No.

Department of Meteorology
Ministry of Disaster Management and Human Rights
The Government of Sri Lanka

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR
IMPROVEMENT OF METEOROLOGICAL AND DISASTER INFORMATION NETWORK
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

June 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

PACIFIC CONSULTANTS INTERNATIONAL

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PREFACE

In response to a request from the Government of Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a basic design study on the project for improvement of meteorological and disaster information network and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Sri Lanka a study team from October 24 to November 28, 2006 and from February 12 to March 10, 2007.

The team held discussions with the officials concerned of the Government of Sri Lanka, 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 Sri Lanka 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 Sri Lanka for their close cooperation extended to the teams.

June 2007

Masafumi Kuroki
Vice-President
Japan International Cooperation Agency

June, 2007

Letter of Transmittal

We are pleased to submit to you the basic design study report on the project for improvement of meteorological and disaster information network in Democratic Socialist Republic of Sri Lanka.

This study was conducted by Pacific Consultants International, under a contract to JICA, during the period from October 2006 to June 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Sri Lanka 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 further promotion of the project.

Very truly yours,

Hiroaki Kurita
Project manager,
Basic design study team on
the project for improvement of meteorological
and disaster information network
Pacific Consultants International

SUMMARY

Summary

The Democratic Socialist Republic of Sri Lanka (hereinafter referred to as Sri Lanka) is suffering every year from floods and landslides caused by rainfalls, in addition to tsunami, such as the one that hit the country's coast facing the Indian Ocean in December 2004.

The torrential rain that occurred in May 2003 caused serious floods and landslides, inflicting damage to about 140,000 households and depriving 235 lives. Property damage amounted to about 56 million U.S. dollars (5.4 billion rupees) which is equivalent to 0.3% of the country's GDP. There were 38 cases of floods and landslides in 2006. Natural disasters caused by torrential rains are occurring every year. It is an urgent task for Sri Lanka to mitigate damage of properties and prevent human lives against natural disaster.

Sri Lanka enacted "Sri Lanka Disaster Management Act, No. 13 of 2005" in May 2005 in response to the tsunami that attacked the country's coast facing the Indian Ocean in December 2004. It also established the "National Council for Disaster Management." The council is composed of related Ministers, the President as the chairman and the Prime Minister as the vice chairman. Based on the Disaster Management Act, the Disaster Management Center was established to manage and mitigate disaster risks.

In February 2006, the Ministry of Disaster Management and Human Rights was established and the Disaster Management Center was incorporated in the Ministry as a subordinate organization. The Department of Meteorology was also incorporated in the Ministry as an important organization for natural disaster forecasting and warning. As a result of the reorganization of the Ministry in January 2007, the National Building Research Organization was incorporated in the Ministry as a subordinate organization.

The Government of Sri Lanka has strengthened disaster management initiatives by enacting laws and making organizational reform, and formulated the Road Map for Disaster Risk Management in December 2005.

The Road Map specifically lists project implementation plans and specified disaster management initiatives, with the 7 components listed below:

1) Policy, institutional mandates and institutional development
2) Hazard, vulnerability and risk assessment
3) Multi-hazard early warning system
4) Planning for disaster preparedness and response
5) Disaster mitigation and integration into development
6) Community-based disaster risk management
7) Public awareness, education and training

Ten projects are planned to be implemented under item 3) Multi-hazard Early Warning System mentioned above. Two projects have higher priority:

- Improvement of Meteorological Observation and Forecasting
- Establishment of Early Warning Centre

With these projects requiring superior planning techniques, the Government of Sri Lanka requested the Government of Japan to implement a grant aid for the plan to improve meteorological information and disaster management networks.

The Department of Meteorology (DoM), belonging to the Ministry of Disaster Management and Human Rights, is in charge of meteorological services. DoM currently collects observed data every 3 hours from 20 synoptic meteorological stations located nationwide, and every 1 hour from relevant meteorological stations in the case of severe weather possibly leading to disaster. It also collects rainfall data once a day from collaborating stations of other organizations. Due to the visual check on the observation by meteorological observers, human error might be occurred in the process of observation. As the observing appliances for wind direction and speed are of low precision, the obtained weather data is of low precision and insufficient reliability. Rainfalls leading to disasters are required to be observed at shorter intervals, but it is presently not possible to identify the changes of rainfall due to the normal 3 hour observation intervals. It takes about 50 minutes (as indicated in the table below) for DoM headquarters to collect the data observed at synoptic meteorological stations. As the data collection depends on ordinary telephone lines, data collection can not be made when the lines are congested. Since the headquarters of DoM manually edits collected data, it is not possible to issue weather forecasts based on highly precise identification of realtime weather phenomena and to promptly issue forecasts and warnings.

As the transmission of weather forecasts and warnings to disaster management related organizations is made by ordinary telephone lines, it raises the issue of inability to transmit or share the data amongst the disaster management related organization when the lines are congested in case of emergency.

Time Needed to Collect Weather Observation Data (current situation)

Item	Work contents	Time needed
Observation	Visual observation by station observer	About 10 minutes
Preparation of observation data in specific format	Manual work by station observer	About 10 minutes
Collection of observed data	Collection of data from stations by telephone voice communication	About 30 minutes
Total		About 50 minutes

The Government of Sri Lanka requested grant aid for items listed below to solve current issues of DoM and to share information among disaster management related organizations and to transmit warnings to possibly affected local residents.

i. Equipment for the meteorological information network: automatic weather observation systems at 20 synoptic meteorological stations and 18 collaborator stations, an interactive telecommunication system connecting DoM headquarters and the synoptic meteorological stations, and a system to transmit observed data to the central display of the headquarters.

ii. Equipment for the disaster management network: communication network system connecting disaster management related organizations (DoM, the Disaster Management Centre (DMC), the Department of Irrigation (DOI), the National Building Research Organization (NBRO), the police, Sri Lanka Rupavahini Corporation (SLRC) and Sri Lanka Broadcasting Corporation (SLBC)), terminals at each of these organizations, the web server at the Disaster Management Centre, dedicated lines and terminals between 7 District Disaster Management Coordinating Units (DDMCUs) and the Disaster Management Centre.

iii. Equipment for the system to improve forecasting accuracy to DoM and DOI: a high resolution picture transmission receiving system, an automatic plotting & analysis system, a data archiving & analysis system, an upper air sounding with GPS system, and MIKE11 for flood forecast: one set each

In response to the request for grant aid, the Government of Japan decided to implement the basic design study and Japan International Cooperation Agency (JICA) twice dispatched a team to Sri Lanka for the basic design study: once from October 24 through November 28, 2006 and the other from February 12 through March 10, 2007. The study team held consultations with DoM, the project executing agency, and disaster management related organizations, such as the Disaster Management Center, and the Ministry of Disaster Management and Human rights, conducted studies, discussed and confirmed the contents of the request, surveyed project sites, and collected necessary background data and materials.

JICA is implementing a Comprehensive Study on Disaster Management, a development study (hereinafter referred to as the "Development Study"), in Sri Lanka, commenced prior to this basic design study. The Development Study is aimed at the mitigation of damage caused by natural hazard, such as floods, landslides and tsunami in the Development Study areas: through revising flood prevention master plan, building early warning and evacuation system, and promoting community-based disaster management project to empower related organizations and, as a result, thereby mitigating disaster damage in the entire country as the overall goal. This basic design study paid consideration to be consistent and coordinated with the Development Study in order to prepare the cooperation plan which is coherent to one study and another.

On the basis of analyses made in Japan, the team further studied the contents and appropriate equipment for the project, estimated the project cost, and prepared a basic design and an implementation plan. Between May 24 and 31, 2007, JICA dispatched the study team to Sri Lanka to explain and discuss the basic design and, as a result, arrived at an agreement in principle with the Government of Sri Lanka.

Concerning the "equipment for disaster management network" for which the grant aid was requested, the study team compared and studied the feasible method of building the communication network of 7 disaster management related organizations; whether establishing the independent network or making use of the existing network operated by the data communication operator in Sri Lanka.. As a result, the team arrived at the judgment that the use of the network of the data communication operators of Sri Lanka is more appropriate from the viewpoint of initial investment and operation and maintenance conditions. Thus, only the terminals to be installed at these organizations are necessary to respond to the request. As these terminals are available in Sri Lanka and it is desirable to introduce them as soon as possible from the viewpoint of disaster management, it is planned to procure them under the pilot projects of the said Development Study.

The intention of the request for the "equipment for the system to improve forecasting accuracy to DoM and DOI" is to further enhance their weather prediction precision. Although the basic direction of the enhancement of the prediction precision is common in both departments, objective of utilizing the forecasting result is different in each department. It is necessary to execute the plan based on the improvement plan on forecasting precision of each department. In this improvement plan, technology transfer by a skilled meteorologist is essentially required along with the equipment introduction plan. The necessary technology transfer would include elements such as improvement of forecasting technology in short and long range for DoM, and improvement of prediction technology on flood for DOI. However, it was recognized that the request is beyond the scope of this project.

The table below shows the contents of the plan finally confirmed with Sri Lankan side.

Equipment Allocation Plan

Sites and Number of Units (sites M1–M20)

Name of Equipment	M1 Anuradhapura	M2 Badulla	M3 Batticaloa	M4 Colombo	M5 Bandarawela	M6 Galle	M7 Hambantota	M8 Jaffna	M9 Katugastota	M10 Katunayaka	M11 Kurunegala	M12 Maha Illuppallama	M13 Mannar	M14 Nuwara Eliya	M15 Pottuvil	M16 Puttalam	M17 Ratmalana	M18 Ratnapura	M19 Trincomalee	M20 Vavuniya
Automatic Weather Observation System																				
Observation items: Wind direction/speed, temperature, humidity, barometric pressure, rainfall and solar radiation data loggers, and power source (solar power generation)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Observation items: Wind direction/speed, temperature, rainfall and solar radiation data loggers, and power source (solar power generation)																				
PC and peripherals for remote monitoring and observation data processing	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Satellite Communication System																				
Parabola antenna and peripherals for VSAT main station transmission (including voice telephone)																				
Parabola antenna and peripherals for VSAT sub-station transmission (including voice telephone)	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Parabola antenna and peripherals for VSAT sub-station transmission																				
Central Operating System																				
COS server, data processing software, PC for monitoring and visualization processor, large screen display and peripherals																				

Sites and Number of Units (sites C1–C18, DOM, total)

Name of Equipment	C1 Wagolla	C2 Polonnaruwa	C3 Moneragala	C4 Matale	C5 Sevanagala	C6 Angunakolapelessa	C7 Ampara	C8 Matara	C9 Deniyaya	C10 Horton Plains	C11 Mt. Pidurutalagala	C12 Aralaganwila	C13 Balangoda	C14 Maliboda	C15 Labugama	C16 Tawalama	C17 Kuwada	C18 Sirikandura	DOM(Colombo)	Total Number of Units
Automatic Weather Observation System																				
Observation items: Wind direction/speed, temperature, humidity, barometric pressure, rainfall and solar radiation data loggers, and power source (solar power generation)																				20
Observation items: Wind direction/speed, temperature, rainfall and solar radiation data loggers, and power source (solar power generation)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		18
PC and peripherals for remote monitoring and observation data processing																				20
Satellite Communication System																				
Parabola antenna and peripherals for VSAT main station transmission (including voice telephone)																			1	1
Parabola antenna and peripherals for VSAT sub-station transmission (including voice telephone)																				19
Parabola antenna and peripherals for VSAT sub-station transmission	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		18
Central Operating System																				
COS server, data processing software, PC for monitoring and visualization processor, large screen display and peripherals																			1	1

To continuously ensure project effects, it is necessary that the equipment and materials to be procured are excellent in reliability, versatility and durability. It is a must to assure easy operation and maintenance after procurement. The study team has considered the operation and maintenance cost aspects as well. From these viewpoints, the team set up a basic policy to introduce equipment and materials that are easy to operate and maintain and that can be managed by the technology available in Sri Lanka.

DoM of Sri Lanka will, by this project, introduce automatic weather observation systems, a satellite communication system and a central operating system for the first time. Guidance shall be given to the staff by the contractor on initial operation, and soft components (technical assistance) by the consultant. Concerning the 7 sites in the northeast area of Sri Lanka, where the Japanese side considers security to be a concern, the equipment shall be delivered to DoM in Colombo. The technology will be transferred to DoM staff by the contractor during the project so that they can install the equipment after completion of the project.

The equipment covered by this project will be installed at 31 sites, excluding the 7 northeast sites. It is necessary to efficiently implement equipment installation, confirmation of collection of observation data by the satellite communication system with DoM headquarters and confirmation

of data editing and processing at the headquarters. It is desirable that the equipment be installed as early as possible at 16 priority sites to be utilized for the drills on disaster management that will be implemented under the said Development Study. The period of work in consideration of these factors is: 4.5 months for detailed design, 11.0 months for equipment procurement and installation, and 1.5 months for soft components after acceptance of the equipment and system: i.e., 17 months in total.

The following matters shall be the responsibility of the Sri Lankan side:

- It is necessary to erect fences at two collaborator stations where automatic weather observation appliance will be newly installed to avoid effects on observed data by entry of any third party.
- It is also required to install the equipment at the 7 northeast sites after completion of the grant aid project.

The project is expected to achieve the following direct benefits:

- Time reduction from 50 min. to 10 min. required for collection of meteorological data;
- Increased stations from 20 to 38 as sources of meteorological observation data; and
- Reduction of interval from 3 hours to 1 hour at normal times and from 1 hour to 10 minutes during severe weather for collection of meteorological observation data.

The following indirect effects are expected to be generated as a result of the improved precision of meteorological observation of DoM as mentioned above:

- Contribution to early transmission of warnings to possible affected residents;
- Contribution to mitigation of property damage by natural disasters and prevention of human lives against natural disaster; and
- Improvement of temporary and spatially meteorological observation density and identification of weather phenomena in better detail thereby contributing to improving weather forecasting accuracy.

In operating and maintaining of the systems to be provided by the project, it is necessary to pay a circuit use charge for satellite communication to the satellite communication operating company and frequency use charge to the telecommunications regulatory commission. It is also necessary to add 5 persons for operation and maintenance of the systems.

As the project meets necessary conditions of grant aid projects of Japan, it is judged that implementation of the project is recommendable for the following reasons:

- The project will directly benefit 8.9 million residents in 7 southwestern provinces where floods and landslides are highly likely to occur, and indirectly benefit the whole population of 19.67 million of Sri Lanka. This project is thus a highly valuable public project.
- The project purpose meets BHN and education and human resources development and contributes to mitigate property damage caused by floods and landslides as rainfall disasters and protect human lives. This is an urgently required project for the safety of people.
- Sri Lanka as the recipient country can operate and maintain the systems by own funds, human resources and technologies, and no excessively high technology is needed for the project.
- The project aims at providing information to enhance the basic life to the people and not for the reason of profitability.
- The project can be implemented with no special difficulty by Japan's grant aid system.

Although the above mentioned effects are expected by executing this Project, further enhancement is necessary to improve the transmission timing of the observed information or warnings to the disaster management related organizations and possibly affected residents by hazard. It is therefore indispensable to utilize the communication network connecting disaster management related organizations that is planned to be introduced under the pilot project of said Development Study. Each disaster management related organization has its own roles: observing weather conditions, issuing warning, transmitting warning, monitoring of warning, and issuing directions. They must play their own roles to ensure mutual cooperation to reduce property damage caused by natural hazard and prevent loss of human lives. DoM should take the leadership by explaining, whenever necessary, the meanings of information, such as meteorological data and warnings provided to other organizations, and make efforts to identify needs of disaster management related organizations for information to be provided by DoM.

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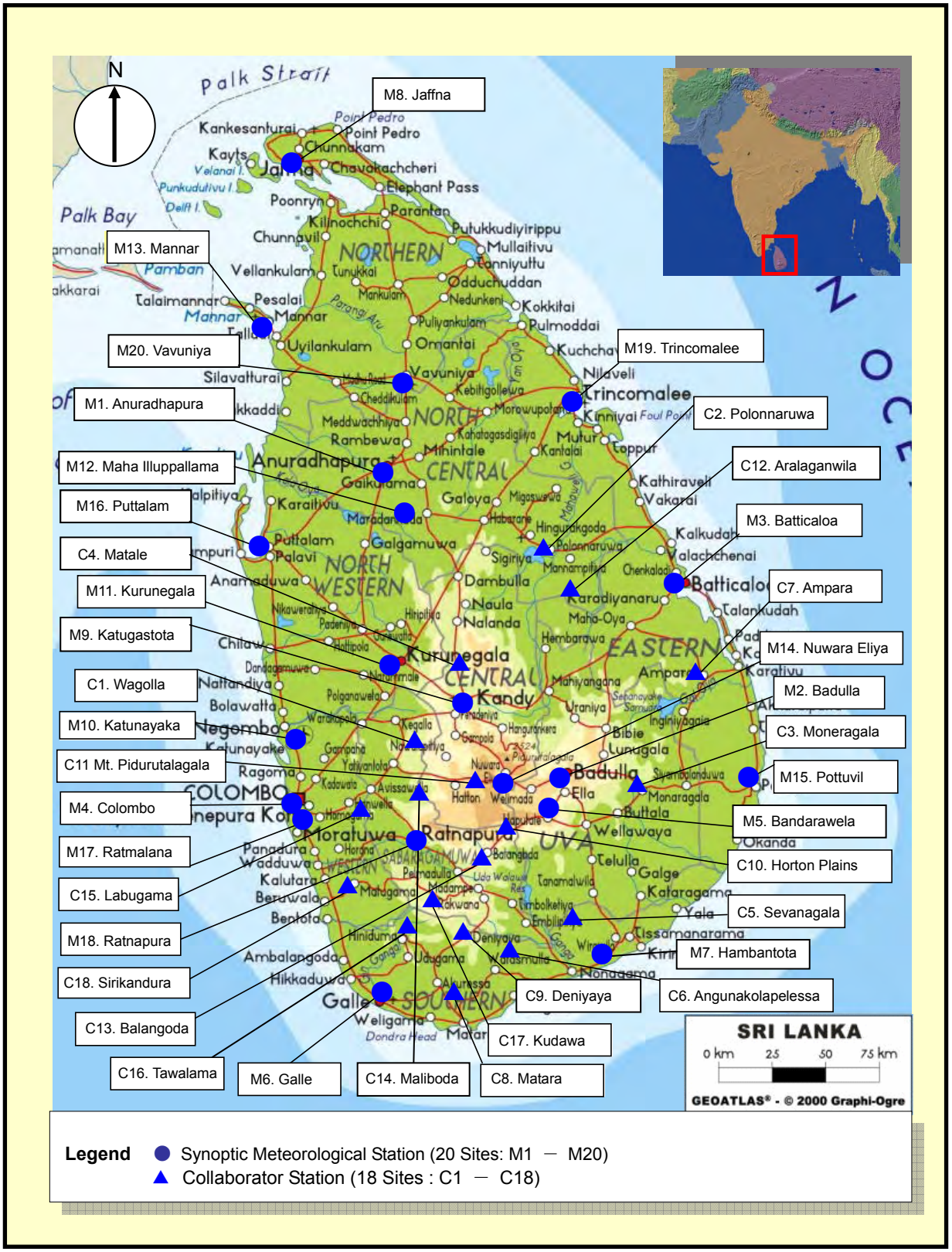

Location Map of Project Site

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ABBREVIATIONS

AWS	Automatic Weather Station
BHN	Basic Human Needs
COS	Central Operating System
DCP	Data Collection Platform
DMC	Disaster Management Center
DOA	Department of Aviation
DOI	Department of Irrigation
DOM	Department of Meteorology
E/N	Exchange of Notes
EIAJ	Electronic Industries Association of Japan
FWA	Fixed Wireless Access
GDP	Gross Domestic Product
GOS	Global Observing System
GPS	Global Positioning System
GSMB	Geological Survey and Mines Bureau
GTS	Global Telecommunication System
ICAO	International Civil Air Organization
ICTA	Information Communication Technology Agent
ICTAD	Institute for Construction Training Department
IEC	International Electrotechnical Commission
ITU	International Telecommunications Union
ITU-T	ITU Telecommunication Standardization Sector
JCS	Japanese Cable Standard
JEC	Japanese Electromechanical Committee
JEM	Japan Electric Machine Industry Association
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standards
LTTE	Liberation Tigers of Tamil Eelam
MOFP	Ministry of Finance and Planning
NARA	Natural Aquatic Resources Research & Development Agency
NBRO	National Building Research Organization
OFDM	Orthogonal Frequency Division Multiplexing
RF	Radio Frequency
TRC	Telecom Regulatory. Commission
UPS	Uninterruptible Power System
VSAT	Very Small Aperture Terminal
WMO	World Meteorological Organization

CHAPTER 1
BACKGROUND OF THE PROJECT

Chapter 1 Background of the Project

1-1 Status and issues of the sector

1-1-1 Status and issues

In the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka"), people have suffered from floods and landslides caused by rainfall every year, in addition to the tsunami that hit the country's coast of Indian Ocean in December 2004. The torrential rain that occurred in May 2003 caused serious floods and landslides, inflicting damage to about 140,000 households and depriving 235 lives. Property damage amounted to about 56 million U.S. dollars (5.4 billion rupees) which is equivalent to 0.3% of the country's GDP. There were 38 cases of floods and landslides in 2006. Natural disasters caused by torrential rains are occurring every year. It is an urgent task for Sri Lanka to mitigate damage of properties and prevent human lives against natural disaster.

The Department of Meteorology (DoM), belonging to the Ministry of Disaster Management and Human Rights, is in charge of meteorological services. DoM currently collects observed data every 3 hours from the 20 synoptic meteorological stations located nationwide and every 1 hour from relevant meteorological stations during severe weather possibly leading to disaster. It collects rainfall data as well once a day from collaborating stations of other organizations. Due to the visual check on the observation by meteorological observers, human error might be occurred in the process of observation. As the observing appliances for wind direction and speed are of low precision, the obtained weather data is of low precision and insufficient reliability. Rainfalls leading to disasters are required to be observed at shorter intervals, but it is presently not possible to identify the changes of rainfall due to the normal 3 hour observation intervals. It takes about 50 minutes (as indicated in the table 1-1) for DoM headquarters to collect the data observed at synoptic meteorological stations. As the data collection depends on ordinary telephone lines, data collection can not be made when the lines are congested. As the headquarters of DoM manually edits collected data, it is not possible to issue weather forecasts based on highly precise identification of realtime weather phenomena and to promptly issue forecasts and warnings. As the transmission of weather forecasts and warnings to disaster management related organizations is made by ordinary telephone lines, it raises the issue of inability to transmit or share the data amongst the disaster management related organization when the lines are congested in case of emergency.

Table 1-1 Time Needed to Collect Weather Observation Data (current situation)

Item	Work contents	Time needed
Observation	Visual observation by station observers	About 10 minutes
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Total		About 50 minutes

It is an urgent task for Sri Lanka to improve the current situation by providing a meteorological information network system with automated weather observation, data collection, and observed data editing and processing method as well as by establishing a dedicated network among disaster management related organizations. The overall goal to improve the situation is mitigation of property damage caused by natural hazard and the prevention of human lives against disaster. And the project objective is realization of the swift and reliable collection of highly accurate weather data and prompt issuing weather forecasts and warnings.

1-1-2 Development plan

After the Indian Ocean Tsunami that hit Sri Lanka's coast facing the Indian Ocean caused by the Sumatra-Andaman Earthquake occurred in December 2004, the country enacted "Sri Lanka Disaster Management Act. No. 13 in May 2005 and set up a National Council for Disaster Management. The council is composed of ministers of related ministries with the President as the chairman and the Prime Minister as the vice chairman. Based on the Disaster Management Act, the Disaster Management Center (DMC) was established to manage and mitigate disaster risks.

In February 2006, the Ministry of Disaster Management and Human Rights was established with DMC being the subordinate organization. DoM became a subordinate organization of the Ministry as an important organization to issue forecasts and warnings of natural disaster. As part of the ministry reshuffled in January 2007, the National Building Research Organization (NBRO) became the Ministry's important organization relating to landslides.

In addition to the improvement of the legal systems and organizations mentioned above, Sri Lanka has strengthened initiatives against natural disaster and prepared the Road Map for Disaster Risk Management in December 2005. The road map specifically lists project improvement plans and specified disaster management initiatives, with the 7 components listed below:

1) Policy, institutional mandates and institutional development
2) Hazard, vulnerability and risk assessment
3) Multi-hazard early warning system
4) Planning for disaster preparedness and response
5) Disaster mitigation and integration into development
6) Community-based disaster risk management
7) Public awareness, education and training

Ten projects are planned to be implemented under item 3) Multi-hazard Early Warning System mentioned above and the following two of them have high priority.

- Improvement of Meteorological Observation and Forecasting
- Establishment of Early Warning Centre

With these projects requiring superior planning techniques, Sri Lanka requested Japan to provide a grant aid for the plan to improve meteorological information and disaster management networks.

1-1-3 Socioeconomic conditions

Sri Lanka has maintained a economic growth rate of 5-6% overall with the steady performance of service industries despite negative factors such as deteriorating security in recent years, natural disasters including the tsunami damage and international price hike of crude oil. The per capita GDP in 2005 was US $1,197.

Natural disasters including frequent floods and landslides affect the economy to a significant extent. The torrential rain in 2003 resulted in serious floods and landslides, killing 235 persons and damaging about 140,000 households amounting to US$ 56 million. Floods and landslides damage more than 100,000 households every year, calling for the establishment urgent countermeasures.

Sri Lanka's three greatest agricultural products are tea, natural rubber and coconuts. Ceylon tea is an established worldwide brand exported globally. Agricultural products including tea are affected by temperature, rainfall, and other meteorological conditions. In terms of production quality and volume, more precise weather information is highly needed.

1-2 Background, history and outline of the request for grant aid

Sri Lanka requested Japan to provide a grant aid for "Plan for Improvement of Meteorological and Disaster Management Information Network" (hereinafter referred to as the "Project"), as described below, for the resolution of issues mentioned in Section 1-1-1 "Status and issues" and Section 1-1-2 "Development plan" and to realize the Road Map for Disaster Risk Management:

i. Equipment for the meteorological information network: automatic weather observation systems at 20 synoptic meteorological stations and 18 collaborator stations, the interactive telecommunication system connecting the headquarters of DoM and the synoptic meteorological stations, and a system to transmit observed data to the central display of the headquarters of DoM.

ii. Equipment for the disaster management network: telecommunications network system connecting disaster management related organizations (DoM, the Disaster Management Centre (DMC), the Department of Irrigation (DOI), the National Building Research Organization (NBRO), the police, Sri Lanka Rupavahini Corporation (SLRC), and Sri Lanka Broadcasting Corporation(SLBC)), terminals at each of these organizations, the web server at the Disaster Management Centre, dedicated lines and terminals between 7 District Disaster Management Coordinating Units (DDMCUs) and the Disaster Management Centre.

iii. Equipment for the system to improve forecasting accuracy to DoM and DOI: high resolution picture transmission receiving system, automatic plotting & analysis system, data archiving & analysis system, upper air sounding with GPS system, MIKE11 for flood forecast; one set each

Item i aims at improving the current situation where "meteorological phenomena cannot be identified in real time bases" and this aim corresponds to the "project for the improvement of meteorological observation and forecasting" specified in the Road Map. Item ii requires equipment and materials for the early transmission, to possibly affected local residents, of the weather forecasts and warnings of DoM for evacuating and sharing information among disaster management related organizations. It also require equipment for related organizations to share meteorological observation data collected on the realtime basis and processed in DOM that is to be utilized for predicting floods and landslides and that corresponds to " the establishment of early warning centre" in the Road Map. Item iii requires equipment for improving forecasting accuracy for the purpose of more precise flood damage analysis and weather forecasting using the observed data that are collected by DoM.

Concerning "equipment for the disaster management network" for which the grant aid was requested in above item ii, the study team compared with and studied feasible method of building the communication network of 7 disaster management related organizations; whether establishing the independent network or making use of the existing network operated by the data communication operator in Sri Lanka. As a result, the study team judged that the use of the network of the data communication operator of Sri Lanka would be proper from the viewpoint of the initial investment and operation and maintenance conditions. Thus, only the installation of terminals at these organizations would be necessary to respond the request. As these terminals are available in Sri Lanka and it is desirable to introduce them as soon as possible from a disaster management viewpoint, it is planned to procure them in the pilot projects of the Comprehensive Study on Disaster Management, assisted as JICA Development Study (hereinafter referred to as the "Development Study").

The intention of the request item iii for the "equipment for the systems to improve forecasting accuracy to DoM and DOI," is to further upgrade their weather forecasting precision. Although the basic idea of upgrading weather forecasting precision is common in both departments, the objective of utilizing forecasted result is different in each department. Thus, it is necessary to implement the plan based on the improvement plan of forecasting precision of each department. In this improvement plan, technology transfer by a skilled meteorologist is absolutely necessary along with the equipment introduction plan. The technology transfer should include such elements as the improvement of short and long range forecasting technologies for DoM, and the improvement of flood prediction technologies for DOI. However, it is considered that the request would be beyond the scope of this project.

As a result of the above considerations, overall assistance from the Government of Japan was formulated to include the provision of the meteorological information network under the grant aid project, and the disaster management communication network into said Development Study as to be realized as shown in Appendix 8.

1-3 Japan's past assistance

Japan has extended cooperation for the disaster management in Sri Lanka, after the tsunami damage inflicted to the country's coast facing the Indian Ocean in December 2004. Such on-going projects are listed in Table below.

Table 1-2 Japan's Technical Cooperation Projects for Disaster Management

Form	Project name	Outline	Period
Project formation study	Project Formation Study for Administrative Disaster Management Reinforcement	The study was to identify the situation of disaster management after the tsunami damage in December 2004 and coordinating Sri Lanka's needs and Japan's resources	2005.9 - 2006.3
Development Study	Comprehensive Study on Disaster Management	The Study concerning floods, landslides and tsunami is to aim at, the revision of the master plan for flood countermeasures, building early warning/evacuation system, and facilitation of community-based disaster management project to empower related organizations and mitigate disaster damage in the target areas.	2006.10 - 2009.3 (Ongoing)

In the Study mentioned above, it is planned to implement the pilot projects in two river basins (Kelani river and Kalu river basins) to build an early warning/evacuation system. The pilot projects are described below.

i. Automation of observation at the hydrological observatories in the two river basins (to observe rainfall and river water level)

ii. Introduction of telemeter systems to transmit hydrological observation data to the headquarters of the Department of Irrigation

iii. Introduction of a dedicated telecommunication network to connect disaster management related organizations and terminals at each organization (at DMC, DOI, DoM, NBRO, the police, SLRC, SLBC and DDMCUs at 7 districts in the southwest of Sri Lanka).

iv. Study on the criteria for flood warning and evacuation instruction, and study on the contents of information to be transmitted/shared

v. Study, analysis and clarification for the transmitting method and procedure on flood warning information: Study and analysis is to be provided for the flow of data and information among

the disaster management related organizations focusing on DMC and considering the system among disaster management related organizations to share/transmit the necessary information definitely to the possibly affected residents.

vi. Execution of the drill on disaster management: disaster management drill is to be executed using the above-mentioned system, which includes observation data collection, issuing of warnings, information shearing, warning transmission/dissemination, evacuation of the residents and necessary management activities.

vii. Monitoring the above-mentioned disaster management drill, and then if required, the system among disaster management related organizations shall be reexamined.

1-4 Other donor assistance

After the tsunami disaster in December 2004, other donor cooperations contributing to the disaster management functions of Sri Lanka are shown in the Table below.

Table 1-3 Outline of Assistance of Other Donors

Execution Period	Organization	Project Name	Amount	Form	Role in achieving a superior plan
2005 ～ 2007	**UNDP (Government of France, Sweden International Development Agency Fund)**	Disaster risk management	US $1.9 million	Technical cooperation	Preparation of a superior disaster management related plan of Sri Lanka including assistance in preparing national disaster management policy, national disaster management plan, national emergency response plan, and road map for disaster management
2007 ～ Ongoing	**WMO USAID**	Project for improving global weather telecommunication network between Colombo and New Delhi	US $185,000	Grant	To strengthen the existing global weather telecommunication lines between Colombo and New Delhi to contribute to the improvement of the forecasting accuracy of DoM of Sri Lanka
Project Formation Stage	**World Bank**	National plan for improving water management	Unknown	Unknown	To improve flood forecast and mitigate flood damage by providing hydrological observatories at the Department of Irrigation

1-5 Results of natural condition survey

As the detailed meteorological observation data of the target areas are not publicized, the study team obtained, from DoM, the past data of monthly highest and lowest temperatures, rainfall, humidity and wind as part of this survey. The data and how to apply them to the basic design are described in section 2-2-1-2 “Policy for natural conditions.”

1-6 Socio-environmental considerations

Equipment to be introduced by the project will not give negatively effects to project sites and surrounding environment.

CHAPTER 2
CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Basic concept of the project

After the Indian Ocean Tsunami hit the country's coast facing the Indian Ocean in December 2004, Sri Lanka has strengthened disaster management initiatives and is continuing the development of the legal systems by setting up necessary organizations and implementation of related projects.

Currently, the Department of Meteorology (hereinafter referred to as "DoM") operates 20 synoptic meteorological observation stations nationwide. But, the observation precision is not adequate for the elements of rainfall, wind speed and wind direction because of the old type of equipment being used and the long intervals of data observation period that is every three hours in normal weather condition and every one hour during severe weather condition when the data is required by concerned observation stations. As observed data is collected through ordinary telephone lines, the observed data cannot be collected when the lines are congested. In addition, collected observation data is processed manually in the headquarters of DoM. These conditions cause physical bottlenecks for the real-time acquisition of meteorological information, forecasting activities and quick issuing of necessary warnings based on the observed data.

