Stringless Paving Machine Control

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Agenda

- Machine Control
  - What is it?
  - Where has it been used?
- 3D Engineered Models
  - What has been done?
  - What are we providing?
  - Approach design
- Housekeeping items

Automated Machine Control

- A.K.A. Automated Machine Guidance (AMG)
- What is Machine Guidance?
  - Machine Guidance is used to accurately position earthwork, base course, milling, and paving equipment on a project.
  - Uses technology to help achieve grade.
    - Rotating lasers, sensors, RTK-GPS/GNSS, Robotic Total Stations

Robotic Total Station and Rover Pole

Concrete Paver - Robotic Total Station

Curb Machine – Robotic Total Station

Asphalt Paver – Robotic Total Station

GPS Base Station

Dozer - RTK GPS

Types of Machine Guidance

- Indicate
- Automatic

Indicate

- Technology on machine indicates grade or cut/fill
- Operator adjusts machine manually to grade

Excavator – RTK GPS Machine Control (Indicate)

Display – Indicate Operation

Automatic

- Technology on machine displays grade or cut/fill
- Operator may choose to run with indicate or automatic
- Machine is controlled automatically through function of hydraulics
- May include horizontal guidance (i.e. steering)

Automatic – RTK GPS

Automatic – Robotic Total Station

Automatic – Robotic Total Station

Where has it been used?

- Earthwork
- Base Course
- Surfacing

Earthwork and Base Course

- Contractor preferred in many NDDOT projects
- 2013 Contract Required Machine Control
  - HWY 22 from Near Stark County Line to Near RP 91
  - HWY 85 from the East Jct 5 West to West Jct 5
  - RTK – GPS/GNSS was used for both projects

Surfacing

- Stringless Concrete Paving
- NDDOT Specs – Stringline Required for Concrete
- HWY 1804 from Jct 23 north to Jct 23B – New Town
  - SP allowing stringless concrete paving
  - Required Robotic Total Station Machine Control
- Williston NW Bypass Phase 1 & Phase 1A
  - Stringless concrete paving added by changeorder
- Watford City SW Bypass
  - Stringless concrete paving added by changeorder

Watford City SW Bypass

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3D Engineered Models

What has been done?

GEOPAK

GEOPAK User Preferences	(Oct '08)	4.1
GEOPAK Database (GPK)	(Oct '05)	4.2.1
Coordinate Geometry	(July '07)	4.2.2
Project Manager	(Oct '05)	4.3
Design and Computation Manager	(Oct '08)	4.4
Digital Terrain Model (DTM)	(June '12)	4.5
Survey Manager Database	(Dec '10)	4.6
Cross Sections and Earthwork	(Dec '13)	4.7
Cross Section Interval	(July '13)	4.7.1
Roadway Designer	(Nov '11)	4.7.2
Criteria Files and Related Input Files	(Nov '11)	4.7.3
Slope Stake Reports	(Nov '11)	4.7.4
Earthwork	(April '13)	4.7.5
DTMs for Automated Machine Guidance (AMG)	(March '14)	4.7.6
AMG Deliverables	(March '14)	4.7.7
Cross Section Sheet Layout Files	(Dec '10)	4.8
Plan Sheet Library	(Nov '11)	4.9
Super Elevation	(July '12)	4.10
Legal Description Editor	(Oct '08)	4.11
Survey Alignment Data Sheets	(Feb '09)	4.12

CADD Standards

4.7 Cross Sections and Earthwork

Dec 2013

Corridor modeling (roadway designer) is the preferred tool for generating surface models. Corridor modeling should be used because the proposed surfaces created from roadway designer are better suited for Automatic Machine Guidance (AMG) projects. Specific surface tolerances can be prescribed and a 3d review of the model and surface can easily be done.

Corridor modeling shall be used for proposed cross sections and surface modeling unless one of these conditions is met.

- Projects that were substantially completed with Geopak criteria by July 22, 2013, do not need to be converted to corridor modeling. Consultants that have started a project with Geopak criteria files, but are not substantially complete, should discuss how to proceed with their NDDOT technical support contact.
- Projects that do not have an existing surface file (dtm, tin, xml) available through typical survey practices can be completed with Geopak criteria. Roadway Designer tools require a DTM. Geopak criteria files only require cross sections. Some NDDOT surveys only provide cross sections directly from raw data. With these surveys, a surface is not created. If cross sections were directly surveyed as linear – transverse shots or cross sections were developed from old plans, an existing surface file might not be created. Sliver grading projects are examples of earthwork projects that usually don't use surface files. Creating cross sections from criteria may be easier in these circumstances and will be allowed.

