RAI Volume 2, Chapter 2.1.1.1, Second Set, Number 2, Supplemental Question 2:

Clarify the apparent discrepancy between maximum probable maximum flood peak flows of 55,240 cubic feet per second shown in Table 7-1 of *Yucca Mountain Project Drainage Report and Analysis* (BSC 2007) and 75,726 cubic feet per second shown in Table 9 of *Flood Hazard Curve of Surface Facility Area in the North Portal Pad and Vicinity* (BSC 2008) provided in the response to Ch 2.1.1.1 Set 2 RAI # 2, RAI 2.2.1.1.1-2-002 (RTN 00071-00-00) and Ch 2.1.1.3 Set 3 RAI # 2, RAI 2.2.1.1.3-3-002 (RTN 00290-00-00).

1. RESPONSE

Because the two analyses were prepared for different purposes, there is no discrepancy between the probable maximum flood peak flow of 55,240 cubic feet per second developed in *Yucca Mountain Project Drainage Report and Analysis* (BSC 2007) and the probable maximum flood peak flow of 75,726 cubic feet per second developed in *Flood Hazard Curve of the Surface Facility Area in the North Portal Pad and Vicinity* (BSC 2008).

The probable maximum flood developed in the drainage report (BSC 2007) used deterministic methods to determine the design bases for the flood protection features of the geologic repository operations area (GROA). The flood hazard curve report (BSC 2008) was developed to provide data to enable a screening evaluation of the probable maximum flood as an external initiating event, as described in SAR Section 1.6.3.4.5. The probable maximum precipitation and probable maximum flood estimates developed in the flood hazard curve report (BSC 2008) are not intended to replace the design basis values for the flood protection features of the GROA. The design basis developed using the drainage report (BSC 2007) provides substantial capacity beyond that required to mitigate the flood that is estimated to occur at the Category 2 event sequence screening threshold frequency.

The flood hazard curve report (BSC 2008) develops a probable maximum flood on a different basis than the drainage report (BSC 2007). The methods and inputs used for the development of a conservative flood hazard curve are presented in Sections 3.2, 4.3, and 4.5 of the flood hazard curve report (BSC 2008). The conservative values used in the flood hazard curve report (BSC 2008) include the following:

- An initial loss parameter of 0 in., representing a totally saturated initial condition, and a uniform loss parameter of 0.1 in./hr, (compared to the use of 1 in. and 1.5 in./hr (except for 0 in./hr for the aging pad area) respectively, used in the drainage report (BSC 2007))

- A time lag parameter using a peak rate factor of 600, representative of steep terrain (compared to 484 used in the drainage report (BSC 2007)).

An explanation of the parameter inputs that contribute to the difference between the probable maximum flood estimates in the drainage report (BSC 2007) and the flood hazard curve report (BSC 2008), based on the probable maximum flood model in the flood hazard curve report (BSC 2008), is found in Section 6.4 of the flood hazard curve report (BSC 2008). The uniform loss parameter and peak rate factor differences, which were deliberately chosen to be conservative for

the hazard curve study, cause most of the difference in the probable maximum flood estimates. In addition, the flood hazard curve report (BSC 2008) probable maximum flood model did not credit the detention ponds in the area of the surface facilities to control runoff as did the drainage report (BSC 2007).

Figure 1 is the flood hazard curve in the flood hazard curve report (BSC 2008, Figure 10), and its development is described in Section 6.5 of that report (BSC 2008). Point 1 on Figure 1 shows that the design basis probable maximum flood flow of 55,240 cubic feet per second, from the drainage report (BSC 2007), occurs at a return period of about 3×10^7 years, which is a probability of approximately 3×10^{-8} per year. Point 2 on Figure 1 shows that the peak flood flow at the screening criterion for external events of 1×10^{-6} per year (1×10^6 year return period) is 40,000 cubic feet per second, thus providing a margin in the capacity of the GROA flood protection features of approximately 38% ((55,240-40,000)/40,000). Point 3 on Figure 1 is the conservative probable maximum flood of 75,726 cubic feet per second developed in the flood hazard curve report (BSC 2008), which occurs at a return period of approximately 909 million years, or a probability of approximately 1×10^{-9} per year, which is 3 orders of magnitude below the external initiating event screening criterion.

In summary, there is no discrepancy between the probable maximum flood values developed in the drainage report (BSC 2007) and the flood hazard curve report (BSC 2008). The adequacy of the design basis probable maximum flood flow is validated by the flood hazard curve report (BSC 2008).

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2007. *Yucca Mountain Project Drainage Report and Analysis*. 000-CDC-MGR0-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070924.0043.

BSC 2008. *Flood Hazard Curve of the Surface Facility Area in the North Portal Pad and Vicinity*. 000-PSA-MGR0-01900-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080204.0007.

