TWO RIVERS

Following is Flow Technologies' response to:

MEMORANDUM
To: Rob Zuber
From: Tim Cazier, P.E.
Date: August 4, 2022
Re: Two Rivers Gravel Pit Mine – Permit No. M-2022-013;
Flood Control Mitigation Plan – Preliminary Adequacy Review

August 27, 2022

DRMS Comment No 1

1. Hydrograph Development: Paragraph 3.2.3 indicates the 10-year flow was subtracted from the inflow hydrograph because "it is estimated the earthen berm will control a 10-yr flood event". This does not seem to be a straight forward assumption. If the entire site is to be flooded, it seems the water elevation of the flood above the berm elevation would be the controlling flow parameter, much as a hydrograph routed through a reservoir controls the depth of overflow in a dam overtopping failure analysis. Please provide some background on why this assumption is reasonable.

Flow Technologies Response:

The full 100-yr design flood will not enter the site due to the mentioned earthen berm. That is, flows with water surface elevations up to the berm crest along both the Big Thompson and South Plate Rivers will by-pass the site and continue downstream, and the remainder will flow over the berm and enter the site. Determining the exact amount of flow controlled by the berm would require rigorous and detailed 2-dimensional surface water hydraulic modeling which is beyond the scope of this study. Due to such, simplifying assumptions and engineering judgement were done. As stated in the Disclaimer, "results provide estimates and relative comparisons of potential for head cutting/erosion on gravel pit riverside berms." Thus a detailed analysis of flows over the earthen berm was not performed because it will not affect the bottom line and purpose of the study.

DRMS Comment No 2

Hydrograph proportionment: Paragraph 3.2.3 references FEMA, Flood Insurance Study, January 20, 2016 as validation for having two-thirds flow through the south side of the Site (Central Field) and the remaining one third flow through the north side of the site. Please: a. Elaborate on the purpose of splitting the flows,

b. Explain if this is used directly in the WinDAM C berm failure analyses or in the hydrograph development for determining water elevation, or somewhere else,

c. Explain how it impacts the approach and results (e.g., how sensitive is the analyses to this 2/3 (3:1 is mentioned in report) ratio)

Flow Technologies Response to a:

The site is located in two "overlapping" floodplains from the South Platte and Big Thompson Rivers. Flows through the site from the two floodplains would not be laminar and separated, and would not combine to result in a single peak flow moving through the site in a downstream direction. Rather, flow through the site would be 2-dimensional with variations through the site. Determining such would require a 2-dimensional flow modeling analysis which is beyond the scope of this study. Also, it would not be reasonable to have the total combined peak discharge from both rivers as the WINDAM design discharge for determining berm erosion at various locations throughout the site.

Thus in lieu of a 2-dimensional flow modeling analysis, engineering judgment, and per the Appendix, "Design Hydrographs (WinDam C Input Hydrographs)," proportioning was estimated based on relative peak discharge for each river. As stated in the Disclaimer, "Analyses in this study - as with any computer modeling of natural processes - is not an exact science and claims can not be made as to its accuracy. However, results provide estimates and relative comparisons of potential for head cutting/erosion on gravel pit riverside berms."

Flow Technologies Response to b:

As mentioned above in "a," these discharges are used in the WinDAM C berm failure analysis for the respective South Platte River, and Big Thompson sides.

Flow Technologies Response to c:

A sensitivity analysis was not performed, is not possible, and not necessary. There is no methodology nor data for this process with which to compare results. Per the Disclaimer, "This study is based on innovative methodology that applies a dam-breach head cutting/erosion computer model (WinDAM C) to gravel pit riverside berms. Such methodology may be unprecedented. The study methodology is based on scientific procedures and associated research, but there are no known historic events nor studies with which to compare methods and results."

DRMS Comment No 3

Hard Armoring: Both paragraphs 3.2 and 4.2 reference Section V, Hard Armoring. Section V is labeled Mitigating Measures and does not discuss any hard armoring. Please provide some discussion on the anticipated hard armoring for reclamation/closure.

