AEC APPLICATIONS GPS/RTS TECHNOLOGY

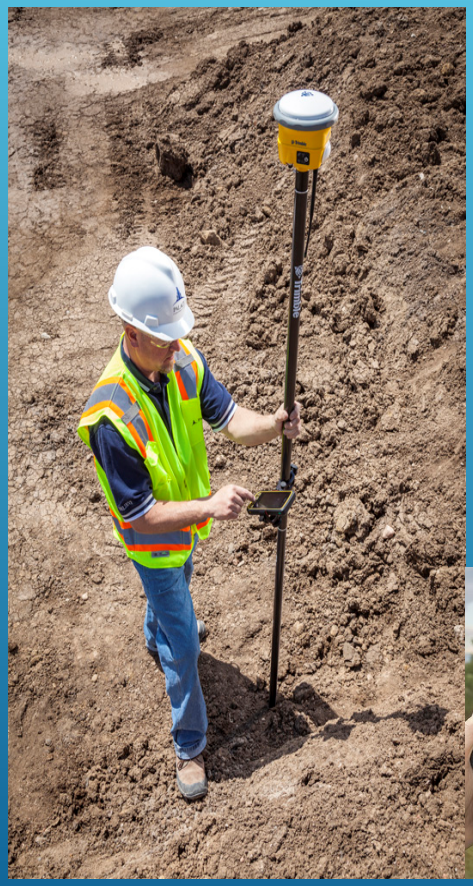
Global Positioning System/Robotic Total Station

Greg Sardinskas-Mobile Inspection Technology Coordinator

MOBILE INSPECTION TECHNOLOGY

- *The overall goal of the Mobile Inspection Technology Unit is to repurpose the electronic engineering data at the construction jobsite using **GPS** and **Robotic Total Station Technology** for Construction Inspection*

GPS (RTN) REAL TIME NETWORK – INTERNET DRIVEN - VRS (VIRTUAL REFERENCE STATION)



GPS Satellite Signals

Connected via Bluetooth

T-10 Rugged Tablet

Obtains real-time corrections from base stations (ACORN website) via internal cellular provider

ACORN

LIST OF NECESSARY EQUIPMENT

Equipment needs:

- GPS Receiver
- GPS Base Station of a CORS Network is not being used
- Tablet or hand held running field software
- Field Rod with Bipod legs
- Internet provider, Sim card, Mifi Device if CORS network is used
- Desk Top PC Software
- Hard line internet connection in field office for remote installation capabilities

PROJECT SELECTION AND SITE CONDITIONS

- Canopy check – will foliage or overhead utilities/structures severely obstruct satellite signal
- Project control – is acceptable project control available for the site
- Cellular service – is the cellular coverage present and reliable or will a base station be required for connectivity to the ACORN network
- EED level of detail – Is the Level of Detail (LOD) in the EED adequate for the GPS/RTS
- Equipment availability – will the appropriate equipment (GPS or RTS) be available for the project

NECESSARY SETUP AND FILES

- Setting up the Equipment/Checking into ground control
  - Get the project control point information from Surveys
  - Create a .csv file for the field software
  - Complete a Site Calibration or Localization to the project control

- Build your office software "Project" with EED
  - 2D Design model or Corridor file
  - 2D Existing planimetric file or ground File
  - 3D Design model or Digital Terrain Model
  - 3D Existing Surface from Surveys (DTM)
  - Geometry files (Construction Base line)

ELECTRONIC ENGINEERING DATA

- Design CAD graphics converted (DGN to DXF)
- Survey CAD graphics converted (DGN to DXF)
- Design Surface Model converted (DTM to Land XML)
- Survey Surface Model converted (DTM to Land XML)
- InRoads converted (ALG to Land XML)
- Future icm files

SPECIFICATIONS

- Stake Requirements
  - No Change
  - Still Required under contract
  - Don't have to rely on stake, could be verified using real time technology
- Measurement of Quantities
  - GPS/RTS methods are approved for measurement for payment where applicable
    - Acceptable vertical and horizontal precision
    - Pay limits are achievable
    - Records examiners trained and provided reference guide
    - Future surface to surface quantities from the models

