MANAGEMENT OF INTERMITTENT WATER DISTRIBUTION SYSTEMS USING GIS

CASE STUDY: HALHULL WATER DISTRIBUTION NETWORK

BY

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COLLEGE OF ENGINEERING AND TECHNOLOGY

PALESTINE POLYTECHNIC UNIVERSITY

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF

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IN

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SUPERVISED BY:

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CERTIFICATION

Palestine Polytechnic University

PPU

Hebron-Palestine

The Senior Project Entitled

Management of Intermittent Water Distribution Systems Using GIS Case Study: Halhull Water Distribution Network

Prepared By

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In accordance with the recommendations of the project supervisors, and the acceptance of all examining committee members, this project has been submitted to the Department of Civil and Architectural Engineering in the College of Engineering and Technology in partial fulfillment of requirements of Department for the degree of bachelor of Science Engineering.

Project Supervisors **Department Chairman**

…………………….. …………………………

إلى من تجسدت السعادة في أحضانهم وارتسمت الفرحة في عيونهم .. ينبوع الحياة الدافئ .. الحياة وبدئها

من □نوا من □ا أن أكون ... فكنت

... أبي وأمي الغاليين

إلى الأحبة و السند من سكنوا مكان الروح من الجسد .. **باقات الأمل**

... إخوتي و أخواتي وأولادهم

إلى القنديل المضيء والشمعة المحترقة .. **من أضاء** لنا طريق **العلم و ا□عرفة** .. مشرفنا الغالي

... د.ماجد أبو شرخ

إلى الأخ والصديق .. من كان لنا العون والسند في مسيرتنا الجامعية .. **الأستاذ الفاضل**

... د . أمجد برهم

إلى الجميلة والجريحة فلسطين .. و إلى من ضحوا من أجلك يا سيدة **الأوطان**

... الشهداء وا□رحى والأسرى

إلى أحبائنا الذين تتوق أنفسهم للتفوق والنجاح ... **كل الراغب□ بالاستزادة وا□عرفة والعلم**

إلى كل هؤلاء نهدي هذا الجهد المتواضع

فريق العمل ... ولدعلي إبراهيم ... أبو الرب محمد

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PROJECT TEAM

ABSTRACT

Management of Intermittent Water Distribution Systems Using GIS

Case Study: Halhull Water Distribution Network

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The overall shortage in water availability in most developing countries -like Palestine- necessitates intermittent supply at a low per capita supply rate. In particular they often lead to inequitable distribution of available water resources. Since these systems are water starved, consumers collect as much water as possible, quantity collected being directly related to pressure at outlets. And since pressures vary greatly in the network, quantity of water supplied is inequitable.

In addition to inequities, low pressures arise because systems are designed based on low per capita allocation and with the assumption that demand is over a 24 hours at about 2.5 times average flow rate. In reality water is drawn in a shorter duration. This implies that the system suddenly becomes undersized because flows in pipes is much greater than anticipated resulting in severe pressure losses. Hence, there is generally a low-pressure regime in the network (Anand, S. and Vairavamoorthy, K. 2005).

In intermittent water networks the quantity of water collected by consumers will be dependent on the driving pressure heads at the outlets and hence the relationship between the pressures in the system and the demands are important, and it cannot be assumed that demand will be met under all conditions. Therefore, the application of standard methods of network analysis to intermittent flow conditions is inappropriate and hence the need for proper management and modified design for intermittent water distribution systems (Anand, S. and Vairavamoorthy, K. 2005).

Proper techniques for asset management is a huge problem faced by engineers in Palestine and GIS holds the key in helping them do this. Also by the use of web based maps of the network, the engineers in the different field offices can by cost-effective means be able to access network information. Once all the network information is stored in a GIS it makes the use of querying possible with easy and helps the planners in better understanding of the system and is able to act in a effective manner to any contingencies that may arise. Use of GIS data through Web based interfaces offers staff and engineers manage the assets in a cost-effective manner. GIS can be used as an integrated tool in processing of spatial data for the overall design and asset management of intermittent water distribution systems. (Halfawy, M. R. and Hunaidi, O. 2008).

The objective of this research work is to highlight how the use of GIS will help for in both design and asset management of water intermittent water distribution systems. The reason the work concentrating on intermittent systems is that these systems are widespread in developing countries like Palestine. The project will take Halhull city in the Hebron Governorate as case study.

Conventionally data on water networks will be collected and stored in paper format in GIS. The main data that will be stored will be pipe and node locations and characteristics, reservoir details, valve details, pumps, etc. The GIS contains a standard database structure to hold all the data that is regularly used for water distribution systems. Generating the mapping of distribution system for various criteria using GIS makes everyday querying based on specific criteria quick, easy and understandable for engineers. With maps and data in the system it is easy to query about all the parts of the water networks and make proper management for intermittent water distribution systems (Anand, S. and Vairavamoorthy, K. 2005).

The work in its end will help the Palestinian water engineers in proper management of the physical assets of water distribution networks. In case of a water systems physical assets includes the network components such as pipelines, storage reservoirs, pumps, valves etc. The key advantages of asset management is that it enhances the knowledge of the engineers of the various assets and their details, helps in logical decision making process, it acts as a framework that provides a measure of the network performance and links it to both short and long term planning thereby helping in optimal improvement of assets at least cost.

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1 *INTRODUCTION*

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CHAPTER ONE
INTRODUCTION

1.1 Background

Intermittent water distribution systems are water networks that operate at intervals i.e. not continuous. It is a fact that the majorities of water supply systems in developing countries like Palestine are water starved and operate intermittently but the need to rethink the design procedure and management has received very little attention (Anand, et al., 2005).

normally, the design of water distribution systems has been based on the assumption of continuous supply. In most of the areas of Palestine water supply is not continuous but intermittent, and this could have been foreseen at the design stage. By trying to fit in a system that was designed to operate as a continuous one to operate intermittently results in severe supply problems in the network and great inequities in the distribution of water.

Geographical Information System (GIS) have been proposed as a means of making information about the system used to provide urban services more accessible and useful. Urban services that appear to be particularly suitable for GIS include the networks for distribution of water, natural gas and electricity as well as collection of sewage (Borrough, 1986; Taylor, 1991; Jacobs et al.; Douglas, 1995; Brebbia and Pascolo, 1998).

In the present study, a geographical information system has to be developed for water supply system management in the Palestinian areas, taking Halhull city as case study for this project. The aim of the proposed water supply system management is to facilitate the water works management by helping maintains the records of leaks and repairs, provide information about all the parts of water network such as pipes, valves, etc. and assist in more regular and advanced decisions for the development and operation of water networks.

The water supply management that has to be developed can be used an on-line information system of the operation and maintenance of the water distribution network. The main Advantage of the system is that the detailed records of water distribution can be maintained and updated easily. Search for specific query is also possible. For example, query about the pipes, valves, storage tanks, etc. The managerial staff can access and use the system without having to learn about the intricacies of GIS software (Dikshit, A. K. (2002).

1.2 Problem Statement

The West Bank and Gaza suffer from a chronic water shortage, preventing sustained economic growth and damaging the environment and health of Palestinians. The shortage of water exists for two primary reasons. One, the Israeli water company (Mekorot's) policy in the West Bank that limited the quantity of water pumped to the Palestinian communities from underground aquifers. The other reason is the rapid growth of the population, inadequate water distribution networks, high drinking water losses and increased agricultural and landscaping activities.

Palestinians have a very low water consumption rate. The average household and urban water consumption is 60 liters a day per person. The World Health Organization recommends 100 liters a day per person for household and urban use. Hundreds of rural villages across the West Bank have no piped water; where residents typically use less than 30 liters per capita per day because of the high costs of water delivered by truck. Fewer and fewer families can afford basic water supplies.

A relevant percentage of population in the West Bank is not connected to municipal networks and relies on water trucking and rain harvesting cisterns to cover its water needs. At the same time, the existing water distribution systems are not covering all the areas and some of the networks and water other infrastructures, like reservoirs and pumping station, have been damaged. The water losses from these networks are more than 50% due to leakage and illegal connection.

In light of the severe water shortage, many municipalities and local councils have had to divide their communities into areas and ration out water on an alternating basis. Water hours and low delivery pressure have long been a part of the daily lives of the people in the West Bank. The problems with delivery of adequate supplies of water to the customers at appropriate pressure have become more and more of a challenge to municipalities throughout the cities, towns, and villages of the Hebron Governorate in the West Bank.
According to the previous problem description and their negative impact on Palestinian life in the Hebron District, there is a need to find solutions that enable solving such problems that the

city, towns and villages suffer from, especially in water networks and water distribution among the people. The problems related to water networks and intermittent systems will be minimized through the development of a data base for water distribution network management using GIS.

Asset management is the systematic process of maintaining, upgrading and operating physical assets (Anand, et al., 2005). In case of water distribution systems, physical assets include the network components such as pipelines, storage reservoirs, pumps, valves etc. The key advantage of asset management is that it enhances the knowledge of the engineers of the various assets and their details, helps in logical decision making process, it acts as a framework that provides a measure of the network performance and links it to both short and long term planning thereby helping in optimal improvement of assets at least cost.

Proper record keeping of the network components is a big task and GIS offers the tools to successfully implement that. Engineers require information on various aspects of the network for administrational as well as maintenance needs. The effective management of a utility requires up-to-date information on the physical resources available to the utility manger and how these resources work together to provide the customer with the utility mandated service. Modern and effective water utility management requires the use of Geographic Information Systems and computerized hydraulic models of the distribution system to accomplish these management goals, and this is the interest of this project.

1.3 Main Goal and Objectives

The main goal of this project is to look into ways in which GIS can be used as an effective tool to help the engineers in the design and asset management of intermittent water distribution systems. The reason the project concentrating on intermittent systems is that these systems are widespread in developing countries as in Palestine.

This project aims at accomplishing the following objectives:

1. GIS can be used as an integrated tool in processing of spatial data for the overall design and asset management of intermittent water distribution systems. This project highlight how through the use of GIS will help for in both design and asset management of water distribution systems.

2. Develop a GIS model for water supply systems management in the Palestinian urban areas in a user-friendly environment, and assist in more regular and advanced decisions for the development and operation of water networks.

3. Gather data on the complete physical and hydraulic description of the Halhull city water distribution system and develop a digital description of the system using the collected data and information, and then develop a model and translate this model into an ArcGIS database of system components.

4. Increase the quantity of potable water supply to the Palestinian people in the project area through good management to the existing water distribution network.

1.4 Methodology

This proposed project was divided into five phases.

Phase 1: Review of literature: During this phase, all the information and previous studies related to this subject were collected and reviewed.

Phase 2: Gather complete physical description and data of the project area water distribution system: For this phase all the information that describes the Halhull city water system such as system maps, as built drawings, network components and system operation will be collected. Differential Global Positioning System (GPS) techniques will be used to gather location information on system components not included on as-built drawings.

Phase 3: Data Storage and Mapping: Data on network components can be stored in GIS for spatial querying. The main data that will be stored will be pipelines characteristics, storage reservoirs, pumps, valve etc. Upon the completion of the data-gathering and storage a series of digital maps describing water system will be developed. The generating maps of the distribution system for various criteria using GIS makes everyday querying based on specific criteria quick, easy and understandable for engineers.

Phase 4: Development of GIS based Utility Management System: The maps and database files will be presented to municipality for verification by the engineering and operations divisions. Corrections will made to any inconsistencies found in the review, then the GIS based utility management model will be finalized. The database consisted of the following items:

A) Physical and location description of the pumps, pipes, valves and miscellaneous fittings in the system were gathered. Element attributes recorded include size, pipe length and diameter, materials, and connectivity to other components of the system. Such parameters as date of installation and condition of the component will be added wherever available.
B) A complete physical and location description on all sources of water was gathered. For sources such as wells, all information about the components of the pumping and disinfections systems and their location with respect to the distribution system will be added to the digital database.

Phase 5: Writing the Report: Upon the completion of the work, one final report was written and submitted to the Department of Civil and Architectural Engineering.

1.5 Structure of the Report

The project report has been prepared in accordance with the objectives and scope of work. The report consists of six chapters.

The title of ***Chapter One "Introduction"*** outlines the background, problem statement, project main goal and objectives, Methodology and structure of the report.

Chapter Two entitled ***"Basic Data of Halhull City"*** describes the project area, geography, climate, land use and road network, and water supplies

Chapter three entitled ***"Gis And Water Network"*** presents the Building a Geodatabase, Creating new items in a geodatabase, Subtypes and attribute domains, Subtypes and attribute domains, defining relationship classes, geometric network, network connectivity, and case study: Halhull water distribution network.

Chapter four entitled ***" Analyzing Geometric Networks "*** presents the Introduction, Geometric networks, Opening a geometric network, Symbolizing network features, Adding network features, Enabling and disabling features, Adding the Utility Network Analyst toolbar, Exploring the Utility Network Analyst toolbar, Flow direction, Displaying flow direction ,Setting flow direction.

Chapter five entitled **"** *Management Of Water Network* **"** presents the Tracing on networks, Tracing operations, Tracing And Management Using Visual Basic.

The overall ***"Conclusions"*** are given in ***Chapter Six***.

CHAPTER

2 *BASIC DATA OF HALHULL CITY*

THIS CHAPTER CONTANT

CHAPTER TWO

BASIC DATA OF HALHOUL CITY

2.1 Introduction

The city of Halhull is part of Hebron District in the south of the West Bank. The Hebron district is characterized by great variation in its topography and altitude where highest elevation (1020 m above sea level) is found in Halhull area. In this chapter, basic data of Halhull city will be briefly narrated. The topography and climate will be described. The water supply and waste water facility will be briefly presented.

2.2 Geography

Halhull is located about 4 km north of the Hebron city and about 30 km south of Jerusalem, as shown on the project location plan, Figure (2.1). Halhull lies in the Hebron district elevated at about 1011 m above mean sea level to the north Hebron mountains and near the water divide line between the western and eastern edges of the mountains. The aerial map of Halhull city is illustrated in Figure (2.2). The total area of the city is about 39000 dounm. Homes and businesses are served by small streets, alleys and dirt paths. The population within the municipal boundary has been determined by the Palestinians Bureau of Statistics. The present total population of the city is estimated at 21078 people.

2.3 Climateological Data

The climatelogical data presented in the following paragraphs were obtained from a survey carried out by Meteorological station which is located at the elevation of +1020 m in the Hebron city. These data are pertinent to the Hebron district which includes the study area.

2.3.1 Temperature

The monthly average temperature in the Hebron district ranges from 7.5˚C to 10˚C in the winter to 22˚C in the summer. The minimum temperature is -3˚C in January, while the maximum temperature is 40 ˚C in August. The ground temperature range from -5˚C in winter to 42 ˚C in the summer.

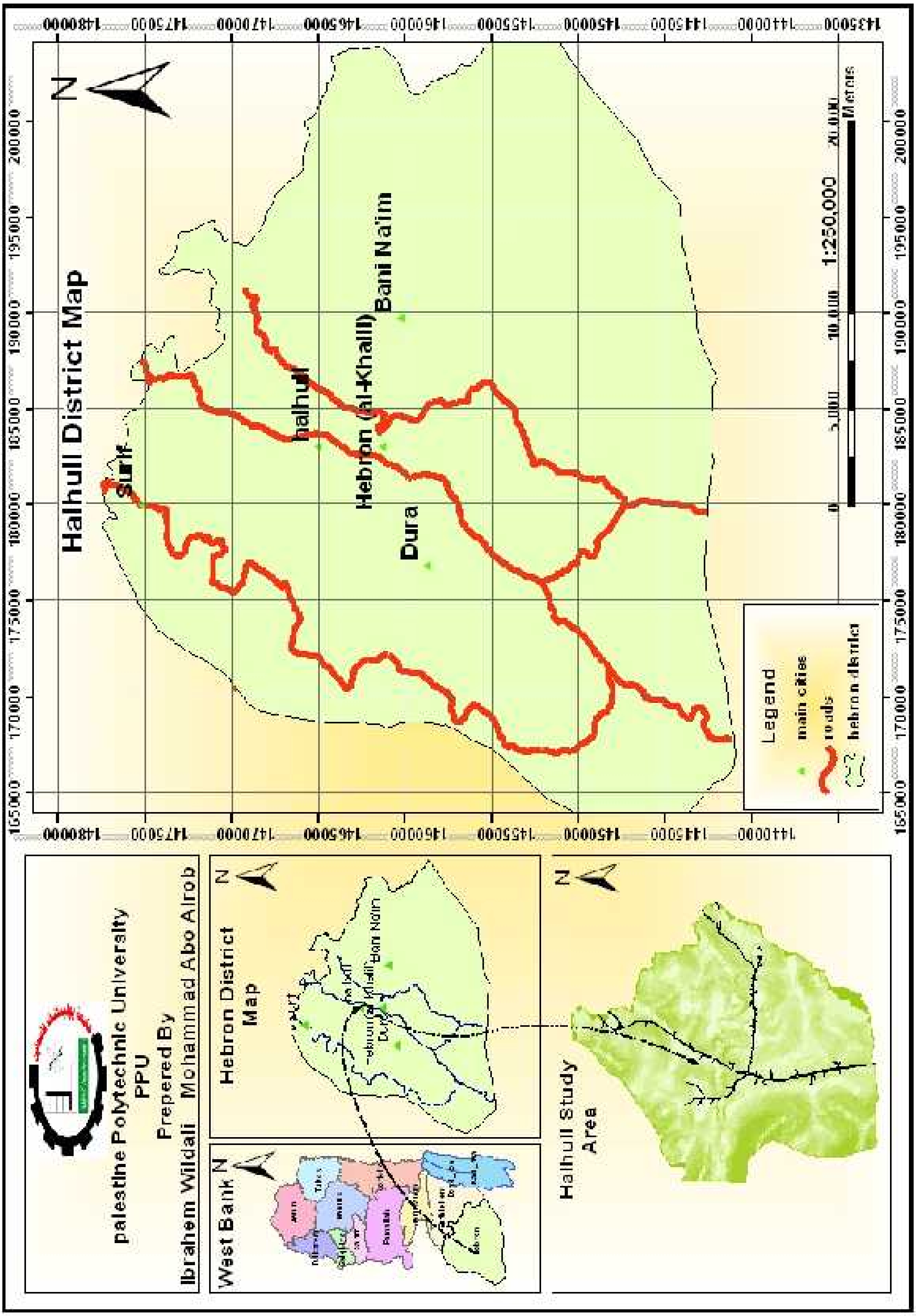


Figure (2.1). Halhull lies in the Hebron district

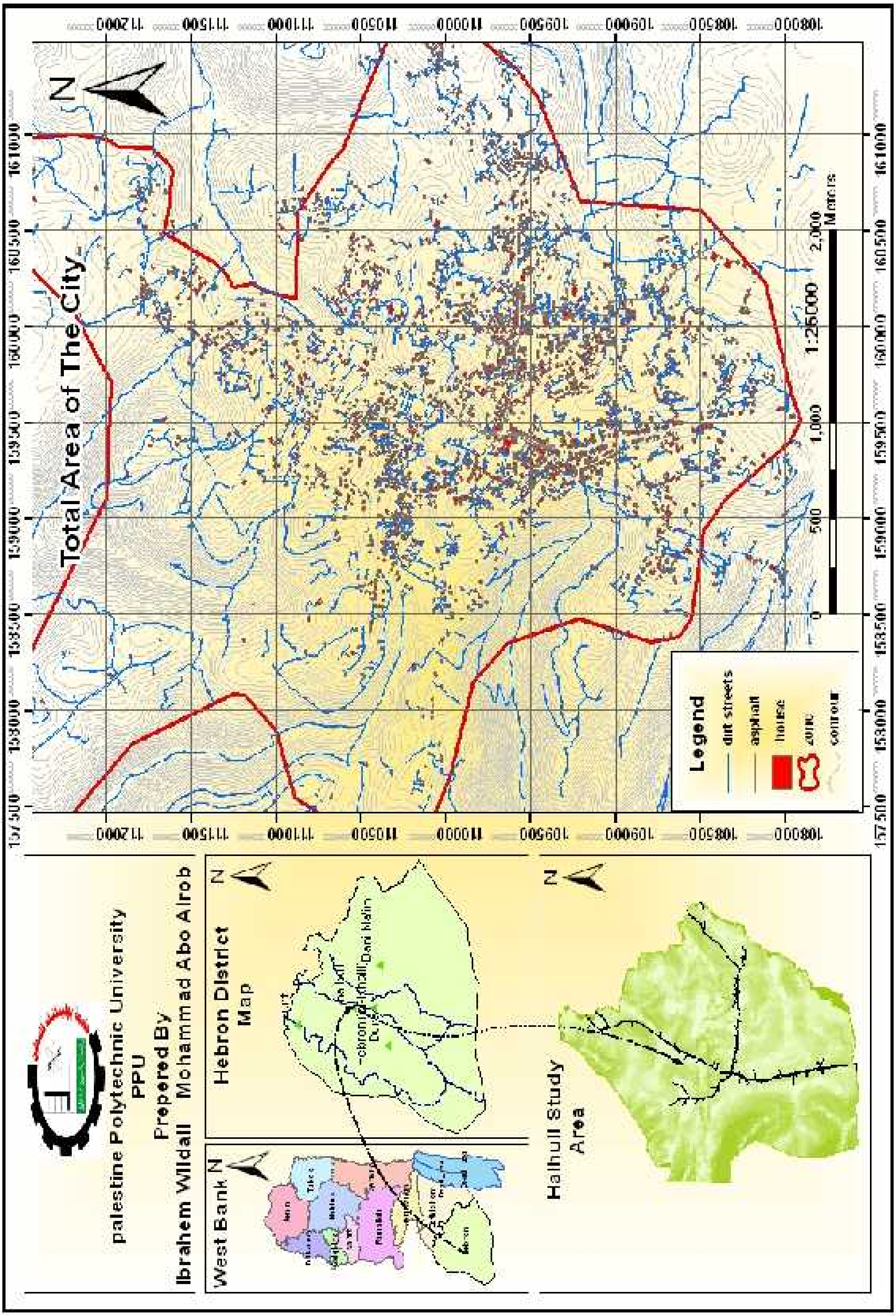


Figure (2.2). The total area of the city is about 39000 dounm

2.3.2 Winds

Western winds prevail in the Hebron district; although, southwesterly winds occur in winter and northwesterly winds occur in summer. During autumn and spring seasons, these western winds from the Mediterranean Sea are humid. Average wind velocities in summer are approximately 10Km/hr during the day, decreasing to 5 km/hr during the night and early morning hours. In winter, velocities reach 35 km/hr. From late April to mid-June, the Hebron district is hit by storms originating from the Arabian Desert. These storms known as Khamaseen bring very hot dry air full of sand and dust.

2.3.3 Evaporation and Humidity

The average annual evaporation in the Hebron district region for the period of 1970-1992 was about 1606.1 mm/year. The mean range of annual relative humidity varies from 60% to 75%, with humidity highest at night and lowest in mid-day. Mean daily evaporation varies from 2 mm/day in December to 8.5 mm/day in August. The average monthly evaporation of Al-Aroub weather station is 230 mm/month in the summer and 80 mm/month in the winter. It should be noted that there are only three months in the year where rainfall exceeds evaporation.

2.3.4 Precipitation

The mean annual rainfall recorded at the Hebron meteorological station for the 1970-1992 period was 601.82 mm/year. The mean annual rainfall in the Hebron district varies from year to year, while the rainfall reaches 1027 mm/year in the wet years; it drops to 200 mm/year during the dry years. The amount of rainfall decreases from 638 mm/year at Al-Aroub in the north to 383 mm/year at A1-Dhahriya in the south, and 200 mm/year at the eastern boundaries of the Hebron district.

The meteorological data recorded at the Hebron weather station are presented Table (2.1)

Table (2.1) : Meteorological Conditions at the Hebron Weather Station for 1992-2007 (Halhull Municipality, 1992-2007).

Month	Rain fall (mm)	Max. Temp (°C)	Min. Temp (°C)	R.H %	Wind km/day	Evaporation mm/month
Jan.	145.15	10.25	3.96	74.19	298.2	65.1
Feb.	131.31	11.50	4.70	72.22	306.7	81.2
March	89.60	14.57	6.46	65.96	303.5	93.0
April	36.98	19.59	9.93	54.62	275.7	138.6
May	4.12	23.63	13.23	48.25	223.5	165.8
June	0.46	25.90	15.77	51.03	221.9	199.5
July	0.00	27.16	17.04	56.77	220.3	220.7
August	0.00	27.23	16.96	59.88	208.8	225.0
Sept.	1.51	25.97	15.94	61.66	194.1	156.6
Oct.	13.59	23.18	14.02	58.89	193.5	111.6
Nov.	63.00	17.50	9.90	64.07	210.1	87.0
Dec.	116.10	12.09	5.62	72.69	242.3	62.0
Total	**601.82**	-	-	-	-	-

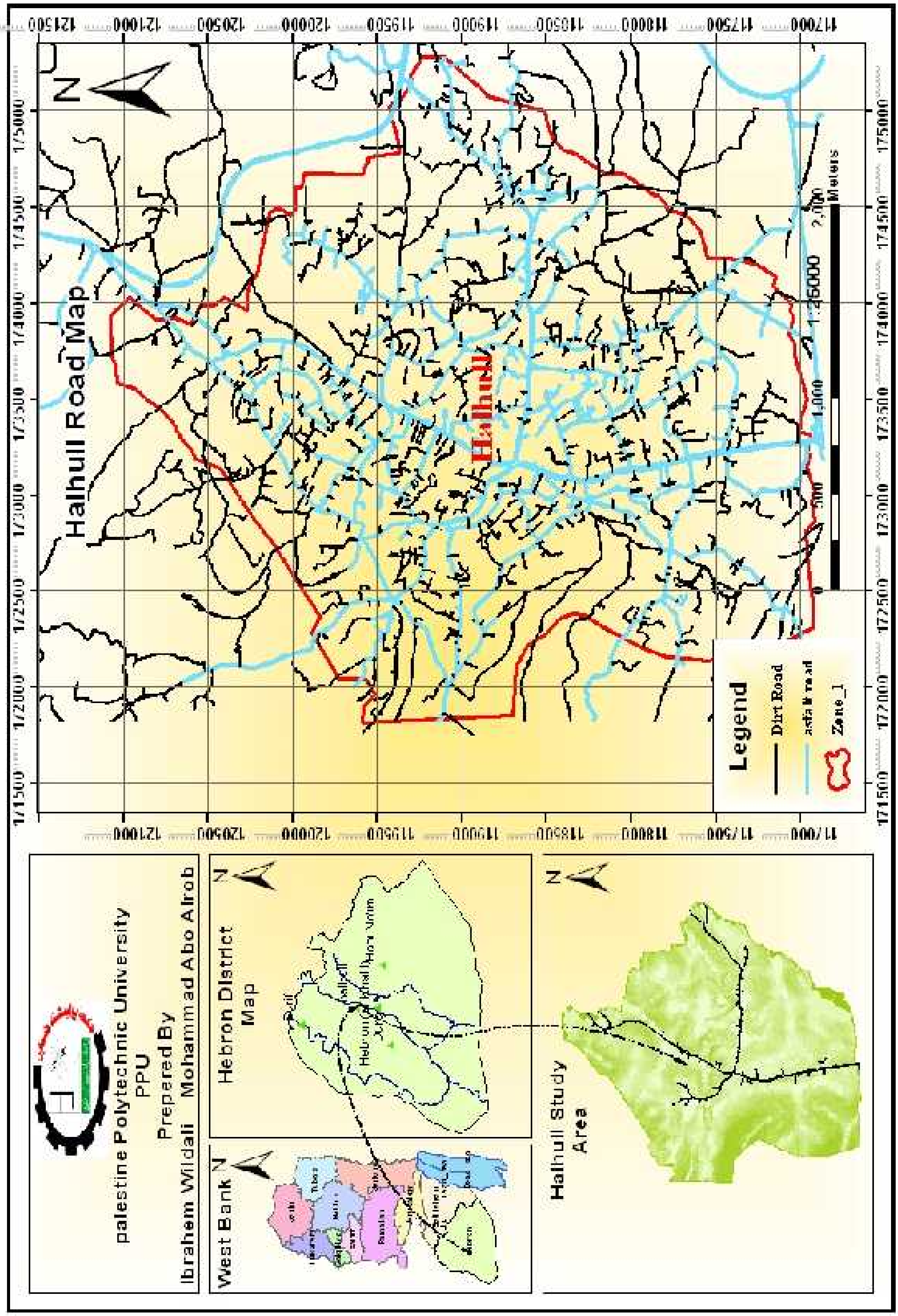
2.4 Land Use and Road Network

2.4.1 Land Use

The land area of Halhull is approximately 39,000 dounm, where 9,000 donums are residential area and the remaining are agricultural lands. There is no clear city plan defining land use in the various zones of Halhull. However, the present residential zone will maintain the same character in the future. With the development of the city, the agricultural areas within the municipal boundaries will gradually be built up.

2.4.2 Roads

The plan of the existing and planned roads in Halhull city has been obtained from Halhull municipality (see Fig. 2.3). The main road which traverses the city from south to north is called the main Road. It connects the Hebron city with Jerusalem and it divide the city into two parts the eastern part and the Western part.



Figure(2.3). The main road which traverses the city

2.5 Water Supplies

The city of Halhull receives its water supply from Herodion wells near Bethlehem, which abstract from the eastern aquifer. Water from Herodion source is conveyed to the municipal boundary by 12" pipeline via Dir shaar pumping station near kfar Etzion. The pipelines owned and operated by Palestinian Water Authority and Israeli water Company, Makorot. These pipelines also supply other Palestinian communities.

The water in the city is distributed by a network of steel pipe lines and one main reservoirs of 500 cubic meter capacity located in Al-Nabi Younas area. The network is branch one and the diameters of the pipelines range from 2" to 10". Presently ninety percent of the residents of Halhull city are connected to water distribution network.

There are many problems with water quality and continuity of supply. The water supply to Halhull fall short of the requirements especially in summer due to limited quantities of water supplied to the city by the Israeli Company Makorot. During summer, the people suffer from water shortages. Plans to rehabilitate the water supply network and to increase supply rates are being prepared by municipality.

2.6 Wastewater Facilities

There are no public wastewater treatment facilities serving the municipality of Halhull. Wastewater from individual residences (homes) is discharged directly into subsurface pits, which allow the water to percolate directly into the surrounding soil and bedrock. The highly permeable soil and bedrock allows untreated wastewater to percolate directly into the underlying aquifer. In many areas, these subsurface see page pits require frequent cleaning and replacement at a considerable expense. The municipality are planning to build sewer network and treatment facility.

CHAPTER

3 *GIS AND WATER NETWORK*

THIS CHAPTER CONTANT

CHAPTER THREE

GIS AND WATER NETWORK

3.1 General

The study of the water network begins in describing the scientific principles governing water network, phenomena, studying network analysis system operating and predicts it's output, and applying the knowledge into water distribution system and environmental engineering projects.

As mentioned earlier, Geographical Information System (GIS) has lead to significant increase in it is use in water network analysis. This chapter explains how to manage the water distribution systems using GIS.

3.2 Building a Geodatabase

The geodatabase supports a model of topologically integrated feature classes, similar to the coverage model. It also extends the coverage model with support for complex networks, topologies, relationships among feature classes, and other object-oriented features. The ESRI ArcGIS applications (ArcMap TM, ArcCatalog TM, and ArcToolbox TM) work with geodatabases as well as with coverages and shapefiles.

The geodatabase provides a generic framework for geographic information. This framework can be used to define and work with a wide variety of different user- or application-specific models. The geodatabase supports object-oriented vector and raster data. In this model, entities are represented as objects with properties, behavior, and relationships. Support for a variety of different geographic object types is built into the system. These object types include simple objects, geographic features, network features, annotation features, and other more specialized feature types. The model allows to define relationships between objects and rules for maintaining referential and topological integrity between objects.

3.2.1 Creating a geodatabase from an existing design

There may be a data model that already exists that may partly or wholly suit your needs. Adopting an existing design can give a quick head start in creating a geodatabase.

3.2.1.1 Data models distributed by ESRI

ESRI and a number of leaders in their disciplines have been actively designing a series of GIS data models using topology and other capabilities in ArcGIS. The goal is to provide a common design framework for key layers of geographic information, and promote openness and interoperability of GIS data. These efforts
have resulted in a series of comprehensive design specifications for a number of thematic layers:
• Census and Administrative Boundaries (applied to U.S.Census geography)
• Hydrography
• Raster imagery and elevation catalogs
• Streets and comprehensive address information
• Transportation (to support linear referencing, navigation,
addressing, and cartography)
• Public Land Survey System (PLSS) (to support a national
database of the legal survey fabric)
• Water facilities
• And numerous other efforts

These data models provide a practical template for implementing a geodatabase. While the industry-specific model to be a great starting point for geodatabase, may also find related models useful. For the latest information on the data

3.2.1.2 Data models from other locations

we may know an ArcGIS user in a similar industry who has successfully implemented a geodatabase. ArcMap and ArcCatalog provide tools that allow to copy the schema from an existing geodatabase. Once copied, the schema can be sent to someone else and adopted as a starting point for a geodatabase design. The tools that allow to copy a schema are discussed later in this chapter.

3.2.1.3 Loading data

Once have obtained a model and customized the schema to suit needs, the next step is to load data into it. can do this by editing the database in ArcMap to create new objects or loading objects from existing shapefiles, coverages, raster datasets, computer-aided design (CAD) feature classes, raster

catalogs, infotm tables, dBASE tables, ArcStorm TM, or Map librarian. Data creation and maintenance may involve managing version and
topology information. ArcCatalog and ArcMap have wizards to help with this Simple Data Loader and Object Loader that will be discussed in the chapter ‘Importing data.

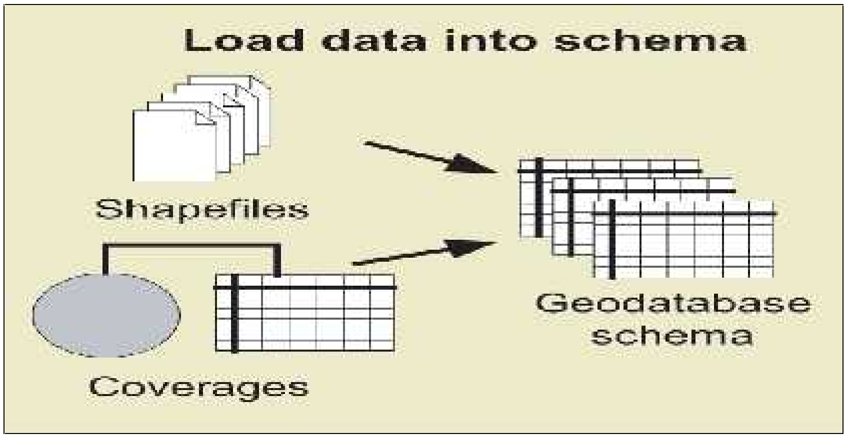


Figure (3.1)Loading data

3.2.2 Creating a geodatabase from scratch

to create all or a part of geodatabase from scratch, the first step is to design what we want to create. When designing a geodatabase should consider such questions as:

• what kind of data will be stored in the database?

• in what projection do want data stored?

• do want to establish rules about how the data can be modified?

• do want to organize object classes such as tables, feature classes, and subtypes of feature classes?

• do want to maintain relationships between objects of different types?

• will database contain geometric networks?

• will database contain topologically related features?

• will database store custom objects?

use the data modeling guidelines in modeling our world once have completed design, the next step is to employ any of three methods to implement it. the method choose depends on the source of data and whether will store custom objects. in practice, we will often use a combination of some or all of the methods outlined here. subsequent chapters show how to perform each task. if geodatabase contains raster data.

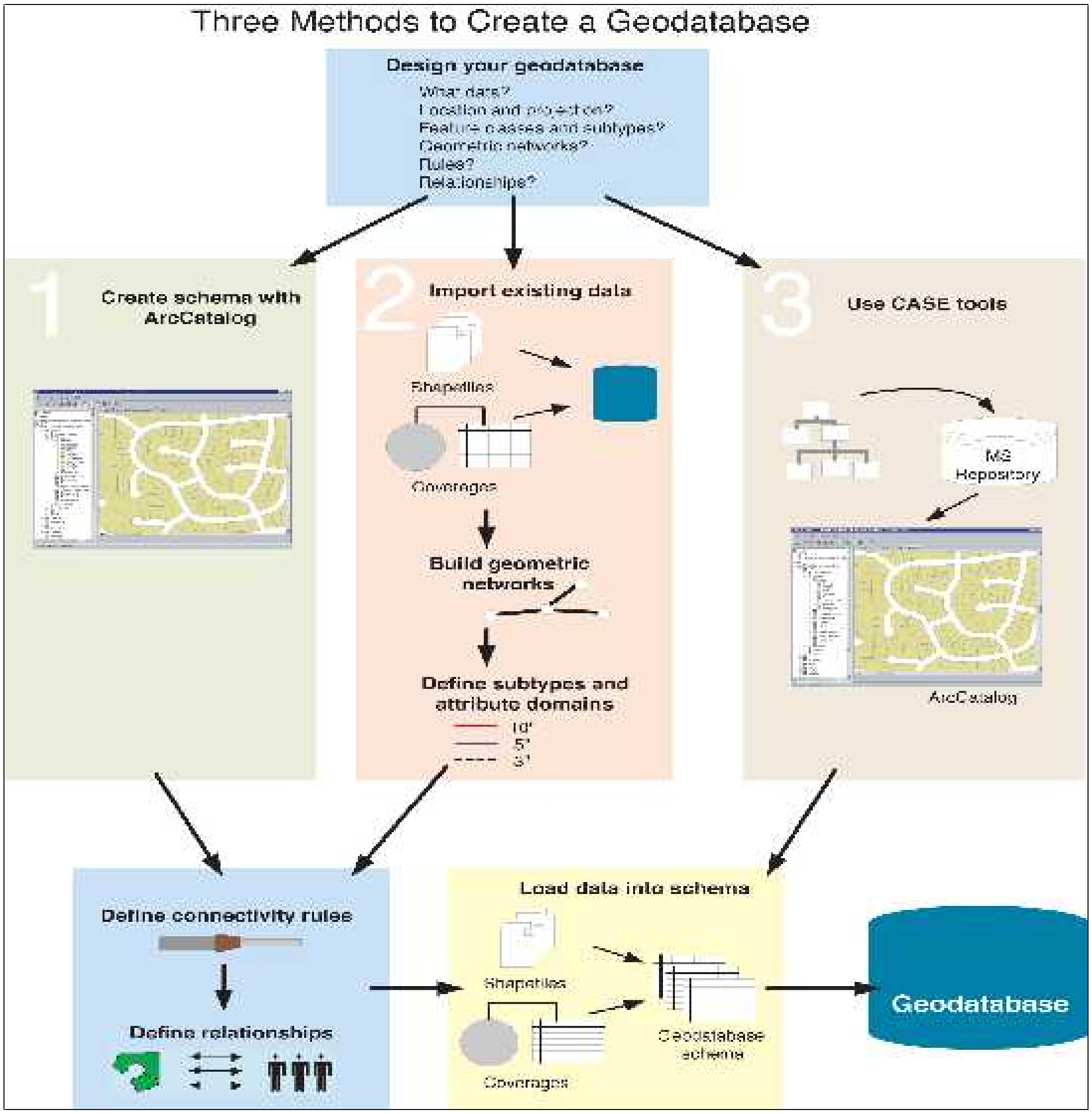


Figure (3.2)Creating a geodatabase from scratch

3.2.3 Creating schema with Arc Catalog

in some cases, we may not yet have any data that we want to load into a geodatabase, or the data we have to load only accounts for part of database design. in this case, can use the tools provided in arccatalog to create the schema for feature datasets, feature classes, tables, geometric networks, topologies, and other items inside the database. arccatalog provides a complete set of tools for designing and managing items will store in the geodatabase.

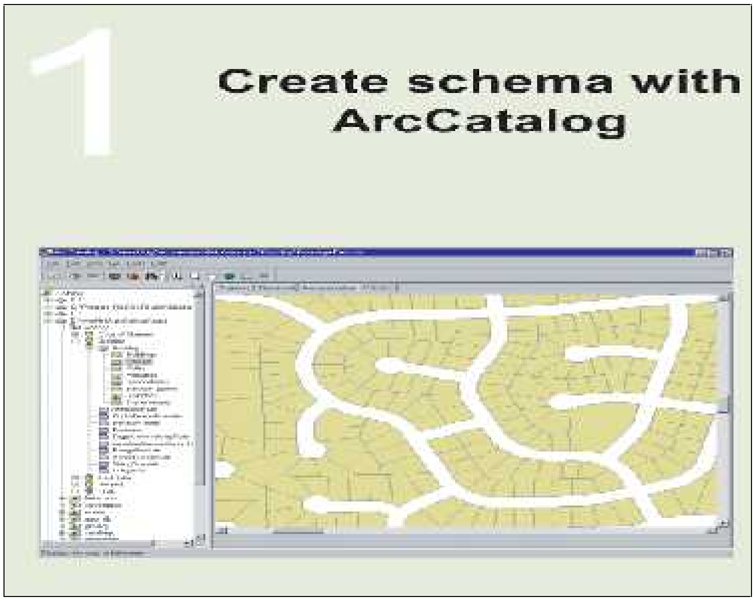


Figure (3.3)Creating schema with Arc Catalog

3.2.3.1 Importing data

it is likely that already have data in various formats shapefiles, coverages, info tables, raster datasets, raster catalogs, and dbase tables that want to store in a geodatabase. may also have your data stored in other multiuser geographic information system data formats such as arcstorm, map librarian, and arcsde. through arccatalog, can convert data stored in one of these formats to a geodatabase by importing it.

when converting data from one of these formats into the geodatabase, both the spatial and nonspatial component of each object is translated. for example, when converting a shapefile to a feature class, both the shapes (geometry) and attributes are stored in the geodatabase. attributes can be left out or renamed. shapefiles of the same spatial extent can be imported into the
same feature dataset. all or some of the feature classes from a coverage can be imported into a feature dataset. topology rules can be created to regulate the spatial relationships between the features and feature classes stored in geodatabase feature datasets.

converting arcstorm and map librarian data is done using tools that are similar to those used for importing coverages. however, must use arcsde for coverages before arccatalog or arctoolbox can access and display arcstorm and map librarian data. if you already have data in a spatial database enginetm (sde) 3.x database, do not need to reload data.

arccatalog contains tools that allow to register the existing data with the geodatabase. once registered, can also use

ArcCatalog to reorganize that data into feature datasets. ArcGIS and geodatabases do not support multiple feature types in a single feature class (for example, points and lines in the same feature class). If any of SDE 3.x layers contain multipleentity types, those must be reorganized into single feature type layers before can view them in ArcInfo or register them with the geodatabase.

