3.7 Floodplain Management Plan

3.7.1 General Concept of Floodplain Management

In general term, floodplains are the lowlands adjoining the river channels, streams or other watercourses, or the shorelines of oceans, lakes, or other bodies of water. They are lands that have been or may be inundated by floodwater. Floodplain management is a broad concept combining various flood management regulatory systems so as to totally reduce flood losses and to conserve natural and cultural resources. Normally floodplain management could be divided into five management systems, but weighting of the combination will vary in accordance with situations of country or region.

Table PI.41 Floodplain Management Framework

1.	Development Policy - Regional development plan - Rural/Agricultural development plan - Urban/City development plan
2.	Land Use Regulations - Urban planning - Housing code - Land use zoning
3.	Flood Control Structural Plan - Dams and reservoirs - Dikes and floodwalls - River channel excavation and dredging - Land treatment
4.	Alleviation of Flooding Impacts - Flood insurance - Tax adjustment - Disaster assistance - Post-flood recovery
5.	Flood Preparedness - Flood proofing - Flood preparedness education and training - Flood forecasting and warning system and emergency plan

In Iran there are no experiences to adopt the floodplain management system. As easily understood in the above table, most of the management systems are based on the national legal system. Therefore application of full-scale floodplain management depends on national policy, legislative preparation and decision-making process.

Some frameworks, however, could be applied to the Madarsoo River basin without national legislative preparation so that the objectives of the master plan, in particular to save people's life, could be realized in the Madarsoo floodplain. This is the standpoint of the master plan for the floodplain management.

3.7.2 Madarsoo River Floodplain and its Management Frame

In the lower reaches of the Madarsoo River, floodwater has eroded erosive soils of the Gorgan Plains together with free meandering and channel downcutting. Finally the river course forms lower terraces at 5-10 m lower than the Gorgan Plain and with about 1 km width. At present the river flows its free meandering courses inside of the lower terraces.

In addition to the topographic features, villages and irrigated farmlands are traditionally located in the Gorgan Plain (upper terraces), while only extensive farmlands are situated in the lower terraces. Thus, if proper information on the flood

hazard area is provided to residents living in the lower reaches, they will not directly suffered from floods at least.

In due consideration of the above mentioned situation, the suitable and bare minimum frameworks are tabulated below for the Madarsoo River floodplain management.

Table PI.42 Floodplain Management Framework in the Madarsoo River

Management Frame	Responsible Agencies
1. Development Policy - Rural development scheme (HADI)	 Housing Foundation of Islamic Revolution
2. Flood Control Structural Plan - Dams and reservoirs - Dikes and floodwalls - River channel excavation and dredging - Land treatment	 MOE, MOJA MOE, MOJA MOE, MOJA MOJA
3. Alleviation of Flooding Impacts - Disaster assistance - Post-flood recovery	 Provincial Disaster Management Committee (PDMC), Imam Khomeini Relief Foundation, Red Crescent Provincial Governor's Office
4. Flood Preparedness - Flood preparedness education and training - Flood forecasting and warning system and emergency plan	 Proposed in the master plan PDMC, Proposed in the master plan

Essential frameworks are (1) rural development scheme, (2) flood preparedness education and training, and (3) flood forecasting and warning system and emergency plan. As for alleviation of flooding impacts, activities on disaster assistance and post-flood recovery are already well organized among the related agencies. It was proven in the recent flood occurred in 10 August 2005. These three schemes are closely related each other as illustrated in the following figure. As easily understanding from the figure, the flood hazard map plays a central role in the proposed floodplain management plan.

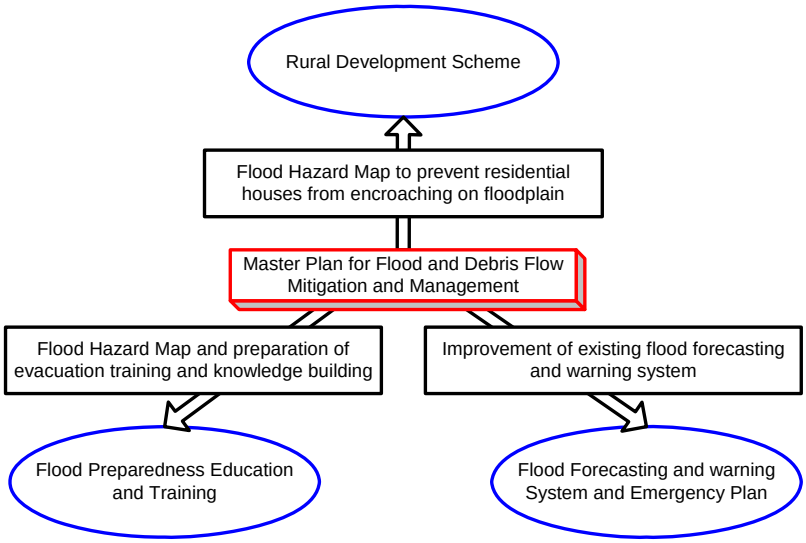


Fig. PI.54 Relationship among Floodplain Management Frames and Master Plan

3.7.3 Publication of Flood Hazard Map

Dissemination of the flood hazard map is broadly adapted in the world as one of the useful non-structural flood mitigation measures. Through dissemination of the flood hazard map, the residents could aware the extent of the possible flood inundation area and the available evacuation routes during floods.

The flood hazard map could also be the guidance for appropriate urban planning and land development. The flood hazard map, in general, contains the information on: (1) the probable extent of flood inundation and (2) the evacuation sites and evacuation routes to be taken during floods. The extent of the probable flood inundation is delineated on the base map. The flood risk map thus prepared should be disseminated to the public through a bulletin, an information board and other available information tools.

3.8 Flood Preparedness Plan

3.8.1 Necessity of Flood Preparedness

Flood preparedness is usually regarded as comprising measures that enable governments, organizations, communities and individuals to respond rapidly and effectively to flood disaster situations. In general flood preparedness measures are:

- Provisions for emergency action, such as evacuation
- Provision of warning system
- Emergency communications
- Public education and awareness
- Training including exercises and tests

The flood preparedness is the most critical and important part in the entire disaster management because it is the nearest and closest provisions to the residents who might be casualties in the floods. The relations between the master plan and flood preparedness are illustrated in the following figure.

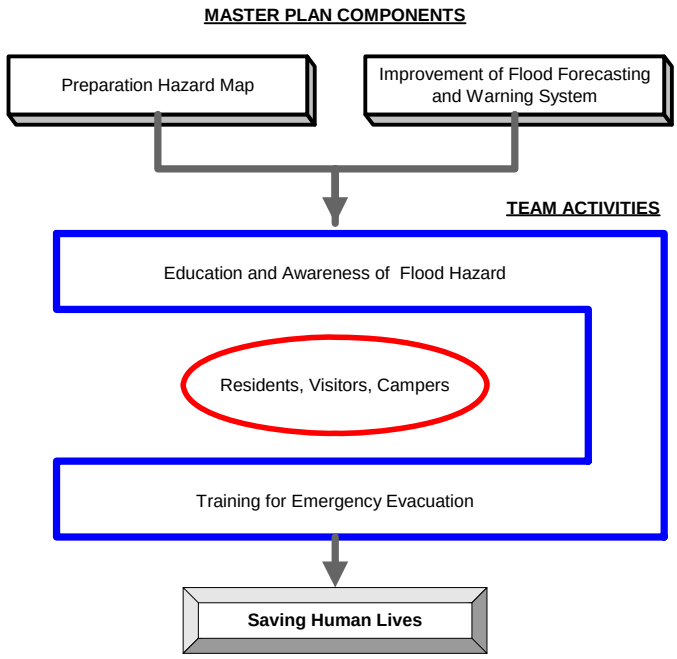


Fig. PI.55 Master Plan Components and Team Activities in Flood Preparedness

3.8.2 Flood Preparedness Activities

Target people are who suffer from severe flood disaster damage include visitors and campers in the Golestan Forest Park. In particular, visitors and campers may have little knowledge and information concerning the risks of flood disaster in the area. When a flood and debris flow disaster occurs, such people would easily panic resulting in a more severe damage, as witnessed in the 2001 flood. In this context, it is necessary to publicize the flood and debris flow hazard map to visitors and campers in the Golestan Forest Park as well as the local inhabitants to avoid such panic and to encourage them make efforts for saving their own lives, helping each other and informing administrations.

In relation to the hazard map, the following public information efforts are also effective for the disaster preparedness:

- Installation of signboards;
- Distribution of leaflet/newsletter; and
- Dissemination of information through Internet.

The team prepared newsletter and Internet homepage to disseminate useful information on flood preparedness. Furthermore, as illustrated in the above figure, the team conducted education and awareness on flood hazard and evacuation training to the village residents through preliminary public hearing in the master plan stage as well as public hearing in the feasibility study stage. The following figure shows photos taken during the preliminary public hearing in the disaster prone villages, Dasht and Terjenly, which were held in September 2005.

Dasht village

Terjenly village

Fig. PI.56 Preliminary Public Hearing in Disaster Prone Village, September 2005

3.9 Summary of Master Plan Component

3.9.1 Proposed Component in the Master Plan

As discussed in Section 3.2 to 3.8, the master plan components became more concrete, their necessary costs are estimated and implementation schedules were proposed. Table PI.43 summarizes the proposed master plan components. As summarized in the table, the master plan integrates newly proposed plans and on-going projects since they are closely related each other. Watershed management plan, including debris flow control plan, is being conducted by MOJA, and flood control plan is also being conducted as a rehabilitation part by MOE and MORT.

Table PI.43 Summary of the Proposed Master Plan Component and Sub-Scheme

Master Plan Component		Sub-Scheme	Component/Scheme Digest	Project Cost (million Rials)
1	Watershed Management Plan	5 sub-basins	Conducting improvement measures combining mechanical, bio-mechanical and biological engineering measures	79,374
2	River Restoration and Improvement Plan	Ghiz Ghaleh	Rehabilitating the damaged earth dam to consolidate stored sediment and constructing channel system in Ghiz Ghaleh	55,890
		Gelman Darreh and Dasht-e-Sheikh	Constructing channel system in three rivers of Gelman Darreh and Dasht-e-Sheikh	195,200
3	Golestan Forest Disaster Management Plan	Flood forecasting and warning system	Improving existing meteo-hydrologic monitoring system, data transmission and processing system to utilize real time data for flood forecasting, and installing warning posts	3,300
4	Debris Flow Control Plan	Assistance for MOJA activities	Constructing sediment control structures and channeling works in debris flow affected villages	-
5	Flood Control Plan	Recommendation to MOE and MORT plans	Rehabilitating damaged structures in both of the 2001 and 2005 floods and establishing the master plan for the Golestan dam basin	-
6	Floodplain Management Plan	Publication of flood hazard map	Publishing the flood and debris flow hazard map and utilizing it for evacuation activities and land use management	-
7	Flood Preparedness Plan	Extension of flood warning system	Installing warning posts at villages located in the middle and lower reaches to announce the flood warning to the villagers	3,300
		Educational assistance	Conducting education and awareness of flood hazard and training exercise for evacuation in the villages	-

3.9.2 Implementation Plan

Regarding the newly proposed projects, their implementation programs were already proposed in parallel with presentation of each component in the previous sections. As for on-going projects such as MOE and MORT rehabilitation projects, these projects are being conducted to restore the damaged structures. Based on the above considerations, the implementation plan is summarized in the following table.

Table PI.44 Implementation Plan of Master Plan Component

M.P. Component		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1.	Watershed Management Plan											
2	River Restoration Plan											
	Sediment Control Dam											
	River Improvement											
3.	Golestan Forest D.M. Plan											
4.	Debris Flow Control Plan											
5.	Flood Control Plan					→	→	→	→	→	→	→
6.	Floodplain Management Plan		→	→	→	→	→	→	→	→	→	→
7.	Flood Preparedness Plan		→	→	→	→	→				→	→
	Extension of Flood Warning											
	Educational Assistance		→	→	→	→	→	→	→	→	→	→

→: Continuous conducting the scheme

3.10 Project Evaluation

3.10.1 Economic Evaluation

Watershed Management Plan

This component is planned by the MOJA, and under studying its detail. The purposes are (1) to mitigate damages caused by flood/debris flow, (2) to control run-off to the rivers, (3) to lengthen time-lag of run-off to the river after rainfall so that peak discharge could be attenuated. The following economic benefits may be derived due to the execution of the plan.

(1) From the terrace field and banquette field including furrow, it is expected that such agricultural products as Olive and so on may be generated. These products will contribute to the farmers' income. It means that the plan contributes to the rural economy.

(2) From the fertilizing and/or planting atriplex as provender, it is expected that breeding of such livestock as sheep, goat and cow will be promoted more than the present situation. From sheep and goat, meat supply to markets could be expected. In other words, this work also contributes to the rural economy.

(3) Cow breeding is usually made for milk, cheese and butter production. Therefore, the dairy industry will also be promoted.

(4) To keep water by roots of such trees and grasses contributes to lengthen time-lag of runoff to the river after rainfall so that peak discharge could be controlled. Therefore, it is expected that damages caused by floods will be decreased or mitigated.

(5) To control of soil erosion contributes to decrease sedimentation of the river so that the river condition and/or discharge capacity of the river will be kept in original situation. This may also contribute to lengthen the lifetime of the Golestan Dam in the downstream of the Madarsoo River.

A part of this Watershed Management Plan is included in the next "River Restoration and Improvement Plan" discussed hereunder.

River Restoration and Improvement Plan

The project site of the river restoration plan is located in the Dasht area upstream of the Madarsoo River. Three major river systems join together in the Dasht plain. These are Gelman Darreh, Dasht-e-Sheykh and Ghiz Galeh rivers. Among them, the watershed management is also planned in the Dasht-e-Sheykh and Ghiz Galeh basins. Therefore the watershed management plan should be premised as an antecedent project.

The River Restoration and Improvement Plan will produce the project benefits in combination with three plans, namely (1) the watershed management works (WM or WMP), (2) the sediment control works (SC or SCD) and (3) the river improvement works including the erosion control works (RI or RIW). Following damages are estimated by deriving from land values including housing, agricultural production and related public facilities. Designed scale of the facilities is for flood/debris flow in 25-year in return period. Damages are to be converted into annual average amount by using probability analysis.

Table PI.45 Estimation of Annual Average Flood Damages by Combination of Plans under the Present and Future Conditions

Under the Present Condition (Million Rials)

Return Period (Year)	Under the Witout Project Condition	Under the Condition with WM		Under the Condition with WM + SC		Under the Condition with WM + SC + RI	
		Remaining Damages	Benefit	Remaining Damages	Benefit	Remaining Damages	Benefit
1	0	0	0	0	0	0	0
5	396	386	10	342	53	0	396
10	565	551	14	495	70	0	565
25	**942**	**902**	**40**	**819**	**123**	**0**	**942**
50	1,341	1,285	56	1,024	317	23	1,317
100	1,663	1,596	66	1,163	500	66	1,597

Under 2025 Year Condition (Million Rials)

Return Period (Year)	Under the Witout Project Condition	Under the Condition with WM		Under the Condition with WM + SC		Under the Condition with WM + SC + RI	
		Remaining Damages	Benefit	Remaining Damages	Benefit	Remaining Damages	Benefit
1	0	0	0	0	0	0	0
5	791	772	19	685	107	0	791
10	1,131	1,102	29	990	141	0	1,131
25	**1,779**	**1,711**	**68**	**1,556**	**224**	**0**	**1,779**
50	2,398	2,306	92	1,897	501	47	2,351
100	2,884	2,777	107	2,122	762	124	2,760

(Note) WM: The Watershed Management Works.
SC: The Sediment Control Dam Construction Works.
RI: The River Improvement Works.

