Memo

To: Steve Kirk, PE

From: Brian Bates, PE

Date: July 11, 2016
Revised July 18, 2016

Subject: Church Creek ICPR Model Evaluation– Check Valve under Winner's Circle

Introduction

Woolpert has created and maintained an Interconnected Pond Routing (ICPR) model for the Church Creek drainage basin for the City of Charleston (City) due to the flooding issues the area currently experiences. The model is updated by Woolpert when requested by the City. In addition, the City periodically requests that Woolpert explore potential solutions for drainage issues and analyze the impact on the watershed.

A drainage channel behind homes on Winner's Circle in the Hickory Farms subdivision drains under Winner's Circle and out to Church Creek. Homeowners adjacent to the channel have expressed concern that the canal remains at "flood stage" due to the stormwater runoff draining from the pond behind the adjacent Sienna neighborhood. Currently there is a block weir that controls the water surface elevation (WSE) in the channel before it exits through three (3) 36 inch reinforced concrete pipes (RCP) under Winner's Circle. The City has proposed to remove one level of block from the block wall and install in-line check valves on the three (3) RCP pipes to prevent Church Creek from backing up into the drainage channel. The reduced wall level will allow the drainage channel to drain to a lower water surface elevation (WSE) during dry conditions. The City has requested that Woolpert model and analyze this proposed project for potential impacts both upstream and downstream of this location. Figure 1: Block Wall and 36" RCP is a picture of the current wall and the three (3) 36" pipes under Winner's Circle. Figure 2: Winner's Circle Map shows the location of the block wall, relevant ICPR nodes, and the drainage channel location.

Figure 1: Block Wall and 36" RCP

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Figure 2: Winner's Circle Map

Model Integration

There are two components within ICPR to be adjusted for this project: the block wall height and the addition of the in-line check valves. Woolpert obtained a rating curve appropriate for a 36 inch check valve that represents the performance of each in-line check valve at different headwater and tailwater conditions. An operating table based on the rating curve that can be used by ICPR to determine flow rates, headwater depths, and tailwater depths due to the in-line check valve was then created. The operating table was applied to each of the three 36" pipes under Winner's Circle.

The second component is to lower the wall height. The ICPR Existing Model indicates that the block wall is currently at an elevation of 4.0 feet. Removing one level of block would drop the top elevation of the wall to approximately 3.33 feet.

The Existing Model in this memo is the most up-to-date ICPR model available (Church Creek ICPR Model Update – Logging Road dated June 28, 2016). The Existing Model was revised to include the lower wall height and in-line check valve to create the Check Valve Model. In the Existing Model, the block wall and three 36 inch pipes are combined in one link (L-B140D1). In the Check Valve Model, L-B140D1 is removed and several new links (L-B139W1, L-B140RC1, L-B140RC2, & L-B140RC3) and one new node (N-B139) were needed to represent the wall and three pipes with in-line check valves.

Model Results

Table 1: Check Valve Max Water Surface Elevations includes the results of the analysis. The lowering of the block wall

and installation of the in-line check valves had negligible effect on the max WSE both upstream and downstream of the pipes. The difference in WSE for Check Valve Model compared to the Existing Model is 0.02 feet or less for all storm events.

