Q^{1/2} \quad \text{[metric units]}$$
$$= 2.676\ e\ Q^{1/2} \quad \text{[ft - s units]}$$

Sediment factor (f)

Although the sediment factor 'f' may the related to bed material size it is considered preferable to determine its value by measuring a similar channel exhibiting regime and using the following equation:

$$f_{vr} = 2.46\ V^2/R \quad \text{(metric units)}$$
$$= 0.75\ V^2/R \quad \text{[ft-s units]}$$

Regime Slope equation

$$S = 0.0003\ f^{5/3} / Q^{1/6} \quad \text{[metric units]}$$
$$= 0.00055\ f^{5/3} / Q^{1/6} \quad \text{[ft-s units]}$$

Lacey Uniform Flow Formula

$$V = R^{3/4} S^{1/2} / N \quad \text{[metric units]}$$
$$= 1.3458\ R^{3/4} S^{1/2} / N \quad \text{[ft – s units]}$$

and $$N = 0.0225\ f^{1/4}$$

Where:

W_s = water surface width [m or ft];
f = silt or sediment factor (may be estimated from bed sediment size, f_m, or to V & R or similar canal in regime, f_{vr});
Q = dominate discharge [m^3/s or ft^3/s];
e = width factor;
V = average velocity [m/s or ft/s];
R = hydraulic radius [m or ft];
S = hydraulic slope;
N = co-efficient of rugosity.

The design procedure is as follows:

- Determine the full supply and design discharges (Q_s and Q_d).
- Adopt suitable values for the sediment factor "f", the width factor "e" and the canal side slope.
- Determine the canal bed slope (S).
- Determine the water surface width (W_s), and then the canal bed width (b).
- By trial, determine a value for "d", so that the canal can carry the required design discharge (Q_d).

If Q_s is not equal to Q_d, check that Q_s can be carried within the provided freeboard, with a reasonable factor of safety. It suggested that not more than half the provided freeboard should be encroached upon. If not, increase both b and d keeping the same b/d ratio calculated above for Q_d. The side slope of the channel has been adopted as 1V:2H.

The top width of the left side embankment has been proposed as 7.3m which also accommodates road/ inspection path over it. Similarly the top width of the right side embankment has been adopted as 3.5m.

Table 7.3 Conveyance System Detail

Dispersal Structure		Muslim Bagh	Killa Saifullah	Wulgai/ Khulgai	Gowal	Shinkai	Humayun Killi
Irrigation System							
Cultivable Command Area (CCA), Ha		1724	2568	2800	3177	3380	3504
Main Canal							
Design Discharge, cumec		56.63	56.63	70.78	70.78	70.78	70.78
Total Length, m		6350	6200	8400	6000	11000	11500
Bottom Width, m		29.55	29.55	33.33	33.33	33.33	33.33
Bed Slope, %		0.012	0.012	0.012	0.012	0.012	0.012
Side Slopes	Internal	1:,1	1:,1	1:,1	1:,1	1:,1	1:,1
	External	2:,1	2:,1	2:,1	2:,1	2:,1	2:,1
Left Side Embankment							
Top Width, m		7.30	7.30	7.30	7.30	7.30	7.30
Side Slops		2:,1	2:,1	2:,1	2:,1	2:,1	2:,1
No. of Cross Regulators		4	4	5	5	5	6
Distributaries							
No. of Distributaries		4	4	5	5	5	6
Total Length, m		10415	12000	18192	14789	15220	16027
No. of Fall Structures		32	11	11	8	8	23

7.2.7 Storage Tanks

The Storage Tanks are meant to store floodwater each year for supplementing the water demand and to add reliability and sustainability within the system of flood irrigation. The Tanks provide opportunity to store water because the duration of floodwater flows is relatively short and all the farmers can not benefit from a particular storm. The Tanks provide an opportunity to expand the duration of water availability and system can be operated as semi-perennial largely due to the availability of storage Tanks. These Tanks are trapezoidal and are bounded by embankment with top width of 7m and side slopes of 2H:1V. A circular intake tower has been proposed to convey water to the command area.

It is pertinent to mention here that the tanks constructed under Shebo Flood Irrigation Scheme in Pishin district are still functional even after 127 years. The details of the proposed tanks are as follows.

Table 7.4 Storage Tanks Detail

Weir Name	Muslim Bagh	Killa Saifullah	Wulgai / Khulgai	Gowal	Shinkai	Humayun Killi
Storage Tanks						
Total No. of Tanks	2	2	2	1	1	1
Bottom Length, m	700	700	700	700	700	700
Bottom Width, m	500	500	500	500	500	500
Top Width, m	7	7	7	7	7	7
Intake Tower	1	2	2	2	2	2
Type	Vertical Circular	Vertical Circular	Vertical Circular	Vertical Circular	Vertical Circular	Vertical Circular
Diameter / Size (D), m	3.00	3.00	3.00	3.00	3.00	3.00
Size of Conduit / Pipe (D), m	0.45	0.45	0.45	0.45	0.45	0.45
Maximum Capacity (MCM)	1.48	1.48	1.48	1.48	1.48	1.48

7.2.8 Cross Drainage Works

To safely pass the stream flood flows across the main and distributaries cross drainage works have been proposed. The structures (culverts) are designed to pass a flood of 1 in 100 years return period. The structure wise details are as follows.

Table 7.5 Cross Drainage Works Detail

Weir Name	Muslim Bagh	Killa Saifullah	Wulgai / Khulgai	Gowal	Shinkai	Humayun Killi
Cross Drainage Works (Culverts)						
Total Number	13	3	2	2	6	2

7.3 STRUCTURAL DESIGN

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

7.3.1 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.

7.3.2 Joints

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

7.3.2.1 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.

7.3.2.2 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.

7.3.2.3 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.

7.3.2.4 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.

7.3.2.5 Water Stops

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

7.4 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. The detailed drawings of the Project components are given in Volume III "Drawings".