On the other hand, for the annual average benefit for the SCD, the followings could be estimated because debris flow brings the crushing damages to the houses and household properties if it occurs.

Table PI.46 Summary of Annual Average Debris Flow Damages and Calculation of Economic Benefit

WMP and SCD under the Present (Million Rials)

Return Period (Year)	Under the Witout Project Condition	Under the Condition with WMP		Under the Condition with WMP + SCD	
		Remaining	Benefit	Remaining	Benefit
1	0	0	0	0	0
5	1,361	1,361	0	0	1,361
10	1,905	1,905	0	0	1,905
25	2,517	2,497	20	0	2,517
50	2,796	2,762	34	0	2,796
100	**2,956**	**2,915**	**41**	**0**	**2,956**

WMP and SCD under 2025 Year Condition (Million Rials)

Return Period (Year)	Under the Witout Project Condition	Under the Condition with WMP		Under the Condition with WMP + SCD	
		Remaining	Benefit	Remaining	Benefit
1	0	0	0	0	0
5	1,944	1,944	0	0	1,944
10	2,722	2,722	0	0	2,722
25	3,597	3,567	29	0	3,597
50	3,995	3,946	49	0	3,995
100	**4,224**	**4,165**	**58**	**0**	**4,224**

(Note) WMP: Contribution from the works on Watershed Management Plan.
SCD: The works on Sediment Control Dam.

In addition to the above, the annual average economic benefit produced by the erosion control structure (ECD) is to be calculated because the riverside agricultural area is completely washed away and it will be no longer usable if the erosion occurs. Accordingly, the direct economic benefit of erosion control works is the amount of damages to the riverside agricultural area to be protected.

Table PI.47 Summary of Annual Average Erosion Damages and Calculation of Economic Benefit

ECD under the Present Condition (Million Rials)

Return Period (Year)	Under the Witout Project Condition	Under the Condition with ECD	
		Remaining Damages	Benefit
1	0	0	0
5	1	0	1
10	2	0	2
25	3	0	3
50	4	0	4
100	**5**	**0**	**5**

ECD under 2025 Year Condition (Million Rials)

Return Period (Year)	Under the Witout Project Condition	Under the Condition with WMP	
		Remaining Damages	Benefit
1	0	0	0
5	3	0	3
10	5	0	5
25	7	0	7
50	8	0	8
100	**10**	**0**	**10**

(Note) ECD: The works on Erosion Control Dam.

Summary of financial and economic costs and their annual disbursement is shown in the following table.

Table PI.48 Summary of Project Cost and Its Annual Disbursement

(Million Rials)

Item	Total Cost	Disbursement									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
WMP Only											
Financial Cost	55,471	18,484	8,227	10,490	6,849	8,344	2,717	180	180	0	0
Economic Cost	50,074	16,686	7,427	9,469	6,183	7,532	2,453	163	163	0	0
WMP + SCD											
Financial Cost	117,474	25,717	14,421	26,862	22,494	24,287	3,260	216	216	0	0
Economic Cost	90,163	20,222	10,991	20,465	17,179	18,528	2,453	163	163	0	0
WMP + SCD + RIW											
Financial Cost	312,670	25,717	14,421	26,862	22,494	35,918	24,247	40,861	40,861	40,645	40,645
Economic Cost	240,690	20,222	10,991	20,465	17,179	30,159	16,189	31,453	31,453	31,290	31,290

Using cash flow of the cost and benefit, the economic evaluation is made. For evaluation, the Net Present Value (NPV, i.e. B-C in terms of the present value), the Economic Internal Rate of Return (EIRR) and the Benefit-Cost Ratio (B/C Ratio) are adopted as evaluation indicators. The discount rate is applied at 10 % taking similar projects in developing countries into account.

Table PI.49 Summary of Economic Evaluation Results

Evaluation Indicator	Under the Present Condition			Under the 2025-Year Condition		
	WM Only	WM + SC	WM + SC + RI	WM Only	WM + SC	WM + SC + RI
NPV	71,667	59,492	-13,852	71,778	63,856	-7,732
EIRR	21.08%	16.40%	8.86%	21.10%	16.77%	9.38%
B/C Ratio	2.89	1.94	0.90	2.90	2.01	0.94

(Note) NPV is expressed by "million Rials".

Needless to say, this kind of project is so called as public works. Especially the works of SC and RI are the pure public works. Several international financing institutions such as World Bank recommend that the EIRR of 5 % can be acceptable as viable from the viewpoint of the basic human needs for the projects in public works.

Furthermore, usually the works of RI need a great of costs but the socio-economic benefits is derived rather not so much comparing with the costs. However, combination with WM and SC shows an enough viability to conduct the project as 16.40 % at the present condition and 16.77 % at 2025-year condition.

Accordingly, the project of this component has the viability to conduct from the viewpoint of basic human needs, but it should be considered to making choice of optional work items taking priority into account.

Golestan Forest Park Disaster Management Plan

Based on various information sources of Golestan Forest Museum and restaurants in the both entrances of the forest, average number of campers and/or visitors for recreation purpose could be estimated at 208 people per day.

On the other hand, according to the information, 194 persons have lost their life with no any survivals in the 2001 Flood because the route passes through narrow valley. This is not so much different number with the abovementioned calculated one. From this viewpoint, it may say that the said assumption is reasonable. If it is assumed that, (1) frequency of flood in the Golestan Forest is one fifth (once every 5 years), (2) the average age of campers and/or visitors who are working at present: 40 years old, (3) the annual damages to human life

caused by floods can be estimated at around Rials 5,875 million/annum [=Rials 55,521,629× 0.7(life cost: 30 % should be deducted)×16.804 (Coefficient of New Hoffmannsche Method) ×45 families×20 %(discount rate for estimation safety)].

If floods occur, the people who are just enjoying in the Golestan Forest must surely lose their life. It means that they lose their expected all the incomes to be gotten in the future after their ends. As a result, the amount of around Rials 5,875 million may be lost as damages in total in case of the same scale of the 2001 Flood. Assuming the damages in 5-year flood to be 1/10 of the said amount, the annual average damages to casualties caused by flood are estimated.

The amount of annual average damages to expected income in total is estimated at a sum of Rials 669 million per annum as shown in the following table.

Table PI.50 Estimation of Annual Average Damages to Expected Income

Without Project

2005-price Level
(1,000 Rials)

Return Period (Year)	Exceedance	Difference of Exceedance	Direct Damages by Return Period (Million Rials)		Annual Average Damages by Return Period (Million Rials)	Cummulative Annual Average Damages (Million Rials)
			Amount	Mean	Segment	
1	1.0000	-	0	0	0	0
5	0.2000	0.8000	587,506	293,753	235,002	235,002
10	0.1000	0.1000	2,179,219	1,383,362	138,336	373,339
25	0.0400	0.0600	4,283,348	3,231,283	193,877	567,216
50	**0.0200**	**0.0200**	**5,875,061**	**5,079,205**	**101,584**	**668,800**

A systematic flood warning system is one of effective measures against floods in the park. This component is a plan to establish a suitable Flood Forecasting and Warning System. Annual cost disbursement is planned as follows.

Table PI.51 Annual Cost Disbursement for Golestan Forest Park Disaster Management Plan

(Million Rials)

Item	Cost in Total	Annual Disbursement				
		2007	2008	2009	2010	2011
Financial Cost	3,215	995	688	526	526	480
Economic Cost	2,902	898	621	475	475	433

Using a cash flow of the cost and benefit, the economic evaluation is made in the same manner of the above “River Restoration and Improvement Plan”. Also for evaluation, the Net Present Value (NPV, i.e. B-C in terms of the present value), the Economic Internal Rate of Return (EIRR) and the Benefit-Cost Ratio (B/C Ratio) are used as evaluation indicators in this component too. The discount rate is applied at 10 % taking similar projects in developing countries into account. The results are summarized as shown in the following table.

Table PI.52 Summary of Economic Evaluation Result

Evaluation Indicator	Under the Present Economic Condition	Under the 2025-Year Economic Condition
NPV	1,513	3,039
EIRR	10.47%	15.06%
B/C Ratio	1.80	2.61

(Note)
NPV is expressed by million Rials.

As shown in the above table, both EIRRs at present condition and at 2025-Year condition are higher than 10 % of the applied discount rate as 10.47 % and 15.06 %, respectively. Thus the Golestan Forest Park Disaster Management Plan has enough viability to execute.

Debris Flow Control Plan

This component consists of construction of sabo dam and channel improvement works in the debris flow prone villages in the area downstream of Tangrah village. It is under planned by MOJA, and will be executed by them.

For instance, in Terjenly village, there are breeding lots of livestocks such as sheep, goat and cow in the residential area. Therefore, if once floods occur, damages are not only to houses and household movables but also to livestock in their residential area.

Flood Control Plan

This component consists of river improvement works for the mainstream of the Madarsoo River. Basically the flood control plan shall be conducted by MOE in cooperation with MORT for the road improvement. Now MOE is going to restart their rehabilitation works, since the recent 2005 Flood destroyed again rehabilitated structures.

The constrictions of some bridges bring about flood damage for the huge areas of several hundred ha upstream of them. Even in rural areas, damages of farmlands might be brought about from the floods. If it is taken into consideration that the targeted areas are the urban areas, they should have several times greater value of land to be damaged when the areas will be left as it is without any counter measures.

Floodplain Management Plan

Because of lack of information concerning the flood occurrence and/or lack of suitable information network system on flood forecasting and warning, people, especially farmers, come into the river-terrace for operation and maintenance of their agricultural land located on it, and they lose their life. As already discussed in the Golestan Forest Park Disaster Management Plan, damages to expected lifetime of the people after their ends will become a huge amount.

If the people can receive the proper warning and/or information on floods and they obey such warning and/or information, they should not lose their life. For realizing this system practically, there should be good reliability between people and the Government. Thus an effort to establish the reliability of the Government is to be needed to the residents too. For this purpose, a suitable and reliable flood forecasting and warning system should be developed.

Flood Preparedness Plan

If flood preparedness could be practically realized and successfully functioned, social effects (or socio-economic effects) derived from such systems and such functions will be great with a little fund of the Government. Considerable social effects and/or socio-economic effects may be as follows:

- To save the people's life (this will mitigate the damages to all the incomes to be gotten in the future.),
- To stabilize the mind of the people,
- To generate a reliability of the people against the Government, and
- To ensure the good relationship between the people and the Government.

The most important thing is to start from a part that could be easy to do. One success leads the next success. Strengthening staffs' capacity of the Government will be gradually established and ensured through this process, and strengthening staffs' capacity of the Government lead further success after that. Then, the people will become to rely on the Government's staffs to

do their best for operating the systems. This component is proposed to give such opportunity. From the socio-economic viewpoint, this component is quite valuable.

3.10.2 Environmental and Social Evaluation

To justify the overall environmental and social effects of the proposed project, its components together with relevant alternatives are individually discussed here. The discussion is based on collection of data/information, consultation with Iranian experts, results of field surveys, exchange of view with local people, and conduction of Scoping for the Study and Initial Environmental Examination.

(1) Watershed Management Plan

This includes afforestation, land treatment, and on-site rainfall detention works, and aims at disaster prevention and enhancement of environmental status of the area. These approaches are environmental-friendly and Iranian experts have sufficient knowledge/skill to execute and maintain them without causing any harm to the environment. These activities are cost-effective, compatible with Islamic teachings and in harmony with people believe. Thus local people would cooperate in execution/maintenance works, ensuring success of the project.

Moreover watershed management tasks have been practiced for a long time in Iran, and local people are quite aware of their equable and equitable benefits, thus no adverse social impacts (conflict among communities/increase in income disparities) is expected. Furthermore this plan will leads to efficient/sustainable utilization of natural resources, creation of job and reduction in migration rate, thereby contributing to enhancement of living status (economically/spiritually) of inhabitants. Vegetation/forest established and rainwater detained through these works, are not only important for environmental enhancement and reduction of flood damages, but also important for keeping the livestock sector alive, because most of livestock depends on natural vegetation/water sources occurring in the areas. Forests will provide cleaner air and healthier society.

Considering the points mentioned above and realizing the fact that presently no better alternative is known, this watershed management plan from environmental point of view is justified as acceptable, thus it can be implemented.

(2) River Restoration and Improvement Plan

This item involves construction of some structures, which are beneficial for protecting people and farmlands against flood and sedimentation hazard. Some jobs are created and overall social status in associated villages is enhanced. Construction of dams and channels has already been practiced in Iran for a long time. Thus Iranians are very familiar to such tasks and have sufficient background/ knowledge and experience to accomplish them. Since local people know benefit of this plan they would cooperate in works for its realization.

There is no better alternative to this plan, so that it is conditionally acceptable from environmental viewpoint, and some of conditions are set herein.

- Heavy construction works should be done in day hours to minimize disturbance of people and wildlife.
- Works requiring disturbance of soil should be haltered in windy hours to minimize the air pollution.
- Wastes generated by machinery (discarded oil) as well by employees should be properly collected and disposed in designated place.
- Dam site should be properly guarded (fenced) to prevent accidental collapse of people and animal into it.

- Since there are many known and unknown historical/cultural objects in the area, the project should highly consider this matter and take proper precautions. In construction phase whenever employees face any ruin/strange object should immediately report it to the nearest office/representative of Cultural Heritage and Tourism Organization.

Moreover the project is advised to have regular contact and consultation with authorities in Cultural Heritage and Tourism Organization and DOE.

(3) Golestan Forest Park Disaster Management Plan

This item proposes establishment of flood warning system and means of evacuating the visitors and campers in case of emergency. Such activities are very suited to Iranian society and acceptable by the people because of their long experiences and history in Iran. They involve only simple construction work, not require large space, and capable of saving lives of people through timely operation. Therefore from environmental viewpoint this plan is acceptable and can be implemented. But project should take some precautionary measures such as:

(a) Test operation should be done in day hours and people are informed about the test well in advance, to avoid any public panic and social disturbance.

(b) Since the instruments are established in the national park, their coloring and decoration is important in matching them with natural environment of the park.

(4) Debris Flow Control Plan

Under this plan some small dams are erected in waterways to minimize the flow of debris toward villages, particularly in Tangrah to Beshoily axis. Implementation of this plan will contribute to social stability and health of inhabitants, by safeguarding them against disasters. From humanitarian (social environment) point of view the plan is welcome, but it is un-pleasure to natural environment, since the proposed dams will insert some negative impacts on flora and fauna at all stage of the project. Upon completion, the erected dams are nuisance to creatures transiting in relevant waterways, and would lessen the natural beauty of landscape. Significant alternative to this plan is the relocation of villages subjected to debris flow, which requires long time study and careful consideration from economic and social aspects. Relocation is a time consuming and expensive approach involving complicated formalities and sophisticated arrangement. In affairs dealing with people's life, "no action" is not a reasonable alternative. Therefore from environmental viewpoint this plan is acceptable with caution.