Table 1: Check Valve Max Water Surface Elevations

Name	Location	Storm	Existing Model Max Stage (ft)	Check Valve Max Stage (ft)	Difference Ex vs. Check Valve (ft)
N-B080	DS in Church Creek	002YR	7.01	7.00	-0.01
		010YR	8.10	8.08	-0.02
		025YR	8.50	8.48	-0.02
		050YR	8.87	8.85	-0.02
		100YR	9.29	9.28	-0.01
N-B120	Intersection of Drainage Channel & Church Creek	002YR	7.10	7.08	-0.02
		010YR	8.28	8.26	-0.02
		025YR	8.65	8.63	-0.02
		050YR	9.00	8.98	-0.02
		100YR	9.40	9.38	-0.02
N-B130	DS of 3-36" RCP	002YR	7.10	7.08	-0.02
		010YR	8.28	8.26	-0.02
		025YR	8.65	8.63	-0.02
		050YR	9.00	8.98	-0.02
		100YR	9.40	9.39	-0.01
***N-B139**	US of 3-36" RCP	002YR	-	7.14	-
		010YR	-	8.27	-
		025YR	-	8.63	-
		050YR	-	8.98	-
		100YR	-	9.38	-
N-B140	US of Headwall	002YR	7.14	7.15	0.01
		010YR	8.28	8.28	0.00
		025YR	8.65	8.65	0.00
		050YR	9.01	9.00	-0.01
		100YR	9.40	9.41	0.01
N-B150	US end of Drainage Channel	002YR	7.14	7.15	0.01
		010YR	8.28	8.28	0.00
		025YR	8.65	8.65	0.00
		050YR	9.01	9.00	-0.01
		100YR	9.40	9.41	0.01
N-B160	US in Church Creek	002YR	7.26	7.24	-0.02
		010YR	8.67	8.67	0.00
		025YR	8.98	8.98	0.00
		050YR	9.29	9.28	-0.01
		100YR	9.65	9.64	-0.01

*N-B139 was not in the Existing Model. It was added to incorporate the check valves.

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The water surface elevations at the upstream and downstream nodes (N-B140 & N-B130) respectively for the Existing Model and the Check Valve Model at the 36 inch pipes is shown in Figure 3: 2-Year Check Valve Water Surface Elevations. The graph only shows the peak of the hydrograph so the minor differences in the water surface elevation are easier to distinguish. Node N-B140 for the Check Valve Model is peaking slightly later and slightly higher than the downstream end of the pipe and the upstream and downstream pipe ends in the Existing Model.

