

# Machine Controlled Muck Excavation

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# Traditional style muck ex and recording of muck







31.7.20

1.1.1007





1. 1. 1997







# Automated Machine Guidance (AMG) Spec

## S-46 (2011) CONSTRUCTION SURVEYING (DIGITAL SURFACE MODEL METHOD USING THE AMG-EXCAVATION SYSTEM)

### S-46.1 DESCRIPTION

This work consists of using automated machine guidance to continually monitor and record muck excavation operations for use in creating the Digital Surface Model used in quantification of excavated volumes (MnDOT 1901.5.A).

The Advanced Materials and Technology Manual and forms are available on the MnDOT Advanced Materials and Technology (AMT) Website at: <http://www.dot.state.mn.us/materials/amt/index.html>.

#### A Definitions

Refer to Section 210 "Definitions" in the MnDOT Advanced Materials and Technology Manual for definitions related to automated machine guidance for excavation method not included below.

**A.1 ADVANCED MATERIALS AND TECHNOLOGY MANUAL.** A Department manual that contains requirements, best practices and examples related to the use of technologies such as the paver mounted thermal profile method, intelligent compaction method and automated machine guidance for excavation. References to the Advanced Materials and Technology Manual from the contract are to the edition in effect on the letting date.

**A.2 AUTOMATED MACHINE GUIDANCE (AMG) – EXCAVATION SYSTEM.** The AMG-Excavation system is a grade control system attached to excavation equipment that uses either a 3D GNSS or Universal Total Station System to document and record excavation depths. The system is integrated with an onboard documentation system that displays real-time color-coded maps of the excavation depths, current excavator location, depth above or below design and more.

**A.3 MUCK EXCAVATION.** See MnDOT 2105.2.A.4/2106.2.A.4.

**A.4 IN-PLACE SURFACE.** Is the surface of the in-place pavement (i.e., concrete, bituminous, surfacing aggregate, bituminous stabilized materials, cement stabilized materials), or topsoil.

**A.5 POND EXCAVATION.** See MnDOT 2105.2.A.5/2106.2.A.5

#### B Acronyms and Abbreviations

Refer to Section 220 "Glossary of Acronyms and Abbreviations" in the MnDOT Advanced Materials and Technology Manual for the full name or meaning of acronyms and/or abbreviations used within this provision.

## S-46.3 CONSTRUCTION REQUIREMENTS

The Department does not guarantee the accuracy and compatibility of electronic data provided by the Department. The Plan documents, originally provided with the Contract, remain the basis of the Contract. The Contractor is responsible for any necessary conversions of the provided electronic data.

### A Equipment Requirements

#### A.1 AMG-Excavation System Requirements

Instrument all excavators used in locations requiring the AMG-excavation method with an AMG-excavation system calibrated according to Manufacturer's recommendations and meeting the requirements of this provision.

- (1) Cloud Computing / Mapping Software  
Use cloud computing/mapping software capable of mapping and exporting the surface model of the bottom of excavation. Ensure the cloud computing/mapping software meets the requirements of this provision and supports the following features:
  - (1.1) Filtering by:
    - (a) date
    - (b) location
    - (c) excavation elevations for lowest elevation
  - (1.2) Ability to map filtered data for excavation elevations.
  - (1.3) Export surface models in LandXML, CSV / text format, TTM, TN3, or in a format approved by the Engineer.
  - (1.4) Import background (corridor) designs and surface models that include station-based alignment data.
  - (1.5) Compile data, to create a composite data set and view, **if more than one excavator** is instrumented with an AMG-excavation system and used in the same required area(s).
  - (1.6) Support triangulated surface models.
  - (1.7) **The data mesh size, after post-processing must be less than or equal to 24 in (600 mm) in the X, Y and Z directions.**

Provide the Engineer with access to the cloud storage and cloud computing prior to the start of excavation efforts requiring the AMG-excavation system until ninety (90) days after final acceptance of all work per MnDOT 1516.2.

Provide the Engineer with training on viewing, filtering and exporting surface models from the Cloud Storage / Cloud Computing software.



