Cooperative Geodetic Activities and National Spatial Reference Framework Modernization Planning in Washington State

NOAA Hydrographic Services Review Panel
Pacific Northwest Public Meeting
Seattle, WA, April 18 - 20, 2017

Gavin Schrock, PLS
Washington State Reference Network

Geodetic Future of WA?

- Reference Framework
- External Drivers
- Internal Drivers
- Passive-Active
- Self-Reliance
- Education Needs

Primary Goal:

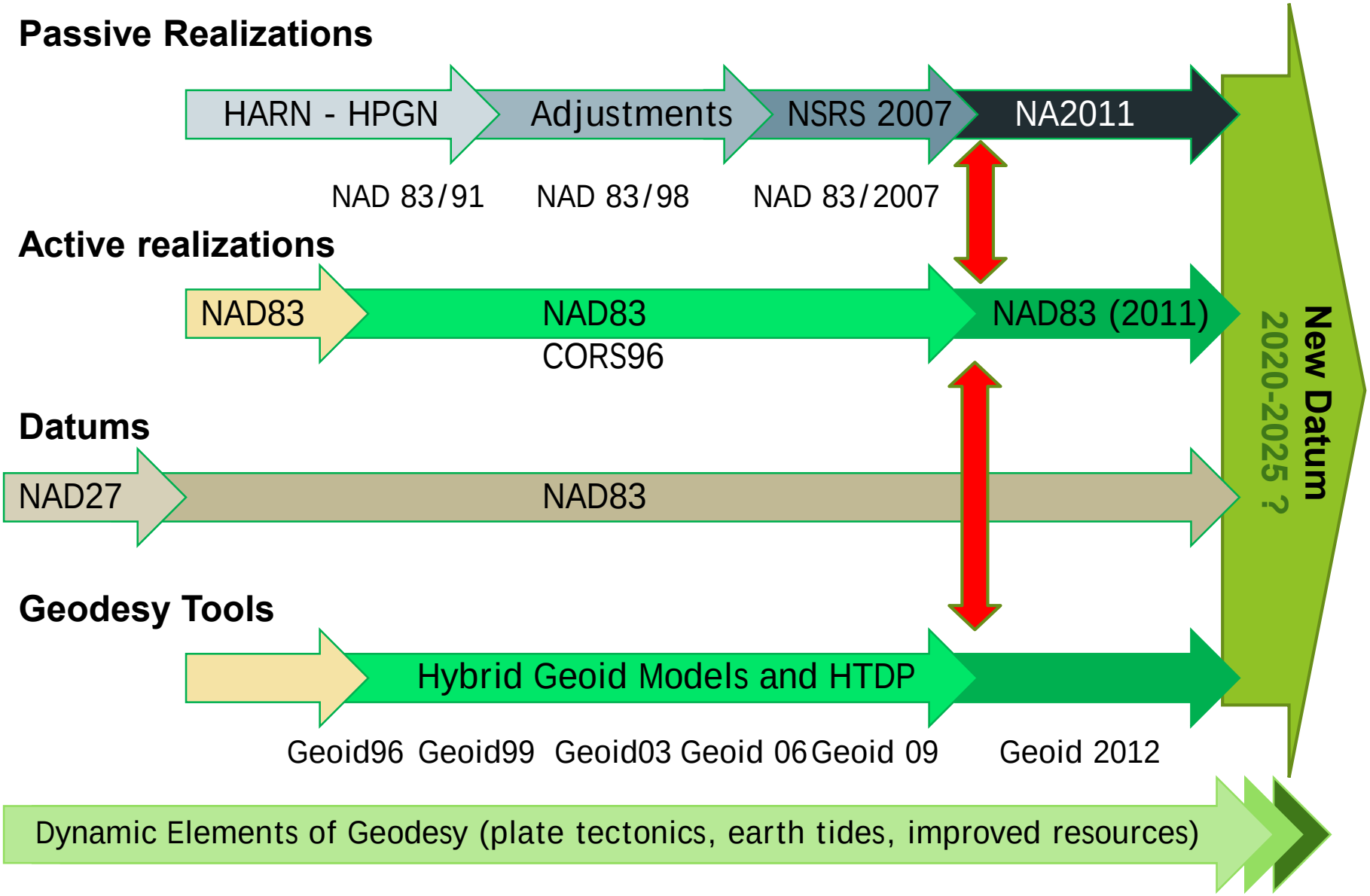
"To Avoid Becoming Worse for the WHERE"

2022

- National Reference Framework Update
- Target for Multiple WA Initiatives
- Rallying Cry

Active and Passive Realizations

Published References and Resources @ Epochs



Geodetic Resources for the State of Washington

SCIENTIFIC
IGS, PANGA
JPL, PBO, etc

ASSOCIATIONS
LSAW, WCCS,
ACSM – NSPS ,etc

FEDERAL
NGS, USGS,
USACE , etc

EDUCATIONAL
SURVEY ING
PROGRAMS , etc

REAL-TIME GNSS NETWORKS

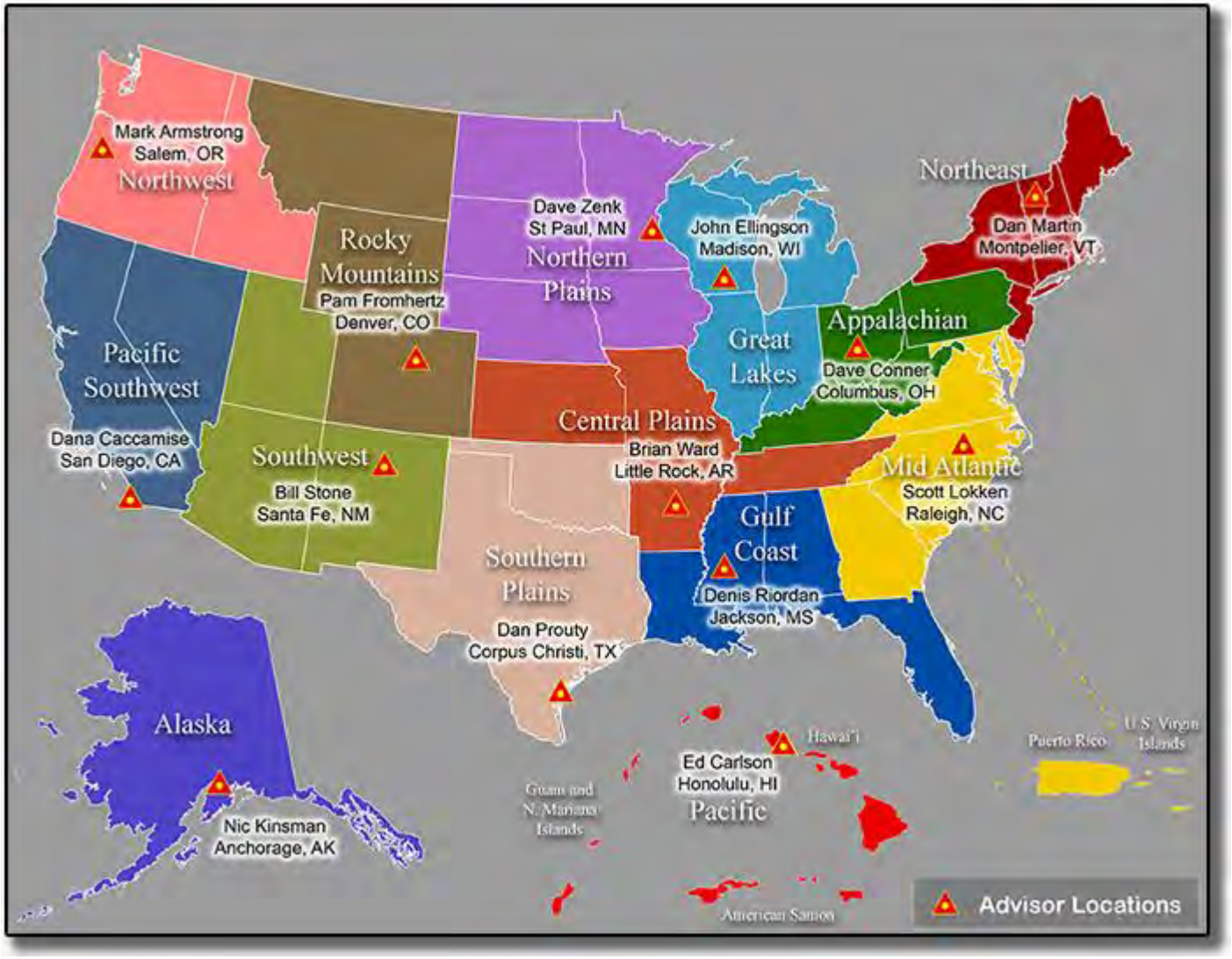
STATE
WSDOT, WADNR,
ECY, etc

LOCAL
CITIES, COUNTIES,
UTILITIES, etc

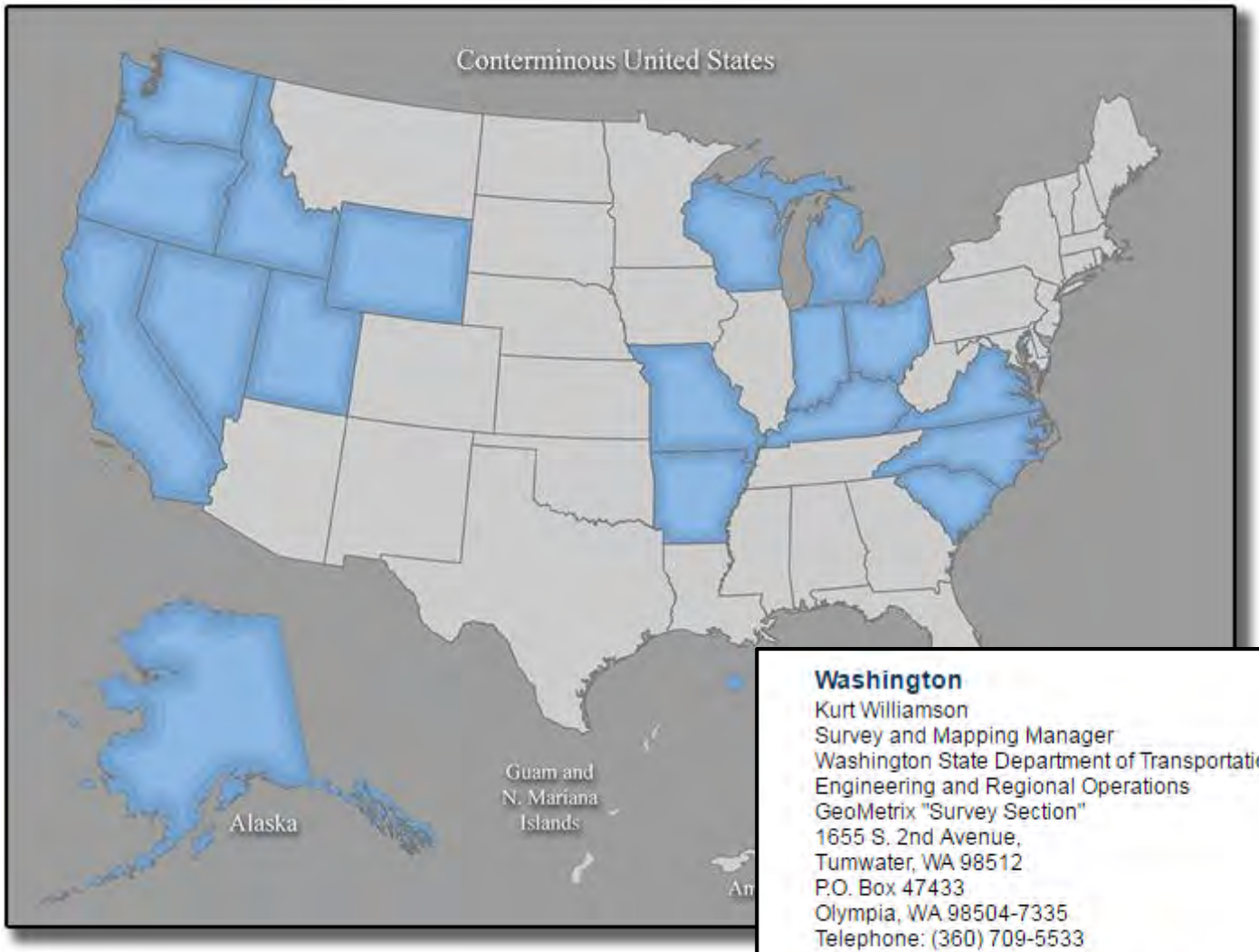
Washington Geodetic Survey

The Washington Geodetic Survey is a non-profit organization formed to advise and support both geodetic resource providers and end-user communities

