SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

April 2014
Board of Consultants Meeting (#4)

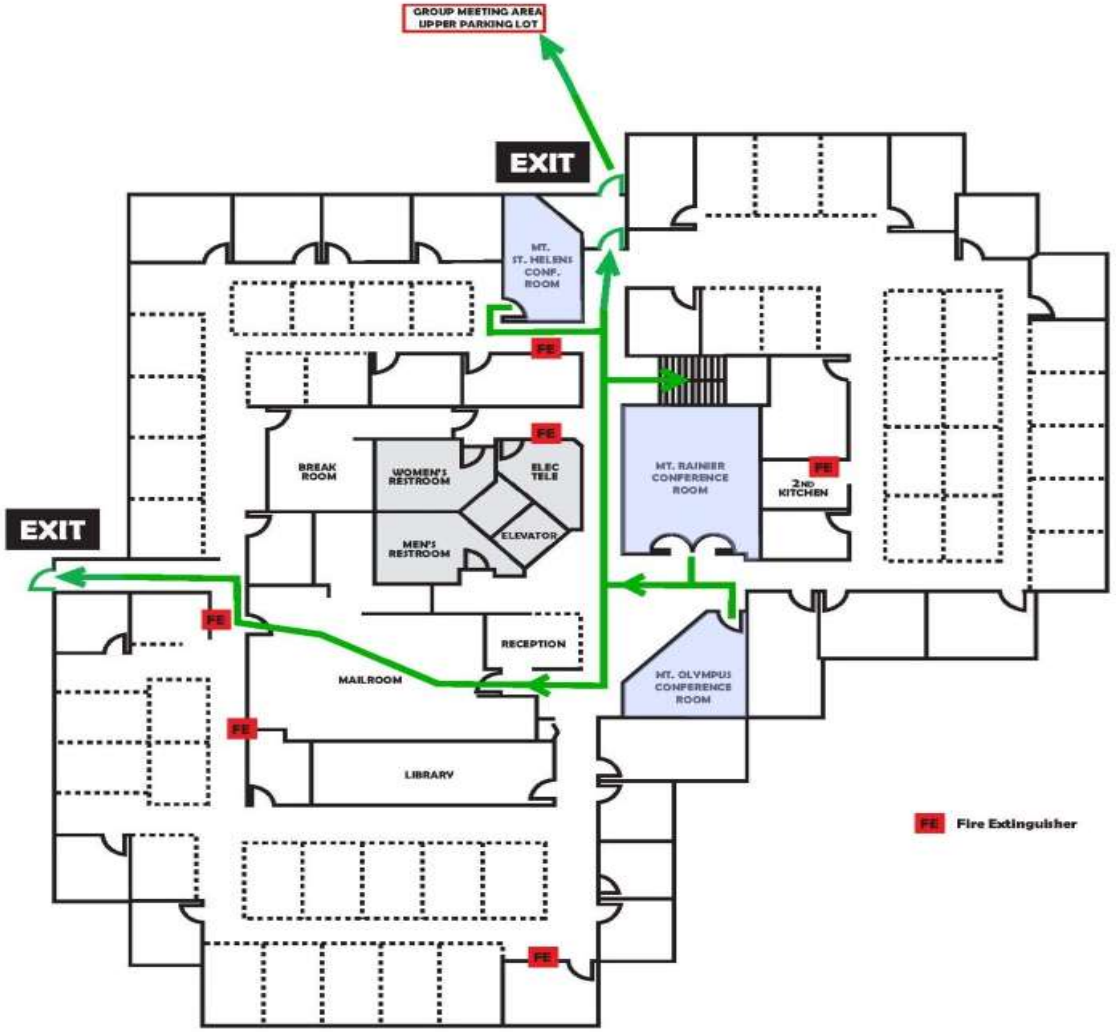
ALASKA ENERGY AUTHORITY

Safety

In this location we are susceptible to:

- Fire
- Earthquake
- Volcanic Eruption

Be aware of exits shown on next slide.



Sea-5 Office
Second Floor Exit Routes

Overview
Updates by:

- **Mike Bruen - MWH**
  - Geotechnical, Geological and Investigations Update
  - Site Specific Seismic Hazard Analysis and Lineament Update
- **Bill Kappel, Doug Hultstrand - AWA**
  - PMP Study update
- **John Haapala, Jill Gray - MWH**
  - PMF Study Update
- **Brian Sadden, Dina Hunt, Farrokh Javanmardi - MWH**
  - Dam Configuration
  - Deterministic Analysis of Intraslab (comment by Norm Abrahamson)
  - FE Analysis Update

Agenda - 1

Wednesday, April 2nd

- **Prior meetings Comment Response Review**
- **2013 Geotechnical Investigation Program**
- **Site Specific SHA & Lineament Update**

(Lunch)

- **PMP Break out Session**
  - PMP Study Update
  - PMF Study Update

(Executive Session)

- **Dam Configuration**
  - Deterministic Analysis of Intraslab
  - Dam Configuration
  - FE Analysis Update

(Adjourn for Dinner)

Agenda - 2

Thursday, April 3rd

- **PMP – Continue Break out Session**
  - PMP Study Update
  - PMF Study Update

  (Resume Executive Session)
- **Dam Configuration**
  - Deterministic Analysis of Intraslab
  - Dam Configuration
  - FE Analysis Update