In order to improve the above conditions, the Government of Sri Lanka planned to implement a project for the improvement of "the Meteorological Observation and Forecasting" in the Component of the Multi-hazard Early Warning (EW) System in the Road Map for the Disaster Risk Management. The objective of this project is to upgrade the equipment and personnel capability in the meteorological observation and forecasting sectors. This Grant Aid Project (hereinafter referred to as the "Project") is planned to achieve the improvement of the meteorological observation accuracy mentioned in the Road Map.

To achieve the above-mentioned objective, the Project is to procure and install equipment for automatic weather observation systems for DoM's 20 synoptic meteorological stations and 18 collaborator stations, a satellite communication system to automatically transmit observed data to the headquarters of DoM, and a central operating system to collect, edit and analyze observed data at the headquarters. Technical assistance called as Soft Components shall also be provided for the purpose of smooth setup, operation and maintenance of these systems and securing the continuity of their cooperation. It is expected that more detailed meteorological phenomena may be observed by improving the density of the meteorological observation network temporally and spatially. The scope of the Project is to procure and install the above-mentioned equipment except for the installation work for the 7 sites located in the north and east part of Sri Lanka where the Japanese side considers having security concern.

2-2 Basic design of the required Japanese assistance

2-2-1 Design policy

2-2-1-1 Basic policy

(1) Scope of cooperation

In order to contribute to the mitigation of damage caused by natural disaster, it is essential to detect the risk of disaster, ensure the issuing of warnings, announce the warnings to general public, and give evacuation instruction to residents that may be affected. It is also needed to exchange and share information on disaster and warnings among the disaster management related organizations. Functions to monitor and manage disaster related information among those institutions are also required. To achieve the benefits of the project, it is necessary to continuously combine a series of these functions as described below:

i. At the synoptic meteorological stations of DoM having staff to observe weather round the clock, automatic weather observation system, communication equipment, and equipment for remote data monitoring/observation data processing of appropriate scale and contents are planned to be installed, and to transmit weather observation data to the headquarters. The staff shall manually observe weather elements, that cannot be automatically observed, transmit observed data to the headquarters and maintain interactive voice communication function between each station and the headquarters even during time when disaster is forecasted.

ii. An automatic weather observation system and communication equipment of appropriate scale and contents are planned to be installed at those collaborator stations that are indispensable for monitoring detailed weather phenomena to promptly transmit observed data to the headquarters.

iii. The headquarters of DoM will collect necessary weather data and information through GTS for forecasting purpose from foreign organizations to make precise analyses and forecasting. Integration, editing and processing of collected data are necessary to comparatively analyze them with observed data obtained through the meteorological information network system.

iv. The forecasting division of the headquarters of DoM will provide processed observation data to the disaster management related organizations and transmit weather information and warnings to the organizations promptly and precisely, especially when an occurrence of disaster is forecasted.

v. DMC will manage the disaster management related organizations; will provide necessary information when disaster may possibly occur and monitor the transmission of disaster warnings to the residents in potentially affected areas.

The scope of the cooperation for the project will be decided upon by taking into accounts its validity and necessity as a grant aid project. The above items "iv" and "v" will be executed under a pilot project of JICA development Study titled Comprehensive Study on Disaster Management (hereinafter referred to as the "Development Study"). As for items "i.," "ii," and "iii," it is valid as a Grant Aid Project because of the reason that they are necessary to understand the real time meteorological phenomena that may cause natural disaster, thereby contributing to the mitigation of property loss and the prevention of the loss of human lives.

(2) Overall design guidelines

The basic design of the Project is based on the following guidelines:

i. The Project is to enable prompt and certain collection of weather observation data thereby contributing to the reduction of damages on rainfall disasters (floods and landslides). Thus, it is necessary to enhance the analysis capability of large-scale weather phenomena, such as high and low atmospheric pressures distribution and cyclone, beyond the territory of Sri Lanka, as well as small scale weather phenomena, such as lightning storms.

ii. For the nationwide synoptic meteorological stations, the observation of meteorological elements are planned to be automated, in order to identify weather phenomena, such as rainfall, for the purposes of weather forecasting and issuing warnings for natural hazard. The automatically observed weather data, together with visually observed data, will then be provided to international organizations. The necessary processing on climate change is also executed. In addition, clarification and processing of observed data shall be made for weather analysis purpose.

iii. Automation of observation elements that are likely affected by topographical and local conditions are planned in order to examine small-scale meteorological phenomena, such as lightning storms, at nationwide collaborator stations.

iv. It is planned to promptly and precisely collect data to be automatically observed from synoptic meteorological and collaborator stations, and also automate the editing and processing of weather information and observed data at the headquarters of DoM that are needed by forecasting officers for meteorological analysis and forecasting.

v. It is planned to introduce an information exchange system, that conforms to the international standard, such as WMO, in order to promptly transmit collected observation data to foreign meteorological organizations as well as to obtain weather information from foreign organizations.

vi. A communication system necessary for collecting weather observation data is planned in order to employ a communication method by which observed data may be promptly, surely and precisely transmitted even during such time when the connection of the public

switched telephone network as well as the cellular mobile telephone network in the country become congested for a reason of natural or social conditions.

vii. Observation staff at each synoptic meteorological station is responsible to transmit weather information to local disaster management related organizations during time when severe weather may possibly cause disaster; thus, they must have reliable interactive communication means with the forecasting officers of DoM headquarters. An interactive communication system is planned between DoM headquarters and synoptic meteorological stations.

viii. Even under severe weather conditions, the system is required to operate. It is therefore planned to take into account a redundancy for the core equipment whose failure might affect the whole system.

ix. To ensure the continuity of the system introduced by the Project, the equipment and materials shall be of high operation and maintenance efficiency and be operable based on the technical level of DoM of Sri Lanka.

x. The equipment and materials provided by the Project are planned not to pose any environmental contamination problems after decommissioning.

xi. By planning excellent power-saving equipment, it shall be possible to reduce operation and maintenance costs and contribute to the reduction of financial burden.

(3) Policy for selecting the sites

As described in Section 2-2-1-1 (2) “Overall design guidelines,” the Project is to cover entire Sri Lanka in terms of weather observation and improve the meteorological information network system to promptly, surely and precisely collect weather information that may involve disaster risk.

The sites shall be selected based on the following criteria:

- Necessity of weather observation
  Necessity of automated observation and importance of the roles of observatories, such as observation report and information dissemination to the disaster management related organizations

- Necessity of the Meteorological Observation for Disaster Management (floods and landslides)
  Necessity of comprehension of rainfall distribution, flood forecasting and landslide forecasting

- Aptitude of Installation of weather observation equipment
  Aptitude for site-specific situations, such as any special topography, absence of nearby

buildings or heat sources affecting observation, enough space for installing equipment, and security of the place where the equipment is to be installed.

- Easiness of operation and maintenance

  Presence of supervisor and sustainable organization for observation, connectivity using communication means, and existence of no obstacles for operation and maintenance

(4) Policy for setting up observation elements for the automated weather observation system

According to the observation manual of WMO, it is recommended that the spatial density of weather observation network can be set roughly at the three scales listed below.

A) An observation network of 100 km mesh or less for the observation of small-scale weather phenomena, such as lightning storms.

B) An observation network between 100 and 1,000 km for medium-scale whether phenomena, such as regional fronts.

C) An observation network between 1,000 and 5,000 km for large-scale whether phenomena, such as low and high pressure distributions.

The synoptic meteorological stations in Sri Lanka are to be deployed according to item B) above and aim at identifying medium-scale phenomena and climatic change. Number of observation elements for the automatic weather observation systems to be installed at the synoptic meteorological stations is planned in accordance with the Section 2-2-1-1 (2) "Overall design guidelines" item ii. It is planned to automate wind observation (direction and speed), temperature, humidity, barometric pressure, rainfall and solar radiation, namely the 6 elements and 7 items.

On the other hand, collaborator stations aim at monitoring small-scale phenomena as described in item A) above, and it is planned to automate wind observation (direction and speed), temperature, rainfall and solar radiation, namely the 4 elements and 5 items that are likely to be affected by topographical and local conditions.

(5) Policy for selecting the communication systems

The grant aid requires for ensuring of the collection of observed data from observatories and interactive communication system between DoM headquarters and synoptic meteorological stations even in congested conditions of the public switched telephone network and cellular mobile telephone network in the country as mentioned in items vi, vii and viii of Section 2-2-1-1 (2) "Overall design guidelines," and the selection of an appropriate communication means should meet the following guidelines:

i. Good communication quality.

ii. Prompt, certain and precise transmission of observed meteorological data and no line congestions, such as public switched telephone network.

iii. Necessary backup system, such as alternative equipment, should be equipped for core functioning part of the communication system whose failure may affect the whole system.

iv. General communication equipment.

v. DoM can operate and maintain it.

vi. DoM can secure a sufficient budget for communication, operation and maintenance costs.

2-2-1-2 Policy for natural conditions

(1) Elevation

The elevations of the sites where the equipment and materials is to be installed under the Project range from 2 to nearly 2,000 m. The highland in the center of the island (Nuwara Eliya region) is as high as 2,000 m. The specifications of the planned equipment and materials shall be designed to meet elevation and barometric pressures.

(2) Temperature

As the central highlands are surrounded by wide lowlands, the climate is quite variable. The annual average temperature is 27ºC and that in the central highlands is 15ºC. Thus, no special consideration is needed for the planned equipment and materials of ordinary specifications meeting the temperature range. The daily temperature change between January and March is great in the highlands and frost develops for 4 days in a year from midnight to the morning, which will be considered for designing the equipment and materials.

(3) Rainfall

The annual rainfall in Sri Lanka ranges from 900 to 6,000 mm depending on location. The greatest rainfall is observed in the west slope of the central highlands. The maximum annual rainfall was 5,457 mm in Ratnapura located in the region. The study team will consider appropriate specifications to address torrential rains of this scale.

(4) Wind

The wind speed of the target sites is normally 1 to 16 m/s according to the weather observation data in recent years. The east, north and north-central regions suffer from the damage of cyclone occurring in the Bay of Bengal. Some dozen or more cyclones hit the island during the past 100 years and it is estimated that the maximum wind speed was 50 m/s. The outdoor automatic weather observation appliances and antennas should be designed not to be damaged by the maximum wind speed.

(5) Lightning

Lightning often occurs between March and April, and between October and November that are inter-monsoon periods. It is a big problem that lightning damages electronic appliances, computers, etc. Direct and induced lightning causes disordering of electronic appliances charging abnormal current and voltage through power and telephone lines. The study team will consider stable power sources free from effects of abnormal current and voltage through existing power and telephone lines for the power sources for weather observation appliances and communication equipment of relatively low power consumption type for synoptic meteorological stations and collaborator stations. Measures to protect weather observation appliances from direct lightning will be considered as well.

(6) Ground

Foundation structures for the Project are poles for automatic weather observation appliances and antennas/support cable anchors. During the field survey, such problems as subsidence or uplifting of pole foundation for existing observation appliances were not observed. Structure design will be prepared in accordance with the local structural guidelines as have been applied to existing weather observation appliances.

(7) Salt damage

Technical specifications for the Project equipment shall be considered for salt damage because several observation stations are located close to the sea.

(8) Earthquake

Sri Lanka is not located in an earthquake zone and little earthquake damage has been observed. Despite of some noticeable earthquakes, no earthquake has deprived human lives or caused collapse of houses for the past 100 years. A noticeable earthquake occurred on December 6, 1993 having the epicenter at a sea bottom 170 km west from Colombo, but no human loss nor collapse of houses were reported. Thus, Project design will therefore be prepared in accordance with the local structural guidelines.

2-2-1-3 Policy relating to socio-economic conditions

Although the main objective of the system to be adopted into this Project is to minimize damage caused by natural hazard, as described in Section 1-1-3 “Socioeconomic conditions”, higher precision of observed data is highly needed because the harvest quality and quantity of farm crops are affected by the temperature or rainfall amount.

The study team will, therefore, take the prompt and precise provision of meteorological information into consideration for the Project to sufficiently use existing web site of DoM.

2-2-1-4 Policy concerning procurement affairs and special situations/commercial customs of industry

(1) Permits and approvals and laws related to the implementation of the Project

1) Labor laws

The Project includes small-scale foundation work, electrical work, equipment installation and other works at Project sites. The labor laws of Sri Lanka provide for contract and employment, equality between both sexes, work hours, intermissions, wages, work rules, labor environment, etc. The law applies to equipment installation in the Project.

(2) Applicable standards and design conditions

The design, procurement, manufacture and installation of devices, equipment and materials to be procured under this Project shall conform to international and Japanese standards issued by the following organizations:

- Technical guidelines of International Telecommunications Union (ITU)
- Recommendations of Telecommunication Standardization Committee, ITU (ITU-T)
- Technical guidelines of International Electrotechnical Commission (IEC)
- 1987 Recommendation of Satellite Communication Committee, Telecommunication Council
- Telecommunications Business Law (Japan)
- Recommended standards of WMO/ICAO
- GOS Technical Manual of WMO
- GTS Technical Manual of WMO
- Japanese Industrial Standards (JIS)
- The Japan Electrical Manufacturers' Association (JEM)
- Electronic Industries Association of Japan (EIAJ)
- Japanese Electrotechnical Committee of the Institute of Electrical Engineers of Japan
- Japan Cable Standard (JCS)

(3) Design standard to be complied with for installation work

The Project will involve civil engineering, electricity and communication equipment works necessary for installing weather observation appliances, satellite communication appliances and data collection appliances (computers, etc). Basically, the study team shall abide by the guidelines in Sri Lanka for the civil engineering, construction and electric equipment works that have been issued by ICTAD (Institute for Construction Training Development). Foreign assistance projects are implemented in accordance with the standards of the assisting countries. In this Project, the local standard will be the basis, but Japanese standards should be referred to in the design.

2-2-1-5 Policy for utilizing local company

It is a first experience for Sri Lanka to establish a meteorological information network as to be provided by the Project and local operators have no experience in installing it. Civil engineering work and transportation work for the installation will be contracted out to local operators as much as possible. There are no companies that have similar experience in installing equipment to be procured under this Project in Sri Lanka. Japanese companies which will be suppliers for this Project shall supervise entire installation work and provide training and instruction to local companies.

As road closure frequently happens in Sri Lanka, information to be provided by local companies will be very useful for the transportation and installation of equipment and materials and the transportation of staff to the sites. There are about 80 to 130 transportation companies of which 8 to 10 companies are quite large. These major local companies have experience in foreign assistance projects. The local transportation companies will be used for transportation work for the Project in Sri Lanka under the supervision of Japanese contractor.

2-2-1-6 Policy concerning operation and maintenance abilities of the executing agency

There are 20 synoptic meteorological stations nationwide at present. Malfunctioning observation appliances are sent to the headquarters in Colombo for repair. The headquarters have 15 maintenance staff for equipment maintenance and woodwork maintenance. They have sufficient capability for the maintenance and repair of existing observation appliances. However, they have no knowledge about the equipment units of the meteorological information network (such as automatic weather observation appliances, equipment for satellite communication system, data processing and analysis equipment) to be provided by the Project. Therefore, sufficient education and training shall be provided to them that they can learn knowledge and technologies for the operation and maintenance of these equipments. The education and training shall be conducted during the initial operation guidance period by contractor installing these equipment and consultants providing soft components.

2-2-1-7 Policy for grades of equipment and materials

As the Project is expected to continuously exhibit its intended effect, equipment and materials to be provided must be of general-use, durable types, and have high cost-performance ability. In addition, these equipments shall be of easily repairable and maintainable. For these reasons, those types of equipment that have proved good performance shall be provided.

(1) Procurement method

Equipment and materials to be procured from overseas for the project should be obtained in Japan and installed by Japanese prime contractor for the following reasons: 1) Connection between the automatic weather observation system, the satellite communication system and the

central operating system shall be guaranteed to function as an integrated system; 2) It is the first time to introduce a meteorological information network system in Sri Lanka and detailed technical support is necessary to establish the system by reflecting the local situations for 20 synoptic meteorological stations and 18 collaborator stations scattering over the country; 3) The Project must be surely implemented within a limited time period based on the rules of Japanese grant aid scheme; and 4) Even if equipments for the Project such as automatic weather observation system, satellite communication system, and central operating system are to be procured from Japanese companies, competitiveness among these companies are maintained.

As for the quality and quantities of locally procurable materials for equipment foundation construction, electrical work, and the installation work related to communication system, such as cables and associated fittings, there are no problems. They should be procured in Sri Lanka to achieve cost reduction.

(2) Installation schedule

As there are 31 sites to install equipment for the Project, installation work shall be simultaneously conducted for effective project implementation purpose. As for the preparation of project implementation schedule, higher priority shall be given to those sites at where the drills on disaster management are planned by a pilot project being implemented as part of the said Development Study.

2-2-2 Basic plan (equipment plan)

2-2-2-1 Formulation of basic plan

(1) Study of the equipment plan

As a result of studies and discussions conducted with the Sri Lankan side, the following matters of the request were agreed upon concerning equipment and materials to be procured for a meteorological information network system to be provided under the Project.

1) Weather observation system

i. Automatic weather observation system

An automatic weather observation system will be installed at 20 synoptic meteorological stations and 18 collaborator stations; it will be able to automatically monitor real time weather phenomena at the synoptic meteorological stations using the remote monitoring/observation data processing PC and input visually observed data in it.

ii. Satellite communication system

A satellite communication system will be utilized so that 20 synoptic meteorological stations and 18 collaborator stations may able to transmit observed weather data to DpM

headquarters and make interactive communications between the headquarters and the synoptic meteorological stations.

iii. Central operating system

This system is to collect observed weather data transmitted from synoptic meteorological stations and collaborator stations and edit, process and display them in accordance with the standards of WMO (World Meteorological Organization). It will also have functions to receive weather data of other countries through GTS (Global Telecommunication System) and transmit Sri Lankan weather data to other countries.

(2) Selection of target sites and automatic weather observation equipment to be installed

The study team examined the site selection standards including detailed requirements and described in Section 2-2-1-1 (3) "Policy for selecting the sites" and, as a result, selected target sites as indicated in Table 2-2 Selection of Target Sites. As all requested sites were confirmed as being necessary and were evaluated as possibly to be implemented, the study team decided to include them in the Project.

As mentioned in the section 2-2-1-1 (4) "Policy for setting observation elements for the automated weather observation system", the observation of those items shown in the table below shall be automated in the synoptic meteorological stations and collaborator stations of DoM, and automatic weather observation appliances shall be planned accordingly.

Visual observation shall be continuously conducted at synoptic meteorological stations by the staff of DoM. The observed data shall be transmitted to DoM headquarters by PCs for remote monitoring/observation data processing every 3 hours.

Concerning those collaborator station sites having no fixed telephones and located beyond the service coverage area of mobile phones, staff will be dispatched from the nearest synoptic meteorological station for data checking as directed by DoM headquarters whenever required in an emergency case.

Table 2-1 Observation Items for Automation

Observatory	Automated observation items	Visual observation items
Synoptic meteorological stations	Wind direction/speed, temperature, humidity, rainfall, barometric pressure and solar radiation	Weather, cloud volume/shape, visibility, etc.
Collaborator stations	Wind direction/speed, temperature, rainfall and solar radiation	—

Table 2-2 Selection of Target Sites

	Site		Necessity for Meteorological Observation		Important Indicator for Disaster (Flood and Land Slide)			Installation Criteria for Automatic Weather Observation Equipment				Criteria for Operation and Management			Evaluation Result
			Necessity of Automated Observation	Role	Precipitation distribution	Flood Prediction	Land Slide	Adequate land feature for installation	No obstacle and heat source affecting observation	Enough space for installation	Adequate security	Custodian of site	Sustainability on Operation and Management	Contactable site	
Synoptic Meteorological Station	M1	Anuradhapura	○	Meteorological Report, Transmitting information to related agencies	○			○	○	○	○	○	○	○	○
	M2	Badulla	○	Meteorological Report, Transmitting information to related agencies	○	○	○	○	○	○	○	○	○	○ Out of coverage (Cellular Phone)	○
	M3	Batticaloa	○	Meteorological Report, Transmitting information to related agencies	○	○		○	○	○	○	○	○	○	○
	M4	Colombo	○	Meteorological Report, Transmitting information to related agencies	○	●		○	○	○	○	○	○	○	○
	M5	Bandarawela	○	Meteorological Report, Transmitting information to related agencies	○	○	○	○	○	○	○	○	○	○	○
	M6	Galle	○	Meteorological Report, Transmitting information to related agencies	○	●		○	○	○	○	○	○	○	○
	M7	Hambantota	○	Meteorological Report, Transmitting information to related agencies	○			○	○	○	○	○	○	○	○
	M8	Jaffna	○	Meteorological Report, Transmitting information to related agencies	○			○	○	○	○	○	○	○	○
	M9	Katugastota	○	Meteorological Report, Transmitting information to related agencies	○	○	○	○	○	○	○	○	○	○	○
	M10	Katunayake	○	Meteorological Report, Transmitting information to related agencies	○			○	○	○	○	○	○	○	○
	M11	Kurunegala	○	Meteorological Report, Transmitting information to related agencies	○	●	○	○	○	○	○	○	○	○	○
	M12	Maha Illuppallama	○	Meteorological Report, Transmitting information to related agencies	○			○	○	○	○	○	○	○	○
	M13	Mannar	○	Meteorological Report, Transmitting information to related agencies	○			○	○	○	○	○	○	○	○
	M14	Nuwara Eliya	○	Meteorological Report, Transmitting information to related agencies	○	○	○	○	○	○	○	○	○	○	○
	M15	Pottuvil	○	Meteorological Report, Transmitting information to related agencies	○	○		○	○	○	○	○	○	○	○
	M16	Puttalam	○	Meteorological Report, Transmitting information to related agencies	○			○	○	○	○	○	○	○	○
	M17	Ratmalana	○	Meteorological Report, Transmitting information to related agencies	○	●		○	○	○	○	○	○	○	○
	M18	Ratnapura	○	Meteorological Report, Transmitting information to related agencies	○	●	○	○	○	○	○	○	○	○	○
	M19	Trincomalee	○	Meteorological Report, Transmitting information to related agencies	○	○		○	○	○	○	○	○	○	○
	M20	Vavuniya	○	Meteorological Report, Transmitting information to related agencies	○			○	○	○	○	○	○	○	○
Collaborator Station	C1	Wagolla	○	Meteorological Report	○	●	○	○	○	○	○	○	○	○	○
	C2	Polonnaruwa	○	Meteorological Report	○	○		○	○	○	○	○	○	○	○
	C3	Moneragala	○	Meteorological Report	○	○		○	○	○	○	○	○	No fixed telephone Out of coverage (Cellular Phone)	○
	C4	Matale	○	Meteorological Report	○	○	○	○	○	○	○	○	○	No Telephone	○
	C5	Sevanagala	○	Meteorological Report	○			○	○	○	○	○	○	○	○
	C6	Angunakolapelessa	○	Meteorological Report	○			○	○	○	○	○	○	○	○
	C7	Ampala	○	Meteorological Report	○	○		○	○	○	○	○	○	○	○
	C8	Matara	○	Meteorological Report	○	●		○	○	○	○	○	○	○	○
	C9	Deniyaya	○	Meteorological Report	○	●	○	○	○	○	○	○	○	○	○
	C10	Horton Plains	○	Meteorological Report	○	●	○	○	○	○	○	○	○	No fixed telephone Out of coverage (Cellular Phone)	○
	C11	Mt. Pidurutalagala	○	Meteorological Report	○	●	○	○	○	○	○	○	○	No fixed telephone Out of coverage (Cellular Phone)	○
	C12	Aralaganwila	○	Meteorological Report	○	○		○	○	○	○	○	○	○	○
	C13	Balangoda	○	Meteorological Report	○	●	○	○	○	○	○	○	○	○	○
	C14	Maliboda	○	Meteorological Report	○	●	○	○	○	○	○	○	○	○	○
	C15	Labugama	○	Meteorological Report	○	●	○	○	○	○	○	○	○	○ Out of coverage (Cellular Phone)	○
	C16	Tawalama	○	Meteorological Report	○	●	○	○	○	○	○	○	○	○ Out of coverage (Cellular Phone)	○
	C17	Kudawa	○	Meteorological Report	○	●	○	○	○	○	○	○	○	No fixed telephone Out of coverage (Cellular Phone)	○
	C18	Sirikandura	○	Meteorological Report	○	●	○	○	○	○	○	○	○	○	○

※Flood Prediction
●: Site in southwest flood-prone region and the surrounding area
○: Site affected by rainfall in northeast monsoon season
※Land Slide
○: Project site in landslide-prone region and the surrounding area

(3) Setup of communication system

The study team conducted comparative examination of the communication system to collect weather observation data from among available surface telephone lines, mobile phone circuits, shortwave wireless circuits, communication circuits of geostationary meteorological satellite (DCP: DCP refers to Data Collection Platform) and satellite communication circuits (VSAT system) as shown in Table 2-3 in accordance with Section 2-2-1-1 (5) "Policy for selecting the communication systems". As a result, the most advantageous circuit in terms of quality, reliability and versatility enabling interactive communication between the headquarters of DoM and synoptic meteorological stations was evaluated as the satellite communication circuit (VSAT system). The Project thus, the satellite communication system (VSAT system) will be used for the Project's communication system. Although the satellite communication system will require rather expensive communication cost and operation and maintenance engineers, DoM may be able to bear the cost. DoM has engineers who have been operating and maintaining radar unit for upper wind observation. It is therefore sufficiently possible to operate and maintain the satellite communication system by training the engineers of DoM.

(4) Central operating system

In accordance with the policy described in Section 2-2-1-1 (2) "Overall design guidelines," items iv and v, functions required for the central operating system are shown below:

1) Collection and transmission of weather data

i. Collection of observed weather data
ii. Transmission of data to the website in DoM headquarters
iii. Data receiving/transmission between Synoptic Meteorological Stations
iv. Transmission of data to other disaster management related organizations
v. GTS data exchange

2) Editing, analysis and display of weather data

i. Editing of observed weather data
ii. Processing of observed weather data (database, graphic display)
iii. Data recording
iv. Data analysis
v. Display data on screen
vi. GTS code generation

Table 2-3 Comparison of Communication Systems

System	Comparison items									Evaluation	Judgment
	Communication Quality	Initial investment	Communication cost	Operation/ maintenance	Maintenance cost by DoM	Versatility	Time lag	Two-way communication	Others		
Digital shortwave radio	Relatively unstable depending on ionospheric layer.	Need radio equipment, antena and terminal equipment.	No cost	by DoM	Equipment maintenance cost and personnel expenditures for the communication circuit.	No problems	Negligible	Possible	Telecommunication Regulatory Commission (TRC) knows illegal stations and is concerned about interference.	Shortwave is affected by ionospheric layer. No communication cost but there are interference problems and maintenance cost is necessary.	×
Fixed telephone	Frequent disturbance depending on sites.	Only communication terminal equipment is needed.	Approx. 1.1 million Rs/year	by Operator	Personnel expenditure to confirm line availability from the terminal is necessary.	No problem	Negligible	Possible	Frequent and prolonged communication failure in the mountains and remote localities. Congestion affected by disaster and emergency may interrupt communication.	There are some sites frequently disturbed. Congestion caused by disaster and emergency is a main concern.	×
Cellular mobile telephone	Good	Only communication terminal equipment is needed.	Approx. 2.2 million Rs/year	by Operator	Personnel expenditure to confirm line availability from the terminal is necessary.	No problem	Negligible	Possible	Impossible to introduce it in all points as mountains and remote localities are beyond coverage. May not be used during disaster and emergency.	Although usable areas are expanding by carrier efforts, there are still some sites beyond network coverage. There is a concern for congestion during disaster and emergency.	×
DCP and GTS	Good	Hub station is not needed.	No costs	by Satellite owner and countries connecting to GTS	Personnel cost to confirm abnormalities involved in observed data is necessary	No problem as weather communication equipment.	Some lag	Impossible	Possible to use METEOSAT*, an European weather satellite. Use it for data collection as an uploading circuit and GTS as a downloading circuit.	Need minimum maintenance cost, but slow transmission speed (300bps). Two-way communication circuits are additionally needed. At present, secured, budget allocation for satellite operation is until 2008.	×
Satellite communication (VSAT)	Good	Relatively high cost. But, it is becoming lower.	Approx. 2.2 million Rs/year	by DoM	Periodical cost for maintenance using instruments and personnel cost.	No problem	Negligible	Possible	Two-way communications are possible to reduce call charge between headquarters and met. stations.	Communication quality and stability are good. It is necessary to properly set up communication cost by a contract with the satellite operator.	○

* METEOSAT, a European weather satellite, is temporarily operated to fill the blank of weather observation on the Indian Ocean.

(5) Structure of the meteorological information network system

Based on the above-mentioned consideration, the planned meteorological information network system is illustrated in Figure 2-1.

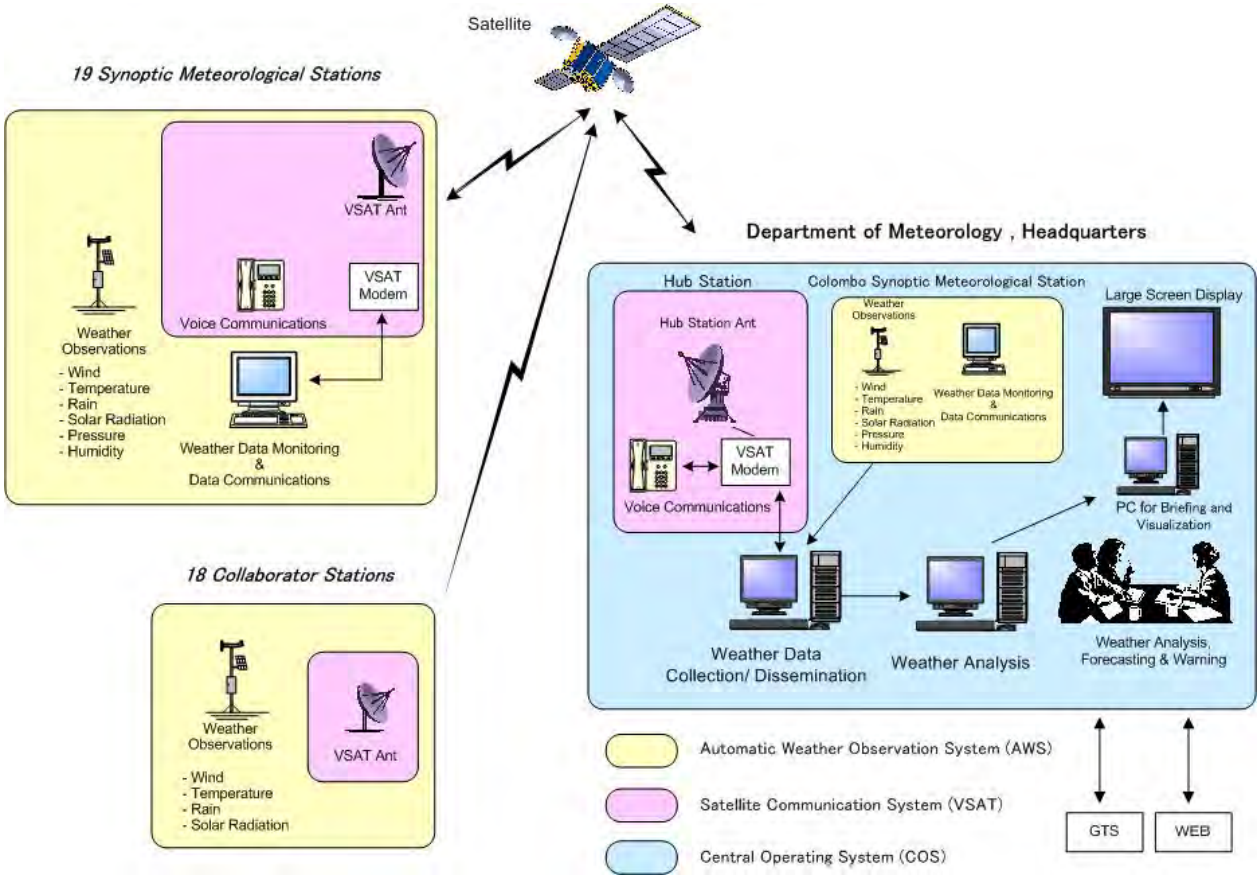


Figure 2-1 Meteorological Information Network System

1) Automatic weather observation station (AWS) system

This system is to automate the observation of 7 weather items, such as wind direction/speed, temperature, humidity, barometric pressure, rainfall and solar radiation at synoptic meteorological stations, and 5 weather items, i.e. wind direction/speed, temperature, rainfall and solar radiation at collaborator stations. The synoptic meteorological stations can make real time monitoring of observed data by connecting the automatic weather observation system with the remote monitoring/observation data processing PCs. It is also possible to input visually observed weather elements into it for transmitting observed data to DoM headquarters.

2) Satellite communication system (VSAT system)

The satellite communication system is to transmit weather data obtained by the automatic weather observation systems to DoM headquarters in Colombo via the satellite. The headquarters will have a hub station to receive data from other observatories. Data from the

Colombo synoptic meteorological station will be directly collected via a communication cable, instead of the satellite, because the station is located in the same premise of the headquarters. Telephones to be installed at 19 synoptic meteorological stations and DoM headquarters, except for the Colombo station, will enable DoM headquarters to make interactive voice calls with these stations via the satellite.

3) Central operating system（COS）

The system is to collect weather data transmitted from 38 observatories distributed nationwide to DoM headquarters in Colombo, calculate hourly and daily statistics for each observation stations, edit and store data as electronic files in accordance with prescribed formats, automatically generate data format to be transmitted to GTS equipment, and automatically acquire GTS data format from the GTS equipment. It is planned to provide a large screen display to view collected and edited observation data at meetings to be held for ordinary weather forecasting.