(5) Flood Control Plan

This plan aims at protecting the farmlands, villages and road network against flood with defined return period. Since livestock largely depend on farm residue, this approach will contribute to sustainability of livestock sector and diet of people. With protection people will get more hope on life and confidence on agriculture/livestock activities, which could enhance the economy and social stability of the area.

(6) Floodplain Management Plan

This plan is of advisory and precautionary types, involving not structural measures, hence inducing no any adverse impact on the environment. In contrary it will play an important role in safety of people, with a low cost and less complicity. Therefore from environmental point of view it can regarded as highly acceptable, and executed at any time.

(7) Flood Preparedness Plan

Under this plan the existing disaster warning system is improved and people are trained to safeguard themselves against disaster and efficiently evacuate in case of emergency. This plan is inline with the strategy of Iranian government for enhancing the capability and readiness of nation in facing disasters. It also matches the effort of State Corps of Unexpected Events, which prepare and disseminate materials to promote the knowledge and understanding of public on disaster and prepare them for dealing with crises of unexpected events.

3.11 Selection of Priority Projects

3.11.1 Criteria for Selection of Priority Projects

Among the master plan components summarized in Table PI.43, priority projects are selected for the feasibility study. For this purpose, the following criteria are set up to screen the suitable priority projects out of the components. The high priority is given to:

(A) Project(s) being located in the most seriously damaged areas; the Golestan Forest Park and Dasht village,

(B) Project(s) bringing out the project effects to save human lives or to improve worsening conditions for a short period; improvement or rehabilitation works to the existing system such as flood forecasting system and rehabilitation of breached dam in the Ghiz Galeh,

(C) Project(s) having high economic efficiency for mitigation of flood damages and saving human lives; flood forecasting and warning system in the Golestan Forest Park,

(D) Project(s) having suitable and essential themes on technology transfer; hydrological designing, structural designing and construction methodology on sediment control dam and erosion control structure, and preparation of flood hazard map on hydraulic simulation,

(E) Project(s) being core concepts with possibility of future expansion in their legal frame work or to the similar river basin; preparation of hazard map in floodplain management and flood preparedness, and designing and constructing process of sediment control dam and erosion control structure.

On the other hand, the on-going project(s) and/or projects that preliminary designing was already completed shall be excluded.

3.11.2 Priority Projects

In due consideration of the criteria enumerated above and salient features of the master plan components, selection process of priority projects are tabulated in Table PI.53. As a selection result, the following three projects are selected.

(1) Construction of sediment control dam in the Ghiz Ghaleh River basin and erosion control structure downstream of Dasht village,

(2) Flood forecasting, warning and evacuating system for Golestan Forest Park disaster management, and

(3) Publication of flood and debris flow hazard map.

In addition, educational assistance for community disaster management is demonstrated in the feasibility study stage as a pilot project.

Regarding on-going projects, the team can provide necessary information and assistance for safe and reasonable designing in the course of the feasibility study stage. These projects are (1) debris flow control plan by MOJA, (2) flood control plan by MOE, and (3) road

rehabilitation by MORT. These projects are also essential to mitigate flood damages and to save human lives from disastrous floods.

No.	Component	Target Area	Major Measures	Specific Features	Priority Project
1	Watershed Management Plan	Headwaters and middle reaches	Watershed management program following the program that the MOJA formulated: mechanical, bio-mechanical, and biological measures	MOJA: planning & implementing	Completion of designing
2	River Restoration Plan	Headwaters: Ghiz Ghaleh, Dast-e-Sheikh, Gelman Darreh Rivers	(1) Construction of sediment control dam for consolidation of stored sediment by the dam breached in the 2001 Flood, (2) Erosion control downstream of Dasht village	New proposition by JICA Team	Urgent needs in Ghiz Ghaleh basin and in the downstream of Dasht village
			(3) River improvement along the three rivers		Long term process
3	Golestan Forest Park Disaster Management Plan	Middle reaches: Golestan Forest Park	Flood forecasting, warning and evacuating system (1) Establishment of real time monitoring system (2) Establishment of early warning system (3) Establishment of evacuating system	New proposition by JICA Team for improvement of existing system	Urgent needs
4	Debris Flow Control Plan	Hillside of middle reaches: Tangrah to Beshoily	(1) Construction of sediment control dam and canal (2) Land treatment and biological measures	MOJA: planning & construction	On-going
5	Flood Control Plan	River course of middle and lower reaches: Tangrah to Golestan Dam entrance	(1) Bank protection in/around housing areas of villages and immediately up and downstream stretches of bridges (2) Improvement of major riparian structures: bridges, revetment	MOE & MORT: planning & construction	On-going
			(3) Elevating road for emergency activities	New proposition by JICA Team	Long term process
6	Floodplain Management	Middle and lower reaches	(1) Publication of flood and debris flow hazard map	New proposition by JICA Team	Urgent needs
			(2) Land use regulation in flood-prone areas		Long term process
7	Flood Preparedness Plan	Entire basin	(1) Extension of flood warning system	New proposition by JICA Team	Long term process
			(2) Educational assistance for community disaster management		Conducting in F/S stage

Table PI.53 Flood and Debris Flow Mitigation and Management Master Plan and Priority Projects

FINAL REPORT (SUMMARY)

PAPER II

Feasibility Study

CHAPTER 1 PRESENT CONDITIONS OF THE PRIORITY PROJECT AREAS

1.1 Dasht Area

1.1.1 Topography

Three major river systems of the Madarsoo River meet in the Dasht basin (flat depression); namely, Gelman Darreh, Dasht-e-Sheikh and Ghiz Ghaleh. After the confluence of three rivers, it is named the Madarsoo. Geomorphological classification in Dasht basin is presented in Fig. PII.1.

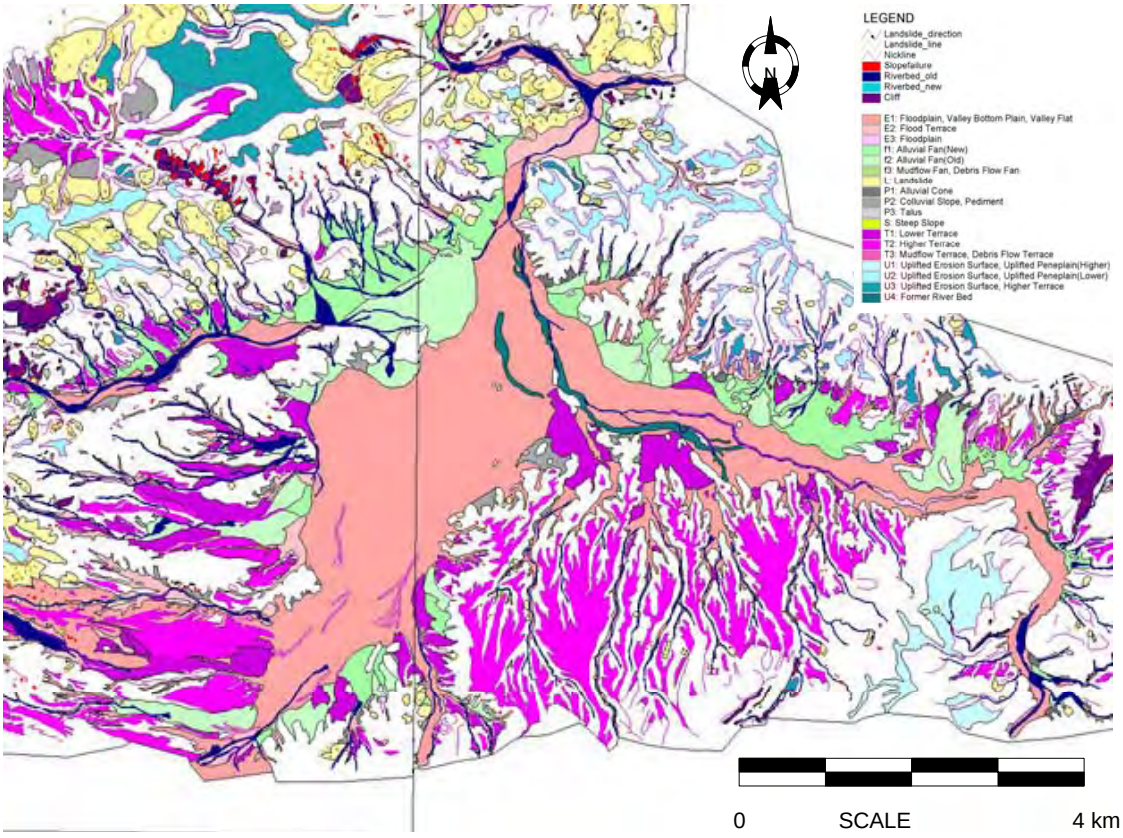


Fig. PII.1 Geomorphological Classification in Dasht Basin

As presented in Fig. PII.1, topographic features in each river are summarized below.

Gelman Darreh River

River course of 350 to 600m wide runs western-ward from the entrance of the Dasht basin to confluence with the Dasht-e-Sheikh. Around the confluence, the river course is getting wide downward up to 1,100 m.

The mainstream flows forming downcutting channel with meandering on the valley-bottom plain in a stretch of 4 km long from the entrance. From 2.5 km upstream of Dasht village, height difference between mainstream and valley-bottom plain becomes very little. In vicinity of Dasht village, valley-bottom plain become narrower due to extrusion of alluvial fan from the Ghiz Ghaleh River. Alluvial fans from numerous tributaries developed along the right bank of the Gelman Darreh in the Dasht basin.

Dasht-e-Sheikh River

The topography of the basin could be characterized as wide valley-bottom plain of alluvial fan origin in the downstream area. Around 5.5 km upstream of Dasht village valley width of mainstream is about 150 m, while around 2 km upstream of Dasht village the valley plain changes to broad one with some undulations and 2.2 km wide.

Upper reaches have the trace of sediment movement and flooding, but the middle and lower reaches with wide valley have little trace of sediment movement. In particular river channels are not prevailing at present in the lower reaches, and partly form the shallow and discontinuous gully valley.

Numerous erosive valleys developed in the hilly areas and terraces along the left bank. In the upper and middle reaches, sediment movement could be seen in the existing river channel, but could not be seen in the downstream area.

Ghiz Ghaleh River

The Ghiz Ghaleh River is focused on sediment control issues so that rehabilitation work is planned for the earth dam breached in the 2001 Flood as a priority project. The basin can be divided into three parts from the geomorphologic features; namely upper, middle and lower reaches.

(1) Upper Reaches

Large well-developed river terraces extend in the upper reaches. Boundaries of both sides to the Madarsoo River and the Dasht-e-Sheikh River are made up of terrace, lower uplifted erosion surface and uplifted peneplain with gentle slopes. Dasht-e-shad village is located on the terraces in the upper most area of the boundary between the Madarsoo basin and the Ghiz Ghaleh basin. The higher terrace among the higher and lower ones extends widely with 30 to 50 m high above the existing riverbed. The Ghiz Ghaleh River and tributaries down-cut the higher terraces and flow down forming box-shaped valley.

Flat field and gentle slope extend widely, and less landslide terrain and gully developed in the upper reaches. Thus sediment yielding may not be intensive compared with those of middle and lower reaches.

(2) Middle Reaches

In contrast to the upper reaches, wide valley bottom plain did not develop in the middle reaches. The middle reaches are narrow path of river valley, and topography of both banks is distinctly different. Large-scale tributaries occur in the left bank, while no large ones occur in the right bank. Sediment movement can be seen in both channels of the Ghiz Ghaleh and tributaries.

In the middle reaches there are many slope failures, small unsteady landslide terrains and new unsteady talus terrains so that they could have been source areas to yield sediment. Active erosion and sediment yielding take place in this area because of significant topographic deformation as a result of river captures, earth movements.

(3) Lower Reaches

Valley bottom plain with 150 to 600 m width has developed in the lower reaches. Originally the river has formed alluvial fans with gentle slope that had the fan end extending at vicinity of Dasht village, and had joined to the Gelman Darreh River. At present the Ghiz Ghaleh River was diverted to the Dasht-e-Sheikh River due to construction of polder diking system after the 2001 Flood.

There are some points at which the floodwater flowed over the boundary of the right bank in the past. The lower terrace with a little height from existing riverbed exists in the left bank forming board valley bottom plain 2.5 km upstream of Dasht village.

This terrace is higher than the saddle portion of the boundary in the right bank so that floodwater and sediment runoff seemed to flow over it to the Dasht-e-Sheikh basin in the past.

Steep slope alluvial fans were formed on valley bottom plain along the tributaries in the left bank. Lots of sediment yielding and transporting can be seen in these tributaries of the left bank.

Upper Madarsoo River

In upper stretch of confluence with the Cheshmeh Khan River, the mainstream of the Madarsoo was gully-like valley with slight erosion, and formed nick point upstream of the confluence, before the 2001 Flood. In the 2001 Flood the gully head significantly widened and progressed upward together with nick point. These topographic changes might be caused by sudden hydraulic changes from dam-up to its collapse during the flood.

In the 2005 Flood, gully head also progressed up to 30 to 50 m upward. The agricultural lands around gully are threatened with bank erosion and collapse.

1.1.2 Flood and Sediment Runoff Issues

Two major tributaries join to the mainstream in the flat topography of Dasht basin. The mainstream is named Gelman Darreh with a drainage area of 787 km^2, while two tributaries are Dasht-e-Sheykh with 125 km^2, and Ghiz Ghaleh with 126 km^2. In the 2001 Flood, three disastrous events occurred in the Dasht area.

(1) Swollen floodwater along the Ghyz Ghaleh breached an earth dam located 4 km upstream of Dasht village, and floodwater convolving stored sediment by the dam rushed towards the village area. After the 2001 Flood polder dike was constructed to protect the village from the direct hitting of floodwater.

(2) Larger and long-lasting floodflow came from the Gelman Darreh after the flood of Ghiz Ghaleh, and it washed away crops and fruit trees in the valley-bottom plain of Dasht area. The simulation results of the 2001 Flood are shown in Fig. PII.2.

(3) Damming up might occur along the Madarsoo River at some upper part of the Golestan Forest during the 2001 Flood, and suddenly collapse due to overtopping stored floodwater. This rapid hydraulic change might induce serious channel scouring and bank erosion along the river course, and valley-head erosion around the upper end of water temporarily impounded occurred and progressed upward.

In due consideration of the above mentioned situations during floods, the following three issues shall be addressed in the River Restoration Plan so that the Dasht village becomes safer and its agriculture-based economy becomes more productive.

(1) Sediment Consolidation in the Ghiz Ghaleh River

The left bank in the middle reaches of the Ghiz Ghaleh basin is the most devastated area in the Madarsoo River basin due to widely extending slope failures caused by deterioration and weathering of base rock. To protect Dasht village against floodflow hit, consolidation of stored sediment in the breached dam basin and controlling of excessive sediment during large floods shall be given a first priority. Otherwise transported sediment will accumulate around immediately upstream of existing polder dike, and finally floodwater easily will rush to the village over the dike.

