South Henderson Combined Sewer Overflow (CSO) Reduction Project

Initial Estimation of CSO Control Volumes For Henderson/Genesee Basins

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HDR

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1.0 Executive Summary

Purpose and Overview

The Washington State Department of Ecology (Ecology) administers the City of Seattle (City) National Pollutant Discharge Elimination System (NPDES) permit for combined sewer overflow (CSO) outfalls. The City is required to abide by a compliance schedule designed to achieve the greatest reasonable reduction of CSOs at the earliest possible date. The City's goal is to reduce CSOs to the Washington State Regulation, which is averaging one untreated CSO per year per outfall, by 2020. Two combined sewer basins that require CSO reduction to meet the current regulation are the Genesee and Henderson Basins.

This study focuses on four key elements as defined below.

- <u>CSO control volume</u>: CSO control volume refers to the quantity of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that the overall CSO frequency is reduced to one overflow per year per outfall. The volume of storage or additional conveyance capacity required to achieve compliance (one overflow per year per outfall) may be significantly higher than the control volume itself due to hydraulic limitations and other factors identified during the subsequent phases of the CSO reduction project.
- <u>Reported CSO Control Volume</u>: CSO control volume that was documented in the Combined Sewer Overflow Reduction Plan Amendment, December 2001 (CSO Plan) for each NPDES outfall.
- <u>Estimated CSO Volume</u>: CSO volume that was estimated with the assumptions described in this study for each overflow structure and CSO event.
- <u>Initial CSO Control Volume</u>: CSO control volume that was calculated based on the Estimated CSO Volumes for each NPDES outfall.

The purpose of this technical study is to evaluate existing data and provide estimates of the Initial CSO Control Volumes required to achieve an average of one untreated CSO per year at both the Henderson and Genesee Basins NPDES outfalls.

Existing Monitoring Data

Geotivity, Inc. (Geotivity) was the flow monitoring contractor for Seattle Public Utilities (SPU) from 1998 to 2006 and reported CSO volumes to SPU monthly for each NPDES outfall. ADS Environmental Services (ADS) became the flow monitoring contractor in 2007. ADS monitoring data and CSO volumes were reviewed from the 12/3/07 storm to determine whether or not the Estimated CSO Volumes appeared reasonable[1].

Flow monitoring began for NPDES overflow structures in the Genesee and Henderson Basins in approximately 2000 – 2001 (start dates vary according to overflow structure). Thus, Geotivity monitoring data from 2000/2001 through 2006 was available for review and evaluation to calculate Estimated CSO Volumes and Initial CSO Control Volumes per outfall. Geotivity monitoring data used in this study is provided in Attachment 1.

[1] The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of an outfall

Methodology

The methodology used to estimate the Initial CSO Control Volumes is briefly described in this section. Geotivity monitoring data from each overflow structure (located in the Genesee and Henderson Basins) was reviewed for each reported CSO event between 2000 and 2006. The overflow structures and monitoring data were evaluated to estimate CSO volumes for the 10 largest reported CSO events per overflow structure. The Estimated CSO Volumes were then ranked (from largest to smallest CSO volume) for each NPDES outfall, and an Initial CSO Control Volume was estimated. A confidence rating between 0 and 5 (lowest to highest) was assigned to each Initial CSO Control Volume to provide a degree of confidence that the Initial CSO Control Volume would adequately reduce the untreated CSO events to an average of one event per outfall per year.

The CSO Plan was then reviewed to document the Reported CSO Control Volumes and compare to the Initial CSO Control Volumes for each NPDES outfall.

Genesee Basin - Findings

The Genesee Basin consists of seven NPDES outfalls. These four NPDES outfalls' Initial CSO Control Volumes received confidence ratings between 1 and 2. The methodologies used to estimate the Initial CSO Control Volumes are listed below for each NPDES outfall in Table 1.

