Chapter

1

Evaluating Existing Conditions

In this chapter, you evaluate and model existing ground conditions. This examination provides the designer with important information regarding how the final design will fit into local surroundings. The existing surface is a prerequisite to the design process and provides the engineer with existing ground elevation and slope information.

First, you create EG surfaces based on contour data provided by the surveyor, which indicate the direction of surface water runoff. Next, you create an existing ground surface by importing data from an external LandXML file. LandXML-based data facilitates the sharing of survey and engineering data, regardless of the tool used to collect the information. Finally, you evaluate the 3D model of an existing surface in order to make correct design decisions. Surface analysis tools enable you to examine critical information about the site in a visual manner, leading to accurate site design.

Objectives

After completing this chapter, you will be able to:

- Describe the workflow for creating existing ground surfaces.
- Generate an EG surface based on contour data.
- Import an EG surface from a LandXML file.
- Evaluate the existing 3D surface model.

Lesson: Creating Existing Ground Surfaces

Overview

This lesson outlines a workflow for creating an existing ground (EG) surface based on existing site conditions. You examine the existing site conditions to verify the validity of data and to determine which physical site features may impact the proposed design.

The following illustration shows a surface generated from imported LandXML survey data, viewed in shade mode.

Objectives

After completing this lesson, you will be able to:

- Describe EG surfaces and explain their relevance to site design.
- Outline the workflow for creating EG surfaces.
- Explain the guidelines for creating EG surfaces.

About EG Surfaces

The basic principles governing the design of roadways begin with examining existing site conditions. This examination provides the designer with important information regarding how the final design will fit into the local surroundings. In addition to adhering to roadway design criteria and local regulations, the designer must also consider the social and environmental impacts of the project. The designer must consider site-related design questions such as: where does the planned roadway tie back into the existing roadway; can the surface water run-off be adequately and efficiently conveyed away from the site; and will adjacent properties require easements or acquisition. By answering these questions, the designer can minimize the impact to the area and keep costs down.

Obtaining an accurate topographic and boundary survey is a critical first step in evaluating the existing site conditions. Such a survey is the basis from which the preliminary and final designs are generated. While the existing topography maps alone are no substitute for actual field reconnaissance, they do provide the designer with a wealth of information that enables the design process to proceed. The designer can immediately evaluate the maps for the best alignment routes and drainage patterns, and can also identify possible property acquisitions. Therefore, it is critical to your entire roadway design process that the EG used in your design be as accurate as possible. All of your horizontal alignments, vertical profiles, slopes, and ties are based on the EG surface.

EG Surface Definition

An existing ground surface is a surface model. The EG surface is a prerequisite to the design process and provides the engineer with existing ground elevation and slope information. The EG surface is required for creating the corridor model and vertical profiles. The EG surface is a mathematical model that attempts to represent the real world site topography.

An accurate EG model provides the user with site information such as model elevations, particularly along the existing roadway where the proposed roadway ties in. Contours of the model indicate the direction of surface water runoff that may be disrupted by your design. A slope analysis or sections through the existing surface provide an early indication of where retaining walls may be needed. Existing features used in the creation of the model, such as adjacent roads, buildings, streams, rivers, rock outcrops, and so on, can substantially impact the final design and the cost of construction.

Survey Data

Survey data representing existing conditions can generally be categorized into two datasets: 2D planar data showing different features on the site, and 3D data that can be used in creating a surface model. The 3D data is critical because it is used to define the surface model, which in turn affects decisions related to geometric design (vertical and horizontal). The surface model also impacts those decisions related to drainage and mass haul. While the 2D planar survey features are not used in the creation of the surface model, they must be considered as they may help the designer identify safety, economic, social, or environmental impacts of the proposed roadway design.

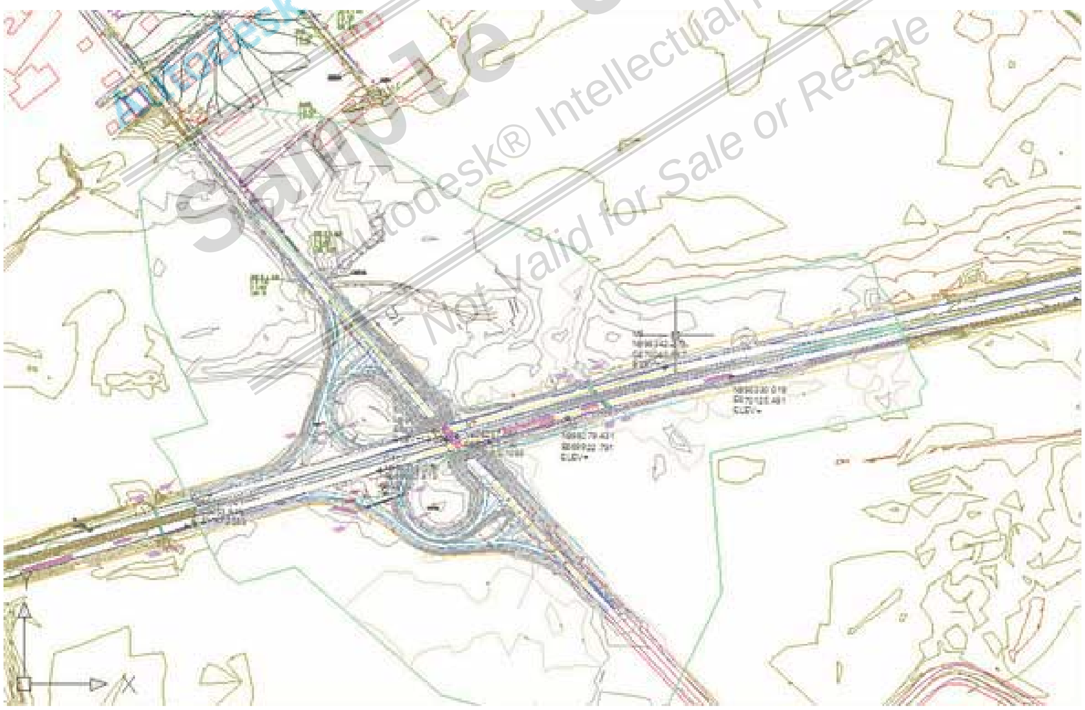
Your goal is to build an EG surface model for your project from the data provided by a surveyor. The surveyor may provide data to the designer in several different formats. A widely accepted deliverable option is a LandXML file generated from a final surface model that has been validated by the surveyor. The LandXML file would therefore contain everything the surveyor used to create the model and would be the most representative of the actual survey data.

If the surveyor provided you with a DWG™ file, it is important that you carefully review the data to see what information is provided in the file. Is there a layer in the file that was turned off that might contain the Triangulated Irregular Network (TIN), which is the model of the existing ground created by the surveyor? Keep in mind that the TIN is a 3D mathematical representation of a surface, using triangles to connect every point and every breakline vertex that the surveyor felt adequately represented the real-world surface. Each triangle face has a slope, as does each of the triangle legs, enabling you to execute functions such as contouring or generating a slope analysis. The surveyor's TIN is an excellent source to build your surface from, since it best replicates the surveyor's model.

Other things to review include whether the feature lines in the file (roadways, buildings, ditches, streams, and so on) are 2D or 3D polylines. If they are 3D, they can easily be added to the EG surface to help shape the surface model. If not, and if the only 3D elements in the file are contour lines, then your EG model will not provide you with enough detailed information to design with. This information may be sufficient for preliminary design purposes, but inadequate for final design.

