

Create Survey Data

Overview

In this lesson, students learn how to use the survey functionality in AutoCAD® Civil 3D® software. This functionality enables you to automatically create pre-engineering base plans and existing ground surface models directly from field survey data.

When you use the Survey features, you can use Total Station and GPS observation data to automatically create pre-engineering base plans and existing ground surface models. You can also edit field data to adjust control coordinates, backsight angles, prism heights, and any other type of observed data.

Surveyors produce information upon which a design can be based. This information is provided to site designers, and usually consists of a pre-engineering base plan, an existing ground surface model, and a reduced coordinate point file.

Objectives

After completing this lesson, students will be able to:

- Configure and identify the main components of the Civil 3D survey environment.
- Create a survey database and network.
- Create figure styles to control the display of figures.
- Create figure prefixes to assign figure styles to figures.
- Describe the main characteristics of the Autodesk field book file format.
- Import a field book file to Civil 3D.

- Make changes to observation data in the survey database.
- Create points and figures from survey data.

Exercises

The following exercises are provided in a step-by-step format in this lesson:

1. Review the Survey Environment
2. Create Survey Database
3. Create a Survey Network
4. Create Figure Styles
5. Create Figure Prefixes
6. Import Survey Data
7. Edit Survey Data

Survey Databases

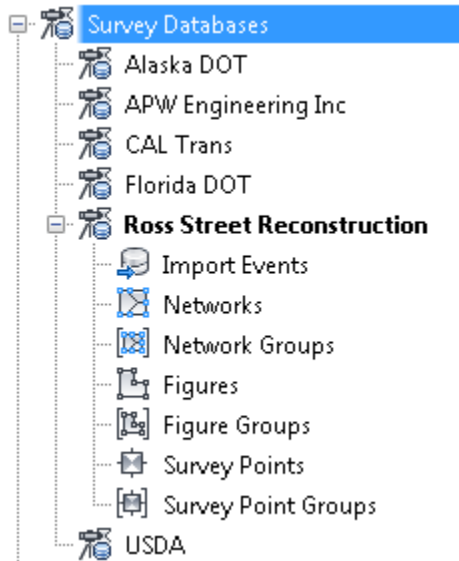
Survey information is the essential starting point for any land development project. Before the planning, feasibility, permitting, or design process can begin, a land survey of the project site must be conducted.

This land survey represents existing conditions and shows the site's boundaries, topography, infrastructure, utilities, and other critical features. Raw data, or field observations such as horizontal angle, vertical angle, and slope distance, is collected using either total station or GPS data collection equipment. Field observation data is shown in the following illustration.

Station:4, Backsight:3							
Number	Angle	Distance	Distance Ty...	Vertical	Vertical Ty...	Target H...	
402	339.2051	148.783	Slope	91.2824	Vertical Ar	5.141	
403	335.5220	145.741	Slope	91.2859	Vertical Ar	5.141	
404	333.2854	148.369	Slope	91.2940	Vertical Ar	5.141	
405	332.5129	145.902	Slope	91.2908	Vertical Ar	5.141	
406	335.2525	143.015	Slope	91.2740	Vertical Ar	5.141	
407	336.4450	150.755	Slope	91.3038	Vertical Ar	5.141	
408	338.2405	148.422	Slope	91.3139	Vertical Ar	5.141	
409	340.2038	147.884	Slope	91.3906	Vertical Ar	5.141	

