



## Fasten Your Seat Belt - Advanced Roadway Design for InfraWorks 360

Eric Chappell – Autodesk

**CV5775-P** In this class we will study Roadway Design for InfraWorks 360 software, the add-on module that brings you engineered horizontal and vertical curves, profile optimization, automatically generated plan and profile sheets in AutoCAD Civil 3D software, and much more. If you thought InfraWorks 360 software was just for making pretty pictures, think again. In this class you'll learn how InfraWorks 360 software can become a powerful engineering design tool for designing and modeling roads the way an engineer would do it.

### Learning Objectives

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

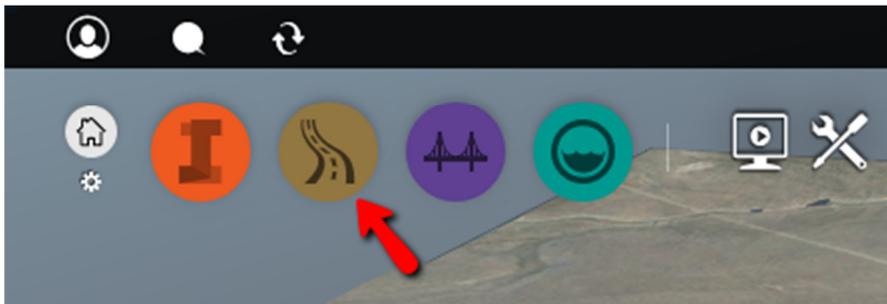
- Understand the capabilities of Roadway Design for InfraWorks 360 software
- Learn how to create, edit, and stylize roads using the tools in Roadway Design for InfraWorks 360 software
- Learn how to apply profile optimization and sight distance analysis
- Learn how to generate AutoCAD Civil 3D software drawings from an InfraWorks software road design

### About the Speaker

*Eric Chappell is a veteran instructor at Autodesk University, this being his 11th consecutive year. In September 2013 he became a member of the Autodesk, Inc., team as a premium services specialist. He is the author of Autodesk InfraWorks and InfraWorks 360 Essentials and AutoCAD Civil 3D 2015 Essentials (Wiley: Sybex) and contributing author of Mastering AutoCAD Civil 3D 2014 (Wiley: Sybex). He formerly served as CAD manager for Timmons Group, a civil engineering consulting firm located in Richmond, Virginia, and he worked as a consultant on projects that included the writing and development of educational and certification materials for Autodesk products. He has also worked for Avatech Solutions (now IMAGINiT Technologies) as a project manager and applications engineer. Before joining Avatech, Eric worked for 10 years in the surveying and civil engineering fields as an employee of H.F. Lenz Company in Johnstown, Pennsylvania.*

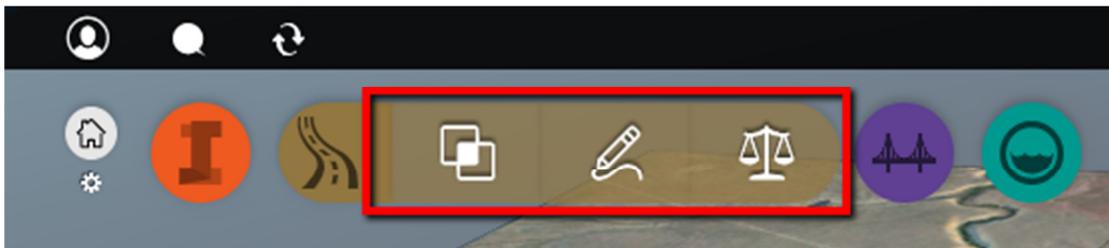
## What is Roadway Design for InfraWorks 360?

Roadway Design for InfraWorks 360 is an add-on module for InfraWorks 360. It adds functionality to InfraWorks 360 that allows you to design roads using engineering approaches and principles such as horizontal and vertical curve geometry, slope grading, intersection design, and many others. How do you know if you have this module included in your installation? The most obvious clue is that you will see the Roadway Design icon on the main toolbar in the top left of your InfraWorks screen.



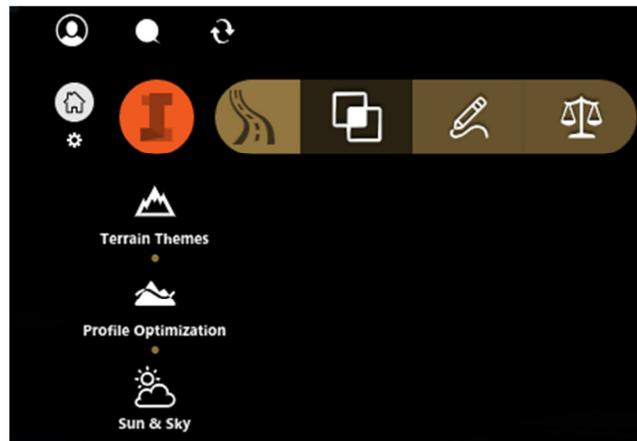
You can only add this module to InfraWorks 360. The standalone version that comes with a Suite, for example, does not have the capability to accept add-on modules. You must also have the roadway design module entitled by your software administrator (which might be you).

What do you get with this module? Well, expanding this toolbar will reveal that you have three main toolsets: Analysis, Design, and Review (from left to right in the image below).



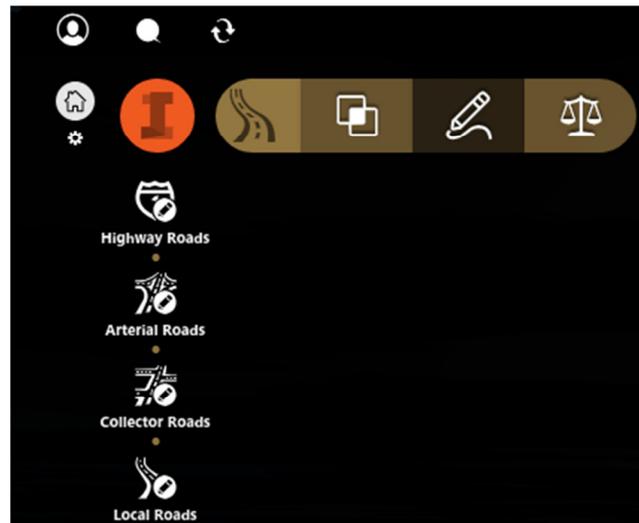
### Analysis

The analysis toolbar has three commands on it, but only one is additional to the InfraWorks core functionality. It is the Profile Optimization tool.



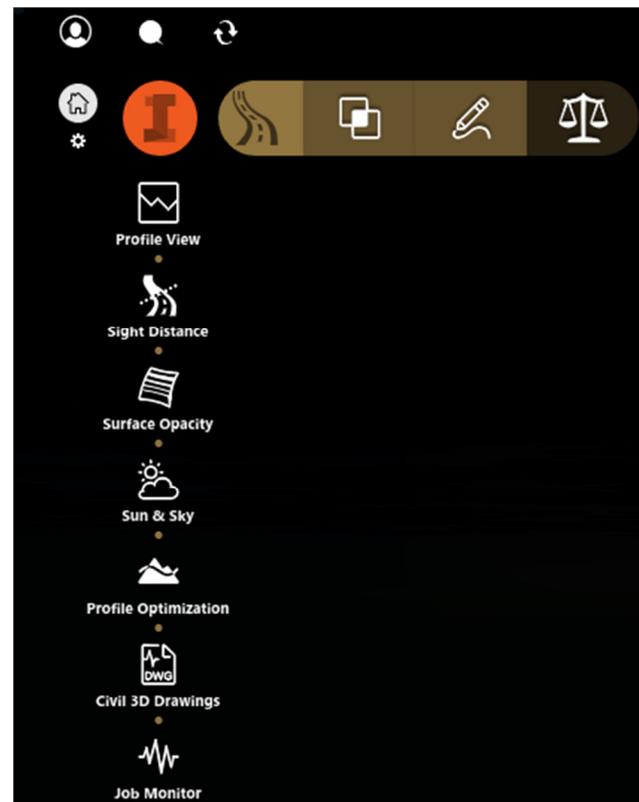
### Design

In this toolset we see the four road types: Highway, Arterial, Collector, and Local. There are some other commands but they are duplicates of InfraWorks Core Features



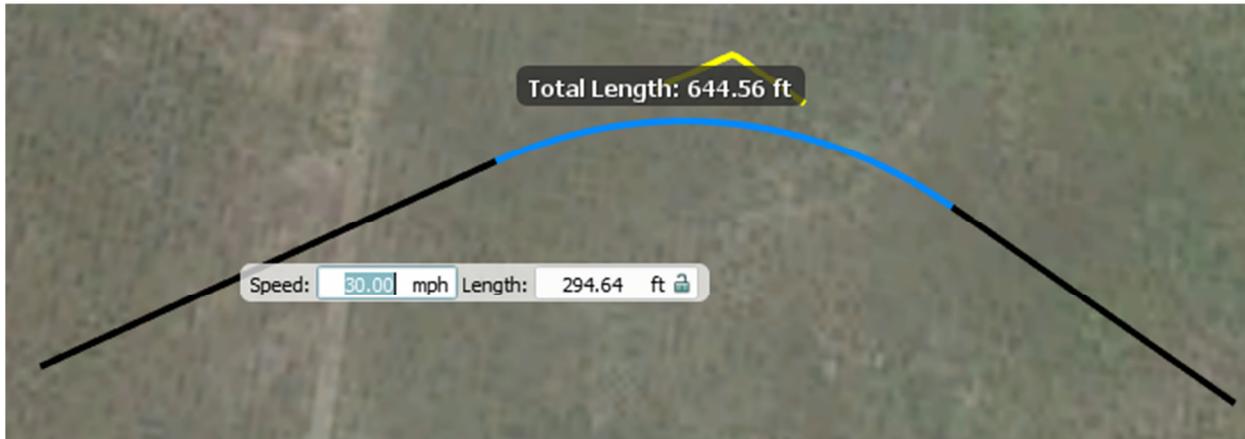
### Review

In this toolset you will find 5 tools that are additional to the core InfraWorks toolset. They are Profile View, Sight Distance, Profile Optimization (also on the Analysis toolbar), Civil 3D Drawings, and Job Monitor. These commands all perform completely different functions so we'll get into the details later on in this document.

