CHAPTER 2 RIVER RESTORATION PLAN

2.1 Issues to be Addressed against Flood

Three large streams join in the flat topography of Dasht area. These rivers are the Gelman Darreh River with a drainage area of 787 km^2, the Dasht-e-Sheikh River with 125 km^2, and the Ghyz Ghaleh River with 126 km^2, respectively. In the 2001 Flood, three disastrous events have been occurred in the Dasht area.

(1) Swollen floodwater along the Ghyz Ghaleh River has breached an existing earth dam located at 4 km upstream of the Dasht Village, and floodwater convolving stored sediment by the dam has rushed towards the village area.
After the 2001 Flood, polder dike has been constructed by MOE- North Khorasan Office to protect the village from the direct hitting of flood flow.

(2) Larger and long-lasting flood flow has come from the Gelman Darreh River, and it has swept away crops and fruit trees in the valley-bottom plain of Dasht area.

(3) Damming up might have been occurred along the Madarsoo River at some upper part of the Golestan Forest during the 2001 Flood, and suddenly collapse due to overtopping 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 area.

These locations in the Dasht area are depicted in the following Photo.

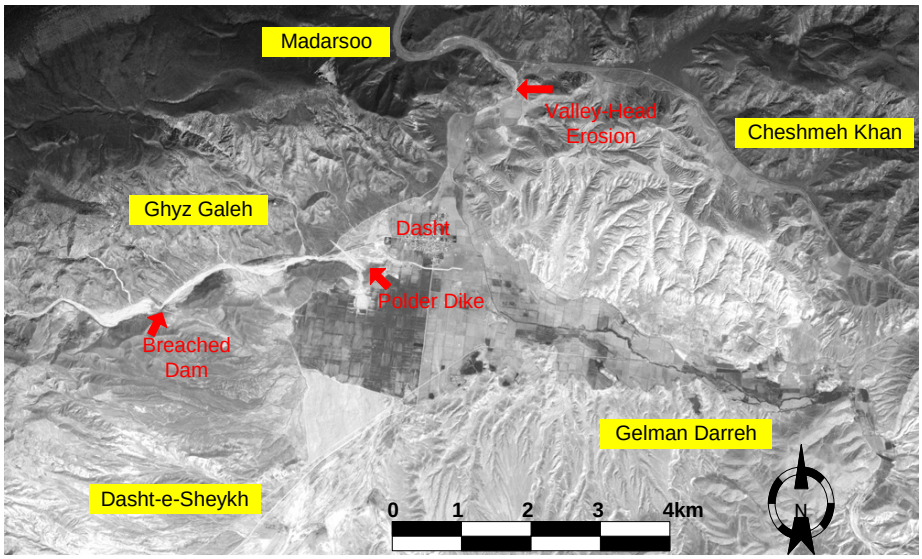


Photo 1.1 Dasht Area (IRS Satellite Image)

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 Ghyz Ghaleh River

The left bank in the middle reaches of the Ghyz Ghaleh River 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 the Dasht village against flood flow 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 area of existing polder dike, and finally floodwater easily will rush to the village over the dike.

(2) Flood Control of Channel Network

According to the Watershed Management Plan designed by MOJA- Golestan Office, the hydrological effects of watershed management shall be premised for the flood control because of already progressing program. After completion of land treatment such as terracing, banquette, furrow and reforestation, the design discharges of the three rivers in 25-year flood are tabulated below.

Table 1.6 A 25-Year Design Flood Discharge with Watershed Management Effect

River	Design Discharge	Remarks
Gelman Darreh River	430 m^3/s	
Dasht-e-Sheikh River	90 m^3/s	
Ghyz Ghaleh River	160 m^3/s	
Madarsoo River	660 m^3/s	After confluence of said three rivers

To ensure the reduction of the flood and crops loss in the widely extending farmlands, the river channel improvement shall be implemented in parallel with the watershed management plan execution.

(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. The valley-head height, which indicates the riverbed difference, is about 7m from the existing riverbed to the upstream channel bed on topographical survey results.

In addition, the unstable riverbanks are prone to collapse and be eroded by flood flow and the erosion head progress 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.

2.2 River Restoration Plan

The proposed river restoration plan aims to protect the human life and private properties, and public infrastructures in and around Dasht village from the flood and/or sediment flow damages under the design scale of a 25-year return period as mentioned already.

The plan contains the main countermeasures to enlarge the flow capacity of the existing channel, to strengthen channel bed stability, bank protection of the existing rivers and to reinforce the valley-head erosion against a probable flood occurrence.

The subject area is composed of the related three river systems; namely Gelman Darreh River, Dasht-e-Sheikh River and Ghyz Ghaleh River, respectively. The proposed river system arrangement based on the probable flood of a 25-year return period is shown in Figure 1.7 and the features of the related river system improvement are described as follows:

(1) Gelman Darreh River

According to the field reconnaissance in this study, the existing channel has the following channel dimensions:

Table 1.7 Features of Existing Channel in the Gelman Darreh River

Item	Dimension	Remarks
Channel Width	About 7 m	In maximum
Channel Depth	About 2.5 m	Without freeboard height
Channel bed Gradient	I = 1/100	Following the ground surface

Based on above the table, the allowable flow capacity of the existing channel is estimated for around 70 m^3/s in maximum with the uniform flow calculation. This estimated flow capacity is about the same as the discharge on a 2-year return period. Under the current condition, it is difficult to accommodate the amount of 660 m^3/s as design discharge unless the channel improvement including the channel enlargement is executed to the current river system.

The proposed river improvement stretch of the Gelman Darreh River (the Madarsoo River after confluence with the Gelman Darreh River and the Dasht-e- Sheikh River) is from the valley-head point nearby the Dasht Village to about 6.5 km in upstream in accordance with the existing agricultural road crossing the Gelman Darreh River.

As regards the erosion control in the valley-head, the channel works is proposed to preserve the appropriate sediment conveyance from the headwater area for the downstream riverbed maintenance. If the sediment conveyance to the downstream is limited with the sediment storage capacity of a gully control dam or erosion control dam, it might be appeared that the downstream riverbed is degraded further by floodwater and the riparian structures along the Madarsoo River are damaged due to the loss of the foundation stability.

The channel improvement of the Gelman Darreh River is mainly proposed to enlarge the channel width for the range from 64.0 m to 46.2 m and design high water level in the middle and upper reaches of the improved stream is set in accordance with the existing ground level as well as possible. The proposed channel alignment follows the existing stream alignment because the existing channel is located on the lower part comparatively in the Gelman Darreh floodplain and it is assumed to collect the floodwater easily over the subject area.

The following table shows the hydraulic calculation results on Section Ge-1, Ge-2 and Ge-3, which is shown in Figure 1.8.

Table 1.8 Hydraulic Characteristics on Section Ge-1

Conditions	Value	Remarks
Riverbed Width	50.0 m	
Water Depth	2.5 m	
Side Slope Gradient	1:2.0	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/100	Same as existing ground surface gradient
Sectional Area (A)	137.50 m^2	
Wetted Perimeter (P)	61.18 m	
Hydraulic Radius (R)	2.247 m	
Flow Velocity (V)	4.90 m/s	
Flow Capacity (Q)	674.1 m^3/s	Design Discharge 660 m^3/s

Table 1.9 Hydraulic Characteristics on Section Ge-2

Conditions	Value	Remarks
Riverbed Width	36.0 m	
Water Depth	2.5 m	
Side Slope Gradient	1:2.0	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/128	Same as existing ground surface gradient
Sectional Area (A)	102.50 m^2	
Wetted Perimeter (P)	47.18 m	
Hydraulic Radius (R)	2.173 m	
Flow Velocity (V)	4.24 m/s	
Flow Capacity (Q)	434.2 m^3/s	Design Discharge 430 m^3/s

Table 1.10 Hydraulic Characteristics on Section Ge-3

Conditions	Value	Remarks
Riverbed Width	33.0 m	
Water Depth	2.5 m	
Side Slope Gradient	1:2.0	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/106	Same as existing ground surface gradient
Sectional Area (A)	95.00 m^2	
Wetted Perimeter (P)	44.18 m	
Hydraulic Radius (R)	2.150 m	
Flow Velocity (V)	4.62 m/s	
Flow Capacity (Q)	439.2 m^3/s	Design Discharge 430 m^3/s

The high flow velocity occurrence for more than 4 m/s in the proposed Sections is assumed based on the consideration of the proposed cross section with the uniform flow calculation under the design scale.

It is predicted that the heavy channel bed scouring and bank erosion in a part of channel reaches may be occurred due to the high flow velocity and the damage scale cased by the scouring and erosion depends on the soil characteristics difference.

Therefore, in the detail design stage, it is recommended to carry out the careful consideration, including the probable flow velocity reduction as well as soil investigation, of the proposed design channel bed and channel bank stabilities against the probable high flow velocity, with the possibility for an introduction of a series of groundsills and/or suitable channel bed protection such as concrete block, gabion mattress and revetment expanding furthermore.

Figure 1.8 and 1.9 show the typical cross section of the proposed Gelman Darreh River and typical drawing of the proposed revetment works, respectively.

In addition, there is the existing bridge constructed with pipe culverts in the middle of the stream and the bridge reconstruction is proposed to maintain the existing agricultural road because of widening the channel width. The typical cross section of the proposed bridge is shown in Figure 1.10.

(2) Dasht-e-Sheikh River

The proposed river improvement stretch of the Dasht-e-Sheikh River is located in the surrounding Dasht village farmlands for the distance of about 5.1km to protect the farmlands from flood inundation due to Dasht-e-Sheikh River.

The improvement plan is mainly proposed to enlarge the channel width for the range from 58.20m to 21.70m to accommodate the design discharge and design high water level of the improvement stream is set in accordance with the existing ground level of the farmlands because the existing river shape of the Dasht-e-Sheikh River has been disappeared currently and when the new channel is planned in the torrential stream, the excavated channel is recommended by taking into account a reliability of flood control and an easy maintenance.

The following table shows the hydraulic calculation results, which are provided with the uniform flow formula, on Section Da-1, Da-2 and Da-3, respectively.

Table 1.11 Hydraulic Characteristics on Section Da-1

Conditions	Value	Remarks
Riverbed Width	25.0 m	
Water Depth	2.5 m	
Side Slope Gradient	1:2.0	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/181	Same as existing ground surface gradient
Sectional Area (A)	75.00 m^2	
Wetted Perimeter (P)	36.18 m	
Hydraulic Radius (R)	2.073 m	
Flow Velocity (V)	3.45 m/s	
Flow Capacity (Q)	258.9 m^3/s	Design Discharge 250 m^3/s

Table 1.12 Hydraulic Characteristics on Section Da-2

Conditions	Value	Remarks
Riverbed Width	45.0 m	
Water Depth	2.5 m	
Side Slope Gradient	1:2.0	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/555	Same as existing ground surface gradient
Sectional Area (A)	125.00 m^2	
Wetted Perimeter (P)	56.18 m	
Hydraulic Radius (R)	2.225 m	
Flow Velocity (V)	2.07 m/s	
Flow Capacity (Q)	258.4 m^3/s	Design Discharge 250 m^3/s

Table 1.13 Hydraulic Characteristics on Section Da-3

Conditions	Value	Remarks
Riverbed Width	8.50 m	
Water Depth	2.5 m	
Side Slope Gradient	1:2.0	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/30	
Sectional Area (A)	33.75 m^2	
Wetted Perimeter (P)	19.68 m	
Hydraulic Radius (R)	1.715 m	
Flow Velocity (V)	7.47 m/s	
Flow Capacity (Q)	252.2 m^3/s	Design Discharge 250 m^3/s

Figure 1.11 and 1.12 show the typical cross section of the proposed Dasht-e-Sheikh River and typical drawing of the proposed revetment, respectively.

Furthermore, the high flow velocity occurrence at more than 3 m/s in the proposed Section Da-1 and Da-3 is assumed based on the consideration of the proposed cross section with the uniform flow calculation under the design scale. It is predicted that the heavy channel bed scouring and bank erosion in a part of channel reaches may be frequently occurred due to the high flow velocity without the riverbed and riverbank protections, while the design flow velocity in the Section Da-2 is much the same as 2 m/s and the heavy scouring is hardly occurred by the design flow.

Therefore, in the detail design stage, it is recommended to carry out the careful consideration, including the probable flow velocity reduction, of the proposed design

channel bed and channel bank stabilities against the probable high flow velocity, with the possibility for an introduction of a series of groundsills and/or suitable channel bed protection such as concrete block, gabion mattress ands revetment expanding furthermore.

In addition, the new bridge construction is proposed to maintain the existing agricultural road because of the new channel excavation. The typical cross section of the proposed bridge is shown in Figure 1.13.

On the proposed plan, the huge excavated material (V= 4.0 million m^3, approximately) may be appeared as the surplus soil during the project implementation. The removal of surplus soil is recommended to reclaim in the immediately southern part of the proposed Dasht-e-Sheikh River because the area, which is spread for about 110 ha, has been devastated due to previous floods and there is a possibility of the development as new agricultural lands to contribute the income increasing for the Dasht villagers.

(3) Ghyz Ghaleh River

Flood flow in the Ghyz Ghaleh River has directly attacked the Dasht village, frequently. The floods have sometimes caused the serious damages in human life and farmlands.

To prevent the damages caused by the flood and/or sediment flow in the Dasht village, the flood and sediment flow control facilities are proposed to arrange in the Ghyz Ghaleh River. The said sediment control facilities are composed of diversion channel from the Ghyz Ghaleh River to new Dasht-e- Sheikh River and sediment control dam including the rehabilitation of the existing earth dam, respectively. The proposed arrangement of the sediment control facilities is shown in Figure 1.14 and the design concept for the structures are mentioned as follows:

(a) Diversion Channel

In the 2001 flood, the Dasht village has significantly sustained the flood damages and suffered the victims and its properties loss caused by flood surging from the southern and western parts of the village through both rivers of the Gelman Darreh and the Ghyz Ghaleh.

The field reconnaissance on this study clarifies the Ghyz Ghaleh River dose not have the confluence of the Gelman Darreh River or the Madarsoo River and the downstream end is replaced by the farmlands. It is assumed that the flood flow seldom occurs in and around the Dasht Village before the 2001 Flood and the farmland reclamation and/or natural forces might make the river course bury gradually.

The proposed diversion channel aims to prevent the flood flow from spreading directly toward the Dasht village. The diversion channel is recommended that the watercourse of the Ghyz Ghaleh River is diverted to the Southwest Dasht farmlands and the channel is connected to the proposed Dasht-e-Sheikh River in order to ensure the appropriate drainage channel system. Design discharge for proposed channel is adopted for 160 m^3/s under the design scale.

The control point of proposed diversion channel can be set on the existing excavated channel in the existing NRGO plantation, which is located at the right bank of 1.5 km downstream from the existing breached earth dam since the end of the existing channel has the natural diversion weir and it is possible that the flood flow run down to the Dasht-e-Sheikh River straight.

(b) Sediment Control Dam

The proposed sediment control dam is planned to control for discharge of the remaining sediment deposit in the existing dam reservoir to the downstream and

to rehabilitate an opening and collapse sections of the existing earth dam caused by the 2001 flood. The following photo shows the current state of the existing earth dam.

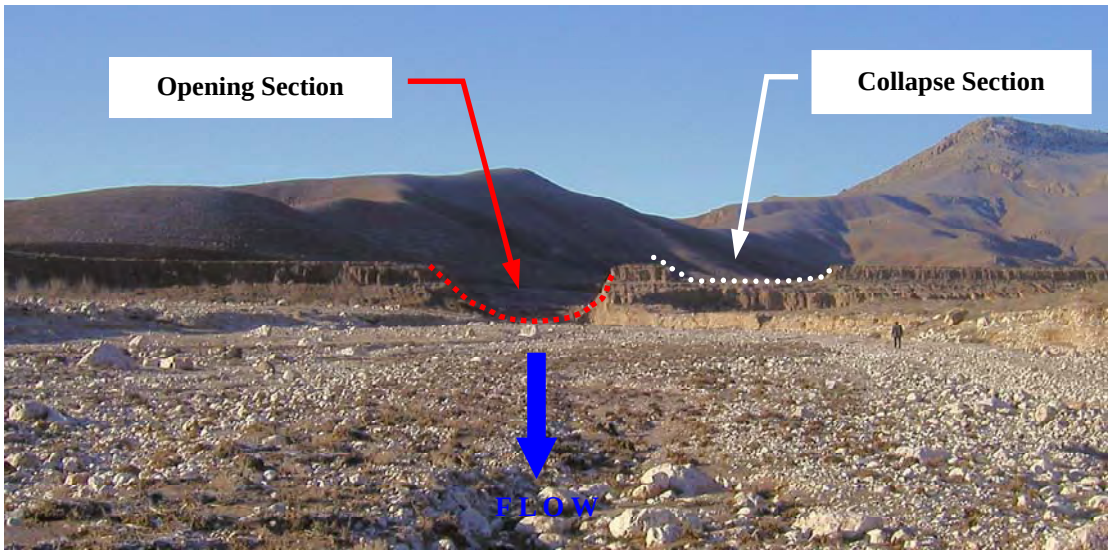


Photo 1.2 Downstream View of the Existing Breached Earth Dam caused by 2001 Flood

The damage scale is spread for 54m wide and 16m high in the opening section, while 59m wide and 4 high in the collapse section.

The design scale of its spillway is provided with a 100-year return period and design invert elevation of its spillway (same as proposed dam height) is considered with the surface elevation of existing sediment deposits in the upstream.

The existing dam is located on rock base in the right bank and on alluvial deposition layer at the left bank. Most part of the dam body is to be placed on the alluvial layer so dam height should not exceed 15 meters from the bottom of dam.

The proposed structural features are recommended as follows:

(c) Location of the dam

In taking into account of the existence of rock exposed at the right bank and consolidated foundation layer under the existing dam at the left bank, the proposed dam should be located at the place as same as the existing one.

(d) Elevation of the spillway crest

Invert elevation of the spillway is set for the future sediment surface to cover the existing sediment surface in the reservoir area.

(e) Type of dam

Concrete gravity type is proposed, unlike the existing earth dam, to expect the concrete material strength and construction ability.

(f) Foundation

The foundation should be placed on a solid riverbed. In this stage of the study, geological investigation is not carried out yet so that soundness of the foundation should be confirmed by sampling with core boring and permeability tests in the next stage. If deep, loose or highly permeable foundation is found out under the dam foundation, additional foundation improvement works should be required.

The typical section of the proposed sediment control dam is shown in Figure 1.15.