  (End Executive Session)
- **2013 Geotechnical Investigation Program**

  (Lunch)
- **PMP/PMF Overview and Update**

  (Adjourn for Dinner)

Agenda - 3

Friday, April 4th

(Resume Executive Session)

- **Dam Configuration**
  - **Deterministic Analysis of Intraslab**
  - **Dam Configuration**
  - **FE Analysis Update**

(End Executive Session)

- **B o C Conclusions and Recommendations**

(Adjourn)

3rd Board Meeting Comments - A

On the general layout of the dam:

- *"The main purpose of the curved layout is to provide wedging action for an improved resistance to downstream sliding and that the effects of such curvature on cantilever stresses may not be significant"*
- *"The geometry of the canyon section, height of the dam, and high earthquake ground motions, suggest that a group of dam monoliths in the narrower central section more likely would stay together, but could potentially separate from the monoliths on the upper abutments"*
- *"Wedging action of the curvature built into the design would constrain movements of the central group of monoliths but the monoliths in the upper abutment, separated from the group by opened joints, might be vulnerable to sliding"*
- *"The B o C suggests comparisons be made between recorded data and the NGA ground motion prediction relationships that are being used in this project. It is also noted that the seismicity data recorded and analyzed by AEIC provide an excellent opportunity for checking ground motion prediction relationships associated with the intraslab earthquakes"*

3rd Board Meeting Comments - B

General design aide-memoire on various topics:

- *"The existence of permafrost within the foundation rock formations and how it has effected or will affect the foundation characteristics (i.e. ice jacking, rock block movements, long term foundation permeability etc.)"*
- *"Thermal considerations regarding placement of RCC directly on the cold foundations and shrinkage"*
- *"The transverse joint spacing that is appropriate for the cold climate and the thermal shock stresses generated by the cold water when the reservoir is impounded"*
- *"Considerations regarding longitudinal cracking from concrete shrinkage and foundation restraint"*
- *"Consideration of foundation grouting within the extremely cold foundation rocks and groundwater"*
- *"The complications of sequencing of the seasonal placements and the thermal effects on the internal stress development. BOC agreed that an RCC structure was acceptable"*

Documents Given to Board

- 14-07-REP PMP Draft Final Report
- 14-07-REP PMP Draft Final Report Appendix – Short List Storm Analyses
- 14-02-REP PMF Study Draft Report
- 14-05-TM Dam Configuration Draft Technical Memo - CEII
- 14-04-TM Deterministic Ground Motion for Slab Events Technical Memo - CEII
- 14-01-TM Interim Crustal Seismic Source Evaluation Technical Memorandum
- 14-06-TM Seismic Monitoring Annual Report for the Period Ending December 31, 2013

Questions for the Board

1. *Do the B o C agree that the configuration of the dam is acceptable as a basis for further design evaluation and optimization (and license application), with the proviso that the dynamic analysis be revised with foundation mass etc. and [results of] Site Specific Seismic Hazard Analysis (SSSHA) studies, [and] site investigation (for the configuration)?*

2. *Does the B o C agree that the interim report of the SSSHA is acceptable with the proviso that further crustal lineament analysis and angled drill holes across the valley under the dam foundation be completed before final seismic criteria can be verified for detailed design ?*

3. *Does the B o C agree that the draft PMP/PMF studies – prior to completing the report – are acceptable for finalizing the feasibility design and that if there are no changes in conclusion during the finalization of the report that the conclusions can be used for the final design of the spillway ?*

4. *Given the configuration presented does the B o C consider that the planned site investigation is appropriate for the provision of data for detailed design of the dam?*

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2013 Site Investigation Update

ALASKA ENERGY AUTHORITY

Geologic and Seismic Hazard Investigations[1]

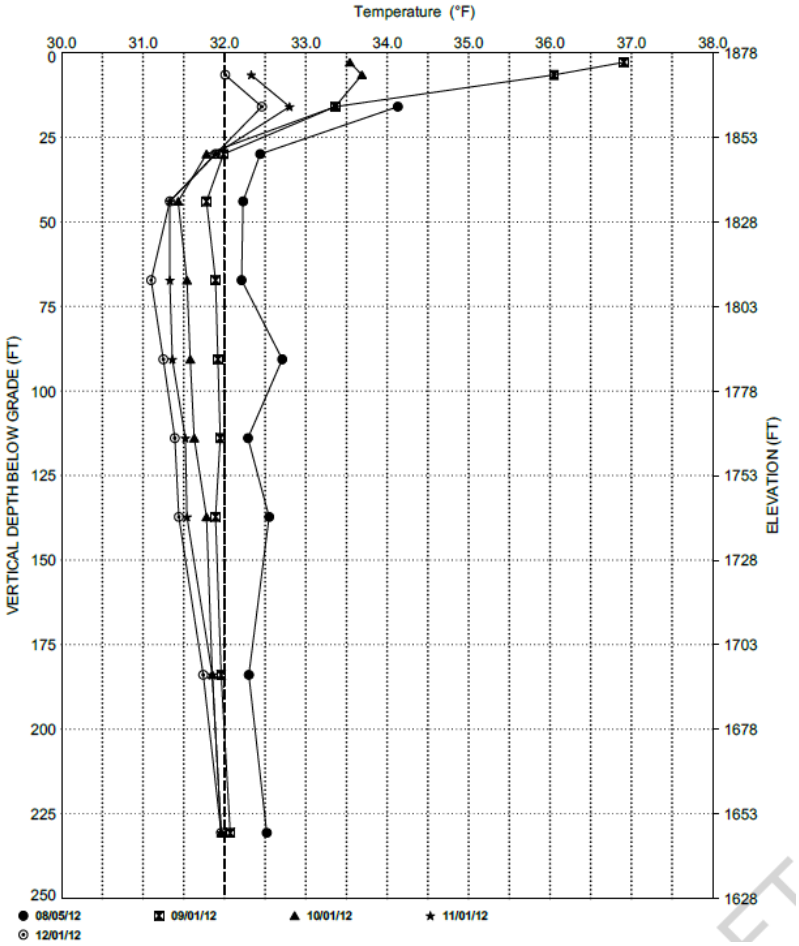
- Retrieval of Geo-Instrumentation Data
- Expansion of Long-Term Seismic Monitoring System
- Lineament Mapping and Evaluation, Field
- IMASW Data Collection

