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The Magic of a Dynamic Differential TIN Surface

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CI3906

Ever wish that AutoCAD® Civil 3D® could create a dynamically linked subgrade surface, while you build and modify your finish ground surface? What is a dynamic differential triangulated irregular network (TIN) surface? It is that magical TIN surface we have all wished there was an easier way to build. It can represent many different types of surfaces. It can be used to build a surface that represents the top of an aquifer or substrate from borehole data. It can be used to build a topsoil stripping surface for a business site design project. Best of all, it can be used to quickly build a multilevel subgrade and/or sub-base surface that is dynamically linked to your parking lot finish ground surface. It is so simple that you will leave this class by asking yourself, "Why have I not used this feature before now?"

Learning Objectives

At the end of this class, you will be able to:

- Understand what a Dynamic Differential TIN Surface (DDTS) is.
- How to use a Dynamic Differential TIN Surface (DDTS) for building the best possible surface from limited bore log data.
- How to use a Dynamic Differential TIN Surface (DDTS) for building a site sub excavation surface.
- How to use a Dynamic Differential TIN Surface (DDTS) for building a site stripping surface.

About the Speaker

Creg Dieziger is a civil/survey Sr. Designer for Morrison-Maierle, Inc., an ENR top-500 design firm. He has over 23 years of experience in the field, and has worked with multitudes civil/survey clients in the fields of land development, treatment plants, airports, highways, bridges, mines, and fish passages. He loves moving dirt and working with data. Among some of Creg's many duties with Morrison-Maierle, Inc. are training and implementing of CADD procedures. He also teaches AutoCAD, Introduction to Survey and Civil 3D at the University of Montana Missoula College.

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Notes:

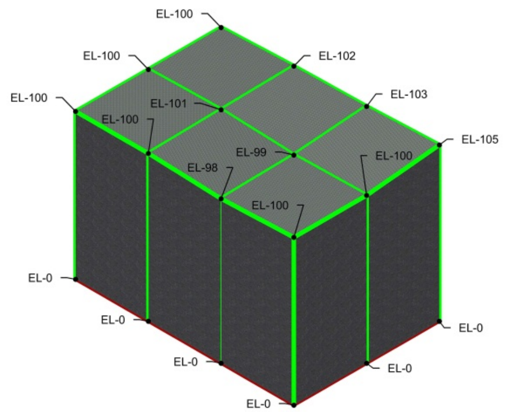
Understanding what a Dynamic Differential TIN Surface (DDTS) is.

Definition of a Dynamic Differential TIN Surface (DDTS):

A surface created from the actual depth (not elevation) of a material layer, then compared to the TIN surface (finish / existing ground surface) from which the depth is measured. The purpose of the DDTS surface is to generate a surface that you are unable to conventionally survey. The DDTS surface may also be a surface that is representative of the subgrade of a finish ground TIN surface. The DDTS surface has a dynamic link to the TIN surface and the material depth surface, so it will change if either the TIN Surface or material depth surface changes.

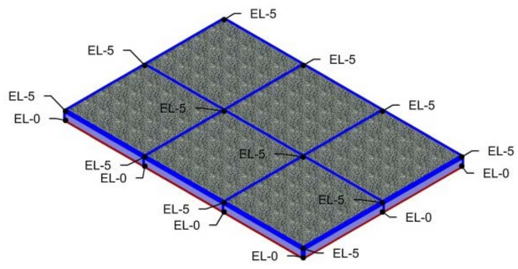
DDTS = Finish (or Existing) Ground Surface – Depth Surface

In the below images show a visual of how this formula works to create the DDTS:



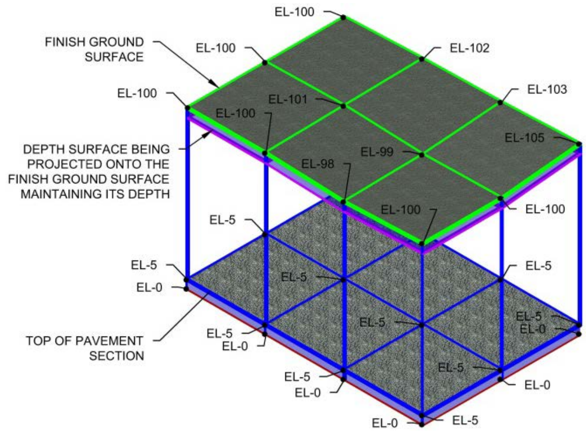
In this image, you see a representative of the Finish Ground Surface. For the purposes of this handout it will be called the Finish Ground Surface. ***Note: You can also use the Existing ground surface.***

DDTS=***Finish Ground Surface***-Depth Surface



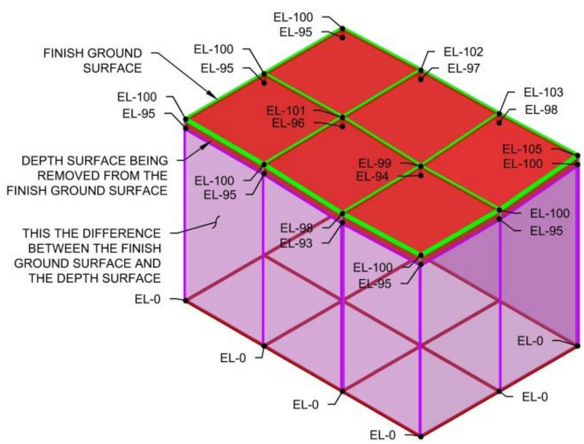
In this image you see the Depth Surface. For the purposes of this handout it will be called the Top of Pavement Section Surface. This surface is used to represent the materials actual depth.