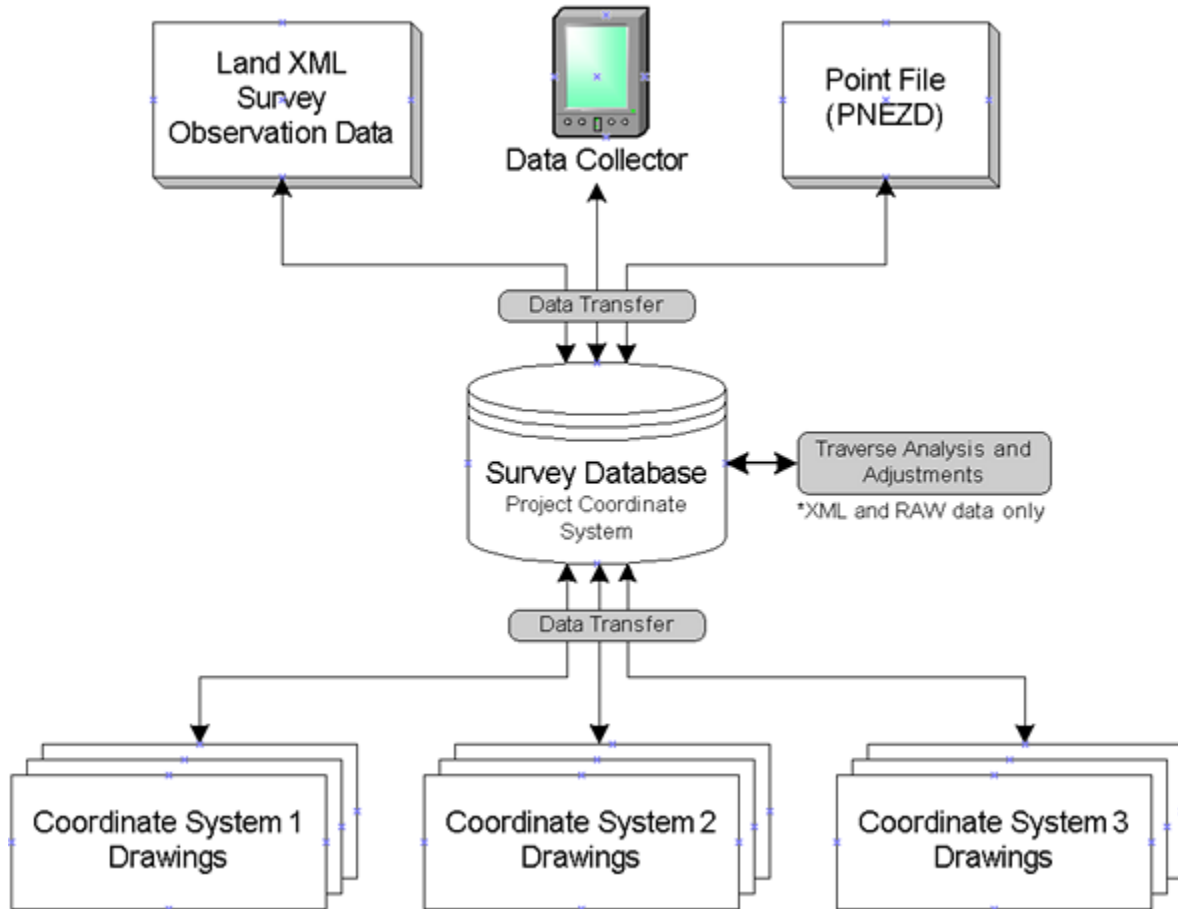
Once collected, this data is stored in a central repository, the survey database. The data in the survey database can be accessed by any user and referenced to any coordinate system. Survey

databases are displayed on the Survey tab of Toolspace, and contain all the control points, known directions, observation measurements, traverse definitions, points, and figure data.



The survey database can be created either locally, or on a network, and you import survey data collected from a number of sources. Survey observation data that resides in the survey database may be recreated in different drawings with different coordinate systems. This is especially useful when you need to produce drawings that represent grid coordinates, as well as drawings that represent ground coordinates from a common survey database.

The survey database is intentionally kept separate and independent of your drawing project by Civil 3D for both practical and legal reasons. Original work done by registered surveyors is information that could have legal implications, and should not be altered without knowing the consequences. Survey databases are created as folders, by default, under C:\Civil 3D Projects.



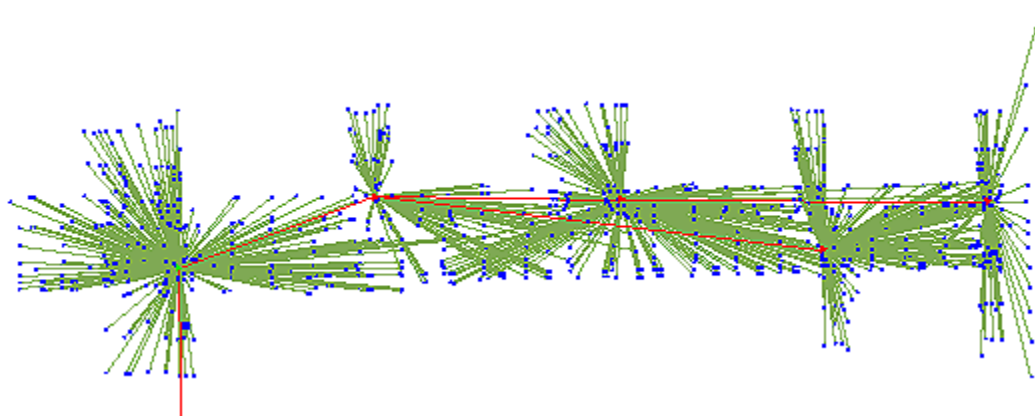
The survey data can be accessed through multiple drawings and can affect other objects, such as points and surfaces. For example, when you change a prism height or a backsight angle, associated point data automatically updates.

Survey data is transformed according to the survey database coordinate system and the individual drawing coordinate system. If the drawing units and coordinate zone differ, then the survey is transformed.

Survey Networks

Survey networks are collections of survey control, instrument setup, and observation data, and are used to edit, organize and manage survey data. Survey networks are typically created for site analysis, boundary survey, boundary analysis, topographic survey, and as-built survey phases of land development projects. Survey networks can also be used to organize survey data geographically.

The following illustration shows a survey network.



