Government of the People's Republic of Bangladesh
Ministry of Water Resources

Bangladesh Water Development Board (BWDB)

Office of the Chief Planning

Upgrading, Updating of Existing SiMS and Development of SiMS-Web, SiMS Google & SiMS App for Smart Phone

SiMS
Smart

SiMS Application

Progress Monitoring

BWDB Asset

Hydraulic Structure (Structure Inventory Integration)

O&M Module

Document Archive

Metadata

Water Management Organization (WMO)

FINAL REPORT
March 2018

Vehicle Tracking

IP Camera

Mobile APK

FFWC

Submitted By

I W M
Water Environment & Climate

INSTITUTE OF WATER MODELLING (IWM)

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The Ministry of Water Resources and the BWDB top management took a timely initiative to implement this project to run in-line with the national dream of "Digital Bangladesh". Honorable Ex-Minister Mr. Anisul Islam Mahmud, MP, Ministry of Water Resources, have shown his keen interest for implementing the digital system for management and monitoring of Water Projects through which access and visualization of information could be efficiently and timely obtained by the policy makers. His effective drive pursued this project to be implemented. His advice and guidance during the presentation before him was very useful in development of this project. The Honorable State Minister, Ministry of Water Resources, Lt. Col. (Retd.) Muhammad Nazrul Islam, Bir Protik, psc, MP, has also showed lot of interests, and encouraged this development. Dr. Zafar Ahmed Khan, Senior Secretary, Ministry of Water Resources gave his views and suggestions on development of the SiMS-Smart to ensure the visual real time monitoring of the BWDB schemes.

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Dr. Mollah Md Awlad Hossain, Director, ICT-GIS Division, worked as Team Leader of this project. He guided the team for design and development of the SiMS-Smart.

EXECUTIVE SUMMARY

Under the Water Management Improvement Project (WMIP), a project namely "Scheme Information Management System (SiMS)" was developed by IWM during 2008-2014 for BWDB. The general and physical features along with available design parameters of structures, embankments and drainage channels of all completed schemes was entered in SiMS's Schemes Inventory Database model. The software was developed as a Standalone desktop application without web functionalities.

Upholding the motto of "Digital Bangladesh", BWDB took initiative to upgrade that SiMS to make it web-based and integrated with GIS and smart devices for BWDB officials to manage and monitor the schemes/projects more efficiently for the whole country. Initially, South-Eastern Zone (SEZ), Chittagong was chosen for the pilot area before implementing the application for all BWDB Zones. Once the application will be successfully implemented in SEZ, SiMS-Smart will be replicated to the rest of the BWDB Zones following the upgradation of SiMS Database. This National level implementation can be implemented Zone by Zone and phase by phase basis.

Technologies adopted for this project are integration of IP-Camera, Mobile Apps and advanced GIS and web technologies for remote information access and visual monitoring. The developed System is named as "SiMS-Smart", referred as Scheme Information Management System with Smart Technologies. The development of SiMS-Smart considered South-Eastern Zone of BWDB as the pilot project area.

The feature database embodied under this project are the embankment, hydraulic structures, canals and protective works of the completed and on-going schemes within the Chittagong South Eastern Zone. Both spatial and non-spatial data were collected, compiled and stored in prescribed format in Oracle database. ArcGIS Server has been deployed for GIS map service. The web application was developed using ASP.NET, JavaScript APIs and other necessary tools. For remote and real-time monitoring, alongside the IP-Camera, Skype has been integrated with SiMS-Smart to make the system more accessible, versatile and cost effective.

Data availability, access and collection process was found to be the most difficult part of this project. However, after the deployment of SiMS-Smart, BWDB relevant officials can populate the database as and when available.

If the developed system is implemented, BWDB will be capable of (a) archiving design and project related documents and maps in digital data storage, (b) visualizing project entities (embankment, structures, canals, protective works etc.) in GIS maps with satellite image background, (c) archiving and visualizing time based physical conditions along with photographs and videos, (d) searching and querying on project entities, (e) quantity and cost estimate of earthworks, structures, excavation etc., (f) budget demand allocation, work selection, work package preparation, preparation of procurement plan and DPP, (g) progress monitoring of on-going activities through online update and visualization in tables, charts, short reports, (h) real-time visual monitoring through integrated Skype and IP-Camera, (i) visualizing Water Management Organization (WMO) information for each scheme/project, (j) managing BWDB asset

information (Land, Vehicle and Key assets), (k) assessing the threat of forecasted flood based on nearest connected FFWC gauges, (l) data collecting and viewing of scheme information through Smart Devices, and (m) real-time monitoring of water levels for auto gauges, especially during the high flood and cyclone storm surges.

To establish the SiMS-Smart for scheme management under a digital platform for Bangladesh it is recommended to (a) replicate the SiMS-Smart in rest of the BWDB zones, (b) establish a permanent unit in BWDB office to adapt SiMS-Smart in scheme/project management, (c) convert all available data of BWDB relevant to SiMS-Smart into SiMS-Smart database, (d) incorporate geographic coordinate system alongside the existing chainage system in embankment, structure and other work locations to make compatible with GIS and online maps, (e) need more and regular inclusive training to BWDB officials on the use of SiMS-Smart, (f) Identify the improvement areas of developed SiMS-Smart through the use of the system at different levels of BWDB officials, (g) periodically update the database and GIS maps for schemes/projects, in case of unavailable data in detail, field survey and assessment could be done, (h) ensure access and share of the data maintaining the confidentiality. BWDB officials could be assigned with exclusive responsibilities for this purpose for maintaining the service.

Acronyms and Abbreviations

ADP	:	Annual Development Program
AIMS	:	Asset Information & Management System
API	:	Application Programming Interface
ArcGIS	:	GIS software System Distributed by ESRI
ASP	:	Active Server Page
BTM	:	Bangladesh Transverse Mercator
BWDB	:	Bangladesh Water Development Board
COM	:	Compiled Object Module
DCMI	:	Dublin Core Metadata Initiatives
DPP	:	Development of Project Proforma
DSS	:	Decision Support System
ESRI	:	Environmental System Research Institute
FCD	:	Flood Control Drainage
FFWC	:	Flood Forecasting and Warning Centre
FFWS	:	Flood Forecasting Warning System
FGD	:	Federal Geographic Data
FGDC	:	Federal Geographic Data Committee
GIS	:	Geographical Information Systems
GUI	:	Graphical User Interface
GoB	:	Government of Bangladesh
GPS	:	Global Positioning System
HTTP	:	Hyper Text Transfer Protocol
IIS	:	Internet Information System
IMED	:	Implementation Monitoring and Evaluation Division
IP	:	Internet Protocol
JS	:	Java Script
LA	:	Land Acquisition
O&M	:	Operation and Maintenance
RBP	:	River Bank Protection

RDBMS	:	Relational Database Management System
PA	:	Project Aid
RPA	:	Revised Project Aid
SDE	:	Spatial Data Engine
SEZ	:	South-Eastern Zone
SiMS	:	Scheme Information and Management System
SIM	:	Subscriber Information Manager
SOC	:	Subscriber Information Container
SOM	:	Server Object Model
SQL	:	Structured Query Language
TOR	:	Terms of Reference
TAPP	:	Technical Assistant Project Proforma
WMIP	:	Water Management Improvement Project
WMA	:	Water Management Association
WMF	:	Water Management Federation
WMG	:	Water Management Group
WMO	:	Water Management Organization
WWW	:	World Wide Web

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1 INTRODUCTION

1.1 BACKGROUND

Under the Water Management Improvement Project (WMIP), a "*Scheme Information Management System (SiMS)*" has been developed through a Consultancy Package of 'Scheme Database Inventory and Mapping' by IWM during 2008-2014 under a consultancy contract under WMIP (contract package no. BWDB: S/4) for BWDB. IWM processed and compiled 630 numbers of completed schemes of BWDB spreading over 8 (eight) BWDB zones. The general and physical features along with available design parameters of structures, embankments and drainage channels of all completed schemes has been entered in SiMS's Schemes Inventory Database model.

In recent years, the information technology has been enhanced further by incorporating better remote access using web and smart devices for management of information. The web technologies incorporated interactive digital mappings which made the information more visual related to real life geographic locations. To keep the developments of BWDB, updated with enhanced ICT facilities, the existing Scheme Information Management System (SiMS) needed to be updated. The update is required both in software and databases, and it required to extend its capacity for management of some assets of BWDB. Also, ongoing projects are felt to be incorporated into the system considering its implementation management and operation procedures.

In this connection BWDB assigned IWM to develop a Web-based SiMS for managing and maintaining the BWDB Schemes and projects spread out all over the South-Eastern Zone (SEZ), Chittagong as pilot area under a contract titled "Upgrading, Updating of Existing SiMS and Development of SiMS-Web, SiMS Google & SiMS App for Smart Phone Project". As per the scope of works in the contract, IWM has updated existing SiMS and developed several modules in web platform and also incorprated latest GIS technologies in web environment backed by a central database. The assigment was started in May 16, 2016 for one year and later on it has been extended for eight months. During this period, alongside the development activities, IWM have made sevral consultation meetings and submitted inception and interim report which are followed by this Draft Final Report.

1.2 OBJECTIVES OF THE ASSIGNMENT

Internet access is expanding with higher bandwidths throughout Bangladesh to support the fulfillment of the national goal of 'Digital Bangladesh'. Like most developed countries, it has been changing the way of communication, business and information exchange rapidly day by bay. Considering the technological advancement of Information arena, BWDB aimed to upgrade the existing Scheme Information Management System (SiMS) application to a web and GIS platform for making information available to every level of users from decision makers to the general users.

The overall objective of this assignment was to develop a Web-based SiMS for managing and maintaining the BWDB Schemes and projects spread out all over the country.

Initially the assignment of SiMS-Smart development was the South-Eastern Zone with the existing and field survey data. Once the SiMS-Smart will be fully operational and meets the purpose it had been planned to be expanded to remaining BWDB Zones with their respective project/scheme level information/data. To integrate project/scheme level data for remaining Zones, it is expected to generate bulk volume of data therefore could be managed if carried out phase by phase. If any further refinement or any new module development could be conducted in the next phase.

The SiMS-Smart comprises of both on-going and completed schemes/projects regardless of their size and type. This SiMS-Smart will support BWDB officials in planning, budgeting, estimating and monitoring the rehabilitation and improvement works for all types of BWDB's schemes and projects. A provision of BWDB Asset Inventory Management is also integrated as a part of the SiMS-Smart.

In addition, as a background map, free online satellite map services has been introduced in SiMS-Smart.

The mobile apps will assist BWDB to enhance their data collection performance as well as to monitor the real-time data capturing status.

The specific objectives of SiMS-Smart are:

i. Transforming the full system into a web-based GIS application with a view to ensuring accessibility of information for the intended target groups.

ii. Integration of project components (structures, embankment, canals and protective works) in order to collect and disseminate relevant information powered by smart device (mobiles, tablets etc.) technologies.

iii. Developing the Asset Information and Management System (AIMS) using data of a small sample area in a sub-module. This could be scaled up under follow up projects.

iv. Build capacity of BWDB through training and technology transfer.

v. Long-term maintenance support to GIS Cell of BWDB through a yearly maintenance program.

Detailed scope of works aiming to the objectives as per ToR has been presented in **Appendix A**.

1.3 THE PROJECT AREA

The project encompasses the BWDB's completed and ongoing projects located within South-Eastern Zone (SEZ), Chittagong covering an area of 21,700 Sq. Km. The SEZ consists of Chittagong O&M Circle and Cox's Bazar WD Circle; several O&M Divisions offices are operated under these two Circle offices. The O&M offices and location map of SEZ, Chittagong are presented in Table 1-1 and in Figure 1-1. The study area covered by 62 numbers of completed FC, FCD, and FCD/I Schemes and 48 numbers of River Bank Protection Projects are presented. A list of completed Schemes/Projects are given in **Appendix-C**.

Table 1-1: BWDB Field offices in SEZ, Chittagong

Zone	Circle	O&M Division
South-Eastern Zone, Chittagong	Chittagong O&M Circle	Chittagong O&M Division-1
		Chittagong O&M Division-2
		Rangamati O&M Division
	Cox's Bazar WD Circle	Cox's Bazar O&M Division
		Bandarban O&M Division

Within the study area there are 13 (thirteen) numbers of ongoing projects under ADP Program in Fiscal Year 2016-17 & 2017-18, a list of those on-going projects is presented in Table 1-2.

Table 1-2: List of On-going scheme/project in FY 2016-17 & FY 2017-18 in the study area

Sl No.	Project Name	Type	BWDB O&M Division/Circle/Zone
1	Water Management Project (WMIP)		
2	Bank Protection Work along the Left and Right bank at Different location of Karnafuli River, Boalkhali & Raikhali Khal under Boalkhali & Rawjan Upazila, Chittagong	River Bank Protection	Chittagong Division-I & II
3	Rehabilitation of BWDB infrastructures Damaged by Natural Disaster in the Coastal Area of Polder No. 64/1A, 64/1B & 64/1C at Banshkhali Upazila in Chittagong District	Rehabilitation Work	Chittagong Division-II
4	Rehabilitation of Damaged Polders under the District of Cox's Bazar	Rehabilitation Work	Cox's Bazar O&M Circle

Sl No.	Project Name	Type	BWDB O&M Division/Circle/Zone
5	Maliara-Bakkhain-Bhandergaon FCDI Project	FCD	Chittagong O&M Division-I
6	River Bank Protection Work on both bank of Sangu and Chandkhali River in Chandanaish & Satkania Upazila of Chittagong District.	River Bank Protection	Chittagong O&M Division-I
7	Rehabilitation of BWDB infrastructures for erosion Protection Drainage and Irrigation improvement in the Coastal Area of Polder No. 61/1 (Sitakunda). 61/2 (Mirersarai) & 72 (Sandwip) in Chittagong District	Rehabilitation Work	Chittagong O&M Circle
8	Rehabilitation of Coastal Polder N.-62 (Patenga), 63/1A (Anowara) & 63/1B (Anowara & Patiya) in Chittagong District	Rehabilitation Work	Chittagong O&M Circle
9	Mirsarai Bangladesh Economic Zone Area (BEZA) Flood Control, Road Cum Embankment Protection & Drainage Project in Chittagong District.	FCD	Chittagong O&M Division-I
10	Bank Protection work on the right bank of the Matamuhuri river near Alikadam Sena Nibash, Bandarban	River Bank Protection	Cox's Bazar O&M Circle
11	Re-Construction of Embankment with Protective work in polder no. 68 of Shahaparia dwip (Sea-dyke) in Upazila-Teknaf & District- Cox' Bazar	Rehabilitation Work	Cox's Bazar O&M Circle
12	Bakkhali River Flood Control, Drainage, Irrigation & Dredging Project (1st Phase) in Cox's Bazar District	FCDI	Cox's Bazar O&M Division
13	Protection of the both bank of Halda River by Bank Protective Work at different locations in Hathazari & Rauzan Upazila in Chittagong District	River Bank Protection	Chittagong O&M Division-I
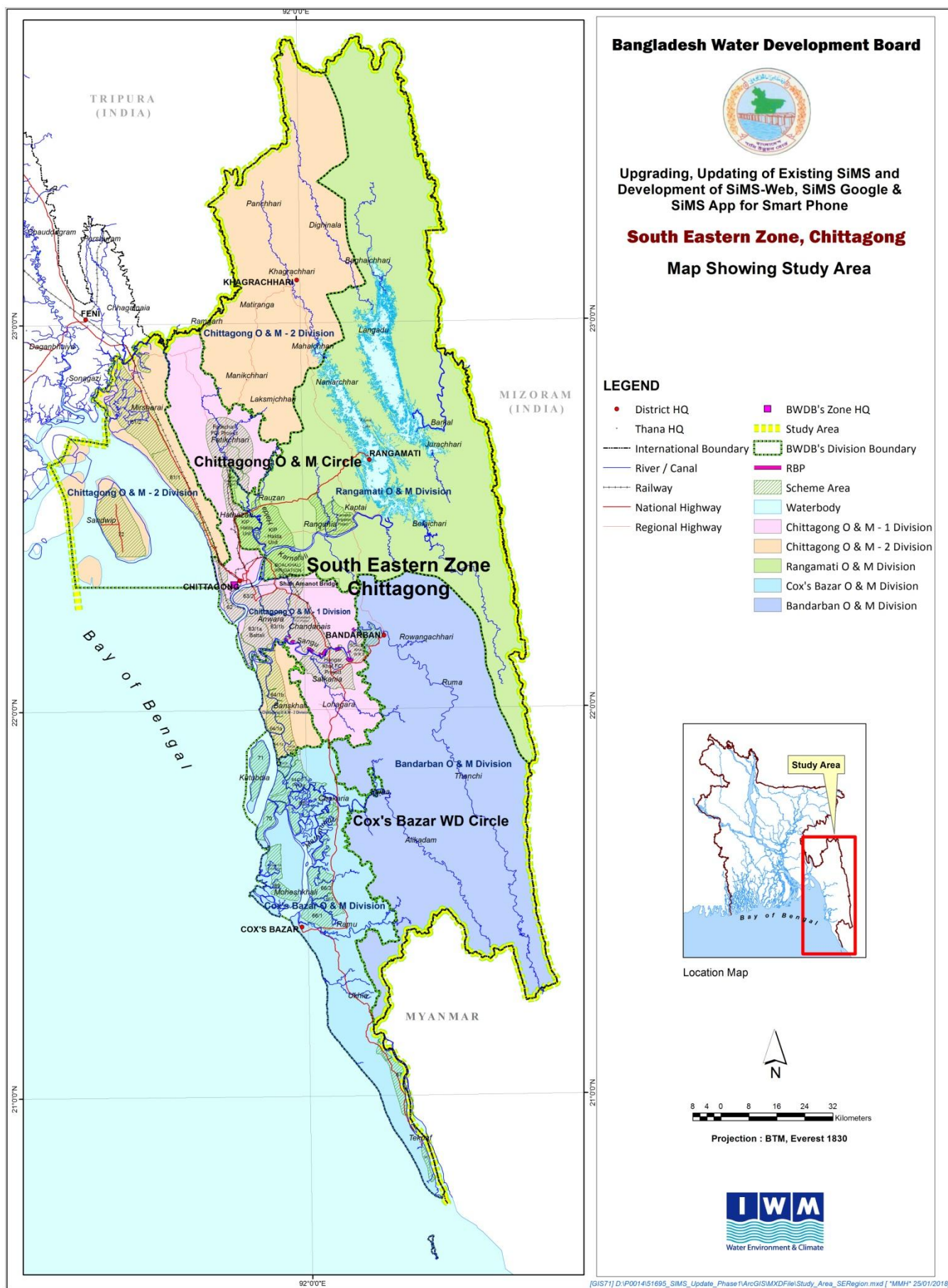
Figure 1-1: Study Area Map

1.4 SCOPE OF SERVICES

As per the ToR of this project, the scope of services was defined in eight major activities. A brief description of the scopes are given below:

1.4.1 UPDATING OF SCHEME DATABASE INVENTORY AND MAPPING

This activity consists of two sub activities: (a) updating of scheme database inventory, and (b) updating of scheme geo-spatial database (GIS mapping).

(a) UPDATING OF SCHEME DATABASE INVENTORY

The existing SiMS database covered only completed BWDB schemes, but the current work covers BWDB completed and ongoing schemes/projects for South-Eastern Zone, Chittagong. The data which are not available in SiMS and in BWDB field offices were collected through field survey to update the Scheme database.

(b) UPDATING OF SCHEME GEO-SPATIAL DATABASE

This task included updating of spatial database in existing SiMS by inclusion of remaining schemes and ongoing projects data for the project area (South-Eastern Zone). The updating of Scheme Level spatial database included the identification and collection of spatial data from available sources in BWDB field offices. These collected spatial data were processed and uploaded into Geo-spatial database.

The scheme information, which are not available from BWDB field offices and or other sources were generated by digitizing from available high-resolution satellite imageries as well as from field survey.

1.4.2 UPDATING OF WATER MANAGEMENT GROUP/ ASSOCIATION/ FOUNDATION DATABASE

This task included adding new data and updating of existing information of Water Management Group/ Association/ Foundation and building GIS layer for covering all the BWDB schemes and projects within the study area.

1.4.3 PRIMARY DATA COLLECTION BY PHYSICAL FEATURE SURVEY

The scheme data which were not available both in existing SiMS and BWDB field offices were required to collect through field survey. Data collection considered following features and information:

a) Embankment's adjoining channel bank-lines have been surveyed where the embankment is under threat of immediate erosion (foreshore distance less than 50m). For other areas, river banks have been digitized from recent satellite imagery as much as possible. For un-identified portion, primary survey was conducted;

b) Alignment of drainage channels including their connectivity with the hydraulic structures. About 500 m drainage channels including up- and down-stream connectivity with hydraulic structure was surveyed and the rest of the channel length were identified from recent satellite imagery;

c) Location and dimension of all hydraulic structures in the project/scheme area;

d) Photographic view of all hydraulic structures.

e) Video of hydraulic structures with adjacent area were incorporated from another BWDB's on-going project (*Review of Physical Condition and Functionality of Existing Hydraulic Structures of BWDB*).

1.4.4 DEVELOPMENT OF A WEB GIS-BASED APPLICATION FOR SIMS AS SIMS-WEB

The activities under this item was to convert the modules of existing SiMS into SiMS-Web application. From now on, the developed system application is termed as **SiMS-Smart**. SiMS-Smart is a GIS enabled interactive web application accessible from anywhere in the world through internet access.

1.4.5 DEVELOPMENT OF AN APPLICATION IN GOOGLE EARTH PLATFORM AS SIMS-GOOLGE

Google has deprecated and discontinued its service to develop application based on its APIs as mentioned in the contract. Hence, after reviews in inception phase by the technical committee this work item was revised that the Sims-Smart application will load google map/ESRI maps/open street maps as a background without any subscription. This will facilitate the visualization of map and satellite views at different zoom and scale levels dynamically.

1.4.6 DEVELOPMENT OF AN ANDROID-BASED SMART PHONE APPLICATION AS SIMS-MOBILE

Mobile technology extends the capability of GIS beyond the office and allows organizations to make more accurate, real-time strategic planning and decisions incorporating in both field and office environments. Android based solutions will provide supports through the immediate access to up-to-date, real-time information, regardless of location, that help to achieve more informed decisions in the relevant fields. This can be utilized for various types of data collection including text, location, audio and video etc.

This task includes development of several mobile apps for smartphone or handheld smart devices for field level data collection, data update to the main database server using user privileges.

1.4.7 PROGRESS MONITORING MODULE

The SiMS-Smart was planned to consider and incorporate the modules for physical works and financial activities, progress and completion schedules of BWDB's O&M works of completed and ongoing projects. The SiMS-Smart have the facilities to generate progress reports using BWDB standard formats in different time periods such as weekly, fortnightly, monthly, quarterly, half yearly and yearly etc. for O&M works and to generate Project Progress according to the IMED formats for BWDB's ongoing projects.

1.4.8 REAL TIME PROJECT MONITORING WITH IP CAMERAS

One of the main tasks of this assignment was to install IP (Internet Protocol) Camera at several selected BWDB's ongoing projects. This is an excellent tool to remotely monitor project activity and quick and easy to use. Provision of storage using NVR or local storage were also included. As per ToR, on pilot basis, Six

(6) IP Camera would be placed on six selected locations at South-Eastern Zone - Chittagong, Sirajganj Hard Point, Chandpur Town Protection, Pani Bhaban at Dhaka, Gopalganj and Narshingdi District.

According to the decision made by the Inception Meeting was to install one IP Camera at Halda Extension Project and the remaining five (5) numbers would be installed at the selected locations by the Chief Engineer, South-Eastern Zone, Chittagong.

Based on the above decision in Inception meeting, the Chief Engineer, SEZ, Chittagong advised to the Executive Engineer of respective Divisions under SEZ to select suitable locations in their divisions to install Six (6) IP camera. Following table shows the final site of installation locations of IP Camera in different field divisions in SEZ.

SL No	Location	O & M Division	Installation Status
1	Pump Station of Halda Extension Project at Sattarghat under Hathazari Sub-Division	Chittagong O&M Division-I	Installed
2	Pump Station of Ichamati Unit of KIP at Rangunia	Rangamati O&M Division	Installed
3	Palakata Rubber Dam under Cox's Bazar Sub-Division	Cox's Bazar O&M Division	Installed
4	Buggujra Rubber Dam under Cox's Bazar Sub-Division	Cox's Bazar O&M Division	Installed
5	Pekua Rubber Dam under Bandarban Sub-Division	Cox' Bazar O&M Division	Installed
6	Dormitory at Nilakkhirchar under the project "BEZA Flood Control Road-cum-Embankment protection & Drainage", Mirsharai Upazila under Sitakunda Sub-Division	Chittagong O&M Division-II	Installed

1.4.9 FLOOD FORECASTING AND WARNING AT SCHEME LEVEL

This task considered the development of a Flood Forecasting and Warning sub-module to interface with Flood Forecasting Warning System (FFWS). Flood Forecasting and Warning Center (FFWC) of BWDB are disseminating the flood forecasting warning information through their website in Bangladesh.

As per technical committee decision, this task was revised to develop a mechanism to relate the scheme protection level (such as embankment crest elevation, top elevation of the hydraulic structure etc.) to the nearest connected FFWC observed/forecasted water level, so that the BWDB field officials will be able to make precautionary arrangement to protect their assets and similarly the scheme inhabitants can save their assets and lives.

As per decision by the Workshop and Awareness Training on SiMS-Smart held on 18th November 2017 at the office of the Chief Engineer, South-Eastern Zone, Chittagong, BWDB to include auto gauge station locations in SiMS-Smart for getting immediate water level information dynamically through **SiMS-Smart** application.

1.4.10 DEVELOPMENT OF AN ASSET INFORMATION AND MANAGEMENT SYSTEM

The BWDB has various kinds of assets for different types of work. Each year a significant amount of money is spent to procure and maintain the assets. This huge task is accomplished at present in an old fashioned and traditional approach which results in a lot of complexities and inconveniences in the perspective of proper management. The scope of this module was revised in the inception and interim report. The scopes were confined to develop modules for a sample area for:

- BWDB Land asset module
- Vehicle Management module
- Key asset management module

Remaining four sub-modules (included in ToR) and scaling up of the first three sub-modules covering all the schemes could be developed in next phase under a separate contract.

1.5 COMPLIANCE WITH CONTRACT

IWM has successfully performed the activities under this project mentioned in Terms of References (TOR). The compliance of TOR along with the assumptions and reasoning are presented in the following Table 1-3.

Table 1-3: Compliance with Contract

Sl No.	Activities as per TOR	Deliverable and Status	Decision of Inception & Technical Committee Meeting	Compliance of Consultants
1	Updating of Scheme Database Inventory and Mapping: 1) Scheme Database Inventory 2) Scheme Geo-Spatial database 3) Updating of Water Management Group/ Association/ Foundation Database	SIMS Database has been enhanced and updated with the updated information/data	As per TOR of the Project	Described in section-3.2 on page 35, section-3.5 on page-50 & section-3.6.9 on page-99
2	Primary data collection by Physical Feature Survey	Primary data collection by physical feature survey has been done for populating SIMS database	As per TOR of the Project	Described in section-3.2.1 on page-36
3	Development of a Web GIS-based Application for SiMS as SiMS-Web	SiMS-Web has been developed and upgraded with the modules, which are available in existing SIMS standalone application. From now on, this application is termed as Sims-Smart.	As per TOR of the Project	Described in section-3.6 on page-60

Sl No.	Activities as per TOR	Deliverable and Status	Decision of Inception & Technical Committee Meeting	Compliance of Consultants
4	Development of an Application in Google Earth platform as SiMS-Goolge	As the APIs of Google Earth have been deprecated by the Google Earth Authority in the end of December 2016, an interface of ESRI online Maps with similar functionalities and tools have been included in place of Google Earth Interface.	In place of Google Earth Interface similar online map interfaces with functionalities such as Open Street maps or Google Map or ESRI Online Maps can be used, which was mentioned in the Inception Report of the project.	Described in section-3.6.2 on page-67 and section-3.7 on page-116
5	Development of an Android-based smart phone application as SiMS-Mobile	SiMS-Smart developed with Android-based smart phone Apps for hand-held smart device-based Scheme/Project level data collection from field. SiMS-Smart also includes Android based mobile apps for vehicle tracking application.	As per TOR of the Project	Mentioned in section-3.8 on page-116 and section-3.12.3 on page 133.
6	Progress Monitoring Module	Modules of Progress Monitoring for O&M and Ongoing projects have been developed with SiMS-Smart.

And also, six (6) numbers of IP Camera has been used for | As per TOR of the Project and according to the Technical Committee decision for selection of specification of IP Camera. | Mentioned in section-3.6.8 on page-90 for O&M Works monitoring, section-3.6.13 page-110 for ongoing project monitoring.

In section-3.9 on |

Sl No.	Activities as per TOR	Deliverable and Status	Decision of Inception & Technical Committee Meeting	Compliance of Consultants
		Real-Time Project Monitoring for selected project sites		page-118 mentioned the real-time project monitoring using IP Camera.
7	Flood Forecasting and Warning at Scheme Sub-System	A module has been developed with SiMS-Smart for Flood Forecasting and Warning Services at Scheme Level on Scheme's physical features. This module pick the current FFWC observed and forecast water level data from nearest FFWC river gauge stations and will be able to relate with the design crest heights of physical features (Embankment & Hydraulic Structure) and present the water level data in this module by accessing FFWC data from FFWC web server database through a Web Service.	This module has been developed with the direction and decision of Technical Committee of the project (see appendix-B)	Described in section-3.10 on page-123
8	Development of an Asset Information and Management System	An Asset Information Module has been developed with SiMS-Smart Application	During Inception, Consultants proposed a small representative area	Detail description of this module development is given in section-3.2.4 on

Sl No.	Activities as per TOR	Deliverable and Status	Decision of Inception & Technical Committee Meeting	Compliance of Consultants
		having Key Asset Sub-Module, Cadastral/Land Information Sub-Module and Instrument & Vehicle Sub-Module. The Land module has been developed for a representative area of Polder 62 which will be replicated for other area in next phases of the project	would be taken for Land Assets development.	page-38 for Asset data collection, and in section-3.12 on page-125

1.6   ADJUSTMENT IN SCOPE OF WORKS

During the inception phase and subsequent stages of work several issues evolved due to some changes in the contract items, which have been made on rational basis. Those are presented in Table 1-4.

Table 1-4: Adjustments in scope of works

Sl No.	Issues	Adjustment	Remarks
1	Deprecated of Google Earth API by the Authority of Google Earth by the end of December 2016. No API support will be provided by Google Earth after the date of deprecation by Google Earth Server.	In place of Google Earth Interface and APIs, SiMS-Smart developed with ESRI Online maps and APIs, which has the similar functionalities and APIs and as SiMS-Smart developed with ArcGIS Web Technology.	Option for choosing ESRI online maps and APIs is appropriate for SiMS-Smart Application as this interface and APIs are the same software origin which will be more stable in this respect.
2	Flood Forecasting and Warning Services. SiMS-Smart application not have the capability of mathematical modelling of forecasting the flood. SiMS-Smart uses and presents the results of FFWC's flood model results of observed and forecast water levels of FFWC river gauge stations nearest to the Schemes/Projects.	A module has been developed with SiMS-Smart for Flood Forecasting and Warning Services at Scheme Level on Scheme's physical features. This module picks the current FFWC observed and forecast water level data from nearest FFWC river gauge stations and will be able to relate with the design crest heights of physical features (Embankment & Hydraulic Structure) and preset the water level data in this module by access FFWC data from FFWC web server database through a Web Service.	Decision was made by the Technical Committee on 1st August 2016 at office of the Director, Planning-I, BWDB. (see Appendix-B)
3	Using dynamic segmentation on web application can be used to	Due to the absent of dynamic segmentation in Linux based	Use of Windows OS instead of Linux OS

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Sl No.	Issues	Adjustment	Remarks
	presents segment-wise conditions, status, works etc. on linear features of Embankment and Riverbank Protection features. Linux based ArcGIS Server has no capability, whereas Windows based ArcGIS Server has this capability in Roads & Highways Extension.	web development platform, ArcGIS Server for MS Windows Platform has been chosen. All the modules development has been developed with web programming, tools and APIs using MS Windows platform. So, the SiMS-Smart Servers have been built on Windows OS platform and the software has been developed under MS Windows platform.	(mentioned in ToR under section-5) has been decided by Technical Committee. Decision was made by the Technical Committee on 1st August 2016 at office of the Director, Planning-I, BWDB. (see Appendix-B)

The minutes and letters consisting the adjustments, decisions and concerns are presented in **Appendix –B**.

1.7 COMPLIANCE WITH THE FEEDBACK ON DRAFT FINAL REPORT (DFR)

After the submission of Draft Final Report in January 2018, a review meeting was held on the Draft Final Report (DFR) on 22nd February 2018 at the conference room of Director General of BWDB office. The meeting was chaired by the Additional Direction General (Planning). The respected BWDB engineers and high officials, project technical committee members were present the meeting. The following observations and feedback were made by the audience and evaluator of the draft report. Accordingly, the consultant team has adapted the recommendations and feedback with the developed SiMS-Smart Software Application which is shown in Table 1-5.

Table 1-5: Compliance with the feedback on Draft Final Report

Sl No.	Issue	Adjustment	Remarks
1	A review meeting should be arranged with the Technical Committee to finalize the System.	The recommendations and suggestions have been adapted in the developed SiMS-Smart Application.	A review meeting with the Technical Committee was held on 26th February 2018 at the Office of the Director Planning-II.
2	A demonstration of SiMS-Smart will be presented for the Engineers of Design, Planning and Hydrology departments of BWDB during the Service Period.	IWM is agreed in this respect.	BWDB will take necessary steps and IWM will provide required technical supports.
3	The Mobile Apps under the project should be described in the Final Report.	Detail description of developed Mobiles are giver in Section 3.8 in page 116	
4	The data of Chittagong Zone should be used as samples in the Final Report.	Data of Chittagong Zone as have been used as samples in the Final Report	
5	A detail description of Implementation of SiMS-Smart should be included in the Final Report.	An Implementation Plan has been given in Section 5, Page 145.	
6	The required amendment of the page 8 & 9 in the DFR should be done in the Final Report.	Required amendment has been done in these two pages as shown in page 7 & 9.	
7	Reference links should be provided in Query/Search of Document Archive Module.	Option for Reference Link has been added in Search/Query of Document Archive Module in section 3.6.11 in page 106.	
8	The existing levels along with design levels of Embankment should be incorporated.	Existing levels along with the design levels of Embankment are implement in the Quantity Estimates Module is	

		shown in Section 3.6.5 in page 80	
9	The possibility of integrating Viber, imo apps can be considered along with Skype.	At present the public API of Viber, imo are not available except the Skype for integrating this facility.	If available of those public APIs within the service period, the developer will then integrate the facility with SiMS-Smart Application.
10	The final report should be submitted incorporating the suggestions and recommendations described in the DFR meeting.	The suggestions and recommendations are given in Section 6 in page 155	

1.8 COMPLIANCE WITH THE RECOMMENDATIONS OF WORKSHOP/TRAINING AT CHIEF ENGINEER OFFICE, SOUTH-EASTERN ZONE, CHITTAGONG

An Awareness and Training Workshop was held on 18th November 2017 at the office of Chief Engineer, South-Eastern Zone, Chittagong. The following observations and recommendations in Table 1-6 were from the workshops.

Table 1-6: Compliance with the Recommendations of Workshop/Training

Sl No.	Issue	Adjustment	Remarks
1	The Automatic Water Level Gauge Stations of Hydrology, BWDB should be included with SiMS-Smart for getting real time river water levels.	A module of Hydrology has been developed for integrating auto gauge stations for observing the real time river water level as shown in Figure 3-76 under section 3.11.	
2	The information of the number plots, land quantities, gazette, status of registration, khatian, dag number etc. of the land plots won by BWDB should be presented in a tabular form in the Assets module of SiMS-Smart.	Land Asset module has been implemented with necessary change requested which is shown in Figure 3-80 and Figure 3-81 under section 3.12.2.	
3	The Chief Engineer of SEZ realized the importance and need for a separate study project on Land Assets to be formulated for South-Eastern Zone, Chittagong.	-	BWDB management will decide for a separate project in this regard.
4	The locational information of latitude and longitude for Embankment, Infrastructure and Riverbank Protection etc. should be stored in SiMS-Smart database.	Already stored and presented in different modules as shown in Figure 3-20.	
5	Should mention River Side and Country Side for quantity estimates in O&M module.	Already included in the O&M module as shown in Figure 3-37 and Figure 3-38.	
6	A work flow diagram for each modules of SiMS-Smart and what next module should be executed need to be included in SiMS-Smart.	Already has been included a Work Flow Diagram in each Module of SiMS-Smart.	
7	The Chief Engineer of SEZ and the Project Director of the project requested the consultants to discuss with IMED about	The IWM consultant has visited the IMED and consult with them and for the possible integration of	This can be implemented through G2G

Sl No.	Issue	Adjustment	Remarks
	the integration of same module in SiMS-Smart to integrated with IMED Project Monitoring Module as SiMS-Smart has the similar Project Monitoring module, which has been developed according to the guidelines of Planning Commission, Bangladesh.	project monitoring part of IMED program with SiMS-Smart. Both parties gave presentations on their respective systems and has been concluded that the Integration of systems is possible. The IMED people informed that the integration can be done following the completion of their training program and project level data entry. This could take longer period which is beyond our project period.	discussion.