Request for additional exceptions to use criteria will be considered. This new standard is not intended to increase project development costs or time. This standard is intended to provide opportunities to use AMG on future projects. Consultants can request exceptions through their NDDOT technical support contact to the NDDOT CADD Support Specialist (Jon Collado). Internal (NDDOT) staff can request exceptions through Jon Collado. Request should indicate specific projects, present status of proposed cross section modeling, and reasons why Geopak criteria is desired for project.

Note a combination of Roadway Designer and Geopak Criteria can be used in some circumstances. Geopak Criteria can supplement the cross sections, but should not be used in any part of the proposed surface modeling.

- Criteria for labeling is allowed.
- Criteria for utilities is allowed.
- Criteria for existing surfaces and As-builts is allowed

4.7 Cross Sections and Earthwork

- Corridor Modeling (roadway designer) is the preferred tool.....
- Corridor Modeling should be used.....
- Corridor Modeling allows.....

4.7 Cross Sections and Earthwork

- Corridor Modeling shall be used for proposed cross sections and surface modeling unless……
  - Project was substantially completed with Geopak criteria before July 22, 2013, or
  - Do not have an existing ground surface file (.dtm, .tin)

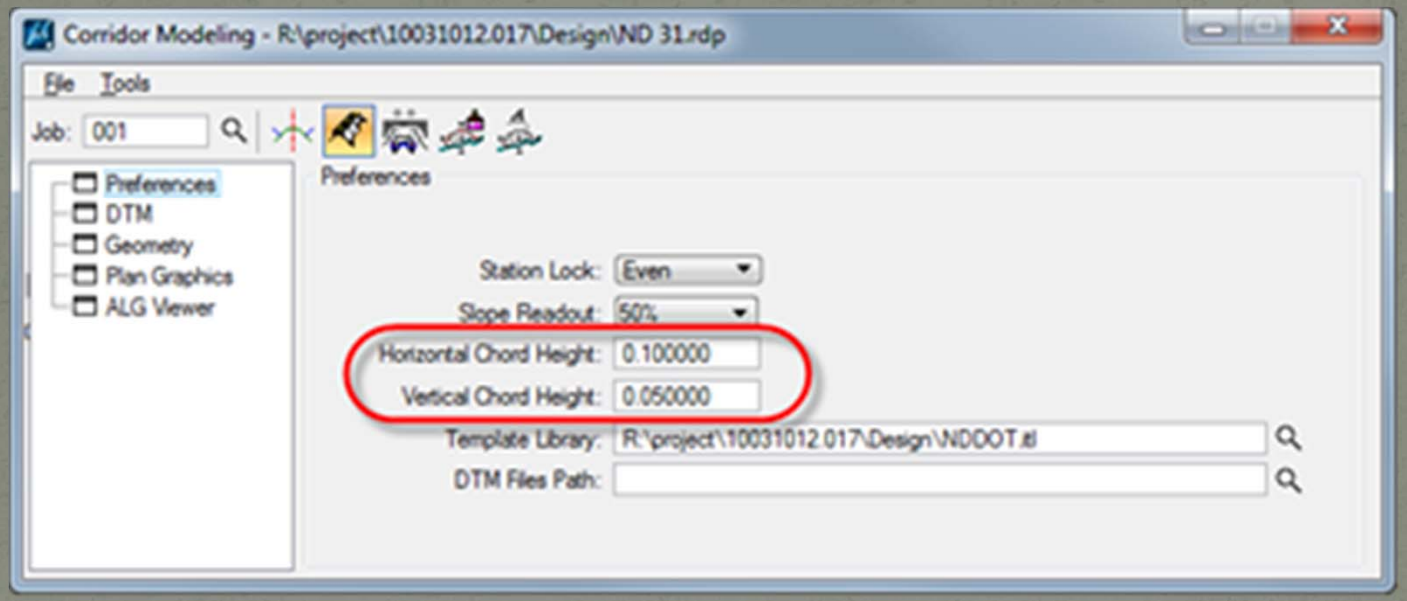
- Overall Goal is to provide opportunities to use AMG

4.7.6 DTM's for AMG

- Provide proposed surfaces with the following Chord Height:

	Minor Rehabilitation *, Structural Improvement	Major Rehabilitation, New/Reconstruction
Horizontal Chord Height Tolerance	0.1 ft	0.1 ft
Vertical Chord Height Tolerance	0.1 ft	0.05 ft

4.7.6 DTM's for AMG



- If you have an existing surface for a sliver grading project you should provide the surface models.

What is being provided?

