

Route 30 Emergency Landslide Repair, Use of Technology to Expedite Action



CENTER FOR IMPACTFUL RESILIENT
INFRASTRUCTURE SCIENCE & ENGINEERING

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by

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In association with

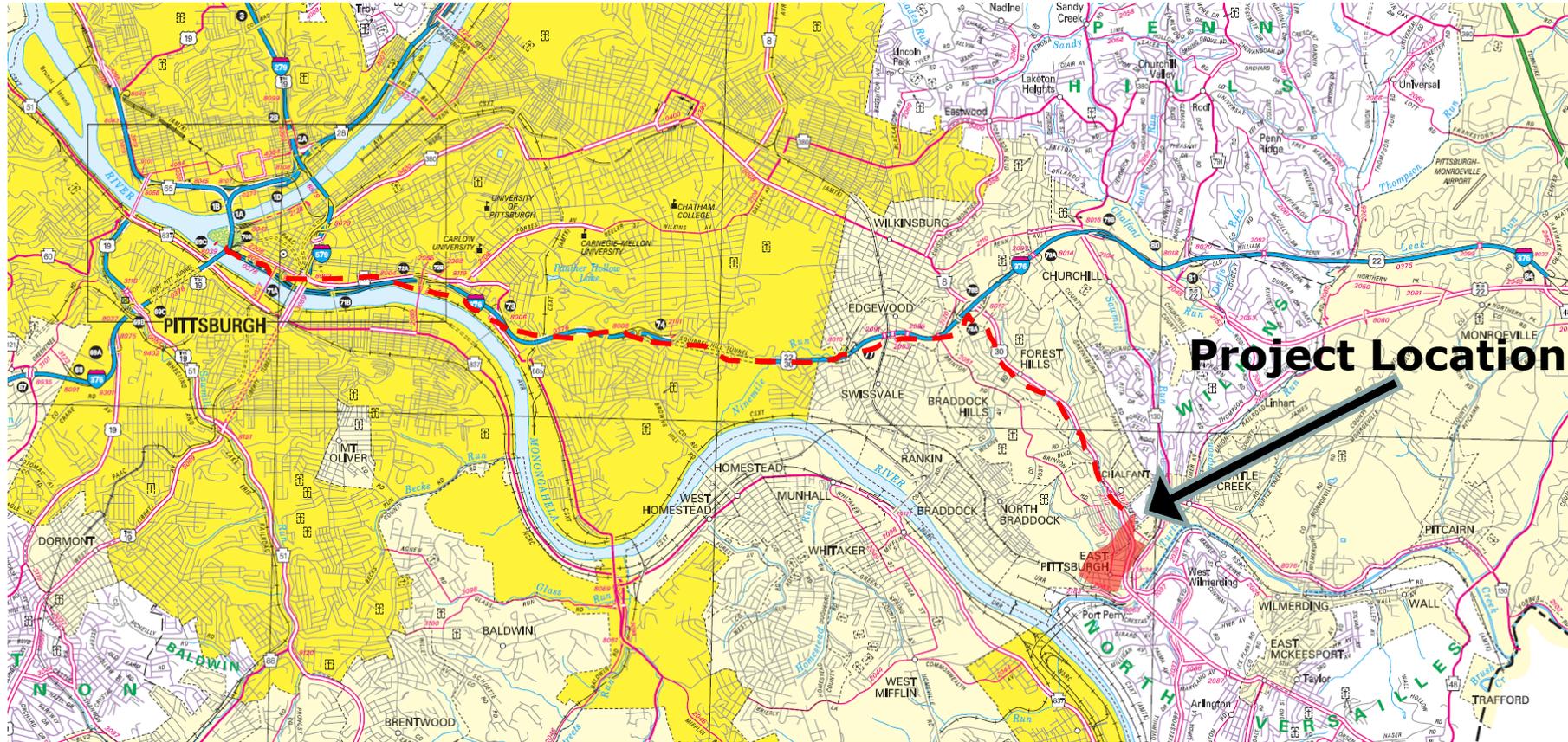
PennDOT District 11-0 and Golden Triangle Construction



*Excellence Delivered **As Promised***



East Pittsburgh Borough / Electric Avenue



- East Pittsburgh Borough adjacent to Electric Avenue
- 30,000 ADT
- Major Artery from eastern communities to Parkway East and City of Pittsburgh

Brief Background

- April 4th – PennDOT and GF were investigating a progressing roadway displacement 'subsidence' feature.
- April 6th – identify retaining wall movement on slope between the roadway and community below – evacuate residents immediately
- April 6th - Close Route 30 and prepare to excavate material above wall
- April 7th – Major Landslide Occurs;



Brief Background

- 35,000 CY of material displaced down a 90 FT high slope over a length of 300 feet
- Directly impacting 2 Apartment Buildings and one residential home.
- A total of 34 residents were displaced, 10 permanently.



What Now?



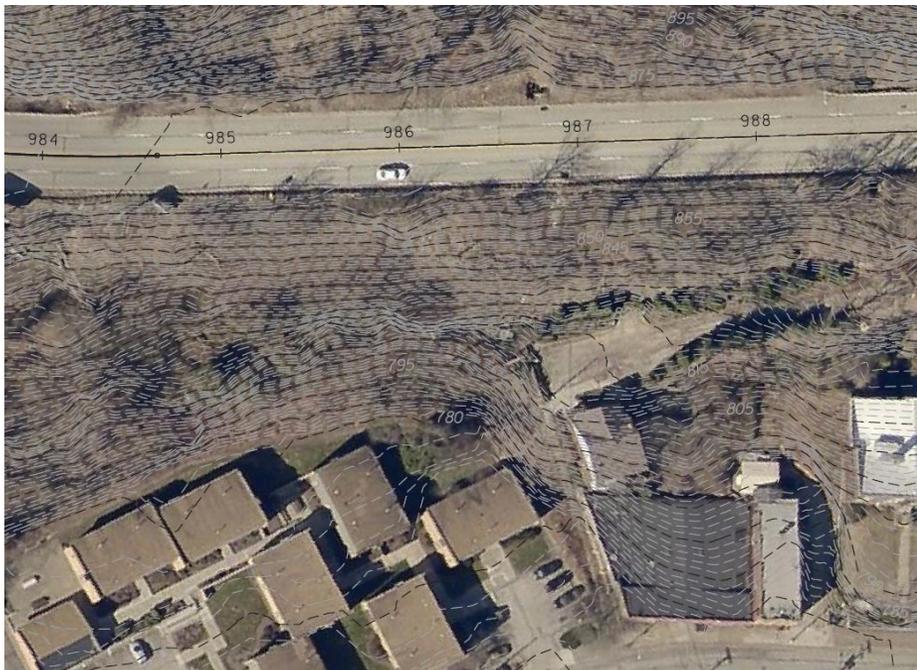
- PennDOT on-call drilling contractor also on site to perform core borings at the direction of GF and PennDOT Geotechnical Unit.
- Various other activities occur concurrently to investigate slide conditions, utilities, rights-of-way, resident needs, and set design concepts in motion.

- PennDOT requests that GF prepare plans to bid a remediation design within two weeks.
- PennDOT emergency on-call contractor on site carefully removing debris and slide material while design is being prepared.