1.9 COMPLIANCE WITH THE DECISION OF TECHNICAL COMMITTEE

A meeting with Technical Committee was held on 9th December 2017 chaired by the Superintending Engineer, office of the Chief Planning, BWDB, Dhaka. The minutes of meeting of this meeting is attached. Several suggestions and recommendations were made by the technical committee. Accordingly, the SiMS-Smart has been adjusted. The compliance of these recommendations is given in the following Table 1-7

Table 1-7: Compliance with decision of Technical Committee

SI No.	Issues	Adjustment	Remarks
1	To include a link of FFWC in the SiMS-Smart Dashboard	Already included FFWC link in SiMS-Smart Application, shown in 3.6.2 under section 3.6.2.	
2	An option should be added for uploading Historical Satellite Images.	An option has already given for uploading satellite images, shown in Figure 3-26 under section 3.6.2.	
3	The facility of saving a segment of a video captured by IP camera is necessary for users	This facility of saving a portion of a video is with the IP camera utility in SiMS-Smart.	
4	A tooltip can be developed for showing the hydraulic structure in Web GIS module	Tooltip facility has already been incorporated for hydraulic structure in Web GIS module, shown in Figure 3-26 under section 3.6.2.	
5	A recommendation of sharing Satellite Images from Department of Bangladesh Haor & Wetlands Development (DBHWD) in the Final Report	Recommendation made (See Ch-6).	
6	The future tasks of this project should be mentioned in the final report of this project as "What Next"/"Way Forward"	"What Next" /"Way Forward" is mentioned in the Conclusion and Recommendations Section as illustrated in See Ch-6	
7	To make clear clolor representation in all windows along with FFWC.	Already has been done to make clear representation of color in different windows of all module in SiMS-Smart	

Sl No.	Issues	Adjustment	Remarks
		application.	
8	To include dynamic segmentation in O&M operation. A tooltip showing location of Hydraulic Structure should be included.	Dynamic segmentation utility has been implemented which is shown in Figure 3-53 under section 3.6.8.	
9	For Scheme/Project coding, the BWDB codes should be matched.	BWDB codes of project/Scheme/system have been added with the Project/Scheme inventory.	
10	To make visible the color representation in Query/Search page.	Already has been done and shown in Figure 3-29 under section 3.6.3.	
11	The components of ongoing cluster Project/Umbrella Project in South Eastern Zone, Chittagong should be treated as Ongoing projects.	Have been considered as specified by the Technical Committee in SiMS-Smart and has been implemented in SMS-Smart.	
12	Forms of Progress Report should be collected from BWDB.	BWDB O&M work Progress Report form have been collected and implemented in SiMS-Smart application.	Any modification or update or any new form could be implemented in service period.
13	Before finalization of Database, the database should be updated with the latest data from field.	The database has been finalized with the available latest data from field.	
14	Any Logo except BWDB should be removed from report. 'Developed by IWM' can be put in a small font if required.	This instruction has been implemented in all dynamic reports produced by SiMS-Smart application.	
15	For WMO, should discuss with ICT cell and the respective wing of BWDB	Already discussed and measured the finalization of WMO module	
16	Should discuss the Design section	Already discussed with BWDB Design Circle-II and developed SiMS-Smart	

Sl No.	Issues	Adjustment	Remarks
	of BWDB for system development.	accordingly. For details see section 3.1.4.	
17	For work Selection an option of CCTF should be added with O&M and ADP.	Already has been incorporated in section 3.6.7.	
18	An option for preparing Compliance Report for remarks of IMED on PCR.	A PCR compliance report is being developed and will be finalized before hosting the system.	
19	An Option should be available for uploading scanned document in SiMS-Smart	Already has been done shown in Figure 3-62 under section 3.6.11.	
20	Document Archiving should have for Scheme/Project.	Already done is shown in Figure 3-62 under section 3.6.11.	
21	The officers selected by BWDB should be given knowledge about the system by the consultants before the Awareness/Dissemination training in the field.	Already provided the training to the selected 5 (five) officers from BWDB on 21-22.11.2017 at IWM training center (See Ch-4). A list of trainees who received the training is also given in Appendix B.	
22	A workshop/ Dissemination training should be arranged in field levels.	An "Awareness, Training and workshop" has been arranged on 18th November 2017 at the Chief Engineer Office, South-Eastern Zone, BWDB Chittagong (See Ch-4). The attendance list is given in the Appendix B of this report.	
23	It should have the assurance of providing any services by the consultants for six (6) months duration after submission of the final report.	Already mentioned in the TOR of the project. IWM will provide any support services concerned with the operation of SiMS-Smart.	

1.10 DELIVERABLES

Output and deliverables from this assignment are given below:

a) Updated Scheme Inventory Database on both completed and ongoing projects of BWDB under the jurisdiction of South Eastern Zone.

- This includes the project relevant information about physical infrastructure with design parameters, which is already available in existing stand-alone SiMS.
- The Physical Infrastructure shall include Hydraulic Structures, Canal/Khal/Channel, Embankment and River Bank Protection Works.

b) A GIS based Web-portal for Accessing Scheme Information through internet.

c) A progress monitoring tool for both completed and on-going projects. This includes the IP camera based Real-Time progress monitoring of the on-going projects.

d) SiMS-Smart with facilities of visualizing scheme information with satellite image or maps (Google maps, images or opens street maps) as background.

e) A mobile application for scheme data collection and view.

f) An Asset Information and Management Systems having the following sub-modules:

    a. Key Assets Information.

    b. Cadastral Management.

    c. Instrument and Vehicle Management.

g) User's Manual including System Operation and Administrative management of SiMS-Smart.

h) Database Technical References.

i) A comprehensive training on SiMS-Smart operations for maximum 20 numbers of BWDB officials.

j) Source codes of all applications.

2   REVIEW OF EXISTING SYSTEMS AND DEVELOPMENT

The existing SiMS database has been developed under the project "Scheme Database Inventory and Mapping" under Water Management Improvement Project (WMIP) of BWDB in 2014. This database contains the inventory of BWDB completed FCD/I projects/Schemes around the country as shown in Table 2-1, total number of Completed FCD/I Schemes are 630 in the country in different BWDB Zones.

Table 2-1: Completed Schemes in Different O&M Zone of BWDB

	BWDB Completed Schemes	Total Schemes
1	Central Zone, Dhaka	112
2	North-Eastern Zone,Comilla	125
3	Mid-Western Zone, Faridpur	51
4	Southern Western Zone, Khulna	71
5	Southern Zone, Barisal	86
6	North Western Zone, Rajshahi	44
7	Northern Zone, Rangpur	61
8	South Eastern Zone, Chittagong	80
	Total	**630**

Source: Final Report of Scheme Inventory and Mapping Project, Under WMIP, 2014

2.1   EXISTING SiMS DATABASE

The existing SiMS database includes the detail information of scheme, design parameters and location information of embankments, hydraulic structures and canals of BWDB Completed FCD/I Schemes. The database also includes O&M Operations, Monitoring of O&M Works, DPP formulation, DPP project Package and Procurement Plan, Monitoring of Ongoing Project Progress, WMO Inventory, Scheme Performance of Agriculture, Socio-Economic and major disaster data in the scheme level.

A unique identifier coding convention has been established for BWDB completed Schemes/projects corresponding to each BWDB Zone, Circle and Division level jurisdictions. The physical features under each Scheme/Project had also been defined by unique codes corresponding to its Scheme/Project and BWDB Division Office Levels. The updated database of SiMS for the current assignment utilized this coding convention for database development.

2.2   EXISTING SiMS APPLICATION

The existing SiMS Application has been in operation from April 2014, which runs on standalone Microsoft Windows (XP) platform. There are two versions of application which are for BWDB Head Quarter and

BWDB Field offices uses. The database engine for Head-Quarter version is Oracle 11g and database for the Field version is MS SQL Server Database 2008.

The existing SiMS consists of the following Modules:

- **Scheme Inventory Database Module** is to maintain all information about individual schemes including all infrastructures with design and as built drawings.

- **GIS/ Mapping Module** is to store and maintain developed maps, facilities to edit/update maps and adding new features including spatial query and analysis facilities.

- **O&M Module** is to store data related to O&M of BWDB schemes, schedule of rates, and help O&M budgeting and produce automated estimates for O&M of each project.

- **Monitoring Module** is to store and maintain O&M implementation data of each year for individual schemes and monitor the target, progress and completion schedule of scheme.

- **Search/ Query Module** is to facilitate to issue preset as well as user defined query for information retrieval.

- **Reports Module** is to generate various types of report based on BWDB requirements.

- **Metadata Module** is to provide a web-enabled meta-data system which will present availability and status of data/information in SiMS with limited access to strategic information for top policy /decision makers.

- **Document Archive** is to store and maintain all projects related documents like feasibility reports, related publications, appraisal reports etc.

- **WMO Information** Module is to store and maintain Water Management Organization elated data such as their organization, status, membership, constitution, and framework.

- **Scheme Performance Module** is to evaluate the environmental, socio-economic and technical performance of schemes based on pre-defined set of performance indicators.

SiMS has the provision of data import and export facilities in encrypted and decrypted forms. SiMS has the capability to keep track of any database session of data updated in the system. The data communication is done through the dissemination of exported encrypted data through portable storage devices. Data entry activities are mainly done at division office levels. Updated data in encrypted form are sent to the concerned Circle office and subsequently the Circle office sends the data to the Zonal office. The zonal office then finally verifies the data and posts it to the central database.

Moreover, the existing SiMS had been developed using Visual Basic Programming Codes, ESRI ArcGIS Software Component Library (COM) and ActiveX Control which are not applicable for current days Web technology.

2.3 IDENTIFICATION OF SCOPES AND GAPS

The existing SiMS application and Database have been reviewed and assessed for its functional capabilities and data requirements, against objectives and requirements of SiMS-Smart; and accordingly, the scopes and gaps have been identified. Those are described below.

In the existing SiMS application, data dissemination protocol was performed with the file transfer from one field office to another which was one of the major problems in existing SiMS. The reason behind is that the SiMS was developed for Standalone Desktop platform which did not support Internet and central database access from remote over the net.

The existing SiMS has been built only for the completed FCD/I Schemes. But it requires to cover all types (FCD/I and River Bank Protection) of BWDB completed and ongoing projects/schemes.

Hence, SiMS-Smart Database has considered a central database having information of both completed and on-going projects comprising hydraulic structures, embankments, canals, protective works and other related information accessible from the internet, obviously through a security procedure. As per the contract, information of BWDB key assets, vehicles and lands are also incorporated in the database.

In respect of accessibility and functional capabilities, the SiMS-Smart has adopted internet-based application development utilizing the Geo-Spatial tools for online interactive visualization. Further, mobile based data collection/view, relating the embankment safety with flood levels were absent in existing SiMS. These came out as new options and functions in SiMS-Smart. Table 2-2 illustrates the comparison between existing SiMS and SiMS-Smart which depicts the identified scopes and gaps that have been upgraded and update in SiMS-Smart.

Table 2-2: Identified Gaps in functional capabilities in existing SiMS

Sl. No	Functional Capability/Tools/Modules	Existing SiMS	SiMS-Smart	Remarks
	Scheme Inventory Database Module			
1	Inventory of Completed Schemes	√	√	Schemes/Projects list collected from existing SiMS and field offices
2	Inventory of Ongoing Projects		√	List of ongoing projects collected from field offices
3	Inventory of Embankments, Canal and Structures of Completed Schemes	√	√	Available list of physical features collected from existing SiMS, BWDB Design Circles and Field Offices
4	Inventory of Embankments, Canal and Structures of Ongoing Projects		√	Available list of physical features collected from existing SiMS, BWDB Design Circles and Field Offices
5	Inventory of Completed RBP	√	√	RBP project inventory was merged with

SI. No	Functional Capability/Tools/Modules	Existing SiMS	SiMS-Smart	Remarks
	Projects	(incomplete)		Scheme/project list
6	Inventory of Ongoing RBP Projects		√	RBP project list collected from BWDB Design Circle and Field offices
7	Photograph of Hydraulic Structure	√ (for few projects)	√	Photograph for all structures have been collected from field survey
8	Video of catchments area for Hydraulic Structure		√	Video for all structures have been collected from field survey
	GIS Mapping			
9	Geodatabase for Physical features of completed Schemes	√ (shapefile) Partial	√	Enterprise Edition Geodatabase developed in Oracle Database System
10	Geodatabase for Physical features of ongoing projects		√	Enterprise Edition Geodatabase developed in Oracle Database System
11	GIS Mapping	√ (standalone)	√ (Web base Maps)	Integrating with vendor based free online Maps/Satellite Images as background of web based GIS module
	O&M Module			
12	O&M Budget	√	√	
13	Quantity Estimate for O&M Works	√	√	
14	O&M Work Authorization/Selection	√	√	Authorization can be done by approved authority (EE, SE , CE, Board) through online
15	Cost-Estimates for O&M Works	√	√	Required schedule of rate database connectivity
	Monitoring Module			
16	Procurement Plan for O&M Projects	√	√	
17	Progress Monitoring for O&M project	√	√	BWDB report forms
	Ongoing Project Monitoring			
18	DPP Preparation		√	According to guidelines of Planning Commission, Bangladesh
19	DPP Project Procurement and Plan		√	Using DPP Guidelines
20	Progress Monitoring of Ongoing Projects		√	Progress Report can use IMED/BWDB forms

Sl. No	Functional Capability/Tools/Modules	Existing SiMS	SiMS-Smart	Remarks
21	Real-Time Progress Monitoring		√	Using IP Camera & Skype
	General Tools			
22	Query Search Module	√	√	Query/Search module has been enabled for spatial and non-spatial searches
23	Scheme Performance Module	√	√	
24	Report Module	√	√	Respective reports will be available with each module
25	Metadata Module	√	√	Dublin Core & FGD elements has been utilized
26	Document Archive	√	√	
27	WMO Information Module	√	√	WMO module has been linked with Scheme features
28	Flood Forecasting and Warning		√	Nearest FFWC Station will be considered for Scheme level Structures
	Asset Information management			
29	Asset Information and Management		√	Only for representative selected Area has been developed
	Platform& Technology			
30	Web Technology		√	Windows based (IIS) Server used
31	Smart Phone Apps		√	Enabled for all types of handheld devices for data collection and Web application is responsive
32	GIS Mapping Capability	√	√	Web based GIS using ArcGIS Server and web technology
33	Data Dissemination Protocol	Offline	Online	Through WWW protocol

Development plan of SiMS-Smart modules has been done based on the above identified scopes to fill the gaps aiming the fulfillment of the contract.

3   SiMS-SMART DEVELOPMENT ACTIVITIES

3.1   REQUIREMENTS ANALYSIS

3.1.1   INITIAL CONSULTATION

An initial consultation meeting was conducted with the Project Director and concerned officials in BWDB immediately after signing of the contract. The team appraised the objectives, scopes, details of assignment and possible deliverables of the project, and requested to provide all required support/information/suggestions during the execution of the project. Several issues were identified and settled in this meeting (Figure 3-1) which are described below.

Study Area

It was decided that the Study Area will cover the updated demarcation of South-Eastern Zone, Chittagong, it consists of Chittagong O&M Circle and Cox's Bazar WD Circle and this two circles contain five O&M Divisions namely, Chittagong O&M Division-1, Chittagong O&M Division-2, Rangamati O&M Division, Cox's Bazar O&M Division and Bandarban O&M Division is shown in Figure 1-1.

Figure 3-1: Initial Consultation Meeting with BWDB Head Office

Flood Forecasting and Warning Services (FFWS)

There are eight numbers of water level gauge stations located on different rivers in this Zone, which are active and being used for water level monitoring; no forecast data are being produced by FFWC. During discussion with Technical committee, it has been decided that observed water level of the above station shall be utilized to relate with the nearest BWDB Schemes/Projects.

Deprecation of Google-Earth API

As the Google Earth APIs has been declared deprecated by the Google Earth authority and no support are providing after the end of 2016, it was decided that alternate solution could be utilized similar to the Google Erath. Hence, ESRI/Open Street/Google Map could be used as background in SiMS-Smart.

Asset management Module

It was decided that the Asset Information Management Modules would be developed for a small representative area in the Study Area.

3.1.2   FIELD VISIT AND CONSULTATION WITH FIELD OFFICIALS

During Interim period, several consultation meetings were held with Chief Engineer Office in South-Eastern Zone, Chittagong and BWDB Divisional Offices.

During the visit of Chief Engineer office, respective Divisional offices of South-Eastern Zone, Chittagong, IWM team discussed with the Chief Engineer and BWDB Executive Engineers about SiMS-Smart System development and requested them for assistances for getting As-Built drawings, design parameters, maps etc. from respective BWDB offices and field visits as well.
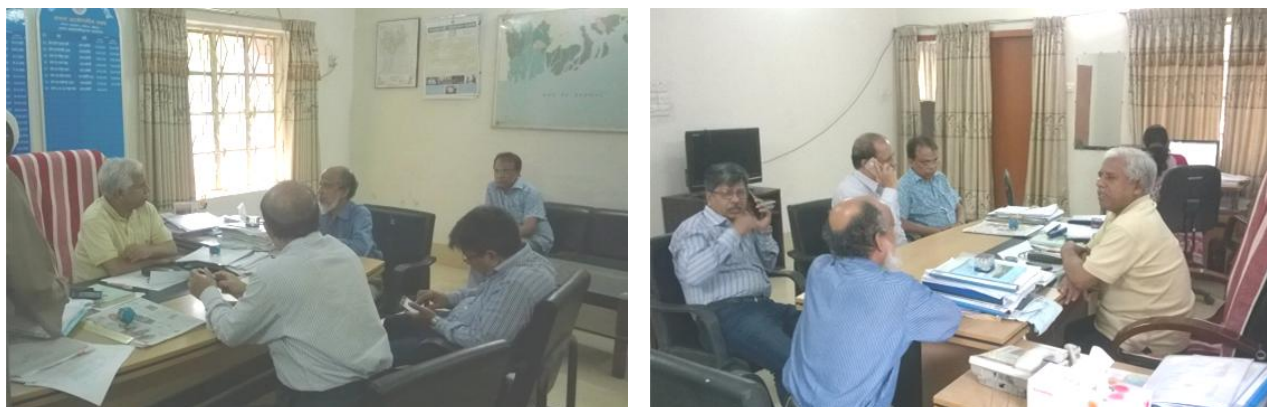
Figure 3-2: Consultation Meeting with Chief Engineer, SEZ, Chittagong on 5th October 2016

The team also visited Chittagong Division-I and Division-II offices from 2nd October 2016 to 5th October 2016. The field officials provided required supports and assistances to collect relevant data, maps, As-Built drawings, documents and manuscripts as available in their offices.

Figure 3-3: Consultation Meeting with Chittagong Division-I on 4th October 2016

The IWM team also visited Cox's Bazar WD Circle Office from 5th October 2016 to 8th October 2016 and arranged a meeting with field Engineers and described the proposed SiMS-Smart system and collected

Figure 3-4: Consultation Meeting at Cox's Bazar WD Circle, on 6-7th October 2016

their views and available data on Scheme/Project features, maps, documents, as build drawings etc.

3.1.3 CONSULTATION MEETING WITH TECHNICAL COMMITTEE

A consultation meeting was held with the Project Technical Committee on 1st August 2016 at the office of the Director Planning-I, BWDB Chaired by Mr. Enayet Ullah, SE, BWDB and Convener of the Technical Committee of this project. The following decisions have been made for developing SiMS-Smart System:

a) The observed/forecast water level of the nearest FFWC Gauge Station to the Scheme/Project would be considered and the design height of Embankment and Structure with nearest distance should be present on the Screen.

b) 'ESRI Roads and Highways Extension' would be required to present the condition of Embankment and protective work on map using dynamic Segmentation. 'ESRI Roads and Highways Extension' is available in ArcGIS server for Windows but not available in Linux operating System. Python, Java and HTM5 and ASP.Net could be used for SiMS-Smart system development.

c) Finally, the Technical Committee decided the Specification of ArcGIS Software and Server Computers, which to be procured from the budget of this project.

It is to be noted that the procurement of 'ESRI Roads and Highways Extension' along with another ArcGIS extension -'Data Interoperability' were dropped later because of no budget was allocated in contract for these item.

All the above decisions were published in a minute which is attached in the **Appendix-B**.

3.1.4 CONSULTATION MEETING WITH BWDB DESIGN CIRCLE-II

A consultation meeting with Superintending Engineer (SE) of BWD Design Circle-II was done about the use of **Schedule of rate** items in SiMS-Smart. Although, the previous SIMS application utilized the standard format of BWDB schedule of rate items (Figure 3-5). SiMS-Smart implemented this standard BWDB format of schedule of rate items. The SE of Design Circle-II agreed to upload their schedule of rates into SiMS-Smart application as routine update using their format. SiMS-Smart has an uploading facility of Schedule of rates and items.

Figure 3-5: Consultation Meeting with Design Circle-II

3.2   DATA COLLECTION AND DATA PROCESSING

At the initial stage of the project, IWM team has identified the required data and their possible sources for different types Schemes and Projects for SiMS-Smart development. These datasets have been collected from primary field survey and secondary sources (Table 3-1).

Overall data requirements (both primary and secondary) for different modules of SiMS-Smart have been identified and classified into major groups for preparing SiMS database, which are:

1. Scheme inventory and each Scheme/Project detail information (Completed and Ongoing)
2. Information of Hydraulic Structure
3. Design parameter of different structures, embankment and bank protection
4. Spatial data of all completed and ongoing schemes/projects including Protective Works
5. Spatial alignments of different features like road, river etc.
6. Condition of Hydraulic Structure, Embankments and Protective Works
7. Land assets data information for a pilot area
8. Other Key Assets data information

Table 3-1: Identified Datasets and their Sources

SL No.	Type of Data	Details of Data	Data Sources
1	Completed Schemes Inventory Data	All FCD/I completed Schemes/project data	Existing SiMS database and BWDB Field Offices
2	BWDB Ongoing Projects in the Project Area	FCD/I and RBP Projects	BWDB Field Office
3	Salient features of Completed Schemes and Project	Location, area, completion period, cost, irrigation and agriculture etc.	Existing SiMS database & BWDB Field Offices
4	Design Parameters of Physical Features (Embankment, Canal, Hydraulic Structure and Protection Work)	As-build design parameters	BWDB design Circle-4 and existing SiMS database and few of them have been collected from respective field offices
5	Spatial Location of Hydraulic Structure	Geographic Coordinates of Latitude and Longitude in WSG84 coordinate system	Primary Field Survey
6	Present Condition of Hydraulic Structures	Condition data of Hydraulic Structures with Video and Photographs	Primary Field Survey
7	GIS Datasets of Completed and Ongoing Scheme/Project	Shapefiles/Geodatabase of Schemes/Project Area (completed and Ongoing)	Existing SiMS GIS database and available GIS data of IWM database

SL No.	Type of Data	Details of Data	Data Sources
8	Spatial Data of Physical Features (Embankment, Canal and Protection Work)	Location alignments of physical features	Existing SiMS GIS Database, available GIS data of IWM and Field offices
9	Schedule of rates	Item description rates	BWDB Design Circle
10	WMO	Objectives and power of WMO, Organogram, Status, constitution, membership and Activities etc.	Field Office, Project Office (not received)
11	Agriculture, Socio-economic and environmental data	Crop Production, Crop Coverage, Crop Yield, Crop Calendar, Land Use, Farm Input, Population, Poverty and wage rate, employment, rural services and major disaster etc.	Respective Field Office/Project Office
12	Asset Management	BWDB's different type of Asset such as Land Assets, Key Assets and Vehicle and Equipment.	South-Eastern Zone-Chittagong (Received)

3.2.1 PRIMARY DATA COLLECTION

- **Hydraulic Structure**

Primary data of Hydraulic Structures of each completed and ongoing schemes/projects in the study area have been collected through Physical Feature Survey using GPS technology along with specific attribute information, present conditions, functional effectiveness (functional/non-functional), overall impacts, and recommendations. This data collection was done using a predefined survey form. A Hydraulic Structure Survey Form is given in **Appendix-D**.

- **Condition of Embankment and Protection Works**

Several survey teams were engaged to collect the real scenario of surroundings areas and conditions of Embankment/Polder, Hydraulic Structure on Embankment and Riverbank protection (RBP) /Protection works. The survey teams have checked and examined the overall conditions on sites and prepared reports on current conditions and probable recommendations for maintenance or rehabilitation works. The captured videos and photographs of surveyed features were also collected. All these surveyed outputs/results have been processed and imported into the SiMS-Smart database. Several data collection forms have been utilized which are presented in **Appendix-D**.

3.2.2 SECONDARY DATA COLLECTION

- **Existing SiMS database**

The available Spatial and non-Spatial data of completed scheme/project have been collected from existing SiMS database, and updated them into updated SiMS-Smart database. These data include inventory of completed schemes and their general information, details design parameters of physical features such as Embankment, Canal, Hydraulic Structures and Protective Works. This also include the available Spatial data of Schemes/Projects and locations of physical features. All these existing Spatial datasets have been reviewed and updated into the SiMS-Smart Geodatabase formats.

- **Design Data**

During the data collection of this project, IWM team has collected design parameters of completed and ongoing scheme/project from BWDB Design Circle-4. These include the design or as-built parameters of Hydraulic Structures, Protective Works and Embankments of the Study Area. The statistics of collected design parameters of physical features from BWDB Design Circle-4 are given in the following Table 3-2:

Table 3-2: Statistics of collected design parameters of Physical Features

No.	Type of Design Parameters	Number of Features Collected
1	Drainage/Irrigation Canal	23
2	Embankment	54
3	Embankment with Protection Work	9
4	Riverbank Protection/Protection Work	208
5	Hydraulic Structure	35

To get the access to the design data it took lots of time and several communications. The data access and availability is difficult and time consuming. The SiMS-Smart has been developed using the available data. It is verbally agreed that, after the deployment of SiMS-Smart the data will be populated by the concerned BWDB officials.

3.2.3 SPATIAL DATA COLLECTION AND PROCESSING

Development of spatial data as GIS datasets mainly proceeded based on archived high resolution recent (2015 -2016) satellite imagery such as QuickBird, RapidEye as well as Google-Earth etc. Resolution of these imageries were less than 0.6 m. These images have been geo-rectified with available ground control points (GCPs).

According to the collected hardcopy of sketched scheme maps from respective BWDB Divisions, different GIS data layers have been digitized from selected imageries. In that way, alignments of embankment,

canal, river, road, railway etc. were prepared by each individual scheme. Canal, River, Irrigation canal etc. were digitized by visual interpretation and identifying the water line, or using reference of other sources. The connectivity with hydraulic structures were carefully considered while digitizing the features. Every hydraulic structure location was collected during Physical Feature Survey, and GIS data layer of schemes' structures were prepared using those surveyed position and were verified with satellite imageries to eliminate error. These data were produced in ESRI shapefile format with prescribed attributes in Geodatabase. The Scheme and respective feature codes of GIS layers were used to relate with non-Spatial datasets in SiMS-Smart database in Oracle.

The secondary data sets, outside of a scheme, such as periphery rivers, drainage canals, roads, railway as well as general administrative units and BWDB jurisdiction boundaries were collected from available secondary data sources.

Project/Scheme Boundary layer is the jurisdictions of a project/scheme area. The project or scheme boundaries were identified according to the features extends on the available hardcopy map. In some cases where actual boundary could not be identified, an arbitrary polygon boundary was drawn which holds all the project features.

Attribution: The attribute information has been created for each feature. All the fields have been defined as same type as in the respective fields in SiMS-Smart database.

Following are the brief information of all spatial data layers in Table 3-3.

Table 3-3: Statistics of Processed Spatial Data

Sl. No.	Type of Scheme	No. of scheme	Embankment/ Polder in km.	Canal in km.	No. of Hydraulic Structure				
					Drainage	Irrigation	River Training	Special	Bridge/ Culvert
1	Completed Schemes	62	625	795	522	112	4	12	1
2	Completed River Bank Protection	10							
3	Ongoing Scheme/Project (Under ADP)	13							
4	Ongoing RBP	24							

3.2.4 LAND ASSET DATA INFORMATION OF A PILOT AREA

A representative area has been selected during field visit for which land information was available. Mr. Abdur Rahim, Assistant Director (Land & Revenue), Chittagong O&M circle, BWDB was assigned by the Chief Engineer, SE Zone for providing required assistance to IWM team for data collection of land assets during the project. The Polder 62 area has been selected under Chittagong O&M Division-I as a pilot area for preparation of land database for SiMS-Smart. Summary of Land Acquisition information

based on CS/RS and BS mouzas were provided by division office from their archives and corresponding mouza sheets have been collected from Department of Land Records (DLRS), Dhaka. It is mentioned here that the Gazette notification of Land Acquisition was declared under a LA Case procedure. Before 1990, all plots under LA cases were denoted by CS/PS/RS mouzas and after 1990 this was followed by BS (Bangladesh Survey) mouza.

LA case information for concerned pilot area has been digitized from raw sheets and a coded database was prepared for further link to spatial mouza layers. Following figures Figure 3-6, Figure 3-7, Figure 3-8 and Figure 3-9 illustrate some sample snapshots of collected LA case data information.
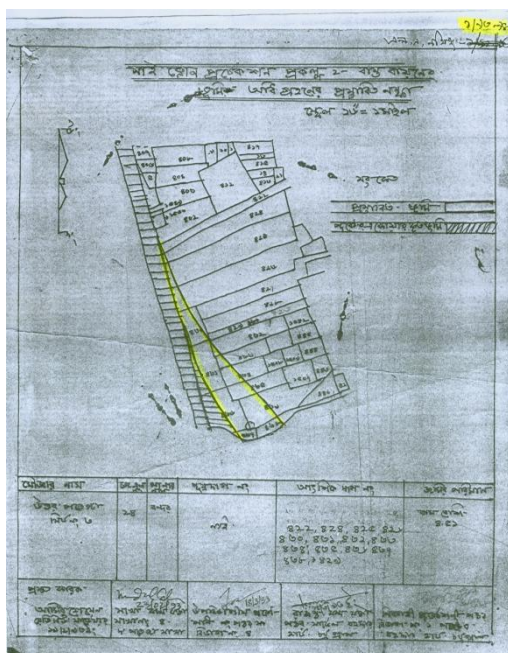
Figure 3-6: Sample of LA case - showing plots in BS mouza
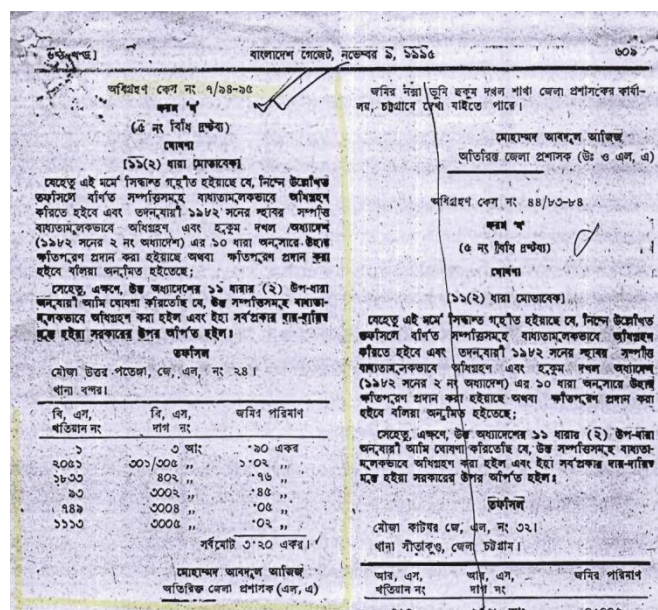
Figure 3-7: Sample of LA case, Gazette Notification

Figure 3-8: Sample of LA Case - Plot Schedule

Figure 3-9: Sample of LA Case - Possession Certificate of Plots

The Collected mouza sheets were scanned and subsequently were geo-corrected using satellite imagery as shown in following Figure 3-10 and Figure 3-11. Portion of mouza plots area (shown as light green polygon color with black line) along the Area of Interest (AOI) of pilot area is shown in Figure 3-12 have been digitized and attributed through ArcGIS service to make a GIS layer in SiMS-Smart application.
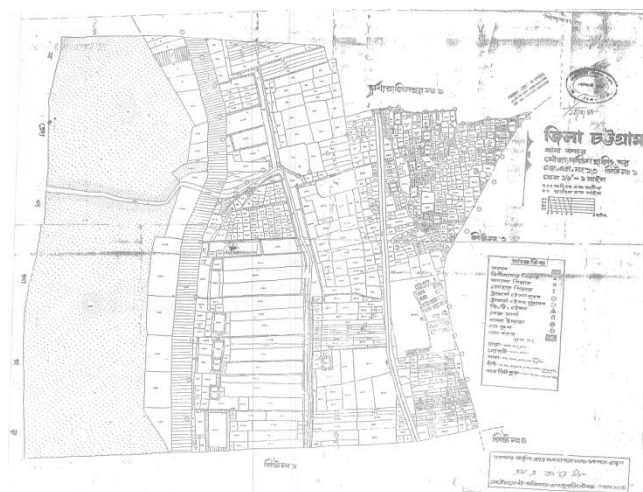
Figure 3-10: Sample of BS Mouza sheet under Polder 62 as Pilot Area

Figure 3-11: Geo-rectification of Mouza sheet using Satellite Images
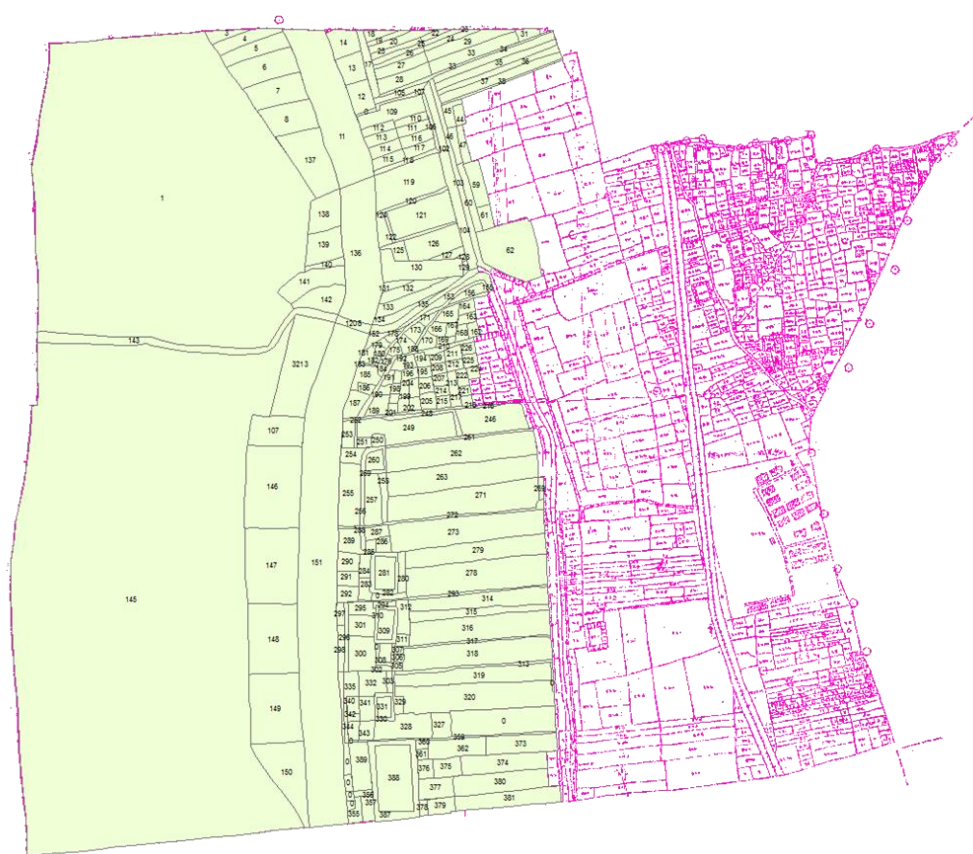
Figure 3-12: Sample Digitized Plot with Plot-ID along the AOI of Pilot Area

10 (Ten) numbers of BS (Bangladesh Survey) mouza cover the whole Polder 62 area. The summary statistics of processing works are shown in Table 3-4.

Table 3-4: Summary Statistics of Mouza Sheets of Polder 62.

Sl	District	Thana/ Upazila	Mouza	BS JL Number	Number of sheets associated with Polder 62	Which Sheet No	Processed
1	Chittagong	Bandar	Maddha Halisahar	001	3	1, 4 & 5	Yes
2	Chittagong	Bandar	Dakkhin Halisahar	023	2	1 & 2	Yes
3	Chittagong	Bandar	Uttar Patenga	024	3	3, 4 & 6	Yes
4	Chittagong	Bandar	Dakkhin Patenga	025	4	1, 2, 3 & 4	Yes
5	Chittagong	Doobol Muring	Uttar Kattali	001	2	2 & 3	Yes
6	Chittagong	Doobol Muring	Dakkhin Kattali	002	2	2 & 3	Yes
7	Chittagong	Doobol Muring	Uttar Halisahar	009	4	1, 5, 7 & 12	Yes
8	Chittagong	Sitakunda	Latifpur	064	2	2	No
9	Chittagong	Sitakunda	Dakkhin Silimpur	063	2	All (1 & 2)	No
10	Chittagong	Sitakunda	Uttar Silimpur	062	4	All (1, 2, 3 & 4)	No

3.3 DEVELOPMENT ENVIRONMENT

At the beginning of the development, considering the contract and previous experiences, the system development platform, software development tools and technologies and database platform have been selected. These were discussed in initial consultation meeting, technical committee meetings, inception meeting, interim presentation and other formal and non-formal communications with relevant project officials. Accordingly, followings development environment was used:

- Operating System: Microsoft Windows
- GIS System: ESRI ArcGIS Server and Desktop
- Database: Oracle
- Server side programming: Visual Studio, ASP.NET (C#)
- Client side programming: JavaScript, JavaScript API for ArcGIS web service
- Mobile Development: Android and iOS

Moreover, Hi-chart, Angular JS, bootstrap etc. open source tools have used for charting and formatting the application pages as and when required. Cordova has been used to develop mobile applications.

