

## ADDENDUM 1: Front Street and Whitehead Intersection Stormwater Infrastructure

TO: City of Key West

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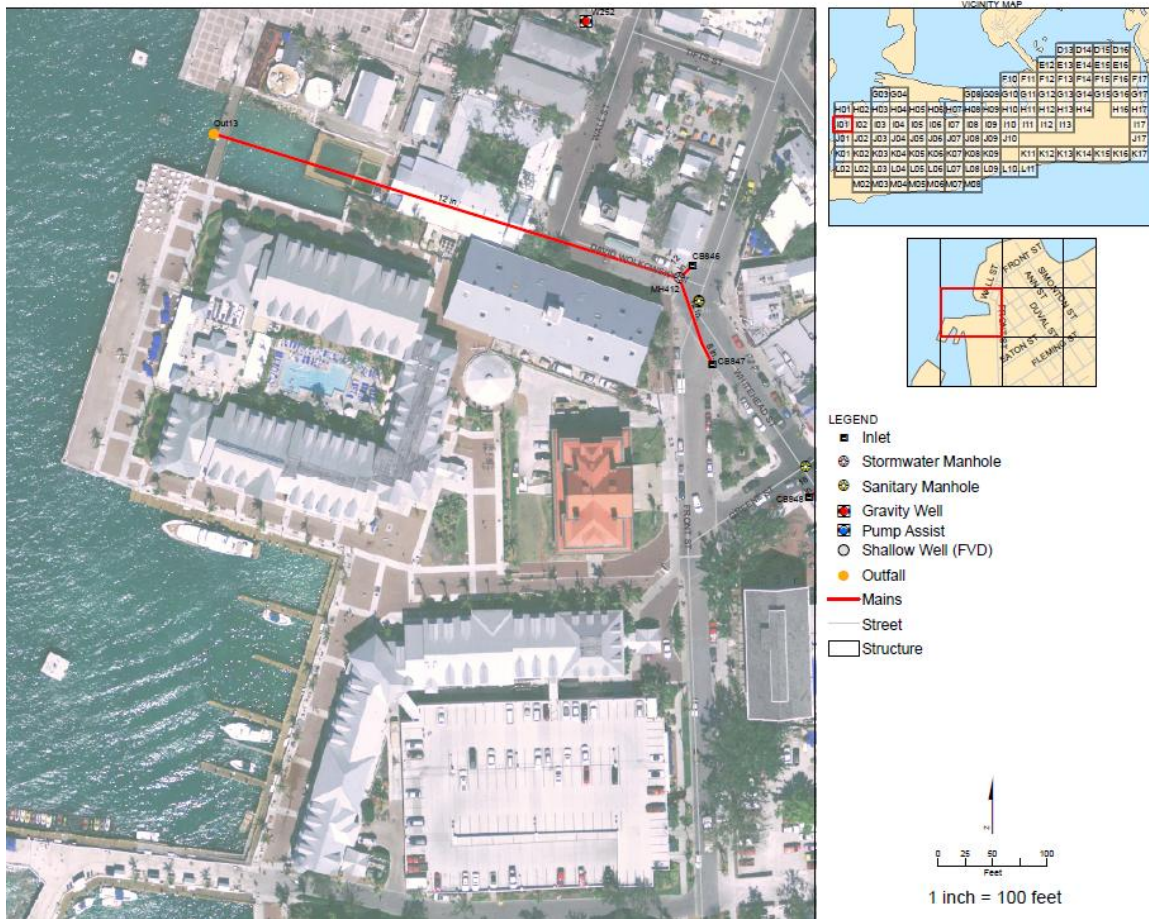
In 2008, the City requested that CH2M HILL evaluate the replacement of a small outfall that leads from the corner of Front Street and Whitehead Street intersection, under the Key West Aquarium, to discharge out of the boat basin. The 2008 evaluation was for the preliminary sizing of a replacement outfall. The recommendation was for a 24-inch plastic pipe (likely PVC) to be routed between buildings to the Mallory Square seawall. It would be difficult to work a pipe between some of the historic buildings there. In 2010, the City rebuilt the seawall on Mallory Square and installed a steel sleeve penetration to accommodate a future pipe outfall, but the remainder of the pipeline was not installed (just a short piece of 36-inch, inner diameter, steel pipe). A 24-inch PVC pipe could be inserted in the sleeve and grouted in place in the future. This pipe penetration was located closer to the parking lot serving Mallory Square (further north of the aquarium). The 2012 Stormwater Master Plan (SWMP) did not look at adjusting the existing pipe or replacing it with a 24-inch pipe because the status of the existing pipe was uncertain.