- Supplemental Information
  - Electronic Design Data

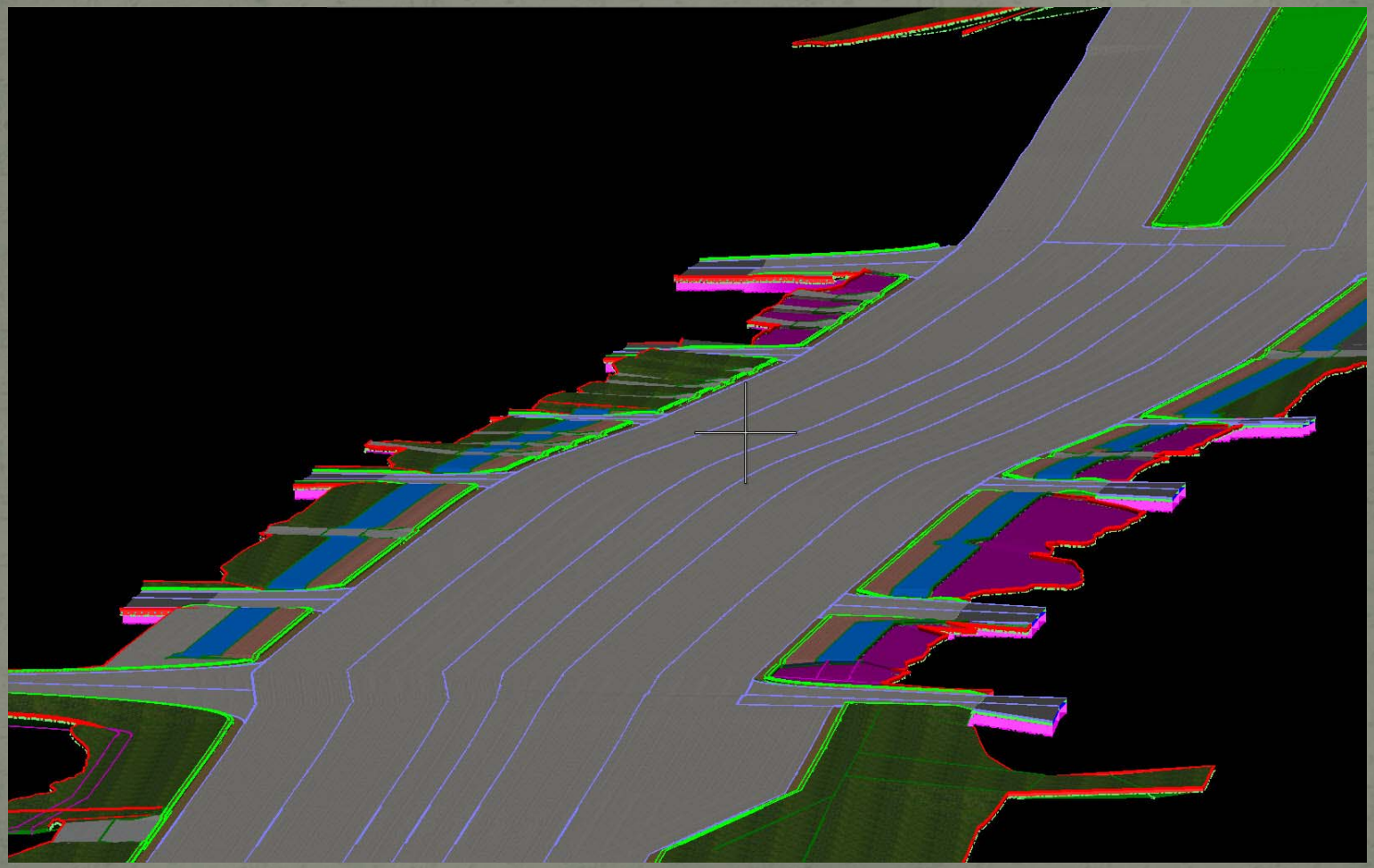
3D Engineered Models

- Provide models for different surfaces
  - Existing Surface
  - Dirt Grade (DG)
  - Top of Base (B1)
  - Top Surface (T)