Survey networks provide a repository for the data collected in land development projects. Each project phase, or location, can be represented by a network in the database. Once the network is created, survey data can be transferred to the database from total station and GPS data files.

You can organize survey data by creating survey networks within the survey database for different stages of a land development project. Survey networks would be created for each of the following project phases:

- Boundary survey
- Topographic survey

Each survey network is displayed in the survey database folder as a separate subfolder, and a survey database may contain several networks. You can import several survey data files, or raw data files, to a single survey network. Survey networks exist in the survey database and can be inserted to, and removed from, any drawing connected to the survey database.

Survey networks contain the following data:

- Setups or stations
- Control points and non-control points
- Known directions
- Observations
- Traverses

The following illustration shows a survey network created in the Survey tab of Toolspace.

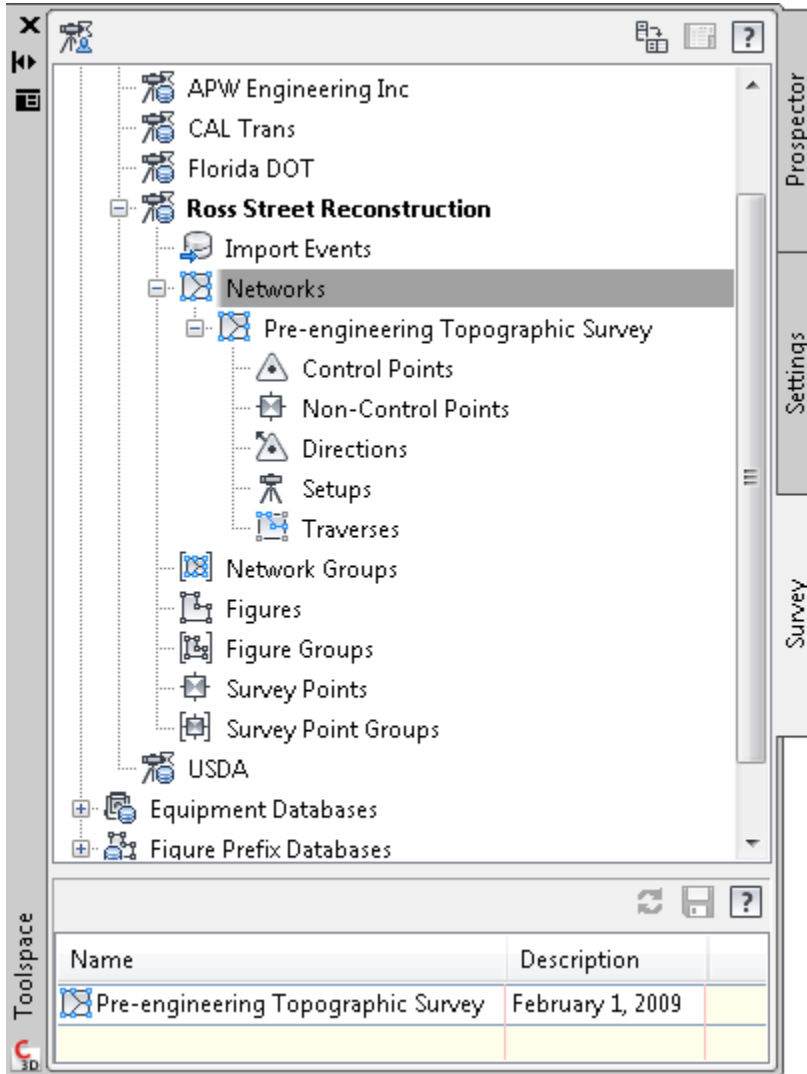


Figure Styles and Prefixes

Many survey crews apply linework connectivity codes during their pre-engineering boundary and topographic surveys. Linework connectivity codes such as Begin, End, Continue, and C3 (to connect three points with an arc) result in the automatic creation of survey figures that represent ditch bottoms, road crowns, and sidewalk edges. The result is that the pre-engineering base plan and existing ground surface model is a direct by-product of the surveyor's field efforts.

The base plan is a plan view drawing that shows existing conditions. The base plan typically consists of linework and symbols. The linework is used to represent pavement edges, centerlines, sidewalk edges, gutter lines, ditches, and other types of linear features. Symbols are used to represent spot features such as catch basins, fire hydrants, and power poles.

The creation of the pre-engineering base plan and the existing ground surface model is typically the responsibility of the survey organization or department. The groups involved with this work strive to automate the processes as much as possible.

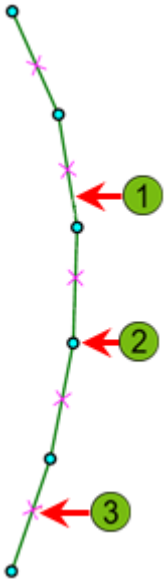
The following elements are required to automate the process:

- Surveyors are consistent with their use of field codes that represent specific features.
- Surveyors apply field connectivity codes to automatically generate base plan linework as the data is imported to AutoCAD Civil 3D. Examples include Begin, End, Continue, C3, and Recall.
- Base plan linework is assigned to layers automatically and can also be defined as breaklines for the surface.
- Point groups for surface modeling are predefined in the drawing template (DWT). These point groups filter invalid data from the surface model, such as pipe inverts and tops of fire hydrants.
- Description key sets associate point style and point label style to each point.
- Civil 3D represents survey data with a survey network object. The Survey Network style, as with other Civil 3D object styles, controls the display of the survey network.