Preliminary Site Mapping - LiDAR

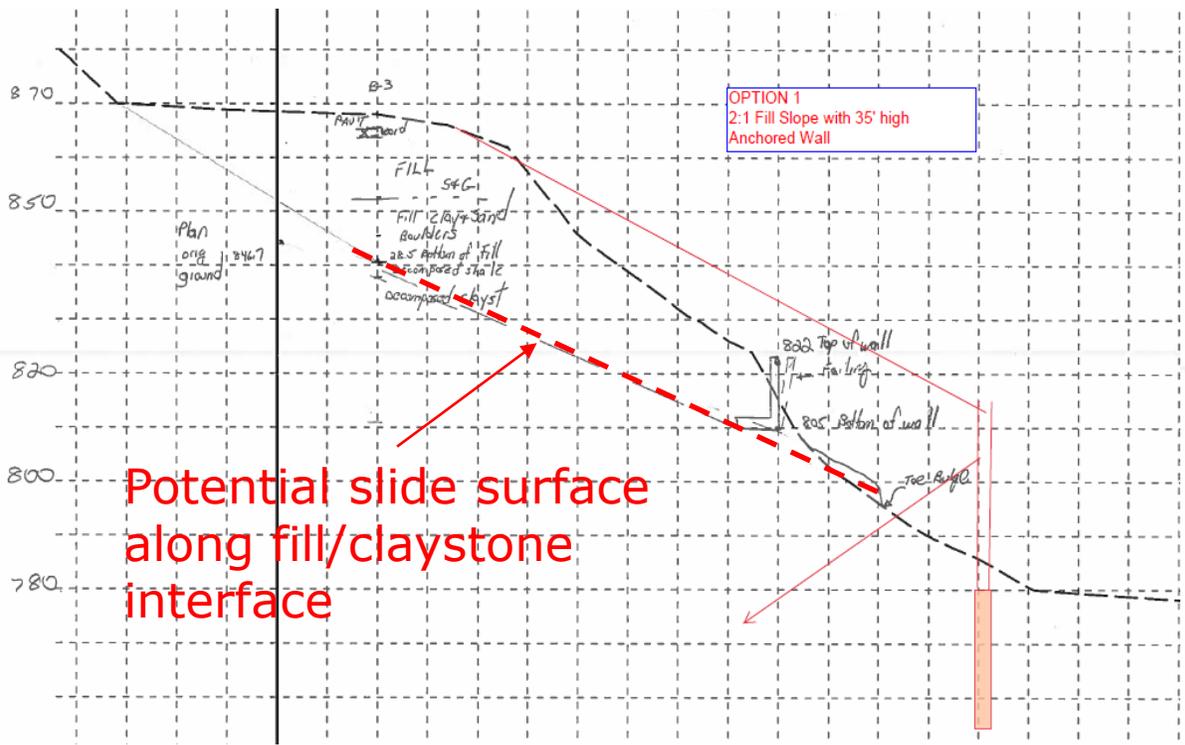
- GF developed a preliminary site plan using 2006 LiDAR imagery from PASDA:
<https://www.pasda.psu.edu/>
- LiDAR - acronym of "*light detection and ranging*" and "*laser imaging, detection, and ranging*"
= *3D laser scanning tool for high-resolution mapping.*



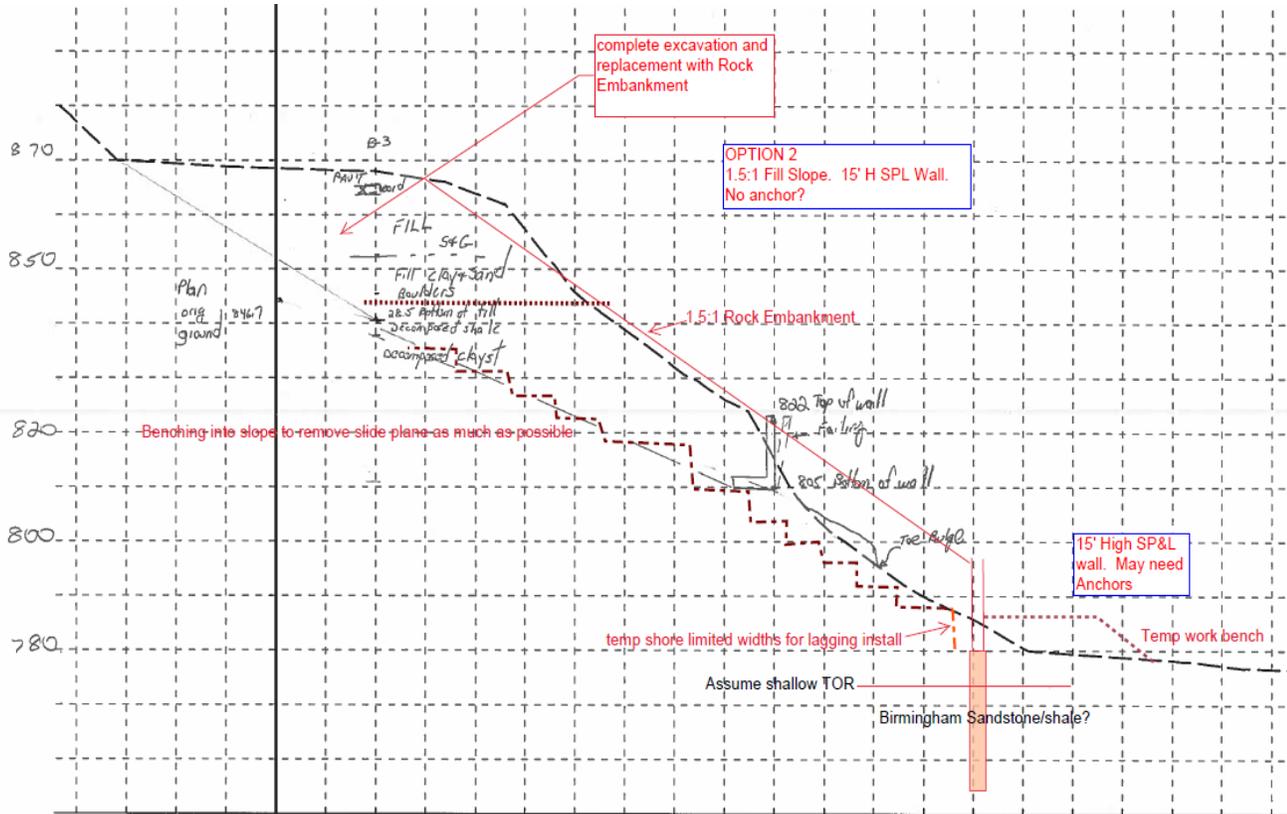
A screenshot of the Pennsylvania Spatial Data Access (PASDA) website. The header features the PASDA logo and the text "PENNSYLVANIA SPATIAL DATA ACCESS The Pennsylvania Geospatial Data Clearinghouse". Below the header is a navigation menu with links for HOME, ABOUT, ADVANCED SEARCH, APPS & TOOLS, SHARE DATA, TUTORIALS & HELP, and CONTACT US. The main content area is divided into several sections: "Access Data" with search boxes for keyword and data provider; "Data Shortcuts" with icons for Imagery, LIDAR & Elevation, Hydrology, Transportation, Boundaries, Recreation, Biota, and Energy; "Base Map Themes" for Pennsylvania Base Map Themes; "New Additions" for PEMA and PA Fish & Boat Commission data; and a footer with "QUICK LINKS", "EVENTS", and "SPOTLIGHT" sections.

