National Geodetic Survey

VECTOR

Vermont Enhanced CORS and Transmission Of Real-time Corrections

Network Status and Current Applications

Daniel J. Martin, National Geodetic Survey
Bill Kules, Little River Survey
Ron Tabor, Vermont Geomatics

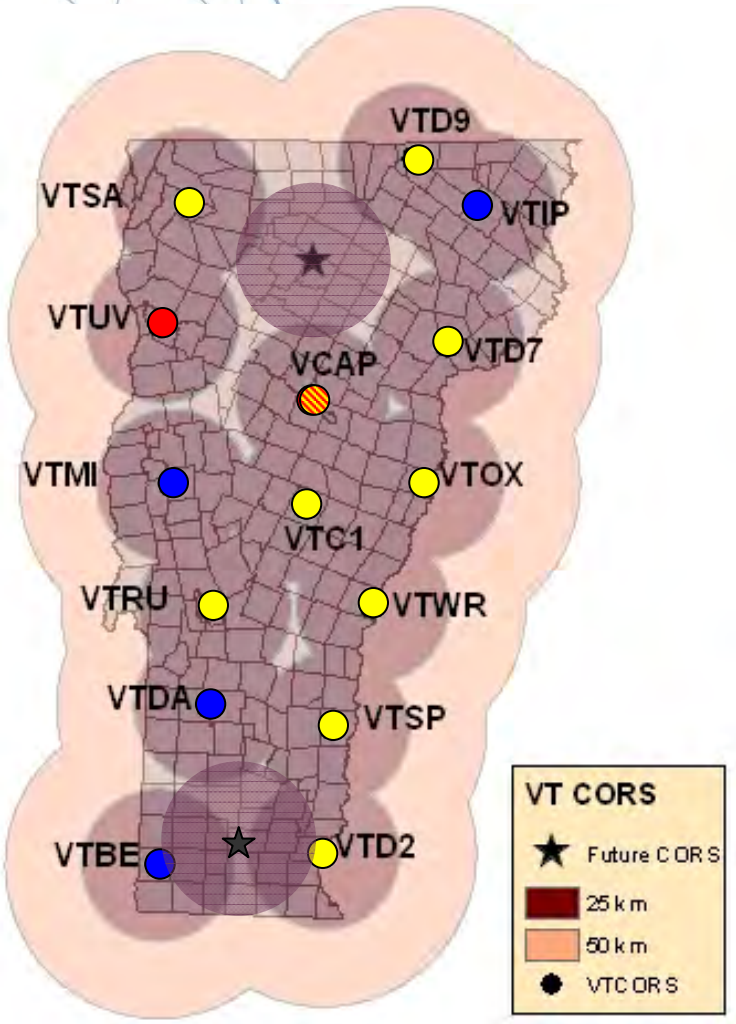
Vermont Society of Land Surveyors
December 19, 2008

National Oceanic and Atmospheric Administration

What is VECTOR??

- Network of Continuously Operating GNSS Reference Stations.
- Provides access to the National Spatial Reference System (NSRS)
- Access available for post processing (Static) and Real-time.

VECTOR Expansion



- 1996 - VCAP
- 2004 - VTUV
- 2006 – VTD2, VTSP, VTWR, VTOX, VTD7, VTD9, VTC1, VTSA, VTRU, (VCAP Upgrade)
- 2008 – VTBE, VTDA, VTMI, VTIP

- Minimum of 1 station needed to fill out network (Eden), ideally another (Dover, Stratton, Jamaica, or Wardsboro)

VECTOR
Site Criteria

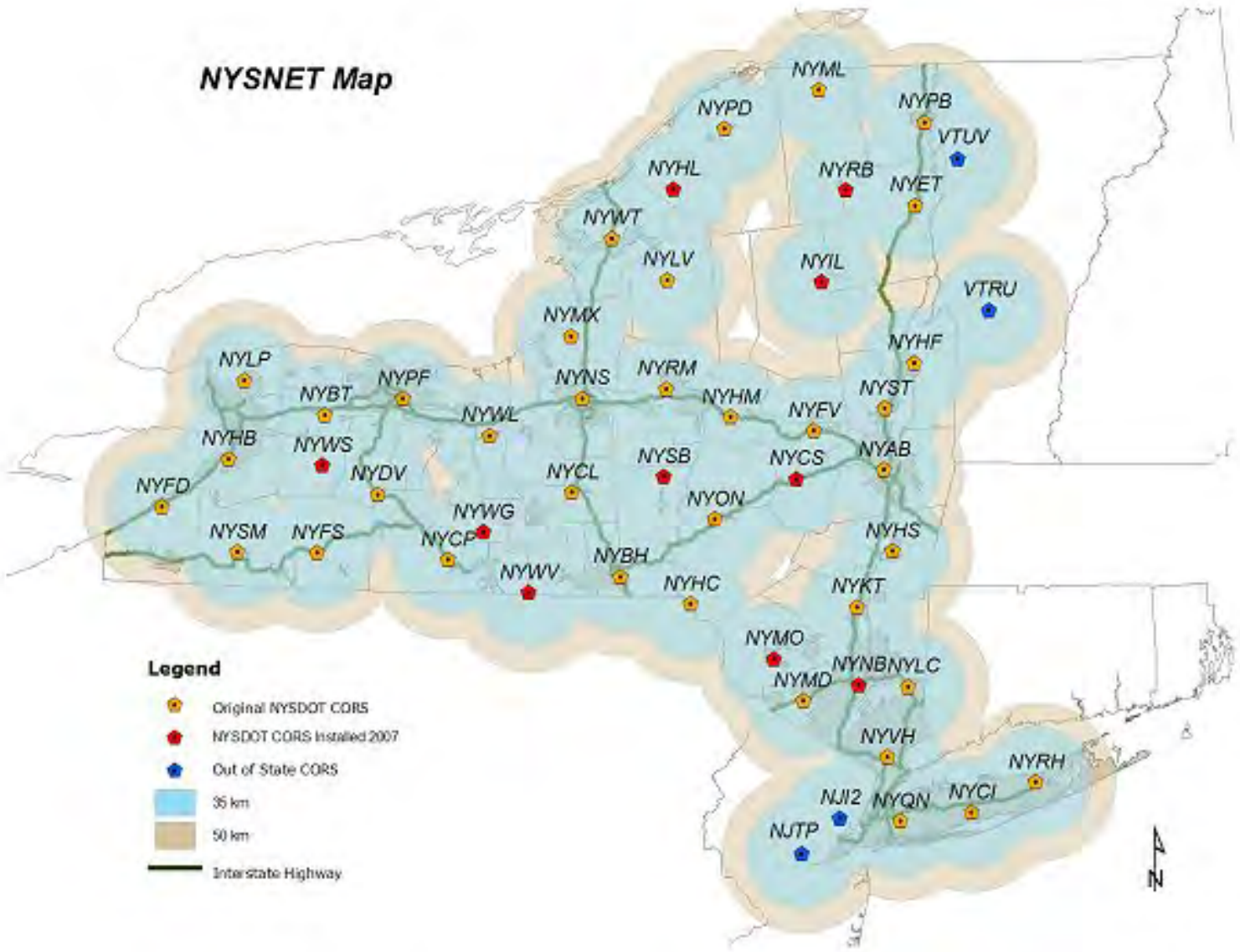
- ≈40-50 km spacing
- Masonry building <= 2 story
- Secure location
- State owned
- Clear view to sky
- Stable/dedicated power source
- High speed internet connection
- Antenna location < 100 meters from receiver location

Static Component of VECTOR

- Hourly files (1-sec)
  - DAT, RINEX v2.1 (no more SSF)
- Online for 45 days (VT-web)
- New download interface (similar to NGS UFC)
- 10 stations are National CORS
- All stations submitted to National CORS
- Preliminary coordinates derived from average of OPUS observations

Real-time Component of VECTOR

- User registration required (form on web)
- RTK data available via IP (cell connection)
- Single baseline RTK
- User must specify which site to receive corrections from by selecting mountpoint
- Field equipment must support NTRIP (Networked Transport of RTCM via Internet Protocol)
- Data streams available in CMR+ and RTCMv2.3 formats.


NYSNET Map
NYML
NYPD
NYPB
VTUV
NYHL
NYRB
NYET
NYWT
NYLV
NYIL
VTRU
NYMX
NYHF
NYLP
NYPF
NYNS
NYRM
NYST
NYBT
NYHM
NYFV
NYWL
NYHB
NYWS
NYSB
NYCS
NYAB
NYDV
NYCL
NYFD
NYON
NYWG
NYSM
NYFS
NYCP
NYHS
NYBH
NYWV
NYHC
NYKT
NYMO
NYNB
NYLC
NYMD
NYVH
NYRH
NJI2
NYQN
NYCI
NJTP
Legend
Original NYSDOT CORS
NYSDOT CORS Installed 2007
Out of State CORS
35 km
50 km
Interstate Highway

KeyNet GPS

RTK GPS Corrections

Home | News | Map | Forums | VRS

Service Updates

2008 Subscriber / Participant Meeting Set

Mount Point Names Change

Techinical Documents

KeyNet GPS Users Guide

TMobil Settings For TSC2

Audiovox TSC2 Setup

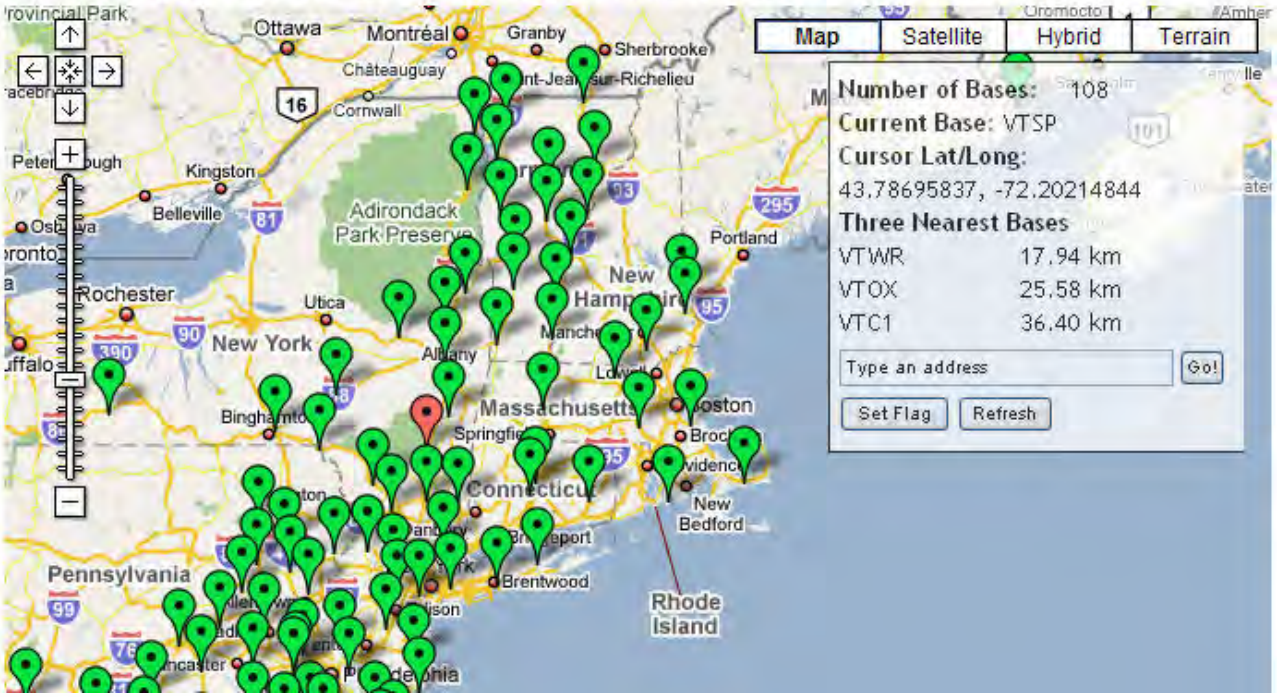
Survey Controller ver 11.32 Configuration for Audiovox Cellular Modem Adapter Using

