City of St. Joseph, Missouri

Facilities Plan

Technical Memorandum No. TM-CSO-4

Main Interceptor Hydraulics and Basement Backup Review

By

Work Order No. 09-001
B&V Project 163509

July 27, 2009

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Main Interceptor Hydraulics and Basement Backup Review

1.0 Executive Summary

The combined sewer system (CSS) model indicated that if 88 million gallons per day (mgd) of flow were treated during a wet weather event (80 mgd from the Whitehead Pump Station and 8 mgd from the In-plant Influent Pump Station), along with implementation of the other Phase IA separation improvements, an annual volumetric percent capture of approximately 60 percent could be achieved. The Phase IA improvements and associated 60 percent capture are therefore predicated on the ability of the CSS to deliver 80 mgd to the Whitehead Pump Station. The purpose of this technical memorandum (TM) is to confirm that the Main (Blacksnake) and Whitehead Interceptors can convey 80 mgd to the Whitehead Pump Station. In addition to analyzing the hydraulic capacity of the interceptors, a review of basement backup reports within the City of St. Joseph, Missouri (City) was conducted to determine if surcharge conditions within the interceptors may be causing the backups.

The CSS model results indicate that the Main and Whitehead Interceptors can convey 80 mgd to the Whitehead Pump Station. A pipeline conditions assessment should be conducted for the Main Interceptor, Whitehead Interceptor, and both force mains from the Whitehead Pump Station to determine if the pipelines are in need of rehabilitation or repairs for conditions which may inhibit the conveyance of 80 mgd. Hydraulic gradeline (HGL) profiles are provided in this technical memorandum showing the maximum water surface elevation within both interceptors for the typical year design events. In addition, basement backup reports were evaluated to determine if surcharging within the interceptors is causing basement backups. The data reviewed indicate that surcharging of the Main and Whitehead Interceptors does not appear to be causing basement backups within the CSS service area of the City.

2.0 Purpose of Technical Memorandum

The purpose of this technical memorandum is to confirm that the Main Interceptor and Whitehead Interceptor can convey 80 mgd to the Whitehead Pump

Station. Also, a review of basement backup reports within the City was conducted to determine if surcharge conditions within the interceptors may be causing basement backups.

3.0 Introduction

The City is developing a Facilities Plan for CSO control improvements that will be required by the United States Environmental Protection Agency (USEPA) and the Missouri Department of Natural Resources (MDNR) as part of the existing Long Term Control Plan (LTCP). As part of the CSS evaluation for the LTCP, Black & Veatch developed a hydrologic and hydraulic model of the CSS. The model was used for evaluating potential improvements to reduce the volume of CSOs from the CSS. The model encompasses the area of the City that is serviced by combined sewers, which is approximately the western half of the City.

In TM-CSO-3a – Phase IA CSO Control Recommended Improvements Model, Phase IA improvements were shown to provide an approximately 60 percent volumetric reduction in CSOs during wet weather events. A key component in being able to achieve the volumetric reduction is increasing the treatment capacity at the Water Protection Facility (WPF). To achieve an influent flow of 88 mgd at the WPF (80 mgd from the Whitehead Pump Station and 8 mgd from the In-plant Influent Pump Station), the existing interceptors delivering flow to the Whitehead Pump Station will need to be able to convey 80 mgd. There are two interceptors that deliver flows from areas north and east of the Whitehead Pump Station. The interceptors combine in a junction box directly adjacent to the pump station and flow through a common interceptor to the pump station wetwell. In this technical memorandum, the Main Interceptor is considered to be the interceptor extending from the Blacksnake Diversion Structure to the Whitehead Pump Station while the Whitehead Interceptor extends from the Whitehead Diversion Structure to the junction with the Main Interceptor. An overview of the interceptors is shown in Figure 1.

