AUTODESK UNIVERSITY 2015

CI9925

Gaming the System: Combine AutoCAD ® Civil 3D ®, Revit ®, InfraWorks ®, and Game Engines for Sites

Andy Carter, PE - CivilE, LLC

Learning Objectives

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

- Develop quick workflows to create compelling and cost-effective visualizations using Infrastructure Design Suite
- Establish a model-based design as a means to coordinate with architects when creating realistic site renderings
- Composite AutoCAD® Civil 3D® surfaces and coverages (grass, pavement, markings) in InfraWorks® in order to create a detailed site model
- Use an InfraWorks model in a game engine to produce real-time visualization deliverable

Description

Intended for intermediate to advanced AutoCAD Civil 3D software users, this class is designed to show land development professionals techniques and nuances for creating renderings and movies of their proposed projects. Utilizing many of the programs provided in Infrastructure Design Suite software (AutoCAD Civil 3D software, InfraWorks software, Revit software, and 3ds Max software), this class will consist of a live demonstration showing how to create compelling and grade accurate visualizations of your site designs.

By treating InfraWorks 360 software as a "level builder" we will explore how to composite existing and proposed ground surfaces, build and apply coverages for pavement and pavement markings, and prepare tree surveys for 3D placement. Finally, we will explore the use of InfraWorks software models in real-time game rendering engines. By capitalizing on real-time engines, we can shortcut long rendering times to create accurate visualizations quickly.

Your AU Expert

Andy Carter, PE *received his BS in civil engineering from the University of Texas at Austin. As co-founder of CivilE, LLC, Mr. Carter is an experienced land development and municipal project designer. He was named Young Engineer of the Year in 2007. His 2-year old firm was selected as winner of the small project award of the* ***2015 Autodesk Excellence in Infrastructure Awards****. Andy was invited to evaluate the functionality of the 2014 release of AutoCAD Civil 3D at Autodes.'s, headquarters. His current passion is real-time site pre-visualization for civil engineering projects.*

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NOTE:

This class handout provides a sequence of the workflow (pics and clicks) presented at the AU2015 class. It is intended to serve as desktop reference for replicating these procedures on your own future projects.

Step 0: An Introductory Primer to Civil Site Visualizations

"Competing among the Goliaths on civil projects, one small firm uses BIM as their slingshot to success."

-BimOnTheRocks.com about CivilE's 3D workflows-

http://bimontherocks.com/small-firm-secret-to-success/

The civil engineering world has been disrupted. Soon, your clients will expect 3D pre-construction visualizations of every project that you design. Those that have access to the Infrastructure Design Suite already possess the required tools to create compelling animations and rendered stills of their design projects.

As a byproduct of model based design (BIM or CIM), civil engineers can coordinate with land planners and architects to create detailed 3D visualizations that are "grade accurate" for their designed sites.

The following advances have allowed for the cost effective creation for 3D visualizations by even the smallest civil design shops:

1) Availability to create detailed proposed TINs with grading tools. (Civil3D)

2) Easy surface compositing and material assignment interface. (Infraworks)

3) 3D building models by architects are now common (Revit)

4) Real-time game engines have matured allowing the creation of quick and detailed renderings and movies without the need for a render farm. (Unity, Unreal, CryEngine, Stingray, Lumion…. Etc.)

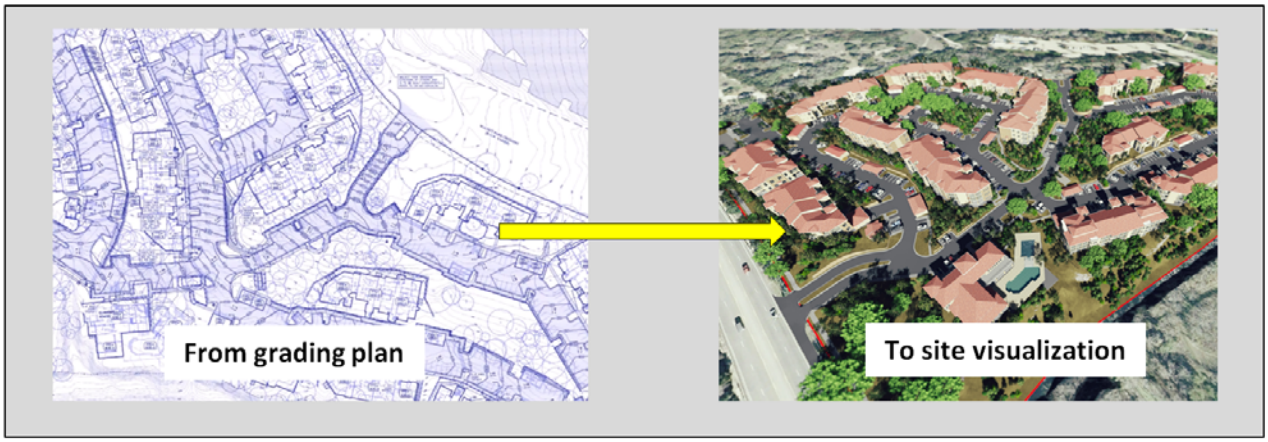


FIGURE 0-1: TAKING CONSTRUCTION DRAWINGS TO RENDERING

The Workflow:

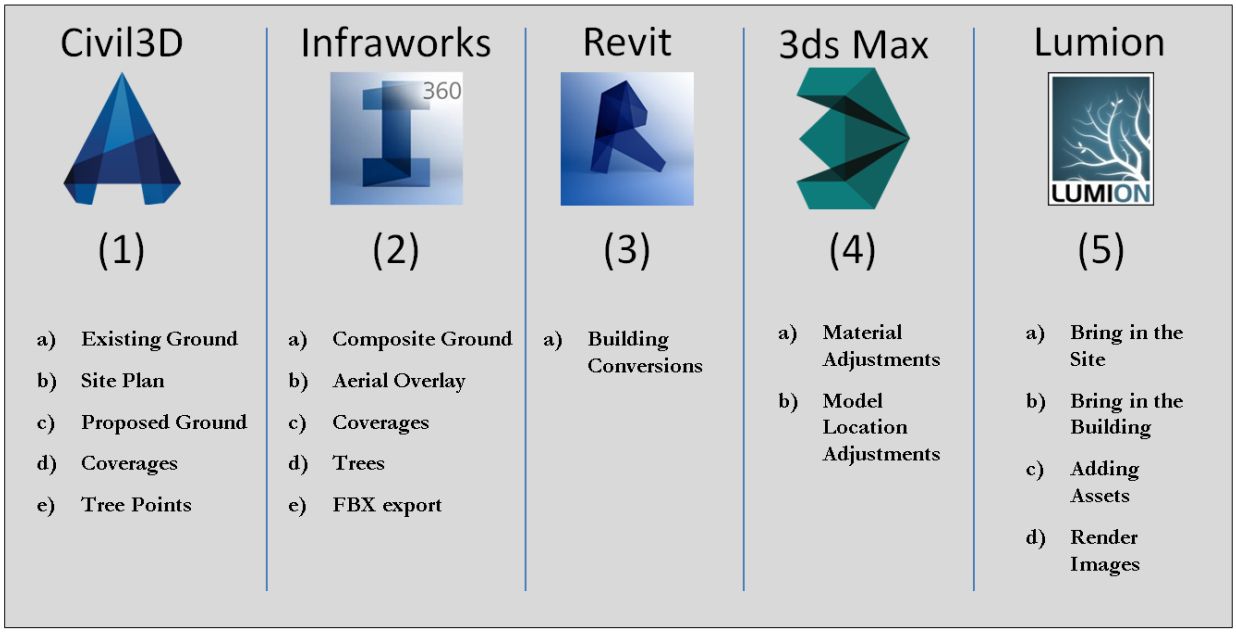


FIGURE 0-2: WORKFLOW SUMMARY

(1) Preparing the Model in Civil3D

You will probably be surprised by how much data you are already generating with your Civil3D project that is necessary for 3D visualizations. As this tutorial assumes that you are at minimum an intermediate user Civil3D, this section provide a quick overview of the data needed and a description of some of the workflow pitfalls.

(1 a): Existing Ground in Civil3D

Set up a new drawing in AutoCAD Civil 3D and define the coordinate zone in the "Units and Zone" tab of the "Drawing Settings". For this drawing we are utilizing "TX83-CF (NAD83 Texas State Plane, Central Zone, US Foot)."

Create an existing conditions surface for the subject site and surrounding area. CivilE typically utilizes a composite of on-the-ground field survey and air-borne LiDAR terrain data.

