HEADWATERS
Consulting, LLC

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Subject: **Maplewood Avenue over North Mill Pond, Portsmouth, NH**
**Additional Water Diversion Alternatives**

Aaron:

We have completed an evaluation of two additional water diversion alternatives for the Maplewood Avenue over North Mill Pond bridge rehabilitation project in Portsmouth. Water Diversion Alternative 2.3 includes twin 48-inch diameter culverts between cofferdams on either side of the bridge and Water Diversion Alternative 2.4 includes a single 72-inch diameter culvert between the cofferdams. The evaluation used the same methodology described in our December 2, 2022 report titled: "Summary Report for Maplewood Avenue over North Mill Pond Bridge Rehabilitation and Water Diversion Hydrologic and Hydraulic Analyses Portsmouth, New Hampshire", including the development of a HEC-RAS two-dimensional (2D) flow model for each alternative.

Assumptions made for these two additional alternatives are the same as those made for Water Diversion Alternatives 2.1 and 2.2 as described in our December 2022 report, which are as follows:

- Top elevation of north cofferdam: 6.5 ft (NAVD88)
- Top elevation of south cofferdam: 6.5 ft (NAVD88)
- Culvert inlet invert elevations: -3.5 ft (NAVD88)
- Culvert outlet invert elevations: -4.5 ft (NAVD88)
- Construction month: October
- Highest high tide elevation: 2-year high water level (6.42 ft, NAVD88)
- Hodgson Brook base flow: 1 cfs
- Rainfall: One 1-year, 24-hour rainfall event (2.66" rainfall depth) with peak freshwater inflow coincident with highest high tide

**Water Diversion Alternative 2.3 – Temporary Twin 48-inch Culverts**

Figure 1 shows a schematic plan view of the cofferdams and temporary culverts evaluated under Water Diversion Alternative 2.3, Figure 2 shows a cross-section at the existing bridge inlet with the temporary culverts installed, and Table 1 summarizes the peak water levels calculated with the model.

*Table 1 – Peak water levels calculated for Water Diversion Alternative 2.3*

| Location | Peak Water Level – Water Diversion Alternative 2.3 (feet, NAVD88) |
|---|---|
| North Cofferdam | 6.42 |
| South Cofferdam | 3.61 |