DDTS=Finish Ground Surface-***Depth Surface***



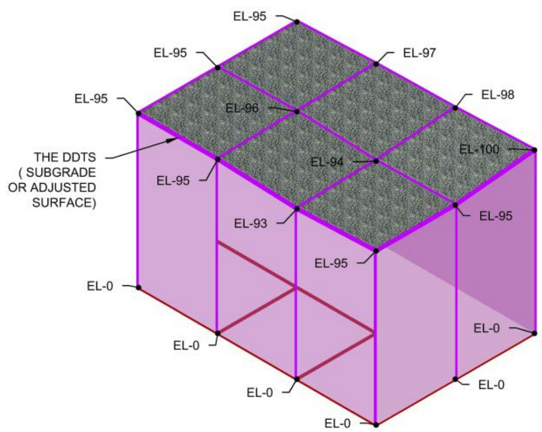
In this image you see the Depth Surface (Top of Pavement Section Surface) being projected up to the Finish Ground Surface with the use of a TIN Volume (Composite) Surface. ***Note: During the projection notice how the Depth Surface maintains it depth relationship, which in this example it 5, but it can vary if needed.***

DDTS=***<u>Finish Ground Surface-Depth Surface</u>***



In this image you see how the Depth Surface (Top of Pavement Section Surface) is removed from the Finish Ground Surface during the creation of the TIN Volume (Composite) Surface.

<u>DDTS=Finish Ground Surface-Depth Surface</u>



In this image you see the completed DDTS surface (Subgrade or Adjusted Surface). In this example the DDTS Surface is exactly 5 lower than the Finish Ground Surface. ***Note: The question of why not just lower the finish ground surface has been asked. Yes in this example that would work, but it would be a static solution. By creating the DDTS surface you are creating a dynamic link between the Finish Ground Surface and the Depth Surface. So if either the Finish Ground Surface or the Depth Surface changes the DDTS surface will dynamically update, saving you time***

<u>DDTS=</u>Finish Ground Surface-Depth Surface

The creation of the DDTS surface uses many of the pre-existing Autodesk Civil 3D workflows (or processes) you use today; however, you are going to use them in a way they were not intended to be used. It is assumed that you already have a working understanding of these workflows. So the majority of them will be glossed over or stated as just a workflow and not described any further. Here is a list of workflows that the three scenarios covered use in this session.

- The creation of a TIN Surface.
- The creation of a TIN Volume Surface (Composite Volume Surface).
- Pasting a Surface into another Surface.
- Adding a Surface Boundary
- Creating a Feature Line
- Creating a Alignment
- Creating a Profile
- Creating a Dynamic Feature Line from a Layout Profile
- Creating a Corridor

The objective of this class is not to teach you how to perform these workflows. The objective is to show you how to use these workflows in a way to achieve a new and beneficial result.

During this session, we will cover three (3) scenarios in which you can use this method. Each of these scenarios will use the same basic steps. However, each has a few differences to help with that particular use of the DDTS surface. At the end of this session, you will have a good understanding of how the DDTS surface works and how to create it.

Scenario No. 1:

Dynamic Differential TIN Surface (DDTS) for building the best possible surface from limited bore log data.

In this scenario, it will show you how to build a surface from bore log depth data. What you are looking for is to have a surface that will show you the best possible representative surface from limited data. This is a typical challenge when dealing with bore log data. The following step will show you how to do this.

Step 1: Data Gathering

Gather your data and determine what material levels you need to have a representative surface for your current project. This data is normally pulled from well logs or bore log data. These logs usually give the type of material and the depth from surface to the top of that material. Normally there is a geographic location also. These three (3) items from the logs are what you need for this scenario. Take this data and generate a point file for input of this data. This point file may be generated from a survey or hand generated text file. This point file is your typical text file PNEZD. The only thing you need to make sure of is that the elevation is the depth from the surface and not an elevation. When you have more than one material level, build a point file for each material type or once the points are imported, create point groups for each material type.

An existing ground TIN surface (EG) of the overall site is needed as part of this scenario.

Step 2: Build a Material Depth TIN Surface

This TIN surface is the built from the point data you just gathered in Step 1. Build a separate surface for each material type. Name this surface "DEPTH-(material type)".

Step 3: Build a Material Depth TIN Volume Surface

Build the material depth TIN volume surface by setting the base surface as your material depth TIN surface created in Step 2, and the comparison surface to the existing ground surface. Name this surface "VOL-DEPTH-(material type)".

By comparing these two surfaces in a volume surface, it will give you actual elevations for the gathered data points. It also does an interpolation between the data points, which is what gives you the more representative top of material surface in the end.

Note: You cannot use a volume surface in the creation of profiles, sections or other volume comparisons. This is the reason for Step 4.

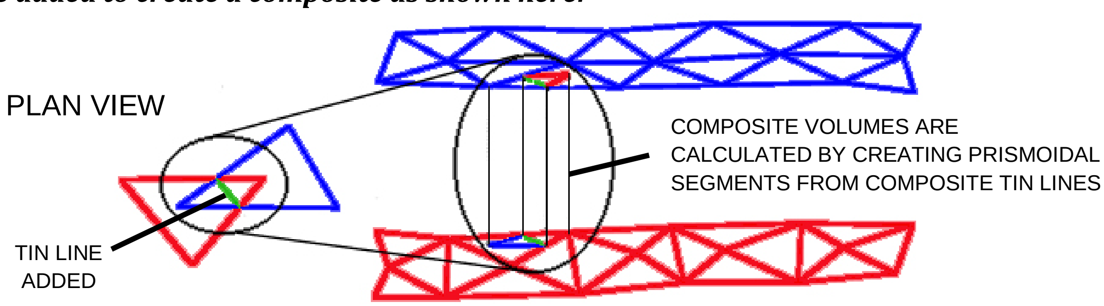
Step 4: Build a Top of Material TIN Surface

To build this surface, create an empty TIN surface. Then paste the material depth TIN Volume surface created in Step 3 into this empty TIN surface. Name this surface "TOP-(material type)".