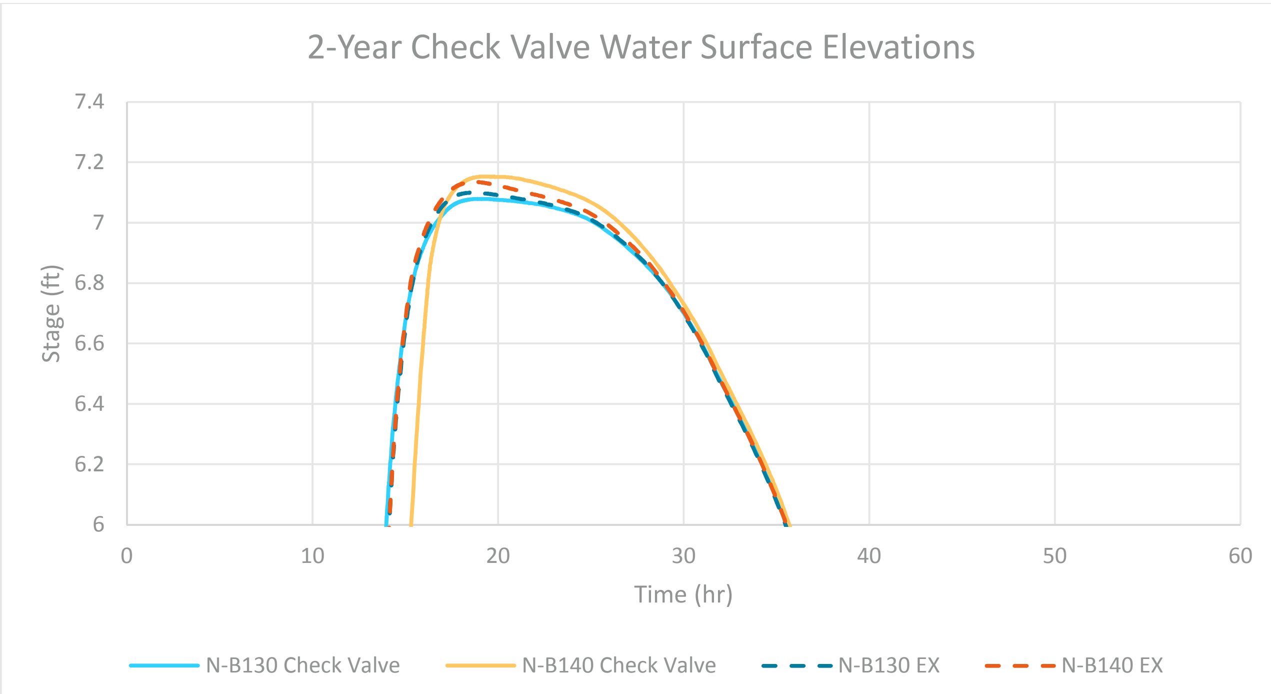

Figure 3: 2-Year Check Valve Water Surface Elevations

The gap between the hydrographs at an approximate time of 15 hours for the Check Valve at N-B140 compared to the other hydrographs is due to the in-line check valve eliminating reverse flow through the pipes. In the Existing Model, water is allowed to flow through the pipes in both directions and equalize the upstream and downstream water surface elevations. In the Check Valve Model, the in-line check valve no longer allows backflow so the upstream side of the pipes take longer to fill up. Once the upstream side is slightly higher than the downstream side, the in-line check valve opens and allows water to start flowing downstream.

Figure 4: 10-Year Check Valve Water Surface Elevations and Figure 5: 25-Year Check Valve Water Surface Elevations show similar results for the 10- and 25-year storm events.