The City has requested an evaluation to compare the results of the proposed new 24-inch pipe to existing conditions estimated in the 2012 SWMP. A new outfall would need to tie back to the low spot near Front and Whitehead Streets intersection as this is the lowest spot. The existing outfall is shown in Figure 1. The short block between Front Street and Wall Street has the small outfall pipe which extends under the aquarium to the Gulf. Stormwater stages up and overtops Wall Street and then overflows between the buildings to the Gulf when very large storms occur. The topographic maps of the area are not detailed enough to discern flow paths between buildings, but this intersection was allowed to stage up in the 2012 SWMP computer model and overtop to the Gulf at elevation 1.8 (NAVD88). Existing gravity wells located on Mallory Square may also accept some of the overflow before running off at breaks in the seawall, but Mallory Square is about at elevation 2.6 NAVD88. In general, the waterfront is adequately drained, but the busy retail area along Wall and Front Streets near Mallory Square needs the outfall.

At Front Street and Whitehead, there is moderate predicted flooding (3 to 6 inches standing water in the streets) for the 10-year storm, but more during the larger storms. The SWMP assumes that the existing pipe is working as designed, but a 12-inch pipe has small capacity (a couple of cubic feet per second). The City operators have reported that this line has a lot of sand in it when cleaned which indicates that it is compromised. Because this existing pipe is small, and is under a historic building and a portion of the aquarium shark tank, the pipe is recommended to be abandoned and to install the new outfall at the seawall. If the existing

outfall pipe becomes fully clogged or collapsed, then standing water would have to top the curb and flow across Mallory Square which would likely cause deeper flooding in the streets.

**FIGURE 1**  
Front and Whitehead Streets Intersection and Existing Outfall



### Proposed New System

The inlets at the Front Street intersection are non-standard and need to be evaluated and most likely will be replaced. A new outfall pipe system would need to start at the Front Street intersection, replace all of the stormwater pipes and inlets in this area, go up David Wolkowsky Street to Wall Street and then northward to the Mallory Square parking lot at Exchange Street. (An alternative route could be directly along Front Street before turning.) Along the street route, additional intersections (Tifts and Wolfson Sts.) could be rebuilt with inlets. The pipeline would then turn and go directly to the seawall along the western edge of the parking lot (Figure 2). The parking lot and Mallory Square is currently served by gravity recharge drainage wells, which would not be tied to the new pipe. At the far right edge of Figure 1, at Greene and Whitehead Streets, there is an existing gravity well that serves the

area just south of the triangular park at the intersection. This intersection was also evaluated here as it could overflow into the subject intersection.

**FIGURE 2**  
Mallory Square Parking Lot Area Existing Infrastructure  
(Adjacent to and North of Figure 1)



The proposed new system is schematically shown in Figure 3. Considering the age and difficulty in dealing with the traffic, utilities, and pedestrian issues (like Americans with Disability Act requirements), it is expected that most of the existing stormwater infrastructure at the Front and Whitehead Streets intersection would be replaced. Since a new pipeline would be routed down Wall Street a couple of inlets should be installed to serve this street, pending detailed survey data. If Front Street was selected as the primary northeast route, then the cost would be similar, on a conceptual level; but without the brick pavers, it may be an easier build.