Network Map

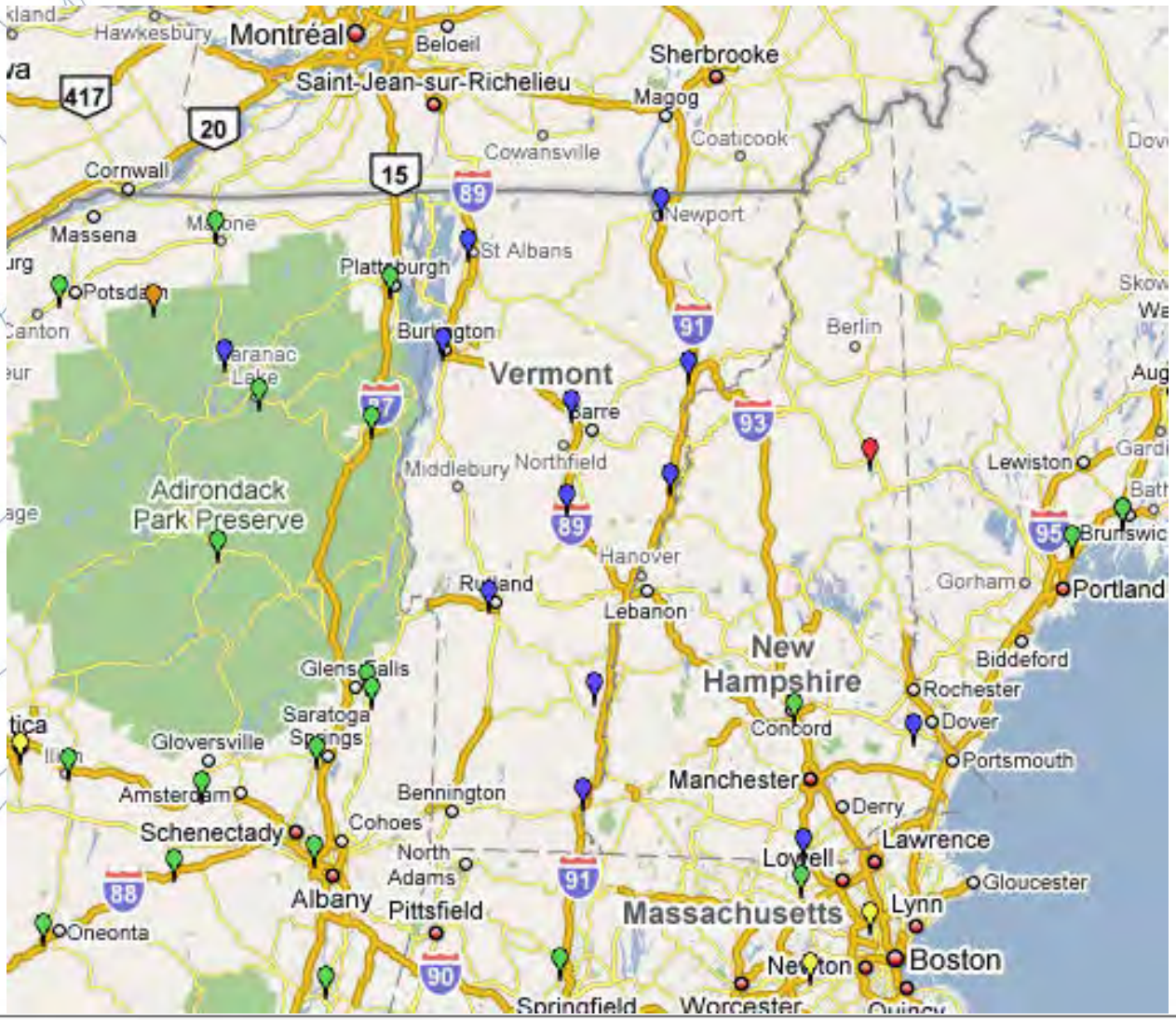
Station connected
Tracking 5 or more satellites.

Station connected
Tracking less than 5 satellites.

Station disconnected
Tracking 0 satellites.



National CORS as of 12/08



How is VECTOR being used

- Static Download from VT and NGS Servers (web)
- Static Download from VT and NGS Servers (ftp)
- Used for OPUS and OPUS_RS Solutions
- Used for OPUS_DB
- Real-time
- Incorporated into other networks (NY, Keynet, MTS)
- Contributing to NOAA weather forecasting (PWV)
- Contributing to the computation of GLONASS orbits

What is OPUS?

- **On-Line Positioning User Service**

- **Processes Dual-Frequency (and single frequency) GPS data**
- **Global availability (masked)**
- **3 goals:**
  - **Simplicity**
  - **Consistency**
  - **Reliability**

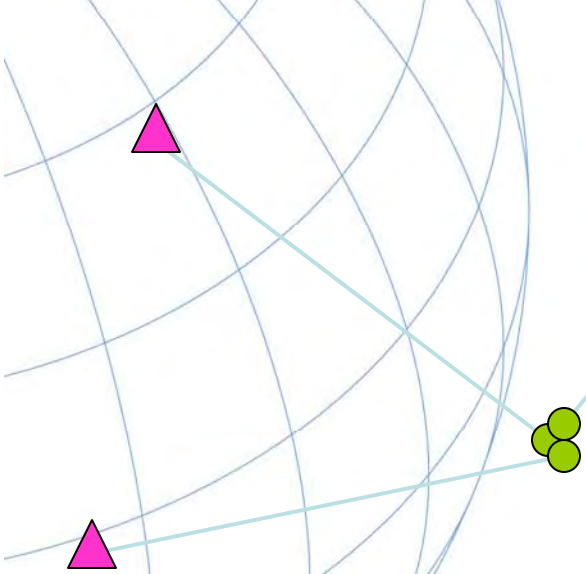
Flavors of OPUS

- OPUS_S (Static)
  - Operational since 2001
- OPUS_RS (Rapid Static)
  - Operational since 2007
- OPUS_DB (Database)
  - Initial Operational Capability (IOC) in 2008
- OPUS_Projects (Network campaigns)
  - Beta (internal testing)
- OPUS_Mapper (L1)
  - Alpha

OPUS_S – Current Status

- Accepts GPS Data in
  - Native receiver format
  - RINEX format (versions 2.0 & 2.1)
- Data Processing
  - Uses three CORS stations
  - Minimum of two hours of dual-frequency data
- Provides
  - NAD83 & ITRF coordinates
  - State plane coordinates
  - UTM coordinates
  - US National grid designator
  - G-file, statistics, etc.

How Does OPUS Compute Position?



NGS-PAGES software used

L3-fixed solution w/ tropo adjusted

3 “best” CORS selected
3 separate baselines computed
3 separate positions averaged

Position differences also include any errors in CORS coordinates

Martin, Dan

From: opus [opus@ngs.noaa.gov]
Sent: Monday, December 15, 2008 2:48 PM
To: Dan.Martin@noaa.gov
Subject: OPUS solution : G056309A.08o 000489432

```
 FILE: G056309A.08o 000489432

                            NGS OPUS SOLUTION REPORT
                            ========================

All computed coordinate accuracies are listed as peak-to-peak values. For additional
information: www.ngs.noaa.gov/OPUS/Using_OPUS.html#accuracy

      USER: dan.martin@noaa.gov                    DATE: December 15, 2008
RINEX FILE: g056309n.08o                           TIME: 19:48:17 UTC


  SOFTWARE: page5  0810.20 master28.pl 081023      START: 2008/11/04  13:40:00
 EPHEMERIS: igs15042.eph [precise]                  STOP: 2008/11/04  19:43:00
  NAV FILE: brdc3090.08n                        OBS USED: 15264 / 16871    :  90%
  ANT NAME: TRM55971.00      NONE               # FIXED AMB:   111 /   123   :  90%
ARP HEIGHT: 2.000                             OVERALL RMS: 0.020(m)


 REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)            ITRF00 (EPOCH:2008.8434)

         X:      1382168.289(m)    0.014(m)          1382167.539(m)    0.014(m)
         Y:     -4305939.217(m)    0.012(m)         -4305937.817(m)    0.012(m)
         Z:      4482857.195(m)    0.008(m)          4482857.147(m)    0.008(m)

       LAT:   44 56 28.49104       0.011(m)       44 56 28.52569       0.011(m)
     E LON:  287 47 46.20981       0.014(m)      287 47 46.19676       0.014(m)
     W LON:   72 12 13.79019       0.014(m)       72 12 13.80324       0.014(m)
    EL HGT:          181.232(m)    0.008(m)              180.092(m)    0.008(m)
 ORTHO HGT:          208.979(m)    0.026(m) [NAVD88 (Computed using GEOID03)]

                         UTM COORDINATES     STATE PLANE COORDINATES
                          UTM (Zone 18)          SPC (4400 VT  )
Northing (Y) [meters]      4980227.787           271272.182
Easting (X)  [meters]       720606.324           523375.038
Convergence  [degrees]        1.97595564           0.20920947
Point Scale                   1.00019847           0.99997100
Combined Factor               1.00017005           0.99994259

US NATIONAL GRID DESIGNATOR: 18TYQ2060680228(NAD 83)


                                BASE STATIONS USED
PID        DESIGNATION                      LATITUDE     LONGITUDE DISTANCE(m)
DJ8959 VTSA ST ALBANS CORS ARP           N444832.646 W0730457.289    70974.6
AF9563 VCAP VERMONT CAPITAL CORS ARP     N441543.106 W0723456.555    81247.7
DJ8955 VTD9 DERBY CORS ARP               N445703.499 W0720936.724     3610.5

                    NEAREST NGS PUBLISHED CONTROL POINT
PG1395      G 56                         N445628.    W0721212.         42.0


                              BASE STATION INFORMATION

                                        1
```

Results not always good…Why?