SECTION 8
ENVIRONMENTAL STUDIES

8.1 GENERAL

Infrastructure project interacts to various degrees on human, biological and physical resources of the project area and environment. This interaction may induce favorable or unfavorable changes in environment. To minimize the adverse affects of environment the detail environmental assessment was conducted in the project area. During the environmental assessment rules and guideline of Pakistan Environmental Agency were followed. Guidelines and regulations relevant to environmental issues are as follows.

- Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000;
- The Land Acquisition Act 1894(including later amendments);
- The Forest Act 1927 and later amendments;
- Baluchistan Local Government Ordinance 1979/80;
- National Resettlement Policy-March 2002;
- National Resettlement Policy Implementation guidelines of October 2002.

According to Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000, Irrigation and Drainage Projects serving less than 15,000 hectares fall under Schedule 1 which require Initial Environmental Examination (IEE). Since the command area of Zhob River dispersal structures ranges from 1700-3500 hectares, it is categorized as Schedule I Projects which require only an IEE.

8.2 SCOPE OF IEE REPORT

The scope of Zhob River dispersal structures IEE report is as follows.

- Carryout study of physical, biological and socio economic environments impacts in project area;
- Identification of environmental issues relevant to dispersal structures and conveyance system;
- Assessment of impacts of project including hazards on local environment;
- Mitigation measures for prevailing/minimizing adverse impacts;
- Environmental Management Plan for smooth implementation of project;
- Proposing compensation mechanism for displaced/ affected population.

8.3 ENVIRONMENTAL IMPACTS

The Initial Environmental Examination (IEE) was carried out to assess the positive and negative impacts of the Project and to recommend mitigation measures.

The detailed check list with result of initial environment examination is given in **Annexure "D"** which reveals that no major adverse environmental impacts are observed except inundation of property, land, houses and other related infrastructure.

The project as a whole will have very positive impacts like ground water recharge, direct irrigation and improvement in socio economic condition of the farmers.

The selected environmental parameters are discussed as follows.

8.3.1 Impacts on Physical Environment

a) Impact on Land Resources

During the quarrying of construction materials the natural habitats will be disturbed. Impact will be minor negative.

Due to increase in water availability additional area will be cultivated which will improve soil texture and structure. Anticipated impact will be moderate positive.

b) Impact on Water Resources

Due to construction of this scheme the surface and ground water availability will increase which has positive impact on water resources. Flood will be controlled and diverted for irrigation purpose for crops will have also positive impact.

Ground water quality and water table will increase which has positive impact on water resources. Due to steep slope and less vegetation in catchment area the sedimentation will be high and results in siltation which ultimately has a negative impact.

c) Impact on Climate

Minor improvement of local climate is expected due to storage of water. Impact will be minor positive.

8.3.2 Impacts during Construction

Dust and smoke will be generated during rock blasting, haulage of construction materials, vehical exhausts and burning of wastes. Anticipated impact is moderate negative.

Excavation of soil will damaged the local habitats and usage of explosives for demolition of rocks will cause negative impacts.

Generation of wastes and waste water at construction camps will cause moderate negative impacts.

All above impacts are temporary and will disappear on completion of construction. Minor attention is required by implementing agencies to cope with these negative impacts during construction phase.

8.3.3 Impacts on Biological Environments

Natural habitats both flora and fauna will affect during the construction of the scheme which will impact minor negative.

After completion of scheme impact will be positive due to water availability. The vegetation and fisheries will be flourished and major positive impacts will be expected.

8.3.4 Impacts on Human/ Social Environment

The scheme has positive impacts on social environment except resettlement in Wulgai and Humayun dispersal structure which will have minor negative impacts. The community is willing to relocate and will be resettled in same location.

8.3.5 Impacts on Economics Environments

Consequent to project activities the income of the locals will increase significantly. Anticipated impact will be moderately positive

8.3.6 Impacts on Institution activities

With the completion of project the activities of governmental and nongovernmental sectors will increase significantly. Expected impacts will be moderately positive.

8.3.7 Impacts on Cultural Environments

Impact on cultural heritage is neutral or zero. As there are no historic sites in the project area.

8.3.8 Impacts on Human Use

With the completion of project the Agriculture, forestry, road, irrigation, recreation, communication, livestock and domestic water supply will improve. Anticipated impact will be moderately positive.

8.4 ENVIRONMENTAL IMPACTS RELATED TO STRUCTURAL COMPONENTS

The impacts were assessed in the light of criteria given as under.

- Magnitude or degree of impact.
- Time and duration of impact
- Likelihood of impact occurrence
- Sensitivity of impact
- Risks related to impact.

Zhob River Dispersal Structure Project has overall positive impact on environment and socio economic point of view for the area and province. There are no irreversible and an irretrievable impact on this project.The area is least environmentally sensitive and significant natural and manmade hazards were not found in the project area.

8.5 RESETTLEMENT ISSUES AND ACTION PLAN

The issue of valuation and compensation of the lands, properties, acquired for the project, is amongst the most critical issue of social acceptability of the project. Accompanying this are the social, cultural and economic upset and activities, through which the displaced people, especially poor, have to undergo on account of the places and relations left behind and in regard to the adjustment to the new places for their surviving.

This plan will address the process to be followed for re-settlement as a result of emergence of the project and includes the following;

- The policy, legal and administrative frame work for re-settlement;
- Procedure for resettlement of moveable and immoveable assets including houses, agriculture land, livestock etc;
- Quantum of public and private lands and other fixed assets to be acquired for the project;
- Budgeting of re-settlement involved;
- Organizational arrangement;
- Procedure for claim registration, compensation and grievance redress mechanism.

8.6 COMPENSATION AND RESETTLEMENT COST

There are two weirs in which resettlement and compensation issues exist. About 1,037 acres of land and twelve households are required to be relocated or compensated. Community is fully supportive and willing for construction of scheme. Community members and tribe elders ensured that they will provide their land for storage tank of water free of cost without any compensation and affectees will be compensated by all tribe's members on equal share basis in shape of land. The details are as follows.

