バングラデシュ国
地方自治農村開発組合省
チッタゴン上下水道公社（CWASA）

バングラデシュ国
チッタゴン上下水道公社
無収水削減推進プロジェクト

プロジェクト事業完了報告書
（資料編）

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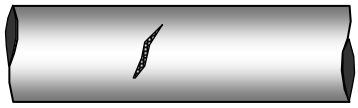
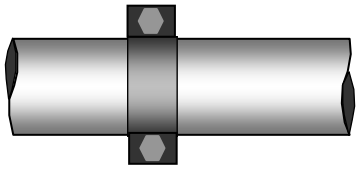
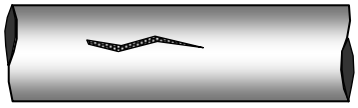
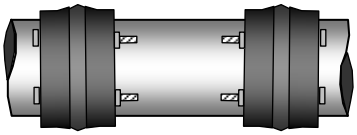
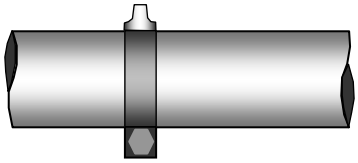
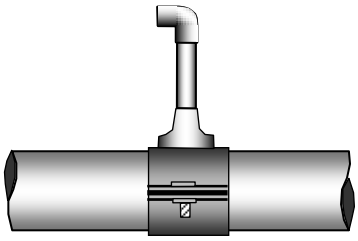
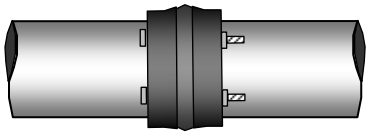
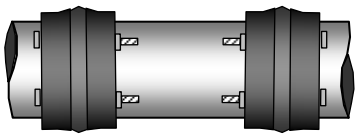
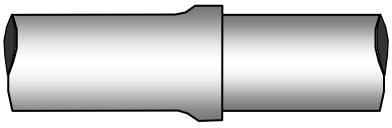
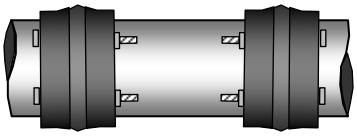
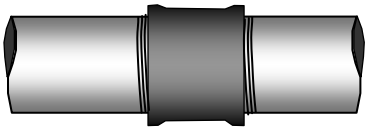
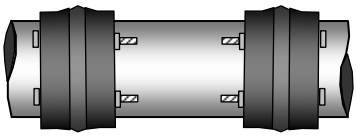
1. Manual for the Leak Repairing Method and Sample Layout of Service Connection

I. Leak Repair

I) Repairing method for distribution pipe

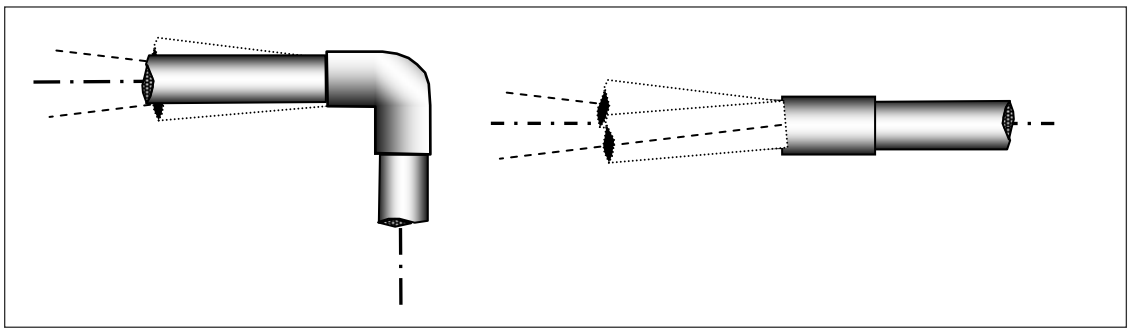
Leak repairing method must chose depend on leak condition. Sample of repairing method under follow:

Leak Type	Damaged Part	Repairing Method
Vertical Crack		 By repair clamp
Horizontal Crack		 Replace to short PVC pipe and connecting by flexible coupling
Tapping & Saddle		 Replace the tapping and saddle.
Gibolut type Joint		 Replace short PVC pipe and connecting by flexible coupling
Socket Type Joint		 Replace to short PVC pipe and connecting by flexible coupling
Screw Type Socket Joint		 Replace to short PVC pipe and connecting by flexible coupling

II) Repairing method for Service connection

If jointing position has roughness aliment, such as not right angle and not strait will occurrence leak easily because it stress is concentrated on that part.

Since you must keep the true aliment such as right angle on bending position where use Elbow socket or strait line for use nipple or socket.



1. Worst sample of tapping and repairing

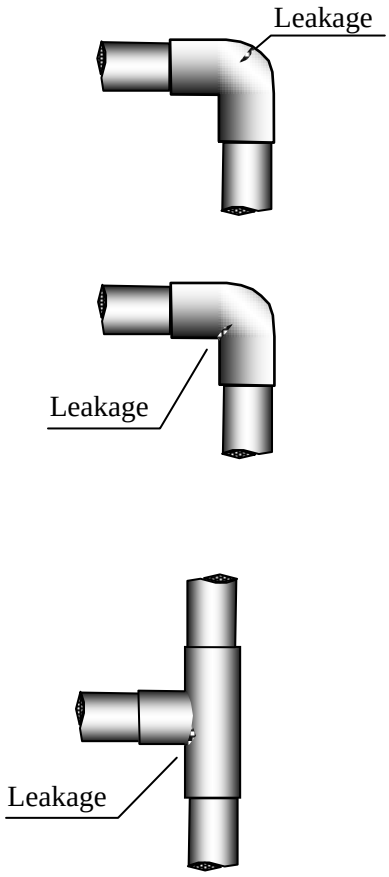
Pipe deeps were 0.1m.
Leak repair was take simple way that wind the steel tape

Fore tapping were take between about 60cm
Normally they must take 30cm space for each

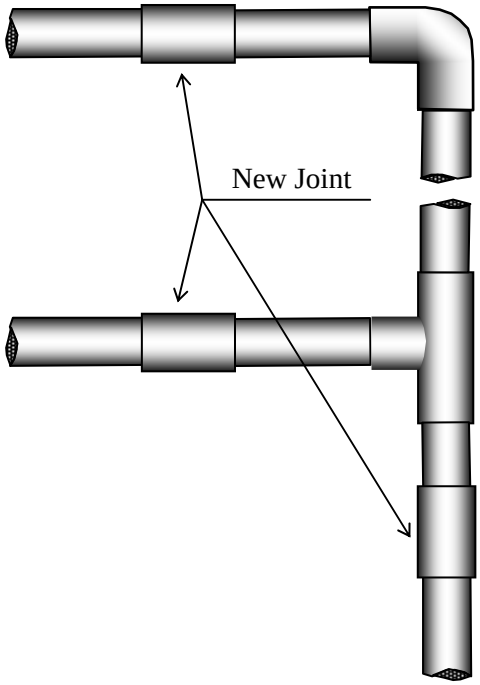
They have big gap between tapping-plug to service- connection, because bending the GI pipe. And they had concreting around the pipe for make forced connection

2. Leak Repairing on Jointing Parts (Elbow and Tie socket)

More leakage occur on jointing parts, since must reduced joint for prevent leak.
When these leaks are repaired, it considers reducing new connection points as much as possible (if it can be done, within two places), and you must decide the cutting point of the pipe.



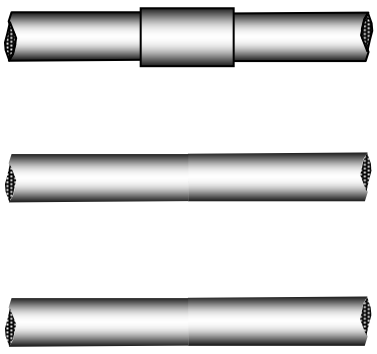
The simple way of repairing it which tied with a rubber tube and to put is being enforced under the present condition.
But, this method is a temporary way, and it is not the everlasting way of repairing it.
Replaced Leaking Elbow Joint is better way as shown in the following sketch.



3, Leak repair on Strait Pipe (Pipe body or Socket)

In case of leak repair method of occurred strait pipe bodies, you had to remove the leak portion of pipe.

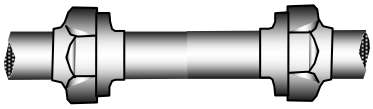
Jointing short pipe that removed portion jointed by nipple socket



The simple way of repairing it which tied it with a rubber tube and to put is being enforced under the present condition.

But, this method is a temporary way, and it is not the everlasting way of repairing it.

Cutting and removed damaged portion, then inserting short pipe.



4, Leak Repair on tapping

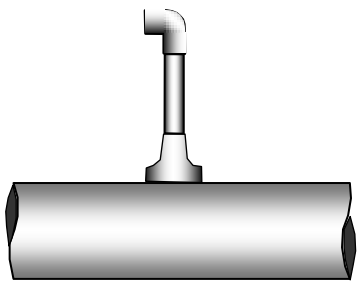
It was adopt direct connection of Service-Pipe connection with out Tapping Saddle in CWASA still now, (It may be only inserted tapping plug directly to the Distribution-Pipe.)

It doesn't glow up to big size leak under low pressure by direct inserted, and it will be occur the leak soon, also it make week the distribution pipe where tapping.

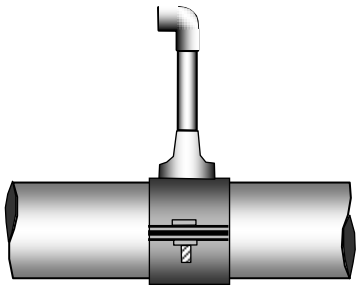
It must mend to Saddle-Tapping when leak repair on direct tapping.

Also CWASA must make plane for implement to saddle tapping to all connection

Current Condition for Direct-Tapping



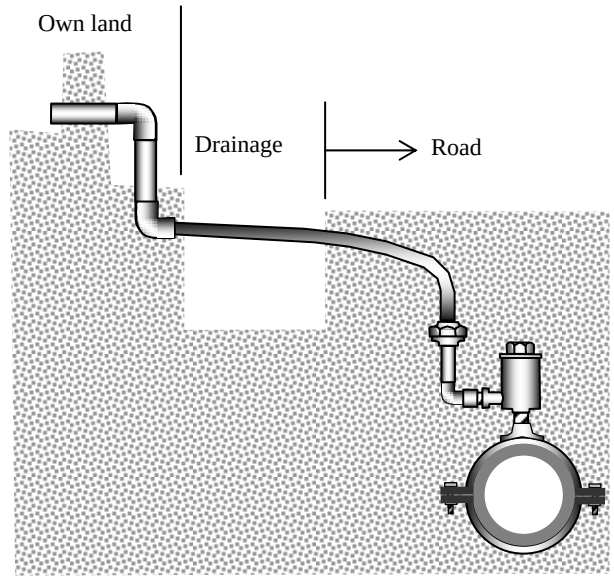
Mended Taping for Saddle-Taping



II, Sample of Service Connection Plumbing

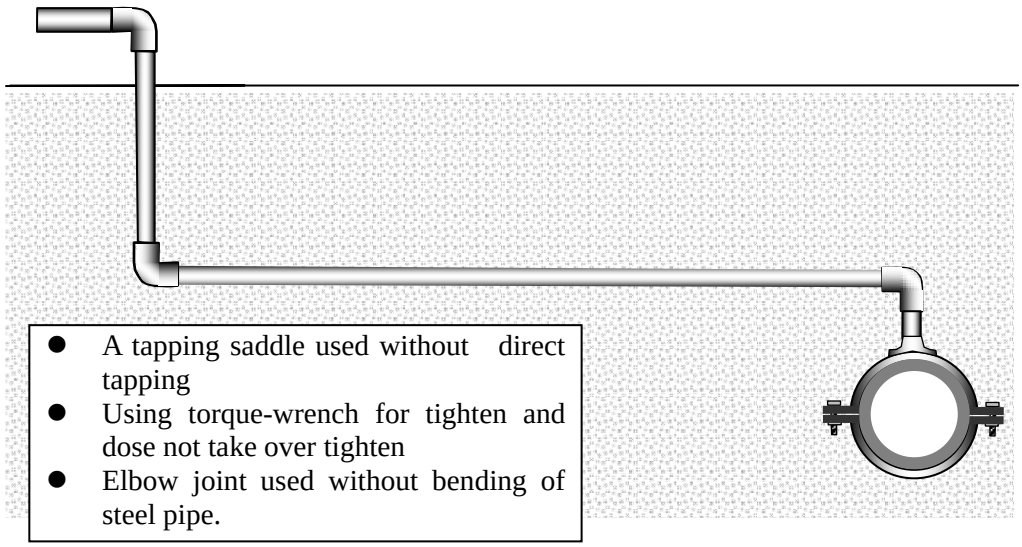
I) Actual condition and normal plumbing for service connection

1. Actual plumbing condition of service connection（GI）



They had hard bending of GI pipe for connecting in narrow space.

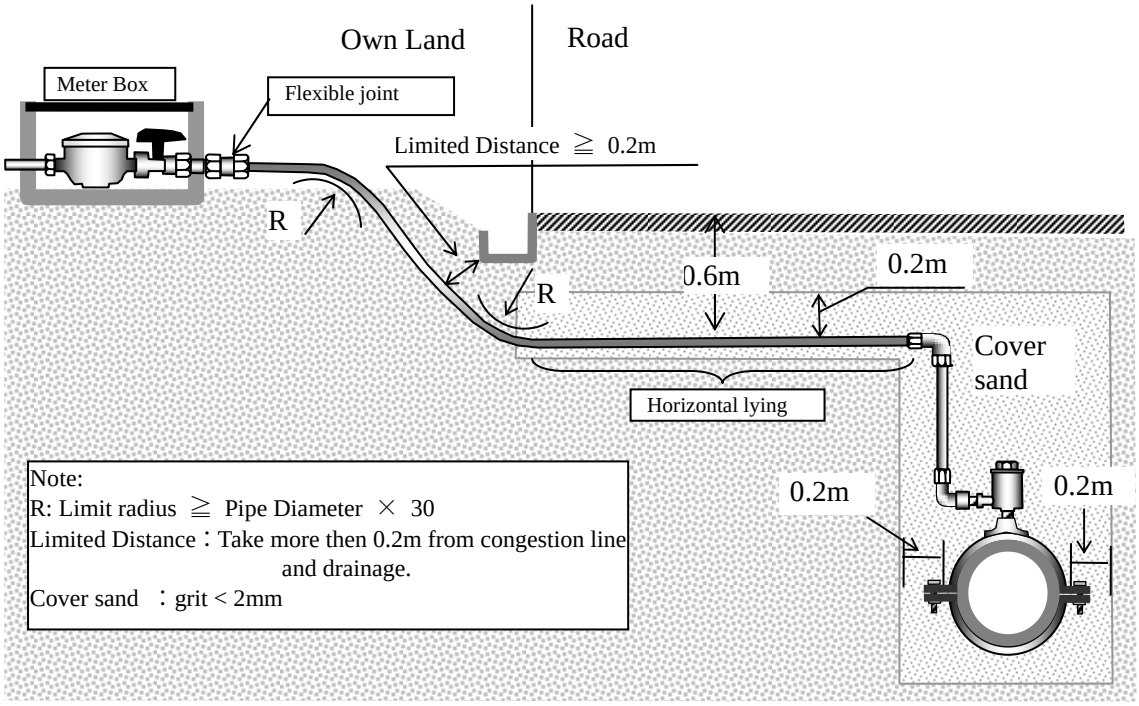
2, Implementation Sample layout for service connection (GI)



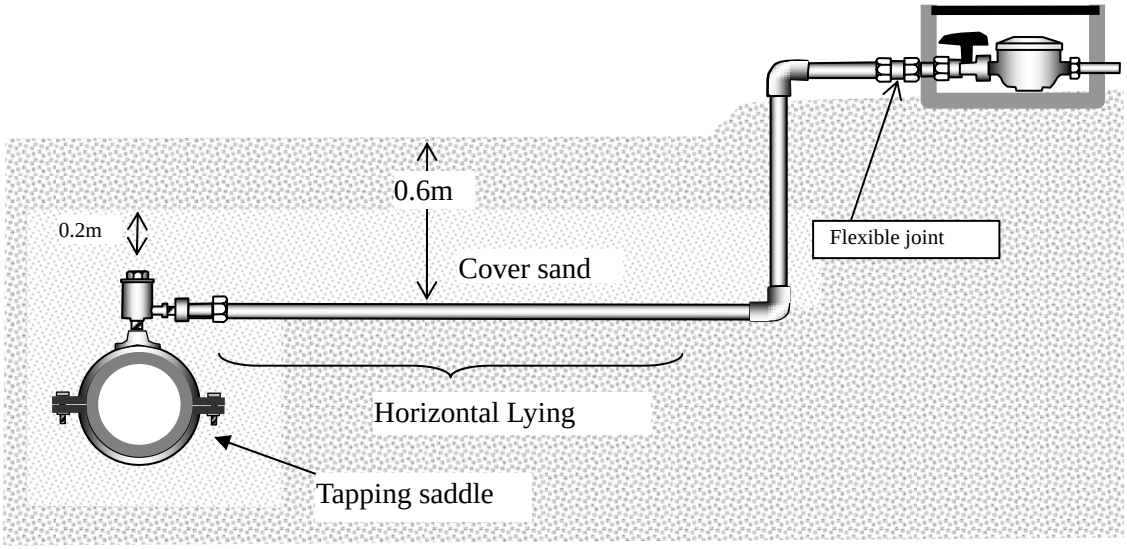
- A tapping saddle used without direct tapping
- Using torque-wrench for tighten and dose not take over tighten
- Elbow joint used without bending of steel pipe.

II) Proposed Implementation of service connection

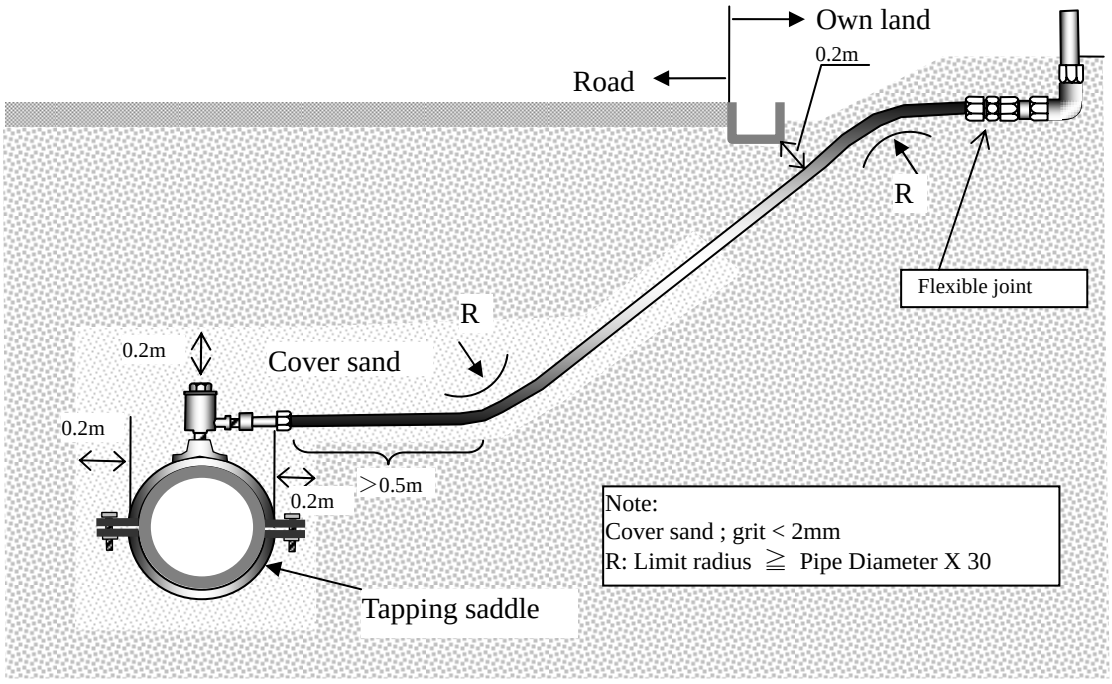
1, Service Connection Layout (Generally)



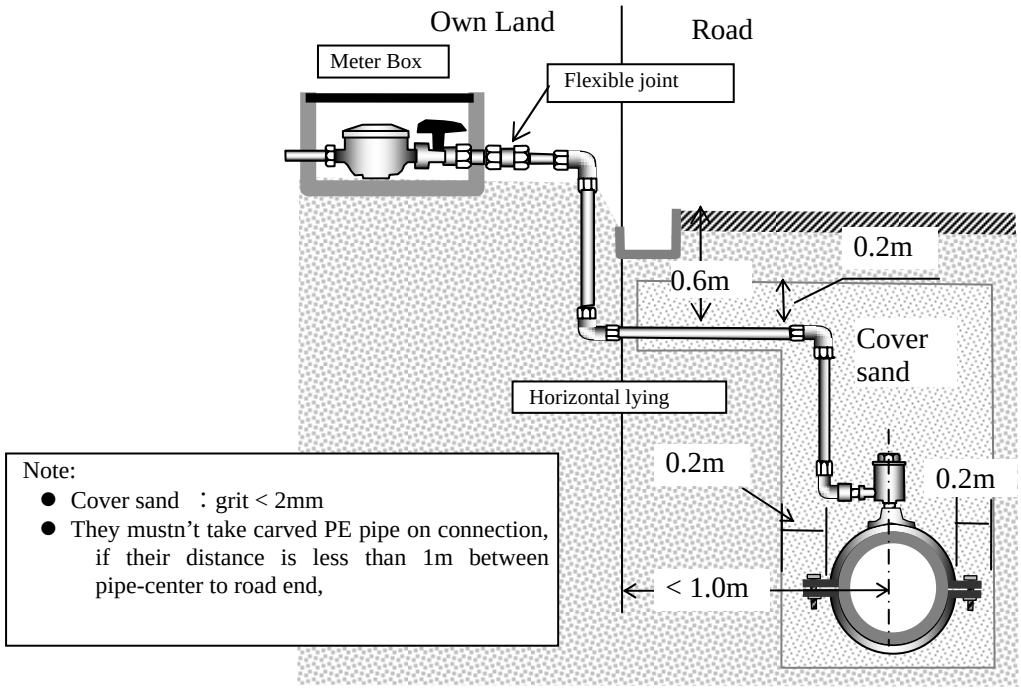
2, Service Connection Layout (Normal plumbing of GI pipe)



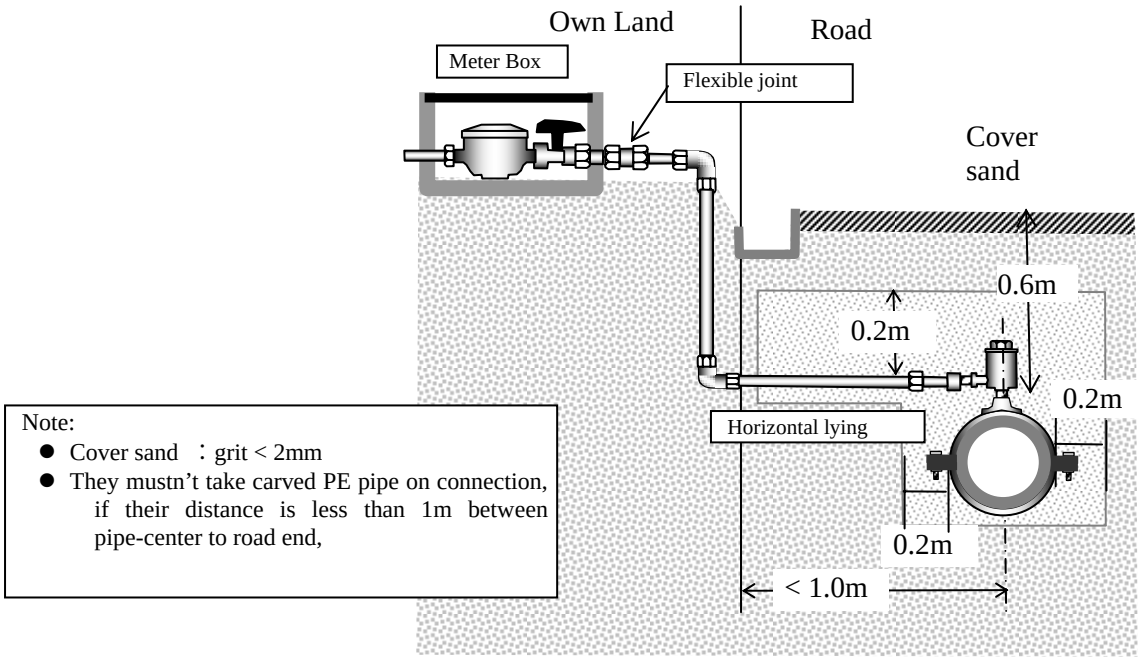
3, Service Connection Layout for PE pipe (in case of the distribution pipe is deep)



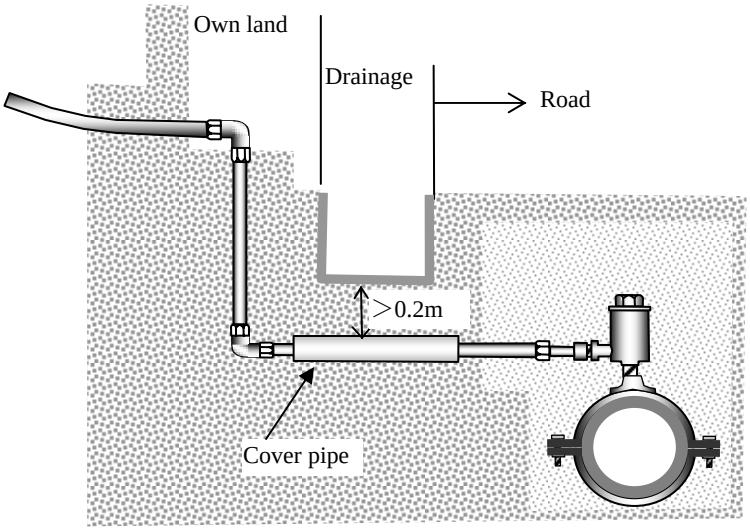
4, Service Connection Layout (in Narrow space)



5, Service Connection Layout (Narrow space and shallow lying)

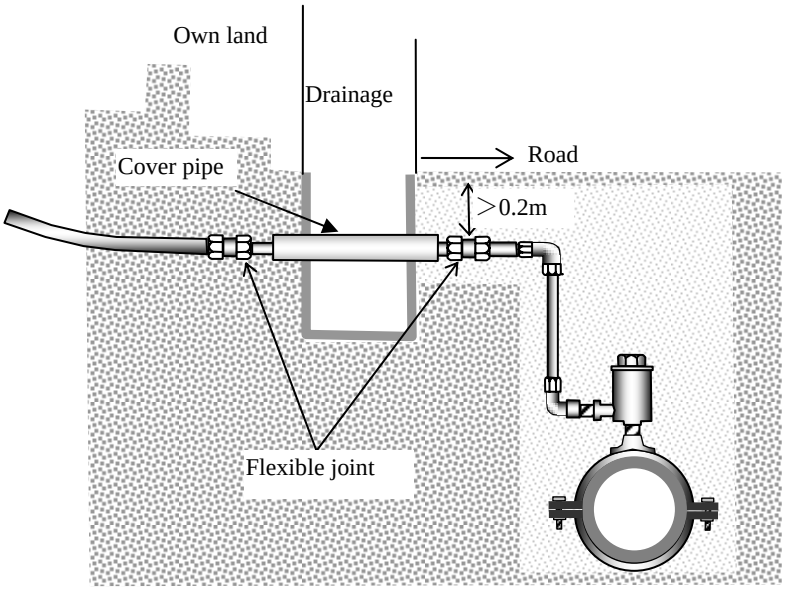


6, Pipe plumbing for across the drainage (case I)



They must using the cover pipe where get across the drainage.

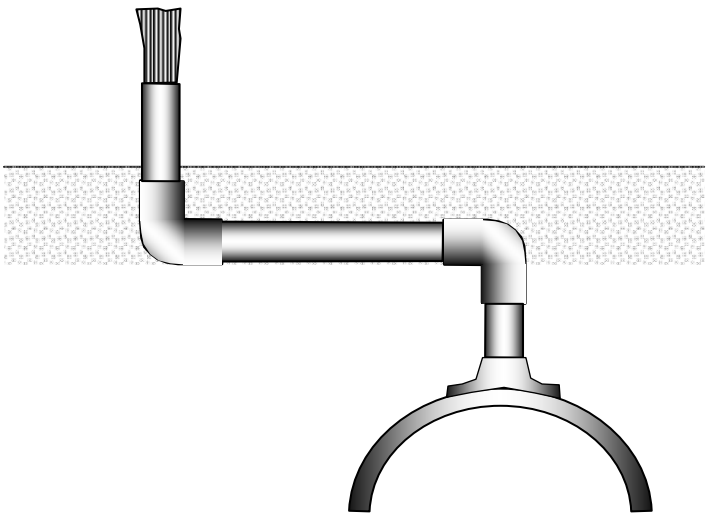
7, Pipe plumbing for across the drainage (case II)



They must using the cover pipe where get across the drainage.

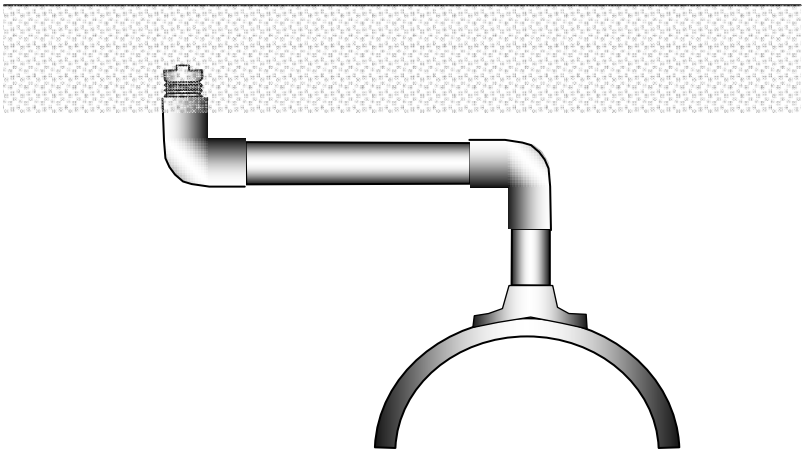
III, Cut off of service connection

Temporally method



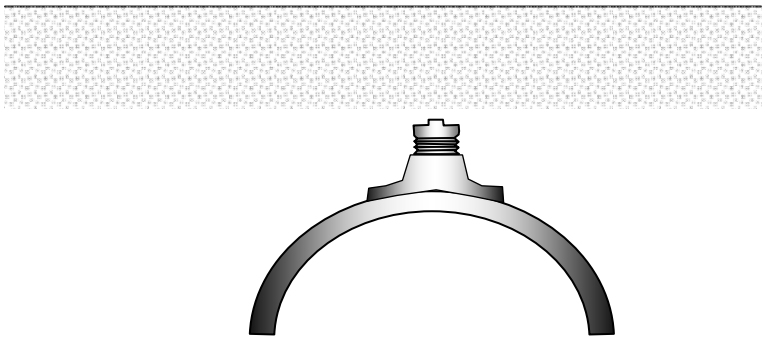
This cut off method which used the wood plug is temporally way that common sight.
But, some consumer who malice pulls out the wood plug easily, and he may use for the injustice.

Normal Cut off Method



It have to alternative but to take this method for cut off, such as pipe in deep or couldn't exposed pipe

Best way



This is normal way for cut off pipe.
It takes plugging on tapping

2. TRAINIG TEXT FOR GIS INSTRUCTION ON GIS DESIGN

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GIS Operation for Facility Management in the PANI

1. Background

1.1. Objective of GIS operation in the PANI

GIS operation in the PANI requires to restore usable GIS datasets and to updating those data from existing CAD drawing datasets and those relational databases in GIS/MIS section at Design Division. That is an activity required for NRW in order to re-compile necessary datasets for NRWmeasures about main pipes and those control facilities, service pipes, servie meters and Account Information for Service connection details.

There was no available GIS datasets for the operation in the PANI but there was only two(2) available CAD drawing datasets to be able to compile GIS datasets in CWASA. Only back up data which the project of Unaccounted Water Management Programme(UWMP) had been built up for initial datasets in the 1990's, were found in a disk drive in a PC without any documentation at the section. But the problems was no capacity to update CAD datasets in CWASA and also everything had started to prepare documentation of datasets to record lists of filename and asessment of datasets with preparation of data specification. There is available data resource found about two(2) main data redources in CWASA for GIS operation as follows:

- CAD Drawing datasets of Record Drawing Map and General Drawing Map
  Only Record Drawing Map in each Mauza, is available for compiling of GIS dataset with necessary editing work in order to develop GIS dataset.

  The map was compiled by several information about Distribution System Register and Service Connection as follows:
  - Distribution System Register consisting of main pipe network and the related facilities of valve, hydrant, reducer, washout and others
  - Service Connectionconsisting of service pipe and service meters with CWASA holding numbers. But CWASA holding number in CSCCR in Sales Division was null in the form since 1998. It was hard for mapping to idendity exact geopgraphic location according to this Holding Number.

  From point of view on Facility Management in asset management, those maps shall be utilized to support daily operation in operations and maintenances in Maintenance Operation Division(MOD) and customer services in Sales Division and Computer Section. This is a requirement to maintain Asset Map for Asset

Management.

The map is a cartographic map for drawing for printing but the map never matchs with available datasets such as GPS positining data, Google image and available dataset in CDA because of inadequate quality control in initial mapping. Nobody knows data specifications with careless awaremness in quality Control in the past data production so that map data had been shifted about six hundres(600) meters approximately. The uniqu map coordinate system was rapped in vails about these issues.

The PANI was facing to restore the past GIS datasets in the UWMP and to update those GIS datasets to the latest status since 1998 in order to carry out the pilot project for NRW in five (5) cases study areas and basic data arrangement of water distribution network in the model area. PANI operation was required to prepare initial GIS datasets with updating based on field verification survey on piplines, pipe leakage survey and the NRW opearation in the project.

- Databases of service meter and customer data in the 1990's
  There are two (2) relational databases of CWASA datasets as follows:
  - Service meter database about approximately 15000 records
  - Customer database about approximately 25600 records

  Databases might have been compiled to relational databases not only for Record Drawing Map but also for Bill Collection by the UWMP.

However only database records in customer database has been constantly updated by Computer Senction but same databases in MIS/GIS section had never updated until September in 2008. The paper form of the Consuomer Service Connection Completion Report(CSCCR) in Sales Division was not effectively fed back to update CWD drawing and databases in the renwal compter system of CAD drawing which was installed in 2008. A new CSCCR since 1998 was not plotted in CAD drawings and this behavor made it hard to map Account location in service meter. And also billing database in Computer Section didn't use CWASA Holding Number and Mauza number but Mohallah which boundaries can't plot in the map. All activities concerened made Asset Management stacked in CWASA.

There are problems and issues in databases to make it difficult to identify geographic locations of service meter and customers in the map because of absence of map updating.

Also there are no cross linkages to share informantion with relevant divisions inside of CWASA.

Moreover, CWASA Holding Number and Address in CDA are not well compiled to commond data items into customer database in Computer Section. Those information among Sales Division, Design Division and Conputer Section are not managed in the map. Also conventional record media and convensional management style make it hard to withdraw neccsary information for updating data under the present operating management system.

The PANI is tying to search any solution to update locations of service meter and customers in the map. The project started archive development of the CSCCR to arrange required information for map updaitng against available paper forms in Sales Division since 2001. These information are being checked with present customer database to be able to identify the locatios, compard with available data records.

Based on available datasets, the PANI started arrangements of GIS datasets in the project area to transfer technology of GIS operation to CWASA.

1.2. Problems in CWASA data

There is no usable GIS datasets in the backup data of CWASA datasets at present. During the preparatory step to analysis data specifications with documentations in the back up data, problems relating to mapping accuracies were made it sure to identify as follows:

- Problem of accuracy of position in mapping with locations of map: Positioning gap about over 600 meters on the coordinates of WGS84 in Figure1.2.1
- Problem of the quality control in initial mapping: Strong local distortions which never match patterns of roads and buildings within one drawing map as shown in Figure1.2.2. This reason was caused by in accurate map of BS Sheet and tracing works to make map compile to a map sheet in the conventional map compiling in missing Quality Control of the 1990's.
- Problem of different line edges in GIS data processing: Problem caused by results (Zig-Zag Lines) of cleaning processing in GIS software as shown in Figure1.2.3

CWASA mapping data is embedded by a special map coordinate system and is having the problem of the resource itself. However, in order to update the data of a water supply facility on CWASA data in the PANI project, it is indispensable t use GPS data and Google image data. Therefore, it becomes the best approach for mapping to make it utilize for those data to transform to the data of CWASA. Then, the project decided to adopt methods to download

satellite image data by Google Earth Pro, to display the image on CWASA mapping data as a back drop data and to arrange positioning data in the field by GPS equipment on Google image data.

Figure1.2.1 CWASA mapping data never match with WGS84

Figure1.2.2 Different mapping accuracy in a map
(A problem of data quality in the preparation work in initial mapping)

Figure1.2.3 Problem of sheared figures

Red line is original data. Red line is GIS backup data. Originally the figure doesn't change in transform process but CWASA data is being sheared.

1.3. Technical issues in GIS arrangement

In order to restore the missing GIS datasets, CAD drawing must be converted to GIS dataset with editing and digitizing with transformation of coordinate system, however there are critical problems on technical issues in Record Drawing Map in order to handle different type of data structures between CAD drawings and GIS data as follows:

1.3.1 Requirement of transformation of unique CWASA coordinate system

Since CWASA coordinate system in Figure1.3.1 was compiled by unique coordinate system configured by transformation multiplied 10,000 against geographic coordinate system on decimal in latitude and longitude., data never match with datasets on WGS1984 or BTM. Data

For example, N92.012234 on decimal degree is projected to 9201223.4 as a local coordinate. Because the distance unit is nearly corresponding to one (1) meter on the grand in a flat area in consideration of standardization of geographic data

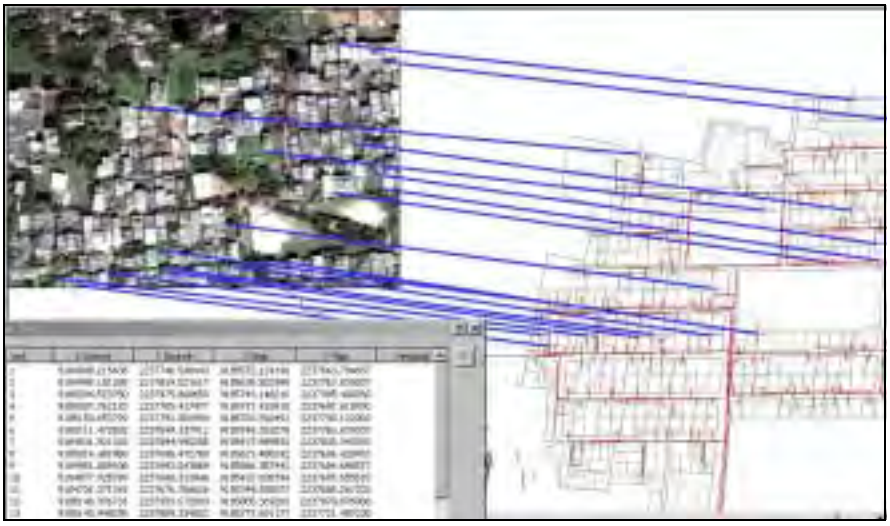
In order to over lay available datasets to CWASA data, dataset must be transformed by the following steps:

- Georeferencing of CWASA datasets to geographic coordinate system on Everest1830.
- Map projection of CWASA datasets to geographic coordinate system on WGS84
- Map projection of CWASA datasets to Bangladesh National Grid Coordinate system:

BTM(Bangladesh Transverse Mercator Projection

Relevant agencies using GIS system generally employs the geographic projection and BTM projection on maps. So it is necessary for CWASA to provide with those datasets to the future.

Original dataset of CWASA CAD drawing



Step1 Transformation from CWASA coordinate system to Everest 1830

Step2 and Step3: Map projection from Everest 1830 to WGS84 and from WGS84 to BTM

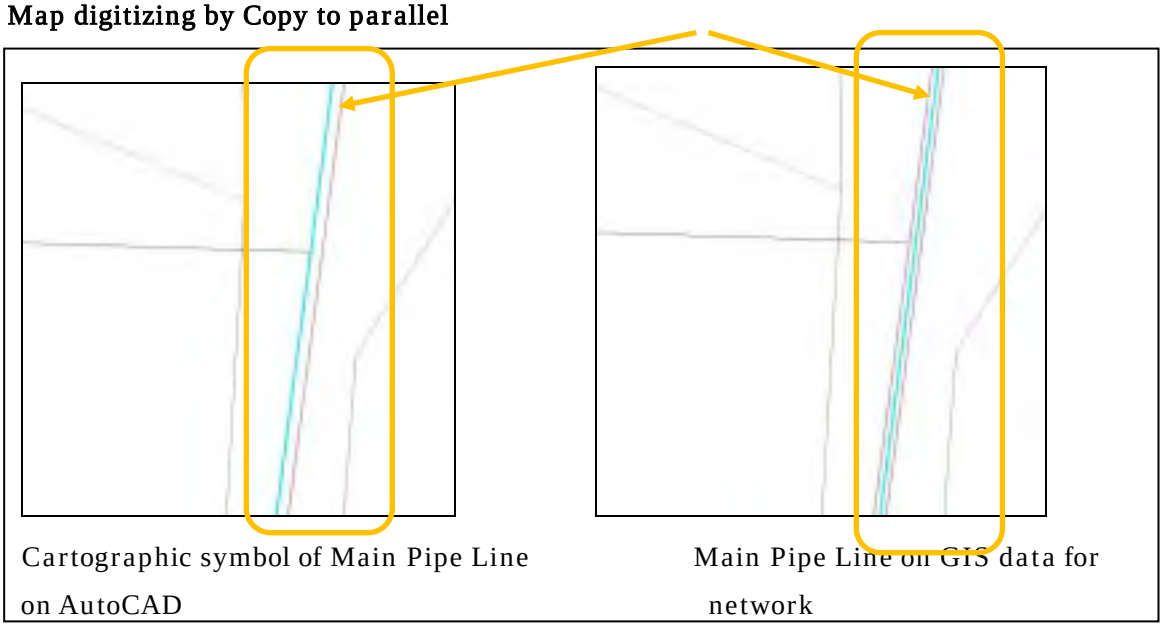
Figure1.3.1 Utilization of Google Image to adjust for CWASA coordinate system

1.3.2 Requirements of editing at symbol data in CAD drawing

(1) Requirement of map digitizing of main pipe in CAD drawing

Since main pipe line on CAD drawing is a line symbol with double lines, a center line of line symbol must be generated by digitizing of a center line in Figure 1.3.2. In order to build the pipe line network in GIS data, a center line must be traced and handled by the CAD data.

Map digitizing by Copy to parallel

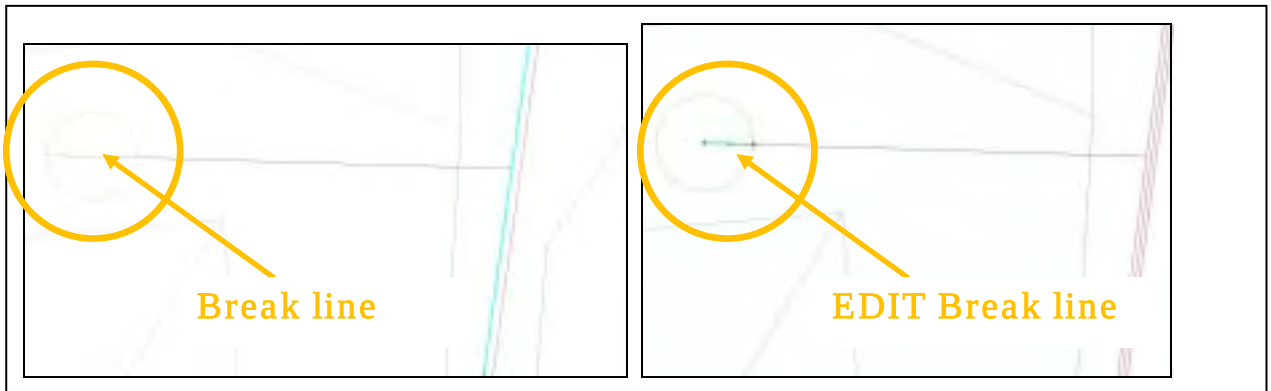


Cartographic symbol of Main Pipe Line on AutoCAD

Main Pipe Line on GIS data for network

(2)Requirement of editing of break pipe line at a circle symbol of meter in CAD Drawing

Since a break pipe line is hidden under a circle symbol of service meter in CAD drawing, a service pipe line shall be ended at a center point of a circle symbol of service meter by editing in Figure1-4. A break line must be made to shorten to a center point at the circle with merge operation to service pipe in Figure 1.3.3.



Break pipe line under a circle symbol of a meter on AutoCAD

Break pipe line on GIS data prepared by data edit under a meter

Figure 1.3.3 Data handling of break pipe line

(3)Requirement of a point generation of a circle symbol

A circle symbol in CAD drawings in Figure 1.3.4 is required by a point generation of its symbol. Attribute of House plot numbers in customer database must be given to GIS data.

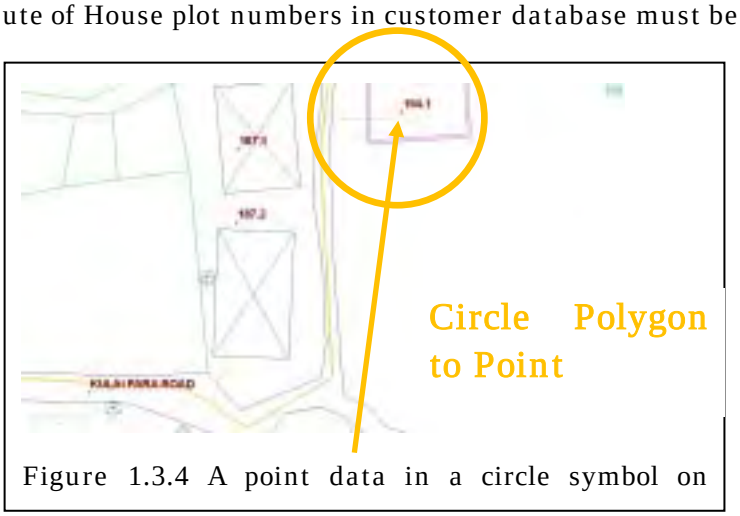
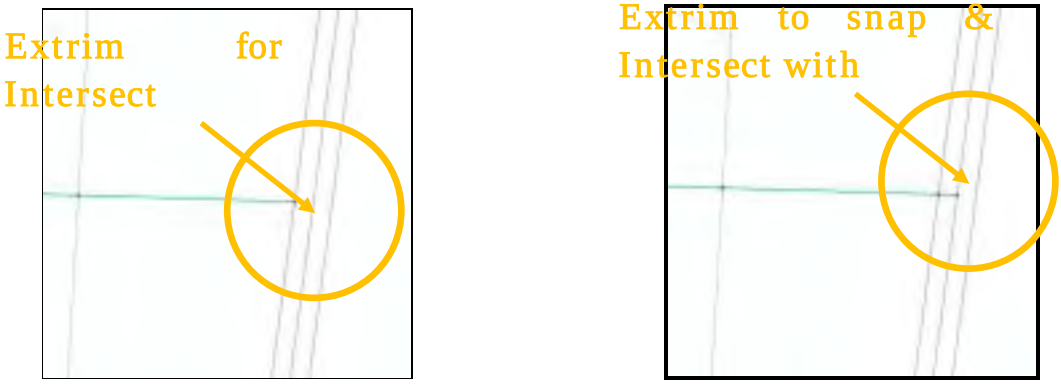


Figure 1.3.4 A point data in a circle symbol on

(4) Requirement of snap operation

According to problems in the preparations of initial datasets and editing of symbols data, a line data is required to snap operations and intersection operation at undershoot of line in Figure 1.3.5 and at overshoot of line in line network. A line GIS data is required to edit data to snap lines together among main pipe line, service pipe line, a service meter. Also break arc operation is required at a point locations on main pipe such as valve, hydrants, and other facilities concerned to Water Distribution Network.



Disconnection of line network on AutoCADdata

Connections of line network on GIS data

Figure 1.3.5 Difconnection of service pipe line

(5) Requirement of data entry of attribute

Since annotation layer in CAD drawing is not attribute of GIS data, the definite attribute must be inputted in editing in Figure1.3.6.

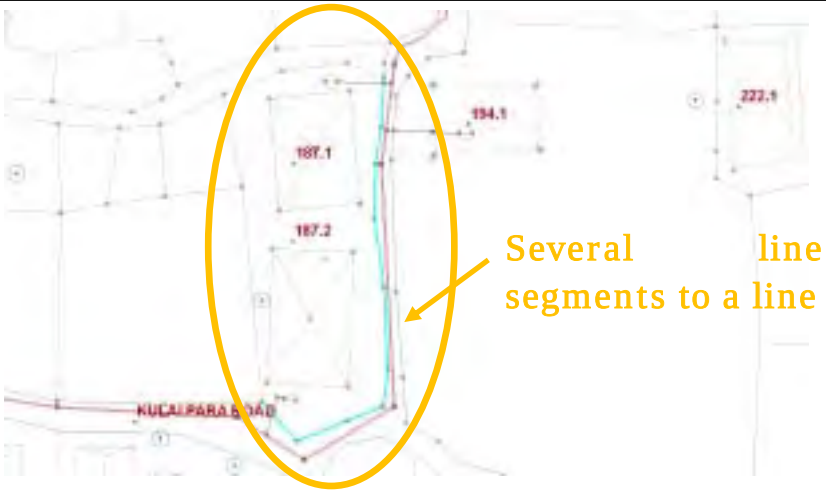
CAD attribute on AtutoCAD　　Label of attributes in GIS data

Data attributes must be recored in database of GIS data in data conversion

Figure1.3.6 Data handling of attribute on CAD to GIS

(6) Requirement of removals of line fragmentations

Since there are many complexes of lines, so called line fragmentations in the Record Drawing Map on CAD drawing, line fragmentations shall be removed to make simple line from node to node in Figure1.3.7. Line fragmentations make data record increase and also make efficiency of data access to slow in software operations..



Data had better not have fragmentations to produce clean GIS data

Figure1.3.7 Line fragmentations on AutoCADdata

2. Facility Management and GIS in PANI

2.1. Facility Management and GIS

CWASA GIS operation is categorized in a field of Facility Managments(FM) in utilities on Social Infrastructures such as Water supply and Serewage, Tele-Communication, Electricity, GAS and etc. The supporting system is develped to assist mapping and databases in daily operation and maintenance by developments of mapping, database, GIS and system.

CWASA had started to develop asset mapping and relational databases for FM during the implemanetaion of the UWMP in the 1990's and GIS system in Facility Management was introduced by this project in the middle of the 1990's by the project. CWASA is one of pioneers of GIS development in Bangladesh.
However GIS system has been stopped until 2009 because of physical problems in suprporting system. Due to requiremts of GIS datasets in the PANI, GIS operation in CWASA was started over by the PANI.

GIS system is utilized to a plat form to develop supprting system for facility management of water suply. The system will be appled to developments for various kinds of operation supports such as researh and development for planning, maintenance support for operation and maintenance, customer service and support and its marketings. The development of FM is closely relating to synchronize those among Mapping, Database and System simultaneously.
GIS software provides with several components of modules to make spatial data handle with relational databases for Facility Management as follows:

- Map digitizing,
- Editing of GIS data,
- Display maps
- Retrive of database
- Spatila data analysis such as overlay and tabulations,
- Cartographic design for map printing
- Applicatuon davelopments in GIS system with customizing of GIS software and system development and so on.

Supporting functions in Facility Mamanagement System tends to depend on the initila system design and a choice of softwares.
In order to establish Facility Management, GIS is often utilized to choose a plat form of FM system in utility management and GIS system makes it easy to handle maps and databases and documents in System in order to support daily operation and maintenance. The system

will be required to develop those applications continuously in the future.

2.2. Supporting system

GIS operation requires carrying out the data processing to develop GIS datasets and a development of relational database in order to support planning and operations. There are hardware and software in GIS system equipped.

Software of ARCGIS are chosen for a plat form of GIS software as follows:

- ARCGIS ARCINFO is to support overall GIS operation to develop GIS data and GIS development for planning, database development, spatial analysis, application development and others.
- ARCGIS ARCVIEW is to support database developments for customer database and house connections and application development and others

Bothe software use common modules with user friendly interface for the operation in the product.

Required task and supporting GIS functions in ARCGIS are summarized in Table2.2.1.

Table 2.2.1 Requirements of task and Supporting function in GIS

Required task in the project	Supporting GIS function
Map digitizing and editing	Map digitizing, editing, topological processing on geometry
Updating of geographic feature on latest satellite image	Image capture, on screen digitizing on topology of geometry
Database retrieve	Database entry, Building of relational database
Identification of geographic location, Compilation of maps	Display of attribute in map for reference, Display overlay to compile some maps, to process among maps,
Extractions of geographic location and attribute required by a condition	Overlay operation with query operation in database to process map among thematic maps
Reference of document	Display of reference by link operation of document and image in database
Tabulation of geographic information	Query operation in database to extract required record with overlay process
Output of map	Map layout and printing

The PANI procures GIS equipment to implement the project operation and to support GIS

training to transfer technology of GIS operation to counterparts. The summary of list of GIS equipment listed in Table2.2.2. The system diagram is shown in Figure2.2.1.

Table2.2.2 Main list of required GIS equipment in the PANI (July 2009)

List of Equipment		Set of Unit
1.	**GIS workstation**	
(1)	GIS workstation for overall GIS processing and facility management	2 sets
	Processor: Intel Core 2 Quad or XEON, RAM MEMORY; 4GB, HDD: more than 320 GB (SATA), DVD/CD+RW dual drive, Graphics accelerator board (suitable for CAD&GIS operation) for DUAL Monitors, Keyboard: USB keyboard, Mouse: USB optical mouse with scroll key, Interfaces ports: Serial, Parallel, graphics, Keyboard, Mouse, USB, Ethernet: On board 10/100/1000 Operating System: Windows 7 downgraded to XP Professional Service pack 3 Monitor: 20" LCD Color Monitor	
2.	**GIS Software and database**	
(1)	ARCGIS 9.3 Desktop ARCINFO (ESRI)	1 license
(2)	ARCGIS 9.3 Desktop ARCVIEW (ESRI)	1 license
(3)	Microsoft Office Professional (MSACCESS) for database development	2 licenses
(4)	Anti Virus software	2 licenses
3.	**Input and Output device**	
	A1 size of Color Inkjet Plotter: HP DesignJet510 42 inch with Ethernet board and option memory	1 set
	A3/A4 Monochrome Multi function Printer/ Scanner: Canon iR2018 UFRII LT	1 set
	A4/A3Color inkjet printer	1 set
4.	**Other equipments of power supply about UPS and Automatic Voltage Stabilizer, network devices about switching hub and network cables**	

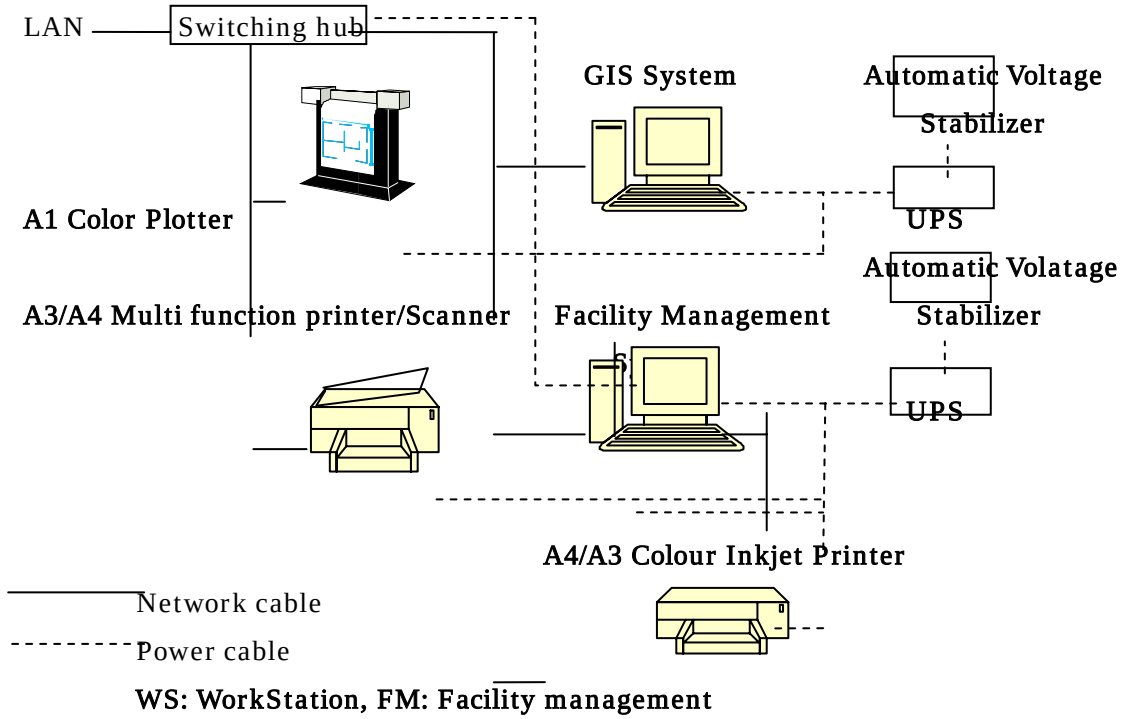


Figure2.2.1 System dialog of GIS workstation in the PANI (July, 2010)

3. Arrangemet of GIS data in the PANI

GIS operation in the PANI will guide to transfer technology to couterarts and to assist one of steps for capacity building of GIS operations throughout arrangements of GIS datasets with training and the On the Job training.

There are several objectives of GIS operation in the PANI as follows:

- Arrangements of GIS datasets in Water Distibution Network about main pipe with pipe diameter and pipe material, location of control valves, locations of other control utilities in pliot project area and the model area.

- Arrangement of GIS datasets in Consumer Service Connection about service pipe line and service meter with custmer data with CWASA Holding Number and Accout Number. Paricularly, these locations must be updated by the present customer database in computer section.

- Arrangement of cusomer database in Consumer Service Connection in pilot project area and model area

  In order to update locations of service meter and customer location in the map, arrangements of data resources identifying map locations are required as follows:

(1) Arranagement of available databases about service meter and initial customer data in GIS/ MIS section

(2) Arrangement of resent customer database in Computer Section

(3) Arrangement of cross check among date records

- Cross check with paper form of the CSCCR in sales Division with preparation of digital archiving and database.
- Cross check of old customer database with preset one in Computer Section
- Cross check with the above data with monthly work sheet in meter readings in Sales Division for data encoding in Computer section.
- Cross check to screen anonymous records which will be necessary to update the location in the map.

Main objective of GIS operation is to restore missing GIS datasets and to update necessary mapping information in pilot project area and in the model area.

3.1 Design work of Mapping Features and GIS datasets

The PANI requires compiling of GIS datasets to achieve definite purpose supporting managements of NRW in pilot project area and in the model area as follows:

- Main pipe with pipe attribute
- Related facilities on main pipe in DSR such as control valve, hydrant, Tees and others.
- Service pipe with property of customers information
- Service meter with property of customer information
- Customer information consisting of Account number, CWASA holding number, Mauza number and so on.

In order to restore GIS datasets, the PANI started preparations of GIS data which operations are done by editing in CAD drawing datasets of Record Drawing Map with transformation to switch over from unique CWASA coordinate system to geographic coordinates on WGS1984. The following is an introduction of database structure of GIS datasets.

3.2 GIS datasets of main pipe and location points of DSR facilities

GIS data of main pipe line is compiled by digitizing and editing of Record Drawing Map in CWASA CAD datasets as follows:

- Main pipe line is digitized by map digitizing of center line of road symbol with double lines with data entry of pipe attribute. See database field of main pipe in Table1.1 in the appendix.
- Facility location point is digitized on nodes points of the above data with data entry of type of DSR facilities such as control valve, hydrant, Tees and others. See database field of main pipe in

Table1.2 in the Appendix.

3.3 GIS datasets of service connection

GIS data of service connection is compiled by editing and digitizing of editing of Record Drawing Map as follows:

- Service pipe is compiled by editing of service pipe and break line of circle symbol of service meter in CAD datasets with snap and intersection in figures and data entry of CWASA Holding number in the attribute. See database field of service pipe in Table2.1 in the Appendix.
- Service meter is compiled by point generation from circle symbol or map digitizing of a center point in circle symbol in CAD drawing and data entry of CWASA Holding number in the attribute. See database items of service meter in Table2.2 in the Appendix.

3.4 Other mapping features

GIS data of other mapping features are compiled by generations of CAD layers in Record Drawing Map as follows:

- Other mapping features are compiled as line GIS data by corresponding line features in CAD datasets Attributes are generated from those in original data. See database field of other line features in Table3.1 in the Appendix.
- Map annotation is generated as a point GIS data from that in CAD datasets Attributes are generated from those in original data. See database field of other line features in Table3.2 in the Appendix.
- There is available GIS dataset of Well in other mapping features by point generation from circle symbol or map digitizing of a center point in circle symbol in CAD drawing and data entry of CWASA Holding number in the attribute. See database items of Wells in Table3.3 in the Appendix.

3.5 Relational Database for GIS datasets in Design Division

Relational database for GIS datasets in Design Division is existed in Design Division, which data status was in 1997. There are two (2) databases requiring to update service connection in the map as follows:

- Database of service meter is a relational databases of GIS datasets about service pipe and service meter. Attributes are generated by this database through CWASA Holding number in GIS data. See database field of service meter database in Table4.1 in the Appendix.
- Database of customer data is a relational databases of GIS datasets about service pipe and service meter. Attributes relating to account information and bill collection are generated by this database

through CWASA Holding number in GIS data. See database field of database of customer database in Table4.2 in the Appendix.

3.6 Other relational databases in Distribution System Register

There are several types of relational databases in DSR (Distribution System Register) supported by dBase IV and PC ARCINFO in the initial mapping in the 1990's at Design Division. See Table3.6.1.

Table3.6.1 List of existing relational databases in Distribution System Register

DB Group	Item	dBASE		Type of Data
Consumer database	Consumer	CWASA_M.dbf	25602	dBASE
	Meter	Meter.dbf	25602	dBASE
DSR databases : Basic data	1 Pipe work	PIPEWORK.dbf		CAD Drawing in CWASA coordinate system
	2 Booster Station	BOOSTERS.dbf		Ditto
	3 Booster Pump	BOO_PUMP.dbf		Ditto
	4 Treatement Plant	TREATMEN.dbf		Ditto
	5 Treatment Pump	TRE_PUMP.dbf		Ditto
	6 Tube Well	TUBEWELL.dbf		Ditto
	7 Reservoir	RESERVOI.dbf		Ditto
DSR databases : Maintenance data	1 Pipe leakage	PIPELEAK.dbf		No record
	2 Booster	BOOSTMNT.dbf		Ditto
	3Treatment plant	TRE_MAIN.dbf		Ditto
	4Tubewell	TUB_MAIN.dbf		Ditto
	5Reservoir	RESERVMNT.dbf		Ditto

Those databases might have been compiled for relational databases of present CAD drawing datasets or missing GIS datasets which production were supported by PCARCINFO in the previous project in the 1990's.

There are two (2) relational databases relating to facility management of DSR (Distribution System Register) as follows:

- Basic data of facility information consisting of
  - Pipe work for properties of main pipe
  - Booster Station for properties of the facility
  - Booster Pump for properties of the facility
  - Treatment Plant for properties of the facility

- Treatment Pump for properties of the facility
- Tube Well for properties of CWASA tubewell
- Reservoir for properties of the facility

Data structures in Basic data are shown in Table5.2 in the Appendix.

- Maintenance data about maintenance records of facilities consisting of
  - Pipe leakage for maintenance record of that record in main pipe
  - Booster for maintenance record of the facility
  - Treatment plant for maintenance record of the facility
  - Tubewell for maintenance record of the facility
  - Reservoir for maintenance record of the facility

Data structures in Maintenance record are shown in Table5.3 in the Appendix.

4. Setup of Coordinate System in GIS dataaset

Coordinate System of GIS dataset in the PANI is adopted by geographic coordinate system on WGS1984 or Bangladesh National Grid Coordinate System so called Bangladesh Transverse Mercator (BTM) instructed by Survey of Bangladesh (SOB) in Table4.1 as follows:

- Geographic Coordinate System on WGS1984
- BTM

Table4.1 Map projection and national Grid

GRID SYSTEM	Geographic Coordinate System on WGS1984	BTM
Projection:	Geographic coordinate	Transverse Mercator
Ellipsoid :	WGS1984	Everest 1830
Datum:	WGS1984	Gulshan
Latitude of Origin:	Greenwich	E 90 00 00 N 00 00 00
Scale Factor:		0.9999
False Easting:		500,000m
False Northing:		-200,000m
Linear Unit:	Degree	Meter

CWASA coordinate system was employed by the project of the Unaccounted Water management Programme in the 1990's. However this coordinate system brought some problems about mismatching of GPS data or GIS datasets of Chittagong Development

Authority(CDA) in the map. The main reasons about missing matching results in products might have been caused by series of quality controls in particular accuracy of mapping data during the past project. Nobody cared critical problems about mapping products.

GIS software is required to set suitable coordinate system to handle for map projection.

5. Understanding GIS especially difference of data stucture

There are some different data structures for data management and different operational functions between CAD and GIS. Typical data problems caused by human being in operators are shown in Figure5.1, so that SNAP option is most important as follows:

- SNAP TO NODE
- SNAP TO VERTEX

The difference of data structure of GIS data and CAD data

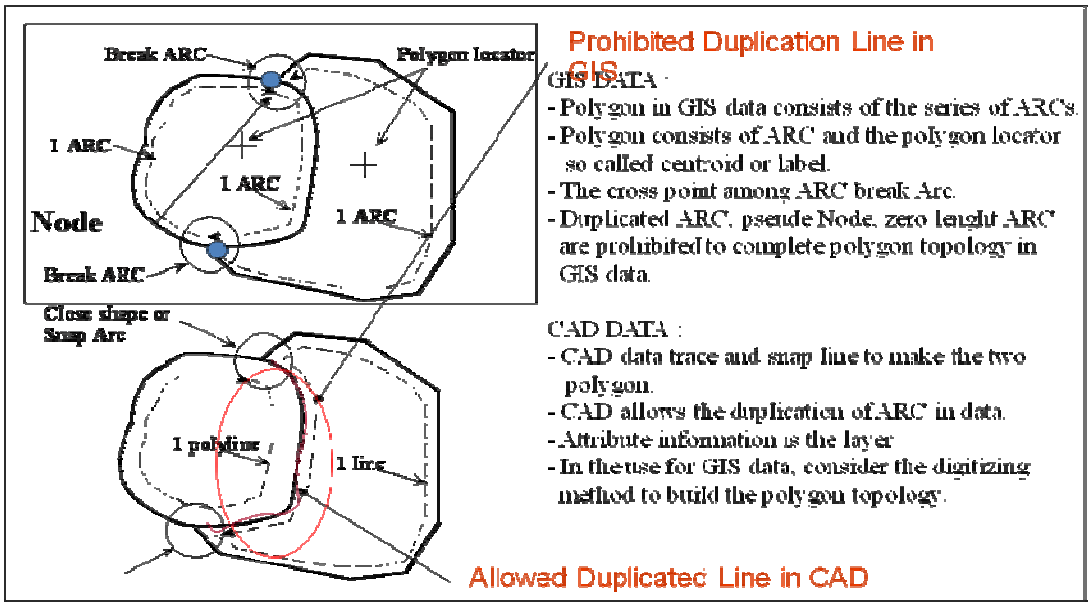


Figure 5.1 Differences of Data structure between CAD and GIS

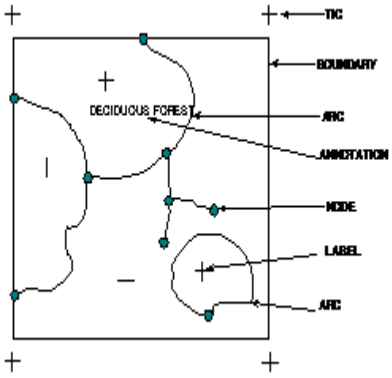


Figure5.2 Coverage and structure in ARC/INFO

Although CAD data is in use of design and cartographic drawing, GIS data basically consists of simple elements such as Point, Line, Polygon and Text. In case of explanation of ARCINFO topology, the coverage is defined as the map sheet to be managed in ARC/INFO in Figure5.2 and it consists of several items of features in Figure5.3 as follows:

- Point: the simplest element. The points composing between nodes are called as "Vertex."
- Node: The start point and the end point of a Line and the cross point of Lines.
- Arc: Arc is defined by a series of sequential points from node to node.
- Polygon: Polygon is defined by a series of connected Arcs
- Label: The point feature at which an area ID is attached to the polygon.
- TIC: Registration points for the coverage domain required map sheet corners
- BND: The range of TIC coordinates(X minimum, Y minimum, X Maximum, Y minimum).