LiDAR Cross Sections

April 6th –Conceptual Option 1



April 6th –Conceptual Option 2



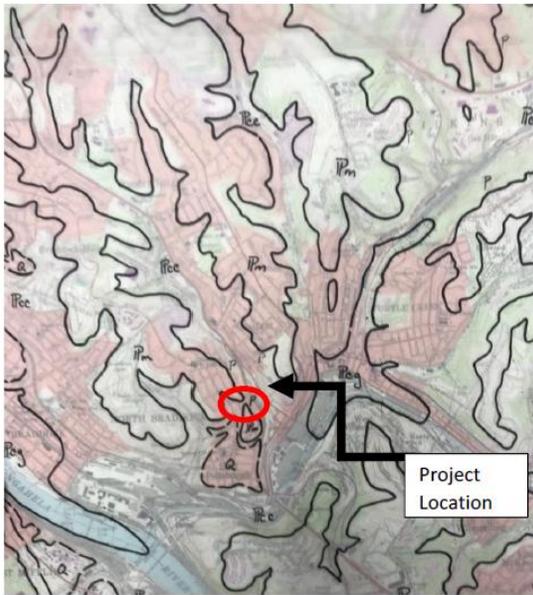
Site History

Geotech resource maps

4.0 Approximate elevation of stratigraphic unit: (See Outcrop/Contacts Map in Geotech Unit)

Outcrop on the base/top of: Pittsburgh Coal

Project Location	Structure Contour Elevation	Surface Elevation	Elevation Difference	Stratigraphic Unit
Seg 230 Off 1700	1000'	870' Roadway	-130' Below	Morgantown Sandstone Massive
Seg 230 Off 1700	1000'	780' Toe	220' Below	Birmingham Sandstone and Shale



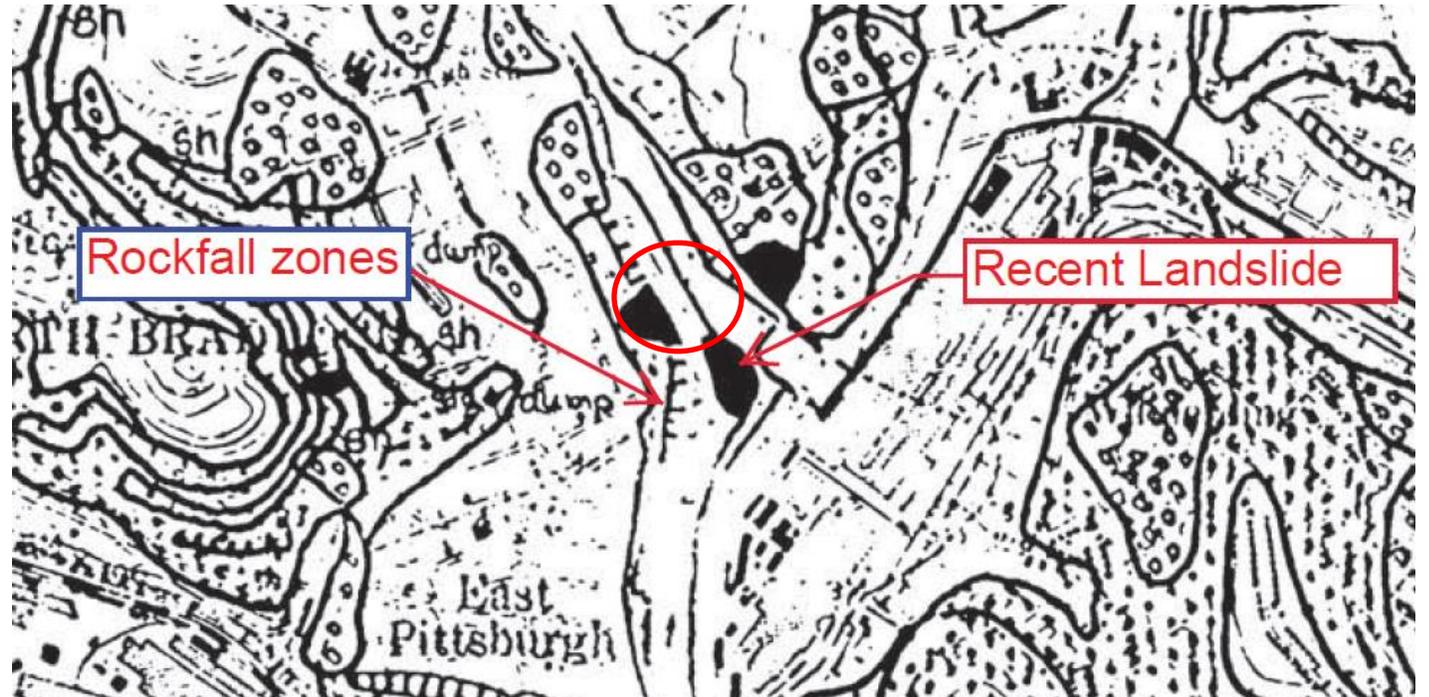
Geologic Contacts

PA DCNR Bureau of Geological Survey
<https://www.dcnr.pa.gov/Geology/>

Allegheny County Landslide Portal
<http://landslide-portal-alcogis.opendata.arcgis.com/>

Stratigraphic units

Landslide susceptibility



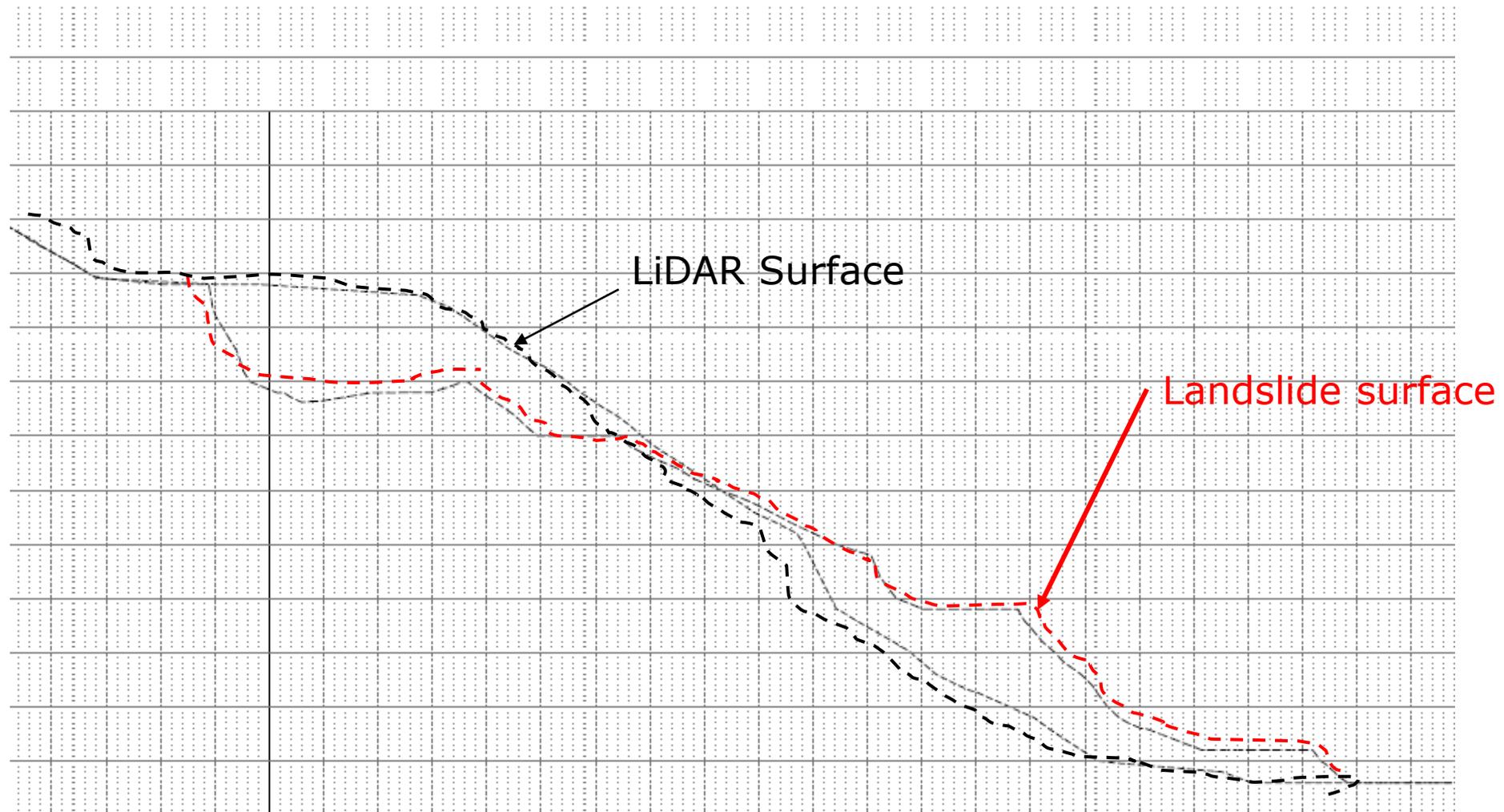
Current Site Mapping Obtained

Within 3 days of the landslide, Gannett Fleming obtained an FAA approved flight plan and used an UAV (drone) to develop detailed mapping suitable for final design.



