NO

BASIC DESIGN STUDY REPORT

ON

THE LAI NULLAH FLOOD FORECASTING AND WARNING SYSTEM PROJECT

IN

THE ISLAMIC REPUBLIC OF PAKISTAN

MARCH 2005

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.

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PREFACE

In response to a request from the Government of the Islamic Republic of Pakistan, the Government of Japan decided to conduct a basic design study on the Lai Nullah Flood Forecasting and Warning System Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Pakistan a study team from August 23rd to September 21st, 2004.

The team held discussions with the officials concerned of the Government of Pakistan, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Pakistan in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the team.

March 2005

Seiji Kojima
Vice-President
Japan International Cooperation Agency

March 2005

Letter of Transmittal

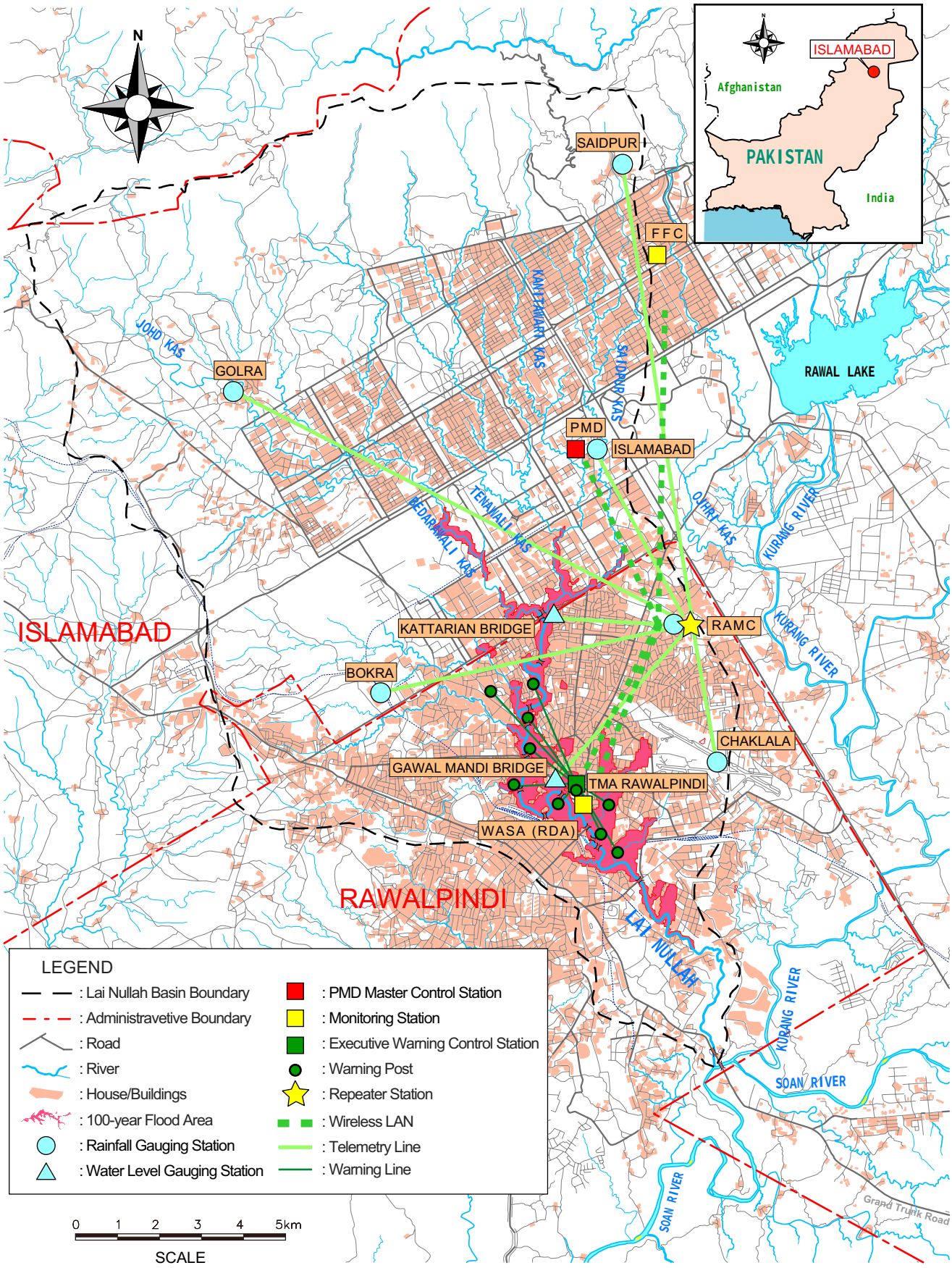
We are pleased to submit to you the basic design study report on the Lai Nullah Flood Forecasting and Warning System Project in the Islamic Republic of Pakistan.

This study was conducted by CTI Engineering International Co., Ltd, under a contract to JICA, during the period from August 2004 to March 2005. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Pakistan and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

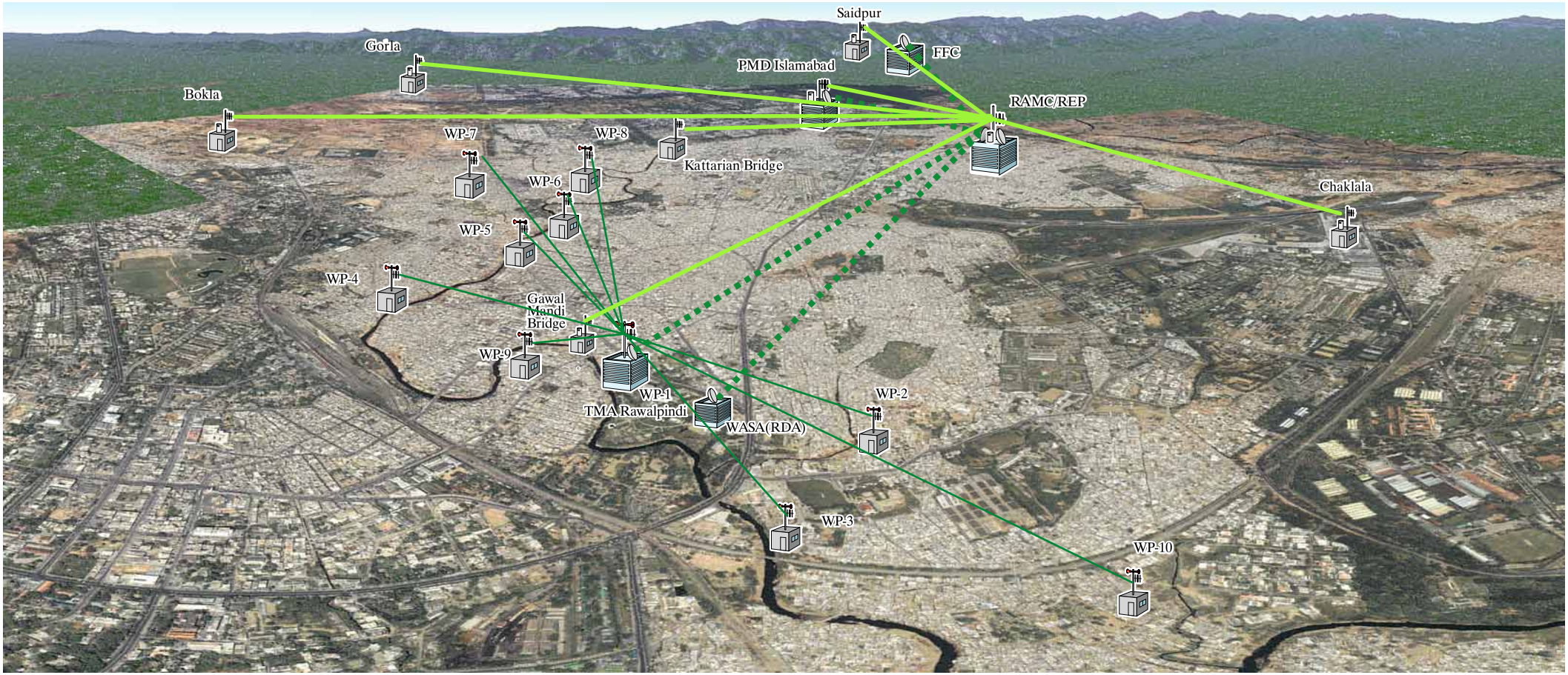
Finally, we hope that this report will contribute to the further promotion of the project.

Very truly yours,

Yuzo Mizota
Project manager,
Basic design study team on
The Lai Nullah Flood Forecasting and
Warning System Project
CTI Engineering International Co., Ltd.



LOCATION MAP



: Wireless LAN Network Link

: Telemetry System Radio Link

: Warning System Radio Link

PERSPECTIVE MAP

ABBREVIATIONS

A/P	Authorization to Pay
AAGR	Annual Average Growth Rate, %
B/A	Banking Arrangement
CCC	Concept Clearance Committee
CDA	Capital Development Authority
CDWP	Central Development Working Party
CIF	Cost, insurance and Freight
DFID	Department for International Development
DMD of WASA	Deputy Managing Director of WASA
E/N	Exchange of Notes
EAD	Economic Affairs Division
ECNEC	Executive Committee for National Economic Council
EIA	Environmental Impact Assessment
EOJ	Embassy of Japan in Pakistan
FFC	Federal Flood Commission
FOB	Free on Board
GOP	Government of Pakistan
IBRD	International Bank for Reconstruction and Development
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
IEE	Initial Environmental Examination
L/A	Loan Agreement
M/M	Man Months
MWP	Ministry of Water and Power
N/V	Note Verbal
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
ODA	Official Development Assistance
PDD	Planning and Development Department
PEPA	Pakistan Environmental Protection Agency
PEPD	Punjab Environmental Protection Division
PMD	Pakistan Metrological Department
PMU	Project Management Unit
PQ	Pre-Qualification
RAMC	Rawalpindi Agromet Center
RCB	Rawalpindi Cantonment Board
R/D	Record of Discussions
RDA	Rawalpindi Development Authority
RMC	Rawalpindi Municipal Corporation
SDO	Small Dams Organization, Irrigation and Power Development, Punjub
TMA	Tehsil Municipal Administration-Rawalpindi
TOR	Terms of Reference
UNDP	United Nations Development Program
WAPDA	Water and Power Development Authority
WASA	Water and Sanitation Agency
WMO	World Meteorological Organization

SUMMARY

The Lai Nullah Basin has a catchment area of 234.8 km^2, extending to the twin cities of Islamabad and Rawalpindi. The twin cities/capital of Pakistan are becoming strategically important, playing pivotal and catalytic roles in promoting regional economic development and reducing poverty in the region through the trade opportunities emerging with neighboring countries and the increasing presence in domestic business development.

The Lai Nullah Basin receives heavy rainfall averaging 500 mm in the monsoon season (July-September) every year, which normally leads to heavy flood discharge. During the last 60 years (1944-2004) a total of 19 flood events had occurred. In other words enormous flood damage broke out almost once in every three years.

On July 23, 2001, an unprecedented rainfall occurred over Islamabad-Rawalpindi resulting in 620 mm of rain in a span of about 10 hours. The flood had caused the worst damage in the basin including death of 74 people and the complete or partial destruction of about 3,000 houses.

The Study on Comprehensive Flood Mitigation and Environmental Improvement Plan for the Lai Nullah Basin (the Master Plan Study) was undertaken by the Federal Flood Commission (FFC) of the Ministry of Water & Power (MWP), through a technical cooperation provided by the Japan International Cooperation Agency (JICA) during the period May 2002 to September 2003.

Based on the Master Plan, the Government of Pakistan requested the Government of Japan to provide assistance through Japanese Grant Aid for the installation of equipment and facilities for the Lai Nullah Flood Forecasting and Warning System in August 2003.

In response to the above request, the Government of Japan had decided to conduct the **Basic Design Study for the "Lai Nullah Flood Forecasting and Warning System Project** (hereinafter referred to as “the Project”) and entrusted the study to JICA. JICA dispatched the Basic Design Study Team to Pakistan for the field survey and data collection from August 23, 2004 to September 21, 2004 and, after the technical examination of the study results in Japan, the Team was dispatched again to Pakistan to discuss the Draft Report from February 20, 2005 to March 4, 2005. After the deliberations, the Pakistani side basically agreed to the contents of the Basic Study Report.

The overall goal of the Project is to mitigate flood damage, particularly, death and injury to residents in the capital city. The specific objective of the Project is the prompt evacuation of residents to safer locations. To attain the above objectives, Japanese Grant Aid aims at the procurement and installation of equipment as well as the construction of required facilities.

The FFC is the agency responsible for undertaking the Project. The implementation agencies are the Pakistan Meteorological Department (PMD) which is in charge of flood forecasting, and the TMA-Rawalpindi which is in charge of flood warning and evacuation operations to safer locations. Furthermore, the Water and Sanitation Agency (WASA) of the Rawalpindi Development Authority (RDA) and FFC will function as the monitoring agencies to assist in the flood fighting activities of TMA-Rawalpindi and to coordinate the agencies concerned respectively.

The equipment and facilities to be installed in the Project are listed in the Table below.

Table List of Equipment and Facilities for the Project

(1)	Pakistan Meteorological Department (PMD)	
	Development of master control station (data processing and radio equipment)	1 site
	Improvement of existing rainfall station (telemetry rainfall gauge with automatic recorder)	4 sites
	Installation of new rainfall station (telemetry rainfall gauge with automatic recorder)	2 sites
	Installation of water level station (telemetry water level gauge with automatic recorder	2 sites
	Patrol car	1 unit
(2)	Tehsil Municipal Administration of Rawalpindi (TMA-Rawalpindi)	
	Development of executive warning station (data monitoring system, integrated warning system and radio equipment)	1 site
	Installation of warning post (radio and warning equipment)	10 sites
	Patrol car	1 unit
(3)	Federal Flood Commission (FFC)	
	Development of monitoring station (data monitoring system)	1 site
(4)	Water and Sanitation Agency (WASA)	
	Development of monitoring station (data monitoring system)	1 site

These equipment and facilities have been selected to increase the accuracy of flood forecasting and to expand the transmission network of flood warning operation in consideration of reliable operation during flood time to attain the overall goal or objective of the Project.

The activities required for the smooth start of operations and the sustainable execution of operation and maintenance of the proposed system are as follows:

(1) Effective Operation and Maintenance of the System

(2) Flood Forecasting and Warning based on adequate analysis of hydrological observation data

These activities could be attained through the technical guidance services on fundamental knowledge and techniques to be provided under the “Soft Component” of the Japanese Grant Aid Scheme.

The implementation period of the project will be four (4) months for the detailed design and preparation of tender documents and seventeen (17) months for the procurement and construction works, comprising a total of more or less twenty-one (21) months of project implementation. The total project cost has been estimated at 714 million Japanese Yen, of which 674 million Japanese Yen will be the amount coming from Grant Aid and 41 million Japanese Yen will be the amount from local funds.

The flood prone areas cover around 7.5 km^2, and there will be about 150,000 people living therein as project beneficiaries. The Project is envisioned to increase the accuracy of flood forecasting operations and to enhance the transmission network of flood warning operations.

The table below lists down the issues before the proposed system is undertaken and the outputs after the system is completed.

Table Present Issues and Outputs of the Proposed Flood Forecasting and Warning System

Present Issues	Outputs of Proposed System
I Increase in Accuracy of Flood Forecasting Operations	
1. Number and allocation of rainfall gauges are not adequate to evaluate the average mean rainfall in the basin. Rainfall/river water level data are transmitted by voice communication, which causes misinformation, and data are not recorded correctly and orderly.	1. Real-time and accurate observation of rainfall/river water level is possible and data are automatically recorded.
2. Judgment on the possibility of flood is not clear and not made promptly before river bank overflow because flood prediction is based on river water level observation only without simultaneous observation of rainfall. Flood evacuation time to a safer place is not enough.	2. Real-time rainfall and river water level is available for the prediction of water level. Flood can then be predicted before river bank overflow. The flood prediction will result in enough time for safe evacuation. [1)]
II Reinforcement of Transmission Network of Flood Warning Operations	
1. Audible range of the warning system can cover only around 10% of the inundation area of a flood equivalent to the 2001 flood (100-year return period flood).	1. Audible range of warning system will cover around 60% of the inundation area of a flood equivalent to the 2001 flood (100-year return period flood).
2. Prompt instructions or warning could not be made because the system uses the voice communication system.	2. Prompt and integrated warning operation is possible.
3. Staffs of agencies concerned do not have experience on the new system to be installed in the Project.	3. Staffs of agencies concerned in operation and maintenance can be trained through the technical guidance services. 1)

1) Technical Guidance may be available under the Soft Component of Japanese Grant Aid to accomplish Items 2 and 5.

In addition, some indirect effects are expected, such as stabilization of people's livelihood, improvement of living conditions and poverty reduction in the capital region of Pakistan due to flood-disaster mitigation. The improved living conditions in the capital region have spillover effects on the socio-economy of the whole country.

The flood forecasting and warning system is still new in Pakistan, although flood forecasting and warning operations are already being undertaken by the Pakistan Government. The Pakistan Government has enough budget and number of technical staff for operation and maintenance.

Technical guidance services on fundamental knowledge and techniques are required for the smooth start of operations and the sustainable execution of operation and maintenance of the system under the "Soft Component" of the Japanese Grant Aid Scheme as mentioned above. The Project will definitely contribute to the mitigation of flood disasters, especially death and injury to residents in the capital region, which translate to Basic Human Needs. Therefore, the Project would qualify to be implemented under Japan's Grant Aid Scheme.

However, to increase the effectiveness of the Project, the following items need to be undertaken by the Pakistan Government, or through other ways of technical cooperation:

(a) Improvement on Accuracy of Flood Prediction and the Staged Flood Warning Code;

(b) Formulation of Flood Risk Management Plan and Flood Evacuation Plan including Flood Hazard Map; and

(c) Execution of Public Awareness Campaign on the Mitigation of Flood Damage.

The accuracy of flood prediction should be increased and the staged flood waning code should be improved, based on the accumulated rainfall and water level data, the results of repetitive flood run-off and inundation analyses on various hyetographs, and the flood prediction analysis.

The flood risk management plan should be formulated for the mitigation of flood damage, comprehensively considering the flood forecasting and warning system, the structural flood control plan, and other methodologies. The local government should prepare the flood risk management plan together with flood hazard map within its limited financial resources.

A public awareness campaign is required so that residents in possible inundation areas will understand in detail the flood disaster management, flood evacuation plan and flood hazard map. The campaign should result in a more effective utilization of the system, and should ensure flood disaster mitigation considering the characteristics of local disasters.

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CHAPTER 1 BACKGROUND OF THE PROJECT

The Lai Nullah Basin has a catchment area of 234.8 km^2, extending to the twin cities of Islamabad and Rawalpindi. The Lai Nullah Basin receives heavy rainfall averaging 500 mm in the monsoon season (July-September) every year, which normally leads to heavy flood discharge. During the last 60 years (1944-2004) a total of 19 flood events had occurred. In other words enormous flood damage broke out almost once in every three years.

On July 23, 2001, an unprecedented rainfall occurred over Islamabad-Rawalpindi resulting in 620 mm of rain in a span of about 10 hours. The flood had caused the worst damage in the basin including death of 74 people and the complete or partial destruction of about 3,000 houses.

The Study on Comprehensive Flood Mitigation and Environmental Improvement Plan for the Lai Nullah Basin (the Master Plan Study) was undertaken by the Federal Flood Commission (FFC) of the Ministry of Water & Power (MWP), through a technical cooperation provided by the Japan International Cooperation Agency (JICA) during the period May 2002 to September 2003.

The flood mitigation projects proposed by the Master Plan Study involve structural and non-structural measures, environmental improvement and strengthening of institutional setup. The implementation program has been divided into three (3) phases, corresponding to the Urgent Project, the Short-Term Project and the Long Term Project, with 2012 as the target completion year, as shown in Figure 1.1.

Contents of the Project	Step-wise Implementation		
	Urgent (2004～'05)	Short Term (2006～'07)	Long Term (2008～'12)
■ Structural Method			
1) Community pond	■		
2) Supplemental river improvement	■	■	
3) Flood diversion channel		■	■
■ Non-structural Method			
1) Flood forecasting and warning system	■		
2) Flood hazard map		■	■
■ Environment Improvement			
1) Right-of-way control of the river	■	■	■
2) Solid wastes dumping control into the river	■	■	■
3) Improvement of drainage/sewerage	■	■	■
■ Strength of Institutional Setup			
1) Integrated river management	■		
2) Task force for flood mitigation project	■		
3) Land administration	■		
4) Strengthening of legal setup	■		
5) Capacity building	■	■	■

Figure 1.1 Comprehensive Flood Mitigation and Environmental Improvement Plan for the Lai Nullah

Based on the Master Plan, the Government of Pakistan requested the Government of Japan to provide assistance through Japanese Grant Aid for the installation of equipment and facilities for the Lai Nullah Flood Forecasting and Warning System as one of urgent projects on Lai Nullah Basin in August 2003.