Table 1. Methodology for Estimated CSO Volumes – Genesee Basin

Outfall	Estimated CSO Volume Methodology
NPDES #40	Broad-crested weir Double-sided weir
NPDES #41	Outlet-controlled (submerged) broad-crested weir with restrictive capacity in outfall pipe
NPDES #42	Broad-crested weir
NPDES #43	Broad-crested weir

Initial CSO Control Volumes were not estimated for two NPDES outfalls (NPDES #38 and #165). A control volume for NPDES #38 outfall was not estimated because less than one year of monitoring data was available for evaluation — the overflow structure was renovated and CSO Basin 39 flows were redirected to the NPDES #38 outfall in early 2006. A control volume for NPDES #165 outfall was not estimated because assumptions used to estimate CSO volumes could not be determined for 6 of the largest 10 reported CSO events.

One outfall (NPDES #37) is currently in compliance, with only one reported CSO to Ecology from March 2000 through December 2006; thus, a CSO control volume is not required for CSO Basin 37.

Henderson Basin – Findings

The Henderson Basin consists of seven outfalls. These four NPDES outfalls' Initial CSO Control Volumes received confidence ratings between 2 and 3. The methodologies used to estimate the Initial CSO Control Volumes are listed below for each NPDES outfall in Table 2.

Table 2. Methodology for Estimated CSO Volumes – Henderson Basin

Outfall	Estimated CSO Volume Methodology
NPDES #44	Broad-crested weir
NPDES #47	Broad-crested weir
NPDES #49	Broad-crested weir
NPDES #171	Broad-crested weir Outlet-controlled with flow rate limited to 16 million gallons per day (mgd)

Initial CSO Control Volumes were not estimated for two NPDES outfalls (NPDES #45 and #46) and CSO Basin 47 South (Overflow Structure 47B). A control volume for NPDES #45 outfall was not estimated because the location of the monitor in Overflow Structure 45B could not be determined. A control volume for NPDES #46 outfall was not estimated due to inconsistencies in historical data and the CSO Annual Reports. A control volume for Overflow Structure 47B was not estimated due to questionable monitoring data associated with several of the reported CSO events.

One outfall (NPDES #48) is currently in compliance, with no reported CSOs to Ecology from 2001 through 2006; thus, a CSO control volume is not required for CSO Basin 48.

Conclusions

The Initial CSO Control Volumes are preliminary and based on engineering judgment and information available at the time this report was prepared. These CSO control volumes should not be used as a basis for design of CSO control facilities. Calculating accurate CSO control volumes is not possible due to the following influences:

- The volume of some CSO flows could be restricted due to pipeline capacity during CSO events; thus, a possibility exists that not all the flow discharges through the outfall pipe (e.g., sewer backups).
- CSO volumes were not estimated in all cases due to insufficient data (e.g., inconsistent depth measurements).
- The actual locations of the depth sensors (and corresponding sensor-to-weir heights) for the Geotivity monitoring periods are unknown and could not be confirmed. The sensor-to-weir height highly influences CSO volume calculations using weir equations.
- Potential outlet control and submerged conditions should be incorporated into CSO volume estimates when applicable.
- CSO volumes may not have been estimated for depth measurements when the meter was potentially malfunctioning (e.g., reading depths higher than surface elevation). In some instances, a CSO volume may have been associated with these depth readings.

Table 3 summarizes the Reported and Initial CSO Control Volumes for Genesee Basin NPDES outfalls as well as the CSO frequency five-year moving average (2002-2006)[2]. Table 4 summarizes the Reported and Initial CSO Control Volumes for Henderson Basin NPDES outfalls as well as the CSO frequency five-year moving average (2002-2006)[2]. These control volumes differ for the following reasons:

