Activity Report

and

Operation Manual for GIS Data Management

October 26, 2011

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Bangladesh Digital Mapping Assistance Project
(BDMAP)

Index

1. Summary

This short report summarizes my activities conducted between September 9, 2011 and October 26, 2011 as a JICA Expert in charge of GIS Data Management.

In the first half of year 2011, hardware and software for IDMS project were installed by vendors and basic training on their use was conducted. Definition of the data to be produced by Photogrammetry Unit and Cartography Unit as well as the contents of GIS database had been discussed by SOB staff but definitions of the database were still not in the final one.

Under these circumstances, my major activities were to check the GIS database design and readiness of GIS Unit for actual work of IDMS project, to identify any items which may affect the smooth production of the 1/25,000 and 1/5,000 scale maps and GIS database.

It should be noted that my observation is based on the information I collected or given by SOB staff. There is a possibility that the information collected was incomplete or I misunderstood the situation. I would appreciate it very much if SOB staff inform of any misunderstanding if it exists in this report. This report is written as one method of communication between SOB and JICA Expert.

2. Readiness of GIS Unit as of September 23, 2011

2.1 Training

In 2010, introductory training on GIS concept and basic operation was conducted by hired local consultants. And in 2011, a series of training of ArcGIS operations was conducted by the software vendor between May and September. Titles of the training provided to me by GIS Unit are as listed below.

- On the Job Training – Digital Mapping Unit (DMU) Training material-vol.1 (GIS and Cartography workshop) May 2011
- On the Job Training – Digital Mapping Unit (DMU) Training material-vol.2 (GIS and Cartography workshop) May 2011
- On the Job Training – Digital Mapping Unit (DMU) Training Syllabus (GIS

Workshop)

- On the Job Training – Digital Mapping Unit (DMU) Training Material-vol.3 (GIS Workshop) May 2011
- On the Job Training – Digital Mapping Unit (DMU) Supervisor Training Material vol.1 (GIS Workshop) June 2011

Although the title of the material include the words "On the Job Training", no on-the-job training was conducted. Correct title would be "On-Site Training."

Some other training such as for the management of database was conducted for a small group of SOB staff.

According to the explanation of GIS Unit staff, typical training period is one to two weeks and printed training materials were delivered to the participants.

It is difficult to assess the present technical level of GIS Unit staff in GIS and related software operation until they are fully tested. However, considering the fact that GIS operation techniques can be acquired through intensive self training or through actual work and that GIS Unit did not spend enough time in self training after the IDMS project was started, it is hard to conclude that the staff already has sufficient technical capacity in carrying out GIS work the GIS Unit is responsible.

2.2 Design of GIS database

It was found that during the past 12 months, SOB had a series of discussions to determine the contents of GIS database and reached a tentative conclusion. Based on this tentative conclusion a hired consultant made a tentative design of geodatabase and workflow diagram as shown in Figure 1 and 2.

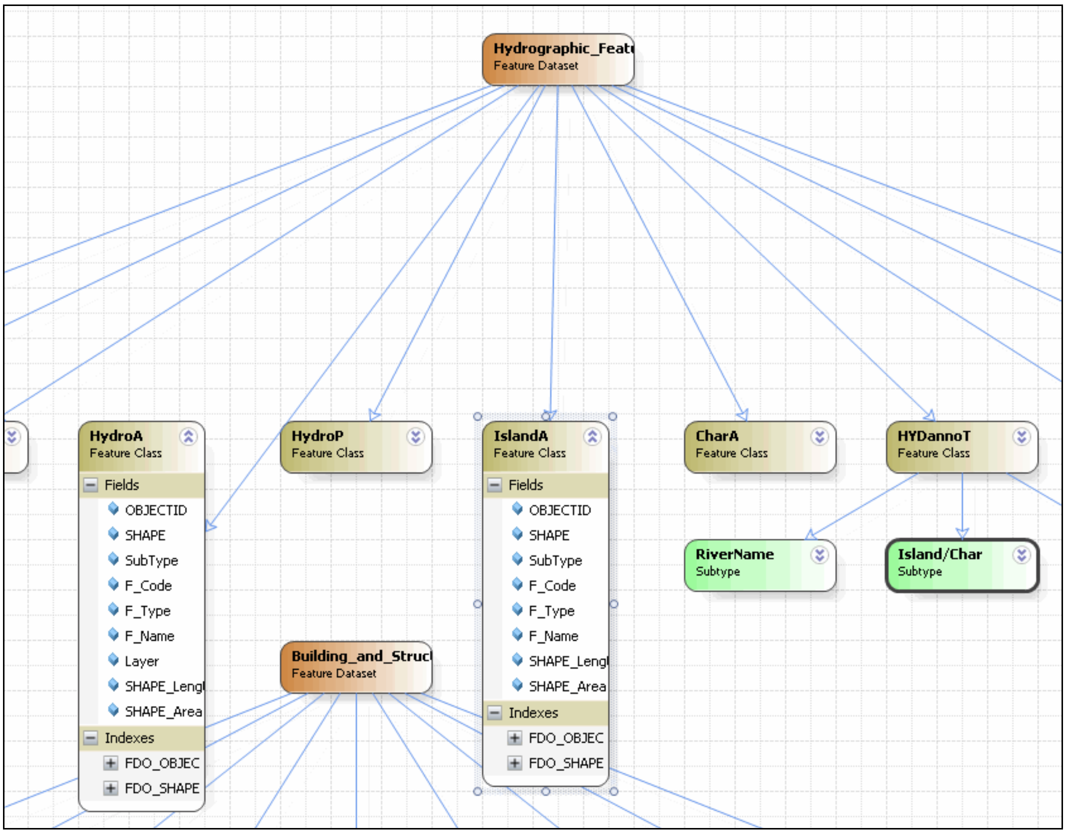


Figure 1. Tentative Design of GIS database

One thing which should be noted is that Photogrammetry Unit and Cartography Unit have already fixed the specifications of their output. That is, for Photogrammetry Unit the specifications of data they produce and for Cartography Unit the specifications of data they should receive from GIS Unit and also what they produce were fixed.

So, it is the responsibility of GIS Unit to determine the method of importing data from Photogrammetry Unit, producing necessary data and exporting the completed data to Cartography Unit.

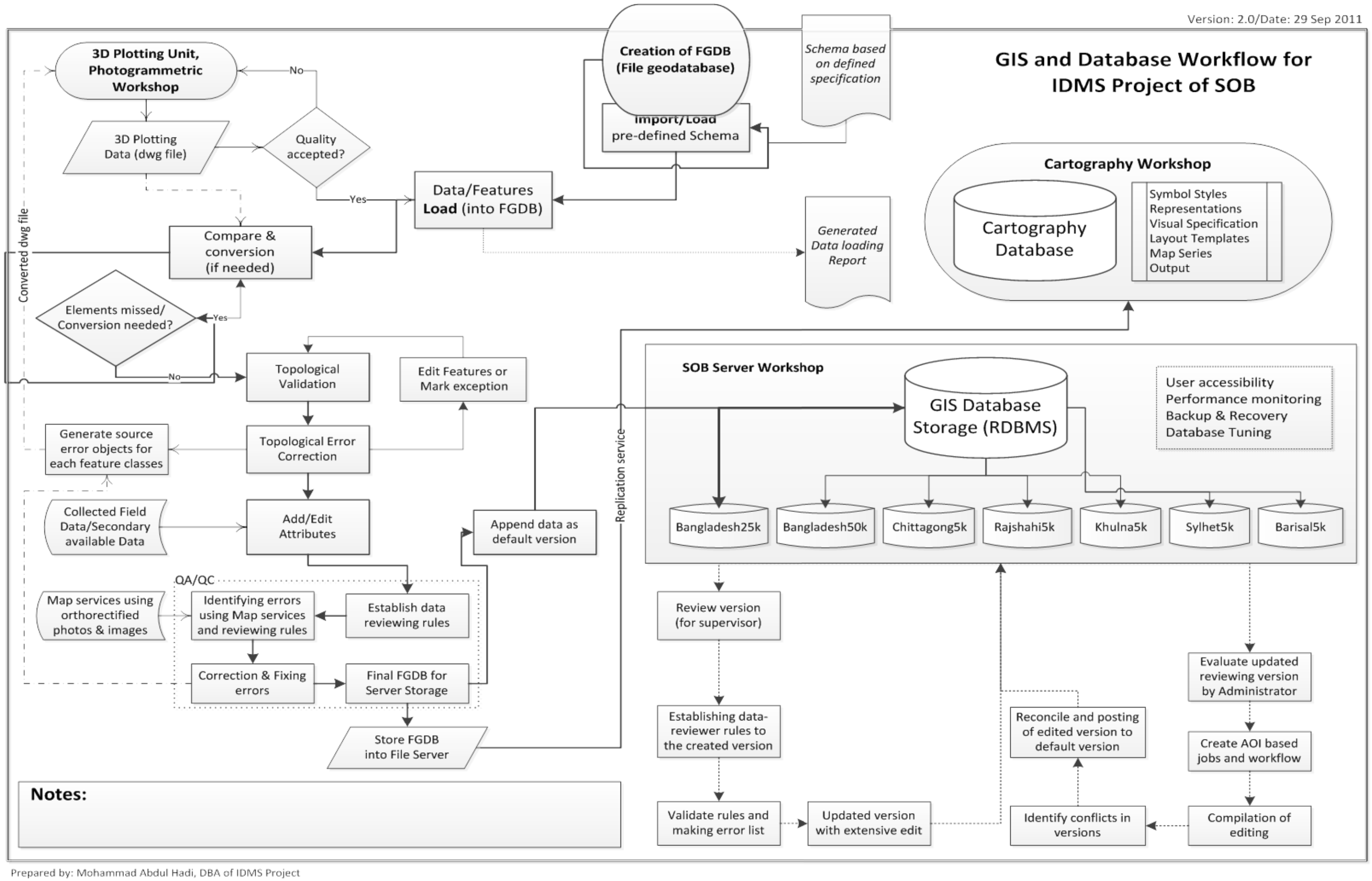


Figure 2. Tentative Workflow of GIS Unit

The GIS database design GIS Unit made for 1/25,000 map has following characteristics.

- Some features have too many categories than required in the 1/25,000 scale mapping.
- It is still not clear for me how GIS Unit collects all the information to fill attributes with so many categories.
- In current design of GIS database of SOB, there is a feature of land use border LINES in addition to land use polygons. Usually, borders between different land use areas are not symbolized because unlike administrative boundary it is difficult to determine the hierarchy of land use boundaries. Figure 3 shows one example of over lapping boundaries.

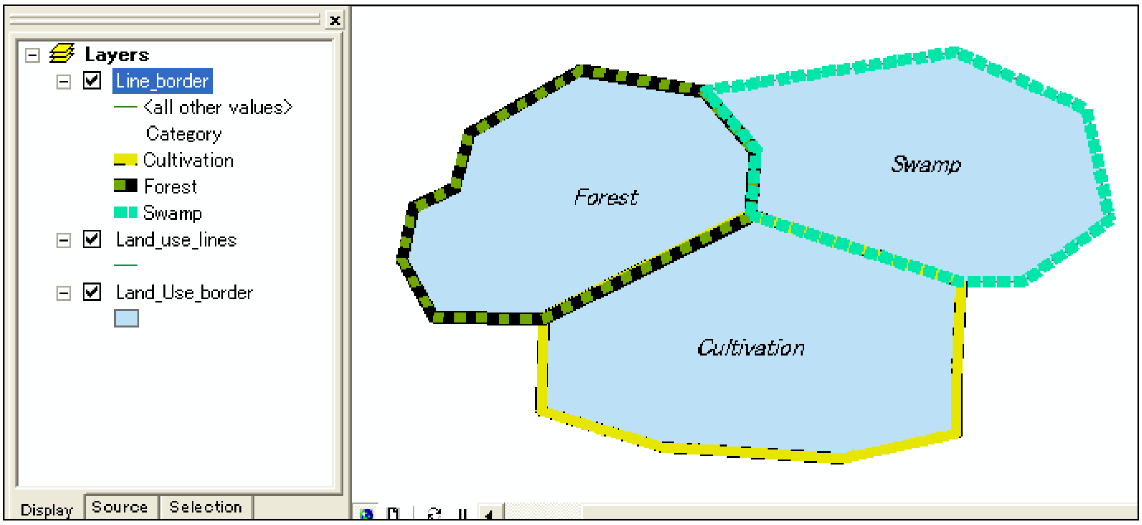


Figure 3. Example of overlapping boundary symbols

- If showing boundaries between different land uses is very important this kind of symbolization would be acceptable. But real problem is that to show boundary symbols, it is necessary to add additional process of converting polygon features into line features.

2.3 Preparatory work

Role of GIS Unit in IDMS project can be categorized as follows:

- Receiving 3D restitution data from Photogrammetry Unit
- Carry out topological check and editing

- Make polygons for some features
- Carry out field verification survey and collect existing information
- Add attribute data
- Complete map data which can be used by Cartography Unit
- Make GIS database

I understand that trial verification survey was conducted for a small area around June 2011 and information was collected mainly on facilities. Place names and other annotations would be collected from existing 1/50,000 map but exact method to use them or add them seems to have not been tested or determined yet.

With the great effort of hired consultant Mr.Hadi, prototype geodatabase design was made as shown in Figure 1 and also efficient method of data loading is now being examined. Also, by a small number of experienced staff of GIS Unit a document titled "User Manual for GIS Operator" is now being made. Draft of the manual is attached to this report as Appendix 1. Mr.Ono also made a sample guideline for the work of GIS Unit. This is attached to this report as Appendix 2.

However, it seems that GIS unit has not carried out any test of adding attribute information to features even though trial field verification survey was conducted a few months ago and data were already in a form of EXCEL file. This kind of test is possible even if complete map data is not provided from Photogrammetry Unit.

Further, as mentioned in Clause 2.2 of this report, design of GIS database has still not been finalized yet. While the design can be altered later, it is obvious that no change is made later.

3. Recommendations

3.1 My observation

In summary, GIS Unit is considered to be not fully ready yet to undertake the real job for which GIS unit is responsible. Points of concern are:

a. Too many categories for some features

For example, Spring/Fall (HydroP) feature has 7 categories. Number of Photogrammetry Unit data to be used to make Spring/Fall feature is 5. This means that GIS Unit has to collect two types of information which will not be provided by Photogrammerty Unit. And actually, only three categories among the 7 categories of GIS database will be shown on the 1/25,000 scale map.

From the point of view of 1/25,000 scale map production, GIS Unit needs to spend time and resources to collect UNNECESSARY information.

It should be noted that information which can be obtained by stereoscopic restitution is limited. For example, type of facilities or type of roads can not be determined on aerial photos. The detailed information should be collected by field verification survey or from existing information. And existing information is often incomplete and GIS Unit has to spend much energy in collecting missing information or editing incomplete information.

b. Potential gap of understanding between Photogrammetry Unit and GIS Unit

GIS Unit provided me with tables of specifications of the data to be handled by three units of IDMS project. I was explained that the tables were the latest version.

However, I found that there were still a number of discrepancies between the data to be produced by Photogrammetry Unit and the data which GIS Unit expects to receive from Photogramemtry Unit. Moreover, it seems to me that different people in GIS Unit have different understanding on the specifications of the data they receive from Photogrammetry Unit.

c. Possible under estimation of the volume of work

There is high possibility that GIS Unit has under estimated the volume of work they have to carry out.　Causes of miscalculation would be:

- GIS Unit miss understand the type of data to be provided from Photogrammetry Unit.
- GIS Unit has not undergone simulation of various types of work they are responsible,

d. Possible under estimation of technical level to be required in actual job

Since GIS Unit has not carried out intensive self training of GIS software operations, there is a possibility that real capacity of GIS Unit has not been assessed. Judging from the fact that so many mistakes were found in the work of Photogrammetry Unit, it is also worried that similar problem impair the work of GIS Unit.

3.2 Advices given

Observing the present situation Mr.Ono took the following actions.

3.2.1 Advice by issuing letters and documents

- Recommendation to start preparation
- Recommendation to review the relation between the data Photogrammetry Unit make and GIS Unit has to make.

Copies of the letters submitted by Mr.Ono to Major Zamil are attached to this report as Appendix 3.

Also as mentioned earlier, Mr.Ono made sample guideline for the work of GIS Unit. This guideline is still tentative because there are so many things which cannot be revealed before actual work of GIS Unit starts.

3.2.2 Verbal conversation with GIS Unit and a consultant

Through verbal conversation with GIS Unit staff and a hired consultant, Mr.Ono tried to understand the present level of readiness of GIS Unit for real work. And during the conversation, Mr.Ono gave some hints to avoid problems particularly to avoid delay in the production of the maps.

3.3 Additional comments

In addition to advices already given, I would like to list some more comments.

- Leading persons of GIS Unit should touch GIS software more often until they are fully confident in the operation. Otherwise they can not lead a pack of un-experienced staff. For the moment, JICA Experts or a hired consultant Mr.Hadi can give advice to GIS Unit. But in the near future, GIS Unit has to work without the assistance from hired consultants or JICA Experts. There is no time for GIS Unit to waste. GIS Unit staff should try their best to fully understand the concept of ArcGIS and related software as well as the details of actual work GIS Unit should undertake. I of course understand that some staff of GIS Unit already has a good understanding on ArcGIS but many other staff of GIS Unit should improve their technical capability of using ArcGIS.

- Every document should carry unique title and identification number together with the date the document was created or modified. Many documents and tables made by GIS Unit do not carry any clue to their validity except for file names. File name is not sufficient because usually we examine the contents of the documents on printed material.

- Improve communication among GIS Unit staff. It was revealed that understanding on the present status of GIS Unit work was not consistent among GIS Unit staff. There was some confusion. If this kind of confusion continues, it is difficult for JICA Experts to provide appropriate or timely advices. Figure 4 is the document I received from GIS Unit as the latest design of data to be used in IDMS project. However, what is written on the document was not exactly the same with what is actually occurring.

GIS SPECIFICATION SCALE 1:25000										
DATASET : BUILDING AND STRUCTURE										
Photogrammetric Input			GIS DATA MODEL						CARTOGRAPHIC DATA	
FEATURE CLASS	GEOMETRY TYPE	FEATURE CODE	FEATURE CLASS	GEOMETRY TYPE	ATTRIBUTE FIELDS	FEATURE CODE	CATEGORY	r	GEOGRAPHIC FEATURE	FEATURE CODE
			Archeological Sites	Point	1. Field Name: F_Code	BLS1401P	Historical/Archeological Sites			
					Alias: Feature Code, Type: String, Length: 8					
					2. Field Name: F_Type					
					Alias: Feature Type, Type: String, Length: 40					
					3. Field Name: F_Name					
					Alias: Monument Name, Type: String, Length: 40					
Peripheral wall	Line	BLS4101L	Fence/Wall (Peripheral)	Line	1. Field Name: F_Code	BLS4101L	Peripheral wall		Peripheral wall	BLS4101L
Peripheral fence	Line	BLS4102L	(FenceL)		Alias: Feature Code, Type: String, Length: 8	BLS4102L	Peripheral fence		Peripheral fence	BLS4102L
					2. Field Name: F_Type					
					Alias: Feature Type, Type: String, Length: 40					
			Building/House	Area	1. Field Name: F_Code	BLS7101A	Building		Building	BLS7101A
			(BuildingA)		Alias: Feature Code, Type: String, Length: 8					

Figure 4. Part of specifications of IDMS project data

3.4 Making printed map for field verification survey

Although no person at GIS Unit mentioned about it, GIS Unit is responsible for printing paper maps which should be used in field verification survey. It is necessary to make a plan to do this work efficiently.

Appendix 1. USER MANUAL FOR GIS OPERATOR

USER MANUAL

FOR

GIS OPERATOR

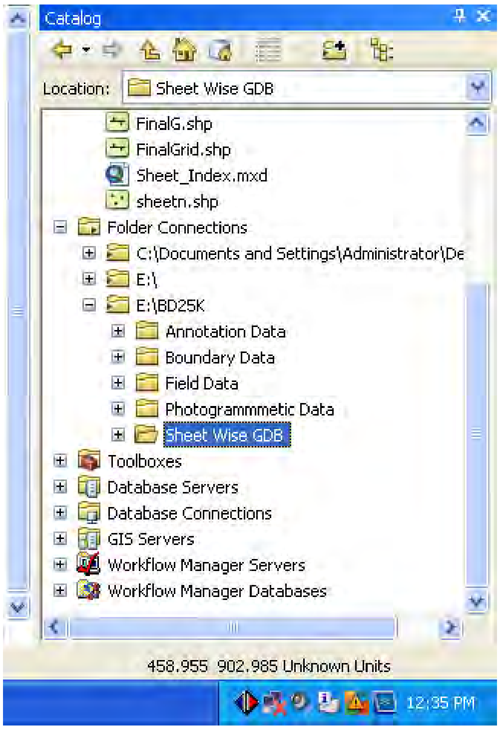
As of October 19, 2011

CONTENTS:

1. Creation of FGBD (File Geodatabase)

Create a folder as **"BD25K"**
This folder contains following folders:

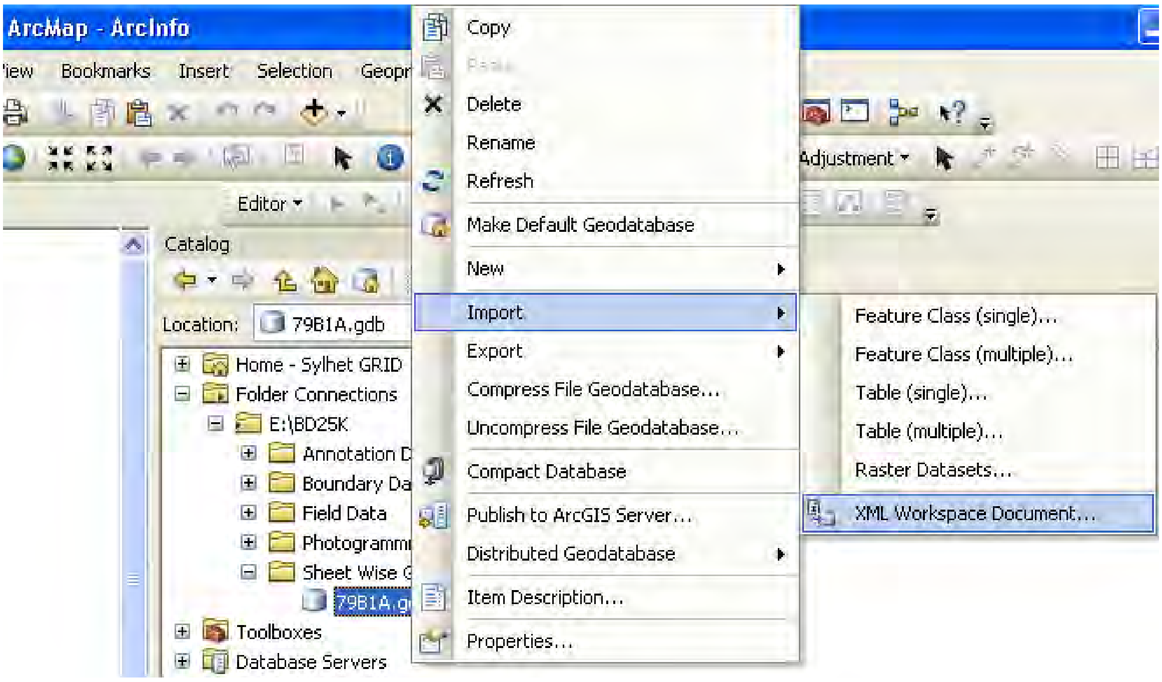
A. Photogrammetric Data
B. Sheet Wise GDB
C. Field Data
D. Annotation Data
E. Boundary Data
F. Miscellaneous



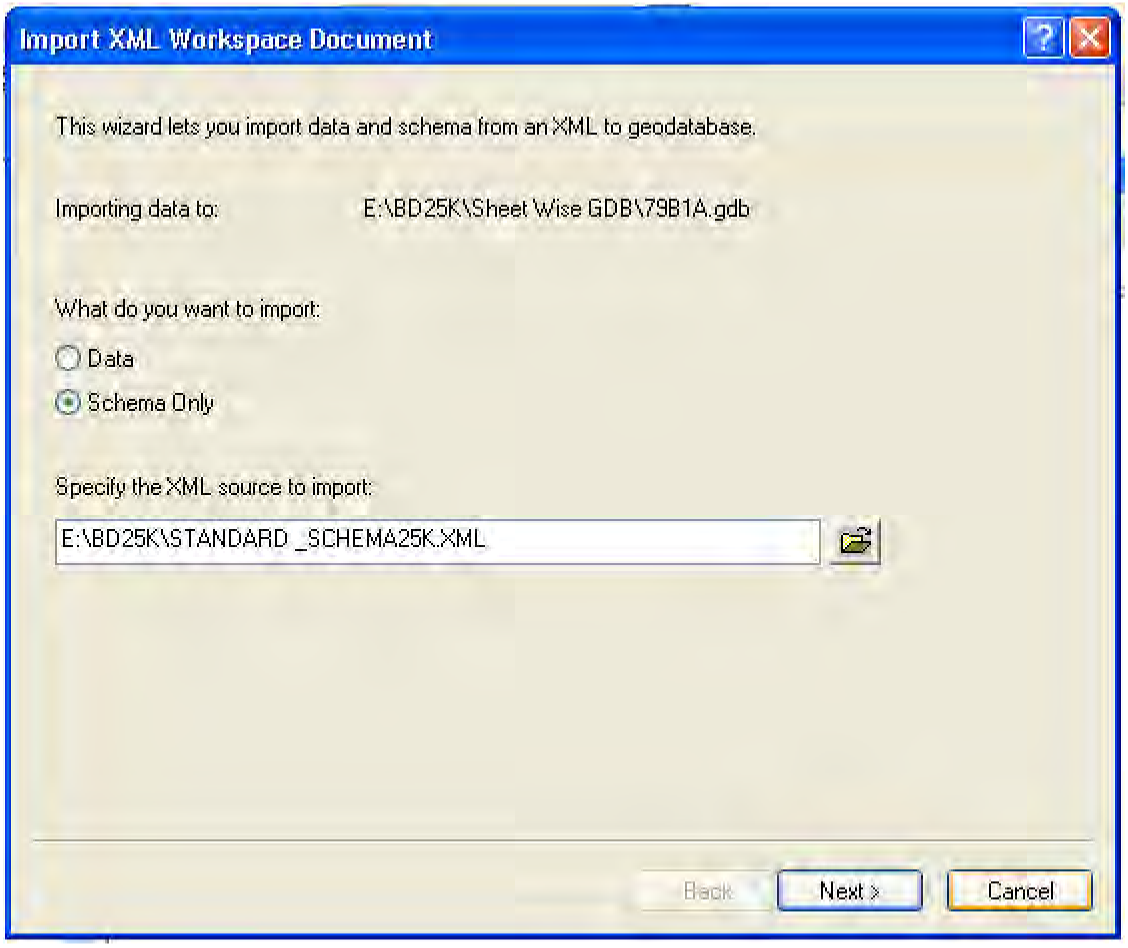
N.B: Mainly creation of sheet wise FGDB and all its components likes Datasets and its projection system, Feature classes, Topology rules etc.
will be done by importing **Pre-defined Schema**.

2. Importing Predefined Schema

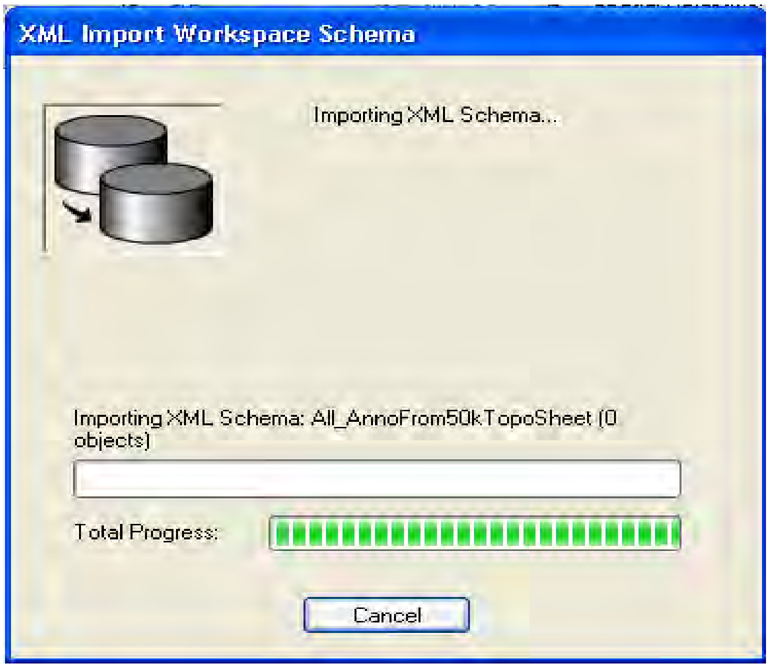
In ***"ArcCatalog"*** browse for the sheetwise FGDB and import schema into FGDB by right clicking on FGDB choose "***import***" then "***XML Workspace Document…***" then "***Open***".



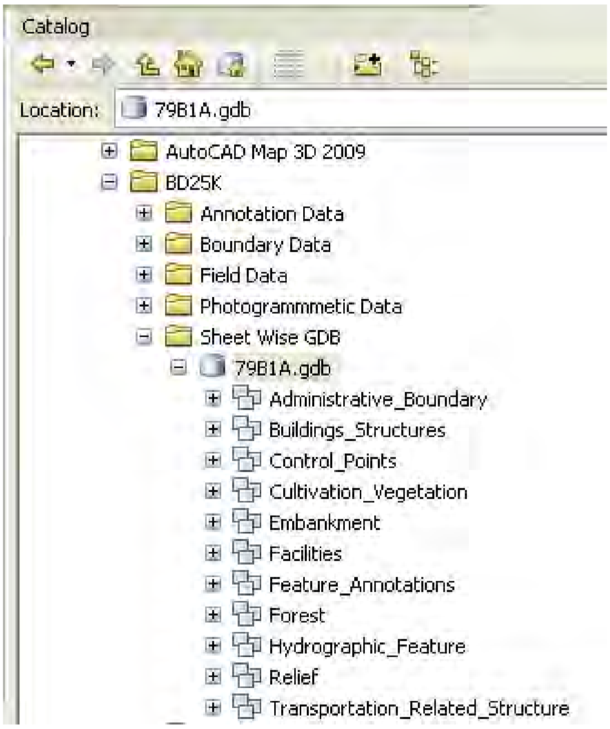
An XML Workspace Document importing wizard will be appeared like this and check “***Schema only***” radio button, define the right location of predefined standard Schema. Press “***Next***” then ***“Finish”.***



At the time of importing schema this wizard will appeared.

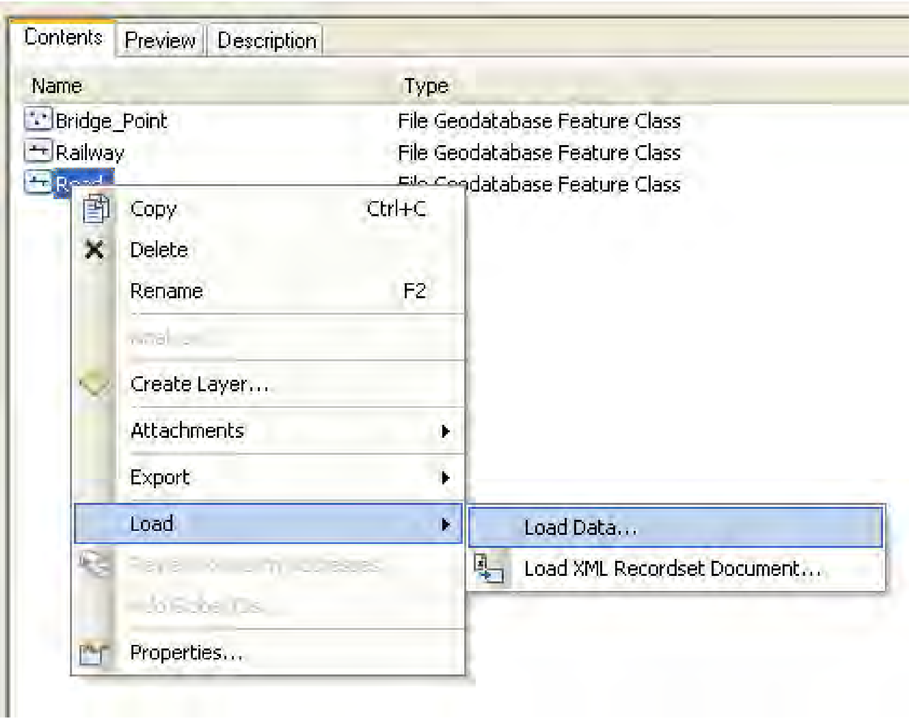


After importing schema the FGDB will be seen like this. All the tables of feature classes will get the structure as per approved specification.

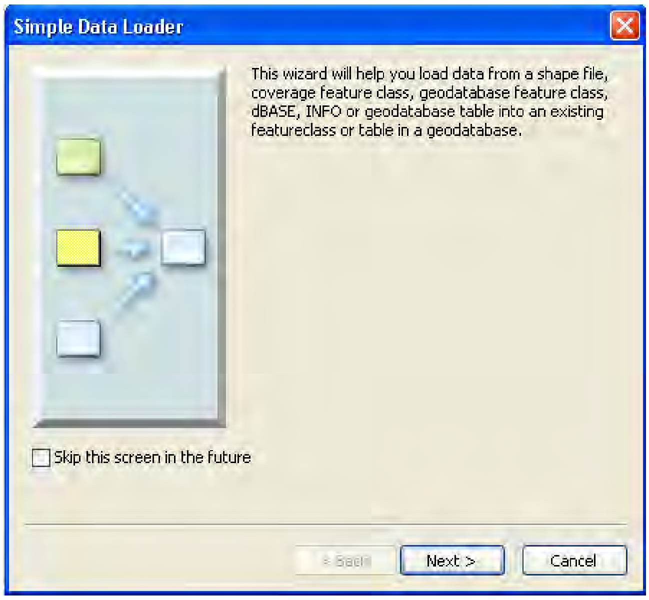


3.DATA /FEATURE LOADING

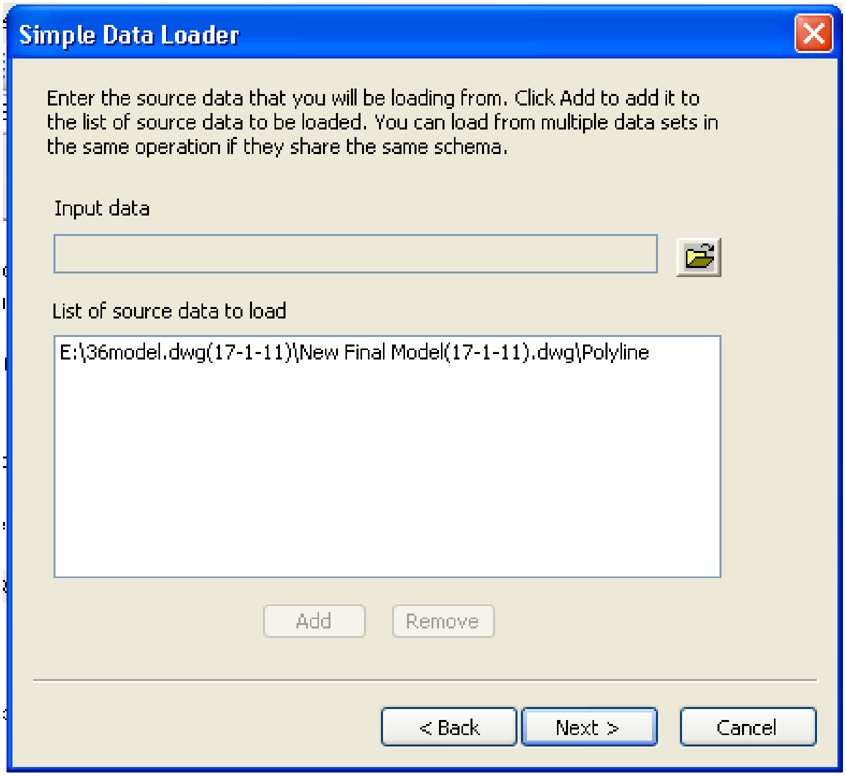
3. To load data in the pre-defined feature class, first we expand the dataset by clicking on to the plus sign of dataset or select the feature class in Catalog window then right click and choose,"***load***"

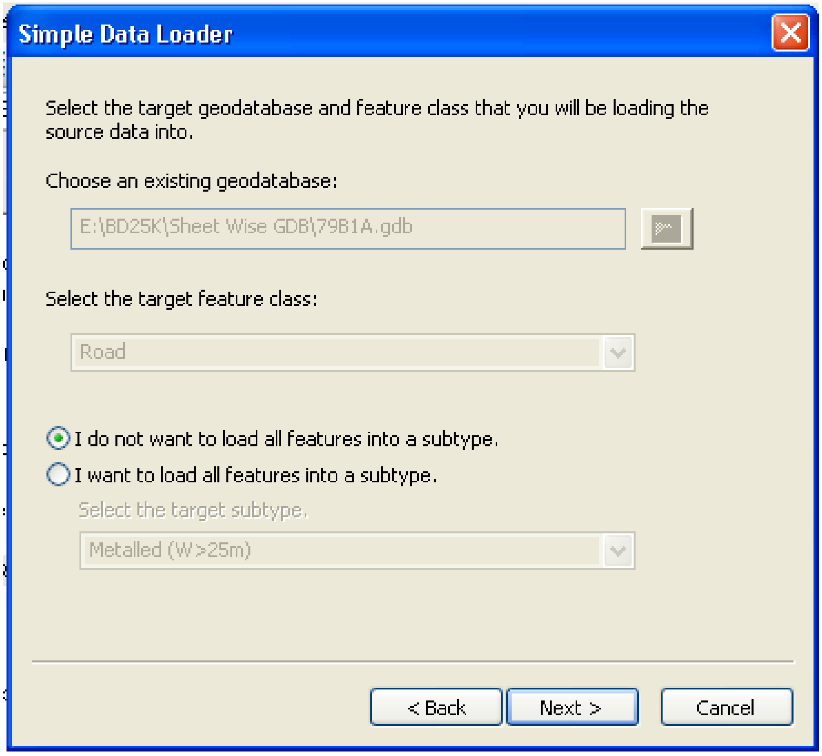


Click “Next” in the “***Simple Data Loader***”

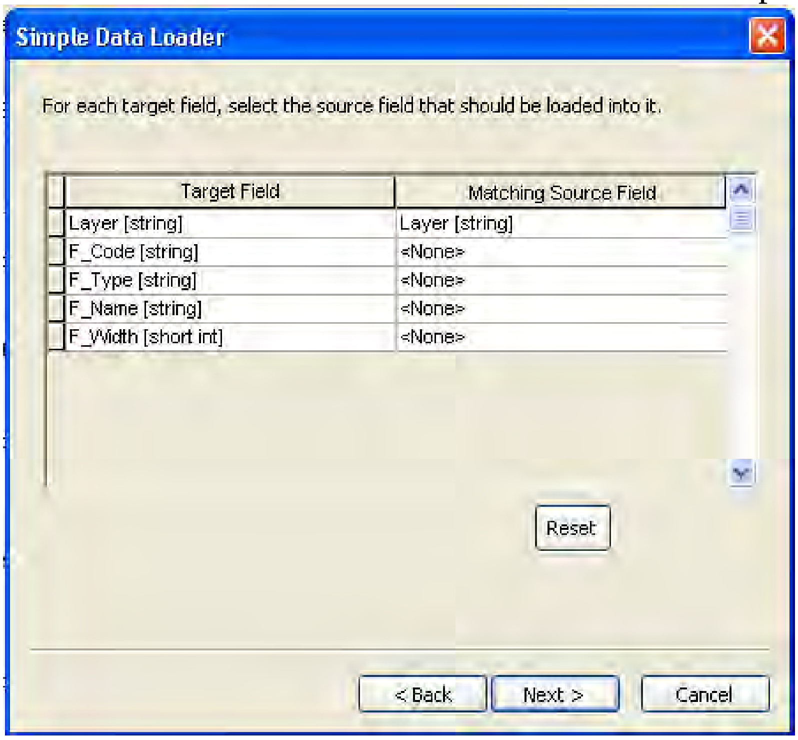


In this stage we will browse for the concern *.dwg line data in the “Input data” box. Click “***Add***” then press “***Next***”.



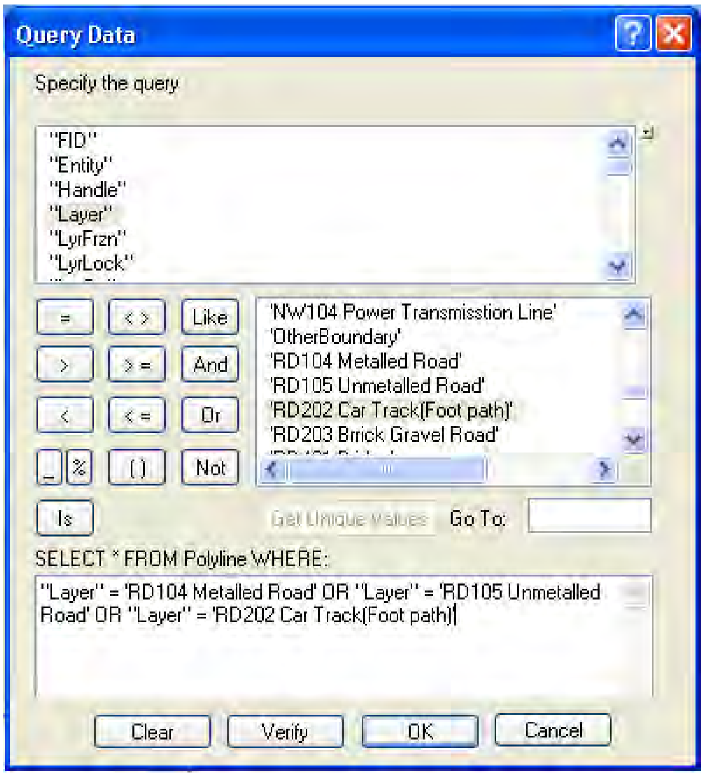


Select the radio button shown as in this wizard then press "***Next***".

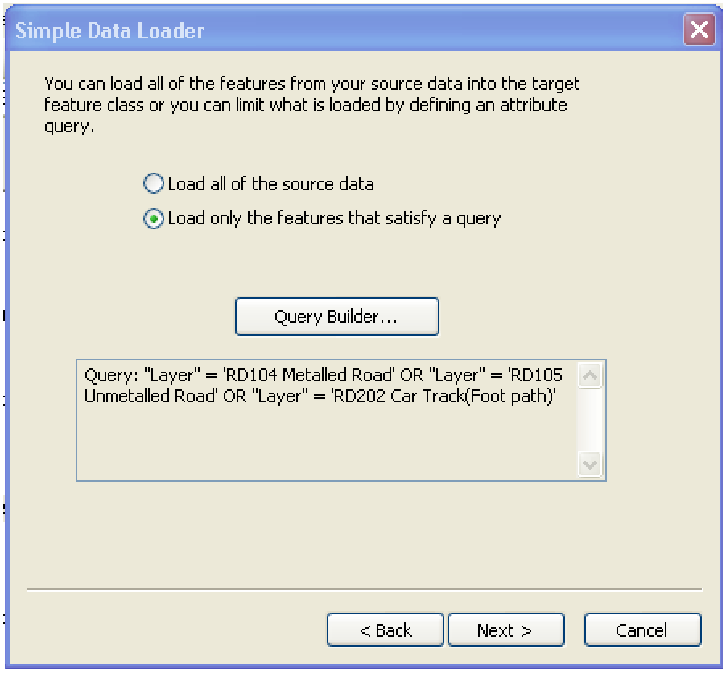


Press "***Next***"

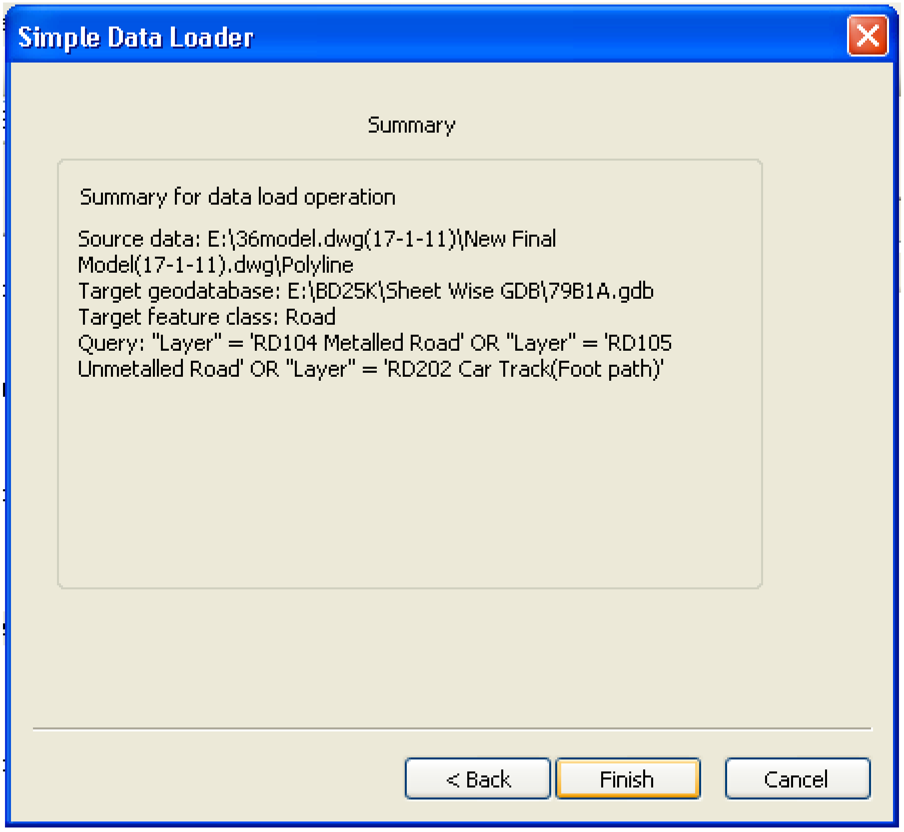
In this wizard chose radio button "***Load only the features that satisfy a query***" then press "***Query Builder***", another wizard named "***Query Data***" will appeared .



In this wizard we will specify the query using "***Layer***" field and get unique values of that layer. Then press "***OK***".



Press “***Next***”.



Press “***Finish***”.

4.Compare And Markup

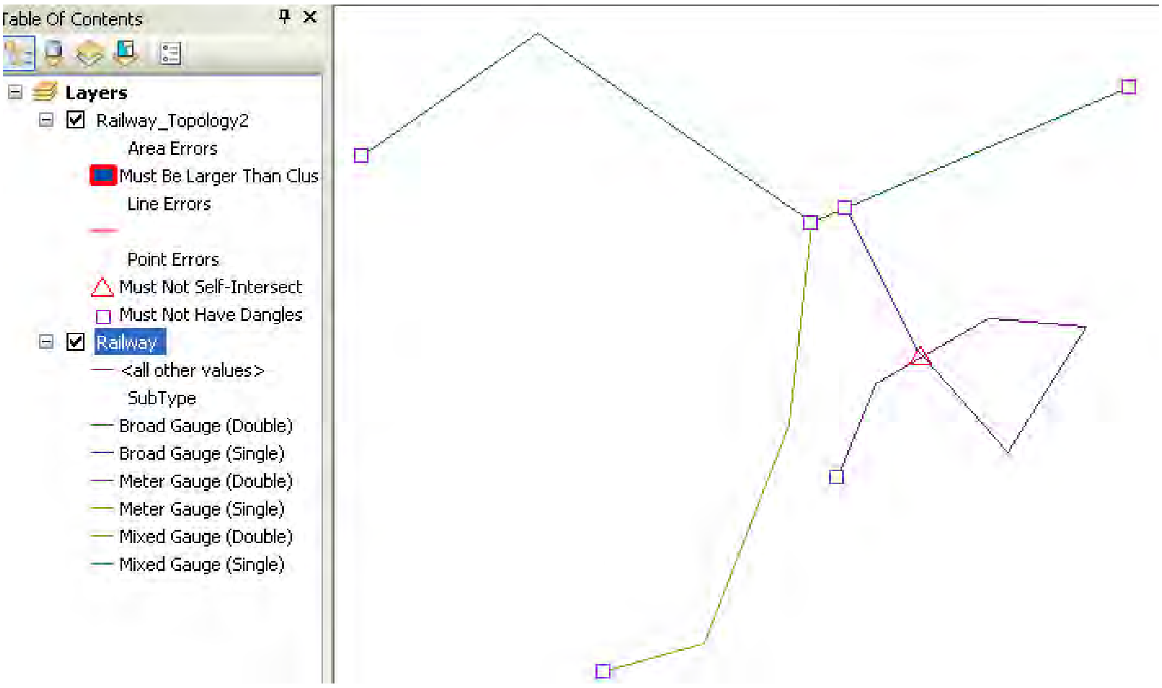
At the time of loading data, a "Data Loading Report" will be generated each time. We have to match between the number of input feature and loaded feature. If both features are not same, load the remaining data only till it found similar and satisfactory. Then proceed for "***Compare and Markup***" for the confused data.