3.4 SYSTEM ARCHITECTURE, COMPONENTS AND MODULES

The SiMS-Smart has been developed with n-tire client server-based Web application in which, the presentation, the application processing and the data management are logically separate processes. In this model, processing is distributed between the client and the server, and business logic is captured in a middle tier. SiMS-Smart performs following three tasks are described in Table 3-5, which correspond to three tiers, or layers, of the n-tier model.

Table 3-5: Basic 3-Layer Architecture of SiMS-Smart

Task	Tire	Description
Web based User interface and Navigation	Tire-1 (Presentation Layer)	This layer provides web-based graphical user interfaces (GUI) to web browser, so that users can interact with SiMS-Smart for browsing Scheme maps, SiMS data query, view, input data, and visualize the results of requests, it also manages the manipulation and formatting of data once the client receives it back from server.
Business logic	Tier-2 (Application Layer)	Business logic, which involves the rules that govern SiMS-Smart application, connects the user in tier 1 with the data in tier 3. The functions that the rules govern closely mimic everyday business tasks, and can be a single task or a series of tasks. The codes in this tier have been developed with security measures for privileged and trusted users to interact with the web functionalities.

Task	Tire	Description
Data services	Tier-3 (Data Management Layer)	Data services are provided by a structured (Geodatabase and non-Spatial database in Oracle) data store, which manages and provides access to the data container and provide data services to the application layer.

3.4.1   ESRI ARCGIS SERVER ARCHITECTURE

SiMS-Smart Application uses ArcGIS Server for managing Spatial features data in Geodatabase and publishing Feature Service and Map Service to SiMS-Smart Application. The ESRI ArcGIS Server implements a three-tier architecture as shown in Figure 3-13. The web server component of the ArcGIS Server architecture provides the functionality of the application server described in the generic multi-tier web GIS architecture. The web server hosts the web services and applications that are developed. It receives requests from clients and relays appropriate tasks to the GIS server.
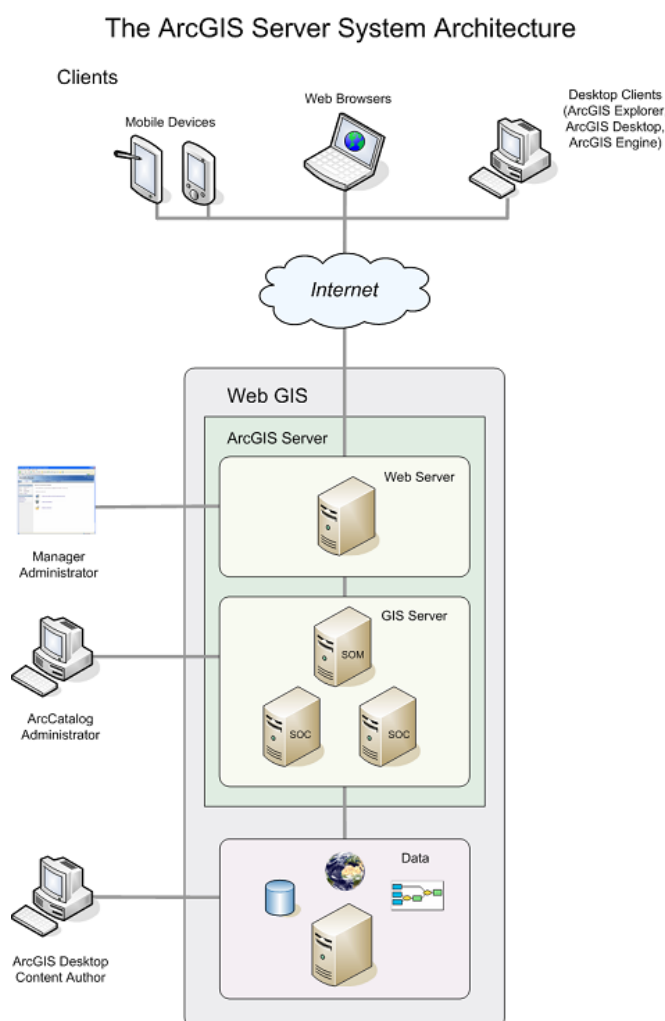
Figure 3-13: ESRI ArcGIS Server Architecture

The GIS server in this architecture is equivalent to the map server in the generic architecture. The GIS server hosts GIS resources of Scheme spatial data in the forms of Geo-database and exposes them as services to client applications. The GIS server itself is composed of two distinct parts: the **server object**

manager (SOM) and **server object containers (SOCs)**. As the name implies, the SOM manages the services running on the server. When a client application requests the use of a particular service, it's the SOM that actually provides one for the client to use i.e. the SOM connects to one or more SOCs. The SOC machine hosts services that the SOM manages.

The database server (Oracle) contains Spatial data resources in SDE Schema that are published as services on the GIS server. These resources are Schemes boundaries, Physical features of Canals, Embankments, Hydraulic Structures, Protection Works and other relevant features in geo-database forms.

3.4.2   BASIC COMPONENTS OF SiMS-SMART SYSTEM ARCHITECTURE

A high-level SiMS-Smart System Architecture is shown in Figure 3-14. The brief overview of basic components of SiMS-Smart Application architecture are given below:

Client: Typically, the client or the user side of the SiMS-Smart refers to the web browser on the user's machine, mobile phone and tablet users and the user interacts the modules and tools of SiMS-Smart from this end.

Server: SiMS-Smart architecture consists of 4 (Four) server components: Web server, Application server, GIS Server (ArcGIS Server) and Database Server (Oracle Database).

Web Server: The web server responds to requests sent from the web browser via HTTP. The SiMS-Smart site that is published on the Internet must have a web server program running in the background in Internet Information Service (IIS). The web server can act as a proxy strengthening the system security and balancing the load between application servers in a clustered environment.

Application Server: Application server is SiMS-Smart software. SiMS-Smart application developed with web API, Web GIS API, Mobile Aps API etc. in several Modules and Tools in a distributed environment. SiMS-Smart application server acts as a middleware that establishes, maintains and terminates the connection between the web server and the GIS/map server. It also manages the concurrent requests and balances the load among GIS Server and Database Server.

GIS Server: GIS server (ArcGIS) is the brain of web GIS functionalities of SiMS-Smart. It provides GIS functions that include spatial analysis, spatial and attribute queries, geo-coding, geo-processing, and generates & delivers dynamic maps to the client based on user requests.

The GIS server can generate output for feature information as a result of a spatial query, such as feature selection or geo-processing, that are sent to the client application for further user interaction.

Database Server: SiMS-Smart uses Oracle Database Server which has twofold data types: i) one is Non-Spatial SiMS data stored in *Oracle schema* which manages different types of Scheme level non-Spatial data, and ii) another is Spatial Data in *Spatial Data Engine (SDE) Schema* which manages Scheme Level Spatial data. A client application gains access to the database through query statements on database from application server.

Functional Approach of SiMS-Smart Application

Data Pool ⟶ User Service validation ⟶ User Service Request ⟶ User Log In

Data Process ⟶ Data Link in Map Services ⟶ Data Output in Maps

GIS Data Process

ArcGIS Desktop

Geo-Database **(ArcGIS Server)**

SIMS Database **Oracle Database Server**

Delivering to

Sharing With

User Permission

BWDB Internal Users

Database Administrator

Workstation

Data Entry and Update

Web Server Security Protocol

Web Server

Real Time Project Monitoring on BWDB Project Site

IP Camera

Tablet User (Smart Mobile Phone Apps)

Mobile Phone Service (Smart Mobile Phone Apps)

Government Ministries/Other Agencies

NGOs

Enterprise

Citigens

Foreigners

Cloud

SIMS-Smart
Server Side Program Modules
Web Application Dashboard
Web based GIS
Online Base Maps (ESRI Base Map/Open Street map)
Smart Mobile Service
Flood Forecasting & Warning Service
Asset Management Module
Vehicle Tracking

Request For
GIS Map Features
Tabular Data
Charts/Graphics
Reports
Data Access through Smart Mobile Phone

Figure 3-14: System Architecture of SiMS-Smart

3.4.3 MODULES OF SIMS-SMART APPLICATION

According to the TOR of the Project, SiMS-Smart has been developed in several numbers of Modules. The concept and workflow of many of the modules have been taken from the existing SiMS standalone application, and translated and upgraded them in to web GIS platform. Apart from the above modules, several new modules have been developed in SiMS-Smart application. A high-level architecture of SiMS-Smart Module is shown in Figure 3-15. In this architecture, Database Server (including Geodatabase) plays a vital role to produce SiMS data (both spatial and non-spatial) access to the Application Server. The Spatial data are fetched from ArcGIS Server with a published GIS services to the Application server. The user's requests originate from client side are accessed through Web-Server to the Application Server and the Application picks require data from database server. In case of GIS maps, application server access spatial data and maps from ArcGIS server through published GIS services. Descriptions of major modules are given below:

1) **Scheme/Project Inventory Module:** This module stores and manages BWDB Scheme/Projects level spatial and non-spatial data. It also includes the design parameters, as-built data, current conditions, pictures and videos etc. of Scheme/Project level physical features such as Embankment, Canal, Hydraulic Structures, Protection works both in spatial and non-spatial data forms.

2) **SiMS-Web Module:** This module visualizes and manages web-based GIS map access through published GIS services and provide links with relevant non-spatial data of Schemes and Scheme level physical features on the web GIS environment. Dashboards, Menus and Sub-Menus of SiMS-Smart Application are organized in this module, so that this module is the opening point of SiMS-Smart Application to use.

3) **Query/Search Module:** In this module, several types Queries such as Spatial, non-spatial and dynamic queries are performed over SiMS Non-spatial and Spatial Database.

4) **O&M Module:** This module stores and manages the relevant data of O&M works. Requirements of O&M module are O&M Quantity Estimates using pre-work survey and design parameters of Embankment and Canal, Cost estimates for re-sectioning, retired embankment, new embankment, re-excavation, excavation, New or reconstruction of Hydraulic Structure, New or repair work for protection work and other works using rates of schedule and non-schedule items, preparation of work budgets including O&M or ADP projects. Work authorization and selection of works should be selected in this stage whether the works would be included in O&M program or in ADP.

5) **O&M Monitoring Module**: In this module, Work package or lot can be developed using authorized works from O&M Module for procurement of O&M works, preparation of procurement plan, procurement process, work award and progress monitoring of O&M works**.**

6) **DPP Formulation:** In this module, creation and formulation of a new DPP providing DPP summary information, financing mode, duration of projects, project locations and location wise budget, year wise budget information and data can be entered. This module has also two sub-modules such as i) Work Component Selection against various predefined Economic Heads, Economic codes and sub-codes, and ii) Work Package/Lot Development for Procurement of DPP project.
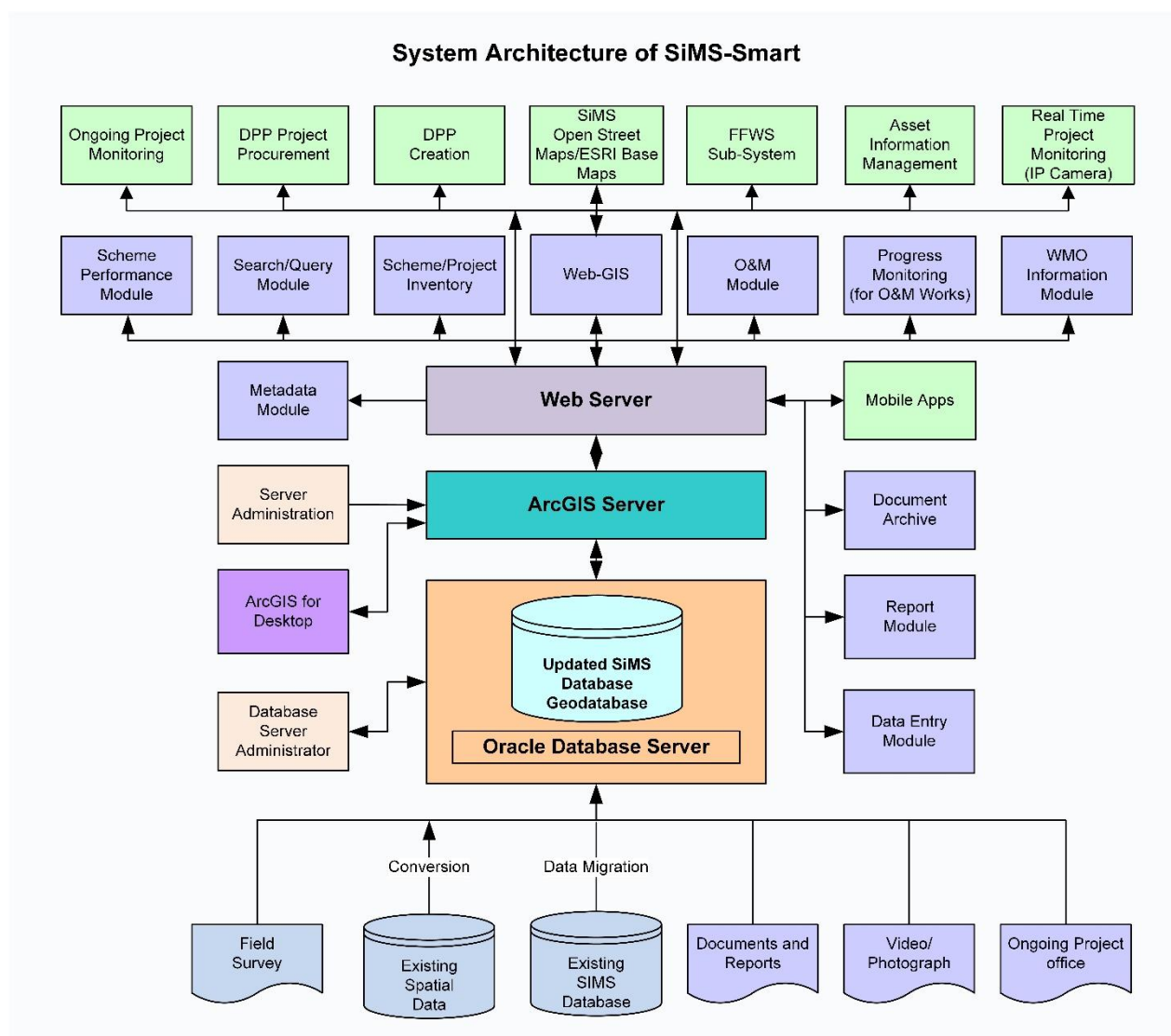
Figure 3-15: Architecture of SiMS-Smart Modules

7) **ADP Project Monitoring**: Following the approval of DPP, the DPP project will be included under ADP program. Subsequently the procurement processes are assumed to be done. This module enables users to monitor the progress by setting up different targets of both financial and physical progress during various time spans to be achieved within the project tenure. The real achievements of both financial and actual works can be entered through this module.

8) **Real-Time Project Monitoring:** The Real-Time Project progress would be monitored by deployed IP camera on the selected project sites. The authorized top management of BWDB and Ministry could

monitor the real-time progress of the project through smart Mobile Phone or Tablet devices or SiMS-Smart in web. For the sites where no IP Camera is available, the integrated "Skype" facilities in SiMS-Smart application could be used.

9) **Mobile Phone Apps Module:** Using this module, the Scheme level data collection from the field could be performed.

10) **Flood Forecasting and Warning Service (FFWS):** Using this module, User could visualize the observed/forecast river water levels of the nearest FFWC River Gauge Stations and could relate the water levels to the design height parameters of selected Scheme's physical features such as Embankments, Dykes, Protection Works and Hydraulic Structures.

11) **WMO Module:** In this module users could get the information of WMO groups, federations, WMO members of a particular Scheme/Project for WMO status, registration, responsibilities for different physical features, meetings, members information etc.

12) **Document Archive Module:** This module stores and manages any published project or scheme reports, manuscripts, design drawings, journals, maps and any other valuable documents in any digital file formats in SiMS-Smart database. The module also could retrieve the stored document from the server using some key information such as name of the document, year or date of published, author, published by and type of document etc.

13) **Asset Information Module:** This module stores and manages the inventory of Land, Equipment, Vehicle and other Key Assets in SiMS-Smart database.

3.5 SiMS-Smart Database Development

Development of SiMS-Smart Database were categorized into two sets of databases which was Geo-Database Development and non-Spatial Database Development. Both these databases are stored in Oracle Database Management System. Geo-Database has been developed with the Scheme Level Spatial features datasets using ArcGIS Editor and ArcGIS Server and stored them into Oracle Database System. The non-spatial database has been developed with design parameters and related information of Scheme level physical features and data. SiMS-Smart database also included a number of tables and database objects to be used by SiMS-Smart Application. The following flowchart in Figure 3-16 outlines the steps of SiMS-Smart database creation, configuration and development in Oracle Database. Furthermore, BWDB Asset data have also been included in SiMS-Smart database.
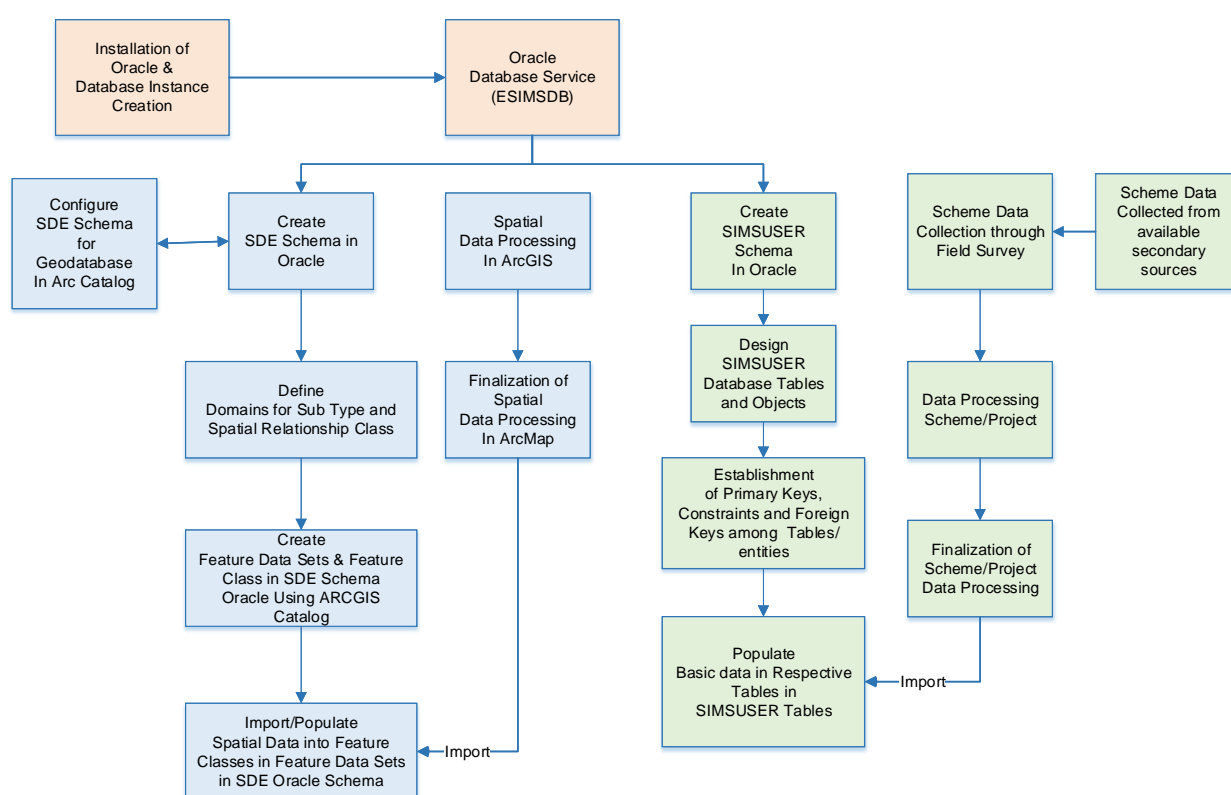
Figure 3-16: Steps for SiMS-Smart Database Creation, Configuration and Development

Further, the foremost and pre-condition of developing a database should have a unique number of coding system on which different database tables or entities will be built. Such coding system will play a vital role to manage, organize and operate the database seamlessly. In this regards a unique numbering system has been developed for SiMS-Smart database development. The existing SiMS was also developed with such type of coding convention, which was utilized in the current development and has been upgraded according to the change in additional Zone inclusion and reorganization of BWDB field offices up to May 2017. Following sub-section describes this upgraded coding system which was utilized for SiMS-Smart database Development.

3.5.1 SCHEME NUMBER SYSTEM

A unique numbering system has been developed for SiMS-Smart database, which has been used as the basic reference for recording, updating and selecting Schemes and related features in the database. Following sub-articles describe this coding convention in detail.

1) Need for a Number Coding System

There are several issues for introducing number coding system:

a. Standard Coding convention for BWDB field unit offices such as Zone, Circle and Division.
b. Standard Coding convention for BWDB completed and ongoing projects.
c. Increase Integrity and consistency of SiMS database.
d. Use of BWDB Coding System in all levels of BWDB management activities for consistencies.

Project inventory and related data contains the following:

a. BWDB field unit office codes - are the basis of organizing completed and ongoing project Inventory database.
b. Scheme/Project Inventory - has been developed by a unique coding convention.
c. Inventory of physical features under each project - are organized by unique feature code.
d. O&M and ADP works, budgets, allocations, progress monitoring and reporting information.

A unique Number Coding is required to define each project and its related physical features in the database in order to collect, record and identify them in the databases.

2) Coding Convention for BWDB Field Unit Office

Coding of BWDB field Unit office is based on the hierarchy of BWDB field office levels by Zone, Circle and Divisions. Following rules have been established for BWDB Unit offices:

Rule 1: Division Codes will be 5 characters in length
Rule 2: Numeric characters 0 to 9 are used
Rule 3: 1st and 2nd character positions are for **Zone** office.
Rule 4: 3rd character position is fixed for **Circle** office serial number
Rule 5: 4th and 5th character positions are fixed for **Division** office serial number

Position	1	2	3	4	5
Character	Z	Z	C	D	D

Where,

i. First two characters **ZZ** are replaced by Zone Number
ii. The 3rd characters of **C** are replaced by Circle Number under a particular Zone
iii. The 4th and 5th position characters of **DD** are replaced by Division Number under a Circle.

Using the above coding convention, all field offices of Zone, Circle and Divisions are numbered in the database, these codes are shown in the following Table 3-6.

Table 3-6: List of BWDB Field Offices with Codes

No	Zone Code	Zone Name	Circle Code	Circle Name	Division Code	Division Name
1	21000	Northern Zone - Rangpur	21100	Rangpur O&M Circle-I	21110	Rangpur O&M Division
					21120	Gaibandha O&M Division
					21130	Kurigram O&M Division
					21140	Lalmonirhat O&M Division
			21200	Rangpur O&M Circle-II	21210	Dalia O&M Division
					21220	Nilphamari O&M Division
					21230	Saidpur O&M Division
			21300	Thakurgaon O&M Circle	21310	Thakurgaon O&M Division
					21320	Dinajpur O&M Division
					21330	Panchagarh O&M Division
2	22000	North-Western Zone - Rajshahi	22100	Pabna O&M Circle	22110	Pabna O&M Division
					22120	Bera O&M Division
			22200	Bogra O&M Circle	22210	Bogra O&M Division
					22220	Sirajganj O&M Division
					22230	Sirajganj BRE (SPI) O&M Division
					22240	Joypurhat O&M Division
			22300	Rajshahi O&M Circle	22310	Natore O&M Division
					22320	Rajshahi O&M Division
					22330	Naogaon O&M Division
					22340	Nawabganj O&M Division
3	23000	Western Zone-Faridpur	23100	Kushtia O&M Circle	23110	Kushtia O&M Division
					23120	Chuadanga O&M Division
					23130	Jhenaidah O&M Division
					23140	Amla W.D. Division
					23150	Magura O&M Division
			23200	Faridpur O&M Circle	23210	Faridpur O&M Division
					23220	Rajbari O&M Division
					23230	Gopalganj O&M Division
					23240	Madaripur O&M Division
					23250	Shariatpur O&M Division
4	24000	South-Western Zone-Khulna	24100	Khulna O&M Circle	24110	Khulna O&M Division-II
					24120	Satkhira O&M Division-I
					24130	Satkhira O&M Division-II
					24140	Bagerhat O&M Division
			24200	Jessore O&M Circle	24210	Jessore O&M Division
					24220	Khulna O&M Division-I
					24230	Narail O&M Division
5	25000	Southern Zone - Barisal	25100	Bhola O&M Circle	25110	Bhola O&M Division-I
					25120	Bhola O&M Division-II
			25200	Barisal O&M Circle	25210	Barisal O&M Division
					25240	Pirojpur O&M Division
					25260	Jhalokati WD Division
			25300	Patuakhali O&M Circle	25310	Patuakhali O&M Division
					25320	Barguna O&M Division

No	Zone Code	Zone Name	Circle Code	Circle Name	Division Code	Division Name
					25330	Patuakhali WD Division
6	26000	South-Eastern Zone - Chittagong	26100	Chittagong O&M Circle	26110	Chittagong O&M Division-I
					26120	Chittagong O&M Division-II
					26130	Rangamati O&M Division
			26200	Cox's Bazar WD Circle	26210	Cox's Bazar O&M Division
					26220	Bandarban O & M Division
7	27000	Eastern Zone - Comilla	27100	Comilla O&M Circle	27110	Comilla O&M Division
					27120	Brahmanbaria WD Division
					27130	Gumti O&M Division
			27200	Chandpur O&M Circle	27210	M.D.P. O&M Division
					27220	Chandpur O&M Division
			27300	Feni O&M Circle	27310	Feni O&M Division
					27320	Noakhali O&M Division
					27330	Lakshmipur O&M Division
					27340	Noakhali WD Division
8	28000	Central Zone - Dhaka	28100	Mymensingh O&M Circle	28110	Mymensingh O&M Division
					28120	Tangail O&M Division
					28130	Netrakona O&M Division
					28140	Jamalpur O&M Division
					28150	Kishoreganj WD Division
					28160	Tangail WD Division
			28200	Dhaka O&M Circle	28210	Dhaka O&M Division-I
					28220	Dhaka O&M Division-II
					28230	Narshingdi O&M Division
					28240	Manikganj WD Division
9	29000	North-Eastern Zone - Sylhet	29100	Sylhet O&M Circle	29110	Sylhet O&M Division
					29120	Sunamganj O&M Division
			29200	Moulvibazar O&M Circle	29210	Moulvibazar O&M Division
					29220	Habiganj O&M Division

3) Coding Convention for BWDB Schemes/ Projects (Completed and Ongoing)

BWDB executes different types of projects such as O&M works for completed Schemes from non-development revenue fund, rehabilitation and capital investment projects under Annual Development Programme (ADP) from development fund. The inventory of all types of projects and schemes (completed and ongoing) have been organized and included in the present updated SiMS-Smart database providing a unique code number to every scheme and project. The individual Scheme/Project has been defined with a unique code number based on Division under which the project is being operated. Following rules were considered for establishing unique to each Scheme/Project:

Rule 1: Each Scheme/project was coded with 7 numeric characters in length.

Rule 2: Numeric Characters of 0 to 9 were used.

Rule 3: 1st and 2nd Character positions were taken from BWDB Zone Code.

Rule 4: 3rd Character position taken from Circle Code.

Rule 5: 4th and 5th Character positions were used for Division Code.

Rule 6: 6th and 7th Character position were used for Scheme serial number within a Division.

Position	1	2	3	4	5	6	7
Code	Z	Z	C	D	D	S	S

Where,

- Z Z   = Zone Code
- C   = Circle Code
- DD   = Division Code
- SS   = Serial Number of Scheme/Project/Sub-project/part of a project in each division.

4) Coding Convention for Physical Features of Scheme/Project

There are four types of Scheme/Project Physical features such as Embankment, Canal, Hydraulic Structure and Protection Works under a particular Scheme have been uniquely coded by following rules.

- Embankment

An Embankment code consists of two parts, Scheme/Project Code is on left side and an Embankment code are on right side by a separator of "/" Character.

Scheme Code	/	Embankment Code

Embankments are coded with E1, E2, E3... etc.

- Canal

A Canal code consists of two parts, Scheme Code is on left side and a Canal code is on right side by a separator of "/" Character.

Scheme Code	/	Canal Code

Canals are coded with C1, C2, C3.. etc.

- Hydraulic Structure

Similarly, Hydraulic Structure code consists of two parts, Scheme Code is on left side and the Structure Code is on the right side by a separator of "/" Character.

Scheme Code	/	Structure Code

Structure are coded with S1, S2, S3 .. or STR0001, STR0002.. or R1, R2, R3.. etc.

- Protection work

Similarly, Protection work code consists of two parts, Scheme Code is on left side and the Structure Code is on the right side by a separator of "/" Character.

Scheme Code	/	Protection Code

RBP are coded with RBP1, RBP2, RBP3 ... etc.

3.5.2 GEO-DATABASE DEVELOPMENT

The spatial database defines the data which are spatially lying on the earth surface. The term spatial in other word 'geo' means the data which are on the earth surface. In this project, ESRI Enterprise Geo-database has been developed to store schemes/projects and related physical features such as Hydraulic Structure, Embankment, Canal and Protection works, BWDB Field unit office such as Zone, Circle and Division in the database.

Geo-database is a central data repository of spatial data storage and management and can be used in desktop, server, or mobile environments and allows user to store GIS data in a central location for easy access with due permission. An Enterprise Geo-Database has been developed in Oracle SDE (Spatial Data Engine) Schema which contains the collection of Spatial Datasets and under each dataset, one or more Feature Class or Feature layers were organized. An internal architecture of SDE Geo-Database is shown in Figure 3-17.
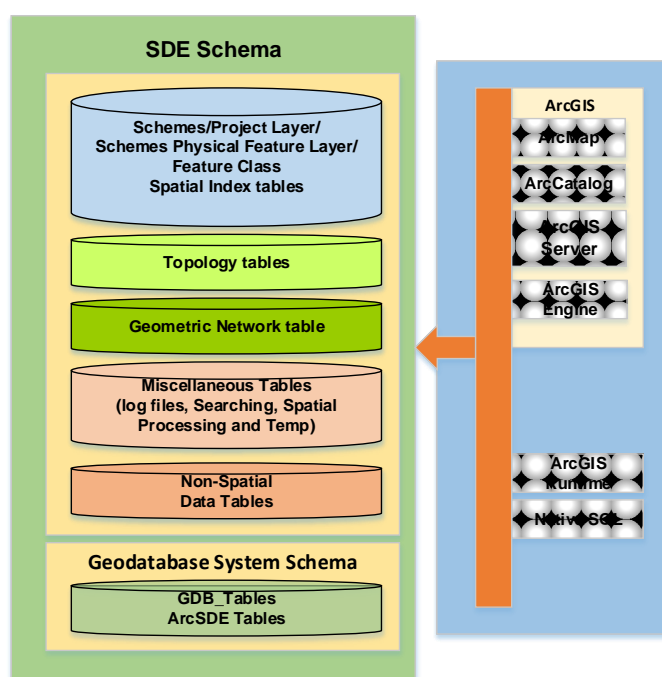
Figure 3-17: Architecture of Spatial Data Engine

During Geo-Database design - conceptual, logical and physical model phases were assessed and a physical model was utilized for populating the Geo-database.

The following steps were considered to develop the Geo-database:

- **Conceptual Design**

  - ➢ Identification of Scheme/project level Information/data
  - ➢ Identification of key information and layer of Scheme and Physical features
  - ➢ Specification of Spatial Reference System, WGS84 spatial reference coordinate system was considered
  - ➢ Specification of scale range and spatial representation

Conceptual data model identifies the highest-level relationships between the different spatial entities of a Scheme/project. Features of conceptual data model were considered:

- ➢ Spatial feature entities and the relationships among them.
- ➢ No attribute was considered at this level.
- ➢ No constraint was considered.

- **Logical Design**

According the data requirements, spatial data processing have been performed individually for each scheme to comply with project goal. For logical design following steps were considered.

- ➢ Database structuring for each feature dataset and Feature Layer/Feature Class
- ➢ Identification of Subtypes fields
- ➢ Identification of Relationships among feature class in each Feature Datasets
- ➢ Definition of Spatial Reference System in this case it was WGS84 System

- **Physical Design**

The physical design describes how spatial data are organized in Geo-Database objects such as schema, Feature Datasets, Feature Class, Tables, Domains, Relationship of different Feature Class/Layers, and storage management as Table Spaces in Oracle.

In Oracle database management System, a database schema was created using ArcGIS desktop through ArcGIS for Server. The relevant database objects and dictionary were generated in the schema to manage the geodatabase objects such as feature datasets, feature class, Tables, Domain Tables for subtypes, user privileges, roles etc. A user defined Table Spaces (a logical storage area in Oracle) is being created in Oracle Database System.

The Spatial Feature Class/ Feature Layers of Scheme's physical features were imported into respective Feature Datasets in geodatabase schema. The subtypes were defined in the geo-database level and Relationships Class was defined among different Feature Class under each Feature datasets. Following steps were followed for physical design of geodatabase:

- ➢ Creation of Geo-Database Schema as SDE

- ➢ Configuration of SDE Schema with respective privileges in Oracle

- ➢ Connect SDE Geo-Database Schema in ArcGIS Desktop

- ➢ Creation of Feature Dataset using ArcCatalog in ArcGIS Desktop

- ➢ Creation of Feature Class/Layers or Tables in respective Feature Datasets using ArcCatalog

- ➢ Add and define field/Column specification is each Feature layers

- ➢ Defined of Subtype field from Domain Tables in Geodatabase

- ➢ Establishment of Relationships Class with Feature Class in each Feature Datasets

- ➢ Populating Domain tables for Subtype values

➢ Importing Spatial Data into respective Feature Class in each Feature Datasets.

Following the completion of Spatial data creation and processed, spatial data have been imported into SDE Geo-Database in Oracle. The following datasets as shown in Table 3-7 have been imported into Geo-Database. The E-R diagram of Geodatabase is shown in Figure 3-18.

Table 3-7: Feature Class/Layer in Geodatabase

Sl. No.	Entity	Feature Class/ Table	Feature Class Type	Relationship	Subtype
1	BWDB Schemes/Projects	SCHEMES	Polygon	DIVISION	Scheme Type Scheme Status
2	Embankment	EMBANKMENT	Line	SCHEMES	Embankment Type
3	Canal	CANAL	Line	SCHEMES	Canal Type
4	Hydraulic Structure	HYDSTRUCTURE	Point	SCHEMES	Structure Type
5	River Bank Protection	RBP	Line	SCHEMES	
6	BWDB Division	DIVISION	Polygon	CIRCLE	
7	BWDB Circle	CIRCLE	Polygon	ZONE	
8	BWDB Zone	ZONE	Polygon		
9	Major River Network	RIVER_ MAJOR	Polygon	-	-
10	Narrow River Network	RIVER_ NARROW	Line		
11	Upazila Administrative Area	UPAZILA	Polygon	-	-
12	Upazila Administrative Boundary	UPAZILA _BND	Line		
13	Upazila Administrative Headquarter	UPAZILA_HQ	Point		
14	Road Network	Road	Line	-	-
15	Bridge and Culvers	BRIDGE	Point	-	-
16	Important Locations	LOCATION	Point	-	-
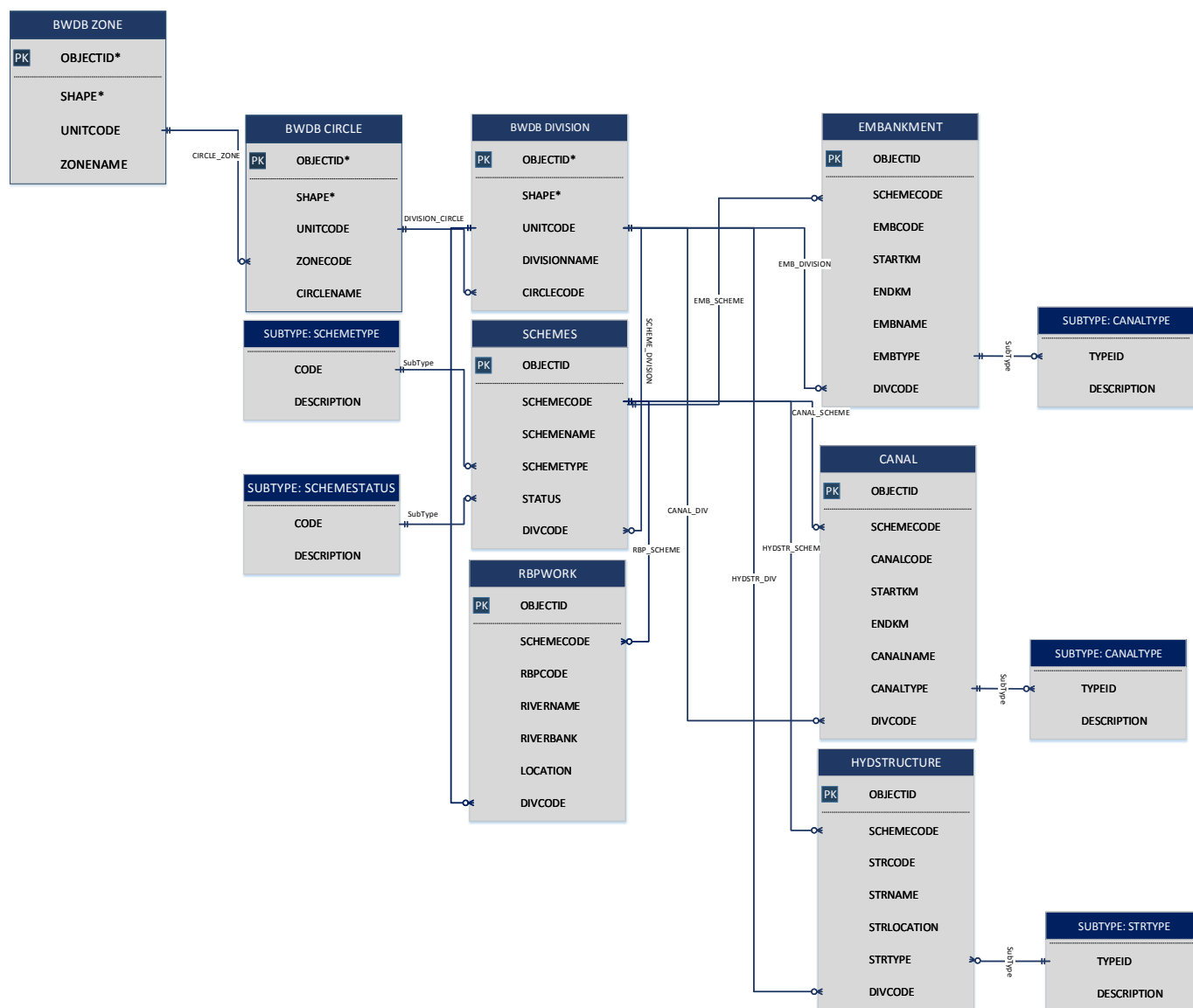
Figure 3-18: E-R Diagram of SiMS Geo-Database

3.5.3 NON-SPATIAL DATABASE DEVELOPMENT

This section outlines the tasks to design, development and implement SiMS-Smart Database for BWDB completed and ongoing Schemes and Projects with their detail physical feature's design and condition data of Canal, Embankment, Hydraulic Structures and Protection Works. The tasks were included for review and assessment of the existing SiMS database and find out the gaps, upgradation and enhancement of SiMS database in relation to the inclusion of BWDB ongoing projects data.