EG Surface Example

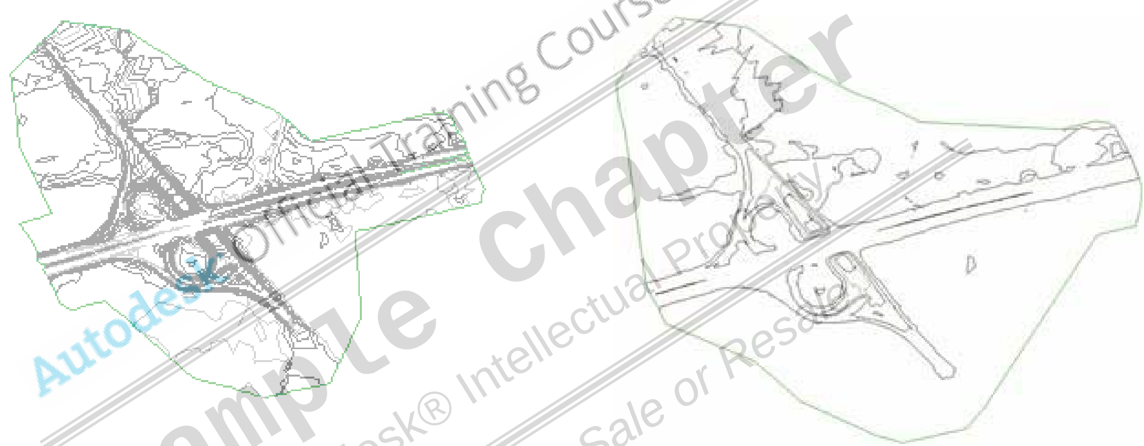
The following illustration shows the existing condition of a surface, supplied by the surveyor. The illustration shows various features relevant to the design: contours that represent EG surface; existing utilities or pipe runs; and existing roads, culverts, trees, fences, and other topology features. These features affect the design because the proposed ramps need to tie into existing conditions, accounting for all constraints imposed by the site conditions and local design standards.



Creating EG Surfaces

The EG surface model is the foundation upon which your proposed roadway design is based. It is therefore a critical component of the design process. Because the EG model is intended to represent the real-world conditions of your site, it is important to understand which data is provided to you by the surveyor and what that data represents. This chapter explores two methods for creating an EG ground surface, and the implications or limitations of each alternative. The workflow outlines two ways of generating an EG surface: from contours and from LandXML.

The following illustration shows two EG surfaces. The surface on the left was generated from contours, and the surface on the right was generated from LandXML data. The image on the right represents the features contained in the LandXML file for the same site. Both of these datasets contain valuable information. While the image on the left appears to contain significantly more data than the image on the right, that dataset is actually less accurate than the LandXML file.



Methods for Generating an EG

Typically, it is the project surveyor who is responsible for providing the civil engineer with an accurate EG surface upon which to build the proposed design. The deliverables provided by the surveyor are specified in their contract, but sometimes these deliverables are not exactly what the engineer needs to import the EG directly into Civil 3D. While not the ideal situation, the engineer may find himself in the common position where he may need to recreate the EG surface in Civil 3D. The engineer must exercise caution when performing this task, as modifying or altering the surveyor's deliverable may introduce liability.

EG surfaces can be:

- Generated based on contours in DWG file.
- Generated by importing data from a LandXML file.
- Created based on paper plans.

DWG File

One method for building an EG surface is to extract relevant data from an electronic file, such as a DWG drawing file provided by the surveyor. This DWG file provides a graphic representation of the EG surface, showing contours, spot grades, buildings, roadways, streams, and so on. Hopefully, the file also contains Triangulated Irregular Network (TIN) lines on a layer that may be turned off or frozen. In conferring with the surveyor, if you determine that he used TIN lines to build his EG surface, generated the contours shown in the DWG file, and did not tweak the contours after the TIN was created, then importing these TIN lines into Civil 3D will generate a very accurate model. Always contour your EG surface and compare it against the contours provided by the surveyor. Be aware that different contouring algorithms may represent the contours slightly different, so you must use judgment in determining if the model is accurate enough.

If the DWG file does not contain the TIN model, and the TIN is unavailable from the surveyor, then you must review the graphics in the DWG file to see whether you can use them to build your own EG model. First, check to see whether all the graphical objects in the file are 3D, and if the elevations assigned to these objects make sense. For example, if there are 3D polylines representing curb lines or edge of pavements in the DWG file, do the elevations of the vertices match with what the contours are showing? Does a 432 contour thread closer to the vertex with an elevation of 431.3, or to the one with elevation 432.2? Does the elevation of a “spot grade” block match the elevation listed as the spot grade label? You must be diligent to check that the 3D graphic data provided correlates to what the contours are representing. If you are satisfied, import the 3D features and spot grades, build the EG surface, and compare the resulting contours with those provided by the surveyor. You may need to adjust the surface, but be aware that there may be liability associated with doing so.

If the graphic features provided in the DWG file (roads, buildings, swales) are 2D only, and only the contours themselves have elevations, you can still build an EG surface. While building an EG surface using only contours may be the most common method of creating an EG, it is also the least accurate method. The contours provided in the DWG file are generated from a model that was built using spot grades and 3D feature lines (breaklines). These contours are a result of how these features influenced that model. Taking those contours and then using them to create a new EG surface does not take into account all the nuances that these feature lines and spot grades brought to the model. Because these features lines and spot grades are not part of the new EG model, the resultant contours are not constrained and will produce odd situations. The most common situation is that ridge lines, valleys, depressions, and streams are not properly represented in the EG model, and usually wind up as “flat” areas in the model. These flat areas become apparent when you cut profiles or sections through these areas. Because the flat areas are distortions of the true surface, they may have impact on your earthwork calculations as well.

LandXML File

Another method is for the surveyor to provide a LandXML file of the EG surface. This file contains all of the same data used by the surveyor to build his EG model, and is therefore an exact replica of the EG surface. The engineer simply imports this file into Civil 3D and builds the EG surface. This is the preferred method for generating an EG surface.

Paper Plans

The least desirable method for building an EG surface is to digitize contours and features from paper plans provided by the surveyor.

Process Outline

The following table describes the engineering tasks for the exercises in these lessons, outlines the software processes for accomplishing these tasks, and lists the software features used in the processes.

	Engineering Tasks	Software Processes	Software Features
1.	Create 3D model of EG from contours.	Create surface object based on contours from the drawing.	▪ Surface ▪ LandXML Export
2.	Create 3D model of EG by importing LandXML file.	Import LandXML file to create EG surface.	▪ Import LandXML ▪ Surface Styles
3.	Evaluate 3D model of existing ground.	Use various Civil 3D tools to evaluate, examine and analyze the 3D model of existing ground.	▪ Surface Styles ▪ Surface Analysis ▪ Surface Labels ▪ Orbit ▪ Object Viewer ▪ Quick Section ▪ Water Drop ▪ Inquiry tool

For more information on the software features, see Help.

Guidelines for Creating EG Surfaces

Keep the following guidelines in mind to mitigate liability issues when you work with survey data.

- The engineer should be aware of the data format that the surveyor is providing as a deliverable for the EG. If capable, the surveyor should provide a drawing file containing a Civil 3D surface of the EG model that you can simply create a data shortcut to. If that is unattainable, the surveyor should provide you with the exact TIN surface he used to generate his survey drawing. If the TIN is not available, then you may be forced to use the surveyors points and breaklines to generate your own EG surface. The latter is discouraged as the drawing file may or may not contain all of the data sets that the surveyor used to generate his EG surface.
- An alternative method of obtaining the EG surface data from the surveyor is in the form of a LandXML file. The engineer should verify with the surveyor that the LandXML file contains all of the elements used to create his final EG surface. If this is the case, then the LandXML file is simply imported into Civil 3D.
- Survey drawings that represent existing conditions often contain contours. The contours are most likely generated from the 3D surface model with software used by the surveyor.

Lesson: Generating EG Surfaces Based on Contours

Overview

In this lesson, you generate an EG surface based on contours. Generating an EG surface from contours is a quick solution, but the engineer must be aware of how the contours were created. Contours provide an analytical representation of the real surface, but depending on how the contours were generated, an EG surface generated from contours may only be accurate enough for preliminary design and rough quantities, but not accurate enough for the final design.

The following illustration shows an EG surface model with contours and a boundary.

Objectives

After completing this lesson, you will be able to:

- Explain the deficiencies of an EG surface generated from contour data.
- List the steps for generating EG surfaces that are based on contour data.
- Generate an EG surface based on contour data.

About Contour-Based EG Surfaces

You can create EG surfaces based on contour data provided by the surveyor. Contours of the model indicate the direction of surface water runoff that may be disrupted by your design.

Definition of Contour-Based EGs

Contour-based EG surfaces are surfaces that are created using only contour data as input. This method is a quick way of generating an EG surface; however, it may not be completely accurate and should be used for preliminary design tasks only.

Key Points

Because contours generated from the new surface may not match the original contours used in creating the model, the engineer may resort to tweaking the model for better correlation. Unfortunately, this introduces data into the model that was not part of the surveyor's original field data collection, and may shift liability to the engineer.