Table 8.1 Compensation and resettlement detail

S. No	Description	Unit	Qty	Rate	Amount in Pak. Rs.
1	Houses	Nos.	12	100000	1,200,000
2	Non cultivable Land for storage Tanks	Acres	900	50,000	4,500,000
3	Cultivable land for Storage Tanks	Acres	137	100000	13,700,000
	Total				**59,900,000**

8.7 MITIGATION MEASURES AND IMPLEMENTING AGENCIES

During the assessment process the nature and quantum of negative impacts has been identified. With a view to minimize/reduce/control their impacts mitigation measures are suggested along with implementing agencies in table below.

Table 8.2 Mitigation and role of Implementing Agencies detail

S. No	Environmental component	Negative Impacts	Mitigation Measures	Parameters for Monitoring	Responsibility/ Action
A	**Physical**				
1	Land Resources	Denudation of quarry sites	• On completion of construction work, the quarry sites must be brought as same situation. • Trees and bushes should be planted to maintain the naturalness of the area.	• Leveling of the area. • Tree Plantation	EMC/Contractor
2	Water	Siltation	• Silt,clay,stones should be avoided in dispersal structure and canals • Wastes and effluents from construction camps should not flow in structures.	• Field and laboratory testing of water and waste water samples in light of NEQS	EMC/Contractor
3	Impacts during construction	Generation of dust	• Dust can be controlled by sprinkling of water at site, minimum use of transport and use of protective gadgets by operator/workers.	• Testing particulate matter, smoke and other pollutants in air samples	EMC/Contractor
		Generation of undesirable Noise	• Impacts of noise may be reduced by proper maintenance of machinery and use of ear muffs/gadgets by the operator/workers.	• Testing of noise level	-do-

S. No	Environmental component	Negative Impacts	Mitigation Measures	Parameters for Monitoring	Responsibility/ Action
		Excavation of soil for dispersal structures	• The borrow pits should be brought to the previous position	• Leveling of borrow areas	-do-
		Usage of Explosive	• The explosive should preferably be used at night time. • Safety precautions must be observed so that life and property may not be damaged. • Controlled blasting techniques should be adopted.	• Determination of oxides of Nitrogen, Phosphorous and Sulpher in air.	-do-
		Generation of Wastes and waste water	• Proper solid waste management system should be adopted from their generation to final disposal. • Water borne sewerage system should be provided. For treatment of waste water septic tanks may be constructed.	• Monitoring of sanitation facilities	-do-
B.	BIOLOGICAL				
	Natural Habitats	Removal of vegetative cover	• On completion of project the disturbed areas be brought in to original form. • Plants should be grown to improve the land scape.	• Progress of tree plantation	-do-
C.	HUMAN ENVIRONMENT				
	Social and life	Resettlement	• Timely and proper payment of compensation prior to commencement of construction work. • Provision of jobs to displaced persons on priority basis	• Complete monitoring of all resettlement procedure	-do-

8.8 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

To implement project safely and smoothly, Environmental Management Plan (EMP) is framed. The plan covers all environmental related activities and respective responsibilities. The EMP consists of Environmental Management Cell (EMC), Mitigation plan and monitoring plan. It covers all stages of project (design, construction and operation).Target to be achieved are earmarked. Actions and responsibilities are defined.EMC will be established in Irrigation department to oversee the project implementation according to IEE report.

8.8.1 Mitigation Plan

It is given in detail in Table 8.2.

8.8.2 Monitoring Plan

EMC will monitor overall project so that all intended activities are undertaken according to environmental assessment.

8.8.3 Monitoring during Construction and Operation Phase

Various monitoring aspects relevant to construction phase and operation phase are given in tables below.

Table 8.3 Monitoring During Construction Phase

S. No	Type of Pollution	Monitoring Parameters	Monitoring Frequency	Responsibility
1	Air Pollution	Particulate Matter(PM_{10}) Carbon Monoxide(CO) Sulphur Dioxide(SO_2) Nitrogen Dioxide(NO_2)	Quarterly	EMC,Project Implementing Agency(Irrigation department)
2	Noise Pollution	Noise level dB(A) scale	-do-	-do-
3	Water Pollution	Temperature PH Turbidity Dissolved Oxygen(D.O) Biological Oxygen(BOD) Chemical Oxygen demand(COD) Total Suspended Solids(TSS) Total Dissolved Solids(TDS) Nitrates E.Coli	-do-	-do-

Table 8.4 Monitoring During Operation Phase

S. No	Type of Pollution	Monitoring Parameters	Monitoring Frequency	Responsibility
1	Air Pollution	Particulate Matter(PM_{10}) Carbon Monoxide(CO) Sulphur Dioxide(SO_2) Nitrogen Dioxide(NO_2)	Six Monthly	EMC,
2	Water Pollution	Temperature PH Turbidity Dissolved Oxygen(D.O) Biological Oxygen(BOD) Chemical Oxygen demand(COD) Total Suspended Solids(TSS) Total Dissolved Solids(TDS)	-do-	-do-

S. No	Type of Pollution	Monitoring Parameters	Monitoring Frequency	Responsibility
		Nitrates E.Coli		

8.9 ENVIRONMENTAL MONITORING/ MITIGATION COST

Environmental monitoring/mitigation cost is as under;

Table 8.5 Detail of Environmental Mitigation cost

S. No	Activity	Cost before construction (PKR)	Annual cost (PKR) during construction	Annual cost during operation (PKR)
1	Resettlement	59,900,000	-	-
2	Monitoring of Water, Air and Noise Pollution	-	690,000	1,000,000
3	Plantation	-	200,000	400,000
	Total	**59,900,000**	**890,000**	**1,400,000**

SECTION 9
PROJECT COST AND IMPLEMENTATION

9.1 ESTIMATED COST

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

Table 9.1 Estimated cost detail

S. No	Description	(Million Rs)		
		Package I	Package II	Total
1	Muslim Bagh Dispersal Structure	1,420.99	--	1,420.99
2	Killa Saifullah Dispersal Structure	--	1,237.50	1,237.50
3	Wulgai/ Khulgai Dispersal Structure	1,456.92	--	1,456.92
4	Gowal Dispersal Structure	--	1,480.48	1,480.48
5	Shinkai dispersal Structure	1,681.97	--	1,681.97
6	Humayun Killi Dispersal Structure	--	1,863.02	1,863.02
	TOTAL	**4,559.88**	**4,581.00**	**9,140.88**
7	2% Contingencies Cost	91.20	91.62	182.82
8	3% Detailed, Design, Supervision, Engineering and Administration Cost	136.80	137.43	274.23
9	6.50% Price Escalation per annum Cost	296.39	297.77	594.16
10	PIU Cost	42.41	42.41	84.81
11	Environmental Monitoring/ Mitigation Cost	31.73	31.73	63.46
	GRAND TOTAL	**5,158.40**	**5,181.95**	**10,340.35**

The detailed BOQ / Engineers Estimate is given in **Annexure E**.