(6) Installation method of equipment at 7 sites located in northeastern areas

The automatic weather observation systems and VSAT systems for the seven sites of Jaffna, Trincomalee, Batticaloa, Mannar, Pottuvil, Ampara, and Vavuniya shall be delivered in Colombo because of the security concerns considered by the Japanese side. The Sri Lanka side shall be responsible for transporting, installing and adjusting these systems for those 7 sites within one year after completion of the Project (by March 2010).

The delivery of equipment for the 7 sites is to be based on the premise that DoM conduct the installation, adjustment, and connection and operation tests of the equipment and materials by itself. These work shall be guaranteed by the technology transfer to be provided to the staff of DoM by the contractor of the Project during project implementation period.

DoM plans to assign 6 persons for the operation and maintenance of the meteorological information network system. The contractor shall train them for the installation, adjustment, trial run and connection test of the system. The contractor shall conduct the installation, adjustment, trial run and connection test of the systems at 31 sites. It is planned to conduct equipment installation by five teams. Each team shall carry out installation work 6 to 7 times. The installation, adjustment, trial run and connection test of the system will be conducted 31 times and on-the-site training will be carried out during this period.

Thus, DoM will have sufficient time to provide the transfer of technologies to its staff members.

2-2-2-2 Equipment allocation plan

The major equipment in accordance with the item 2-2-2-1 “Formulation of basic plan” and objective sites to be installed are shown in the following table:

Table 2-4 Equipment Allocation Plan

Name of Equipment	Sites and Number of Units																																						DOM(Colombo)	Total Number of Units
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18		
	Anuradhapura	Badulla	Batticaloa	Colombo	Bandarawela	Galle	Hambantota	Jaffna	Katugastota	Katunayaka	Kurunegala	Maha Illuppallama	Mannar	Nuwara Eliya	Pottuvil	Puttalam	Ratmalana	Ratnapura	Trincomalee	Vavuniya	Wagolla	Polonnaruwa	Moneragala	Matale	Sevanagala	Angunakolapelessa	Ampara	Matara	Deniyaya	Horton Plains	Mt. Pidurutalagala	Aralaganwila	Balangoda	Maliboda	Labugama	Tawalama	Kuwada	Sirikandura		
Automatic Weather Observation System																																								
Observation items: Wind direction/speed, temperature, humidity, barometric pressure, rainfall and solar radiation data loggers, and power source (solar power generation)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				20
Observation items: Wind direction/speed, temperature, rainfall and solar radiation data loggers, and power source (solar power generation)																					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		18
PC and peripherals for remote monitoring and observation data processing	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				20
Satellite Communication System																																								
Parabola antenna and peripherals for VSAT main station transmission (including voice telephone)																																							1	1
Parabola antenna and peripherals for VSAT sub-station transmission (including voice telephone)	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				19
Parabola antenna and peripherals for VSAT sub-station transmission																					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		18
Central Operating System																																								
COS server, data processing software, PC for monitoring and visualization processor, large screen display and peripherals																																							1	1

2-2-2-3 System plan

(1) Automatic weather observation system

1) System outline

Observation sensors and the observation items described in Section 2-2-2-1 (2) shall be automated at synoptic meteorological stations and collaborator stations. Their measurement range shall be set as follows in accordance with the precision requirement of WMO depending upon the weather conditions at the sites.

Table 2-5 Measurement Scope and Units for Sensors

Elements	Observation method				Planned device
	Device	Observation range	Unit	Position	
Wind direction	Vane	0 to 360 °	1 °	10 m	Ultra Sonic Sensor
Wind speed	Anemometer	0 to 60 m/s	0.1 m/s		
Temperature	Thermometer	-10 to 60 °C	0.1 °C	1.5 m	Electric Thermometer
Humidity	Hygrometer	0 to 100%	1%	1.5 m	Electric Hygrometer
Barometric pressure	Barometer	500 to 1,100hPa	0.1 hPa	0.1hPa	Electric Barometer
Rainfall	Rain gauge	Measurable equal to or more than 200mm/h	0.5 mm	Surface	Tipping-Bucket Rain Gage
Solar radiation	Pyranometer	4.68MJ/m^2	0.1MJ/m^2	Sunny place	Electric Pyranometer

Each sensor should be calibrated in DoM headquarters at least once a year. During the calibration period, an alternative sensor should be installed temporarily so that continuous observation should be made. For this purpose, necessary replacement sensors shall be equipped.

2) Power source

i. Power source for automatic weather observation system

The automatic weather observation system will use solar panel with batteries to meet the conditions described in Section 2-2-1-2 (5), in order to assure supplying the power source for the system during no solar radiation period. By assuming a maximum of 3 days of no solar radiation period based on past observation records, the battery capacity (about 100Ah) is planned to operate the system for 5 days. The configuration of power source is indicated in Figure 2-2.

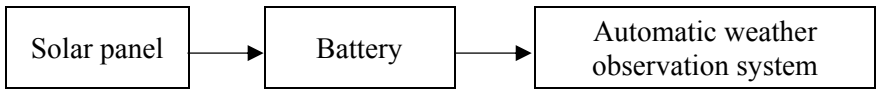


Figure 2-2 Power Source of the Automatic Weather Observation System

ii Power source for remote monitoring/observation data processing PC

The backup time period for uninterruptible power source (UPS) for the PC for remote monitoring/ observation data processing is planned to be 10 minutes to save files used and shutdown the computer power source safely.

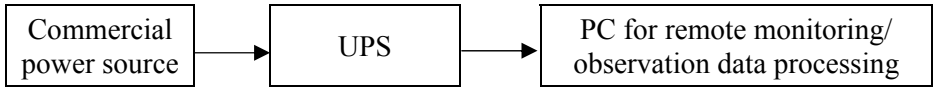


Figure 2-3 Power Source for Remote Monitoring/Observation Data Processing

(3) Satellite communication system

1) System outline

The Project will employ a satellite communication system (VSAT system) connecting DoM headquarters in Colombo and other observatories, which will meet the following conditions:

i. The Project will employ C-band, little affected by rainfall and that can transmit observed weather data and that can make interactive communication during rainfall disaster.

ii. DoM will make a contract with an operator of the C-band satellite that can cover the entire Sri Lanka and that is operated at a position where there are no obstacles in the radio wave propagation path from the surface station.

iii. The frequency band necessary for collecting weather observation data and interactive communication between DoM headquarters and each synoptic meteorological station will be the basis for circuit charge for the satellite operator, and narrow band width will be adopted. Two channels of 32kbps capacity are necessary for interactive voice communication between each synoptic meteorological station and the headquarters and 1kbps transmission capacity per a collaborator station is necessary for data transmission to the hub station. It is planned to set a band width of 500kHz or lower for this purpose.

iv A hub station receives data from all observation stations and controls the interactive voice communication. As interrupting the hub stations affects whole communication system, core part called RF unit will be adopted having backup unit so that it may possible to make continuous operation even if failure in the operating RF unit occurs.

v As for communication equipment, periodical maintenance is required so as to operate it stably. The necessary maintenance tools for this purpose is planned to equip.

2) Power source

Concerning power source conditions, described in Section 2-2-1-2 (5), and the satellite communication system, the link with the satellite must be maintained and energized all times. If the power fails, the whole system among the hub station and terminal-stations must be reset, which may require extra time. The power source of the satellite communication system will therefore be of a combination of solar panel and battery. The battery capacity (about 10kW) is planned to enable operation during maximum 5 days of battery backup time the same for the automatic weather observation system.

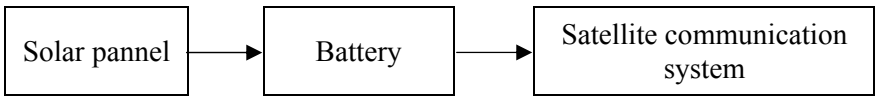


Figure 2-4 Power Source for Satellite Communication System

(4) Central operating system（COS）

1) System outline

The system will be composed of a communication processing (collection and distribution of weather data) system, an analysis (weather information analysis and display) system, and visual information display system. The system is planned to have the following functions:

i. Communication processing system

The system will collect and edit automatic and visual observation elements sent from each observatory, convert them to the WMO format for transmission and receive/transmit weather information between GTS to be developed by DoM. It will also provide weather information within DoM and to external organizations.

ii. Analysis processing system

It will analyze domestic observation data and information from foreign weather analysis centres obtained through the communication processing system to make weather forecasts.

iii. Information display system

It will be composed of PC for forecast analysis and a large-screen display to display the information prepared by the analysis processing system. Forecasting staff will share the information and review the prepared weather forecasts to be issued, and prepare weather warnings upon severe weather and decide their announcement.

2) Power source

The central operating system will be installed at DoM headquarters. As DoM headquarters has power generators, it shall be applied uninterruptible power source (UPS) in addition to the commercial power source. Backup period by UPS shall be 10 minutes for saving computer files used and shutting down the computers safely.

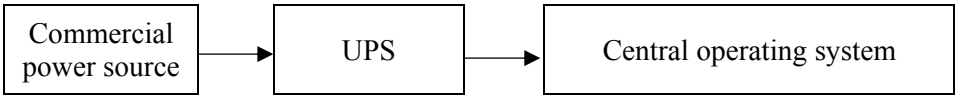


Figure 2-5 Power Source for Central Operating System

(5) Maintenance equipment and materials

It is planned to provide calibration devices necessary for maintaining the automatic weather observation system, replacement sensors for the maintenance of appliances, and the maintenance instruments for the satellite communication system.

1) Calibration devices for automatic weather observation system

It is planned to provide calibration devices to maintain the measuring precision of the automatic weather observation systems that measure wind direction and speed, barometric pressure, temperature, humidity, etc.

Table 2-6 Calibrators for Automatic Weather Observation System

No.	Item name	Purpose	Q'ty
1	Psychrometer Calibrator	To guarantee the precision of temperature and humidity gauges	1
2	Thermometer and Hygrometer Calibrator	To set up a constant temperature and humidity and calibrate thermometer and hygrometer	1
3	Reagent for Humidity Correction	Reagent to generate a constant humidity	1
4	Temperature and Humidity Standard Gauge	To measure temperature and humidity with guaranteed precision	1
5	Standard Temperature Resister	To generate standard resistance for calibration	1
6	Wind Sensor Verifier	To measure the functions of ultra sonic wind sensor	1
7	Digital Barometer	A barometer with guaranteed measurement precision	1
8	Computer (Note Type)	PC to set up measurement environment and verify and record calibration results.	1
9	Digital Multi-meter	To measure voltage and resistance of sensors	1

2) Replacement appliances for maintenance

The observation appliances shall be precisely inspected once a year to identify measurement error near the upper limit, lower limit and middle point of measurement range by using the calibration devices mentioned above. Weather observation shall be continuously conducted by substitute appliances during the inspection period. The precise equipment inspection shall be conducted at DoM headquarters. Three weeks will be necessary for the precise inspection for one observatory. In consideration of the inspection of 38 sites appliances and substitute sensors once a year, three sets of replacement sensors are necessary.

Table 2-7 Breakdown of Replacement Sensors for Maintenance

No.	Sensor	Qty
1	Barometer	3
2	Wind Speed and Direction Sensor	3
3	Thermometer	3
4	Hygrometer	3
5	Pyranometer	3
6	Rain Gauge	3

3) Maintenance equipment for satellite communication system

The following instruments are planned to be provided to maintain transmission power, frequency and other properties prescribed for VSAT system to be employed in the satellite communication system.

Table 2-8 Instruments for VSAT system

No.	Item	Purpose	Q'ty
1	Spectrum analyzer	To measure frequency and modulation properties of signals	1
2	Microwave frequency counter	To measure frequency for the applied microwave band	1
3	Microwave power meter	To measure the power for the applied microwave band	1
4	Microwave power attenuator	To reduce the power to the applicable range of power meter	1
5	Attenuator set for microwave		
6	Coaxial cable set	To connect gauges with the communication equipment	1
7	Digital circuit tester	To measure circuit properties of the components of satellite communication equipment	1

(6) Spare and consumable parts plan

There is no plan to provide spare parts and consumables for the equipment and materials to be provided in this Project.

2-2-2-4 Equipment plan

In the equipment plan, the detailed specifications and quantities of equipment units shall be decided upon as follows in accordance with the contents set up in Sections 2-2-2-2 "Equipment allocation plan" and 2-2-2-3 "System planning" as follows:

(1) Automatic Weather Observation System

Equipment Name	Specification or Composition	Q'ty	Purpose
Synoptic Meteorological Station	Measurement units: Wind speed and direction, Thermometer, Hygrometer, Rain gauge, Barometer, Pyranometer, Data logger, solar panel with battery, Mounting pole for Sensors	20	To make a meteorological observation and record the measured data
Collaborator Station	Measurement units: Wind speed and direction, Thermometer, Rain gauge, Pyranometer, Data Logger, Solar panel with battery, Mounting Pole for Sensors	18	To make a meteorological observation and record the measured data
Computer Hardware for Remote Monitoring/Observation Data Processing	Desktop Type, Display: Min. 15 inches LCD, CPU: Pentium IV 2.8GHz or more, HD: 40GB or more, Memory: 512MB or more, CD-RW Drive: shall be equipped, OS: Min. Window XP Professional (English version), Application: Microsoft Office latest version (English)	20	To monitor meteorological data and input visually observed data. To display data from the department of meteorology in Colombo through the satellite communication system
Computer Software for Remote Monitoring/Observation Data Processing	Automatic data collection: Real time value with every 1-minute interval collections, Data logging: Capable for 3 days long stored at least, System control center for system supervision: With watchdog fault detecting feature, Communications control: TCP/IP based socket protocol, Alarms: Alarms and pop-up screen, Station history view: Graphical trend view, Multiple data transmission: TCP/IP, FTP, SMTP, POP3 etc, Map presentation of the current information, Generating SYNOP weather messages, Data logging electronic form: Binary stored format with Open Database Control, Monthly report in made automatically, English language user interface, Displaying/ printing of table and graphics	20	To monitor meteorological data and input visually observed data. To display data from department of meteorology in Colombo through the satellite communication system
Printer	Color Inkjet type, Size: Up to A3 size, Resolution: Min. 2,400×1,200 dpi	20	To print meteorological observation data
UPS	Operating time: Min. 10 minutes	20	To back up commercial power supply for Computers for metrological data input/output Processing
Maintenance Equipment	Psychrometer Calibrator	1	To maintain measurement precision of sensors
	Thermometer and Hygrometer Calibrator	1	
	Reagent for Humidity Correction		
	Temperature and Humidity Standard Gauge	1	
	Standard Temperature Resister		
	Wind Sensor Verifier	1	
	Digital Barometer	1	
	Computer (Note Type)	1	
	Digital Multi-meter	1	
Replacement Appliance	Thermometer	3	Fallback equipment for the maintenance of sensors
	Wind Speed and Direction Sensor	3	
	Hygrometer	3	
	Barometer	3	
	Pyranometer	3	
	Rain gauge	3	

(2) Satellite Communication System

Equipment Name	Specification or Composition	Q'ty	Purpose
HUB Station Equipment	Operating Frequency: C band (Transmit 5.58 to 6.35 GHz, Receive 3.4 to 4.1 GHz), Space segment requirement: 0.5 MHz or lower	1	To transmit and receive meteorological observation data and verbal communications between hub station and terminal stations
Terminal Station's Equipment for Synoptic Meteorological Station	Operating Frequency: C band (Transmit 5.58 to 6.35 GHz, Receive 3.4 to 4.1 GHz), Space segment requirement: 0.5 MHz or lower	19	To transmit and receive meteorological observation data and verbal communications between the hub station and terminal stations
Terminal Station's Equipment for Collaborator Station	Operating Frequency: C band (Transmit 5.58 to 6.35 GHz, Receive 3.4 to 4.1 GHz), Space segment requirement: 0.5 MHz or lower	18	To transmit meteorological observation data to the hub station
Maintenance Equipment	Spectrum Analyzer	1	To maintain equipment for the satellite communication system
	Microwave Frequency Counter	1	
	Microwave Power Meter	1	
	Microwave Power Attenuator	1	
	Attenuator Set for microwave	1	
	Coaxial cable set	1	
	Digital Circuit Tester	1	

(3) Storage Box

Equipment Name	Specification or Composition	Q'ty	Purpose
Storage Box for Synoptic Meteorological Station	To store the RF Unit, the data logger and the solar battery for Synoptic Meteorological Station	19	To store the RF unit, the data logger and the solar battery for Synoptic Meteorological Station
Storage Box for Collaborator Station	To store the RF Unit, the data logger and the solar battery for Collaborator Station	18	To store the RF unit, the data logger and the solar battery for Collaborator Station

(4) Central Operating System

Equipment Name	Specification or Composition	Q'ty	Purpose
COS Servers	Tower Type Intel-base Server, CPU: Intel Xeon / 3 GHz or more, HD: Serial ATA 160GB or more, Memory: 1GB, CD-ROM / DVD-RW drive shall be equipped, Power Source: 100-240V 50/60Hz, Standard 104 Keyboard and 3-button optical mouse, 17 inch TFT Monitor, OS: Window Small Business Server 2003 (English version)	2	To collect, process, analyze, and store meteorological observation data and display the analysis and processing results.
Monitoring and Visualization Processors	Desktop type, 17 inches TFT Monitor or more, CPU:Pentium 4/2.8GHz or more, HD:80GB or more, Memory: 1GBor more, CD-RW drive: shall be equipped, OS: Window XP Professional (English version)	1	To display data on a large screen for map discussion
Large Display System	Plasma Display or equivalent, Display size: 63V Wide Type (w1393mm×h783mm) or more, Display Resolutions: 1366×768 or more	1	
Data Analyzing Software	Message Routing Features: Routing control based on WMO message headers, Database System: SGL Relational Database Management System, Message Format: WMO-306 Standard Data Format Compatible, Communication Protocols: WMO-386 Standard Communication Protocol Compatible, Data viewing formats: GRIB-1/2, BUFR, NetCDF, Ground Synoptic Observations: WMO FM12 SYNOP, Ship Synoptic Observations: WMO FM13 SHIP, Observation Data: WMO FM15 METAR, Upper Air Observations: WMO FM35 (TEMP)	1	To collect, process, analyze, and store meteorological observation data and display the analysis and processing results. To compose, transmit, and receive GTS messages for WMO
UPS	Operating time: Min. 10 minutes	3	To back up commercial power supply for COS Servers and Monitoring and Visualization Processors
Router	10/100-Mbps LAN	1	To connect the web server of the Department of Meteorology and GTS
Switching TAP HUB	100 Base-TX / 10 Base-T x 8	1	
Printer	Color Inkjet type, Size: Up to A3 size, Resolution: Min. 2,400×1,200 dpi	2	To print data of COS servers and Monitoring and Visualization Processors

2-2-3 Basic design drawing

According to Section 2-2-2 “Basic plan”, system configuration and equipment layout drawings for synoptic meteorological stations and collaborator stations are attached on the next page.

Basic Design Drawings & Equipment List

G-01 Equipment List

A-01 System Configuration－Synoptic Meteorological Station and Collaboration Station
A-02 System Configuration－DoM（Colombo）

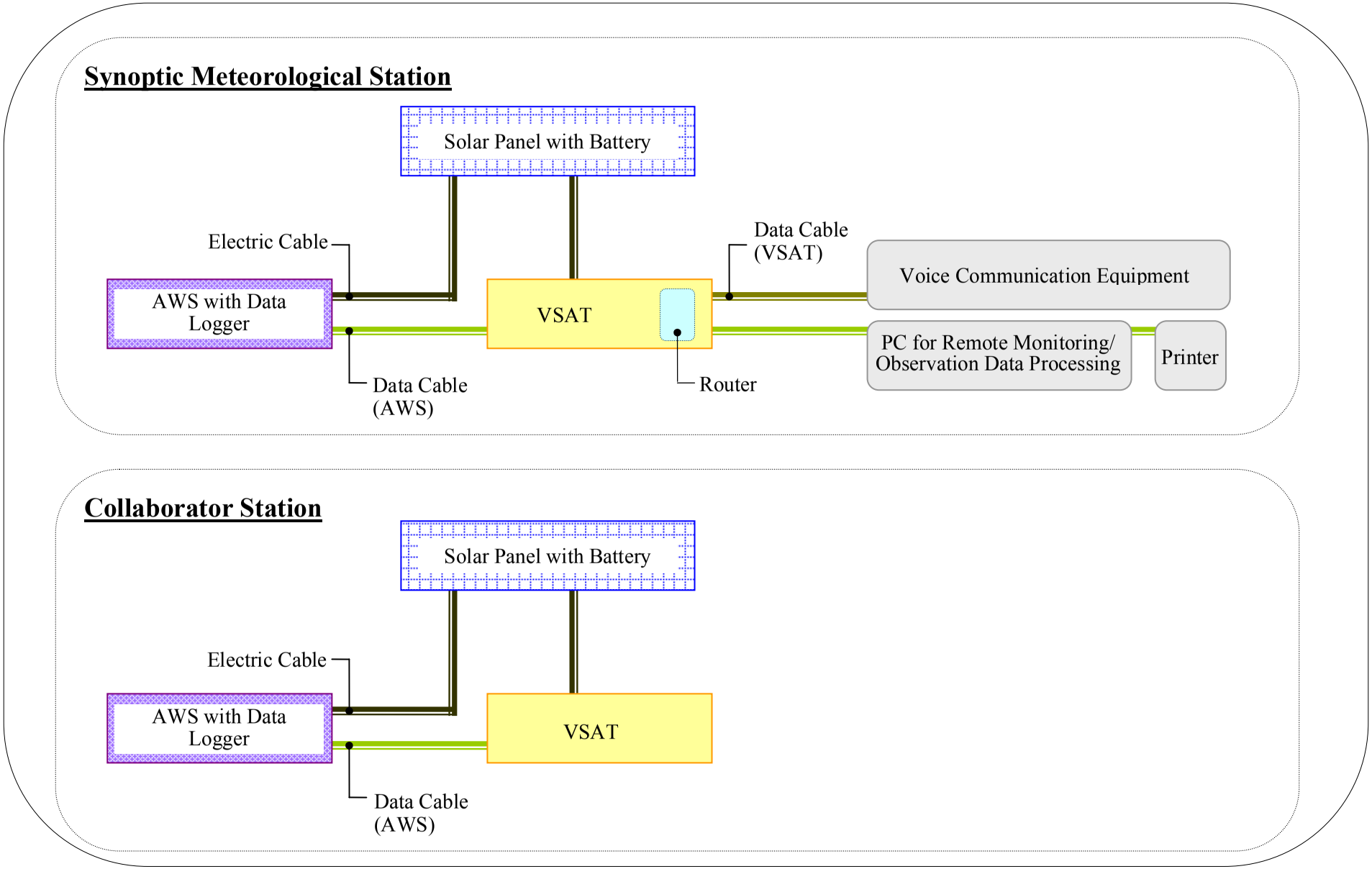
M-01 Equipment Layout－Anuradhapura
M-02 Equipment Layout－Badulla
M-03 Equipment Layout－Batticaloa
M-04 Equipment Layout－Colombo H.Q.
M-05 Equipment Layout－Bandarawela
M-06 Equipment Layout－Galle
M-07 Equipment Layout－Hambantota
M-08 Equipment Layout－Jaffina
M-09 Equipment Layout－Katugastota
M-10 Equipment Layout－Katunayaka
M-11 Equipment Layout－Kurunegala
M-12 Equipment Layout－Maha Illuppallama
M-13 Equipment Layout－Mannar
M-14 Equipment Layout－Nuwara Eliya
M-15 Equipment Layout－Pottuvil
M-16 Equipment Layout－Puttalam
M-17 Equipment Layout－Ratmalana
M-18 Equipment Layout－Ratnapura
M-19 Equipment Layout－Trincomalee
M-20 Equipment Layout－Vavuniya

C-1 Equipment Layout－Wagolla
C-2 Equipment Layout－Polonnaruwa
C-3 Equipment Layout－Moneragala
C-4 Equipment Layout－Matale
C-5 Equipment Layout－Sevanagala
C-6 Equipment Layout－Angunakolapelessa
C-7 Equipment Layout－Ampara
C-8 Equipment Layout－Matara
C-9 Equipment Layout－Deniyaya
C-10 Equipment Layout－Horton Plains
C-11 Equipment Layout－Mt. Pidurutalagala
C-12 Equipment Layout－Aralaganwila
C-13 Equipment Layout－Balangola
C-14 Equipment Layout－Maliboda
C-15 Equipment Layout－Labugama
C-16 Equipment Layout－Tawalama
C-17 Equipment Layout－Kudawa
C-18 Equipment Layout－Sirikandura

G-01 Planned Equipment List

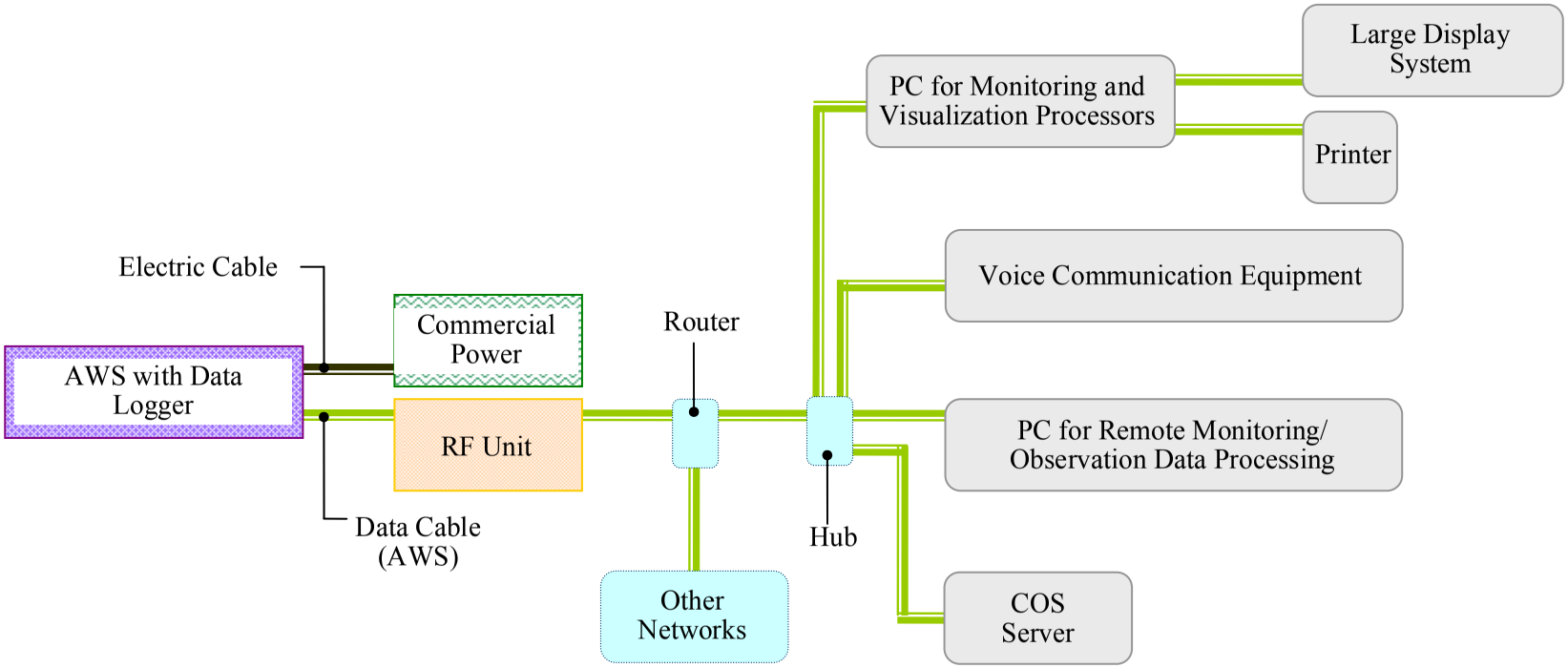
NO.	Equipment Name	Specifications or Composition	Q'ty	unit
1-1	Automatic Weather Observation System for Synoptic Meteological Station	Measurement units: Wind speed and direction, Therometer, Hygrometer, Rain gauge, Barometer, Pyranometer, Data logger, solar panel with battery, Mounting pole for Sensors	20	set
1-2	Automatic Weather Observation System for Collaboration Station	Measurement units: Wind speed and direction, Therometer, Rain gauge, Pyranometer, Data Logger, Solar panel with battery, Mounting Pole for Sensors	18	set
1-1-2-1	Computer hardware for remote monitoring / observation data processing	Desktop Type, Display: Min. 15 inchs LCD, CPU: Pentium Ⅳ 2.8GHz or more, HD: 40GB or more, Memory: 512MB or more, CD-RW Drive: shall be equipped, OS: Min. Window XP Professional (English version), Application: Microsoft Office latest version (English)	20	set
1-1-2-2	Computer software for remote monitoring / observation data processing	Automatic data collection: Real time value with every 1-minute interval collections, Data logging: Capable for 3 days long stored at least, System control center for system supervision: With watchdog fault detecting feature, Communications control: TCP/IP based soclet protcol, Alarms: Alarms and pop-up scre, Station histry view: Graphical trend view, Multiple data transmission: TCP/IP, FTP, SMTP, POP3 etc, Map presentation of the current information, Generating SYNOP weather messages, Data logging electronic form: Binary stored format with Open Database Control, Monthly report in made automatically, English language user interface, Displaying/ printing of table and graphics	20	set
1-1-2-3	Printer	Color Inkjet type, Size: Up to A3 size, Resolution: Min. 2,400×1,200 dpi	20	set
1-1-2-4	UPS	Operating time: Min. 10 minutes	20	set
1-3-1	Psychrometer	Measurement Range: -30～50℃, Accuracy: ±0.3℃	1	set
1-3-2	Theromometer for Temp/Humidity calibrator	Chamber covers, transit, base plate and thermometers	1	set
1-3-3	Humidity Correction Apparatus	Two salt chambers, Chamber covers and transit cover, Base plate, Thermometers, Measurement cup and mixing spoon	1	set
1-3-4	Standard Humidity/ Thermometer	Measurement Range: 0～100%RH, Data transmission: shall be logged, and transferred to PC	1	set
1-3-5	Standard Temperature Generator		1	set
1-3-6	Wind Sensor verifier	Measurement Range: 0～65m/s, 0～360°, field verifier: shall be equipped	1	set
1-3-7	Digital Barometer	Measurement Range: 500～1100hPa	1	set
1-3-8	Computer (Note type)	for cheching the meteological equipment	1	set
1-3-9	Digital Multi-meter	for cheching the meteological equipment	1	set
1-4-1	Thermometer	Replacement appliance for Automatic Weather Observation System	3	set
1-4-2	Wind speed and direction	Replacement appliance for Automatic Weather Observation System	3	set
1-4-3	Hygrometer	Replacement appliance for Automatic Weather Observation System	3	set
1-4-4	Barometer	Replacement appliance for Automatic Weather Observation System	3	set
1-4-5	Pyranometer	Replacement appliance for Automatic Weather Observation System	3	set
1-4-6	Rain gauge	Replacement appliance for Automatic Weather Observation System	3	set
2-1	Satellite Communication System HUB Station Equipment	Operating Frequency: C band (Transmit 5.58 to 6.35 GHz, Receive 3.4 to 4.1 GHz), Space segment requirement: 0.5 MHz or lower	1	set
2-2	Satellite Communication System Terminal Station's Equipment for Synoptic Meteorological Station	Operating Frequency: C band (Transmit 5.58 to 6.35 GHz, Receive 3.4 to 4.1 GHz), Space segment requirement: 0.5 MHz or lower	19	set
2-3	Satellite Communication System Terminal Station's Equipment for Collaborator Station	Operating Frequency: C band (Transmit 5.58 to 6.35 GHz, Receive 3.4 to 4.1 GHz), Space segment requirement: 0.5 MHz or lower	18	set
2-4-1	Spectrum Analyzer	Frequency: 6 GHz or higher	1	set
2-4-2	Microwave Frequency Counter	Resolution: 10 Hz or lower	1	set
2-4-3	Microwave Power Meter	Frequency: 6 GHz or higher	1	set
2-4-4	Microwave Power Attenuator	Attenuation: 20dB, Input power 4	1	set
2-4-5	Attenuator Set for microwave	Frequency: dc to 18.0 GHz	1	set
2-4-6	Coaxial cable set	Connection cable for Maintenance equipment	1	set
2-4-7	Digital Circuit Tester	600V or more	1	set
3-1	Storage Box	To store the RF Unit, the datalogger and the solar battery for Synoptic Meteorological Station and Collaborator Station	37	set
4-1	COS Servers	Tower Type Intel-base Server, CPU: Intel Xeon / 3 GHz or more, HD: Serial ATA 160GB or more, Memory: 1GB, CD-ROM / DVD-RW drive shall be equipped, Power Source: 100-240V 50/60Hz, Standard 104 Keyboard and 3-button optical mouse, 17 inch TFT Monitor, OS: Window Small Business Server 2003 (English version)	2	set
4-2	Monitoring and Visualization Processors	Desktop type, 17 ichi TFT Monitor or more, CPU:Pentium 4/2.8GHz or more, HD:80GB or more, Memory: 1GBor more, CD-RW drive: shall be equipped, OS: Window XP Professional (English version)	1	set
4-3	Large Display System	Plasma Display or equivalent, Display size: 63V Wide Type (w1393mm×h783mm) or more, Display Resolutions: 1366×768 or more	1	set
4-4	Data Analyzing Software	Message Routing Features: Routing control based on WMO message headers, Database System: SGL Relational Database Management System, Message Format: WMO-306 Standard Data Format Compatible, Communication Protcols: WMO-386 Standard Communication Protcol Compatible, Data viewing formats: GRIB-1/2, BUFR, NetCDF, Ground Synoptic Observations: WMO FM12 SYNOP, Ship Synoptic Observations: WMO FM13 SHIP, Observation Data: WMO FM15 METAR, Upper Air Observations: WMO FM35 (TEMP)	1	set
4-5	UPS	Operating time: Min. 10 minutes	3	set
4-6	Router	10/100-Mbps LAN	1	set
4-7	Switching TAP HUB	Network Port: 100Base-TX/10 Base-Tx8	1	set
4-8	Printer	Color Inkjet type, Size: Up to A3 size, Resolution: Min. 2,400×1,200 dpi	2	set