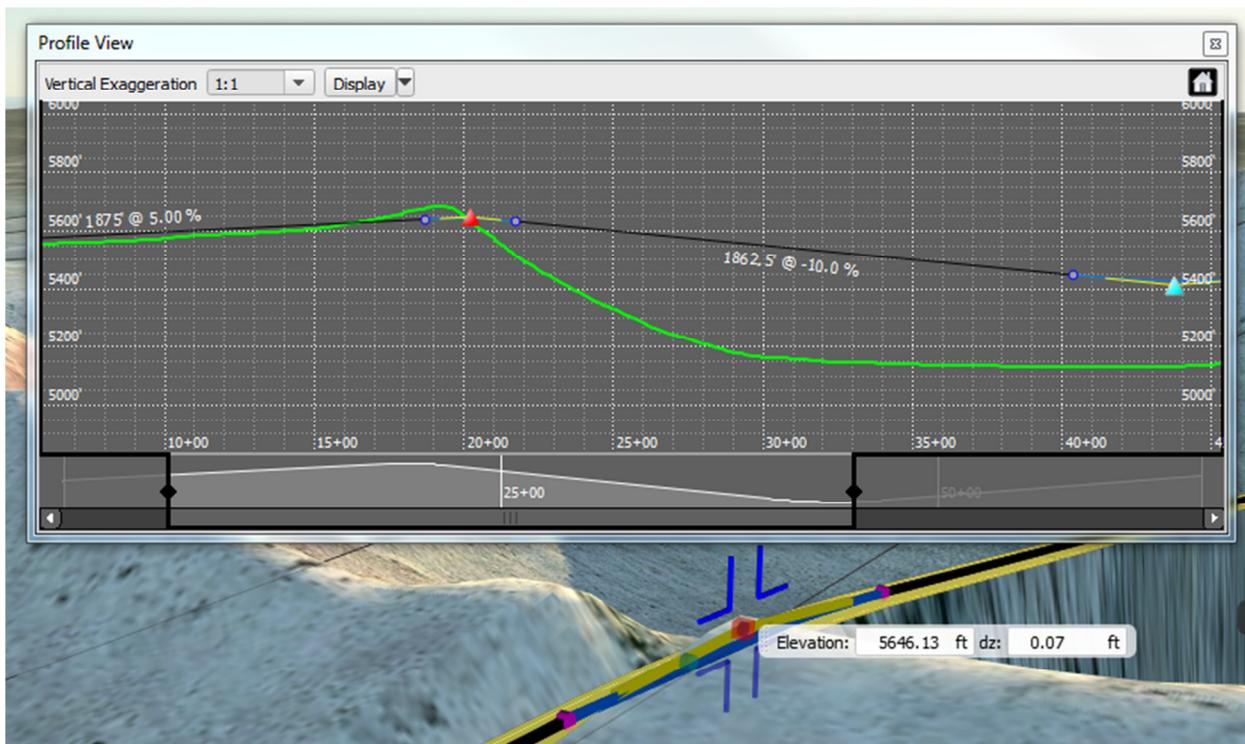


Seeing the tools gives you an idea what commands are available but until you use them, you won't see that these tools actually work differently than core InfraWorks tools. For

example, when you draw a road using one of the road tools, the geometry is line-curve-spiral (spiral is optional) like you would see when designing an alignment in Civil 3D, for instance. This is much different from the spline behavior of the core InfraWorks road tools.



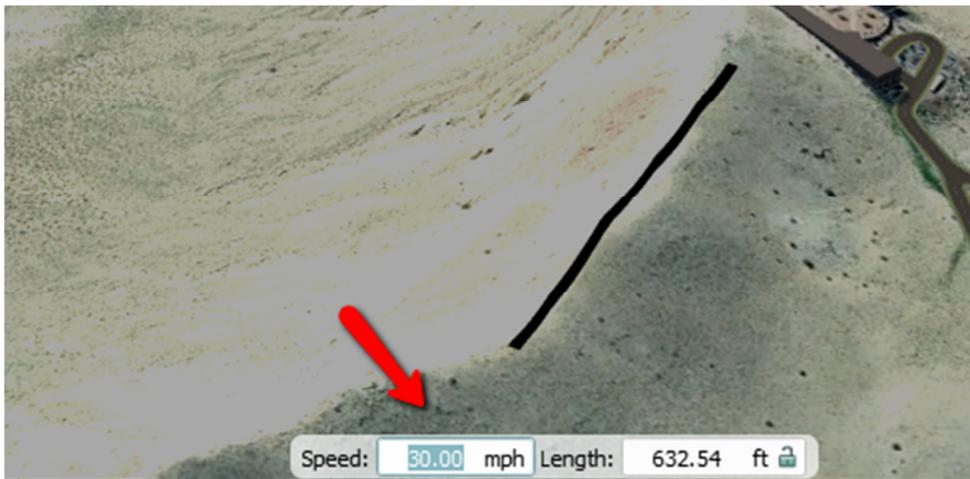
You'll find these types of differences with vertical design as well with the ability to grip-edit the elevation of a PVI within the model or within the Profile View window.



And there are many other examples where the roadway module adds design-level functionality to road design.

## Creating Roads

Creating roads with the roadway module is easy. Simply click one of the road tools on the Design toolbar. The tools are named Highway Roads, Arterial Roads, Collector Roads, and Local Roads. The default design speed for each one of these is highest for Highway Roads and decreases as you move through the tools to Local Roads. Why is this important? The design speed controls the defaults for horizontal and vertical geometry. You can also change the design speed to whatever you want after clicking the first point.



From there it's just a matter of clicking points in the model that represent PI's (points of intersection) for the roads. InfraWorks will automatically place a curve at each PI as long as the minimum geometry will "fit". This is a great feature of the roadway module because you're automatically laying out roads that "work" according to accepted standards (currently AASHTO standards are the only ones available).

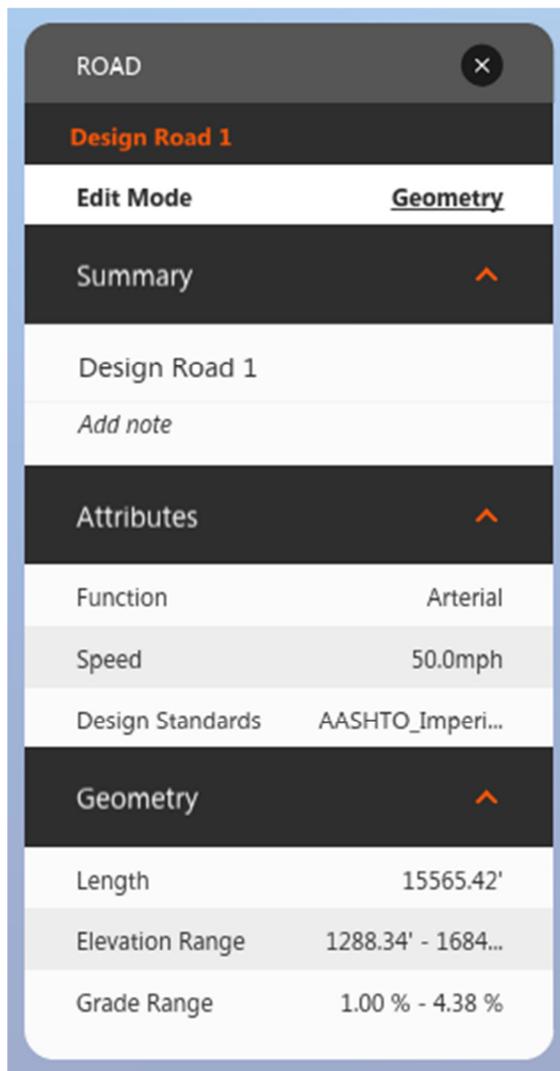


## Editing Roads

As you might guess, while creating roads is incredibly simple, the tools available for editing roads are quite sophisticated, especially when compared with the InfraWorks core tools. The additional tools provided by the Roadway module include a new asset card, new gizmos (a 3D version of AutoCAD grips), windows, context menus, and more. Of all the available modules, Roadway Design for InfraWorks 360 has the highest volume of additional tools.