NGS Regional Advisor



NGS Coordinator - WA



Washington
Kurt Williamson
Survey and Mapping Manager
Washington State Department of Transportation
Engineering and Regional Operations
GeoMetrix "Survey Section"
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WilliaK@wsdot.wa.gov

WSDOT GeoMetrix
Geodetic Survey Office

Washington State
Department of Transportation

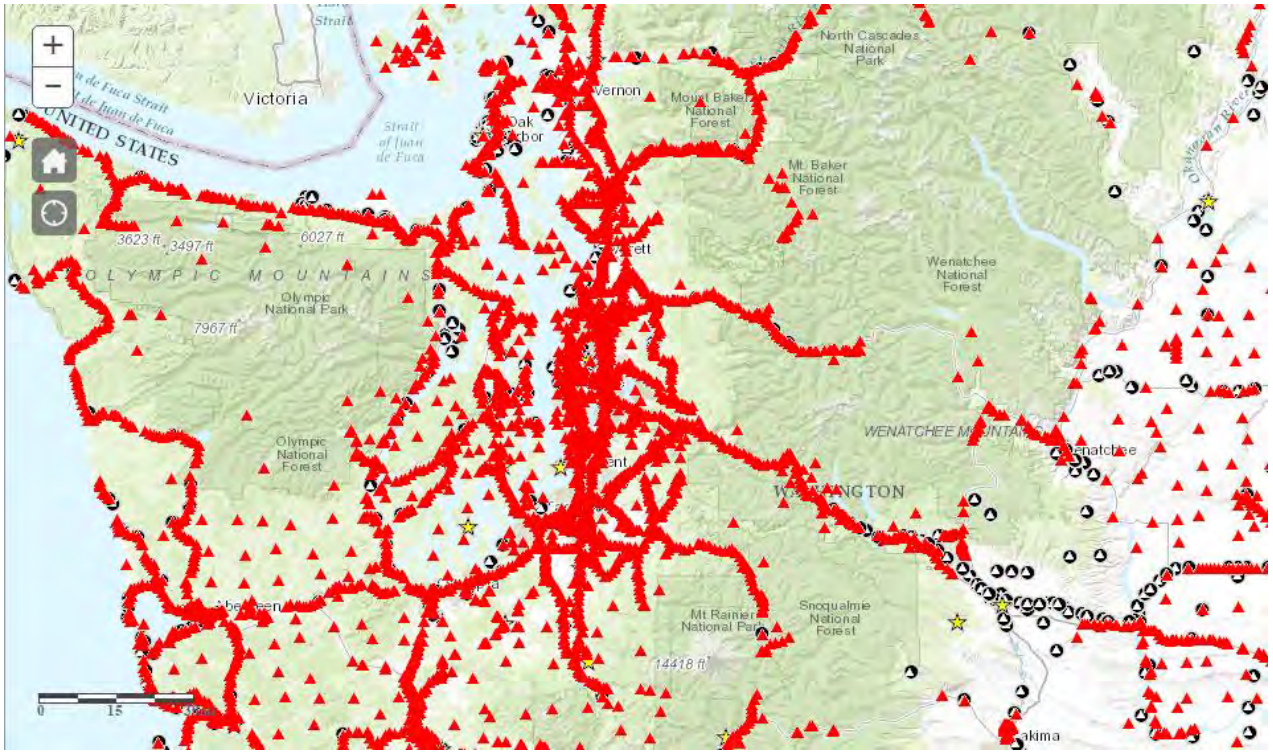
WSDOT GeoMetrix
Geodetic Survey Office

<u>Cool geodetic things that WSDOT does for our state:</u>

Geodetic Levels

GPS Campaigns

Control !!



WSDOT GeoMetrix
Geodetic Survey Office

Washington State Department of Transportation

Geographic Services

SURVEY INFORMATION SYSTEM **Report of Survey Mark**

				ACCOUNTS INFORMATION		
Designation:	944 7130 TIDAL D	**T.R.S:**	24N, 4E, 6	**BOOK**	**PROJECT**	**INVOICE**
Monument ID:	6957	**Corner Code:**		321	MS4466	23-07029
NGS Pid:		**State Route:**				
State:	WASHINGTON	**Mile Post:**				
County:	KING	**Station:**				
Region:	NW	**Offset:**				
Nearest Town:	SEATTLE	**Owner:**	GS			
USGS Quad:	SEATTLE SOUTH	**Bearing:**	M			

TO REACH THE STATION FROM THE VEHICLE ENTRANCE TO THE WASHINGTON STATE FERRY DOCK AT COLMAN DOCK, SEATTLE (AT THE INTERSECTION OF ALASKAN WAY AND YESLER WAY), GO NORTHWEST 0.1 MILE ALONG ALASKAN WAY TO MARK ON RIGHT. IT IS LOCATED IN A CONCRETE BASE FOR THE OVERHEAD PEDESTRIAN WALKWAY FROM THE FERRY TERMINAL, AND IS ON THE SOUTHWEST SIDE OF MARION STREET, 4.0 METERS @ 135 DEGREES FROM THE NORTHWEST CORNER OF "COMMUTER BUILDING" (825 WESTERN AVE), 35.5 METERS @ 235 DEGREES FROM THE EASTERLY RAIL OF STREETCAR LINE SEPARATING ALASKAN WAY AND PARKING AREA UNDER VIADUCT, 5.8 METERS @ 325 DEGREES FROM THE APPROXIMATE CENTERLINE OF MARION STREET, AND 20.6 METERS @ 270 DEGREES FROM BM TIDAL 25 RESET. THE MARK IS A NATIONAL OCEAN SURVEY BRASS DISK SET LEVEL WITH THE CONCRETE SURFACE.

Survey Control

Datum: NAD 83/91 **Date:** 10/31/2007

Lat: 47 36 11.50 N **Long:** 122 20 14.71 W **Ellips:** (M) (USFt) **Geoid:** (M)

Washington State Plane Zone: North

Northing	**Easting**	**Scale**	**Comb Factor**	**Conv Angle**
68170. (M) 223654 (USFt)	386908. (M) 1269380 (USFt)	0.99998235		-1 07 11.4

Ortho: Date: 01/18/2015

Datum: NAVD 88

Elevation: 5.517 (M) 18.100 (USFt)

Survey Info	Accuracy	Network	Method
Horizontal	10 M+	OTHER	GPS
Ortho	1 CM	PRIMARY	DIFF LEVELS

wsrn.org

Washington State Reference Network

A Regional Cooperative of Real-Time GPS Networks.

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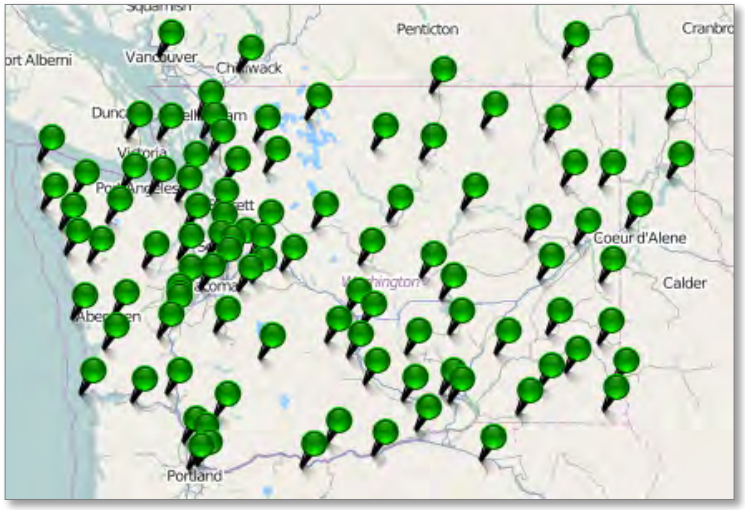
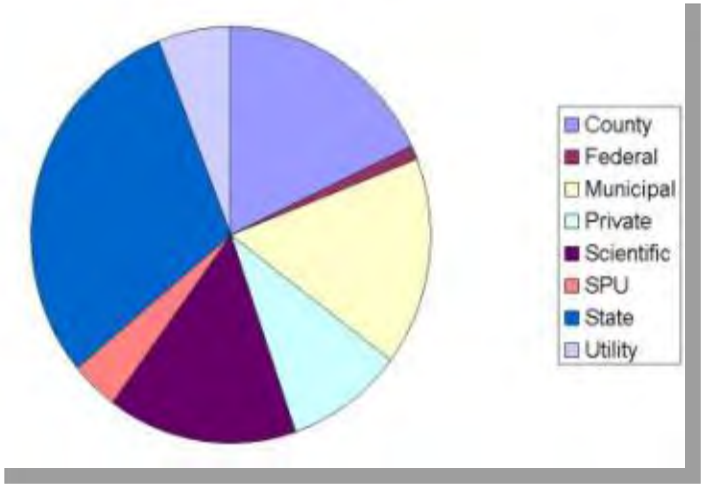
Public-Private Cooperative



- 10 NGS CORS
- 8 Earthscope PBO
- 3 Seattle Public Utility
- 21 at WSDOT sites
- 11 private sites
- 60 public/community sites

112 Stations

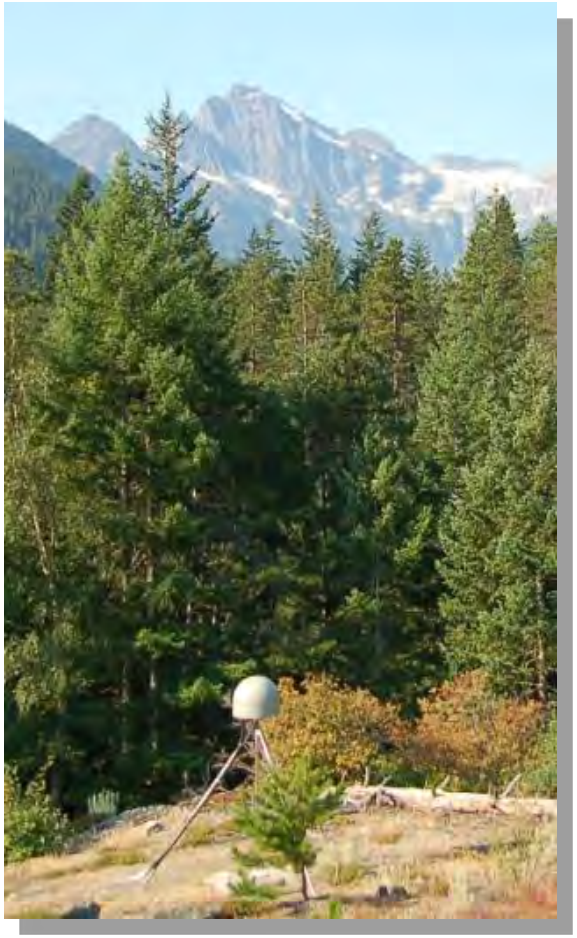
(+ 8 contingency)



KOOT - Kootenai County Airport

WsDOT Mount – Walla Walla

PBO, WSRN & CWU Collaborations



P444 – Ross Lake

SC02 – Friday Harbor

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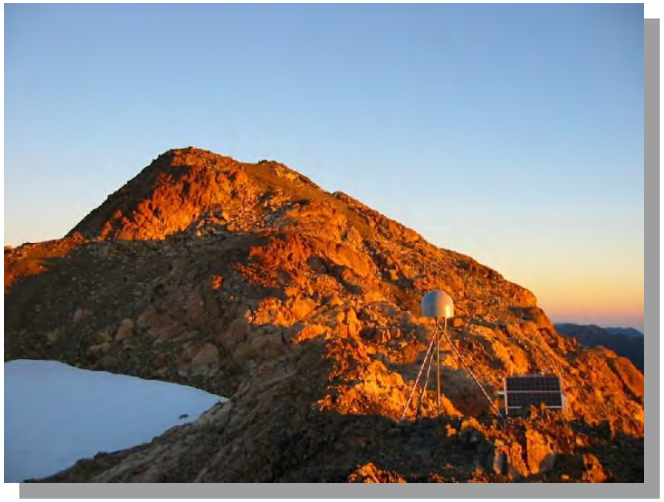
A Regional Cooperative of Real-Time GPS Networks.

Challenging Environments

Cougar

WA

Storm Damage



SC03 Mt. Olympus

HAHD – Palmer WA

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User comms

Settings

Geodesy & Surveying

Passwords

Urban Legends

Server issues

Has become a default geodesy and surveying support line….
But is not chartered to do that role…

wsrn.org A Regional Cooperative of Real-Time GPS Networks.

Washington State Reference Network

Washington Geodetic Survey presents the One-Day Seminar:

DATUM MATTERS

with

Dave Doyle

Geodesy Editor- Professional Surveyor Magazine
NGS Chief Geodetic Surveyor (Ret.)