The process "***Compare and Markup***" can be made overlaying data on orthophoto. Then send the markup report to Photogrammetric Unit.

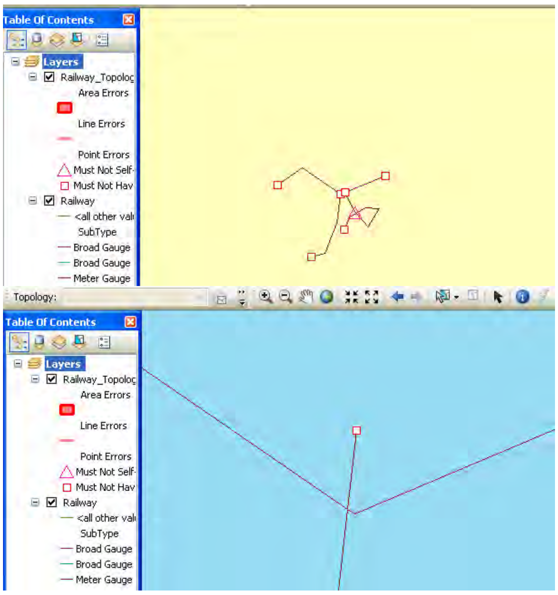
Similarly, load all the data into concern feature classes those are received from Photogrammetric unit after completion of joined checking (Both GIS and Photogrammetric people) in the Photogrammetric Section.

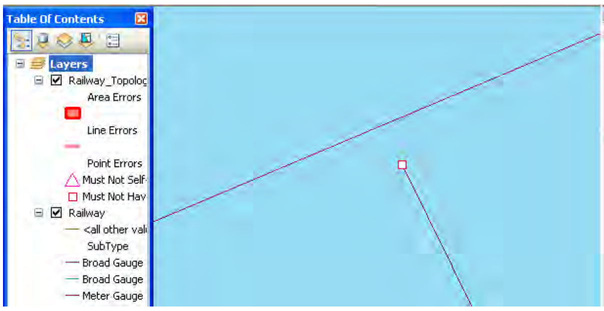
3.FIXING UP TOPOLOGICAL ERRORS

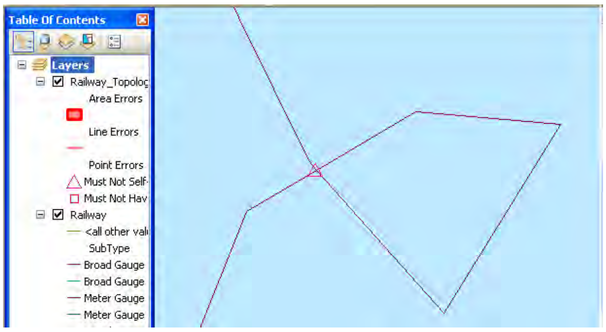
When We load data in the concern feature classes the pre-defined Topology rules automatically detect errors.



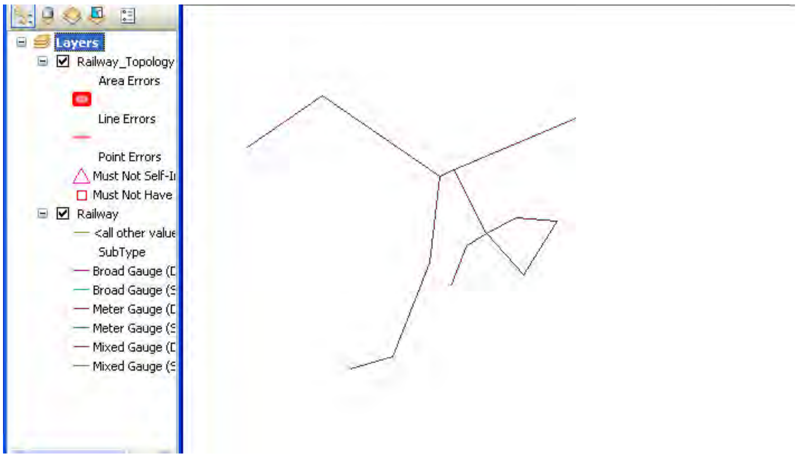
After detecting errors we have to be sure about the type of errors to solve it. Such as, is it dangles (maybe undershoot or overshoot) or self-intersect etc. To be confirmed we have to zoom in to check for every error and fixed up logically.







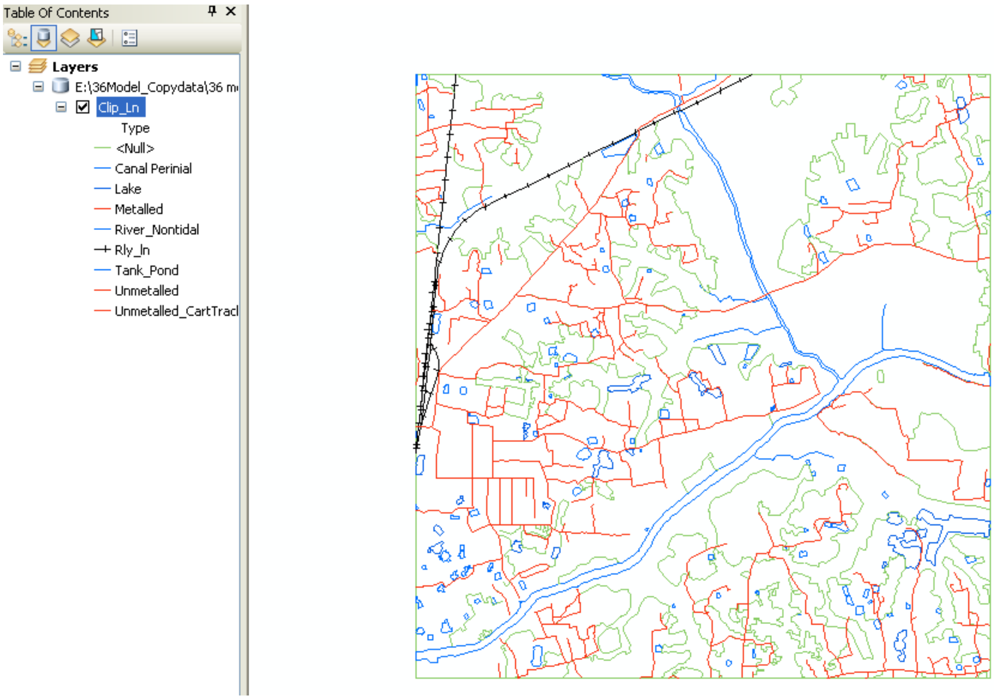
After fixing topological errors data will seen like this.



After completing this process, all individual classes will become error free data.

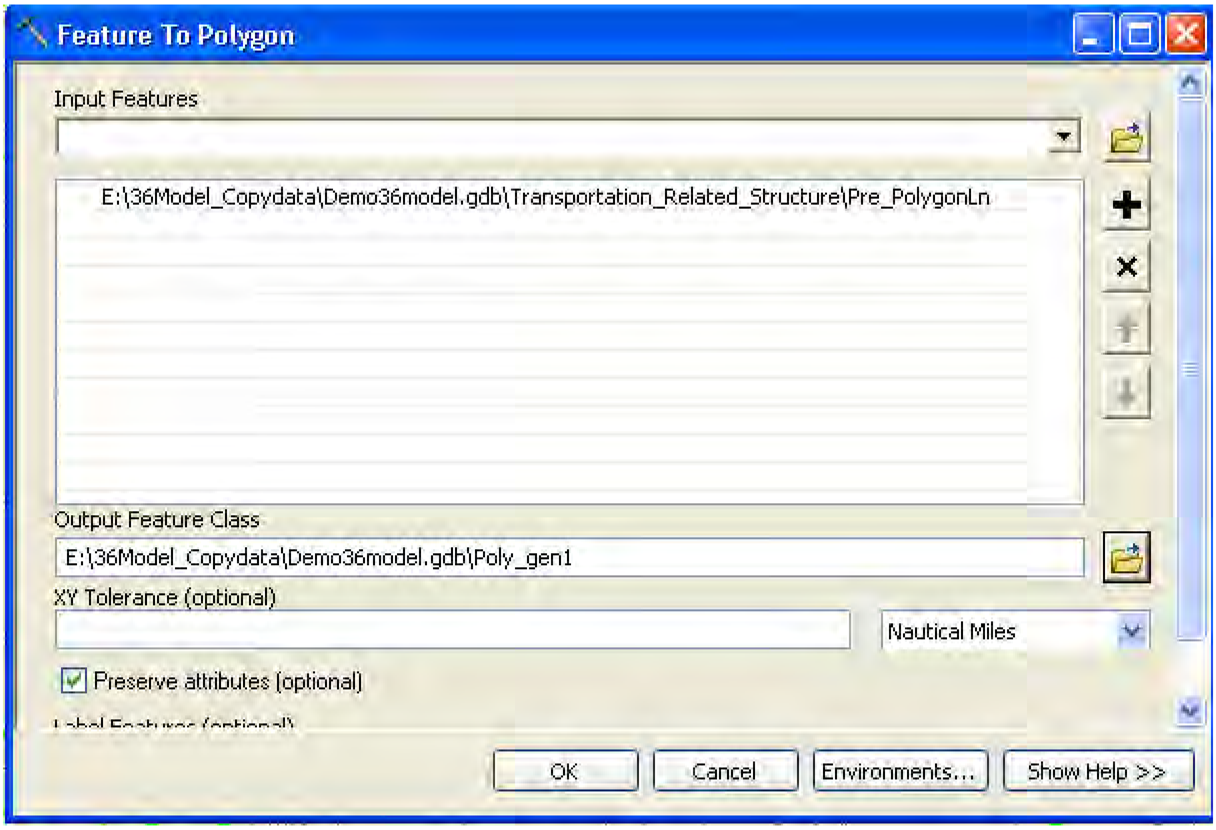
[4.CONVERTING FEATURE TO POLYGON.]

The feature to be converted to polygon along with associated feature(i.e for vegetation associated feature may be roads ,railways, hydrographic features etc.) will be considered as source data to be converted.. To do this we have to have one temporary line feature class that contains all the line data that will take part in this converting process. To create one pre-polygon-line feature class we have to "***Append***" feature classes as mentioned above. Under shown image is an example of pre-polygon-line feature.

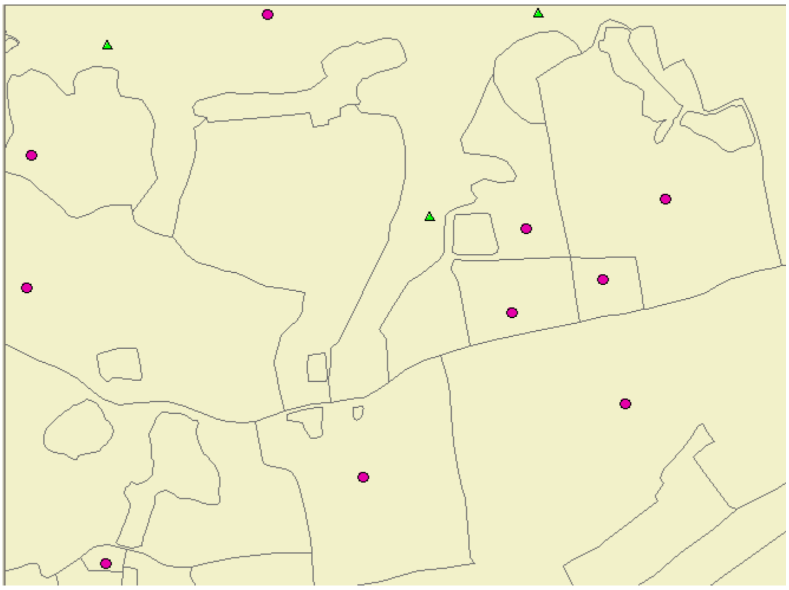


In this stage we have to run once topological error fixing procedure because the source data appended from different feature classes.

After completing topological error fixing operation, open ***"Arc Toolbox"*** and expand "***Data Management Tool***" then double click on "***feature to polygon".*** Specify the output feature class name and then press "***OK***".

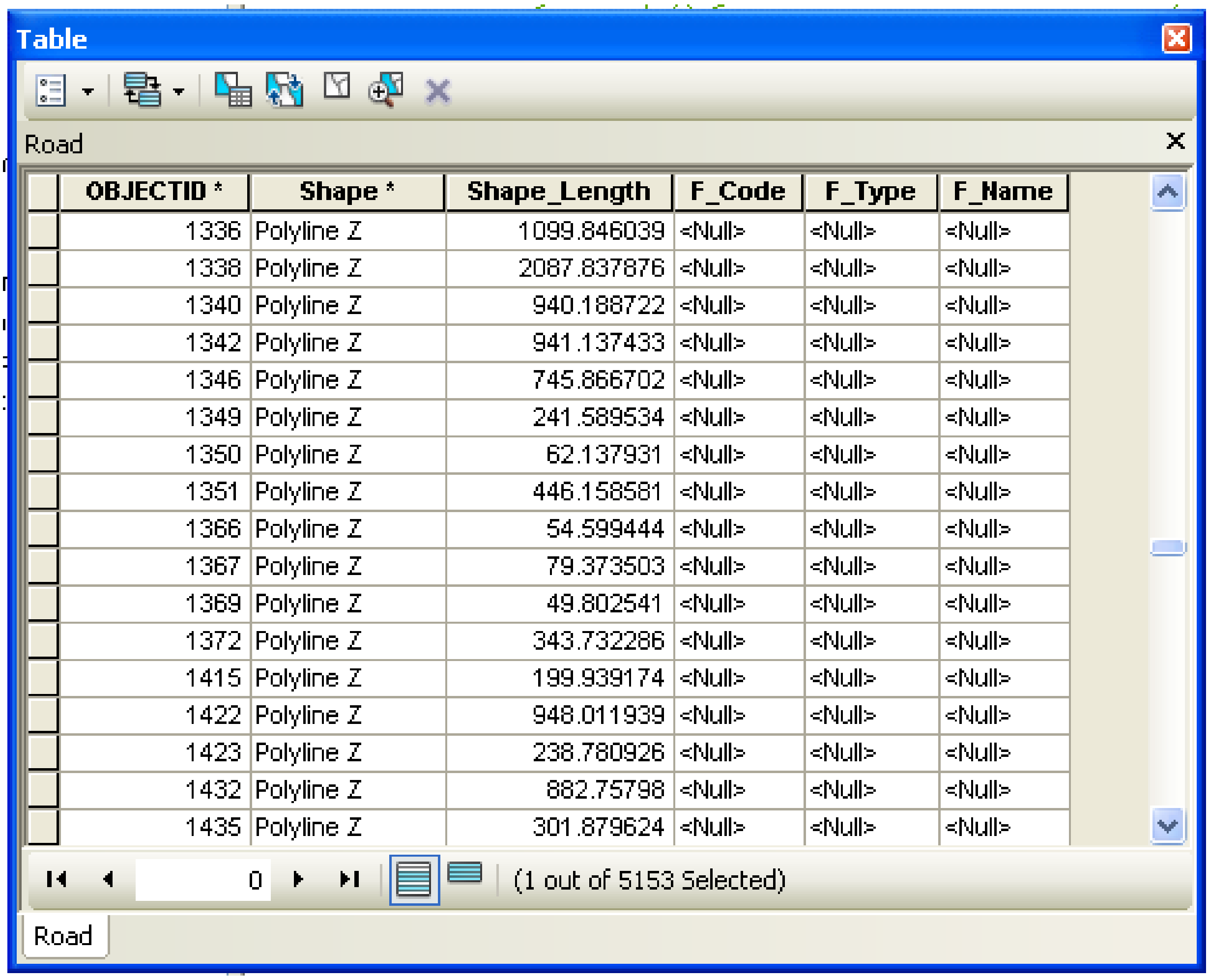


Now we classify necessary polygons between cultivated and uncultivated area from the newly created polygon using points supplied by Photogrammetric section. This can be done by "***Selection by Location***" method and delete unnecessary polygons.



4.ADD / EDIT ATTRIBUTES

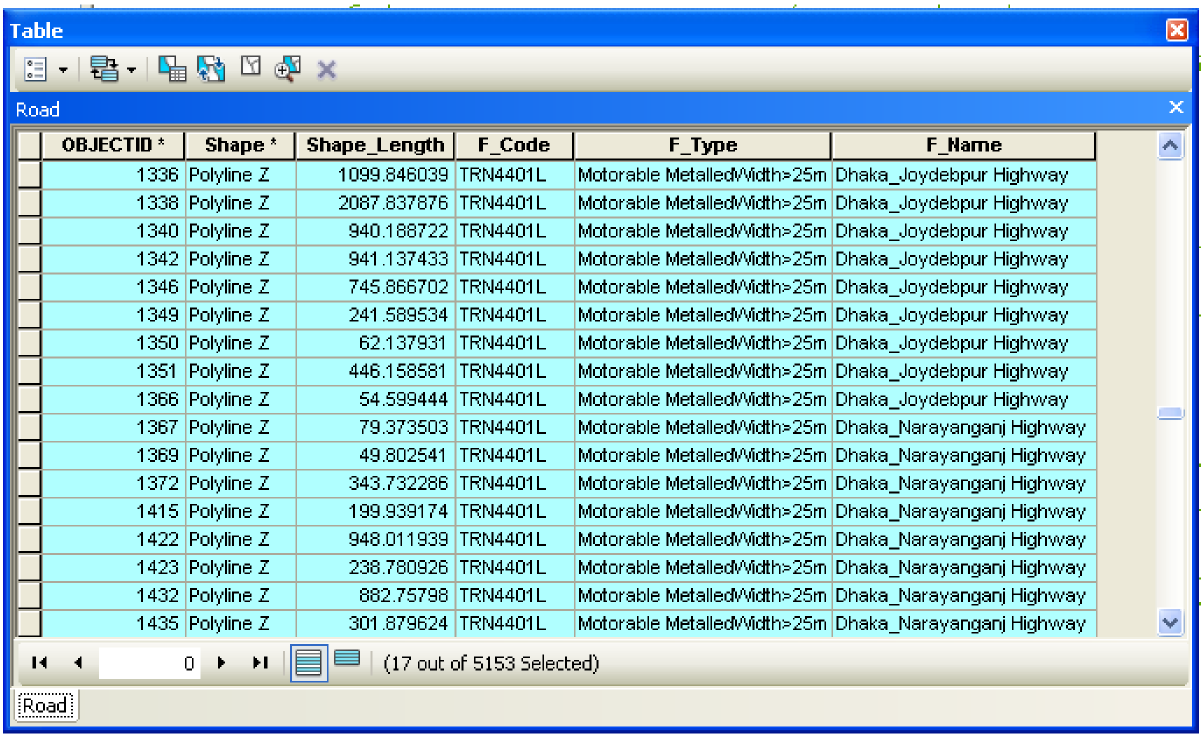
Basically we add all specified attributes as per specification. Hence ,in some attribute table we have to add some necessary fields such as F_Code, F_Type, F_Name .For example now we will add attributes in the attribute table of ***"Road Network"***



OBJECTID *	Shape *	Shape_Length	F_Code	F_Type	F_Name
1336	Polyline Z	1099.846039	<Null>	<Null>	<Null>
1338	Polyline Z	2087.837876	<Null>	<Null>	<Null>
1340	Polyline Z	940.188722	<Null>	<Null>	<Null>
1342	Polyline Z	941.137433	<Null>	<Null>	<Null>
1346	Polyline Z	745.866702	<Null>	<Null>	<Null>
1349	Polyline Z	241.589534	<Null>	<Null>	<Null>
1350	Polyline Z	62.137931	<Null>	<Null>	<Null>
1351	Polyline Z	446.158581	<Null>	<Null>	<Null>
1366	Polyline Z	54.599444	<Null>	<Null>	<Null>
1367	Polyline Z	79.373503	<Null>	<Null>	<Null>
1369	Polyline Z	49.802541	<Null>	<Null>	<Null>
1372	Polyline Z	343.732286	<Null>	<Null>	<Null>
1415	Polyline Z	199.939174	<Null>	<Null>	<Null>
1422	Polyline Z	948.011939	<Null>	<Null>	<Null>
1423	Polyline Z	238.780926	<Null>	<Null>	<Null>
1432	Polyline Z	882.75798	<Null>	<Null>	<Null>
1435	Polyline Z	301.879624	<Null>	<Null>	<Null>

In this example we have no attribute in the table .Now we will add necessary attribute in this table.

After adding attribute table will look as below.



Table

Road

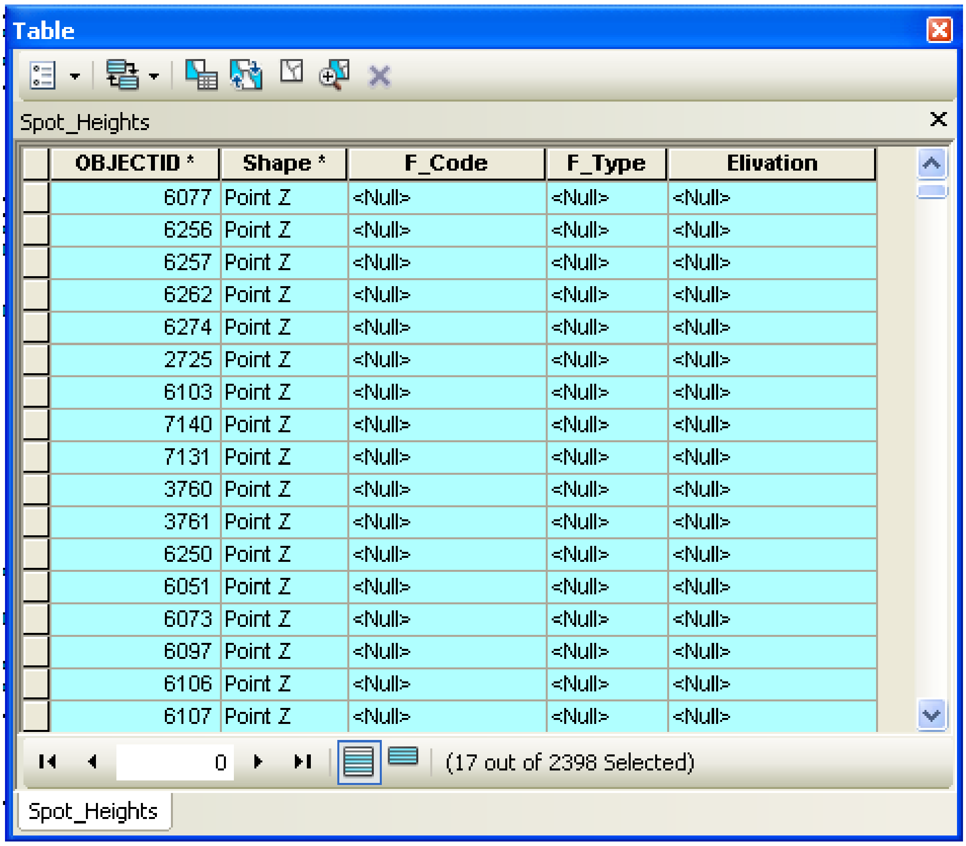
	OBJECTID *	Shape *	Shape_Length	F_Code	F_Type	F_Name
	1336	Polyline Z	1099.846039	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Joydebpur Highway
	1338	Polyline Z	2087.837876	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Joydebpur Highway
	1340	Polyline Z	940.188722	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Joydebpur Highway
	1342	Polyline Z	941.137433	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Joydebpur Highway
	1346	Polyline Z	745.866702	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Joydebpur Highway
	1349	Polyline Z	241.589534	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Joydebpur Highway
	1350	Polyline Z	62.137931	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Joydebpur Highway
	1351	Polyline Z	446.158581	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Joydebpur Highway
	1366	Polyline Z	54.599444	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Joydebpur Highway
	1367	Polyline Z	79.373503	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Narayanganj Highway
	1369	Polyline Z	49.802541	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Narayanganj Highway
	1372	Polyline Z	343.732286	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Narayanganj Highway
	1415	Polyline Z	199.939174	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Narayanganj Highway
	1422	Polyline Z	948.011939	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Narayanganj Highway
	1423	Polyline Z	238.780926	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Narayanganj Highway
	1432	Polyline Z	882.75798	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Narayanganj Highway
	1435	Polyline Z	301.879624	TRN4401L	Motorable MetalledWidth>25m	Dhaka_Narayanganj Highway

0 (17 out of 5153 Selected)

Road

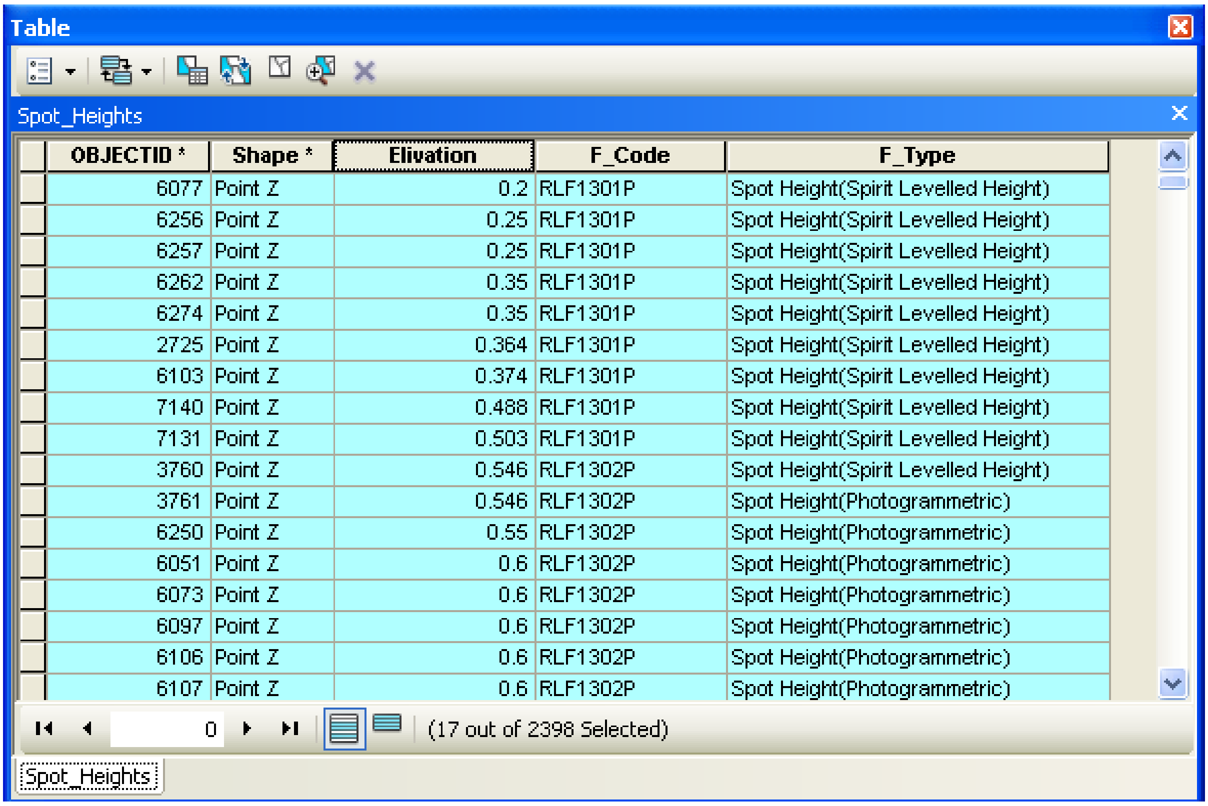
Similarly we can add attributes in all the tables for all the feature classes. All these attributes are derived from the field or other relevant sources rather then photogrammetric unit.

But some attributes will come from Photogrammetric unit directly (like spot height, contour elevation) .In that case we will Edit attributes.



OBJECTID *	Shape *	F_Code	F_Type	Elivation
6077	Point Z	<Null>	<Null>	<Null>
6256	Point Z	<Null>	<Null>	<Null>
6257	Point Z	<Null>	<Null>	<Null>
6262	Point Z	<Null>	<Null>	<Null>
6274	Point Z	<Null>	<Null>	<Null>
2725	Point Z	<Null>	<Null>	<Null>
6103	Point Z	<Null>	<Null>	<Null>
7140	Point Z	<Null>	<Null>	<Null>
7131	Point Z	<Null>	<Null>	<Null>
3760	Point Z	<Null>	<Null>	<Null>
3761	Point Z	<Null>	<Null>	<Null>
6250	Point Z	<Null>	<Null>	<Null>
6051	Point Z	<Null>	<Null>	<Null>
6073	Point Z	<Null>	<Null>	<Null>
6097	Point Z	<Null>	<Null>	<Null>
6106	Point Z	<Null>	<Null>	<Null>
6107	Point Z	<Null>	<Null>	<Null>

After Editing the table will be seen like this.



OBJECTID *	Shape *	Elivation	F_Code	F_Type
6077	Point Z	0.2	RLF1301P	Spot Height(Spirit Levelled Height)
6256	Point Z	0.25	RLF1301P	Spot Height(Spirit Levelled Height)
6257	Point Z	0.25	RLF1301P	Spot Height(Spirit Levelled Height)
6262	Point Z	0.35	RLF1301P	Spot Height(Spirit Levelled Height)
6274	Point Z	0.35	RLF1301P	Spot Height(Spirit Levelled Height)
2725	Point Z	0.364	RLF1301P	Spot Height(Spirit Levelled Height)
6103	Point Z	0.374	RLF1301P	Spot Height(Spirit Levelled Height)
7140	Point Z	0.488	RLF1301P	Spot Height(Spirit Levelled Height)
7131	Point Z	0.503	RLF1301P	Spot Height(Spirit Levelled Height)
3760	Point Z	0.546	RLF1302P	Spot Height(Spirit Levelled Height)
3761	Point Z	0.546	RLF1302P	Spot Height(Photogrammetric)
6250	Point Z	0.55	RLF1302P	Spot Height(Photogrammetric)
6051	Point Z	0.6	RLF1302P	Spot Height(Photogrammetric)
6073	Point Z	0.6	RLF1302P	Spot Height(Photogrammetric)
6097	Point Z	0.6	RLF1302P	Spot Height(Photogrammetric)
6106	Point Z	0.6	RLF1302P	Spot Height(Photogrammetric)
6107	Point Z	0.6	RLF1302P	Spot Height(Photogrammetric)

Appendix 2.　Sample Guideline for the Work of GIS Unit

Bangladesh Digital Mapping Assistance Project

(BDMAP)

Sample Guideline for the Work of GIS Unit

Version 1

October 23, 2011

Index

Preface

First of all, this draft guideline was prepared to show GIS Unit of the Survey of Bangladesh (SOB) one example of operational guideline. Since many things about the GIS Unit’s work are still uncertain as of writing this document, this guideline need to be modified along with the progress of the work of GIS Unit in IDMS project.

Secondly, while this guideline explains detailed operation of ArcGIS (ArcInfo) software, explanation is limited to the types of operation necessary for GIS Unit.

In traditional digital photogrammetric mapping, software to be used for restitution and GIS data construction was different. For the restitution work, CAD software such as AutoCAD or Microstation was used. Then the CAD data were sent to GIS software for topology construction and checking.

However, with the improvement in the functionality of GIS software, CAD software is replaced by GIS software for some parts of the mapping work.

In case of IDMS Project of SOB, initial restitution is implemented by using CAD software but subsequent map editing work, which was usually done by CAD software, is implemented by using GIS software.

This sample guideline focuses on the work of GIS Unit in IDMS project, particularly for the parts in which GIS and related software are used, and not on all the work of the IDMS project in which GIS software is used.

It should be kept in mind that there may be more than one method or procedure for each step of work. The best work method will be chosen after experiencing actual work by GIS Unit.

1. Objective of this Guideline

Objective of this guideline is to show GIS Unit staff contents of the work they should carry out and also recommended work flow for major work items so that every staff use the same method and follow the same work flow.

For some type of work there will be more than one method or work flow. In such a case alternative methods are explained. Factors to determine a method or workflow among multiple alternatives will be:

- Contents and characteristics of input data
- Contents and characteristics of output data
- Technical capability of staff who carry out the work
- Available software
- Work of other related units
- Available time
- Stability of electricity supply

Idealistically, a method or workflow which is easy to understand and efficient and which can reduce chance of mistakes will be chosen. But often such method or workflow can be found only after actual work starts and GIS Unit encounters many problems. So, again this guideline is only a base and should be modified or changed incorporating findings GIS Unit will acquire along with the progress of its work.

2. Task of GIS Unit in the IDMS Project

As of October 23, 2011, tasks of GIS Unit in the IDMS project are as follows:

(1) Make complete topological data from 3D plotting data for 1/25,000 and 1/5,000 scale mapping and for GIS database.
(2) Carry out field verification survey to collect attribute data.
(3) Collect attribute information from existing materials.
(4) Add collected attribute information to geographic features.
(5) To complete data which will be used by Cartographic Unit for final editing.
(6) Manage GIS database

This document covers item (1), (4) and (5).

Actual work to be done by GIS Unit by using ArcGIS software will be basically the same whether the data is for mapping or for GIS database construction except for one condition. Production of mapping data is more urgent than GIS database construction. Delay in map data production at the GIS Unit causes delay in the subsequent cartographic processes and affects the entire schedule of IDMS project.

3. Design of SOB GIS database

Design of GIS database of SOB as of October 23, 2011 is as shown on separate document titled “GIS Specification Scale 1:25,000.”

It seems that SOB’s GIS database for 1/25,000 map is designed to contain much more detailed data than required in 1/25,000 mapping. Also, the database is designed to use one server to store and manage datasets.

This presents two potential problems.

(1) Possibility that too much time is spent in collecting and editing data to fill database even if not all the data are required in the 1/25,000 scale mapping.

(2) Possibility that software to manage work process such as Data Reviewer and Work Flow Manager cannot be operated properly because GIS Unit staff is still not familiar with the software.

(3) Possibility that server machine does not work because of electricity supply problem

But fortunately, as explained later, major part of the GIS Unit work can be done by using File Geodatabase created in PC of each operator. Therefore, even if problems related to server operation arises, GIS Unit can continue working. Important point will be that GIS Unit staff is capable of dealing with change in production procedures.

4. Breakdown of Work of GIS Unit

As explained in Chapter 1 of this document, tasks of GIS Unit covered by this guideline are the following three items.

- ■ Make complete topological data from 3D plotting data.
- ■ Complete data which will be used by Cartographic Unit for final editing.
- ■ Add collected attribute information to geographic features.

As of October 16, 2011, work flow for these three tasks is as shown in Figure 1. According to the work flow, breakdown of work items of GIS Unit will be as follows:

(1) Creation of FGDB
(2) Import/Load Predefined Schema
(3) Quality check
(4) Data/Feature load (into FGDB)
(5) Matching （Comparing）and Conversion (if needed)
(6) Elements missed/Conversion needed
(7) Topological Validation and QC
(8) Edit features of mark exception
(9) Topological error correction
(10) Generate source error objects for each feature classes
(11) Add/edit attributes
(12) Identify errors using Map Service and reviewing rules
(13) Correction and fixing errors
(14) Append data to specific version

One prominent characteristic of this work flow design is that topology and other necessary editing work can be done on File Geodatabase environment. This means that this type of work can be done even though server environment is not ready yet or SOB is still not familiar with the operation of database or work management software such as Work Flow Manger.

Further, it should be noted that the work of GIS Unit is not simple and cannot be automatic. Correction of topology and other types of errors is the kind of work which requires continuous concentration and decision making of operators. The same is true for Add/Edit Attribute process.

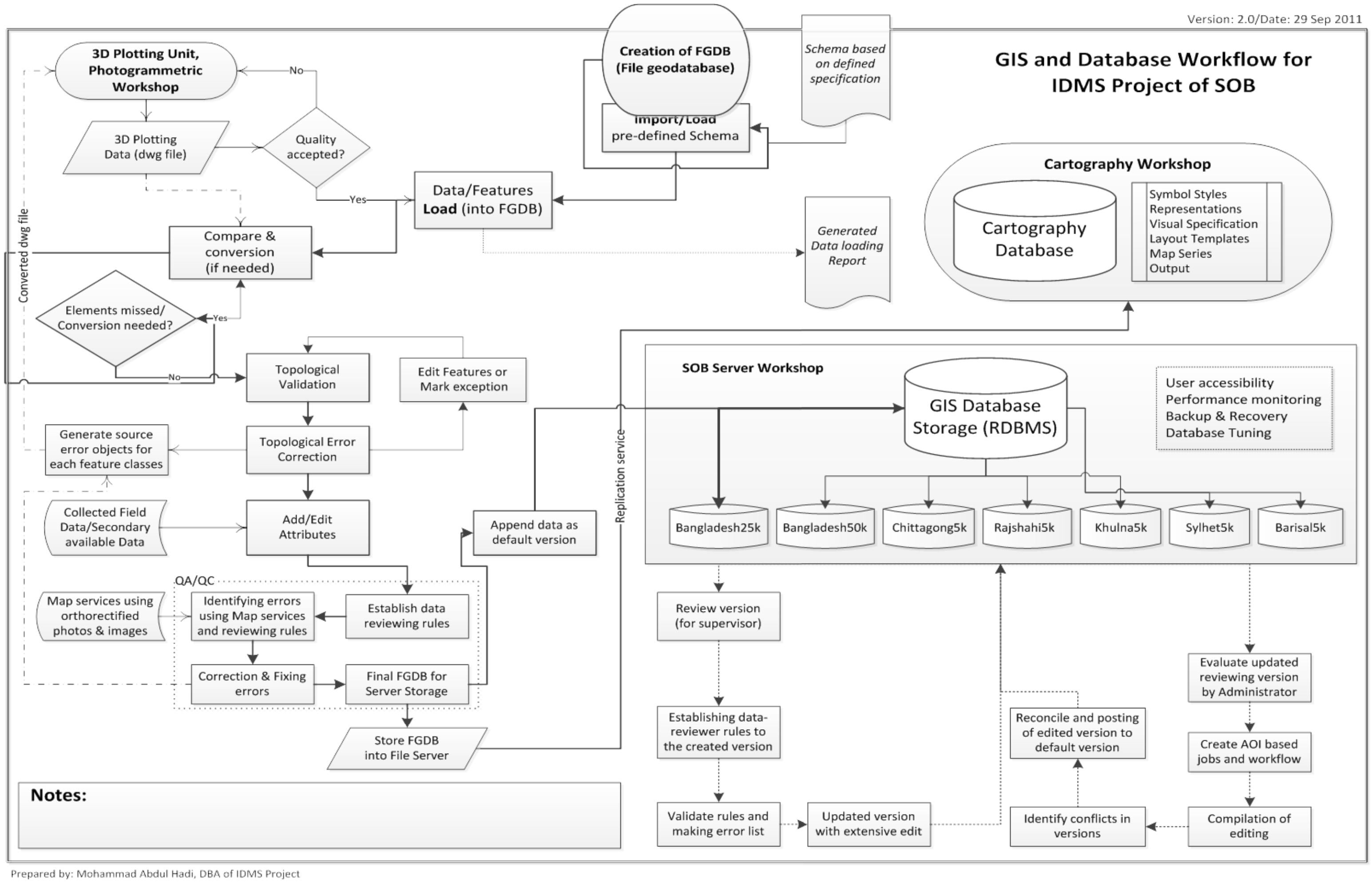


Figure 1. Work Flow of GIS Unit

5. Detailed Work Procedures

This chapter explains step by step work of each work item of the GIS Unit listed in Figure 1.

5.1 Creation of FGDB

Geodatabase construction is made by using software named ArcGIS Diagrammer. Figure 2 shows a part of the image of constructed geodatabase on ArcGIS Diagrammer. (*As of October 20, 2011 this structure is still under review and will be revised.*)

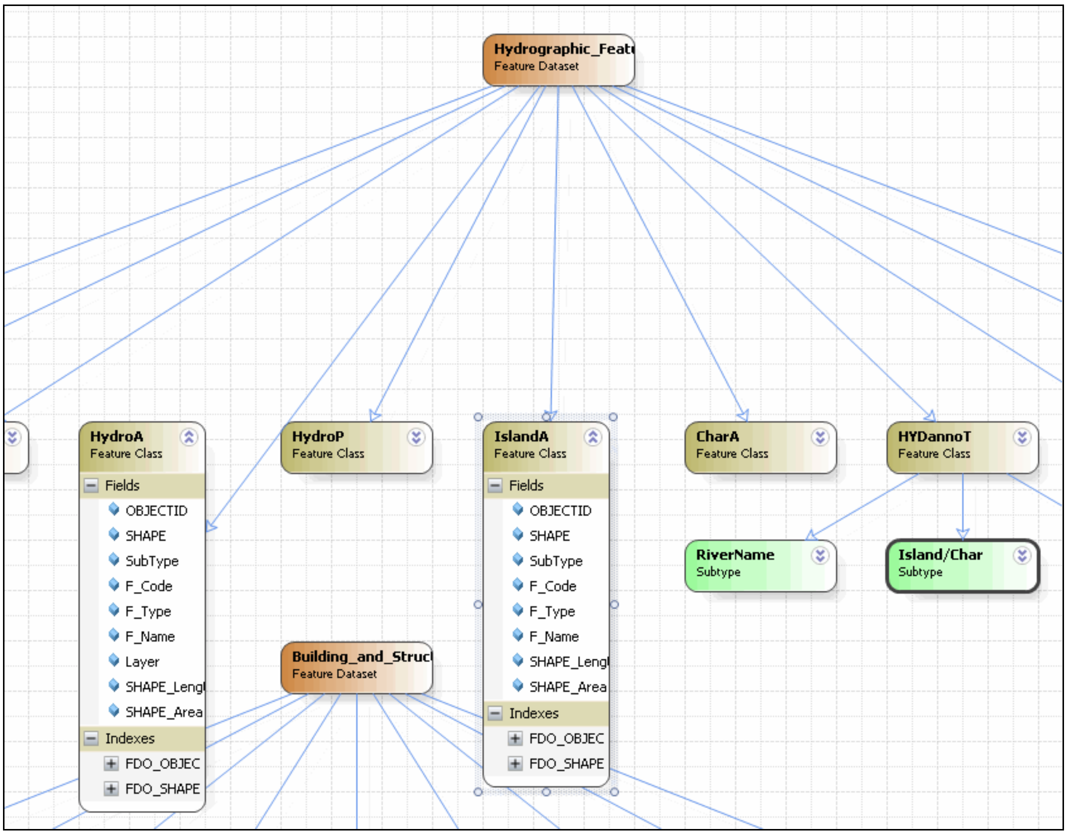


Figure 2. Geodtabase construction on ArcGIS Diagrammer

By using ArcCatalog menu, an empty file geodatabase will be created in a computer of each operator. This work should be done by each operator.

Geodatabase design or SCHEMA made on ArcGIS Diagrammer can be published in XML format and imported into empty Geodatabase. The process of this work will be handled by Supervisor or Administrator of GIS UNIT. Although this work is not so complicated but it would be better that a small number of staff do this work to avoid any confusion or mistakes.

5.2 Import/Load Predefined Schema

First, Administrators or Supervisors will publish database structure in XML schema from Diagrammer software. Then they will copy the schema to each computer of operator.

By using ArcCatalog menu, each operator must IMPORT the pre-defined schema to create feature class and features in an empty file geodatabase.

Detailed operation of ArcGIS is explained in Appendix 1 “Geodatabase Construction.”

5.3 Quality Check

This is a very simple check of data quality.

(1) At first, GIS Unit checks the following items:

- If file names are in accordance with a pre-determined naming rule.
- If right files were received or not. For example, check to see if all the files to cover one sheet or block are received or not.

(2) If necessary, check printed map sheet layout to confirm if the files of the correct sheets or blocks are stored in the specified folders.

(3) If anything wrong is found, GIS Unit will report it to Photogrammetry Unit for clarification or correction. And record of such a report should be kept by Supervisors or Administrators. Any type of method or format is useful for this purpose as far as GIS Unit can trace the following information.

- Block or sheet number
- File name
- Operator name
- Type of mistakes or questionable items (including coordinates)
- Date found

- Date reported to Photogrammetry Unit
- Name of a person of Photogrammetry Unit to whom the report is made
- Action taken by Photogrammetry Unit
- Date the corrected data are returned to GIS Unit
- Name of a person of GIS Unit who received the corrected file
- File name if a new number is given

Just like 3D data receiving job, Quality Checking should be done by Administrator(s).

5.4 Data/Feature Load (into FGDB)

5.4.1 Characteristics of data provided by Photogrammetry Unit

(1) Grouping

If DWG files are imported into ArcGIS, data of same geometry are grouped together in one feature class. For example, linear features such as roads and transmission lines are stored in a same one feature as shown in Figure 3.

In order to use these data in ArcGIS, contents of the DWG layer need to be separated according to the type of feature such as Bridge_Road or Land_Use_Boundary. This can be done by using SELECT function of ArcGIS.

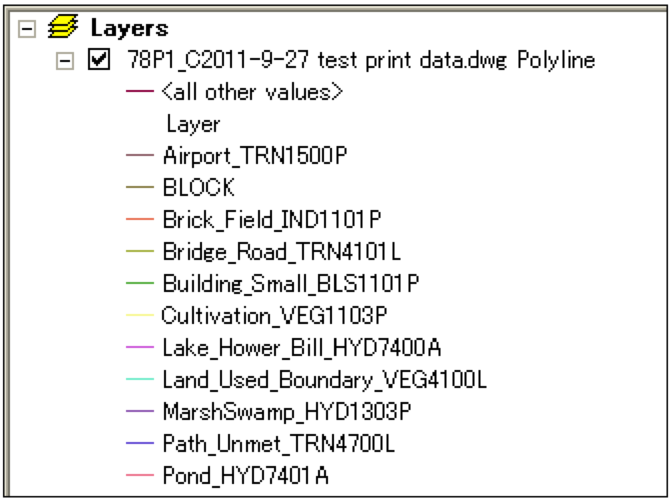
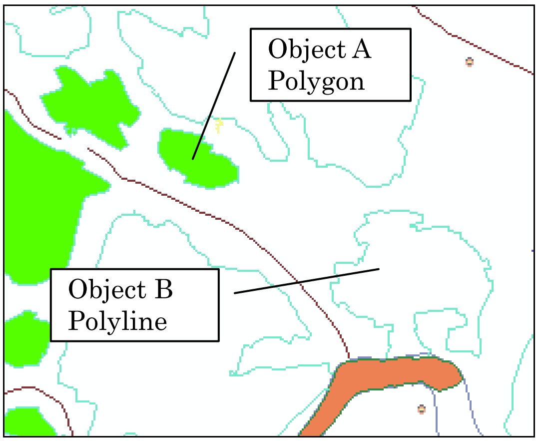


Figure 3. Various features in one layer

(2) Special definition of Polygon

Also, if a linear object is in a shape of polygon in DWG file, it is classified as polygon by ArcGIS This sample is shown in Figure 4.



Object A in Figure 4 is treated as Polygon because the object is formed by a line of the same feature.
Object B in Figure 4 is NOT treated as polygon, despite the fact that it looks like a closed geometry, because one side of the object is formed by a border with other feature.

Figure 4. Polyline and Polygon

This means that even if you find a polygon feature class in DWG data imported into ArcGIS, it does not contain all objects which are supposed to be regarded as polygon on ArcGIS.

5.4.2 Data transfer methods

There are two methods in data transfer. One is through database server and the other is by using portable HDD or DVD.

(1) Through database server
A person in charge of the operation of the Photogrammetry Unit informs GIS Unit the name or location of folder(s) which contain 3D plotting data. GIS Unit opens the specified folders and confirms if there are correct dwg files in them.

(2) By using media
In case that HDD or DVD is used, Photogrammetry Unit just copies target files and give it to GIS Unit.

In both cases, person(s) in charge of this data transaction should be Administrator(s).

If database server operation encounters any problem, it is highly recommended that data transfer will be done by using media. This may reduce confusion and save time provided that file version is managed properly.

5.4.3 Sequence of data loading

Some files produced by Photogramemtry Unit in DWG format do not match with ArcGIS feature classes of a file geodatabase. For example, in order to create polygon of land use, many line features such as road and path are required. Polygon objects already formed in DWG, such as pond, are also required to make land use polygons.

This means that if all the DWG files are imported into file geodatabase, many intermediate data remains when final feature data such as land use polygons are generated.

So, there are two methods in loading data into a file geodatabase.

a. Load the data into a file geodatabase after all the necessary features for geodatabaes are generated by using DWG files.

b. Load the original DWG files into geodatabase and make necessary features by using data already stored in the database.

In either case, file management is quite important. If GIS Unit does not want unnecessary files reside in geodatabase, then, method “a” will be better.