- Different methodologies were used to estimate Reported and Initial CSO Control Volumes. Reported CSO Control Volumes were estimated based on modeling efforts and precipitation data from 1995 - 1999 as described in the CSO Plan (see Section 6.1 for more details). Initial CSO Control Volumes were estimated based on overflow measurements at overflow structures from approximately 2000 – 2001 to 2006 (start dates vary according to overflow structure).
- Some overflow structures were hydraulically modified since the Reported CSO Control Volumes were estimated.
- Calibration of model for Reported CSO Control Volumes is based on precipitation data from 1995 – 1999. Initial CSO Control Volumes were based on flow monitoring data from approximately 2000 – 2001 to 2006 (start dates vary according to overflow structure).
- Confidence ratings assigned to Initial CSO Control Volumes are low (see Table 3 and Table 4 for assigned confidence ratings). A confidence rating between 0 and 5 (lowest to highest) was assigned to each Initial CSO Control Volume to provide a degree of confidence that the Initial CSO Control Volume would adequately reduce the untreated CSO events to an average of one event per outfall per year.

Table 3. Reported and Initial CSO Control Volumes for Genesee Basin per NPDES Outfall

NPDES Outfall	Reported CSO Control Volume (Gallons)	Initial CSO Control Volume (Gallons)*	Confidence Rating for Initial CSO Control Volume	CSO Frequency Five-Year Moving Average (2002-2006)
37	Not estimated	0	NA	0.2
38	Not estimated	Not estimated	NA	1.2
40	1,720,000	70,000	2	1.0
41	0	1,270,000	1	15.0
42	290,000	720,000	2	4.4
43	445,000	1,490,000	1	5.2
165	97,000	Not estimated	NA	3.6

NA = Not Applicable

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

[2] The CSO frequency five-year moving average was calculated based on CSO Annual Reports submitted to Ecology. These CSO Annual Reports are included in Attachment 1.

Table 4. Reported and Initial CSO Control Volumes for Henderson Basin per NPDES Outfall

NPDES Outfall	Reported CSO Control Volume (Gallons)	Initial CSO Control Volume (Gallons)*	Confidence Rating for Initial CSO Control Volume	CSO Frequency Five-Year Moving Average (2002-2006)
44	2,581,000	5,660,000	3	18.2
45	420,000	Not estimated	NA	2.4
46	943,000	Not estimated	NA	3.2
47 (CSO Basin 47 North)	871,000	1,410,000	2	13.6 (NPDES #47)
47 (CSO Basin 47 South)	184,000	Not estimated	NA	13.6 (NPDES #47)
48	0	0	NA	0.0
49	1,143,000	2,730,000	2	2.2
171	353,000	16,500,000	2	9.0

NA = Not Applicable

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

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2.0 Project Overview

2.1 Purpose

The purpose of this technical study is to provide initial estimates of the combined sewer overflow (CSO) control volumes required to achieve an average of one untreated CSO per year per outfall at the Genesee and Henderson Basin National Pollutant Discharge Elimination System (NPDES) outfalls. This report was prepared to fulfill the Scope of Work Order 7.2 (Initial Estimation of Overflow Control Volumes).

2.2 Background

The Washington State Department of Ecology (Ecology) administers the City of Seattle (City) NPDES permit for CSO outfalls. The City is required to abide by a compliance schedule designed to achieve the greatest reasonable reduction of CSOs at the earliest possible date. The City's goal is to reduce CSOs to the Washington State Regulation, which is averaging one untreated CSO per year per outfall, by 2020.

This study focuses on four key elements as defined below.

- <u>CSO control volume</u>: CSO control volume refers to the quantity of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that the overall CSO frequency is reduced to one overflow per year per outfall. The volume of storage or additional conveyance capacity required to achieve compliance (one overflow per year per outfall) may be significantly higher than the control volume itself due to hydraulic limitations and other factors identified during the subsequent phases of the CSO reduction project.
- <u>Reported CSO Control Volume</u>: CSO control volume that was documented in the Combined Sewer Overflow Reduction Plan Amendment, December 2001 (CSO Plan) for each NPDES outfall.
- <u>Estimated CSO Volume</u>: CSO volume that was estimated with the assumptions described in this study for each overflow structure and CSO event.
- <u>Initial CSO Control Volume</u>: CSO control volume that was calculated based on the Estimated CSO Volumes for each NPDES outfall.