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

2-1-1 Objective and Scope of the Project

The overall goal of the "Lai Nullah Flood Forecasting and Warning System Project" to be implemented by the Government of Pakistan (hereinafter referred to as "the Project") is to mitigate flood damage, particularly, death and injury to residents in the capital region. The specific objective of the Project is the prompt evacuation of residents to safer locations. To attain the above objectives, the Government of Pakistan has decided to request the Government of Japan for Japanese Grant Aid for the procurement of equipment as well as the construction and installation of required facilities.

The Project will require a flood evacuation plan that should include a flood hazard map, as well as a flood risk management plan for the mitigation of flood damage though the effective utilization of the system. With these flood evacuation and flood risk management plans and the cooperation of all residents and citizens' organizations in the Lai Nullah Basin, the Project is expected to effectively function as a flood forecasting and warning system.

Figure 2.1 below outlines the relationship between the Project and Japanese Grant-Aid. The Japanese Grant-Aid is to be earmarked for the construction and the installation of a real-time observation system of rainfall and river water level gauge stations, data processing system for flood prediction, and flood warning system for the safe evacuation of inhabitants to pre-designated safe locations.

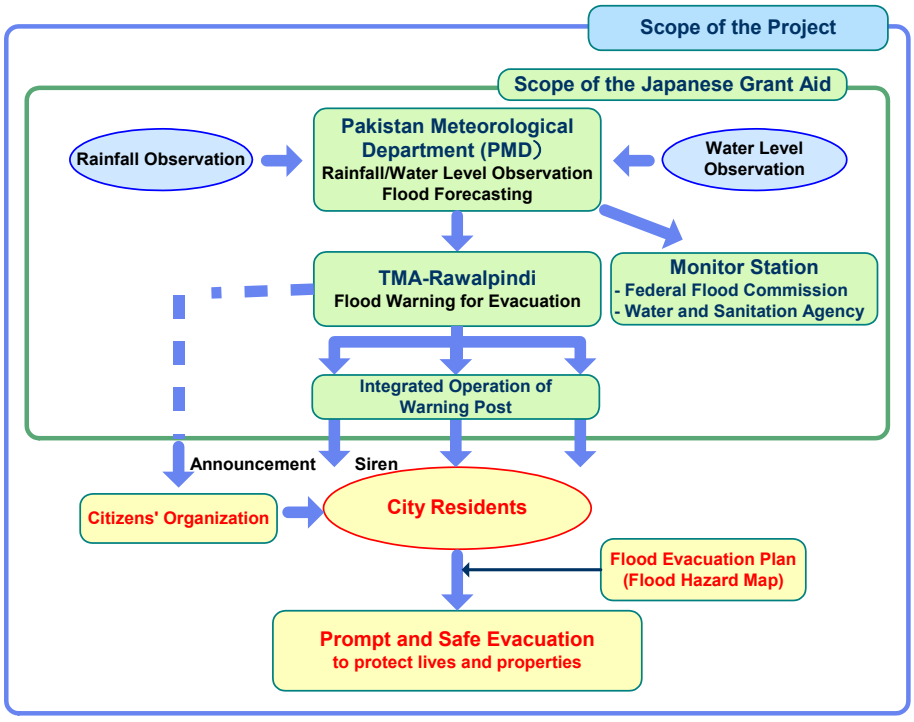


Figure 2.1 Relationship between the Project and Japanese Grant Aid

The Project is to be implemented by the four (4) agencies concerned, namely:

(1) The Pakistan Meteorological Department (PMD), the agency that will be in charge of flood forecasting;

(2) The Tehsil Municipal Administration of Rawalpindi (TMA-Rawalpindi), the agency that will be in charge of flood warning for the safe evacuation of residents from flood risk areas;

(3) The Federal Flood Commission (FFC), the agency that will coordinate the activities of the agencies concerned in the Project; and

(4) The Water and Sanitation Agency (WASA) of Rawalpindi Development Authority (RDA), the agency that will provide flood fighting assistance to TMA.

2-1-2 Outline of the Project

The equipment and facilities that had been originally requested for the Project by the Government of Pakistan are listed in Table 2.1 below.

Table 2.1 List of Equipment and Facilities Requested for the Project

(1)	Pakistan Meteorological Department (PMD)	
	Development of master control station (data processing and radio equipment)	1 site
	Improvement of existing rainfall station (telemetry rainfall gauge with automatic recorder)	4 sites
	Installation of new rainfall station (telemetry rainfall gauge with automatic recorder)	2 sites
	Installation of water level station (telemetry water level gauge with automatic recorder	2 sites
	Patrol car	1 unit
(2)	Tehsil Municipal Administration of Rawalpindi (TMA-Rawalpindi)	
	Development of executive warning station (data monitoring system, integrated warning system and radio equipment)	1 site
	Installation of warning post (radio and warning equipment)	10 sites
	Patrol car	1 unit
(3)	Federal Flood Commission (FFC)	
	Development of monitoring station (data monitoring system)	1 site
	Patrol car	1 unit
(4)	Water and Sanitation Agency (WASA)	
	Development of monitoring station (data monitoring system)	1 site

The activities required to attain the objective of the Project are explained in Items (1) to (5) below, as follows:

(1) Execution of the Effective Operation and Maintenance of the System

The PMD, TMA, FFC and WASA, which will undertake the operation and maintenance of the system, do not have enough knowledge on the hydrological data processing and telecommunication functions of the flood forecasting and warning system to be installed. The activities required for the effective operation and maintenance of the Project are as follows:

(a) The establishment of an organizational structure and the clarification of roles of staff on the effective operation and maintenance as well as the flood forecasting and evacuation warning announcement.

(b) The preparation of a manual on effective operation and maintenance and the training on techniques and judgment in connection with the basic activities of operation and maintenance. Detailed inspection and repair works for the

system are to be undertaken by expert engineers of a private/local company.

(c) The training at site of technical staff for operation and maintenance on the prompt discovery of defects and the prompt execution of adequate judgment on countermeasures to be provided.

(2) Execution of Flood Forecasting and Warning based on Adequate Analysis of Hydrological Observation Data

For the efficient, accurate and prompt dissemination of flood forecasts and warning, adequate flood run-off and flood prediction analyses utilizing the accumulated hydrological observation data are required. A staged flood warning code stipulating the rules of flood forecasting and warning has to be prepared by PMD and suggested for improving by TMA-Rawalpindi in the non-flood season, with the agreement of all agencies concerned as well as the coordination and final decision of FFC. In addition, the code has to be specified in the annual flood relief plan to be prepared by TMA-Rawalpindi.

(3) Improvement on Accuracy of Flood Prediction and the Staged Flood Warning Code

The accuracy of flood prediction should be increased and the staged flood waning code should be improved, based on the accumulated rainfall and water level data, the results of repetitive flood run-off and inundation analyses on various hyetographs, and the flood prediction analysis. In addition, the flood run-off model should be improved for a more accurate flood prediction, utilizing the accumulated rainfall and water level data.

(4) Formulation of Flood Risk Management Plan and Flood Evacuation Plan including Flood Hazard Map

The flood risk management plan should be formulated for the mitigation of flood damage, comprehensively considering the flood forecasting and warning system, the structural flood control plan, and other methodologies. The local government should prepare the flood risk management plan within its limited finance, together with the strict implementation of the following:

(a) The formulation of a flood evacuation plan which shall include a flood hazard map;

(b) The prevention of illegal dumping of solid waste into the river/drainage channels and of encroachment of informal dwellers into the channels; and

(c) The regulation of land use so as not to increase the peak flood runoff into the river channels.

The participation of local residents, NGOs, union councils, TMA and other local level organizations is required in the formulation of a detailed flood evacuation plan for the effective mitigation of flood disasters. The flood evacuation and flood risk management plans should lead to further disaster mitigation with more effective utilization of the proposed flood forecasting and warning system.

(5) Execution of Public Awareness Campaign on the Mitigation of Flood Damage

A public awareness campaign is required so that residents in possible inundation areas will understand in detail the flood disaster management, flood evacuation plan and flood hazard map. The campaign should result in a more effective utilization of the system and should ensure flood disaster mitigation considering

the characteristics of local disasters. The possible activities under the proposed public awareness campaign are as follows:

(a) The preparation of a manual on flood disaster mitigation for easier understanding of residents, especially, the old people and children;

(b) The preparation of an evacuation manual showing the organizational structure of information dissemination, the flood hazard map and the evacuation methodology at each local union, considering the opinion of local people and the local government units;

(c) The preparation of public information campaign materials such as posters and calendars on flood risk management, flood evacuation and flood forecasting and warning;

(d) The actual practice of execution of public awareness campaign and evacuation training to confirm the adequacy of the above manuals and materials regarding prompt flood evacuation; and

(e) The evaluation and improvement of the public awareness campaign for more effective activities.

Items (1) and (2) above are essential for the smooth start of operations and the sustainable execution of operation and maintenance of the proposed system. They may be attained through the technical guidance services on fundamental knowledge and techniques to be provided under the "Soft Component" of the Japanese Grant Aid Scheme.

On the other hand, Items (3), (4) and (5) are not obligatory conditions for carrying out the operation and maintenance activities, but they are required to increase the effective utilization of the system. They are not qualified under the soft component of Japanese Grant Aid, but should be undertaken by the executing agency itself or through other ways of technical cooperation.

2-1-3 Output of the Installation of Flood Forecasting and Warning System

As stated before, the Project objective is the prompt and safe evacuation of residents through the proposed flood forecasting and warning system, which will include the evacuation plan, the flood risk management plan and the public awareness campaign. In the present condition and before the Project is undertaken, warning and evacuation activities of flood disaster mitigation are being carried out during the flood risk time zone, resulting in injury and loss of life because of the following reasons:

(1) The possibility of flood is being judged through the water level only without accurate rainfall observation;

(2) The possibility of flood is not judged promptly before river overflow;

(3) The warning system covers only 10% of the possible inundation areas and each site is not sufficient to operate without integration; and

(4) The required evacuation time, as gathered from the interview-survey, is from 1 to 6 hours because of insufficient information on the evacuation activities.

After the completion of the Project, some activities of flood disaster mitigation could be undertaken before the flood risk time zone because of the following reasons:

(1) Flood prediction time will be possible at 1 to 2 hours before river overflow due to the observation of real time rainfall and river water level;

(2) Integrated warning operation will be possible through the ten (10) warning posts that could cover sixty 60% of the possible inundation areas; and

(3) The required evacuation time would be shortened from 1 to 2 hours through the adequate evacuation plan.

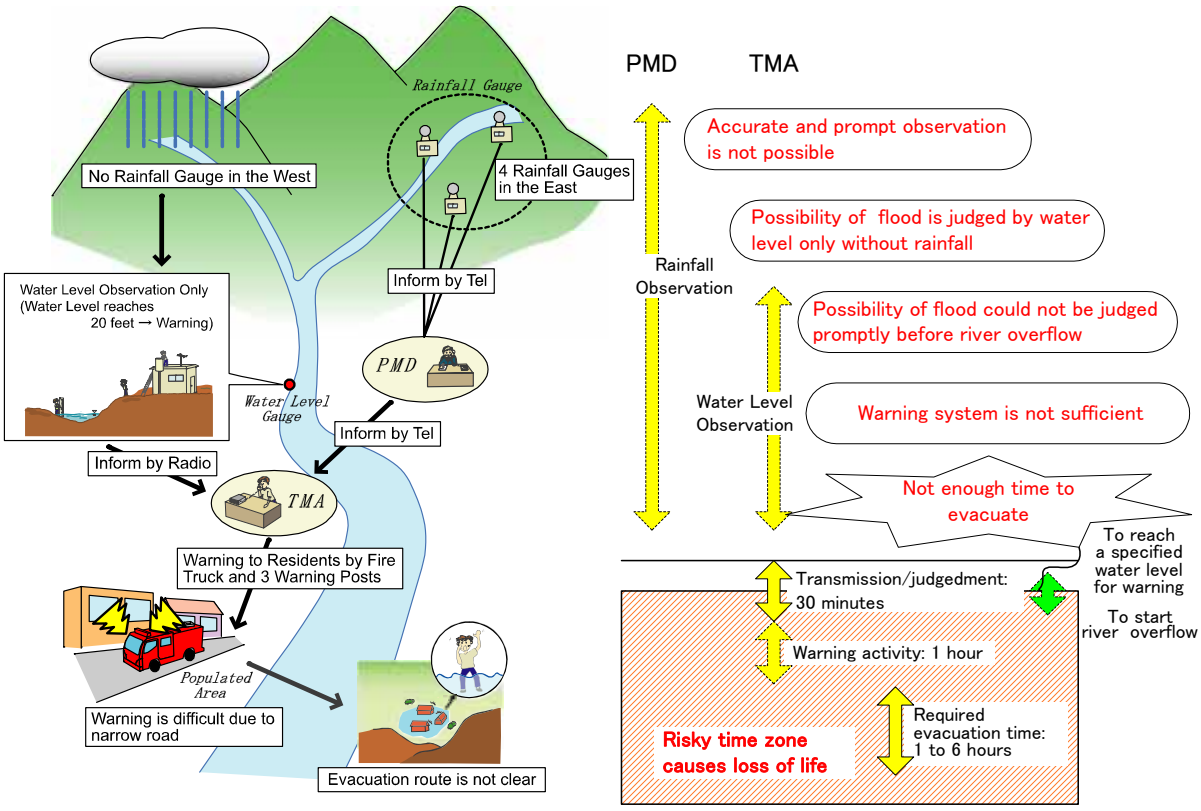
The prediction time can be made longer by repeated flood run-off analysis and the accumulation of hydrological observation data in the proposed system. The evacuation time can be made shorter through the formulated flood evacuation and flood risk management plans, as well as the public awareness campaign.

Table 2.2 below lists down the issues before the proposed system is undertaken and the outputs after the system is completed. The following Figure 2.2 outlines the issues before the Project is undertaken and the outputs after the Project is completed.

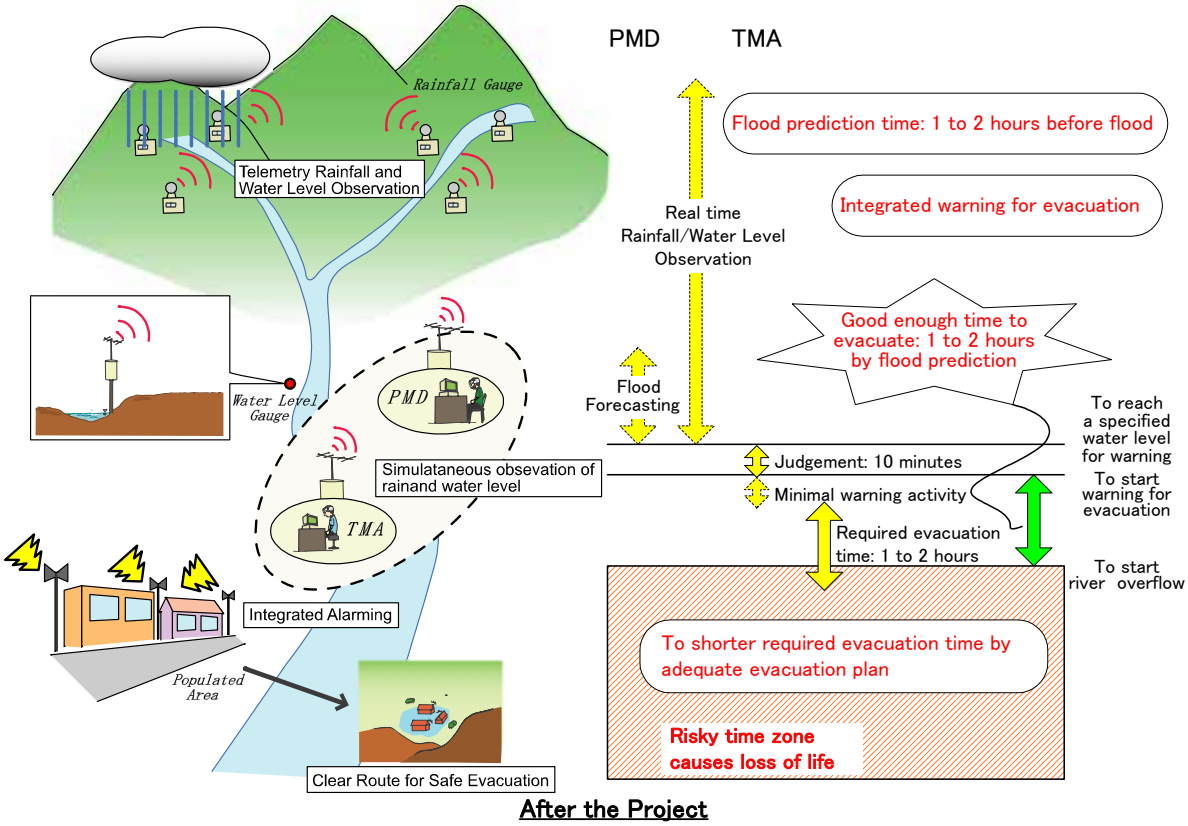
Table 2.2 Present Issues and Outputs of the Proposed Flood Forecasting and Warning System

Present Issues	Outputs of Proposed System
1. Number and allocation of rainfall gauges are not adequate to evaluate the average mean rainfall in the basin. Rainfall/river water level data are transmitted by voice communication, which causes misinformation, and data are not recorded correctly and orderly.	1. Real-time and accurate observation of rainfall/river water level is possible and data are automatically recorded.
2. Judgment on the possibility of flood is not clear and not made promptly before river bank overflow because flood prediction is based on river water level observation only without simultaneous observation of rainfall. Flood evacuation time to a safer place is not enough.	2. Real-time rainfall and river water level is available for the prediction of water level. Flood can then be predicted before river bank overflow. The flood prediction will result in enough time for safe evacuation. [1)]
3. Audible range of the warning system can cover only around 10% of the inundation area of a flood equivalent to the 2001 flood (100-year return period flood).	3. Audible range of warning system will cover around 60% of the inundation area of a flood equivalent to the 2001 flood (100-year return period flood).
4. Prompt instructions or warning could not be made because the system uses the voice communication.	4. Prompt and integrated warning operation is possible.
5. Staffs of agencies concerned do not have experience on the new system to be installed in the Project.	5. Staffs of agencies concerned in the operation and maintenance can be trained through technical guidance services. [1)]

1) Technical Guidance may be available under the Soft Component of Japanese Grant Aid to accomplish Items 2 and 5.



Before the Project



After the Project

Figure 2.2 Outline of Issues Before the Project and Outputs After the Project

2-2 Basic Design under the requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Design Policy

The "Study on Comprehensive Flood Mitigation and Environmental Improvement Plan for the Lai Nullah Basin" (hereinafter referred to as "the Master Plan Study") has been undertaken with the technical cooperation of the Japan International Cooperation Agency (JICA) from May 2002 to September 2003. In this Master Plan Study, the "Lai Nullah Flood Forecasting and Warning System Project" (the Project) has been proposed as one of the urgent projects, so that the Basic Design Study for the Project was based on the Master Plan Study.

The basic design policy to build up the flood forecasting and warning system is hereinafter explained.

(a) Expansion of Rainfall Observation Network

All of the four (4) existing rainfall gauges are situated in the eastern side of the Lai Nullah Basin, as shown in Figure 2.3, and this makes it impossible to accurately estimate the average rainfall in the entire basin. Therefore, two (2) additional rainfall gauges are required on the western side.

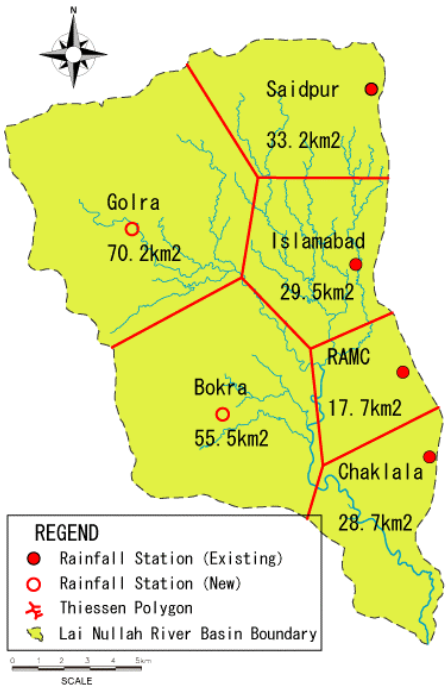


Fig. 2.3 Location and Thiessen Area of Rainfall Gauges

Real-time and automatic rainfall observation data at all six (6) gauges are to be transmitted by an integrated telemetry radio system. Figure 2.3 shows the areas of Thiessen Polygon of rainfall gauges. These areas are less than 100 km^2 in size, which is the value recommended by the World Meteorological Organization (WMO).

(b) Improvement of River Water Level Observation

Real-time and automatic river water level observation at the Kattarian and Gawal Mandi bridges are to be made through an integrated telemetry radio system. River water level gauges are to be installed at the downstream of these bridges in consideration of easiness of discharge observation.