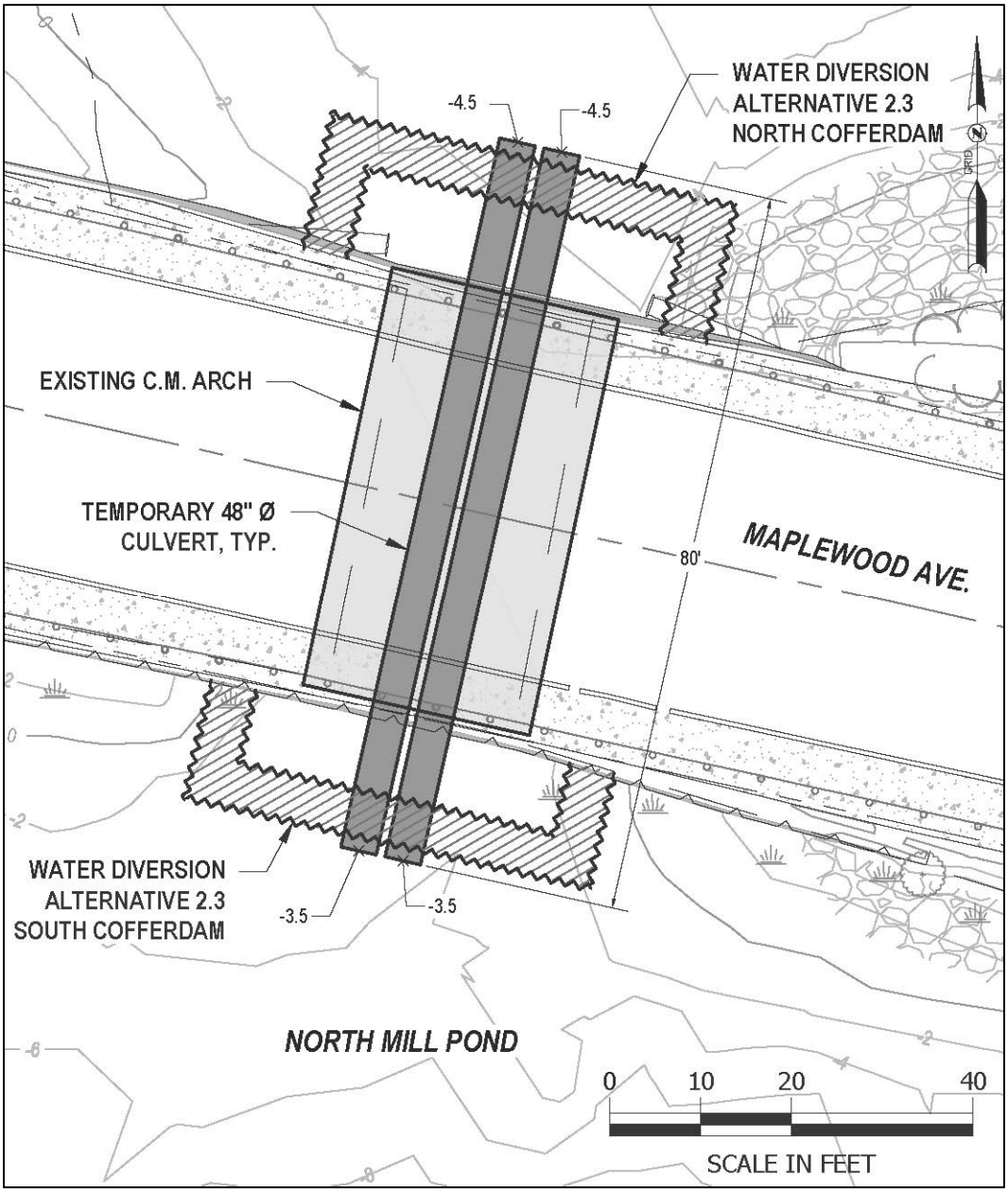


*Figure 1 – Water Diversion Alternative 2.3 Schematic Plan*

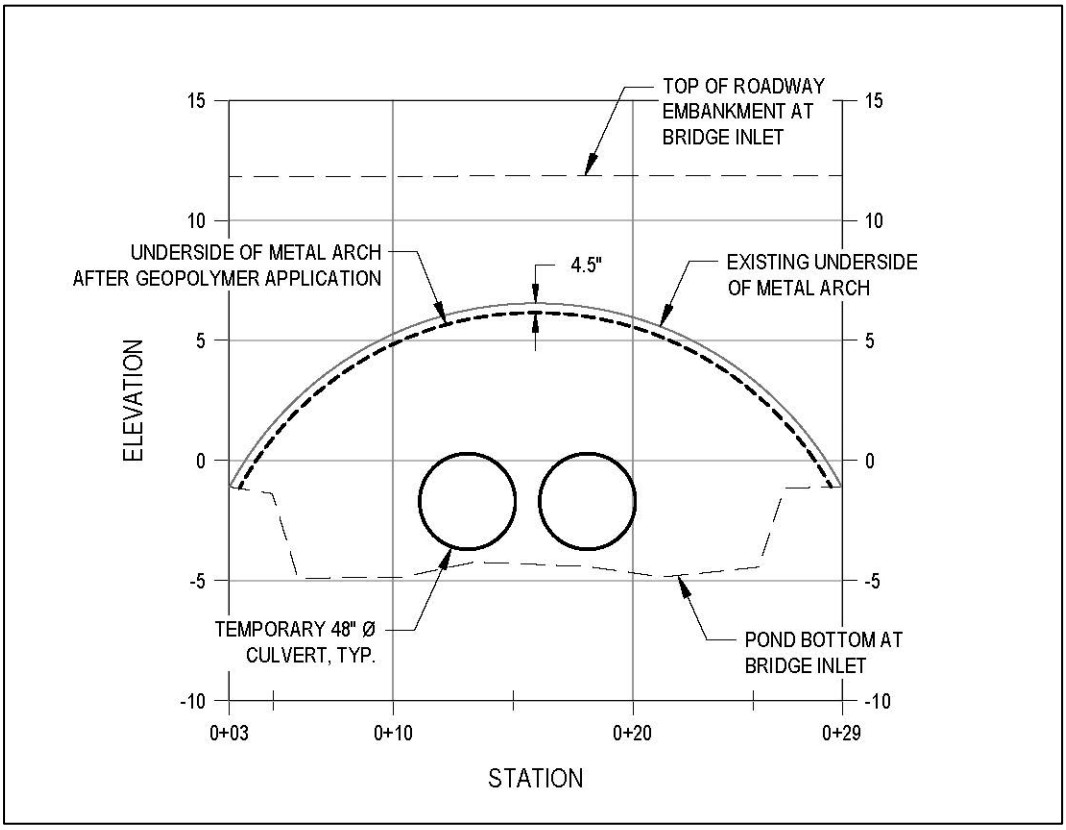


*Figure 2 – Water Diversion Alternative 2.3 Bridge Inlet Cross-Section*

Figure 3 shows the stage and flow hydrographs calculated at the bridge with the HEC-RAS 2D model for Water Diversion Alternative 2.3. The headwater stage hydrograph represents water levels on the south side of the south cofferdam, the tailwater stage hydrograph represents water levels on the north side of the north cofferdam, and