Modernization of the National Spatial Reference System - Keeping Pace with Changes in Positioning Technology and User Expectations in a Dynamic World + WSRN Updates

8:30am – 4:00pm October 25th, 2013
Blencoe Auditorium
Renton Technical College, WA
$90 – Lunch Provided

Page 1 of 3

User training and geodesy seminars

In cooperation with WGS and LSAW

Washington Geodetic Survey Presents the one day seminar:

"2022"

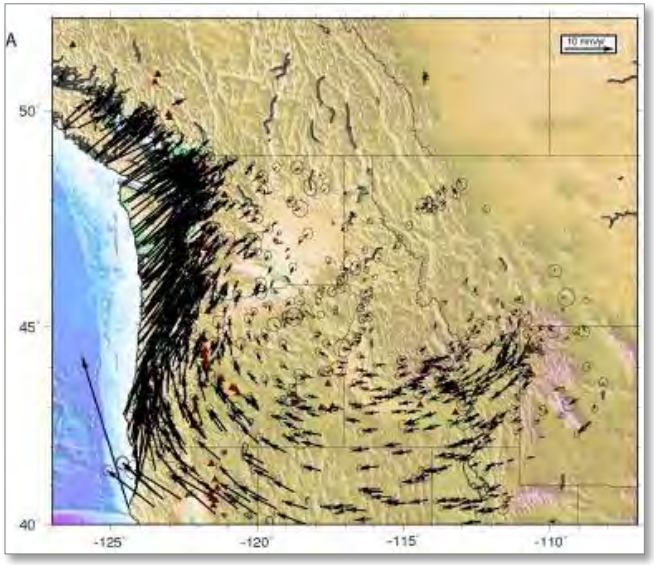
Preparing for Reference Framework Updates

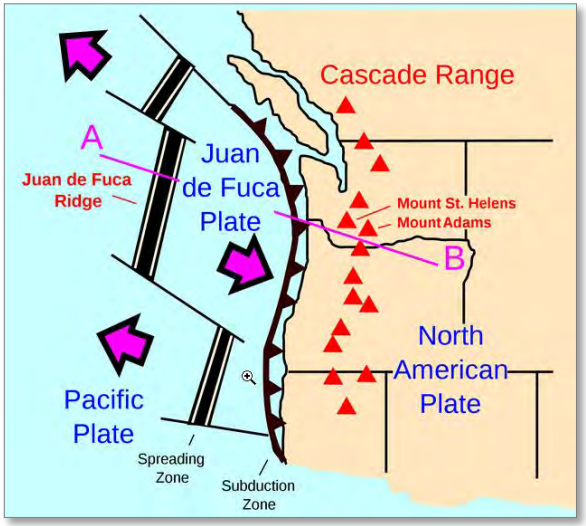
Featured Presenter
Dr. Dru Smith
National Spatial Reference System (NSRS)
Modernization Manager
National Geodetic Survey

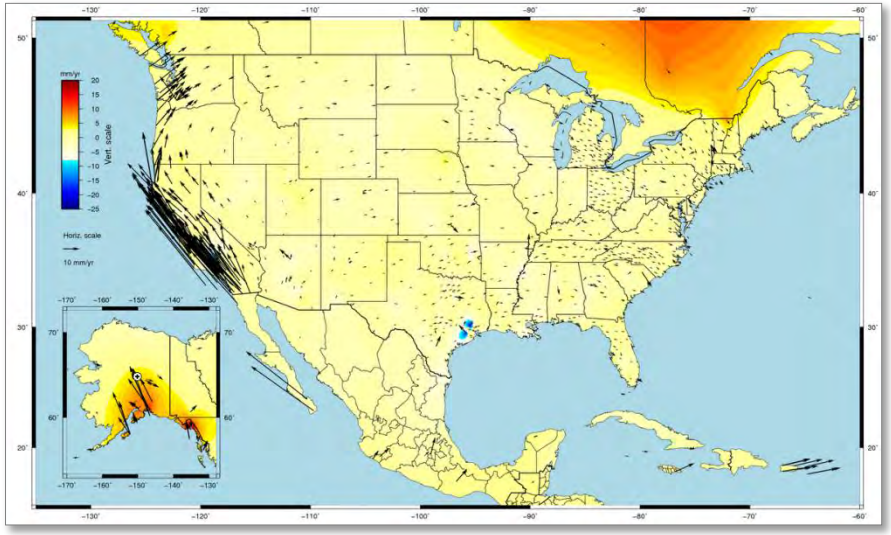
- *An overview of the planned NSRS update*
- *What to expect – vertical – horizontal – temporal*
- *Actions Washington can take to prepare*
- *Updates from the LSAW & WGS 2022 teams*

Save the date:
8:30am – 4:00pm February 12th, 2016
Blencoe Auditorium
Renton Technical College
$65* – Lunch Provided
Admission includes optional WGS membership. *Students free
Register at: http://www.gsow.org/wgs-2016-seminar-2022/
Questions? Email: wgs.seminars@gmail.com

Velocity - Network Integrity Management

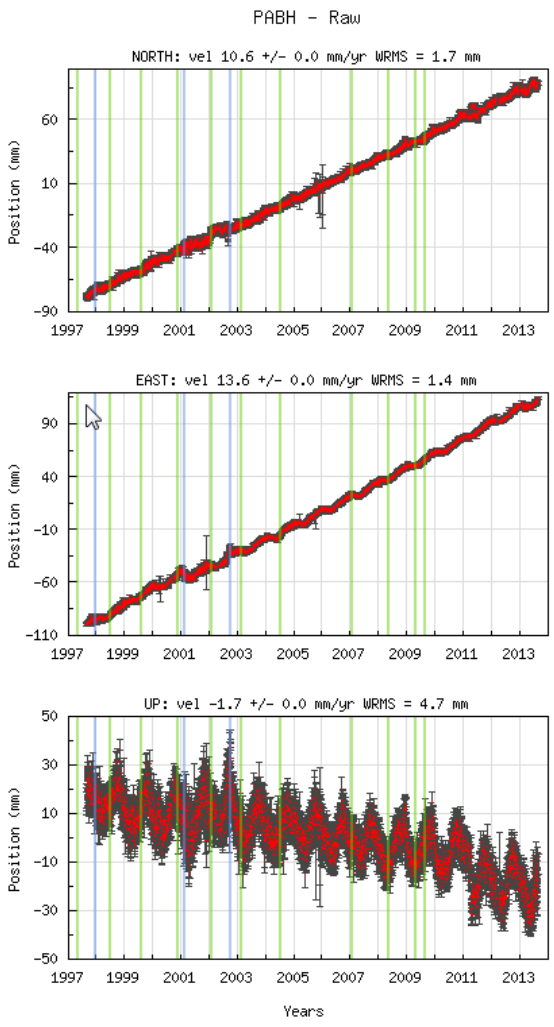




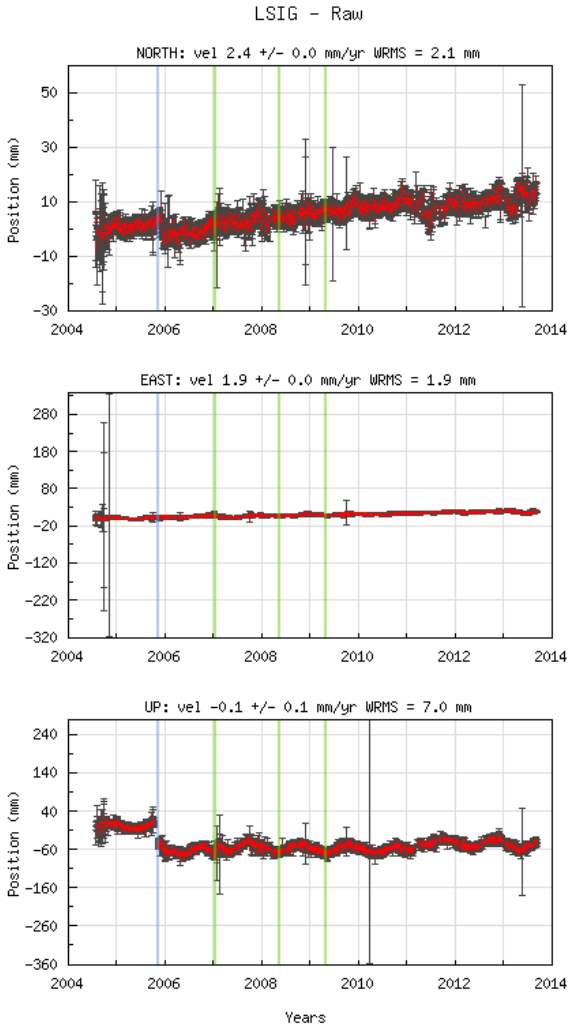


Velocity - Network Integrity Management

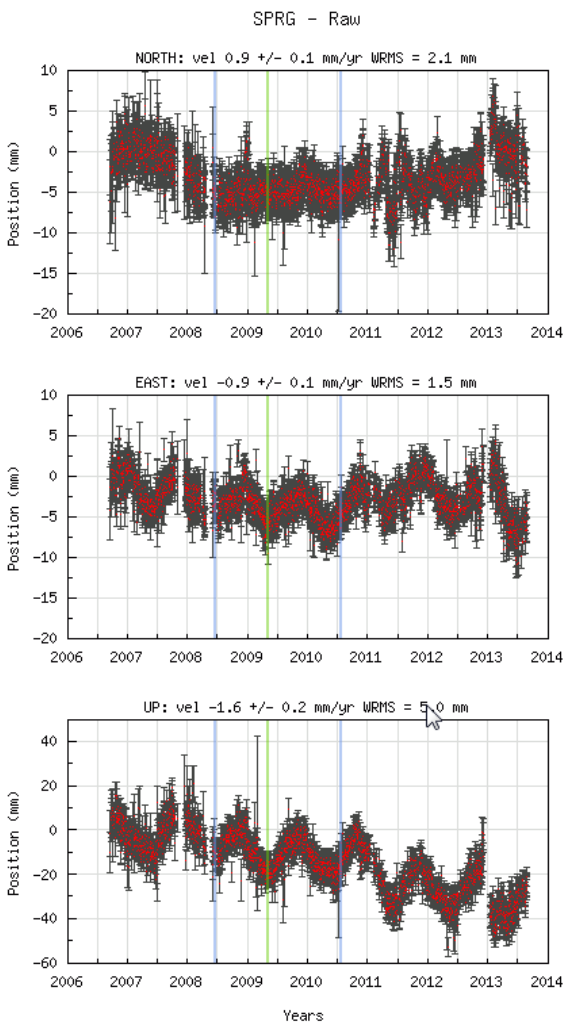
Costal



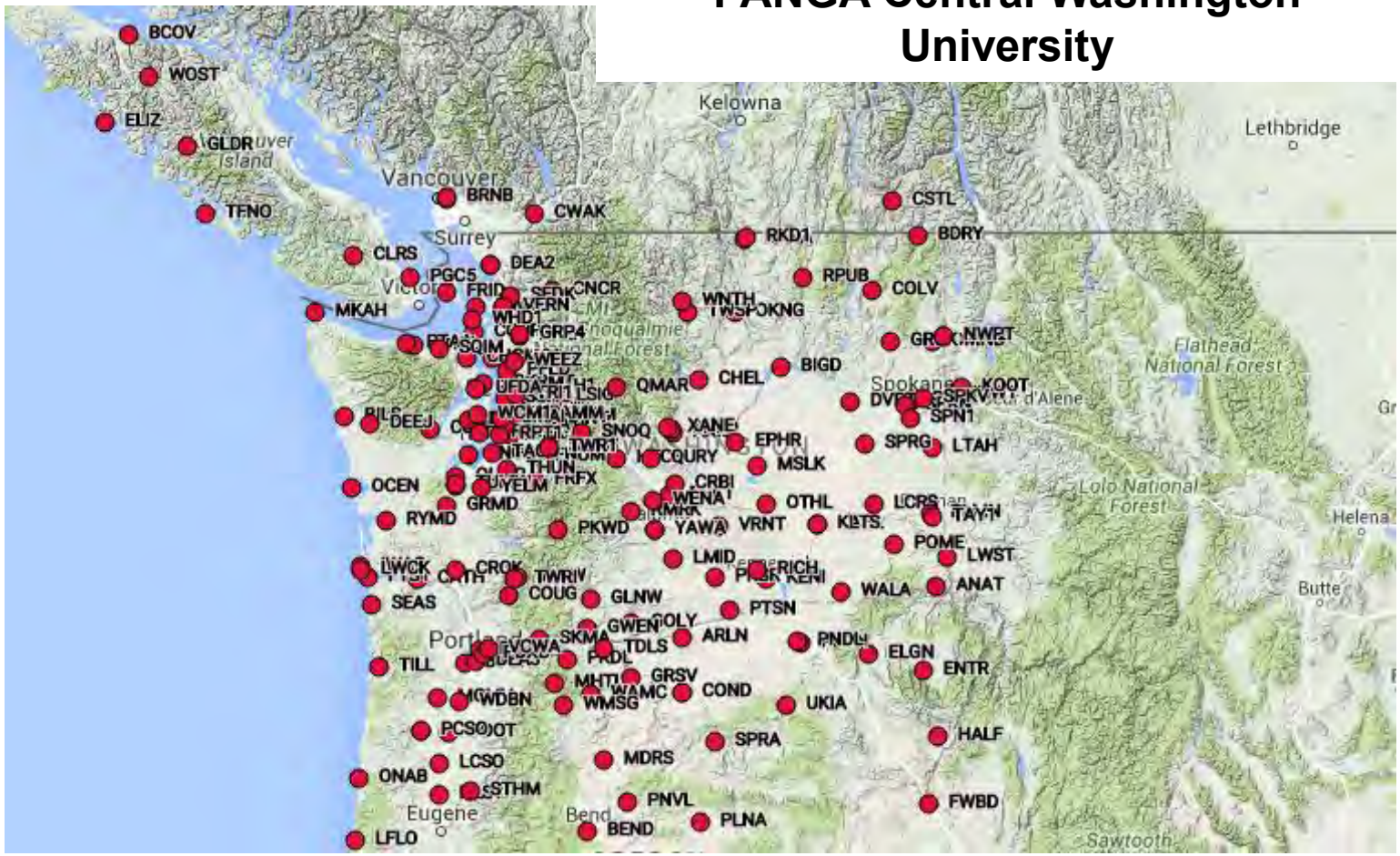
Central (Puget)