Definition of Survey Figures

Survey figures are polyline objects that contain line and arc segments. You use survey figures to connect similar survey features such as pavement edges, fence lines, and sidewalks. Some survey figures can be used as breaklines for the surface model. Survey figure styles control the display of survey figures.

The following illustration shows the graphical components of a survey figure.



- 1 Figure line.
- 2 Vertex marker with marker style.
- 3 Midpoint markers placed at segment midpoints.

Definition of Survey Figure Prefixes

Survey figure prefixes automate the assignment of survey figure styles, which are used to control the display of the survey figures. Survey figure prefixes can also assign figures to layers and tag specific figures as breaklines. Survey figure prefixes are stored in an external file called the figure prefix database.

Survey Figure Prefix Database

Figure prefixes are stored in a figure prefix database. Prior to creating the figure prefixes, you need to set the path and create a figure prefix database. The figure prefix database should be centrally located locally on a computer network for all users to access. A sample figure prefix database is shown in the following illustration.

Name	Breakline	Layer	Style	Site
BV	<input checked="" type="checkbox"/> Yes	C-ROAD-BLVD	Existing Boulev	Survey Si
BW	<input checked="" type="checkbox"/> Yes	C-ROAD-SWLK	Existing Sidew	Survey Si
CL	<input checked="" type="checkbox"/> Yes	C-ROAD-CNTR	Existing Cente	Survey Si
EP	<input checked="" type="checkbox"/> Yes	C-ROAD-EPAV	Existing Edge	Survey Si
FW	<input checked="" type="checkbox"/> Yes	C-ROAD-SWLK	Existing Sidew	Survey Si

Importing Survey Data

You can import a number of survey data types to a survey database. Working with survey field book files enables you to edit and adjust the survey observation data directly within the Civil 3D environment. Any data created from importing survey field book files, such as points, figures, and surfaces, automatically updates when you edit survey observation data. You import survey data to begin the base plan creation and surface modeling process.

About Field Book Files

Field book files are your primary source of survey data. Field book files can be created from total station and GPS data files. Different brands of survey data collectors have their own observation data file format that can be converted to field book files, and then imported to Civil 3D. Field book files contain survey observation data such as control coordinates, station setup information, instrument and prism heights, backsight angles and sideshot data (slope distance, horizontal angle, and vertical angle).

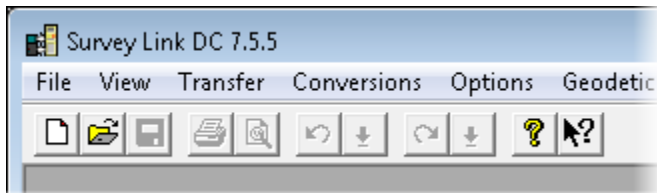
When you import a survey field book file to a survey network, the network in the survey database is populated with observation data. The coordinates of the survey points and figures are also calculated. The following illustration shows a survey field book file containing observation data.

```
5 Ross Street.fbk - Notepad
File Edit Format View Help
JOB Ross Street Avenue! DT02-01-2009 TM10:29:05
UNIT METER DMS
EDM OFFSET 0.0000
SCALEFACTOR 1
HORIZ ANGLE RIGHT
VERT ANGLE ZENITH
NEZ 1 5452310.3890 493970.3250 80.5050 "MONV4116UTM"
NEZ 2 5452304.8087 494174.6058 79.6490 "MONV654"
STN 1 1.800 "MONV4116UTM"
AZ 1 2 91.33531
BS 2 0.00000
! BS check 1-2: ZE90.18217,SD204.359,HD err=0.001,vD
err=0.003, Angular err=0.00062
PRISM 1.567
F1 VA 20 87.18413 15.666 92.02083 "POLER"
F1 VA 21 93.37010 16.634 91.52436 "TSR"
F1 VA 22 82.03279 18.155 91.50313 "LP"
F1 VA 23 81.28000 16.885 91.47238 "LP"
F1 VA 24 90.58058 21.247 91.45570 "TRR .2D"
BEG EW
F1 VA 25 83.41157 25.706 91.51512 "EW"
F1 VA 26 79.51421 25.943 91.47358 "EW"
BEG EW
```

Number	Data type	Description
1	NEZ - coordinates	Typically these are the points that the instrument is positioned over as well as the backsight point.
2	STN	Station setup command and height of instrument.
3	BS	Backsight angle.
4	PRISM	Rod height.
5	F1 VA	Sideshot observation data.
6	BEG	Begin statement to begin a figure. Other examples of linework connectivity codes include End, Continue, C3 (to connect three points with an arc), and Recall.