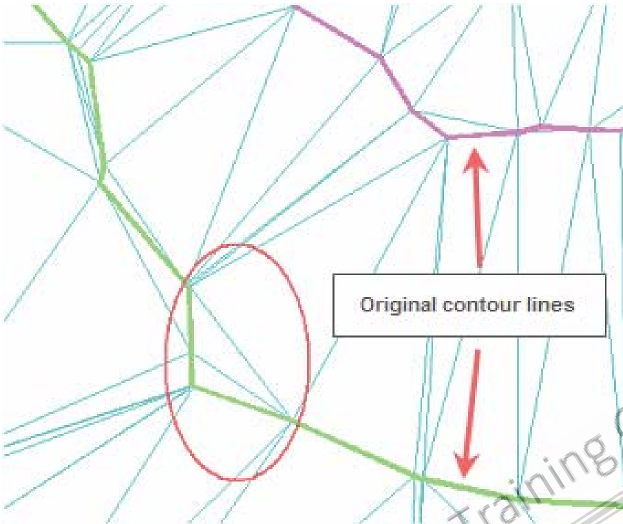
The reason that contour-based surface models may be inaccurate relates to how models are contoured. Take the surveyor's model for example; the surveyor collects points and breaklines (curbs, buildings, pavement edges, and so on) in the field, all points that reflect a change in the actual surface. The surveyor builds his model based on this data and then generates the contours. In building the model, the software analyzes all of the data in the model and generates 3D triangle (TIN) faces that connect all of the points and feature line vertices. When contouring the model, Civil 3D analyzes these 3D faces and "threads" the contours through the triangle edges at the correct elevations based on the slope of that line. As the software generates the contour, it may add additional vertices to the contour line to provide a smooth appearance. The more "smoothing" applied to a contour, the more vertices are generally added to the contour.

Finally, when you use the resulting contours in building a new model, the software treats the contours as breaklines. Because these breaklines (contours) have so many vertices due to prior smoothing, the resulting TIN model has many more 3D faces. Because there are no spot grades or feature lines in this new model to influence the TIN to represent high or low areas, the software may triangulate in unexpected ways. Typically the result is a flat area where there might really be a ridge line or low area. Depending on the extent of the flat area and the contour interval, a significant volume of cut or fill may be missed.

Example of EG Based on Contour Data

Often, you are provided with polyline data representing contours. You use these polylines to create a surface. As mentioned earlier, a surface model is always treated as a network of triangles by the software. You can apply the appropriate surface style to show the triangles. Sometimes, the surface triangles are oriented incorrectly, producing a flat surface rather than a three-dimensional one. You can edit the surface by changing the direction of the triangle lines. However, if surface was supplied as TIN file, mesh, 3D lines, or solids, there would be no need for interpretation or editing of the triangles.

The following illustration shows a detail view of a surface created from contours. The magenta and green lines represent the original contour lines used in creating the surface. All of the triangles shown between the vertices of these two lines imply that there is a slope between the two lines. However, the two triangles shown in the circled area illustrates how the software can mis-interpret the data. Since all three points on each of these two triangles falls on the same contour, each point has the same elevation, and both of those triangles are considered "flat triangles".



You can change the direction of triangle lines to improve the accuracy of the surface. In the following illustration, two triangle edges that connected the same contour were edited. In the original version of the surface, the contours were oriented from upper left to lower right. In the current version, they are oriented from lower left to upper right.

While Civil 3D has tools you can use to easily modify these triangle faces, the sheer number of triangles that may need to be modified can be substantial. In this illustration, there are several more triangles that need to be edited to avoid flat areas.

Generating EG Surfaces Based on Contours

This section describes the steps for generating EG surfaces from contours. First, on the base map provided by the surveyor, you need to examine site conditions such as drainage areas, culverts, manholes, trees, utilities, and features that represent design constrains or features you need to tie into. After the site conditions are examined, you then evaluate 3D data that will be used to create the EG surface.

Process Description

First, you open the DWG file provided by the surveyor and determine if the contours have the appropriate elevations assigned to them. If not, then modify each contour so that the elevation matches the contours label. Isolate all of the layers that contain the contours to be included in your EG surface.

Next, you create a “temporary” surface in the surveyors drawing file. This surface is temporary because you want to utilize the data in the file, but you do not want to modify his original data. Once you build the EG model you will export the EG surface out of this file via LandXML for ultimate use in another design file. You exit the surveyor’s file without saving any changes.

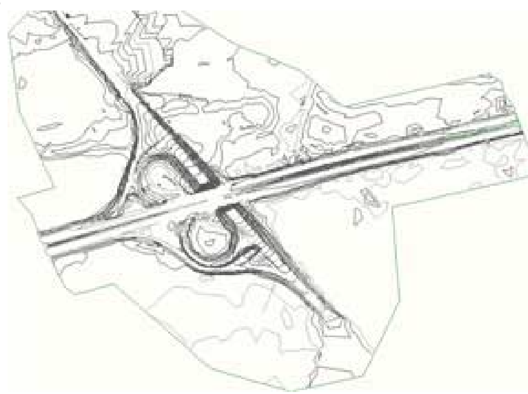
Finally, you export the EG surface using LandXML so that the surveyor’s drawing can be closed without saving these changes. The LandXML file will be imported into another design file.

Process: Generating EG Surfaces from Contours

The following steps outline the process for generating EG surfaces from contours.

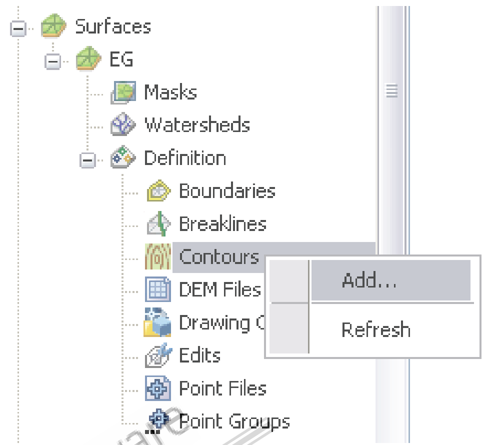
1. Evaluate survey data.

- Check if contours have correct elevation.
- Check for possible point data and point elevations.
- Check for possible breaklines and their elevations.
- Check for other available data that can contribute to quality of EG or its interpretation, such as DEM (Digital Elevation Model), aerial photos, etc.



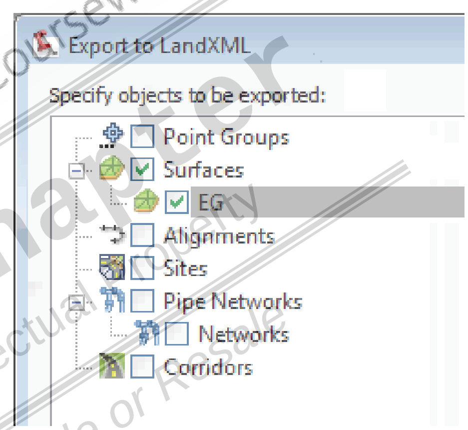
2. Create "temporary" EG surface in surveyor's drawing file.

- Create a surface object.
- Add contours to the surface object.
- Add other required objects to the surface object (point groups, breaklines, and so on).
- Add a boundary to the surface object.



3. Extract data from original survey drawing.

- Export data to LandXML.

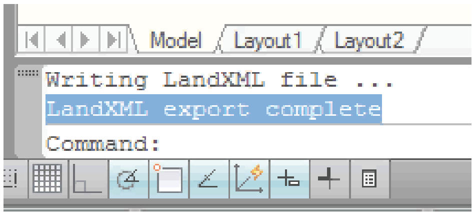


Guidelines

- You must always check the data that you intend to incorporate in your design. Checking the contours supplied by the surveyor prior to building an EG surface is no exception. Verify that the polylines representing the contours have the correct elevations assigned to them. If not, you must modify the polylines to have the correct elevations prior to importing into.
- Be aware of polylines with an elevation of 0 (zero). While the intent of this polyline may be to represent a 2D feature, an elevation of 0 is still a valid elevation. If the topography of your site is not near 0, such as near sea level, make sure you don't include these polylines when you select the contours for the model. Civil 3D uses any polyline that you select when building the model, and the contour results of incorporating a contour with an elevation of 0 may be problematic.

Exercise: Generate an EG Surface Based on Contours

In this exercise, you create an EG based on contours. You also add a boundary to the EG surface.



The completed exercise

1. Open *ExistingCondition.dwg*.

   This drawing shows you the survey data provided by a surveyor.

2. Review the data. Select some objects in the drawing. Use the List command or the Properties dialog box to check whether the contours have elevations assigned. Also check that the elevations assigned match the contour labels.

