Hydraulic Analysis of Puppy Creek, Lowell, AR

near AR-264

Hydraulics and Technical Services Branch

U.S. Army Corps of Engineers – Little Rock District

700 W. Capitol Ave

Little Rock, AR 72201

Date: April 24, 2018

(this page intentionally blank)

Executive Summary

This document summarizes the hydraulic analysis of the effects modifications to the culvert and channel will have on the water surface elevation on Puppy Creek at its crossing with AR-264. For flows ranging from the 25 yr to the 500yr events, several different scenarios were modeled including

- Original conditions with blocked culvert
- Cleared culvert
- Clear culvert with some sediment and debris in culvert
- Cleared culvert with cleaning out of channel downstream of culvert
- Cleared culvert with cleaning out of channel upstream of culvert
- Cleared culvert with cleaning out channel both upstream and downstream of culvert

The largest decrease in water surface elevation was obtained from cleaning of the culvert. While modifying the entrance and exit of the channel did result in modifications to the water surface elevation they were not as significant as cleaning out the culvert and keeping it free of sediment. Our recommendation is to clean out the culvert and the channel within 100 ft. above and below the culvert to allow for a smoother transition from the stream to the culvert. If funding is limited, then cleaning out the culvert will have the largest impact on lowering the water surface elevation upstream of the culvert, but without removing the debris and gravel immediately upstream and downstream of the culvert, channel sediment will probably redeposit in the left most box culverts.

Introduction

The city of Lowell, AR requested a hydraulic analysis of water surface elevation at and near where Puppy Creek crosses under Arkansas Highway 264 between Franklin Ave, and Center Drive (Figure 1). The purpose of the investigation is to determine ways to reduce the water surface elevation upstream of the culvert crossing Highway 264. A hydraulic model was created using the Hydrologic Engineering Center River Analysis System (HEC-RAS). The model extends from downstream of Puppy Creek's crossing with Lincoln St, and downstream of Puppy Creek crossing with Dixieland Road (Figure 1, Figure 2).

Figure 1. Google Earth view of study area with Puppy Creek outlined in blue, point of interest shown as yellow tack.

Figure 2. View of hydraulic model and cross-section extents.

Existing Conditions Model Geometry

- Overbanks and Channel Sections: 2015 Lidar. It was assumed that the LiDAR picked up the channel sections.
- Culverts and lake outlet structures were estimated based on field measurements and LiDAR, except for AR-264. Arkansas Department of Transportation, ARDOT, provided as-built drawings for this culvert.

Discharge Data

Discharge data was developed using the United States Geological Survey (USGS) Streamstats website. https://streamstats.usgs.gov/ss/

Model and Scenario Runs

Several different scenarios were run including

- Original conditions with blocked culvert (Block Culvert)
- Cleared culvert (clearculvert)
- Clear culvert with some sediment and debris in culvert (sedculvert)
- Cleared culvert with cleaning out of channel downstream of culvert (DSxsecmod)
- Cleared culvert with cleaning out of channel upstream of culvert
- Cleared culvert with cleaning out channel both upstream and downstream of culvert (BothXsecMod)

in parentheses is listed the plan name.

The six different scenarios were modeled to investigate the effects cleaning out the culvert and the upstream or downstream channel will have on the water surface elevation upstream of the culvert. The channel upstream of the culvert is partially blocked on the left side. Sediment has started to build up in the left two most culvert boxes to several feet in depth (Figure 4 - Figure 5). At a field visit the depth was estimated at 3 to 4 feet. The cleaning out of the channel upstream of the culvert consisted on removing deposited sediment that is blocking the culvert. The goal was to clean out the channel so sediment is not blocking the approach to the culvert and then to smoothly transition from the culvert opening back to the normal channel width. The channel was cleaned out and slowly tapered back to normal channel width over approximately 200 ft.

The channel downstream of the culvert partially blocks flow out of the culvert. The left bank has debris and sediment built up in front of it. There are shrubs and trees starting to grow in this channel, which can also impede flow (Figure 6-Figure 7). The channel was cleaned out similar to the upstream channel with sediment cleaned out to not block the culverts and then to taper back to normal channel.

Figure 3. Upstream of culvert looking downstream towards Highway 264 on right bank.

Figure 4. Upstream of culvert looking downstream towards Highway 264 on left bank.

Figure 5. Downstream view looking upstream at Highway 264 culvert

Figure 6. Downstream view looking upstream into Highway 264 culvert: Culvert adjacent to right bank.

Several different flow events were obtained from USGS Stream Stats for the area for the 25, 50, 100, and 500 year events.