The database also includes O&M Works, Quantity and Cost Estimates, Schedule of Rates, Ongoing Project Works, DPP Information, O&M and DPP project Procurement, BWDB O&M and Ongoing Project Monitoring, WMO information and Scheme/Project performance on Agriculture, Socio-Economic and Water Resources data for implementing the Web-based SiMS Application.

The basic Schemes and related data have been collected from primary field survey and secondary available sources and uploaded into the database as the skeleton of SiMS-Smart database, on the other hand, the remaining datasets will be filed up or generated by BWDB users while operating the system.

While performing the database design structuring, following steps were followed:

- Conceptual Design

In conceptual design, different entities (similar data objects) have identified and their relationships-how they relate each other were established. The conceptual design of SiMS-Smart database was determined following the review of existing SiMS database and the review of new entities which were added into the SiMS-Smart database particularly for the ongoing BWDB project data sets.

- Logical Design

The logical data model structures the physical design and implementation of the database. It contains the representation of the entities, the attributes, the relationships, and the unique identifiers of each datasets/tables represents in the database.

- Physical Design

Following Features of the physical data model were considered:

- Specification of all tables and columns in each entity or table.
- Foreign keys to identify relationships between tables.
- Allowed de-normalization and normalization of entities based on the SiMS-Smart database requirements considered the business logic of the BWDB for operating the database.
- Developed the physical data model based on Oracle Database System

Following steps of physical data model were followed:

- Conversion of entities into tables.
- Establish relationships through Primary and Foreign Keys (referential integrity of entities).

- Conversion of attributes into columns.
- Creation of Physical data model based on physical constraints / requirements.
- Creation of User Schema in Oracle as the container of all the database objects
- Schema is the Owner of Database object in Oracle

An Entity Relationship (E-R) Diagram of SiMS-Smart database has been included in **Database Reference Manual**.

A standard coding convention for BWDB O&M offices of Zone, Circle and Division and BWDB Schemes and Projects was introduced in the existing SiMS on which the database was built. The enhanced upgraded SiMS-Smart database utilized this coding convention for managing and organizing the project/scheme wise physical features under each BWDB field offices jurisdiction.

3.6 GIS-BASED APPLICATION DEVELOPMENT FOR SiMS

This section outlines the enhancement, conversion, and development of modules available in the existing SiMS standalone application into SiMS-Smart Application.

3.6.1 SCHEME/PROJECT INVENTORY DATABASE MODULE

A Scheme inventory database module already exists in the existing SiMS. The content of this inventory included BWDB completed Schemes, Scheme's physical features such as Embankments, Canals, Hydraulic Structures with their locations, as-built design parameters in the database. In the present assignment, it has been enhanced and upgraded by inclusion of BWDB ongoing projects and their respective physical features, location of Protective works, present conditions of Hydraulic Structures, Embankment and Protection works.

A user friendly Graphical User Interface (GUI) in web environment has been developed for selecting, adding, updating and deleting features in the database in web environment.

The content of the major data items/parameters of each Scheme/Project and their physical features are shown in the following Table 3-8.

Table 3-8: Contents of Major Items in Upgraded SiMS-Smart Database Inventory

Sl No	Data Item	Description
A	Scheme/Project General Information	
	Scheme/Project Code	Scheme/Project Unique Identifier
	Scheme/Project Name	Name of Project/Scheme
	BWDB Division	BWDB Division in where the project is located
	Project Type	Type of the Project (FCD/FCDI/RBP/FC/I etc.)
	Project Status	Status of Project (Complete/Ongoing)
	Project Cost	Project Cost in BDT
	Project Area	Project Area (Ha)
	Beneficial Area	Project Beneficial Area (Ha)

Sl No	Data Item	Description
	Year of Construction	Year of Construction of Project
	Year of Completion	Year of Completion
	Donor	Funding Source of Construction of Project/Scheme
	Upazila	Name of Upazila(s) where the project/Scheme is situated
	District	Name of District(s) where the project/Scheme is situated
B	**Physical Features of Scheme/Project**	
	Embankment length	Length of Embankment in Km
	Length of Irrigation Channel	Length of Irrigation Channel in Km
	Length of Drainage Canal	Length of Drainage Canal in Km
	Number of Hydraulic Structures	Number of Hydraulic Structure in different types
	Length of Protective Work	Length of protective work in Meter
C	**Embankment General Information**	
	Embankment Code	Embankment Unique Identifier
	Scheme Code	Scheme Unique Identifier
	Embankment Type	Embankment Type (Embankment, Sea Dyke, Interior Dyke, Irrigation Dyke)
	Embankment Start Location	Start Chainage of Embankment
	Embankment End Location	End Chainage of Embankment
D	**Embankment Design Parameters**	
	Start & End Elevation of Embankment	Start and End Elevation in MPWD
	Start and End Top width	Embankment Top width at start and end chainage in Meter
	Side Slope	River and Country Side slopes
	Berm parameters	Berm parameters include Berm Width, Berm Elevation and Berm Slopes for River and Country Sides
	Revetment Type	Type of Protection work, if it is a protection work
	Revetment Length	Length of Protection work, if it is a protection work
E	**Canal General Information**	
	Canal Code	Canal Unique Identifier
	Scheme Code	Scheme Unique Identifier
	Canal Type	Canal Type (Embankment, Sea Dyke, Interior Dyke, Irrigation Dyke)
	Canal Start Location	Start Chainage of Canal
	Canal End Location	End Chainage of Canal
F	**Canal Design Parameters**	
	Canal Start and End Bed Level	Canal Start and End Bed level in m PWD
	Canal Start and End Bed Width	Canal Start and End Bed width in Meter

Sl No	Data Item	Description
	Canal Left and Right Bank Width	Width of Left and Right Bank of Canal
	Canal Inner Slopes (Right and Left Side)	Canal Inner Right and Left Side Slopes
	Canal Berm Parameters	Berm parameters include Berm Width, Berm Elevation and Berm Slopes for left and right Inner Sides
	Canal Outer Slopes	Canal Left and Right Outer Slopes
	Canal Bank Elevation	Canal Right and Left Bank Elevation
	Canal Start and End Location	Canal Start and End Chainage in meter
G	**Hydraulic Structure General Information**	
	Structure Code	Structure Unique Identifier
	Scheme Code	Under which Schemes the Structure is located
	Structure Name	Structure Name
	Structure Type	Structure Type
	Start and Completion Year of Construction	Start and End Year of Construction of the Structure
	BWDB Division	Under which BWDB Division the Structure is located
	Structure Location	Structure Location (Location's Local Name, Mouza, Union, Upazila etc.
	Geographic Coordinate	Geographic Coordinate of Latitude and Longitude in (DD) in WGS84 System
	Chainage on Embankment	Chainage Km of Embankment on which the Structure is located
	Embankment Name	Embankment Name
	Chainage on Canal	Chainage Km of Canal on which the Structure is located
	Canal Name	Canal Name
H	**Hydraulic Structure Design Parameters**	
	Vent Number	Number of Vent
	Vent Size	Vent Size (Height, Width or Dia)
	Invert Level/Sill Level	Invert Level in mPWD
	Sofit Level	Sofit Level in mPWD
	Deck Level	Deck Level in m PWD
	R/S and C/S Gate Type	River and Country Side Gate Type
	Floor Length	Floor Length in meter
	U/S and D/S Apron Level	Up- and Down-Stream Apron Level in m PWD
	U/S and D/S Cutoff Wall Depth	Up- and Down-Stream Cutoff Wall Depth in meter
	Average Ground Level	Average Ground Level
	C/S and R/S Design Highest Water Level	C/S and R/S Design Highest Water Level in m PWD
	Design Water Level/ Full Supply Level	Design Water Level in m PWD

Scheme inventory can be generated in SiMS-Smart by BWDB field office such as Zone, Circle and Division, as well as administrative areas such as Division, District and Upazila. Further, the inventory can be drilled down up to structure level in any scheme. The screenshot of scheme inventory generation is presented in Figure 3-19.

Figure 3-19: Scheme/Project Inventory

Furthermore, the detail of general information of Scheme/Project and list of Physical Features like Embankment, Canal, Hydraulic Structure, Protection Works can be found by selecting a Scheme/Project from Scheme tabular lists. The detail information and design parameters of each physical feature of particular Scheme/Project can also be found by selecting any feature from respective tabular lists are shown in Figure 3-20, Figure 3-21, Figure 3-22 and Figure 3-23 respectively.

Figure 3-20: General Information of Embankment

Figure 3-21: General Information of Canal

Figure 3-22: General Information of Hydraulic Structure

Figure 3-23: General Information of Protective Work

3.6.2 WEB BASED GIS MODULE

A web-based GIS module has been developed with the extended and advanced capabilities of web GIS functionalities with online published maps such as Open Street Maps and ESRI base Maps as background. This module provides facilities for selection, scale change, off/on layers, zooming facilities, feature identification, spatial queries etc.

GIS module loads GIS feature data, maps, image, tables through services from ArcGIS Server. ArcGIS Server makes the GIS data available to web application with an Internet connection. This is accomplished through web services, which allow a powerful server computer to receive and process requests for information sent by users. In SiMS-Smart application the ArcGIS Server creates, manages and distributes GIS Services to web application where the spatial data comes from the Enterprise Geo-Database stored in Oracle SDE Schema. The non-spatial data can also be accessed from Oracle database in the web server. The architecture of ArcGIS Server, Database Server and Web Server is shown in Figure 3-24.
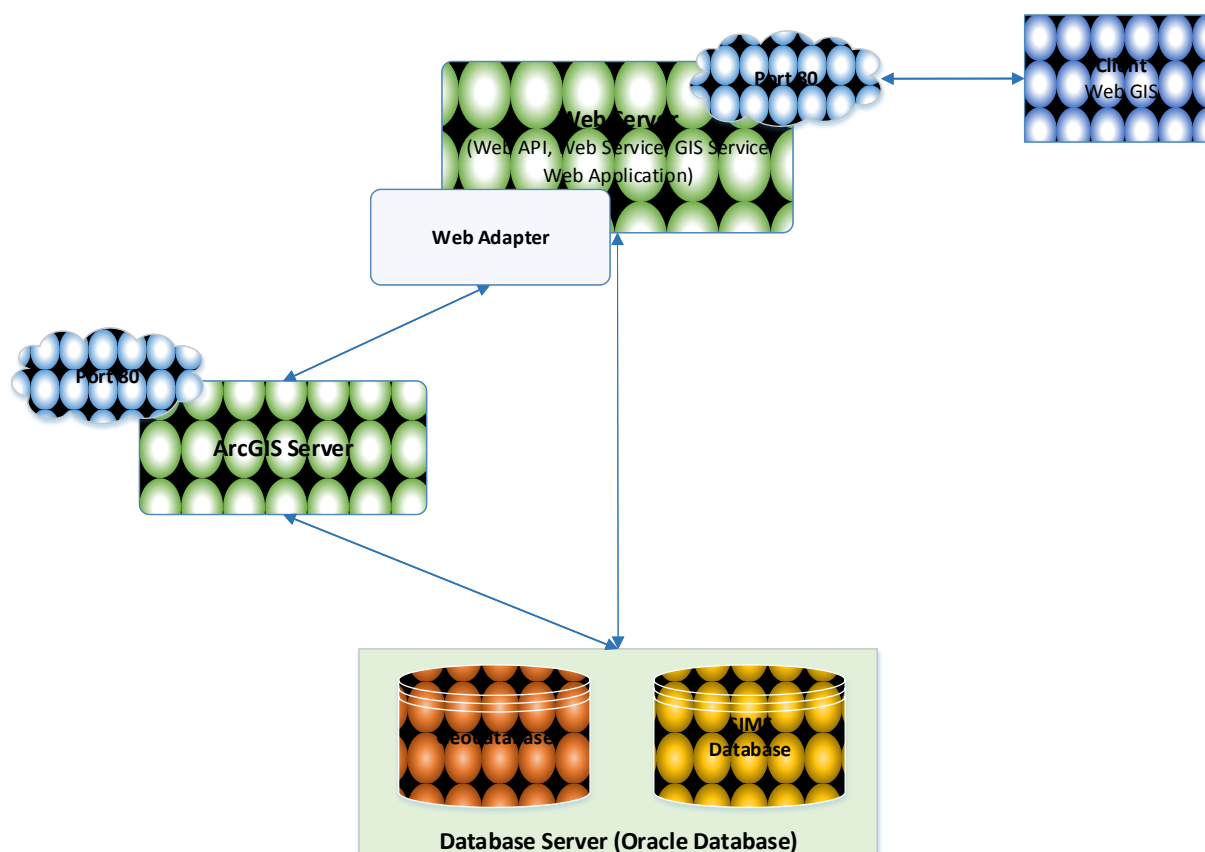
Figure 3-24: Architecture of Database, ArcGIS server and Web Server

The spatial data in GIS services and the non-spatial data are tied and joined with the common key fields in spatial and non-spatial datasets.

The Web GIS module has been configured using WGS84 Geographic Coordinated System in order to integrate with online dynamic Open Street Maps/ESRI online Base maps/Google Maps as background. Accordingly, the Scheme/Project related spatial datasets, maps and satellite imageries have been prepared/converted in WGS84 Coordinate System to relate with background online maps consistently.

As per the TOR, SiMS-Smart would have been integrated with Google Earth. This integration of Google Earth could not be developed due to the unavailability of Google Earth API which has been deprecated by the Google authority (https://developers.googe.com/earth-engine/). In place of Google Earth Interface, ESRI online Satellite Maps has been integrated in the Web GIS module as background. The valid license users of ArcGIS software can use this facility which is similar to the Google maps.

This Web based GIS Module is the starting point to the SiMS-Smart Application in which all dashboards, menus, sub-menus are systematically organized as shown in Figure 3-25. The users can interact or use any modules or tools from this Interface.
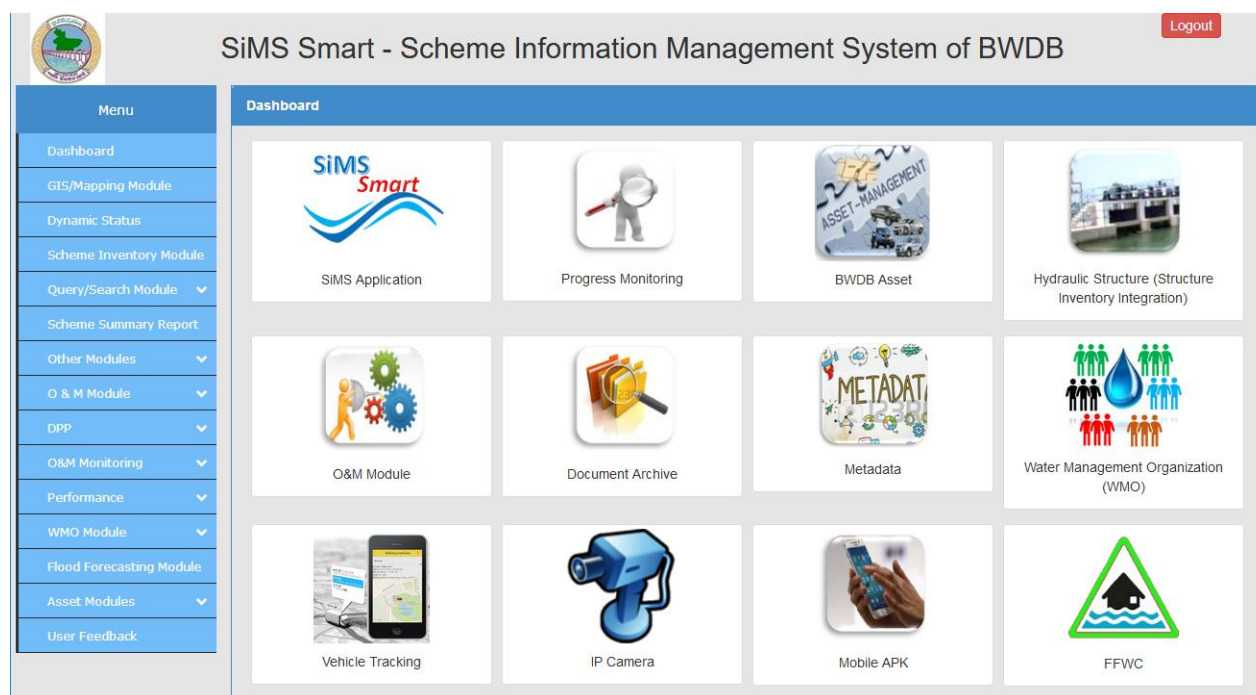
Figure 3-25: SiMS-Smart Dashboard and Menus

A tool has been developed with to visualize the recent changes of earth surface by adding historical satellite images, which could help BWDB to relate the recent changes of Scheme/Project maps and features. A screen-shot of this functionality is shown in Figure 3-26.
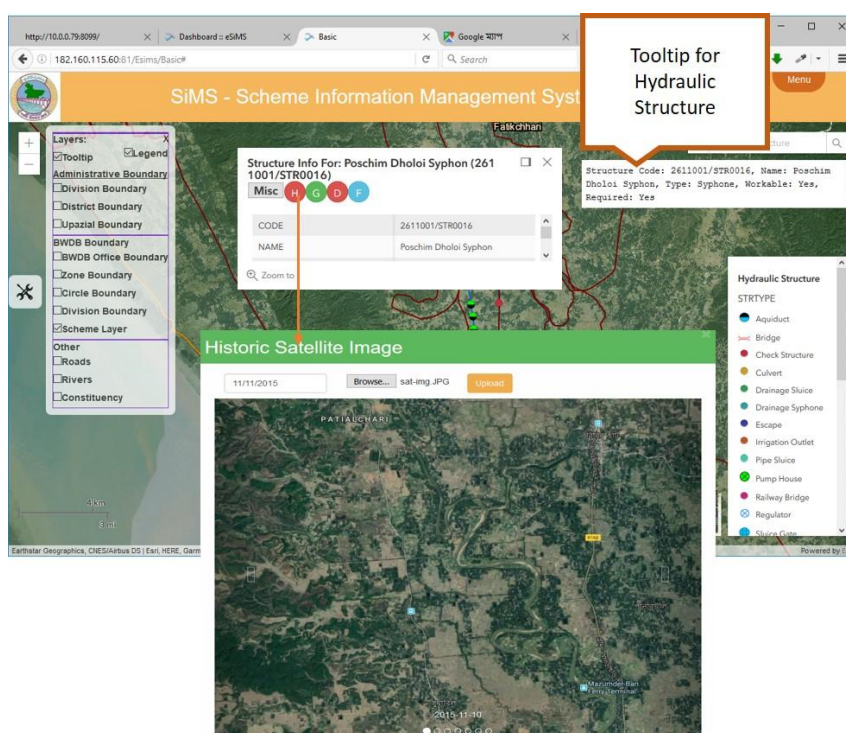
Figure 3-26: Historical satellite images upload system and Hydraulic Structure Tooltip

3.6.3 SEARCH/QUERY MODULE

A robust Web GIS based Search/Query module has been implemented in SiMS-Smart application. The Search/Query module works both on spatial and non-spatial datasets in Web based GIS environment. The Search/query module of existing SiMS has been extended by incorporating BWDB ongoing projects. Web GIS based Search/Query module has developed based on the following Spatial and non-Spatial data items:

1. BWDB Completed and Ongoing Schemes/Projects

2. Schemes/Projects under each BWDB Field units, such as ZONE, Circle and Division

3. Schemes/Projects locations by general administrative areas (Division, District and Upazila)

4. Scheme/Project Type

5. Scheme/Project Status (Complete/Ongoing)

6. Area (Actual and Beneficial)

7. Development Partners/Funding Source

8. Scheme/Project Name or (any part of name).

9. Start and Completion year of Scheme/Project Construction

The user can set any combination of the above features/items to issue a query in Web GIS environment. The following Figure 3-27 shows the architectural diagram of Query/Search module and the Figure 3-28 shows the data flow diagram of this module.

Figure 3-28 shows the data flow for user entered Search Criteria on Schemes/Project attributes and selection of BWDB field unit office such as Zone, Circle and Division or Selection of General Administrative area of Division, District and Upazila for which the Query/Search are to be executed. The query results of this module will display in tabular form and also in Report form for printing or export in various file formats such PDF, Excel, Word etc.
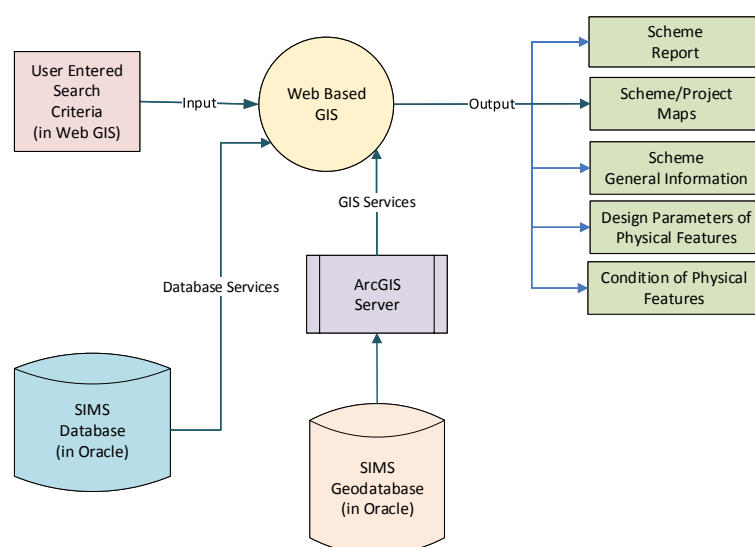
Figure 3-27: System Component Diagram of Search/Query Module

Data Flow Diagram of Search & Query Module

Input: BWDB Schemes/Project, Query Criteria
Process: Selection of Schemes based on User Query
Output: List of Schemes by Zone, Circle and Division with Scheme/Project Attributes in tabular and report forms
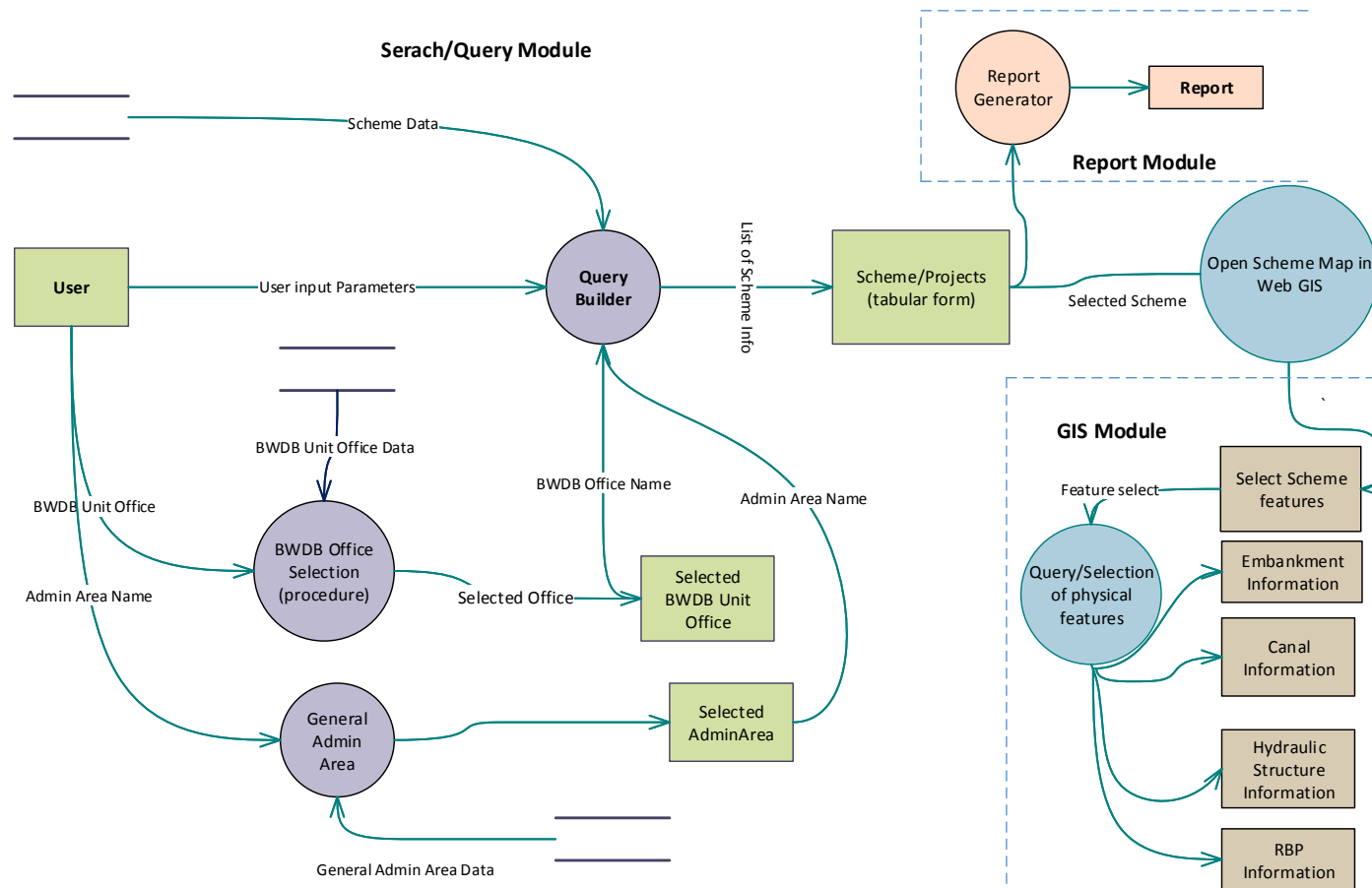
Figure 3-28: Data Flow Diagram of Search/Query Module

The Search/Query Module in SiMS-Smart include General Search, Spatial Search and Custom Dynamic Search operations.

General Search/Query is a robust search operation by BWDB Units (Zone, Circle and Division) or by General Administrative Area (Admin. Division, District and Upazila) along with Scheme Type, Scheme Status, Scheme Area (Gross/Beneficial Area), Donors, by key words of Scheme name, and Scheme Codes. This type of Search/Query implementation is shown in Figure 3-29.

Figure 3-29: General Search/Query Operation

Spatial Search is a robust operation in GIS map features Layer (Schemes, Embankment, Canal, Hydraulic Structure and Protection Works) by their Type, Status, Feature Code, Feature Name, BWDB Division etc. This Search implementation is shown in following Figure 3-30.
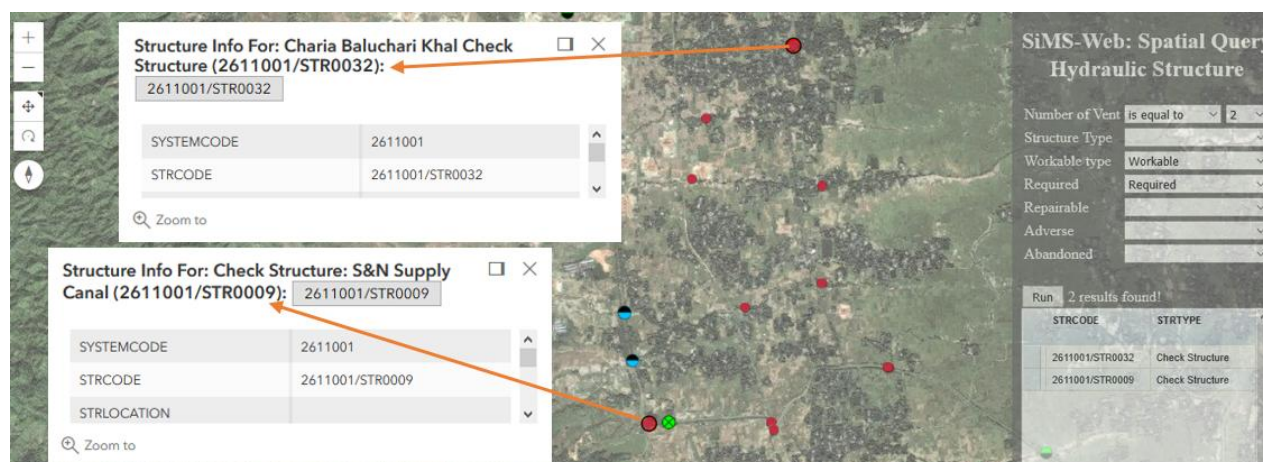
Figure 3-30: Spatial Search/Query in GIS

Custom and Dynamic Search/Query is also a robust Search operation which has implemented on any database Table, by any fields and column values dynamically is shown in the following Figure 3-31.

Figure 3-31: Custom Search/Query operation

3.6.4 DEVELOPMENT OF O&M MODULE

This module will be used to store O&M data of BWDB Completed Schemes such as Pre-work section data of Embankment and Canal, Schedule of Rates, O&M Budget, O&M Work programs, Quantity Estimates of Earthwork volumes, Slope areas for protection works, cost estimates etc.

This module will help BWDB for O&M work budgets and procedures for O&M estimates of each project. A user-friendly web enabled GUI has been developed to add, delete, update and edit O&M related data. The module has been developed with concepts and procedures which are available in the existing SiMS application.

The Module stores data related to following four aspects with the ultimate purpose of preparing the annual budget.

1. O&M requirement of BWDB Schemes
2. Schedule of Rates
3. Quantity Estimates for Embankment and Canal
4. Cost Estimates for Embankment and Canal

1) O&M Requirement of Scheme

The maintenance requirement of each scheme has to be assessed by field officials by preliminary inspection and reporting, then by actual survey and measurement and finally by preparing the drawings as applicable. Some of the salient data for maintenance requirement with respect to each kind are:

a.   Required quantity of earthwork for re-sectioning of embankment.

b.   Required quantity of earthwork for re-excavation of drainage channel and/or irrigation canal.

c.   Required quantity of concrete repair works.

d.   Required quantity/number of protection materials in U/S and D/S of hydraulic structures, slope protection of embankment and river bank protections.

e.   Required quantity and number of mechanical parts of structures such gates, hoist etc.

2)   Schedule of Rates

Schedule of Rates for all O&M Circles will be available in the SiMS-Smart Application if Design Circle-II upload the Schedule of rates for respective circles and years in the system. An uploading facility is available in SiMS-Smart application. Design Circle II of BWDB prepares, update and maintain Schedule of Rates in two Volumes for all O&M Circles of BWDB in both soft copy and hard copy.

3)   O&M Estimates

A format is available in the existing SiMS, which has been utilized in this module for preparing estimate of each category of O&M works for Embankment, Structure, Canal and Protection Works. In general, the following estimates can be prepared from this module.

1.   Repair, re-sectioning and retirement of embankment.

2.   Re-excavation of drainage channels and irrigation canals.

3.   Repair of hydraulic structures with associated protective and mechanical works.

4.   Repair of revetments at embankments and river banks.

5.   Repair of operational buildings.

6.   Revised estimate and schedule if any.

4)   O&M Budget and Work Selection

In this section, O&M budget can be prepared according to the cost estimates of O&M works, and thereby selection of O&M works (work authorization) can be done through this module. Moreover, preparation of annual O&M budget for O&M works of each scheme/project under an O&M Circle and Division can be done using this module.