### The Road Asset Card

When you click on a design road, you'll see the Road asset card which has many functions. It manages several different features sets of a design road and you can choose which one using the Edit Mode option. Edit modes include: Geometry, Style, Lanes Forward, Lanes Backward, and Roadside Grading.



## Gizmos

The roadway module offers a whole set of gizmos for graphical editing. The following gizmos can be used to change values or the location of the associated key geometric components.



Point of intersection (PI)



Tangent



Point of curvature (PC) or point of tangency (PT)



Curve radius



Point of vertical intersection (PVI)



Point of vertical curvature (PVC) or point of vertical tangency (PVT)

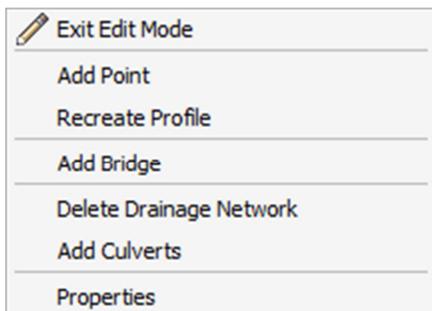


High/low point (vertical curve)

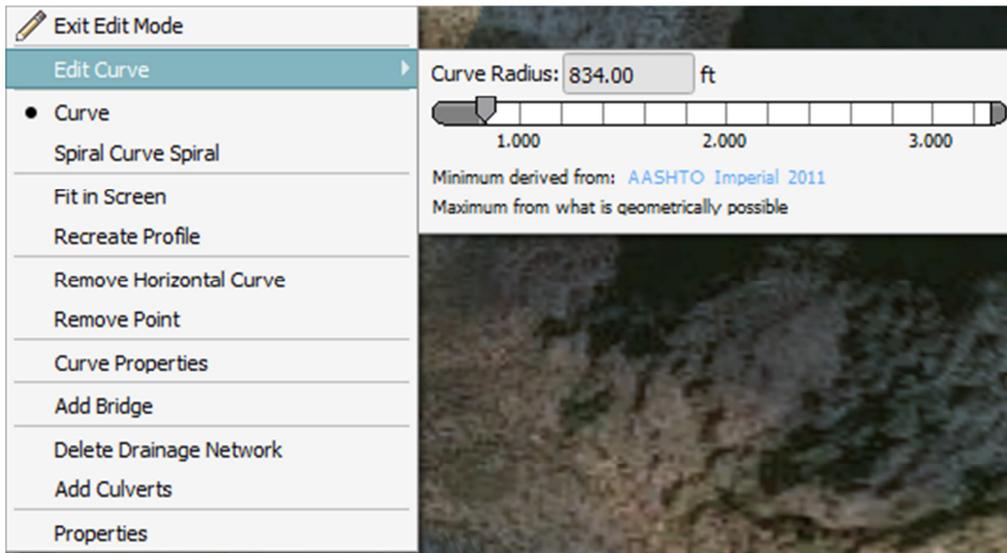
## Context Menus

The roadway module provides several additional context menus that allow you to perform key operations with your road design.

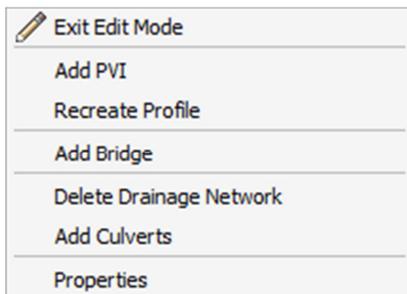
If you right-click a tangent section of a road in plan view you'll see the following context menu which allows you to add points (PIs) to the layout as well as other functions.



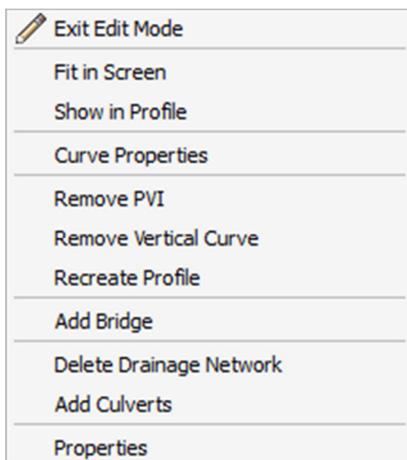
If you right-click a curve or PI in plan view, you'll see this context menu which allows you to remove PIs, design curves and spirals, and more.



If you right-click a tangent while in 3D view, you'll get this menu where you can add PVI's along with other functions, depending on which modules you are entitled to.

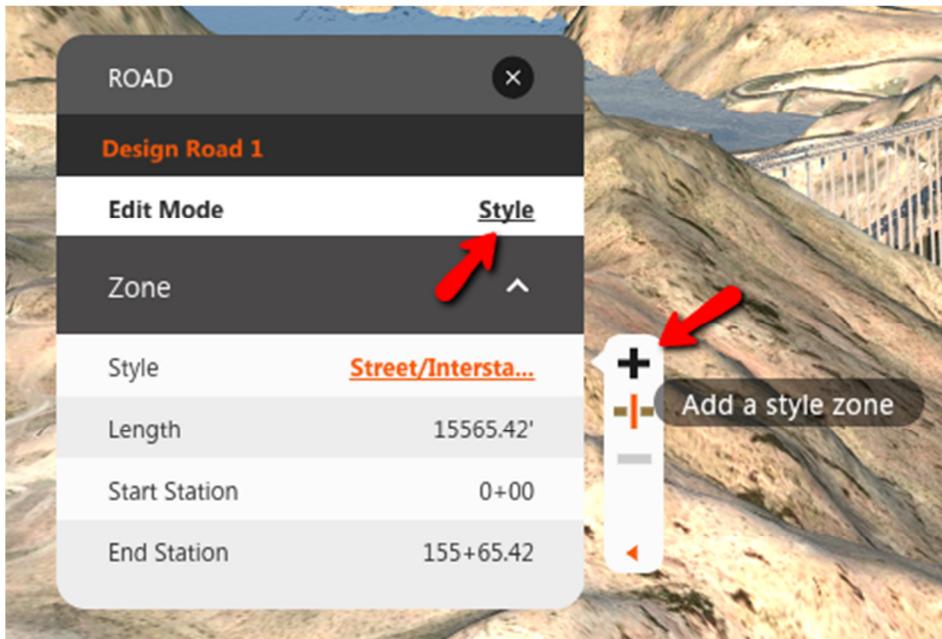


If you right-click a vertical curve or PVI while in 3D view, you'll see this menu where you can remove the PVI, see curve properties, add or remove a vertical curve, and much more.



## Style Zones

One of the advanced features with the roadway module is that you can create multiple style zones on your road and apply a different style to each one. The process is simple: just set the Edit Mode to Style on the Road Asset card, then use the icons on the fly-out to add or split a style zone.

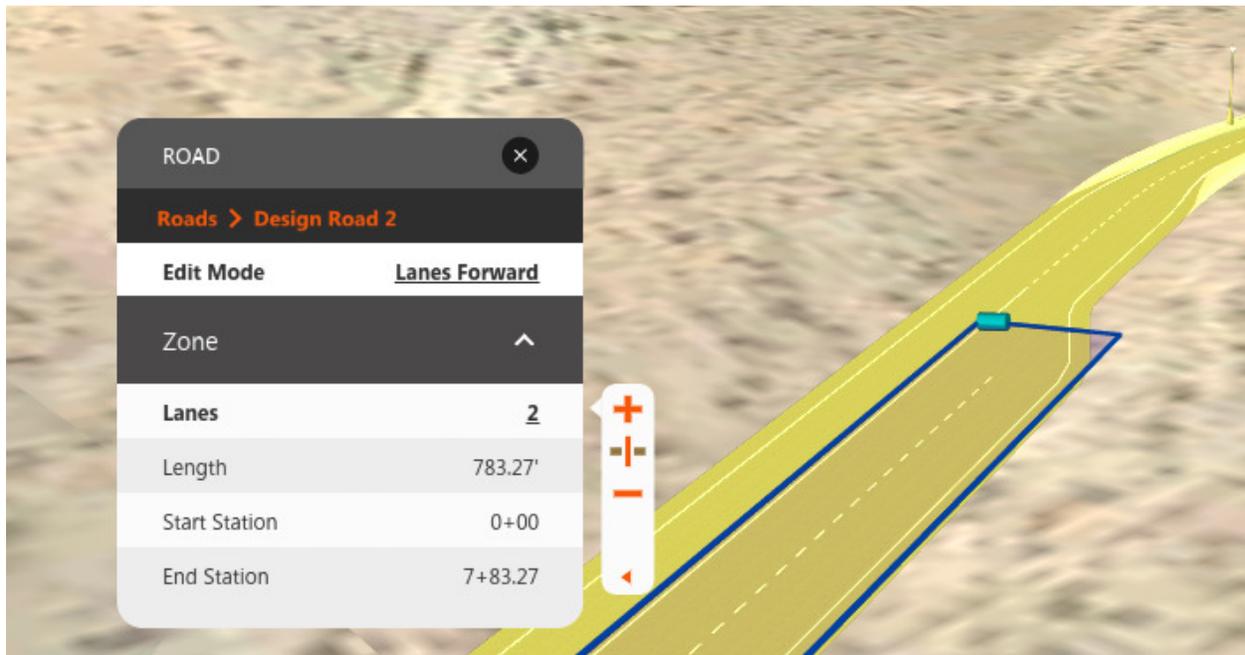


Next you'll be prompted to select a style for the new zone. Just pick what you want and click the model to locate the new zone (one point to split and two points to add a new zone). At any time you can use the Road asset card in Style mode to change the style applied to a zone. You can also use the style zone gizmos to graphically change where a style zone starts and ends.