[1] Limited Field Activities Due to Restricted Land Acce**ss**

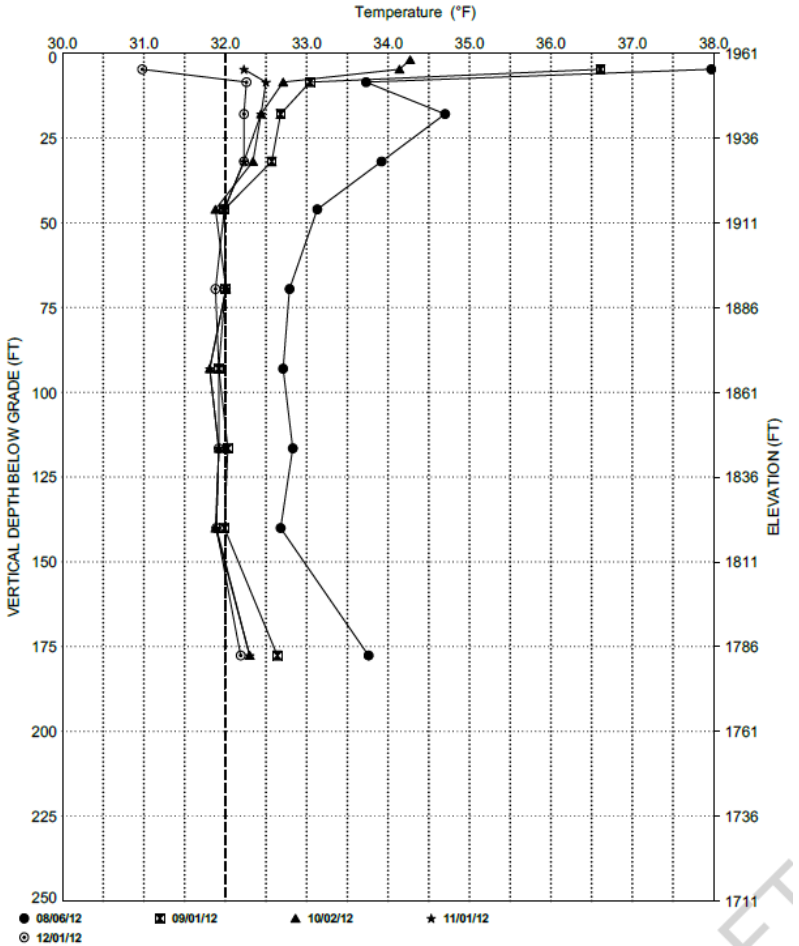
Other Geology and Seismic Tasks

- Geology and Soils – Mineral Resources Assessment (interim)
- Cement Source Assessment
- Exploration and Testing Program 2013-15
- Updates to Top of rock isopach, bedrock geology, selection of engineering properties of rock mass
- Foundation characterization for inputs to FEA
- Revised Intraslab Source Characterization
- Potential Mmax for ASZ