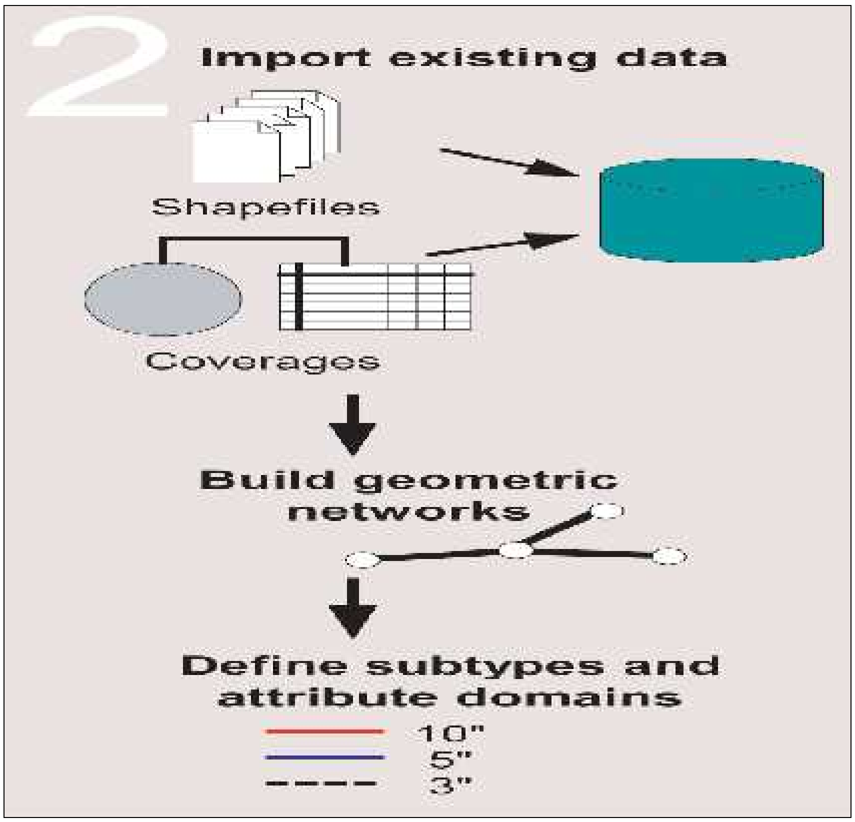


Figure (3.4)Importing data

3.2.3.2 Building geodatabases with CASE tools

Unified Modeling Language is a graphical language used to develop software systems and database design. With UML class diagrams can design items in a geodatabase schema, such as feature datasets, feature classes, tables, geometric networks, and relationships. Once the UML diagram is complete,can use theComputer-Aided Software Engineering tools subsystem in ArcCatalog to generate a new geodatabase schema from the diagram.

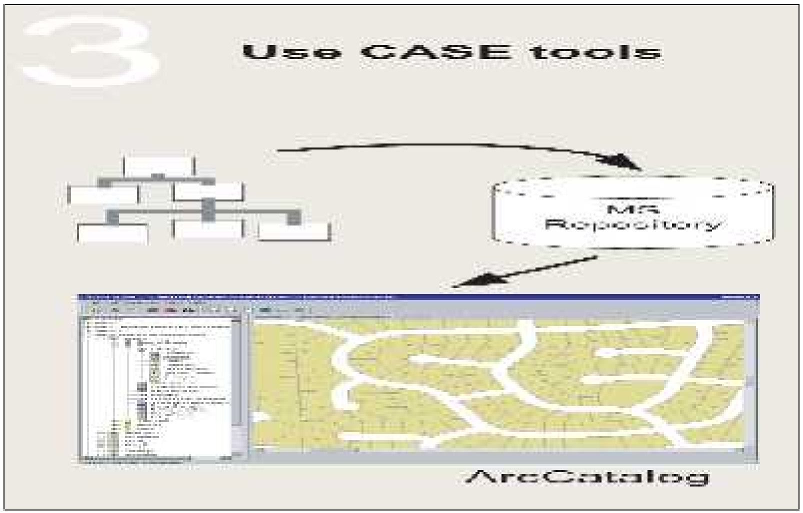


Figure (3.5)Building geodatabases with CASE tools

3.2.3.3 Further refining the geodatabase

Whether load data manually or use ArcCatalog to create the geodatabase schema, can continue to define geodatabase by establishing how objects in the database relate to one another. Using ArcCatalog, can establish relationships between objects in different object classes, connectivity rules for objects participating in geometric networks, and topological rules for features in topologies. Some of these relationships and rules may be part of the schema that CASE tools generate, but often will want to further refine what is generated by CASE to meet geodatabase design. Note that topologies cannot be designed with the existing CASE tools. can continue to use the geodatabase management tools in ArcCatalog to refine or extend a geodatabase once it has been designed and implemented.

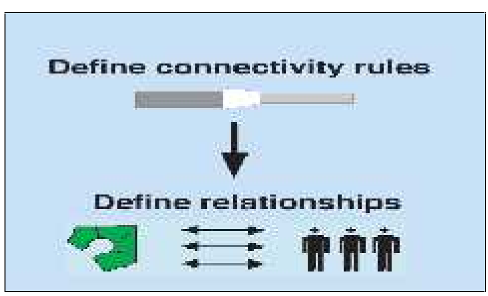


Figure (3.6)Further refining the geodatabase

3.2.4 Geodatabases and Arc Catalog

ArcCatalog allows to easily view and modify the contents of geodatabase. ArcCatalog contains a full suite of tools to create and manage geodatabase.

3.2.4.1 Accessing geodatabases in ArcCatalog

can manage geographic data in a variety of formats in ArcCatalog. Some of the formats that can manage directly include personal geodatabases, shapefiles, ArcInfo coverages,
rasters, TINs, and tables. In addition to managing data on desktop or local network, can manage remote ArcSDE geodatabases by creating a connection to the database. Database connections to remote geodatabases behave similarly to personal geodatabases, with one important difference: when delete a personal geodatabase, the database itself is deleted from the disk. When delete a remote geodatabase connection, however, only the connection is deleted the geodatabase and its data are unaffected.

3.2.5 Geodatabases and ArcMap

ArcMap allows to edit the contents of geodatabase. ArcMap contains a full suite of tools to edit simple features, geometric networks, and topologies in geodatabase.

3.2.5.1 Editing geodatabases in ArcMap

we can edit geographic data in a variety of formats in ArcMap. ArcView seats of ArcMap can be used to edit simple features in shapefiles and personal geodatabases. ArcInfo and ArcEditor seats have more extensive toolsets with special tools for creating and editing geographic data in topologies or geometric networks and performing spatial adjustment and disconnected editing.

3.2.5.2 Editing geometric networks

Editing features in a geometric network allows to maintain network connectivity of specified types of features and let’s move connected features without breaking the connections as
well as add junctions to certain types of edges without splitting them. Geometric networks are useful for modeling connected linear features, such as pipes, cables, and streams, and for modeling points that represent nodes in the network such as valves, switches, and stream confluences or gauging stations. Geodatabases and ArcMap The features that participate in a geometric network become network feature classes, not simple feature classes.

3.2.5.3 Disconnected editing

ArcInfo and ArcEditor seats of ArcMap can be used to check out data from your geodatabase to use while disconnected from the network. This is especially useful for remote offices that need to work with a portion of the database without incurring networkrelated performance problems and for people who need to take a part of the geodatabase out into the field for editing or analysis on a field computer.

3.3 Creating new items in a geodatabase

The first step in creating any database is to design the tables it will contain. A good design will ensure that data retrieval is fast and efficient. Modeling Our World discusses the considerations to take into account when build a geodatabase. Once design is complete, can start using tools in ArcCatalog to create tables, feature datasets, and feature classes. After adding data to tables and feature classes, can build indexes for the appropriate fields to improve query performance. can also grant and revoke privileges on table, feature class, or feature datasets for another database user. After creating feature classes, tables, and feature datasets, can refer to further relationship classes, topologies, and geometric networks. To create raster-based items, such as raster datasets, raster catalogs, or raster attributes, refer to the chapter ‘Building a raster geodatabase. ArcView can create simple feature classes and tables in a personal geodatabase.

3.3.1 Geodatabase items

Geodatabases organize geographic data into a hierarchy of data objects. These data objects are stored in feature classes, object classes, and feature datasets. An object class is a table in the geodatabase that stores nonspatial data. A feature class is a collection of features with the same type of geometry and the same attributes. A feature dataset is a collection of feature classes that share the same spatial reference. Feature classes that store simple features can be organized either inside or outside a feature dataset. Simple feature classes that are outside a feature dataset are called standalone feature classes. Feature classes that store topological features must be contained within a feature dataset to ensure a common spatial reference. ArcCatalog contains tools for creating object classes (tables), feature classes, and feature datasets. Once these items are created in the geodatabase, further items such as subtypes, relationship classes, geometric networks, and topologies can also be created.

3.3.2 ArcGIS data types

When creating tables, will need to select a data type for each field in the table. The available types include a variety of number types, text, date, BLOB, or globally unique identifier (GUID). Choosing the correct data type allows to correctly store the data and will facilitate analysis, data management, and business needs.

3.4 Importing data

With ArcCatalog, we can import shapefiles, coverages, CAD data, and INFO and dBASE tables into a geodatabase. For each feature class and table import, create a new feature class or table in the geodatabase. we can also load data from any of these formats into an existing feature class or table.

3.4.1 Importing data into new feature classes and tables

ArcCatalog contains tools that import a coverage, shapefile, CAD file, INFO table, database table, geodatabase feature class, or table. The tools also allow to import more than one feature class and table at the same time. For each feature class or table import, create a new feature class or table in the geodatabase. As the geodatabase stores data different from the formats importing, ArcCatalog will automatically convert the geometry and fields import to types used by the geodatabase.

3.5 Subtypes and attribute domains

When maintaining geographic database, care must be taken to ensure that when edit the data do so in a manner that is consistent with the system are modeling. The geodatabase together with the ArcMap Editor provides mechanisms to ensure that the data store in geodatabase is consistent with data model. The geodatabase has several data integrity and data management capabilities, including validation rules, subtypes, relationship classes, geometric networks,

3.5.1 subtypes and attribute domains

The geodatabase stores objects. These objects may represent nonspatial real-world entities, such as manufacturers, or they may represent spatial objects such as pipes in a water network. Objects in the geodatabase are stored in feature classes (spatial) and tables (nonspatial). The objects stored in a feature class or table may be organized into subtypes and can have a set of validation rules associated with them. The ArcInfo system uses these validation rules to help maintain a geodatabase that contains valid objects.

3.5.2 Working with attribute domain properties

The Domains tab of the Database Properties dialog box includes a list of all the domains that exist in a geodatabase. Each domain's name, description, properties, and valid set of values are displayed. From this dialog box, can also add, remove, and modify domains. An explanation of how to use this property page to manage geodatabase's domains.

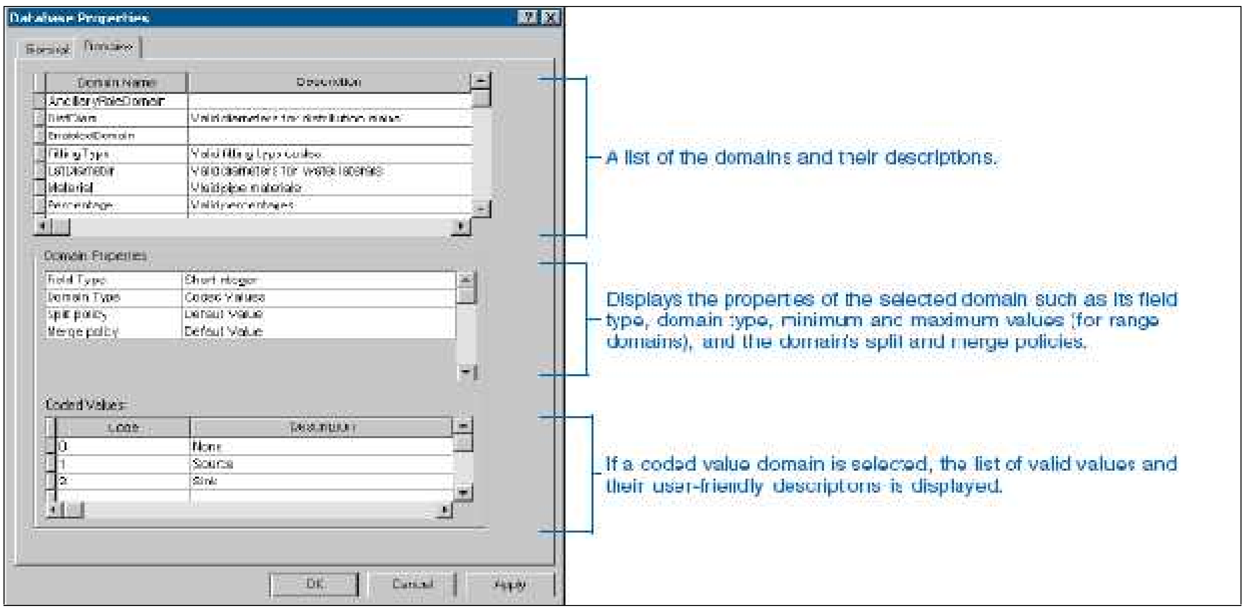


Figure (3.7)Working with attribute domain properties

3.6 Defining Relationship Classes

Objects in a real-world system, such as an water network or a parcel database, often have particular associations with other objects in the database. For example, in an water network, support meter . In a parcel database, a parcel will have one or many owners.

These kinds of associations between objects in the geodatabase are called relationships. Relationships can exist between spatial objects (features in feature classes), no spatial objects, or spatial and no spatial objects. While spatial objects are stored in the geodatabase in feature classes and no spatial objects are stored in tables, relationships are stored in relationship classes.

To store relationships, such as between water network and meter, must create a relationship class. If, in geodatabase, transformers also have relationships to transformer attribute objects, then a second relationship class is required to store those relationships.

3.6.1 Relationship classes in Arc Catalo

We can work with relationship classes in Arc Catalog. Relationship classes can exist both inside feature datasets and at the root level of the geodatabase.

When look at a particular relationship class in the Arc Catalog tree as shown in Figure (3.1), it is not immediately evident how feature classes or tables are related. However, by examining the properties of both the feature class or table and the relationship class, can achieve a clear picture of this.

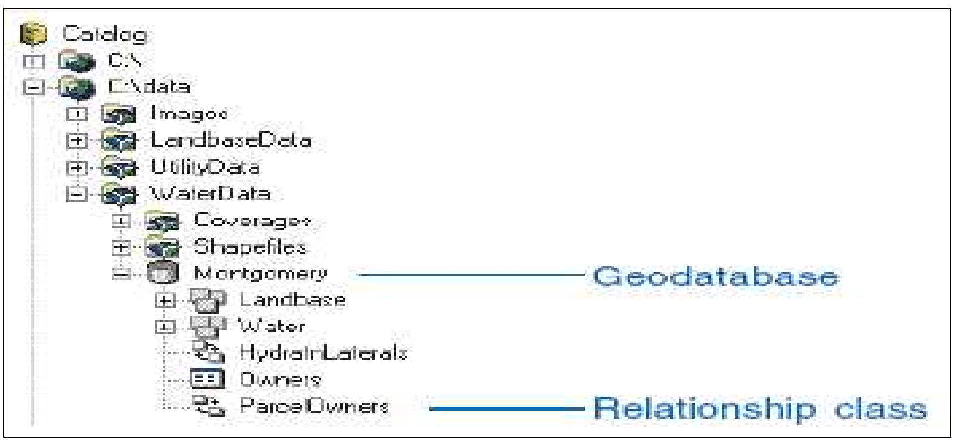


Figure (3.8) Relationship Classes Appear in the Arc Catalog Tree

3.6.2 Relationship classes in Arc Map

Once we have established a relationship class between feature classes or tables, can use these relationships in Arc Map. For example, when identify a feature in the map, can see all of the objects related to that feature. When working with tables, can select one or more rows or features and open the related table to see the selected objects.

we may want to use fields on a related table or feature class to symbolize or label map. Once have added a feature class to map that participates in a relationship class, can do this by establishing a join between the feature class and its related feature class or table. can use these joined fields like that in feature layer.

For more information on maps, feature layers, symbolizing, and labeling your features, see Using Arc Map. There are also a number of tools in Arc Map for editing relationships and related objects. For example, when select a feature, can edit the properties of its related objects. we can also use Arc Map to add new relationships and delete existing relationships.

3.6.3 Simple relationship class

To create new relationship classes between any feature classes or tables within geodatabase using tools in Arc Catalog. These tools can be used to create simple, composite, and attributed relationship classes. Relationship classes appear in the Arc Catalog tree, and can inspect their properties as well as the relationships for any particular feature class. The example in this task shows how to create a relationship class between a feature class that stores parcel objects and a table that stores owner objects. It is a simple, non attributed relationship. In the database, a parcel can be owned by a single owner, and an owner can own a single parcel, so it is a (one to one) (1–1) relationship.

3.6.4 Composite relationship class

The relationship will be non attributed; composite relationships are by definition one-to-many (1–M) relationships. a composite relationship involves many of the same steps used in the task for creating a simple relationship. the steps outlined here reflect the differences between the two tasks including using different origin and destination classes.

3.5.5 Attributed relationship class

Any relationship class-whether simple or composite, of any particular cardinality can have attributes. Relationship classes with attributes are stored in a table in the database. this table contains at least the foreign key to the origin feature class or table and the foreign key to the destination feature class or table. an attributed relationship can also contain any other attribute. the example in this subtask shows how to create a simple relationship between a feature class that stores water laterals and a feature class that stores hydrants. Water lateral objects have their own attributes, and hydrant objects have their own attributes. The relationship class in this example describes which water laterals feed which hydrants. Because want to store some kind of information about that relationship, such as the type of riser connecting the two, can store this information as attributes in the relationship class.

3.7 Geometric Network

The movement of people, the transportation and distribution of goods and services, the delivery of resources and energy, and the communication of information all occur through definable network systems. In the geodatabase, networks are modeled as a one-dimensional no planar graph, or geometric network, that is composed of features. These features are constrained to exist within the network and can, therefore, be considered network features. The geodatabase automatically maintains the explicit.

Topological relationships between network features in a geometric network. Network connectivity is based on geometric coincidence, hence the name geometric network. A geometric network has a corresponding logical network. The geometric network is the actual set of feature classes that make up the network. The logical network is the physical representation of the network connectivity. Each element in the logical network is associated with a feature in the geometric network. Once a geometric network is in place, Arc Map and Arc Catalog have tools that treat the network features in a special way. Editing and tracing on the network, as well as managing the feature classes participating in the network, are all handled automatically by Arc GIS.

3.7.1 Network feature types

Geometric networks consist of edge network features and junction network features. An example of an edge feature is a water main, while a junction feature might be a valve. Edges must be connected to other edges through junctions. Edge features are related to edge elements in the network, and junction features are related to junction elements in the logical network See Figure (3.9) Water Facility Object Model and Figure(3.10) Water Facility Data Types.

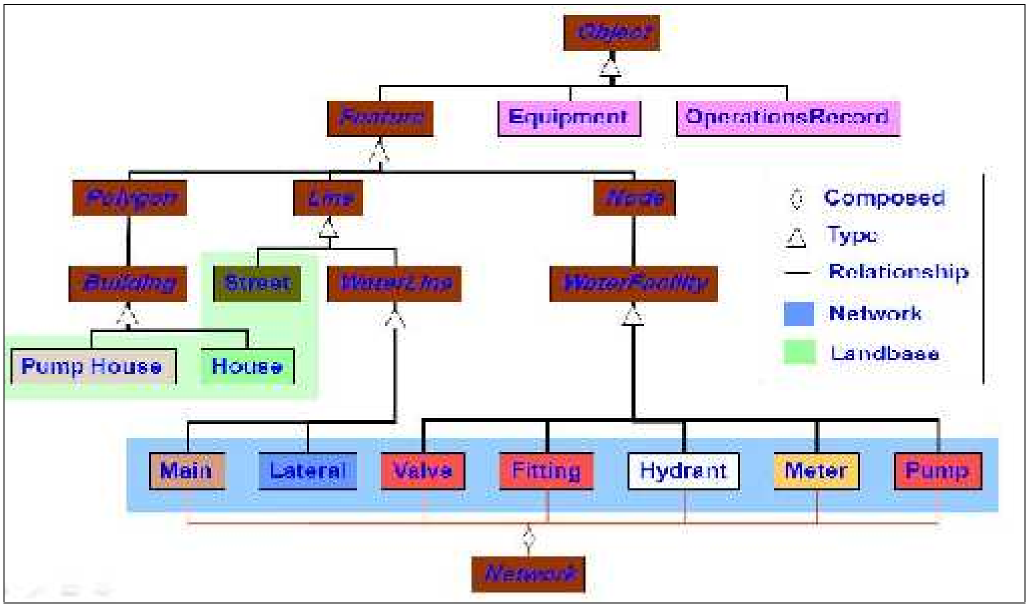
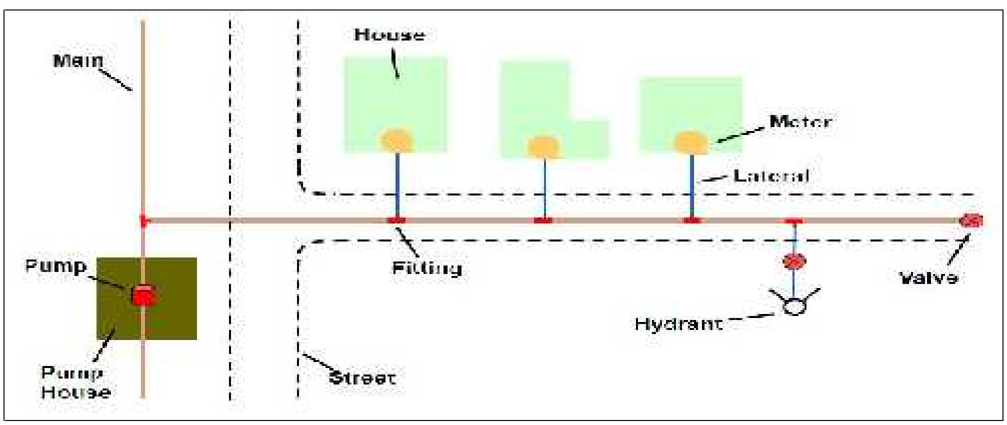


Figure (3.9) water network distribution



Figure(3.10) Water Facility Data Types

There are two broad categories of network feature types: simple and complex. Simple network features correspond to a single network element in the logical network. A complex network feature corresponds to more than one network element in the logical network. A simple edge feature corresponds to a single network edge element in the logical network. Simple edges are always connected to exactly two junction features, one at each end. If a new junction feature is snapped midspan on a simple edge (thereby establishing connectivity), then that simple edge feature is physically split into two new features. Complex edges correspond to one or more edge elements in the logical network. Complex edges are always connected to at least two junction features at their endpoints but can be connected to additional junction features along their length. If a new junction feature is snapped midspan on a complex edge, that complex edge remains a single feature. Snapping the junction does cause the complex edge to be split logically—for example, if it corresponded to one edge element in the logical network before the junction was connected, it now corresponds to two edge elements (See Figure (3.11).

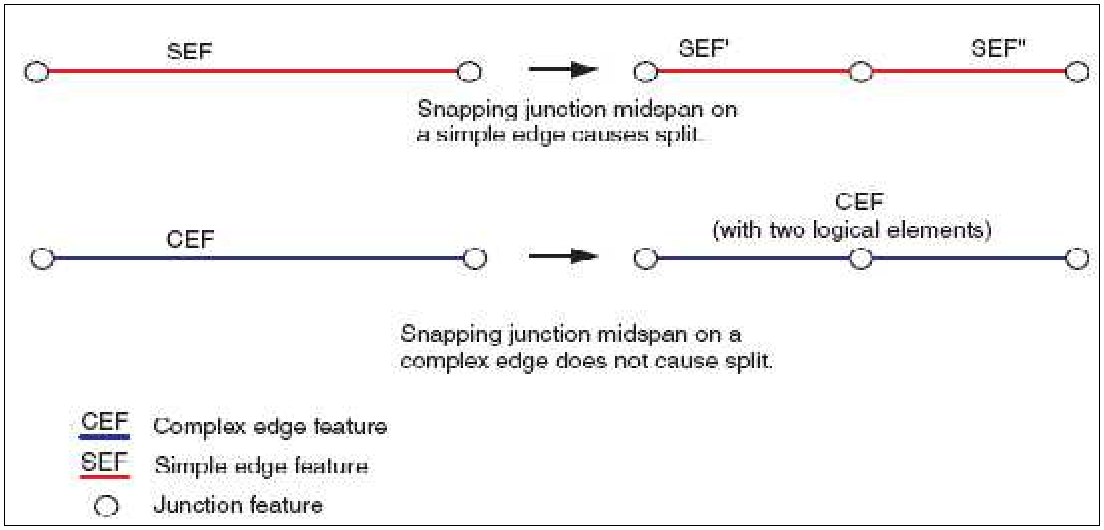


Figure (3.11) Simple and Complex Edges features

(1) Orphan junction feature class: When the first feature class is added to the geometric network, a simple junction feature class is created, called the orphan junction feature class. The name of the orphan junction feature class corresponds to the name of the geometric network appended with Junction. The orphan junction feature class is used by the geometric network to maintain network integrity. Every edge in the geometric network must have a junction connected to its endpoints. During network building, an orphan junction will be inserted at the endpoint of any edge at which a geometrically coincident junction does not already exist. Orphan junction features can be removed from the geometric network by subsuming them with other junction features.

(2) Sources and meter: Networks are often used to model real-world systems in which the direction of movement through the network is well defined. In a water network, the flow direction may not be as well defined as in an water network, but the flow of water may be from a pump station to a customer or from customers to a treatment plant. Flow direction in a network is calculated from a set of sources and meter. In the above examples, water flow are driven by sources and sinks. Flow is away from sources, such as the such as a water treatment plant (in the case of a wastewater network). Junction features in geometric networks can act as sources or meter. When you create a new junction feature class in a network, can specify whether the features stored in it can represent sources, sinks, or neither in the network. If specify that these features can be sources or sinks, a field called Ancillary Role is added to the feature class to record if the feature is a source, meter, or neither a source nor a sink. When calculate the flow direction for a geometric network in Arc Map, the flow direction will be calculated based on the sources and meter in the network. For example, may have a tank in water network that is down for maintenance, so its role in the network will be changed (temporarily) from source to none. The flow for the network is recalculated by the system; any traces on the network will be affected by the change in flow direction caused by the state of the tank. For more information on calculating flow direction and using flow direction in network analysis, see Using Arc Map.

(3) Network weights: A network can have a set of weights associated with it. A weight can be used to represent the cost of traversing an element in the logical network. For example, in a water network, a certain amount of pressure is lost when traveling the length of a transmission main due to surface friction within the pipe. Weights are calculated based on some attribute of each feature as presented in Figure (3.12). In the transmission main example above, an attribute that affects the weight would be the length of the feature. A network can have any number of weights associated with it. Each feature class in the network may have some, all, or none of these weights associated with its attributes. The weight for each feature is determined by some attribute for that feature. Each weight can be associated with one attribute in a feature but, at the same time, can be associated with multiple features. For example, a weight called Diameter can be associated with the attribute Diameter in water main features and can also be associated with the attribute Dia in water lateral features. A network weight value of zero is reserved and is assigned to all orphan junction features. Also, if a weight is not associated wit any attributes of a feature class, then the weight values for all network elements corresponding to that feature class will be zero.

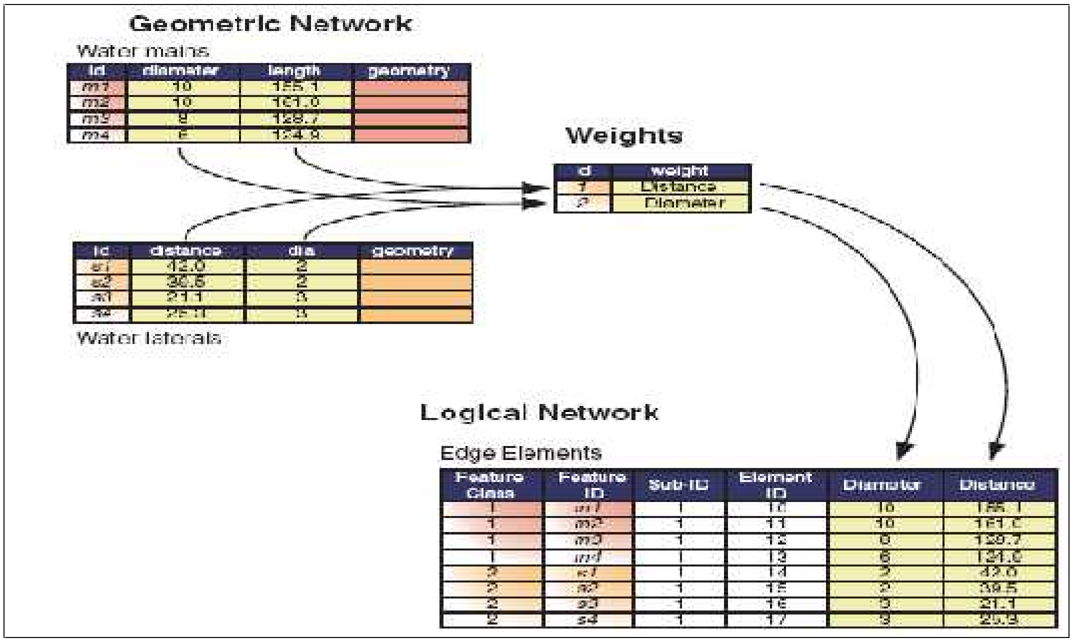


Figure (3.12) Weight and Attribute for Each Feature

3.7.2 How networks are built

Building networks from existing features is a computationally intense operation that may take a considerable amount of time and system resources, depending on the number of input features. If those features require snapping, the network building operation will spend most of its time in the feature snapping phase. The network building process proceeds in the following sequence:

1. If snapping is specified, snap simple features.
2. If snapping is specified, snap complex features.
3. Create an empty logical network.
4. Create the network schema in the database.
5. Extract attributes from the input feature classes for weight calculations.
6. Create the topology.
7. Create orphan junctions as required, add input junction features to the logical network, and initialize the junction enabled values.
8. Set weight values for the junction elements.
9. Add edges to the logical network.
10. Set weight values for the edge elements.
11. Create all necessary indexes in the database.

3.7.3 Adjusting features

When snapping features during network building, it is important to understand how the geometry of features is adjusted when snapping. All or part of any feature in a feature class that was specified as being adjustable in the Build Geometric Network wizard can potentially be moved. Those features that are in feature classes that are not adjustable will remain fixed throughout the network building process.

All features in all feature classes have equal weights when being adjusted during snapping. This means that if the endpoints for two edges need to be snapped and both features can be adjusted, then they will move an equal distance to snap together. If one of the features is not adjustable, then only the adjustable feature will move to snap to the static feature.

3.7.4 Identifying network build errors

When building a geometric network, the feature classes that are selected to participate in the network may contain features whose geometries are invalid within the context of a geometric network. These geometries include:

- features that have empty geometry
- edge features that contain multiple parts
- edge features that form a closed loop
- edge features that have zero length.

At the end of the build process, a summary of these errors displays in a dialog box. Features with invalid geometries are also identified and recorded in the network build errors table.

3.7.5 Schema locking

An exclusive lock is required on all of the input feature classes when building a geometric network. If any of the input feature classes have a shared lock, the network will not be built. If any of the feature classes in a network have a shared or exclusive lock, that lock is propagated to all of the other feature classes in the network. For more information on exclusive locks and schema locking, see the chapter ‘Creating new items in a geodatabase.

3.8 Network Connectivity

In most networks, you do not want all edge types to be able to logically connect to all junction types. Similarly, not all edge types can logically connect to all other edge types through all junction types. For example, in a water network, a hydrant can connect to a hydrant lateral but not to a service lateral. Similarly, in the same water network, a 10-inch transmission main can only connect to an 8-inch transmission main through a reducer. Network connectivity rules constrain the type of network features

that may be connected to one another and the number of features of any particular type that can be connected to features of another type. By establishing these rules, along with other rules such as attribute domains, we can maintain the integrity of the network data in the database. At any time, you can selectively validate features in the database and generate reports as to which features in the network are invalid—that is, are violating one of the connectivity or other rules.

There are two types of connectivity rules: edge–junction and edge–edge rules. An edge–junction rule is a connectivity rule that establishes that an edge of one type may connect to a junction of another type in Figure (3.13) water distribution System management using GIS connectivity An edge–edge rule is a connectivity rule that establishes that an edge of one type may connect to an edge of another type through a set of junction types. Edge–Edge rules always involve a set of junctions. can establish and modify the connectivity rules for a network from within Arc Catalog by modifying the geometric network properties. can establish connectivity rules between two feature classes, a feature class and the *subtype* of another feature class, or a subtype of one feature class and a subtype of another. In the water network example above, a connectivity rule would be established between two subtypes of the same edge feature class and a subtype of a third junction feature class (8-inch and 6-inch transmission mains and reducer valves).

3.8.1 Establishing connectivity rules

Connectivity rules are established and modified using the geometric network's Properties dialog box in Arc Catalog. The two examples given here describe how to establish an edge–junction rule and an edge–edge rule. For simplicity, each is done separately in the examples, but any number of rules can be established or modified for the network at a single time.

3.9 Case Study: Halhull Water Distribution Network

An Arc GIS 9.2 was used to process the water network analysis and generate the geometric network required to the develop geodatabase and utility network analyst. The original procedure was created the geometric network in Arc GIS 9.2 project, and convert to identify and fill sinks, to generate geometric network, connectivity, digitizing, analysis, and management. The procedures are as follow.

1. Triangulated Irregular Networks (TIN) for Halhull was fined as appear in Figure (3.14).
2. The main water network pipe was created as shown Figure (3.15).
3. The sources of water and reservoirs in Halhull was located as presented in Figure (3.16).

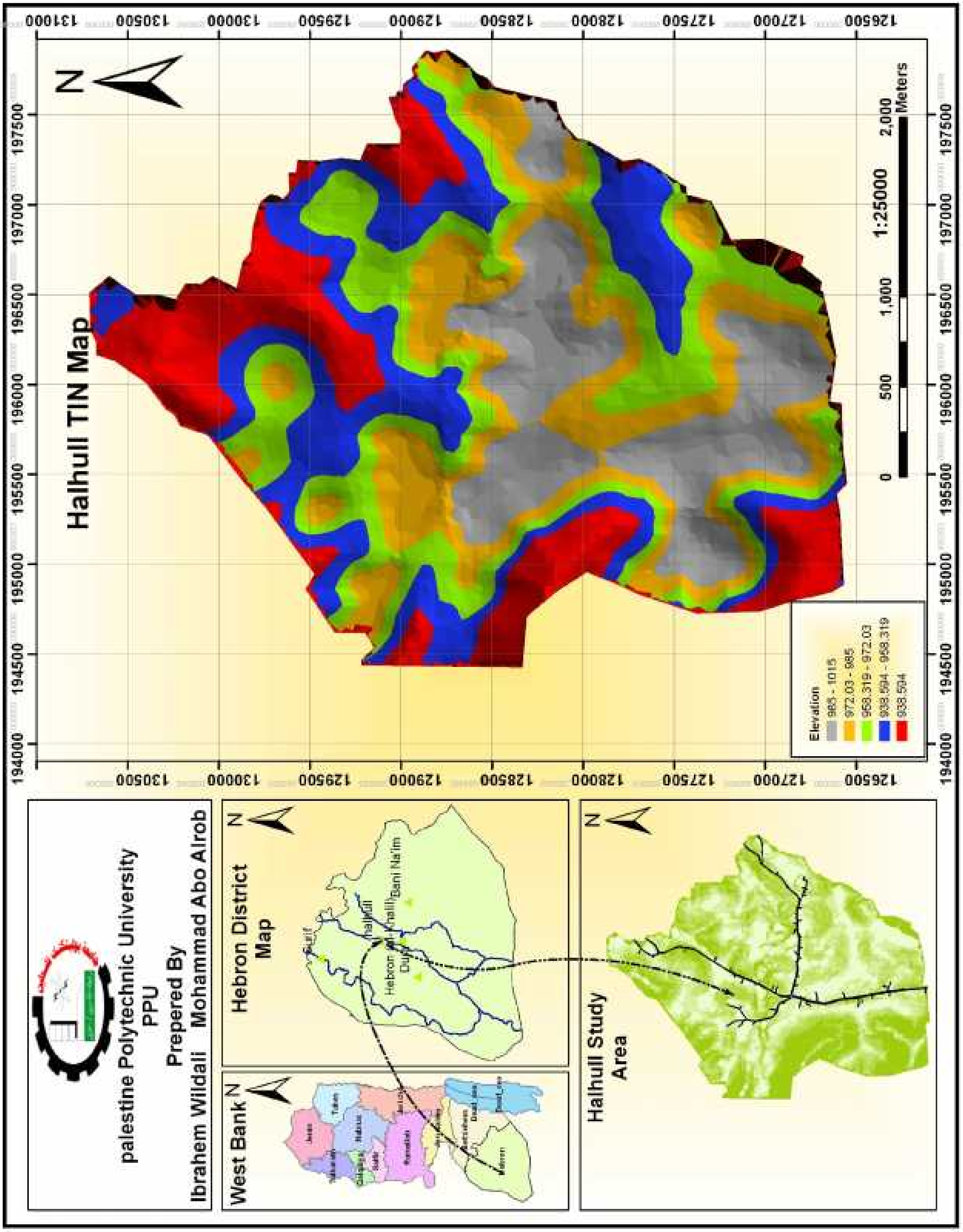


Figure (3.14) Triangulated Irregular Networks (TIN)

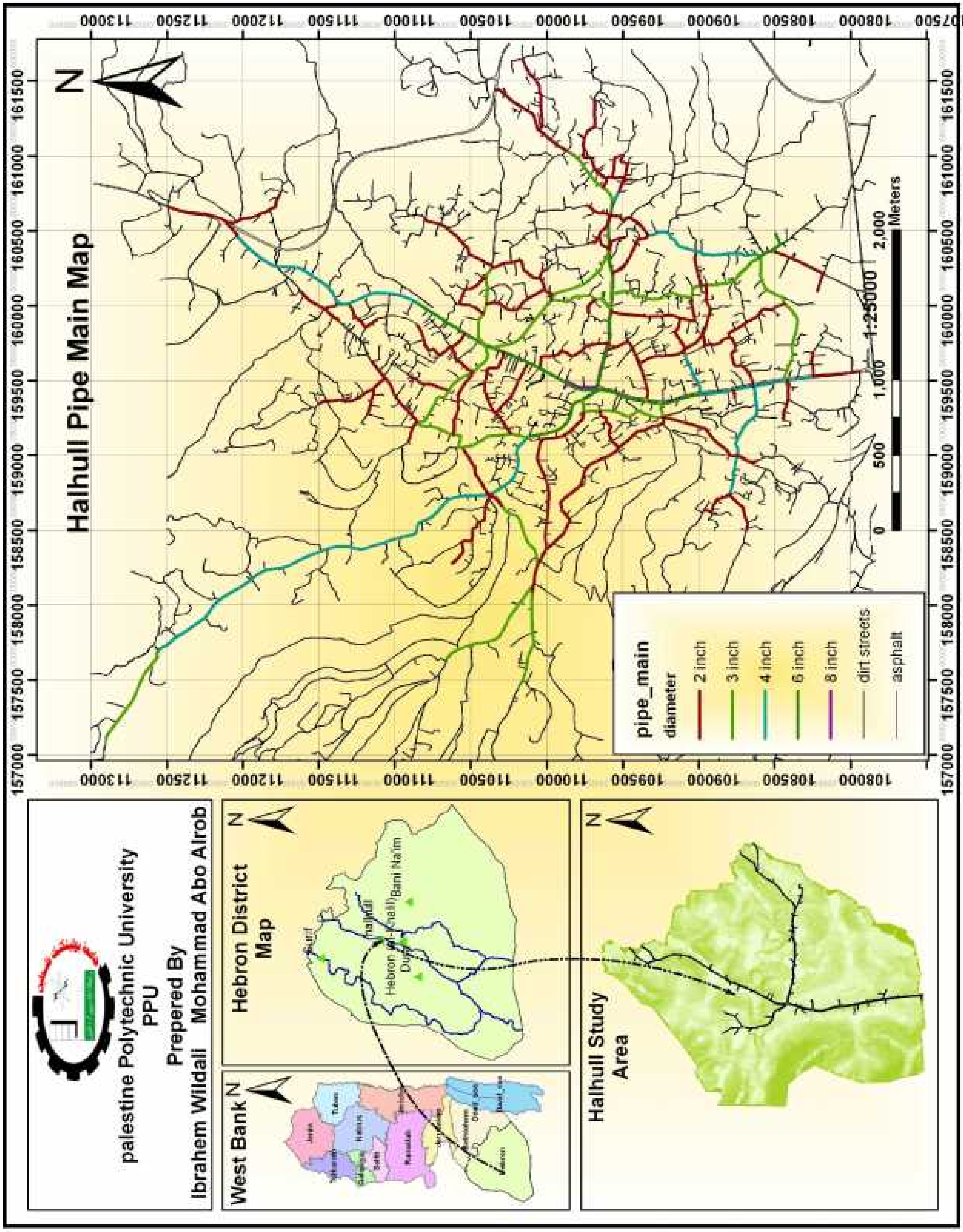


Figure (3.15) The Main Water Network Pipes Line

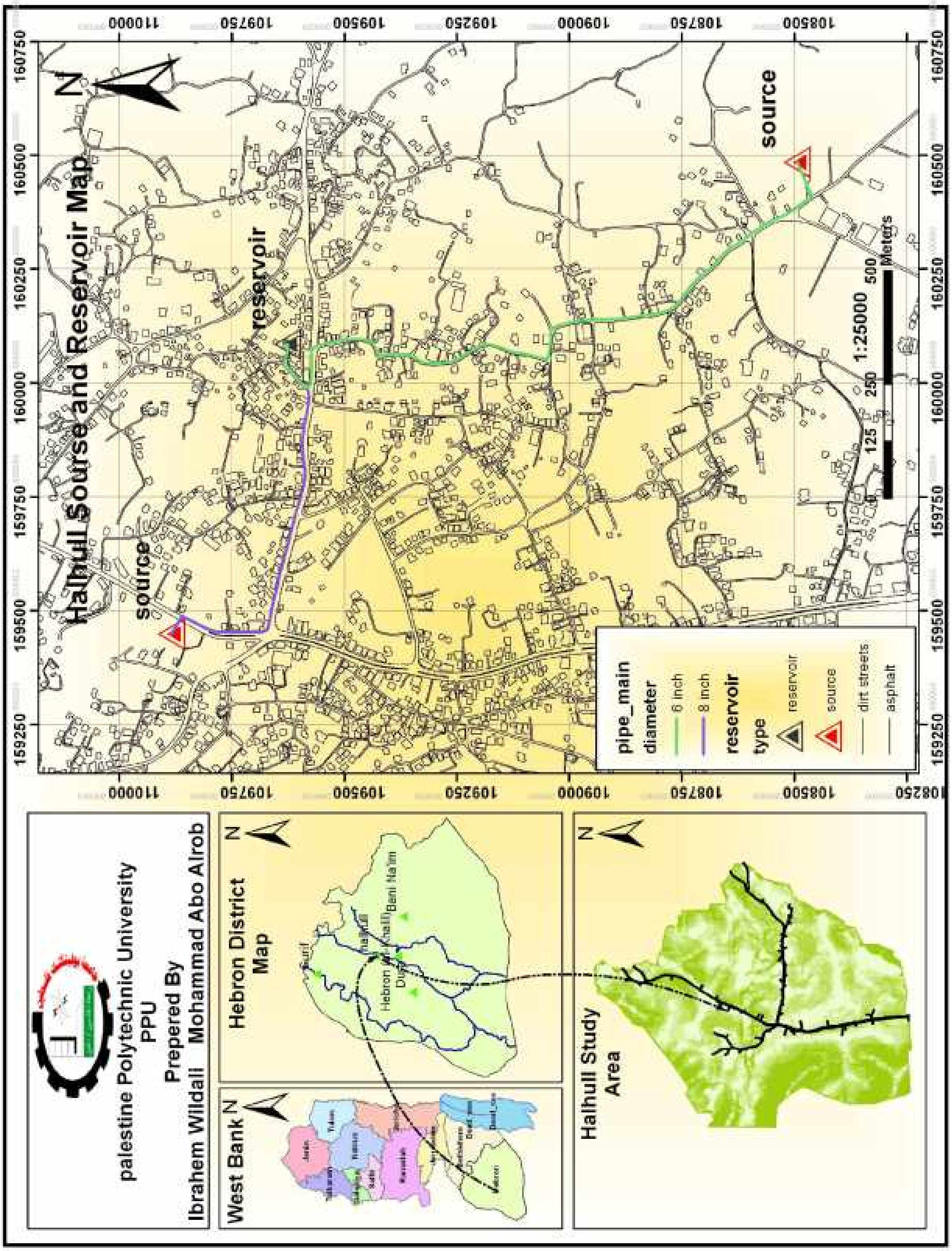


Figure (3.16) The Sources of Water and Reservoirs in Halhull Area

CHAPTER

4 *ANALYZING GEOMETRIC NETWORKS*

THIS CHAPTER CONTANT

CHAPTER FOUR
ANALYZING GEOMETRIC NETWORKS

4.1 Introduction

The economic foundation of the modern world is its infrastructure-the collection of cables, pipelines, and wires that enables the movement of energy, commodities, and information. This infrastructure can be modeled as networks. ArcGIS provides a complete model for capturing, storing, and analyzing networks.