SPECIFICATIONS (CONTINUED)

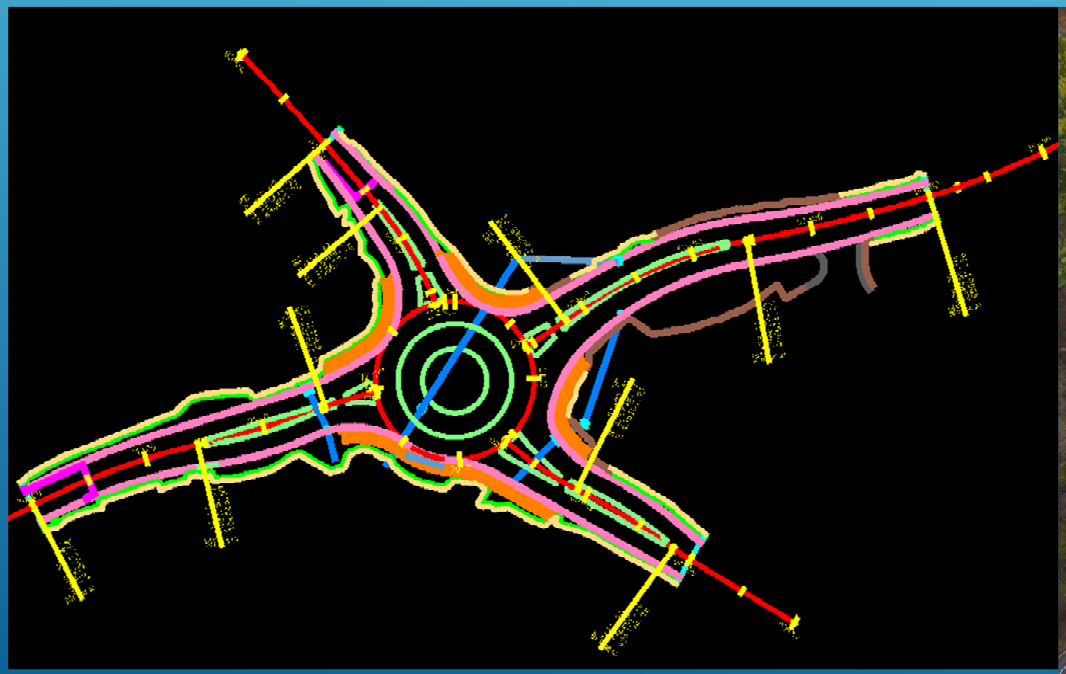
- Equipment Approved for Method of Measure / Basis of Payment
  - GPS and RTS approved for use by choice not mandated
  - Users must provide training proficiency documentation during records review
  - Difficulties getting it approved]
- Information "Collected verses Measured"
  - Any Contract Pay Items are measured for Payment
  - Subterranean and above ground utilities are geospatially collected
  - As-built data