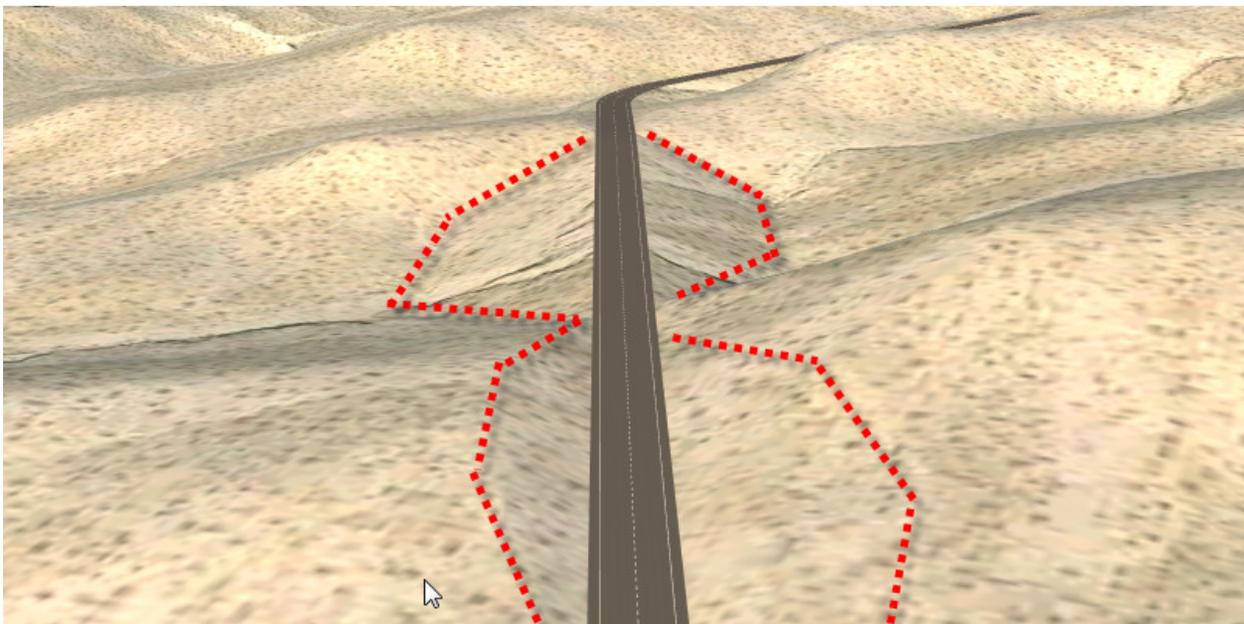
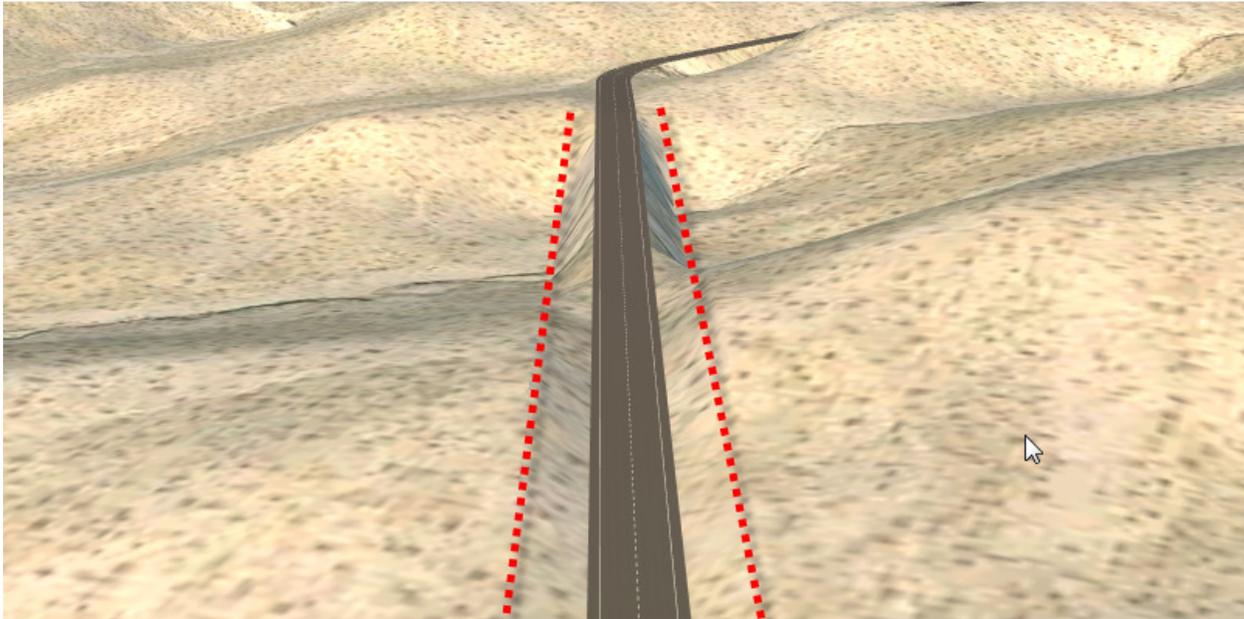
## Lane Zones

Another advanced feature with the roadway module is that you can change the number of lanes within a given section of road through the use of lane zones. Lane zones function much like style zones in that you can add zones or split current zones. Then it's just a matter of setting the number of lanes for a given zone by clicking it and setting the Lanes value in the Road asset card. To do this, you'll need to have the Edit Mode option set to either Lanes Forward or Lanes Backward. Like style zones, there is a gizmo that lets you graphically set the start or end point of a zone.

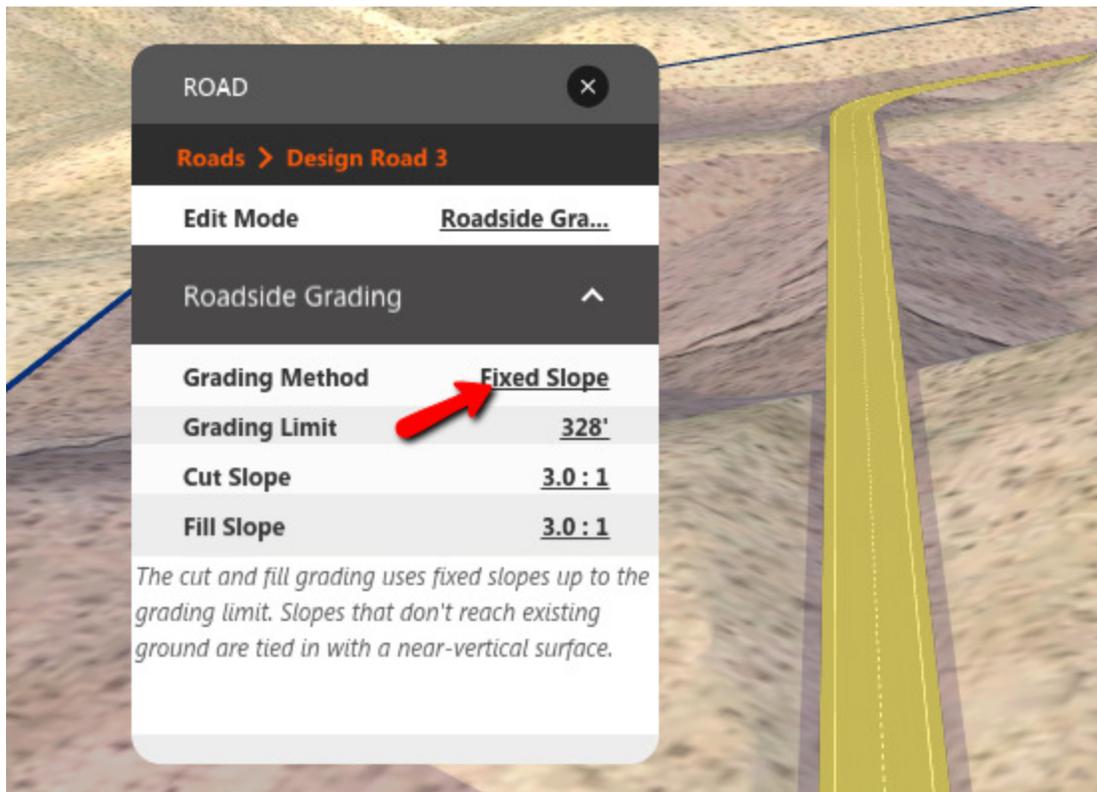


## Roadside Grading

One of the most powerful features of the roadway module is the ability to create fixed-slope roadside grading. The road tools in the core InfraWorks tool set only perform fixed-width grading which means that the location where the slope ties into existing ground is at a fixed distance from the road. Often, this is not a practical or desired configuration for true engineered roads. In those instances, a fixed-slope approach is typically desired where the configuration is holding a constant slope and tying in along an irregular path. In the two images below, the first road is shown with fixed width grading. Notice how the slopes at the far end are exceedingly steep and how overall the tie-in occurs along a straight line. In the second image, a constant slope of 3:1 is held allowing more practical slopes and a tie-in line that meanders.