Three (3) major tributaries or river basins join at the upstream of Kattarian Bridge in the Lai Nullah river basin. The whole concentrated flood discharge at the bridge causes the flood inundation and damage in Rawalpindi. A water level gauge at Kattarian Bridge is then required to be

installed for the earlier observation of flood discharge and for earlier flood warning dissemination.

Another major tributary or basin west of the Lai Nullah River in which the Bokra rainfall gauge is to be installed joins the Lai Nullah in the stretch between Kattarian Bridge and Gawal Mandi Bridge, causing the rise of river water level and the inundation of Rawalpindi. Since the flow capacity in the downstream of Gawal Mandi Bridge is lower than the one in the upstream, serious flood inundation areas expand near or downstream of Gawal Mandi. The installation of a water level gauge is then required at Gawal Mandi Bridge for the judgment on the starting and closing of flood forecasting and warning dissemination activity.

(c) Increase of Accuracy of Flood Forecasting

Hourly rainfall observation is required to accurately predict flood discharge at an earlier time considering that flood travel time from the hilly area to the flood prone areas in the Lai Nullah Basin is around 2 to 3 hours.

Real-time and automatic observation data of rainfall and water level are required to be recorded in the specified form and be processed automatically by sequential processing with the specified figure.

The flood water level is to be predicted on the basis of real time rainfall and water level data. The accuracy of prediction is to increase through repeated analysis of flood runoff using the accumulated rainfall/water level data. The rainfall, water level and flood information predicted are to be transmitted to the monitoring facilities in TMA-Rawalpindi, FFC and WASA for more adequate and precise monitoring.

(d) Improvement of Flood Evacuation Warning System

Figure 2.4 shows the allocation of warning posts in the possible inundation areas. Ten (10) warning posts are planned to be installed at sites or lands possessed by the agencies concerned in the Project and the public facility sites allowing such land use. The executive warning station in TMA-Rawalpindi can conduct the integrated operation of all the 10 warning posts.

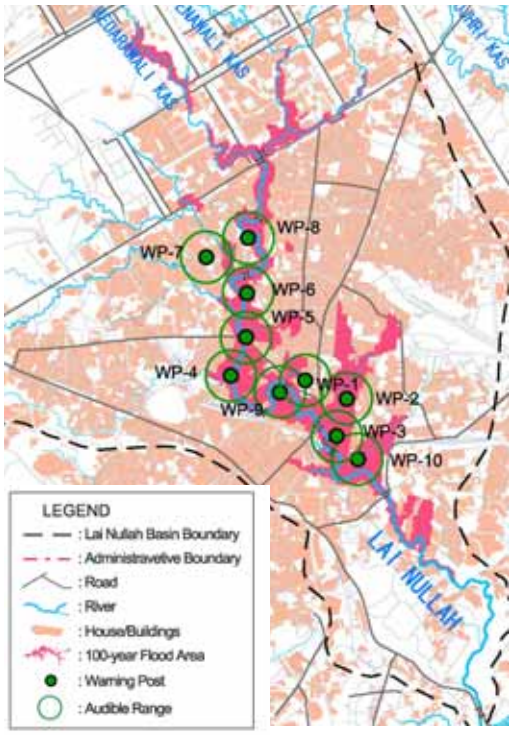


Figure2.4 Allocation of Warning Posts in Possible Inundation Areas

The sites have been investigated considering easy accessibility and easy procurement of electric power supply. The possible coverage ratio of alarm by the ten (10) warning posts in an area equivalent to the 2001 flood area

(100-year return period flood) will be around 60%; while, the audible ratio of the presently existing three (3) warning posts is estimated at around 10% only of the 2001 flood area.

Inaudible areas are to be covered by warning vehicles and other methods such as radio, telephone, mosque speakers, etc.

(2) Policy on Natural Conditions

The Project Area has higher precipitation and humidity in the rainy season compared to the other regions of Pakistan. In flood time, the Project Area exhibits high temperature and humidity as well as thunderstorms as the typical environmental condition in Southeast Asia. Due to seismic and strong wind forces, it is also considered to design high-tower water level gauge stations and elevated warning posts. It is thus required to design equipment or facilities to be installed in the Project Area taking account of the following considerations:

(a) Outdoor equipment should be dust-proof and waterproof, and the design should consider countermeasures to damage by insects, house lizards, and other small creatures.

(b) Unmanned equipment rooms should be damp-proof structures.

(c) A lightning protection system should be installed at each stations concerned.

(d) Equipment/facilities to be installed in open air such as antenna mast, rainfall gauge, solar panel, tower of water level gauge, station house, etc., should be designed considering wind force and seismic force in accordance with the structural standard in Pakistan.

(3) Policy on Social and Economic Conditions

For the installation of new stations for rainfall gauge, water level gauge, repeater and warning, the compound of existing public facilities should be selected considering easier land acquisition, security, and safety.

(4) Policy on Construction/Procurement

Construction equipment and materials should be, in principle, procured locally in Pakistan. Heavy construction equipment such as excavators, truck cranes and damper trucks can be procured from the lease companies in Islamabad and Rawalpindi.

The main equipment and materials for this project shall be procured in Japan. Since it is necessary to verify the integrated operation of the system, the installation work should be supervised by Japanese engineers of the contractor, in principle.

(5) Policy on the Use of Local Company

For the installation works, a local company specialized in telecommunication systems may be subcontracted with supervision provided by the Japanese engineer of the contractor.

(6) Policy on Operation and Maintenance

Systems design should be undertaken in consideration of easier operation and maintenance. New stations for rainfall gauge, water level gauge and warning

should be installed at accessible places easier to maintain. For easier maintenance, spare parts and consumable parts should be procured by the local contractor in Rawalpindi and Islamabad. Operation and basic maintenance works of the system should be undertaken by the present staff in agencies concerned such as TMA-Rawalpindi, PMD, FFC and WASA. Detailed inspection and repair works of the system should be implemented by expert engineers of a private company in or near Rawalpindi and Islamabad.

(7) Policy on Design Scale of Facilities and Equipment

The Project Area involves the capital city which is very important in social and economic aspects. The facilities of the system are to be designed for protection against the scale of the 2001 flood or a 100-year return period flood. The proposed system should be reliably activated during flood time to perform the overall goal or objective of the Project. The systems design is to be conducted in consideration of the following standards:

(a) Standard Specification of Telemetry System, Ministry of Land, Infrastructure and Transport, Japan

(b) Standard Specification of Discharge Warning System, Ministry of Land, Infrastructure and Transport, Japan

(c) Standards of the Institute of Electric and Electronics Engineers, USA

(d) Standard of River and Sabo Engineering, Ministry of Land, Infrastructure and Transport, Japan

Popular technical standards in Pakistan may also be applied in the design of the system, considering easier operation and maintenance.

(8) Policy on Methods of Construction/Procurement and Construction Schedule

Major construction works, especially soil works should be conducted during the non-flood season. Augured cast-in-place pile should be employed for the foundation of towers of water level gauge stations considering avoidance of vibration and noise in dense housing areas.

2-2-2 Basic Plan

Selection of the required facilities/equipment has been made based on the design policy explained in Section 2.1. Some equipment are not to be procured under the Japanese Grant Aid for reasons given in Table 2.3

Table 2.3 Equipment not to be Procured under the Japanese Grant Aid

(1)	Flood Information Display Boards (Plasma Display) for FFC and WASA: The operation console of the computer provided for data collection will already show the flood information on display.	2 sets
(2)	Generators for FFC and WASA: The installation of a generator on rooftops is technically difficult. Besides, it is possible to use the portable type generator and the uninterrupted power supply (UPS) for computers and servers.	2 sets
(3)	Patrol Car for FFC: For the monitoring of flood situation, a computer is required to be installed at the agency responsible for managing flood control in the Lai Nullah Basin. The monitoring during flood time is possible without a patrol vehicle.	1 set

The basic plan for designing the flood forecasting and warning system is hereinafter explained.

2-2-2-1 Total System Plan

The concept of the total system is shown in Figure 2.5. The basic configuration of the total system consists of the equipment necessary for PMD to provide the rainfall and water level observation, flood prediction and forecasting services; the equipment necessary for TMA to issue flood evacuation warning; and the flood monitoring equipment to be installed at FFC and WASA. The observed and processed flood information in the master control station of PMD are to be edited in the form of a flood warning bulletin, which has to be transmitted to TMA and the monitoring stations via the existing FAX link, or the Internet via a web server. The executive warning station (Disaster Prevention Center) in Rawalpindi City is to be responsible for issuing flood evacuation warning through the Warning Subsystem.

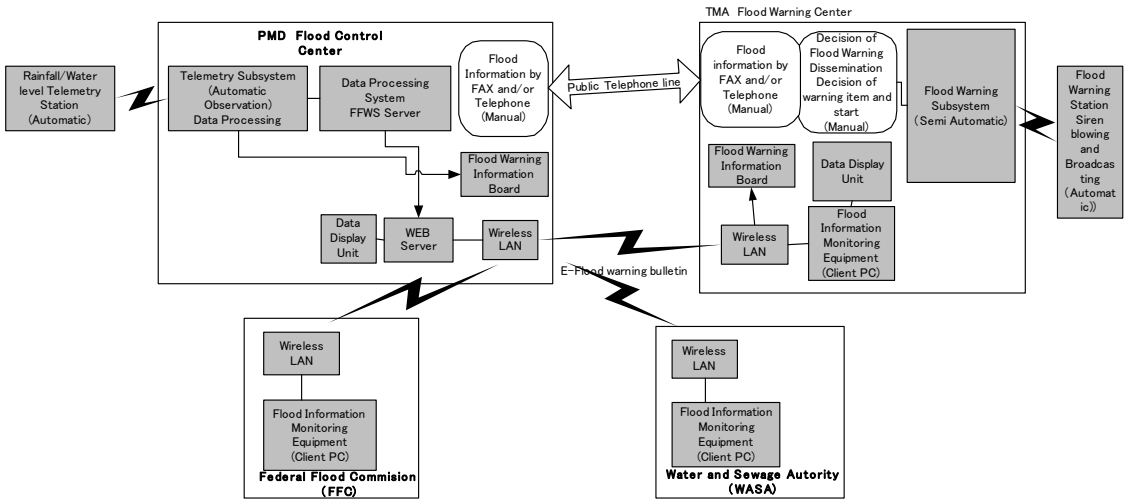


Figure 2.5 Concept of the Total Flood Forecasting and Warning System

The location and functions of the stations and the agencies responsible for the Flood Forecasting and Warning System are listed in Table 2.4.

Table 2.4 System Summary

Station	Function	Organization in Charge
1. Master Control Station		
1.1 PMD, Islamabad	• Flood forecasting; data collection • Data processing • Dissemination of flood information to related agencies (Data transmission subsystem	PMD
2. Rainfall Gauging Station		
2.1 PMD, Islamabad	Automatic rainfall data observation (Telemetry subsystem)	PMD
2.2 Saidpur		
2.3 Gorla		
2.4 Bokla		
2.5 RAMC		
2.6 Cgajlala		
3. Water Level Gauging Station		
3.1 Kattarian Bridge	Automatic water level data observation (Telemetry subsystem)	PMD
3.2 Gawal Mandi Bridge		
4. Repeater Station		
4.1 RAMC Telemetry Repeater	• Repeater function for telemetry	PMD
4.2 RAMC Wireless LAN Repeater	• Repeater function for wireless LAN	
5. Monitoring Station		
5.1 FFC	Flood information monitoring (Data transmission subsystem)	FFC
5.2 WASA of RDA	Flood information monitoring (Data transmission subsystem)	WASA of RDA
6. Executive Warning Station		
6.1 TMA Rawalpindi: -- Warning Control & Supervision	Control and supervision of warning system	TMA
-- Flood Information Monitoring	Flood information monitoring (Data transmission subsystem)	
7. Flood Warning Post		
7.1 WP-1: TMA Rawalpindi	Flood evacuation warning by motor siren and loudspeaker	TMA
7.2 WP-2: Christian Colony		
7.3 WP-3: Water Treatment Facility adjacent to MC		
7.4 WP-4: Ratta Amral Bridge		
7.5 WP-5: Gunj Mandi Bridge		
7.6 WP-6: Pir Wadhai Bridge		
7.7 WP-7: Fire Station Pir Wadhai		
7.8 Sector IV-B, Khayaban Park		
7.9 WP-9: Gawal Mandi Children's Park		
7.10 WP-10: Gpvernment Middle School, Dhoke		

* Two (2) units of 4WD vehicles are required for emergency and operation/maintenance.

2-2-2-2 Equipment Installation Plan

The sites for installing equipment and materials have been investigated before the design of equipment, and the necessity of building stations and the installation sites have been defined. It has been avoided as far as possible to acquire new lands for those sites and it has also been planned to build stations on lands possessed by the agencies concerned in this project and the public facility sites allowing the land use.

The installation sites of those stations are shown in Table 2.4. The stations to be newly built to install the equipment are two (2) rainfall gauging stations (Gorla and Bokla), two (2) water level gauging stations (Kattarian and Gawal Mandi), and nine (9) warning posts (WP-2 to WP-10). Other equipment will be installed in the existing buildings.

2-2-2-3 Securing Wireless Links

(1) Provisional Approval of Radio License

Negotiations to confirm the possibility of acquiring licenses to use the frequency of 400MHz for the requested telemetry and warning subsystems and the frequency of 5.2GHz for the wireless LAN have been made with the Frequency Allocation Board (FAB) of the Pakistan Telecommunication Authority (PTA) and a provisional approval has been obtained for the use of three (3) frequencies between 400MHz and 450MHz for telemetry and warning and the frequency of 5.752GHz to 5.875GHz for the wireless LAN. The official licenses are to be obtained after the wireless equipment has finally been decided and the applications for individual stations are filed.

(2) Theoretical Study on Wireless Links

The link design using the frequency bands for which the provisional licenses have been granted was made on a map in order to calculate the given radio strength, the signal-to-noise ratio and the communication reliability of each link.

(3) Study on Link with Wireless LAN by Mirror Tests

The wireless LAN uses a high frequency band and requires a highly straight propagation on a line-of-sight path. Thus, the communication reliability has been verified in mirror tests. The operating frequencies for the wireless LAN to be installed at PMD are approximate to those used for the existing meteorological radar installed at PMD. Therefore, interference on the radar has been calculated and confirmed to be negligible.

(4) Study on Radio Links and Repeater Stations by Radio Propagation Tests

There are a number of buildings and trees across the boundary from Islamabad to Rawalpindi, and they could cause disturbances to radio propagation. Therefore, it has been planned to install repeater stations at appropriate sites in order to secure good radio propagation between the project sites.

A repeater station was verified to build for the telemetry subsystem and the wireless LAN at the rainfall gauging station installed in the premises of Rawalpindi Agromet Center (RAMC). The link design sheet and the results of radio propagation tests are shown in Table 2.5.

Table 2.5 Outline of Radio Propagation Test Results

Telemetry Link 402MHz, 2W output, 3 element Yagi, antenna height 10m

Base station	Partner Station	Radio propagation value		Adjustment					Judgment
		Receiving power	S/N	Antenna	TX output	Antenna height	Adjustment value	After adjustment	
RAMC	Saidpur	31.5dB/μV	59.4dB	3-ele Yagi	10W	7m	7	38dB/μV	Good
	Golra	15.0dB/μV	54.0dB	5-ele Yagi	10W	15m	13	28dB/μV	Good
	Bokra	37.7dB/μV	60.4dB	3-ele Yagi	10W	10m	8	45dB/μV	Good
	Chaklala (Airport)	42.5dB/μV	60.8dB	3-ele Yagi	1W	4m	8	48dB/μV	Good
	Kattalian Bridge	16.0dB/μV	52.1dB	5-ele Yagi	10W	15m	13	29dB/μV	Good
	Gawal Mandi Bridge	11.7dB/μV	39.8dB	5-ele Yagi	10W	15m	13	24dB/μV	Good
	RAMC		49.0dB	3-stage collinear	10W	33m		+8.0dB/μV	Good

Warning Link 402MHz, 2W output, 3 element Yagi, antenna height 10m

Base station	Partner Station	Radio propagation value		Adjustment					Judgment
		Receiving power	S/N	Antenna	TX output	Antenna height	Adjustment value	After adjustment	
TMA Rawalpindi	WP-2	40.3dB/μV	48.0dB	3-ele Yagi	1W	15m	6	46dB/μV	Good
	WP-3	32.4dB/μV	47.0dB	3-ele Yagi	1W	15m	6	38dB/μV	Good
	WP-4	38.7dB/μV	48.0dB	3-ele Yagi	1W	15m	6	44dB/μV	Good
	WP-5	34.4dB/μV	47.60dB	3-ele Yagi	1W	15m	6	40dB/μV	Good
	WP-6	18.7dB/μV	49.0dB	5-ele Yagi	10W	15m	12	40dB/μV	Good
	WP-7	36.0dB/μV	55.1dB	3-ele Yagi	1W	15m	6	42dB/μV	Good
	WP-8	36.0dB/μV	55.1dB	3-ele Yagi	1W	15m	6	42dB/μV	Good
	WP-9	61.0dB/μV	48.0dB	3-ele Yagi	1W	15m	6	67dB/μV	Good
	WP-10	36.7dB/μV	59.8dB	3-ele Yagi	1W	15m	6	42dB/μV	Good
	TMA			3-stage collinear	10W	27m		+8.0dB/μV	Good

Wireless LAN Link Mirror Test: Confirmed on sunlight refraction

Base Station	Partner Station	Line of sight	Adjacent obstruction	Antenna height	Adjustment	Judgment
RAMC		Yes	None	20m from ground	None	Good
	FFC(New building)	Yes	None	55m from ground	None	Good
	WASA	Yes	None	24m from ground	None	Good
	TMA	Yes	Yes	27m from ground	None	Good

2-2-2-4 Study on Subsystems

To examine the optimum system, the total system of this project has been divided into a hydrological data collection subsystem, a data processing/transmission subsystem and a flood evacuation warning subsystem, as discussed below.

(1) Hydrological Data Collection Subsystem

The hydrological data collection subsystem uses the telemetry technology to collect hydrological data from remote points, and there are various link systems for data collection. Feasible in Pakistan are V-SAT, a portable phone system and radio telemetry system.

The portable phone system is not suitable for such a disaster prevention system because the traffic in case of a disaster abruptly increases, disabling or making call connections difficult. The V-SAT system has no problem of communications as such, but the equipment cost and the running cost are too high if the uninterrupted power supply is taken into account.

On the other hand, the radio telemetry system is economical from the general viewpoint because the initial investment for it is surely high, but it incurs no running cost. It can also secure highly reliable and real-time communications in case of a disaster. Therefore, this radio telemetry system that can provide the most stable and reliable communications is adopted for this project.

(2) Data Processing/Transmission Subsystem

For the data transmission system that is feasible in Pakistan, the wireless LAN system, the ISDN telephone network and the V-SAT system are available. The ISDN telephone network is inferior in reliability because it may be damaged and cause link disconnections due to traffic congestion in case of a flood. It is also inferior in maintainability because it is incapable of self-recovery in case of link disconnections.

On the other hand, the wireless LAN system allows high-speed data transmissions and is an optimum system that can be used as a private network not only for data transmissions but also image transmissions. In Pakistan, the 5.7GHz band is permitted for the wireless LAN, which can be used effectively even though the attenuations under rainfalls have to be considered on a short-range link of about 5 to 6 km.

(3) Flood Evacuation Warning Subsystem

The warning subsystem is a remote controlled system for which accurate operation is required. For this purpose, radio control, telephone network control and portable phone control systems are available. The control system over the general public telephone network could not be adopted because the telephone lines are submerged and unusable during floods.

Therefore, the control system using a radio link which is widely used in many countries has been adopted for this project. This control system has the trouble of filing an application for frequency license, but it provides the most stable links for disaster prevention systems at a low running cost and it is the most suitable for broadcasting operations.

As a result of the above examinations, the radio telemetry system has been adopted as the hydrological data collection subsystem, the wireless LAN system as the data

processing/transmission subsystem, and the radio control system as the flood evacuation warning subsystem respectively.

2-2-2-5 Equipment Plan for Hydrological Telemetry Subsystem

The telemetry subsystem will consist of six (6) rainfall gauging stations and two (2) water level gauging stations whose data are to be automatically collected and transmitted through the repeater station with the existing 100-foot tower at RAMC to the telemetry supervisory and control system that will be installed at the Pakistan Meteorological Department (PMD).

The telemetry supervisory and control system at PMD will provide automatic observation of hydrological data at 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 supervisory and control equipment at the start of rainfall and when the water level reaches the levels of caution and warning.

When PMD has received the start request signal, the start command is sent to all the gauging stations, which start observations. The supervisory and control equipment will calculate the hourly and 3-hour rainfall data and check the correlations between the rainfall data and the water level data. If the data reaches a warning value, the supervisory and control system will issue a warning.

