Understanding the 3D Construction Model

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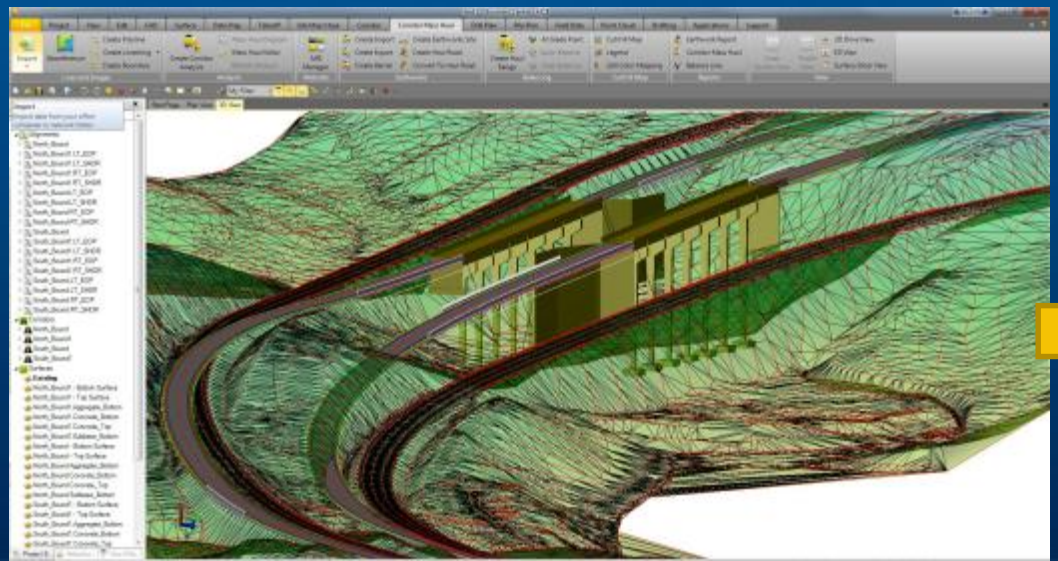
Trimble Navigation

3D Constructible Model

- What kind of data can be used and the advantages, disadvantages and pitfalls
- How the contractor will the use the data for more than just a design for machine control
- How it forms the basis of the Trimble® Connected Site®



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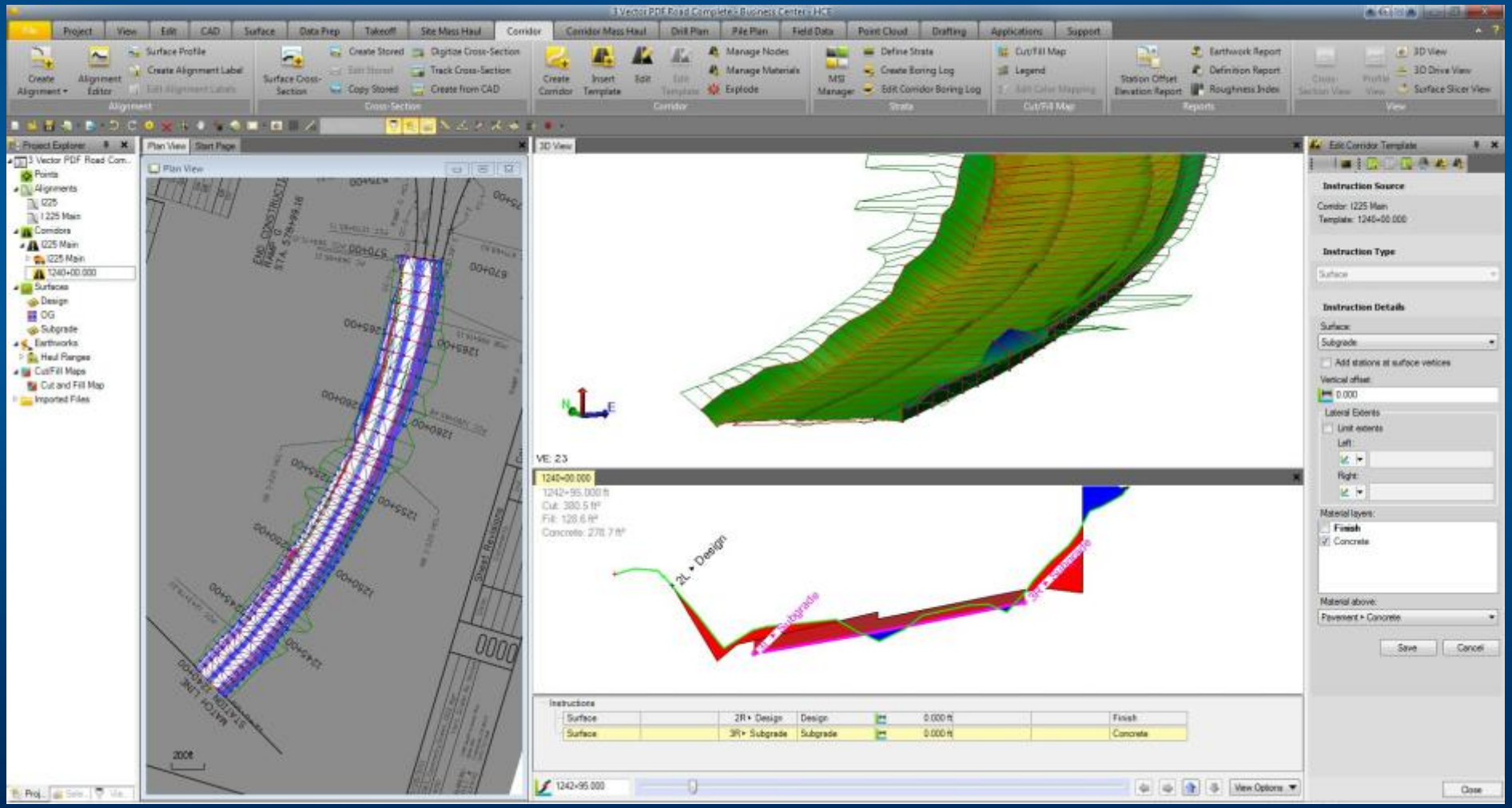
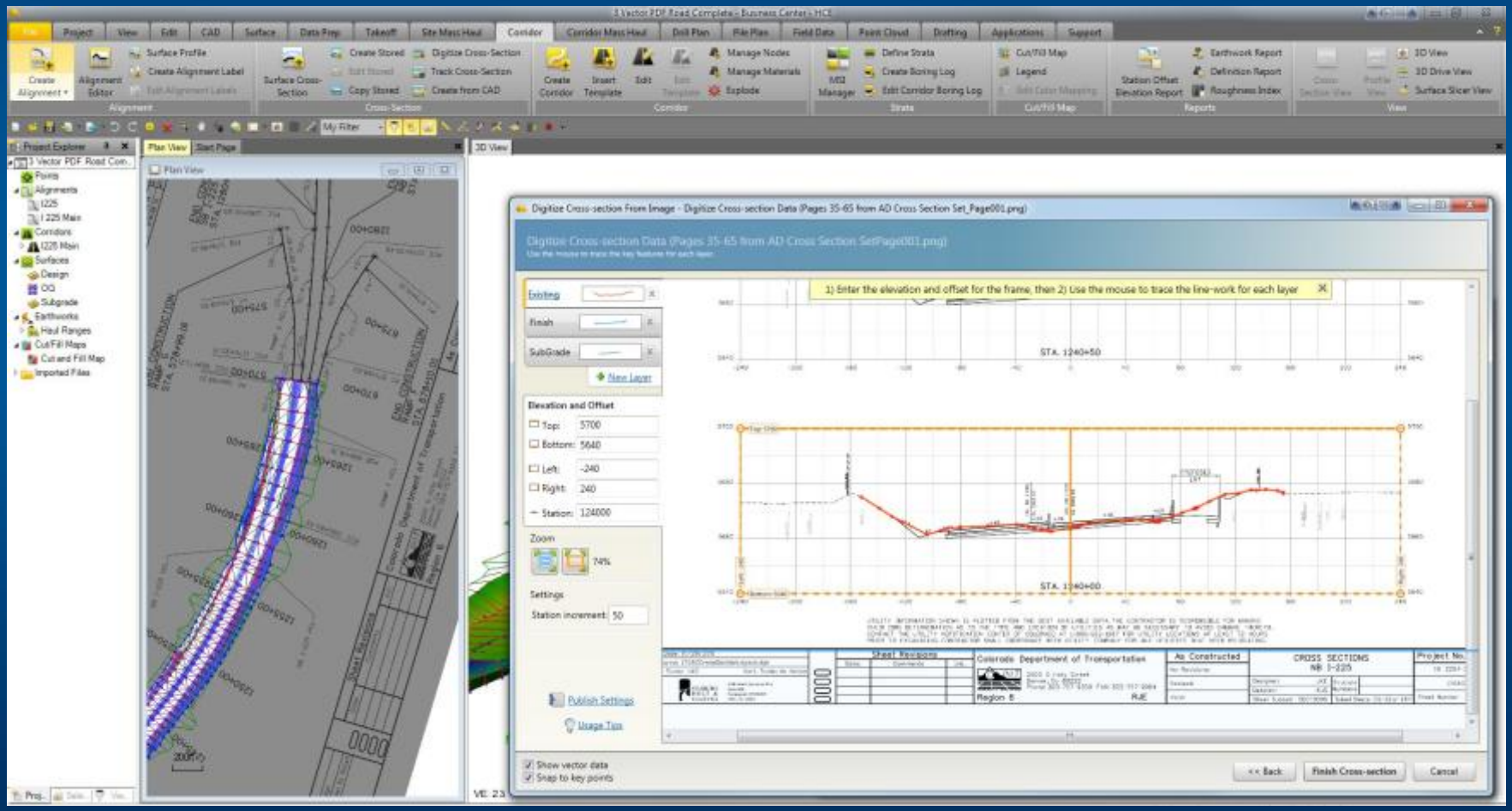
Business Center - HCE