9.2 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 are based on prevailing market rates. Detailed rate analysis has been carried out for each item of work.~~
- Extensive survey was carried out for the collection of prevailing rates of construction materials, labor and construction machinery. In addition the recently awarded tenders and estimates of works of similar nature were also studied.

9.3 DETAILED DESIGN, ADMINISTRATION AND ENGINEERING COST

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.

9.4 PHYSICAL AND FINANCIAL CONTINGENCIES

Physical and financial contingencies have been provided at the rate of 2% of the total base cost to allow for the design changes, delays, logistical changes keeping in mind the site specific conditions.

9.5 PROJECT IMPLEMENTATION

The Project is planned to be implemented over a period of 4 years (48 months) from the date of start including detailed design stage. Due to financial constraints the overall project has been divided into two packages each spread over a period of two years (24 months).

Serious steps need to be taken to implement the project so safeguard against cost over run. The detailed implementation schedule in the form of Gantt Chart is given in **Figure 9.1**.

9.6 OPERATION AND MAINTENANCE

The annual operation and maintenance cost of the Project has been estimated as Rs. 51.70 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, 6 mechanical and civil operators and other support staff will be employed during the operation and maintenance of the scheme.

SECTION 10
ECONOMIC AND FINANCIAL ANALYSES

10.1 BENEFITS OF THE PROJECT AND ANALYSIS

10.1.1 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 irrigation projects based on a breakdown 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.* A value of 85% is calculated for Steel and 72% for Cement.

Table 10.1 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**

10.1.2 Labour

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 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 600 per day in the scheme area for the common masonry work and Rs. 1000 per day in the city Quetta. Therefore the shadow ~~wage rate / conversion rate is valued at 80% of the financial cost.~~

10.1.3 Machinery and Transport

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

10.1.4 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 D

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

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 five years 2006-07 to 2010-11. 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.

10.2 PROJECT COSTS

10.2.1 Scheme Construction Costs

Scheme construction cost is estimated to be Rs 10,340.35 million including 3% of consultancy, engineering and administration cost and 4% for physical and financial contingencies.

It is assumed that the Project will be implemented in a period of two years and the financial phasing is as given in section 9.5. Economic development costs are estimated by converting at the CCF.

10.2.2 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 50 years and more. The discounting factor reduces the present values to almost making no effects in the overall returns in the 50th year.

10.2.3 Scheme O&M costs

O&M costs of the existing schemes are included in the benefit stream as an expense foregone. The maintenance cost of the new scheme comprising of civil works has been taken as 0.5% of the capital cost.

10.2.4 Land Development

Land development costs are included in the analysis. Land is a limiting factor and the command area soils are suited to irrigate agriculture and therefore land development costs are include all the schemes.

10.2.5 Command Area Development

Command area development costs are included in 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.

10.3 SCHEME BENEFITS

10.3.1 Agriculture Benefits

Suitable cropping pattern is essential for maximum benefits from project. Besides water available for crops, the following factors should be considered.

- Existing cropping pattern and cropping intensities
- Climatic condition of the area.
- Demand of crop in the area.
- Socio economic condition of the area.

Keeping in view above assumptions new cropping pattern has been designed. Proposed cropping pattern has been design according to soil, climate and demand of the area.

Due to cropping pattern, modern technology and water availability the yield of the area in acreage and production will increase. The changes in cropping pattern and yield with or without project are as under.

Table 10.2 Crop Production

Crop	Current		At Full Development		Without Project Yield		With Project Yield	
	Hectares	Acres	Hectares	Acres	Kg / Ha	Kg/ Acre	Kg/ Ha	Kg/Acre
Rabi Crops								
Wheat	61	150	1596	3943	1112	450	3954	1600
Rabi Vegetable	-	-	1934	4778	--	--	23475	10500
Rabi Pulses	-	-	304	750	--	--	1384	560
Kharif Crops								
Orchards	-	-	89	220	--	--	23475	9500
Kharif Vegetables	-	-	1024	2530	--	--	23475	10500
Pulses	-	-	848	2095	--	--	1384	560
Kharif Fodder	162	400	1233	3045	4942	2000	29652	12000
Sorghum	546	1350	6644	16410	1112	450	3954	1600
Maize	202	500	3482	8600	4942	2000	34594	14000
TOTAL	**971**	**2400**	**17,154**	**42,371**				

For each crop, financial and economic gross margins with or without project are determined. The increase in yield with project shows increase in economic change.

10.3.2 Livestock

Increase in yield of fodder production and crop residue significant increase in livestock. In analysis livestock production is not included.

10.3.3 Other Agriculture Benefits:

In addition to the benefits like increase in crop production, livestock etc, agriculture development will directly or indirectly enhance employment opportunities. Expansions in agro based industry will also a source of employment

Infrastructure saved

The damages caused by the floods will be reduced with the implementation of the project. As such the loss of:

- Private property including houses, livestock, land, crops and human lives will be saved.
- Government property including public buildings, roads and other public facilities will also be saved.

Improvement in Health Condition

There will be improvement in human diet and nutrition due to increased income. The increased income will also enable them to afford better health facilities.

Improvement in Regional Environment

With the increase in availability of water supply, there will be increase in availability of the basic food products to the people and also there would be increase in the income of people of regional due to multiplier effect.