A warning display panel also is to be provided to issue visible and audible warnings to alert the PMD personnel if rainfall and water levels reach the warning values. The warning display panels are to be installed in PMD and TMA-Rawalpindi in order to display the same information on the panels.

(1) Telemetry Supervisory and Control Equipment

The main component equipment and functions of the telemetry supervisory and control system to be installed in the Pakistan Meteorological Department (PMD) are shown in Table 2.6

(2) Rainfall Gauging Station

The component equipment and functions of the rainfall gauging station are given in Table 2.7, while the station configuration is in Fig. 2.6.

Table 2.6 Functions of the Telemetry Supervisory and Control Equipment

Equipment	Function (Purpose and Major Specifications)	Quantity
Telemetry Supervisory and Control Equipment	The telemetry Supervisory and Control Equipment shall summon 10 pieces of observation data on rainfall or water level from stations automatically at constant times and store the data in the FFWS server. When water level at observation stations reaches the danger level, it shall observe automatically and capture the latest data.	1
PC-type Operation Console	PC-type operation console shall be provided for data collection and control of repeater station. Observation station calling time shall be every 10, 30 and 60 minutes. Also, it shall display the repeater station status.	1
Printer	The printer shall print tables and graphics of hydrological data in color.	1
Flood Warning Information Board	The flood warning and information shall give visual and audible alarm when water level and rainfall reach the warning level.	1
400MHz Radio Equipment	The 400MHz radio equipment shall consist of a transmitter and a receiver to send control commands to observation stations for them to send accumulated data to the supervisory and control station.	1
Antenna System	Antenna system shall be connected to the radio equipment and form a wireless link with the repeater station.	1
DC Power Supply Unit	DC power supply unit shall provide DC power to the supervisory and control equipment and the radio equipment. The unit shall be operational for about 10 minutes during power failure.	1
Data Processing Equipment	Data processing equipment is to process hydrological data and graphics and shall consist of the FFWS server, the web server, the Client PC and the network equipment.	1
Flood Information Display Board	The Flood information display board with plasma display panel is to display tables, graphics and maps processed by the FFWS server.	1
Wireless LAN System	Wireless LAN system is to provide data transmission from the master control station to all flood monitoring stations.	1
IP Telephone Set	Exclusive telephone line using wireless LAN is to provide communication between the master control center and the monitoring stations.	2
UPS	The uninterrupted power supply for client PC and server is to provide power during commercial power interruption.	1
Voltage Regulator Equipment and Lightning Protection Devise	The Voltage Regulator Equipment is provided to keep stable power supply, and the Lightning Protection Devise is also provided to protect equipment from damage by lightning.	1
Emergency Power System (Engine Generator)	Diesel Engine Generator is to provide 48 hours of electric power during commercial power failure.	1
Emergency Vehicle with siren, warning light and searchlight	If observation station has trouble during flood, maintenance staff shall go to the site by the emergency vehicle to back up data. This vehicle shall also be utilized for maintenance work on observation station during normal periods.	1

Table 2.7 Functions of the Telemetry Rainfall Observation Equipment

Equipment	Function (Purpose and Major Specifications)	Quantity
Telemetry Observation Equipment	Observation equipment shall send out collected data according to the observation command from the supervisory and control station. It shall also detect the rainfall beginning signal and inform the supervisory and control station.	1
Data Memory Pack	Data Memory Pack shall memorize at least 3 months of rainfall data as backup of the observed rainfall data.	1
Tipping Bucket Rainfall Gauge	Tipping Bucket Rainfall Gauge is to measure and send out rainfall of 1mm of 1 tip to the observation equipment by pulse signal.	1
400MHz Band Radio Equipment	400MHz band radio equipment shall consist of a transmitter and a receiver to send accumulated data to the supervisory and control station by command signal.	1
Antenna System	Antenna System shall be connected with the radio equipment to form a wireless link with the repeater station.	1
Solar Panel and Distribution Board	Solar panel shall be used for charging the battery.	1
Battery	Battery shall ensure operation without 7 days of sunshine as the power of the above equipment.	1

(3) Water Level Gauging Station

The component equipment and functions of the water level gauging stations are given in Table 2.8, while the station configuration is in Fig. 2.7.

Table 2.8 Functions of the Water Level Gauging Equipment

Equipment	Function (Purpose and Major Specifications)	Quantity
Telemetry Observation Equipment	Observation equipment shall send out collected data according to the observation command from the supervisory and control station. Also, it shall detect the signal when reaching danger level and inform the supervisory and control station.	1
Data Memory Pack	Data Memory Pack shall memorize at least 3 months of water level data as backup of the observed water level data.	1
Float-Type Water Level Gauge	Float-type water level gauge shall measure and send out water level of 1cm unit to the observation equipment as the BCD signal.	1
400MHz Band Radio Equipment	400MHz band radio equipment shall consist of a transmitter and a receiver to send accumulated data to the supervisory and control station by command signal.	1
Antenna System	Antenna System shall be connected with the radio equipment and form a wireless link with the repeater station.	1
Solar Panel and Distribution Board	Solar panel shall be used for charging the battery.	1
Battery	Battery shall ensure operation without 7 days of sunshine as the power of the above equipment.	1

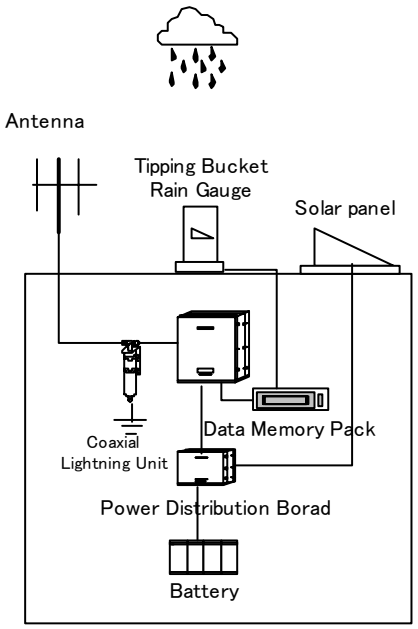


Fig. 2.6 Configuration of Rainfall Gauging Station

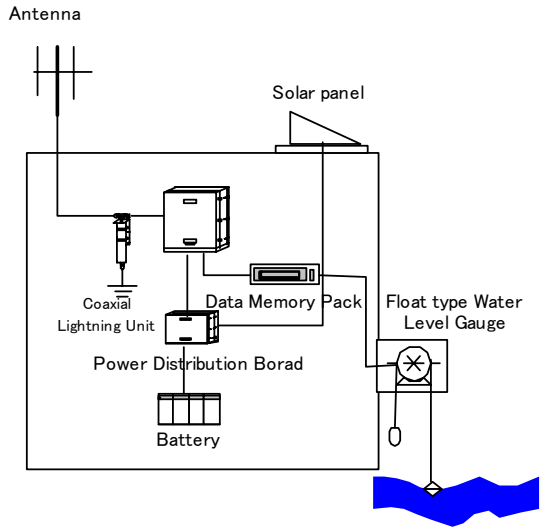


Fig. 2.7 Configuration of Water Level Gauging Station

(4) Repeater Station

The repeater station to be installed at RAMC consists of a telemetry repeater, a wireless LAN repeater and rainfall gauging equipment. The component equipment and functions of the repeater stations are given in Table 2.9, while the station configuration is in Fig. 2.8.

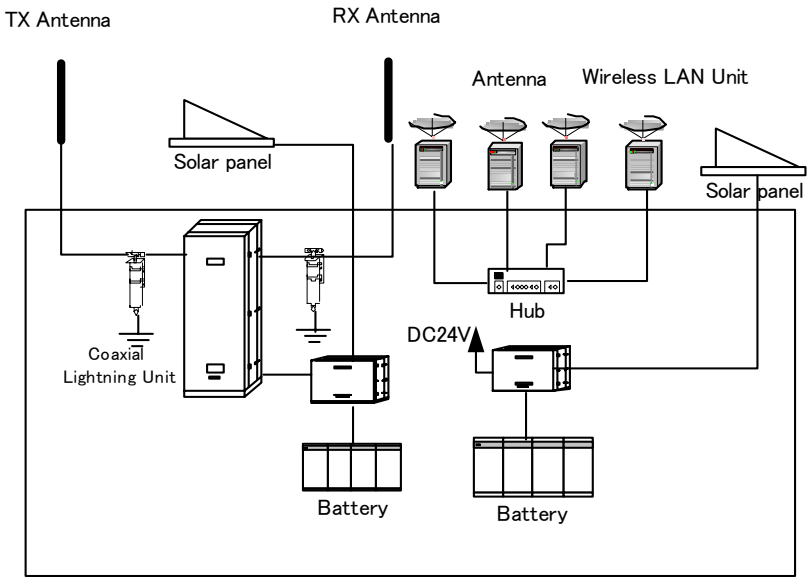


Figure 2.8 Configuration of the RAMC Telemetry/Wireless LAN Repeater Station

Table 2.9 Functions of the Repeater Equipment

Equipment	Function (Purpose and Major Specifications)	Quantity
Telemetry Radio Repeater Equipment	Signals between the telemetry supervisory and control station and each gauging station are repeated by the equipment to transmit the observed data accurately. The status data of the repeater equipment is also transmitted. The transmitter-receiver system is duplicated so that when one transmitter fails to operate, operation is automatically switched over to the standby transmitter.	1
400MHz Radio Equipment	The equipment shall consist of a transmitter and a receiver. Command from the supervisory and control station is to be sent through the equipment to each gauging station, which will in turn transmit accumulated data to the supervisory and control station.	2
Antenna System	The antenna system shall be connected with the radio equipment to form a radio link with the repeater station.	2
5.7GHz Wireless LAN Outdoor Unit	The unit shall receive the wireless LAN outputs at PMD and repeat them to the monitoring station. This system is a 1 to 1 repeating system. Therefore, it is necessary to install 4 wireless LAN for the 4 directions.	4
Telemetry Observation Equipment	The collected data is to be sent out under the observation command from the supervisory station, and the rainfall start signal is to be detected and sent to the supervisory station.	1
Data Memory Pack	The rainfall data for 3 months or more is to be stored as backup data.	1
Tipping Bucket Rainfall Gauge	Rainfall of 1mm per tip shall be measured and sent out as a pulse signal to the rainfall gauging station.	1
DC Power Supply Unit	The battery is to be charged from a commercial power source.	1
Storage Battery	The battery shall ensure 3 days of power supply to the above DC power supply unit.	1

2-2-2-6 Equipment Plan for Data Processing/Transmission Subsystem

The data processing/transmission subsystem shall consist 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 connect both equipment.

(1) Data Processing Equipment

The functions of the data processing equipment to be installed at PMD are given in Table 2.10 and the hardware configuration is in Fig. 2.9. The equipment is to create the database, based on the hydrological observation data, and to process the data.

Table 2.10 Functions of the Data Processing Equipment

Equipment	Function (Purpose and Major Specifications)	Quantity
Data Processing System	FFWS Server: To edit, store and process collected data	1
	Web Server: To transmit processed data to monitoring station as web information	1
	Client PC: To perform data processing and make programs	1
	Network devices: To connect the above-mentioned equipment	1
	Printer and peripherals	1
Flood Information Display System	To display tables and graphics on the large-scale plasma display unit after processing by the FFWS server.	1
5.7GHz Wireless LAN System	To disseminate the flood information stored at the web server of PMD to the monitoring stations with IP telephone system.	1
UPS	To provide short period standby power supply for server and client PC during power interruption.	5

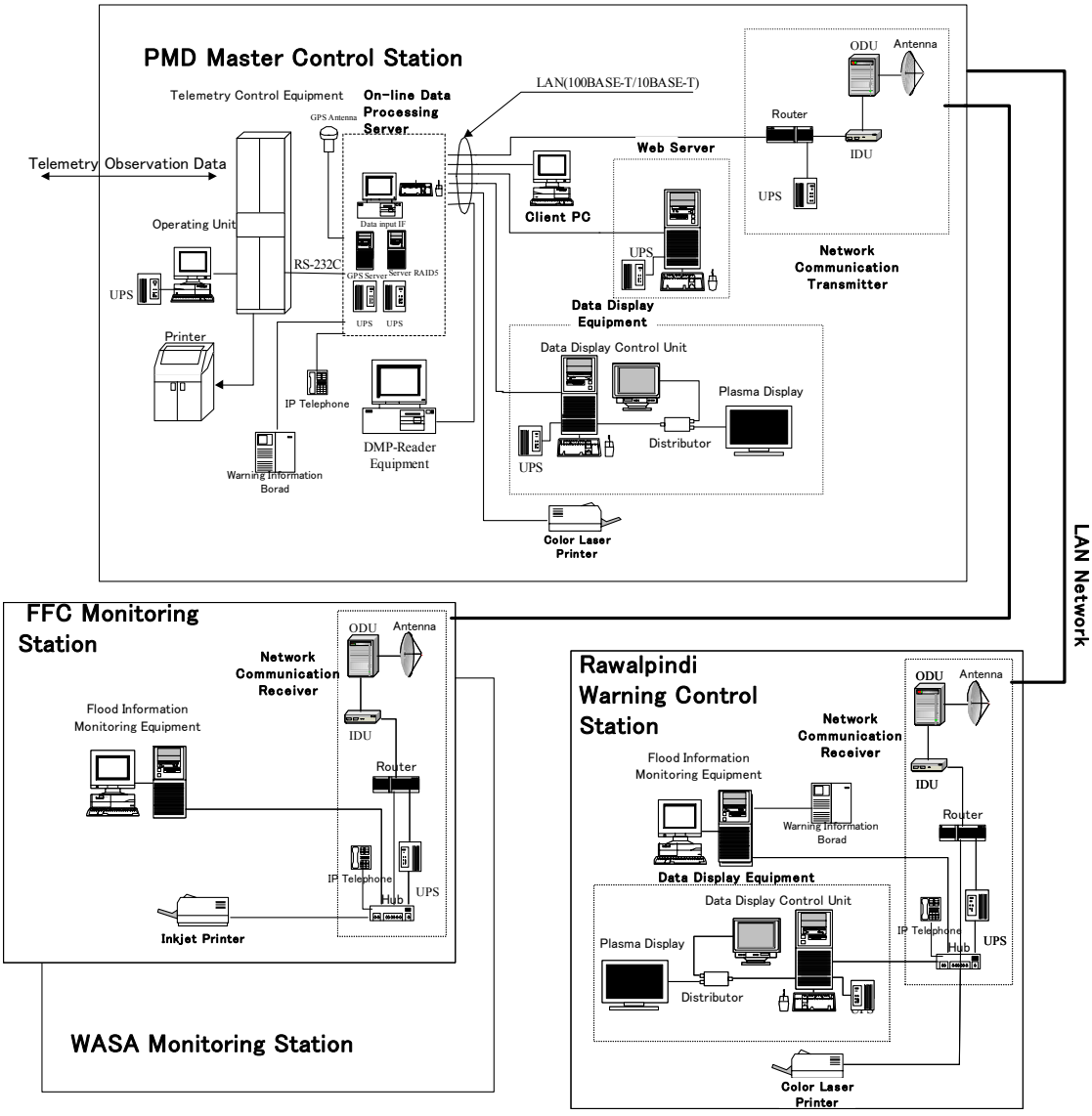


Fig. 2.9 Hardware Configuration of Data Processing/Transmission System

(2) Flood Information Monitoring Equipment

The flood information monitoring equipment is to be installed at FFC and at WASA. Equivalent equipment also is to be installed at the Executive Warning Station in TMA. The flood information is to be stored in the web server at PMD, and each monitoring station could access information as needed. Each monitoring station is to be connected individually to the web server through the wireless LAN. Once connected, the monitoring station would be able to monitor real-time flood information which can be updated in 10-minute intervals. The functions of flood monitoring equipment are given in Table 2.11.

Table 2.11 Functions of the Flood Monitoring Equipment

Equipment	Function (Purpose and Major Specifications)	Quantity
Wireless LAN System	Data transmission network shall consist of 5.7GHz band wireless LAN to send flood information from PMD to monitoring station.	1
Antenna System	For wireless LAN equipment.	1
Client PC and Printer	To display the contents of FFWS web and print necessary data	1
Flood Information Display Equipment	This equipment shall consist of a plasma display unit and its control PC to display flood warning information from PMD.	1
IP Telephone Set	The exclusive telephone line using wireless LAN shall provide communication between the master control center and the monitoring station.	1
UPS	The uninterrupted power supply for client PC and server shall provide power during commercial power interruption.	1
Air Conditioning Unit	Shall be installed at the warning control room to provide the cooling system for equipment.	1

2-2-2-7 Equipment Plan for the Flood Evacuation Warning Subsystem

The warning control and supervisory equipment to be installed at the Executive Warning Station (Disaster Prevention Center) of Rawalpindi City is planned to control and supervise the 10 warning posts to be installed mainly along the Lai Nullah River. When flood information is received from PMD, the TMA will send out flood warning and evacuation warning in accordance with its flood operation standard through the flood evacuation warning supervisory and control equipment. Based on this warning order, each warning station will sound a siren in any of the following patterns that are so simple for people to easily understand the meaning of the siren sounds:

(1) For Flood Warning: Five (5) repetitions of sound for 10 seconds followed by a pause of 5 seconds

(2) For Evacuation Warning: Five (5) repetitions of sound for 50 seconds followed by a pause of 10 seconds

(3) For Warning Release: The siren is not sounded, but information is broadcast through the sound system or loudspeakers that the flood danger has gone.

All the warning posts shall basically be subject to general control because the possible flood inundation area is not so large. However, the control and supervisory equipment shall have the functions of individual sequential control and individual control to meet various flood types.

All the warning posts are to be located in densely populated urban areas where 10 m or higher buildings stand around them. Therefore, it has been planned to install sirens at about 10 m high and loudspeakers at around 14 m high on a pole of 15 m high in order to secure the sounding coverage of sirens and loudspeakers as wide as possible. It has been planned to secure a sounding coverage of 500 m radius for siren warning. If power failure would occur in case of flood, the sirens will be inactive. For such event, the loudspeakers are designed to broadcast a pseudo-siren sound (560Hz equivalent to a siren sound) from an internal amplifier.

(1) Executive Warning Station (Disaster Prevention Center)

The main equipment and functions of the Disaster Prevention Center (Flood Evacuation Warning Supervisory and Control Station) are given in Table 2.12.

Table 2.12 Functions of the Executive Warning Station

Equipment	Function (Purpose and Major Specifications)	Quantity
Flood Warning Control and Supervisory Equipment	The equipment is to send control signal to flood warning station to sound the siren or activate broadcasting, and supervise the warning station operation status.	1
PC-Type Operation Console	All operation and supervision of station status shall be made from the PC-type operation console.	1
Serial Printer	All operation records and station status are to be printed by the serial printer.	1
Flood Warning Information Board	When water level and rainfall reaches warning level, the flood warning information board shall give visual and audible alarm.	1
IP Telephone Set	Exclusive telephone line using wireless LAN shall be provided between the master control center and the monitoring station.	2
400MHz radio Equipment	400MHz band radio equipment shall consist of a transmitter and a receiver to send status data to the supervisory and control station in response to a command signal.	1
Antenna System	Antenna System shall be connected to the radio equipment to form a wireless link with the warning posts.	1
DC Power Supply Unit with Battery	The unit shall revert from AC power to DC power before power is supplied to all equipment except sirens. It shall be able to provide power to equipment for around 10 minutes of commercial power failure.	1
Automatic Voltage Regulator and Lightning Protection Device	AVR shall be provided to obtain stable commercial power supply. A lightning protection device shall also be provided to protect equipment from damage due to lightning surge.	1
Emergency Power Supply (Engine Generator)	Diesel Engine Generator shall provide electric power during commercial power failure. It shall be able to provide 48 hours of electric power during power failure.	1
Air Conditioning Unit	Air conditioning unit is to be installed at the warning control room as the cooling system for equipment.	1
Emergency Vehicle with Siren, Warning Light and Searchlight	Emergency vehicle shall be used as evacuation guide during floods. This vehicle shall be utilized for maintenance work on warning posts during normal periods.	1

(2) Warning Post

The main equipment and functions of the warning posts are given in Table 2.13, while the hardware configuration of the station is in Fig. 2.10.