# GPS Mounted Backhoe

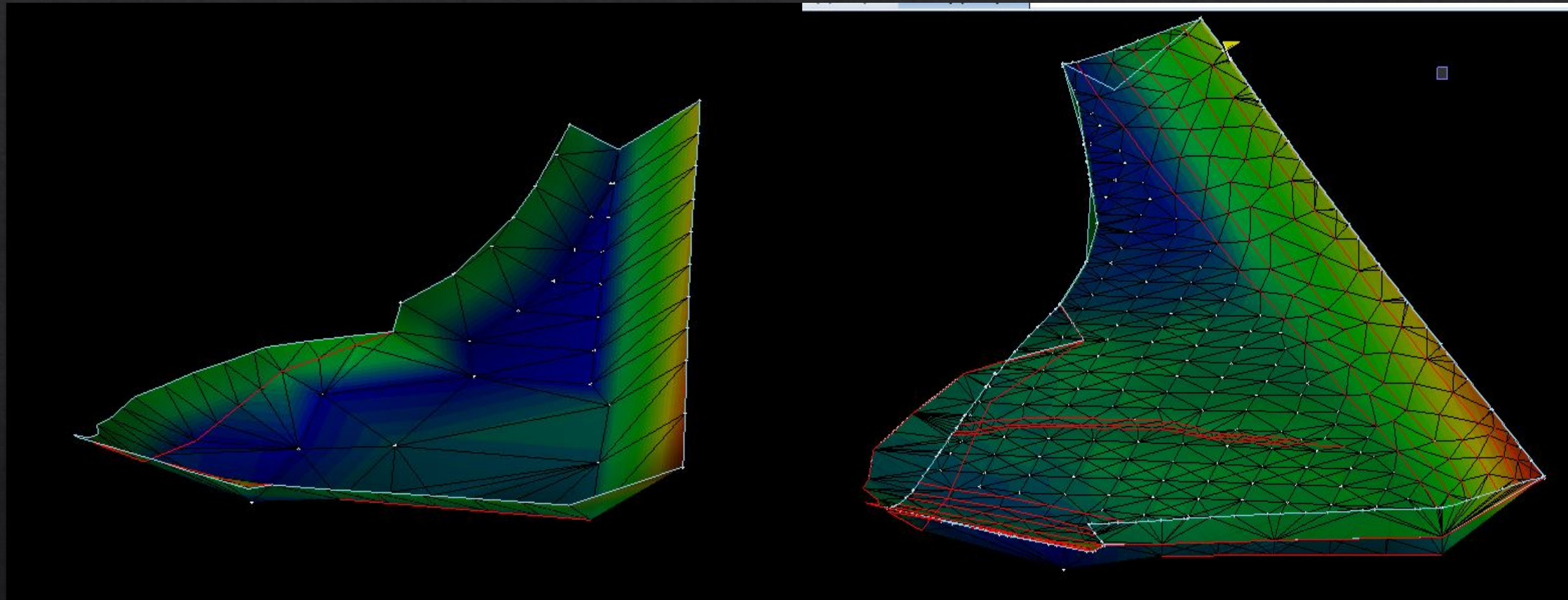






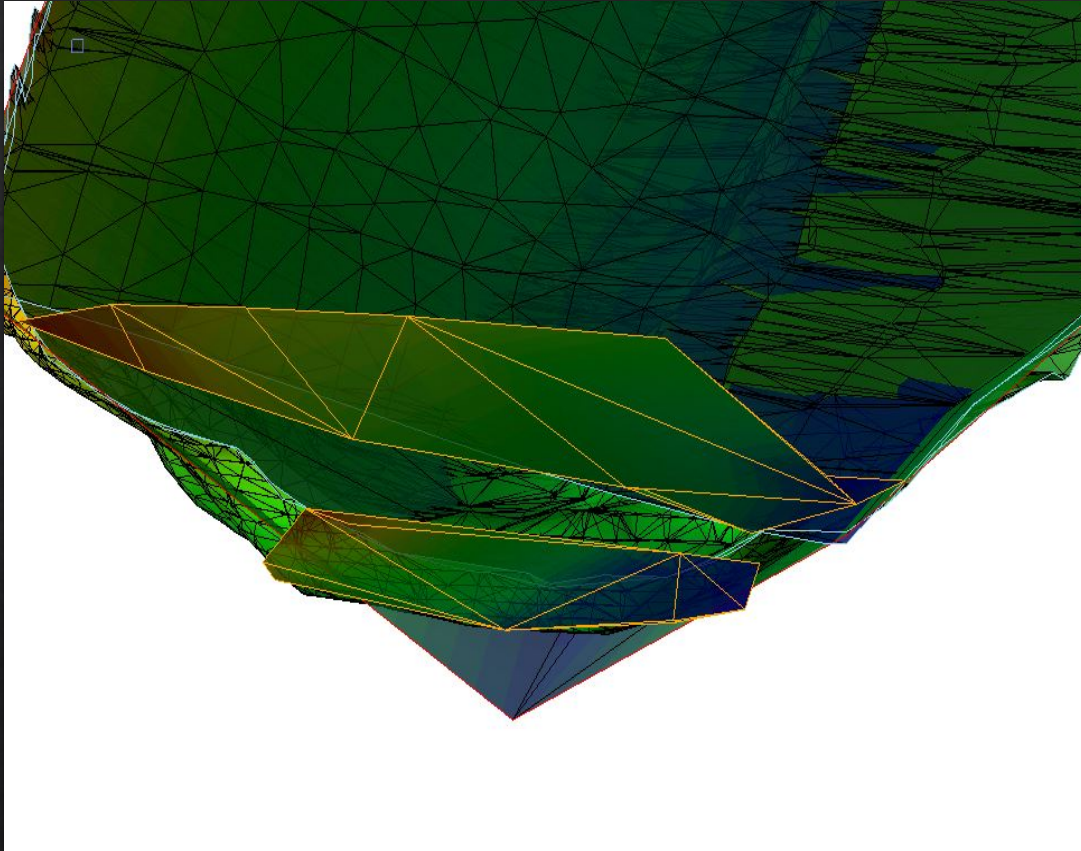


# Muck Planned Bottom    Muck Planned Top





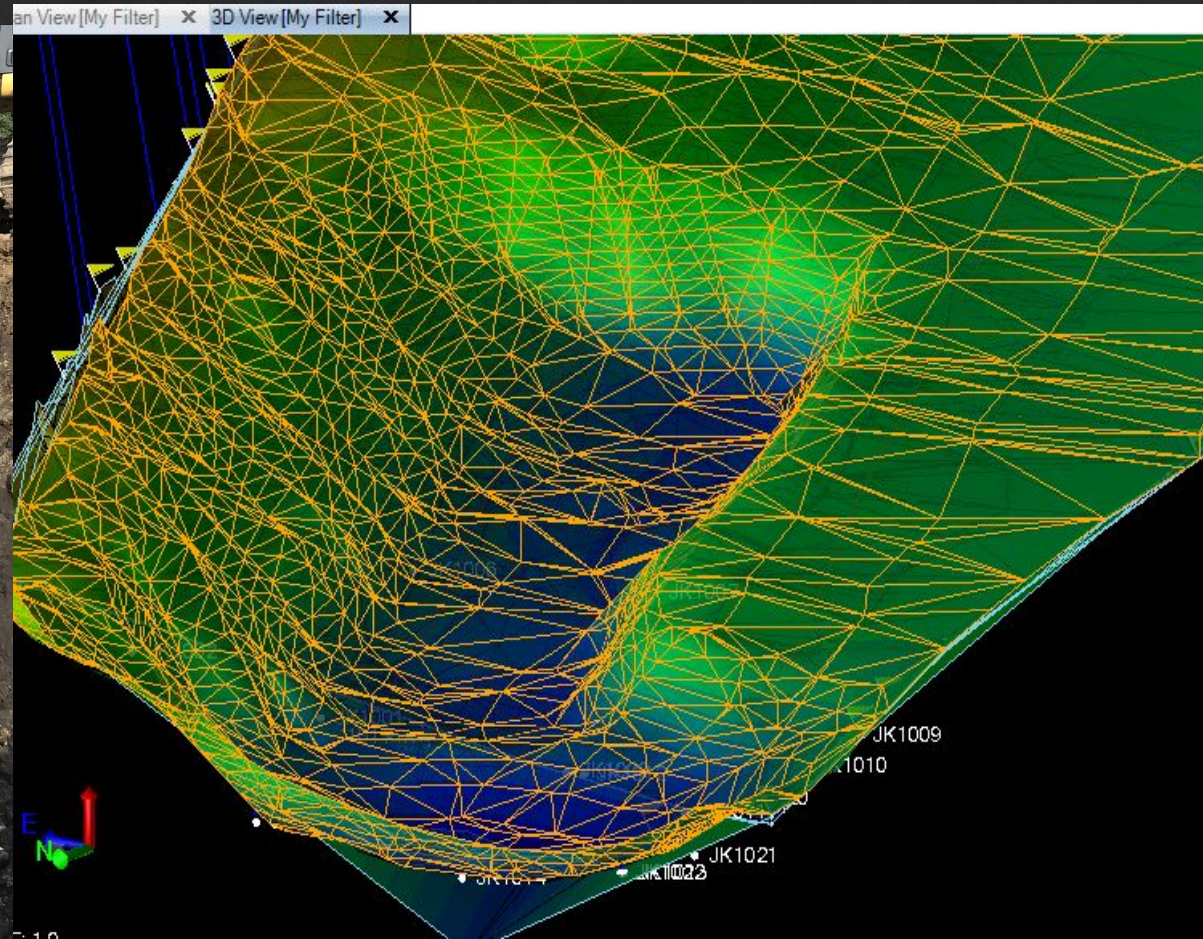
# First day Checks



- ✓ Set elevation marks for excavator
- ✓ Test an area, shoot by hand and compare volumes with contractor
- ✓ Check the panned surfaces match field conditions.