10.3.4 Non Agricultural Benefits:

i) Women Empowerment

Women participation in economic development is quite vital. In rural area the women role is mainly limited to being a house wife, fetching water for drinking, home consumption, washing cloth and arrangement of water and fodder for animals etc. In all these activities the women usually spend 4-6 hours. To overcome their problem drinking water facilities, special washing and animal structures have been proposed so that they can save their precious time and utilize it instead on income generating activities like embroidery, house gardening etc and can play a role in economic development.

ii) Poverty Alleviation

The Net value of production of crops will increase from Rs. 18.10 million to Rs. 3311.25 million in without and with project situations respectively. This will create additional 3,246 full time job opportunities at full development. Hence the scheme development will contribute in the poverty reduction in the scheme area.

10.4 FINANCIAL / ECONOMIC ANALYSIS (WITH ASSUMPTIONS)

10.4.1 Financial Analysis

a. Quantifiable Output of the Project.

The benefits likely to accrue from the implementation of small dams Project are both tangible as well as intangible. The tangible benefits are those which can be directly expressed in monetary terms. These are represented by incremental crop production made possible by the implementation of the proposed project.

Based on the component wise agronomic data related to present and future cropping intensities, crop yields and associated crop inputs, crop budgets under with and without project conditions of economic and financial; prices have been prepared. Total GVP, cost of production NVP and incremental benefits have been computed by multiplying respective acreage under without and with project conditions and are shown in the following tables.

Table 10.3 G V P, FARM COST AND NVP UNDER "WITHOUT PROJECT" CONDITIONS
FINANCIAL PRICES

Million Rs.

Crops	Area (Hectares)	GVP (per Hectares)	GVP	Farm Cost	NVP
Rabi Crops					
Wheat	61	0.02	1.02	0.35	0.67
Kharif Crops	0				
Maize	202	0.01	1.06	0.83	0.23
Khraif Fodder	162	0.01	2.40	0.78	1.62
Sorghum	546	0.01	2.85	2.24	0.61
Total	**971**	**0.04**	**7.33**	**4.19**	**3.13**

Table 10.4 GVP, FARM COST AND NVP UNDER "WITH PROJECT" CONDITIONS
FINANCIAL PRICES

Million Rs.

Crops	Area (Hectares)	GVP (per Hectares)	GVP	Farm Cost	NVP
Wheat	1596	0.15	235	55	180
Rabi Pulses	304	0.07	21	4	17
Rabi Vegetable	1934	0.43	829	167	662
Sub-Total	3,833				
Kharif Crops					
~~Orchards~~	~~89~~	~~0.57~~	~~51.02~~	~~6.78~~	~~44.24~~
Kharif Vegetables	1,024	0.53	542.19	80.98	461.21
Kharif Pulses	848	0.07	59.68	12.17	47.51
Sorghum	6,641	0.07	460.01	150.10	309.91
Kharif Fodder	1,232	0.22	270.40	18.04	252.36
Maize	3,480	0.24	842.80	97.77	745.03
Sub-Total	**13,314**				
Total	**17,147**		**3311.25**	**592.09**	**2719.16**

Table 10.5 Financial Analysis

Year	Project Cost				Project Benefits		Net Benefits (M.Rs)
	Capital Cost	O&M	Existing Agriculture Benefits	Total	Agriculture	Total	
1	2129.5			2129.5			-2129.5
2	3059.1			3059.1			-3059.1
3	2078.8			2078.8			-2078.8
4	3072.9			3072.9			-3072.9
5		51.7	3.13	54.8	125.34	125.3	70.5
6		51.7	3.13	54.8	266.37	266.4	211.5
7		51.7	3.13	54.8	622.34	622.3	567.5
8		51.7	3.13	54.8	1300.53	1300.5	1245.7
9		51.7	3.13	54.8	1892.32	1892.3	1837.5
10		51.7	3.13	54.8	2685.20	2685.2	2630.4
11		51.7	3.13	54.8	2692.48	2692.5	2637.6
12		51.7	3.13	54.8	2703.76	2703.8	2648.9
13		51.7	3.13	54.8	2715.30	2715.3	2660.5
14		51.7	3.13	54.8	2719.16	2719.2	2664.3
15		51.7	3.13	54.8	2719.16	2719.2	2664.3
16		51.7	3.13	54.8	2719.16	2719.2	2664.3
17		51.7	3.13	54.8	2719.16	2719.2	2664.3
18		51.7	3.13	54.8	2719.16	2719.2	2664.3
19		51.7	3.13	54.8	2719.16	2719.2	2664.3
20		51.7	3.13	54.8	2719.16	2719.2	2664.3
21		51.7	3.13	54.8	2719.16	2719.2	2664.3
22		51.7	3.13	54.8	2719.16	2719.2	2664.3
23		51.7	3.13	54.8	2719.16	2719.2	2664.3
24		51.7	3.13	54.8	2719.16	2719.2	2664.3
25		51.7	3.13	54.8	2719.16	2719.2	2664.3
26		51.7	3.13	54.8	2719.16	2719.2	2664.3
27		51.7	3.13	54.8	2719.16	2719.2	2664.3
28		51.7	3.13	54.8	2719.16	2719.2	2664.3
29		51.7	3.13	54.8	2719.16	2719.2	2664.3
30		51.7	3.13	54.8	2719.16	2719.2	2664.3
31		51.7	3.13	54.8	2719.16	2719.2	2664.3
32		51.7	3.13	54.8	2719.16	2719.2	2664.3
33		51.7	3.13	54.8	2719.16	2719.2	2664.3
34		51.7	3.13	54.8	2719.16	2719.2	2664.3
35		51.7	3.13	54.8	2719.16	2719.2	2664.3
36		51.7	3.13	54.8	2719.16	2719.2	2664.3
37	307.3	51.7	3.13	362.1	2719.16	3026.45	2664.3

FIRR **13.50%**

10.4.2 Economic Analysis

a. Approach to Economic Analysis

The analysis has been carried out in economic prices. The financial prices have been shadow priced to remove distortions on account of taxes and subsidies as well as shortages or surpluses of labour and materials. Shadow pricing has been undertaken by valuing inputs and outputs at border prices expressed in Pak Rupees. As the rupee is generally free to float in the international currency market, it has not been necessary to shadow price foreign exchange.

b. Parameters for Economic Analysis

Price Datum

In the economic analysis, both costs and benefits have been expressed at a constant of price year 2012.