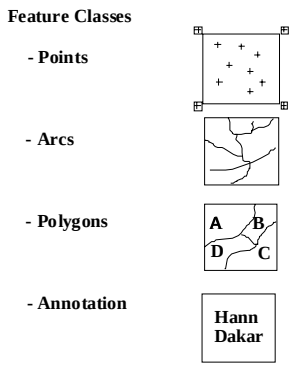


Figure5.3 Feature class of GIS data

GIS data is required to re-produce all data to provide with usable data conditions for GIS operation. However, current AutoCAD data uses cartographic symbols in the data only, so those symbolic data directly cannot use for GIS data and the following editing process is required:

- A digitizing of a center line of main pipe line to establish pipe line network
- Nodes connections among lines of main pipe lines, service pipe lines, break pipe lines with meters and hydrants.
- Cleaning of line fragmentations
- Buildup of topological relations on geometric figure data.

In order to process GIS data from CAD data, GIS data process needs the cleaning process to eliminate the geometric relations. Data structure is composed to those simple data.

- Data structure of GIS data

  GIS data is composed by figures and those attributes identifying spatial locations. GIS data structure consists of Point, ARC, Polygon and Text in Figure5.3. Data structure is very simple but not that in CAD.

(1)Point

Point is a data identify a single location and its attribute is attached to that at a location point.

(2)Line/ARC/Polyline

Line is a sequential data consisting of a series of points form start Node to end Node. Internal points in a line is so called vertex. The attribute is attached to that of line information.

At the intersection point among lines, lines shall be split at the point. Geometry of lines is used about length of line section and node information of the start point of line and the end point of line.

The relationship between Arc and Node:

- Arc is that a series of point which has X and Y coordinates in Figure5.4
- Node is that the start point and the end point of Arc. The intermediate point between the start point and the end point is so called as the Vertex in Figure5.5

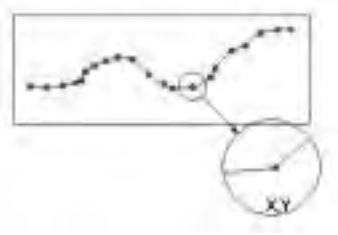


Figure5.4 ARC and Node

(3)Polygon

A polygon constitutes it at a label point representing a respect of figure data and a figure of a serial line constituting a respect (Centroid).Geometry of a figure has constitution of Node constituting a line constituting a polygon, a joining related (the right polygon, the left polygon) line of a respect in a line, and information to represent a respect is added to a figure attribute as an attribute. a parameter of Geometry, Area and Perimeter, an item described already are. See Figure5.6.

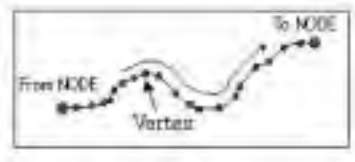


Figure5.5 Node and Vertex

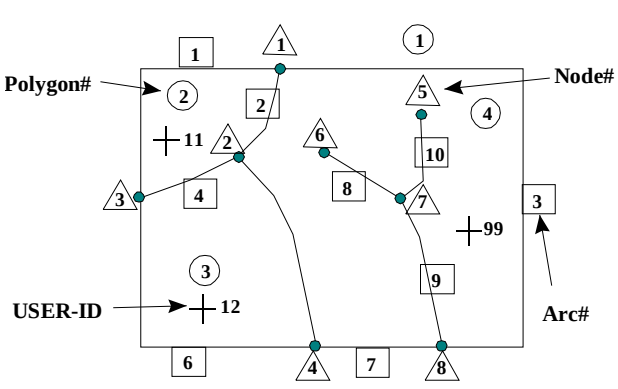


Figure5.6 Polygon data

(4) Text

A text constitutes it by a letter in point data of a position by data to let display a letter, a symbol.

- Topology

Topology defined has the following rules to handle GIS data.

Topology means spatial relations among figures: Consequence and Connection;

The simple data structure composes to a complex of figures as follows:

- Point (the most simplest element)
- ARC (A series of sequential points)
- Area (A series of connected ARCs)

The topology protects to create the meaningless figure data

- ARC is a representative of linear feature in whole or part by simple line
- ARC forms the edge of boundaries or the part of thematic area of polygons.

The topology is defined as a relationship between the connectivity and neighborhood of a feature represented by ARCs, and the data is recorded in a number of lists of features.

- Polygon topology is the list of the ARCs to form the boundary of a polygon.
- ARC-Node topology is the list of the start point and the end point of ARC
- ARC-Polygon topology is a list of the left side and the right side of polygon.
- Node topology is the list of ARCs to be connected by Node.

Scheme of Topology relation is shown in Figure5.7.

TOPOLOGY STRUCTURE

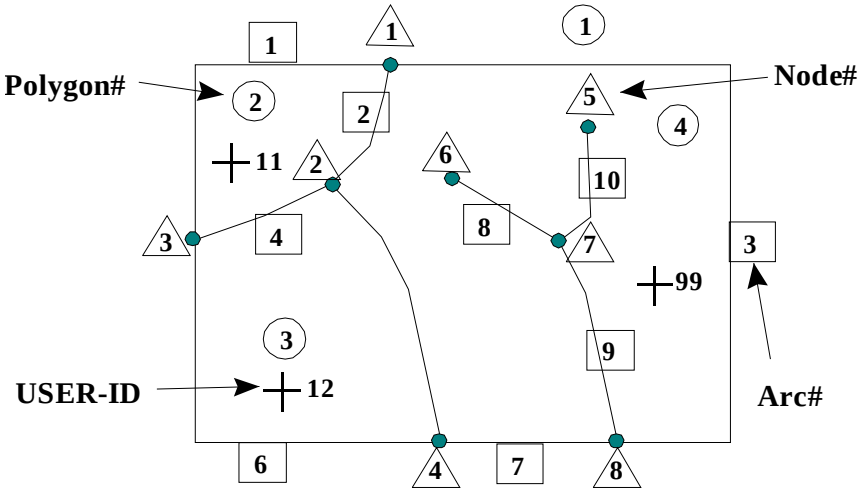


Figure5.7 Topology Structure

NODE TOPOLOGY

NODE#	ARC#
1	1,2,3
2	2,4,5
3	1,4,6
4	5,6,7
5	10
6	8
7	8,9,10
8	3,7,9

ARC TOPOLOGY

ARC#	FROM	TO	LPOLY	RPOLY
1	1	3	2	1
2	1	2	4	2
3	1	8	1	4
4	3	2	2	3
5	4	2	3	4
6	4	3	1	3
7	8	4	1	4
8	6	7	4	4
9	8	7	4	4
10	7	5	4	4

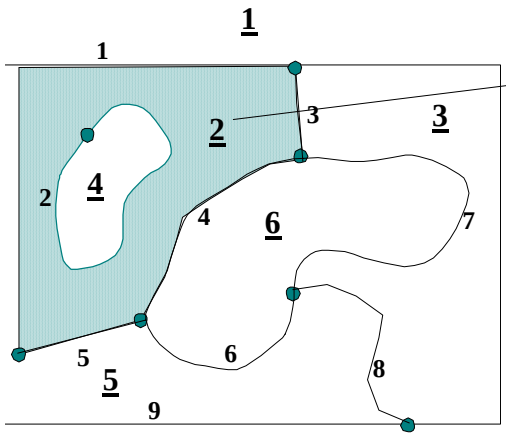
POLYGON TOPOLOGY

POLY#	USER-ID	ARC#
1	0	1,3,6,7
2	11	1,2,4
3	12	4,5,6
4	99	2,3,5

- **Check points for map editing in GIS operation**

Basically GIS data is required to prepare simple features of line and points. According to rules of Topology mentioned, figures must to be processed by certain rules.

If there is a cross point among ARCS, A Node point shall be put and lines segments shall be divided to several ARCS at the junctions. It is necessary to eliminate figural errors on geometry. Supposed errors in digitizing and editing are shown in Table5.1 and Figure5.8 as follows:



Polygon Line List

Poly#	Line#
2	1, 3, 4, 5, 0, 2
3	3, 10, 8, 7
4	2
5	5 ,6, 8, 9
6	4, 7, 6

Line Coordinate List

Line#	XY Pairs
1	5,3, 5,5 8,5.....
2	4,4 4,5 .....
3	9,4 8,5 .....
4	8,3, 9, 4, ...
5	.....
6	.....

PAL file stores those lists of topology structure.

Table5.1 Supposed errors on topology

Errors	Point	Line	Polygon	Text
Missing label	○	○	○	○
Overshoot		○	○	
Undershoot		○	○	
Bad arc: incomplete arc with mistake in digitizing		○	○	
Duplicate arcs		○	○	
Too many vertices: Generalize		○	○	
Missing arc		○	○	
Duplicated labels	○		○	○
Edge matching		○	○	

(1)ARC

- Duplicated Arc
- Removal of duplicated Nodes
- Overshooting
- Undershooting
- Topology: Point, ARC, POLYGON
- Edge Matches of ARCA and POLYGONS
- Dangle

(2)Line

- Check Overshooting and Undershooting and node connections among ARCS
- Dangle of ARC such as zero length ARC
- Duplicated ARCs
- Start node and end node composing to line
- Split of line section at the junction across ARCS

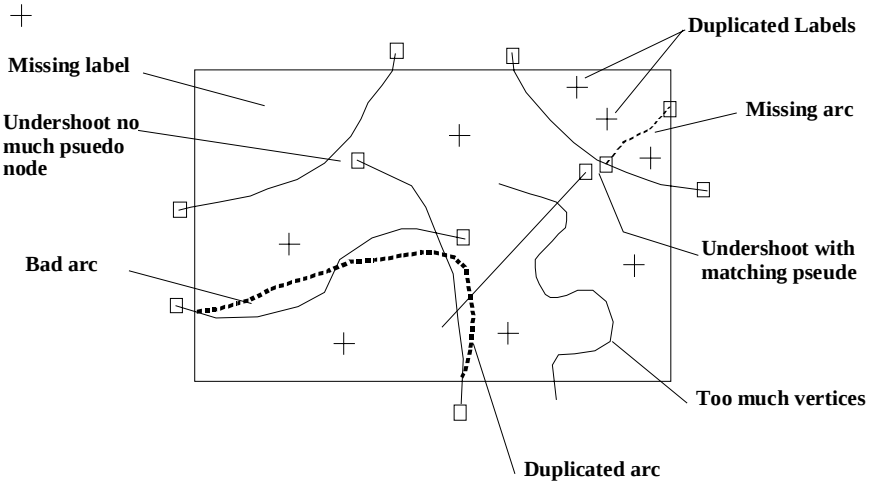
(3)Polygon

- Connections of Nodes among ARCS
- Polygon topology

(4)Text

Text is located in a point features. A point of polygon is defined to a Label in ARCGIS.

Error check and Supposed errors in coverage



Example of ArcInfo coverage

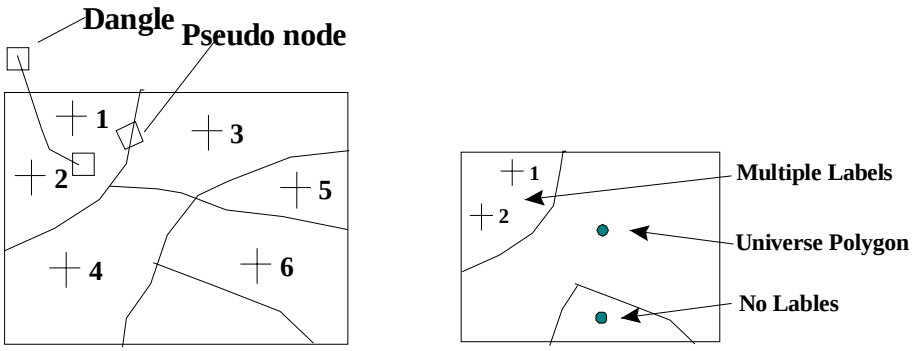


Figure5.8 Supposed errors in digitizing

- **Attribute in database**

Database design depends on Mapping GIS software used. Generally attribute of database field recorded in database is defined to numeric Text, date and others. The following format is supported in Table5.2.

Table5.2 Attribute of database field

Format	
D	Date
C	Character（Text）
N	Numeric
I	Integer
B	Binary Integer
F	Binary Float

GIS user design the data format in database design and is required to utilize operational skill of database software.

Database operation and Geometry（Length、Area、perimeter、others）

In data editing, the following errors are detected and eliminated by means of Geometry of topology and record query in database operation in map editing.

- Detection of small polygon and eliminate of those polygons
- Detection of Zero-length Arc and removal of those ARCS

- **Database operation**

Database operation is utilized as follows:

- Add field and delete field in database
- Query searching data by SQL statement and data handling by calculation
- Editing data by query operation in database
- Search of map features by query operation in database
- Editing of data by query operation
- Editing of database by using joint operation of relational databases in Figure5.9.

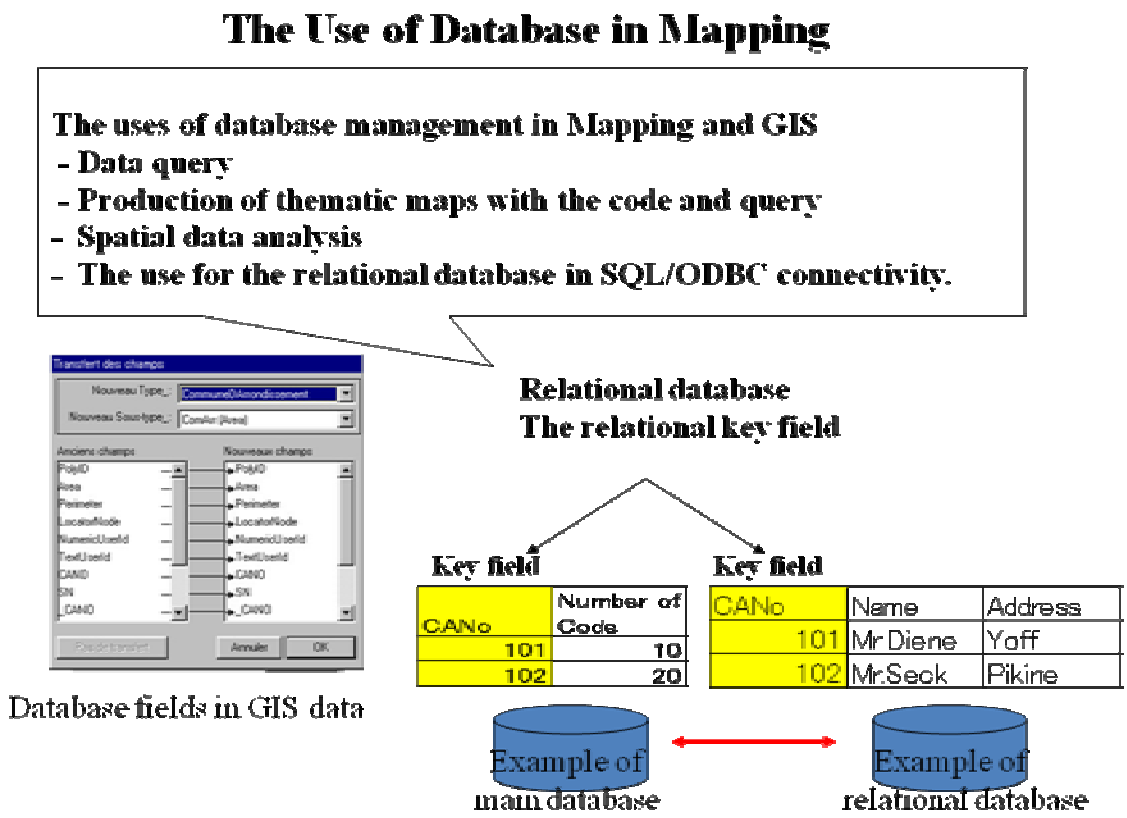


Figure5.9 Scheme of relational database

Training of GIS consists of as follows:

- Instruction of GIS and GIS development
- Understanding GIS
- Work frame for GIS datasets
- Instruction of GIS datasets and GIS system: Guidance of basic operation of ARCMAP
- Practice of GIS operation

6. Vision for GIS development of Facility Management in CWASA

6.1 Management Scheme of Water supply and GIS

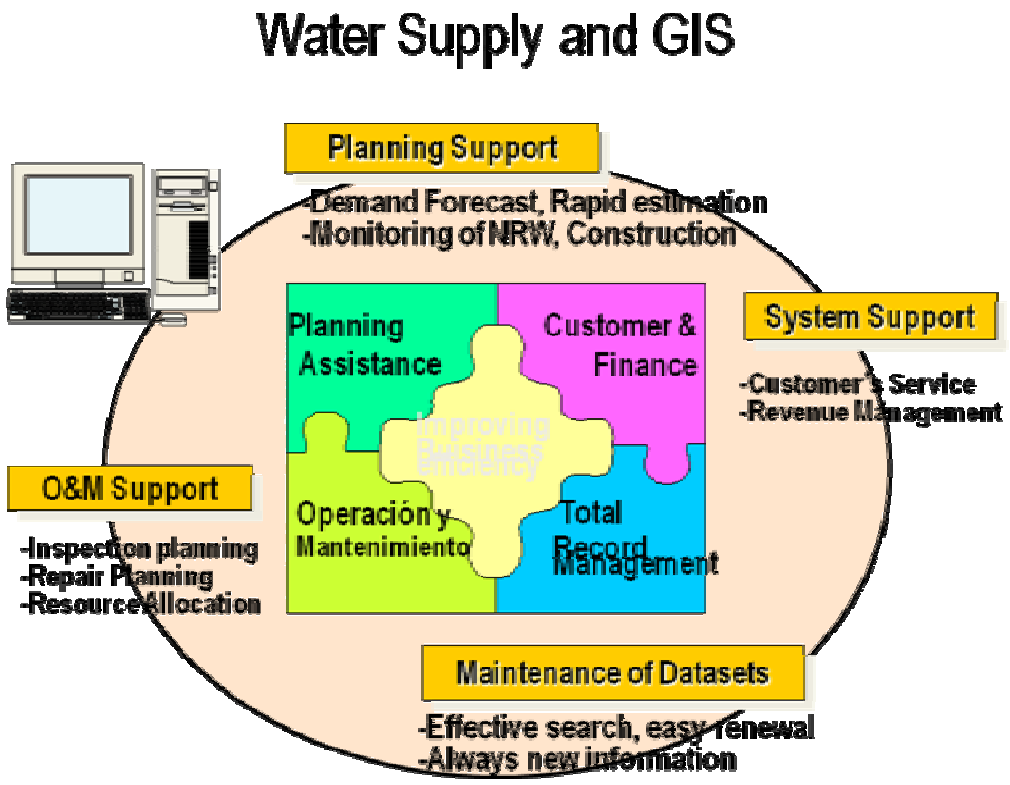


Figure6.1.1 Scheme of Facility Management

- This example shows GIS application to facility management of water supply in Figure6.1.1.
- Asset maps are linked to facility inventory book. Every figured data corresponds to tabulation data. Both of the data can be referred easily on system.
- This system may contribute to improvement of business or administrative efficiency such as
  - Planning management
  - Customer management
  - Maintenance & operation
  - Drawing management

6.2 Examle of asset management in System1

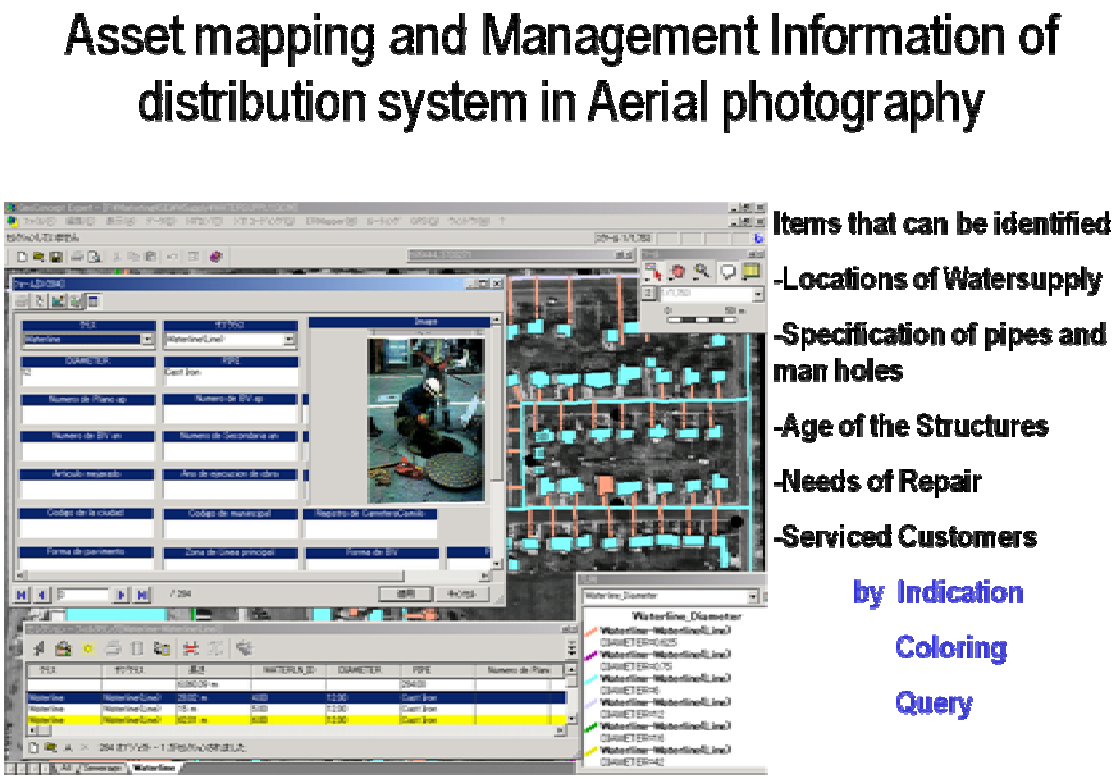


Figure 6.2.1 Exsamle of Asset management in System1

- Each service pipe in the map corresponds to tabulation data as shown in Figure6.2.1. This map works as a facility inventory.
- We can distinguish the facilities (pipes and related facilities) according to their attributes, such as year constructed, pipe material, pipe diameter, properties of service meter and customers and so on.
- We can easily comprehend the sewerage construction plan and monitor its progress.

6.3 Examle of House Connection in asset management in System2

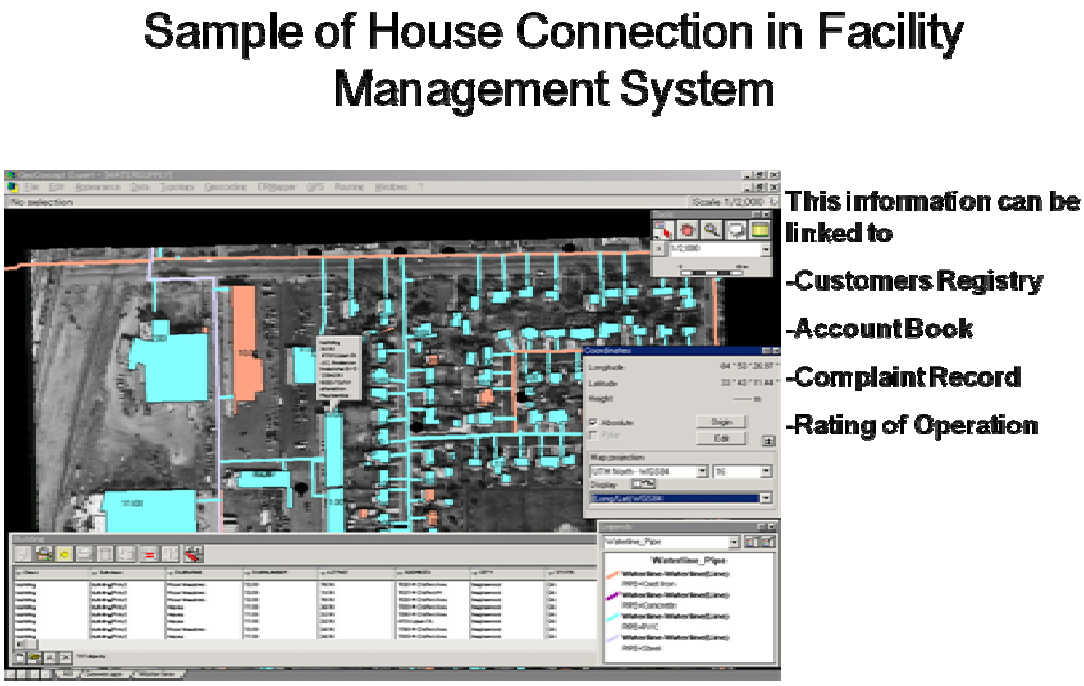


Figure 6.3.1 Exsamle of Asset management in System2

- The color hatched buildings have been connected to service connection.in Figure6.3.1.
- This map can be linked to the customer registry and account book.
- If clicked a one of the buildings, an attribute table is launched to show name of the customer, history of His/her payment, complaint record, etc.
- Persons in charge know the service ratio (served households / total households), rate of operation (water volume / capacity), total charges and collected fees of the area.

7. INTRODUCTION OF GIS OPERATION in CWASA DATA

The operation of GIS is utilized to the facility management not only for NRW operation but also for the managements in water supply. There are application developments in the arrangements of Information Management System used by map and database, which fields are for data management in each sections, mapping and facility management, facility managements in operation and maintenance, analytic purpose for pipe network analysis or simulation in planning support, customer management.

7.1. Display of pipe network

In GIS, the drawing can be produced by display of individual color assigned to each attribute in map items. Figure7.1.1 is the example to assign and to display colors against type of pipe. GIS data of main pipe is linked to attributes of diameter and pipe materials.

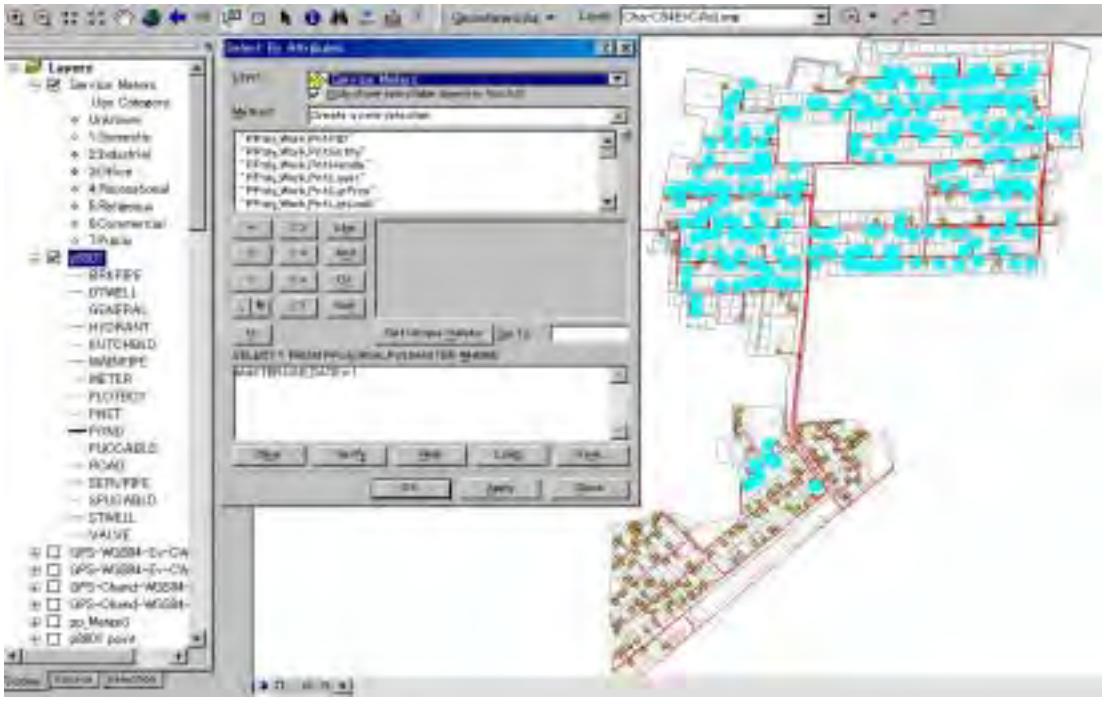
Figure7.1.1 Example of pipe line network

Map is composed by main pipe, valve, service pipe, and service meter and plot number.

7.2. Example of query data

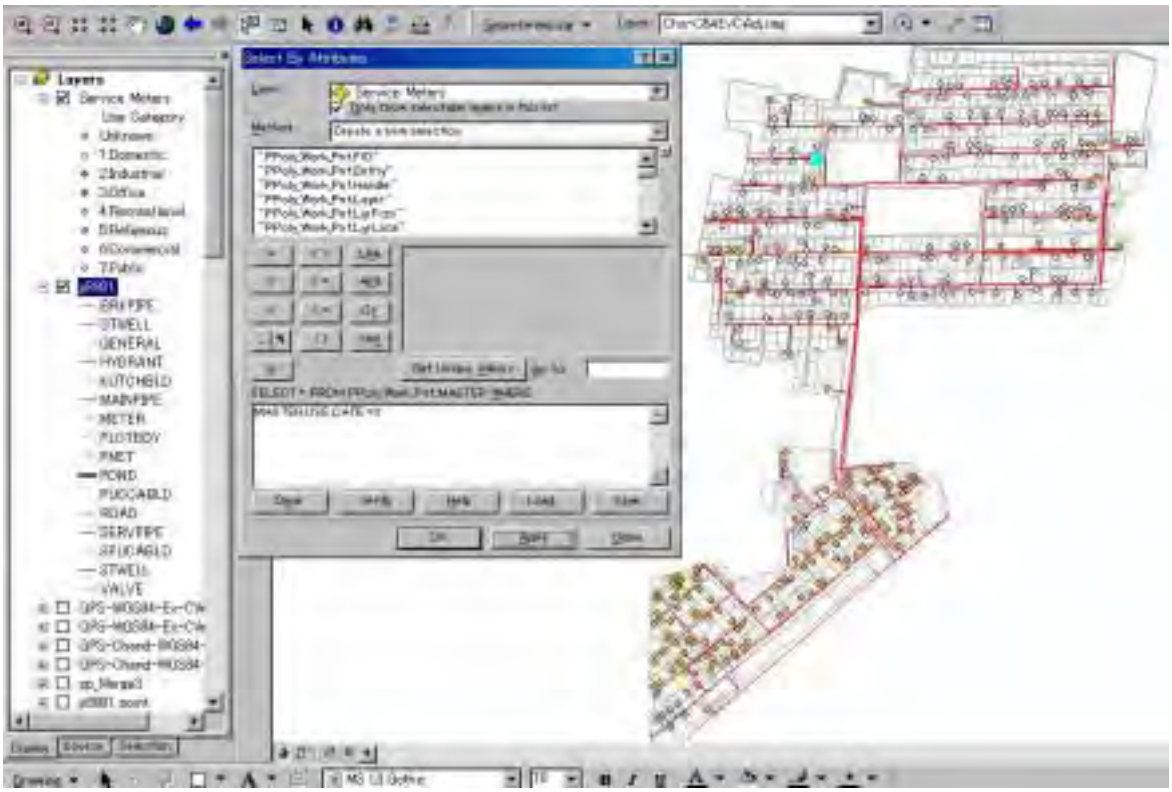
There are functions to select target records by conditioned query in database and to display the locations on view window. Map overlay processing is one of the characteristics in GIS operation. Overlay processing is used frequently also for preparation of tabular data.

Figure7.2.1 to Figure7.2.4 is an example of query of GIS data which location data is linked to database of water meter in CWASA. Query examples are selected and displayed about types of water for Domestic, Industrial and Commercial from seven categories. Moreover, another example is shown to query to select records to use hand pump in service meters also.



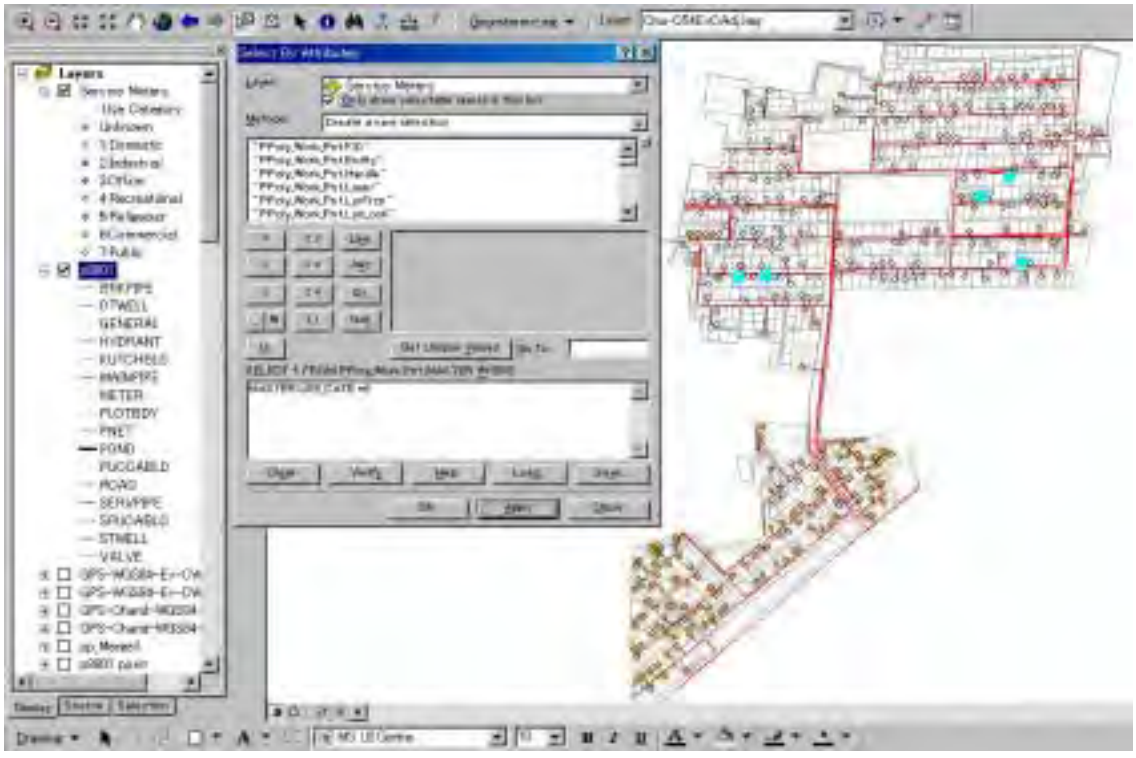
1. Query operation selecting for Domestic use

Figure7.2.1 Query operation and display overlay of maps



2 Query operations selecting for Industrial use

Figure7.2.2 Query operation and display overlay of maps



3 Query operation selecting for Commercial

Figure7.2.4 Query operation and display overlay of maps

4 Query operation selecting hand pump

Figure7.2.4 Query operation and display overlay of maps

7.3. Example of buffer search

Functions to analyze spatial distribution in data by the buffer area are utilized in GIS analysis frequently. GIS analysis utilizes analysis function A buffer means the domain area which is equivalent to the geometric distance of a certain distance from the object on a map. For example, in order to produce a material how water supply meter is distributed in the distance from a water supply valve, the point location data of a water valve is displayed in the map view. Next, the buffer area which calculated the area of the buffer in a certain distance from each valve is produced. According to display overlay with buffer data and a water supply distribution map, a map of distribution of the water supply meter within the buffer is shown in Figure7.3.1.

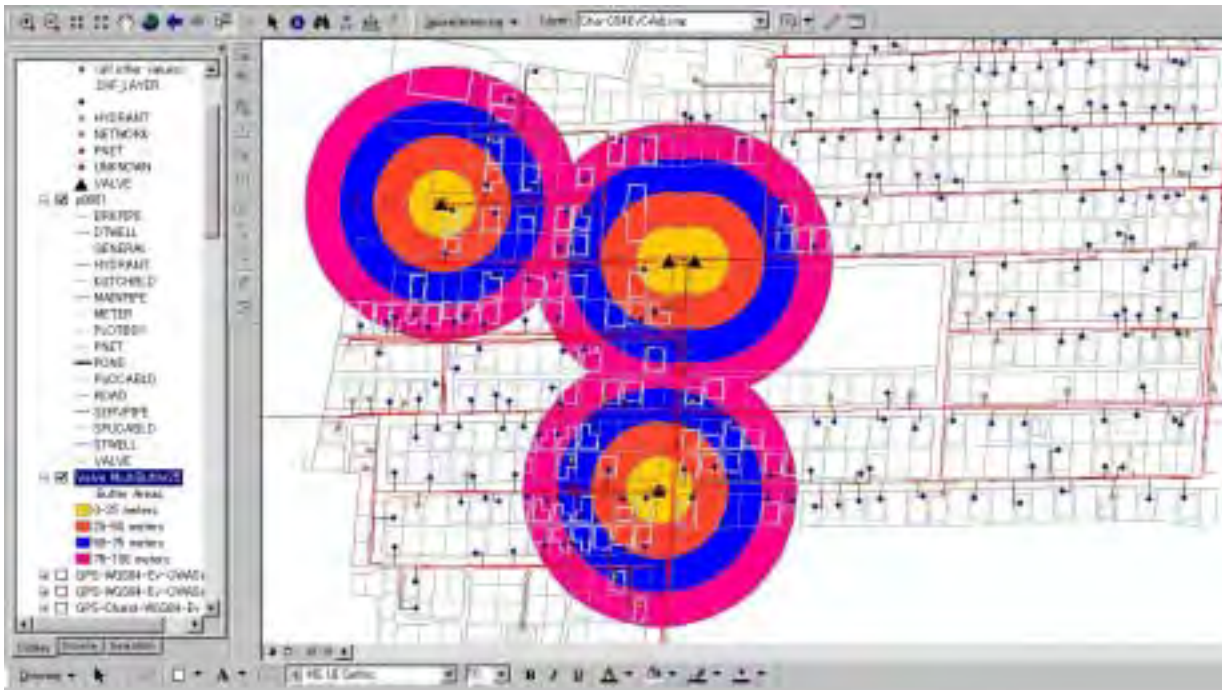


Figure7.3.1 Buffer operation from valves

7.4. Example of buffer query and tabulation

GIS operation can provide the calculation of required quantities for planning support by using of tabular tables in the database operation other than buffer query.

The next example in Figure7.4.1 is produced for the distribution map of the service meter which influences when one valve is closed. In this example, the position of the valve to shut is chosen and the map to be calculated the buffer area of 100 meters is displayed in order to choose the service meters which corresponds in this buffer area.

Ammeter information in selected meters are displayed in the database tables. Selected data could be utilized for tabular data.

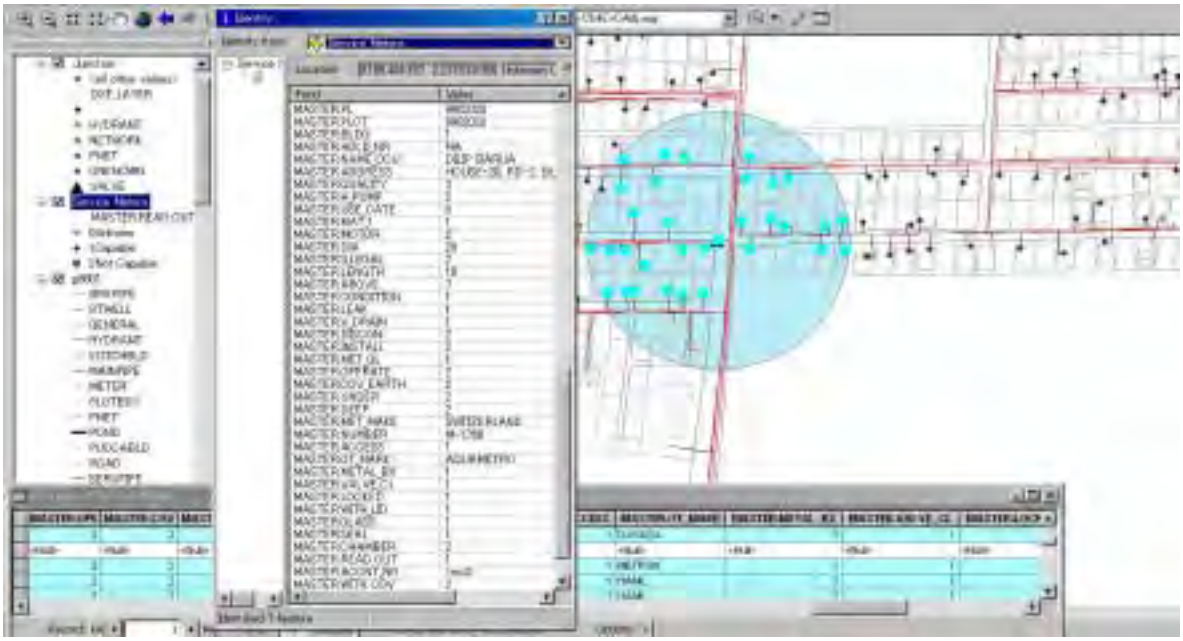


Figure7.4.1 Example of buffer analysis for service meter
Service meters within 100 meters buffer area from a valve location

7.5. Example of display attributes

In GIS, it has a function to display the attribute of the figure in a map on a screen. In order to refer to the attribute of the water supply meter displayed on the screen, the figure of the meter in a screen is chosen individually, and the attribute of water supply meter is displayed on a screen in Figure7.5.1.

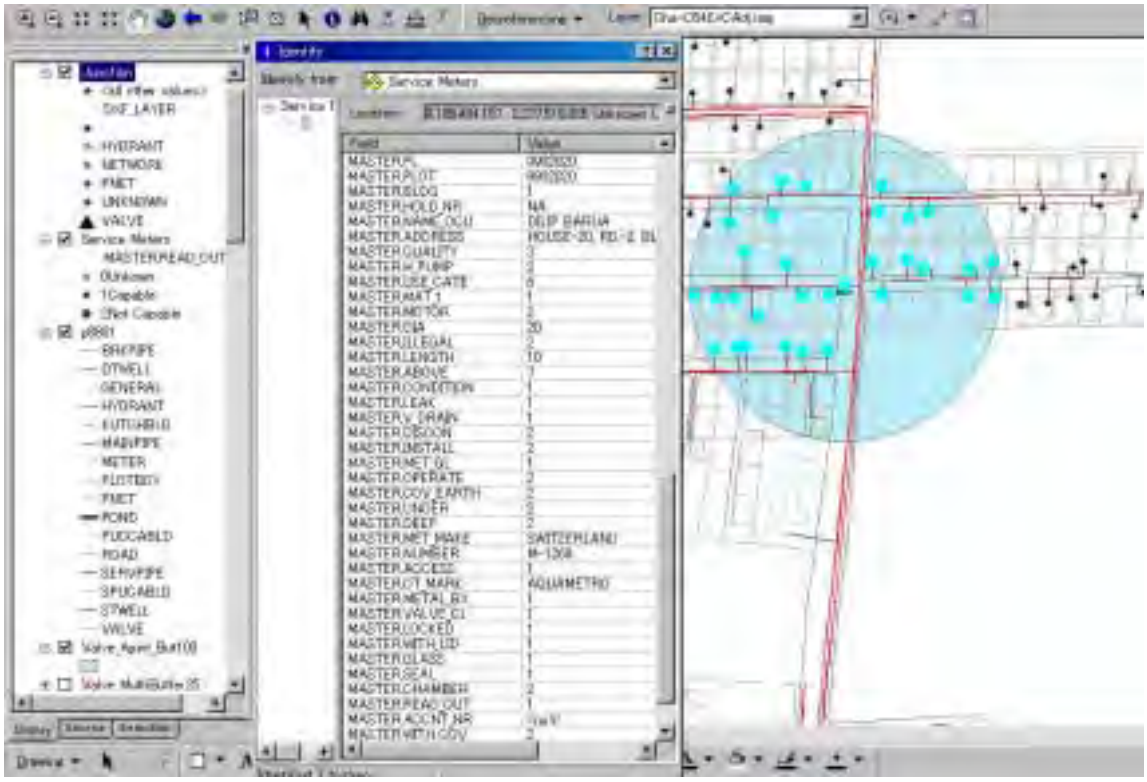


Figure7.5.1 Attribute display on screen

Attribute table is displayed on the screen window by click operation selecting figure.

8. Contents of Training

GIS training is carried out about technical instruction for production of GIS data by the On the Job Training（OJT）style against 5 counterparts.

(1)Objective of GIS Training

The objective of Training is to master basic operation of software to be required for production of GIS data by the OJT through practical data production.

(2)Participants of GIS Training

The participant is requested to nominate maximum 5 persons as follows:

- 1 person from the present counterpart in PANI project
- 1 person from Design Division for maintenance of GIS data, customer information data and facility data of main water distribution
- 1 person from Sales Division for maintenance of customers information and its updating
- 2 persons from each Maintenance Operation Divisions for maintenance of facility for Water distribution pipeline

(3)Training time

The full time assignment of counterpart is principally required in the training.

(4) Period of training

The period of training is divided to 2 phases about a basic training and OJT training for data production through the OJT in the period from the middle of July in 2010 to March in 2012.

(5)Goal of Training

The goal of training is to set a level for operator itself to be able to operate basic operation of GIS software.

(6)Work area for Training

The work area for Training is as follows:

- 2 zones in the model area: Zone3 and Zone2
- 1 pilot project area: CWASA counterparts themselves produce GIS data

(7) Training Instructor

Training instructor is as follows:

- Japanese GIS Expert,
- Local GIS Expert,
- Other project staff

(8)Contents of training

Contents of training in Table8.1 are composed as follows.

- Basic training in the first phase for 4 weeks for production of GIS data consists of about:
  - Lecture training for 1 week about Understanding of GIS, Understanding of data structure, Introduction of GIS software, Understanding of CWASA GIS data and practice of GIS software.
  - Operation practice for three weeks about basic operations of GIS software for map digitizing, editing, database entry and its editing, map projection and geometric transformation, database operation, map drawing

- OJT Training for the second phase to produce outputs of the project by OJT consists of as follows:
  - Mastering of basic operation and preparations of GIS data in Zone3
  - Productions of GIS data by the OJT in Zone2

- Production of GIS data by trainees in 1 pilot project area, particularly in Harishahar

(9)Mastering items in training

The capability to be mastered through training is as follows.

- Understanding of GIS
- Issue and solution of CWASA data
- Method of production of GIS data: Map digitizing, editing of GIS data, database operation, operation of a relational database, map drawing
- Georeferencing process of GIS data: georeferencing and map projection
- Updating of GIS data about service pipe, service meter and customer data

(10)Training result

Training result is as follows:

- GIS data of distribution main network (pipe diameter more than 100mm)
- GIS data of service connection(service pipe, service meter and customer data)
- GIS data of underground utility

9. Instruction materials in Training

Instruction material in Training is as follows:

- GIS Training Document
- GIS DATA STRUCTURE IN THE PANI
- TECHNICAL NOTES FORCWASA DATASETS
- A GUIDANCE OF BASIC OPERATION FOR ARCMAP

Table8.1 Schedule of GIS Training (Tentative)

Activities \ Time	1 week	3 weeks	To the end of the last phase in PANI
Basic Training Lecture training for 1 week about ● Understanding of GIS, Understanding of data structure, Introduction of GIS software, Understanding of CWASA GIS data ● Practice of GIS software	◄►		
Operation practice for 3 weeks about ● Basic operations of GIS software for map digitizing, Editing, Database entry and its editing, Map projection and Geometric transformation, Database operation, Map drawing for production of GIS data		◄►	
OJT Training Second phase for basic operation of GIS software and to produce outputs of the project about: ● Mastering of basic operation and preparations of GIS data in Zone3 ● Productions of GIS data by the OJT in Zone2 ● Production of GIS data by trainees in 1 pilot project area, particularly in Harishahar			◄►

APPENDIX1
GIS DATA STRUCTURE
IN PANI

Table 1.1 Database item of Main pipe

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Line				
OBJECTID	Object ID number:		Long	4	0	0	Numeric
LENGTH	Length of ARC in geometry	LENGTH	Double	19	0	0	Numeric
DXF_LAYER	Type of feature: PNET, MAIN PIPE	LAYER	Text	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1,2,3,5,6,7,9,31,40	COLOR	Short	4	4	0	Numeric
Pat	Name of pipe line: Pat compiled by a prefix of “DN”, Pdia and Pmat.	PAT	T ext	30	0	0	
Pdia	Pipe diameter: 0, 50, 100, 150, 200, 225, 250, 275, 300, 400, 450, 500, 600, 700, 900, 1200, others	PDIA	Short	2	0	0	Numeric
Pmat	Pipe material: AC, AC/MS, AC/PVC, AS, CI, DI, GI, MS, OVC, PVC/AC, W and others	PMAT	Text	20	0	0	

Table 1.2 database item of Related Facilities of DSR such as control valve, hydrant, Tees and others

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Point				
OBJECTID	Object ID number:		Long	4	0	0	Numeric
DXF_LAYER	Type of feature: VALVE, JUNC(Loop over), JUNCC(Crossing), HYDRANT, TEES, NETWORK, WASHOUT, REDUCER, UNKNOWN	LAYER	Test	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1,2,3,5,6,7,9,31,40	COLOR	Short	4	4	0	Numeric
MapSheet	Name of Drawing name	MAPSHEET	Text	5	0	0	
Facility	Name of facility	PAT	Text	30	0	0	
Mauza_No	Mauza number	MAUZA	Text	5	0	0	
WARD_NO	Ward Number	WARD	Text	10	0	0	

Table 2.1 database item of Service Pipe

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Line				
OBJECTID	Object ID number:		Long	4	0	0	Numeric
LENGTH	Length of ARC in geometry	LENGTH	Double	19	0	0	Numeric
DXF_LAYER	Type of feature: SERVPIPE	LAYER	Text	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1,2,3,5,6,7,9,31,40	COLOR	Short	4	4	0	Numeric
Pat	Name of pipe line: Pat compiled by a prefix of “DN”, Pdia and Pmat.	PAT	T ext	30	0	0	
Pdia	Pipe diameter:	PDIA	Short	2	0	0	Numeric
Pmat	Pipe material: PVC and others	PMAT	Text	20	0	0	
Ref	Holding number	PMAT	Text	10	0	0	
ARef	Plot number	AREF	Text	10	0	0	
BRef	Building number	BREF	Text	2	0	0	
CRef	Holding Number calculated by ARef, Bref and CRef	CREF	Text	15	0	0	
Mauza_No	Mauza number	MAUZA	Text	15	0	0	
WARD_NO	Ward Number	WARD	Text	10	0	0	
Geo_Ref_CWASA1	Georeferencing code compiled by Mauza number and CRef	GEOREF 1	Text	15	0	0	
Geo_Ref_CWASA2	Georeferencing code compiled by ward and existing CRef in CWSA referencing code	GEOREF 2	Text	20	0	0	
Pat	Name of pipe line: Pat compiled by a prefix of “DN”, Pdia and Pmat.	PAT	T ext	30	0	0	

Table 2.2 Database item of Service Meter

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Point				
OBJECTID	Object ID number:		Long	4	0	0	Numeric
DXF_LAYER	Type of feature: SERVPIPE	LAYER	Text	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1,2,3,5,6,7,9,31,40	COLOR	Short	4	4	0	Numeric
Ref	Holding number	PMAT	Text	10	0	0	
ARef	Plot number	AREF	Text	10	0	0	
BRef	Building number	BREF	Text	2	0	0	
CRef	Holding Number calculated by ARef, Bref and CRef	CREF	Text	15	0	0	
Mauza_No	Mauza number	MAUZA	Text	15	0	0	
WARD_NO	Ward Number	WARD	Text	10	0	0	
Geo_Ref_CWASA1	Georeferencing code compiled by Mauza number and CRef	GEOREF1	Text	15	0	0	
Geo_Ref_CWASA2	Georeferencing code compiled by ward and existing CRef in CWSA referencing code	GEOREF2	Text	20	0	0	

Table 3.1 Database item of Other line features

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Line				
OBJECTID	Object ID number:		Long	4	0	0	Numeric
LENGTH	Length of ARC in geometry	LENGTH	Double	19	0	0	Numeric
DXF_LAYER	Type of feature: BRKPIPE, DTWELL, GENERAL, KUTCHBLD, PLOTBDY, ROAD, SPUCABLD, STWELL	LAYER	Text	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1,2,3,5,6,7,9,31,40	COLOR	Short	4	4	0	Numeric
Mauza_No	Mauza number	MAUZA	Text	15	0	0	
WARD_NO	Ward Number	WARD	Text	10	0	0	

Table 3.2 Database item of Map Annotation

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Point				
OBJECTID	Object ID number:		Long	4	0	0	Numeric
DXF_LAYER	Type of feature: GENERAL,NOTES, PIPEATT, PLOTTEXT, ROADTEXT, SERVPLOT	LAYER	Text	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1,2,3,5,6,7,9,31,40	COLOR	Short	4	4	0	Numeric
Map Sheet Name	Map sheet name	MAPSHEET	Text	10	0	0	
Mauza_No	Mauza number	MAUZA	Text	15	0	0	
WARD_NO	Ward Number	WARD	Text	10	0	0	

Table 3.3 Database item of Wells

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Line				
OBJECTID	Object ID number:		Long	4	0	0	Numeric
LENGTH	Length of ARC in geometry	LENGTH	Double	19	0	0	Numeric
DXF_LAYER	Type of feature: DTWELL, STWELL	LAYER	Text	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1,2,3,5,6,7,9,31,40	COLOR	Short	4	4	0	Numeric
Type of Well	Type of Well: Deep well or Shallow well.	Typewell	Text	30	0	0	
ARef	Plot number	AREF	Text	10	0	0	
BRef	Building number	BREF	Text	2	0	0	
CRef	Holding Number calculated by ARef, Bref and CRef	CREF	Text	15	0	0	
Mauza_No	Mauza number	MAUZA	Text	15	0	0	
WARD_NO	Ward Number	WARD	Text	10	0	0	
Geo_Ref_CWASA1	Georeferencing code compiled by Mauza number and CRef	GEOREF1	Text	15	0	0	
Geo_Ref_CWASA2	Georeferencing code compiled by ward and existing CRef in CWSA referencing code	GEOREF2	Text	20	0	0	

Table 4.1 List of service meter database: Master.dbf about 15825 records

Num	Field Type	Field Type	Width	Dec	Index	Description
1	GEO_REF	Character	13		N	Geo reference
2	RECORD	Numeric	5	0	N	Record
3	THANA	Character	2		N	Thana code
4	TH	Character	1		N	1st Character of Thane
5	MAUZA	Numeric	2	0	N	Mauza code
6	MZ	Character	2		N	1st character of mauza
7	SECTION	Numeric	2	0	N	Section
8	DATE	Date	8		N	Date
9	PLOT	Numeric	7	0	N	Plot number
10	PL	Character	7		N	Plot ?
11	BLDG	Numeric	3	0	N	Building
12	NAME_OCU	Character	25		N	Name of occupation
13	HOLD_NR	Character	9		N	Holding number
14	ADDRESS	Character	40		N	Address
15	QUALITY	Numeric	1	0	N	Quality?
16	USE_CATE	Numeric	1	0	N	Use category
17	H_PUMP	Numeric	1	0	N	Yes=1, No=2
18	MOTOR	Numeric	1	0	N	Yes=1, No=2
19	MAT_1	Numeric	1	0	N	GI=1, MS=2, PVC=3, UPVC=4, Other=5-?
20	DIA	Numeric	6	2	N	In mm
21	LENGTH	Numeric	6	0	N	?
22	ILLEGAL	Numeric	1	0	N	Yes=1, No=2
23	ABOVE	Numeric	6	2	N	In mm
24	CONDITION	Numeric	1	0	N	?
25	V_DRAIN	Numeric	1	0	N	Yes=1, No=2
26	LEAK	Numeric	1	0	N	Yes=1, No=2
27	INSTALL	Numeric	1	0	N	Yes=1, No=2
28	DISCON	Numeric	1	0	N	Yes=1, No=2
29	OPERATE	Numeric	1	0	N	Yes=1, No=2
30	MET_GL	Numeric	1	0	N	Yes=1, No=2
31	UNDER	Numeric	1	0	N	Yes=1, No=2
32	COV_EARTH	Numeric	1	0	N	Yes=1, No=2
33	DEEP	Numeric	1	0	N	Yes=1, No=2
34	MET_MAKE	Character	12			Country of the meter make
35	NUMBER	Character	12			Meter number
36	OT_MARK	Character	10			Other mark
37	ACCESS	Numeric	1	0	N	Yes=1, No=2
38	VALVE_CL	Numeric	1	0	N	?Yes=1, No=2
39	METAL_BX	Numeric	1	0	N	Yes=1, No=2
40	WITH_LID	Numeric	1	0	N	?Yes=1, No=2
41	LOCKED	Numeric	1	0	N	?Yes=1, No=2
42	SEAL	Numeric	1	0	N	Yes=1, No=2
43	GLASS	Numeric	1	0	N	Yes=1, No=2
44	READ_OUT	Numeric	1	0	N	Yes=1, No=2
45	CHAMBER	Numeric	1	0	N	Yes=1, No=2
46	WITH_COV	Numeric	1	0	N	Yes=1, No=2
47	ACCNT_NR	Numeric	10	0	N	Account number
48	ACC_HOLD	Character	25			Account holder
49	H_ADDRES	Character	35			Account holder address

Table4.2 List of customer database: CWASA_M.dbf or cwasamas.dbf about 25602 records

Num	Field Type	Field Type	Width	Dec	Index	Description
1	ACCOUNT	Character	8		N	Account name
2	NAME	Character	25		N	Name
3	ADDR1	Character	30		N	Address1
4	ADDR2	Character	30		N	Address2
5	CLASS	Character	1	0	N	Class
6	CATEGORY	Numeric	1	0	N	Category
7	MTRSTATUS	Numeric	1	0	N	Meter status
8	MTRTYPE	Numeric	1	0	N	Meter type
9	WRCODE	Numeric	2	0	N	Water code
10	NBILL	Numeric	2	0	N	Number of bill
11	WCONSIZE	Numeric	2	0	N	?W con? size?
12	WCONDATE	Date	8		N	?W con? Date
13	WATERFEE	Numeric	6	0	N	Water fee
14	MEMONO	Character	10		N	Memo number
15	MTRINSDATE	Date	8		N	Mater install date
16	METERNO	Character	14		N	Meter number
17	MTRWIDTH	Numeric	2	0	N	?Meter width
18	AVGCONSUM	Numeric	10	3	N	?Average consumption?
19	WATERBILL	Numeric	9	2	N	?Water bill
20	EXCISE	Numeric	9	2	N	?Excise
21	PREVREAD	Numeric	10	0	N	?Previous meter reading
22	PREVDATE	DATE	8		N	?Previous date of meter reading
23	PRESREAD	Numeric	10	0	N	?Pressure reading
24	PRESDATE	DATE	8			?Pressure reading date
25	BILLNO	Character	10			Billing number
26	RICODE	Character	3			?RI code
27	ENTBY	Character	3			?Person who entries
28	FLAG	Numeric	1	0	N	?Flag

Table5.2.1 BOOSTER STATION PUMP DETAILS: BOO_PUMP.dbf

Num	Field Type	Field Type	Width	Dec	Index	Description
1	SER_BOOST	Character	4		N	Serial Number of the Booster Pump Station
2	NAME	Character	20		N	Name of the Booster Station
3	PUMP_NR	Character	12		N	Pump Reference Number
4	PUMP_SER	Character	2		N	Pump Serial Number
5	PUMP_MANUF	Character	15		N	Pump Manufacturer
6	PUMP_DFL	Numeric	6	3	N	Pump Duty Flow
7	PUMP_DHD	Numeric	6	1	N	Pump Duty Head
8	PUMP_EFF	Numeric	5	2	N	Pump Efficiency
9	MOTO_NR	Character	10		N	Motor Reference Number
10	MOTO_SER	Character	2		N	Motor Serial Number
11	MOTO_PW	Numeric	6		N	Motor Power (KW)

Table5.2.2 TREATMENT WORKS DETAILS: TREATMEN.dbf

Num	Field Type	Field Type	Width	Dec	Index	Description
1	SER_TREAT	Character	4		N	Serial Number of the Treatment works
2	NAME	Character	25		N	Name of the Treatment works
3	STREET	Character	25		N	Location: Street name
4	WARD	Numeric	2	0	N	Location: Ward code
5	THANA	Numeric	2	0	N	Location: Thana code
6	YEAR_CONS	Numeric	4	0	N	Year of Construction
7	MOD	Numeric	1	0	N	Maintenance of Division
8	TREATTYPE	Character	30		N	Treatment Detail: Treatment Type
9	UNIT_NO	Numeric	2	0	N	Treatment Details: Number of each units
10	VOL_UNIT	Numeric	3	0	N	Treatment Details: Volume of each unit
11	REMARK	Character	50		N	Treatment Details: Remarks
12	VOL_STOR	Numeric	3	0	N	Storage details: Volume storage in meter cube
13	DEPTH	Numeric	4	2	N	Storage details: Depth (m)
14	TWL	Numeric	5	2	N	Storage details: TWL(meters above datum)

Table5.2.3 TREATMENT PUMP DETAILS: TRE_PUMP.dbf

Num	Field Type	Field Type	Width	Dec	Index	Description
1	SER_TREAT	Character	4		N	Serial Number of the Treatment Plant
2	NAME	Character	25		N	Name of the Treatment Plant
3	PUMP_NR	Character	8		N	Pump Reference: Pump Reference Number
4	PUMP_SER	Character	2		N	Pump Reference: Pump Serial Number
5	PUMP_MANUF	Character	20		N	Pump Reference: Pump Manufacturer
6	PUMP_DFL	Numeric	6	3	N	Pump Reference: Pump Duty Flow
7	PUMP_DHD	Numeric	6	1	N	Pump Reference: Pump Duty Head
8	PUMP_EFF	Numeric	5	2	N	Pump Reference: Pump Efficiency

9	MOTO_NR	Character	10		N	Motor Reference: Motor Reference Number
10	MOTO_SER	Character	2		N	Motor Reference: Motor Serial Number
11	MOTO_PW	Numeric	5		N	Motor Reference: Motor Power (KW)

Table5.2.4 TUBEWELL PUMPING STATION DETAILS: TUBEWELL.dbf

Num	Field Type	Field Type	Width	Dec	Index	Description
1	SER_TUBEW	Character	5		N	Serial Number of the Tubewell
2	ID	Character	4		N	Identification
3	NAME	Character	25		N	Name of the Tubewell
4	STREET	Numeric	25		N	Location: Street name
5	WARD	Numeric	2	0	N	Location: Ward code
6	THANA	Numeric	1	0	N	Location: Thana code
7	YEAR_CONS	Numeric	4	0	N	Year of Construction
8	P_MANUFACT	Character	20		N	Pump: Pump Manufacturer
9	P_SERIALNR	Numeric	15		N	Pump: Pump Serial Number
10	M_SERIALNR	Numeric	11		N	Pump: Model Serial Number
11	MOD	Character	1	0	N	Maintenance of Division
12	DUTYFLOW	Numeric	7	4	N	Pump: Duty Flow
13	DUTYHEAD	Numeric	6	2	N	Pump: Duty Head

Table5.2.5 RESERVOIR ANS WATER TOWER MAINTENANCE RECORD: RESERVOI.dbf

Num	Field Type	Field Type	Width	Dec	Index	Description
1	SER_RESERV	Character	3		N	Serial Number of the Reservoir or Water Tower
2	NAME	Character	25		N	Name of the Reservoir or Water Tower
3	STREET	Character	25		N	Location: Street name
4	WARD	Numeric	2	0	N	Location: Ward code
5	THANA	Numeric	1	0	N	Location: Thana code
6	MOD	Numeric	1	0	N	Maintenance of Division
7	YEAR	Numeric	4	0	N	Year of Construction
8	CONSTRUCT	Numeric	1	0	N	Material of Construction: Code: Steel=1, R/C=2;
9	TYPE	Numeric	1	0	N	Type of Construction: Code; Below grand=1, Above=2, Water tower=3;
10	VOLUME	Numeric	6	0	N	Volume of Mb
11	DEPTH	Character	5	2	N	Depth
12	TWL	Numeric	5	2	N	TWL(meters above datum)
13	DATE_MAIN	Date	8		N	Date of Maintenance
14	DESCRIPTIO	Character	25		N	Description of Maintenence

Table5.3.1 PIPE LEAKAGE AND MAINTENANCE RECORD: PIPELEAK.dbf

Num	Field Type	Field Type	Width	Dec	Index	
1	DATE	Date	8		N	Date of Pipe Leakage maintenance
2	STREET	Character	25		N	Location: Street name
3	WARD	Numeric	2	0	N	Location: Ward code
4	THANA	Numeric	1	0	N	Location: Thana code
5	MOD	Numeric	1	0	N	Maintenance of Division
6	MONTH	Numeric	2	0	N	Month of Pipe Leakage
7	YEAR	Numeric	4	0	N	Year of Pipe Leakage
8	NODEFROM	Numeric	3	0	N	Node Number From
9	NODETO	Numeric	3	0	N	Node Number To
10	NODEREF	Character	3	0	N	Nearest Node Reference
11	LEAKTYPE	Numeric	1	0	N	Leak type: Code; Minor=1, Major=2
12	LK_DESCRIP	Character	50		N	Description of Leak
13	REPAIRDATE	Date	8		N	Date of Repair
14	DESCRIPTIO	Character	50		N	Description of Repair

Table5.3.2 BOOSTER STATION MAINETENCE RECORD: BOOSTMNT.dbf

Num	Field Type	Field Type	Width	Dec	Index	Description
1	SER_BOOST	Character	4		N	Serial Number of the Booster Station
2	NAME	Character	25		N	Name of the Booster Station
3	MONTH	Numeric	2	0	N	Month of Construction?
4	YEAR	Numeric	4	0	N	Year of Construction?
5	DATEMAINTA	Date	8		N	Date of Maintenance
6	DES_MAINTA	Character	25		N	Description of Maintenance
7	DATEFAIL	Date	8		N	Date of Failure
8	DES_FAIL	Character	25		N	Description of Failure
9	DATEREPAIR	Date	8		N	Date of Repair
10	DES_REPAIR	Character	25		N	Description of Repair

Table5.3.3 TREATMENT WORKS MANTENENCE DATABASE DETAILS: TRE_MAIN.dbf

Num	Field Type	Field Type	Width	Dec	Index	Description
1	SER_TREAT	Character	4		N	Serial Number of the Treatment Works
2	NAME	Character	25		N	Name of the Treatment Works
3	MONTH	Numeric	2	0	N	Month of Construction?
4	YEAR	Numeric	4	0	N	Maintenance Record: Year of Construction?
5	DATE_MAINT	Date	8		N	Maintenance Record: Date of Maintenance
6	DES_MAIN	Character	25		N	Maintenance Record: Description of Maintenance
7	DATE_FAIL	Date	8		N	Failure record: Date of Failure
8	DESC_FAIL	Character	25		N	Failure record: Description of Failure
9	DATE_REPAI	Date	8		N	Failure record: Date of Repair
10	DESC_REPAI	Character	25		N	Failure record: Description of Repair

Table5.3.4 TUBEWELL MAINTENANCE RECORD: TUB_MAIN.dbf

Num	Field Type	Field Type	Width	Dec	Index	
1	SER_Tubewell	Character	5		N	Serial Number of the Tubewell
2	MONTH	Numeric	2	0	N	Month of Construction?
3	YEAR	Numeric	4	0	N	Year of Construction?
4	DATEMAIN	Date	8		N	Maintenance Record: Date of Maintenance
5	DESC_MAIN	Character	25		N	Maintenance Record: Description of Maintenance
6	DATEFAIL	Date	8		N	Failure Record: Date of Failure
7	DESC_FAIL	Character	25		N	Failure Record: Description of Failure
8	DATEREPAI	Date	8		N	Failure Record: Date of Repair
9	DESCREPAI	Character	25		N	Failure Record: Description of Repair

Table5.3.5 RESERVOIRS & WATER TOWERS MAINTENANCE RECORD: RESERVMNT.dbf

Name	Field Type	Field Type	Width	Dec	Index	
1	SER_RESERV	Character	3		N	Serial Number of Reservoir or Water Tower?
2	NAME	Character	25		N	Name of the Reservoir or the Water Tower
3	MONTH	Numeric	2	0	N	Maintenance Record: Month of Construction?
4	YEAR	Numeric	4	0	N	Maintenance Record: Year of Construction?
5	DATE_MAIN	Date	8		N	Maintenance Record: Date of Maintenance
6	DESCREPAI	Character	25		N	Maintenance Record: Description of Maintenance

APPENDIX2

TECHNICAL NOTES FOR CWASA DATASETS

1. Profiles of GIS development

The initial GIS system in CWASA had been installed by the project of "Un Accounted Management Programme" which Howard Humphreys and Partners Limited(HHP) in association with Lahmeyor International Development Planners & Consultants(DPC), Puraloy Kaushali Limited, Sheltech Consultants Limited during the period from nineteen ninety-three (1993) to nineteen ninety seven (1997). In this background of this project, there was a previous study in 1990 that Aqua Consultant and Associates Ltd were appointed to carry out a Water Distribution and Management Study for CWASA on a preliminary area situated in the central part of Chittagong. This study was recommended that in order to improve water distribution and management and reduce system loss as follows:

- Carry out an extensive replacement programme of non working meters;
- Rectify the practice of under reading metered consumption;
- Rectify the practice of billing non domestic consumers at the cheaper domestic rate;
- Submit up to date bills to defaulters;
- Form a task force to identify illegal connections;
- Reduce leakage by replacing

Existing data sets in the preset asset management were composed by various kinds of survey activities in the last project.