OPUS solution : CP19294A.08o 000491796 - Message (Plain Text)

File Edit View Insert Format Tools Actions Help Adobe PDF

Reply | Reply to All | Forward

Extra line breaks in this message were removed.

From: opus [opus@ngs.noaa.gov] Sent: Thu 12/18/2008 1:34 PM

To: Martin, Dan

Cc:

Subject: OPUS solution : CP19294A.08o 000491796

```
FILE: CP19294A.08o 000491796

                         NGS OPUS SOLUTION REPORT
                         ========================

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: www.ngs.noaa.gov/OPUS/Using_OPUS.html#accuracy

      USER: dan.martin@state.vt.us                    DATE: December 18, 2008
RINEX FILE: cp19294m.08o                              TIME: 18:33:46 UTC


  SOFTWARE: page5  0810.20 master10.pl 081023      START: 2008/10/20  12:14:00
 EPHEMERIS: igs15021.eph [precise]                  STOP: 2008/10/20  18:20:00
  NAV FILE: brdc2940.08n                        OBS USED: 13654 / 16385    :  83%
  ANT NAME: TRM55971.00      NONE               # FIXED AMB:    77 /   140    :  55%
ARP HEIGHT: 2.000                             OVERALL RMS: 0.020(m)


 REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)            ITRF00 (EPOCH:2008.8023)

         X:      1420019.355(m)    0.123(m)            1420018.606(m)    0.123(m)
         Y:     -4299652.120(m)    0.043(m)           -4299650.717(m)    0.043(m)
         Z:      4477455.321(m)    0.118(m)            4477455.273(m)    0.118(m)

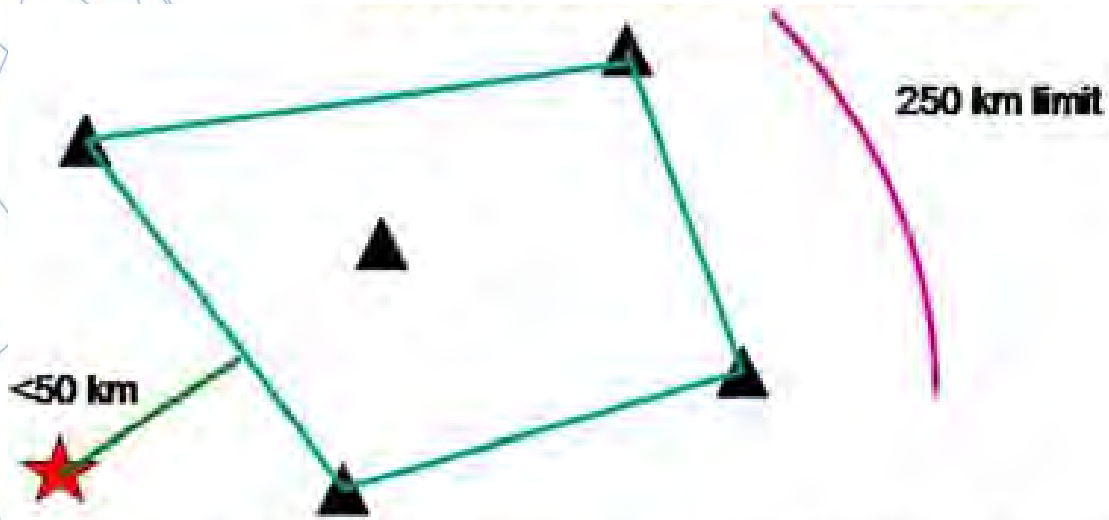
       LAT:    44 52 13.26549      0.087(m)         44 52 13.30020       0.087(m)
     E LON:   288 16 35.46496      0.117(m)        288 16 35.45261       0.117(m)
     W LON:    71 43 24.53504      0.117(m)         71 43 24.54739       0.117(m)
    EL HGT:           434.235(m)    0.103(m)                433.090(m)    0.103(m)
 ORTHO HGT:           461.569(m)    0.106(m) [NAVD88 (Computed using GEOID03)]
```


Map
Satellite
Hybrid

OPUS-Rapid Static (OPUS-RS)

- 15-minute to 4-hour sessions
- ties to 3 – 9 CORS (< 250km)
- uses RSGPS vs. PAGES software
- P1/P2 code & L1/L2 phase observations
- resolves all ambiguities with LAMBDA (Least Squares Ambiguity Decorrelation Adjustment)
- similar to Real-Time Network computations
- RSGPS solution modes:
  - network: solves ambiguities, tropo, iono
  - rover: tropo and ion interpolated to rover
- ~10,000 lines of code

OPUS-RS Reference Station Search Algorithm



- Sort stations in CORS network by distance from rover. Select up to nine CORS that are less than 250 km from rover, with suitable data.
- No solution is attempted if fewer than three CORS selected.
- No solution attempted if distance from rover to polygon enclosing selected CORS is greater than 50 km.

OPUS-RS Output

NGS OPUS-RS SOLUTION REPORT

USER:	william.stone@noaa.gov	DATE:	October 29, 2007
RINEX FILE:	1207287x.07o	TIME:	14:39:04 UTC
SOFTWARE:	rsgps 1.09 RS11.prl 1.12	START:	2007/10/14 23:27:15
EPHEMERIS:	igr14490.eph [rapid]	STOP:	2007/10/15 00:00:15
NAV FILE:	brdc2870.07n	OBS USED:	1962 / 2082 : 94%
ANT NAME:	ASH701975.01A	QUALITY IND.	34.21/ 37.91 *
ARP HEIGHT:	0.0	NORMALIZED RMS:	0.307

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.78627)	
LAT:	36 2 52.79767	0.008(m)	36 2 52.81498	0.008(m)
E LON:	252 2 18.45532	0.013(m)	252 2 18.41156	0.013(m)
W LON:	107 57 41.54468	0.013(m)	107 57 41.58844	0.013(m)
EL HGT:	1974.304(m)	0.005(m)	1973.396(m)	0.005(m)
ORTHO HGT:	1995.280(m)	0.026(m)	[Geoid03 NAVD88]	

"#Fixed Ambiguities" replaced by "Quality Indicator"

- average of W-ratio (separation between candidate sets of ambiguities) of last 3 epochs
- reported as network mode / rover mode
- look for values > 3 for confidence in solution

OPUS-RS Output

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ANT

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EL HGT:	1974.304(m)	0.005(m)	1973.396(m)	0.005(m)
ORTHO HGT:	1995.280(m)	0.026(m)	[Geoid03 NAVD88]	

"Overall RMS" replaced by "Normalized RMS"

- unitless quantity, "expected" = 1
- aka standard deviation of unit weight
- if > 1, noisy data somewhere
- typically <1, meaning noise less than expected

OPUS-RS Output

NGS OPUS-RS SOLUTION REPORT

USER:	william.stone@noaa.gov	DATE:	October 29, 2007
RINEX FILE:	1207287x.07o	TIME:	14:39:04 UTC
SOFTWARE:	rsgps 1.09 RS11.prl 1.12	START:	2007/10/14 23:27:15
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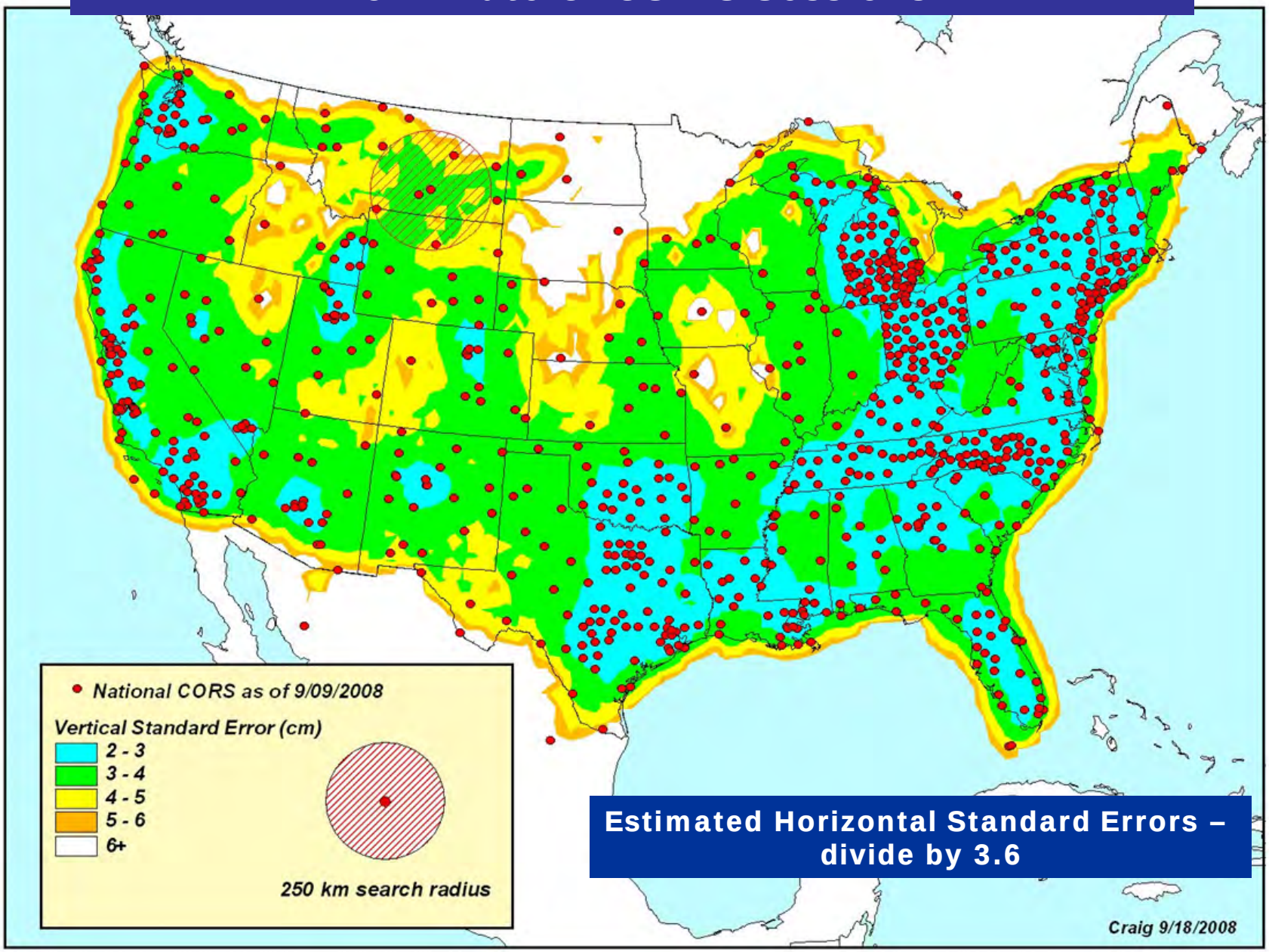
EL HGT:	1974.304(m)	0.005(m)		1973.396(m)	0.005(m)		
ORTHO HGT:	1995.280(m)	0.026(m)		[Geoid03 NAVD88]			

Peak-to-Peak replaced by Est. Standard Deviations

- approximately 95% confidence
- derived from scatter of single baseline solutions
- formal standard deviations (optimistic) available in Extended Output

Estimated Vertical Standard Errors – f(IDOP & RMSD)
15-Minute OPUS-RS Sessions



Estimated Horizontal Standard Errors – divide by 3.6

OPUS_DB

- Uses OPUS processor
- Minimum of 4 hours of dual frequency data
- If criteria is met mark can be published> 4 hour duration
  - > 70% observations used
  - > 70% ambiguities fixed
  - < 0.04m horizontal peak-to-peak (VT 0.03)
  - < 0.08m vertical peak-to-peak (VT 0.055)
  - < 0.03m RMS
  - IGS precise or rapid orbits (available next day)

- **metadata:**
  - quality survey mark
  - photos of mark & equipment
  - mark details (name, type, stability)
  - description to aid mark recovery

OPUS: Online Positioning User Service

upload | view | about

compute an accurate position for your GPS data file

1. enter your email address

dan.martin@state.vt.us

2. attach your DATA file

G:\PlanSupp\Geodetic\PROJECTS\20[Browse...