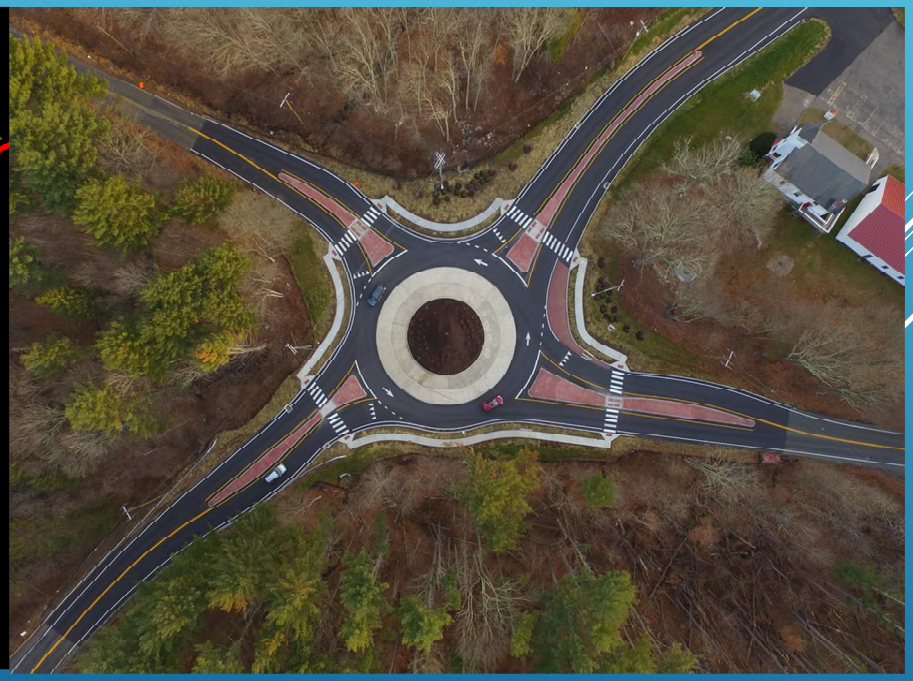
SPECIFICATIONS CONTINUED

- Handling Design Initiated construction change orders
  - Follows current change order process (Digital Project Development Manual)
  - Currently provided by Field Construction personnel
- Manuals and Work Flows
  - Yearly dynamic training manual
  - Operational guide
  - GNSS RTK Guide
  - Records Examiners Guide

ROUNDABOUT PROJECTS

- Projects with complex geometry
- Several Irregular shaped area measurements
- Real time Cut and Fill Verification in relation to the 3D model
- Horizontal layout in relation to the construction base lines





LIMITATIONS TO THE TECHNOLOGY

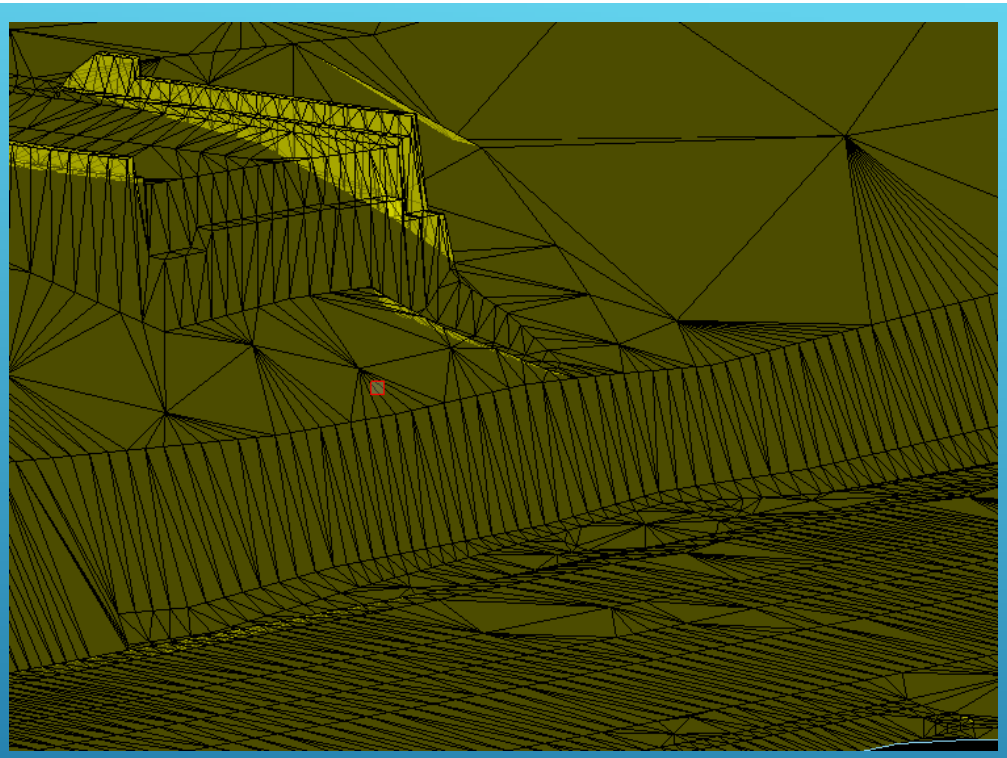
- The following items can obstruct the GPS signal
  - Tree canopy
  - Tall building
  - Over head wire clusters
  - Using the rover close to street signs
  - Weak cellular signal