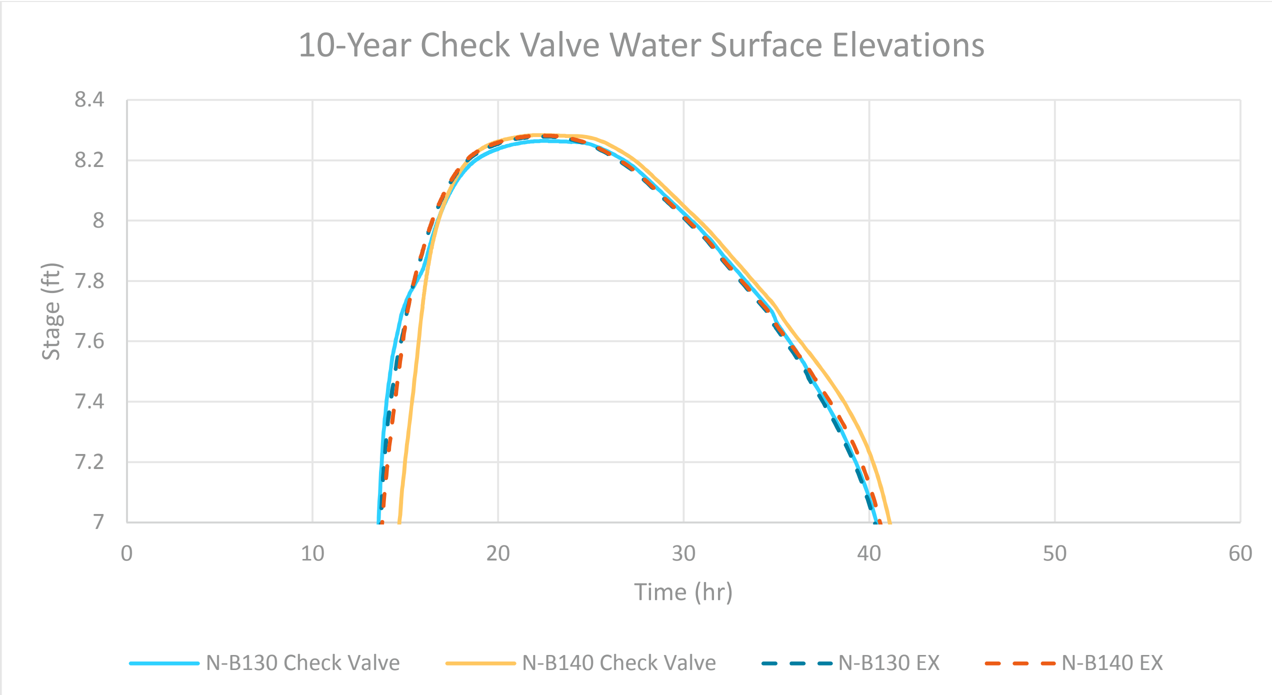

Figure 4: 10-Year Check Valve Water Surface Elevations

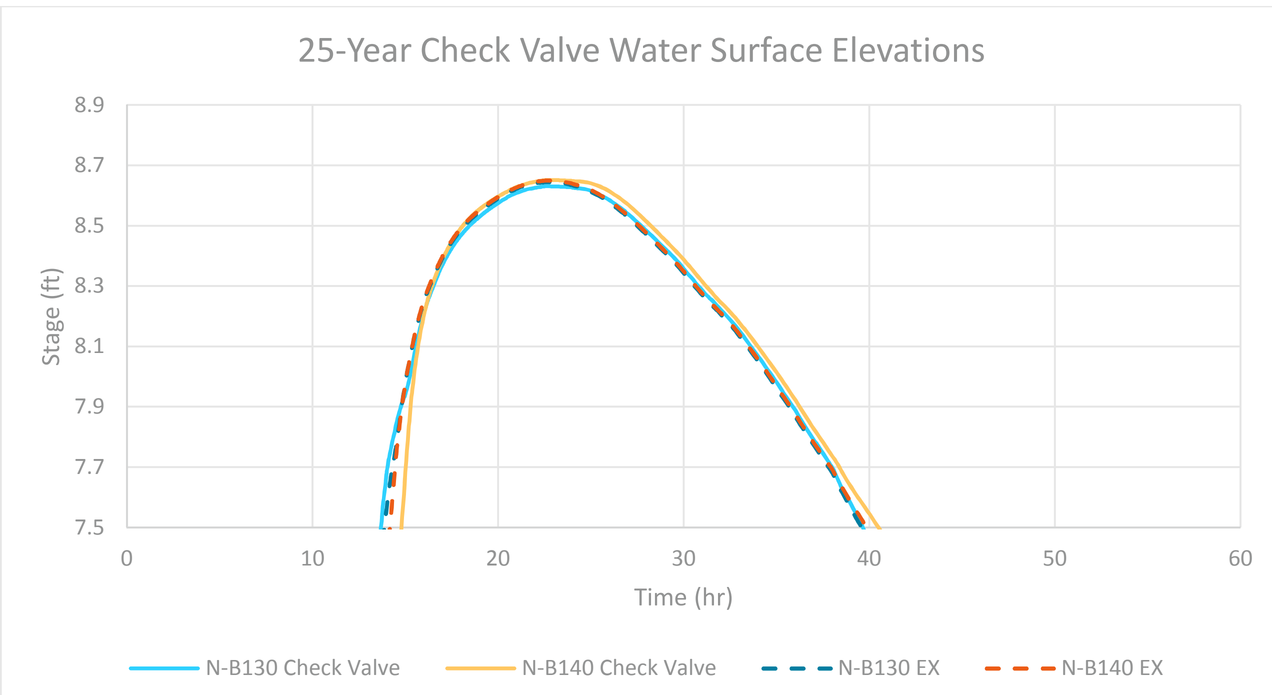

Figure 5: 25-Year Check Valve Water Surface Elevations

Conclusion

The benefits of lowering the block wall and installing the in-line check valves include lowering the drainage channel by approximately 8 inches during dry conditions and preventing water from daily tidal cycles and small storm events from backing up into the drainage channel behind the homes along Winner's Circle. Lowering the top of the wall elevation and installing in-line check valves will not worsen peak flooding or decrease the peak WSE during the 2-year and greater storm events either upstream or downstream of this location. However, Winner's Circle currently overtops during the 10-year storm event and all larger storm events. The in-line check valves will not prevent water from overtopping the road and impacting the drainage channel and adjacent yards in large storm events just as it does now.