Two combined sewer basins that require CSO reduction to meet the current regulation are the Genesee and Henderson Basins. The Genesee Basin consists of the following:

- 8 CSO basins (CSO Basins 37, 38, 39, 40, 41, 42, 43, and 165)
- 4 CSO control facilities
- 7 outfalls to Lake Washington
- 2 pump stations

The Henderson Basin consists of the following:

- 7 CSO basins (CSO Basins 44, 45, 46, 47, 48, 49, and 171)
- 5 CSO control facilities
- 7 outfalls to Lake Washington
- 2 pump stations

Geotivity, Inc. (Geotivity) was the flow monitoring contractor for Seattle Public Utilities (SPU) from 1998 to 2006 and reported CSO volumes to SPU monthly for each NPDES outfall. ADS Environmental Services (ADS) became the flow monitoring contractor in 2007. Flow monitoring did not begin for NPDES overflow structures in the Genesee and Henderson Basins until approximately 2000 - 2001 (start dates vary according to overflow structure). Thus, Geotivity monitoring data from 2000/2001 through 2006 was available for review and evaluation to calculate Estimated CSO Volumes and Initial CSO Control Volumes per outfall. Geotivity monitoring data used in this study is provided in Attachment 1.

2.3 Report Overview

This report is divided into the following sections and appendices.

Sections

Section 1	Executive summary.
Section 2	Overview and purpose.
Section 3	Summary of methodology used to estimate Initial CSO Control Volumes.
Section 4	Summary of results for Genesee Basin per overflow structure and NPDES outfall from Geotivity monitoring data; includes a brief description of conveyance system hydraulics, methodology for Estimated CSO Volumes, Initial CSO Control Volumes, and corresponding confidence ratings.
Section 5	Summary of results for Henderson Basin per overflow structure and NPDES outfall from Geotivity monitoring data; includes a brief description of conveyance system hydraulics, methodology for Estimated CSO Volumes, Initial CSO Control Volume estimates, and corresponding confidence ratings.
Section 6	Summary of CSO Plan; includes summary of study area model development and application, Reported CSO Control Volumes for each NPDES outfall in the Genesee and Henderson Basins, and a comparison of Reported and Initial CSO Control Volumes for each NPDES outfall.

Appendices

Appendix A	Schematic flow diagrams of each overflow structure for the Genesee and Henderson CSO basins.

The appendices listed below include details of assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events and a sample of depth versus time plots for each overflow structure.

Appendix B	NPDES #38 outfall.
Appendix C	NPDES #40 outfall.
Appendix D	NPDES #41 outfall.

Appendix E	NPDES #42 outfall.
Appendix F	NPDES #43 outfall .
Appendix G	NPDES #165 outfall.
Appendix H	NPDES #44 outfall.
Appendix I	NPDES #47 outfall.
Appendix J	NPDES #171 outfall.
Appendix K	NPDES #49 outfall.

Attachments

Attachment 1 CD that contains Geotivity monitoring data (2000 – 2006), CSO Annual and Monthly Reports (2000 – 2006) that were submitted to Ecology, and other supporting files used for CSO reporting.

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3.0 Methodology

The methodology used in estimating the Initial CSO Control Volumes is described in the following steps.