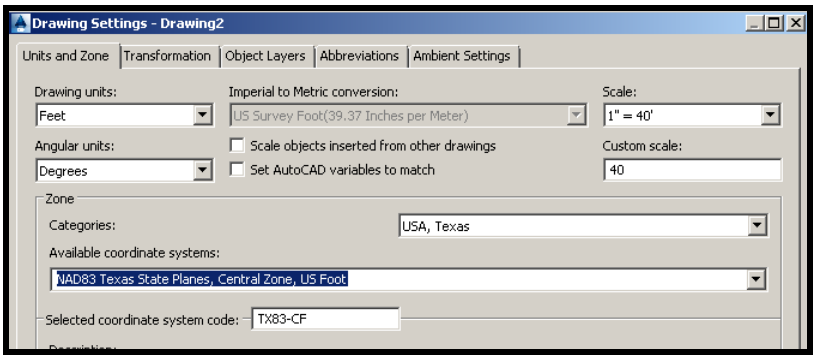


FIGURE 1A-1: DRAWING UNIT SETUP

Export the existing ground as an IMX file (under the output tab of the Civil3D Ribbon)

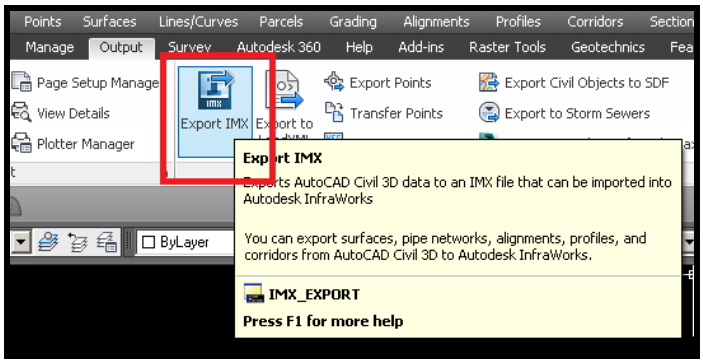


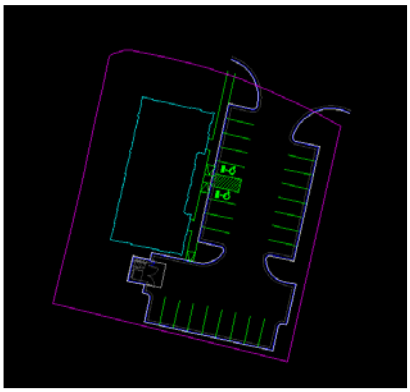
FIGURE 1A-2: EXPORT EXISTING SURFACE AS IMX FILE

The existing ground surface is provided as "CI9925-IMX-ExistingGround.imx" in the tutorial resource files.

(1 b): Site Plan in Civil3D

Create a two dimensional base file that includes the site plan line work. For CivilE layers created typically include the following:

- Property boundary
- Pavement
- Back of curb
- Face of curb
- Edge of Gutter
- Edge of asphalt
- Sidewalk limits
- Building slab limits
- Pavement markings
- Parking stripes
- Crosswalks
- Centerline markings



The ACAD siteplan is provided as "CI9925-ACAD_SitePlan.dwg" in the tutorial resource files.

(1 c): Proposed Ground Civil3D

This is the most important and the most time consuming step. Utilizing Civil3D's robust tool set, create a detailed proposed grading plan of the site. Teaching site grading is beyond the scope of this writeup. For sites, CivilE LLC typically grades a site consisting of (a) draped feature lines, (b) stepped offsets and multiple grading infills.

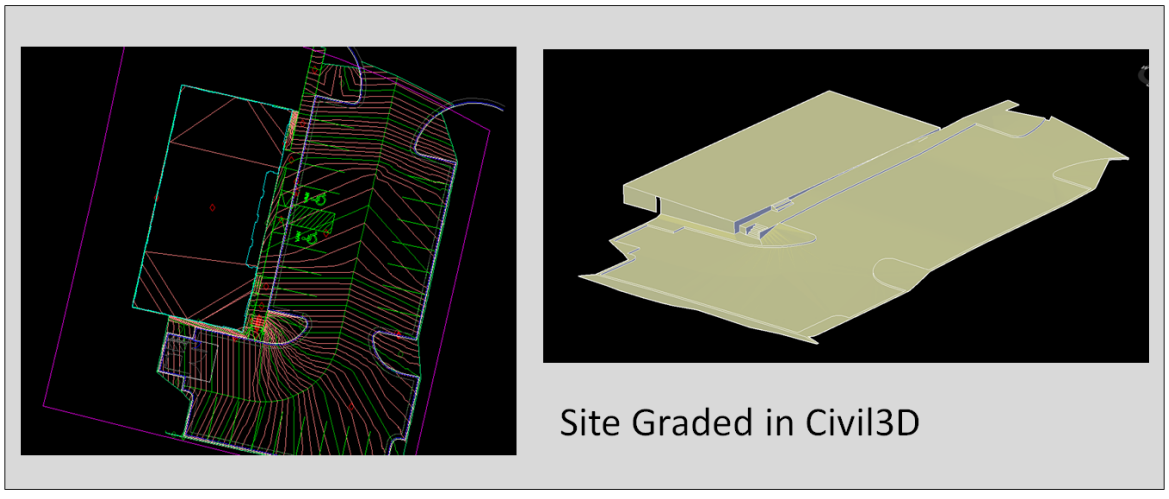


FIGURE 1C-1: PROPOSED GROUND GRADED FROM FEATURE LINES

The Graded site is provided as "CI9925-C3D_GradedSite.dwg" in the tutorial resource files.

Export the proposed ground (or the multiple ground surfaces) as an IMX files.

The Exported finished ground is provided as "CI9925-C3D_GradedSite.imx" in the tutorial resource files.

WARNING #1: [No Waffles]
Vertical faces such as retaining walls, curb faces and exposed building slabs once created should be oversampled. For example, for curbs we typically add points at 0.4' intervals to the feature line at the back, face and lip of gutter. This will help eliminate "waffling" when imported into Infraworks.

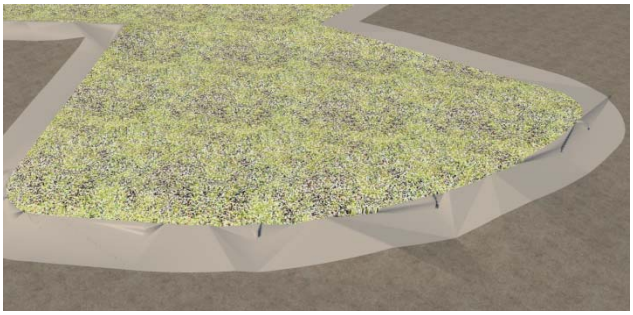


FIGURE 1C-2: CURB WAFFLING EXAMPLE

(1 d): Coverages Civil3D

Getting ready for Infraworks, it is necessary to create coverages for the various materials that you wish to apply to the site. Coverages are created from closed polylines. CivilE typically creates coverages for:

- Total site boundary
- Asphalt pavement limits
- Concrete gutter limits
- Sidewalks
- Building slabs
- Retaining walls

Similar to old school hatching, we don't want coverages with islands. There may be some intermediate work to create closed polylines that don't have islands.

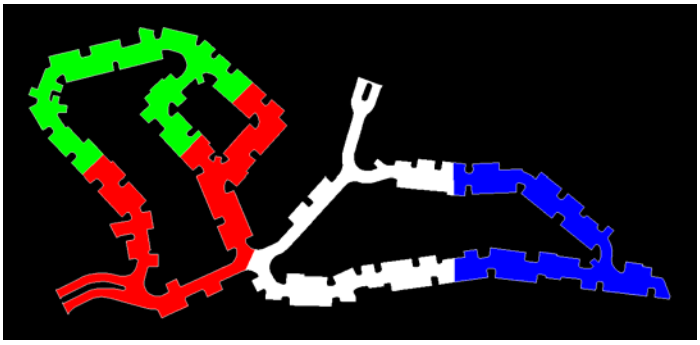


FIGURE 1D-1: PAVEMENT COVERAGE POLYLINES WITH NO ISLANDS

For near vertical faces such as retaining walls, curb faces and exposed building slabs, we like to create coverages that overshoots the top and toe of the wall by about 0.10 feet.

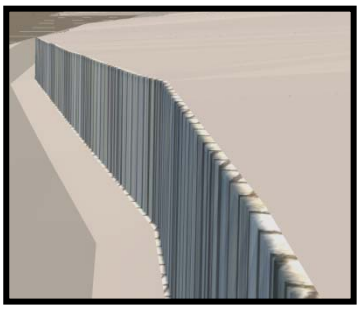


FIGURE 1D-2: WALL COVERAGE OVER DRAPING

A file of closed polylines to be used as coverages is provided as "CI9925-ACAD_Coverages.dwg" in the tutorial resource files.