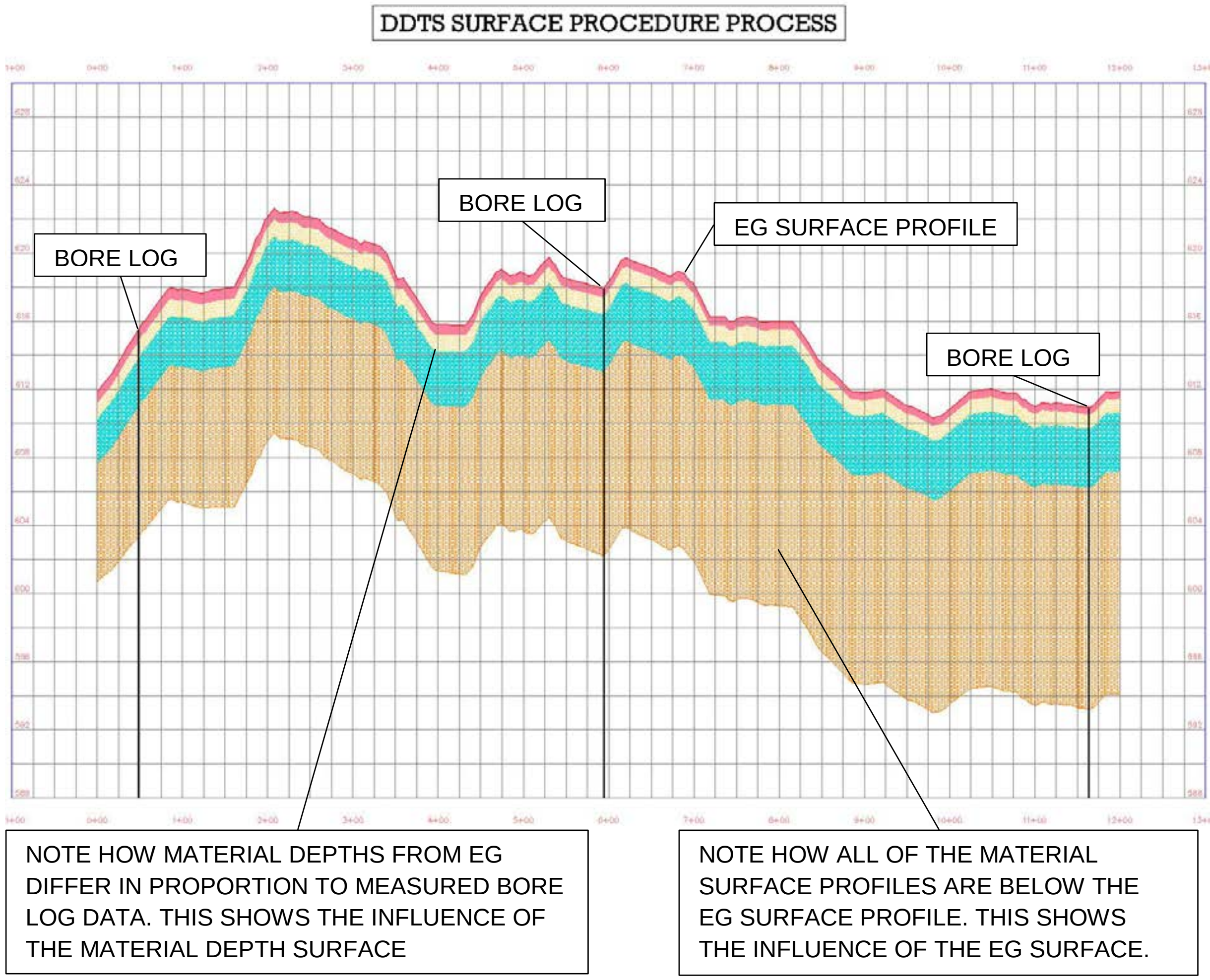
You now have a surface for cutting profiles, sections and use for volume comparisons.