Table 2.13 Functions of the Flood Warning Equipment

Equipment	Function (Purpose and Major Specifications)	Quantity
Flood Warning Equipment	The flood warning equipment shall sound the siren by control command from the supervisory and control station. Also, it shall report the operation condition of all equipment to the supervisory and control station.	1
Siren and Control Board	The siren shall emit three patterns of sound: “Flood Warning”, “Evacuation Warning”, and “Call-Off Warning” depending on the supervisory and control station command.	1
Loudspeaker	The loudspeaker shall emit an artificial siren sound when there is a power failure and broadcast warning announcements.	1
Sound Collection Microphone	When siren or loudspeaker is being operated, the microphone shall collect the actual sound and send it back to the supervisory and control station for confirmation and recording.	1
Warning Light	The evolutional warning shall light up at the start of warning until warning call-off.	1
400MHz Radio Equipment	400MHz band radio equipment shall consist of a transmitter and a receiver to receive control commands from the supervisory and control station and to send back status information.	1
Antenna System	Antenna System shall be connected to radio equipment and form a wireless link with the warning supervisory and control station.	1
DC Power Supply Unit with Battery	The unit shall revert from AC power to DC power to supply all equipment except sirens. It shall be able to provide power to equipment for around 5 days of commercial power failure.	1

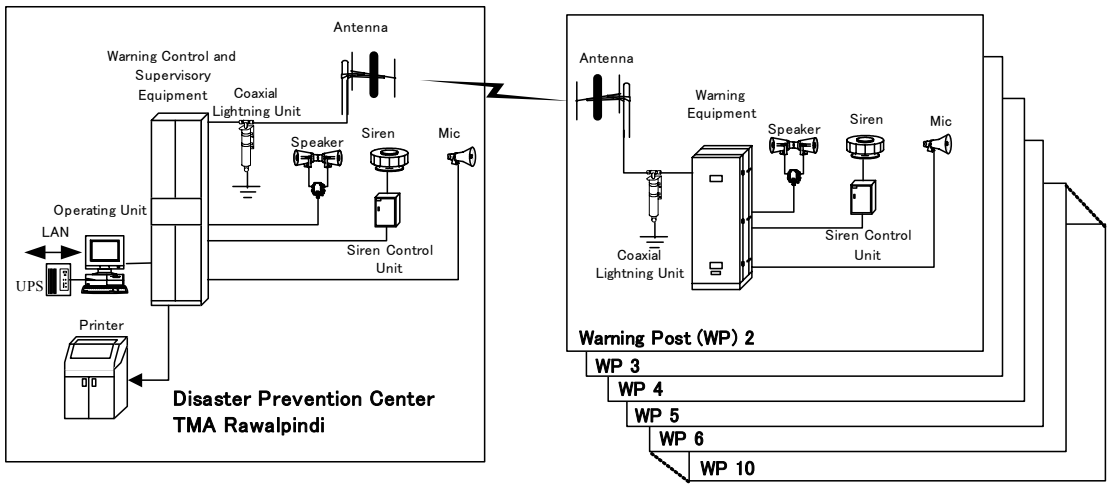


Figure 2.10 Hardware Configuration of Warning Posts

2-2-2-8 Equipment for Operation and Maintenance

Equipment and materials for maintenance management are to consist of emergency maintenance vehicles, measuring instruments and spare parts for systems maintenance and operation.

(1) Emergency Maintenance Vehicle

The emergency maintenance vehicles to be provided shall be one (1) for the Pakistan Weather Bureau (PMD) for operation and maintenance and one (1) for TMA-Rawalpindi for back-up of flood warning patrol. For purposes of proper

identification, the body of vehicles should be painted in red and the project name and logo shall be conspicuously painted on the vehicle. The feature and the quantity of the emergency maintenance vehicle are shown in Table 2.14.

Table 2.14 Function of Emergency Maintenance Vehicle

Equipment	Function (Purpose and Major Specifications)	Quantity
Emergency Maintenance Vehicle (Patrol Car)	- The vehicle is to be dispatched to do the backup of data and so on when a serious problem occurs at any observation station in flood season and data could not be transmitted and so on. - When the problem occurs at a warning post during flood, the vehicle is dispatched to the warning post to disseminate the flood warning or evacuation instruction by loudspeaker to the surrounding residents. - At normal time, the vehicle shall be used for the maintenance management of the system. - Many narrow roads exist in Rawalpindi City and are not accessible by a full-sized car. Therefore, small sized 4WD vehicles will be provided. - For urgent night passage in case of flood, the vehicle shall be equipped with a siren, a public address system, a searchlight and so on.	2

(2) Measuring Instruments

The types of measuring instrument to be procured shall be kept at minimum for personnel of the executing agencies to conduct simple maintenance work such as checking of power output, low frequency level and voltage of unit and battery where no electronics knowledge is required. One set each of these measuring instruments will be provided to PMD to conduct maintenance work on the hydrological data collection subsystem and to TMA to conduct maintenance work for the flood warning subsystem. The features and quantities of measuring instruments are shown in Table 2.15.

Table 2.15 Function of Measuring Instrument

Equipment	Function (Purpose and major Specifications	Quantity
Through-type Power Meter	For measurement of radio frequency output power: Frequency range： ５０50～500MHz Measuring range： ０～30W	2
Level Meter （one pair）	For measurement of low frequency of radio equipment output and oscillating low frequency signal: Measuring frequency range：200Hz～10kHz Oscillation frequency：200Hz～9.99kHz（10Hz step）。	2
Portable Engine Generator and Battery Charger	For battery recharging in case the battery at telemetry and warning equipment becomes weak: Battery charger, 12Vtype is used for telemetry and warning posts, and 24V type is used for wireless LAN equipment.	2

(3) Spare Parts

Spare parts/units shall be provided for the major equipment purchased in Japan. In case of trouble, the defective parts/units shall be changed with the spare part or unit to recover the original function. The features and quantities of spare parts are shown in Table 2.16.

Table 2.16 Kinds of Spare Parts

Subsystem	Major Spare Parts	Quantity
Hydrological Data Collection Subsystem	Major unit for Telemetry Supervisory and Control Equipment;, Major equipment for Telemetry Repeater Equipment; Major unit for Telemetry Observation Equipment; Tipping bucket type rain gauge; Shaft encoder for water level gauge; and Telemetry radio equipment	1
Data Processing/Data Transmission Subsystems	Router, Hub and Wireless LAN	1
Flood Warning/Evacuation Subsystems	Major unit for Warning Control and Supervisory Equipment; Major unit for Warning Post Equipment; Radio equipment; Loudspeaker; Power amplifier (100W) for Warning Post	1

2-2-2-9 Structural Plan

The new structures to be constructed are the rainfall gauging stations (2 places), the water level gauging stations (2 places), and the warning posts (9 places). The design scale of these structures shall be the magnitude of the July 2001 flood or 100-year return period. Firstly, therefore, a comparison between the simulated flood water level of a 100-year return period and the highest recorded flood water level was made for each study site. Then, the rooms were planned to have higher elevations.

The water level gauging stations are to be constructed in the Lai Nullah River. Therefore, the elevation of gauging rooms was determined considering a freeboard of 1.2m above their design high water levels. This freeboard of 1.2m was adopted referring to the Law of River Structures of Japan. The structural plans are described below.

(1) Rainfall Gauging Station

(a) Golra

The construction site of this station is a concave land near a road, and was a small and shallow pool during the field survey of the Basic Design. Therefore, land consolidation, e.g., embankment and drainage canal, is necessary before construction. Height of the floor from the ground was set at 1.2m. This is because the inundation depth of this site was 1.2m at the time of the 1995 flood. Moreover, it is necessary to assign a security guard to watch over the installed equipment. Therefore, a gauging room as well as guard room, bath, kitchen and verandah will be constructed. The structural plan of the gauging room is, as follows

Table 2.17 Structural Plan of Golra Rainfall Gauging Station

Item	Plan
Floor Plan	Width 2m, Length 2m, considering operation and maintenance of the equipment
Facility Plan	Air-vent pipe, glass block for lighting, monkey ladder for roof inspection
Material Plan	Reinforced concrete slab and column, brick wall with cement plaster

(b) Bokra

As in the Golra rainfall gauging station, it is necessary to assign a security guard to watch over the installed equipment. Therefore, a gauging room as

well as guard room, bath, kitchen and verandah will be constructed. The structural plan of the gauging room is, as follows:

Table 2.18 Structural Plan of Bokra Rainfall Gauging Station

Item	Plan
Floor Plan	Width 2m, Length 2m, considering operation and maintenance of the equipment
Facility Plan	Air-vent pipe, glass block for lighting, monkey ladder for roof inspection
Material Plan	Reinforced concrete slab and column, brick wall with cement plaster

(2) Water Level Gauging Station

(a) Kattarian Bridge

This station is to be located at the left bank 35m downstream from the piers of the bridge under construction in the Lai Nullah River. The left bank is selected because there is no service road along the right bank and private lands extend until the edge of the right bank. The water level gauging tower is to be built in the river channel 15m away from the top of the slope, and is designed not to affect flood flows

The gauging room is to be linked with the bank by a footbridge and spiral stairs. Considering safety of the installed equipment, the spiral stairs and pole on the bank is to be surrounded with a fence.

The structural plan of the gauging room and water level gauging tower is, as follows:

Table 2.19 Structural Plan of Kattarian Water Level Gauging Station

Item	Plan
Floor Plan of Gauging Room	Width 2.5m, Length 2.5m, considering operation and maintenance of the equipment and diameter of tower
Area of Riverbank Protection	10 meters upstream of the tower, and 10 meters downstream of the tower
Area of Riverbed Protection	10 meters around the tower
Tower Section	Inner diameter 90cm considering up and down movement of a person for inspection, operation and maintenance of the station
Structural Plan of Tower	High Water Level = EL. 505.6 m Velocity of High Water Level = 4.8 m/s Normal Water Level = EL. 495.0 m Velocity of Normal Water Level = 0.8 m/s Design Horizontal Seismic Coefficient = 0.075g
Facility Plan of Gauging Room	Air-vent pipe, glass block for lighting, monkey ladder for roof inspection
Material Plan of Gauging Room	Reinforced concrete slab and column, brick wall with cement plaster

(b) Gawal Mandi Bridge

This station is to be located at the right bank 35m downstream from the existing Gawal Mandi Bridge. The right bank is selected because the watercourse is formed at the left bank side. The water level gauging tower is

to be placed in the river channel 15m away from the top of the slope, and is designed not to affect flood flows.

The gauging room is to be linked with the bank by a footbridge and spiral stairs. Considering safety of the installed equipment, the spiral stairs and pole on the bank will be surrounded with a fence.

The structural plan of the gauging room and water level gauging tower is, as follows:

Table 2.20 Structural Plan of Gawal Mandi Water Level Gauging Station

Item	Plan
Floor Plan of Gauging Room	Width 2.5 m, Length 2.5 m, considering operation and maintenance of the equipment and diameter of tower
Area of Riverbank Protection	10 meters upstream of the tower, and 10 meters downstream of the tower
Area of Riverbed Protection	10 meters around the tower
Section of Tower	Inner diameter 90cm considering the up and down movement of a person for inspection, operation and maintenance of the station
Structural Plan of Tower	High Water Level = EL. 498.3 m Velocity of High Water Level = 3.7 m/s Normal Water Level = EL. 488.7 m Velocity of Normal Water Level = 0.7 m/s Design Horizontal Seismic Coefficient = 0.075g
Facility Plan of Gauging Room	Air-vent pipe, glass block for lighting, monkey ladder for roof inspection
Material Plan of Gauging Room	Reinforced concrete slab and column, brick wall with cement plaster

(3) Warning Posts (WP-2 to WP-10)

In principle, an elevated floor style is adopted for the new warning posts to be constructed. This is because the sites of the warning posts were inundated considerably in the 2001 flood. The elevated height of the floor of each post is shown in Table 2.21 below. Considering safety of the installed equipment, the warning posts are to be surrounded with a fence.

Table 2.21 Elevated Height of Floor of Warning Post

Warning Post	Place	Height of Floor from the Ground (m)
WP-2	Christian Colony Arra Muhallah	4
WP-3	Treatment Plant near MC Dispensary	6
WP-4	Ratta Amral Bridge	2
WP-5	Back of Tube Well, Gunj Mandi Bridge	4
WP-6	Tube Well near Pir Wdhai Bridge	7.5
WP-7	Pir Wadhai Fire Brigade	1
WP-8	Park, Section IV-B Khayalean	1
WP-9	Gawal Mandi Children's Park	5
WP-10	Government Middle School, Dhoke Chiraghdin	5

The structural plan of rooms of these warning posts is, as follows:

Table 2.22 Structural Plan of Warning Posts

Item	Plan
Floor Plan	Width 2.5m, Length 2.5m, considering operation and maintenance of the equipment
Structural Plan	Design Horizontal Seismic Coefficient = 0.075g
Facility Plan	Air-vent pipe, glass block for lighting
Material Plan	Reinforced concrete slab and column, brick wall with cement plaster

2-2-3 Basic Design Plan

2-2-3-1 Equipment Design

(1) PMD Master Control Station

The layout plan of equipment is shown in Drawings attached. This station shall consist mainly of telemetry supervisory and control equipment and data processing equipment, which are to be installed in a partitioned half space of the second floor of the PMD Library building. The space is to be air-conditioned to protect the equipment against high temperature.

A tipping bucket rainfall gauge is planned to be installed on the rooftop of the building. The telemetry UHF antenna and the wireless LAN Outdoor Unit (ODU) are to be installed on the rooftop where the meteorological radar antenna radome is installed, and to be fed into the equipment room. The emergency-use power generator is to be installed in the power generator room for the existing meteorological radar. The commercial power is to be branched from the power distribution board in the power generator room and additionally fed into the equipment room on the second floor of the building.

(2) Telemetry Rainfall Gauging Station

The layout plan of equipment is shown in Drawings attached. The rainfall gauging station will be provided with rainfall observation equipment, data memory equipment (DMP: Data Memory Pack) and batteries in a new or existing station house. A solar cell battery is to be used as the power source. The details of the installations are given in Table 2.23.

Table 2.23 Equipment Plan of Rainfall Gauging Station

Station Name	Location	Antenna Mast/Pole	Installation Site of Solar Panel and Rain Gauge
Saidpur Rainfall Gauging Station	PMD Saidpur Seismological Observatory (Existing)	7m high antenna pole installed on backside wall of existing building.	Rain gauge installed on the roof of seismological sensor room
Golra Rainfall Gauging Station	New station building constructed at site adjacent to animal hospital	10m high steel-plate assembled antenna mast erected at the site	Solar panel and rain gauge installed on the roof of new building
Bokra Rainfall Gauging Station	New station building constructed at site of public institute	15m high steel plate assembled antenna mast erects in the site	Solar panel and rain gauge installed on the roof of new building
RAMC Rainfall Gauging Station	Equipment installed at the existing building of the PMD-RAMC observatory.	The gauging equipment is connected with repeater equipment by wire.	Rain gauge installed on the roof of existing building
Chakrara Rainfall Gauging Station	Equipment installed in the PMD office at Islamabad Airport Terminal Building	An antenna pole installed on the roof of airport terminal building	Solar panel and rain gauge installed on the roof of airport terminal building
PMD-Islamabad Rainfall Gauging Station	Equipment installed in the 2nd floor of PMD Library Building	The gauging equipment connected to telemetry supervisory equipment by wire.	Rain gauge installed on the roof of library building

(3) Telemetry Water Level Gauging Station

(a) Kattarian Bridge Water Level Gauging Station

The layout plan of equipment is shown in Drawings attached. A station house and an open cylinder for water-level meter will be installed in the water on the right bank of Lai Nullah River close to the Kattarian Bridge. The water level gauging equipment, DMP and batteries will be installed in a new gauging station house to be built. The solar cell panel will be installed on the rooftop of the new station house. A steel-plate assembled antenna mast of 15 m high will be installed in the riverside site and fitted with an antenna and a lightning arrester.

(b) Gawal Mandi Bridge Water Level Gauging Station

The layout plan of equipment is shown in Drawings attached. A station house and an open cylinder for water level meter will be installed in the water on the left bank of Lai Nullah River close to the Kattarian Bridge. The water level gauging equipment, DMP and batteries will be installed in a new gauging station house to be built. The solar cell panel will be installed on the rooftop of the new station house. A steel-plate assembled antenna mast of 15m high will be installed in the riverside site and fitted with an antenna and a lightning arrester.

(4) Repeater Station (RAMC)

The layout plan of equipment is shown in Drawings attached-1. The repeater station, which will be installed within the RAMC of PMD, shall consist of repeater equipment, DC power supply equipment and batteries that will be installed in the existing RAMC station house. The UHF antenna and the wireless LAN ODU are to be mounted on the existing 100 feet high tower. A low-loss type cable is to be connected to the antenna, which will be mounted on a high point in

order to suppress the loss. An Ethernet composite cable combined with a power cable is to be connected to the wireless LAN ODU. The station house is to be air-conditioned to protect the equipment against high temperature. Commercial power is to be branched from the power distribution board that will be added to the existing power distribution for this project.

(5) Flood Monitoring Station

(a) FFC Monitoring Station

The present FFC is planned to be relocated to the Sheheed-e-millat building located in the blue area of Islamabad City before August 2005. The equipment including client PCs and plasma display equipment is to be installed on the 13th floor of the building. The wireless LAN ODU is to be mounted on an antenna pole of 7m high on the rooftop of the elevator equipment shed on the building rooftop along which the Ethernet composite cable combined with the power cable is to be connected to the wireless LAN ODU.

The layout plan of equipment is shown in Drawings attached. The equipment room on the 13th floor is to be air-conditioned to protect the equipment against high temperature. The commercial power is to be branched from the power distribution board on the 13th floor.

(b) WASA Monitoring Station

A monitoring room is planned to be provided on the 2nd floor of the WASA Building Annex in Rawalpindi City, in which client PCs and a plasma display panel are to be installed. The wireless LAN ODU is to be mounted on an antenna pole of 11m high on the rooftop and an Ethernet composite cable combined with a power cable to be connected to the ODU.

The layout plan of equipment is shown in Drawings attached. The commercial power is to be branched from the power distribution board on the 2nd floor.

(6) TMA-Rawalpindi Executive Warning Station

The executive warning station will occupy a room on the 2nd floor of the Rawalpindi City Hall and be provided with warning supervisory and control equipment, monitoring equipment and power supply equipment. This station is planned to serve as the warning station WP-1 and to be fitted with warning equipment, a siren control board and other equipment for warning.

A self-standing antenna pole of 11m high will be installed along the wall of the old elevator equipment room site. On this antenna pole, a warning antenna, a wireless LAN ODU and the existing VHF antenna will be mounted. A lightning arrester will be mounted on the tip of the antenna pole to protect the equipment against lightning damage.

Since the height of this pole exceeds 30 m above the ground, an air obstruction light will be installed on the tip of the antenna pole. In addition, a motor siren and a loudspeaker will also be installed on the rooftop. Commercial power will be fed from a transformer on a nearby pole directly to the rooftop and an electric power meter will be fitted on the external wall of the elevator equipment room by the Rawalpindi City Office (TMA).

The unused elevator equipment room will be used as the engine generator room, in which a power distribution board will be provided and connected to the external power meter to feed power into it. The layout plan of equipment is shown in Drawings attached.

(7) Warning Post

New houses for all the warning posts will be built on TWA's own lands. Each house will be fitted with warning equipment, a siren control board and DC power supply equipment. A steel-plate assembled pole of 15 m high will be built in the station site and a lightning arrester will be mounted on its utmost top, under which an antenna and four (4) loudspeakers will be installed.

Commercial power will be fed into the station house from the on-pole transformer near it. The work of installing an electric power meter on the station house wall and connecting it to the transformer will be undertaken by the Pakistani side.

The details of each warning post are given in Table 2.24, and the site and the equipment configuration layout are shown in individual figures as indicated in that table. The layout plan of equipment is shown in Drawings attached.

Table 2.24 Equipment Plan of Flood Evacuation Warning Post

Warning Post	Location	Siren Installation Site
WP-1	TMA Rawalpindi Building	On the rooftop
WP-2	At the site of Christian Colony Arra Muhallah	On the rooftop of new building
WP-3	At the site of WASA Water Treatment Plant adjacent to MC Dispensary	On the rooftop of new building
WP-4	At the site of TMA Ratta Amral Bridge	On the antenna mast above 14 meters high from the ground.
WP-5	At the site of TMA Gunj Mandi Bridge	On the rooftop of new building
WP-6	Sidewalk joined to Pir Wadhai Bridge	On the roof top of new building
WP-7	In the site of Pir Wadhai fire station	On the antenna mast above 14 meters from the ground.
WP-8	At the site of Khayaban Park Sector IV-B	On the antenna mast above 14 meters from the ground.
WP-9	At the site of Children's Park at Gawal Mandi	On the rooftop of new building
WP-10	At the site of Government Middle School at Dhoke Chiraghdin	On the rooftop of new building

2-2-3-2 Facility Design

(1) Rainfall Gauging Station

The new Gorla and Bokra rainfall gauging station houses shall be 2 m floor wide, 2 m floor deep and 2.5 m high. The station houses shall be provided with ventilation ducts, glass blocks for lighting and a ladder for rooftop maintenance. An administrator shall be stationed in each rainfall gauging station for security for the facilities. For this purpose, an administrator's room, a toilet room, a kitchen and a corridor are planned to be provided, for which the Pakistan Goverment will be responsible. The floor plans, elevations and sectional plans of both rainfall gauging station are shown in Drawings attached.