Eastern



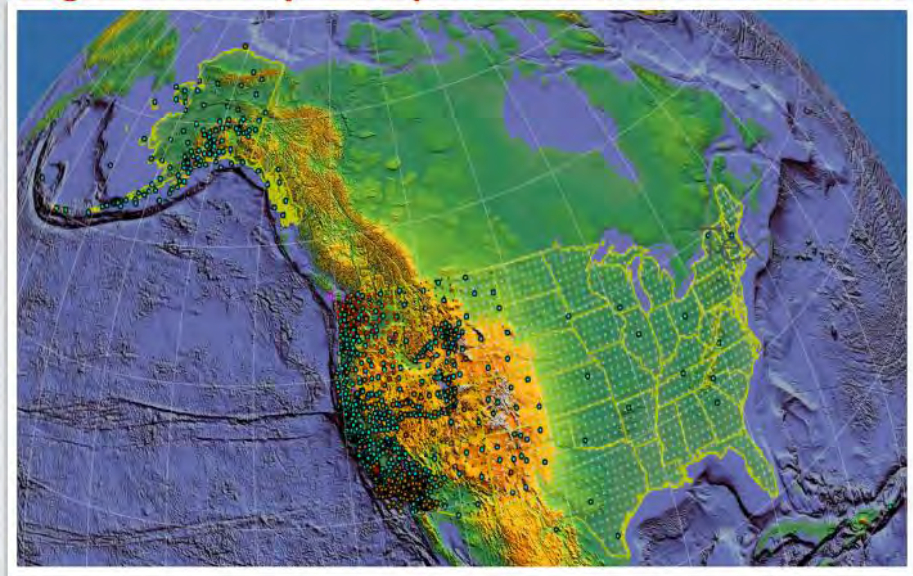
PANGA Central Washington University



UNAVCO

EARTHSCOPE: INTEGRATION OF GEODESY AND SEISMOLOGY

Designed as a 15 year experiment set to sunset in 2018



PBO is the geodetic component of EarthScope (~$200M):
1100 cGPS, 78 BSM, 6 LSM, 26 tiltmeters

Technical advancements:

- *community data formats for real-time GPS*
- *collocation of accelerometers & high-rate GPS*
- *Cascadia & planned GAGE upgrades*
- *changes in the landscape with vendors*

Integrative science:

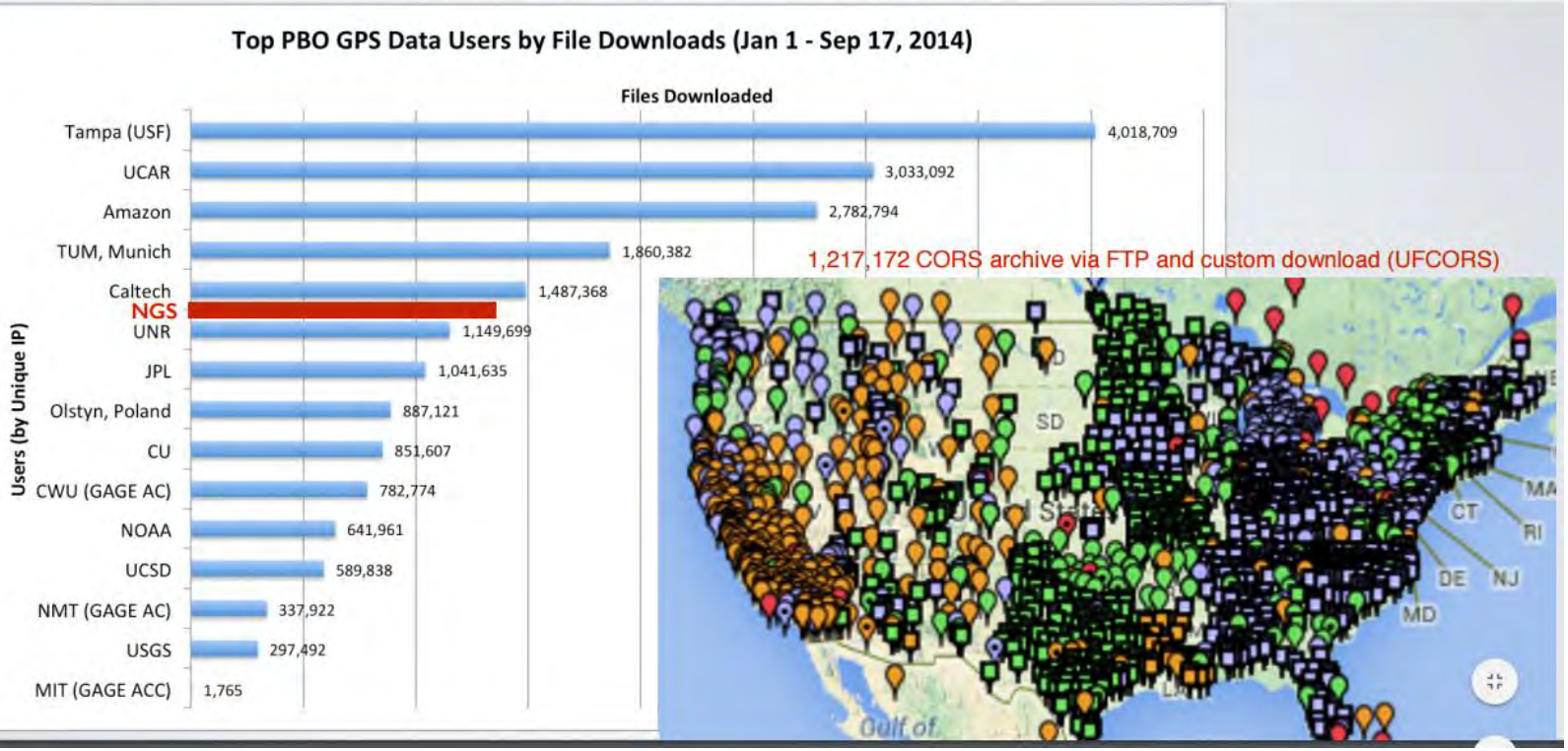
- *tomography & kinematics for geodynamics*
- *episodic tremor and slip*
- *GPS seismology*
- *early GPS centroid determination*
- **Total EarthScope Budget: ~$600M**