Flow Technologies Response:

A separate hard armoring document is to be prepared by Raptor Materials, LLC.

DRMS Comment No 4

4. Variable Water Surface Elevation: As expected for a river flood and depicted in Figure 8, the water surface elevation varies from the upstream to downstream segments of both rivers. The DRMS' understanding of WinDAM C is that it assumes a uniform flow elevation over the embankment being analyzed. How is the fact that the water elevation is not uniform in this scenario accounted for in the modeling?

Flow Technologies Response:

Water surface profiles depicted in Figure 8 are those of the South Platte River along Central Field and do not pertain to WinDAM C analyses. Per Section VI of the report, "as an extra measure of confidence that the likelihood for head cutting into Central Pit would be small, the 100-yr water surface profile was evaluated via HEC-RAS." Thus, the HEC-RAS analysis was done to demonstrate that the berm would not overtop during a 100-yr flood event, and so a breach would not occur. Also Section VI of the report states, "in addition to WinDAM C head cutting/erosion analysis, the riverside berm length overtopping analysis indicates that much of the riverside berm would not overtop, and a breach develop, thereby minimizing the susceptibility to Central Pit capturing the river.

DRMS Comment No 5

Fill Time Estimates – Central Pit: The fourth column in table on p. 30 suggests a nearly uniform incremental delta for every 10 feet of pit depth. This suggests the pit being analyzed for a depth/storage relationship has nearly vertical side walls. Are the pit walls in the berm failure scenarios being analyzed vertical and is this condition reflected in the WinDAM C analyses?

Flow Technologies Response:

The depth/storage relationship is based on estimated pit extraction. The slope of the pit side walls are not a factor in WinDAM C analyses; rather, elevation-volume data are used in the model input.

DRMS Comment No 6:

Central Pit Groin Training Channels Calculations: On p. 41 is a Mannings normal depth flow calculator for a 25-foot bottom width with 1H:1V side slopes. It is unclear as to the purpose of this image. Based on the Mannings n = 0.025, it would appear this is likely an earth-lined channel. As such, a 1H:1V slope is not likely to be stable for long. Please indicate the purpose of this image and justify the channel geometry depicted in it.

Flow Technologies Response:

The image (table) mentioned is a visual to present the parameters for calculation of training channel dimensions and flow capacity. Note that the heading on the table states, "For future reference if needed." Thus training channels may – or may not - be used depending on progress of extraction.

Should the training channels be needed, they will be excavated into existing soil conditions. It is important to note that stability of the training channels is not critical because (1) there is a small probability that they will ever be needed, and (2) should training channel erosion occur, it may increase the cross-sectional area resulting in a higher flow capacity. That will be beneficial for decreasing head cutting at susceptible berm areas due to less flow (that is, less flow would be available to erode a riverside berm). Because gravel mining is somewhat "design/build," and if it is deemed that channel stability is an issue, then a channel lining (such as turf reinforcement mats or riprap) can be placed in the earthen training channels.

DRMS Comment No 7:

HEC-RAS Output: Several of the HEC-RAS cross section output results indicate additional cross-sections may be warranted: a. The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

b. Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Please provide rationale for not including additional cross sections

Flow Technologies Response to a:

The HEC-RAS analysis - as stated on page 21 of the report – was performed "As an extra measure of confidence that the likelihood for head cutting into Central Pit will be minimal." It is not a factor in estimating berm erosion, and the study and report will stand without it. HEC-RAS output often displays the verbiage that "additional cross-sections may be needed" which is not of practical relevance in many cases. Based on engineering judgement, the necessity for such is not necessary because of the relatively short channel reach and low channel gradient. If additional cross-sections were added, results would indicate a negligible change in water surface profile, and have no effect on the purpose and final results of the study.

Flow Technologies Response to b:

*HEC-RAS output often displays the verbiage, "*Warning: The energy loss was greater than 1.0 ft (0.3 m) between the current and previous cross section. This may indicate the need for additional cross sections*." The same discussion applies as for "Comment a" above.*