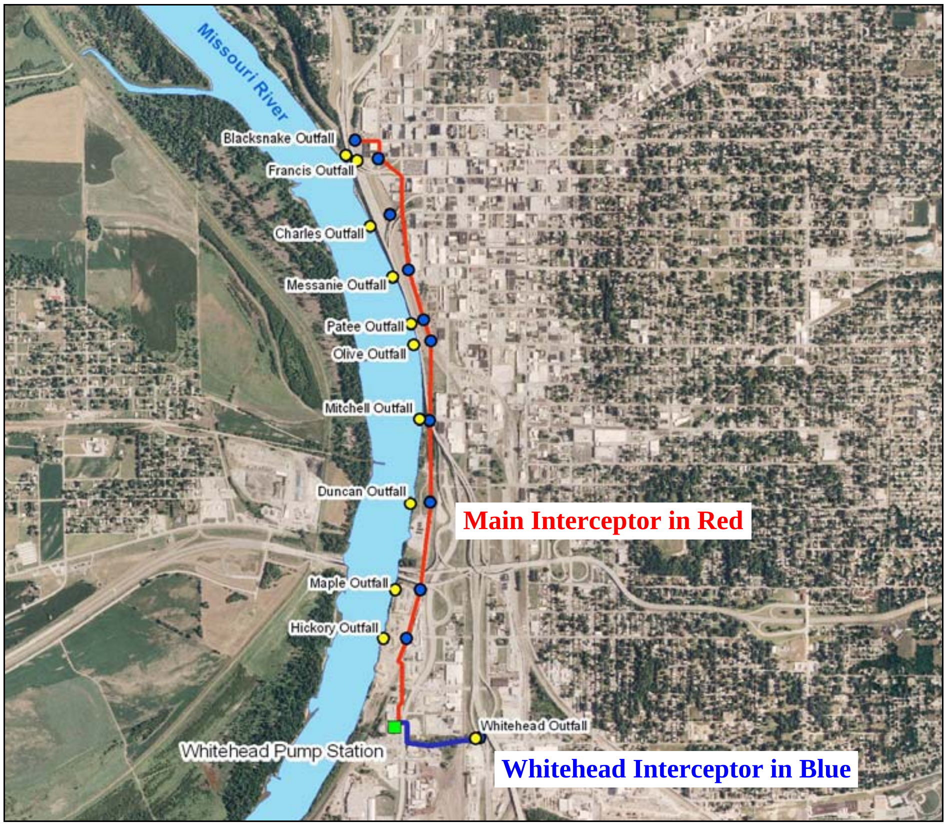

Figure 1 – Plan View of Main Interceptor and Whitehead Interceptor

This technical memorandum provides the hydraulics evaluation results of the interceptors. In addition, a review of basement backup reports was conducted to determine if interceptor surcharging appears to be responsible for any sewer backups into private residences.

4.0 Interceptor Hydraulics Evaluation

Currently, the Whitehead Pump Station conveys up to 27 mgd (when no flow is received from the In-plant Influent Pump Station) to the WPF during wet weather events. However, more flow can be conveyed by the interceptors than the pump station can convey, so sluice gates at the interceptor junction box (located near the Whitehead Pump Station) and at the Whitehead Diversion Structure are closed to reduce the flow and protect the pump station. To increase the volumetric capture of CSOs, the Phase IA improvements require 80 mgd to be conveyed by the interceptors to the Whitehead Pump Station.

Using the Phase IA CSS model, an evaluation of the results related to the Main and Whitehead Interceptors was conducted. The record drawings for both interceptors were reviewed and small adjustments were made to the model pipe length segments to better approximate the specific hydraulic characteristics of the interceptors. Additionally, energy losses were included at bends and flow transitions to more closely represent the losses and corresponding hydraulic gradeline through the interceptors. As described in both TM-CSO-2 – CSS Model Calibration and Existing Conditions and TM-CSO-3a, for CSS modeling, the typical year is approximated by eight design storms. For each design storm, the CSS model was evaluated to determine if 80 mgd could be conveyed by the interceptors.

For each design storm, the CSS model confirmed that 80 mgd could be conveyed through the interceptors. For the small Design Events, A and B, there is less than 2 hours during those events where 80 mgd is pumped (1 hour and 1.5 hours, respectively). As the storms get larger, the hydraulic gradeline elevation increased and the time that the Whitehead Pump Station would continually pump 80 mgd increased. For Design Event H, 80 mgd is pumped for approximately 13 hours.