1. Review SPU Combined Sewer Overflow Annual Reports (2000 - 2006) to document the largest CSO events reported to Ecology annually. CSO Annual Reports (2000 – 2006) are included in Attachment 1.
2. Rank the 10 largest reported CSO events per NPDES outfall in descending order of volume (largest to smallest). It was assumed for this evaluation that the largest CSO events and volumes were reported from the corresponding monitoring period (2000/2001 – 2006). Some NPDES outfalls have less than 10 reported CSO events, so only the number of reported CSO events was ranked in these cases.
3. Review and evaluate available Geotivity monitoring data for each reported CSO event. The available monitoring data (e.g., depth, velocity, float switch, etc.) was reviewed to determine data availability, reasonable depth measurements, float switch on/off corresponding to assumed sensor-to-weir height, etc.
4. Determine assumptions that will be used to calculate Estimated CSO Volumes. The following information/documentation was provided for overflow calculations:

- Geotivity Site Investigation Forms for NPDES outfalls of the Genesee and Henderson Basins. The forms indicate the installation date, type of overflow structure, length/width/height of overflow structure (e.g., weir) from the invert (bottom) of the channel, etc. The forms do not include information regarding the locations of the depth/velocity sensors; it was assumed (in most cases) that the depth sensors were installed in the invert of the channel.
- ADS Site Reports. The ADS reports indicate the site name, address/location, maintenance hole (MH) number, pipe diameter(s), schematic diagrams of structures, installation date, types of sensor devices, weir measurements (length, width, and height), and location of sensors in overflow structures.
- ADS calculation spreadsheets. The spreadsheets indicate the equations used in estimating CSO volumes, sensor-to-weir height (alarm setting), and weir length.
- As-built drawings of the overflow structures. These drawings were used to verify dimensions reported.
- Miscellaneous spreadsheets found in files that were provided.

5. Independently evaluate overflow structures and data to calculate Estimated CSO Volumes for each reported event (listed in Step #1). Using the information provided and available Geotivity monitoring data (provided in Attachment 1), assumptions were applied to estimate CSO volumes for each reported CSO event. In general, either the sharp-crested weir or broad-crested weir equations (free-flowing condition) were used to estimate overflow rates.

Sharp-crested weir equation:

$$Q = 3.33 * L * H^{1.5}$$

Q = overflow rate in cubic feet per second (cfs)

L = length of the weir in feet

H = head over the crest of the weir in feet

Broad-crested weir equation[3]:

$$Q = 2.62 * L * H^{1.5}$$

Q = overflow rate in cubic feet per second (cfs)

L = length of the weir in feet

H = head over the crest of the weir in feet

An inter-event time (IET) of 24 hours, as defined by Ecology, was used for differentiating CSO events.

6. ADS monitoring data from the 12/3/07 CSO event was also reviewed to determine if the largest CSO events may be outlet-controlled. If the CSO events are outlet-controlled, then Estimated CSO Volumes may be lower (overflow rate estimates would be less in a submerged versus free-flowing condition). The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of the outfall. Thus, the data was used to determine whether or not a CSO event may be outlet-controlled (submerged condition).
7. Determine recurrence interval for each CSO event (see Table 5 for example of calculations) and estimate Initial CSO Control Volume for each NPDES outfall. Recurrence interval is defined as the approximate time duration in which one untreated CSO per outfall would occur. For example, Table 5 indicates that with a CSO control volume of approximately 8.7 MG, on average, one untreated CSO would occur every 8.67 years at NPDES #49 outfall.

- Recurrence Interval[4]:

$$T = (m + 1 - 2\theta) / (i - \theta)$$

T = recurrence interval in years

m = years of record

i = rank of the overflow volume ordered 1 to N

N = number of overflow volumes in ranking

θ = weighting factor = 0.40

- Once the recurrence interval has been calculated for each Estimated CSO Volume, the control volume can be determined. The control volume is the CSO volume with a recurrence interval of 1 year. The Initial CSO Control Volume is bolded in Table 5 for Overflow Structure 49.

  In cases where NPDES outfalls have multiple overflow structures, control volumes were estimated for each overflow structure and summed (based on date of reported CSO event) for the Initial CSO Control Volume per NPDES outfall.