Steps for O&M Work execution flow diagram is shown in following Figure 3-32. The following Figure 3-33 and Figure 3-34 illustrate the data flow diagram of Quantity (Earthwork) Estimates for Embankment and Canal. Figure 3-35 illustrates the typical dataflow diagram for Cost Estimates of Embankment wok and the same approach is applied for the cost estimates for Canal, Hydraulic Structure, Protection Work and Other Miscellaneous works. Figure 3-36 illustrates the Dataflow diagram of the selection of work components of Embankment, Canal, Hydraulic Structure, Protection Works and Other miscellaneous works for O&M and ADP projects.

```
┌─────────────────┐
│   Selection     │
│   Of Woks       │
└─────────────────┘
         │
         ▼
┌─────────────────┐
│   Pre-Work      │
│   Survey        │
│ Data Collection │
└─────────────────┘
         │
         ▼
┌──────────────────────┐                                    ┌─────────────────────┐
│ Preliminary/Revision │◄───────────── No ──────────────────│        Is           │
│ Quantity Estimates   │                                    │ Authorized/approved │
│     (Post Work)      │                                    │     O&M works       │
└──────────────────────┘                                    │   By Board/CE       │
         │                                                  │     /SE/EE          │
         ▼                                                  └─────────────────────┘
┌──────────────────────┐                                             │
│ Preliminary or Revised│──── Revised ────►                         Yes
│    Cost Estimates     │                                            │
└──────────────────────┘                                            ▼
         │                                          ┌─────────────────────────┐
         ▼                                          │        Define           │
┌──────────────────────┐                            │     O&M Project         │
│   Budget Demand       │                           │ Integrate one or more   │
│       for             │                           │    work components      │
│    O&M Works          │                           └─────────────────────────┘
└──────────────────────┘                                       │
         │                                                     ▼
         │                                          ┌─────────────────────────┐
         │                                          │        Define           │
         ▼                                          │      O&M Works          │
┌──────────────────────┐                            │    Packages/Lots        │
│         Is           │                            └─────────────────────────┘
│      Approved         │                                       │
│        by             │                                       ▼
│       Board           │                           ┌─────────────────────────┐
└──────────────────────┘                            │   Procurement Plan      │
  │                 │                                │    & Execution          │
  No               Yes                               │   Of O&M Work           │
  │                 │                                │     Packages            │
  ▼                 │                                └─────────────────────────┘
┌─────────────┐     │                                          │
│ Not Approved│     │                                          ▼
│  & Cancel   │     │                                ┌─────────────────────────┐
└─────────────┘     ▼                                │         O&M             │
             ┌──────────────────┐                    │    Work Package         │
             │ O&M Budget       │                    │       Award             │
             │ Allocation       │                    │  & Contract Signing     │
             └──────────────────┘                    └─────────────────────────┘
                                                                │
                                                                ▼
┌──────────────────┐                                ┌─────────────────────────┐
│ Physical Progress│───────────────────────────────►│  Progress Monitoring    │
│ Financial Progress│                               │   O&M work Package      │
└──────────────────┘                                └─────────────────────────┘
                                                                │
                                                                ▼
                                                    ┌─────────────────────────┐
                                                    │  Completion of O&M      │
                                                    │        Works            │
                                                    └─────────────────────────┘
```

For Revision & Adjustment

Final Allocation

Figure 3-32: BWDB O&M Work Execution

Data Flow Diagram of Quantity Estimates for Embankment
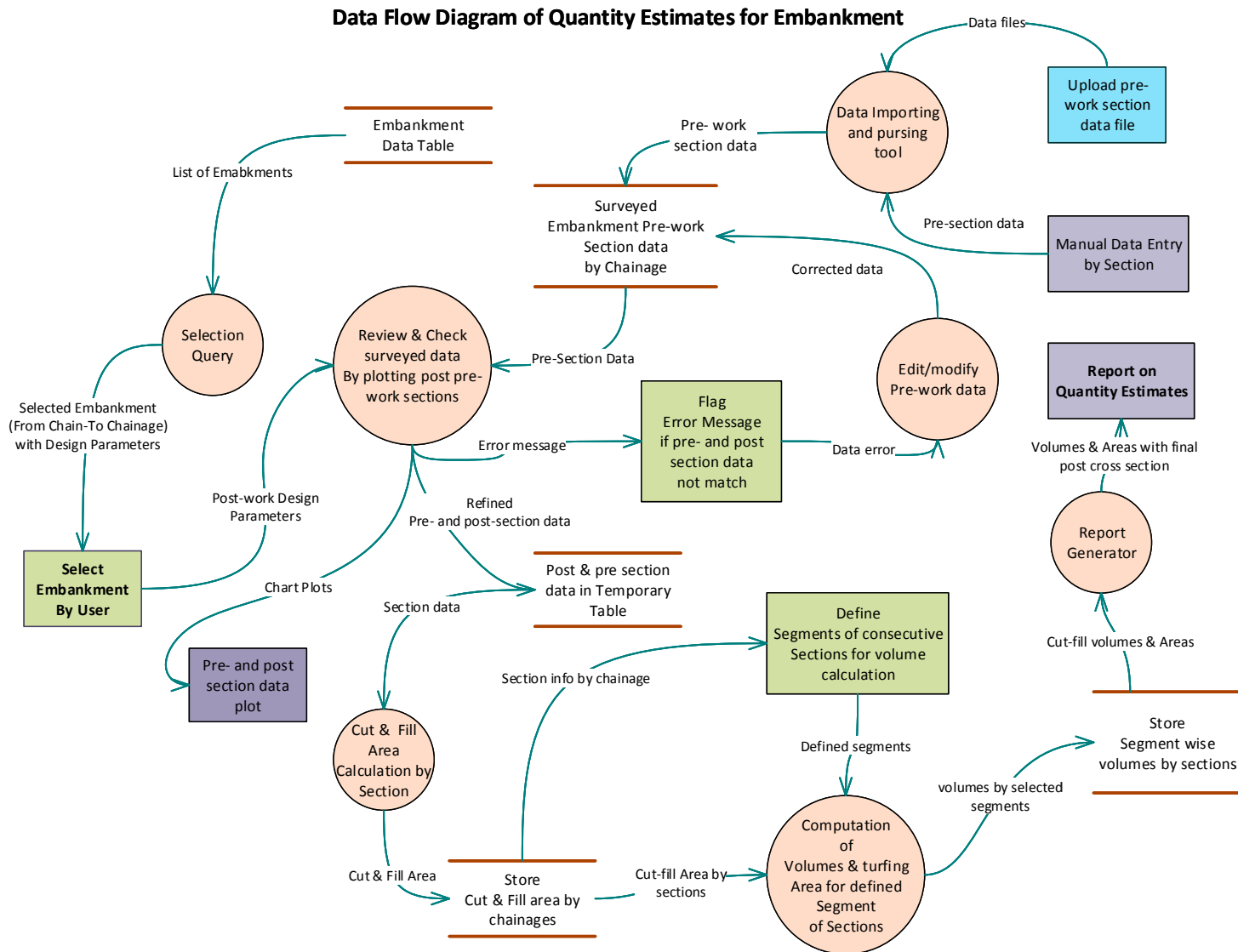
Figure 3-33: Data Flow Diagram of Quantity Estimate for Embankment

Data Flow Diagram: Quantity Estimates for Canal
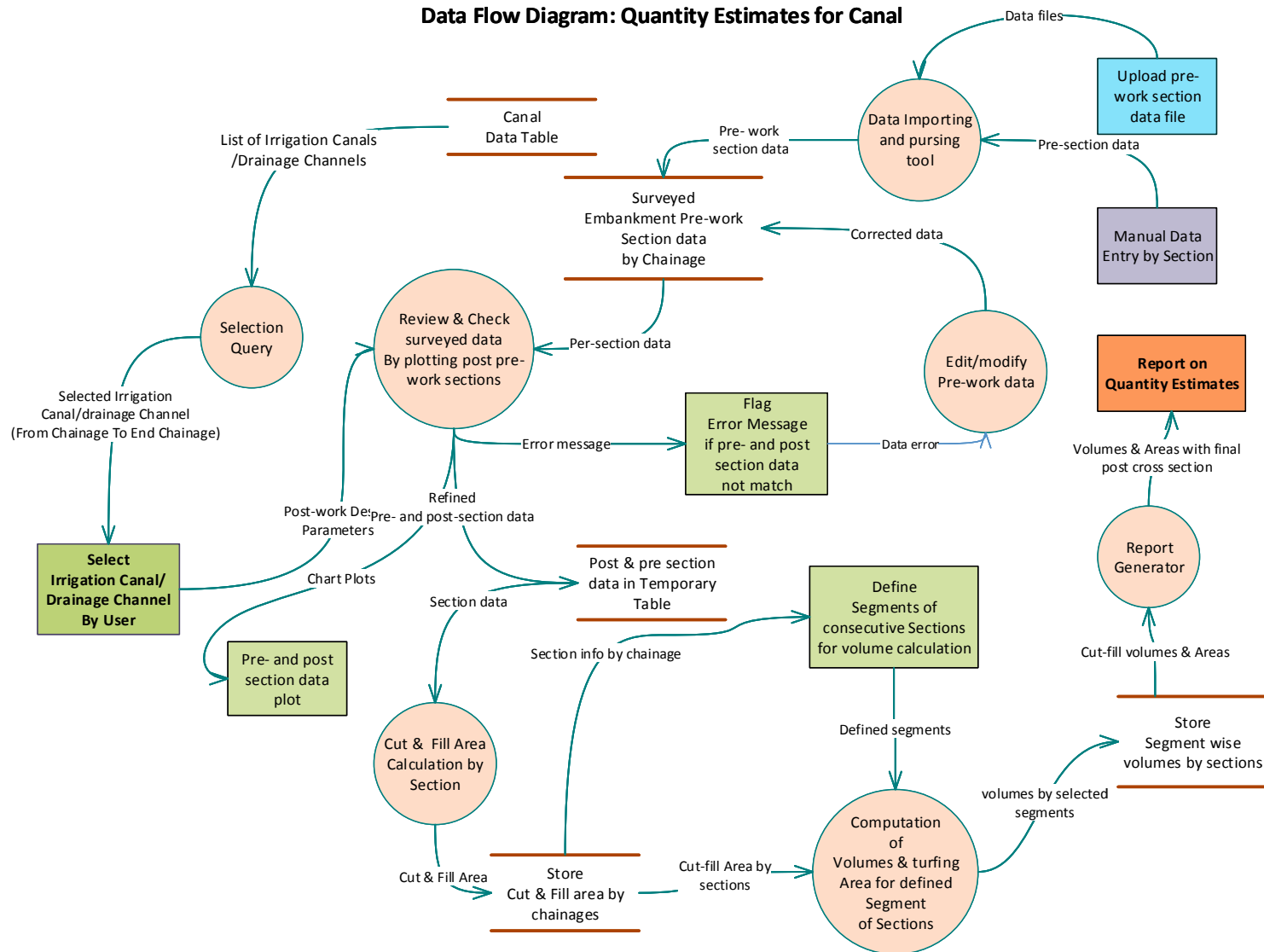
Figure 3-34: Data Flow Diagram of Quantity Estimate for Canal

Data Flow Diagram for Cost Estimate for Embankment
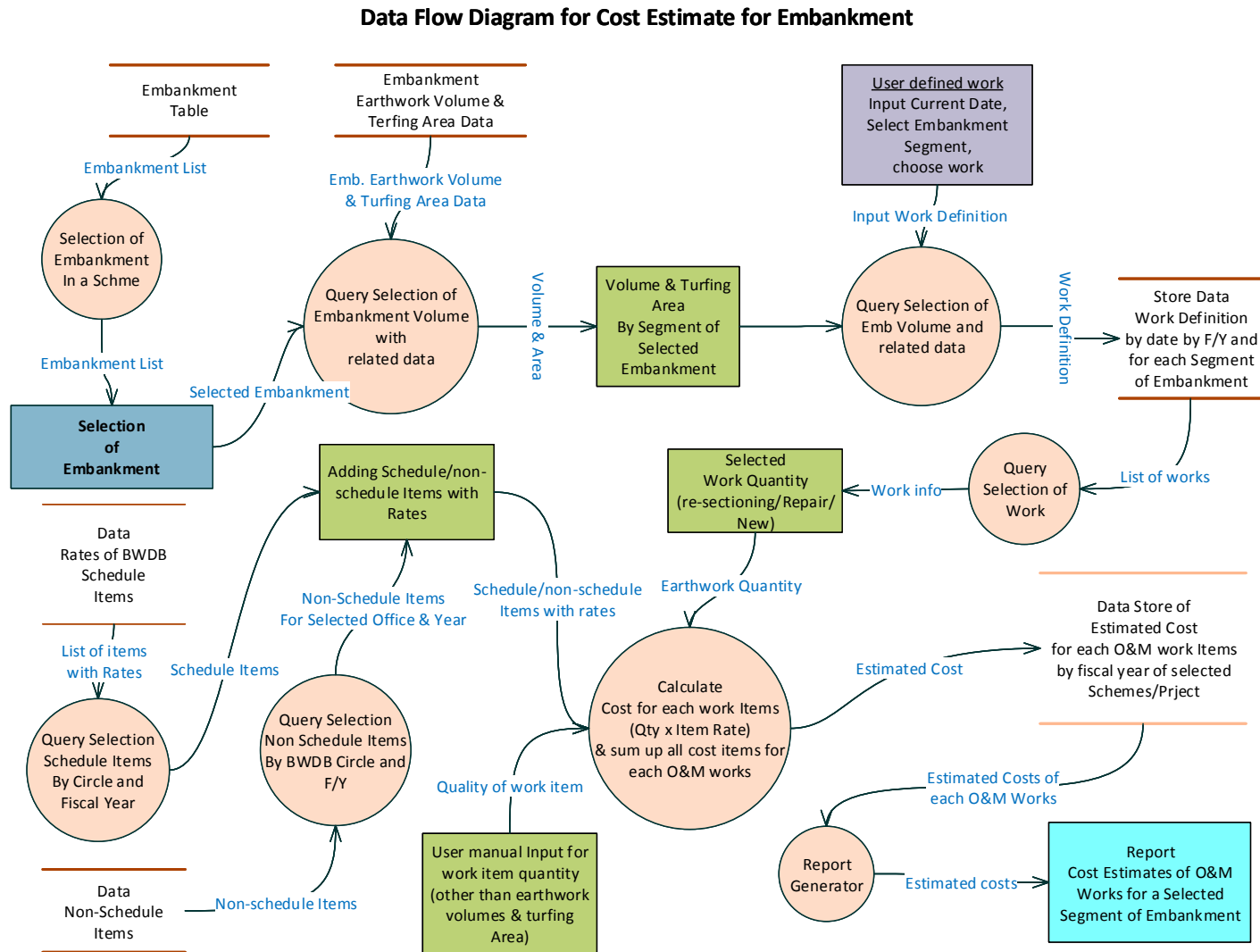
Figure 3-35: Cost Estimates for Embankment

Data Flow Diagram of Selected O&M/ADP Work Components
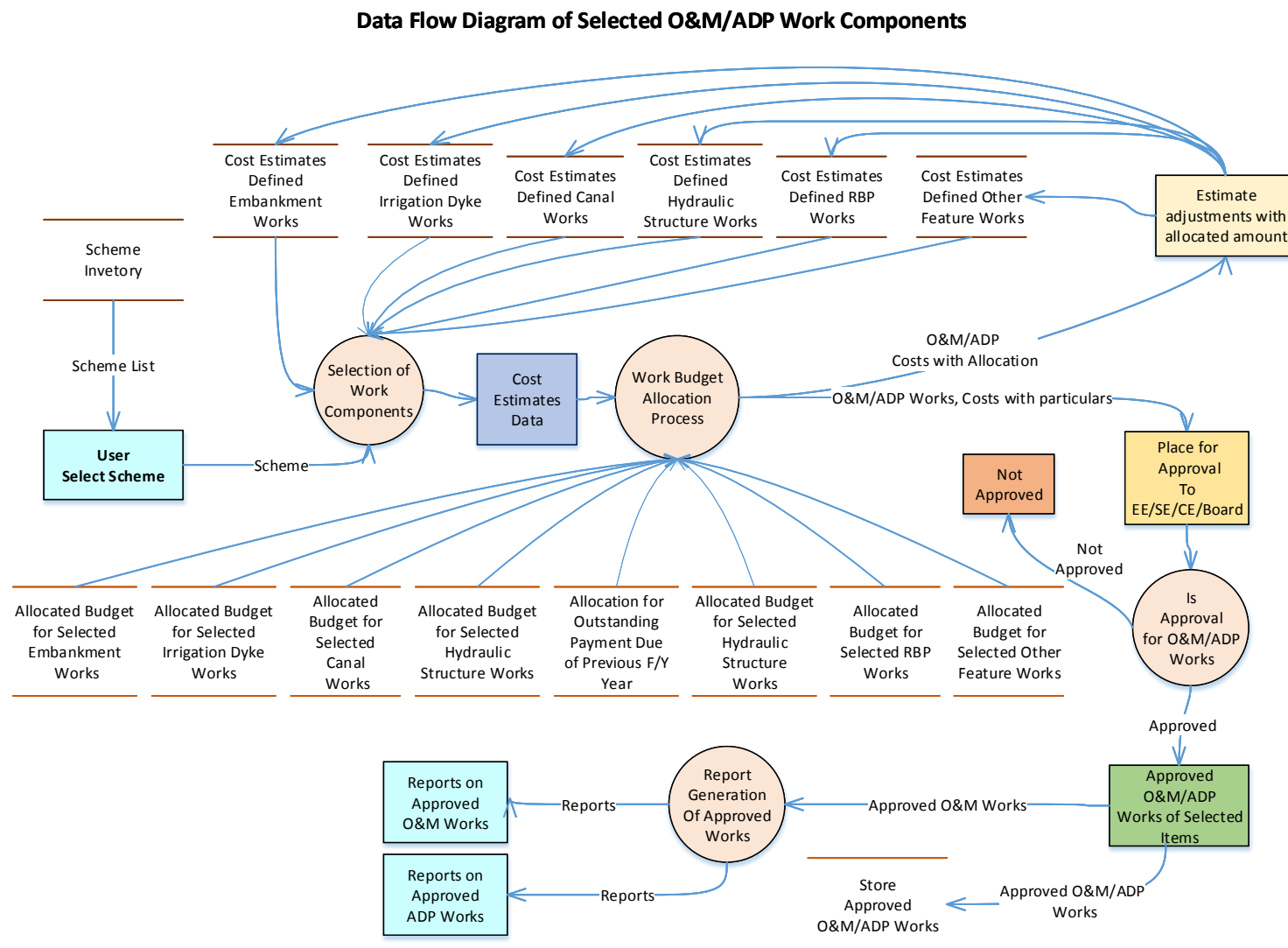
Figure 3-36: Work Component Selection for O&M and ADP Project Works

3.6.5   QUANTITY ESTIMATE

To estimate earthwork quantity for embankment/dyke or canal, pre and post work survey data and design parameters of that feature should be loaded into database. The screenshot of Cut/Fill estimate module is presented in Figure 3-37.
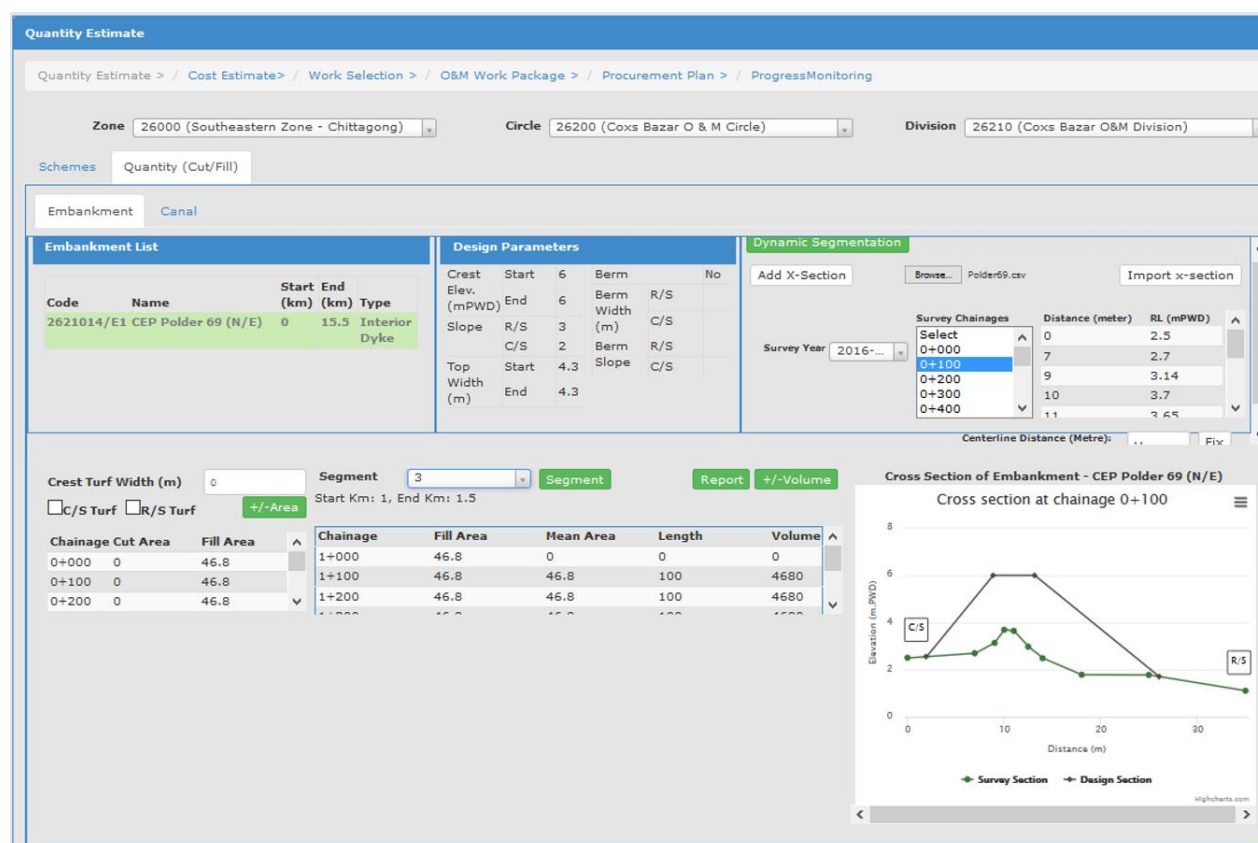
Figure 3-37: Quantity Estimate (Cut/Fill) for Embankment

If data are loaded properly, Quantity Estimate window shows the associated data for each embankment reach. The list of the embankment reaches is displayed on the top-left, design parameters on top-middle and survey data on top-right of the screen showing in Figure 3-37. Using the preconstruction survey data and design parameters, the cross-section chart of selected chainage at the bottom-left of Figure 3-37 is drawn on the screen (enlarged view is given in Figure 3-38).
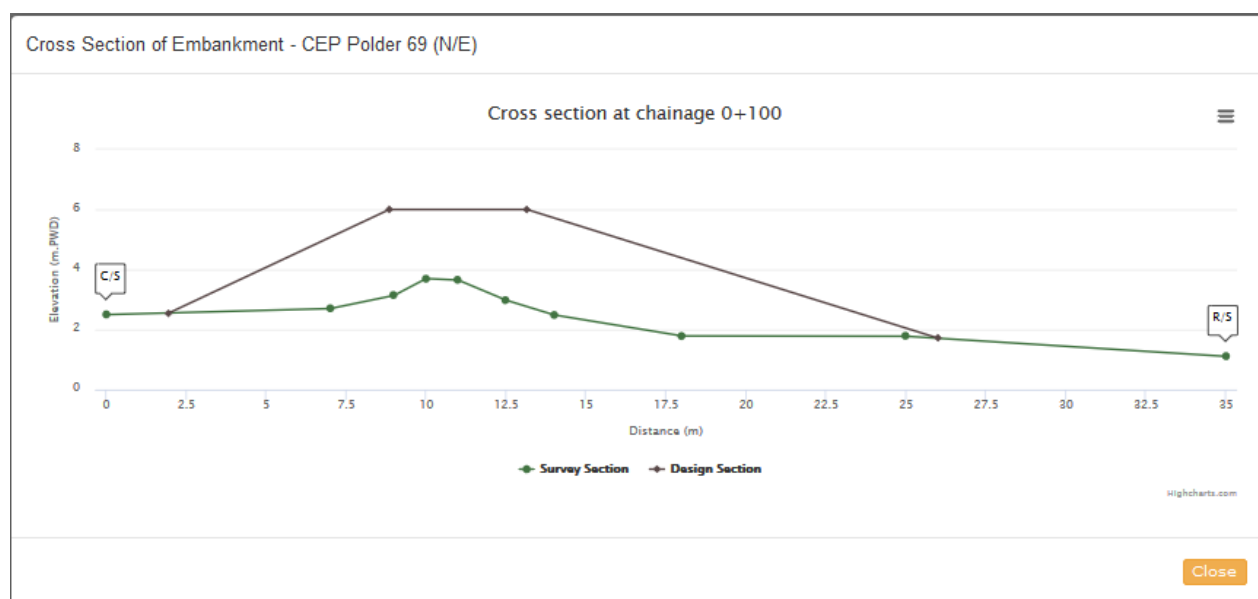
Figure 3-38: Cross Section of Embankment at a specific chainage

This chart shows pre-work section (Green line) along with superimposed design section (Brown line) according to design parameters.

Earthwork quantity from each section to successive section is calculated along with fill area, segment length and volumes as shown in Figure 3-39 and stored in the database.

Chainage	Fill Area	Mean Area	Length	Volume
0+000	46.8	0	0	0
0+100	46.8	46.8	100	4680
0+200	46.8	46.8	100	4680

Figure 3-39: List of calculated earth volume in-between two consecutive sections

Earthwork quantity for canal is estimated in the same way as embankment which is described above but in a separate module. The snapshots of canal earthwork estimates are shown in Figure 3-40 and Figure 3-41.
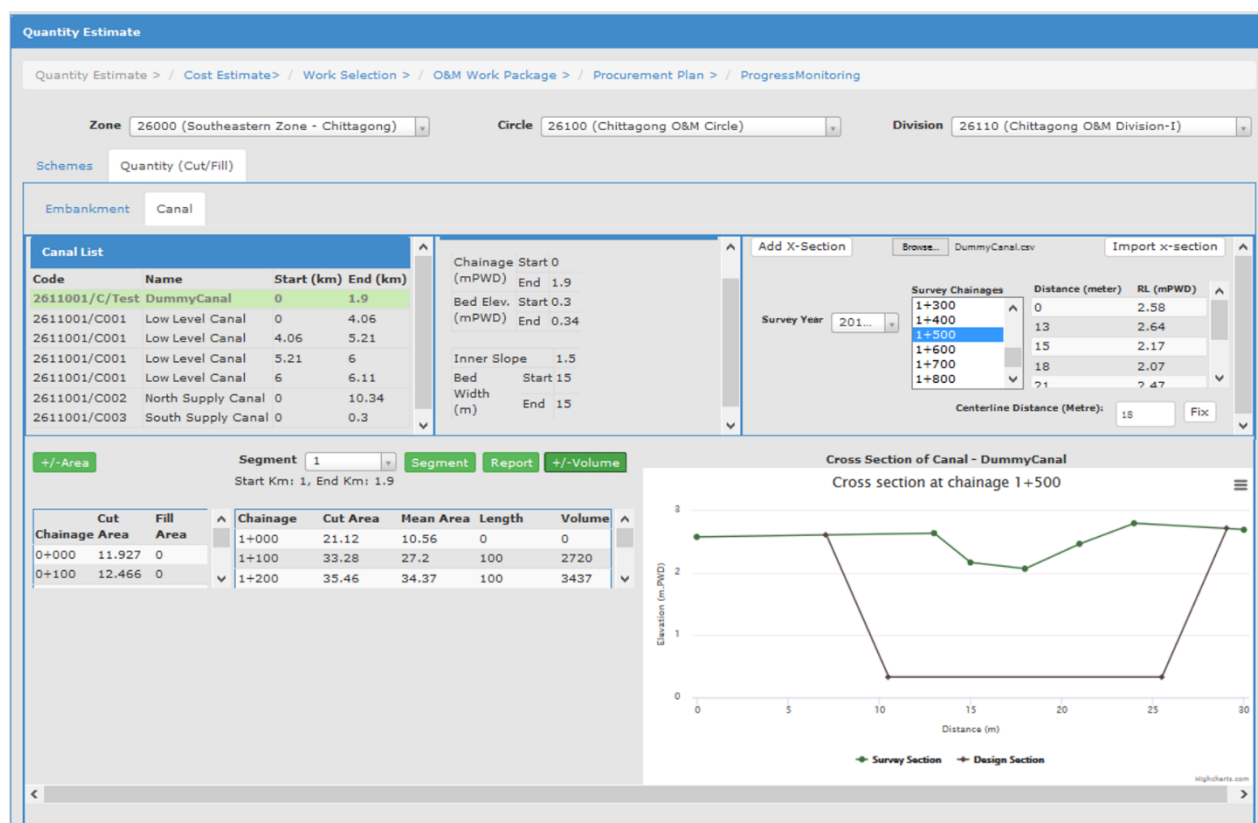
Figure 3-40: Quantity Estimate (Cut/Fill) Canal
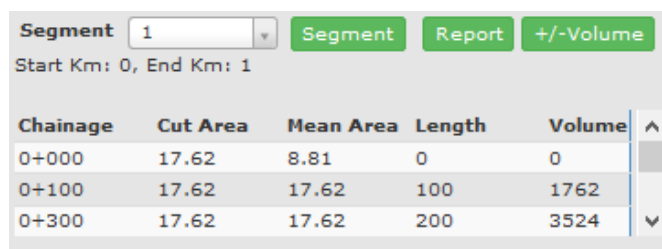
Figure 3-41: Earthwork volume calculation for canal

Similar to embankment, all the results are stored in database permanently.

3.6.6   COST ESTIMATES

Individual forms are available for estimating cost of works of different type of physical features. Different forms have been developed to estimate cost for following features:

- Embankment
- Canal
- Dyke
- Hydraulic Structure
- Bank Protection Work
- Other Work

In Embankment Cost Estimation form, cost can be estimated for different works of embankments. Prior condition for cost estimation is that, earthwork volume should be calculated (described in Section 3.6.5) for the segment on which work to be done. A screenshot for cost estimation of embankment is presented in Figure 3-42. For cost estimation, defining new work, update and delete options are made available in this module.

Figure 3-42: Defining work for cost estimation of embankment

The cost of a work is the summation of cost of one or more sub-works. Costing of a sub-work has been presented in Figure 3-43. Quantity of earthwork volume or slope area is imported automatically from database which was stored during quantity estimate. This has been discussed in section 3.6.5.

Figure 3-43: Cost of sub-works with a work of embankment

A separate module and interface has been developed for cost estimation of canal. Based on the quantity estimates stored into the database, this module calculates the cost of canal works segment by segment and stores into the database. A snapshot of this module is shown in Figure 3-44. In this calculation, scheduled item and non-scheduled items are considered separately. The estimation process followed existing BWDB estimation procedures for both quantity and cost estimates.

Figure 3-44: Cost Estimate for Canal

The cost estimation of Dyke is done through a developed "Cost Estimate for Dyke" module which has a similar visual interface like embankment cost estimate is shown in Figure 3-45.

Figure 3-45: Cost estimation of Dyke.

Estimating cost of works of different types of Hydraulic Structures has been done with "Cost Estimate for Hydraulic Structure" form is shown in Figure 3-46. If quantity of work is given for sub-works then cost will be calculated automatically.

Figure 3-46: Cost Estimate for Hydraulic Structure

Cost estimation for Bank Protection Work has been done using "Cost Estimate for Protective Works" form is shown in Figure 3-47 using underlying estimation module.

Figure 3-47: Cost Estimate for Bank Protection

Cost estimation for Other Works have been done though "Cost Estimate for Other Works" form is shown in Figure 3-48 in the same way as Hydraulic Structure as described above.

Figure 3-48: Cost Estimate for Other Works

All the results of all estimates are stored in database permanently.

3.6.7   WORK AUTHORIZATION/SELECTION

After estimating the cost of a work, in Work Authorization stage, whether a work should be included in O&M or ADP; this can be done using following form is shown in Figure 3-49. Budget for this work is authorized during selection.

Figure 3-49: O&M Work Selection

3.6.8   DEVELOPMENT OF O&M MONITORING MODULE

This section outlines the O&M Works Monitoring process in SiMS-Smart application. O&M Monitoring module consists of O&M Package/Lot Development, Preparation of Procurement Plans, Tendering Process and O&M Work Monitoring.

The Monitoring Module stores and maintains O&M implementation data of each year for individual schemes and monitor the target, progress and completion schedule of schemes. This module includes O&M Work Package and Lot development, Procurement Plans and Tendering processes, and the Physical and Financial progress monitoring during the project tenure. This module is capable of producing different types of BWDB used standard progress monitoring reports on fort-nightly, monthly, quarterly, half yearly etc. This module requires following O&M works related data to implement the module:

1. Estimated cost of O&M works and Budget

2. O&M Work Package and Lot Development

3. Procurement Plans

4. Tendering Process and milestone deliverables

5. Actual cost of implementation offered by Contractor

6. Target time of O&M Works

7. Actual time of completion

8. Number and name of structure, length and reach of embankment, drainage channels/irrigation channel, protection works repaired with cost under an individual scheme

9. Physical and Financial progress of O&M Works

10. Contractor Information etc.

The following Figure **3-50** illustrates SiMS-Smart interface of O&M Work Package or Lot development. It requires to create a new O&M Work Package/Lot for one or more selected work components under O&M budget for a selected Scheme/Project in a particular Fiscal Year. The O&M work components include O&M works for new/re-sectioning of Embankment, excavation/re-excavation of canals, repair/new protection works, and reconstruction/construction/repair works for Hydraulic Structure. Each work package also includes the quantity of different of works, estimated cost and contracted amount after awarding the package. This interface also includes the procurement methods, approval authority and funding sources etc. Figure **3-54** shows the dataflow diagram for performing the package development.

The following Figure **3-51** illustrates the SiMS-Smart Interface of O&M Work Procurement Plan, which includes different dates of procurement stages for tendering the process and start and completion of project, project award dates with reference, Contractor Information are also can be entered in this web interface. And, following Figure **3-55** shows the dataflow diagram of this O&M Work Procurement Plan.

Finally, Figure **3-52** shows how to input the Actual and Financial Progress of awarded O&M works in SiMS-Smart interface. The physical work progress can be input by any dates or any date of intervals and the same time financial expenditures can be input with same way. According the progression date inputs, cumulative Actual and Financial progress can automatically be shown in the system. After completion, the project, the progress will be updated by 100% both for actual and financial progress. The user could generate several types of Progress Report by Weekly, Fort-nightly, Monthly, Quarterly, Half Yarely and Annually. Accordingly, Figure **3-56** shows the dataflow diagram of O&M monitoring interface in SiMS-Smart.

Figure 3-50: O&M Work Package

Figure 3-51: O&M Package Procurement Plan

Figure 3-52: Progress Monitoring for O&M Project

Updated status of physical features of embankment following the completion of O&M works, the user need to be update the status of the respective segments of embankment using Dynamic Status Tool. This tool will be able to show the segment of Embankment according to the status such as 'Good', 'Poor' and 'Bad' highlighting in different colors on GIS map as shown in Figure 3-53. This tool is also capable of storing the historical information of embankment status.

Figure 3-53: Utility of Dynamic Segmentation for embankment

Data Flow Diagram for O&M Work Package Development
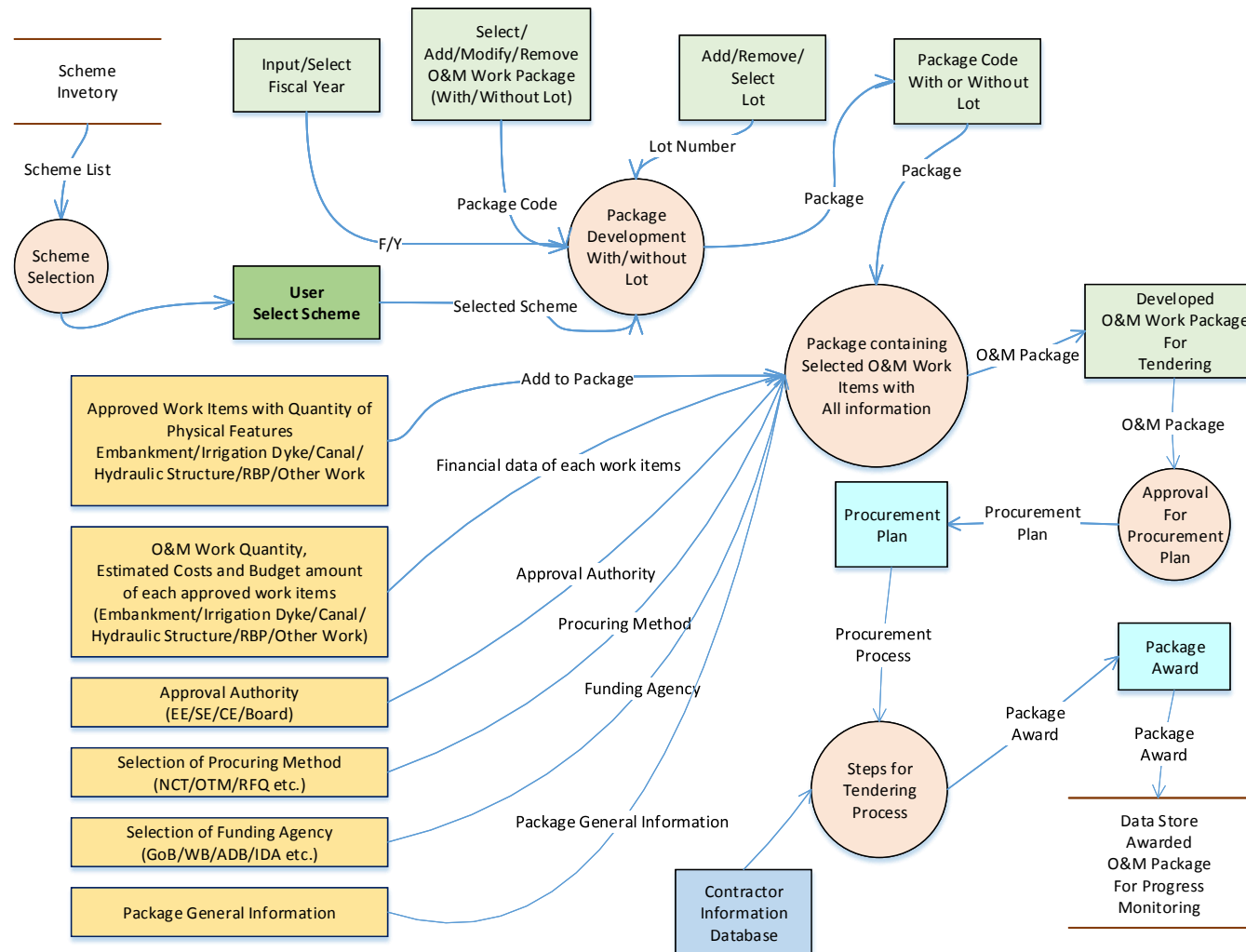
Figure 3-54: Dataflow Diagram of O&M Work Package Development

Data Flow Diagram for Procurement Plan for O&M Works
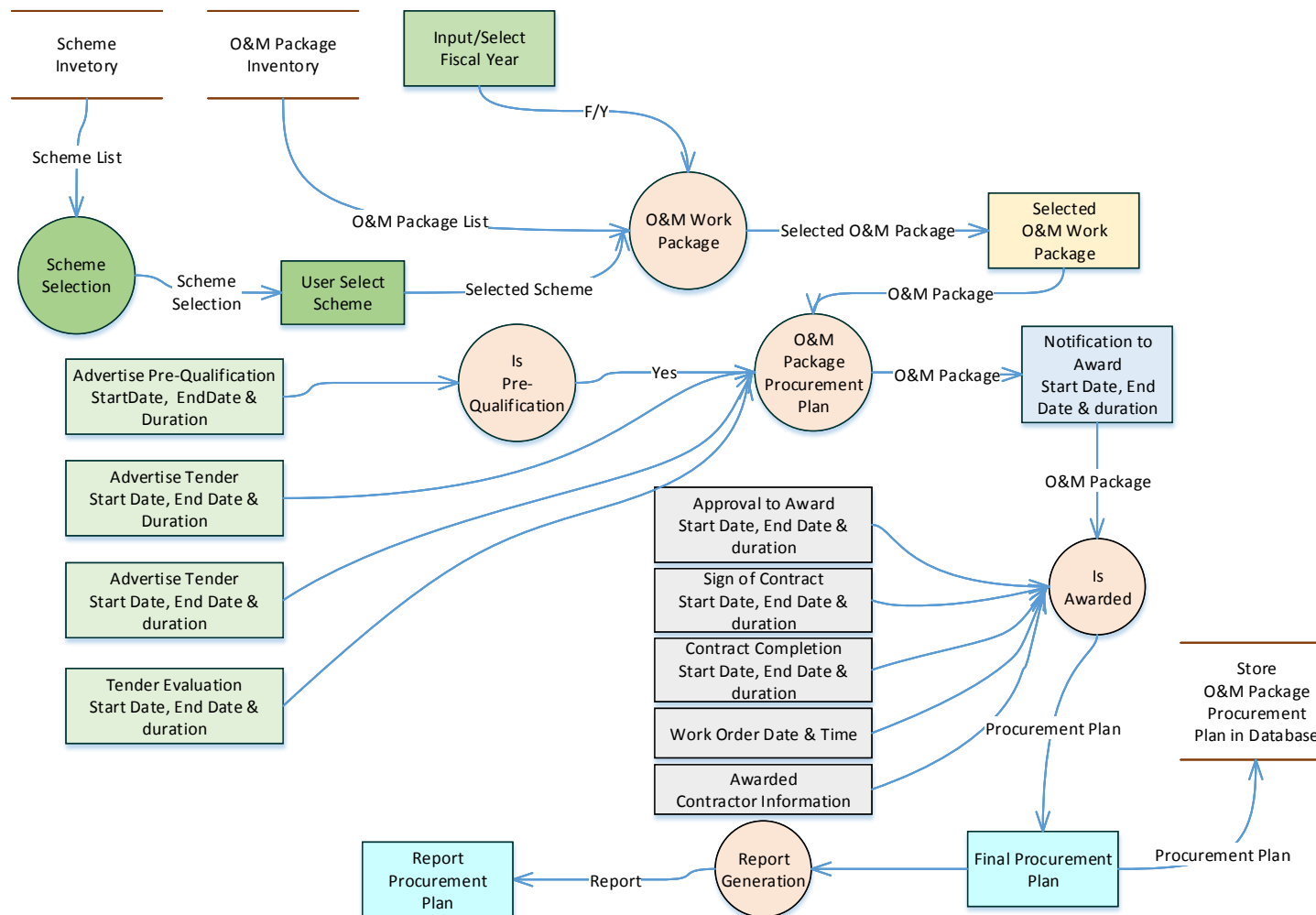
Figure 3-55: Dataflow Diagram for Procurement Plan for O&M Works