Creating Field Book Files

You can create field book files using the Survey Data Collection Link program found on the ribbon, Create Ground Data panel. The Survey Data Collection Link program is shown in the following illustration. You can also create field book files using the applications available from the survey data collector manufacturers.



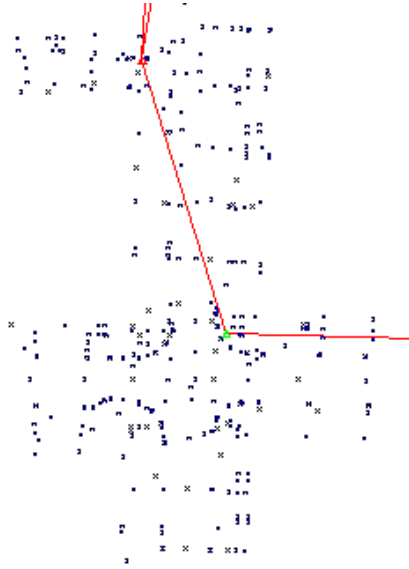
Importing Field Book Files

After you create the survey database and the survey network, you import the field book file to the survey network. You can import any number of field book files to a survey network.

When you import the field book file, the survey network in the survey database is populated with the survey observation data. You also have the option to create the following drawing objects:

- Survey network
- Survey points
- Survey figures

A survey network is shown in the following illustration.



The survey network is an object that visually represents the data in your survey. It is used for editing and analyzing survey data. After the survey has been analyzed for errors and adjusted, the survey network is removed from the drawing. The adjusted points and the figures are then inserted to the drawing from the survey database.

Working with Survey Data

You can edit and perform traverse adjustments on survey data. You insert the survey network to the drawing, from the survey database, to perform traverse analysis and adjustments. Once the edits and adjustments are complete, you remove the survey network from the drawing and then create the survey points and survey figure objects in the drawing directly from the data in the database. When you adjust and edit the survey network data again, the survey drawing objects automatically update.

Survey Data Characteristics

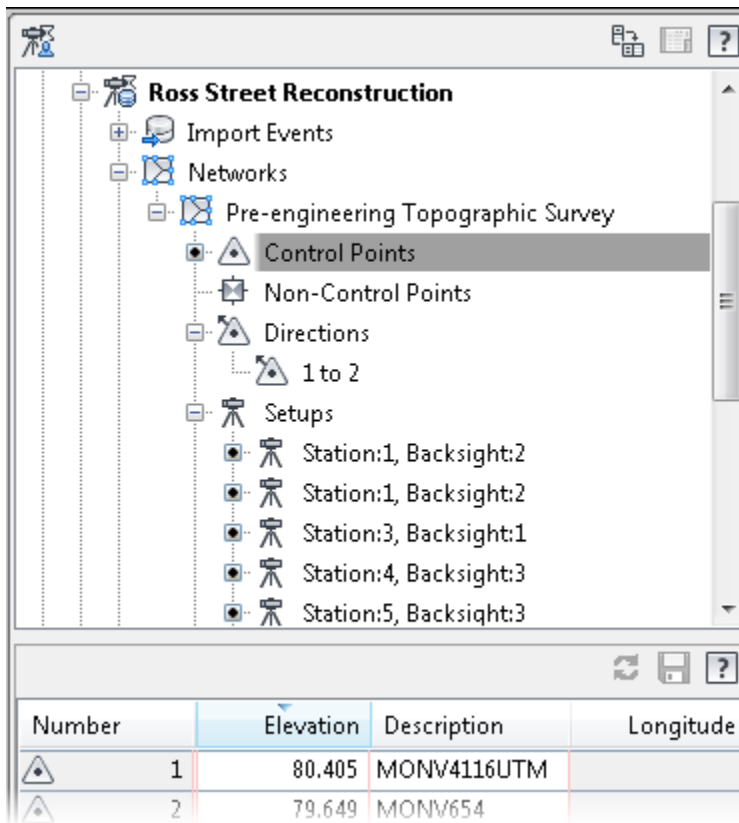
Survey network, point, and figure data are stored in the survey database and can be removed from, or inserted into, the drawing at any time. When you make changes to survey observation data, all associated data automatically updates.

For instance, if you change the prism height for a series of observed points, the observed point elevations update. Similarly, if you change the coordinate of a control point, the coordinates of the points observed (surveyed) from that control point update.

Observation Data Example

Survey observation data is displayed in the Survey Network on the Survey Toolspace. After you import the field book file, you can expand the trees in the Networks collection to see observation data. When you edit the observation data, you change the contents of the Survey database. You then recalculate the Survey Network.

The following illustration shows the control points, directions, and setups in a survey network.