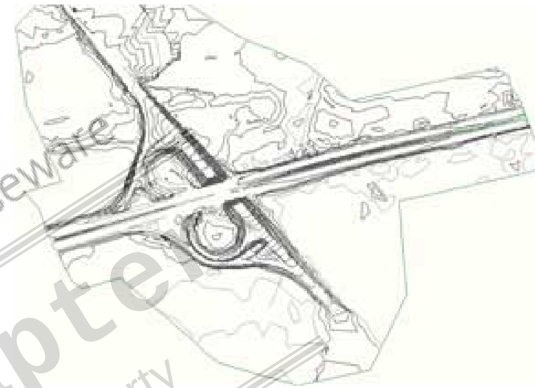
3. In Toolspace, Prospector tab, right-click Surfaces. Click Create Surface.

4. In the Create Surface dialog box, for Name, enter **EG**. Click OK.

   It is suggested that you enter a description for your contours. It is good practice to create a description for all of your objects, one that provides sufficient information to enable other users to understand the source of the data. For example, the description should include the source of the data used to create the model, the date the model was created, and the name of the user who created the surface. Experience has shown that a good description significantly helps other team members collaborating on a large project to quickly identify who created the surface object and when it was created.

5. Isolate the following layers: C-TOPO-MINR, C-TOPO-MAJR, C-TINN-BNDY and 0 (the surface layer).

   This action isolates the contours and boundary that you will add to the surface.



6. In Prospector:
   - Expand Surfaces, EG, Definition.
   - Note all of the various object types that can be included to build a surface model. In this example, you add contours only.

7. Right-click Contours. Click Add. In the Add Contour Data dialog box, enter a meaningful description for the contours. Click OK.

8. When prompted to Select Contours, use a window to select all of the controls in the drawing.

9. Press ENTER.

   The Panorama with Event Viewer opens, notifying you about the progress. Depending on the quality of the data, you may receive different errors and warnings.

10. Close Panorama.

11. Next, you add a boundary to the EG surface. A boundary is added to the surface model to define and control the extents to which the data is interpolated. The boundary is used to prevent the software from extrapolating and generating triangles beyond the extent of where the survey was performed. Boundaries can also be added to the surface to prevent interpolation inside this area.

In Prospector, under Definition, right-click Boundaries. Click Add.

12. In the Add Boundaries dialog box, click OK.

13. When prompted to Select Object(s), select the green polyline in the C-TINN-BNDY layer.

At this point you have created the EG surface. Because the EG surface was created inside the survey file, you want to export the surface out of this file so that you can close the surveyor's drawing without having modified it.

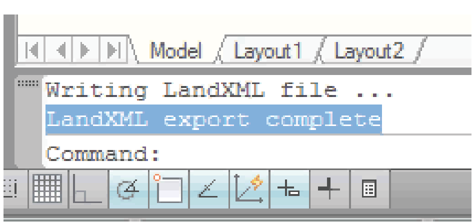
14. In Prospector, right-click EG surface. Click Export LandXML.

15. In the Export to LandXML dialog box, verify that EG is selected. Click OK.

16. In the Export LandXML dialog box:

- Navigate to the course folder.
- For File Name, enter **srEG.xml**.
- Click Save.

17. On the command prompt, you are notified that the LandXML export is complete. The EG surface has been exported to LandXML file.



18. Close the drawing.

Lesson: Generating EG Surfaces from a LandXML File

Overview

In this lesson, you create an existing ground surface by importing data from an external LandXML file.

Large projects often require you to obtain data from or to share data with consultants, subcontractors, or professionals in other disciplines. These colleagues might not use AutoCAD® Civil 3D® or AutoCAD®. AutoCAD Civil 3D provides you with tools that you can use to move data across platforms, software versions, and CAD standards.

A LandXML file that you can import into Civil 3D is shown in the following illustration.


```
            <Author createdBy="" createdByEmail="" company=""
companyURL="" timeStamp="2008-07-19T11:04:10"></Author>
      </Application>
      <Surfaces>
            <Surface name="EG" desc="Existing Ground">
                  <SourceData>
                        <Contours>
                              <Contour elev="14.5">
                                    <PntList2D>
998290.04285588837 669760.95060047298 998292.042010737
669759.15322051581 998293.10197060974 669758.19775330019
998287.25269872288 669763.39145865676 998285.9168030119
669761.31452906923 998286.38068644877 669760.10544728627
998284.10286354821 669759.88575378107 998282.36618304555
669759.7182528628 998283.3140578398 669762.77993475017
998283.98986266705 669764.96281734586 998284.37661831046
669766.06761157734 998284.49842261197 669766.20909955015
998284.83960216155 669766.12699584069 998285.03293108137
669765.93638272386 998287.02672238217 669764.722550062
998288.97419215448 669761.99399531132 998292.05471168447
```


Objectives

After completing this lesson, you will be able to:

- Explain the uses of LandXML and list the types of data you can import using LandXML.
- List the guidelines for importing and working with LandXML data.
- Generate an EG surface from an imported LandXML file.

About LandXML

AutoCAD Civil 3D contains tools that you can use to import LandXML-based data into your drawings. These tools facilitate the sharing of survey and engineering data, regardless of the tool used to collect the information.

Definition of LandXML

Extensible Markup Language (XML) describes a universal data exchange format that facilitates the transfer and sharing of information between different applications on the World Wide Web. LandXML is a non proprietary open standard that is based on the XML specification. It is designed specifically for the transfer of civil engineering design and survey measurement data between dissimilar applications. Data that is stored in LandXML format can be used by any software program that uses LandXML standards.

A sample portion of a LandXML file is shown in the following illustration.


```
<LandXML xmlns="http://www.landxml.org/schema/LandXML-1.1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.landxml.org/schema/LandXML-1.1
http://www.landxml.org/schema/LandXML-1.1/LandXML-1.1.xsd"
date="2008-07-19" time="11:04:10" version="1.1"
language="English" readOnly="false">
      <Units>
            <Metric areaUnit="squareMeter" linearUnit="meter"
volumeUnit="cubicMeter" temperatureUnit="celsius"
pressureUnit="milliBars" diameterUnit="millimeter"
angularUnit="decimal degrees" directionUnit="decimal degrees">
</Metric>
      </Units>
```


For more information, visit *www.landxml.org*.

Data You Can Import Using LandXML

You can import point, surface, and site data from LandXML files. This feature is useful when you exchange data with other software applications, or if you want to use Civil 3D conceptual design tools with data that was collected using different tools.

You can import the following types of data from LandXML:

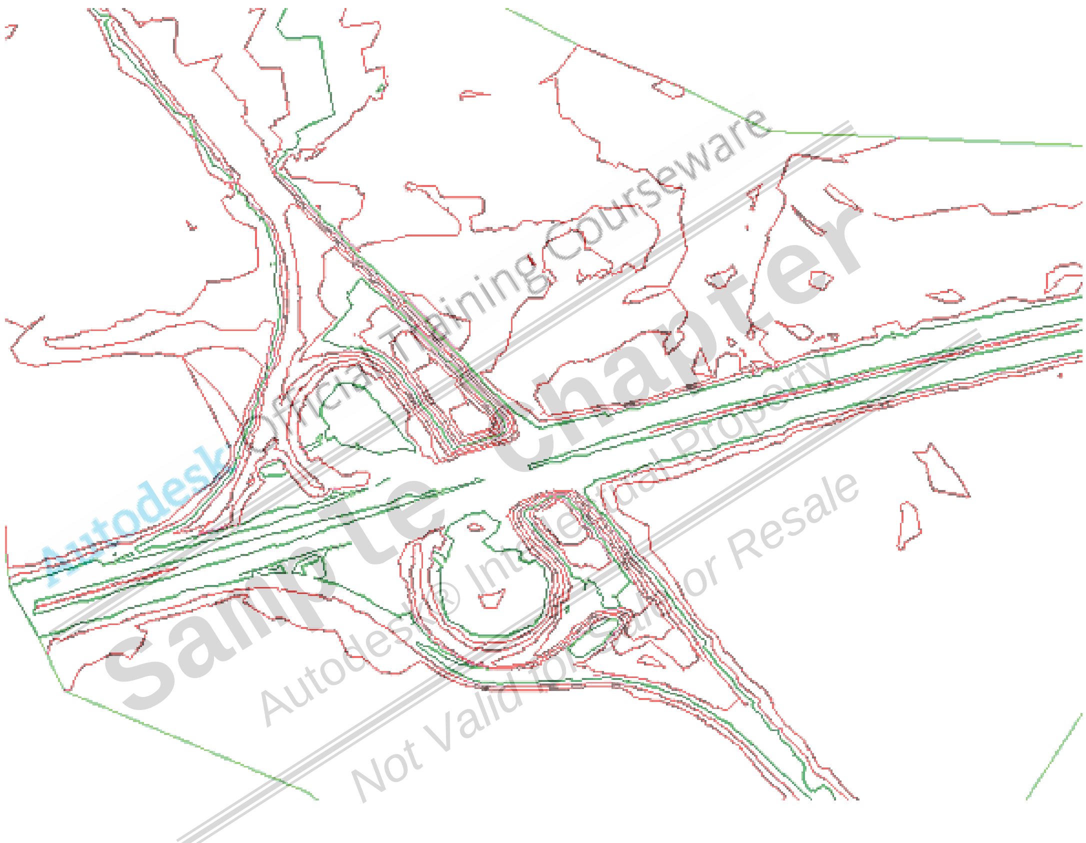
- Coordinate geometry (COGO) points
- Point groups
- Surfaces
- Parcels
- Alignments
- Alignment profiles