Data Flow Diagram for O&M Works Progress Monitoring
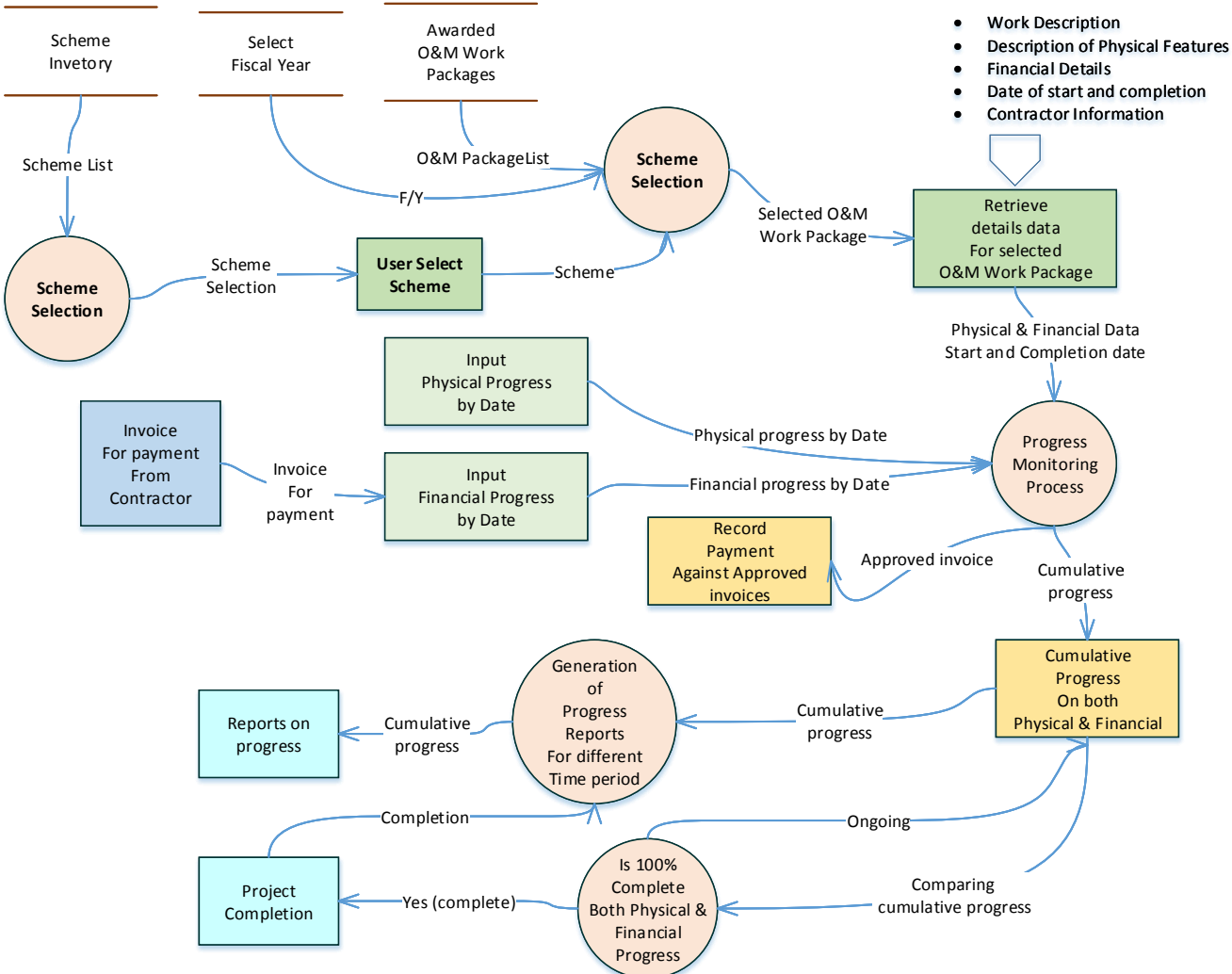
Figure 3-56: Dataflow Diagram of O&M Works Monitoring

3.6.9 DEVELOPMENT OF WMO INFORMATION MODULE

WMO module has been implemented in SiMS-Smart as it is available in the existing SiMS. The updated WMO module in Web stores and maintains the Water Management Organization related information and data such as WMO organization framework, Roles and responsibilities down to the Scheme features levels, WMO status, membership, constitution etc. Information about WMO include:

1. Water Management Group (WMG) at village level

2. Water Management Association (WMA) at polder level

3. Water Management Federation (WMF) at project level

The WMO Module stores following data:

a. Objectives and power of WMO

b. Organization

c. Status

d. Membership

e. Constitution

f. Framework

g. Roles and Responsibilities of members

h. Name of members under different levels of WMO

i. Details of Meetings and Resolution

j. Different types reports can be generated from web based WMO Module

The following Figure 3-57, shows the high-level architecture of WMO module. WMO works under each Schemes/Projects, which may have different types of organization such as WMO Group, WMO Federation and WMO Association. The individual members of the above WMO organizations have been assigned different types responsibilities of protection, conservation and security of Scheme physical features. The WMO also includes the Constitution and regulation information, Meeting records and resolutions, and relationship with BWDB Officials.
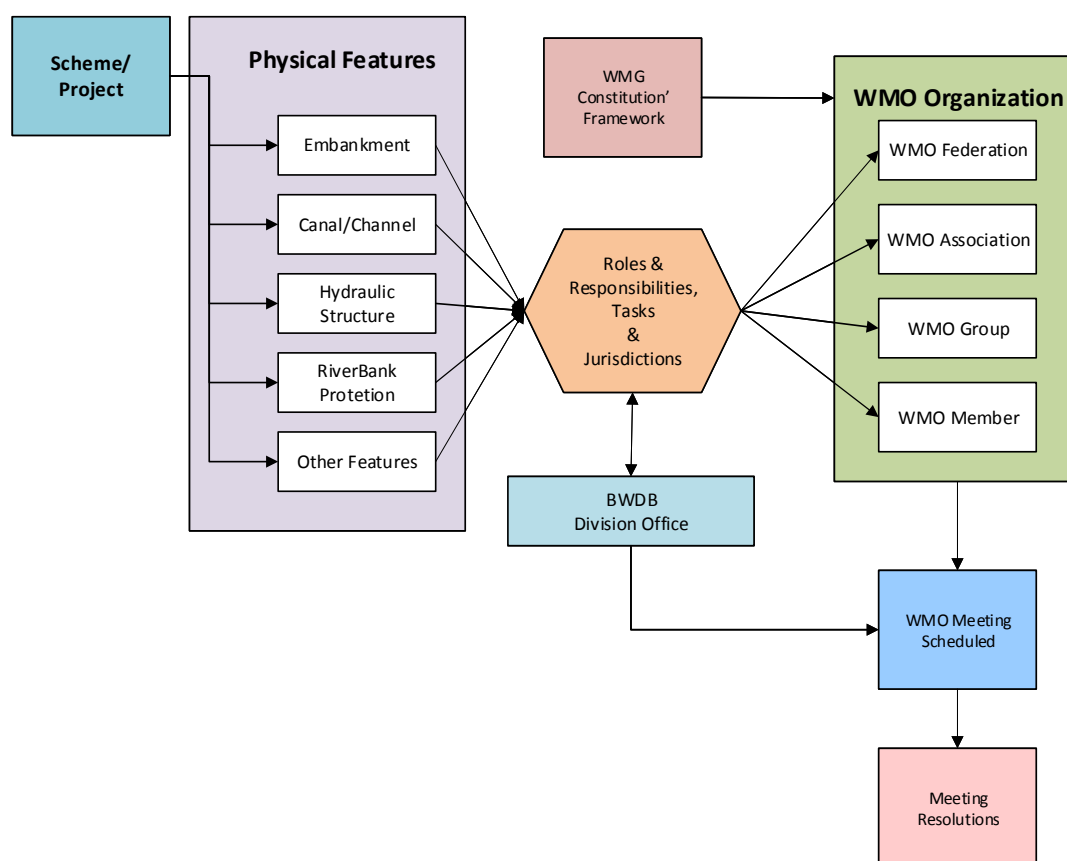
Figure 3-57: Implementation of WMO Module

Following Figure 3-58 shows how to input different type WMO attributes in SiMS database through SiMS-Smart. The attributes of WMO have been categorized by Type and Number of WMO, WMF Information, Area of Operation, Physical Features under WMO and each category include one or more attributes to be entered using this interface. Figure 3-59 includes the information of WMO for each selected Scheme or project, and Figure 3-60 shows the detail information of each member of WMO.

WMO Module : Water Management Organization Information

Zone
26000 (Southeastern Zone - Chittag...)

Circle
26100 (Chittagong O&M Circle)

Division
26110 (Chittagong O&M Division-I)

Scheme
2611001 (Halda Extension Irrigation...)

● Type and Number of WMO
○ WMF Information
○ Area of Operation
○ Physical Feature Under WMO

Save/Update

Name	Existing Value	New Value
Water Management Group(WMG)	2	
Water Management Association (WMA)	1	
Water Management Federation (WMF)	1	

Zone
26000 (Southeastern Zone - Chittag...)

Circle
26100 (Chittagong O&M Circle)

Division
26110 (Chittagong O&M Division-I)

Scheme
2611001 (Halda Extension Irrigation...)

○ Type and Number of WMO
● WMF Information
○ Area of Operation
○ Physical Feature Under WMO

Save/Update

Name	Existing Value	New Value
WMF Name	2	2
Registration No.	2.2	2.2
Registration Date	22/5/2017	22/5/2017

Zone
26000 (Southeastern Zone - Chittag...)

Circle
26100 (Chittagong O&M Circle)

Division
26110 (Chittagong O&M Division-I)

Scheme
2611001 (Halda Extension Irrigation...)

○ Type and Number of WMO
○ WMF Information
● Area of Operation
○ Physical Feature Under WMO

Save/Update

Name	Existing Value	New Value
Number of Village	12	
Number of Union	55	
Number of Pourashava	56	
Population	12	
Number of Agriculture Household	10	
Gross Area	24	
Cultivable Area	22	
Irrigable Area	10	

Zone
26000 (Southeastern Zone - Chittag...)

Circle
26100 (Chittagong O&M Circle)

Division
26110 (Chittagong O&M Division-I)

Scheme
2611001 (Halda Extension Irrigation...)

○ Type and Number of WMO
○ WMF Information
○ Area of Operation
● Physical Feature Under WMO

Save/Update

Name	Existing Value	New Value
Perepheral Embankment	5	
Internal Embankment	12	
Main Khal	15	
Secondary Khal	12	
Tertiary Khal	3	
Drainage Khal	15	
Main Inlet	20	
Other Inlet	3	
Outlet	12	
WCS	14	
Bridge/Culvert	15	

Figure 3-58: Water Management Organization

Water Management Organization Information

Zone	Circle	Division	Scheme
Pick a Zone ▾	Pick a Circle ▾	Pick a Division ▾	Pick a Schemem ▾

WMO Type	WMO Code	Name of WMO	
Pick a WMO Type ▾			**Save**

Code	Name	Scheme
001	Aso-001	2111001 - Water Control Structure at Sheikpara, Bara Rasuipur and Falia
10001	TEST NAME OF FEDERATION	2812011 - Jhony Khal Sub-Project
281211-A01	3 No. SC WMO TEST DATA	2812010 - Patha Khali-Konai Beel Project
555	TEST WMO FOR BWDB	2812013 - Compartmentalization Pilot Project (CPP)
221	31654sfsdfsdfdf	2812011 - Jhony Khal Sub-Project
220	asdfasdfadsf	2611001 - Halda Extension Irrigation Project
2812012	TestWmo	2812013 - Compartmentalization Pilot Project (CPP)

Figure 3-59: Water Management Organization Information

Group Member Information

Zone	Circle	Division	Scheme
26000 (Southeast... ▾	26100 (Chittagon... ▾	26110 (Chittagon... ▾	2611001 (Halda E... ▾

WMO	Member Id	Name	Father's Name
220 (asdfasdfadsf... ▾	1100	Name 1100	Father 1100

Mobile No	Position	Village	Post Office
17722125412222	Pos	vil	po

Division	District	Upazila	Union
Pick a Division ▾	Pick a District ▾	Pick a Upazila ▾	unio

| | | | | | | | | **Save** |

Id	Name	Father's Name	Position	Village	Post Office	Union	Upazila	District	Mobile No	WMO code
1100	Name 1100	Father 1100	Pos	vil	po	unio	201535	2015	17722125412222	220

Figure 3-60: WMO Member Information

3.6.10 SCHEME PERFORMANCE MODULE

A Scheme Performance module has been developed to evaluate the technical, agricultural, socio-economic and environmental performance of scheme based on pre-defined set of key performance indicators. The indicators have been defined according to the performance module of existing SiMS. The key performance parameters of FCD/FCDI and Protective work project have been considered as follows:

A. Technical
   a) Breach of Embankment
   b) Area of Inundation
   c) Area of Water Logging

B. Agriculture
   a) Changing in cropping pattern, cropping intensity, crop yield and crop production
   b) Change in land use pattern
   c) Change in Irrigable Area
   d) Change in Farm Requirement
   e) Change in Farm Requirements
   f) Cost-benefit ratio

C. Socio-Economic
   a) Population Distribution by gender, by age group, by occupation and house holds
   b) Income and Expenditure by house-holds, Poverty and Housing Condition, Land Ownership by house-holds and Labour Wage Rates
   c) Facilities: Drinking water and sanitation, Educational Institutes, NGOs and Communications.

D. Water Resources
   a) Condition of Physical Features (Embankment/Polder, Canal, Hydraulic Structure and Protection Works etc.)
   b) Damage in House/Occupancies, Agricultural Lands, Crops etc.

The performance target can be set against some parameters such as, Irrigable Area, Cropping Insensitivity, Agricultural Production and Annual O&M Costs. After project investment, achievements of selected indicator values need to be entered into this module, so that the performance of the selected scheme/project can be evaluated by the achievements of selected Indicators towards the targets set out before the project investments. The score (points) obtained by each Indicator values can be aggregated by Scheme.

The existing SiMS developed the following Indicators shown in Table 3-9, and Table 3-10 Scoring system for evaluating the performance of Scheme/Project. The web version of this module utilized the same Indicator and scoring system.

Table 3-9: Weights of Performance Indicators

Indicator No.	Performance Indicator	Indicator	Given Weight	Actual Weight
1	Inundation due to breach of embankment	ha	10	
2	Damage to property/asset by floods/ cyclone	Tk	10	
3	Damage to agricultural crops due to floods/cyclone	Tk	10	
4	Increase/decrease of irrigable area	ha	10	
5	Increase/decrease of cropping intensity	%	10	
6	Increase/decrease of agricultural production	M. Ton	10	
7	Increase/decrease of O&M Cost	Taka	10	
8	Attendance of Meeting by WUG	%	10	
		Total:	80	

Table 3-10: Distribution of Scores against each Indicator

Assessment of Weight by Point Scores:

Indicator 1: No inundation = 10, Total inundation= 0, Partial inundation = 5
Indictor 2 & 3: No damage = 10, Complete damage= 0, Partial damage = 5
Indicator 4, 5, 6 & 7: Increase = 10, No increase or decrease= 8, Decrease = 0
Indicator 8: > 80% presence = 10, < 50% presences= 5, 50% - 80% presence = 8

(Source: Existing SiMS Application, 2014)
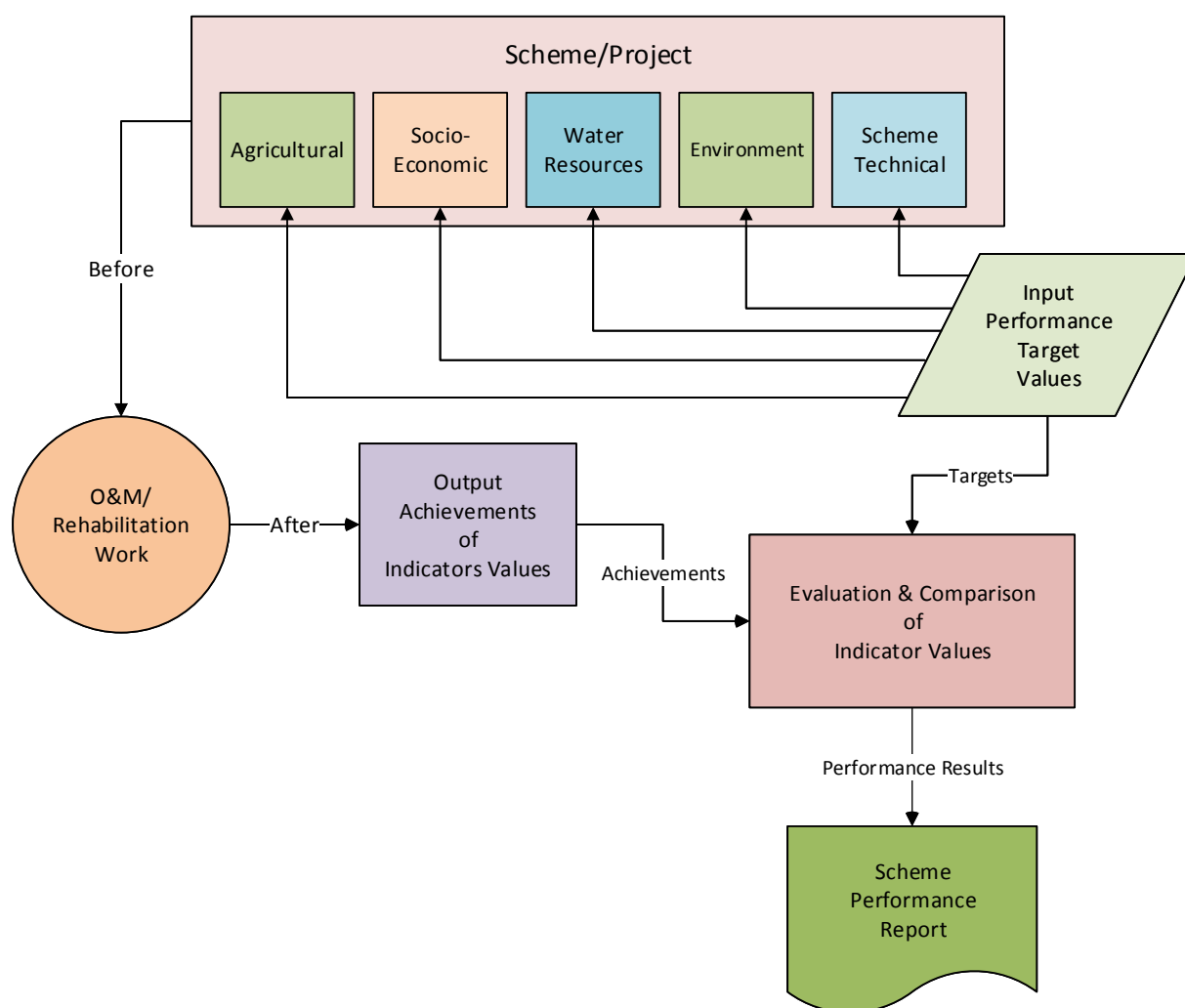
Figure 3-61: Scheme/Project Performance Diagram

The above Figure 3-61 outlines the architecture of scheme performance module, to measure the performance of each Scheme/Project requires various items of Agricultural, Socio-Economic, Water resources, Environmental and Scheme Technical information set out as targets before any investment works and after investment the achievements can be compared using several indicators values as indicated in the above figure.

3.6.11 DOCUMENT ARCHIVE MODULE

A Document Archive Module has been developed and integrated into the SiMS-Smart application. The purpose of this module is to store and maintain all projects related documents such as feasibility reports (Executive Summary), related publications, appraisal reports etc. Documents can be uploaded into the system from user interface. The stored documents can be queried/retrieved and will be displayed within web application. A web interface of Document Archive is shown in Figure 3-62.

Figure 3-62: Document Archive

3.6.12 REPORT MODULE

A web-based Report Module has been developed in this SiMS-Smart Application. The module has been enhanced and upgraded incorporating BWDB Ongoing Projects. The report module generates various types of reports ranging from simple project listing to O&M, ADP Ongoing Projects, Project monitoring Reports on O&M and Ongoing Projects (IMED formats), DPP project Creation, according to BWDB requirements. Several reports are generated from respective modules and tools in the SiMS-Smart application. A user-friendly GUI has been developed, through which the user can generate different types of report based on the selection. A list of reports that can be generated through this module are:

i. List of Completed and On-going Schemes

ii. Office-wise Scheme/Project List

iii. Earthwork Quantity Estimates for Canal and Embankment

iv. Cost Estimates of O&M Works for Embankment, Canal, Dyke, Protection Work and Hydraulic Structures

v. Approved list of O&M and ADP Project works Selection

vi. Procurement Plans for O&M Works

vii. Procurement Plans for Ongoing Project under ADP

viii. O&M Work Progress (BWDB Format)

ix. Ongoing Project Work under ADP in IMED Format

x. Number of Completed Schemes - Type, Zone, Circle and Division wise

etc.

Most of the reports can be generated from respective module levels. Different types of sample reports are included in the Appendix-E, two sample reports are embedded in the following Figure 3-63 and Figure 3-64 for Earthwork Quantity and Cost Estimates.

Embankment Earthworks

Reports on Earthwork Volume and Turfing Area Calculations and Pre and Post Cross Sections for Embankment

Abstract of Earthwork Volume Calculation for CEP Polder 69 (N/E) of CEP Polder 69 (North East) in between 1 Km. to 1.5 Km. based on 2016-17 year survey under Cox's Bazar O&M Division

Earthwork Fill Volume :

Location Chainage (Km)	Fill Area (Sq. Meter)	Mean Fill Area (Sq. Meter)	Section Length (Meter)	Fill Volume (Cubic Meter)
1+000	46.8	0	0	0
1+100	46.8	46.8	100	4680
1+200	46.8	46.8	100	4680
1+300	46.8	46.8	100	4680
1+400	46.8	46.8	100	4680
1+500	46.8	46.8	100	4680
		Total	500	23400

Turfing Area Calculation :

Chainage	Left Turf Length (Meter)	Right Turf Length (Meter)	Total Turf Length (Meter)	Section Length (Meter)	Mean Turfing Area (Sq. Meter)
1+000	0	0	0	0	0
1+100	0	0	0	100	0
1+200	0	0	0	100	0
1+300	0	0	0	100	0
1+400	0	0	0	100	0
1+500	0	0	0	100	0
			Total	500	0

Pre-Section Survey Data :

Chainage (Km)	Centerline (m)	Distance (Meter)	RL (mPWD)
1+000	11	25	1.78
		18	1.79
		35	1.11
		0	2.5
		7	2.7
		9	3.14
		10	3.7
		11	3.65
		12.5	2.98
		14	2.49
1+100	11	0	2.5

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Figure 3-63: Quantity estimate report for Embankment

Embankment Cost Estimation Report

This estimate amounting to Tk. 2522533118.02 (Two Arab Fifty Two Crore Twenty Five Lakh Thirty Three Thousand One Hundreds Eighteen) only has been framed to meet up the probable cost for and Resectioning of Flood Embankment CEP Polder 69 (N/E) of CEP Polder 69 (North East) during 2016-17.

The present condition of the estimated portion of above flood embankment is not in proper section to protect flood, hence the mentioned flood embankment portion is essential to repair. The estimate has been prepared considering the minimum requirement as per budget provision.

The rates of the items have been taken from the current schedule of rate under Coxs Bazar O & M Circle for the year 2016-17.

Abstract cost of Estimate for Resectioning work of CEP Polder 69 (N/E) from Km 0 to Km 2.9 of CEP Polder 69 (North East) under Coxs Bazar O&M Division during the year 2016-17.

Item Code	Description	Quantity	Unit	Rate (Taka)	Costs (Taka)
(1)	(2)	(3)	(4)	(5)	(6)=(3)x(5)
16-120-40	Construction of embankment: 0 to 6m height; 85% compaction.. 0 m to 6 m height & above with 85% compaction. No of Lead(s): 80	135720.00	cum	232.29	2522111904.00
40-110-20	Supply & stacking: sand cement block (6:1) : 30cmx30cmx30cm. block size 30cmx30cmx30cm.	1280.00	each	191.42	245017.60
48-100	Dressing & close turfing : 200mmx200mmx75mm durba sods ..... Fine dressing and close turfing of the slopes and the crest of embankment with 75mm thick, good quality durba or charkanta sods of size 200mm x 200mm, with all leads and lifts, including ramming, watering until the turf grows properly, maintaining etc. complete (measurement will be given on well grown grass only). as per direction of Engineer in charge.	6354.00	sqm	27.73	176196.42
				Total:	2,522,533,118.02

Certified that the estimate has been prepared on the basis of approved design/drawing and examined on the basis of schedule of rates of Coxs Bazar O & M Circle BWDB, Coxs. The items provided are fully appropriate and essentially required, the verified estimated amount of TK. 2522533118.02 (Two Arab Fifty Two Crore Twenty Five Lakh Thirty Three Thousand One Hundreds Eighteen) only is recommended for sanction.

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Figure 3-64: Cost estimate report for Embankment

3.6.13 DEVELOPMENT PROJECT PROFORMA/PROPOSAL (DPP) MODULE

Annual Development Programme (ADP) is a sum of yearly cost development projects, following the approved development Project Proposal. Generally, GoB undertakes two types of development projects: investment projects and technical assistance projects. The first one is called the 'Development Project Proforma (DPP)' and the other is known as the 'Technical Assistance Project Proforma (TAPP)'.

As a water sector, BWDB formulates DPP for new or rehabilitation projects for ADP program. SiMS-Smart includes the formulation of DPP, DPP Project Procurement and Project progress monitoring capabilities. The concepts and knowledge of DPP formulation, Project procurement process and Progress monitoring have been coined from the DPP formulation Guides and Progress monitoring reports using IMED formats. SiMS-Smart includes the capabilities of DPP creation, Defining Project components, Package Development, Procurement Plan and Project Progress Monitoring.

a) DPP Creation

Formulation of DPP includes following items of Data:

- Project Title.

  Basic Information such as Sponsoring Ministry/Division, Implementing Agency, Concerned Sector/Sub-sector of ADP and Concerned Division of Planning Commission.

- Objectives and targets of the project.

- Project implementation period.

  Date of Commencement and the Date of Completion of Project.

- Estimated cost of the project (In Lakh Taka).

- Mode of Financing with sources such a GoB, PA, RPA, Own Fund and others with different modes loan, credit, equity and others and yearly allocations.

- Location of project.

The screenshot of DPP Information is presented in Figure 3-65.

Figure 3-65: DPP Information

b) **Project Components**

SiMS-Smart stores the data items of Revenue Components, Capital Component, and Physical Component with their Economic Code and Sub-Code, Work Items, Quantity and Estimated cost of each selected items are shown in Figure 3-66.

Figure 3-66: Project Component

c) Package Development

SiMS-Smart enables to develop work package and Lot for procuring the selected items of components in DPP. Package development include the Work items of different selected components, quantities of each components, budgets (estimated costs), Contract price if awarded, Tendering Method, Approval Authority and start and completion of work package is shown in Figure 3-67.

Figure 3-67: Package Development

d) **Procurement Plan**

Procurement plan includes the tendering process of the date of Advertisement for Pre-Qualification (if require), date of Advertisement of Tender, date of Tender Opening, date of Tender Evaluation, date of Approval to Award, date of Notification to Award, date of Sign of Contract, Contract Completion date, Contractor details are shown in Figure 3-68.

Figure 3-68: Procurement Plan

e) Project Progress Monitoring

Once the project is awarded, progress monitoring will be reported using IMED progress monitoring reports. SiMS-Smart enables to produce progress monitoring report using various types of reports such as fort-nightly, monthly, quarterly, yearly and project completion using IMED formats. The contents of these reports are the current progress of physical and financial, cumulative progress of physical and financial, project expenditure, and information of fund release from different modes are shown in Figure 3-69.

Figure 3-69: Project Progress and Monitoring

f) Integration of DDP module with IMED

An issue of integration of DPP module of SiMS-Smart application with the PMIS application of IMED has been raised by the Chief Engineer, South-Eastern Zone, Chittagong in the workshop, which has been held at the Chief Engineer office, Chittagong on 18th November 2017. Currently, the BWDB officials are using PMIS application of IMED for formulation of DPP and project progress monitoring.

In this respect IWM team visited IMED on 12th and 13th December 2017 for exploring the possible solution to integrate DPP module of SiMS-Smart with PMIS of IMED. The two systems have been demonstrated by IWM and IMED officials respectively and concluded that DPP modules in two systems are similar and could be integrated. It was also mentioned that if SiMS-Smart provides DPP information in a file or other means, the PMIS of IMED could be populated the DPP

information through uploading the exported file or other means from SiMS-Smart. IMED people mentioned that the integration will possible during the second phase implementation of PMIS application. The IMED is currently providing training to project PDs as one of their tasks in first phase of their project. The integration can be possible following the completion of IMEDs tasks in its first phase. IWM has integrated an "Export to IMED" tool to generate an intermediate file which could be read by IMED application in future. During the "import" module development in IMED application, IWM will provide necessary support.

Figure 3-70: Consultation Meeting with IMED Officials

3.7 Google Earth Platform based Application Development as SiMS-Google

According to the TOR, a Google Earth Platform Based module SiMS-Google should have been developed but it was unfortunate, the Google Earth API has been deprecated by the end of 2016 by Google Earth Authority (https://developers.googe.com/earth-engine/). In place of Google Earth Interface, ESRI online Maps has been integrated with the Web GIS module without any subscription. The valid license users of ArcGIS software can use this facility which is similar to the Google maps. This change was informed in inception phase and agreed by the project technical committee.

3.8 Smart phone application Development as SiMS-Mobile

State of the Art of the modern Smart Phone Technology extends the capability to do the work beyond office and allows organizations to make more accurate, real-time strategic planning and decisions incorporating both field and office environments.

3.8.1 The Mobile Apps

A mobile application has been developed which will be used for field data collection for physical features, such as, design parameters and time-based condition of Embankments, Hydraulic Structures, Canals and Protection Works of BWDB Projects/Schemes. User will be able to collect field data in offline mode. The

collected data from scheme will be stored into the mobile device and could be synchronized with the SiMS-Smart database server when it is in online mode. The collected data will temporarily be stored in the database server which need to be validated by authenticated user (admin) to store permanently into the database. During the data collection session, real-time photographs and videos of features, date and time, and the geographic location where data collection has been done will be captured and stored.

This mobile application could be installed on smart phones and tablets and will run when registered through SiMS-Smart. A conceptual architecture diagram of this module is shown in Figure 3-71
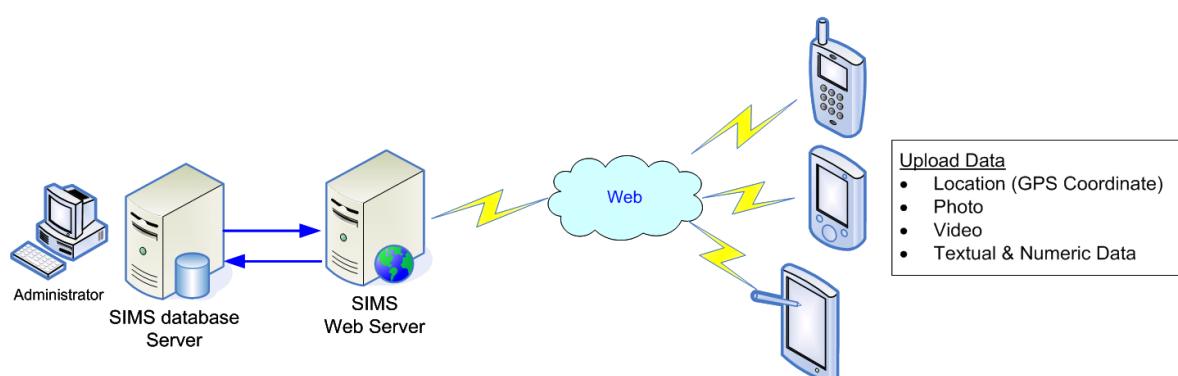
Figure 3-71: Conceptual Architecture of Mobile Apps

The developed mobile application has several screens for collection of design and condition data for hydraulic structures, embankment, canal and protective works. The application maintains a SQLite database inside the device storage to store the collected information. A snapshot in Figure 3-72 of SiMS-Mobile is presented in below.
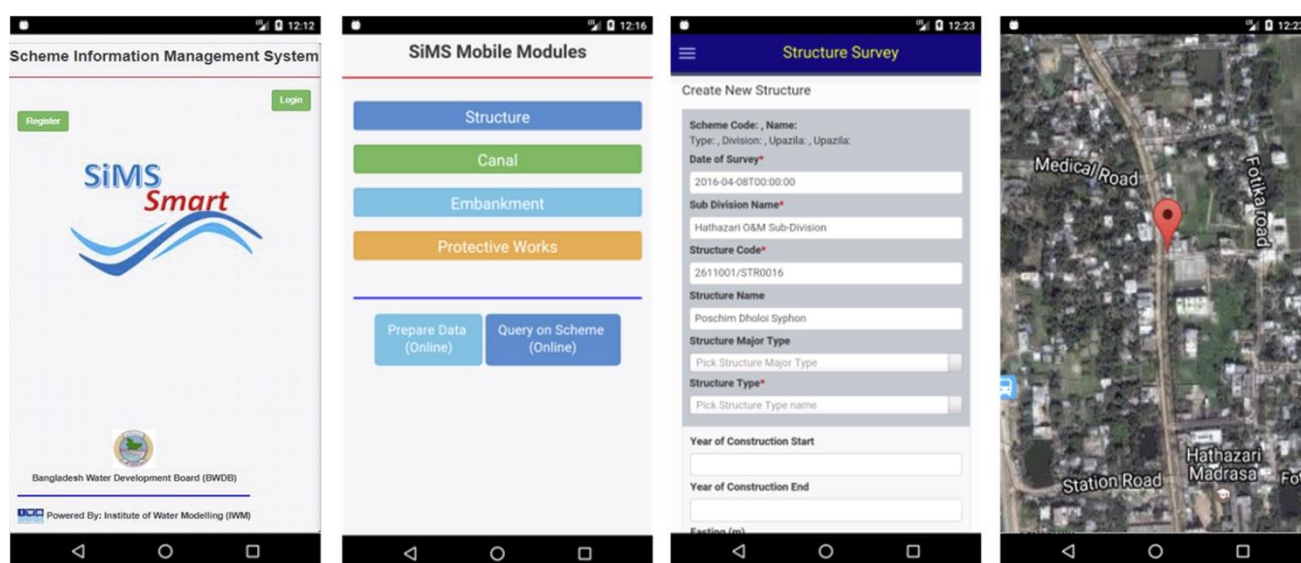
Figure 3-72: Field Data Collection Using Smart Mobile Phone

3.9   REAL TIME PROJECT MONITORING

For real time monitoring using IP-Camera was selected for six locations in the contract. As an example, a snapshot of the IP-Camera based remote view is presented in Figure 3-73.
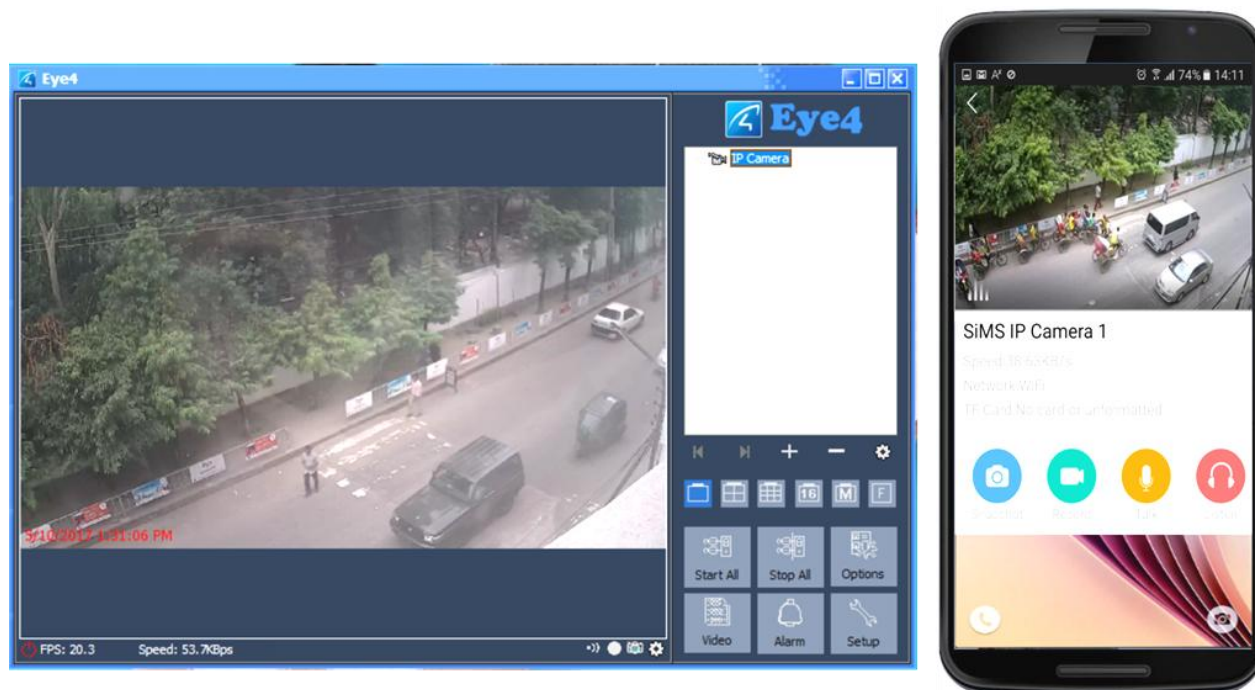
Figure 3-73: IP-Camera example for real-time monitoring

Now-a-days, the hi-end IP-Camera comes with its own application for both desktop and as Mobile Apps. Those are easily installable and useable. Six IP-Camera have been procured and have installed on different selected locations in the South-Eastern Zone. These installation locations have been chosen by the respective BWDB divisional engineers. The relevant software has also been installed in the PC/Laptop/Mobiles of the respective BWDB offices. The installed locations are:

1. Pump Station of Halda Extension Project at Sattarghat under Chittagong O&M Division-I
2. Pump Station of Ichamati Unit of KIP at Rangunia under Rangamati O&M Division
3. Palakata Rubber Dam under Cox's Bazar Sub-Division, Cox's Bazar O&M Division
4. Buggujra Rubber Dam under Cox's Bazar Sub-Division, Cox's Bazar O&M Division and
5. Pekua Rubber Dam under Bandarban Sub-Division, Cox' Bazar O&M Division
6. Dormitory at Nilakkhirchar under the project "BEZA Flood Control Road-cum-Embankment protection & Drainage", Mirsharai Upazila under Sitakunda Sub-Division, under Chittagong O&M Division-II.