What we can do with networks in ArcMap?

ArcMap provides a rich set of tools that perform many common network analysis tasks on geometric networks. Some of the common types of analyses that can perform on network using ArcMap are:

1. Trouble call analysis: determines the likely cause of a problem based on the location of customers with service problems.
2. Isolation traces: determines which switches have to be opened in order to close water to a part of the network.
3. Contaminant tracing: determines whether a particular site is a possible cause of contamination. Before we can work with geometric networks in ArcMap, we need to build a geometric network. While network features can be both created and edited in ArcInfo and ArcEditor, they are read-only in ArcView. how to build a geometric network using ArcCatalog, see Building a Geodatabase.

4.2 Geometric network

Networks consist of two fundamental components: edges and junctions. The edges and junctions in a network are topologically connected to each other. An edge is a type of network element that has a length and through which some commodity flows. water network, pipes, and stream reaches are examples of edges. A junction occurs at the intersection of two ormore edges and allows the transfer of flow between edges. Fuses, switches, service taps, and the confluence of stream reaches are examples of junctions. Edges connect to each other at junctions; the flow from edges in the network is transferred to other edges through junctions. In ArcGIS, feature classes can participate together in a network.

Feature classes representing transmission lines, switches, fuses, and transformers can all be part of the same network. Because the features have geometry and can be mapped, the network of features is called a geometric network. a geometric network contains the connectivity information between edges and junctions and defines rules of behavior such as which classes of edges can connect to a particular class of junction or to which class of junction two classes of edges must connect. To create a geometric network, use a wizard to specify which feature classes will participate in the network, or create an empty network and add feature classes to it later. Once the network is created, it is maintained throughout the life cycle of the database. ArcGIS maintains the connectivity information whenever edit the participating feature classes of a geometric network. The connectivity rules and relationships that define in the geodatabase can be validated at any time to discover features that violate the established rules.

ArcGIS includes a variety of tools for analyzing networks and a rich set of objects for building custom networks with complex behavior. For more information on modeling networks in ArcGIS, see Modeling Our World. To learn how to create geometric networks and define connectivity rules, and for information on defining relationships between feature classes, see Building a Geodatabase. To learn about editing geometric networks, see Editing in ArcMap.

4.3 Opening a geometric network

Geometric networks are objects within the geodatabase. Geometric networks are automatically maintained by ArcGIS when their feature classes are edited. In order to work with a geometric network in ArcMap, must load a minimum of one feature class that participates in the network. If want to work with only the feature

classes that participate in the network for example, if are performing some analysis on the network then we can load only these feature classes by loading the network object. If want to load all of the feature classes in the feature dataset that contain the network for example, if want to produce a printed map of the network can open the network by loading the feature dataset that contains the network.

4.4 Symbolizing network features

we can use symbology in ArcMap to easily identify enabled or disabled features, sources, or sinks in your network. All network features can beeither enabled or disabled. Enabled features allow flow to pass through them, while disabled features do not. The status of each feature is stored in the Enabled field of the feature class’s attribute table. The values in this field are defined by a coded value attribute domain and can only be 0 or 1. Features with a value of 1 are enabled, and those with a value of 0 are disabled. By symbolizing your features using this attribute, we can quickly tell which features are enabled and which are disabled. A junction feature can act as a source or a sink (or neither). When build a geometric network, specify which feature classes contain sources or sinks. Those feature classes have an attribute named AncillaryRole that contains this information. The values in this field are defined by a coded value attribute domain. A value of 1 represents a source, and a value of 2 represents a sink

A value of 0 means that the feature is neither a source nor a sink. By symbolizing features using this attribute, can quickly tell which junctions are sources and sinks. For more information on attribute domains, see Building a Geodatabase.

4.5 Adding network features

Adding features to a network is the same as adding features to any dataset. However, when features are added to a network, they connect topologically to other features in the network. These connections are automatically maintained inside the geodatabase and are based on geometric coincidence. For example, a junction must be coincident with an edge endpoint in order to be connected. To ensure geometric coincidence, use snapping when editing network features. In this example, a new service is added to the network to provide water to a building. The new service connects to a water main on one end and snaps to a building on the other. In order to ensure that the new feature in the services feature class connects to the water main on one end and touches the building on the other, must use snapping.

4.6 Enabling and disabling features

Any feature in a geometric network can be enabled or disabled. An enabled feature allows flow to pass through it, while a disabled feature does not. Disabling features allows to treat features as if they were disconnected from the network, without actually removing the topological connections that they have to other features in the network. By default, all features in a geometric network are enabled when create the network. To enable or disable a feature, its Enabled attribute must be edited in the Attributes dialog box.

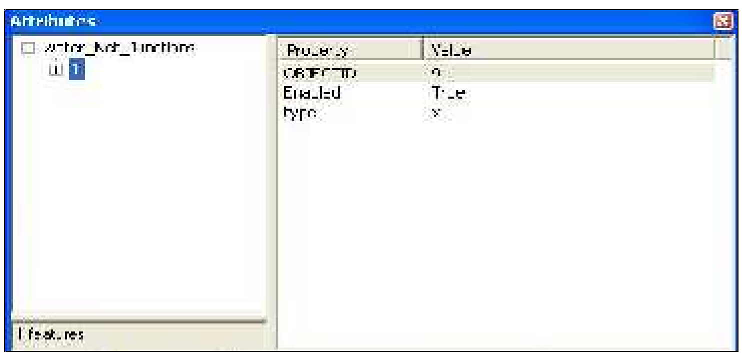


Figure (4.1) Enabling and disabling features

4.7 Adding the Utility Network Analyst toolbar

In order to use ArcMap to analyze networks, must load the Utility Network Analyst toolbar. This toolbar contains most of the tools needed to perform the analysis tasks presented later in this section.

4.8 Exploring the Utility Network Analyst toolbar

The Utility Network Analyst toolbar is divided into two sections. The left side of the toolbar lets choose a network with which to work and to set and display its flow direction. The right side of the toolbar lets set up and perform trace operations on the current network.

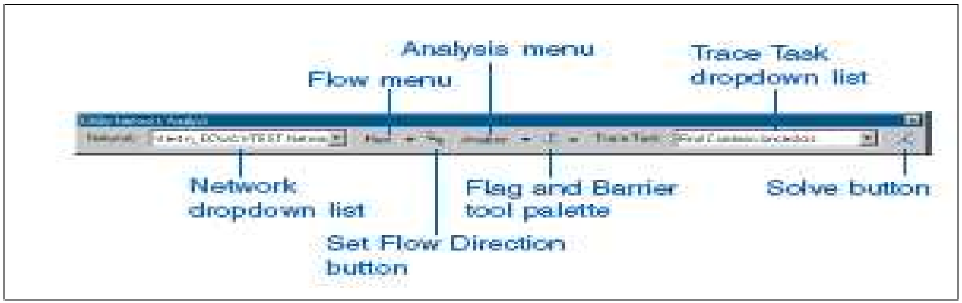


Figure (4.2) Exploring the Utility Network Analyst toolbar

The Network dropdown list contains all of the geometric networks that are currently loaded in ArcMap. To work with a network in ArcMap for example, set the flow direction or perform a trace operation must choose the network in this list. The Flow menu contains items for displaying the flow direction of the features in the network. Clicking the Flow menu reveals three items: Display Arrows For, Display Arrows, and Properties.

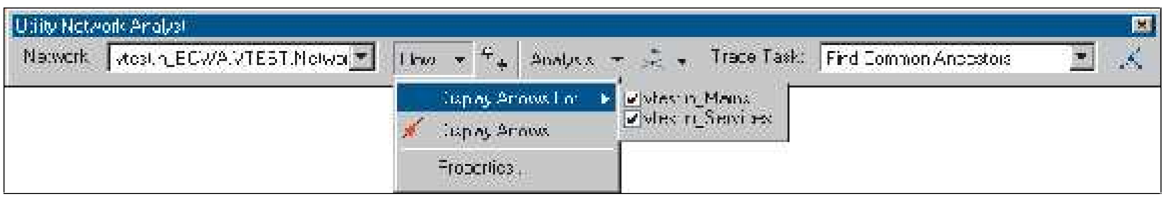


Figure (4.3) the Utility Network Analyst

Clicking Display Arrows For produces a list of the edge feature classes in network. By checking items in this list, can specify for which layers to display flow direction. The Display Arrows command is a toggle button that turns on or off the display of flow direction arrows for network. Clicking the Properties command opens the Flow Display Properties dialog box. The Arrow Symbol tab lets specify the symbol, size, and color of the arrows used to indicate flow direction. The Scale tab lets specify the scale range in which the arrows are displayed. Clicking Display

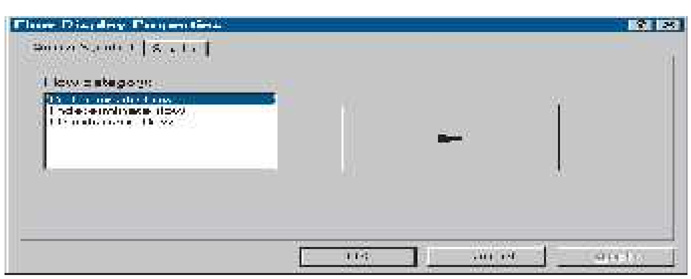


Figure (4.4) the Flow Display Properties

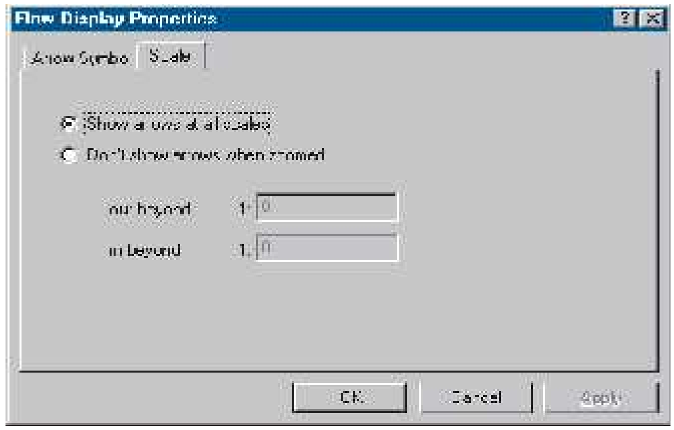


Figure (4.5) the Flow Display Properties

The Set Flow Direction button establishes flow direction in the network. This button is enabled when network contains feature classes that have designated as containing persistent sources and sinks. The Analysis menu contains commands for setting up network to perform trace operations. Clicking the Analysis menu reveals five commands: Disable Layers, Clear Flags, Clear Barriers, Clear Results, and Options.

Figure (4.6) the Utility Network Analyst

Clicking Disable Layers displays a list of feature classes contained in the geometric network. By checking feature classes in this list, can disable feature classes in trace operations. This makes trace operations behave as if all of the features in those feature classes are disabled. The Clear Flags and Clear Barriers menu items remove flags and barriers, respectively, from the network. Clicking Clear Results clears the results of the previous trace operation. Clicking Options opens the Analysis Options dialog box. This dialog box allows to specify options for subsequent trace operations. The General tab of the Analysis Options dialog box lets specify on which features trace tasks are performed. we can perform trace tasks on all of the features in the network, only the selected features, or only the unselected features. can specify whether or not trace tasks that consider flow direction include edges with indeterminate or unspecified flow direction. we can also use this tab to specify the snapping tolerance for placing flags and barriers on the map.

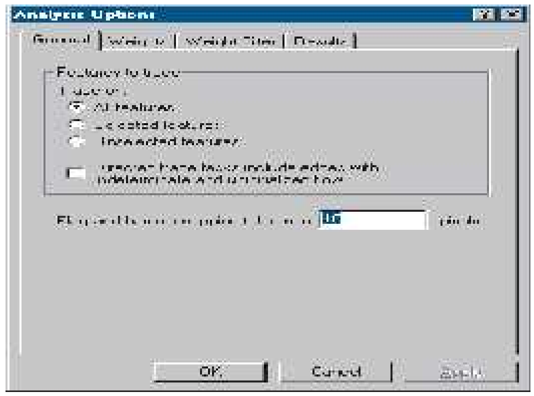


Figure (4.7) the Utility Network Analyst

The Weights tab lets specify which network weights are used when tracing. For example, the Find Path trace task uses weights to determine the cost of including a network feature in the result of the trace task.

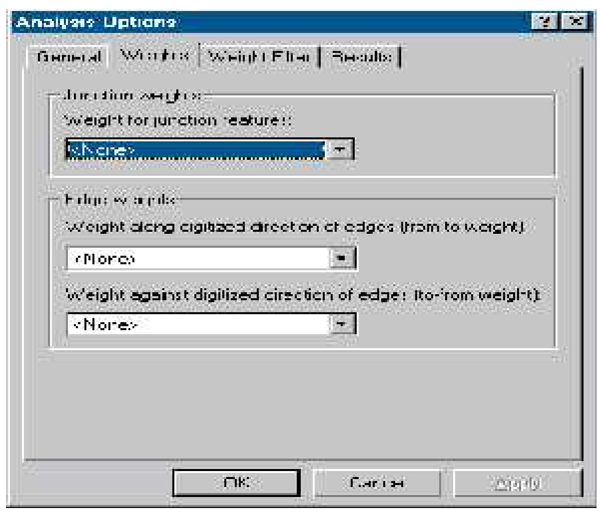


Figure (4.8) Analysis weights Options

The Weight Filter tab lets to specify which network features can be traced based on weights assigned to the network features. For both edges and junctions, can specify valid ranges of weights for features that may be traced.

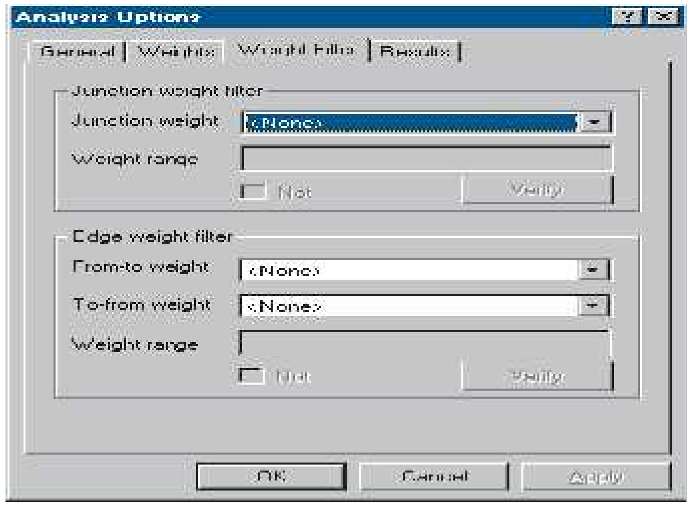


Figure (4.9) Analysis weights Filter Options

With the Results tab, can determine in which format want to receive the results of trace operations. Results can be given as drawings overlaid on the map or as a set of selected features. If choose to draw the results, can choose to render only the parts of complex edges that are actually traced, rather than the entire complex feature. can also specify whether the results will include features that are traced during the operation or features stopping the trace. Finally, can specify whether the results include both edge and junction features.

Figure (4.10) Analysis Result Options

The Trace Task dropdown list contains a list of all the trace operations that can perform using the Utility Network Analyst toolbar. ArcGIS comes with nine built-in trace operations. While the Trace Task dropdown list is used to select the trace task, the Solve button is used to perform the trace operation once have finished configuring trace operation using the toolbar. The Solve button performs the trace operation that selected in the Trace Task dropdown list; it does this using the parameters that specified using the Analysis Options dialog box and the placement of flags and barriers on the network.

4.9 Flow direction

In network applications, knowing the flow direction along network edges is essential. Establishing the flow direction in a geometric network determines the direction in which commodities flow along each edge. The flow direction in a network is determined by the connectivity of the network, the locations of sources and sinks in the network, and the enabled or disabled state of features. Sources and sinks drive flow through a geometric network. Sources are junction features that push flow away from themselves through the edges of the network. For example, in a water distribution network, pump stations can be modeled as sources, since they drive the water through the pipes away from the pump stations. Sinks are junction features that pull flow toward themselves from the edges in the network. For example, in a river network, the mouth of the river can be modeled as a sink, since gravity drives all water toward it. Flow moves away from sources and toward sinks. Because flow direction can be established with either sources or sinks, it usually suffices to specify only sources or only sinks in a network. It is important to remember that disabled features are accounted for when setting flow direction. Disabling a feature makes it act as if flow cannot pass through it. Thus, disabling a feature means that the flow direction cannot be set for the disabled features or for those features that are connected to the sources or sinks exclusively through the disabled feature. After set the flow direction for network, an edge has one of three categories of flow direction: determinate, indeterminate, or uninitialized.

4.9.1 Determinate flow direction

If the flow direction of an edge can be uniquely determined from the connectivity of the network, the locations of sources and sinks, and the enabled or disabled states of features, the feature is said to have determinate flow. Determinate flow for an edge is specified as either with or against the direction in which the feature was digitized.

4.9.2 Indeterminate flow direction

Indeterminate flow direction in a network occurs when the flow direction cannot be uniquely determined from the connectivity of the network, the locations of sources and sinks, and the enabled or disabled states of the features. Indeterminate flow commonly occurs for edges that form part of a loop, or closed circuit. It can also occur for an edge whose flow is determined by multiple sources and sinks, where one source or sink is driving the flow in one direction through the edge, but another source or sink is driving it in the opposite direction. For example, an edge that has a source at both of its ends will have indeterminate flow.

4.9.3 Uninitialized flow direction

Uninitialized flow direction in a network occurs in edges that are isolated from the sources and sinks in the network. This can happen if the edge is not topologically connected through the network to the sources and sinks or if the edge is only connected to sources and sinks through disabled features.

4.9.4 Specifying flow direction

All geometric networks that have flow have sources and sinks. In some cases, may not know the locations of the sources and sinks, but may know the flow direction. If this is the case, must choose the junctions in network to act as sources and sinks that produce the correct flow direction. After setting the flow direction for network, indeterminate flow may occur, even when know the direction of flow. This is because the flow direction is determined by properties of the network or the features making up the network in addition to the connectivity or locations of sources and sinks. For example, in a water network, the flow direction in a pipe is determined by the difference in water pressure between the ends of the pipe. The pressure at each end of the pipe is affected by such things as the material out of which the pipe is made, the pipe diameter, the flow rate through the pipe, the physical configuration of the pipe (including any bottlenecks, valves, or sharp bends), the temperature of the water, the elevation of the ends of the pipe, and the connectivity of the network. Since ArcGIS deals with general networks (and not with domain-specific types of networks), this information is not used to set the flow direction. Thus, the flow direction may be set to indeterminate for some edges in these networks. A set of similar variables exists in every domain. Developers can write custom flow-direction solvers that use these variables to find determinate flow direction in domain-specific networks.

4.10 Displaying flow direction

Network flow direction specifies the direction in which commodity flows through the network. ArcGIS stores this information for edge features in a network. can display the flow direction for edges using the Utility Network Analyst toolbar. can display which edges have determinate flow direction, indeterminate flow direction, or uninitialized flow.

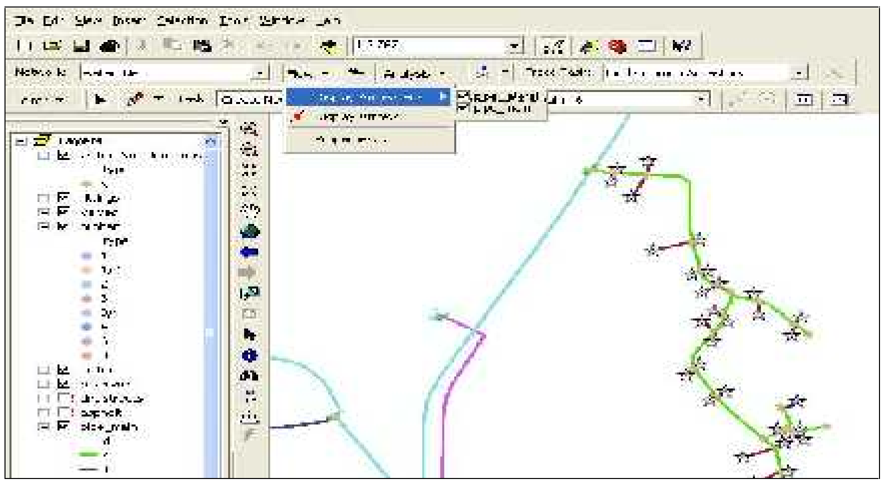


Figure (4.11) Displaying flow direction

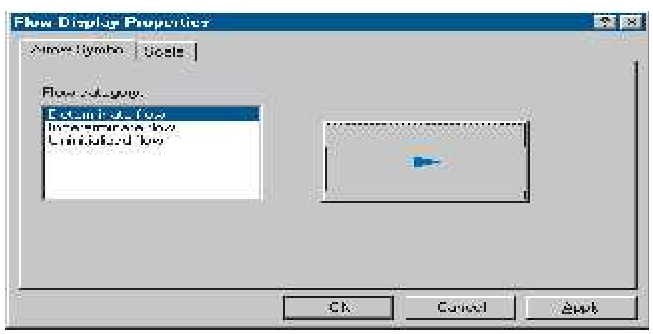


Figure (4.12) flow direction type

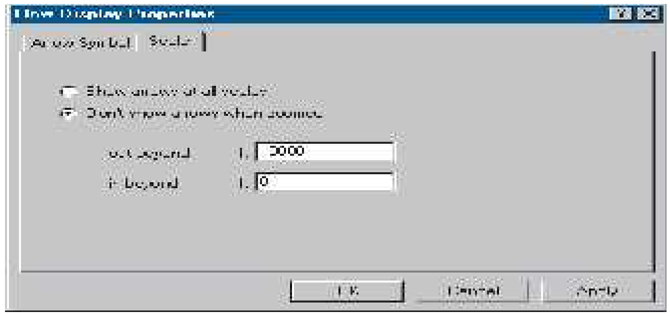


Figure (4.13) flow direction proprieties

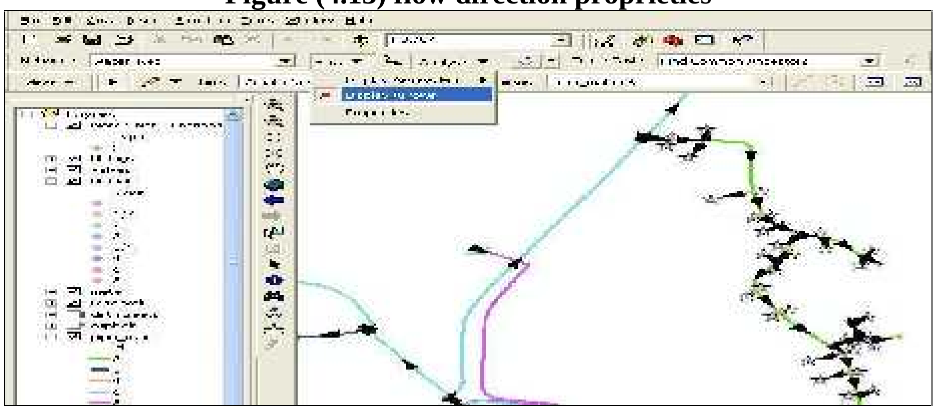


Figure (4.14) direction flow

4.11 Setting flow direction

we can use ArcMap to maintain flow direction in geometric network. ArcMap uses the network connectivity, the enabled or disabled state of network features, and the locations of sources and sinks to establish flow direction. must set flow direction whenever:

1. Create a new geometric network.
2. Add or remove features from the network.
3. Reshape features so as to change the network connectivity.
4. Connect or disconnect features.
5. Add or remove sources or sinks.
6. Enable or disable features.
7. Reconcile a version. Setting the flow direction establishes the correct flow direction for the new network connectivity.

In order to set flow direction, network must contain at least one junction feature class that specified as containing sources and/or sinks.

Figure (4.15) Creating sources and sinks

CHAPTER

5 *MANAGEMENT OF WATER NETWORK*

THIS CHAPTER CONTANT

5.1 **Tracing on networks**

5.2 **Tracing operations**

5.3 **Tracing And Management Using Visual Basic**

CHAPTER FIVE

MANAGEMENT OF WATER NETWORK

5.1 Tracing on networks

Network analysis involves tracing. The term tracing is used here to describe building a set of network elements according to some procedure. can think of tracing as placing a transparency on top of a map of network and tracing all the network elements that want to include in your result onto the transparency. When working with networks, tracing involves connectivity. A network element can only be included in a trace result if it is in some way connected to other elements in the trace result. The trace result is the set of network features that is found by the trace operation. For example, suppose want to find all of the features upstream of a particular point in a water network. Using a transparency placed over the map of the water network, could trace over all of the branches of the river that were upstream of that point. What is drawn on the transparency after this would be desired result. Similarly, when perform a trace operation in ArcMap, result is a set of the network elements included in the trace. In ArcMap, trace results can either be drawings on top of map or a selection.

5.1.1 Flags and barriers

In ArcMap, flags define the starting points for traces. For example, if are performing an upstream trace, use a flag to specify where the upstream trace will begin. Flags can be placed anywhere along edges or on junctions. When performing the trace operation, ArcMap uses the underlying edge or junction feature as the starting point of the trace operation. Network elements connected to these edges or junctions are considered for inclusion in the trace result. Barriers define places in the network past which traces cannot continue. If are only interested in tracing on a particular part of network, can use barriers to isolate that part of the network. Like flags, barriers can be placed anywhere along edges or on junctions. When performing trace operations, ArcMap treats the underlying network features as if they are disabled, thus preventing the trace from continuing beyond these features.

5.1.2 Disabling features

Disabling features is a more permanent method of creating a barrier at a particular location. In a municipal water network, for example, if a water main has been opened and capped due to a road construction project, water cannot flow through that section of the water main. Disabling the network feature representing this water main would stop a trace at this feature.

5.1.3 Disabling feature layers

In some cases, disabling entire layers may be necessary. For example, by disabling the switches layer in an water distribution network and tracing from some point in the network, can find the switches that need to be thrown to isolate this point from the network; these will be the features at which the trace operation is stopped.

5.1.4 Weights

Edges and junctions can have any number of weights associated with them. A weight is a property of a network feature typically used to represent a cost for traversing across an edge or through a junction. An example of an edge weight is the length of the edge. In a shortest path analysis, would choose this weight if wanted the resulting path to be of the shortest length. Another example is the valve to traversing an edge in an water network. Using a valve weight, the shortest path would be the path of least valve. When build a network, specify which attributes of edge and junction feature classes will become weights. can use these weights to specify the cost of including a feature in the results of a trace operation. Of the trace tasks included with ArcGIS, only the

1. Find Path,

2. Find Path Upstream, and

3. Find Upstream Accumulation

trace tasks use weights to calculate the cost of the trace. To find the cost using these trace tasks, must specify which weights to use. For junction features, a single weight is used. For edge features, two weights can be used: one along the digitized direction of the edge feature (the form to weight) and one against the digitized direction of the edge feature (the to–from weight). The digitized direction of an edge feature refers to the order in which the shape nodes of the feature are stored in the geodatabase. can specify a different weight for each direction of an edge for cases where tracing an edge in one direction has a different cost from tracing it in the other direction.

5.1.5 Weight filters

We can use a weight filter to limit the set of network features that may be traced. A weight filter specifies which network features can be traced based on their weight values. A weight filter serves the same purpose as creating a selection of network elements based on a simple SQL query, except that the performance of the weight filter is much faster. Using a weight filter, specify valid or invalid ranges of weight values for network features that may be traced. As with using weights to represent the cost of including a feature in trace results, a single weight is used for junction features, and two weights may be used for edge features.

5.1.6 Traced features and features stopping

When tracing using the

1. Find Connected,
2. Trace Downstream, or
3. Trace Upstream.

trace tasks, can return either the features that are traced or the features that stop the trace. Features that are traced are those that are actually traced over by the operation. Features that stop the trace are those features past which the trace cannot continue. Features that stop the trace include the following:

1. Disabled features
2. Features upon which barriers are placed
3. Traced features that are only connected to one other feature (deadends)
4. Features that have been filtered out with a weight filter.

5.1.7 Using selections to modify trace tasks

When tracing, ArcMap lets use selections to modify trace tasks in three main ways. First, the Analysis Options dialog box lets specify whether the trace operation is performed on all features in the network, on the selected features only, or on the unselected features only. Tracing on just the selected features means that unselected features act as barriers, while tracing on just the unselected features means that selected features act as barriers. By using selections in this manner, we could, for example, perform a trace operation to produce a set of barriers for a subsequent operation, or build a selection query to produce a set of network features upon which to perform a trace operation. ArcMap also lets specify which layers are selected when performing a trace operation.

From the Selection menu in ArcMap, we can specify which layers can and cannot be selected. When ArcMap returns the results of a trace operation as a selection set, the settings you specify in the Selection menu are used to determine which features should be included in the selection set returned by the trace. Finally, we can also use the interactive selection method set through the Selection menu to specify the behavior of the resulting selection set. can create a new selection, add the results of your trace operation to the current selection, select the results of trace operation from the current selection, or remove the results of trace operation from the current selection. By using the power of selections in ArcMap, can use the simple trace tasks included with ArcMap to perform compound and complex trace operations.

5.1.8 Putting it all together

This section introduced some concepts can use when constructing traces to perform on network. can return the trace results as a selection set, disable individual features or entire feature layers, place barriers on edges or junctions, include the traced features or the features stopping the trace, trace only on selected or unselected features, specify which layers to include in the results, and use different selection methods. All of these concepts can be used simultaneously when creating a trace result. Combining these concepts in trace operations allows to execute powerful traces on network.

5.2 Tracing operations

Using the Utility Network Analyst toolbar with water network, we can do the following:

1. Trace downstream.
2. Trace upstream.
3. Find the upstream accumulation.
4. Find an upstream path to thesource.
5. Find common ancestors.
6. Find connected features.
7. Find disconnected features.
8. Find a path.
9. Find loops.

we can use these simple tasks to perform many useful network analyses. can also combine these with other features of ArcMap to perform complex network analysis operations. To find all network elements that lie downstream of a given point in network, use the.

1. ***Trace Downstream task***. To find all network elements that lie upstream of a given point in network, see figure (5.1)
2. ***Trace Upstream*** task. To find the total cost of all network elements that lie upstream of a given point in network, see figure (5.2)
3. ***Find Upstream Accumulation task***. To find an upstream path from a point in the network to the source, see figure (5.3)
4. ***Find Path Upstream task***. To find the common features that are upstream of a set of points in network,
5. ***Find Common Ancestors task***. To find all of the features that connected to a given point through network,
6. ***Find Connected task***. To find all of the features that are not connected to a given point through network, see figure (5.4)
7. ***Find Disconnected task***. To find a path between two points in the network, see figure (5.5)
8. ***Find Path task***. The path found can be just one of a number of paths between these two points depending on whether or not network contains loops. see figure (5.6)
9. ***Find Loops task***. Loops can result in multiple paths between points . see figure (5.7)

