

Susitna-Watana Hydroelectric Project Document

ARLIS Uniform Cover Page

<p>Title:</p> <p>AEA Susitna-Watana BOC Meeting - comment and response log</p> <p><i>Title varies on caption of each section with inclusion of meeting number, place, and date:</i> "#1 in Bellevue, WA (November 1-2, 2012)" "#2 in Bellevue, WA (March 7-8, 2013)" "#3 in Anchorage, AK (May 29-30th, 2013)"</p>		<h1>SuWa 279</h1>
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<p>Notes:</p>		

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April 29, 2014

Mr. Douglas L. Johnson, P.E.
FEDERAL ENERGY REGULATORY COMMISSION
Regional Engineer, Portland Regional Office
Division of Dam Safety and Inspections
805 S.W. Broadway, Suite 550
Portland, Oregon 97205

Subject: Board of Consultant Meeting #4
Susitna-Watana Hydroelectric Project P-14241-AK

Reference: AEA Letter to William H. Allerton, P.E. filed November 16, 2012

Dear Mr. Johnson:

The fourth Susitna-Watana Hydroelectric Project Independent Board of Consultants (BOC) meeting was held April 2-4, 2014 in Bellevue, Washington at the office of MWH Global Inc. The purpose of the meeting was to update and solicit advice from the BOC and advisors on the status of the Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) studies, the Site Specific Seismic Hazards Analysis studies, and the 2014 geotechnical investigation program plans. The progress of the RCC dam configuration feasibility and design studies was presented and discussed. A summary of the Boards comments follows.

The BOC agrees that if the planned site investigation program confirms that there are no shears, linear features or faults found that can negatively affect the performance of the dam, the configuration of the dam would be acceptable as a basis for further design evaluation, analysis and license application. The Site Specific Seismic Hazard Analysis (SSSHA) studies that are being conducted and presented are reasonable and appropriate for determining project feasibility and to serve as a basis for further design evaluation and optimization.

The SSSHA studies cover lineament, probabilistic, and deterministic seismic hazard analyses and are detailed enough to provide preliminary design ground motions for the project. Sensitivity analyses show that further analysis of regional crustal lineaments will not significantly impact the design ground motions in the period range of significant dam response. However, further analysis of site area lineaments and angled drill holes are necessary to assess potential for fault rupture under the dam as a result of primary, secondary, or sympathetic fault displacement.

The BOC agrees that the PMF inflow hydrograph presented in the draft PMF report represents generally appropriate assumptions and modeling methodologies and the study is sufficiently

Mr. Johnson, P.E.

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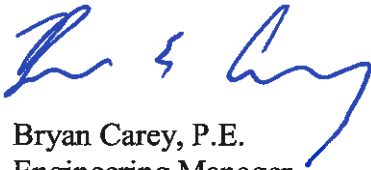
complete to be used in feasibility design.

The proposed and planned Site Investigation Program for the project entails a phased series of field investigations that respond to several of the BOC comments and concerns. The primary focus of the program is to characterize and confirm the geologic/geotechnical conditions in the dam site area. The main objectives include; 1) investigation and verification of the fracture and shear zones and geologic features, 2) evaluation of the potential for offset displacements in the foundation due to earthquake motions; 3) delineation of the frozen ground and groundwater conditions (adits) and 4) evaluation of the abutment stability. The BOC considers the present detailed and phased site investigation appropriate for developing the data for supporting the feasibility and design of the dam.

Attached are the BOC Final Report #4, the BOC Final Report #4 with AEA responses, and the BOC Comment Log for meetings 1,2,&3 with BOC comments.

Thank you for your assistance and please let me know if there is anything else you need.

Sincerely,

A handwritten signature in blue ink, appearing to read "Bryan Carey".

Bryan Carey, P.E.
Engineering Manager

cc: Mr. Wayne Dyok, P.E., Alaska Energy Authority, Susitna-Watana Project Manager
Attached Distribution List

The attachments are being made publicly available by uploading them to the "Documents" page of AEA's licensing website,
<http://www.susitnawatanahydro.org/type/documents>.

Attachments: BOC Final Report #4
BOC Final Report #4 with AEA Responses
BOC Comment Log for Meetings 1, 2 & 3 with BOC Comments

AEA Susitna-Watana BOC Meeting #1 in Bellevue, WA (November 1-2, 2012) - Comment and Response Log