Exchange Rate

In view of the existence of a truly floating exchange rate Rs. 96/- to a US$ 1 as prevailing in the year 2010 has been taken to workout export parity prices and would be adopted throughout the analysis.

Standard Conversion Factor (SCF)

The standard conversion factor is used to estimate economic accounting prices of goods, which cannot be revalued at border prices because of constraints of information, time etc. The SCF (0.92) is particularly used in

- The calculation of basic parameters, where national values that are not project specific are needed and
- The revaluation of minor non-traded goods for which specific conversion factor are not available unless the specific conversion factors are very similar to standard conversion factor.

It is advisable to use SCF as sparingly as possible, SCF is an average and therefore specific conversion factor may be used whenever possible. The conversion factors workout in small Dam Project PC-I study for cement and steel have been used as 0.72 and 0.85 respectively. The SCF is calculated as a ratio of world (border) to domestic prices of imports & exports by estimating the weighted average of the scales of protection on imports and exports. SCF based on 5 years is given in Table 10.6.

Table 10.6 Derivation of Standard Conversion Factor (Amount in Pak. Rs.)

Description	2006-07	2007-08	2008-09	2009-10	2010-11	Average
Total Import	1,851,806	2,512,072	2,723,570	2,910,975	3,455,286	2,690,742
Total Export	1,029,312	1,196,638	1,383,718	1,617,458	2,120,847	1,469,594
Import Duties	138,692.0	156,662.0	146,439.0	156,554.0	179,723.0	155,614
Sales Tax on Imports	111,108	150,724	163,414	174,659	207,317	161,445
Subsidies on Imports	25,488	62,500	57,800	86,300	97,450	65,908

Description	2006-07	2007-08	2008-09	2009-10	2010-11	Average
Export Duties	2,573.3	2,991.6	3,459.3	4,043.6	5,302.1	3,674
SCF						**0.95**

Source: Government of Pakistan, Finance Division

Standard Conversion Factor = (M+X) / {(M+Tm) + (X-Tux)}

Where: M = CIF value of imports
X = FOB value of exports
T_m = Net value of taxes on exports

Discount Rate

The selection of an appropriate discount rate or 'Cash Flow' analysis is a matter of considerable importance.

In Pakistan, the marginal productivity of capital is believed to lie somewhere between 10 and 12 percent. A notification by the Financial Division, Budget Wing Government of Pakistan dated June 2012 regarding rate of mark-up chargeable on development loans and advances by the Federal Government to the Provincial Governments indicates a mark-up rate of 13.65%. The Opportunity Cost of Capital (OCC) in this appraisal has thus been taken as 13.65% for economic appraisal.

Border Prices

Border prices of wheat, rice, cotton and sugarcane for which Pakistan enters into foreign trade have been updated on the basis of latest available Commodity Forecasts for October, 2010 (World Bank Development Prospects). Border prices of major inputs i.e. chemical fertilizers have also been calculated on this basis.

Boarder prices have been converted to rupee prices by using an exchange rate of Rs. 96 to a US Dollar. Necessary adjustments were made to account for transportation and handling charges between the port and market as well as from the market to the farm-gate.

Domestic Prices

The estimation of benefits and farm costs is based on farm gate prices of inputs and outputs. For this purpose, the commodities have been categorized as traded and non-traded. The traded commodities are valued at farm gate by applying their FOB/CIF prices (Export & Import parity prices) and the incidental charges there upon. A Standard Conversion Factor (SCF) of 0.95 has been applied to the financial prices of the non-traded commodities to work out their economic values.

For non-traded commodities, data from Agriculture, Marketing & Grading Deptt. Quetta, Bureau of Statistics and Command area of Project have been collected and processed. The marketing margin and hauling expenses have been deducted from the wholesale market prices to arrive at the farm gate prices.

There has been a rising trend in the prices of these commodities in the past and its determination over the future period is difficult to predict with a reasonable degree of certainty. Thus, to avoid too much subjective estimation in the prices, it has been assumed that any increase in the prices of farm products will be balanced by the corresponding increase in the cost of various inputs required for the production of these commodities and the investment made for implementation of the project. Hence constant prices have been used for analysis.

Certain corps like Wheat, Sorghum and pulses by-products of Wheat bousa & Sorghum stalks and Fodder their values have also been included in the estimation of crop benefits.

The main outputs required for the production of crops are fertilizers, seed, insecticides, mechanical and labour, hand tools, etc. because of distortion in prices of these commodities due to government policies and market imperfections, differentiations have been made between the financial and economic prices of these inputs by applying the standard conversion factor. Economic and financial prices are given in Tables

Table 10.7 Economic and Financial Prices (Rs. / kg)

	Economic	Financial
Rabi Crops		
Wheat	31.44	26.75
Rabi Vegetables	11.49	12.77
Rabi Pulses	40.95	45.5
Kharif Crops		
Orchards	21.97	24.41
Kharif Vegetables	16.39	18.21
Kharif Pulses	40.95	45.5
Kharif Fodder	6.66	7.4
Sorghum	13.7	15.24
Maize	6.3	7

Table 10.8 Import Parity Price of Wheat

Description	Price
Wheat Un-milled, Hard Red winter (HRW) US Delivered at Gulf Port	289
Transport and handling charges	79
Value of Export at FOB Million Rupees.	368
Exchange Rate	85
Wheat HRW Imported CIF price at port of Karachi (Rs/M. Tons) /a	31280
~~Handling at Port (Wharfage) and~~	
Shifting from wharf to vessel Adjusted by SCF /b	47.22
Handling and transportation between	
Port and market (Muzaffarbad) adjusted by SCF. Rs/M. Ton /c	1170
Local market Price Rs/M. Ton	32497.22
Handling and transportation between	
farmgate and market adjusted by SCF. Rs/M. Ton /d	1057.50
Farmgate price of Wheat -- Rs/M. Ton	31439.72
Rs/Kg.	**31.44**

World Bank" Commodity Price Data" April 2012
/b Section 4 SRO guide Karachi Port Trust
/c Pakistan Railway Freight charges Adjusted by SCF.
/d Field Survey and estimated by consultants
SCF = 0.90

10.4.3 Crops Budgets

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.