For more information, see LandXML Import and Export in the AutoCAD Civil 3D User's Guide.

Example of Design Data You Can Import

In addition to providing base property and features data, a survey firm can create TINs for the site and provide you with the surface in LandXML format. Receiving data in LandXML format ensures that you receive an accurate TIN model from which you build contours, create road profiles, or carry out other design tasks.

The following illustration shows an existing ground surface created from a LandXML file with an applied contours style.



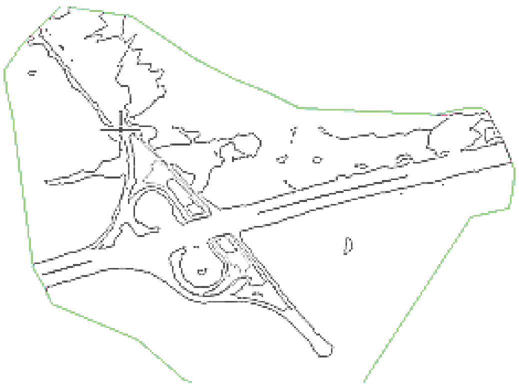
Guidelines for Importing LandXML Data

Keep the following guidelines in mind when importing LandXML data and creating surfaces from the data.

- If you create a surface by importing a LandXML file, the file is always referenced when you rebuild the surface. If you move the drawing file, the LandXML file must accompany it. This behavior is similar to that of external references. Deleting, moving, or renaming the LandXML file makes the surface invalid. To avoid broken references to LandXML files, you can create a surface snapshot that retains an image of the surface data at the time it was imported. You can set a LandXML setting to specify that a surface snapshot be created in the surface definition when a surface is imported from LandXML.
- It is important to use an appropriate drawing template when importing from LandXML files. Drawing templates store object styles that reflect pertinent CAD standards, including layer schemes, color schemes, plot styles, and so on. Because of the large number of settings, object styles are a fairly complex matter to handle. It is recommended that they be created by a CAD manager, CAD department, or consultant.

Exercise: Generate an EG Surface Based on LandXML Data

In this exercise you will create an existing ground surface by importing data from a LandXML file.



The completed exercise

1. Click File menu > Open.

   In the Select a File dialog box, change Files of Type to *.dwt. Select *AutoCAD Civil 3D (Metric) NCS LDT.dwt*. Click Open.

2. Click File menu > Import > Import LandXML.

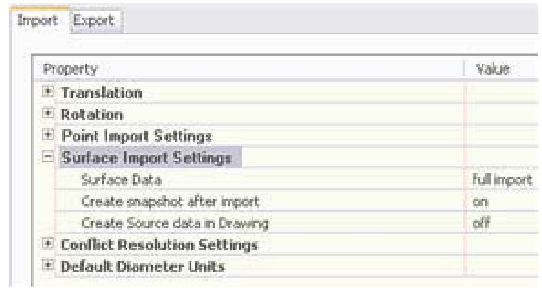
3. In the Import LandXML dialog box:

   - Navigate to where you installed the data files.
   - Click *srEG.xml*.
   - Click Open.

4. In the Import LandXML dialog box, click Edit LandXML Settings.

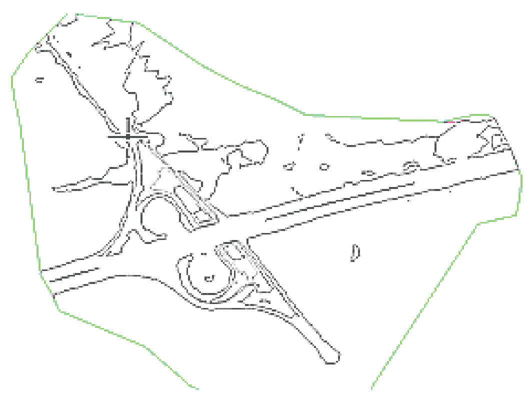
5. In the LandXML Settings dialog box, Import tab, expand Surface Import Settings:

   - For Surface Data, click Full Import.
   - For Create Snapshot after Import, click On.
   - For Create Source Data in Drawing, click Off.
   - Click OK.



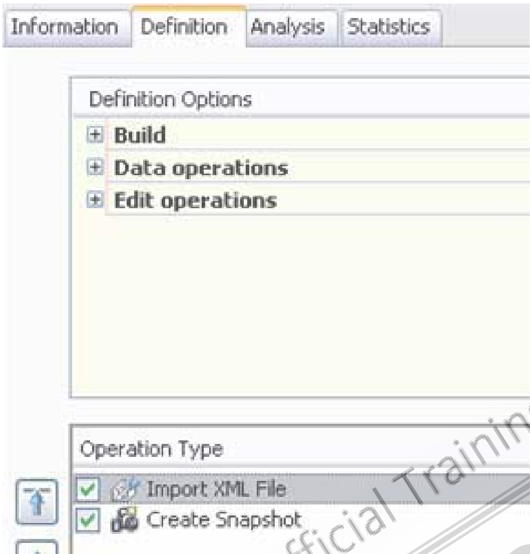
The Full Import option imports any points and faces present in the LandXML file. The Create Snapshot after Import option enables you to specify that a surface snapshot is created in the surface definition subsequent to importing a LandXML surface. The Create Source Data in Drawing setting imports any surface source data (breaklines, contours, points, and chains) into the drawing as 3D polylines and points. Setting the Create Source Data in Drawing to Off prevents all of the LandXML data from being created inside the DWG file. Because Civil 3D references the LandXML file when rebuilding the surface, there is no need to have these graphic elements in the actual file.

6. In the Import LandXML dialog box, click OK. The LandXML surface is imported into your drawing.



7. In Prospector expand Surfaces. Right-click EG. Click Surface Properties.

8. In the Surface Properties dialog box, Definition tab, for Operation Type, notice the Import XML File operation that shows the path to the LandXML file.



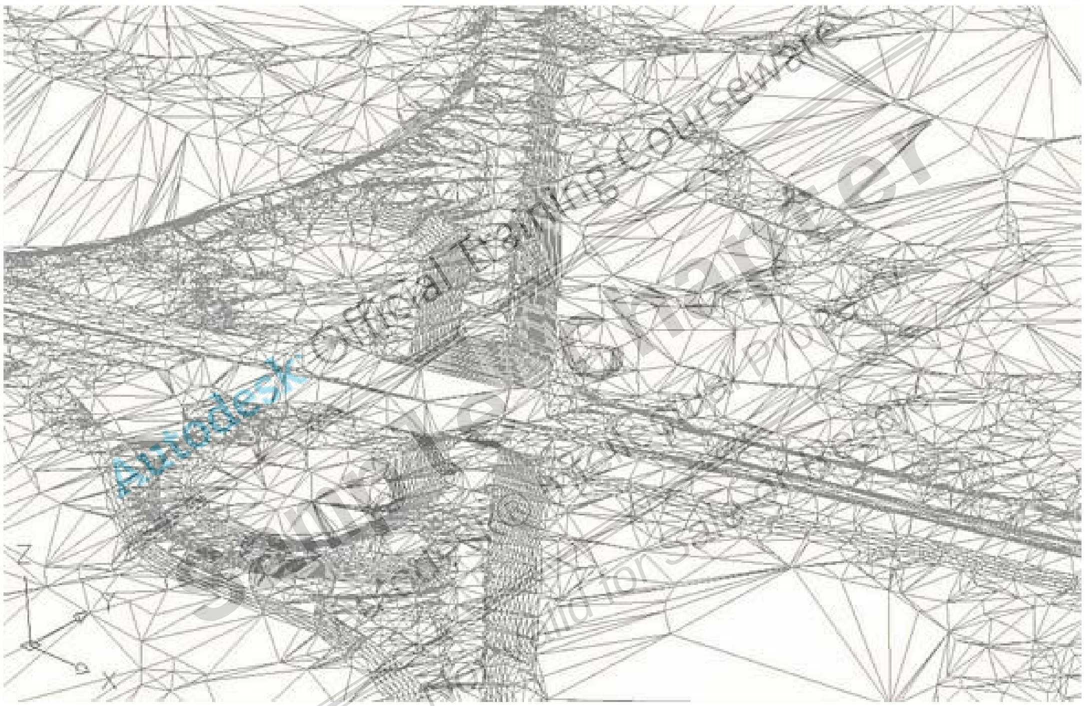
Click OK to close the Surface Properties dialog box.