What Kind of Data can be Used?

- These are the least productive for the contractor
  - Paper / hand entry
    - Tools designed for re-creation not design
    - Add bore hole data to define strata
  - PDF, JPG
    - Background images
    - Cross sections
    - Approximate locations

Digitizing PDF Cross Sections



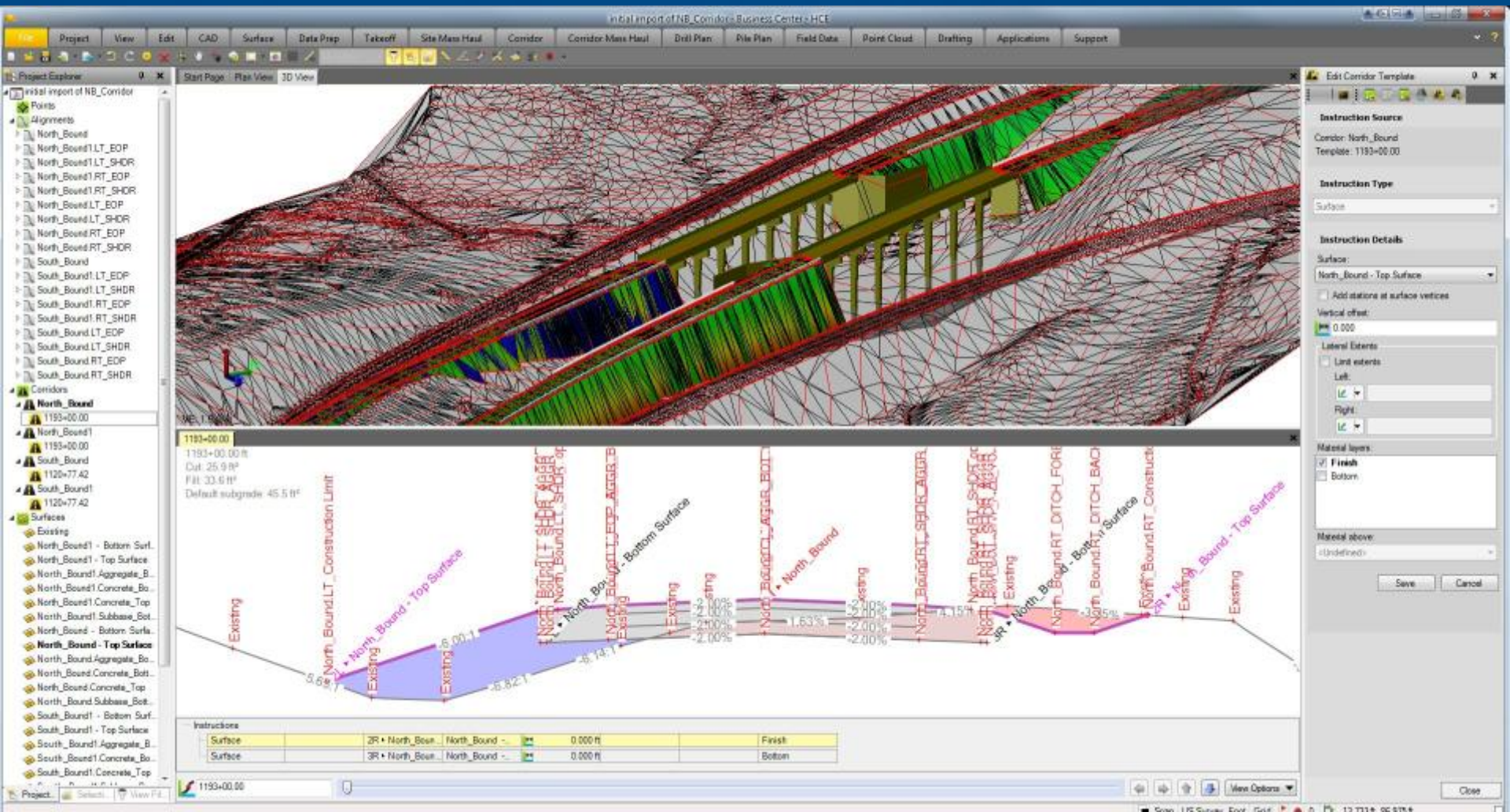
The Most Common Formats

- Survey
  - Coordinate system definition
  - Site calibration
  - Points
  - Point clouds
  - Linework
  - Feature codes
  - Surfaces
- CAD (.dxf, .dwg, .dgn, .ifc)
  - Lines
  - Points
  - 3D faces
  - Text
  - Blocks
  - Cross sections as lines