Following is the outline of work flow for both methods.

a. Load completed GIS data into geodatabase

- Open ArcGIS
- By using ADD DATA command, add all the DWG file into a data pane.
- Right click the added DGW file and open Properties
- Choose Symbology and set to show every features according to layer name

- By using functions of ArcGIS select or generate desired features and store them in temporary folders.
- After this preparatory work, load the completed data into a geodatabase.

b. Load data to geodatabase first and make GIS data from them

- By using ArcCatalog menu and Simple Loader function, load DWG files into each feature. Selection of files to be loaded to each feature will be done manually or by using a custom made program.
- After every necessary DWG files are loaded into geodatabase, then generation of features such as land use polygon will be carried out. The output of this operation will be stored in the same geodatabase.
- After data loading, Administrator/Supervisor will open the Geodatabase by using ArcCatalog to check to see if all the dwg files were loaded in proper space of the Geodatabase. File transfer can also be checked by reading a report to be generated by ArcGIS.

Detailed operation of ArcGIS operation is given in Appendix 2. “Import DWG files to Geodatabase”

5.5 Matching (Comparing) and Conversion (if needed)

(1) Administrator checks if contents of the neighboring sheets match.

(2) If not, Photogrammetry Unit will be informed of the problem for correction.

(3) Necessary data management should be practiced here to trance the problem and its solution.

5.6 Elements missed/Conversion needed

(1) Administrator checks if any elements are missing on each features.

(2) If any mistake is found, it is reported by Administrator to Photogrammetry Unit for

correction.

(3) Necessary data management should be practiced here to trance the problem and its solution.

5.7 Topological validation and QC

(1) Making polygons from polylines

In Photogrammetric Restitution process, polygon features such as land use are often drawn by polylines of two different features such as of vegetation boundaries and road lines. Before topological validation, these polylines should be converted into polygons.

This process will be done manually because automatic identification of target features – such as polygons of vegetation – is not easy and incomplete. General work flow will be as follows.

- In ArcGIS, add every features which are necessary to generate polygons. Typical features to be added to ArcGIS will be:
  - Land use boundary
  - Roads (every type of roads)
  - Paths
  - Single river lines
- Conduct initial topology check to each feature and make necessary corrections
- Use Feature To Polygon function of ArcGIS, generate polygons = at this stage polygons which should not be handled as polygons are also generated.

(2) Topological errors are checked by using topological rules already included in schema for each feature.

Detailed procedure to make polygon features is explained in Appendix 3 “Polyline to Polygone Conversion and Feature Selection.”

5.8 Edit features of mark exception

(1) Check to see if errors other than topological nature exist.

(2) If such an error exists, then it will be fixed.

5.9 Topological error correction

(1) Topological errors will be corrected.

(2) After error correction, data will be checked visually, if there are any remaining errors.

To some extent topological error correction can be done by batch processing by setting parameters such as length of dangles to be trimmed. However, not all the errors can be corrected by this method. So, manual checking and manual correction of errors is inescapable.

Detailed procedure of ArcGIS operation is given in Appendix 4 “Topology Error Checking and Error Correction.”

5.10 Generate source error objects for each feature class

For example, buildings should be digitized in polygons. However, there may b e an error that polygon is not rectangle but in triangle shape. If all the mapping is done in two dimensional mode there would be no problem if GIS Unit correct such an error in two dimensional editing. But in IDMS project, all the features have three dimensional information except for administrative boundaries. Therefore, polygons or lines can be changed only three dimensional environment. This further means that correction must be done by Photogrammetry Unit.

This kind of error is called Source Error.

5.11 Add/Edit attributes

There is more than one method to enter attribute data.

One is simply opens tables and enters data or information one by one in editing mode as follows:

(1) Open a target feature layer.
(2) Start Edit mode
(3) Open table
(4) Enter values or information to relevant fields from various information sources including the result of field verification survey and existing data.
(5) Stop editing and save the file

Other method is making EXCEL or DBF files which contain attribute data and ID of features and importing or appending the files into geodatabase. But this is possible only when ID of features for which attribute data must be collected can be identified before attribute data collection work.

5.12 Identify errors using Map Service and reviewing rules

This is a process of final error checking. Generated features will be overlaid on orthophotos to check to see if no feature is missing and all the features generated are correct.

In order to make this work efficient, Map Service function of ArcGIS Server is used.

5.13 Correction and fixing errors

Any error found in step 5.12 should be correct by GIS Unit.

5.14 Append data as default version

After error correction, completed data will be stored in a server.

6. Database Type

As shown in Figure 1, GIS data generation work can be done by using File GEODATABASE. This means GIS data are stored in computer of each operator until Supervisor or Administrator approves to send the data to a central server.

7. Unit of Work

Work at GIS Unit will be done for each sheet or block as one unit. An operator is responsible to complete the map data for assigned sheet or block.

8. File Version Management Method

It is necessary to determine file naming rules. At least the following information should be included in file name.

- Date created or modified
- Original or revised

The file naming rule to be used in IDMS project will be as described below:

To be filled later.

9. Use of Work Management Software

IDMS project introduced ESRI software for the management of the IDMS project work. They are:

- Data Reviewer
- Work Flow Manager

It is expected that GIS related work can be managed efficiently by using these two types of software. However, it should be noted that not all the work cannot be managed by software. Some works need to be managed manually or by using separate tools such as work management sheets.

10. Quality Control

10.1 Principles of quality control

It is obvious that number of errors in produced data must be kept at minimum level. Quality control is a measure to make the error minimum.

Principles of quality control are as follows:

- Operators understand the contents of their work – procedures and rules
- Operators follow pre-determined procedures and rules
- Operators keep the documented records of their work
- Operators understand the contents of both upstream and downstream work

Some precautions to reduce mistakes are:

- Copy file so that original file cannot be accidentally damaged
- Check file name if it is correct or not
- If incorrect, get a correct one and also report it to the person in charge of that file naming or data delivery.
- Record any unclear points for clarification with superior persons
- Make corrections
- Record any corrections made to make it sure that every errors are corrected
- Re-check corrected parts

Work procedure changes according to the progress of technical skill of SOB staff or due to some other reasons. For example, suppose there are two methods in doing one job. It is important to record the reason why one is selected. This information is useful later in reviewing which method is suitable considering changes occurred in operators, organizations or request from third paries.

Sample is given below.

	A. Operator is responsible for one sheet	B. Operator is responsible for only a quarter of a sheet
Quality control	A>B	
Job speed	A<B	

10.2 Work rules

Rules to be applied to the work of GIS Unit is basically the same with the rules applied in photogrammetric mapping. Please refer to the rules defined in <u>the guideline for digital mapping to be conducted by Photogrammetry Unit.</u>

Without knowing the mapping rules and standards used in Photogrammetry Unit, GIS Unit cannot carry out its task in appropriate way.

10.3 Error checking method

Error can be checked by more than one method.

- By human eye
- By using software – logical check
- By using pre-determined quality control tables

It is important not to rely too much on automatic error checking method. In case of IDMS project, ESRI software is used for the management of the work. The reports to be generated by the software are important tool for quality control. Therefore, it is quite important to fully understand the contents of the reports and action to be taken if any problem is detected.

11. GIS Software Operation Manual

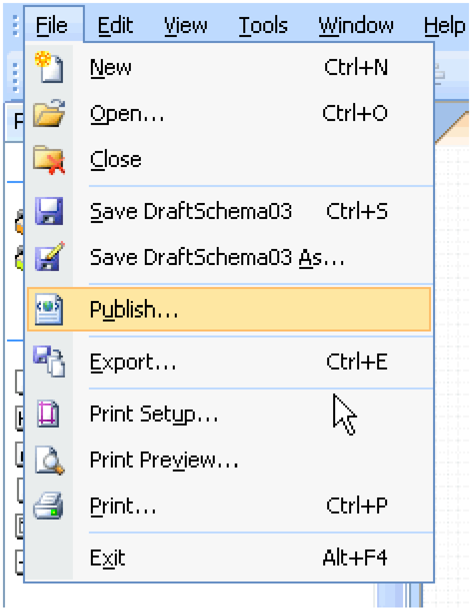
Step by step explanation on the use of software is provided in Appendix 1 of this guideline. ArcGIS software used to make operation manual is Version 9.3. Since SOB is using ArcGIS Ver.10 and Version 10 has much more useful functions than Version 9.3, these manuals also have to be reviewed and modified.

Appendix 1. Geodatabase Construction
Appnedix 2. Input DWG file into geodatabase
Appendix 3. Polygon generation
Appendix 4. Topology checking and error correction

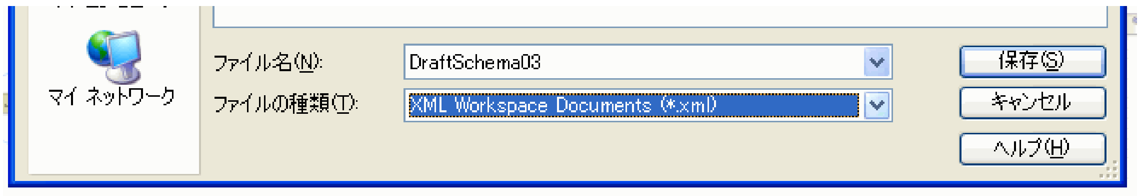
Appendix 1. Geodatabase Construction (ArcGIS 9.3)

After designing geodatabase on ArcGIS Diagrammer, that file can be PUBLISHED in XML format. Then, this XML schema can be imported into an empty File or Personal Geodatabase in each computer. This document explains to import database schema into empty file geodatabase.

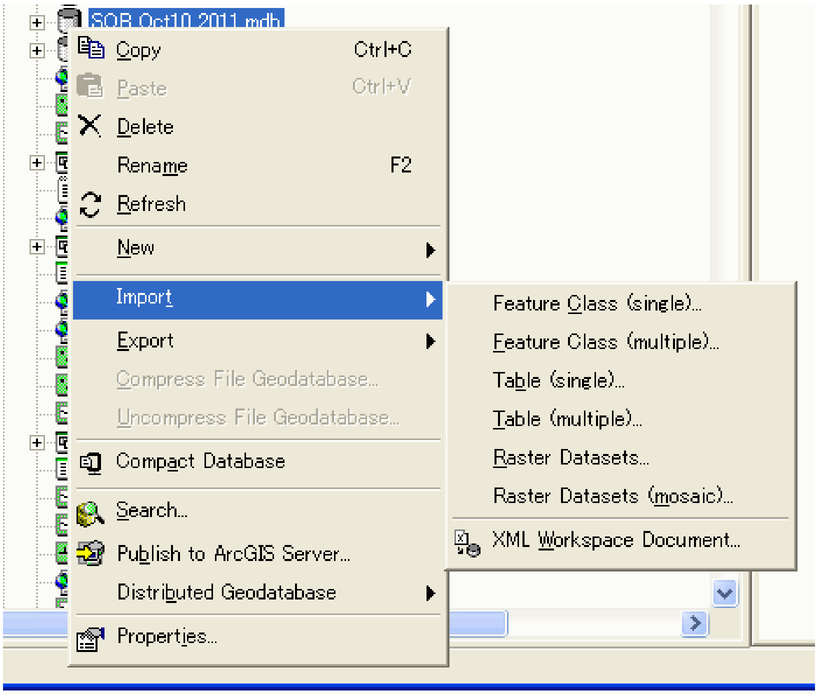
1. Publish command on ArcGIS Diagrammer



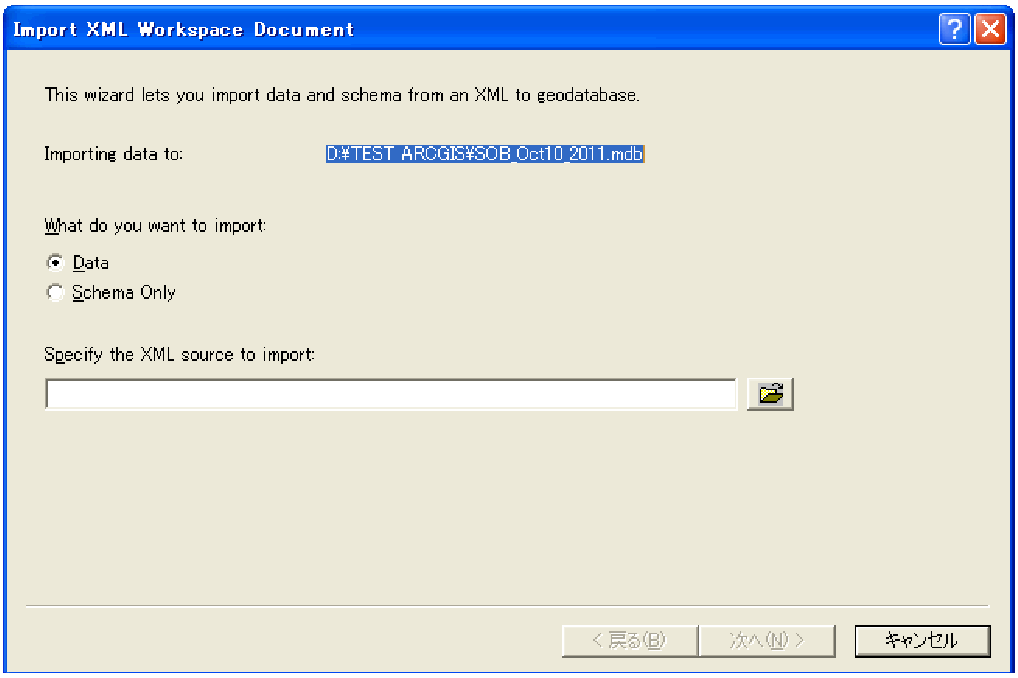
2. Specify the type of Publish format – automatically set as XML



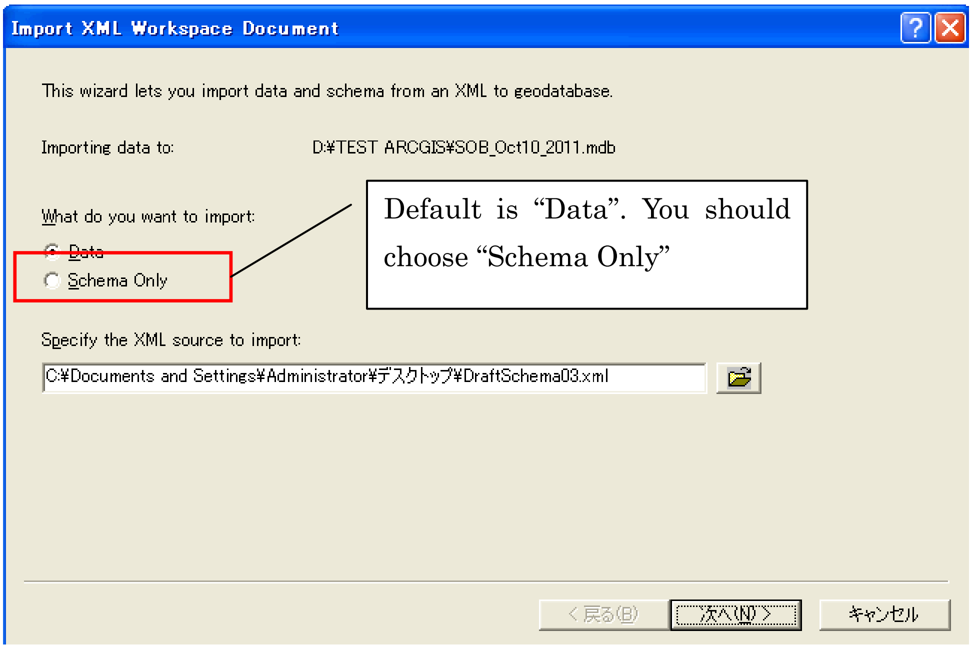
3. Import XML schema into a geodatabase – select XML Workspace Document



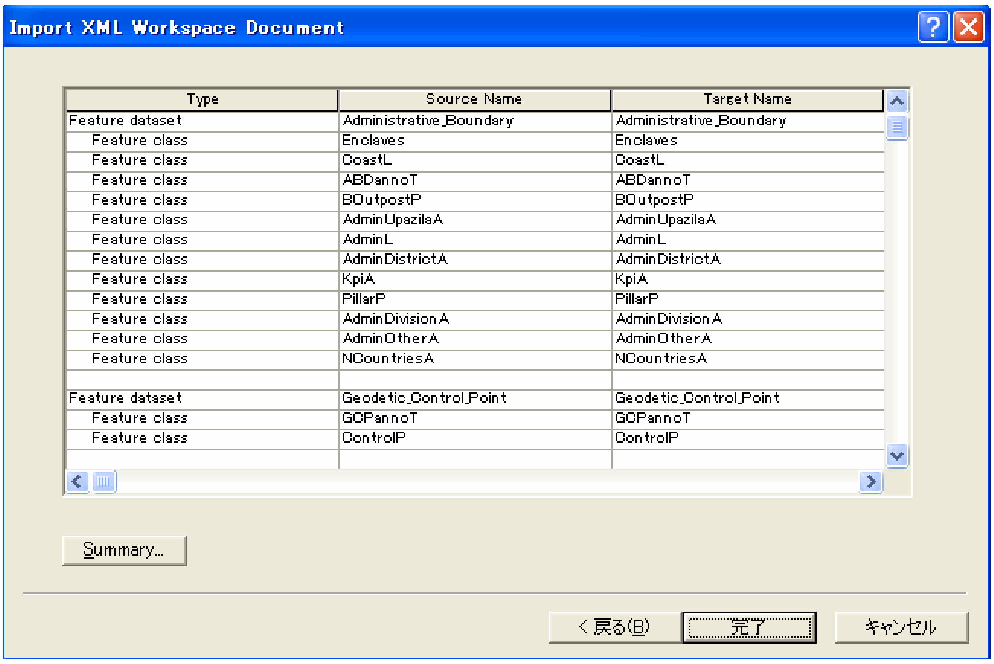
4. A window to specify XML source to import



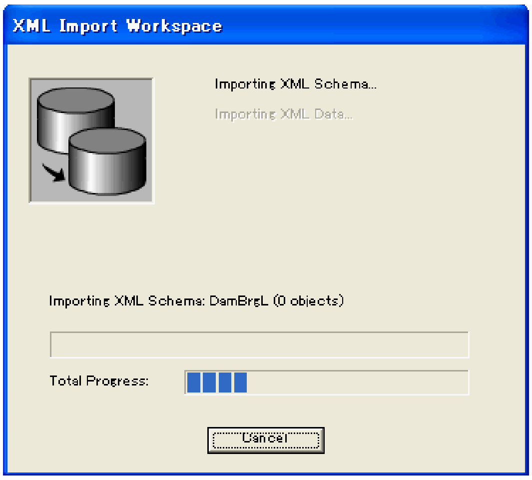
5. Specify XML source



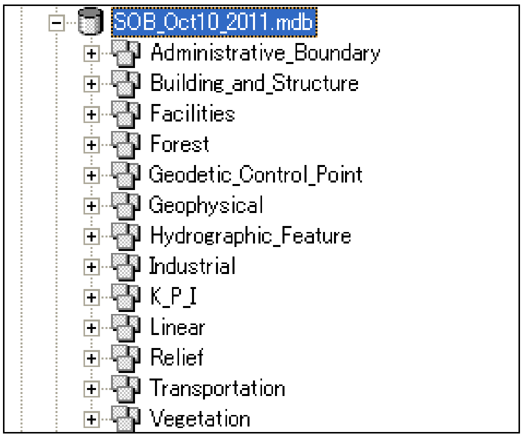
6. Confirmation window



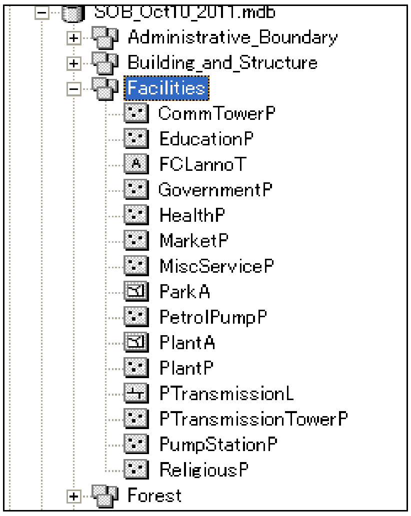
7. Importing



8. Imported schema – Feature classes

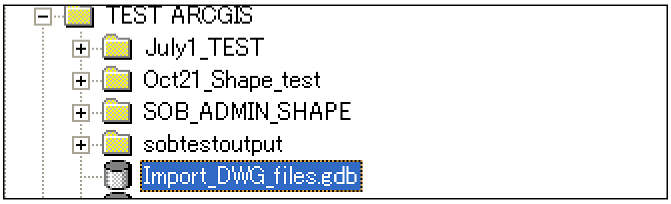


9. Imported schema - features

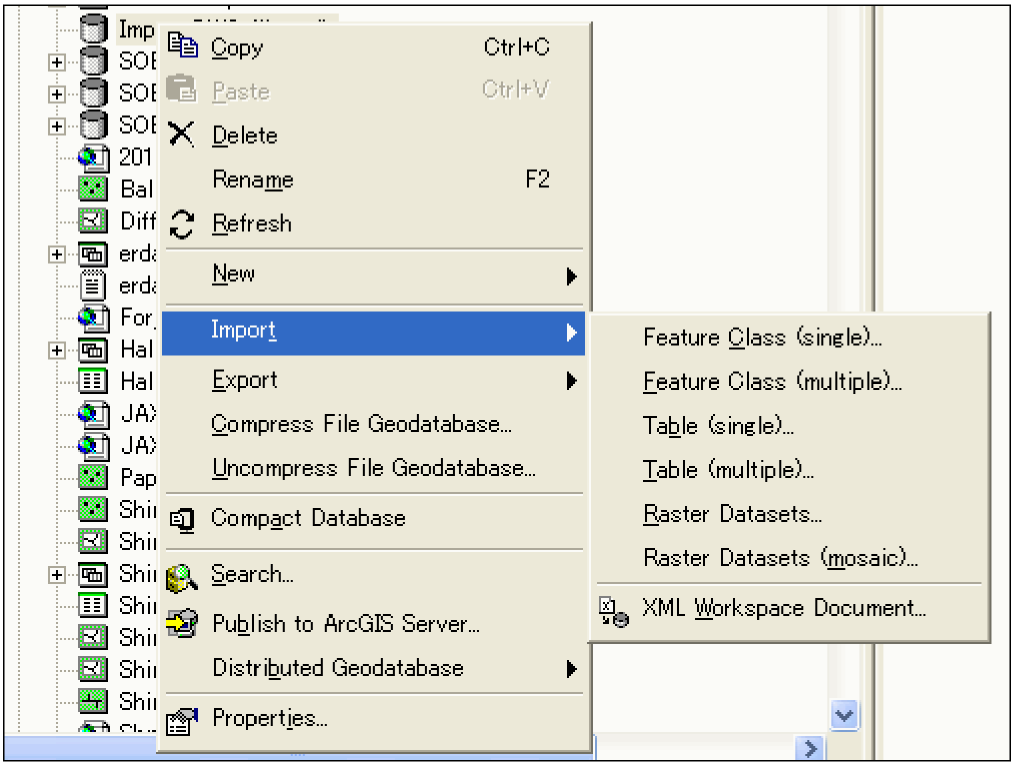


Appendix 2. Import DWG file to Geodatabase (ArcGIS 9.3)

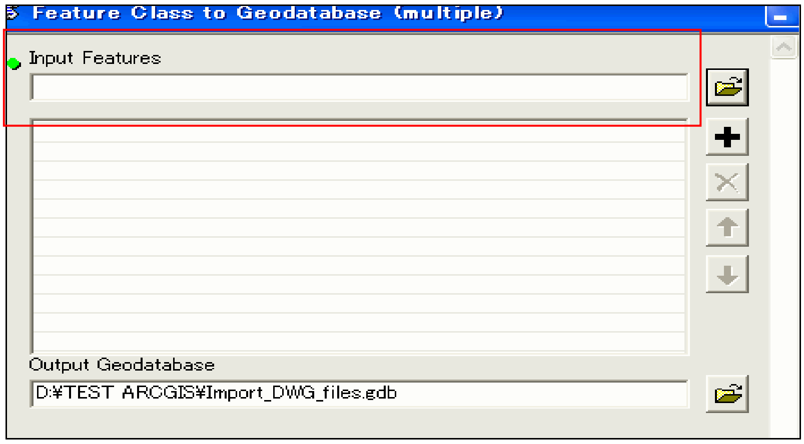
1. On ArcCatalog, select a Geodtabase to which DWG files are imported



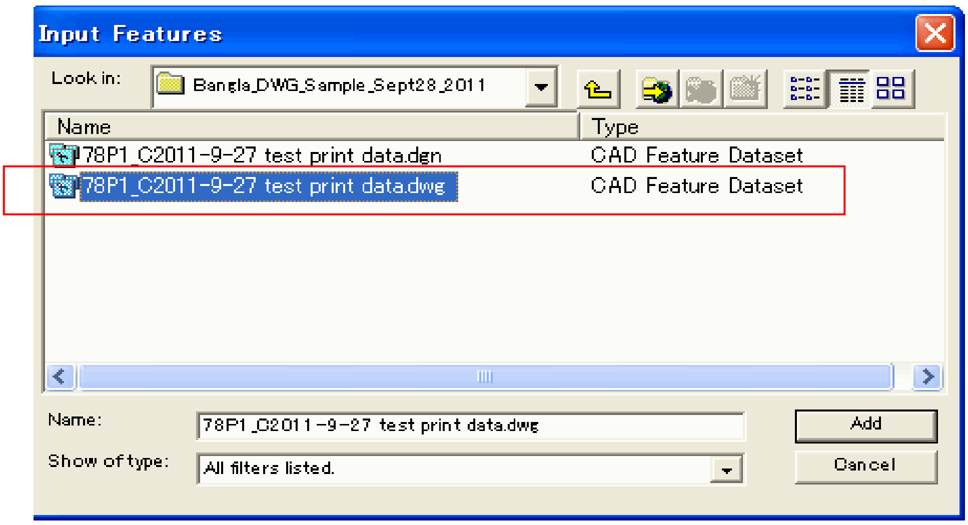
2. Right click and show a pull down menu then select Import
   Then select "Feature Class (multiple)"



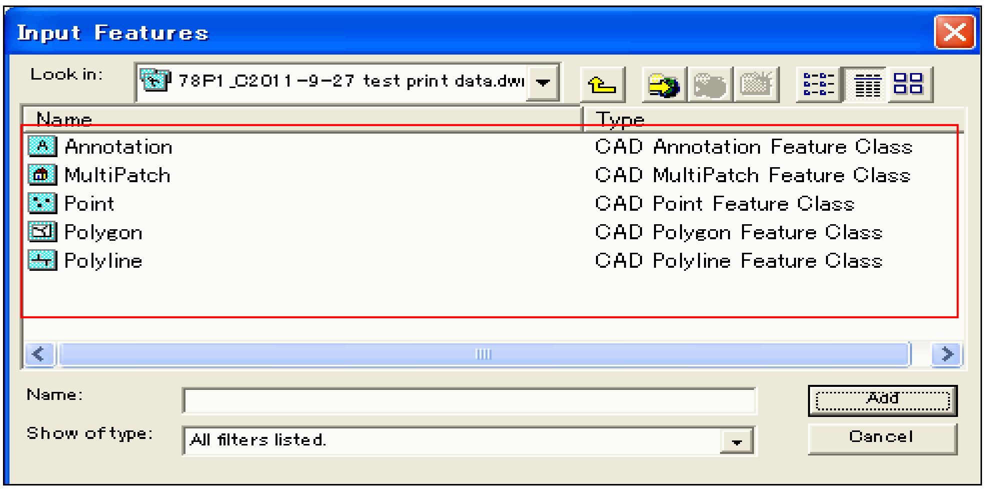
3. Select Input Features



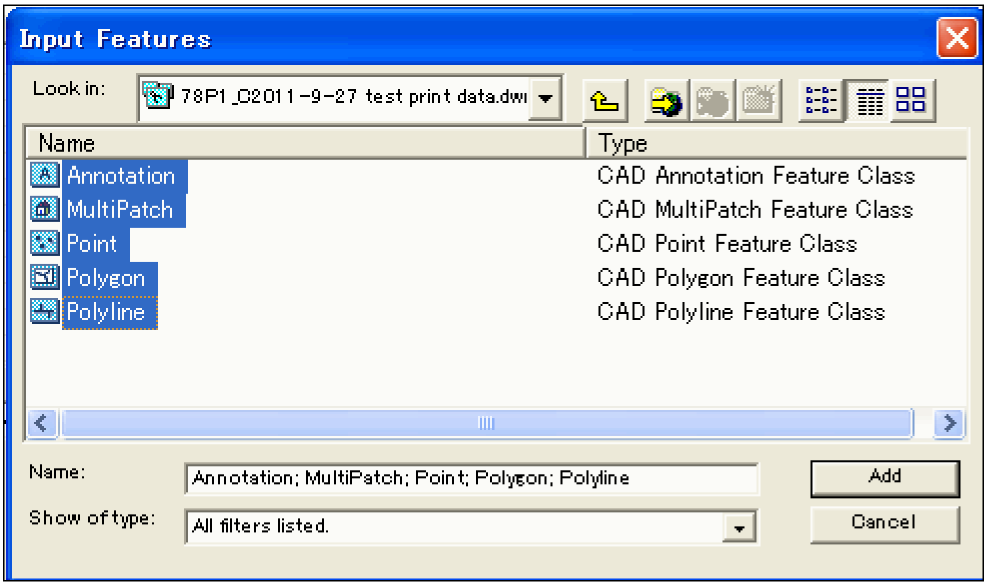
4. Select Input Features



5. Contents of the selected features are shown

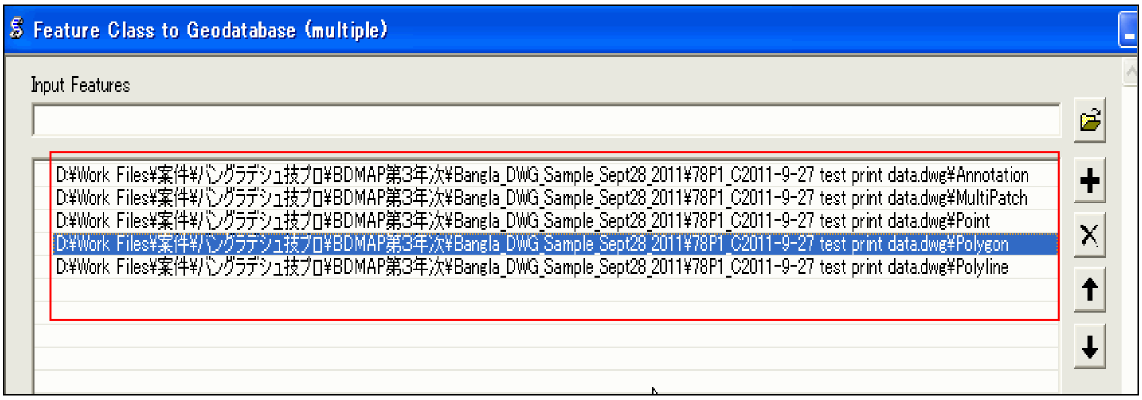


6. Select contents to be imported

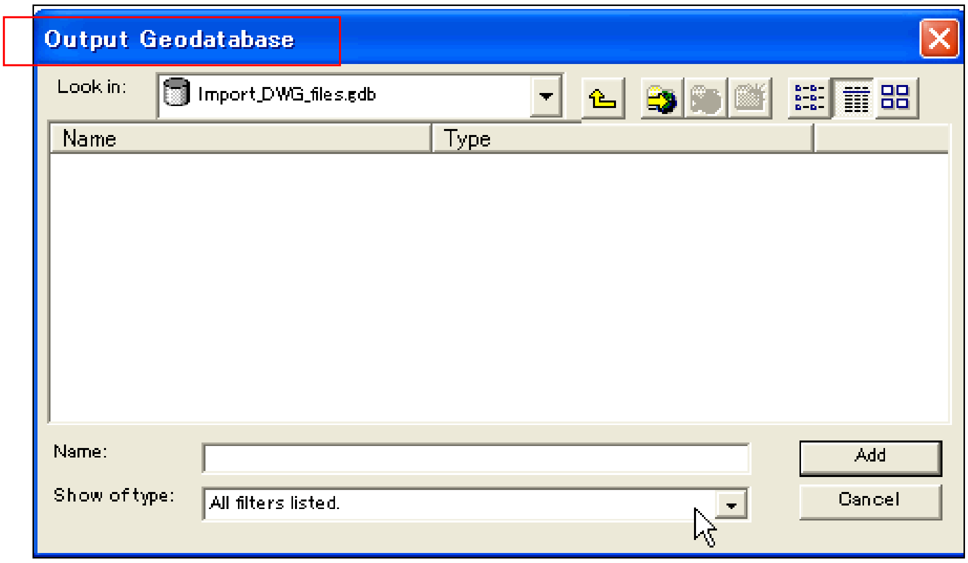


Note: DWG files are grouped into five types as shown above. In this case Polygon does not mean Polygon Features of geodatabase. It simply means polylines which are closed.

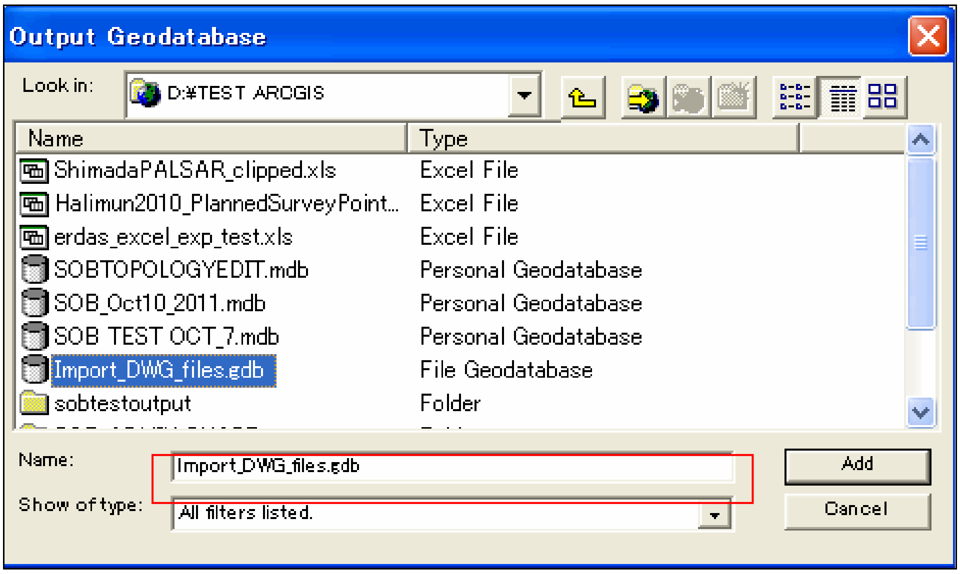
7. Selected contents are shown in a pane



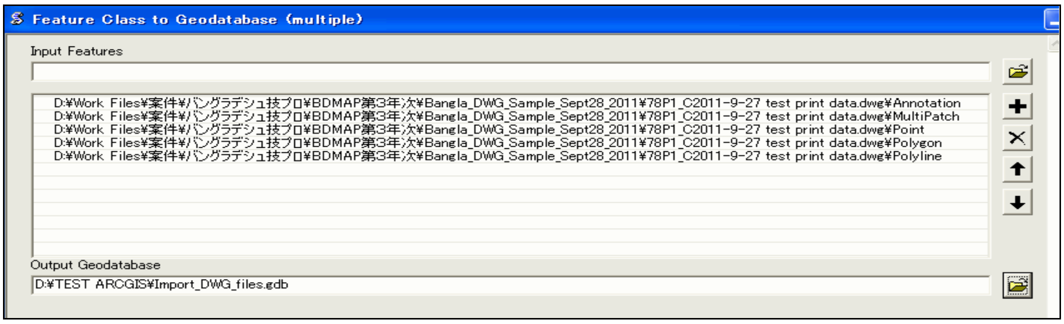
8. Define Output Geodatabase



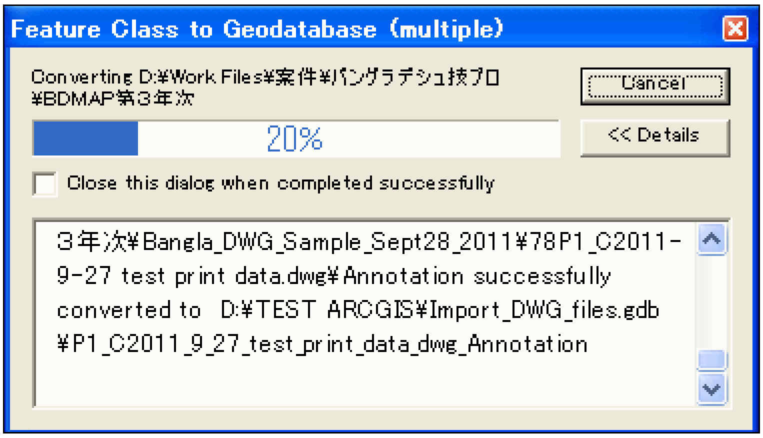
9. Define Output Geodatabase



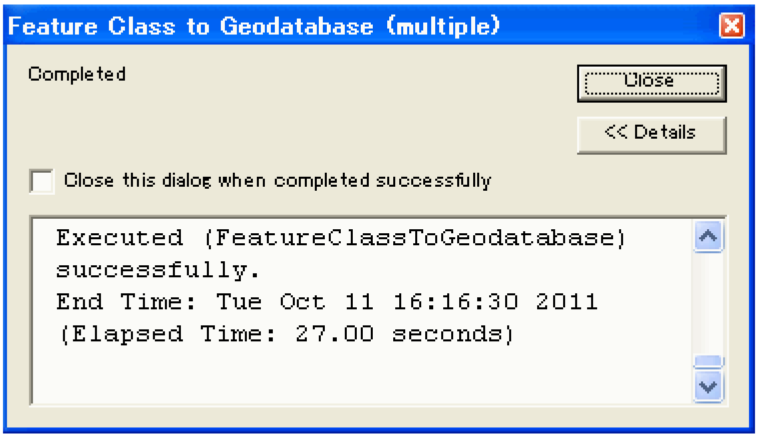
10. Output Geodatabase name is entered in a pane



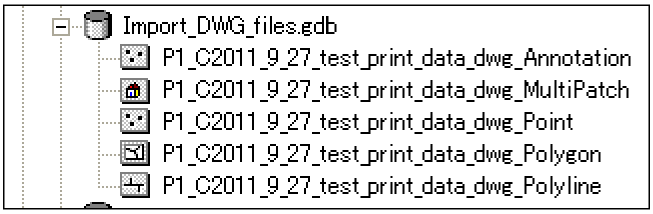
11. DWG data are being imported



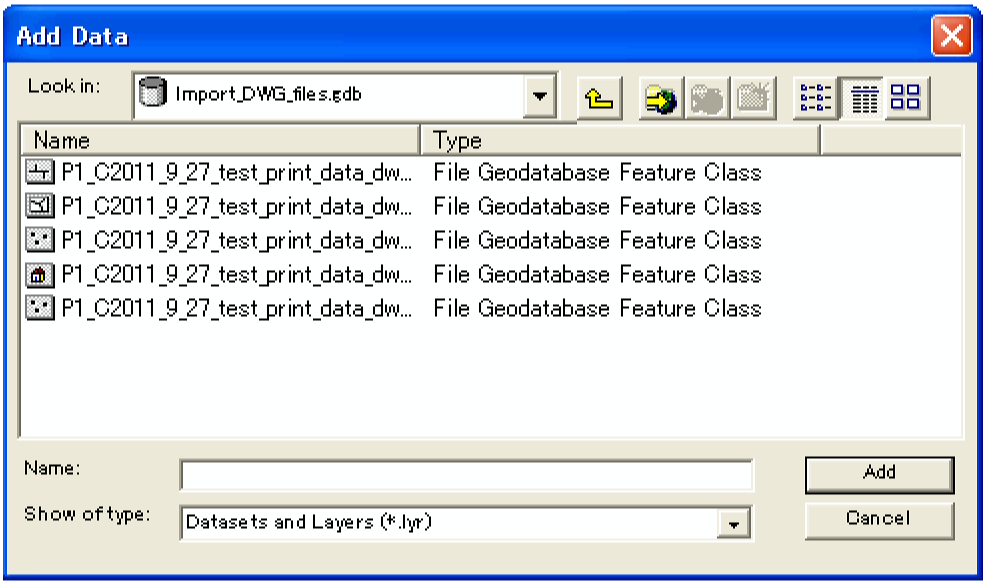
12. DWG data import completed



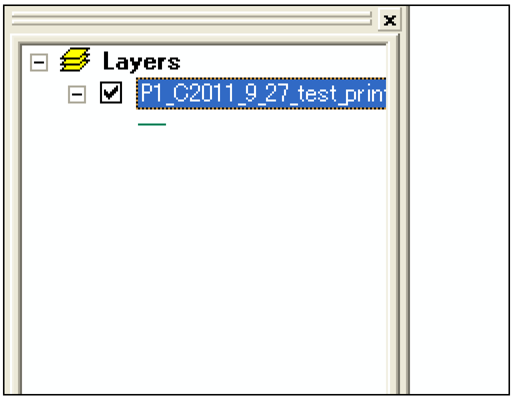
13. Imported DWG files are shown on ArcCatalog



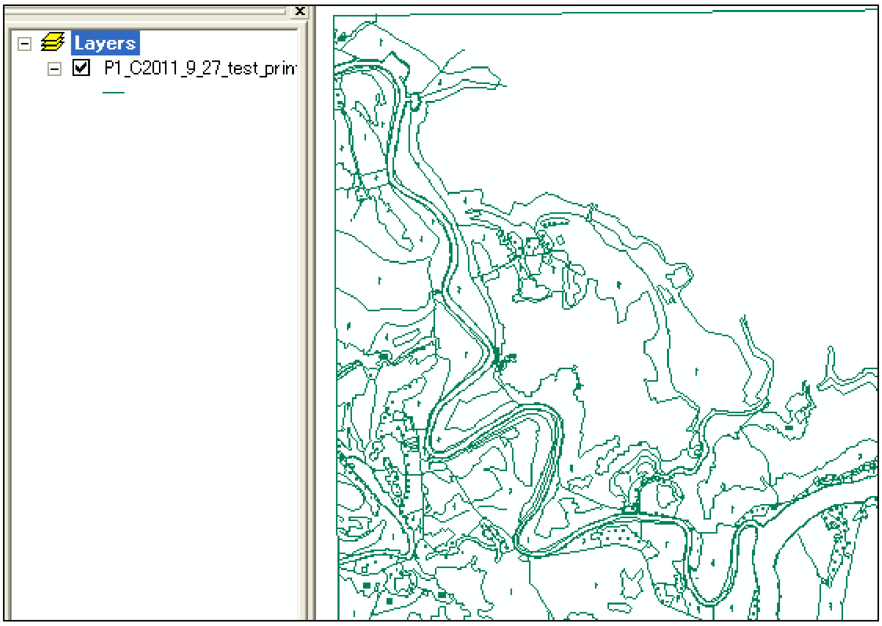
14. Add imported and converted DWG files onto ArcGIS



15. Imported and converted DWG data are shown as a single layer

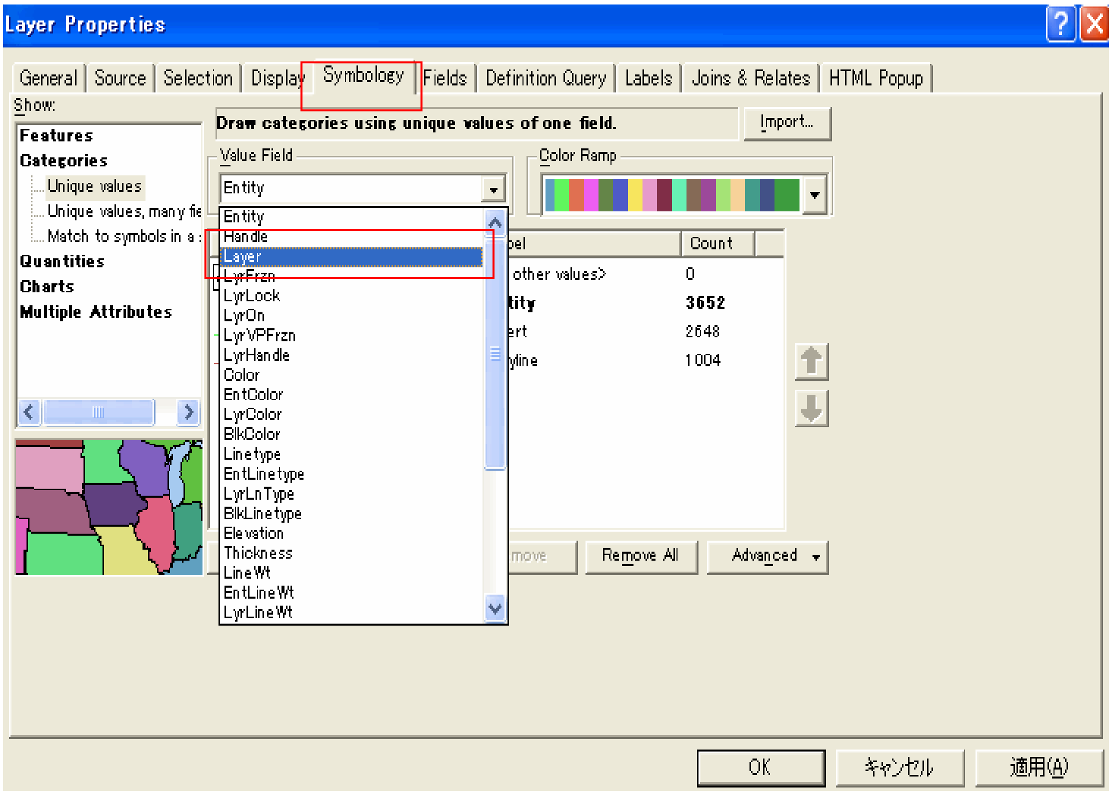


16. Imported data

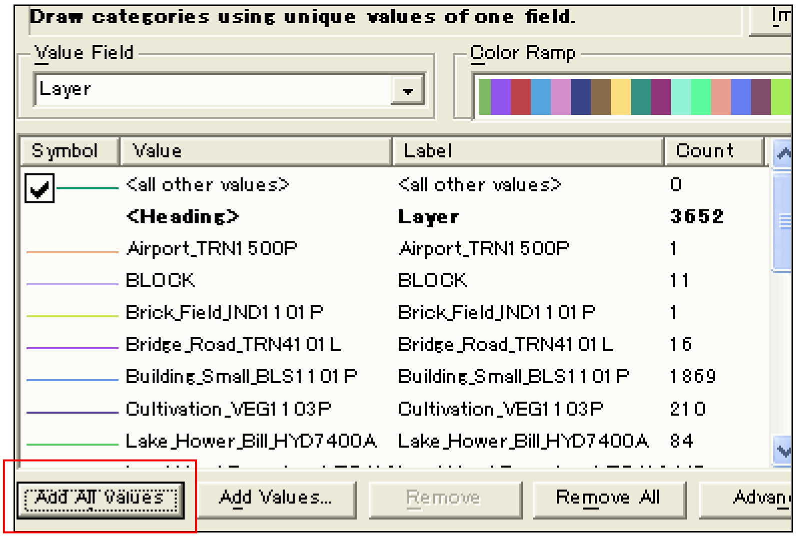


17. Show all features

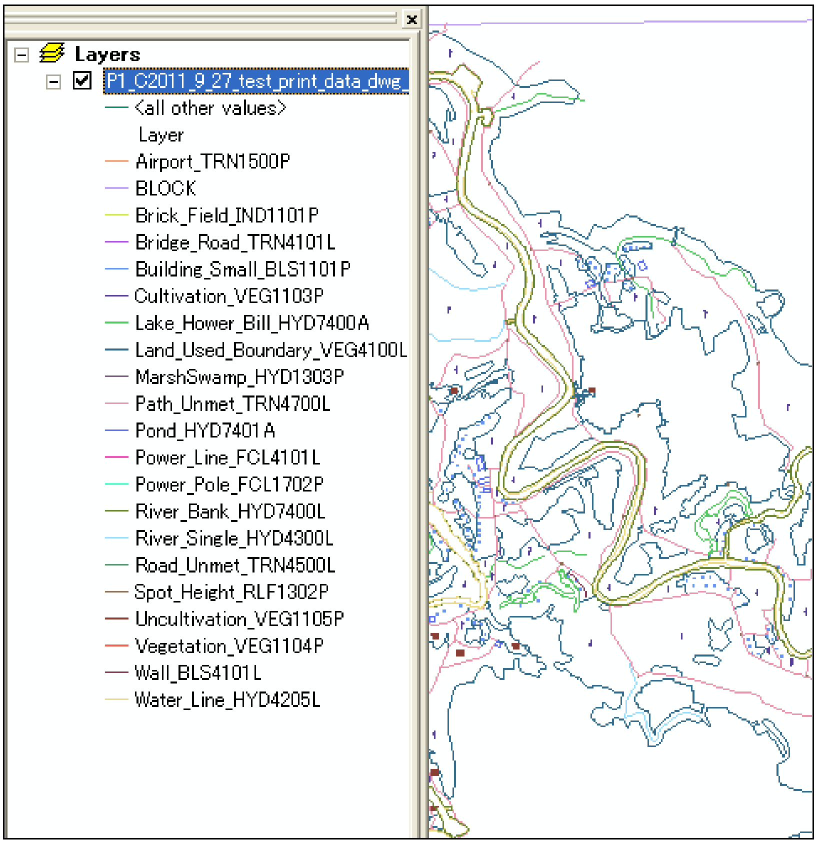
By right clicking the layer open Layer Properties. Then select Symbology.