Results

The results are summarized in the following plots (Figure 7-Figure 12). The inundation extents for cleaning out the channel upstream of the culvert resulted in the same upstream inundation extents as cleaning out both upstream and downstream channels, so only both upstream and downstream channel clean out scenario is shown. Figure 7 and Figure 8 summarize the inundation extents for the 100 year storm. Two plots are necessary because modifying the channel upstream resulted in a minor drop in water surface elevation (0.1-0.3 ft) in the upstream extent and this resulted in an increase (0.1 – 0.3 ft) in water surface elevation downstream near the culvert. These are small water surface elevations changes and are within the error tolerance for this model. Overall, cleaning out the culvert of all debris had the most significant effect on the resulting inundation.

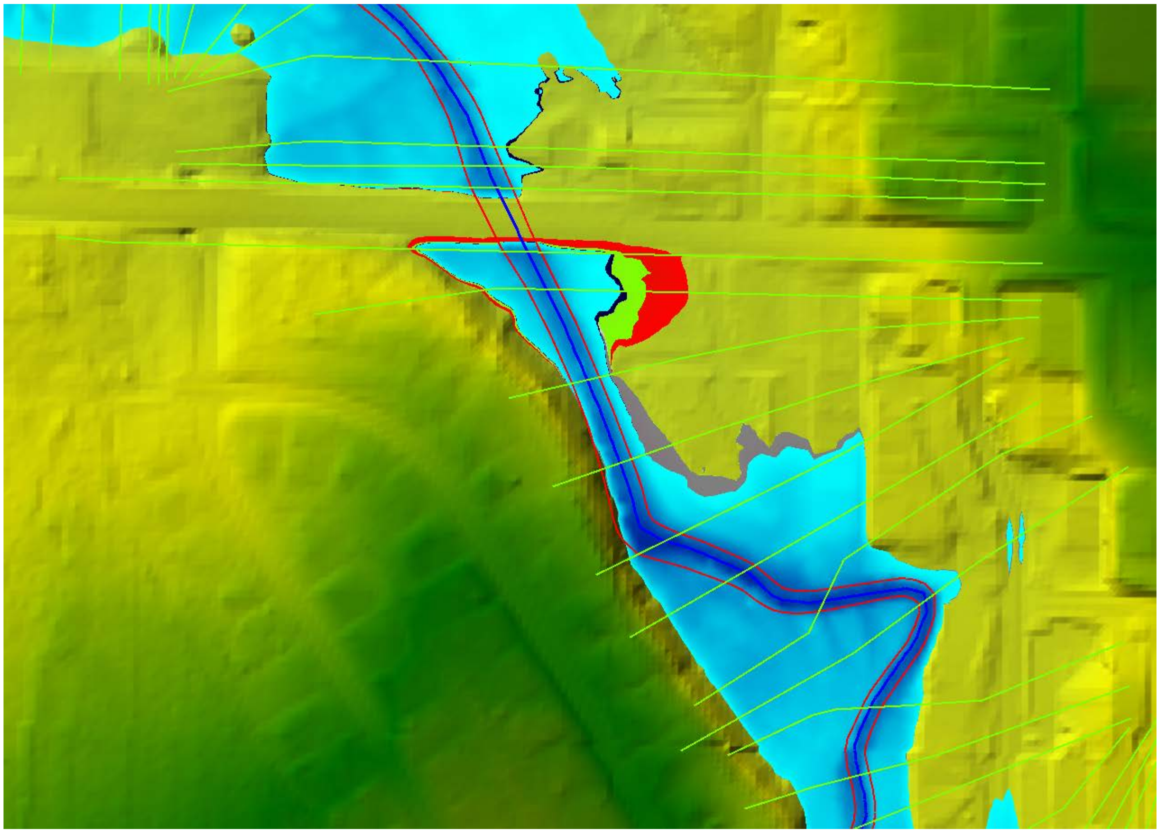

Figure 7. RAS Inundation map red (original), green (sediment in culvert), dark grey (clean culvert and channel DS), light blue (clean both upstream and downstream channel).