**FIGURE 3**  
Conceptual Route of the Proposed Replacement Outfall



### ICPR Modeling Results

The 2012 SWMP simulated the corner at Front and Whitehead as node 2000 (N2000) in the model. The next block upstream (Greene and Whitehead, node 2010 [N2010]) can overflow and drain into N2000 through the street (about 180 feet away). The elevations are low in this area and the existing gravity recharge well at N2010 does not have much capacity. Therefore, the 2012 SWMP suggested adding a second gravity well in the block to the south. While the capacity was still low because of the low elevations and pressure heads, the second well reduced the peak elevation of the design storms enough to warrant recommending another well in the vicinity.

Table 1 lists the peak stormwater stages (elevations in NAVD88 datum), from the SWMP and new simulation. The threshold for recommending projects was more than a 0.2 feet reduction in peak elevations during the 10 year, 24-hour design storm.

**TABLE 1**

ICPR Modeling Results of Peak Elevations During Design Storms

*(Reference: 2012 SWMP for all but New Outfall Column)*

<b>Intersection</b>	<b>Node</b>	<b>Design Storm</b>	<b>Existing</b>	<b>Existing</b>	<b>Alternative 2</b>	<b>New Outfall</b>	<b>Difference in Peak</b>
<b>Front and Whitehead</b>	Infrastructure =>		12-inch outfall	Plugged outfall, no overtopping seawall	12-inch outfall	24-inch Outfall only	New Outfall vs. Existing w/ outfall
	N2000	5yr-24hr	1.88	2.31	1.82	1.36	0.52
		10yr-24hr	1.94	2.36	1.84	1.60	0.34
		25yr-72hr	2.06	2.47	1.92	1.76	0.30
		100yr-72hr	2.20	2.61	2.05	1.93	0.27
<b>Greene and Whitehead</b>	Infrastructure =>		Existing well only	Existing well only	1 more well	1 more well	
	N2010	5yr-24hr	2.32	2.36	1.79	1.79	0.53
		10yr-24hr	2.36	2.41	1.86	1.86	0.50
		25yr-72hr	2.45	2.53	2.07	2.07	0.38
		100yr-72hr	2.57	2.69	2.33	2.33	0.24

The street intersection at Front and Whitehead is at about elevation 1.72 NAVD88 and the elevation of the intersection at Greene and Whitehead is about 2.32 NAVD88. From Table 1, one can see that the peak elevations at Greene are only a little above the intersection in the existing conditions and are reduced with an additional well, so no affect at N2010 related to the new outfall is estimated. However, there is a significant change (0.34 feet reduction) at N2000 during the 10-year storm, assuming that the outfall is working or not. The new outfall will keep the peak elevation of smaller storms out of the street.

## **Recommendations**

Given the high pedestrian traffic and retail in the area, in general, and the need to serve this complex intersection around Front, Greene and Whitehead Streets, the new outfall replacement (N2000) is recommended as a higher priority than the new gravity well at N2010. The existing well almost serves the N2010 subbasin, but an additional well is still recommended to serve the block of Whitehead Street south of Greene Street for design storms in excess of the 5-year storm.

### **Opinion of Total Project Capital Cost**

The outfall replacement would require about 900 feet of 24-inch pipe, 5 manholes, about 3 inlets in addition to rebuilding the intersection at Front and Whitehead. A water quality control box should be installed prior to the outfall to trap trash. This project would cost between \$358,000 and \$558,600 using the SWMP 2011 cost data. Given the proximity to the Gulf and heavy traffic, the total project cost would likely be toward the high side of this range.

Depending on the local conditions, a gravity well project costs between \$265,000 and \$385,000 if one includes replacing the whole intersection. . A single well in a baffle box, with 1 inlet, will be about \$121,000 to \$205,000. Given the high traffic along Whitehead, a mid-range value should be considered here.