These pages are formatted to be printed on 11" x 17" paper in Landscape format								
Item No.	BOC Document & Date	Page or Sheet #	Technical Category	Comment	Response	Response by and Date	Status	Notes
1	BOC MTG-1 Final Report, Nov. 9, 2012	2 of 8	Hydrology & Meteorology	Probable Maximum Precipitation (PMP) 1) Transposability. What techniques will be used for horizontal transpositioning of selected storms? How will observed precipitation values be modified in the process? What are the linear limits of transposability (i.e., how far away from the target area could a storm be and still be transposable)?	Covered in Board Meeting 2A. AWA will follow HMR, WMO, and our standard procedures for quantifying transposition factor of the final short list of storms used to derive PMP. This includes using the updated 2-sigma SST climatology to determine the ratio of precipitable water (PW) at the in-place storm location vs. the transposition location within the basin. This will be done on the gridded basis, i.e. each grid cell will have this calculated individually. Observed precipitation values will be modified based on the combination of the in-place maximization factor, the horizontal transposition factor, and the orographic transposition factor. The linear multiplication of these three factors will results in the total adjustment factor for each individual storm at each grid cell. The transpositionability limits of the storms is TBD and will be a function of the storm type, the individual characteristics of each short list storm (which has yet to be developed) and the meteorological analysis and judgment of AWA in conjunction with discussions with the BoC. It is assumed that because all storms considered for this study will have occurred within or upwind of the basin to the coastline, transposition limits should be fairly straightforward. We will not be transpositioning storms from the interior of Alaska across major mountains ranges, such as the Alaska Range or St Elias Range. In addition, AWA will generally follow the HMR and WMO guidelines of limiting transpositioning of storms to less than 6° of latitude, as moving beyond these bounds could potentially change the storm dynamic structure of a given storm event.	AWA 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
2	BOC MTG-1 Final Report, Nov. 9, 2012	2 of 8	Hydrology & Meteorology	2) Maximization. Will moisture maximization be done exclusively with sea surface temperature analysis or will other techniques be used as well? Will there be any verification of the SST-based maximization (e.g., surface dew point analyses)?	It is anticipated that all storms will be maximized using SSTs unless a storm event being analyzed DID NOT have rainfall at several of the upwind weather stations (i.e. Talkeetna, Anchorage, Kenai, Seward, etc). Assuming each upwind station had rainfall during the rainfall period being analyzed for a given storm event, it is required that SST be used as the rainfall at the upwind stations "contaminates" the dew points reading that would have otherwise been used. This follows the same guidance as used in previous AWA studies, HMRs 57 and 59, and the WMO PMP Manual. As an example, all storms used in both the Lewis River and Piru Creek PMP studies required SST for the storm maximization calculations and it is initially assumed the same will result in this study.	AWA 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
3	BOC MTG-1 Final Report, Nov. 9, 2012	2 of 8	Hydrology & Meteorology	3) Barriers. The basin in question is surrounded by higher terrain, so some barrier-based moisture reduction is expected. Please describe the procedure you will use for this project.	AWA will use the proportionality constant to quantify the effects of upwind and within basin orographics on rainfall from one location (grid cell) to another. In addition, the general inflow direction for each short list storm event will be determined and used to calculate the "effective barrier height" from each of those directions from the coastline into the basin. This will provide a minimum elevation to be used with each inflow direction in the maximization processes. Specific details on these calculations and processes will be provided in upcoming memos, teleconferences, and meetings. It is AWA's intention to ensure that all involved have complete understanding of these processes, how they affect PMP, and how they are used to quantify orographic effects on rainfall production from one location to another.	AWA 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
4	BOC MTG-1 Final Report, Nov. 9, 2012	3 of 8	Hydrology & Meteorology	4) Elevation corrections for moisture. How will moisture corrections (e.g., reductions in available moisture) be done in areas of high relief?	Per the discussion in the previous response, the proportionality constant and effective barrier heights will be determined. This will allow for explicit evaluations of the amount of moisture available to each short list storm, at each grid cell within the basin following standard (HMR, WMO, AWA) procedures to determine PW at a given elevation.	AWA 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
5	BOC MTG-1 Final Report, Nov. 9, 2012	3 of 8	Hydrology & Meteorology	5) How adequate is the data set for snowpack (SWE and depth)? How will the data be distributed (grid in GIS; Point values only; Basin average; By elevation band)?	The snowpack data is less than for many other watersheds due to the very large size of the basin and relatively few snowpack stations, but it is still expected to be adequate. The available snowpack data and analysis results are expected to be distributed by sub-basin and by elevation band based on precipitation data from PRISM.	JH 5/13/13	Response accepted.	Snowpack
6	BOC MTG-1 Final Report, Nov. 9, 2012	3 of 8	Hydrology & Meteorology	6) Will glacier dynamics be addressed (in terms of areal extent or water release)?	The largest glaciers have been put in separate sub-basins where their special water release characteristics can be addressed.	JH 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.

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7	BOC MTG-1 Final Report, Nov. 9, 2012	3 of 8	Hydrology & Meteorology	7) The issue of "how many storms should be chosen for detailed analysis?" has been addressed. AWA's contract calls for 10 storms. This is probably adequate, unless some older storms are found (see item 8. below).	Agreed, and AWA will let the data tell us the answer. If our storm search shows that 20 storm are required, we will use those, if it show 5 storms are required we will use those. Ten storms is an estimate based on previous PMP work along the West Coast and AWA's judgment. AWA will work with the BoC and hydrologist in this process of determining the final number of storms to be used in PMP development. The most importantly aspect is to ensure that no storm(s) is left off the list that could control the PMP values at any area size or duration.	AWA 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
8	BOC MTG-1 Final Report, Nov. 9, 2012	3 of 8	Hydrology & Meteorology	8) When asked about climate change effects on precipitation intensity, Bill Kappel stated that it is unlikely that future climate will cause a significant increase in PMP, and that our historical storm data is adequate for assessing future scenarios. However, the primary model of climate variability in Alaska is the Pacific Decadal Oscillation (PDO), which has a quasi-cyclical variation of about 50 years. This led to generally warm conditions from about 1920 to 1945, cooler conditions from the late forties through 1976-77, and warmer again through the late 1990s. Somewhat cooler conditions have returned since then. It would be interesting to identify a few storms from the two earlier periods to see if there were noticeable variations in precipitation intensity. This could be done in a "screening" capacity using a simple approach such as AWA's SPAS-Lite.	AWA agrees with this statement and has an excellent understanding of the PDO cycle, as well as its interactions (positive and negative feedback) with other cycles on varying timescales such as ENSO, MJO, AO, etc. Each of these climatic patterns affect the frequency and strength of storm systems which occur in the region. Unfortunately, the resulting affects are not well understood at a quantifiable level. Instead, AWA's storm search methods are all encompassing as far as period of record is concerned and therefore extend back to as far as the storm record allows. Generally, this include ~100-years of data. This period of record inherently includes storm events that have occurred during each potential combination of climatic cycles (i.e. +PDO, -PDO, La Nina, El Nino, etc) that would be expected over the useful lifetime of this project (50-100-years or more). If the final short list of storms does not include events that occurred during each of the cycles, AWA will try to identify storms from each cycle period if possible and provide a high level analysis of these results. However, there may be a reason that PMP-level storms don't occur during one of the cycles and the data is trying to tell us a story. This will be an ongoing investigation during the short list storm development process. If these investigations require substantial work outside of the current scope for PMP development, AWA will work with the project lead and BoC to make appropriate out-of-scope determinations.	AWA 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
9	BOC MTG-1 Final Report, Nov. 9, 2012	3 of 8	Hydrology & Meteorology	9) AWA acknowledged that some storms may persist beyond 72 hours, and that, in fact, the critical PMF period may be for 96 hours or more. AWA should consider these longer-duration events in their analyses.	AWA concurs and will let the data tell us what the appropriate PMP duration should be. It should be noted that it is also possible the PMP storm may be less than 72-hours. AWA will place no constraints on this duration at this time, but instead this will be based on the storm data from the short list of storms.	AWA 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
10	BOC MTG-1 Final Report, Nov. 9, 2012	3 of 8	Hydrology & Meteorology	COINCIDENT HYDROMETEOROLOGIC CONDITIONS - We concur with the approach described, but note that extreme snow water equivalents deserve special attention. We understand that in many scenarios and locations the depth of snow during the PMP will be so great as to be no limiting; however, there may be scenarios, seasons, and elevation bands where the snow water equivalent does limit the potential runoff.	Storm sequences of 96 hours or more, depending on analysis by AWA, will be included in the determination of the critical PMF inflow hydrograph. No predetermined maximum storm sequence length will be set.	JH 5/13/13	Response Accepted. Adopted probable maximum storm length of 216 hours is consistent with observed events and adequate to cover basin and reservoir response time.	
11	BOC MTG-1 Final Report, Nov. 9, 2012	3 of 8	Hydrology & Meteorology	PROBABLE MAXIMUM FLOOD (PMF) - We concur with the elements and sequence of analyses for the PMF study as proposed by MWH and believe that if successfully executed they will provide the hydrologic information necessary to meet the public safety requirements of the project with respect to flood discharge capacity and flood loading. Model selection. MWH proposes to use the HEC-1 model for the analysis. HEC-1 is a spatially lumped, single event model that has been in widespread use for PMF hydrograph development for several decades (with updates). Most of its computational algorithms (with the important exception of snowmelt, as discussed below) have been incorporated in the HEC-HMS model, which was intended to replace HEC-1. The primary advantages of HEC-HMS over HEC-1 are the Windows user interface, the Gems extension which offers the capability to work with ArcGIS data, and the option to use spatially distributed runoff algorithms. None of these are necessities in the proposed Susitna-Watana study and we have no objections to MWH's preference for HEC-1, which offers the advantages of transparency and a clearly documented energy budget snowmelt routine.	Agreed. The HEC-1 Flood Hydrograph Package will be the rainfall-runoff model used to derive the PMF.	JH 5/13/13	Response Accepted. BOC concurs with use of HEC-1.	