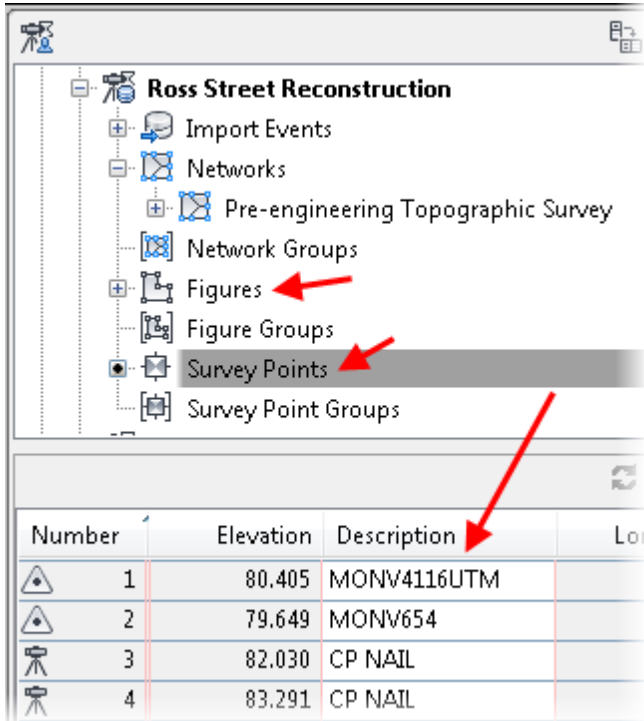
The screenshot displays the Survey Network interface for a project named "Ross Street Reconstruction". The tree view shows the following structure:

- Import Events
- Networks
 - Pre-engineering Topographic Survey
 - Control Points (selected)
 - Non-Control Points
 - Directions
 - 1 to 2
 - Setups
 - Station:1, Backsight:2
 - Station:1, Backsight:2
 - Station:3, Backsight:1
 - Station:4, Backsight:3
 - Station:5, Backsight:3

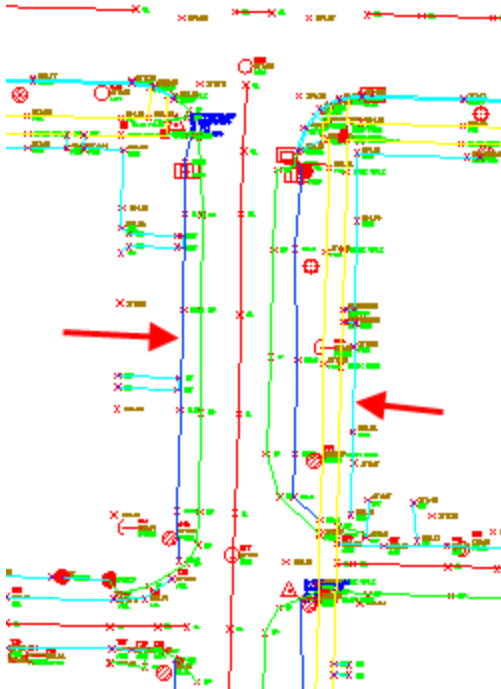
Below the tree view is a table with the following data:

Number	Elevation	Description	Longitude
1	80.405	MONV4116UTM	
2	79.649	MONV654	

Survey observation data also consists of all of the observed figures and points as shown in the following illustration.



After importing the survey network to the drawing so you can visualize, check, and adjust your survey, you then remove the network from the drawing and create survey points in the drawing. You can then import the survey points and figures to the drawing. These are shown in the following illustration.



Key Terms

Survey Tab	The Survey tab is positioned below the Prospector tab and the Settings tab in the Toolspace window. You use the Survey tab to manage survey databases, survey networks, survey data, and survey system settings.
Base Plan	The base plan is the Civil 3D drawing that represents existing conditions before the design begins. Base plans show existing features such as roads, sewers, light poles, and manholes. These features are represented using Civil 3D point objects to represent spot features, and feature lines to represent linear features. The engineer must become familiar with the existing conditions prior to beginning the design work. Base plans are created directly from the survey raw data file.
Observation Data	Observation data is the raw data format created from Total Station survey data-collection equipment. Survey observations typically consist of a measured horizontal angle, vertical angle, and slope distance record. The survey raw data file also contains information such as control coordinates, height of instrument, and height of rod. The final coordinates are calculated when the survey data is imported to Civil 3D.
Reduced Coordinates	Reduced point coordinates are created from observation data. Reduced coordinates typically refer to the northing and easting point coordinate attributes. Survey sideshot points are represented with angular measurements in observation data. When imported to the drawing, sideshot point data is converted to reduced coordinate point data.
Field Book File	The field book (FBK) file is an AutoCAD Civil 3D observation file. Different brands of survey data collectors have their own observation data file format. These observation data files are converted to the AutoCAD Civil 3D field book files, which are then imported to AutoCAD Civil 3D. Coordinates are calculated as field book file data imported to the Civil 3D drawing.
Survey Database	The survey database is an external database that stores the observation data. The survey database is populated with observation data when the field book file is imported. The location of the survey database defaults to the <i>\Civil 3D Projects\</i> location on your hard drive. The survey database can be accessed from any drawing to create base plan data.

