Gannett Fleming

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October 23, 2009

Mr. Rick Smith
Township Manager
East Goshen Township
1580 Paoli Pike
West Chester, PA 19380

**Re: Hershey's Mill Dam – Dam Break Analyses Review, Assessment of Classification and Report**

Dear Mr. Smith:

Gannett Fleming has completed review of the following documents in accordance with our Agreement for Hershey's Mill Dam, Dam Break Analyses Review and Report. The referenced dam break analyses provided by the Pennsylvania Department of Environmental Protection (PADEP) are the primary focus of this report.

1. Break analyses and information provided by PADEP, apparently prepared to establish the dam size/hazard classification for the Hershey's Mill Dam, which is C-2.

2. Cover Memorandum prepared by Yerkes Associates, Inc. dated 9-15-2009, for Hershey's Mill Dam, Inundation Study with revised data.

   Review of information included in this document "that during the 100-yr storm event the dam will be overtopped by approximately 1.72 feet of water" appears to support results as presented by PADEP. PADEP reports the dam will be overtopped by 1.15 feet.

3. Letter from Yerkes Associates, Inc. dated 9-15-09 regarding Hershey's Mill Dam / Draining & Storage Volume.

   Review of information included in this document appears to indicate that significant siltation of the impoundment has occurred, and that because of "the amount of accumulated silt in the reservoir that the potential for catastrophic failure of the dam is remote, but there is no precise method of determining the odds that that will occur", and that "there is a substantial possibility that the debris carried in the stream channel will block the culverts under Greenhill Road, especially if one of the large trees on the dam topples and is carried downstream"

These documents are referenced as Items 1, 2 and 3, respectively, in the following text.

**Review of Break Analyses and information provided by the Pennsylvania Department of Environmental Protection (PADEP)**

The break analyses were completed for two storm events; the 100-Year and 2-Year return frequencies, using the HEC1 Computer Program developed by the U. S. Army Corps of Engineers. The Program is typically used and accepted as a standard for dam modeling purposes.

HEC1 Program Data Entry

1. The drainage area is entered as 1.8 square miles (1,152 acres) and closely matches (1,199 acres) information included in Item 2 above.

2. The total 100-Year, 24 hour duration precipitation depth is entered as 8.15 inches. This depth is consistent with published National Oceanic and Atmospheric Administration (NOAA) point precipitation information included in Item 1.

3. No reference is given with respect to the temporal distribution for precipitation; however it appears to be generally consistent with information published by the Natural Resources Conservation Service (NRCS).

4. The Curve Number is reported as 64. This evaluation of surface cover is consistent with the calculations included in Item 1 and is judged to be a relatively pervious representation.

5. The Lag Time is appropriately entered as 0.74 hours which is typically computed as sixty percent of the time of concentration (1.23 hours).

6. Impoundment stage/storage is entered as impoundment water surface area at specific elevations (see Table 1) which is in accordance with generally accepted procedures.

Table 1

| PADEP Stage (Elevation, Feet) | *Stage per Yerkes Assoc., Inc. Existing Plan* | Stage Description | Impoundment Surface Area (Acres) per PADEP | Program Calculated Storage (Acre Feet) |
|---|---|---|---|---|
| 437. | | Assumed Impoundment Bottom | 0 | 0 |
| 448. | *446.78* | Existing Spillway Crest | 7 | 26 |
| 450.5 | *449.0* | Existing Top of Dam | 10 | 47 |

Note: The assumed PADEP impoundment bottom elevation is in close agreement with information provided by East Goshen Township via email dated 9-23-09.

Table 2 is prepared for general comparison between the PADEP analyses information and information provided by Yerkes Associates, Inc.

Table 2

| Comparison Information | PADEP | Yerkes Assoc., Inc. |
|---|---|---|
| Freeboard = top of dam elevation – spillway crest elevation | 2.5 Feet | 2.22 Feet |
| Surface Area at Spillway Crest | 7 Acres | Approx 2.21 Acres (based on assumptions/calculations) |
| Surface Area at Dam Crest | 10 Acres | Not available |
| Freeboard Storage | 21 Acre Feet | 6.6 Acre Feet (per Item 3) |

(Note: The apparent datum correlation based on spillway crest elevation is: Existing Conditions Plan datum prepared by Yerkes Associates, Inc. plus 1.22 feet = PADEP datum.)

7. Hershey's Mill Dam stage/discharge is entered in accordance with the generally accepted weir discharge relationship.

8. Hershey's Mill Dam overtopping stage/discharge is entered in accordance with the generally accepted weir discharge relationship.