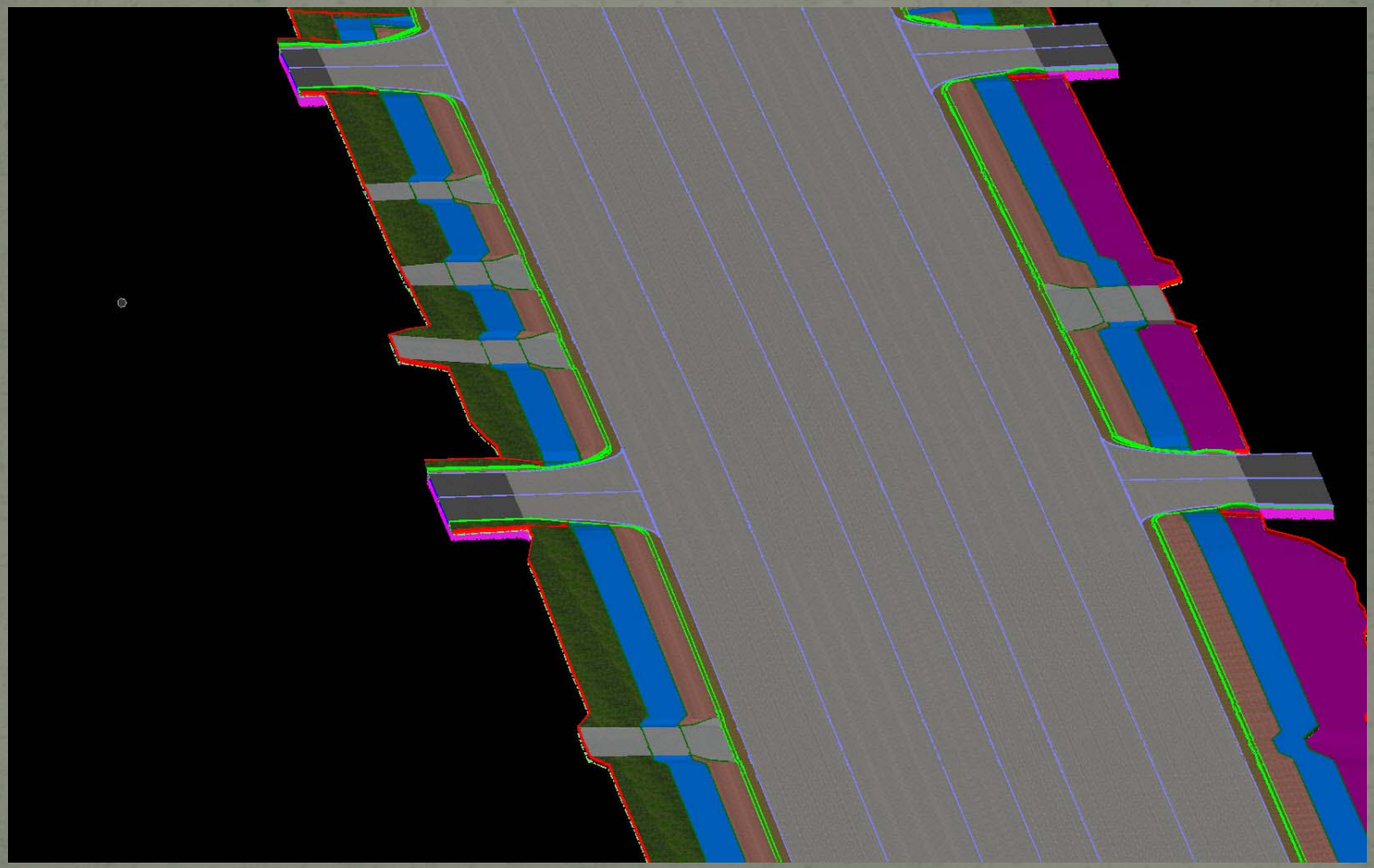
4.7.7 AMG Deliverables

- Surface Models
  - .tin
  - .dtm
  - .xml – Universal file
- All three file types for each surface model