The Most Feature-Rich

- Design (LandXML, .ttm, Bentley MX, 12D, GENIO, REB, InRoads, NovaPoint, …)
  - Alignments
  - Surfaces
  - Breaklines
  - Points
- 3D model (.icm.dgn, .pro, .vce, .vcl)
  - Breaklines
  - Points
  - Surfaces
  - Alignments
  - Corridors / templates
  - Meshes
  - CAD

Results from Importing Bentley's .icm.dgn



Checking and Enhancing the Data

- Even perfect data needs some help
- What you design is not what gets built
- Less than perfect data needs a lot of rework by the contractor
- The needs of the many (contractors) outweigh the needs of the few (designers)

Get the Coordinates Right

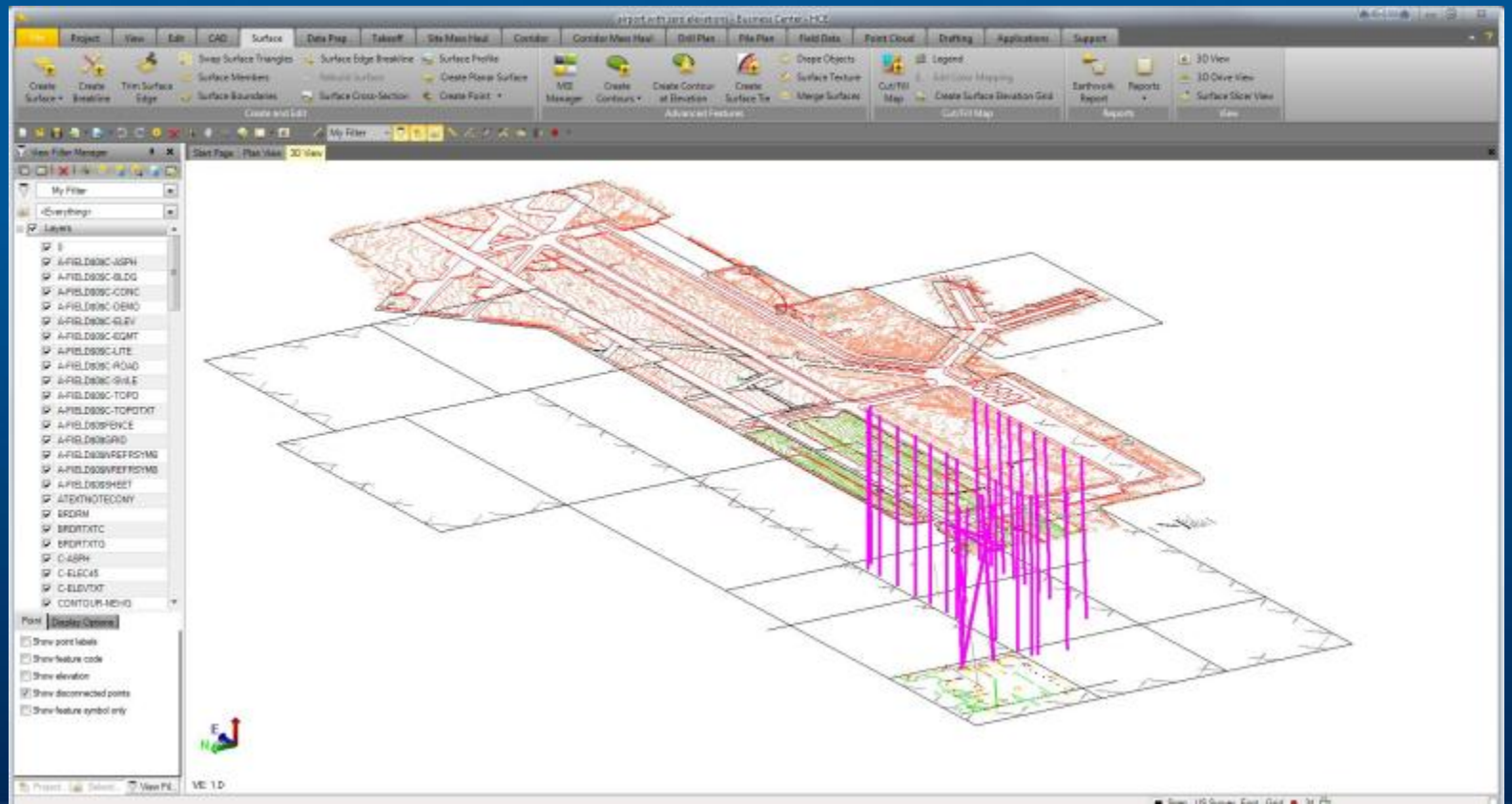
- Use the correct units and coordinate system, Feet, US Survey Feet, Meters
- The proper coordinate system and calibration must be sent to all field systems
- All systems must calculate the same
- New control points must be imported and synchronized with all devices

Organize the Data

- When creating data for the field you want the minimum amount of data and choices
- Layers, linetypes, colors and names must make sense for the field devices
- The work order tells the operator what to build where