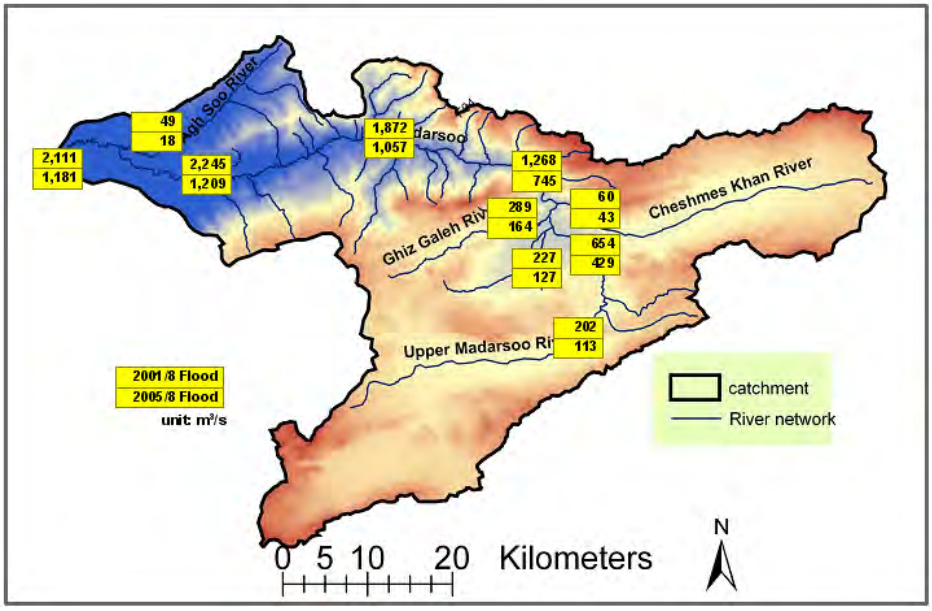


Fig. PII.2 Flood Peak Discharge in the 2001 and 2005 Floods (Simulation Results)

(2) Flood Control of Channel Network

Hydrological effects of watershed management shall be premised for the flood control because of already progressing program. After land treatment such as terracing, banquette, furrow and reforestation, the design discharges of the three rivers in 25-year flood are shown in Fig. PII.3 as spatial distribution of design discharges.

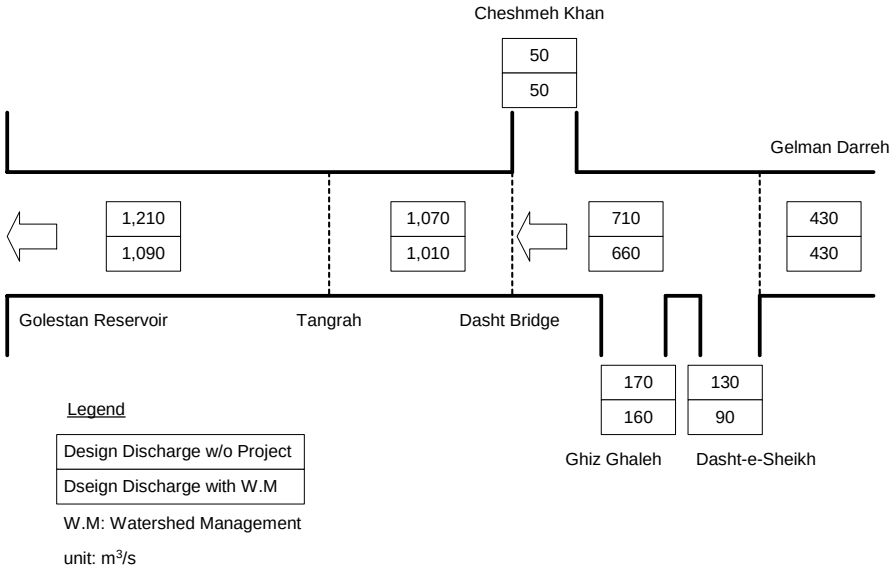


Fig. PII.3 Spatial Distribution of 25-Year Design Discharge

To reduce the flood loss of crops in the widely extending farmlands, the river channel improvement shall be planned in parallel with Watershed Management.

(3) Erosion Control

As described above, valley-head erosion occurred in parallel with river channel degradation around the confluence with the Cheshmeh Khan River in the 2001 Flood. In addition, the erosion head progressed some 50 m upstream in the 2005 Flood. Under this situation, some part of farmlands will be lost flood by flood. Thus erosion

control measures such as a gully control dam or channel works shall be done in this area.

1.1.3 Geological Investigation Results

Objectives of geological investigation are to investigate the geological condition of foundation for proposed structures such as sediment control dam and erosion control dam. The electric prospecting aims to mainly investigate the depth of basement rocks.

Geology of the Proposed Sediment Control Dam in Ghiz Ghaleh River

The fan deposit is widely distributed in the left bank and basement rocks are distributed in the right bank. The foundation of dam will be fan deposit in the left bank, recent riverbed deposit in the riverbed, and basement rocks of Sandstone and Slate Alternation in the right bank. Sandstone and Shale Alternation will come into NIUR Formation in Silurian period of Paleozoic Era.

Based on the result of electric prospecting, the ground layers can be divided into the following three layers from the resistivity:

1st layer [30 to 1,100 ohm-m]: It may be mainly composed of dried gravel.

2nd layer [30 to 200 ohm-m]: It may be composed of gravel with clay.

3rd layer [40 to 60 ohm-m]: It may be mainly composed of basement rocks (around 15 m deep).

The depth of 3rd layer coincides approximately with the depth of basement rocks. It is also supposed that low resistivity of 40 to 60 will hint the distribution of sedimentary rocks such as sandstone, shale, and slate.

N-Value of Standard Penetration Test (SPT) is more than 50 for the riverbed deposit mainly composed of sand and gravel. The angle of internal friction will be estimated more than 44.5 degrees on the basis of Dunham's conversion formula ($\phi = (12N)^{1/2} + 20$).

Confluence of the Madarsoo and the Cheshmeh Khan

(1) Soil Condition

Dolomite of MILA Formation in Cambrian Period is distributed in the left bank and Jurassic limestone is distributed in the right bank. Riverbed and floodplain deposits are distributed in the riverbed with a thickness of about 19 m. Old debris flow deposit or old talus deposit is distributed with a thickness of more than 5 m under the riverbed deposit.

The horizontal layered silt with granule to pebble layers is distributed on the floodplain of the Madarsoo River at the confluence with the Cheshmeh Khan River with the thickness of more than 5 m. These fine materials might have been deposited in a lake that might be naturally formed by damming-up by debris flows of the Cheshmeh Khan River in the past.

The lower part of the riverbed deposit, cohesive clay layer with a few granules is distributed from the depth of 13 to 19 m. This might be also lake deposit.

Under the riverbed deposit, there is some deposit including rounded and angular granule to pebble of limestone, sandstone, and shale.

(2) Engineering Geology

N-Value of Standard Penetration Test (SPT) is more than 50 for the riverbed deposit composed of sand and gravel. The angle of internal friction will be estimated more than 44.5 degrees on the basis of Dunham's conversion formula ($\phi = (12N)^{1/2} + 20$).

Clay layer of riverbed deposit distributed from 8.2 to 13.3 m is categorized "hard" with a N-value of 29 to 41. The bearing capacity (qa) will be estimated 29 to 41 tf/m^2 (qa=(1.0-1.3)N). But, clay layer of lake deposit distributed from 13.3 to 19.2 m is categorized "stiff to very stiff" with a N-value of 14 to 24. The bearing capacity (qa) will be estimated 14 to 24tf/m^2 (qa=(1.0-1.3)N).

Old talus deposit or old debris flow distributed under the lake deposit is also categorized "hard" with a N-value of more than 50.

It is supposed that the bearing capacity of the horizontal layered silt with granule to pebble layers on the floodplain will be almost same as lake deposit from the result of SPT.

1.2 Golestan Forest National Park

1.2.1 Topography

According to geological study results, geological structures are clearly different between left and right banks. For instance, there is no fault and fold in the left bank, while there are many faults and folds in the right bank. The Madarsoo River may flow following the boundary of geological structures like faults. The geomorphological classification is shown in Fig. PII.4.

The Madarsoo River flows through gorge in both sides of steep valley wall with about 300 m high from existing riverbed. Valley of mainstream is about 60 to 200 m wide. From the photographs taken before the 2001 Flood, riverbed with no vegetation was only about 20 to 50 m wide. In contrast, the riverbed extends over the valley bottom plain after the 2001 Flood. Furthermore, intensive bank erosion occurs along the flood terraces and the end of alluvial fans.

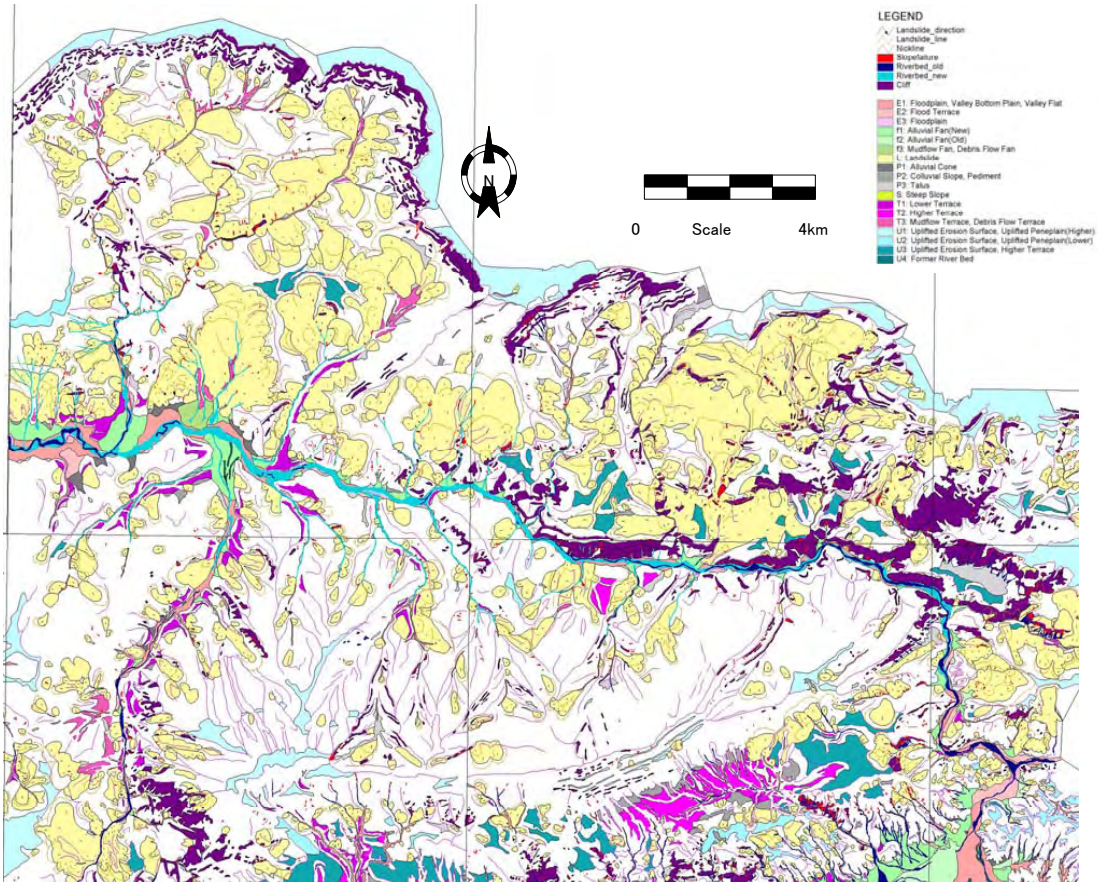


Fig. PII.4 Geomorphological Classification in Golestan Forest

1.2.2 Flood and Sediment Runoff Issues

In the 2001 Flood, around 200 visitors and campers died in the park. Most of the camping sites are situated on the previous debris flow deposits due to flat topography, and usually campers and visitors enjoy its natural environment extending over 15 km along the riverbank. In the 2001 flood, debris flow occurred in the six mountain streams in the park. Debris flow in five streams out of six attacked the camping sites. Furthermore extremely large floodflow coming from the upper stretch simultaneously swept away visitors and campers as well as natural forest alongside of the Madarsoo River course in the park. Thus the Golestan Forest Park area is the most disastrous part in the Madarsoo River basin from floods.

For instance, the floodwater depth is simply computed using average river width and riverbed slope, and flood discharges of the 2001 and 2005 Floods. In order to know the rough situation of floodwater in the Golestan Forest gorge, floodwater depth was calculated using uniform flow formula of manning with average slope, river width in minimum and maximum cases. Table PII.1 tabulates the computation results, and it indicates that floodwater might rise 3 to 4 m in the narrow portion of the gorge in the 2001 Flood. This computation implies that people visiting the forest park cannot find the suitable evacuating way under tremendous downpour such as the 2001 and 2005 floods. Therefore early warning and evacuation out of the park is crucial in saving lives of the visitors.

Table PII.1 Flood Flowing Situation in the Golestan Park

Flood	Golestan Forest	Peak Discharge (m^3/s)	Riverbed			
			Average Slope (%)	Width (m)	Roughness Coefficient	Floodwater Depth (m)
2001	Entrance	1,270	1.9	60	0.045	3.3
				200		1.6
	Outlet	1,870		60		4.2
				200		2.0
2005	Entrance	750		60		2.4
				200		1.1
	Outlet	1,060		60		3.0
				200		1.4

1.3 Valley-bottom Plain and Gorgan Floodplain Areas

1.3.1 Topography

The Madarsoo River forms the valley with 400 to 600 m width at the vicinity of Tangrah village. Valley-bottom plains as well as alluvial fans and lower terraces formed by the tributaries can be found in the valley. Valley-bottom plains consist of river channel, high-water channel with thick vegetation, and general surface of valley-bottom plain.

In a stretch of about 21 km downward from Tangrah, the Madarsoo mainstream runs to the west on the valley-bottom plain with meandering constricted by both sides of hill slope. The valley-bottom plain gradually becomes wider in accordance with going downward.

In vicinity of Agha Mish village, the wide lower terrace can be seen along the mainstream. From geomorphological viewpoints, the river stretch of about 6 km from Agha Mish to Kalaleh Bridge can be defined as a transition segment, in which the geomorphologic features change from valley-bottom plain to the Gorgan plain.

From Kalaleh Bridge, the Madarsoo enters onto the wide plains, which was formed by the Gorgan River. In a stretch of about 15 km from the bridge to entrance of the Golestan reservoir, the Madarsoo River freely meanders forming lower terraces with 300 m to 1,000 m, and river channel downcuts the erosive materials of the Gorgan plain. The lower terraces are

situated at about 10 m lower than the plain surface. Fig. PII.5 presents the lower terraces and the mainstream on the Gorgan plain near Kalaleh Airport using satellite imagery.