NSF

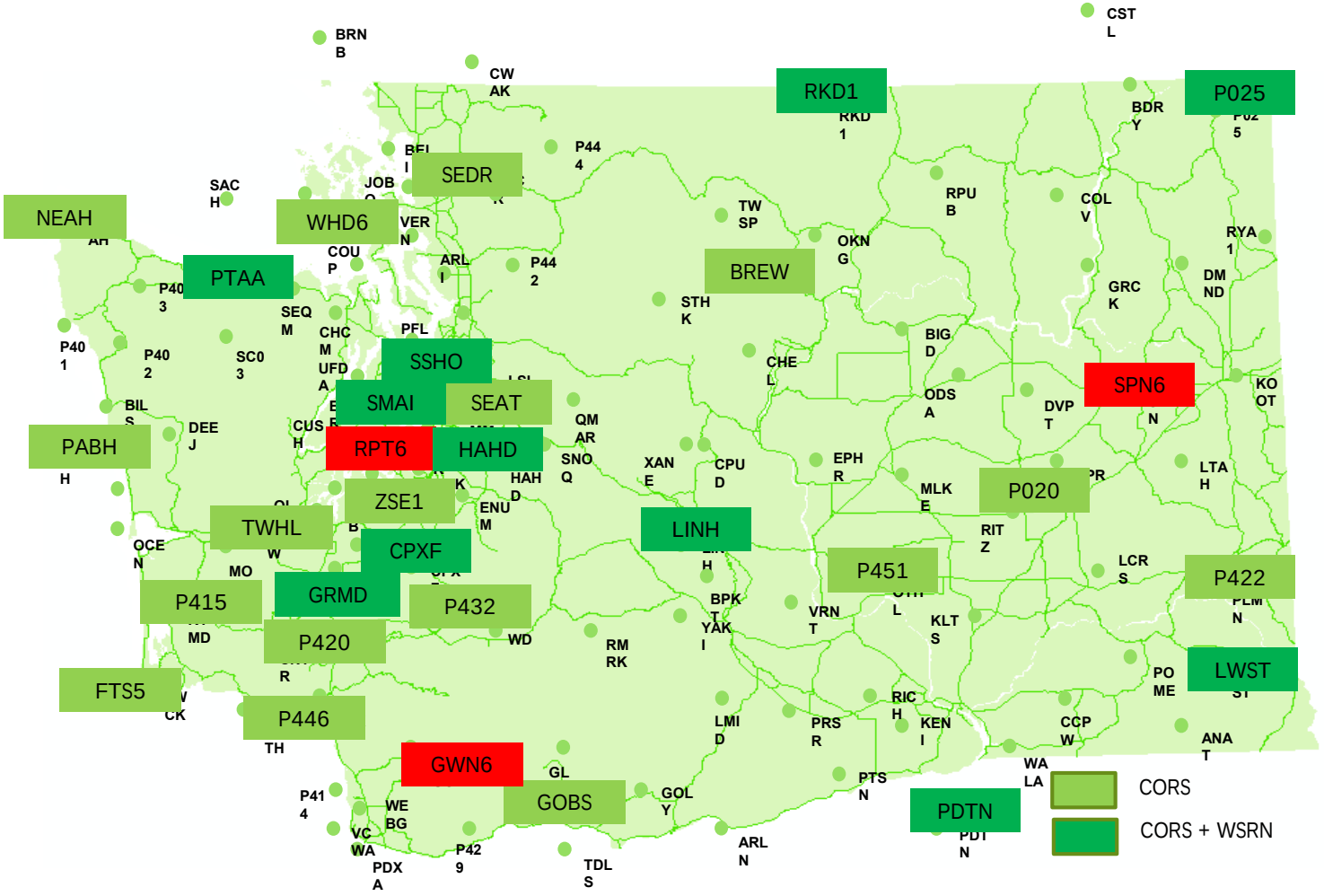
earthscope

UNAVCO

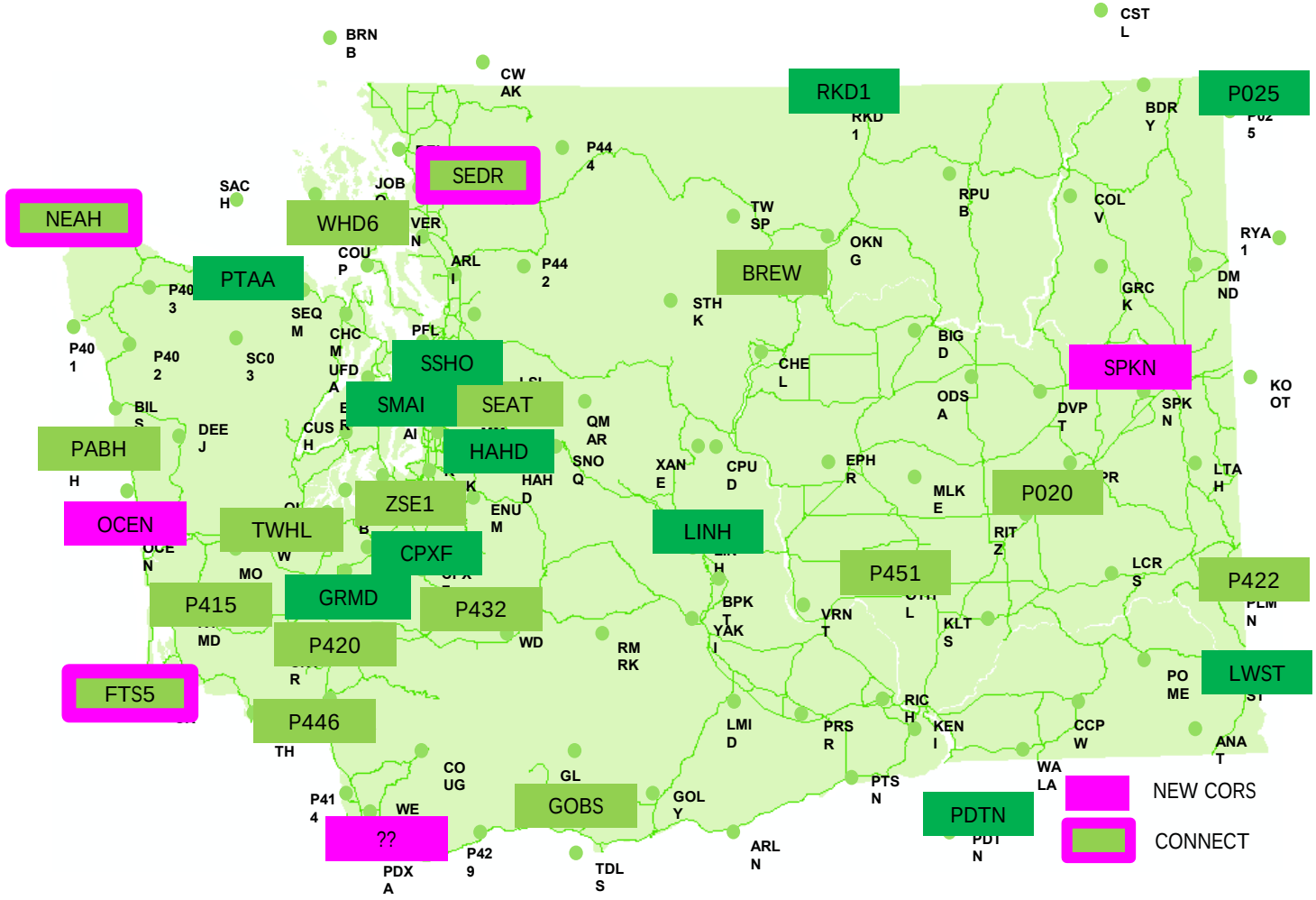
NGS - CORS & OPUS: PBO DATA REDISTRIBUTION



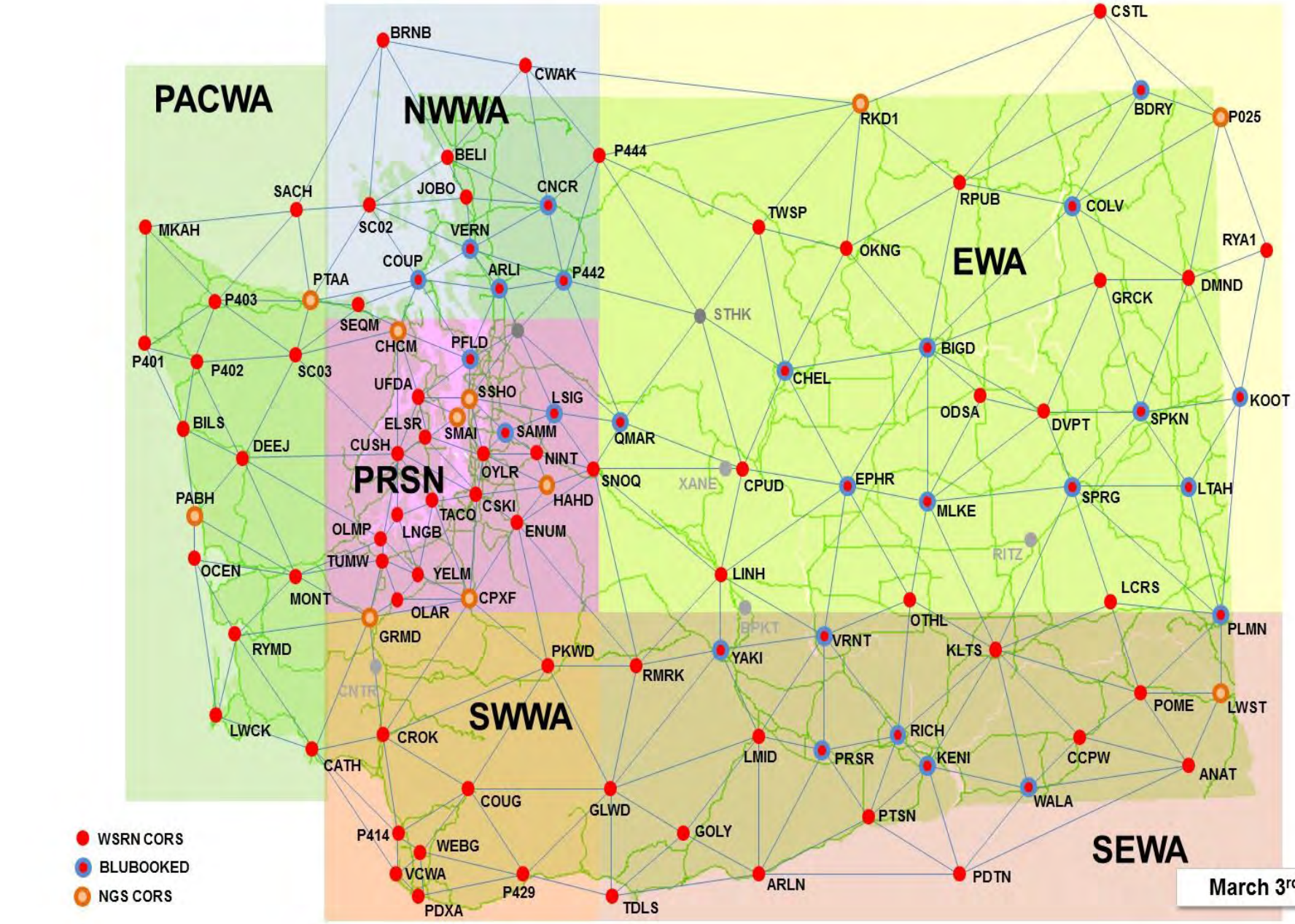
National CORS & WSRN CORS – Decommissioned Sites



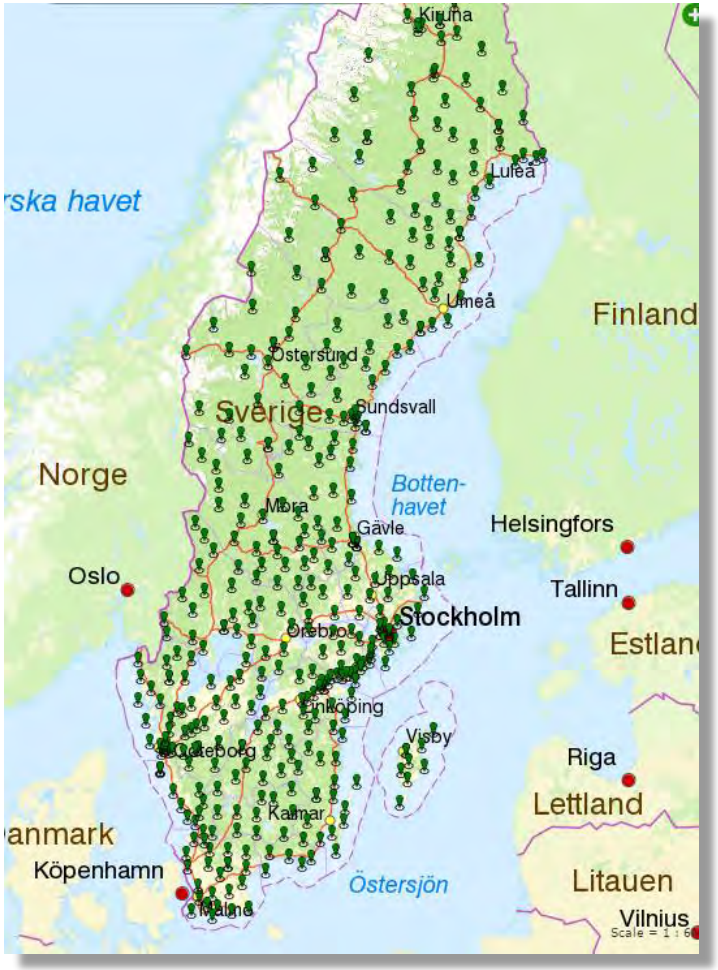
National CORS & WSRN CORS
Proposal to Replace/Augment