- Compilation of As Built Drawing

  Water distribution network were obtained from CWASA design section and the quality and accuracy of the record drawings and general maps were complied for water distribution network.
- Compilation of existing Network Details

  The collected data includes all existing relevant details on pipelines, booster stations, tube wells, reservoirs and treatment works. The information on the fixed assets was used in the network analysis model and to establish the Distribution System Register.
- Prediction of Population Estimation

  Population estimation was predicted on Thana boundary which defined to grouping code for record drawing in Table1.1.

Table1.1 Population estimation and Grouping code for record drawing

List of Thana	Groping code for record drawing
Kotwali	K
Double Mooring	D
Panchlaish	P
Pahartoli	P
Chandgaon	C
Bandar	B
Hathazari(part)	H

- Development of Consumer data

  Customer Survey concerned to several survey activates about Distribution network, Consumers, Unconnected Holdings, Private Tube wells, Hydrants, Religious Institutions, Pilot areas, Connections Outside Pilot Areas, Trial Hotels at Connections and Public Educations;

- Consumer and Status in Customer data

  Customer data was categorized to types of customers and status of domestic type in Table1.2.

Table1.2 Categories of Consumer and Status of domestic type

Consumer Categories	Domestic type
Normal (in 29 Mohallas)	Domestic or Non- domestic
Bulk Supply Government	Domestic or Non- domestic
Normal Government	Domestic or Non- domestic
Bulk Supply Private	Domestic or Non- domestic
Religious Institutions	Domestic or Non- domestic
Street Hydrants	Domestic or Non- domestic
Disconnected	Domestic or Non- domestic

Water Consumption and Billing data concerned consisted of the following items:

- Raw water consumption
- Holding numbers:

  Holding number based on land registry plot numbers is shown on the Record Drawings.
- CWASA Billing system

  Billing database in CWASA transferred from XENIX computer to MS-DOS. Master database adding to the consumer survey details about account number, meter number, account holder name, full address and category at October in 1995 and transaction

database adding to water distribution system (network analysis) and revenue at March in 1995 were transferred.

- Consumer survey including Property Identification, House Connection Details, Water Meter and Consumer Enquiry

  Consumer survey and unconnected holdings survey developed the definite databases to the present CWASA customer management.

- Compilation of Preparation GIS data

  Basic map detail in general map was compiled on Mauza maps with references of related maps. Consumer was plotted on Mauza map in the survey. Distribution Network was compiled by Built drawing and survey. Contents and format of record Drawings digitized on A3 size of map sheets consisted of Basic maps details, Consumer details, and Distribution network details. The printing scale of Record Drawings is at 1:1,000 to support A1 size format.

  Distribution network survey was compiled on Mauza maps in A3 sheets for convenience used as the base map for the survey. The data included Pipe diameter material, location etc. culvert crossing and bridge, Valve, air valve, washouts and etc.

- The network analysis system and Distribution System Register data

  As found a description of supporting system, so called WEB in the draft final report, the system was using data concerning to:

  - Mains network,
  - Customer demands,
  - Fixed head sources(reservoir and pumps),
  - Variable flow/head pumps,
  - Pressure reducing valves,
  - Pressure sustaining valves,
  - Non-return valves and
  - Throttled valves

  Behind on this background, it was supposed that the present data of Distribution System Register was compiled to the present data about Pipework, Booster Stations, Tube Wells, Treatment Works, Reservoirs and Water Towers.

Due to the implementation of the last project, CWASA had established the present GIS system to manage asset maps and relational databases relating to the Distribution System Register and the Record Drawing for the Facility Management of water supply throughout the implementation of the program.

1.1. Map resources for Geographic Information data set

Those exiting data sets of GIS, CAD and databases were compiled by available data resources with field verification surveys as follows:

- Various different mapping systems of the project area
- Water network as built drawings
- Existing network details of pipelines, booster stations, reservoirs, treatment works etc.
- Population estimations
- Consumer data; and
- Water consumption and billing data

Mapping resources for data sets consisted of available data resources from relevant agencies as follows:

- The Bakhradbad Gas Company having a mapping system for Chittagong area for base map
- Mauza map on Land Registry Department for record drawing and general arrangement drawing
- Control points and georeferencing of geographic coordinate in Survey of Bangladesh
- Reference of approved building permission in Chittagong Development Authority
- Holding numbers in Chittagong City Corporation
- Other information from Bangladesh Railways, Chittagong Roads and Highway Department, Public Works Department, Housing Settlement and Real Estate Agencies

Based on these mapping resources, map feature was consisted of:

- Plot boundaries,
- Mauza and Thana Boundaries,
- Pucca, Semi Pucca and Kutcha building,
- Road kerbsider only where no shared boundary is present to indicate a road,
- Railway network(as single lines),
- Main Water Network – Service connections to property,
- Feature within the network such as valves, pumps, meters and hydrants,
- Deep and Shallow Tube Wells and
- Control Points(for linking sheets together

1.2. GIS database found

The maps and relational databases for asset mapping were compiled to CAD drawing map on AutoCAD in the backup data. According to the backup data in CWASA, there are mainly three principle data found as follows:

(1) Record Drawing Map As Build Drawing

Record Drawing Map which is a CAD drawing map at a scale of 1:1000 mainly consisted of three mapping components in Figure 1.3 as follows:

- Basic Map Details which was compiled about the information mapping features from the Mauza map and collected maps, and map objects for cartographic designs
- Consumers Details which was compiled by mapping of building and location of customer on the Mauza map and table list of customer information including ownership and attributes of service connection based on the result of consumer survey during the distribution network survey
- Distribution Network Details which were compiled by pipe attribute of main pipe line and attributes of facility concerned to main pipe line.

Table 1.3 Information included on the Record Drawings

Group	Features/Information
Basic Maps Details	Map sheet number/adjacent sheet index, Orientation or north arrow, scale bar, Street name and width, ponds, etc., Other frame sheet information
Consumer Details	Buildings locations and boundaries, Block(plot) numbers, Holding number, Consumer's postal address, Water account numbers, Measurement of service line material(length), Size(diameter) and service line material, Type of connection, and Meter number
Distribution Network Details	Mains and sizes, Material of pipes, Years mains were installed, Distances of mains from property, Main valves and numbers Location of shallow and deep wells

There was no GIS backup data for Record Drawing Map.

(2) General Map

General Map which is a CAD drawing map at a scale of 4:000 mainly consisted of three mapping components as same as those in Record Drawing Map in Figure 1.4 as follows:

- Basic Map Details which was same components in Record Drawing Map and was compiled about the information mapping features from the Mauza map and collected maps, and map objects for cartographic designs
- Distribution Network Details which was compiled by main pipe line with pie attributes, location of main hydrants with attribute and location of non-WASA tube wells
- Other Summary and Reference Information which was compiled by Outline boundaries of Record Drawing, reference information of map sheet numbers and consumer information

Table 1.4 Information included on the General Maps

Group	Features/Information,
Basic Maps Details	Map sheet number/adjacent sheet index, Orientation or nothr arrow, scale bar, Street name and width, ponds, etc, Other frame sheet information
Distribution Network Details	Mains and sizes, Material of pipes, Years mains were installed, Location of street hydrants, Number of street hydrants, Location of non-WASA tube wells, Number of non-WASA tube wells
Other Summary and Reference Information	Outline boundaries of Record Drawing which from the boundary of the GM, Sheet numbers of referenced Record Drawing, Number of consumers included in each Record Drawing by type of consumers, Total number of consumers included in the General Map

There was no GIS backup data of General Map.

(3) Distribution System Register

There were maps and databases about the Distribution System Register consisting of seven (7) basic data for water facilities and five (5) maintenance data as shown in Table1.5.

Table1.5 List of Distribution System Register maps and databases

Basic data	Maintenance data
Pipe work, Booster Station, Booster Pump, Treatment Plant, Treatment Pump, Tube Well, Reservoir	Pipe leakage, Booster, Treatment plant, Tubewell, Reservoir

Database format of the data was supported by dBase IV. Unique coordinate system was adapted to CWASA CAD drawing dataset.

There was no updating of basic data for water facilities and also was no record in maintenance data.

The mapping and GIS data was compiled to the Record Drawing maps composed by composed by the following information:

- Basic map details which the information collected from the Mauza map
- Consumers details which the information has been collected from the consumer survey and form the Mauza sheets updated during the distribution network survey
- Distribution network details which the information has been extracted from the as built drawings available and from the distribution network survey and the databases item consists of Pipework, Booster Station, Treatment Works, Tubewells and Reservoir.

There are two map resources for Record Drawing which are:

- Record Drawing maps at a scale of 1:1000
- Preparation of General maps at a scale of 1:4000

Total amounts of 604 map sheets about the Record Drawing were produced as built drawings in the project and these maps were expanded to 727 of map sheets until 1998.

2. Georeferencing for data set of CWASA dataset

CWASA dataset is basically generated by Mauza map on Land Registry Department. The data could have projected by Bangladesh Transverse Mercator (BTM) projection which Survey of Bangladesh defines as the following parameters in GIS software. Georeferencing parameter in PCARCINFO is shown in Table1.6.

Table1.6 Definition of Georeferncing in PCARCINFO Coverage file

Items in a projection	Parameter	Notes
Projection:	Transverse	Projection name
Units:	Meters	Distance unit
Xshift;	0	Shift value of X direction
Yshift:	-2000000	Shift value of Y direction
Spheroid:	Everest	Spheroid in datum
Parameters:	Required parameters for transverse projection	
	0.9996	Scale factor
	90 00 00	Central meridian: Longitude
	00 00 00	Central meridian: Latitude
	500000	False northing
	0	False easting

Availabe databases in CWASA is listed in Table1.7. But those data was too old to utilize PANI GIS operation because of out of updating since 1998.

Table1.7 List of Distribution System Register Fixed Asset Database

DB Group	Item	dBASE		DWG&AIC
Consumer database	Consumer	CWASA_M.dbf	25602	DWG
		WSA01-32		DWG
		cwasamas.dbf		DWG
		Master.dbf	15825	DWG
		DSRFADPI.DBF		DWG
		GCONSU.DBF	1	DWG
		OUTDBF.DBF	9, 0	DWG
		TEM.dbf	1100	DWG
		NONMATCH.DBF	3252	DWG
	Meter	Meter.dbf	25602	DWG
		Met1.dbf	605	DWG
	Index?	RDPLOTID.dbf	19297	DWG
		INTDBF.dbf		DWG
		Temp.dbf	292	DWG
DSR databases : Basic data	1 Pipe work	PIPEWORK.dbf		DWG&AIC
	2 Booster Station	BOOSTERS.dbf		DWG&AIC
	3 Booster Pump	BOO_PUMP.dbf		DWG&AIC
	4 Treatement Plant	TREATMEN.dbf		DWG&AIC
	5 Treatment Pump	TRE_PUMP.dbf		DWG&AIC
	6 Tube Well	TUBEWELL.dbf		DWG&AIC
	7 Reservoir	RESERVOI.dbf		DWG&AIC
DSR databases : Maintenance data	1 Pipe leakage	PIPELEAK.dbf		**No record**
	2 Booster	BOOSTMNT.dbf		**No record**
	3Treatment plant	TRE_MAIN.dbf		**No record**
	4Tubewell	TUB_MAIN.dbf		**No record**
	5Reservoir	RESERVMNT.dbf		**No recprd**

2. Data set of the Record Drawing Map on AutoCAD data

2.1 Georeferencing for data set of AutoCAD files for the Record Drawing maps

As AutoCAD only supports a flat projection system, a curved projection for maps has not been implemented.

Obviously, a small amount of distortion occurs due to the transformation of data from curved to flat. However, because the study area is relatively is small, these errors are not significant. Combined with digitizing, scaling and original map accuracy errors, the margin of error caused by the transformation will be negligible.

If real world coordinates are known, they should be calculated to degree to, minutes, seconds and fractions of seconds.

Latitudinal values are held in AutoCAD X axis and Longitudinal Y axis. Because one drawing unit equals one meter, the figures above need rounding. Figures are truncated to 5 decimal places. To keep the scale factors aligned with the chosen AutoCAD scale, the decimal point is moved 5 places to the right, creating an integer number. Original coordinates of

91.81555166, 22.336952777

Are converted and held within AutoCAD as:

X = 9181555, Y = 2233695

This ensures that when maps are linked together, they will be to a constant and geo referenced accurately. Each sheet georeferenced points in order for the map to be located in the correct position. Upon editing a map without georefernced points, the adjacent maps should be attached to the current drawing as Xreference files, in order that edge matching of boundaries can be performed. Once boundaries have been correlated, the reference files can be detached from the drawing, and the maps updated. By using this technique, the map coverage will be updated as part of a 'patch work quilt' of individual maps.

This scheme should be employed to ensure real world coordinates of the individual Mauza/sheet drawing are correct.

Table2.1 Information included on the Record Drawings

Group	Features/Information	Presentation form	Notes
Basic Maps Details	Map sheet number/adjacent sheet index	Graphics/Text	
	Orientation or north arrow, scale bar	Graphics/Text	
	Street name & width, ponds, etc	Graphics/Text	
	Other frame sheet information	Graphics/Text	
Consumer Details	Buildings locations and boundaries	Graphics/Text and Table	
	Block(plot) numbers	Graphics/Text and Table	1
	Holding number	Graphics/Text	2
	Consumer's postal address	Graphics	
	Water account numbers	Table	
	Measurement of service line material(length)	Graphics	3
	Size(diameter) and service line material	Table	
	Type of connection	Table	
	Meter number	Table	4
Distribution Network Details	Mains and sizes	Graphics/Text	
	Material of pipes	Graphics/Text	
	Years mains were installed	Graphics/Text	5
	Distances of mains from property	Graphics	6
	Main valves and numbers	Graphics/Text	
	Location of shallow and deep wells	Graphics/Text	

#1:Present to maintain network connectivity after valve, meter intersection etc. Layer will be invisible by default. Sections removed by symbol insertion will be transferred to this layer.

#2:Pond also refer to other large bodies of water such as lake, reservoirs etc.

#3:Features such as scale bar, north arrow, map frame edge etc.

#4:Pipe attribute text contain details such as diameter, material etc.

#5:Refer to general notes and text etc that will appear on recorded drawings and general maps

#6:Refer to Non CWASA tube wells

#7:Control Points are present on each map sheet and are used to link together individual sheets

#8:Block Zone will show the study area boundaries as superimposed onto the 1:4,000 base maps

Table2.2 Information included on the General Maps

Group	Features/Information	Presentation form	Notes
Basic Maps Details	Map sheet number/adjacent sheet index	Graphics/Text	
	Orientation or nothr arrow, scale bar	Graphics/Text	
	Street name and width, ponds, etc	Graphics/Text	
	Other frame sheet information	Graphics/Text	
Distribution Network Details	Mains and sizes	Graphics/Text	
	Material of pipes	Graphics/Text	
	Years mains were installed	Graphics/Text	1
	Location of street hydrants	Graphics	
	Number of street hydrants	Table	
	Location of non-WASA tube wells	Graphics/Text	
	Number of non-WASA tube wells	Table	
Other Summary and Reference Information	Outline boundaries of RD which from the boundary of the GM	Graphics/Text	
	Sheet numbers of referenced RD	Graphics/Text	
	Number of consumers included in each RD by type of consumers	Table	
	Total number of consumers included in the GM	Table	

#1:Present to maintain network connectivity after valve, meter intersection etc. Layer will be invisible by default. Sections removed by symbol insertion will be transferred to this layer.

#2:Pond also refer to other large bodies of water such as lake, reservoirs etc.

#3:Features such as scale bar, north arrow, map frame edge etc.

#4:Pipe attribute text contain details such as diameter, material etc.

#5:Refer to general notes and text etc that will appear on recorded drawings and general maps

#6:Refer to Non CWASA tube wells

#7:Control Points are present on each map sheet and are used to link together individual sheets

#8:Block Zone will show the study area boundaries as superimposed onto the 1:4,000 base maps

2.2 Map Feature in the Record Drawing

The map feature consists of the following layers

- Plot boundaries
- Mouza and Thana Boundaries
- Pucca, Semi Pucca and Kutcha building
- Road kerbsider only where no shared boundary is present to indicate a road
- Railway network(as single lines)
- Main Water Network – Service connections to property
- Feature within the network such as valves, pumps, meters and hydrants
- Deep and Shallow Tube Wells
- Control Points(for linking sheets together

In addition to those, the following textual attributes are also present

- Road Names
- Leak Names, Prominent buildings, Housing Estates names and Paddy Fields
- Plot Numbers and suffix numbers of buildings within plots
- Pond indicator

The following features are omitted from the maps, as the information was not captured during the consumer survey or is not required.

- Vegetation.
- Paddy fields cross hatching symbology.
- Contours.
- Bridges, culverts etc.
- Small rivers and streams running through Plot areas.
- Road centre lines.

The name of the Record Drawing Maps is applied by the following rules.

(1) Thana/ Mouza Sheet:

- Thana is always one Character(D,P,K,B,S,M)
- Mouza is always two Digits
- Sheet is always two Digits
- Revision status is as per the Brown and Root Civil/Howard Humphreys Operating Procedures OP401

An example of a file name is "D1001.DWG".

(2) Record Drawing Files:

As record Drawings could contain several individual map sheets, the following naming convention has been adopted:

RD_THANA/MOUZA/MAP NR.

- Thana is always one Character
- Mouza is always two Digits

An example of Record Drawing file name is *"RD_D1001.DWG".*

(3) General Map Drawing Files

General Maps follows a similar convention to record drawinfs, though because of their smaller scale they display a greater area. The following conventions has been adopted in this case:

THANA/NAME

Thana is always one Character

An example of General Map file name is "GM_D01.DWG".

2.3 Plot Numbering Convention (CWASA Holding numbers)

For each Mouza, plot numbering stars at 1. Although the number of sheets per Mouza varies, each plot within a Mouza has a unique number.
To identify individual buildings within a Plot area, each building is labeled 'plot no. building no'(for example 122.1, 122.2, 122.3 for three buildings on one plot).

(1) Halishahar Housing Society

Plot numbers are not identical. Plots are numbered by four tyoes of variable i.e. BLOCK, ROAD, LANE & HOUSE. For Making an identical holding number for the whole area, a combination of those four variable is used.

Example:
For a House in Block 'K', Road 4, Lane 4 and House 4
Holding nr. Will be: 1140404.1
Where, from the right
.1 for Property (1 digit)
04 for House 4 (2 digit)

04 for Lane4 (2 digit)
4 for Road 4 (1 digit)
11 for Numeric Conversion of Block 'K'

(2) Khulshi Housing Area

The holding number in Road 4 and House 8

Holding n.r will be 408.1
Where, from right
.1 for Property (1 digit)
08 for House 8 (2 digit)
4 for road 4 (2 digit)

(3) Hill View Housing Society

Existing Plot numbers are identical for each Block(4 blocks). Housing numbers are combination of Block number and Plot number

Example:
For a Housing in Block 'A', road 1 and House 50

Holding nr will be 1150.1
Where, from right
.1 for Property (1 digit)
50 for House 50 (2 digit)
1 for road 1 (1 digit)
1 for Numeric Conversion of Block 'A'

(4) Chandagaon CDA Housing

Existing Plot numbers are identical for each Road. A combination of Road ref and Plot number is used here.

Example:
For House in road 1 and House 1

Holding nr. Will be 7788999.1
Where, from right
.1 for Property (1 digit)
999 for House 999 (3 digit)

88 for Road 88 (2 digit) [00 stands for no number present]
77 for Block 77 (2 digit) [99 stands for unnamed block]

For better file management, a new Mauza number also provided for the housing areas which are started below:

Table2.3Suggested Mouza Number for the Housing Areas

Housing Society	Thana	New Mauza number
Hill View	Panchlaish	66
Khulshi	Panchlaish	77
Chandgaon	Panchlaish	88
Haishahar	Doublemooring	99

APPENDIX3.

A GUIDANCE OF BASIC OPERATION FOR ARCMAP

1. A Guidance of Basic Operation for ARCMAP

ARCMAP provides with functions of GIS operation as a platform of map management in ARCGIS product. There are three types of products depending on a choice of the product for GIS operation by user as follows:

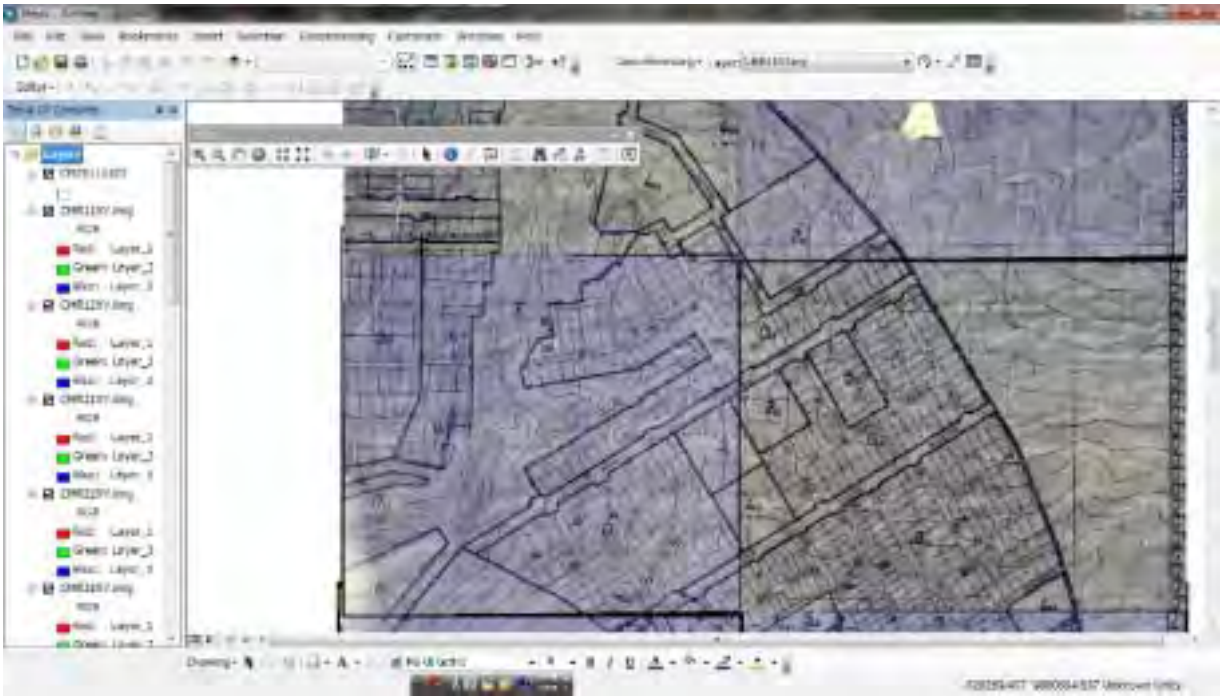
- ARCGIS ARCVIEW: A common platform of GIS operation in ARCGIS product
- ARCGIS ARCEDITOR: Functions of mapping and editing are strengthened in the product.
- ARCGIS ARCINFO: A fully functions for overall GIS operation in the ARCGIS

As a guidance of software introduction, the document was prepared for trainees who started to understand GIS and the basic training of the software operation. The detail shall be referred to reference manuals in the products by users or participation of training course in the suppliers.

1.1 Basic operation of ARCMAP

1.1.1 Start up of ARCMAP

From a task bar in the Windows Program, start ARCMAP. The window of Data View is displayed as an initial window shown in Figure1.1.1.1.



There are several menus in main windows in ARCMAP as follows:

- File consisting of modules to support file management in Data View
- Edit consisting of modules to support editing work in Data View
- View consisting of modules to support view control in Data View and Layout View
- Insert modules to support map layout in Layout View
- Selection modules supporting editing work in Data View
- Tool modules supporting editing work in Data View
- Window modules supporting editing work in Data View
- Help modules supporting editing work

1.1.2 Data View and Layout View

There are two (2) main windows manage GIS data as follows:

- Data View introduced in the previous sub chapter 1.1.
- Layout View managing to cartographic layout for output of ARCGIS in Figure 1.1.2.1. Both windows are switchable to display by a button selection by the mouse.

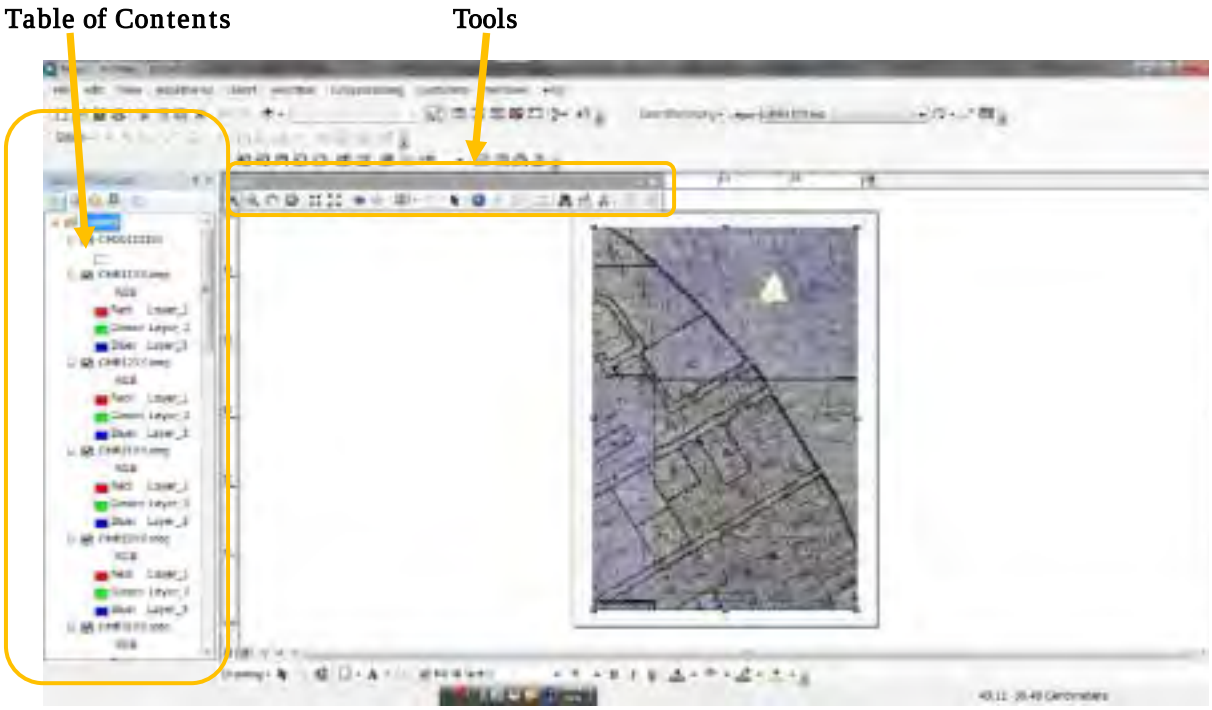


Figure1.1.2.1 Layout View of ARCMAP

1.1.3 Table of contents

The window of “Table of Contents” in Figure1.1.3.1 manages GIS data layer about vector data, image data and database in “Data View” and “Layout View” to set GIS data in the window, to control map scale, to configure layers such as legend, label, setup of link options with document and relational databases and so on. Any GIS data and relational databases are managed by this window.

Figure1.1.3.1 Table of Contents

1.1.4 Tool bar

It is a toolbar consisting of icons to manage GIS data in Data View in Figure1.1.4.1 as follows:

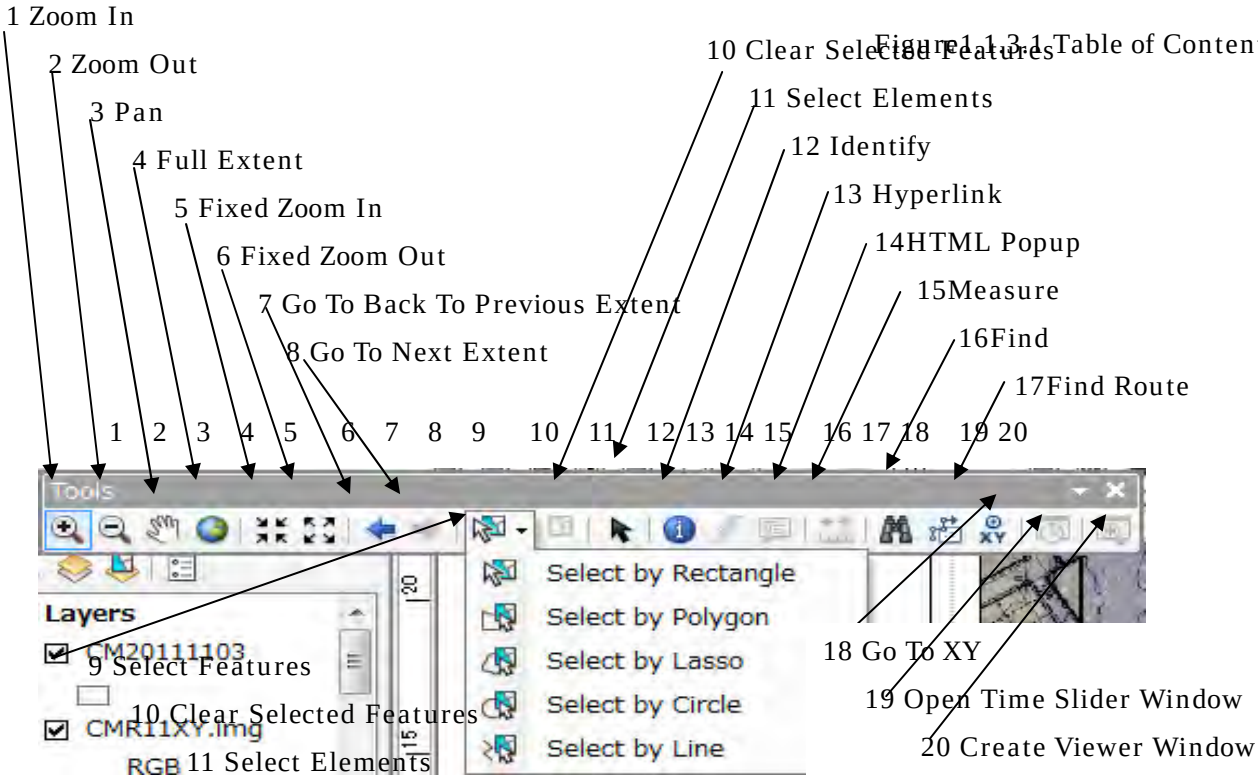


Figure1.2.4.1 Tool Menu

- 1 Zoom In  is operated by drag to drop of the mouse in Data Window if the icon is active
- 2 Zoom Out  is operated by drag to drop of the mouse in Data Window if the icon is

active

- 3 PAN  is operated by a click and a drag of the mouse in Data Window if the icon is active
- 4 Full Extent  is operated by a single click on the icon
- 5 Fixed Zoom In  is operated by a single click on the icon
- 6 Fixed Zoom Out  is operated by a single click on the icon
- 7 Go To Back To Previous Extent  is operated by a single click on the icon
- 8 Go To Next Extent  is operated by a single click on the icon
- 9 Select Features  is operated by the left click of the mouse with shift key if the icon is active and alternative options are provided by “Select by Rectangle”, “Select by Polygon”, “Select by Lasso”, “Select by Circle” and “Select by Line”.
- 10 Clear Selected Features  is operated by the click on the icon
- 11 Select Elements  is operated by the left click of the mouse to select graphic elements in Data View if the icon is active
- 12 Identify  to display attributes in the Attributes window is operated by a single click of the mouse in Data View if the icon is active
- 13 Hyperlink  displaying an object of document, image and object in Data Window is operated by the left click of the mouse if the icon is active.
- 14 HTML Popup describes how to use HTML pop-ups, which can be used to display information about each feature as formatted reports using XML style sheets (XSL) or as HTML displays. This also enables access to HTML Web pages for each feature.
- 15 Measure  about distance and area is operated by the mouse operation about line digitizing or polygon digitizing in Data View if the icon is clicked
- 16 Find  showing quick search of record and its geographic location in the window.

- 17 Find Route 
- 18 Go To XY 

showing a location is operated by the key in of X Y coordinates in the window.
- 19 Open Time Slider Window 
- 20 Create Viewer Window 

1.2 Menu modules

1.2.1 File Menu

"FILE" menu consists of several modules in Figure1.2.1.1 as follows:

- New
- Open
- Save
- Save As
- Save A Copy
- Add Data
- Sign In
- ArcGIS Online(R)
- Page and Print Setup
- Print Preview
- Print
- Create Map Package
- Export Map
- Map Document Properties
- Exit

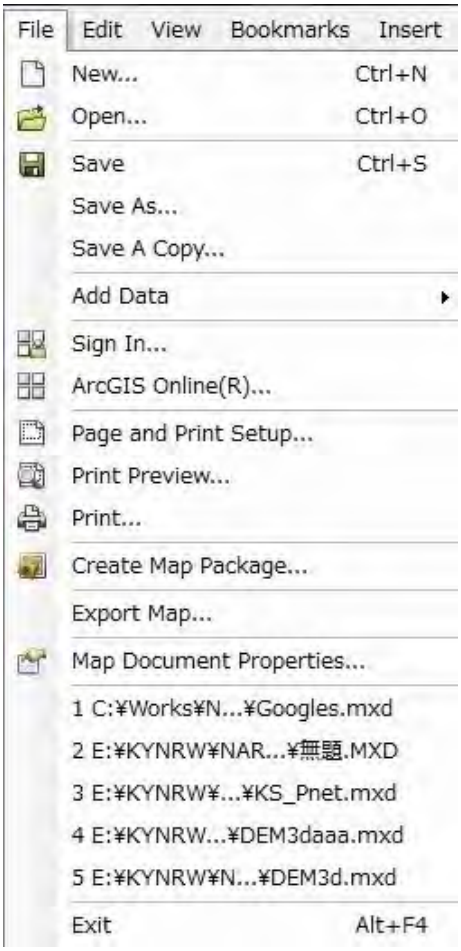


Figure1.2.1.1 File Menu

1.2.2 Edit Menu

"EDIT" menu consists of several modules in Figure1.2.2.1 as follows

- Undo Ctrl+Z
- Redo Ctrl+Y
- Cut Ctrl+X
- Copy Ctrl+C
- Paste Ctrl+V
- Paste Special...
- Delete Delete
- Copy Map To Clipboard
- Select All Elements
- Unselect All elements
- Zoom to Selected elements

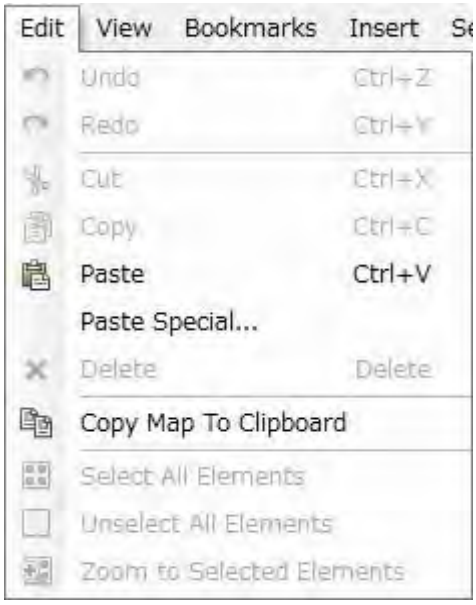


Figure1.2.2.1 Edit Menu

1.2.3 View Menu

"VIEW" menu consists of several modules in Figure1.2.3.1 as follows:

- Data View
- Layout View
- Graphics: "Create", "Create Scatter Plot Matrix...", "Manage" and "Load" in Figure1.2.3.2
- Reports: "Create Report", "Load Report" and " Run Report" in Figure1.2.3.3
- Scroll Bars
- Status Bar
- Rulers
- Guides
- Grid
- Data Frame Properties...
- Refresh F5
- Pause Drawing F9

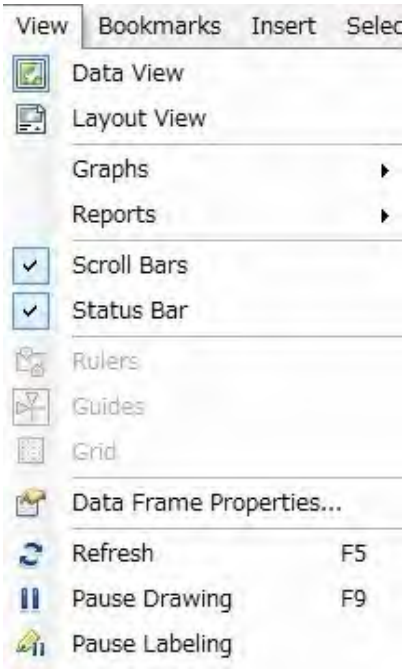


Figure1.2.3.1 View Menu

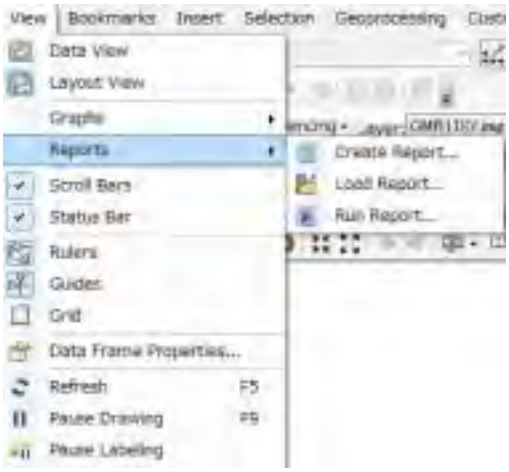


Figure1.2.3.2 Sub menu of Graphics

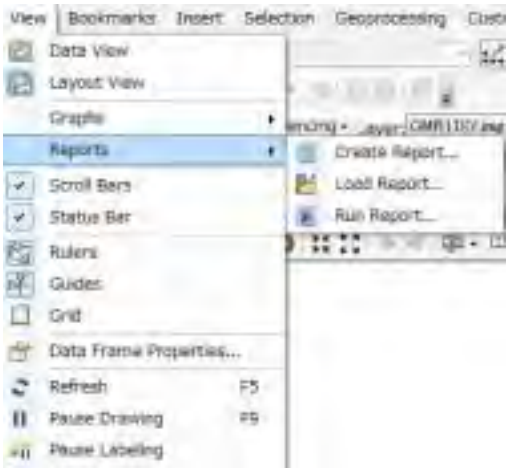


Figure1.2.3.3Sub menu of Report

1.2.4 Bookmarks

"BOOKMARKS" menu consists of several modules in Figure1.2.4.1 as follows

- Create…
- Manage…

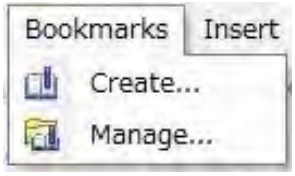


Figure1.2.4.1 View Menu

1.2.5 Insert Menu

"INSERT" menu on Layout View Window consists of several modules for cartographic design in Figure1.2.5.1 as follows:

- Data Frame
- Title
- Text
- Dynamic Text
- Neatline…
- Legend
- North Arrow
- Scale Bar…
- Scale Text…
- Picture…
- Object…

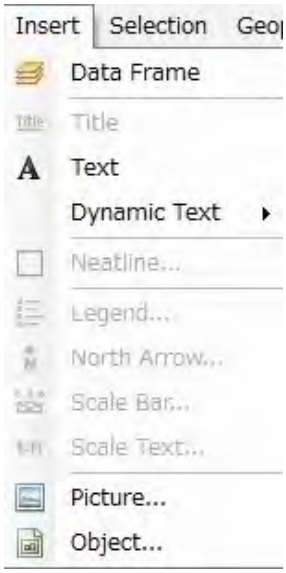


Figure1.2.5.1 Insert Menu

1.2.6 Selection Menu

"SELECTION" menu consists of several modules in Figure1.2.6.1 as follows:

- Select By Attributes
- Select By Location
- Select By Graphics
- Zoom To Selected Features
- Pan To Selected Features
- Statistics
- Clear Selected Features
- Interactive Selection Method consisting of sub menus about "Create New Selection", "Add to Current Selection", #Remove From Current Selection" and "Select From Current Selection" in Figure1.2.6.2.
- Selection Options…

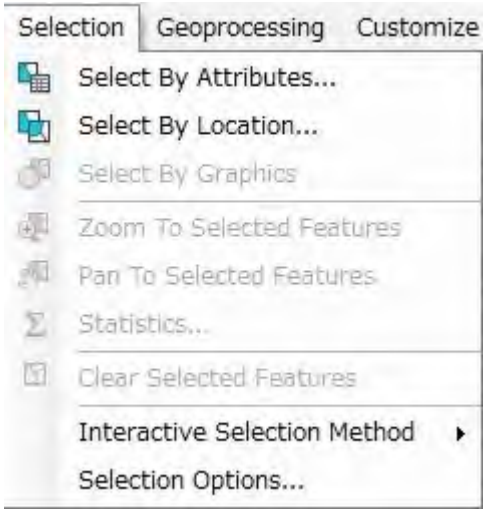


Figure1.2.6.1 Selection Menu

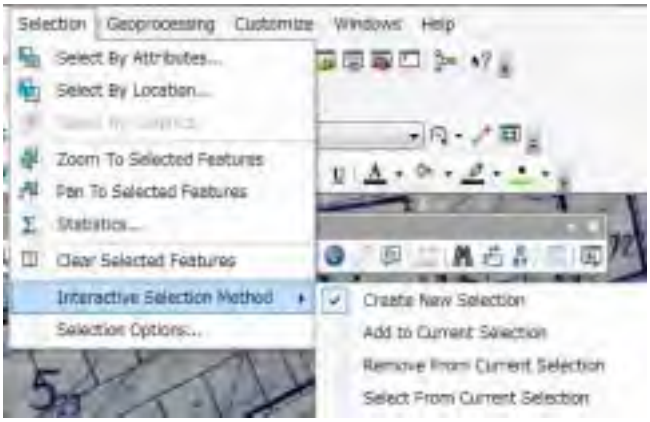


Figure1.2.6.2 Sub menu of Interactive Selection Mode

1.2.7 Geoprocessing

"GEOPROESSING" menu consists of several modules in Figure1.2.7.1 as follows:

- Buffer
- Clip
- Insert
- Union
- Merge
- Dissolve
- Search For Tools
- ArcToolbox
- Environments…
- Results
- Model Builder
- Python
- Geoprocessing Resource Center
- Geoprocessing Options…

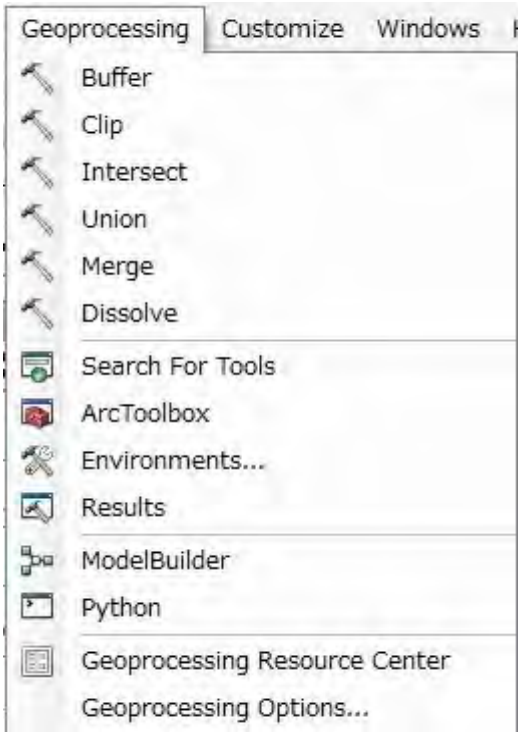


Figure1.2.7.1 Geoprocessing Menu

1.2.8 Customize

"CUSTOMIZE" menu consists of several modules in Figure1.2.8.1 as follows:

- Toolbars consisting of all sub menus to select and to display sub menus in Data View Window in Figure1.2.8.2.
- Extensions…
- Add-In Manager
- Customize Mode…
- Style Manager…
- ArcMap Options…

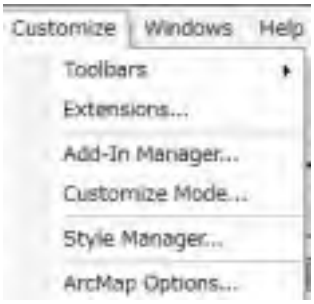


Figure1.2.8.1 Customize Menu

1.2.9 Window Menu

"WINDOW" menu consists of several modules in Figure1.2.9.1 as follows:

- Overview
- Magnifier
- Viewer
- Table Of Contents
- Cataloge
- Search Ctrl+F
- Image Analysis

Figure1.2.9.1Window Menu

1.2.10 Help Menu

"HELP" menu consists of several modules in Figure1.2.10.1 as follows:

- ArcGIS Desktop Help F1
- ArcGIS Desktop Resource Center to access to the WEB server in ESRI
- What's This shift+F1

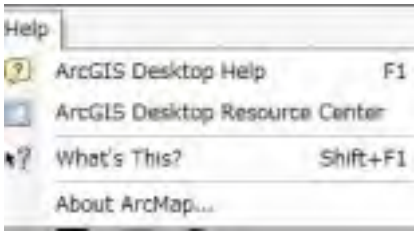


Figure 1.2.10.1 Help Menu

- About ArcMap… to show product information in the window.

3. Terms of Works for Preparation of GIS Datasets and Databases on GIS Design

OBBRIGATION

ARCGIS:	Product name in Earth Science Research Institute (ESRI), USA
ARCMAP:	ARCMAP software in ARCGIS products in Earth Science Research Institute (ESRI) in USA
BTM:	Bangladesh Transverse Mercator
CAD	Computer Aide Drawing
CDA:	Chittagong City Corporation Development Authority
C/P	Counterpart
C/S:	Computer Section in CWASA
CSCCR:	Consumer Service Connection Completion Report
CWASA:	Chittagong Water Supply and Sewerage Authority
DB:	Database
D/D:	Design Division in Chittagong WASA
DMA:	District Meter Area
DPI:	Dot Per Inch
DSR:	Distribution System Register
DXF:	Data Exchange Format in CAD data
ESRI:	Earth Science Research Institute in USA
GCP:	Ground Control Point
GIS:	Geographic Information System
GPS:	Global Positioning System
MIS:	Management Information System,
MOD:	Maintenance Operation Division in Chittagong WASA
NRW:	None Revenue Water
O&M:	Operation and maintenance
PANI:	Project for Advancing Non Revenue Water Reduction Initiative
RDBMS	Relational Data Base Management System
SC:	Service Connection
S/D:	Sales Division in CWASA
SOB:	SUEVEY OF BANGLDESH
UGUM:	Under Ground Utility Map
UTM:	Universal Transverse Mercator
VW1:	World View1 High Resolution Satellite Image supplied by Digital Globe Corporation in USA
WB:	World Bank

Contents

COMPLETION REPROT (CSCCR)

APPENDIX4: DATA SPECIFICATION OF BILLING DATABASE IN COMPUETR SECTION

APPENDIX5: DATA SPECIFICATION OF GIS DATASETS IN BUILDING SURVEY

APPENDIX6: DATA SPECIFICATION OF FIELD VERIFICATION SURVEY IN THE MODEL AREA

APPENDIX7: DATA SPECIFICATION OF FIELD SURVEY DATABASE IN THE PILOT PROJECT AREA

APPENDIX8: DATA SPECIFICATION OF MAP DIGITIZING OF UNDERGROUND UTILITIES

APPENDIX9: HANDLING OF BILLING DATA IN THE NRW

APPENDIX10: MONITORING DATA OF FLOW MEASUREMENTS AT SERVICE METERS

APPENDIX11: DATA SPECIFICATION OF GIS DATA AND DATABASES IN TESTPIT EXCAVATION

APPENDIX12: SUEVEY DATABASE AND GIS DATA IN LEAKAGE SURVEY

Chapter1 General Provisions

(Purpose)

Article1 "Terms of works" describes guidelines of preparations about GIS datasets and databases for the Project for Advancing Non Revenue Water Reduction Initiative, hereinafter referred as PANI, in order to require to produce supporting datasets on GIS data and databases in the None Revenue Water, hereinafter referred as NRW, based on available asset data in Chittagong Water supply and Sewerage Authority, hereinafter referred as CWASA. Particularly there was absence of GIS dataset and a relational database which provided with usable conditions for GIS operation in order to utilize counter measures for the None Revenue Water, hereinafter referred as NRW, as PANI was being required. The preparing steps are directly relating to rationalizations of Management Information System, hereinafter referred as MIS, on Information Infrastructure in CWASA.

There are several pillars in ROAD MAP to challenge capacity developments on GIS data and databases in the NRW on facility Management, if CWASA strongly requires taking actions to restore the not-functional GIS operations on Management Information System, hereinafter referred as MIS, to the future.

(Requirement of GIS Operation in PANI)

Article2 GIS Operation in PANI shall be required to compile available datasets in order to support the NRW as follows:

- Compiling GIS datasets and relational databases of service meters and customer information to map the geographic location of facilities about Distribution System Register, hereinafter referred as DSR and Service Connection, herein after referred as SC in existing CWASA asset data, which had been developed in the 1990's by the previous project and also which was required to update data by field verification surveys for the NRW in the Pilot Project Areas and in the Model Area.
- Transform CWASA coordinate system to WGS1984 in order to adjust the present CWASA missing coordinate system on satellite image.
- Verifying GIS datasets by reference of As Built Drawing and compiling of field verification survey data in Pipeline Survey and Pipe Leakage Survey for the NRW in the Pilot Project Areas.
- Compiling Customer data and billing data in order to monitor water consumption and billing charge as an indicator of the counter measure for the NRW in the Pilot Project Areas.
- Desktop survey for building to apply estimation for districted water demand analysis in

the Model Area

- Supporting for planning and implementation of the NRW in the Pilot Project
- Strengthening to support asset mapping and MIS in CWASA to the future.

(Available Data Resources for GIS Dataset and Relational Databases in CWASA)
Article3 There are available data resources to compile GIS datasets and relational databases for the NRW of CWASA as PANI shall require developments as follows:

- GIS datasets in DSR main facilities consisting of main pipes and facilities relating to distribution water network such as control valves, network junctions and others.
- GIS datasets in SC consisting of service pipes, service meters and relational databases of Service Connection details
- Relational Databases mainly relating to consumer connection about
  - Service meter in SC details which was developed by last CWASA NRW project in the 1990's
  - Customer data in SC details which also was developed by same as the service meter as follows:
    - ✧ Billing data in C/S consisting of customer information details, monthly water consumptions and billing data in the section in order to monitor the countermeasures in the NRW.
    - ✧ Compiling of survey database in Pipeline Survey and pipe leakage survey in order to update GIS datasets in the Pilot Project Area
  - Monitoring of the NRW data to compile flow measurement, meter testing data and in Water Distribution and others
  - And etc.

PANI compiles necessary information for which the NRW needs to compile GIS datasets with preparations of relational databases which are key information to make counter measures utilize in the planning and implementation of the NRW.

(Available Mapping Features compiling GIS datasets in PANI)
Article4 Available mapping features compiling GIS datasets in PANI shall be basically required to utilize existing CWASA CAD datasets mainly consisting of facilities in DSR and those in SC. Facilities in DSR include main pipe and related facilities such as Control valves, Network Junctions, Hydrants, Washouts and so on. Those in SC include Service pipes, Service meters and Customer Information which is directly related to billing database and which is composed of a relational database for the monitoring in the NRW.
PANI has to restore the past initial GIS datasets by compiling of available backup data with

updating of GIS data by field verification survey data in the Pilot Project Areas and in the Model Area.

(Preparation of GIS datasets)
Article5 Preparations of GIS datasets shall be compiled by data feature, based on original data structures of CWASA CAD datasets without changing structures. According to type of GIS data features about a point, a line , a polygon and text annotation, PANI compiles GIS datasets as follows:

- Line features of Main pipes and Service pipes
- Point features of Facilities related to DSR and Service meters in SC
- Map annotation of initial mapping datasets on Mauza map

ALL CAD layers are separated to the above GIS datasets with consideration of different data structures with CAD drawing data.

(Requirement to Edit Data Structure in GIS Dataset)
Article6 GIS dataset shall be required to provide with usable data structures on topology which is relating to geometries in mapping features when CAD dataset will be converted to GIS dataset. There are several technical issues on editing of GIS datasets in order to produce reliable GIS datasets with consideration of intersection of lines, snapping nodes among lines, attributes managed in database and so on.
Map annotation in CAD data is visually displayed in the data but map annotation in GIS datasets must be handled by a relational database in GIS data. Those differences should be considered in the production of GIS datasets in PANI by CWASA counterparts.

(Definition of GIS datasets and Relational Databases in PANI)
Article7 PANI shall define GIS datasets and Databases which supports activities of implementation of the NRW as follows:

(Items of GIS datasets)
Item1 GIS datasets shall be defined by line features and point features in GIS datasets as follows:

- Line features of GIS datasets are:
  - ✧ Main pipes in DSR with attributes of type of facility and pipe attributes
  - ✧ Service pipe in SC with attributes of type of facility, pipe attributes and Account Number in billing data.
- Point features of GIS datasets to identify locations at facility are:

- ✧ Related facilities in DSR with attribute of type of facility and others about Control Valves, Junctions, Hydrants, Washouts and others
- ✧ Service meter with attribute of type of facility and Account Number in billing database.

(Items of Relational Databases)

Item2 Items of relational databases shall be mainly linked to GIS datasets in SC details as follows:

- Service meter about SC details in the formally developed in Design Division, hereinafter referred as D/D
- Customer data about SC details in the formally developed in D/D
- Consumer Service Connection Completion Report hereinafter referred as CSCCR, which is one of key information in Customer Management in Sales Division, hereinafter referred as S/D. The forms was required to compile database to record the information details, service connection details, sketch maps with archiving and other documents with archiving in the report.
- Building database to apply estimations of water demand analysis prepared by image interpretation of buildings survey in Desktop Survey
- Billing databases in C/S to update Customer Information details and to monitor monthly water consumption in the Pilot Project Areas.
- Survey databases which data are compiled by field verification survey data of Pipeline Survey and Pipe Leakage Survey in the Pilot Project Areas, which data is mainly verified about SC details in the NRW
- Monitoring databases which are counter measures in the NRW to compile flow measurement results and metering test results and other information to support the NRW in the Pilot Project Area.

All databases are designed to link together with GIS datasets through a primary key filed of Account Number among data.

(Requirement of the latest mapping feature compiling datasets in PANI)

Article8 PANI shall be required to refer the latest mapping features in the Pilot project area and in the Model Area by a procurement of High Resolution Satellite Image of World View1 image. The beneficiaries of data resource will be brought to CWASA as follows:

- Solution of missing matching problems of georeferencing system with GPS data and other mapping resources in Bangladesh
- Updating of CWASA data as a latest status

- Reference of land cover changes in CWASA operations
- Building survey in Desktop Survey to identify buildings of SC details for Demand Analysis in the NRW.

(Policy of Preparation of GIS Datasets and Databases in PANI)

Article9 There are several policies shall be required to compile GIS datasets and databases which PANI supports to implement activities of the NRW based on available CWASA data resources. PANI updates necessary data conducting to field verification surveys in Pipeline Survey and Pipe Leakage Survey. PANI compiles only necessary GIS datasets in the Pilot Project Areas but that didn't extend updating of original mapping features in the areas except mapping in Halishahar area. There are some policies in preparation of datasets in PANI as follows:

- GIS dataset is restored to recover the past initial GIS datasets at the initial production of CWASA data in the 1990's.
- GIS datasets are only compiled by available datasets in CWASA as PANI requires.
- Updating of GIS data and databases are limited by field verification surveys for the NRW in the Pilot Project Areas and in the Model Area.

(Editing Policy of GIS Datasets)

Article10 Editing policy of GIS dataset shall be required to prepare usable GIS data set by editing of CAD data structures in data conversion. There are requirements of editing datasets to modify data structures which were caused by careless Quality Control in the initial mapping on CAD drawing. All GIS datasets should be corrected about data structures on topology in the geometry by editing process. Editing work should be taken cares of intersections among line segments and snaps of nodes at line segments.

GIS software provides with editing module on topology to process intersection, undershoots and overshoots. In the preparation of GIS dataset, operator should understand a significant of editing in GIS operation. Without proper understanding of this issue, GIS operation makes it hard to handle GIS data in the real GIS operation.

(The Production Area of GIS Datasets)

Article11 GIS datasets in PANI described in the guideline shall be required to correspond to production of datasets based on available CWASA datasets to cover in the Pilot project area and in the model area.

(Geodetic Parameter of GIS Dataset)

Article12 The conformed ellipsoid and other geodetic parameters of the GIS dataset to

handle with this regulation shall be defined as follows:

1) The conformed ellipsoid: Everest 1830(Bangladesh published coordinates)
   - A semi major axis, a = 6377,276.345 m
   - Flat efficiency, f = 1/300.8017
2) the three (3) Molodensky constants (DX, DY, DZ) required for datum transformations of WGS1984:
   - ΔX = -283.729m,
   - ΔY = -735.942m,
   - ΔZ = -276.923m;
3) A standard of a plane position
   - The primary control point (Dhaka)
   - Latitude: 23°47′49.4850
   - Longitude: 90°25′06.5527
4) A standard of height
   - The primary bench mark Dhaka

   The averaged sea in the Bay of Bengal Sea in Dhaka is defined as zero-meter at the primary bench mark Dhaka.

(The Unit to Use)

Article13 The GIS basic data bases on the surveying unit which shall be handled by the digital mapping as follows:

1) Length: meter,
2) Square: km2
3) Angle: degree, minute, second

(Map Projection in GIS Datasets in PANI)

Article14 Map projection to handle in PANI shall be handled by a geographic coordinate system on WGS1984 and the Bangladesh Transverse Mercator, hereinafter referred as BTM, projection. Relevant agencies are used to adopt both coordinates system in the digital mapping and GIS development so that PANI utilizes both of coordinate system to handle GIS datasets. A coordinate system is flexibly selected by operator. As once established georeferencing parameters in GIS software, operator can easily project data to BTM and other reference system.

(Map Projection on WGS1984)

Article15 GIS data in PANI follows Map Projection on WGS1984 shall be set to match CWASA coordinate system to a worldwide coordinate system in order to solve issues on initial

mapping data. Parameter of coordinate system on WGS1984 is refereed as follows:

- Coordinate system is recommended to use decimal degree
- Geodetic datum is selected by WSG84

Parameter should be set by GIS operator in GIS software.

(Map Projection on BTM)

Article16 Map projection on BTM shall be easily utilized to transform the coordinate system in GIS datasets. The follows is a description of BTM.

(A Central sutra line of longitude)

Item1 A Central sutra line of longitude shall be employed at Longitude 90 degree and Zone number of UTM is employed at 46, and a scale factor of UTM is adopted by 0.9996.

(A plane coordinate system)

Item2 A plane coordinate system shall be defined as X against Easting and Y against Northing. The coordinate at the center line of longitude is defined as 500 kilometers against X and that at equator is defined as zero against Y.

(Parameters of Map Projection for GIS datasets)

Article17 Parameters of map projection set for GIS basic data shall be employed about BTM as follows:

1) The conformed ellipsoid: Everest 1830(Bangladesh published coordinates)
   - A semi major axis, a = 6377,276.345 m
   - Flat efficiency, f = 1/300.8017
2) The two shift values (Shift X, Shift Y) required for datum transformations of WGS1984:
   - X Shift = -283.729 m,
   - Y Shift = -735.942 m
3) Scale factor in BTM projection
   - Scale factor: 0.9996
4) Longitude of Center projection for BTM projection
   - Longitude: 90°00′00.00 (DMS)
5) Latitude of origin projection for BTM projection
   - Latitude: 00°00′00.00(DMS)
6) False Easting and False Northing for BTM projection
   - False Easting: 500,000m
   - False Northing: -2,000,000.0m

(Preparation Unit of GIS Dataset)

Article18 The preparation unit of the GIS basic data shall be based on the map sheet of exiting CWASA GIS datasets in the 1990's as the coverage area shown in Table1. The compiling GIS data is only limited to produce data in the Pilot project areas and in the model area.

Table1 the preparation unit of GIS datasets in CWASA coverage area

The preparation unit	Map scale	Area of preparation of GIS dataset
Mauza map	Seamless scale based on 1 / 5,000: 2500m x 3000m	Longitude:92 ° 04' 47.056"E - 92 ° 41'47.056"E
		Latitude : 22 ° 12'24.865'N' - 22 ° 28'56.413"N
		BTM X: 674,500 - 714,500
		BTM Y: 457,000 - 487,000

(Procedures for Production of GIS Datasets and Databases in PANI)

Article19 A work procedure for production of GIS dataset and databases in PANI shall be established by real preparations of those datasets thorough the Pilot Project. The work procedures are divided to twelve (12) components of ROAD MAPs as a mile stones in production of the NRW datasets to sustain GIS operation in CWASA shown in Figure1. Each Road Mas is being instructed about the detailed preparation of datasets against counterparts in CWASA during the period of the enforcement of PANI.

The detail in each ROAD MAP is individually instructed in the next Chapter. All those steps are required for counterpart to master the detail operation as follows:

- ROAD MAP1: Compiling GIS Datasets to Restore Initial Data from CAD Drawing Files with Georeferencing in ROAD MAP2
- ROAD MAP2: Transform CWASA Coordinate System
- ROAD MAP3: Compiling Existing Relational Databases of Service Meter & Customer with Updating
- ROAD MAP4: Compiling Database of Consumer Service Connection Completion Report
- ROAD MAP5: Compiling Customer Data and Monthly Billing Data
- ROAD MAP6: Compiling Existing As Built Drawing Maps
- ROAD MAP7: Compiling Building Survey Data
- ROAD MAP8:Compiling Field Verification Survey data To Update GIS Datasets in the Model Area
- ROAD MAP9:Compiling GIS Datasets of the Underground Utility Map
- ROAD MAP10: Compiling Field Verification Data of Pipe Survey and Pipe Leakage Survey in the Pilot Project Areas
- ROAD MAP11: Compile NRW Databases to support Monitor & Action for the NRW
- ROAD MAP12: Compile survey database of Test Pit excavation to support O&M on FM

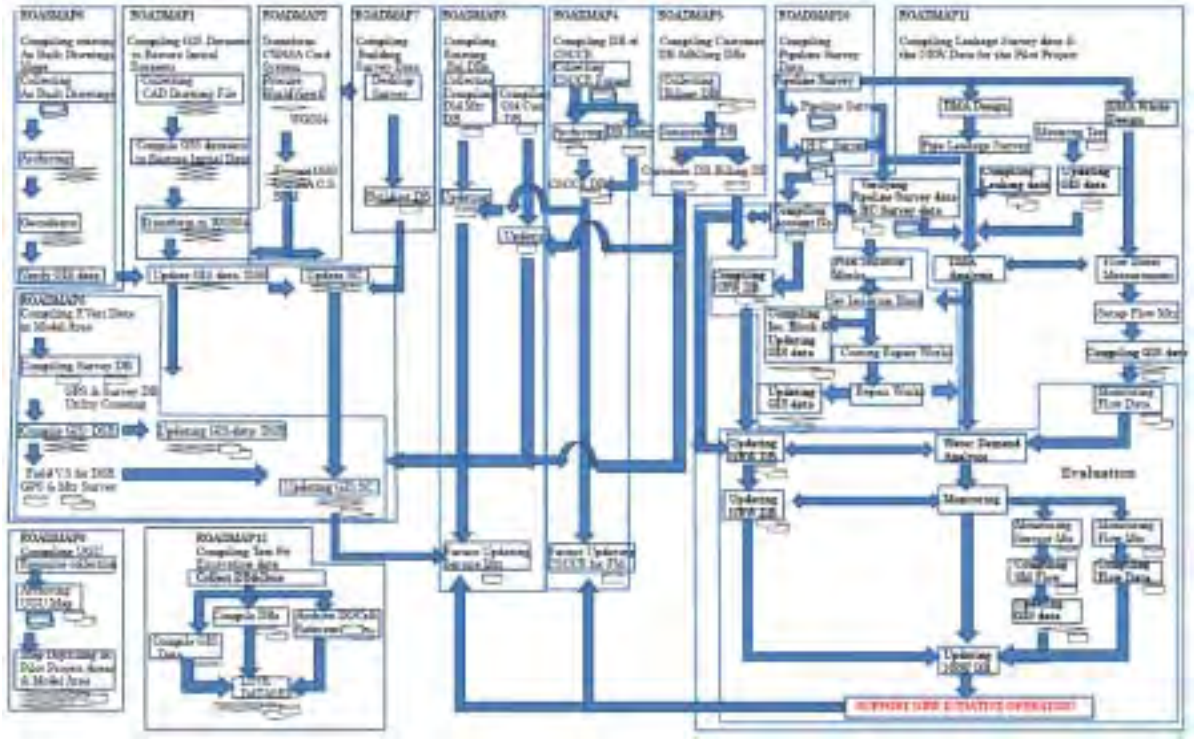


Figure1 ROADMAPS on GIS operation in the NRW as Pillars in Capacity Development

(Attention to Quality Control)

Article20 The working person in charge should be required to pay attention to quality control to secure necessary data quality without careless mistakes and production poor quality data. After the preparations of GIS datasets are finished, data should be plotted to a paper in order to check the output, and it should be examined by the visual check.

(Cross Check of Datasets)

Article21 The checking inspection shall be cared at the ending time of each work by the working person in charge. Any careless mistakes should be omitted in the production GIS datasets.

(Feedback of Result to Operation)

Article22 The result of GIS datasets as mentioned in the guideline shall be just to compile necessary GIS datasets to support the NRW in the Pilot Project Areas and in the Model Area. The data produced should be applied to extensions of production of GIS datasets until covering with the whole CWASA coverage area to develop the Facility Management System to support practical operation in Sale division, Maintenance Operation Division and other divisions in CWASA.

(Orientation of Updating of mapping features in GIS datasets)

Article23 The present mapping features in CWASA GIS datasets shall be required to update other mapping features except GIS datasets which PANI produced, by using the latest mapping resources or those in relevant agencies. It is a requirement to sustain maintenance of asset mapping in CWASA to the future, which is dispensable activity from a point view on Asset Management.