2012 Geotechnical Instrumentation – Temperature

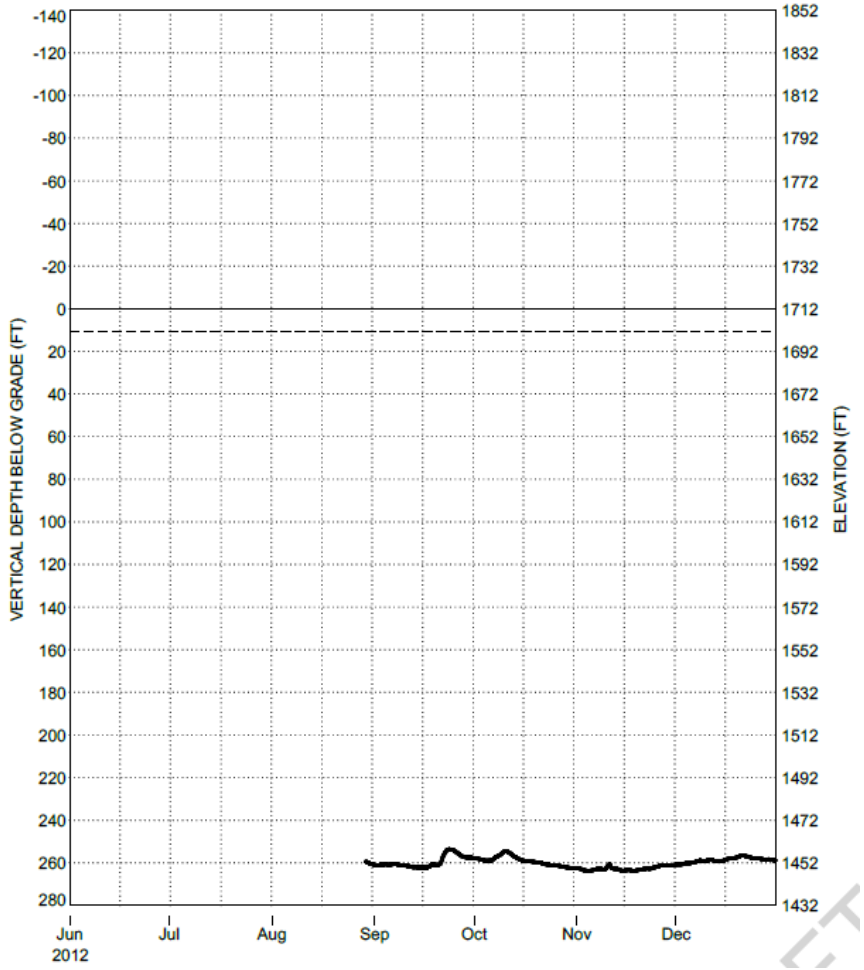


DH12-1

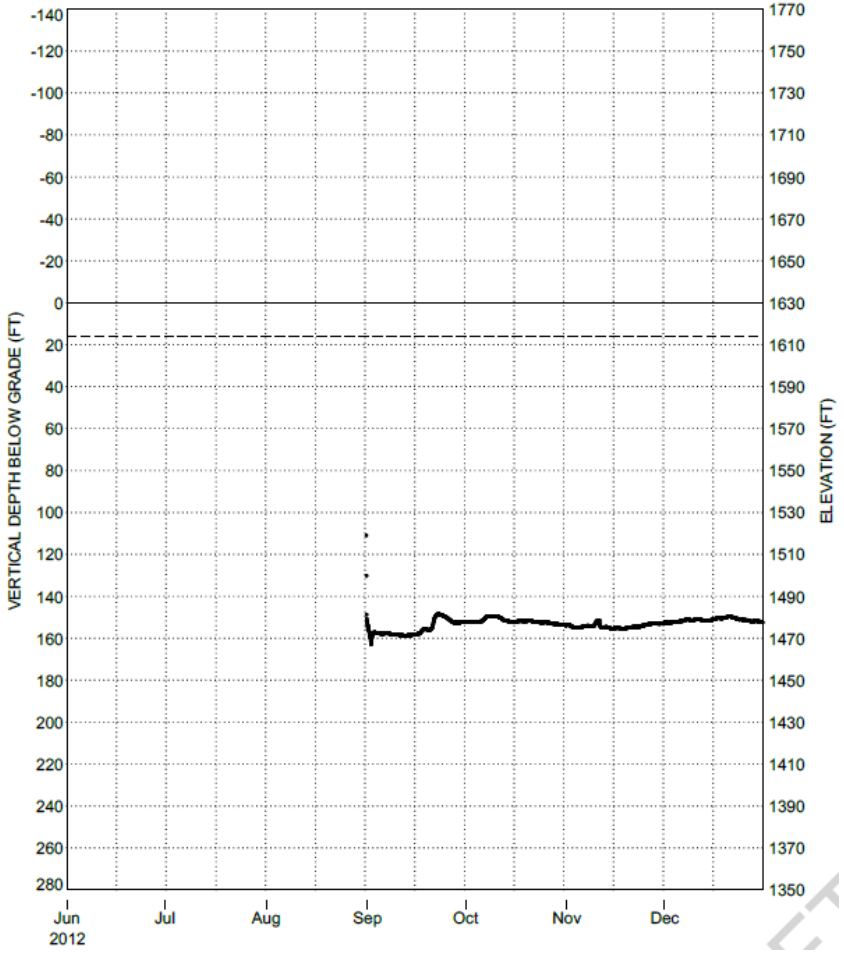


DH12-2

2012 Geotechnical Instrumentation – Groundwater



DH12-3



DH12-4

2013 Seismograph Stations

ID Name	Reference ID	Location	Instrument Type	Installation Date	Coordinates (NAD83)		Elevation	
					Latitude	Longitude	m	ft
WAT1	WAT	Watana Dam Site	SM, BB	8/31/2012	62.83000	-148.55331	714	2343
WAT2	New Five / Two	Tsusena Butte Area	SM, BB	9/3/2012	62.96111	-148.58666	1354	4442
WAT3	New Three	Fog Creek	SM, BB	10/13/2012	62.68107	-148.53689	1522	4993
WAT4	jay	Jay Creek	BB	8/29/2012	62.83454	-147.94151	1176	3858
WAT5	DED'	Deadman Mtn	BB	8/4/2013	63.06243	-148.22858	1691	5548
WAT6	New Nine	Oshetna Area	BB	8/5/2013	62.58083	-147.74001	1681	5515
WAT7	New Eight		SM, BB	8/5/2013	62.83312	-148.84764	1232	4042
WAT1 GPS	GPS	Watana Dam Site	GPS	7/31/2013	62.83486	148.55105	737	2117
ToHon	toHON	Honolulu	R	8/13/2012	62.99494	-149.26302	1694	3947