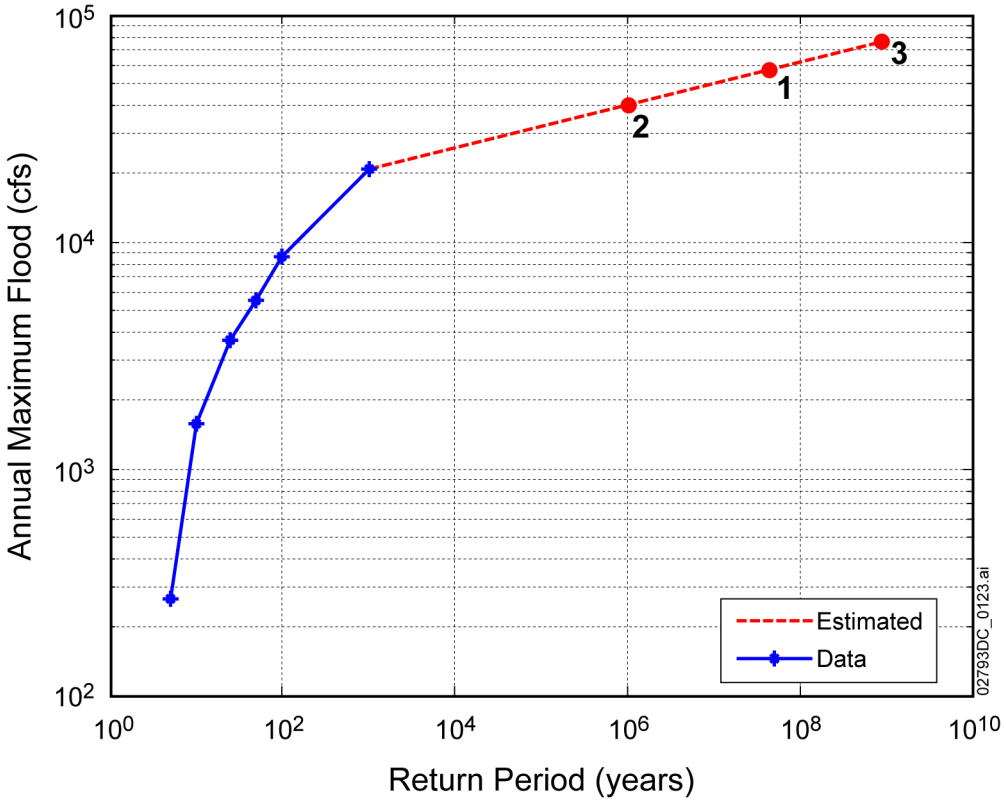

Figure 1. Flood Hazard Curve

RAI Volume 2, Chapter 2.1.1.3, Third Set, Number 2, Supplemental Question 3:

Clarify the rationale for screening out the external flood as an external hazard in Section 6.5.2 of the *External Events Hazards Screening Analysis* (BSC 2008a) because the probable maximum flood does not exceed the site flood diversion capacity.

1. RESPONSE

The site flood diversion capacity has been established as 55,240 cubic feet per second on the basis of the probable maximum flood calculated in *Yucca Mountain Project Drainage Report and Analysis* (BSC 2007). External floods are screened out as external hazards because the frequency of exceeding this capacity (approximately 3×10^{-8} per year) is less than the Category 2 event sequence screening threshold (1×10^{-6} per year). The peak flood flow at a frequency of 1×10^{-6} per year is 40,000 cubic feet per second. Furthermore, the frequency of exceeding the probable maximum flood as calculated in *Flood Hazard Curve of the Surface Facility Area in the North Portal Pad and Vicinity* (BSC 2008b) is approximately 3 orders of magnitude less than the Category 2 event sequence screening threshold.

External Events Hazards Screening Analysis (BSC 2008a, Section 6.5.2) summarizes the screening analysis for external floods. The last sentence of Section 6.5.2, part 3, of the screening analysis (BSC 2008a) states, "Because the frequency of the PMF is less than 10^{-6} per year; the PMF does not exceed the site's flood diversion capacity…." An expansion of this statement (in underline) for clarification is:

- "Because the frequency <u>of the 55,240 cubic feet per second peak flow PMF estimated in the *Flood Hazard Curve of the Surface Facility Area in the North Portal Pad and Vicinity* (BSC 2008b)</u> is less than 10^{-6} per year; <u>the flood flow at a million year return period does not exceed the site's flood diversion capacity</u>; the PMF does not exceed the site's flood diversion capacity.…"

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2007. *Yucca Mountain Project Drainage Report and Analysis*. 000-CDC-MGR0-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070924.0043.

BSC 2008a. *External Events Hazards Screening Analysis*. 000-00C-MGR0-00500-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080219.0001.

BSC 2008b. *Flood Hazard Curve of the Surface Facility Area in the North Portal Pad and Vicinity*. 000-PSA-MGR0-01900-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080204.0007.

RAI Volume 2, Chapter 2.1.1.7, Third Set, Number 1, Supplemental Question 4:

Clarify the flood analysis and design calculations including the storage capacity, maximum flood detention time, and inlet and outlet structures for the three detention basins southeast of the geologic repository operations area North Portal shown on the probable maximum flood inundation map provided as Figure 2 in the response to RAI 2.2.1.1.7-3-001.

1. RESPONSE

Runoff from the North Portal facilities area (subbasins NPP1, NPP2, and NPP3 on Figure 1 in the response to RAI 2.2.1.1.7-3-001) was modeled in the *Yucca Mountain Project Drainage Report and Analysis* (BSC 2007) as being detained on site and collected in detention ponds located at the southern and eastern boundaries of the North Portal facilities area. This analysis made an assumption that detailed design will ensure that releases from the detention ponds through their outlet works will be controlled such that outflows will have no significant effect on peak flows in the downstream channel.

These proposed detention basin areas are downhill from important to safety facilities at the surface geologic repository operations area, and significant land area is available for locating the basins. The design of the detention basins (including storage capacity, maximum flood detention time, and inlet and outlet structures) is part of detailed design and is scheduled for future completion.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2007. *Yucca Mountain Project Drainage Report and Analysis*. 000-CDC-MGR0-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070924.0043.