SMS: Synoptic Meteorological Station
CS: Collaborator Station

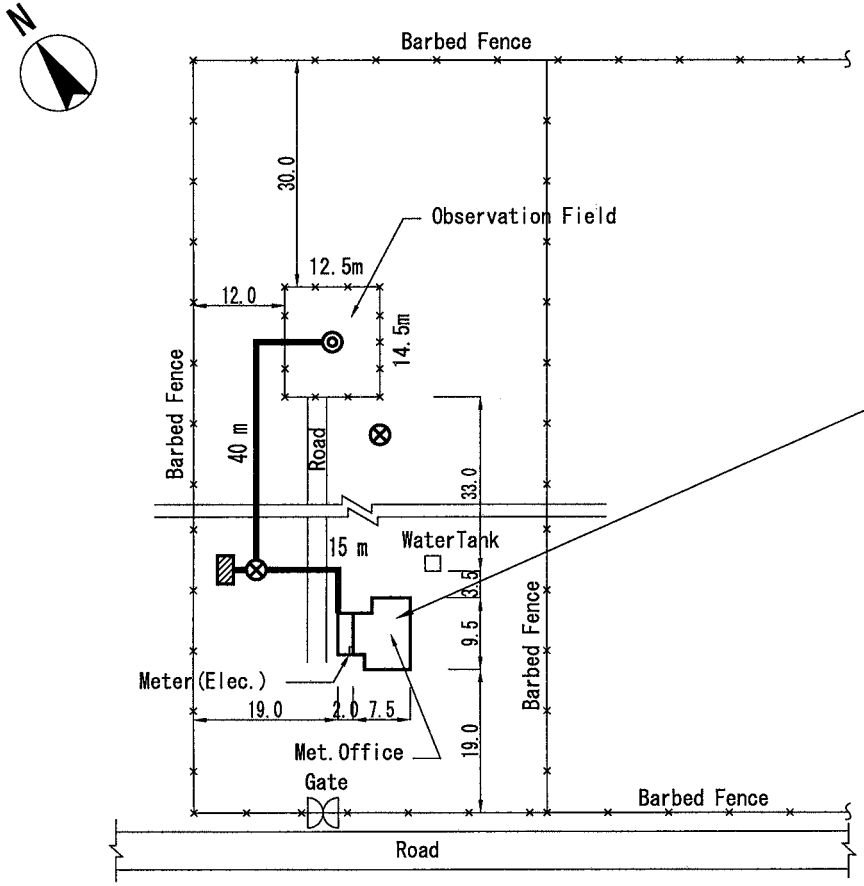


A-01 System Configuration—Synoptic Meteorological Station and Collaboration Station

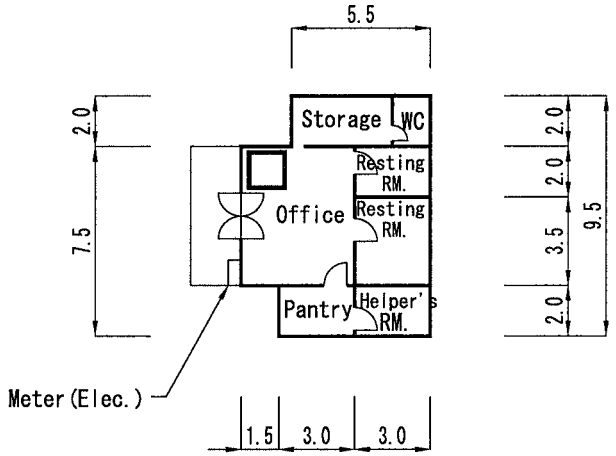
DoM（Colombo）



A-02　System Configuration－DoM（Colombo）



Layout Plan S=1/1000



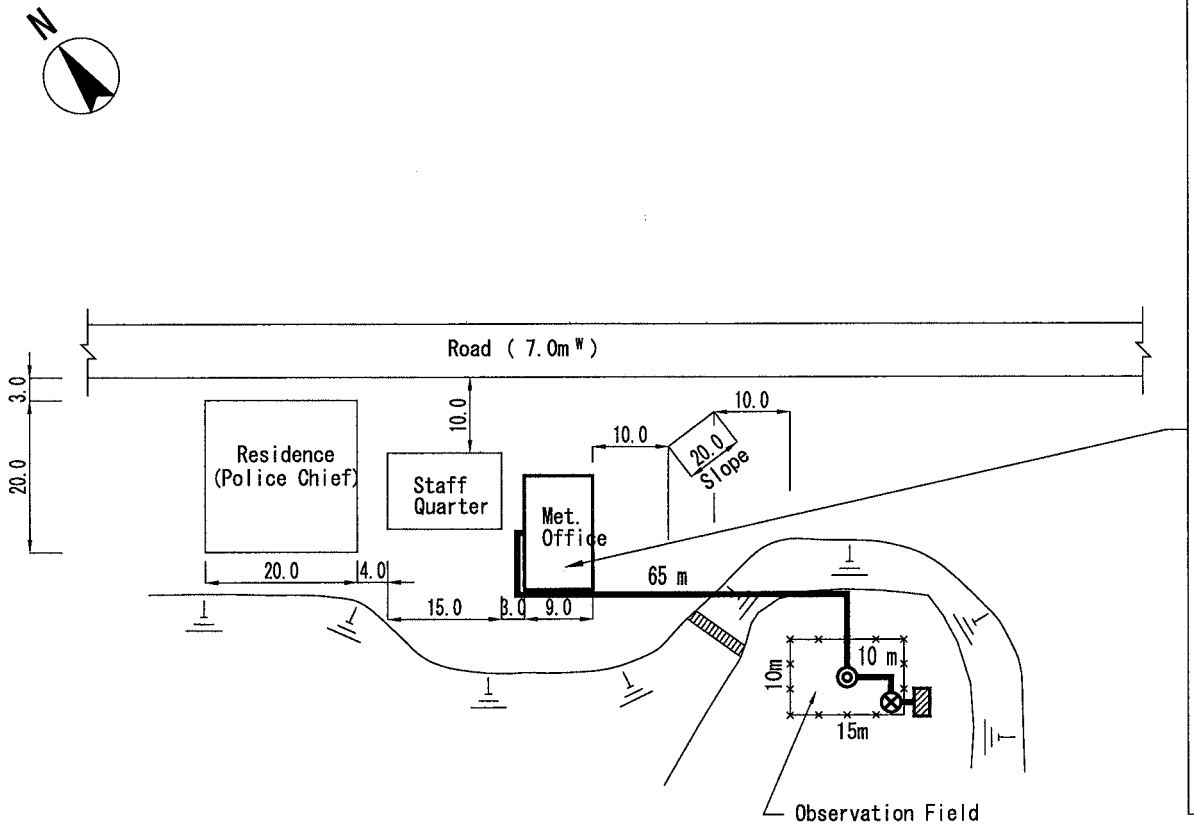
Ground Floor Plan S=1/300

Unit:m

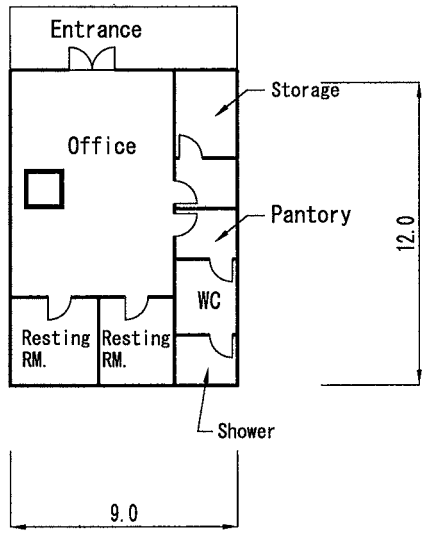
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M1 Equipment Layout - Anuradhapura



Layout Plan S=1/1000



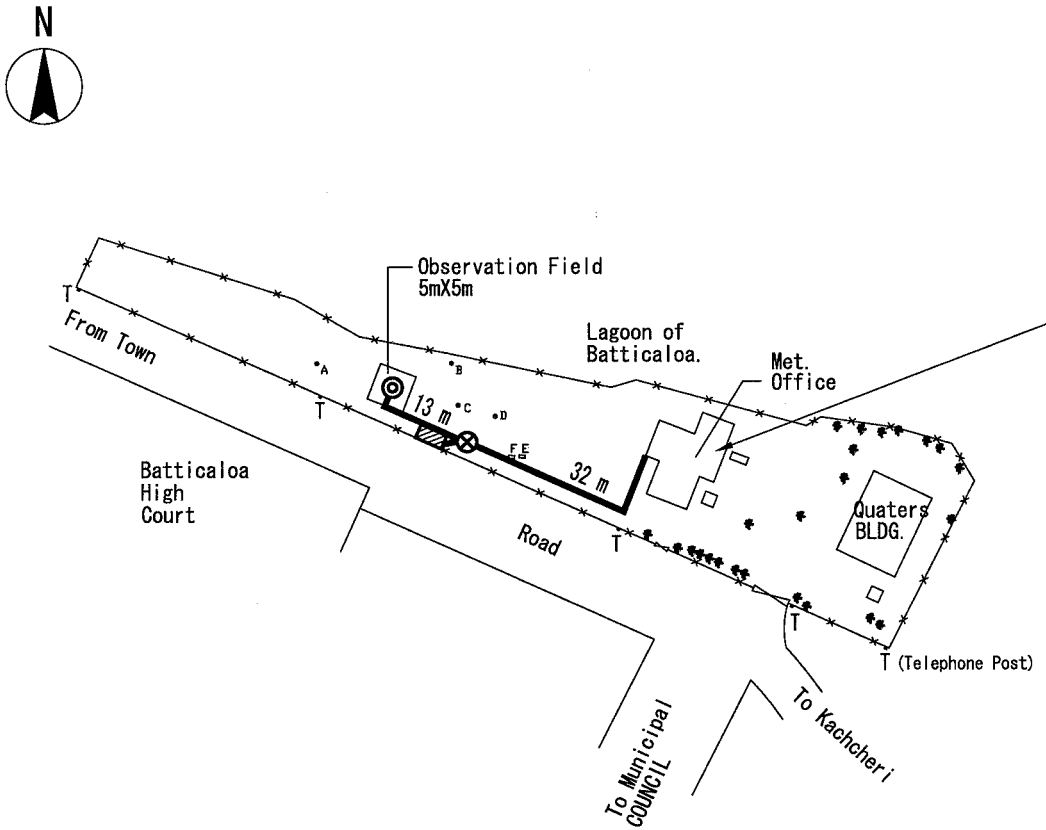
Ground Floor Plan S=1/300

Unit:m

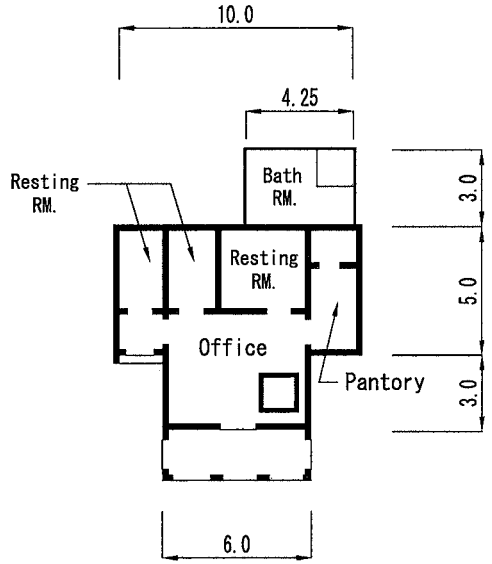
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M2 Equipment Layout - Badulla



Layout Plan S=1/1000



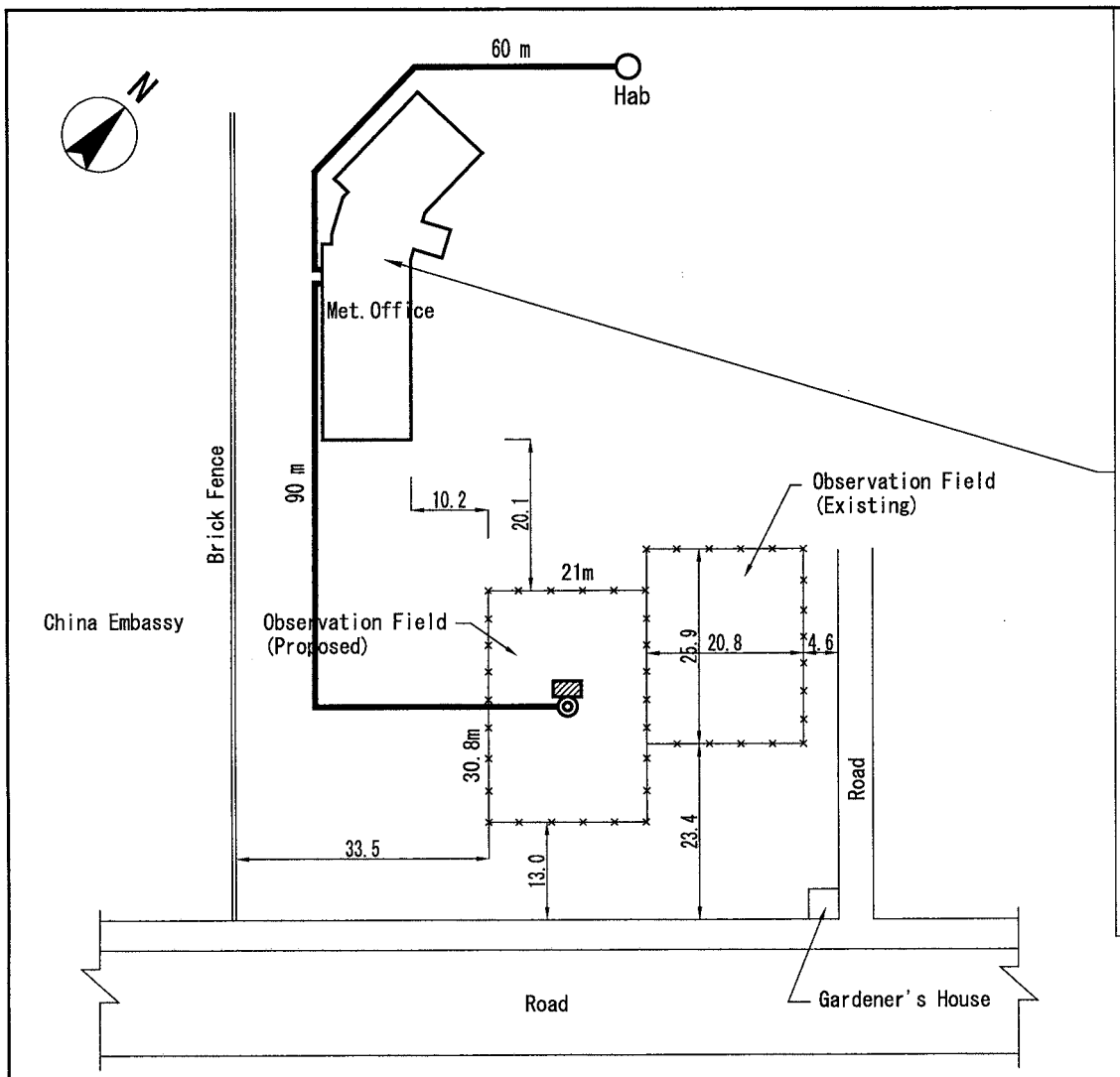
Ground Floor Plan S=1/300

Unit:m

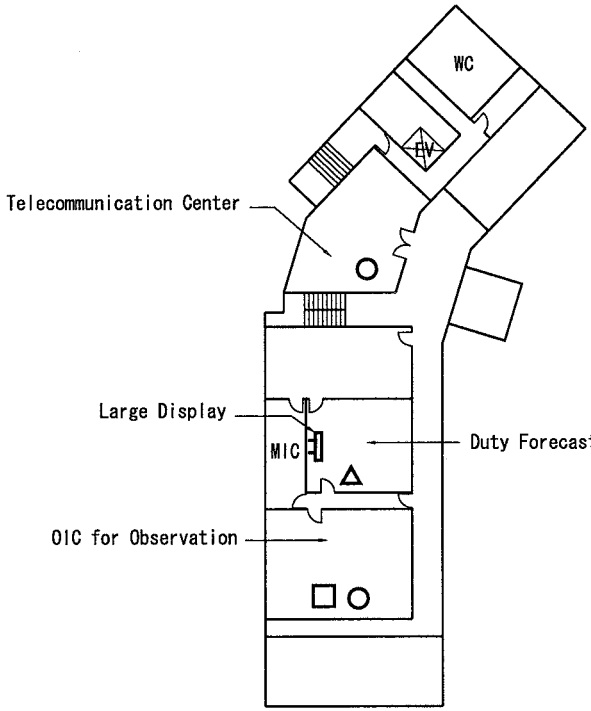
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M3 Equipment Layout - Batticaloa



Layout Plan S=1/1000



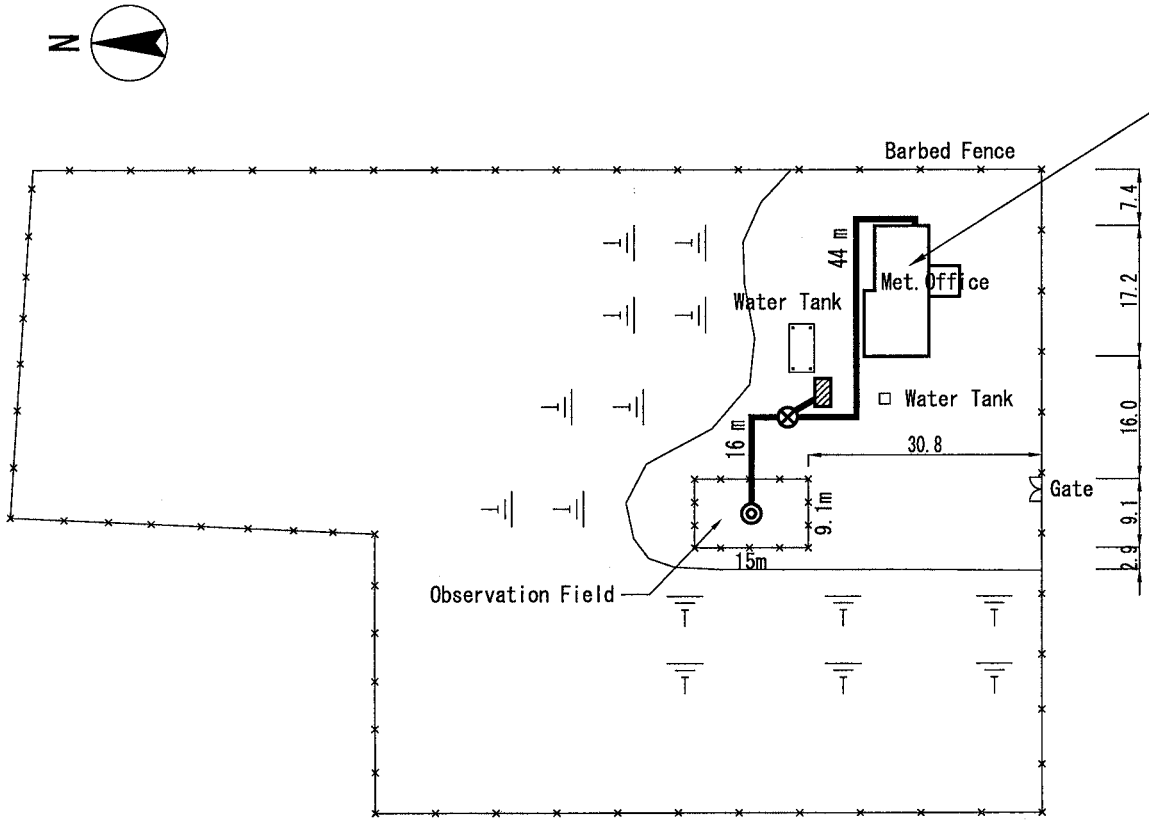
Ground Floor Plan S=1/500

Unit:m

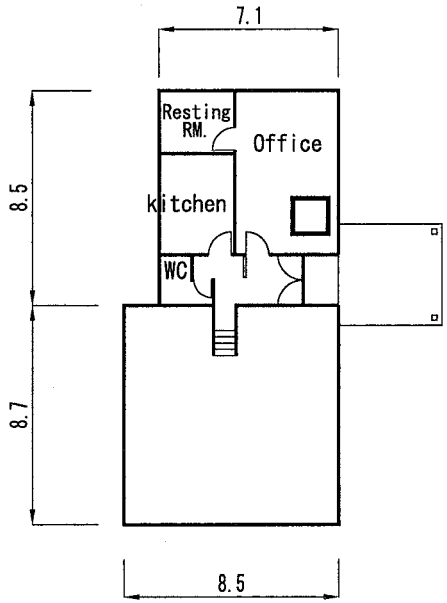
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel
- Large Display
- COS Server
- PC for Monitoring and Visualization Processor

M4 Equipment Layout - Colombo H. Q.



Layout Plan S=1/1000



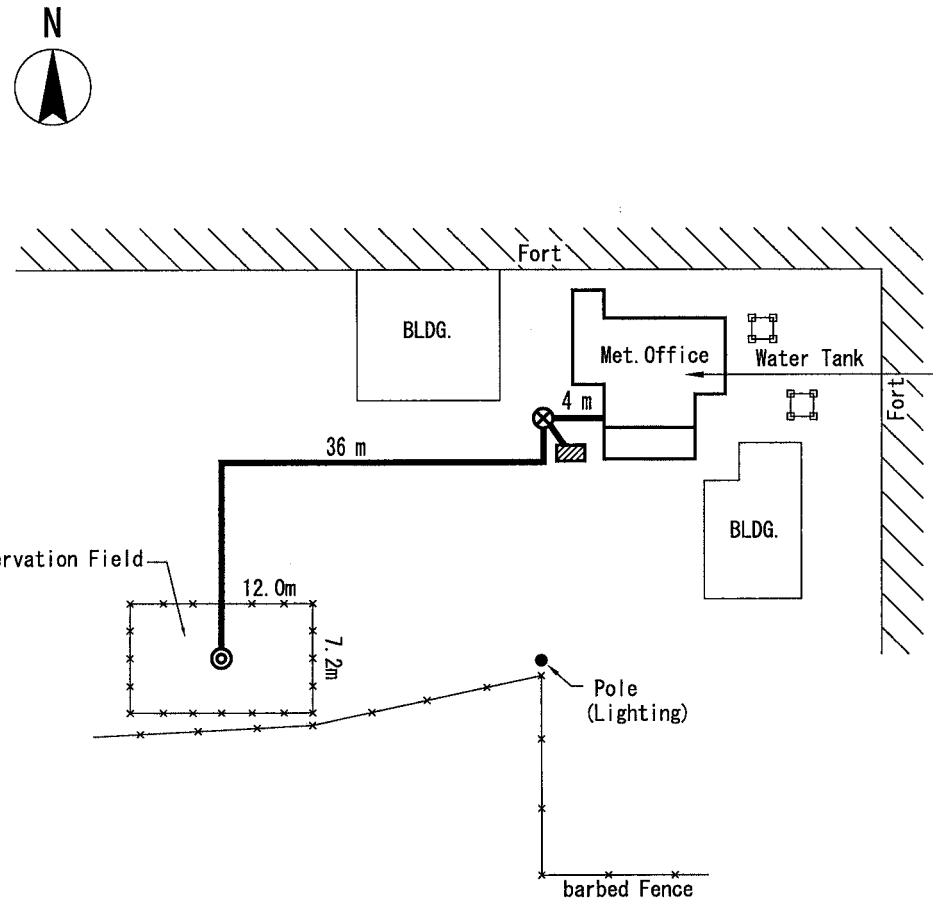
Ground Floor Plan S=1/300

Unit:m

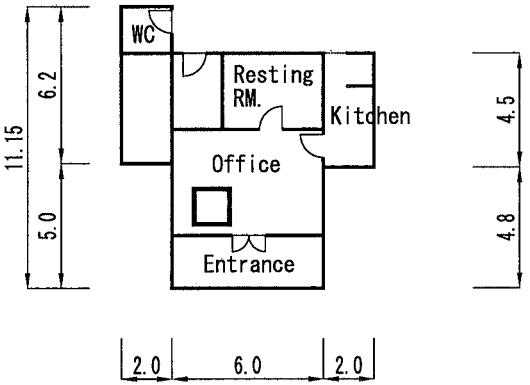
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M5 Equipment Layout - Bandarawela



Layout Plan S=1/500



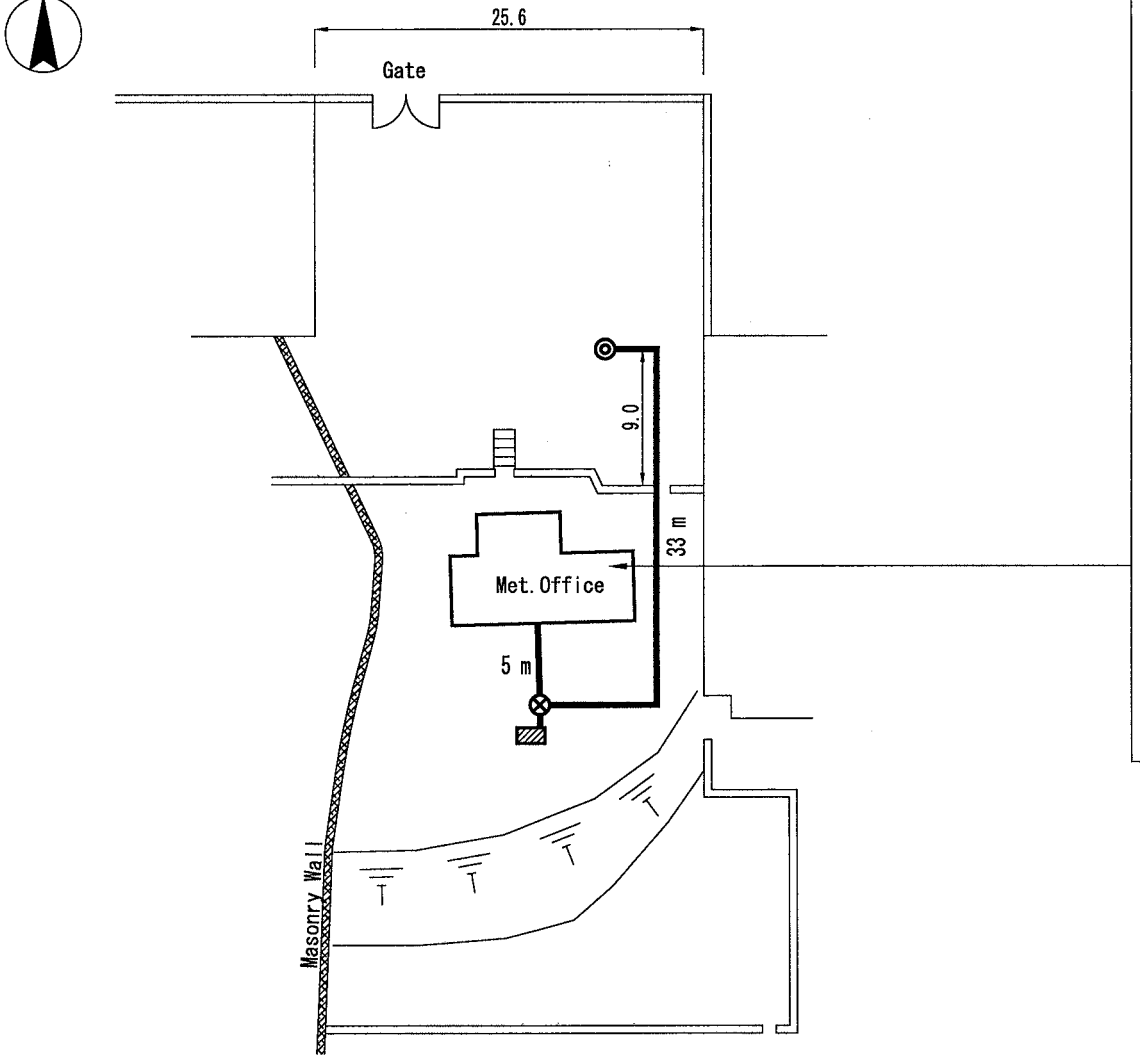
Ground Floor Plan S=1/300

Unit:m

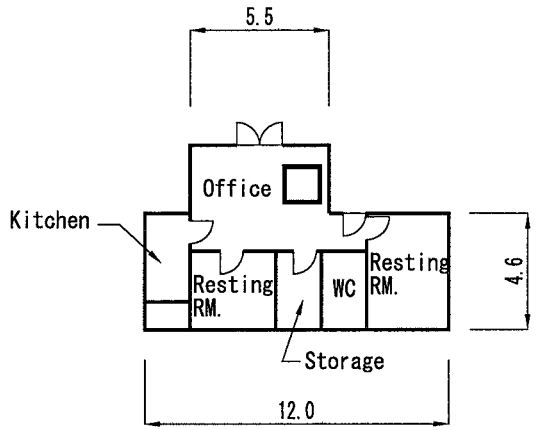
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M6 Equipment Layout - Galle



Layout Plan S=1/500



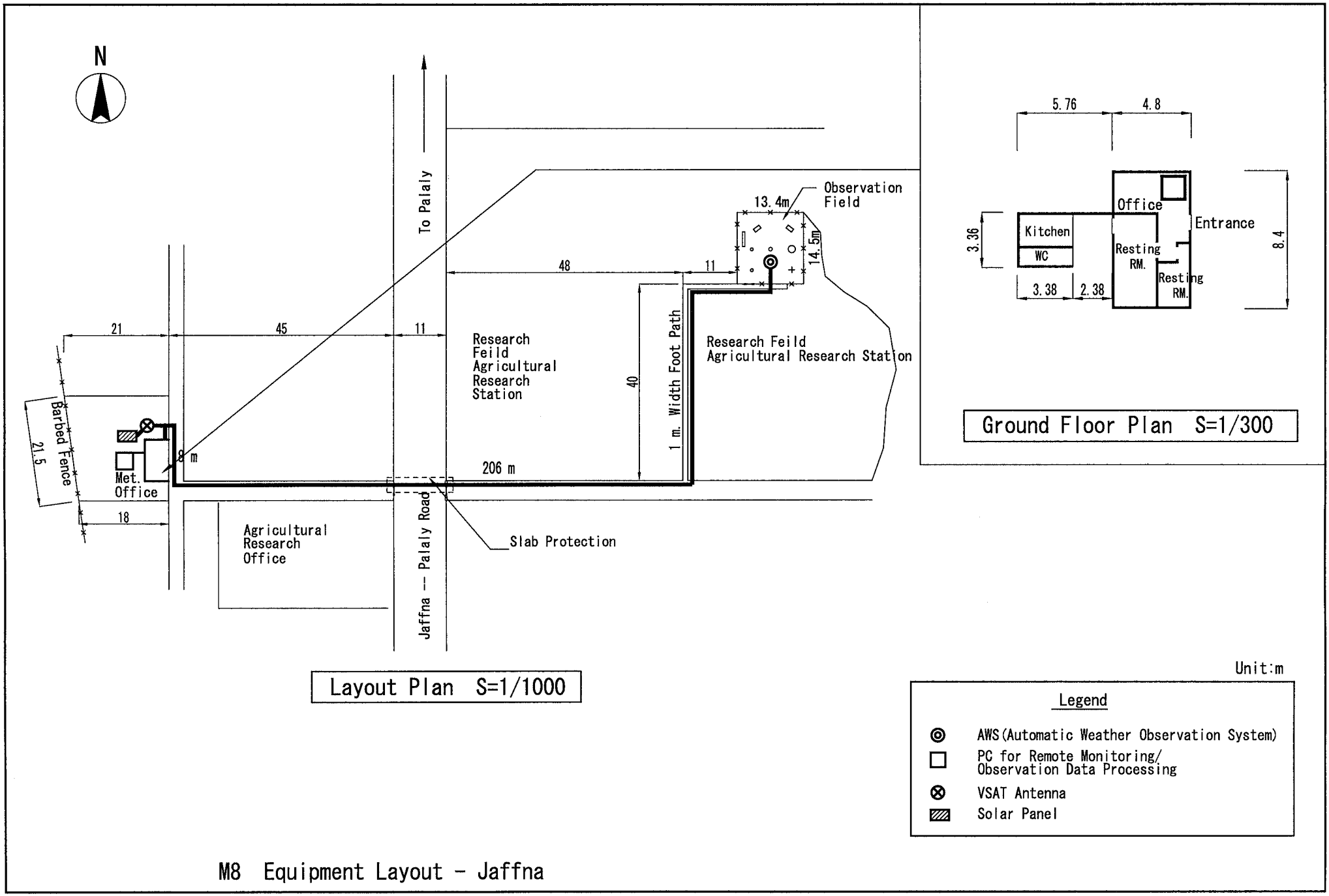
Ground Floor Plan S=1/300

Unit:m

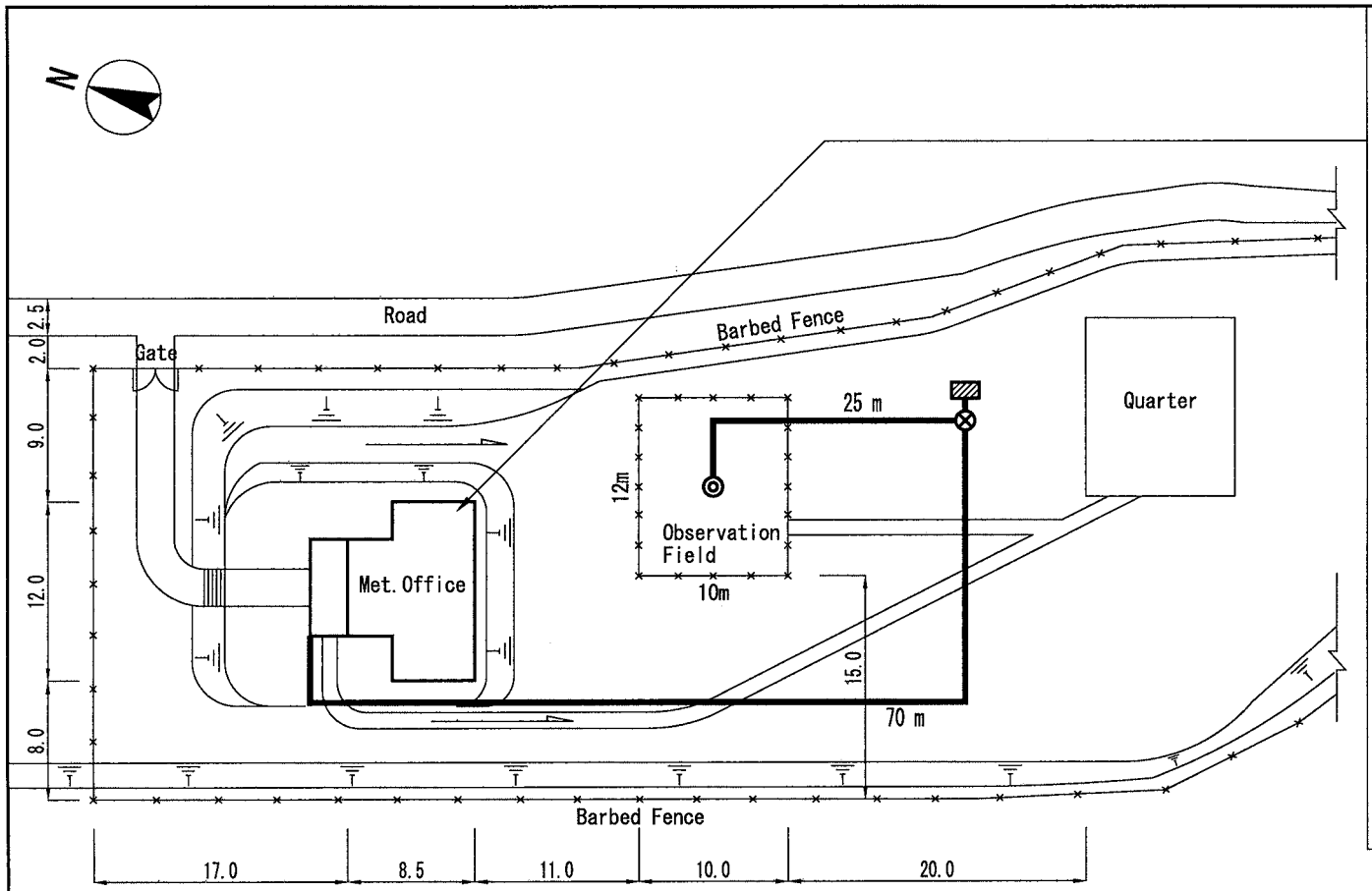
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