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12	BOC MTG-1 Final Report, Nov. 9, 2012	4 of 8	Hydrology & Meteorology	Calibration and Verification. MWH has identified a number of storm/flood events and gage locations that may be used for model calibration and verification, and proposes to calibrate the model on at least two events and verify it on at least one. Applied Weather Associates will support this work by providing spatial and temporal histories of the associated storms. The calibration/verification process is essential to developing a reliable model and we strongly endorse this effort. The Gold Creek gage, located at a drainage area about 1,000 square miles more than the project area, provides the most comprehensive and long-term flow record and is expected to be a leading source of stream flow data for calibration. However, care should be taken, if at all possible, to use multiple stream gages – including some of the within-basin gages with a shorter period of record than the Gold Creek gage – in the calibration and verification effort. This will provide additional information on sensitive or critical subareas within the basin.	Agreed, as discussed further at BOC Meeting 2A.	JH 5/13/13	Response accepted. Model calibration has made use of multiple gages in the watershed	
13	BOC MTG-1 Final Report, Nov. 9, 2012	4 of 8	Hydrology & Meteorology	Reservoir Routing. The significance of reservoir routing and the related issues of hydrograph shape and volume (as opposed to peak flow only) will depend on the spillway configuration, freeboard allowance, and reservoir level regime proposed for the project. These elements of the project are still not well defined but we urge both MWH and Applied Weather Associates to remain open to the possibility that a long-duration, high-volume event will be the critical one in establishing the PMF reservoir elevation. Furthermore, if reservoir storage is intended to be used in passing the PMF, we will request additional information on the expected rate and spatial distribution of sediment deposition in the reservoir.	Agreed with regards to long-duration, high volume events. Sedimentation analysis would be a study done by others, or potentially information from the 1980s could be used.	JH 5/13/13	Response Tentatively Accepted. Although sedimentation analysis is not part of the PMF study, depending on the importance of storage in the final results the BOC may request reservoir routing sensitivity analyses assuming a loss of storage due to	
14	BOC MTG-1 Final Report, Nov. 9, 2012	4 of 8	Hydrology & Meteorology	Energy Budget Snowmelt Routine. MWH proposes to use the energy budget snowmelt routine as recommended in FERC's Engineering Guidelines. We concur with this approach, because the energy budget method is much better suited for estimating the impacts of extreme rates of precipitation and wind on snowmelt than temperature-index methods.	Agreed.	JH 5/13/13	Response Accepted.	
15	BOC MTG-1 Final Report, Nov. 9, 2012	4 of 8	Hydrology & Meteorology	Limiting PMF Analysis to May – October. MWH provided historic peak flow data representing 59 years of record at the Gold Creek gage downstream of the project in support of their proposal to analyze PMP and PMF only for the months of May through October. The maximum recorded flows in November-March are generally an order of magnitude smaller than the maximum recorded flows in the summer and early fall months. (April falls in between.) In addition, MWH reported that peak snowmelt months are from late spring through summer, and provided a preliminary reservoir level schedule which includes a drawdown, relative to the normal maximum storage, of 30 to 100 feet in the winter months with the lowest pool projected for April. In light of this information we agree that the months of May through October are probably an appropriate focus for the PMP/PMF analysis. However, a review of annual flow hydrographs at the Gold Creek gage shows that (1) flow hydrographs for the period November - April are generally missing and have been reconstituted; and (2) it is not unusual for the reconstituted or estimated flow hydrograph to begin rising steeply in mid to late April and continue rising into May. Based on these observations we request that AWA and/or MWH provide confirmation that extreme precipitation/temperature events occurring in May and later adequately (or conservatively) represent the potential for such events in April.	Covered in BOC Meeting 2A. Derivation of the PMF inflow hydrograph will be limited to the months of May through October.	JH 5/13/13	Response Accepted. Analyses through March 2014 did include April events. MWH's and AWA's reports convincingly demonstrated that the combinations of mechanisms needed for "worst-case" flooding would not be plausible in November - March.	
16	BOC MTG-1 Final Report, Nov. 9, 2012	5 of 8	Hydrology & Meteorology	Other sources of flooding. We understand that the potential for glacial dam break floods is being addressed in a separate study. We recommend that the findings of this study be considered in hydrologic design of the project.	Noted - glacial specific studies are to be done by others.	JH 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	
17	BOC MTG-1 Final Report, Nov. 9, 2012	5 of 8	Seismic	<u>PROBABLE SITE SPECIFIC SEISMIC HAZARD EVALUATION</u> 1) Conduct sensitivity studies using an existing hazard model to evaluate potential impact of new data before starting additional data collection: - Focus on what is most important to hazard at the dam site - May be able to limit studies of crustal faults to faults that pass within the site region (about 20 km radius)	Agreed. In keeping with recommendations by our seismic hazard consultant, we intend to conduct sensitivity studies as part of the seismic hazard study.	MB 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.