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[3] Kulin, Gershon and Philip Compton. 1975. A Guide to Methods and Standards for the Measurement of Water Flow. U.S. Department of Commerce, National Bureau of Standards.
[4] Schaefer, MG. 2008. Analysis of the frequency of storms in 1998-2007 period relative to storms in the period from 1978-2007 for generation of combined sewer overflows. MGS Engineering Consultants, Inc. submitted to Seattle Public Utilities in January 2008.

Table 5. Example of Recurrence Interval Calculations for Estimated CSO Volumes (Overflow Structure 49)

Rank	Reported CSO Event (Date)	Estimated CSO Volume (Gallons) per Event	Recurrence Interval, T (Years)
1	1/17/2005	8,697,835	8.67
2	11/6/2006	5,018,162	3.25
3	11/14/2001	3,754,978	2.00
4	12/26/2006	2,734,158	1.44
5	**12/16/2001**	**2,471,087**	**1.13**
6	11/18/2003	1,192,066	0.93

8. Identify confidence rating (0 [lowest] to 5 [highest]) for each CSO control volume (see Table 6 for descriptions of each confidence rating). These ratings provide the degree of confidence that the Initial CSO Control Volume estimate would be adequate to ensure an average of one untreated CSO per outfall per year.
9. Review the CSO Plan to document the Reported CSO Control Volumes. Compare the Reported and Initial CSO Control Volumes for each NPDES outfall.

Table 6. Confidence Ratings

Confidence Rating	Description
0	Engineering judgment with no supporting data.
1	Verification of major factors required before drawing conclusions.
2	Limited information available – requires major assumptions to draw conclusions.
3	Some information available – requires some assumptions and verification to draw conclusions.
4	Most information available to draw conclusions with minor assumptions.
5	All information available to draw reasonable conclusions.

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4.0 Genesee Basin – Findings

The Genesee Basin consists of eight CSO basins corresponding to NPDES outfalls designated by NPDES 37, 38, 39, 40, 41, 42, 43, and 165. The Genesee Basin, NPDES outfalls, and CSO basins are shown in Figure 1. In January 2006, CSO Basins 38 and 39 were combined into a single outfall, and the combined basin is referred to as Basin 38 in this study.

Recent CSO reporting to Ecology indicates that CSO Basin 37 is in compliance. CSO Basins 38, 40, 41, 42, 43, and 165 currently appear to exceed more than an average of one untreated CSO per outfall per year.