(A system to Operate)

Article24 A GIS system shall be required to operate production of GIS datasets and relational databases for the NRW in PANI. A GIS system should be provides with definite functions as follows:

1) The function of Map Digitizing to input GIS datasets including the On Screen Digitizing
2) The function of editing data which performs the move, the append and the delete of figure data and which editing should be supported by topology on geometry
3) The split function and the joint function of line data and polygon data.
4) The functions of map coordinate system to manage map projection
5) The function to image data handling for georeferencing, transform, map projection and spatial adjustment to shear local distortions.
6) The import and the export of the data produced with other systems
7) Database function
8) The spatial query function and the display function of the data
9) The overlay data processing function
10) The function of cartographic layout to output maps
11) The function of output maps and printout

Chapter2 ROADMAPS

2.1 ROAD MAP1: Compiling GIS Datasets to Restore Initial Data

(Compiling GIS Datasets to Restore Initial Data)

Article25 Compiling GIS Datasets to Restore Initial Data shall be required to restore initial GIS datasets for the NRW in PANI from existing CWASA datasets. Only CAD Drawings found in the backup data in D/D should be required to convert to GIS datasets by series of data processing in order to restore usable GIS data with updating of those data.

There are three (3) steps to compile usable GIS datasets in the pilot project area as follows:

- The first step is required to compile initial GIS datasets in the 1990's. PANI required restoring usable GIS datasets with editing of data structures from CWASA CAD Drawing datasets. This means, data structure of CAD drawing was unsuitable for GIS operation in CWASA so that PANI had to start compiling usable GIS datasets on available data resources in CWASA.
- The second step is required to transform a unique CWASA coordinate system to general coordinate system on WGS1984 or BTM in Bangladesh. There are some issues of positional accuracy and precisions in initial CAD drawing datasets which was caused by shortage of quality Control in the initial preparation. There are hard distortions not to be able to transform the original shapes of mapping data in the datasets.
- The third step is required to update GIS datasets as the latest data status by using available CWASA data resources and field verification surveys.

There are several steps required to produce GIS datasets in Figure2.1 as follows:

- Compiling GIS Datasets to Restore Initial Data
- Transform CWASA Coordinate System For Updating of GIS data in the ROAD MAP2
- Updating GIS Datasets: DSR & SC on As Built Drawings in ROADMAP6
- Updating GIS Datasets: DSR& SC by Field Verification Survey in ROADMAP8
- Updating old relational. databases of SC by CSCCR with billing data in ROADMAP3 in the future
- Verifying the above databases with Field Verification Surveys in the future

Data specification of GIS datasets in production of GIS data in the PANI is referred to the APPENDIX1: DATA SPECIFICATION OF GIS DATASETS AND DATABASES.

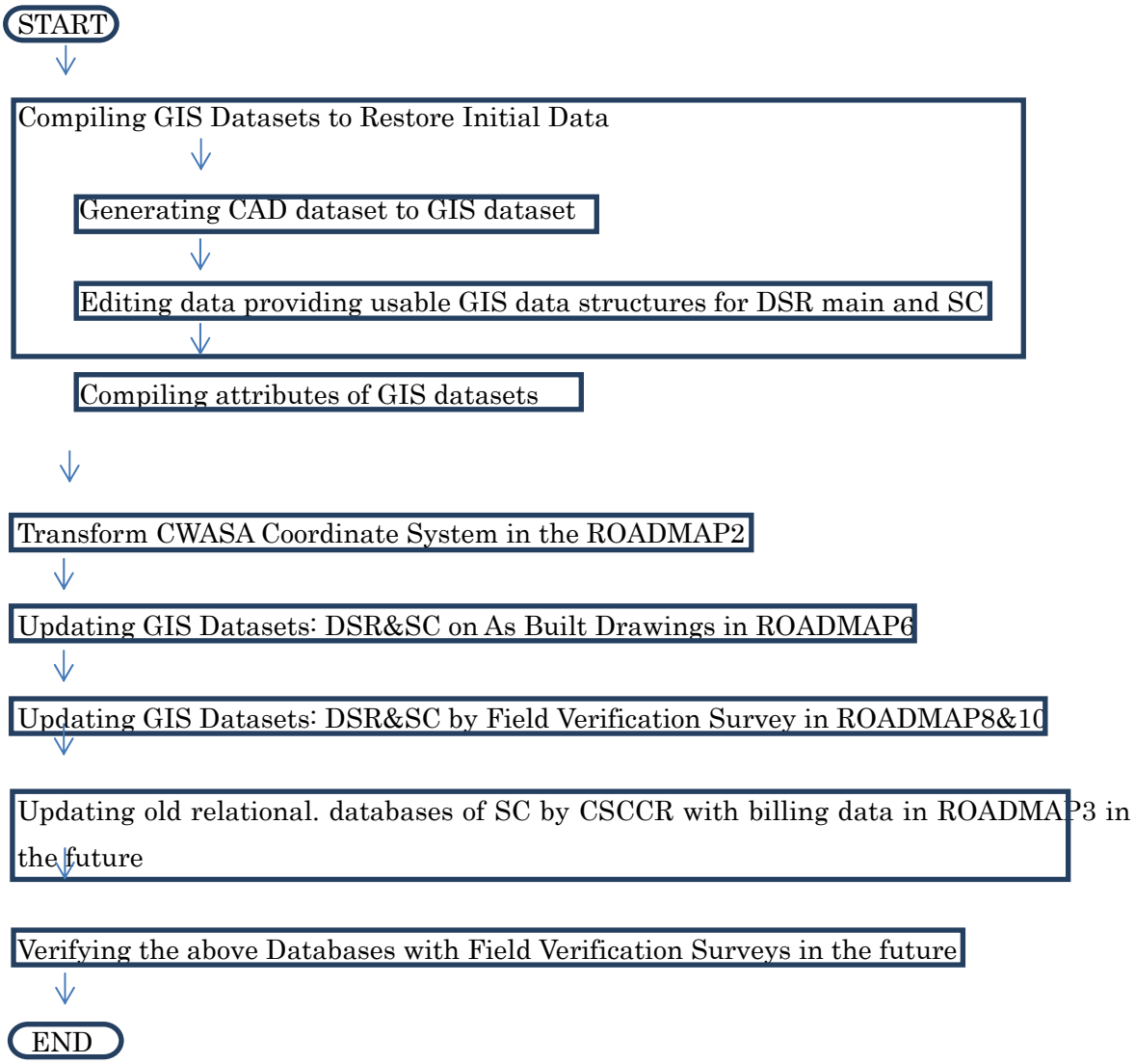


Figure2 1 Flow chart of Compile GIS Datasets to Restore Initial Data

(Compiling GIS Datasets to Restore Initial Data)

Article26 Compiling GIS Datasets to Restore Initial Data shall be mainly handled by three (3) steps to process data in Figure2.2 as follows:

- Generating CAD dataset to GIS dataset
- Editing data providing usable GIS data structures for DSR main and SC
- Compiling attributes of GIS datasets

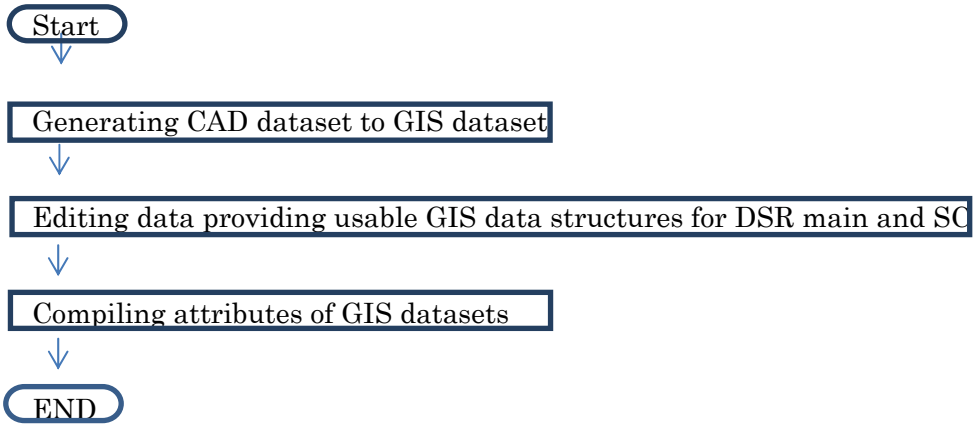


Figure2 2 Flow chart of Compile GIS Datasets to Restore Initial Data

(Generating CAD datasets to GIS datasets)

Article27 Generating CAD datasets to GIS datasets shall be generated from CAD drawing to GIS data by data conversion in GIS software. There are alternative methods to convert CAD data to GIS data in GIS software. There are two (3) features of GIS data in data conversion as follows:

- Line feature including pipelines, service meters and buildings, roads and other lines except point features
- Point feature about mainly map annotations
- Polygon feature about mainly symbol of service meter

All data layers are generated to GIS data individually.

(Editing data providing usable GIS data structures for DSR main and SC)

Article28 Editing data providing usable GIS data structures for DSR main and SC shall be required to correct geometric features on topology such as point, line and polygon with processing of intersections and snaps of nodes at overshoots and undershoots. CWASA CAD drawing is a cartographic drawing data which is compiled by symbol data. The data is unsuitable to process GIS data but there is no choice of data resources to start GIS operation in CWASA.

There is an issue to different data structures between CAD data and GIS data which is required to edit data to provide usable GIS data structures about:

- DSR: Main pipes with attributes
- DSR facilities such as control valves, junctions, hydrant, washout and others
- SC: Service pipes and Service meters with attributes of Customer Information and Account Information

Key points in editing work are as follows:

- Main pipes and service pipes should be established about network topology. A line should be defined from a start note to end node.
- All lines should be intersected at the crossing points of lines.
- A center point of polygon at service meter should be generated by data and an end node of service pipe should be extended to the center point.

The detail operation is instructed by operation manual for GIS operation in the training manual.

(Compiling attributes of GIS datasets)

Article29 Compiling attributes of GIS datasets shall be required to give data attributes of map annotation of in DSR Main and SC. There is an issue of attribute in CAD layers which is only layer to display map annotation in the data structural layer information is never converted to database of GIS data although only CAD own layer information is converted to GIS data.

All attributes required to GIS data should be compiled by operator manually.

(Transform CWASA Coordinate System in the ROAD MAP2)

Article30 Transform CWASA Coordinate System in the ROAD MAP2 shall be required to transform GIS Datasets to WGS1984/BTM with Spatial Adjustment. The detail is referred to in chapter 2.2: ROADMAP2.

(Updating GIS Data on As Built Drawings)

Article31 Updating GIS Data on As Built Drawings shall be required to update GIS Datasets: DSR&SC on As Built Drawings in ROADMAP6. The detail is referred to in chapter 2.6: ROADMAP6.

(Updating GIS Data on As Built Drawings)

Article32 Updating GIS Data on As Built Drawings shall be required to update GIS Datasets: DSR&SC by Field Verification Survey in ROADMAP8. The detail is referred to in chapter 2.8: ROADMAP8.

(Updating old Relational Databases of SC in ROADMAP3 in the future)

Article33 Updating old Relational. Databases shall be required to update old relational. databases of SC by CSCCR with billing data in ROADMAP3 in the future.

Update Databases of Service Meter and Customer data on CSCCR & Billing Database

The detail is referred to in chapter 2.3: ROADMAP3.

(Verify the above in Field Verification Surveys)

Article34 Verify the above in Field Verification Surveys shall be required to verify the above Databases with Field Verification Surveys in the future

2.2 ROAD MAP2: Transform CWASA Coordinate System For Updating of GIS data

(Transform CWASA Coordinate System)

Article35 Transform CWASA Coordinate System shall be to compile usable GIS datasets for updating data to be able to make CWASA Coordinate System transform to the world geodetic coordinate system on WGS1984 by using World View1 Image on the latest Mapping Resources. The procedure of transform in Figure2.3 is as follows:

- The first Transform from CWASA Coordinate System to Everest1830 Coordinate System
- The second Map projection from Everest 1830 Coordinate System to WGS1984 System convertible to BTM Coordinate System
- The third adjust matching to handle hard distortions caused by the past initial datasets

Significant transform of CWASA datasets is referred to the APPENDIX2: SIGNIFICANR TRANSFORM FOR CWASA GIS DATASETS.

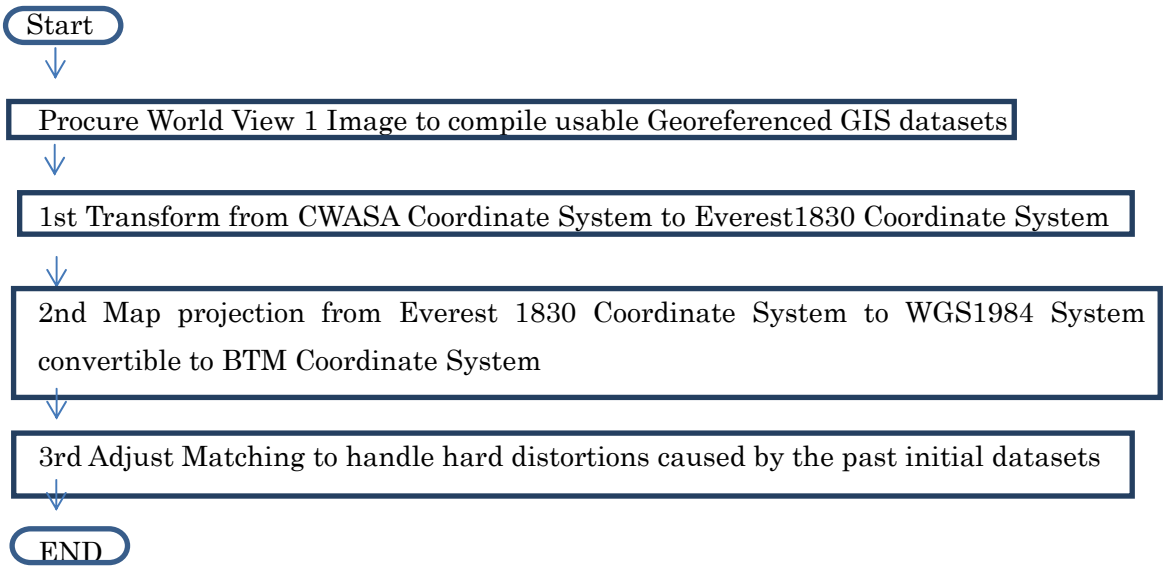


Figure2 3 Flow chart of Transform CWASA Coordinate System

(The first Transform CWASA Coordinate System to Everest1830)

Article36 The first transform of CWASA Coordinate System shall be required to match the unique coordinate system data with the world geodetic system on WGS1984 such as GPS positioning data, Google Earth image, and topographic maps in SOB and available GIS datasets in CDA. The unique CWASA coordinate System makes it hard to overlay data with available datasets. All mapping features were compiled in unique geographic coordinate

system which that on decimal is multiplied by ten thousands (10000) and there was another issue not to match CWASA data caused by Mauza map in BS sheet. It was supposed that past CWASA data was adopt by ellipsoid system on Everest 1830 according to evidences in the backup data in CWASA. CWASA data will not be usable without this matching process with available mapping resources.

In order to correct missing coordinate system in CWASA data to adjust with GPS data, initial transformation should be processed to fill geographical gaps in data. The process required is initially required to transform the present coordinate system in GIS data. The transform will project the geographic coordinate system on Everest 1830 and the data is initially transferable to match with GPS positioning data and other mapping resources out of CWASA.

(The second map projection from Everest 1830 to WGS1984)

Article37 The second map projection from Everest 1830 to WGS1984 shall be required to project data from the geographic coordinate of decimal degree on Everest 1830 to that on WGS1984 by using geodetic datum parameter in the pre-defined ones in System. The coordinate system on WGS1984 is synchronized to match with that on the BTM Coordinate System easily in GIS software. Once set a georefrencing system in the GIS dataset, GIS software can handle to any map projections easily.

(Third Spatial Adjustment)

Article38 Third Spatial Adjustment shall be required to adjust spatial locations in order to handle hard distortions caused by poor quality control in the production of initial dataset in the past. It is hard to transform data in strong distortions by using the model calculation in transformation algorithm in system. Those distortions shall be adjusted by the spatial adjustment tool to try to match data in GIS software.

Mauza map required is utilized to reference information of GIS datasets such as location of cadaster parcel and map annotations to identify locations of water facilities although updating is required in the future.

2.3 ROAD MAP3: Compiling Existing Relational Databases of Service Meter & Customer with Updating

(Compiling Existing Relational Databases of Service Meter & Customer Data with Updating)
Article39 Compiling Existing Relational Databases of Service Meter & Customer Data with Updating shall be expected to update Relational databases of service meter and customer data on MIS in D/D, which data had been compiled to databases by the WB project in the 1990's. However there is no updating record in those databases at present.

These databases are updated by reference of CSCCR basically when D/D receives CSCCR document month by moth from S/D.
It is expected to update these databases by the above actions in the future.

Compiling Existing Relational Databases of Service Meter & Customer Data with Updating in Figure2.4 is as follows:

- Compiling old Relational Databases of Service Meter and Customer data
- Compiling CSCCR database in ROADMAP4
- Updating the above Databases referred by available data resources in the future
- Compiling the NRW Databases for the Pilot Project in the future
- Updating Attributes of SC details from GIS data in the future

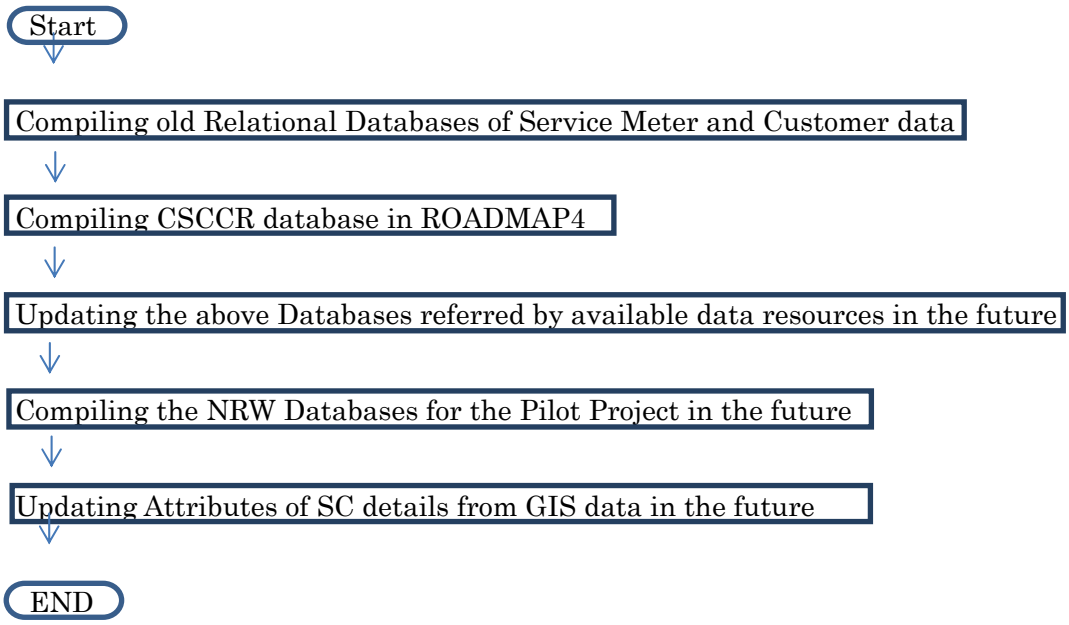


Figure2 4 Flow chart of Compile Existing Relational Databases with Updating

(Compiling Existing Relational Databases of Service Meter and Customer data)
Article40 Compiling Existing Relational Databases of Service Meter and Customer

data is required to generate old databases of meter for SC details and customer data for billing data. D/D shall be keeping backup files of dBASE format in PC. In the beginning of PANI, databases were generated to worksheets of MSEXCEL and databases of MSACCESS. There was no updating of databases since year 1998 to the present.

(Compiling CSCCR database in ROADMAP4)

Article41 Compiling CSCCR database in ROADMAP4 shall be required to prepare CSCCR database in order to update those old databases. The detailed process is explained in next Chapter "Compiling Database of CSCCR".

PANI had to prepare this kind of databases for the Record Management in consideration of the present CWASA operation way.

(Updating Databases referred by available data resource in the future)

Article42 Updating Databases referred by available data resources in the future shall be required to do by references of CSCCR in ROADMAP4 and Billing data in C/S in the future. There is no expectation to be able to update old databases under the present data situation in CWASA so that it will be expected to do it in the future.

(Compiling the NRW Databases for the Pilot Project in the future)

Article43 Compiling the NRW Databases for the Pilot Project in the future shall be required to arrange initial databases required to compile the NRW database from CSCCR database in next chapter of "Compiling CSCCR database in ROADMAP4 directly.

There is no expectation to be able to update old databases under the present data situation in CWASA so that it will be expected to do it in the future.

(Updating Attributes of SC details from GIS data in the future)

Article44 Updating Attributes of SC details from GIS data in the future shall be required to update those databases by references of CSCCR in ROADMAP4 with real time updating of SC details and Billing Data in C/S at Commercial Division in the future.

There is no expectation to be able to update old databases under the present data situation in CWASA so that it will be expected to do it in the future.

2.4 ROAD MAP4: Compiling Database of Consumer Service Connection Completion Report

(Compiling Database of CSCCR)

Article45 Compiling of CSCCR, so named Compile Database of Consumer Service Connection Completion Report in S/D, shall be provided to basic information to support updating of existing Relational databases about Customer Information Details and SC details on MIS which the last NRW project had compiled to Mapping datasets in the 1990's. CSCCR is one of key information in CWASA Asset Management in order to manage Customer Service and Billing Collection. The document compiles all data concerned to initial installation of SC and Customer Information with attached documents in the process of customer's application as follows:

- One (1) page of completion report to provide with applicant information, locations and ownership of cadaster parcel and addresses and approval document, SC details, and billing information.
- Sketch drawing at the site identifying service pipe and service meter
- Location map in BS sheet identifying the location in the map.
- Other attachment relating to document for activation from Relevant agencies

Existing databases of service meter details and customer information in GIS section at D/D would be updated by reference of CSCCR. However there were some issues about not to be provided with geo coding to select local data and to be vacant in CWASA holding number for geo coding and to be vacant in SC details.

It was necessary for PANI to refer CWASA Holding Number to identify a location of Service meter and sketch drawing to map SC and to update missing information about SC details. However there was miserable situation for the document to be scattered among different divisions and to be existed in paper archives. In order to select data in the Pilot Project Areas, available document about eighteen thousand (18000) had to be searched to find target data. Considered with the future requirement from point of view on Record Management, PANI developed a supporting database in MSACESS to manage the record with preparation of archiving documents in order to reserve paper resources.

There is another issue required to purchase the present data status of SC details and Customer Information in CSCCR after the application process according to daily operation of meter reading.

As S/D manages Customer Management, database support is required to establish the modernization of management in system under rationalizations of CWASA Management

System.

In order to compile paper form of CSCCR, there are several steps required to develop the database in Figure2.5 as follows:

- Resource collection
- Archive Paper Form and Sketch drawings
- Database Entry of the Form & Compiling Databases
- Update a Relational. DB of Service meter and customer data in the future
- Compiling NRW Databases in the Future
- Feedback to database from GIS data in the NRW in the future

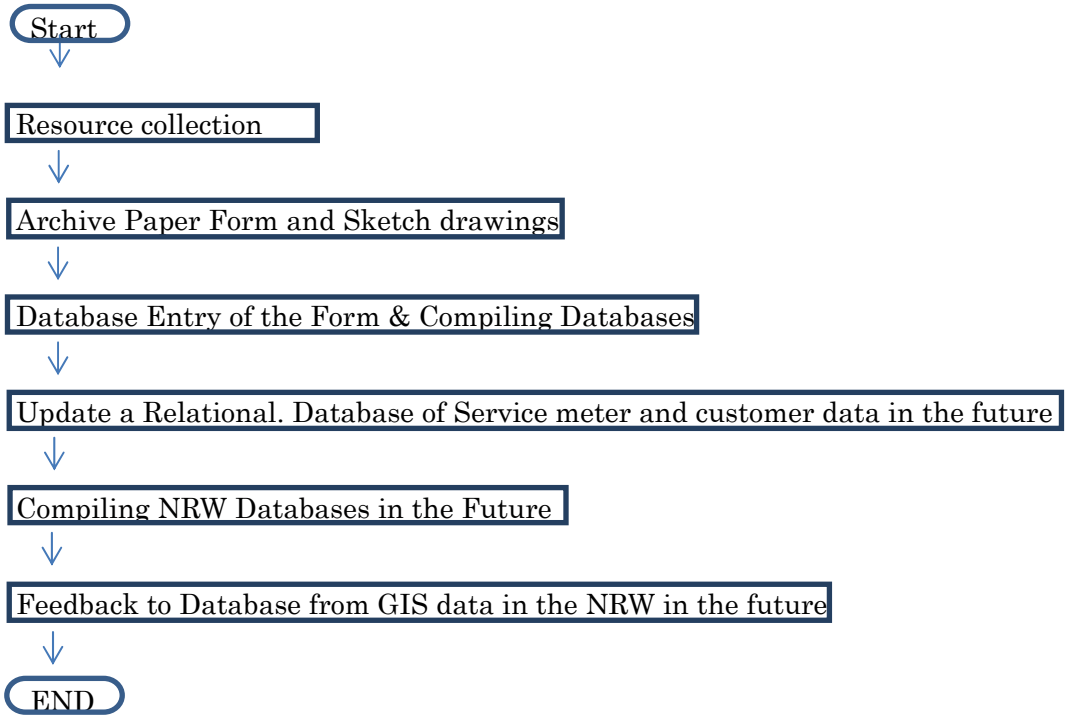


Figure2 5 Flow chart of Compile Database of CSCCR

(Resource collection)

Article46 Resource collection shall be required for S/D to make CSCCR gather from S/D itself, D/D, C/S and others. In order to avoid scattering documents and to miss document in paper, S/D shall utilize modernization of management media to switch over from paper to database in modernized PC management. Not expected the situation, the future management unit on MIS in CWASA shall collect the form to process into database.

(Archiving Paper Form and Sketch drawings)

Article47 Archiving Paper Form and Sketch drawings shall be required to reserve paper document to digital archive by scanning of document. Document is processed to save graphic file of document in each page by scanner. Operator must pay attention to name document to manage scanned data. Account Number is suitable to set a prefix for name of document with combination of sequential number or unique naming rule in CWASA.

(Database Entry of the Form & Compile Databases)

Article48 Database Entry of the Form & Compile Databases shall be required to entry data into database of MSACCESS in which PANI prepared the data entry form for encoding work. Data items are compiled into the entry form in database. There are two (2) types of data composed to the form by text items and graphic items.

The details are instructed by the operation manual of CSCCR in the appendix of Operation Manual for database of CSCCR. Graphic files such as signature, sketch drawings, reference maps are compiled to the form by Hyperlink to display the object in the screen.

Data entry method of CSCCR and data specification in database is referred to the APPENDIX3: DATA ENTRY FOR CONSUMER SERVICE CONECTION COMPLETION REPORT (CSCCR).

(Updating a Relational Database of Service Meter and Customer Data in the future)

Article49 Updating a Relational Database of Service Meter and Customer Data in the future shall be required to update existing database of service meter details and custom database in D/D according to reference of CSCCR. However the CSCCR is not effective to utilize updating of database and mapping features in D/D at present.

CSCCR should be updated by S/D with updating of SC details and customer management details by daily operation of meter reading.

(Compiling NRW Databases in the Future)

Article50 Compiling NRW Databases in the Future shall be required to provide the NRW databases to be transformed from CSCCR directly. There are same issues in the previous chapter “Updating a Relational. Database of Service meter and customer data in the future”.

(Feedback of DB from GIS data in the NRW in the future)

Article51 Feedback of Database from GIS data in the NRW in the future shall be required to make GIS data give back to update CSCCR database to fill vacant items in the report by Field Verification Survey Data in the Future.

All vacant items in the report should be verified to fill vacant items in the form by field verification survey in Pipeline Survey or Leakage Survey in the activities of the NRW.

2.5 ROAD MAP5: Compiling Customer Data and Monthly Billing Data

(Compiling Customer Data and Monthly Billing Data)

Article52 Compiling Customer Data and Monthly Billing Data shall be required to make it sure to identify Account Number of customers and monthly Billing data in the pilot project areas or in the target area for the NRW enforcement.

Account Number is a primary key field to establish Relational databases in GIS datasets in S. All attributes concerned are closely linked by Account Number in Billing data

There are two (2) data resources to be divided as follows:

- Customer information to manage general customer information such as name of owner, attributes of ownerships, type of water use, Sealing Number of service meter and other general details in SC.
- Monthly billing data to manage monthly water consumptions to calculate bill charge to customers.

NRW is required to calculate monthly amount of water consumptions and bill amount during a monthly term in meter readings between a date on the previous month and that on the present month. All billing data should be calculated by work sheet with cross check of missing data records. There is no usable condition corresponding to utilize the NRW directly. There are some missing records or strange records existing in the resent database. There are several steps required to compile Billing data in Figure2.6 as follows:

- Generating Billing Data from C/S
- Compiling Present Customer Information data in the pilot project area
- Compiling Monthly Billing data in the pilot project area
- Monitoring Water Consumptions and Billings in the pilot project
- Continuously monitoring of billing data to support the NRW Operation

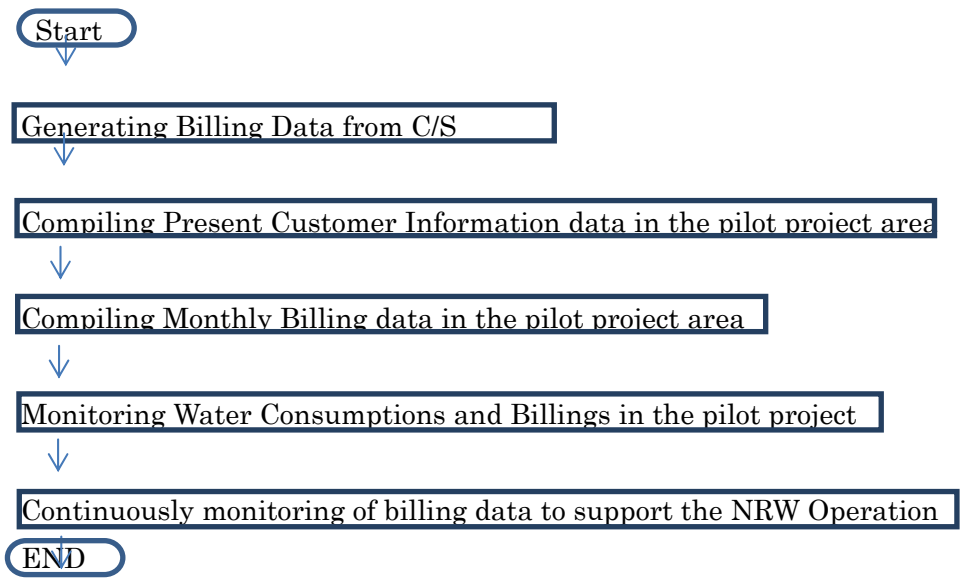


Figure2 6 Flow chart of Compile Customer Data and Monthly Billing Data

The detailed instruction of data handling is instructed by work manual referred in APPENDIX9: HANDLING OF BILLING DATA IN THE NRW.

(Generating Billing Data from C/S)

Article53 Generating Billing Data shall be required to collected soft copy of billing data from C/S. Export files in FOX PRO software will be supplied by the section. However there is an issue not to provide a database field to identify a locality in the database so that all data concerned had been supplied by the section in order to select necessary billing data from the whole data. The master file of Billing database is required to prepare for the pilot project for the NRW.

Export file will be compiled into database individually. There are thirty-three (33) files covering with the CWASA service area. The files should be merged to a master file of Billing database for the NRW.

(Compile Present Billing databases in the pilot project area)

Article54 Compiling Present Customer Information data in the pilot project area shall be manually identified to select required Account Numbers in the pilot project area by the list of Account Number in the field verification survey data. Selected database records should be compiled to worksheet in MSEXCEL. There are some difficult cases not to be able to arrange monthly data according to monthly calendar. A worksheet in MSEXCEL is suitable to arrange and to handle data base record easily in consideration of sequences of monthly data and also with cross check of missing billing data to adjust calculations in available data. If missing data or missing term found in billing data, monthly data should be handled by calculation of data in the missing term.

Data specification of customer information and billing database are referred to the APPENDIX4: DATA SPECIFICATION OF BILLING DATABASE IN C/S.

(Compiling Monthly Billing data in the pilot project area)

Article55 Compiling Monthly Billing data in the pilot project area shall be required to calculate monthly amount of water volumes and billing charges a term of meter readings. Water consumption and billing charge in each Account Number is handled in worksheet of MSEXCEL by calculations of days' portion in the previous month and those in the present month in meter readings.

(Monitoring Water Consumptions and Billings in the pilot project)

Article56 Monitoring water consumption and billing data in the pilot project shall be sequentially required to monitor the data. Same procedures in the process will be repeated to support the NRW.

(Sustainable Monitoring of Water Consumptions and Billing to support the NRW)

Article57 Sustainable Monitoring of Water Consumptions and Billing shall be required to monitor counter measures of the NRW periodically after the pilot project will be terminated from point of view on Facility Management for Customer Service and the initiatives of Water Supply Management in the future.

2.6 ROAD MAP6: Compiling Existing As Built Drawing Maps

(Compile Existing As Built Drawing Maps)

Article58 Compiling Existing As Built Drawing Maps in GIS section at D/D shall be required to verify present GIS datasets which initial datasets had been compiled in the 1990's. It is a significant to refer existing As Built Drawings to verify the present GIS datasets not only for the pilot project of the NRW but also for enforcement of Facility management of Asset management on MIS.

There are several steps updating GIS datasets in order to enforce the NRW. As the first step of updating GIS data, there are some procedures to handle the drawings in Figure2.7 as follows:

- Collect Maps in D/D
- Archive Paper Maps by Scan
- Georeferencing of Map Image Data
- Verify GIS data to Update Locations and Attributes of Data about DSR Main and SC
- Sustainable development of archiving library of the drawings to the future

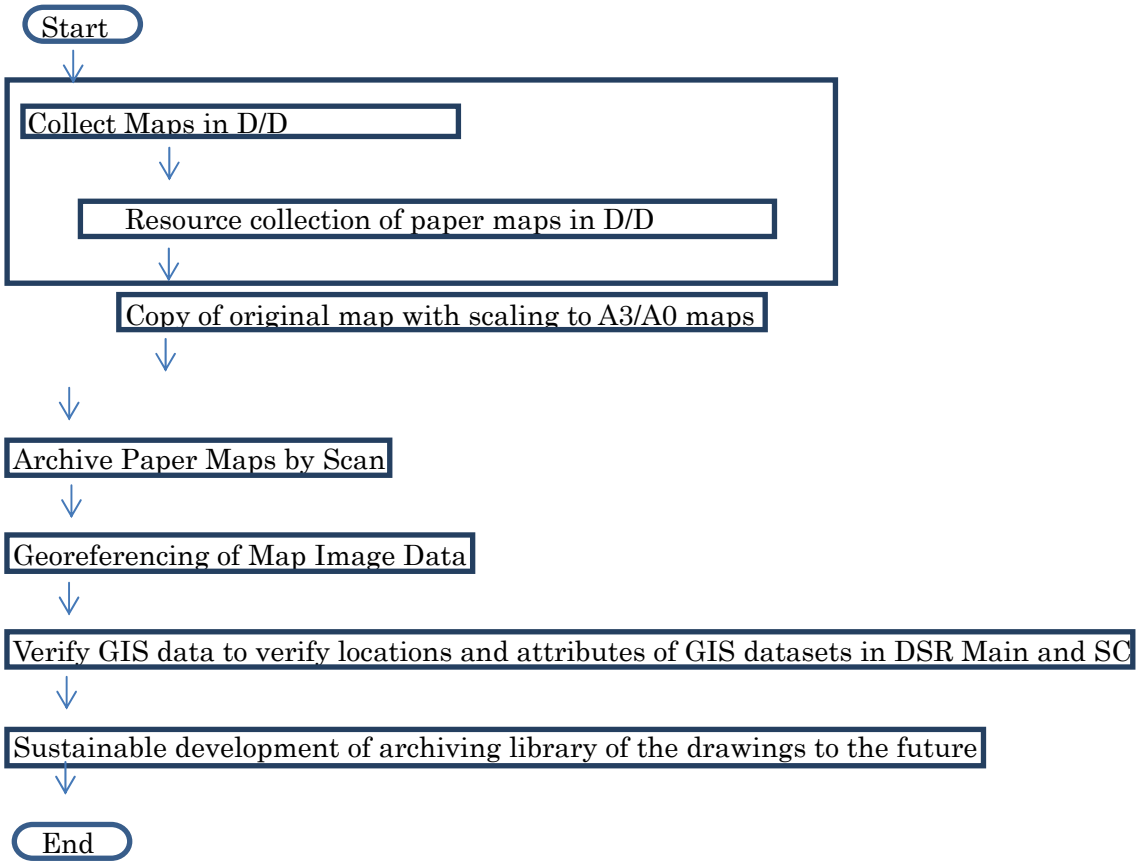


Figure2 7Flowchart of Compile Existing As Built Drawing Maps

(Collecting maps in GIS Division)

Article59 Collecting maps in GIS Division shall be required to collect paper maps to compile work sheet for scanning process. The step consists of two (2) steps about Resource collection of paper maps in D/D and Copy of original map with scaling to A3/A0 maps as a preparatory work.

(Resource collection of paper maps)

Item1: Resource collection of paper maps in D/D shall be required to collect available As Built Drawings in the D/D. Most maps are still kept by papers media such as blue prints and printed maps. There is an issue to switch over recording media. In order to process paper maps must be collected to preserve maps in digital archives in the next step.

(Copy of original map)

Item2 Copy of original map shall be required to prepare a work map to set up for a scanner with zoom controlling for reduction of paper size to adjust to A3 size or A0 size in the scanner

format. A3 size paper is suitable for smooth scanning process. According to setup condition to scan map, map resolution could be required for screen digitizing.
The resolution shall be carefully checked by a person in charge of GIS.

(Archiving Paper Maps by Scanner)
Article60 Archiving Paper Maps shall be required to save paper size for scanning of a copied map in the scanner setting. A setup of resolution in the scan process should be set about 300 DPI or larger resolution. There are several conditions to set up in the scan process as follows:

- Resolution is 200 DPI to 300DPI
- Color mode is Grey scale
- Graphic format is JPG format.

Scanned data shall be checked to judge availability for screen digitizing after scanned maps.

(Georeferencing of Map Image Data)
Article61 Georefencing of Map Image data shall be required to transform image data to match with World View1 image by using GCP, so called Ground Control Point) which is a corresponding point between pixel coordinate on image data and a geographic coordinate system on WGS1984 or BTM in World View1.

(Verifying GIS data on As Built Drawing)
Article62 Verifying GIS data on As Built Drawing shall be required to verify locations and attributes in GIS data by overlay to refer to As Built Drawings. Some GIS data of DSR Main and SC should be checked and updated by this process.

(Sustainable development of archiving libraries)
Article63 Sustainable development of archiving library of the drawings shall be required to reserve the CWASA asset maps from point of view on Record Management to the future. All papers concerned should be recommended to switch over definite media from analog to digital in order to establish the future data library in CWASA.

2.7 ROAD MAP7: Compiling Building Survey Data

(Compiling Building Survey Data)

Article64 Compiling building Survey Data shall be required to develop building database to correspond to estimate demand and supply of water supply in the sub zoning block which is relating to water distribution in Pipeline network plan according to image interpretation of buildings on satellite image in reconnaissance survey of the Desktop Survey. There are several items available to be able to interpret on Satellite image about building structure and building stories in the interpretation.

The information will be applied to estimate demand and supply about water supply in the area by references of field verification survey data for the NRW in the pilot project.

There is procedure for building survey in Figure2.8. The information will made to feed back to estimate analysis of demands and supply for the NRW and the sub zoning process to divide to Distribution Water Network System corresponding to the CWASA Operations in the Future.

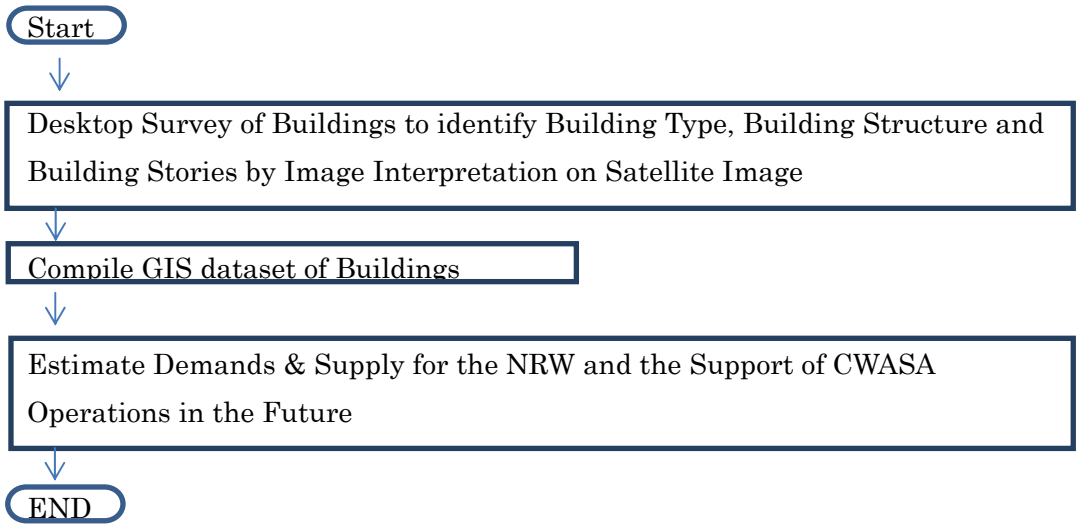


Figure2 8Flow chart of Compile Building Survey Data

(Desktop Survey of Buildings)

Article65 Desktop Survey of Buildings shall be required to identify Building Type, Building Structure and Building Stories by Image Interpretation on Satellite Image. There are required items to interpret in the image interpretation as follow:

- Building structure: PACCA, SEMI PACCA and KATCH in Bengali classification of Buildings
- Building Stories: numbers of stories in the building

(Compile GIS dataset of Buildings)

Article66 Compile GIS dataset of Buildings

In the step of the previous chapter, a point feature of GIS data about building is digitized at a center point of building with consideration of parcel plot area with required attributes.

Data specification is referred to the APPENDIX5: DATA SPECIFICATION OF GIS DATASET INN BUILDING SURVEY.

(Estimate Demands & Supply for the NRW and the Support of CWASA Operations)

Article67 Estimate Demands & Supply for the NRW and the Support of CWASA Operations shall be applied in the future.

Based on overlay operation with buildings and the definite area such as ward boundary, sub zoning block of Distribution Water Network System, the information will be utilized to estimate relatively counter measures to support the planning and implementation of the Action.

2.8 ROAD MAP8: Compiling Field Verification Survey data for GIS Dataset

(Objective of Compiling Field Verification Survey data for GIS dataset)

Article68 Compiling Field Verification Survey data shall be required to make field collection data utilize to update GIS datasets in the model area. There are two (2) field data collections to verify locations of facilities to update GIS datasets in PANI.

(Field Verification for DSR Main in the Model Area)

Item1: Field Verification for DSR Main in the Model Area shall be required as follows:

- To verify locations to update GIS data about main pipes and facilities relating to DSR Main in the area.
- To identify locations of utility crossings among pipe lines with Gas pipes, Electric lines, Telecommunication lines, rivers and Canals.

(Field Verification for Account Survey about SC in Zone3 of the Model Area)

Item2: Field Verification for Account Survey about SC in Zone3 of the Model Area shall be required as follows:

- To verify a location of service meter in existing As Built Drawings
- To update Account Number of service meters of GIS data in the area.

The work flow is shown in Figure2.9.

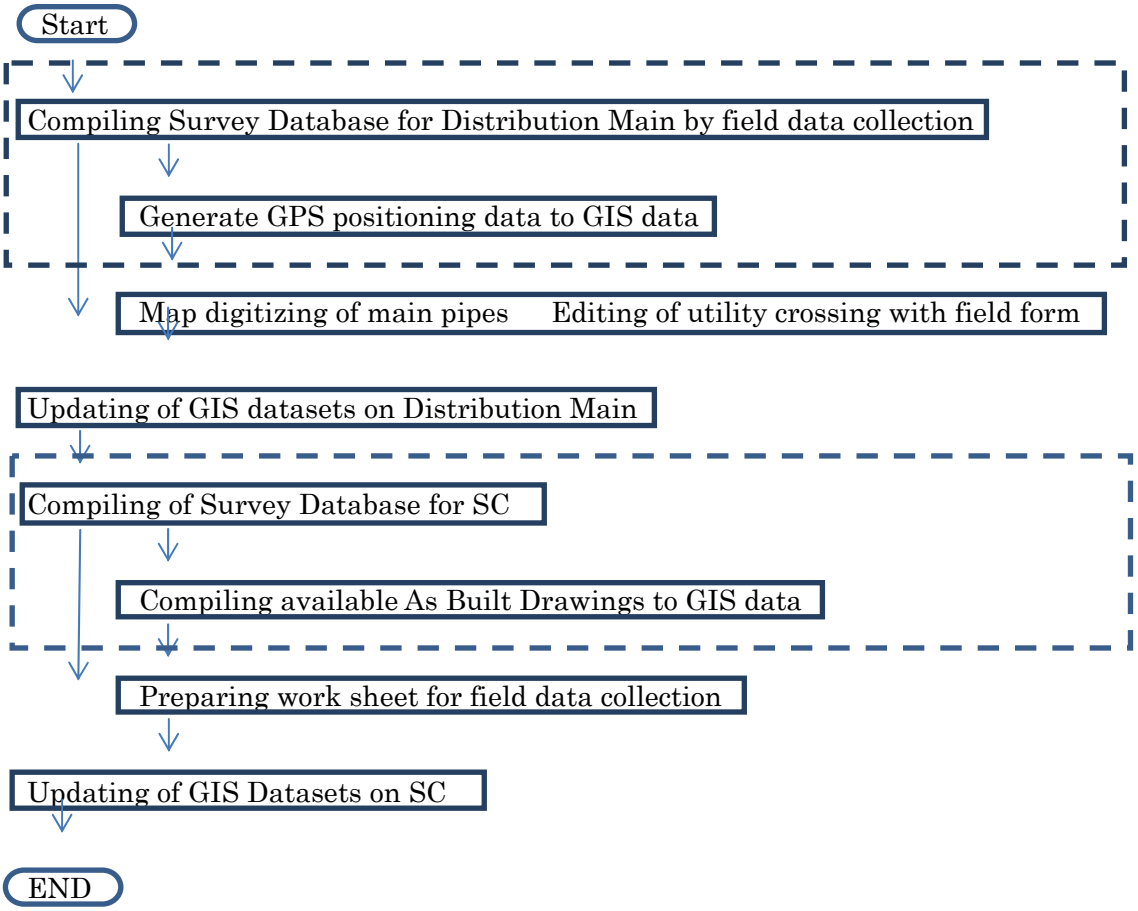


Figure2 9 Flow chart of Compile Field Verification Survey data for GIS Dataset

(Compiling Survey Database for DSR Main)

Article69 Compiling Survey Database for DSR Main in the Model Area shall be required to compile field collection data into sprat sheet of MSEXCEL to arrange Relational databases which are compiled by GPS positioning data, Field survey forms, photos at surveying points and sketch drawings at utility crossings. There are two (2) MSEXCEL files and graphic files of photos files and sketch drawing of utility crossing at surveying points in order to compile Relational databases to GIS datasets with those survey forms.

Data specification of surveying databases about compiling GPS data and Field Verification Survey data and that of GIS specification are referred to APPENDIX6: DATA SPECIFICATION OF FIELD VERIFICATION SURVEY IN THE MODEL AREA. Data specification of Service Connection Survey in the model area is referred to APPENDIX7: DATA SPECIFICATION OF FIELD SURVEY DATABASE IN THE PILOT PROJECT AREA.

The procedure shall be required to as follows:

(Generating GPS positioning data to GIS data)

Item1 : Generating GPS positioning data to GIS data: Field verification data shall be compiled to two (2) types of field databases about MSEXCEL files referred in the APPEXDIX2.

The data form provides with columns of geographic coordinates positioned by a handheld GPS receiver. All positioned points are generated to GIS datasets with Relational databases of survey data. Graphic files are compiled to GIS datasets by a setup of hyperlink table as an object of survey items in the form.

(Map digitizing of main pipes)

Item2: A line feature of main pipe shall be required to digitize by the On Screen digitizing with consideration of a line section of main pipe with reference of As Built Drawings, as generated a point feature in Item1.

(Editing of utility crossing with field form)

Item3: A point feature of GIS data shall be required to compile to GIS data by selection of target records of utility crossing data, based on generating of field collection data in Item1.

(Updating of GIS datasets on DSR Main)

Item4 Locations of existing main pipes and facilities related in DSR Main shall be required to updated data by overlay of the above GIS datasets with references of existing GIS datasets. Based on patterning of pipe section from GPS positioning data, operator shall decide updating sections and update GIS datasets with overlay of existing main pipes and

facilities with consideration of matching gaps of GPS data caused by positioning errors among GPS satellites. It tends to be some gaps considered about one (1) meter to three (3) meters approximately.

(Updating GIS Datasets on DSR Main)

Article70 Updating GIS Datasets on Distribution Main shall be required to update pipe sections based on GPS positioning data with overlay of existing GIS data and editing of data manually.

Locations of existing main pipes and facilities related in DSR Main shall be updated by overlay of the above GIS datasets with references of existing GIS datasets. Based on patterning of pipe section from GPS positioning data, operator should decide updating sections and update GIS datasets with overlay of existing main pipes and facilities with consideration of matching gaps of GPS data caused by positioning errors among GPS satellites. It tends to be some gaps considered about one (1) meter to three (3) meters approximately.

(Compiling Surveying Database for SC)

Article71 Compiling Surveying Database for SC shall be required to update location of SC in customer in Zone3 of the Model Area with Field Verification Survey. In order to identify a building of SC where customer applied to CWASA because CSCCR is insufficient to update definite location based on CWASA reference system composed by Mauza, plot number and building number. There are vacant columns and absences of sketch map of SC point. Considered with an order of mapping processes, the first propriety should be to identify a building location of SC. The following priorities of detail mapping should be sustained by CWASA continuously. There is a preparatory work required before field verification to make it efficient to perform field verification as follows:

(Compiling Available As Built Drawings to GIS data)

Item1: Paper map of As Built Drawings map shall be required to process georeferenced image data to overlay on existing GIS data, if existed available As Built Drawings in the area. Some information could be referred about locations of service pipes, service meters and Account Number within old built up data because there are many Account Numbers which are still utilized in Billing database in C/S in case of Zone3 of the Model Area.

In the preparatory work, a missing point feature of service meter with attribute of Account Number is added to existing GIS dataset in order to support field data collection for field verification team.

(Appling Survey form in the Pilot Project Area)

Item2 Existing survey form in the Pilot Project Area shall be required to utilize for Account Survey to verify record verification data in the field. Most important thing is to identify Account Number in the building or in the cadaster parcel to make it sure to identify ownership of customer.

(Preparing work sheet for field data collection)

Item3 Work sheet shall be required to prepare for field data collection by preparation of plot files of GIS data and Satellite image with overlay of map annotations identifying road name and bench mark point and so on., based on preparations in the previous items.

(Update GIS Datasets on SC)

Article72 Update GIS Datasets on SC shall be required to verify and to update Account Number of service meter by reference of field data collection.

Account Number is updated by reference of survey form. Also a new connection not to be digitized in GIS data should be updated by reference of sketch drawing in the work sheet in the field.

2.9 ROAD MAP9: Compiling GIS Datasets of the Underground Utility Map

(Compile GIS Datasets of Underground Utilities Map)

Article73 Compile GIS Datasets of Underground Utilities Map shall be required to produce reference maps of the Underground Utilities about Gas pipes, Electricity lines and Tele-Communication lines in order to support the NRW plan and the evacuations of pipelines and facilities related in the repair works or replacement works. Map resources are referred by collections of the Utility Maps in Relevant agencies.

In order to produce those reference maps, there are several steps required to compile GIS data in Figure2.10 as follows:

- Collect resources including resource collection of reference maps from Relevant agencies and Copy of original map
- Archive Paper Maps by scan
- Map Digitizing to Produce GIS datasets on the above maps
- Prepare the NRW identifying Utility Crossing and Excavation in the Repair Work in the future

The detail of data specification of Map digitizing is referred to the APPENDIX8: DATA SPECIFICATION OF MAP DIGITIZING OF UNDERGROUND UTILITIES.

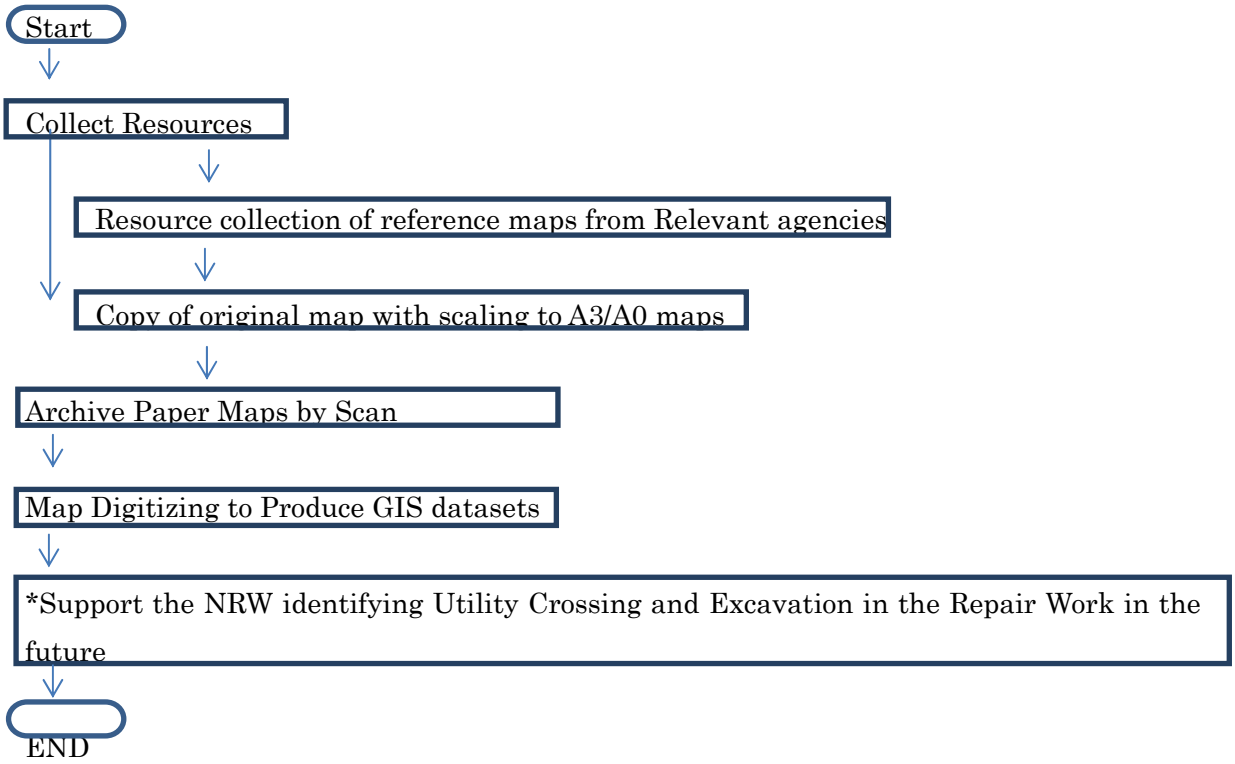


Figure2 10 Flow chart of Compile GIS Datasets of the Underground Utility Map

(Collect Resources)

Article74 Collect Resources shall be required to prepare data resources for map digitizing. There are Underground Utility maps required to refer those locations about Gas pipes, Electricity lines and Tele-Communication lines in the repair work in the NRW.

(Resource Collection of reference maps from relevant agencies)

Item1 Reference collection of maps from relevant agencies shall be required to collect those original maps for map digitizing from relevant agencies in the CWASA coverage area. There are several maps concerned to CWASA pipe line in relevant agencies.

(Copy of original map)

Item2 Copy of original map shall be required to prepare a work map to set up for a scanner with zoom controlling for reduction of paper size to adjust to A3 size or A0 size in the scanner format. A3 size paper is suitable for smooth scanning process. According to setup condition to scan map, map resolution could be required for screen digitizing.
The resolution shall be carefully checked by a person in charge of GIS.

(Archiving Paper Maps by Scanner)

Article75 Archiving Paper Maps shall be required to perform scanning of a copied map by the scanner. A setup of resolution in the scan process should be acquired by 300 DPI or larger resolution. There are several conditions to set up in the scan process as follows:

- Resolution is 200 DPI to 300DPI
- Color mode is Grey scale
- Graphic format is JPG format.

Scanned data shall be checked to judge availability for screen digitizing after scanned maps.

(Map Digitizing to Produce GIS datasets)

Article76 Map Digitizing to Produce GIS datasets shall be required to digitize a line feature of utility line or a point feature of facility location by data specification of Map digitizing for the Underground Utility Map as referred in the reference. Screen digitizing is operated by software of ARCMAP in ARCGIS or other software such as AUTOCAD and available mapping software.
In map digitizing, operator shall be paid attention to establish topology of data features in GIS. Careless mistakes caused by human being should be prohibited to compile a clean data.

(Support the NRW in the future)

Article77 Compiling of GIS dataset shall be required to identify a location of Utility Crossing and reference information to apply an excavation in the Repair Work in the future.

Article78

2.10 ROAD MAP10: Compiling Pipeline Survey Data in the Pilot Project Areas

(Updating GIS data and Compiling Customer database for the NRW database)

Article79 GIS operation shall be required to support requirements to updating GIS data and databases in activities Relating to Pipeline Survey in the pilot project in Figure2.11 as follows:

- Updating GIS data in pipelines and facilities in DSR main and SC details
- Arranging Account data to compile the NRW database utilized by Account number and generating billing database in C/S
- Preparing the NRW database to calculate amount of monthly water consumption and billing charge in database
- Updating GIS data and the NRW database by verifications in Leakage Survey
- Updating GIS data according to repair works in Isolation Block works

All the above details were being verified by Pipeline Survey with a preparation of the field survey form in most of cases, but the all survey data was verified by Leakage Survey in the project.

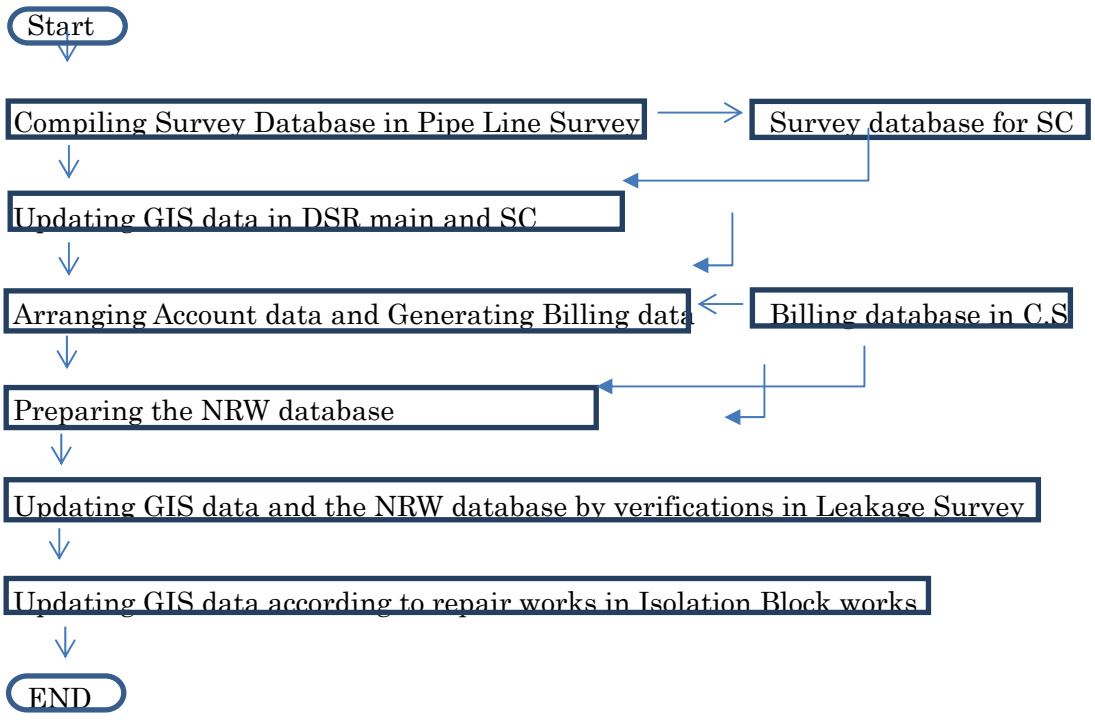


Figure2 11 Flow chart of Compile Pipeline Survey Data in the Pilot Project Areas

The detail preparation compiling the NRW database shall be referred to the Operation manual in the APPENDIX7: DATA SPECIFICATION OF FIELD SURVEY DATABASE

IN THE PILOT PROJECT AREA, APPENDIX9: HANDLING OF BILLING DATA IN THE NRW, and APPENDIX10: MONITORING DATA OF FLOW MEASUREMENTS AT SERVICE METERS.

(Compiling Survey Database in Pipe Line Survey)

Article80 Compiling Survey Database in Pipe Line Survey shall be required to compile a database in the field verification survey of SC details in Pipeline Survey including customer details, SC details, household and building details for prediction of water demands in and Survey. Unfortunately, survey form for main pipes and other facility details in DSR main was not prepared by Pipeline Survey in PANI.

Survey databases was designed to compile items in field verification in SC to make data link to GIS data though a key field of Account Number.

(Updating GIS data in DSR main and SC)

Article81 Updating GIS data in pipelines and facilities in DSR main and SC details shall be required to update locations and attributes of GIS data in DSR and SC.

There are several updating of GIS data required to verify locations and attributes in the field as follows:

- Main pipes and facilities in DSR main: Control valves, network junctions, hydrant, washouts and etc.
- Service pipes, service meters and Account number in SC

All the above details were going to be verified by Pipeline Survey with field survey databases in most of cases, but all survey data was verified by activities in Leakage Survey in the project.

Attributes relating to SC details are linked to GIS data by updating of Account Number in service pipes and service meter in GIS data.

(Arranging Account data and Generating Billing data)

Article82 Arranging Account data and Generating Billing data shall be required to arrange Account number in the pilot project area and to generate billing data from C/S in the pilot project area, in order to prepare the base line data for the NRW database. There is a difficulty to select necessary Account Number in the present Billing databases in C/S. All relating data initially have to be prepared by lists of Account Number in Field Verification Survey with cross check of billing database manually.

There are steps required prepare for the database as follows:

- Arranging list of Account Number from field survey database

- Referring the above Account Number in customer data in billing database.
- Collecting billing database from C/S
- Selecting billing data according to list of Account Number in the survey database

In order to arrange billing data records in billing database, missing terms in the records in meter readings in each Account Number should be checked. If missing term was found, calculation of monthly water consumption and billing charge must be paid attention to handle calculation by portions of monthly days in dates in meter readings.

(Preparing the NRW database)

Article83 Preparing the NRW database shall be required to calculate monthly amount of water consumption and billing charge by dates in meter readings in database. Missing term in the records in meter readings in each Account Number should be carefully checked to handle calculation of water consumption and billing data in missing term. There are steps to prepare the NRW database as follows:

- Calculation of monthly amount of water consumption and billing charges in the worksheet
- Arranging data in missing term with data handling in the work sheet
- Arranging calculation data to compile a Relational database to GIS data through Account Number

The NRW database is linked to GIS data by a key field of Account Number between data.

(Updating GIS data and the NRW database by verifications in Leakage Survey)

Article84 Updating GIS data and the NRW database by verifications in Leakage Survey is finally to verify GIS data and the NRW databases by results of that field verification in Leakage Survey. The first Pipeline Survey was incomplete to update data so that the field data results should be verified by leakage survey for all required data for updating GIS data and the NRW databases.

(Updating GIS data according to repair works in Isolation Block works)

Article85 Updating GIS data according to repair works in Isolation Block works is to update GIS data according to repair works for pipeline facilities in the enforcement of Isolation Block works. GIS data should be updated by items relating to repair works.

2.11 ROAD MAP11: Compiling Leakage Survey data and the NRW data for the Pilot Project

(Compiling Leakage Survey data and the NRW data for the Pilot Project)

Article86 There are several requirements to update GIS data and databases in activities relating to Leakage Survey and the NRW data in the Pilot Project. The activities included most of activities in Pipeline Survey in PANI.

According to procedures of activities in Leakage Survey and the measures for the NRW, there are several steps to update GIS data and the NRW databases in order to implement the measures for the NRW in the Pilot Project as follows:

- Updating GIS data by verifications of Pipeline Survey data in Leakage Survey
- Updating of the NRW database in the verification of Leakage Survey
- Compiling GIS data in the leakage survey in DMA Design
- Updating of GIS data compiled by Metering test
- Updating GIS data set in the Isolation block
- Updating GIS data in repair works in isolation works
- Compiling GIS data of flow meter in the DMA Whole Design
- Updating of the NRW database in Water Demand Analysis
- Updating of GIS data to measure in the evaluation of the NRW
- Support the NRW INITIATIVE OPERATION

Updating of GIS data and databases are enforced by the activities of the NRW shown in Figure2.12.

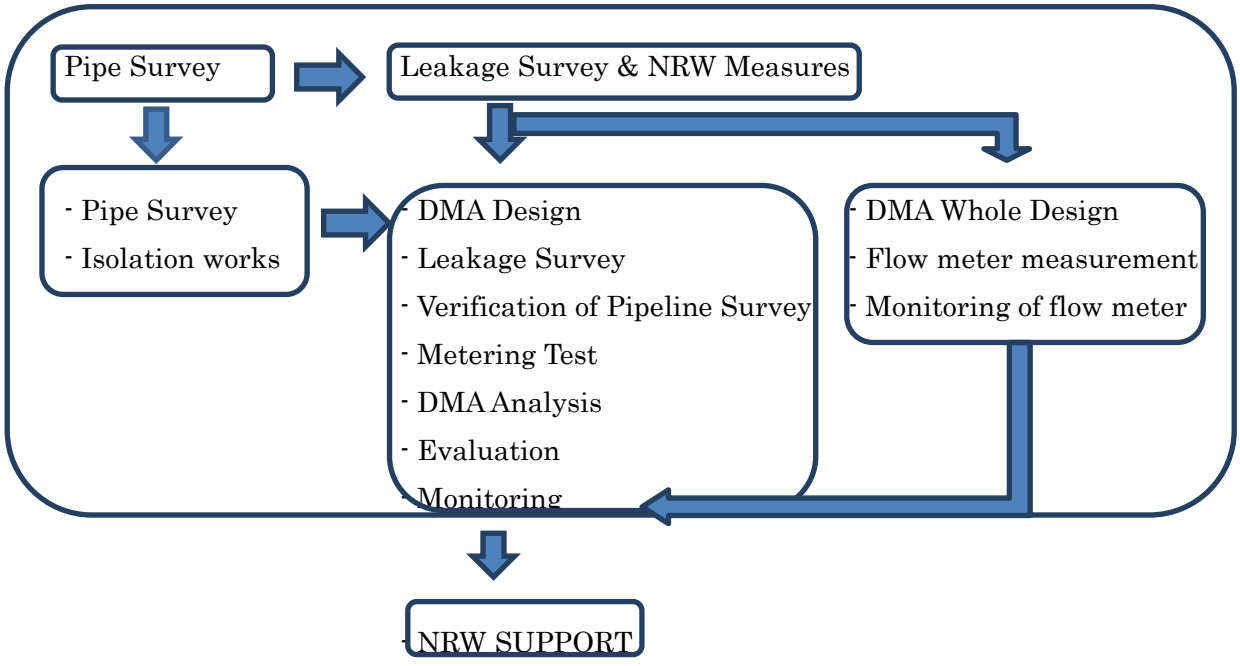


Figure2 12 Activities Relating to updating of data in Leakage Survey and the NRW measures

(Updating GIS data by verifications of Pipeline Survey data in Leakage Survey)

Article87 Updating GIS data in results of Pipeline Survey data should be verified by Leakage Survey. There are survey data required to verify locations and attributes as follows;

- Main pipes and facilities relating to DSR mains
- Service pipes, service meters, Account numbers and SC details and etc.

This verification is required to finalize preparations of baseline data on GIS data and the NRW databases for DMA design.