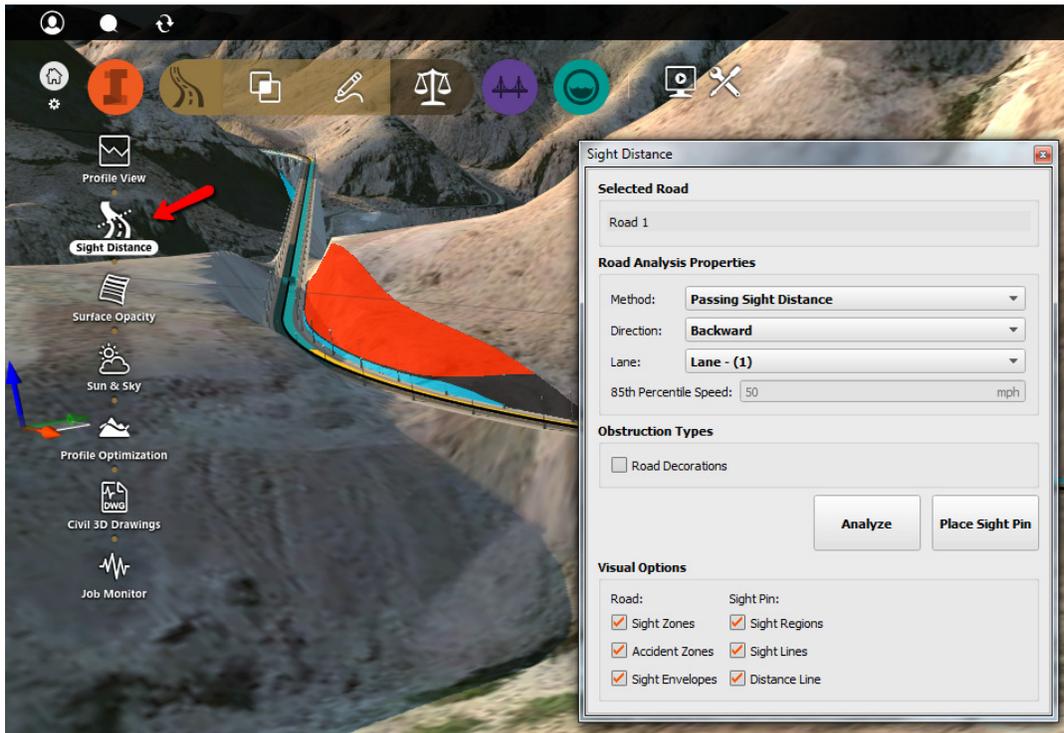


By default, a road will be created with fixed-width grading. To change to fixed-slope grading, simply select the road to show the Road asset card, set the Edit Mode to Roadside Grading, and select Fixed Slope. Set the Cut Slope and Fill Slope values to match your design requirements. You'll also want to set the Grading Limit value to a large number, otherwise your slopes will be "cut short" and be graded vertically outside the grading limit.

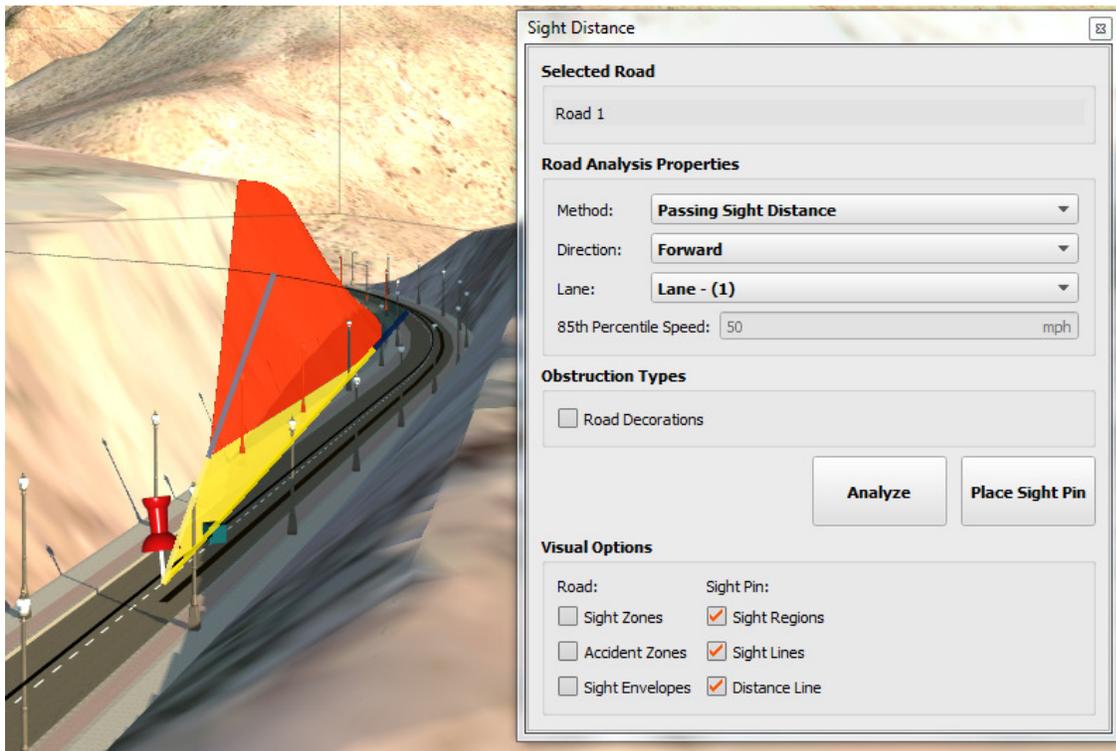


## Sight Distance Analysis

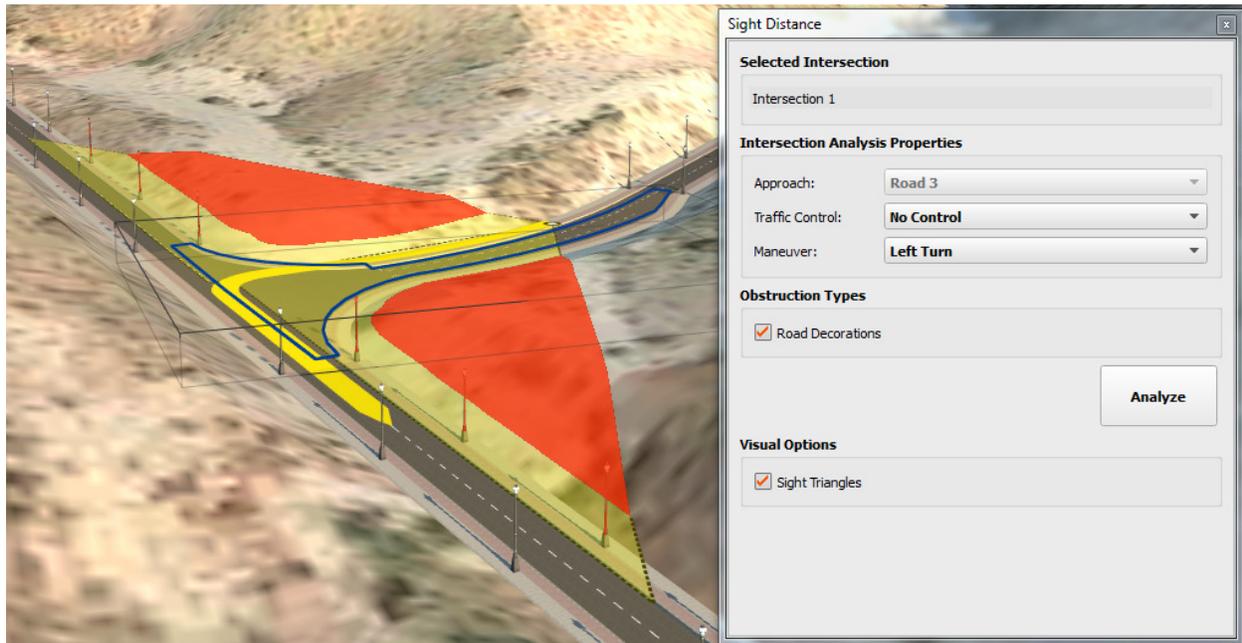
Adequate sight distance is a deal breaker in most road design projects. InfraWorks has a robust set of graphical dynamic sight distance tools that let you know if your design is going to work very early in the design process. To launch the tool you simply click the Sight Distance icon on the Analysis toolbar and then click the road you would like to analyze. Next, select the Method: passing or headlight sight distance, and choose the direction and lane. You can also include road decorations (signs, light posts, etc.) in the analysis. Once you have chosen all your options, simply click Analyze and watch the model come to life. Colors in the model will indicate where there is a clear line of sight where there is sight failure due to the curvature of the road, and where there are obstructions.