US 2 – Ray ND



US 2 – Ray ND



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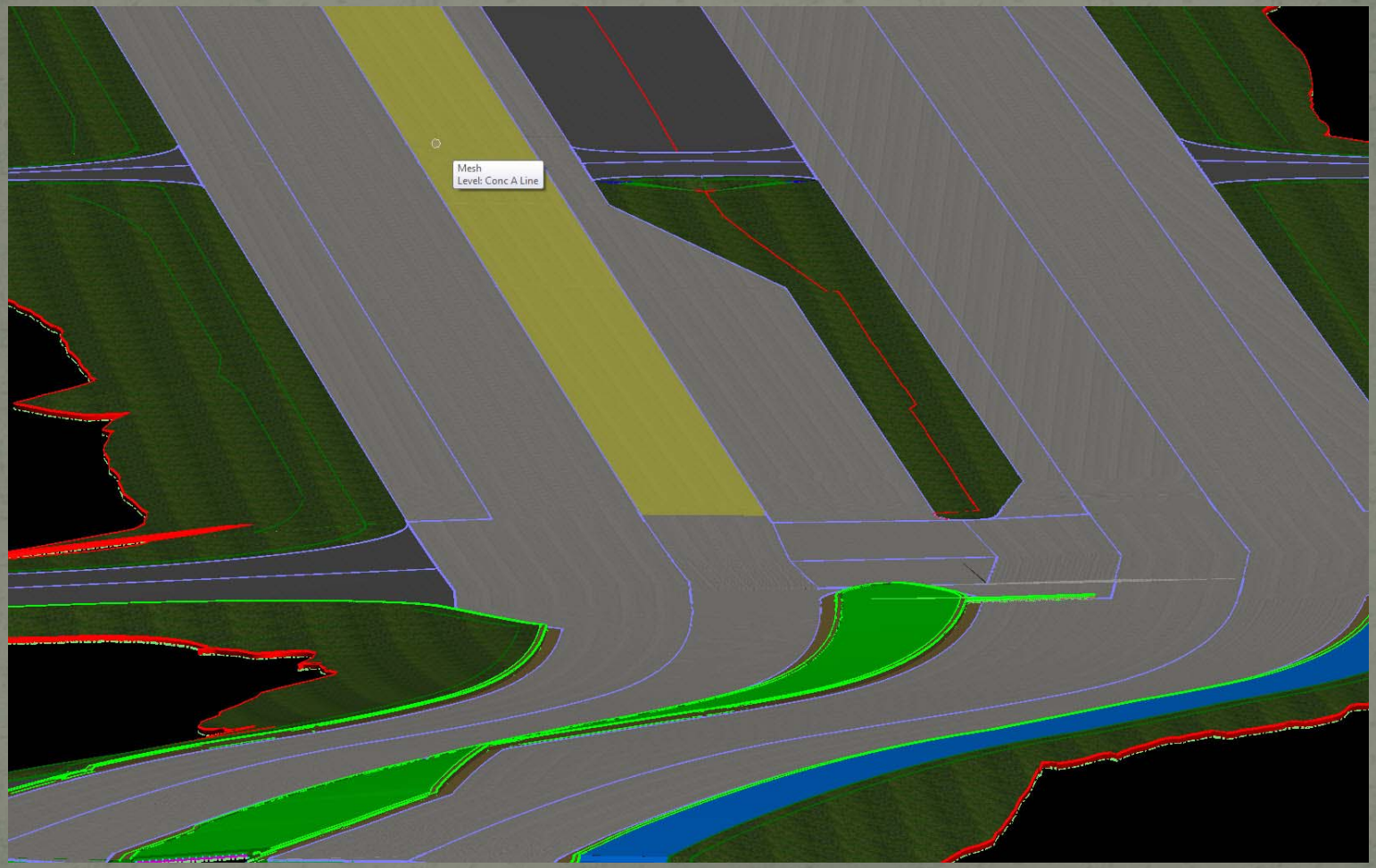

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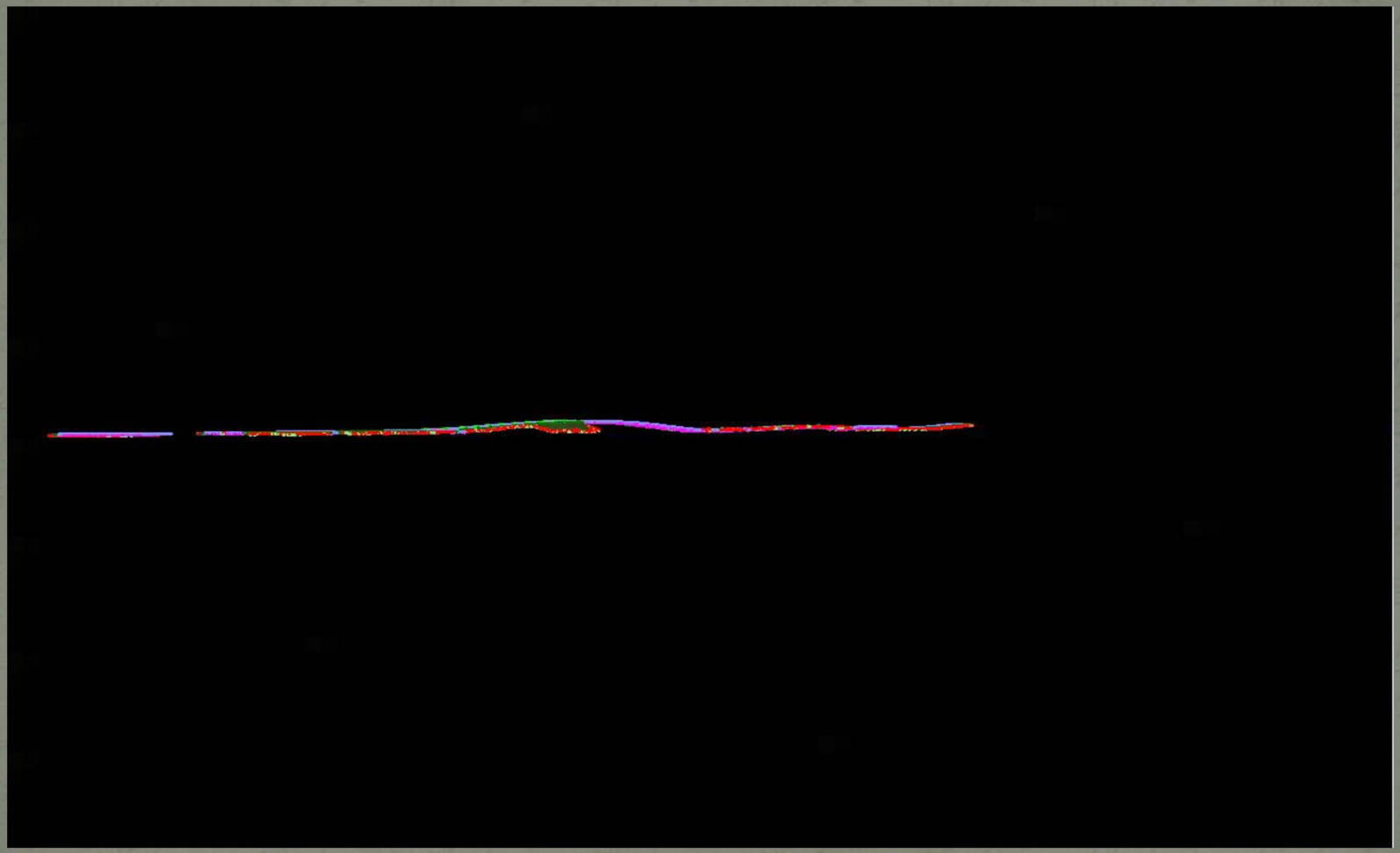