Solution:

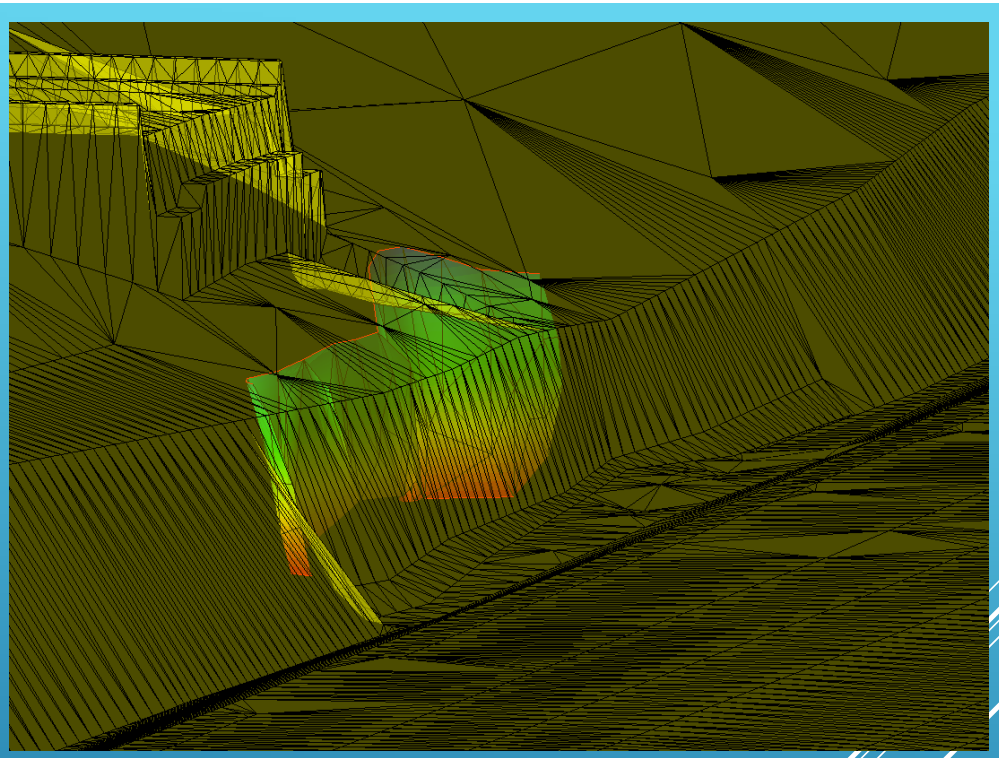
- Robotic Total Station (RTS) with data collector or tablet running same SCS900 software

ROBOTIC TOTAL STATION TECHNOLOGY

- Robotic Total Station use for Inspection
  - Re-section into the ground control provided by Surveys
  - Laser from the Total Station follows the prism mounted at the top of the field rod
  - Laser/Prism guided one person operation
  - Work flow is the same for field measurements
  - Milling elevation
  - Gutter slope checks
  - Material thickness measurements
  - Grade check tolerance reporting
  - Target-less direct read
    - Vertical face surface collection
    - High speed roadway data collection
- Limitation:
  - "Line of Site"
  - Quality of survey control
  - Delicate equipment



EXISTING



AFTER

ROCK EXCAVATION RTS TARGET LESS DIRECT READ

TRAINING

- Product training provided by a certified Trimble trainer
- CTDOT inspection work flow training is provided by AEC
- Field support provided by a DOT work group consisting of personnel from AEC, OOC, and Surveys
- 3 Tier Proficiency process
  - Tier 1 project start up, verification of station and offset
  - Tier 2 Linear, area and single point shots including reporting and measurements will be used for final payment
  - Tier 3 Surface creation and volume measurements for final payment

GPS REPORT CONTENTS

- Check vertical/horizontal precision for linear and area measurements (shall not exceed 0.15ft per measurement)
- For Volume and elevation verification measurements, precision for each measurement should not exceed 0.082ft unless tighter tolerances are required
- Precision type must be RTK Fixed
- Northing, Easting, Elevation, Station, Offset, and measurement date must be displayed for each reading
- Verify the alignment used, the work order name and date, report heading, line labels, and project units
- Review the included image