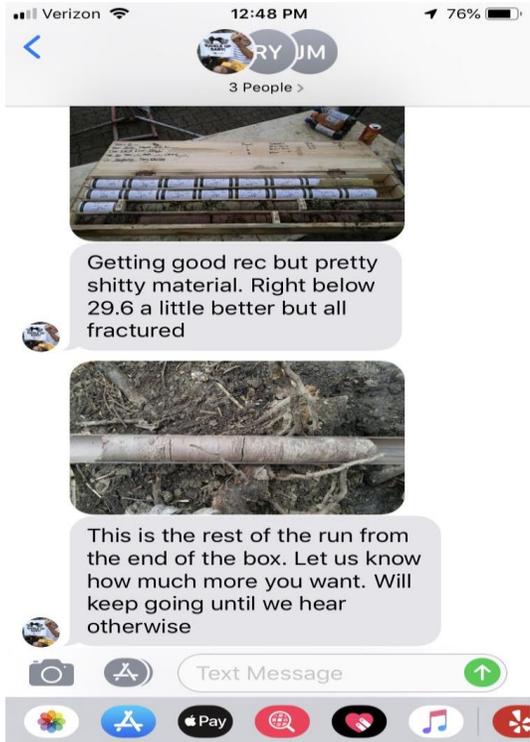
New Cross Sections vs 2006 LiDAR

April 11th - Updated Mapping comparison:



Realtime Data Transfer

- TEXT MESSAGES; PHOTOGRAPHS E-MAILS
- Photos of core samples with text descriptions of materials for realtime decision making based upon boring data and termination criteria
- Texting of hand written field boring logs for realtime input and adjustment of geotechnical design models
- Screenshot of survey instrument transmitting borehole locations upon completion prior to continued ground disturbance.

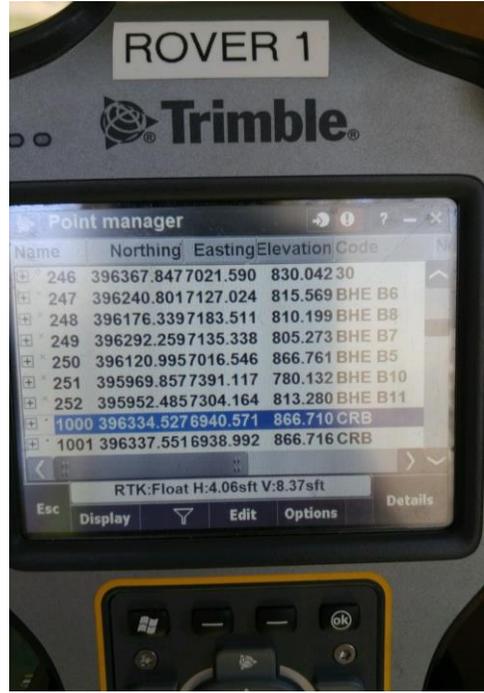


INSPECTOR'S FIELD LOG

BORING NO. _____ SHEET _____ OF _____

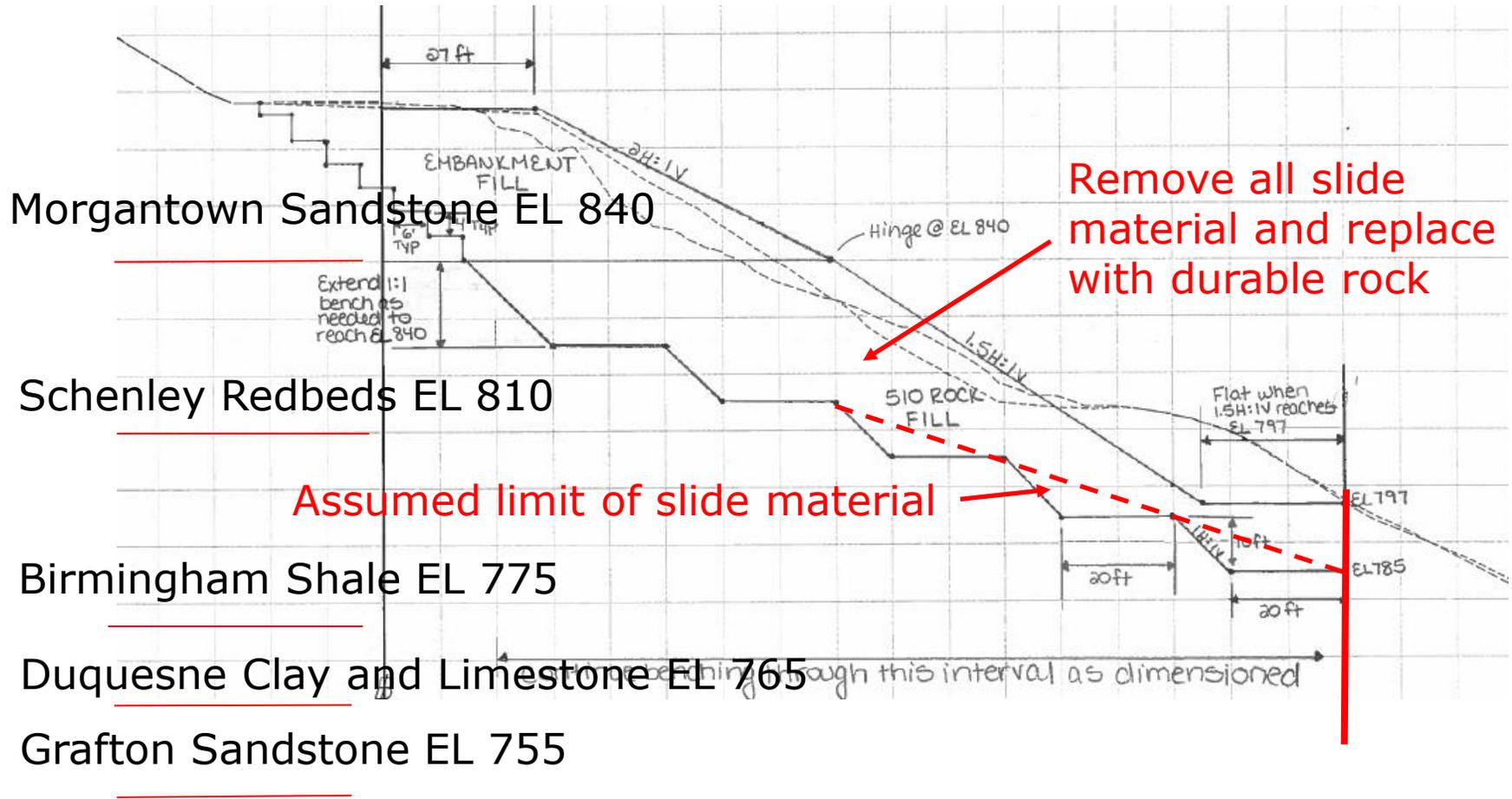
DISTRICT 113 COUNTY Allegheny

DEPTH (FT)	SAMPLE NO. AND DATE COLLECTED	DIAMETER OF SAMPLE	WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX	TESTS	REMARKS
21.0-27.0	10	1.0					21.0-27.0 Dry and sand, loose gravel, shift to hard, moist, heterogeneous, medium to low plasticity, brown and light brown, fm (2/10-6)
27.0-30.0	5	1.1					27.0-30.0 Brown, fine sand, little clay, very loose, wet to moist, well-sorted, dark gray, residual, RFD=578
30.0-38.1	20	1.5					30.0-38.1 Si. Stone, gray, medium hard, slightly weathered to fresh, narrow to medium bedding, flat dip, jointed, steep dip, narrow openings, RFD=578
38.1-40.2	100	1.0					38.1-40.2 Loose, black, soft to medium hard, fresh, laminated to thin bedding, flat dip, no apparent jointing, Duquesne local, RFD=10
40.2-42	100	1.0					40.2-42 Claystone, gray, soft