# Beginning Muck Ex S.P 0804-81

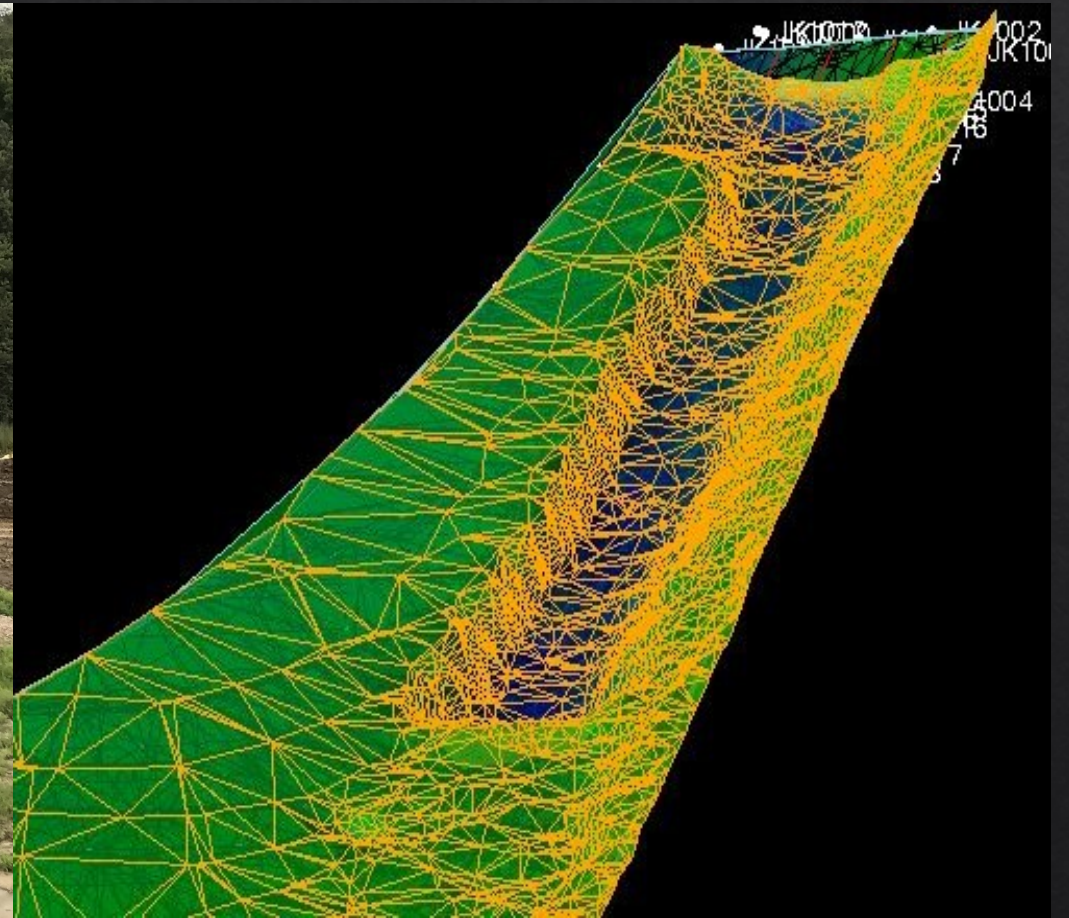




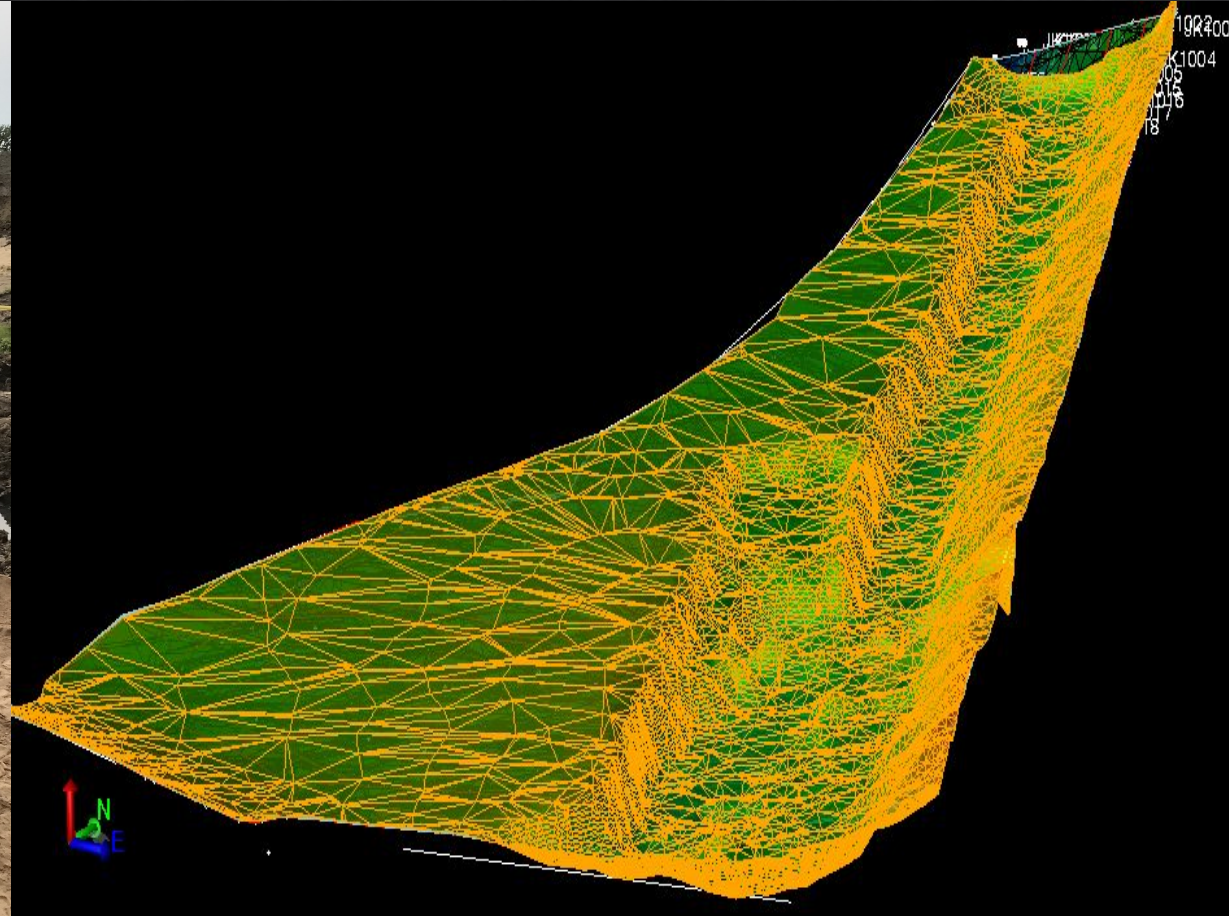
Progress image



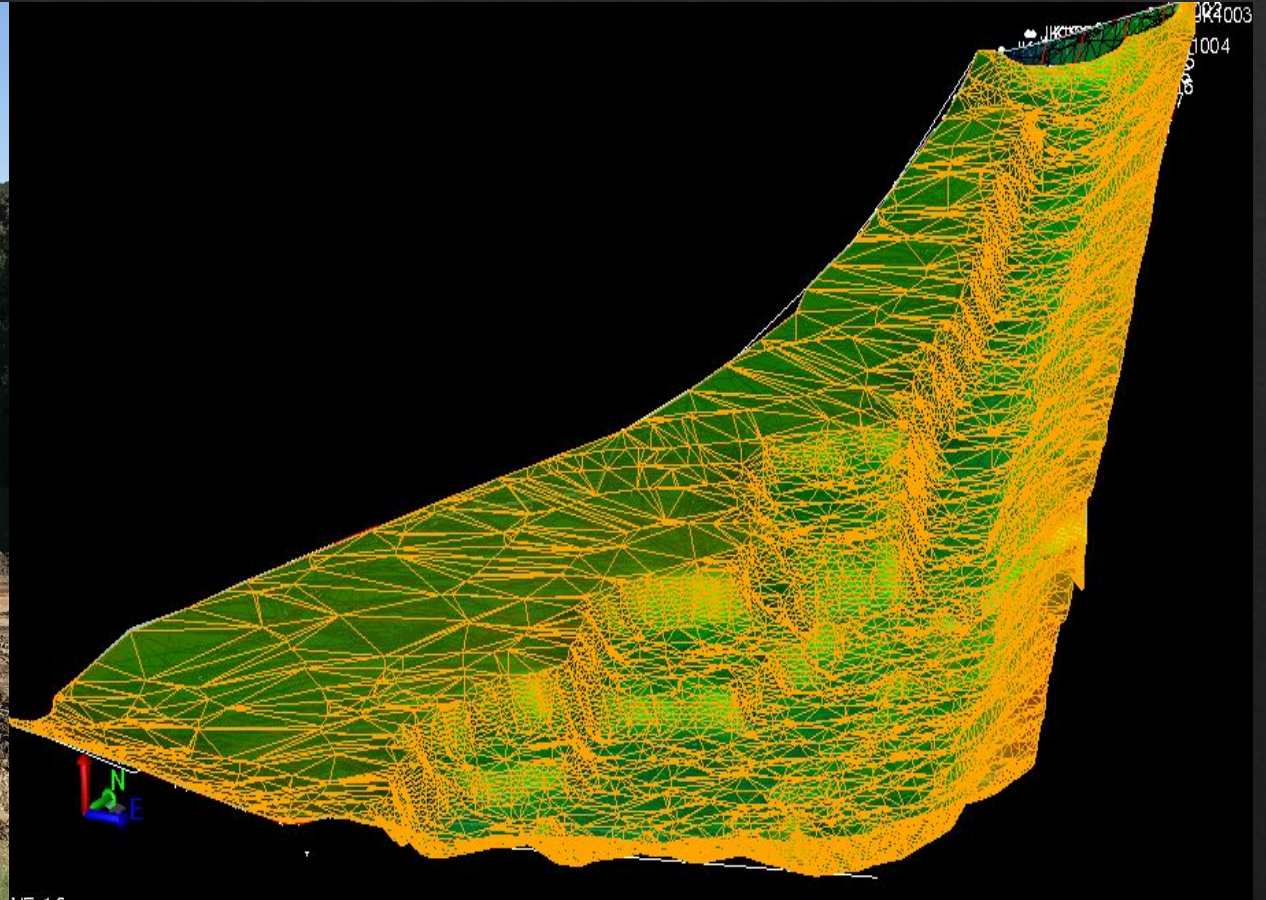
3D image of Progress



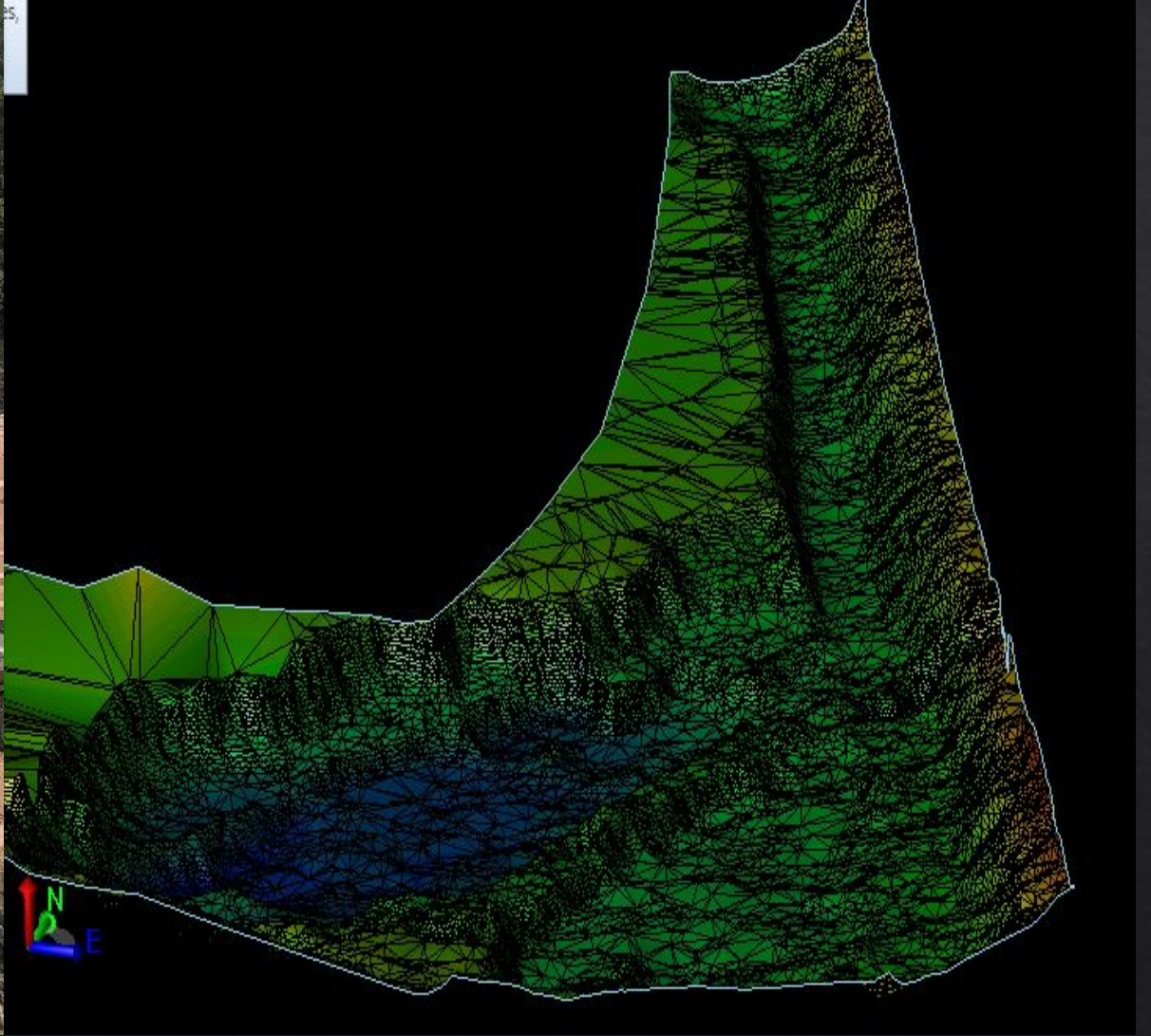






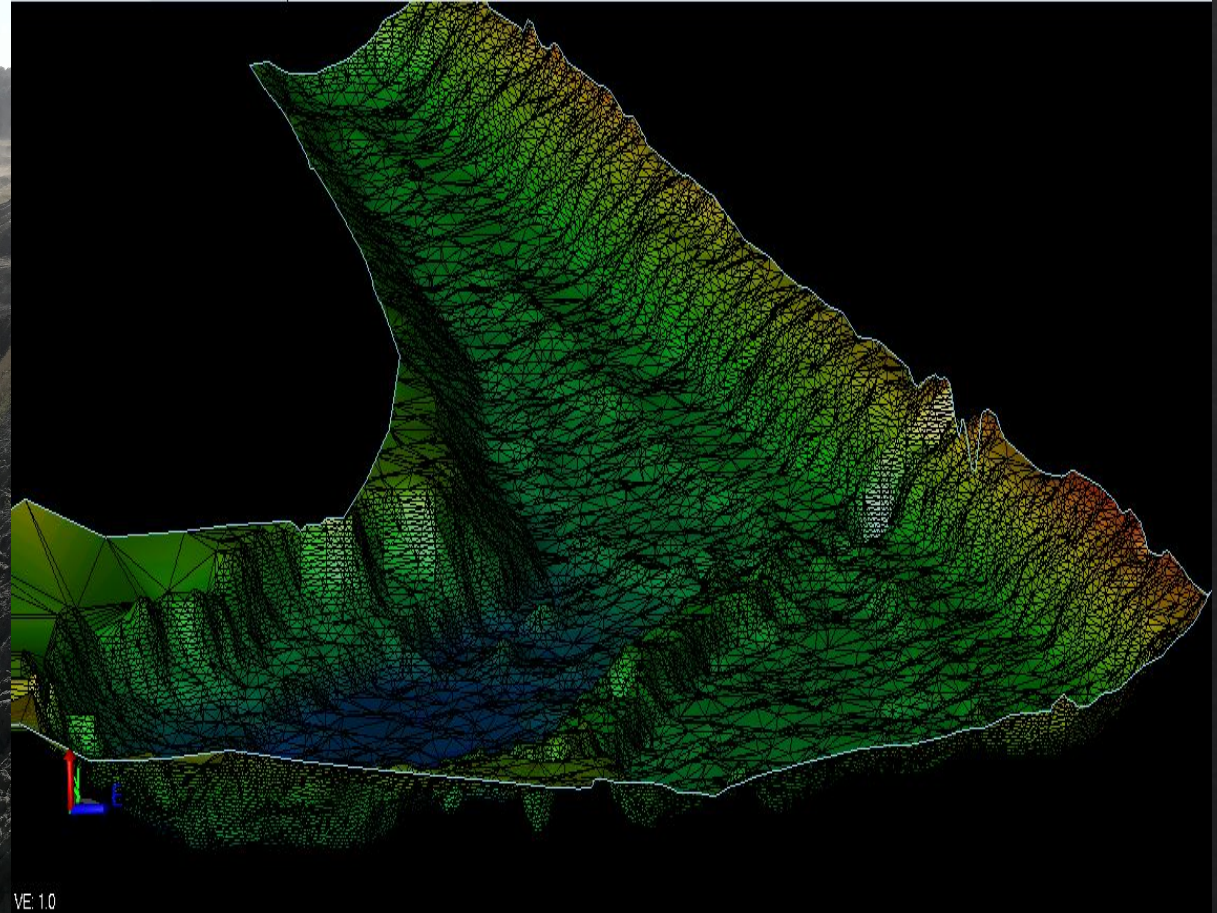






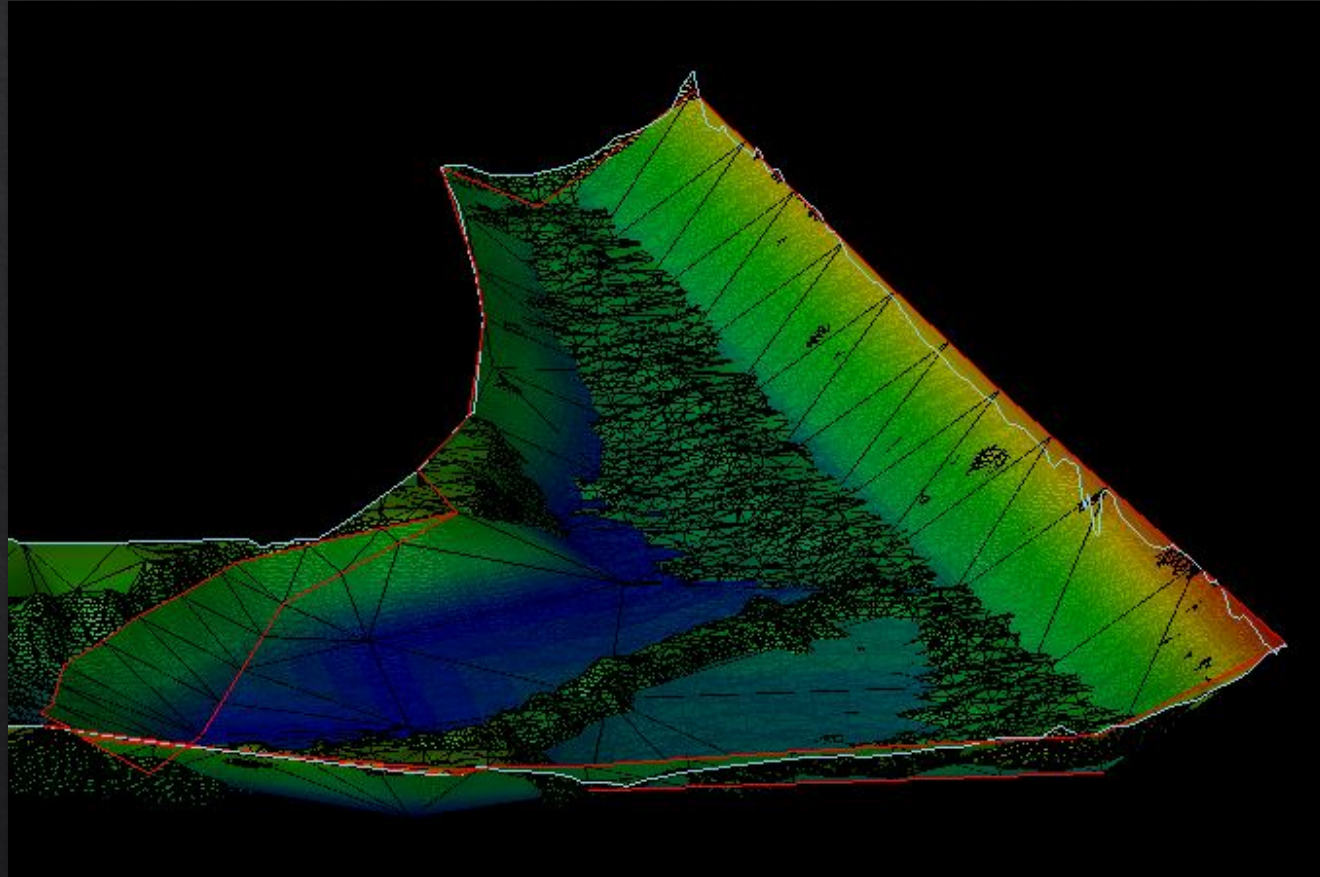