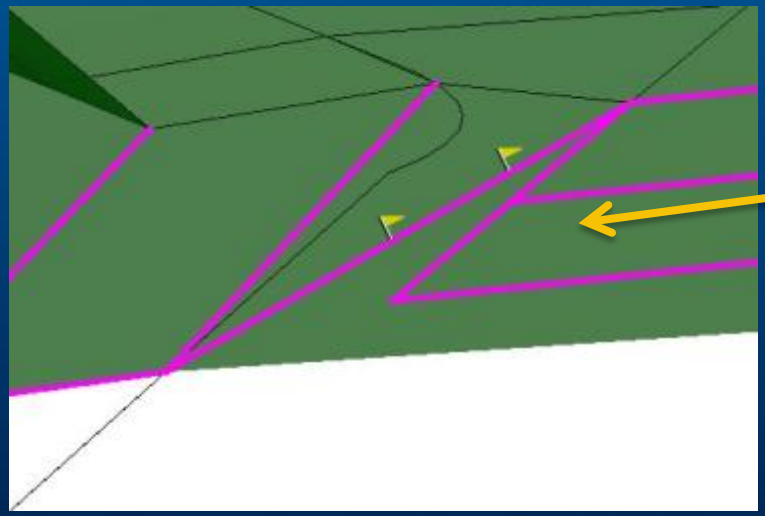
Elevate the Data

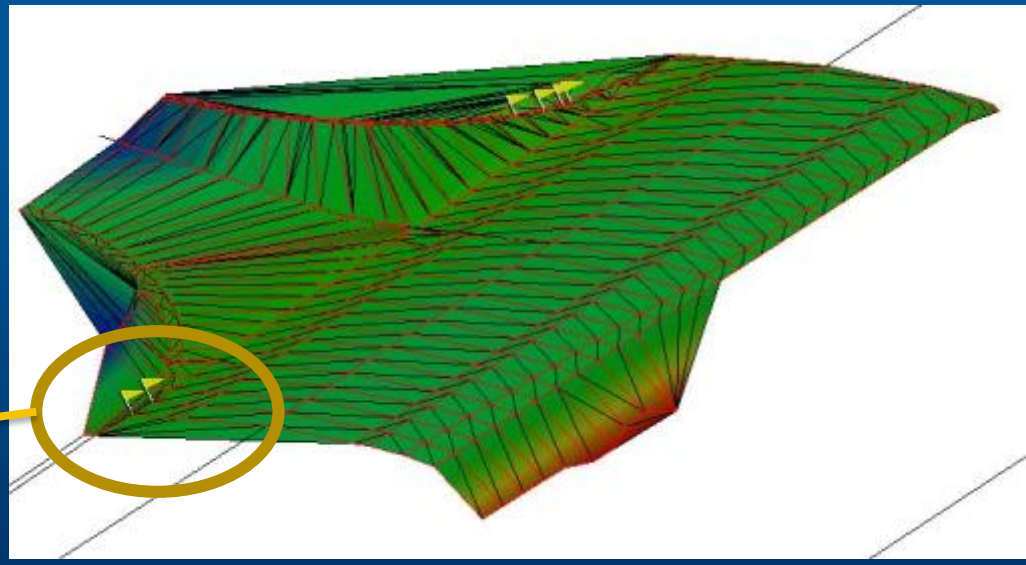
- **Frequently elevations are so unreliable that users will first set all objects to a null elevation and then elevate every object.**



Check for Errors

- The most common mistake is having one XY position with two elevations
- The second most common is a design conflict with crossing lines with different elevations

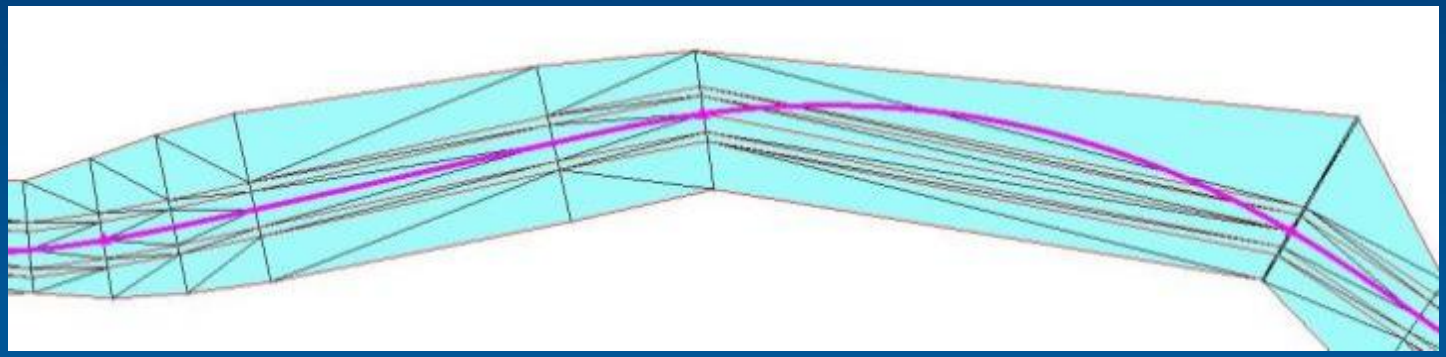


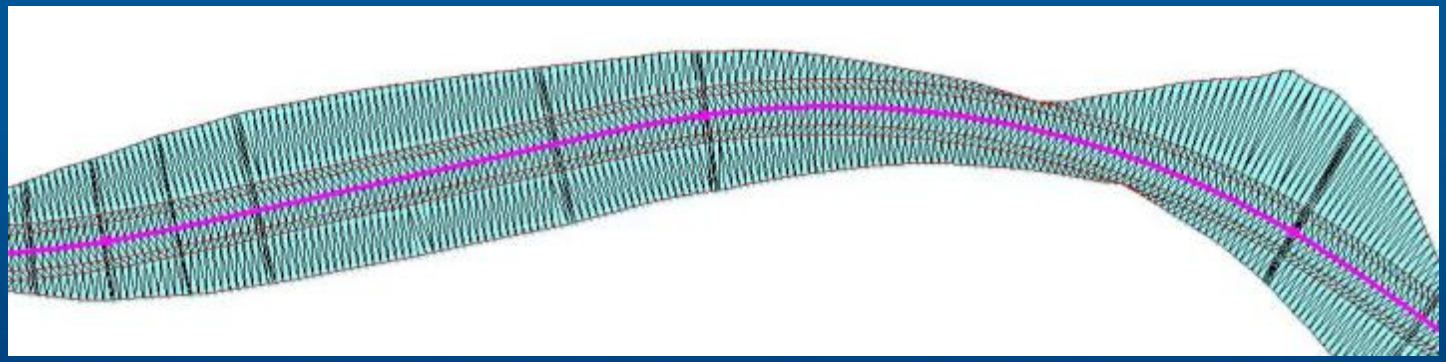


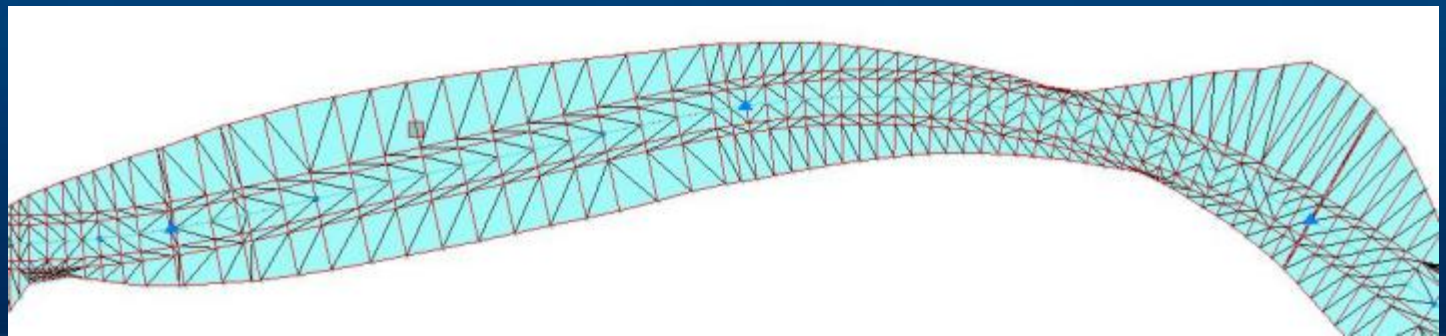
Clean up the Data

- Duplicate linework
- Gaps and overlaps of ends
- Too short at ends
- Wrong length
- Undesirable colors, layer, linetypes
- Arcs, spirals created as segmented lines
- No naming information
- No station information
- Blocks