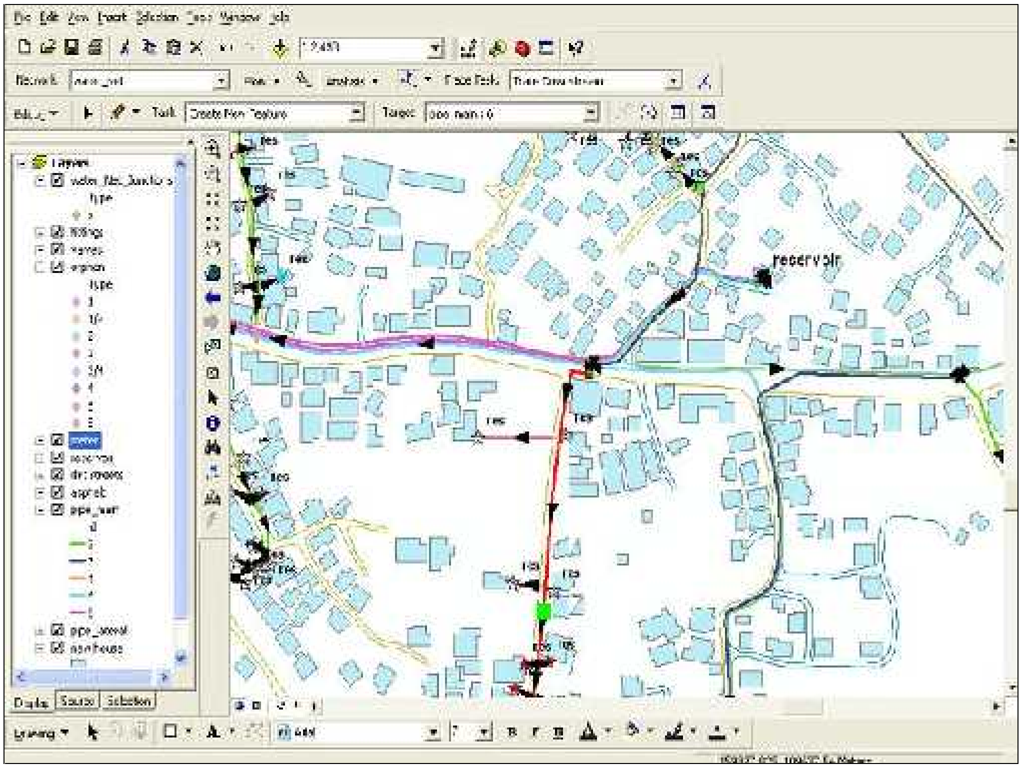


Figure (5.1) ***Trace Downstream***

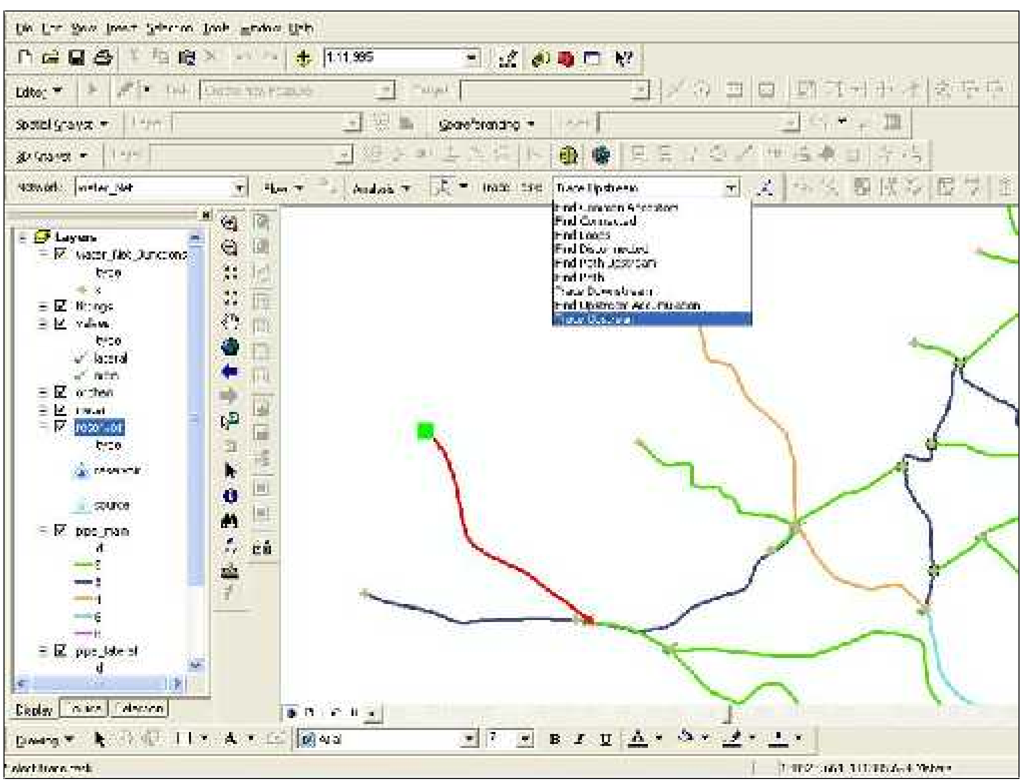


Figure (5.2)Trace upstream

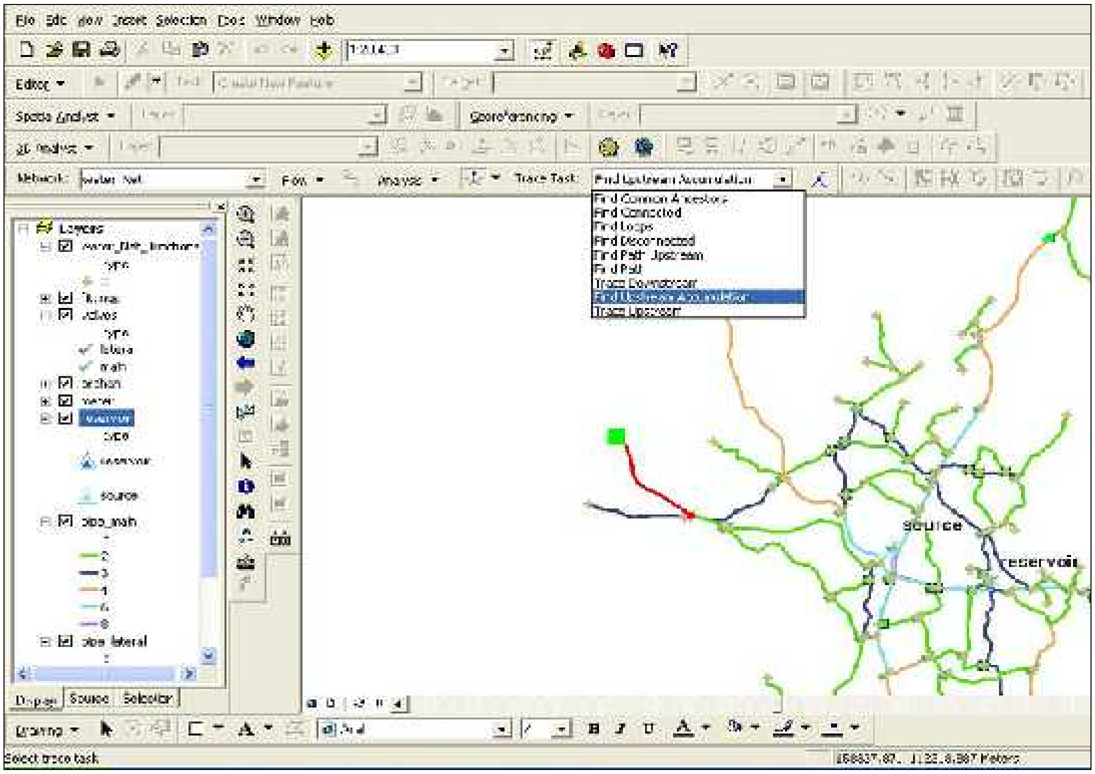


Figure (5.3)*Find Upstream Accumulation*

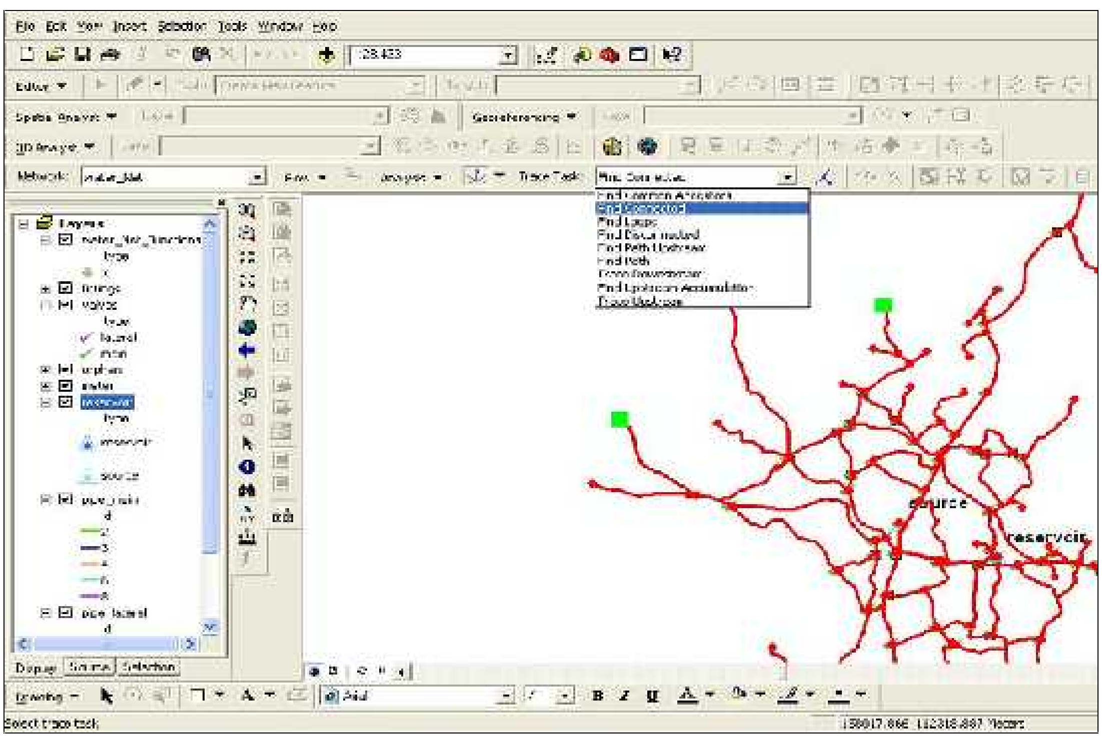


Figure (5.4) Find connected features

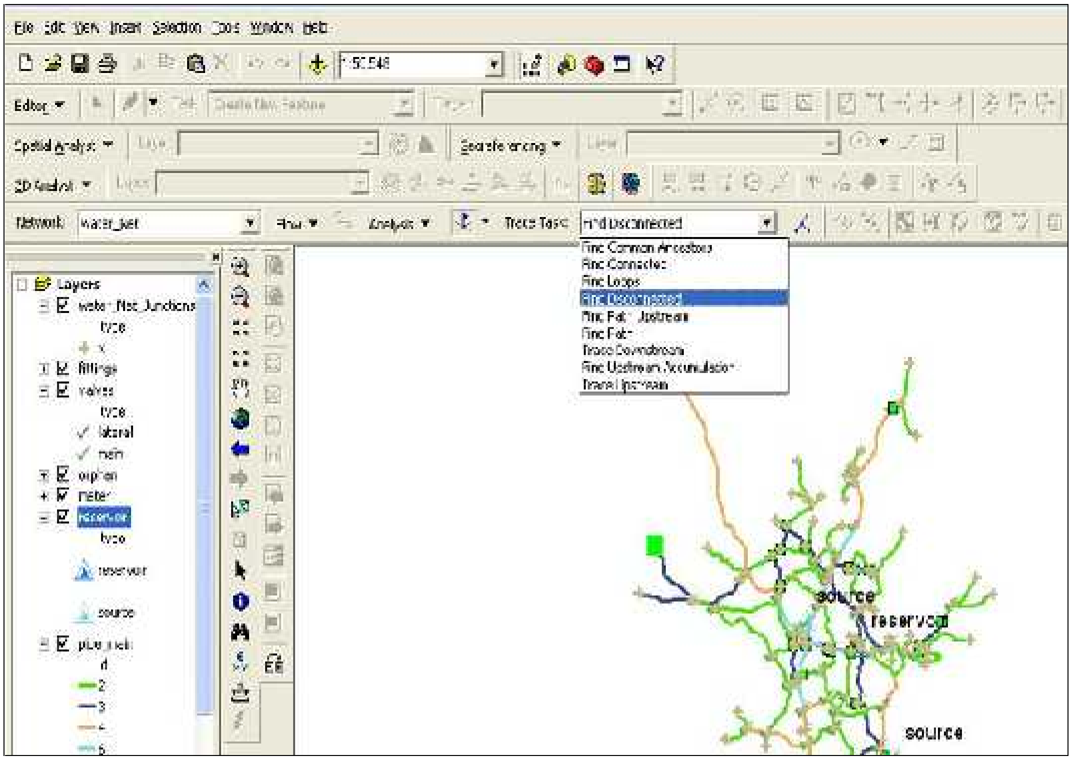


Figure (5.5)*Find Disconnected* features

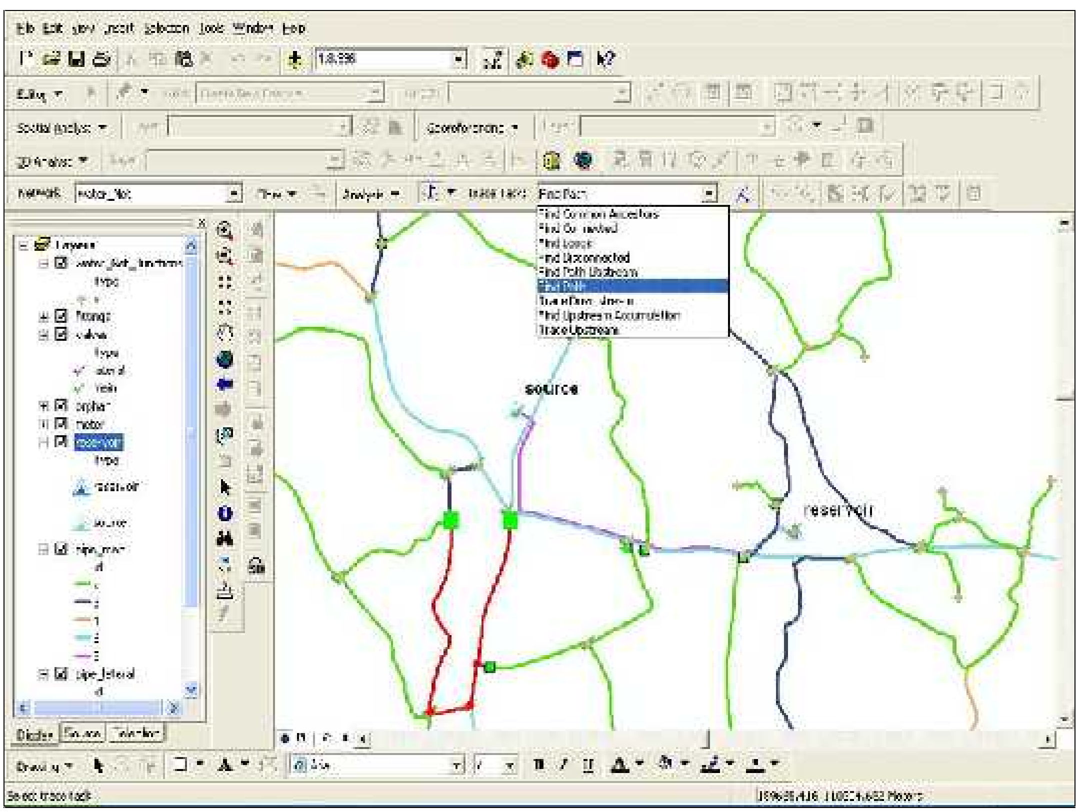


Figure (5.6)*Find Path task*

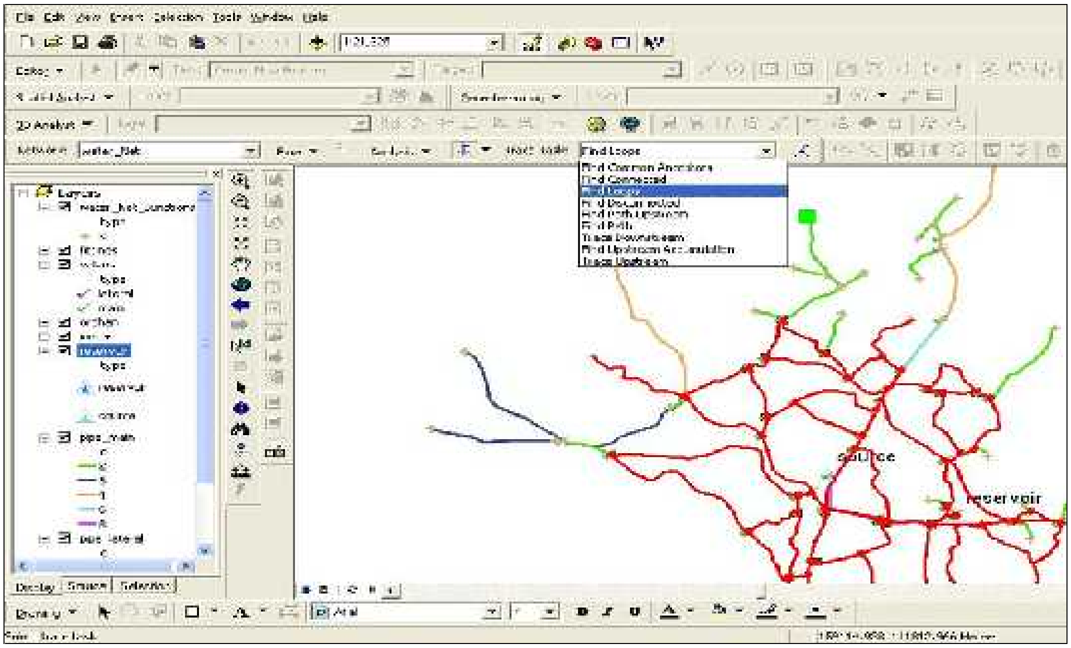


Figure (5.7)*Find loop*

5.2.1 Finding the upstream accumulation without weights

By default, the Find Upstream Accumulation trace task does not use weights. If do not use weights, the cost reported is the number of edge elements in the result

5.2.2 Finding an upstream path with weights

By default, the Find Path Upstream trace task does not use weights. If use weights, the upstream path found to the source is the shortest path based on the weights you specify. To specify weights, total cost means total pipe distance (5050.7 m) see figure (5.8)

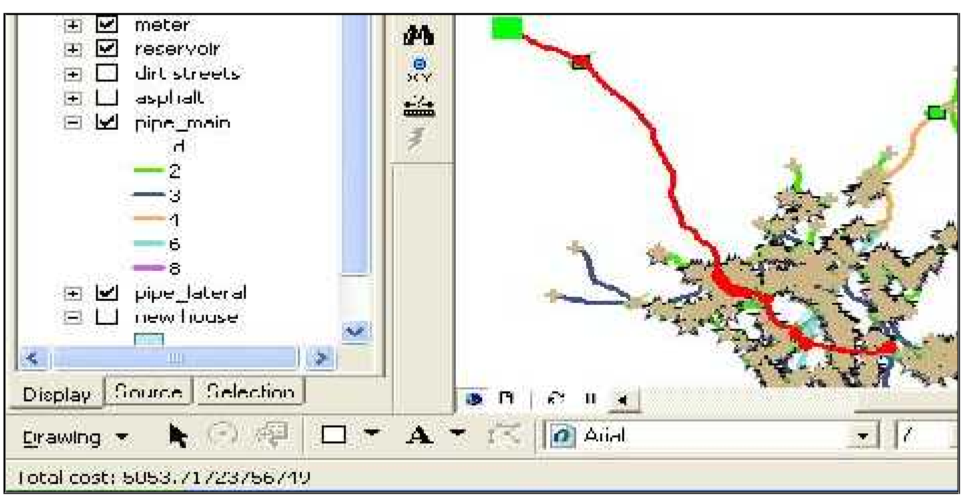


Figure (5.8)Finding an upstream path with weights

5.2.3 Using Find Connected or Find Disconnected

To Find Disconnected trace task always returns the features that the Find Connected trace task does not. The results of one of these trace tasks are often easier to view and analyze than the results of the other. For example, suppose have a mostly connected network and would like to check to make sure all of water network features are connected to each other. Performing a Find Disconnected trace task and checking to see if no features are returned is easier than performing a Find Connected trace task and making sure all of features are returned.

5.2.4 Weight filter syntax

When create a range expression for a weight filter, must use correct syntax. can specify multiple valid or invalid ranges for each weight. must delimit each range with commas. Each range can include a single value or a range of values. To specify a range of values, type a hyphen between the lower and upper bounds of the range.

5.2.5 The Find Path trace task

When use the Find Path trace task, the flags place on the network must be either all edge flags or all junction flags. cannot find a path among a mixture of edge and junction flags

5.2.6 Finding paths without Weights

By default, the Find Path trace task does not use weights. If do not use weights, the shortest path based on the number of edge elements in the path is found.

5.2.7 Finding a downstream path

Find a downstream path using a process similar to finding an upstream path.

5.3 Tracing And Management Using Visual Basic

Visual Basic for Applications. The embedded programming environment for automating, customizing, and extending ESRI applications, such as ArcMap and ArcCatalog. It offers the same tools as Visual Basic (VB) in the context of an existing application. A VBA program operates on objects that represent the application, and can be used to create custom symbols, workspace extensions, commands, tools, and other objects that can be plugged into the ArcGIS framework.

5.3.1 Management Using Visual Basic

With any development programming language, can configure additional buttons to run specific ArcMap commands such as the Zoom In or management tools normally accessed through toolbar buttons and menus. Exploring contains sample Visual Basic for Applications (VBA) code that we can use to run a variety of ArcMap commands from the management.

5.3.2 Using Visual Basic

We need to install the command Valve since it's not available by default in the tool bar See fig(5.9)

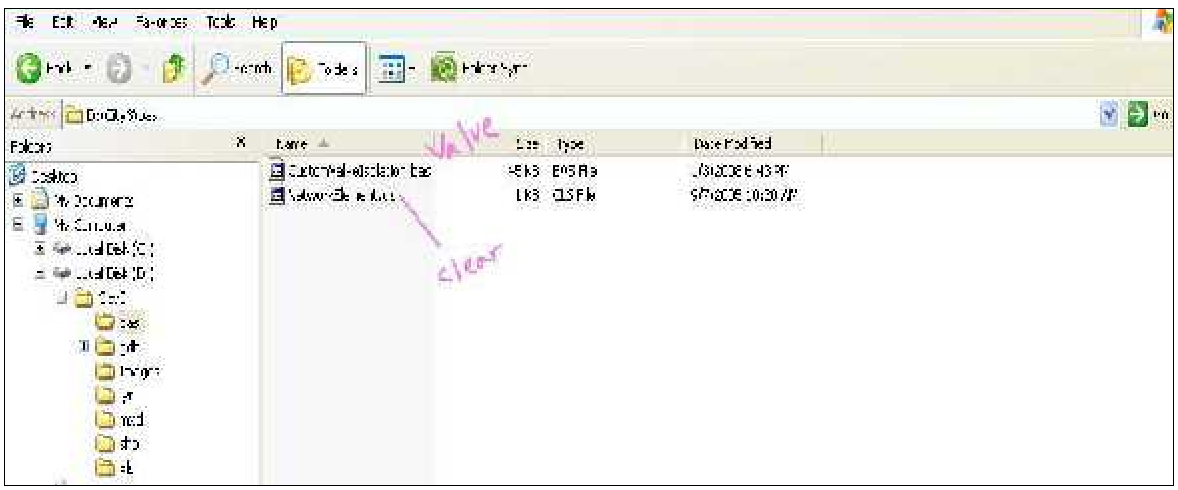


Fig (5.9) the valve file design by visual basic

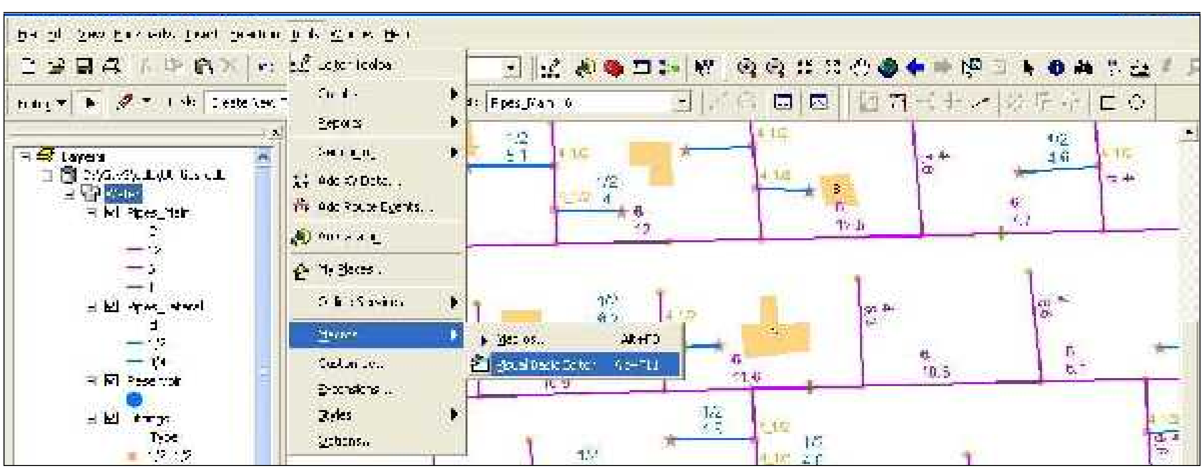


Fig (5.10) Import File To Gis

Replace the name of the geometric network, water source and vale layer by the names that have in system, see Fig (5.11)

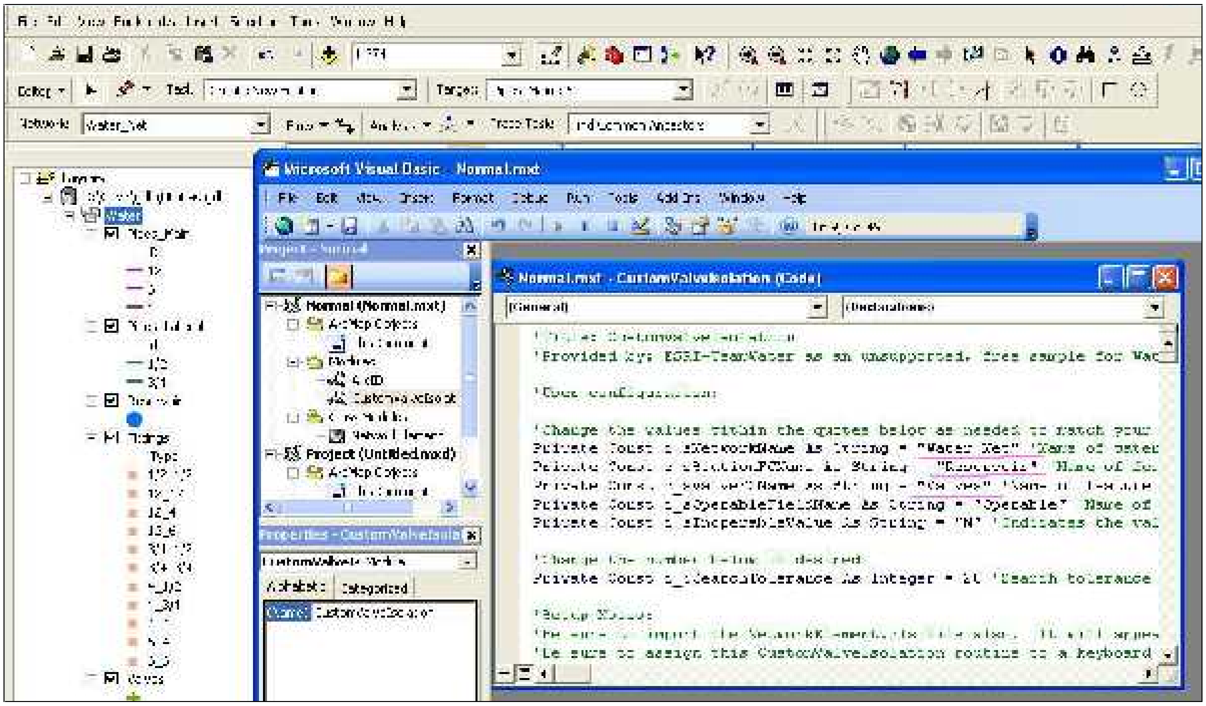


Fig (5.11) Defined Code From Gis

Make keyboard shortcut for the two commands, see Fig (5.12)

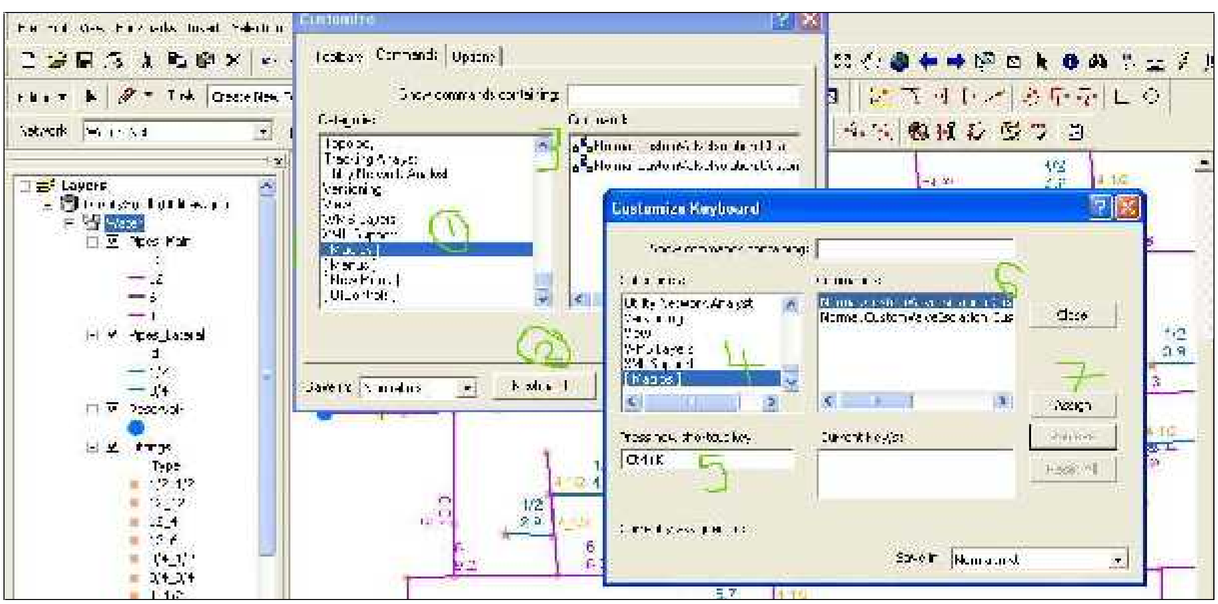


Fig (5.12) Defined Key

5.3.3 Tracing and Management Using The Visual Basic

Network analysis involves tracing. The term tracing is used here to describe building a set of network elements according to some procedure. can think of tracing as placing a transparency on top of a map of network and tracing all the network elements that want to include in your result onto the transparency using visual basic.

When working with networks, tracing involves connectivity. A network element can only be included in a trace result if it is in some way connected to other elements in the trace result.

The trace result is the set of network features that is found by the trace operation. For example, suppose want to find all of the features upstream of a particular point in a water network.

Using a transparency placed over the map of the water network, could trace over all of the branches of the net work that were upstream of that point. What is drawn on the transparency after this would be desired result, This trace between two valves, see fig (5.13).

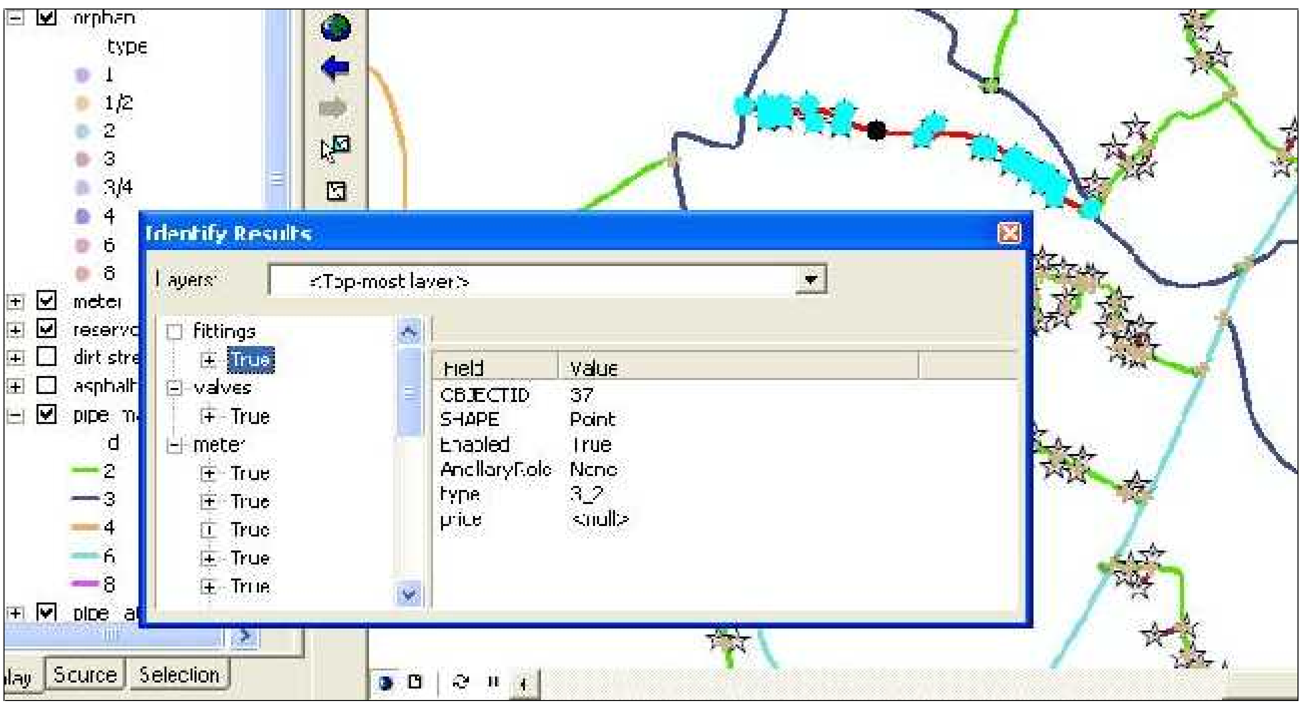


Fig (5.13) Find Upstream Accumulation using (VBA)

Similarly, when perform a trace operation in ArcMap, result is a set of the network elements included in the trace. In ArcMap, trace results can either be. Drawings on top of map or a selection.

APPENDIX

Appendix-A

GIS AND WATER NETWORK

Appendix-B

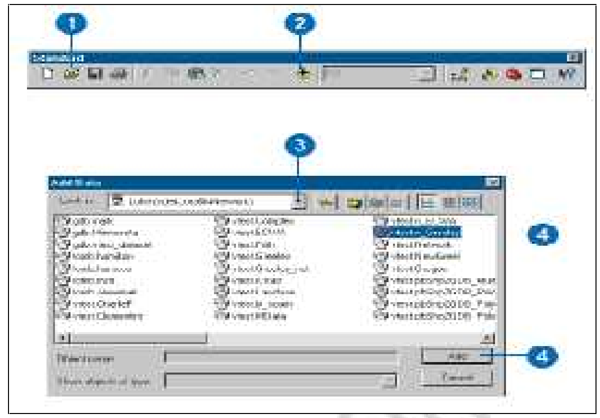
Analyzing Geometric Networks

Opening a geometric network

1. Open the document to which you want to add the network data or create a new document.
2. Click the Add Data button.
3. Navigate to the feature dataset in the geodatabase that contains the network you want to open.
4. Double-click the feature dataset to view the feature classes and geometric networks that it contains.
5. Click the geometric network and click Add.
Your geometric network is added to ArcMap

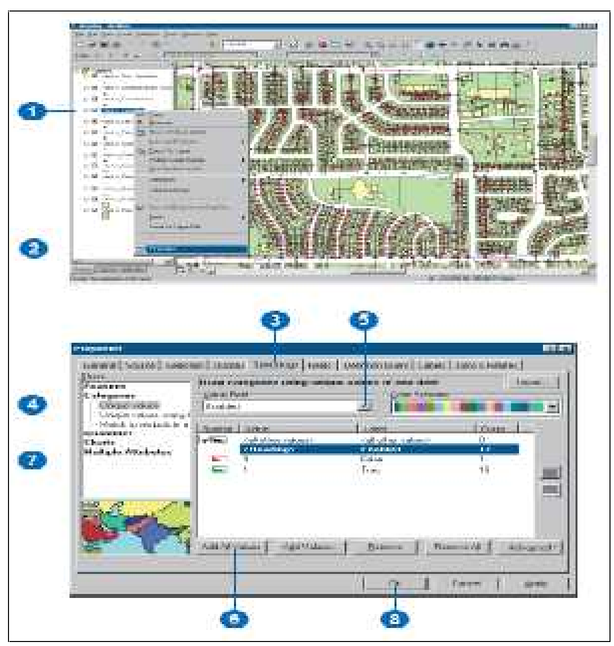
Opening a feature dataset containing a geometric network

1. Open the document to which you want to add the network data or create a new document.
2. Click the Add Data button.
3. Navigate to the feature dataset in the geodatabase that contains the network you want to open.
4. Click the feature dataset and
click Add. The feature dataset containing your geometric network is added to ArcMap.



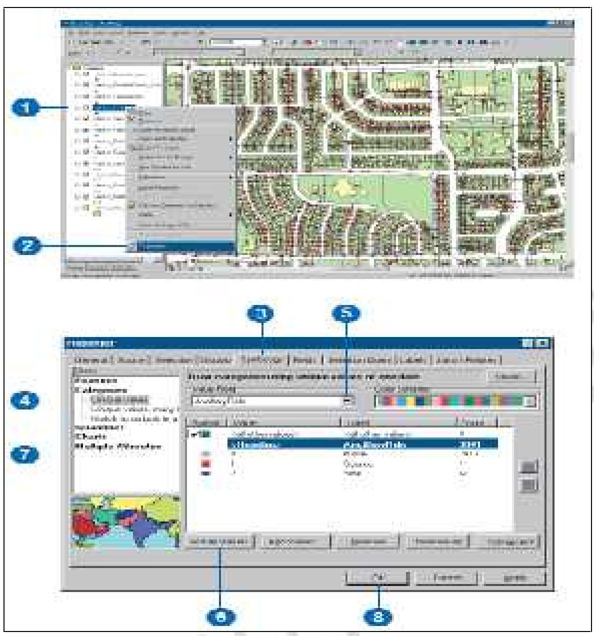
Displaying enabled and disabled features in a layer

1. In the table of contents, rightclick the feature layer for which you want to display enabled and disabled features.
2. Click Properties.
3. Click the Symbology tab.
4. Click the Categories item in the list and click Unique values in the expanded list of items.
5. Click the Value Field dropdown arrow and click Enabled to use this attribute for the symbolization.
6. Click Add All Values.
7. To change the symbol for a particular value, double-click the symbol.
8. Click OK when you are finished formatting the symbols.



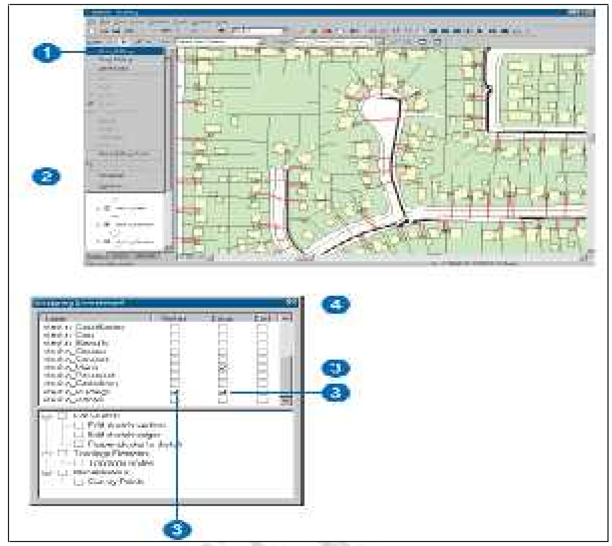
Displaying source and sink features in a layer

1. In the table of contents, rightclick the feature layer for which you want to display source and sink features.
2. Click Properties.
3. Click the Symbology tab.
4. Click the Categories item in the list and click Unique values in the expanded list of items.
5. Click the Value Field dropdown arrow and click AncillaryRole to use this attribute for the symbolization.
6. Click Add All Values.
7. To change the symbol for a particular value, double-click the symbol.
8. Click OK when you are finished formatting the symbols.

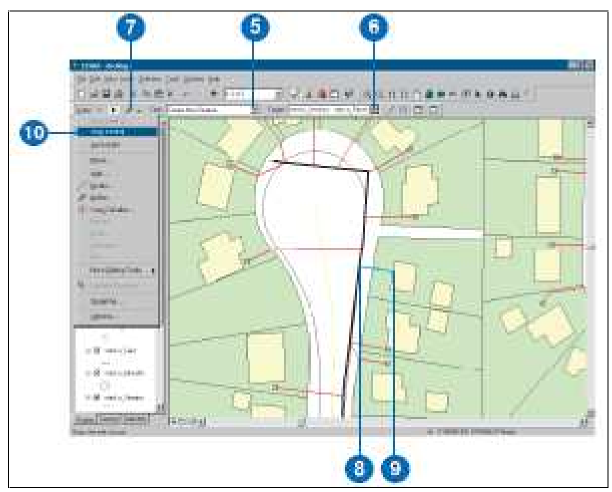


Adding network Features

1. Click Editor and click Start Editing.
2. Click Editor and click Snapping.
3. In the Snapping Environment window, set the appropriate snapping properties.
4. Close the Snapping Environment window. U



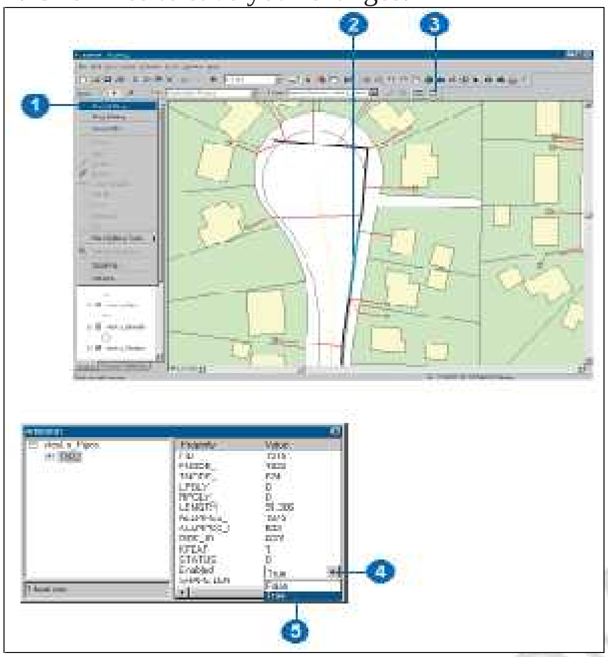
5. Click the Task dropdown arrow and click Create New Feature.
6. Click the Target dropdown arrow and click the layer to which you want to add a feature.
7. Click the Sketch tool.
8. Point to a position on the feature where the new feature is to connect. A target appears to show that snapping is on. Click to create the first vertex of the new feature.
9. Create the remaining vertices of the sketch and doubleclick to finish it.
10. Click Editor and click Stop Editing.
11. Click Yes to save your changes.



Enabling and disabling features

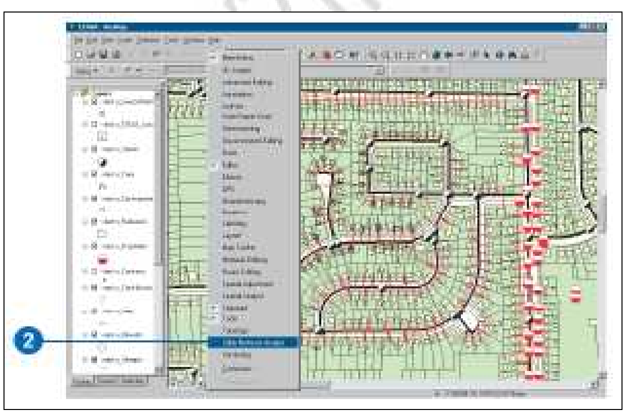
1. Click Editor and click Start Editing.
2. Click the Edit tool and click the feature that you want to enable or disable.
3. Click the Attributes button.

4. Click in the Value column next to the Enabled property. A list box opens showing all of the valid codes for this attribute, as defined by the coded value attribute domain for the Enabled attribute.
5. Click True to enable the feature. Click False to disable the feature.
6. Click Editor and click Stop Editing.
7. Click Yes to save your changes.



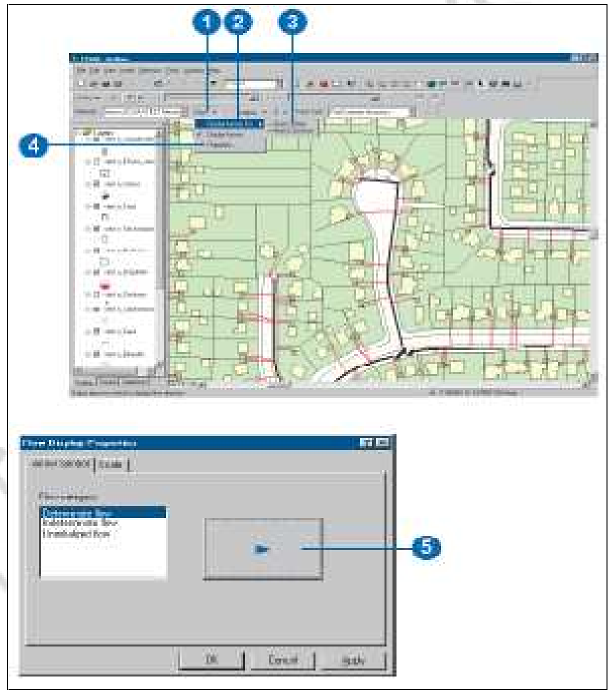
Adding the Utility Network Analyst Toolbar

1. Right-click the Main menu.
2. Click Utility Network Analyst.
3. Dock the toolbar to the ArcMap window. Now, each time you start ArcMap, the toolbar will be displayed.

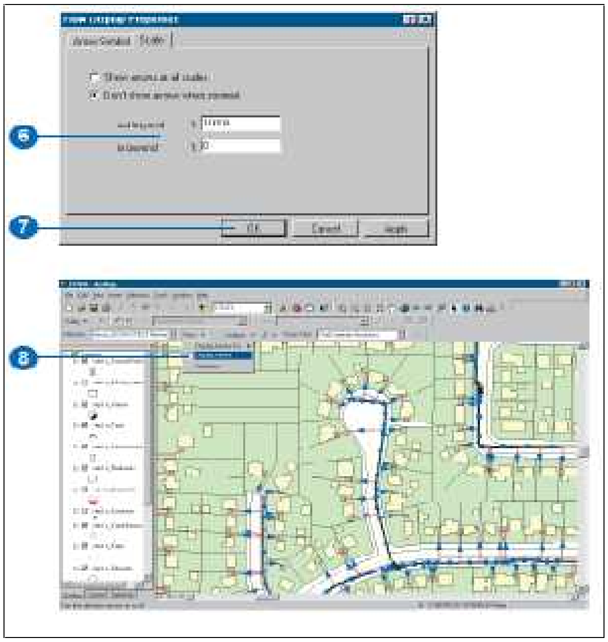


Displaying flow Direction

1. Click the Flow menu on the Utility Network Analyst toolbar.
2. Point to Display Arrows For.
3. Check the layers for which you want to display flow direction.
4. Click Properties.
5. Click the Arrow Symbol tab. Click a Flow category in the list and click the button to specify the size and color of the flow direction arrows

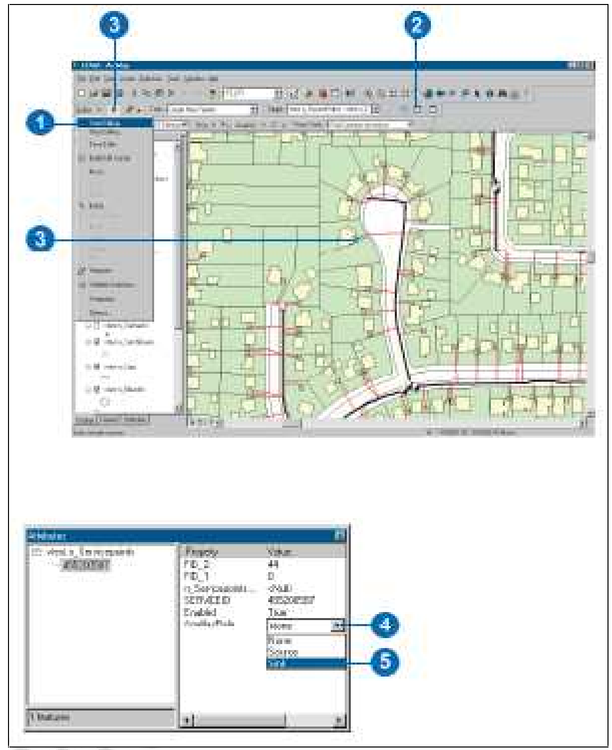


6. Click the Scale tab and specify the scales at which you want to display the flow direction arrows. To show the arrows at all scales, click Show arrows at all scales. To only show the arrows within a scale range, click Don’t show arrows when zoomed and type the scale range limits in the text boxes.
7. Click OK.
8. Click Flow and click Display Arrows. The arrows symbolizing the flow direction are displayed.