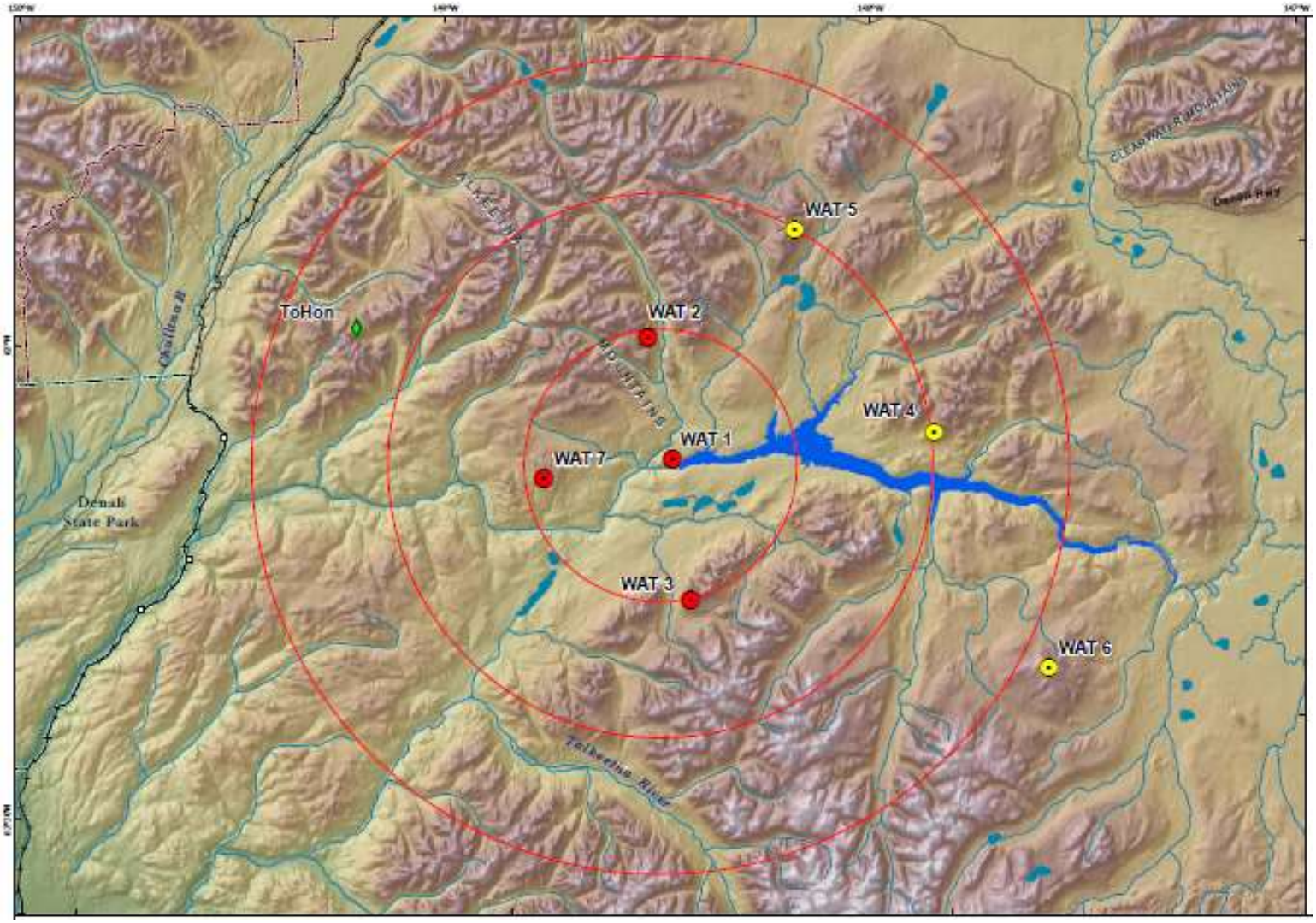
Key BB - Broadband

SM - Strong Motion

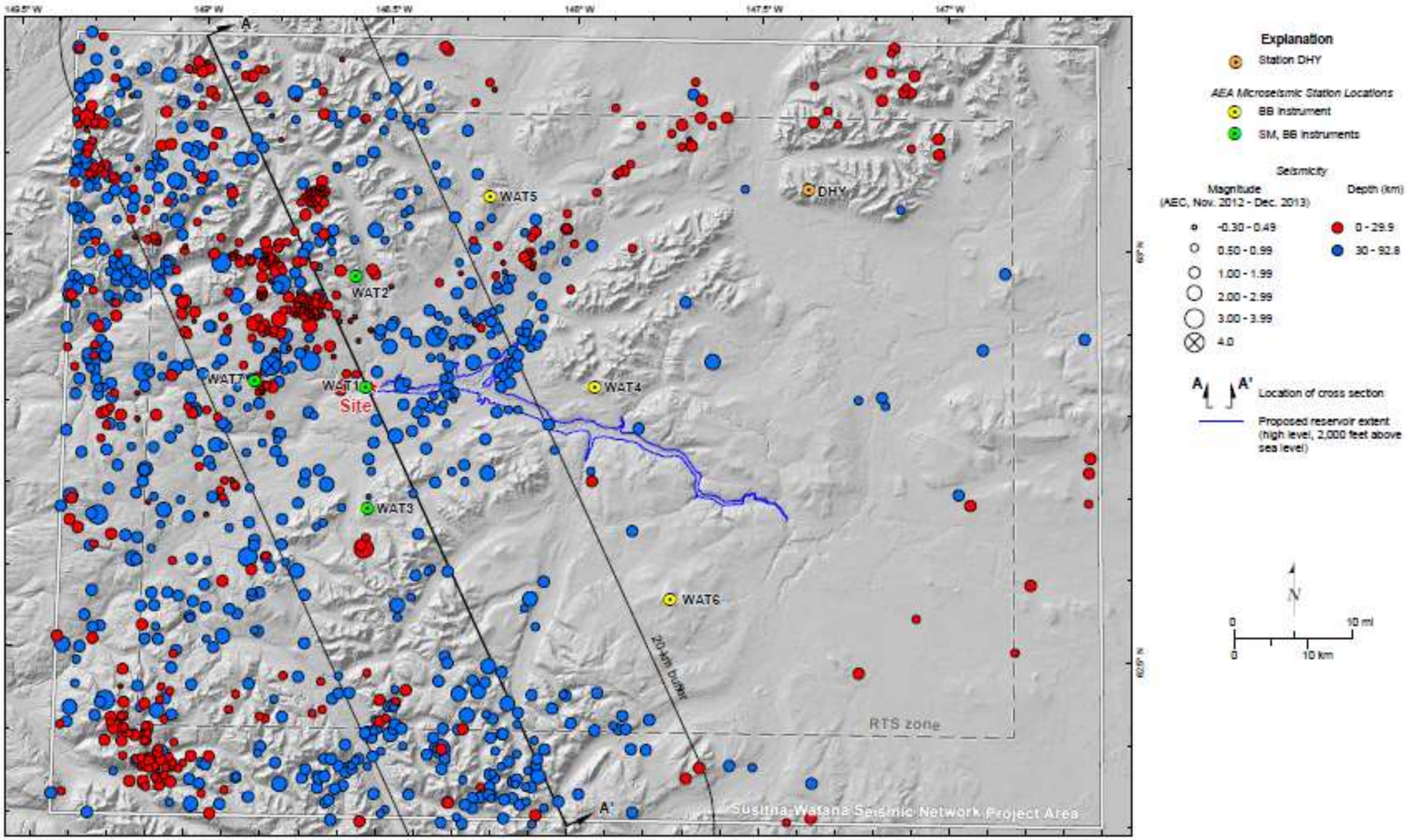