Washington State Reference Network



Meanwhile in Scandinavia…



Evaluating Legacy Passive Control

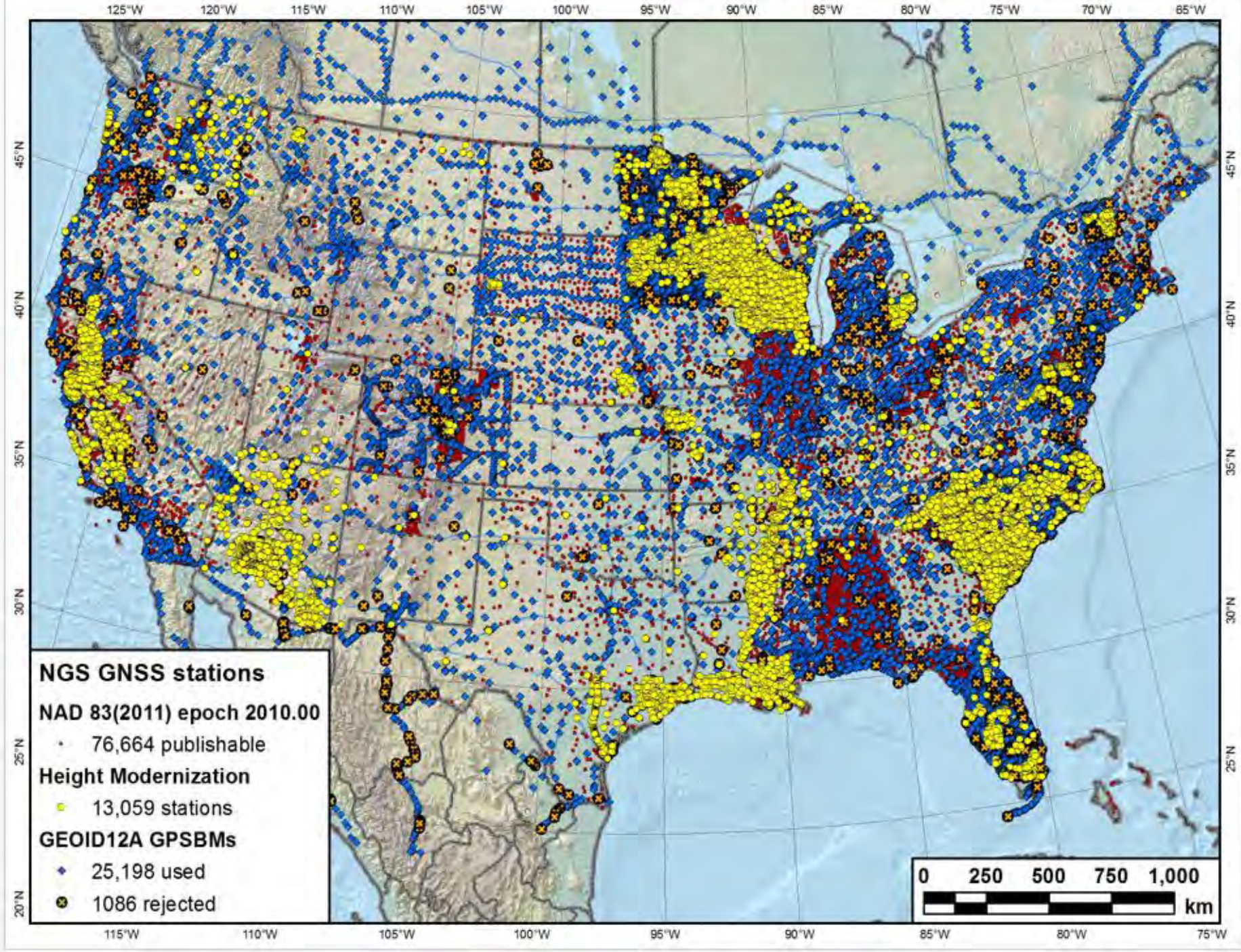
- VANPORT

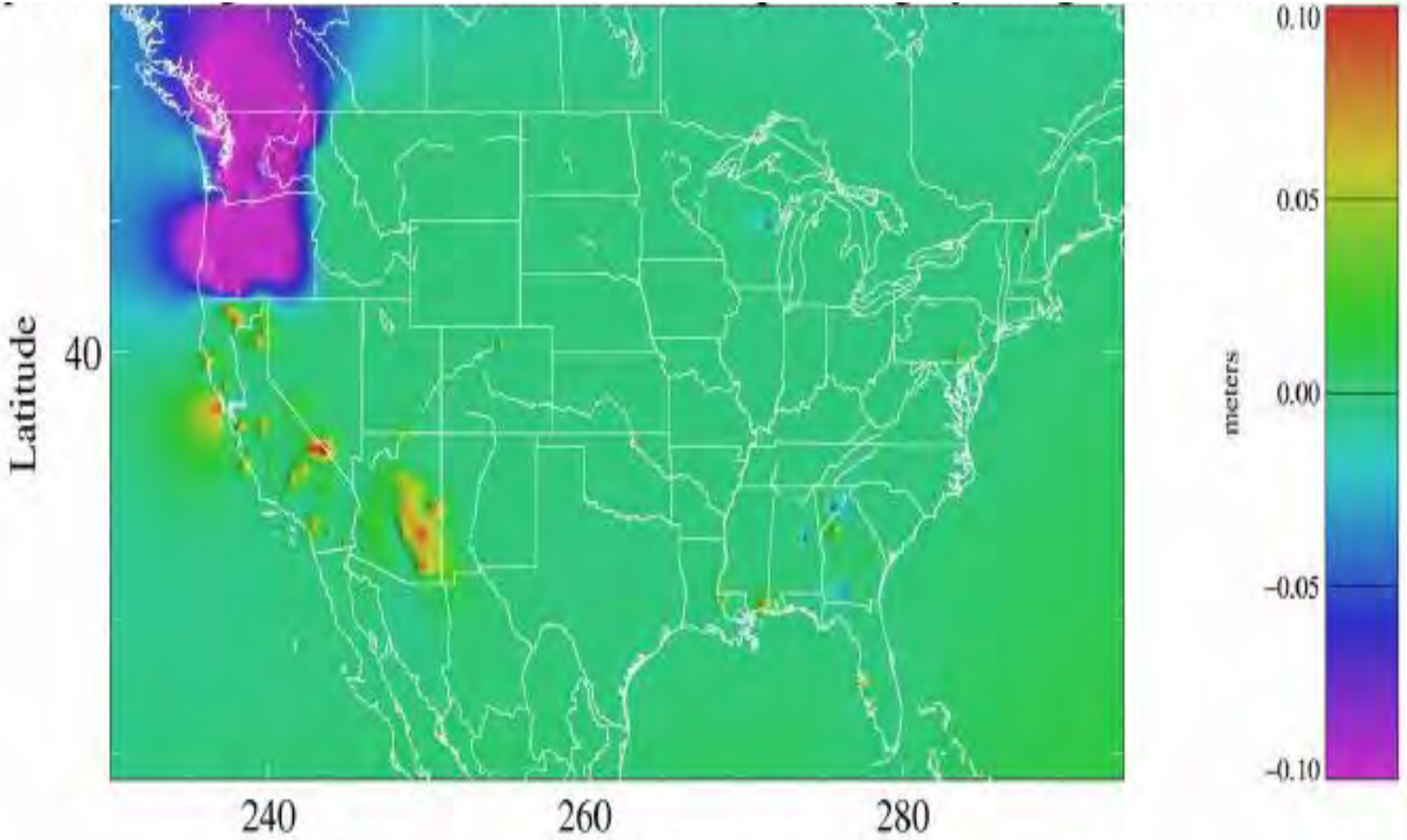
- NGS 2007 N34353.516 E331375.047 ELLIP -13.710
- GEOID03 ORTHO 9.068
-
- NGS 1998 N34353.390 E331375.017 ELLIP -13.713
- GEOID03 ORTHO 9.074

- NGS 1991 N34353.390 E331375.017 ELLIP -13.500
- GEOID03 ORTHO 9.287

- WSDOT 1991 N34353.389 E331375.013 ELLIP -13.537
- ORTHO 9.068

- CLARK COUNTY 1991 N34353.390 E331375.017 ELLIP -13.562
- NGVD29 8.009 = NAVD88 ORTHO 9.065


125°W
120°W
115°W
110°W
105°W
100°W
95°W
90°W
85°W
80°W
75°W
70°W
65°W
45°N
40°N
35°N
30°N
25°N
20°N
NGS GNSS stations
NAD 83(2011) epoch 2010.00
76,664 publishable
Height Modernization
13,059 stations
GEOID12A GPSBMs
25,198 used
1086 rejected
0 250 500 750 1,000
km



Ellipsoid heights in database as of 28APR00 minus those in gpsbm99.022 file

WGS Goals for 2022

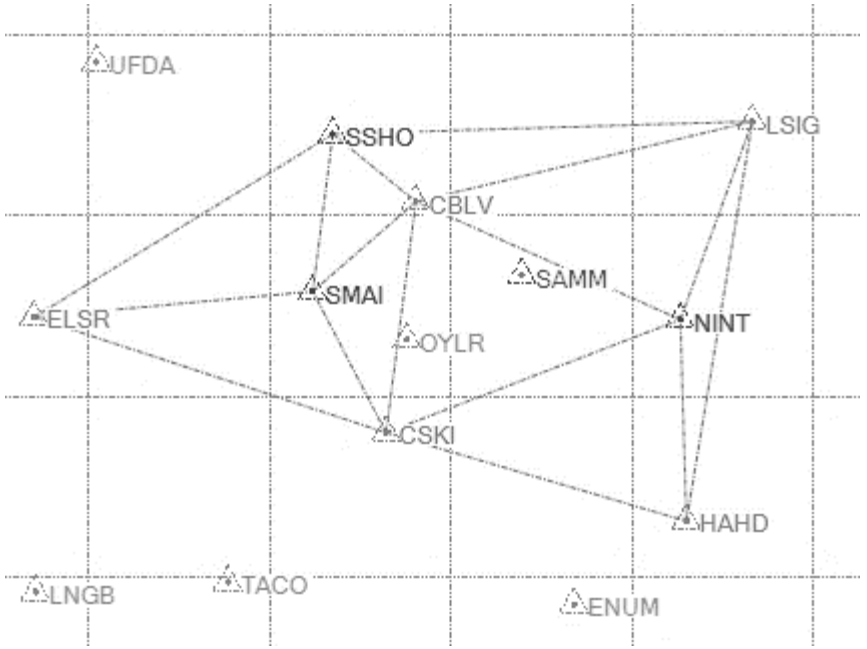
- Prepare end user constituencies for the prospect of diminishing passive control
- Improve understanding of geodesy among end user constituencies
- Develop SOP for spot checks, calibrations, and time-dependent transformations
- Preserve in-state resources and expertise

WSRN Goals for 2022

- Multi-Constellation
- New Receivers and Antennas
- Additional Stations
- Comms Upgrades
- Online Post-Processing
- Velocity-Centric Procedures
- Transformation Parameter
- Roll-Your-Own-Check-Mark
- PPP Services
- Mobile Apps

Multi-Constellation

Test Subnet



Dual Frequency

- GPS Navstar
- GLN Glonass
- BDS Beidou (Compass)
- GAL Galileo
- QZS QZSS

Broadcast Formats

RTCM3.2 MSM	(Single-Base and Network)	e.g.	PRSNVRSRTCM_M32	or	SSHO_M32
CMRx	(Single-Base and Network)	e.g.	PRSNVRS_CMRx	or	SSHO_CMRx

Multi-Constellation

Mix-n-Match

Depending on implementation in your specific gear, you may be able to mix and match constellations without a minimum number of satellites for each constellation

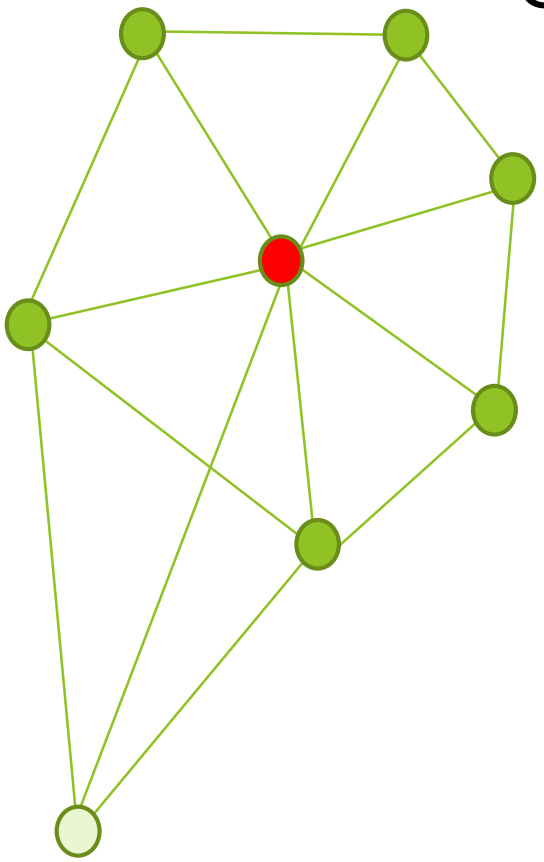
Satellites Tracked:22

GPS (9):	5, 7, 8, 9, 16, 23, 27, 28, 30
GLONASS (9):	5, 6, 7, 8, 9, 16, 17, 18, 24
Galileo (3):	1, 9, 19
BeiDou (1):	12

Third Frequency

Until such time as there are a minimum number of L5/E5 satellites in view at a given time, the benefit of the third frequency may not be realized. But when there are enough, gains are expected.

Online Post-Processing



NAD83-2011 @ epoch 2010.00 Measurement method: Antenna Ground Point (AGP)		
Coordinate	**Value**	**σ [m]**
X [m]	-2175326.717	0.003
Y [m]	-3610705.070	0.005
Z [m]	4771193.854	0.004
Latitude	48° 43' 48.77295" N	0.002
Longitude	121° 04' 3.10969" W	0.002
El. height	494.212	0.006

wsrn

WSRN - WAPUS - Online Post Processing Report

http://www.wsrn.org

Order Information

Order ID: 10028
Uploaded file(s): 0367260C.T02
Upload date: 09/19/2016 14:29:00 UTC

Antenna:
Name: 146
Height: 2.000
Reference: Bottom of antenna mount

Processing Information

Session:
Start time: 09/16/2016 21:05:02 UTC
End time: 09/16/2016 21:10:02 UTC

Solution type: Static
Processing interval: 5 s
Ephemeris type: Broadcast
Reference frame: NAD83-2011
Tectonic plate: North America

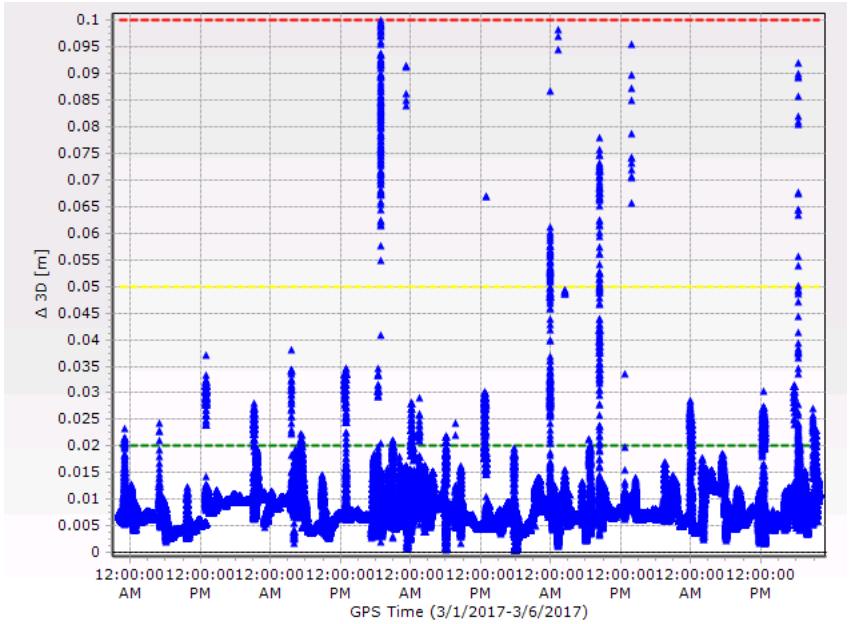
Baselines

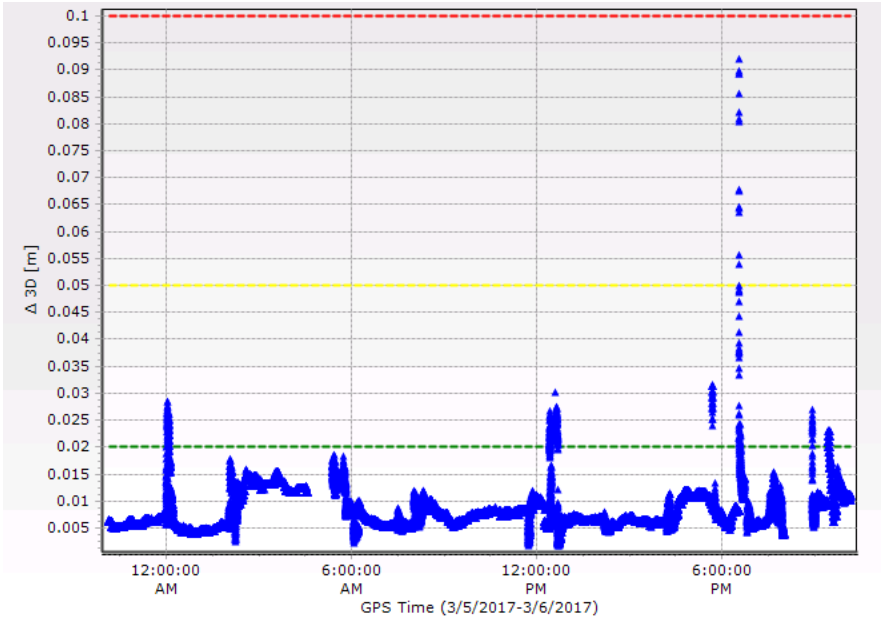
Station Code	Distance [km]	Observations (# total / # usable / # used / %)	Used satellites
SSHO	4.55	301 / 60 / 59 / 98%	10 GPS / 8 GLN / 4 GAL
SMAI	19.02	301 / 60 / 59 / 98%	10 GPS / 8 GLN
SAMM	23.05	301 / 60 / 59 / 98%	9 GPS / 4 GLN
OYLR	23.50	301 / 60 / 59 / 98%	10 GPS / 7 GLN
PFLD	24.02	301 / 60 / 59 / 98%	10 GPS / 8 GLN
UFDA	31.98	301 / 60 / 59 / 98%	8 GPS / 7 GLN