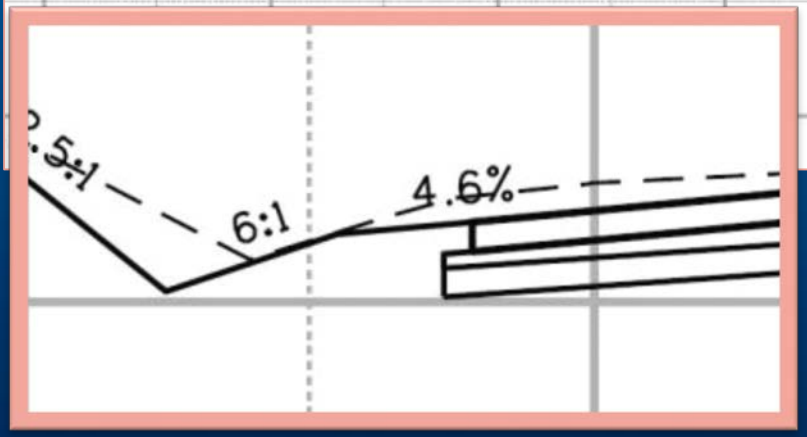
Enhance the Data







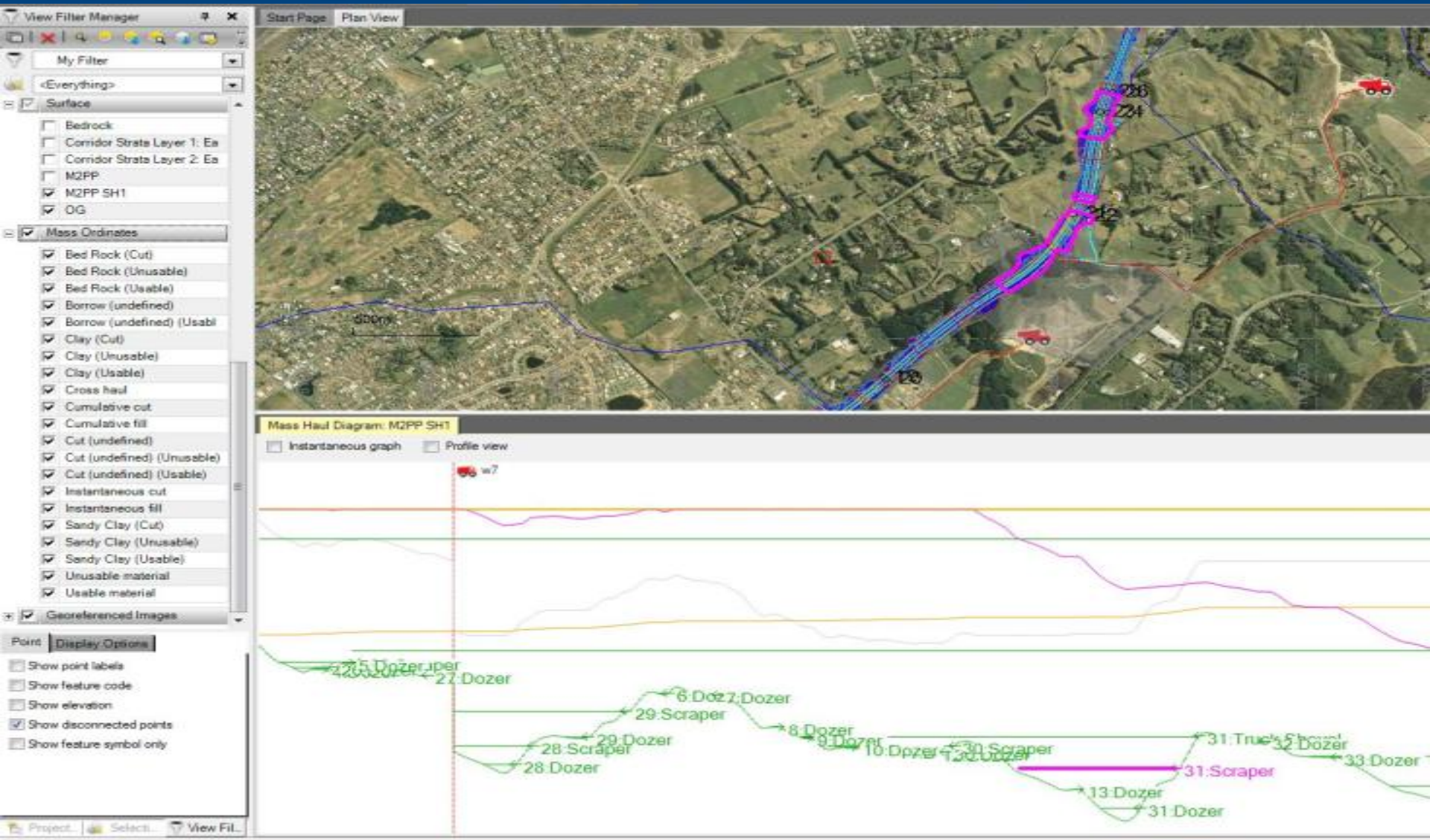
Model How it will be Constructed



How the Data will be Used

- 3D models for machine control and layout
  - Points, lines, alignments, templates, surfaces
- Calculation of quantities
- Mass haul planning
- Sending work orders with subsets of the data to field devices
- Managing the Connected Site
- Project tracking