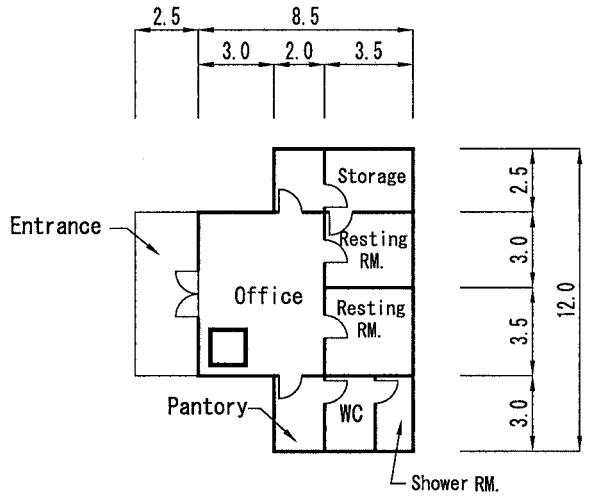
M7 Equipment Layout - Hambantota



M8 Equipment Layout - Jaffna



Layout Plan S=1/500



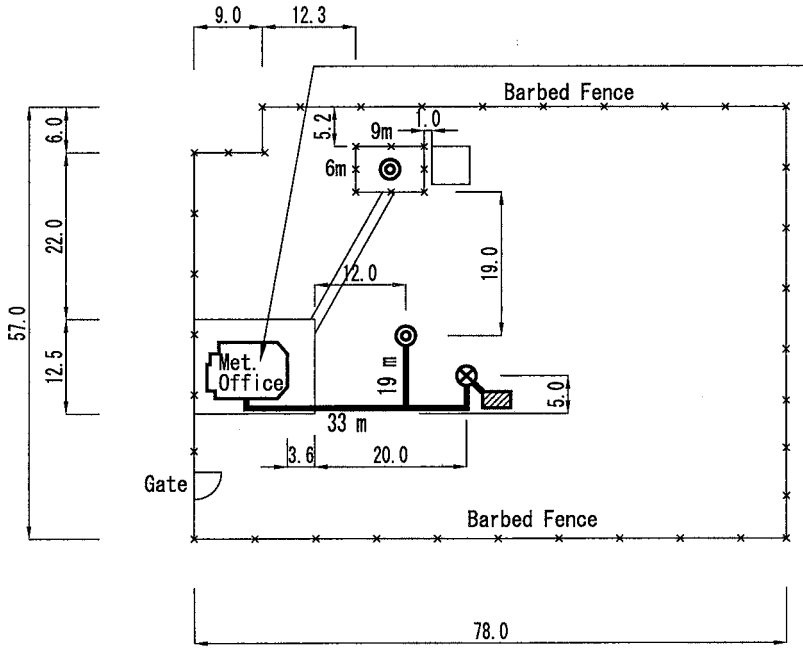
Ground Floor Plan S=1/300

Unit:m

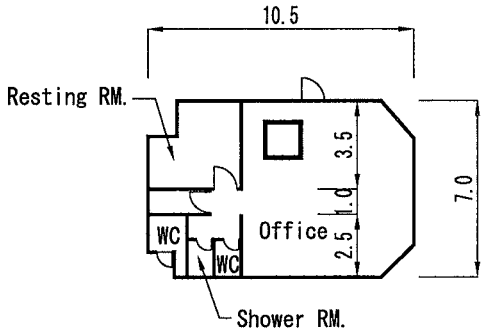
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M9 Equipment Layout - Katugastota



Layout Plan S=1/1000



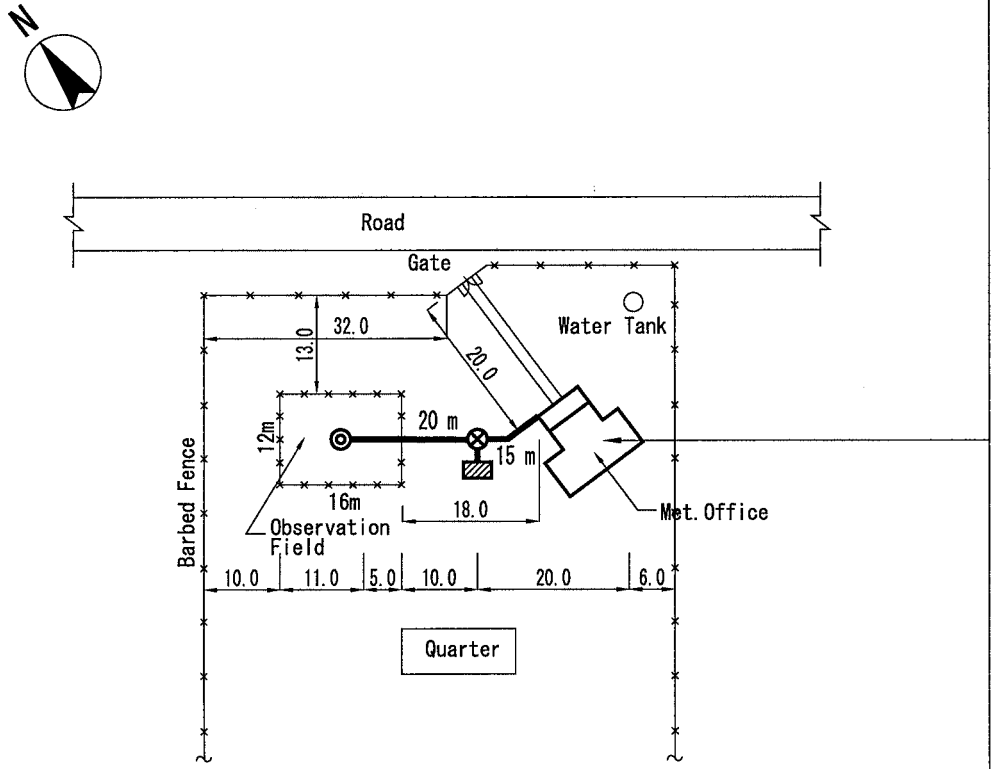
Ground Floor Plan S=1/300

Unit:m

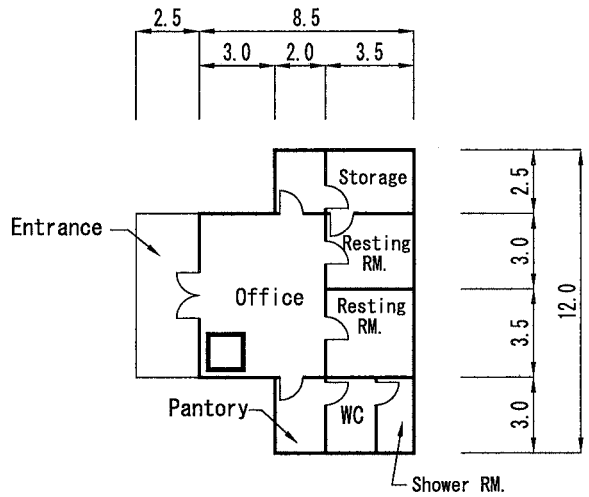
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M10 Equipment Layout - Katunayaka



Layout Plan S=1/1000



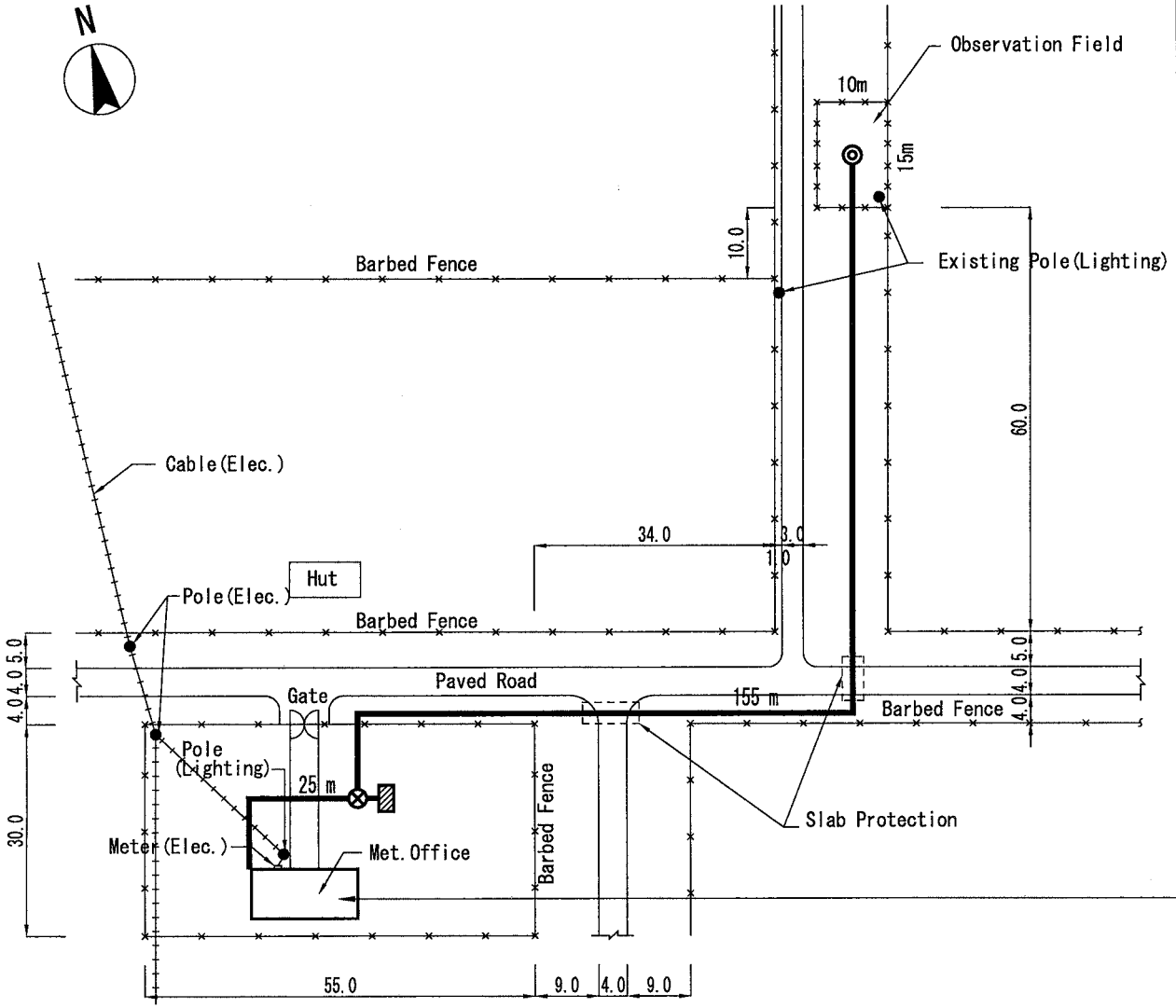
Ground Floor Plan S=1/300

Unit:m

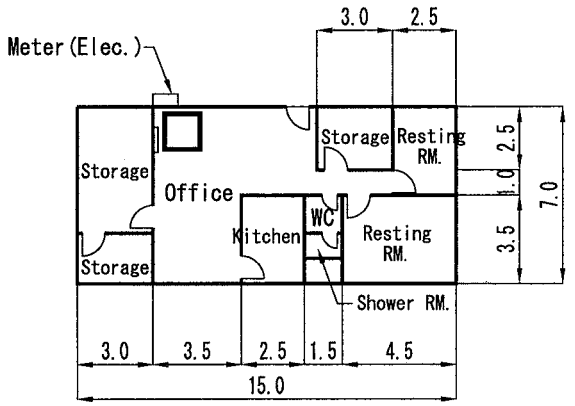
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M11 Equipment Layout - Kurunegala



Layout Plan S=1/1000



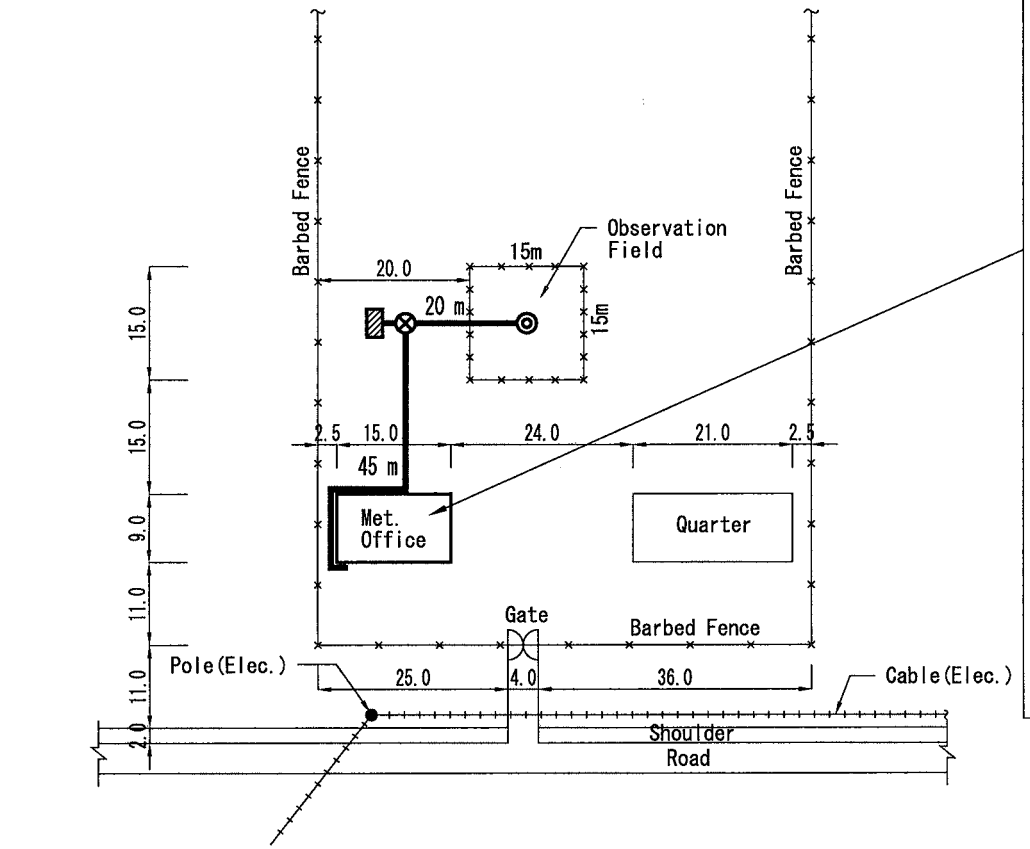
Ground Floor Plan S=1/300

Unit:m

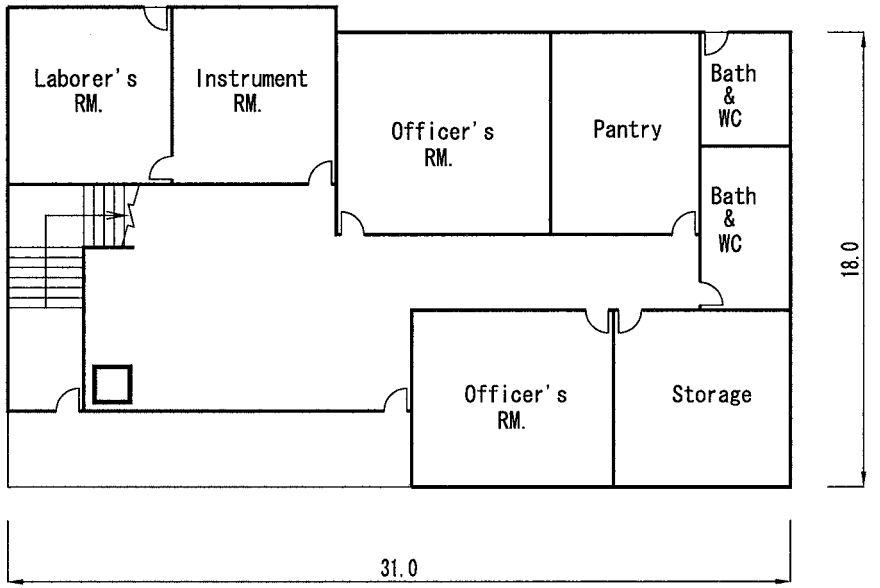
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M12 Equipment Layout - Maha Illuppallama



Layout Plan S=1/1000



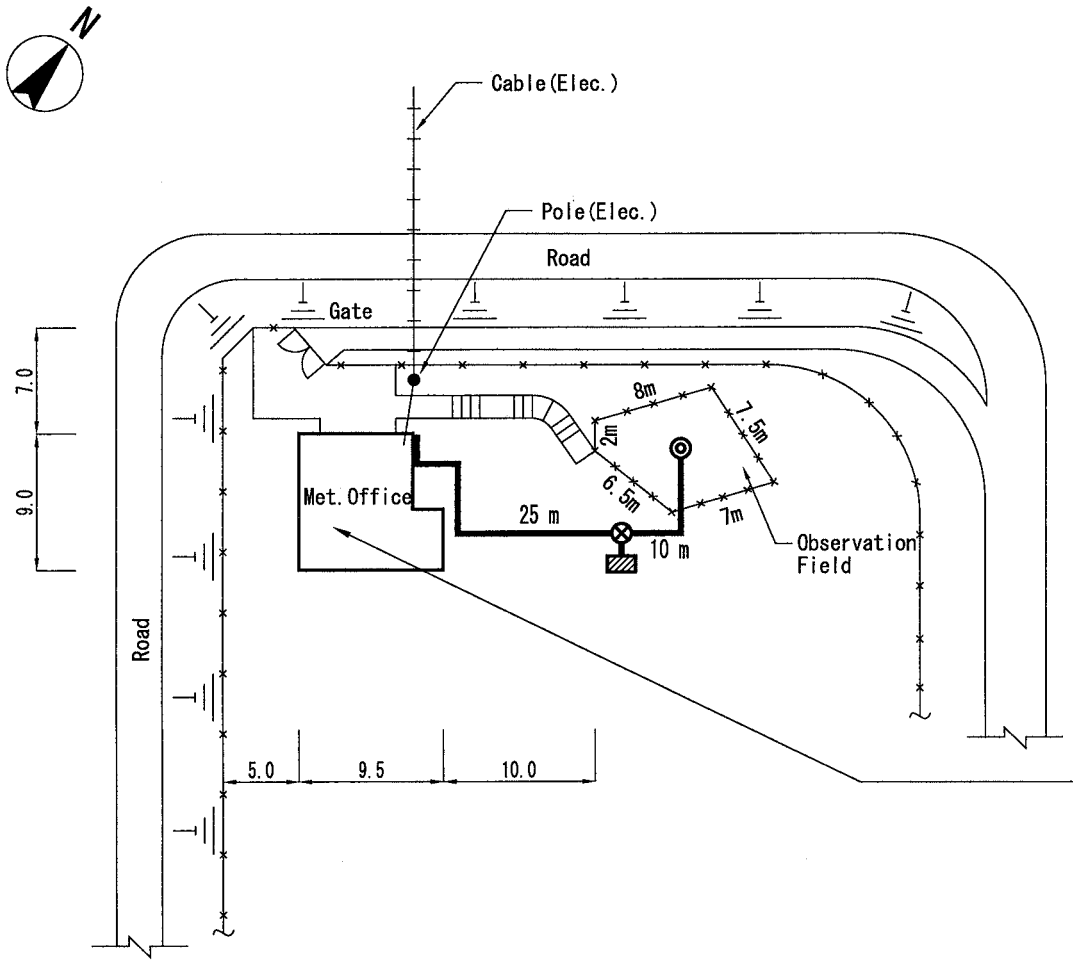
Ground Floor Plan S=1/300

Unit:m

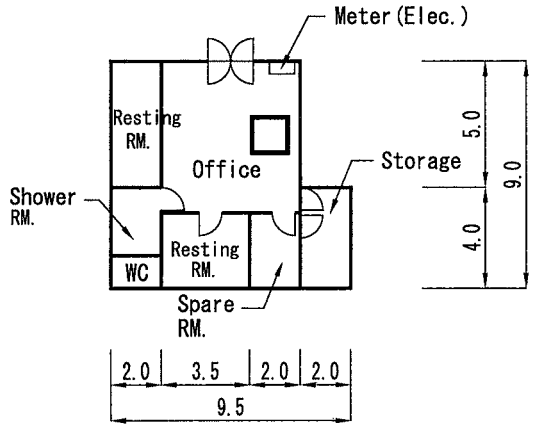
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M13 Equipment Layout - Mannar



Layout Plan S=1/500



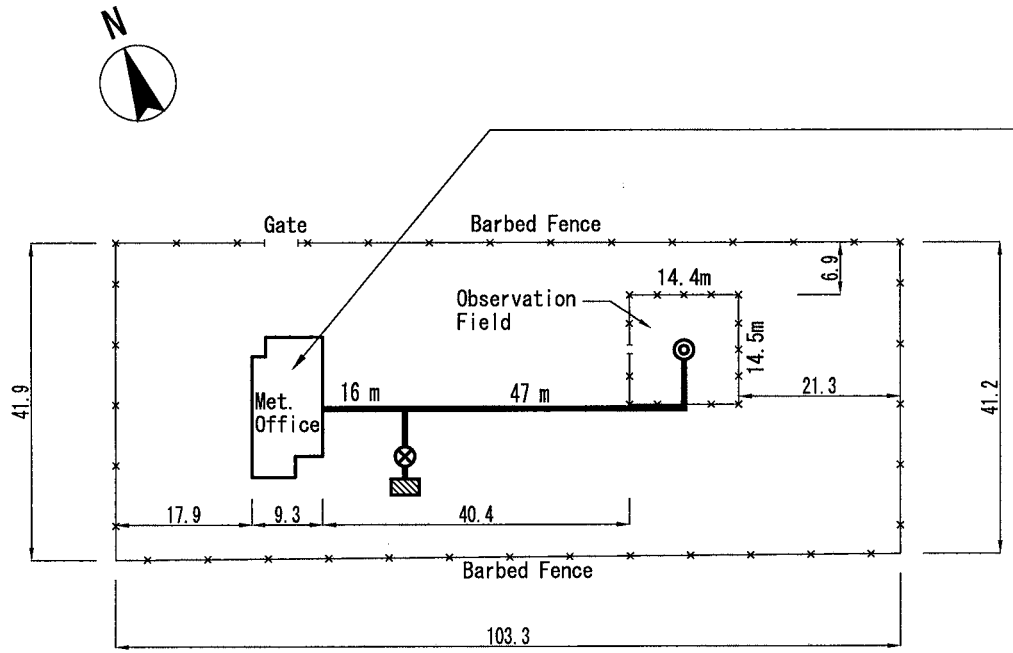
Ground Floor Plan S=1/300

Unit:m

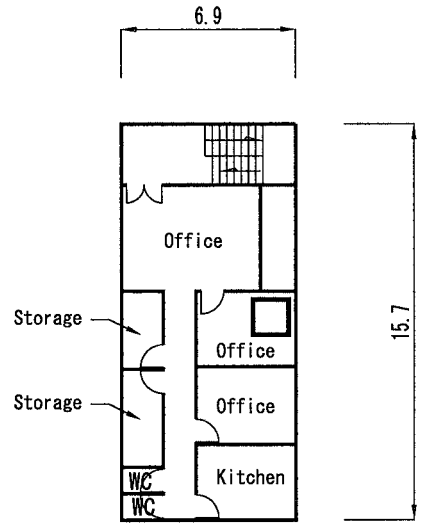
Legend

- AWS (Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M14 Equipment Layout - Nuwara Eliya



Layout Plan S=1/1000



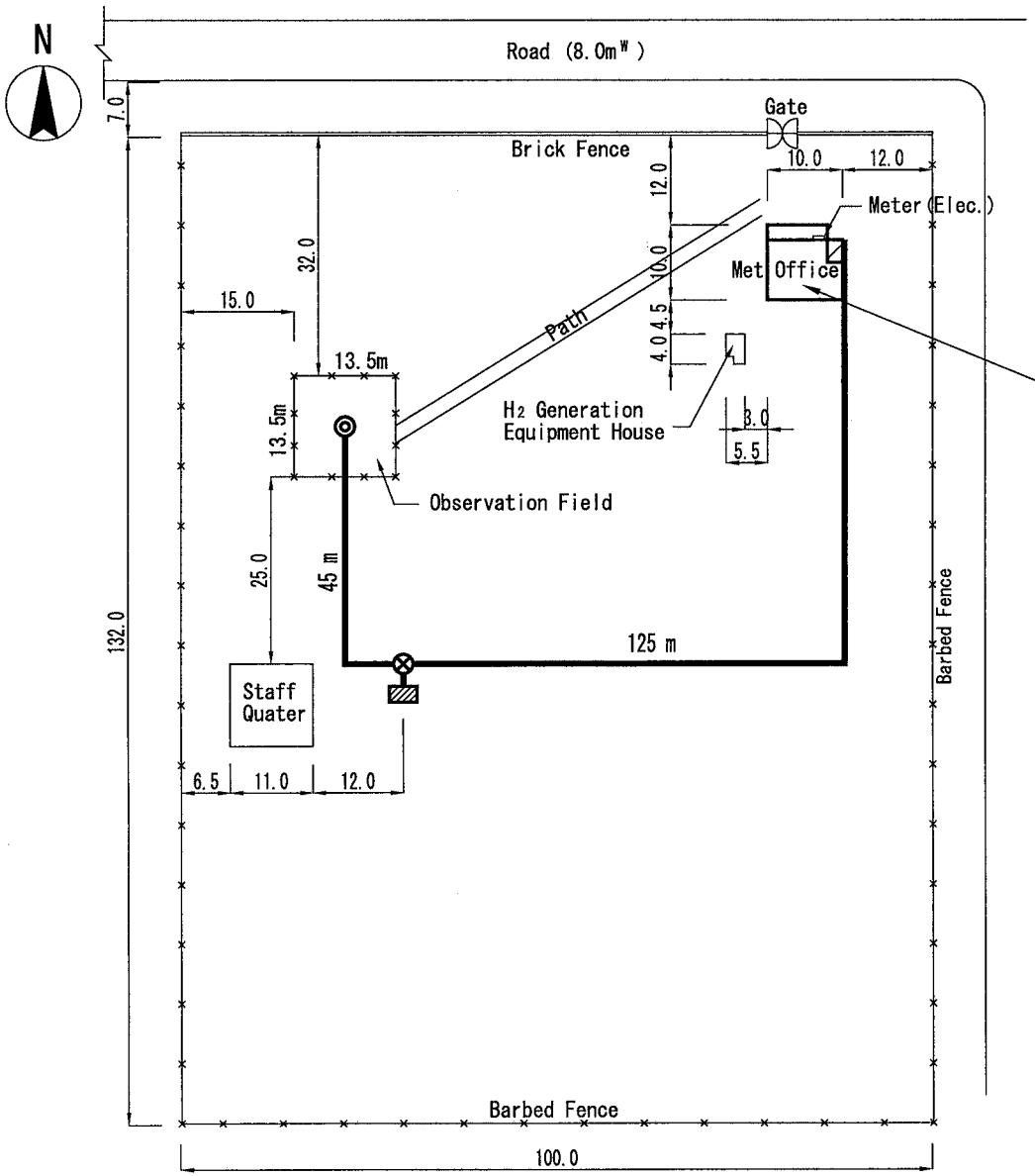
2nd Floor Plan S=1/300

Unit:m

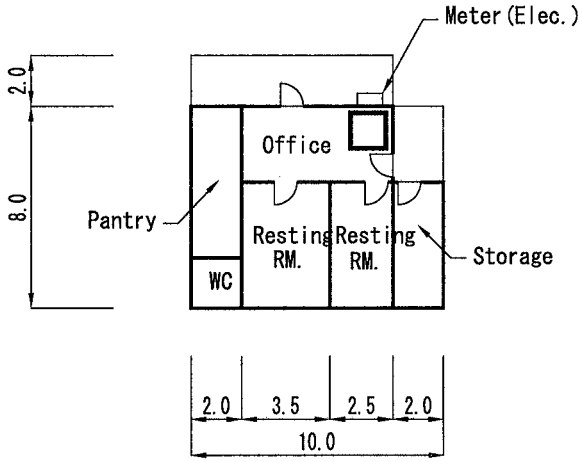
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M15 Equipment Layout - Pottuvil



Layout Plan S=1/1000



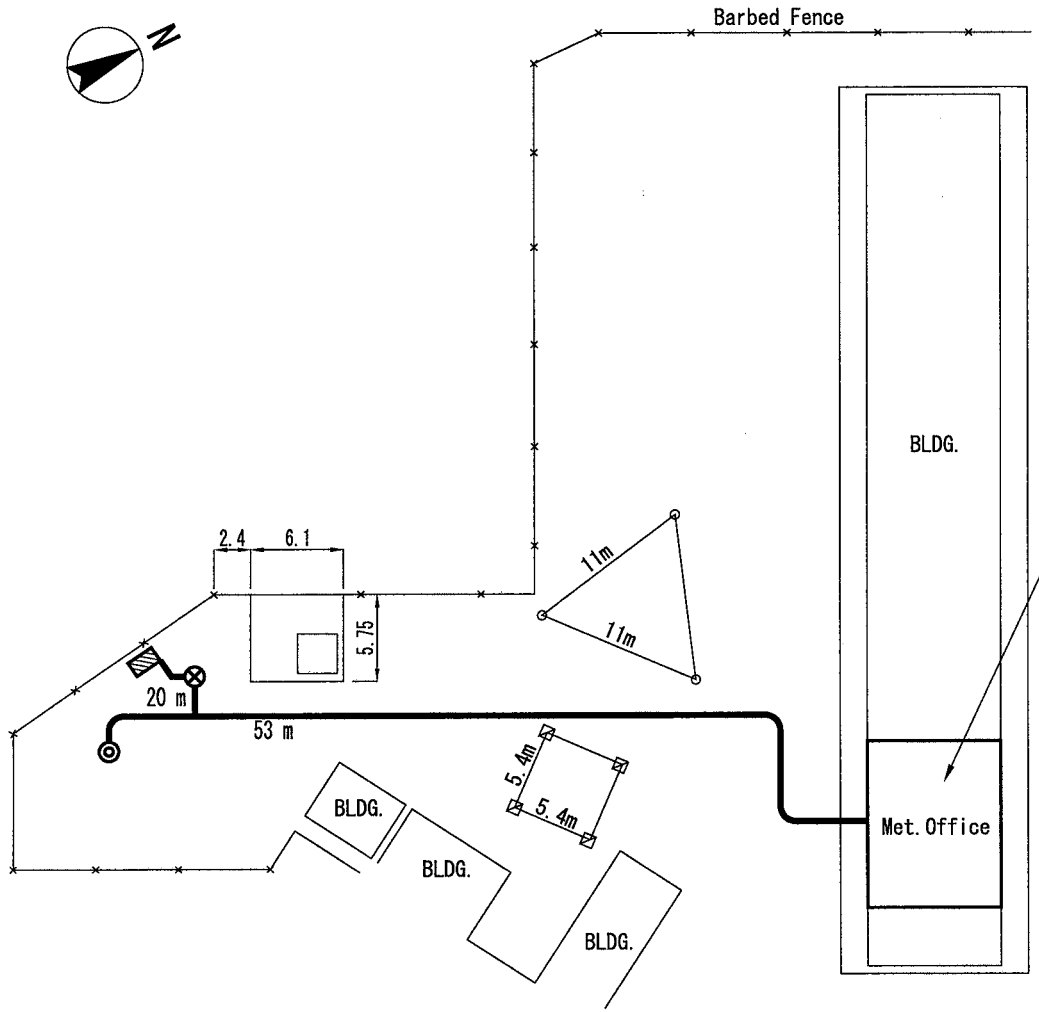
Ground Floor Plan S=1/300

Unit:m

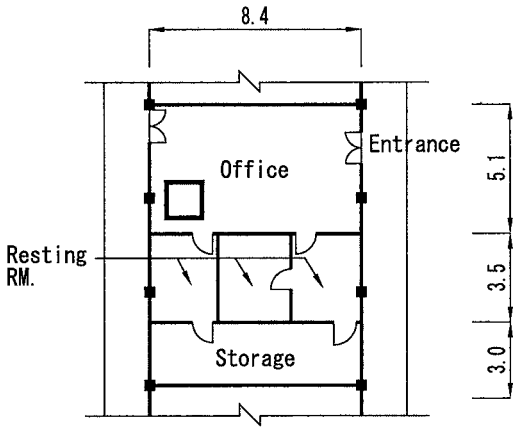
Legend

- AWS (Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M16 Equipment Layout - Puttalam