18. Select Layer and then click Add All Values



19. All the features are shown in the pane. Vector data are shown in different colors.



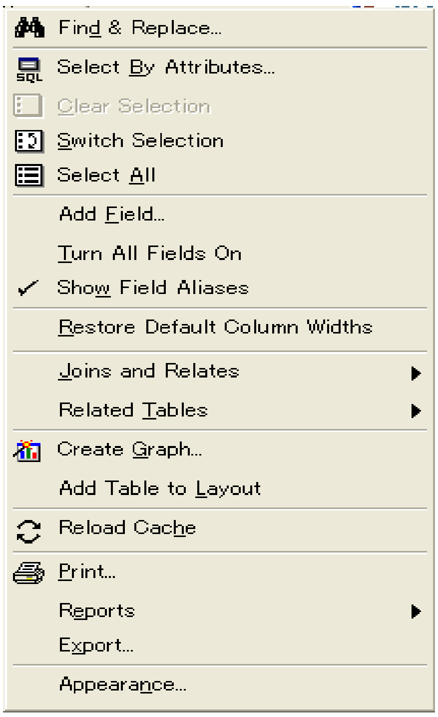
20. Open table

In the column of Layer you can find that many different features are stored in single file. So, you have to separate each feature into independent layer.

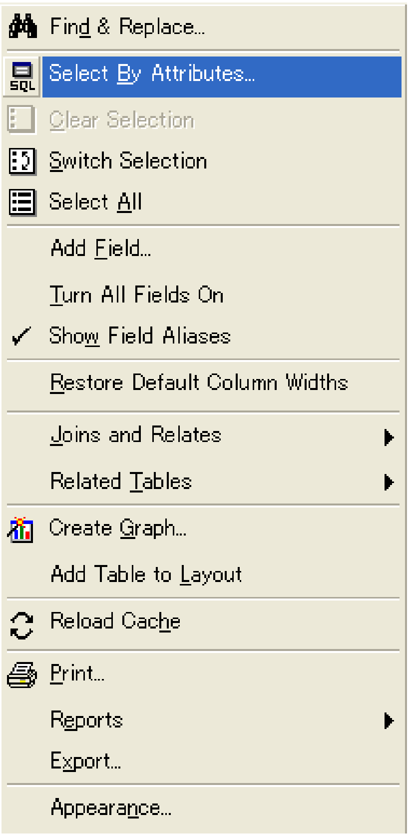
Attributes of P1_C2011_9_27_test_print_data_dwg_Polyline

OBJECTID *	Shape *	Entity	Handle	Layer
43	Polyline Z	Polyline	2C28	Path_Unmet_TRN4700L
44	Polyline Z	Polyline	2E6A	Path_Unmet_TRN4700L
45	Polyline Z	Polyline	2E95	River_Single_HYD4300L
46	Polyline Z	Polyline	2FF8	Path_Unmet_TRN4700L
47	Polyline Z	Polyline	3013	Path_Unmet_TRN4700L
48	Polyline Z	Polyline	3608	Path_Unmet_TRN4700L
49	Polyline Z	Polyline	364A	Path_Unmet_TRN4700L
50	Polyline Z	Polyline	3655	Path_Unmet_TRN4700L
51	Polyline Z	Polyline	3686	Path_Unmet_TRN4700L
52	Polyline Z	Polyline	369C	Path_Unmet_TRN4700L
53	Polyline Z	Polyline	4242	Lake_Hower_Bill_HYD7400A
54	Polyline Z	Polyline	4350	Lake_Hower_Bill_HYD7400A
55	Polyline Z	Polyline	435B	Lake_Hower_Bill_HYD7400A
56	Polyline Z	Polyline	436B	Lake_Hower_Bill_HYD7400A
57	Polyline Z	Polyline	4404	Path_Unmet_TRN4700L
58	Polyline Z	Polyline	442D	Land_Used_Boundary_VEG4100L
59	Polyline Z	Polyline	4456	Land_Used_Boundary_VEG4100L
60	Polyline Z	Polyline	4480	Path_Unmet_TRN4700L
61	Polyline Z	Polyline	44A1	Path_Unmet_TRN4700L
62	Polyline Z	Polyline	44EA	Path_Unmet_TRN4700L
63	Polyline Z	Polyline	4558	Path_Unmet_TRN4700L
64	Polyline Z	Polyline	455C	Path_Unmet_TRN4700L
65	Polyline Z	Polyline	4577	Path_Unmet_TRN4700L
66	Polyline Z	Polyline	458F	Path_Unmet_TRN4700L
67	Polyline Z	Polyline	49D6	Path_Unmet_TRN4700L
68	Polyline Z	Polyline	49EE	Path_Unmet_TRN4700L
69	Polyline Z	Polyline	61D3	Land_Used_Boundary_VEG4100L

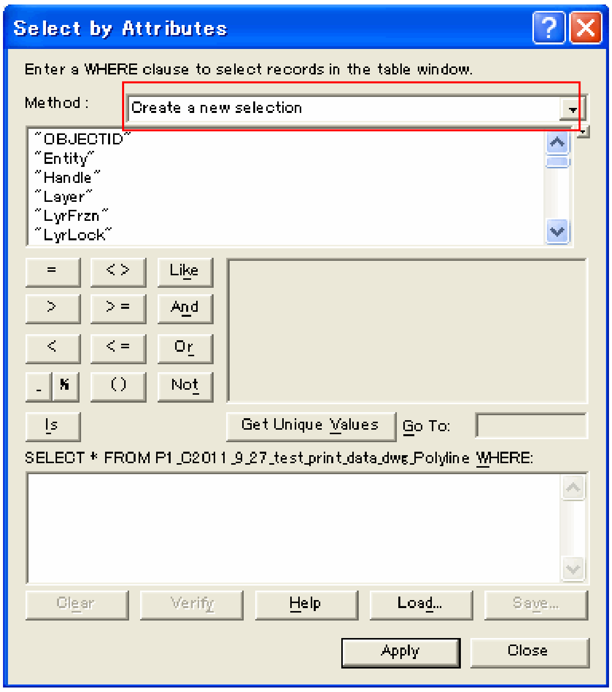
21. Click Option button which exists in the lower right corner of the table. A pull down menu appears.



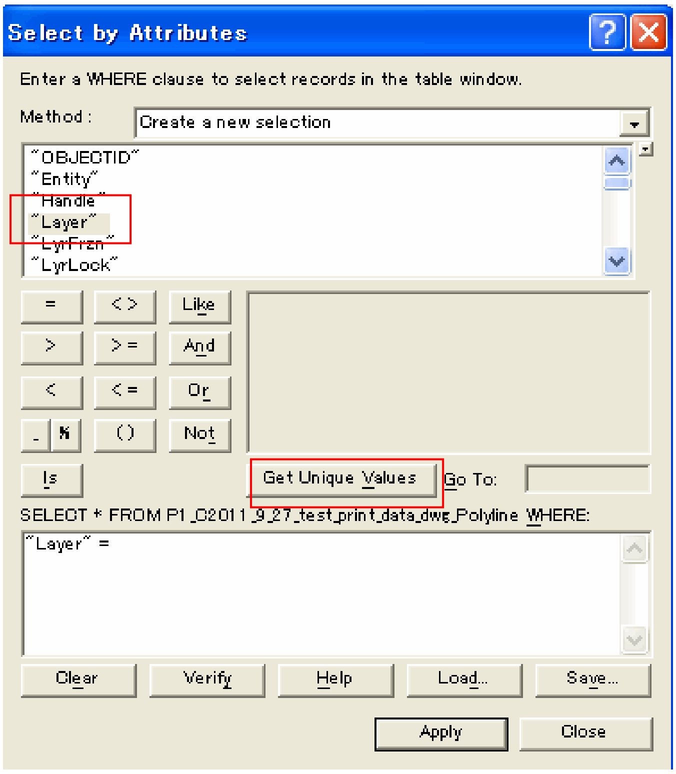
22. Select "Select By Attributes"



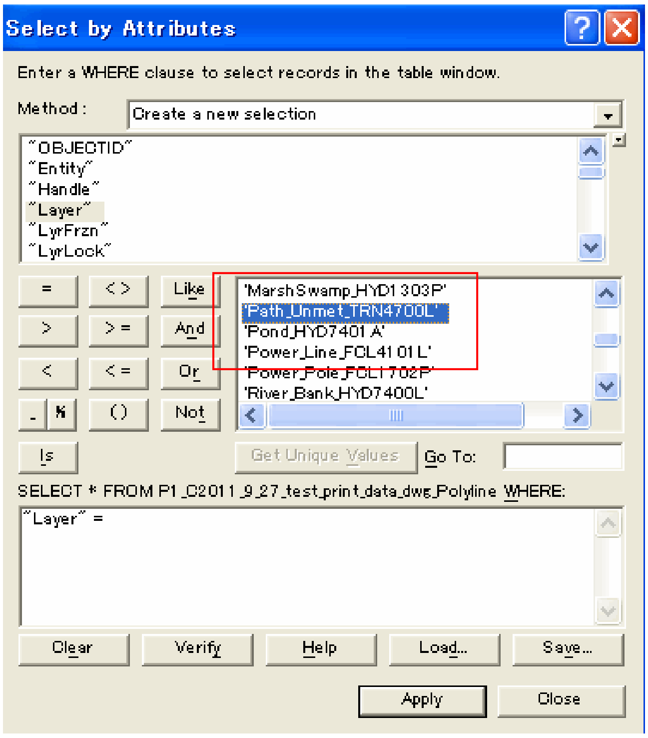
23. Select by Attributes windows opens



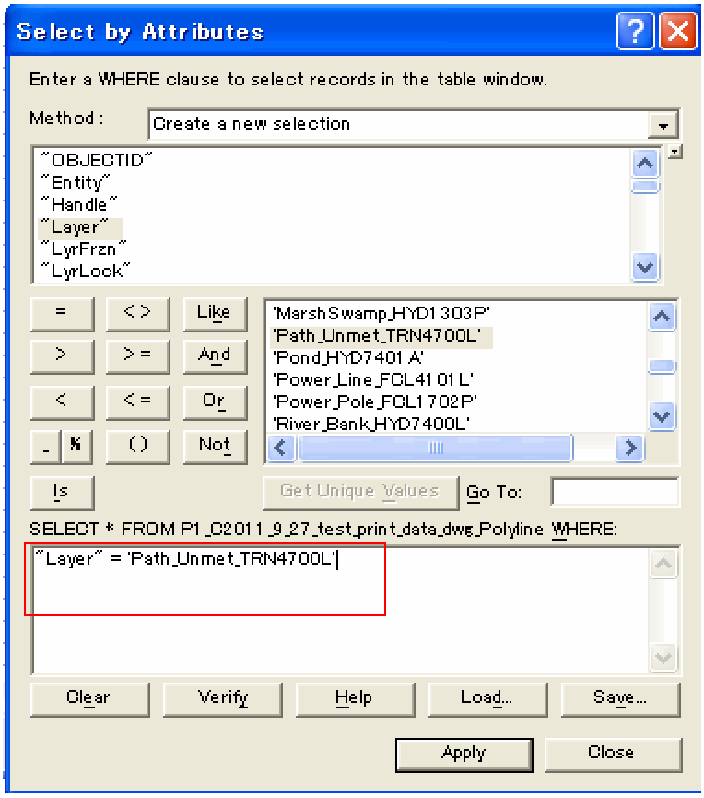
24. Select “Layer”



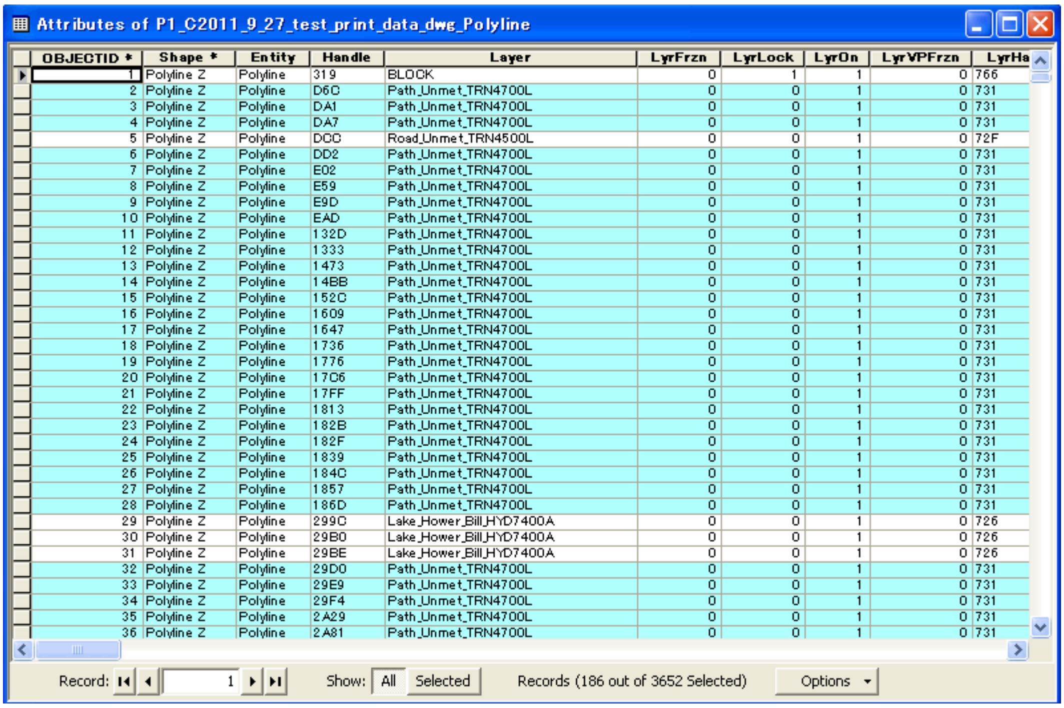
25. Then select a particular feature you want to separate from others



26. Type of feature to be separated is shown in a pane.



27. Result of selection. Selected features are shown in light blue.

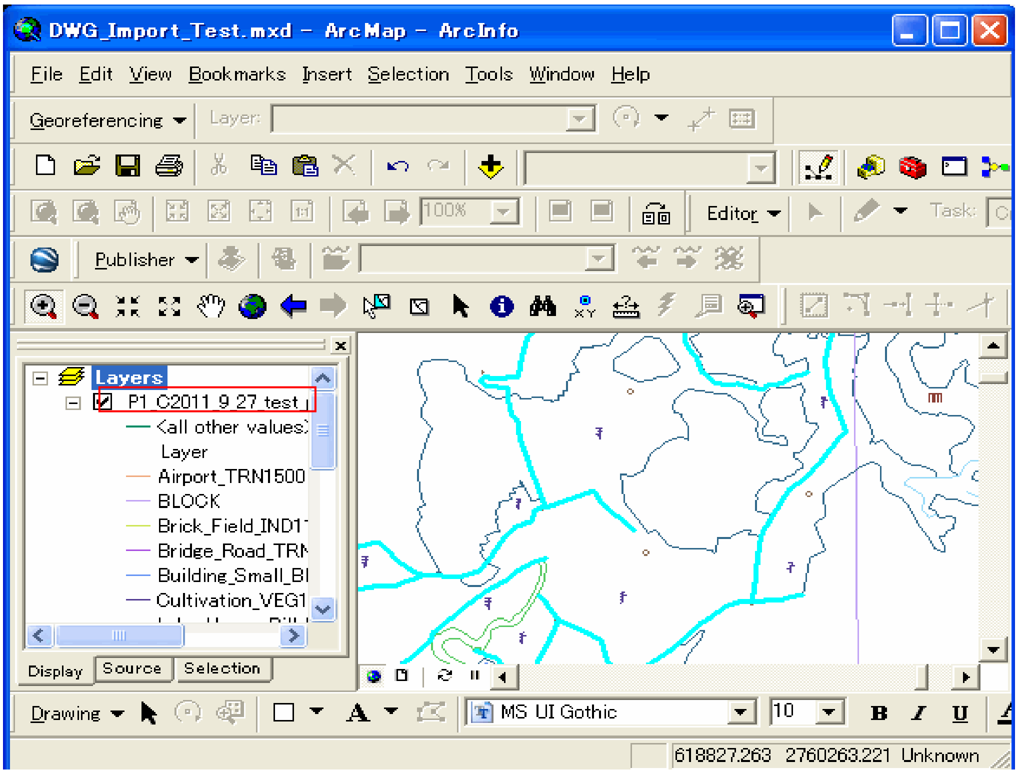


Attributes of P1_C2011_9_27_test_print_data_dwg_Polyline

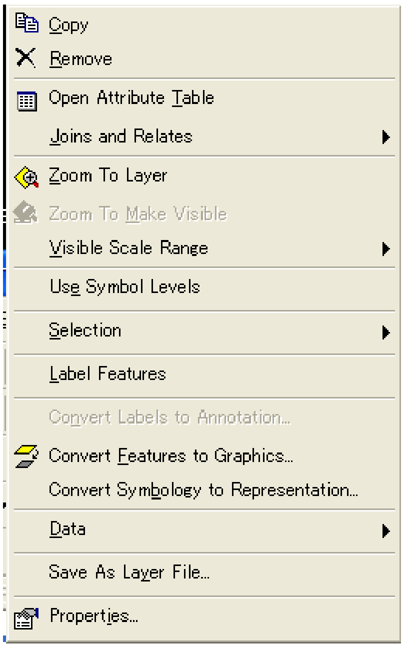
OBJECTID *	Shape *	Entity	Handle	Layer	LyrFrzn	LyrLock	LyrOn	LyrVPFrzn	LyrHa
1	Polyline Z	Polyline	319	BLOCK	0	1	1	0	766
2	Polyline Z	Polyline	D6C	Path_Unmet_TRN4700L	0	0	1	0	731
3	Polyline Z	Polyline	DA1	Path_Unmet_TRN4700L	0	0	1	0	731
4	Polyline Z	Polyline	DA7	Path_Unmet_TRN4700L	0	0	1	0	731
5	Polyline Z	Polyline	DCC	Road_Unmet_TRN4500L	0	0	1	0	72F
6	Polyline Z	Polyline	DD2	Path_Unmet_TRN4700L	0	0	1	0	731
7	Polyline Z	Polyline	E02	Path_Unmet_TRN4700L	0	0	1	0	731
8	Polyline Z	Polyline	E59	Path_Unmet_TRN4700L	0	0	1	0	731
9	Polyline Z	Polyline	E9D	Path_Unmet_TRN4700L	0	0	1	0	731
10	Polyline Z	Polyline	EAD	Path_Unmet_TRN4700L	0	0	1	0	731
11	Polyline Z	Polyline	132D	Path_Unmet_TRN4700L	0	0	1	0	731
12	Polyline Z	Polyline	1333	Path_Unmet_TRN4700L	0	0	1	0	731
13	Polyline Z	Polyline	1473	Path_Unmet_TRN4700L	0	0	1	0	731
14	Polyline Z	Polyline	14BB	Path_Unmet_TRN4700L	0	0	1	0	731
15	Polyline Z	Polyline	152C	Path_Unmet_TRN4700L	0	0	1	0	731
16	Polyline Z	Polyline	1609	Path_Unmet_TRN4700L	0	0	1	0	731
17	Polyline Z	Polyline	1647	Path_Unmet_TRN4700L	0	0	1	0	731
18	Polyline Z	Polyline	1736	Path_Unmet_TRN4700L	0	0	1	0	731
19	Polyline Z	Polyline	1776	Path_Unmet_TRN4700L	0	0	1	0	731
20	Polyline Z	Polyline	17C6	Path_Unmet_TRN4700L	0	0	1	0	731
21	Polyline Z	Polyline	17FF	Path_Unmet_TRN4700L	0	0	1	0	731
22	Polyline Z	Polyline	1813	Path_Unmet_TRN4700L	0	0	1	0	731
23	Polyline Z	Polyline	182B	Path_Unmet_TRN4700L	0	0	1	0	731
24	Polyline Z	Polyline	182F	Path_Unmet_TRN4700L	0	0	1	0	731
25	Polyline Z	Polyline	1839	Path_Unmet_TRN4700L	0	0	1	0	731
26	Polyline Z	Polyline	184C	Path_Unmet_TRN4700L	0	0	1	0	731
27	Polyline Z	Polyline	1857	Path_Unmet_TRN4700L	0	0	1	0	731
28	Polyline Z	Polyline	186D	Path_Unmet_TRN4700L	0	0	1	0	731
29	Polyline Z	Polyline	299C	Lake_Hower_Bill_HYD7400A	0	0	1	0	726
30	Polyline Z	Polyline	29B0	Lake_Hower_Bill_HYD7400A	0	0	1	0	726
31	Polyline Z	Polyline	29BE	Lake_Hower_Bill_HYD7400A	0	0	1	0	726
32	Polyline Z	Polyline	29D0	Path_Unmet_TRN4700L	0	0	1	0	731
33	Polyline Z	Polyline	29E9	Path_Unmet_TRN4700L	0	0	1	0	731
34	Polyline Z	Polyline	29F4	Path_Unmet_TRN4700L	0	0	1	0	731
35	Polyline Z	Polyline	2A29	Path_Unmet_TRN4700L	0	0	1	0	731
36	Polyline Z	Polyline	2A81	Path_Unmet_TRN4700L	0	0	1	0	731

Record: 1 Show: All Selected Records (186 out of 3652 Selected) Options

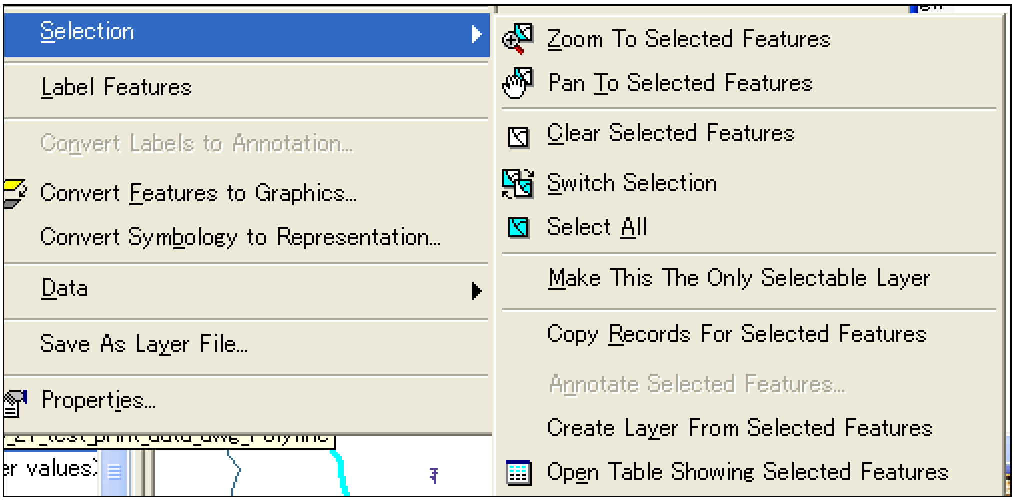
28. Selected features are highlighted in light blue also in map window. Then right click on the layer in a pane.,



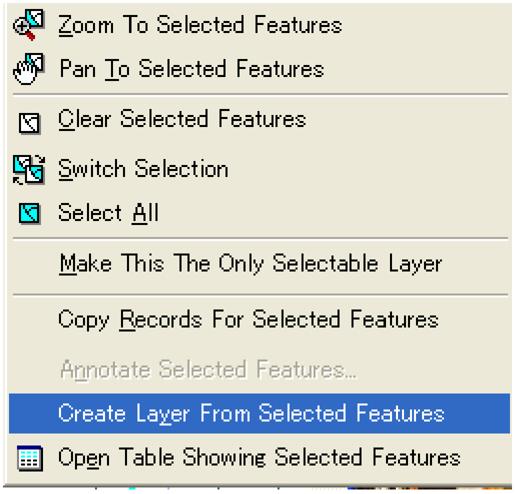
29. A pull down menu opens.



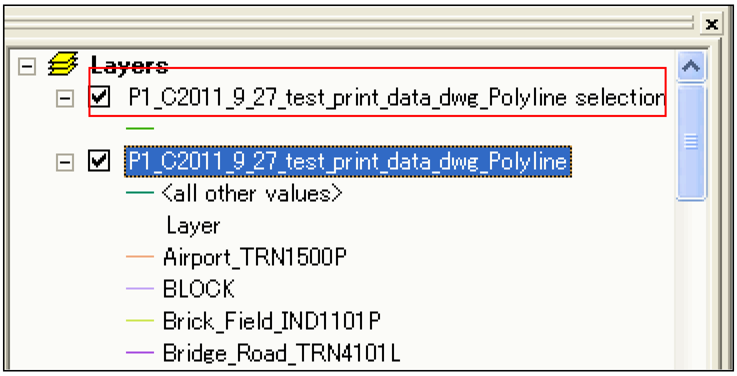
30. Click “Selection” and another menu opens



31. Choose “Create Layer From Selected Features”

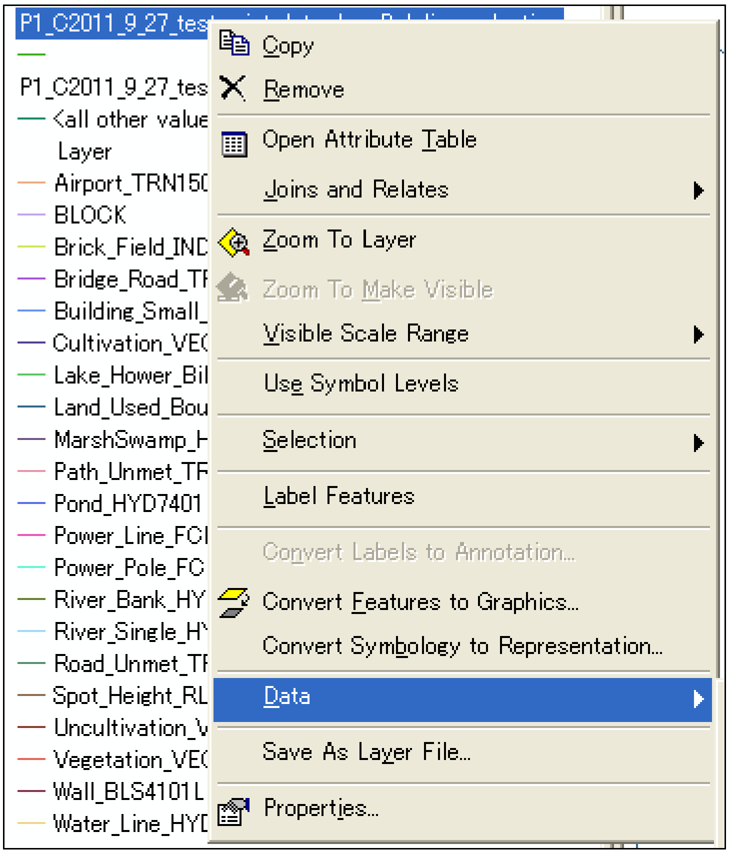


32. A new layer is added to data pane

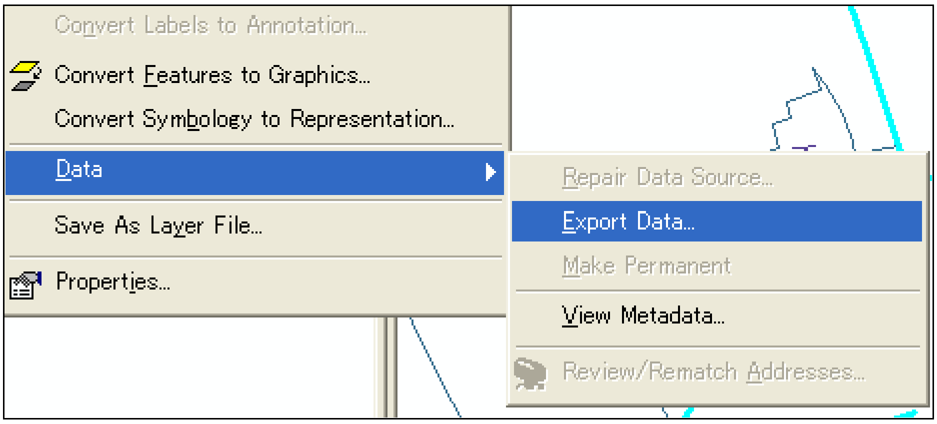


33. Now, save the created layer.

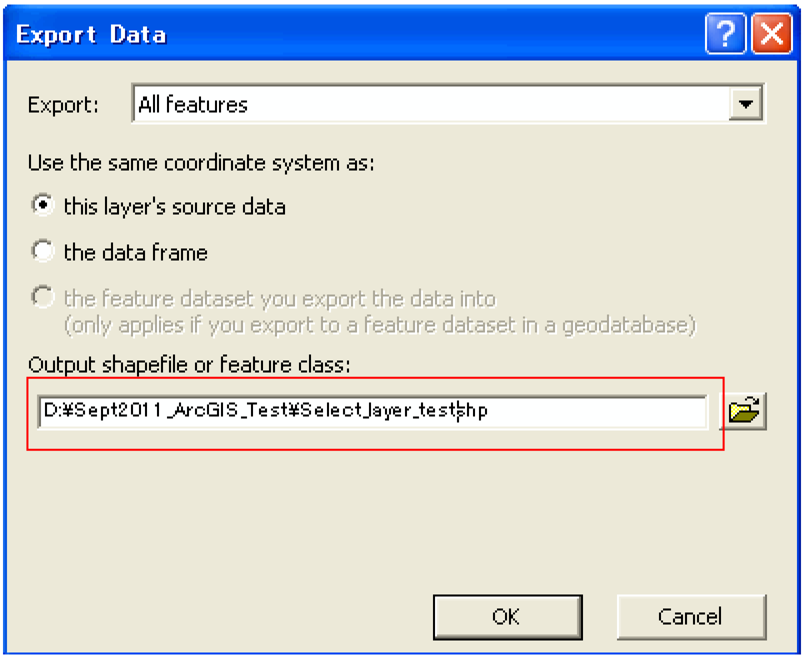
Right click the newly added layer and select "Data" on a pull down menu.



34. Then select "Export Data"

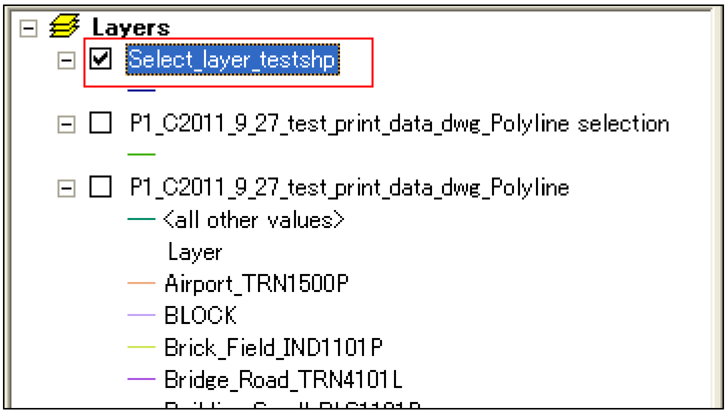


35. Define the place and name of Output shapefile.



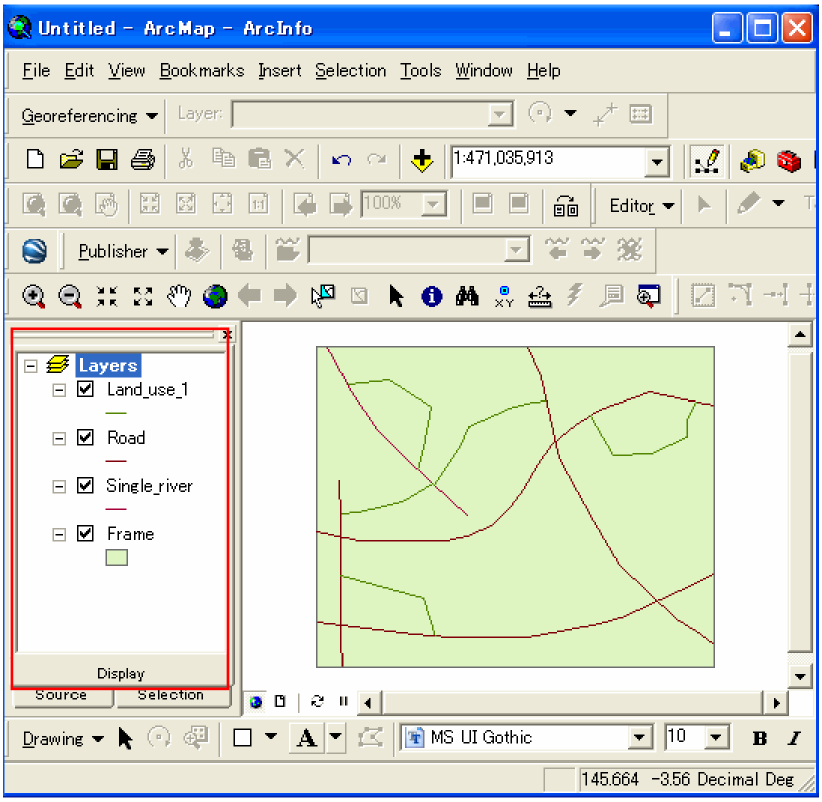
36. You are asked to add the data to the map. Click YES

37. Exported data is now added to a data pane. By seeing the vector data of the added layer, it is possible to check if data of the selected feature are stored as a separate layer.

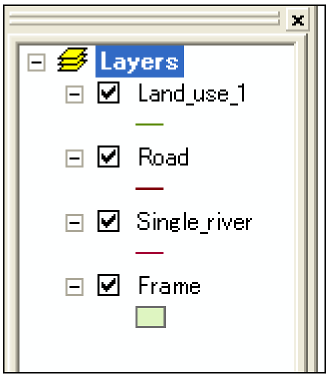


Appendix 3. Polyline to Polygon Conversion and Feature Selection (ArcGIS 9.3)

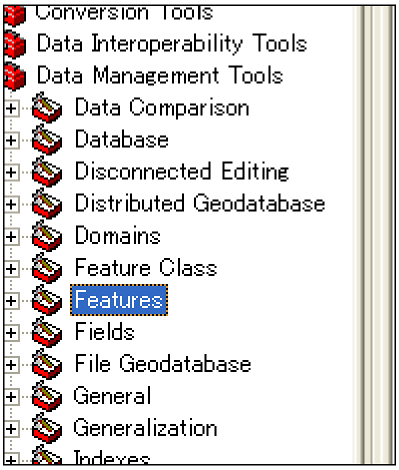
1. All the relevant line feature data must be added to ArcGIS.



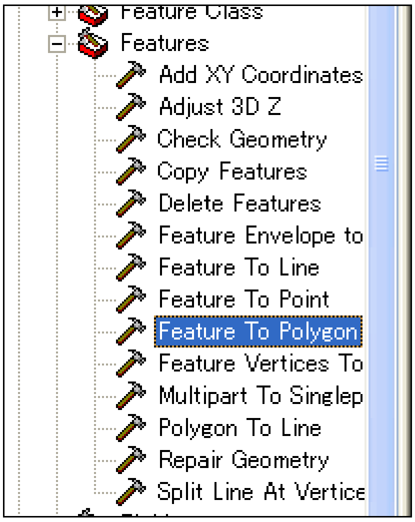
2. In this example, four features are added including a rectangular frame feature.



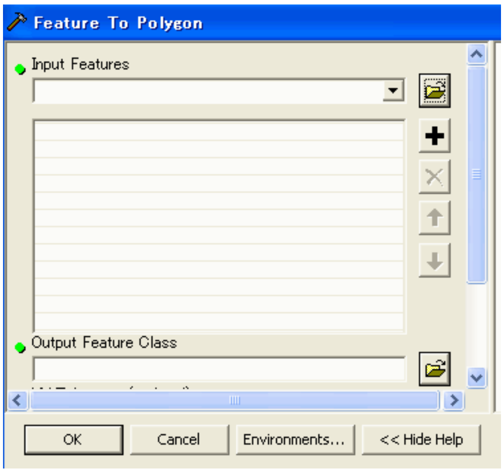
3. Open Tool Box and select Features under Data Management Tools



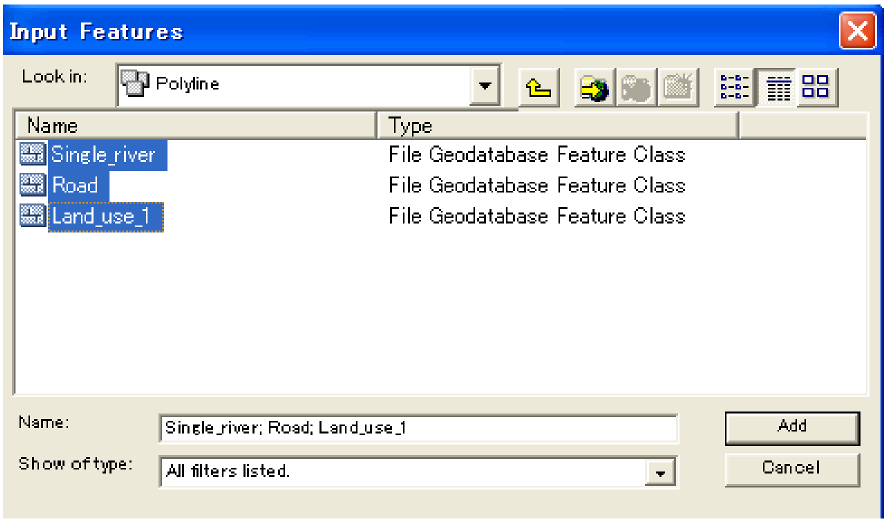
4. Then, select "Feature To Polygon" function.



5. Feature To Polygon function window opens.

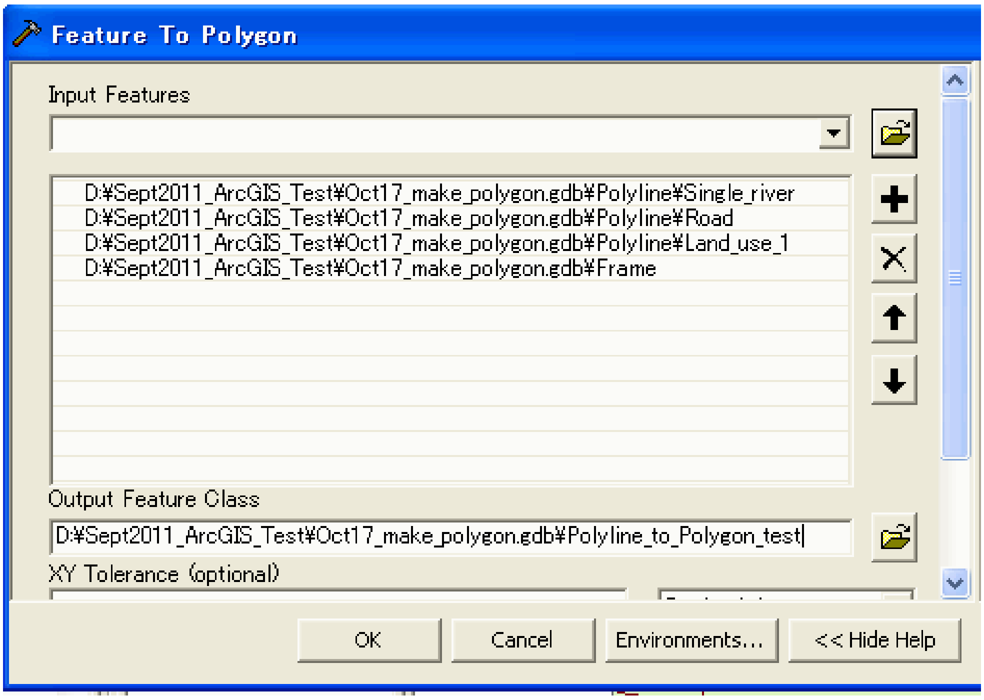


6. Select Input Features

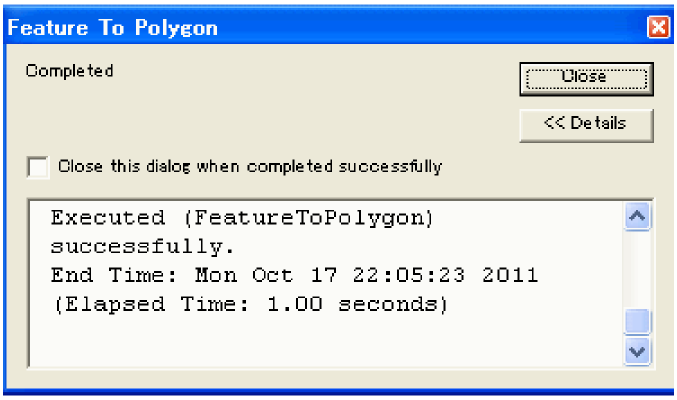


7. Input features are selected.

Also, Output Feature Class Name must be typed in.

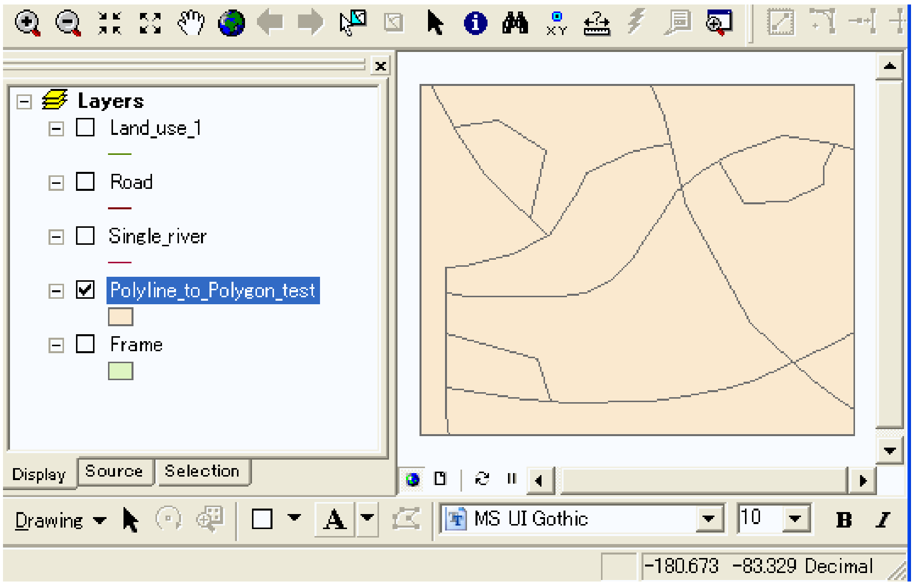


8. Feature To Polygon calculation completed



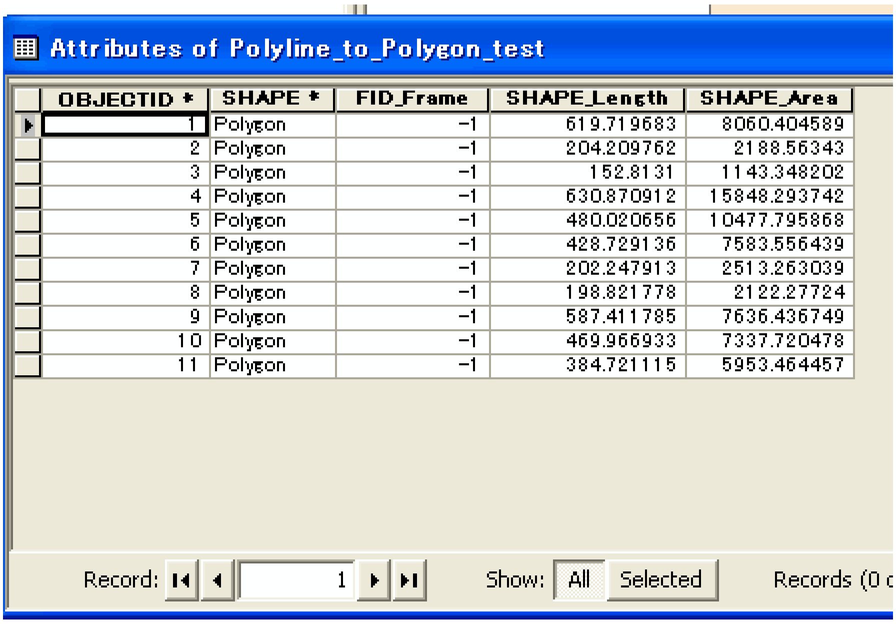
9. Result of Feature To Polygon calculation is added to data pane.

10. Add result looks like this



11. Table of the result of Feature To Polygon calculation is as shown below.

At this moment, generated polygons do not have any attribute information which can be used to identify if a polygon is of vegetation or others.

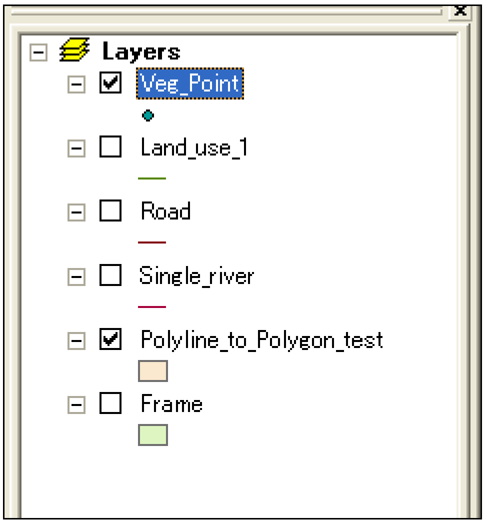

Attributes of Polyline_to_Polygon_test

OBJECTID *	SHAPE *	FID_Frame	SHAPE_Length	SHAPE_Area
1	Polygon	-1	619.719683	8060.404589
2	Polygon	-1	204.209762	2188.56343
3	Polygon	-1	152.8131	1143.348202
4	Polygon	-1	630.870912	15848.293742
5	Polygon	-1	480.020656	10477.795868
6	Polygon	-1	428.729136	7583.556439
7	Polygon	-1	202.247913	2513.263039
8	Polygon	-1	198.821778	2122.27724
9	Polygon	-1	587.411785	7636.436749
10	Polygon	-1	469.966933	7337.720478
11	Polygon	-1	384.721115	5953.464457

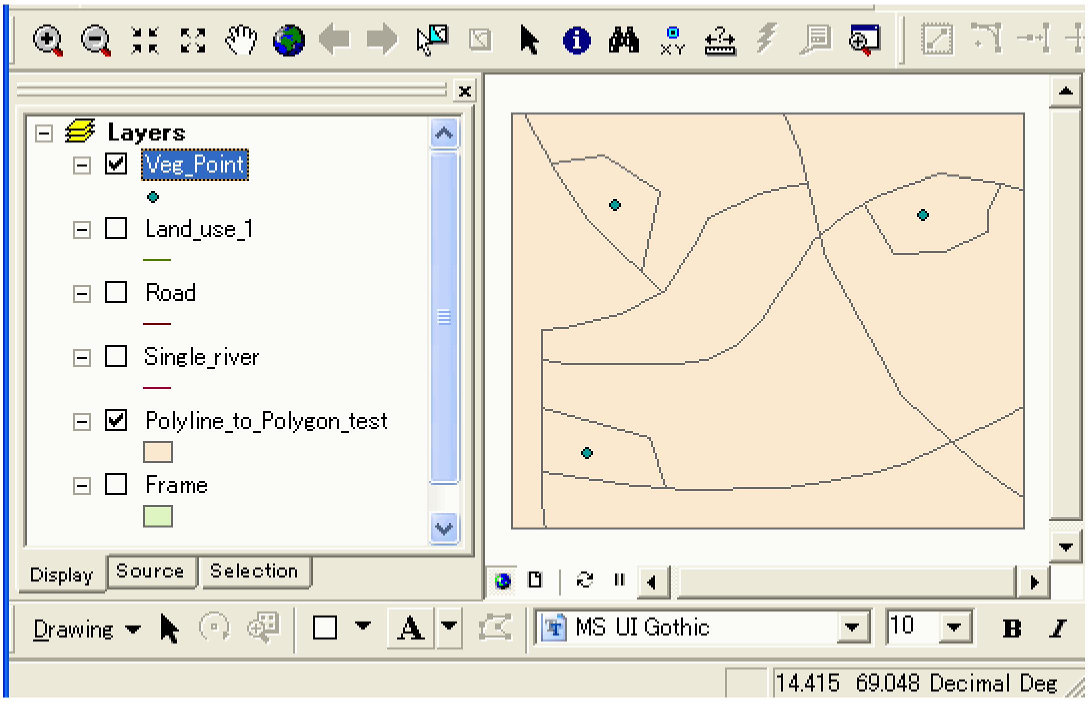
Record: 1 Show: All Selected Records (0 c

12. Create a new point feature in ArcCatalog and add it into a data pane.

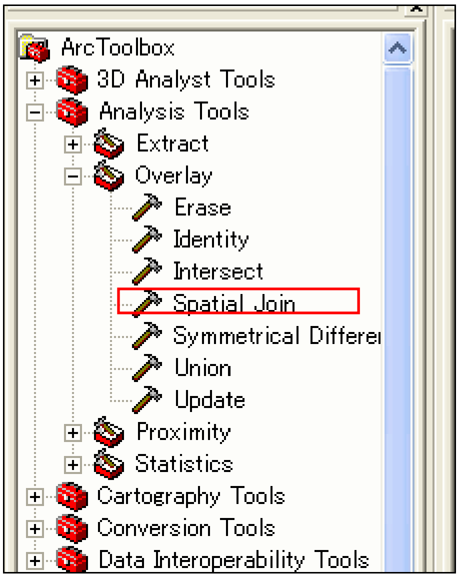
Then, using edit function of ArcGIS, create points inside polygons which are the target of selection. If vegetation polygon is a target, put points inside vegetation polygon. This work will be done by showing orthophoto in the background of vector data.