You can use the Visual Options section to choose which components you would like to see. Also, the Place Sight Pin tool can be used to analyze a specific location on the road.



Sight distance analysis is also available for intersections. The options for intersections are a bit different because now you're dealing with turn direction and the type of traffic control (stop versus yield, etc.) The outcome is the same, however, with live graphics appearing in the model to show you how your design performs from a sight distance perspective.



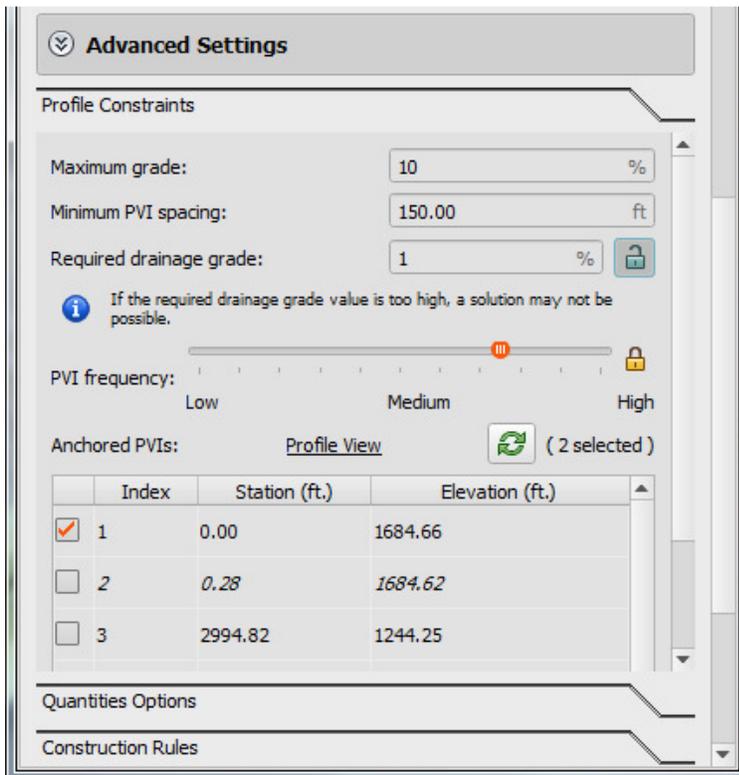
## Profile Optimization

As with any design, cost is always a major concern and one of the biggest costs associated with road construction is earthmoving. For this reason, you will often want to design the most cost-effective profile which limits cut and fill and reduces mass haul. For a stretch of road that is several miles or more, this is a daunting task requiring many iterations. Thankfully, InfraWorks has the ability to perform a profile optimization. It uses the power of cloud computing to choose the best profile for your road which minimizes earthwork while adhering to design standards. On top of all this, the process will also compute costs and generate a report giving you an early estimate of construction cost for the design you're considering.

To launch this function you click Profile Optimization on the Analysis toolbar and click the road you would like to optimize. Next you choose a design speed and expand Advanced Settings where you will configure the details of your optimization.

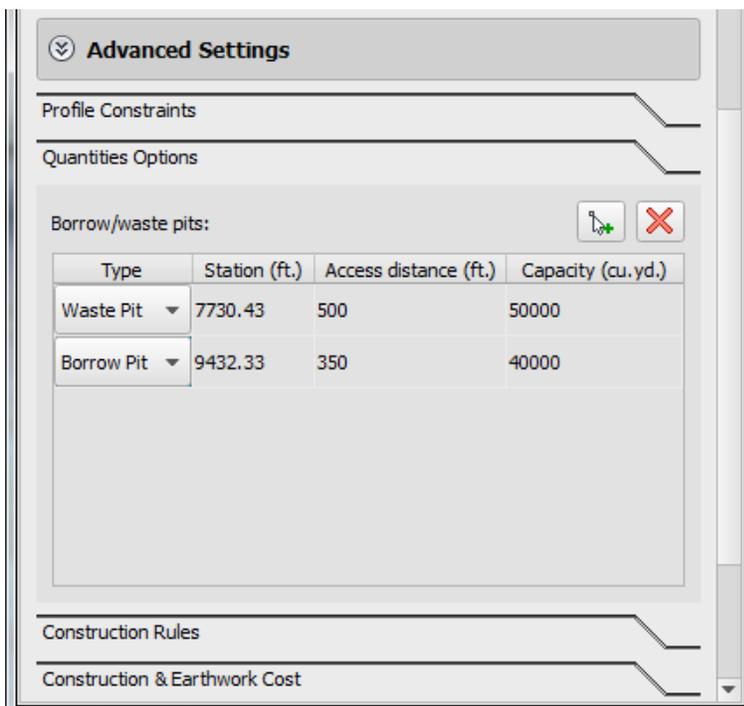
## Profile Constraints

In this section you will configure the design constraints that the optimization process will adhere to. Here you can control things like maximum and minimum grades, PVI spacing, and anchoring of PVIs.



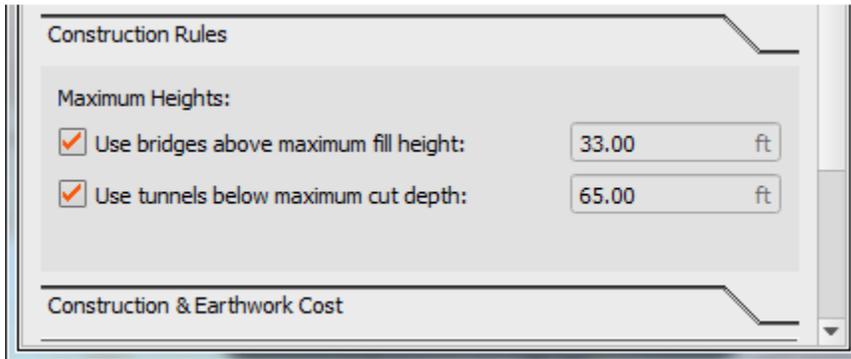
### Quantities Options

Here you can add borrow and waste pit locations to help influence the mass haul outcome.



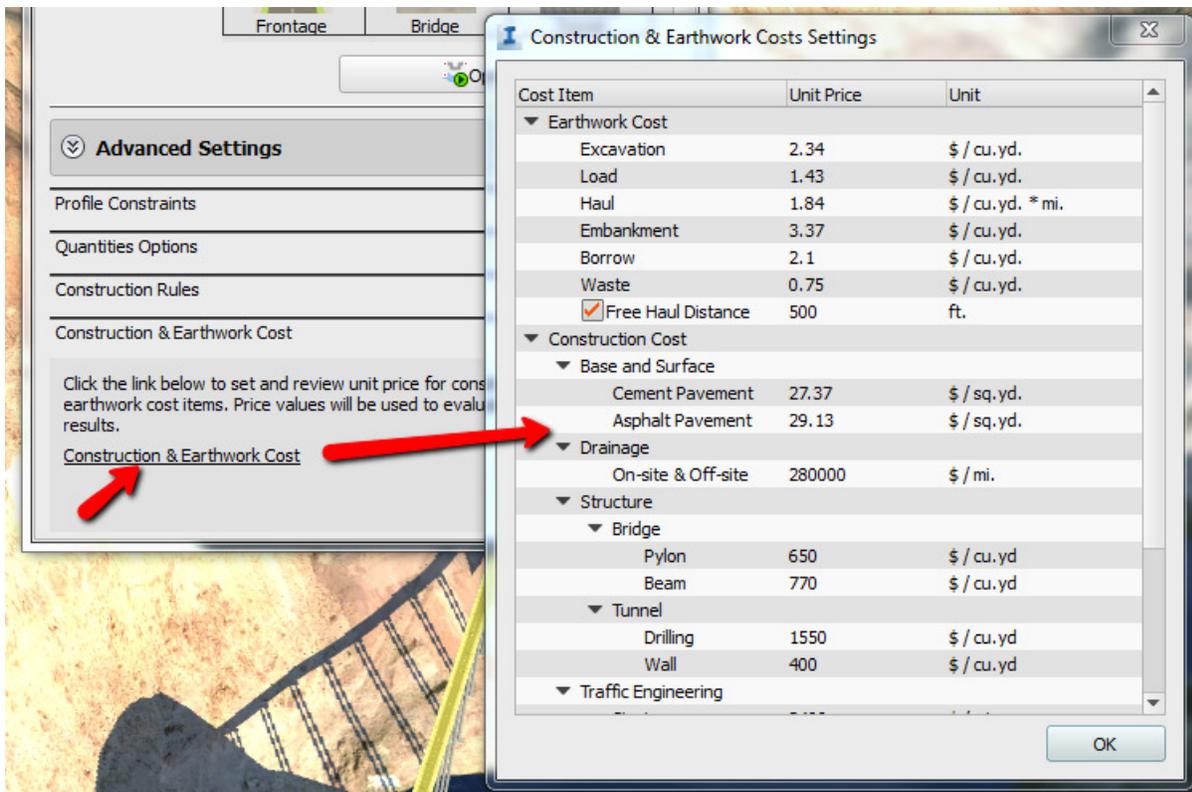
## Construction Rules

The optimization process will automatically add bridges and tunnels based on the settings you apply here. The bridges and tunnels will be included in the cost analysis performed as part of the optimization process.