3. select your antenna type

TRM55971.00 Zephyr GNSS Geodetic Model 2

4. add your antenna height

2.000 meters

5a. customize your solution, report, and publishing options

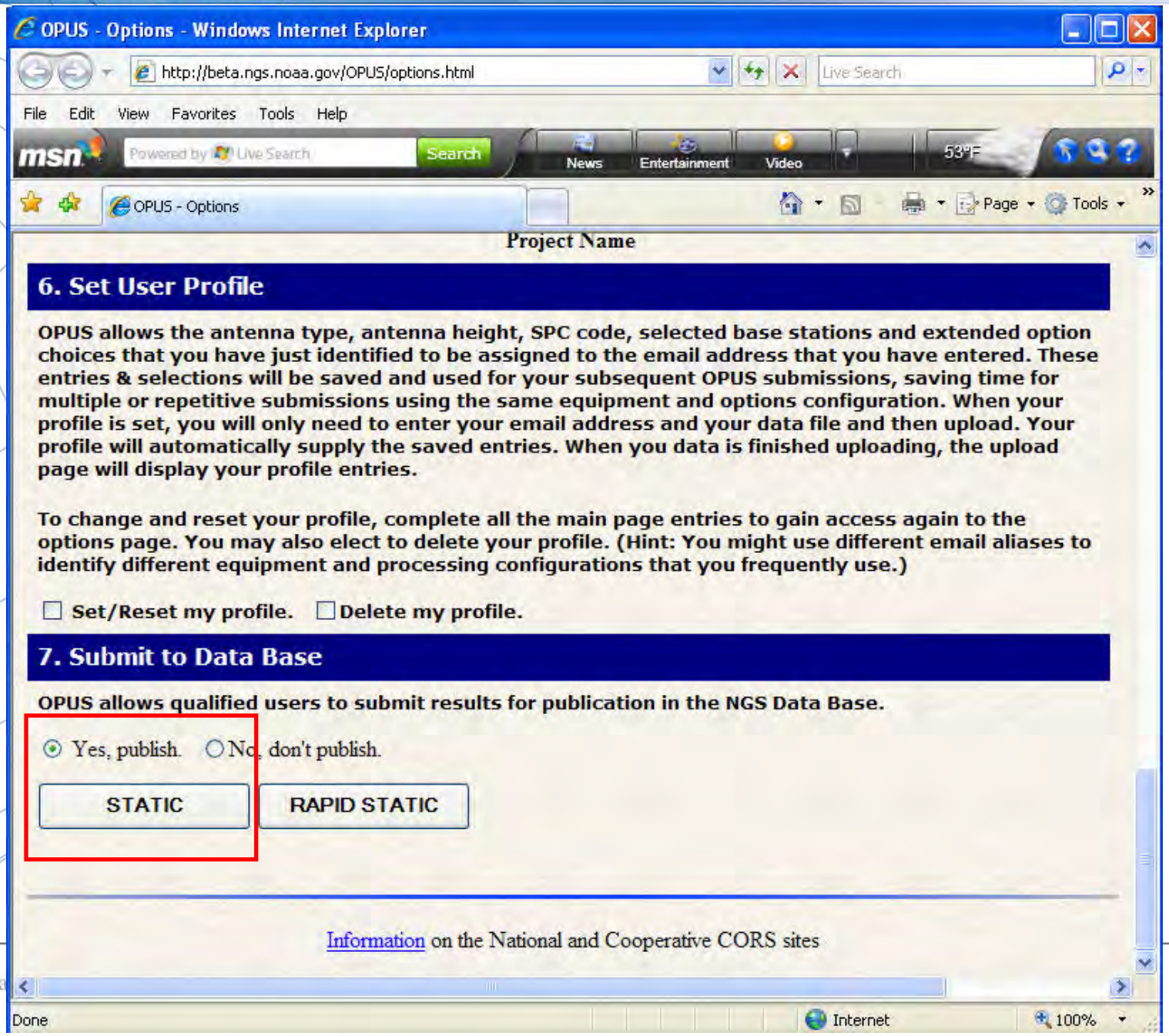
OPTIONS

-or-

5b. choose a processor

Upload to RAPID-STATIC for L1/L2 GPS data > 15 min. < 2 hrs.

Upload to STATIC for L1/L2 GPS data > 2 hrs. < 48 hrs.


OPUS - Options - Windows Internet Explorer
http://beta.ngs.noaa.gov/OPUS/options.html
Live Search
File Edit View Favorites Tools Help
msn
Powered by Live Search
Search
News
Entertainment
Video
53°F
OPUS - Options
Page
Tools
Project Name
6. Set User Profile
OPUS allows the antenna type, antenna height, SPC code, selected base stations and extended option choices that you have just identified to be assigned to the email address that you have entered. These entries & selections will be saved and used for your subsequent OPUS submissions, saving time for multiple or repetitive submissions using the same equipment and options configuration. When your profile is set, you will only need to enter your email address and your data file and then upload. Your profile will automatically supply the saved entries. When you data is finished uploading, the upload page will display your profile entries.
To change and reset your profile, complete all the main page entries to gain access again to the options page. You may also elect to delete your profile. (Hint: You might use different email aliases to identify different equipment and processing configurations that you frequently use.)
Set/Reset my profile.
Delete my profile.
7. Submit to Data Base
OPUS allows qualified users to submit results for publication in the NGS Data Base.
Yes, publish.
No, don't publish.
STATIC
RAPID STATIC
Information on the National and Cooperative CORS sites
Done
Internet
100%

Martin, Dan

From: opus [opus@ngs.noaa.gov]
Sent: Monday, December 15, 2008 2:48 PM
To: Dan.Martin@noaa.gov
Subject: OPUS solution : G056309A.08o 000489432

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 FILE: G056309A.08o 000489432

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         Y:     -4305939.217(m)    0.012(m)         -4305937.817(m)    0.012(m)
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 ORTHO HGT:          208.979(m)    0.026(m) [NAVD88 (Computed using GEOID03)]

                         UTM COORDINATES     STATE PLANE COORDINATES
                          UTM (Zone 18)          SPC (4400 VT  )
Northing (Y) [meters]      4980227.787           271272.182
Easting (X)  [meters]       720606.324           523375.038
Convergence  [degrees]        1.97595564           0.20920947
Point Scale                   1.00019847           0.99997100
Combined Factor               1.00017005           0.99994259

US NATIONAL GRID DESIGNATOR: 18TYQ2060680228(NAD 83)


                                BASE STATIONS USED
PID        DESIGNATION                      LATITUDE     LONGITUDE DISTANCE(m)
DJ8959 VTSA ST ALBANS CORS ARP           N444832.646 W0730457.289    70974.6
AF9563 VCAP VERMONT CAPITAL CORS ARP     N441543.106 W0723456.555    81247.7
DJ8955 VTD9 DERBY CORS ARP               N445703.499 W0720936.724     3610.5

                    NEAREST NGS PUBLISHED CONTROL POINT
PG1395      G 56                         N445628.    W0721212.         42.0


                              BASE STATION INFORMATION

                                        1
```

Step 2 of 4: Identify your Mark

An OPUS solution report is now being prepared. When complete, it will be e-mailed to you.

PUBLISHING

Describe New* Mark | Describe Recovered* Mark | Abort

* Confused? New and recovered marks are described here.

OPUS ENTRIES

e-mail address: dan.martin@noaa.gov
Uploaded File Name: 5600326A.08o
Selected Antenna: TRM55971.00
Antenna Height(m): 2.000

OPTIONS

State Plane Code: AUTO
Extended Output: YES
Submit to NGS Database: YES
User Selected Base Stations: NONE
User Excluded Stations: NONE
User Selected Project Name: NONE

Step 3 of 4: Describe Recovered Mark

for data file: g056309n.08o

REQUIRED

Enter the mark's PID: PG1395 | Find PID | no PID ? |

Close-up photo: G:\PlanSupp\Geodetic\PROJECTS\2008_Air\200 Browse...

Horizon photo: G:\PlanSupp\Geodetic\PROJECTS\2008_Air\200 Browse...

OPTIONAL

Mark Condition

- (•) Good condition
- ( ) Poor, disturbed, mutilated, requires maintenance

Descriptions

RECOVERED AS DESCRIBED

(Amend existing description, if necessary. Max. characters=500) 22

Continue | Abort

Privacy Policy: All data you voluntarily provide here will be shared publicly on datasheets (example). See also our NOAA Privacy Policy.

Step 2 of 4: Identify your Mark

An OPUS solution report is now being prepared. When complete, it will be e-mailed to you.

PUBLISHING

Describe New* Mark | Describe Recovered* Mark | Abort

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OPUS ENTRIES

e-mail address: dan.martin@noaa.gov
Uploaded File Name: 5600326A.08o
Selected Antenna: TRM55971.00
Antenna Height(m): 2.000

OPTIONS

State Plane Code: AUTO
Extended Output: YES
Submit to NGS Database: YES
User Selected Base Stations: NONE
User Excluded Stations: NONE
User Selected Project Name: NONE

Step 3 of 4: Describe New Mark

for data file: 5600326o.08o

REQUIRED

Designation: VTNH BRM 56

Stamping : 56 700 S 47 06 E

Type: D = Disk | DR = Reference mark disk

IF Type ="Rod": Rod Depth ____ Sleeve Depth ____ ft m

Setting: 30 = Light structures (other than listed below)

specific setting: ____

Descriptions :

