

# Initial Study Report Meeting

## *Study 16.6 Site-Specific Seismic Hazard*

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# Study 16.6 Status

## ISR documents (ISR Part D Overview):

- Initial Study Report: Parts A, B and C (June 3, 2014)
- 2014 Study Completion Report (SCR) (November 4, 2015)

## Status:

- The Site Specific Seismic Hazard Study for the Susitna-Watana Hydroelectric Project has been completed.

## Study 16.6 Objectives

1. **Lineament mapping and analysis**, desktop study and field evaluation
2. **Identify the seismic sources** along which future earthquakes are likely to occur, including the potential for reservoir-triggered seismicity
3. Characterization of the **degree of activity, style of faulting, maximum magnitudes**, and recurrence information of each fault for D/PSHA
4. Develop maps and tables depicting **the spatial and geometric relations of the faults and seismic source zones** together with specific distance parameters to evaluate ground motion parameters from each source
5. Assemble available historical and Project **long-term monitoring network seismicity data** for the region, including maximum and minimum depth of events
6. Determine the distance and orientation of each fault with respect to the site
7. Estimate the **earthquake ground motions** at the proposed dam site, updating previous studies to include changes in practice and methodology since the 1980s
8. Prepare a supporting design report that includes the **seismic criteria** and results of dam stability analysis under seismic loading (see dam analysis, this is not part of the seismic characterization)
9. Use of Board of Consultants for independent technical review and guidance during development of site-specific studies

## *Study 16.6 Components*

1. Methods (ISR Part A, Section 4.1; pg 2)
2. Review of Project Documentation (ISR Part A, Section 4.1, pg. 3)
3. Seismic Hazard Analysis (ISR Part A, Section 4.1, pg 3)
  - Crustal Seismic Source Evaluation
  - Preliminary PSHA
4. Long-Term Earthquake Monitoring System (ISR Part A, Section 4.2; pg 4)
5. Preliminary Reservoir Triggered Seismicity (ISR Part A, Section 4.3; pg 5)

## *Study 16.6 Variances*

While there was no access to CIRWG lands in 2013, suitable sample sites were located elsewhere to meet the Study Plan objectives and complete the study.

# *Study 16.6 Summary of Results*

## *(ISR Part A Section 5 and SCR Section 5)*

- **Review of Project Documentation**

- Review geologic, geotechnical, and seismic data within the Project area. Contact technical experts in the Alaskan seismotectonics
- Development of an initial geological and seismotectonics database and library.

- **Crustal Seismic Source Assessment**

- Lineament mapping and analysis for fault studies using LiDAR and IFSAR data; 22 lineament groups and 3 broader lineament areas were identified for evaluation
- Two lineament groups, associated with the Sonona Creek and Castle Mountain faults, were found to have justification for consideration as a crustal seismic source.
- Talkeetna Fault, a NE-NW feature, is not active in the contemporary stress regime
  - Trenching of a scarp - geomorphic evidence supports that the scarp is likely an ice-marginal feature not formed by surface fault rupture
  - Geophysical surveys and mapping by Twelker et al. (2014) interpreted the Talkeetna fault to be a series of complex, high angle, NE-trending fault strands, which strands appear to be cross-cut and truncated by N-NW trending bedrock faults.

# *Study 16.6 Summary of Results*

## *(ISR Part A Section 5 and SCR Section 5)*

- **Crustal Seismic Source Assessment (continued)**
  - Dam site fault rupture evaluation was performed
    - Field investigations imply that there is less continuity of dam foundation geologic structures (i.e., geologic features) than has previously been depicted.
    - Shear features may be present in the foundation, however there is evidence to support a lack of surface displacement along these features in the last 12,000 to 15,000 years
- **Long-Term Seismic Monitoring**
  - A total of 2,523 earthquakes have been recorded from a 26 month period
  - Earthquakes in the Project area form two distinct groups, crustal events between 0 and 16 mi depth and intermediate depth events below 19 mi in the subducting Pacific plate.
  - The largest event in 2014, ML 4.6, occurred on November 29, 2014 at a depth of 37.9 mi (62.1 km), with an epicenter 24.5 mi (40 km) southeast of the proposed Watana dam site

# *Study 16.6 Summary of Results*

## *(ISR Part A Section 5 and SCR Section 5)*

- **Seismic Hazard Assessment, preliminary**
  - Seismic source model has three sources: (1) crustal faults, (2) subduction zone interface, and (3) the intraslab
  - Deterministic evaluations found the intraslab (subduction) source produces the largest PGA at the site
  - Field investigations / evaluations did not identify any specific features with evidence of late Quaternary faulting within at least 25 miles (40 km) of the Watana dam site
  - DSHA - a peak ground acceleration of 0.81g
  - PSHA – Mmax = 8.0; peak ground acceleration of 0.66g @5,000 yrs.
- **Seismic Design Criteria, Preliminary Ground Motion – intraslab rupture**
  - MCE
    - Interface 88th percentile, M9.2 at a rupture distance of 78 km, PGA=0.58g
    - Intraslab 84th percentile, M7.5 at a hypocentral distance of 50km, PGA=0.69g
    - Intraslab 69th percentile, M8.0 at a hypocentral distance of 50km, PGA=0.81g
    - Crustal 84th percentile, M7.0 at a rupture distance of 3.5km, PGA=0.49g
  - OBE – peak ground acceleration of 0.27g @500 yrs.



# *Study 16.6 Summary of Results*

## *(ISR Part A Section 5 and SCR Section 5)*

- **Reservoir Triggered Seismicity**

- Empirical data suggest most RTS events will have relatively small magnitudes and would most likely occur within 10 years of initial reservoir filling.
- From observations to date, the maximum RTS magnitudes may be on the order of 6.3 to 6.5, a lower magnitude than the seismic design criteria used in the dam analysis.
- The maximum credible earthquake (MCE) will generate earthquake ground motions greater than those from the expected maximum RTS event.

# *Study 16.6 Summary of Results Technical Memoranda / Reports*

- Site-Specific Seismic Hazard Study Summary Report, October 2015
- Seismic Hazard Characterization and Ground Motion Analyses for the Susitna-Watana Dam Site Area, February 2012
- Lineament Mapping and Analysis for the Susitna-Watana Dam Site, March 2013
- Watana Seismic Network Station Vs30 Measurements for the Susitna-Watana Dam Site, March 2014
- Crustal Seismic Source Evaluation for the Susitna-Watana Dam Site, May 2015
- Revised Intraslab Model and PSHA Sensitivity Results for the Susitna-Watana Dam Site Area, April 2014
- Briefing Document - Discussion of MCE and OBE, April 2014
- Susitna-Watana Hydroelectric Project Seismic Network 2013 Annual Seismicity Report, March 2014

# *Study 16.6 Summary of Results Technical Memoranda / Reports*

- Susitna-Watana Hydroelectric Project Seismic Network 2014 Annual Seismicity Report, March 2015
- Susitna-Watana Seismic Monitoring Project: January–June 2015, September 2015
- Preliminary Reservoir Triggered Seismicity, March 2013

## *Steps to Complete Study 16.6*

The Site Specific Seismic Hazard Study for the Susitna-Watana Hydroelectric Project has been completed.

## *AEA Proposed Modifications to Study 16.6 in ISR (ISR Study 16.6, Part C – Section 7.1.2)*

AEA plans no modification of the methods for this study, as this study is now complete.

## *Licensing Participants Proposed Modifications to Study 16.6?*

- Agencies
- CIRWG
- General Public