There are storm events that occur during a typical year that are smaller than Design Event A. Although it is not critical from a volumetric capture standpoint that a peak flow of 80 mgd is conveyed during these small storms before CSOs occur, it is desirable. Therefore, hydraulic bottlenecks along the interceptor that increase the hydraulic gradeline but can be easily mitigated were investigated. Specifically, one bottleneck location was identified. This location occurs where the 54 inch Main Interceptor joins with the 48 inch Whitehead Interceptor at a junction box. Downstream of this junction box, a 54 inch combined interceptor conveys the Main and Whitehead Interceptor flows to the Whitehead Pump Station. Upon review of the pipe diameters, the conveyance area of the upstream interceptors was not maintained in the downstream interceptor. As part of TM-CSO-9 – Whitehead Pump Station Improvements, a solution for this bottleneck will be recommended. Improvements at this location will reduce the hydraulic gradeline in the interceptor and thus maximize the amount of flow conveyed to the pump station before CSOs occur.

Figures 2 and 3 show the maximum hydraulic gradeline that occurs in the Main and Whitehead Interceptors respectively for each typical year design storm. The interceptor bottleneck improvement, presented previously, is not reflected in the hydraulic gradeline in the figures.

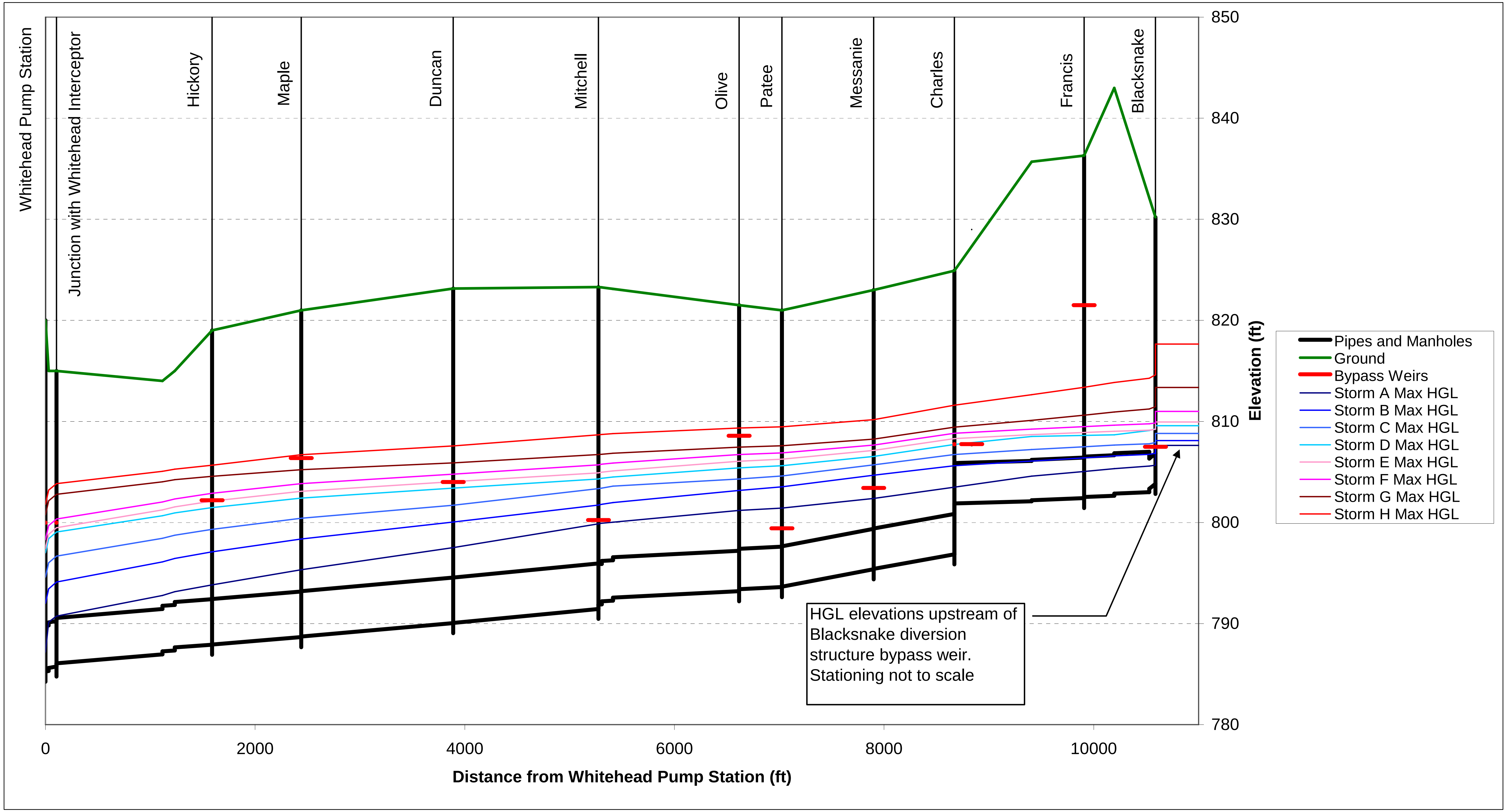

Figure 2 – Main Interceptor Profile for Typical Year Design Events after Phase IA Improvements