```
TO THE GATE AT THE PEASLEE FARM, VT RTE 102 WEST
OF GUILDHALL VILLAGE.  THE MARK IS A 12.5 CM
DIAMETER UNITED STATES SUPREME COURT BOUNDARY
REFERENCE MARK TABLET. 12.4 M E OF AND ABOUT 0.2
M LOWER THAN THE CENTERLINE OF A FIELD DRIVE,
24.8 M W OF THE PROJECTED CENTERLINE OF AN OLD
RAILROAD BED, 11.8 M S OF THE CENTERLINE OF A
FIELD DRIVE WHICH PASSES THROUGH THE OLD
RAILROAD BED AND CONNECTS TWO FIELDS, AND 0.2 M
NE OF FIBERGLASS WITNESS.
```

(describe the mark, witness ties, etc., to enable future recoveries. Max. characters=500)

Close-up photo: G:\PlanSupp\Geodetic\PROJECTS\VTNH\Esse Browse...

Horizon photo: G:\PlanSupp\Geodetic\PROJECTS\VTNH\Esse Browse...

OPTI

Stability: B = Monument will probably hold position well

Magnetic: N = No magnetic material

Application: O = Other special application, see descriptive text

Dan.Martin@noaa.gov: Inbox

Compose Reply Reply All Forward Delete Printable Add Addresses Previous Next Close

From opus <opus@ngs.noaa.gov>
Sent Monday, December 15, 2008 3:05 pm
To Dan.Martin@noaa.gov
Subject OPUS Recovery Mark: RINEX FILE: g056309n.08o.gz, DESIGNATION: G 56

The following contribution has been submitted to OPUS for publication in the OPUS Database. Please visit the link below to verify that the information you provided is correctly presented on the new datasheet.

When the datasheet is viewed, two buttons will be displayed at the top of the new datasheet web page. Please select the appropriate button to accept or withdraw your contribution. An action must be taken for the datasheet to be published or withdrawn.

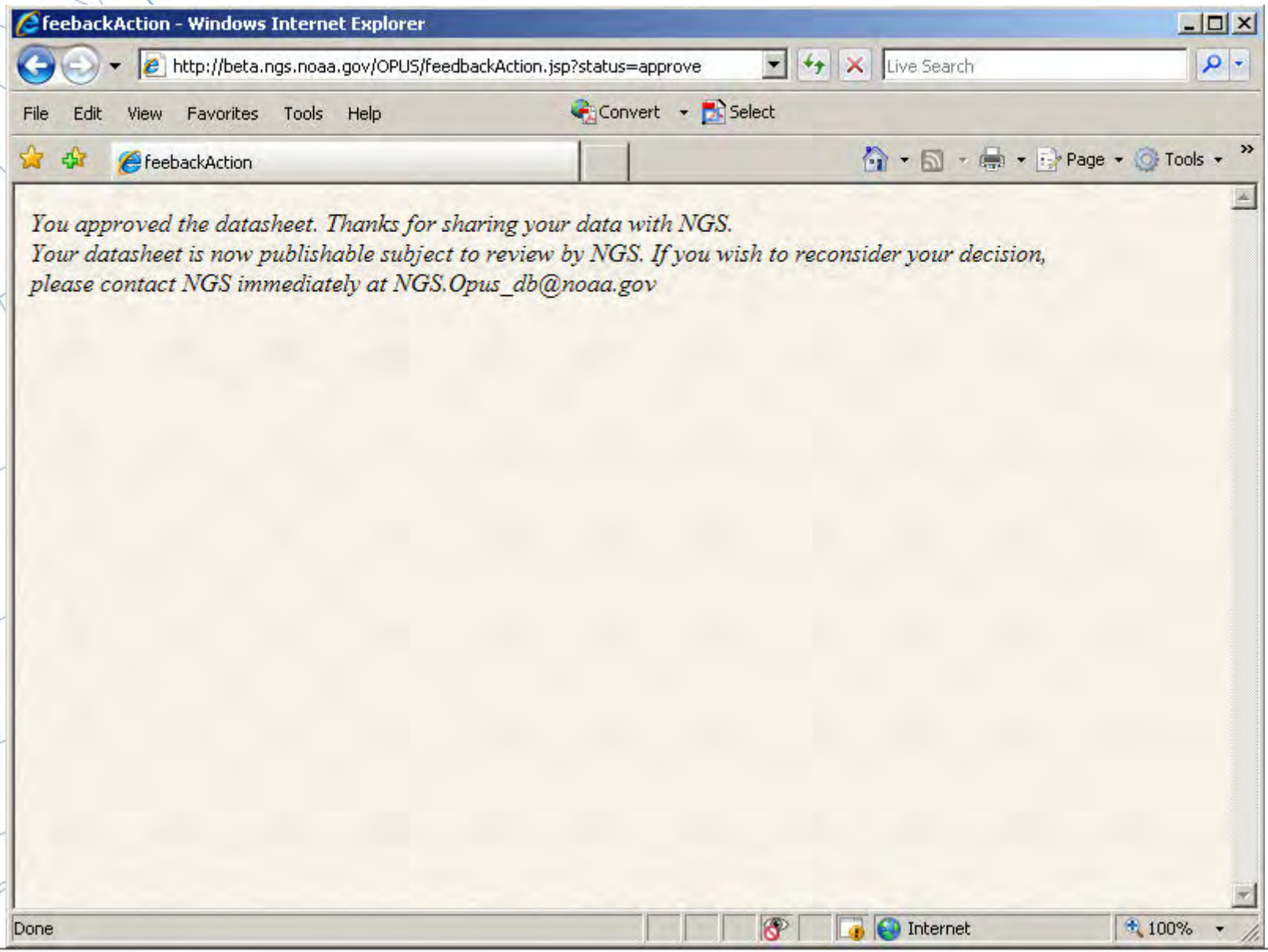
The OPUS Team.

RINEX FILE: g056309n.08o.gz
DESIGNATION: G 56

http://beta.ngs.noaa.gov/OPUS/getFeedback.jsp?id=000489432

Almost Done

MHTML Document


feebackAction - Windows Internet Explorer
http://beta.ngs.noaa.gov/OPUS/feedbackAction.jsp?status=approve
Live Search
File Edit View Favorites Tools Help
Convert
Select
feebackAction
Page
Tools
You approved the datasheet. Thanks for sharing your data with NGS.
Your datasheet is now publishable subject to review by NGS. If you wish to reconsider your decision,
please contact NGS immediately at NGS.Opus_db@noaa.gov
Done
Internet
100%

Sun Java™ System Messenger Express Welcome Dan Martin