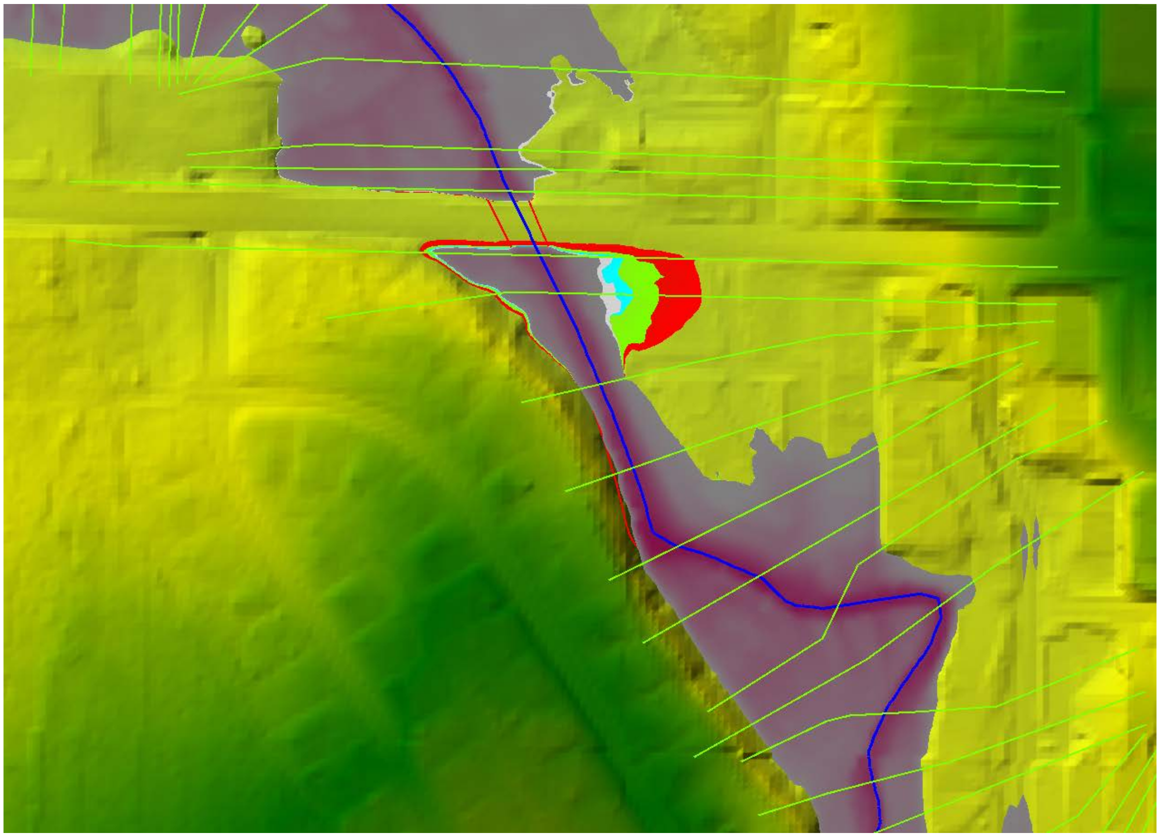

Figure 8. RAS Inundation map red (original), green (sediment in culvert), light gray (clean culvert), dark grey (clean culvert and channel DS), light blue (clean both upstream and downstream channel).

Figure 9 - Figure 12 show a profile plots for the 25 year to 500 year storms. The drop in water surface elevation ranges from 0.5 ft to 3 feet depending on the location and the scenario, whether cleaning out just the culvert or the channel and the culvert.