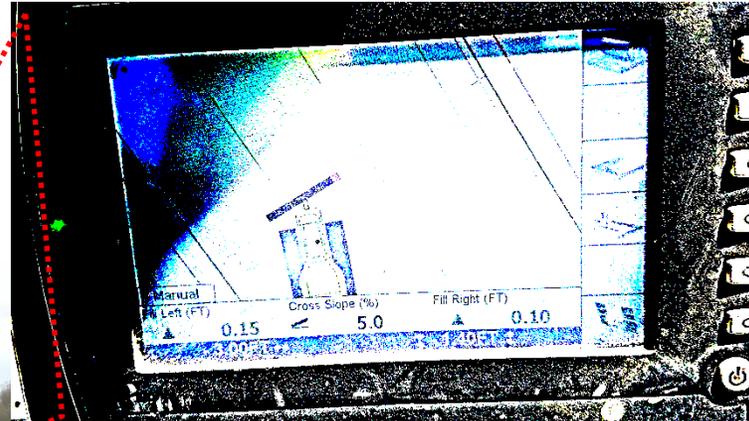


▶ Geotechnical Design Model

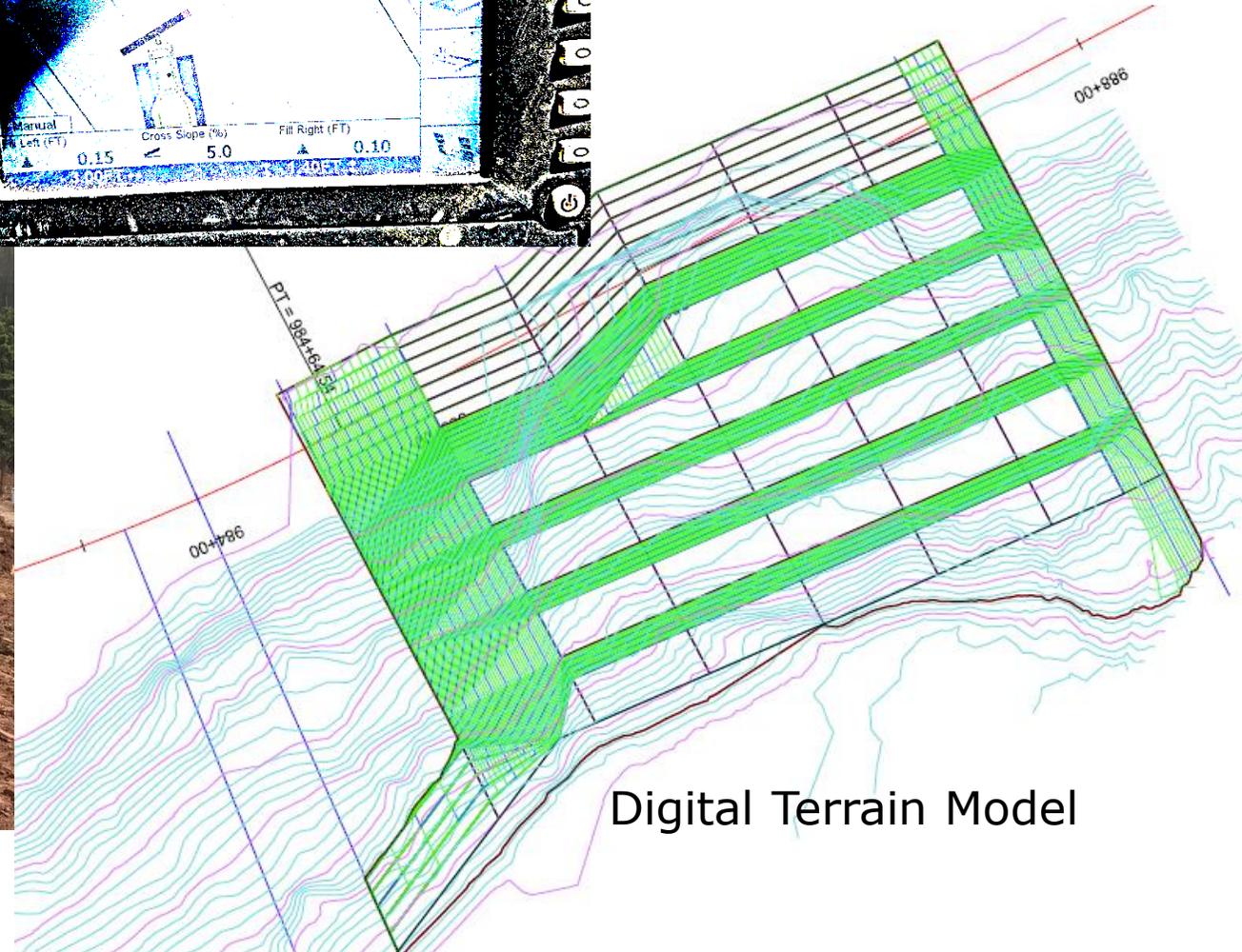
April 10th -12th : Stability Analysis



Contractor Realtime Excavation Data



Machine Grading
Guidance System



Digital Terrain Model

- Real time checking of bench elevations

▶ Geotechnical Field Adjustments



UAV Construction Monitoring

- UAV mapping was also performed at regular intervals under PennDOT directives in order to monitor construction progress during 24 hour / 7 days per week operations.
- Identified Technologies of Bridgeville provided the UAV services.
- The drone was flown generally weekly and developed:
 - 3D records of the project progress
 - Quantities of excavation and fill vs. previous flights for progress payments
 - As-built cross sections of final excavation and fill grades.
- Lesson learned. UAV Construction surveys used independent references; therefore, they were not completely compatible with UAV design survey or contractor machine files.