Layout Plan S=1/500



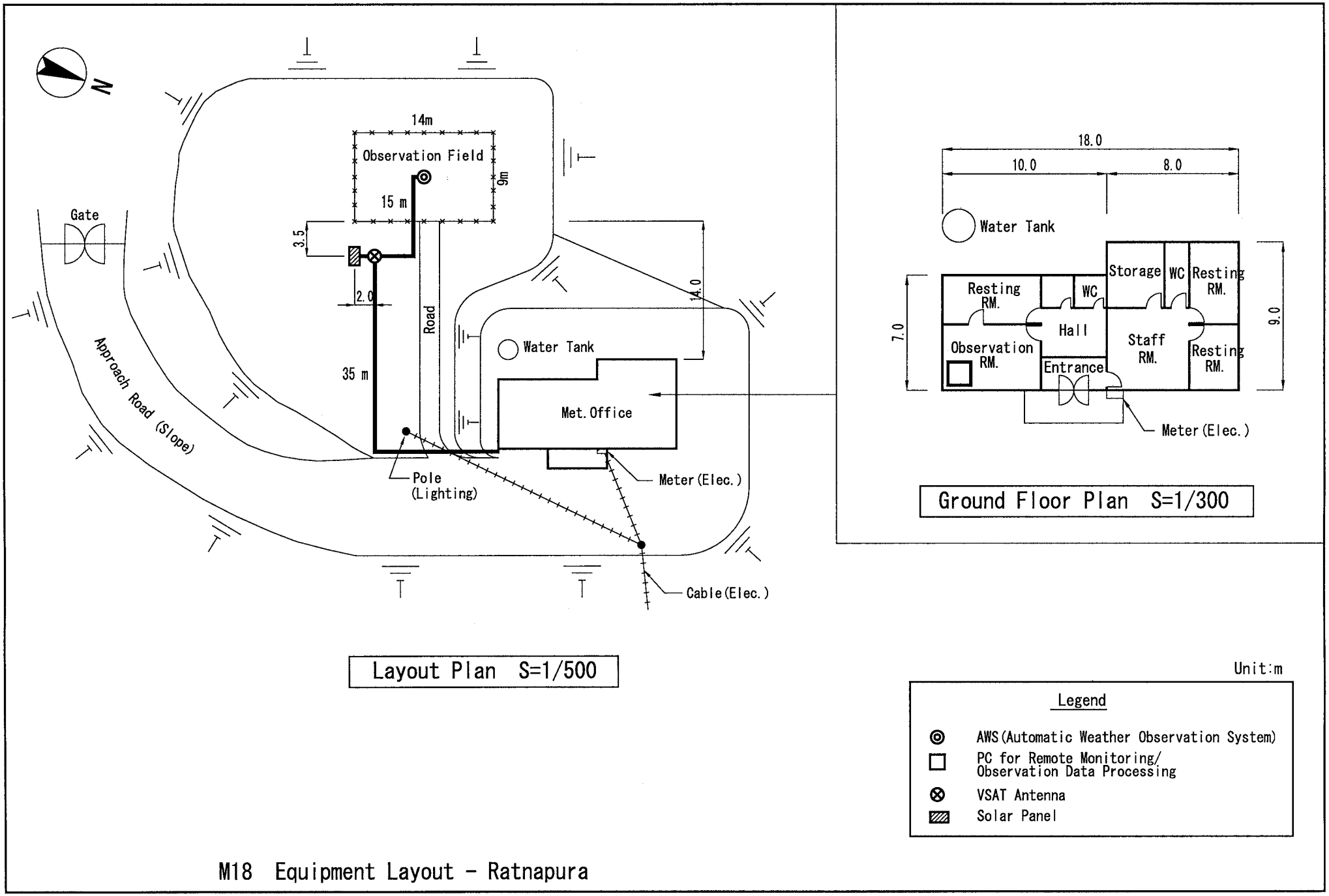
Ground Floor Plan S=1/300

Unit:m

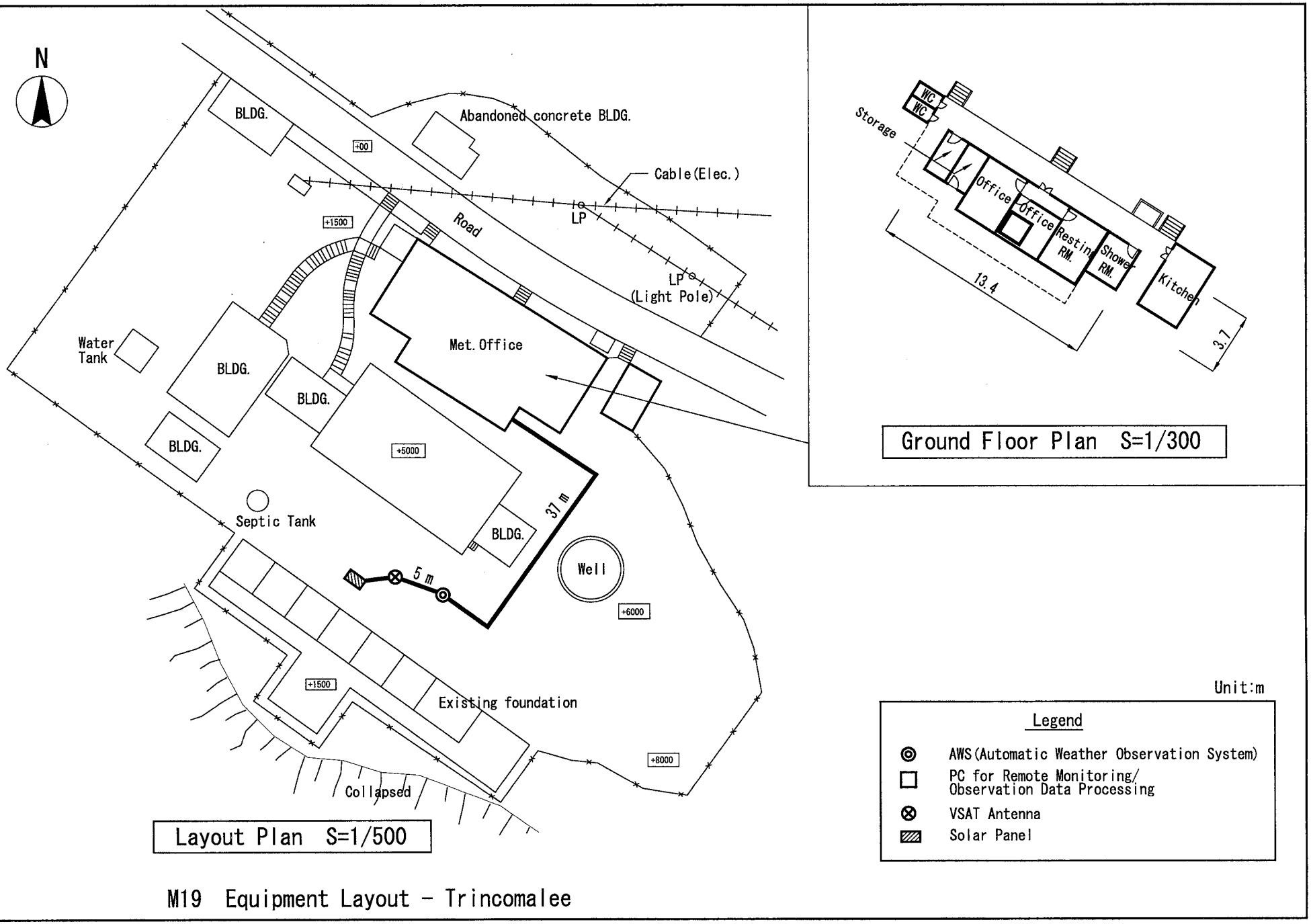
Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

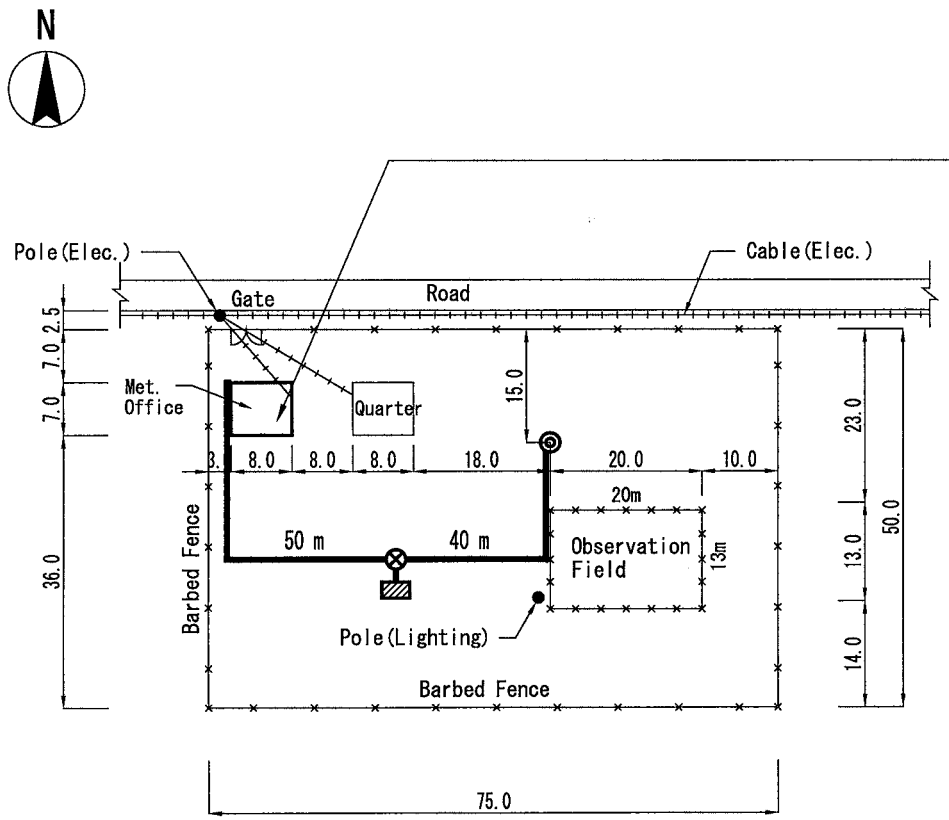
M17 Equipment Layout - Ratmalana



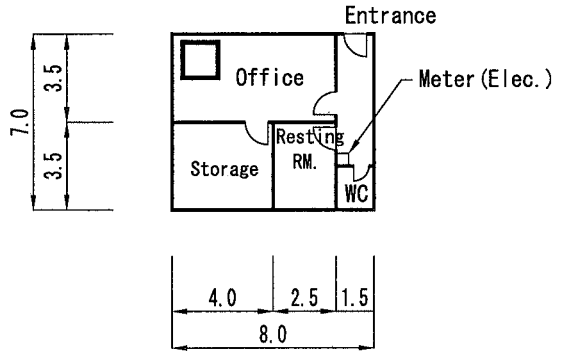
M18 Equipment Layout - Ratnapura



M19 Equipment Layout - Trincomalee



Layout Plan S=1/1000



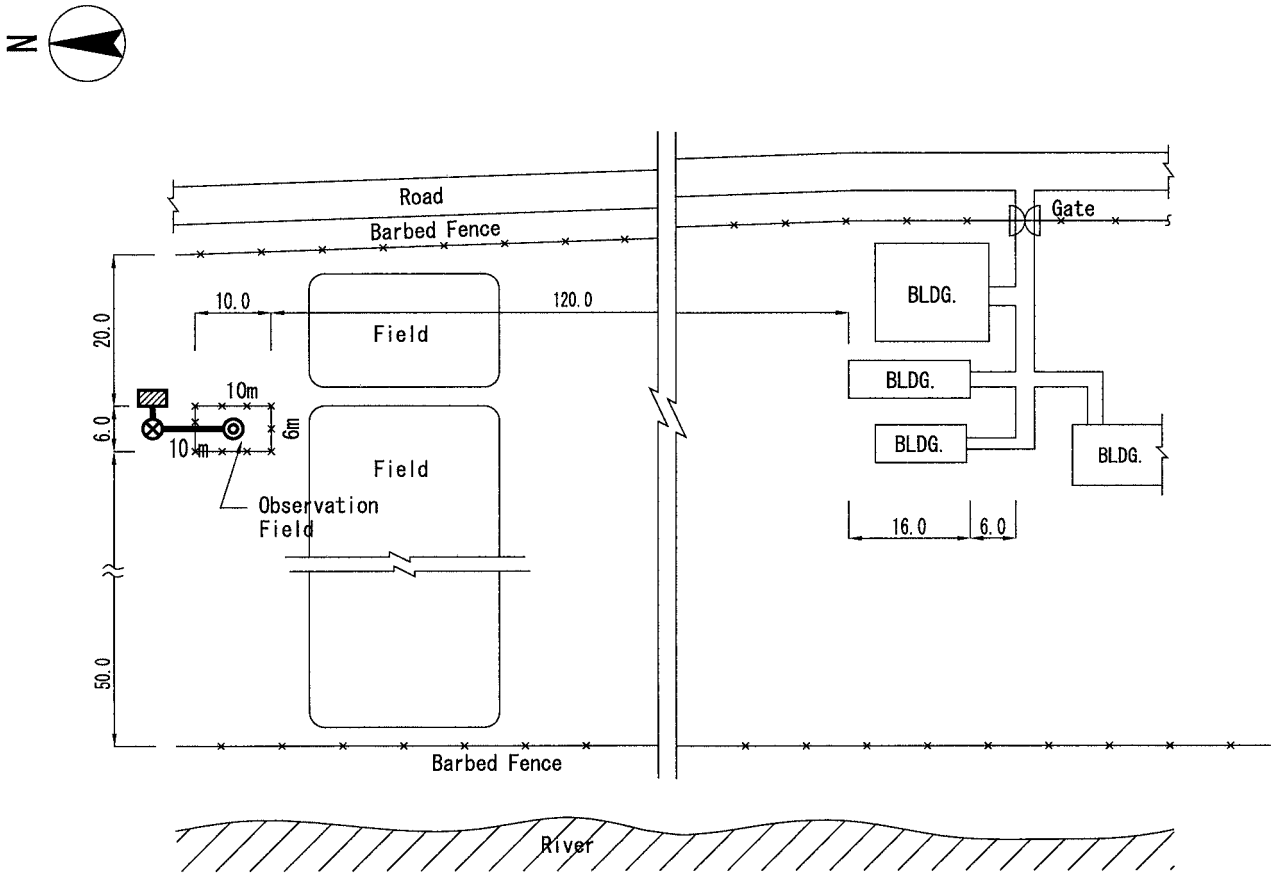
Ground Floor Plan S=1/300

Unit:m

Legend

- AWS(Automatic Weather Observation System)
- PC for Remote Monitoring/ Observation Data Processing
- VSAT Antenna
- Solar Panel

M20 Equipment Layout - Vavuniya

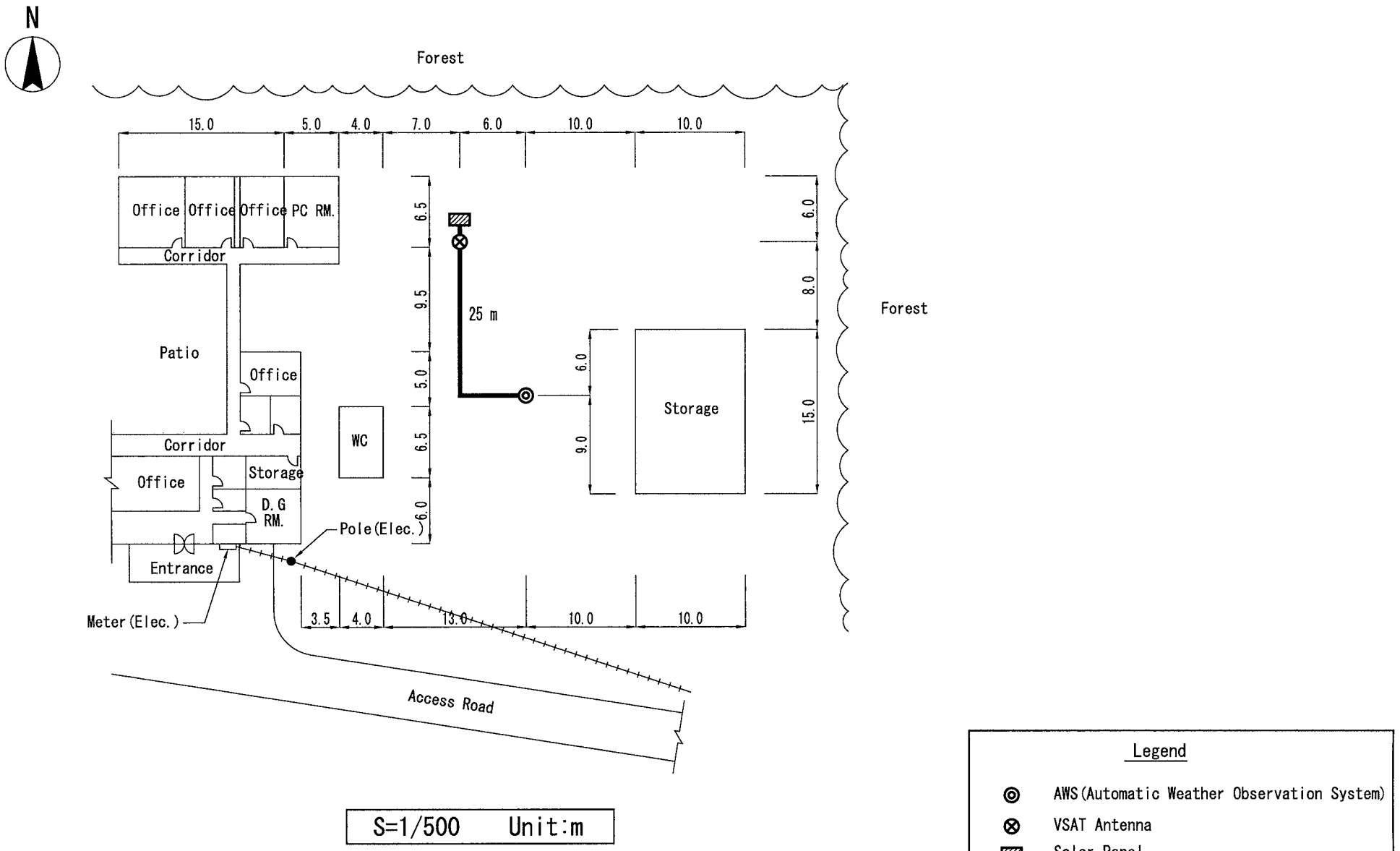


S=1/1000 Unit:m

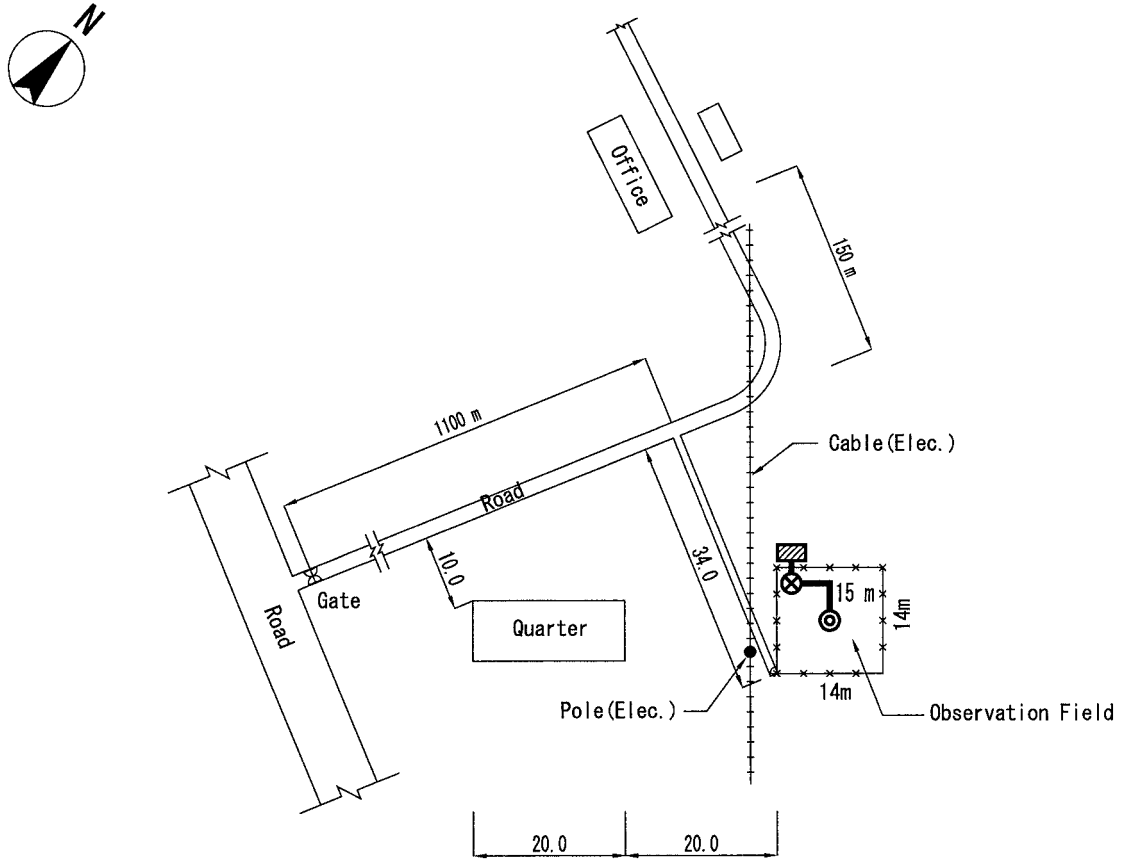
Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C1 Equipment Layout - Wagolla



C2 Equipment Layout - Polonnaruwa

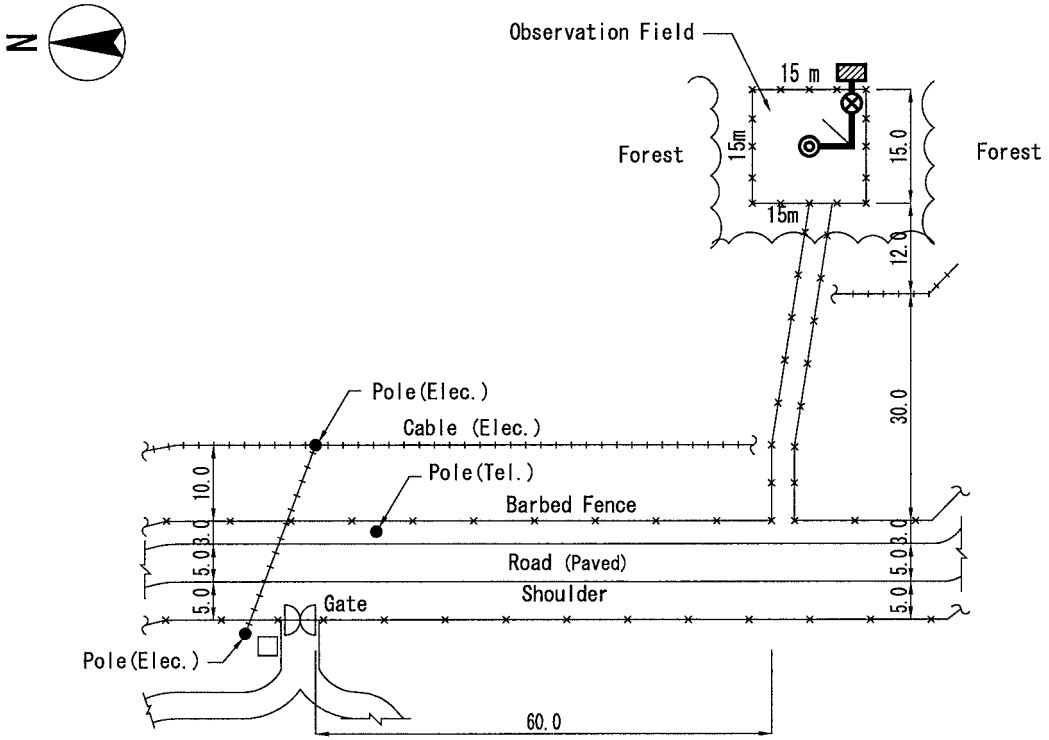


S=1/1000 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C3 Equipment Layout - Moneragala

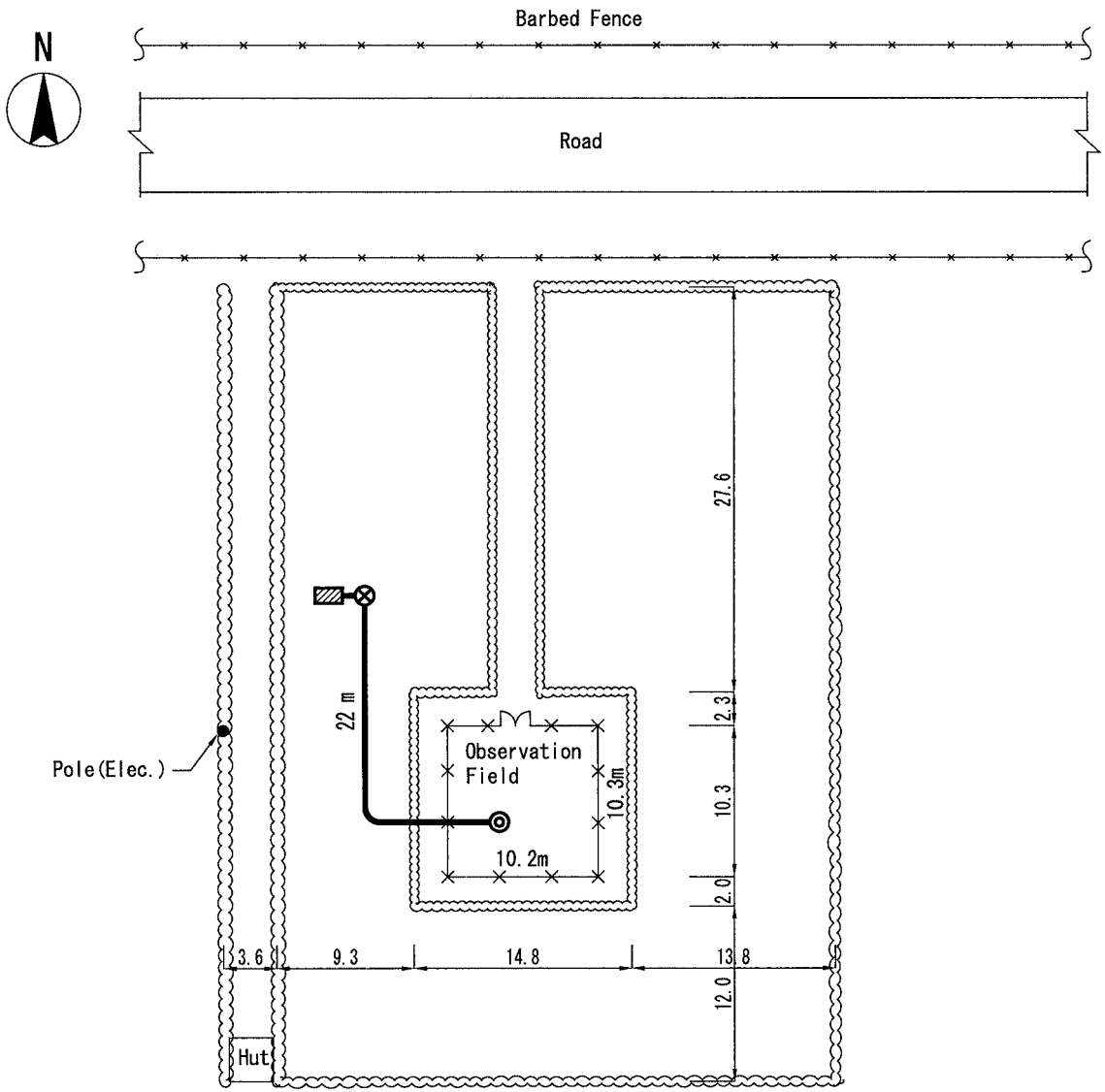


S=1/1000 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C4 Equipment Layout - Matale

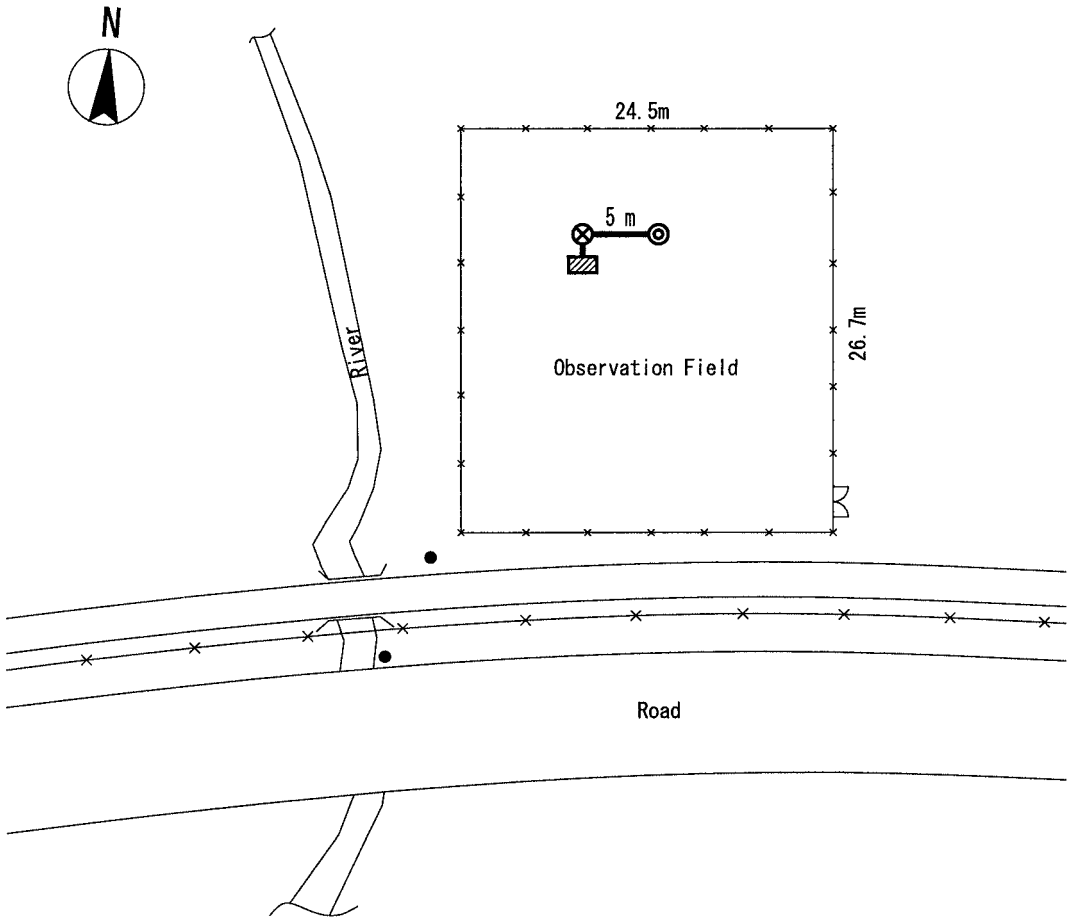


S=1/500 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C5 Equipment Layout - Sevanagala