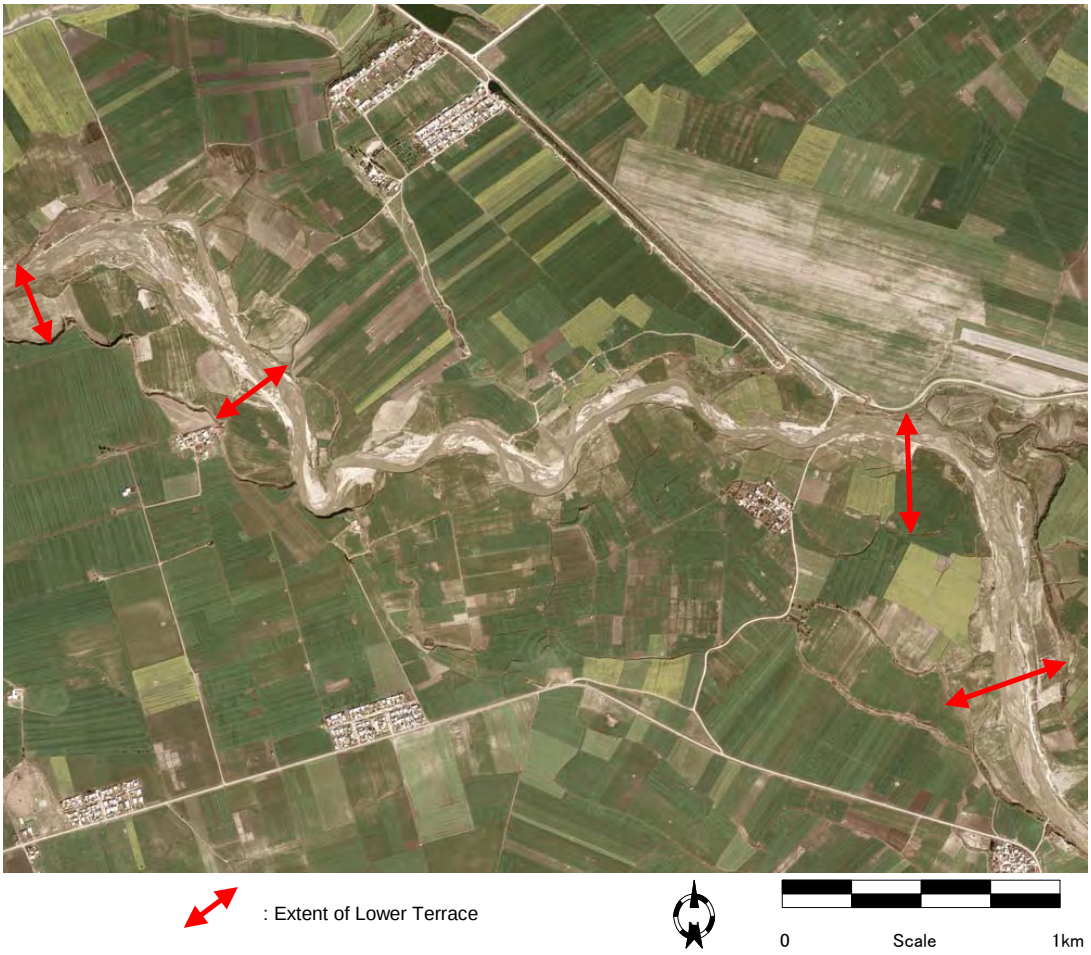


Fig. PII.5 Lower Terrace near Kalaleh Airport along the Lower Madarsoo

1.3.2 Flood and Sediment Runoff Issues

Structural Measures

After demolition of structures of road and riverbank during the disastrous 2001 flood, MOE and MORT conducted urgent rehabilitation works to the damaged structures. In particular, MOE has a responsibility to hydrological and hydraulic analysis for river structures. MOE is preparing two-phased plan: namely urgent measures and master plan.

The urgent measures were carried out at various damaged portions, such as protective revetment along the bends of river course, and transversal structures of bridges to connect villages to the arterial road running along the Madarsoo River. Some structures were completed and others were under construction in summer 2005.

The 2005 Flood made an attack to the Madarsoo River basin. The recently rehabilitated structures and newly installed flood control structures were seriously damaged again. After the flood disaster, MOE is preparing or modifying their rehabilitation plan based on the damages experienced. Furthermore the master plan being prepared by MOE should be also adjusted to the statistic background of rainfall affected by recent successive floods in 2001, 2002 and 2005. The MOE master plan and rehabilitation plan will be elaborated, and the structures to be constructed by MOE and MORT shall be much more strengthened to the previous one.

Non-structural Measures

Some villages located in the valley-bottom plain, in particular villages located between Kalaleh Bridge and 14-metry Bridge, are partially submerged in the large-scale flood time. According to the interview survey to the villagers, the flooding water had not high velocity in the inundation areas of the villages. Thus there can be high possibility to save resident's lives from flooding if appropriate information was given to the villagers and proper knowledge was built in them.

On the other hand, all villages located in the Gorgan Plain downstream of the Kalaleh Bridge are situated on the higher terrace of the plain. The floodwater flows down confining in the lower terrace along the river course. In this area resident's lives can be completely saved from the flood disaster if proper knowledge was built in them.

CHAPTER 2 RIVER RESTORATION PLAN IN DASHT AREA

2.1 Sediment Control Dam Designing

2.1.1 Basic Design Conditions

The purpose of the sediment control dam works is to control sediment, aiming exclusively at preventing the excessive sediment, which has been stored in the reservoir area until the dam breached in the 2001 flood, from flowing out to the downstream of the Ghyz Ghaleh River during the probable flood and preventing the direct flood damage to the Dasht village.

Basic design criteria of the sediment control dam works are shown as follows;

- Design Discharge flow is taken into account of followings;

  for dam designing; 100-year flood, 300 m^3/s

  for channel designing; 25-year flood, 160 m^3/s

- Invert elevation of spillway section in floodway is set to cover the reservoir sediment surface with future sediment surface assumed with 1 % in slope derived from half of 2 % of the present streambed in the site.
- Floodway flow capacity is calculated with conventional formula derived from weir formula, while the channel flow capacity is provided with the uniform flow calculation suggested by Manning.
- New earth dam to close the opening section of the existing dam is to be placed directly on the permeable riverbed materials or sand and gravel layers. Therefore foundation treatment is necessary to secure the water-tightness for preventing a piping problem through the bottom of the foundation.
- Regarding countermeasures against piping problem, it is proposed with soil blanket, which is constructed with an impermeable material such as silt or clay soil, in the immediate upstream of the dam to extend the effective seepage length.
- In case of the earth dam scheme, the riverbed material for 2.0 m deep underneath the new earth dam is replaced with the appropriate soil blanket material or equivalent since the riverbed surface in the breached dam section is turbulent by flood flow and has insufficient bearing capacity.
- In case of concrete dam scheme, it is proposed that the foundation improvement is employed with cement mixing into the sand-gravel-layer such as soil cement method or Sabo Cement-Sand-Gravel method (hereinafter called as Sabo-CSG) to ensure the subgrade reaction improvement and seepage length extension.

2.1.2 Alternative Study

Three cases are elaborated for the alternative study based on the field topographical conditions and environmental aspects. These alternatives features are described as follows:

First one is as Case-A, which consists of the concrete main dam located at the opening section of the existing earth dam, the concrete apron, the sub-dam for stilling basin, and also concrete blocks for riverbed protection.

Second one is as Case-B, which consists of newly excavated floodway located on the exposed basement rock of the right bank, the concrete intake, the concrete revetment along the floodway and concrete blocks for channel bed protection.

Third one is as Case-C, which composes of newly excavated floodway located on the left existing earth dam, the concrete intake, the concrete revetment along the floodway and concrete blocks for channel bed protection.

Those are compared and the optimum case is selected from the viewpoints of construction cost, effects to the environment and workability.

Geological Condition of Foundation

Result of the geological survey is shown as follows;

- The core drilling works results show a base rock at around 15 m deep and no groundwater in any course of the drilling works in the streambed. It is expected that 10 m height class dam can be constructed at the site from the viewpoint of strength of the layers since the core drilling result that the N-value is over 50 with Standard Penetration Test (SPT) under the riverbed surface. Regarding permeability of the riverbed material, it is concluded that the said sand and gravel layers generally have quite high values based on the field reconnaissance.
- As long as the dam is planned for sediment control, not storing water, high permeability itself is not adverse condition but against piping. Therefore, height of dam should be limited not to cause high water head and some kind of treatment or improvement should be given to the sand and gravel layers underneath the dam foundation so as not to encourage piping problem.

Design Conditions in Common to Alternatives

The individual proposed floodway on the alternatives should be satisfied with the requirement shown as follows;

- To locate the invert level of the proposed spillway, which the future sediment surface in the upstream should cover the present riverbed surface so as not to scour the sediment in the reservoir area of the old dam,
- To design the spillway flow capacity with discharge of 100-year return period and channel capacity with 25-year return period, and
- To design the structure to satisfy stability against tilting and sliding.

Freeboard for proposed floodway should be 0.8 m added at the elevation of the high water level.

The crest elevation of proposed earth dam should be added with 2 m high to the elevation of the crest of the spillway sidewall section to take into account of unknown factor like surging water, which has been happened in the 2001 Flood, while frequently crest of earth dam type is added with 1m higher than the concrete dam crest.

Alternatives

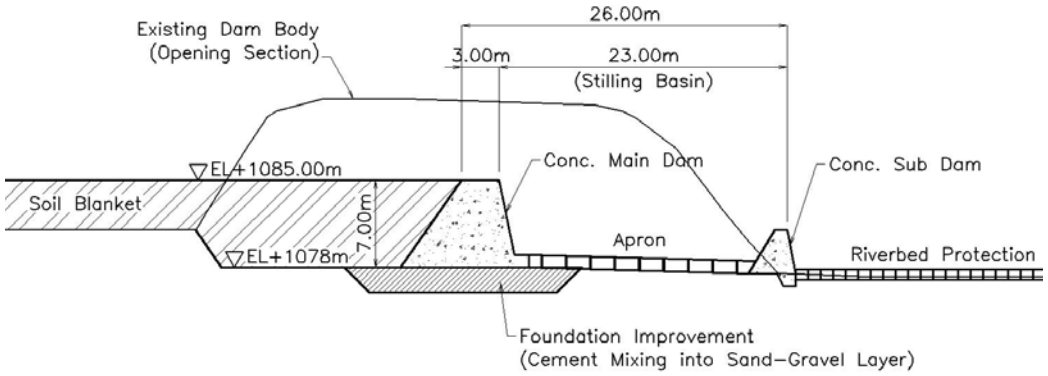
The following three alternatives are considered:

Case- A is consisted of concrete dam with spillway to close the opening of the existing earth dam and to connect up the existing earth dam.

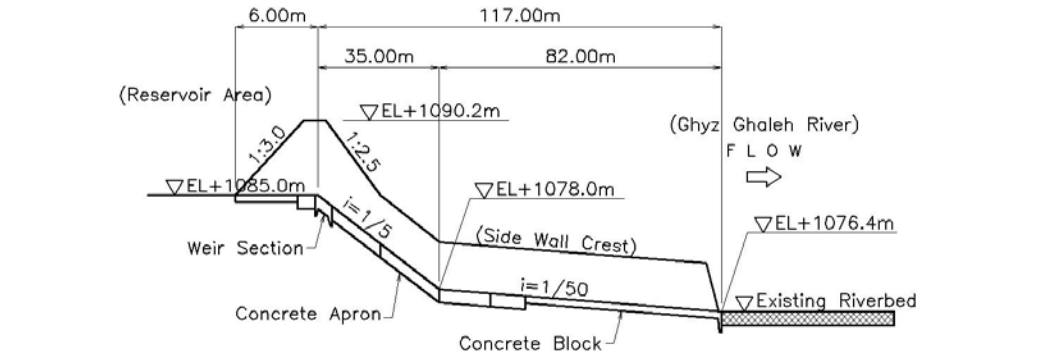
Case- B is consisted of new floodway and new earth dam to close the opening section of the existing earth dam. The floodway is composed of inlet section, weir section and chute channel section. The floodway is located on the exposed bedrock in the right bank. The amount of right hilly area excavation shall be utilized to close the opening section of the existing earth dam since the floodway construction works generates more quantity of excavation than the other alternatives.

Case-C consists of new floodway located at the left bank and new earth dam to close the opening section of the existing dam.

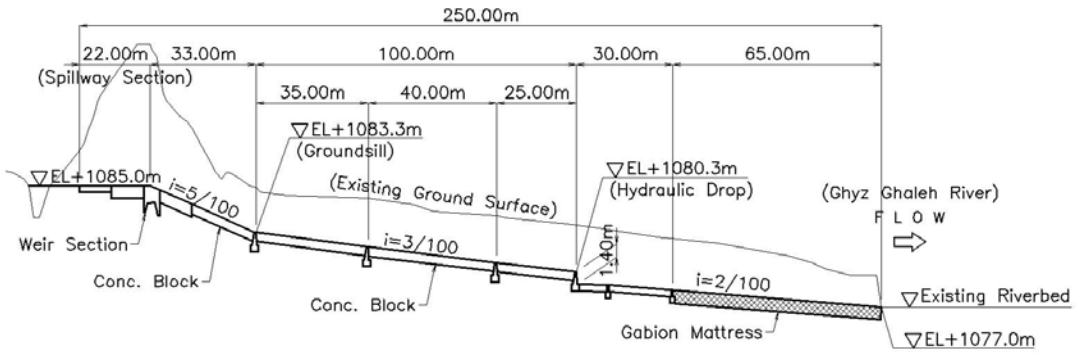
These alternatives of longitudinal profile are illustrated in Fig. II.6.



Case-A: Concrete dam with spillway



Case-B: Earth dam with floodway at right bank



Case-C: Earth dam with floodway at left bank

Fig. PII.6 Longitudinal Profile of Floodway in Alternatives

Comparison of the Structural Measures

Comparison of Case-A, -B and -C is summarized in the Table PII.2. The comparison results are described below.

- The most expensive works is extracted as Case-B because of the largest quantity of excavation and comparative larger amount of concrete placement among the alternatives.
- Case-B has also environmental negative effects because of the largest man-made slope appearance on the right side mountain due to excavation works for new spillway construction. Thus it is apprehensive about the natural environment changing after construction period.
- Case-A is the second expensive case and this case has disadvantage on workability, which could cause additional cost of temporary cofferdam.

- Case-C is the most inexpensive and its disadvantage is not critical because the modification scheme based on the Case-C can overcome the problems.

Therefore, Case-C is most preferable among the three alternatives.