(Updating of the NRW database in the verification of Leakage Survey)

Article88 The NRW database preliminary compiled by the Account Survey of Pipe Survey should be verified to complete the final database by cross check of Account Number in Billing database to extract billing data in each account number. And also calculations of monthly amount of water consumption and billing charge should be completed in the database.

Data specification of survey database in Leakage survey shall be referred to APPENDIX12: SUEVEY DATABASE AND GIS DATA IN LEAKAGE.

(Compiling GIS data in the leakage survey in DMA Design)

Article89 Result of leakage survey in field is compiled to GIS data at leaking point with compiling database about leakage descriptions in DMA Design.

(Updating of GIS data compiled by Metering test)

Article90 GIS data should be updated to verify metering status in use by compiling metering test data in service meters. The metering status and function of metering will be checked about connection details by metering test at service meters.

Compiling of testing data is referred to the APPENDIX10: MONITORING DATA OF FLOW MEASUREMENTS AT SERVICE METERS.

(Updating GIS data in the Isolation block)

Article91 GIS data should be updated by setting of delineation of isolation block for a plan for repair works in the Isolation block about locations and attributes in facilities.

(Updating GIS data according to repair works in isolation works)

Article92 According to repair works in isolation works about pipelines and facilities, GIS data should be synchronized to update locations and attributes in real time..

(Compiling GIS data of flow meter in DMA Whole Design)

Article93 GIS data of flow meter is compiled about point locations of flow meter to make flow data link in order to access flow volumes for DMA Whole Design.

(Updating of the NRW database in Water Demand Analysis)

Article94 The NRW database should be updated continuously by progresses in Water Demand Analysis to analyze counter measures of the NRW.

(Updating of GIS data in the evaluation of the NRW)

Article95 Updating of GIS data to measure in the evaluation of the NRW is to relate updating of GIS data as follows:

- Compiling flow data in service meters and updating of GIS data in service meter
- Compiling a monitoring data of the supplied water in flow meter
- Updating the NRW database according to the monitoring of water flow

The process is repeated to make it sure to optimize the evaluation of counter measures in the NRW.

(Support the NRW INITIATIVE OPERATION)

Article96 Support the NRW INITIATIVE OPERATION is to support the NRW operations on GIS and databases in order to support monitoring of the NRW and taking actions for the NRW. There are several kinds of supports on the NRW in CWASA as follows:

- Supports on GIS and databases for Monitoring and Analyzing the NRW
- Action Supports for Counter Measures improving the NRW and Revenue:
  - Visualizations of Irregularities of Water consumptions,
  - Identifications of inefficient areas requiring to the NRW measure,
  - Virtual simulations improving the NRW Quantities & Billing,
  - CWASA's Action Support on the NRW Operation: Restrictions/ Disconnection/Penalties, Public Relations and etc.
  - Monitoring for Revenue Collection
- Improving of supporting data on GIS data and databases in Facility Management in the MOD
- Improving MIS on Information Infrastructure

2.12 ROAD MAP12: Compiling field databases about Test Pit Excavation data

(Necessity to compile field databases in Test Pit Excavation)

Article96 Activity in Test Pit Excavation GIS operation shall be compiled to survey databases in order to manage field verification data for O&M in CWASA. GIS system can support the Record Management on Test Pit Excavation for information supply to the maintenance works in O&M on Facility Management. GIS provides with useful functions to

handle various datasets about documents, GIS data, survey data, object files in the document such as MS OFFICE files, graphic data, PDF data. All document files concerned to field verification are mutually linked to a location map of Test Pit Excavation Site in GIS system.

Data specification of GIS data and databases shall be referred to APPENDIX11: DATA SPECIFICATION OF GIS DATA AND DATABASES IN TESTPIT EXCAVATION.

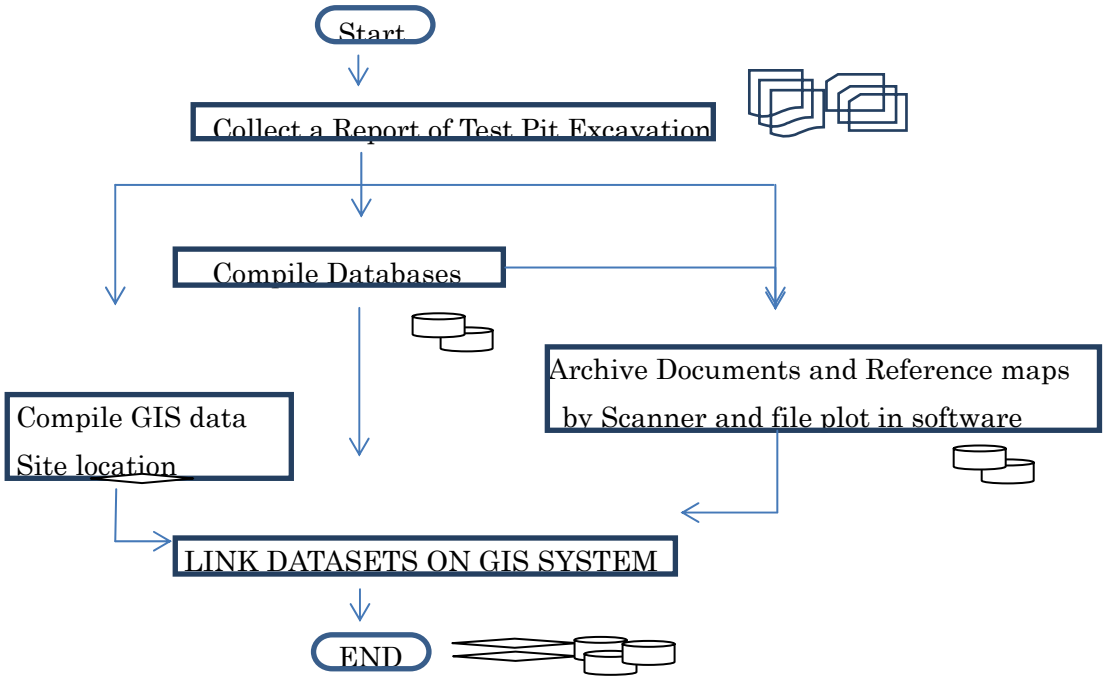


Figure3.19 Flowchart of Compile field databases about Test Pit Excavation data

(Collect a Report of Test Pit Excavation)

Article97 A Report of Test Pit Excavation shall be collected to start design of database and design of database components with specifications linking to GIS system. Through this step, the work schedules and the work volumes shall be estimated by GIS developer.

There are several documents composing to the report of Test Pit Excavation as follows:

- Test Pit Excavation Information,
- Location Map,
- Summery Sheet,
- Cross- Section Drawing,
- Photo Sheet-1(Operation and Measurement),
- Finding from Test pit Excavation and
- Appendixes.

(Compile Databases in the Report)

Article98 Information shall be compiled to relational databases according to the database design in previous Article. There are mainly three (3) groups formulating relational databases in the report as follows:

- Group1: Sprat sheet in MSEXCEL to compile summary details at each site in the report.
  The data shall be encoded to sheet in MSEXCEL files with compiling of datasets about data in the following group, which data will be managed by the file names of data in next Groups in order to set Hyperlink operation to popup data on the Window.
- Group2: Documents data about pages of reports in each site, photo pages, and other paper documents for archive documents.
  All these data in the report shall be archived to document data files to set objects of hyperlink in the databases on sprat sheet in the previous Article.
- Group3: Attached maps about sketch drawing forms in the site, cross section maps and bedding layers in the site

The attached maps shall be prepared to plot files for archive files in database. The data file will be produced by plot file in CAD drawing.

(Archive Documents and Reference maps)

Article99 Documents, pictures and drawing map in Group2 and Groupe3 in the previous Article shall be converted to document files as an object file in database by scanner or plot filed in printing process in CAD data. Those data files will be compiled into databases by encoding of a file name with data path in order to set popup the archived files in display window by hyperlink.

(Compile GIS data)

Article100 Location map of Test Pit excavation site shall be mapped to a point feature of GIS data according to map coordinate in the sites. The coordinate data shall be mapped to GIS data easily. GIS data shall add necessary data fields to link data with all archived data files and to popup those data by hyperlink.

(Link datasets on GIS System)

Article101 Databases and archived data files shall be linked to together with GIS data to as follows;

- Set all hyperlinks to archived data files in database of sprat sheet.
- Set RELATE and HYERLINK in GIS datasets as follows:

- Set GIS data and databases by RELATE in order to establish relational databases.
- Set HYPERLINK in GIS data to indicate database fields required to popup archived document data files on Map Window.

Chapter3 GIS Operation to re-build GIS datasets on CWASA Assets

3.1 Import

(Requirement to Restore GIS datasets from Existing CWASA Assets)

Article102 The task shall be required to re-build the initial GIS datasets from available Cartographic Drawings on CAD in the first step of GIS operation as follows:

- GIS datasets about main pipes and relating facilities to control water distribution on Distribution System Register
- GIS datasets about service pipes and service meters on Service Connection with the connection details and customer data in billing

Editing process in GIS operation shall be required to fix data problems and to produce useable GIS datasets, science there are several problems and issues in original CAD drawings which had been caused by anonymous Technical Control and Quality Controls to have made any Mapping and GIS operations stack as follows

- No function of GIS operation in CWASA on Facility Management
- No existence of useable GIS dataset with provision of building topology and relational database as attribute
- Stack operation to transform unique coordinate system in original datasets which coordinate system was transformed about 10000 against a geographic coordinate on decimal because of unsuitable geographic coordinate with miss-matching with GPS data and datasets in relevant agencies
- Hard to update datasets on available datasets in relevant agencies and general data resources
- Absence of relational databases directly to be generated from relevant divisions because of conventional business operations with paper media and human protocols inside CWASA.

(General Procedure to restore GIS datasets from CWASA CAD drawings)

Article103 In order to restore GIS data on CWASA Asset datasets, CAD data shall be started to import CAD drawings to GIS dataset by GIS software and the imported data shall be edited to provide with GIS data structure with compiling database in GIS datasets.
There is an only AUTOCAD dataset available to compile GIS datasets in CWASA but is no available GIS datasets in the backup data in CWASA. CAD datasets had been prepared for cartographic drawings to plot paper outputs in the 1990's so that all datasets shall be edited with compiling attributes in GIS database after imported to GIS datasets by GIS operation at the beginning of GIS operation in the NRW management.
There are several steps of data processing required to compile initial GIS datasets in order to restore past GIS datasets in CWASA assets in Figure3.1 as follows:

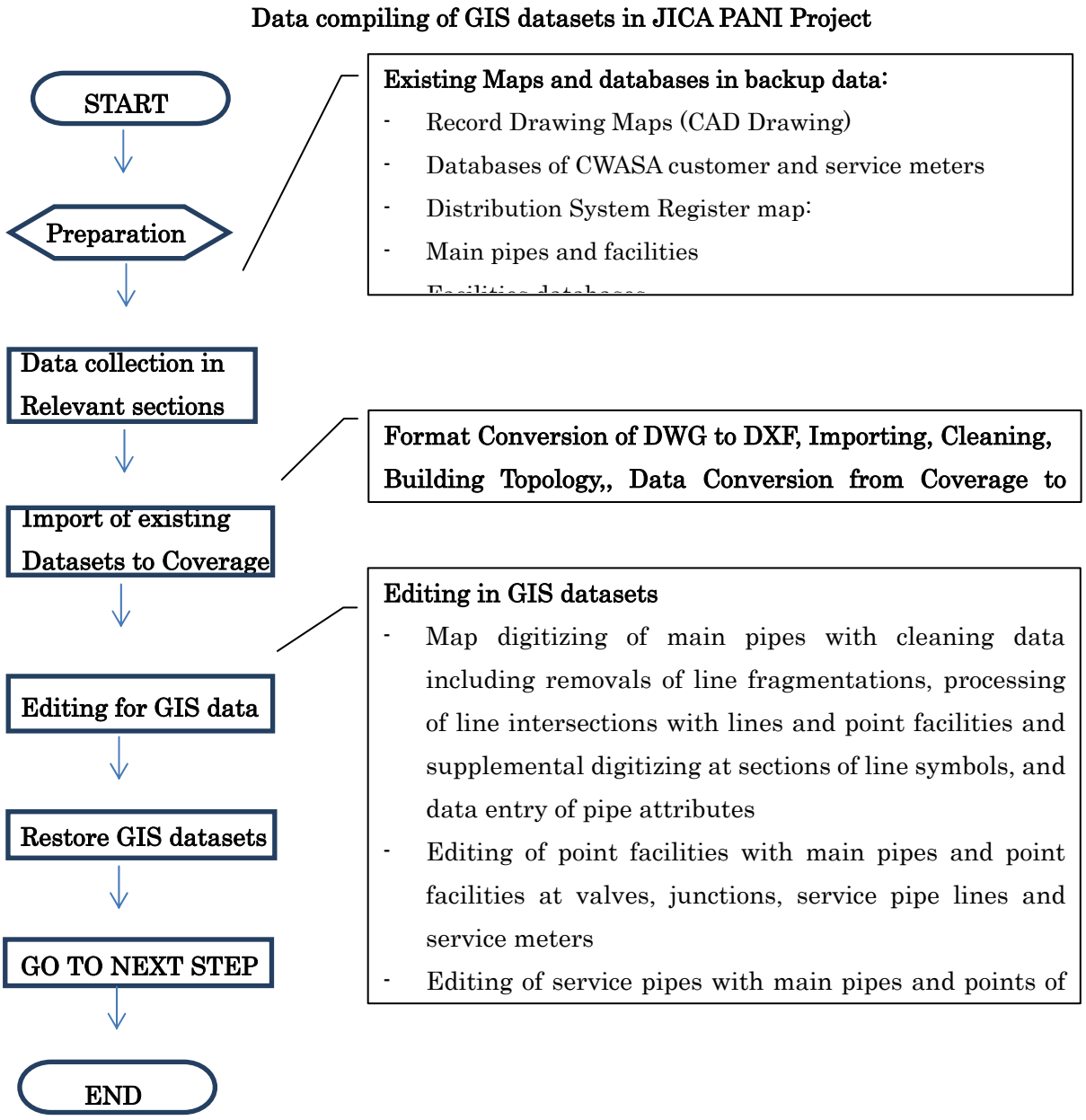


Figure3.1 Flow chart of preparation of GIS datasets in the project

(Policy of GIS operation to recover initial GIS datasets)

GIS operation to recover initial GIS datasets shall be taken account in the operation as follows:

- Repair the above problems to fix on available datasets
- Policy of data handling in CWASA datasets

(Repair the above problems to fix on available datasets)

Item1 GIS operation shall limit to fix the above technical problems in order to restore GIS datasets in 1998 and to update GIS datasets with new data about Consumer Service Connection since 1998 and afterwards as follows:

- to repair geometries of mapping features and compiling attributes in CAD datasets to prepare useable GIS datasets for NRW operation,
- to recovery mapping accuracies by a switching over to a new georeferencing coordinate system to set proper GIS datasets,
- to recover missing relational database in mapping features as attributes
- to update the above GIS datasets

(Policy of Data Handling in CWASA datasets)

Item2 PANI shall never change original layer's information in existing CAD dataset in order to preserve past mapping features in production of initial GIS datasets. Only necessary GIS data shall be produced to add for NRW management and also database item in each theme shall be added in GIS datasets.

(Necessities of GIS operation to fix technical problems in original datasets)

Article104 In order to solve problems on technical issues in past twenty (20) years caused by the past project, GIS operation shall be required to take several steps generally in order to compile GIS dataset as follows:

- Restore the initial GIS datasets from existing CAD datasets
- Transform GIS datasets on CWASA coordinate system and adjust local distortions caused by original data on High Resolution Satellite Image or other mapping resources.
- Verify and update GIS datasets on As Build Drawings and Field Verification Survey and Service Connections with Consumer database in C/S and Consumer Service Connection Completion Report with those sketch maps which data is available from 2001 to the present

(Restore the initial GIS datasets)

Item1 Operation shall be required to repair geometries in geographic features for mapping features to be imported to GIS datasets in order to prepare useable GIS datasets and to recover missing database in mapping features as attributes as follows:

- To import CAD data to GIS datasets by importing in GIS software
- To make data to clean as follows:
  - ✧ To make line fragmentations to eliminate,

- ✧ To make a main pipe to intersect at crossing point among main pipe, a location point of facilities and service pipes
- ✧ To generate a point GIS datasets of service meter
- ✧ To make a service pipe to extend to a point location of service meter

➢ To make data attribute to entry to GIS datasets such as pipe attributes and customer data

(Transform GIS datasets on CWASA coordinate system)

Item2 Operation shall be required to recovery mapping accuracies by a switching over a new georeferencing coordinate system to set GIS datasets as follows:

➢ To transform GIS dataset to proper coordinate system on WGS84 and BTM on World View1 with ground control points field acquired by GPS receiver in route survey
➢ To adjust mapping elements by manual operation in editing

(Verify and update GIS datasets)

Item3 Operation shall be required to recover missing relational database in mapping features as attributes and to update GIS datasets as follows:

➢ To verify and update GIS datasets with As Build Drawing Map
➢ To verify and update GIS datasets of service connection on Customer Database and Service Connection Completion Report in Sales Division

(Preparation of usable GIS datasets for NRW measure)

Article105 GIS datasets shall be compiled by editing in GIS operation as follows:

- Line feature of Main pipe in Water Distribution Main
  GIS dataset shall be compiled about line feature of Main pipes which compose line networks with attributes of pipe diameter and material.
- Point features of related facilities to control water distribution on main pipes
  GIS dataset shall be compiled about point locations of those facilities on main pipes about 1: Valve, 2: Air Release Valve, 3: Wash Out, 4: Hydrant, 5:Loop Over, and 6:Other features.

➢ Line feature of service pipes.
  GIS datasets shall be compiled to build line networks with attributes of service meter and Account Number in Customer data by editing line features and editing line features with point feature of service meters.
➢ Point feature of service meter

GIS datasets shall be a point feature of meter symbol on CAD drawing with attributes of service meter and Account Number in customer data.

(Line feature of Main pipe in Water Distribution Main)

Item1 Line data of distribution water main pipe shall be prepared by digitizing a center line of double lines symbol at main pipes in CAD data and cleaning and editing data about line fragmentations, intersections, compiling attribute about a pipeline name, pipe diameter and pipe material.

(Point features of related facilities to control water distribution on main pipes)

Item2 Point data of those facilities shall be digitized at intersections at facilities on main pipes by Break Arc or Split Arc and attributes shall be compiled about type of facilities in CAD layer as follows:

- 1: Control Valve,
- 2: Air Release Valve,
- 3: Wash Out,
- 4: Hydrant,
- 5: Loop Over, and
- 6: Other features.

(Line feature of service pipes)

Item3 Service pipe shall be a line network with attributes of service meter and customer data. GIS datasets shall be compiled to build line networks with attributes of service meter and Account Number in Customer data by editing line features and editing line features with point feature of service meters.

GIS dataset shall be prepared by editing work of line features with main pipes on distribution water main. Particularly line features of service meters also shall be required to edit line fragmentations as same as that of distribution water main pipe. Attribute of service pipe shall be compiled about CWASA holding number or Account in billing database which all information are compiled by CSCCR.

The item of editing work shall be as follows:

- Generation of a center point at service meter and extend of a service pipe line to the center point of service meter

  Since service meter in CWASA data was digitized by a circle symbol, GIS data was required to prepare a center point of its data so that GIS data of service pipe is required to extend the line to its central point.

- Editing of line connections at intersection of lines and snap of lines
- Elimination of line fragmentations
- Data entry of Holding Number to attribute:
  This code consists of Mauza number, Plot number and Building number, and is an important georeferncing code for map positioning.

(Point feature of service meter)

Item4 Service meter shall be generated about a point feature in circle symbol on CAD drawing by feature conversion about polygon to point with attributes of service meter and customer data. As well as that of service pipe, attribute of service meter shall be compiled about CWASA Holding Number or Account Number in billing database.
The item of editing work shall be as follows:

- Generation of a center point at service meter by feature conversion about polygon to point against polygon data of circle symbol of service meters.
- Data entry of CWASA Holding Number in CSCCR in sales division and Account Number in billing data in to attributes of service meter

  CWASA Holding Number is important key for Geo-Coding combined by Mauza number, Plot Number and Building Number in CSCCR. Account Number is also a primary key to handle service connection details in CSCCR and customer data in billing system in C/S.

(Data importing of CAD dataset to GIS dataset)

Article106 DWG format of CAD data shall be imported to GIS data by importing command in GIS software. Original CAD data with data structure is directly imported to GIS datasets by the importing process.

(Import CAD datasets to GIS datasets)

Item1 Layers of CAD datasets consist of thematic maps in GIS datasets according to available GIS software as follows:

- Point features about locations of water supply facility
- Line features about water supply pipes and line edges composing base maps of BS sheets for CWASA CAD Drawings
- Polygon features about circle symbols of service meters and wells
- Text features about annotation data in GIS datasets equal to text layers in CAD drawing

GIS software handles to import CAD datasets in the software to prepare data features of GIS datasets. In case of PANI GIS operation, there are alternative approaches to import

CAD datasets in GIS datasets as follows:

- Use data conversion module about export in GIS software in batch process
- Use data export in GIS software. In interactive process

Both approaches will be chosen performed by GIS operator.

In PANI operation, the next procedure shall be recommended as follows:

- Convert original CAD data with DWG format to DXF data in to order prepare lower version data with DXF files in AUTOCAD 2000 R14 or AUTOCAD 2004 in AUTOCAD software.
- Import CAD dataset to ARCINFO by "DXFARC" in ARCINGO WORKSTATION.
- Process "CLEAN" to clean geometries of features with options of ZERO Fuzzy tolerance, "BUILD" to calculate Topology of data features and also "JOINITEM" to link together with coverage data and generated data in the importing process on original data. In this process, ARCINFO coverage will be produced as shown in Table3.1.

Table3.1 List of ARCINF Coverage

Data Feature	Descriptions
Point	Text annotation of text layer in CAD dataset
Line	all line features in all layers in CAD datasets
Polygon	Circle symbols in CAD drawings such as service meters, deep wells and shallow wells.

Original data structures and all attributes in CAD datasets are generated to those in GIS datasets without attributes of those figures because Text Layer in CAD dataset can be never transferred to GIS datasets in the operation.

All attributes in GIS datasets will be handled by GIS operator in the nest step2 of the Editing process.

(Preparation of GIS data features)

Item2 Imported GIS data shall be divided to feature GIS datasets as shown inTable1.

Process ARCTOSHAPE to convert from coverage to shape file according data features in Table3.1 a rule of naming of GIS dataset in each shape files shall be followed by the following prefixes in each data as the following examples:

- ***CW_p7701***: Line feature in Shape file is combined by a prefix of "CW_" and original file name.
- ***CW_p7701Poly***: Polygon feature in Shape file is combined by a prefix of "CW_" ,

original file name and a prefix of "Poly" to indicate polygon feature

- ***CW_p7701An***: Point feature for text annotation e in Shape file is combined by a prefix of "CW_" , original file name and a prefix of "An" to indicate text annotation"

(Post preparation of a point feature in polygon feature)

Item3 Since figures about only circle symbols with original data structures and original attributes in CAD datasets shall be imported without attributes of GIS datasets, so that a point feature of the above feature shall be generated by a data conversion module about polygon feature to point feature in order to generate a label or a centroid of polygon circles which are representative points under a circle symbol in Figure3.2.

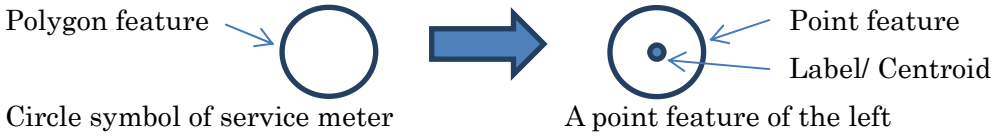


Figure3.2 Generate a point under circles symbols in polygon features.

A rule of naming of dataset in shape file shall be prepared by preparations of prefixes as follows:

- ***CW_p7701p***: Point feature in Shape file is combined by a prefix of "CW_" , original file name and a prefix of "p" to indicate point feature

(Preparation of point features at line segmentations)

Item4 A start node and an end node at one line(ARC) shall be generated by a module of line to point in GIS software or digitize point features at any intersection between main pipes and facilities to control water distribution such as pump stations, control valves and street hydrants and washouts and so on.

All those point features shall be required to help for map digitizing about those facilities in Water Distribution Main.

A rule of naming of dataset in shape file shall be prepared by preparations of prefixes as follows:

- ***CW_p7701Pif***: Point feature in Shape file is combined by a prefix of "CW" , original file name and a prefix of "Pif" to indicate point location of polyline facilities such as the above, Tees and locations of bulk meters and etc.

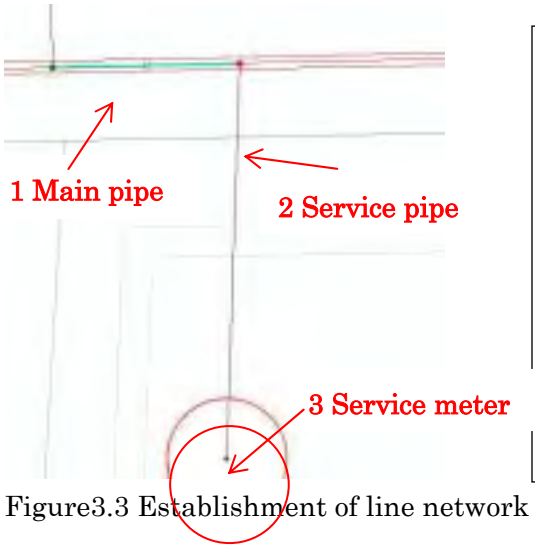
3.2 Edit

(Necessity to re-build GIS datasets for pipeline network and service connection)

Article107 NRW operation shall be required to re-build GIS datasets with relational databases concerned to Asset Management in order to implement the NRW measures. GIS dataset shall be required to restore initial GIS datasets about main pipes, facilities to control water distribution, service pipes and service meters from available CAD drawings.

In order to establish pipeline networks in water supply shown in Figure3.3, there are several requirements to clean up any topological errors on geometries about symbols of CAD data in GIS datasets by editing as follows:

- Intersect lines at crossing points,
- Delete short lines in intersection process,
- Snap nodes in overshoot and in undershoot,
- Attribute entry in databases,
- Generate a point features in service meter and delete a break line in the circle,
- Extend the end node of service pipe to a point feature of service meter,
- Attribute entry in databases and etc.



1. Line feature of main pipe edited by Intersect lines, Snap Nodes in overshoot and undershoot, attribute endtry in databases and etc.
2 Line feature of service pipe edited by Intersect lines, Snap Nodes in overshoot and undershoot, attribute entry in database and etc.
3. Point features of service meter edited by

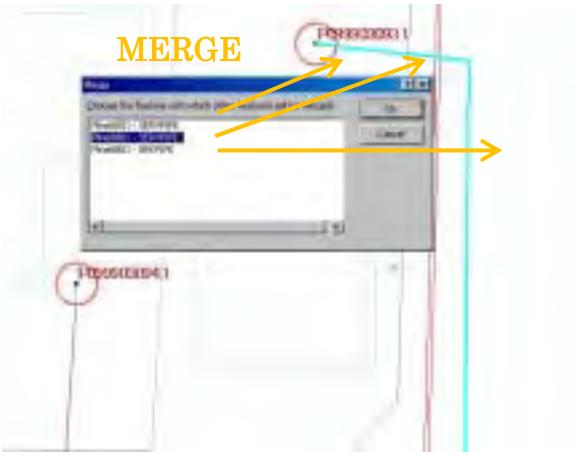
Figure3.3 Establishment of line network

There are so many complexes of lines, so called line fragmentations of mapping features in original CAD datasets, so that fragmentations shall be cleaned to make a simple line feature from node to node in Figure3.4 by editing follows:

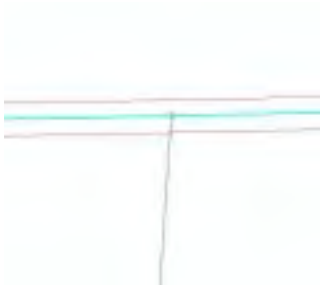
- Select line elements in each lines and Merge those lines to a single line

If found any intersection between main pipes and service pipes, operator shall process to intersect in order to brake lines at crossing points of lines. And also line fragmentations shall be merged to a simple line by cleaning and so on.

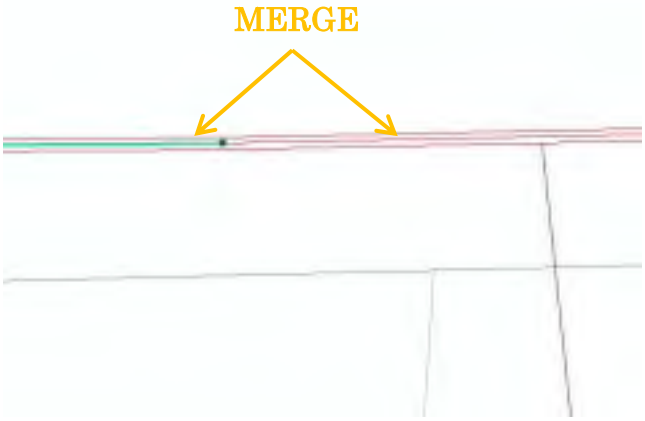
Line fragmentations make efficiency slow to access data in software operations. All line data in the Record Drawing Map of CAD data have line fragmentations so that GIS data shall be required to clean data without line fragmentations by editing.



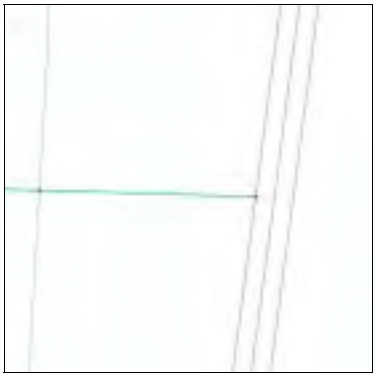
Merge operation to eliminate fragmentations



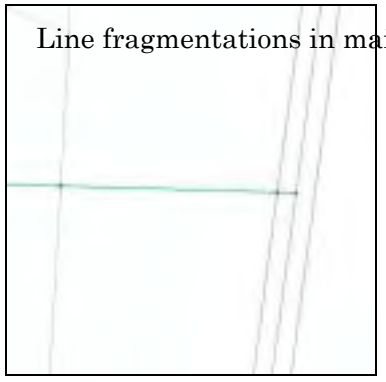
Before intersection



Line fragmentations in main pipes



Disconnected lines of service meter network on GIS data on AutoCADdata



Snap and intersection of lines connectioned lines and main pipe on AutoCADdata

Editing to intersect lines

Figure3.4 Examples of Cleaning of figures (Editing for line network)

(Necessity to edit GIS datasets at symbols)

Article108 Imported GIS data at symbol data in AUTOCAD data such as double lines in main pipes and a circle symbol of service meter shall be required to edit data with editing of service pipes, in order to produce simple data features and to build pipeline networks on geometries in GIS dataset as follows:

- Editing of main pipes with digitizing pipelines
- Editing of main pipes at facilities and digitizing point features
- Editing of service pipes
- Editing of service meters and service pipes

(Editing of main pipes with digitizing pipelines)

Item1 Editing of main pipes with digitizing pipelines shall be required to produce GIS dataset of main pipes with digitizing pipelines with data entry of pipe attributes.

The operation shall be required to edit data as follows:

- Digitize a line feature to trace a centerline on double symbol lines in main pipes
- Edit line features on main pipes to clean data as follows:
  - ✧ Snap nodes to intersected lines between line features in undershoot
  - ✧ Intersect pipelines in overshoot and delete short lines and also merge lines
  - ✧ Brake lines at a point location of facilities to control water distribution and digitize a point feature of pipeline Facilities with attribute at the point
- Data entry of pipe attributes about Design Pipe Name, pipe diameter and pipe material

(Editing of main pipes at facilities and digitizing point features)

Item2 Editing of main pipes at facilities and digitize point features at facilities shall be required to produce a point feature of GIS dataset about facilities to control water distribution on main pipes. This shall be required to edit to break lines at locations of facilities on main pipes. Point locations of facilities in Distribution System Register such as a valve, a reducer, a junction and etc., shall be produced by screen digitizing of a point features with data entry of attributes as follows:

- Break a line at a location of facilities to control water distribution on main pipes.
- Digitize a point feature with snap nodes at main pipes
- Date entry of attribute about type of facility and etc.

(Editing of service pipes)

Item3 Editing of service pipe shall be required to produce GIS dataset of service pipes with attributes of Service Connection Details.

The operation shall be required to edit line features of service pipes to build a simple line

topology among main pipes and service meters as follows:

- Edit line feature to clean data as follows:
  - ✧ Snaps nodes among features in undershoot
  - ✧ Intersect line features to snap nodes among features and delete a short line in over shoot
  - ✧ Merge line segments to eliminate line fragmentations to make a simple line feature from a start node to the end node
- Data entry of attributes about Account Number and CWASA Holding Number in Service Connection details

  CSCCR and billing databases are directly linked to GIS datasets of service pipes and service meters through primary keys about Account Number and CWASA Holding Number in CSCCR.

(Editing of service meters and service pipes)

Item4 Editing of service meters and service pipes shall be required to produce GIS dataset of service pipes. The operation shall be required to edit data as follows:

- Generate a point features of service meters at a circle symbol
- Edit service pipe to extend an end node of service pipe to a point feature of service meter
- Data entry of attributes in Service Connection detail as same as those in Service pipes

(Requirements of editing process)

Article109 Editing process to produce usable GIS datasets for GIS operation in NRW management shall be required to edit GIS datasets as follows:

- Digitize a center line on line symbol in main pipes
- Edit main pipes and screen digitizing of point facilities on main pipes
- Cleaning line features
  - Snap nodes between lines in undershoot with intersection of lines
  - Intersect lines in overshoot and delete short lines with merge lines
  - Intersect lines and merge lines on pipelines
  - Brake lines at point locations of facilities on pipeline network
  - Merge line segments to eliminate line fragmentations to make a simple line feature from a start node to the end node
- Generate a point features of service meters at circle symbol
- Extend the end node of service pipe to a point feature of service meter

(Digitize a center line on line symbol in main pipes)

Article110 Digitize a center line on line symbol in main pipes shall be edited to produce main pipes by screen digitizing to trace a center line on double lines in main pipes as follows:

- SELECT a line as shown in Figure3.5.
- COPY this ARC and PASTE TO PALALLEL with an offset value

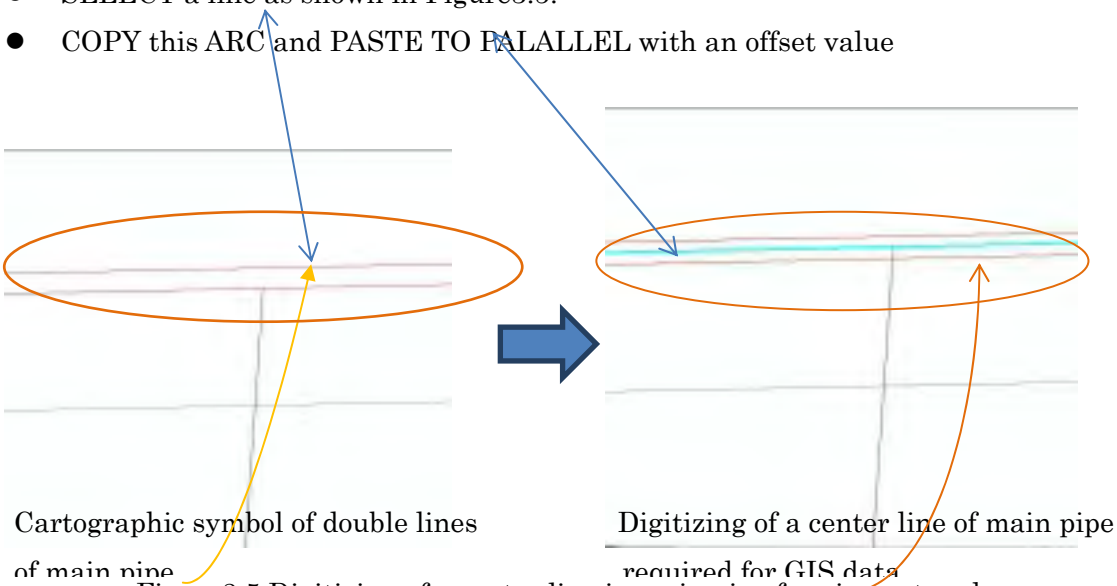


Figure3.5 Digitizing of a center line in main pipe for pipe network

(Edit main pipes and screen digitizing of point facilities on main pipes)

Article111 Edit main pipes and screen digitizing of point facilities on main pipes shall be required to produce a point feature of facilities to control water distribution on main pipes as follows:

- Editing of lines on main pipes at facilities to control water distribution
- Edit lines at loop over among main pipes at networks

(Editing of lines on main pipes at facilities to control water distribution)

Item1 Edit lines on main pipes at facilities to control water distribution shall be required to edit main pipes in order to break line at a location of facilities on main pipes, and also a point location of facility shall be digitized at nodes to be broken lines with snap nodes of main pipes. As CAD dataset was symbolized for cartographic drawing in the past, it was required to digitize a point feature of GIS datasets about the location at facilities as shown in Figure3.6.

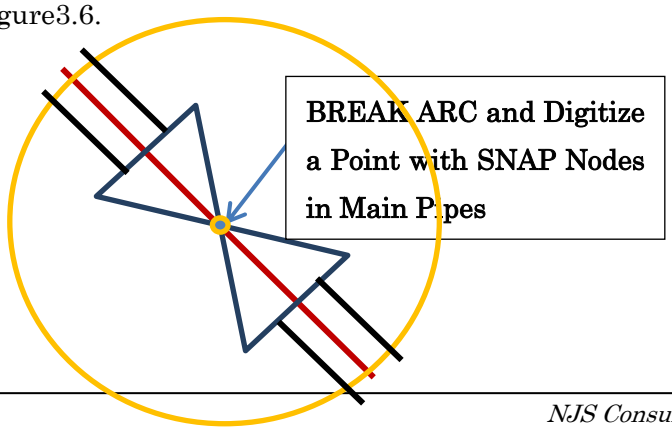


Figure3.6 Point digitizing of facilities and break lines at facilities on main pipes

(Edit lines at loop over among main pipes at networks)

Item2 Edit lines at loop over among main pipes at networks shall be required to complete missing line elements on main pipes and to prepare GIS datasets at loop over in network on main pipes.

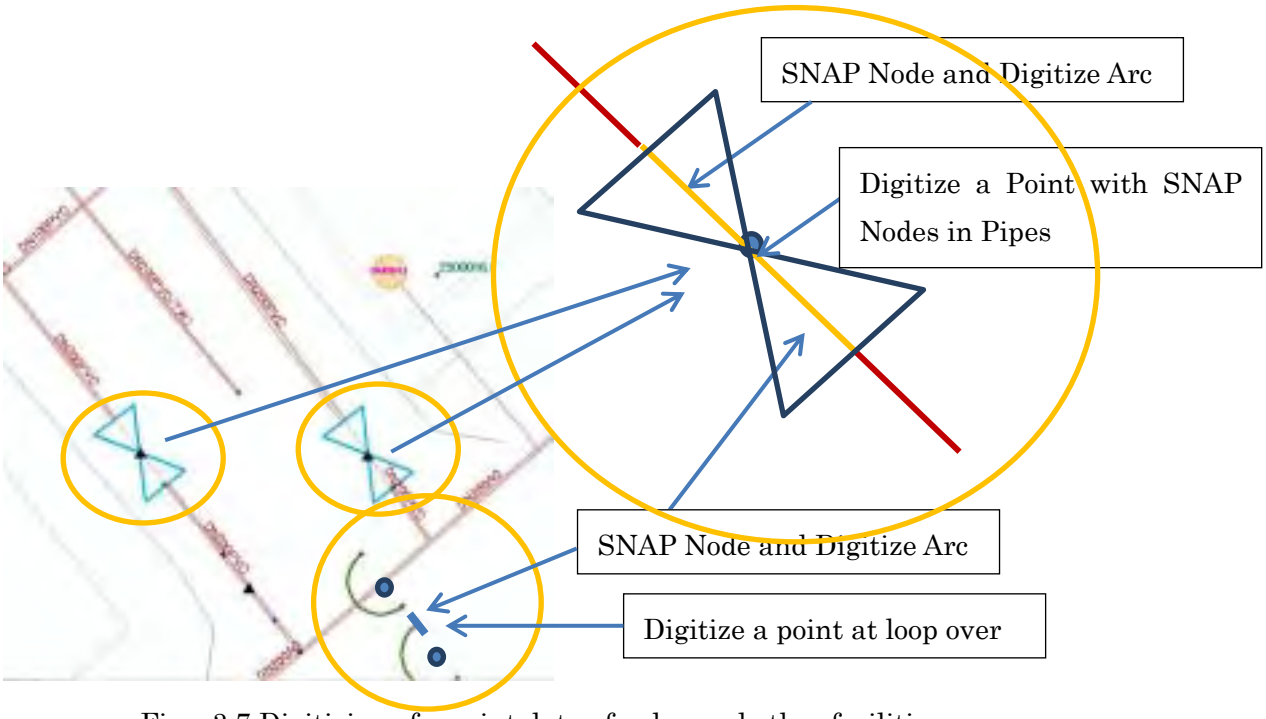
Line features and point features at facilities on main pipes about valves and loop overs shall be required to edit GIS data shown in Figure3.7 as follows:

- Edit main pipes and digitize a point feature at facilities about control valves with data entry of those attributes
- Edit symbol ARC and main pipes at loop overs on main pipes and digitize a point feature of a facility at crossing point of pipes with data entry of its attribute.

(Cleaning line features)

Article112 Cleaning line feature shall be required to clean data structure and to build line topology in GIS datasets as follows:

- Snap nodes between lines in undershoot with intersection of lines
- Intersect lines in overshoot and delete short lines with merge lines
- Break lines at a point location of facilities
- Intersect lines and merge lines on main pipes
- Merge line segments to clean line topology on pipeline network
- Edit circle symbol and brake line at service meters



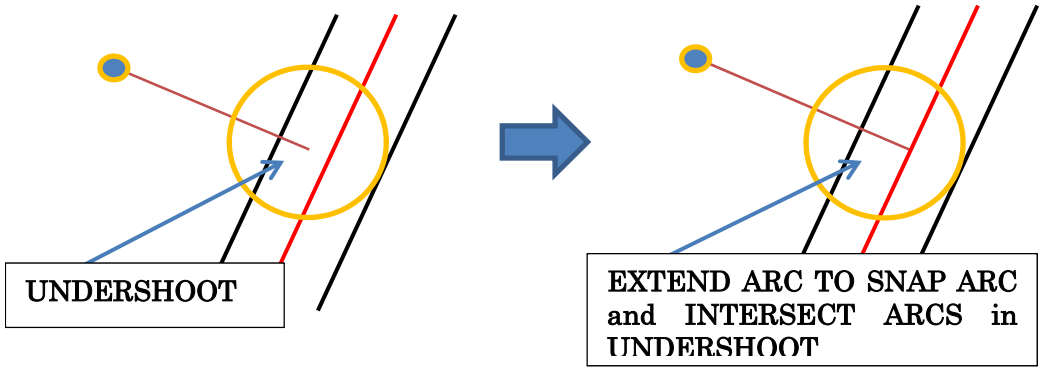
Figur3.7 Digitizing of a point data of valve and other facilities

(Snap nodes between lines in undershoot with intersection lines)

Item1 Snap nodes between lines in undershoot with intersection lines shall be required to clean GIS dataset and to build line topology in GIS datasets.

According to problems in production of initial CAD datasets, editing of symbols data and line features shall be required to clean GIS dataset by snap operations among features and intersection operation at undershoot of lines shown in Figure 3.8 and at overshoot of lines in line network.

A line feature of GIS dataset shall be required to edit data to snap lines together among main pipes, service pipes and a service meters. Also break line operation also shall be required to build line topology at points on main pipes such as control valves, hydrants, and other facilities relating to distribution water network.



Disconnection of line network on AutoCADdata

Connections of line network on GIS data

(Intersect lines in overshoot and delete short lines with merge lines)

Item2 Intersect lines in overshoot and delete short lines with merge lines shall be required to clean GIS dataset and to build topology in GIS datasets.

According to problems in the preparations of initial datasets and editing of symbols data, a line data shall be required to snap operations and intersection operation at undershoot of line in Figure3.9 and at overshoot of line in line network.

A line feature of GIS dataset shall be required to edit data to snap lines together among main pipes, service pipes and a service meters. Also break line operation also shall be required to build line topology at points on main pipes such as control valves, hydrants, and other facilities relating to distribution water network.

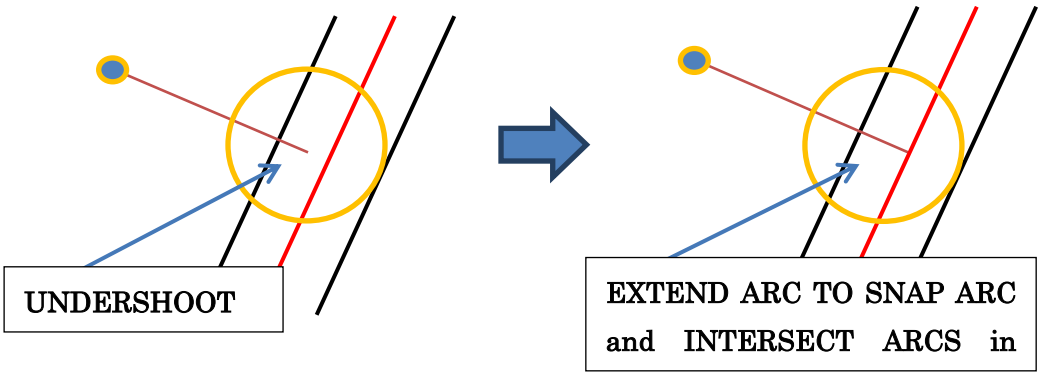


Figure 3.9 Difconnection of service pipe line in undershoot

(Brake lines at point locations of facilities)

Item3 Brake lines at point locations of facilities shall be required to clean GIS dataset and to build topology in GIS datasets as shown in Figure3.10. A line feature of main pipes shall be broken at a location of facilities to control water distribution.

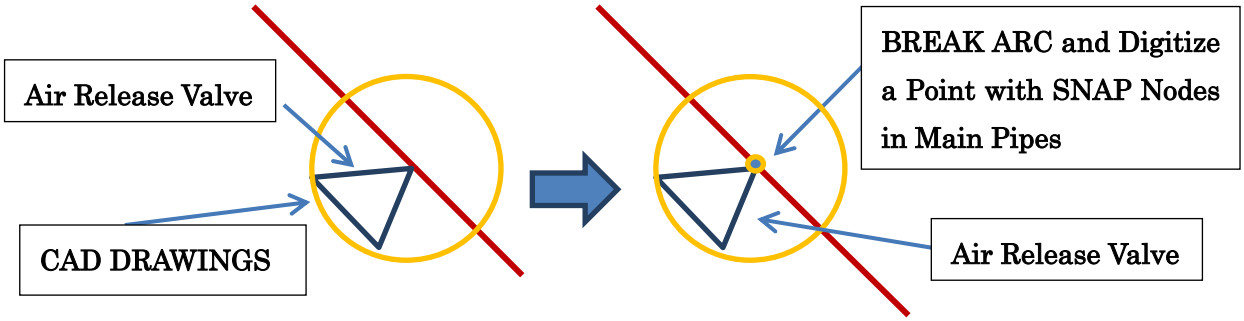


Figure 3.10 Brake lines at point location of facilities

(Intersect lines and merge lines on main pipes)

Item4 Intersect lines and merge lines on main pipes shall be required to clean GIS dataset and to build line topology in GIS datasets. Process intersection between lines and delete short lines which was created by intersection lines. And also merge lines of main

pipes to prepare a simple line shown in Figure3.11.

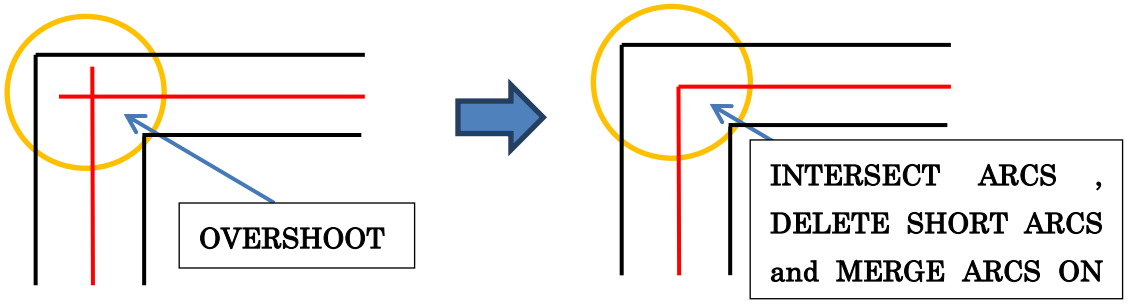


Figure3.11 Intersect lines and merge lines on main pipes

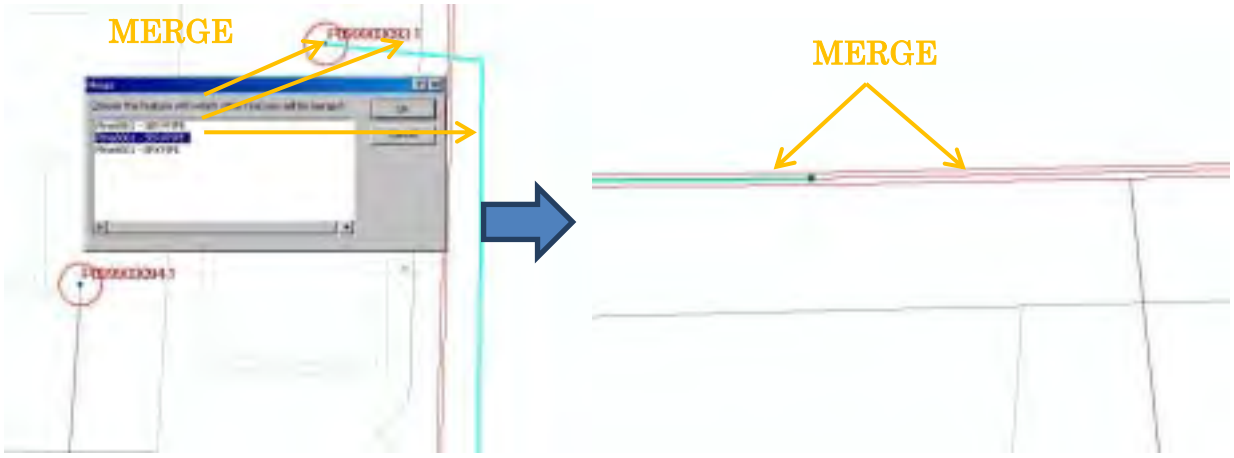
(Merge line segments to clean line topology on pipeline network)

Merge line segments to clean line topology on pipeline network shall be required to clean GIS dataset to make a simple line feature from a node to a node and to build simple line topology in GIS datasets.

In order to remove fragmentized lines in original data and to produce a simple line in GIS dataset, a cleaning process shall be required by merge operation with editing of figures shown in Figure3.12 as follows:

- Select line segmentations in each main pipes and each service pipes
- Merge those lines to a single line.

If found any intersection between main pipes and service pipes, process intersection to brake lines at cross points of lines and line fragmentations shall be merged to a simple line.



Merge operation to remove line fragmentations Remove line fragmentations on main pipes by merge lines

Figure3.12 Cleaning of figures (Editing for line network)

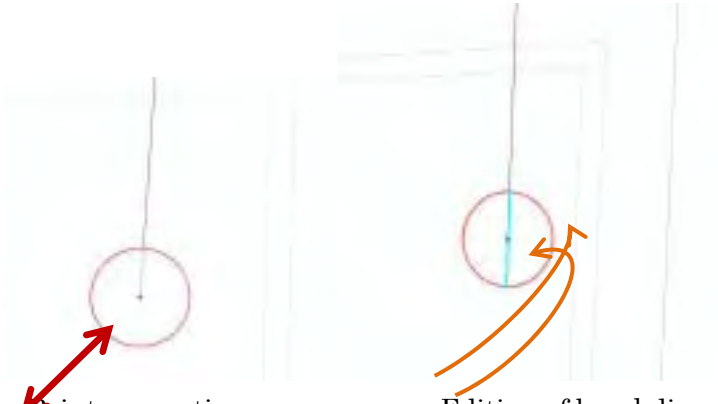
Item5 Edit circle symbol and break line at service meters shall be required to prepare a point features of service meter from circle polygon and to edit a break line at service meter in mapping feature of CAD drawing as follows:

- Generate a point features of service meters at circle symbol

- Edit a brake line of service meter or extend a service pipe to a service meter

(Generate a point feature of service meters at circle symbol)

Article113 GIS data shall be required to digit a center point of a circle symbol. Before the operation, a center point shall be generated by a polygon of circle symbol of CAD data in service meter as shown in Figure3.13. The data shall be utilized for editing of break line and a break line under circle symbol shall be shortened to a center of its circle symbol by editing.



Point generation of service meter

Editing of break line to shorten to a center circle

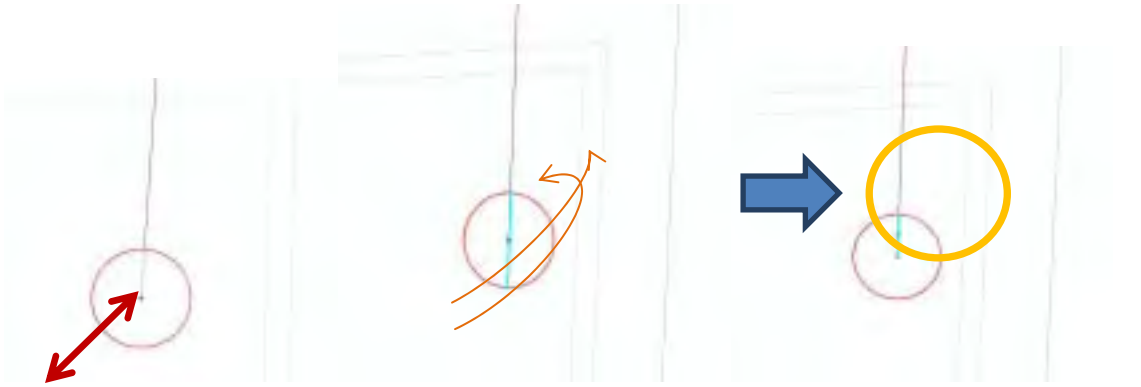
Figure3.13 Editing of circle symbol and editing of break line with service pipe

(Edit a brake line of service meter or extend a service pipe to a service meter)

Article114 GIS data shell be required to edit a brake line of service meter or extend a service pipe to a service meter shall be required to clean GIS dataset and to build line topology in GIS datasets.

There are two (2) alternative choices for editing a line at service meter and editing a line feature of service pipe shown in Figure3.14 as follows:

- Editing a line feature at service meter
  Edit a break line to shorten to a center point of a circle symbol since a service meter on CAD consists of a circle symbol and break line under circle symbol and a break line shall be merged with a service pipe.
- Editing a line feature of service pipe
  Delete a break line and extend an end node of a service pipe to snap with a point feature at service meter.



Point generation of service meter | Editing of break line to shorten to a center circle | Result of the left editing

Figure3.14 Editing of circle symbol and editing of break line with service pipe

(Data entry of attributes)

Article115 Data entry of attributes shall be required to input attributes into GIS dataset as follows:

- Pipe attributes on main pipes
- Attributes of facilities to control water distribution on main pipes
- Attributes of service pipes and service meters)

(Pipe attributes on main pipes)

Item1 Item1 Pipe attributes on main pipes shall be inputted in Table3.2 as follows:

- Pipe diameter
- Pipe attribute
- Design Pipe name

Table3.2 Add field and Data entry of attributes in main pipes

Database item	Type	Length	Definition in da entry	Examples
Pat	Text	15	Design pipe name	DN100PVC
Pdia	Int		Pipe diameter	100
Pmat	Text	15	Pipe material	AC

(Attributes of facilities to control water distribution on main pipes)

Item2 Attributes of facilities to control water distribution shall be inputted in Table3.3 as follows:

- Type of facility
- Remarks

Table3.3 Add field and Data entry of attributes in main pipes

Database item	Type	Length	Definition in da entry	Examples
TypeF	Text	20	Type of facility	Air release valve
Description	Text	80	Description of facility	

(Attributes of service pipes and service meters)

Item3 Attributes of service pipes and service meters shall be inputted in Table3.4 as follows:

- Aref: the first 3 character of Mauza number in CSCCR
- Bref: Plot number in BS sheet in CSCCR
- Cref: Building number in parcel plot in CSCCR
- Ref: CWASA Holding Number combined by Aref, Bref and Cref in CSCCR
- Account : Account Number in CSCCR
- Remarks

All attributes in Service Connection details shall be directly generated from CSCCR by a primary key of CWASA Holding Number. And also billing database shall be directly generated to service meters by a primary key of Account Number in CSCCR.
The above relational databases were already built up by past project in CWASA.

Table3.4 Add field and Data entry of attributes in Service pipes and Service meters

Database item	Type	Length	Definition in da entry	Examples
Aref	Text	3	first 3 character of file nam	P88
Bref	Text	10	Plot number in BS sheet	000097.1
Cref	Text	2	Building number in parcel plot from 1	1
Ref	Text	15	CWASA Holding Number combined by Aref, Bref and Cref in the above	P88000097.1
Account	Text	8	Account Number in Billing database	062210

(Link of GIS data and database)

Article116 Link of GIS data and database shall be required to make GIS dataset build relational databases mutually among datasets to support the NRW management and Facility Management.

In order to manage attribute in GIS data in database, it is required to edit to link figure data to database record in database. In the CWASA map data attribute of figures has ever not been managed because of data structure of CAD layer in Figure3.15.

CAD attribute on AtutoCAD　　Label of attributes in GIS data

Data attributes must be recored in database of GIS data in data conversion

Figure3.15 Data handling of attribute on CAD to GIS

Attribute is only displayed in the text layer and it is not linked with database record. So it is necessary to separate figure and text in layers and to edit to make each figure to link to attribute in database as follows:

- Main Pipe：Diameter, material as shown in Figure 3.16
- Service Pipe：information of consumer connection and customer information as shown in Figure3.17
- Service Meter：information of consumer connection and customer information

GIS datasets of service pipes and service meter shall be linked to database of CSCCR through CWASA Holding Number which is a Geo-coding to map data locations as shown in Figure 3.18.

Figure3.16 Entry of pipe attribute to main pipe

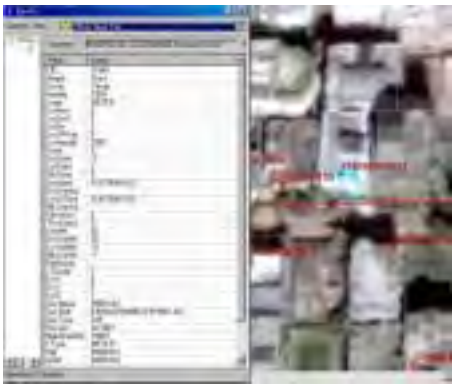
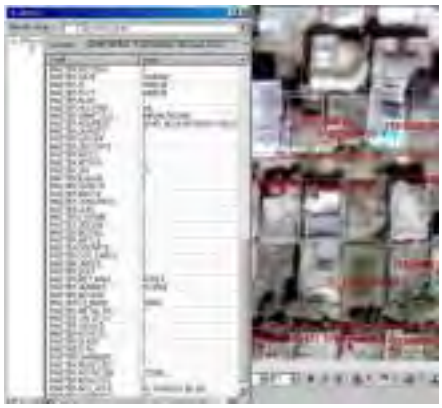


Figure3.17 Database record service pipe and service meter



3.3 Georeferencing and Transform

(GIS dataset and set up of Georeferencing)

Article117 GIS dataset shall be required to define a coordinate system to handle spatial location of geographic features for Georeferencing. Georeferencing is generally one of important process to access GIS dataset so that a setup of a coordinate system in GIS datasets shall be defined in order to handle different types of coordinate system data if GIS operator sets up a proper coordinate system.

(Change a map coordinate system of CWASA dataset)

Article118 A map coordinate system in CWASA dataset shall be required to change to make an unique coordinate system shift to a suitable one according to existing geodetic datum in Survey of Bangladesh as follow:

- Geographic coordinate system on WSG1984 in Bangladesh

- Bangladesh Transverse Mercator System in Bangladesh

Both coordinate systems are synchronized together in Bangladesh based on worldwide Geodetic System on WGS1984.

(Requirement of Transform and project of CWASA CAD datasets)

Article119 Transform and project of CWASA CAD datasets shall be required to process data as follows:

- CWASA Local Coordinate to Everest1830
- Project Everest 1830 to WSG84
- Spatial Adjustment on WGS84
- Project WGS84 to BTM

(CWASA Local Coordinate to Everest1830)

Item1 Operation shall be required to enforce the process by technical instruction on GIS training as carefully as possible. GCP file shall be preserved with work notes. Pay attention to careless mistakes in preparation of GCP process and that in a reversed GCP file. All mistakes shall be prohibited to process data.

(Project Everest 1830 to WSG84)

Item2 Operation shall be required to enforce the process by technical instruction on GIS training as carefully as possible. GCP file shall be preserved with work notes. Operation shall be carefully to process data. All mistakes shall be prohibited to process data with your cross check.

(Spatial Adjustment on WGS84)

Item3 Operation shall be required to carefully process GCP data for Spatial Adjustment in order to get most reasonable results against parts of strong distortions which were caused by missing quality control in the previous project.

Operator shall be required to repeat trials and errors to get a better matching result. GCP files shall be preserved with technical notes by operator.

(Project WGS84 to BTM)

Item4 Operation shall be required to carefully process project module with cross check of matching result with satellite image.

(Preparation GCP files to transform CWASA Coordinate System)

Article120 GCP to transform CWASA Coordinate System shall be required to reserve with suitable naming of the file as examples shown as follows:

- CW_D0911.txt GCP file CWASA Drawing VS Satellite image
- CW_D0911_Rev.txt ReversedGCP file of the above
- WGS_D0911.txt GCP file for Spatial Adjustment

Naming of GIS dataset in Transform and Project is as follows:

- EV_D0911 Georeferenced GIS dataset transformed from CWASA coordinate system to geographic Coordinate on Everest 1830
- WGS_0911 Projected GIS dataset from Everest 1830 to WGS84
- BTM_D0911 GIS dataset on BTM Coordinate System

If operator follows the above rules, operator can restore a series of data processing in TRANSFORM and PROJECT from original CWASA datasets any time, if there are something wrong in data processing. Operator can returned to previous step of data processing again.

(Cross check of results about transform and project)

Article121 Cross check of results about transform and project shall be required to judge accuracy and precision on matching result visually during the data processing. If found matching errors, operator shall be required to fix matching errors by spatial adjustment as much as possible.

Operator shall be required to get reasonable results by trials and errors of transform and spatial adjustment.

(Requirement of documentations in data processing with schedule)

Article122 Cross check list managing descriptions and schedules in data process shall be required to prepare by a manager, in order to avoid conflictions of personal works and duplications of data access from different persons and so on. All cross check shall be done with work records by a manager. GIS operator shall report your own work to a manager in real time.

(Records of data problems and data issues on technical operation)

Article123 GIS operator shall take a note about in order to report data problems and technical issues to a manager.

(Documentation of work profiles)

Article124 Work profiles shall be required to report profiles of series of data processing and the documents shall be reserved by manager.

3.4 Updating GIS datasets with available CWASA datasets

(Updating initial GIS datasets by available CWASA datasets)

Article125 Initial GIS datasets shall be required to update by references of available CWASA data resources before activities of field verification surveys as follows:

- As built drawings in D/D available to verify locations of main pipes and facilities to control Distribution Water on main pipes.
- Existing databases about service meters about 12,000 records and customer information about 25,600 records in D/D available to update GIS datasets. At least those databases shall be provided in initial GIS datasets by existing data resources but the data were too old to update service connection details to be the latest status of data.
- CSCCR available to update locations of facilities and to update all attributes in Service Connection details at initial data production for Asset Mapping in water supply.

If the above data resources are not available for updating of initial GIS dataset, GIS operator shall request to the Action Team to enforce field verification surveys including Account Survey and detailed Service Connection Survey. GIS operation shall be always required to update GIS datasets in real time by using reports of Operation and Maintenance or results of field verification surveys. There are three (3) data resource required to check updating of GIS dataset by GIS operator.

(Requirement of a plot map for verification of dataset)

Article126 Preparation of a plot map shall be required to verify initial GIS datasets with a reference of As built drawings in D/D as follows:

- Set map layout to produce a plot map in a large paper format such as A1 size or A0 size.
- Plot out the above map layout into a plotter device.

A plot map shall be utilized to verify locations of facilities in initial GIS datasets.

(Verify initial GIS datasets by a reference of As Built drawing)

Article127 Initial GIS datasets shall be required to verify dataset in a plot map with a reference of As Built drawing as follows:

- Verify locations of main pipes
- Verify point location of facilities on main pipes

The plot map shall be taken to D/D to verify maps with a plot map.

(Verify locations of main pipes)

Item1 Locations of main pipes shall be required to verify definite locations of main pipes in a plot map by hand drawing with a reference of As Built drawing. Pay attentions as follows:

- Verify locations of which sides there are main pipes runs
- Verify pipeline sections and pipe attributes about pipe diameter and pipe material
- If found any differences in a plot map with a reference of As Built drawings, draws the definite location of main pipes with pipe attributes in a plot map by sketch drawing.

(Verify point location of facilities on main pipes)

Item2 Point locations of facilities on main pipes also shall be required to verify the exact locations at facilities in a plot map by a reference of As Built drawing. Pay attentions as follows:

- Verify locations of facilities on main pipes
- Verify attributes of facilities
- If found any differences in a plot map with a reference of As Built drawings, draws the definite location with attribute of facilities in a plot map by sketch drawing.

(Update initial GIS datasets by a revised plot map)

Article128 Initial GIS datasets shall be required to update data with a reference of a revised plot map in the previous steps of Item1 and Itme2 by editing of GIS dataset.

(Updating GIS datasets by existing databases in CWASA)

Article129 Initial GIS datasets shall be required to verify attributes of Service Connection details according to references of existing two (2) databases in the previous datasets in D/D. The databases formulating most items in CSCCR had been compiled to set relational databases for Service Connection details for operation and Maintenance by the previous project in the 1990's. The project had established the present management styles in CWASA, so that attributes in Service Connection details about service meters and customer information at the time might be directly generated to those for initial CAD datasets. However there are still issues remaining against updating of Service Connection details in the CSCCR itself in Sales Division and D/D.

In order to generate attributes of those databases into initial GIS datasets in Service pipes

and service meters, set GIS datasets as follows:

- Check primary keys about CWASA Holding Number and Account Number in both databases.
- Sets a field of CWASA Holding Number or Account Number in initial GIS datasets of service pipes and service meters with preparations as follows:
  - Step1: Set Mauza Number in attribute table in GIS datasets
  - Step2: Set Plot Number in attribute table in GIS datasets
  - Step3: Set building number in attribute table in GIS datasets
  - Step4: Set CWASA Holding Number to joint by combinations of the above Step1, Step2 and Step3
- Set relations of GIS datasets and relational databases through primary keys.
  If necessary, export GIS data after joint relational database in GIS datasets.

(Updating GIS datasets by CSCCR)

Article130 Initial GIS datasets shall be required to update with references of CSCCR documents. There are two (2) databases in Article5 developed by the previous project in 1990's. However there are critical issues in CSCCR which numbers of new service applications had not yet been encoded in the above databases since 1998 so that PANI developed a database of CSCCR in order to make paper documents modernize database with digital archives of sketch drawings about 18,000 records since 2001.

If CSCCR database provides with all items in original application documents with sketch drawings and reference maps of BS sheets in Sales Division, man powered field verification Survey shall be saved in initial asset mapping, but it doesn't expect for CSCR to utilize updating of GIS datasets because most data items are still null in the form, particularly, Account Number and CWASA Holding Number. Both key items are important Geo-Code not only to map an exact location for Service Connection in Asset map, but also to update Account information, Customer Information and the connection details in Operation and Maintenance.