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18	BOC MTG-1 Final Report, Nov. 9, 2012	5 of 8	Seismic	2) Use the PSHA (Probabilistic Seismic Hazard Analysis) to help guide selection of a reasonable deterministic event: -Selection of Ground motion variability level (med, 84th) is still more dominant than the nominal variation in earthquake magnitude adopted	Agreed.	MB 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
19	BOC MTG-1 Final Report, Nov. 9, 2012	5 of 8	Seismic	3) Consider using "Approved" simulation methods for key cases (in early 2014): - M7.5-M8 slab earthquakes - M9-M9.5 interface earthquakes	Agreed. Due to funding, this activity may not be completed until 4Q13.	MB 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
20	BOC MTG-1 Final Report, Nov. 9, 2012	5 of 8	Seismic	4) Should collect data to constrain the VS30 (shear wave velocity in the upper 30 meters) for ground motion models	Agreed. These measurements will be collected during the 2013 field season.	MB 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
21	BOC MTG-1 Final Report, Nov. 9, 2012	5 of 8	Seismic	5) Consider the full network (new and existing) - What is the current broadband and strong motion instrumentation in the region? - A single strong motion recording is not of much value. Need min of about 5 stations within 100 km to be able to understand recording at dam, i.e., earthquake source, ray path, site response? - Develop an instrumentation plan that will provide results useful to ground motion evaluation, not just RTS (Reservoir Triggered Seismicity) For further details of the above see the attached presentation by N. Abrahamson (Attachment D to the BOC report).	Three additional BB seismographs are being installed in 3Q13. In addition, 3 SM seimogrpahs will be installed in conjunction with the BB at three of the 6 BB stations. The range of the network will be expanded to 30 miles.	MB 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	BOC Concurrence
22	BOC MTG-1 Final Report, Nov. 9, 2012	6 of 8	Seismic	The BOC feels that it would be helpful to the project for Dr. Abrahamson to provide a Table of readings of seismographs which recorded motions at various distances from the 2002 Denali M 7.9 earthquake. This information from the Denali Earthquake would be most useful as a calibration and verification of the scientific information and equations proposed. This information also may be more appropriate to consider in determining an attenuation relationship for this project as opposed to information from around the world. In addition, any computational model should be calibrated to the measurements obtained from the 2002 Denali Earthquake.	The project team has the recorded motions for the 2002 Denali M 7.9 EQ. An article on the 2002 Denali EQ was provide to the BOC: Martirosyan, A., Hansen, R., and Ratchkovski, N. (2004). Strong-Motion Records of the 2002 Denali Fault, Alaska, Earthquake, Earthquake Spectra, 20, 579-596	MB 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	BOC Concurrence
23	BOC MTG-1 Final Report, Nov. 9, 2012	6 of 8	Seismic	ADDITIONAL RECOMMENDATIONS NOT REFERRED TO OR DISCUSSED IN THE SEISMIC STUDY PLAN - Ice Jacking Concerns. Given the present considerations of a concrete dam option (RCC), the existing foundations and associated stability and shear strength of the foundation rocks are a significant factor. Thus, the concerns regarding permafrost as well as ice jacking within the exposed foundation rocks should be explored. If ice conditions and ice jacking have moved the foundation rocks it can be a serious reduction of the shear strength properties of the foundations being considered for the concrete dam. Therefore, future geologic and geotechnical explorations should focus on this aspect of the Project. Perhaps select borings and adits into suspicious areas should be considered to establish or disprove the ice jacking concerns.	Exploratory adits have been proposed to be excavated. Priority will be given to the left abutment adit to evaluate the presense of frozen ground and the potential for ice-filled discontinuities.	BES 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	BOC Concurrence and encourages adit construction ASAP

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24	BOC MTG-1 Final Report, Nov. 9, 2012	6 of 8	Seismic	Additional Considerations on Earthquakes. In addition to the proposed studies of earthquakes to arrive at the ground motions based on the most current models, it is the judgment of the BOC that work should be done within the current study or future studies to give some guidance on the possibility of the design earthquake producing a displacement or offset along the dam foundation. These features should be studied and investigated and a determination should be made whether this potential fault is a credible concern to be addressed in the design of the dam. This effort is recommended to avoid a fault being discovered during excavation along the footprint of the dam during construction. It may be necessary to align additional exploration borings or excavated adits to explore and/or eliminate such conditions. Earlier geologic studies of linear features of the site indicated a linear feature, shown on one of the plans presented during the meeting, called the "Watana Feature" that ran along the Watana River. The possibility of such a feature should be further studied and essentially discounted. Earlier studies (1980's) attempted to drill exploratory borings crisscrossing the river to investigate the continuity of the geology within the river bottom. It is not certain that the possibility of a shear/fault feature was discounted or not. This potential should be studied by an additional geologic expert like William Lettis, who is associated with the present study team. If sympathetic displacements along this feature or other linear features within the dam footprint cannot be discounted then discontinuous displacements should be considered. If it is deemed that this consideration is possible then consideration of a different type of dam may be necessary. Various dam types are available that are less sensitive to displacements and offsets and that can safely be designed to accommodate such conditions. Thus, the study plans need to address the potential of less desirable foundations such as ice jacking within the existing foundation rocks as well as the potential of foundation displacements. Until these conditions can be better understood, the type of dam must be considered preliminary. The upcoming spring geological/geotechnical study program must address these issues.	AEA believes that offset is very unlikely, but the Site investigation will be planned to include drillholes across the area of any potential geologic feature having the potential for offset and a fault evaluation will be undertaken.	BES 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	BOC to review additional 2013 field studies in the vicinity of the dam site
25	BOC MTG-1 Final Report, Nov. 9, 2012	7 of 8	Geotechnical	FERC REQUESTED THAT THE FOLLOWING ADDITIONAL QUESTION BE ADDRESSED BY THE BOC - Does the BOC agree that the type of dam being considered (RCC) is the most appropriate type of dam for this site?	As stated in BOC Mtg 1 - Final Report, this question is to be addressed at the next BOC meeting (#2) scheduled for March 7-8, 2013.	DOWL HKM/ Schnabel	To be addressed during the BOC #2 Meeting. The 2013 field studies and mapping will determine the final acceptance	Complete. No further action required on this for BOC MTG-1