Table PII.2 Comparison among the Alternatives

Case	Profile	Advantage	Disadvantage	Quantity (cu.m) of Main Dam Section			Direct Construction Cost
				Excavation	Embankment	Concrete	
A	Construction of concrete dam with spillway to close the opening of the existing dam	Flood water shall be discharged into the existing water course with the original flow direction since a center line of the proposed spillway on the concrete dam is set on the center line of the existing water course. It is not necessary to construct a new floodway. It is expected to minimize the change for natural environmental and existing hydraulic conditions in the upstream and downstream of the existing dam.	Flood might flow over the dam construction site or additional diversion works is required during the construction period. A turbulent flow is prone to appear in immediate downstream of the dam since the high velocity flow fallen down from the spillway is created thought the dam height. The foundation of proposed dam shall be improved to resist the required subgrade reaction generated by main dam body stability since the existing riverbed has been turbulent caused by several flood.	81,400	52,000	10,100	3.87 Billion Rials
B	Construction of new floodway on the right bank Construction of new earth dam to close the opening of the existing dam	New floodway can be placed on the solid foundation as exposed basement rock and the floodway distance can be shorter than the Alternative Case- C. It is expected to reduce construction volume of the required riverbed protection along new floodway.	Flood might flow over the dam construction site or additional diversion works is required during construction period. There is an unknown factor for the hydraulic influence on confluence between the new waterway and the Ghyz Ghaleh River because of new floodway construction. The heavy excavation volume, which is generated from the open cut of the right mountain, is required to construct spillway section of the new floodway.	103,000	65,800	9,700	3.93 Billion Rials
C	Construction of new floodway on the left bank Construction of new earth dam to close the opening of the existing dam	The new floodway construction site is not close to the exiting dam rehabilitation site, comparatively. New floodway, after construction, can be utilized as temporary diversion channel during closing works of the existing dam opening section. It is expected to continuously execute the construction work for all year around and to contribute the construction period and expense reductions.	Floodway shall be constructed on the soil or sand-gravel layer. There is an unknown factor for the hydraulic influence on confluence between the new waterway and the Ghyz Ghaleh River because of new floodway construction.	74,900	63,300	7,400	3.35 Billion Rials

Note: Quantities and costs above the table show the amount of construction work volume for respective essential structures only.

Design Conditions of Selected Alternative

(1) Design Discharge

Inlet and weir sections of spillway shall be designed to accommodate discharge of 100-year flood, while floodway channel section is designed on the discharge of 25-year flood because inlet section would have more destructive damage than channel section due to probable floods.

The spillway section is applied with weir formula due to effects of backwater and water head loss, while hydraulic characteristics of channel section is provided with uniform flow calculation.

(2) Channel Bed Protection

Channel bed protection is designed with combination of groundsill or hydraulic drop, apron and concrete blocks. Design is carried out in individual sections enclosed by groundsill or hydraulic drop since the proposed water surface profile is broken off by a completed overflow appearance at the hydraulic drop structure. Profile arrangement of respective sections is shown in Fig. PII.7.

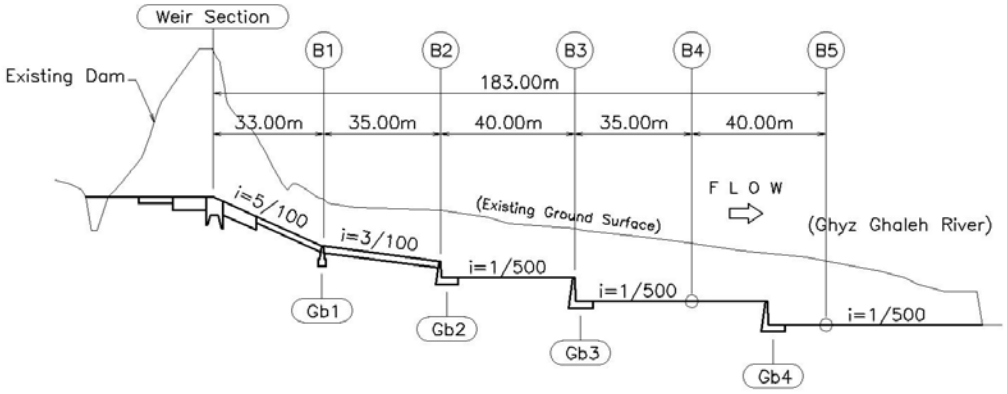


Fig. PII.7 Schematic Profile Arrangement for Bed Protection

Furthermore, a groundsill is designed to control flow direction at the bending portion of the channel and/or riverbed unstable section and hydraulic drop is set to gentle the channel bed gradient more than the original one.

2.1.3 Preliminary Design of Sediment Control Dam

The proposed plan, longitudinal profiles along the dam axis and along the channel centerline of the planned sediment control dam are shown in Figs. PII.8 to PII.10. The typical cross section of the new earth dam to close the opening of the existing dam is shown in Fig. PII.11.

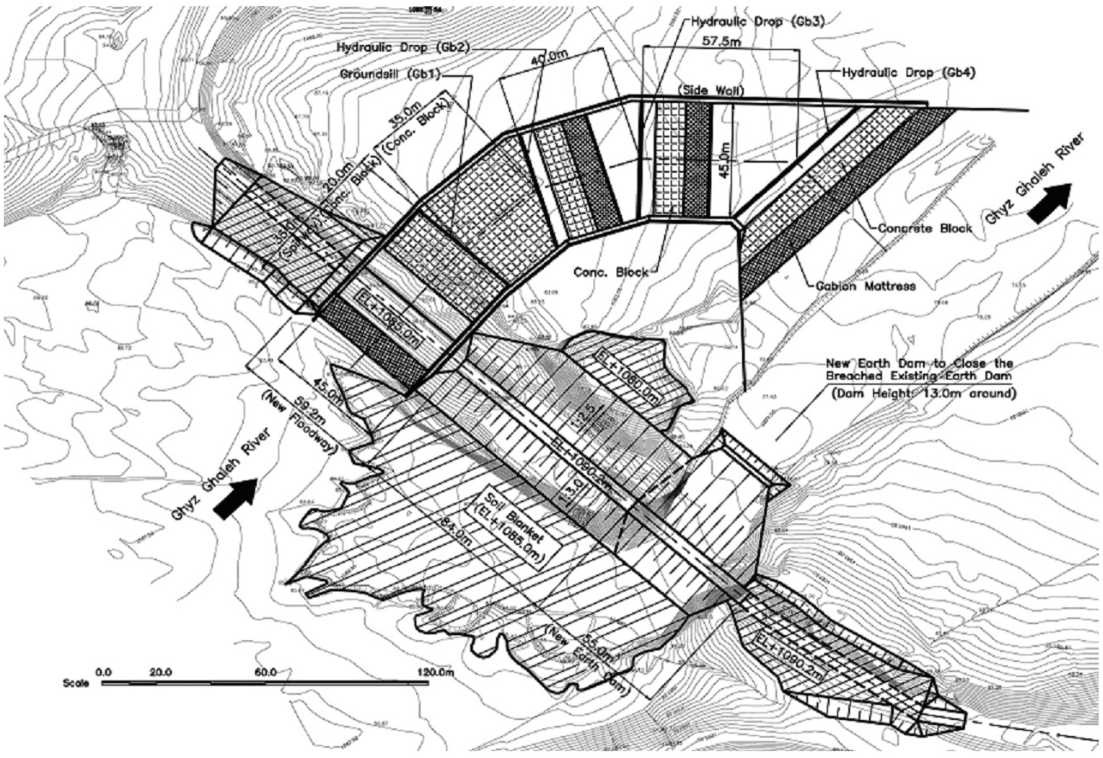


Fig. PII.8 Plan of Proposed Sediment Control Dam Works

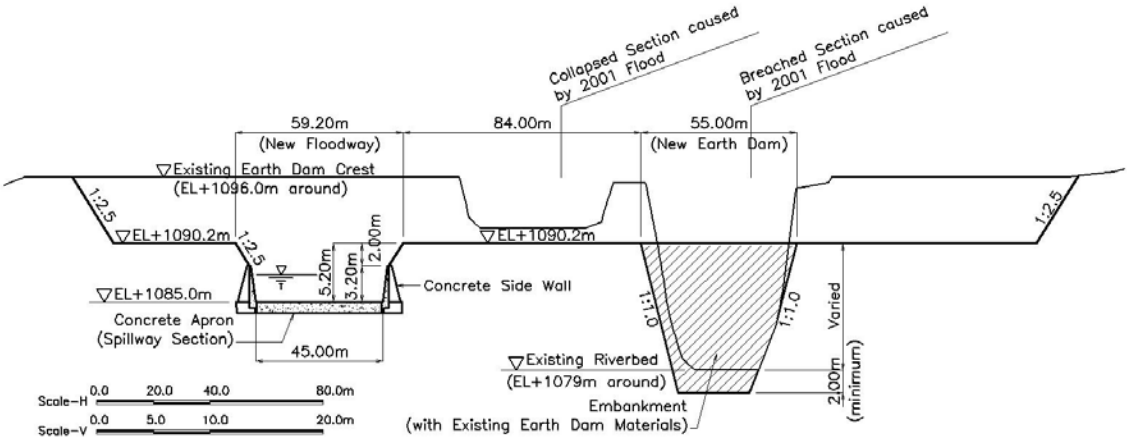


Fig. PII.9 Typical Cross Section of Proposed Sediment Control Dam Works

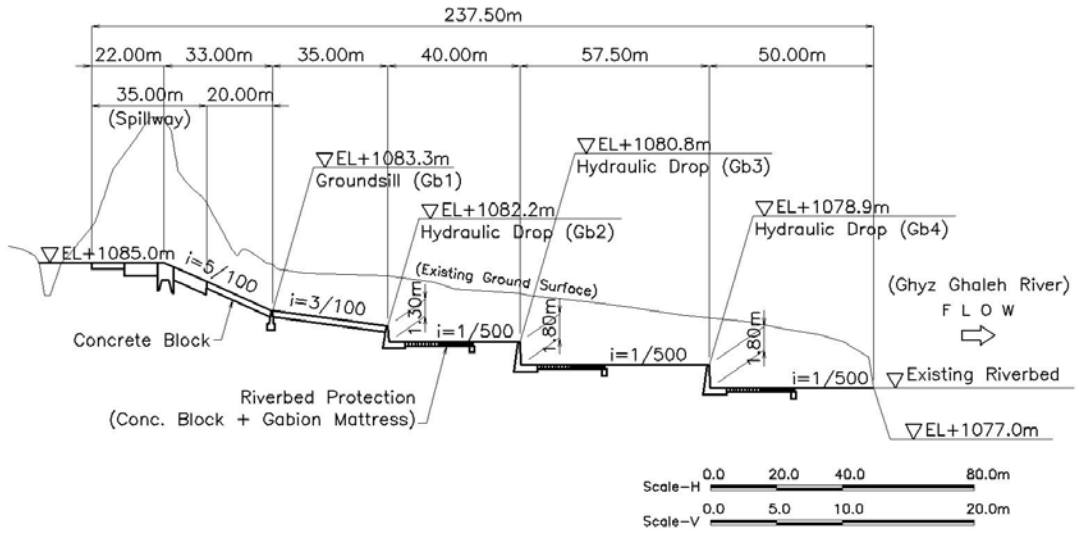


Fig. PII.10 Longitudinal Profile of Proposed Floodway

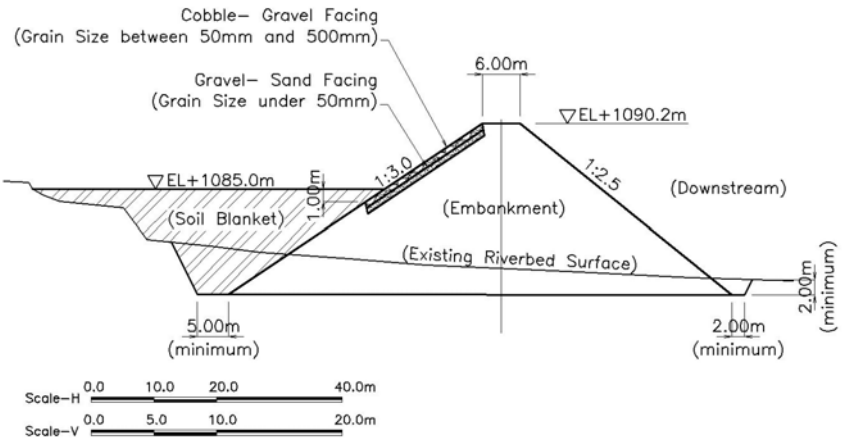


Fig. PII.11 Typical Cross Section of New Earth Dam

Project Cost

Works quantity and project cost for the sediment control dam are estimated based on the abovementioned plan and the summary is shown in the following table.

Table PII.3 Summary of Project Cost

Alternative-C

Work Item	Quantity	Unit	Unit Price (Rials)	Amount (1,000 Rials)
I. Construction Base Cost				**8,739,000**
1. Preparatory Works (10% of Sub-total of Item 2 to 3)	1	l.s.		795,000
2. Sediment Control Dam (including rehabilitation of the breached existing dam)				7,944,000
a. Excavation				
- Sand & Gravel	92,300	m^3	7,000	646,100
b. Random Backfilling	2,500	m^3	7,000	17,500
d. Embankment	36,000	m^3	11,000	396,000
c. Soil Blanket	24,900	m^3	11,000	273,900
e. Removal of the Surplus Soil	29,000	m^3	19,000	551,000
f. Sodding	2,500	m^2	1,000	2,500
g. Concrete				
- Plain Concrete	2,010	m^3	270,000	542,700
- Reinforced Concrete (including 20kg rebar)	2,350	m^3	355,000	834,250
- Wet Stone Masonry	830	m^3	227,000	188,410
h. Slope Facing				
- Cobble- Gravel Facing (t=50cm)	1,930	m^3	34,000	65,620
- Gravel- Sand facing (t=50cm)	1,930	m^3	9,000	17,370
i. Gabion Mattress	2,090	m^3	149,000	311,410
j. Concrete Block				
- 1.9ton/piece		nos.	602,000	0
- 1.2ton/piece		nos.	443,000	0
- 0.6ton/piece	9,146	nos.	301,000	2,752,946
- 0.5ton/piece		nos.	235,000	0
- Gravel Bedding under the Conc. Block	2,200	m^3	9,000	19,800
k. Miscellaneous (20% of "a" to "j")	1	l.s.		1,324,494
II. Land Acquisition Cost				**0**
a. Dry Farming Land	0	m^2	400	0
b. Irrigated Land	0	m^2	4,200	0
c. Orchard	0	m^2	11,000	0
d. Residential Area		m^2	60,000	0
III. Administration Cost (5% of Item I)	1	l.s.		**437,000**
IV. Engineering Cost (10% of Item I)	1	l.s.		**874,000**
V. Physical Contingency (20% of Item I + II + III + IV)	1	l.s.		**2,010,000**
VI. Total				12,060,000
Round Total				**12,060,000**

Note:
-Unit price is as of 2004 (in accordance with the Islamic Year of 1383).
-Unit price is provided from the Iranian work efficiency issued by the Management and Project Organization (PMO) in 2004.
-Number of individual ratio for indirect cost is referred with the previous JICA study adopting.

2.1.4 Conclusion and Recommendation

Alternative study is carried out with three alternatives selecting Case-C and preliminary design of the selected alternative is also carried out in some aspects to confirm the technical feasibility. The execution with the sediment control dam plan is presenting the following

technical advantages and resulting in confirming that the proposed sediment control dam scheme is technically feasible.

- Discharge of the sediment accumulated in the reservoir area of the Ghiz Ghaleh River is restricted on the site with the crest elevation at EL+1085 m of the new spillway weir in the upstream end of floodway and that is the main purpose of this project.
- Stability of the new earth dam is secured to utilize watertight soil employed from some part of the existing dam with enough quantity located in situ.
- Risk of flood during construction period is minimized with applying two phased construction works with temporary cofferdam.
- Adverse effects to the environment are minimized with excavation carried out only in the existing dam area.
- It can be realized to reduce the construction cost for riverbed protection works employing hydraulic drop structures since the hydraulic drop structure contributes to maintain the gentle channel bed slope gradient and avoid the high flow velocity occurring during the flood time.