GPS - GPS

R - Repeater

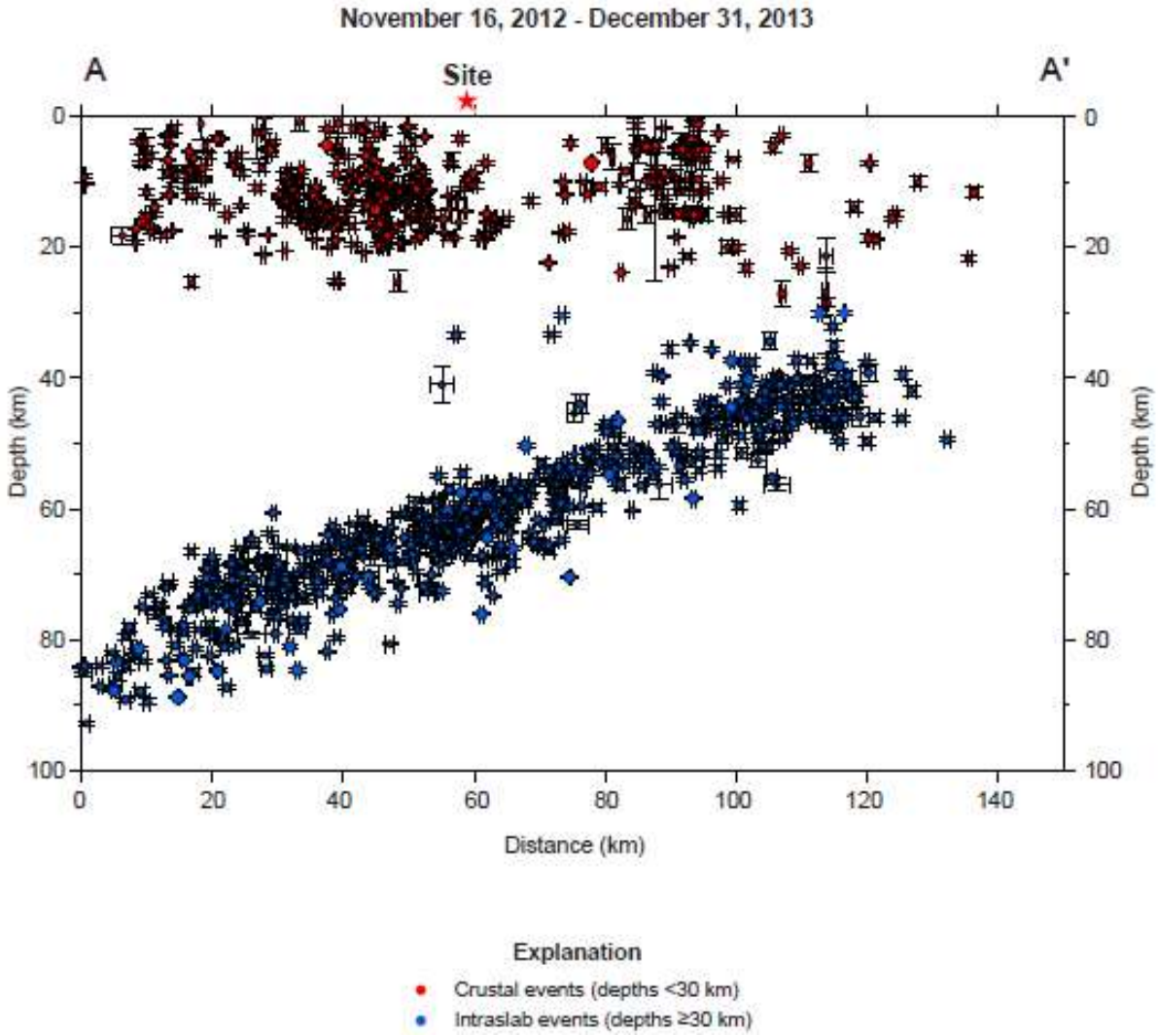
Long-Term Seismic Monitoring System