Folders | Inbox | Sent | Trash | Drafts | Addresses | Options

Dan.Martin@noaa.gov: Inbox

Compose | Reply | Reply All | Forward | Delete | Printable | Add Addresses | Previous | Next | Close

From	NGS.Opus_db@noaa.gov
Sent	Tuesday, December 16, 2008 12:47 pm
To	NGS.Opus_db@noaa.gov , Dan.Martin@noaa.gov
Subject	Opus submission(ID=000489432)

Submitter dan.martin@noaa.gov approved the datasheet for ID=000489432

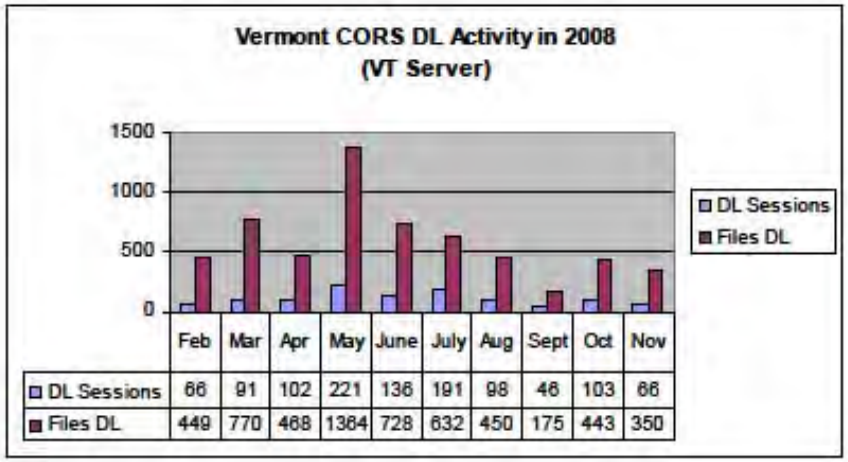
OPUS-Projects

- Managers can define a project
  - Process any number of stations under a project
  - Project can span several days to weeks
  - Contract work
- Project processing
  - Each dataset sent to OPUS but identified with a project
  - Results returned to submitter a few minutes later
  - Manager can monitor processing and submission
- Final adjustment
  - Entire project adjusted as one campaign
  - Review & submission to NGS

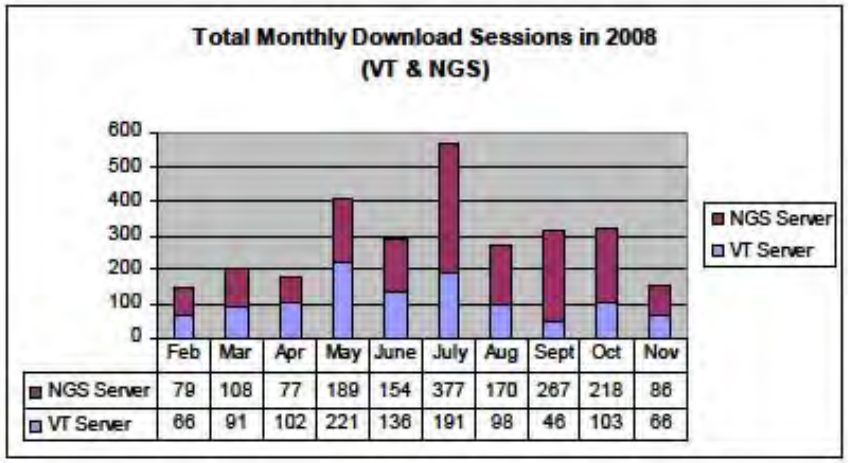
OPUS_Mapper

- Compute a differential pseudo range solution for less expensive GPS receivers
- Aimed at the GIS community who do not require cm level accuracies
- Allows processing in a consistent approach and “certify” their locations in the NSRS
- Generate rapid static solution from seconds or minutes of data
- Accuracies: A few decimeters to a meter horizontally

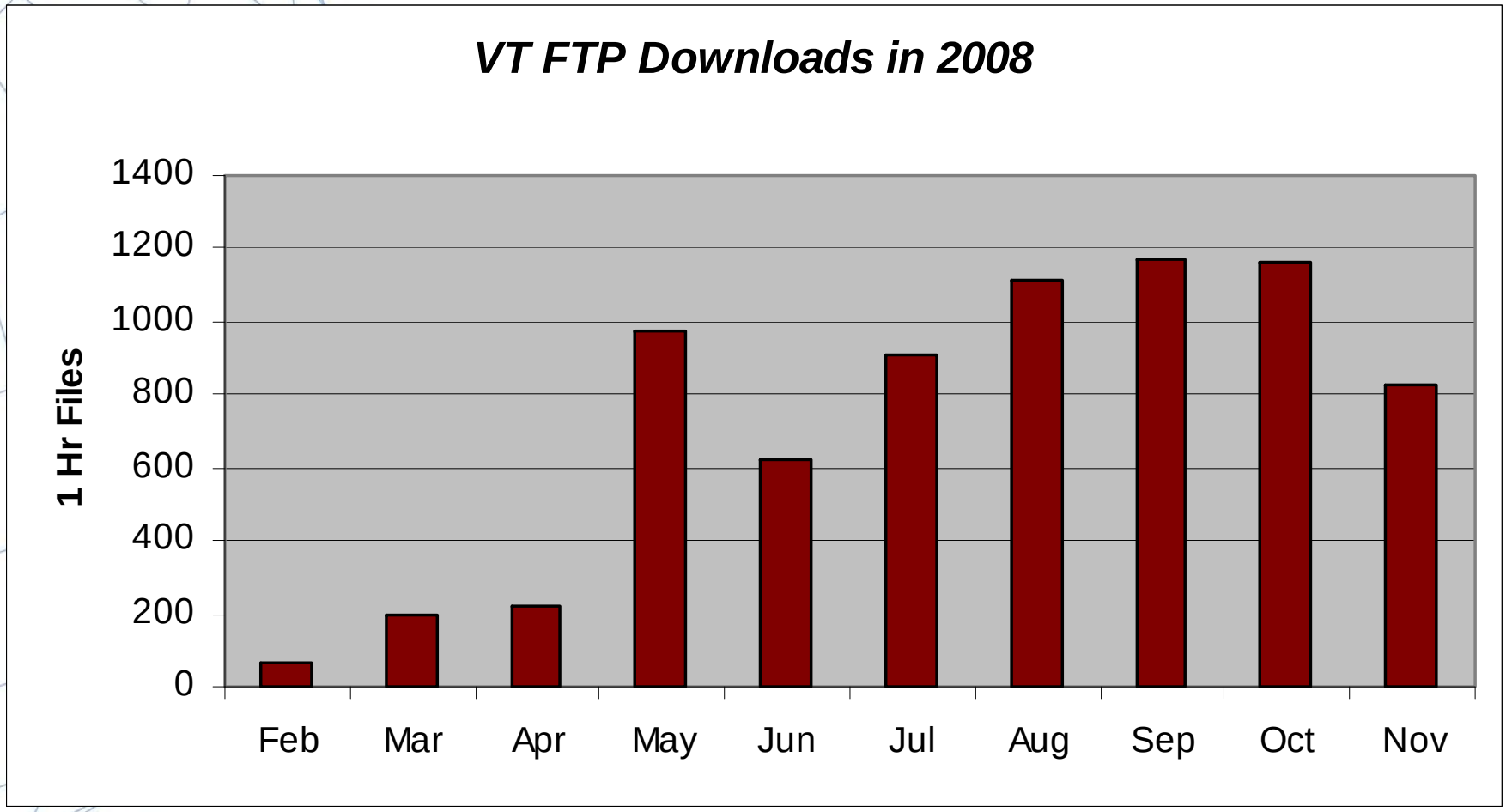
VT CORS Downloads for 2008



	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
DL Sessions	66	91	102	221	136	191	98	46	103	66
Files DL	449	770	468	1364	728	632	450	175	443	350



	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
NGS Server	79	108	77	189	154	377	170	267	218	86
VT Server	66	91	102	221	136	191	98	46	103	66


VT FTP Downloads in 2008
1 Hr Files
1400
1200
1000
800
600
400
200
0
Feb
Mar
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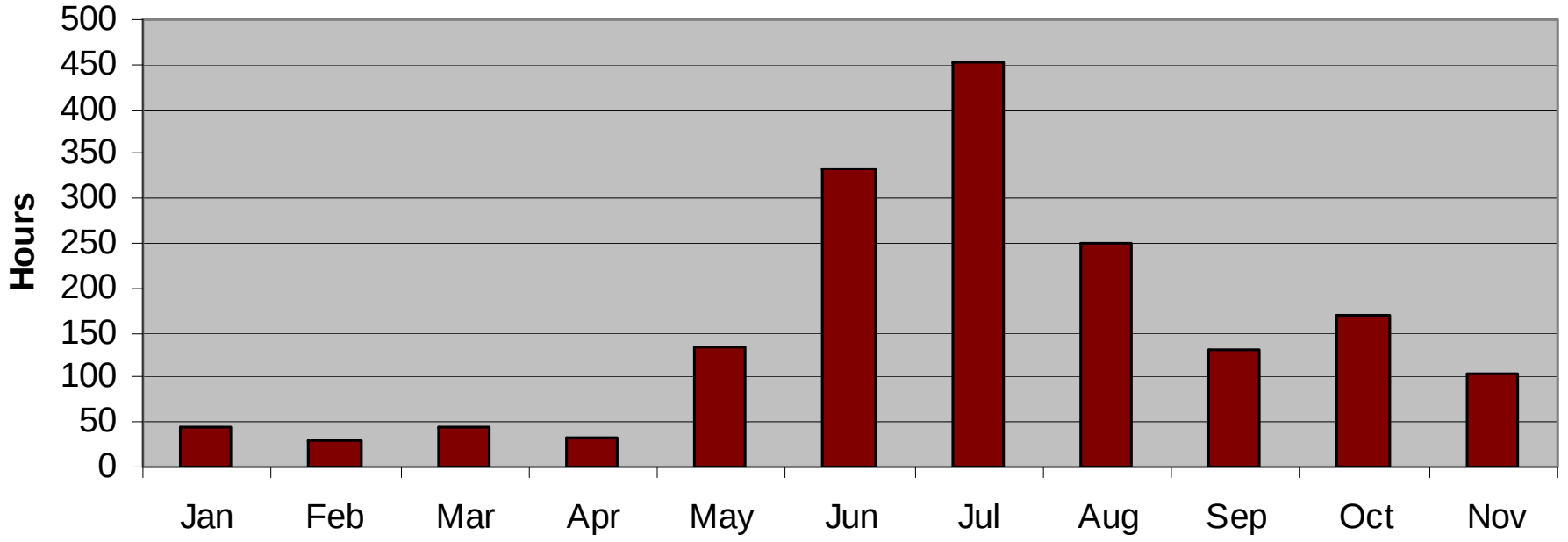
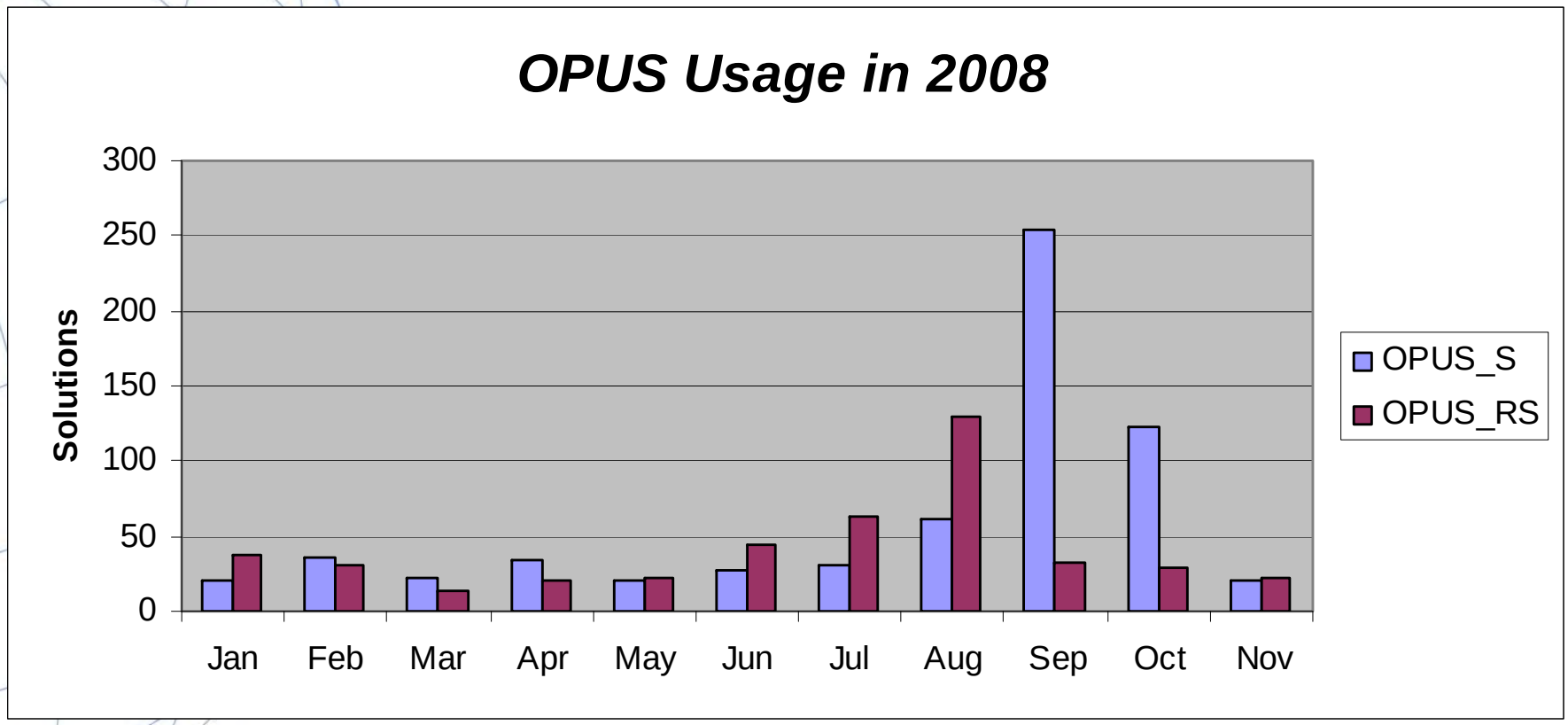
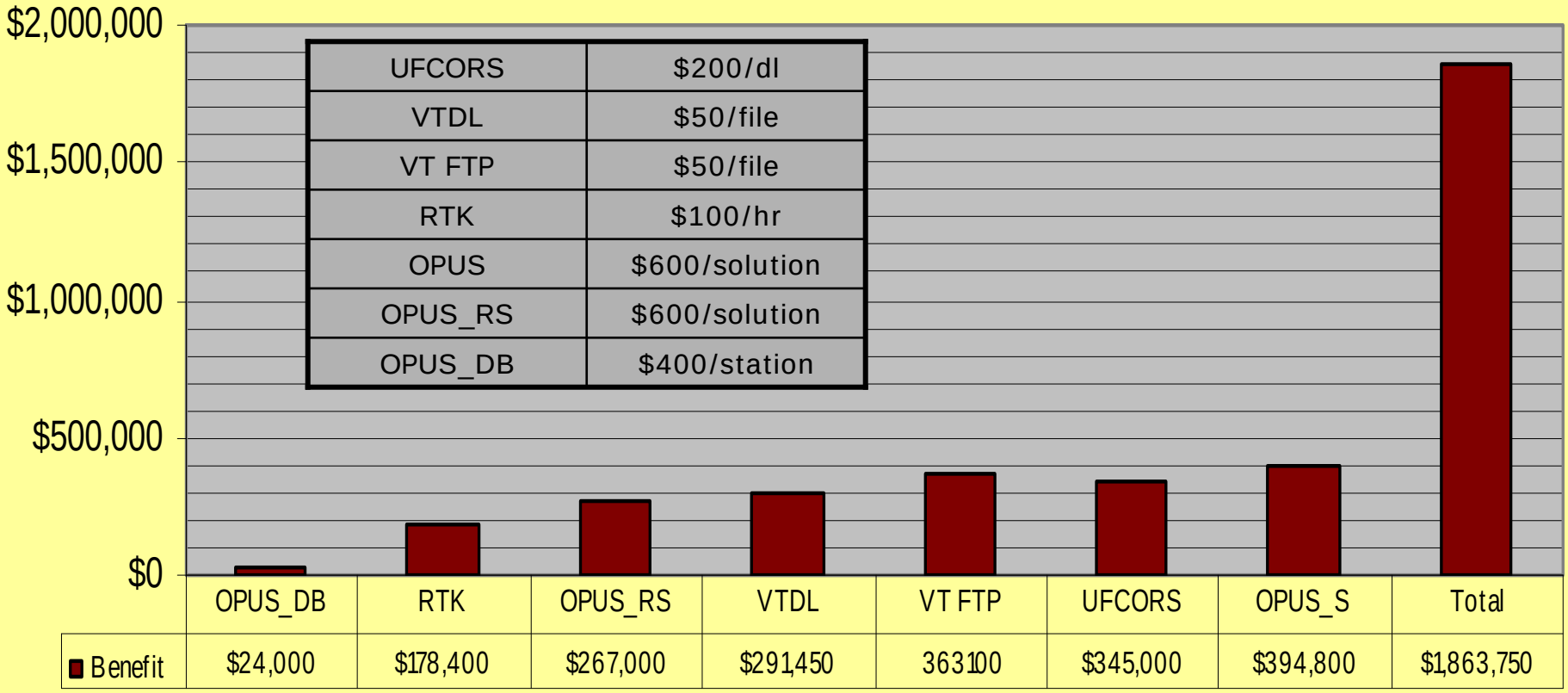
Jul
Aug
Sep
Oct
Nov

Real Time Use in 2008




OPUS Usage in 2008
Solutions
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
OPUS_S
OPUS_RS

2008 Benefits of VT CORS as of Nov. 30

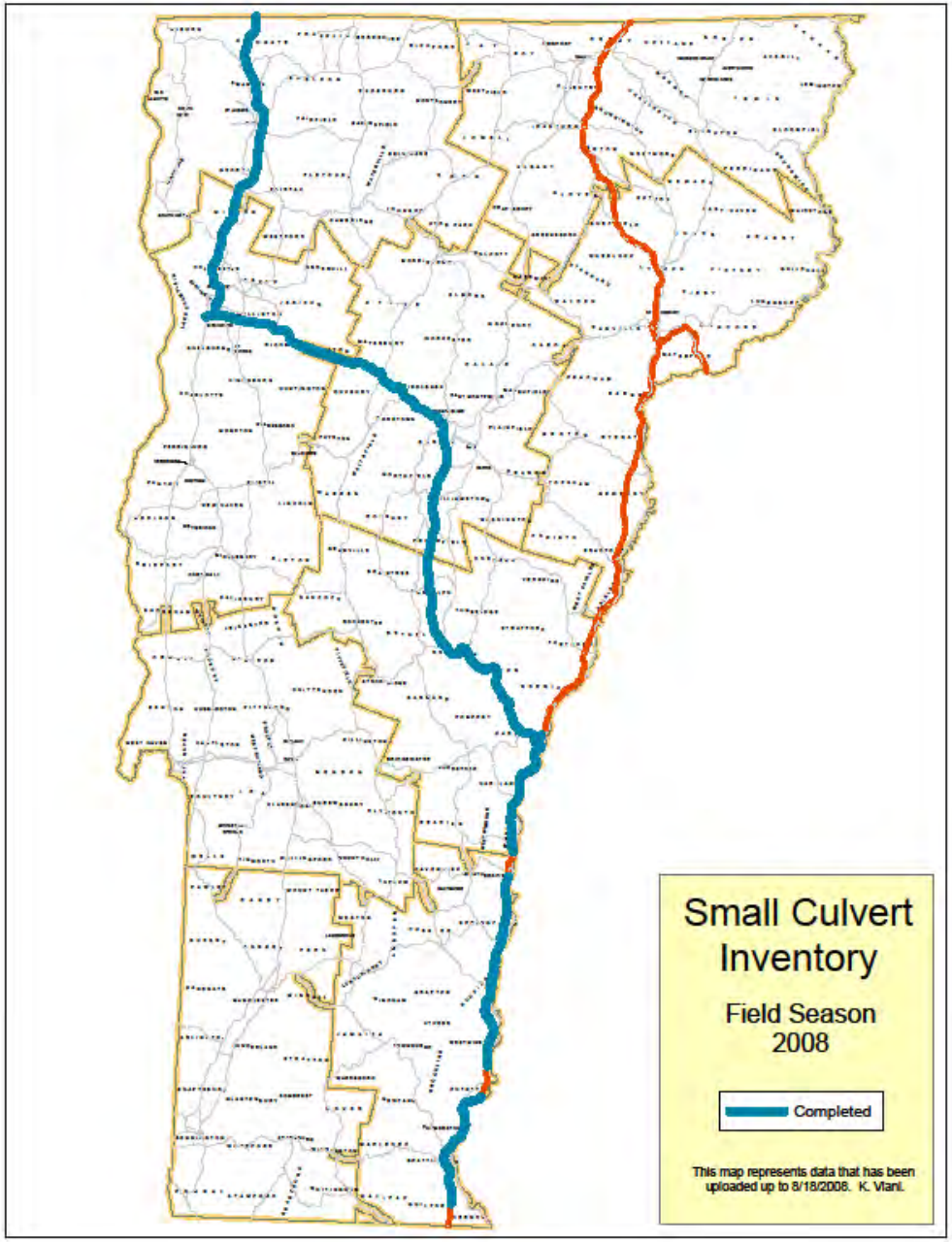


	OPUS_DB	RTK	OPUS_RS	VTDL	VT FTP	UFCORS	OPUS_S	Total