This study has been carried out as preliminary designing so that the more detail in survey, planning and design should be conducted to elaborate the implementing plan. In this regard, followings are recommended.

- To carry out further site survey to identify watertight layer with trial excavation.
- To conduct the laboratory test for embankment applicability to know how much of the density is obtained as well as trial compaction tests in situ using actual site material.
- To execute the detailed design with the required additional survey results to determine the detail dimension of the structures, to estimate the project cost precisely and to elaborate the implementation schedule.
- To consider the protection work on the front slope of dam body against overtopping floodwater such as concrete lining or placement of concrete block, if necessary after detailed hydrological designing, for securing the safety of dam body.

2.2 Riverbank Stabilization Works Designing

2.2.1 Objectives

The riverbank stabilization works of the Madarsoo River nearby Dasht village is the proposed structural countermeasure to prevent the above said damage to the Dasht village. The works has the following three objectives.

- To stabilize the existing unstable riverbanks of the Madarsoo River nearby Dasht village;
- To prevent the farmland from losing further caused by flood, and
- To reduce an exceeding sediment conveyance into the downstream of the Madarsoo River.

Additionally, the structure to be proposed is one of the essential structures for the River Restoration Plan under the Master Plan. This structure shall be set with the most downstream of the Gelman Darreh River improvement since it is expected that its function is not to stabilize the existing riverbanks but also to maintain the river course in the upstream as same function as the groundsill.

This riverbank stabilization works can bring the further effect to prevent the flood damage from appearing in and around the Dasht village under the proposed design scale when the river improvement works of the Madarsoo River and the Gelman Darreh River nearby Dasht village will be executed in accordance with the Master Plan scheme and the improved river system will be connected to the riverbank stabilization works.

2.2.2 Design Conditions

Design Discharge

The design discharge applied to the proposed structures is in accordance with the flood discharge under 25-year return period.

The hydrological study have provided the probable flood discharges to the mainstream and the major tributaries of the Madarsoo River basin in and around Dasht village as already illustrated in Fig. PII.3.

Design Water Level

Design water level for proposed channel sections is provided with the Manning Formula, which calculates an hydraulic state under the uniform flow condition, since the existing riverbed slope gradient of the Madarsoo River basin is steep as same as torrential stream riverbed slope gradient and supercritical flow is prone to occur under the hydraulic calculation.

On the other hand, design water level of the spillway section on the proposed dam or hydraulic drop structure is provided with the weir formula taking into account of the backwater effects.

Freeboard

Required freeboard height shall be determined with the design discharge scale. The freeboard has the margin against unexpected wave height and overtopping. Required dike crest or spillway section height is made from the sum of the design water depth and the required freeboard height.

The freeboard height in the torrential stream is required higher than the river course on an alluvium plain since the riverbed change and/or sediment discharge are occurred frequently during the flood time and water surface is prone to become turbulent in the torrential stream. Thus determination of the required freeboard height in the torrential stream shall be considered with design discharge but also with channel bed gradient.

For instance, relation between design discharge and required freeboard height, which the Japanese Technical Guideline for river works recommends, is tabulated below.

Table PII.4 Relation Between Design Discharge and Required Freeboard

Design Discharge	Freeboard Height (minimum)
Less than 200 m^3/s	0.6 m
200 to 500 m^3/s	0.8 m
More than 500 m^3/s	1.0 m

Table PII.5 Relation Between Channel Bed Gradient and Required Freeboard

Bed Gradient	More than 1/10	1/10 to 1/30	1/30 to 1/50	1/50 to 1/70	1/70 to 1/100	Less than 1/100
h/H	0.50	0.40	0.30	0.25	0.20	0.10

Sources: River Works in Japan complied under River Bureau in the Ministry of Land, Infrastructure and Transport, Japan River Association, 1997

In the above table, “h “ and “ H” indicate the freeboard height based on the design discharge and the design water depth, respectively. Value of h/H shall be set up more than value shown above table.

Geological Condition Based on the Geological Investigation

According to the above geological investigation results, it is assumed that the proposed structural foundation is adopted with a spread foundation type.

One borehole drilling including SPT has been carried out for the preliminary design of the proposed riverbank stabilization works so that it is insufficient to implement the detailed design and construction stage. Consequently, before the implementation stage, the additional detailed geological investigation shall be executed including laboratory tests to ensure the more reliable results of the geological characteristics.

2.2.3 Alternative Study

Consideration of Proposed Channel Section

(1) Channel Stretch between Dasht Bridge and Nick Point

The existing waterway hydraulic characteristics between the bridge and the nick point could be set up as presented in the following table.

Table PII.6 Topographic Relation between Dasht Bridge and Nick Point

Location	Riverbed EL.	Distance	Assuming Riverbed Gradient
Riverbed Difference Point	EL+956.5m	640 m	I = 1/260
Dasht Bridge (Existing)	EL+954.0m		

The channel section accommodating the design discharge of Q_{25} = 660 m^3/s in accordance with 25-year return period is designed with the uniform flow calculation of the Manning's Formula. The hydraulic calculation results are shown below.

Table PII.7 Hydraulic Calculation Results in the Downstream Reaches

Conditions	Value	Remarks
Riverbed Width	55.0 m	
Water Depth	3.3 m	
Side Slope Gradient	1:0.5	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/260	Same as existing riverbed gradient
Sectional Area (A)	186.95 m^2	
Wetted Perimeter (P)	62.38 m	
Hydraulic Radius (R)	2.997 m	
Flow Velocity (V)	3.68 m/s	
Flow Capacity (Q)	688.6 m^3/s	Design Discharge: 660 m^3/s

Required freeboard height is 1.0m high based on the design discharge and the value of h/H is 1.0m/3.3m = 0.303 with riverbed gradient I=1/260. The value satisfies the standards shown in both Tables PII.4 and PII.5. Therefore, the freeboard height of 1.0m is adopted.

(2) Channel Stretch Upstream of Nick Point

According to the field reconnaissance and a map measurement with scale of 1:25,000, the ground surface slope gradient of the Dasht basin is about 1/100 between the nick point to the confluence of the Madarsoo River and the Dasht-e-Sheikh River.

In terms of economic and social environmental aspects on the channel improvement, the proposed channel bed gradient is adopted as same as the existing surface gradient to reduce the excavation volume and to avoid setting the proposed design water level higher than the existing ground surface.

Proposed channel width follows the immediate downstream river width of 55.0 m as well as the downstream stretch between Dasht bridge and the nick point.

The channel section accommodating the design discharge of 660 m^3/s in accordance with 25-year return period is designed with the uniform flow calculation of the Manning's Formula. The hydraulic calculation results are shown below.

Table PII.8 Hydraulic Calculation Results of the Upstream Section

Conditions	Value	Remarks
Riverbed Width	55.0 m	
Water Depth	2.5 m	
Side Slope Gradient	1:0.5	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/100	Same as existing ground surface gradient
Sectional Area (A)	140.63 m^2	
Wetted Perimeter (P)	60.59 m	
Hydraulic Radius (R)	2.321 m	
Flow Velocity (V)	5.01 m/s	
Flow Capacity (Q)	704.3 m^3/s	Design Discharge: 660 m^3/s

Required freeboard height is 1.0 m high based on the design discharge and the value of h/H is 1.0 m/2.5 m = 0.40 with riverbed gradient I=1/100. The value is satisfies the standards shown in both Tables PII.4 and PII.5. Therefore, the freeboard height of 1.0 m is adopted.

Consideration of Optimum Structural Type for the Countermeasures

Three types are elaborated for alternative schemes based on the topographic and hydraulic conditions. These alternative features are:

- Alternative-A is composed of concrete main dam, sub-dam, concrete apron with stilling basin and concrete block.
- Alternative-B is composed of concrete main dam, sub-dam, concrete apron with stilling basin, hydraulic drop structure and concrete blocks for the riverbed protection.
- Alternative-C consists of three hydraulic drop structures and concrete blocks for the riverbed protection.

The following conditions are set up for preparation of the alternatives.

- The downstream design riverbed is in accordance with the existing riverbed.
- The upstream design channel bed is set on the proposed channel bed considered with proposed river channel improvement of the Gelman Darreh River.
- Proposed concrete apron surface is set based on the difference between the conjugate depth of the hydraulic jump and downstream water depth.
- Proposed drop height are considered with the condition that the conjugate depth of the hydraulic jump is about the same as the design water depth on the channel.
- Proposed spillway invert width of the main dam and/or hydraulic drop structure is 55.0 m wide as same as the width immediately downstream of spillway in the Madarsoo River.
- The bottom of main dam is set on the concrete apron surface below 2.0 m deep to prevent the unexpected scouring caused by the water falling down from the spillway section.
- The bottom of sub dam is set on the bottom of concrete apron below 2.0 m deep.

Salient features of the three alternatives are tabulated in the following table.

Table PII.9 Salient Features of the Alternative Dimensions

	Structural Scale					
	Downstream Design Riverbed	Conc. Apron Surface	Main Dam Height	Hydraulic Drop Structure		Upstream Channel Bed
				Nos.	Drop Height	
Alternative-A	EL+956.5 m	EL+954.0 m	9.0 m	N/A	N/A	EL+963.0 m
Alternative-B		EL+954.6 m	5.8 m	1	2.0 m	
Alternative-C		N/A	N/A	3	2.0 m	

These alternatives are compared and the optimum structural type is selected from the viewpoints of structural characteristics, social environment and construction cost. The schematic drawings of the three structural combinations for the riverbank stabilization works are shown in Fig. PII.12 and their comparison is tabulated in Table PII.10.

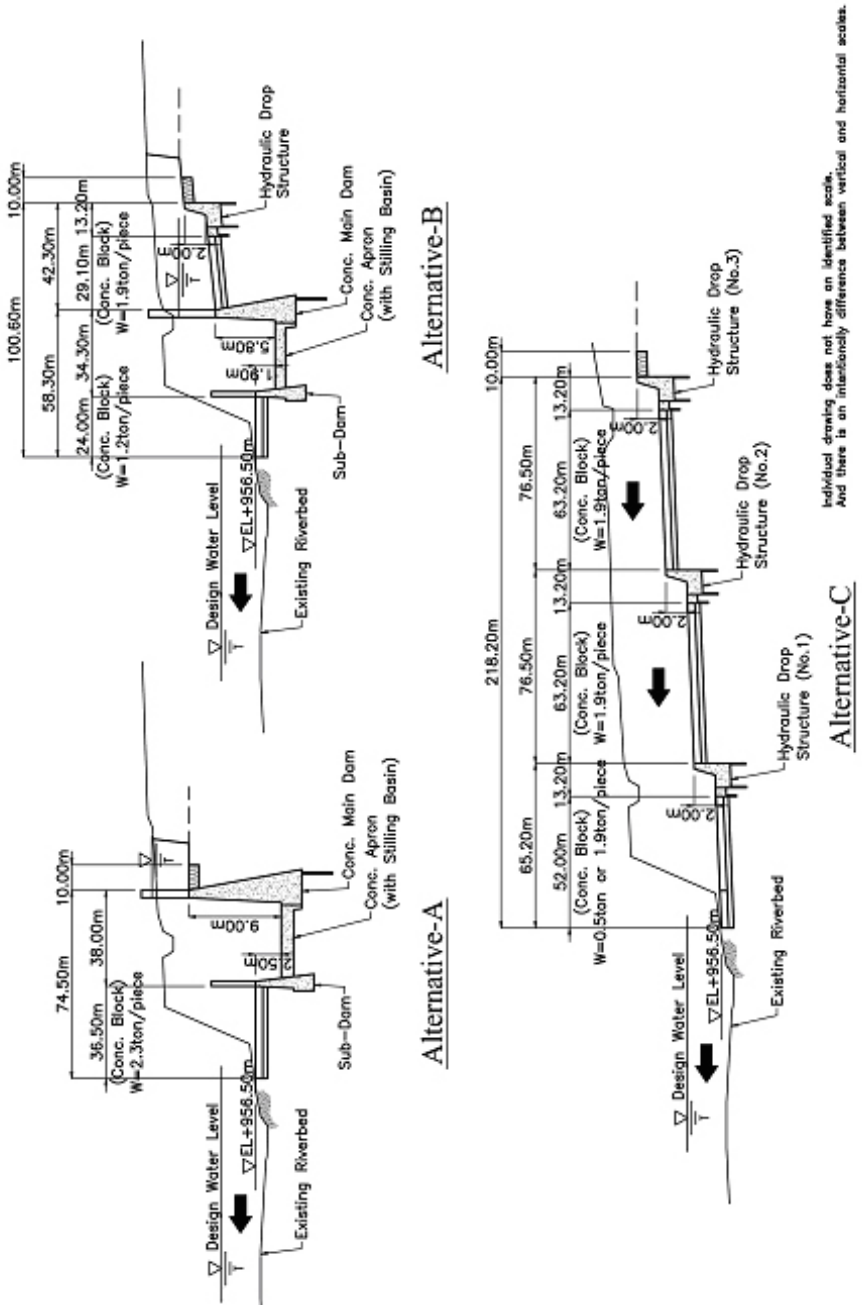


Fig. PII.12 Structural Alternatives for Riverbank Stabilization Works

Table PII.10 Comparison of Alternatives for Riverbank Stabilization Works

	Alternative- A (Concrete Dam Type)	Alternative-B (Concrete Dam + Hydraulic Drop Type)	Alternative-C (Hydraulic Drop Structure Type)
General View	Refer to Fig. PII.12	Refer to Fig. PII.12	Refer to Fig. PII.12
Structural Characteristics	❑ The countermeasure is composed of concrete main dam, sub-dam, concrete apron (with stilling basin), concrete blocks and revetment as riverbank protection. ❑ Dam height of 9.0m is required to retain the existing riverbed difference by itself. ❑ The entering flow as kinetic energy created by flood flow fallen down is the strongest among other alternatives. ❑ The entering flow has high velocity flow of more than 15m/s on the concrete apron, so that there is a possibility to appear a heavy turbulent flow on the riverbed protection and to affect an immediate riverbed condition. ❑ Soil improvement works shall be required in implementation stage since subgrade reaction of the main dam exceeds an allowable bearing capacity.	❑ The countermeasure is composed of concrete main dam, sub-dam, concrete apron (with stilling basin), hydraulic drop structure, concrete blocks and revetment as riverbank protection. ❑ Dam height of 5.8m and drop structure difference of 2.0m are required to retain the existing riverbed difference. ❑ The entering flow as kinetic energy created by flood flow fallen down is smaller than Alternative-A because the installation of hydraulic drop structure can reduce the proposed dam height.	❑ The countermeasure is composed of three (3) hydraulic drop structures, concrete blocks and revetment as riverbank protection. ❑ Proposed drop structure height of 2.0m is required individually. ❑ It is required to keep the interval of 76.5m between the drop structures since hydraulic profile is set smoothly. ❑ The potential energy created by flood flow is the smallest among the three alternatives. ❑ It is expected to reduce the effect on riverbed change in the downstream section of the Madarsoo River.
Required Land Area	A1 = 84.5m X 94.0 m = 7,950 m^2	A2 = 110.6m X 92.0m = 10,180 m^2	A3 = 228.2m X 84.4 m = 19,260 m^2
Construction Cost	8.05 billion Rials (direct cost only)	7.83 billion Rials (direct cost only)	11.94 billion Rials (direct cost only)
Evaluation	Advantageous with regard to required area to be constructed, however, problem is left in possibility of turbulent flow effect and the countermeasure against the exceeding allowable bearing capacity. **(Inadequate)**	Cost performance is the best among the others. It is expected to reduce the effect of downstream stretch against a turbulent flow more than Alternative-A. **(Adequate)**	This type is more costly than other alternatives and the largest area is required by the construction. **(Inadequate)**

2.2.4 Preliminary Design of Riverbank Stabilization Works

Optimum Structural Type

Based on the comparison for the structural type selection, Alternative-B (Concrete Dam and Hydraulic Drop Structure Type) is selected for the following reasons.