Seismicity: Inception – December 31, 2013



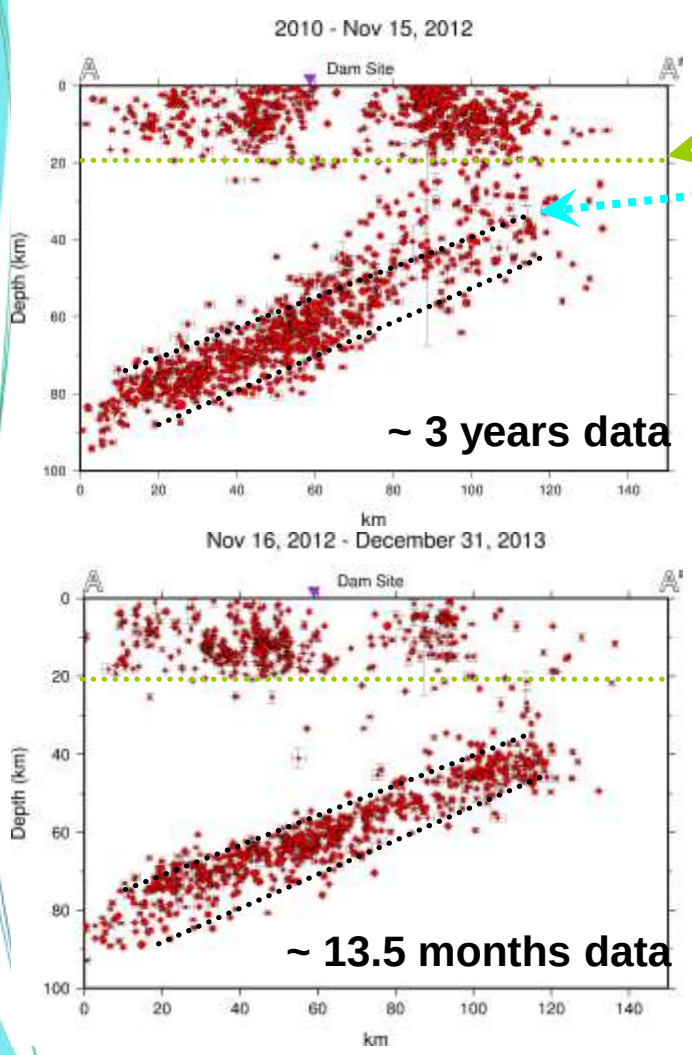
Seismicity: Inception – December 31, 2013