Plan your Mass Haul



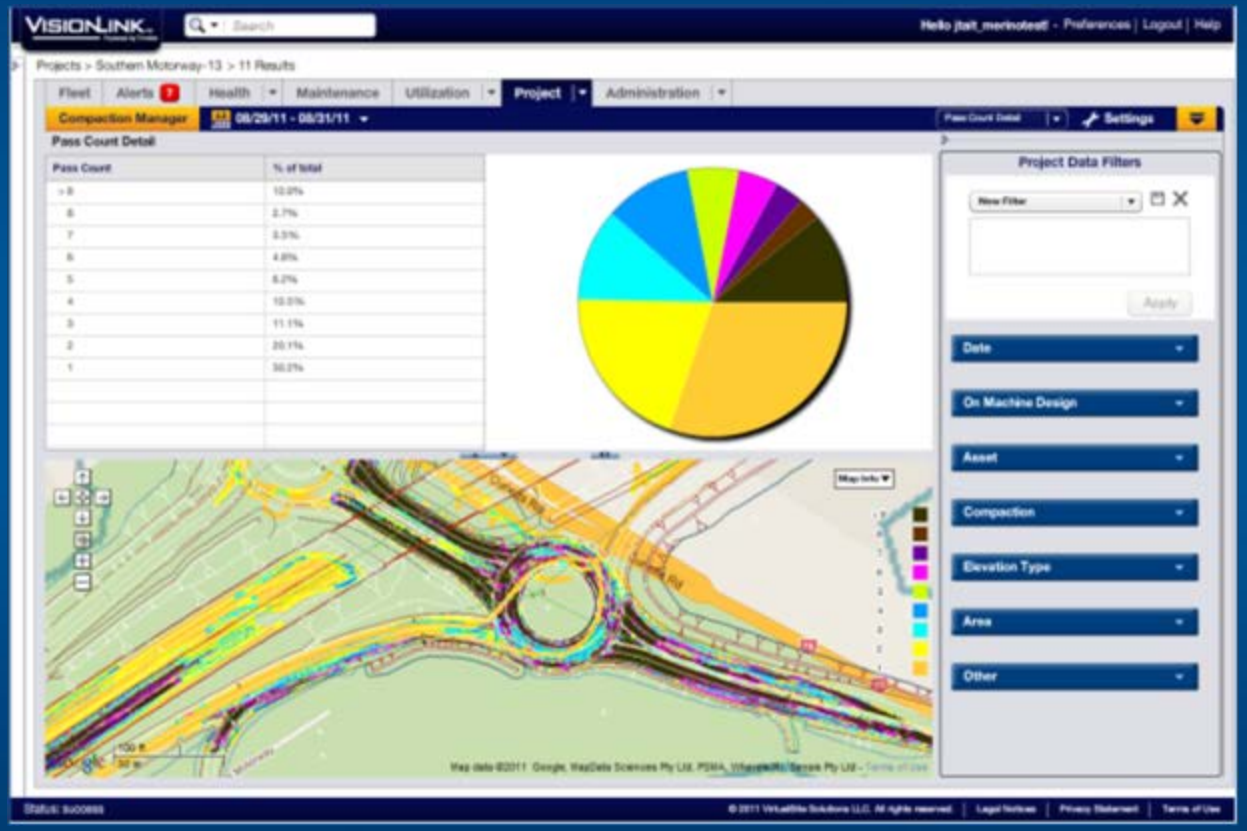
Connect the Site

Volumes - Displays

- Coverage maps
- Elevation maps
- Elevation profiles
- Cut/fill maps
- Summary volumes

Compaction displays

- Temperature
- CCV/CMV values
  - Summary
- Pass count
  - Summary
  - Detail



3D Construction Model in Use

M2PP Survey System

Will Newall - Survey Manager

NZ TRANSPORT AGENCY

MacKays to Peka Peka

New Zealand Government

M2PP Project Overview

- MacKays to Peka Peka (M2PP) 18km 4-lane expressway in New Zealand
- 18 structures
- End to end cycleway
- Links to local roads
- Alliance
- Fletcher / Beca / Higgins / NZTA

M2PP Project Challenges

- 3 million + m^3 earthworks
- Potentially over 800,000 m^3 peat to remove
- Earthworks claims by volume
- Haul distance?
- Data management
- 55 properties to move / demolish
- Archaeology

Survey Infrastructure

Survey Infrastructure

- Project divided into 3 zones
- Each sector is +/- 6km
- Project lends itself to GNSS
- 3 base stations (1 for each zone)
- Increased redundancy
- Single base solutions (not network)
- 8mm H / 15mm V (plus 1ppm)
- Internet-based corrections

System Components

Machine Control

- GNSS mounted on machines
- Similar precisions to survey GNSS, if calibrated appropriately, plus any hydraulic sag
- 50 ton excavator to <50mm
- D8 dozer to <30mm
- Machine blades measure the surface
- All connected to the cloud

2D Monitoring

- Haul distance – very difficult to measure
- Location GPS on each dumper / scraper
- Named cut/fill boundaries generated from Business Center – HCE mass haul
- Automatic logging of load and dump locations
- Results and totals emailed daily
- Totals verified against 3D volumes

The “Cloud”

- Trimble’s Connected Community
- Base stations, field controllers, 3D machine control, 2D machines all connected to the “Cloud”
- Upload / download field controllers remotely
- Upload / download machine control remotely
- Download as-built surface from machine blades
- First / last / lowest / highest / boundary