# Finished Muck Site



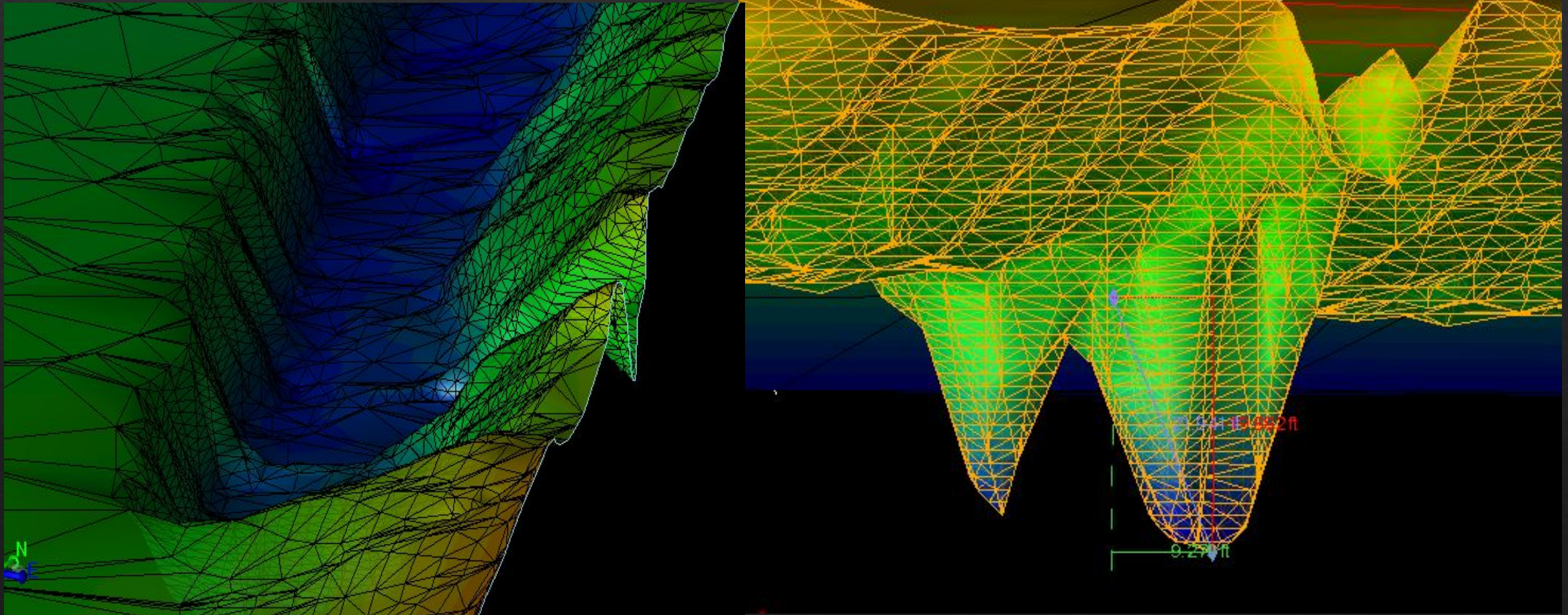


# Panned Bottom VS Muck Excavated



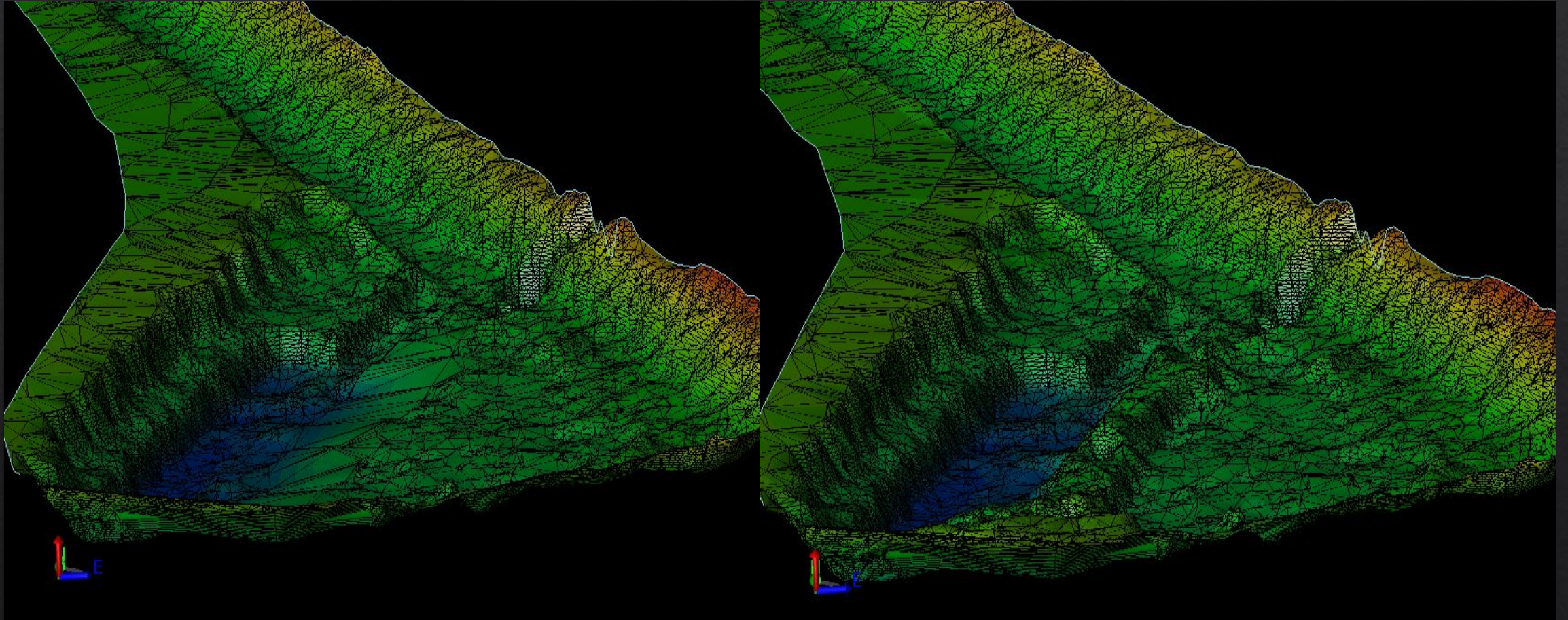


# Sensor on bucket malfunctioned





Machine Was turned off for part of a Day





# Constant Adjustment

- ◆ Quantity of the holes Created from malfunctioned sensor:  
120 CY
- ◆ Quantity of the muck that was missed when the machine was turned off  