This step shall be always required to update GIS datasets in real time by references of CSCCR in the daily operations for service pipes and service meters.

(Requirement of documentations in updating process)

Article131 Activities for updating process shall be required to record a monitoring sheet with lists of accounts and present updating status in data either updated or not updated. GIS operator shall reports to a manager about the work process and also a manager shall monitor those quantities of updating status in data with their notes in real time. A monitoring sheet shall be prepared to avoid conflictions in the work.

3.5 Update GIS datasets by field verification surveys

(Update GIS datasets by field verification surveys)

Article132 Update GIS datasets shall be required to update initial GIS datasets by references of results in field verification surveys as follows:

- Route Survey on main pipes with Utility Crossing Surveys
- Service Connection survey including Account survey, Building survey and detailed surveys

Each field survey is required to prepare survey forms definitely in order to compile field survey logs and field information. The field data shall be required to compile a relational database not only for updating of GIS datasets but also for those for Operation and Maintenance on Facility management in CWASA Asset Management.

(Route Survey on main pipes)

Item1 GIS datasets on main pipes shall be verified about locations of facilities and those attributes according to field inspections with GPS Survey in the field as follows:

- GPS Survey to position a point on main pipes and a point at facilities on main pipes with field logs in the positioning
- Utility Crossing Survey on main pipes against other utility lines in the underground with field survey form
- River Crossing Survey and River Crossing Survey on main pipes with field survey forms

The above items are being required for Facility Management for Operation and maintenance, and the information shall be required to update in real time, if something events happen in O&M.

Based on GPS positioning data and field survey form to note the positioning record in the field, GPS survey data shall be generated to GIS datasets as follows:

(Service Connection Survey)

Item2 GIS datasets in Service Connection shall be verified about locations of facilities and those attributes in particular Account Number by field verification survey on Service Connection in the NRW management as follows:

- Account Survey identifying locations of customer about Account Number, Customer Information and,

- Detailed Survey on Service Connection consisting of verifications of the whole items on CSCCR and Building Survey.

(Requirement of materials for field verification surveys)

Article133 Field verification surveys shall be required to prepare plot maps and survey forms to record field logs as follows:

- Materials for Route survey on main pipes and
- Materials for Service Connection Survey

(Preparations of materials for Route Survey on main pipes)

Item1 Route Survey shall be required to use a plot map from available GIS datasets to guide navigation in the survey route. A plot map shall be supplied into survey team as follows:

- A plot map compiled by main pipes and facilities on satellite image with overlay of map annotations of land marks, word boundaries, road edges, others.
- Blank forms recording field logs for GPS survey
- Blank forms recording a sketch drawing for Utility Crossing and River Crossing and other field notes

(Preparations of materials for Service Connection Survey)

Item2 Service Connection Survey shall be required to use a plot map of available GIS datasets to guide navigation in the survey. A plot map shall be supplied into survey team as follows:

- A plot map compiled by service pipes and service meters with labels of Account Numbers on satellite image with overlay of other line maps in GIS datasets, map annotations of land marks, word boundaries and others.
- Blank forms recording field logs in the survey

A sketch map will be drawn to verify definite locations of service connections about service pipes and service meters in the survey and also latest buildings edges or road edges are directly drawn in a plot map by hand writing.

The sketch shall be a reference map for updating of GIS dataset in next updating process.

(Compiling field databases and GIS datasets on field collection data)

Article134 Field activities' records in field data collection shall be required to compile field databases with necessary preparations of GIS datasets for updating of initial GIS

datasets. All survey information shall be compiled to databases which are utilized to relational databases in GIS datasets.

(Compiling GPS Survey data and Survey forms in databases)

Item1 Positioning data at facilities acquired by GPS Survey with Survey forms recording descriptions of pipe sections and field logs will be generated to GIS datasets as follows:

- Download GPS data from a GPS receiver to produce a point feature of GIS dataset on main pipes
- Define projection in GIS dataset

(Map digitizing of main pipes and editing of facilities in GPS Survey points)

Item2 A line feature of main pipes shall be required to digitize a line feature of GIS dataset on GPS positioning data with references of field survey forms as follows:

- Digitize a line feature of main pipes with data entry of pipe attributes according to field survey form recording pipe sections and pipeline nodes.
- Exports the above file or update a master file of main pipes on field data collection.
- Selects necessary points to export point feature of facilities on main pipes such as control valves, air release valves, reducers, washouts, hydrants and others by reference of field survey forms.
- Exports the above data or updates a master file of field verification data on facilities.

In case of field verification survey for Service Connection, if GPS survey is enforced in the survey, prepares a line feature of service pipes or a point feature of service meter according to downloaded GPS data in the previous step.

(Compiling datasets for Utility Crossing Surveys and River Crossing Surveys)

Item3 There are preparations of datasets about two (2) additional surveys in Route Survey relating to utility crossing as follows:

- Utility Crossing Survey to map utility crossing points on main pipes and other underground utility lines about Gas Pipes, Tele-Communication lines, Electricity lines and others.
- River Crossing Survey and Canal Crossing Survey on main pipes

Accurate survey points shall be positioned by GPS Survey with field survey form including sketch drawings and photos in the site. The information will be support for Operation and Maintenance regarding to activity for Test Pit Excavation particularly.

All surveyed information shall be compiled to a point feature of GIS datasets for Operation and Maintenance on Facility Management to the future.

(Compiling databases in Service Connection Survey)

Item4 Service Connection details shall be required to verify and to update all aspects in the field. Field logging records shall be directly encoded into the databases. The database will be able to make database link to GIS datasets on Service Connection through a primary key of Account Number. If CWASA Holding Number is functioning, this field is also available for link operation.

(Update GIS datasets of main pipes)

Article135 Main pipes in initial GIS dataset shall be required to update data with display overlay of satellite image and field collection data in GPS data as follows:

- Overlay initial GIS datasets and other referenced data in filed verification Survey on Satellite image. Pay attention to as follows:
  - Verify locations of which sides there are main pipes runs
  - Verify pipeline sections and pipe attributes on main pipes

- If found remarkable changes in main pipes, edit line features and point features on main pipes with snap nodes and intersections.
  - If found differences in GIS dataset remarkably, edit definite data with corrections of attributes.

- If found changes a little or if not judged the change, don't update GIS dataset order field verification survey again. Because think about positioning accuracies of a GPS receiver. Positioning errors in a GPS receiver are depending on GPS chip in the model. If error gaps are within five (5) meters and locations on satellite image are not changed much, GIS data may not be updated necessarily. This step is important and this operation shall be paid attention to decide updating GIS dataset by GIS operator.

If operator decided that field verification data is not enough to update data, GIS operation shall take action for field verification in the field again.

GIS operation always shall be required to update GIS datasets in real time by utilization of results in field verification survey.

Maintenance Operation Divisions shall be required to manage records in Operation and Maintenance in real time. If maintenance event will be happened, GIS datasets on main pipes shall be updated with preparation of field logs to note services.

(Update GIS datasets in Service Connection)

Article136 GIS datasets in Service Connection shall be required to update data in real time on Pipeline Survey or the field verification survey in the NRW management as follows:

- Edits locations of service pipes and service meters or digitize new elements of those features with references of a plot map manually or scan the revised plot map with georeferencing. A revised plot map with sketch drawing is only for reliable data resource for updating of datasets in this moment.
  Also the scanned map of the map will guide to updating of geographic features of pipeline facilities, road edges and building edges in the work.
- Update attributes of Account Number in service pipes and service meters
- Edit or update geographic features of building edges or road edges in GIS datasets
- If GPS survey is utilized in the survey, GIS dataset shall be updated by overlay of GPS datasets on satellite image precisely.

(Compiling databases in the field verification survey)

Article137 Survey items shall be recorded into database to record field logs, sketch drawings and photos in the field. In particular, sketch drawings and photos will be useful for next works in Operation and Maintenance on Facility Management. The preparation of field database is required as follows:

- Compiles field logging records in database in Route Survey
- Compiles GPS Survey data in Route Survey
- Compiles digital archiving of PDF files or graphic files about sketch drawings and renaming of photo files or compile the above information to Microsoft Office Documents as an object of database item.
- Compiles survey forms in Utility Crossing Survey and River Crossing Survey with preparations of digital archiving of sketch drawings and photos.

All survey items related are utilized for reference information supporting Operation and Maintenance in the future.

(Requirement of updating CSCCR from updated GIS datasets)

Article138 CSCCR shall be required to update data in real time according to updated GIS data on field verification survey results. Updated GIS datasets in Service Connection details shall be backed to updating of CSCCR according to any field verification survey or any

events in Operation and Maintenance in real time.

3.6 Compile field databases about Test Pit Excavation

(Necessity to compile field databases about Test Pit Excavation)

Article139 Results of Test Pit Excavation shall be required to record surveying database in order to verify reality of cross sections among main pipes and other utility lines in the underground. The real situation of cross section layers and utility crossing in the underground shall be recorded by plot samples of Test Pit Excavation. The information shall be utilized for repair works and replacement works in Operation and Maintenance. The site selection is basically sampled by Route Survey on main pipes.

(Data resources in Test Pit Excavation)

Article140 The report of Test Pit Excavation is consisting of several documents with site maps as follows:

- Test Pit Excavation Information
- Location Map
- Summery Sheet
- Cross- Section Drawing (Field Verification Survey H Test-Pit Excavation Result)
- Photo Sheet-1(Operation)
- Photo Sheet-l(Measurement)
- Finding from Test pit Excavation
- Appendix about:
    - Site Observation Sheet (Conflicts Identification)
    - Site Observation Sheet
    - Test Pit Observation Sheet
    - Pavement Chart
    - Procedure of Test Pit Excavation
    - Road Cutting Permission from CDA

However, data sheet tables in the current report forms are not suitable to compiles records in database, so that components in the report are only compiled to object files of digital archives such as PDF files or available objects such as Microsoft Office documents, graphic files and others as follows:

- Site map of Test Pit Excavation
- Excel sheet to main tables in Test Pit Excavation
- Cross section map at site

- Photo records in the sites
- Cross bedding of vertical layers in the underground and etc.

Coordinates of site location for excavation points were verified by survey instruments in the field.

(Compiling GIS datasets for Test Pit Excavation)

Article141 Compiling GIS datasets for Test Pit Excavation shall be utilized by a point location of Test Pit Excavation sites and the reports as follows:

- A point feature of site locations for Test Pit Excavation
- Attributes of the above about
  - Excel sheet of main tables in Test Pit Excavation
  - Cross section map at site
  - Photo records in the sites
  - Cross bedding of vertical layers in the underground and etc.

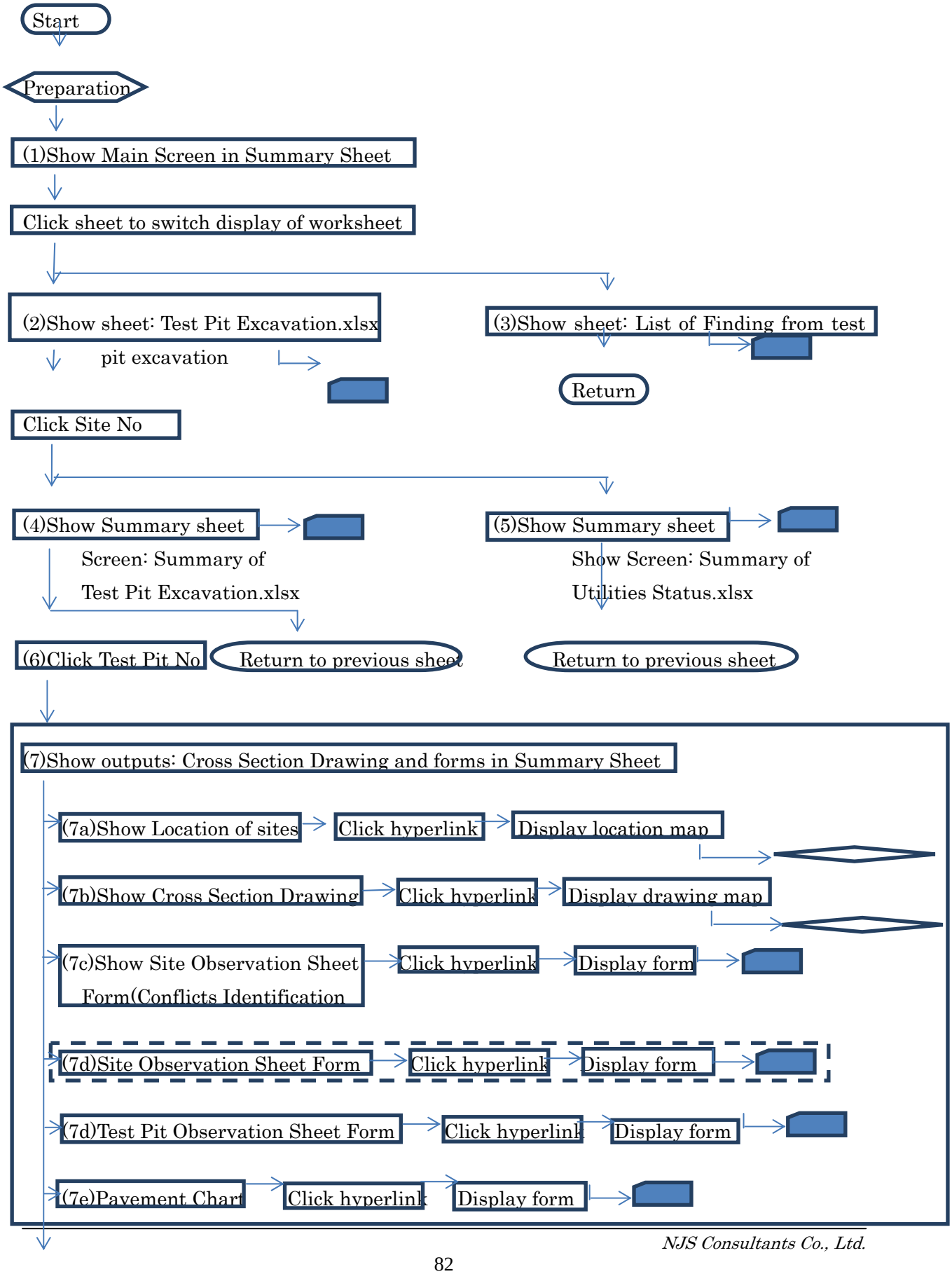
(Supporting of Test Pit Excavation Site)

Article142 Test Pit Excavation data shall be managed by MS EXCEL files to demonstrate test Pit Excavation activities with hyperlink operation to display any objects in the report. Hyperlink operation is an useful tool to link to show objects in system.

GIS software is also provides with hyperlink so that MS EXCEL sheet shall be imported to databases of GIS datasets or to make data joint to GIS datasets directly to demonstrate results.

Figure3.19 is examples of a design of MS EXCEL for Test Pit Excavation Data.

Data specification of GIS data and databases shall be referred to APPENDIX11: DATA SPECIFICATION OF GIS DATA AND DATABASES IN TESTPIT EXCAVATION.


Start
Preparation
(1)Show Main Screen in Summary Sheet
Click sheet to switch display of worksheet
(2)Show sheet: Test Pit Excavation.xlsx
pit excavation
(3)Show sheet: List of Finding from test
Return
Click Site No
(4)Show Summary sheet
Screen: Summary of
Test Pit Excavation.xlsx
(5)Show Summary sheet
Show Screen: Summary of
Utilities Status.xlsx
(6)Click Test Pit No
Return to previous sheet
Return to previous sheet
(7)Show outputs: Cross Section Drawing and forms in Summary Sheet
(7a)Show Location of sites
Click hyperlink
Display location map
(7b)Show Cross Section Drawing
Click hyperlink
Display drawing map
(7c)Show Site Observation Sheet
Form(Conflicts Identification
Click hyperlink
Display form
(7d)Site Observation Sheet Form
Click hyperlink
Display form
(7d)Test Pit Observation Sheet Form
Click hyperlink
Display form
(7e)Pavement Chart
Click hyperlink
Display form

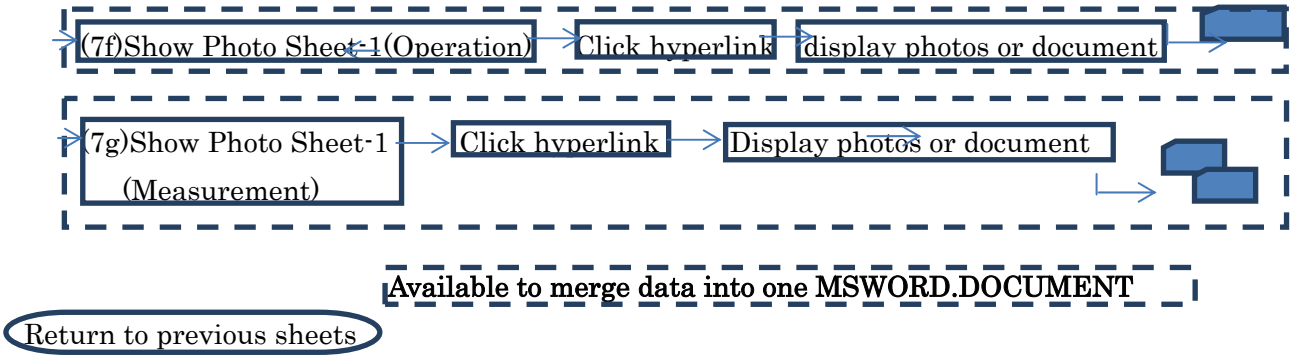


Figure3.19 Example of Data Management for Test Pit Excavation

3.7 Compile field databases about Leakage Water Survey

(Support of GIS operation for Leakage Survey)

Article143 Field data on Leakage survey shall be required to compile a location map to indicate leakage points with preparation of field logs by GIS operation as shown in Figure3.20. The survey data consists of as follows:

- A Location of leakage water in the survey
- Survey form for leakage survey compiled by:
  - Leakage Number,
  - Account Number,
  - Leakage Type in Facility and leakage about
    - ✧ Distribution(Body, Joint, Tapping, Valve and other) and
    - ✧ Service Connection(Body, Joint, Valve and other)
  - Pipe Diameter
  - Pipe Material,
  - Date of inspection
  - Sketch drawing
  - Remark,
  - Surveyor and Identifier with date

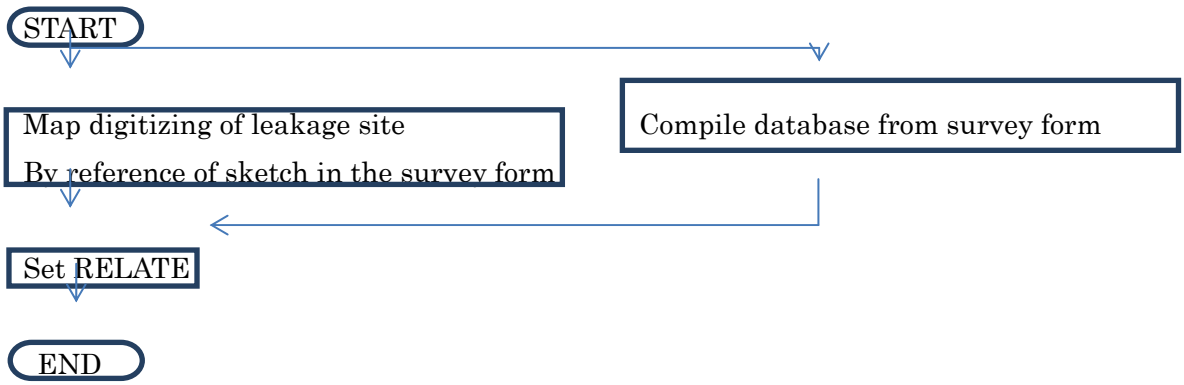


Figure3.20 Flow chart to produce GIS data supporting for Leakage Survey

(Production of GIS data for Leakage Survey)

Article144 Field data in the survey form on Leakage survey shall be linked to a point feature of GIS data to show a location of leakage site by RELATE to set relational databases. A site location shall be digitized by map digitizing with reference of sketch drawing in the survey form. Items in the form shall be encoded into database records and each record shall be linked to together.

Data specification of GIS data and databases in Leakage Survey shall be referred to

APPENDIX12: SUEVEY DATABASE AND GIS DATA IN LEAKAGE SURVEY.

Chapter4 NRW Management and GIS Operation

4.1 Task of GIS operation in NRW Management

(Task of GIS operation in NRW Management)

Article143 GIS operation shall support tasks to support the NRW Management as follows:

- Supply and Maintenance: Development and Maintenance of datasets
- Support for Operation and Planning: Maintenance of datasets and utilization of GIS operation as a supporting tool in the NRW Management

GIS operation provides Information Management in order to support the NRW Management in Figure4.1.

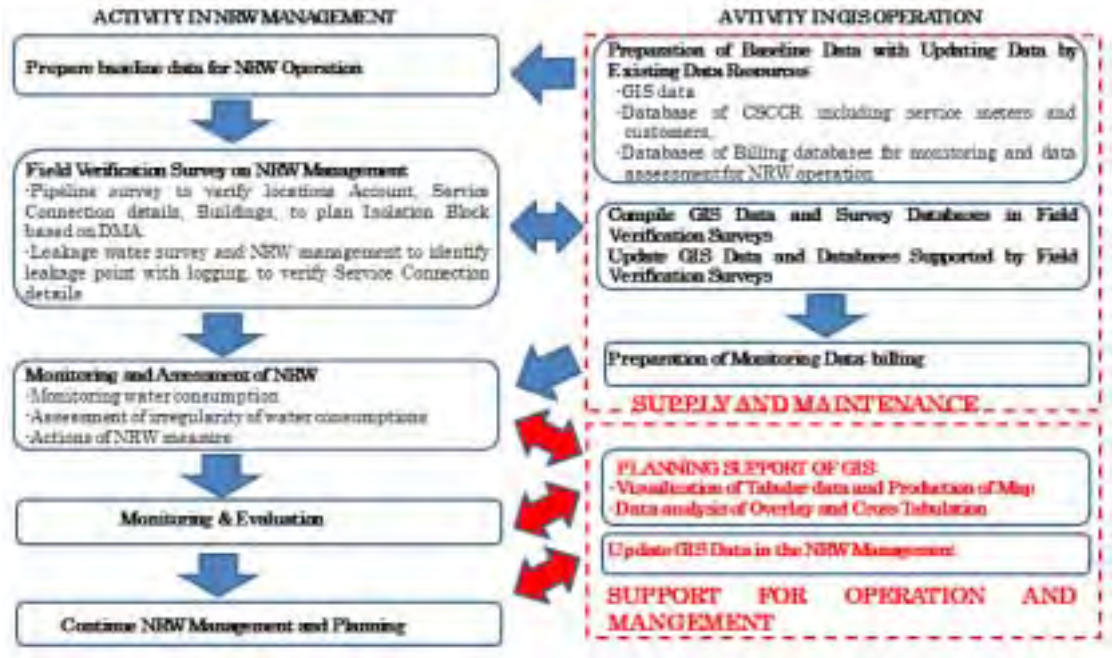


Figure4.1 NRW Management and GIS Operation

(Supply and Maintenance)

Article144 GIS operation shall supply and maintain necessary GIS datasets and relational databases to develop base line data for the NRW Management. Key activity is to develop GIS datasets and to update GIS datasets in the NRW Management.

Required instruction is guided in Chapter3 in Terms of Works.

The data shall be mainly supported to develop a part of asset mapping data and relational databases in Information Management on Facility Management by activities relating to map digitizing, editing of data and compiling databases in GIS Operation. There are several steps to supply baseline data initial GIS datasets for the NRW operation in Figure4.2 as follows:

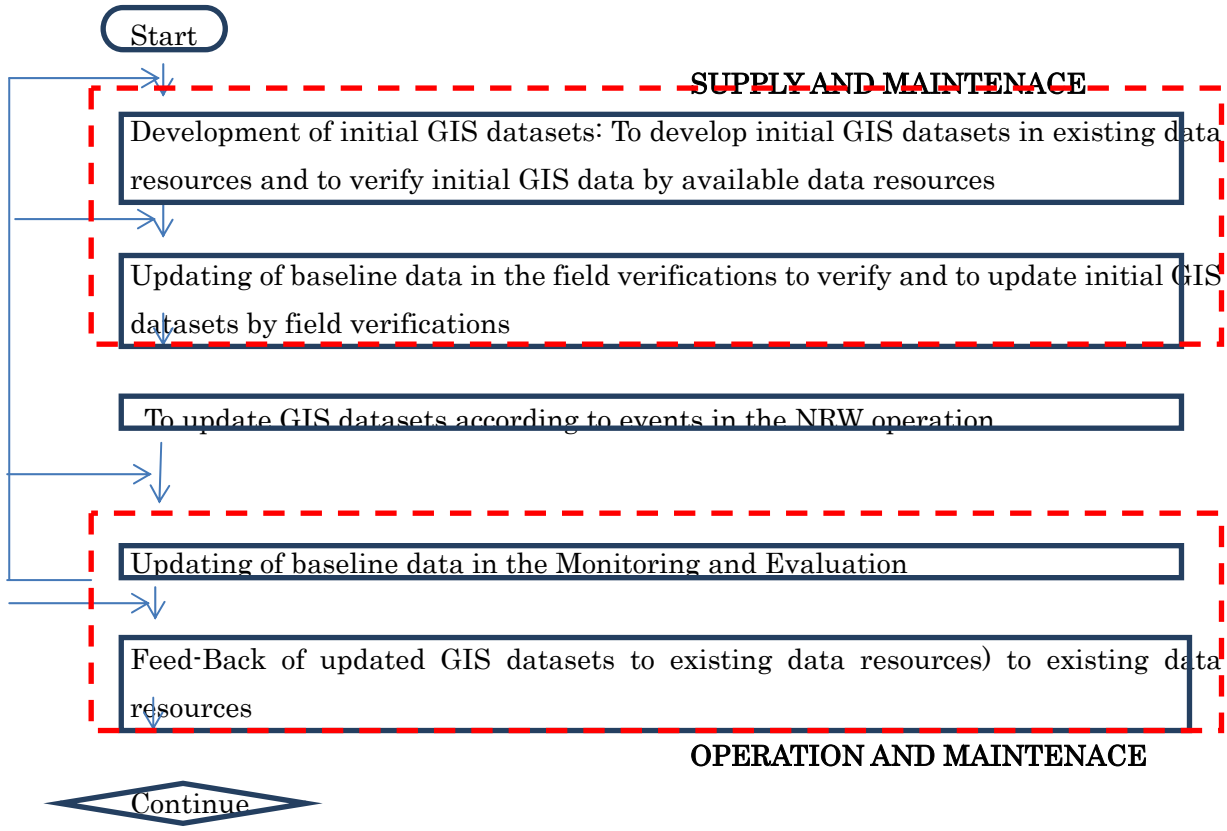


Figure4.2 Orientation of GIS development in Supply and Maintenance

(Development of initial GIS datasets)

Itme1 Development of initial GIS datasets for base line data for the NRW Management shall be as follows:

- To develop initial GIS datasets in existing data resources about maps, databases and materials of documents and available information.
- To verify geographic features and the attributes in initial GIS datasets by available data resources of As- Built drawings and CSCCR. Then, the data shall be supplied to next activities in the NRW operation.

(Requirement of updating of baseline data in the field verifications)

Item2 Baseline data of GIS datasets shall be verified and updated to be a latest status of data by field verification surveys on Pipeline Survey, Leakage Water Survey with verifications of Service Connection in the NRW operation. Updating of GIS dataset is mainly supported by those field operations with support to compile survey databases.

There are two (2) activities to update GIS datasets and relational databases as follows:

- To verify and to update initial GIS datasets by the above field verifications

- To update GIS datasets according to events of the repair works or the replacement works in the process of Isolation Block to set DMA design in the NRW operation.

Through the above updating, initial GIS dataset will be completed for next step of the NRW operation for monitoring, evaluation and the measures.

(Requirement of updating of baseline data in the Operation and Management)

Item3 Baseline data of GIS datasets in Service Connection shall be updated to be a latest status of data by the NRW actions mainly to service pipes and to replace meters in customers. Updating of GIS data shall be synchronized to take action in order to maintain GIS data and relational databases in Service Connection.

(Feed-Back of updated GIS datasets to existing data resources)

Item4 Updated GIS datasets shall be feed-back to update existing data resources in CWASA such as database of CSCCR and its form in S/D, D/D and MODs, Service meter databases and customer databases in D/D and MODs, Information of Geo-Coding in CSCCR to billing database in C/S. the information will be contributed to develop Management Lodgers on Facility Management in CWASA.

4.2 Supporting work of GIS operation to NRW Management

(Utilizations of GIS functions in the NRW Management)

Article145 GIS operation shall support management and planning in order to supply required maps and databases which will be prepared by GIS functions as follows:

- Display various GIS datasets on Map Window: GIS data(Grid data, Rater data and Vector data), relational databases, Documents, Graphic data and others
- Display visualization of data by JOIN and RELATE: Tabular data of sprat sheet, profiles of time series of data in NRW measures and etc.
- Retrieve of GIS data on Map Window to check attributes in GIS data.
- Query records to select necessary records to handle data on Map Window and Attribute Table
- Visualization of data, profiles of time series of data in NRW measures and etc.
- Spatial data analysis to overlay maps and preparation of tabular data
- Production of thematic map
- Map layout to prepare cartographic layout for Map printing
- Map printing
- Data exchange to import and to export among system
- Utilizations of extension modules for Data Processing and Data Analysis: 3D data, Spatial Analysis, GPS, COGO, and others utilities, which are extension modules to add on GIS software.

(Support for Operation and Planning)

Article146 GIS operation shall support management and planning in order to supply required maps and databases which will be prepared by GIS functions. The most important functions are utilized to support the NRW Management for NRW Management as follows:

- To display GIS datasets and relational databases on Pipeline networks, Service Connections, Test Pit Excavations, Leakage Water Surveys and result of data analysis in the NRW operations such as tabular data of DMA design, monitoring of water flow and billing data in the management.
- To display selected data in GIS datasets and relational databases by using query in the tables, in order to search required conditions in the Operation and Management
- To display(visualize) tabular data on GIS data for the NRW management in order to make monitoring data linked to service meters plotting water consumptions, water billing, time series of those data into bar chart or pai chart.
- To support data analysis to process cross tabulations data in GIS data with WARDS, DMA Area, in order to supply statistics data in the Management.

- To support simulations of the NRW countermeasures for suitability of water distributions in the areas and simulations of increase of revenues and so on.
- To support production of maps in display window about thematic maps and evaluation maps for the Management.
- To support map printing of the above.

(Required GIS operation to support Operation and Management)

Article147 GIS operation shall be required to operate several modules to support the Operation and Management. Particularly, several modules shall be require to master for GIS operation as follows:

- RELATE to set relational databases between two(2) datasets
- QUERY to select necessary records in Attribute tables
- ANALYSIS TOOLS for EXTRACT(CLIP, SPRIT), OVERLAY(IDENTITY< INTERSECT, UNION, UPDATE) and PROXIMITY(BUFFER) to calculate required features to extract data in data analysis
- Other Geo-processing tools to merge and dissolve GIS data

(RELATE)

Article148 RELATE is to set relational databases to join two (2) data tables through key primary field in both data. RELATE only links to data table together by set RE. Tabular data in monitoring data and data analysis in DMA design will be linked to GIS data by RELATE easily.

Visualization of tabular data plotting to service meters in GIS data will be support by RELATE operation. There are several maps available to produce map about distribution maps of Service Connection details, billing data and time series of those data such as monthly consumptions, annual consumptions and so on.

(QUERY)

Article149 QUERY is import operation to select necessary records in attribute table in GIS data and database by a setup of condition in SQL expression according to criteria in the management.

There are two (2) types of query operation as follows:

- Select By Attributes: Query to select records in attribute table by conditions in SQL Statement.
- Select By Location: Spatial Query to select records in target feature based on their location relative to features in another layer. There are several options to use variety of selection methods to select point features, line features, or polygon features in one layer

that are near or overlap the features in the same or another layer. There are options for Spatial Query about "Intersect", "Are within a distance of", "Are within", "Are completely within", "Contain", "Completely contain", "Have their centroid in", "Share a line segment with", "Touch the boundary of", "Are identical to", "Are crossed by the outline of", "Contain (Clementini)" and "Are Within (Clementini)". The option chosen is depending on the criteria for spatial query.

(ANALYSIS TOOLS)

Article150 ANALYSIS TOOL consists of three(3) categories to support data analysis as follows:

- EXTRACT to calculate required features to extract data
- OVERLAY to calculate required features to process and analyze data
- PROXIMITY to calculate the proximity of features required features for Data analysis such as BUFFER and others

(EXTRACT)

Article151 GIS operation shall be required to operate modules in EXTRACT to calculate required features to extract data about

- CLIP to clip portions of the input coverage into multiple GIS data
- SPRIT to divide into several GIS data according to GIS data for split operation

(CLIP)

Item1 CLIP extracts input features that overlay the clip features in order to cut out a piece of one feature class using one or more of the features in another feature class as a "cookie cutter", as shown in Figure4.3.

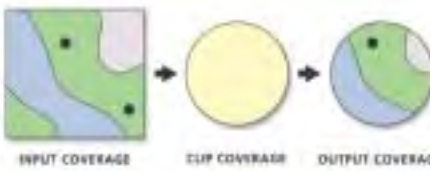
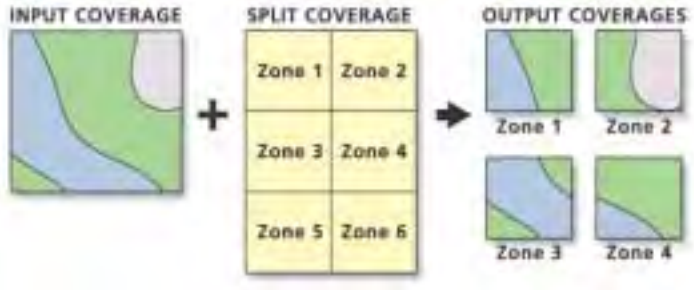


Figure4.3 CLIP operation

This is particularly useful for creating a new feature class – also referred to as study area or area of interest (AOI) – that contains a geographic subset of the features in another, larger feature class.

(SPLIT)

Item2 SPLIT is for Input GIS data to divided into several GIS data by split GIS data as shown in Figure4.4



(OVERLAY)

Article152 GIS operation shall be required to operate modules in OVERLAY to calculate required features to process and analyze data. There are mainly key modules in OVERLAY in Table4.1 as follows:

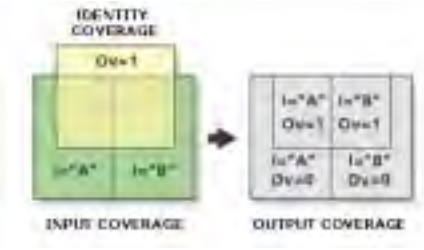
- IDENTITY,
- INTERSECT,
- UNION,
- UPDATE

Table4.5 Main moduled in OVERLAY

Tool	Binary or multiple overlay	Input data type	Overlay data type	Output
IDENTITY	Binary	Any	Polygon or same as input	Input features, split by overlay features
INTERSECT	Multiple	Any	N/A	Only features common to all input layers
UNION	Multiple	Polygon	N/A	All input features
UPDATE	Binary	Any	Polygon	Input feature geometry replaced by update layer

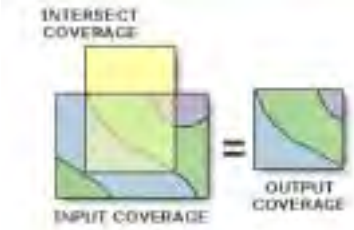
(IDENTITY)

Item1 IDENTITY computes a geometric intersection of the input features and identity features as shown in Figure4.5. The input features or portions thereof that overlap identity features will get the attributes of those identity features.



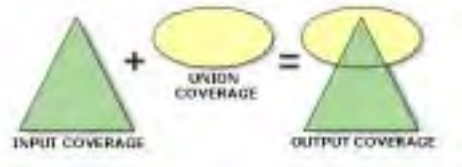
(INTERSECT)

ITEM2 INTERSECT computes a geometric intersection of the input features as shown in Figure4.6. Features or portions of features which overlap in all layers and/or feature classes will be written to the output feature class.



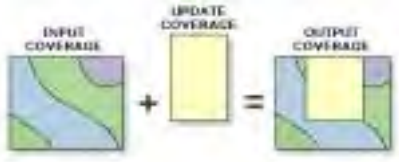
(UNION)

Item3 UNION computes a geometric intersection of the input Features as shown in Figure4.7. All features will be written to the input Feature Class with the attributes from the Input Feature, which it overlaps.



(UPDATE)

Item4 UPDATE computes a geometric intersection of the Input Features and Update Features as shown in Figure4.8. The attributes and geometry of the input features are updated by the update features in the output feature class.



(PROXIMITY)

Article153 GIS operation shall be required to operate modules in PROXIMITY to calculate the proximity of features required features for Data analysis. There are several useful modules for Spatial Analysis. Particularly BUFFER is very famous to set Proximity in GIS Data Analysis to support for operation and planning. BUFFER is often utilized for OVERLAY process and Spatial Query of "Select By Location" to set required criteria for decision making support.

(BUFFER)

Buffer creates buffer polygons around input features to a specified distance as shown in Figure4.8. An optional dissolve can be performed to combine overlapping buffers. There are three (3) types of buffers depending on input features about point feature, line feature and polygon features.

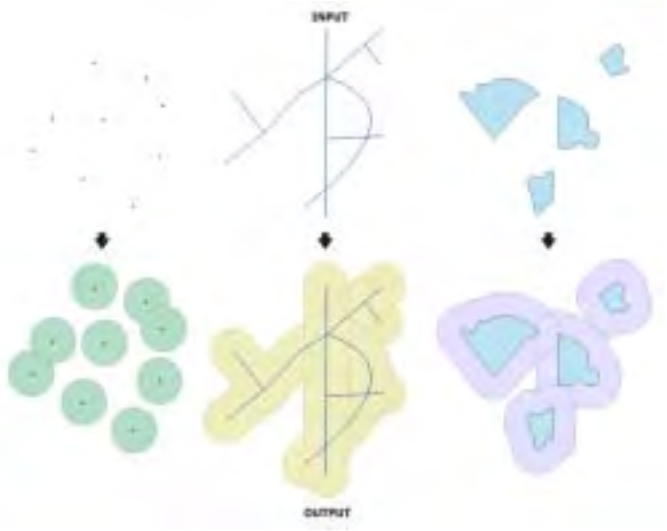


Figure4.8 BUFFER: Point Buffers, Line Buffers and Polygon Buffers

Output
of
GIS Mapping of Distribution Network
In
PANI Project

2012 May

Mohammad Dalower Hossain
Mohammad Al-Amin

BETS Consulting Services Ltd.

GIS Output

Field Verification Data of Pilot Area

Asset Map of GIS Dataset for Pilot Area

Asset Map of GIS Dataset on Satellite Image

Monthly Consumption Data of Pilot Area

Monthly Billing Data of Pilot Area

Map to Demonstrate Time Series of Water Consumption in Pilot Area

Map to Demonstrate Time Series of Monthly Billing in Pilot Area

Underground Utility Map of Pilot Area on Satellite Image

Leakage Map of Pilot Area

Field Verification Data of Model Area

Asset Map of GIS Dataset for Model Area

Monthly Consumption Data of Zone – 3

Monthly Billing Data of Zone – 3

Output
of
GIS Mapping of Distribution Network
In
PANI Project

2012 May

Table of Content

Annex:

Background

The Project for Advancing NRW Reduction Initiative (hereinafter referred to as PANI) is intended to enhance capability of Chittagong WASA in reduction of Non-Revenue Water (NRW) through technology transfer from JICA Expert Team including OJT for leakage detection and repair work as well as formulation of NRW Reduction Plan.

Along with the implementation of the Project, CWASA has started building up technology on NRW in the Pilot Project Area and also has identified priority area for replacement of deteriorated distribution pipelines, particularly main pipeline using Asbestos Cement Pipes (hereinafter referred to as ACP) and designated as model area.

CWASA is required to start over capacity building on Mapping and GIS throughout the PANI in order to support NRW. Prior to implement major rehabilitation work, re-establishment of distribution network drawings with the use of GIS-based mapping system is deemed indispensable, because the existing CAD drawings have technical deficiency on their accuracy of coordinates and lack of appropriate update in the past ten years.

PANI has therefore decided to engage services of local consultants to conduct GIS operation, database operation, map survey, field verification and preparatory work for GIS mapping in Pilot Project Area and in Model Area.

1. Scope of GIS Mapping

1.1 Operation and technical instructions on Mapping and GIS

a) Project operation and assistant for JICA GIS Expert to accomplish overall operations on Mapping, GIS and database in PANI.
b) Development work of GIS Databases with JICA GIS Expert.
c) Editing and updating of GIS datasets on NRW operation for distribution of water supply network and service connection with uses of High Resolution Satellite Image, field survey data and customer database in project areas.
d) Instruction and supervising to data encoders in encoding field survey results to database and in encoding the consumer service completion report and compiling of encoding data with customer database in computer section.
e) Technical supervising of mapping and GIS operation to CWASA counterpart in PANI.
f) Compiling and updating of encoded data and link them to digital map with the use of coordinated obtained by GPS instruments for field verification survey of customers in Pilot Projects Areas and Model area.
g) Print out GIS output and all collected data / information together with database.
h) Training support of GIS basic operation to counterpart staff.
i) Support in conducting workshop, seminar etc.
j) Preparation of project reports with appendixes and outputs for final report in PANI.

1.2 Supporting work to local GIS Expert and PANI operation

a) Operation support on Mapping and GIS in Pilot Project Areas and Model Area corresponding to service area of distribution network and service connection referring to existing CAD drawings of CWASA with updating.
b) Editing and updating of GIS datasets on NRW operation for distribution of water supply network and service connection with uses of High Resolution Satellite Image, field survey data and customer database in project areas.
c) Cross check of encoding data in Consumer Service Connection Completion Report with customer database in computer section.
d) Compiling and updating of field verification data in distribution network and service connection survey in Pilot Project Areas and Model Area.
e) Arrangement of identification of customer locations in GIS data by reference of customer dataset in project areas.
f) Preparation of GIS database in Model Area and support of technical training of CWASA counterpart staff with local GIS Expert.
g) Support in conducting workshop, seminar etc.
h) Print out GIS output and all collected data / information together with database to support local GIS Expert and JICA Expert.

2. Operation and technical instructions on Mapping and GIS in Pilot Areas

2.1 Encoding of Field Survey Data

At the end of the day each service connection survey team give data to GIS team for encoding and updating. Data entry form was prepared in Microsoft Access for encoding field data. After encoded data in Microsoft Access, cross checking of those information has done with customer data in computer section. If any miss matching has been founded, that information given to field survey team for checking. Field survey teams have taken two pictures for each service connection; one for meter and another for structure. Those pictures number have also encoded in field survey database.

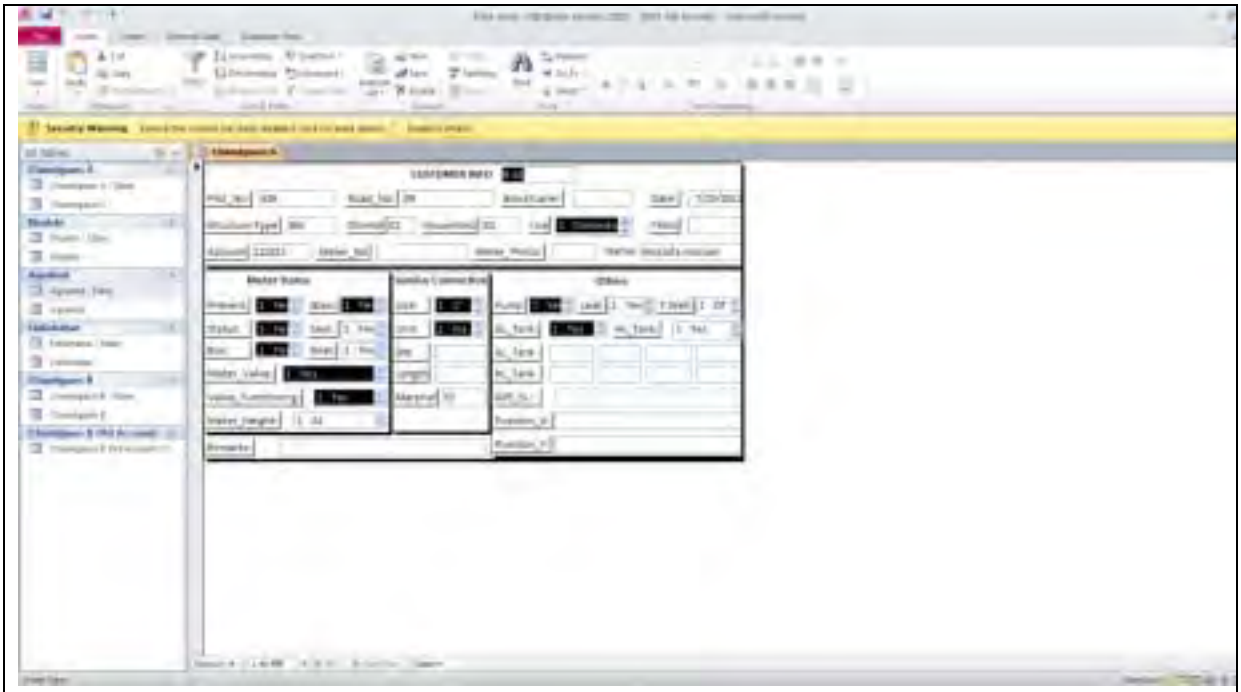


Figure 2.1: Updated meter information in Chandgaon B Area

Progress and Achievement:

Encoding of field survey data of all Pilot Project area completed.

2.2 Updating of Main Pipe and Service Connection

Updating work is performing based on field survey data. Field survey team draw sketches of structures, service pipes and indicate location of main pipes on the provided field survey map. Length, connection size, unit and material of service pipe, meter status and other information were encoded in field survey form. While updating service connections, length of service connection is taken from field survey form. Structures is drawn from World View1 images and verified from field survey data.

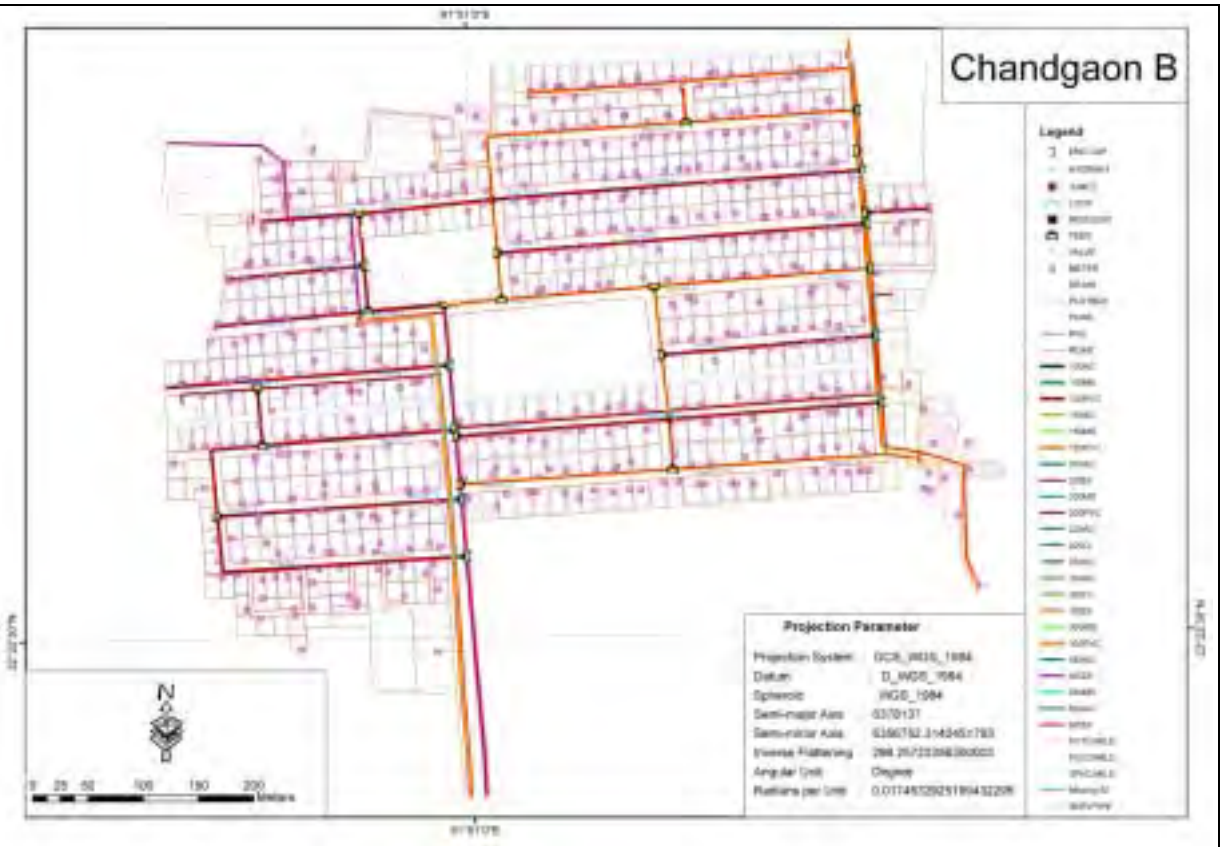


Figure 2.2: Updated GIS map of Chandgaon B area

Progress and Achievement:

Updating of main pipes and service connections in all Pilot Project area completed.

2.3 Preparation of Meter Replacement Map

While collecting consumer information field survey teams has also gather meter status that means whether meter is available or not. If meter is available then they have checked whether it is functioning or not and record that on consumer information sheet. Later GIS team prepared meter replacement map based on field survey data and handed over to leakage detection team for meter replacement. On that map different colors are used to indicate meter status for example one color is for no meter, another color is for malfunctioning meter and another color for functioning meter.

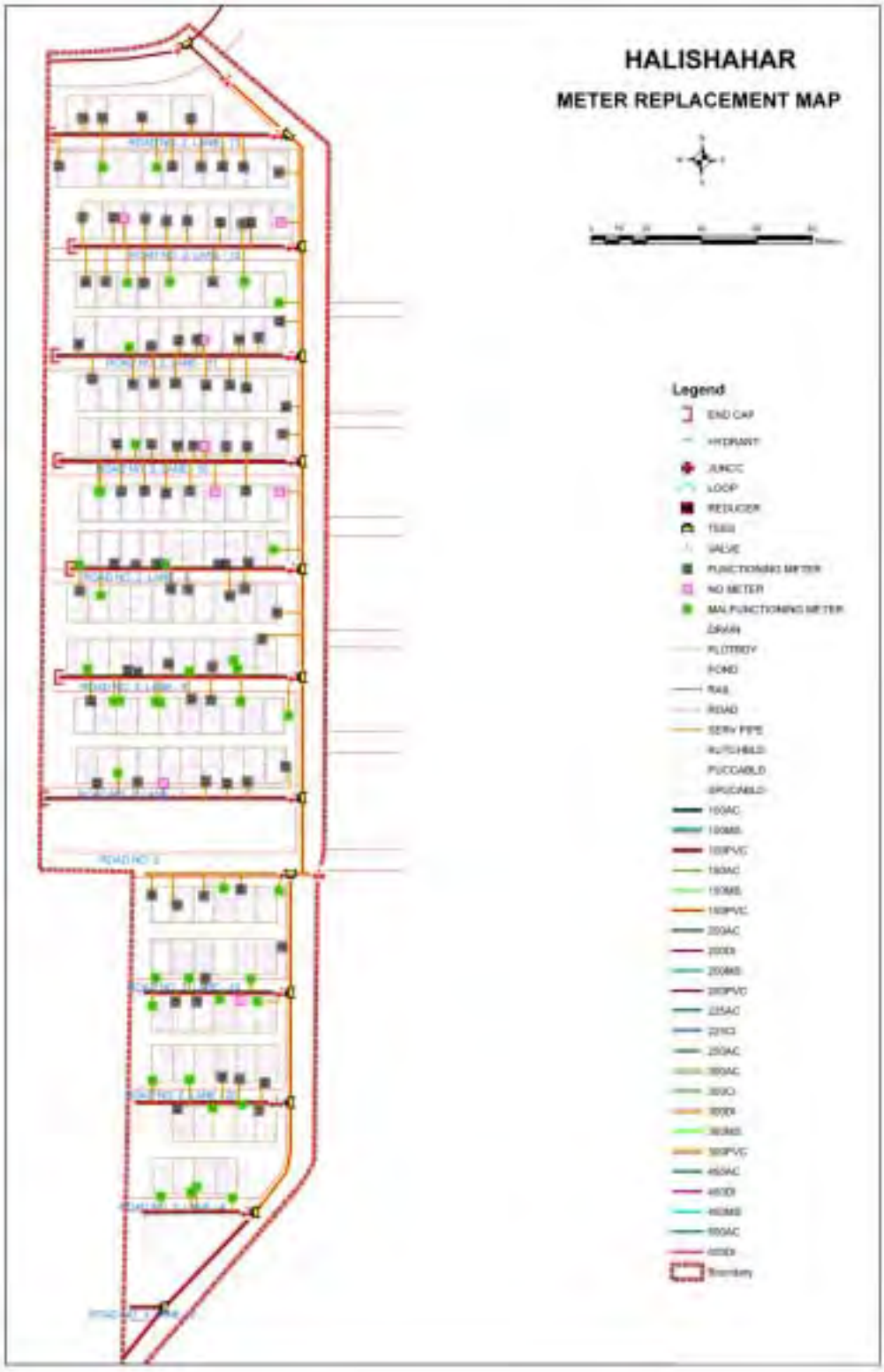


Figure 2.3: Meter replacement map of Halishahar Area

2.4 Updating of Meter Information

Last year leakage detection team had collected all consumer information in Khulshi and Chandgaon A area. GIS team encoded that data in Microsoft Access in order to prepare consumer database. Later GIS team has provided list of accounts including address where there was no meter or mal functioning meter. Based on that list, leakage detection team have installed or replaced meter of that consumers. After installation or replacement, they provide new meter number of those accounts. GIS team have prepared another two fields in Microsoft Access to encode new meter number with installation date while previous meter number has been kept as reference.

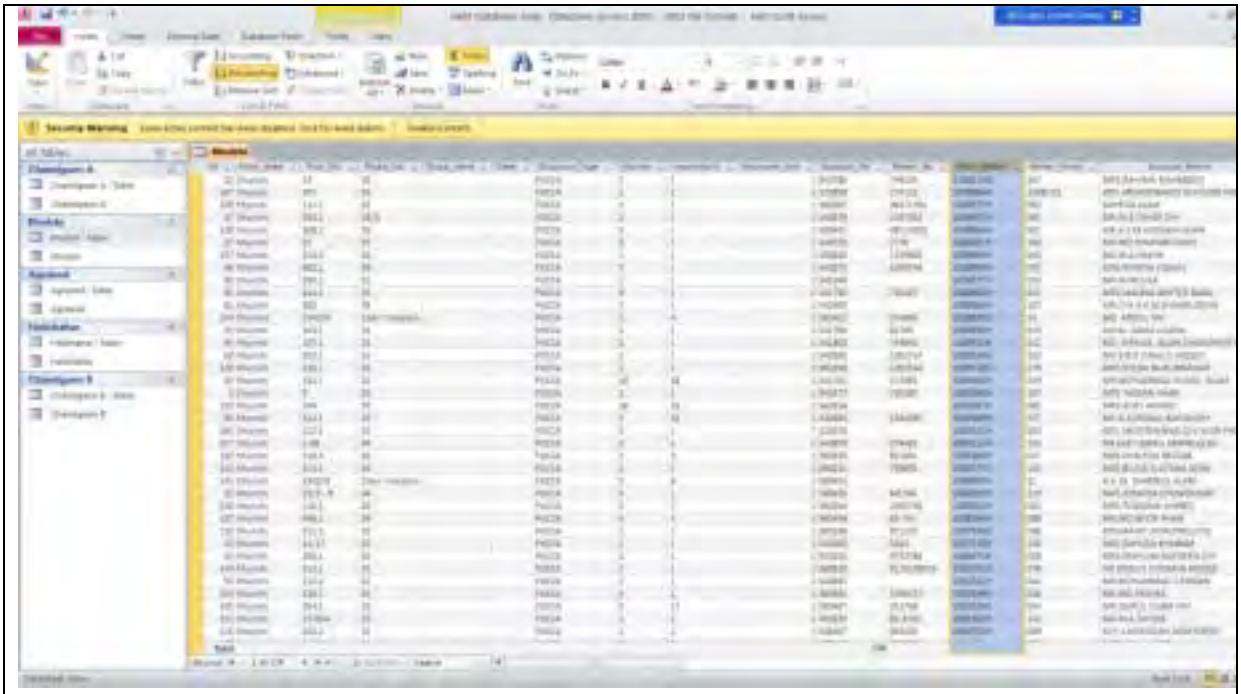


Figure 2.4: Updated meter information in Khulshi Area

Progress and Achievement:

Updating of meter information completed.

2.5 Preparation of Leakage Map

Leakage detection team has identified leakage on main pipe and service connection under normal pressure and in some cases in high pressure. GIS team provided map to leakage detection team to pin point leakage location. Later GIS team has integrated that data to GIS.

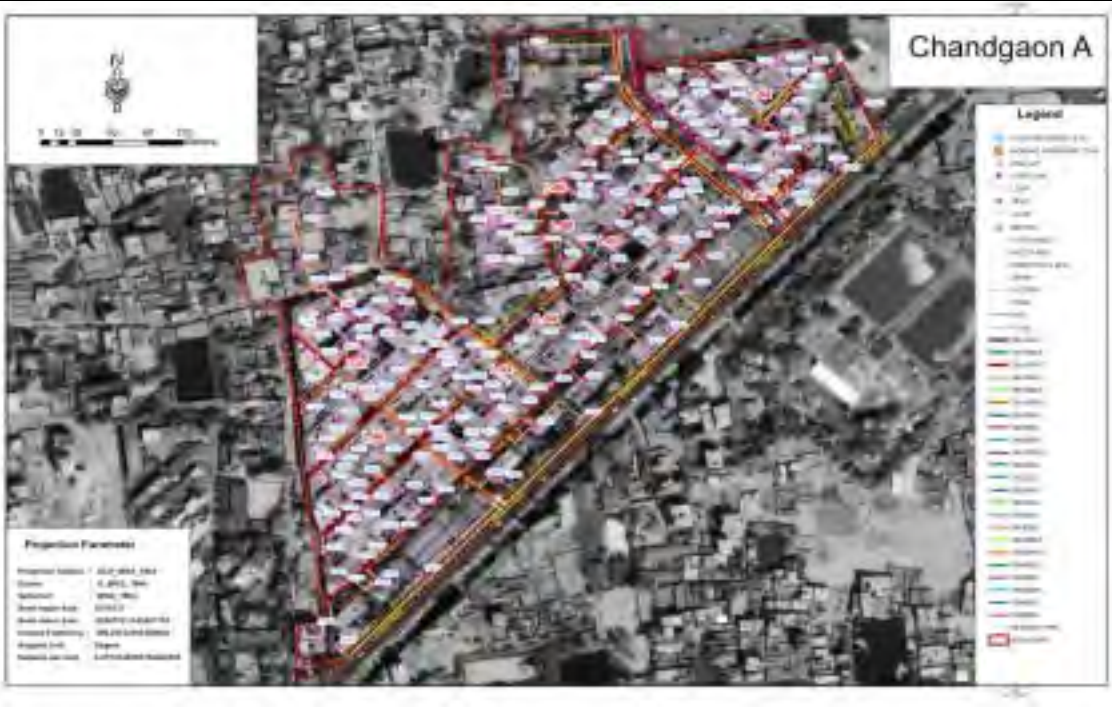


Figure 2.5: Leakage map of Chandgaon A

Progress and Achievement:

Leakage map preparation completed.

2.6 Calculation of Monthly Consumption

Computer section of CWASA maintains billing data of consumers. PANI project collected that data from computer section in order to calculate monthly consumption of each consumer within project area. CWASA meter inspector hardly collect meter reading at the first day of the month. There was no specific date for collecting meter reading. Also it was found that billing was done together for two or three month in many accounts. Based on meter, gallon (UK) and cubic meter (m^3) were used as unit of consumption. There were only three category used for classifying use of structure such as domestic, non-domestic and mixed. In case of mixed use, one field namely "NBILL" was used in computer section database to indicate how much percent were non-domestic. In case of no meter or defected meter, average consumption was used for billing. Average consumption would be average of last three month when meter was functioning or 150 / 250 / 450 / 750 gallon (UK) per day (for ¾" or 1" / 2" / 4" / 6" connection size consecutively) which one was bigger. After calculating monthly consumption, it was merged with field survey data based on account number. Some inconsistency found in billing data such as defected meter shown as functioning meter. Average consumption of 150 gallon (UK) per day was used where there was no meter from the installation of connection without considering number of family on that structure.

Progress and Achievement:

Monthly consumption of each consumer from January 2009 to January 2012 in all Pilot Project area

completed.

2.7 Preparation of Map to Demonstrate Time Series of Water Consumption

GIS team has calculated water consumption from January 2009 to January 2012. After calculating monthly consumption that data has been incorporated with GIS datasets. After that GIS team has prepared map to demonstrate monthly consumption and monthly revenue of each consumer.

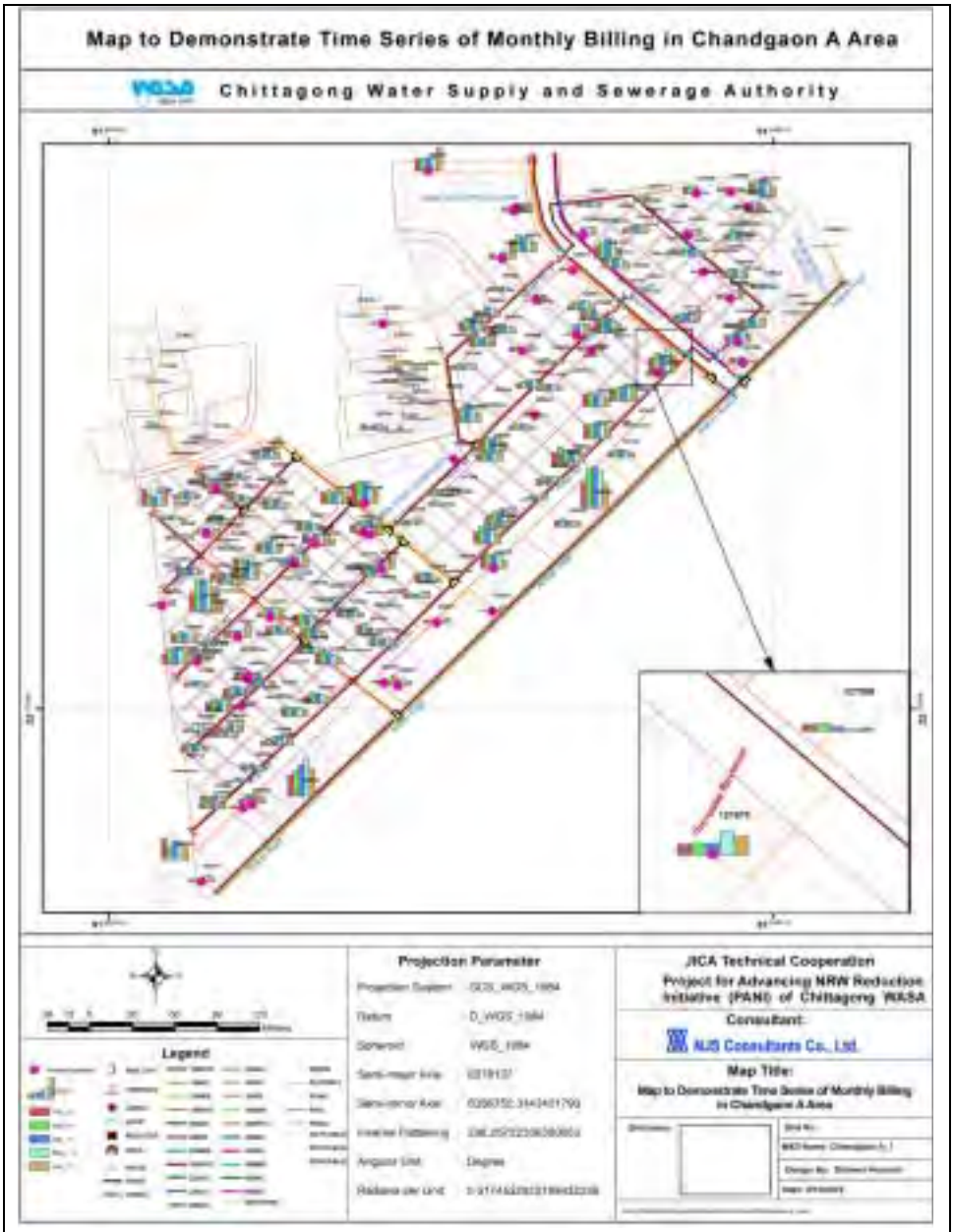


Figure 2.6: Updated meter information in Khulshi Area

2.8 Preparation of Database for Mapping Features

While updating GIS datasets, database also prepared for each mapping features. For identifying features on cadastral map, geocoding also encoded against each mapping features. Detailed descriptions of database are given in Table 2.1 to Table 2.8.