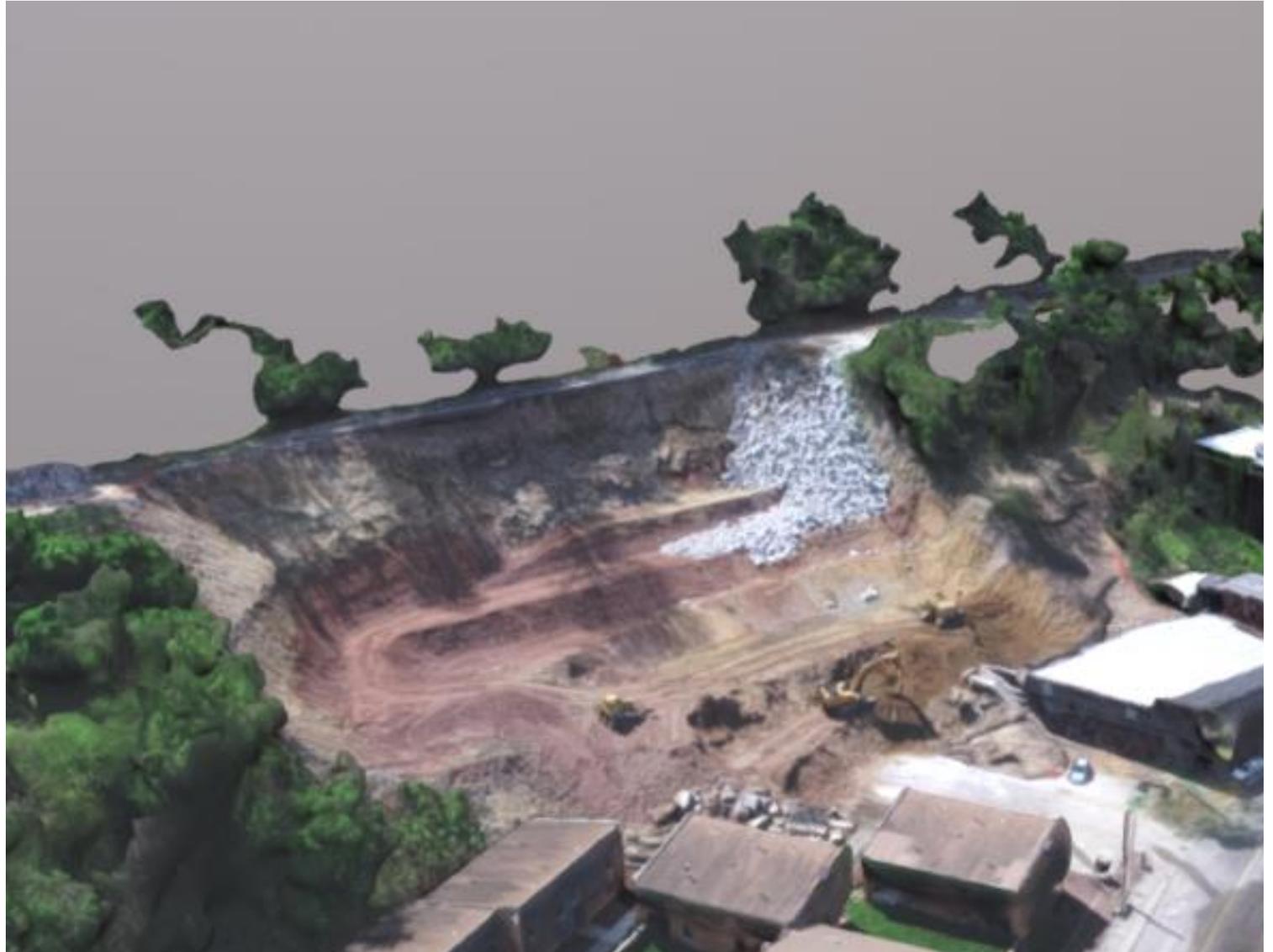
UAV 3D Models

3D photo from 4/13/18 showing initial landslide removal operations



UAV 3D Models

3D photo from 05/09/18
showing completion of bench
excavation and beginning of
rock embankment placement



UAV 3D Models

3D photo from 06/01/18 showing retaining wall construction and rock embankment placement.



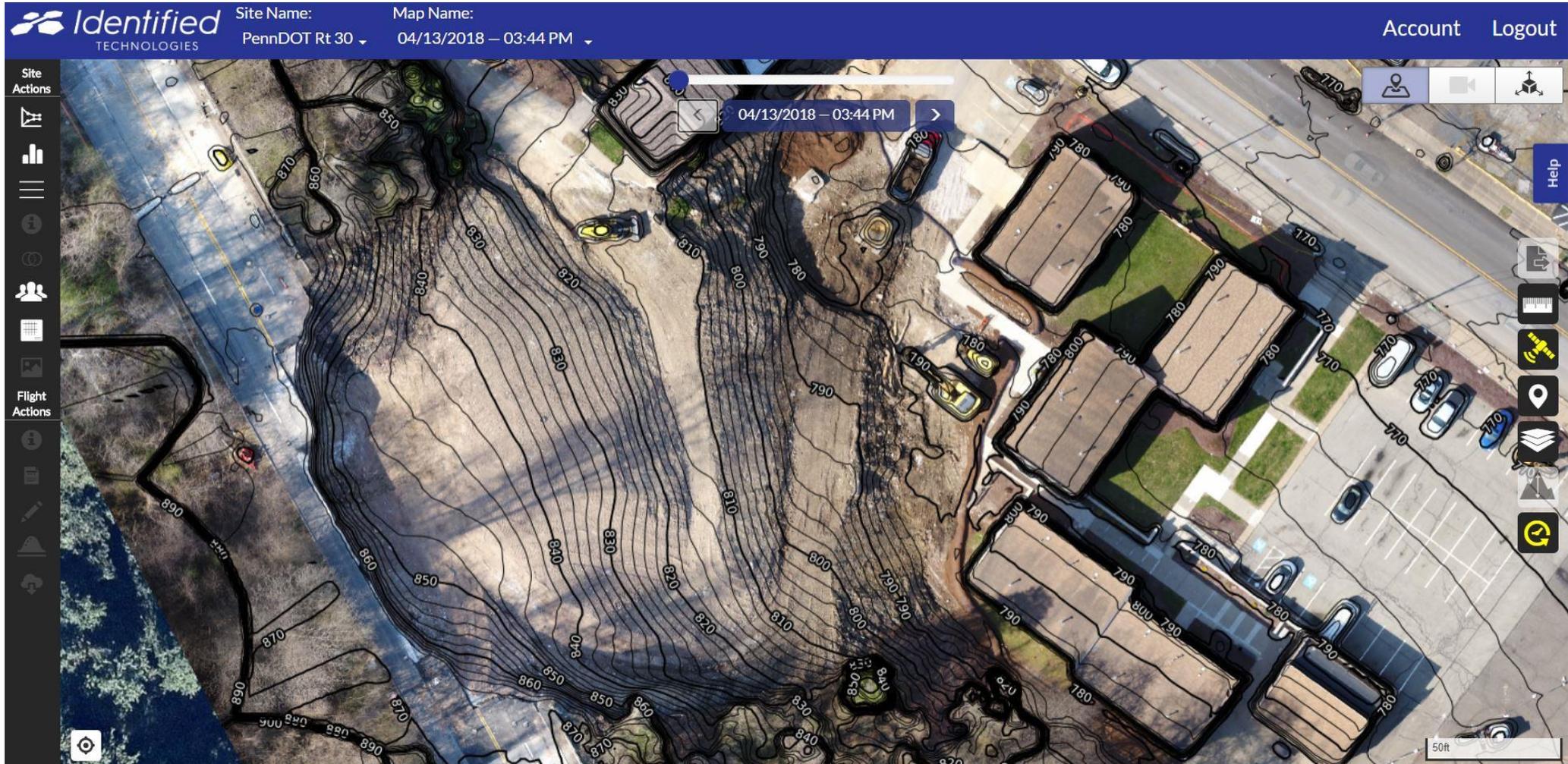
UAV 3D Models

3D photo from 06/19/18 showing substantially complete retaining wall construction and rock embankment.



