

Grade Verification of Construction Terrains

The steps below will assist surveyors and designers using OpenSite Designer or OpenRoads Designer to analyze grade verification points supplied during construction against design terrains. Due to a defect in ODOT's current platform, **grade verification must be performed outside of ProjectWise**, with the DGN, XML and CSV files stored on the C: or F: drive, or crew server share.

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Requirement 1 – The Design Terrain

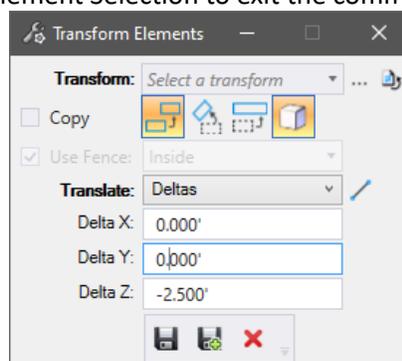
Prior to analyzing the elevations of grade verification points, a design terrain for the material course that you are verifying is required. It is important to understand the location of the edges of the corridor backbone for the different materials. For example, the finish grade surface (FG) for grade verification extends only to the edges of pavement on either side, while the subgrade surface (SG) will extend to the subgrade shoulder hinge point, some distance beyond the edge of pavement.

“[Creating 3D Design Deliverables from ORD](#)” was presented at the 2022 ODOT TRAM Conference (Traffic-Roadway-Access Management), and outlines five methods of creating terrains from a corridor. One of those terrains is the best beginning point for grade verification. If the corridor is available, create the terrain needed to verify the construction surface from the feature definitions or meshes in the corridor file.

The example steps below will show how to create a very quick design terrain from a LandXML surface file provided by a contractor that does not contain any feature definitions, but contains only triangle points and faces. The surface that was received is a combined finish grade (FG). The subgrade surface is what needs to be verified, and in the backbone the subgrade is 2.5 feet below the finish grade.

Example of Creating Quick SG from Combined FG LandXML File

1. On the C: drive, create a new file from a 3D seed file; name it CS_C#####_TERR_XXX-YY_###.dgn, for example, CS_C98765_TERR_A_SG_01.dgn.
2. Use Terrain>Create>From File and select the LandXML file to import the terrain model for FG. In the File Options, set the Feature Definition to Terrain\Design_Boundary, then click [Import].
3. To make a quick SG in the backbone area from the FG - use Terrain>Edit>Transform with no “Transform” selected, “Copy” Unchecked, “Enable to translate elements” and “Apply transforms to Z or Elevation values” icons selected (highlighted yellow), and “Translate” set to Deltas as shown below with the depth of the surfacing entered in the Delta Z. Follow the prompts and data point in the same location twice to “Accept Point” and then “Accept Transform”. <Esc> or use Element Selection to exit the command.



- Rename the terrain to indicate SG and remember that outside the edges of pavement lines – this terrain is invalid because the subgrade shoulder, ditch and catch have all been lowered 2.5 feet.
- It is good technique to select the boundary and choose “Set as Active Terrain Model” before exiting the file.

For the grade verification procedure (all data saved to the C: drive) you will typically work in a new DGN file (from either 2D or 3D seed) and attach a reference to the design terrain. The analysis process will add data to field books created in your DGN file.

Requirement 2 – The Grade Verification Points

Oregon DOT provides a Text Import Wizard (TIW) that will automatically process the contents of a grade verification point file; however, the file extension must be .csv. The format inside must include a header row, and each row of data must be in the format point number, northing, easting, elevation, alpha code. The alpha code must be one of four defined for grade verification points.

Grade Verification Point Types, Alpha Codes, and Feature Definitions

There are four types of grade verification points:

TYPE A (GVPA): Using All ACP Courses vertical staking tolerance of +/- 0.02 ft (no specification for construction tolerance). Typically coded for GV shots on asphalt surfaces within the roadbed.

TYPE B (GVPB): Using Specification 00640.44 Aggregate Surface Tolerance "within 0.04 foot". Typically coded for GV shots on top of rock surfaces within the roadbed.