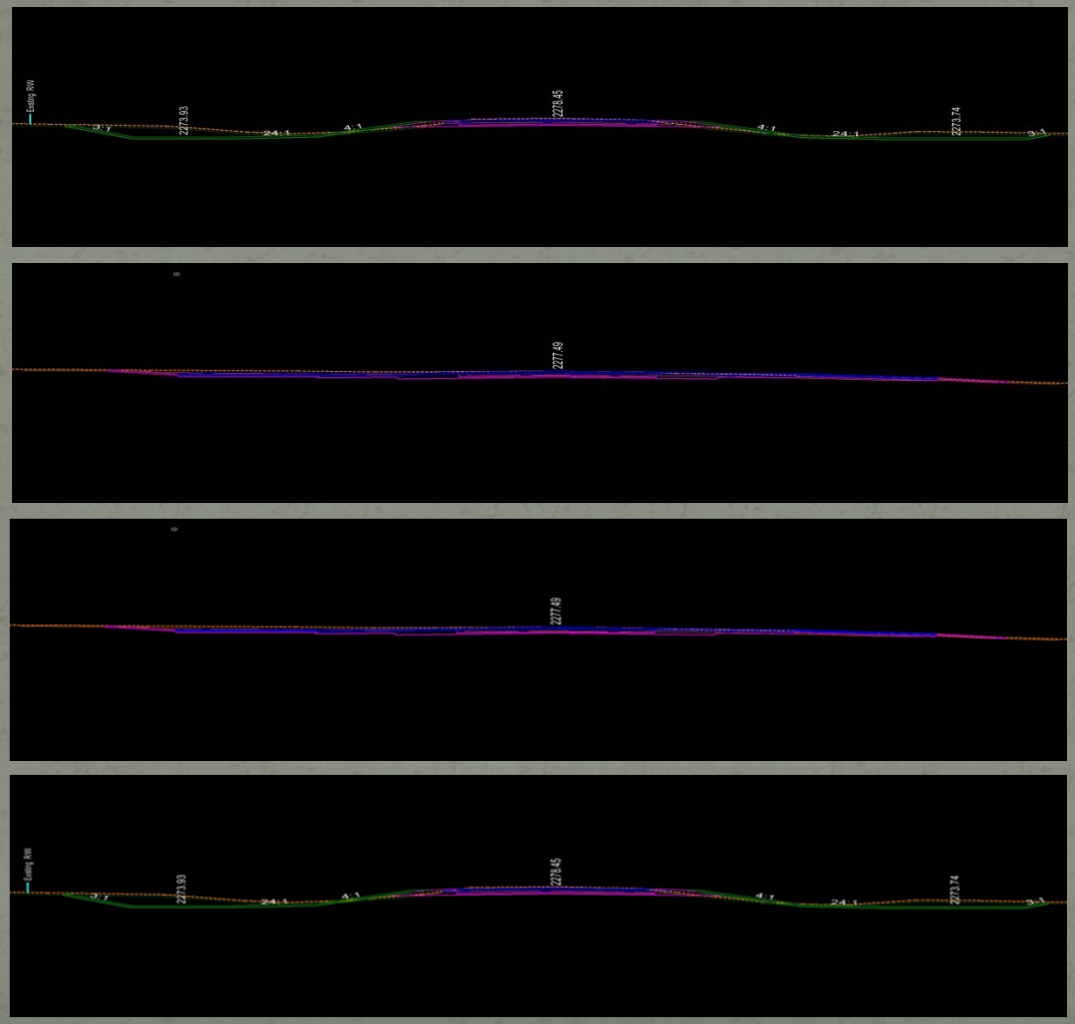
4.7.7 AMG Deliverables

- Include other design files
  - Control
  - Design
  - DS-Align
  - Profile
  - RW_BNDY
  - Topog
  - XSEC
  - RDM – 3d file

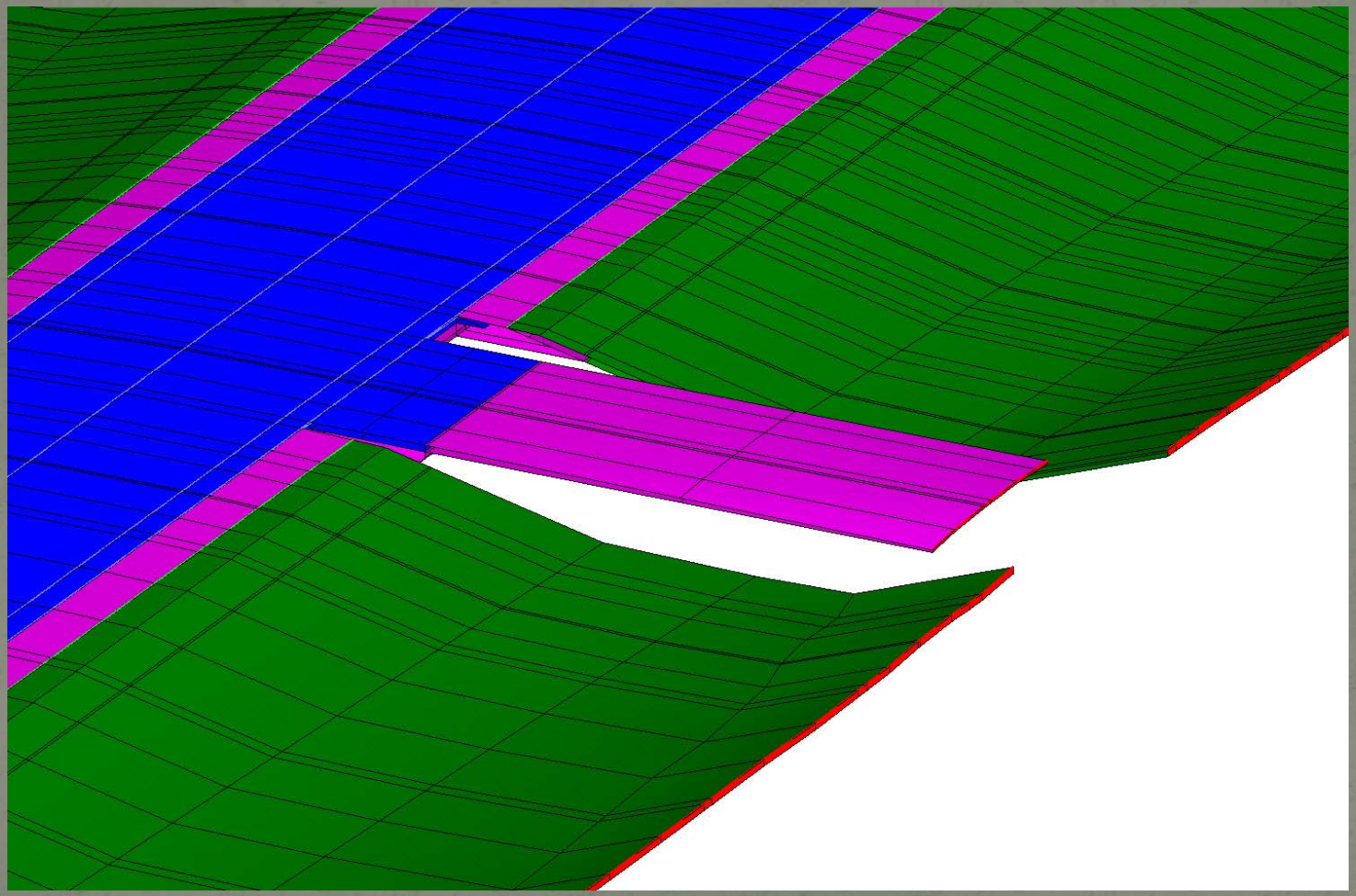
4.7.7 AMG Deliverables

- Alignment Information
  - .gpk
  - .alg
- AAReadMe File
  - Information key (general description of files)
    - Alignments, etc
  - Describe any limitations
    - Approaches were modeled without inslopes
    - Bridge ties were not modeled
    - Use plan information to build ……