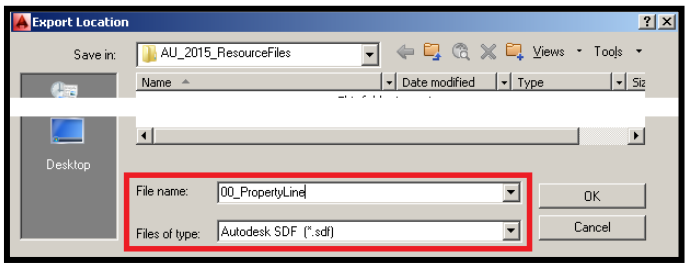
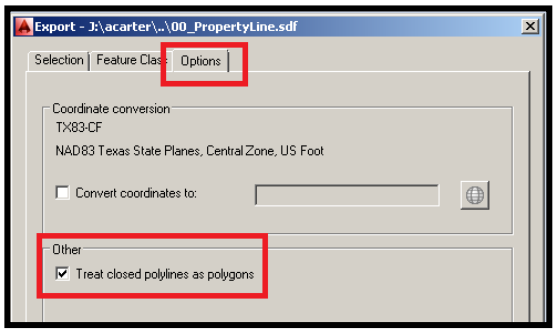


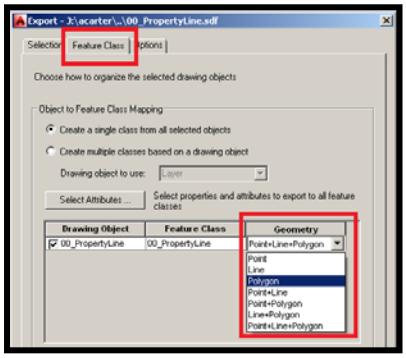
FIGURE 1D-3: "MAPEXPORT" COMMAND FROM ACAD

Utilizing the **"MapExport"** command in Civil3D, export each coverage grouping (such as asphalt pavement limits) of the closed polylines as an AutoCAD SDF file.

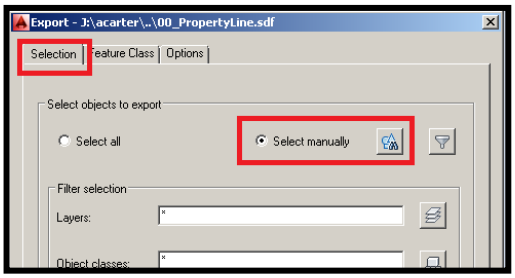
On the Options tab check the "Treat closed polylines as polygons"



On the feature class tab select the "Polygon" option from the Geometry drop down.



On the selection tab select the "Select manually" radio button. Then select the closed polylines to export.



Once completed successfully, you will have several SDF files with the coverage polygons (pavement, sidewalk, site, retaining walls, etc…).

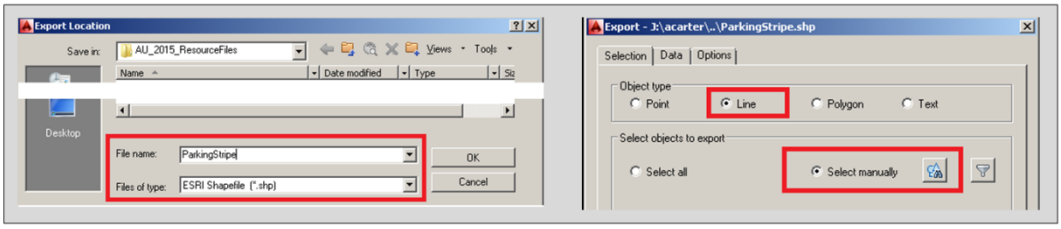
Bonus (EXTRA CREDIT**)**

Pavement Markings:

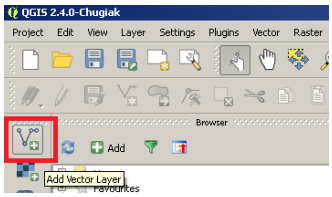
Pavement markings (such as parking stripes, handicapped crosswalks) require a little bit more work. Typically these are drawn as simple lines in the ACAD basefile. To create a painted line with the correct width, CivilE utilizes QGIS (http://www.qgis.org/en/site/) to buffer the lines into polygons. These buffered polygons are then converted to a pavement marking SHP file.

Steps:

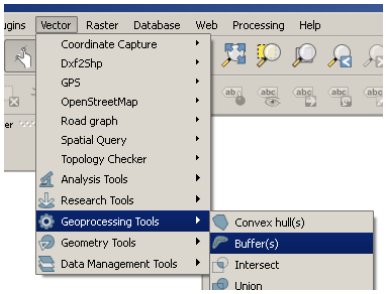
1) Use the "Mapexport" option and export the parking stripe lines an ESRI SHP file.



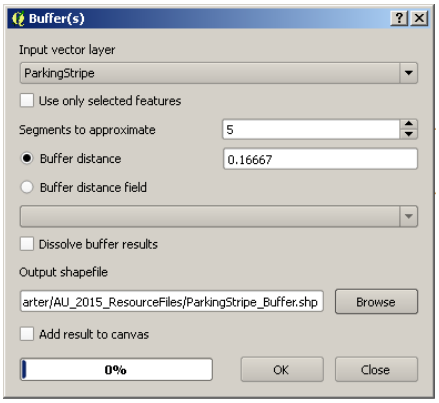
2) Open QGIS and add the ParkingStripe shapefile.



3) Under the "vector" option in QGIS, select "Geoprocessing Tools" and then "Buffer".



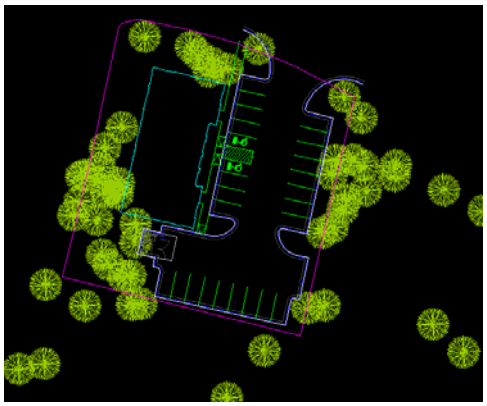
4) In the buffer tool, we choose to buffer the parking stripes a distance of 0.1667 feet. This will create 4 inch wide parking stripes.



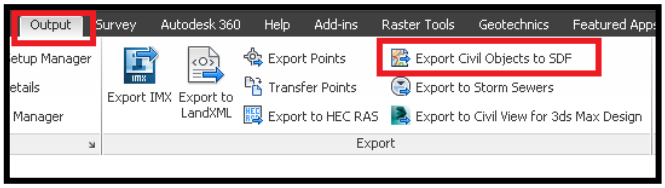
(1 e): Tree Points Civil3D

To simplify this tutorial, we are going to assume that all the trees are the same species with the same trunk diameter. We will utilize a point group in a Civil3D file that represents the surveyed trees that are to remain after construction.

A Civil3D file with the points of trees to remain is titled "CI9925-C3D_TreePoints.dwg" in the tutorial resource files.



Under the output tab in Civil3D, select the “Export Civil Objects to SDF” option.

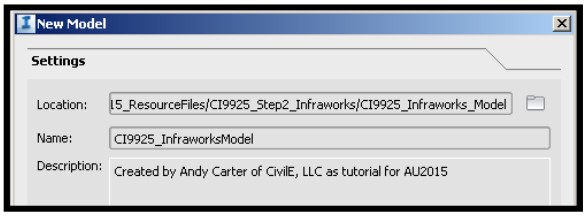


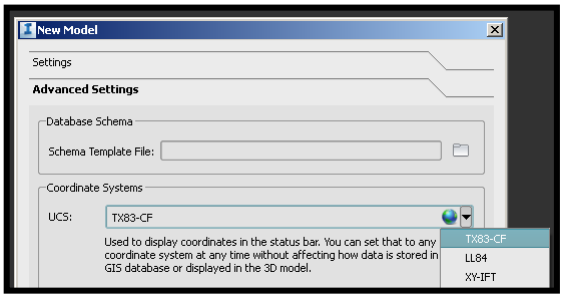
Since the only Civil3D objects in the file are Tree points, the created SDF [CI9925-C3D_TreePoints.sdf] contains the tree points for Infraworks.

TAKE A BREAK… you have now completed preparation of files for Infraworks.

(2) Infraworks Model

For this project, Infraworks will be utilized as an aggregator of surfaces, orthographic aerial photos, coverages and trees. Start by creating a new Infraworks model.

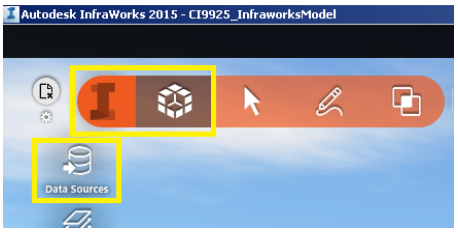




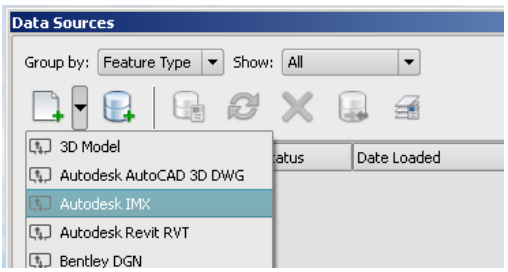
In the “Advanced Settings” tab, select the coordinate system as “TX83-CF” to match the exported coverages and surfaces from the base file.