TYPE C (GVPC): Using Specification 00330.70 Subgrade "tolerance of plus or minus 0.06 foot". Typically coded for GV shots on subgrade surfaces within the roadbed.

TYPE D (GVPD): Using Wetland Mitigation Control Stakes vertical staking tolerance of +/- 0.20 ft (no specification for construction tolerance). Intended for GV shots on constructed surfaces outside the roadbed.

INPUT for Grade to be Verified

Type (Grade Verification)	Alpha Code	Tolerance	Feature Definition	Cell Placed
A	GVPA	+/- 0.02'	Surv_GV_Pt_A	GVPTA – cyan triangle?
B	GVPB	+/- 0.04'	Surv_GV_Pt_B	GVPTB – orange triangle?
C	GVPC	+/- 0.06'	Surv_GV_Pt_C	GVPTC – magenta triangle?
D	GVPD	+/- 0.20'	Surv_GV_Pt_D	GVPTD - blue triangle?

PROCESSED OUTPUT for Grade Verification

Type	Alpha Code	Feature Definition	Cell Placed
A Pass	GVPAP	Surv_GV_Pt_A_Pass	GVAPass – cyan circle
A Fail	GVPAF	Surv_GV_Pt_A_Fail	GVFail – red hexagon
B Pass	GVPBP	Surv_GV_Pt_B_Pass	GVBPass – orange circle
B Fail	GVPBF	Surv_GV_Pt_B_Fail	GVFail– red hexagon
C Pass	GVPCP	Surv_GV_Pt_C_Pass	GVCPass – magenta circle
C Fail	GVPCF	Surv_GV_Pt_C_Fail	GVFail– red hexagon
D Pass	GVPDP	Surv_GV_Pt_D_Pass	GVDPass – blue circle
D Fail	GVPDF	Surv_GV_Pt_D_Fail	GVFail– red hexagon

Example of Creating a Grade Verification File for Import from Contractor TXT File

- Open the .txt point file received from contractor using Notepad++ or other text editor with no formatting.
- Ensure that there is a header row; the following may be copied and pasted. The format of the header row is not critical because this row will be skipped.
Point Number,Northing,Easting,Elevation,Alpha Code
- Ensure that the alpha code is set to one of the four listed above and is set to the tolerance for the surface you are verifying.
- Save the file as a normal text file, but use the extension .csv instead of .txt.

```

1 Pt, N, E, Elev, Code
2 SG1, 269983.617, 260949.013, 2189.641, GVPC
3 SG2, 269984.023, 260959.990, 2189.741, GVPC
4 SG3, 269981.225, 260986.757, 2189.256, GVPC
5 SG4, 269959.246, 260984.359, 2189.320, GVPC
6 SG5, 269960.721, 260957.791, 2189.852, GVPC
7 SG6, 269961.408, 260946.357, 2189.747, GVPC

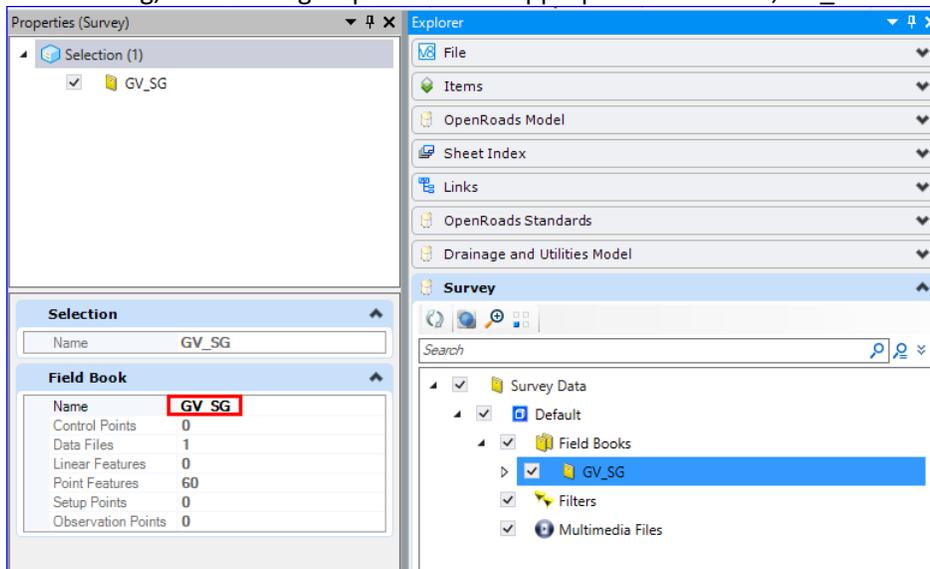
```