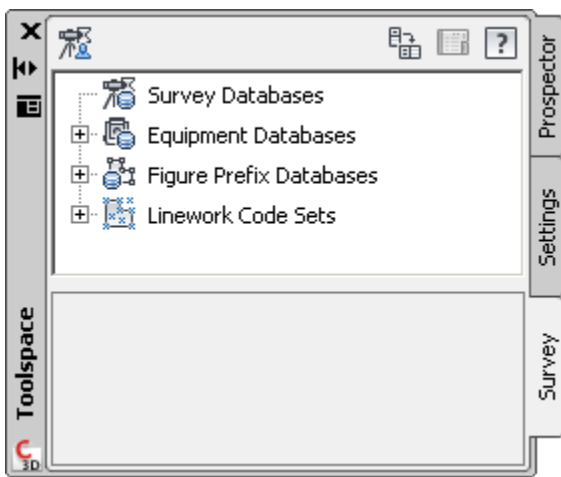
Survey Network	A survey network is a collection of related control points, instrument setups, survey observations, and defined traverses. Survey networks are stored in the survey database, and a single survey database can contain several survey networks.
Figures	Civil 3D figures are used to represent the base plan linework such as pavement edges, centerlines, gutter lines, and sidewalks. In the field, surveyors apply figure connectivity codes (Begin, End, Continue, and so on) to automatically generate the base plan figures. Surveyors assign names to figures using the Begin command. Figures can be converted to breaklines for surface modeling. Figure display is controlled with a figure style. Figures are organized in figure groups.
Figure Prefix Database	The figure prefix database assigns figure styles to survey figures. The figure prefix database also assigns certain figures as breaklines for existing surface models.

Exercise 1: The Civil 3D Survey Environment

In this exercise, students configure and become familiar with the survey environment. The configuration of the workspace involves positioning the Toolspace, turning off scroll bars and closing unwanted toolbars.

The following elements of the Toolspace window are used in the Civil 3D survey environment:

- Prospector tab: Shows survey networks and figures in the drawing.
- Settings tab: Used to create survey network styles and figure styles.
- Survey tab: Used to create and manage survey databases and survey networks.

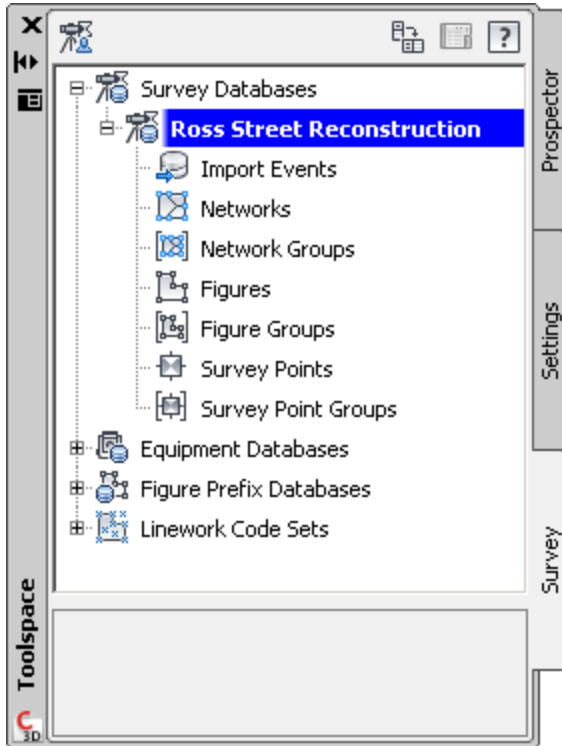


You can also access the Survey command from the menu and from the command line.

For this exercise open ... \I_CreateSurveyData-EX1.dwg (M_CreateSurveyData-EX1.dwg).

Exercise 2: Create Survey Database

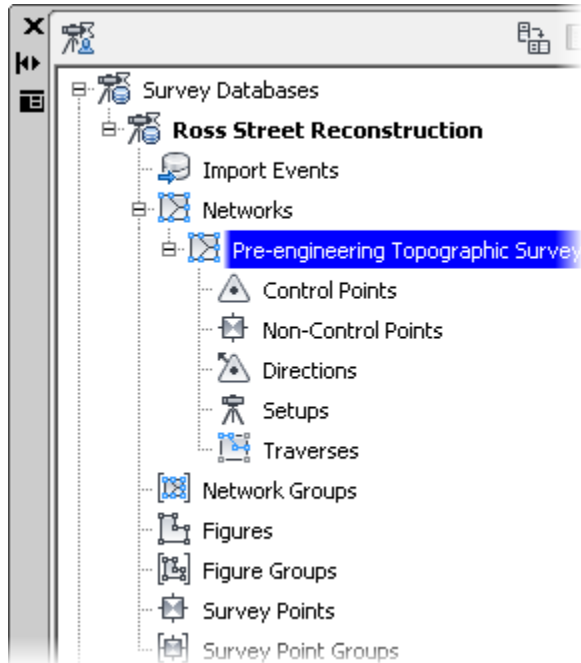
In this exercise, students create the survey database and students modify the survey database settings. The survey database is an external location where survey data is stored.