AEA BOC Comments & Response Log - MEETING TWO-A REPORT (04/04/13)

AEA BOC: 2A
PROJECT: SUSITNA WATANA BOC

NOTES:

Item No.	Sheet No. / Page No.	Design Document	Design Group	Comment By	Comment	Comment Date	Response By	Response Date	Response	Status	Notes
1	2	AEA BOC Workshop 2A-	Meteorology / Hydrology	George Taylor / Ellen Faulkner	Short storm list. We concur with the methodology used to develop the short storm list and the final results.	4/16/2013	AWA		Agreed.	No change following Meeting 4.	
2	2		Meteorology / Hydrology		Storm maximization process. In general the approach adopted by AWA is the accepted and most effective way to maximize moisture for historic storms. During our discussion, AWA mentioned a willingness to consider larger (regional) source areas for SST, and we believe that such a procedure would be helpful. An approach using a wider source area allays concerns that the maximization process (in which the moisture source location is shifted by exactly the same vector as the storm center) generates a redundant reduction when combined with the proportionality constant method for orographic transposition.	4/16/2013	AWA		Covered in BOC Meeting 2A.	No change following Meeting 4.	AWA procedure is similar to that used in HMR-57. Considering the dearth of ground measurements of humidity in Alaska, using sea surface temperatures is certainly the favored approach. G Taylor, 4/17/14
3	2		Meteorology / Hydrology		Transposition of SPAS DAD analyses. It is our opinion that storms separated from the target basin by significant terrain boundaries should not be transposed into the basin. Based on the information presented to date, we concur with AWA's proposal to exclude storm centers south of the coastal mountains. The suggested sensitivity analysis would be informative but we do not believe it is essential to the present study.	4/16/2013	AWA		Agreed.	No change following Meeting 4.	
4	2		Meteorology / Hydrology		Proportionality constant and orographic transposition. AWA's proportionality constant approach appears to be superior to any other such technique, particularly the storm separation approach. Nevertheless, since the technique is still relatively new, the Board would like to continue to review results of AWA's activities in this regard. In particular, we would like to review proportionality constant results for each individual storm when they become available.	4/16/2013	AWA		Agreed.	AWA has modified its approach to storm transposition. The new method was discussed in Meeting 4 and, while subtle, seems to be an improvement.	AWA calls its method the "Orographic Transposition Factor (OTF)". It is obtained by normalizing observed rainfall, transposing to the target watershed, and converting back to rainfall depth. G Taylor, 4/17/14
5	2		Meteorology / Hydrology		Meteorological time series development. In our opinion AWA's proposed approach is appropriate and valid. Identifying the most critical intersection between rainfall potential, temperature, and snowpack depth is key to the PMF development.	4/16/2013	AWA		Agreed.	No change following Meeting 4.	
6	2		Meteorology / Hydrology		Other comments. We are in agreement with the work to date on the PMF model development and calibration, and agree with the calibration event selection process and outcomes. For our next meeting we would like to review existing information on permafrost within the basin, although it is understood that soil cover is thin to nonexistent over most of the basin.	4/16/2013	JH	5/13/2013	To be supplied at the next BOC meeting.	Accepted - The depth and spatial extent of permafrost has been addressed in the draft PMF report and the very low calibrated loss rates - while they	E Faulkner, 4/18/2014

AEA Susitna-Watana BOC Meeting #2 in Bellevue, WA (March 7-8, 2013) - Comment and Response Log