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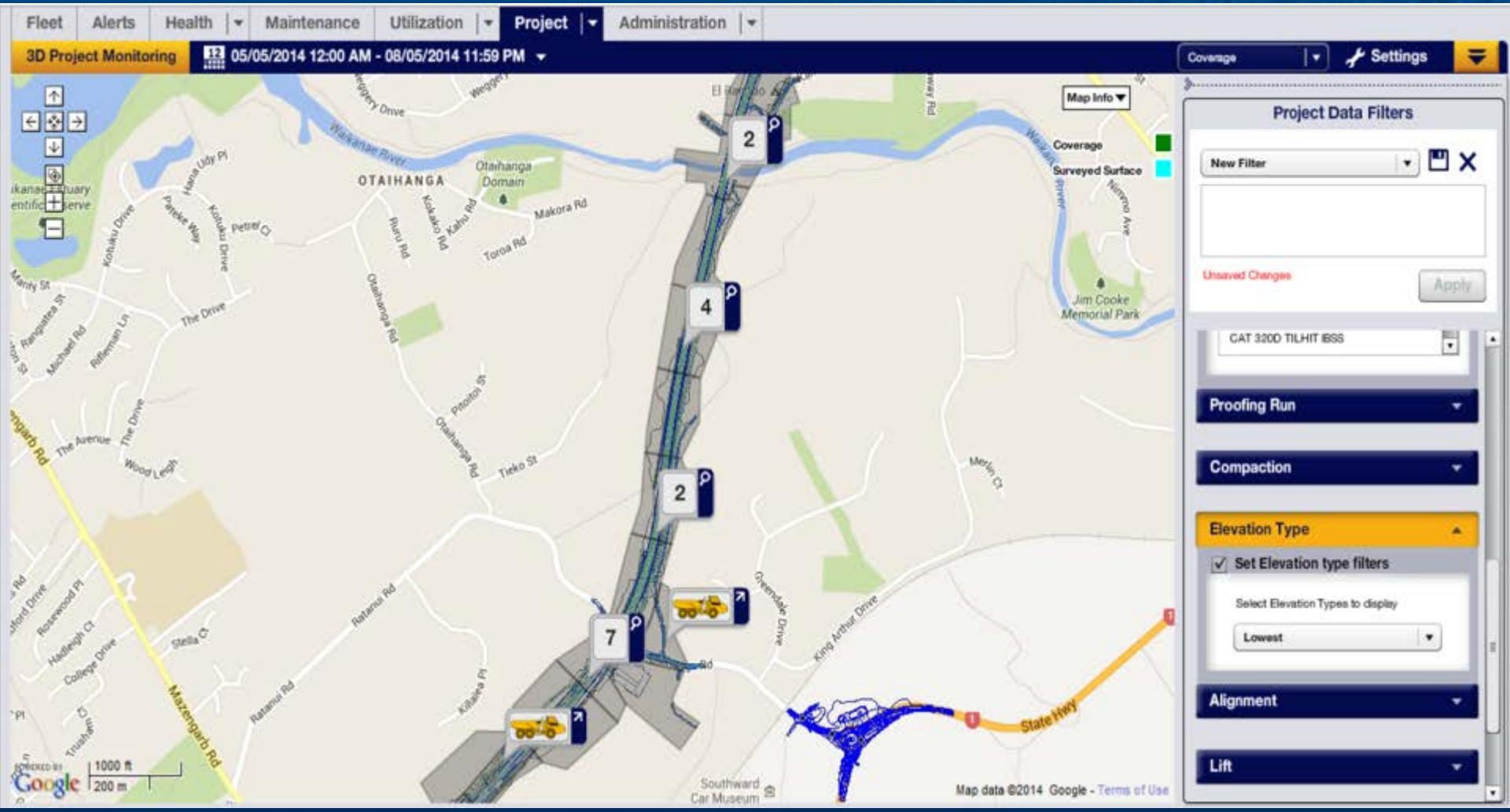
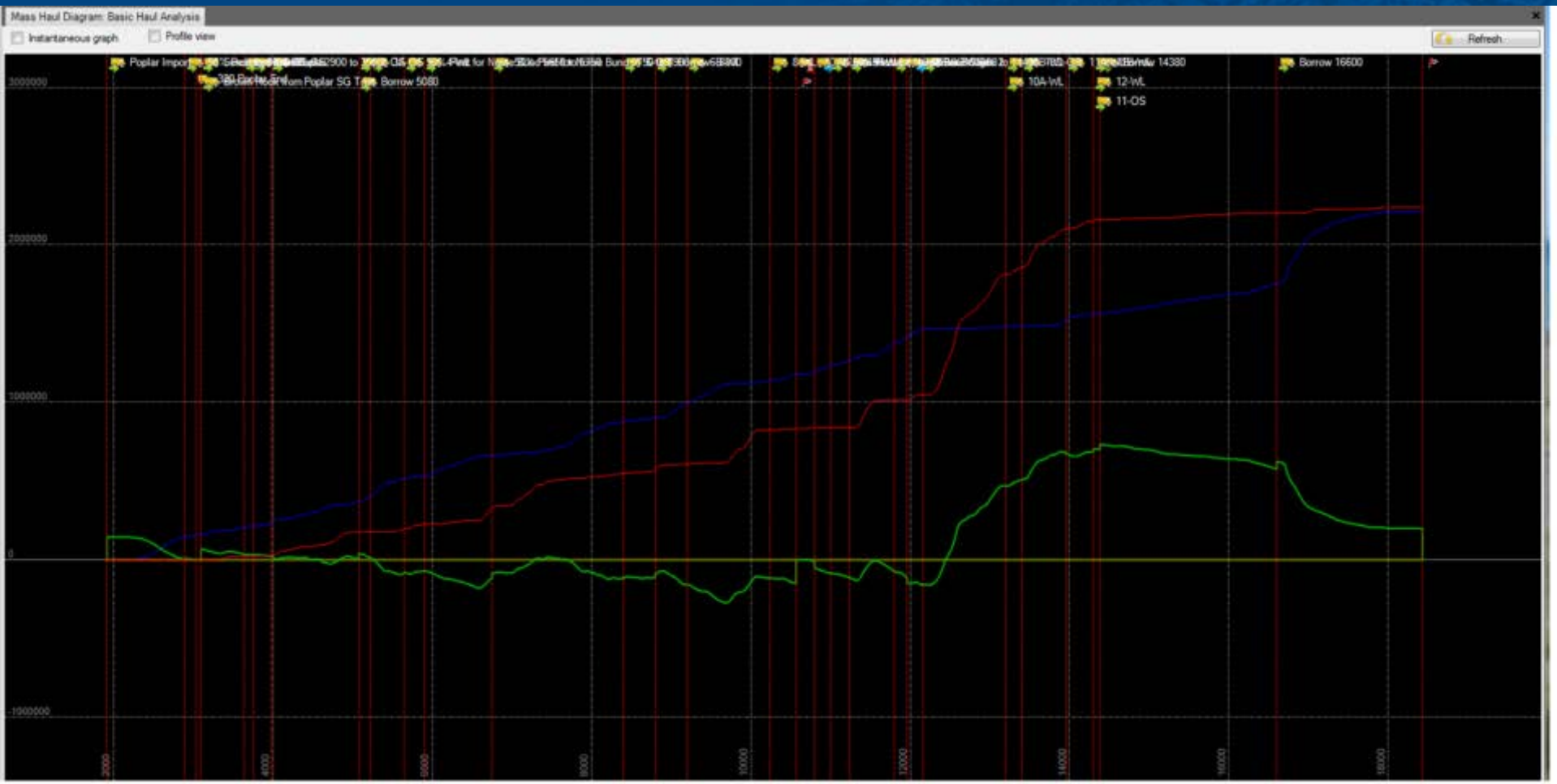
VisionLink