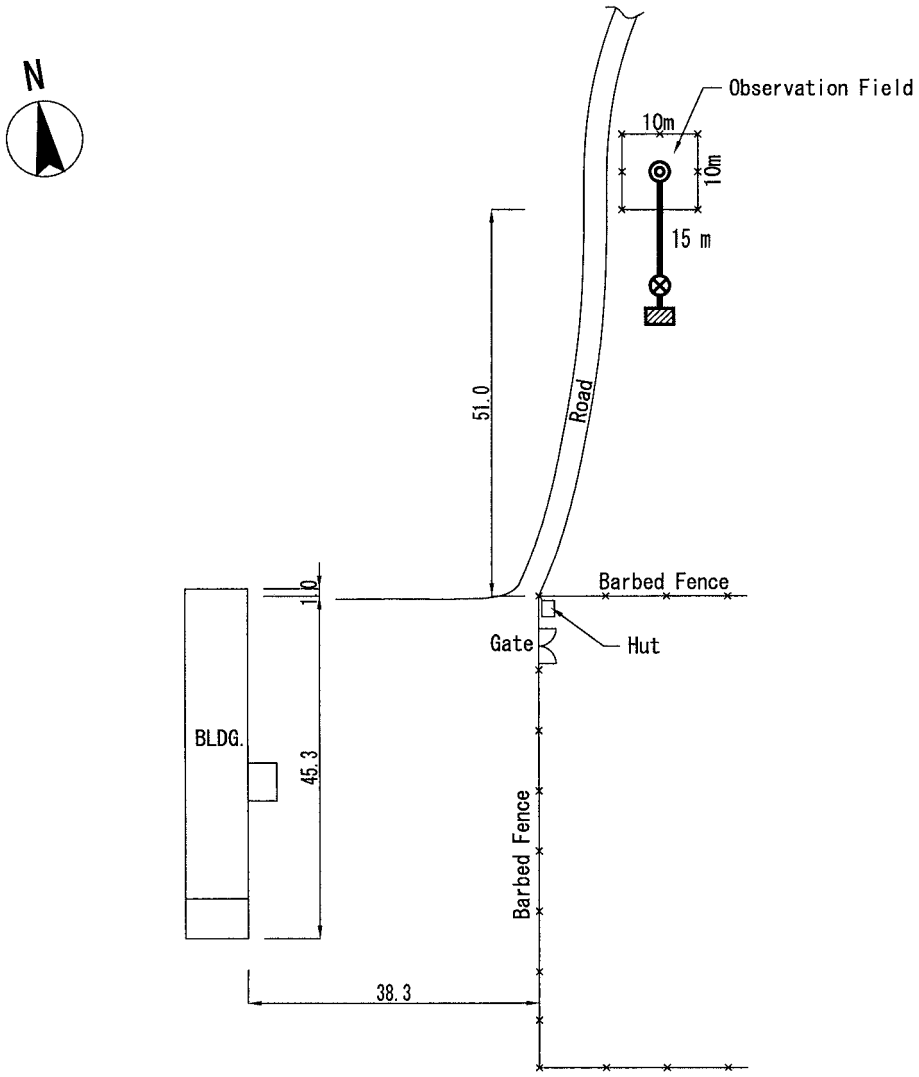


S=1/500 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C6 Equipment Layout - Angunakolapelessa

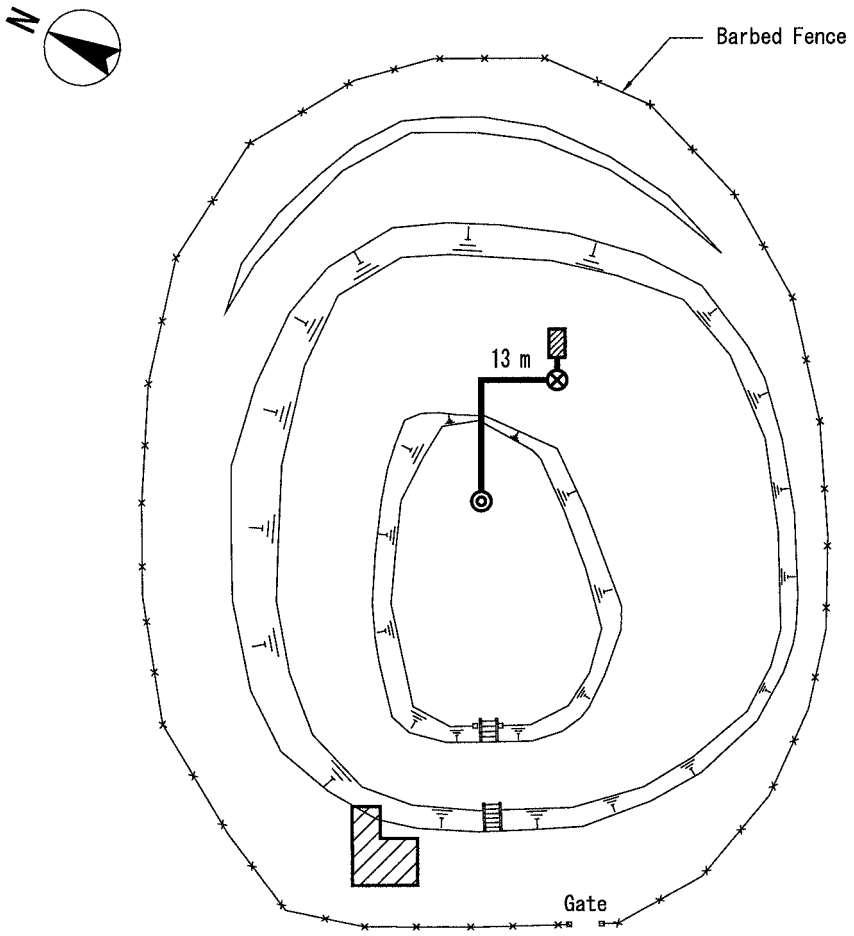


S=1/1000 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C7 Equipment Layout - Ampara

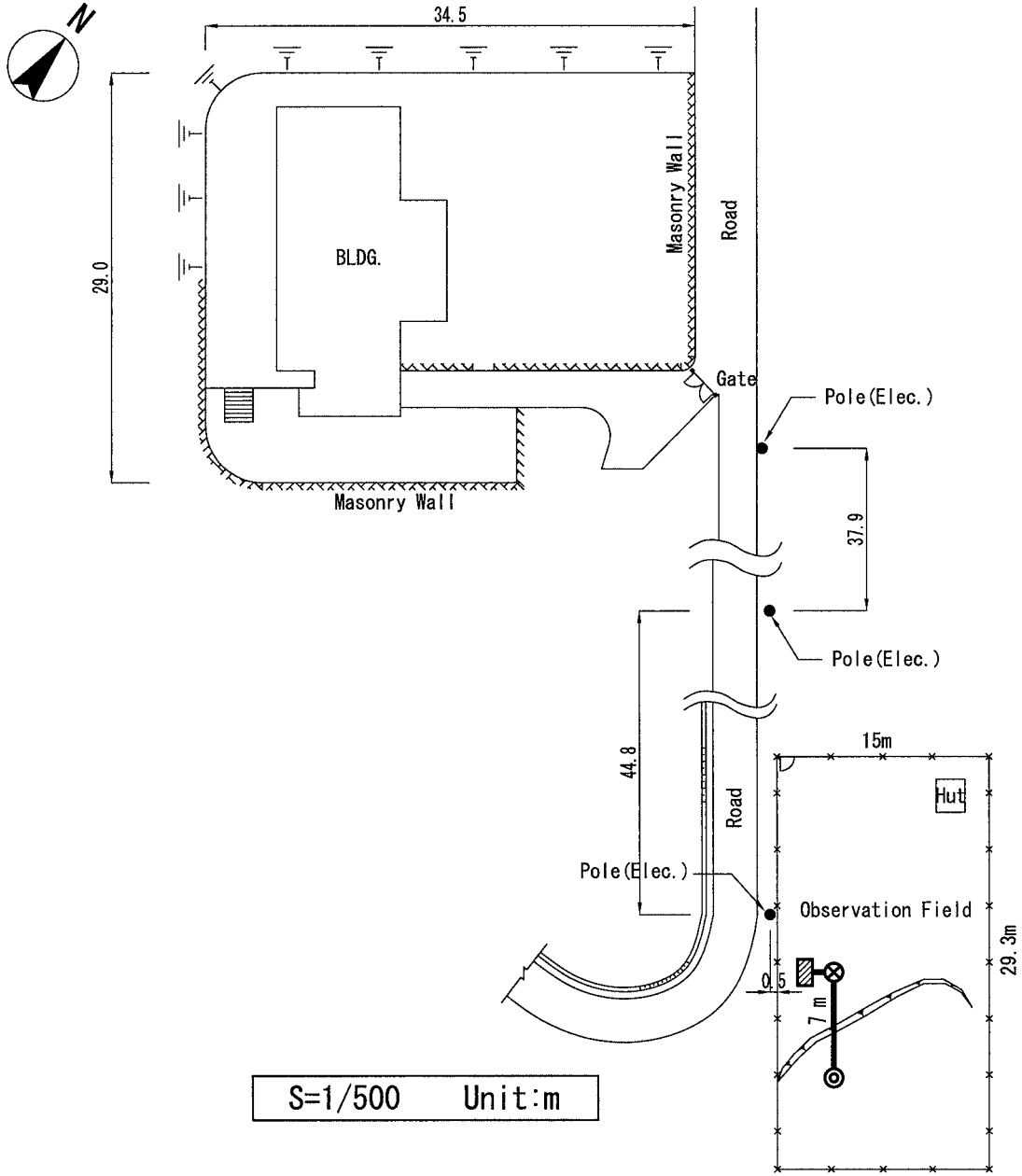


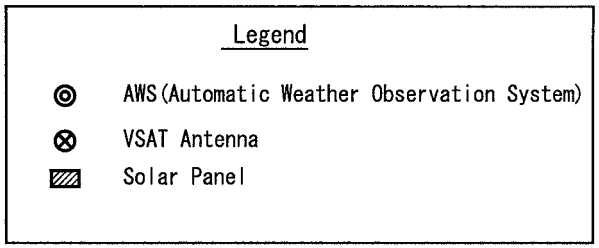
S=1/500 Unit:m

Legend

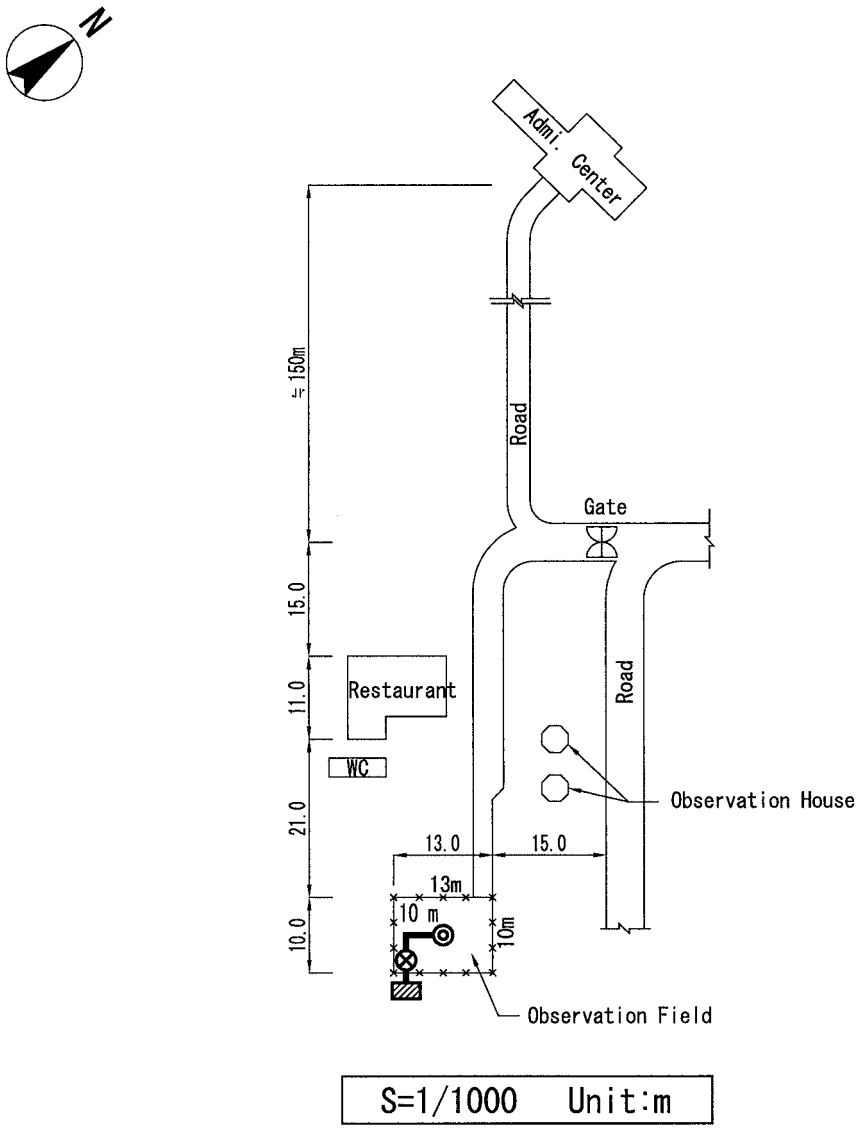
- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C8 Equipment Layout - Matara





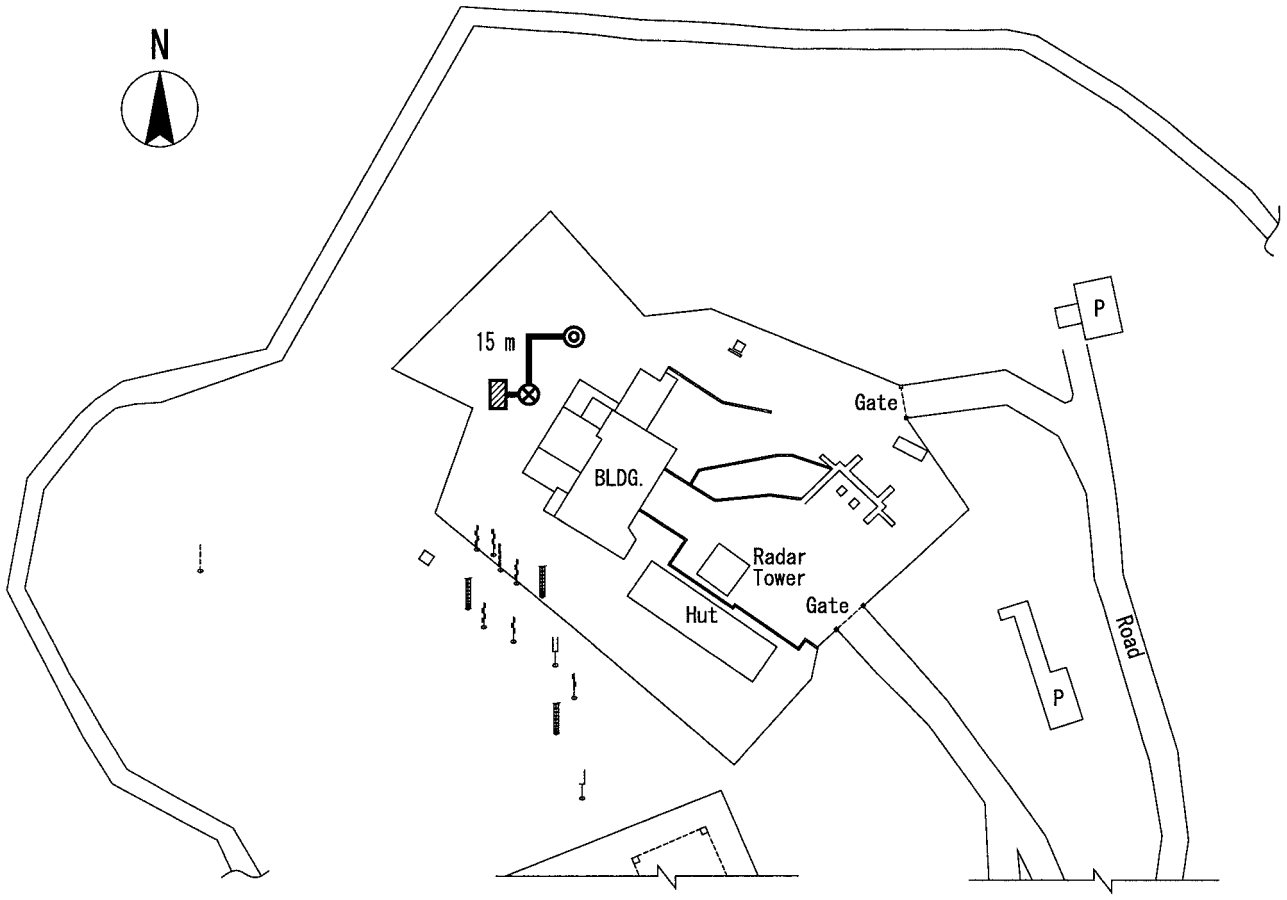
C9 Equipment Layout - Deniyaya



Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C10 Equipment Layout - Horton Plains

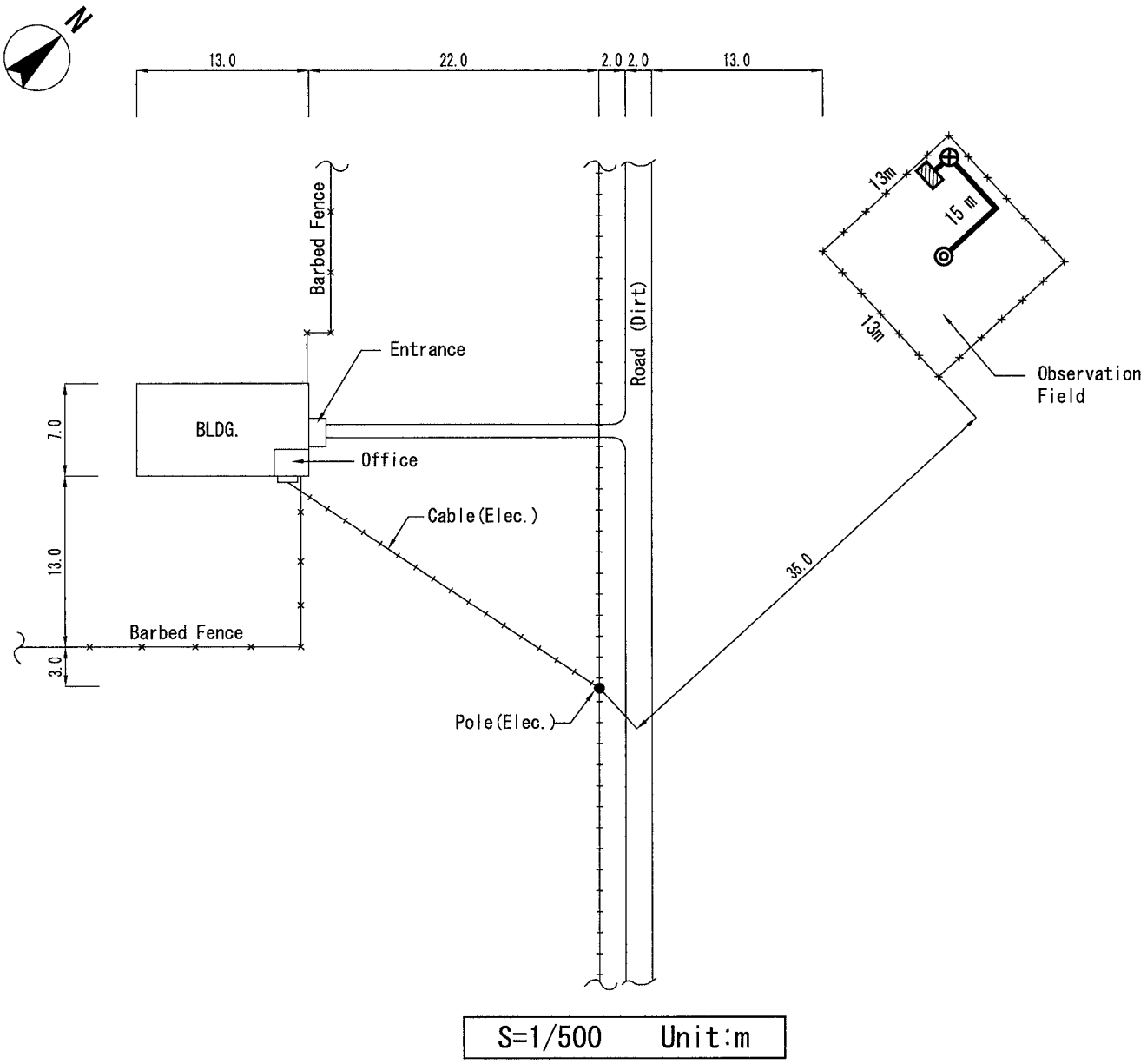


S=1/1000 Unit:m

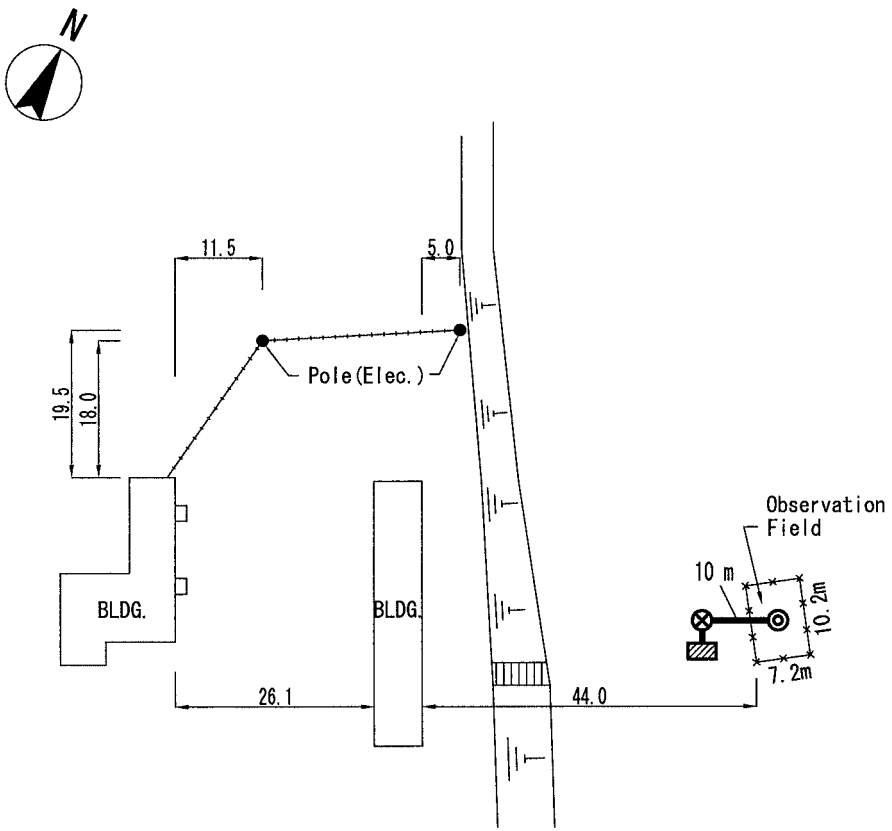
Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C11 Equipment Layout - Mt. Pidurutalagala



C12 Equipment Layout - Aralaganwila

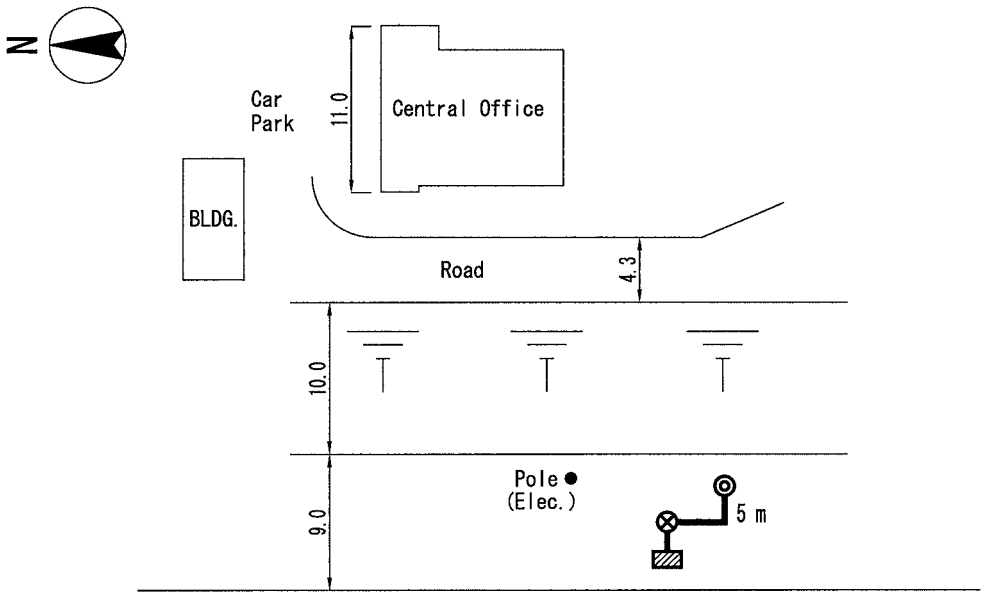


S=1/1000 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C13 Equipment Layout - Balangoda

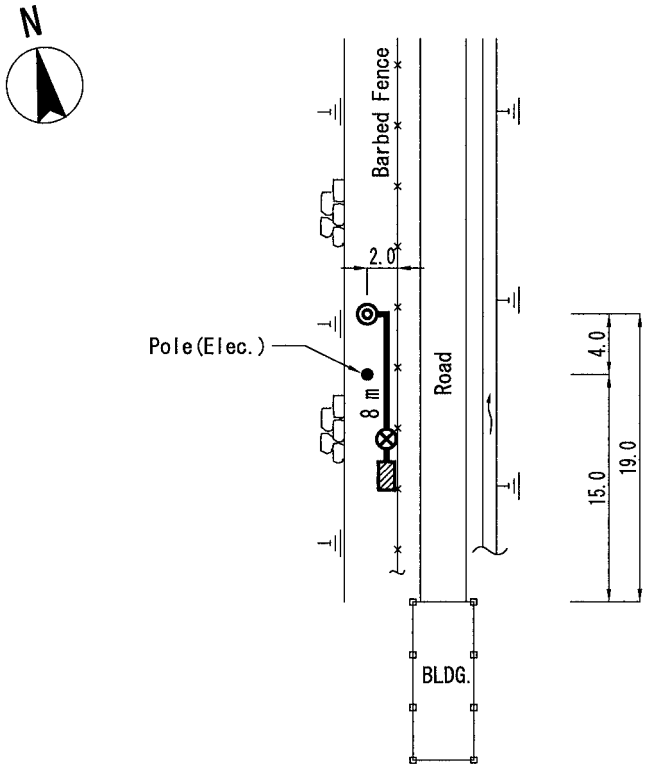


S=1/500 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C14 Equipment Layout - Maliboda

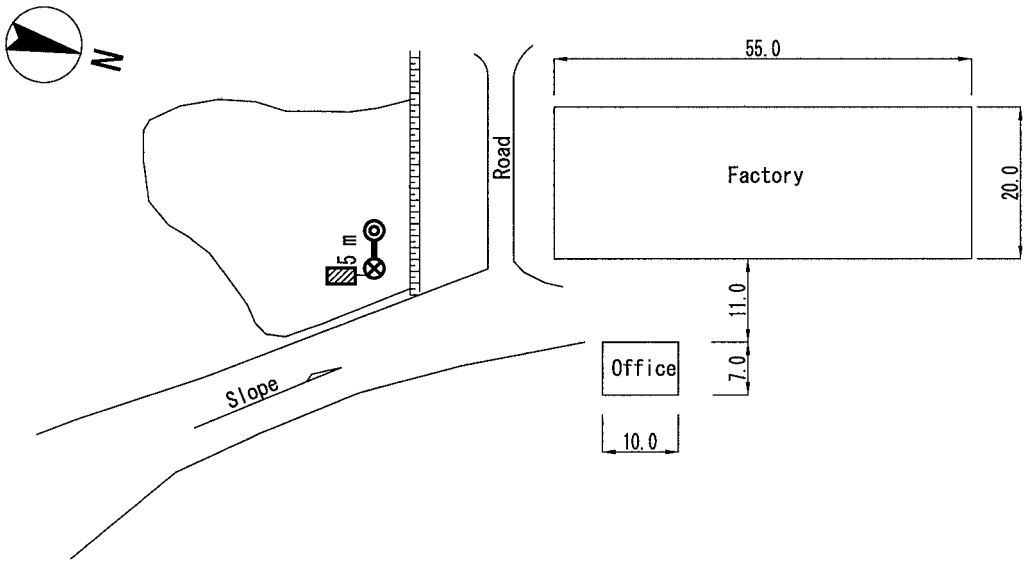


S=1/500 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C15 Equipment Layout—Labugama

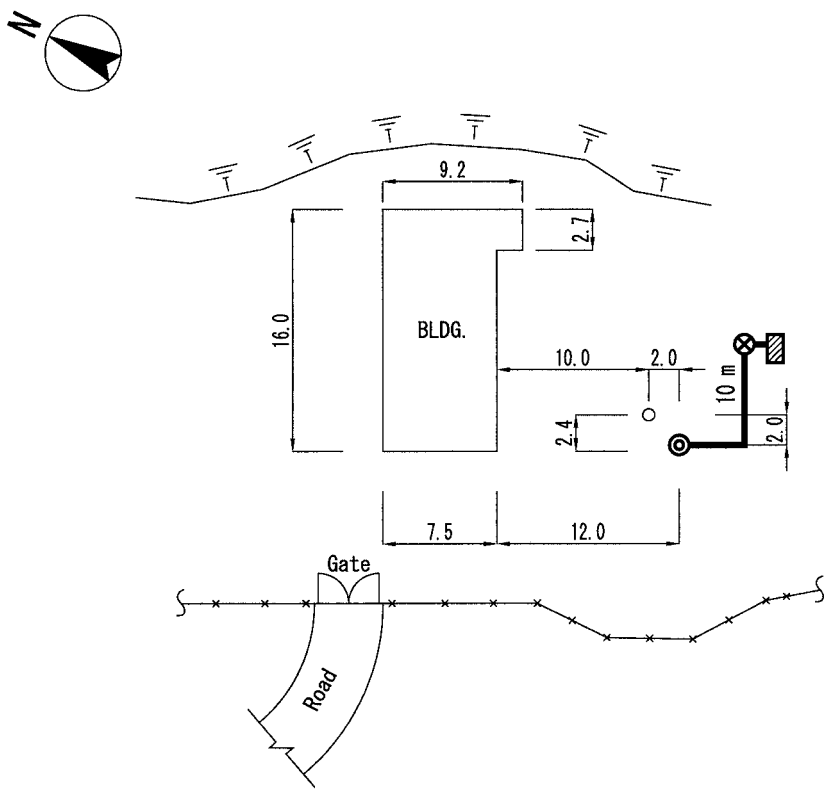


S=1/1000 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C16 Equipment Layout - Tawalama

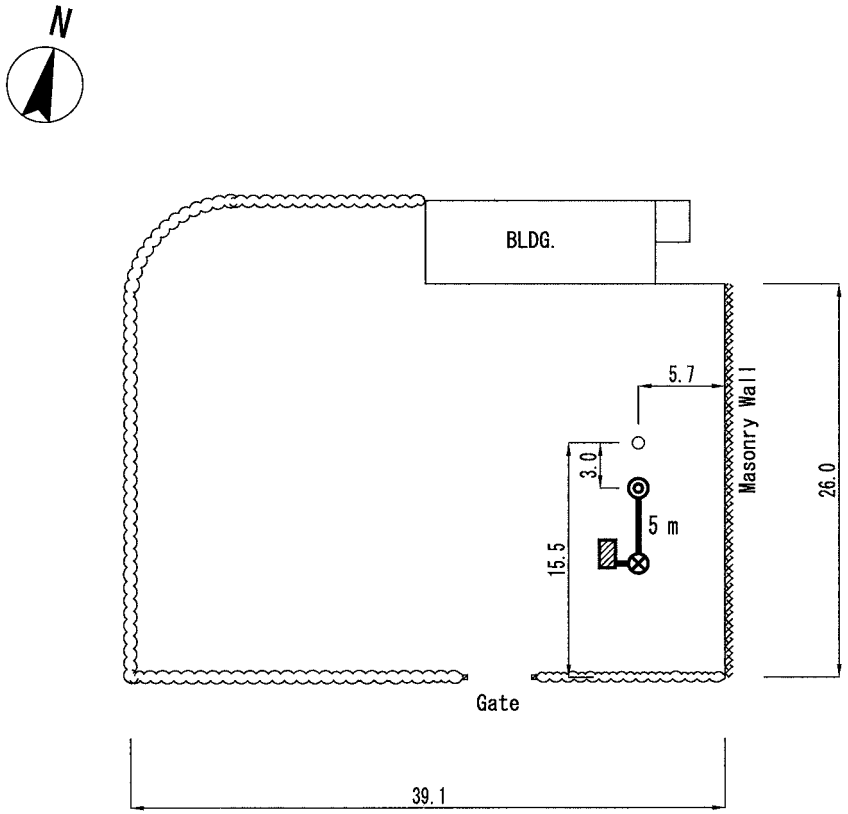


S=1/500 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C17 Equipment Layout - Kudawa



S=1/500 Unit:m

Legend

- AWS(Automatic Weather Observation System)
- VSAT Antenna
- Solar Panel

C18 Equipment Layout - Sirikandura

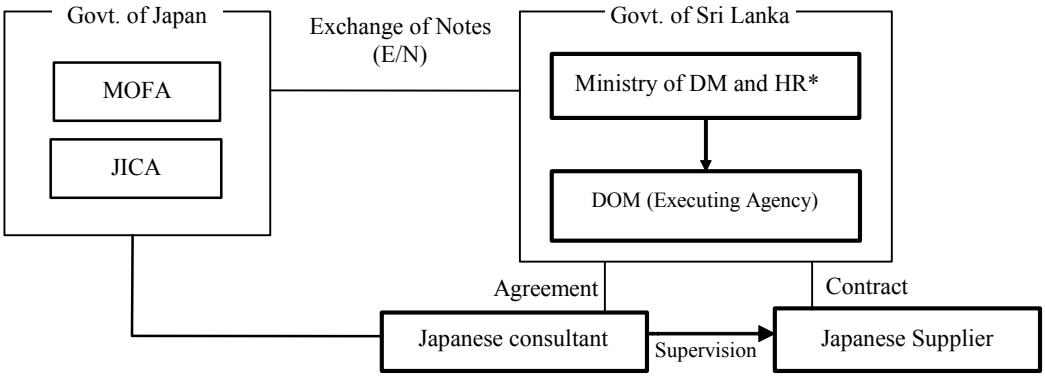
2-2-4 Implementation plan

2-2-4-1 Implementation policy

(1) Basic matters

1) Implementation scheme

The Project shall be implemented according to the implementation scheme of the organizations concerned illustrated in Fig. 2-6 and in accordance with the implementation procedures of the grant aid of Japan.