Grade Verification of Construction Surfaces Procedure

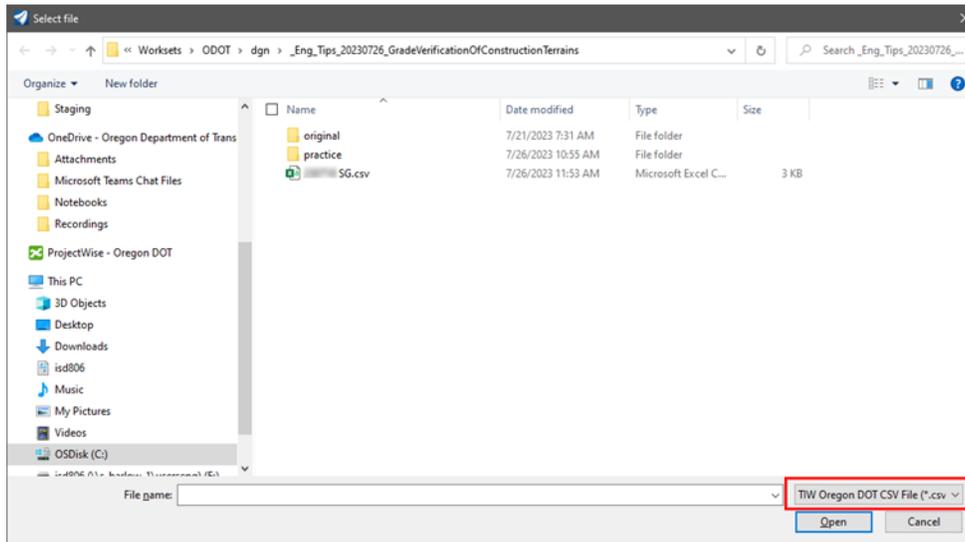
Proceed with grade verification if you have a design terrain for the material layer and a correctly formatted grade verification point .csv file, both stored on the C: drive. These instructions allow designers to remain in the OpenRoads Modeling workflow and take advantage of right-click menus that are available in the Survey group of the Explorer dialog.

Import Grade Verification Points into an Analysis DGN File

1. Create a new DGN file on the C: drive; name it something like CS_C#####_GV_SG_01.dgn.
2. Attach the design terrain for the material layer as a reference and fit the view.
3. In the Explorer dialog box, expand the Survey group, then expand Survey Data and Default to see the Field Books category.
4. Right-click on Field Books and choose New... from the right-click menu. This will immediately create a new field book with a default name.
5. With the Field Books category expanded, select Field Book 1.
6. Use the Properties dialog, Field Book group to enter an appropriate name like, GV_SG.



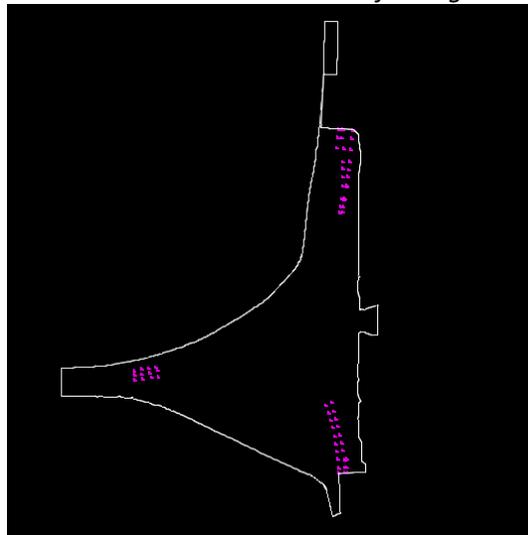
7. **With the ACTIVE DGN open from your C: or F: drive, or from a crew server share** - In the Explorer dialog box, with the Field Books category expanded as shown above, right-click on the *new* field book and choose Import>File... from the right-click menu. This will open a Select file dialog.
8. In the bottom right corner of the Select file dialog, set the filter to **TIW Oregon DOT CSV File (*.csv)** as shown below – it's about midway down the pick list.