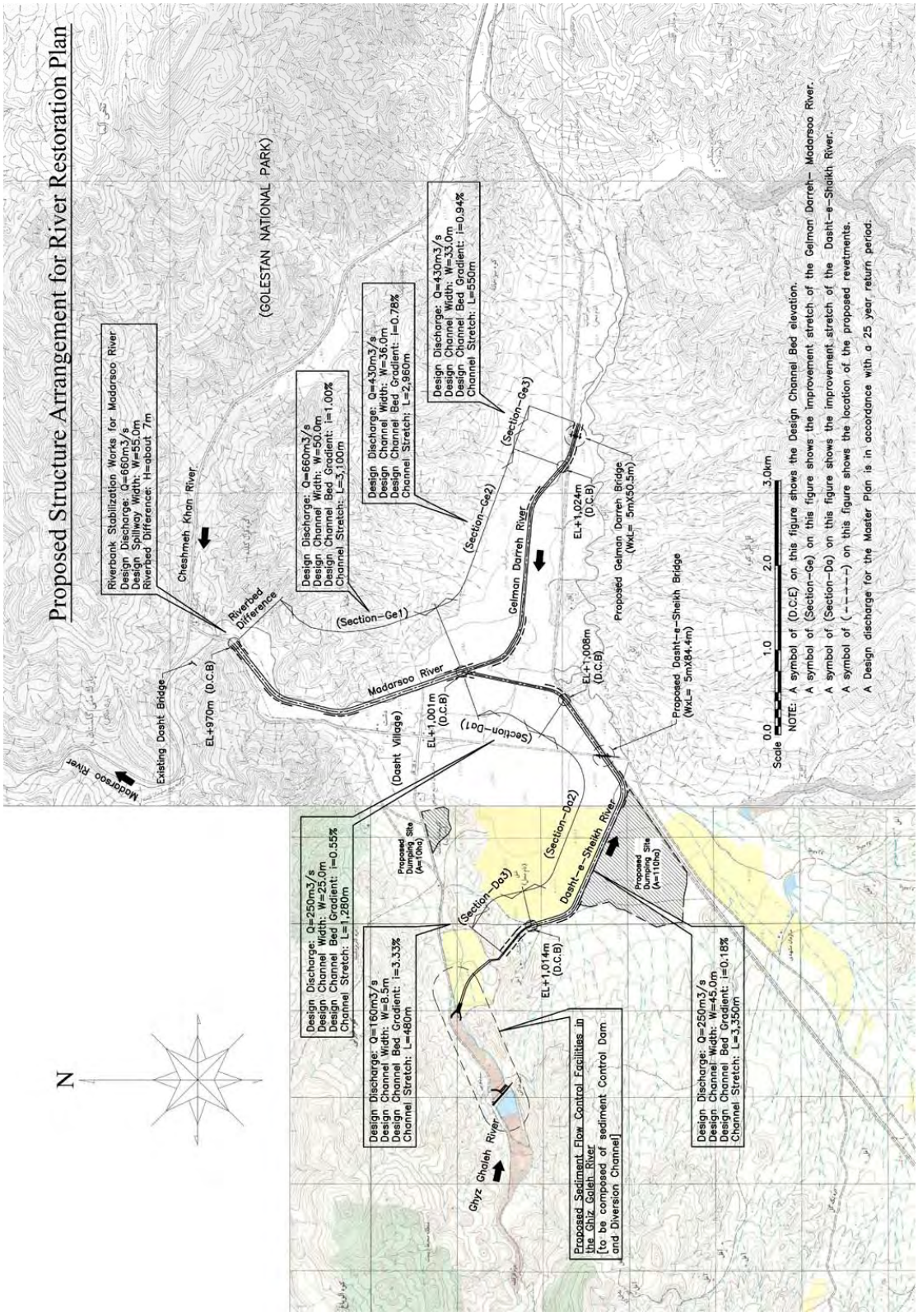


Figure 1.7 Proposed Arrangement of River Restoration Plan

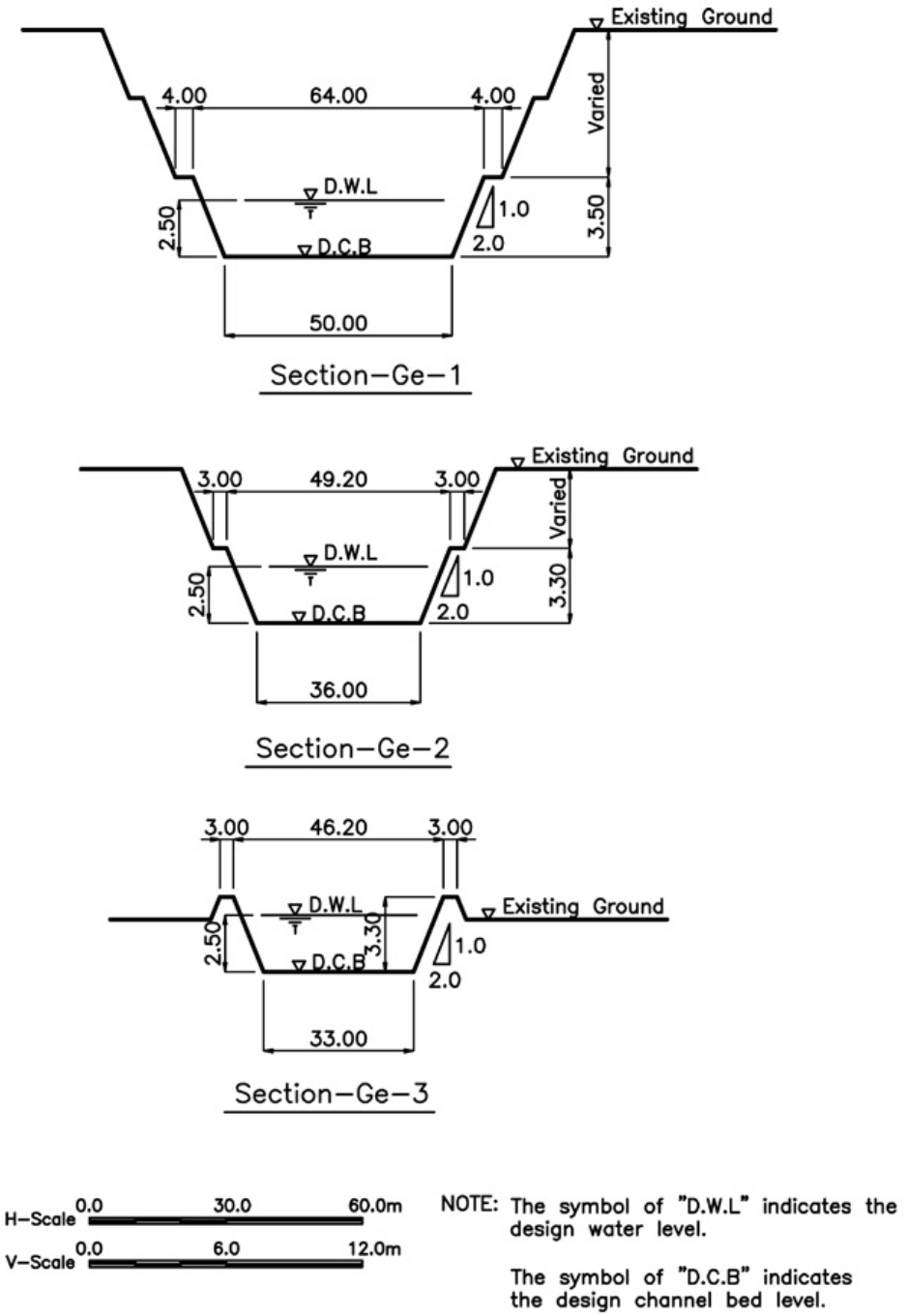


Figure 1.8 Typical Cross Sections of the Proposed Gelman Darreh River

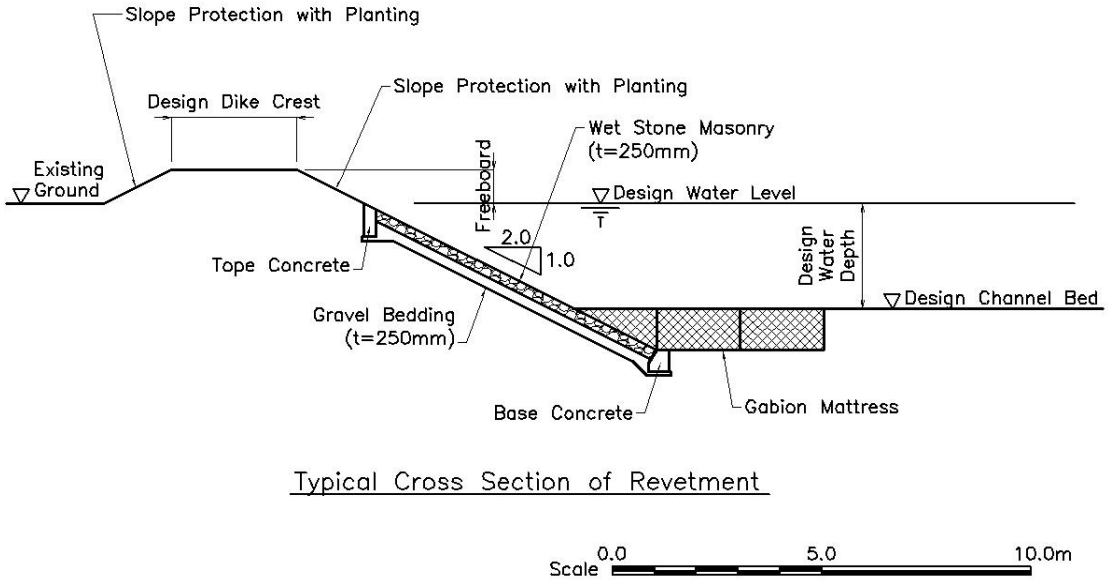


Figure 1.9 Typical Drawing of the Proposed Revetment

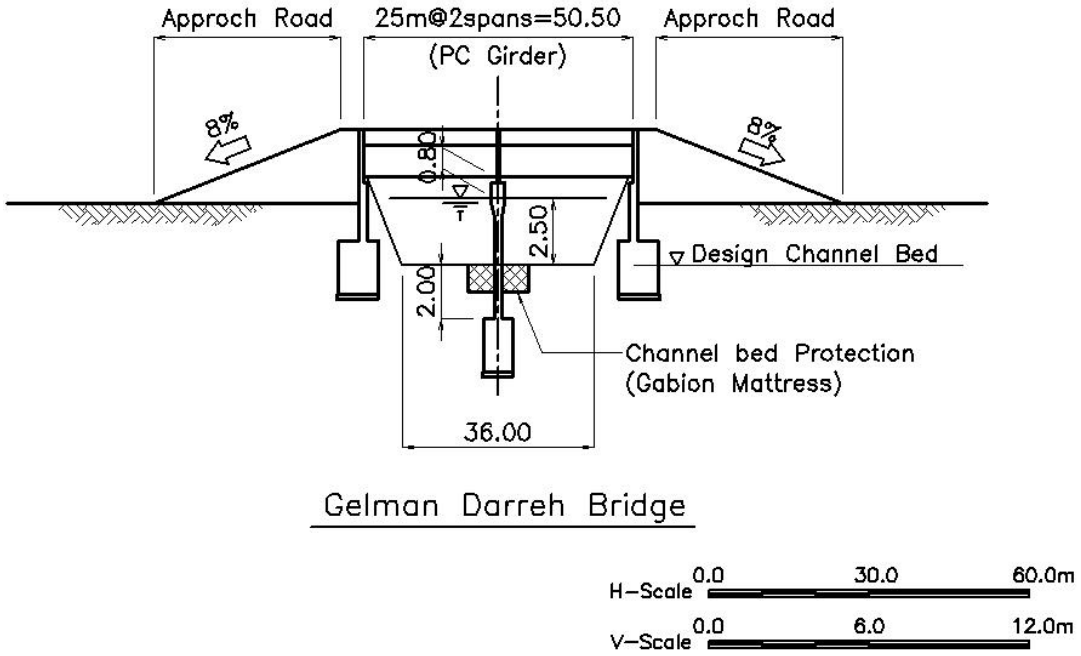


Figure 1.10 Typical Section of the Proposed Gelman Darreh Bridge

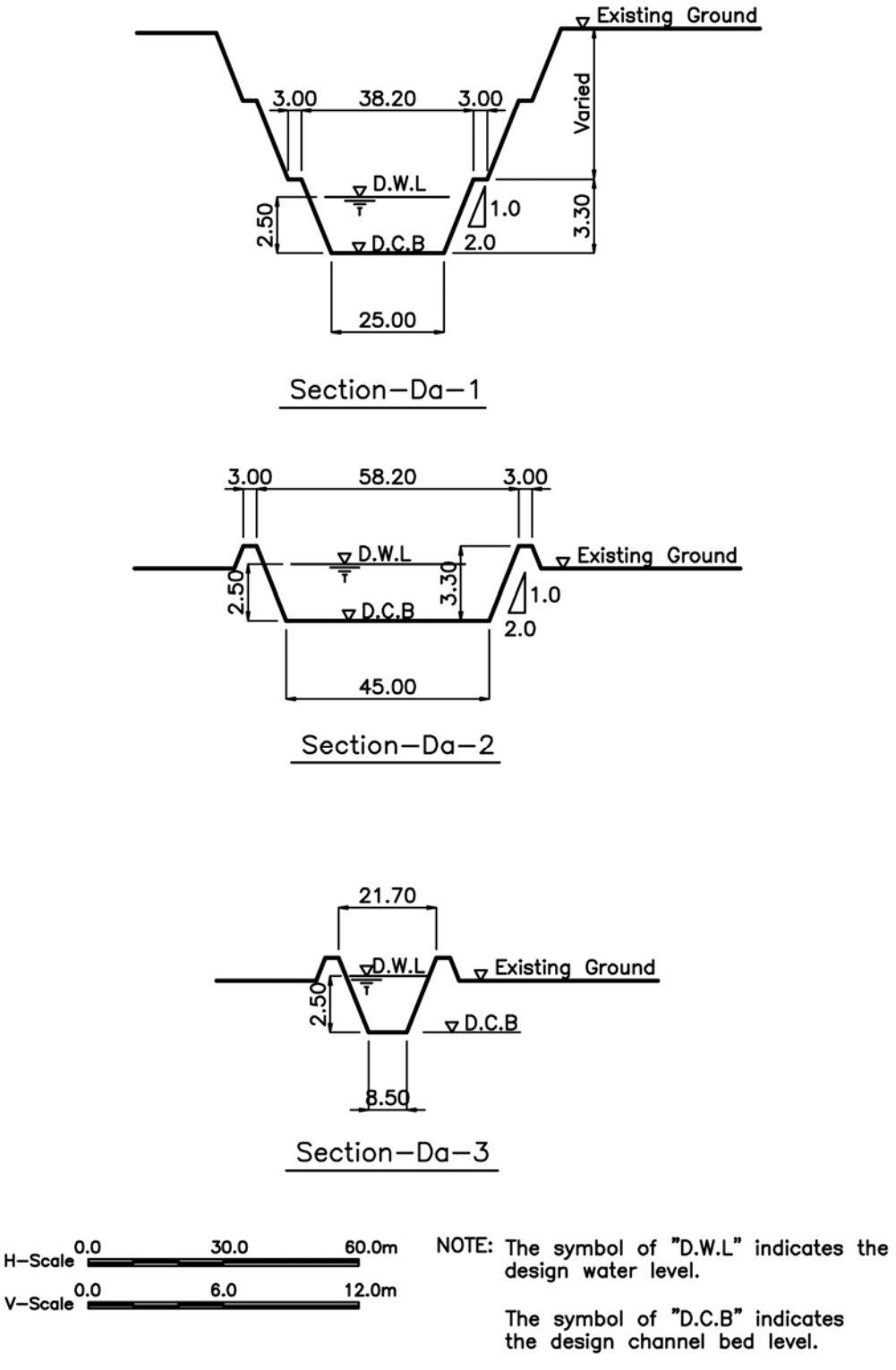


Figure 1.11 Typical Cross Sections of the Proposed Dasht-e-Shaikh River

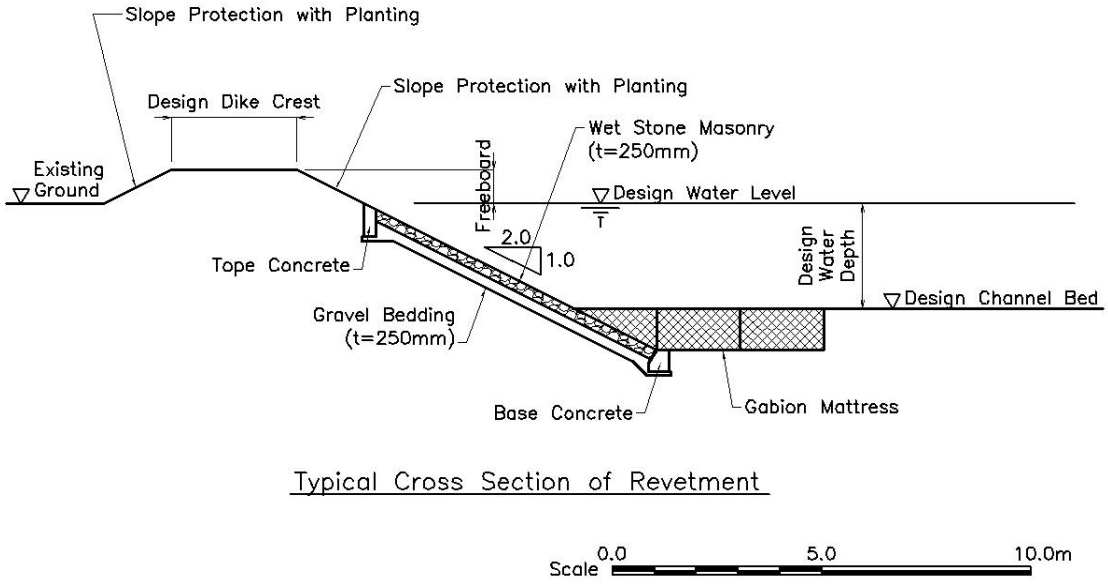


Figure 1.12 Typical Drawing of the Proposed Revetment

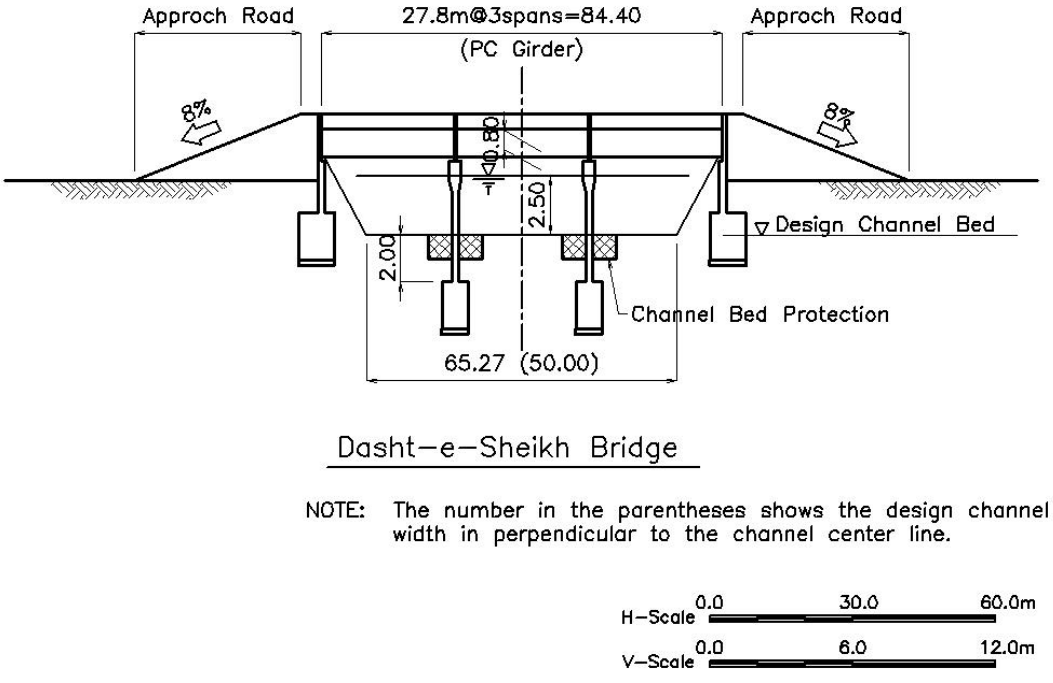


Figure 1.13 Typical Section of the Proposed Dasht-e-Shaikh Bridge

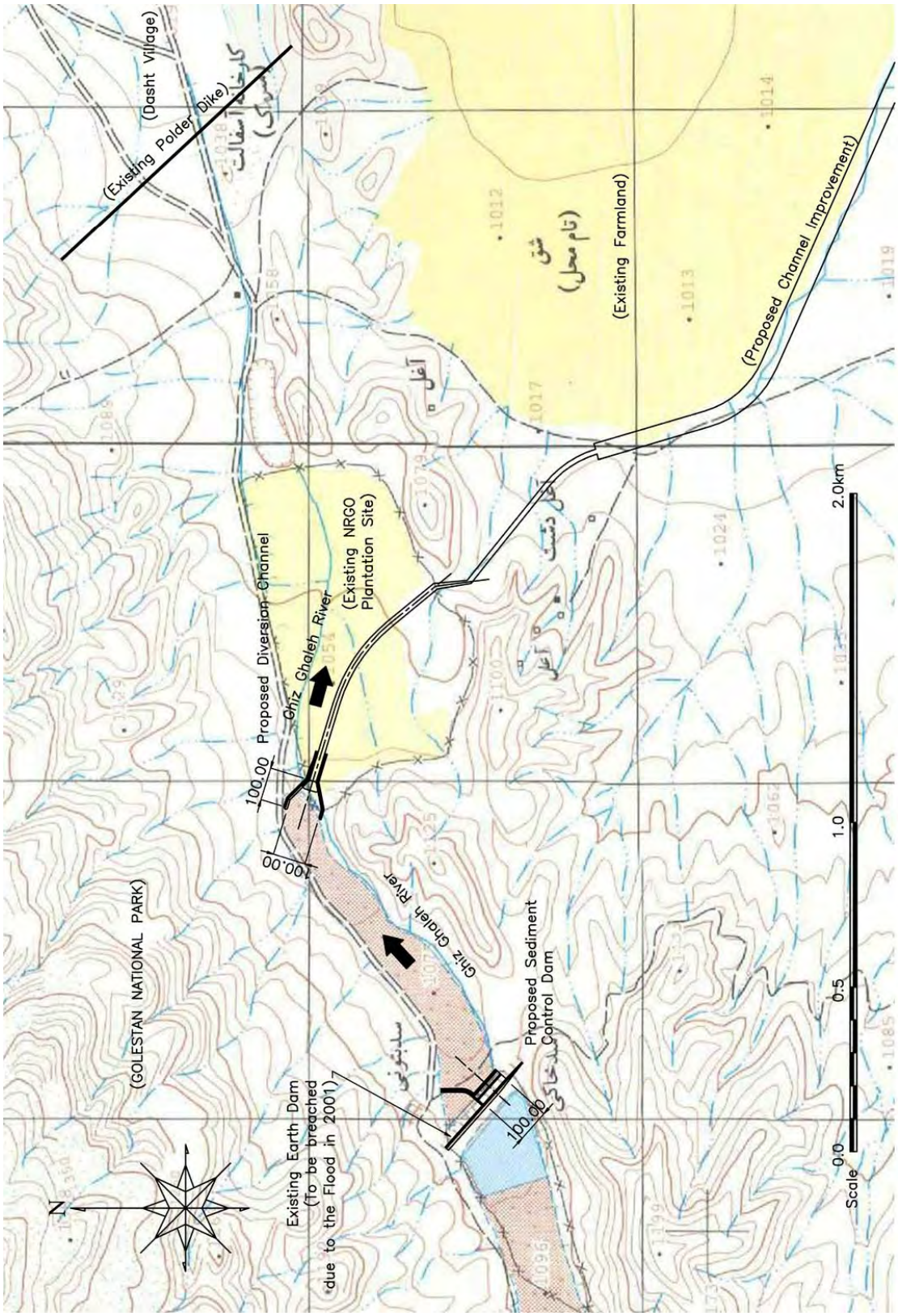


Figure 1.14 Proposed Arrangement of Sediment Control Dam Facilities

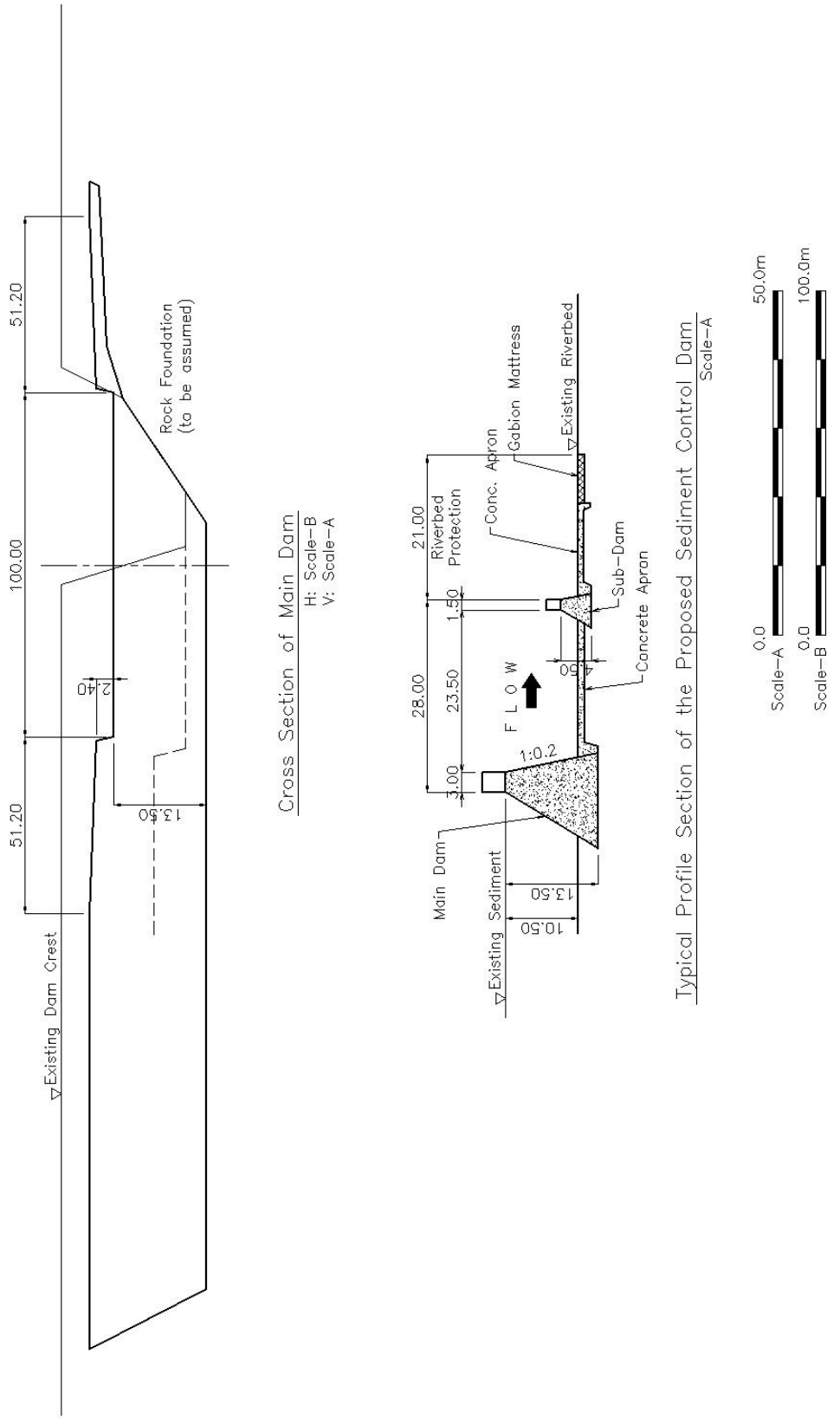


Figure 1.15 Typical Section of Proposed Sediment Control Dam

CHAPTER 3 FLOOD CONTROL PLAN

3.1 Present Status

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.

(1) Urgent Measures

The major task of urgent measures is rehabilitation of structures damaged by the 2001 Flood. The river improvement stretch is about 65 km from Kalaleh Bridge through the Golestan Forest National Park up to Dasht Bridge. The design discharge in the urgent plan ranges between 250 m^3/s of the upper stretch near the Golestan Forest Park and 400 m^3/s of the lower stretch near the Kalaleh Bridge, on the basis of 50-year design flood.

MOE selected nine locations for the urgent river improvement works; namely 1) Golestan National Park, 2) Tangrah Check Point, 3) Terjenly, 4) Sadegh Abad Diversion Dam, 5) Loveh Bridge, 6) Korang Kaftar Bridge, 7) 14 Metry Bridge, 8) Ajen Ghareh Khojeh and 9) Kalaleh Bridge, from upstream.

Most of the locations were completed before the recent flood attacked in the Madarsoo River basin on 10 August 2005.

(2) Master Plan in the Golestan Dam Basin

MOE simultaneously has been formulating the master plan covering the Golestan dam basin including the Madarsoo River basin. A 100-year return period was adopted as a design scale. However, the master plan has not been finalized yet.

Under the above situation, the 2005 Flood made an attack to the Madarsoo River basin. The damage situations at major sites are summarized in Table 1.14. As described in the table, the recently rehabilitated structures and newly installed flood control structures were seriously damaged in one or two years after completion of construction works.

After the flood disaster, MOE has to prepare or modify 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. Therefore, the JICA team will propose some recommendations from engineering and disaster management viewpoints to MOE so that the master plan and rehabilitation plan will be elaborated, and the structures to be constructed by MOE and MORT will be much more strengthened to the previous one. Furthermore some confusion and discrepancies originated from both parties' master plan could be avoided in this manner.

The recommendation points are:

1. Hydrological Planning,
2. Structural Considerations,
3. Critical Constrictions of the Madarsoo River Course, and
4. Road Improvement for Smooth Emergency Activities.

Table 1.14 (1) Flood Disaster Situation in 2005 Flood along the Madarsoo River

	14 Metry Bridge One of serious narrow passes in the lower reaches. Floodwater flows down over the road. (Photo taken on August 10, 2005)
	Loveh Bridge The right bank approach of submerged bridge part is washed away. Bolder spur dike in the downstream of the bridge to protect Loveh village is also swept away. (Photo taken on August 10, 2005)
	Beshoily Bridge Serious constriction in the middle reaches. Floodwater inundates over the valley-bottom plain. (Photo taken on August 10, 2005)
	River Bend in Terjenly village River floodwall constructed by MOE is destroyed due to insufficient foundation depth. (Photo taken on August 12, 2005)
	River Bend in Tangrah village River floodwall constructed by MOE is fallen down due to insufficient foundation depth. The downstream end of dike in the right bank is breached and watercourse turns to right landside. (Photo taken on August 10, 2005)

Table 1.14 (2) Flood Disaster Situation in 2005 Flood along the Madarsoo River

	Golestan Forest Approach road of temporary bridge is washed away. (Photo taken on August 10, 2005)
	Golestan Forest River floodwall undertaken by MORT in downstream of the Dasht Bridge is broken down due to insufficient foundation depth. (Photo taken on August 12, 2005)
	Dasht Bridge Flood flow near flood peak is passing over and through the Dasht Bridge. (Photo taken by MOJA-North Khorasan on August 10, 2005)