Locations of installed IP Camera with site environment are shown in the following Figures:

1. IP Camera Site:　　　　Pump Station of Halda Extension Project at Sattarghat under Chittagong O&M Division-I
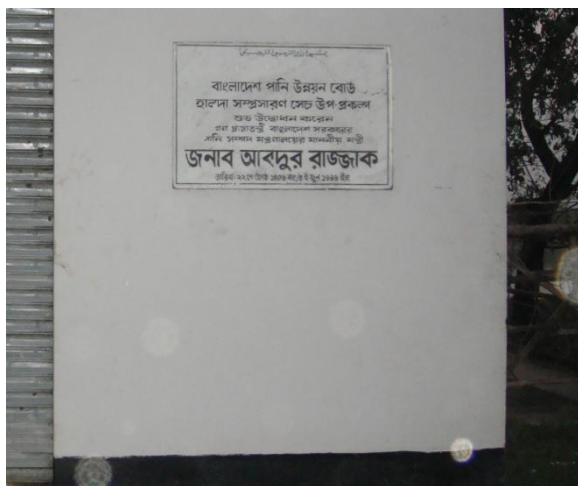
Photograph - 1

Photograph - 2

Photograph - 3

2. IP Camera Site:　　　　Pump Station of Ichamati Unit of KIP at Rangunia under Rangamati O&M Division

Photograph - 1

Photograph - 2

Photograph - 3

3. IP Camera Site:	Palakata Rubber Dam under Cox's Bazar Sub-Division, Cox's Bazar O&M Division	
Photograph - 1	Photograph - 2	Photograph - 3

4. IP Camera Site:	Buggujra Rubber Dam under Cox's Bazar Sub-Division, Cox's Bazar O&M Division	
Photograph - 1	Photograph - 2	Photograph - 3

5. IP Camera Site: Pekua Rubber Dam under Bandarban Sub-Division, Cox' Bazar O&M Division

| Photograph - 1 | Photograph - 2 | Photograph - 3 |

6. IP Camera Site: Dormitory at Nilakkhirchar under the project "BEZA Flood Control Road-cum-Embankment protection & Drainage", Mirsharai under Sitakunda Sub-Division, Chittagong O&M Division-2

| Photograph - 1 | Photograph - 2 | Photograph - 3 |

The IP-Camera requires higher band width to transmit the video data over the net. But practically almost in all the cases the schemes are apart from the urban area where internet/ speed is low. Hence, as a alternative, Skype video communication for real time monitoring has been integrated into the SiMS-Smart. This option has free mobility and is more versatile than the fixed IP-Camera system, which is costlier and requires extra physical installation arrangement, security and cares.

The Skype based video communication is free for SiMS-Smart to smart mobile phone when it is connected to internet. A snapshot of Skype based monitoring of a sluice is presented in below. A demonstration using the Skype option from SiMS-Smart was presented to the Honorable Water Minister and the Secretary on 8 August 2016 in IWM conference room.

Figure 3-74: Real Time monitoring using integrated Skype

3.10 FLOOD FORECASTING AND WARNING SUB-SYSTEM DEVELOPMENT

Flood Forecasting and Warning Center (FFWC) of BWDB are disseminating the forecasted and observed water levels in their gauges on rivers through their website. A display module has been developed showing FFWC's Forecast/Observed water level of connected nearest FFWC Gauge Station of Embankment or Structure along with the distance between Scheme Structure/embankment and Gauge Station. Design Level of Embankment/ Structure is also shown to realize the status of threat for corresponding embankment or structure during flood season. Using this information, the BWDB field officials will be able to make precautionary arrangement to protect embankment and assets; and similarly, the scheme inhabitants can take care of their assets and lives.

In SiMS-Smart database a data table has been devised having scheme id, nearest connected FFWC gauge id, danger level, embankment crest elevation, maximum highest water level, average ground elevation of the scheme, distance from scheme to nearest FFWC gauge, latest FFWC water level for each scheme. The SiMS-Smart application reads the FFWC data and stores into this table. With all these information, this module generates a graphical output as shown in Figure 3-75. The upper part of the figure shows the chart produced by FFWC which is directly pulled from their website, and the lower figure shows the generated protection level of scheme either by embankment crest level or level of deck of sluice/regulator. The blue line in lower part of the Figure 3-75 shows the latest water level at the FFWC gauge. This module read the latest observed water level and forecasted water level from FFWC database through a service.
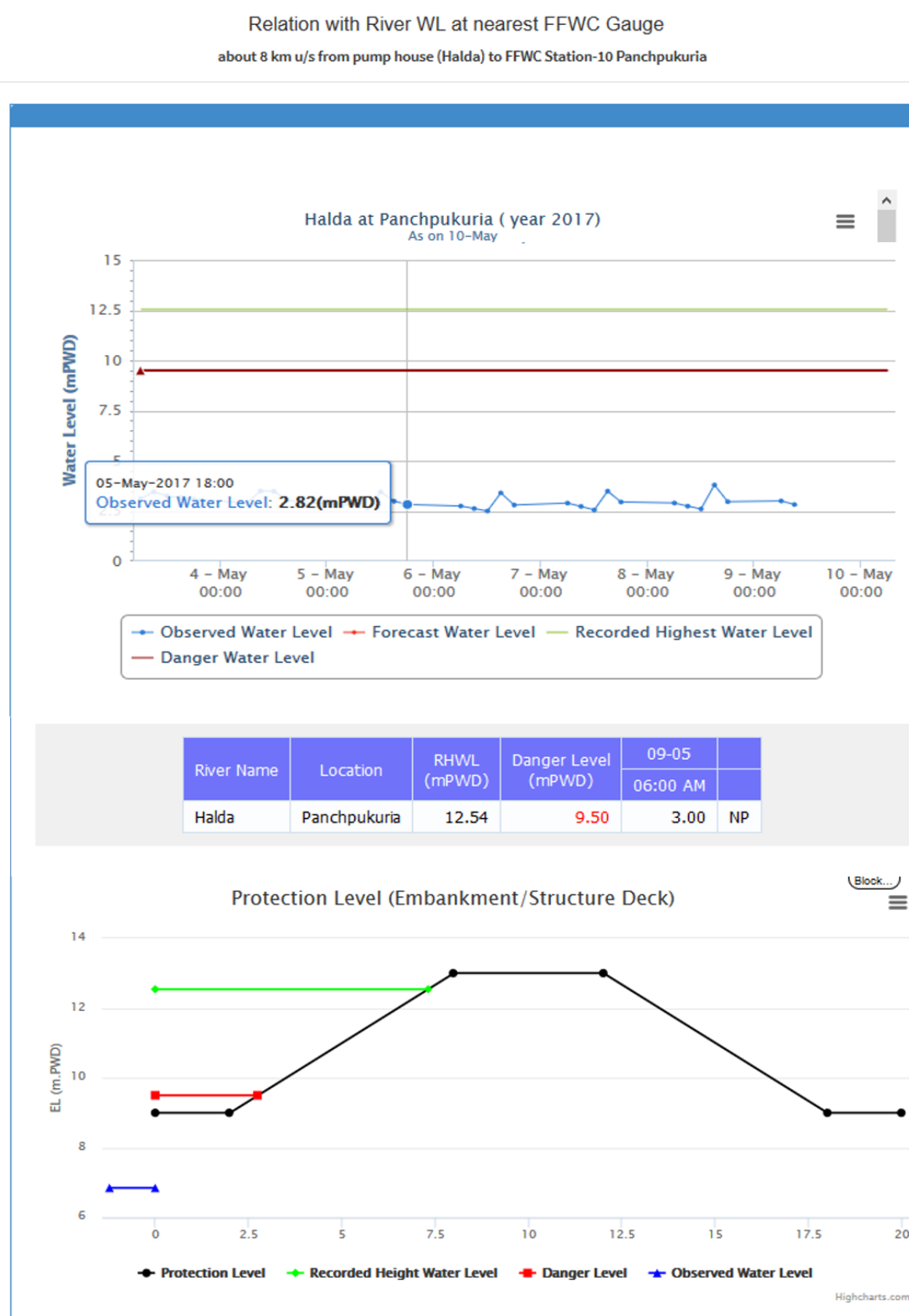
Figure 3-75: Flood Forecasting Water Level relation with Scheme protection level

3.11 INTEGRATION OF AUTO GAUGE WATER LEVEL

A number of auto gauge has been installed by Hydrology, BWDB where water levels are collected continuously and stored in a database in BWDB's Hycos Server. An API has been developed and hosted in this server located on http://www.hhycos.bwdb.gov.bd: 8099 to read (read-only) water level data in SiMS-Smart as shown in Figure 3-76. This will help to know real-time water level chart in any of those stations, especially during flood and cyclone.
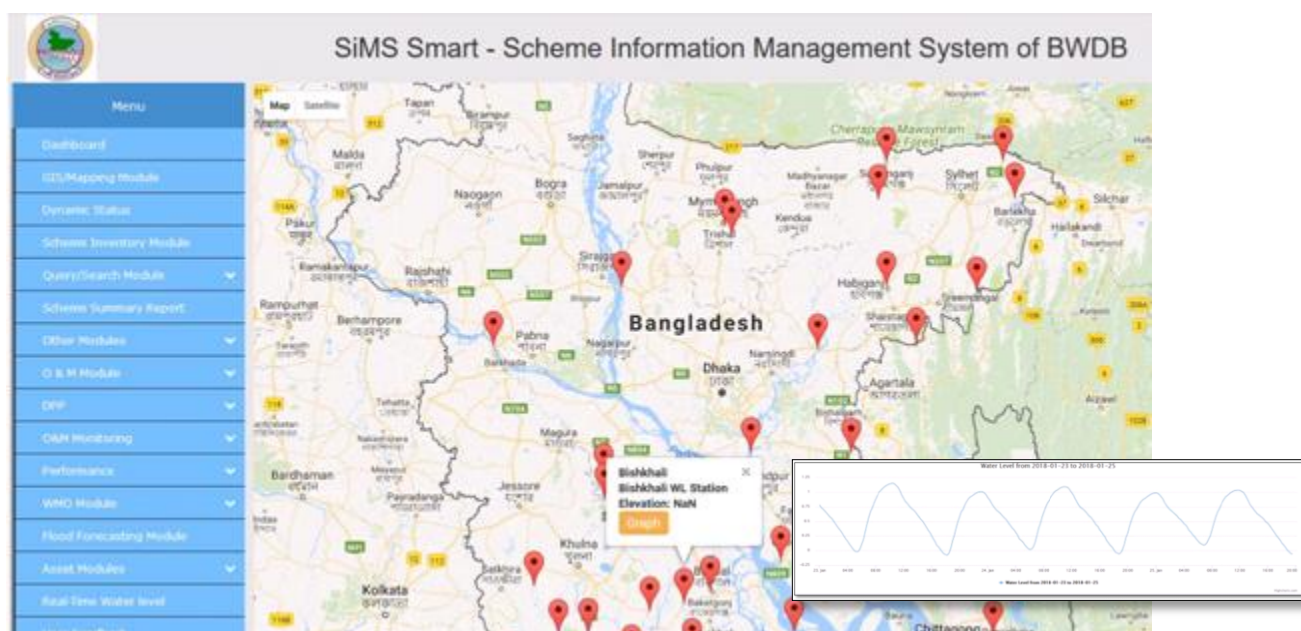
Figure 3-76 :Integration of FFWC auto gauge river water level

3.12   ASSET INFORMATION MANAGEMENT SYSTEM (AIMS)

The Asset Information & Management System (AIMS) will ensure the achievement of the utmost benefit from the resource invested against fixed and moveable assets of BWDB.

The BWDB has various kinds of assets for different type of works. Each year a significant amount of money is spent to procure and maintain the assets. This development considered only **three sub-modules:**

- Key Asset Information Module
- Cadastral/land Information Module
- Instrument & Vehicle Management Module

Data availability and access was found as a big hindering issue for BWDB assets. Specially the information of BWDB land was complicated at its own nature on top of its availability and access. IWM team targeted a sample area for development of each of three modules. The most of the data were collected from Chittagong O&M office.

3.12.1 KEY ASSET INFORMATION MODULE

A module in SiMS-Smart has been developed for BWDB Key Assets which include data/information of BWDB office and Residential buildings, officers and Staffs with asset allotments, and other necessary assets such as house-keeping appliances, electric and electronic appliances, office furniture, Gas and Electric meters, connecting wire and cables, pipes, Masonry items, machinery tools and accessories etc.

The Inventory of Building (Office and Residential) includes the following data items:

- Building Identifier Code
- Responsible Office
- Project Office with Project name
- Building Name
- Number of Story
- Build up Area
- Building Type (Pucca/Semi-Pucca/Tin-Shed/Semi-Tin-Shed)
- Status (abandoned/in use)
- Type of use
- Land Quantity
- Khatian No
- Dag No
- Mouza
- Year of Construction
- Construction cost with Land
- Depreciation Value
- Current Use
- BWDB Section Office
- BWDB Sub-Division
- BWDB Division
- Upazila
- District
- Last Update
- Update by
- Remarks
  etc

The SiMS-Smart Key Asset (Office Building) Interface is shown in the following Figure 3-77.

Figure 3-77: Key Asset Information - Office Buildings

The Inventory of Other Key Assets includes the following data items:

- Asset Identifier Code
- Responsible Office
- Project Office with Project name
- Description of Asset
- Unit (number/each/item/meter/Piece)
- Quantity in Number
- Asset Type

- Asset Location (where is the asset located)
- Current Condition (good/poor/bad)
- Status (abandoned/in Use)
- Name of the Section BWDB office
- Name of BWDB Sub-Division
- Name of BWDB Division
- Remarks
  etc.

The SiMS-Smart Other Asset Interface are shown in the following Figure 3-78 & Figure 3-79.

Figure 3-78: Other Assets Interface

Other Asset

Office	Asset Type	Asset Head	Document
26001 (Chittagong O&M Circle)	Residencial Building	3001 (Residencial Building)	Inventory of Assets - (2015)

Asset Information   Search

Sl No.	Name of Colony	Location	Residential Building Type	Residential Building Area	Construction Year	User Name & Designation	Unused Home Type	Unused Home Area	Rentable Room Type	Rentable Room Area	Current Status	Other Information	Comments
6	cox's bazar por coloney	Cox's Bazar Pouroshova	২য় তলা পাকা ভবন (ব্যারাক)	3092	১৯৬৬-৬৭	১। খালী আছে।	-	-	-	-	-	-	-
6	cox's bazar por coloney	Cox's Bazar Pouroshova	২য় তলা পাকা ভবন (ব্যারাক)	3092	১৯৬৬-৬৭	২। আবুতাহের এম.এল.এস.এস।	-	-	-	-	-	-	-
6	cox's bazar por coloney	Cox's Bazar Pouroshova	২য় তলা পাকা ভবন (ব্যারাক)	3092	১৯৬৬-৬৭	৩। ওরাজি উল্লাহ এম.এল.এস.এস।	-	-	-	-	-	-	-
6	cox's bazar por coloney	Cox's Bazar Pouroshova	২য় তলা পাকা ভবন (ব্যারাক)	3092	১৯৬৬-৬৭	৪। বুধু মিয়া, চৌকিদার।	-	-	-	-	-	-	-
6	cox's bazar por coloney	Cox's Bazar Pouroshova	২য় তলা পাকা ভবন (ব্যারাক)	3092	১৯৬৬-৬৭	১। মোঃ ছাইদুর রহমান এম.এল.এস.এস	-	-	-	-	-	-	-
6	cox's bazar por coloney	Cox's Bazar Pouroshova	২য় তলা পাকা ভবন (ব্যারাক)	3092	১৯৬৬-৬৭	২। নাছিরুল হক এম.এল.এস.এস।	-	-	-	-	-	-	-
6	cox's bazar por coloney	Cox's Bazar Pouroshova	২য় তলা পাকা ভবন (ব্যারাক)	3092	১৯৬৬-৬৭	৩। মোস্তফা মোল্লা ইলেট্রিশিয়ান।	-	-	-	-	-	-	-
6	cox's bazar por coloney	Cox's Bazar Pouroshova	২য় তলা পাকা ভবন (ব্যারাক)	3092	১৯৬৬-৬৭	৪। হাফেজ মোঃ ফরিদুল আলম ইমাম	-	-	-	-	-	-	-
7	cox's bazar por coloney	Cox's Bazar Pouroshova	আধা পাকা টিনশেড		1994	১। সিবিএ অফিস	-	-	-	-	-	বাসাটি মেরামত প্রয়োজন।
7	cox's bazar por coloney	Cox's Bazar Pouroshova	আধা পাকা টিনশেড		1994	২। সিবিএ অফিস	-	-	-	-	-	-
7	cox's bazar	Cox's Bazar	আধা পাকা		1994							

Figure 3-79: Key Asset Information - Residential Building

3.12.2 CADASTRAL/LAND INFORMATION MODULE

SiMS-Smart database can store and manage BWDB land information/data of all types of acquired and Khas lands on which different types of BWDB establishments such as office buildings, residential buildings, physical features like Embankments, Canals, Hydraulic Structures, Protection Works etc. are situated. A Land database has been developed with the key information such as LA Case Number, Plot Number, Project name, Mouza, JL Number, Khatian number, dag number, CS/RS/BS number, CS/RS/BS Quantity, porcha number, porcha record quantity, quantity of acquired land, estimated amount, paid amount, not recorded quantity, cause of not recorded quantity, steps of recovery, used quantity, unused quantity, TAX status, erosion quantity, sub division, division, circle, zone, upazila, district etc.. It also covers plot information such as acquired tenancy quantity, khas quantity, own quantity, tafsil quantity, affected land quantity, current occupants, land class remarks, etc. Land information has been kept in Oracle Database.

The obtained land information are stored into the tables after digitalization, and the Mouza maps have been converted into GIS system. As reference of original, the PDF files have also been archived which could be retrieved from this module.

BWDB Land information can be accessed from the developed module into the Asset Information System. The GIS interface gives the facilities of interactive access to this land information. Figure 3-80 shows the snapshot of the Land Information module which displayed the interactive retrieval of LA Case information in Patenga (Polder 62).
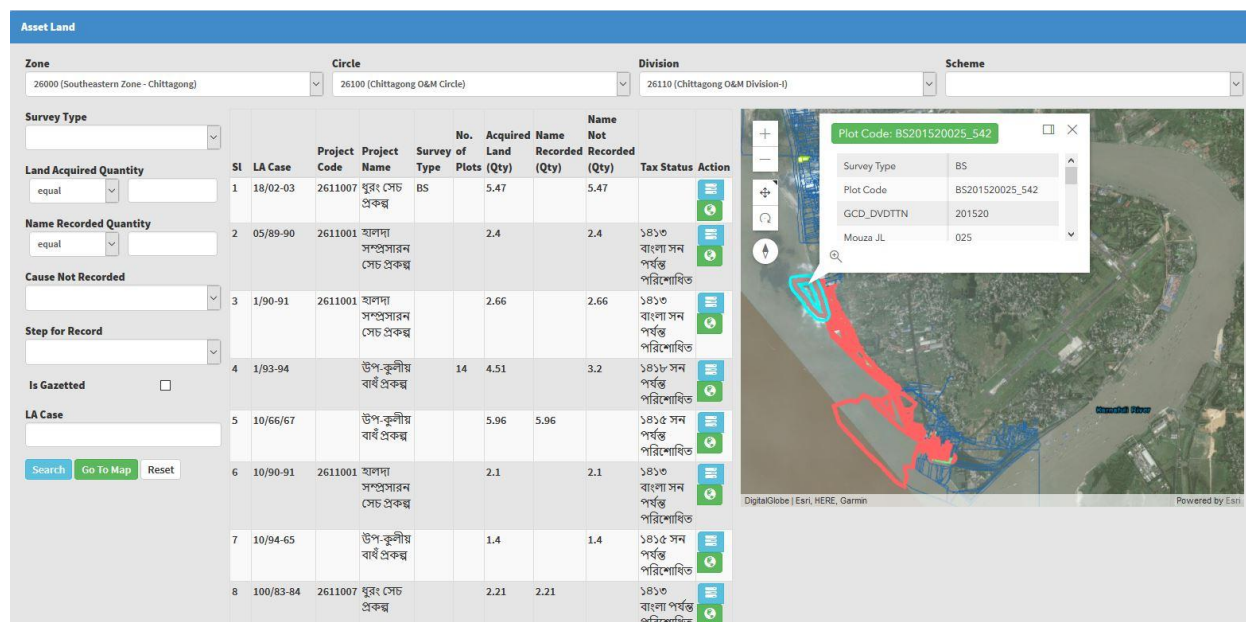

Figure 3-80: LA Case Information

Figure 3-81: Plot Information

Coding for Land Information System

Acquired Plot of BWDB for the pilot area according to different LA case has been tabulated as a database from the collected different possession paper by following structure is shown in Figure 3-82.

PLOTCODE	DISTGEOCODE	THNGEOCODE	SCHEMECODE	SCHEMENAME	LA_CASE_NUM	SURVEYTYPE	THANANAME	MOUZA_JL	MOUZANAME	MOUZA_SHT	ACQ_PLOTS	ACQ_TYPE	ACQ_AREA_ACRE	TOT_AREA_ACRE	PLOT_TYPE	KHATIAN
BS1520024_422	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	422	Partial				
BS1520024_424	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	424	Partial				
BS1520024_425	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	425	Partial				
BS1520024_426	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	426	Partial				
BS1520024_429	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	429	Partial				
BS1520024_430	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	430	Partial				
BS1520024_431	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	431	Partial				
BS1520024_432	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	432	Partial				
BS1520024_433	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	433	Partial				
BS1520024_434	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	434	Partial				
BS1520024_435	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	435	Partial				
BS1520024_436	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	436	Partial				
BS1520024_437	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	437	Partial				
BS1520024_438	15	20	2611006	Polder 62	001/1993-94	BS	Bandar	024	Uttar Patenga	03	438	Partial				
BS1520024_3	15	20	2611006	Polder 62	007/1994-95	BS	Bandar	024	Uttar Patenga	01	3	Partial	0.900			1
BS1520024_301	15	20	2611006	Polder 62	007/1994-95	BS	Bandar	024	Uttar Patenga	02	301	Partial				2051
BS1520024_305	15	20	2611006	Polder 62	007/1994-95	BS	Bandar	024	Uttar Patenga	02	305	Partial				2051
BS1520024_402	15	20	2611006	Polder 62	007/1994-95	BS	Bandar	024	Uttar Patenga	03	402	Partial	0.760			1833
BS1520024_3002	15	20	2611006	Polder 62	007/1994-95	BS	Bandar	024	Uttar Patenga	04	3002	Partial	0.450			93
BS1520024_3004	15	20	2611006	Polder 62	007/1994-95	BS	Bandar	024	Uttar Patenga	04	3004	Partial	0.050			749
BS1520024_3005	15	20	2611006	Polder 62	007/1994-95	BS	Bandar	024	Uttar Patenga	04	3005	Partial	0.020			1113

Plot or Dag Number (This can be up to 5 digits)

Figure 3-82: Sample of LA Case Database

"**PLOTCODE**" is the common primary field which is used for join and link between secondary LA case database and Mouza GIS shapefile. This code has been developed under this project for unique identification of a plot in the context of Bangladesh with following characteristics:

It is essential to understand the Mouza and its identification in the land system of Bangladesh. Following snapshot Figure 3-83, describe the unique identification of a Mouza including its plot's number:

Survey duration/ time and it denote type of survey like CS/RS/BS etc.

Mouza Sheet Number

Mouza's JL Number, this number also refers to Mouza name under that survey time. This JL is **not equal to BBS's Geocode number.**
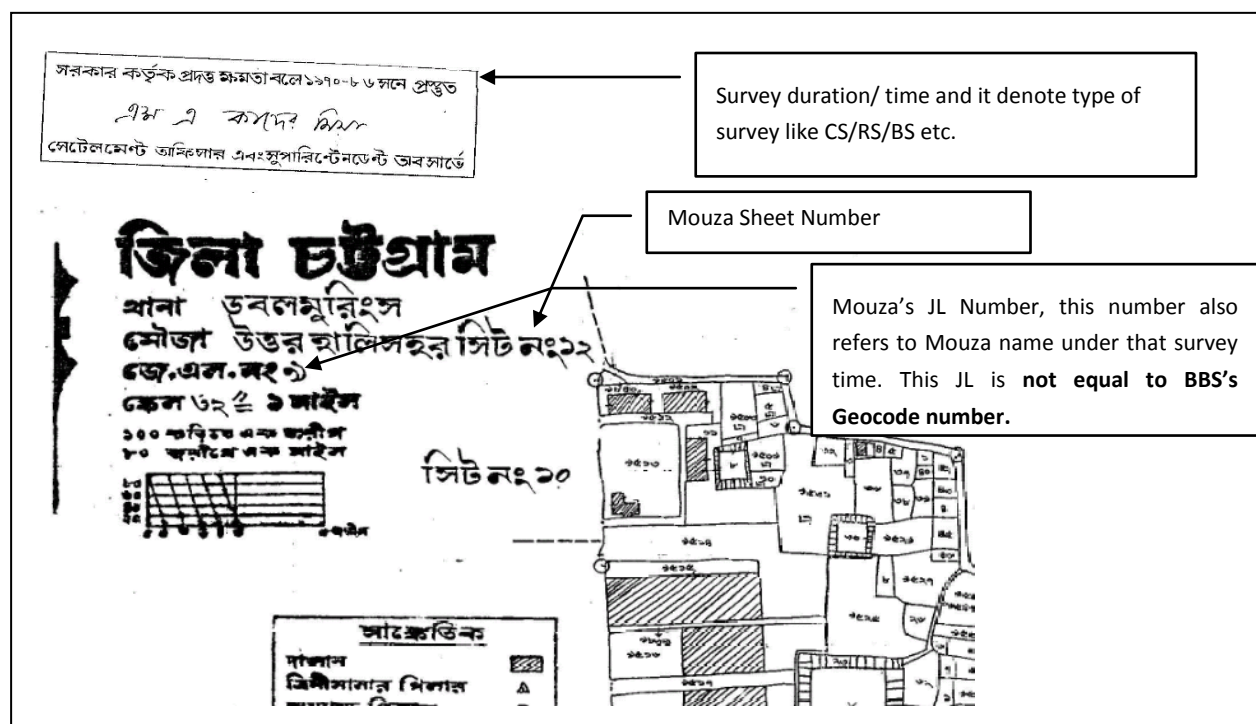
Figure 3-83: Mouza sheet and its characteristics

According to above nomenclature of a Mouza sheet, it is recommended to add Geocode value (developed by BBS, GoB) of District & Thana/ Upazila before Mouza's own identity code. In CS (Cadastral

Survey, begin from 1888) there were some different administrative jurisdictions like Tripura District (now under India), Porgona under Thana, etc. In that case Geocode will not applicable. Those cases might be treated with alphabet character code, which represents the name of District or Porgona instead of recent Geocode number. Referring to the above aspects, plot code has been recommended in following format.

A	A	B	B	C	C	D	D	D	_	E	E	E	E	E

Sample of PLOTCODE: **BS1502023_20422** where 15 (fifteen) digit has to be used to preserve its unique nature in the context of whole Bangladesh.

Description of PLOTCODE: 1st and 2nd digits (**AA**) are using for identity of Survey time of Mouza. It can be

> **CS** (Cadastral Survey, 1888-1940);
>
> **RS** (Revised Survey, 1933-1952, only for Chittagong, Faridpur & Bakerganj Dist);
>
> **SA** (Settlement Acquisition survey, 1956-1962)
>
> **PS** (Pakistan Survey, some where it was used in the LA case paper),
>
> **BS** (Bangladesh Survey, 1990-till now),
>
> **MS** (Mahanagar Survey),
>
> **DC** (Dhaka City Jorif, 1996-2010),
>
> **Etc.**

3rd and 4th digits (**BB**) are using for District Name (Geocode from BBS);

5th and 6th digits (**CC**) using for Thana/ Upazila Name (Geocode from BBS);

7th to 9th digits (**DDD**) are using for Mouza JL (Jurisdiction List) number;

10th (one) digit as "**_**" is using for separator as distinct identification of plot/dag number;

11th to 15th 5 digits (**EEEEE**) are using for plot/dag number of the Mouza sheet.

3.12.3 INSTRUMENT AND VEHICLE MANAGEMENT MODULE

Some information for instrument and vehicle are obtained from Chittagong O&M Division-II office in hardcopy sheets. Those have been analyzed and tabulated in organized manner into the SiMS-Smart Database. The snapshot of the data structure is presented below in Figure 3-84.
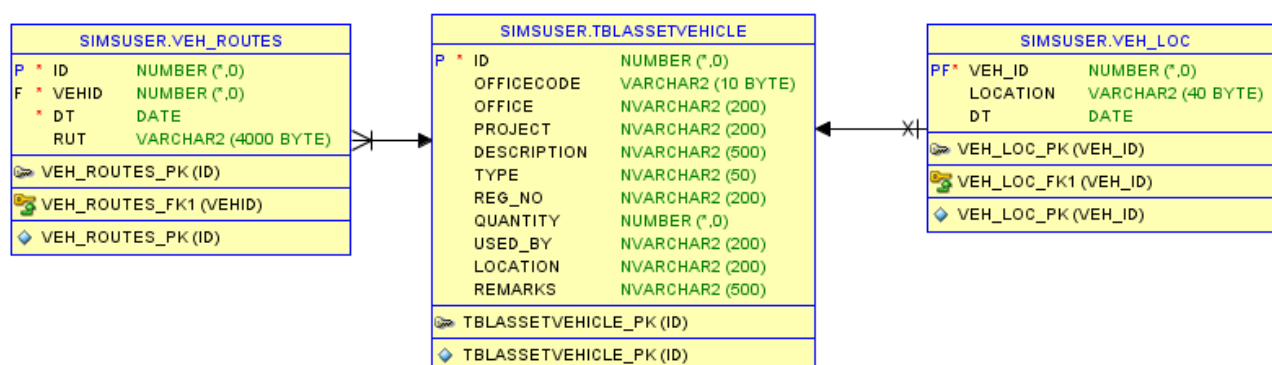
Figure 3-84: Tables for vehicle and tracking history

3.12.3.1 VEHICLE TRACKING

Mobile Providers are providing the variety of services to users. Vehicle tracking is done using a device called "vehicle tracker". The device consists GPS and SIM card and takes geo location (latitude and longitude) and transmits that to the requester application either at a predefined interval or in response to an SMS. The recipient application plots the location in GIS map/Google maps at user end.

Under this project no budget for Vehicle Tracking device was allocated. Hence an application has been developed and integrated into the SiMS-Smart to track any device having GPS and SIM card that transmits the location. It could be mobile phone, laptop, or vehicle tracking device. A module developed under this project could be installed in a smart phone and that can mimic as a vehicle tracker device which could be tracked from SiMS-Smart application using the received location data. The location will be displayed on web GIS map dynamically. All the locations will be stored into a separate table to preserve the traveled routes and times.

A snapshot of the operation of this module is presented in Figure 3-85.
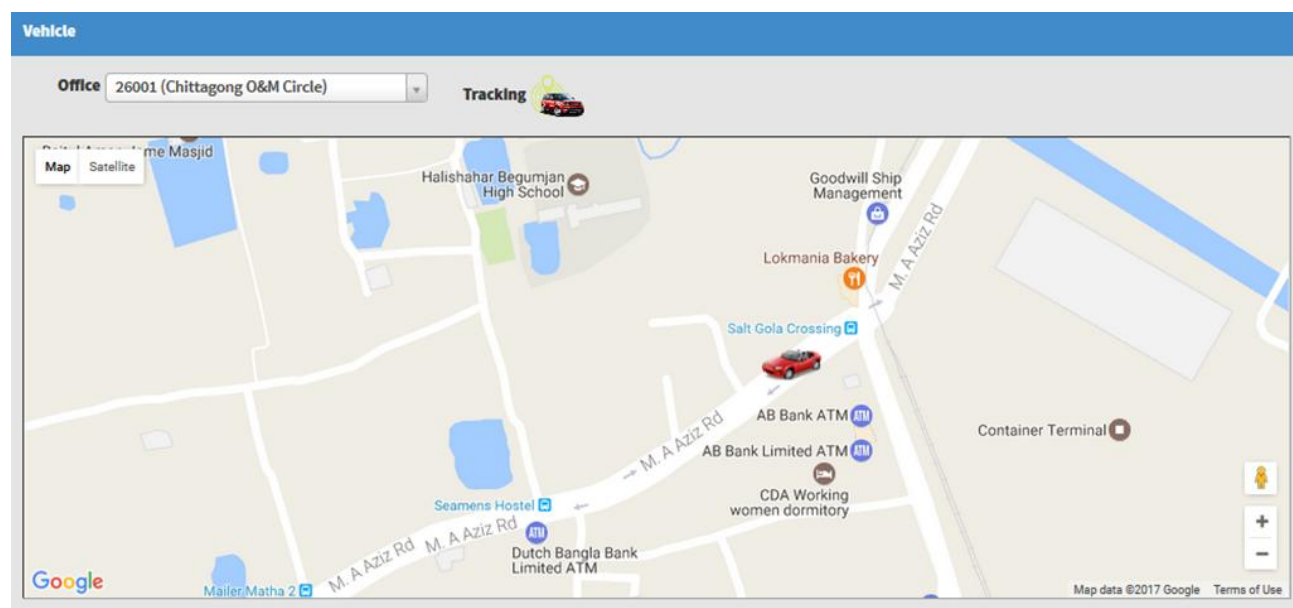
Figure 3-85: SiMS-Smart Vehicle Tracking module

3.13 DEVELOPMENT OF SYSTEM SECURITY MODULE

The security system is a very important module in multiuser and sensitive data oriented application. SiMS-Smart application is intended to be used by BWDB officials at various levels for information view, edit and adding. Lower level officials will update the data while the higher levels will usually query and view information at different summarized levels. But, there will requirement of some updating and adding data in higher levels also. The rights and authorities of changing the data must have been respected in the system to make the SiMS Database reliable and useful. Considering these issues, role-based security system has been applied in SiMS-Smart application. This security system is integrated with the all modules of the system. The security modules will manage the user access privilege to other modules of the System.

System administrator will be capable to maintain the security module. System administrator will create users, role and grant or revoke access privilege to the users. User menu privileges and user activity (add/ edit /delete/ cancel/ print) will be managed by this module.

The roles are defined in a hierarchical sequence. If superior user approved any process, then subordinate role based user will be unable to change that. Other hand superior role based user will be able to change information of roles finalized and process or approved by the subordinate.