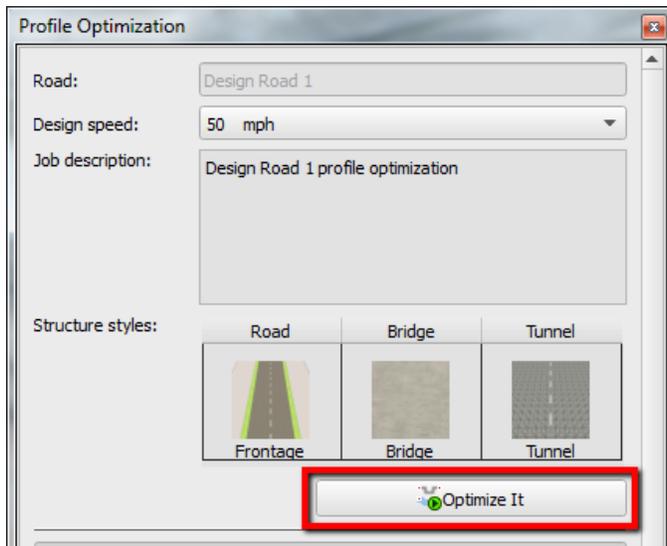


## Construction and Earthwork Cost

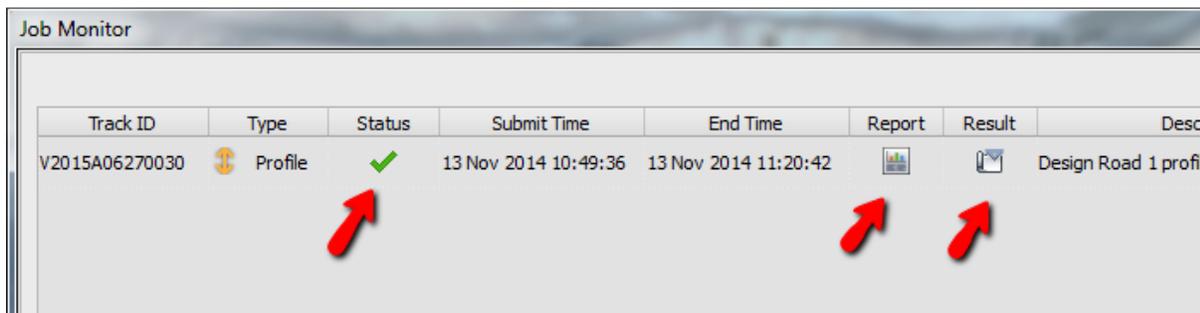
Here you can specify the unit prices for the various items that will be used to estimate the cost of your proposed design.



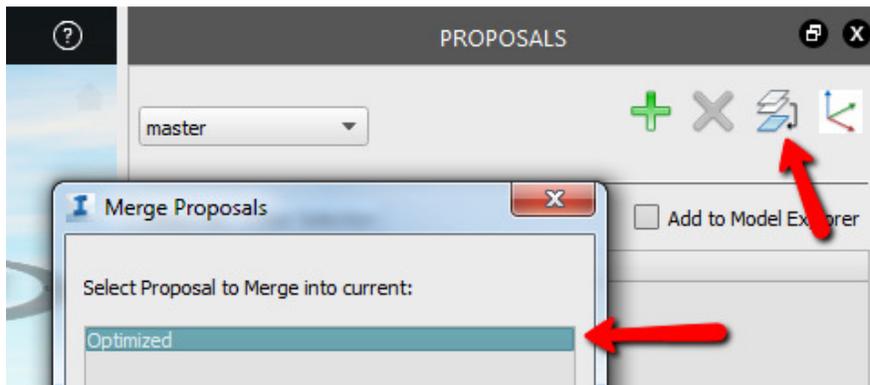
Once you've configured the optimization settings in all areas, you can click Optimize It.



The optimization job will then be listed in the Job Monitor. You can close the Job Monitor window and keep checking back by clicking Job Monitor on the Review toolbar. Alternately you can wait to receive an e-mail containing your optimization report; another indicator that the optimization is complete. Once you've receive your e-mail or the Status column in the Job Monitor indicates that the optimization is complete, you can use the Result column to download an IMX containing the new road (with its newly optimized profile) or the Report column to download a report showing a graphic of the optimized profile along with the cost analysis.



When you download the IMX file using the icon in the Result column, a new proposal will be created to house the newly designed road. This is a good thing because you don't want the newly designed road to get mashed in with your original design. Once you've reviewed the optimized design and you're happy with it, you can use the Merge Proposals function to merge it into your original proposal.



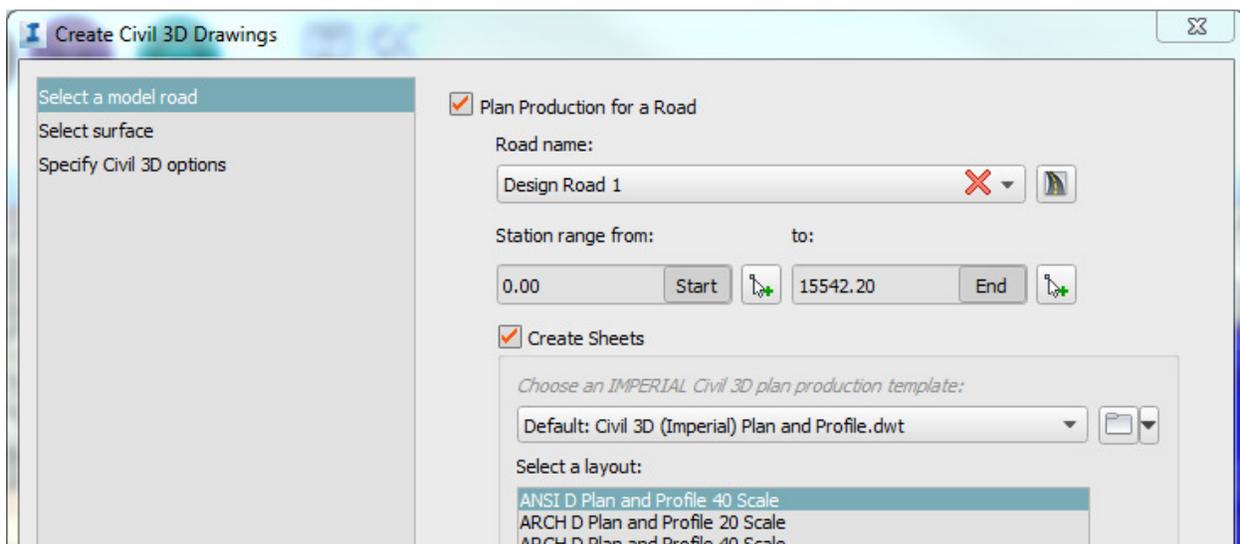
## Export to Civil 3D

Once you've developed your preliminary design in InfraWorks it's time to move on to detailed design in Civil 3D. At this point you will want as much of your InfraWorks design to carry over as possible so that you can minimize the amount of work. This is where the Civil 3D Drawings command comes in very handy.