Table 2.1: Data specification of Main pipe (PNET)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Line				
OBJECTID	Object ID number	OBJECTID	Short	0	4	0	Numeric
LENGTH	Length of ARC in geometry	LENGTH	Double	19	15	4	Numeric
DXF_LAYER	Type of feature is defined by WB Project. PNET is defined by a center line of main pipes.	LAYER	Text	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1, 2, 3, 5, 6, 7, 9, 31, 40. PNET is assigned to 40.	COLOR	Short	0	4	0	Numeric
Pat	Name of pipe line: Pat is compiled by a prefix of “DN” / “TN”, Pdia and Pmat. DN stand for Distribution Network and TN stand for Transmission Network.	PAT	String	30	0	0	
Pdia	Pipe diameter is defined in metric system as follows: 0, 50, 100, 150, 200, 225, 250, 275, 300, 400, 450, 500, 600, 700, 900, 1200 and others	PDIA	Short	0	4	0	Numeric
Pmat	Pipe material: AC, AC/MS, AC/PVC, AS, CI, DI, GI, MS, OVC, PVC/AC, W and others. Domain was defined as follows: 1: AC is for Asbestos Cement 2: DI is for Ductile Iron 3: GI is for Galvanized Iron 4: PVC is for Poly Vinyl Chloride 5: CI is for Cast Iron 6: MS is for Mild Steel 7: Others are combined the above.	PMAT	Text	10	0	0	
Label	Label of pipe line is defined by a combination of fields of Pdia and Pmat	Label	String	15	0	0	
Checked	Status of pipe network	Checked	Short	0	4	0	Number
Label2	Label for facility in main pipe and service pipe for WaterCAD.	Label2	String	10			

Table 2.2: Data specification of Related Facilities of DSR such as control valve, hydrant, and others (DSRF)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Point				
OBJECTID	Object ID number:	OBJECTID	Short	0	4	0	Numeric
DXF_LAYER	Type of feature is defined as follows: VALVE, LOOP (Loop over) , JUNCC (Crossing), HYDRANT, TEES, NETWORK, WASHOUT, REDUCER and UNKNOWN	LAYER	Test	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1,2,3,5,6,7,9,31,40	COLOR	Short	0	4	0	Numeric
MapSheet	Name of Drawing name was defined by the WB project based on combination of thana name and Mauza map	MAPSHEET	String	5	0	0	
Facility	Attribute of facility. For TEES and JUNCC, facility will be diameter of connected pipes; for other features, facility will be Pat of connected pipe.	PAT	String	30	0	0	
Mauza_No	Mauza number is defined by map sheet number of Mauza map	MAUZA	String	5	0	0	
WARD_NO	Ward Number is defined by Ward Boundaries in CDA	WARD	String	10	0	0	
Angle	Rotation angle required for adjustment with connected pipe	ANGLE	Short	0	3	0	Numeric

Table 2.3: Data specification of Service Pipe (SERV)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Line				
OBJECTID	Object ID number:	OBJECTID	Short	0	4	0	Numeric
LENGTH	Length of ARC in geometry	LENGTH	Double	19	15	4	Numeric
DXF_LAYER	Type of feature: SERVPIPE	LAYER	String	31	0	0	
DXF_COLOR	Color of feature defined by the WB project as follows: -2, 1, 2, 3, 5, 6, 7, 9, 31 and 40. SERV is assigned to 31.	COLOR	Short	4	4	0	Numeric
Pat	Name of pipe line: Pat compiled by Pdia and Pmat.	PAT	Text	30	0	0	
Pdia	Pipe diameter same as that in Main pipes, Pipe diameter is compiled by a diameter in metric system of Service Pipe in the Field Database. Domain of diameter is as follows; 1: 1 inch compiled to 25mm 2: 3 / 4 inch compiled to 20mm 3: 2inches compiled to 50mm 4: 4inches compiled to 100mm	PDIA	Short	0	4	0	Numeric

Pmat	Material of Pipe in Main pipe and Service pipe. Domain of Pmat is as follows: 1: AC is Asbestos Cement 2: DI is Ductile Iron 3: GI is Galvanized Iron 4: GI+PP is combined by Galvanized Iron & Polyethylene Pipe 5: GI+PVC is combined by Galvanized Iron & PVC 6: PP is Polyethylene Pipe 7: PP+GI+PVC is combined by Polyethylene Pipe& Galvanized Iron & Polyethylene Pipe 8: PVC	PMAT	String	10	0	0	
Ref	Holding number given by CCC or CDA	REF	String	10	0	0	
ARef	Plot number is defined in BS sheet	AREF	String	10	0	0	
BRef	Building number within one plot	BREF	String	2	0	0	
CRef	Plot number is combined by ARef and BRef	CREF	String	15	0	0	
Mauza_No	Mauza number is defined by first letter of Thana, last two number of JL number and two letter of sheet number	MAUZA	String	5	0	0	
WARD_No	Ward Number is defined by Chittagong City Corporation	WARD	String	10	0	0	
Geo_Ref_1	Georeferencing code compiled by Mauza_No and CRef	GEOREF1	String	20	0	0	
Geo_Ref_2	Georeferencing code compiled by WARD_No and Geo_Ref_1	GEOREF2	String	20	0	0	
Label	Label of facility is combined by Pdia and Pmat	Label	String	15	0	0	
SF_ID	A record number of surveying database	SF_ID	String	10	0	0	
Account	Account number	Account	String	10	0	0	
Checked	Check status of pipe network. Status is as follows: 1: Checked 0: incomplete	Checked	Short	0	4	0	Number
Label2	Label of facility in main pipe and service pipe for Water CAD A prefix of label is as follows: 1: MP: A prefix of “MP-“ is for Main Pipe, 2:P:A prefix of “P-“ is for a node point on main pipe	Label2	String	10	0	0	

Table 2.4: Data specification of Service Meter (METR)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Point				
OBJECTID	Object ID number:	OBJECTID	Short	0	4	0	Numeric
DXF_LAYER	Status of service meter. OK_MTR is used for functioning meter, MALF_MTR is used for malfunctioning meter and NO_MTR is used for no meter	LAYER	String	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1, 2, 3, 5, 6, 7, 9, 31, 40. METR is assigned to 2.	COLOR	Short	4	4	0	Numeric
FType	Feature type. METER is used for service meter	FTYPE	String	8	0	0	
Ref	Holding number given by CCC or CDA	REF	String	10	0	0	
ARef	Plot number is defined in BS sheet	AREF	String	10	0	0	
BRef	Building number within one plot	BREF	String	2	0	0	
CRef	Plot number is combined by ARef and BRef	CREF	String	15	0	0	
Mauza_No	Mauza number is defined by first letter of Thana, last two number of JL number and two letter of sheet number	MAUZA	String	5	0	0	
WARD_NO	Ward Number is defined by Chittagong City Corporation	WARD	String	10	0	0	
Geo_Ref_1	Georeferencing code compiled by Mauza_No and CRef	GEOREF1	String	20	0	0	
Geo_Ref_2	Georeferencing code compiled by WARD_No and Geo_Ref_1	GEOREF2	String	20	0	0	
SF_ID	A record number of surveying database	SF_ID	Short	2	0	0	Number
Account	Account number	Account	String	10	0	0	
Pilotarea	Number ID of pilot project area. Domain of pilot project area is as follows: 1:Khulshi, 2: Chandgaon A, 3: Chandgaon B, 4: Agrabad and 5:Halishahar	Pilotarea	Short	0	4	0	Number

Table 2.5 Data specification of Leakage Point (LEAK)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Point				
OBJECTID	Object ID number	OBJECTID	Short	0	4	0	Numeric
DXF_LAYER	Type of feature: LEAK	LAYER	Text	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1, 2, 3, 5, 6, 7, 9, 31, 40.	COLOR	Short	0	4	0	Numeric

Leak_No	Leakage number		String	4	0	0	
Leak_Con	Condition for leakage		String	20	0	0	
Pipe	Pipe where leakage occurred: SERVICE PIPE or MAIN PIPE						
Pat	Diameter and material of pipe where leak occurred. In case of distribution network prefix "DN" will be added before diameter.	PAT	String	30	0	0	
Ref	Holding number given by CCC or CDA	REF	String	10	0	0	
ARef	Plot number is defined in BS sheet	AREF	String	10	0	0	
BRef	Building number within one plot	BREF	String	2	0	0	
CRef	Plot number is combined by ARef and BRef	CREF	String	15	0	0	
Mauza_No	Mauza number is defined by first letter of Thana, last two number of JL number and two letter of sheet number	MAUZA	String	5	0	0	
WARD_NO	Ward Number is defined by Chittagong City Corporation	WARD	String	10	0	0	
Geo_Ref_1	Georeferencing code compiled by Mauza_No and CRef	GEOREF1	String	20	0	0	
Geo_Ref_2	Georeferencing code compiled by WARD_No and Geo_Ref_1	GEOREF2	String	20	0	0	

Table 2.6 Data specification of other line features (OTHF)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS	Shape	Line				
OBJECTID	Object ID number:	OBJECTID	Short	0	4	0	Numeric
LENGTH	Length of ARC in geometry	LENGTH	Double	19	15	4	Numeric
DXF_LAYER	Type of feature is as follows: BRKPIPE, DTWELL, GENERAL, KUTCHBLD, PLOTBDY, ROAD, SPUCABLD and STWELL	LAYER	String	31	0	0	
DXF_COLOR	Color of feature defined by the WB project as follows: -2, 1,2,3,5,6,7,9,31 and 40	COLOR	Short	0	4	0	Numeric
Mauza_No	Mauza number is defined by first letter of Thana, last two number of JL number and two letter of sheet number	MAUZA	String	5	0	0	
WARD_NO	Ward Number is defined by Chittagong City Corporation	WARD	String	10	0	0	

Table 2.7 Data specification of Map Annotation (ANNO)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Point				
OBJECTID	Object ID number:	OBJECTID	Short	0	4	0	Numeric
DXF_LAYER	Type of feature: GENERAL,NOTES, PIPEATT, PLOTTEXT, ROADTEXT, SERVPLOT	LAYER	String	31	0	0	
DXF_COLOR	Color of feature defined by the WB project arranged by -2, 1,2,3,5,6,7,9,31,40	COLOR	Short	4	4	0	Numeric
DXF_TEXT	Annotation of feature	TEXT	String	40	0	0	
DXF_ANGLE	Rotation angle required for adjustment with features	ANGLE	Float	0	0	0	Numeric
MapSheet	Name of Drawing name was defined by the WB project based on combination of thana name and Mauza number	MAPSHEET	String	10	0	0	
Mauza_No	Mauza number is defined by first letter of Thana, last two number of JL number and two letter of sheet number	MAUZA	String	15	0	0	
WARD_NO	Ward Number is defined by Chittagong City Corporation	WARD	String	10	0	0	

Table 2.8 Data specification of Wells (WELL)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Point				
OBJECTID	Object ID number:	OBJECTID	Short	0	4	0	Numeric
DXF_LAYER	Type of feature: DTWELL, STWELL	LAYER	String	31	0	0	
DXF_COLOR	Color of feature is defined by the WB project as follows: -2, 1, 2, 3, 5, 6, 7, 9, 31 and 40. Color 2 assigned for tube well.	COLOR	Short	0	4	0	Numeric
Ref	Holding number given by CCC or CDA	REF	String	10	0	0	
ARef	Plot number is defined in BS sheet	AREF	String	10	0	0	
BRef	Building number within one plot	BREF	String	2	0	0	
CRef	Plot number is combined by ARef and BRef	CREF	String	15	0	0	
Mauza_No	Mauza number is defined by first letter of Thana, last two number of JL number and two letter of sheet number	MAUZA	String	5	0	0	
WARD_NO	Ward Number is defined by Chittagong City Corporation	WARD	String	10	0	0	
Geo_Ref_1	Georeferencing code compiled by Mauza_No and CRef	GEOREF1	String	20	0	0	
Geo_Ref_2	Georeferencing code compiled by WARD_No and Geo_Ref_1	GEOREF2	String	20	0	0	

Comment	Additional information about Tube well	Comment	String	32	0	0	
Pump_Name	Pump name	Pump_Name	String	50	0	0	
Sketch	Hyperlink to Site Observation Sheet indicating tube well locations and adjoining pipes	Sketch	String	50	0	0	

Progress and Achievement:

GIS dataset preparation has been finished in Pilot Project.

3. Operation and technical instructions on Mapping and GIS in Model Area

3.1 Hyperlinking Spot Pictures and Intersection Sketches to GPS Point Database

Network survey engineers collected GPS data in about 3,300 locations. While collecting GPS data, they took picture of that spot so that later they can identify that location. After submitting that picture with GPS data to GIS section, all pictures are renamed based on GPS observation point number. Sometimes they took two or more pictures in a spot. For that reason GIS section inserts "P1" for first picture and "P2" for second picture before GPS observation point number. After renaming picture, next step is to link that picture to GPS data base. Network survey engineer also made sketches of intersections which showed all main pipe lines on that location.

Progress and Achievement:

Hyperlinking of spot pictures and intersection sketches completed.

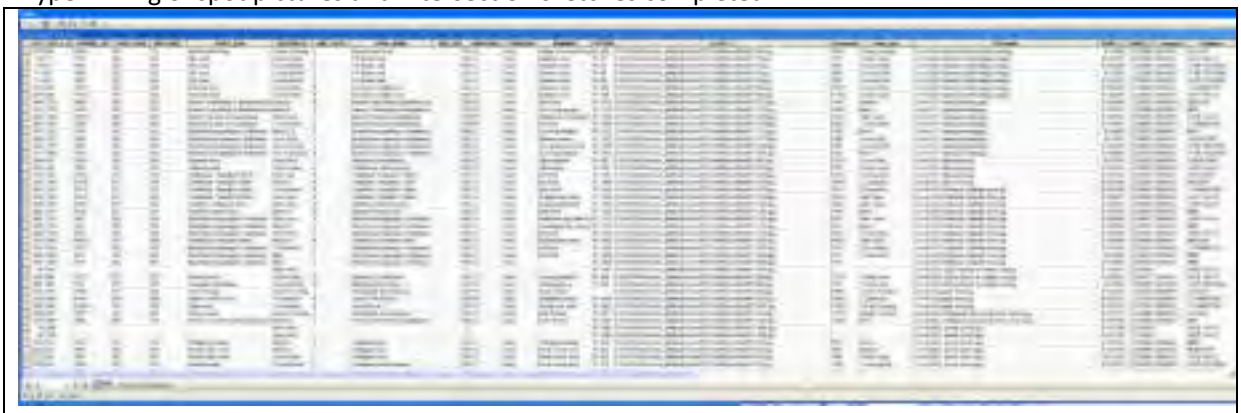


Figure 3.1: Database showing hyperlink of spot pictures and intersection sketches

3.2 Manual Adjustment of Underground Utility Network

One of the major concerns in CWASA CAD drawings is to indicate only water supply network, no other utility network. For repairing or replacement of water pipes excavation is mandatory. During excavation work, major issue is identifying location of other utility network so that excavation may not affect or destroy other network. Focusing on this issue, drawing of utility network such as gas, telephone and electricity were collected from concerned agency. After collection it was observed that, there was no coordinate system appeared and drawn not to scale. Again road shape and alignment missing in many drawings and not matching with present alignment if present. For those reasons, last year subcontract was given to local contractor for digitization and geo-referencing of underground utility maps. Subcontractor has submitted geo-reference file as text file which indicate boundary of that drawing. For matching with present road alignment, manual updating has become mandatory.

Progress and Achievement:

Manual adjustment of all utility networks in Pilot Project Area and Zone – 3 of Model Area completed.

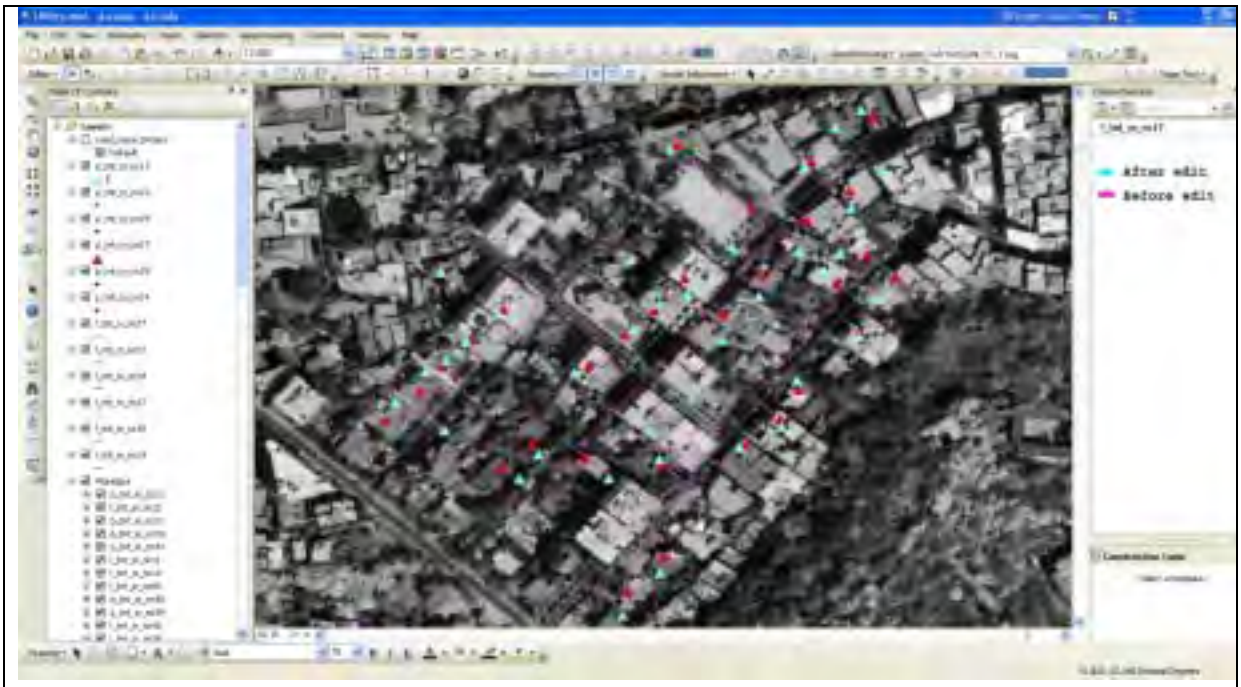


Figure 3.2: Manual adjustment of telephone network

3.3 Preparation of Database for Underground Utility Network

GIS team has also prepared database for underground utility network. Table 3.1 and Table 3.2 indicate database structure of underground utility.

Table 3.1: Data specification of Underground Utility Network (Line Feature)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Line				
OBJECTID	Object ID number:	OBJECTID	Short	0	4	0	Numeric
LENGTH	Length of ARC in geometry	LENGTH	Double	19	15	4	Numeric
Layer	Utility: Gas Line, Telecom Line	Layer	String	50	0	0	
Type	Type of utility line: 4 bar, 10 bar etc.	Type	String	50	0	0	
Name	Name of utility line	Name	String	50	0	0	
Capacity	Capacity of utility line	Capacity	String	50	0	0	
Material	Material of utility line	Material	String	50	0	0	
Diameter	Diameter of utility line	Diameter	String	50	0	0	
Status	Status of utility line	Status	String	50	0	0	
Note	Remarks about utility line	Note	String	50	0	0	

Table 3.2: Data specification of Underground Utility Network (Point Feature)

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Line				
OBJECTID	Object ID number:	OBJECTID	Short	0	4	0	Numeric
Layer	Facility: Valve, Reducer, DP etc.	Layer	String	50	0	0	
Type	Type of facility: pole, wall etc.	Type	String	50	0	0	
Name	Name of facility	Name	String	50	0	0	
Capacity	Capacity of facility	Capacity	String	50	0	0	
Route_Name	Route name	Route_Name	String	50	0	0	
Note	Remarks about utility line	Note	String	50	0	0	

3.4 Preparing Cross Section, Top View etc. of Test Pit Location in Zone – 3

Last year underground utility survey team have conducted test pit excavation of 40 locations in Zone – 3 of Model area to identify exact location of water pipes including other utility such as gas pipe and telephone network. While carrying out test pit excavation, they had prepared free hand sketch of cross section, top view and cross section of pavement. But due to time constraints, they could not prepare top view and cross section of pavement in test pit location in AutoCAD. This year GIS team prepared those drawings in AutoCAD 2009.

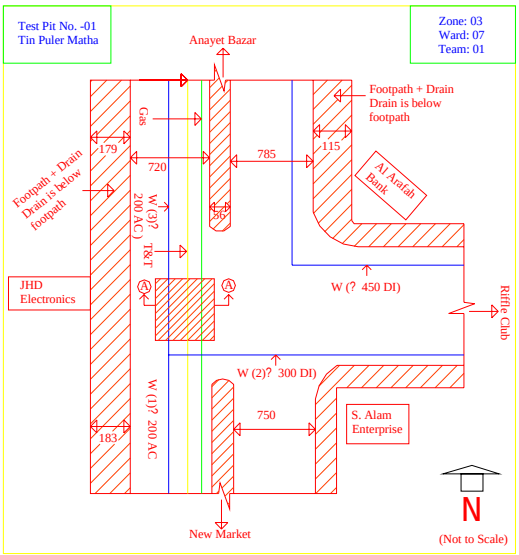


Figure 3.3: Sample top view of test pit location

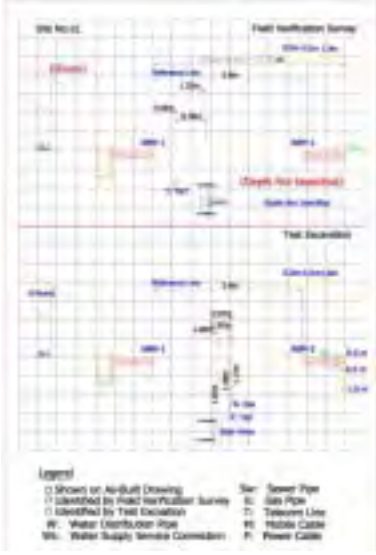


Figure 3.4: Sample cross section of test pit location

Progress and Achievement:

Top view and pavement cross section of all test pit locations completed.

Table 4.3: List and description of sub holders of Test Pit

Main Holder	Sub Holder1	Sub holder2	
Test Pit	Finding		PDF file about Summary of Findings from Test Pit Excavation at site
	Location Map		PDF file about location map at site
	Pavement Chart		PNG file about Pavement chart: Cross section of bedding layers at site
	Reason		PDF file about original sketch drawing about Site Observation Sheet-2
	Shape		Test_pit_Location.shp Intersection_Name.shp
	Test Pit Cross Section		PDF file and JPG file about Test Pit Cross Section at site
	Test Pit Picture	Measurement	PDF file about pictures at site
		Operation	PDF file about pictures in Excavation at site
	Test Pit Top View		PDF file and PNG file about Test Pit Top View
	Title Page		PDF files about Click Title to See Details of Test Pit Site Number
			Data Sheet.xls Summary sheet.xls Test Pit Excavation Information.xls

Table 4.4: Database Structure of Test Pit

Name	Definition of Field	Alias	Type	Length	Precision	Scale	Number Format
FID	Internal Id of ARCGIS managing database record in GIS data: Predefined field in ARCGIS:	FID	Object ID	4	0	0	
Shape	Feature type of geometry in shape file: Predefined field in ARCGIS		Point				
OBJECTID	Object ID number:	OBJECTID	Short	0	4	0	Numeric
Detail	Hyperlink title page of test pit	Detail	String	200	0	0	
Obs_Sheet	Hyperlink Site Observation Sheet – 2 (reason)	Obs_Sheet	String	150	0	0	
Conflict	Hyperlink test pit excavation information	Conflict	String	150	0	0	
Operation	Hyperlink photo of operation	Operation	String	150	0	0	
Measure	Hyperlink photo of measurement	Measure	String	150	0	0	
Top_View	Hyperlink top view of excavated site	Top_View	String	150	0	0	
Cross_Sec	Hyperlink cross section of excavated site – before and after excation	Cross_Sec	String	150	0	0	
Pavement	Hyperlink pavement chart of excavated site	Pavement	String	150	0	0	
Findings	Hyperlink to result of excavated site	Findings	String	150	0	0	
Summary	Hyperlink summary of excavation	Summary	String	150	0	0	
Mauza_No	Mauza number is defined by first letter of Thana, last two number of JL number and two letter of sheet number	MAUZA	String	5	0	0	
WARD_NO	Ward Number is defined by Chittagong City Corporation	WARD	String	10	0	0	

Pit_No	Test pit number compiled by Zone and test pit number	Pit_No	String	10	0	0	

3.5 Updating of Consumer's Information in Zone – 3

Last year field survey team collected consumers information in Zone – 3 of Model area. Survey ?team submitted all data to GIS group for encoding and updating of service connection. Last year GIS team encoded all data in Microsoft Access 2010. After encoding it was found that there were some irregularities available such as no account number, meter information missing, duplicate account number in two accounts etc. This year GIS team marked all those anomalies and handed over that data to field survey team for rectification.

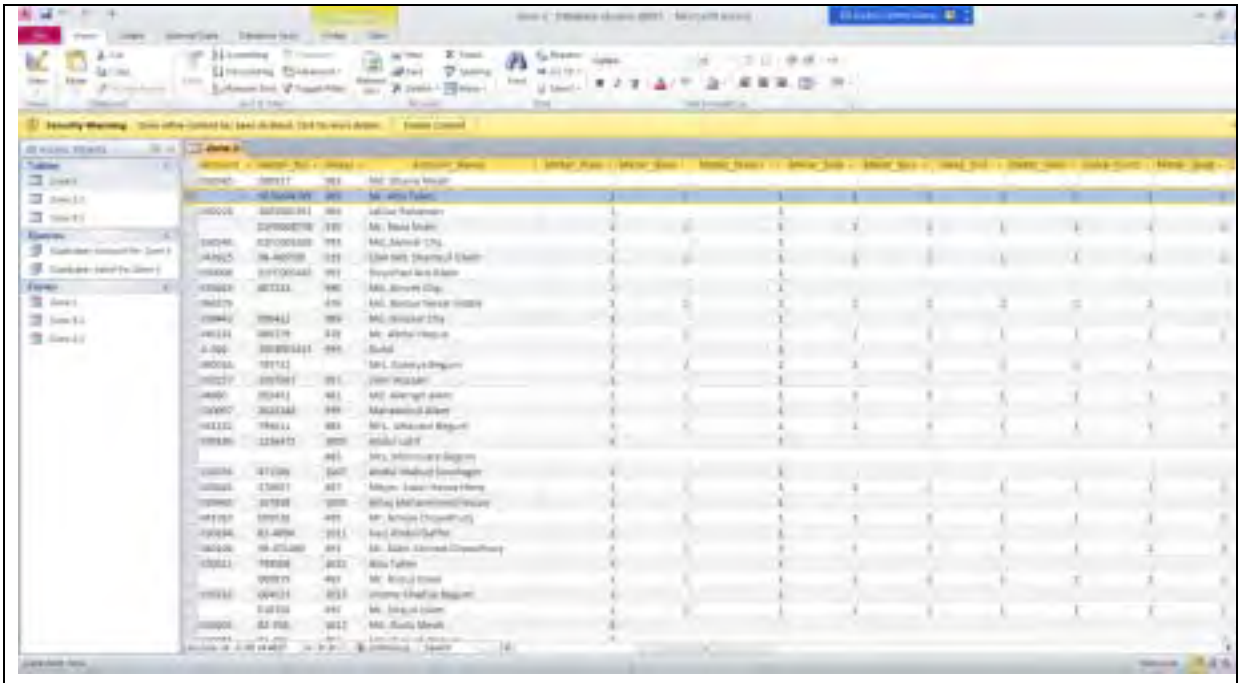


Figure 3.5: Missing information in field survey data

Progress and Achievement:

Encoding of consumer information in Zone – 1 is ongoing.

3.6 Preparing Sub Zone in Zone – 3 for Meter Replacement

For the purpose of meter replacement, network survey team demarcate sub zone in Zone – 3 of Model Area. Field survey team will collect all consumers' information in each sub zone and start meter reading immediately. While carrying out meter replacement in one sub zone, other field survey team will collect consumer information in another sub zone. GIS has prepared sub zone map which has been checked by network survey team.

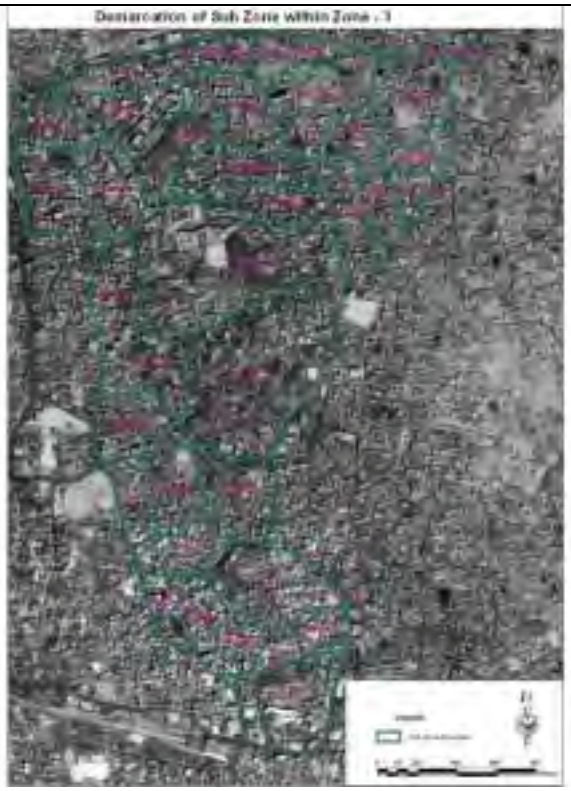


Figure 3.6: Demarcation of sub zone within Zone – 3

Progress and Achievement:

Preparation of sub zone map in Zone - 3 completed.

3.7 Segregate Account Number in Each Sub Zone of Zone – 3

For the purpose of meter replacement, network survey team demarcate sub zone in Zone – 3 of Model Area. Field survey team will collect all consumers' information in each sub zone and start meter replacement immediately. While carrying out meter replacement in one sub zone, other field survey team will collect consumer information in another sub zone. GIS team has segregated account number in sub zone and handed over to network survey team. GIS team has also prepared meter replacement map for each sub zone of Zone – 3.

Progress and Achievement:

Preparation of account number list in each sub zone is completed.

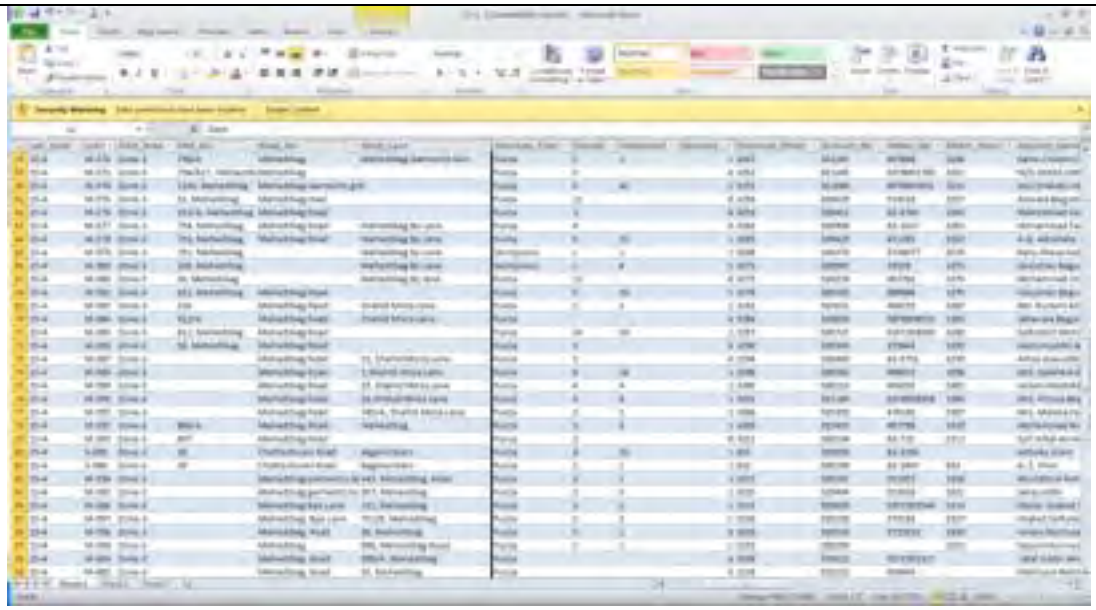


Figure 3.7: Account number in sub zone – 15-4

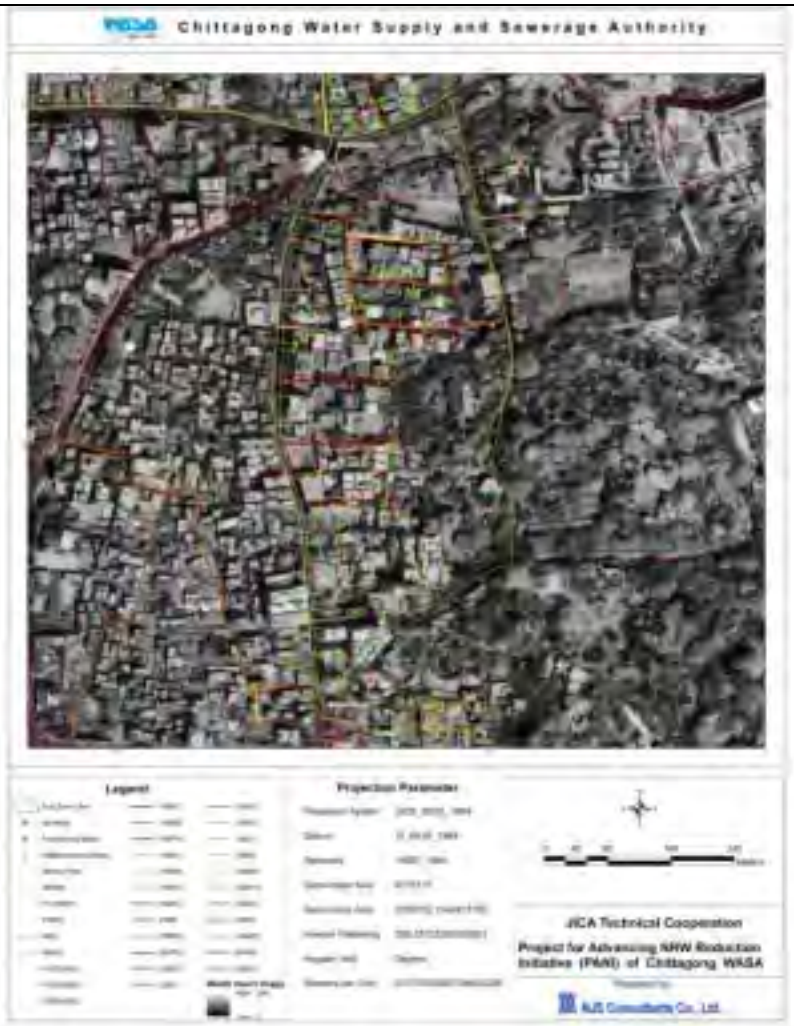


Figure 3.8: Meter replacement map in sub zone – 15-4

3.8 Preparation of Base Map for Field Survey in Zone – 1

After adjustment of CWASA CAD drawing with World View1 image, it was required to update and prepare GIS dataset. GIS team was prepared base map for field survey in order to update service connection and main pipes with attributes. Base map indicating only main pipes, road names etc. For encoding consumer information another survey form was given to field survey team.

Progress and Achievement:

Preparation of base map for field survey has been finished for all Pilot Project Areas and Zone – 1 of Model Area.

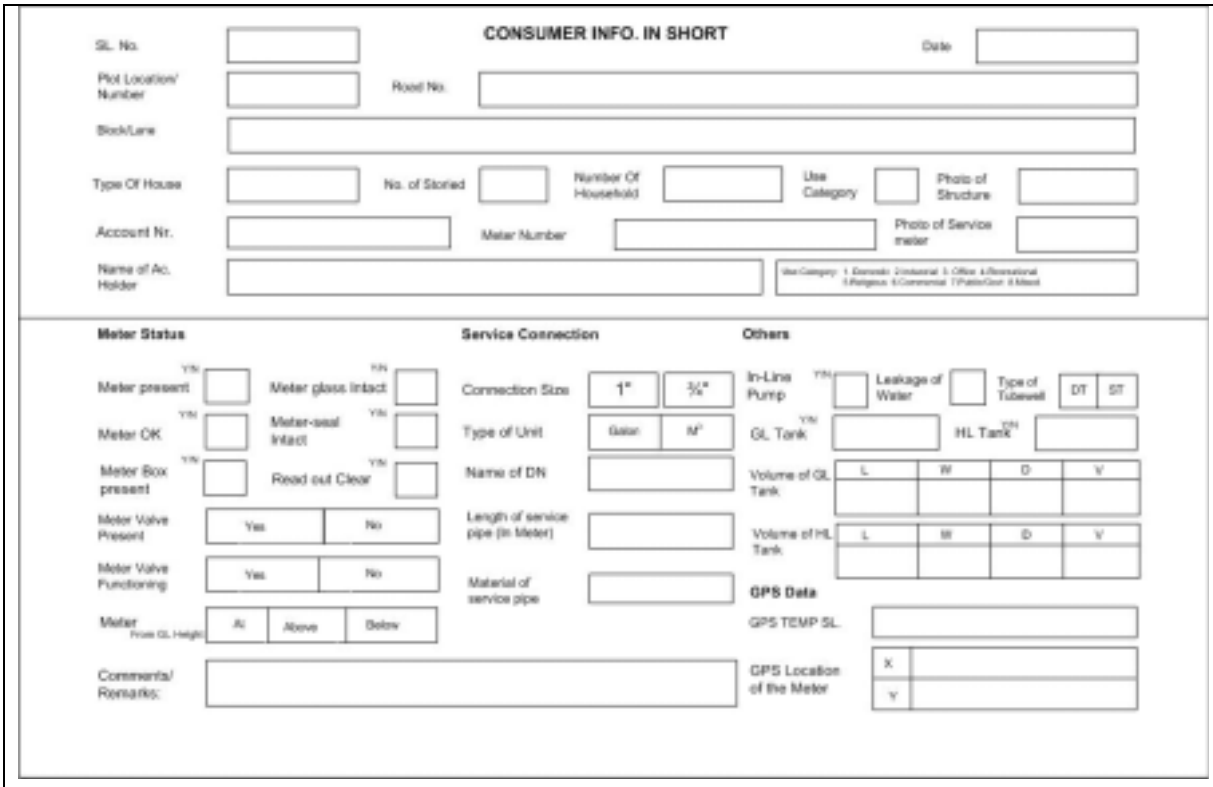


Figure 3.9: Field Survey Form for service connection survey

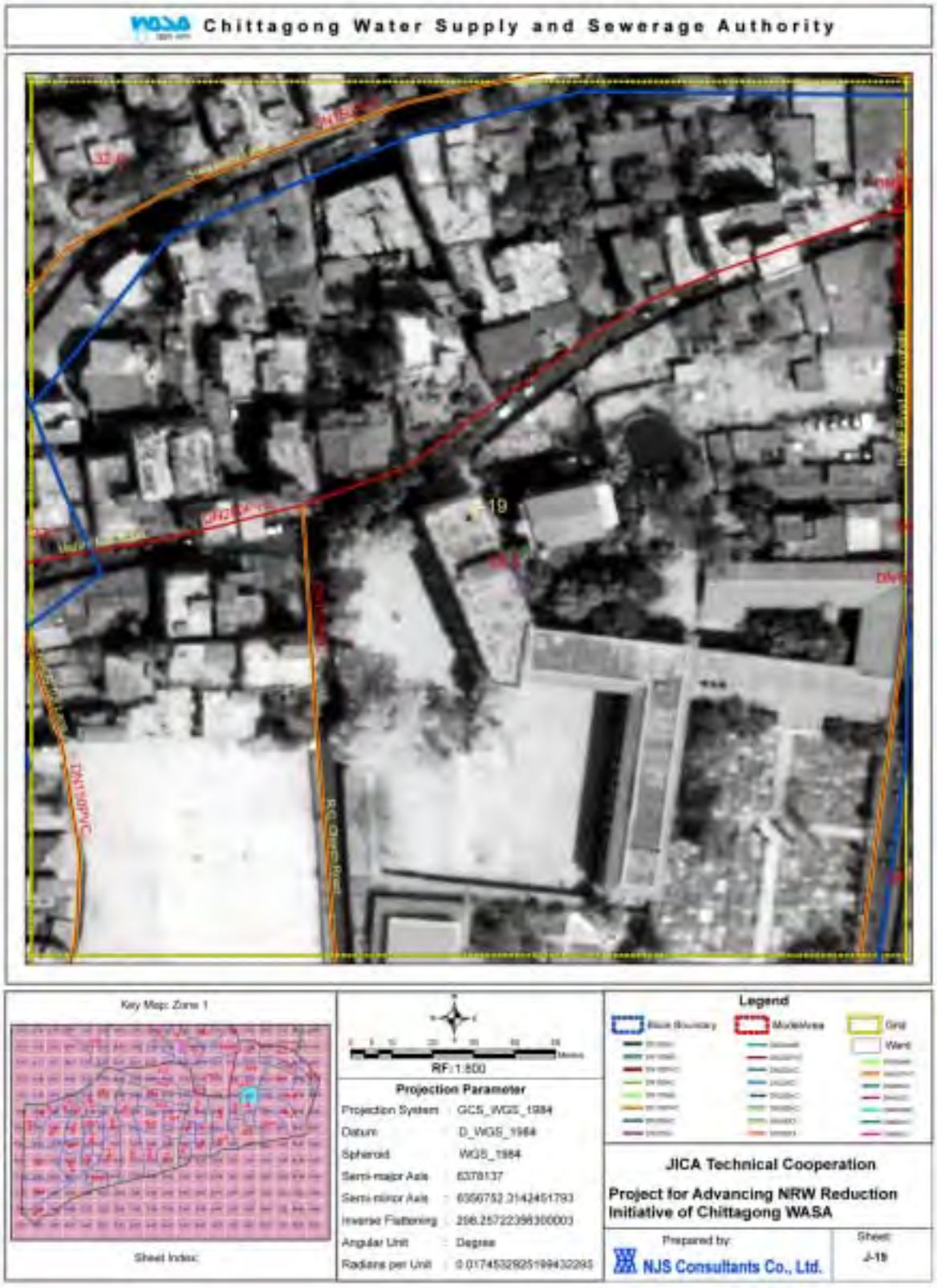


Figure 3.10: Base Map for Field Survey in Zone – 1

3.9 Encoding of Field Survey Data of Zone – 1

At the end of the day each service connection survey team gave data to GIS team for encoding and updating. Data entry form was prepared in Microsoft Access for encoding field data. After encoded data in Microsoft Access, cross checking of those information was done with customer data in computer section. If any miss matching was found, that information given to field survey team for checking. Field survey team was taken two pictures for each service connection; one for meter and another for structure. Those pictures number were also encoded in field survey database.

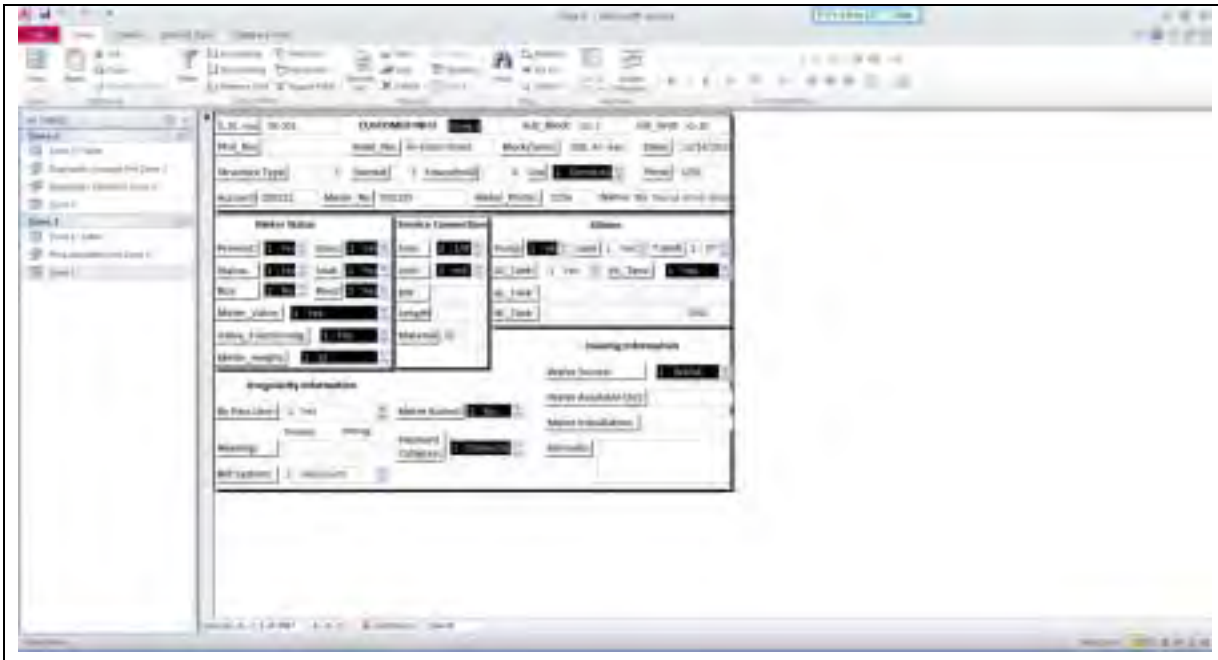


Figure 3.11: Field data entry form for Zone – 1

Progress and Achievement:

1800 consumers information have been encoded in Zone – 1.

3.10 Preparation of Conflict Map

After drawing pipe network from GPS survey points, GIS team identified some areas where pipe attribute in CWASA as built drawing and CAD drawing differs with field verification survey. GIS team prepared drawing for those areas showing all pipe line with attribute and handed over to field survey team for verification.

Figure 3.12: Conflict identification map

3.11 Preparation of Map of Proposed Sites for Test Pit Excavation

Last year, PANI team conducted excavation work in 41 locations of Zone – 3 in order to identify exact location of utility network. Locations were selected on that places where as built drawing of CWASA, CAD drawing which prepared by World Bank financed project and opinion of CWASA plumber are different. This year JICA had carried out same activity in Zone – 1 of Model area. For this purpose, GIS team had prepared map of possible locations for excavation in consultation with field survey team.

Figure 3.13: Proposed sites for test pit excavation in Zone – 1

3.12 Encoding of Consumer Service Connection Completion Report

During applying for new connection each consumer has to fill up some forms indicating address with holding number, mouza sheet name, Jurisdiction Line (JL) number, plot number, Thana etc. which is basic information for identification of consumer. After completion of connection, Sales Division of CWASA prepared one report for each connection which is named as Consumer Service Connection Completion Report (CSCCR). That report consist of one sheet for consumer information with account number, one sketch indicating service connection from main pipe with structures and copy of mouza sheet with marking the connection plot. The Consumer Service Connection Completion Report (CSCCR) is key information for managing house connection and customer service from point of view on Facility Management in CWASA. However the report is still managed by analog media in paper. The report is required to update existing CWASA GIS dataset since the end of the 1990's until the present. The report is being required to modernize the management of the information in the report from paper to digital which is relating to preparation of archived document for map updating in asset management. The PANI project is highly demanded to CWASA to start the archive development and database entry. Encoding of CSCCR form and scanning of service connection sketches were continuing this year.

Progress and Achievement:

So far 22,000 CSCCR form encoded in database and same number of sketches are scanned and attached in the database as hyperlink.

3.13 Preparation of Reading Inspector (RI) Code Map

At present CWASA sub divided its service area based on Mahallah and inspectors is responsible for collecting meter reading on specific area. But there is no mahallah map available in CWASA or in other organizations. CWASA also deployed inspectors solely for collecting meter reading of connections in government offices. PANI team is planning to reorganize meter inspectors area based on ward which has specific boundary and its map is widely available in different organizations. In order to do so, preparation of map of existing meter inspector's jurisdiction is required. So far GIS team has prepared RI code map for Zone – 3 of Model Area based on account survey and by querying that accounts RI code from billing section database.

Figure 3.14: RI code of Meter Inspector in Zone – 3

3.14 Preparation of Deep Tube Well (DTW) Map

CWASA is extracting major portion of supplied water from Deep Tube Wells (DTW). At present total 89 deep tube wells is functioning but there is no GIS based map and database is available which indicate their locations and production history. PANI team is intended to prepare maps and database of all existing water sources of CWASA. As a result of that PANI leakage survey team has surveyed 50 deep tube wells thorough GPS which indicate their locations and also setting up flow meter to identify production capacity of those well.

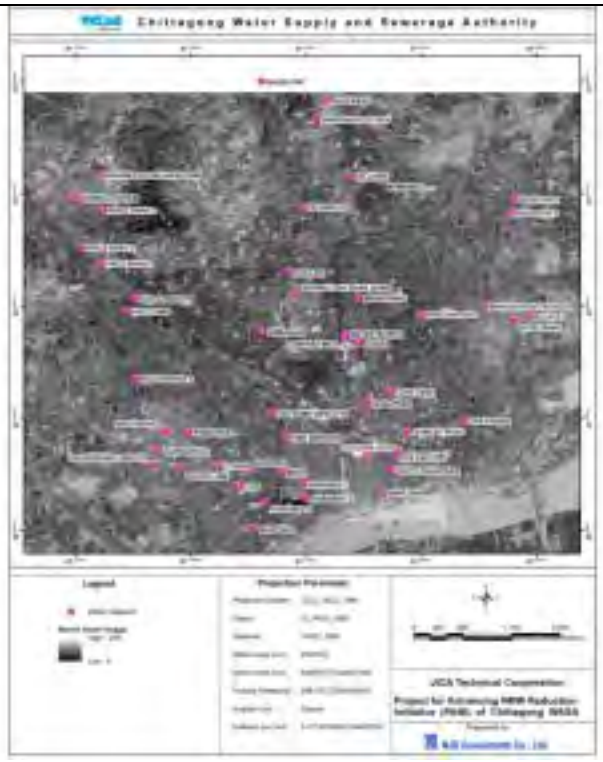


Figure 3.15: Map indicating DTW locations

3.15 Training Support to Counterpart Staff

CWASA doesn't have efficient personnel for handling GIS operation. A major objective of PANI project is to arrange OJT for CWASA persons especially in GIS. JICA GIS Expert is assisted in preparation of operation manual and providing training on basic GIS operations to counterpart staff. Training support is providing to counterpart staff of NRW management team.

Progress and Achievement:

Providing training on Road Map – 5 (Calculating Monthly Consumption in Zone – 3 of Model Area).

4. Support Service to Karnaphuli Water Supply Project (KWSP) of CWASA

Karnaphuli Project is one of the JICA ODA Loan project to CWASA. Based on the instruction given by the

JICA, PANI GIS team provided mapping support to Karnaphuli Water Supply Project. First of all proposed transmission and distribution network drawings have been geo-referenced based on high resolution satellite image of PANI. This has been done in order to check conflicts between existing and proposed pipes.

C-2 components of KWSP which consists of construction of new transmission and distribution network required topographic survey in order to identify ground level. For that reason GIS team of PANI prepared Bench Mark (BM) map of Chittagong Development Authority which indicate Reduced Level (RL) of that point. Later they will identify those BM on the field and will use as reference point.

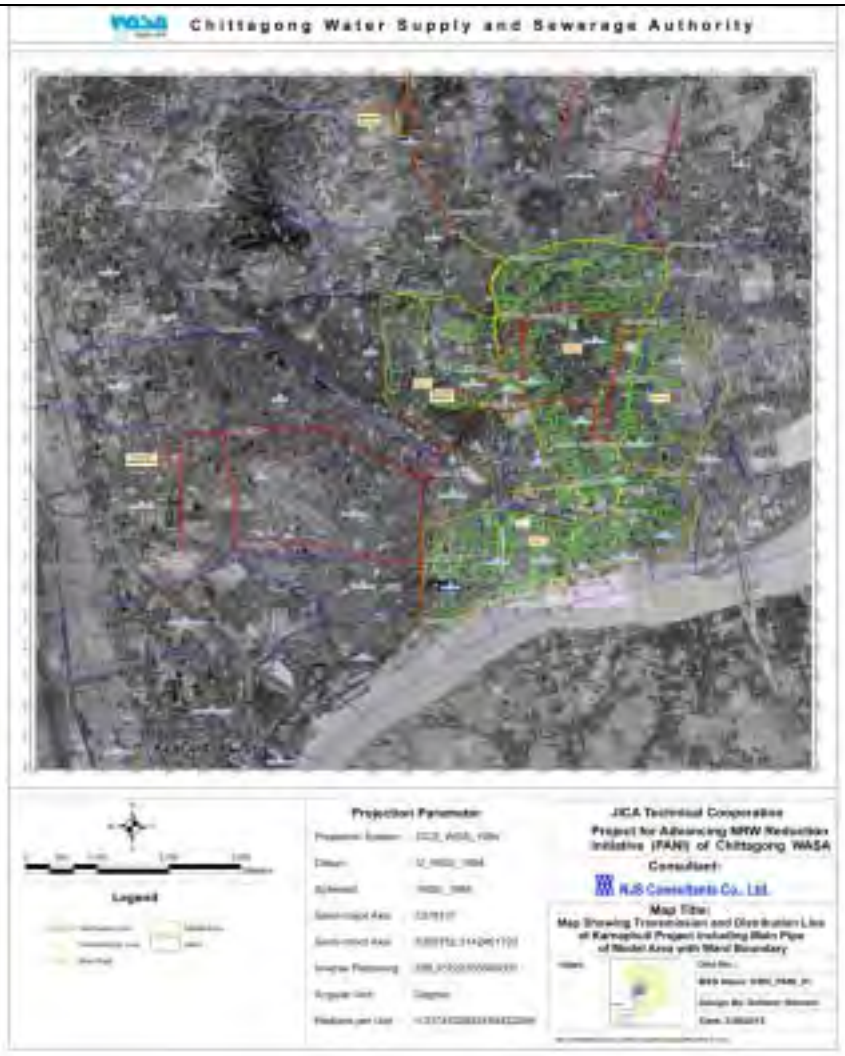


Figure 4.1: Map showing proposed transmission and distribution network of Karnaphuli Project with main pipe in Model Area of PANI

5. GIS Output

Following GIS output has been prepared for Pilot Project Area and Model Area

SL No.	Title		Area
1.	Field Verification Data		Pilot Area
	1.1	Field Verification Data of Khulshi Area	
	1.2	Field Verification Data of Chandgaon A Area	
	1.3	Field Verification Data of Chandgaon B Area	
	1.4	Field Verification Data of Agrabad Area	
	1.5	Field Verification Data of Halishahar Area	
2.	Asset Map of GIS Dataset		Pilot Area
	2.1	Asset Map of GIS Dataset for Khulshi Area	
	2.2	Asset Map of GIS Dataset for Chandgaon A Area	
	2.3	Asset Map of GIS Dataset for Chandgaon B Area	
	2.4	Asset Map of GIS Dataset for Agrabad Area	
	2.5	Asset Map of GIS Dataset for Halishahar Area	
3.	Asset Map of GIS Dataset on Satellite Image		Pilot Area
	3.1	Asset Map of GIS Dataset for Khulshi Area on Satellite Image	
	3.2	Asset Map of GIS Dataset for Chandgaon A Area on Satellite Image	
	3.3	Asset Map of GIS Dataset for Chandgaon B Area on Satellite Image	
	3.4	Asset Map of GIS Dataset for Agrabad Area on Satellite Image	
	3.5	Asset Map of GIS Dataset for Halishahar Area on Satellite Image	
4.	Monthly Consumption Data		Pilot Area
	4.1	Monthly Consumption Data of Khulshi Area	
	4.2	Monthly Consumption Data of Chandgaon A Area	
	4.3	Monthly Consumption Data of Chandgaon B Area	
	4.4	Monthly Consumption Data of Agrabad Area	
	4.5	Monthly Consumption Data of Halishahar Area	
5.	Monthly Billing Data		Pilot Area
	5.1	Monthly Billing Data of Khulshi Area	
	5.2	Monthly Billing Data of Chandgaon A Area	
	5.3	Monthly Billing Data of Chandgaon B Area	
	5.4	Monthly Billing Data of Agrabad Area	
	5.5	Monthly Billing Data of Halishahar Area	
6.	Map to Demonstrate Time Series of Water Consumption		Pilot Area
	6.1	Map to Demonstrate Time Series of Water Consumption in Khulshi Area	
	6.2	Map to Demonstrate Time Series of Water Consumption in Chandgaon A Area	
	6.3	Map to Demonstrate Time Series of Water Consumption in Chandgaon B Area	
	6.4	Map to Demonstrate Time Series of Water Consumption in Agrabad Area	
	6.5	Map to Demonstrate Time Series of Water Consumption in Halishahar Area	
7.	Map to Demonstrate Time Series of Monthly Billing		Pilot Area
	7.1	Map to Demonstrate Time Series of Monthly Billing in Khulshi Area	
	7.2	Map to Demonstrate Time Series of Monthly Billing in Chandgaon A Area	
	7.3	Map to Demonstrate Time Series of Monthly Billing in Chandgaon B Area	
	7.4	Map to Demonstrate Time Series of Monthly Billing in Agrabad Area	
	7.5	Map to Demonstrate Time Series of Monthly Billing in Halishahar Area	

SL No.	Title		Area
8.	Underground Utility Map on Satellite Image		Pilot Area
	8.1	Underground Utility Map of Khulshi on Satellite Image	
	8.2	Underground Utility Map of Chandgaon A on Satellite Image	
	8.3	Underground Utility Map of Chandgaon B on Satellite Image	
	8.4	Underground Utility Map of Agrabad on Satellite Image	
	8.5	Underground Utility Map of Halishahar on Satellite Image	
9.	Leakage Map		Pilot Area
	9.1	Leakage Map of Khulshi Area	
	9.2	Leakage Map of Chandgaon A Area	
10.	Field Verification Data		Model Area
	10.1	Field Verification Data of Zone – 3	
	10.2	Field Verification Data of Zone – 1	
11.	Asset Map of GIS Dataset		Model Area
	11.1	Asset Map of GIS Dataset for Zone – 3	
	11.2	Asset Map of GIS Dataset for Zone – 1	
12.	Monthly Consumption Data of Zone – 3		Model Area
13.	Monthly Billing Data of Zone – 3		Model Area

Annex 1 Manual for Updating GIS Dataset from Field Verification Data

1. Background

CWASA has prepared CAD drawings of distribution network in the middle of 1990's. CWASA has never updated those CAD drawings after initial preparation due to lack of efficient manpower. There were no database on those drawings and unique co-ordinate system were used which never match with other co-ordinate system. Co-ordinate transformation, preparation of database and updating works is mandatory for preparing GIS datasets.

2. Objective

Objective of updating works is to verify and confirm attributes and location of pipes and wells, status of meters and drawing of other mapping features such as structures, roads, plot boundary etc.

3. Methodology

There are several steps required for updating works:

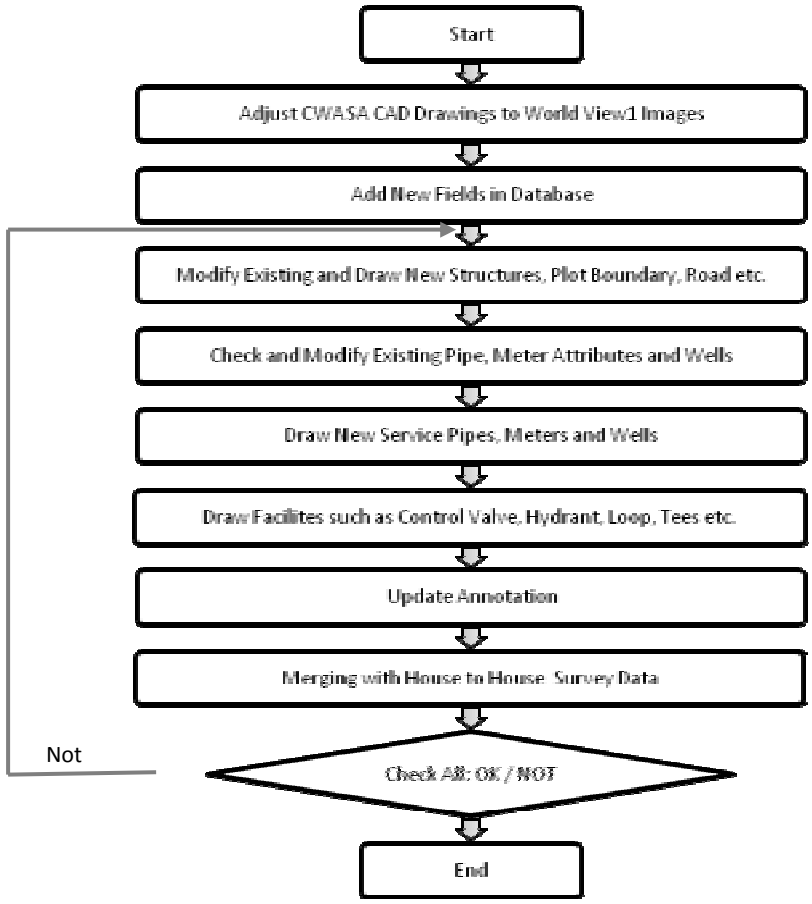
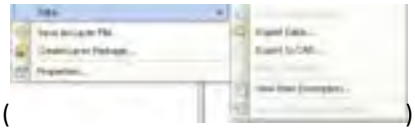
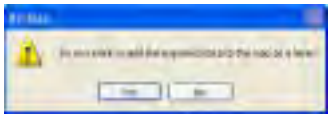
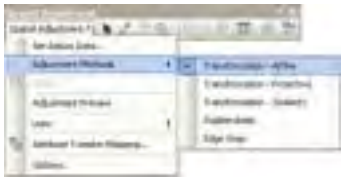
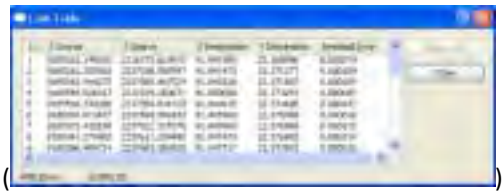


Figure 1.1: Methodology of updating GIS dataset from field survey

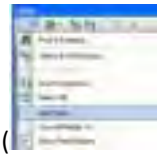
4. GIS Operation

4.1 Adjust CWASA CAD Drawing to World View1 Images

As unique geographic coordinate in initial CWASA CAD dataset, never match with other GIS datasets in Chittagong Development Authority (CDA) and Survey of Bangladesh (SOB). PANI project introduced a new image datasets of World View1 corresponding to WGS84 and BTM which objective was to shift coordinate system from CWASA to a standard coordinate system in Bangladesh. For adjustment with World View1 images you have to add record drawing from personal geodatabase and World View1 images from hard drive by clicking "Add Data"() in ARCGIS. Then right click on record drawing in "Table of Content" window of ARCGIS and select "Data" and select "Export Data" () to convert from personal geodatabase to shape file. "Export Data" window will appear (), give file same as record drawing name and click "OK". Click "Yes' when prompted (when  will appear). New shape file will appear on the Table of Content window having same name as previous one. Right click on record drawing in "Table of Content" window and select "Remove" (). "Spatial Adjustment" () and "Editor" () toolbars have to be added to ARCGIS by right clicking on "Menu" bar and then selecting required toolbars. Click on "Editor" in "Editing" toolbar and select "Start Editing". Components of "Editing" toolbar will be activated. Click on "Spatial Adjustment" from "Spatial Adjustment" toolbar and select "Set Adjusted Data". "Choose Input for Adjustment" window () will appear, select "All features in this layer" and click "OK". Check "Transformation-Affine" is selected or not by clicking "Spatial Adjustment" and then on "Adjustment Method" (). If it is not selected then select "Transformation-Affine". Click "New Displacement Link" () button and select point (called control point) from shape file which can be identifiable in World View1 image and then select that point in World View1 image. Select 5-10 control points (evenly distributed in shape file) in similar way and locate that point in World View1 image. Click "View Link Table" button from "Spatial Adjustment" toolbar. "Link Table" window

() will appear showing residual error of each point. If any point has bigger residual errors delete that point and select another control point. After selecting all points close "Link Table" window and select "Spatial Adjustment" from "Spatial Adjustment" toolbar and then select "Adjust". Shape file will be overlaid on World View1 image. Sometimes it will be found that shape file matches very well with images except some portion. In that case after initial adjustment, select () that portion and adjust again by following same procedure. While adjusting some part within a shape file select "Selected Features" in "Choose Input for Adjustment" window. Save all link file by selecting "Save Link File" from "Link" under "Spatial Adjustment" menu in "Spatial Adjustment" toolbar. Use those link file for adjusting point and annotation feature by selecting "Open Link Table" from "Link" option in "Spatial Adjustment" menu. Click "Editor" in "Editor" window and click "Save Edits" and then "Stop Edits". Now, shape file is ready for preparation of database and updating of features.

4.2 Add New Fields in Database

While exporting from personal geodatabase to shape file all layers in CAD drawing convert to individual field in shape file. Right click on shape file in "Table of Content" window and select "Open Attribute Table". Table window will open showing all fields. Click on "Table Option" () and select "Add Field". "Add Field" window () will appear. Write down field name, select type and precision or length on that window. Similarly add all fields required for updating features. All fields name with their attributes are given in Database Structure Chapter.

4.3 Modify Existing and Draw New Structures, Plot Boundaries and Roads etc.

Click on "Editor" in "Editor" toolbar and then select "Start Editing" for updating of features. Right click on menu bar and select "Snapping" toolbar. Click on "Snapping" () and select "Use Snapping". First check in field survey map whether that structure is pucca or semi pucca or kutcha. If the structure is pucca then click on shape file name and then select rectangle from "Construction Tools" window (). Click on one corner of structure in image and then click on next corner and then next corner of structure.

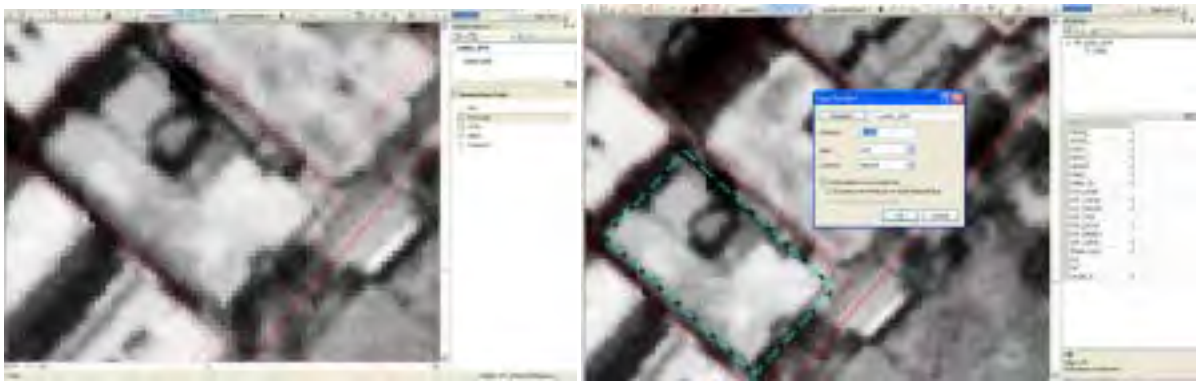


Figure 1.2: Methodology of drawing pucca structure

Click on “Editor” in “Editor” toolbar and then select “Copy Parallel”. “Copy Parallel” window will open, write 0.5 in distance field and select “Left” from “Side” field and click “OK”. Click on  deselect button on “Tool” toolbar and then click on  select button and select newly created both rectangle on view window. Click “Editor” in “Editor” window and select “Merge”. Both rectangles will treat as one object in GIS and will look like  . Then fill up all blank fields on “Attributes” window. By this way draw all pucca structures within that Pilot Project Area. For semi pucca structure, draw first rectangle as did for pucca structure then select “line” from “Construction Tools” window and join two opposite corner of rectangle. Select  rectangle and both diagonal line and merge them. Rectangle and line will treat as one object and will look like  . Then fill up all blank fields on “Attributes” window. Similarly draw all semi pucca structure on that area. For kutcha structure, draw first rectangle as did for pucca structure and then draw a line in the center of the rectangle which is parallel to the longer arm and length will be half of longer arm. Then draw line to join end of that line to the corner of the rectangle. Select  all line and rectangle and merged them as did before. Kutcha structure will look like  . Then fill up all blank fields on “Attributes” window. For roads, draw line at the both edge of the road.

4.4 Check and Modify Existing Pipe, Meter Attributes and Wells

Double click on shape file name in “Table of Content” window or click right mouse on shape file name and select “Properties”. “Layer Properties” window will appear having many tab options. Click on “Symbology” tab and then click on “Categories”. Select “DXF_LAYER” from drop down arrow in “Value Field” and select “Add All Values”. All fields’ value in DXF_LAYER will become visible with symbol. Double click on symbol of MAINPIPE, “Symbol Selector” will come into view. Choose one symbol for MAINPIPE on that window and click “OK”. This is usually done to differentiate that feature from others. Do same for PNET and SERVPIPE.

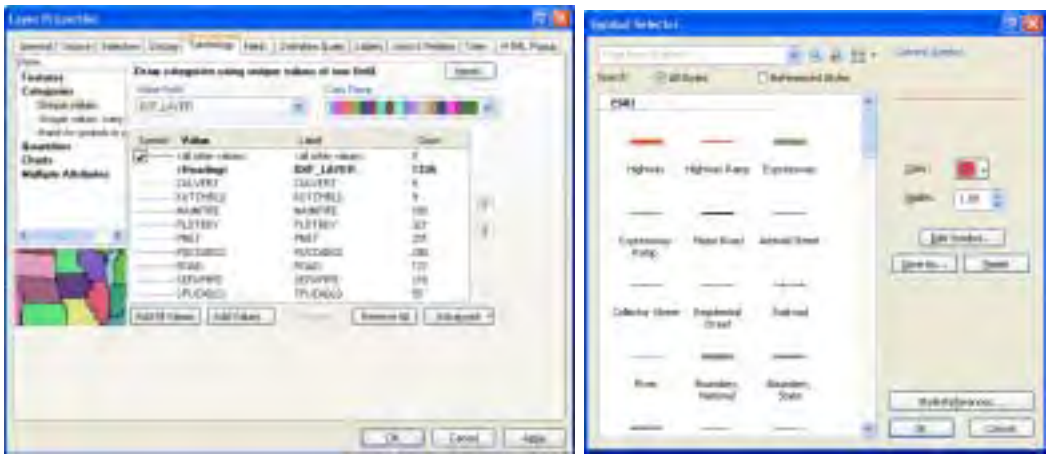


Figure 1.3: Layer Properties and Symbol Selector window

Select one existing PNET and click on "Attributes" icon ( ) in "Editor" toolbar. Attributes window will appear on right side of view window. Check all fields in attribute window with field survey map and modify if required. Do same for SERVPIPE also. Input "Account" number and "Survey ID" number from field survey to "Account" and "SF_ID" field. Make sure that all SERVPIPE is connected to PNET. If you found some gap within SERVPIPE and PNET, add "Advance Editing" toolbar by right clicking on menu bar and then selecting "Advance Editing". Select PNET where SERVPIPE will meet and then click on "Extend" tool ( ) in "Advance Editing" toolbar and select SERVPIPE which will extend. Check all PNET on that shape file so that there must have breakup in PNET where SERVPIPE connected to that. For breaking PNET first select PNET which you want to break then select "Split" tool ( ) from "Editor" toolbar and click on PNET where SERVPIPE is connected. Select all meters and wells one by one and then check all attributes with field survey map and encode Account number and Survey ID in the database.