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Item No.	BOC Document & Date	Page or Sheet #	Technical Category	Comment	Response	Response by and Date	Status	Notes
1	BOC MTG-2 Final Report	1 of 3	Geotechnical, Structural, Concrete, Hydroelectric	The BOC is of the opinion that the 700 foot "gravity arch" dam structure being considered is not appropriate for the shape of the valley at the Watana location. A straight or slightly curved RCC gravity structure with 1V: 0.85H, as presented in the NTP 13, Technical Memorandum No. 1 (Updated Alternatives Evaluation) is far more appropriate.	See answer to item 2	BES 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	Concept was studied and revised
2	BOC MTG-2 Final Report	2 of 3	Geotechnical, Structural, Concrete, Hydroelectric	It appears from the studies presented, a hybrid configuration consisting of a central arch with outer gravity sections on both abutments, have been attempted to force fit a "gravity arch" section into the present topography. Further, the gravity sections are aligned such that they might be susceptible to down-slope sliding. Given the fact that the Watana Dam will not only be a very high dam but will also be in a seismically active area subject to very high seismic motions and deformations, it seems that tried and true methods combined with simple and predictable geometry are in order. There is a big difference between a "curved gravity dam" and a "gravity arch dam". The curved gravity dam is designed as a gravity structure dependent on the weight of the dam for stability, while the gravity arch dam is a reduced gravity structure which depends on the combined arch and gravity actions to resist loads, provided that the valley shape will permit the arch action to be fully developed. This dam will not only be among the highest dams in North America, it will also be the highest RCC dam constructed in a high seismic area of North America.	The feasibility studies for the project are progressing with the aim of the selection of an optimal arrangement for the dam at the site, taking into account the foundation and abutment conditions. The presentation to the Board of Consultants at this meeting was not of the final proposed arrangement, but only a "snapshot" of the design during the optimization process. AEA expects to continue to analyze various dam geometries, - including the results of the site investigations as they become available - and will take into account the opinions of the Board in the preparation of the final recommended proposal.	BES 5/13/13	Response Accepted by BOC	BOC Concurrence
3	BOC MTG-2 Final Report	2 of 3	Geotechnical, Structural, Concrete, Hydroelectric	Since the construction period for the dam is restricted to the 5-6 summer months, high RCC placing rates are planned, therefore simplicity in the details of the design are important considerations. The need for contraction joint grouting and, therefore, post cooling of the RCC will be required for the gravity arch dam, as being considered, will require many additional items to be incorporated into the RCC, such as waterstops, grout tubes and cooling water tubes, all of which will be serious impediments to achieving high RCC placement rates. Thus, a cautious and conservative approach, such as a design with a simple configuration that can be analyzed and constructed with high level of confidence, should be taken in the selection of the type of RCC structure, as described in the comments above.	The opinion of the Board of Consultants is noted	BES 5/13/13	Response Accepted. BOC will review future work and will comment if needed.	BOC Concurs and details to be included in future studies
4	BOC MTG-2 Final Report	2 of 3	Geotechnical, Structural, Concrete, Hydroelectric	Based on the maps and materials supplied, the lineaments indicated on earlier maps and studies, such as the Watana Lineament, have been indicated as insignificant and not a cause for potential foundation movement at the site. The planned 2013 and 2014 site investigation program will further investigate several earlier indicated linear features and shears to further confirm the stability of the geologic and foundation conditions.	Agreed	BES 5/13/13	Response Accepted. BOC will review future work and will comment if needed.	To be included in the 2013 and 2014 field investigation and mapping programs
5	BOC MTG-2 Final Report	2 of 3	Geotechnical, Structural, Concrete, Hydroelectric	In addition, several borings and test trenches as well as mapping and age dating of materials will be conducted to ensure the understanding and confirmation of the earlier studies and conclusions.	Additional site investigations are planned including a fault evaluation study.	BES 5/13/13	Response Accepted. BOC will review future work and will comment if needed.	To be included in the 2013 and 2014 field investigation and mapping programs
6	BOC MTG-2 Final Report	2 of 3	Geotechnical, Structural, Concrete, Hydroelectric	Other significant investigations entail exploratory adits in each abutment to investigate the character of identified shears as well as the effects of ice and frozen conditions on the stability of rock conditions and rock foundation blocks.	The designers agree and endorse the need for exploratory adits to investigate the rock mass at depth in the abutments	BES 5/13/13	Response Accepted. BOC will review future work and will comment if needed.	To be included in the 2013 and 2014 field investigation and mapping programs

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7	BOC MTG-2 Final Report	2 of 3	Geotechnical, Structural, Concrete, Hydroelectric	The BOC encourages the use of all of the methods and technology [listed in above comments] and in particular the exploratory adits. The adits will be the most positive proof method to establish the significance of the foundation features; and thus are highly recommended.	Agreed	BES 5/13/13	Response Accepted. BOC will review future work and will comment if needed.	To be included in the 2013 and 2014 field investigation and mapping programs
8	BOC MTG-2 Final Report	3 of 3	Geotechnical, Structural, Concrete, Hydroelectric	Further it is recommended that the 2013 field mapping and studies regarding the shear structures named GS4 and GS5 should be confirmed and located more accurately.	Agreed	BES 5/13/13	Response Accepted. BOC will review future work and will comment if needed.	To be included in the 2013 and 2014 field investigation and mapping programs
9	BOC MTG-2 Final Report	3 of 3	Geotechnical, Structural, Concrete, Hydroelectric	Once located accurately [shear structures, GS4 and GS5] and confirmed, the dam alignment should be adjusted to eliminate founding the dam footprint on any of these structures.	The nature of these features and their characterisation will be undertaken during the site investigation, and the treatment (or design) necessary will be examined during the design process. If treatment or design is not sufficient, then consideration will be given to relocating the dam.	BES 5/13/13	Response Accepted. BOC will review future work and will comment if needed.	To be included in the 2013 and 2014 field investigation and mapping programs
10	BOC MTG-2 Final Report	3 of 3	Geotechnical, Structural, Concrete, Hydroelectric	It is recommended that the energy of the geologists and the funding be focused on the mapping, drilling and adits at the dam site area in a major effort to define the geometry of the shears in order to locate the dam such that any offsets occurring along these features during an earthquake do not need to be considered. This activity must be given the highest priority compared to lineament studies at significant distances from the possible dam site.	Agreed	BES 5/13/13	Response Accepted. BOC encourages urgency of this work and will review future work and will comment if needed.	To be included in the 2013 and 2014 field investigation and mapping programs
11	BOC MTG-2 Final Report	3 of 3	Geotechnical, Structural, Concrete, Hydroelectric	Regarding the development of the seismic design criteria for the Project, the BOC would be interested in seeing the data; namely the accelerations, velocities, displacements and attenuations recorded at the seismic stations during the recent large Alaska earthquakes. This information should be instrumental in selecting the seismic parameters for design.	Sent	MB 5/13/13	Response Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
12				The BOC would like to review the following at the next meeting in May:				
	BOC MTG-2 Final Report	3 of 3	Geotechnical, Str	1. The proposed design earthquake(s) and associated ground motions for various features of the Project.	1. AEA will provide the planning criteria that are being used in the feasibility design analysis. The proposed criteria for final design will not be available by May	BES 5/13/13	Response Tentatively Accepted. BOC will review future work and will comment if needed.	"Response" Statement subject to BOC Concurrence.
				2. Preliminary dynamic analysis of gravity section subjected to the design earthquake motions.	2. AEA will provide analyses completed by the time of the May meeting - probably only 2D analyses		Tentatively Accepted	
				3. Preliminary thermal analysis for gravity dam.	3. AEA will perform a basic 2D analysis in time for the May meeting, but notes that the actual thermal conditions will be much more complex than that - and thus little can be surmised from a simple 2D analysis		Tentatively Accepted	