	Dasht Bridge Immediately downstream of the Dasht Bridge is seriously scoured. (Photo taken in middle of August, 2005)

3.2 Recommendations on Flood Control Plan

The following are recommendations to rehabilitation plan and flood control master plan being prepared by MOE and road improvement plan conducted by MORT.

3.2.1 Hydrological Planning

According to a study by MOE for urgent rehabilitation works along the Madarsoo River, the design discharge has been estimated at 250 m^3/s in the Golestan Forest, and 400 m^3/s in the Kalaleh Bridge under design scale of a 50-year return period. However, the latest study results reveal that the August 10 Flood in 2005 is almost equivalent to 25-year flood. Its peak discharges might be 700 m^3/s at Dasht Bridge, 1,010 m^3/s at Tangrah, and 1,090 m^3/s at 14 Metry Bridge based on hydro-hydraulic simulation made by the JICA study team.

Furthermore, the historical disastrous 2001 Flood is evaluated as an event in 55-year recurrence. Therefore a 100-year flood should be larger than the 2001 Flood. These hydrological considerations are important to improve the planning process for flood control in this region.

3.2.2 Structural Considerations

According to MOE explanation, the river floodwall has an embedment of 1.5m deep underneath the riverbed surface. Thus many parts of the floodwall are damaged during the 2005 Flood due to the local riverbed scouring at the foot of floodwalls.

Frequently, torrential stream riverbed tends to make degradation seriously because of steep riverbed gradient and high flood flow velocity, in particular along the concave bank in the bend. Therefore, the determination of a suitable embedment depth of the riparian structures shall be considered carefully based on integrating previous and recent one.

In Japan, base elevation of the foundation is determined in the following manner.

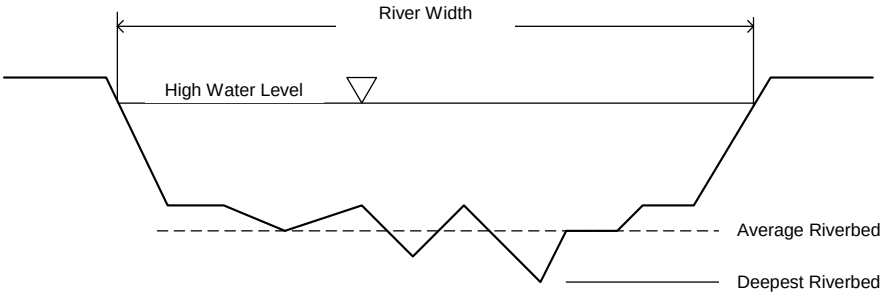


Figure 1.16 General Parameters of River Channel

(a) Cross-sectional survey is made immediately after floods.

(b) Average riverbed height is estimated as:

Average riverbed height = high water level – (area below high water level / river width at high water level)

(c) Riverbed scouring depth is estimated as:

Riverbed scouring depth = average riverbed height – deepest riverbed height

(d) Design riverbed scouring depth shall be set up enveloping scouring depth at each cross-section in a river stretch. It may be set up at the maximum depth in a stretch.

(e) Structural foundation base shall be designed at 1-2 m deep below design scouring depth as:
Design structure foundation base = average riverbed height – design scouring depth – margin safety depth (1 to 2 m)

3.2.3 Critical Constrictions of the Madarsoo River Course

River Features

This flood control plan is applied to the downstream of the Madarsoo River, which is located between Golestan Dam reservoir and Tangrah village for about 64km. The subject reaches show the topographical characteristic composed of low water channel, large floodplain and high terrace as natural levee has created by river meandering and scouring for a long time.

According to the cross section survey along the Madarsoo River obtained from MOE-Golestan office, the flow capacity analysis is carried out for the existing low water channel. The results of flow capacity and existing low water channel arrangement are shown in Figure 1.17 and 1.18.

It is assumed that the critical constrictions of the Madarsoo River are in the lower reaches for about 10km from Golestan Dam and the existing bridge sections except the Kalaleh Bridge. Especially, the 14 Metry Bridge and the Besh Oily Bridge sections are made most narrow by the bridge constructions in the middle reaches of the Madarsoo River, and in the recent flood, those narrow sections have caused the flood inundation in and around the bridge section (refer to Table 1.14).

To prevent the flood damage to the existing farmland on the floodplain, the river improvement, including the river widening and reconstruction of the existing bridge, is proposed.

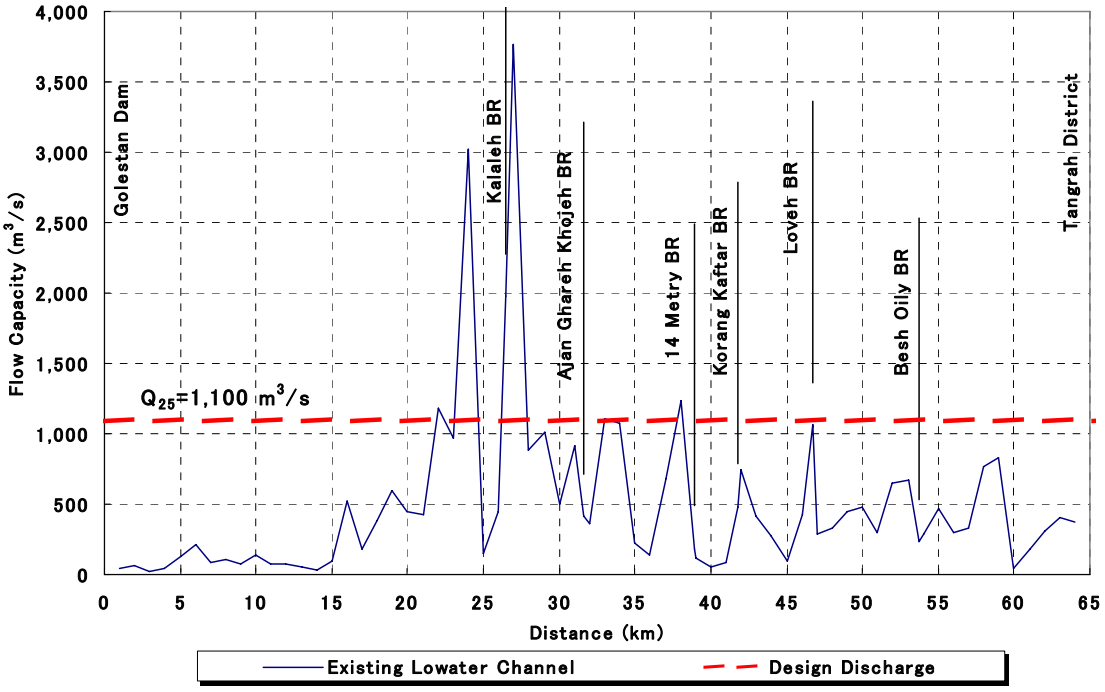


Figure 1.17 Flow Capacity in the Low Water Channel along the Madarsoo River

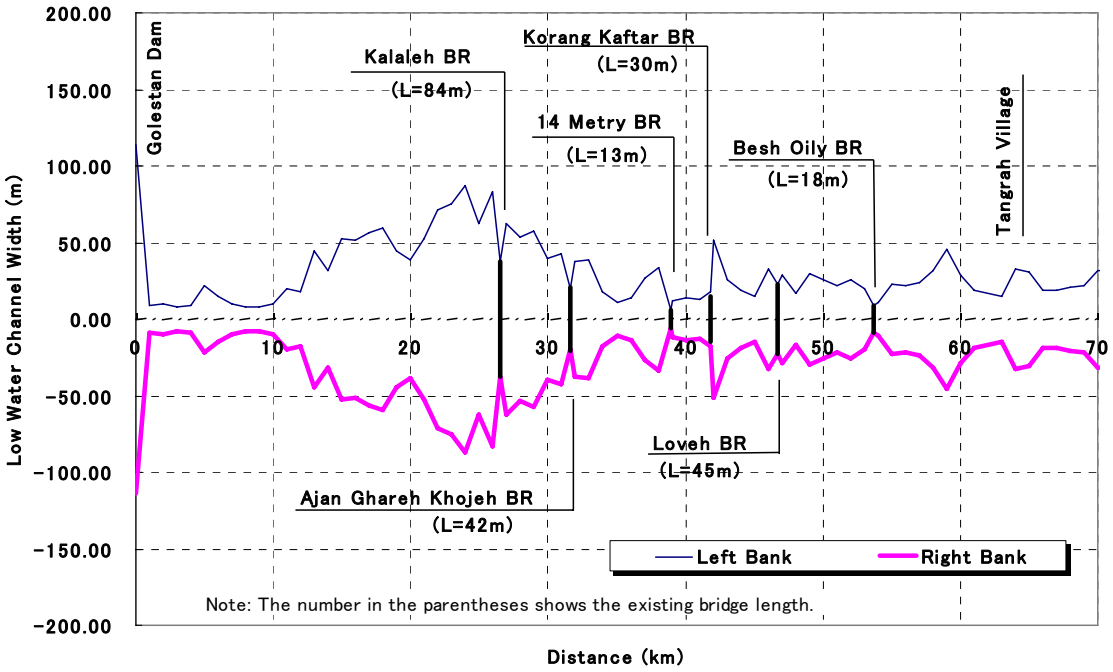


Figure 1.18 The Existing Low Water Channel Arrangement

Proposed Flow Section for the Low Water Channel

According to the interview survey to MOE-Golestan office, it is obtained that there is a design scale for the river improvement and the design scale for the Madarsoo River basin is a 25-year return period for a rural area or a 100-year return period for an urban area.