(2) Water Level Gauging Station

The new Kattarian Bridge and Gawal Mandi water level gauging stations shall be built with water level observation tower foundations (cast-in-place piles and foundation footings). Each station shall consist of the main body of the observation tower (open cylinder), the station house (a house on the water level observation tower, a supervision bridge and a spiral staircase), the riverside protecting embankment (piled stones), and floor protector (cushion cages).

Each station house shall be 2.5m wide, 2.5m deep and 2.5m high and fitted with ventilation ducts, glass blocks for lighting and a ladder for rooftop maintenance. The floor plan, vertical section and structural diagrams are shown in Drawings attached.

(3) Warning Post

Nine (9) warning posts, WP-2 to WP-10 are to be built. Each station house shall be 2.5m wide, 2.5m deep and 2.5m high, and fitted with ventilation ducts and glass blocks for lighting. The floor elevation of station houses varies from 1m to 7.5m. The floor plans, elevations and sectional diagrams of WP-2 to WP-10 are shown in Drawings attached.

2-2-4 Implementation Plan

2-2-4-1 Implementation and Procurement Policy

It is necessary to procure consulting services with engineers from Japan to supervise and implement the work because the equipment installation and adjustment works require a special technology.

For the local procurement of equipment and materials as well as the equipment installation work, local contractors and constructors familiar with the local circumstances shall be used to promote the work efficiency.

The facilities to be newly built consist of 13 stations, which are dispersed far and wide, namely; two (2) rainfall gauging stations, two (2) water level gauging stations and nine (9) warning posts. The equipment are to be installed after the station houses are built and the construction work for the facilities shall have to be implemented by strictly observing the work processes.

Furthermore, the water level gauging stations to be installed in the Lai Nullah River will be subjected to torrents in the event of flood. It is, therefore, required that these stations shall have a high quality of work to avoid possible breakdown in the event of flood.

To realize a high-quality construction work by strictly following the work processes, the constructors are required to observe process control and quality control very strictly. Thus, it is necessary to refer the construction work to Japanese constructors.

The implementing system on the Pakistani side is largely divided into the construction stage and the maintenance and operation stage, for each of which the implementing system shall be organized for this project.

The implementing system in the construction stage shall be coordinated by the Federal Flood Committee (FFC) and supervised by the Pakistan Meteorological Department (PMD), which will undertake the actual installation and operation of the telemetry observation equipment and the data processing/transmission system, and by the

Tehsil Municipal Administration of Rawalpindi (TMA), which will undertake the actual installation and operation of the warning system.

2-2-4-2 Implementation Conditions

The results of investigation into the circumstances of Islamabad and Rawalpindi areas that this project is focused on will be described with regard to construction and procurement below.

Islamabad is the metropolitan city of Pakistan in which many high-rise buildings stand, and road construction and house-building works are vigorously being done; the construction industry appears to be developing actively. Especially in Kattarian Bridge that is one of the construction sites in this project, the bridge construction work is underway, and the rehabilitation work after a fire disaster is also underway at the new relocation site for the FFC monitoring station. It is supposed that there is no problem in procurement of construction materials and construction works.

With regard to the installation and maintenance and operation of the telecommunication systems, on the other hand, there are companies that can undertake and implement the works of system design, marketing and sale, installation and maintenance of computer systems and radio communications systems. They have sufficient capability for implementing this project under the supervision of and consultation with Japanese engineers.

The main equipment and materials for this project will be procured in Japan and it is necessary to verify the integrated operation of the system, so that the installation works should be supervised by the engineers of the contractor in principle. For the installation works, a local company specialized in telecommunication system works will be subcontracted with supervision by a Japanese engineer.

For adjustment and inspection, expert engineers for each type of equipment will be dispatched to the sites for the required periods to verify the integrated system performance. The local companies capable of these works were investigated and it has been confirmed that some of them are capable of performing the works.

It has also been confirmed that there are three (3) or more companies which are capable of doing the installation works of the communications equipment at sites in tie-up with the manufacturers, providing maintenance services for individual warranty periods and for periods of charged maintenance under maintenance contracts with the implementing agency in Pakistan.

The Kattarian Bridge and Gawal Mandi Bridge water level gauging stations are planned to be installed in the stream of Lai Nullah River. Piles of 762mm in diameter (4 piles of 18m at Kattarian and 4 piles of 15m at Gawal Mandi) shall be used for the foundations of those stations.

2-2-4-3 Scopes of Work

The scopes of work of construction, procurement and installation are shown in Table 2.25.

Table 2.25 Scopes of Work of Construction/Procurement/Installation

		Item	Work by Japan	Work by Pakistan
Construction	1	Rainfall Gauging Station (Golra/Bokra), Gauging room	○	
	2	Golra/Bokra Stations except for gauging rooms, land consolidation of Golra Station		○
	3	Water Level Gauging Station (Kattarian Bridge/Gawal Mandi Bridge), Water level gauging tower, gauging room, foot bridge, spiral stairs, river bank protection, river bed protection	○	
	4	Warning Posts (WP-2 to WP-10), Station houses, spiral stairs	○	
	5	Warning Posts (WP-2 to WP-10) and Water Level Gauging Station (Kattarian Bridge/Gawal Mandi Bridge), Fence		○
	6	TMA, Fence for rooftop oil tank		○
Procurement	1	Telemetry system equipment	○	
	2	Data transmission system equipment	○	
	3	Warning system equipment	○	
	4	Wireless LAN equipment	○	
	5	Desktop computer	○	
	6	Emergency-use engine generator, UPS, Solar battery	○	
	7	Plasma-display, IP telephone	○	
	8	Emergency vehicles	○	
Installation	1	Installation of Equipment	○	
	2	Installation of antenna mast (including steel plate assembled antenna mast, steel pole antenna mast and foundation works)	○	
	3	Feed-in work of commercial power (AC 220V) from a transformer on a nearby pole to the rooftop and installation of electric power meter on the external wall of TMA equipment room		○
	4	WP-2 to WP-10, feed-in work of commercial power from the on-pole transformer near the station house and installation of electric power meter on the station house wall		○

2-2-4-4 Supervision by Consultant

The construction of facilities is to be conducted in seven (7) months during the dry season after the contracts are awarded to contractors. The facilities to be constructed consist of thirteen (13) stations, which include two (2) rainfall-gauging stations, two (2) water level gauging stations, and nine (9) warning posts.

The equipment required should arrive at each site after each station is completed. After the arrival, the work of unpacking, mobilization and installation, acceptance inspection and handover of the equipment should be made within about six (6) months. The system to be installed consists of the hydrological data collection subsystems, data processing/transmission subsystems and flood evacuation-warning subsystems.

The consultant shall supervise the procurement and construction works for the stations and system, and shall check whether process control, quality control and workmanship

control of facilities, as well as the entire system integration, are being implemented in the appropriate manner. For this purpose, the consultant supervision system is established, as shown in Table 2.26.

Table 2.26 Procurement/Construction Supervision System

Personnel		Resident/Spot	Contents of Work	Reason for Adoption
Supervision of procurement and construction	Japanese engineer	Spot	Supervision of preliminary discussions, site inspection, acceptance test and handover of equipment	As general supervisor of the procurement and construction supervision services
Resident supervision of procurement	Japanese engineer	Resident	Supervision services for the procurement of all equipment	Required to provide sufficient supervision services for the subsystems to be installed
Supervision of construction	Japanese engineer	Spot	Completion and acceptance inspectionsAcceptance and flaw inspections	As inspection engineer of construction works
Resident supervision of construction	Japanese engineer	Resident	Supervision services for the construction of all facilities	Required to provide sufficient supervision services for 13 stations and water level observation towers and raised-floor type stations to be installed
Inspection engineer	Japanese engineer	Spot	Inspection at start of manufacture	As inspection engineer of equipment in Japan
Driver	Local employee	Resident	Driver for Japanese engineers	Driver for Japanese engineers
Miscellaneous services	Local employee	Resident	Office Utilityman	For miscellaneous jobs and security in case of the engineer's absence

2-2-4-5 Quality Control Plan

(1) Equipment Quality

The inspection described below shall be made to keep the quality of equipment constant from the procurement to the completion of installation work.

(a) Inspection

The contractor shall inspect all equipment and materials to be shipped from Japan the with respect to the following items, and certify in the acceptance certificate for each item of inspection that the quantities, performance and delivery time conform to the contractual conditions.

(i) Factory Acceptance Test

The contractor, after the completion of manufacture and inspection of equipment and the purchase of materials, shall check and confirm the integrated operation of the system, and if the performance and quantities of equipment and materials satisfy the required specifications, shall perform the acceptance test in the presence of the client at the contractor factory.

(ii) Packing Inspection

The contractor, after completing the packing and the preparation for shipment of all equipment and materials after satisfactorily executing the factory acceptance test, shall perform the packing inspection to inspect the packing quantities, cargo forms, case markings of the equipment and materials in the packing lists and check that the packing is durable for the sea transportation and the inland transportation in Pakistan.

Export packing shall be as follows:

Main Equipment and Materials

The goods shall be contained in vacuum sealed packages and in wooden crates to withstand the vibrations during transportation.

Antenna Poles

The goods shall be reinforced and packed in wooden crates.

(iii) Shipping Inspection by a Third Party Organization

The goods shall be inspected by a third party organization before shipment and after the completion of packing inspection to check that they are properly shipped.

(iv) Inspection of Quantities of Equipment and Materials in Pakistan

The quantity inspection of all the equipment and materials shipped from Japan and those procured in Pakistan shall be made at a designated place in Islamabad to check and confirm that no equipment and materials are missing.

(v) Completion and Handover Inspection

The contractor, after completing the civil engineering and installation works including the adjustment and inspection of the entire system, shall check the quantities and performance of the equipment and materials and submit an inspection completion report certifying that the whole work has been satisfactorily completed.

(vi) Free-of-Charge Warranty Period

The contractor shall warrant the quality of equipment and materials for one (1) year after the completion and handover inspection is completed and, if any trouble occurs, shall rectify them without delay and additional cost to the client/owner.

(b) Sea Transportation, Inland Transportation and Storage

For sea transportation, the goods shall normally be shipped on a ship of Pakistani flag. The vessel assignment schedule, in which one or two ships are available per month, shall be investigated to make up the transportation plan. The equipment and materials procured in Japan shall be shipped from Yokohama Port, and arrived at Karachi Port by sea transportation.

The equipment and materials concerned shall then be transported by land from Karachi Port to either PMD-Islamabad or TMA-Rawalpindi, where

they will be kept in custody. Then, the equipment concerned will be moved to each installation site in accordance with the construction plan.

The materials including the steel poles procured in Japan shall be shipped from Karachi Port by inland transportation and moved to the premises of either PMD-Islamabad or TMA-Rawalpindi where the materials concerned will be kept in custody by each related office. These materials shall be moved individually into each installation site in accordance with the construction plan.

The equipment procured in Japan shall be transported in export packing to Yokohama or an equivalent place and shipped to Pakistan by sea transportation. Upon arrival at the Karachi Port, customs clearance shall be made by the Pakistani side and, after the customs clearance, the contractor shall undertake the inland transportation to the place of custody in each related office. Then, the contractor shall transport the equipment to each site as needed in accordance with the work schedule.

The contractor shall investigate the circumstances of inland transportation from Karachi to Islamabad to check on whether there are any special conditions including land transportation tax in order to make up the transportation plan that will not cause any delay.

(c) Process Control

The contractor shall examine the manufacturing periods of all the equipment and the procurement periods of all the materials in order to shorten the manufacturing periods. The antenna poles shall be procured locally to build the antenna masts when the station houses are built in order to do the installation works in a short period, because the works are to be done during the rainy season. The progress of the entire project shall be controlled by means of the PERT-Critical Path Method (PERT-CPM).

(2) Construction Quality

The quantity of concrete per station in this project is relatively low, so that concrete quality control items, testing method and testing frequency shall be as set forth in Table 2.27.

Table 2.27 Quality Control of Concrete

Quality Control Item	Testing Method	Testing Frequency
Slump	Slump Test	2 times/day per concrete type
Compressive Strength (Material Life: 28 days)	Compressive Strength Test	Once per placing work and per placing day using 3 samples per test

The results of quality control tests shall be analyzed using the statistical method (histograms and control charts) to judge whether the materials satisfy the quality standard and whether their quality is stable.

2-2-4-6 Procurement Plan

(1) Telecommunications Equipment

This project relates to a disaster prevention system for which high system reliability is required. Therefore, the telemetry and warning equipment which will

constitute the key system of this project shall conform to Telecom Specifications No. 21 and No. 27 of the Ministry of Land, Infrastructure and Transport (MLIT) of Japan whose specifications for telemetry and discharge warning systems are intended for highly sophisticated and reliable disaster prevention systems.

On the other hand, the basic specifications of the wireless LAN equipment shall conform to the international standard of the Institute of Electric and Electronics Engineers.

Since the processed telemetry data are to be transmitted through the wireless LAN to each monitoring station, the telemetry equipment and the wireless LAN equipment shall function as a single system. Hence, the main component equipment for the telecommunications system shall be procured from manufacturers that are familiar with the specifications issued by the MLIT in consideration of the integrity of telemetry, wireless LAN and warning equipment, the simple system configuration, and the familiarity of the implementing agency with the maintenance and operation work

There are five (5) companies that are familiar with the specifications of the MLIT and have supply records of telemetry and warning equipment in Japan. Of these companies, three (3) have supply records of flood forecasting and warning systems and associated equipment. These three (3) companies have local offices or agents in Pakistan and are deemed to be able to respond to the requirements of the implementing agency in Pakistan for the systems operation and maintenance required after the delivery of equipment.

On the other hand, it is desirable that the development of on-line data processing (automatic data entry and plotting) and arithmetical data processing (flood forecasting), which are the key functions of the data processing subsystem, shall be carried out by expert engineers in various fields including hydrology, computer systems and software programming and that such functions shall be developed in Japan because professional technology in the special field of flood forecasting is required. In addition, it is also necessary that these functions shall be developed using the procured computer system.

The data processing systems consist of the data processing server, personal computers and printers. They are not manufactured in Pakistan at present but in third countries. However, they, with the English version of operating system, can be procured in Pakistan. Hence, these computer systems and printers shall be procured in Pakistan taking the after-sales service into account.

(2) Telecommunication Materials

The installation materials will mainly be imported because most of the required materials are not kept in stock in Pakistan, or are supplied only in large quantities or at an uncertain delivery time. If the materials are procured in Pakistan, there is anxiety that some with inferior durability in a low level of specifications may be mixed in the procured materials.

For example, there are many coaxial cables locally available that are not protected with polyethylene sheaths as used in Japan, but with vinyl sheaths. There are also many easily deformable fittings, and some cable ducts are inferior in quality having projections in the inner linings and thus resulting in breaks.

Therefore, the cables, cable ducts and fittings shall be procured in Japan where procurement is available in small orders and delivered promptly at the specified time.

Antenna masts consist of self-standing iron poles of 10m to 15m in height, but the self-standing steel plate-assembled poles (5m to 10m high) are adopted to mount antennas because they can be built on a small patch of land, with low depths of rooting in foundations and in an easy way of construction, taking into consideration that the warning posts are to be installed in sites situated in narrow urban areas and that transportation to the sites and the construction of foundations are facilitated.

If an iron pole is to be installed on the rooftop of an existing building, which may provide a wider area for installation, a non-self-standing antenna pole (5m – 10m) may be adopted.

The steel plate-assembled poles are of Japanese make and shall be procured from Japan. Antenna poles are available in Pakistan, but shall be procured from Japan to ensure the high quality of uniform melt zinc plating.

(3) Local Procurement

Locally manufactured equipment and materials shall be procured from approved suppliers in Pakistan that can well satisfy the required delivery time and prices. According to the survey, the following equipment and materials can be procured in Pakistan and from any third country:

(a) Personal computer

(b) Data processing server

(c) Printer

(d) Wireless LAN equipment

(e) Air-conditioning equipment

(f) Emergency vehicle

2-2-4-7 Implementation Schedule

The works, ranging from the detailed design to the call for tenders, contractual works, construction/procurement supervision and inspection, shall follow the following procedures:

(1) Detailed design for equipment procurement and station construction, and preparation of tender documentation;

(2) Support in tendering works and the evaluation of tender results;

(3) Attendance and advice in various proceedings from tendering to contract award;

(4) Supervision of equipment procurement and the station construction done by contractors;

(5) Monitoring of progress of the works together with the Pakistani organization concerned;

(6) Inspection; and

(7) Preparation of reports.

This project is to be started when the Exchange of Notes (E/N) for Grant Aid for this project has been executed between the governments of Japan and Pakistan.

After the E/N, the implementing agency of Pakistan is to enter into an agreement with a Japanese consultant for the implementation of this project. The Japanese consultant is to start executing the detailed design and prepare the tender documentations after the agreement for consulting services is approved by the Government of Japan.

Likewise, the consultant is to obtain approval of tender documentations by both the governments of Japan and Pakistan and do all the works including support on tendering, tender evaluation, negotiations between the implementing agency of Pakistan and the successful bidder, and the contract award to the bidder/contractor. The contract with the contractor is to become effective upon approval by the Government of Japan.

As shown in Figure 2.11, the implementation period of the project will be four (4) months for the detailed design and preparation of tender documents and seventeen (17) months for the procurement and construction works, comprising a total of around twenty-one (21) months of project implementation.

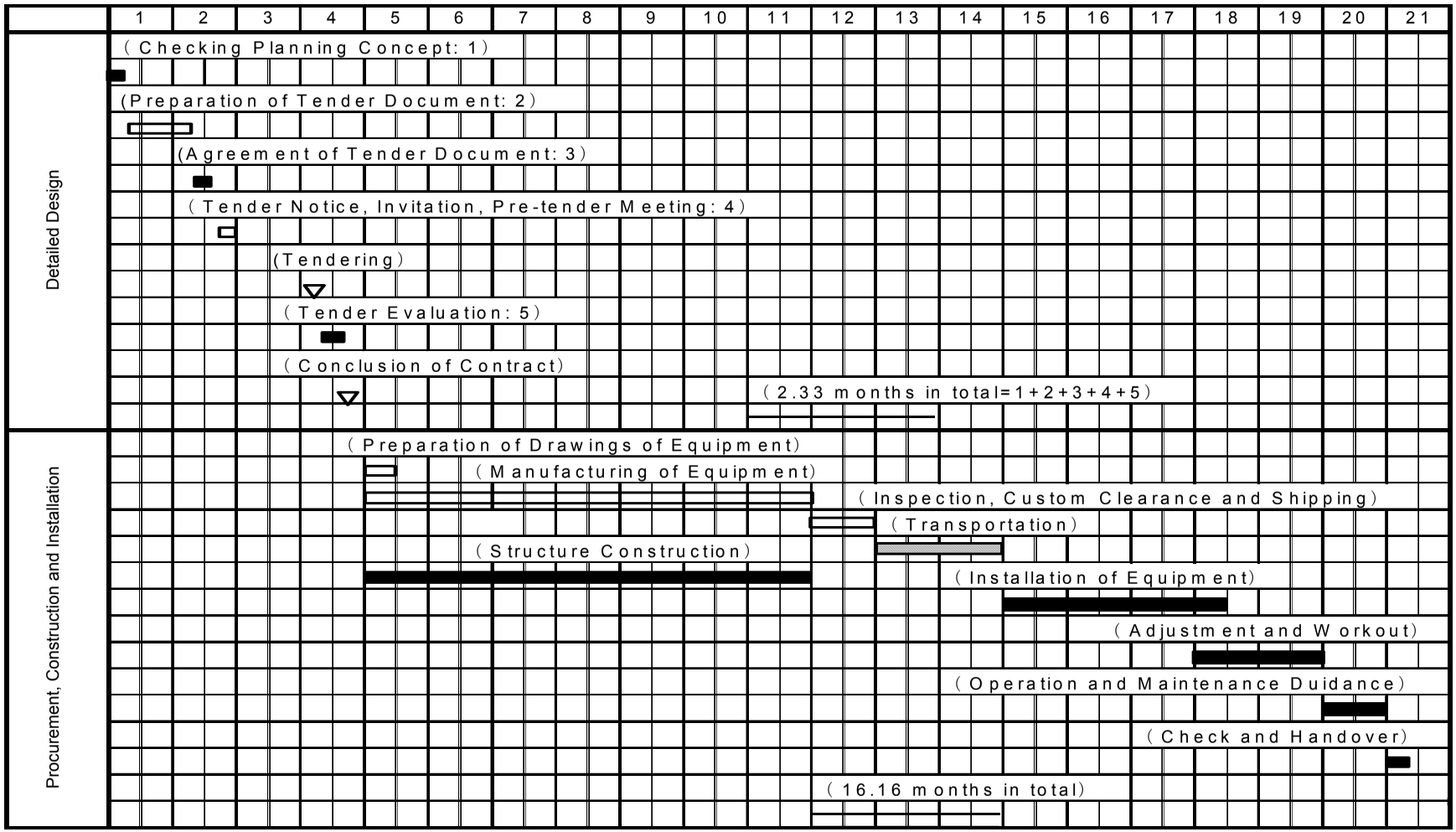


Figure 2.11 Implementation Schedule

2-3 Obligations of the Recipient Country

2-3-1 Obligations of the Recipient Country

The obligations of the Government of Pakistan, the recipient country, are hereinafter explained.