10.4.4 Project Benefits

The implementation of project will result in increased crop production, resulting in increase in cropping intensity from 14.54% to 100% and improvement in yield /acre whereas fisheries will be developed in the reservoir area. The benefits from farm forest have also been taken into account. Moreover, economic evaluation of the proposed development programme has been carried out by translating these benefits into monetary terms.

To be realistic, the project returns must be assessed at their true value to the national economy rather than their mere profitability to the farmer. The following criteria have been assumed in determining the economic benefits of the Project.

- In the absence of a reliable estimate of variety-wise production of major crops, where price differentials for various varieties are substantial, as for example wheat, a uniform price level has been used.
- In order to visualize realistically the impact of increase in production brought about by the provision on augmented water supplies and to offset inflation, the prices have been kept constant for computing the agricultural benefits.
- In other cases, the Government creates incentives by providing subsidy on farm inputs and reducing the farm prices to well below their true costs; for instance fertilizer, insecticides, pesticides and other farm inputs. Thus, farmers pay less than their real prices. These taxes, duties and subsidies are considered as transfer payments that are not counted for while developing economic costs and benefits.

a. Agriculture Benefits

The estimation of crop benefits in the area based on the per acre crop budget for individual crops has been worked out for "with " and "without" project conditions at economic prices as well as financial prices are produced in the feasibility report.

The benefits have been expressed in terms of Net Value of Production (NVP), which is the difference between the Gross Value of Production (GVP) and the estimated Production Costs. Incremental benefits anticipated to flow from project implementation are the difference between the NVP "with" and "without" project situation. On the basis of per acre analysis, NVP "with" and "without" project situation have been worked out and shown in Table 10.9 and Whereas incremental benefits are given in Tables-10.10.

Table 10.9 G V P, FARM COST AND NVP UNDER "WITHOUT PROJECT" CONDITIONS
ECONOMIC PRICES

Million Rs.

Crops	Area (hectares)	GVP (per	GVP	Farm	NVP
Rabi Crops					
Wheat	61	0.02	1.11	0.32	0.80
Kharif Crops	0				
Maize	202	0.00	0.95	0.75	0.20
Khraif Fodder	162	0.01	2.16	0.00	2.15
Sorghum	546	0.01	3.50	1.16	2.35
Total	**971**	**0.042**	**18.17**	**5.49**	**12.68**

Table 10.10 GVP, FARM COST AND NVP UNDER "WITH PROJECT" CONDITIONS
ECONOMIC PRICES

Million Rs.

Crops	Area (Hectares)	GVP (per	GVP	Farm	NVP
Rabi Crops					
Wheat	1596	0.16	257.21	54.89	202.32
Rabi Pulses	304	0.06	19.23	3.42	15.81
Rabi Vegetable	1934	0.39	745.91	146.04	599.87
Sub-Total	**3833**				
Kharif Crops					
Orchards	89	0.52	45.92	5.89	40.03
Kharif Vegetables	1024	0.48	487.97	70.60	417.37
Kharif Pulses	848	0.06	53.71	9.55	44.16
Sorghum	6641	0.06	414.00	121.14	292.87
Kharif Fodder	1232	0.20	243.36	15.63	227.73
Maize	3480	0.22	758.52	83.98	674.54
Sub-Total	**13314**				
Total	**17,147**		**3,026**	**565**	**2,461**

Table 10.11 Economic Analysis

Year	Project Cost				Project Benefits		Net Benefits (M.Rs)
	Capital Cost	O&M	Existing Agriculture Benefits	Total	Agriculture	Total	
1	1703.6			1703.6			-1703.6
2	2447.3			2447.3			-2447.3
3	1663.0			1663.0			-1663.0
4	2458.3			2458.3			-2458.3
5		46.5	5.50	46.5	116.8	116.8	70.2
6		46.5	5.50	52.0	250.1	250.1	198.1
7		46.5	5.50	52.0	579.9	579.9	527.8
8		46.5	5.50	52.0	1212.2	1212.2	1160.2
9		46.5	5.50	52.0	1764.3	1764.3	1712.3
10		46.5	5.50	52.0	2511.2	2511.2	2459.2
11		46.5	5.50	52.0	2511.2	2511.2	2459.2
12		46.5	5.50	52.0	2511.2	2511.2	2459.2
13		46.5	5.50	52.0	2511.2	2511.2	2459.2
14		46.5	5.50	52.0	2511.2	2511.2	2459.2
15		46.5	5.50	52.0	2511.2	2511.2	2459.2
16		46.5	5.50	52.0	2511.2	2511.2	2459.2
17		46.5	5.50	52.0	2511.2	2511.2	2459.2
18		46.5	5.50	52.0	2511.2	2511.2	2459.2
19		46.5	5.50	52.0	2511.2	2511.2	2459.2
20		46.5	5.50	52.0	2511.2	2511.2	2459.2
21		46.5	5.50	52.0	2511.2	2511.2	2459.2
22		46.5	5.50	52.0	2511.2	2511.2	2459.2
23		46.5	5.50	52.0	2511.2	2511.2	2459.2
24		46.5	5.50	52.0	2511.2	2511.2	2459.2
25		46.5	5.50	52.0	2511.2	2511.2	2459.2
26		46.5	5.50	52.0	2511.2	2511.2	2459.2
27		46.5	5.50	52.0	2511.2	2511.2	2459.2
28		46.5	5.50	52.0	2511.2	2511.2	2459.2
29		46.5	5.50	52.0	2511.2	2511.2	2459.2
30		46.5	5.50	52.0	2511.2	2511.2	2459.2
31		46.5	5.50	52.0	2511.2	2511.2	2459.2
32		46.5	5.50	52.0	2511.2	2511.2	2459.2
33		46.5	5.50	52.0	2511.2	2511.2	2459.2
34		46.5	5.50	52.0	2511.2	2511.2	2459.2
35		46.5	5.50	52.0	2511.2	2511.2	2459.2
36		46.5	5.50	52.0	2511.2	2511.2	2459.2
37	827.0	46.5	5.50	52.0	2511.2	2787.8	2735.7

EIRR 14.87%

10.4.5 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.