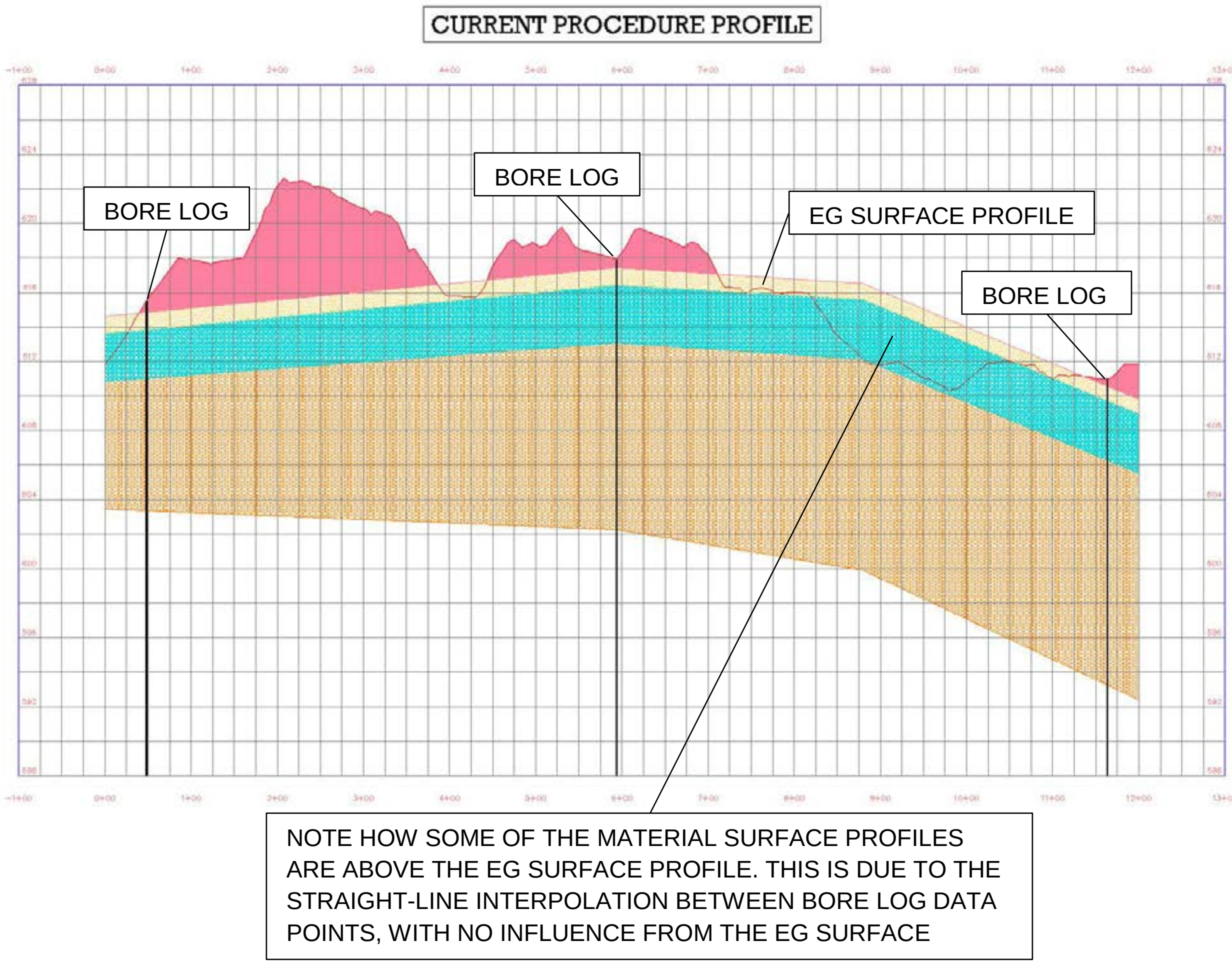
Note: By using the old method of just the data by itself at its actual elevation to create this surface; you get a direct interpolation between data points. With this new method, you get an interpolation between data points that is influenced by the existing ground surface. This is done through the process Civil 3D uses in the calculation of a Composite surface (TIN volume surface).

A Composite surface is created by combining TIN edges from top & bottom surface. Where TIN lines are added to create a composite as shown here:



Note: A great way to display these levels of materials is by using Profiles and Profile View Hatch.





Note: The final surface in this scenario is what I term semi-dynamic. This is because if you have more bore log data to add you can add it to the surface created in Step 2 named "DEPTH-(material type)". Then it is just a matter of rebuilding the surfaces (if the Automatic Rebuild, is not set "on" for each of the surfaces). If the Existing Ground Surface changes it is just a matter of rebuilding the surfaces.

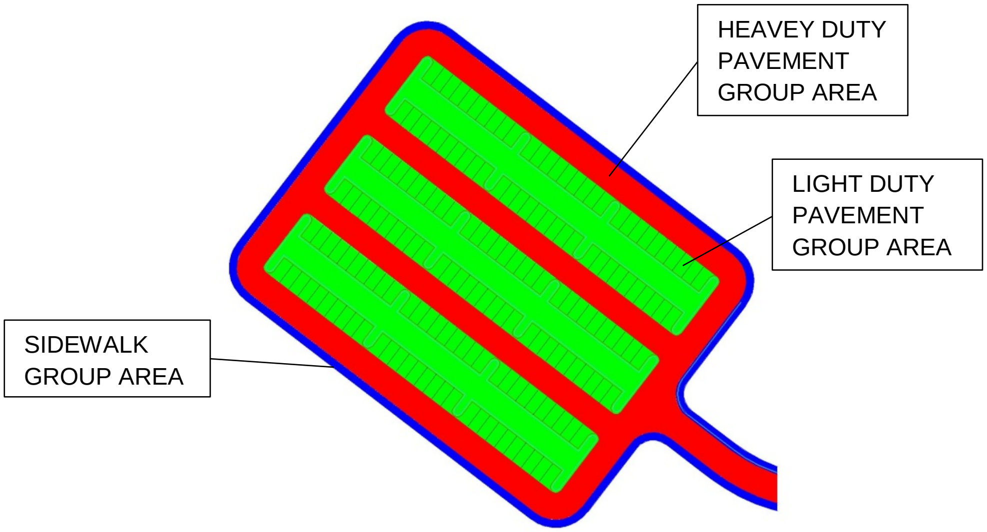
Scenario No. 2:

Dynamic Differential TIN Surface (DDTS) for building a site sub-excavation surface.

This scenario will show you how to build a DDTS Surface for a parking lot to generate earthworks and material quantities. The basic concept of the DDTS Surface is to have a sub-excavation surface that changes relative to the finish ground. The following step will show you how to do this:

Step 1: Define Site Section Depths

The first thing you need to do is define the different sections and their areas. Group these areas by material type, section depth, and use. Some of the different groups you might consider are pavement, sidewalk, building foundations and many others. Define each of these areas with a closed polyline. Some of the areas may need more than one enclosed area to define it.