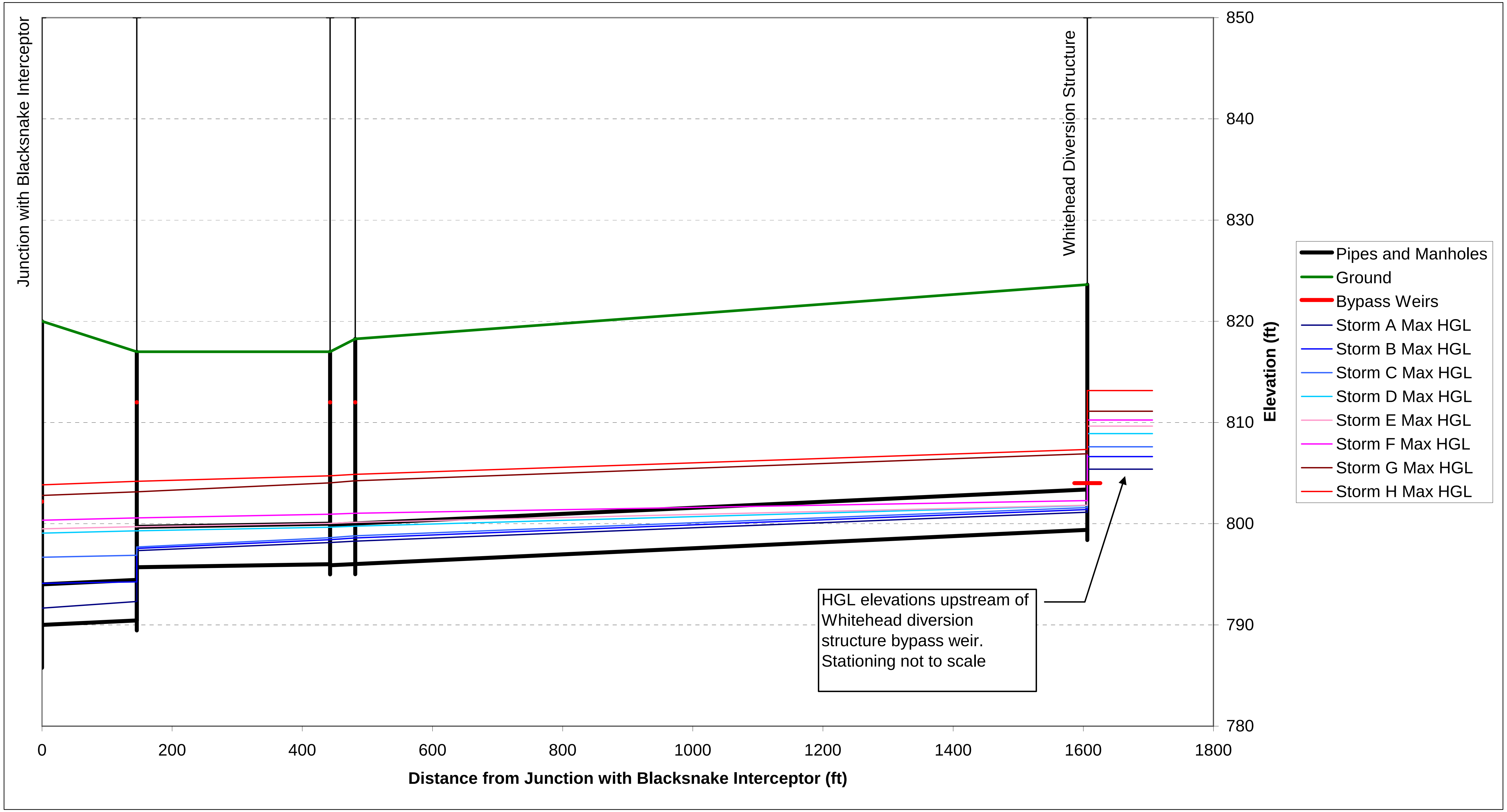

Figure 3 – Whitehead Interceptor Profile for Typical Year Design Events after Phase IA Improvements

5.0 Basement Backup Evaluation

Many CSSs have problems during wet weather events with combined sewage backing up in the collection system and entering private residences through floor drains and other direct connections. When this occurs, it is termed a basement backup. The cause of basement backups is highly variable. It can be caused by obstructions in the downstream sewer, such as tree root intrusion into the sewer lines; a temporary clogging of a private residence connection to the City-owned sewer system; or in some cases, the CSS does not have adequate capacity to convey the peak flows. The first two cases are maintenance issues that can be handled by the City’s sewer maintenance department, but do not require costly sewer replacement in most cases. However, an undersized sewer system which causes sewer backups can require significant and expensive sewer replacement programs if widespread throughout a community.

The intent of this technical memorandum was not to provide a detailed evaluation of all the basement backup problems within the City, but rather to evaluate recent reports of sewer backups to see if any appear to be caused by surcharging near the Main Interceptor or the Whitehead Interceptor. If there are many problems near the interceptors, then diversion structure modifications that involve raising overflow weirs should be eliminated from further consideration.

To perform the evaluation, City staff provided basement backup reports that had been collected between March 2007 and April 2009. The data indicated that there had been 70 basement backup reports in that time frame. Of these 70 reports, there were 65 unique addresses. Only five properties had reported two basement backups within this time frame. From the addresses provided in the reports, each basement backup report was geocoded (i.e., the process of locating an address geographically). A map of the 65 locations reporting a basement backup issue is presented in Figure 4.