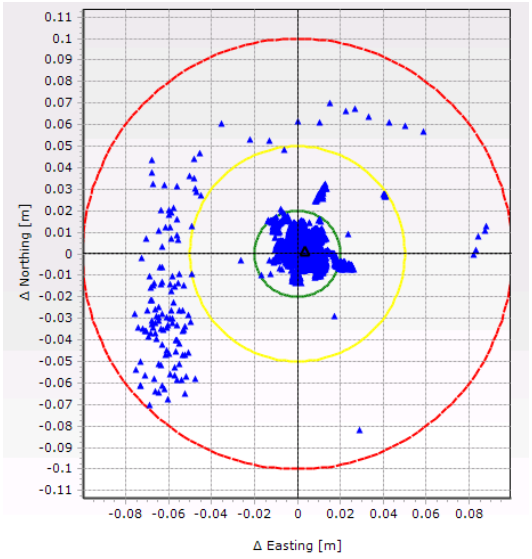
Final Results for: 2___

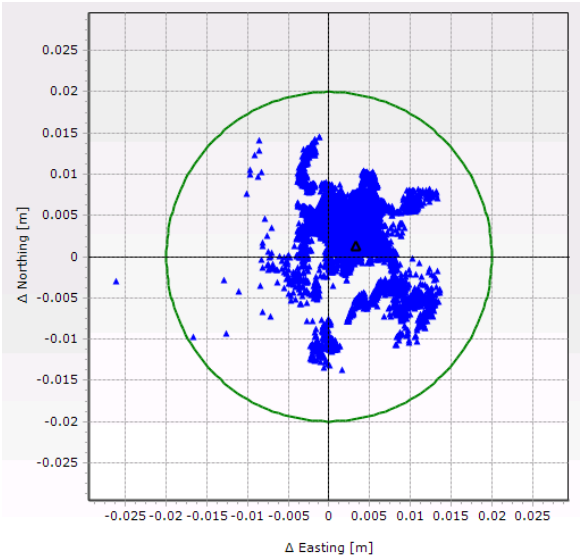
NAD83-2011 @ epoch 2010.00 Measurement method: Antenna Ground Point (AGP)		
Coordinate	**Value**	**σ [m]**
X [m]	-2295805.381	0.007
Y [m]	-3637980.630	0.008
Z [m]	4693234.720	0.011
Latitude	47° 40' 59.82560" N	0.008
Longitude	122° 15' 16.64819" W	0.005
El. height	-8.360	0.012

Upgraded Rover Monitors









Contrasting Solutions

	RTN	Fixed base RTK	Mobile Base RTK
Orbits	Ultra-Rapid +	Broadcast or Ultra-Rapid	Broadcast
Base - stability	High Quality	Should be high quality	Should be high quality - might not
Antenna	Geodetic	Should be high quality	Should be high quality - might not
Receiver	Geodetic	Should be high quality	Should be high quality
Geodetic Reference	Established and Monitored	Established	Published or User Derived
Redundancy	High	Medium	Low- No
Baselines	<70km	10-30km (varies on iono conditions)	10-30km (varies on iono conditions)
Iono mitigation	High	Low	Low
Tropo mitigation	High	Low	Low

GPS on Bench Marks

National Geodetic Survey

March 6, 2017

GPS on BM Links
Home
Recover
Observe
Report
Web Map
GPS on BM FAQ
GPS on BM One Pager

Webinar Information
2016 Video
2015 Video

Related Links
NGS Data Explorer
DSWorld
OPUS Upload
Mark Recovery Form
Photo Submission
GEOID12B
2014 Campaign

For geocachers:
Hunt for marks!
Bench Mark Hunting

What is GPS on Bench Marks?

Improve the National Spatial Reference System (NSRS):

Recover: Look up the description of an existing bench mark and visit the bench mark of your choice.
Observe: Record field notes, take digital photos, and collect GPS observations or coordinates for the bench mark you visit.
Report: Use online tools to send the information to NGS.

Where?

Currently there are over 400,000 bench marks across the Conterminous United States (CONUS), Alaska, Hawaii and all U.S. territories. Tidal marks and bench marks are used for determining heights. Use the maps to prioritize which bench marks to observe.

Who can participate?

Anyone with Global Positioning System (GPS) enabled phones, hand held devices or survey-grade GPS receivers can participate. Recommended procedures vary depending on the type of equipment used.

When should I start?

You can collect and share information any time. Join volunteer efforts across the United States in celebration of National Surveyors Week beginning March 19, 2017. Contact the local **National Society of Professional Surveyors** chapter or your **NGS geodetic advisor** to learn about projects being planned in your local area.

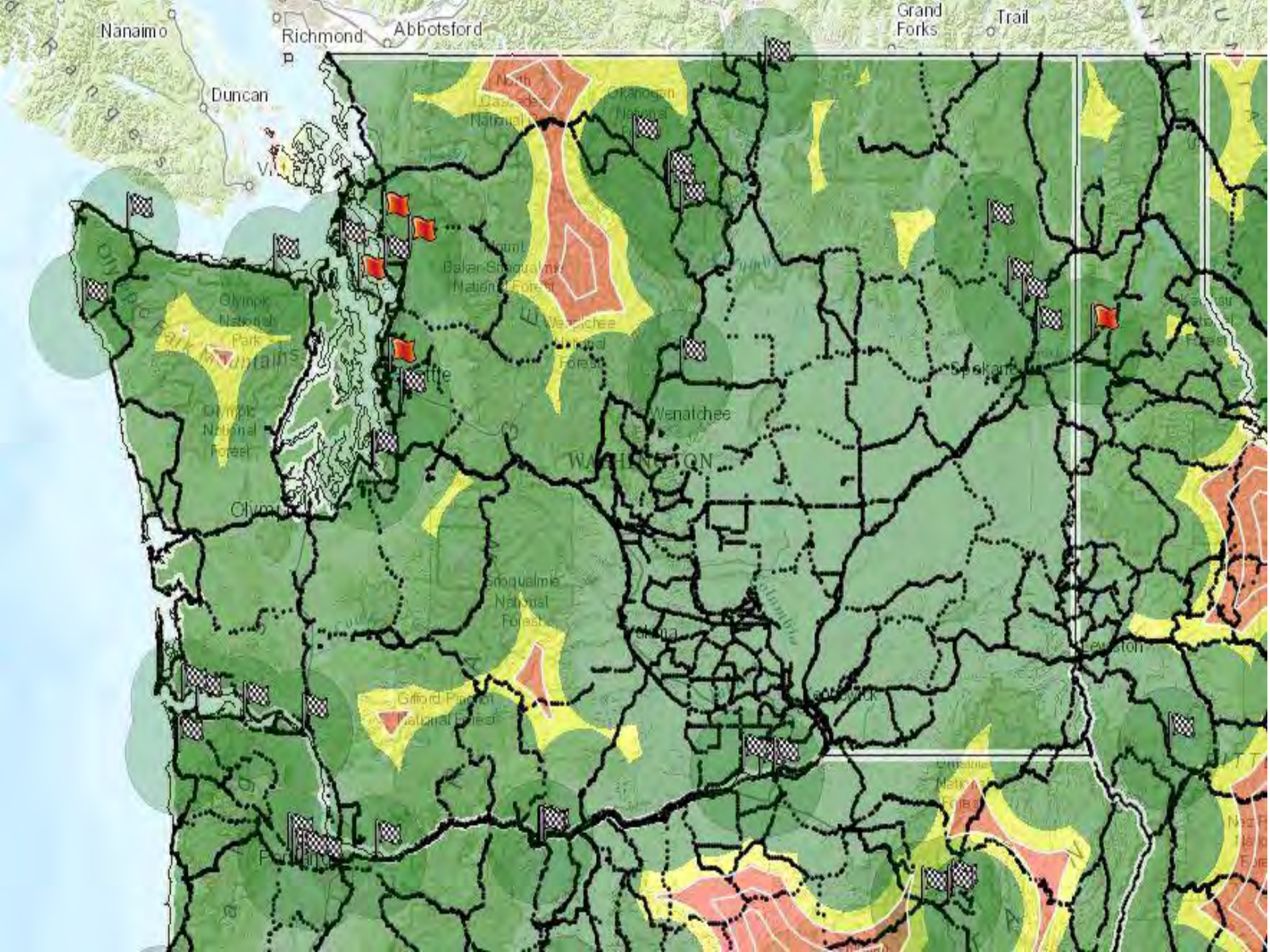
Recover Observe Report

More information on Recover, Observe, Report please check out the videos of the 2015 and 2016 webinars we recorded for people to learn more. Click on the image to see this years webinar or the menu to the left for 2015 Video

GPS on BM Webinar Video and Information

The maps below show the distance to nearest bench mark used in GEOID12B as well as the estimated accuracy. The accuracy is highly correlated to the distance to nearest bench mark. You can help improve the next geoid by helping to fill these gaps and limit the distance between observed bench marks.

GEOID12B Distance to Nearest Bench Mark Map


Nanaimo
Richmond
Abbotsford
Grand Forks
Trail
Duncan
Wanatchee

Height Modernization

WGS
Control Warehouse
Proposed Upgrade

Reset Table

ID	State	PointDesignation	County_Municipality	data_steward	STR_Primary
48204	WA	3685-5801	City of Seattle	SEATTLE	S28 T24N R4E

Survey Control Point Standard Data Sheet

WGS Survey Data Warehouse

Designation: 2609CC 58A-RED FLG
Juris: City of Seattle
State: WA

PLSS Control: No
Horizontal Control: No
Vertical Control: Yes

DB ID: 2806
Point Alias: 7575

Geocode
BLM Designation

Horizontal Information

Feet Unit Type: US Survey
Northing (ft): 239962
Easting (ft): 1270593
Northing (m): 73140
Easting (m): 387277
Latitude: 47 38 52.66234
Longitude: -122 20 01.67302
Scale factor:
Combined Grid:

Coord System Zone: WA North 4601
Horizontal Datum: NAD 1983/91
Horizontal Method: Computerized Map Scaling
Horizontal Accuracy: <=50.000m / 164.042ft.
Horiz Calc by: City of Seattle
Horiz Calc Date: 01-14-2003
Convergence:
Accuracy Type: Local

PLSS Sections

PLSS Section Primary: S18 T25N R04E
PLSS Section Alt 2:
PLSS Section Alt 1:
PLSS Section Alt 3:

Vertical Information

Ortho (ft): 60.344
Ortho (m): 18.39288799
Ellip (ft):
Ellip (m):
Geoid (ft):
Geoid (m):
Accuracy Type: Local

Vertical Datum: NAVD88
Vertical Method: Digital Level
Vertical Accuracy:
Vertical Calc by: City of Seattle
Vert Calc Date: 05-15-2002
Geoid Method: N/A

Data Steward Information

Steward: SEATTLE
Contact: Seattle Public Utilities
Address: 700 5th Ave, Ste. 4900
City: Seattle
ZIP: 98124-4018
Phone: 206-866-6093
Email: spu_landsurvey@seattle.gov