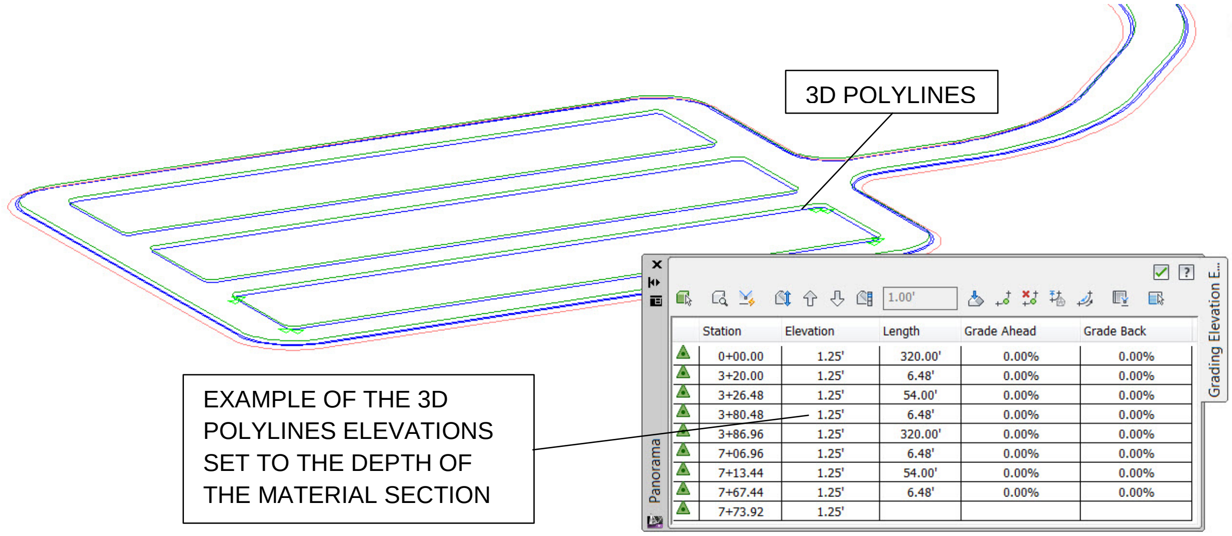


Note: Use layers to help you keep each area grouped and easy to isolate from the other areas. This will also serve as a great reference for each of the "section area" material types.

Step 2: Build 3D Polylines, Feature Lines, and/or Dynamic Profile Feature Lines

For this step of the workflow, you need to isolate the polylines created in Step 1. You will now need to convert these polylines to your favorite linear 3D objects in Civil 3D. You can use a 3D polyline, feature line and/or dynamic profile feature line. After you have created the 3D objects, assign each of them with their actual section depth. A few examples when developing a subgrade DDTS are:

- The project normal pavement section is 3" of asphalt, 6" of base gravel, and 6" of subbase gravel. This gives the project normal pavement section a total depth of 15" so set the 3D object elevation at 15" (or 1.25').
- The project sidewalk section is 4" of concrete and 6" of base gravel. This gives the project sidewalk section a total depth of 10" so set the 3D object elevation at 10" (or 0.833').



Note: Do not worry about grade breaks. All you need is the extent of each area; the reasoning for this will become apparent later.

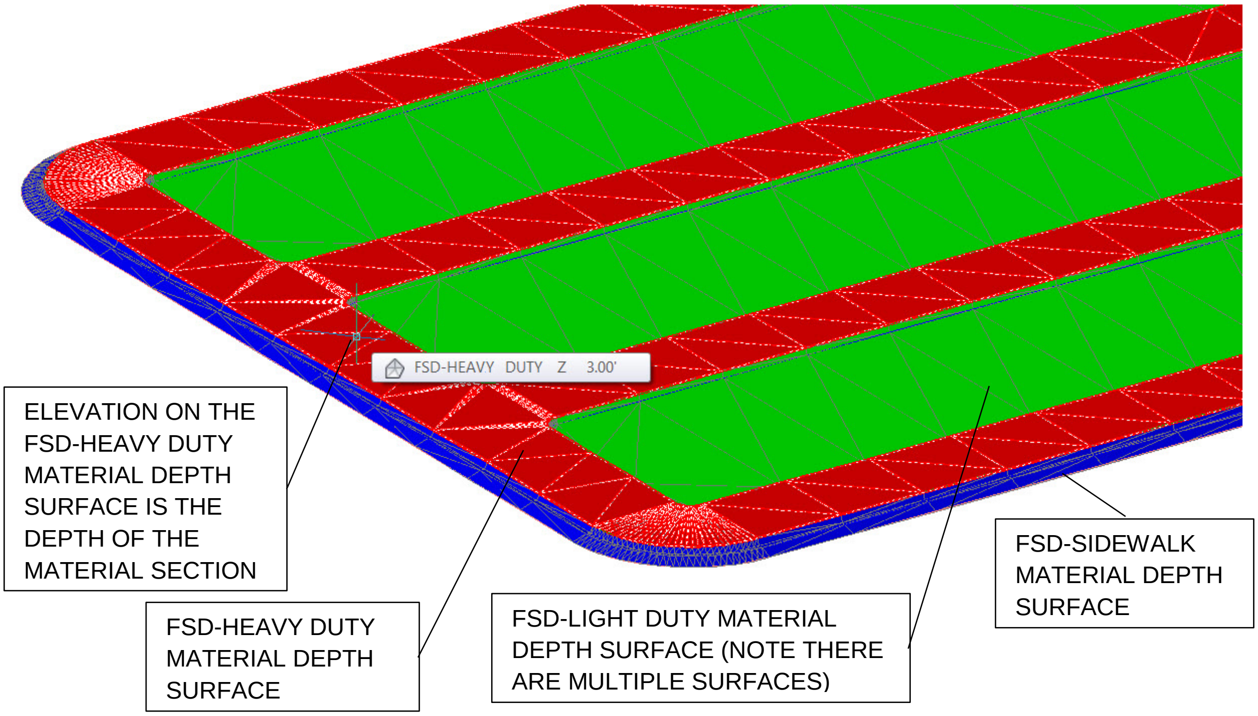
Note: Where area edges adjoin each other offset the shallowest area edge in about 0.01'. This will prevent any conflicts when using them as break lines.

Note: If a portion of two areas overlap, trim the shallowest area, leaving the deepest area. Remember, this will create an edge overlap of the areas so be sure to offset the common line in of the shallowest area also.

Step 3: Build Finish Subgrade Depth TIN Surface
In this step, there are a couple of options that can be used. I will describe both methods and you can decide for yourself which you would prefer to use. As both methods have positives and negatives, the use of one method over the other will depend on the scenario.