Largest Crustal and Intraslab Recorded Events

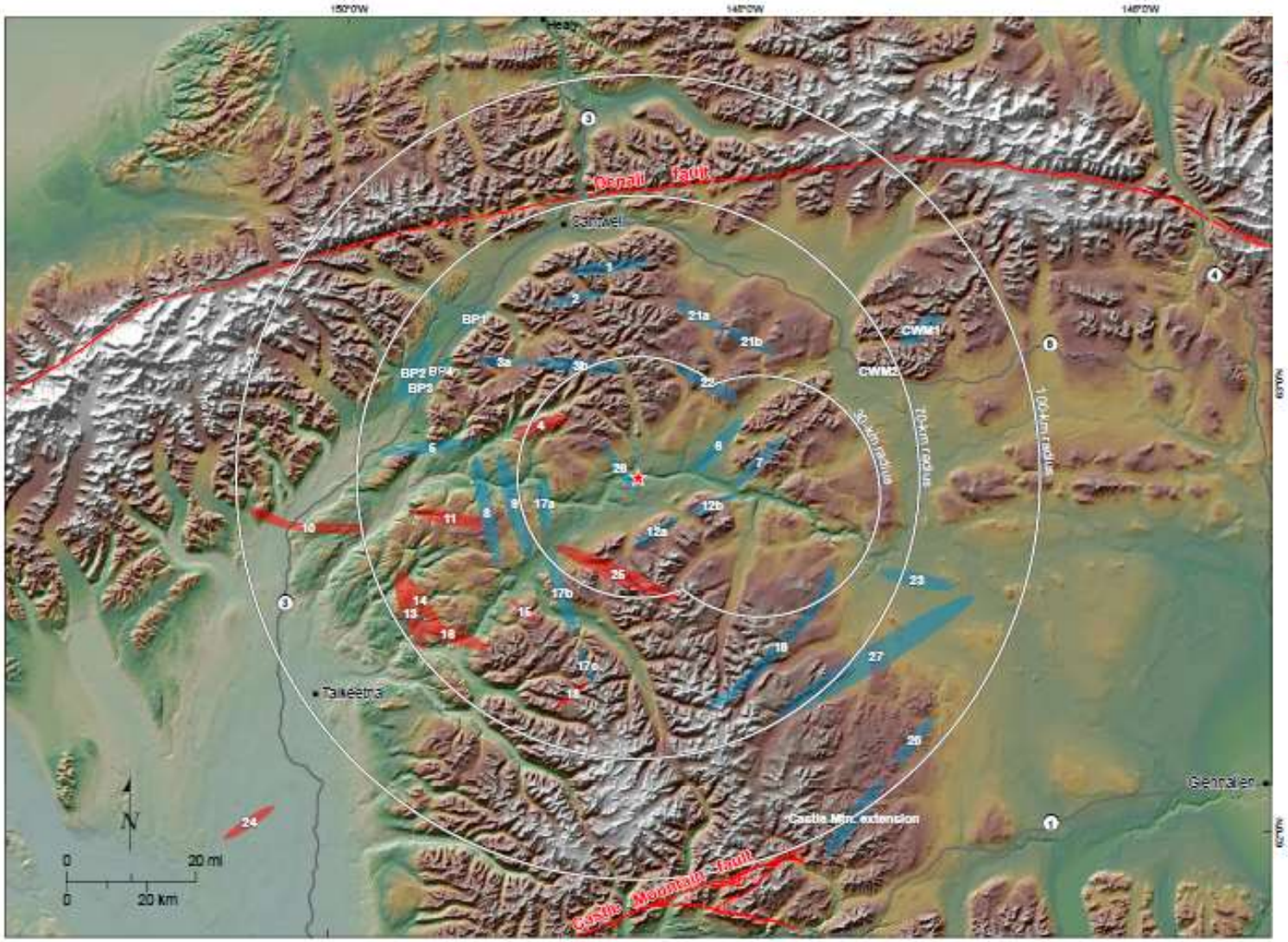
Largest Crustal Event											
Year	Month	Day	Hour	Min	Sec	Lat (N)	Lon (W)	Depth (km)	Mag (ML)	Epicentral Distance to Site (km)	Hypocentral Distance to Site (km)
2013	7	24	18	16	59.506	62.922	-148.712	11.1	3.8	14.20	18.02
Largest Intraslab Event											
Year	Month	Day	Hour	Min	Sec	Lat (N)	Lon (W)	Depth (km)	Mag (ML)	Epicentral Distance to Site (km)	Hypocentral Distance to Site (km)
2013	10	23	7	38	21.625	62.852	-148.804	67.6	4.0	13.98	69.13

Earthquake Event Data from Seismic Monitoring



- Resolution
  - Crustal seismicity depth cutoff
  - Distance to and characteristics of intraslab source
- Goals
  - Identify "hidden" seismogenic structures near site
  - Obtain local focal mechanism data for seismic sources (stress orientations)
  - Obtain ground motion recordings at the site to evaluate and modify attenuation relationships
  - For all tasks (including RTS monitoring) depth resolution at site and reservoir area is paramount

Field Work for Crustal Seismic Source Assessment



Summer 2013 IMASW Data Collection

- IMASW collected at 7 installed and planned seismic stations
  - Reference for GM data
  - 92 m lines; 24-channel system
- Updated Vs30 for preliminary site PSHA

Seismic Station IMASW Summary

Line ID	Geology – USGS, Wilson, Acres		Vs30 (m/s)
	Unit	Name	
WAT-1, N-S	**Tkgg**	**Gneissose granitic rock**	737
WAT-1, E-W (Line 3)			1083
WAT-2, N-S	**Tpgr**	**Granitic rocks**	2758
WAT-2, E-W			2746
WAT-3, N-S	Psz	Basaltic to andesitic metamorphosed	2823
WAT-3, E-W			3154
WAT-4, N-S	JPmb	Marble	1744
WAT-4, E-W			2037
WAT-5, N-S	**Tegr**	**Granitic rocks**	2243
WAT-5, E-W			2068
WAT-6, N-S	Jtr	Trondhjemite	2588
WAT-6, E-W			2706
WAT-7, N-S	**TKgg**	**Gneissose granitic rock**	1879
WAT-7, E-W			2296