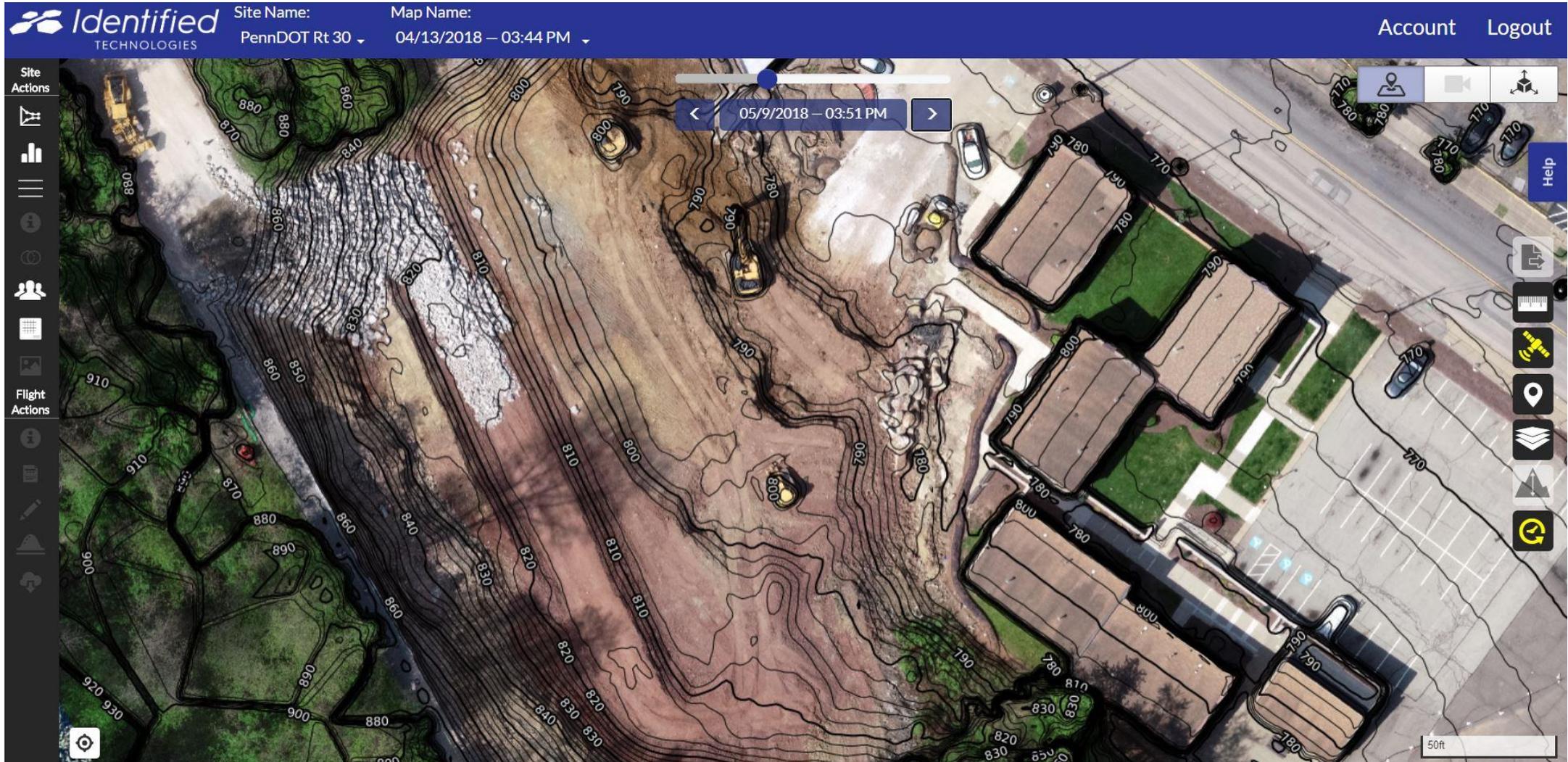
Contour Plans of UAV 3D Models

- Contours of excavation progress @ 4/13/18



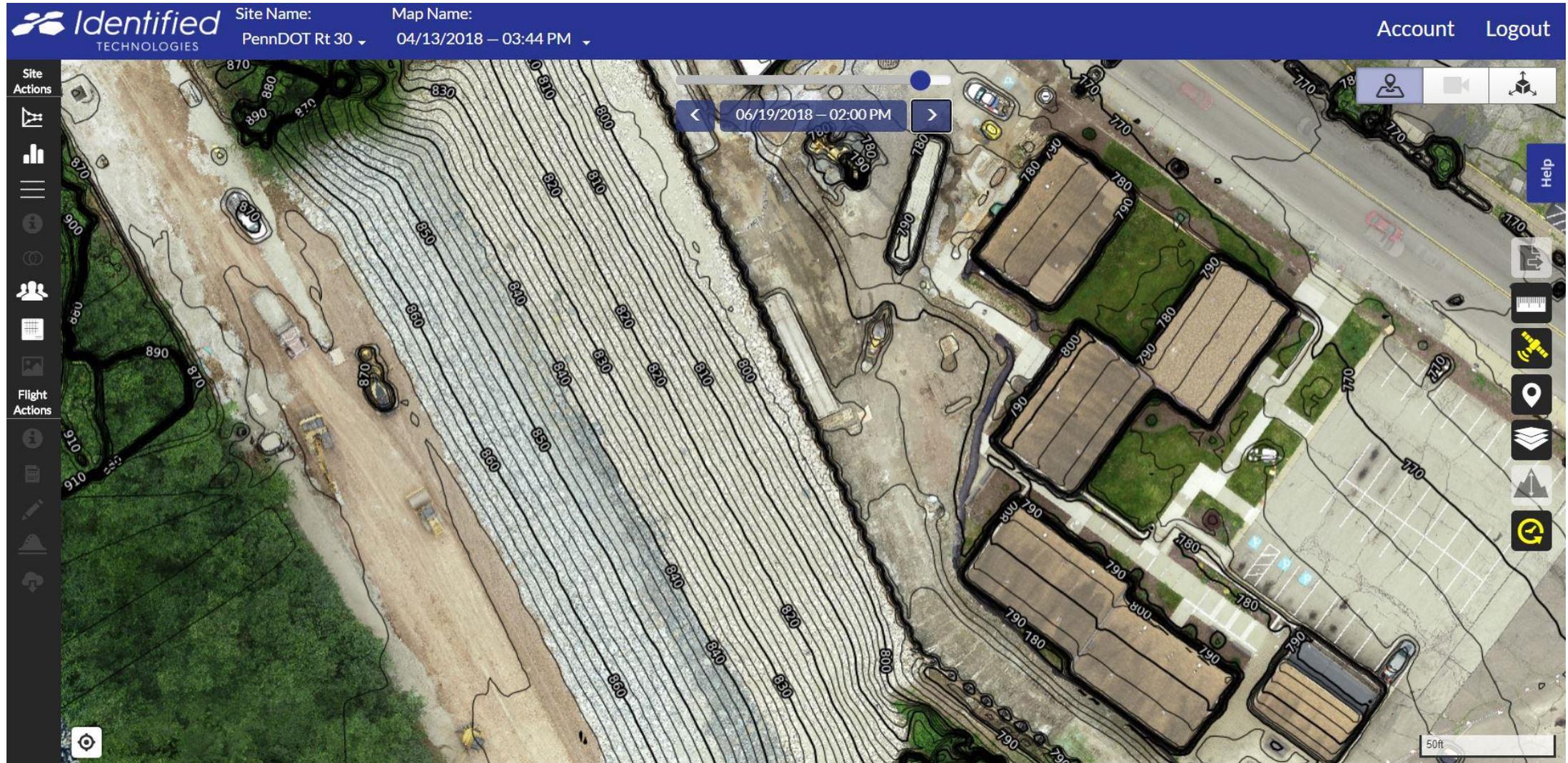
Contour Plans of UAV Models

- Contours of completed excavation on 5/9/18



Contour Plans of UAV Models

- Contours of completed earthwork on 6/19/18



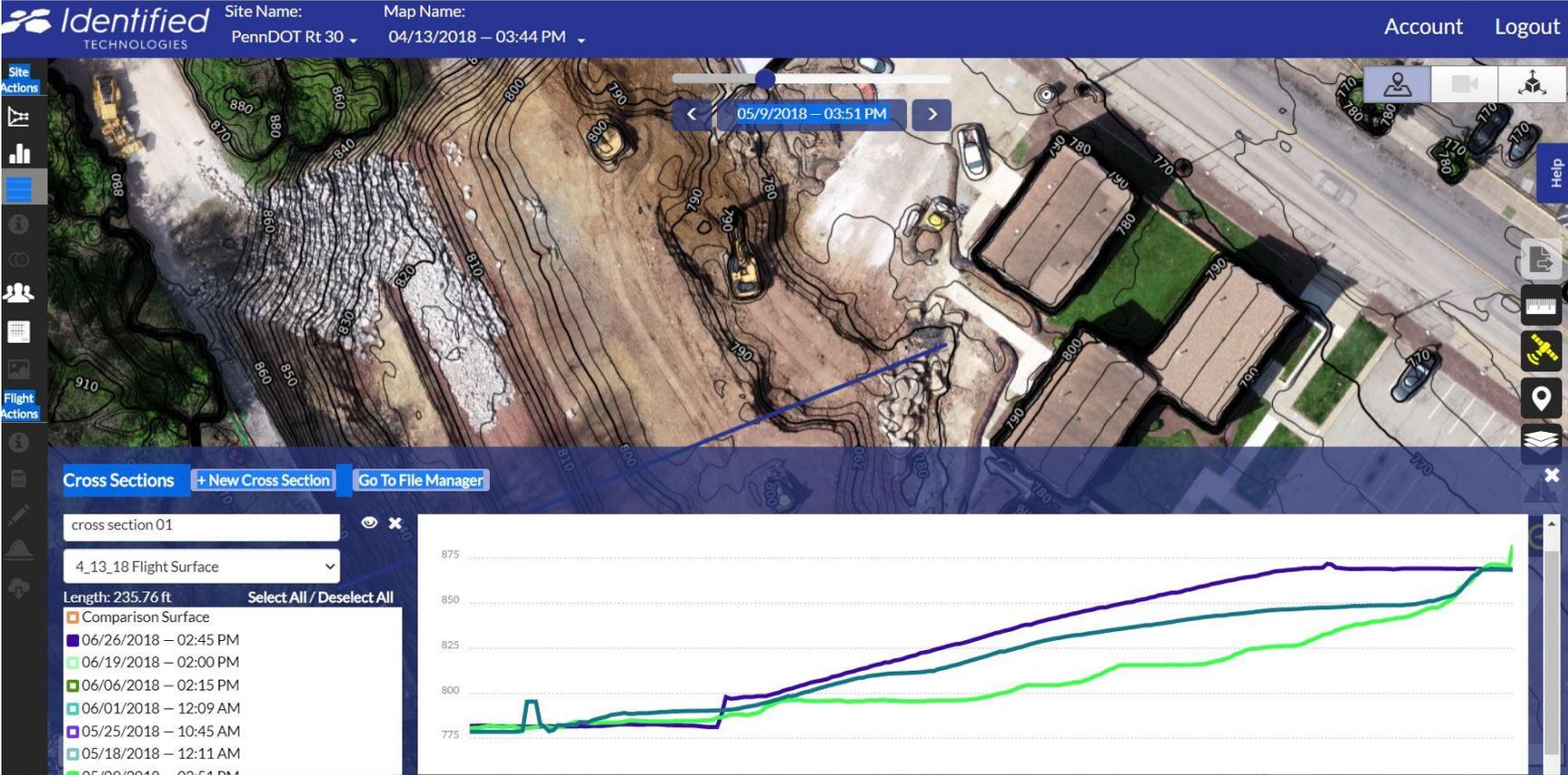
Progress Tracking

Software can be used to track:

- Excavation depth, area, volumes;
- Backfill depth, area volumes;
- Quantities;
- Production rates;

Can be applied amongst various desired intervals of interest.

Helps the project team evaluate a number of schedule related variables.

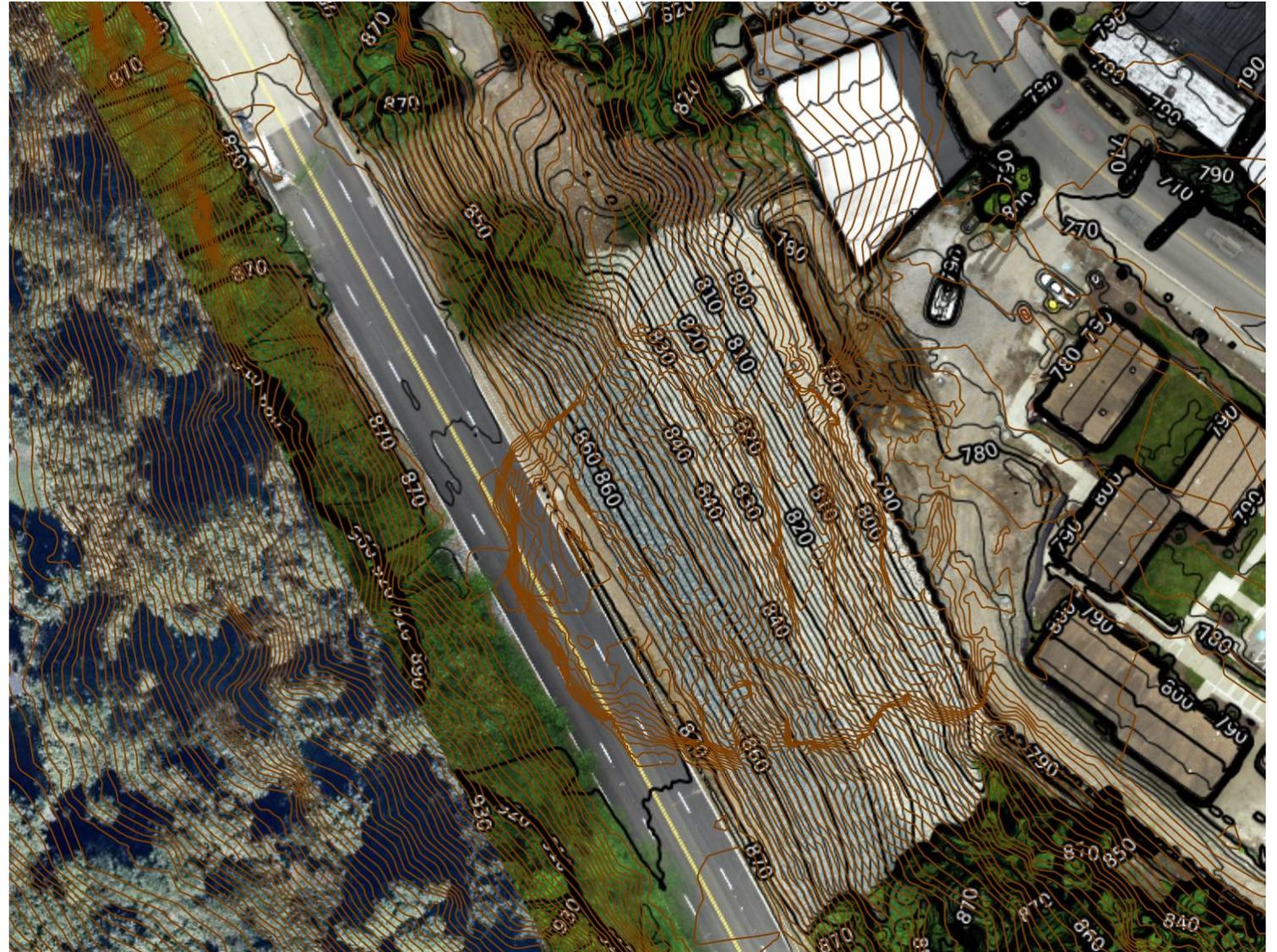


Contour Plan Comparisons

Contour plots of original grades
vs. final grade

or any interim 3D image
modeled by the UAV survey

presented to compare areas
change.



Specific Material Tracking Example

Software allows identification and spatial recognition of user defined material placement at any comparative interval.

The screenshot displays the Identified Technologies software interface. At the top, the site name is 'PennDOT Rt 30' and the map name is '04/16/2018 - 03:31 PM'. The main map shows a topographic view with contour lines and several blue-outlined regions labeled 'Foreign Borrow', '510 Rock', and 'Additional Excavation'. A data panel on the left provides a summary of the 'Foreign Borrow' region, including its area and a line graph showing cut and fill volumes over time.

Site Name: PennDOT Rt 30
Map Name: 04/16/2018 - 03:31 PM

Tracking Cut/Fill
Select Comparison Surface: 5_9_18 Flight Surface

Foreign Borrow
Area: 32,563.9 ft²

Date	Cut (yds ³)	Fill (yds ³)	Net (yds ³)
4/13/18	18,559	-294	18,265
4/16/18	17,806	-297	17,509
5/1/18	18,404	-290	18,114

▶ The Finished Product