(1) The potential energy created by probable floodwater at the proposed dam spillway is reduced comparatively because the installation of proposed hydraulic drop structure in the upstream side of the concrete dam could reduce the concrete dam height.

(2) The reduction of the potential energy is expected to bring the effect mitigating the downstream riverbed scouring caused by the floodwater and to contribute stabilizing the existing riverbed further.

(3) Cost performance is the best among the three alternatives, and it is expected that the required area to place the proposed structures can be set on the current devastated area without the land acquisition of the farmland.

The salient structural dimensions of the concrete dam and hydraulic drop structure are tabulated below.

Table PII.11 Essential Dimensions for Riverbank Stabilization Works

Structural Features	Value	Remarks
(**Concrete Dam**)		
Design Dam Crest Width	B = 3.0 m	Required by dam stability
Design Dam Height	H = 7.8 m	
Design Downstream Slope Gradient	1: 0.20	Required by dam stability
Design Upstream Slope Gradient	1: 0.75	Ditto
Seepage Blockage Wall for Concrete Dam	L = 3.0 m	Required by dam stability Against uplift
Design Upstream Concrete Block Weight	1.9 ton/piece	
Design Downstream Concrete Block Weight	1.2 ton/piece	
(**Hydraulic Drop Structure**)		
Design Drop Height	H = 2.0 m	
Design Drop Crest Width	B = 2.3 m	Required by drop structure stability
Design Footing Length	L = 5.0 m	
Design Footing Thickness	T = 1.5 m	Required by drop structure stability
Design Cutoff Height	H = 1.5 m	

Drawings of plan and typical sections for the proposed riverbank stabilization works are shown in Figs. PII.13 to PII.15, respectively.

Preliminary Project Cost

The preliminary project cost estimate for the selected alternative as the optimum structural scheme is shown in the following table based on the results of preliminary design calculation and topographical survey.

The components of indirect cost mentioned below are referred to the estimate manner as well as the previous JICA study report on “the Integrated Management for Ecosystem Conservation of The Anzali Wetland in the Islamic Republic of Iran, March 2005”.

Table PII.12 Preliminary Project Cost Estimate

Alternative-2

Work Item	Quantity	Unit	Unit Price (Rials)	Amount (1,000 Rials)
I. Construction Base Cost				**8,611,000**
1. Preparatory Works	1	l.s.		783,000
(10% of Sub-total of Item 2 to 3)				
2. Riverbank Stabilization Work for Madarsoo River at Dasht Village				7,828,000
a. Excavation				
- Sand & Gravel	72,300	m^3	7,000	506,100
b. Random Backfilling	9,560	m^3	7,000	66,920
c. Backfilling with Compaction	1,940	m^3	9,000	17,460
d. Embankment		m^3	11,000	0
e. Removal of the Surplus Soil	61,000	m^3	19,000	1,159,000
f. Gravel Bedding	3,210	m^3	9,000	28,890
g. Sodding	1,730	m^2	1,000	1,730
h. Concrete				
- Plain Concrete	8,550	m^3	270,000	2,308,500
- Reinforced Concrete (including 20kg rebar)	1,270	m^3	355,000	450,850
- Wet Stone Masonry	2,880	m^3	227,000	653,760
i. Gabion Mattress	710	m^3	149,000	105,790
j. Concrete Block				
- 1.9ton/piece	1,080	nos.	602,000	650,160
- 1.2ton/piece	1,295	nos.	443,000	573,685
k. Miscellaneous	1	l.s.		1,305,155
(20% of "a" to "j")				
II. Land Acquisition Cost				**0**
a. Dry Farming Land	0	m^2	400	0
b. Irrigated Land	0	m^2	4,200	0
c. Orchard	0	m^2	11,000	0
d. Residential Area		m^2	60,000	0
III. Administration Cost	1	l.s.		**431,000**
(5% of Item I)				
IV. Engineering Cost	1	l.s.		**862,000**
(10% of Item I)				
V. Physical Contingency	1	l.s.		**1,981,000**
(20% of Item I + II + III + IV)				
VI. Total				11,885,000
Round Total				**11,890,000**

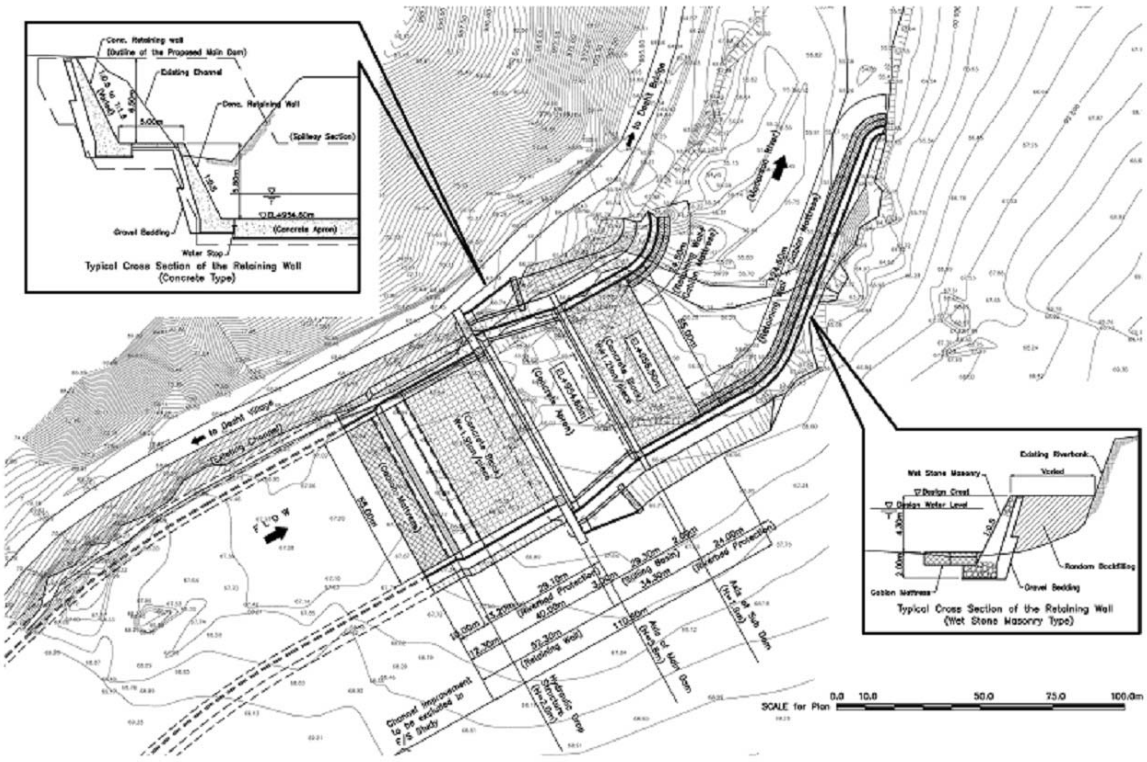


Fig. PII.13 Plan of Proposed Riverbank Stabilization Works

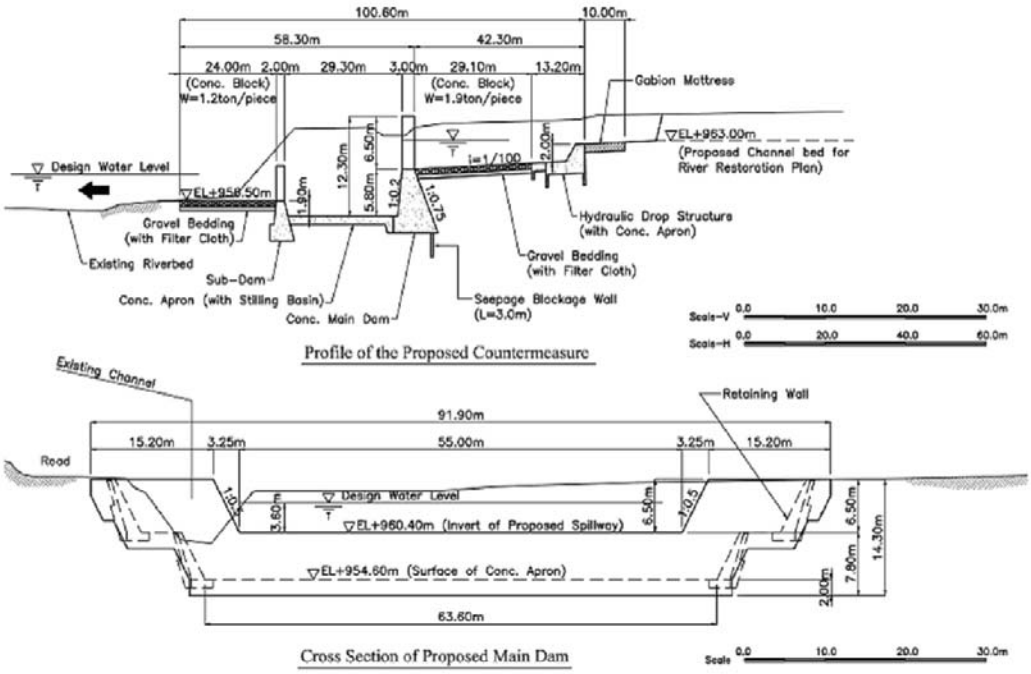


Fig. PII.14 Typical Sections of Proposed Riverbank Stabilization Works

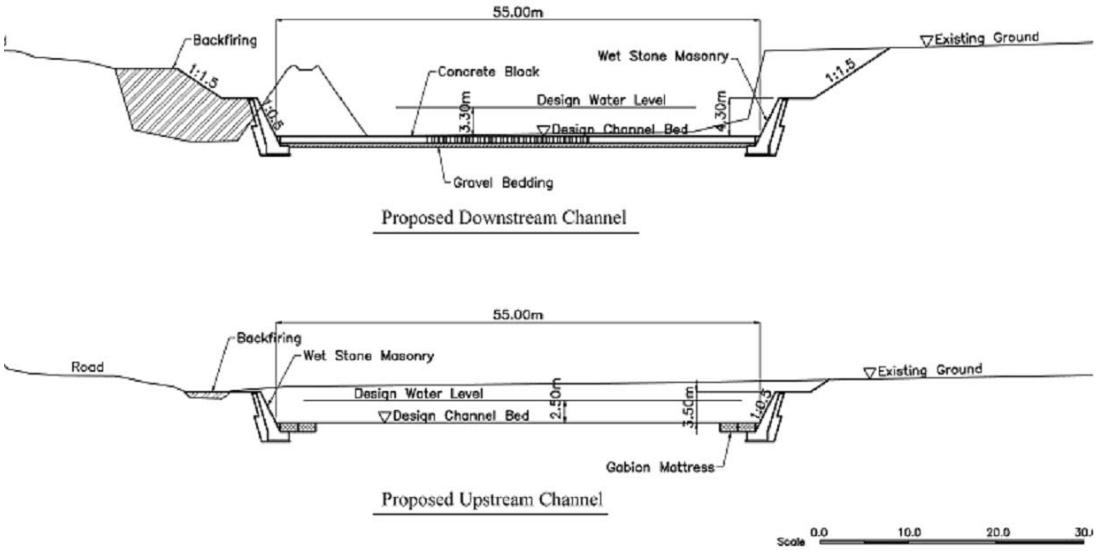


Fig. PII.15 Typical Cross Section of Proposed Channel Works

2.2.5 Recommendation

(1) Necessity of Detailed Design Stage Execution

The study results are limited to the preliminary design level and it shall be conducted to further elaborate the implementation plan with the additional detailed survey, geological investigation, planning and design for the proposed structures in order to prepare the necessary documents such as detail design drawings, more precise construction quantity, tender documents including technical specifications, etc.

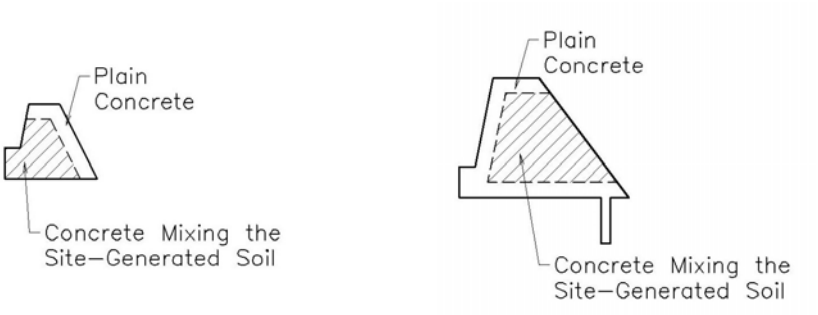
(2) Utilization of the Site-Generated Soil

According to the geological field reconnaissance, the riverbeds in the Madarsoo River and the Ghyz Ghaleh River are thick covered with coarse sand, which is relatively

good quality for concrete materials caused by the ancient sediment deposit in the Cambrian Period or the Jurassic Period. It is recommended to conduct the detail applicable study including the design of mix proportion for the site-generated soil utilization for the concrete material on the detail design stage.

If the coarse sand of the site-generated soil might be applied to the aggregate material of the appropriate concrete, the surplus soil generated by the excavation is utilized as the useful construction materials and it is expected to reduce the construction cost of the hauling and removal of surplus soil expenses.

In the proposed countermeasures, the proposed applicable section with the concrete mixing site-generation soil is shown with the following examples.



(Sub-Dam Section) (Main Dam Section)

Fig. PII.16 Example of Proposed Applicable Sections for Utilization of Generated Gravel and Soil

(3) Early Implementation of Flood Control in the Gelman Darreh River

This works is one of the essential structural measures for river restoration plan, which is proposed in the Master Plan. In viewpoints of the Dasht village protection against the probable floods, it is insufficient to protect the Dasht village with the proposed riverbank stabilization works independently unless the channel improvement will be executed to control the flood discharge and the channel is completely connected to the proposed riverbank stabilization works.

After the riverbank stabilization works completion to be proposed, it is desirable to execute the channel improvement as soon as possible to reduce the flood damage occurrence in and around the Dasht village. Furthermore MOE-North Khorasan is planning the flood control dam located at the entrance of Dasht basin in the Gelman Darreh River. Such large-scale reservoir is one of the alternatives to the said river improvement. Thus it is also recommended that MOE-North Khorasan shall conduct careful and technical-sound investigation for the dam planning.