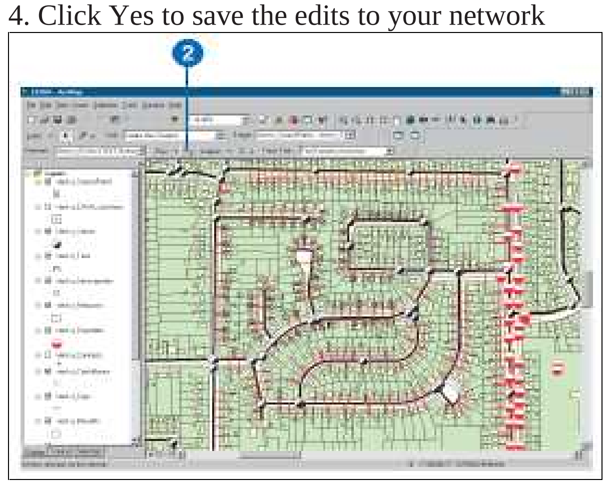
Creating sources and sinks

1. Click the Editor menu and click Start Editing.
2. Click the Attributes button.
3. Click the Edit tool and click the feature that you want to set as a source or sink. This feature must belong to one of the feature classes that you specified as containing sources and sinks when you built your network.
4. In the Attributes window, click the Value column next to the AncillaryRole property.
5. Click Source or Sink to designate this feature as a Source or Sink. You can undo this later by clicking None in this list.
6. Click Editor and click Stop Editing.
7. Click Yes to save the edits to your network



Setting flow direction

1. Click the Editor menu and click Start Editing.
2. Click the Set Flow Direction button on the Utility Network Analyst toolbar. This sets the correct flow direction for your network.
3. Click Editor and click Stop Editing.
4. Click Yes to save the edits to your network



Appendix-C

Management Of Water Network

CHAPTER

6 *CONCLUSIONS*

CHAPTER SIX
CONCLUSIONS

In this project an attempt is made to develop a Geographical Information System (GIS) model for asset management of intermittent water distribution systems that widely spread in the Palestinian communities taking Halhull city water network as case study for this project. The main conclusions drawn from the preliminary present study are:

1. The application of GIS technology for the effective design and management of intermittent water distribution systems is nowadays used in different places and its very important subject. The governments in developing countries should begin to tap in the benefits offered by the use GIS in this regard.

2. The huge rate of population increase in developing countries coupled with severe water shortage has force engineers to rethink effective ways for managing water utilities and GIS application holds the key to an integrated approach to help solve this problem.

3. The proposed project will help the municipalities and local councils in the Palestinian Territories in effectively asset management of the water distribution network to run, and develop long term financial forecast of network asset maintenance as a part of process to adopt continuous improvement programmed for the management of these assets.

4. As this system provides complete life coverage starting from planning until replacement and is very useful for future network forecasting. Up to 10 to 40 years analysis can be done through this asset management, and it tells the inspector how much time it will take to inspect particular network. Expansion and modification can be done more effectively in this road asset management.

5. Using GIS in water distribution system asset management give more accurate result if it is related it with some other water network system asset management software's.

GLOSSARY

Glossary

ArcInfo workspace
A file-based collection of coverages, grids, triangulated irregular networks (TINs), or shapefiles stored as a directory of folders in the file system.

ArcSDE
Server software that provides ArcSDE client applications (such as ArcGIS Desktop, ArcGIS Server, and ArcIMS) a gateway for storing, managing, and using spatial data in one of the following commercial database management systems: IBM DB2 UDB, IBM Informix, Microsoft SQL Server, and Oracle.

attribute
1. Information about a geographic feature in a GIS, generally stored in a table and linked to the feature by a unique identifier. For example, attributes of a river might include its name, length, and average depth.
2. In raster datasets, information associated with each unique value of raster cells.

attribute domain
In a geodatabase, a mechanism for enforcing data integrity. Attribute domains define what values are allowed in a field in a feature class or nonspatial attribute table. If the features or nonspatial objects have been grouped into subtypes, different attribute domains can be assigned to each of the subtypes.

attribute table
A database or tabular file containing information about a set of geographic features, usually arranged so that each row represents a feature and each column represents one feature attribute. In raster datasets, each row of an attribute table corresponds to a certain region of cells having the same value. In a GIS, attribute tables are often joined or related to spatial data layers, and the attribute values they contain can be used to find, query, and symbolize features or raster cells.

attributes dialog box
In ArcMap, a dialog box that displays attributes of selected features for editing.

CAD
A computer-based system for the design, drafting, and display of graphical information. Also known as computer-aided drafting, such systems are most commonly used to support engineering, planning, and illustrating activities.

CAD feature class
A read-only member of a CAD feature dataset, comprising one of the following: polylines, points, polygons, multipatch, or annotation. The feature attribute table of a CAD feature class is a virtual table comprising select CAD graphic properties and any existing field attribute values.

check-out geodatabase
A personal or ArcSDE geodatabase that contains data checked out from a master geodatabase.

connectivity
1. In a geodatabase, the state of edges and junctions in a logical network that controls flow, tracing, and pathfinding.
2. In a coverage, topological identification of connected arcs by recording the from-node and to-node for each arc. Arcs that share a common node are connected. See also arc–node topology.

connectivity rule
A rule that constrains the type and number of network features that can be connected to one another in a geodatabase. There are two types of connectivity rules: edge–junction and edge–edge.

coordinate system
A fixed reference framework superimposed on the surface of an area to designate the position of a point within it; a reference system consisting of a set of points, lines, and/or surfaces; and a set of rules, used to define the positions of points in space in either two or three dimensions. The Cartesian coordinate system and the geographic coordinate system used on the earth's surface are common examples of coordinate systems.

coordinates
Values represented by x, y, and possibly z that define a position in terms of a spatial reference framework. Coordinates are used to represent locations on the earth's surface relative to other locations.

coverage
A data model for storing geographic features using ArcInfo software. A coverage stores a set of thematically associated data considered a unit. It usually represents a single layer, such as soils, streams, roads, or land use. In a coverage, features are stored as both primary features (points, arcs, polygons) and secondary features (tics, links, annotation). Feature attributes are described and stored independently in feature attribute tables. Coverages cannot be edited in ArcGIS.

cracking
A part of the topology validation process in which vertices are created at the intersection of feature edges.

cubic convolution
A resampling method that uses an average of the nearest 16 cells to calculate the new cell value.

current task
During editing in ArcMap, a setting in the Current Task dropdown list that determines the task with which the sketch construction tools (Sketch, Arc, Distance–Distance, and Intersection) will work. The current task is set by clicking a task in the Current Task dropdown list.

custom behavior
A set of methods, functions, or operations associated with a geodatabase object that has been specifically created or overridden by a developer.

custom feature
In geodatabases, a feature with specialized behavior instantiated in a class by a developer.

custom object
An object with custom behavior provided by a developer.

data
Any collection of related facts arranged in a particular format; often, the basic elements of information that are produced, stored, or processed by a computer.

data source
Any geographic data. Data sources may include coverages, shapefiles, rasters, or feature classes.

data type
The attribute of a variable, field, or column in a table that determines the kind of data it can store. Common data types include character, integer, decimal, single, double, and string.

data view
An all-purpose view in ArcMap and ArcReaderTM for exploring, displaying, and querying geographic data. This view hides all map elements, such as titles, North arrows, and scalebars.

database
One or more structured sets of persistent data, managed and stored as a unit and generally associated with software to update and query the data. A simple database might be a single file with many records, each of which references the same set of fields. A GIS database includes data about the spatial locations and shapes of geographic features recorded as points, lines, areas, pixels, grid cells, or TINs, as well as their attributes.

Data set
Any organized collection of data with a common theme.

decimal degrees
Values of latitude and longitude expressed in decimal format rather than degrees, minutes, and seconds.

default junction type
In geometric networks, the user-established junction type that automatically connects two edge types in the absence of a current user choice, in cases where two edge types may be

connectable through more than one junction type. An edge may also have a default end junction type, used for the free ends of new edges.

digitizing

The process of converting the geographic features on an analog map into digital format using a digitizing tablet, or digitizer, which is connected to a computer. Features on a paper map are traced with a digitizer puck, a device similar to a mouse, and the x,y coordinates of these features are automatically recorded and stored as spatial data.

dimension feature class

A collection of spatial data in the geodatabase that shares the same dimension features. Like other feature classes in the geodatabase, all features in a dimension feature class have a geographic location and attributes and can either be inside or outside a feature dataset.

direct connect

A two-tier configuration for connecting to a spatial database. Direct connect moves processing from the server to the client. It does not require the ArcSDE Application Server to connect to a spatial database. With direct connect, ArcSDE processing still occurs, but it primarily happens on the client side.

disconnected editing

The process of copying data to another geodatabase, editing that data, then merging the changes with the data in the source or master geodatabase.

distance units

The units of length (for example, feet, miles, meters, or kilometers) that are used to report measurements, dimensions of shapes, and distance tolerances and offsets.

double precision

The level of coordinate exactness based on the possible number of significant digits that can be stored for each coordinate. Datasets can be stored in either single or double precision. Double-precision geometries store up to 15 significant digits per coordinate (typically 13 to 14 significant digits), retaining the accuracy at much less than one meter at a global extent.

edge

A line between two nodes, points, or junctions that forms the boundary of one or more faces of a spatial entity. In an image, edges separate areas of different tones or colors. In a topology, an edge defines lines or polygon boundaries; multiple features in one or more feature classes may share edges.

edge element

A line connecting nodes in the network through which a commodity, such as information, water, or electricity, presumably flows.

edge–edge rule

In geodatabases, a connectivity rule that establishes that an edge of type A may connect to an edge of type B through a junction of type C. Edge–edge rules always involve a junction type.

edge–junction cardinality

In a relationship between objects in a geodatabase, the number of edges of one type that may be associated with junctions of another type. Edge–junction cardinality defines a range of permissible connections that may occur in a one-to-many relationship between a single junction and many edges.

edge–junction rule

A connectivity rule in geodatabases establishing that an edge of type A may connect to a junction of type B.

Editor toolbar

In ArcMap, a set of tools that allows the creation and modification of features and their attributes.

extensible markup language (XML)

Developed by the World Wide Web Consortium (W3C), XML is a standard for designing text formats that facilitates the interchange of data between computer applications. XML is a set of rules for creating standard information formats using customized tags and sharing both the format and the data across applications.

feature

1. A representation of a real-world object on a map. Features can be represented in a GIS as vector data (points, lines, or polygons) or as cells in a raster data format. To be displayed in a GIS, features must have geometry and locational information.
2. A group of spatial elements that represents a real-world entity. A complex feature is made up of more than one group of spatial elements: for example, a set of line elements with the common theme of roads representing a road network.

feature attribute table

See attribute table.

feature class

A collection of geographic features with the same geometry type (such as point, line, or polygon), the same attributes, and the same spatial reference. Feature classes can stand alone within a geodatabase or be contained within shapefiles, coverages, or other feature datasets. Feature classes allow homogeneous features to be grouped into a single unit for data storage purposes. For example, highways, primary roads, and secondary roads can be grouped into a line feature class named “roads”. In a geodatabase, feature classes can also store annotation and dimensions.

feature dataset

A collection of feature classes stored together that share the same spatial reference; that is, they have the same coordinate system, and their features fall within a common geographic area. Feature classes with different geometry types may be stored in a feature dataset.

field

A column in a table that stores the values for a single attribute. See also attribute, column.

geodatabase

An object-oriented data model introduced by ESRI that represents geographic features and attributes as objects and the relationships between objects but is hosted inside a relational database management system. A geodatabase can store objects, such as feature classes, feature datasets, nonspatial tables, and relationship classes.

geodatabase data model

A geographic data model that represents real-world geographic features as objects in an object-relational database. In the geodatabase data model, features are stored as rows in a table, and geometry is stored in a shape field. Objects in the geodatabase data model may have custom behavior.

geometric network

Topologically connected edge and junction features that represent a linear network such as a road, utility, or hydrologic system.

identity

A topological overlay that computes the geometric intersection of two coverages. The output coverage preserves all the features of the first coverage plus those portions of the second (polygon) coverage that overlap the first. For example, a road passing through two counties would be split into two arc features, each with the attributes of the road and the county it passes through.

IP address

Internet protocol address. The identification of each client or server computer on the Internet by a unique number. IP addresses allow data to travel between one computer and another via the Internet and are commonly expressed as a dotted quad, with four sets of numerals separated by periods.

item

1. An element in the Catalog tree. Items include data sources, such as shapefiles and geodatabases, and nonspatial elements, such as folders.
2. A column of information in an INFO table. See also field.

junction element

In a linear network, a network feature that occurs at the intersection of two or more edges or at the endpoint of an edge that allows the transfer of flow between edges.

logical network
An abstract representation of a network. A logical network consists of edge, junction, and turn elements and the connectivity between them. It does not contain information about the geometry or location of its elements.
map
1. A graphic depiction on a flat surface of the physical features of the whole or a part of the earth or other body, or of the heavens, using shapes to represent objects and symbols to describe their nature; at a scale whose representative fraction is less than 1:1. Maps generally use a specified projection and indicate the direction of orientation.
2. The document used in ArcMap to display and work with geographic data. In ArcMap, a map contains one or more layers of geographic data, contained in data frames, and various supporting map elements, such as a scalebar.
multipart feature
A feature that is composed of more than one physical part but only references one set of attributes in the database. For example, in a layer of states, the state of Hawaii could be considered a multipart feature. Although composed of many islands, it would be recorded in the database as one feature.
multipoint feature
A feature that consists of more than one point but only references one set of attributes in the database. For example, a system of oil wells might be considered a multipoint feature, since there is a single set of attributes for multiple well holes.
nearest-neighbor resampling
A technique for resampling raster data in which the value of each cell in an output grid is calculated using the value of the nearest cell in an input grid. Nearest-neighbor assignment does not change any of the values of cells from the input layer; for this reason, it is often used to resample categorical or integer data (for example, land use, soil, or forest type). See also bilinear interpolation, cubic convolution.
network trace
A function that follows connectivity in a geometric network. Specific kinds of network tracing include finding features that are connected, finding common ancestors, finding loops, tracing upstream, and tracing downstream. See also geometric network.
node
In a geodatabase, the point representing the beginning or ending point of an edge, topologically linked to all the edges that meet there.
object
In GIS, a digital representation of a discrete spatial entity. An object may belong to an object class and will thus have attribute values and behavior in common with other defined elements.
object class
A collection of objects in the geodatabase that have the same behavior and the same set of attributes. All objects in the geodatabase are stored in object classes.
password
A secret series of characters that enables a user to access a computer, data file, or program. The user must enter his or her password before the computer will respond to commands. The password helps ensure that unauthorized users do not access the computer, file, or program.
File geodatabase
A geodatabase that stores data in a single-user relational database management system. A File geodatabase can be read simultaneously by several users, but only one user at a time can write data into it.
point
A zero-dimensional abstraction of an object; a single x,y coordinate pair that represents a geographic feature too small to be displayed as a line or area at that scale.
point mode digitizing
A method of digitizing in which a series of precise points, or vertices, are created. See also stream mode digitizing.
polygon

A closed, two-dimensional figure with at least three sides that represents an area. It is used in GIS to describe spatial elements with a discrete area, such as parcels, political districts, areas of homogeneous land use, and soil types.

relationship

An association or link between two objects in a geodatabase. Relationships can exist between spatial objects (features in feature classes), nonspatial objects (rows in a table), or spatial and nonspatial objects.

relationship class

An item in the geodatabase that stores information about a relationship. A relationship class is visible as an item in the ArcCatalog tree or contents view.

schema

The organization and definitions of the feature classes, tables, and other items in a geodatabase. Creating or deleting items or changing their definitions modifies the schema. The schema does not include actual data, only its structure.

schema-only check-out

A type of check-out that creates the schema of the data being checked out in the check-out geodatabase but does not copy any data.

segment

A line that connects vertices. For example, in a sketch of a building, a segment might represent one wall.

select

To choose from a number or group of features or records; to create a separate set or subset.

selected set

A subset of features in a layer or records in a table that is chosen by the user.

selection anchor

In an ArcMap editing session, a small “x” located in the center of selected features. The selection anchor is used in the snapping environment or when rotating, moving, and scaling features.

server

A computer in a network that is used to provide services, such as access to files or e-mail routing, to other computers in the network. Servers may also be used to host Web sites or applications that can be accessed remotely.

service

A collection of persistent, server-side software processes that provides data or computing resources for client applications. Examples include ArcSDE Application Server, ArcIMS Application Server, and DBMS server.

shape

The characteristic appearance or visible form of a geographic object. Geographic objects can be represented on a map using one of three basic shapes: points, lines, or polygons.

shapefile

A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class.

simple feature

A point, line, or polygon that is not part of a geometric network and is not an annotation feature, dimension feature, or custom object.

single precision

Refers to a level of coordinate exactness based on the number of significant digits that can be stored for each coordinate. Single precision numbers store up to seven significant digits for each coordinate, retaining a precision of ±5 meters in an extent of 1,000,000 meters. Datasets can be stored in either single or double precision coordinates. See also double precision.

snapping

An automatic editing operation in which points or features within a specified distance or tolerance of other points or features are moved to match or coincide exactly with each other’s coordinates.

snapping environment

Settings in the ArcMap Snapping Environment window and Editing Options dialog box that define the conditions in which snapping will occur. These settings include snapping tolerance, snapping properties, and snapping priority.

snapping priority

The order in which snapping will occur by layer during an ArcMap editing session, set from the Snapping Environment window. See also snapping environment.

snapping properties

In ArcMap editing, a combination of a shape to snap to and a method for what part of the shape will be snappped to. Snapping properties can be set to have a feature snap to a vertex, edge, or endpoint of features in a specific layer. For example, a layer snapping property might allow snapping to the vertices of buildings. A more generic, sketch-specific snapping property might allow snapping to the vertices of a sketch being created.

spatial database

Any database that contains spatial data.

spatial domain

For a spatial dataset, the defined precision and allowable range for x and y coordinates and for m- and z-values, if present. The spatial domain must be specified by the user when creating a geodatabase feature dataset or standalone feature class.

spatial reference

The coordinate system used to store a spatial dataset. For feature classes and feature datasets within a geodatabase, the spatial reference also includes the spatial domain.

SQL

See Structured Query Language.

Structured Query Language (SQL)

A syntax for defining and manipulating data from a relational database. Developed by IBM in the 1970s, SQL has become an industry standard for query languages in most relational database management systems.

subtype

In geodatabases, a subset of features in a feature class or objects in a table that share the same attributes. For example, the streets in a streets feature class could be categorized into three subtypes: local streets, collector streets, and arterial streets. Creating subtypes can be more efficient than creating many feature classes or tables in a geodatabase—for example, a geodatabase with one dozen feature classes that have subtypes will perform better than a geodatabase with one hundred feature classes. Subtypes also make editing data faster and more accurate because default attribute values and domains can be set up. For example, a Local Street subtype could be created and defined so that whenever this type of street is added to the feature class, its speed limit attribute is automatically set to 35 miles per hour.

symbol

A graphic representation of a geographic feature or class of features that helps identify and distinguish it from other features on a map. For example, line symbols represent arc features; marker symbols, points; shade symbols, polygons; and text symbols, annotation. Many characteristics define symbols including color, size, angle, and pattern.

symbology

The set of conventions, or rules, that defines how geographic features are represented with symbols on a map. A characteristic of a feature may influence the size, color, and shape of the symbol used.

table

A set of data elements arranged in rows and columns. Each row represents an individual entity, record, or feature, and each column represents a single field or attribute value. A table has a specified number of columns but can have any number of rows.

table of contents

A list of data frames and layers on a map that shows how the data is symbolized.

topology

1. In geodatabases, a set of governing rules applied to feature classes that explicitly define the spatial relationships that must exist between feature data.

2. In an ArcInfo coverage, the spatial relationships between connecting or adjacent features in a geographic data layer (for example, arcs, nodes, polygons, and points). Topological relationships are used for spatial modeling operations that do not require coordinate information. See also arc–node topology, polygon–arc topology.

topology rule

An instruction to the geodatabase defining the permissible relationships of features within a given feature class or between features in two different feature classes.

union

A topological overlay of two polygonal spatial datasets that preserves features that fall within the spatial extent of either input dataset; that is, all features from both coverages are retained. See also identity, intersect.

vertex

One of a set of ordered x,y coordinate pairs that defines a line or polygon feature.

work flow

An organization's established processes for design, construction, and maintenance of facilities.

workspace

A container for geographic data. A workspace can be a folder that contains shapefiles, an ArcInfo workspace that contains coverages, a geodatabase, or a feature dataset.

XML Metadata Interchange (XMI)

A standard from Object Management Group (OMG) that specifies how to store a UML model in an XML file. ArcGIS can read models in XMI files.

XML recordset document

An export file containing the features or records from an individual geodatabase feature class or table. Data in the file is encoded in XML and can be imported into an existing feature class or table.

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REFERENCES

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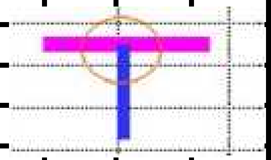
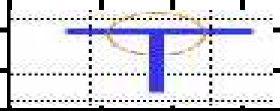
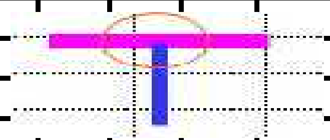




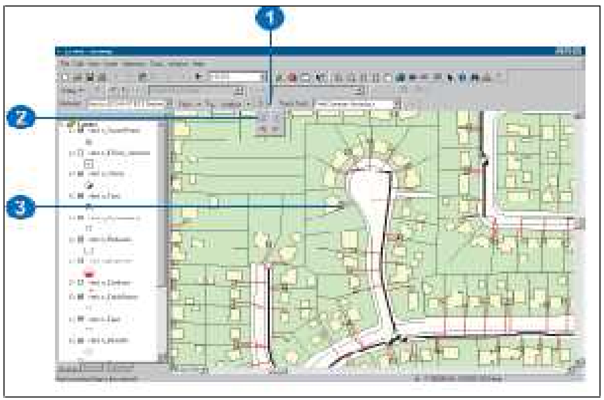


Fig(3.13) water distribution System management using GIS connectivity

Tracing Operations

Adding flags and barriers

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow.
2. Click the button representing the flag or barrier element that you want to add to the network.
3. Point to the edge or junction feature to which you want to add the flag or barrier.
4. Click to add the flag or barrier.

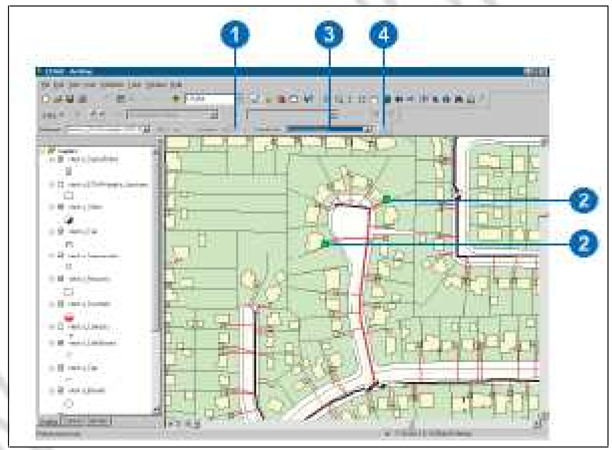


Tracing downstream

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point from which you want to trace downstream.
3. Click the Trace Task dropdown arrow and click Trace Downstream.
4. Click the Solve button. All of the features downstream of your flags are displayed.

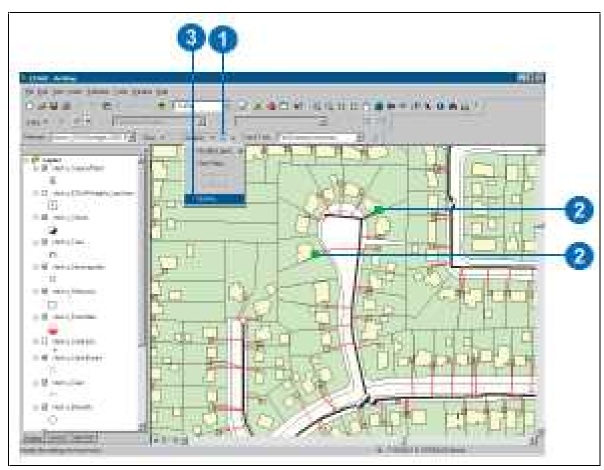
Tracing upstream

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point from which you want to trace upstream.
3. Click the Trace Task dropdown arrow and click Trace Upstream.
4. Click the Solve button. All of the features upstream of your flags are displayed.

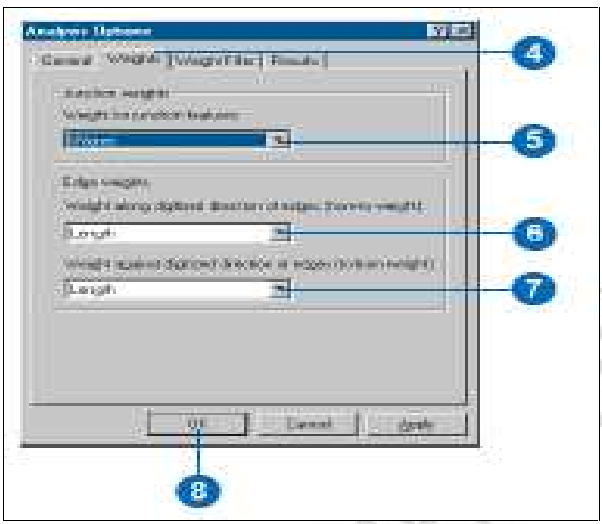


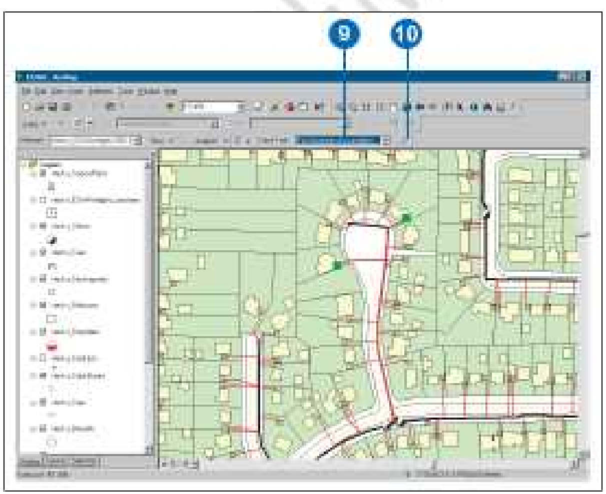
Finding the upstream accumulation

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point from which you want to find the upstream accumulation.
3. Click Analysis and click Options.



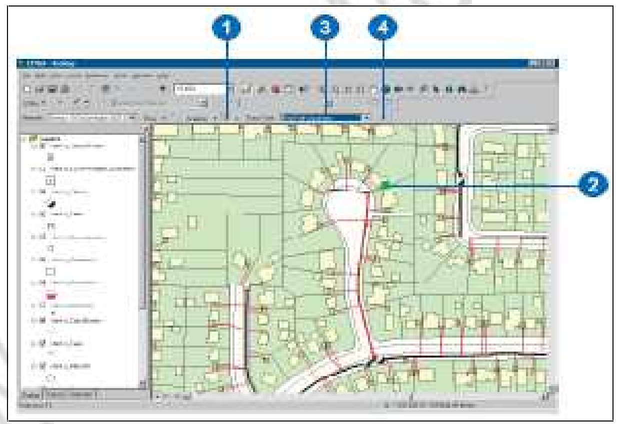
4. Click the Weights tab.
5. Click the Junction weights dropdown arrow and click the name of the weight you want to use for junctions.
6. Click the from–to edge weight dropdown arrow and click the name of the weight you want to use for tracing edges along the digitized direction.
7. Click the to–from edge weight dropdown arrow and click the name of the weight you want to use for tracing edges against the digitized direction.
8. Click OK.
9. Click the Trace Task dropdown arrow and click Find Upstream Accumulation.
10. Click the Solve button. All of the features upstream of your flags are displayed, and the total cost of these features is reported in the status bar.





Finding an upstream path to the source

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find an upstream path to the source.
3. Click the Trace Task dropdown arrow and click Find Path Upstream.
4. Click the Solve button. For each of your flags, an upstream path from the flag to the source is displayed.

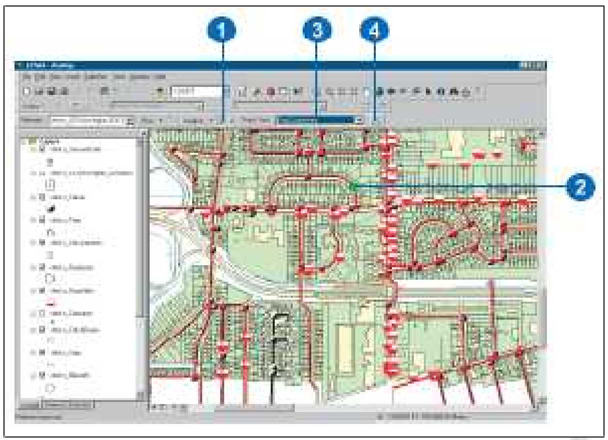


Finding common ancestors

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find the common ancestors.
3. Click the Trace Task dropdown arrow and click Find Common Ancestors.
4. Click the Solve button. The features that are upstream of all of your flags are displayed.

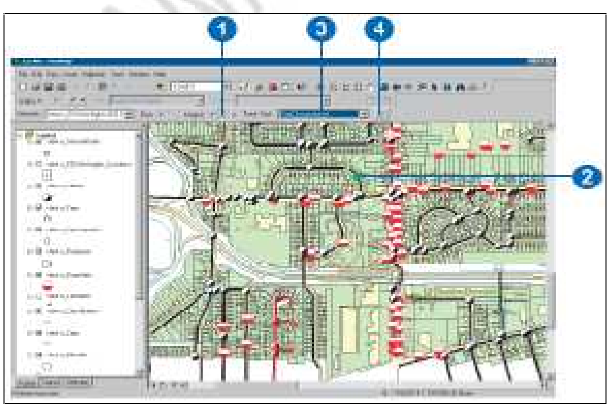
Finding connected features

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find the connected features.
3. Click the Trace Task dropdown arrow and click Find Connected.
4. Click the Solve button. The features that are connected to the features on which you placed your flags are displayed.



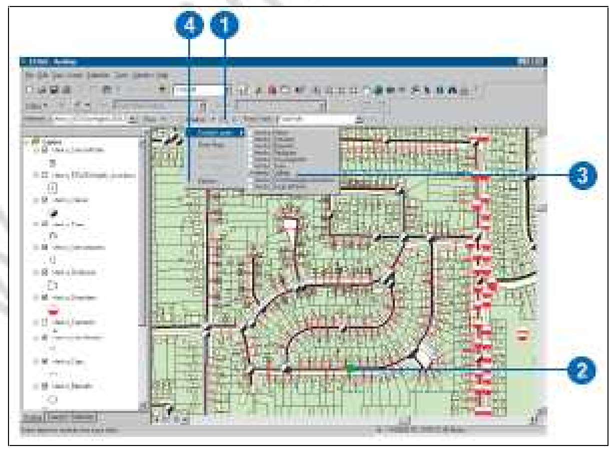
Finding disconnected features

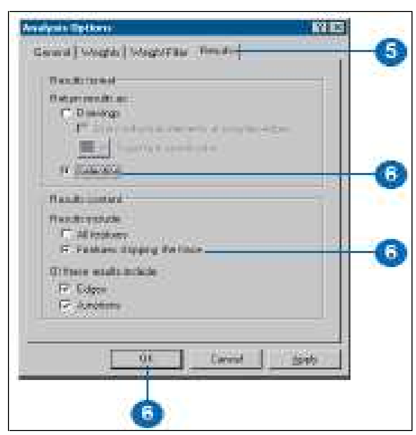
1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find the disconnected features.
3. Click the Trace Task dropdown arrow and click Find Disconnected.
4. Click the Solve button. The features that are not connected to the features on which you placed your flags are displayed.



Isolating a point on the network

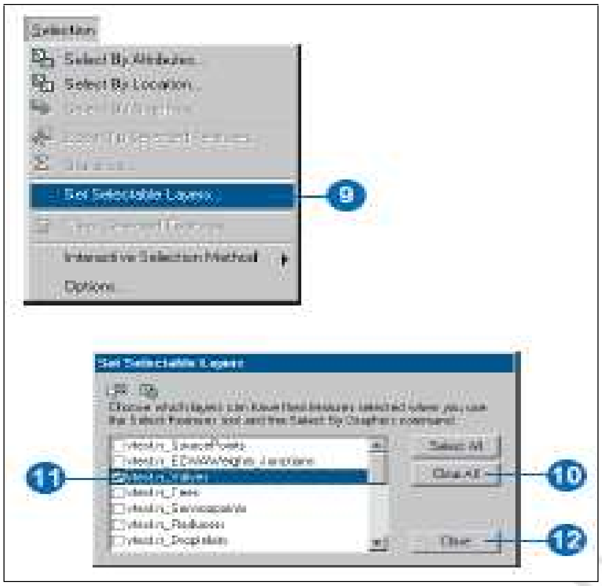
1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click on the map to place a flag at the point you want to isolate.
3. Click Analysis and click Disable Layers. Check the layer or layers containing the features that will be used to isolate this point.
4. Click Analysis and click Options.
5. Click the Results tab.
6. Click Selection in the Results format section.
7. Click Features stopping the trace in the Results content section.
8. Click OK

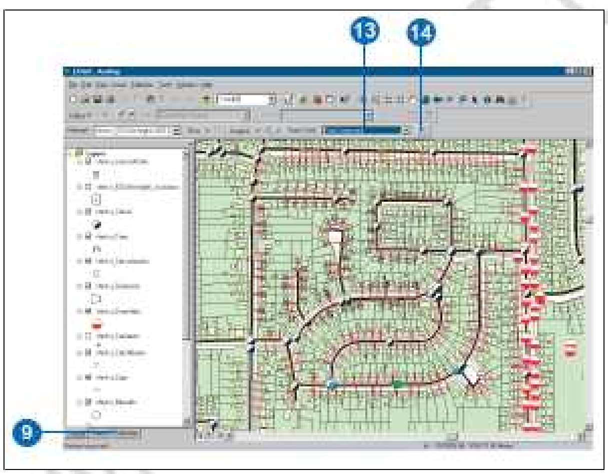




9. Click Selection on the Main menu and click Set Selectable Layers. Or, click the Selection tab on the table of contents.
10. Click Clear All to uncheck all the layers.

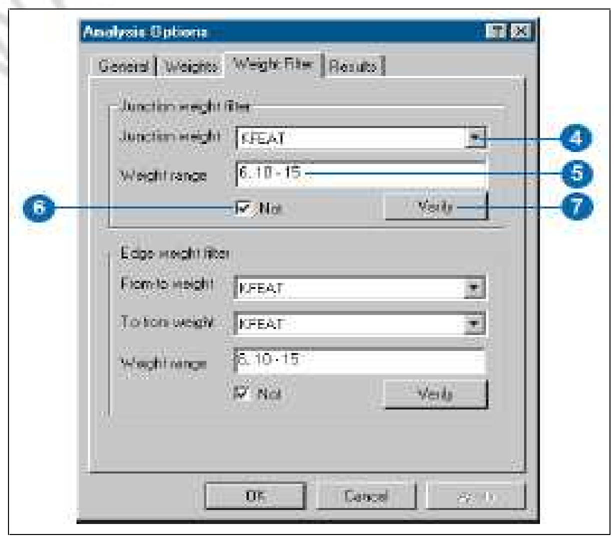
11. Check the layers that contain the features that will be used to isolate your point in the network.
12. Click Close.
13. Click the Trace Task dropdown arrow and click Find Connected.
14. Click the Solve button. The features that are selected can be used to isolate your point in the network.





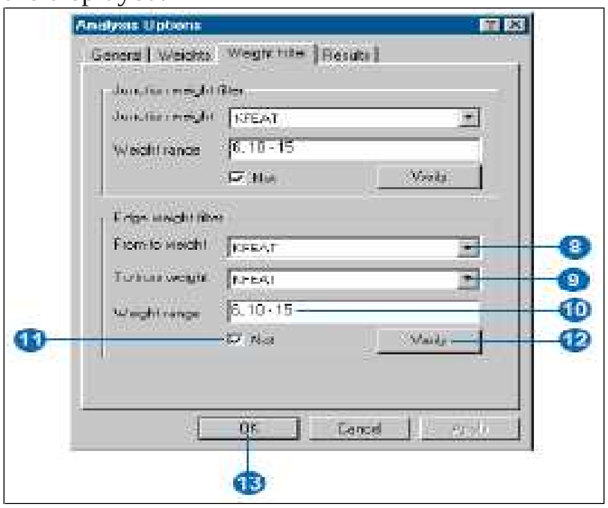
Finding connected features using weight filters

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find the connected features.
3. Click Analysis and click Options.
4. Click the Weight Filter tab. Click the Junction weight dropdown arrow and click the name of the weight you want to use to filter junctions.
5. In the Weight range text box for junctions, type the expression you want to use to filter junctions.
6. Check the Not check box to exclude this range.
7. Click Verify to check the syntax of the junction weight filter.



8. Click the From-to weight dropdown arrow and click the name of the weight you want to use to filter edges along their digitized direction.
9. Click the To-from weight dropdown arrow and click the name of the weight you want to use to filter edges against their digitized direction.
10. In the Weight range text box for edges, type the expression you want to use to filter edges.
11. Check the Not check box to exclude this range.

12. Click Verify to check the syntax of the edge weight filter.
13. Click OK.
14. Click the Trace Task dropdown arrow and click Find Connected.
15. Click the Solve button. The features that are connected to the features on which you placed your flags, using the weight filter you specified, are displayed.

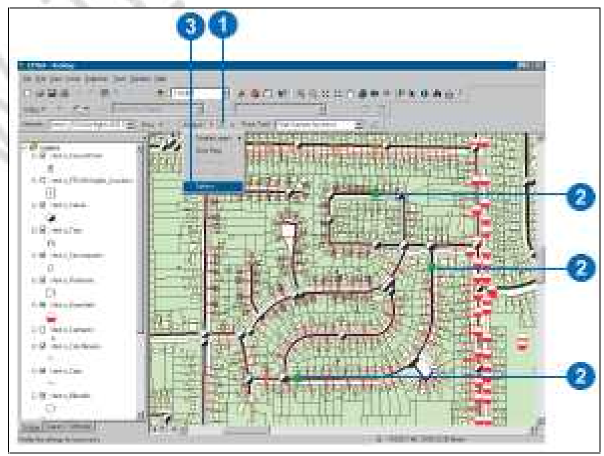


Finding a path

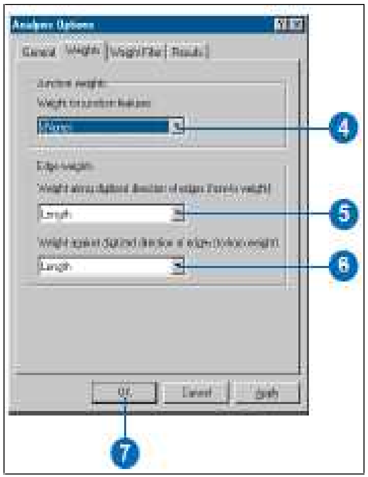
1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags on the features among which you want to find a path.
3. Click the Trace Task dropdown arrow and click Find Path.
4. Click the Solve button. A path between the features on which you placed flags is displayed.

Finding the shortest path

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags on the features among which you want to find a path.
3. Click Analysis and click Options.

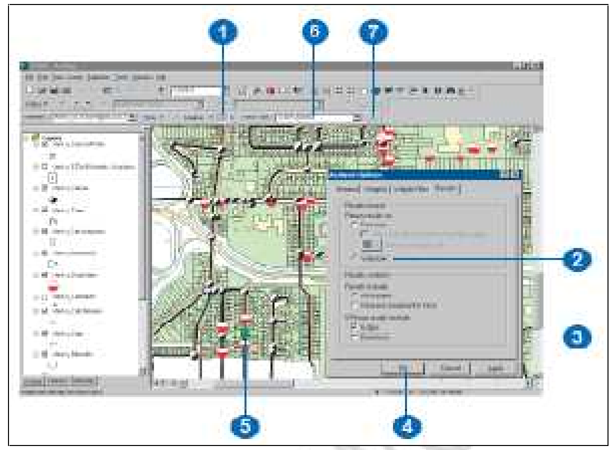


4. Click the Weights tab. Click the Junction weights dropdown arrow and click the name of the weight you want to use for junctions.
5. Click the from–to edge weight dropdown arrow and click the name of the weight you want to use for tracing edges along the digitized direction.
6. Click the to–from edge weight dropdown arrow and click the name of the weight you want to use for tracing edges against the digitized direction.
7. Click OK.
8. Click the Trace Task dropdown arrow and click Find Path.
9. Click the Solve button. The shortest path based on the weights you chose is displayed. The total cost of this path is reported in the status bar.