9. Still in the Select file dialog select the CSV file you prepared with the grade verification points for the material layer and click [Open]. The points will be imported and appear within the boundary of the terrain.

Analyze Elevations of Grade Verification Points and Generate Report

10. Use Terrain>Analysis>Points>Analyze Elevation and follow the prompts as follows:
 - a. **Select Terrain** – *left-click* on the design terrain boundary.
 - b. **Locate First Element** – you will *enter two data points: imagine* a rectangle that encompasses all of the grade verification points and (1) left-click on its imaginary upper left corner; then, (2) left-click on the imaginary lower right corner (*yes, this will work with any two diagonal corners*) – the points will all highlight.
 - c. **Locate Next Element Reset To Complete** - *right-click* to continue the command. (*If you missed any points, you may left-click on them to add them to the set before right-clicking to continue.*)



- d. **Enter Tolerance Value** – *left-click* to accept any tolerance value and continue – the Bentley Civil Report Browser will open displaying the default TerrainCheck style sheet. (*If you do wish to use the default style sheet, you may enter a specific tolerance value (in feet), but this tolerance value is not used in ODOT's custom style sheet.*)
11. In the Bentley Civil Report Browser, expand the Custom group at the upper left and select the ODOTerr_GradeVerification_Report_HTML.xsl style sheet.

Bentley Civil Report Browser - C:\Users\isd806\AppData\Local\Temp\RPTid3raskx.xml

File Tools

Custom

- ODOTrrw_Desc_HrvyCL.xml
- ODOTrrw_Desc_LINE.xml
- ODOTrrw_Desc_TRACT.xml
- ODOTrrw_Desc_WIDTH.xml
- ODOTrrw_Desc_WIDTH_NAMED.xml
- ODOTTerrainCheck.xml
- ODOTTerr_ConfPnt_Out_Txt.xml
- ODOTTerr_ConfPnt_Report_HTML.xml
- ODOTTerr_GradeVerification_Out_Txt.xml
- ODOTTerr_GradeVerification_Report_HTML.xml**

Cant
 Civil Terrain
 Civil Geometry
 Civil Survey
 Corridor Modeling
 Evaluation

- CrossSectionGradebook.xml
- CrossSectionGradebookfromCL.xml
- CrossSectionGradebookNE.xml
- CrossSectionGradebookWide.xml
- EarthworkQuantities.xml
- ElementsComponentQuantitiesReport.xml
- ElementsComponentQuantitiesReportSummary.xml
- EndAreaVolume.xml
- MassHaulToTIW.xml
- Quantities by Named Boundary Report.xml
- SightVisibilityAlternateReport.xml
- SightVisibilityReport.xml
- TerrainCheck.xml
- Volumes.xml

Legal Description
 Map Check
 Milling
 Stakeout
 Station Offset
 Superelevation
 Template Library
 Turnouts
 Tools

ODOT Terrain Grade Verification Point Report

Report Created: Thursday, July 27, 2023
Time: 2:39:34 PM

Terrain Name - A_SG
Terrain Last Modified - 2023-07-26T18:48:34.486-07:00

Summary				
	GVPt A TOL= 0.02	GVPt B TOL= 0.04	GVPt C TOL= 0.06	GVPt D TOL= 0.2
Total Points	0	0	60	0
Valid Points	0	0	60	0
Pass	0	0	60	0
Fail	0	0	0	0
%Pass	0%	0%	100%	0%