13. Points are created inside target polygons.

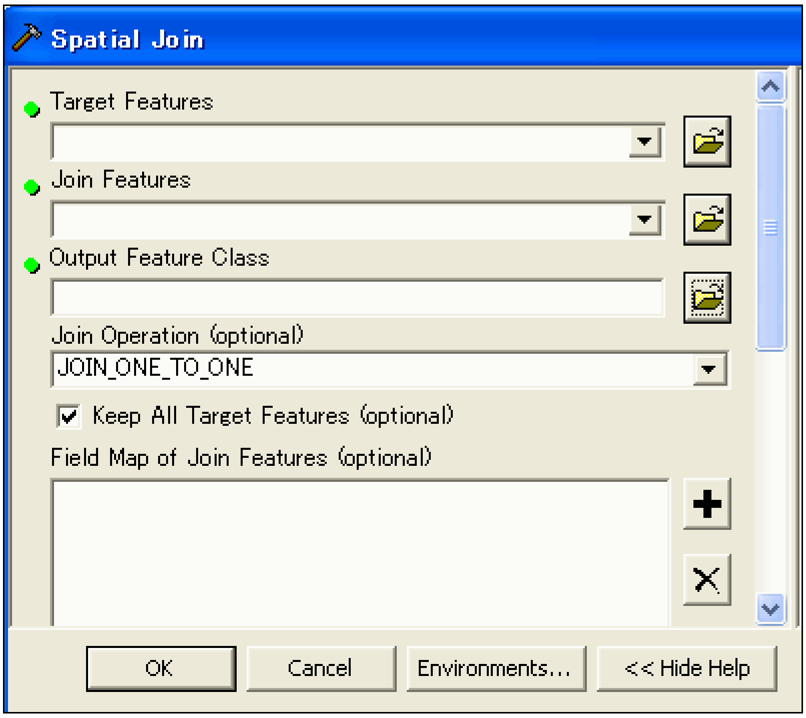


14. To extract only target polygons, use Spatial Join function.



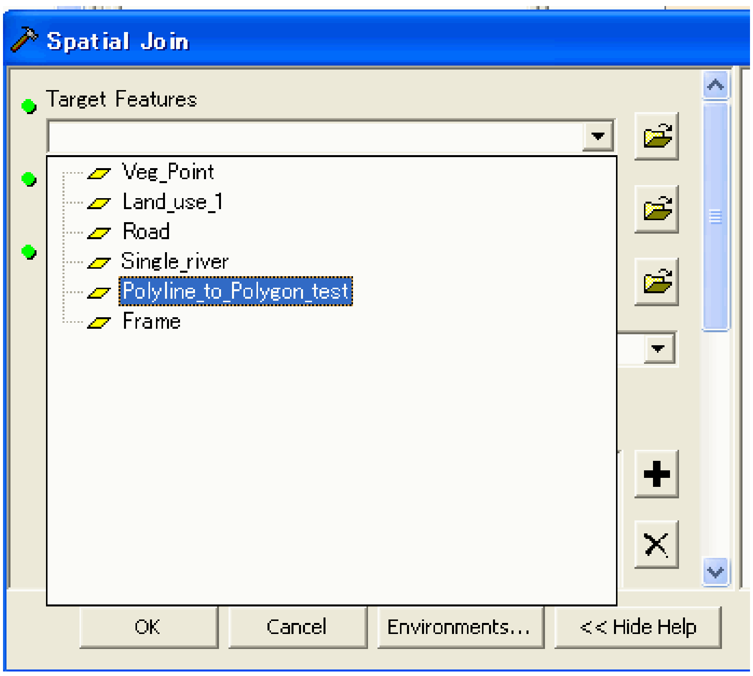
Step 14 to Step 25 can be replaced Step 30 to Step 34 explained at the end of this document.

15. Spatial Join window opens

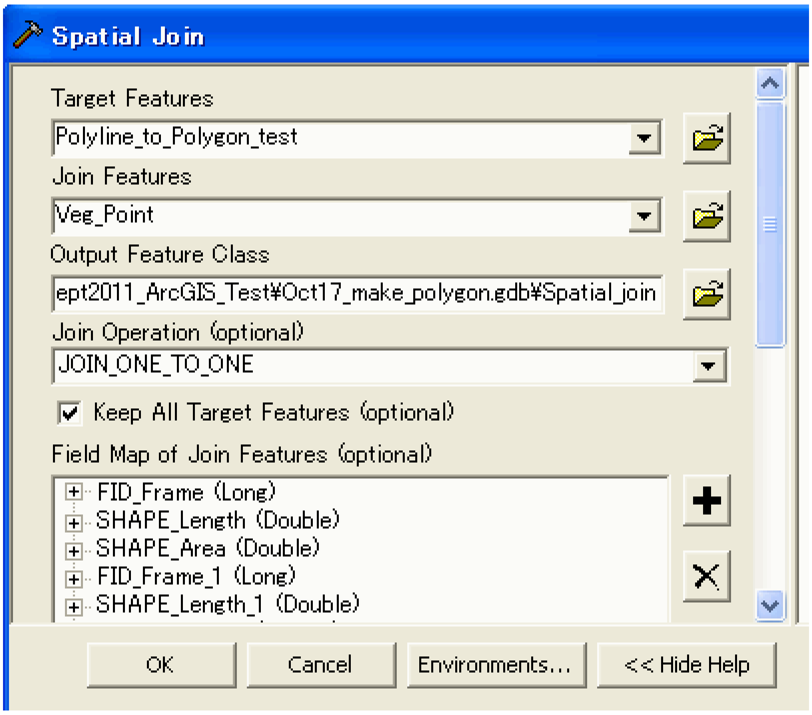


16. Select Target Features, Join Features and Define Output Feature Class

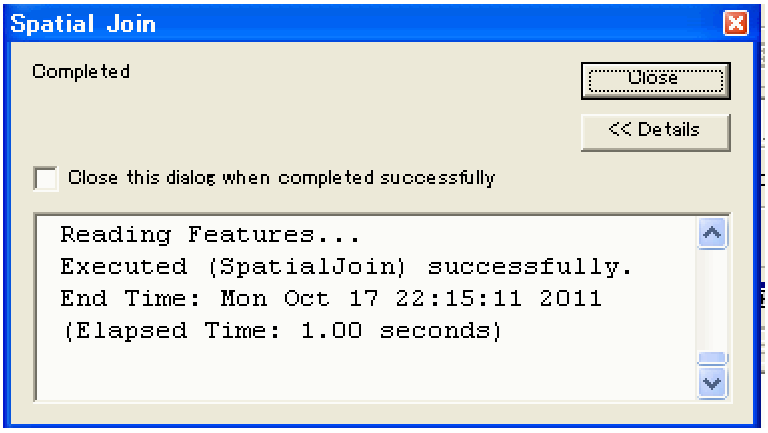
In this case target feature is polygon feature and join feature is point feature. Also select JOIN_ONE_TO_ONE



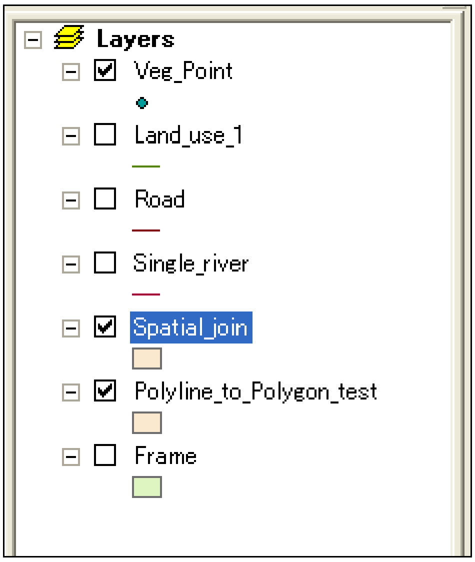
17. All necessary information entered.



18. Spatial Join calculation completed

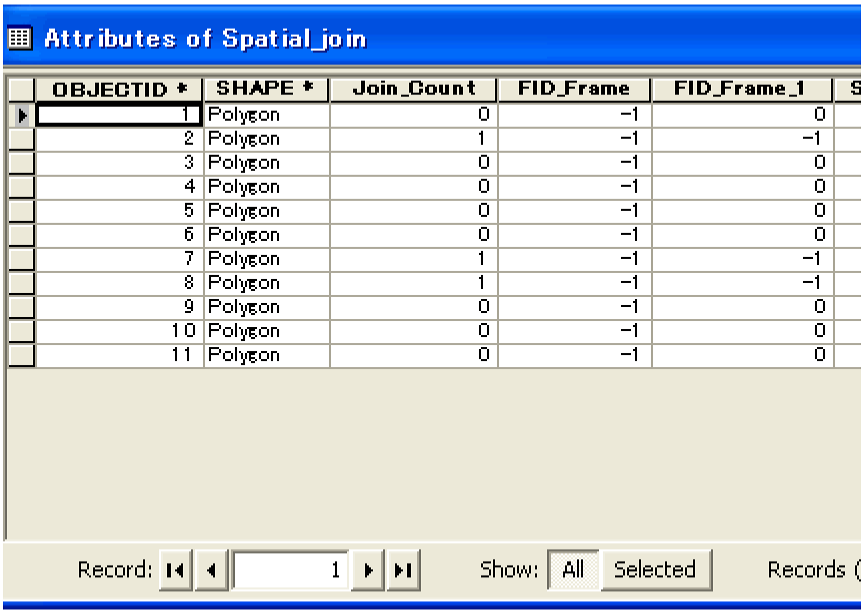


19. Result of Spatial Join is added to data pane.



20. Table of the result of Spatial Join looks like this.

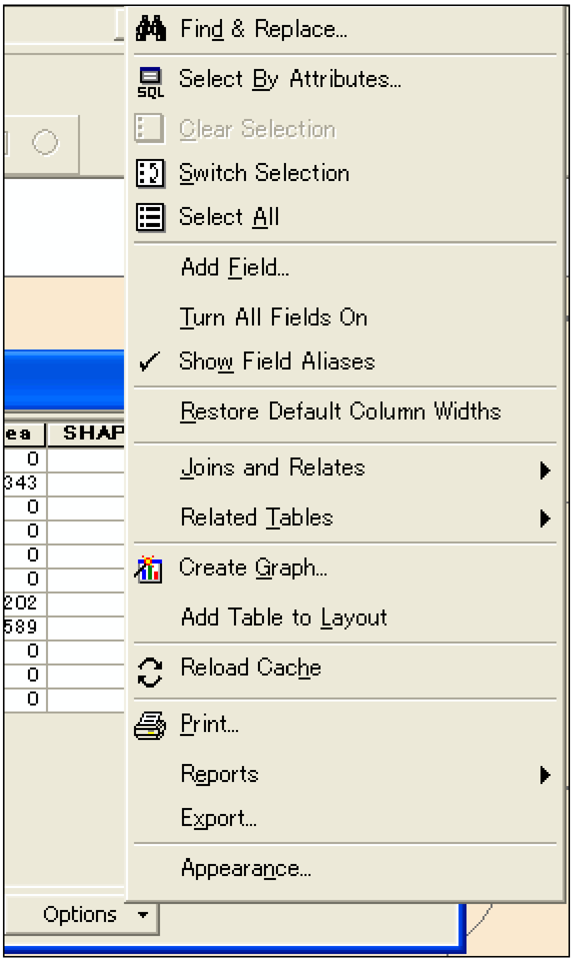
Please note that Joint_Count column has number 0 or 1. Objects with “1” are polygons which has Point within them – this means they are polygons we need to extract.


Attributes of Spatial_join

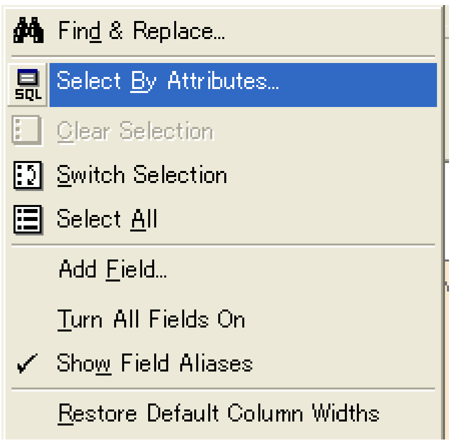
OBJECTID *	SHAPE *	Join_Count	FID_Frame	FID_Frame_1
1	Polygon	0	-1	0
2	Polygon	1	-1	-1
3	Polygon	0	-1	0
4	Polygon	0	-1	0
5	Polygon	0	-1	0
6	Polygon	0	-1	0
7	Polygon	1	-1	-1
8	Polygon	1	-1	-1
9	Polygon	0	-1	0
10	Polygon	0	-1	0
11	Polygon	0	-1	0

Record: 1 Show: All Selected Records (

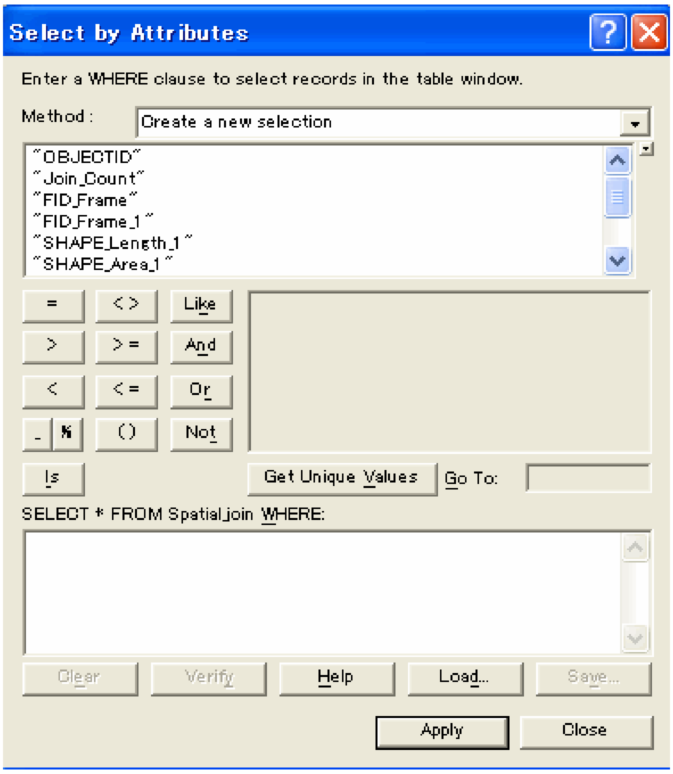
21. Click “Options” button on the table and a pull down menu appears.



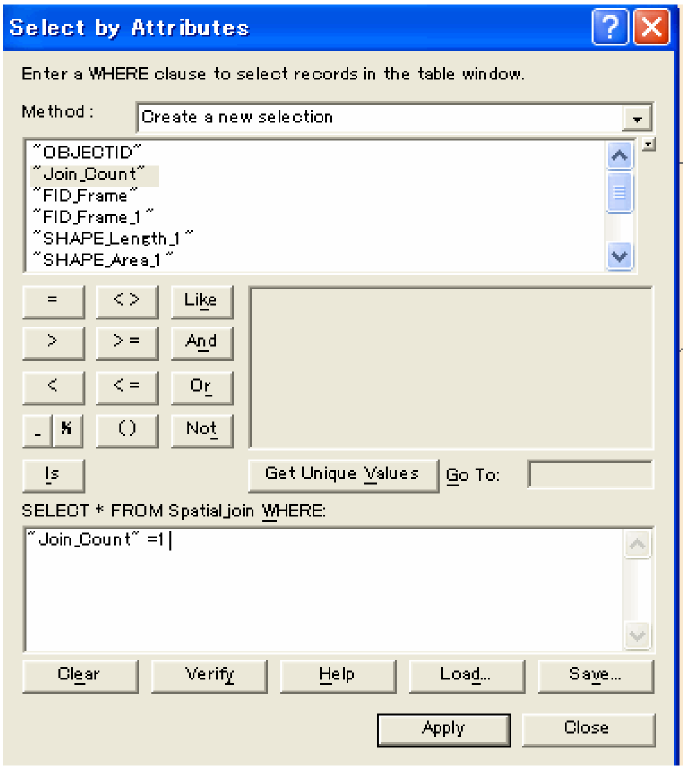
22. Choose “Select By Attributes”



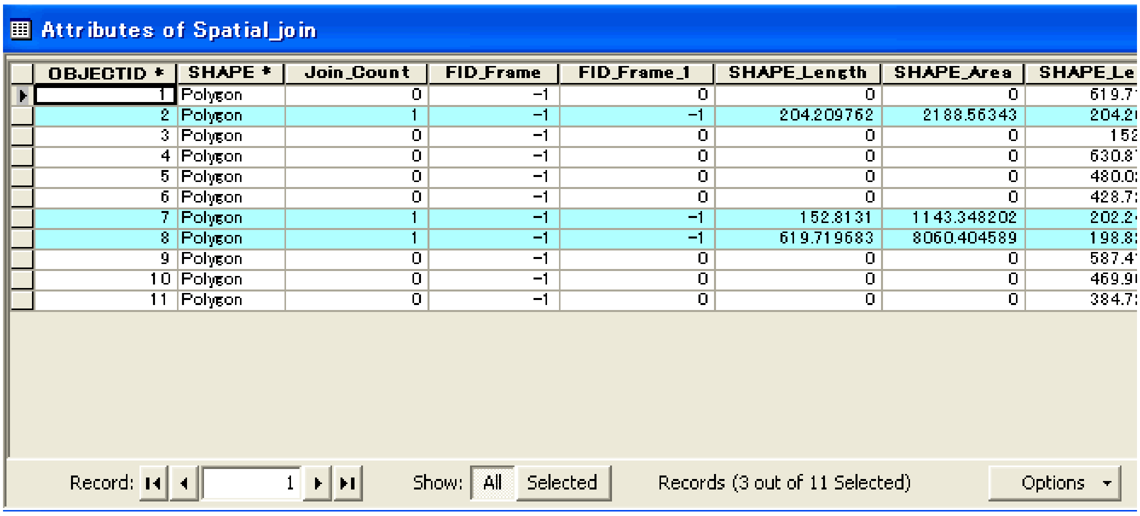
23. Select by Attributes window opens



24. Select "Join_Count" and set the parameter as 1.



25. Objects which has value 1 in the column of Join_Count are selected.

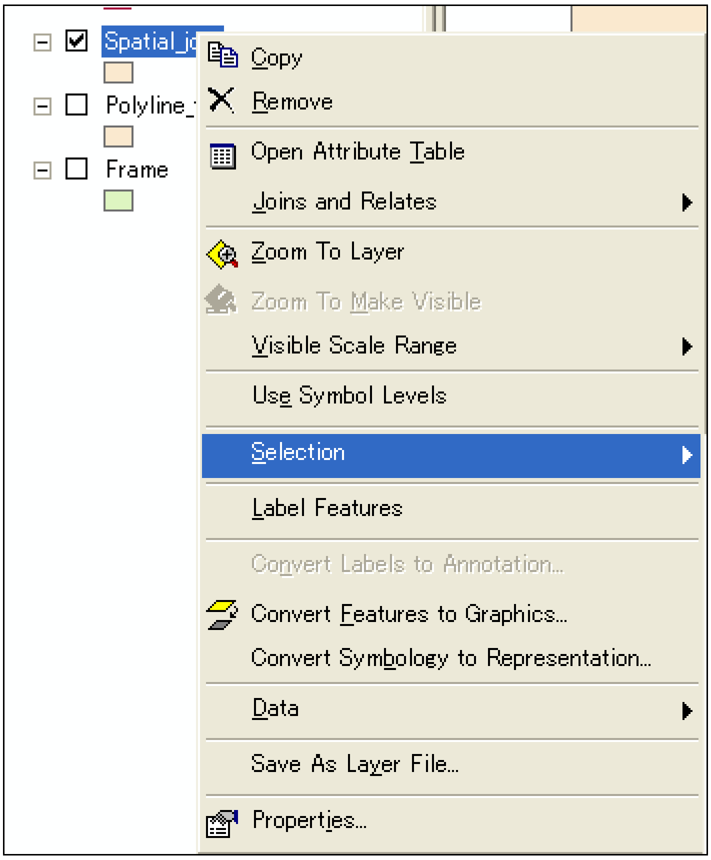


Attributes of Spatial_join

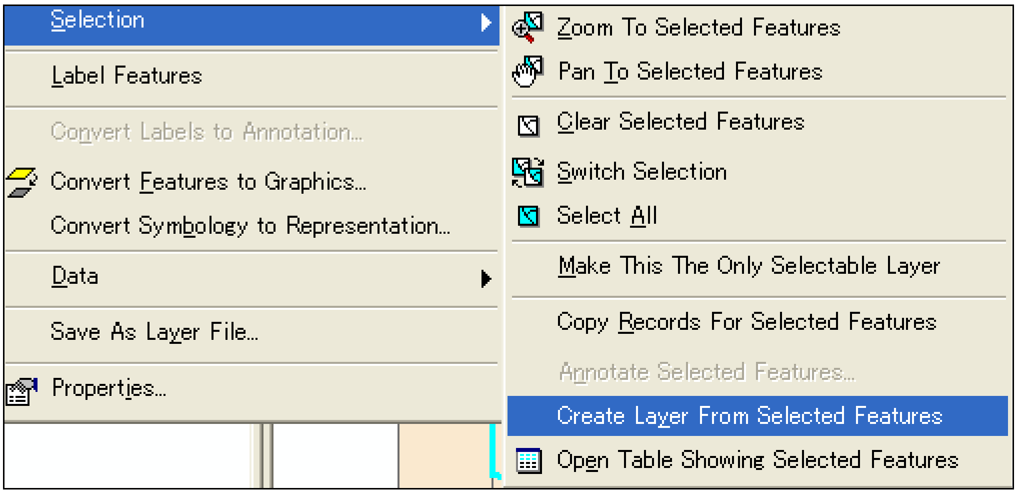
OBJECTID *	SHAPE *	Join_Count	FID_Frame	FID_Frame_1	SHAPE_Length	SHAPE_Area	SHAPE_Le
1	Polygon	0	-1	0	0	0	619.7
2	Polygon	1	-1	-1	204.209762	2188.56343	204.2
3	Polygon	0	-1	0	0	0	152
4	Polygon	0	-1	0	0	0	630.8
5	Polygon	0	-1	0	0	0	480.0
6	Polygon	0	-1	0	0	0	428.7
7	Polygon	1	-1	-1	152.8131	1143.348202	202.2
8	Polygon	1	-1	-1	619.719683	8060.404589	198.8
9	Polygon	0	-1	0	0	0	587.4
10	Polygon	0	-1	0	0	0	469.9
11	Polygon	0	-1	0	0	0	384.7

Record: 1 Show: All Selected Records (3 out of 11 Selected) Options

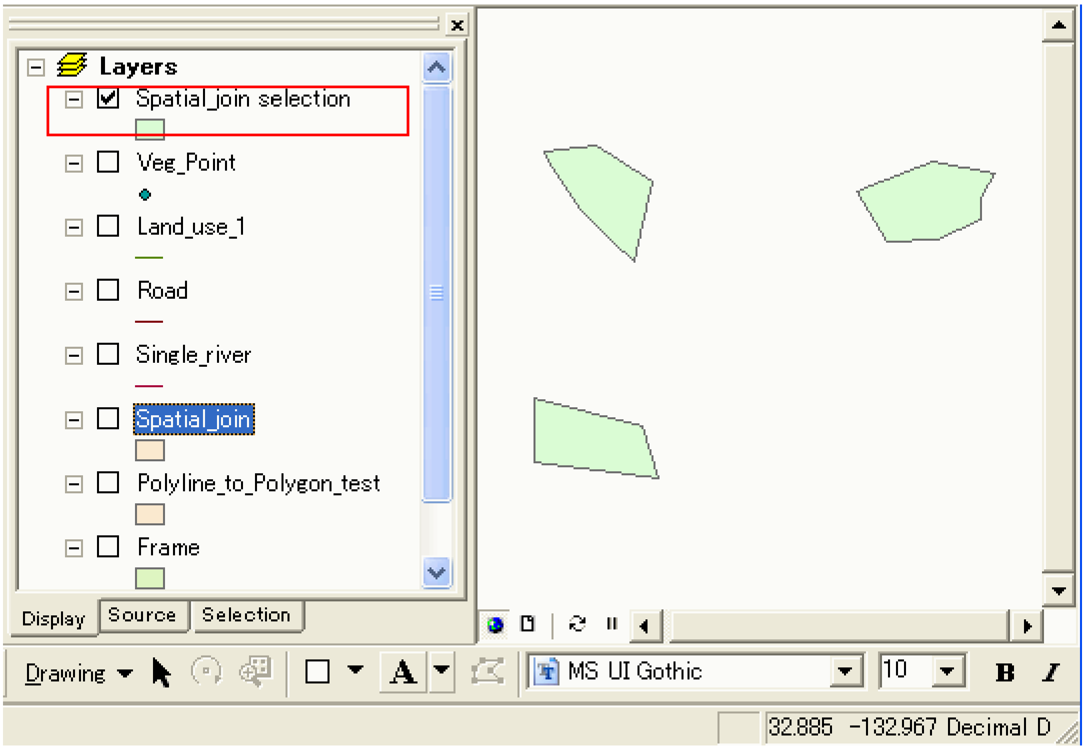
26. Then, right click the file name of the target features on data pane then click "Selection"



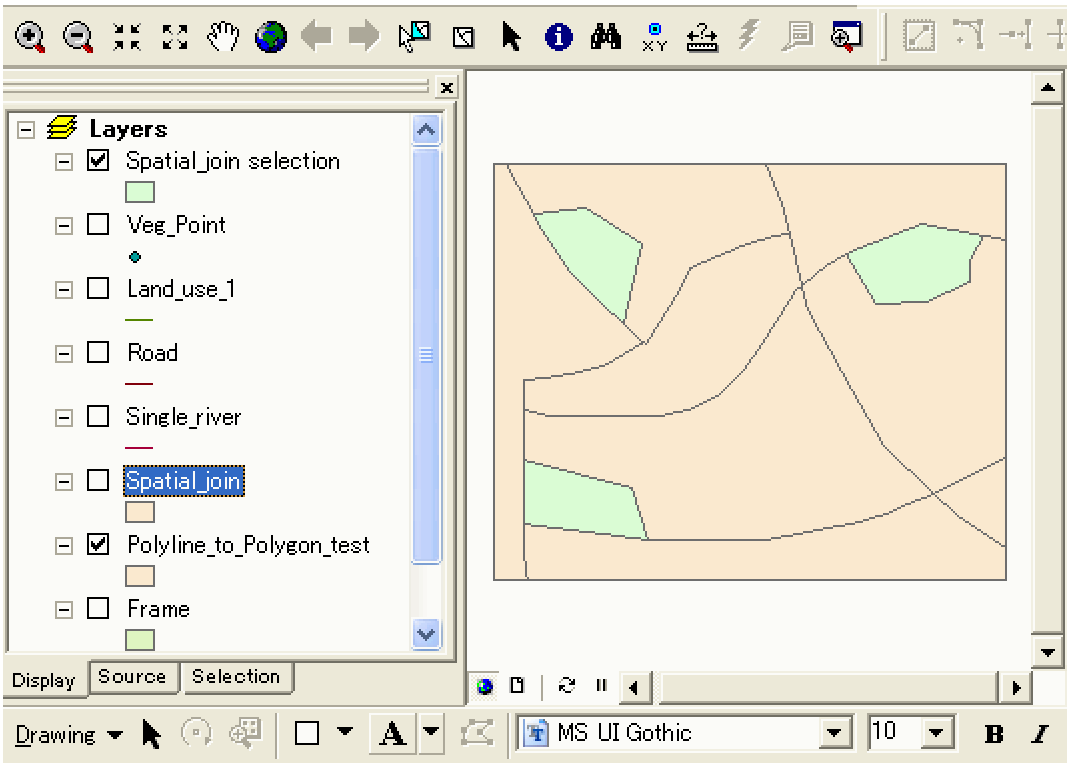
27. Then choose "Create Layer From Selected Features"



28. A new feature is added

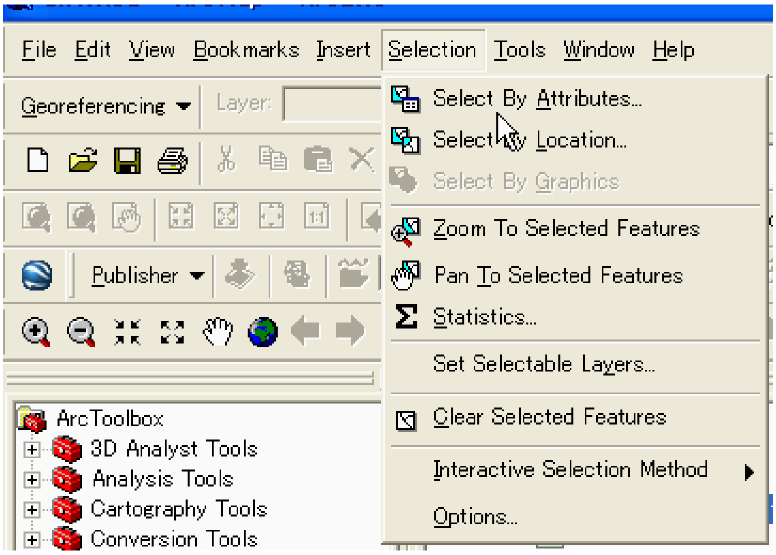


29. Selected polygons with original polygon data.

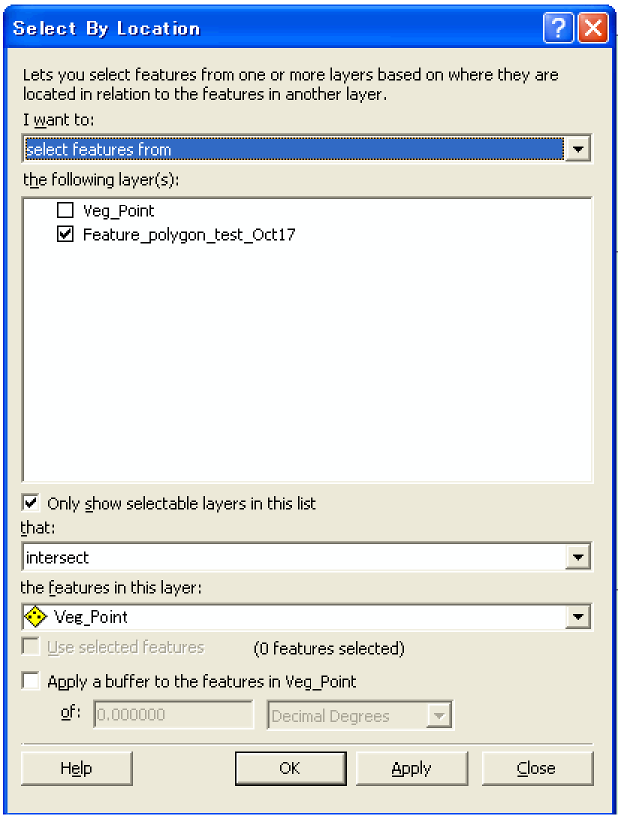


Step 14 to Step 25 explained above can be replaced by Step 31 to Step 34 as shown below.

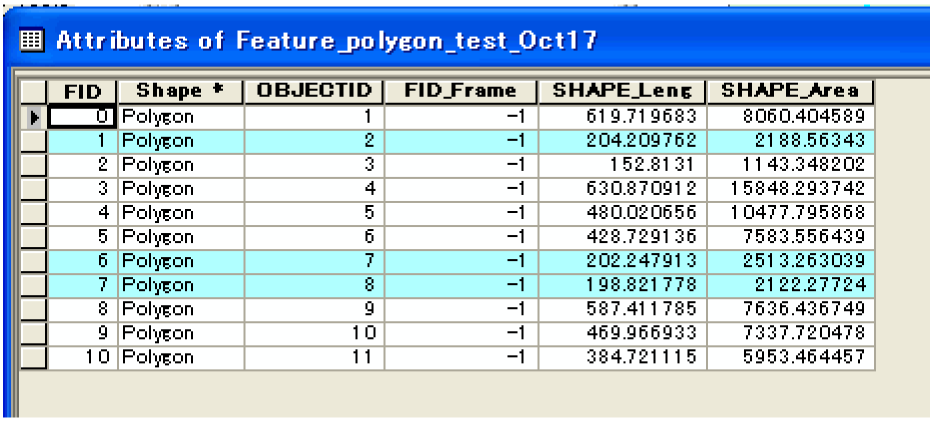
30. Click "Selection" in the main menu of ArcGIS



31. Select By Location Menu opens.
Select target features. Then choose Interset.



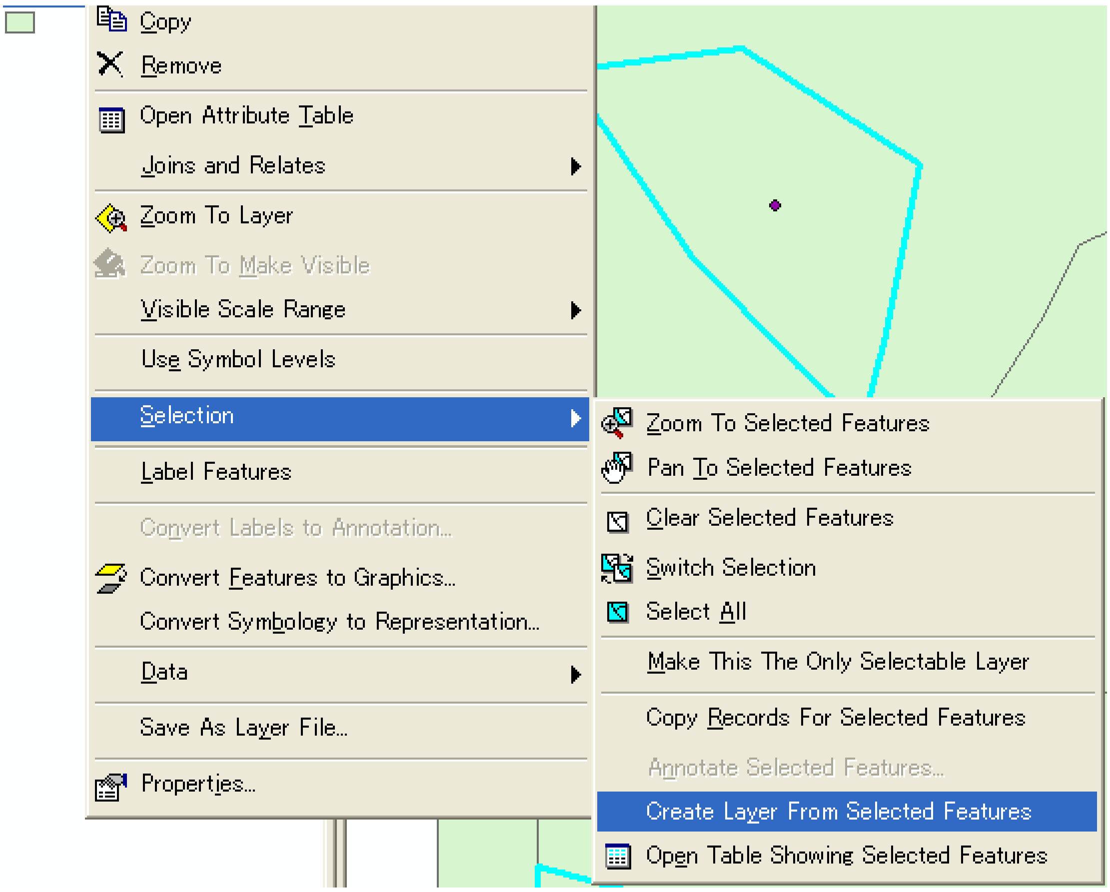
32. Result of the selection



Attributes of Feature_polygon_test_Oct17

FID	Shape *	OBJECTID	FID_Frame	SHAPE_Leng	SHAPE_Area
0	Polygon	1	-1	619.719683	8060.404589
1	Polygon	2	-1	204.209762	2188.56343
2	Polygon	3	-1	152.8131	1143.348202
3	Polygon	4	-1	630.870912	15848.293742
4	Polygon	5	-1	480.020656	10477.795868
5	Polygon	6	-1	428.729136	7583.556439
6	Polygon	7	-1	202.247913	2513.263039
7	Polygon	8	-1	198.821778	2122.27724
8	Polygon	9	-1	587.411785	7636.436749
9	Polygon	10	-1	469.966933	7337.720478
10	Polygon	11	-1	384.721115	5953.464457

33. Then choose “Create Layer From Selected Features” to save the selected objects in one layer.



Appendix 4. Topology Error Checking and Error Correction

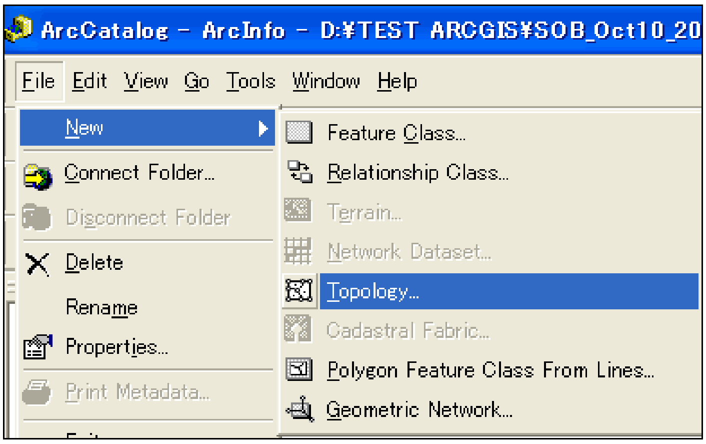
（ArcGIS 9.3）

1.Topology Rule Making

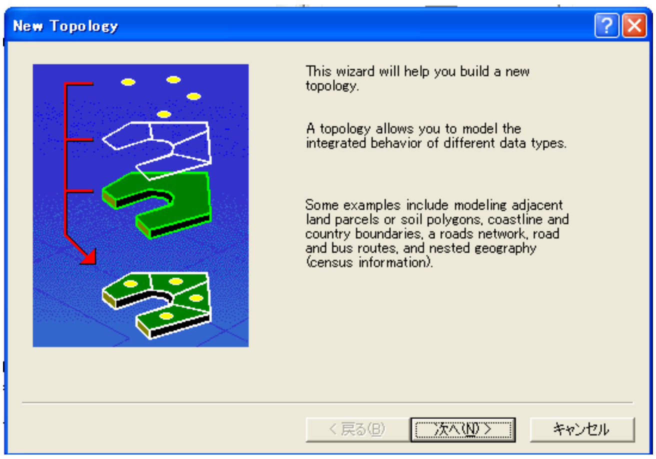
Topology rule is stored in a Feature Class under a geodatabase.

2. Topology Rule Making

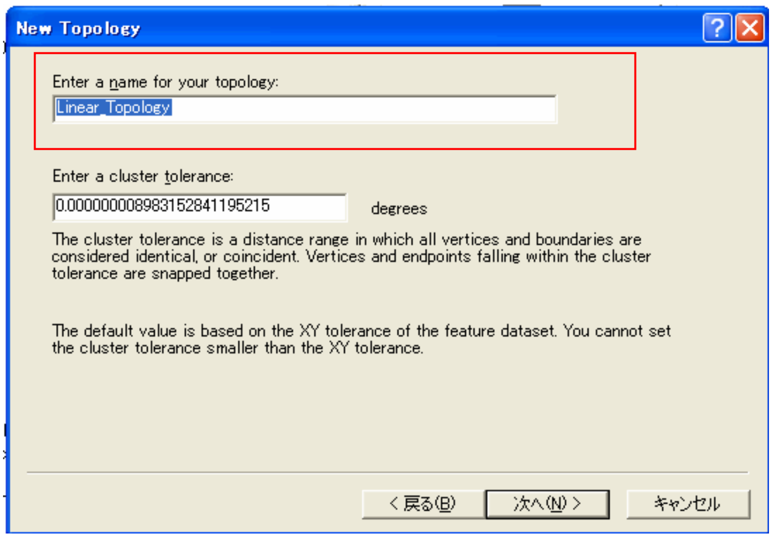
On ArcCatalog menue, select File → New → Toplogy



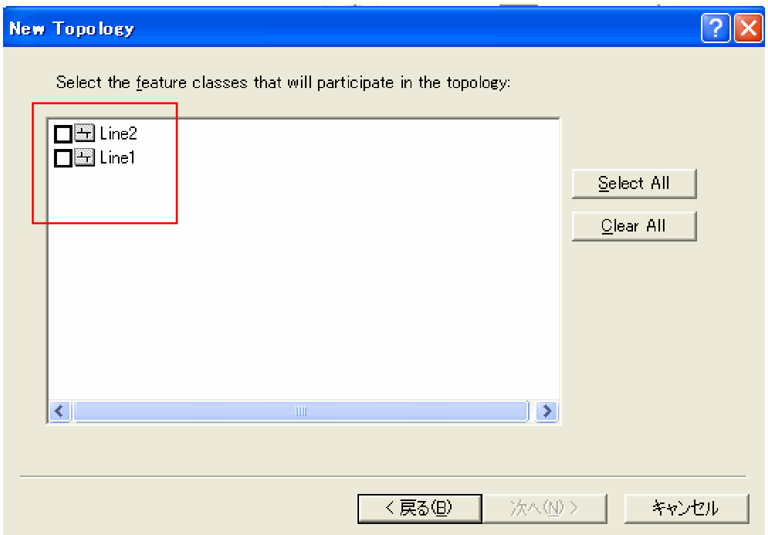
3. New topology defining menu opens.



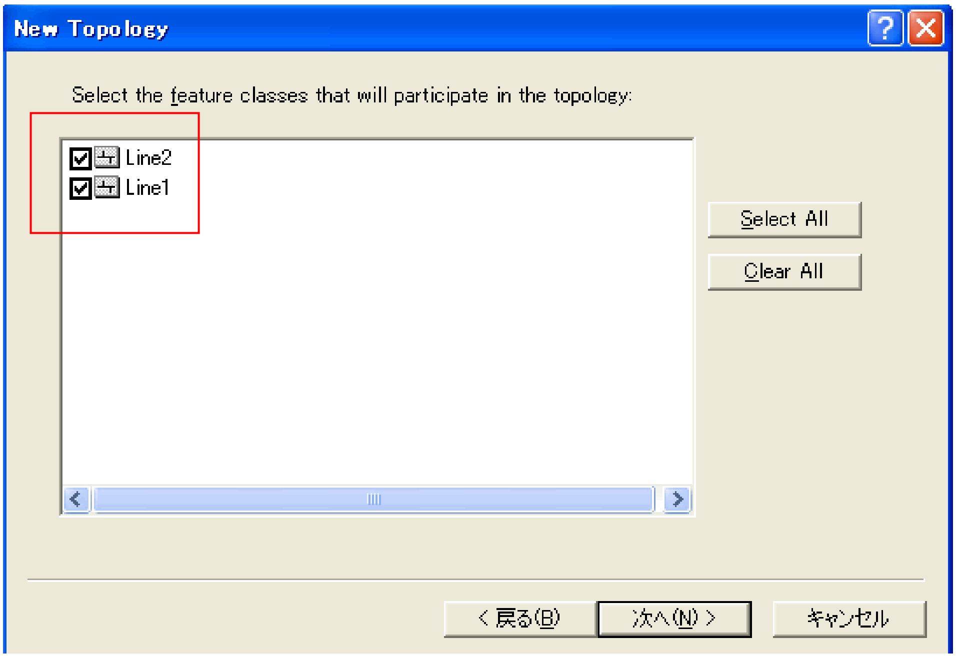
4. Enter a name of new topology



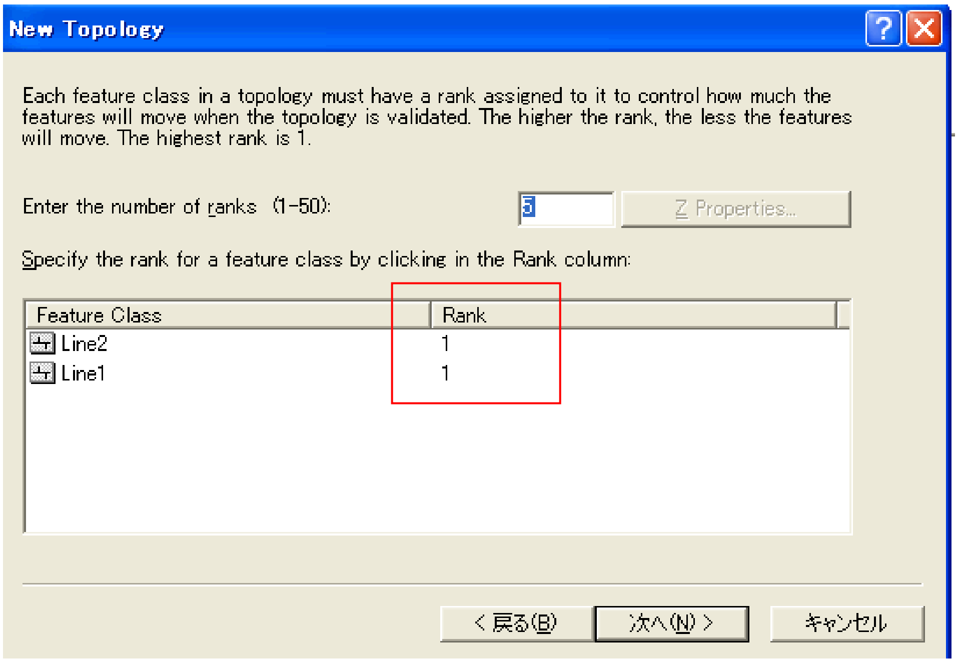
5. Select the feature classes that will participate in the new topology.



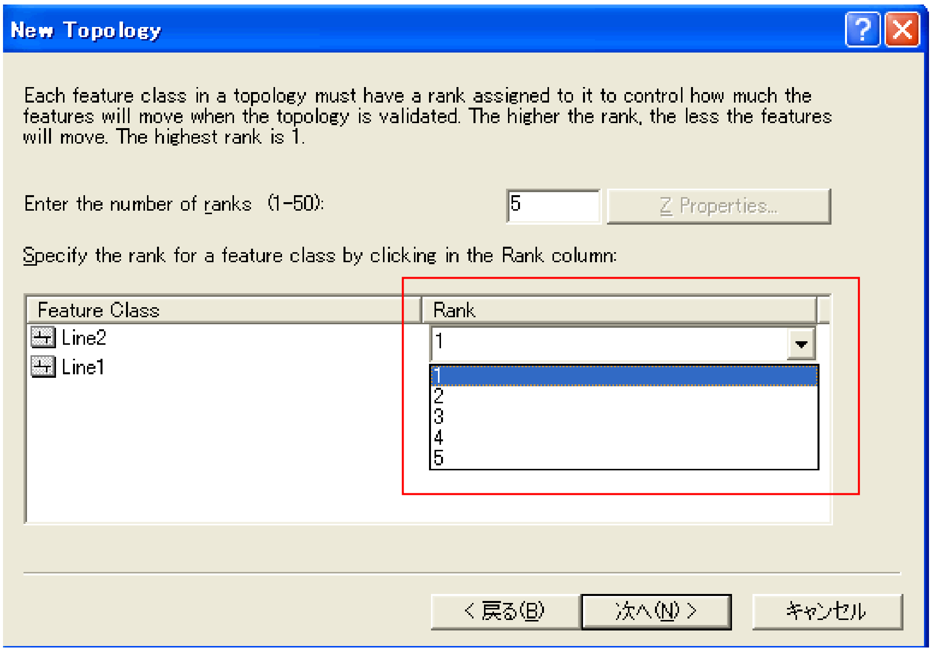
6. In this case Line 1 and Line 2 are selected.