(2 a): Composite Ground Infraworks

Add the existing ground to the newly created Infraworks model. Click the “I” and then the “Create and Manage your model” followed by the “Data Sources” button.

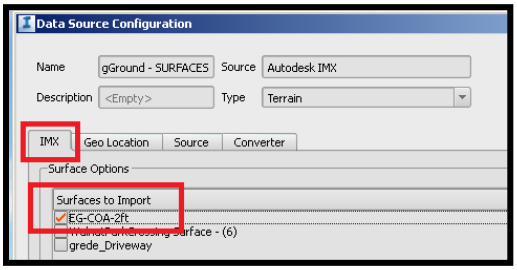


From the “Data Sources” window, select the “IMX” option and select the previously exported files for

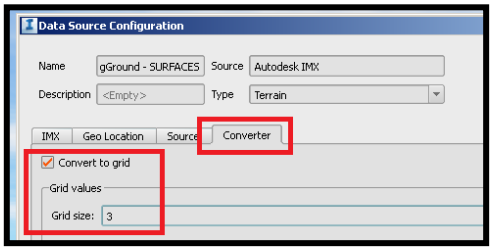


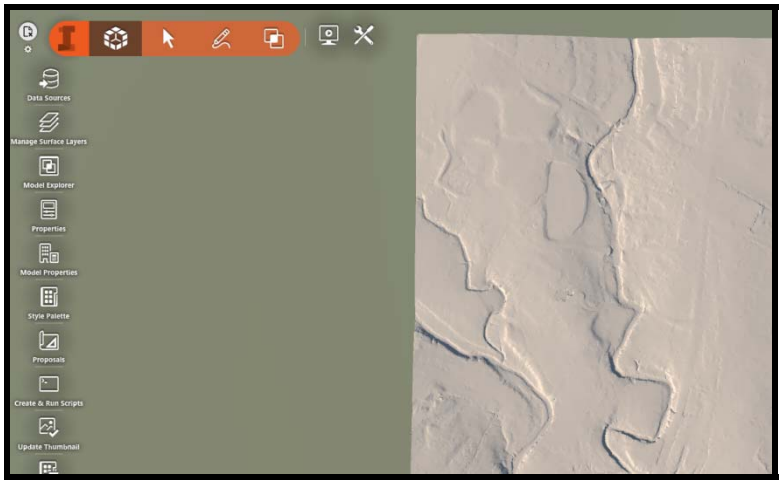
the existing conditions surface file. Configure the dataset as appropriate.

Right click on the imported IMX file and select "Configure" as necessary. In the "IMX" tab select the EG-COA-2ft surface.



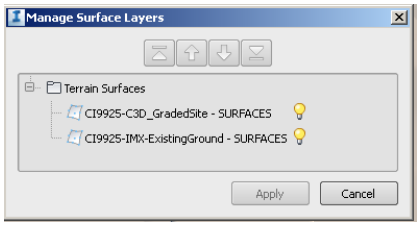
Under the "Converter" tab of the importer set a grid size for the imported Existing ground surface to 3 meters. This will speed up processing of the file. Select "Close and Refresh" to complete the configuration.





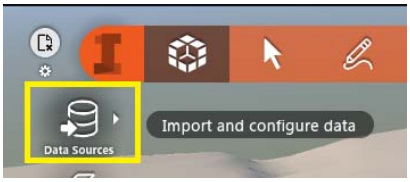
Import the proposed grade surface's IMX file (CI9925-C3D_GradedSite.imx) in a similar fashion. When configuring, **DO NOT** select a grid conversion on the import of the proposed surface grade as this will "ugly" up your hard work.

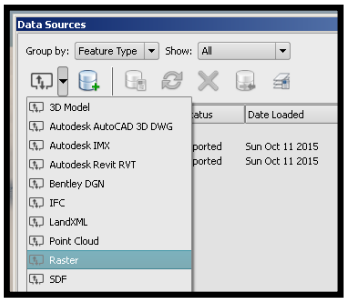
Under “Manage Surface Layers”, the order of the surface stack can be adjusted. Surfaces are pasted from bottom to top. We like to refer to this as the “Surface stack”.

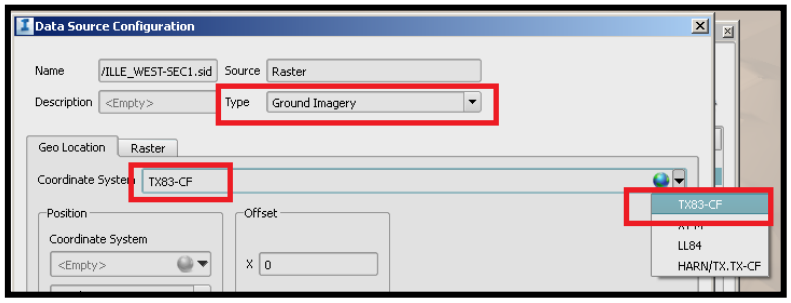


(2 b): Aerial Overlay Infraworks

Add the aerial ortho-photograph to the Infraworks Model and drape on the composite terrain. Select the “Data Sources” button and add a “Raster”. Right click on the data source to configure and select the “Ground Imagery” type. You may need to correct the coordinate system of the aerial to “TX83-CF”. Select the “Close and Refresh” button.







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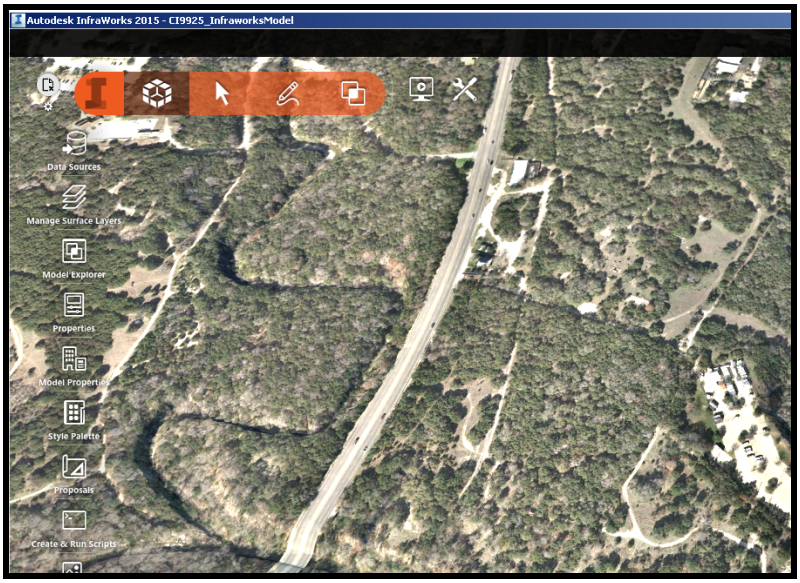
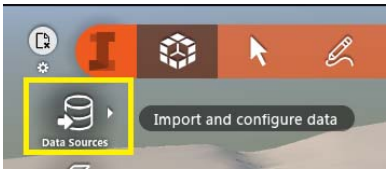
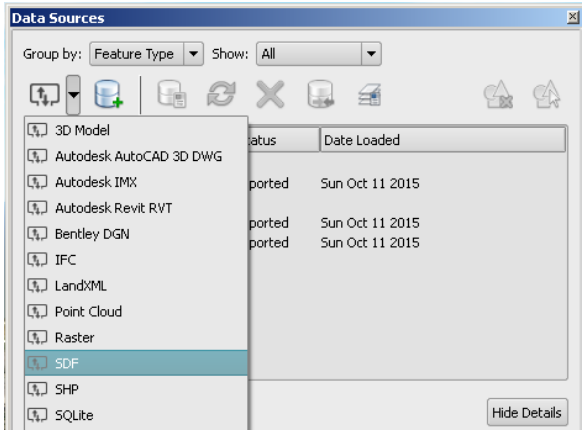


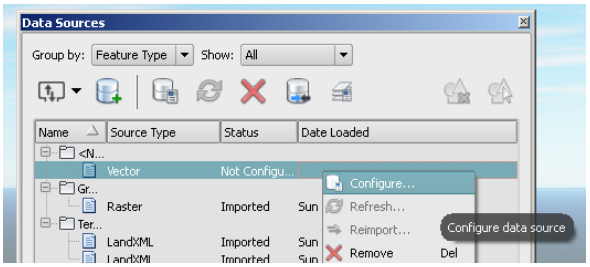
(2 c): Add Coverages Infraworks

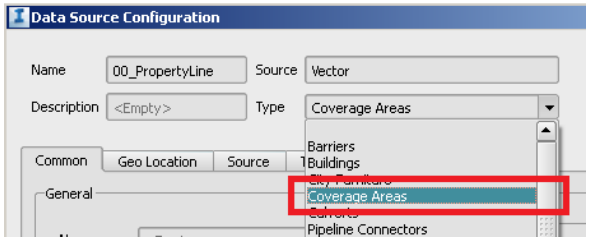
Now add all the coverage SDF and SHP files that were created in step 1d. Select the "SDF" option to add the coverages.