Total Number of Grade Verification Points = 60
Total Number of Valid Points = 60

Pnt No	Northing	Easting	Pnt Elev	TM Elev	TM Delta	Result	Feature
SG1	269983.6170	260949.0130	2189.641	2189.688	-0.047	PASS	Surv_GV_Pt_C_Pass
SG2	269984.0230	260959.9900	2189.741	2189.745	-0.004	PASS	Surv_GV_Pt_C_Pass
SG3	269981.2250	260986.7570	2189.256	2189.212	0.044	PASS	Surv_GV_Pt_C_Pass
SG4	269959.2460	260984.3590	2189.320	2189.285	0.035	PASS	Surv_GV_Pt_C_Pass
SG5	269960.7210	260957.7910	2189.852	2189.815	0.037	PASS	Surv_GV_Pt_C_Pass
SG6	269961.4080	260946.3570	2189.747	2189.717	0.030	PASS	Surv_GV_Pt_C_Pass
SG7	269933.0830	260943.1020	2189.820	2189.768	0.052	PASS	Surv_GV_Pt_C_Pass
SG8	269930.9880	260961.7680	2189.803	2189.762	0.041	PASS	Surv_GV_Pt_C_Pass
SG9	269928.2090	260981.9190	2189.381	2189.360	0.021	PASS	Surv_GV_Pt_C_Pass
SG10	269895.1020	260978.0120	2189.487	2189.456	0.031	PASS	Surv_GV_Pt_C_Pass
SG11	269894.0870	260960.2000	2189.847	2189.814	0.033	PASS	Surv_GV_Pt_C_Pass
SG12	269877.1290	260958.5760	2189.875	2189.849	0.026	PASS	Surv_GV_Pt_C_Pass
SG13	269872.4100	260976.8710	2189.522	2189.482	0.040	PASS	Surv_GV_Pt_C_Pass
SG14	269854.5460	260973.2470	2189.599	2189.552	0.047	PASS	Surv_GV_Pt_C_Pass
SG15	269853.0260	260958.1960	2189.885	2189.854	0.031	PASS	Surv_GV_Pt_C_Pass

- Choose File>Save As>Microsoft Excel (*.xlsx) to save the report as a spreadsheet with your other data.

Graphically Display Processed Grade Verification Points – Point Number and Delta

When there are failures, it can be beneficial to see the locations graphically. The steps below will display the processed or analyzed point with a symbol that includes the point number and the elevation difference between the point and the terrain. A negative delta indicates that the grade verification point is below the design surface. A red hexagon symbol indicates that the grade verification point is out of tolerance. The style sheet uses alpha codes from the Processed Output table shown on page 2.

Export Grade Verification Processed Points to a TXT File

- In the Bentley Civil Report Browser, expand the Custom group at the upper left and select the ODOTTerr_GradeVerification_Out_Txt.xml style sheet. (If you have closed the report browser, go through step 10 above again to display your analyzed points first.)
- Choose File>Append on the Save As dialog and ensure that “Save as type” is set to Text File (*.txt), enter a file name like Processed_A_SG_Out.txt and save with your other data on the C: drive.

Import Grade Verification Processed Points into a new Field Book in DGN File

- In the Explorer dialog box, in the Survey group, right-click on the Field Books category and choose New... from the right-click menu. This will immediately create a new field book with a default name.
- Use the Properties dialog, Field Book group to enter an appropriate name for the processed points like, GV_Processed_SG.
- In the Explorer dialog box, right-click on the “processed” field book and choose Import>File... from the right-click menu. This will open a Select file dialog.
- In the bottom right corner of the Select file dialog, set the filter to **TIW Oregon DOT TXT File – GradeVer Pnt Processed (*.txt)**.
- Still in the Select file dialog select the TXT file with the processed grade verification points and click [Open]. The points will be imported into their field book and appear within the boundary of the terrain.

Control the display of the points from the different field books using the Explorer dialog. It may be beneficial to use an override symbology on the referenced terrain at this point to help make decisions about failing points. The picture below shows a failing point (red hexagon). The terrain is displayed with the Subgrade_1_Triangles override symbology to see the triangles.