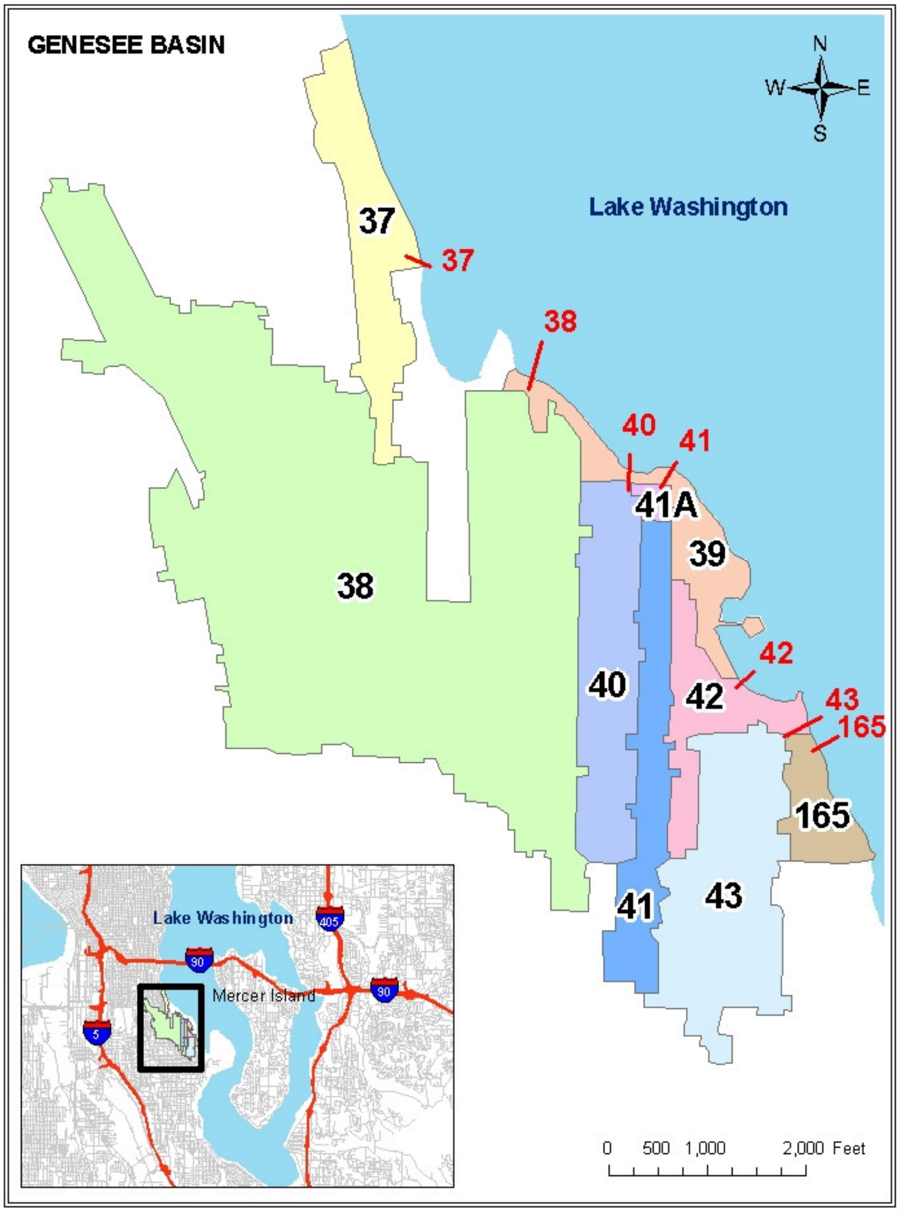

Figure 1. Genesee Basin

4.1 Summary of Initial CSO Control Volumes

Table 7 and Figure 2 display the Initial CSO Control Volumes for Genesee Basin NPDES outfalls that were estimated following the methodology presented in Section 3.0. Sections 4.2 through 4.8 describe the specific assumptions used to estimate Initial CSO Control Volumes for each NPDES outfall. NPDES #37 outfall is currently in compliance. Control volumes were not estimated for NDPES #38 outfall and NPDES #165 outfall (justifications described in Sections 4.3.2 and 4.8.2, respectively).

Table 7. Initial CSO Control Volumes for Genesee Basin per NPDES Outfall

NPDES Outfall	Initial CSO Control Volume (Gallons)*	Confidence Rating
37	0	NA
38	Not estimated	NA
40	70,000	2
41	1,270,000	1
42	720,000	2
43	1,490,000	1
165	Not estimated	NA