the flow hydrograph shows the cumulative flow through the two temporary 48-inch culverts. The maximum combined flow through the culverts from south to north (outgoing tide) is approximately 235 cfs with a maximum flow velocity of about 9.4 ft/s in each pipe. From north to south (incoming tide) the maximum combined flow is approximately 285 cfs with a maximum flow velocity of about 11.3 ft/s in each pipe.

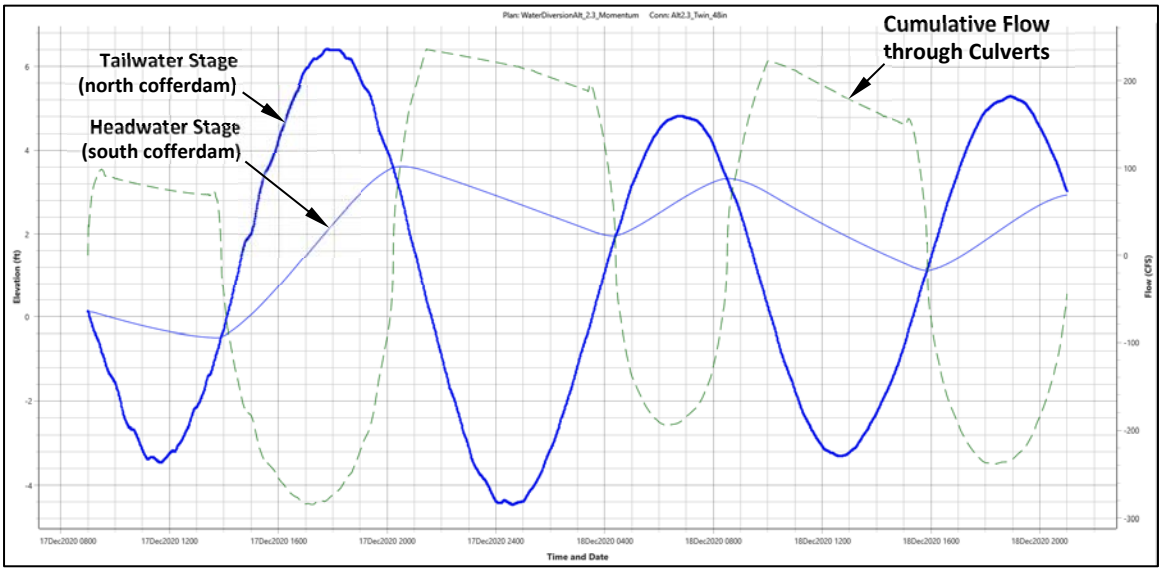


*Figure 3 – Stage and flow hydrographs calculated at the bridge for Water Diversion Alternative 2.3*