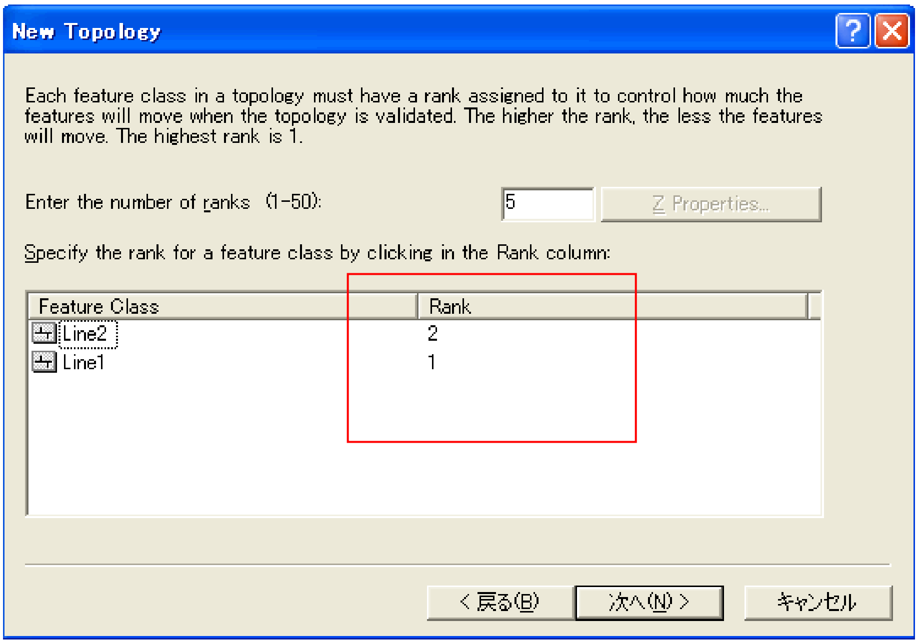
7. Rank is selected.



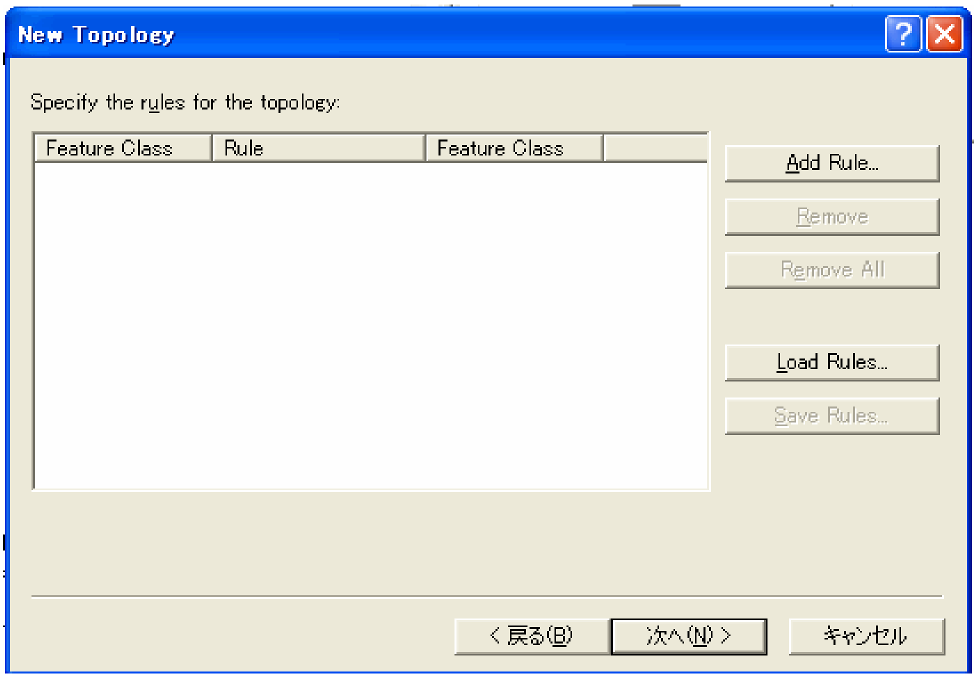
8. Rank can be changed by clicking number in Rank column.



9. Rank is changed.

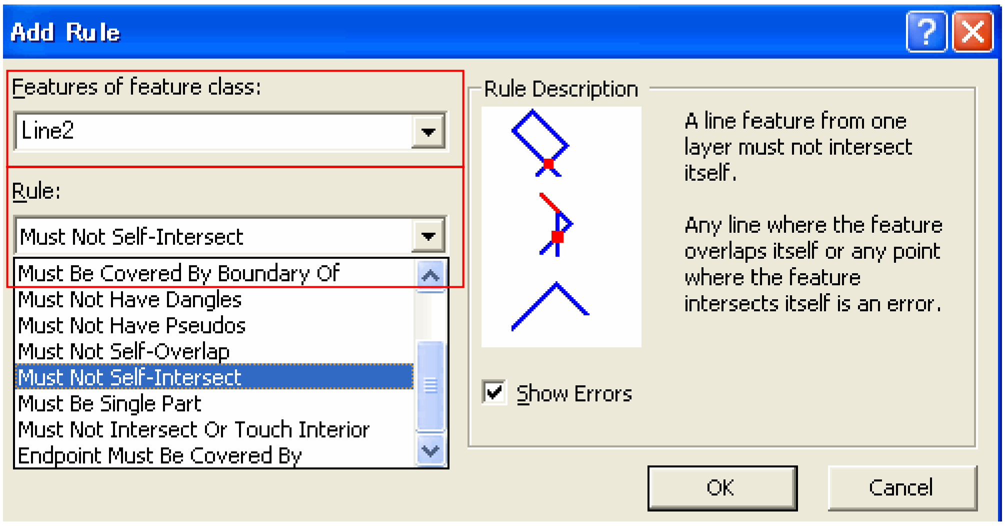


10. A window to specify topology rule opens.

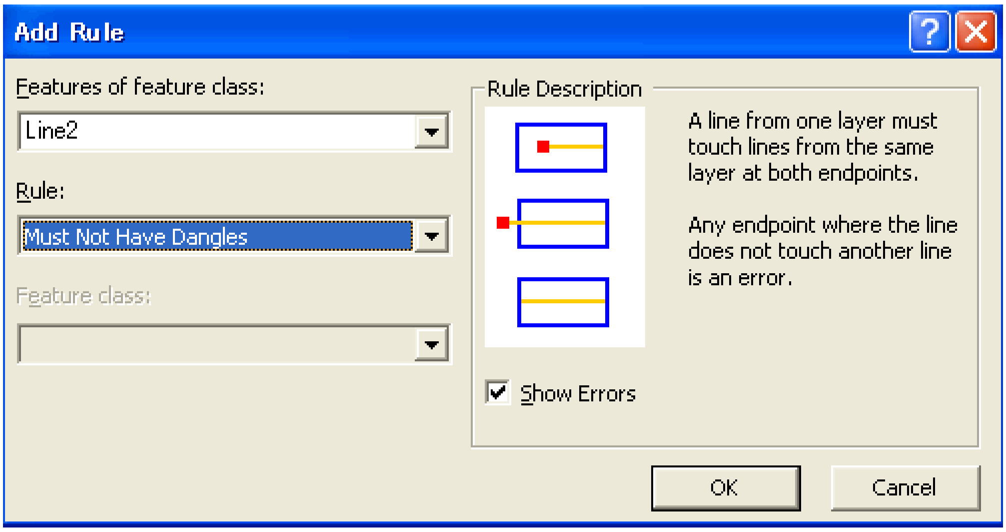


11. Add rule windows opens

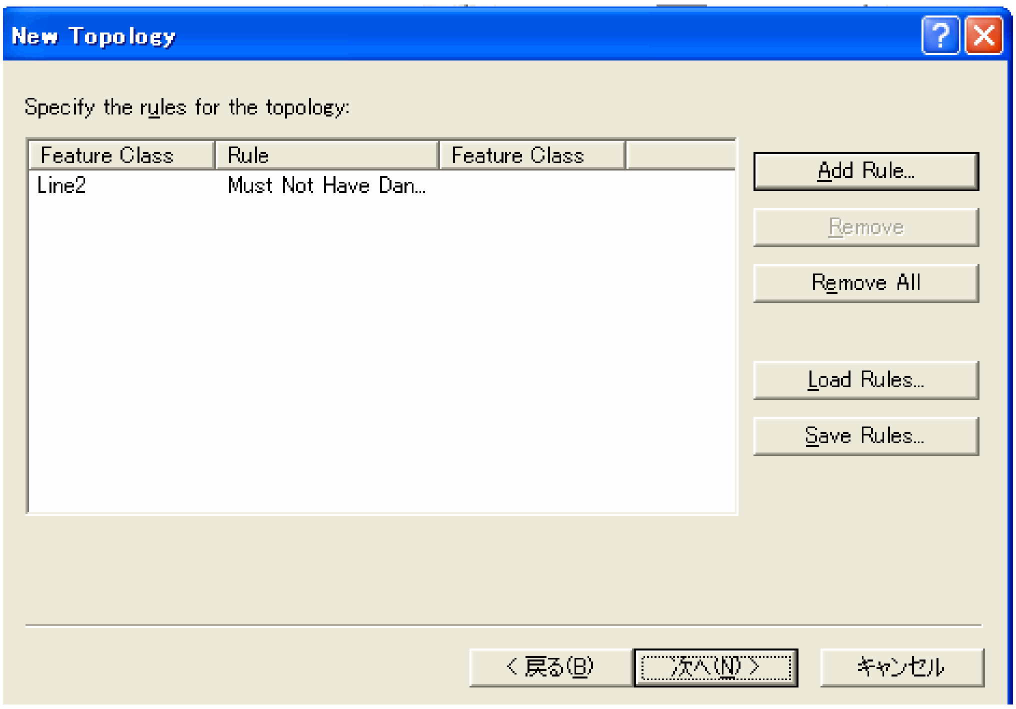
Select target feature class and then select rule.



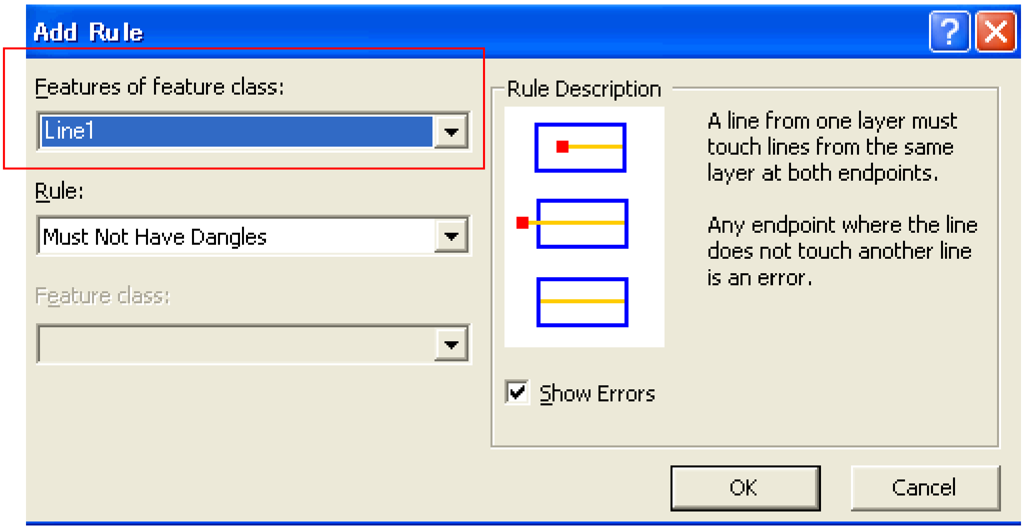
12. Rule is selected.



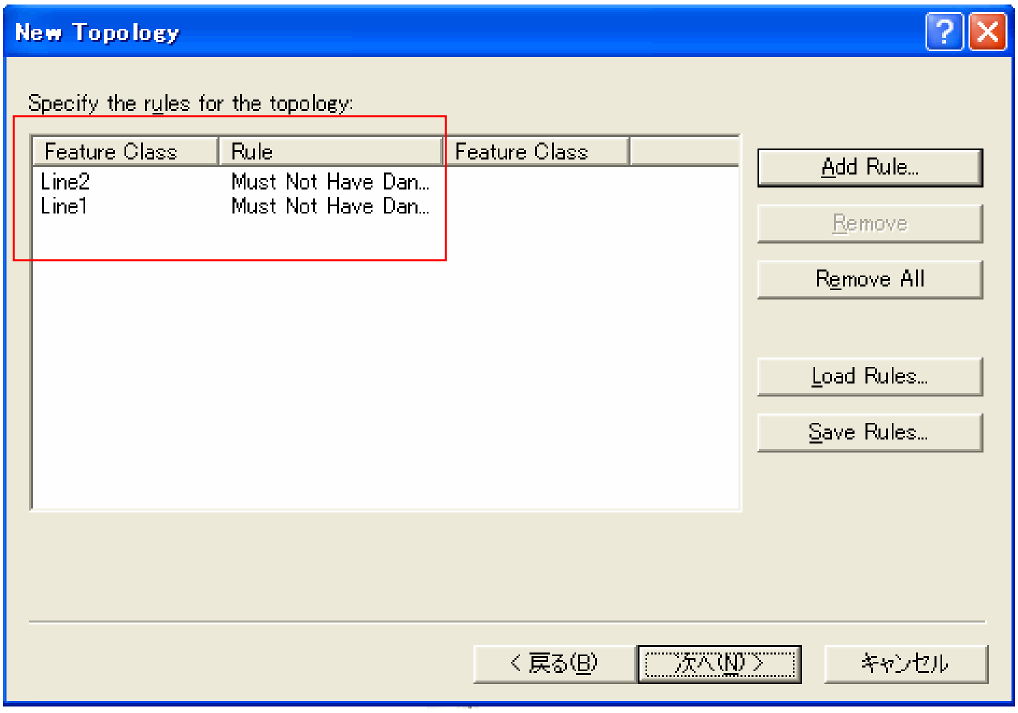
13. Rule is added for one feature – Line 2.



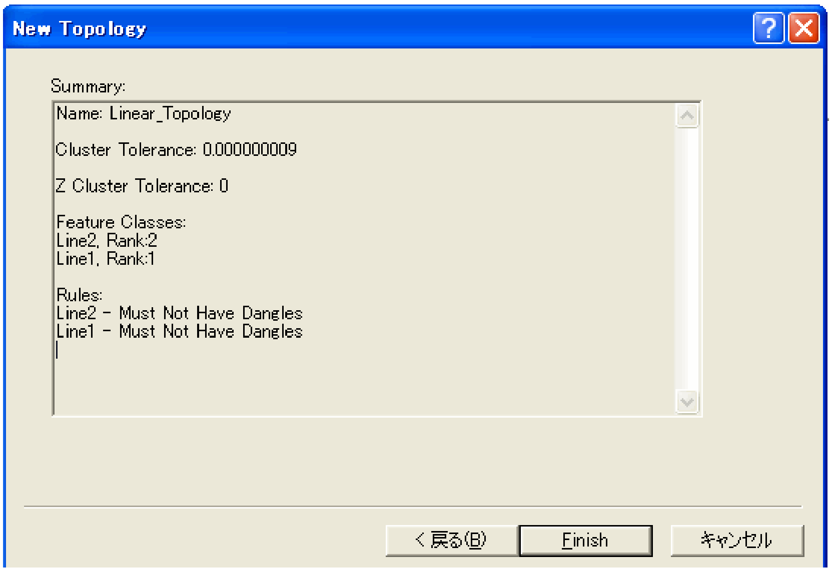
14. Add rule for other feature – Line 1.



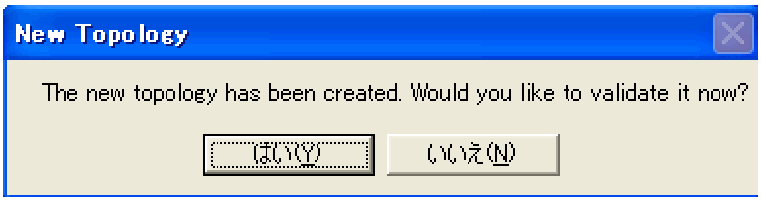
15. Rules are added for each feature.



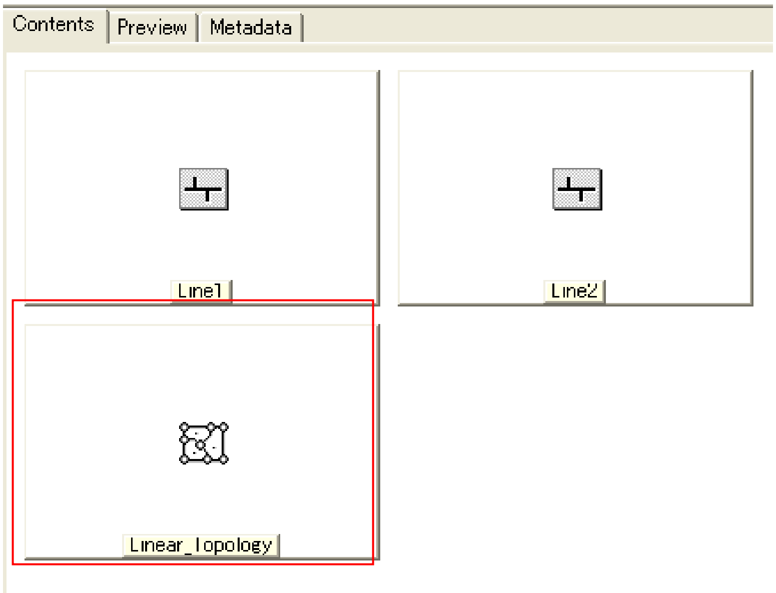
16. New topology rule confirmation window opens



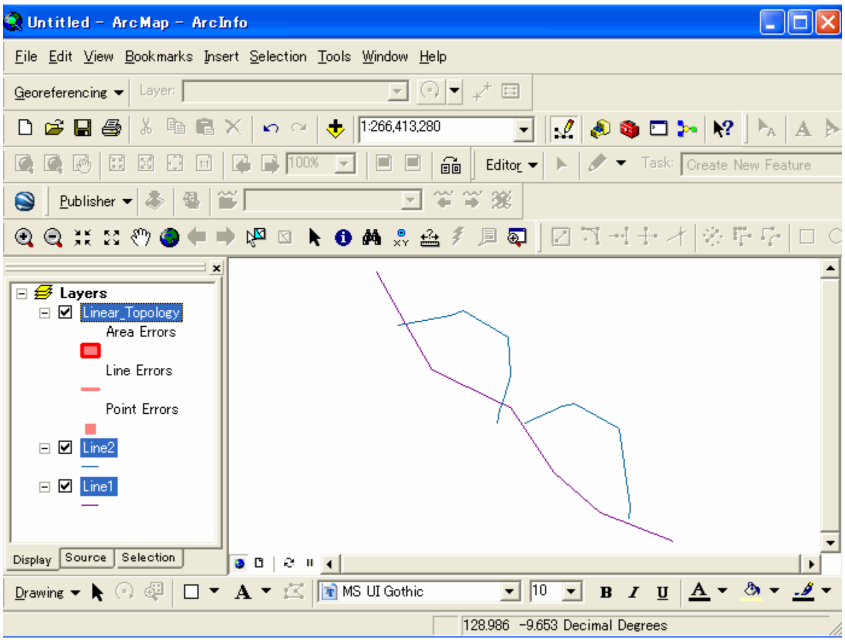
17. Topology validation window opens.



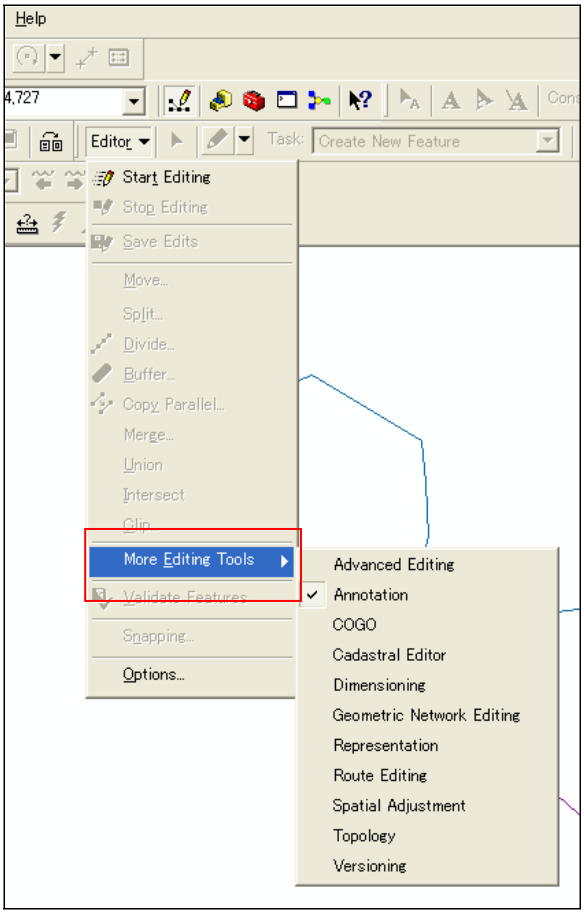
18. Select NO in this case. On ArcCatalog possible to check if a topology was added or not.



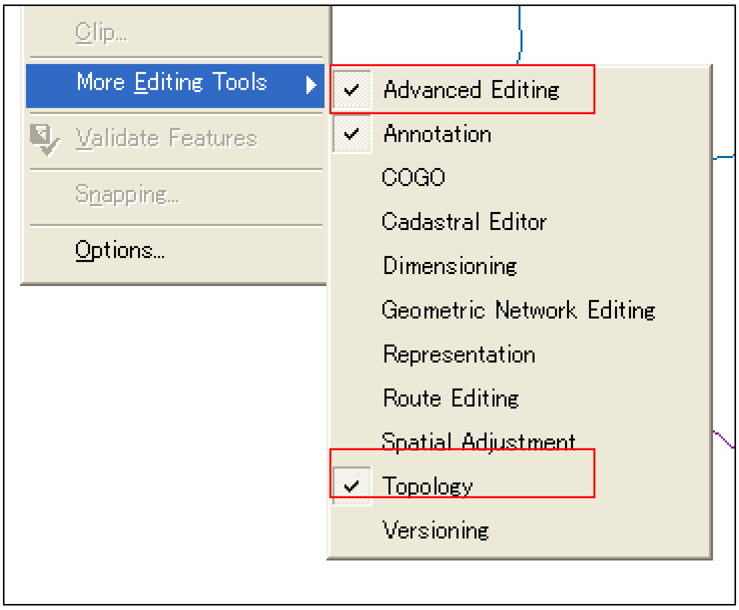
19. Open ArcGIS and add Line 1, Line 2 and a topology.



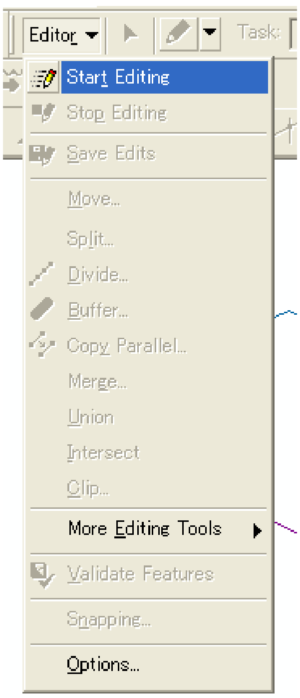
20. Add topology editing tools



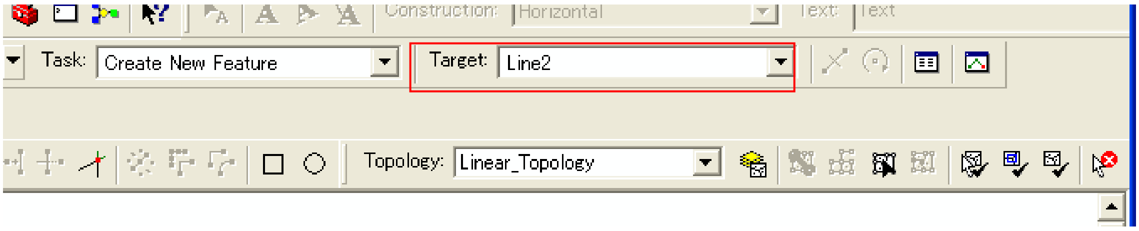
21. Adding topology editing tools



22. Start editing

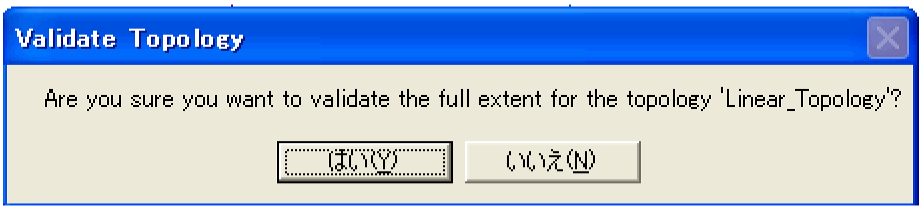


23. Select Target feature

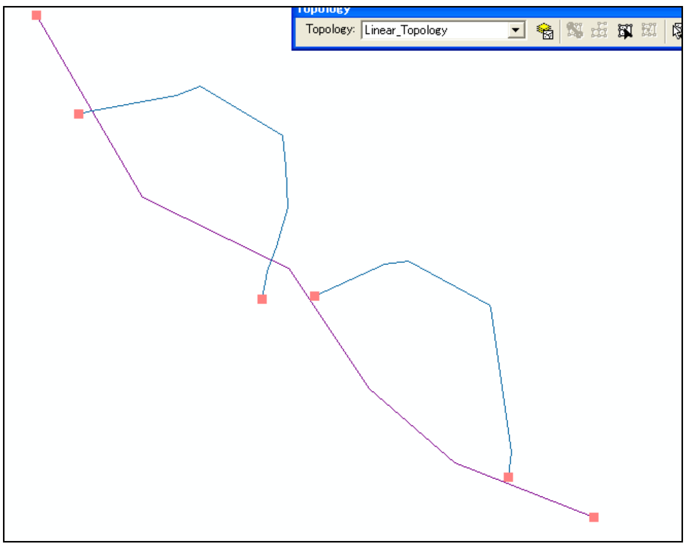


24. First validate topology

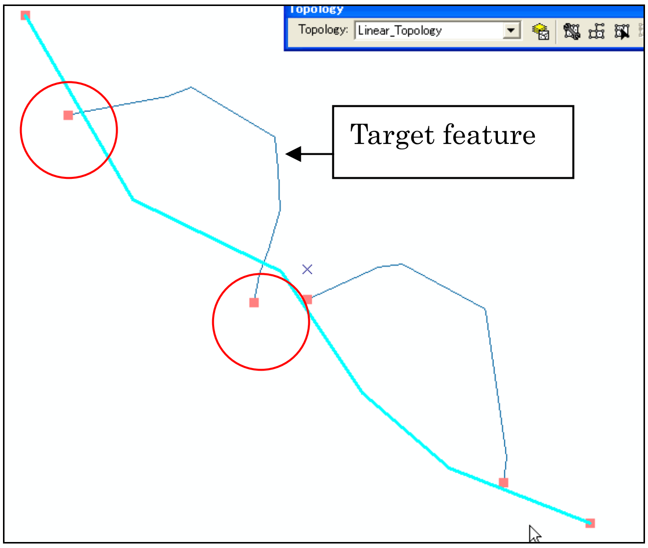
25. Validate topology



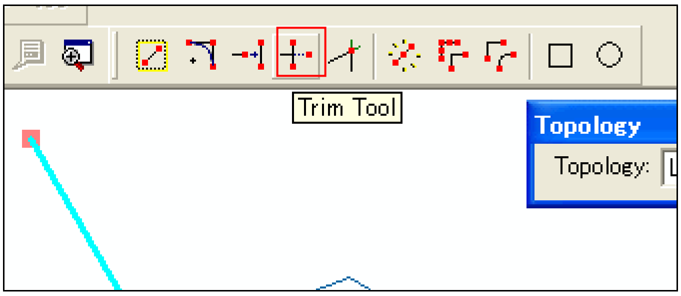
26. Topology errors are indicated by Pink Squares.



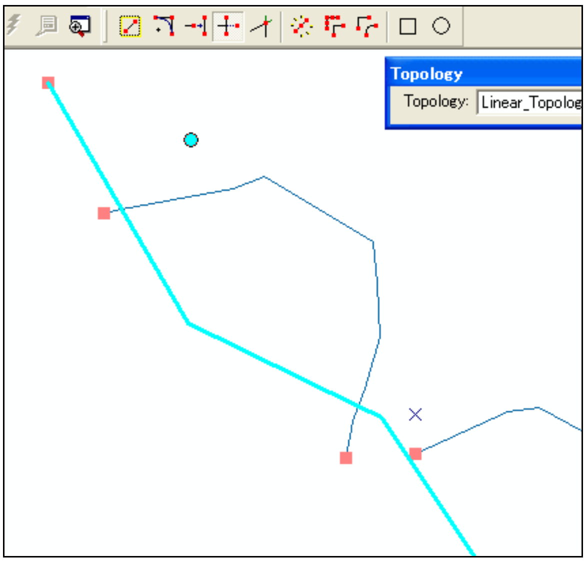
27. Click a feature which is used to trim targeting feature.



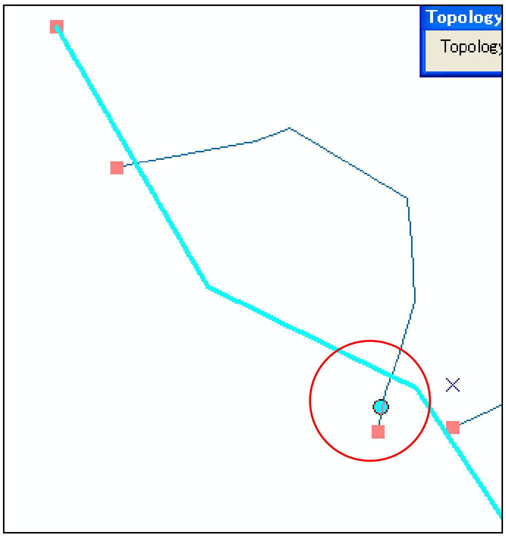
28. Then select Trim Tool in Advanced Editing Tools.



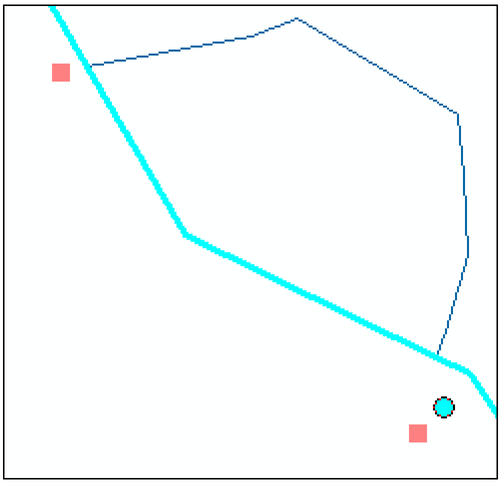
29. A light blue dot appears on a screen



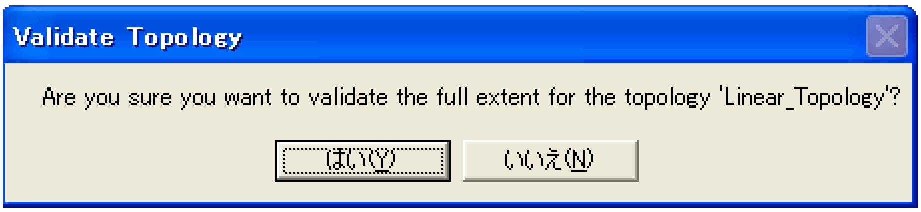
30. Bring a light blue dot onto a part of a feature to be trimmed.



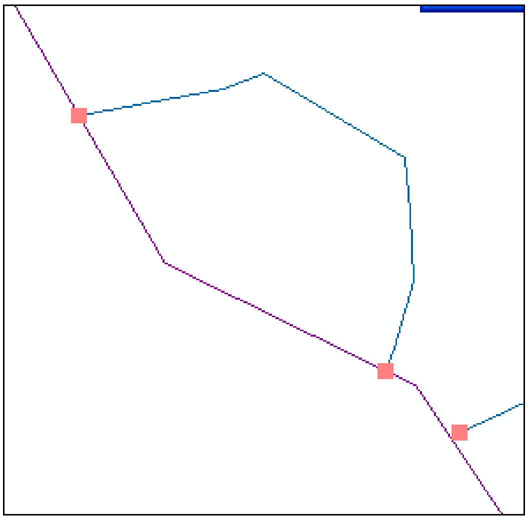
31. By clicking a mouse, dangles of target feature are trimmed.



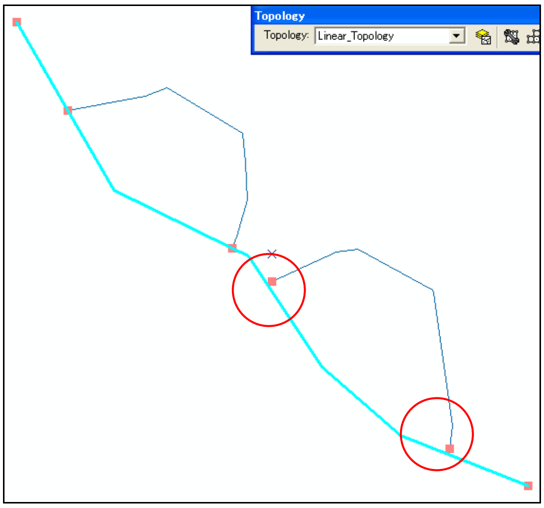
32. Validating topology again



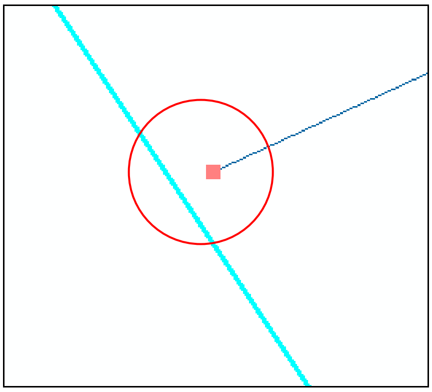
33. Now it is confirmed that dangles of the target feature were trimmed.



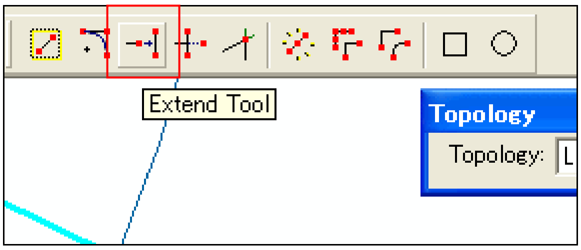
34. Now, solving problem that one feature is not connected to other feature



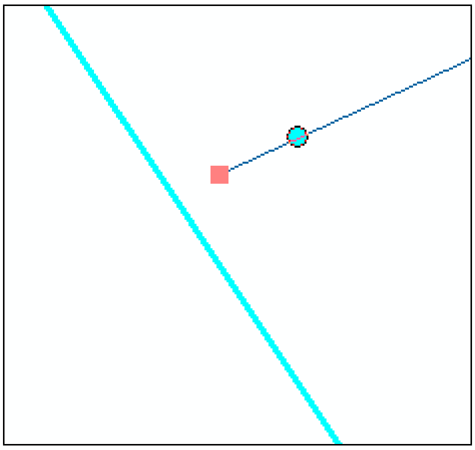
35. Enlarged problem area



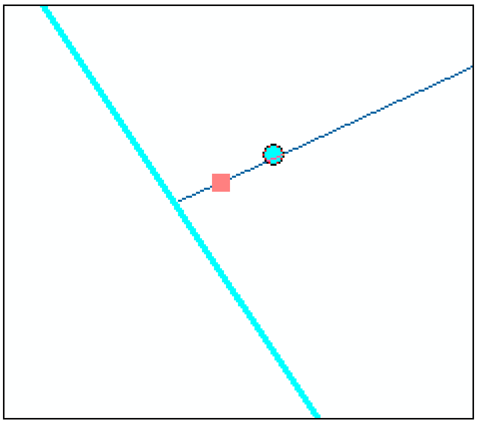
36. Select Extend Tool this time.



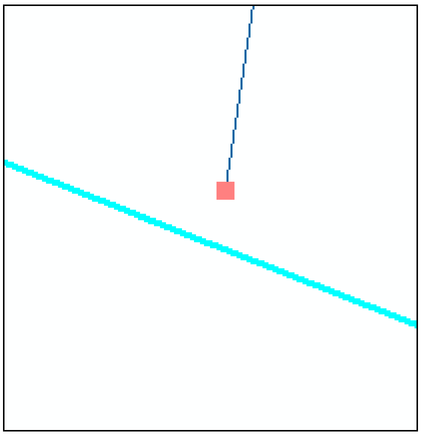
37. Light blue dot appears on screen.



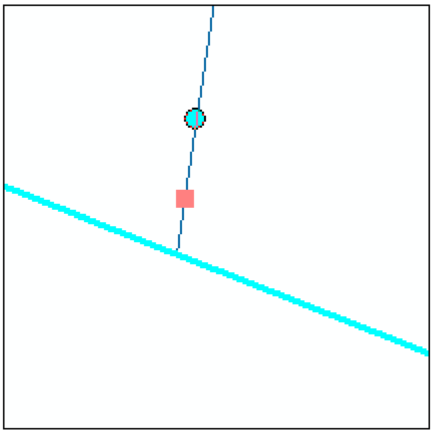
38. By clicking a mouse, target feature is extended until it hits other feature.



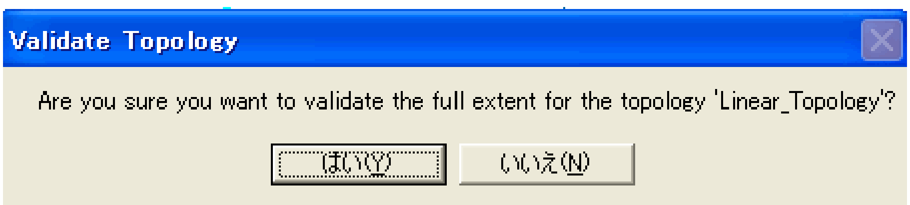
39. In case of Extend Tool, editing must be done one by one for each part.



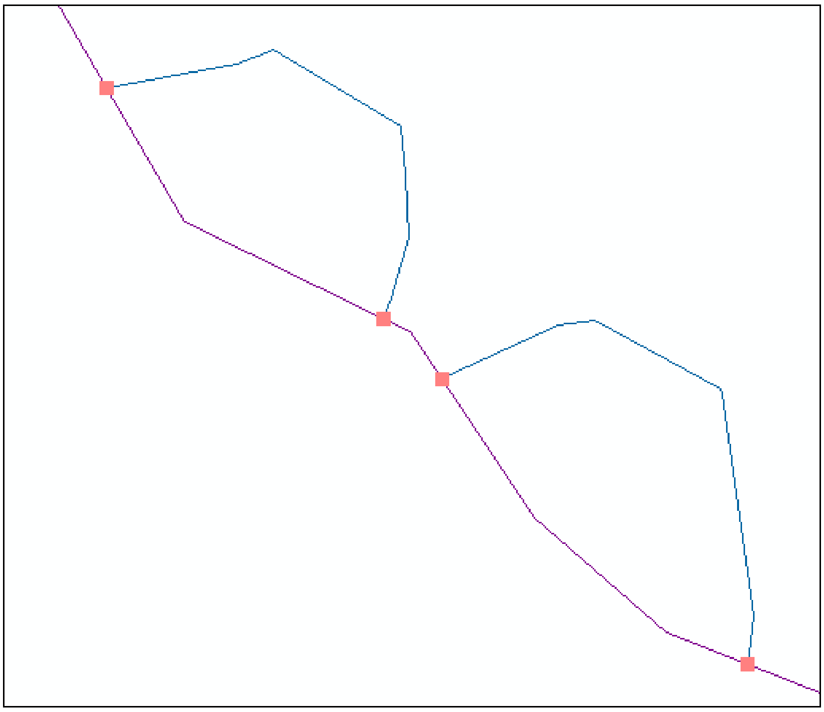
40. Another line of target feature is extended.



41. Validate again



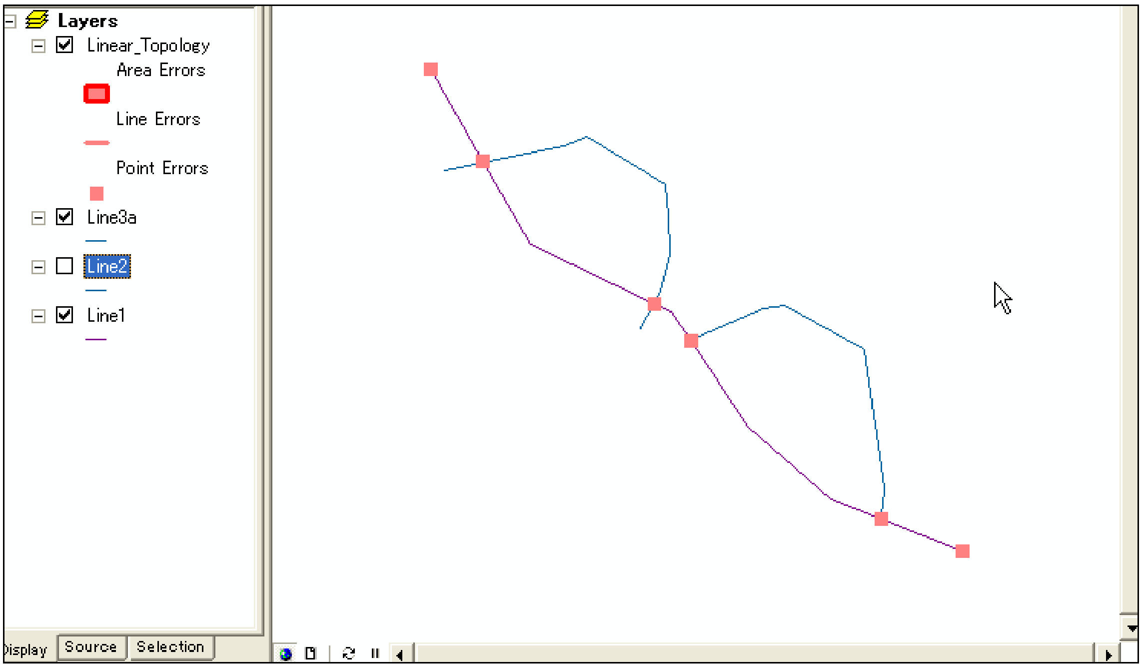
42. All the topology errors were corrected.



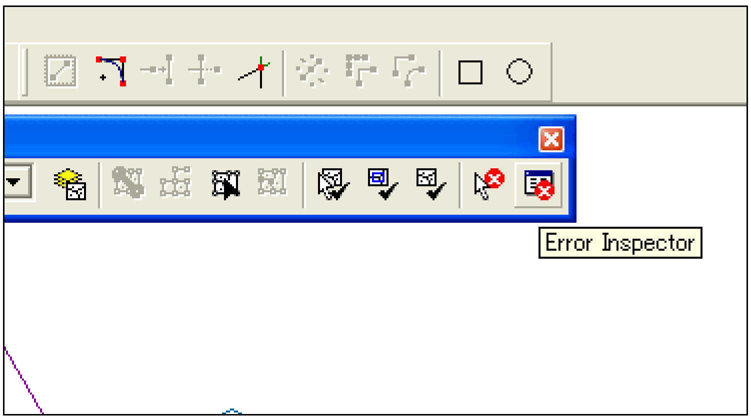
<Possibility of using batch error correction method>

It is possible to correct multiple topological errors together. However, this method is often complicated and moreover if number of errors exceeds a certain limit, it does not work. Following is the procedure to use batch method.

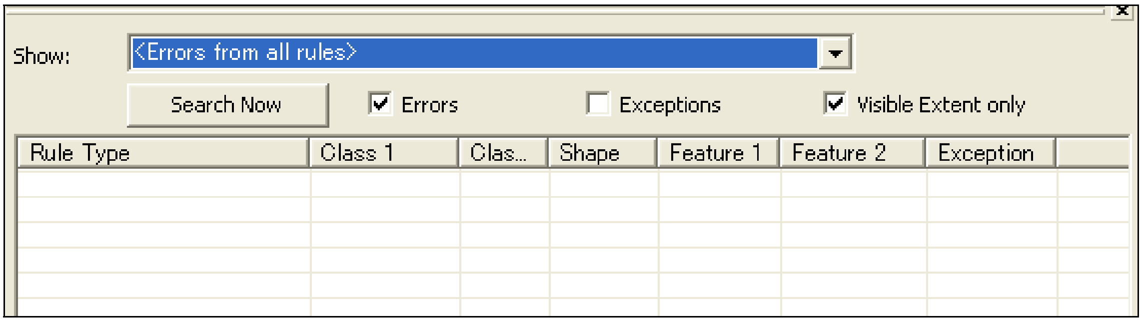
43. Suppose there are topological errors as shown below.



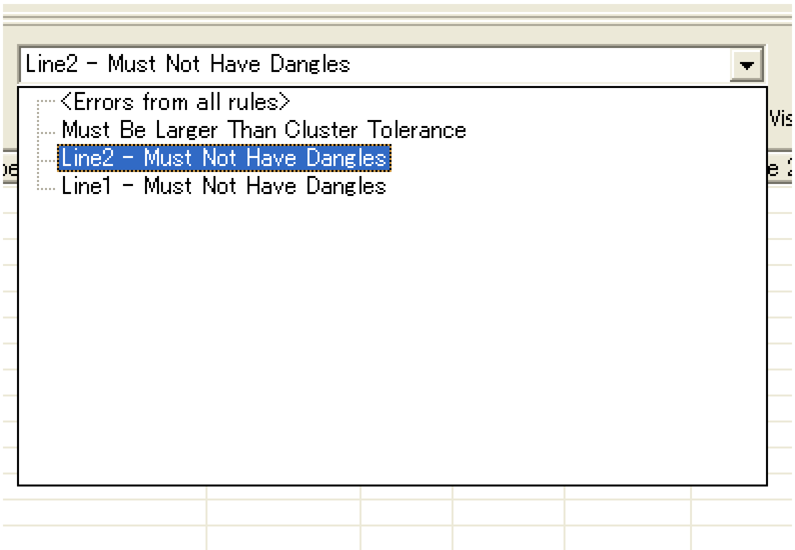
44. In Edit mode, click Error Inspector button.