This command will extract the alignment and profile of your InfraWorks road and generate a complete set of plan & profile sheets in Civil 3D. The command is set up in wizard form with three dialogs:

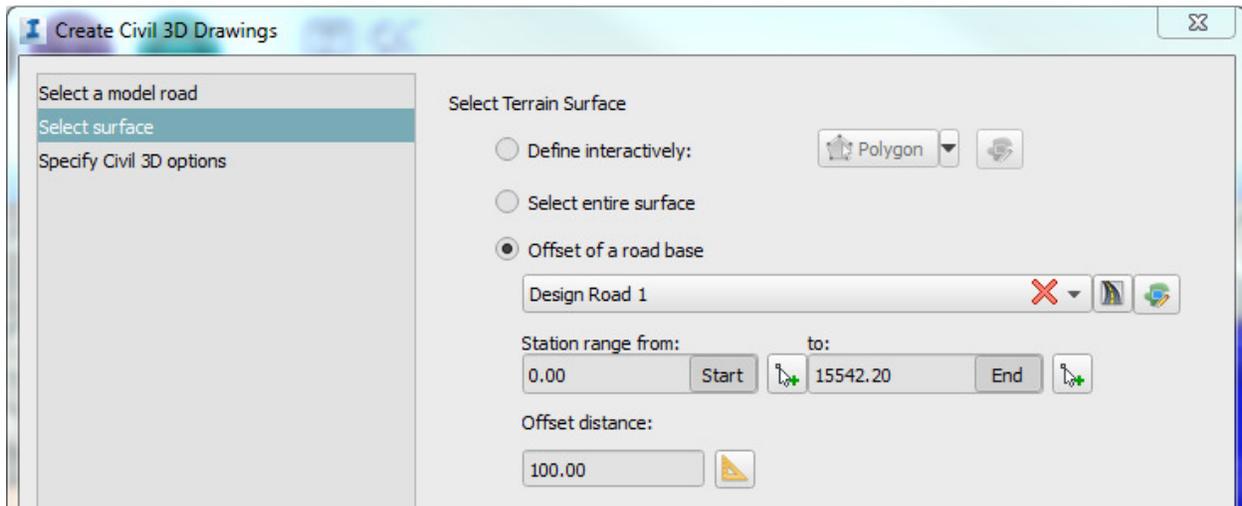
### Select a Model Road

On this dialog you will select the road that you want to export. You can also indicate a station range if you do not want to export the entire road. You will also specify the template that will be the basis of your plan and profile sheets. If you're familiar with the plan production tools in Civil 3D, this would be the same template that you would select for that function. In fact, many of the same settings from plan production appear on this dialog.



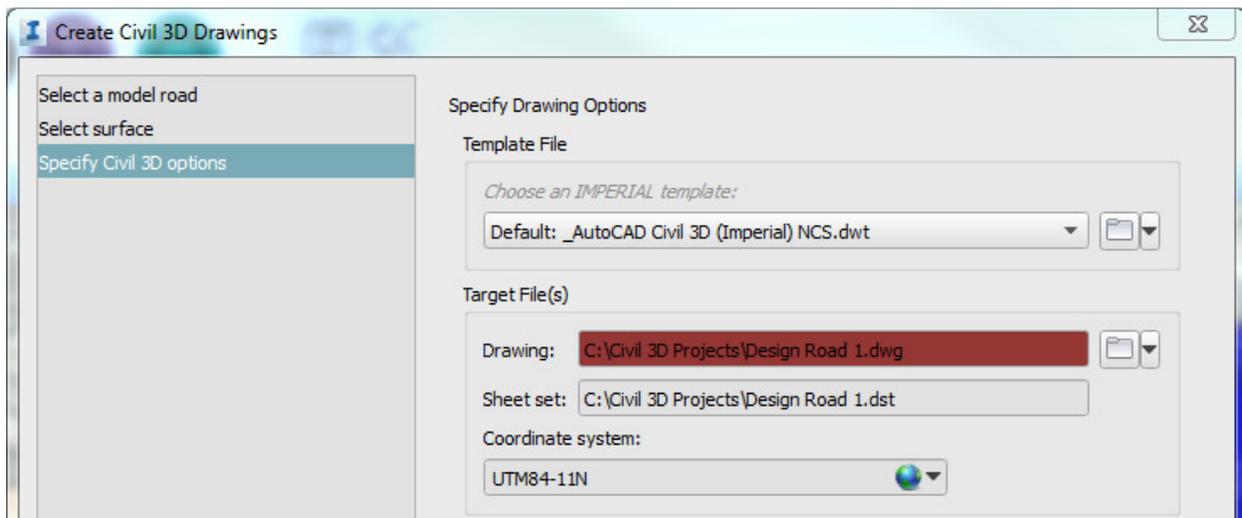
### Select Surface

On this dialog you will define the limits of the terrain surface that will be extracted from InfraWorks. It can be defined interactively using a polygon or bounding box, by specifying an offset from the road centerline, or by simply exporting the entire terrain surface.

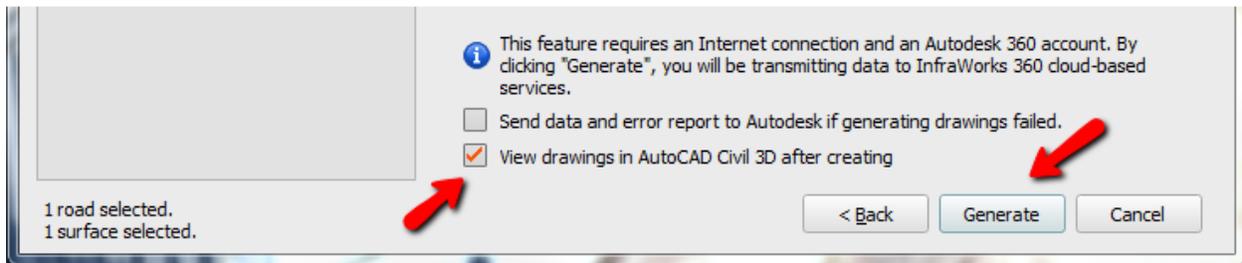


### Specify Civil 3D Options

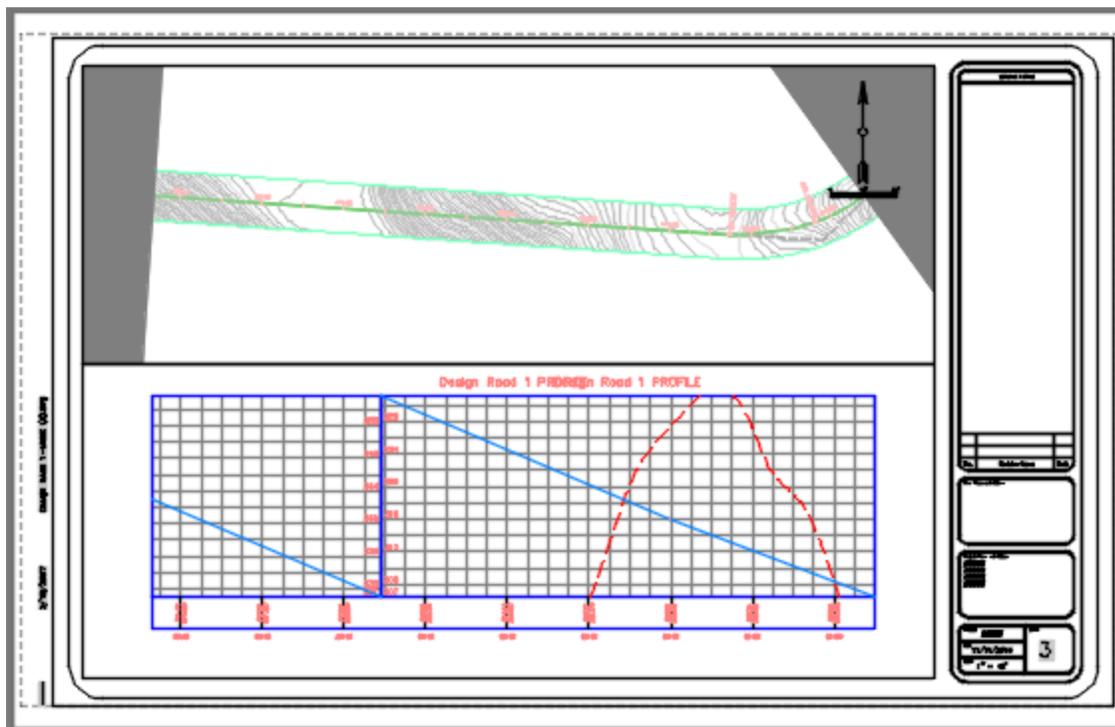
In this dialog you will choose the template file for the “base” drawing: the one that will contain the full alignment and profile. You will also specify the location where this drawing will be saved as well as the location of the DST file that will store the sheet set information. Yes, it even creates a sheet set, consistent with the functionality of the plan production features of Civil 3D.



Once you’ve configured all your settings you simply click Generate and the request will go to the cloud for processing.



If you check the appropriate box you can even have Civil 3D open automatically to show you the resulting drawing set.



## Intersections

Another great feature of the roadway module is the way it handles intersection design. With core InfraWorks it's a "you get what you get" scenario: you really have no control over the outcome of an intersection. With the roadway module, you can adjust the curb return radii, add turning lanes, control paint striping, and more. You can even choose a design vehicle and have InfraWorks design the intersection for you.



## Summary

Roadway Design for InfraWorks 360 allows you to perform engineering-based preliminary road design by adding the following functions to InfraWorks 360:

- Horizontal curve and spiral geometry
- Vertical curve geometry
- Profile view
- Gizmos for performing horizontal and vertical editing
- Rules-based design which controls horizontal and vertical geometry
- Style zones
- Lane zones
- Roadside grading
- Sight distance analysis
- Profile optimization
- Automatic export to Civil 3D
- Intersection design

With these advanced capabilities you can perform some serious preliminary road design that can be carried through to detailed design in Civil 3D with little to no loss of effort.