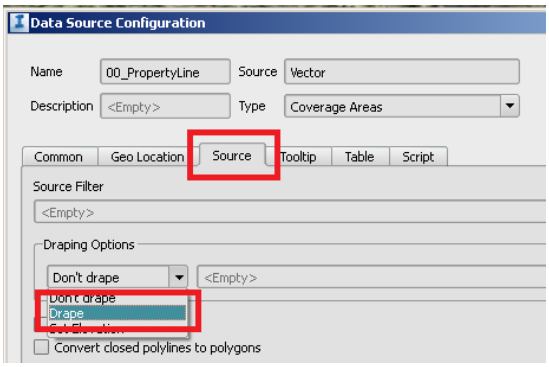


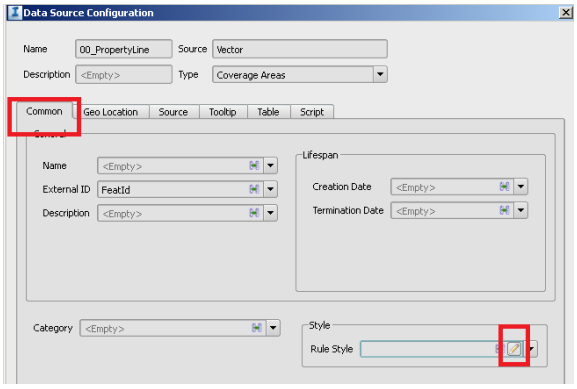
Once imported, right click the vector layer and select "Configure". Select "Coverage Area" as the type.



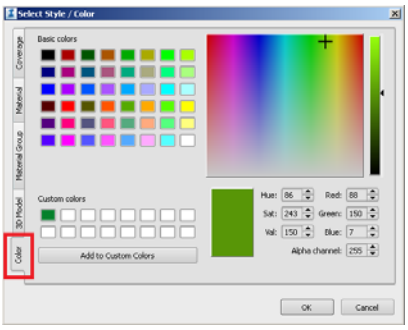


On the Source Tab select the "Drape" option. On the Common tab select the "Select Style / Color" pencil icon.





In the "Select Style / Color" window pick an appropriate color for the coverage. It is important for later that all coverages have a different color.

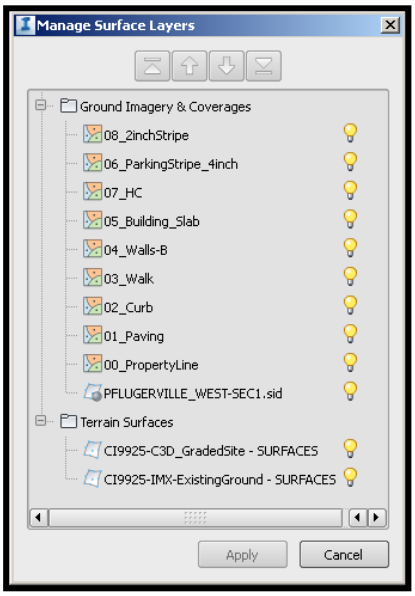


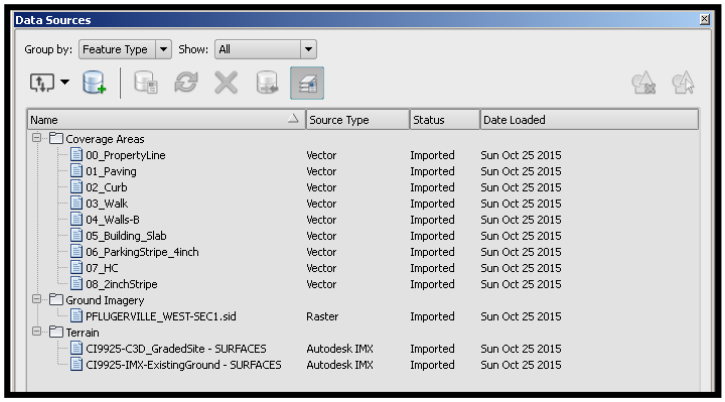
Repeat this step for each desired coverage. Don't forget to add the Parking Stripe and Handicapped stripes (which are ESRI Shapefiles) as coverages as well. For the shapefiles you may need to select the "TX83-CF" as the appropriate coordinate zone.

Coverage Tip:

CivilE likes to name our coverages with a numerical prefix (such as 00… 01… 02…)

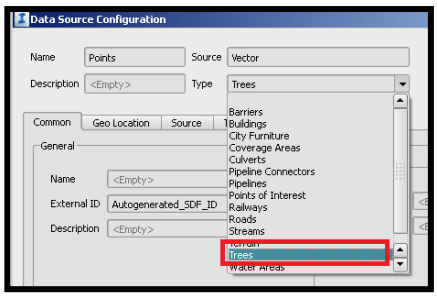
This helps us stack the coverages appropriately after imported in Infraworks.



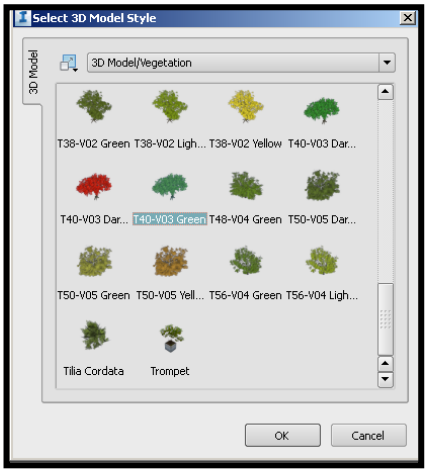


(2 d): Adding in Trees

Import the SDF file created from Civil3D points into Infraworks. When configuring select the type as “Trees”. Select the “Drape” option on the source tab.

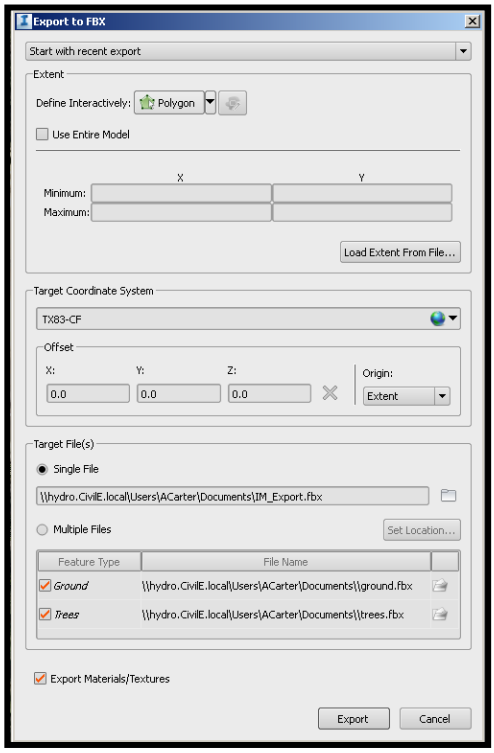


Select the “Pencil” icon on the “Rules Style” option.Select the ‘T40-V03 Green’ tree.



(2 e): Infraworks FBX Export

The last step in Infraworks is to export the desired portion of the model as an FBX file. Under the “Settings and Utilities” option Select the “Export FBX” button. A “Single File” is desired with the “Export Materials / Textures” also selected. Draw a limits to export and save that file.



The exported FBX file is titled "CI9925_FBX_Export.fbx" in the tutorial resource files.

(3) Converting a Revit file for Game Engines

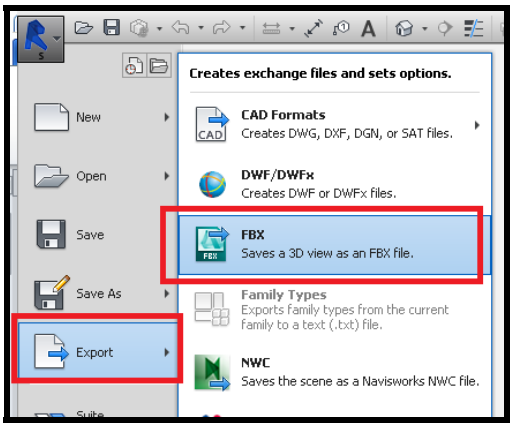
To get the Revit model to be game engine compliant, we will utilize a tool created for a game engine titled "Lumion". Download and install the appropriate "Revit to Lumion Bridge" for your version of Revit. This free add-in is available at….

http://lumion3d.com/revit-to-lumion-bridge/

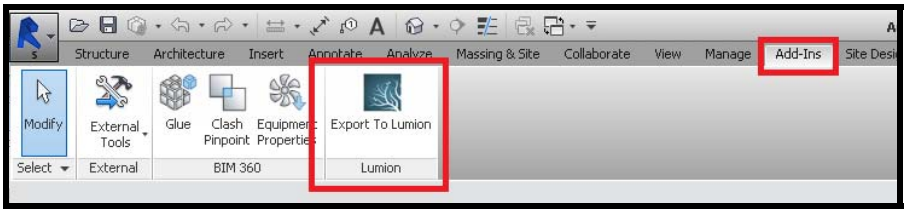
This add-in coverts a Revit building model to a Collada (DAE) file. Experiments have shown that using this tool provides a cleaner material mapping conversion of compound objects.