10.4.6 Establishing Perennial Crops

It is assumed that with the development of the scheme the supply of irrigation water will become perennial and the scheme's cropping pattern will change from grain to vegetables and fruits (perennial) crops which have higher economic returns.

In most cases perennial crops are intercropped for a few years during establishment. The inter cropping of vegetables or fodder has been built into the orchards budgets.

10.5 ESTIMATING FIRR AND EIRR

The IRR is estimated by entering the costs streams and benefits streams in columns of a spreadsheet, calculating the net cash flow 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 13.50% and the EIRR at 14.87% 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 10.12. The scheme is not unduly sensitive to departures from the design.

Table 10.12 Sensitivity of FIRR and EIRR

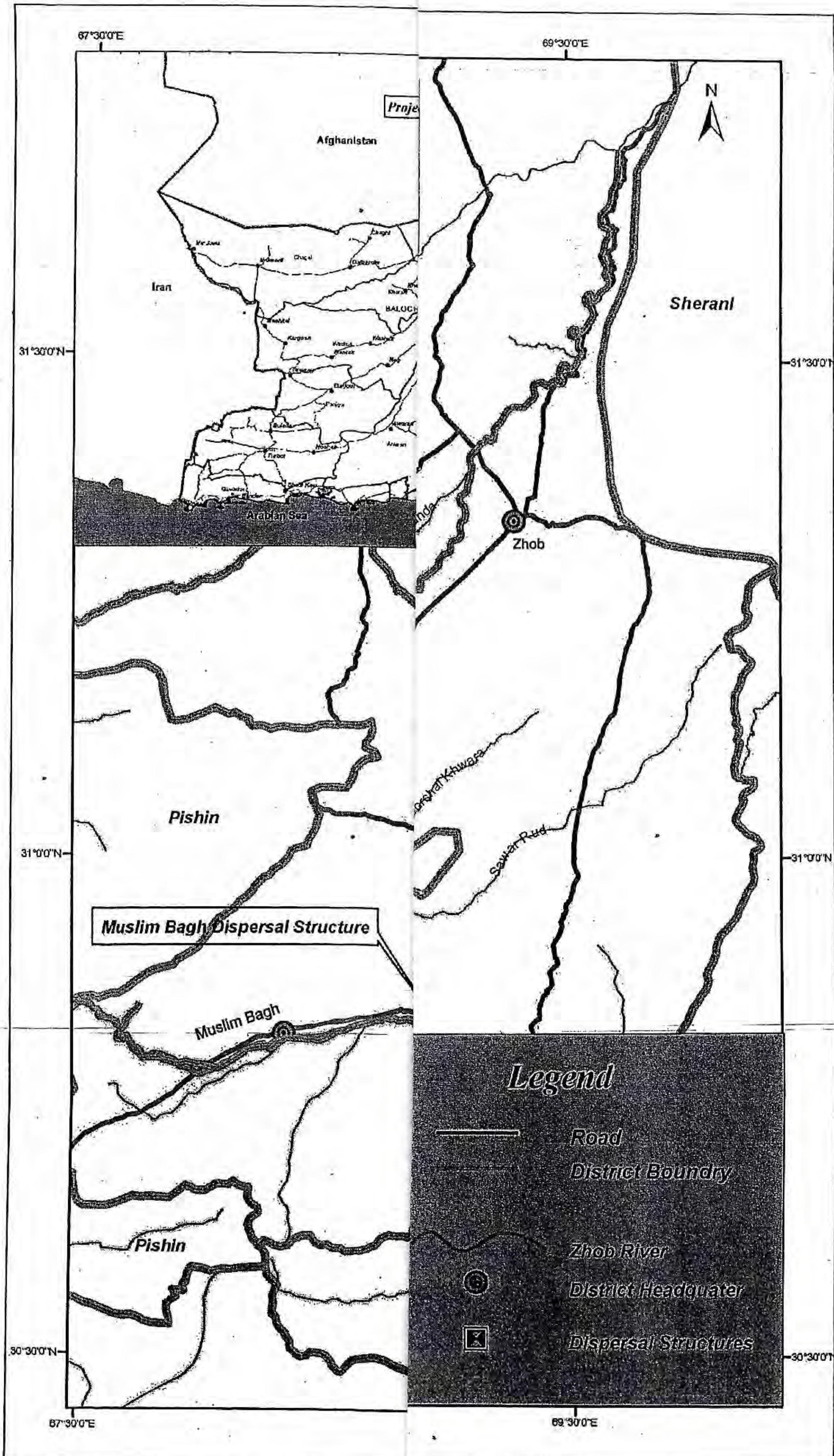
Assumption	Drip Irrigation System	
	FIRR	EIRR
Base Model	13.50%	14.87%
Benefits delayed 3 years	10.72%	11.66%
Incremental benefits reduced by 20%	11.25%	12.47%
Construction costs increased by 20%	11.90%	13.13%
Benefits reduced and costs increased by 20%	10.73%	12.94%

The Net Present Value and Benefit Cost Ratio at different discount rates have been calculated as follows.

Table 10.13 Net Present Value and Benefit Cost Ratio

Discount	Cost	Benefits	NPV	B/C Ratio
10	6,803.98	11,744.6	4,940.7	1.73
12	6,458.67	6,751.1	292.5	1.05
14	6,149.73	6,751.1	601.4	1.10
16	5,869.95	5,260.6	(609.3)	0.90

The detailed financial and economic analyses are given in Annexures F and G.



CLIENT:

IRRIGATION DEPARTMENT
GOVERNMENT OF BALOCHISTAN

CONSULTANTS:

CAM
CONSULTA
CONSULTING ENGIN

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