In the lower and middle of the Madarsoo River, the large floodplain is spread due to the river meandering and sediment deposition for a long time. At present, the floodplain is utilized as farmlands. The residential area along the Madarsoo River is comparatively located on the higher elevation than the floodplain in order to protect the residential are from the flood damage.

Consequently, the river improvement for low water channel is proposed to introduce the design scale of a 25-year return period based on the current land use aspects. The following table shows the design discharge in the JICA study result.

Table 1.15 Probable Design Discharge with 2005 Flood Type

Return Period	Design Discharge (m^3/s)			
	Golestan Dam	14 Metry Bridge	Tangrah	Dasht Bridge
25- year	1,100	1,100	1,050	700
50- year	1,600	1,600	1,450	1,050
100- year	2,300	2,300	2,050	1,450

The required flow sections are provided with the uniform flow calculation by Manning's formula based on the design discharge. The determination of proposed flow sections follows the criteria as follows:

Roughness coefficient for the uniform flow calculation is adopted for n=0.035 based on the field reconnaissance.
Proposed design water level shall be in accordance with the existing floodplain surface as much as possible to avoid the flood damage spreading further into landside area due to dike breaching and/or collapse.

Proposed design flow velocity is set for less than 3 m/s without riverbank protection, principally. When the flow velocity is more than 3 m/s, the placement of required revetment works and groundsill works shall be considered to protect the riverbank and riverbed stabilities.
Proposed river width is minimized as much as possible to reduce the required land acquisition and compensation cost in the project implementation.

Based on the above criteria, the proposed low water channel arrangement and typical cross sections are shown in Figure 1.19 and 1.20, respectively.

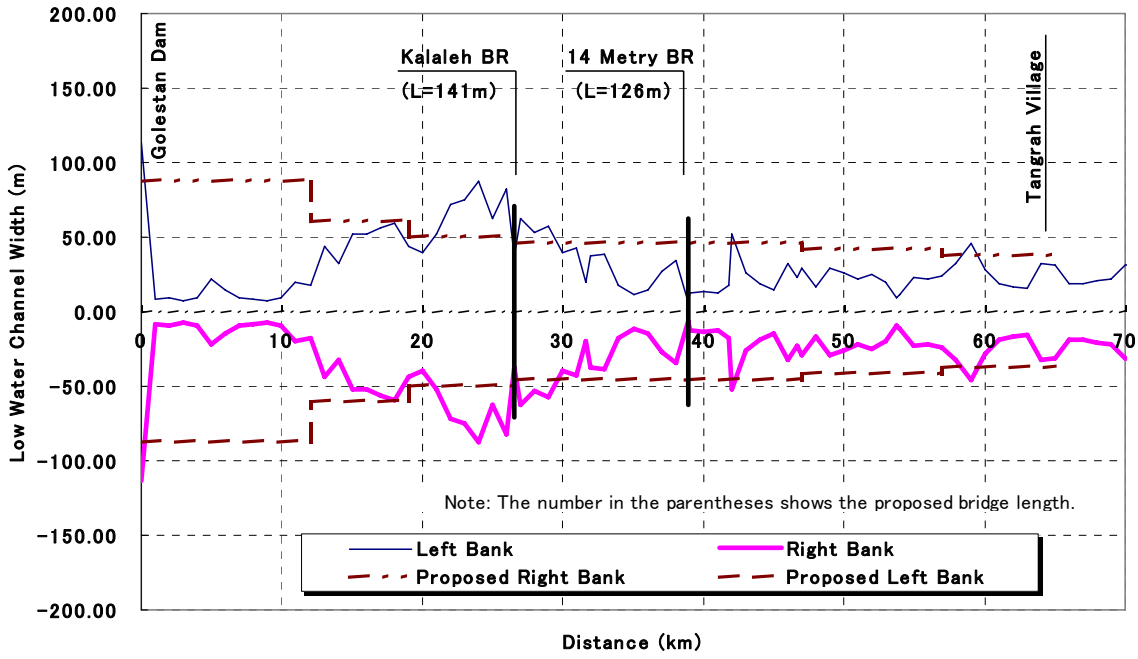
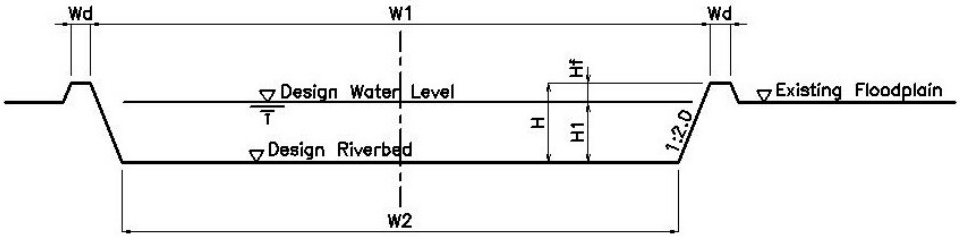


Figure 1.19 Proposed Low Water Channel Arrangement



Typical Cross Section of the Proposed Low Water Channel

Dimensions

River Stretch	W1 (m)	W2 (m)	Wd (m)	H1 (m)	Hf (m)	H (m)	Riverbed Gradient
0.0km to 12.0km	178.0m	160.0m	5.0m	3.0m	1.0m	4.0m	i=1/600
12.0km to 19.0km	121.0m	105.0m	5.0m	3.0m	1.0m	4.0m	i=1/260
19.0km to 26.5km	101.0m	85.0m	5.0m	3.0m	1.0m	4.0m	i=1/175
26.5km to 47.0km	91.0m	75.0m	5.0m	3.0m	1.0m	4.0m	i=1/135
47.0km to 57.0km	84.0m	68.0m	5.0m	3.0m	1.0m	4.0m	i=1/110
57.0km to 64.0km	74.0m	58.0m	5.0m	3.0m	1.0m	4.0m	i=1/80

Note:
1. These proposed cross sections are provided with the method of uniform flow calculation
2. Roughness coefficient n=0.035 is applied to this consideration based on the field survey.

Figure 1.20 Typical Cross Section of Low Water Channel

3.2.4 Road Improvement for Smooth Emergency Activities

During 2001 flood, the main road between Kalareh and Tangrah has been closed here and there along the Madarsoo River caused by flood inundation from the Madarosoo River and/or debris flow avalanches from the mountain streams, so that it is experienced that the sufficient emergency activities to the victim have hardly done with the main road and have been delayed.

To avoid road closing during and after the flooding, it is proposed that the existing road system shall be raised to strengthen against flood damages, especially between 14 Metry Bridge and Tangrah village. The appropriate height of raising road shall be determined with flood inundation model simulation.

According to the flood simulation analysis without countermeasures, it is assumed that four (4) locations between 14 Metry Bridge and Tangrah on the main road are covered with water on the condition of the 100-year flood.

The following table and Figure 1.21 show the submerged location and its estimated water depth based on the flood simulation analysis.

Table 1.16 Presumed Main Road Damage

Location	Presumed Main Road Damage due to Flood Inundation		
	Distance (m)	Max. Water Depth (m)	Remarks
Besh Oily (1)	1,070	3	A 100-year return period
Besh Oily (2)	480	4	Ditto
Terjenly	480	3	Ditto
Tangrah	1,200	3	Ditto

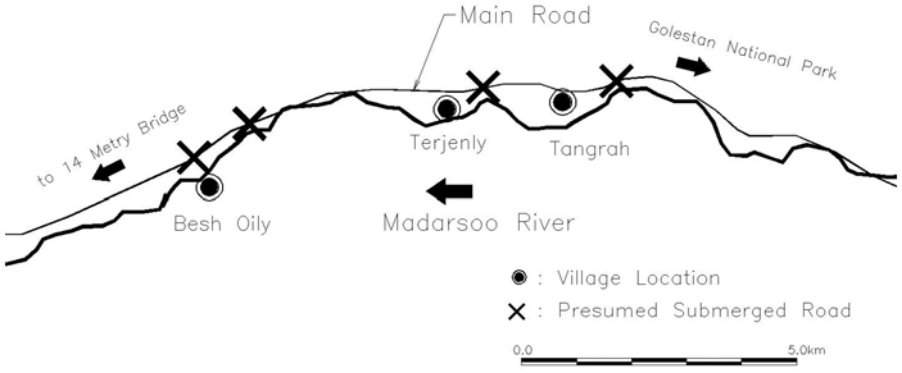


Figure 1.21 Presumed Locations of Submerged Main Road

The height of the proposed road raising is recommended to add the freeboard height (1.0m) on the required height in order to ensure the traffic situation during flood time.

SUPPORTING REPORT I (MASTER PLAN)

PAPER XI

Flood Forecasting and Warning System

THE STUDY ON FLOOD AND DEBRIS FLOW IN THE CASPIAN COASTAL AREA FOCUSING ON THE FLOOD-HIT REGION IN GOLESTAN PROVINCE

SUPPORTING REPORT I (MASTER PLAN)

PAPER XI FLOOD FORECASTING AND WARNING SYSTEM

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CHAPTER 1 GENERAL CONDITION

1.1 Telecommunication Conditions in the Study Area

1.1.1 Fixed Telephone Service

Fixed telephone service handle by the Iranian Telecommunication Company. The diffusion rate of the nation is 18,497,653 lines against 60,055,488 population (1996-7 Senses) equivalent 30 lines/100 persons. Golestan Telephone Company gives telephone service in Golestan province having 378,715 lines against 1,426,288 population equivalent 26 lines /100 persons. There are 1,055 villages within Golestan Telephone Company responsible area. Telephone lines already install at 977 villages out of 1,055 and remaining 980 villages is under expansion of telephone lines using WLL technology. Fixed telephone service among the Madarsoo river is well installed and ordinarily 56kbs quality is guaranteed. Telecommunication Company has basic standard to install the public telephone exchange those village living inhabitants over the 100 population. Village telephone exchange has Microwave network or fiber optical cable network to connect nearest bigger telephone exchange and distribute to village subscribers through electronics switch. However, small village, such as Hagholikhajeh, Kahrizli, and so on, do not have telephone exchange.

1.1.2 Mobile Telephone Service

There is only one service provider for mobile telephone, Mobile telephone Company belonging to the Iranian Telephone Company that is one of government enterprise. 6,681,554 sets of hand terminal are operational in Iran that is equivalent 36 sets/100 persons. About 64,670 sets hand terminal are operational within Golestan territories that is equivalent 4.5 sets/100 persons and 116 mobile base stations were installed in the area. Semens GSM model 900 is installed. There is no service coverage map provided by the supplier. Installation of mobile base station in urban area employed micro cellular that have many base station in short distance. However, mountainous area dose not have such plural base station. It has installed on the top of mountain to keep wide propagation. It can cover huge service area. But mobile telephone service is not cover all area due to obstruction of the mountain. Therefore, this service is not covered entire project site.

1.1.3 Radio Communications

Radio Communication Regulatory of Iran (RCRI) is implementing agency for the management and control of the telecommunication in the I.R. Iran. Frequency allocation of radiotelephone network shall apply the to Radio Communication Regulatory of Iran, address to Shariati Avenue, near Seed khan Dan Bridge, Hoveizeh Streets, Sahand Ally, Teheran.

1.2 Electrical Condition

1.2.1 Power Distribution Condition

The power distribution system among the river basin has two (2) types of power line. One is 4,400V middle voltage 3 phases line and other one is 220V low voltage 3 phases or 5 phases line. 4,400V is step down by the transformer that is installed depending on the demand of the customers. Voltage fluctuation is quite huge.

1.2.2 Power Failure in the River Basin

Normally, power supply within the river basin is stable. Planed power down is announced to the public prior to the installation. However, power failure during the flood is another story. In accordance with previous disaster management survey, power failure occurred in very early stage of flood on 2001. Lower middle basin area started power failure 30 minutes after starting the flood. Even lower basin area, after one (1) hour of starting the flood, power failure started and Mosque loudspeaker could not work. Therefore, power back-up system for the flood warning equipment is essentially needed.

CHAPTER 2 PRESENT CONDITION FOR EXISTING EARLY FLOOD WARNING SYSTEM

2.1 Organization for Flood Management in Golestan Province

The institutional and legal system of the nation has been described on the Progress Report section 2.10. Present organization setup for the Golestan province is as follows.

Provincial Disaster Management Committee

General Governor of Golestan province succeeded the existing organization of Mazandaran Province to organize Golestan Disaster Management Committee among the government agencies. 27 provincial and governmental agencies are member of committee. Figure 2.1 shows organization chart with major acting members during flood.

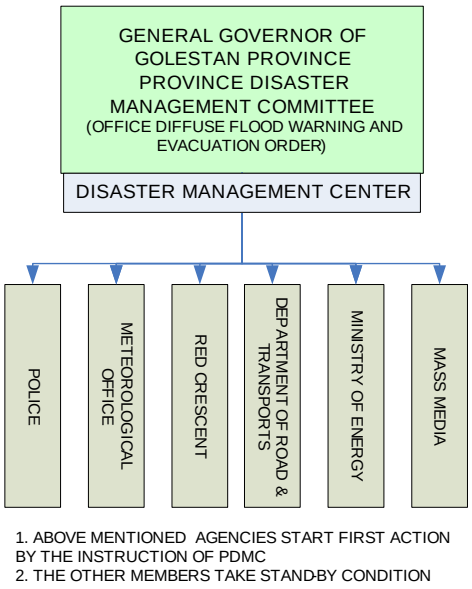


Figure 2.1 Flood Management Organization Chart for Golestan Province

The committee members list is shown in below.

Table 2.1 Members list for Disaster Management Committee

Organization in Province	Code
Governor General (Chairmanship)	GG
Managing Director of the Red Crescent in Province	PDMC
General Managing Road and Transportation in Province.	RTP
General Managing of MOE in Province	MOE
General Managing of Meteorological Office in Province	MOG
Commander of the Disciplinary Region in Province.	DRP
Managing Director of Water and Sewage Company in Province	WSCP
Managing Director of Telecommunication Company.	GTC
Managing Director of the Regional Power Company in Province.	RPCG
Chairmanship of Managing and Planning Organization in Province.	MPO
Senior Commander of Islamic Revolutionary Guard Crops in Region (or in Province.)	IRGC
Senior Commander of the Army in Region	ARMY
Commander of Besiege Resistance Forces in Province.	BRF
Chairmanship of Commercial Organization in Province.	COP
General Managing Voice and Vision of the Islamic Republic of Iran. (Radio &TV).	RADIO/TV
Chairmanship House and Urban Making Organization in Province.	HUMO
Chairmanship of MOJA in Province.	NOJA
Chairmanship of Islamic Assembly (Council) in Province.	ICP
General Managing of State Welfare Organization in Province.	SWOP
General Managing of Economic and Finance Affairs in Province	EFAP
General Managing of Culture and Islamic Guide in Province.	CIGP
General Managing of House Court (Administration of Justice)	HC
Chairmanship of Education Organization in Province.	EOP
Mayor of the City Center in Province.	CITY
Chairmanship of Islamic Republic House Foundation in Province.	IRHF
Chairmanship of the Municipals Organization in Province.	MOP

2.2 Present Flood Information Flow

Figure 2.2 shows present flood information flow. All flood information are concentrated into the Province Disaster Management Center. PDMC will issue necessary instruction and order to related agencies as well as inhabitants in disaster area. Initial information of the flood comes from Meteorological Office to PDMC formed by a weather bulletin and flood warning notice. PDMC issue an order to take action for flood to all concerning agencies.

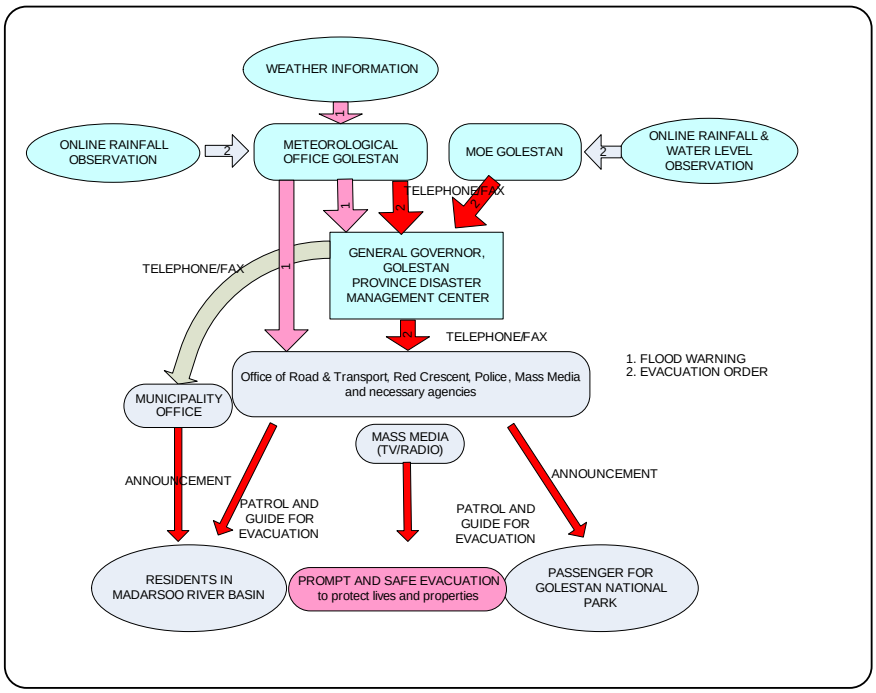


Figure 2.2 Present Flood information flow

2.3 Meteorological Office Golestan (MOG)

At first place, MOG issues two (2) kinds of weather information to PMDC as well as related government agencies and public. Flood Notice is closely related with the flood forecasting and warning system. However, accuracy of the information is not high from viewpoint of flood forecasting system that makes based on global weather information. Increase of accuracy for spot weather forecasting is not easy. It will require 3 hourly weather forecast and the Radar Rain gauge system etc.

Weather Bulletin

MOG shall issue the weather bulletin address to the concerned governmental agencies when stormy weather especially heavy rainfall is foreseen. The general weather situation will describes on the bulletin at least 48 hours to one week ahead of the occurrence of phenomenon. The Appendix 01 shows the weather bulletin on the flood of August 10 issued by MOG.

Flood Warning Notice

After weather bulletin issued, if the probability of flood occurrence will be increased within short period by their weather forecasting, MOG shall diffuse the flood warning notice to the General Governor Office and Disaster Management Committee for preparation of flood warning, evacuation and fighting. The Appendix 02 shows that Notice on the flood of August 10 issued by MOG Golestan.

2.4 Province Disaster Management Center (PDMC)

The core organization of the disaster prevention and fighting is Provincial Disaster Management Center under the control of General Governmer of the Golestan Province. The PDMC is decision-making organization for the disaster measure and necessary action shall be taking by the committee members based on their disaster prevention and fighting action program. Therefore, Committee has only four (4) staff and no flood fighting materials.