Option 1:
Build a Finish Subgrade Depth (FSD) TIN surface for each material group area. Add the 3D objects for that material group area created in Step 2 as break lines. Edit the surface either by creating an enclosed polyline surface boundary around the entire area or by deleting the TIN lines that do not fall within that group's area. Name the surface "FSD-(area type or name)". Do this for each of the material group areas. When all of the section area surfaces are created, create a FSD TIN surface. This is done by creating an empty TIN surface. Call this surface "FSD", and paste each of the section area FSD surfaces into this one, starting from the inside areas and working out. Be sure to, either create a polyline to use as a surface boundary for each group or delete all TIN lines that do not fall within the material group areas.

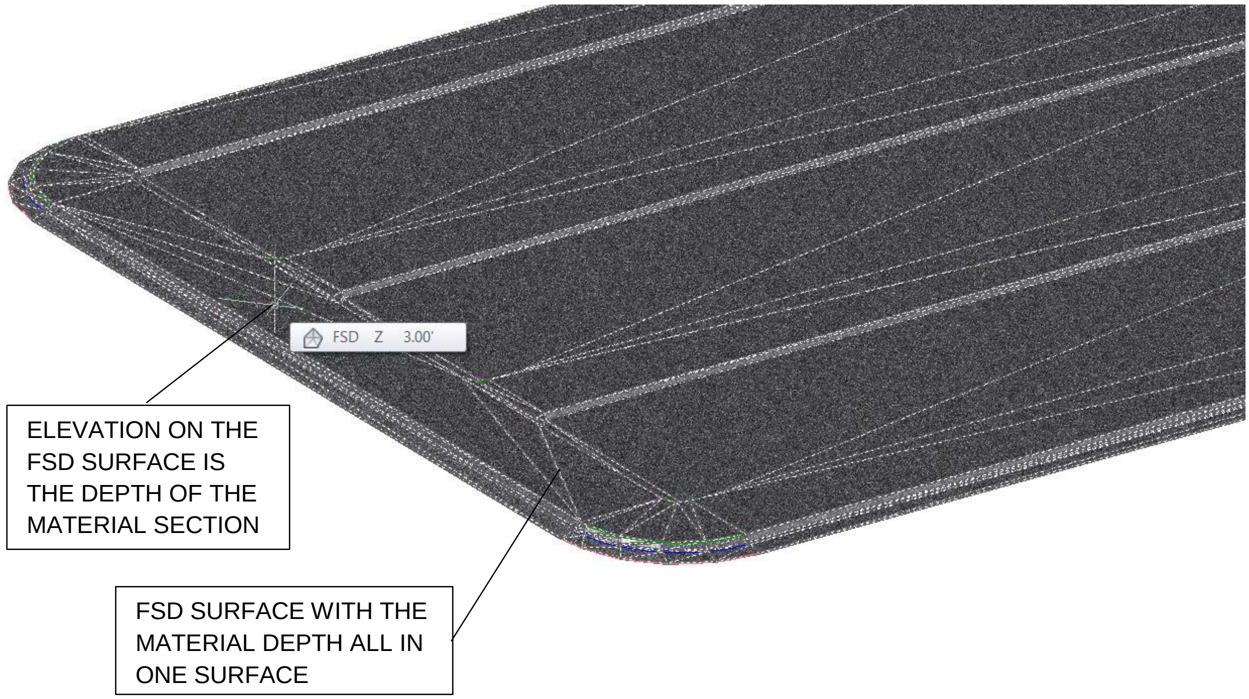
Note: Option 1 allows you to have a flexible surface but is more complicated because it is made up of many smaller surfaces.



Option 2:

Build a Finish Subgrade Depth (FSD) TIN surface for the entire site. Add all of the section area 3D objects you created in Step 2 as break lines. Edit the surface either by creating an enclosed polyline around the entire group of areas or by deleting the TIN lines that do not fall within a section area. Name the surface “FSD”.

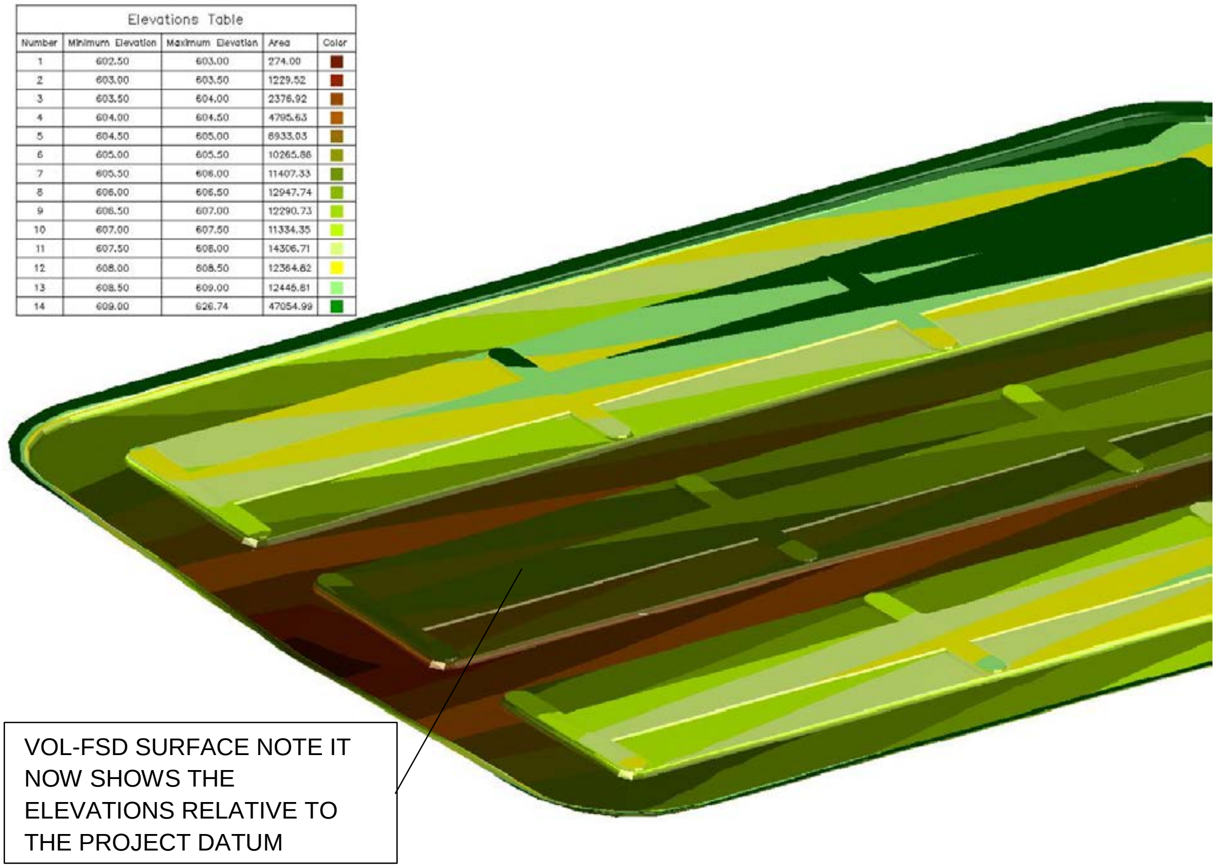
Note: Option 2 allows you to have one simple surface with not much flexibility for material type or depth revisions.