Figure 1.4: Extend method

Figure 1.5: Split method

4.5 Draw New Service Pipes, Meters and Wells

Select line from "Construction Tools" window and draw service pipe as drawn in survey map. While drawing, length of service pipe should be taken from "Field Survey Form". Make sure that "Snapping" is on while editing. Break PNET on that point where service pipe is connected to that. Encode Account number and Survey ID in database from field survey form and from field survey map. Click on shape file name in "Create Feature" window and select point from "Construction Tools" for drawing service meter. Then click at the end point of

service pipe, new point feature will generate. Encode Account number and Survey ID in database from field survey form and from field survey map. Draw all tube-wells as indicated in survey map and encode data.

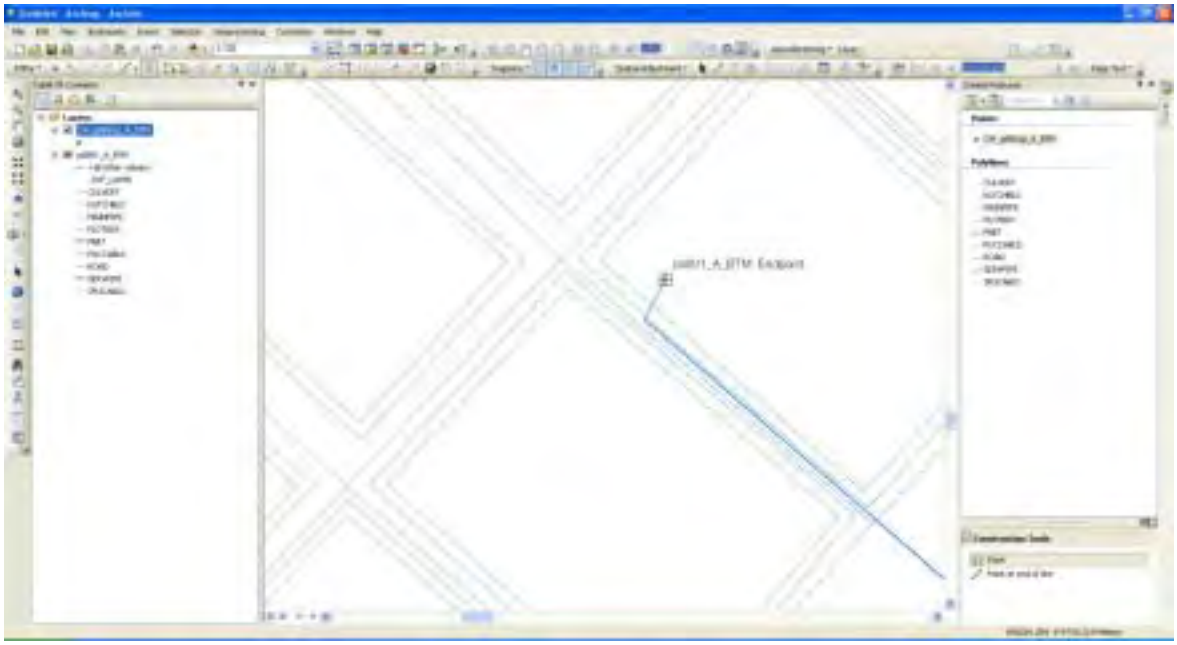


Figure 1.6: Adding service meter at the end of service pipe

4.6 Draw Facilities such as Control Valve, Hydrant, Loop, Tees etc.

Facilities related to distribution network such as valve, hydrant, loop over, wash out, reducer must be drawn as point feature. While drawing those features make sure that snapping is enabled and those features must be located over PNET. PNET must break at point where facilities such as valve or reducer are. In case of loop over one PNET will pass through another PNET without braking. But in junction all PNET will split and point feature will locate at their intersection. When there is T-intersection one point will have to add on that point. After adding one point, all fields in attribute table must be encoded.

4.7 Update Annotation

Double click on shape file name in “Table of Content” window or click right mouse on shape file name and select “Properties”. “Layer Properties” window will appear having many tab options. Click on “Labels” tab and then click on “Label feature in this layer”. Select label field “DXF_TXT” and chose color and font and then click “OK”. If annotation is missing in any structure then add point and update database. While making annotation, first write plot number then add “.” and after that add building number. For PNET annotation will be DN then pipe diameter in mm and then pipe material. For facilities annotation will be name of that facility.

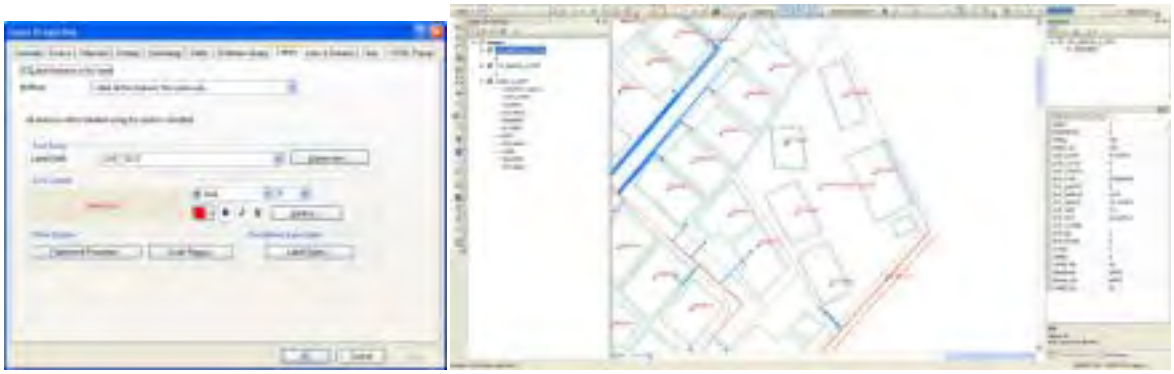


Figure 1.7: Labeling of features and updating of annotation

4.8 Merging with Field Survey Data

Data entry form was prepared in Microsoft Access for encoding survey data. Add ( ) that file in ARCGIS as you do for shape file. After that click right mouse over the shape file of line feature which has been updated and click on “Join and Relates” and then “Join”. “Join Data” window will come into view choose “Join attributes from a table” and give SF_ID field in first field and then select MS Access table from second field and after that choose ID in third field and click “OK”. Do same for meters and other facilities.

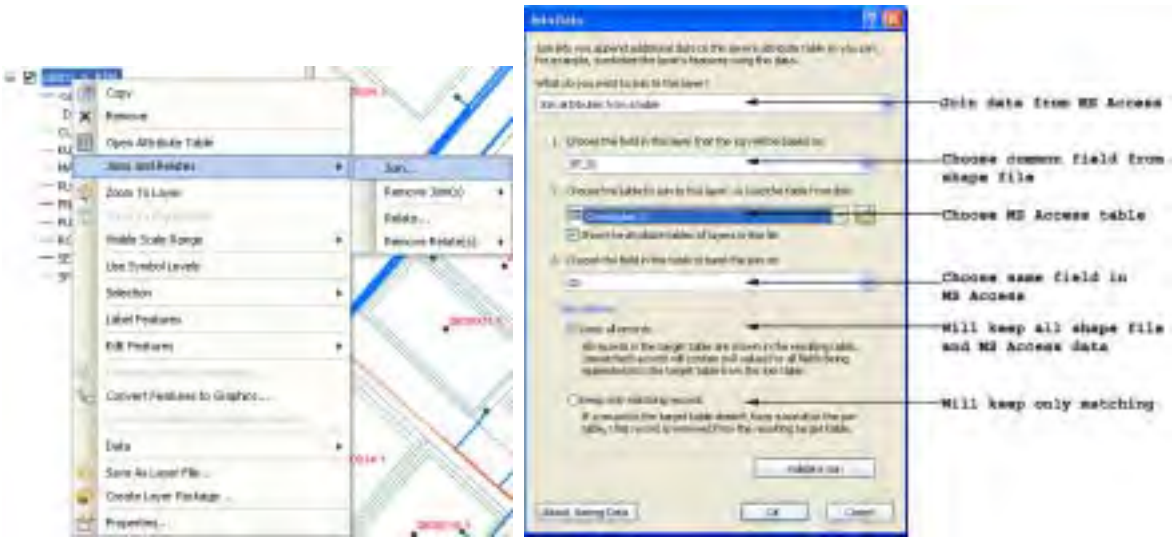


Figure 1.8: Joining with field data

After that open attribute table and check all features with field survey data. If any inconsistency found make correction by following above technique. If no error found, save edits and stop edits.

Annex 2 Handling of Billing Data in NRW

1. Objective

Billing data in Computer Section is required to arrange counter measures for NRW to monitor as follows:

- Monthly record of water consumption in service meter
- Monthly billing charge for revenue collection

Both items are simultaneously relating to indicators for the NRW management. However, the present billing data is not directly provided with necessary conditions to be able to apply to monitoring process for the NRW. Billing data is required for checking of missing records and preparation of data fields in order to calculate monthly consumption.

2. Methodology

There are several steps required to arrange a relational database of billing data to link to GIS datasets for the NRW as follows:

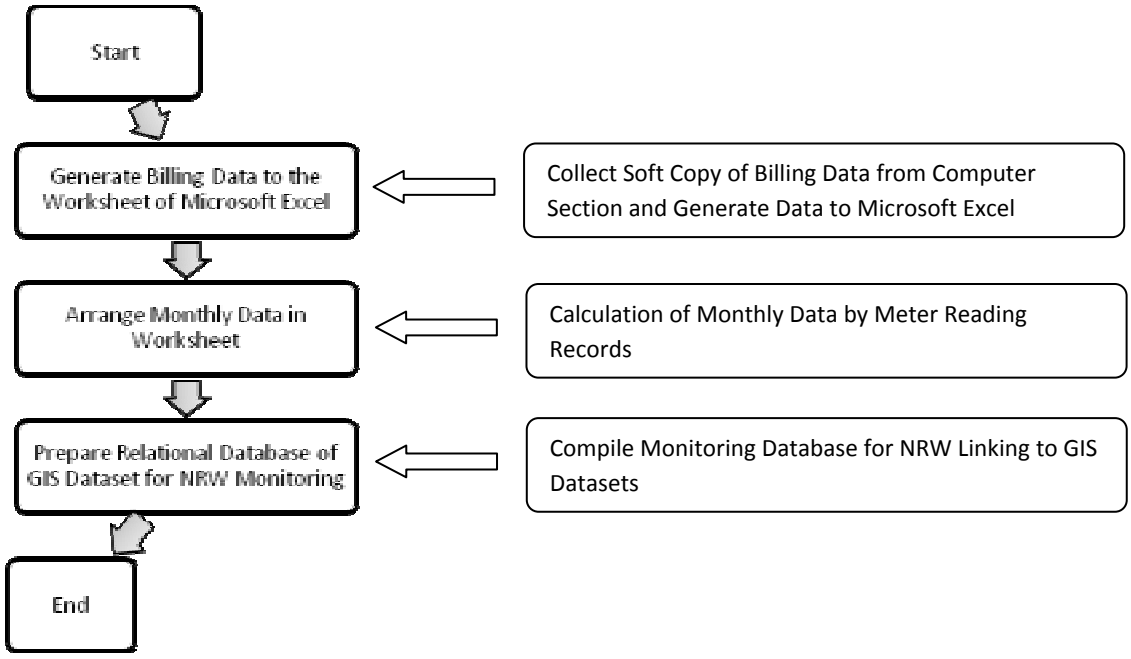


Figure 1.1: Methodology of preparing NRW database

2.1 Generate Billing Data to the Worksheet of Microsoft Excel

This step is required to arrange monthly billing data according to monthly data calendars in meter readings because date of meter reading is not yet fixed to operate in each month. There are some missing records found in present billing data records and also there are some careless mistakes caused by human beings in the step of meter reading and encoding works in Sales Division and data entry in Computer Section.

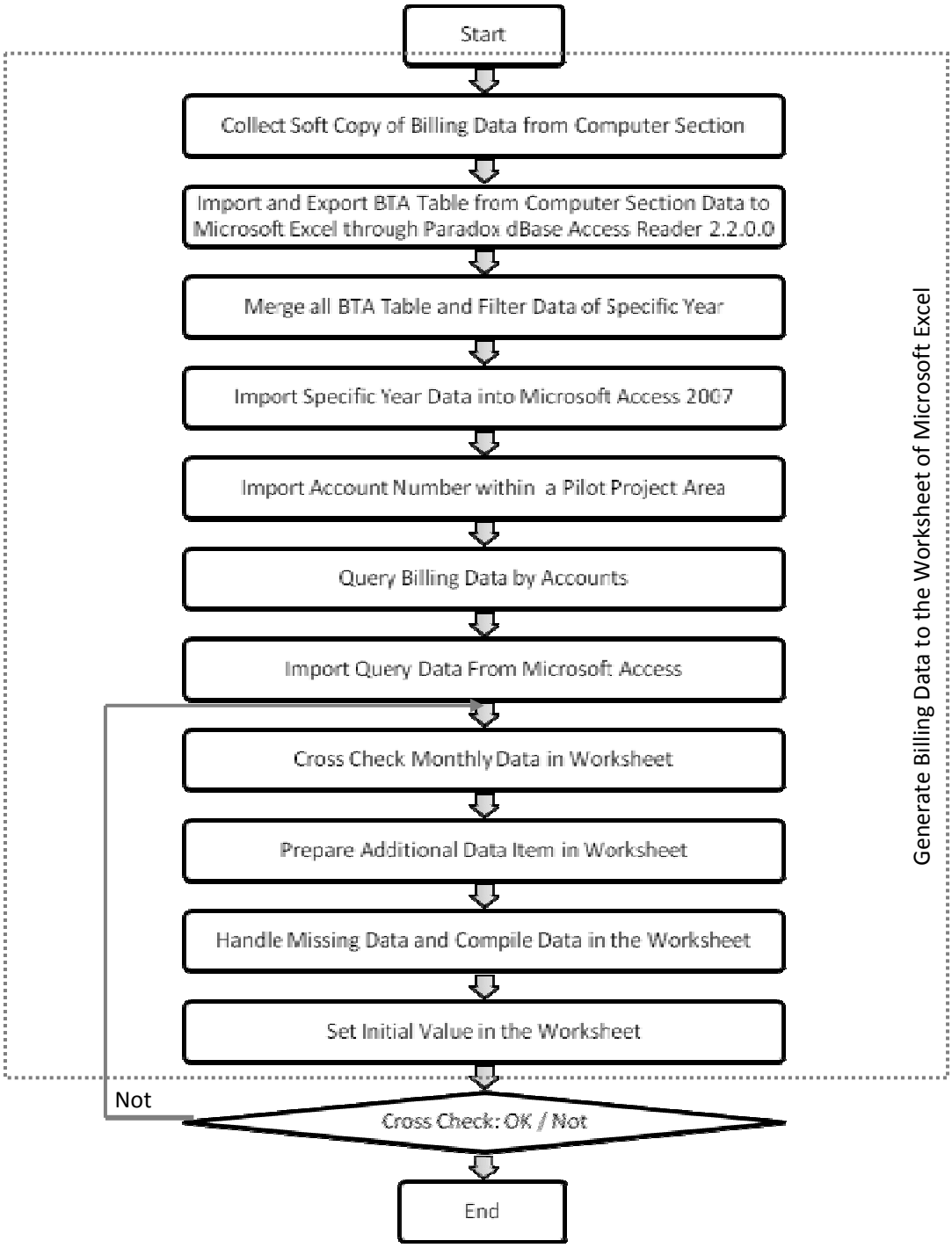


Figure 2.1: Flow chart for generating billing data to worksheet of Microsoft Excel

All data concerned should be checked to verify the unknown part of data in the worksheet. If missing part of monthly data was founded in the data record, the data should be handled to calculate monthly water consumption and billing amounts by two (2) dates of meter reading between the previous data and the present dates in the next step. Also there are some data items to be added into the worksheet in order to make it easy to calculate monthly data in the next step.

2.1.1 Collect Soft Copy of Billing Data from Computer Section

Billing data will have to be collected from computer section of CWASA.

2.1.2 Import and Export BTA Table from Computer Section Data to Microsoft Excel through Paradox dBase Access Reader 2.2.0.0

Computer Section of CWASA maintains data in Visual FoxPro. Visual FoxPro generates tables of which extension is dbf. Microsoft Access 2007 or Microsoft Excel 2007 can't import directly those dbf tables. For this reason Paradox dBase Access Reader 2.2.0.0 (which is free software) have to be downloaded from http://www.sportamok.com/development/delphi/8-paradox-dbase-reader link and installed by double clicking icon of paradox-dbase-setup.exe and then by following on screen instructions.

After installation, double click on Paradox dBase Access Reader (located on desktop or from start menu →all programs → paradox-dbase-reader→ paradox-dbase-reader) and click "Open File" from "File" menu and locate data from Computer Section.

All files within that source will appear under "General" on View Tab of Paradox dBase Access Reader. Whenever you click one file on general tab, file description will be displayed on right side of file list and field description under file list.

Click BTA01.dbf from file list and you will see file description on right side of the list and field description under the list.

Then click on "Data" of view tab, you will see all data on that table. Simply click on drop down arrow on export menu and click "Excel File". "Save Result As" window will appear and locate path where you want to save data as .xls format. Follow same procedure for all BTA files (1-33). After exporting all BTA files close Paradox dBase Access Reader.

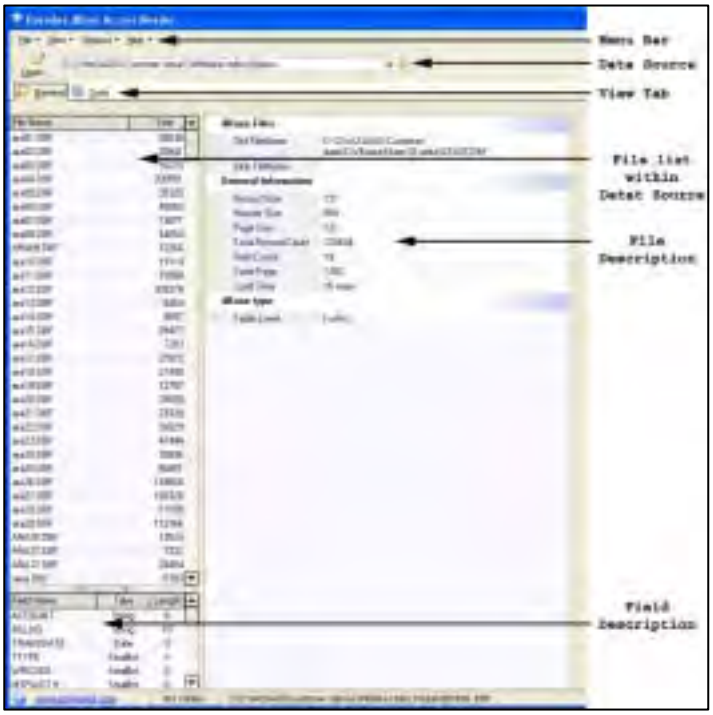


Figure 2.2: User Interface of Paradox-dBase Access Reader

2.1.3 Merge all BTA Tables

Open new file in Microsoft Excel 2007 and save as BTA2010.xlsx. Open BTA01.xls file which was saved before from Paradox dBase Access Reader 2.2.0.0 and copy all data and paste into BTA2010. Open

BTA02.xls and copy all data except first row (which contain column headings) and paste into next row of previously pasted data in BTA2010. Follow same procedure for all BTA and save BTA 2010.

Click A1 cell of BTA2010 and click "Filter"  from "Sort & Filter" option in "Editing" toolbar under "Home" menu in the ribbon. One downward arrow will appear on each cell in first row. Click downward arrow on TRANSDATE column. One pop-up window will appear and deselect Select All on that window and then select 2010 and press Ok. Then copy all data and paste into sheet 2 on that file. Rename sheet 2 as BTA2010, save file and close Microsoft Excel.

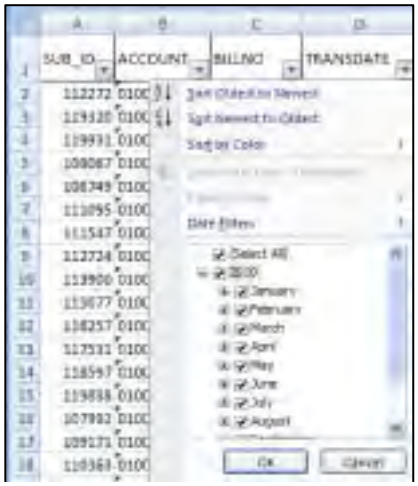


Figure 2.3: Pop up window for data filter

2.1.4 Open Specific Year Data in Microsoft Access 2007

Open one new file in Microsoft Access 2007 and save it as BTA2010.accdb. Import BTA2010 data from Microsoft Excel by selecting "Excel" in  "Import" toolbar under "External Data" menu in the ribbon of Microsoft Access 2007. Whenever "Excel" is clicked one new window will appear namely "Get External Data – Excel Spreadsheet". Browse previously saved BTA2010.xlsx file and click "Ok" on that window. Another window (Import Spreadsheet Window) will appear showing all worksheet on that file and select BTA2010 spreadsheet and click "Finish". One new table (BTA2010: Table) will appear in navigation pane of BTA2010.accdb.

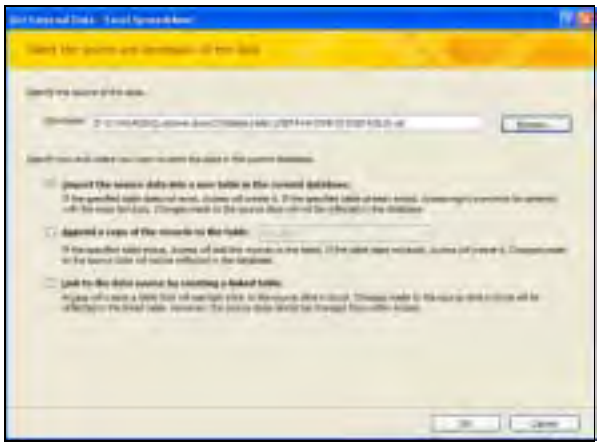
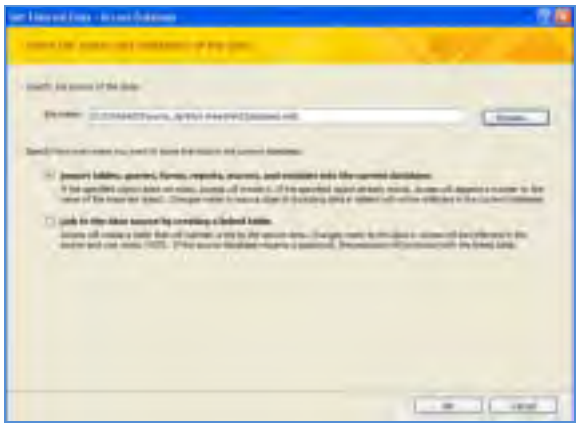


Figure 2.4: Get External Data and Import Spreadsheet Wizard for importing Excel data into Access

2.1.5 Import Account Number within a Pilot Project Area

Import account number of a Pilot Project Area from Field Database.mdb by selecting "Access"  in "Import" toolbar under "External Data" menu in the ribbon of Microsoft Access 2007. Whenever "Access" is clicked one new window will appear namely "Get External Data – Access Database". Browse previously saved Field Database.mdb file and click "Ok" on that window. Another window (Import Objects) will appear showing all table, form, query etc. on that file and select Khulshi from Table Tab and click "Finish". One new table (Khulshi: Table) will appear in navigation pane of BTA2010.accdb.



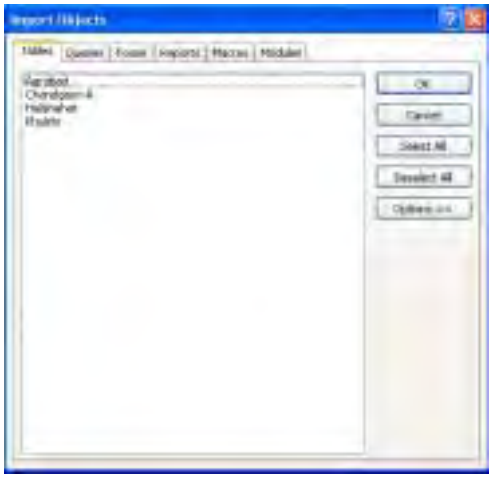
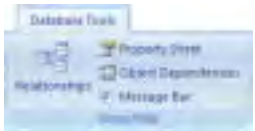


Figure 2.5: Get External Data and Import Objects for importing Access data into Access

2.1.6 Query Billing Data by Accounts

After importing both tables relationship between them have to be established. Click "Relationships"  icon on "Show/Hide" toolbar under "Database Tools" menu in ribbon of Microsoft Access. One empty window namely "Relationships" will appear and click on right mouse anywhere on that window and select "Show Table". "Show Table"  window will appear showing all tables and queries in the Microsoft Access file. Double click on BTA2010 and Khulshi (or select BTA2010 and click Add and select Khulshi and click Add), both table with fields will appear on blank area of Relationships window and click Close. Click and hold left mouse on Account_No field (move vertical

scroll bar down to find this field) in Khulshi table and drop on ACCOUNT field on BTA2010 Table. Another window will appear namely "Edit Relationship" which will display relationship field of both tables. Click "Create", then save (Ctrl + S) relationship and close relationship window.

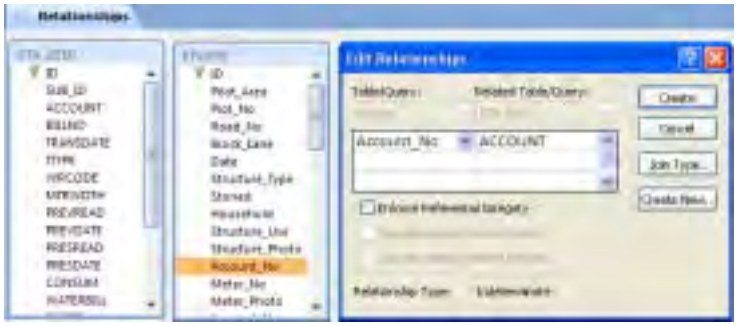
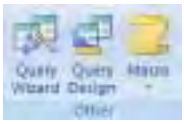


Figure 2.6: Edit relationship window for establishing relationship between two tables in Access

Open "Query Wizard" 

from "Other" toolbar in "Create" menu in Microsoft Access 2007 ribbon. "New Query" window will appear. Click "Simple Query Wizard" and click "Ok". "Simple Query Wizard" will appear showing all tables/queries with their fields. Select "Table: Khulshi" from drop down arrow under "Tables/Queries". Available fields will be displayed on left side of the wizard. Select "Account_No" from "Available Fields" and then click 

to add this field then select "Table: BTA 2010"from "Tables/Queries". Then click 

to add all fields for selected. Click "Next" and then "Next" and type "Khulshi Query" on box given under heading "What title do you want for your query?". Then click "Finish" to finish the query wizard. Result of the query will open automatically on the document view window. Save the file and close Microsoft Access 2007.

Figure 2.7: Query Wizard in Microsoft Access 2007

2.1.7 Import Queried Data from Microsoft Access 2007

Open BTA2010.xlsx file, move to new sheet and rename as Khulshi. Click on A1 cell of Khulshi sheet. Click "From Access" 

from "Get External Data" toolbar under "Data" menu in the ribbon of Microsoft Excel 2007. "Select Data Source" window will appear and browse and select BTA2010.accdb file and then select "Ok". "Select Table" window will appear showing all tables and

queries on that file. Select “Khulshi Query” from “Select Table” window and click “Ok” and then click “Ok”. All queried data will be appeared on Khulshi sheet.

Figure 2.8: Import data from Microsoft Access 2007 to Microsoft Excel 2007

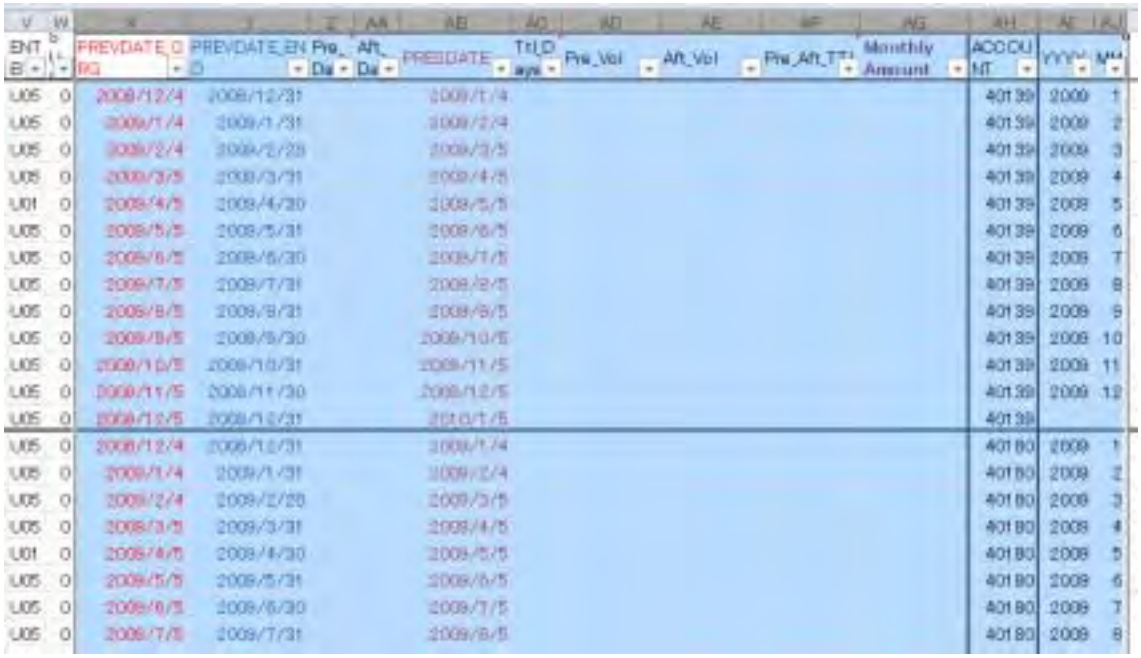
2.1.8 Cross Check Monthly Data in Worksheet

Time series of monthly data records in each ACCOUNT NUMBER must be checked in the worksheet according to date of meter reading in the data. Additional two columns namely BLOCK and PILOT_ID must be inserted for identification of Mahallah and Pilot Areas. Block is the first two digits of Account_No and PILOT_ID 1: define Khulshi, 2: define Chandgaon A Block, 3: define Chandgaon B Block, 4: define Agrabad, 5: define Halishahar and 13: define Zone – 3 of Model Area.

Figure 2.9: Computer Section Data in Worksheet of Microsoft Excel

2.1.9 Prepare Additional Data Items in Worksheet

In order to calculate monthly consumption in the account, a part of calculation block is required for preparation of necessary data fields and also for cross check of data records in the worksheet as shown in Figure2.10.



ENT		PREVDATE_O RG	PREVDATE_EN D	Pre_ Da	Aft_ Da	PRESDATE	Ttl_D ays	Pre_Vol	Aft_Vol	Pre_Aft_TTl	Monthly Amount	ACCOU NT	YYYY	MM
U05	0	2008/12/4	2008/12/31			2009/1/4						401 39	2009	1
U05	0	2009/1/4	2009/1/31			2009/2/4						401 39	2009	2
U05	0	2009/2/4	2009/2/28			2009/3/5						401 39	2009	3
U05	0	2009/3/5	2009/3/31			2009/4/5						401 39	2009	4
U01	0	2009/4/5	2009/4/30			2009/5/5						401 39	2009	5
U05	0	2009/5/5	2009/5/31			2009/6/5						401 39	2009	6
U05	0	2009/6/5	2009/6/30			2009/7/5						401 39	2009	7
U05	0	2009/7/5	2009/7/31			2009/8/5						401 39	2009	8
U05	0	2009/8/5	2009/8/31			2009/9/5						401 39	2009	9
U05	0	2009/9/5	2009/9/30			2009/10/5						401 39	2009	10
U05	0	2009/10/5	2009/10/31			2009/11/5						401 39	2009	11
U05	0	2009/11/5	2009/11/30			2009/12/5						401 39	2009	12
U05	0	2009/12/5	2009/12/31			2010/1/5						401 39		
U05	0	2008/12/4	2008/12/31			2009/1/4						401 80	2009	1
U05	0	2009/1/4	2009/1/31			2009/2/4						401 80	2009	2
U05	0	2009/2/4	2009/2/28			2009/3/5						401 80	2009	3
U05	0	2009/3/5	2009/3/31			2009/4/5						401 80	2009	4
U01	0	2009/4/5	2009/4/30			2009/5/5						401 80	2009	5
U05	0	2009/5/5	2009/5/31			2009/6/5						401 80	2009	6
U05	0	2009/6/5	2009/6/30			2009/7/5						401 80	2009	7
U05	0	2009/7/5	2009/7/31			2009/8/5						401 80	2009	8

Figure2.10 Prepare data items for calculation of monthly consumptions

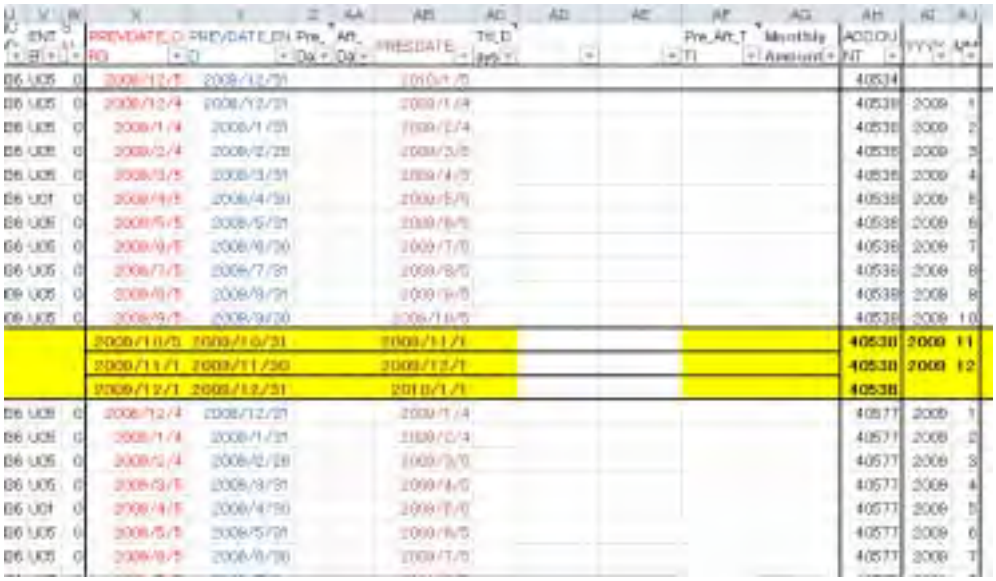
To prepare work fields for arrangement data and cross check in billing data, data should be defined as follows:

- PREVDATE_ORG is defined by DATE to be copied by PREVDATE in the original database
- PREVDATE_END is defined by DATE to define the end of day at PREVDATE
- Pre_Days is defined by NUMBER to count day amount in the month of previous date in meter reading.
- Aft_Days is defined by DAY amount in the month of the present date in meter reading.
- PRESDATE is defined by DATE to be copied by PRESDATE in the original database
- Ttl_Days is defined by NUMBER to count day amounts between PREVDATE and PRESDATE
- Pre_Vol is defined by FLOAT to calculate monthly amounts of water volumes in the Pre_Day.
- Aft_ Vol is defined by FLOAT to calculate monthly amounts of water volumes in the Aft_Day.
- Pre_Aft_TTl is defined by FLOAT to check amounts of water volumes in the record which is summed by those in Pre_Vol and those in Aft_Vol.
- Monthly Amount is defined by FLOAT to calculate actual monthly water volumes for a monitoring of NRW.
- ACCOUNT is defined by STRING to be copied by ACCOUNT in the original
- YYYY is defined by Number to arrange yearly record which is equal to YEAR in the record
- MM is defined by Number to arrange monthly data from January to December in the record.
- All additional data items should be grouped in MSEXCEL and all data items also should be groped in MSEXCEL.

2.1.10 Handle missing data and compile data in worksheet

According to dates on meter readings in the data, arrange monthly records in each ACCOUNT NUMBER in the worksheet from January to December in the YEAR. If you find missing terms in the records of meter

readings, you have to prepare monthly data in that term. However, there are several cases of preparing those records according to the sequence of date in meter readings. The arrangement depends on condition of data. See examples in Figure2.11 for arranging data by cross check.



Case1: Arrangement of missing parts in the worksheet

Case2: Missing data of missing part in the worksheet arrangement

Figure 2.11: Case examples of arrangement of missing data in the worksheet

2.1.11 Set initial value in the worksheet

Set initial values in the worksheet according to description of the definition of data in section 2.1.9 so that the worksheet is ready for calculation in the next step.

2.2 Arrange Monthly Data in Worksheet

This step is required to calculate monthly water consumption from service meter record and monthly billing amounts for the NRW. Based on the arrangement in the previous step, consumption data are calculated in worksheet.

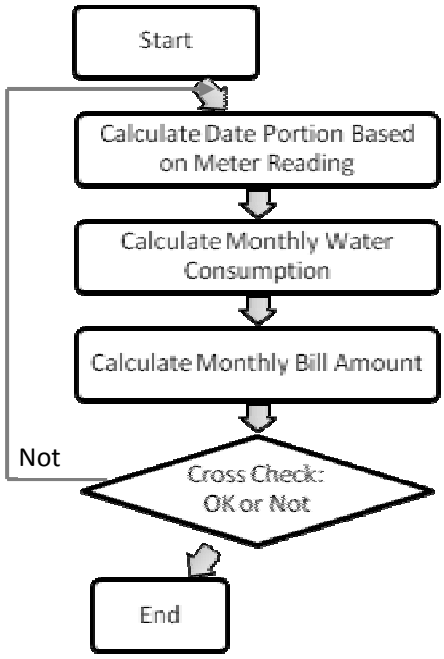


Figure 2.12: Work procedure for calculating monthly billing data

There are three (3) types of calculations in this step. Those calculations are given below:

2.2.1 Calculate Date Portion Based on Meter Reading

To calculate monthly water consumption, first of all you have to calculate date portion of additional data items based on meter reading:

Figure 2.13: Example of calculating date portion and monthly consumption

Table 2.1: Equation of fields in date portion of data items

Field Name	Equation
PREVDATE_ORG	= PREVDATE
PREVDATE_END	For January' 2010=1/31/2010, February' 2010=2/28/2010, same as for other, Input Manually
PRESDATE2	= PRESDATE
Pre_Day	=DAYS360(PREVDATE_ORG, PREVDATE_END)+1
Aft_Days	=DAY(PRESDATE2-1)
Ttl_Days	= Pre_Days + Aft_Days

If it is observed that billing is done for two or more month together in any account then PRESDATE2 will have to input manually by keeping same day on next month of PREVDATE_ORG. For blank row:
PREVDATE_ORG = PRESDATE2 of previous row
PRESDATE2 = same day on next month of PREVDATE_ORG

2.2.2 Calculate Monthly Water Consumption

To calculate monthly water consumption, data items will have to calculate based on equation given in Table 2.2.

Table 2.2: Equation of fields in monthly consumption portion of data items

Field Name	Equation
Pre_Vol	= CONSUM *Pre_Days/Ttl_Days
Aft_Vol	= CONSUM * Aft_Days /Ttl_Days
Pre_Aft_TTl	= Pre_Vol + Aft_Vol
Monthly Consumption	= Aft_Vol of this billing month + Pre_Vol of next billing month
Year	Input manually based on PREVDATE_END
Month	Input manually based on PREVDATE_END

If it is observed that, billing is done for two or more month together in any account then calculation will be different in Pre_Vol and Aft_Vol column.
Pre_Vol = CONSUM * Pre_Days / (PRESDATE – PREVDATE)
Aft_Vol = CONSUM * Aft_Days / (PRESDATE – PREVDATE)

For calculating Pre_Vol and Aft_Vol of blank row CONSUM, PRESDATE and PREVDATE of this row will be used. First copy account number of that row and paste into account_no and ACCOUNT column of blank row. Do same for WRCODE and NBILL also. While calculating monthly consumption of blank row:

Pre_Vol = CONSUM * Pre_Days / (PRESDATE – PREVDATE)
Aft_Vol = CONSUM * Aft_Days / (PRESDATE – PREVDATE)

Other equation will be same and similarly fill up all blank rows. See Figure 2.13 for better understanding.

2.2.3 Calculate Monthly Bill Amount

Additional seven columns will have to add to the right side of month column in order to calculate monthly bill amount. Those seven columns description is given Table 2.3.

Table 2.3: Description of fields in monthly billing portion of data items

Field Name	Description
Pre_Vol_m3	Amount consumed on Pre_Days in cubic meter
Aft_Vol_m3	Amount consumed on Aft_Days in cubic meter
Pre_Bill	Billing amount in Pre_Vol_m3
Aft_Bill	Billing amount in Aft_Vol_m3
Pre_Aft_TTl_Bill	Billing amount on that billing month
Monthly_Bill	Billing amount on that month
Monthly_Bill_With_VAT	Billing amount on that month with VAT

PREVDATE_ORG	PREVDATE_END	Pre_Days	Aft_Days	PRESDATE2	TTL_Days	Pre_Vol	Aft_Vol	Pre_Aft_TTl	Monthly Amount	ACCOUNT2	YYYY	MM	Pre_Vol_m3	Aft_Vol_m3	Pre_Bill	Aft_Bill	Pre_Aft_TTL_Bill	Monthly_Bill	Monthly_Bill_With_VAT
11/15/2009	11/31/2009	47	3	1/4/2010	50		8000.00	8000.00	8233.35	04680	2010	1	0.00	27.24	0.00	154.72	154.72	1480.08	1702.07
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5/4/2010	5/31/2010	28	3	6/4/2010	31	188.29	41.71	431.00	385.41	04680	2010	6	188.29	41.71	2211.17	236.91	2448.08	1622.36	1865.60
6/4/2010	6/30/2010	27	3	7/4/2010	30	143.90	27.10	171.00	248.07	04680	2010	7	143.90	27.10	1385.13	153.93	1539.28	1480.02	1840.96
7/4/2010	7/31/2010	28	3	8/4/2010	31	270.97	29.03	300.00	139.49	04680	2010	8	270.97	29.03	1539.10	164.90	1704.00	1360.27	1564.31
8/4/2010	8/31/2010	28	3	9/4/2010	31	110.45	22.55	133.00	252.95	04680	2010	9	210.45	22.55	1195.37	128.07	1323.44	1456.75	1652.76
9/4/2010	9/30/2010	27	3	10/4/2010	30	250.40	25.60	156.00	194.50	04680	2010	10	250.40	25.60	1508.67	145.41	1454.08	1104.78	1270.50

Figure 2.14: Example of calculating monthly bill amount

2.2.3.1 Understanding of WRCODE and NBILL in Computer Section Data

WRCODE is combination of three components such as use of structure (domestic or non-domestic), status of meter (ok or defected) and unit of consumption (cubic meter or Gallon). CWASA always use Gallon of UK system where I Gallon = 0.00454 cubic meter. WRCODE may vary from month to month within one service connection based on replacement of meter. Following WRCODE used in computer section database:

1. DOM-MET-LITER (Domestic type structure, meter working and unit of consumption is cubic meter)
2. DOM-MET-GALLON (Domestic type structure, meter working and unit of consumption is gallon)
3. DOM-DEF-LITER (Domestic type structure, defected Meter and unit of consumption is cubic meter)
4. DOM-DEF-GALLON (Domestic type structure, defected Meter and unit of consumption is gallon)
5. NON-MET-LITER (Non-domestic type structure, meter working and unit of consumption is cubic meter)
6. NON-MET-GALLON (Non -domestic type structure, meter working and unit of consumption is gallon)
7. NON-DEF-LITER (Non-domestic type structure, defected Meter and unit of consumption is cubic meter)
8. NON-DEF-GALLON (Non-domestic type structure, defected Meter and unit of consumption is gallon)

NBILL is percentage of non-domestic use within a domestic type structure. This is used for those structures where some part is used for shop or office and other part is domestic.

2.2.3.2 Calculating Monthly Consumption in Cubic Meter

For applying same formula, monthly consumption data of all accounts should be converted into cubic meter based on WRCODE. Following formula should be used in Pre_Vol_m3 column for converting Pre_Vol amount into cubic meter:

=IF($J2=1,AE2,IF($J2=3,AE2,IF($J2=5,AE2,IF($J2=7,AE2,AE2*0.00454))))

Where, J2 = WRCODE, AE2 = Pre_Vol

Use following formula in Aft_Vol_m3 column for converting Aft_Vol amount into cubic meter:

=IF($J2=1,AF2,IF($J2=3,AF2,IF($J2=5,AF2,IF($J2=7,AF2,AF2*0.00454))))

Where, J2 = WRCODE, AE2 = Aft_Vol

2.2.3.3 Calculating Monthly Gross Billing Amount

After finishing calculation of monthly consumption in cubic meter, gross billing amount will be calculated based on WRCODE and NBILL. From January 2010, CWASA was applying BDT 5.86/cubic meter tariff for domestic type connection and BDT 16.09/cubic meter tariff for non-domestic connection. From December 2010, tariff rate has been increased to BDT 5.96/cubic meter for domestic connection and BDT 16.89/cubic meter for non-domestic connection. Following formula should be used in Pre_Bill column for calculating billing amount in Pre_Vol:

=IF($U2 = 0, IF($J2=1,AL2*5.68, IF($J2=2,AL2*5.68,IF($J2=3,AL2*5.68,IF($J2=4,AL2*5.68, AL2*16.09)))), ((AL2*$U2%*16.09)+AL2*(1-$U2%)*5.68))

Where, U2 = NBILL, J2 = WRCODE and AL2 = Pre_Vol

Use following formula in Aft_Bill column for calculating billing amount in Aft_Vol:

=IF($U2 = 0, IF($J2=1,AM2*5.68, IF($J2=2,AM2*5.68,IF($J2=3,AM2*5.68,IF($J2=4,AM2*5.68, AM2*16.09)))), ((AM2*$U2%*16.09)+AM2*(1-$U2%)*5.68))

Where, U2 = NBILL, J2 = WRCODE and AM2 = Aft_Vol

Pre_Aft_TTl_Bill will be sum of Pre_Vol and Aft_Vol column.

Monthly_Bill will be sum of Aft_Vol in this billing month and Pre_Vol in next billing month.

2.2.3.4 Calculating Monthly Billing Amount with VAT

15% VAT (Value Added Tax) will be applicable on gross payable amount. So for calculating total amount following calculation will be used:

Monthly_Bill_With_VAT = Monthly_Bill + Monthly_Bill * 0.15%

2.3 Prepare Relational Database of GIS Dataset for NRW Monitoring

In order to arrange several monthly data for the NRW monitoring to GIS dataset, the required data in the previous step are compiled to a relational database of GIS datasets for the NRW management.

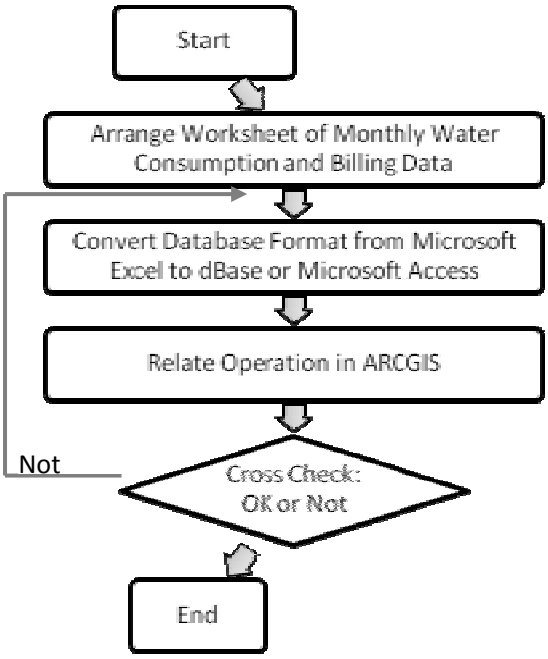


Figure 2.15: Work flow for preparation of relational database of NRW monitoring

2.3.1 Arrange Worksheet of Monthly Water Consumption and Billing Data

Based on the worksheet in the chapter 2.2.2, the data of calculation's results are arranged to the worksheet in each ACCOUNT NUMBER as shown in Figure 2.16. The worksheet will be arranged to provide data format to be linked to a relational database for GIS datasets through a key field of ACCOUNT number.

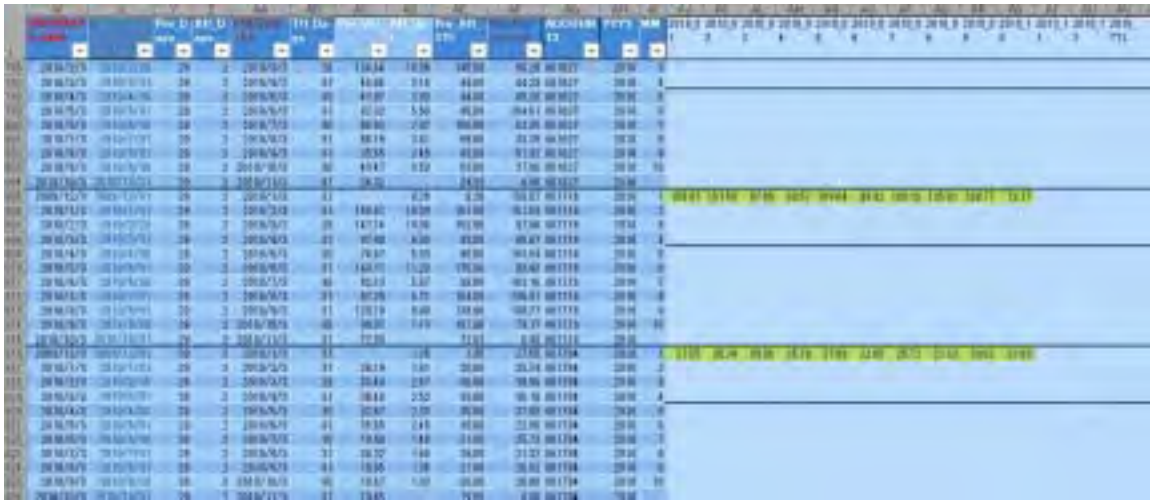


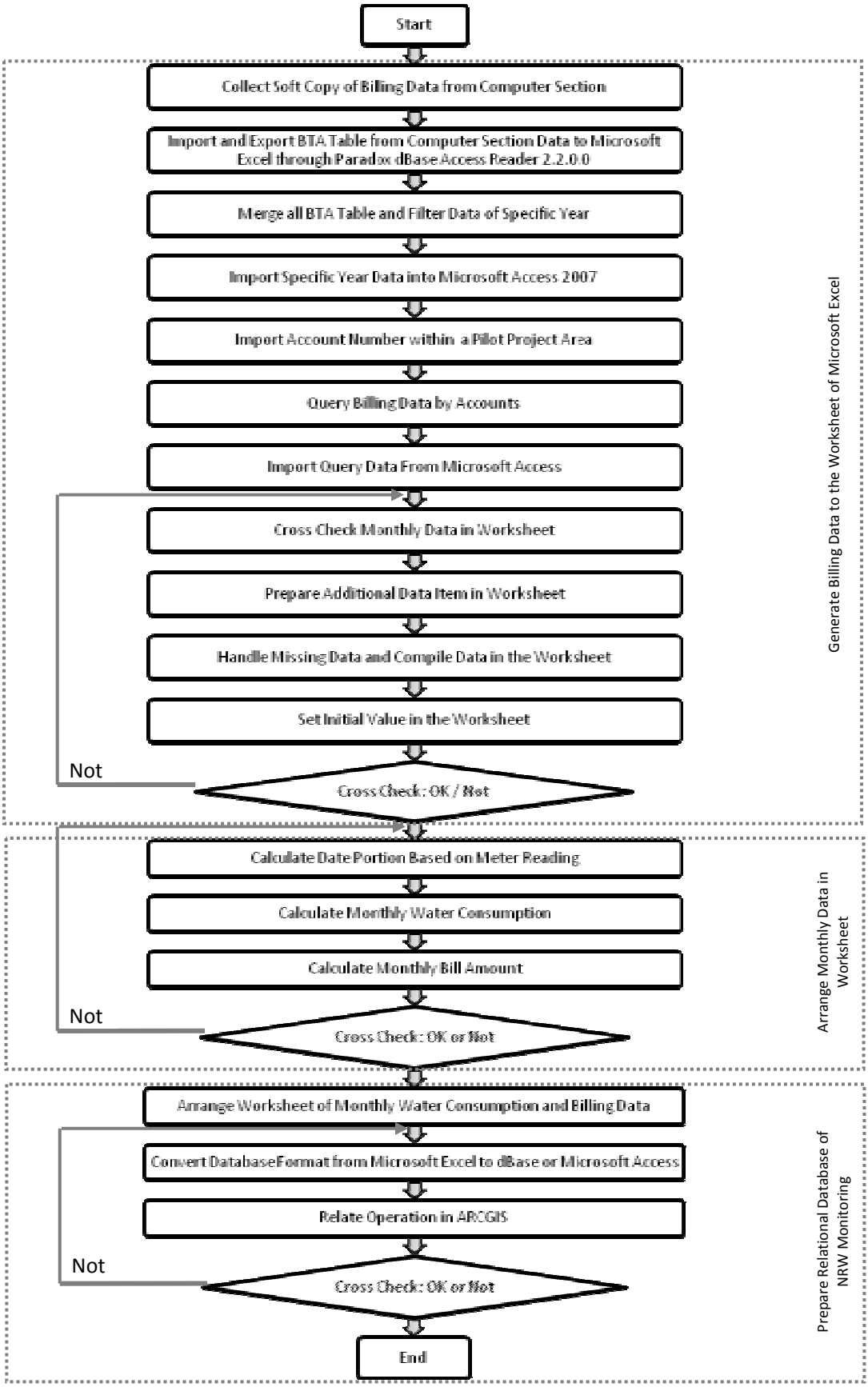
Figure 2.16: Arrangement of result of monthly water consumption in the worksheet

2.3.2 Convert Database Format from Microsoft Excel to dBase or Microsoft Access

Worksheet of Microsoft Excel can be converted to Microsoft Access by following the same procedure as described in section 2.1.4. After that you can convert to dBase format by selecting "More" and then selecting "dBase File" from "Export" toolbar under "External Data" menu in the ribbon of Microsoft Access 2007.

2.3.3 Relate Operation in ARCGIS

Relational database in section 2.3.2 can be linked to ARCGIS datasets through "Joins and Relates" command and by selecting ACCOUNT as common field.


Start
Collect Soft Copy of Billing Data from Computer Section
Import and Export BTA Table from Computer Section Data to Microsoft Excel through Paradox dBase Access Reader 2.2.0.0
Merge all BTA Table and Filter Data of Specific Year
Import Specific Year Data into Microsoft Access 2007
Import Account Number within a Pilot Project Area
Query Billing Data by Accounts
Import Query Data From Microsoft Access
Cross Check Monthly Data in Worksheet
Prepare Additional Data Item in Worksheet
Handle Missing Data and Compile Data in the Worksheet
Set Initial Value in the Worksheet
Not
Cross Check: OK / Not
Generate Billing Data to the Worksheet of Microsoft Excel
Calculate Date Portion Based on Meter Reading
Calculate Monthly Water Consumption
Calculate Monthly Bill Amount
Not
Cross Check: OK or Not
Arrange Monthly Data in Worksheet
Arrange Worksheet of Monthly Water Consumption and Billing Data
Convert DatabaseFormat from Microsoft Excel to dBase or Microsoft Access
Relate Operation in ARCGIS
Not
Cross Check: OK or Not
End
Prepare Relational Database of NRW Monitoring

Annex 3 Manual for Field Verification Data Encoding

1. Background

CWASA was prepared CAD drawing of distribution network in the middle of 1990's. There were no database on those drawings and unique coordinate system were used. After initial preparation of those CAD drawings, have never been updated due to lack of efficient manpower. PANI project is going to prepare GIS database. For this purpose, all CAD drawing of CWASA have been geo-referenced with high resolution satellite image (World View). After that it is required to update based on extensive field survey. GIS team prepared one form for service connection survey which was filled by surveyor on the field.

2. Objectives

Objective of field data entry is to encode all information related to service connection so that GIS team can update maps based on those data and can link up with computer section database of CWASA.

3. Procedure of Data Entry

For encoding field data one database namely "Field Database" was prepared in Microsoft Access. One form (including table) for each Pilot Project Area was created so that merging operation with GIS became easy. Outlook of form in Microsoft Access is very similar to field survey form. Following steps have to be followed for encoding field data:

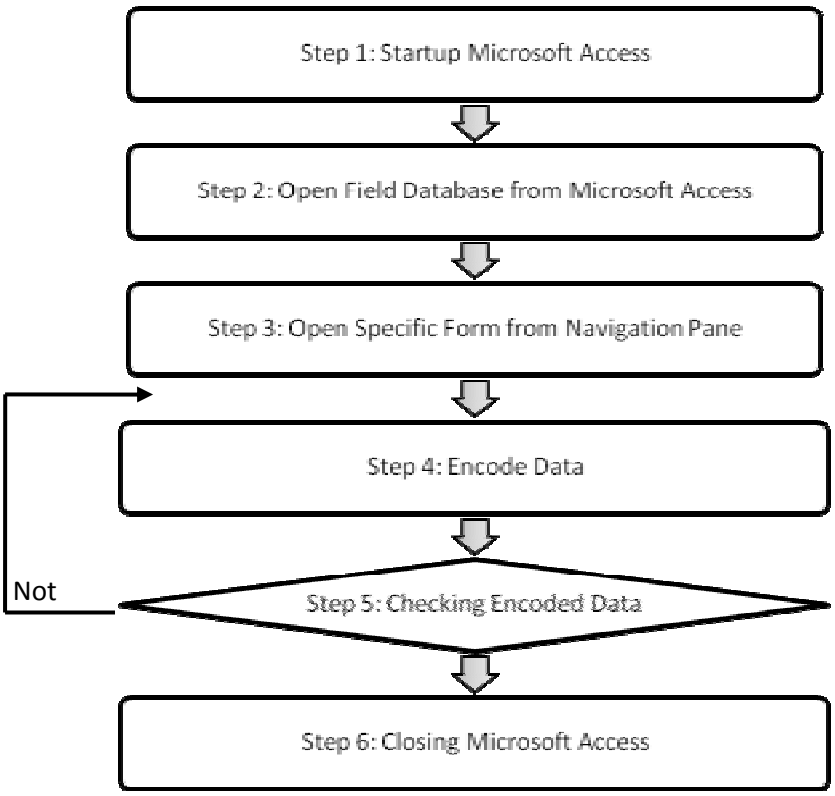


Figure 1.1: Flow chart of field data entry

Step 1: Startup Microsoft Access

Open Microsoft Access from Start Menu of Taskbar.

Start →All Programs →Microsoft Office →Microsoft Office Access 2007.

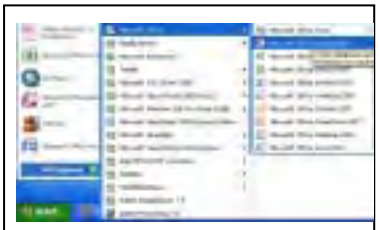


Figure 1.2: Open Microsoft Access from Start Menu

Step 2: Open Field Database from Microsoft Access

Click the Microsoft Office Button, and then click the database that you want to open, if it appears in the right pane of the menu.

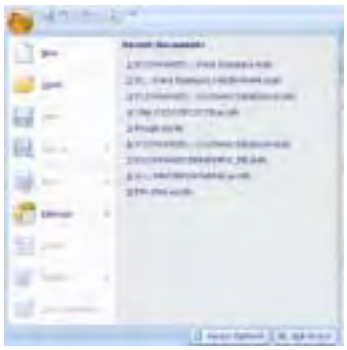


Figure 1.3: Open database in Microsoft Access

Or click the Microsoft Office Button, and then click Open. When the Open dialog box appears, browse hard drive and click on file name, and then click Open.

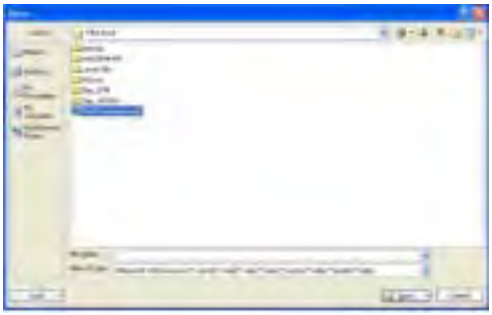


Figure 1.4: Open database in Microsoft Access

Step 3: Open Specific Form from Navigation Pane

Double click on name of the form which appears in Navigation Pane (marked as 1 in Figure 1.5) for which you want to encode data. Whenever you will double click, the specific form will open on the right side of Navigation Pane (in document window).

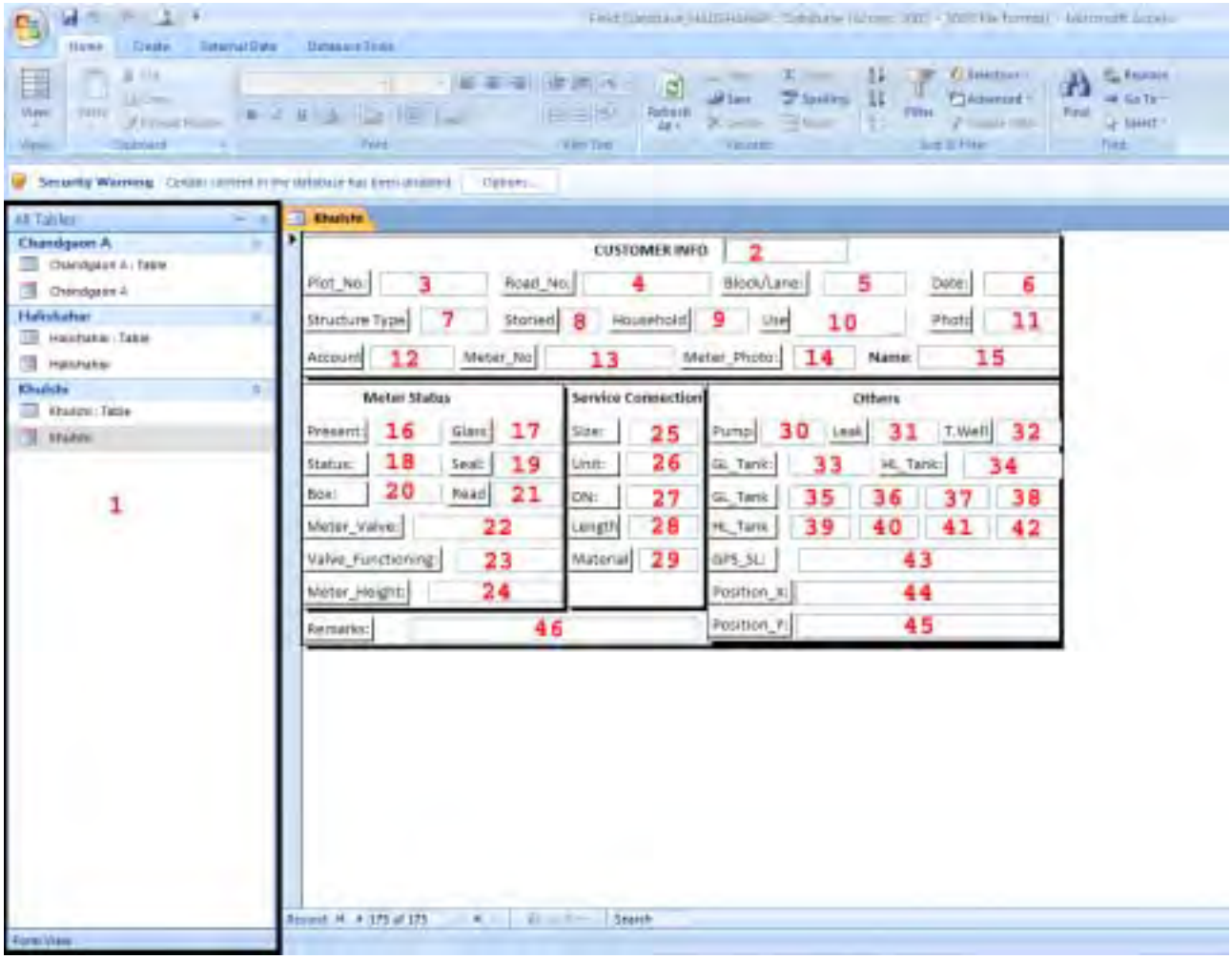


Figure 1.5: User Interface of Field Database

Step 4: Encode Data

After opening specific form in document window click on the right side field of CUSTOMER INFO (marked as 2 in Figure 1.5) and encode Pilot Project Area name (for example: Khulshi or Agrabad etc.). After encoding finish on that field press Enter or Tab on your keyboard. Cursor will move to next field for encoding plot number (marked as 3 in Figure 1.5). Same way fill up all fields and press Enter or Tab for moving the cursor from encoded field to next field (cursor will move on ascending order of given number in Figure 1.5). In some fields coding was used for encoding. This was done in order to minimize typing error as GIS software treat Y or y as different. Description of each field with coding is given in Table 1.1.

Step 5: Checking Encoded Data

Whenever cursor move to Remarks field check encoded data very carefully before pressing Enter or Tab in keyboard. After checking all fields press Enter or Tab in keyboard for saving data and for opening new form for encoding. You can also check data, add new and move to different record by selecting option from Record Bar in document window.

Figure 1.5: Record bar in document window

Step 6: Closing Microsoft Access

Close Microsoft Access when encoding finish. No need to save separately.

Table 1.1: Description of field with code

Serial No.	Window / Field Name	Code	Description
1	Task Pane		Show all forms, tables and queries on database
2	Customer Info		Area name
3	Plot_No		Plot number
4	Road_No		Road number or road name
5	Block / Lane		Block name or Lane name
6	Date		Date of data collection
7	Structure Type		Type of structure such as pucca, katcha etc.
8	Storied		Number of storied on that building
9	Household		Number of household on that building
10	Use	1: Domestic, 2: Industrial, 3: Office, 4: Recreational, 5: Religious, 6: Commercial, 7: Govt., 8: Mixed	Use of structure
11	Photo		Structure photo number
12	Account		Account number
13	Meter_No		Meter number
14	Meter_Photo		Meter photo number
15	Name		Name of account holder
16	Present	1: yes, 2: No	Meter present or not
17	Glass	1: yes, 2: No	Meter glass intact or not
18	Status	1: yes, 2: No	Meter status ok or not
19	Seal	1: yes, 2: No	Meter seal intact or not
20	Box	1: yes, 2: No	Meter box present or not
21	Read	1: yes, 2: No	Meter read out clear or not

Table 1.1: Description of field with code （Cont'd）

Serial No.	Window / Field Name	Code	Description
22	Mete_Valve	1: yes, 2: No	Meter valve present or not
23	Valve_Functioning	1: yes, 2: No	Meter valve functioning or not
24	Meter_Height	1: At, 2: Above, 3: Below	Meter height from ground level
25	Size	1: 1", 2: ¾", 3: 2", 4: 4", 5: 1.5"	Connection size
26	Unit	1: gallon, 2: m^3	Unit of consumption
27	DN		Diameter and material of main pipe
28	Length		Length of service pipe
29	Material		Material of service pipe
30	Pump	1: yes, 2: No	In line pump present or not
31	Leak	1: yes, 2: No	Leakage of water or not
32	T.Well	1: Deep, 2: Shallow	Tubewell present or not
33	GL_Tank	1: yes, 2: No	Ground level tank present or not
34	HL_Tank	1: yes, 2: No	High level tank present or not
35	GL_Tank_1		Length (in meter) of GL_Tank
36	GL_Tank_2		Width (in meter) of GL_Tank
37	GL_Tank_3		Depth (in meter) of GL_Tank
38	GL_Tank_4		Volume (in liter) of GL_Tank
39	HL_Tank_1		Length (in meter) of HL_Tank
40	HL_Tank_2		Width (in meter) of HL_Tank
41	HL_Tank_3		Depth (in meter) of HL_Tank
42	HL_Tank_4		Volume (in liter) of HL_Tank
43	GPS_SL		Point number in GPS
44	Position_X		X coordinate in GPS point
45	Position_Y		Y coordinate in GPS point
46	Remarks		Comments