Note: Don't have a Revit model for your site's buildings? Ask the project architect. I bet they do!

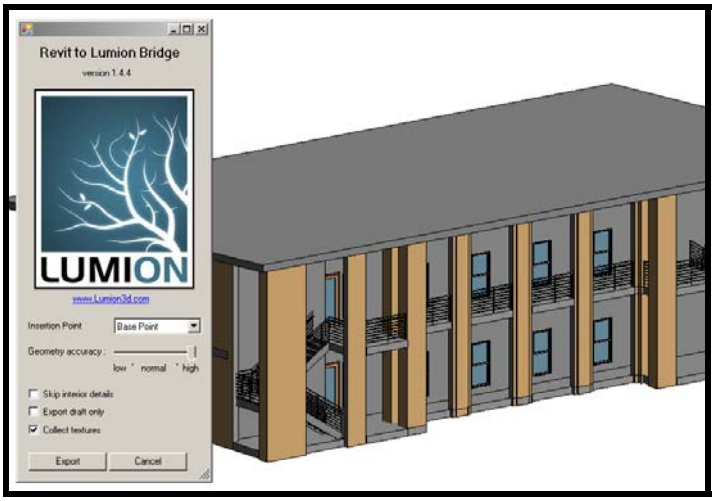
An alternate method of export is to utilize the FBX export tool provided in Revit.



(3 a) Open the Revit File and Convert



Open the project Revit file. Select the Add-ins tab and select the "Export to Lumion" button. Select the default options and click Export.



Revit model provided is "CI9925_Building.rvt".

Converted DAE file is "CI9925_Building.dae".

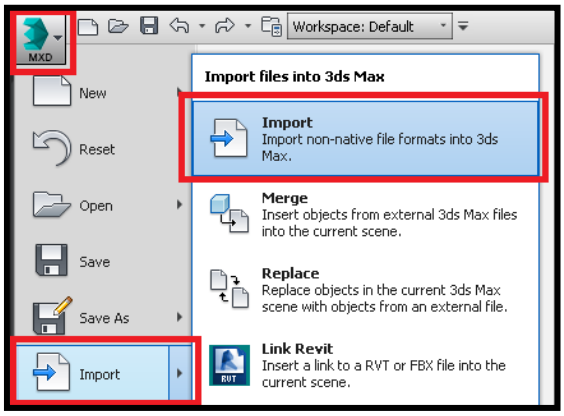
(4) 3D Mesh Modifications

We have now created an FBX file for the site and a DAE (and/or FBX) file for the building. These files may need to have some pivot point and material adjustments made prior to insertion into a game engine. We will quickly jump in and out of 3DS MAX to perform proper adjustments. Depending on how the Infrawork model was built, you may be able to skip these steps.

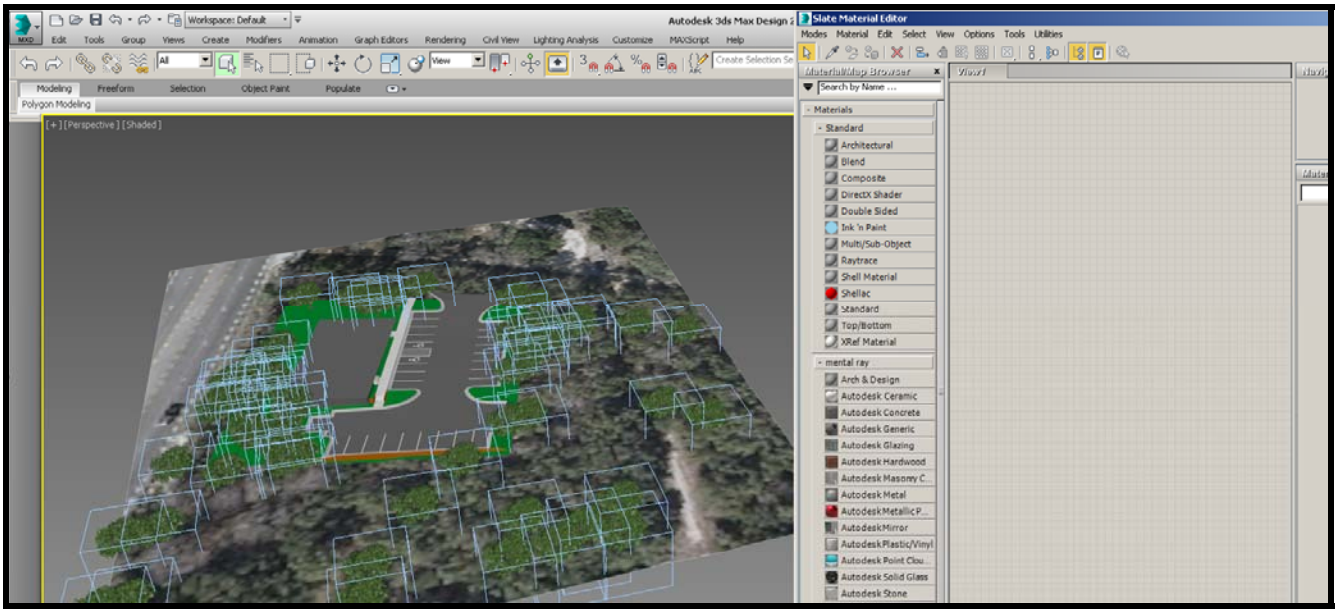
(4 a) Site FBX Material adjustments

Material assignment from the FBX exported from Infraworks can be a little sloppy. Without some correction, we typically see material names like "Material 1" and "Material 2(1)". This makes adjustments downstream in our game engine of choice difficult to adjust.

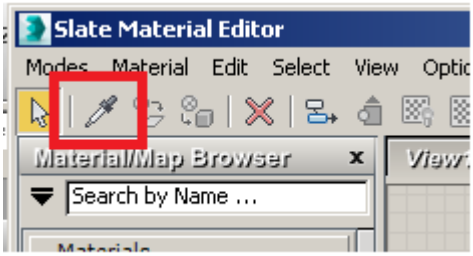
To correct these issues, open the exported FBX for the site in 3DS MAX.



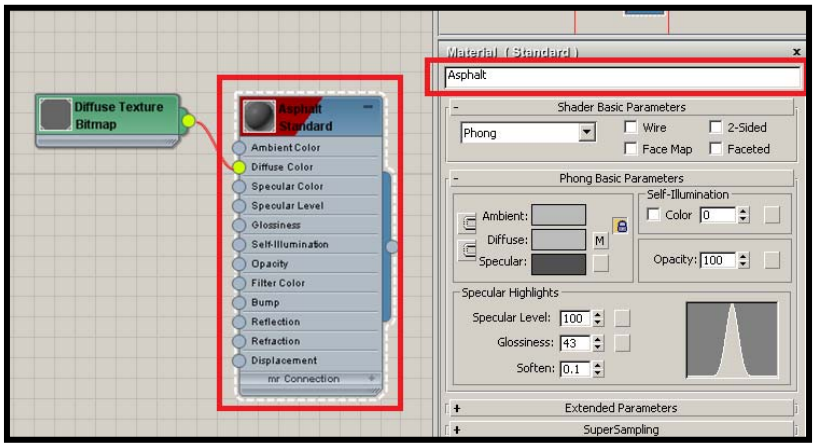
We will utilize the slate material editor to assign proper name to the exported site. With the file open in 3DS MAX, type “M” on the keyboard to open the slate material editor.



Select the “Pick Material from Object” icon in the slate material editor. This looks like an eyedropper.

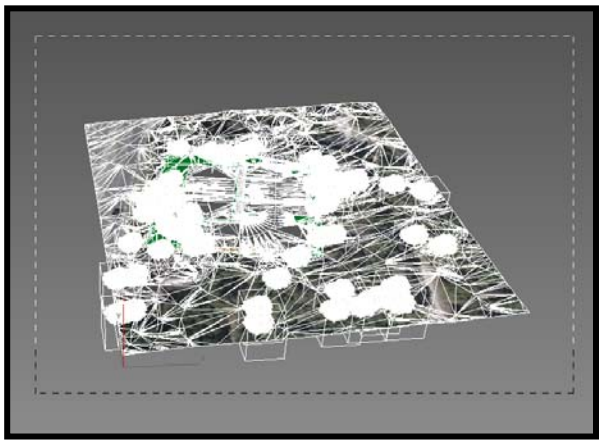


Select a material on the mesh and you will see it added to the slate material editor. Double click on the Material/Standard node in the slate material editor. And change the name to the appropriate value. In this case, we are typing in “Asphalt”.