Step 4: Build Finish Subgrade Volume TIN Surface

Build the Finish Subgrade Volume TIN Surface by setting the base surface as your FSD TIN surface created in Step 3, and the comparison surface as the existing ground surface. Name this surface "VOL-FSD".

By comparing these two surfaces in a volume surface it will give you actual elevations for the section areas. It also does an interpolation between the TIN lines, which is what gives you the grade breaks without also drawing them in the subgrade.



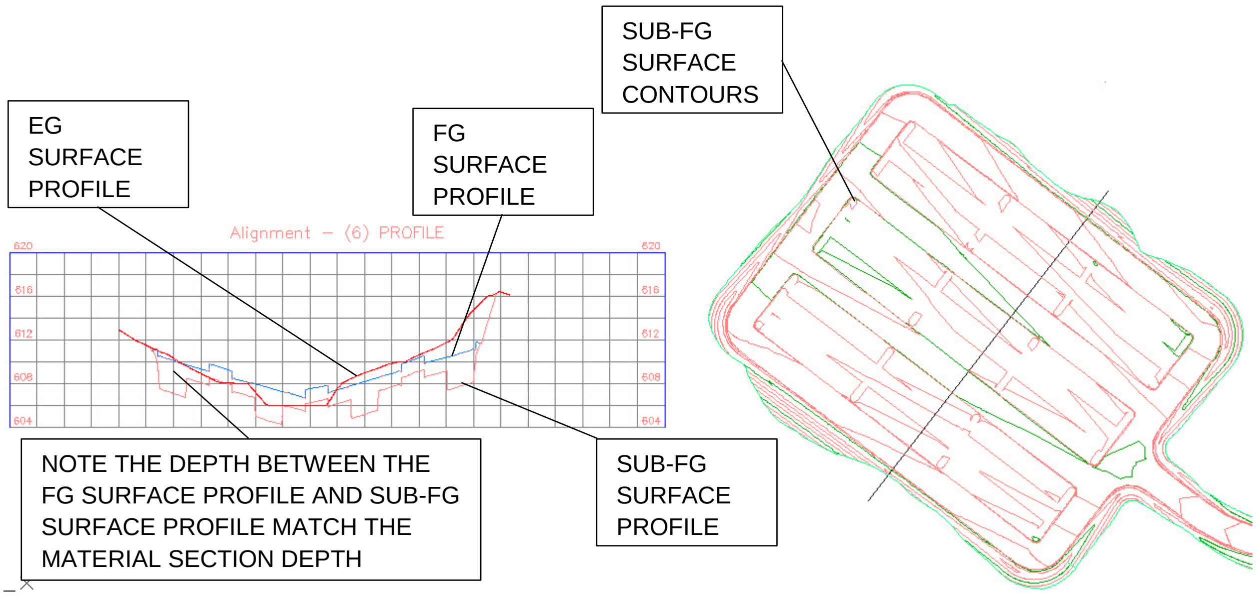
Elevations Table				
Number	Minimum Elevation	Maximum Elevation	Area	Color
1	602.50	603.00	274.00	
2	603.00	603.50	1229.52	
3	603.50	604.00	2376.92	
4	604.00	604.50	4795.63	
5	604.50	605.00	6933.03	
6	605.00	605.50	10265.86	
7	605.50	606.00	11407.33	
8	606.00	606.50	12947.74	
9	606.50	607.00	12290.73	
10	607.00	607.50	11334.35	
11	607.50	608.00	14306.71	
12	608.00	608.50	12364.82	
13	608.50	609.00	12445.81	
14	609.00	626.74	47054.99	

Note: You cannot use a volume surface in the creation of profiles, sections or other volume comparisons. This is the reason for Step 5.

Step 5: Build Finish Subgrade TIN Surface

To build this surface, create an empty TIN surface. Then paste the VOL-FSD TIN Volume surface created in Step 4 into this empty TIN surface. Name this surface “SUB-FG”.

You now have a surface for cutting profiles, sections and use for volume comparisons.



Note: The final surface in this scenario is what I term semi-dynamic. This is because if a section area changes in either its extents or depth, all you have to do is adjust the 3D object created in Step 2. Then it is just a matter of rebuilding the surfaces (if the Automatic Rebuild, is not set "On" for each of the surfaces). This is also true if the existing ground changes.

Scenario No. 3:

Dynamic Differential TIN Surface (DDTS) for building a site stripping surface.