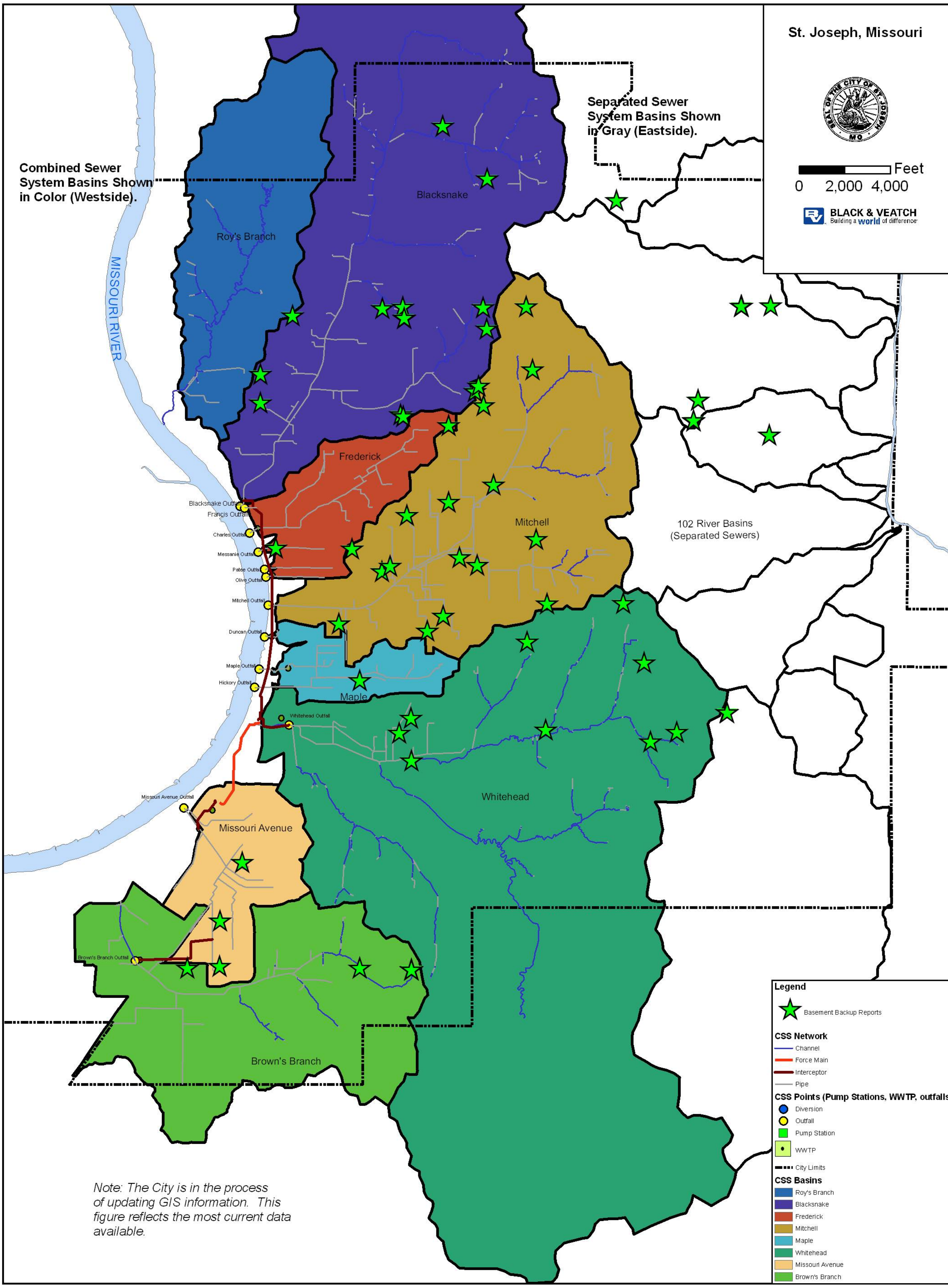

Figure 4 – Located Basement Backups Occurring Between March 2007 and April 2009

Most of the basement backups are located in the upper portions (i.e., along the collector sewers) of the sewer system and not along the main interceptors. Only one location appears to be close to the Main Interceptor, but if a system has significant capacity limitations, it would be unusual to have only one report. Having only one report indicates that there is not a major and reoccurring basement backup problem along the Main Interceptor. Based on the information provided, it does not appear that the surcharge conditions within the Main Interceptor are causing basement backups issues in the combined sewer system.

6.0 Conclusions and Recommendations

From the modeling conducted for the proposed Phase IA CSO improvements, it appears that the combination of the existing Main and Whitehead Interceptors can convey 80 mgd to the Whitehead Pump Station. A pipeline conditions assessment should be conducted for the Main Interceptor, Whitehead Interceptor, and both force mains from the Whitehead Pump Station to determine if the pipelines are in need of rehabilitation or repairs for conditions which may inhibit the conveyance of 80 mgd.

Although the CSS modeling does not indicate that modifications to the existing diversion structures are needed to convey 80 mgd, adding more conveyance area at the dry weather flow openings (i.e., increasing the diameter of the orifices) could help supply 80 mgd to the Whitehead Pump Station if a rain storm is not constant over the watershed. The model simulates design storms that occur over the entire watershed so the 80 mgd flow to the pump station comes from all of the upstream diversion structures. All basins are contributing flow with the distribution dependent on the hydraulic conditions within the interceptor and diversion structures, which change during the course of the storm. If a storm occurs only in the Blacksnake Basin, the flow into the interceptor may not reach 80 mgd even though the flow to the Blacksnake Diversion Structure is well above 80 mgd. The reason would be that the head required to get 80 mgd from the Blacksnake Diversion Structure cannot be achieved with the current configuration. Increasing the size of the orifices will allow more flow into the interceptor if the interceptor is not at capacity. Whether to add conveyance area will be considered in TM-CSO-8 – Diversion Structure Modifications.

From the review of the basement backup data, it does not appear that surcharging within the Main and Whitehead Interceptors is causing basement backups within the CSS service area of the City.