Security modules will manage the following features:

- User will get the information about all the modules and sub modules of the system.
- User can easily manage various role's information by creating a new role, assigning multiple users to that role and also by assigning sets of permission to that role.
- User can also manage the user's information of this system by changing their status, resetting the current password and assigning a new role.

This system has some major user roles namely System Administrator, Super User, Data Entry Operator, Visitor etc. These user groups have different access permission as per the access privileges and can perform different activities. These roles are assigned against different users from the security module as shown in Table 3-11.

Table 3-11: User role categories

User ROLES	Activities
System Administrator	Will act as a super admin of the system. Has access in every part of the system. Administrator has access to perform any task related with this system.

User ROLES	Activities
Super User	Will perform every task which is relevant with subordinates role.
Data Entry Operator	Will perform every relevant task with extra temporarily defined task.
Visitor	Will perform every relevant task with extra temporarily defined task.

The main login page requires a user and a password as shown in Figure 3-86.

Figure 3-86: Login page

The internal table and process identifies the role of the user who logged-in. If the user is Security Administrator he will be able to navigate to the User Admin page with capabilities creating, deleting, role assigning functionalities.

The Security Administrator will be able to create a list of Employees of BWDB who will be using the SiMS Application, and set of roles. After that he will be able to make Users from the employees and assign roles.

The privileges in the roles are to be maintained in hierarchical order as per the real life authorities of BWDB officials from SDE →XEN→SE→CE→ADG→DG and so on. Once the data update by the lower official is approved by the superior, it shall not be possible to edit any further by the subordinates. This will be implemented during the operation of SiMS-Smart as per decision of the concerned official. The Role and permission, and User creation has been shown in Figure 3-87 and in Figure 3-88.

Figure 3-87: Role and Permission

Figure 3-88: User Entry

3.14 METADATA MODULE

Metadata defines the data about data. A metadata is a language presented using controlled format. The creation of metadata is essential to the quality of datasets. In order to prepare a metadata of a particular dataset, data to be preserved and discovered, certain criteria need to be met within the metadata. Various types of standard Metadata forms are available. Among them Dublin Core Metadata (DCM) terms and Federal Geographic Data (FGD) Standard terms were used for developing metadata for SiMS datasets. These two metadata standards are generic and common for preparing metadata of any spatial and non-spatial datasets, and both these are ISO certified.

Dublin Core

- The Dublin Core Metadata Element Set is a vocabulary of 15 properties for use in resource description
- The name "Dublin" is due to its origin at a 1995 invitational workshop in Dublin, Ohio; "core" because its elements are broad and generic, usable for describing a wide range of resources

- Dublin Core Metadata Initiatives (DCMI) - http://dublincore.org/documents/dces/

- Standard at Library of Congress- http://www.loc.gov/standards/

FGD Standard

- The FGDC or Federal Geographic Data Committee promotes sharing of the nation's geospatial resources. The FGDC metadata standard was adopted in 1994.

- The FGDC is a metadata standard developed to determine the robustness, the method of accessing, and successful transfer of geospatial data.

- FGD Standard- http://www.fgdc.gov/metadata/geospatial-metadata-standards

Guidelines for DCMI and FGD guidelines were followed to identify the Elements or Terms stated in http://dublincore.org/documents/dces/ (Table 3-12). The Implemented interfaces of Meta Data Module in SiMS-Smart are shown in Figure 3-89 and Figure 3-90.

Table 3-12: Metadata Terms and Elements

No.	Elements	Definition	Description
1	Name of Data layer/Title	A name given to the resource.	Typically, a Title will be a name by which the resource is formally known
2	Data Type/Type	The nature or genre of the resource.	To describe the file format, physical medium, or dimensions of the resource, use the Format element.
3	Subject	The topic of the resource.	Typically, the subject will be represented using keywords, key phrases, or classification codes.

No.	Elements	Definition	Description
			Recommended best practice is to use a controlled vocabulary.
4	Description/Abstract	An account of the resource.	Description may include but is not limited to: an abstract, a table of contents, a graphical representation, or a free-text account of the resource
4.1	Abstract	Abstract of dataset	Brief description of abstract
4.2	History	History of dataset	History of datasets of sources, context and how data has been captured
4.3	Process Description	Data process	
4.4	Purpose		
5	Coverage	The spatial or temporal topic of the resource, the spatial applicability of the resource, or the jurisdiction under which the resource is relevant	Spatial topic and spatial applicability may be a named place or a location specified by its geographic coordinates. Temporal topic may be a named period, date, or date range. A jurisdiction may be a named administrative entity or a geographic place to which the resource applies. Recommended best practice is to use a controlled vocabulary such as the Thesaurus of Geographic Names [TGN]. Where appropriate, named places or time periods can be used in preference to numeric identifiers such as sets of coordinates or date ranges.
5.1	Spatial		
5.2	Temporal		
6	Date/Publication date	A point or period of time associated with an event in the lifecycle of the resource.	Date may be used to express temporal information at any level of granularity.
7	Originator/Creator	An entity primarily responsible for making the resource	Examples of a Contributor include a person, an organization, or a service. Typically, the name of a Contributor should be used to indicate the entity.
8	Contributor	An entity responsible for making contributions to the resource.	Examples of a Contributor include a person, an organization, or a service. Typically, the name of a Contributor should be used to indicate the entity.
9	Publisher	An entity responsible for making the resource available.	Examples of a Contributor include a person, an organization, or a service. Typically, the name of a Contributor should be used to indicate the entity.

No.	Elements	Definition	Description
10	Source	A related resource from which the described resource is derived.	The described resource may be derived from the related resource in whole or in part. Recommended best practice is to identify the related resource by means of a string conforming to a formal identification system.
11	Relation	A related resource.	Recommended best practice is to identify the related resource by means of a string conforming to a formal identification system.
12	Language	A language of the resource.	Recommended best practice is to use a controlled vocabulary such as English/Bangla/French etc.
13	Rights	Information about rights held in and over the resource	Typically, rights information includes a statement about various property rights associated with the resource, including intellectual property rights.
14	Identifier	An unambiguous reference to the resource within a given context.	Recommended best practice is to identify the resource by means of a string conforming to a formal identification system.
15	Format	The file format, physical medium, or dimensions of the resource.	Examples of dimensions include size and duration. Recommended best practice is to use a controlled vocabulary such as the list of Internet Media Types [MIME].
16	Attribute Column Description		
	Column Name	Column Definition	Column Description

Figure 3-89: Metadata Items

Figure 3-90: Metadata - Item Elements

4 TRAINING AND WORKSHOP

Training and workshop is an essential componentfor making sustainable and seamless operation of SiMS-Smart in the long run. An in-depth on hand training and an awareness & training workshop have been conducted by IWM for the BWDB officials.

4.1 TRAINING ON SiMS-SMART APPLICATION TO BWDB ENGINEERS

A training programme has been provided to the selected Engineers from BWDB headquarter on the developed SiMS-Smart System, which was held in IWM training center during 21-22 November 2017. The major training topics were:

- Introduction of overall SiMS-Smart System
- SiMS Database
- GIS Interface
- Operation and Use of SiMS Module
- SiMS Mobile and IP-Camera communication

The BWDB nominated 5 (five) engineers who received the training. Following are the list of Trainees as shown in Table 4-1. The detail of this training programme is given in Appendix B.

Table 4-1: List of Trainees

Sl. No.	Officer's Name	Designation and Office
1	Mr. Rashedul Kabir	Executive Engineer, Chief Engineer, Design Circle, BWDB, Dhaka
2	Mr. Abdullahil Baki Md. Ruhunnabi	Programmer, Contract & Procurement Cell, BWDB, Dhaka
3	Mrs. Farzana Ahmed	Sub-Divisional Engineer, Planning-1, BWDB, Dhaka
4	Mr. Abdur Rahman Tazkia	Assistant Engineer, Planning-1, BWDB, Dhaka
5	Mr. Md. Atikul Islam	Assistant Engineer, Planning-1, BWDB, Dhaka

4.2 AWARENESS AND TRAINING WORKSHOP ON SiMS-SMART APPLICATION

An Awareness and Training Workshop on SiMS-Smart has been arranged by IWM at the office of the Chief engineer, South-Eastern Zone, Chittagong on 18th November 2017 only for the officials of the South-Eastern Zone, Chittagong. The objectives of this programme were to make awareness of SiMS-Smart application and how to make it operationalize through their daily routine works in the field offices. The workshop was chaired by the Chief Engineer, South-Eastern Zone, Chittagong where the Project Director (PD) of the project was the Chief Guest. The Workshop had two sessions, one was the general understanding and awareness of SiMS-Smart to the participants and another was demonstration and on-

hands training on SiMS-Smart. Some photographs of this event are presented below. The detail programme schedule and list of participants is given in Appendix B.

Photograph-1

Photograph-2

Photograph-3

Photograph-4

Photograph-5

Photograph-6

5   SYSTEM HANDOVER AND IMPLEMENTATION

System handover, installation at the client site, system operational and proper implementation will make the success of this project. To make sustainable of the use of SiMS-Smart in all BWDB offices, it should be ensured that the system is up and running and under regular use. The use of SiMS -Smart would have to be made mandatory.

5.1   SYSTEM HANDOVER

The System handover is a process of transferring the developed software product to the concerned department of BWDB will be responsible forexecutuion.

In DFR presentation meeting GIS Unit of BWDB has been recommended to take over the SiMS-Smart. It is presumed that this unit is technically capable of receiving and implementing the developed system.

The developed SiMS-Smart application, procured ESRI ArcGIS Server, ArcGIS Desktop and procured Server computers and Cell Phones have been handed over to the Chief Planning Office of BWDB. The six (6) numbers of IP Camera have already been installed at selected locations in SEZ, Chittagong. The Server Computers have pre-loaded with SiMS Oracle database, ArcGIS server, ArcGIS Desktop Software and SiMS-Smart Application Software. The SiMS-Smart Application, GIS, Database and Web Servers will be installed in GIS Unit (or elsewhere as instructed) of BWDB Head Office.

The following Hardware and Software listed in Table 5-1 have been handed over to the Project Authority.

Table 5-1: List of Software and Hardware

Sl No.	Items	Specifications	Quantity
1	Server Computer	**Brand & Model**: DELL, POWEREDGE T430 **Form Factor**: Tower **Processor**: 1x Intel Xeon E5-2620, 8C **HDD**: 4x600 GB SAS, 10K RPM Hot plug **RAM**: 32 GB DDR4 ECC **ODD**: DVD- Writer **PSU**: 2 unit of Hot Swap Redundant **OS**: Preloaded Windows 2012R2 Standard 64bit **Monitor**: DELL 18.5" WLED **Warranty**: 3 years' full	01 pc
		Brand & Model: DELL, POWEREDGE T430 **Form Factor**: Tower **Processor:** 1x Intel Xeon E5-2603, 6C **HDD:** 4x600 GB SAS, 10K RPM Hot plug **RAM**: 32 GB DDR4 ECC **ODD**: DVD- Writer	01 pc

Sl No.	Items	Specifications	Quantity
		PSU: 2 unit of Hot Swap Redundant **OS**: Preloaded Windows 2012R2 Standard 64bit **Monitor**: DELL 18.5" WLED **Warranty**: 3 years' full	
2	Software	ESRI ArcGIS 10.5 (**latest version**) for Server Advanced Edition (Enterprise) **perpetual license** including available Extensions, ArcGIS Portal, ArcGIS SDK and APIs for Apps development. The Software will be operated under Windows 64-bit Operating System.	01 pc
		ArcGIS 10.5 (**latest version**) for Desktop Standard Edition, **Single Perpetual license**. The Software will be operated under Windows 64-bit Operating System.	01 pc
3	IP Camera & Accessories	**IP Camera**: DAHUA, DH-SD-6C220I-HC, 20X, 2MP, 100M IR, 1-year warranty **NVR**: DH-NVR4104H, 1-year warranty **PSU**: SMPS: 12V 2A, 6 months' warranty **HDD**: 1TB SATA, 1-year warranty **Router**: TP-Link 3G/4G, 1-year warranty **Network Cable**: Micronet CAT6 UTP **UPS**: 1200VA POWERPAC Offline, 1-year warranty **Modem**: 3G USB **Accessories:** GI Pipe, Power cable, Steel Tray	06 pcs
4	Smart Phone	**Brand & Model**: HUAWEI GR5 2017 (Premium) **RAM**: 4GB, ROM:64GB **Screen**: 5.5" FHD Curved Glass display & metallic **OS**: Android Marshmallow v6.0 **Camera**: Dual (12+2) MP & 8MP **CPU**: 2.1GHzOcta-Core+ I5 Coprocessor **Warranty**: 1 year for set and 6 months for Battery with Charger **Memory**: Team 64GB Memory (Lifetime warranty)	12 pcs

5.1.1   INSTALLATION OF SIMS-SMART

Installation of SiMS-Smart include the installation of Hardware, Database and Software at the Client Office. Database, GIS and Web Server configuration is a major part of installation of SiMS-Smart. The overall system is presented in Figure 5-1
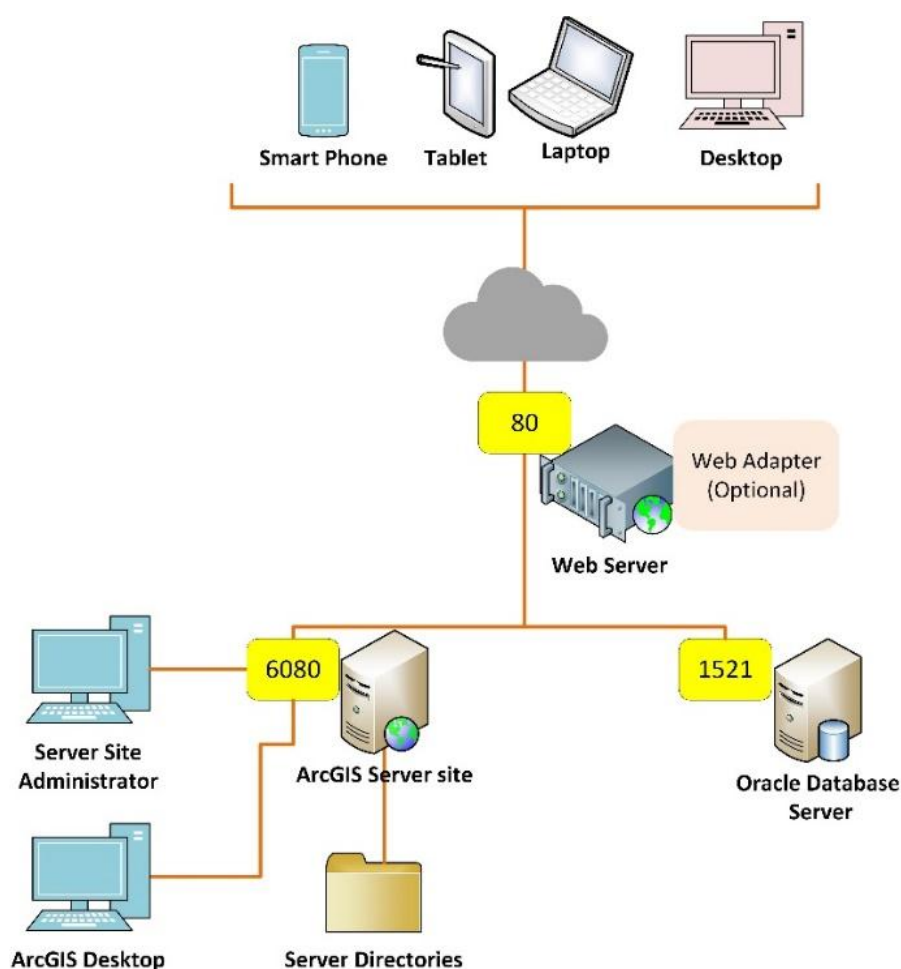
Figure 5-1: SiMS-Smart Servers Configurations

- **GIS Server**
  ESRI ArcGIS Server software is installed in a Server with required configuration. The ArcGIS Server will manage, control and provide the developed services of Maps, Features to the clients over the Internet. The GIS Server will connect with the Oracle database server to pull Geodatabase stored in Spatial Database Engine (SDE) schema.

- **Database Server**
  Oracle Database System needs to be installed in the database server computer where developed Spatial database and non-spatial database will be stored.

o **Spatial Database:**

This database contains ESRI Geodatabase of the related physical features of BWDB schemes and projects such as Embankment, Canal, Hydraulic Structure, Protection work and related other features. The geodatabase is stored in the Spatial Data Engine (SDE) Schema. SDE Schema need to be created as a database Schema in Oracle database as a master spatial data engine providing required SQL privileges.

o **Non-Spatial Database**

The non-spatial database includes the scheme/project inventory, design parameters of physical features, pre-work survey data, Schedule of rates, quality and cost estimates, O&M works, O&M and Ongoing project progress, DPP information, Land and other assets etc.

- **Web Application Server**

The Microsoft Internet Information Service (IIS) is installed in a server computer where SiMS-Smart application is deployed. The connectivity of GIS services are established through ArcGIS Adapter. The ArcGIS Adapter is also installed in this server.

- **Installation of ArcGIS Desktop**

ArcGIS for desktop software is installed in a separate desktop or a client computer. ArcGIS requires to create ArcGIS Map and Feature services connecting with the ArcGIS Server. ArcGIS Desktop is also required for GIS data preparation, processing and editing for geo-database development.

- **System Configuration**

The ArcGIS Server, Oracle Database, SDE Schema is properly configured using the standard procedures in software manuals. IWM prepared and provided a Technical Referenced Manual.

5.1.2 SYSTEM DEPLOYMENT AND HOSTING

All the Servers are installed and preloaded with the data. The System will be hosted using the IP address provided by the client at BWDB Head Office.

5.2   IMPLEMENTATION PLAN

The implementation plan includes how SiMS-Smart application will be made operational initially for all levels of BWDB field offices of South-Eastern Zone, Chittagong and BWDB head office. After successful implementation, the system will be gradually made operational in remaining BWDB Zones, Circles and O&M field divisions by populating the respective data into SiMS-Smart database.

In order to make successful implementation of the system, an affordable implementation plan need to be followed. The plan will contain a brief description of the major tasks involved and resources requirements to support the implementation effort such as costs, logistic supports, staff resource requirements, facilities, materials, training etc. and any site-specific implementation requirements, which are briefly discussed in this section. In this context, BWDB GIS Unit could take the lead for management and maintenance of the System and to provide required user supports to zonal, circle and divisional offices.

5.2.1 USERS OF SIMS-SMART APPLICATION

BWDB should identify and select the appropriate uses of the SiMS-Smart at all levels of the offices from data entry to planning, management, monitoring and decision-making levels.

Various levels of SiMS-Smart users could be identified as shown in Figure 5-2 including the Ministry, the BWDB Head Office, Project Offices, BWD Zones, Circles, BWDB O&M Divisions and general users. All these users might utilize the System for their regular activities within the department.
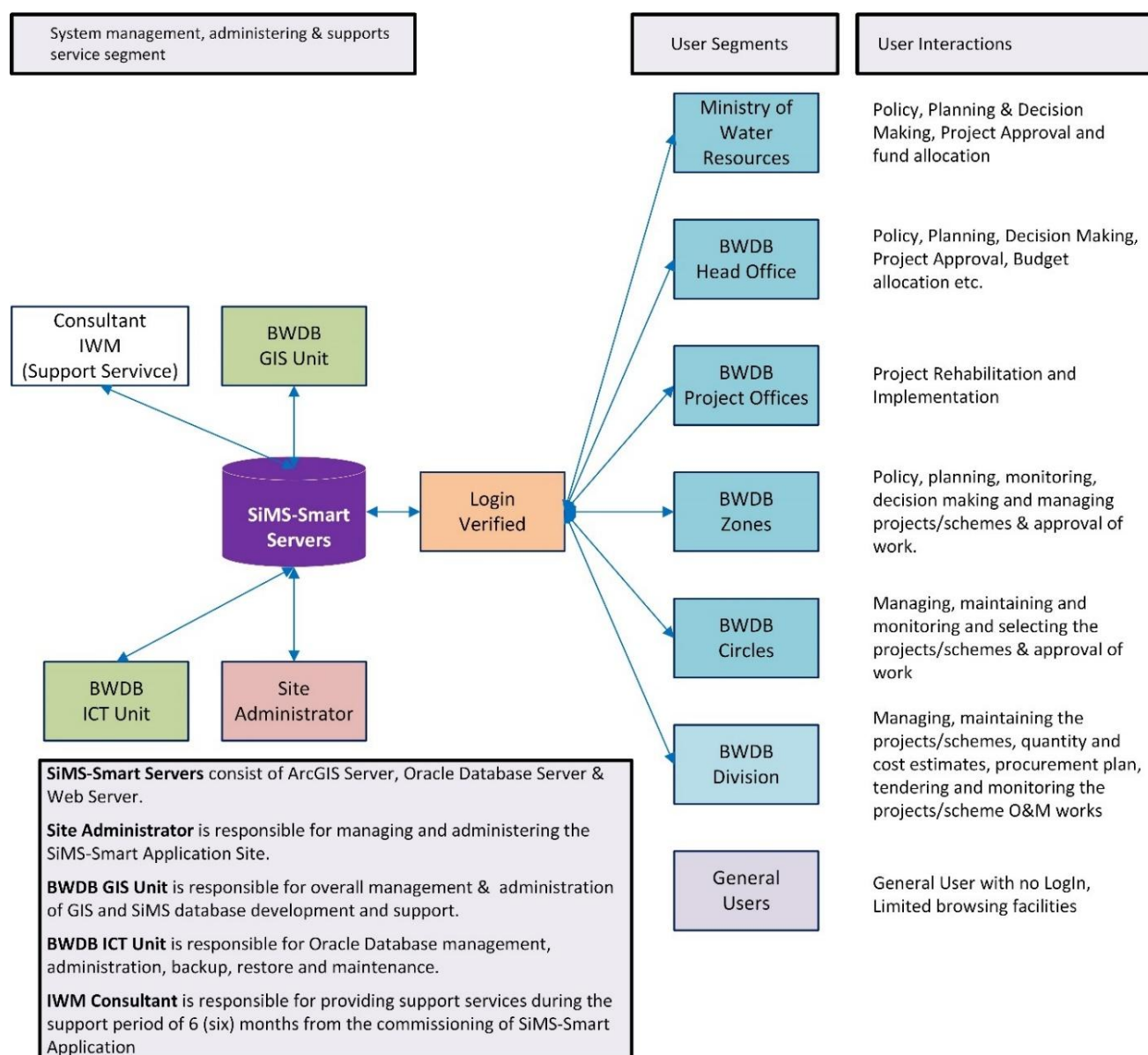
Figure 5-2: User Segments in SiMS-Smart

The access rights, viewable outputs are to be defined by the BWDB management during the operational planning where IWM would provide the technical support as and when required. IWM will provide support services up to 6 months after handing over the system.

5.2.2 INSTITUTIONAL SETUP

An institutional set up will be required for persistent implementation and operation of the SiMS-Smart Application from BWDB's part. Since the developed system is web and central server based, it will be installed in central location with required ICT facilities in BWDB head office. The BWDB GIS Unit can take the roles of SiMS-Smart implementation. The following Figure 5-3 shows the proposed organization of GIS unit under the Chief Planning/Monitoring Office of BWDB. The roles and responsibilities of each positions of the team are described in this section.
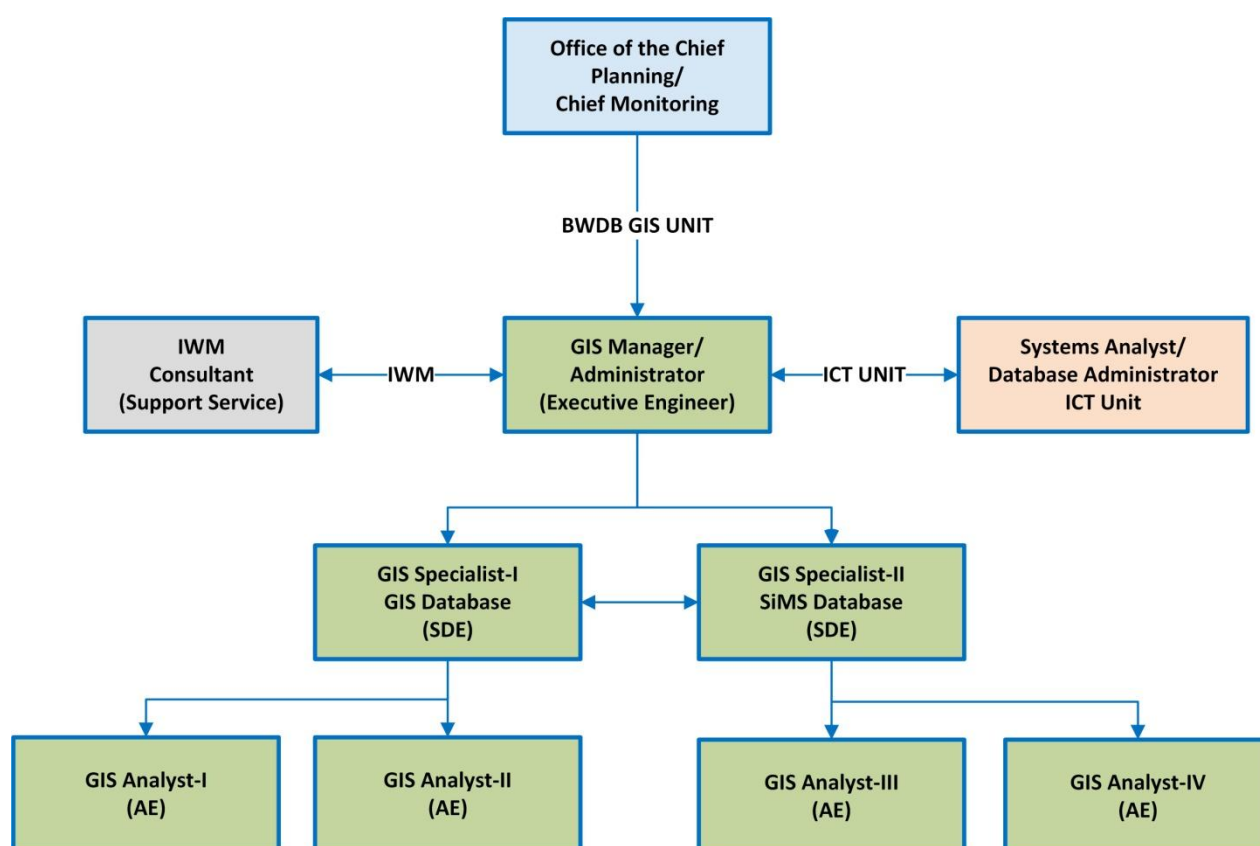
Figure 5-3: Proposed SiMS-Smart Implementation Unit (GIS Unit)

GIS Manager/Administrator:

Under the direction of Chief Planning/Monitoring, GIS Manager/Administrator will manage, supervise, monitor, control and administer the SiMS-Smart System. It is preferable that this person will have the knowledge of BWDB Scheme Information to coordinate GIS and Database activities relating to SiMS-Smart System. The person will manage and prepare general planning for the GIS Unit and will be the Administrator of SiMS-Smart Geodatabase system. The person will make liaison with other wings of BWDB as well as the focal point for outside organization. It is recommended that this position will be permanent and non-transferable. This position could be equivalent as a SE/XEN.

GIS Specialist:

Responsible for providing support and management of SiMS-Smart based GIS and Database tasks; able to plan and coordinate GIS database activities in relation with SiMS-Smart System. Able to develop quality control standard of GIS development; able to analyze and resolve system issues in a time manner; perform data validation checking what users enter the data in SiMS-Smart; able to oversee data flow, management and distribution activities held in SiMS-Smart from all levels of BWDB users; able to maintain documents, reports and quality of services held in GIS unit; provide technical guidance to SiMS-Smart and GIS/database within BWDB. GIS Specialist will be working under the guidance of GIS Manager/Administrator. It is recommended that this position will be permanent and non-transferable. This position could be equivalent as a XEN/SDE.

GIS Analyst:

GIS Analyst will be responsible for providing support to the GIS Specialist and GIS Administrator to make efficient use of SiMS-Smart System. The professional will be working as a SIMS-Smart System implementer to assist BWDB users particularly the field level users in using SiMS-Smart Application in their day-todays activities. The professional is expected to be working under the direction of GIS Specialist and GIS Manager. It is recommended that this position will be permanent and non-transferable. This position could be equivalent as an SDE/AE.

Systems Administrator (ICT Unit):

SiMS-Smart Application is web GIS based application constitutes a three-tier application of ArcGIS Server, Oracle Database Server and Application on Web Server. These need to be managed, configured, monitored and administered by a technical ICT specialist. The System Administrator will be responsible for managing, controlling, maintaining and administering this ICT base infrastructure of SiMS-Smart. He will also assist GIS Manager/Administrator in preparing the yearly maintenance budgets and maintaining the SiMS-Smart infrastructure in BWDB covering hardware, software, internet etc. System Administrator will advise ICT related issues to the GIS Manager. The System Analyst of BWDB ICT Unit could serve this position.

IWM Consultant for Support Service:

The developer team of IWM will provide required support services for 6 (six) months period after the handover of SiMS-Smart Application. IWM team will assist BWDB GIS Unit in order to make sustainable operation of SiMS-Smart as per contract. If any error exception might come in utilizing the system, IWM supporting team will resolve the errors for smooth operation.

5.2.3 USER LEVEL FEEDBACK

Since, the System will be used by different types of users from various levels of BWDB filed unit offices such as Zone, Circle, Division, Sub-division and Sections etc. if any user would face any problem/exception could communicate with the GIS Manager/Administrator through Email communication. An Email

(bwdbsims1@gmail.com) communication system is embedded with SiMS-Smart Application. User could send any feedback message to the GIS Manager/Administrator. The GIS Manager/Administrator or any personnel of GIS UNIT would keep a log inventory of User feedback messages and accordingly resolve the problems and notify the users through email communication.

5.2.4 TRAINING AND TECHNOLOGY TRANSFER

Training and Technology transfer is a vital to operationalize the System within BWDB. During the project tenure, an awareness and hands on training has been provided by the consultant to the engineers of South-Eastern Zone, Chittagong and another technical training has also been provided to the selected engineers of BWDB head office who might take the responsibilities of making operational the system within BWDB in the long run. During the implementation period, the users may require further training for smooth operation which might be provided by BWDB GIS Unit. The trained BWDB officials shall be able to train other officials throughout the local offices on use of SiMS-Smart.

5.2.5 GIS AND DATABASE UPDATE

GIS and Database update is one of the main tasks for sustaining the system for operation within BWDB. This task includes the update of GIS layers and database, this is a continuous process to make the system always updated. GIS Unit will have to take the responsibilities for update or adding new GIS layers. No other office or department within BWDB should be allowed to perform this GIS data update except under high supervision.

The Schedule of Rate data should be uploaded or any modification should be performed exclusively by the respective officer of the Design Circle.

5.2.6 DATABASE BACKUP, RECOVERY AND RESTORE

All the tasks relating to SiMS Database Recovery and Restore will be performed by BWDB ICT Unit. Standard Oracle Backup instructions need to be followed. The geodatabase backup in the Oracle SDE Schema should be performed by the GIS Unit as well as by ICT Unit.

5.2.7 SERVER ADMINISTRATION AND MANAGEMENT

All servers of GIS, Database and Web servers will be managed, maintained and administered by the GIS Unit in collaboration with ICT unit of BWDB.

5.2.8 BUDGET AND LOGISTIC RESOURCES

An annual budget will be required to fulfill the costs of maintaining the software and hardware of SiMS-Smart system infrastructure. Also, a budget provision should be kept annually for visiting BWDB field offices by System Implementers from GIS Unit.

5.2.9 National Scale Implementation

Actually, SiMS-Smart Application has been developed for use of all the BWDB schemes/projects of entire country. As a pilot basis it has to be operationalized in the South-Eastern Zone, Chittagong. After successful operation—all remaining BWDB Zones and offices will be brought under SiMS-Smart. In order to do that, SiMS-Smart could be operationalized phase by phase following the respective data updating to the system. The developed system could require further enhancements based on new requirements and technology evolutions.

5.2.10 Awareness Connecting with Digital Bangladesh

BWDB may arrange a national seminar with the stakeholders to disseminate the achievements of SiMS-Smart. This will make BWDB a step forward towards the Digital Bangladesh and will make information/knowledge integration with National Digital System.

6 CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

SiMS-Smart development is aimed towards digital management of the project monitoring and implementation of BWDB projects in line with national vision "Digital Bangladesh". If the developed system is implemented, BWDB will be capable of:

- Archiving design and project related documents and maps in digital data storage.
- Visualizing project entities (embankment, structures, canals, protective works etc.) in GIS maps with satellite image background.
- Archiving and visualizing time based physical conditions along with photographs and videos.
- Searching and querying on project entities.
- Quantity and cost estimate earthworks, structures, excavation etc. for project entities.
- Budget demand allocation, work selection, work package preparation, preparation of Procurement Plan and DPP.
- Progress monitoring of on-going activities though online update and visualization in tables, charts, short reports etc.
- Realtime visual monitoring through integrated Skype and IP-Camera
- Visualizing Water Management Organization (WMO) information for each scheme/project
- Managing BWDB Asset for Land, Vehicle and Key assets.
- Assessing the threat of forecasted flood based on nearest connected FFWC gauges.
- Data collecting and viewing of scheme information through Mobile Apps.
- Getting real-time water levels from auto-gauge stations during flood and cyclone

The web application for above systems has been developed following the contracted items under this project for SE zone of BWDB. The system requires inserting and updating of data for each scheme of entire Bangladesh.

6.2   LIMITATIONS

There were several hindering issues during the execution of the project, some of which were overcome by the assistance of the Project Director and the Technical Committee. Also, there were some technical and non-technical issues without which the development could have achieved better results. The limitations found were namely:

- Access and unavailability scheme/project data, drawing, maps, reports

  To get the access to the data in Design office of BWDB was a difficult task in absence of data sharing protocols, which is very common in many organizations of Bangladesh. IWM team was allowed only to record data in 'hand written' mode from as-built drawing and design sheets. The process was very slow. Finding the drawings for schemes of this study area from huge volume of documents was also a time-consuming work.

- Extension of ArcGIS Software procurement

  It had been assumed in the SiMS-Smart software development phase that functionality of two ArcGIS Extensions - 1. Data Interoperability & 2. ERSI Roads and Highways will use in the core module. However, due to budget constraint, these two-proposed additional extensions could not be purchased. But the functional requirement has been developed by IWM and integrated under this development.

- Connectivity of IP Camera

  Selected all sites of IP Camera are far beyond of ISP connection, thus IP camera has been installed with mobile SIM supported instrument. So, communication could be seriously disrupted due to weak signals from nearest mobile tower. The IP-Camera requires higher band width to transmit the video data over the internet. But in most of the cases the schemes are situated far apart from the urban area where internet speed is not upto the mark. Hence, as a stronger alternative, Skype video communication for real time monitoring has been integrated into the SiMS-Smart.

- Asset module development

  BWDB Land information is highly unavailable. Alongside the general land information, the knowledge about the lands with locations, relevant maps, acquisition records were not found available in organized state. It requires dedicated efforts of BWDB officials to gather that information. Under this study, IWM could collect only a small set of hardcopy data regarding BWDB's land assets and properties and few maps with the help of the CE, Chittagong. The software component has been developed using this information. To implement all the land information in this zone require a separate project, which is also the opinion of the Chief Engineer, Chittagong.

Vehicle and other key asset modules have been developed with a set of data collected from a sample area of Chittagong BWDB O&M office. IF any further data is required, should be collected, compiled and integrated into this module.

Provision of vehicle tracking system could not be possible due to budget constraint. Still, a vehicle tracking module has been developed based on mobile device tracking technology—which could be upgraded to vehicle tracking device mapping in a later phase of works.

6.3   RECOMMENDATIONS AND WAY FORWARD

The main project activities under this contract was to develop a web based solution for Scheme Information Management System (SiMS). Alongside, other advanced ICT facilities like IP-Camera, Mobile Apps, online vehicle management etc. were also considered to bring the scheme management into a diverse digital platform. Accordingly, all the modules have been developed using available datasets. At this stage, the following recommendations are suggested to make the SiMS-Smart functional and further improved.

- Replicate the SiMS-Smart in rest of the BWDB zones phase by phase.

- Establish a permanent unit in BWDB office to adapt SiMS-Smart in scheme/project management.

- Convert all available data of BWDB relevant to SiMS-Smart into SiMS-Smart database.

- Incorporate geographic coordinate system alongside the existing chainage system in embankment, structure and other work locations to make compatible with GIS and online maps

- Provide training to BWDB officials from lower level to highest levels on use of SiMS-Smart.

- Identify the 'areas of improvement' of developed SiMS-Smart through use at different levels of BWDB officials.

- Update the database and GIS maps for all the projects, in case of unavailable data detail filed survey and assessment could be done.

- Establish full data access and sharing mechanism respecting the confidentiality. Respective BWDB official could be assigned with exclusive responsibilities for this purpose. Because without the data no system is useful.

- There is a good dataset of high resolution satellite images in Bangladesh Haor Development Board. That could be used for mapping schemes more accurately. An organization level communication could be done to use that dataset for BWDB.

- Detail GIS maps for all schemes and projects including detail information of Hyd. Structures, Embankments, khals, protective works, land use, drainage and irrigation system, settlement, elevations, etc. need to be prepared and incorporated into SiMS-Smart database.

- All lands and assets of BWDB should be digitalized and incorporated into SiMS-Smart.