In this scenario, will show how to build an existing ground surface with the topsoil removed in order to generate quantities. The following steps will show you how this is done.

Step 1: Data Gathering

Gather your data and determine what the topsoil depths are throughout the project. Take this data and generate a point file for input of this data. This point file may be generated from a survey text file or hand input generated. This point file is a typical text file PNEZD format. The only thing you need to make sure of is that the elevation is the depth from the surface and not an elevation.

Other data that is needed is an existing ground TIN surface (EG).

Step 2: Build a Topsoil Depth TIN Surface

This TIN surface is built from the point data you just gathered in Step 1. Name this surface "DEPTH-TOPSOIL".

Step 3: Build a Topsoil Depth TIN Volume Surface

Build the Finish Subgrade Volume TIN surface by setting the base surface as your DEPTH-TOPSOIL TIN surface created in Step 2 and the comparison surface to the existing ground surface. Name this surface "VOL-DEPTH-TOPSOIL".

By comparing these two surfaces in a volume surface, it will give you actual elevations for the gathered data points. It also does an interpolation between the data points, which is what gives you the more representative surface in the end.

Note: You cannot use a volume surface in the creation of profiles, sections or other volume comparisons. This is the reason for Step 4.

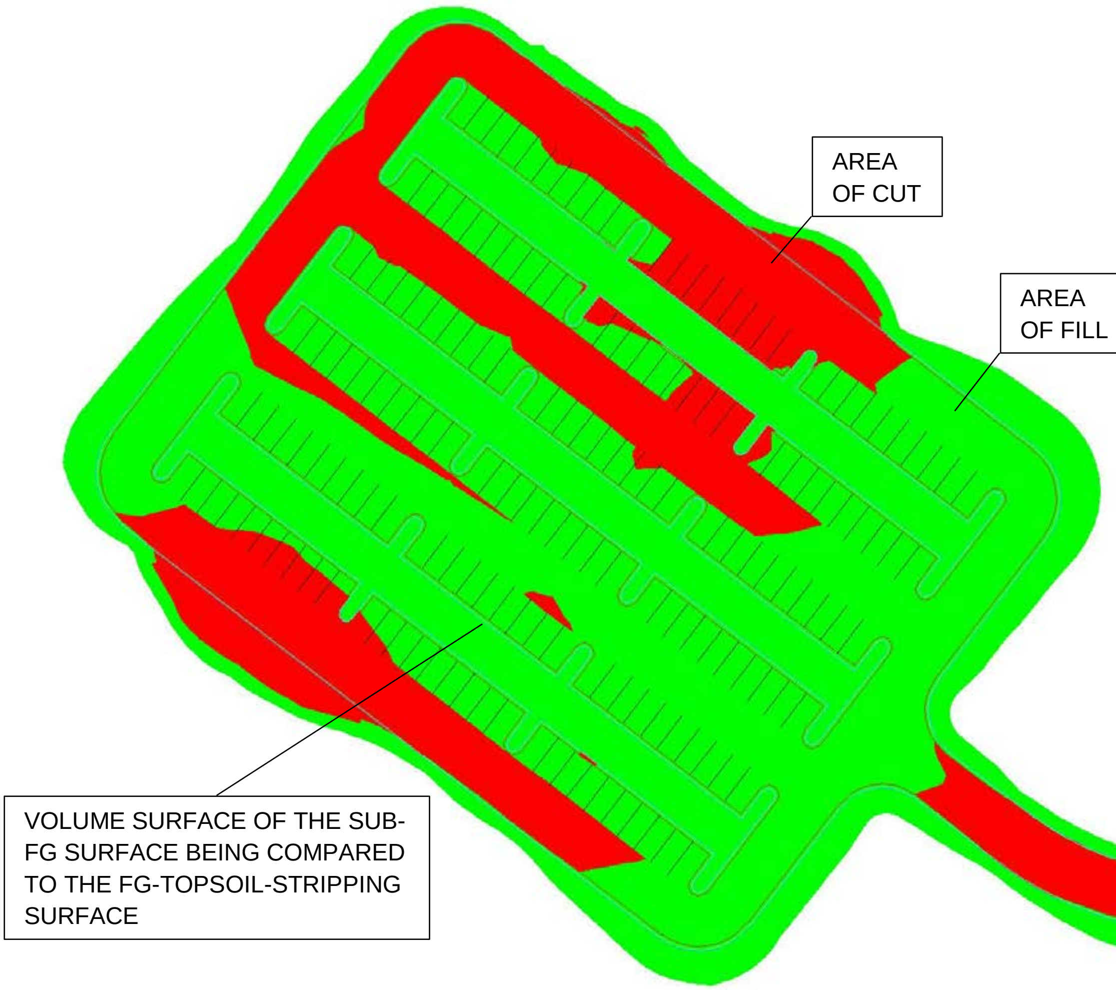
Step 4: Build Topsoil Stripping TIN Surface

To build this surface, create an empty TIN surface. Then paste the VOL-DEPTH-TOPSOIL TIN volume surface created in Step 3 into this empty TIN surface. Name this surface "FG-TOPSOIL-STRIPPING".

Note: A good use for this surface is daylighting to with either a grading object or corridors.

Note: You may consider using the new feature in Civil 3D 2013 of setting a surface as a surface boundary for this surface.

Note: The final surface in this scenario is what I term semi-dynamic. This is because if you have more data to add you can add it to the surface created in Step 2 named "DEPTH-TOPSOIL". Then it is just a matter of rebuilding the surfaces (if the Automatic Rebuild, is not set "On" for each of the surfaces). This is also true if the existing ground changes.



Uses for these surfaces

From all of these scenarios you have generated surfaces that can be used for a variety of things. The biggest use is to generate volume reports. You can also use them in section and profile views. Display these sections and profiles in the view with hatching to give you a great display of imported material, cut material and fill material.