REPORTING OF FIELD DATA - GPS

Company Name

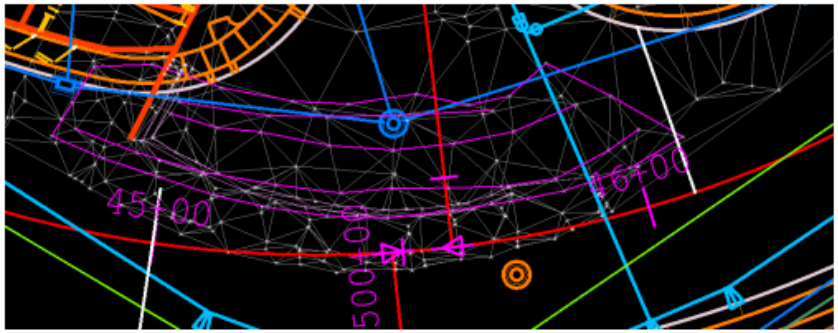
Progress payment 1a 04/15/2016

Work Order Name:	20160415 earth ex retaining wall
First Access:	4/15/16 11:07 AM
Last Access:	4/15/16 11:48 AM
Operator Name	-
Site Name	Farmington 51-260
Design	Design_Existing DTM
Units:	(US Survey Feet)
Total Number of Points:	42

Sort **Output Report**

Line Name	Measured N	Measured E	Measured Elv	Measured Station	Measured Offset	Alignment Name	Precision H	Precision V	Precision Type	Date
stage 1a vb	825077.882	980341.495	247.015	44+41.276	-11.458	Rte-4	0.026	0.044	RTK Fixed	4/15/2016
stage 1a vb	825071.550	980330.980	246.506	44+28.777	-8.660	Rte-4	0.026	0.046	RTK Fixed	4/15/2016
stage 1a vb	825066.916	980317.815	245.668	44+14.362	-7.477	Rte-4	0.026	0.045	RTK Fixed	4/15/2016
stage 1a vb	825064.759	980307.197	245.033	44+03.162	-7.450	Rte-4	0.026	0.048	RTK Fixed	4/15/2016
stage 1a vb	825062.968	980295.725	243.977	43+91.164	-7.365	Rte-4	0.031	0.059	RTK Fixed	4/15/2016
stage 1a vb	825061.424	980282.552	242.763	43+77.475	-7.034	Rte-4	0.027	0.046	RTK Fixed	4/15/2016
stage 1a vb	825061.848	980270.380	241.922	43+64.916	-7.879	Rte-4	0.026	0.047	RTK Fixed	4/15/2016
stage 1a vb	825063.597	980258.508	241.221	43+52.547	-9.395	Rte-4	0.026	0.045	RTK Fixed	4/15/2016
stage 1a vb	825066.092	980247.809	240.523	43+41.189	-11.124	Rte-4	0.029	0.054	RTK Fixed	4/15/2016
stage 1a vb	825069.804	980236.719	239.846	43+29.081	-13.458	Rte-4	0.027	0.050	RTK Fixed	4/15/2016
stage 1a vb	825073.489	980225.742	239.289	43+16.869	-15.175	Rte-4	0.027	0.051	RTK Fixed	4/15/2016
stage 1a vb	825078.011	980215.472	238.606	43+05.006	-17.267	Rte-4	0.028	0.055	RTK Fixed	4/15/2016
stage 1a vb	825084.721	980219.684	240.306	43+07.693	-24.804	Rte-4	0.029	0.050	RTK Fixed	4/15/2016
stage 1a vb	825092.070	980223.879	241.633	43+10.396	-32.930	Rte-4	0.027	0.047	RTK Fixed	4/15/2016
stage 1a vb	825092.524	980235.472	243.997	43+23.643	-35.689	Rte-4	0.027	0.047	RTK Fixed	4/15/2016
stage 1a vb	825090.788	980240.773	245.055	43+30.148	-34.809	Rte-4	0.028	0.047	RTK Fixed	4/15/2016
stage 1a vb	825087.773	980249.445	246.079	43+40.669	-32.862	Rte-4	0.028	0.046	RTK Fixed	4/15/2016
stage 1a vb	825085.073	980263.715	246.952	43+57.407	-31.046	Rte-4	0.027	0.045	RTK Fixed	4/15/2016
stage 1a vb	825084.486	980274.847	247.508	43+70.256	-30.430	Rte-4	0.028	0.047	RTK Fixed	4/15/2016
stage 1a vb	825086.527	980288.233	248.005	43+85.851	-31.605	Rte-4	0.028	0.052	RTK Fixed	4/15/2016
stage 1a vb	825084.293	980298.622	247.800	43+97.384	-28.108	Rte-4	0.028	0.046	RTK Fixed	4/15/2016