Especially, PDMC takes an active part for coordination of flood warning, fighting and recovery of damages by the flood. PDMC staffs are always prepare the disaster occurring. Telephone including mobile telephone and facsimile use for communication between PDMC and MOG There is impossibility to miss the telephone call because all staffs of PDMC are prepared for disaster in 24 hours. When PDMC instruct flood measure to the related agencies, the agencies shall obey such instruction. Same time flood information convey to the Ministry of Interior for preparation of flood at the adjacent river basin. If flood become seriousness, PDMC establish flood measure task force at Gorgan city or the disaster site and call necessary committee members for discussion of countermeasure. On the both of 29 -30 August and 9 – 10 August flood, PDMC conducts such action especially to the Red crescent, the police and the office of road and traffic. They closed the road and go for patrol in the Golestan National Park to evacuate passengers who were stayed in the park. As the result, there is no report for casualties and damages on houses within the Madarsoo river basin.

Meantime, Iran has Natural Disaster Prevention week on early October something same as like a Disaster Prevention day in Japan. However, simulation drill for flood fighting is not executed in Golestan Province.

2.5 Red Crescent Golestan

This organization is most organized and powerful for disaster prevention operation. They have enough experience staffs and relief goods. Red Crescent Golestan has responsibility to act necessary prevention, evacuation and rescue before, during and after against disaster. There is Red Crescent Road Center in Gorgan City and major township has branch offices in province that is mainly work on traffic accident rescue. Same time, Road center has function of local disaster rescue center. At first, Red Crescent receives weather bulletin and flood notice from MOG. Then Red Crescent receives dispatch order to the disaster site from Disaster Management Center. Nearest branch office staff of Red Crescent, including flood specialist and volunteers dispatch to the disaster site for flood evacuation and fighting aid to coordinate with Village chief. In this action, young volunteers play main role of the action. Therefore, Red Crescent promotes [one from one family program] to increase numbers of volunteers.

2.6 Early Flood Warning System Arrangement

2.6.1 MOG Data Collection system

MOG, under I.R. Iranian Meteorological Organization installed three (3) climatologic and rain gauge stations through public telephone line and two (2) stations are located within Madarsoo river basin. Furthermore, the MOG plans to expand four (4) more rainfall gauging stations.

Table 2.2 Inventory of existing online observation station of Met. Golestan office

Station	Class	Location (Deg. Min)		Elevation	River Basin	Remarks
		Long. E	Lat. N			
Golestan Park	Climatologic	55.47	37.24	460	Madarsoo	Existing
Dasht	Clmatologic	56.00	37.18	1,005	Madarsoo	Existing
Farsian Farang	Rain gauge	55.37	37.13	670	Oghan	Existing
Hossein Abad Kalposh	Clmatologic	55.45	37.13	1,540	Oghan	planning
Ghaleh Ghafeh	Rain gauge	55.29	37.03	1,200	Chehl Chay	planning
Bidak	Rain gauge				Madarsoo	planning
Dasht Shad	Rain gauge				Madarsoo	planning

There are three (3) kinds of observation station in MOG system.

(a) Climatologic station measures five elements of weather data and rainfall data. Commercial power source is used as power supply.

(b) The rain gauge station is same configuration except power supply. Power supply has two kinds, AC220V supply use especially rain and snow gauging and solar panel power supply use only rainfall gauge.

(c) All stations are connected through public telephone line. It can connect as online during stormy weather depending on connection at MOG office.

The equipment diagram of the MOG station is shown in Figure 2.3.

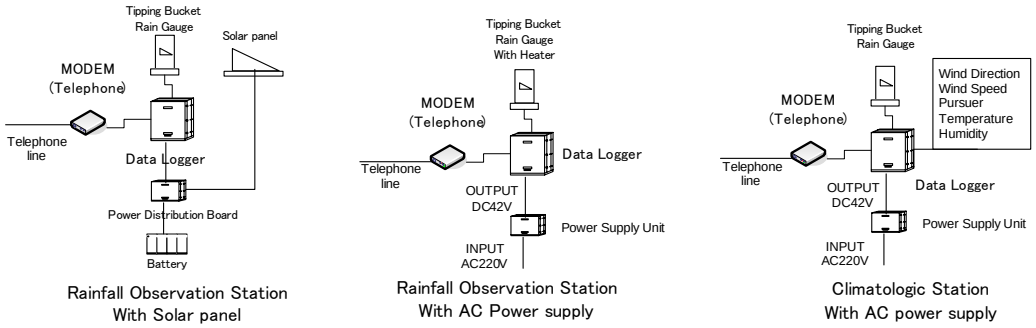


Figure 2.3 Existing MOG System Equipment Diagram

2.6.2 MOE Data Collection System

Ministry of Energy, Golestan office installed online observation stations for flood monitoring and warning after 2001 and 2002 floods. The four (4) stations out of six (6) are located in Madarsoo river basin. The following stations are connected to MOE-Golestan office through the telephone network.

Table 2.3 Inventory existing online observation station of MOE Golestan

Station	Class	Location (Deg. Min)		Elevation	River Basin	Remarks
		Long. E	Lat. N			
Tangrah	Water level	55.44	37.27	330	Madarsoo	
Dasht	Water level			1,005	Madarsoo	
Galikesh	Rain gauge	55.27	37.15	250	Oghan	
Dasht	Rain gauge				Madarsoo	
Narab	Rain gauge				Tillabad	
Dashy Shad	Rain gauge	55.55	37.16	1540	Madarsoo	

There are two (2) kinds of online station in MOE system.

(a) The rain gauge station is same configuration with AC220V supply use rain and snow gauging

(b) Water level station measures water level data and non-charging battery is equipped.

(c) All stations are connected through dial up public telephone line.

The equipment diagram of the MOE station is shown in Figure 2.4.

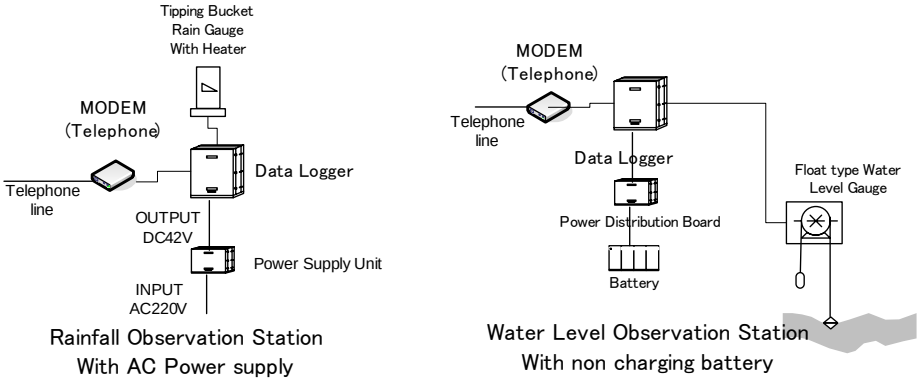


Figure 2.4 Existing MOE System Equipment Diagram

2.6.3 Data Transmission System

Data transmission system of existing meteorological and hydrological observation station has two (2) kinds, public telephone line and GSM mobile telephone network. Only two (2) SYNOPTIC stations are connected by GSM mobile telephone network. The existing online stations within the Madarsoo river basin are connected with public telephone network. GSM mobile telephone network is not used as of today. MOG Golestan has plan to change public telephone line to GSM MODEM to solve interfacing problem between telephone network and data logger.

2.6.4 Data Processing system

The personal computer based data collection system for both MOG and MOE.

(1) MOG system

MOG online data collection system software, made by German Mevis T. version 1.7 UMAD has an automatic observation function. One of control function is polling instant value (ON/OFF) and can be set any time interval including online mode. This shall use for automatic observation of online station every one hour data collection. System has two inputs, one is GSM MODEM and other is public telephone network MODEM. In case of flood event, both lines shall connect as online bases. Therefore, real time online observation data for two stations can be received. Network connection for PC is shown in Figure 2.5.

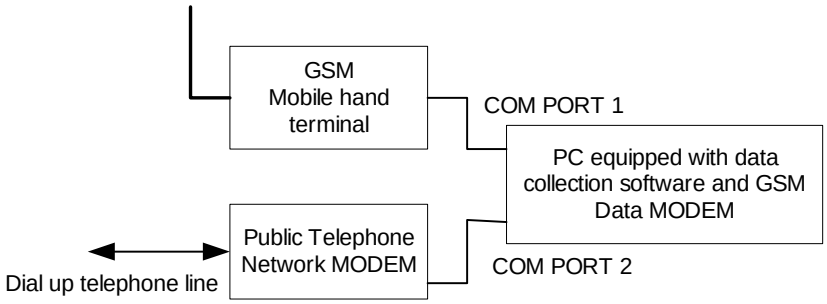


Figure 2.5 Network Connection Diagram for MOG System

The flowing graph is a data one of example an output of processing result of MOG data collection PC.

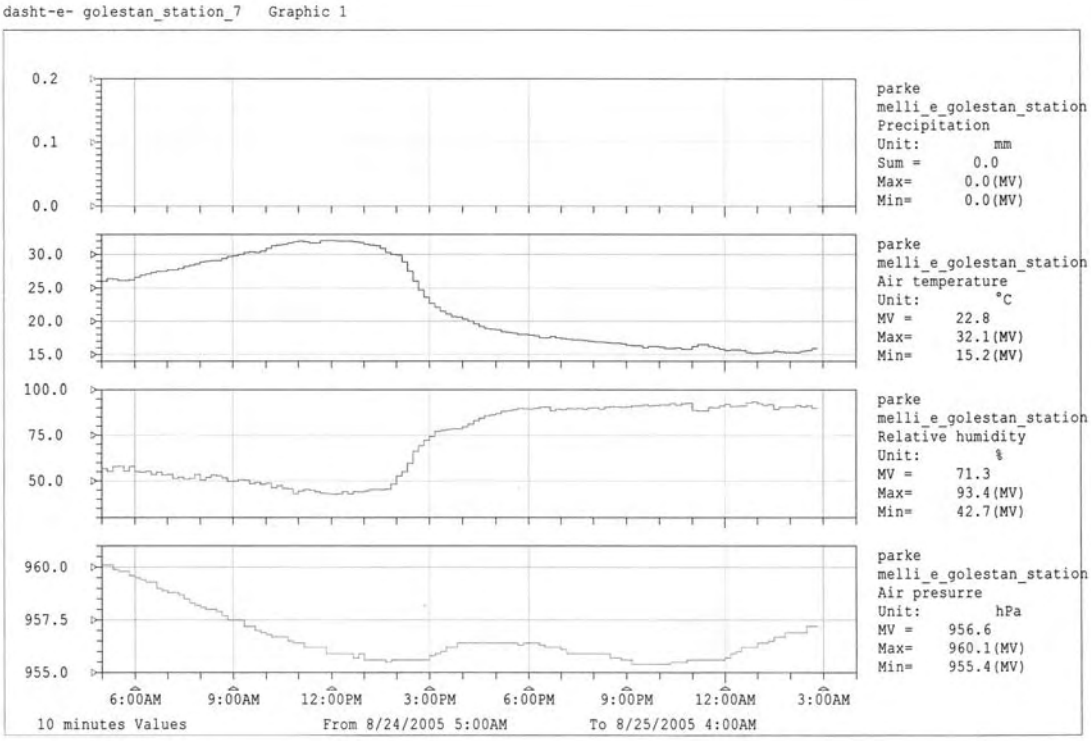


Figure 2.6 Example of a Graphic of MOG data collection PC

(2) MOE System

MOE data collection system software, made by OTT [HIDLAS] has function for automatic data collection. This function dose not use so far. It shall use for automatic observation of station every one hour data collection. Network connection for PC is shown in Figure 2.7

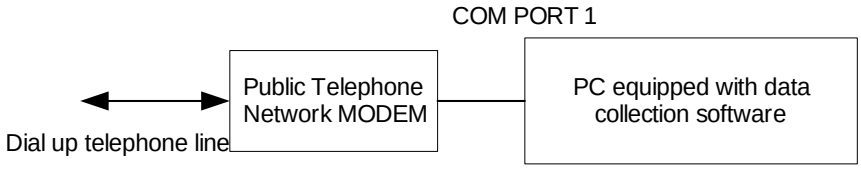


Figure 2.7 Network Connection Diagram for MOE System

2.7 System Operation Condition

2.7.1 MOG System

Meteorological data collection rule is different from hydrological data collection. They have three kinds of time interval for data collection as follows.

Table 2.4 Observation Time Interval

Type of station	Data collection interval	Observation time
Synoptic station	24 times a day	Every one hour
Climatologic	Three times a day	6:30, 12:00, 18:30
Rain gauge observation	Once a day	18:30

1. Synoptic station observes meteorological data automatically and memorized in the data logger and send to the data collection computer every one hour. This is real time data collection
2. Climatologic station is called from data collection PC at MOG through the dial-up telephone MODEM at fixed time interval manually. Then Climatologic station send back previous data stored in the data logger. When stormy weather is foreseen, telephone connection can connect continuously as online operation. Also, all station can call by polling mode in fixed time interval. However, automatic real time polling mode is not equipped so far.
3. Non-telephone connection climatologic station, observer measures temperature, humidity, wind direction, wind speed, pressure, rainfall, and record on the logbook. Then he will inform latest data to MO G through the telephone 3 times a day.
4. Rain gauge station is called from data collection PC at MOG through the dial-up telephone MODEM at fixed time interval manually. Then Climatologic station send back previous data stored in the data logger. When stormy weather is foreseen, telephone connection can connect continuously as online operation. Also, all station can call by polling mode in fixed time interval.
5. Non-telephone connection rain gauge station, observer measures rainfall, and record on the logbook. Then he will inform latest data to MO Golestan through the telephone once a day.
6. Hardware of rainfall gauging stations are no problem so far except Hagholkhajeh station. The data logger and battery has been stolen since its installed. Small space with very low fence caused problem. It must be reserve large space and install high toll fence for the security purpose.
7. Telecommunication problem is still remain caused by poor installation of outside plant. The performance between telephone exchange is no problem. MOG tries to change the network from telephone line to GSM MODEM. However, GSM mobile telephone service is not cover entire responsible area of MOG. Therefore, telephone line online station will be remaining until GSM mobile telephone service expands their service coverage into the responsible area.

2.7.2 MOE System

1. Basic requirement of hydrological data collection is made every one hour. On the other hand, flood forecasting and warning system requires 10 minutes data collection interval especially during rain start. The time interval of MOE online observation station is basically every two (2) hours and after office hour (14 o'clock) no observation is made up to 8 o'clock. In view of flood forecasting and warning system operation, MOE online data collection system is not functioned well.
2. Rain gauge and water level ovservation stations are called from data collection PC at MOE through the dial-up telephone MODEM at fixed time interval manually. Then station send back previous data stored in the data logger. Therefore, this system is not real time data collection system.

2.8 System Maintenance Condition

Normally, meteorological service requires 24 hours operation and maintain weather instruments in good condition always. Therefore, MOG have maintenance team to repair the weather measuring instruments including rainfall observation equipment. However, there is

no regular and preventive maintenance work. Maintenance team will visit the site when trouble is happened.

MOE dose not have maintenance team. The operator of the data collection system will visit the site when trouble is happened. If it is defects of the equipment in the system, MOE ask repair work to the system supplier. There is no regular and preventive maintenance work.

CHAPTER 3 AUGUST 10TH FLOOD IN MADARSOO RIVER BASIN

3.1 Playback of Events

In the evening of August 9 to morning of August 10, 2005, heavy rain fell over the Madarsoo river basin. It caused medium scale flood in the basin and caused serious damages on road and bridge inside of Madarsoo river basin and numbers of casualties on outside of Madarsoo river basin. On August 10 morning, temporally flood survey was conducted along with the Madarsoo river basin. Also, interview survey conducted with concerning agencies to confirm their activities before and during the flood. The reproduce of each phenomenon and action taking by the concerning agencies is as follows.

Date		Phenomenon and Action
August 6	08:00	MOE could not collect all online observation station data due to telephone line and equipment problems.
August 7		Meteorological Office issued weather bulletin to concerning agencies and private sector.
August 8	09:00	MOG report the flood forecasting to the General Governor and copy to 14 government agencies and private companies
August 9	09:00	Red Crescent Golestan National Park Branch was stand-by for rescue action.
August 9	09:00	Disciplinary region and Traffic police were stand-by for dispatch the officers.
August 9	17:00	Road for Golestan National Park was closed at an entrance by Disciplinary region and Traffic police.
August 9	19:00	Rainfall started at Golestan National Park
August 9	20:00	Water level at Tangrah was increasing.
August 9	21:00	Peak rainfall (80mm/hour) recorded at Golestan Park rain gauge station by online data collection mode.
August 9	01:00	Noise by rolling stones in the riverbed became maximum. Estimated water level at Tangrah was 420cm.
August 10	02:00	Water level of Dasht indicated highest water level 502cm(This data got on August 21 from data logger)
August 10	02:00	Road at 14meter bridge was closed by the traffic police.
August 10	04:00	14 meter bridge was coved by flood water.
August 10	06:00	Maximum flood water covers on the road about 500m to west side from the bridge.
August 10	11:30	14 meter bridge road was open for public.
August 10	13:00	Removal of debris along with the international corridor started by Office of Road and Transport.
August 10	16:00	There was no casualty within the National Park area, reported by Red Crescent.
August 10	16:00	Staff of MOE came to Tangrah water level station for data checking. Unfortunately, no data was recording on the data logger due to equipment trouble.
August 10	18:00	There was no casualty along with Madarsoo river, reported by radio news. However, there are many casualties Agh Soo river basin. Around 36 persons were killed by the flood in accordance with radio report.

3.2 Oservations

The followings are observations of action taken by related agencies in August 10 flood in view of early flood warning system.

1. MOG issued reliable flood notice having good enough lead time.
2. Related agencies such as police, Ministry of Road & Transport, Red Crescent, DOE Park office took stand-by 24 hours prior to flood and took suitable action before, during and after flood.
3. However, in view of early warning system, MOE could not take any proper action and they could not warn flood coming. MOE system was breaking down before the flood and MOG online system also could obtain Golestan national park rainfall data only. Other station data did not receive due to the telephone line problems.

CHAPTER 4 MAJOR PROBLEMS AND POSSIBLE SOLUTIONS FOR THE EXISTING SYSTEM

On site survey was conducted to gain knowledge of the condition for existing online data collection system. Basically, both MOG and MOE data collection system are not prepared for the flood forecasting and warning system. In view of such point, the following problems are discovered.

4.1 Data Collection system

1. MOG system collected past 1 hour, 3 hours, 6 hours and 24 hours data for weather forecasting purpose in normal condition. Once rainfall starts, MOG will connect particular station as online bases to obtain real time data. However, it is not automatic real time observation mode.
2. MOE system collected past 2 hours data for hydrological data collection purpose. The flood forecasting and warning system shall require to measure real time rainfall and water level data at least every 1 hour interval.
3. The data transmission network by the public telephone is not keep high reliability. It easily disconnected especially during heavy rain and flood.
4. Tangrah water level observation station is not prepared for serious flood situations. Height of water level gauge container is lower than previous 2001 flood water level mark. Extension of well and support material will be necessary.

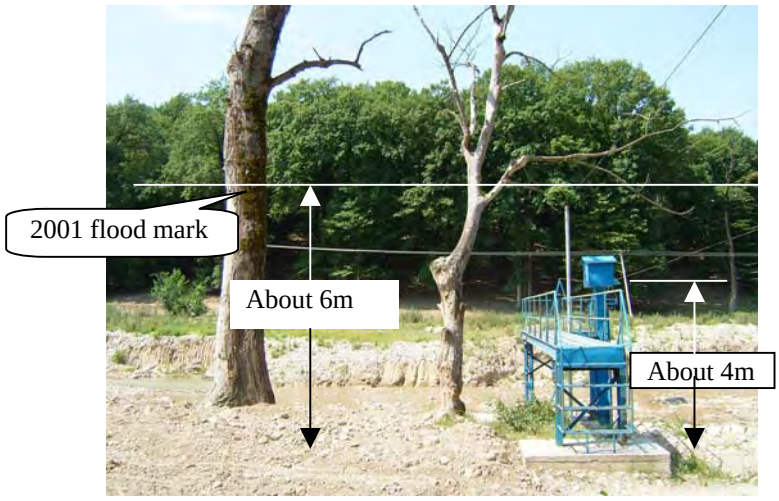


Figure 4.1 Tangrah Water Level gauging Station

5. Dasht water level station: Water intake of the steel pipe well was blocking by sediment at the bottom. It seems to be no water inlet into the well. In addition, there some holes middle of the well but diameter of the hole is too small. It seems to create time delay during high water level.