2,895 CY
- ◆ Constant Adjustment to add to the quantity  
2,775 CY



# Final Muck Quantity Reports

## Earthwork Volume Report

Job: Quantity Report FINAL  
Units: Ft-CY  
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Unclassified surface compared to Unclassified surface

Surfaces	
mucktopCHK	Classification: Unclassified
Surface Report FINAL	Classification: Unclassified

## Bank Volumes Based on Surface Geometry Alone

Cut material	48,578.6 yd <sup>3</sup>
Fill material	3,367.6 yd <sup>3</sup>
Excess	45,211.0 yd <sup>3</sup>

## Volume Report Design vs. Existing

	Total	Cut	Area Fill	OnGrade	Volume Cut	Fill	Comp/Ratio Cut	Fill	Compact Cut	Fill	Export Import	Change Per .1 Ft
Job Site	98,940	94,793	2,568	1,579	46,726	184	1.00	1.00	46,726	184	46,542	366
Unspecified	27,985	11,664	15,735	586	1,855	1,631	1.00	1.00	1,855	1,631	224	104
Job Total	126,925	106,457	18,303	2,165	48,581	1,815			48,581	1,815	46,766	470

MnDot Muck Total 48,579 CY + 2,775 CY

51,354 CY

Contractor Muck Total 48,581 CY + 2,775 CY

51,356 CY

Total estimated plan quantity:  
51,326 CY



Questions?