9. Save the drawing as InterchangeDesign_01.dwg.

Lesson: Evaluating the Existing 3D Surface Model

Overview

In this lesson, you evaluate the 3D model of an existing surface. You need to be familiar with the 3D model to make the correct design decisions.



3D model of surface showing TIN lines

Objectives

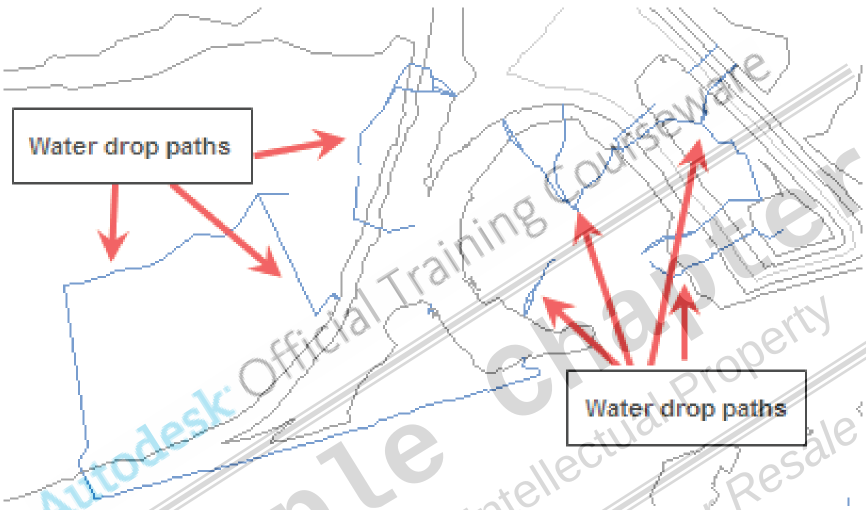
After completing this lesson, you will be able to:

- Define surface analysis and explain its purpose.
- List and describe the tools you can use to analyze surfaces.
- Explain how you use the analysis tools to evaluate surfaces.
- Use the available tools to explore and evaluate the EG surface model.

About Surface Analysis

Evaluating existing site conditions is critical to accurate site design. Although it is always a good idea to visit the site, it may not always be possible. At a minimum you should review site photos. In addition, there are surface analysis tools you can use to examine information about the site in a visual manner. For designers, working with analysis tools can provide information about the whole site rather than only a portion of it.

The following illustration shows one example of surface analysis. The result of a water drop analysis is shown, with water drop lines converging in catchment areas.



Surface Analysis Definition

You use surface analysis tools to display surface object information in a meaningful way. The way that information is displayed conveys a different message, depending on the analysis tool, and goes beyond what individual spot grades or labels can provide. The different types of surface-related evaluation includes the display of contours, elevations, slopes, slope arrows, watersheds and water drop paths.

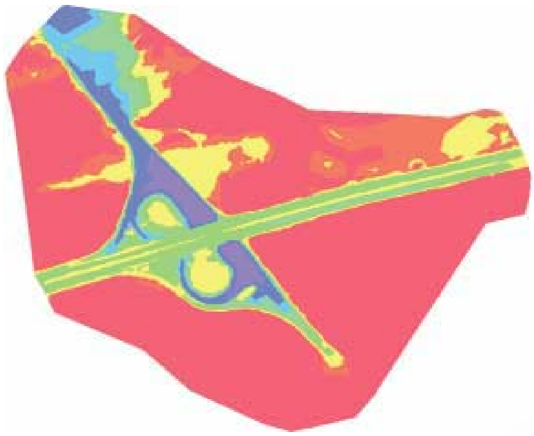
Types of Analysis

The following chart lists and describes the types of analyses you can perform on surfaces.

Type	Description
Directions	Used for aspect analysis. Renders surface triangles by direction they face.
Elevations	Used for elevation banding analysis. Renders surface triangles by elevation range.
Slopes	Renders surface triangles by the slope range they fall within.
Slope Arrows	Used for slope direction analysis. Places a slope directional arrow at each triangle centroid. The arrow color is based on the color assigned to a slope range.
Contours	Renders contour lines according to their elevation range.
User-Defined Contours	Renders user-defined contour lines by elevation range.
Watersheds	Renders watersheds by type.
Contour Problems	Used to locate contour problems that are drawn according to the surface style's contour settings.
Water Drop	Used to trace the path that water would take across a surface.

Surface Analysis Examples

The following illustrations depict a surface that is evaluated using several tools.



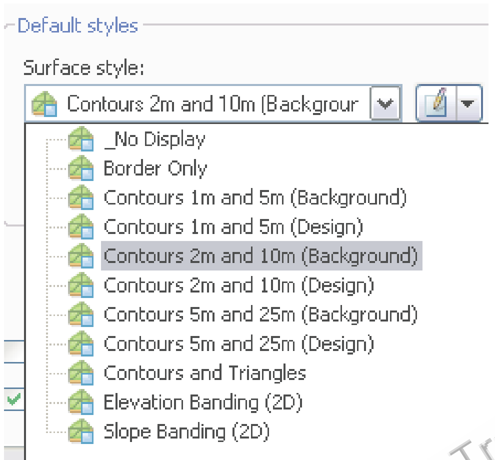
Surface showing elevation banding

Surface showing TIN and contours

Tools for Evaluating Surfaces

There are several analysis tools you can use to evaluate surfaces.

The following illustration shows some of the surface styles you can use to evaluate surfaces.



Surface Evaluation Tools

- **Surface Style**
  Assigning different Surface Styles to a surface is one of the most basic tools for evaluating a surface. For example, using a surface style that displays the contours can be used to evaluate surface elevations, while using a surface style that shows triangles may reveal irregularities in the surface.
- **Surface Analysis**
  Surface analysis works in concert with surface styles. When a surface analysis is performed, you use a surface style that supports the analysis display.
- **Surface Labels**
  You use surface labels to provide additional pertinent information. You can label contours, spot elevations, and slopes. Contour labels is a common type of labels applied to a surface. You can choose to label an individual contour or label all contours.
- **Orbit**
  Use the Orbit tool to rotate the surface in the drawing. Orbit is useful for displaying the exaggerated elevations of a surface. These elevations are most evident along the bottom of the surface where a prominent ridge appears.
- **Object Viewer**
  Object Viewer is similar to Orbit. The difference is that object is viewed and orbited in a separate window.
- **Quick Profile**
  A quick profile is a temporary object that is useful for evaluating elevation information along a line, polyline, feature or lot line, survey figure, or along a series of points that you select. A quick profile is removed when a drawing is saved or closed.

- **Water Drop**
  Water Drop shows you water drainage for a site. It will trace the path for imaginary drops of water from any arbitrary point on the surface, to the point where it would eventually drain to. In addition, the water drop tool provides a visual way to evaluate slopes.
- **Inquiry Tool**
  The Inquiry Tool contains two inquiry types that are applicable to surfaces. Specifically, it can provide information on surface elevation and grade at a single point, and surface elevation and grade between points.