Well Bottom

Figure 4.2 Dasht Water Level Station

The telephone pole installed in a riverbed easily wash away when flood coming. As result, telephone pole near the station washed away and cut out telephone line on August 10 flood.

(1) Both water level stations of MOE needs battery charger by solar panel. Existing station will exchange the battery for charging when it exhausts power. Solar panel can be charged all the time to solve battery charging work.

(2) MOE Dasht rain gauge equipment installed on 30cm high foundation. At least 1m height of foundation shall be necessary preparing the heavy rainfall and flood.

Figure 4.3 MOE Dasht Rain Gauge Station

4.2 Data Processing system

(1) MOE data collection system is not automatic real-time system.

(2) There is no data exchange between MOG and MOE. Also, MOE and MOG observation station duplicated at same place such as Dacht and Tangrah and near future Dasht Shad. Unified data at same place will be necessary. For such reason, data exchange system will be needed.

(3) Common rule for data collection system should be established.

(4) Observation time for MOD is Greenwich Mean Time (GMT) and MOE uses local time. The local time is superior on the flood forecasting and warning system.

CHAPTER 5 ESTABLISHMENT OF FLOOD FORECASTING AND WARNING SYSTEM

Existing early flood warning system is operating in its own way. It was proofed by August 10 flood. However, weather bulletin by MOG gives global information for rainfall data that is not precise rainfall data particularly in Golestan province. As the result, a hitting rate of rainfall and flood is rater low that has natural reason. However, it will cause two major problems that (1) People no longer believe the official information. (2) Unnecessary human power and facilities will spend for flood preparation for a long time. To improve the hitting rate of the flood, the flood forecasting and warning system shall be established to provide precise and proper flood forecasting and supplying suitable information to decision makers at PDMC.

5.1 Basic Requirement of the Flood Forecasting and Warning System

The FFWS establish to disseminate reliable early flood warning information to the public as earlier than possible. Disseminating of flood warning and evacuation order in proper lead time of the flood can be saved human lives and properties of the inhabitants and passenger in the national park. Once FFWS is established, stability and reliability of the system is absolutely necessary to avoid lacking of information during the flood.

Basic requirement of the flood forecasting and warning system is as follows.

Table 5.1 Requirements of FFWS

Requirement	Correspondence with existing system	Newly equipped
Integrated data collection and processing shall be made at FFWS center	Separate data collection and processing is made at MOG and MOE.	Temporary, FFWS center will establish at MOE and integrated data will produce at MOE FFWS center
Data collection shall be made automatic real time polling bases.	Possible to make modification at MOE office and MOG equipment.	Modification of software for real time automatic polling system
Common operation rule shall establish	Independent operation at MOG and MOE	Unified operation rule shall employ
Most reliable data transmission network shall be selected.	Public telephone network is used.	Change to GSM from public telephone line as much as possible.
Concerning agencies shall have the same flood information on real time bases.	None	Flood monitoring subsystem will be installed at MOG, MOE and PDMC.
Warning level of each water level gauge and rainfall gauge shall be set.	MOG and MOE has idea for warning rainfall and water level but it is not executed.	Temporary warning level will set and calibrate to match with actual situation
Additional rain gauge and water level gauge is necessary	Existing stations are available at Met. Climatologic station.	Four rain gauge and two water level gauge will newly install.
System shall be operated under sever weather condition and during flood.		Improvement works are necessary on several stations.
Power supply back up shall be considered.	No power back up to water level gauging	Solar panel back up power will install at water level and rain gauge station.
Flood warning and evacuation order to residents of villages shall be disseminated immediately and correctly when flood warning and evacuation order informed.	None	Flood warning equipment will newly install.
Flood warning and evacuation order shall be heard as wider than possible in particular place to the residents.	None	Flood warning equipment will newly install.

The improved flood forecasting and warning system should design based on utilizing of existing facilities as much as possible considering the abovementioned requirements for the Madarsoo river basin FFWS.

The flood forecasting and warning system (FFWS) is consists of three (3) parts, automatic data collection subsystem, data processing and transmission subsystem and flood warning subsystem. The basic design of the FFWS shall be approached as following manner.

5.2 Total System Plan

The existing flood information system of weather bulleting and flood notice from MOG shall remain as it is. In addition to the existing system, the FFWS will be established utilizing existing equipment and facilities as much as possible. MOG will observe rainfall through existing and additional rain gauge station and collected data shall transfer to the MOE FFWS center by digital telephone network. MOE will also observe own gauging through existing and additional rain gauge and water level station. Temporary, the Flood Forecasting and Warning Center will establish at MOE water affairs. The FFWS center will make integrated data processing and data is edited in the form of a flood forecasting and Warning information. This flood information shall transfer to the PDMC immediately by the digital telephone network through the data transmission system. Same time related agencies can be accessed to MOE WEB server to obtain the latest flood information on graphic and table bases. PDMC is responsible for issuing a warning and evacuation order to concerning agencies as well as municipality within Madarsoo river basin through the telephone or FAX. Each municipality officer where flood warning post equipped is responsible to operate flood warning equipment by manual operation. Warning for passengers in the Golestan National Park shall be done by present flood warning method that is the police shall close the entrance of national park road and the patrol car call attention to the passenger for evacuation to outside of the park. The concept of the total system is shown in Figure 5.1. The location of Gauging station and Warning Post is as per attached Figure F1-1.

Proper position of the FFWS Center will be in the PDMC. Nevertheless, there is no hydrological engineer to analysis hydrograph and setting the threshold level of rainfall and water level. Therefore, the FFWS Center will be transferred to PDMC near further considering the reinforcement of human power.

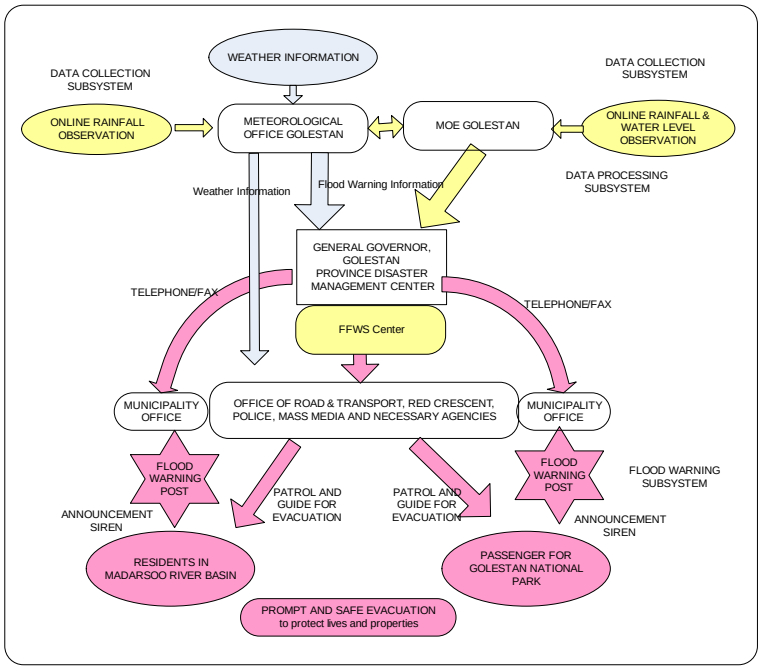


Figure 5.1 Total system concept

5.3 System design

5.3.1 Data Collection Subsystem

Data collection subsystem will design to improve the system function of the existing online data collection system and expansion of numbers of station as follows.

Improvement of the system

1. The existing online observation equipment is used.
2. GSM mobile telephone network will use for data transmission network as much as possible.
3. If the station where dose not cover in mobile telephone service, public telephone line will used.
4. Solar panel will install at water level and rainfall gauging station.
5. The rainfall and snow gauge station will have AC power supply together with back up battery.
6. Rise up water well and equipment container of water level gauging station from the riverbed.
7. Rise up the foundation of rain gauge and data logger container from the ground.

Additional observation station

In addition to the existing observation stations of MOG and MOE, the following observation stations should be necessary for improvement of accuracy of flood forecasting. All of the candidate rain gauge station is located in the existing Meteorological climatologic or rain gauge station except two water level stations. Priority will give to GSM mobile telephone network fro the data transmission network. Please note that the expansion plan is apart from expansion plan of MOG.

Table 5.2 List for Additional Observation Station

Station	Class	Location (Deg. Min)		Elevation (m, ASL)	Possible connection	Remarks
		Long. E	*Lat. N*			
Nardin	Rain gauge			1,395	Telephone line	Climatologic, MOG
Soodaghlan	Rain gauge			1,345	Telephone line	Climatologic, MOG
Haghaikhajeh	Rain gauge			1,265	GSM Mobile	Rain gauge, MOG
Sefid Dally	Rain gauge					Rain gauge, MOG
Gelman Darreh	Water level	408,565	4,128,602	1,080		New site
Ghyz Galeh	Water level			1,540	Telephone line	New site

5.3.2 Data Processing subsystem

Modification for automatic real time polling for all station calling will gives on existing data collection software to enable automatic observation function. However, every one hour Real time observation will not be required during normal season. Therefore, the following operation rule will be discussed with MOG and MOE.

Table 5.3 Setting of Calling Interval

Season	Data collection Interval	Calling mode
Normal Season	As it is	Manual dial up calling
Summer Season	Every one hour	Automatic Real time calling
Flood Period	Every 10 minutes	Automatic Real time calling

Ideal real time online system requires individual dedicated telephone lines for each observation station. But it will not realistic from economical point of view. Therefore, automatic polling will be added in the existing software that will makes it possible by one telephone line.

5.3.3 Flood warning subsystem

(1) Necessity for installation of warning post

The flood forecasting system will give early flood warning information. The related agencies take necessary action based on such information. After that, information dissemination system (warning post) to inform flood warning and evacuation order should be necessary for inhabitants who lives and work within the Madarsoo river basin. The warning posts will install in each village where inundation area among the Madarsoo river basin. This warning post will also use for public information broadcasting during normal period.

(2) Warning Post installation

The following 25 new warning posts are planed to disseminate warning information to particular area. Planned warning post will install from Ghazal Police station where is entrance of Golestan National Park from east side, up to mouth of Golestan Dam. Necessity numbers of warning post will discuss with concerning agencies and village residents. The warning post will install at the village office or house of the village master.

Table 5.4 List of New Flood Post

Station	Place	Connection method	Operation by
WP-1 Dasht	Within Mosque compound	Public telephone line	Village chief
WP-2 Ghazal Police	Ghazal Police station	MORT Radio network	Chief of police station
WP-3 Tangeh Gol	DOE office	DOE Radio network	Staff of DOE office
WP-4 Tangrah	National Park Office	Public telephone line	Staff of National Park Office
WP-5 Terjenly	Center of the village	Public telephone line	Village chief
WP-5 San Jangal	Center of the village	Public telephone line	Village chief
WP-6 Besh Oily	Center of the village	Public telephone line	Village chief
WP-7 Google Bozorg	Center of the village	Public telephone line	Village chief
WP-8 Google Kochak	Center of the village	Public telephone line	Village chief
WP-9 Sadegh Abad	Center of the village	Public telephone line	Village chief
WP-10 Loveh	Center of the village	Public telephone line	Village chief
WP-11 Agh Ghamish	Center of the village	Public telephone line	Village chief
WP-12 Koran Kaftar	Center of the village	Public telephone line	Village chief
WP-13 14 M	Center of the village	Public telephone line	Village chief

Station	Place	Connection method	Operation by
Bridge			
WP-14 Ganjig Shahrak	Center of the village	Public telephone line	Village chief
WP-15 Amam Jafar	Center of the village	Public telephone line	Village chief
WP-16 Abn Shir Mely	Center of the village	Public telephone line	Village chief
WP-17 Ajen Ghareh Khojeh	Center of the village	Public telephone line	Village chief
WP-18 Chaghar Shirmely	Center of the village	Public telephone line	Village chief
WP-19 Gharavol	Center of the village	Public telephone line	Village chief
WP-20 Kose	Center of the village	Public telephone line	Village chief
WP-21 Ghilanshah	Center of the village	Public telephone line	Village chief
WP-22 Gink Lic	Center of the village	Public telephone line	Village chief
WP-23 Ghakh Ghand	Center of the village	Public telephone line	Village chief
WP-24 Khojeh Lor	Center of the village	Public telephone line	Village chief
WP-25 Gharkar	Center of the village	Public telephone line	Village chief

Total system diagram for data collection and data processing/transmission subsystem is shown in Figure 5.2.

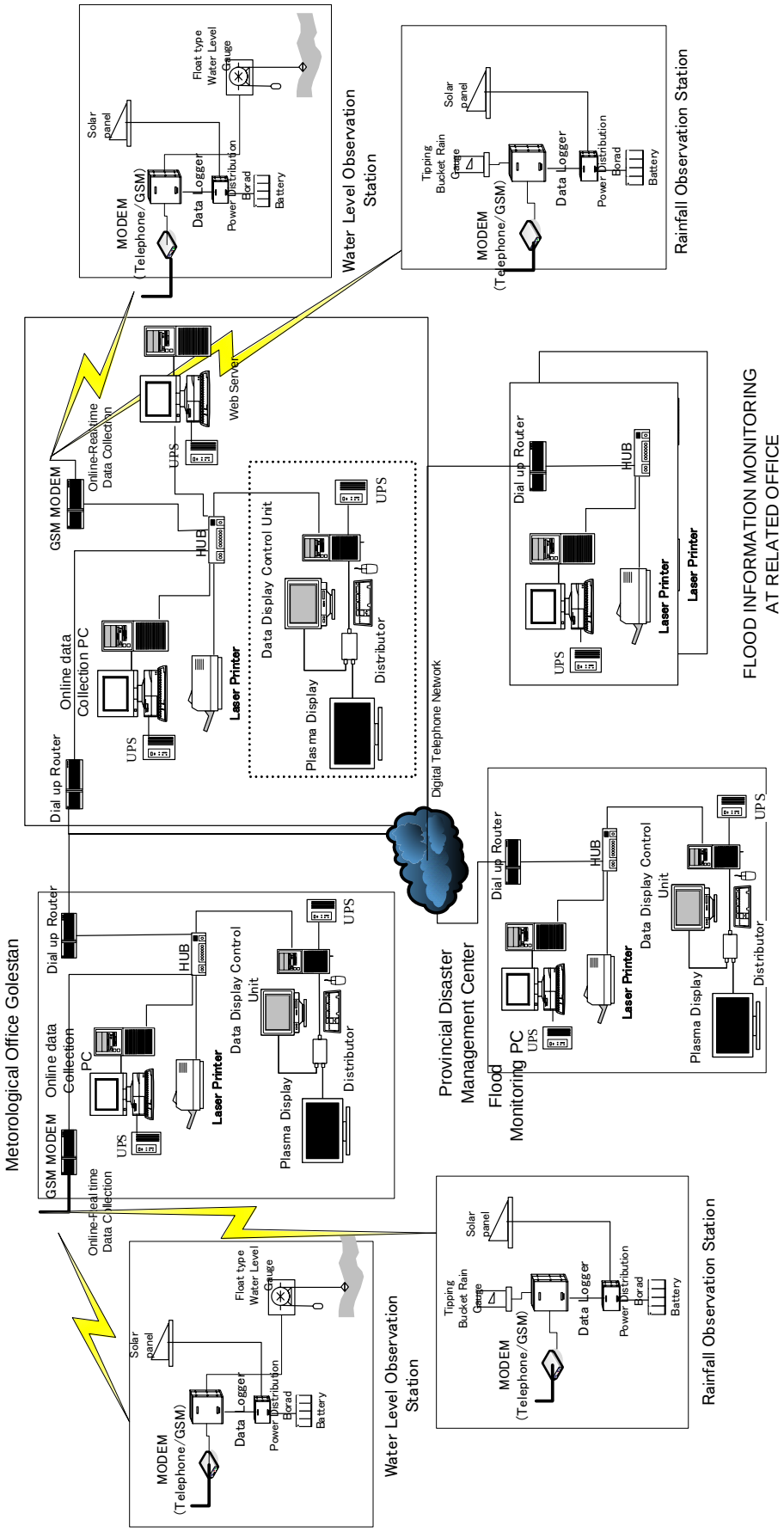


Figure 5.2 Total System Diagram for data collection and data processing Subsystem

Figure 5.3 shows connection of warning post. Manual flood warning operation system is proposed. Once the flood warning will issue, PDMC call by telephone to all concerning villages to start flood warning operation. The operator of warning post shall start operation as following operation procedure.

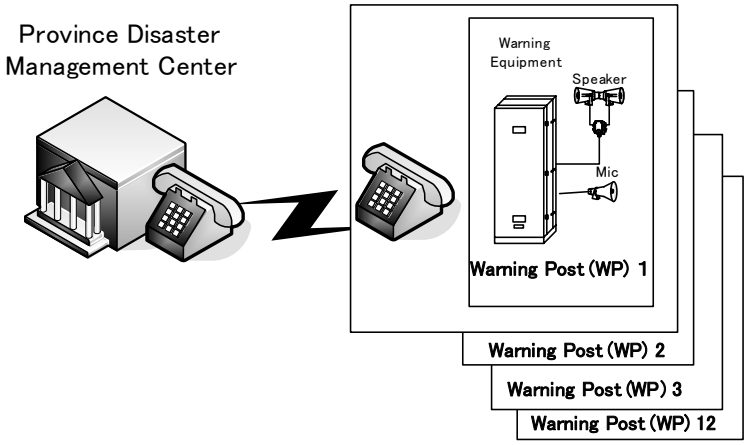


Figure 5.3 Concept of Warning Post Connection

5.4 Study of Subsystems

The total system of this project was divided into a Hydrological and meteorological data collection subsystem, a data processing/transmission subsystem and a flood warning subsystem in order to examine the optimum system.

5.4.1 Hydrological Meteorological Data Collection Subsystem

The data collection subsystem uses the telemetry technology to collect data from remote points, and there are various link systems for data collection. Feasible in IR Iran are public telephone network, a GSM mobile phone system and radio telemetry system. The GSM mobile phone system is suitable for such a telemetry system. However, the traffic in case of a disaster abruptly increases, disabling or making call connections difficult. The telephone network system has no problem of communications as such, but poor installation of telephone line connection at out side plant caused disconnection problem. On the other hand, the radio telemetry system is quite reliable network from the general viewpoint. It can secure highly reliable and real-time communications in case of a disaster. However, the initial investment cost for it is high. Also, this radio network has a trouble of filing an application for frequency license and complicated network design including set up of repeater station is required. In view of above study, GSM mobile telephone network with MODEM will provide the project. The summary is shown in Table 5.5.