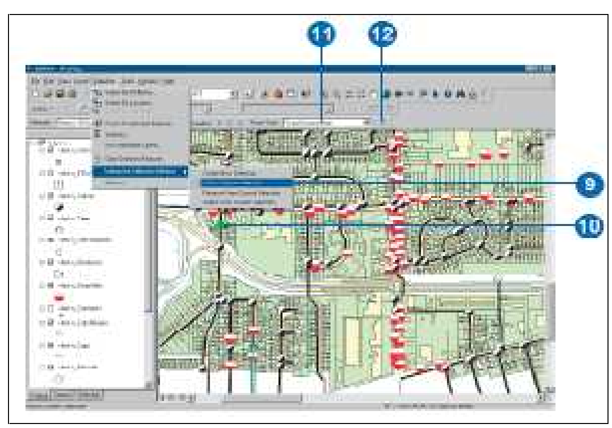


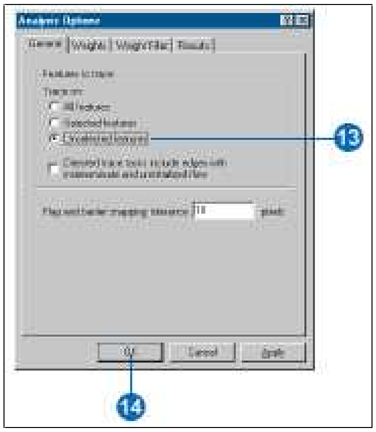
Finding an upstream path

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and click the Add Junction Flag tool.
2. Click Analysis and click Options. Click the Results tab. Click Selection to return the results of trace tasks as selections.
3. Uncheck Junctions. This returns only edges in the results.
4. Click OK.
5. Click on the map to place a flag at the destination point.
6. Click the Trace Task dropdown arrow and click Trace Upstream.
7. Click the Solve button.
8. Click Analysis and click Clear Flags.



9. From the Main menu, click Selection. Point to Interactive Selection Method and click Add to Current Selection.
10. Click on the map to place a flag at the origin point.
11. Click the Trace Task dropdown arrow and click Trace Downstream.
12. Click the Solve button.
13. Click Analysis and click Options. Click the General tab and click Unselected features to treat the current selection as barriers.
14. Click OK

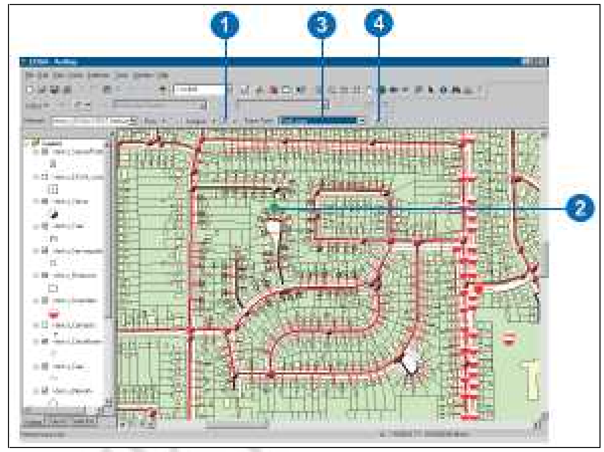




15. From the Main menu, click Selection. Point to Interactive Selection Method and click Create New Selection.
16. Click on the map to place a flag at the destination point.
17. Click the Trace Task dropdown arrow and click Find Path.
18. Click the Solve button. If it exists, the result will be an upstream path from the origin point to the destination point.

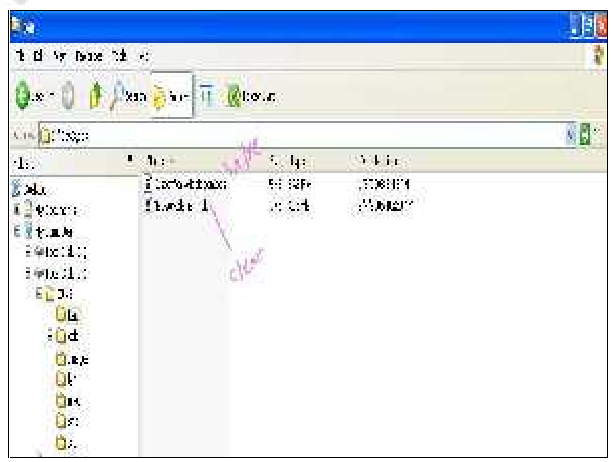
Finding loops

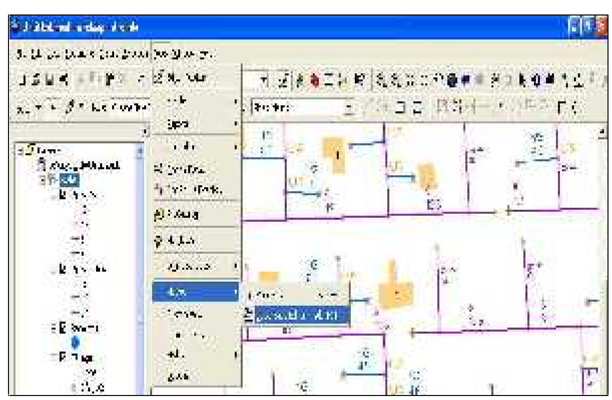
1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place at least one flag on each connected component in which you want to find the loops.
3. Click the Trace Task dropdown arrow and click Find Loops.
4. Click the Solve button. For each connected component on which you placed a flag, the features that loop back on themselves (i.e., can be reached from more thanone direction) are displayed.

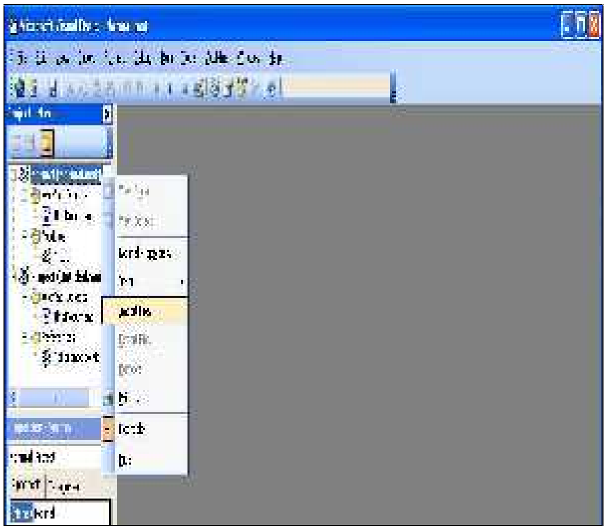


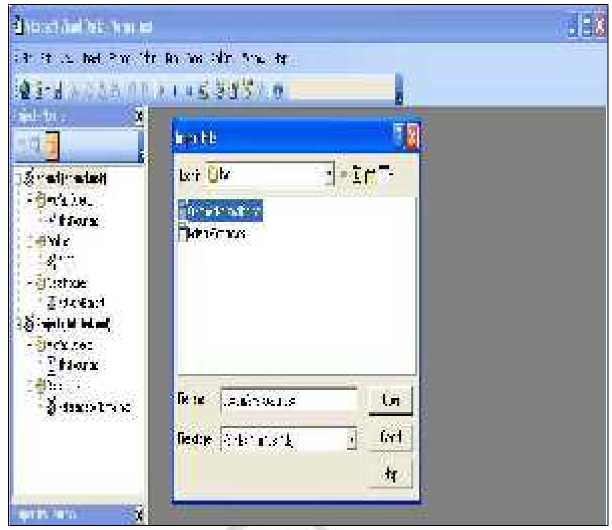
Tracing And Management Using Visual Basic

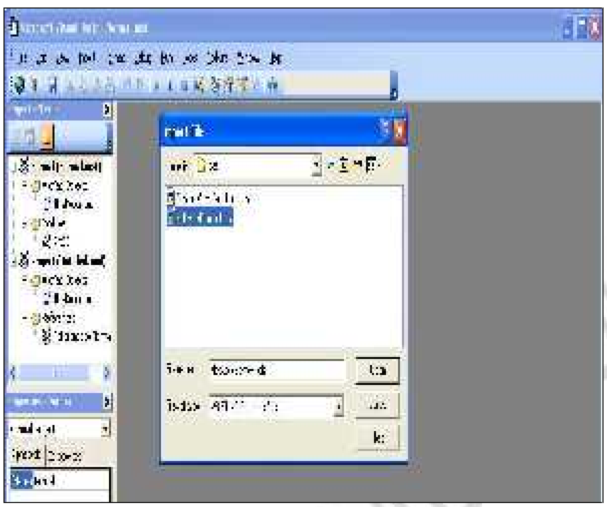
We need to install the command Valve since it's not available by default in the tool bar

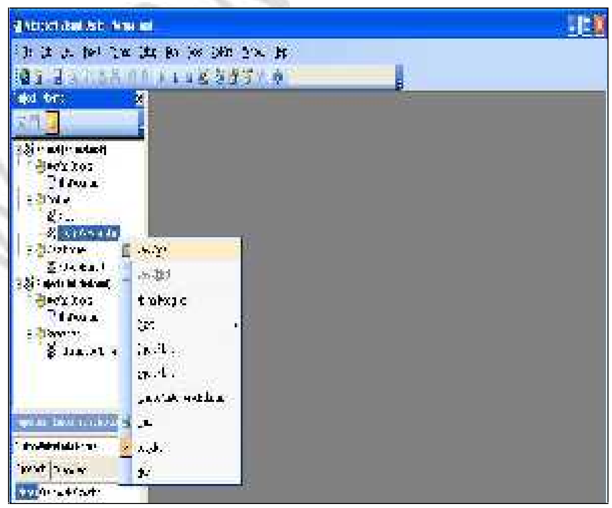


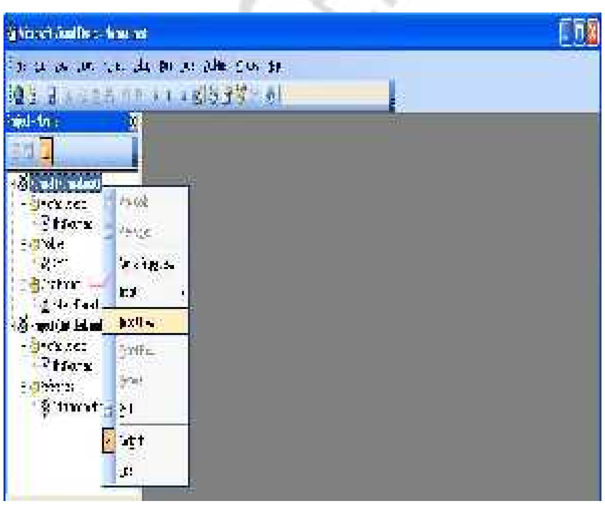


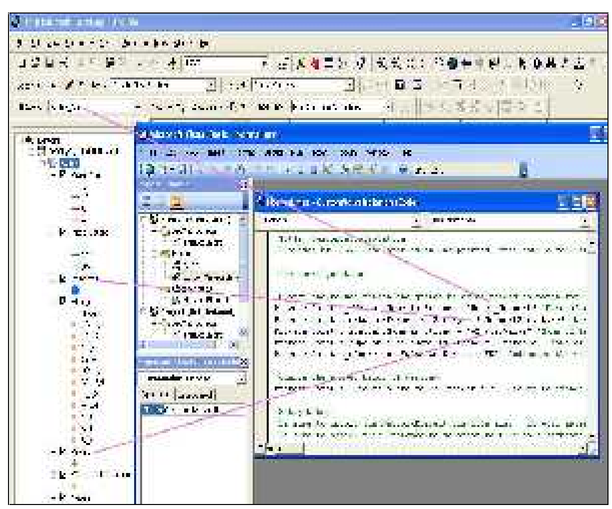


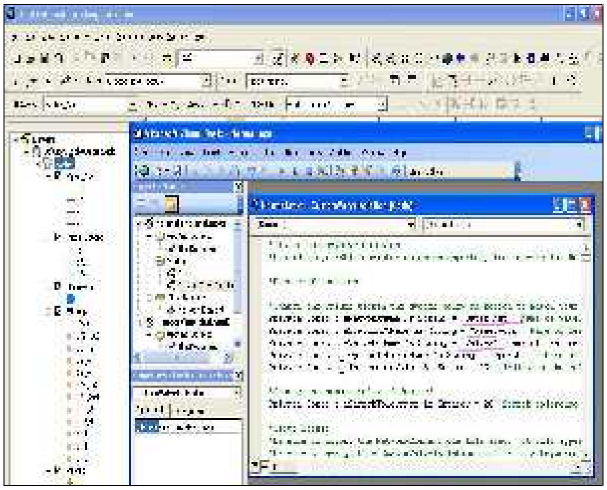


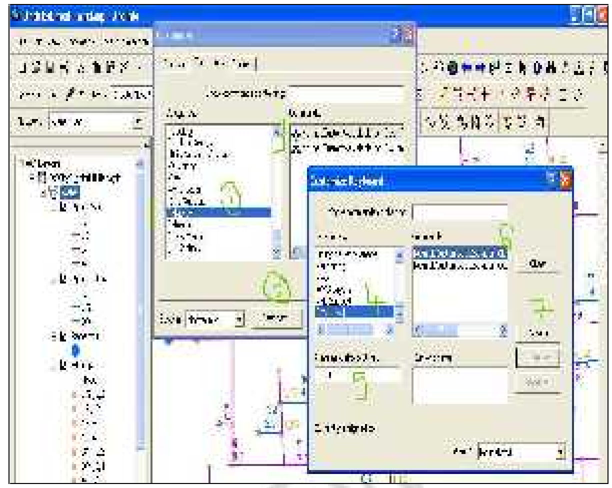


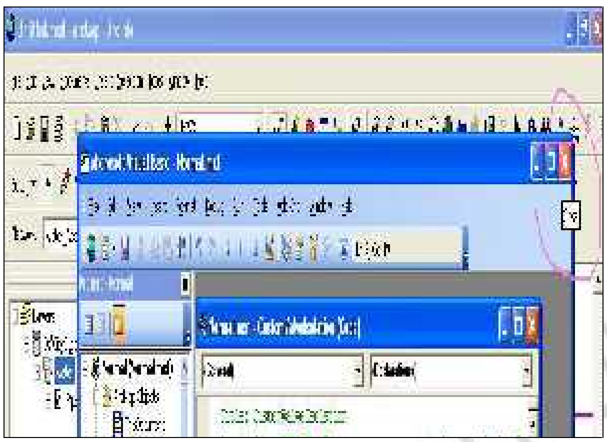


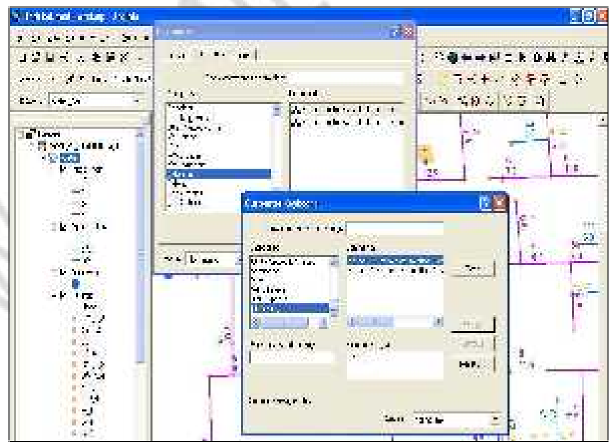


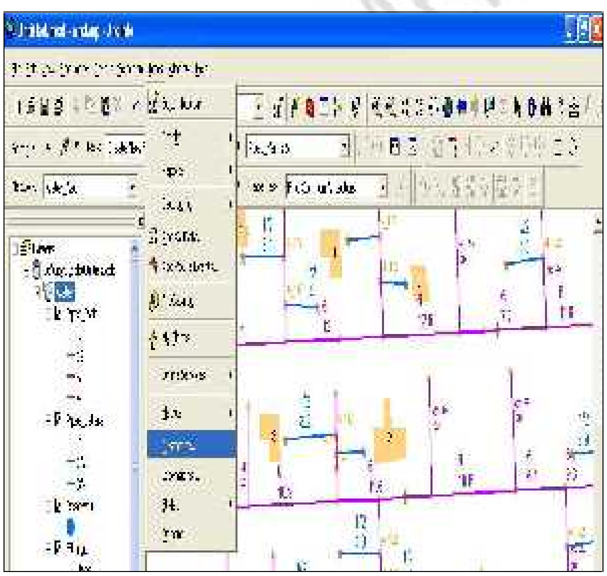


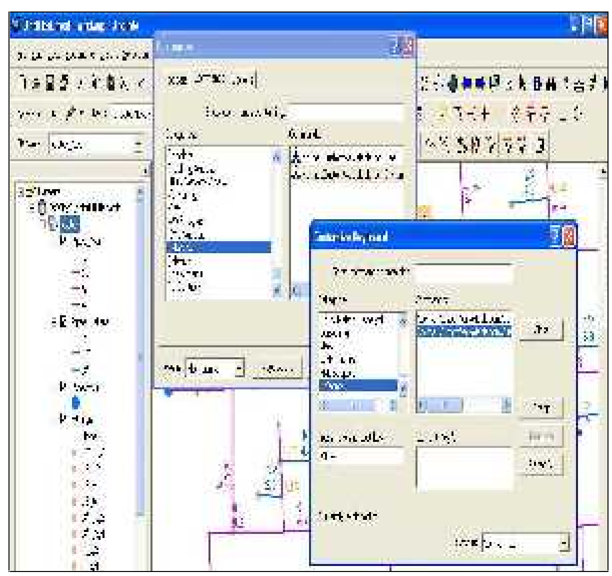


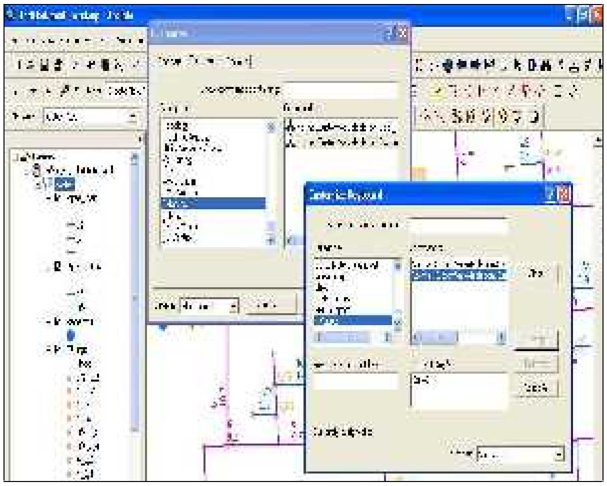


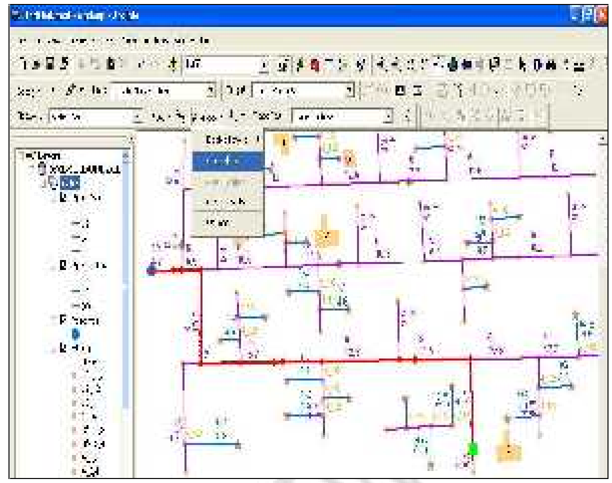


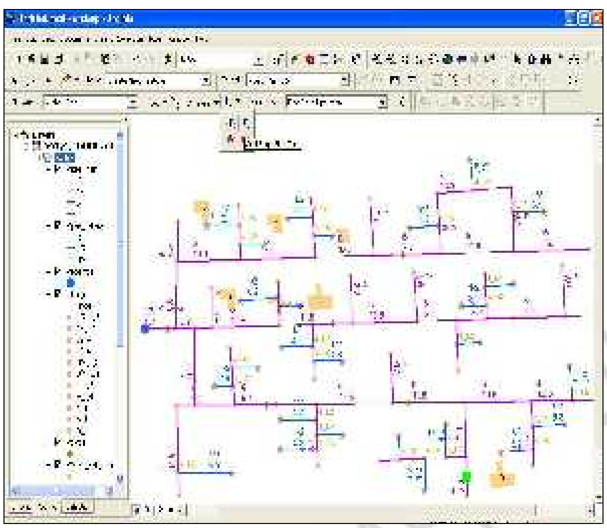


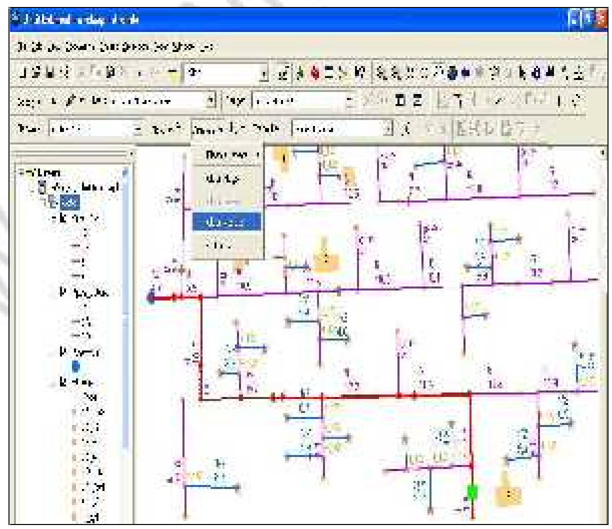


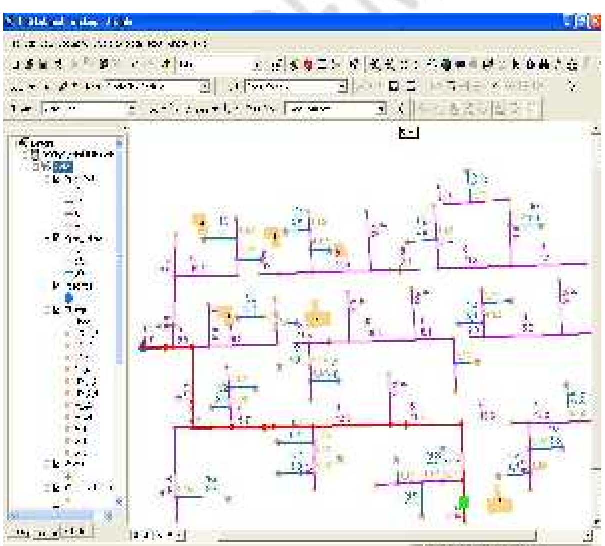






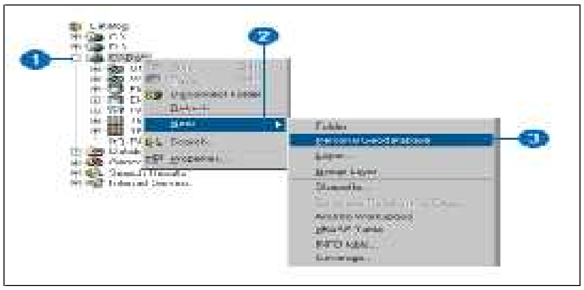






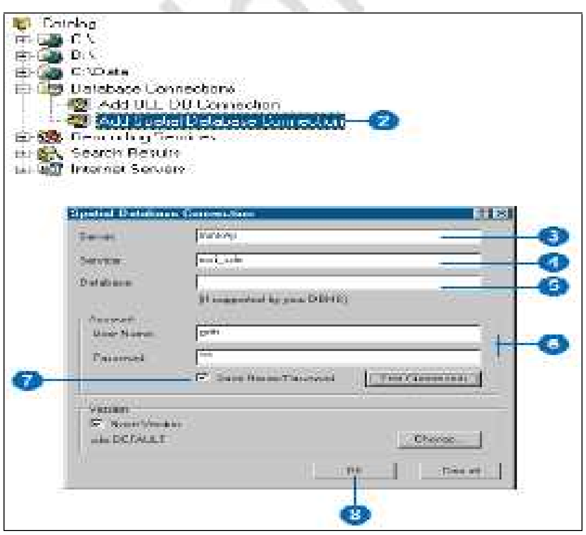
Creating a new File Geodatabase

1. Right-click the location in the ArcCatalog tree where you want to create the new file geodatabase.
2. Point to New.
3. Click Personal Geodatabase. ArcCatalog creates a new File geodatabase in the location you selected and sets its name to edit mode.
4. Type a new name for this personal geodatabase.
5. Press Enter.



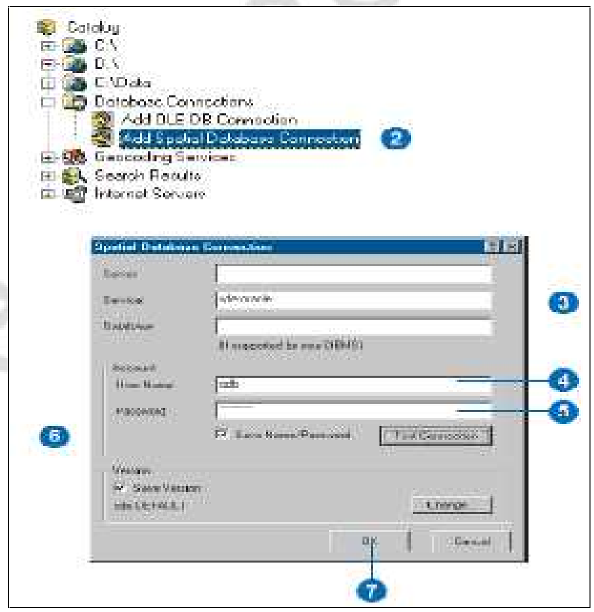
Adding a connection to an ArcSDE geodatabase service in ArcCatalog

1. Double-click Database Connections.
2. Double-click Add Spatial Database Connection.
3. Type either the name or the Internet Protocol (IP) Address of the server to which you want to connect.
4. Type either the name or the TCP/IP port number of the ArcSDE service to which you want to connect.
5. Type the name of the database to which you want to connect if your DBMS supports it; otherwise, skip to step 6.
6. Type the username and password with which you will connect to the ArcSDE geodatabase.
7. Check the check box to save the username and password in the connection file so that you can connect to the database in the future without being prompted to log in.
8. Click OK.
9. Type a new name for the spatial database connection.
10. Press Enter.



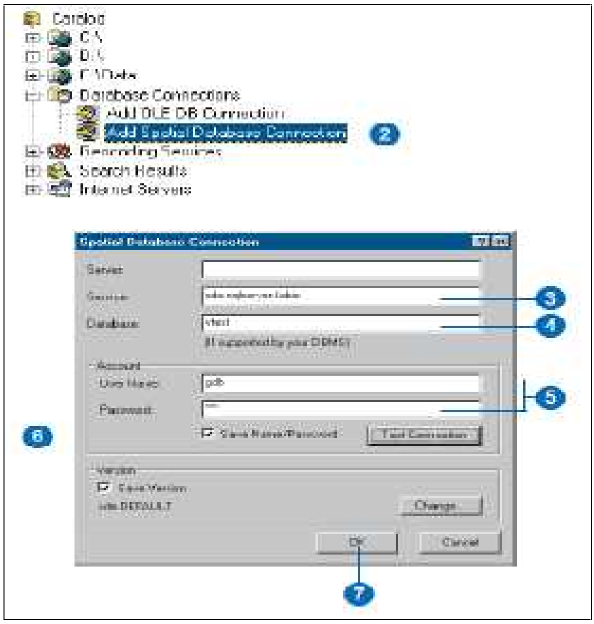
Adding a direct connection to an Oracle geodatabase in ArcCatalog

1. Double-click Database Connections.
2. Double-click Add Spatial Database Connection.
3. If you're connecting to Oracle8i, type "sde:oracle" in the Service box. If you're connecting to Oracle9i, type "sde:oracle9i".
4. Type the username.
5. Type the password followed By oracle network service name>".
6. Check the check box to save the username and password in the connection file so that you can connect to the database in the future without being prompted to log in.
7. Click OK.
8. Type a new name for the spatial database connection.
9. Press Enter.



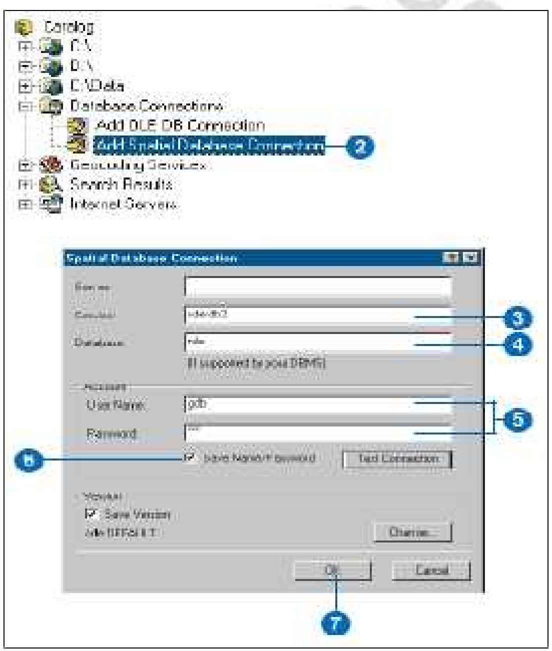
Adding a direct connection to a SQL Server geodatabase in ArcCatalog

1. Double-click Database Connections.
2. Double-click Add Spatial Database Connection.
3. Type "sde:sqlserver:<name or the IP Address of the server>" in the Service box. In this example, the server name is fabio.
4. Type the name of the database want to connect to.
5. Type the username and password.
6. Check the check box to save the username and password in the connection file so that you can connect to the database in the future without being prompted to log in.
7. Click OK.
8. Type a new name for the spatial database connection.
9. Press Enter.



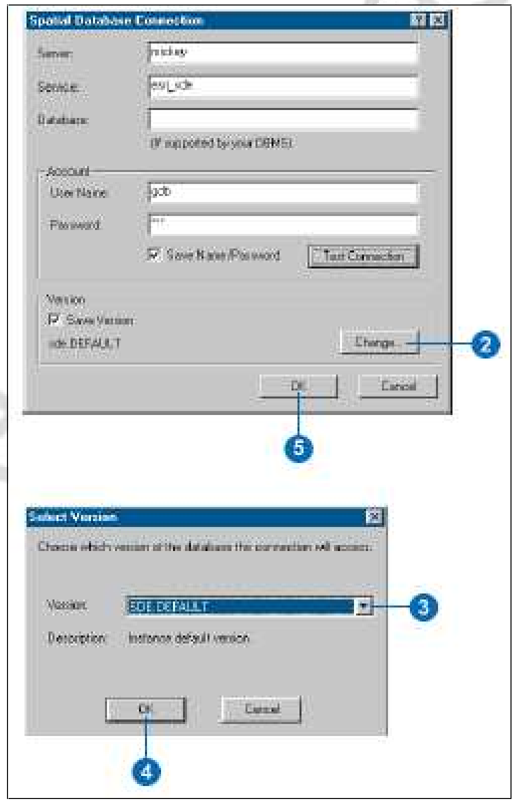
Adding a direct connection to a DB2 or Informix geodatabase in ArcCatalog

1. Double-click Database Connections.
2. Double-click Add Spatial Database Connection.
3. If you're connecting to DB2, type "sde:db2" in the Service box. If you're connecting to Informix, type "sde:informix".
4. Type the name of the database you want to connect to.
5. Type the username and password.
6. Check the check box to save the username and password in the connection file so that you can connect to the database in the future without being prompted to log in.
7. Click OK.
8. Type a new name for the spatial database connection.
9. Press Enter.

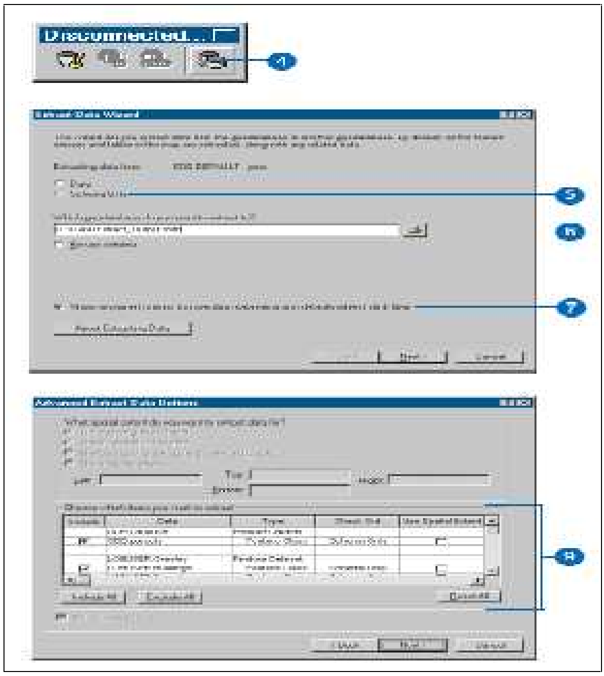


Connecting to an alternative version of the Database

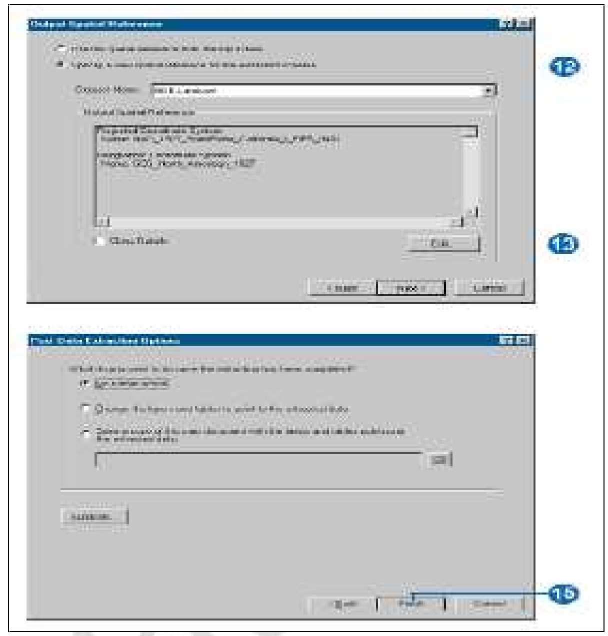
1. Follow steps 1 through 7 for adding a connection to a spatial database geodatabase service or direct connect in ArcCatalog.
2. Click Change.
3. Click the Version dropdown arrow and click the version you want to access.
4. Click OK.
5. Click OK in the Spatial Database Connection dialog box.
6. Type a new name for the spatial database connection.
7. Press Enter



1. Start ArcMap.
2. Use the Add Data button to add the data that you want to export schema from to the data frame.
3. Click View, click Toolbars, then choose Disconnected Editing to display the Disconnected Editing toolbar.
4. Click the Extract Data command on the Disconnected Editing toolbar to start the Extract Data wizard.
5. Click Schema Only.
6. Navigate to the geodatabase you want to export the schema into or type its path. If the geodatabase doesn't already exist, it will be created.
7. Check Show advanced options.
8. Click Next.
9. The list of data to export schema from expands to include all the data in any feature dataset and any related data. For example, if you have just one feature class from a feature dataset in the data frame, all feature classes in the feature dataset are shown.

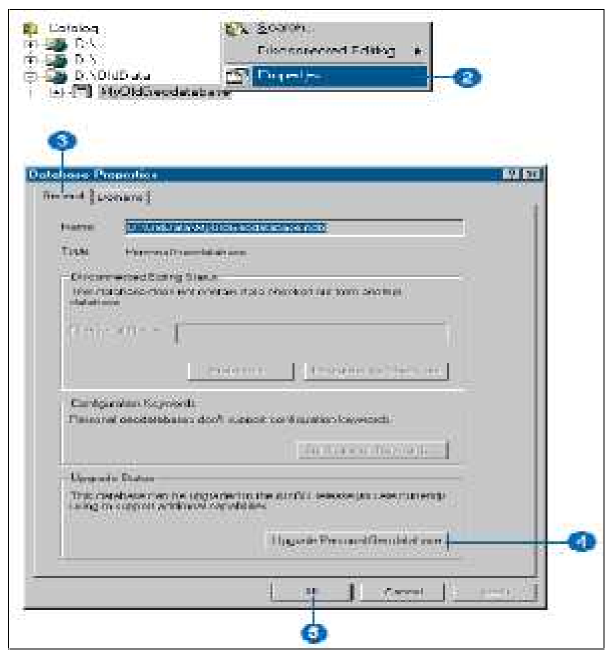


Uncheck a check box if there is a feature class, table, or relationship class you don't want to export schema from. If you leave a box checked for a feature class in a network or topology, the schema from all the feature classes in the network and topology will export.
10. Click Next.
11. If you want the output schema to have the same spatial reference as the source data, skip to step 14.
12. Click Specify a new spatial reference.
13. Click Edit to display the Spatial Reference Properties dialog box and set a spatial reference for the output schema. The one spatial reference you choose will become the spatial reference for the entire schema you extract.
14. Click Next.
15. Click Finish to export the schema.



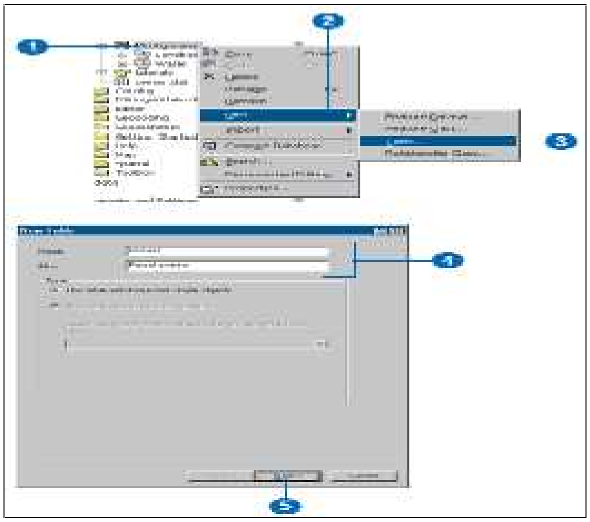
Creating new items in a geodatabase

1. Start ArcCatalog.
2. Right-click the geodatabase you want to upgrade and click Properties.
3. Click the General tab.
4. Click Upgrade Personal Geodatabase.
5. Click OK

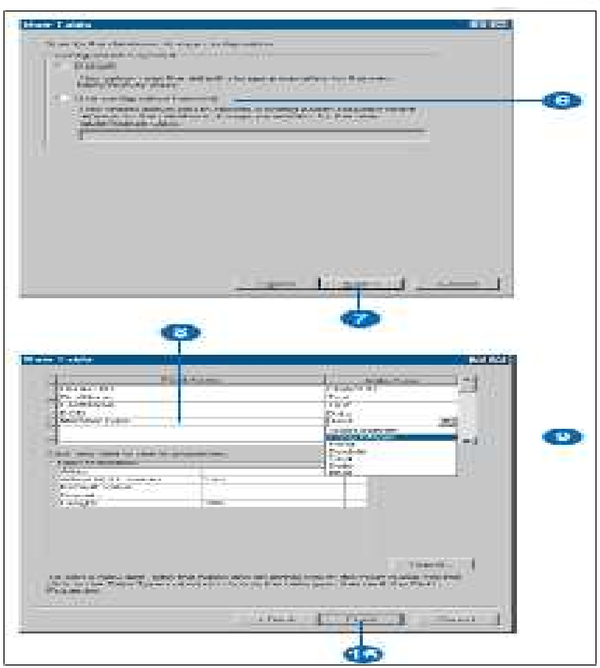


1. Right-click the database in the ArcCatalog tree in which you want to create a new table.
2. Point to New.
3. Click Table.

4. Type a name for the table. To create an alias for this table, type the alias.
5. Click Next.

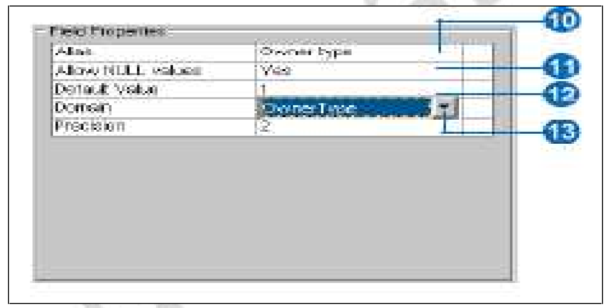


If your geodatabase does not use ArcSDE, skip to step 8.
6. If you want to create the table using a custom storage keyword, click Use configuration keyword and type the keyword you want to use.
7. Click Next.
8. Click the next blank row in the Field Name column and type a name to add a field to the table.
9. Click in the Data Type column next to the new field's name and click its data type.



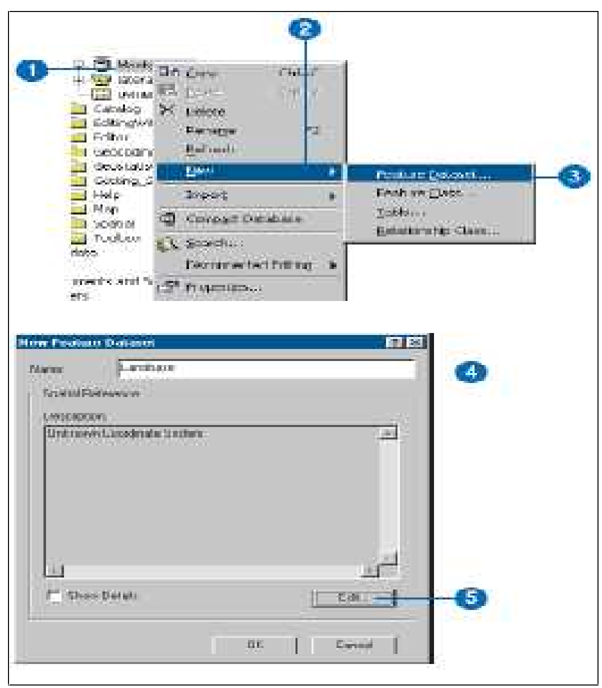
10. Click the field next to Alias and type the alias for this field.

11. Click the field next to Allow NULL values, click the dropdown arrow, then click No to prevent nulls from being stored in this field.
12. Click the field next to Default Value and type the value to associate a default value with this field.
13. Click the field next to Domain, click the dropdown arrow to see a list of the domains that apply to this field type, then click the domain to associate a domain with this field.
14. Set field properties by either clicking the property in the dropdown list or typing the property value, specific to the type of field.
15. Repeat steps 8 through 14 until all the table's fields have been defined.
16. Click Finish.