As shown in Figure 3, water levels south of the bridge never get as high or as low as the water levels on the north side. This is due to the limited discharge capacity of the temporary culverts and the relatively short time between the crests and troughs of the tide cycles which combine to prevent the portion of North Mill Pond on the south side of the road from filling or draining to the same water level as in the portion of the Pond north of the road.

## Water Diversion Alternative 2.4 – Single 72-inch Culvert

Figure 4 shows a schematic plan view of the cofferdams and temporary culvert evaluated under Water Diversion Alternative 2.4, Figure 5 shows a cross-section at the existing bridge inlet with the temporary culvert installed, and Table 2 summarizes the peak water levels calculated with the model.

*Table 2 – Peak water levels calculated for Water Diversion Alternative 2.4*

| Location | Peak Water Level – Water Diversion Alternative 2.4 (feet, NAVD88) |
|---|---|
| North Cofferdam | 6.42 |
| South Cofferdam | 3.82 |

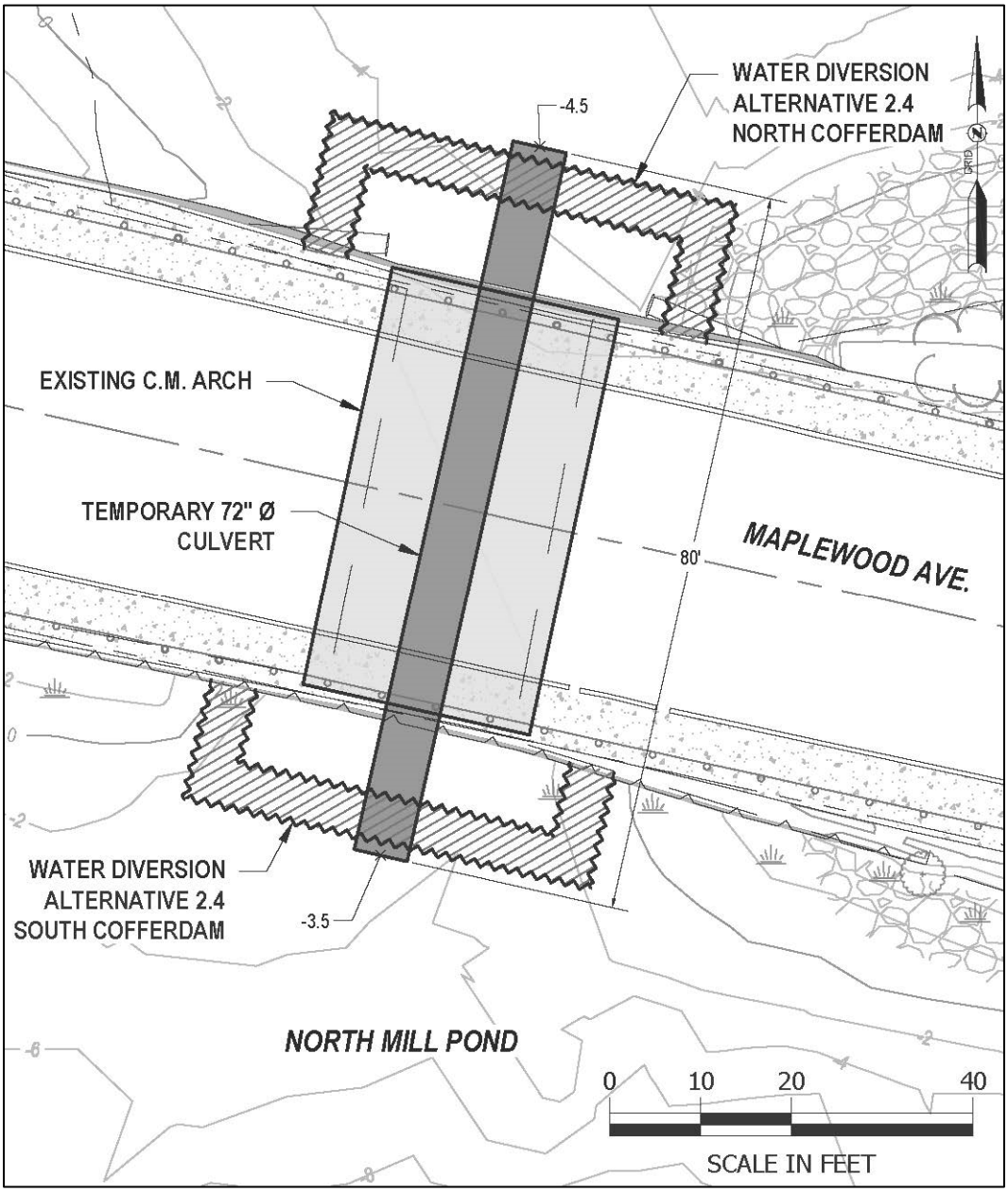


*Figure 4 – Water Diversion Alternative 2.4 Schematic Plan*

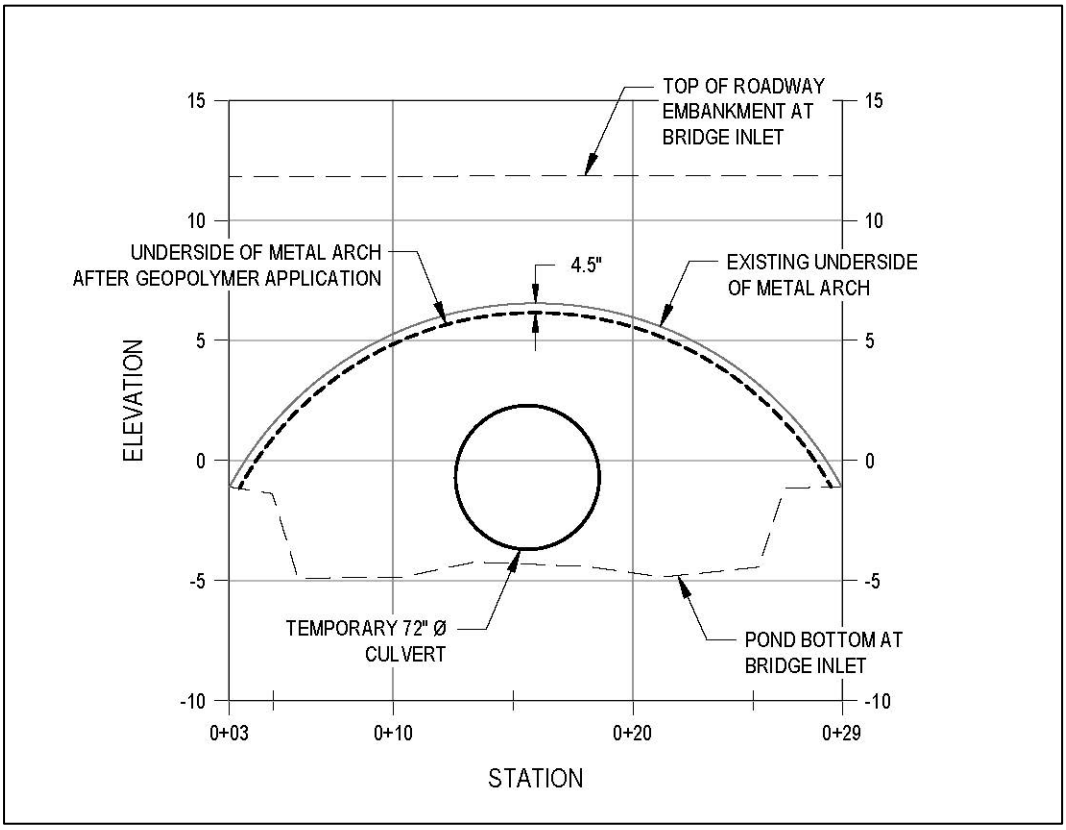


*Figure 5 – Water Diversion Alternative 2.4 Bridge Inlet Cross-Section*

As compared to Water Diversion Alternative 2.3, maximum water levels on the south side of the bridge are 0.21 feet higher. This appears to be because, at the invert elevations assumed, the single 72-inch pipe has a greater capacity than the two 48-inch pipes when water is flowing from north to south, allowing greater tidal inflow, but less capacity when flow is from south to north, reducing the level to which the portion of North Mill Pond on the south side of the bridge drains.