(1) Golra Rainfall Gauging Station

The Pakistani side (the Government of Pakistan) shall be responsible for developing the site for the Golra Rainfall Gauging Station and for constructing the rooms and facilities for the administrator (refer to Table 2.28). Inasmuch as the landowner of site had definitely promised to provide his land for the purpose, no land acquisition problem is anticipated.

In this connection, the Pakistani side had earnestly requested that the Administrator's Room with toilet and kitchen should be attached to the Gauging Room, and this is acceptable. However, the gauging room should be structurally separated from the Administrator's Room, toilet and kitchen, considering that construction of the Administrator's Room and facilities and the Gauging Room may be done at different times. The possible floor layout of the rooms and facilities to be constructed by the Pakistani side is shown in Drawings attached.

Table 2.28 Works to be done by Pakistan for Golra Rainfall Gauging Station

Work by Pakistan	Outline of Facility
Site Development	Embankment (0.6m, 50m^2)
Administrator's Room	Floor space, 7.5m^2 (3m × 2.5m)
Toilet	Floor space, 4.5m^2 (3m × 1.5m)
Kitchen	Floor space, 4.625m^2 (1.85m × 2.5m)
Corridor	Floor space, 6.45m^2 (4.3m × 1.5m)
Staircase	1.2m in height
Facilities	Electric power supply, water supply and drainage
Electric Power Supply	Feed-in works of commercial power (AC220V triple phase) from a transformer on a nearby pole and installation of electric power meter
Water Supply	Well and pump

(2) Bokra Rainfall Gauging Station

The works to be done by the Pakistani side for the Bokra Rainfall Gauging Station are the rooms and facilities for the Administrator, as outlined in Table 2.29. No land acquisition is required.

The Pakistani side had earnestly requested that the Administrator's Room with toilet and kitchen should be attached to the Gauging Room, and this is acceptable. However, the gauging room should be structurally separated from the Administrator's Room, toilet and kitchen, considering that construction of the Administrator's Room and facilities and the Gauging Room may be done at different times. The possible floor layout of the rooms and facilities to be constructed by the Pakistani side is shown in Drawings attached.

Table 2.29 Works to be done by Pakistan for Bokra Rainfall Gauging Station

Work by Pakistan	Outline of Facility
Administrator's Room	Floor space, 7.5m^2 (3m × 2.5m)
Toilet	Floor space, 4.5m^2 (3m × 1.5m)
Kitchen	Floor space, 4.625m^2 (1.85m × 2.5m)
Corridor	Floor space, 6.45m^2 (4.3m × 1.5m)
Staircase	0.45m in height
Facility	Electric power supply, water supply and drainage
Electric Power Supply	Feed-in works of commercial power (AC220V triple phase) from a transformer on a nearby pole and installation of electric power meter
Water Supply	Feed-in works from existing water main and installation of water meter

(3) Kattarian Bridge Water Level Gauging Station

The works to be done by the Pakistani side for the Kattarian Bridge Water Level Gauging Station is the fence for the protection of equipment to be procured, as outlined in Table 2.30. This fence is to be installed along the maintenance road of the Lai Nullah River. The required road width (minimum around 3m) has already been secured, and it is presumed that there is no problem in the construction of this station.

Table 2.30 Works to be done by Pakistan for Water Level Gauging Stations

Work by Pakistan	Outline of Facility
Fence	2.5m in height, around 13.5m in length

(4) Gawal Mandi Bridge Water Level Gauging Station

The works to be done by the Pakistani side for the Gawal Mandi Bridge Water Level Gauging Station is the fence. The outline, purpose and feasibility of this station are the same as those of the Kattarian Bridge Water Level Gauging Station.

(5) TMA-Rawalpindi Executive Warning Station

The Executive Warning Station is to be provided in the existing building of TMA-Rawalpindi. The works to be done by the Pakistani side for this station is the feed-in work of commercial electric power for the equipment to be procured and the construction of oil tank guard on the rooftop, as outlined in Table 2.31 below.

Table 2.31 Works to be done by Pakistan for TMA-Rawalpindi Warning Control Station

Work by Pakistan	Outline of Facility
Oil Tank Guard	Brick wall (2m × 1.2m x height 2.5m)
Feed-in works of Commercial Power Supply	Feed-in works of commercial power (AC220V single phase) from a transformer on a nearby pole to the rooftop and installation of electric power meter on rooftop wall

(6) Warning Posts

The works to be done by the Pakistan side for the warning posts (WP-2 to WP-10) are the fences for the protection of equipment to be procured and the feed-in works of commercial power supply, as outlined in Table 2.32. No land acquisition is anticipated for the warning posts.

Table 2.32 Works to be done by Pakistan Government for Warning Posts

Work by Pakistan	Outline of Facility
Fence	2.5m in height, around 27m in length
Feed-in works of Commercial Power Supply	Feed-in works of commercial power (AC220V triple phase) from a transformer on a nearby pole and installation of electric power meter

2-3-2 Project Cost

The total project cost has been estimated at 714 million yen under the conditions of the Japanese Grant-Aid system. The costs to be borne by either Japan or Pakistan have been estimated based on the scopes of work mentioned before. The results of cost estimation are as follows:

(1) Cost to be borne by Japan (673.6 Million Yen)

This cost estimate given in Table 2.33 below is provisional and would be further examined by the Government of Japan for the approval of the Grant.

Table 2.33 Project Cost to be borne by Japan

Item			Project Cost (Million Yen)
Equipment	Lai Nullah Flood Forecasting and Warning System	Hydrological Data Collection Subsystem, Data Processing/Transmission Subsystem, Flood Evacuation Warning Subsystem, Measuring Instrument, Spare Parts, Facilities	607.0
Detailed Design, Procurement Supervision and Technical Guidance Services			66.6
Total			673.6

(2) Cost to be borne by Pakistan (19.6 Million Rupees)

The cost to be borne by the Pakistan Government are given in Table 2.34 below.

Table 2.34 Project Cost to be borne by Pakistan

Item	Project Cost (Million Rs.)
Land Consolidation and Related Facilities	3.1
Electricity and Water Supply Connection	0.9
Fencing	4.3
Banking Arrangement	8.1
Administration Cost	3.3

(3) Estimation Conditions

The conditions adopted for the estimation of project cost are as follows:

Time of Estimation	:	September 2004
Currency Exchange Rates	:	1 Rs. = 2.07 Yen, 1 US$ = 111 Yen and 1 EUR = 135 Yen
Implementation Schedule	:	Schedule of detailed design, equipment procurement and installation are given in the implementation schedule shown elsewhere in this report.
Banking Arrangement	:	This cost is estimated at 2.5% of the cost to be borne by Japan.
Others	:	This project is to be implemented in accordance with the Japanese Grant-Aid System.

2-4 Project Operation and Maintenance Plan

2-4-1 Organizational Structure

(1) Organization for Systems Operation

The operation of the Lai Nullah Flood Forecasting and Warning System is to be undertaken by the four (4) agencies concerned, namely:

The operation of the Lai Nullah Flood Forecasting and Warning System is to be undertaken by the four (4) agencies concerned, namely:

(a) The Pakistan Meteorological Department (PMD) where the master control station of the system is to be installed will be the agency in charge of flood forecasting;

(b) The Tehsil Municipal Administration of Rawalpindi (TMA-Rawalpindi) where the executive warning station or the disaster prevention center is to be installed will be the agency in charge of flood warning for the safe evacuation of residents in the basin;

(c) The Federal Flood Commission (FFC) will be the agency to coordinate the activities of the agencies concerned in the Project; and

(d) The Water and Sanitation Agency (WASA) of Rawalpindi Development Authority (RDA) will be the agency to assist TMA in the flood-fighting activities.

The organizational structure for system operation is shown in Fig. 2.12.

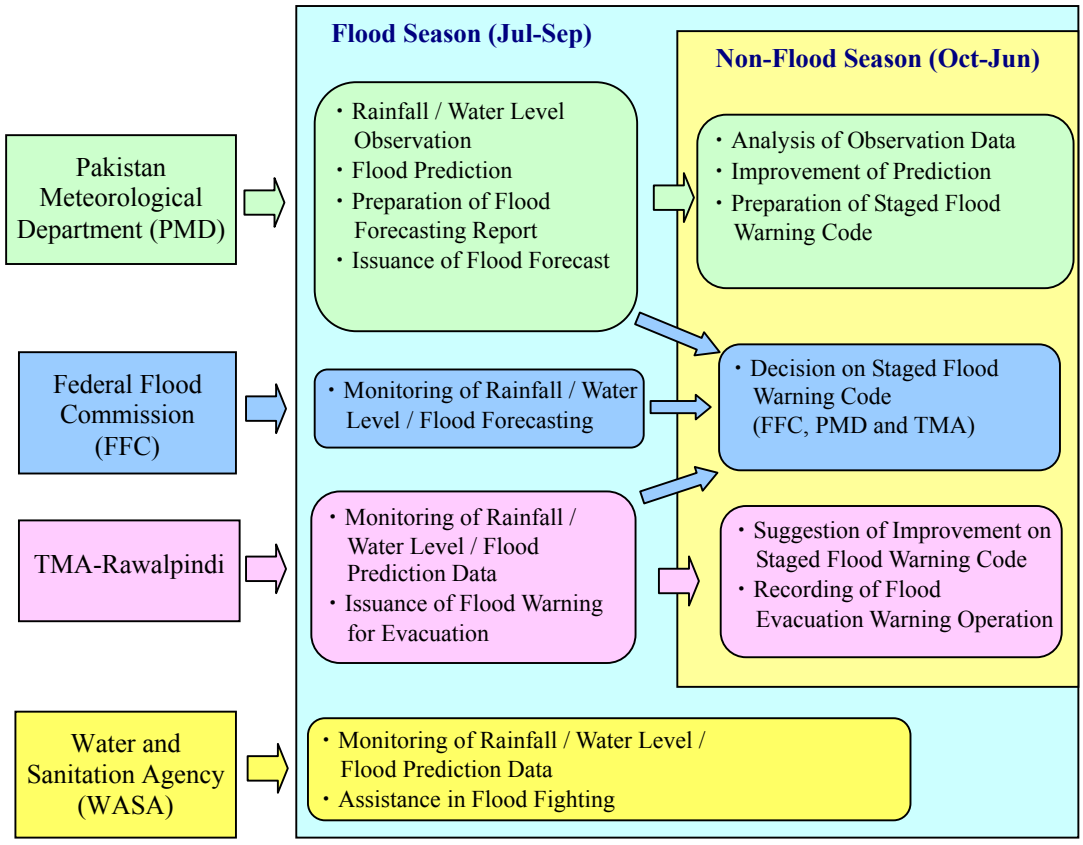


Fig.2.12 Organizational Structure of Systems Operation

(2) Organization for Systems Maintenance

Maintenance works are essentially required to operate the system with reliability and sustainability. The classifications, target stations and contents of the maintenance work are tabulated given in Table 2.35.

Table 2.35 Outline of Maintenance Works

Classification	Target Station	Contents
Daily Maintenance in Flood Season	Master Control Station; Executive Warning Station; Monitor Station	Cleaning, General inspection
Quarterly Inspection (every 3 months) in Non-flood Season	All Stations	Cleaning, General inspection, Simple test
Annual Inspection in Non-flood Season	All Stations	Cleaning, General inspection, Detailed test
Troubleshooting, if required	All Stations	Detailed test, Replacement of parts

Daily maintenance work in flood season and quarterly inspection (every 3 months) shall be conducted by the agencies concerned. Since detailed annual inspection (every year) and troubleshooting will require high technological skills,. I it is not practicable to train the staff of agencies concerned as specialists, or to employ new specialist.

The high-tech inspections could be sublet to a private company with sufficient expertise. In this regard, it is advisable to have the high-tech inspections conducted by the expert personnel of computer and telecommunication equipment companies in Islamabad or Rawalpindi conduct the high-tech inspections.

The stations subject to maintenance works are shown in Table 2.36. The PMD shall be responsible for the daily and quarterly inspection of telecommunication systems in all monitoring stations, because they affect the entire system. FFC and WASA shall be responsible for the annual inspection and troubleshooting of telecommunication equipment in monitoring stations that will be conducted by the subcontracted private company.

Table 2.36 Target Stations for Maintenance Works for by Each Agency

Responsible Agency	Station
PMD	Master Control Station; Rainfall/Water Level Gauge Station; Relay Station
TMA	Executive Warning Station; Warning Post
FFC	FFC Monitoring Station
WASA	WASA Monitoring Station

Table 2.37 Contents and Periods of Assignment for the Operation and Maintenance

Person in Charge	Major Equipment	Flood Season (July - September)	Non-Flood Season (October - June)	Flood Season (Jul. - Sep.)	Non-Flood (Oct. - Jun.)	Total Month
PMD	- Hydrological Observation - Data Processing - Monitoring - Telecommunication					
Chief		- Preparation of flood forecasting messages - Issue of flood forecasting to concerned agencies and residents	- Improvement of staged flood warning code in collaboration with TMA and FFC - Maintenance of equipment	(0.5month)	(1month)	1.5
Deputy Chief				(0.5month)		0.5
Hydrologist A		- Monitor of rainfall and water level - Flood prediction, and preparation of a draft flood forecasting message	- Rainfall analysis and runoff calculation - Recording of observation data - Preparation of a draft staged flood warning code	(3month)	(3month)	6.0
Hydrologist B				(1.0month)	(3month)	4.0
Telecommunication Engineer		- Daily inspection of equipment - Trouble shooting of equipment	- Quarterly and annual inspection of equipment - Trouble shooting of equipment	(1.5month)	(1month)	2.5
Computer Engineer				(1.5month)	(1month)	2.5
				Total		17.0
TMA	- Monitoring - Warning - Telecommunication					
Chief		- Issue of flood warning for evacuation	- Improvement of a staged flood warning code in collaboration with PMD and FFC - Maintenance of equipment	(0.5month)	(1month)	1.5
Deputy Chief				(0.5month)		0.5
River Engineer		- Monitor of water level, rainfall and flood forecasting	- Preparation of a draft staged flood warning code	(3month)	(1month)	4.0
Telecommunication Engineer		- Daily inspection/trouble shooting of Equipment	- Quarterly and annual inspection of equipment - Trouble shooting of equipment	(1.5month)	(1month)	2.5
Computer Engineer				(1.5month)	(1month)	2.5
				Total		11.0
FFC	- Monitoring - Telecommunication					
Flood Control Planner A		- Monitor of water level/rainfall/flood forecasting - Coordination with concerned agencies	- Improvement of a staged flood warning code in collaboration with PMD and TMA	(3month)	(1month)	4.0
Flood Control Planner B				(1.0month)		1.0
Computer Engineer		- Daily inspection/trouble shooting of Equipment	- Quarterly and annual inspection of equipment - Trouble shooting of equipment	(1month)	(1month)	2.0
				Total		7.0
WASA	- Monitoring - Telecommunication					
River/Drainage Engineer		- Monitor of water level/rainfall/flood forecasting - Support of TMA for flood fighting		(3month)		3.0
Computer Engineer		- Daily inspection/trouble shooting of equipment	- Quarterly and annual inspection of equipment - Trouble shooting of equipment	(1month)	(1month)	2.0
				Total		5.0
Outsourcing	- Data Processing - Monitoring - Telecommunication					
Telecommunication Engineer		- Annual inspection of equipment - Trouble shooting of equipment		(1month)		1.0
Computer Engineer				(1month)		1.0
				Total		2.0

2-4-2 Staff Assignments

The contents and periods of assignment of staffs of agencies concerned are shown in Table 2.37. The period required for around around-the the-clock monitoring is about ten (10) to twenty (20) days (0.5 month on average) in a year. It is not practicable for t each agency to assign staffs for operation/maintenance exclusively in a whole year. Therefore, the task task-force system is recommendable, in which staffs are assigned for a necessary period during the flood season or the non-flood season. The required number of staffs of the agencies concerned is shown in Table 2.43

2-4-3 Operation and Maintenance Costs

(1) Required Budget

The facilities and equipment that would will require repair and replacement at an earlier time are the computer equipment, followed by the telecommunication equipment, hydrological observation equipment and, finally, the concrete structures.

The economic life of equipment and facilities is hereinafter explained with an example, although economic life would will vary depending on the adequacy of operation and maintenance activities. It is required that parts of computer equipment like such as disk drives would bear to be exchanged in every three to five years. In the case of telecommunication equipment, the economic life time of parts would is longer but they should be changed in every 10 to 15 years.

The hydrological observation equipment will have a longer lifetime without malfunction because they have been fabricated to function under harsh natural circumstances. The durability of concrete facilities is, generally, 30 to 50 years.

The hydrological observation equipment which has been fabricated to function under harsh natural circumstances, have a longer life time without malfunction. The durability of concrete facilities would be generally 30 to 50 years.

The cost of operation and maintenance is has been estimated based on the experiences in Japan. The adequate annual adequate appropriation is one (1) percentage of equipment cost for the purchase of parts and other expenses for the operation and maintenance works within three (3) years after installation of the equipment is one percent (1%) of the equipment cost, and it would will be desirable to maintain a budget of three percent (3%) of equipment cost after five (5) years of installation to have adequately adequate funds for extending the usable life extension of equipment with a budget of three (3) percentage of equipment cost after five (5) years of installation.

Outsourcing cost is required to for undertake undertaking the expertise inspection works. Present The present staff is to be assigned for a necessary period during flood season or non--flood seasons, about 25 % a year at the maximum, as shown in Table 2.37. The Personnel cost is not included in the operation and maintenance cost. Total annual required number of staff is shown below.:

Table 2.38 Required Number of Staff for the Operation and Maintenance

PMD	TMA	FFC	WASA	Total
17 man months	11 man months	7 man months	5 man months	40 man months

In consideration of the above conditions, the required annual cost required for the operation and maintenance will be 1% of equipment cost and outsourcing cost within three (3) years after installation of equipment. Four (4) years after the completion of the system, 3% of equipment cost and outsourcing cost will be required to finance the operation and maintenance works. (See Table 2.39)

Table 2.39 Required Budget for the Operation and Maintenance

Agency	Operation and Maintenance Cost	Outsourcing Cost	Required Budget
Within 3 years after the completion (1% of equipment cost and outsourcing cost)			
PMD	Rs.700,000 (1,450,000 yen)	Rs.140,000	Rs.840,000
TMA	680,000 (1,400,000 yen)	Rs.140,000	Rs.820,000
FFC	Rs.20,000 (50,000 yen)	Rs.10,000	Rs.30,000
WASA	Rs.20,000 (50,000 yen)	Rs.10,000	Rs.30,000
Total	Rs.1,420,000 (about 3 million yen)	Rs.300,000 (about 600,000 yen)	Rs.1,720,000 (about 3,600,000 yen)
On and after 4 years of the completion (3% of equipment cost and outsourcing cost)			
PMD	Rs.2,080,000 (4,300,000 yen)	Rs.140,000	Rs.2,220,000
TMA	Rs.2,030,000 (4,200,000 yen)	Rs.140,000	Rs.2,170,000
FFC	Rs.60,000 (130,000 yen)	Rs.10,000	Rs.70,000
WASA	Rs.60,000 (130,000 yen)	Rs.10,000	Rs.70,000
Total	4,230,000 (about 8,800,000 yen)	Rs.300,000 (about 600,000 yen)	Rs.4,530,000 (about 9,400,000 yen)

Note: Rs.1.0 = 2.07 yen

The annual budget required for the operation and maintenance is estimated at Rs.1.72 million (3.6 million yen) within 3 3 years after the completion of the system and Rs.4.53 million (9.4 million million yen) on and after after 4 years of the of completion of the system.

(2) Possibility of Budget Allocation for the Operation and Maintenance

Table 2.40 shows the average increases of the annual budget of PMD and TMA--Rawalpindi for the past three three (3) years, while Table 2.41 shows the budgetary allocations in PMD and TMA for the repair and construction of facilities/equipment in PMD and TMA for the past 3 years including 2004. The maximum required budget required by PMD and TMA for the operation and maintenance of the proposed system shown in Table 2.40 is only 5% and 2% respectively of the budget for repair and construction of facilities/equipment shown in Table 2.41.

The required annual budget required for the operation and maintenance is to be shared at only one to three percent (1-3%) of the average increase in the annual budget. Practically, it would be possible for each agency to allocate the a budget for operation and maintenance. because The the required budget for the FFC and WASA will be minimal so that it could be allocated in each agency. Therefore, it

is evaluated that PMD and TMA will be able to allocate sufficient funds for operation and maintenance.