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				4. Reduced height of spillway gates & piers for improved cross-valley response of the piers.	4. While recognizing the impetus for limiting the pier height, until the PMP and PMF studies are complete in October or November (so that proper flood routing can be performed) AEA considers that focus on this aspect of the design is unwarranted. For the purposes of studying construction planning, and the associated cost estimation, AEA proposes to continue to use the 1980s spillway configuration, but will reassess the design after the PMF has been determined.		Include Spillway Pier Studies as soon as PMF Studies are Complete	
				5. Identify the existence of the shear zones and confirm their locations on the present mapping results of early geologic mapping.	5. Identification of the shear zones and confirming their locations on the present mapping will be performed as a part of this year's site investigations. The results of earlier geophysical mapping will be presented at the BOC meeting 3.		To be included in the 2013 and 2014 field investigation and mapping programs	

AEA Susitna-Watana BOC Meeting #3 in Anchorage, AK (May 29-30th, 2013) - Comment and Response Log

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Item No.	BOC Document & Date	Page or Sheet #	Technical Category	Comment	Response	Response by and Date	Status	Notes
1	BOC MTG-3 Final Report, June 5, 2013	1 of 5	Geotechnical, Structural, Concrete, Hydroelectric	<p>The BOC visited the dam site on Wednesday May 29, 2013 from the air on a helicopter and could land only on the state-owned highest point on the right river bank. The helicopter ride started from Talkeetna along the Susitna River to the dam site at Watana and further upstream to observe potential landslide sites within the reservoir. Both the right and left abutments were observed flying relatively close to the river banks noting the slope conditions, presence or lack of surficial geologic features, and the planned left abutment adit location. Overall, persistent NW-SE geologic features topped with rock outcrop were evident at repeated intervals near and upstream of the dam site. The closest such geological feature was observed to be several hundred feet upstream, but not at the dam alignment. Traces of the geologic features GF4 and GF5 identified within the right abutment were not visible on the surface and could not be observed from the air, but they will be investigated by the planned 2013-2014 borings and seismic refraction surveys.</p> <p>Based on the above observations and information gathered recently and during previous investigations, the BOC concurs with the current location of the dam alignment pending the results of the geotechnical/geological investigations planned for 2013-2014. The observed geometry of the site with a relatively narrow section at the river channel and flatter slopes at the upper elevations confirms the BOC's previously recommended slightly curved gravity dam section for this site. The BOC is in agreement with the revised gravity dam configuration curved at a radius of 3500 feet and notes that the main purpose of such a 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. As such the reduction of the high cantilever tensile stresses from the 2D analysis should be accomplished by other means such as sloping the upstream face and the use of lower rock modulus in the upper foundation layer, as discussed in the BOC response to Question 2. 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. In this situation, the 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 and could benefit from a defensive design such as stepping of the dam-foundation contact and other means that improves their resistance.</p>	The opinion of the Board of Consultants is noted. Configuration optimization continues - as far as is reasonable - in the absence of update specific foundation information that will eventually be obtained from a focused site investigation program.	BES 1/15/14	BOC Concur with Response. The final dam location and orientation will be confirmed following the 2013 Field Investigation and mapping program	
2	BOC MTG-3 Final Report	2 of 5	Geotechnical, Structural, Concrete, Hydroelectric	Further, the BOC concurs with the axis of the dam being rotated upstream away from the alteration zone on the left abutment. Consistent with this rotation, the spillway has appropriately been moved to the right side to project directly into the river channel. All in all, the revised dam configuration fits reasonably well to the site geometry and provides a sound baseline design for feasibility studies, while linear features crossing the dam are being investigated to confirm the stability of the geologic and foundation conditions. In the event that features crossing the dam are more extensive than presently envisioned it may be necessary to move the dam alignment to a location away from such features.	The opinion of the Board of Consultants is noted.	BES 1/15/14	BOC Concur with Response. The final dam location and orientation will be confirmed following the 2013 Field Investigation and mapping program	
3	BOC MTG-3 Final Report	2 of 5	Geotechnical, Structural, Concrete, Hydroelectric	<p>At the last BOC Meeting (Meeting No. 2) the Board asked that the following be produced for review at this meeting; Meeting No. 3:</p> <ol style="list-style-type: none"> 1. The proposed design earthquake(s) and associated ground motions for various features of the Project 2. Preliminary dynamic analysis of a gravity section subjected to the design earthquake motions 3. Preliminary thermal analysis for a gravity dam 4. Reduced height of spillway gates & piers for improved cross-valley response of piers 5. Identify the existence of the geologic features and confirm their locations on the present mapping. Results of early geologic mapping" <p>All of the above items were addressed with the exception of No. 4. Item 4 will not be addressed until enough information on the PMF is developed and instead the original spillway design, from the old 1980's configuration, will be used. The Board concurs with that approach.</p>	The opinion of the Board of Consultants is noted.	BES 1/15/14	All listed items are still being studied and need to be concluded and presented to the BOC	
4	BOC MTG-3 Final Report	3 of 5	Geotechnical, Structural, Concrete, Hydroelectric	In response to a previous BOC comment concerning comparison of available recorded data with the attenuation relationships proposed for prediction of ground motions at the dam site, the BOC was furnished with a published paper entitled "Strong Motion Records of the 2002 Denali Fault, Alaska, Earthquake." This paper published in 2004 provides a comparison of recorded data with several pre NGA attenuation relationships. The BOC suggests similar comparisons be made using 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. These data may be useful in removing some uncertainties associated with the site-to-source distance and Vs30 values.	Work is ongoing within the project team with regard to this matter.	BES 1/15/14	To be presented at the next BOC Meeting	

AEA Susitna-Watana BOC Meeting #3 in Anchorage, AK (May 29-30th, 2013) - Comment and Response Log

