Pennsylvania Department of Environmental Protection
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Bureau of Waterways Engineering

717-772-5947

RECEIVED
BY:
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Todd D. Trotman, P.E.
Advanced GeoServices
1005 Andrew Drive
West Chester, PA 19380-3446

RE: Meeting Follow-Up and Review of Detailed Hydrologic Model (dated February 4, 2010)
Hershey Mill Dam
East Goshen Township, Chester County
DEP File No. D15-125

Dear Mr. Trotman:

This is in reference to the Detailed Hydrologic Model for the Hershey Mill Dam, which was discussed and submitted during your recent meeting with Dam Safety representatives on February 24, 2010. Thank you for meeting with us and explaining the approach you took in developing this more detailed model of the watershed upstream of Hershey Mill Dam. The hydrologic model for the 100-year flood is hereby approved as the spillway design flood for Hershey Mill Dam. The following comments are applicable to this determination:

1. In 2006, this office determined a 100-year spillway design flood of 2,098 cfs based on SCS Type II distribution of a precipitation depth of 8.15 inches (NOAA 90% confidence interval). In 2009, using a frequency distribution of NOAA 100-year precipitation depths for durations of 5 minutes through 24 hours, the 100-year peak flow for the watershed was reduced to 1,748 cfs.

2. In your more detailed HEC-HMS model, the watershed is divided into 20 sub-areas, and the flood flows are routed through various detention basins and roadway culverts. The following additional changes are made to the watershed hydrology:

   - The unadjusted NOAA rainfall depths for the site are utilized rather than the depths for the 90% confidence interval. This lowers the 24-hour precipitation depth from 8.15 inches to 7.48 inches.

   - The runoff curve numbers are reduced based on recommendations in a recent research document. The curve number reduction is associated with the recommendation to change the initial abstraction ratio from the 0.2 to 0.05.

1. I reviewed the proposed hydrologic model by applying the same changes to the Department's HEC-1 model for Hershey Mill Dam and comparing the results. The DEP model uses a single drainage area, and this was not changed. Also, I did not add any upstream routing. First, the 100-year rainfall depths were revised to the NOAA depths that are not adjusted for the 90% confidence interval. This single change to the unadjusted NOAA precipitation depths reduced the 100-year peak in the DEP model to 1,432 cfs. Next, I reduced the weighted curve number for the watershed to calibrate the HEC-1 model to the peak flow of 1,089 cfs that is proposed for the SDF. This calibration required lowering the runoff curve number from 64

to 57. In the research document on curve numbers, the recommended change in initial abstraction ratio would reduce a curve number of 65 to 52. Therefore the reduction to 57 was less than the research recommendation. Comparing the DEP model changes with the submitted HEC-HMS model, it appears that there was a minimal impact on the peak flow that was associated with the division of the watershed into 20 sub-areas and the routing of the flow through the culverts and detention basins.

4. Regarding the recommended adjustment in runoff curve numbers, the following observations are pertinent:

   - A curve number of 85 is reduced to approximately 80 (a difference of 5), whereas a curve number of 60 is reduced to 46 (a difference of 14). The curve number adjustment is proportionally larger for lower curve numbers. Therefore, a change in peak flows will be greater for undeveloped areas, and for areas with better hydrologic soil conditions.

   - This reduction in the curve number only affects the first few inches of rainfall. For example, if the curve number is reduced from 70 to 58.5 under these recommendations, it will only reduce the amount of runoff during the first 3.05 inches of rainfall.

   - At the meeting you stated that your firm may recommend detailed hydrologic studies for other dam owners. For high hazard dams, where the SDF is as high as the probable maximum flood (PMF), the adjustment in curve numbers will generally have a very minimal impact on the peak flow rate. A more detailed hydrologic study, similar to the model developed for Hershey Mill Dam, is unlikely to reduce the spillway design flood for most high hazard dams.

5. The report on the detailed hydrologic model for Hershey Mill Dam states that the model is reasonable and consistent with observations of roadway overtopping that has occurred in the past. For example, the model shows that the downstream roadway will overtop by about 2 inches in the 10-year flood model, and the report also states that this is consistent with PennDOT requirements for culvert capacity. These observations may be interesting, but are considered insufficient to provide a basis for calibrating a model and to assure that it is reliable.

6. In summary, the proposed reduction in Spillway Design Flood is based on the elimination of conservative assumptions in the calculations as follows:

   - A more moderate distribution of the precipitation is applied. This is acceptable because the use of the Type II distribution can result in depths of rainfall in short time periods that are greater than the NOAA site-specific precipitation depths for the same duration.

   - The NOAA precipitation depths with the 90% confidence interval are reduced to the unadjusted depths for the same duration and frequency. Although the more conservative depths provide a factor of safety which is desirable for high risk dams, it does not seem necessary for this site where the downstream roadway is inundated by the 10-year flood.

   - Runoff curve numbers have been reduced based on recommendations in a recent research paper. This research article, *Curve Number Hydrology State of Practice,* was published by ASCE in 2009 and prepared by the ASCE/EWRI Curve Number Hydrology Task Committee. It is based on extensive research and provides a reliable recommendation. Whether Dam Safety should accept this change in all cases has not been determined. It will have a minimal impact on the magnitude of the SDF for high

hazard dams that require spillway designs in the range of the 0.5 to full PMF. For this particular dam, and for other dams where the consequences of failure of the dam are non-high hazard, it seems to provide an acceptable basis to moderately reduce the peak flow of the spillway design flood. .

7. A factor of safety is provided in the design of a dam by either (1) conservative hydrologic assumptions regarding the rainfall and watershed, or (2) the addition of freeboard. This approval of a significant reduction in the spillway design flood (SDF) is based on the judgment that a conservative factor of safety is not as essential in the design of the improvements to this dam because:

   - The downstream impacts are limited to the inundation of one public roadway.
   - This public roadway is also inundated by floods with a greater frequency than the 100-year SDF.
   - Downstream of the public roadway, there is little, if any, potential for development which could increase the hazard potential of the dam.

8. With the new detailed model, the 100-year peak is reduced to 1,089 cfs. At the meeting, it was questioned (1) whether the detailed hydrologic study could warrant reducing the hazard class of the dam from C-2 non-high hazard to C-3, and (2) whether the spillway design flood could be further reduced to the 50-year frequency flood event. Please be advised as follows:

   - Because of the location of the roadway immediately downstream of the dam, there is no possibility that the dam could fail without inundating the roadway. Therefore, the classification of the dam cannot be change from C-2 non-high hazard to C-3.
   - The Department will not consider reduction of the spillway design flood to a 50-year event. The 100-year design flood is required for a C-2 dam under Section 105.98 of the Chapter 105 Rules and Regulations.

With the Department's acceptance of the revised hydrologic model, the owner should proceed in a timely manner with the development of a conceptual plan to safely accommodate the design flood. Should you have any questions concerning this letter or the dam, please contact me at the above number.

Sincerely,

Ronald C Mease

Ronald C. Mease, P.E.
Hydrologic and Hydraulic Engineering Consultant
Division of Dam Safety

cc: Louis F. Smith, Jr., East Goshen Township Manager
David Lakatos, Lakatos Consulting