REPORTING OF FIELD DATA - GPS



Date	4/15/2016	
Time	11:51:03 AM	
Description	stage1a progress payment	
Volume type	Surface to surface volume	
Total fill volume	180.832 cu yds	
Surface area	2551.121 usft²	
Boundary	stage 1a vb	
System Check	Date	4/15/2016
	Time	11:20:25 AM
	Point name	34
	Measured N	825131.351 usft
	Measured E	980405.131 usft
	Measured Z	250.179 usft
	Delta N	0.082 usft
	Delta E	0.033 usft
	Delta Elv	0.007 usft

REPORTING OF FIELD DATA - RTS

Company Name

Company address
City, State ZIP Code
Phone Number / Fax Number

Client: -

Work Order Name: 10302015splitisld2
First Access: 10/30/15 9:25 AM
Last Access: 11/9/15 9:22 AM
Operator Name -
Site Name Seymour #124-162
Design des_124-162

Units: (US Survey Feet)
Total Number of Points: 55

Sort **Output Report**

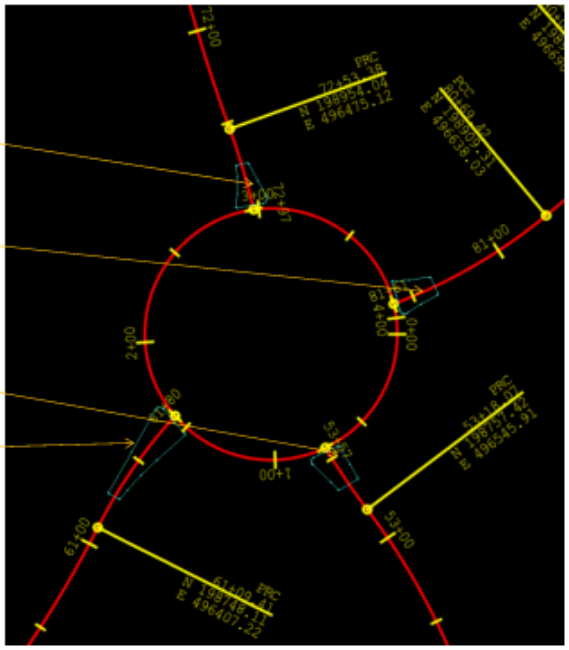
Point Name	Line Name	Measured N	Measured E	Measured Elv	Precision Type	Measured Station	Measured Offset	Alignment Name	Date
LinePt6	188nisld2area	198936.265	496484.928	316.140	TS	72+73.239	-3.722	CL_188N	10/30/2015
LinePt7	188nisld2area	198927.462	496489.482	316.609	TS	72+82.833	-5.673	CL_188N	10/30/2015
LinePt8	188nisld2area	198919.466	496494.120	317.014	TS	72+91.573	-8.151	CL_188N	10/30/2015
LinePt9	188nisld2area	198918.031	496494.449	317.052	TS	72+93.014	-8.129	CL_188N	10/30/2015
LinePt10	188nisld2area	198916.224	496493.699	317.101	TS	72+94.562	-6.977	CL_188N	10/30/2015
LinePt11	188nisld2area	198915.570	496491.902	317.082	TS	72+94.779	-5.078	CL_188N	10/30/2015
LinePt12	188nisld2area	198914.785	496487.116	317.040	TS	72+94.436	-0.241	CL_188N	10/30/2015
LinePt13	188nisld2area	198913.243	496479.023	316.992	TS	72+94.048	7.989	CL_188N	10/30/2015
LinePt14	188nisld2area	198913.757	496478.349	316.961	TS	72+93.375	8.525	CL_188N	10/30/2015
LinePt15	188nisld2area	198920.322	496478.961	316.722	TS	72+87.027	6.332	CL_188N	10/30/2015
LinePt16	188nisld2area	198929.105	496479.019	316.385	TS	72+78.449	3.964	CL_188N	10/30/2015
LinePt17	188nisld2area	198934.652	496478.427	316.119	TS	72+72.907	2.968	CL_188N	10/30/2015
LinePt18	188nisld2area	198935.244	496478.820	316.103	TS	72+72.451	2.420	CL_188N	10/30/2015
LinePt19	188nisld2area	198936.601	496484.273	316.105	TS	72+72.733	-3.192	CL_188N	10/30/2015
LinePt20	holbrisld2area	198874.895	496558.609	320.389	TS	81+57.417	10.850	CL_Holbrook	10/30/2015
LinePt21	holbrisld2area	198875.514	496559.019	320.390	TS	81+56.784	11.276	CL_Holbrook	10/30/2015
LinePt22	holbrisld2area	198875.851	496567.341	320.533	TS	81+48.669	8.424	CL_Holbrook	10/30/2015
LinePt23	holbrisld2area	198877.619	496577.885	320.692	TS	81+38.058	5.696	CL_Holbrook	10/30/2015
LinePt24	holbrisld2area	198877.371	496578.538	320.705	TS	81+37.565	5.191	CL_Holbrook	10/30/2015
LinePt25	holbrisld2area	198868.954	496582.355	320.939	TS	81+37.742	-4.049	CL_Holbrook	10/30/2015