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5	BOC MTG-3 Final Report	3 of 5	Geotechnical, Structural, Concrete, Hydroelectric	The Board is encouraged that the presently proposed dam now incorporates a gravity dam section with a downstream slope of 0.9H to 1.0V and a slight upstream curvature. This section is an improvement over the previous cross sections and is felt to be more appropriate given the difficult site and high seismic requirements. Based on the dynamic analysis results presented for the above section, it appears that there is an excessive tension calculated along the upstream portion on the dam. The Board recommends two enhancements to more accurately realize and reduce the dynamic response of the dam: 1) consider sloping the upstream face of the dam and 2) consider reducing the modulus of the upper layer of the foundation rock to account for the existing and blast generated fractures near the ground surface. An upstream slope of 0.2H to 1.0V together with a downstream slope of 0.7H to 1.0 V would be an appropriate section to analyze and would not increase the current volume of the concrete. In addition, a variation on the foundation rock modulus varying from 500,000 psi to 1,000,000 psi would be an appropriate consideration to assess sensitivity of the results to rock modulus. With consideration of these two modifications the Board feels that the tensile zones will be smaller and more localized as well as manageable. The Board also recommends that the yield acceleration be calculated, as a gravity section, for each cross section studied.	Potential variations of dam geometry continue to be investigated. Matters raised by the Board of Consultants are being addressed.	BES 1/15/14	To be considered and analyzed and presented at the next BOC Meeting	
6	BOC MTG-3 Final Report	3 of 5	Geotechnical, Structural, Concrete, Hydroelectric	The Board does appreciate that this phase of the Feasibility need not get into the final design details however, it also feels that there are significant basic conditions that influence the performance of the dam, especially the response to seismic loading, and the internal stresses developed from extreme temperature loading. These factors can and may well affect the feasibility and estimated cost of the Project.	The opinion of the Board of Consultants is noted. Temperature studies are delayed slightly as the construction sequencing is investigated.	BES 1/15/14	BOC Concur with Response.	
7	BOC MTG-3 Final Report	3 of 5	Geotechnical, Structural, Concrete, Hydroelectric	Whether the present Feasibility Report addresses or tries to address all of the potential conditions of the dam and its environs is up to both the Owner and the Engineer, however there are serious conditions and considerations that eventually must be addressed. The following are several considerations identified, that need to be recognized: <ul style="list-style-type: none"> o The existence of permafrost within the foundation rock formations and how it has affected or will affect the foundation characteristics (i.e. ice jacking, rock block movements, long term foundation permeability etc.) o Thermal considerations regarding placement of RCC directly on the cold foundations and shrinkage. o 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. o Considerations regarding longitudinal cracking from concrete shrinkage and foundation restraint o Consideration of foundation grouting within the extremely cold foundation rocks and groundwater. o The complications of sequencing of the seasonal placements and the thermal effects on the internal stress development <p>The above considerations are just a few, when taken piecemeal appear to be insignificant, however the total of the above and many other conditions of the site need to be taken seriously and into consideration to fully accomplish the successful design and construction of the dam. Thus, the Board recommends that several of the above conditions be factored into the feasibility report, especially consideration of a sloping upstream face and reduction of the foundation modulus. The upstream sloping face enhances both the static and dynamic stability as well as reducing the Westergaard hydrodynamic forces on the upstream face.</p>	The team fully recognise the importance of the matters raised - as well as others - and is working as fast as possible towards a design status that accommodates these outstanding matters. However, finalisation of project proposals is hugely dependent on the results of as yet unfinished site investigation & drilling, materials testing, geological characterization, lineament analysis and adit construction - all of which are dependent on access to the land at the site. Engineering judgement is being made and assumptions made to facilitate the completion of a draft design and draft feasibility report.	BES 1/15/14	BOC Concur with the response and encourages the geological characterization and finalization of the foundation conditions	
8	BOC MTG-3 Final Report	4 of 5	Geotechnical, Structural, Concrete, Hydroelectric	New information on Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) included Applied Weather Associates' update on the analysis of historic storms for PMP development and HEC-1 model calibration, and MWH's discussion of how snowmelt and glacier ice melt would be addressed in modeling the PMF. Otherwise, Applied Weather Associates and MWH provided a synopsis of the information discussed at the April 3-4, 2013 PMP/PMF Workshop. <p>The Board concurs with MWH's proposal to develop the spatial distribution of the 100-year snow water equivalent (SWE) based on limited SWE observations and an assumed proportionality between SWE at various recurrence intervals and total October-April precipitation. This is appropriate for the months of May and June which could see significant snowpack remaining over at least part of the basin. For the later summer months the only snow- or ice-covered areas would be the glaciers in the headwater areas. The glaciers will contribute meltwater coincident with the PMP, which MWH proposes to represent as the 100-year, 3-day flow volume at the nearest downstream gage. This may prove to be a very conservative assumption, as the largest floods recorded at the upper watershed gages are probably a combination of summer storm runoff and glacier melt.</p>	The 100-year 3-day flow volume was intended to be used as an upper bound comparison parameter to ensure that snowmelt was not over-estimated. The actual modeled method for glaciers will be to treat them as an essentially unlimited snowpack with snowmelt determined by the energy budget method. The general lack of meteorological data at high elevations suggests the desirability of making approximate checks of the PMF where possible.	JCH 1/24/14	The BOC Concures, however, The Final presentation of the AWA Studies should be presented at the next BOC Meeting	
9	BOC MTG-3 Final Report	4 of 5	Hydrology & Meteorology	In the letter report on the April 3-4 PMP/PMF workshop, the Board members at the workshop stated an opinion that historical storms occurring south of the coastal range should not be transposed into the Susitna basin, because the coastal mountains create an effective moisture barrier. The basin flyover tour on May 29 supported the assessment of the southern mountain range as a significant topographic barrier relative to the project watershed. The airplane basin tour also provided the opportunity to note numerous pools of standing water in the low-relief eastern subbasins (e.g. subbasin 17), indicating at least seasonally impervious soils	Agreed.	JCH B. Kappel 1/24/14	currently waiting on response to Comment	