Repeat this step to name the material for every coverage that you utilized in your Infraworks model. We like to have materials with names like grass, curb, sidewalk, walls, striping , etc…

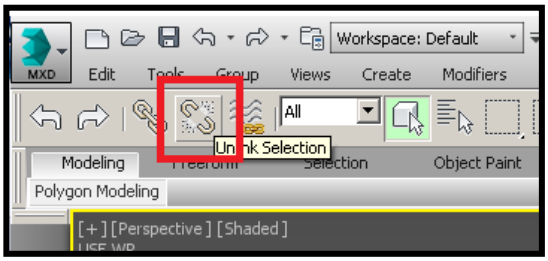
(4 b) Model location adjustments



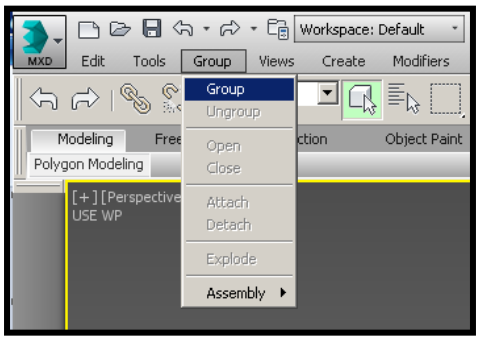
The FBX model exported out of Infraworks is typically not in the coordinate system that it was created in. While the X,Y coordinates are adjusted, the Z elevation is typically maintained. The pivot location for the model is normally down at 0,0,0. So when an exported FBX model is brought into a game engine, the mesh is floating up in space at the elevation it was modeled at in Civil3D.

Moving the model down to a more reasonable elevation requires the following steps.

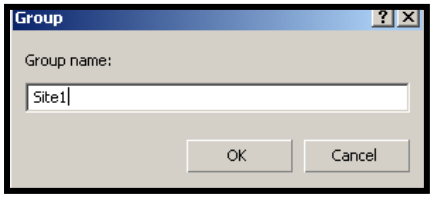
In 3DS MAX, window select all the object for the site model.



Click the “Unlink Selection” button.

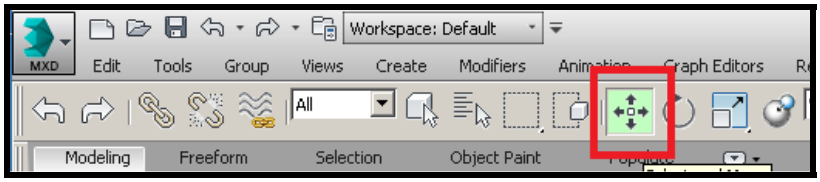


Select the “Group” option from the menu bar.

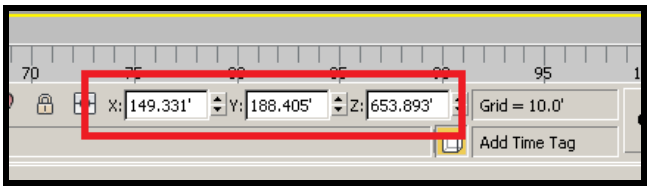


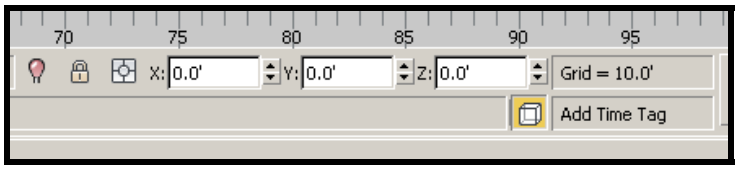
Name the group something meaningful… “Site1”.

Select the “Select and Move” button.

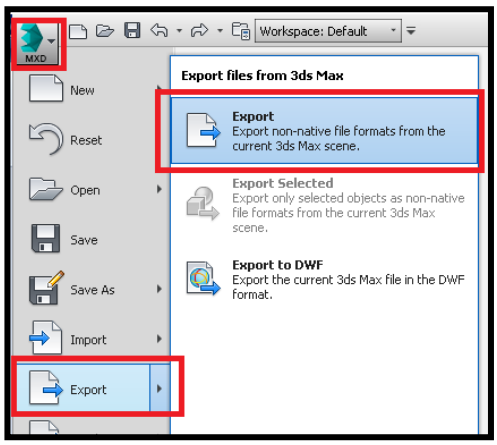


Move the group to (0,0,0) utilizing the key-in options at the bottom of the 3DS MAX screen.





Now that the model has reasonable material names and is moved to a reasonable location, export the model from 3DS MAX.



The cleaned up and exported FBX file is titled “CI9925_FBX_Export_SiteClean.fbx” in the tutorial resource files.

(5) Bringing it all to a Game Engine

There are many game engines available. The interface to these engines can be complex with a steep learning curve. As of last year some of these game engines are free (Unity: http://unity3d.com/ , Unreal Engine: https://www.unrealengine.com/) . Last year, Autodesk even released their own game engine called Stingray (http://www.autodesk.com/products/stingray/overview).

CivilE has experimented with many of these engines. We have discovered that currently the easiest to learn and quickest to use for a civil engineering professional is an engine called Lumion. http://lumion3d.com/. **There is a free demo that watermarks the images.**

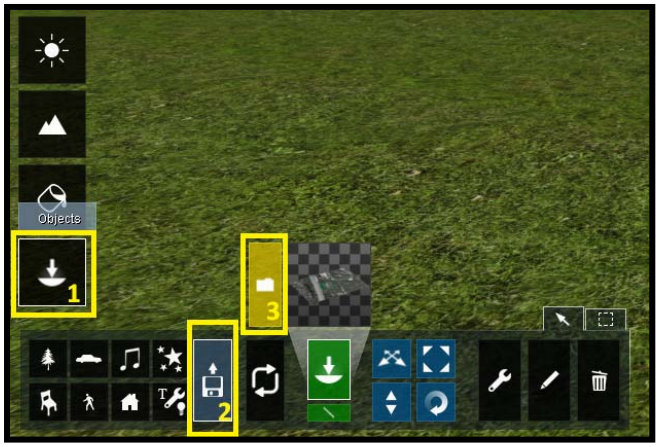
This engine is marketed towards architects and therefore works really well with site data from Infraworks. Materials and assets come standard with the purchased package which speed up workflows and eliminate the need to build an inventory prior to rendering a project.

Here is our workflow in Lumion.

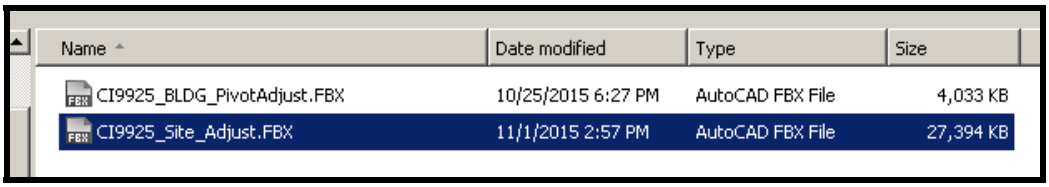
(5 a) Bringing the Site into Lumion

Open Lumion and create a new project. In the "New" tab, select the "Plain" option.

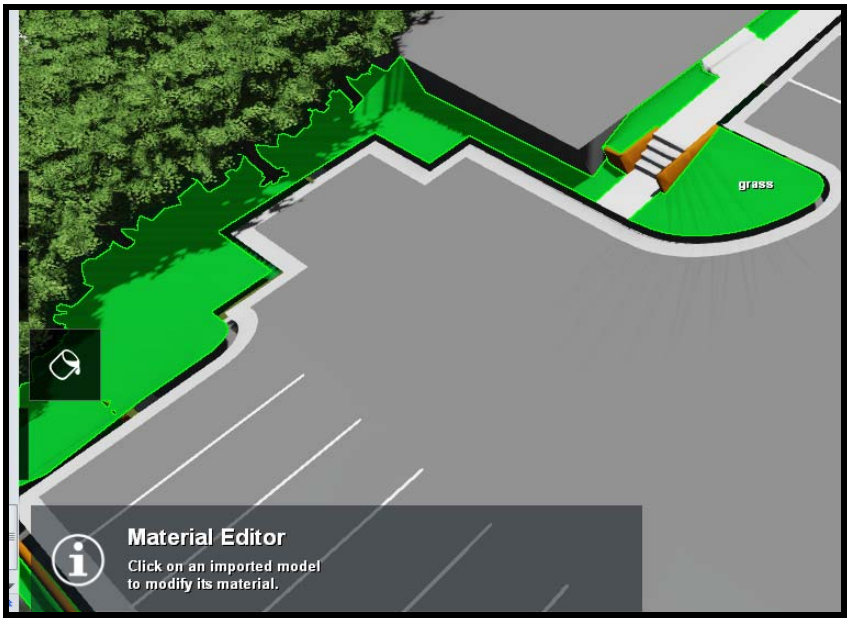
Import the “Site” FBX into Lumion by clicking “Objects… Import… Add a New Model”