Organization: Seattle Public Utilities
Contact Title: Land Survey Section
State: WA

Mon Details

Mon Condition:
Set
Mon Type:
Benchmark
Visit Date:
no date entered
Visit by:
City of Seattle
Date Set:
04-15-2002
Mon set by:
City of Seattle
Cased Mon:
No
Project/Survey#:

Field Book #:
2609 CC
Page#:
58
Document File Ref:
N/A
PLS ID #:

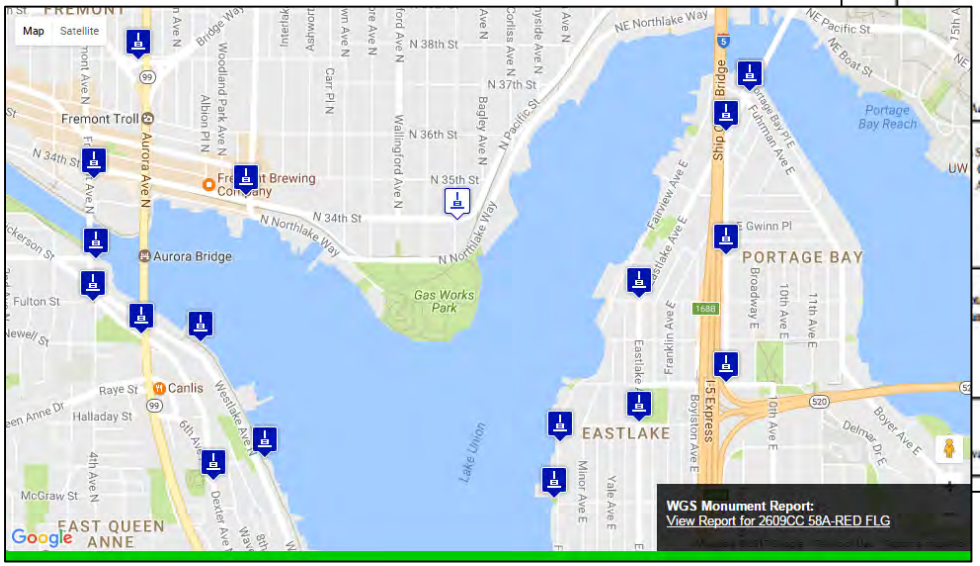
PLS ID Name:

Reference Information

mped \0"C of SW\" \0"7575W\" 1ft north of intx bkewW's at SE corner N 34th St & Meridian Ave N N 34th St & Meridian Ave N .

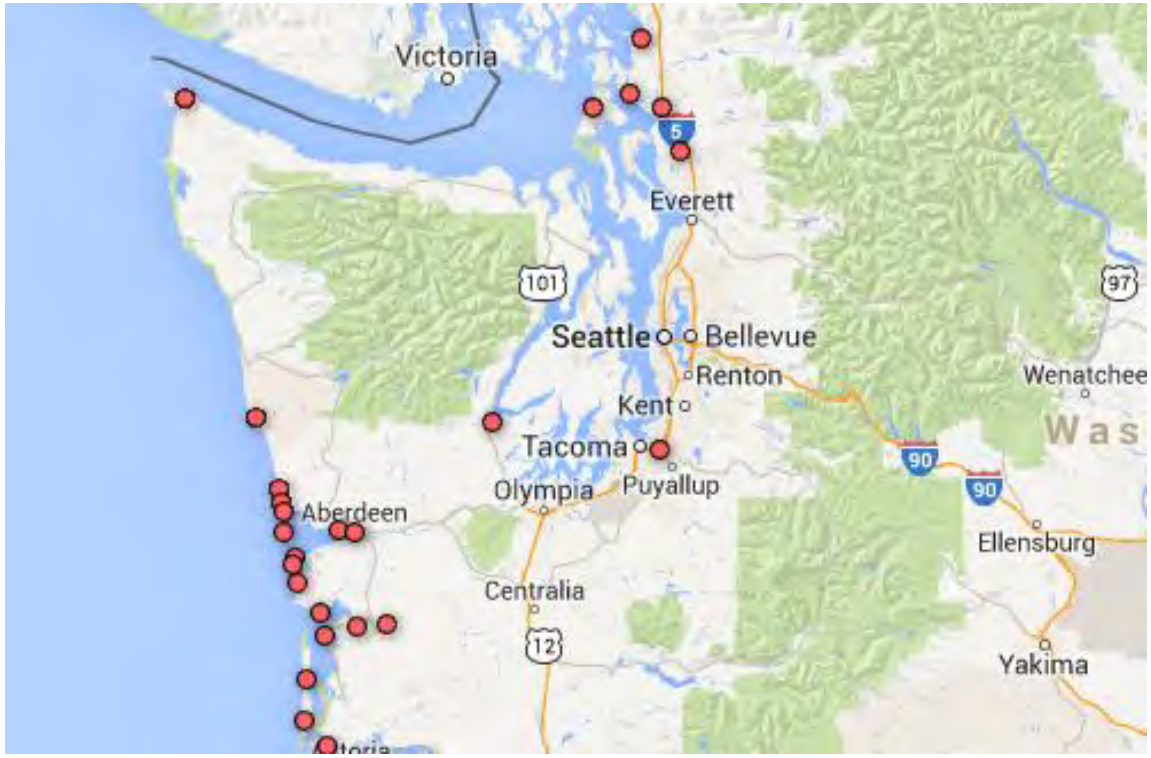
Photos

vailable



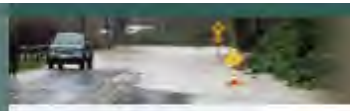

Every Inch COUNTS!
CABLE CROSSING
DO NOT DISMISS WHAT APPEARS TO BE INSIGNIFICANT

Sea Level Rise Map Shows 30 Wash. Towns Inundated



NOAA's Coastal Mapping Program

- NOAA nautical charts
- Other important applications:
  - Used in defining the United **States' territorial limits**
  - Coastal resource management
  - Storm surge and coastal flooding modeling
  - GIS analysis
  - Benthic habitat mapping
  - **Many more…**



Flood Plain Management

RiskMAP Projects

Washington State Risk MAP and Discovery

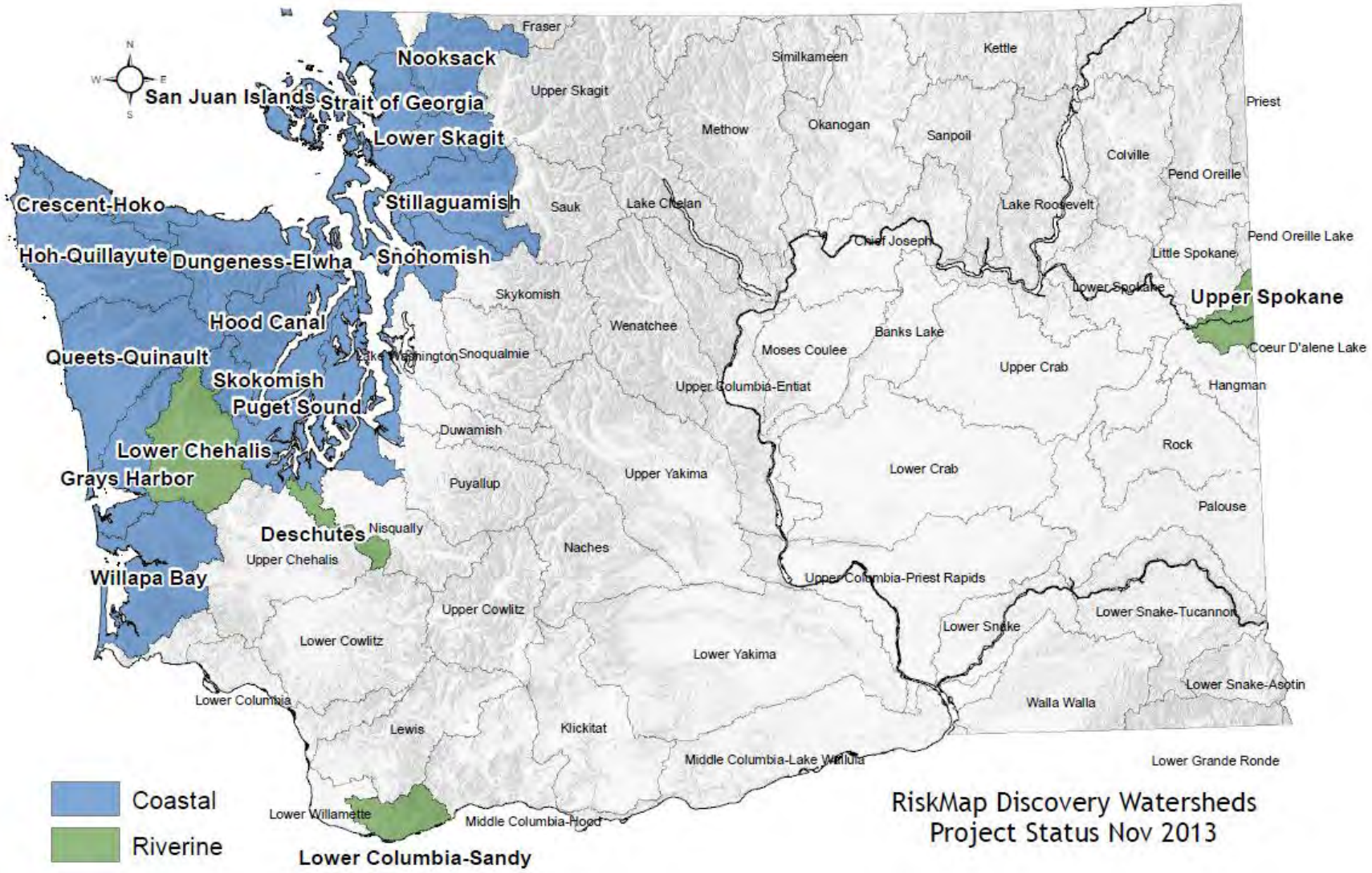
As part of FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program, the Federal Emergency Management Agency (FEMA) and the Washington State Department of Ecology will be working with communities across Washington to develop a more accurate understanding of their flood risk and help them plan for and communicate that risk. Learn more about Risk MAP

During the "Discovery" process, FEMA and Ecology will work closely with communities to determine where flood risk projects will be conducted as part of FEMA's Risk MAP program. Flood risk projects will include the development of easy-to-use risk assessment tools and data where appropriate as well as updated Flood Insurance Rate Maps. This information can help communities:

- Create or improve mitigation plans with actionable mitigation activities
- Make informed decisions about local development or ordinances
- Communicate flood risk more effectively to the people who live and do business there
- Create a long-term vision for their watershed

The Department of Ecology fully supports FEMA's efforts to help communities in Washington State become more resilient to the damage and financial burden that can accompany flooding. Ecology encourages members who are contacted by FEMA or Ecology representatives to participate in this discovery process. This will ensure that FEMA receives all relevant local data and information that can be used to improve the value of the flood risk products to the communities.

Download map (PDF)


Nooksack
San Juan Islands
Strait of Georgia
Lower Skagit
Stillaguamish
Crescent-Hoko
Hoh-Quillayute
Dungeness-Elwha
Snohomish
Hood Canal
Queets-Quinault
Skokomish
Puget Sound
Lower Chehalis
Grays Harbor
Deschutes
Willapa Bay
Fraser
Upper Skagit
Similkameen
Kettle
Priest
Methow
Okanogan
Sanpoil
Colville
Pend Oreille
Sauk
Lake Chelan
Lake Roosevelt
Chief Joseph
Pend Oreille Lake
Little Spokane
Lower Spokane
Upper Spokane
Skykomish
Wenatchee
Banks Lake
Moses Coulee
Coeur D'alene Lake
Lake Washington
Snoqualmie
Upper Crab
Upper Columbia-Entiat
Hangman
Duwamish
Rock
Lower Crab
Upper Yakima
Puyallup
Palouse
Nisqually
Naches
Upper Chehalis
Upper Columbia-Priest Rapids
Upper Cowlitz
Lower Snake-Tucannon
Lower Snake
Lower Cowlitz
Lower Yakima
Lower Snake-Asotin
Lower Columbia
Walla Walla
Lewis
Klickitat
Middle Columbia-Lake Wallula
Lower Grande Ronde
Lower Willamette
Middle Columbia-Hood
Lower Columbia-Sandy
Coastal
Riverine
RiskMap Discovery Watersheds
Project Status Nov 2013

USACE Levee Safety Program Mission

Work with stakeholders to assess, communicate, reduce and then manage the residual risks to people, the economy, and the environment from inundation associated with the presence of levee systems.

Points to Tie

USGS Stream Gauges
USACE Gauges
NOAA Gauges
NGS CORS
NGS OPUS-DB
NGS NSRS Control Points

*

*

gavin.schrock@seattle.gov