For this exercise, open ... *I_CreateSurveyData--EX2.dwg (M_CreateSurveyData-EX2.dwg)*.

Exercise 3: Create a Survey Network

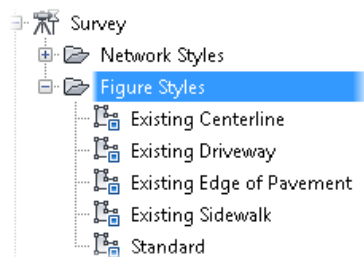
In this exercise students create a survey network. The survey network is in a survey database and stores related survey data.



For this exercise open ... \I_CreateSurveyData-EX3.dwg (M_CreateSurveyData-EX3.dwg).

Exercise 4: Create Figure Styles

In this exercise students create figure styles. Figure styles control the display of the figures, or the base plan linework.



For this exercise open ... \I_CreateSurveyData-EX4.dwg (M_CreateSurveyData-EX4.dwg).

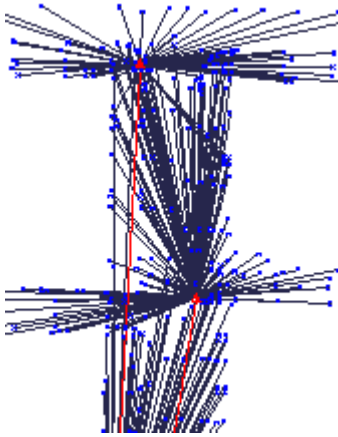
Exercise 5: Create Figure Prefixes

In this exercise students create figure prefixes for the existing centerline, pavement edges, sidewalks, and driveways. When survey observation data is imported, the figure name is matched against the figure prefix.

For this exercise, open ...*I_CreateSurveyData-EX5.dwg (M_CreateSurveyData-EX5.dwg)*.

Exercise 6: Import Survey Data

In this exercise students import data to the survey network, in the survey database, from a field book file. A field book file contains observed, or raw survey data.



For this exercise, open ...*I_CreateSurveyData-EX6.dwg (M_CreateSurveyData-EX6.dwg)*.

Exercise 7: Edit Survey Data

In this exercise students edit the survey observation data in the survey database.

For this exercise open... *I_CreateSurveyData-EX7.dwg (M_CreateSurveyData-EX7.dwg)*.

Students must complete the prior exercises before working through this exercise.

Assessment

Challenge Exercise

Instructors provide a master or challenge exercise for students to do based on this lesson.

Questions

1. What is a survey observation data file?
2. What does a surveyor typically create from observation data?
3. Who is this information delivered to in the site design process?
4. What types of features in Civil 3D are used to represent base plan linework and breaklines for existing ground surface models?
5. What types of features in Civil 3D are used to represent spot features on the base plan and locations for the existing ground surface model?
6. Explain how the survey database works.
7. What are the primary functions of the figure prefix database?
8. What is the primary function of the survey network?

Answers

1. A survey observation data file contains all the survey field measurements. A survey observation data file is also known as a raw data file. This information usually is keyed-in control coordinates, instrument setup locations, instrument height, backsight points and angles, rod heights and sideshot data, which is measured with a horizontal angle, vertical angle, and slope distance.
2. Surveyors create a model of existing conditions from observation data. The model consists of a base plan drawing in plan view, an existing ground surface model, and points with reduced coordinates.
3. Surveyors deliver their finished product to designers. Designers then create detailed design documents for construction. These contract packages contain construction drawings, construction staking data, and quantity reports.
4. Figures.
5. Points.
6. The survey database is an external file that is created prior to importing survey data. The survey database stores survey observation data. Multiple users can create their own survey drawings from data residing in a single survey database.
7. The figure prefix database assigns figure styles to survey figures. The figure prefix also identifies certain figures as existing ground surface model breaklines.

8. The survey network is a graphical representation of the survey data. You can make changes to survey network data from the Survey Toolspace. The survey network is updated after changes have been saved.

Lesson Summary

This lesson introduced students to survey functionality in AutoCAD Civil 3D. Surveyors provide data to engineers upon which a land development design can be based. This data represents existing conditions and consists of reduced point coordinates, a plan view base plan drawing, and an existing ground surface model.

Surveyors collect this data using Total Station and GPS survey data collection equipment. Data recorded with Total Station data collectors is referred to as observation data, which consists of actual field measurements. The Civil 3D observation data file format is field book (FBK). Points with coordinates are created when observation data is imported to the Civil 3D drawing.

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