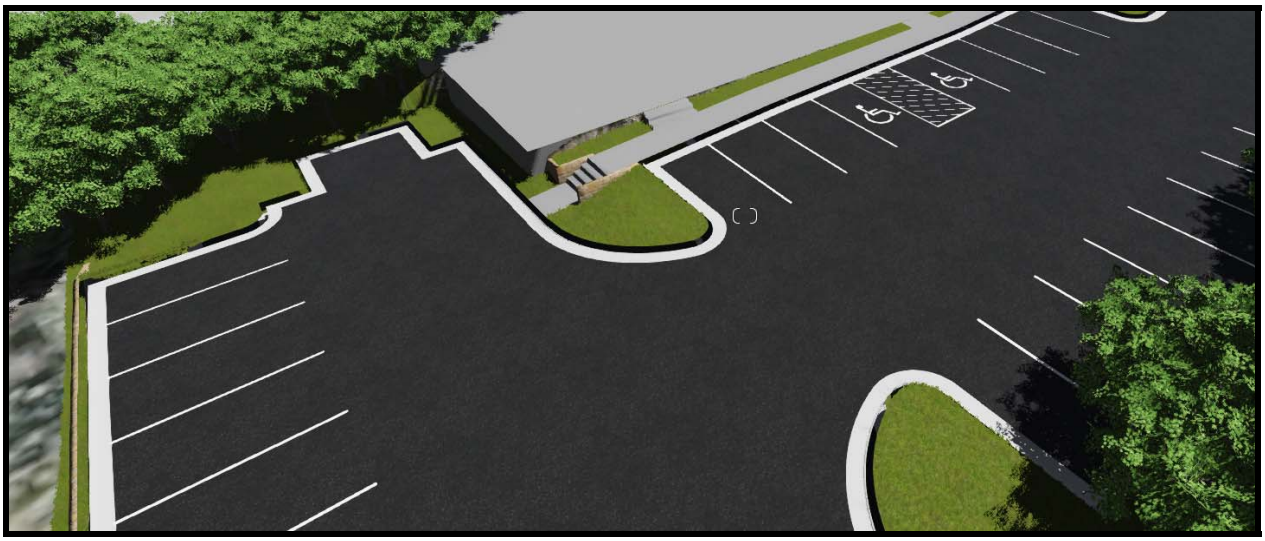
Select the adjusted site model “CI9925_Site_Adjust.FBX”



Pick a point on the site to add the model and navigate to the site. Select the Materials icon (Paint Bucket) and change the assigned material.

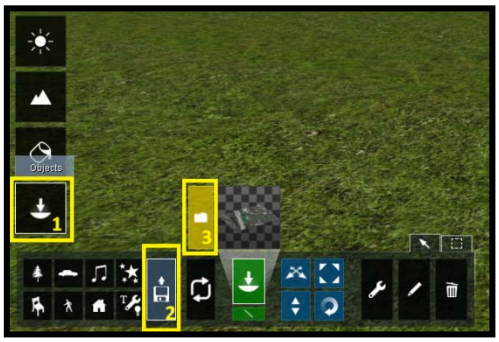


The “grass” material should be assigned to a “Terrain” style. Play with the other styles to get a desired look.



(5 b) Bringing the Building into Lumion

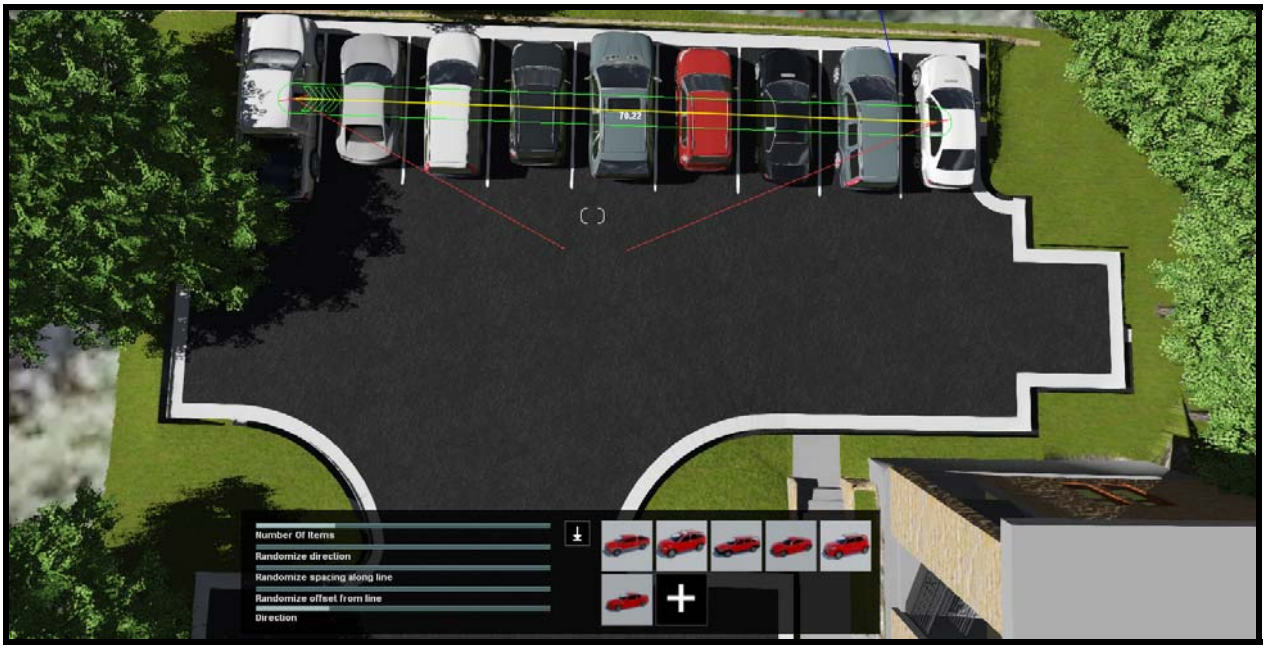
In step 3a, we utilized the Lumion bridge to create a Collada (DAE) file of the Revit building. Similar to 5a, import the building file to Lumion. Select the CI9925_Building.dae



Rotate the building into place, and paint materials until you get a desired look to the building.

(5 c) Adding Assets

Lumion has a substantial library of Cars, trees, plants, lightpole and people that help “dress up” the site. We will add some cars using the mass placement tool.



Next we will add some trees, fences and other furniture for additional detail.

This image was rendered in less than 3 seconds!

Image filters can be utilized to soften the image and convey that the design is conceptual. We like to use the sketch filter to reflect the preliminary nature of the design.

The GOAL…. Quick and easy conceptual renderings. These can be used to communicate the site plan with investors, bankers and the public.

As game engines and shaders improve over the next few years, it is foreseeable that site visualizations are likely to migrate to a realtime workflow. The benefit is the creation of images and movies without the need of a render farm. With the Civil Infrastructure Suite tools, Autodesk is placing all the tools in the hand of civil professionals to prepare their data for ingestion into a realtime game engine.

So get going on figuring out your strategic workflows!!

SUMMARY: Running this tutorial to conclusion, you will have taken the following

(1) a 2D AutoCAD site plan
(2) a surface model graded in Civil3D
(3) a Revit model

and created a compelling 3D model of the site in a realtime game engine. We utilized Infraworks as an intermediate tool to aggregate surfaces and coverages to create a grade accurate 3D mesh file of the civil site design. Using 3DS MAX, we made some minor tweaks to the material naming and mesh locations.

Taking these data into a game engine built for architects, we were able to quick create a view of the site that is more understandable to the general public.

**Visit the Autodesk University web site for class CI9925 to find the supporting files utilized in this tutorial.

About CivilE, LLC

CivilE, is a 5-person civil engineering firm located in Austin, Texas celebrating their second anniversary. CivilE is recognized as a regional leader in their use of Civil3D as they employ BIM to improve multi-disciplinary design collaboration. With a BIM workflow, CivilE, LLC has proven that Autodesk's tools can empower small engineering firms to create compelling visualizations within the constraints of a small project's budget.

CivilE

CIVIL ENGINEERING FOR CENTRAL TEXAS

They specialize in site development (residential, mutli-family, commercial and light industrial). Their staff has been recognized nationally as experts in sub-division design and floodplain management.

CivilE is always interested in partnering with like-minded firms to create successful projects.

Discover their story at: **http://www.civiletexas.com**

Contact us at: acarter@civiletexas.com

P: **512-402-6878**