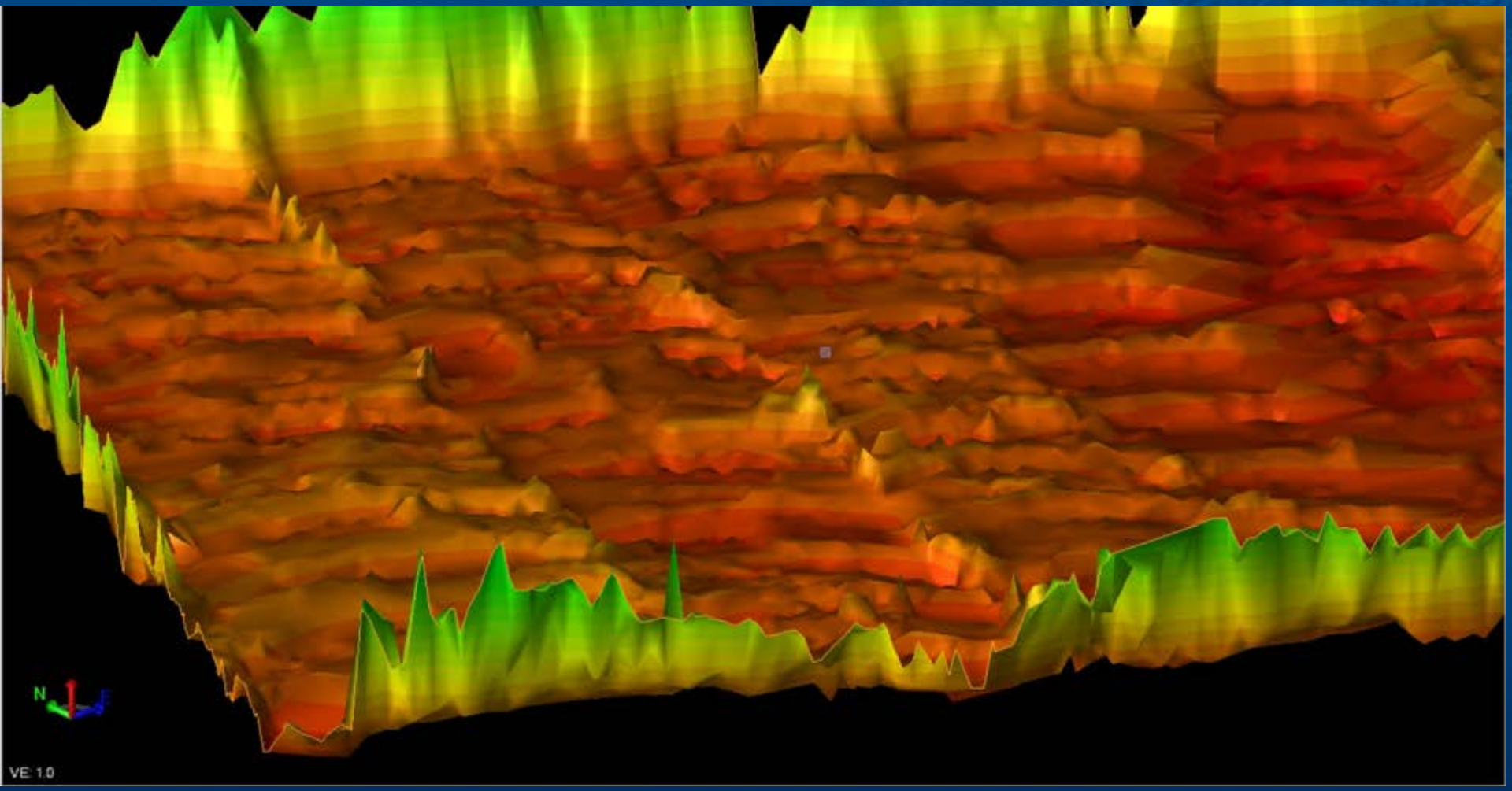
The “Linchpin”

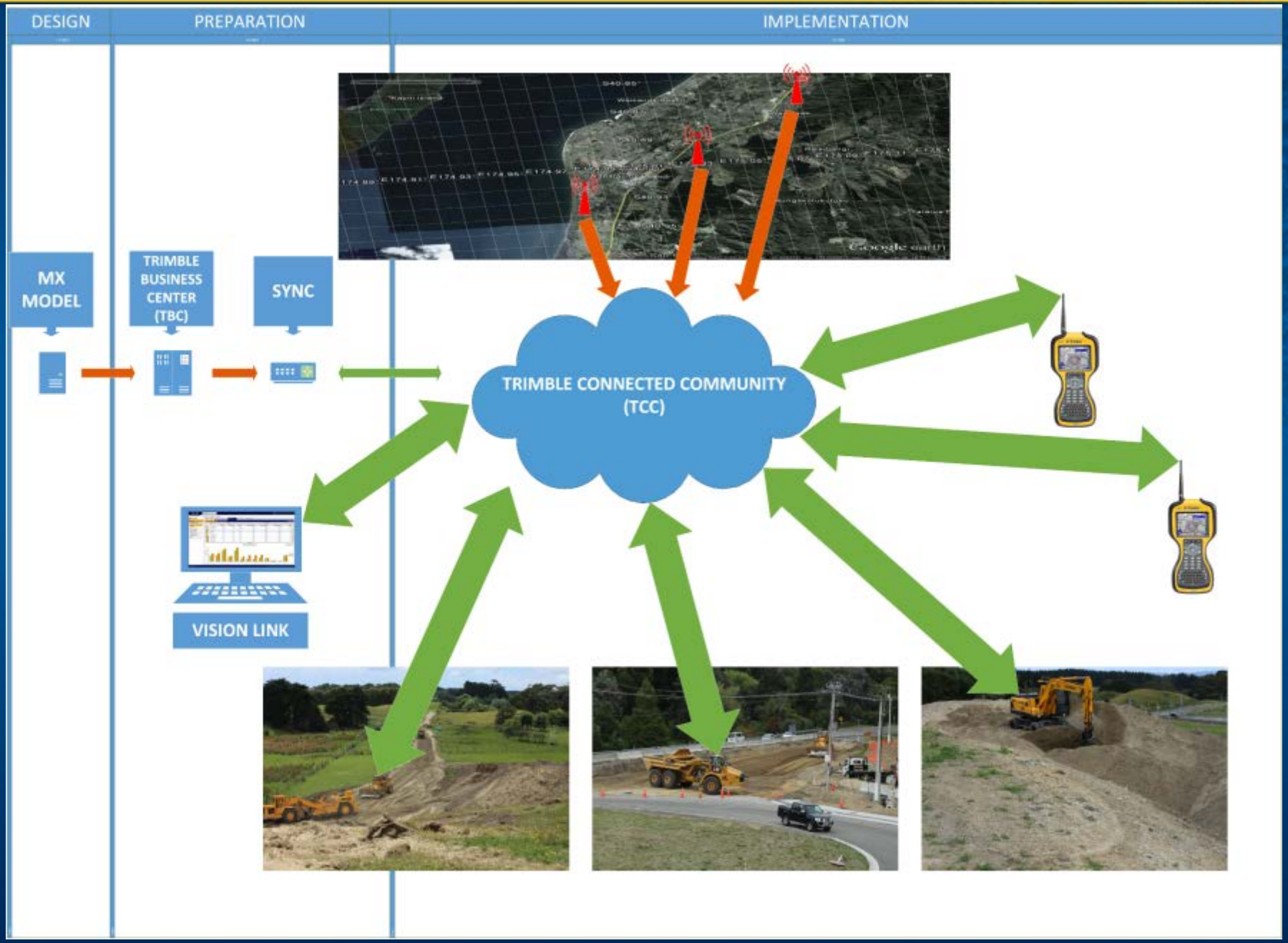
- Business Center - HCE
- Data prep from Bentley’s MX platform and DWG files
- Mass haul analysis can take all the potential variables to suggest the most cost-effective and efficient earthworks construction program
- Variables: Haul routes, borrow and waste sites, EGL, peat models, constraints, etc.
- Volumes / claim calculations

Mass Haul Analysis



3D As-Built Data




DESIGN
PREPARATION
IMPLEMENTATION
MX MODEL
TRIMBLE BUSINESS CENTER (TBC)
SYNC
TRIMBLE CONNECTED COMMUNITY (TCC)
VISION LINK

The Benefits to the Project

- Reduction in re-work
- Minimal set-out
- Increased Safety
- Faster / easier data transfer
- Effective data management
- More effective planning
- Clearer monthly claim process
- Increased efficiency

The Story from Will

The Construction Model and Connected Site

Thank You!