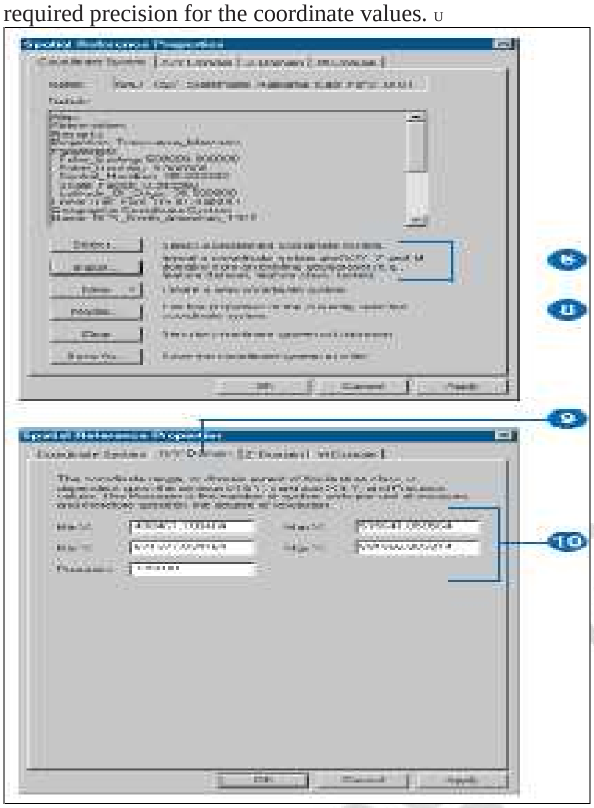


Creating a feature dataset with a predefined coordinate system

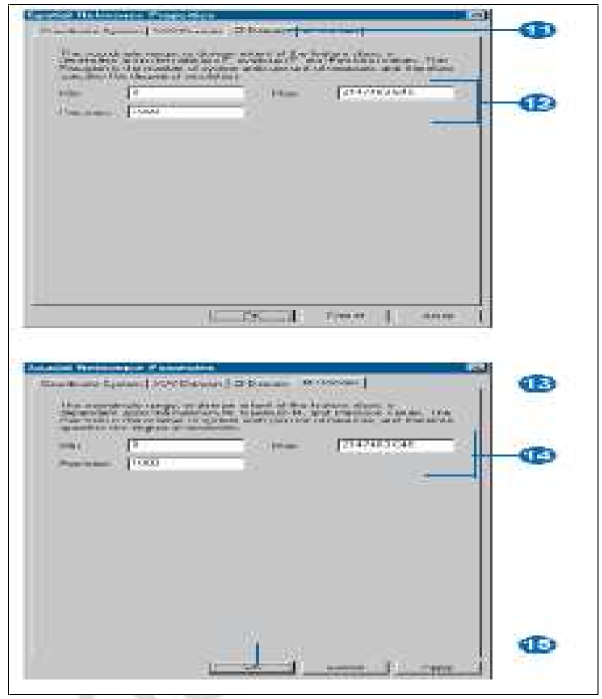
1. Right-click the database in the ArcCatalog tree in which you want to create a new feature dataset.
2. Point to New.
3. Click Feature Dataset.
4. Type a name for the feature dataset.
5. Click Edit to define the feature dataset's spatial reference.



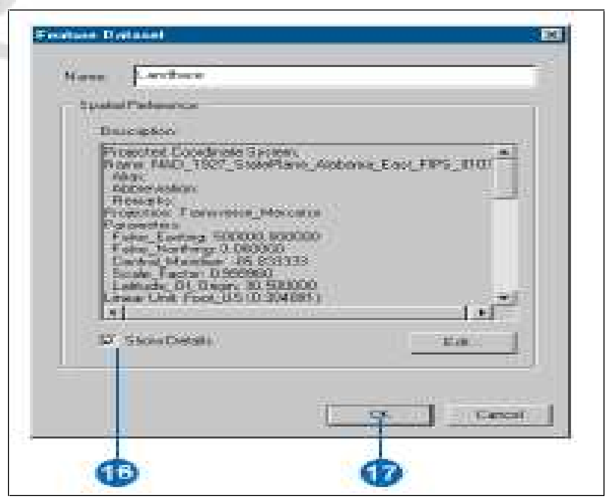
6. Click Select or Import to set the feature dataset's spatial reference.
7. Navigate to the spatial reference you want to use or navigate to the feature class or feature dataset whose spatial reference you want to use as a template.
8. Click Modify if you want to change any parameters in the coordinate system you have chosen. Edit the coordinate system's parameters and click OK.
9. Click the X/Y Domain tab.
10. Type the minimum x, minimum y, maximum x, and maximum y coordinate values for the dataset and type the required precision for the coordinate values.



11. Click the Z Domain tab.
12. Type the minimum z-value and maximum z-value for the dataset and type the precision required for the z coordinates if any feature class in the feature dataset will have z-values.
13. Click the M Domain tab.
14. Type the minimum m-value and maximum m-value for the dataset and type the precision required for the m values if any feature class in the feature dataset will have m-values.
15. Click OK.



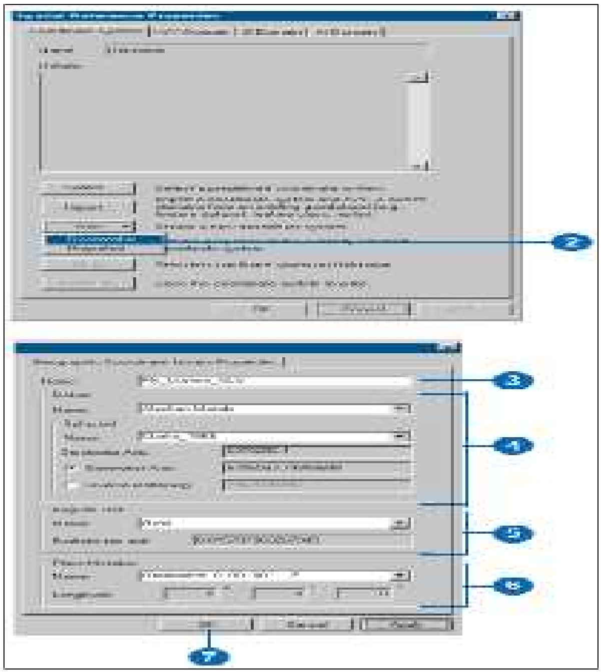
16. Check Show Details to see the details of your new dataset's spatial reference.
17. Click OK



Defining new geographic coordinate systems

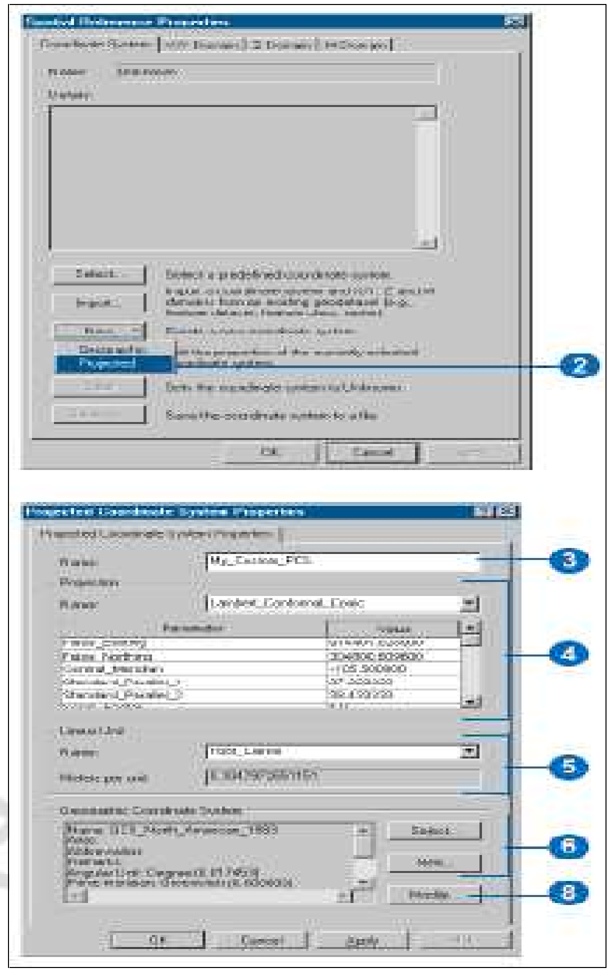
1. Follow steps 1 through 5 for 'Creating a feature dataset with a predefined coordinate system'.
2. Click New and click Geographic.
3. Type a name for the coordinate system.
4. Type the parameters for a custom datum or choose a predefined datum from the dropdown list.
5. Type the angular unit or choose a predefined angular unit from the dropdown list.
6. Type the degrees, minutes, and seconds defining the prime meridian's longitude, or choose a predefined prime meridian from the dropdown list.
7. Click OK.

8. Follow steps 9 through 16 for ‘Creating a feature dataset with a predefined coordinate system



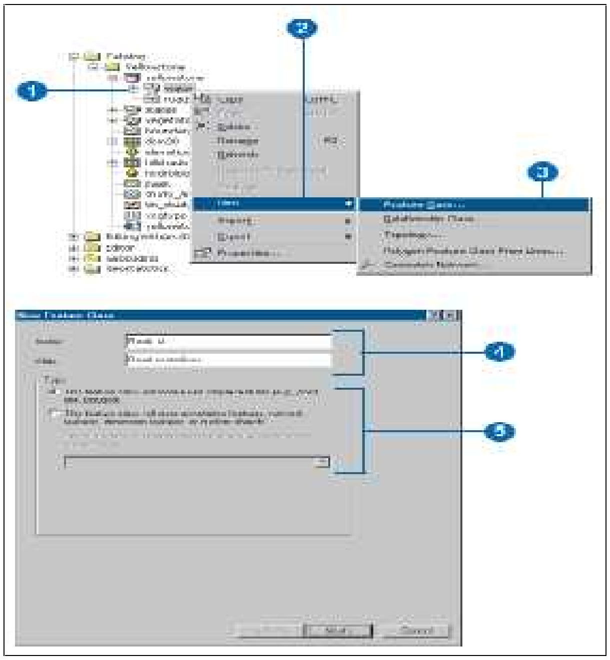
Defining new projected coordinate systems

1. Follow steps 1 through 5 for ‘Creating a feature dataset with a predefined coordinate system’.
2. Click New and click Projected.
3. Type a name for this coordinate system.
4. Choose a projection from the dropdown list and type the appropriate parameter values for that projection.
5. Type the linear unit or choose a predefined linear unit from the dropdown list.
6. Click Select or New to set the geographic coordinate system.
7. Navigate to the geographic coordinate system or navigate to the feature class or feature dataset whose geographic coordinate system you want to use as a template.
8. Click Modify if you want to change any parameters in the geographic coordinate system you have selected.
9. Click OK.
10. Follow steps 9 through 16 for ‘Creating a feature dataset with a predefined coordinate system



Creating a feature class in a feature dataset

1. Right-click the feature dataset in the ArcCatalog tree in which you want to create a new feature class.
2. Point to New.
3. Click Feature Class.
4. Type a name for the feature
class. To create an alias for this feature class, type the alias.
5. Specify the type of features the feature class will contain. Click Next.



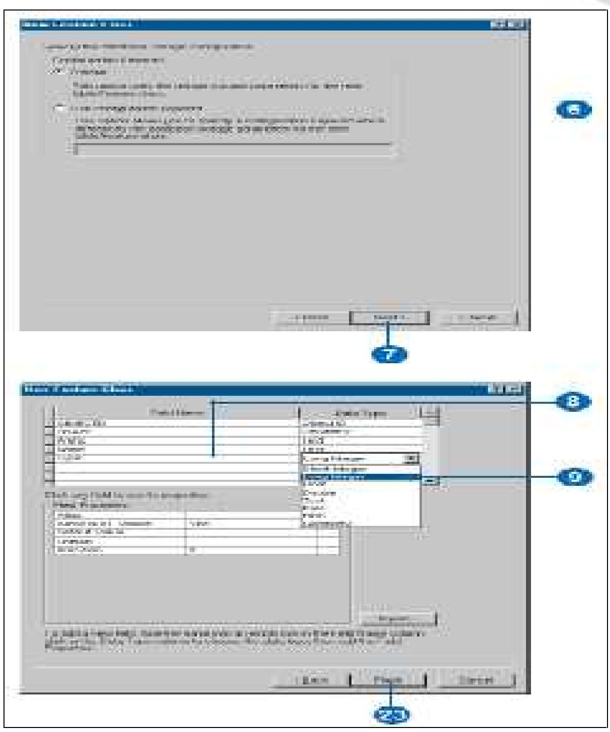
If your geodatabase does not use ArcSDE, skip to step 8.

6. Click Use configuration keyword and type the keyword you want to use if you want to create the table using a custom storage keyword.

7. Click Next.

8. Click the next blank row in the Field Name column and type a name to add a field to the feature class.

9. Click in the Data Type column next to the new field's name and click its data type.



10. Click the field next to Alias and type the alias for this field.

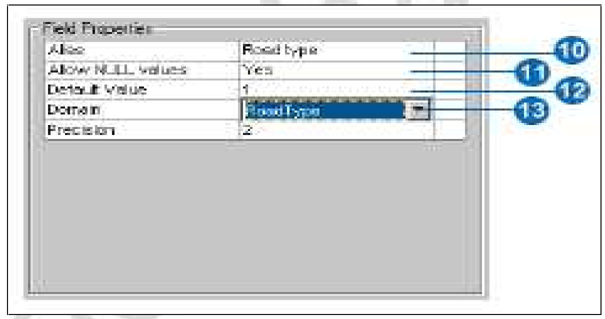
11. Click the field next to Allow NULL values, click the dropdown arrow, then click No to prevent nulls from being stored in this field.

12. Click the field next to Default Value and type the value to associate a default value with this field.

13. Click the field next to Domain, click the dropdown arrow to see a list of the domains that apply to this field type, then click the domain to associate a domain with this field.

14. Set field properties by either clicking the property in the dropdown list or typing the property value, specific to the type of field.

15. Repeat steps 8 through 14 until all the table's fields have been defined.



16. Click the name of the geometry field in the Field Name column.

17. Click the field next to Alias and type the alias to create an alias for the geometry field.

18. Click the field next to Allow NULL values, click the dropdown arrow, then click No to prevent null shapes from being stored.

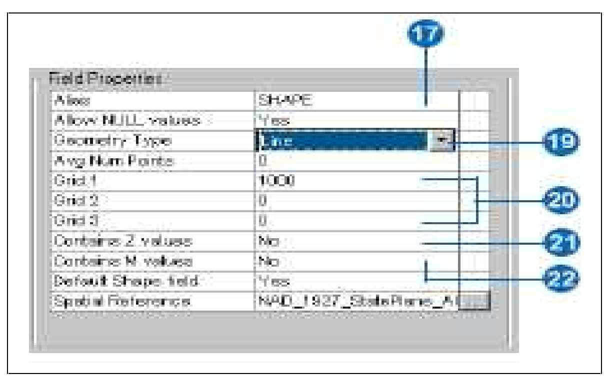
19. Click the field next to Geometry Type, click the dropdown arrow, and click the type of features you want to store in this feature class.

20. Click the fields next to the grid size you want to specify and type the grid value to set the spatial index grid parameters for the feature class.

21. Click the field next to Contains Z values, click the dropdown arrow, and click Yes if you want the shapes in this feature class to store zvalues.

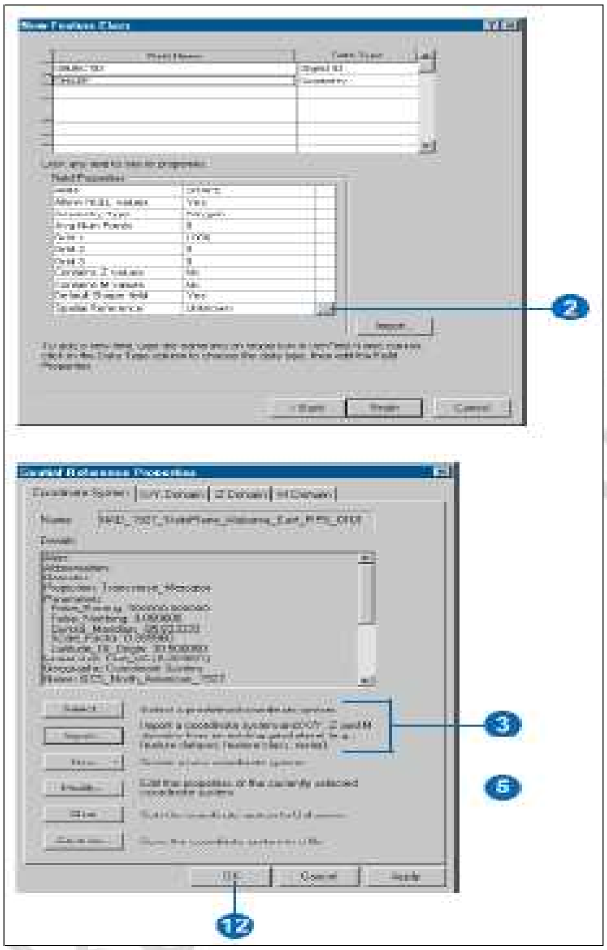
22. Click the field next to Contains M values, click the dropdown arrow, and click Yes if you want the shapes in this feature class to store mvalues.

23. Click Finish.

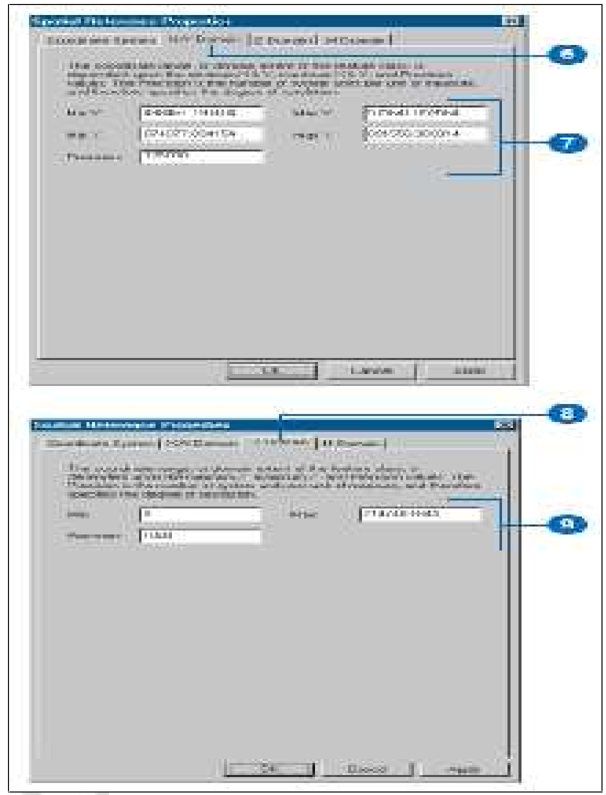


Creating a standalone feature class

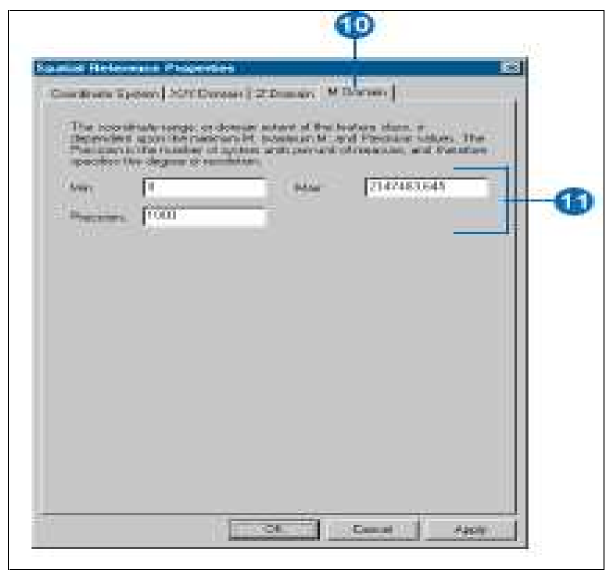
1. Follow steps 1 through 22 for ‘Creating a feature class in a feature dataset’.
2. Click the Spatial Reference properties button to define the feature class’s coordinate system.
3. Click Select or Import to set the feature dataset’s spatial reference.
4. Navigate to the spatial reference you want to use or navigate to the feature class or feature dataset whose spatial reference you want to use as a template. Click Add.
5. Click Modify if you want to change any parameters in the coordinate system you have chosen. Edit the coordinate system’s parameters and click OK.



6. Click the X/Y Domain tab.
7. Type the minimum x, y and maximum x, y coordinate values for the dataset and type the required precision for the coordinate values.
8. Click the Z Domain tab, if present. If your feature class does not store z-values, skip to step 10.
9. Type the minimum z-value and maximum z-value for the dataset, then type the precision required for the z coordinates.



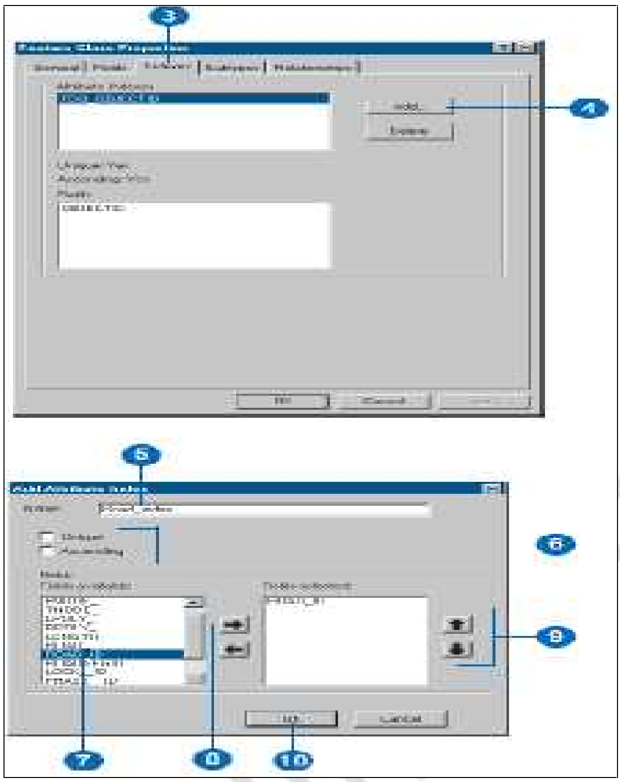
10. Click the M Domain tab, if present. If your feature class does not store m-values, skip to step 12.
11. Type the minimum m-value and maximum m-value for the dataset, then type the precision required for the m-values.
12. Click OK



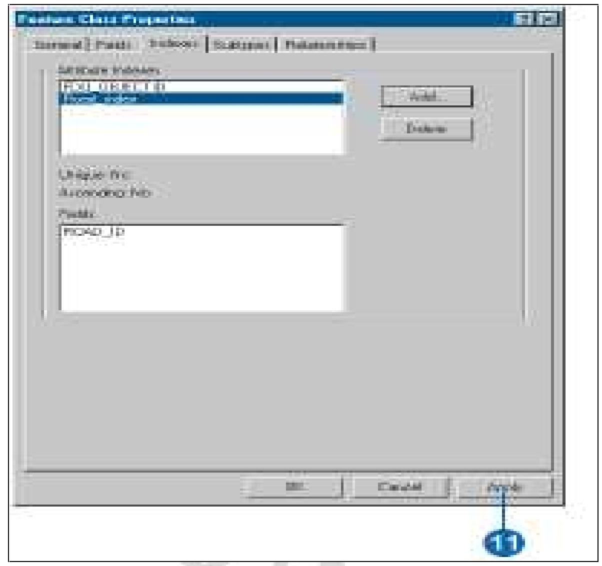
Creating a new attribute index

1. Right-click the table or feature class in the ArcCatalog tree for which you want to create an index.
2. Click Properties.
3. Click the Indexes tab.

4. Click Add.
5. Type the name for the new index.
6. Check the Unique check box if your field values are unique. Check the Ascending check box to create an ascending index. Data in an ascending index is returned in ascending order.
7. Click the field or fields for which you want to build this index.
8. Click the arrow button to move the fields to the Fields selected list.
9. Use the up and down arrows to change the order of the fields in the index.
10. Click OK. u

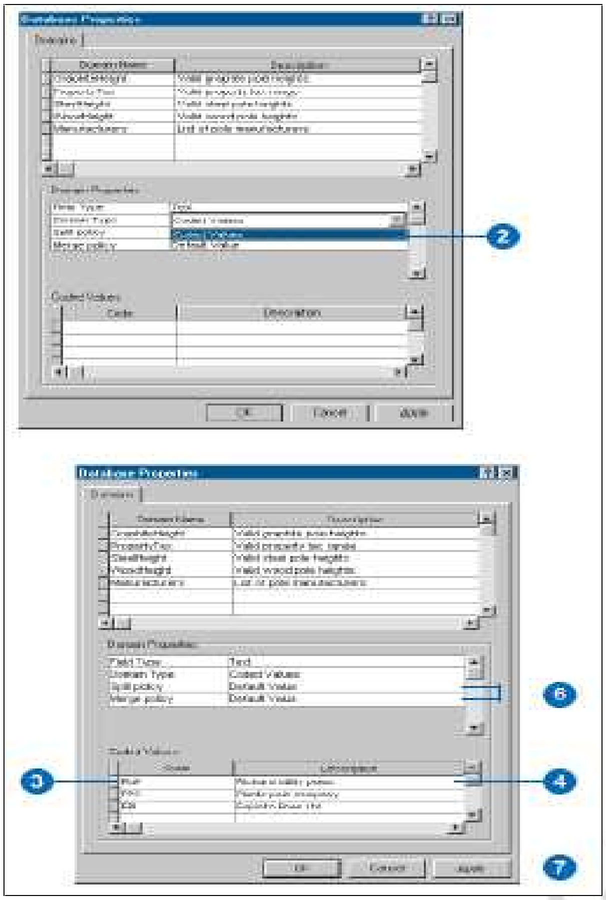


11. Click Apply to build the Index

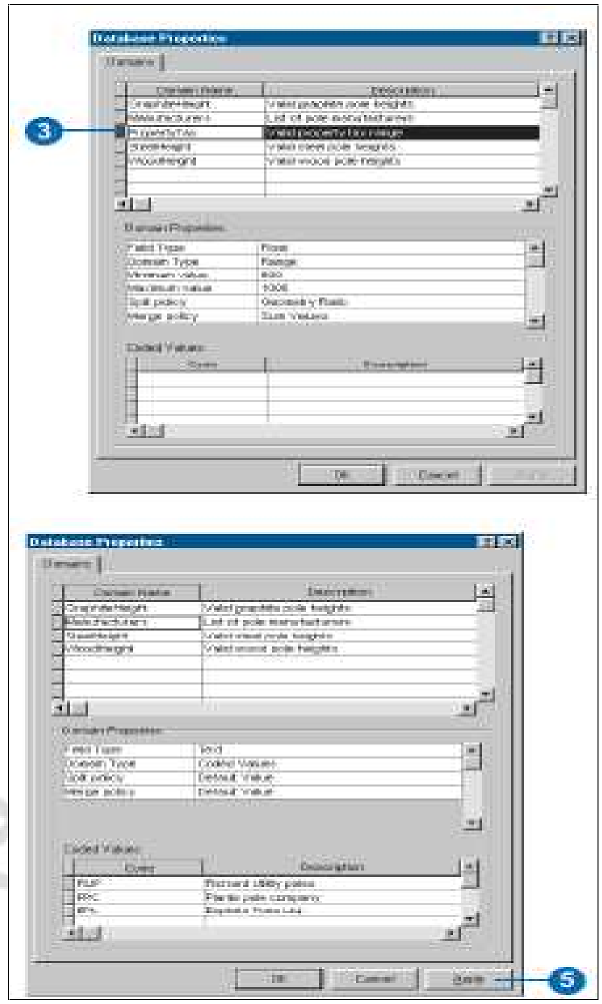


Creating a new coded value domain

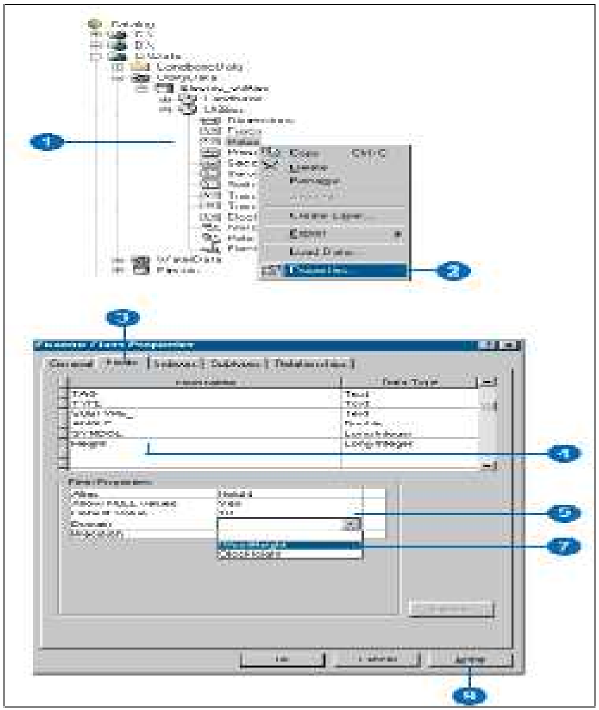
1. Follow steps 1 through 4 for ‘Creating a new attribute range domain’.
2. Click the field next to Domain Type, click the dropdown arrow, and click Coded Values from the list of domain types.
3. Click the first empty field under Coded Values and type the first valid code.
4. Press the Tab key or click the new coded value’s Description field. Type a user-friendly description for this coded value.
5. Repeat steps 3 and 4 until all valid values and their descriptions have been typed.
6. Click the field next to Split policy, click the dropdown arrow, and click the split policy for the new domain. Do the same for the merge policy.
7. Click Apply to create the new domain in the geodatabase or OK to create the domain and close the dialog box.



1. Right-click the geodatabase in the ArcCatalog tree and click Properties.
2. Click the Domains tab.
3. Click the domain you want to delete by clicking the left tab in the grid.
4. Press the Delete key.
5. Click Apply to delete the domain from the geodatabase or OK to delete the domain and close the dialog box.

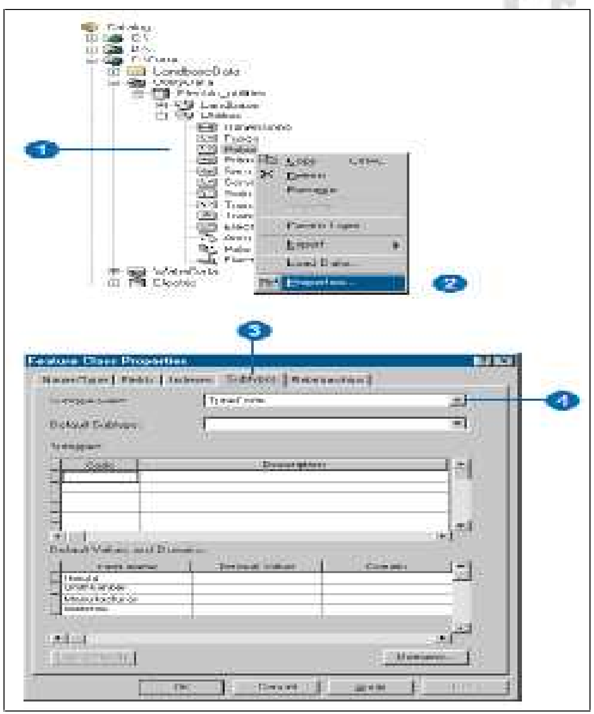


1. Right-click the table or feature class in the ArcCatalog tree with which you want to associate domains.
2. Click Properties.
3. Click the Fields tab.
4. Click the field for which you want to create a default value and associate a domain.
5. Click the field next to Default Value and type the default value.
6. Skip to step 9 if you don’t want to associate a domain to the field.
7. Click the field next to Domain, click the dropdown arrow, and click the domain you want to associate with the field. Only those domains that apply to the field type are displayed in the list.
8. Repeat steps 4 through 7 until you have associated default values and domains for all fields that you want t have these properties.
9. Click Apply

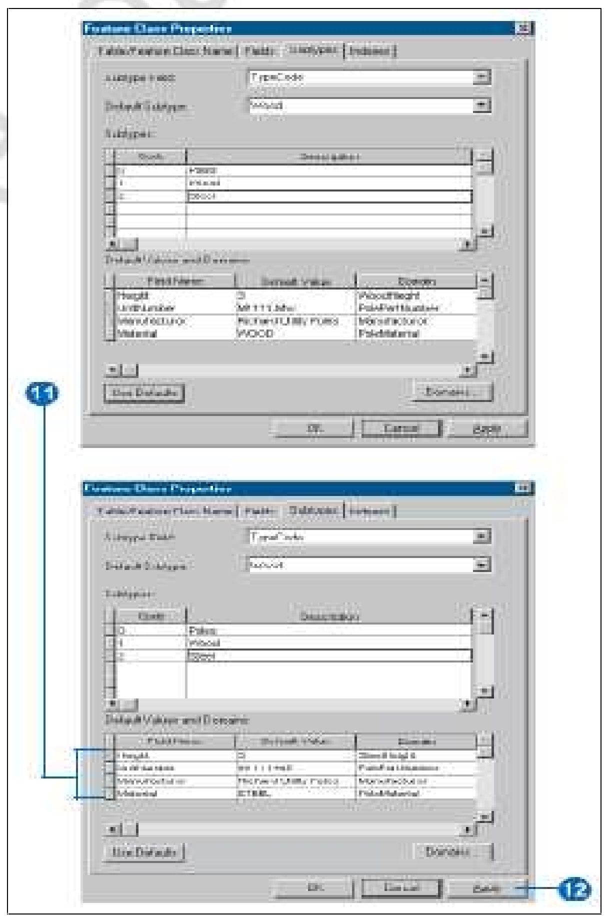


Creating new subtypes for a feature class or table

1. Right-click the feature class or table in the ArcCatalog tree to which you want to add subtypes.
2. Click Properties.
3. Click the Subtypes tab.
4. Click the dropdown arrow and click the subtype field from the list of available long integer and short integer fields.

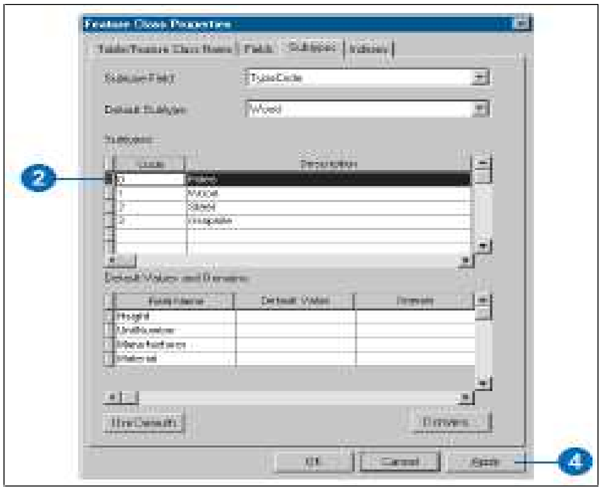


5. Click the first empty field under Code and type an integer value that will be the code for that subtype to add a new subtype.
6. Press the Tab key or click the Description field and type a description for the subtype.
7. Type a default value in the appropriate field in the table for each field.
8. Click the Domain field, click the dropdown arrow, and click the domain from the list of domains to associate an attribute domain with a field for the new subtype. Only those domains that apply to the field type are displayed in the list.
9. Click the dropdown arrow and click it from the list of subtypes to set this subtype as the default subtype.
10. Repeat steps 5 through 8 to add additional subtypes. You can reset the default subtype at any time.
11. Click Use Defaults to have your new subtype take all of the default values and domains from the default subtype when adding a new subtype. You can then modify all or some of these.
12. Click Apply to create the new subtypes in the geodatabase or OK to create the subtypes and close the dialog box when you are finished creating your subtypes and have selected the default subtype



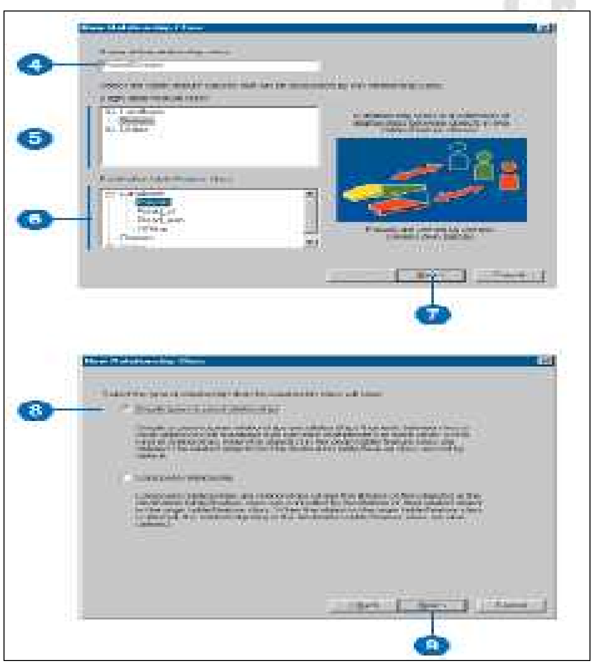
1. Follow steps 1 through 3 for 'Creating new subtypes for a feature class or table'.
2. Click the left tab next to the subtype you want to delete.
3. Press the Delete key.

4. Click Apply to delete the subtype from the geodatabase or OK to delete
the subtype and close the dialog box.

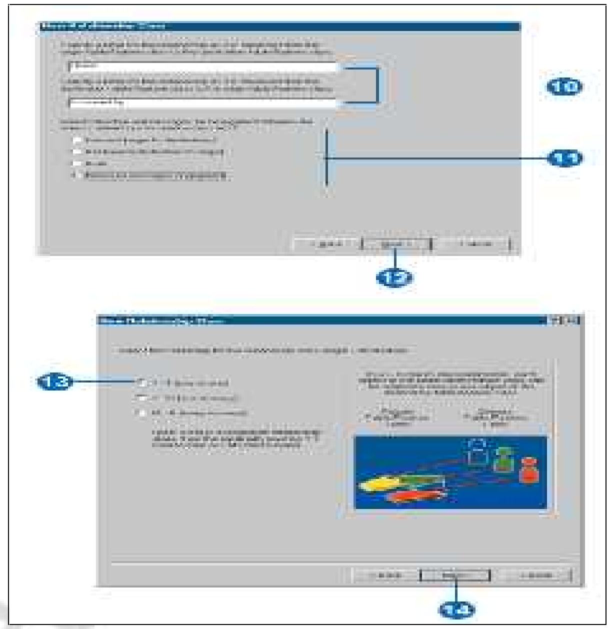


Defining relationship classes

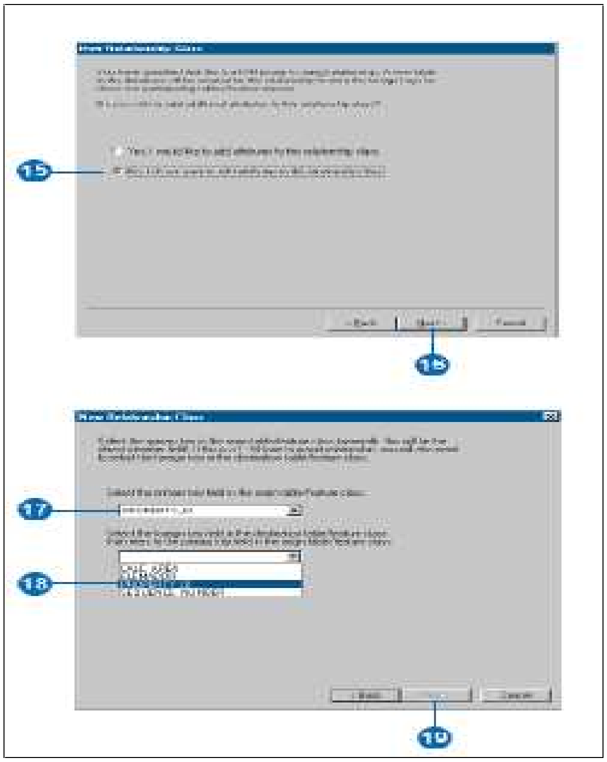
1. Right-click the geodatabase or feature dataset, in the ArcCatalog tree, in which you want to create the new relationship class.
2. Point to New.
3. Click Relationship Class.
4. Type the name for the new relationship class.
5. Click the origin table or feature class.
6. Click the destination table or feature class.
7. Click Next.
8. Click Simple (peer-to-peer) relationship.
9. Click Next. u



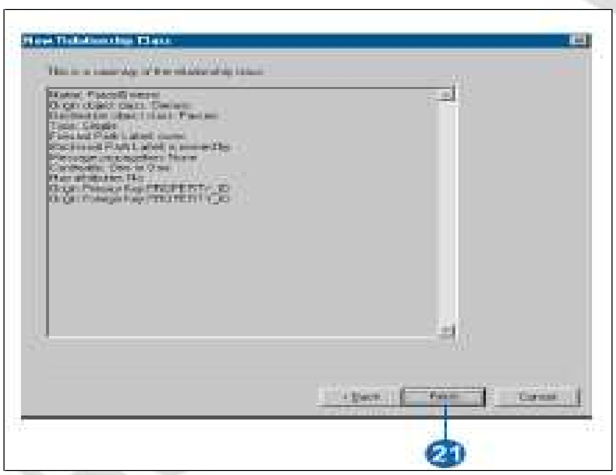
10. Type the forward and backward path labels.
11. Click the message notification direction.
12. Click Next.
13. Click the first cardinality option. In this example, an owner can own a single parcel and a parcel can be owned by a single owner, so this is a one-to-one (1–1) relationship.
14. Click Next. u



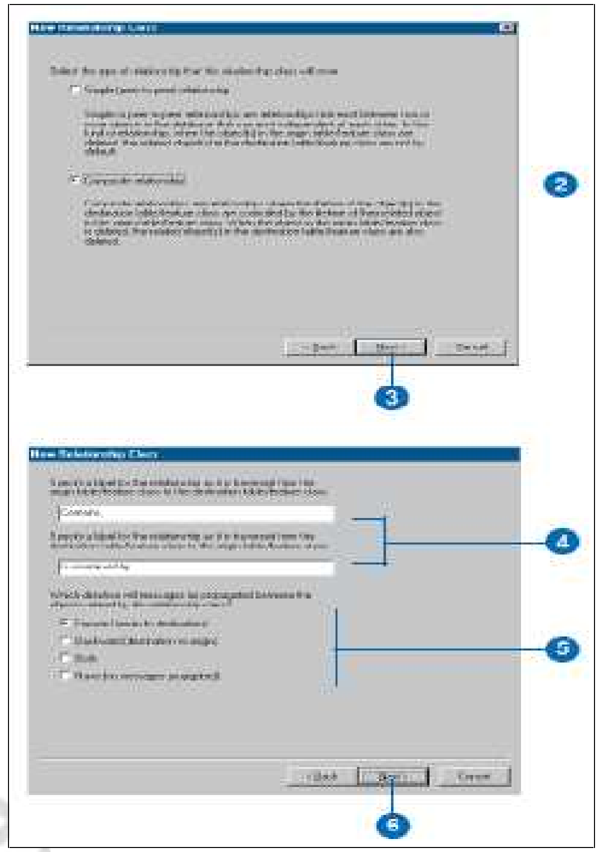
15. Click No. The relationship class does not require attributes in this example.
16. Click Next.
17. Click the dropdown arrow to see a list of fields from the origin table or feature class. Click the primary key for this feature class or table.
18. Click the dropdown arrow to see a list of fields from the destination table or feature class. Only those fields that are the same type as selected in step 17 are displayed. Click the foreign key that refers to the primary key selected in step 17.
19. Click Next. u



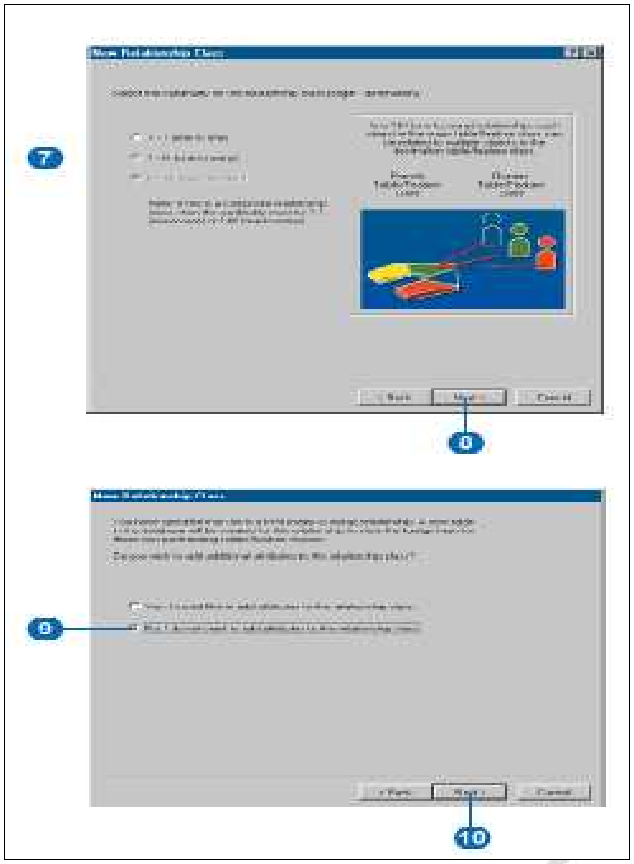
20. Review the options you specified for your new relationship class. If you want to change something, you can go back through the wizard by clicking Back.
21. Click Finish to create the new relationship class when satisfied with your options.