*Ministry of Disaster Management and Human Rights

Figure 2-6 Project Implementation Scheme

i. The Government of Japan, after its cabinet approval, will sign the exchange of notes (E/N) with the Government of Sri Lanka concerning the grant aid.

ii. After the Notes exchanged by the two governments, a Japanese consultant and the Executing Agency in Sri Lanka will make contract on the design and supervision work of the Project. The consultant will start the work immediately after obtaining the verification of the Ministry of Foreign Affairs of Japan.

iii. According to the tender guidelines of JICA, Japanese procurement firms will be invited for tendering. While the tender administrator is the executing agency of Sri Lanka, the consultant will assist in the tender procedures under the guidance of JICA.

iv. The awarded successful tenderer will make a procurement contract with the Sri Lankan side and start works immediately after obtaining the verification of the Government of Japan.

2) Design and supervision policies of the Japanese consultant

The Japanese consultant to implement design and supervision work shall fulfill its roles in order to smoothly implement the Project and achieve the purpose of the cooperation under

the “Guidelines for Consulting Works concerning Grant Aid” issued by JICA. The firm shall conduct all necessary work and make efforts to be trusted by the Project executing agency of Sri Lanka, considering fairness and neutrality for Japanese suppliers.

(2) Utilization of local transportation company

The Project will cover 38 sites, 20 synoptic meteorological stations (including DoM in Colombo) and 18 collaborator stations scattering throughout Sri Lanka. The transportation routes are between Japan and Colombo, and Colombo and these 38 project sites. It would be appropriate to employ a Japanese transportation company for the transportation between Japan and Colombo for making smooth equipment shipping procedures and reliable shipping to maintain the project schedule. On the other hand, it would be effective to utilize local transportation companies because they are familiar with the local transportation situations under the supervision of the Japanese transportation company in order to achieve project installation work within intended installation period and with required quality.

(3) Utilization of local firms for equipment installation

Local firms have no experience in installing automatic weather observation equipment and satellite communication appliances to be connected with the equipment, that are to be procured under the Project, and insufficient knowledge and abilities required for their installation. Thus, a Japanese firm shall be the prime contractor of the Project and oversee the entire installation work. It would be possible to carry out economical and high quality installation work by using local firms providing with appropriate training and guidance under the supervision of the prime contractor.

(4) Utilization of local consultants

There are those companies in Sri Lanka that can conduct consultant work, such as architectural design and civil engineering design work. However, there are no such consultants that have sufficient knowledge about meteorological information network, such as one to be installed for the Project, and that can conduct consulting work at a neutral position.

In general, it is evaluated that local consultants, including architects and civil engineering design offices, have not sufficient experience to become a prime contractor to handle a large scale project, such as foreign assistant projects. For this reason, local consultants will be used as the assistants of the Japanese consultant for the Project and transfer of technologies will be provided to them through project implementation.

2-2-4-2 Implementation conditions

(1) Matters to be considered for installation

1) Installation method of equipment at 7 sites

As described in Section 2-2-2-1 (6), installation work at the 7 sites in the northeast area should be accomplished under the responsibility of the Sri Lankan side.

2) Security measures

The consultant and the prime contractor shall assign a Japanese person in Colombo. In case of emergency, such as a terrorist alert, this person shall contact the Japanese Embassy and JICA Office in Colombo and provide information to those persons engaged in project implementation at various sites for taking appropriate measures as well as to confirm their safety. In addition, an emergency call network shall be established and a mobile phone shall be provided to every person who is engaged in project implementation. Further, whenever it is necessary to move close to a concerned area, personnel shall move by two cars.

3) Schedule plan

If the implementation of the Project is planned to be completed in approximately one year period for the 31 sites, the number of teams to simultaneously conduct equipment installation work and the number of installation sites per each team would be 5 teams and 6 sites respectively (one team has to take care of 7 sites).

When preparing the Project implementation schedule it shall be carefully prepared so that equipment transportation and installation may be efficiently conducted at all 31 sites.

In addition, in order to utilize the disaster management drills to be conducted under the said Development Study, the implementation schedule shall be so prepared to implement those 16 sites[1] with high priority whose early installation is highly desired.

4) Considerations for not to hinder the operation of existing observation facilities

As existing facilities will not be used for this Project, there will be no factors in the Project that may interfere the operation of the existing facilities. However, it is necessary to prepare the Project installation plan by taking into consideration the following points:

i. Automatic weather observation system to be installed in weather must be installed in a location not to hinder weather observation by the existing observation facilities.

[1] Labugama, Maliboda, Wagola, Ratnapura, Sirikandura, Balangoda, Colombo, Ratmalana, Kudawa, Deniyaya, Tawalama, Galle, Matara, Angunakolapelessa, Mt. Pidurutalagala, Horton Plains; 16 sites in total

ii. DoM headquarters operates various weather observation facilities round the clock. It should be confirmed that installation of equipment under this Project will not disturb the operation of these facilities with the responsible persons of the organization.

(2) Considerations for procurement

Equipment and materials to be locally procured for this project should be selected from those that have uniform quality and stable supply. During project implementation period, it is necessary to confirm that material specifications meet required levels with reference to the mill sheet of reinforcing bars and the results of concrete strength tests.

2-2-4-3 Scope of works

When the project is implemented under the grant aid project of the Government of Japan, each country involved shall be responsible for the procurement and installation of project components as shown in Table 2-9.

Table 2-9 Major Undertakings to be Borne by Each Government

No.	Components	To be Borne by Grant Aid	To be Borne by Sri Lankan Side
1	Space for the installation of equipment and materials		●
2	Indoor space for the installation of equipment and materials		●
3	Sites for storing installation materials		●
4	Primary wiring of indoor electricity		●
5	Removal of existing equipment and materials		●
6	Obtaining permission for using frequencies from the telecommunications regulatory commission		●
7	Contract with a satellite operation company for satellite communication		●
8	Installing fences for two collaborator stations		●
9	Desks for mounting procured equipment		●
10	Cost of equipment and materials	●	
11	Cost of packing and transporting equipment and materials	●	
12	Cost of inland transportation of equipment and materials	●	
13	Cost of delivering, installing and adjusting equipment and materials	●	
14	Cost of soft components	●	
15	Tax exemption		●

2-2-4-4 Consultant supervision

The Japanese consultant will engage in the supervision of equipment installation work pursuant to the following policies.

- The meteorological information network system will be composed of three components: automatic weather observations system, satellite communication system, and central operating system. The consultant will confirm whether the system interfaces meet the specifications.
- As the installation sites are many (31 sites), the consultant will monitor, as appropriate, installation progress at each site and supervise work to complete of installation within the specified time schedule.
- The consultant will supervise technology transfer to be provided by the equipment supplier so that the staff of DoM may be able to install, adjust and test equipment units.
- The consultant will collect security information to be shared with the supplier to assure safety.

Under these policies, as part of the supervision work of the consultant for this Project, the consultant will station one management engineer in Colombo and one engineer to patrol each site. Expert engineers will be dispatched to installation site, depending on the progress of installation work. The consultant will witness the test and inspection of equipment and materials at manufacturers' plants during manufacturing or before shipping in Japan to confirm that the equipment and materials meet the specifications. The consultant will engage in the following supervision work:

- Confirmation and approval of manufacturing drawing, necessary documents for equipment and materials
- Attending factory test
- Supervising the progress and safety control of the supplier
- Attending equipment installation, adjustment and trial-run
- Approval of acceptance inspection procedures and inspection plan
- Attending the acceptance inspection (final inspection) and issuing of inspection completion certificates
- Executing technical assistance called soft component
- Preparation of monthly and completion reports to be submitted to the related organizations.

2-2-4-5 Procurement plan

(1) Suppliers of equipment and materials

The major items to be procured for this Project are shown below:

i) Automatic weather observation systems;
ii) Satellite communication system;

iii) Central operating system; and
iv) Materials for civil engineering work, mainly concrete, for installing the facilities.

Cement, aggregates for concrete, reinforcing bars, timbers for formwork, and other materials for civil engineering work shall be procured locally because they are widely available in Sri Lanka and meet international standards. Other equipment shall be procured from foreign countries because they are not manufactured in Sri Lanka. As after-sales services are indispensable for those equipment and materials, they shall be supported by their local agencies.

The external source of procurement shall be Japan as mentioned in Section 2-2-1-8 (1).

As a result, equipment and materials will be sourced as follows:

Table 2-10 List of Sources of Equipment and Materials

Equipment	Source of Procurement		
	Sri Lanka	Japan	Third Country
[Equipment]			
Automatic Weather Observation System		○	
Remote Monitoring/Observation Processing PC		○	
Calibrating Equipment for AWS system		○	
Satellite Communication System		○	
Voice Communication Equipment		○	
Maintenance Instruments for Satellite Communication System		○	
Data Collection/Analysis Processing Servers		○	
PC for Monitoring and Visualization Processors		○	
Large Screen Display		○	
Data Analyzing Software		○	
Percentage (%)	0%	100%	0%

Materials	Source of Procurement		
	Sri Lanka	Japan	Third Country
[Materials]			
Installation Materials			
Reinforcing Bar	○		
Cement・Aggregates	○		
Boards	○		
Materials for Electricity/Communication Facility			
Cables	○		
Percentage (%)	100%	0%	0%

(2) Procurement plan

The procurement contract shall include responsibility for design, manufacture, coating, factory test and inspection, packing, transportation, installation, testing by the suppliers, acceptance inspection pursuant to the specifications of equipment prepared by the consultant, and delivers them after fully confirming the operation by site test and inspection. The suppliers shall obtain approval for inland transportation and installation, prepare necessary materials for work at each site, and fully discuss with the executing agency. Equipment installation shall be conducted under the following policies:

1) Installation work

As local firms have no experience in installing an automatic weather observation system and a satellite communication system, they shall conduct unpacking of the equipment and materials, installation of their foundations, assembly and their installation. Japanese engineers shall be in charge of equipment adjustment, trial-run, initial operation guidance. As local firms have no experience in assembling and installing automatic weather observation system, Japanese supplier staff shall provide the local firms with training for installation.

2) Technology transfer to DoM personnel

As for the seven sites locating in the northeastern region, equipment and materials for them will be delivered in Colombo. DoM shall transport the equipment and materials to each of these sites and install them by its own responsibility.

In order that DoM may be able to install equipment and materials on its own, the contractor shall provide technology transfer to DoM staff for their installation, adjustment and trial-run during project implementation period.

(3) Transportation plan

The locally procured materials (mostly civil engineering use materials for installing equipment), the contractor shall purchase them from local firms and deliver them to each project site. As for equipment to be procured in Japan, they shall be shipped by sea from Japanese ports (Yokohama, etc.) to the Port of Colombo. The contractor shall deliver them to each site after their customs clearance. As there are 31 project sites throughout Sri Lanka, the equipment shall be divided for each site at a temporary warehouse after unloading at the Port of Colombo and delivery them to each concerned site. All equipment and materials will be transported by trucks.

2-2-4-6 Initial Operation guidance plan

As the automatic weather observation systems, a hub station and terminal-stations of satellite communication system and the central operating system provided by the Project are to be introduced for the first time for DoM staff, the study team planned to provide initial operation guidance.

(1) Automatic weather observation systems

1) Items, contents and methods of guidance

The initial operation guidance for the automatic weather observation systems will be conducted by the following contents and methods by the engineers of the system installation contractor for DoM staff.

Table 2-11 Initial Operation Guidance for Automatic Weather Observation System

Item	Contents	Guidance method
Initial operation guidance	• Confirmation of sensor connection and sensor handling • Confirmation of data logger connection and handling and operation • Confirmation of power source connection and handling (incl. solar panels with battery) • Confirmation of communication test and operation • Measure taking against interruption	Guidance for and confirmation of connection and test, handling, and operation using operation manual in order to confirm the learning level of weather observation staff

2) Implementing plan

The initial operation guidance at each observatory will be provided by a Japanese engineer of the Japanese contractor and a local engineer for two days after the installation, adjustment and trial-run of the automatic weather observation system at the observatory.

(2) Satellite communication system

1) Items, contents and methods of guidance

The initial operation guidance for the satellite communication system will be provided to DoM's weather observation personnel by the engineers of the firm in charge of system installation in accordance with the following contents and methods:

Table 2-12 Initial Operation Guidance for the Satellite Communication System at Each Observation Station

Item	Contents	Guidance method
Initial operation guidance	• Explanation on the functions and operation of the equipment (wireless device, voice telephone, modem, rooter, solar panel with batteries) • Explanation on system operation conditions • System operation exercise • Measure taking against interference	To explain functions using the operation manual and to provide guidance for equipment handling and operation using operation manual to confirm the learning level of weather observation staff.

Table 2-13 Initial Operation Guidance for the Hub Station of Satellite Communication System

Item	Guidance contents	Guidance methods
Initial operation guidance	• Explanation about the operation of appliances (wireless devices, voice call devices, modem, rooter, solar battery and battery) • Device operation exercises • Explanation on how to judge the device operation conditions • Explanation on the screen configuration, screen switching and monitoring and the contents of the network management system • Ordinary monitoring contents, points and manner of confirmation of the network management system • Guidance on disorder detection functions, manner of confirming contents and response	To explain equipment operation and provide guidance for equipment handling and operation by using the operation manual for the communication center and the electronics technology department staff and to confirm their learning level.

2) Implementing plan

At each station, the initial operation guidance will be provided for one half day by one Japanese engineer of the Japanese contractor and a local engineer after the installation, adjustment, trial-run and connection test with the hub station.

At the hub station, the initial operation guidance will be provided for 2 days by one Japanese engineer of the Japanese contractor and a local engineer after the installation, adjustment and trial-run, and station connection tests of the satellite communication system.

(3) Central operating system

1) Items, contents and methods of guidance

The initial operation guidance for the central operating system will be provided by the engineers of the firm in charge of system installation to DoM personnel in accordance with the following contents and methods:

Table 2-14 Initial Operation Guidance for the Central Operating System

Item	Contents	Guidance method
Initial operation guidance	• Explanation on system outline • System operation • Explanation about the basic operation and handling method • Explanation about handling each programme • Operation guidance and exercise of each programme • Explanation about the maintenance of various tables or the like • Operation guidance and exercise of various tables or the like • Measure taking against interruption	Explanation by using the operation manual to weather observation staff, communication center staff, electric/electronic engineers, and forecasting staff to confirm their learning level.

2) Implementing plan

The initial operation guidance for the central operating system will be provided for 6 days by one Japanese engineer of the Japanese contractor and a local engineer after connection test between the automatic weather observation system, the satellite communication system and COS and connection test between COS-GTS lines.

2-2-4-7 Soft component (technical assistance) plan

(1) Necessity of introducing the soft component

Concerning the meteorological information network system to be introduced by the Project, it is necessary to provide guidance for its operation and maintenance and to newly set up a work flow ranging from weather observation, data transmission, editing, and processing of the automatically collected data for analysis and forecast by forecasting officers because of the reason that DoM personnel of Sri Lanka have no experience in them. Related persons should also know how to obtain weather data in the case of disorder of the automatic weather observation systems and how to edit data at the headquarters.

Concerning disaster management responsibilities, DoM is to provide weather forecasting and to issue weather warnings, DOI to issue flood warnings, NBRO to issue landslide warnings, the police, SLRC and SLBC to transmit warnings, and the DMC to be responsible for issuing evacuation instruction and liaising with related organizations and DDMCUs. Also, the disaster management related organizations will share weather observation data of DoM. It is therefore necessary to educate them how to interpret weather observation data for forecasting and warning.

It is necessary to provide soft component, including all of them, for smooth setup of the introduced systems and securing the achievements of the Project.

(2) Objectives of the soft component

The objectives of the soft component are shown below;

1) DoM can operate and maintain the meteorological information network system to be introduced under this Project

2) Disaster management related organizations (DMC, DoM, DOI, NBRO, Police, SLRC, SLBC, DDMCUs) can interpret shared meteorological observation data, forecast and warnings for proper utilization

(3) Contents of the soft component

As listed below, the soft component pertaining to the meteorological information network system to be introduced by the Project will include: 1) those for DoM concerning the meteorological information network system, and 2) those for disaster-related organizations for upgrading the understanding of weather observation information to be obtained through the meteorological information network system.

1) Soft component for DoM concerning the introduction of meteorological information network system

Contents

i. Guidance for proper editing, filing and provision of observed data to weather forecasters
ii. Guidance for proper operation and maintenance of observation appliances and communication systems and management of precise observation
iii. Guidance for swift forecasting and improvement of forecasting accuracy in accordance with the improvement of observation precision
iv. Guidance for swift and proper response against anomaly
v. Guidance for conveying proper forecast and warning to disaster-related organizations and synoptic meteorological stations

Attendance

No.	Department	Guidance items	No. of required attendants
1	Observation Dept.	Items i, ii, iii and iv above	5
2	Telecommunication Center	Items i, and iv above	5
3	Electronics Dept.	Items ii, and iv above	4
4	Met Station observers	Items i, ii, iv, and v above	20
5	Forecasting Dept.	Items iii, iv and v above	4
Total			38

Method of technical guidance

Technical guidance will be given using a series of manuals for weather data collection, processing and edition, and analysis and forecasting, work flow materials, manuals corresponding to the activities mentioned above, explanation by lectures, and by using the central operating system to be installed by the grant aid.

At the local synoptic meteorological stations, representative observers gathered in regions will participate five times in lectures and exercises concerning the operation and maintenance of the automatic weather observation systems, and how to deal with disorders.

Implementation period

System Management	: 57 days
Data Processing	: 39 days
Analysis and Forecasting	: 43 days

2) Soft component to be given to disaster management-related organizations concerning the utilization of weather observation information to be obtained by the automatic weather observation systems

Contents

i. For disaster-related organizations, guidance for accurately understanding the weather forecasts, advisory and warning

ii. For DOI, NBRO and DMC, explanation about weather observation data, such as rainfall to be available from DoM, in order to utilize it for flood analysis, landslide analysis and evacuation analysis

iii. Guidance for the staff of DoM so that they may make disaster-related organizations understand weather information and data provided by DoM

iv. DoM will provide guidance to their staff so that they can identify needs for weather information required by disaster-related organizations

Attendance

No.	Organization	Guidance items	No. of required attendants
1	DMC, Early Warning Dept.	Item i and ii above	2
2	DMC, Emergency Operation Center	Item i and ii above	2
3	DoM, Forecasting Dept.	Item i, ii, iii and iv above	2
4	Department of Irrigation, Hydrology Dept.	Item i and ii above	3
5	National Building Research Organization, Landslide Studies and Services Division	Item i and ii above	3
6	Police Communication Center	Item i above	2
7	Sri Lanka Rupavahini Corporation	Item i above	2
8	Sri Lanka Broadcasting Corporation	Item ii above	2
9	District Disaster Management Coordinating Units	Item ii above	7
Total			25

Method of technical guidance

The technical guidance will be given by explaining what weather observation data, forecasts and warning will be available for the disaster management-related organizations. Joint meetings will be organized to identify the needs of disaster management-related organizations for the data and information of DoM.

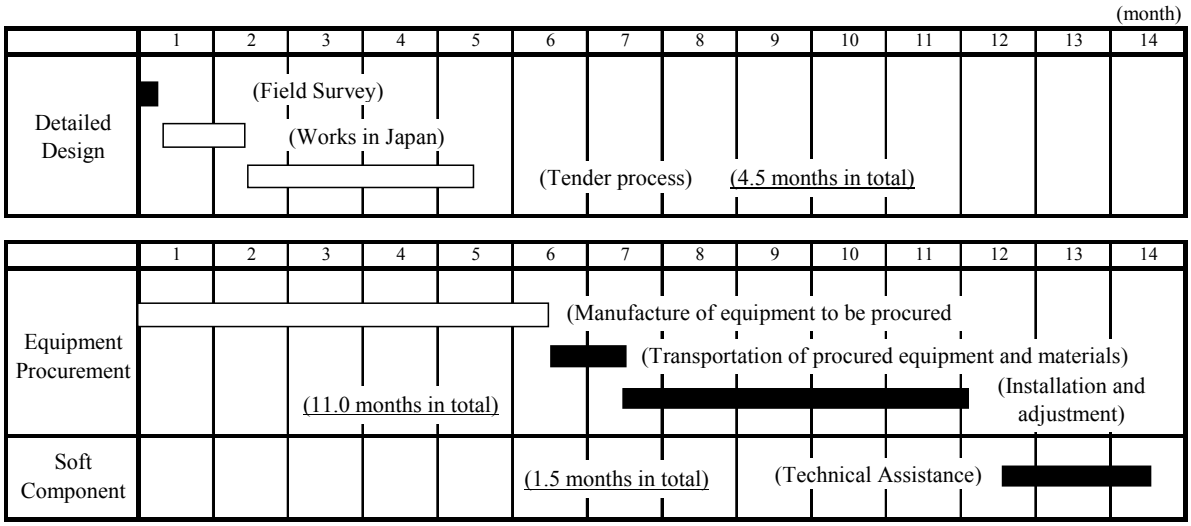
Implementation period

Implementation period：20 days

2-2-4-8 Implementation schedule

A reasonable procurement and installation schedule for this Project is shown in the Table below. The detailed design of the Project will take 4.5 months, and procurement, transportation and installation 11.0 months, soft component 1.5 months; i.e. 17 months in total. Higher equipment installation priority will be given to those 16 sites where early installation is highly desired by the said Development Study. It is noted that equipment and materials for the 7 sites in the northeastern area to be delivered in Colombo as described in Section 2-2-2-1 (6).

Table 2-15 Implementation Process



2-3 Obligations of recipient country

Upon the implementation of this Project as a grant aid from Japan, Sri Lanka shall be responsible for those items indicated in Section 2-2-4-3 "Scope of works". Both the governments of Japan and Sri Lanka have confirmed the needs for taking the following measures:

(1) Undertakings to be borne by Sri Lankan side

1) Procedures for lands

In this Project, procured equipment and materials will be installed at the sites of synoptic meteorological stations and collaborator stations and the buildings of the synoptic meteorological stations. In order to install the equipment except for the premises of DoM, land-use permission is required. Such permission is required from five synoptic meteorological stations (Galle, Katunayaka, Ratmalana, Trincomalee, Maha Illuppallama) and all collaborator stations, and it is confirmed that all necessary land-use permissions were obtained for those sites.

2) Satellite communication contracts with a satellite operator and procedures relating to Telecommunications Regulatory Commission

The Project's satellite communication system will use commercial communication satellite(s) for which its use contract will be made with the communication satellite operating company. Procedure necessary to acquire required communication frequency band from Telecommunications Regulatory Commission shall be completed by June 2008 before the disembarkation of the equipment.

3) Tax exemption

Sri Lanka will exempt customs duties, domestic taxes and other charges for Japanese nationals entering the country to procure equipment and materials based on the procurement contract of the Project and to implement various activities. The country will also facilitate customs clearance of procured equipment and materials, and exempt taxes for them.

4) Convenience provision

To accord Japanese nationals, whose services may be required in connection with the supply of the products and the services under the verified contract, such conveniences as may be necessary for their entry into Sri Lanka and stay therein for the performance of their work.

5) Banking arrangements (B/A), Authorization to pay (A/P)

Sri Lanka will open a bank account in its name at a Japanese bank and issue Authorization to pay (A/P) to the bank. Based on the Banking Arrangement (B/A), the Sri Lankan side should bear an advising commission of an Authorization to Pay and payment commission to the Bank.

(2) Works by Sri Lanka

1) Erecting fences

At the two collaborator stations in Maliboda and Tawalama, their equipment installation sites are not at the places where conventional equipment units are installed. The new installation sites may be accessed by third parties other than the administrators. The Sri Lankan side shall therefore construct fences there by the end of June 2008.

2) Preparation of desks for equipment

DoM and synoptic meteorological stations need to have desks for placing the equipment. It is confirmed that existing desks may be usable for this purpose; hence, the Sri Lankan side should newly purchase additional desks if necessary.

3) Preparation of primary side indoor electric wiring

At DoM headquarters, it is necessary to prepare primary side electric wiring required for VSAT hub station before the start of installation. It has been confirmed that existing facilities are sufficient, but the Sri Lankan side shall be responsible for any necessary electric wiring.

4) Installation of Equipment at 7 sites located in the northeastern area

As described in Section 2-2-2-1 (6), the equipment is to be installed by the Sri Lankan side within one year (March 2010) after the completion of the Project.

2-4 Project operation and maintenance plan

(1) Automatic weather observation systems

The automatic weather observation systems can automatically log weather data every 10 minutes in the data logger, and constantly monitor weather conditions by the PC for remote monitoring and observation and operation of observing appliances. At the observation reporting time of every three hours which is considered necessary for identifying weather phenomena of a certain time and spatial scale as recommended by WMO, weather observers at synoptic meteorological stations shall notify the headquarters by inputting the data of visual observation items into the remote monitoring and observation data processing PC, in addition to the automatic observed and transmit data by automatic weather observation system and VSAT system.

As a system has been established to operate and maintain at the synoptic meteorological stations round the clock by the weather observers of DoM, it is planned to train them by initial operation guidance and soft component for smooth set up of the management and maintenance.

The soft component shall be provided for the collection and analysis procedures of observed weather data, and technical support related to observed data to be transmitted to DoM headquarters and weather forecasting and warning to be transmitted from the headquarters to the stations.

The operation and maintenance of automatic observation appliances at collaborator stations shall be periodically conducted by DoM headquarters and observers of the synoptic meteorological stations. When emergency response is needed for a collaborator stations that are located without fixed telephone and outside the mobile phone service area, certain staff shall be dispatched from a nearest synoptic meteorological station pursuant to the direction of DoM headquarters.

The automatic weather observation appliances shall be periodically calibrated in accordance with the plan stated in 2-2-2-3 (5) 2), with the calibration devices.

As for automatic observation items, observers shall concurrently observe weather elements by the conventional methods for a certain period of time for the comparison and continuity verification of observed values.

(2) Satellite communication system

A network between DoM headquarters in Colombo and each regional observatory through satellite communication system (VSAT system) will be built by the Project. The headquarters shall have a hub station and each observatory shall have a terminal station. The hub station will

be responsible for operation and maintenance, operation monitoring, and technical guidance for the communication circuit.

A person in charge of the hub station shall monitor and control the operation of the entire communication circuit and secure necessary circuit with the satellite operator and take necessary measure upon the occurrence of any emergency. An officer in charge in the headquarters shall provide assistance for equipment operation to weather observation personnel at terminal stations.

In order to operate and maintain the satellite communication system, 6 experts will be required including five electronics experts (1 engineer and 4 technicians) to be newly employed by DoM. They will be provided with technologies by the technology transfer to be provided by the contractor at the site upon the completion of equipment installation, adjustment, trial-run and connectivity test. Soft component will be useful for the smooth setup of operation and maintenance by technical assistance for the entire system, including maintenance and inspection, and emergency measure taking.

The circuit use charge for the satellite communication shall be paid by DoM by making a contract with the satellite communication operating company. The frequency use charge for the satellite communication shall also be paid by DoM to the telecommunications regulatory commission of Sri Lanka. DoM should secure sufficient budgetary amount for these payments.

(3) Central operating system

The system will be composed of a communication processing function for exchanging of weather information with external parties, including foreign countries, and transmitting analyzed forecast data to synoptic meteorological stations, and analysis processing function for editing, analyzing, graphic display and transmission of information from the forecasters. It will be also a center for operating and maintaining the entire system, and monitoring all observatories.

The central operating system is thus operated by the communication center, the observation department and the forecasting department at DoM headquarters. The staff of the electronics technology department will provide technical support.

The contractor shall provide guidance for initial operation for the communication center, the observation department, the electronics department and the forecasting department. The soft component will be helpful for the smooth setup of operation and maintenance and assure sustainability of the cooperation achievement by training them on new work procedure, disorder response, and handling method of observation data collected by the conventional methods.

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

Chapter 3 Project Evaluation and Recommendations

3-1 Project effect

The following table shows the specific effects (results) expected to be achieved by the implementation of the project for the project objectives.

Table 3-1 Project Effects

Area	Measures in the project	Direct effects	Indirect effects
Improving the precision of weather observation	・ Introduction of automatic weather observation appliances (AWS system) ・ Guidance by soft component (technical assistance)	・ Improvement of accuracy of automated observation elements ・ Reduction of time from 50 min. to 10 min. required for collection of weather observation data ・ Reduction of observed data collection intervals from 3 hours to 1 hour for normal weather and from 1 hour to 10 min. for severe weather	・ Contribution to early transmission of warnings to possibly affected residents ・ Contribution to the mitigation of physical damage caused by natural disaster and the prevention of human lives against natural hazard.
Improving speed, certainty and precision to collect weather observation data	・ Introduction of satellite communication system (VSAT system) ・ Guidance by soft component (technical assistance)	・ Reduction of time from 50 min. to 10 min. required for collection of weather observation data ・ Reduction of observed data collection intervals from 3 hours to 1 hour for normal weather and from 1 hour to 10 min. for severe weather ・ No circuit congestion on data/voice communication	・ Contribution to early transmission of warnings to possibly affected residents ・ Contribution to the mitigation of physical damage caused by natural disaster and prevention of human lives against natural hazard.
Identifying weather phenomena on realtime basis and electronically transmitting observed data at each meteorological station	・ Introduction of computerized automatic data processing and analysis (COS system) ・ Guidance by soft component (technical assistance)	・ Reduction of time from 50 min. to 10 min. required for the collection of weather data ・ Reduction of weather data collection intervals from 3 hours to 1 hour for normal weather and from 1 hour to 10 min. for severe weather	・ Contribution to early transmission of warnings to possibly affected residents ・ Contribution to the mitigation of physical damage caused by natural disaster and prevention of human lives against natural hazard
Comprehending Meteorological Phenomena	・ Introduction of AWS, VSAT, and COS system ・ Guidance by soft component (technical assistance)	・ Increase the number of weather data collection sources from 20 stations to 38 stations	・ Improvement of temporal and spatial density of weather observation to identify weather phenomena in more detail ・ Contribution to early transmission of warnings to possibly affected residents ・ Contribution to the mitigation of physical damage caused by natural disaster and prevention of human lives against natural hazard.

3-2 Recommendations

The Project is expected to acheve direct and indirect effects mentioned in the previous section and contribute to strengthening disaster management functions of Sri Lanka. It is therefore considered as being highly reasonable to implement the Project by a grant aid from Japan. Considering the issues mentioned below in implementing the project, the study team makes below recommendations to make envisaged project effects much higher and more efficient and maintain them over a long term.

3-2-1 Issues to be addressed by the recipient country and recommendations

i. Concerning the 7 sites in the northeast area covered by the Project, it is planned that the meteorological appliances and communication equipment be delivered at Colombo and DoM shall be responsible for installation, adjustment, test and operation within 1 year after the completion of the Project. DoM needs to surely perform the installation.

ii. Most of the disasters in Sri Lanka are floods and landslides caused by rainfall. Thus, it is important to strengthen disaster management functions in order to precisely identify rainfall. The meteorological information network system to be introduced by the Project will contribute to identifying rainfall in real-time basis and forecasting rainfall. However, it cannot identify the area of rain clouds, especially extensive distribution of rain clouds. DoM of Sri Lanka plans to introduce a radar system for monitoring rain clouds by its own funds. Once the radar is installed, the surface observation data collected by the system to be introduced by the Project may be able to calibrate data observed by the radar for effective mutual use. It is highly desired that a project for installing the radar will be promoted for collecting more precise weather data and providing weather information to the disaster management related organizations.

3-2-2 Technical cooperation and tie-up with other donors

i. The meteorological information network system to be introduced by the Project will strengthen the weather observation activities of DoM. In addition, it is necessary to transmit the observed information or warnings to organizations related to disaster management and the residents in possibly affected areas by natural hazard within proper timing. It is therefore indispensable to utilize the communication network connecting such disaster management organizations, which is planned to be introduced under the pilot project that is being studied as JICA's Development Study. Each disaster management organization has its own role in observing weather, issuing warning, transmitting warning, monitoring warning, and issuing appropriate directions by shearing necessary information. They must play their own roles and ensure mutual cooperation to reduce property damages caused by natural hazard and prevent human lives against the hazard. DoM should take the leadership to explain, whenever necessary, the meanings of weather information, such as meteorological data, and hazard

warnings to be provided to other organizations and make efforts to identify needs of disaster management organizations so that DoM may be able to provide needed information to them.

ii. The Project aims at improving the weather observation precision of DoM. To mitigate damage to be caused by natural disaster, it is necessary to issue more correct weather information and precise warnings to local residents. In order to issue more precise forecasting, it is necessary to provide technology transfer by the skilled meteorologist for enhancement of forecasting accuracy in addition to the improvement plan and additional equipment procurement plan. It is desirable therefore to carry out technical cooperation after the completion of the Project in order for further improving weather forecast precision.