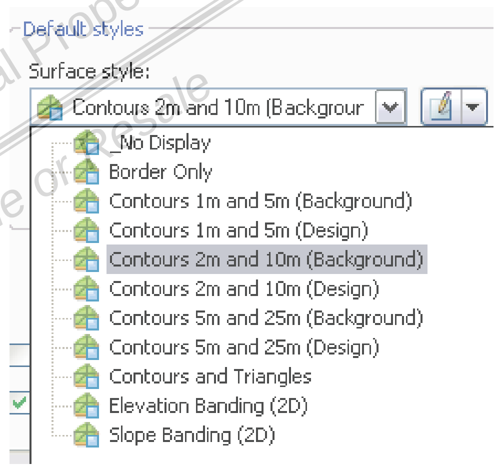
Evaluating the Existing 3D Surface Model

You can use several methods to evaluate the 3D model of existing surfaces.

Process: Evaluating the Existing 3D Surface Model

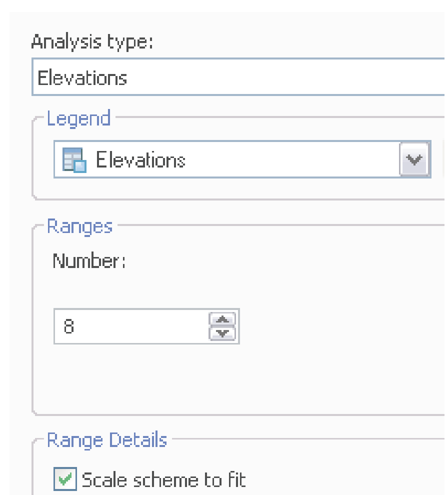
The following steps outline several methods that you can use to evaluate the 3D model of existing surfaces.

1. Select appropriate surface style.



2. Configure Surface Analysis.

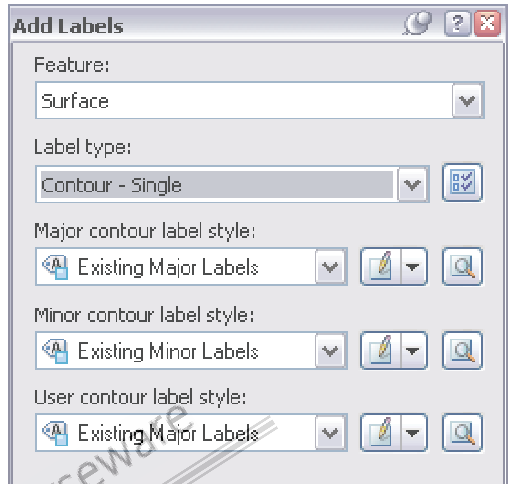
- In Surface Properties, Analysis tab, select analysis type and configure analysis parameters.
- Set surface style that supports the analysis display.



3. Create surface labels.

■ Select features to label.

■ Select label types and label styles.



4. Explore surface using Orbit.

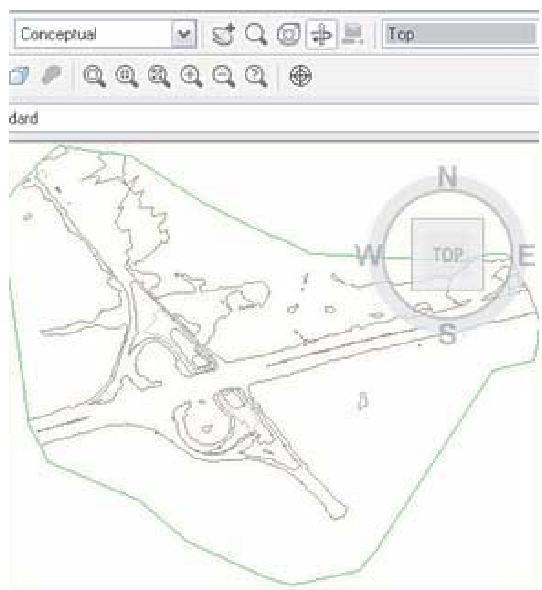
■ Rotate surface to perform analysis.

■ Use Shade and Shademode commands to enhance analyses.

5. Explore surface using Object Viewer.

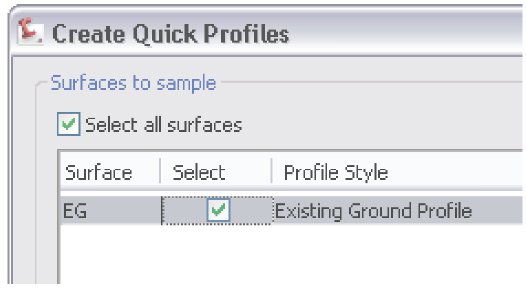
■ Explore surface using various visual display styles and view controls.

■ Manipulate object as desired.



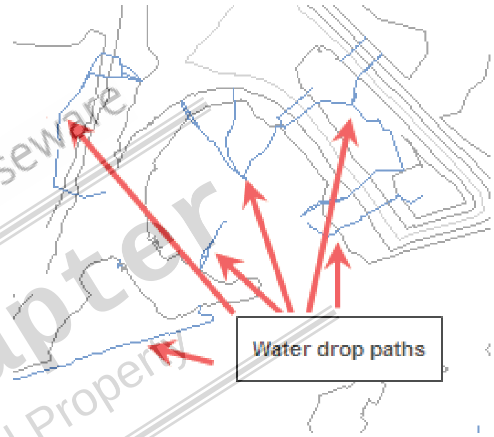
6. Use Quick Profile to create temporary profiles.

- Right-click a linear object, select Quick Profile.
- Note the changes reflected in the profile.



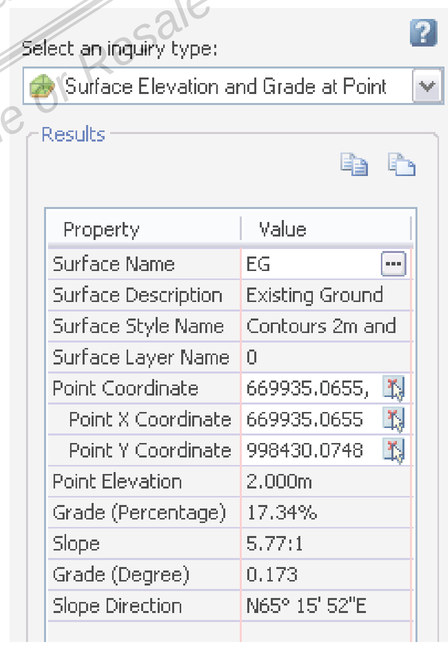
7. Explore surface water drop path.

- Select points of interest on drawing to determine water drop paths.



8. Use the Inquiry tool to view surface information.

- Select Inquiry Type (Surface).
- Use Surface Elevation and Grade at Point, or Surface Elevation and Grade Between Points to view the relevant information.
- Select points of interest on drawing.



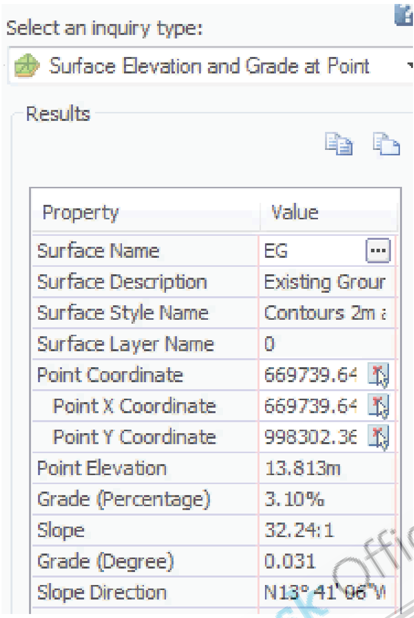
Guidelines

Keep the following guidelines in mind when evaluating surfaces.

- It is always important to visit the site when possible to examine existing conditions that may not be displayed by your data.
- Use the available tools and commands to become familiar with the surface. At minimum you should use surface styles, object viewer, and quick profile.
- Civil 3D also provides the capability to drape an image to the surface and to directly import an image from Google Earth. This process can help you evaluate the surface and site conditions, especially when a physical inspection is not possible.

Exercise: Explore and Evaluate the EG Model

In this exercise, you use various tools to explore and evaluate the EG surface model.