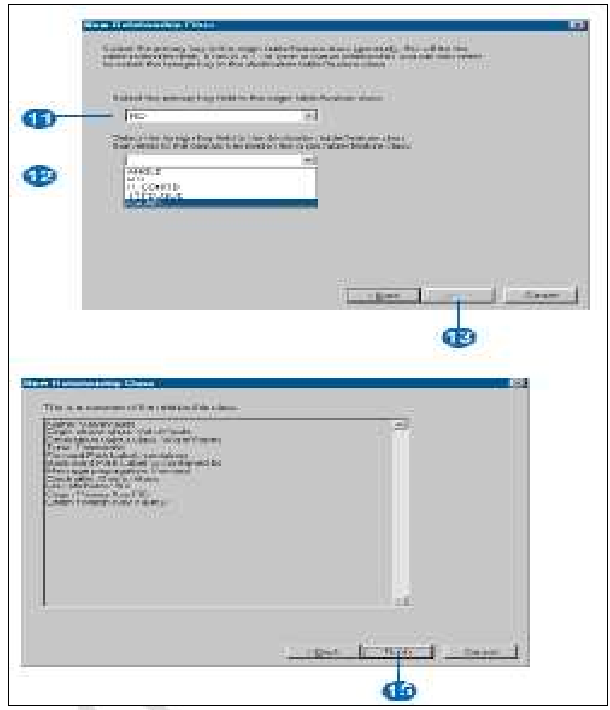
1. Follow steps 1 through 7 for ‘Creating a simple relationship class’.
2. Click Composite relationship.
3. Click Next.
4. Type the forward and backward path labels.
5. If you need to turn on messaging, click the message notification direction.
6. Click Next



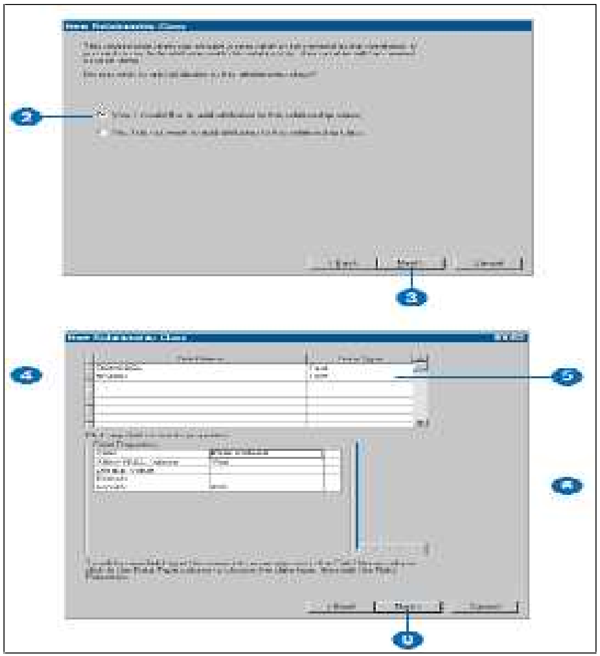
7. Click the second cardinality option. A composite relationship is, by definition, a 1–M
or 1–1 relationship.
8. Click Next.
9. Click No. The relationship class does not require attributes in this example.
10. Click Next. u



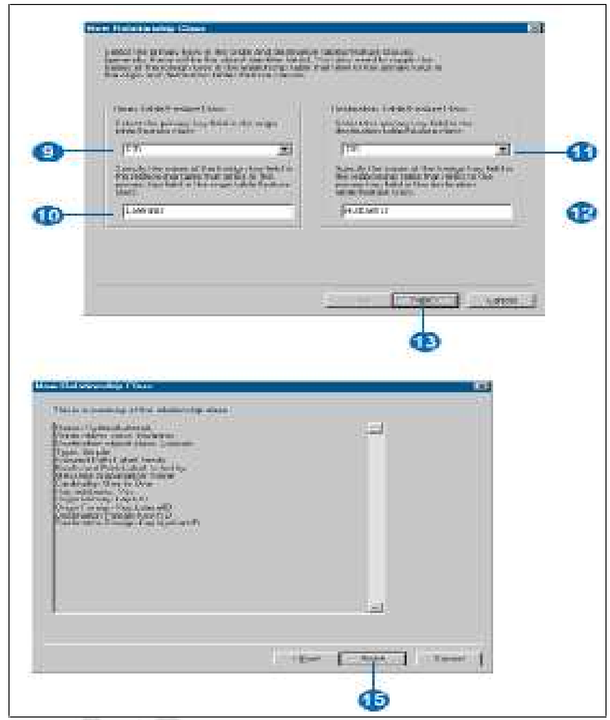
11. Click the dropdown arrow to see a list of fields from the origin table or feature class.
Click the primary key for this feature class or table.
12. Click the dropdown arrow to see a list of fields in the destination table or feature class. Only those fields that are the same type as selected in step 11 are displayed. Click the foreign key that refers to the primary key selected in step 11.
13. Click Next.
14. Review the options you specified for your new relationship class. If you want to change something, you can go back through the wizard by clicking Back.
15. Click Finish to create the new relationship class when satisfied with your options.



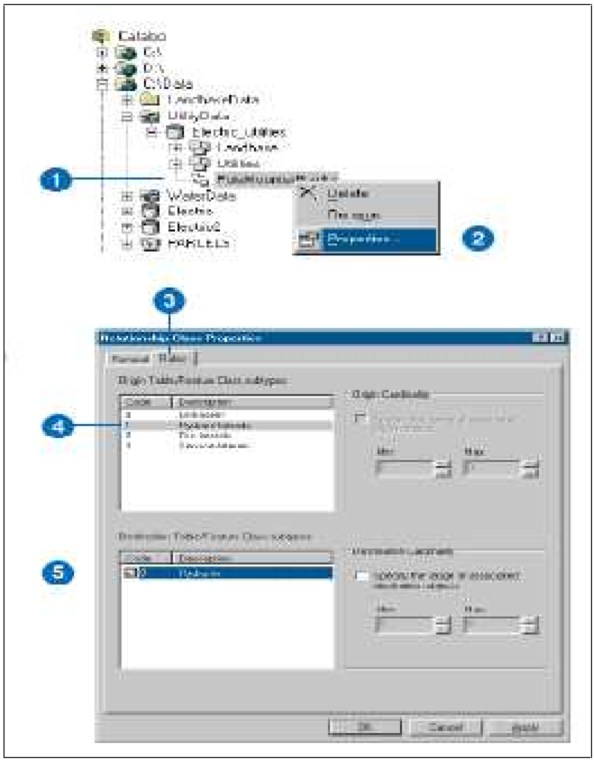
1. Follow steps 1 through 14 for ‘Creating a simple relationship class’ or steps 1 through
8 for ‘Creating a composite relationship class’.
2. Click the first option to add attributes to the relationship class.
3. Click Next.
4. Click the next row in the Field Name column and type a name to add a field.
5. Click in the Data Type field next to the new field’s name, then click its data type.
6. Set the new field’s properties in the property sheet.
7. Repeat steps 4 through 6 until all the relationship class’s fields have been defined.
8. Click Next



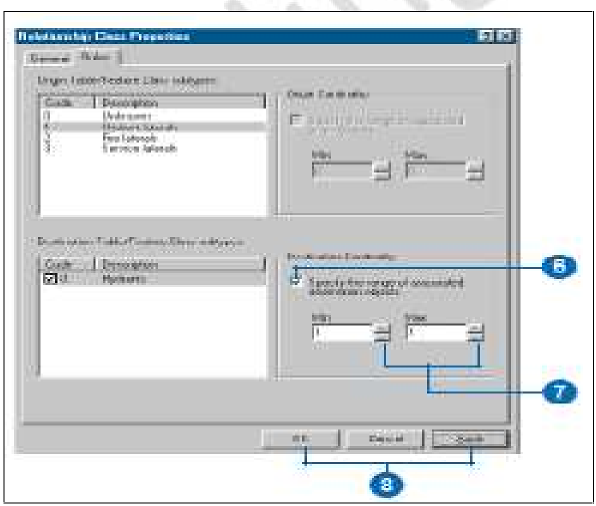
9. Click the dropdown arrow to see a list of fields from the origin table or feature class. Click the primary key for this feature class or table.
10. Type the name of the foreign key field for the origin table or feature class.
11. Click the dropdown arrow to see a list of fields from the destination table or feature class. Click the primary key for this feature class or table.
12. Type the name of the foreign key field for the destination table or feature class.
13. Click Next.
14. Review the options you specified for your new relationship class. If you want to change something, you can go back through the wizard by clicking Back.
15. Click Finish to create the new relationship class when satisfied with your options.



1. Right-click the relationship class in the Catalog tree.
2. Click Properties.
3. Click the Rules tab.
4. Click the subtype that you want to associate with a relationship rule if your origin class has subtypes. If the origin class has no subtypes, the relationship rule will apply to all features.
5. Check the subtype that you want to make relatable to the selected subtype in the origin class if the destination class has subtypes. If the destination class has no subtypes, the relationship rule will apply to all features.



If one or both sides of the relationship class is a many, you can limit the specific range of cardinality. In this example, the origin side of the relationship is a 1, so you cannot modify its range. However, the destination side is a many, so you can modify its range.
6. Check the check box to specify the range of destination objects per related origin objects.
7. Click the up and down arrows to increase or decrease the minimum and maximum number of related destination objects.
8. Repeat steps 4 through 7 until you have specified all of the relationship rules for this relationship class. Click OK or Apply to create the rules in the database.

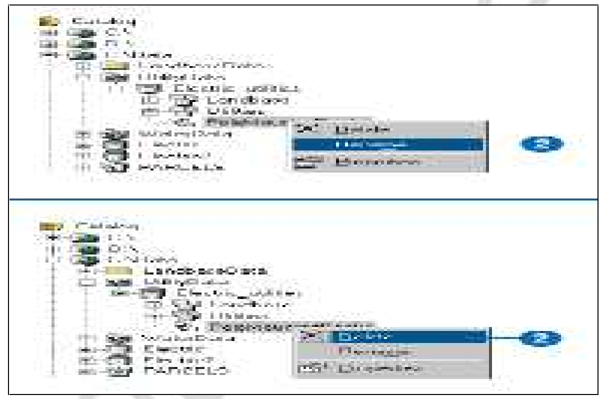


Renaming a relationship class

1. Right-click the relationship class that you want to rename.
2. Click Rename.
3. Type the new name and press Enter.

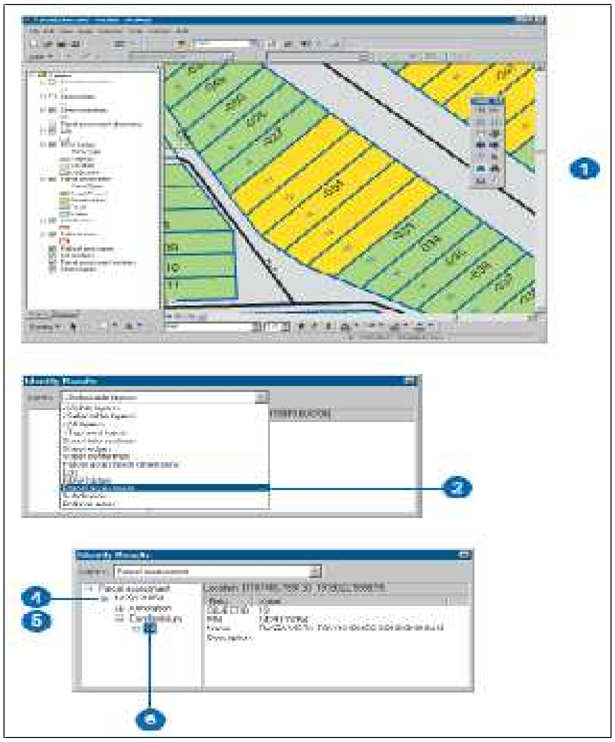
Deleting a relationship class.

1. Right-click the relationship class you want to delete.
2. Click Delete.



Exploring the related objects of a feature

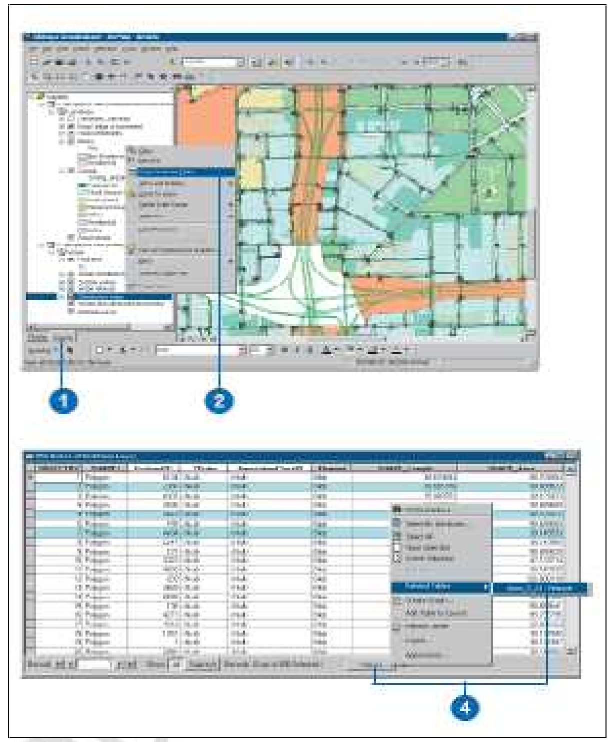
1. Click the Identify tool in ArcMap.
2. Click the Layers dropdown arrow and click the layer in your map whose features you want to identify in the Identify Results dialog box.
3. Click the feature on the map.
4. Double-click the feature in the left panel of the Identify Results dialog box.
5. Double-click the relationship path label.
The related objects are listed below the path label.
6. Click the related object whose properties you want to explore



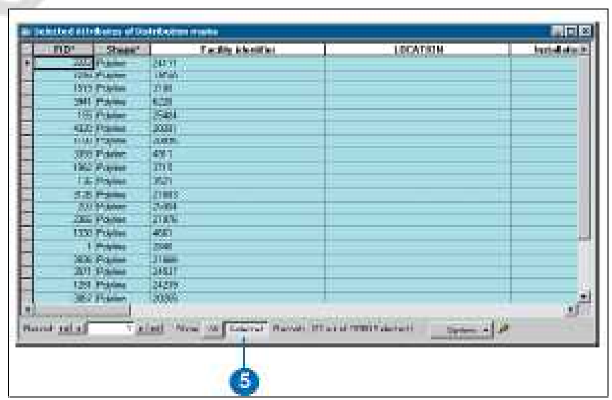
Exploring the related objects of an object in a Table

1. Click the Source tab on the ArcMap table of contents.
2. Right-click the name of the object of interest and click Open Attribute Table. The table that contains the objects whose related objects you want to explore will open.
3. Select the objects whose related objects you want to explore.
4. Click Options, point to Related Tables, and click the path label for the relationship.

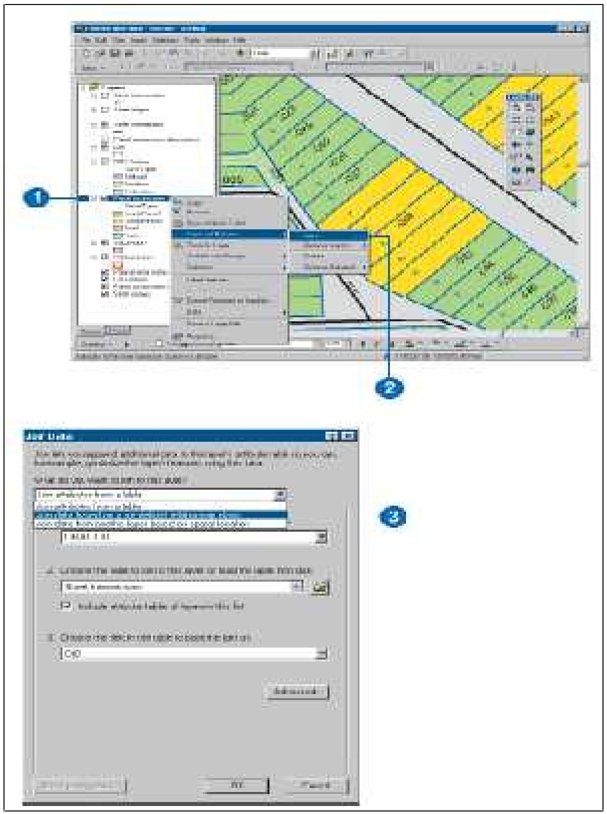
U



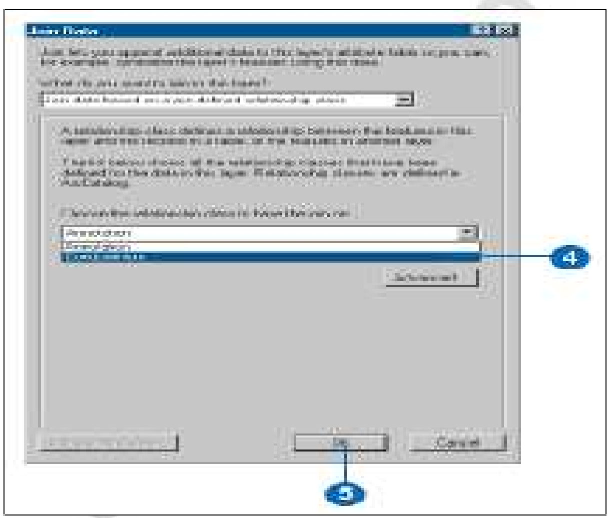
A new table dialog box opens for the related table.
5. Click Show Selected to display only those objects related to the selected objects in the first table.



1. Right-click the feature layer in the ArcMap table of contents.
2. Point to Joins and Relates and click Join.
3. Click the Join options dropdown arrow and click Join data based on a predefined relationship class.

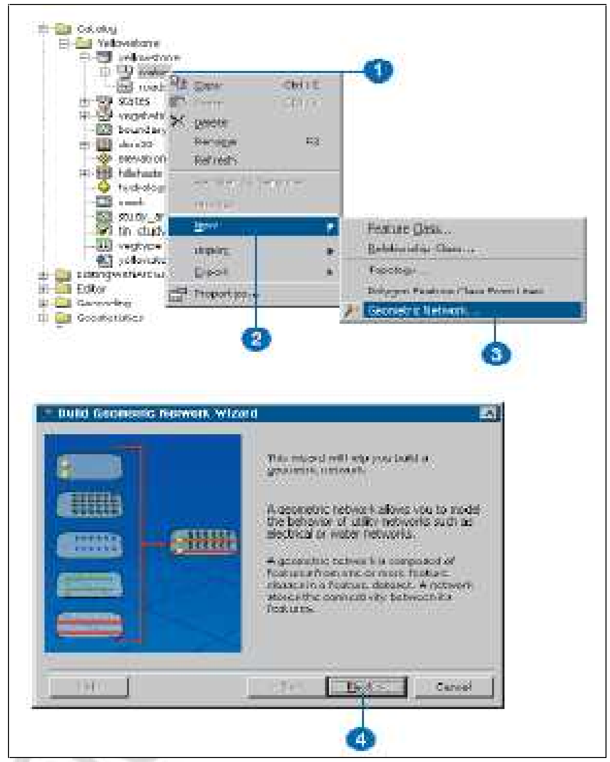


4. Click the dropdown arrow to get a list of relationship classes, then click the relationship class.
5. Click OK. You can now use the related fields for labeling, symbolizing, and querying your features.

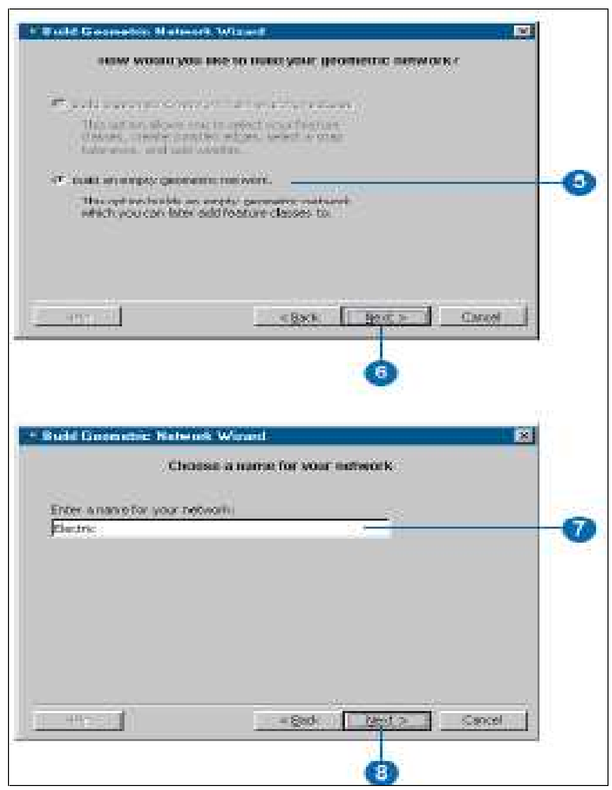


Geometric networks

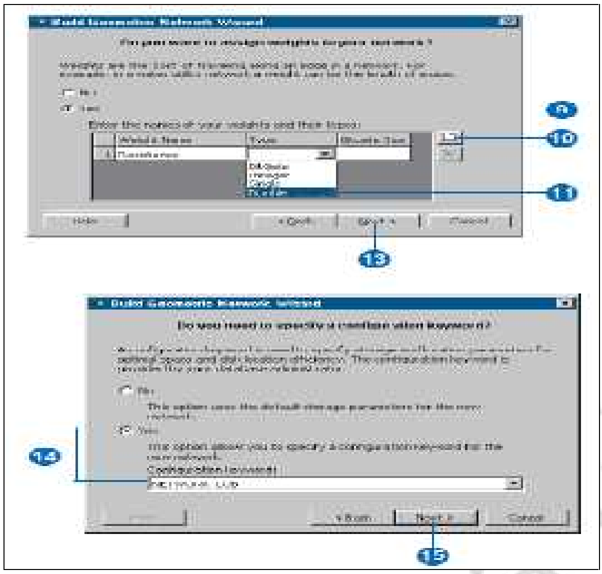
1. Right-click the feature dataset that will contain the network.
2. Point to New.
3. Click Geometric Network.
4. Read the information on the first panel and click Next



5. Click the second option tobuild an empty geometric network.
6. Click Next.
7. Type a name for the new geometric network.
8. Click Next. u

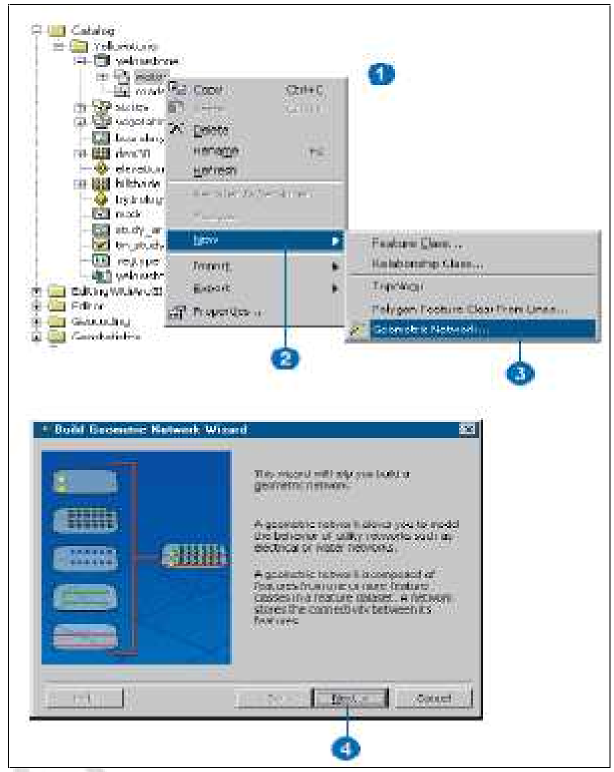


9. Click Yes if you want to include weights in the network; otherwise, skip to step 13.
10. Click the New button and type a name to add a new weight.
11. Click the dropdown arrow and click the weight type.
12. Repeat steps 10 and 11 until all of the network's weights have been defined.
13. Click Next.
14. Click Yes and type the name of the keyword if your geodatabase is stored in an ArcSDE database and you have a configuration keyword for the network storage. If not, skip to step 15.
15. Click Next.

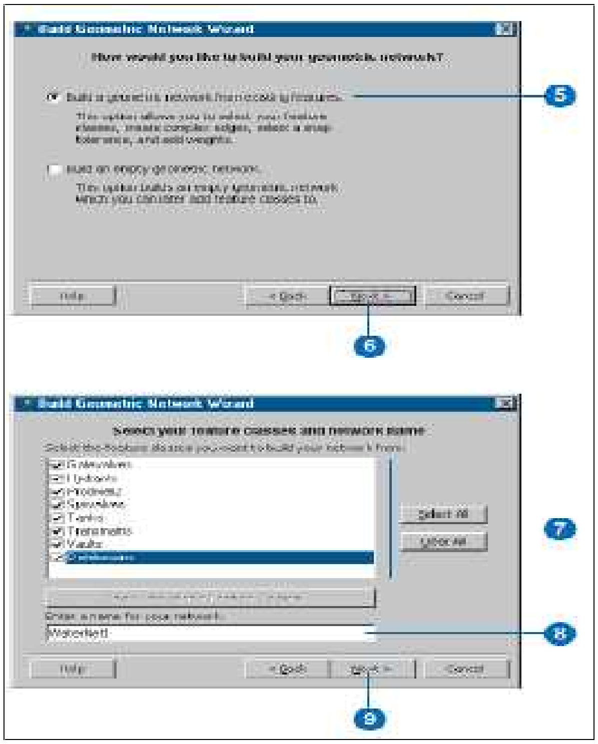


16. Review the options you specified for your new network. If you want to change something, you can go back through the wizard by clicking the Back button.
17. Click Finish to create the new geometric network

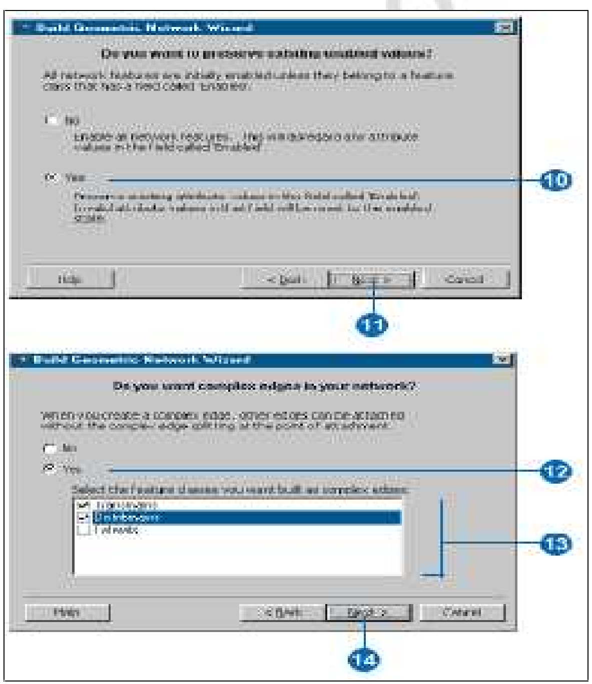
1. Right-click the feature dataset that will contain the network.
2. Point to New.
3. Click Geometric Network.
4. Read the information on the first panel and click Next.



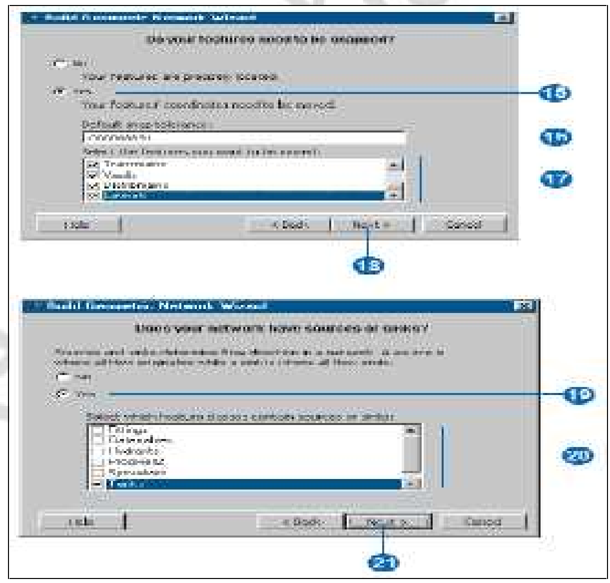
5. Click the first option to build a geometric network from existing features.
6. Click Next.
7. Click the feature classes that you wish to include in this geometric network.
8. Type a name for the new geometric network.
9. Click Next.



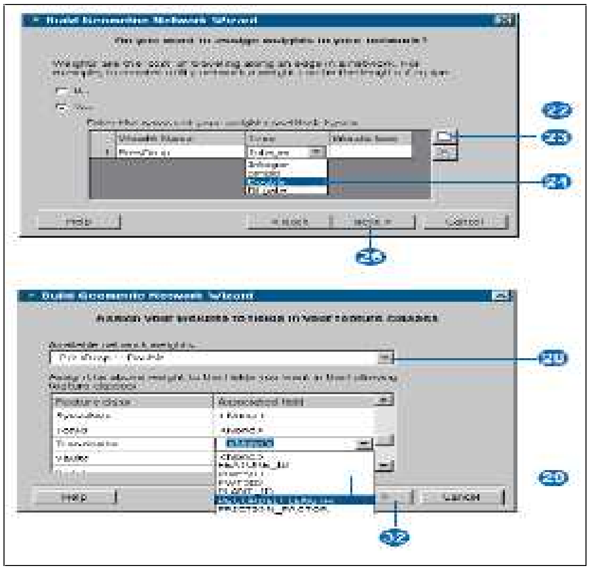
.10. If any of the feature classes used to be part of a network, you can choose to keep enabled values for the new network you are creating. If this panel doesn't display, skip to step 12.
11. Click Next.
12. Click Yes if you want some of the input line feature classes to become complex edges, otherwise skip to step 14.
13. Check the line feature classes that you want to become complex edges. Those that are not selected will become simple edges.
14. Click Next.



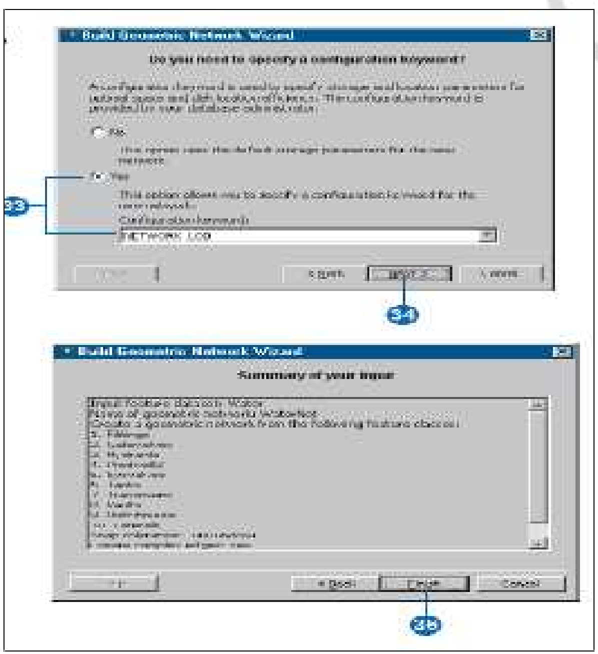
15. Click Yes if you want features in some of the input feature classes to be automatically adjusted and snapped during the network building process; otherwise, skip to
step 18.
16. Type a snapping tolerance if you don't want to use the default tolerance.
17. Check the feature classes whose features you want automatically adjusted and snapped. Feature classes that are not selected are not adjusted.
18. Click Next.
19. Click Yes if you want features in some of your junction feature classes to be able to act as sources or sinks; otherwise, skip to step 21.
20. Check those junction feature classes that you want to store sources and sinks.
21. Click Next. u



22. Click Yes if you want to add weights to your network. Otherwise, skip to step 26, then skip over steps 27
through 31.
23. Click the New button to add a new weight.
24. Type a name for the new weight, click the dropdown arrow, and click a weight type.
25. Repeat steps 23 and 24 until all of the network's weights have been defined.
26. Click Next.
27. Assign the weights, if you added any, to specific fields in each feature class.
28. Click the dropdown arrow and click the network weight to which you will assign an attribute.
29. Click the dropdown arrow and click the field you want associated with this weight.
30. Repeat step 29 for each feature class that you want
to associate with this weight.
31. Repeat steps 28 through 30 until you are finished associating network weights with feature class attributes.
32. Click Next.

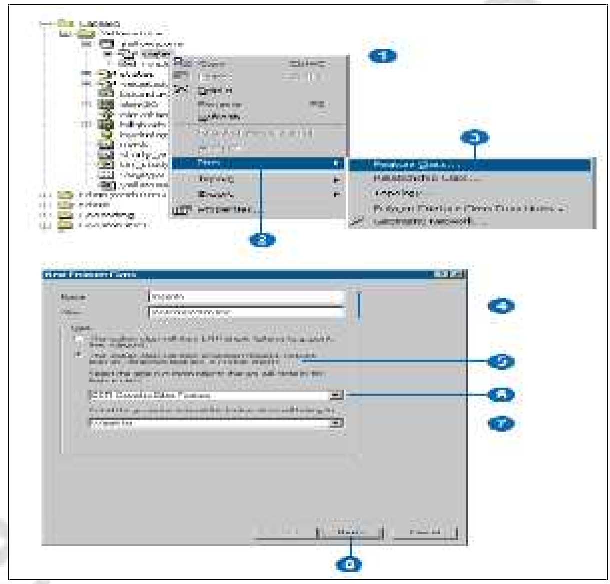


33. Click Yes and type the name of the keyword if your geodatabase is stored in an ArcSDE database and you have a configuration keyword for the network storage. If not, skip to step 36.
34. Click Next.
35. Review the options you specified for your new network. If you want to change something, you can go back through the wizard by clicking the Back button.
36. Click Finish to create the new geometric network

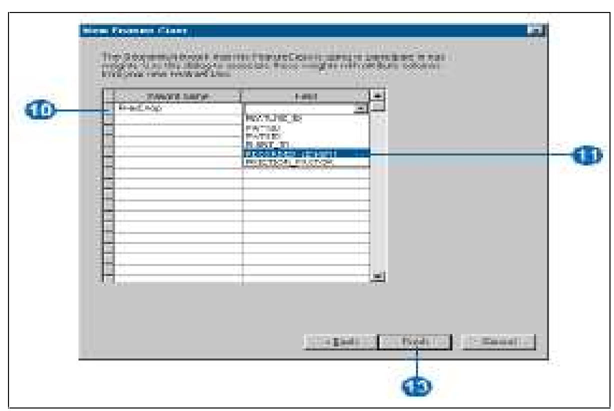


Creating a new network edge feature class

1. Right-click the feature dataset that contains the network.
2. Point to New.
3. Click Feature Class.
4. Type a name and an alias for the new feature class.
5. Click the second option to store network objects in the feature class.
6. Click the dropdown arrow and click ESRI Simple Edge Feature to create a feature class that stores simple edges. Click ESRI Complex Edge Feature to create a feature class that stores complex edges.
7. Click the dropdown arrow and click the geometric network in which this feature class will participate.
8. Click Next. u

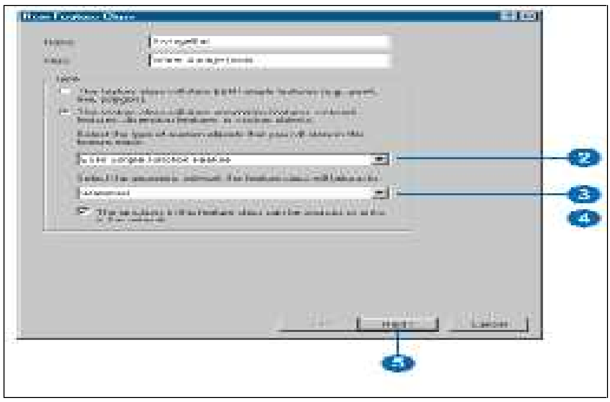


9. Follow the steps for 'Creating feature classes' as described in the chapter 'Creating new items in a geodatabase' in this book. You will be presented with an additional dialog box where you can associate the network's weights with fields in the feature class.
10. To associate a weight in the network with a field in this new feature class under Field, click the field next to the weight you want to associate.
11. Click the name of the field in the dropdown list to associate with this weight.
12. Repeat steps 10 and 11 until you have associated the weights in the network with fields. You do not have to associate all of the weights with fields.
13. Click Finish



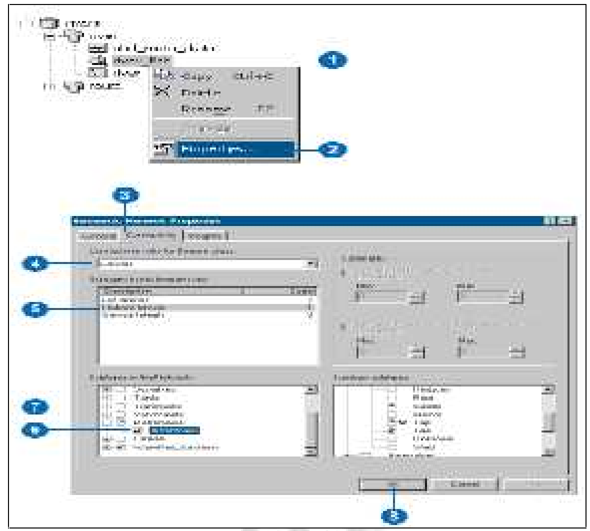
Creating a new network junction feature class

1. Follow steps 1 through 5 for ‘Creating a new network edge feature class’.
2. Click the dropdown arrow and click ESRI Simple Junction Feature to create a feature class that stores network junctions.
3. Click the dropdown arrow and click the geometric network in which this feature class will participate.
4. Check the box to allow the junctions in this feature class to be able to act as sources or sinks in the network.
5. Click Next.
6. Follow steps 9 through 13 for ‘Creating a new network edge feature class



connectivity rules
Adding an edge–edge rule

1. Right-click the geometric network.
2. Click Properties.
3. Click the Connectivity tab.
4. Click the dropdown arrow and click the feature class for which you want to create a rule.
5. Click the subtype of the feature class if your feature class has subtypes.
6. Navigate to and check the edge feature class or subtype you want to make connectable to this edge subtype or feature class.
7. Browse to and check the junction feature classes and subtypes through which these edge feature classes or subtypes will be permitted to connect.
8. Click OK to create the rule in the database.



Adding an edge–junction rule

1. Follow steps 1 and 2 for ‘Adding an edge–edge rule’.
2. Click the Connectivity tab.
3. Click the dropdown arrow and click the feature class for which you want to create a rule.
4. Click the subtype of the feature class if your feature class has subtypes.
5. Navigate and check the junction feature class or subtype you want to make connectable to this edge feature class or subtype.
6. Click the check box and enter the minimum and maximum number of permissible edges if you want to restrict the number of edges of this type that can connect to a single junction of this type.
7. Check the check box and type the minimum and maximum number of permissible junctions if you want to restrict the number of junctions of this type that can connect to a single edge of this type.
8. Click OK to create the rule in the database