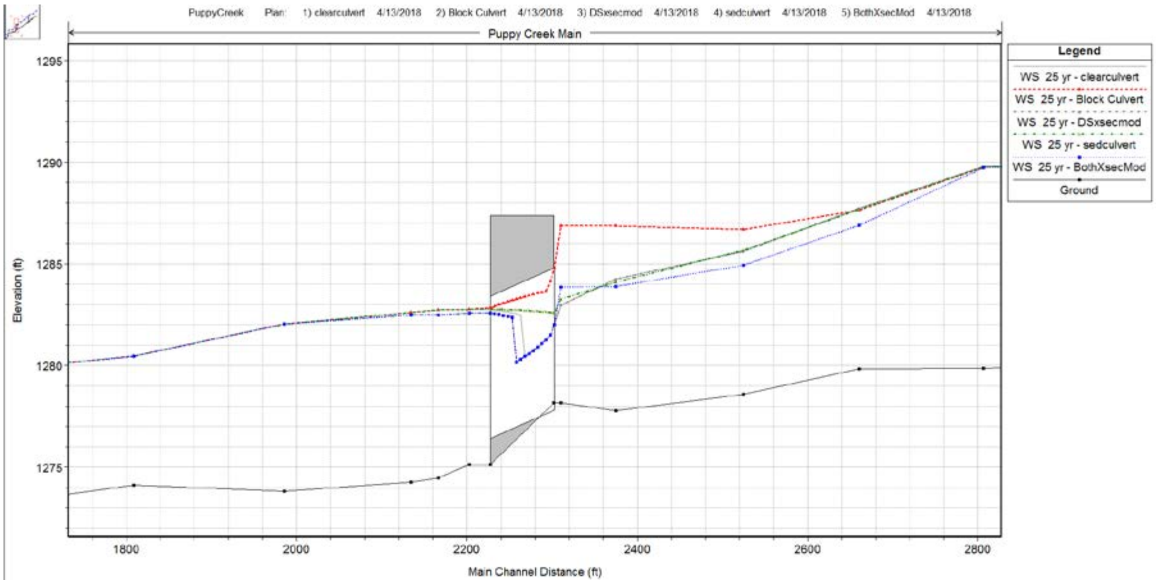

Figure 9. 25 year storm for red (original- blocked), green (sediment in culvert), light gray (clean culvert), dark grey (clean culvert and channel DS), blue (clean both upstream and downstream channel).

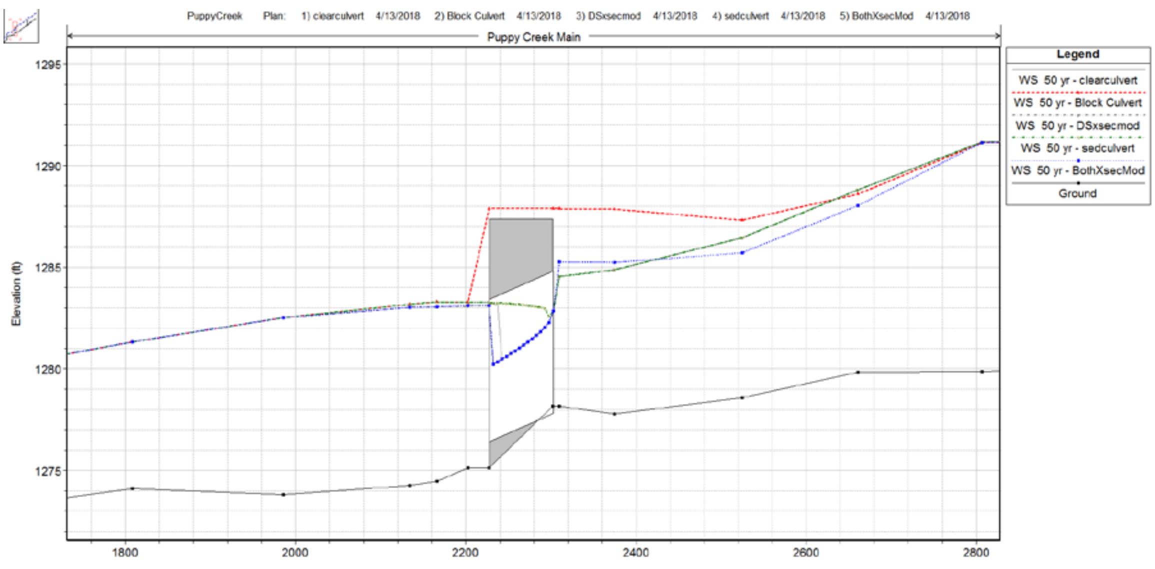

Figure 10. 50 year storm for red (original- blocked), green (sediment in culvert), light gray (clean culvert), dark grey (clean culvert and channel DS), blue (clean both upstream and downstream channel).