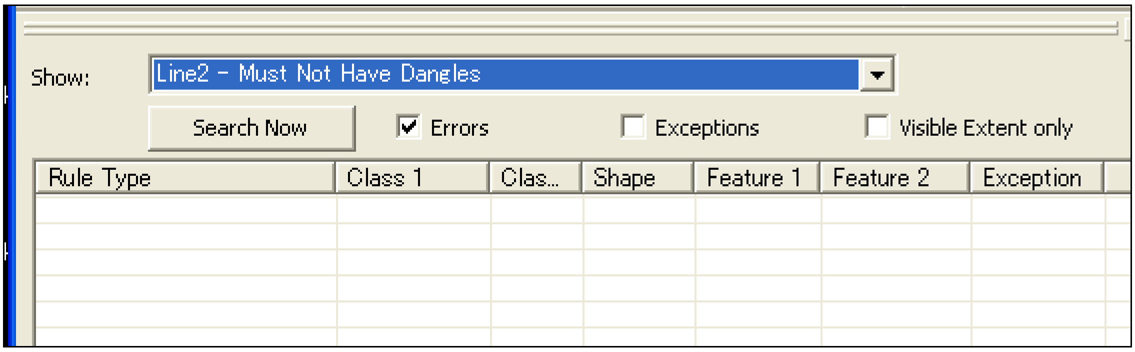


45. Error inspector windows opens

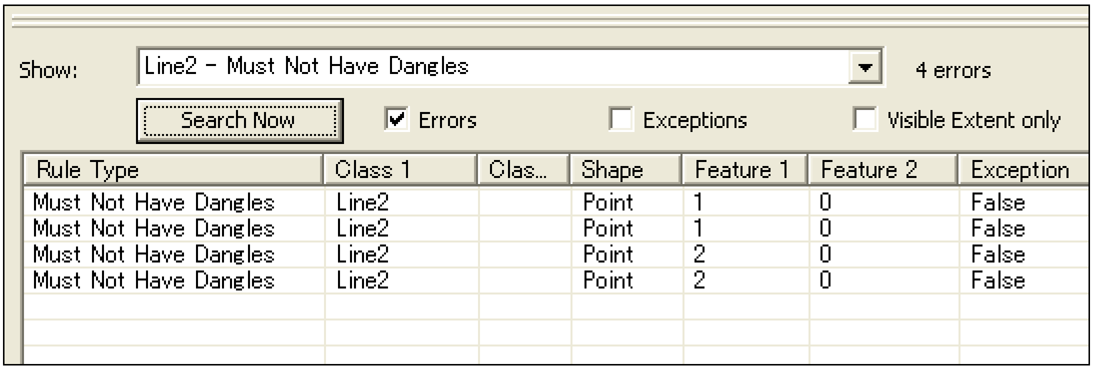


46. In "Show" window, choose "Must Not Have Dangles" rule

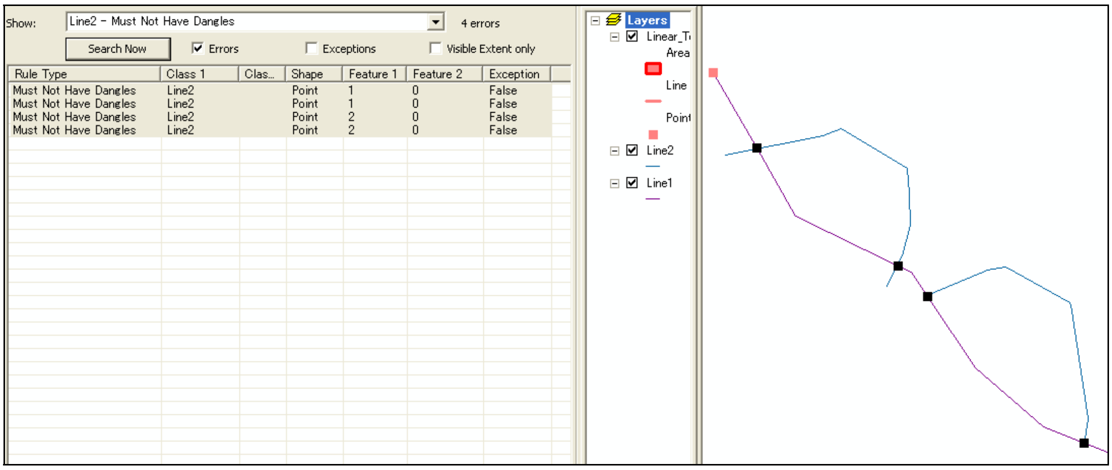




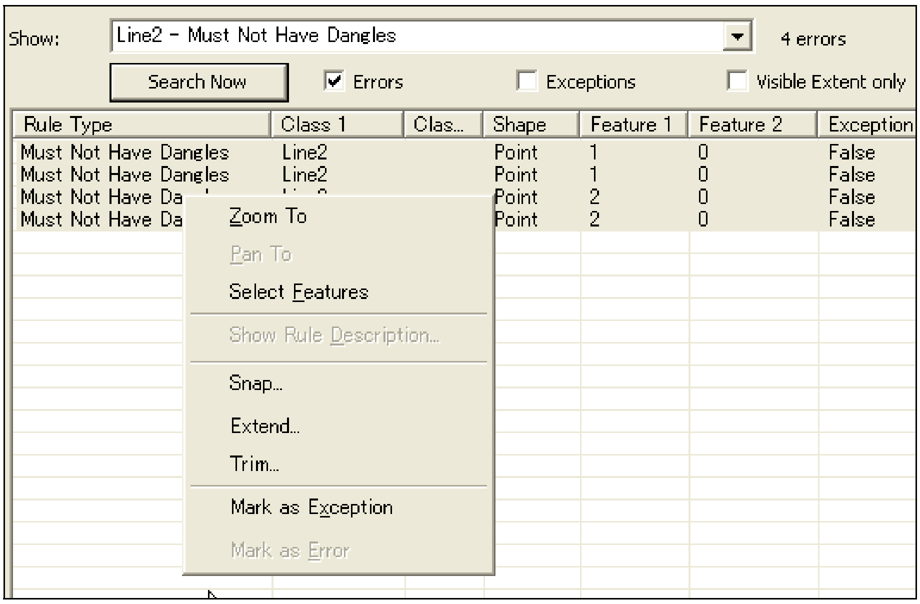
47. Errors of "Must Not Have Dangles" are listed



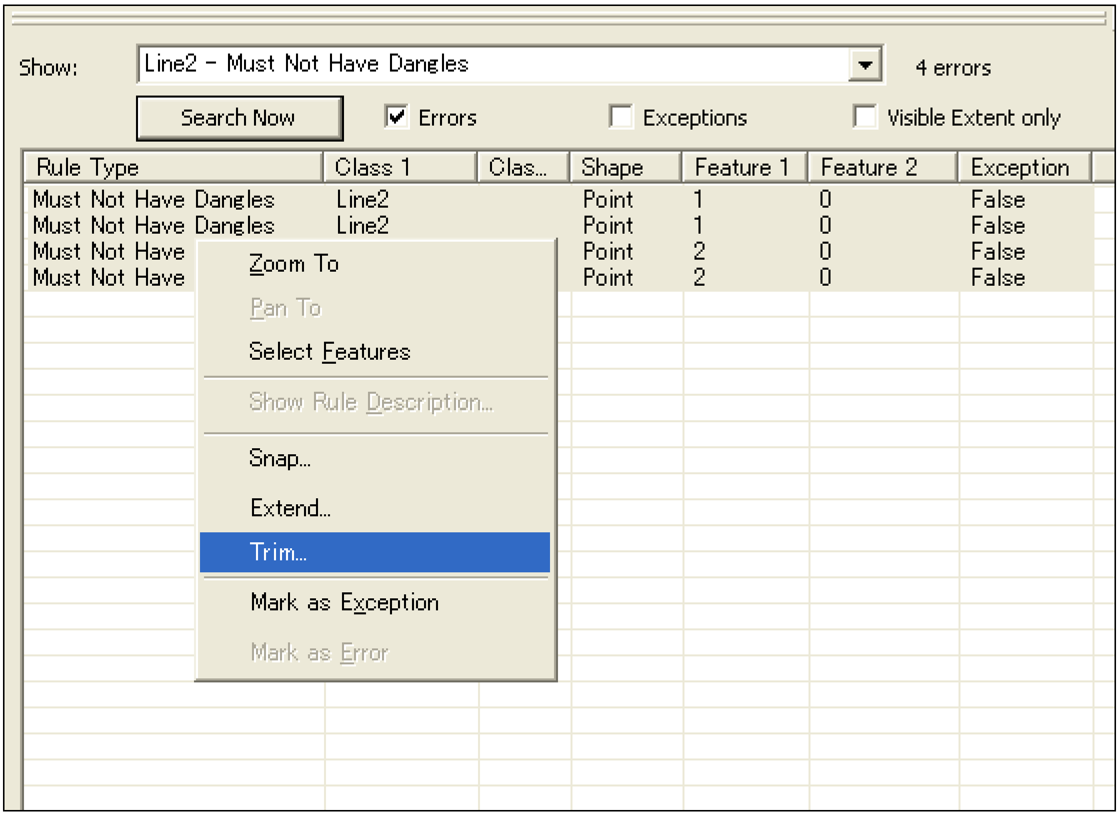
48. The four errors are shown by black square symbols on the map



49. By right clicking the selected errors a pull down window appearas

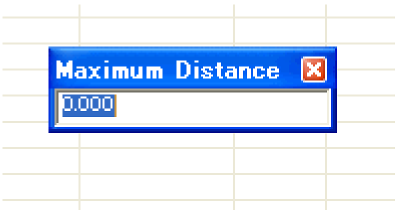


50. Select trim



51. Next set maximum distance

This distance means dangles which exceed this limit will not be trimmed.



This is dangerous because if length of line segments which are not dangles are within this limit, they are deleted as dangles. This is the reason why topological errors should be corrected manually.

Bangladesh Digital Mapping Assistance Project (BDMAP)

Production Manual of Digital Compilation

Jan 2012

Yoshiteru MATSUSHITA
Bangladesh Digital Mapping Assistance Project

Contents

Production Manual for Digital Compilation for IDMS project

This manual provides an overview of Digital Compilation and Map Compilation process in aerial mapping.

I What is Digital Compilation

Overview

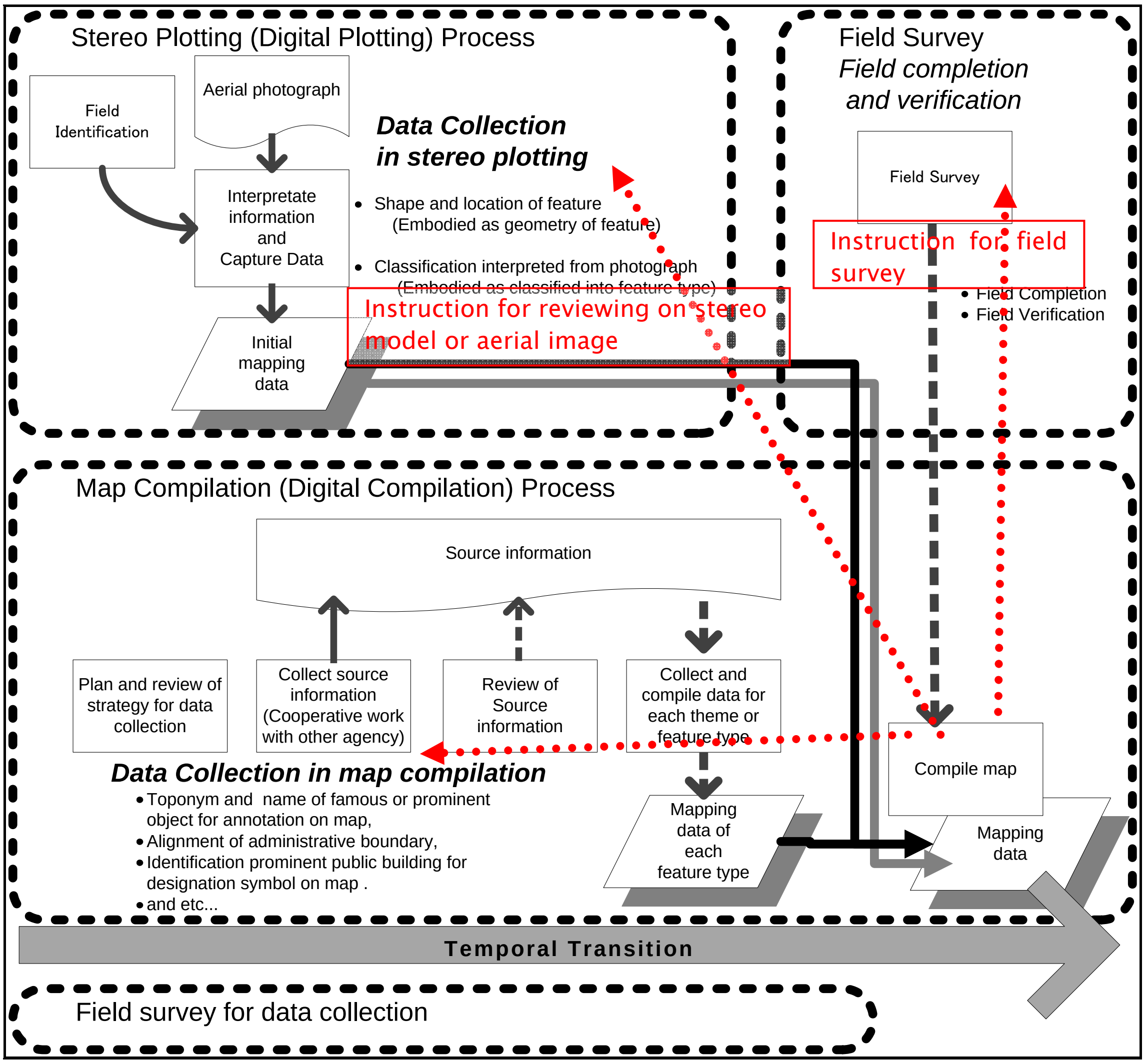
In this manual, "Digital compilation" means map compilation process in preparation of digital topographic map with digitally method, using digital equipment and material: computer hardware and software and digital data stored in computer. Map compilation process is one of universal and essential process in topographic mapping production flow, whether your mapping is analog mapping or digital mapping.

Map compilation process involves following operations: collecting various information from various sources and semantically adding, selecting, modifying information, and checking and fixing error.

Moreover, Map compilation process including cartography editing processes: design and assignment map symbol to map, cartographic representation editing, map finishing and so on. Finally information is merged and organized as one map.

In general, in case of topographic mapping with aerial survey method, map compilation is post-process of stereo plotting. In aerial survey-based mapping, principal information source is aerial photographs, especially for collecting geometry of features. In general, mapped object and phenomenon is distinguished visible and invisible information. In case of appearing objects and phenomenon in aerial photograph, shape, arrangement and position of targets and some attribute of them are interpreted and obtained from aerial photograph. On the other hand, in case of no appearing target object on aerial photograph by some reason: hided by cloud or trees, or target phenomenon is essentially invisible things; which doesn't have its physical substance and doesn't appears as shape, texture or other in aerial photograph, those type of information cannot be captured and obtained from aerial photograph in stereo plotting process.

Several type of information necessary for structuring map is invisible things: some attribute of object: name, classification, type and others; alignment of administrative boundary and others; they don't appear on aerial image and they should be correct from other data source. Those types of information should be collected from various information sources except aerial image, and organized as one map. Normally those data collecting process is executed in map compilation process.



Data Collection Process in stereo plotting and map compilation (in whole aerial mapping process)

In aerial mapping, essentially mapped objects are distinguished into two types. One is identifiable information on photograph; the other is not identifiable on photograph. In stereo plotting process, mapped objects with physical substance are captured as vector geometry and classified into feature types based on following information: its shape, alignment, texture and other characteristics, which information appeared in aerial image. On the other, mapped objects without physical substance, they aren't collected from aerial image in stereo plotting process; they are collected and organized from various appropriate sources in map compilation process. For these reasons, data collection in aerial mapping is not only done exclusively in stereo plotting process. Data collection process in aerial mapping is done in some process, stereo plotting, field survey, and map compilation. Data collection process means not only process for inputting and digitizing data but also gathering and reviewing of information source, validating and checking for construction of data structure and others, these operations are also component of map compilation. Therefore, map compilation involves data collection process.

Data Collection in stereo plotting

In aerial mapping, vector mapping data mainly obtained from aerial image by stereo plotting operator. Stereo plotting operator captures target objects and phenomenon on the earth as set of figures: point, line and area, from stereo pair of aerial imagery using stereo plotter. Through the whole mapping process, not only in stereo plotting process, mapped objects and phenomenon are categorized as feature type.
Mapping specification and instruction should be prepared in advance of starting data collection. In mapping specification and instruction, target objects and phenomenon which match to universe of discourse of your mapping are defined and modeled as geographic feature. Stereo plotting operator should identify and classify target object and phenomenon on aerial photograph as geographic feature, with referring and following to mapping instruction, and stereo plotting operator should capture objects and phenomenon as figures, which match to defined feature type. As end of stereo plotting process, vector mapping data is organized as initial data of topographic map and sent to next process.

Mapping information is principally obtained from aerial photograph or other imagery in aerial mapping, but stereo plotting only obtain information identifiable from photograph. Therefore some thematic information and toponym which cannot be obtained from aerial imagery should be collected in other data collecting process.

Data Collection in map compilation and field survey

Typical types of information which cannot be obtained from aerial imagery should be collected and compiled in map compilation and field survey process, from various information sources.
For examples,

- ❑ Toponym and other object name for map annotation
- ❑ Alignment and attribute of administrative boundary and related features
- ❑ Existence of some prominent public facility for assigning prescribed symbol to indicate existence of the target facility on topographic map
- ❑ Classification of object and other attribute of feature which cannot be obtained from photograph in stereo plotting process

Compile map

After collecting information, collected information is integrated as one map. In process to complete as one map following operation will be conducted, generalization, selecting and omitting, symbolizing, checking and quality control.

Field Verification or Completion Survey

Usually, there are some cases with unclear or questionable things in stereo plotting and map compilation process. Those cases require on-site confirmation to clear them. As action for solving unclear or questionable things on map, field verification and compilation survey is conducted.

This Field Verification or Completion Survey is not same as field survey for correcting information explained in previous paragraph about field survey for data collection purpose.

The essence, background, aim, procedure, and target of among them are different. In practical working situation, sometimes those different type field works will be attempted to implement by same field party at same time. Whether those different type field works will be done at once or not, person involving those processes should understand difference of concept among them to plan and implement them appropriately. And also person involving input findings from field work into mapping database should understand above things to design approximately mapping database and data handling procedure.

Especially, in case of conducting data collecting field survey and verification survey at same time, surveyor should understand that which survey type now they are conducting in every time and in everywhere. In IDMS project, those different characteristic field survey works may conducted at the same moment and the same time.

The findings from field verification survey or completion survey will be integrated into mapping data in compilation process.

Digital compilation and Map compilation in IDMS Mapping

Map compilation has variety of work, process, and doer and so on, explained in previous. In general, map compilation has difficulties to understand and explain as single concept and as single process. For easily understanding and explaining about map compilation process, map compilation process is regarded and explained as repacked to smaller size.

In practical, processes involving map compilation is carried out by several team, party, section, unit in mapping agency. And also there are several difference and characteristic in mapping data and information which prepared in sub processes in map compilation. And according to need, each data and information should be regarded as specific data and information based on difference and characteristic among them.

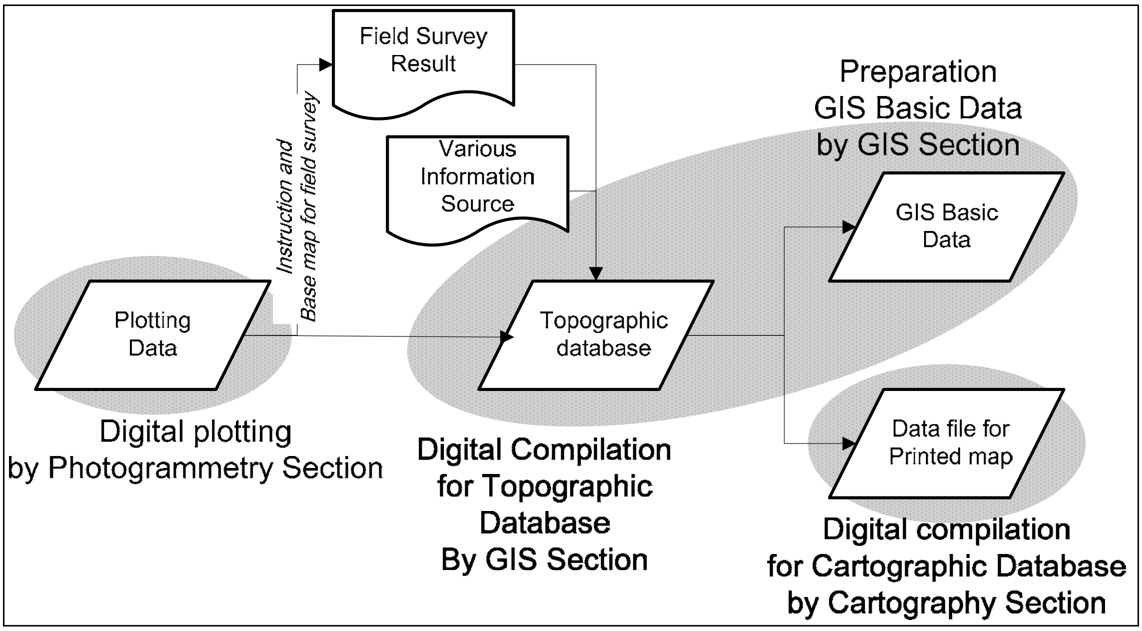
Map compilation process or related data is distinguished as sub processes or data package, based on variety of implementer or responsibility of the sub process, or variety of characteristic of final or intermediate data and information in sub process.

In project design of IDMS project explained in the Total design Document (TTD) prepared by French consultant for SOB, map compilation process is regarded and explained as two distinct processes, based on distinction of implementation unit in SOB and characteristic of produced mapping data.

One is compilation process for Topographic Database: The process regarded that a GIS section performs it in SOB, another one is compilation process for Cartographic Database: The process regarded as that the Cartography section performs it in SOB.

- ❑ Compilation process for completion of Topographic Database is done by GIS section.
- ❑ Compilation process for perfection of Cartographic Database is done by Cartography section.

Two Digital compilation process in IDMS



II Significant differences of "digital mapping" and "digital compilation" between IDMS project and existing mapping of SOB.

As premise for thinking and considering of something about digital compilation work: defining scope, planning, scheduling, preparing specification, and etc, staff of SOB must understand about significant differences between conventional mapping work of SOB and new IDMS mapping work. Some required procedure, thinking and skill in IDMS mapping are completely different with conventional mapping.

Significant facts for SOB, first one is that principal way of IDMS mapping is aerial mapping way, second is IDMS mapping is not updating existing map: producing every topographic map as new map.

Newly preparation topographic map with aerial mapping method are unfamiliar experience for present staff of SOB. And staff of SOB doesn't realize like that. Staff of SOB may not realize it without try to work for each process of aerial mapping and new map production by themselves. However staff of SOB usually would like to do avoid trying something preliminarily before starting practical work.

For latest staff of SOB, conventional digital mapping work is digitizing old printed map to reproduce printed map with computer mapping methodology in its inception, and to update information spotty based on field work in now. In this conventional mapping for SOB, geometry of almost geographic feature extensively on map is obtained by tracing of existing map on computer screen. Updated information is mainly spot information based on field work: position is determined by field worker or mapping operator, based on relative position to other existing features on map, some extensive geographic feature is determined its location by handy GPS in spotty. Actually, above methods has potential to realize positional accuracy of 1:50,000 mapping.

Thorough this conventional process, Operator of computer mapping is not required manipulation and judgment about data acquisition and editing which required in aerial mapping process.

All target information for digitizing work is appeared as scanned image of existing map. (This digitizing work corresponds to data collection process: data capturing work by digital stereo plotting in IDMS mapping.)

On the contrary, in aerial mapping process, all engineer and technician engaged in data collection, editing, and compilation process: stereo plotter operator, surveyor, field worker, cartographer, CAD and GIS operator is required skill and background of poisoning on map and imagery, data mining, sorting out information to accomplish mapping work.

Furthermore, in designing mapping specification for conventional mapping of SOB, it is not necessary to consider issues beyond requirement for tracing existing map. Existing is past product map which has been completed by another surveyors and cartographers in the past time. Basic geometry of extensive geographic feature on map has surveyed by forepassed surveyors with different survey instrument and methods from now and objects on map are result of selection, generalization, symbolization by past cartographers.

Some conventional mapping specification and application rules depend on past survey method and demands and different survey method with IDMS. So in preparation of mapping specification, it is necessary to review the compatibles of each conventional specification and rule with new mapping method for IDMS aerial mapping.

IDMS mapping is preparing maps newly with photogrammetry method: it requires skill, knowledge and judgment related with data acquisition and compilation using combination of various data source and visible and invisible information. In IDMS mapping, principal information source is aerial and satellite imagery, but not only them. In IDMS mapping, staff of SOB should become skilled in the use of multiple information source which constituting newly topographic map.

Those in above are significant difference with just only digitizing one existing map. Data capturing by existing map digitizing is handling information from single source. On the contrary, preparing newly map by aerial mapping requires handling with multiple information sources in relevantly.

Preparing specification and mapping standard for IDMS aerial mapping

In IDMS, preparing newly spatial information and topographic map with photogrammetry mapping will be conduct.

On executing aerial mapping, staff of SOB is capturing geographic information from latest aerial image and compile information as topographic map and spatial data framework with speculation, judgment and deciding by themselves according to specification, standard or guideline. And for implementation of IDMS mapping, each section or responsible person in SOB for every process of IDMS mapping have to prepare specification of product and guideline of production process.

More precisely, staffs of cartography section have to understand of differences from existing mapping procedure and prepare some specification and guidance for photogrammerty mapping; this is additional or new things for staff of SOB. For GIS section, about field explore or survey work, it is necessary to analyze the differences between existing field work for updating map and new aerial mapping and establish feasible and effective work flow and plan for field survey. Furthermore it is necessary to establish work plan; how to correct information expect vector mapping information obtained by stereo plotting in compilation process. In IDMS mapping, map compilation is executing by GIS section. GIS section is correcting and compiling information as part of cartography (topographic mapping) process.

Deference of methodology of checking and verifying mapping result

In photogrammetry mapping method for IDMS mapping, the procedure of checking or verifying of mapping result also will have significant difference between IDMS mapping and conventional mapping of SOB. SOB must understand this fact for planning and implementing whole mapping process.

In conventional mapping work of SOB: digitizing and updating of existing map, latest aerial photograph and other imagery are not prepared and not utilized. Data collection, checking and verification is mainly depend on comparing with field site.

On the contrary, in IDMS mapping, SOB will prepare and utilize latest color aerial and satellite imagery and color digital ortho mosaic from flame image. This color aerial image information is expected not only use as source information for data acquisition but also must use as reference information for checking and verifying of mapping result in various production processes and phase.

By using aerial or satellite imagery, it is no necessary that everything is checked or verified in the field. This is most important concept and fact for designing and planning of whole mapping process of IDMS. Items required verifying and confirming in field should be more decrease than conventional mapping in SOB.

In first, vector mapping result can / should be checked and verified with referencing to aerial or satellite imagery. In each data capturing and compilation process, mapping data can / should be compared with imagery shown on computer screen or hardcopy output on the spot.

Target issues of checking and verifying mapping data are issues about completeness, positional accuracy, and thematic accuracy of mapped object. About mapped objects on vector mapping data which have captured from aerial or satellite imagery, almost target features are able to check and verify with comparison with aerial or satellite imagery about those position and thematic classification.

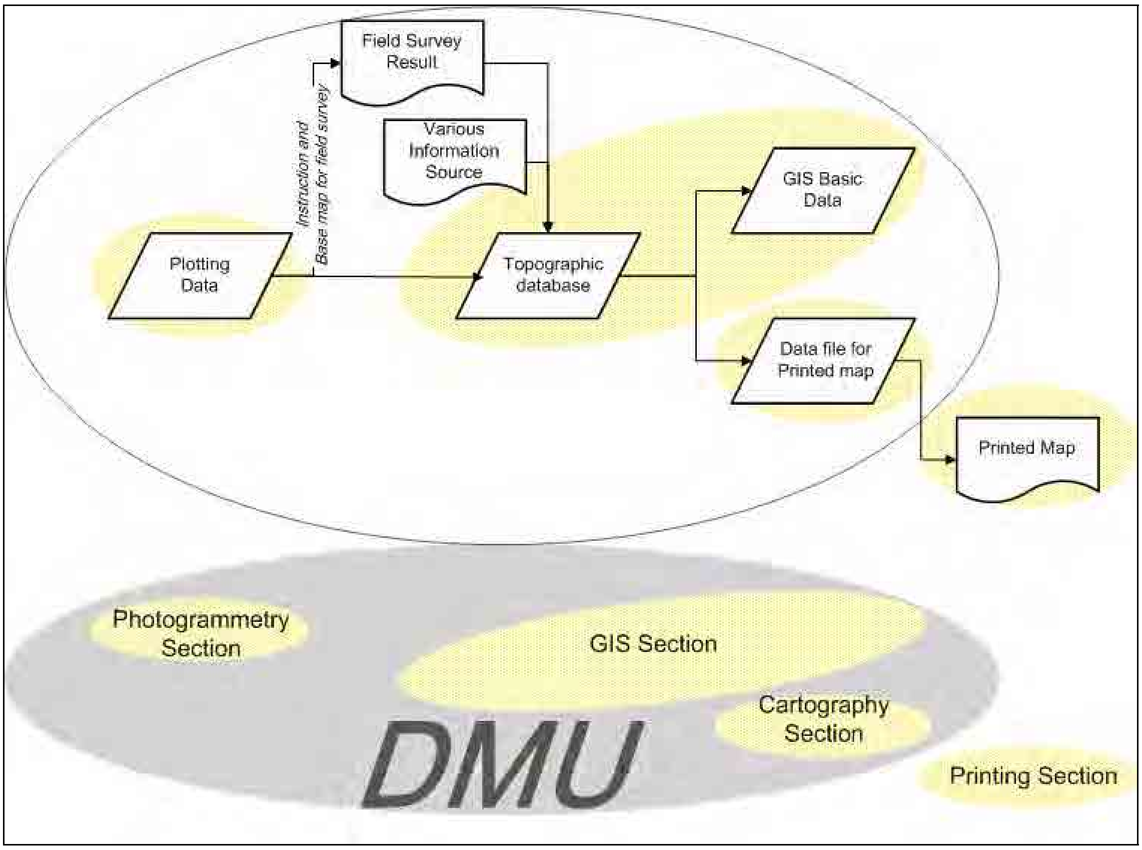
In Addition to above the changes reference information for checking and verifying mapping data by employing aerial mapping method, in IDMS project, latest computerized photogrammetric technology and equipment will be introduced into SOB: digital aerial camera, digital ortho photo and mosaic, vector computer mapping with softcopy stereo plotter will be used. These latest technology make more easy preparing and utilizing aerial image superimposed with vector mapping data. Especially, softcopy stereo plotter and digital ortho photo mosaic provide helpful circumstance and information for checking and verifying mapping information. Computer mapping operator: stereo plotting operator and CAD/GIS operator for data inputting and map editing should /can perform data capturing and checking of mapping data in simultaneously, in every time, with fully utilizing of advantage of new digital photogrammetry technology and equipment. In data capturing, stereo plotting and CAD/GIS operators should pay attention in computer screen about completeness of capturing result with reference to background imagery of aerial photo or other information source (scanned map and others).

Changing data collection method, information source brings changing existing concept in SOB about field survey (Field verification survey).

In IDMS mapping, as the result of employing aerial mapping method, procedure of field survey process will be made different from conventional mapping of SOB.

As explained in above, in existing map updating work of SOB, main information source of data collection for newly additional object is field survey. And in typical concept of conventional field survey, SOB calls this data collection process in field as “field verification”. But comparison with general survey and mapping concept, this SOB calls “field verification” does not correspond to verification process. Conventional “field survey” work in SOB is mainly data collection process for newly additional object with field survey. On the other, in IDMS mapping, aerial image will be utilized as principal information source for data collection process.
Mapping from aerial or satellite imagery substitutes data collecting almost information in field. In aerial mapping, it is not rational to collecting all data in field.
SOB is required changing idea for designing and planning fieldwork and other mapping process.

III Domain of Digital Compilation in IDMS project



Compilation for Topographic Database (Performed by GIS Section)

This is compilation process for completion of Topographic Database ; this process is expected mainly performed by GIS section in Total Design Document (TTD) for IDMS and latest structure in SOB. This process includes following procedures

- ❑ Preparing and organizing database as a repository of mapping data
- ❑ Data collection and inputting for geographic feature types not obtained from aerial photograph
- ❑ Data editing

Preparing and organize database as repository of mapping data and compilation mapping information.

According to design of IDMS project by SOB, software for building and managing of mapping data in photogrammetry process is CAD software. Digital plotting process prepares initial topographic map data using softcopy stereo plotter with CAD software. Therefore, output data from digital plotting is CAD data. In contrast to digital stereo plotting process, digital compilation process is performed with GIS software as mapping tool and data file is employed the native format of GIS software. After digital compilation process GIS database is use as repository of all mapping data including intermediate result and final products. Therefore, at beginning procedure in digital compilation for preparing topographic database, data exchange process is required: CAD mapping data by stereo plotting process is going to be imported into GIS database. This data exchange treat two things: One is data exchanging between two difference software packages, the other is data exchanging between CAD and GIS software. Concept of first in above one is very simple: this is just only data exchanging between different file format and structure for different software package. Both formats are designed for optimizing to function of each software package. In IDMS project,. this issue match to the data exchange process from CAD data by photogrammetry unit into GIS database in GIS unit .Concept of second one is difficult to explain in short sentence and this issue is not appropriate discussing and explaining in this paragraph because this second issue is not match topic in this paragraph. Fundamentally history of development way of CAD and GIS software / system has followed different way and both of them have different background of their development. So in general, there are discussing about difference and common between CAD and GIS software and systems: about difference of definition, concept, function, data structure, usage, and so on. As limit to IDMS project, the GIS software will be utilized as mapping tool. As limitedly mentioning about usage of CAD and GIS software as mapping tools: tool for inputting data and editing mapping data, there are no significant difference between CAD and GIS. In addition, especially about mapping purpose and function, CAD and GIS are developing with borrowing and integration advantage from each other.

Finally this GIS database is completed as “Topographic database”. Topographic database is eventually used as master database of digital topographic map data in SOB. Moreover, Topographic map database will be used as source information of some derivative products from SOB’s Topographic database: Hardcopy topographic map and GIS Basic data and other spatial data or maps by SOB. Fundamentally

Data collection and inputting for geographic feature types not obtained from aerial photograph

As already explained in previous chapter, digital compilation process in IDMS mapping is not only process of editing and compiling the data which come from digital plotting process. Some type of information which not employed to capture from aerial photograph are collected in digital compilation process from materials excepting stereo plotting or field survey result. Normally, unseen object and phenomenon on the earth surface is not shown on aerial or satellite imagery. Theoretically, in photogrammetry mapping, information which cannot obtain from aerial or satellite imagery is to be collected in some other way excepting stereo plotting.

Information should be collected and input to Topographic Database at this compilation process: expected to perform by GIS section, e.g.

- ❑ Geodetic control point (GPS point, Triangulation point, and Bench Mark)
- ❑ International boundary and boundary pillars
- ❑ Administration unit and administration boundary
- ❑ City, town, village name
- ❑ Route information of railway network with arrangement of railway station, kilometer stone, and railway gauge type
- ❑ Route information of inland water transportation
- ❑ List of government building feature instance
- ❑ List of prominent object which will be annotated on map
- ❑ Information of arrangement of reserved forest area and its boundary

Summarize the target issues, object, and coverage of field survey and prepare instruction and guide map for field survey

In above listed items,"❑List of government office", those type of list: the list of target object, it will be useful as information for planning and evaluating result of field survey. The list shows number of targets in the area, and whether the survey covers items necessary or whether the survey dares to cover too much things. The list is useful for planning, monitoring and evaluating for conducting field work.

Note, following paragraph principally mention about data collection for 1/25,000 mapping in map compilation process. For 1/5,000 mapping it is necessary to consider about some difference in between 1/5000 and 1/25,000 mapping.

Object adopted in the list explained in above is only limited to government office features and some public facilities: significant and prominent instance on mapping area. These features are expressed as designation symbols for prominent or important things on 1/25,000 topographic map. They are prominent or important government office and some public facilities in target area: e.g. Fire service, Police station, Post office, Courthouse, Upazila office, T&T office and something.

Farther more, second point; this listing not required for covering every instance of government office and installation relevant above feature type. Only covering significant and prominent instance in target area is enough. The reason is that, designation symbol for particular used building on 1/25,000 topographic map is not required to show every instance. It is enough to indicate significant and prominent instances on topographic map.

Aim and procedure of this listing is not for entirety surveying, only preparing information for planning and checking result of field survey; figuring out distribution and quantity of the prominent and indispensable instance for representing as point symbol on topographic map. This list is not just used as input data of mapping, and other specific purpose GIS database.

Especially 1/25,000 in rural area mapping, it is expected that number of prominent government office which relevant to be shown on map is few; it may one or two instance per one village or town, several instances per one Upazila, or city. If the few prominent office or installation is missed on the map, the map will be disputed about lack of quality of map, and production methodology is imperfect: not fulfilling completeness. For avoiding like this unpleasant result, it is necessary to prepare the premise information for planning of field survey before starting compilation and dispatching field surveyors to field. For preparing good planning and scheduling for field survey and ensure for getting good quality and result for field survey, preliminary listing of object of survey is indispensable approach. Compiler (commander, cartographer) have to know following facts in advance and approximately, quantity and distribution of police station, fire station, post office, and etc in target area. This is useful information for rational and appropriate planning of compilation and field survey and finally this action make sure to ensure for completeness.

SOB already have 1/50,000 existing map, normally object are already annotated on 1/50,000 topographic map; also they are annotated on 1/25,000 map.

Collect toponym information from suitable information source and establish toponym database as part of Topographic Database.

It is clearness that arrangement of place name related with administrative information and alignment of administrative boundary will have difficulties through the topographic mapping process. Staff of SOB must take action of planning and preparation work for collecting, arranging information of community name and administrative boundary on topographic map. In general, mapping organization is not authorities for demarcating administrative information. Mapping organization just only provides base map data. Demarcation of boundary will be done by another authorized agency with base map data.

Compilation for Cartographic Database（By Cartography section）

This compilation is compilation for perfection Cartographic Database. Cartographic Database is drawing data which has WYSIWYG image of printed map. Finally this data file use for creating the original printing plate of hard copy printed map. Generally, this process is called as map finishing. Source information of Cartographic Database is Topographic Database. At this compilation process, in first import mapping data equivalent of Digital Landscape Model (DLM) from Topographic

Database. Then, make cartographic representation editing and make perfection mapping data equivalent of Digital Cartography Model (DCM).

IV GIS Basic Data (Spatial Data Infrastructure)

As explanation in previous in this document, Topographic Database and Cartographic Database are prepared in digital compilation process in IDMS topographic mapping. Those databases are prepared and utilized for preparing mainly hardcopy printed topographic map.

In addition, digital mapping data for public GIS user will be prepared. This is call as "GIS Basic Data" in this document.

Characteristics of GIS Basic Data is

- GIS Basic Data can be use as base map, not thematic information.
- GIS Basic Data is DLM data, not DCM data.
- GIS Basic Data is basic data spatial data, framework information for every GIS user.
- Information in GIS Basic Data is extracted from information of topographic mapping.
- Public accessibility and usage in user in outside SOB.

GIS Basic Data is also derivable information from Topographic Database like Cartographic Database. But GIS Basic Data is DLM Data.

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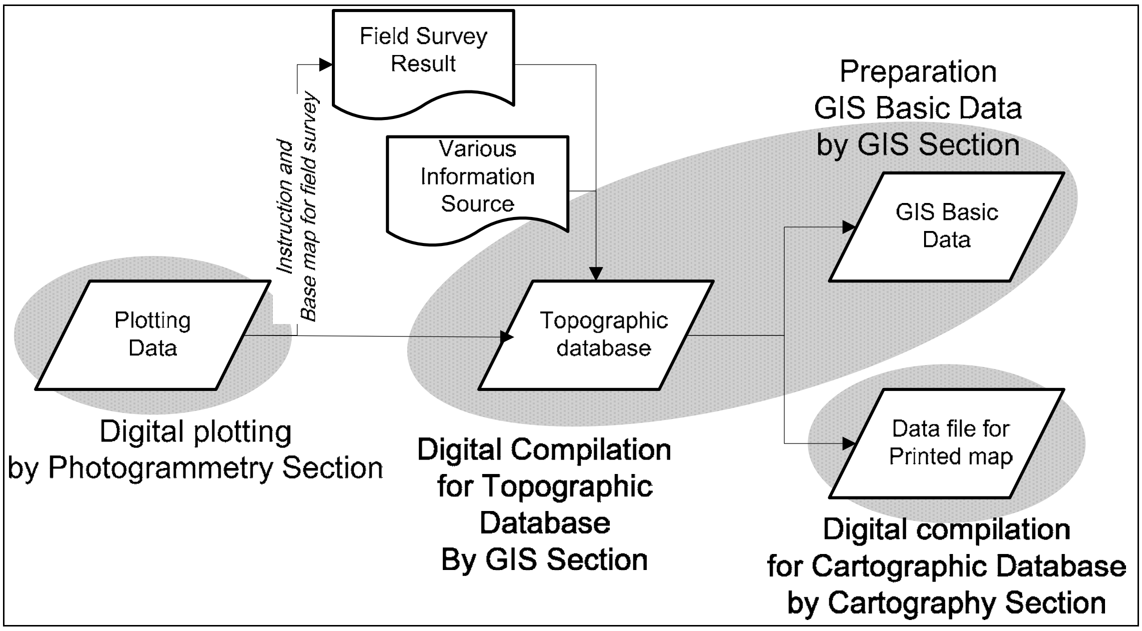

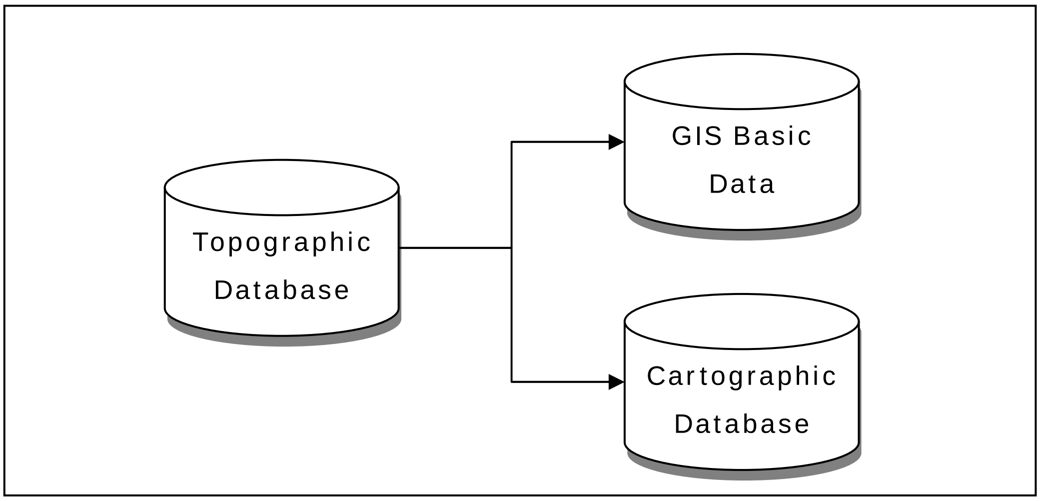
GIS Basic
Data
Topographic
Database
Cartographic
Database

V Difference of Digital Landscape Model (DLM) data and Digital Cartographic Model (DCM) Data

Agency preparing topographic maps using computer mapping system generally have two types of digital topographic map data through the process of topographic mapping. One is Digital Landscape Model (DLM) and another one is Digital Cartographic Model (DCM).

DCM data correspond to digital topographic data made cartographic representation.

A typical example of DCM topographic mapping data is content WYSIWYG image of hard copy printed map.

DLM data correspond to digital topographic data without cartographic representation.

Cartographic representation makes summarize and modification of information and shape of figure on map, with purpose of showing the selected relevant information on limited space on hardcopy map with readily understanding of map user.

On the other hand, in recent years, computer, internet, GPS, GIS and other related technology and device have widely spread and became popular. This trend makes growing demand for the digital topographic map and spatial information. Users need to handle mapping information on computer with function of hardware and software.

In case of handling vector mapping data in computer program, algorithm of detecting and analyzing vector mapping information is mainly to focuses on geometry figures and continuously in a feature object, and connectivity between adjacency feature objects. Therefore, in case of mapping information handling in computer program, the exact position and continuousness of figures is most indispensable information. Characteristic of DLM data: free from influence of cartographic representation and retaining the exact position and consciousness of geographic feature is important.

Hard copy printed map have already made done something by cartographers: summarizing and modification of information for the purpose of preparing specific scaled topographic map. This manipulation is helpful for human perception of map user, but not helpful for analysis purpose with computer program.

Cartographic representation spoil necessary information for computer analysis: exact position of geographic features on map corresponds to target object and phenomenon in real world and spoil continuously and connectivity of figure constituting geographic feature on map.

In addition, if you find the word, “Real positioning data” and “Cartographic drawing data” or “Cartographic representation data” in explaining by Japanese expert for similarity topic, these words point same concept of digital topographic map data. Real positioning data is map information equivalent of DLM data. And Cartographic Representation or Cartographic Drawing data is map information equivalent of DCM data.

VI Public needs for DLM mapping information bring innovations in product and production approach of digital topographic mapping.

Before introducing practical use of computer in topographic mapping

Before introducing computer mapping method into cartography (the activity of making maps), cartographer produced elaborately map with manually drawing with ink and pen. Cartographer applied cartographic representation: displacement, disconnection omission, simplification, combination, smoothing, and generalization, for representing the selected relevant information on limited space on hardcopy map. In these days, product of topographic mapping was only hardcopy map.

In the beginning days of using computer in topographic mapping

After the late 1970's, graphic drawing system with CRT display and digitizer created, and computer mapping is put to practical use.

At the beginning of using computerized graphic processing system for topographic map production, mainly computer was used as trace and reproduction tools substituted for on manual.

Exactly computer mapping was applied for fair drawing for hard copy map and digitalization of hardcopy map.

Cartographers prepared digital topographic map equivalent of DCM, completely have WYSIWYG geometry of final image of hard copy map.

At that time, main products of topographic mapping was still hard copy topographic map only.

In that period, for mapping agency, it was enough to prepare fair drawing data with computer mapping method. Fair drawing data is only utilized for making the original plate of map printing inside of mapping agency. No further utilize was done. No necessary to consider about interoperability at that moment.

On the other hand, mapping agency and other agency started preparing GIS basic data separately topographic mapping production process, at this time, vector GIS basic dataset mainly was prepared as deliverable from hardcopy map, by digitizing or scanning hardcopy map. Digital topographic map data was still used for reproduction of map.

At that time, in mapping agency, almost their digital mapping dataset have characteristic of drawing data.

Demand for real positioning data (DLM) and innovations in mapping instruments bring changing of methodology and product of digital topographic mapping.

After the1990's, personal computer, internet, GPS, are rapidly spread into consumer use level.
Those trends encourage popularizing GIS technology and drove demand for utilizing digital topographic map data having DLM characteristic.
Users of map, GIS, Internet, navigation system and so on, users in any technical domain, industry and level, they intend to use topographic mapping data in computer as base map information and spatial data framework.
As a consequence, now mapping organization needs to prepare and maintain two types of digital topographic map data having DLM and DCM characteristic in their topographic mapping procedure. So at first, digital topographic map data with DLM map character is prepared through the digital plotting and compilation process. After DLM map integrated from various information source, in next, digital topographic map with DCM information is prepared. This second process is made cartographic representation to DLM map data and record as DCM information file. Printing plate data of hard copy topographic map will be created from this DCM. In addition, beside of DCM and hard copy map, GIS Basic data will be created from DLM topographic map. GIS Basic data is also digital topographic map with DLM characteristic optimized as public access dataset.

VII Latest trend of technical approach of topographic mapping in this decade

As already explained in previous chapter, by movement of widespread of using computer, Internet and GPS in recent years, take shifting of hardcopy map to digital map which have DLM information for instance, it has varied needs for product of topographic mapping.
And development of equipment and software technology in this decade has made varied some detail work and data flow of preparation of mapping data.
In digital cartographic editing, approach for creating DCM information, and form and entity of DCM information has varied with performance enhancement of mapping software brought by processing capacity improvement of computer hardware.
And some procedure and process in digital mapping production are relocated among digital plotting, digital compilation and other process.
For example, digital stereo plotter gets the function for editing figure and attribute in mapping data with overlaying aerial images. Some procedure and process regarded as portion of editing process in conventional becomes to regarded as portion of stereo plotting process.

It is assumed that some description of work flow and data flow in Total Design Document (TTD) v2 of IDMS project are also influenced the technical trend noted in above.
Those new approach in this decade require different concept and implementation from conventional approach in several and more years ago.

As a practical matter, some variation on technical approach in digital topographic mapping is expected between 1/5,000 urban mapping in 2002-2004 for Dhaka and 1/5,000 mapping in IDMS. In particular, procedure and intermediate dataset related with preparing DCM information in digital compilation process will be changed.

For staff of SOB, it may have some difficulties to understand about description on TTD v2. There are some gaps between trend of latest technology and knowledge and experience got from past experienced project. So it will be explained about some trends in this decade in following, about mapping, especially related with digital compilation process.

Developing mapping software with idea of portrayal

Transition of DCM or fair drawing of topographic map

Development of computer hardware and software brings innovation in production methodology and content of cartographic representation for digital topographic mapping.

Mapping agency conventionally used to maintain DLM data file and DCM data file distinctively in one topographic mapping production in digitally. The mainstream technique in those days was preparing WYSIWYG image of hard copy topographic map with cartographic representation: DCM information was expressed and recorded as arrangement of series of figure on drawing data file. Main usage and characteristic of drawing data file is reproduction of printed map. Drawing data file is not DLM data. Drawing data file is not suitable for using for directly use in computer, for analyzing work. What is worse, there are inconveniences in using DCM data for map revising work. The characteristic of DCM has difficulties to directly edit geometry of feature in map revising work.

Therefore, mapping agency has prepared and maintained both master file of DLM and DCM data in one mapping production.

In conventional approach of preparing master drawing of depicting image of topographic map or its DCM data is arrangement of figures constitute cartographic representation.

- ❑ Figure on digital data file has same shape depicting of topographic map.
- ❑ Figure constituting depicting of map is displaced from location of target object.
- ❑ Figure constituting depicting of map has not continuously of target feature, Broken line, dashed line, dotted line, interrupted line, short dashed line and dot-dashed line, indivisibly drawing component element of line as independent figure.

Content information on DCM drawing data is figure element of output depicting by cartographic representation. The main application of DCM drawing data file is reproduction topographic map with hard copy printing. Content of DCM drawing data does not have suitable characteristic for other utilization: directly analyze in computer purpose. In this case geometry of feature object and portrayal is not separated.

Portrayal approach for preparing DCM in cartographic representation process

Recently, by improving of processor speed of computer, new approach of expressing cartographic representation has been in practical use. In this approach, map symbol and representation is rendered as depicting image derivative from DLM data element by portrayal. It has been possible to handle distinctly geometry of feature object and its portrayal.