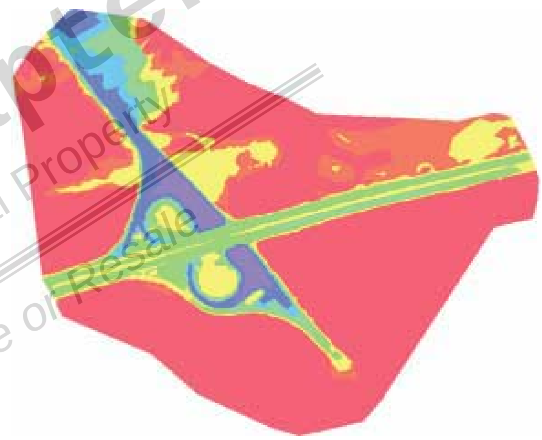
The completed exercise

1. Open *Evaluate Surfaces_04.dwg*.
2. Hover the cursor over several of the features in the drawing. Note that the tooltip shows the elevation for that feature.
3. In Prospector, expand Surfaces. Right-click EG. Click Surface Properties.
4. In the Surface Properties dialog box, Information tab, for Surface Style, click Contours 1m and 5m (Design). Click OK.

   The surface displays using the new style.

5. In the drawing area, select the surface. Right-click. Click Surface Properties.
6. In the Surface Properties dialog box:
   - For Surface Style, click Elevation Banding (2D).
   - Click the Analysis tab to explore the other analysis types available.
   - With Elevations selected, click Apply.
   - Click OK.

   In the drawing area, the elevations are represented by different colors.

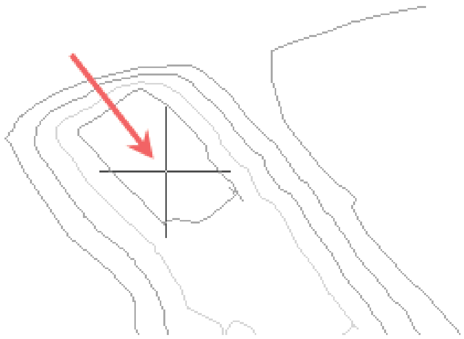


7. Select the surface. Right-click. Click Surface Properties.

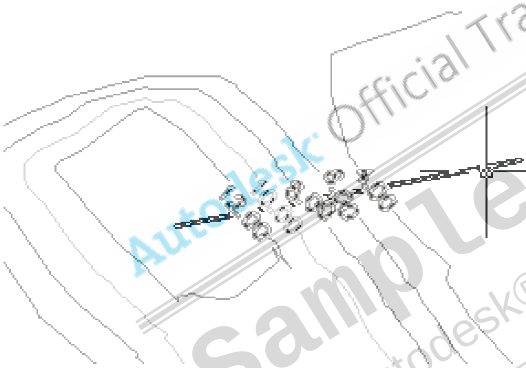
   In the Surface Properties dialog box, Information tab, change Surface Style to Contours 2m and 10m (Background). Click OK.

   Note the change to the drawing.
8. Click Surfaces menu > Add Surface Labels > Contour - Multiple.

9. When prompted to Specify First Point, click in the area shown in the following illustration.



10. When prompted to Specify Next Point:
    - Click as shown in the following illustration. The line crosses multiple contours.



    - Press ENTER. This places contour labels at crossing points. As you move the line's vertices, the labels also move.

You may place a crossing line in a separate layer and turn it off, to show labels only, without the line.

11. Click View menu > Orbit > Constrained Orbit.

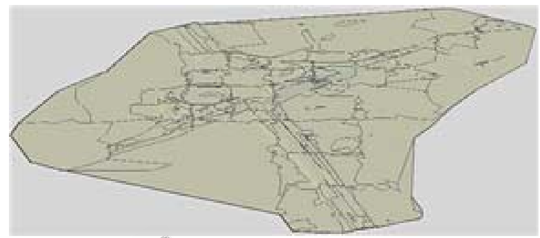
12. Notice that the UCS icon and mouse icon have changed. This indicates that you are in 3D Orbit mode.

13. Click inside the drawing area. Press the left-button. Move your cursor up and down, left and right to examine the surface from different angles. Press ESC to exit the Orbit mode. The surface's TIN triangles are displayed.

14. At the command prompt, enter **shademode**. Press ENTER.

15. When prompted to Enter an Option, enter **Conceptual**. Press ENTER.

The shaded mode of surface provides a better view for visualization.



16. Notice the WCS icon in the upper right-hand corner of drawing area.

Change the view of the drawing by manipulating the WCS icon.

17. To return to the original view:
    - At the command prompt, enter **shademode**. Press ENTER.
    - When prompted to Enter an Option, enter **2dwireframe**.
    - Enter **plan**.
    - Press ENTER twice.

The model regenerates and returns to the original view.

18. In the drawing area, select the surface. Right-click. Click Object Viewer.

The Object Viewer opens. Here you can explore the surface in similar manner to Orbit, but in a separate window.

19. In the Object Viewer, move your cursor up and down, left and right to explore the surface from different angles. Experiment with the different views available. Close the Object Viewer when done.

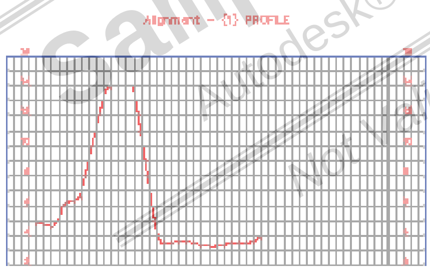
20. Draw a two-segment polyline within the surface boundary. Press ENTER.

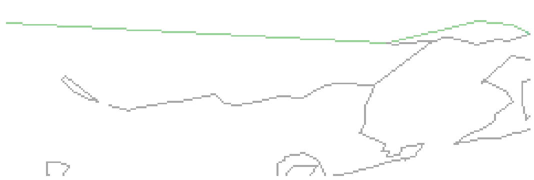
21. In the drawing area, select the polyline. Right-click. Click Quick Profile.

22. In the Create Quick Profiles dialog box, click OK.

23. When prompted to Select Profile View Origin, click in the drawing area next to the surface. This places a quick profile in the drawing and opens Panorama with Event Viewer.

24. Close the Panorama to view the profile.





One of the advantages of Civil 3D is dynamic objects. If you move the polyline vertices, the profile view updates automatically.

25. Move the polyline vertices to explore different profiles at critical design points and observe the quick profile updates.

26. Delete the polyline when you finish exploring the surface. This removes the temporary profile view.

27. Click Surfaces menu > Utilities > Water Drop.

28. In the Water Drop dialog box:

- Notice the Path Layer. This setting indicates where the polyline that represents the water drop path will be placed.
- Notice the Path Object Type. Here, you select a 2D polyline or 3D polyline for the Water Drop Path.
- Click OK.

29. When prompted to Select Point, select several points on the surface. Observe the water drop path from the selected point to the lowest point of the local watershed. An example is shown.

30. Press ENTER to exit the command.

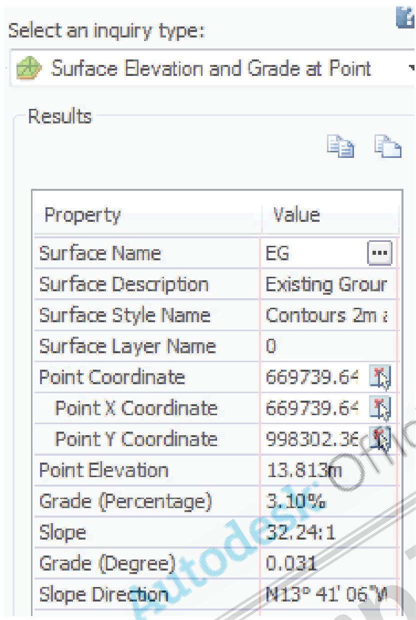
31. Delete the polylines you created with Water Drop.

32. Click General menu > Inquiry Tool.

33. In the Inquiry Tool palette:

- Under Select an Inquiry Type, click Surface.
- Expand Surface.
- Click Surface Elevation and Grade at Point.

34. When prompted to specify Point for Elevation and grade, click several points on the surface. For each point, you receive valuable information, such as Coordinates, Elevation, Grade, Slope, and so on. The following illustration shows an example of the information received for one point.



35. When done, close the Inquiry Tool palette.

36. Close the drawing. Do not save the changes.

Chapter Summary

In this chapter, you evaluated and modeled existing ground conditions. This examination provided the designer with important information regarding how the final design fits into local surroundings. The existing surface is a prerequisite to the design process and provides the engineer with existing ground elevation and slope information.

Having completed this chapter, you can:

- Describe the workflow for creating existing ground surfaces.
- Generate an EG surface based on contour data.
- Import an EG surface from a LandXML file.
- Evaluate the existing 3D surface model.