Table 5.5 Summary of network comparison

Transmission Method	Merit	Demerit
Dial up Telephone line	*Easy installation by user side. *No own maintenance work	*Low transmission speed *If trouble occurred, takes long time for restore. *Pay monthly due for subscription.
Dedicated exclusive telephone line	*Online data can be obtained from the observation station continuously. * High line quality	**Telephone subscription become high.*
GSM MODEM	*Easy installation by user side. *No own maintenance work	*It must be within GSM service coverage *Pay for monthly due of subscription. *No connection during traffic congestion time such as flood.
VHF/UHF Radio link	*Real time data collection can be made. *Promised Stable and reliable data transmission *No communication charge.	*Complicated process for frequency application. *High installation cost including repeater station cost. *Own maintenance is necessary

(1) Telephone Line

Telephone line connection has two (2) kinds, public telephone line with dial and dedicated exclusive telephone line. Dial up public telephone line is most economical way to connect. However, it has disadvantageous for traffic congestion and can not make online connection. On the other hand, dedicated exclusive telephone line is exactly for online connection purpose. It can realize continuous high-speed connection and directory connect between the stations.

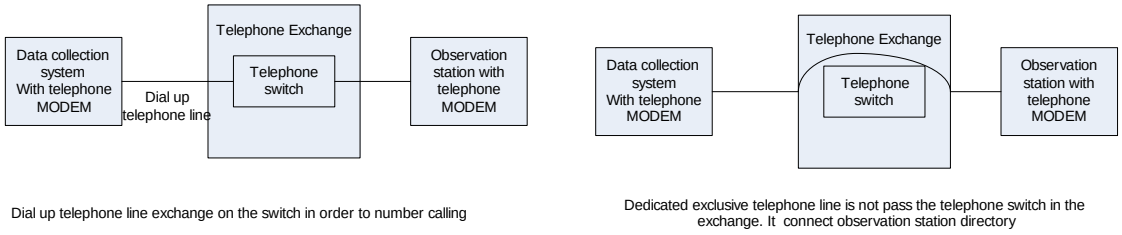


Figure 5.4 Dial up and Dedicated Telephone Line

(2) GSM data network data collection system

GSM mobile network data collection system has several kinds of transmission method. GSM DATA will employ to cope with long data transmission by Climatologic station.

<u>*Short Message Service (SMS)</u>

The service will give short message transmission within 160 characters that is enough capacity for rainfall and water level data transmission. Data collection PC can call observation station by polling mode and the observation station can activate data collection PC by event reporting method if observation station has such alarm

detective function. PSTN MODEM can be used between data collection station and Exchange

*Circuit Switched Data (GSM DATA)

Maximum 9,600 bps data transmission can be possible by this method. This method is suitable for polling call system.

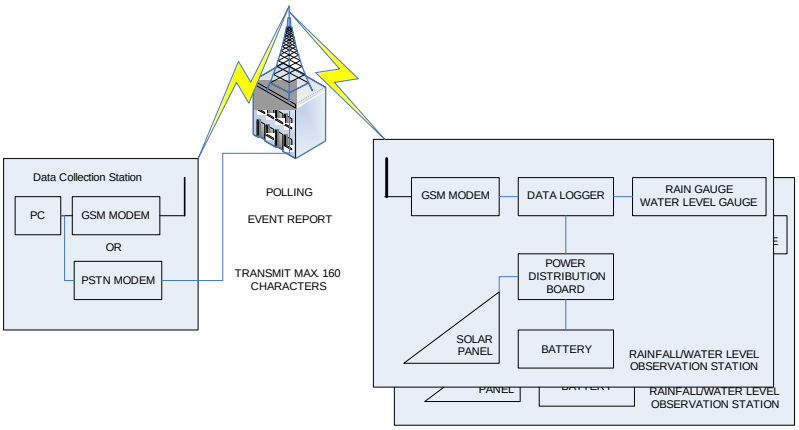


Figure 5.4 Concept of GSM-GSM Network

(3) Data Processing and Transmission Subsystem

The system will use existing data processing software to add some improvement. For the data transmission system that is feasible in Iran, the digital telephone network such as ISDN and ADSL are available. The telephone network has the disadvantages that it is inferior in reliability because it may be damaged and cause link disconnections due to traffic congestion in case of a flood. In considering present situation and cost, ADSL or ISDN line will use for the connection between MOE flood forecast station and flood monitoring station.

(4) Flood Warning Subsystem

The flood warning equipment will have two types such as remote controlled and manual controlled system. The remote control system has a warning supervisory and control station that control and supervise the warning post from distance area through radio network or wired network. The remote control system requires high performance to confirm sure operation from the remote area. Therefore, complicate and costly equipment is required. On the other hand, manual controlled system is not required high performance and costly equipment because confirmation can be made by the operator directory. Therefore, manual controlled flood warning equipment is newly introduced as flood warning subsystem. When flood event occur, PDMC shall gives operation instruction to the warning post operator through telephone. The operator shall take necessary operation to start recorded tape replay or voice broadcasting for flood information dissemination to the public.

5.5. Equipment Plan

The locations and functions of stations and the responsible agencies for the improving Flood Forecasting and Warning System Project are listed in Table 5.6 below.

Table 5.6 System Summary

Station	Function	Organization in charge
1. MOG data collection Station		
1.1 Real time data collection equipment	• Real time data collection • Data processing • Transmit collected data to the MOE system. • Access the MOE Web server to receive flood information	Meteorological Office
1.2 Flood monitoring equipment		
2. Met. data observation Station		
2.1 Golestan National Park	Automatic rainfall data observation	Existing
2.2 Dasht		
2.3 Farsian Farang		
2.4 Nardin		Additional
2.5 Soodaghlan		
2.6 Haghaikhajeh		
2.7 Sefid Dally		
3. MOE data collection station		
3.1 Real time data collection equipment	Real time data collection Data processing	MOE
3.2Flood Information Transmission equipment	Dissemination of flood information to related agencies	
4. MOE data observation Station		
4.1 Tangrah Water level	Automatic real time observation station including 2 additional water level gauging stations	Existing
4.2 Dasht Water level		
4.3 Dasht Rainfall		
4.4 Narab Rainfall		
4.5 Dasht Shad Rainfall		
4.6 Gelman Darreh water level		Additional
4.7 Ghyz Galeh water level		
5. Flood Monitoring Station		
5.1 PC and peripherals	Access to MOE Web server to receive flood information	PDMC, Red Crescent, etc.
6. Flood Warning Post		
6.1 WP-1: Dasht Village	Flood warning equipment by loudspeaker	DOE
6.2 WP-2: Ghazel Police		Police
6.3 WP-3: Tangeh Gol		Village com.
6.4 WP-4: Golestan Park Office		Village com.
6.5 WP-5: Terjenly		Village com.
6.6 WP-6: San Jangal		DOE
6.7 WP-7: Besh Oily		Village com.
6.8 WP-8: Coogle Kochak		Village com.
6.9 WP-9: Sadegh Abad		Village com.
6.10 WP-10: Loveh		Village com.
6.11 WP-11: Agh Ghamish		Village com.
6.12 WP-12: Koran Kafter		Village com.

Note: Village com.:Village community

5.5.1 Real time Data Collection Subsystem

The data collection subsystem consists of two (2) groups, MOG System and MOD system as described system summary. In total ten (10) rainfall gauging stations and four (4) water level gauging stations will operate. Data collection PC at MO and MOE will collect data automatically from each rain and water level gauging station. The data collection PC at MO and MOE provides automatic observation of hydrological and meteorological data in the intervals of 10 min., 30 min. and one hour. The gauging equipment is not only capable of transmitting observed data in response to the observation command, but also has an event-actuated function to automatically send a start request signal to the data collection PC at the start of rainfall and when the water level reaches the levels of caution and warning. When MO and MOE receives the start request signal, the start command is sent to all the gauging stations, which start observations. The data collection PC calculates the hourly and 3-hour rainfall data and checks the correlations between the rainfall data and the water level data. If the data reaches a warning value, the PC issues a warning. The warning display will be installed in MO, MOE and PDMC in order to display the same information on the PC display.

(1) Real time Data Collection PC

The main component and functions of the observation data collection system to be installed in MOG and MO are tabulated in Table 5.7.

Table 5.7 Functions of Data Collection PC Equipment

Equipment	Function	Quantity
PC type Operation Console	PC type operation console provide for data collection. Observation station calling time is every 10, 30 and 60 minutes. Process data display on graphics and table and transfer to the Web server automatically.	1
Telephone/GSM MODEM	To connect public telephone line or GSM mobile base station for online operation	1
Printer	Pinter will print data table, graphics of hydrological data by color.	1
DC Power Supply Unit	DC power supply unit provide the DC power to supervisory and control equipment and radio equipment. The unit can be operational about 10 minutes during power failure.	1

(2) Rainfall Gauging Station

The component equipment and functions of the rainfall gauging station are tabulated in Table 5.7. and 5.8. and the station configuration in Fig. 5.5.

Table 5.7 Functions of Rainfall Observation Equipment

Equipment	Function	Quantity
Data Logger	Data logger stores water level data every 10 minutes and sends out collected data according to the observation command from the data collection station. Also, it detects the signal when reaching danger level and it informs a data collection station.	1
Telephone/GSM MODEM	To connect public telephone line or GSM mobile base station for online operation	1
Tipping Bucket Rainfall Gauge	Tipping Bucket Rainfall Gauge measures and it sends out the rainfall of 1 mm of 1 tip to the observation equipment by the pulse signal.	1
Solar panel and distribution board	Solar panel makes charging to the battery.	1
Battery	Battery secures operation without 7 days of sunshine as the power of the above equipment.	1

Table 5.8 Function of Rainfall & Snow observation Equipment

Equipment	Function	Quantity
Data Logger	Data logger stores water level data every 10 minutes and sends out collected data according to the observation command from the data collection station. Also, it detects the signal when reaching danger level and it informs a data collection station.	1
Telephone/GSM MODEM	To connect public telephone line or GSM mobile base station for online operation	1
Tipping Bucket Rainfall and Snow Gauge	Tipping Bucket Rainfall Gauge measures and it sends out the rainfall of 1 mm of 1 tip to the observation equipment by the pulse signal. Electric heater melt snow and measure snow water.	1
DC power supply	Input 220V Output DC48V	1
Battery	Battery secures operation without 3 days of supply power as the power of the above equipment.	1

5.5.2 Water Level Gauging Station

The component equipment and functions of the water level gauging station are tabulated in Table 5.9 and the station configuration is shown in Figure 5.5.

Table 5.9 Function of Water Level Gauging Equipment

Equipment	Function	Quantity
Data Logger	Data logger stores water level data every 10 minutes and sends out collected data according to the observation command from the data collection station. Also, it detects the signal when reaching danger level and it informs a data collection station.	1
Telephone/GSM MODEM	To connect public telephone line or GSM mobile base station for online operation	1
Float type water level gauge	Float type water level gauge measures and sends out the water level of the 1 cm unit to the observation equipment as the BCD signal.	1
Solar panel and distribution board	Solar panel makes charging to the battery.	1
Battery	Battery secures operation without 7 days of sunshine as the power of the above equipment.	1

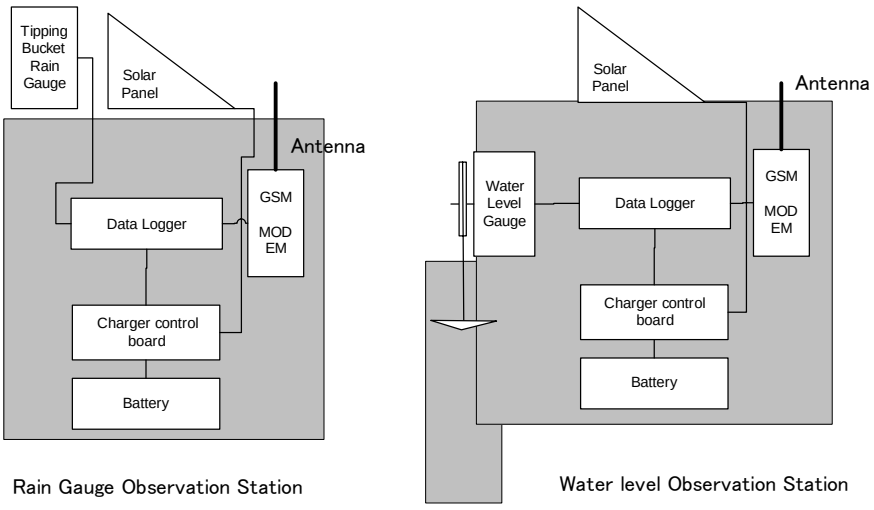


Figure 5.5 Block Diagram for GSM Online Observation station

5.5.3 Data Processing & Monitoring Subsystem

The data processing/transmission subsystem consists of the data processing equipment to be installed at PMD, the flood information monitoring equipment to be installed at FFC and WASA, and the wireless LAN to be connected to the above equipment.

(1) Data Processing Equipment

The functions of the data processing equipment to be installed with the telemetry supervisory and control equipment at PMD are tabulated in Table 1.17 and the hardware configuration of the data processing equipment in Fig. 1.12. The equipment is used to create the database based on the hydrological observation data and to process the data.

Table 5.10 Functions of Data Processing Equipment

Equipment	Function	Quantity
Compute equipment	Web Server: To transmit processed data to monitoring station as Web information.	1
	Client PC: Perform data processing and makes programs.	1
	Network devices: To connect above mentioned equipment.	1
	Plasma Data Display system	1
	Printer and peripherals.	1
Dial up Router	To connect public digital network with dial tone	1
UPS	Short period stand by power supply unit for server, client PC during power interruption.	1

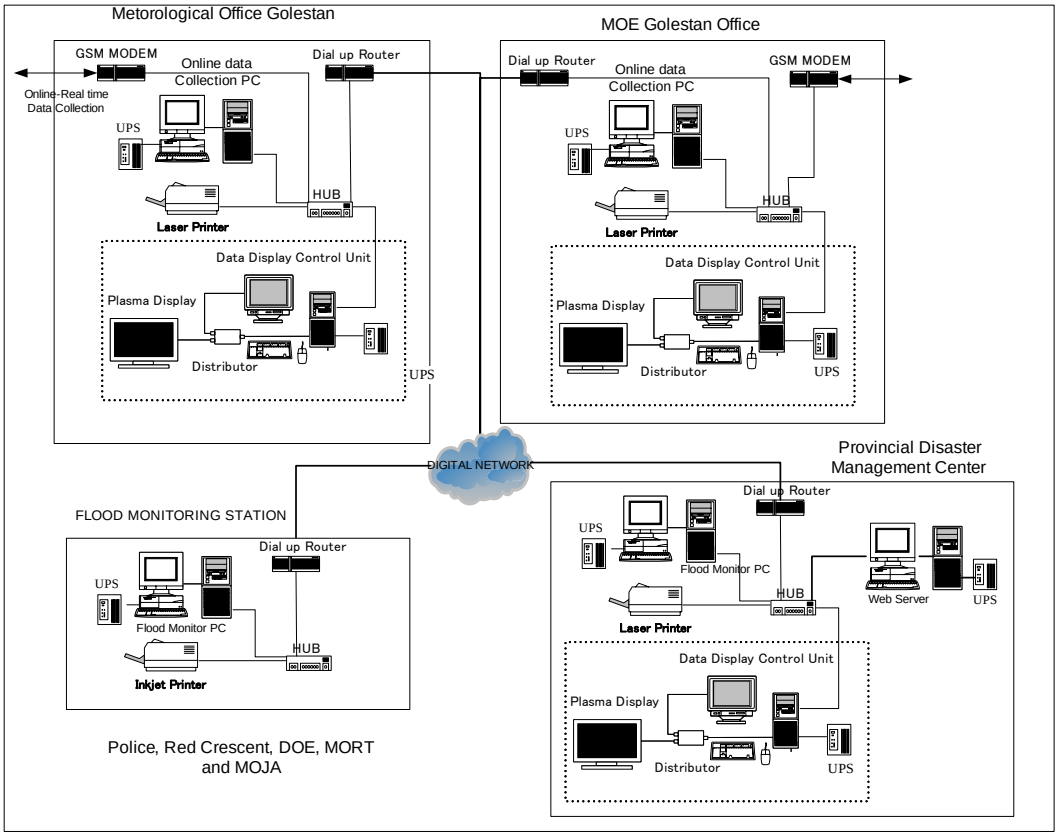


Figure 5.6 Equipment diagram for Data Processing and Monitoring Subsystem

5.5.4 Flood Information Monitoring Equipment

The flood information monitoring equipment will be installed at PDMC, MOG and Red crescent. The equivalent equipment will also be installed at the Flood Forecasting and Warning Center in MOE. The flood information is stored in the WEB server at MOE, and each monitoring station can access to the information as it is needed. Each monitoring station is connected individually to the WEB server through the public digital network. Once it is connected, the monitoring station can monitor the real-time flood information that is updated in 10-minute intervals.

Table 5.11 Function of Flood Monitoring Equipment

Equipment	Function	Quantity
Dial up router	To access the Web server at MOE to obtain details flood information in graphs and table	1
Switching HUB	Connection of PC and router	1
Client PC	Display the contents of Web server	1
Jet ink Printer	Print necessary data	1
UPS	Uninterrupted power supply for client PC and server will provide for power interruption.	1

5.5.5 Flood Warning Subsystem

(1) Warning method

The warning post will install a voice amplifier and loudspeaker to generate artificial siren sound. The motor siren is not recommended that dose not operate in the event of power failure.

(2) Equipment configuration

Warning post will equip the voice amplifier, loudspeakers and tape recorder. Recorded tape contain of artificial siren sound and announcement for flood warning and evacuation instruction play back by the tape recorder. In addition, necessary information for flood will broadcast through microphone.

Commercial power line will get damage and power failure will occurs during flood. On other hand motor siren consume huge current for operation. There is uneconomical to install the power back up for the motor siren. Therefore, voice amplifier back up with DC power supply unit is used. It can be operated around two (2) days without power supply. Sound reach distance of the loudspeaker is more less 300m radius. Two (2) loudspeakers will install between 600m distance in the village if necessary.

(3) Warning Operation

When receiving flood information from PDMC, send out the flood or evacuation warning in accordance with its flood operation rule through the public telephone line. Based on this warning order, each warning post start operation in any of the following patterns that are so simple for people to easily understand the meanings of the sounds:

For flood warning: 5 repetitions of a sounding for 10 sec. and a pause for 5 sec.

For evacuation warning: 5 repetitions of a sounding for 50 sec. and a pause for 10 sec.

For warning release: The siren does not sound, but it is broadcast that a flood danger has gone.

All the warning stations are located in the densely populated areas. Therefore, it was planned to install a loudspeaker at about 8m high on a pole of 10m high in order to secure the sounding coverage of the loudspeaker as wide as possible. It was planned to secure a sounding coverage of 300m radius for warning sound. The loudspeaker is designed to broadcast a pseudo siren sound (560Hz equivalent to a siren sound) from an internal amplifier.

(4) Flood Warning Post

The main equipment and functions of the warning station is described in Table 5.12 and the hardware configuration of the station is shown in Figure 5.7.

Table 5.12 Functions of Flood Warning Equipment

Equipment	Function	Quantity
Voice Amplifier	Voice amplifier broad cast tape message and voice message for flood warning. The equipment operate by manual operation by the operator.	1
Tape Recorder	Three (3) kinds of siren pattern and message will record and broadcast for each occasion.	1
Loudspeaker	Loudspeaker will make blowing artificial siren sound when power failure and broadcast warning announcement.	1
Warning light	The evolutional warning light gives light during start of warning until warning call off.	1
DC Power Supply Unit with battery	The unit converts AC power to DC power to supply all equipment. It can give the power to equipment around 3 days commercial power failure.	1

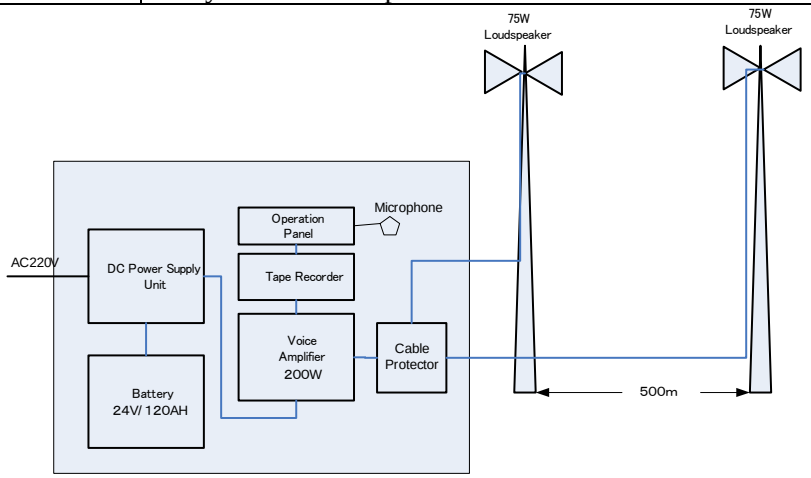


Figure5.7 Equipment Block Diagram for Warning Post

5.6 Operation and Maintenance cost

When the FFWS go into operation, the cost of the following items should be in to account. Roughly, 10% of equipment cost will be necessary for such O/M cost.