Benefit	$24,000	$178,400	$267,000	$291,450	363100	$345,000	$394,800	$1,863,750

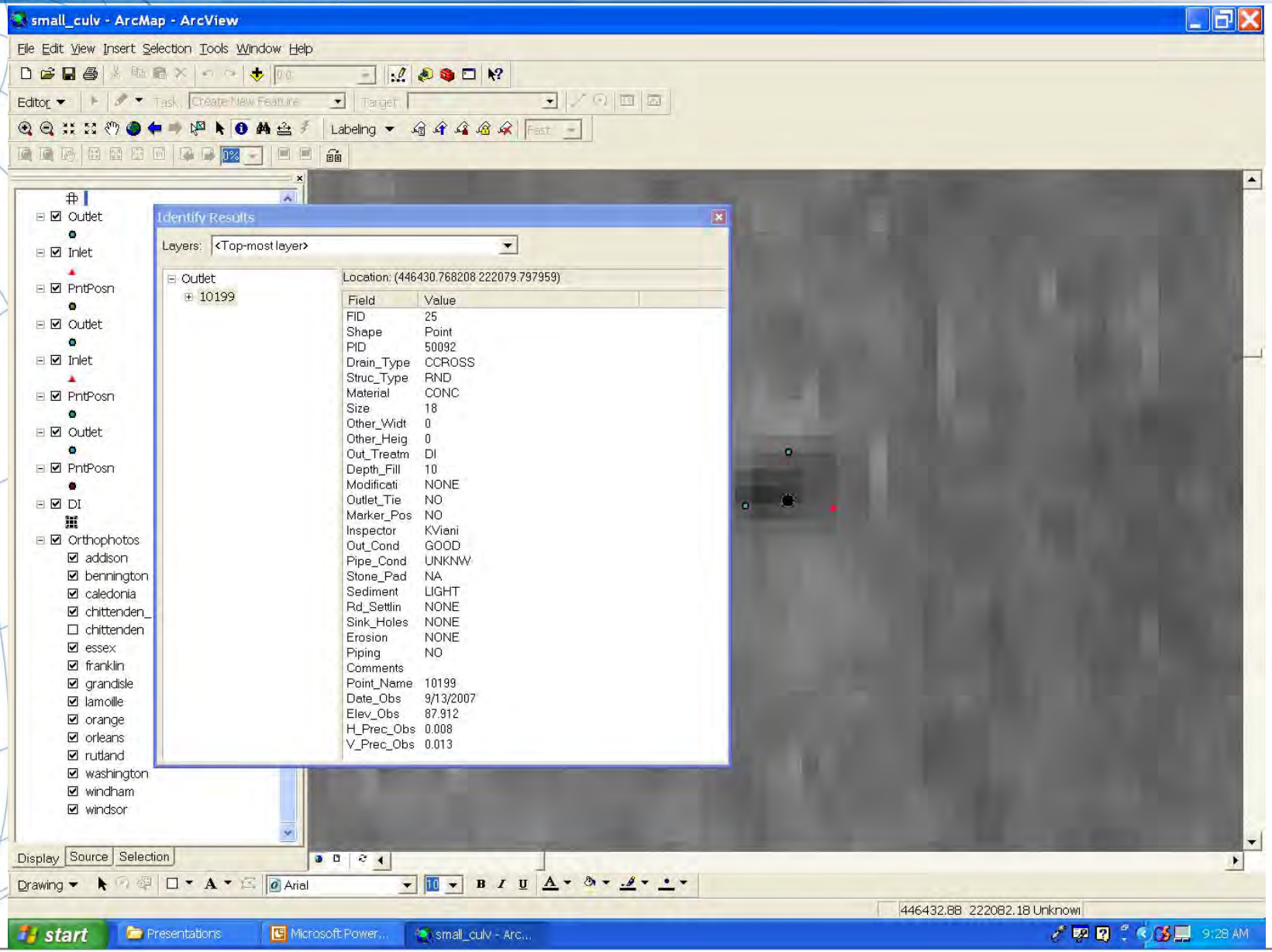
QA/QC for LiDAR (Real-time)

Interstate Small Culvert Inventory 2007-2008

- I89
  - ≈4000 Culverts
  - ≈2800 DI's
  - ≈10,800 Total Shots
- I91 (first 95 miles)
  - ≈2700 Culverts
  - ???? DI's
  - ≈5400 Total Shots+DI's
- 59 crew weeks
  - ≈ $60k savings



I89 Small Culvert Inventory


small_culv - ArcMap - ArcView
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essex
franklin
grandisle
lamoille
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rutland
washington
windham
windsor
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Layers: <Top-most layer>
Outlet
10199
Location: (446430.768208 222079.797959)
Field
Value
FID 25
Shape Point
PID 50092
Drain_Type CCROSS
Struc_Type RND
Material CONC
Size 18
Other_Widt 0
Other_Heig 0
Out_Treatm DI
Depth_Fill 10
Modificati NONE
Outlet_Tie NO
Marker_Pos NO
Inspector KViani
Out_Cond GOOD
Pipe_Cond UNKNW
Stone_Pad NA
Sediment LIGHT
Rd_Settlin NONE
Sink_Holes NONE
Erosion NONE
Piping NO
Comments
Point_Name 10199
Date_Obs 9/13/2007
Elev_Obs 87.912
H_Prec_Obs 0.008
V_Prec_Obs 0.013
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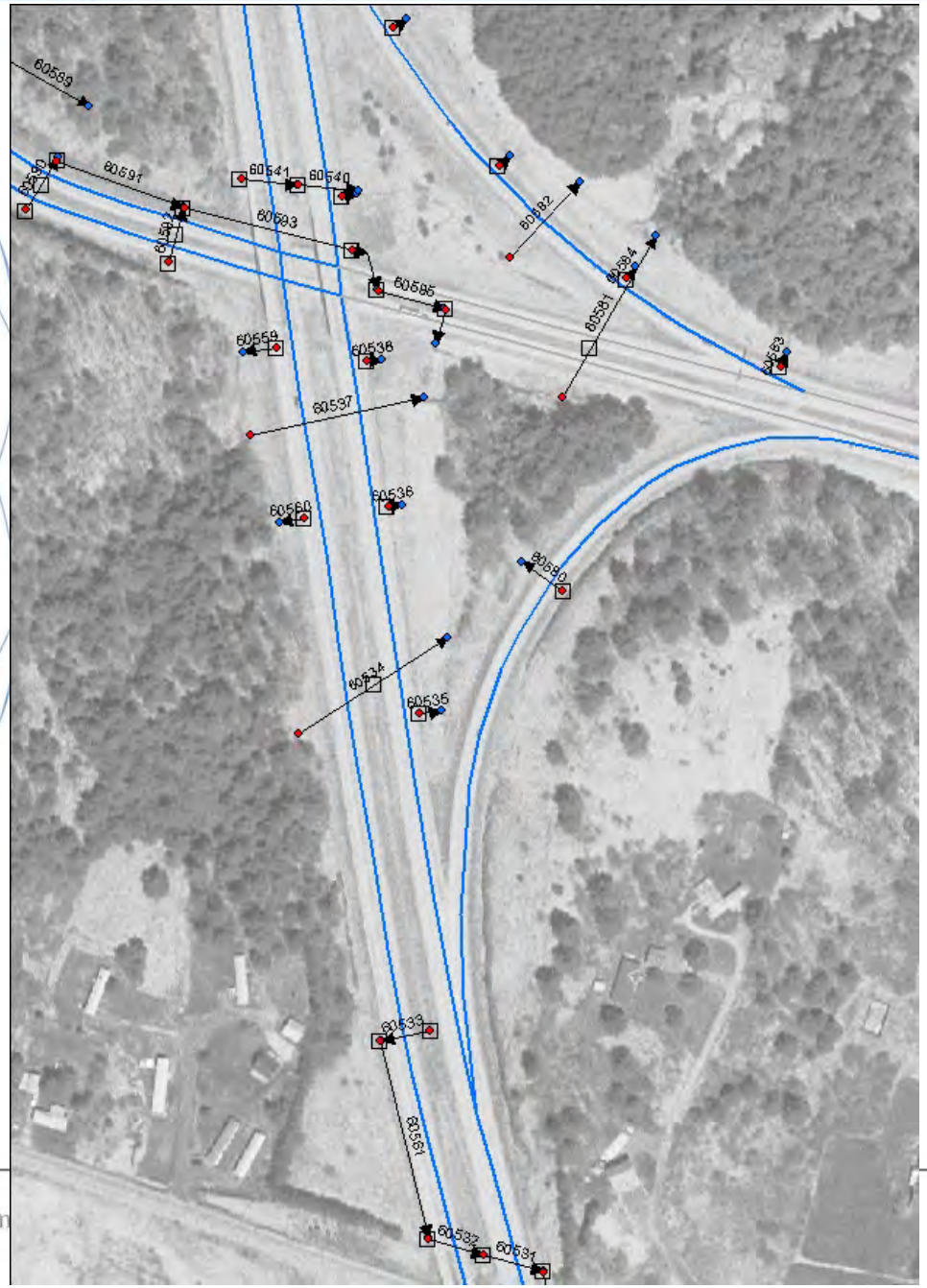
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Other Uses – Jason Dattilio, L.S., Button Professional Land Surveyors

"As you are aware GPS surveying is the State of Vermont has come a long way in the decade. I can remember when Montpelier was the only CORS Station available, now we are well on our way to having a network of coverage across the entire state. Gone are the days of the back pack systems and utilizing survey grade equipment only to run control networks or place a project on Vermont State Plane."

"Currently at Button Professional Land Surveyors we're utilizing our Trimble R8 GPS System almost on a daily basis…"

"Many advantages can be provided by having a survey grade GPS system. They will allow you to be more creative, and in most cases more efficient. Checking your GPS work is critical, but with the proper downloading and processing procedures you will feel confident that your work was collected properly. Feeling comfortable with ;your work may take a while, but certainly this is not uncommon with surveyors or with anyone using something that is new."