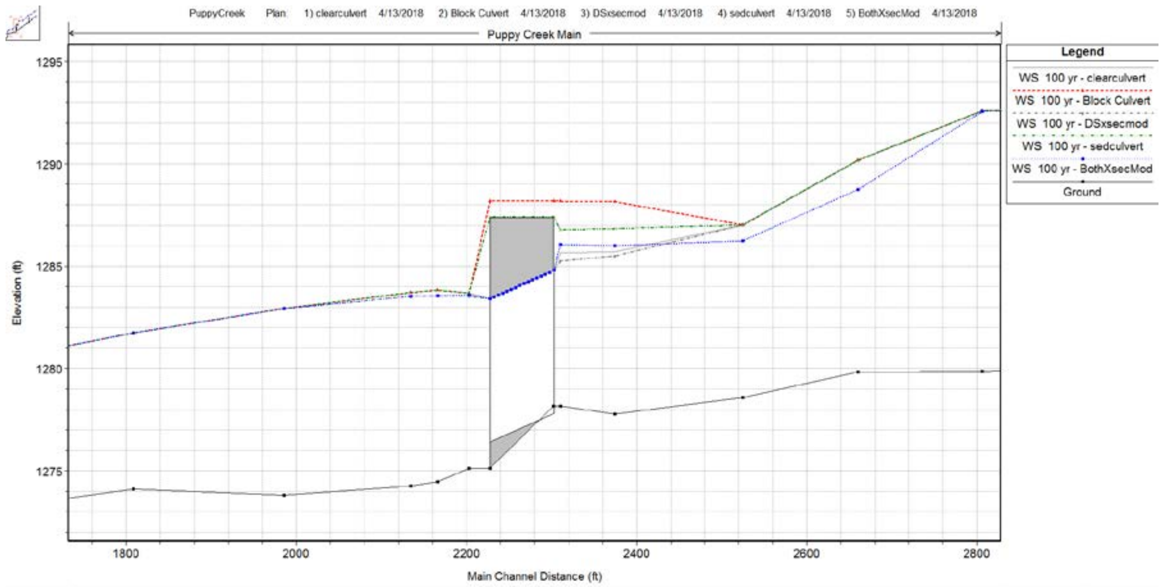

Figure 11. 100 year storm for red (original- blocked), green (sediment in culvert), light gray (clean culvert), dark grey (clean culvert and channel DS), blue (clean both upstream and downstream channel).

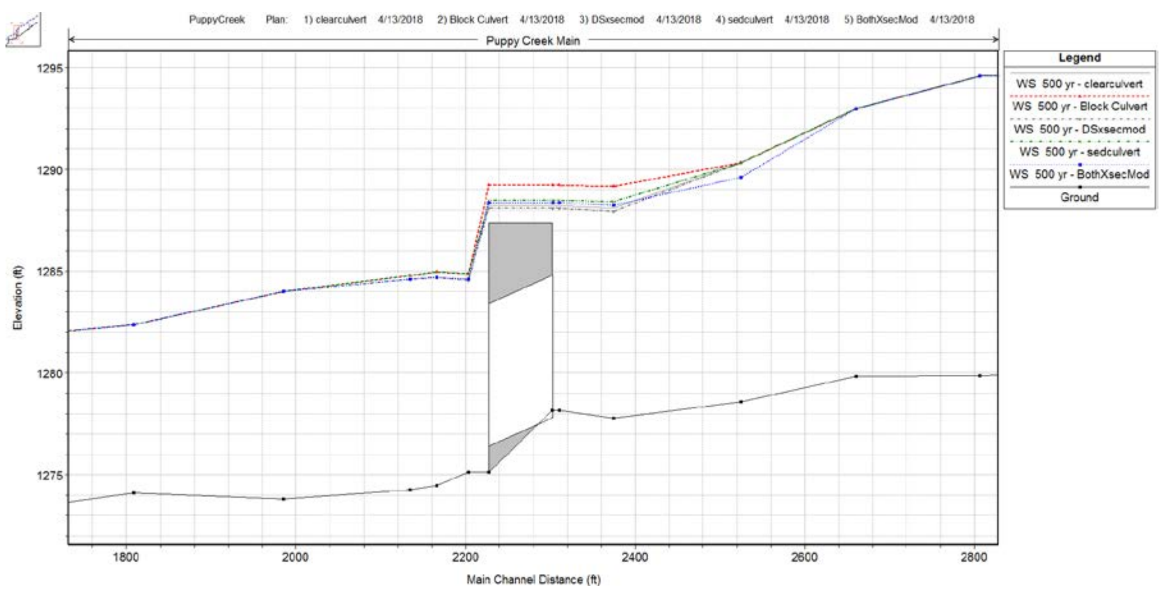

Figure 12. 500 year storm for red (original- blocked), green (sediment in culvert), light gray (clean culvert), dark grey (clean culvert and channel DS), blue (clean both upstream and downstream channel).

A significant drop in the water surface elevation near the culvert was seen with just cleaning out the culvert of the several feet of debris that has built up in it. Clearing of the channel upstream and downstream whether together or separately did show minor decreases in the water surface elevation. These were minor considering that the amount of work to modify the channel and that sediment would redeposit in the areas over time.

Conclusion

Cleaning out the culvert alone had the largest effect on decreasing the water surface elevation. If the culvert was allowed to fill with minor sediment again, the water surface elevation will be higher than a clear culvert. Cleaning out the channel both upstream and downstream will help to reduce sediment deposition in the culverts. Our recommendation is to clean out the culvert and to clean up the sediment in the channel to within 100 ft above and below the culvert to allow for a smoother transition from the stream to the culvert. If funding is limited, then cleaning out the culvert will have the largest impact on lowering the water surface elevation upstream of the culvert, but without removing the debris and gravel immediately upstream and downstream of the culvert, channel sediment will probably redeposit in the left most box culverts.