1. Operation cost such as observation station guardians allowance, telephone, power rate and consumables, printer ink and papers.
2. Maintenance cost such as transportation and allowance for regular maintenance work and repair fee including spare parts to the supplier.

5.7 Rough Cost Estimate

Improvement of the flood forecasting and warning system equipment procure from Iranian market. Foreign country made equipment will be purchase from authorized dealer in Iran. Trial cost estimate for abovementioned FFWS is made. Ancillary work such as station housing, water level well, security fence and land acquisition is not included and all taxes are also not included in the cost estimate. It will quote separately.

Table 5.13 Budgetary Cost Estimate Unit: In 1 thousand Rial

	Equipment	Quantity	Unit	Amount
1	Rain gauge station equipment	4	60,000	240,000
2	Water level gauging station equipment	2	90,000	180,000
3	Improvement of existing gauging station	7	30,000	210,000
4	Improvement of data collection station at MOG	1	165,000	165,000
5	Improvement of data collection station at MOE	1	202,500	202,500
6	Flood monitoring station	3	52,500	157,500
7	Flood warning post	25	67,500	1,687,500
	Total for equipment			**2,842,500**
	Installation for above			568,500
	Grand Total			**3,411,000**

APPENDIX 01 WEATHER BULLETIN

سازمان هواشناسی کشور
I.R.OF IRAN
METEOROLOGICAL
ORGANIZATION

اداره کل هواشناسی استان گلستان

بسمه تعالی

« اطلاعیه »

تاریخ: ۱۳۸۴ /۵/ ۱۶

شماره: ۱۵۶۹/۱۰۰

پیوست: .....

برادر گرامی جناب آقای مهینی

استاندار محترم استان گلستان

سلام علیکم

احتراماً - براساس نقشه های پیش یابی بتدریج طی روزهای آینده زبانه های سامانه کم ارتفاع بریده واقع بر روی دریاچه آرال درتراز میانی جو با زبانه های سامانه پرفشار درسطح زمین همراه گردیده و با ارسال امواج ناشی از آن استان گلستان تحت تاثیر این سامانه قرار می گیرد . بنابراین از اواخر وقت دوشنبه ۸۴/۵/۱۸ لغایت پنجشنبه استان گلستان از جوی ناپایدار همراه با **ابرناکی ، رگبـــار و رعـد وبـرق و وزش بـاد** برخوردار خواهد شد . بنابراین طی روز هـای یادشـده آبگرفتـگی برخـی معـابر عمومـی و بـالاآمدن سـطح رودخانه ها همراه با طغیان دور از انتظار نیست لذا پیشنهاد می شود مسافرین و ساکنین حاشیه رودخانـه از توقف درحریم رودخانه ها و مسیل جداً خودداری نمایند .

سمیه ملاحی
کارشناس پیش بین

محمد هاشم قاسمی کبریا
از طرف مدیر کل هواشناسی استان گلستان
عبدالرضا ...

رونوشت:

- دفتر نماینده محترم ولی فقیه دراستان گلستان جهت استحضار
- معاونت محترم هماهنگی امور عمرانی و ریاست ستاد حوادث غیر مترقبه استان گلستان
- معاونت محترم برنامه ریزی ، اداری و مالی استانداری گلستان
- دبیر محترم ستاد حوادث غیر مترقبه استان گلستان
- ریاست محترم سازمان مدیریت و برنامه ریزی استان گلستان
- مدیر کل محترم راه و ترابری استان گلستان
- ریاست محترم موسسه تحقیقات پنبه کشور
- ریاست محترم سازمان جهاد کشاورزی استان گلستان
- مدیر کل محترم امور آب استان گلستان
- مدیر کل محترم اطلاعات استان گلستان
- فرماندهی محترم ناحیه انتظامی استان گلستان
- ریاست محترم خبرگزاری جمهوری اسلامی ایران
- مدیر عامل محترم شرکت آب و فاضلاب استان گلستان
- مدیر عامل محترم شرکت مخابرات استان گلستان
- فرمانده محترم پلیس راه استان گلستان
- مدیر کل محترم حمل و نقل و پایانه های استان گلستان
- مدیر عامل محترم شرکت گاز استان گلستان
- مدیر عامل محترم شرکت آب و فاضلاب روستائی استان گلستان
- مدیر کل محترم محیط زیست استان گلستان
- ریاست محترم سازمان صدا و سیمای استان گلستان
- مدیر کل محترم میراث فرهنگی و گردشگری استان گلستان
- مدیر کل محترم بنیاد مسکن استان گلستان
- ریاست محترم دانشگاه منابع طبیعی و علوم کشاورزی گرگان
- مدیر عامل محترم جمعیت هلال احمر استان گلستان
- ریاست محترم سازمان آموزش و پرورش استان گلستان
- مدیریت محترم فرودگاههای استان گلستان
- مدیر عامل محترم شرکت برق استان گلستان
- فرماندهی محترم ارشد نظامی آجا دراستانهای گلستان و مازندران

گرگان ـ اداره کل هواشناسی استان گلستان ـ صندوق پستی ۳۹۵ ـ ۴۹۱۶۵

● تلفن : ۲۲۳۳۸۰۴ ● دورنویس : ۲۲۳۳۸۰۴
۲۲۲۲۳۴۲ ۲۲۲۲۳۴۲

Date : 2005.8.7

Number:1600-1569.

Information letter

General office meteorology of golestan province.

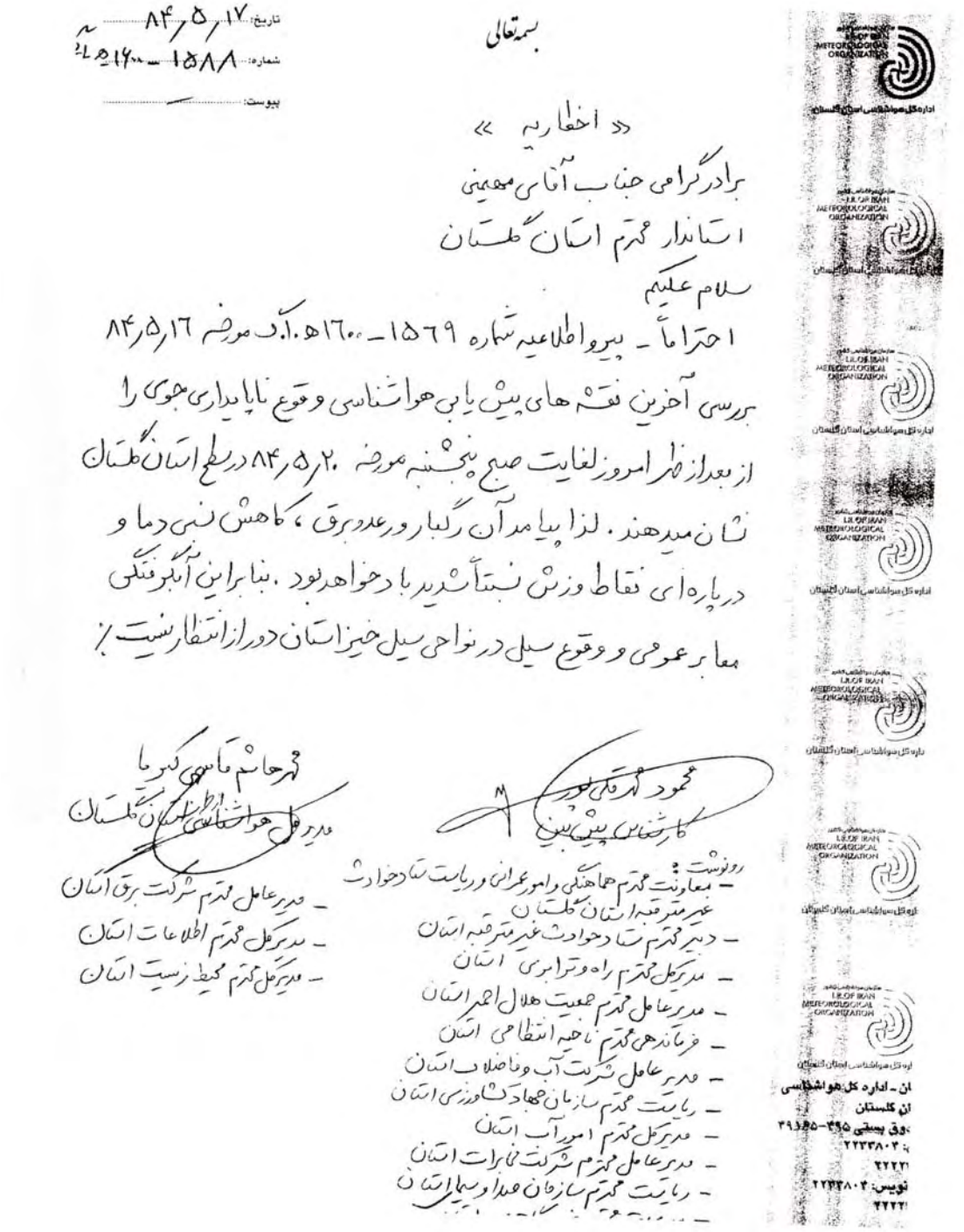
Dear Mr. mohimani
Governor General of Golestan province.

Respectfully, according to forecast maps, gradually in future day's tongues of low height mass on the ARAL lake in the middle level of atmosphere along with tongue of high pressure mass on the ground and with sending waves that arising of that Golestan province is under affect of this mass. Therefore from the last times of Monday 2005.8.9 up to Tuesdays, Golestan have instability atmospheric condition in company with cloud, shower, thunderbolt and blowing (wind). Therefore in these mentioned days, dewatering of general passages and overflowing of the rivers and along with flooding will be expected (is not far from our expectation). And so we recommended that passengers and residents margin of rivers completely prevented from stopping in the come of influence of rivers

Sign by:somayeh mallahi (forecast expert) &
Mohammad hashem gasemi kabir (director general , meteorology of golestan province)

- *Office, honorable deputy of District Court of Justice.*
- *Honorable assistant agreement of Reconstructions Affairs and chairmanship of Disaster Management Center.*
- *Honorable assistant of planning, administrative and financial affairs.*
- *Honorable secretary of Disaster Management Center*
- *Honorable director general of Golestan province.*
- *Honorable director general, Road and Transportation.*
- *Honorable chairmanship of Institution Cotton Investigations country.*
- *Honorable chairmanship of MOJA.*
- *Honorable director manager of Water Affairs.*
- *Honorable director manager of Information.*
- *Honorable office of a commander Disciplinary region.*
- *Honorable chairmanship News Agency of I.R.I.*
- *Honorable Managing Director, Company of Water & Sewages.*
- *Honorable managing director Telephone Company.*
- *Honorable commander of Road Police.*
- *Honorable Director General of Transportation.*
- *Honorable managing director of Gas company.*
- *Honorable managing director Rural Water and Sewages Company.*
- *Honorable general managing of Department of Environment.*
- *Honorable chairmanship Voice & Vision of I.R.I*
- *Honorable director managing of Cultural Heritage and Tourism.*
- *Honorable director general, House Foundation.*
- *Honorable chairmanship University of N.R.G.O and Agriculture of Gorgan.*
- *Honorable director managing of the Red Crescent.*
- *Honorable chairmanship of Education Organization.*
- *Honorable chairmanship Airports.*
- *Honorable director managing Power Company.*
- *Honorable senior commander of AGA in Golestan and Mazandaran province.*

APPENDIX 02 FLOOD NOTICE



تاریخ: ۸۴/۵/۱۷
شماره: ۱۵۸۸ - ۱۶۰۰ه
پیوست:

بسمه تعالی

« اخطاریه »

برادر گرامی جناب آقای معینی
استاندار محترم استان گلستان

سلام علیکم

احتراماً - پیرو اطلاعیه شماره ۱۵۶۹ - ۱۶۰۰ه.آ.ب مورخه ۸۴/۵/۱۶ بررسی آخرین نقشه های پیش یابی هواشناسی وقوع ناپایداری جوی را از بعداز ظهر امروز لغایت صبح پنجشنبه مورخه ۸۴/۵/۲۰ در سطح استان گلستان نشان میدهند. لذا پیامد آن رگبار و رعدوبرق، کاهش نسبی دما و در پاره ای نقاط وزش نسبتاً شدید باد خواهد بود. بنابراین آبگرفتگی معابر عمومی و وقوع سیل در نواحی سیل خیز استان دور از انتظار نیست./

محمود گهرقلی پور
کارشناس پیش بین

فرهاشم قاسمی کیرما
مدیرکل هواشناسی استان گلستان

رونوشت:
- معاونت محترم هماهنگی و امور عمران و ریاست ستاد حوادث غیرمترقبه استان گلستان
- دبیر محترم ستاد حوادث غیرمترقبه استان
- مدیرکل محترم راه و ترابری استان
- مدیرعامل محترم جمعیت هلال احمر استان
- فرماندهی محترم ناحیه انتظامی استان
- مدیرعامل شرکت آب و فاضلاب استان
- ریاست محترم سازمان جهاد کشاورزی استان
- مدیرکل محترم امور آب استان
- مدیرعامل محترم شرکت مخابرات استان
- ریاست محترم سازمان حفاظت محیط زیست استان

ان - اداره کل هواشناسی
ان گلستان
-ق پستی ۴۹۵-۴۹۱۵۵-۳۹
: ۲۲۳۳۸۰۲
۲۲۲۲۱
نویس: ۲۲۳۳۸۰۲
۲۲۲۲۱

Letter Hard

Date 2005.8.8
Number: 1600-1588
General office meteorology of Golestan province

Written notice

Dear Sir Mr. Mohimani
Honorable Governor General of Golestan Province

Respectfully, following of information letter number 1600-1569 date of 2005.8.7, consideration last weather forecast show that atmospheric instability from today afternoon (pm) up to Thursday morning date of 2005.8.11 in the Golestan province. Therefore after that it may be happen, shower, thunderbolt, relative decreasing of weather and in some point relative intense blow. Therefore dewatering of general passages and flood happening in flood region of province is not far from expectation. (it may be happened)

Signed by: Mahmood Mohammad Golipour.
(forecast expert)

Mohammad Hashem Gasemi Kebriya
(Director General of Meterology Golestan Province).

Copy to:
-Honorable assistance of agreement and reconstructive affairs and chairmanship of D.C.M (Disaster management center) of Golestan province.
-Honorable secretary D.C.M of province.
-Honorable director general ministry of road and transportation of province.
-Honorable managing director of the Red Crescent.
-Honorable office of a commander of disciplinary region of province.
-Managing director water and Sewage Company of province.
-Honorable chairmanship, MOJA of province.
-Honorable director general water affairs of province.
-Honorable managing director telephone company of province.
-Honorable managing director power company of province.
-Honorable chairmanship voice &vision of I.R.I
-Honorable director general of information in province.
-Director managing D.O.E of province.

APPENDIX 03 LOCATION OF GAUGING STATION AND WARNING POST

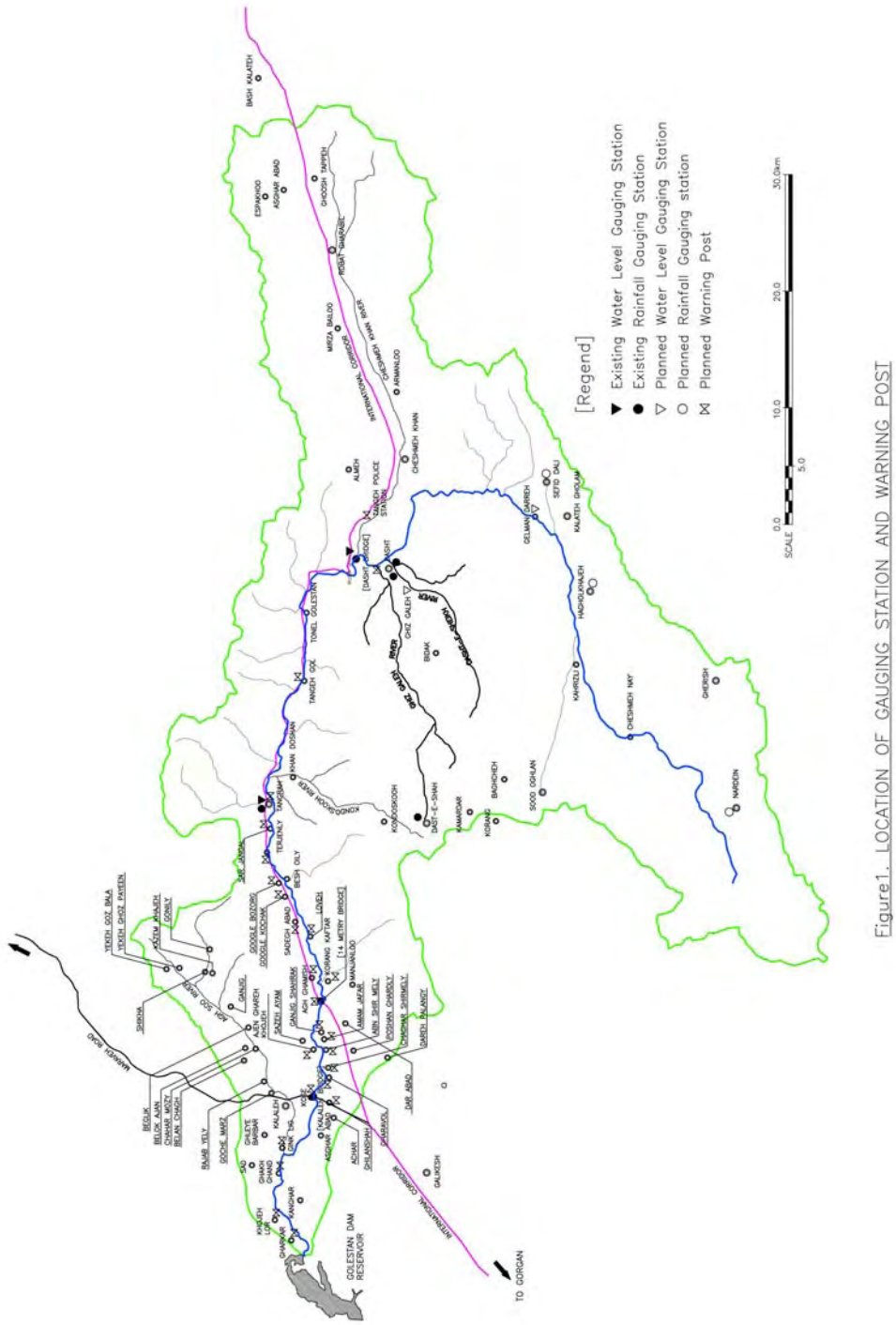


Figure1. LOCATION OF GAUGING STATION AND WARNING POST