9. Three flood routing scenarios are considered for the 100 Year event:

   100-Year Break Data Scenarios:

Table 3

| Parameter | Plan 1, No Break | Plan 2 Break | Plan 3 Break |
|---|---|---|---|
| Breach Bottom Elevation (Feet) | NA | 443.25 | 442.7 |
| Break Bottom Width (Feet) | NA | 40 | 40 |
| Break Sideslopes (Horizontal to Vertical) | NA | 1:1 | !:1 |
| Time to Develop Break (Hours) | NA | 0.5 | 0.5 |
| Water Surface Elevation to Initiate Break (Feet) | NA | 451.64 | 450.08 |

The results at Hershey's Mill Dam are:

Table 4

| Parameter | Plan 1, No Break | Plan 2 Break | Plan 3 Break |
|---|---|---|---|
| Peak Discharge (Cubic Feet per Second) | 2,075 | 2,651 | 3,173 |
| Impoundment Stage (Feet) | 451.65 | 451.65 | 451.22 |

Embankment failure for Plan 2 is initiated at the maximum computed 100-Year stage without break which is the generally selected stage because it represents the most conservative condition. Plan 3 break elevation is Elevation 450.08, which is 2.08 feet above the spillway crest.

10. Greenhill Road Hydraulic Input (modeled as a dam embankment):

The Greenhill Road embankment is modeled as a dam embankment which is consistent with generally accepted procedures. The stage storage relationship is apparently prepared from stage area information:

Table 5

| Stage (Feet) | Greenhill Road Impoundment Surface Area (Acres) |
|---|---|
| 435.5 | 0 |
| 440. | 1 |
| 450. | 2.6 |

The Greenhill Road culvert rating was prepared based on two corrugated metal pipe (CMP) arches, approximately 65 inches by 43 inches at invert Elevation 435.5 feet and one 36 inches diameter corrugated metal pipe at invert Elevation 436.0 feet:

Table 6

| Stage (Feet) | Discharge (CFS) |
|---|---|
| 435.5 | 0 |
| 436. | 14.4 |
| 437. | 63.5 |
| 438. | 136 |
| 439. | 224 |
| 440. | 292 |
| 441. | 359 |
| 442. | 395 |

Low Elevation of Greenhill Road (embankment) = Elevation 442.
Length of road embankment for overtopping = 500 feet
Discharge Coefficient = 2.65

The results at Greenhill Road are presented in Table 7:

Table 7

| Parameter | Plan 1, No Break | Plan 2 Break | Plan 3 Break |
|---|---|---|---|
| Peak Discharge (CFS) | 2,116 | 2,580 | 3,018 |
| Impoundment Stage (Feet) | 443.17 | 443.37 | 443.55 |
| Discharge Depth above Low Road Elevation (Feet) | 1.17 | 1.37 | 1.55 |

Review Conclusions:

1. A dam permit was apparently not prepared for the original construction of Hershey's Mill Dam. Information has been submitted by East Goshen Township to PADEP and PADEP has issued an application number for the dam.

2. It is unclear if previous hydrologic/hydraulic analyses completed for Hershey's Mill Dam has been accepted by PADEP. The analyses prepared by PADEP (dated September 2006) may have been completed in an effort to classify the dam without any other information available.

3. Two alternative breach bottom elevations (Elevations 443.25 and 442.7) were considered, possibly for siltation considerations. It is noted that the impoundment bottom elevation used for stage storage computation corresponds to Elevation 437.0.

4. PADEP included two 3 feet by 6 feet arch culverts at invert Elevation 435.5, and one 36 inch diameter culvert at invert Elevation 436 for the Greenhill Road embankment. Review of the Existing Conditions Plan prepared by Yerkes Associates, Inc. indicates two 65 inches by 43 inches arch culverts at approximate invert Elevation 432.67 and one 60 inches by 42 inches CMP arch at invert Elevation 432.17. While there are differences in the existing versus PADEP culvert sizes and therefore rated culvert capacities, the net consequences is probably inconsequential when considering the proximity of the dam to the culverts and the fact that debris and other material will likely severely restrict hydraulic capacity of the culverts during a dam break condition.

5. Review of the PADEP results for Greenhill Road indicates that the road would be overtopped by 1.17 feet for the no break condition, and the incremental increase in depths are 0.2 feet and 0.38 feet for breach Plans 2 and 3, respectively.

6. Hershey's Mill Dam is located "on a natural watercourse" and the contributory drainage area exceeds 100 acres. Accordingly, the structure is regulated under the Section 302 of the Flood Plain Management Act (32 P.S. § 679.302). The size classification is Class C (impoundment storage equal to or less than 1,000 acre feet and dam height equal to or less than 40 feet) and the hazard potential Classification is judged Category 2 (Pennsylvania Code, Title 25, Paragraph 105.91).

7. Per Pennsylvania Code, Title 25, Paragraph 105.91, *a dam or reservoir shall be classified in accordance with size and the hazard potential which might occur in the event of an operational or structural failure.* Based on review of the analyses prepared by PADEP, overtopping of Greenhill Road occurs with and without dam break for the 100-Year event. Presuming the loss of access to Greenhill Road and its closure is considered "short duration public inconvenience", the C-2 Classification appears to be appropriate.

Accordingly, based on review of the PADEP analyses and related information, Gannett Fleming concurs with the current C-2 Classification for Hershey's Mill Dam.

We appreciate this opportunity to provide engineering services to East Goshen Township. Please call the undersigned at 610-650-8101 (ext 7126) if you have any questions.

Very truly yours,

GANNETT FLEMING, INC.

RICHARD E. HORVATH, P.E.
Project Manager

REH/rh

c. Esther McGinnis
Paul Schweiger
R. Scott Hughes
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