Approach Modeling



Approach - 3D Model View

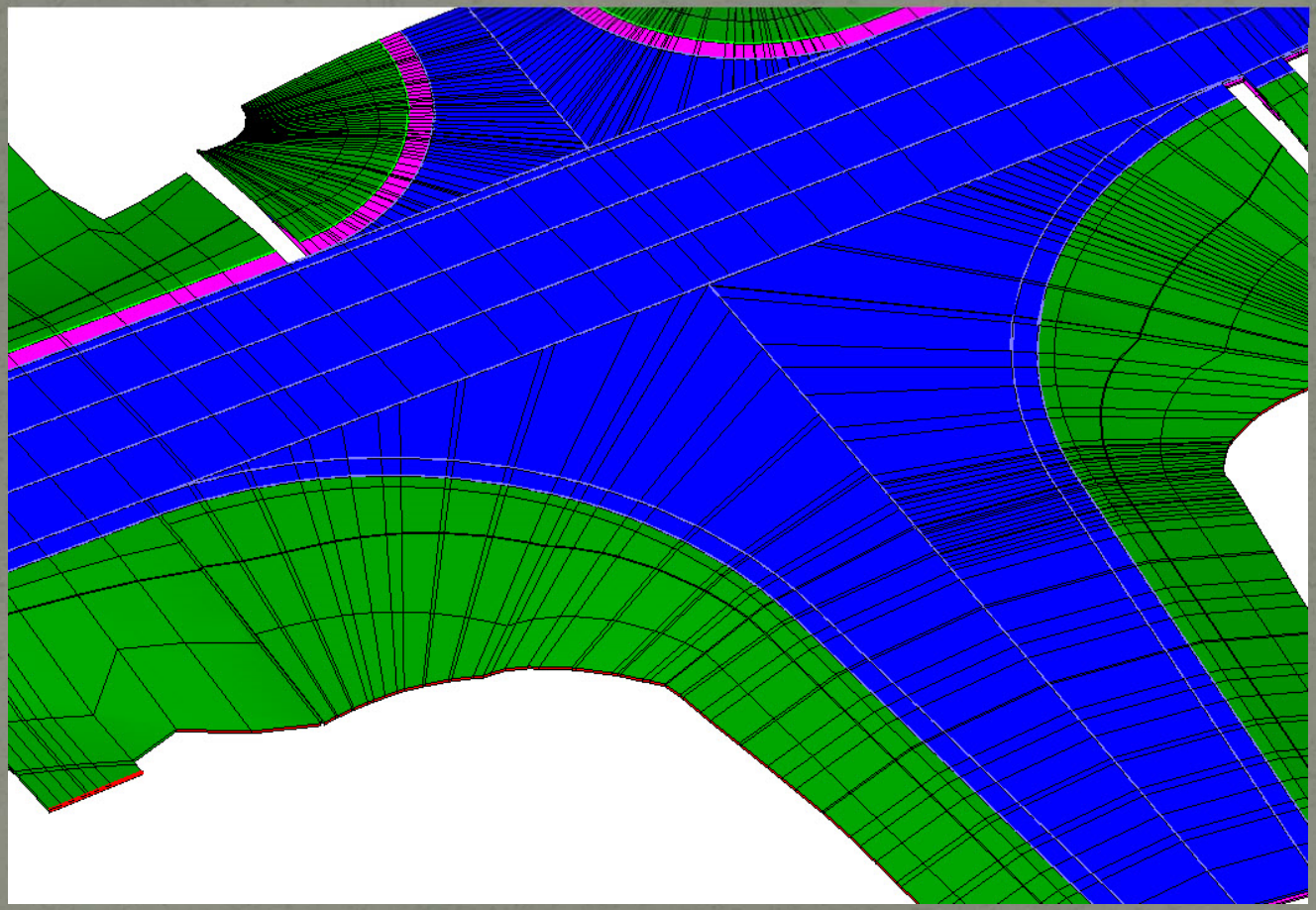


Approach Modeling

- Four cross section method is acceptable for earthwork calculations
- Reduced effort in design phase
- Increased construction staking requirement

- Civil Cells using templates Geopak SS3
- Reduced effort to design compared to previous version
- Decrease construction staking requirements

Complete Approach Design 3D Model



Please remember!

- Creating surface models
  - International Feet

Check and recheck then check again!

- Files
- Surface model limitations – Include in AAReadme

Questions