Table 2.40 Ratio of Budget Required for Operation and Maintenance

Item	PMD	TMA
Annual Average Increased Increase of Budget	Rs.64 million	Rs.102 million
Budget Required Budget for O&M	Rs.840,000 to Rs.2,220,000	Rs.820,000 to Rs.2,170,000
Ratio of Required Budget Required for O&M in the Annual Average Increased Budget	1 to 3%	1 to 2%

Table 2.41 Budget for the Repair and Construction of Facilities/Equipment

Fiscal Year	PMD	TMA
2002	Rs.47 million	Rs.156 million
2003	Rs.49 million	Rs.122 million
2004	Rs.53 million	Rs.146 million

2-5 Soft Component Plan

(1) Background and Objective of the Soft Component Plan

The agencies concerned, namely; the Pakistan Meteorological Department (PMD), the Tehsil Municipal Administration of Rawalpindi (TMA-Rawalpindi), the Federal Flood Commission (FFC) and the Water and Sanitation Agency (WASA) of Rawalpindi, which are to undertake the operation and maintenance of the system, do not have enough knowledge on this kind of flood forecasting and warning system to be installed.

To start the operation of the proposed system smoothly and to ensure the sustainable execution of operation and maintenance, technical guidance services are required, which could be carried out under the "soft component" of the Japanese Grant Aid.

The objective of the technical guidance services under the soft component is "to improve the technical capability of personnel in properly undertaking the management and operation and maintenance (O&M) of the flood forecasting and warning system."

(2) Output of the Soft Component Plan

The expected output or benefits of the technical guidance services to be provided under the soft component of Japanese Grant Aid are as follows:

Management Aspect

(a) The clarification of the roles of responsible persons and technical staff in the execution of sustainable and effective activities concerning overall management and operation/maintenance of the system;

(b) The production of a manual on effective operation and maintenance and the education of personnel concerned on techniques and judgment with regard to the basic activities of operation and maintenance;

(c) The compilation of records of all data/information regarding rainfall/water level observation and the flood forecasting and warning activities;

(d) The education of technical staff on the prompt detection of defects of the system and on rendering adequate judgment on countermeasures to be provided; and

(e) The education of technical staff on the effective operation of the monitoring and warning system.

Technical Aspect

(a) The education of technical staff on flood prediction based on flood run-off and inundation analysis; and

(b) The education of technical staff on timely and adequate flood forecasting and warning by repetitive flood run-off and inundation analysis, and by analyzing the relation between precipitation and flood water levels

(3) Activities and Input Plan

Table 2.42 gives the outline of activities of the technical guidance services on operation and maintenance.

Table 2.42 Activities of Technical Guidance Services

Activities of Technical Guidance Services	Group of Trainee	Period of Guidance
Management Aspect		
1. Formulation of Organizational Structure - Formulation of the organizational structure for overall management and operation/maintenance of the system - Clarification of the roles of responsible persons and technical staff in agencies concerned	Group E	2 weeks
2. Preparation of Manual of Operation and Maintenance (O&M) - Establishment of the O&M rules during flood season and non-flood season - Formulation of the procedures and forms of backup and recording of telemetry rainfall/water level data, flood information data, and warning operation data	Group C	3 weeks
3. Lecture and Practice of System Maintenance Activities - Instruction and practice of system maintenance and prompt detection of defects, and rendering judging on adequate countermeasures	Group C	2 weeks
4. Lecture and Practice on the Transmission of Flood Information - Instruction and practice of the methodology of transmission of flood information such as weather information, rainfall/water level data, and flood prediction data, from PMD to other agencies concerned	Group E	1 week
5. Lecture and Practice on Monitoring Operations - Instruction and practice of the operation of monitoring system at PMD, TMA, FFC and WASA	Group C	1 week
6. Lecture and Practice on Warning Operations - Instruction and practice of integrated warning operation using warning posts and emergency vehicles	Group D	2 weeks
7. Evaluation of Technical Guidance - Evaluation of the results of technical guidance services and confirmation of their effectiveness, and lecture on the overall management and operation of the system	Group E	1 week
Technical Aspect		
1. Lecture on Flood Run-off and Inundation Calculation Program - Explanation of the structure and contents of the calculation program - Instruction and practice of the flood run-off and inundation calculation, including operation of the program	Group A	3 weeks
2. Lecture on the Procedures of Flood Prediction - Explanation of the procedures of flood prediction including the required hydrological data and the issues concerning the procedures	Group E	1 weeks
3. Lecture on the Analysis of Hydrological Observation Data - Instruction on the methodology of hydrological analysis of observation data in consideration of the hydrological features of Lai Nullah Basin	Group B	1 weeks
4. Lecture on the Flood Run-off and Inundation Model in Lai Nullah - Instruction on the flood run-off and inundation model of the Lai Nullah and the methods of improving the model	Group B	1 weeks
5. Practice of Flood Run-off and Inundation Calculation in Lai Nullah - Instruction and practice of flood run-off and inundation calculation for the Lai Nullah Basin.	Group A	3 weeks
6. Lecture of Flood Forecasting and Warning Dissemination - Instruction on the rules of flood prediction and warning dissemination including methods of improving certain issues	Group B	1 weeks
7. Evaluation of Technical Guidance - Workshop to evaluate the results of the technical guidance services and to discuss a more adequate staged flood warning code	Group E	1 week

The minimum number of trainees required in each expertise is tabulated in Table 2.43.

Table 2.43 Number of Trainees Required in Each Expertise

Agency	Chief/ Assistant Chief	Hydrologist/ Hydraulics Engineer (River/Flood Control Engineer)	Telecommunication Engineer	Computer Engineer
PMD	2 persons	2 persons	1 person	1 person
TMA	2 persons	(1 person)	1 person	1 person
FFC		(2 persons)		1 person
WASA		(1 person)		1 person

The trainees are to be grouped in the technical guidance according to specialty, as follows:

Table 2.44 Grouping of Trainees according to Specialty

Group	Target Agency	Specialty of Trainees
Group A	PMD	Hydrological/Hydraulic/River/Flood Control Engineer
Group B	PMD, TMA, FFC, WASA	Hydrologist/Hydraulic Engineer
Group C	PMD, TMA, FFC, WASA	Telecommunication Engineer/Computer Engineer
Group D	TMA	Telecommunication Engineer/Computer Engineer
Group E	PMD, TMA, FFC, WASA	All Trainees

The Manual of Management and Operation of the entire system, including the roles of agencies and staff concerned, is to be prepared, explained and practiced during the technical guidance services in cooperation with the agencies concerned; whereas, the detailed manual of operation and maintenance for all equipment is to be provided by the equipment supplier.

The Manual of Management and Operation shall contain the following:

(a) Clear description of the organizational body tasked with the system management and responsibilities

- Responsibility of each agency (PMD, TMA, FFC and WASA)
- Responsibilities of Master Control Station in PMD
- Responsibilities of Executive Warning Station in TMA
- Detailed contents of activities of each staff concerned during flood season (July to September) and non-flood season

(b) Manual of methodology of flood forecasting and warning operation

- Rainfall amount and water level to start the watching/monitoring of flooding situation and to alarm/announce flood warning for the evacuation
- Rule and measures of system operation during flood forecasting and warning
- Reporting/Recording form of flood forecasting and flood evacuation warning

(c) Manual of system maintenance

- Manual of system maintenance during flood season and non-flood season
- Recording of hydrological observation data including backup system
- Recording of inspection and maintenance activities on the system

The input from the Japanese side (Soft Component of Japanese Grant Aid) shall be one (1) telecommunication engineer with expertise on overall management of flood forecasting and warning systems, and one (1) hydrological/hydraulic engineer with expertise on flood run-off and the inundation model in Lai Nullah. The service period shall be around 2.5 months.

The input from the Pakistan Government on the technical guidance services shall be the preparation or provision of a lecture room and two (2) sets of computers for the hydrological and hydraulic analysis.

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3-1 Effects of the Project

(1) Direct Effect

Equipment and facilities proposed under the Japanese Grant Aid Scheme for the flood forecasting and warning system in the Lai Nullah Basin consist of the flood prediction system, the observation system, and the transmission system of flood warning. With the installation of these equipment and facilities, the accuracy of flood forecasting will be increased and the transmission network of flood warning network will be enhanced.

Benefit areas of the system to be installed are the flood prone areas downstream of the Lai Nullah River. Project beneficiaries (around 150,000 people) are the residents of densely populated areas (around 7.6 km^2) of the capital region of Islamabad and Rawalpindi.

The issues affecting the present flood forecasting and warning system and the effects of the system to be installed under the Japanese Grant Aid Scheme as monitored using "objectively verifiable indicators" are shown in Figure 3.1. The details of issues and effects are given in the attached Table 3.1.

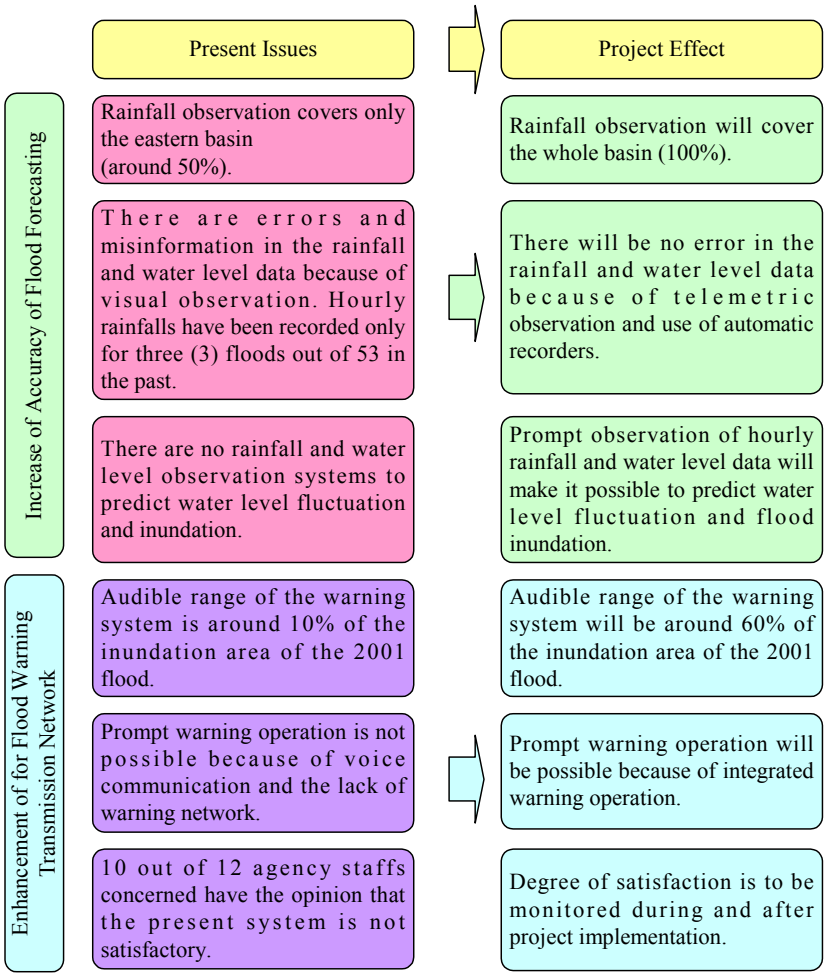


Figure 3.1 Issues on the Present System and Effects of the Flood Forecasting and Warning System proposed under the Japanese Grant Aid Scheme

Table 3.1 Present Issues and Project Effects

Present Issues	Scopes of Project	Project Effects
1. Increase of Accuracy of Flood Forecasting		
1.1 Improvement of Rainfall Observation System		
・Four (4) rainfall gauges are presently situated in the eastern side of the Lai Nullah Basin, and this makes it impossible to accurately estimate the average rainfall in the entire basin.	・Two (2) telemetry rain gauges will be installed in the western side of the Lai Nullah Basin. ・Four (4) existing rain gauges will be telemeterized.	・It is possible to accurately estimate the average rainfall in the entire basin.
・Visual observation of rainfall gauge may cause errors in observation data. ・Hourly visual observation in night time may cause inaccurate observation. ・Data transmission by voice communication may cause misinformation and delay of transmission. ・Hourly rainfalls have been recorded only for three (3) floods out of 53 floods in the past.		・Real-time rainfall amount can be observed at the PMD central office. ・Rainfall amount can be recorded correctly and orderly at PMD without misinformation.
1.2 Improvement of Water Level Observation System		
・Visual observation of staff gauge may cause errors in observation data. ・Hourly visual observation in night time may cause inaccurate observation. ・Data transmission by voice communication may cause misinformation and delay of transmission. ・No flood water level is recorded.	・Two (2) telemetr water level gauges will be installed at Katarian and Gawal Mandi bridges, and transmitted to PMD at real time.	・Real-time river water level can be observed at the PMD central office. ・River water level can be recorded correctly and orderly at PMD without misinformation.
・Around 80% of flood runoff discharge concentrates at Katarian bridge, which cause the flood damage in Rawalpindi. However, no river water level observation has been conducted at this location.		・Earlier observation of flood water level which may cause flood inundation in Rawalpindi is possible.
・Around 90% of flood runoff discharge concentrates at Gawal Mandi Bridge, which cause the flood damage in Rawalpindi. However, no real-time and automatic river water level observations have been conducted at this location.		・Accurate and earlier observation of flood water level which may cause flood inundation is possible. ・Announcement of the cancellation of flood evacuation advisories to residents is possible based on the water level/rainfall observation.
1.3 Development of Flood Forecasting System in Pakistan Meteorological Department (PMD)		
・Rainfall/water level data are manually recorded in the computer, which may result in misrecording of data. ・Basically, no flood forecasting operation has been conducted up to the present. ・Rainfall/water level data is not accurately transmitted to TMA-Rawalpindi, which is in charge of flood evacuation operation.	・Real-time rainfall/water level will be automatically monitored and recorded in computer.	・Rainfall/water level will be recorded accurately and orderly into the computer. ・Flood forecasting will be conducted by using real-time rainfall and water level observation. ・Real-time rainfall/water level data and flood forecasting information will be transmitted promptly to TMA-Rawalpindi.
・In case of trouble of rainfall/water level observation, a countermeasure is required.	・One Patrol car will be made available.	・Patrol car could be used for going to the observation site and solve any trouble.
2. Reinforcement of Flood Warning System		
2.1 Development of Integrated Flood Warning System in TMA-Rawalpindi		
・Audible ratio signals of the existing three (3) warning posts cover only around 10% of the inundation area. ・The existing fire brigade car could not pass through the narrow road in the populated possible inundation area.	・ Ten (10) warning posts will be provided to increase the audible range.	・Possible coverage range of alarm by 10 warning posts will be around 60% of the 2001 flood area.
・Prompt dissemination of flood alarm is not possible because of voice communication from the water level observation site to the office in charge of alarm dissemination. ・The present alarm system consists of the siren only without voice announcement, which causes misunderstanding with other types of disaster alarm.	・Integrated warning system consisting of siren signals and loudspeaker announcements will be installed at TMA-Rawalpindi.	・Prompt and accurate flood warning operation will be conducted integratedly in TMA-Rawalpindi.
・In case of trouble in the warning system, a countermeasure is required.	・One Patrol car will be make available.	・In case of trouble, immediate inspection/repair will be possible. ・Warning by patrol car instead of warning post will be possible.
2.2 Development of Monitoring System in FFC and WASA		
・The FFC which is in charge of flood control of the Lai Nullah and the coordination office of flood forecasting activities has no flood monitoring system.	・Flood monitoring system will be installed.	・Effective coodination will be possible among the agencies concerned in flood forecasing and warning. ・The adequate flood control plan will be studied and proposed based on the results of flood monitoring.
・The WASA which is assisting TMA-Rawalpindin in flood fighting activities has no flood monitoring system.	・Flood monitoring system will be installed.	・Prompt flood fighting assistance to TMA-Rawalpindi will be possible by the monitoring system.

The effects of the project will come out in the target year 2010, or three years after its completion. The evaluation of project effect will be conducted using the above project effect indicators for monitoring. The outline of the baseline survey is attached in the Appendix, which survey has been carried out aiming to establish the objectively verifiable indicators.

(2) Indirect Effect

The indirect effects of installation of the flood forecasting and warning system in the capital region will be as follows:

(a) Safety against flood disasters will increase through the reduction of death and injury and of damage on movable properties, because of the increase of accuracy of flood prediction and the improvement of flood warning operation for the evacuation of residents to safe locations. This will result in the stabilization of people's livelihood, the improvement of living conditions, and the eradication of poverty in the capital region.

(b) The mitigation of flood damage, improvement of living conditions, and stabilization of people's livelihood in the capital region, which are the centers of political and economic activities, will have spillover effects on the socio-economy of the whole country of Pakistan.

(c) The improved technology on flood forecasting to be executed by the Pakistan Meteorological Department (PMD) through the Project could be adopted for the Indus River Basin, and would contribute to the mitigation of flood damage nationwide.

(d) The realization of flood damage mitigation in the capital region due to the Project would lead to the recognition of the adoptability of the flood forecasting and warning system to other flood prone areas in Pakistan as an urgent countermeasure to flood disasters, which will be promoted through the Federal Flood Commission (FFC).

(e) The establishment of the flood evacuation warning system in Rawalpindi will propel the effective utilization of the existing communication system, e.g., the loudspeaker system of mosques, and will strengthen the flood evacuation capability of the communities. Hence, evacuation activities will be more orderly and effective with the establishment of flood evacuation plans and the dedicated participation of residents, NGOs and the local governments.

3-2 Recommendations

In order to realize and sustain the positive effects and increase the effectiveness of the Project, the following activities need to be properly undertaken:

(1) Effective operation and maintenance of the flood forecasting and warning system;
(2) Execution of Flood forecasting and warning operation based on adequate analyses of hydrological observation data;
(3) Improvement of the accuracy of flood prediction and the staged flood warning code based on the accumulated hydrological observation data;
(4) Formulation of the flood risk management plan and the flood evacuation plan based on the flood forecasting and warning system; and
(5) Execution of public awareness campaign concerning the mitigation of flood damage to be attained with the flood forecasting and warning system.

Among the boxed items above, items 1 and 2 are required for the smooth start of operations and the sustainable operation and maintenance of the proposed system, and these could materialize through the "Soft Component" of the Japanese Grant Aid Scheme. Items 3, 4 and 5 on the other hand are required for the more effective utilization of the system, and their realization under another sort of Japanese technical cooperation is suggested.

Figure 3.2 shows the present issues and the objectively verifiable indicators of project output when the technical cooperation is obtained and carried out together with the Japanese Grant Aid Scheme.

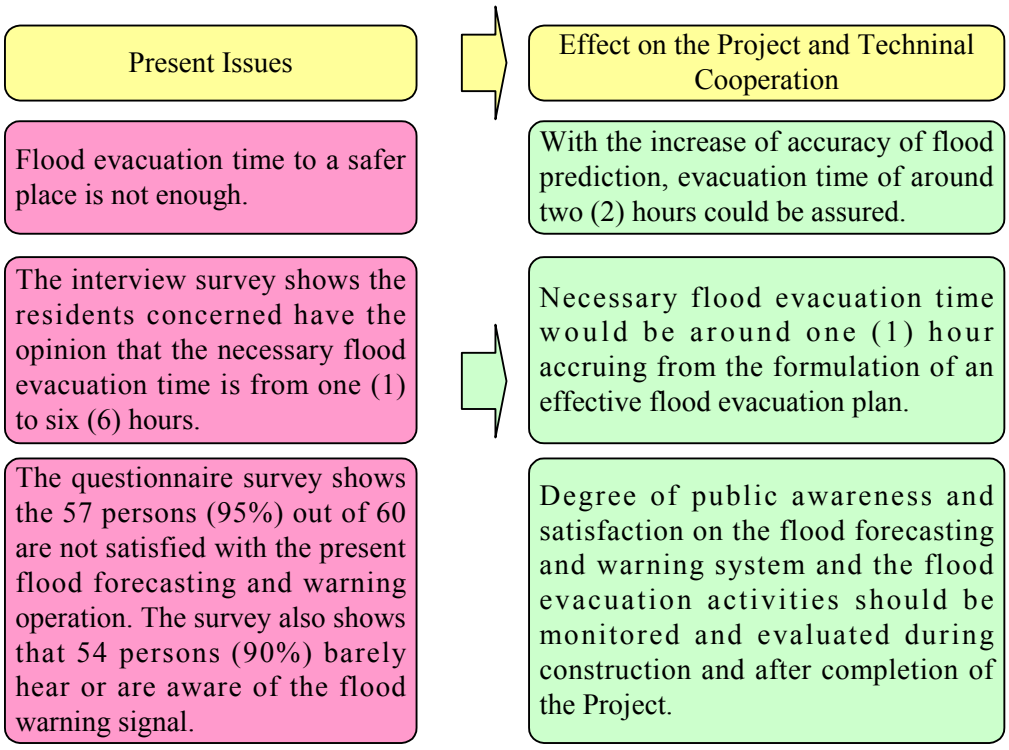


Figure 3.2 Indicators of Project Output on the Present Issues under the Japanese Grant Aid Scheme and the Technical Cooperation