The maximum flow through the 72-inch culvert from north to south (incoming tide) is approximately 318 cfs (as compared to 285 cfs for Water Diversion Alternative 2.3) with a maximum flow velocity of about 11.2 ft/s in the pipe. From the south to north (outgoing tide) the maximum flow is about 220 cfs (as compared to 235 cfs for Water Diversion Alternative 2.3). with a maximum flow velocity of about 7.8 ft/s in the pipe. Figure 42 shows the stage and flow hydrographs calculated at the bridge with the HEC-RAS 2D model for Water Diversion Alternative 2.4.

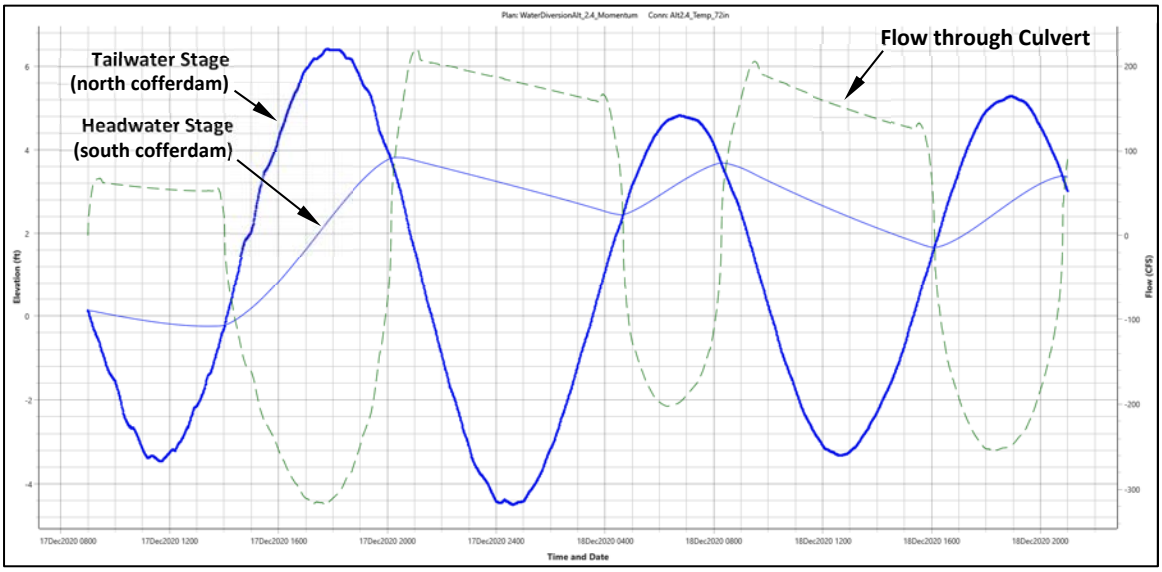


*Figure 6 – Stage and flow hydrographs calculated at the bridge for Water Diversion Alternative 2.4*

I can be reached at (603) 616-6850 or via email at sean@headwatershydrology.com if you have any questions.

Respectfully submitted,

Digitally signed by Sean P. Sweeney
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