REPORTING OF FIELD DATA - RTS

Date	11/9/15
Time	9:20:38 AM
Description	Stamped Concrete
Area	250.011 usft²
Date	11/9/15
Time	9:20:49 AM
Description	Stamped Concrete
Area	283.916 usft²
Date	11/9/15
Time	9:21:03 AM
Description	Stamped Concrete
Area	295.031 usft²
Date	11/9/15
Time	9:21:17 AM
Description	Stamped Concrete
Area	639.664 usft²

Instrument setup

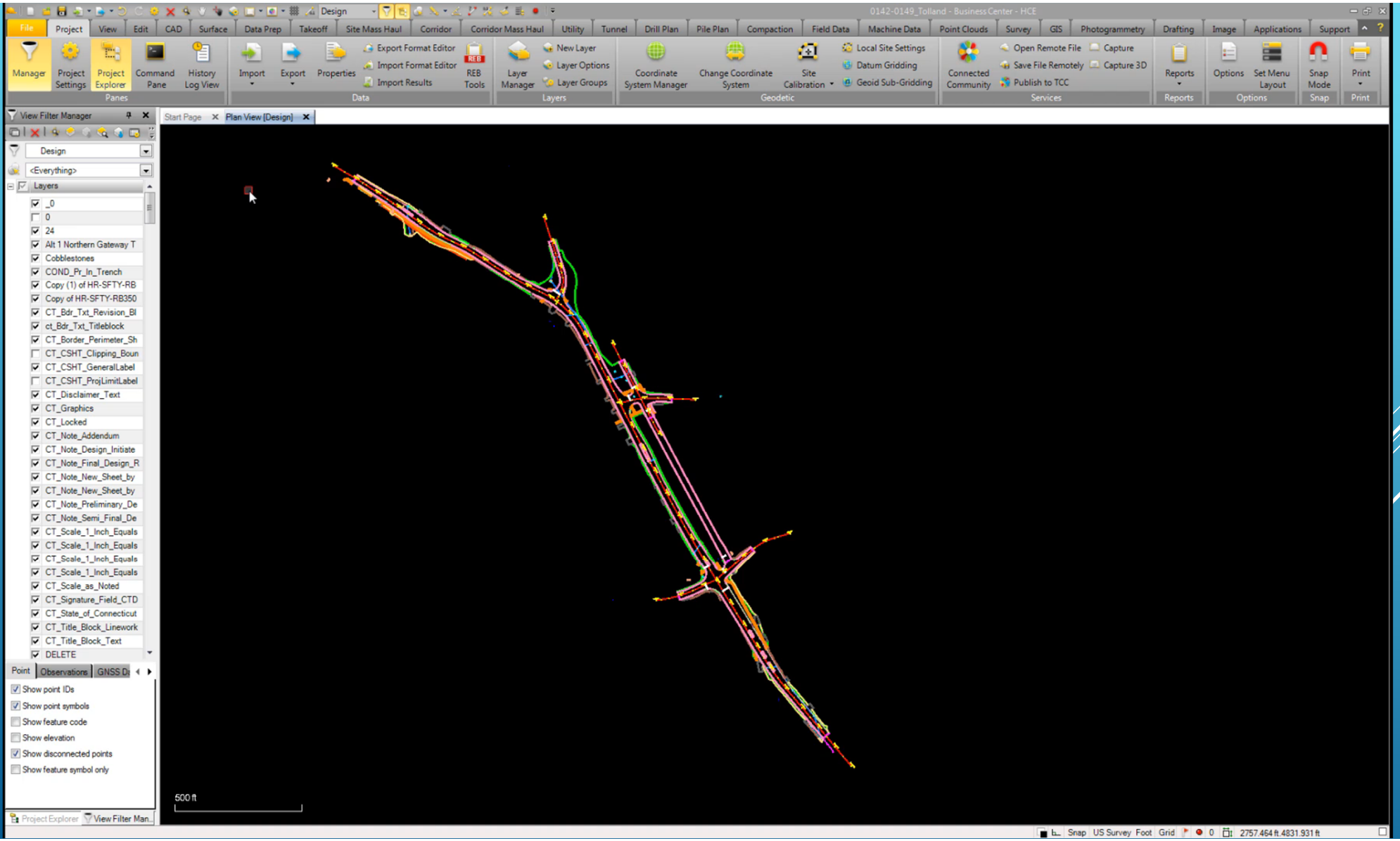
Date	10/30/15
Time	9:46:43 AM
Control point name	1110
Control point name	302
Precision-Horz	0.003 usft
Precision-HA	0°00'03"
Precision-Dx	0.001 usft
Precision-Dy	0.004 usft
Precision-Dz	0.014 usft
Instrument type	Trimble SPS620 5/5
Easting	496497.650 usft
Northing	198844.494 usft
Elevation	329.517 usft



RECORD BACKUP AND SOFTWARE RETENTION

- The Electronic files must be stored and backed up in a consistent manner.

  The **source data**, **each program file**, and any **computer-generated reports** is saved electronically and backed up in ProjectWise.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File
Project
View
Edit
CAD
Surface
Data Prep
Takeoff
Site Mass Haul
Corridor
Corridor Mass Haul
Utility
Tunnel
Drill Plan
Pile Plan
Compaction
Field Data
Machine Data
Point Clouds
Survey
GIS
Photogrammetry
Drafting
Image
Applications
Support
Manager
Project Settings
Project Explorer
Command Pane
History Log View
Panes
Import
Export
Properties
Export Format Editor
Import Format Editor
Import Results
REB Tools
Data
Layer Manager
New Layer
Layer Options
Layer Groups
Layers
Coordinate System Manager
Change Coordinate System
Site Calibration
Local Site Settings
Datum Gridding
Geoid Sub-Gridding
Geodetic
Connected Community
Open Remote File
Save File Remotely
Publish to TCC
Capture
Capture 3D
Services
Reports
Options
Set Menu Layout
Snap Mode
Print
View Filter Manager
Design
<Everything>
Layers
Start Page
Plan View [Design]
Point
Observations
Show point IDs
Show point symbols
Show feature code
Show elevation
Show disconnected points
Show feature symbol only
500 ft
Snap
US Survey Foot
Grid
2757.464 ft,4831.931 ft