BPLS Applications

- Establishing Control
- Tying out Random Trav.
- Elevations for Flood Cert.
- Topo to generate surfaces
- Locate boundary evidence
- Locate wetlands
- Establish True North on tower site surveys
- Horizontal and vertical construction layout
- Setting Property Corners
- Searching for control
- Static Observations
- Forensic surveys
- As-built surveys

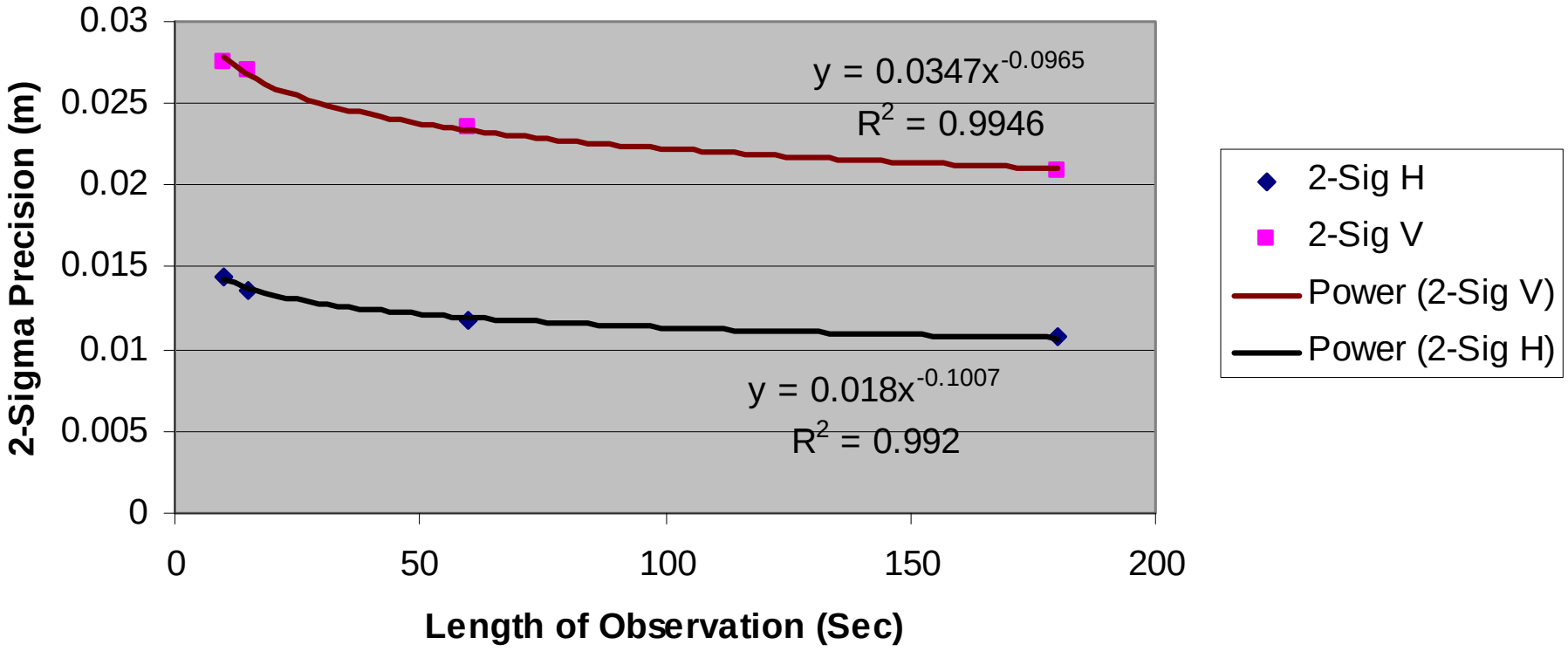
BPLS Notes On Procedures and Usability

- Build in redundancy for important points
  - Second shot taken with different initialization and new tripod setup (rotated)
  - View residuals, and field average if within tolerances (0.03') (0.03'-0.06' typical)
  - Topo pts. for 5 sec., control and property corners for 15 sec.
- Field calibrations used when called for. Always check into other points (H&V) to verify calibration
- Using CORS and Geoid for positions, try to verify by checking into known NSRS control if possible.

2 Sigma Horizontal and Vertical Precisions vs.Time

Horizontal Coeficient of Correlation = 0.899

Vertical Coeficient of Correlation = 0.947



http://vcap.aot.state.vt.us/Advisor/advisorpresent.htm

Edit View Favorites Tools Help Convert Select

Vermont Geodetic Survey - NGS Advisor

RMONT

Vermont Geodetic Advisor

Agency of Transportation

Vermont Geodetic Advisor

- CORS Presentation - January 24, 2008 Maine Society of Land Surveyors
- NGS Activities and Initiatives - January 25, 2008 Maine society of Land Surveyors
- VT RTK Case Study - March 07, 2008 American Congress on Surveying and Mapping
- VT State Plane - April 11, 2008 Vermont Society of Land Surveyors

Questions / Discussion

- Should VT surveying standards include provisions utilizing GPS methodologies?
- What about reporting/documentation?
- Is it time to consider non-relative or “CORS relative” accuracy standards? What positional error for 1:20,000 when positioning from 20km (12.5mi)?
- What are the issues when mixing networks?
- What are the issues when mixing methods?
- What are the real benefits to the surveyor?
- Are there benefits to using dual constellation receivers?
- Are there real benefits or is it just another way to skin the cat?