Characteristics of this portrayal approach are

- DCM portrayal is rule based rendering result from DLM feature; this rule based approach has affinity with function and content of mapping GIS database.
- Controlling rendering rule for DCM portrayal has flexibility, so it possible to assign default rendering rule for all feature object in each feature type based on database attribute by single operation, and also to assign the individual rule for individual feature object by manual operation, considering the individual situation of each feature object.
- Possible to render any different appearance of feature object: shape, geometry and position, which different from original feature object without any modification of original feature object: shape, position and geometry.
- For particular feature object made no display on DCM, exactly set to no-rendering status on rendering rule for target feature object. It is no necessary for deleting geometry of feature object from database.
- For simplification for cartographic representation on DCM, no necessary simplify geometry of feature object on DLM data.
- Stroke of dashed line is controlled by semi automatic or automatic function as portrayal without modification and losing continuously of feature object.
- Rule based rendering approach bring simples for recording and tracing for errors and changes. These functions also bringing of affinity with database.
- Reduce cost and inconvenience for maintenance both DLM and DCM.
- It is possible to produce several different thematic map derived from one DLM database by preparing several individual rendering rule sets for each thematic map.

Concept and procedure of portrayal DCM from DLM here are. Digital topographic map information of DLM is stored as fixed existence information having original geometry in database. This is DLM features.

And in the same database substance, content of cartography representation (portrayal) is stored as rendering rule. Software apply rendering rule to DLM feature object and portray DCM contents on monitor screen and print device. About outline of data flow, you understand sufficiently as follows, DCM feature don’t have fixed figure substance on the database, DCM exist as rendering rule in system. In case of revising editing work for existing map features, CAD/GIS operator edit geometry and attribute of target feature of DLM only, and edit portrayal rule for DCM related with target features.

TIME

<table>
<tr><th></th><th>DLM</th><th>DCM</th></tr>
<tr><td>❑ Hardcopy map only</td><td colspan="2">Manual drawing only
(No distinction DLM and DCM)</td></tr>
<tr><td>❑ Hardcopy map
❑ Drawing data file have WYSIWYG image of hardcopy map</td><td>-</td><td>Data file</td></tr>
<tr><td>❑ Hardcopy map
❑ Drawing data file have WYSIWYG image of hardcopy map (DCM)
❑ Utilizable mapping information with GIS and other program (DLM)</td><td>Data file</td><td>Data file</td></tr>
<tr><td colspan="3">Separation of feature geometry and portrayal for feature</td></tr>
<tr><td>❑ Hardcopy map
❑ Rendering information of WYSIWYG image of hardcopy map (DCM)
❑ Utilizable mapping information with GIS and other program (DLM)</td><td colspan="2">Unified in database
Fixed Feature / Rule based rendering</td></tr>
</table>

Fig. Transition of DCM or fair drawing of topographic map

In fact, in Dhaka 1/5,000 urban mapping project, conducted in 2002 – 2004, three configurations of digital topographic mapping data were prepared.

DLM map data of topographic map, DCM map data of topographic map, and GIS basic data compiled from DLM topographic map data.

Content	Type	Software	File Format
Topographic map data [Topographic Data]	DLM	Bentley Micro Station	DGN
Topographic map data [Symbolization Data]	DCM	Bentley Micro Station	DGN
GIS Basic Data	DLM	ESRI ArcGIS	ESRI Shape

In Dhaka urban mapping project, CAD system was mainly employed for production DLM and DCM data file. One of familiar approach for getting WYSIWYG image data of depicting of hardcopy topographic map with CAD system is following procedure. In first, prepare duplicate of DLM CAD data file as new initial data file of DCM and add modification to original figures from DLM data as cartographic representation editing. Finally figures for representing WYSIWYG of hardcopy map were prepared. This approach is different approach from latest portrayal approach with database function.

Especially, there were difficulties for real time rendering on monitor fairly depict of “special line” satisfying demands of cartographical line stroke adjustment. ”Special line” means dashed line, chained line, alternate long and short dash line, and some chained or dashed-line including some point mark. At that time, mainly due to processing speed of computer, there were some technical difficulties and inconvenience of rendering adjusted stroke line.

Therefore, it was adopted the approach that rearranging individual “physical” figures consisting of special line consisting topographic map. By this methodology, we could get good appearance of depict of topographic map with cartographic requirement, but we lost continuousness of line for GIS analysis.

In Dhaka 1/5,000 Urban mapping, in first, completed DLM characteristic topographic data called “Topographic Data”, then prepared initial data of DCM file by preparing duplicate of DLM data as “Symbolization Data”; then, on the “Symbolization Data” file, made cartographic representation in manually. For line figure with dashed stroke, ran program for rearranging figures for representing special dashed lines for cartography representation with configuration of dash-line stroke .

Advantages of portrayal approach for data maintenance and map revising work

In conventional digital cartography approach, it is necessary for maintaining distinct data files for DLM and DCM data file for map revising work. Particularly in case of adding new information, or modifying existing information on digital mapping data which already has been made cartography representation editing. Digital cartographer necessary to edit DLM and DCM data files. And digital

cartographer distinctly edits and maintains both file in every minute.
This conventional approach makes hard work for digital cartographer to maintain change control for revising map.
In employing this new technical approach: preparing DCM information as portrayal and stored DLM and DCM stored in same database repository bring simple work procedure and operation to digital cartographer. Simple work procedure and operation reduce troubles and inconveniences of map compilation and revising work. In case of editing existing content for map revising work, CAD/GIS operator get off editing both DCM and DLM data with taking care both consistency.

This procedure is adding and modifying shape and attribute of target feature on DLM information, and then change portrayal rule for DCM information for target feature in same database repository.

In IDMS project, according to latest information at December 2010, for digital compilation work, desktop and server application develop by ESRI will be procured to SOB. This software also has packaged portrayal functions.
Some name of CAD or GIS software package implemented portrayal approach for cartographic representation.

Software	Function or module Name	Vendor
Arc GIS	Representation	ESRI
Bentley CAD Script	Bentley CAD script	Bentley
GeoMedia	Map Publisher	Intergraph

As theoretical explanation, DCM and DLM are able to be considered as two distinct substance of database. Aside from above explanation, if SOB make full use of latest GIS software and server function in practical production process of cartography work, those two different types of map information: DLM and DCM information will be handled as one database repository: Cartographic Database. This essential is that those content information on map: DLM and DCM are different. But in now latest hardware and software technology make possible that DLM and DCM are stored and manipulated as one database repository.
As suggestion in this manual for SOB, the idea to handle DLM and DCM as single database repository brings some technical hurdle for SOB staff, especially in its inception. SOB staff is required to understand some complicate concept and operation way brought by using new technique.
But that new technical way expect to bring convenience to SOB staff, to deduce trouble with

maintenance multiple information and dataset. This technical approach especially has beneficial effect for map revising work phase.

Employment softcopy stereo plotter bring some changes in digital topographic mapping

Digital stereo plotter (Soft copy stereo plotter) integrated CAD function brings some new idea, new working flow and data flow to topographic mapping process. It innovate detail procedure of aerial mapping and topographic mapping.

Development and popularization of digital stereo plotter for data capturing in digital topographic mapping brings that vector map information is handled as digital data from at the moment of its obtained in stereo plotting, and stored in memory or storage as digital mapping file.
It brings possibility that digital topographic mapping data keep as the identical information in fully digitalized dataflow, from data capturing process to its compilation process.
Recording and keeping information as digital through whole workflow, make free from lose accuracy caused by copy and reproduction media to media and retain exact position and shape of obtained data in digital plotting to final product.
On the contrary, mapping information drawn to hard copy media made copy and reproduction to another media, or made digitalization by using digitizer or scanner.

In addition, z coordinate of features (position on height direction) obtained by stereo plotter is also retained to final product in fully digitalized work flow.
In previous days, hardcopy map is main product in topographic mapping. Hypsography feature show as contour line and height information with text labels on paper plane. Demand for digital mapping data with Z coordinate of features is rare. So z coordinate of feature is discarded on the way of compilation process and not introduced to final product.
Furthermore, technical trend: handling digital mapping data on computer software and utilizing analysis demands to retain Z coordinate of feature in mapping data.

But in practical mapping production process, implementing to retain Z coordinate of feature have to resolve technical and cost difficulties. Data compilation with treatment Z coordinate is required additional technical skill, procedure, software, time and cost. Retaining Z coordinate for all features for final product is not practical idea. It is necessary to investigate about reasonableness to retaining Z coordinate in compilation process.

Just for confirmation, description about reasonableness of retaining Z coordinate of feature in above is not discussing about necessity of stereo plotter and stereo plotting. Whether final mapping product required height information or not, essentially shape and position of features on map by photogrammetric mapping is orthogonal projected with scale of feature determined using height information. For acquiring shape and position of object with orthogonal projected from aerial photograph, height measurement function and projection transform mechanism of stereo plotter is necessary.

In practical phase of implementation of digital mapping, SOB has to consider and decide about following issues involved in height information in digital topographic map as final product of IDMS.

- Demand and necessity of retaining height information of features
- Validation of required and adopted accuracy of height information
- Sorting features into required height information and non required
- Methodology of assign and showing height information for required feature

Checking and correction of geometry of feature object with stereo plotter

Popularization of digital stereo plotter (softcopy stereo plotter) integrated CAD function brings process for checking and correction of geometry of obtained feature object into stereo plotting process. In the first decade of this century, Personal Computer (PC) based digital stereo plotter have widely spread in data capturing process of topographic mapping.

Integration of softcopy stereo plotter with CAD and GIS database make come true that data capturing, fairing and verifying can be done at the same instant with stereo scopic view.

On the contrary, conventional workflow of topographic mapping, obtained features by stereo plotting are sent to compilation process. Compilation process make fair correction to features and checking and correction relatively location with related feature objects and adjacent feature objects.

Softcopy stereo plotter has necessary devise and function of superimposing vector mapping data and stereo model image in wide area screen with full color and high resolution, and vector editing function on stereo scopic view.

Confirmation and fair correction for acquired figure is done simultaneously with data capturing by stereo plotting operator. Softcopy stereo plotter superimpose image of stereo model and capturing vector data in display device, operator can monitor assurance of own operation simultaneously with data capturing.

Furthermore, digital stereo plotter with CAD has function of printing vector data with aerial image to hardcopy or monitor. It can support preparing of the drawing map for inspection with CAD and GIS function. Normally, checking for plotting data is performed in stereo plotting process simultaneously or immediately after accomplishing data capturing.

Therefore, there is one point out that duties and work amount of stereo plotting operator more increase than past days and it is necessary that to estimate more time and cost for stereo plotting process.

Evolution of graphic output and data editing with stereo plotter

Function / Method and equipment	Superimposing obtained vector data and stereo mode scopic view	Fair correcting and Editing function
Analogue mapping Analogue Stereo Plotter+Drawing table	×	Edit (analogue) fair correction of drawing
Digital mapping Analogue Stereo Plotter+Rotary Encoder+CAD In early phase	× Vector only	○
Analogue Stereo Plotter+Rotary Encoder+CAD In late phase	○	○
Digital stereo plotter (Integrated CAD function)	◎	◎

VIII Spatial data modeling

Universe of discourse

Spatial data, including digital topographic map data is abstraction model of real world.
Modeling for geographic phenomenon in real world at randomly and without any logical rule is not rational idea. It is necessary to define scope about target geographic phenomenon involving your topographic mapping as universe of discourse.

The scope of subject of your map and spatial dataset should be limited subject in the universe of discourse of your spatial dataset.
In the course of discussion about the universe of discourse of your spatial data model for topographic mapping, geographic object or event on the surface of the earth involving your topographic mapping would be defined.

The main purpose of dataset for Topographic Database prepared in IDMS project is preparing dataset utilize as master repository of topographic map information for preparing 1/25,000 and 1/5,000 topographic map.
The content of Topographic Database is geographic information elements which constitute topographic map prepared by IDMS project and those limited content should be modeled as geographic feature in this dataset.
Content and topic in mapping information based on other needs: not based on needs for 1/25,000 and 1/5,000 topographic mapping is out scope of the universe of discourse for this dataset, and should be aside from this dataset's content.
In theoretically, preparing specific purpose mapping information and preparing general purpose mapping information should be treated as different things. It is not rational to treat data model for special map for particular institution and facility complex, land use classification dataset and Topographic mapping data. It is difficult to prepare 1:2,000 map for particular installation and 1:25,000 topographic map from same spatial data design for 1:25,000 topographic mapping.
SOB should understand differences between preparing particular purpose map and topographic map. Preparing for particular purpose map is outside the scope of IDMS for IDMS. SOB should prepare another data model and database for particular survey and mapping work one by one, not combine everything into topographic mapping data model for IDMS mapping.

Feature and Geometry

In spatial data modeling, target object on the target surface or plane is modeled as geographic feature. Shape and location or position of feature is expressed as figure having appropriate dimension: point, line, or polygon.

Attribute

Attribute data describes the characteristic of spatial feature.

Objects could be classified as typical type or group having similar or same thematic attribute is classified as same feature type. Furthermore, object classified into certain feature type may have more detail information characteristic of object: name, history, owner of object and so on, is stored as attribute of feature. Attribute of feature is normally stored in attribute table in dataset.

Mapping Scale and geometry of feature

Data modeling, according to purpose and target mapping scale of dataset, appropriate dimension and geometry for feature is different.

		Large scaled map	Small scaled map
Object	Building	Polygon (Area)	Point
	Tree and Woods	Point	Polygon (Area)

		Large object	Small object
Object	Building	Polygon (Area)	Point or no indication
	Lake	Polygon (Area)	Point or no indication

Generally, it is possible to compile to create smaller scale map from larger scale map. Oppositely to prepare larger scale map compiling from smaller scale map is impossible. Exacting representative position information as a point feature from an area feature on map is pertinent, but exacting and representing position information as an area feature from a point feature on map is not pertinent.

Portrayal

Portrayal is issues of how to show the information on map.

In digital cartography using database, implementation of controlling portrayal rule for group of features or individual feature is stored in database as attribute. And criteria of assigning portrayal rule depend on attribute of feature.

As already mentioned in previous chapters, in the days of digital topographic mapping preparing hardcopy map only, it is unnecessary to distinguish configuration of depicting information as portrayal. On hard copy map, depicting as map is stable. Because is impossible and no necessary to change dynamically configuration of depicting of map already drowned on hard copy paper map.
In recent digital cartography, development of computer technology brings us flexibility of cartography representation on computer software. We can regards as separate things, spatial information and issue of portrayal in data modeling. It is possible to dynamically change configuration of depicting information for map. Controlling portrayal with database brings for us flexibly configure portrayal of map information considering situation of each feature on map.

Introduction to Features

From ISO 19101, "A feature is an abstraction of a real world phenomenon"; it is a geographic feature if it is associated with a location relative to the Earth. Vector data consists of geometric and topological primitives used, separately or in combination, to construct objects that express the spatial characteristics of geographic features. Raster data is based on the division of the extent covered into small units according to a tessellation of the space and the assignment to each unit of an attribute value. Attributes of (either contained in or associated to) a feature describe measurable or describable properties about this entity. Unlike a data structure description, feature instances derive their semantics and valid use or analysis from the corresponding real world entities' meaning. Documenting feature instances, types, semantics and their properties is often detailed in an information model.

Open Geospatial Consortium Inc.
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Version: 5.0 Category: OpenGIS® Abstract Specification Topic Volume
Editors: Cliff Kottman and Carl Reed

Introduction of Information Models

An information model details how to take real world ideas or objects and make them useful to a computer system. In the geospatial world the focus is on depicting things in the real world as points, lines, or polygons (the geometry "primitives" we use to assemble location data about those real world objects) and their attributes (information about those objects). When linked together, a pair (geometry and attributes) representing one or more real world objects, is called a feature.

In ISO 19101, there is the concept of the Domain reference model. The DRM provides a high-level representation and description of the structure and content of geographic information. For the purposes of this document, the information and domain reference models are synonymous.

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IX Technical topics for digital compilation work in IDMS

Classify road feature for generalization (selection and omission)

As preliminary process of doing selection and omission for road feature, assigning classification information on road features based on some specified criterion would be done.

Normally, item of criterion is following

- Level of importance
- Surface type
- Width of road
- Differentiation by motorable or un- motorable

In above, width of road is enumerated as criterion for road classification.

Main purpose of this classification with some numerical or thematic attribute is exactly offering information for making judgment of selection and omission for cartographic representation.

Especially, for making omission road in crowded area, it is necessary to identify narrow road which suitable for not indicated on final cartography representation. This approach includes collecting and assigning some attribute information for road features, but this approach does not intend to prepare the road inventory database. Therefore it is no necessary that try to measure width of every road segments and store value of width into database.

In convention and fundamental of cartography, selection and omission for road feature in crowded area would be result of comprehensively consideration by cartographer based on some information: mapping data, aerial imagery, field result, existing map and other information.

In digital cartography representation, database and rule based portrayal approach assisted software function require some input data and parameter: location, attribute of feature object, for manipulating on database: select, extract, and sort record.

For this, it is enough to identify width of road in relatively with other road. Absolute values of road width are exactly not required.

Therefore, it is no necessary that to require making measurement to stereo plotting operator. Instead of applying assign some attribute information as criterion for database manipulation, there is selectable option that cartography operators observe, identify and pick target feature object for omission based on mapping data and ortho photo and other information.

On cartography feature type list for IDMS mapping, criterion of road classification states standard value width of feature instance width as 12ft (3.65m) and 20ft (6.1m). This standard value is exactly rough idea for classify road in relatively. For comparison, this 12ft and 20ft come from conventional classification idea using field survey by SOB. In the adoption of this figure for road width, 12 ft and

20 ft, considered general width of vehicles. Width of Auto truck and Bus is 2.5m. Exact size of Sedan car (TOYOTA COROLLA) is 1.695m.

Matter of edge matching and extent of data to handle in mapping

This is topics about technical transition of edge matching with introducing digital mapping method and development of instrument for digital mapping.

Edge matching in stereo plotting process

In work flow of photogrammetry mapping with using stereo plotter, stereo plotting carries on unit by stereo model pair. Everything done by model by model, this restriction comes from basic theory of photogrammetric mapping, even digital mapping or analog mapping. In conclusion, minimum working and administrative unit of data capturing in stereo plotting is model by model. After completion of data capturing for one stereo model, captured data should be done fully inspection about quality: completeness, logical consistency, positional accuracy, temporal accuracy, and thematic accuracy about that mapping information.

Generally, it is better that a checking and correction for certain process should be completed in that process.

In consideration capability of latest photogrammetric mapping system, they are integrated function of checking and correcting vector mapping data. This integration make possible to perform all necessary checking and collection errors in mapping data with digital stereo plotting system. The current standard procedure for data checking and correcting for stereo plotting data should be completed in stereo plotting process.

Some checking is done in simultaneously with data capturing and some checking is done at timing of accomplish of data capturing.

After accomplish of checking and correcting error on mapping data for each stereo model, model by model stereo plotting data is put together adjacent model and unified as one data with particular extent.

In practical process of IDMS mapping, the particular extent for handling data in digital compilation process may be designed with progress of stereo plotting work for certain duration, per weeks or per month.

And also edge matching between vector mapping data for already prepared in previous lot and ready in next lot should be perfectly performed in stereo plotting process.

After completion of preparation mapping data covered with particular extent by stereo mapping process, data would be sent to compilation process.

Edge matching in compilation process

In conventional approach of map compilation work, compilation work tends to be performed by map sheet unit. Because all process in map compilation is performed on hardcopy media.

In latest digital mapping procedure, mapping data is stored into digital data from an initial stage of data capturing process. Therefore compilation work free from restriction of hardcopy media size and mapping data can be maintained as seamless.

Maintaining mapping data as seamless dataset brings some advantage for data maintenance.

- ❑ Reduce the target dataset of maintenance work.
- ❑ Apply one logical consistency in one dataset.

Edge matching method also has been changed with conventional method by introducing digital mapping method.

In previous age, when stereo plotting data was recorded on hardcopy media: plastic film or paper, mapping information was not free from restriction of size and extent of hardcopy media.

In digital mapping, data is stored in electric data, so it comes free from restriction of hardcopy media and data stored as "seamless data" has particular extent. The particular extent is able to set wider than provided by media size.

Coordinate systems

Coordinate system is critical and basement mechanism of cartography and GIS.

Understanding about coordinate system and applying coordinate system to map properly is important topic mapping and GIS work.

If applying coordinate system to the map is improperly, the map to be useless thing.

When working with map data lay on different coordinate systems, and handing coordinate system is incorrectly, position of data become wrong and unable to overlay multiple map datasets,

In some case of coordinate system conversion include changing map projection.

Applying different map projection, feature on map to be transformed.

Generally, coordinate system conversion to be done prior than compilation process. And before starting compilation process, it is necessary to check the result of coordinate system conversion in carefully.

In technical advising for sample map preparing, the reason why to mention about coordinate system in priority to other things is to be prevent concern about wrong handling of coordinate systems.

In sample map preparing, using following data and following coordinate systems.

Data		Coordinate system	Datum name /Referenced Ellipsoid
Source data	1/5,000 digital topographic map by Dhaka project	Projected Coordinate system Bangladesh grid*	Gulshan Datum /Everest 1830
	GIS basic data derived from 1/5,000 digital topographic map by Dhaka project	Projected Coordinate system Bangladesh grid*	Gulshan Datum /Everest 1830
	Ortho photo image by Dhaka project	Projected Coordinate system Bangladesh grid*	Gulshan Datum /Everest 1830
Compiling data	Map sheet grid (Neat line)	Geographic Coordinate system	WGS84 datum /WGS1984
Compiling data	1/:25,000 map by IDMS project.	Projected Coordinate system Bangladesh grid*	WGS84 datum /WGS1984

*"Bangladesh Grid" on this paper is terms for Projected Coordinate system with transverse Mercator projection, central meridian 90 degrees East.

Coordinate Conversion and Coordinate Transformation with Geographic Transformation

Coordinate Conversion

Coordinate conversion is to convert coordinates on the different coordinate system, in coordinate conversion both coordinate system which depend on the same datum and reference datum of the ellipsoid. For example, apply to different projected coordinate system with changing map projection or apply coordinate system changing from geographic coordinate system to projected coordinate system or reverse way.

Coordinate conversion process is without changing datum and referenced ellipsoid of the datum, in other words coordinate conversion is not include changing geographic coordinate system, so it is no necessary applying geographic transformation.

Converting coordinate between Geographic coordinate system depend on Gulshan datum and projected coordinate system depend on Gulshan datum, this operation correspond to Coordinate Conversion.

Coordinate Transformation with geographic transformation (datum transformation).

Coordinate transformation is to transform coordinates on the deferent coordinate system, and both coordinate systems depend on deferent datum and reference ellipsoid of datum.

Coordinate transformation involve geographic transformation (datum transformation).

In this preparing sample map , Dhaka 1/5,000 map is used as source map.

Datum of Dhaka 1/5,000 map is Gulshan303 datum. Gulshan303 datum reference to Everest 1830 ellipsoid. Otherwise, a datum which to be applying for sample map is WGS1984 datum (reference ellipsoid is WGS 1984).

X In procedure giving cartographic representation

Classification for feature in target mapping scale

Classify the feature based on specified criterion, e.g size of feature, level of importance of feature, and store the classification information in attribute table of feature.

Assign the general rendering rule for cartographic representation

Assign the general rendering rule for feature, according to classification.
Elements of rule are mainly map symbol, size, indicate/no-indicate.

Rendering cartographic representation in target mapping scale

Render feature object with cartographic representation referencing to rendering rule.
It is possible to render output depicting figure as same or different geometry of target input feature object.

e.g For rendering cartographic representation for Building and house feature.
Input geometry is polygon.

- ❑ Output geometry is polygon or point (control by rendering rule)
- ❑ According to select and sort out by size of target feature object, it can be control to assign one by one feature.
- ❑ By rendering rule, building and house have more particular size are sorted out and rendered as polygon.
- ❑ Less than particular size is rendered as point or rendered as omitted feature: no indicated.
- ❑ Furthermore, it can be assigned rotation angle for point rendering one by one, reference to azimuth of original polygon feature on DLM.

Resolve for conflicting feature

In case of conflicting in neighboring feature objects with cartographic representation, make displacement, disconnect, aggregation, thinning out or hide the feature for resolve graphic conflict in DCM.. Software has some functions of detecting graphic conflict for making assistance to operator.

Modification of shape of feature

In case of shape of feature too much complex, make simplification and smoothing to feature.

Above is rough outline of cartographic representation with portrayal approach with database.

Semi automatic approach using algorism refer to combined extraction and classification analysis by shape, position, and size of feature and some attribute information of feature and rendering rules.
For smoothly implementation for this approach, it is important that shape and location feature should be captured without arbitrarily modification.

XI Arranging of specifications

Type of specifications for topographic mapping

I Map symbols and its applications rules

1. Element of map symbol and its application rules (indispensable items)
   - i. A variety of map symbol in the map series
     - Map symbol Regardless of size and form of an oblique shadow, it is displayed in a symbol defined in rule.
     - True shape A reduced scale makes orthographic projection of object , and it is displayed.
   - ii. Annotation It is displayed information of a subject by a letter. Principle of expression
   - iii. Expressed with true shape (orthogonal projection) and expressed with symbolized
   - iv. Indications for height

II Instruction (Procedure) manual

- i. Existing documentation of mapping standard by SOB

Element of map symbol and appropriate employment

Line type

In a topographic map symbol, typical employment of line type in cartography is followings

Solid line	Solid line is typically employed for indicating entity of visible object.
Dashed line, Dotted line	Dashed and Dotted line is typically employed for indicating entity of invisible object, under –construction structure, unpaved surfaced road, trail, vegetation boundary, imaginings, or administrative boundary.

Line width (Line weight), thickness

Line Color

Connection of line, Parallel array of line

Connecting straight lines with different thickness

General case

Exceptional case   Overhead, elevated road

Connecting straight lines at corner with different thickness

Stroke adjustment of dashed line

In cartography, line stroke of dashed line is generally demanded to adjust at bifurcation point or intersection of multiple lines.

As already explained in previous chapter, in old digital mapping technique, output image of hardcopy map was implemented by arranging pieces of figure on DCM data file. For implementing appearance of adjusted stroke of dashed line, line figures or spindly polygon figures was arranged on canvas on computer as fraction of dashed line. In series of arranging the figures expressing adjusted dashed line, length of each line pieces and interval of each gaps among line pieces constituting dashed stroke line should be adjusted with consideration about appearance at corner, intersection, and junction with other line.

In this approach, dashed line is not able to treat as one continuous line on software program. Each short line segment expressing one dash segment is detected as one figure with geometry. So this set of segmented figures on DCM file is not suitable for GIS usage.

On the contrary with previous days, in now, improvement of capacity of computer hardware and software bring innovation for adjustment stroke of dashed line. Arrangement of feature object on mapping data and portrayal for cartographic representation has made separating. All substance of line feature objects is arranged as continuous line geometry between intersections as DLM. Portrayal function of software dynamically draw dashed line symbol as DCM from substance of DLM continuous line feature object. Software detects end, corner and intersection of line features and adjust dash scroll for each line segment. In ArcGIS: the GIS software expected to use digital compilation process in IDMS, the function explained in above is implemented as the “Representation”.

Good examples and bad examples are shown below.

- Branch and intersection of a dashed line
- Branch and intersection of a dashed line and a solid line
- Connecting arc of dashed line and straight line
- Connecting extension of solid line and dashed line
- Parallel of a dashed line expressing the same feature
- Parallel of a dashed line expressing different feature

About building and building symbol

In discussing with staff of SOB about expression on map, data-structure and capturing way for building features, SOB staff usually make peculiar explaining. In this topic, “building” means to any public or non public construction and structure: building, house and structure with general and specific usage will be indicated on 1/25,000 topographic map.

This peculiar explanation may come from lack of understanding basic concept for way of expression on map, principle of data capturing and data-structure of digital topographic map for the 1/25,000 hardcopy map and its digital topographical map.

Comment for above issue as followings.

1. Basic rule for building, house and other construction feature

In displaying building: building, house, and other construction feature is employed following general rules.

Building and house is displayed as its orthogonal projected shape on mapping scale with area geometry.

In case of size of external shape of object is not enough for displaying with orthogonal projected shape with polygon geometry on mapping scale, object would be displayed as point symbol.

In case of size of external shape of object smaller than standard for indicated as point symbol on map. Or the object exists with other objects in congested area. The object would not to be indicated (eliminated) on topographic map.

In addition, in case objects have close formation and each object is small, aggregation technique would be applied.

This is a general rule employ to all buildings, houses and structures (constructions) on map, whether building and house is public building or not and having specific function displayed with particular map symbol or not.

2. Basic rule for building usage symbol

Building usage symbol: Japanese experts sometimes just call as "building symbol" is employed for indicating on map specific usage and function of building. Building usage symbol is normally marker symbol and put overlay with area geometry or point symbol for building, house and structure (construction) on topographical map.
On topographic map, for building, house, and structure which have specific function: government offices and public facilities are indicated its function with specified building symbol or annotation.
It is more efficient to employ specified building symbol than using text annotation for frequented function. Generally if function of building is indicated by marker symbol, it is not necessary employing both the point symbol and the text annotation for the same explanations for the same mapped object.

From here is description of problem mentioned at the beginning of this section.
About building and facilities structure which have a function specially displayed with building symbol on map, it is tended to hear the following explanation from SOB staff about the data acquisition approach, data-structure and way to indicate on topographical map and its digital data.
For example, about issue of railway station or bus terminal will be explained as following.

Cartography specification for 1/25,000 map just only require that only existence of railway station or bus terminal is indicated as point marker symbol overlay with building or structure (construction) shape.

However, explaining of SOB staff for like this issue is following.
"Capture the extent of target site as polygon feature." In this example, extent or parcel of railway station facilities and bus terminal facilities would be captured as specific feature with polygon geometry.

It has been already described by 1. in above. That is general rule for every building, house, and other structure (construction) whether these building has specification function explained in 2. If targets are appear in source imagery: targets are not behind under cloud or trees, shape of buildings to be captured from imagery in stereo plotting. But function of building is not to be identified from imagery.
Marker point symbol for specific building function on topographic map is arranged with overwrapping on polygon or point feature for general building, house, and structure. Identification and classification for specific building function depend on interpretation from several information sources: imagery, existing map, inventory list of public facilities, findings from field work and so on.

Data acquisition standard

In practical working of topographic mapping, criterion of data acquisition standard is two types. Expressed with numeric thing and expressed with non numeric thing.

- ❑ Unable to be expressed numerically
  - Qualitative — A notable, prominent, important object and phenomenon

- ❑ Enable to be expressed numerically
  - Quantitative — Length, width

In case of using function of database and computer software for classification feature by size or certain attribute, numerical criterion are useful.
And in case that it cannot expect the work: judgment and compilation by expert cartographer, numerical criterion is useful in sometime.
In case of employment of referencing and classification function of database software, or in case that it cannot expect compiling map by person of experience, it is better to prepare the criterion distinguished by numeric value instead of the criterion depend on experience and knowledge of expert.

Comparison between numerical criterion and un-numerical criterion or standard

Criterion and standard cannot express as numeric	Criterion and standard express as numeric
Can take the general idea that it is difficult to show it in numerical value definitely in an criterion.	
In case of a worker group acquiring training and experience, can take high interpretation by a cartographer in compilation. However, it is difficult to explain the basis of interpretation as comprehensible criterion.	
Unification of interpretation becomes difficult in case there is not it in an operator group acquiring education and experience handed down among limited groups.	

Comparison of some example of timing and approach of selecting information and applying the data acquisition standard in mapping process

Timing In data acquisition and collecting process: stereo plotting process, other data input and compilation process or field survey; selection of information is performed by operator and surveyor consider with particular mapping scale ,purpose and use of map. By this approach volume of data and work volume of data acquisition process can be restricted. Otherwise if interpretation of selection of data by operator and surveyor is irrelevance; it cannot assure quality of result; especially completeness and classification of feature. Finally data acquisition has to be done it over. In case of operator and surveyor don’t share similar knowledge and experience through the handing down in certain organization it may difficult to assure homogeneous content and quality in result with this approach.	Timing In data acquisition process, apply only filtering by size (an area, length or other) as minimum criterion, and every other things can be acquired. By this way, operator of data acquisition can be free from puzzled of selection of object and phenomenon. It may possible to produce mapping data not limited for specific purpose. After completion of data acquisition, it is possible to filter information by numerical or other criterion for processing and omitting information with assistance of database software function.
In case of conventional topographic mapping; product is only hard copy map; there is no room for argument about content of data and data acquisition standard depend on mapping scale and purpose.	In case of product is not only hard copy map; required considering and preparing output for several mapping scale or use of data, this approach admit of selecting information from initial plotting data considering not only one purpose; various purpose, needs or scale of mapping
Before starting practical operation, it necessary to carry on pilot study work for grasping of tendency and characteristic of data acquisition standard; it is difficult to validate data acquisition standard without pilot study.	

Preparing specification of map annotation

Cartography section must prepare detail specification of map annotation.

First, list the item of necessary annotation for 1/25,000 topographic map. This list contains definition of itemize of annotation and format and style of annotation: type of annotation and target object and phenomenon, font style (Roman (Normal), Italic, Oblique), font size, weight of font (light, medium bold and more), name of computer font and etc.

After completion of listing of annotation by cartography section, GIS section have to start collecting and compiling of source information for preparing map annotation. Several expected information sources outsider or insider of SOB is necessary to be checked about its validity, reliability and accessibility of information. As a basis of demands by cartography section, GIS section has to examine how to collect information and how to establish the database for annotation with consideration for feasibility and cost.

Arrangement of map symbol

Too much big size of map symbol brings more limitation for amount of information indicating on map. For relevantly indicating information on limited space on the map, it is necessary to add some manipulation for map representation: emphasis, omission and displacement to crowded features, based on suitable standard and interpretation.

If size of map symbol is smaller, it brings less necessity of map representation manipulation in above mentioned.

In manually drawing cartography work using ink and pen, to draw too much small symbol or feature is difficult. In digital mapping method, it is possible to draw smaller symbol and feature than manually drawing. In computer mapping, using smaller symbol is not concern things.

Meanwhile, for map printing and map reading, there are some difficulties on using smaller map symbols.

In addition, it is some difficulties in digital cartography to use perfectly same design of manual cartography.

If there are no concerns about difficulties in map printing and map reading caused by symbol size issue, it can be possible to use smaller map symbol. And then using smaller map symbol brings for operator ease of incorporating complex information in limited space on map.

XII Project scope and work planning, how to proceed work

Project scope

This document is production manual for digital compilation. Mentioning about the project scope of IDMS in this manual is out of scope of this manual.
A scope of IDMS has been uncertain therefore scope of digital compilation process is also uncertain. What will you produce in digital compilation process? Answer of this questions still uncertain. This situation is should be settled.

At beginning of December 2010, serious situation has still continued and observed. Project scope of IDMS project has been uncertain and unpublicized among SOB staffs.
This serious situation has always glimpsed in discussion about content of Topographic Database, and discussion about GIS database release for public in IDMS.
There is lot of the underspecified in that discussion. What is the substance and content of the mapping data, spatial data, GIS database in IDMS? What is "Topographic Database" and "GIS database release for public" in IDMS project.?

There were several ideas and understands about detail of IDMS mapping product of each SOB staff. But there was no unified idea as SOB. Therefore discussion with SOB staff goes round and round and gets nowhere.
Somebody told about substance or content of GIS database and GIS working in IDMS project, but it seems that those ideas were unreasonable from the technical and objective view point. This troubled scene gave suggestion of defective of project scope of IDMS project in SOB staff; the uncertainly or the unpublicized of scope.
In order to breakthrough this troubled situation, at 14th December, one meeting was called. The main agenda of meeting is to confirm following issues about IDMS mapping: Aim of preparing digital topographic map database, definition of content of data, order and dependency among products and procedures.

These outstanding pending problems have been brought to this meeting and confirmed and resolved. According to some conclusion at this meeting, it comes around to discuss about specification of GIS database, Topographic database and Cartographic database.

Preparing operation plan and use of WBS

Generally, in digital compilation process, more engineers are concerned with this process, and this is work to compile different information into as one map. Furthermore in IDMS project, every map sheets are produced as result of newly aerial survey and mapping. Therefore process and required skill of compilation process of IDMS is completely different from SOB's existing digital mapping work which mainly composed of tracing the existing hardcopy topographic map produced by the past cartographer.

In addition, for IDMS project, new software for map compilation and cartography representation is will be introduced and staff of SOB must become proficient in new software.

There are a lot of uncertain things in production of IDMS mapping. SOB must exactly clarify every uncertain matter one by one and establish production procedure of IDMS mapping.

This pointed out is map compilation process of topographic database carried by GIS section and cartographic representation editing of cartographic database by Cartography section.

How do establish work procedure without fail.

In general, when everyone starts a new thing, it is the actual situation that everyone has difficulties for making idea for first step. It is difficult to get effective answer that what should do next with haphazard handling.

Even if you already have background of the thing that you are going to do, it may often happen to accident to overlook some important thing, requirement, result and work.

Afterword, you become aware, and hurry-scurry, and often have the failure that you were not finally in time for.

For accomplishing the project purpose without failure, it is important to investigate and understand that what is your required product and result of your project; and what is your necessary activity for getting or preparing your product and result. These issues should be completely listed without any missing and redundancy. There is effective approach for above mentioned issue, this approach is named as WBS.

WBS is abbreviation of Work Breakdown Structure. WBS is one of tool and technique of project management and system engineering. By well using WBS, you can smoothly and precisely identify the discrete products and results of project and can list up necessary activity for each discrete project result or product without any exception and redundancy.

Furthermore, through the process creating WBS, you can get to know more about outline of project and make visible out line of project. By using WBS, you can precisely share out line of project with all concerned in the project.

Main purpose of creating WBS

Main aim and merit of well using WBS is to make assistance for identifying and defining entire activities of your project with mutually exclusive and collectively exhaustive. By creating WBS, you finally completely identify and make the definition of the items of discrete results and products (deliverables) of project as “Work package” at the lowest level in WBS.
Then you extract items from Work package in WBS and you organize the necessary activities for each Work package as activity list of the entire your project.

Firstly you organized activity list including entire activities correspond to activities extracted from the lowest level of WBS with mutually exclusive and collectively exhaustive. And next you settle detail description, work flow, schedule, cost estimation and process of each activity on activity list. By following this procedure you make possible to establish work plan, work procedure, and instruction and manual with some completeness and exactitude.
After entering executing phase of project, items on activity list are also appropriate to use as base of Earned Value Management (EVM); EVM map on graph following dimension in time series, Planed Value (PV), Earned Value (EV), and Actual Cost (AC).; these dimension is quantity of work and cost for each activity as value in planning and resulting. ; monitoring variances of each indicator, you can measure and evaluate for performance of project.

In your WBS, it to be identified entire deliverable activity of them of project, you may prevent a blunder; overlooked the product or service of project which you have been required, overlooked the something you should have done it. And you can take plenty of time for preparatory measures in advance.

On the other hand, in case that identification of deliverable and task is incompleteness, by WBS or another tools or method; you are going to cope with unexpected things in too lately; and project is to be failing.

Procedure of creating WBS

Call together

Having discussing with multiple participators is better way for completely dredging up and organizing element of WBS: subdivisions deliverables of project and identification necessary activities.
Creating WBS by single person is possible, however creating WBS with multiple person is better;

diversity of idea is effectiveness for preparing WBS without missing deliverables and related works.

In general, content of input information of WBS is following things involved in the project, scope, requirement, policies, and procedures.
Through procedure for creating WBS, if you realize some difficulties understanding project scope, for example, the expected product or service of project is still not definite at this phase, you necessary to suspect incompleteness of the project scope, and as necessary, it is necessary to back to previously project management phase: defining project scope.

Approach

Participants identify the element of WBS: deliverables and related work in the project, with exchanging ideas each other. And make visualize finds from discussion on large format paper, whiteboard, card, or other hard copy materials.
In case if you want to record into PC software and preparing WBS chart on computer simultaneously, you may use video projector.
Each WBS element; project deliverables should be defined as noun phrase.
By using noun phase for project deliverable, you may avoid confusing project deliverables and activities.

Decomposition and arrangement Level-1 elements

Define project objective and arrange it as Level-1elements on chart. In case project scope or scope of parent project has already defined. You should understand and follow the scope of parent project.
If participants of discussion are not able to make consensus or share idea, it is suspect that participates lack of understanding or project scope definition has not completed. That is not usual situation. But in SOB, incomplete project scope and incompleteness understanding project scope by staff is usual situation.

Decomposition and arrangement Level-2 elements

Define final products, services, and results will be provided to customer. If final product, service and result of project have already defined by project scope, you should correctly understand project scope and decompose and arrange Level-2 elements.
In this phase, if some deliverables failed to make consensus with participates are shown on chart, it is suspected that project scope has not completed. As quickly as possible, you should define the project and define the expected products, services and results of your project. For example, SOB staff s has not identified, defined and understood about map, data, and other related information will be produced by them in their project. This comes from incompleteness scope definition.

Finally, these final products in projected.

Decomposition and arrangement less or equal Level-3 elements

Identify cross-sectional work item without missing: identify common items to other deliverables and intermediate products in project,

The thing which cannot be putin WBS tree may be put towards in beside in temporary. There may be a thing promoted to level 2.

If there is the element which should be considered to move another tree section interval, move to under other appropriate tree or branch.

Decompose items until further breakdown until impossible

Decomposing each item in level 2 and 3 into more small logical unit to succeed from upper level with employing 100% rule.

Continue to decompose until appropriate size (a work package) for plan and control considering complexity and cost of each item. Finally work package will be identified by this process.

Preparation WBS dictionary

Prepare WBS dictionary. WBS dictionary define the contents about each WBS element.

On WBS chart, WBS element put as their name by noun. Contents of each element define in WBS dictionary.

If there is difficulty for making of a definition in this procedure, review the element whether proper as deliverables in project.

Work package

Elements appeared in lowest level is called as “work package”. Generally, work package appear in low lank than level 4 or level4. Charges for preparation of each deliverable are assigned by unit in work package. A level lower of work package level is “activity level.”

Note, scope of creating WBS is until decomposition and identification to work package level. Identify activity and preparation of activity list from findings of WBS is next process.

Activity level

Extract and identify activities from work package. Project managing: planning, implementing, monitoring, and checking, everything going by unit of activity.

Activity is describe as name of activity or “doing … .

The list of activities is activity list. If a work plan is written down in the right side of activity list, an activity schedule table is become. If the results are written down, it is activity results table.

Assigning WBS number

For all elements in WBS, assign unique identification number.

Preparation activity list

Prepare “Activity list” from findings of WBS chart. Activity list is not part of WBS chart.

Basic rule for preparing WBS

100 percent rule

Each WBS element of upper level contains every lower elements

WBS element and level ordering

Level 1 element is a program element, project or subprogram

Level 2 elements are the major elements subordinate to the Level 1 major elements

About decompressing and elements and under Level 3

In rule for preparation of WBS, it is difficult to identity that what focus on for decomposition of WBS elements. There are 4 typical analysis patterns of WBS element and decomposition approach.

<table>
<tr><td>Decomposition approach focusing on product</td><td colspan="2">Physical component of products</td></tr>
<tr><td>Decomposition approach focusing on service</td><td colspan="2">Decomposition of work item.
It may difficult to identity final products</td></tr>
<tr><td>Decomposition approach focusing on result</td><td colspan="2">Process oriented project
It may difficult to identity final products</td></tr>
<tr><td rowspan="4">Cross sectional approach</td><td rowspan="4">Work item relating cross sectional with each level WBS element
To be more precise, it will be applied for Project management, planning, design, investigation</td><td>Integrated element
Fabrication</td></tr>
<tr><td>Analytical element
System analysis,
Research</td></tr>
<tr><td>Process
Procedure and progress of work</td></tr>
<tr><td>Project management element</td></tr>
</table>

Project management element	Project management, one of cross sectional elements. It should be arranged in Level2 in any kind of project.

Roaming wave planning

Stepwise refinement

XIII Compilation for Topographic Database

Typical procedure of compilation for topographic database (map compilation) is follow.

- ❑ Inputting and compiling information source from except stereo plotting.
- ❑ Inputting and compiling information from field survey.
- ❑ Inputting and compiling toponym information use for annotation of topographic map.
- ❑ Buildup data structure for data set purpose

  Data structure for digital mapping data for printed topographic map emphasis consciousness of line feature and building up polygon geometry, for cartographic representation.

Inspection items at editing DLM topographic information (Positional file) is in following table.

Timing **and inspection Unit of inspections**	**Inspection Items**	**Inspection methods**	**Prevention measures against error**
Digital Plotting Model *Receive at Compilation* Particular extent	Existence of out range of specification		
Digital Plotting Model *Receive at Compilation* Particular extent	Duplicate acquisition, Geometry on Geometry	Visual or Logical check	
Digital Plotting Model *Receive at Compilation* Particular extent	Validity of Classification	Visual check on display or color inspection map	Regulate by data input interface
Digital Plotting Model *Receive at Compilation* Particular extent	Validity of Classification Code, and Geometry	Visual or Logical check	Regulate by data input interface
Digital Plotting Model *Receive at Compilation* Particular extent	Self crossing error in a feature object	Visual or Logical check	Partly, Regulate by data input interface
Digital Plotting Model Receive at Compilation Particular extent	Closure principle of polygon geometry	Visual or Logical check	Regulate by data input interface

Digital Plotting Model *Receive at Compilation* Particular extent	Continuousness of line, Multipart line	Visual or Logical check	
Digital Plotting Model *Receive at Compilation* Particular extent	Joining between feature and feature （Model boundary）	Visual or Logical check	
Digital Plotting Model *Receive at Compilation* Particular extent	Unnecessary polygon boundary （at Model boundary）	Visual or Logical check	
Digital Plotting Model Receive at Compilation Particular extent	Validity of Direction of feature object (Spatial object)	Visual or Logical check	

XIV Compilation for cartographic database

Cartography Representation Editing

(Editorial process of preparing fair drawing data of printed map.)

Data preparing Cartographic Representation Data

Map Representation（Cartographic Representation）

Cartographic representations in IDMS mapping is provided take advantage of database function. Refer to classification information of feature on database and drive rendering rule associated with feature classification and render portrayal of cartographic symbol and representation.

Main procedure of cartographic representation

- ❑ Establish the cartography specification (Map symbol and application rule)
- ❑ Designing of classification and rendering rule
- ❑ Prepare classification information (Thematic and quality base)
- ❑ Assign global rendering rule to classification
- ❑ In case of detect some less than perfect things and place in representation by global rule, improve global rule or apply override rule to get perfect representation.

Following is sorting out of cartographic representation, conventional concept and technique and related functions, manipulations, and of software program.

Validity of this sorting out is susceptible. It may other person has other idea.

Reduction		
Symbolization (assign map symbol to features)		
Generalization	Selection (with Omission)	
	Modification of figures (Simplification)	Simplification, Combination, Smoothing
Empathizing	(Smoothing) Displacement Disconnection Symbolize (assign color, line type)	

◦

The priority of processing in map compilation

Generally, by convention of cartography, compilation process to be done with priority by indented theme or group of geographic features, the general priority is following.

- ❑ Organize and edit for geodetic control points.
- ❑ Organize and edit for Frame work features, ("Frame work feature" terms to River, Shoreline, Road, and Railway features)
- ❑ Organize and edit for a building and point symbols features
- ❑ Organize and edit for Topography
- ❑ Organize and edit for Administration boundary
- ❑ Organize and edit for Vegetation boundary and vegetation symbol

XV Quality elements of Geographic information (Digital topographic map and GIS data)

Quality elements of Geographic information (Digital topographic map and GIS data)ISO19113 Geographic information Quality principles shows idea for quality of geographic information

Quality

- Totality of characteristics of a product that bear on its ability to satisfy stated in product specification and implied needs.

Product specification

- Description of the universe of discourse and a specification for mapping the universe of discourse to a dataset

Universe of discourse

- View of the real or hypothetical world that includes everything of interest

Quantitative quality information and non-quantitative quality information

Quantitative quality information

Data quality elements	completeness	presence and absence of features, their attributes and relationships
	logical consistency	degree of adherence to logical rules of data structure, attribution and relationships (data structure can be conceptual, logical or physical)
	positional accuracy	accuracy of the position of features
	temporal accuracy	accuracy of the temporal attributes and temporal relationships of features
	thematic accuracy	accuracy of quantitative attributes and the correctness of non-quantitative attributes and of the classifications of features and their relationships

Non-quantitative quality information

Data quality overview element

- Purpose
- Purpose shall describe the rationale for creating a dataset and contain information about its intended use.
- Lineage

  Lineage shall describe the history of a dataset and, in as much as is known, recount the life cycle of a dataset from collection and acquisition through compilation and derivation to its current form.

- Usage

Usage shall describe the application(s) for which a dataset has been used. Usage describes uses of the dataset by the data producer or by other, distinct, data users.