NA = Not Applicable

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

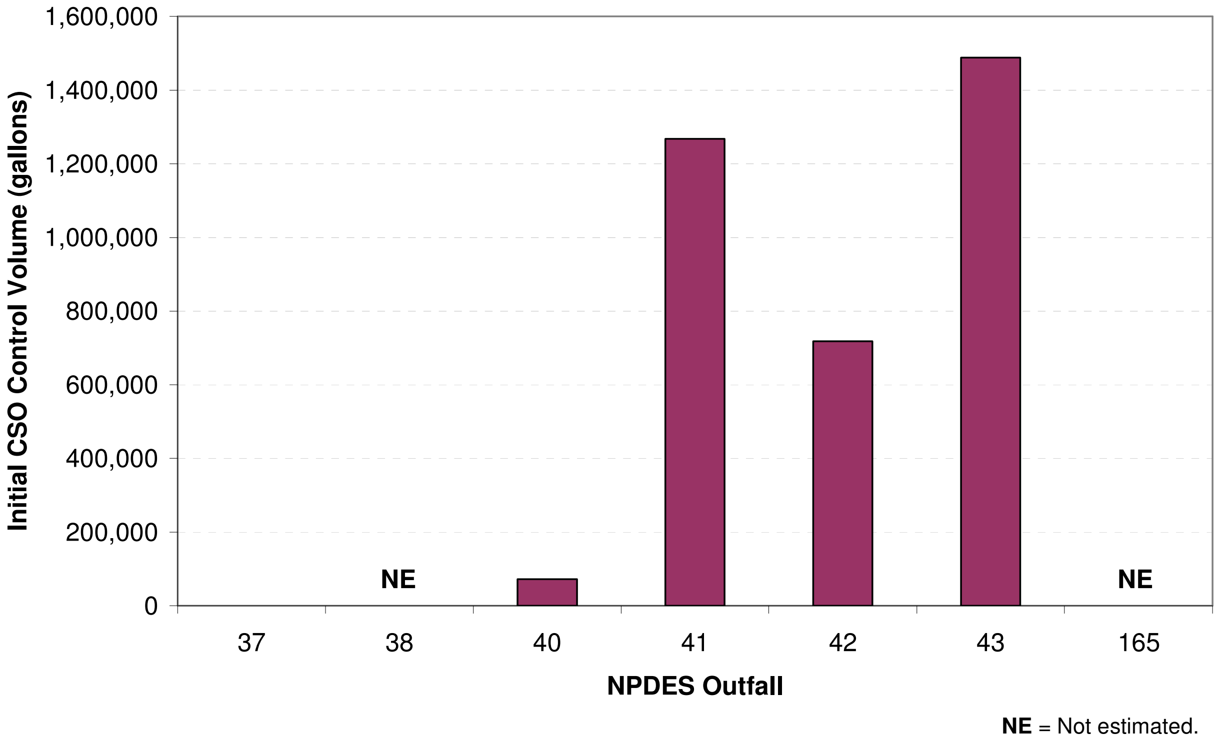

Figure 2. Initial CSO Control Volumes for Genesee Basin per NPDES Outfall

4.2 CSO Basin 37

NPDES #37 outfall is currently in compliance with only one CSO reported to Ecology from March 2000 through December 2006. A CSO control volume is not required for CSO Basin 37 based on historical Geotivity monitoring data.

4.3 CSO Basin 38

As a part of the CSO Retrofit Program, NPDES #39 outfall was abandoned in January 2006. The related CSO overflow point has been redirected to discharge through NPDES #38 outfall.

In October 2005, the overflow structure was renovated with two weirs, baffle, hydraulic regulating device, and 23,700 gallons of additional storage. Due to the revised hydraulic configuration of the outfall and redirecting of flows, only monitoring data after January 2006 was evaluated to estimate the Initial CSO Control Volume.

4.3.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 8 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix B.1.

Table 8. Overflow Structure 38 - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir
Sensor-to-Weir Height	42.3 inches
Weir Length	96 inches

Figure 3 indicates that the Geotivity sensor (at time of photograph) was located in the invert of the channel.

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 96 inches (dimension indicated on ADS Site Report). After the overflow structure was renovated in October 2005, a sensor-to-weir height of 42.3 inches was assumed (approximate weir height reported by ADS in February 2008).

Figure 3. MH 059-451: Geotivity sensor

4.3.2 Initial CSO Control Volume

Geotivity monitoring data is available from 12/19/01 through 12/30/06. Within this time period, nine CSO events were reported. Three of the nine reported CSO events have occurred after the hydraulic configuration of the overflow structure was revised in October 2005 and redirecting of CSO Basin 39 flows in January 2006. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[5] are shown for the three CSO events in Figure 4 below.

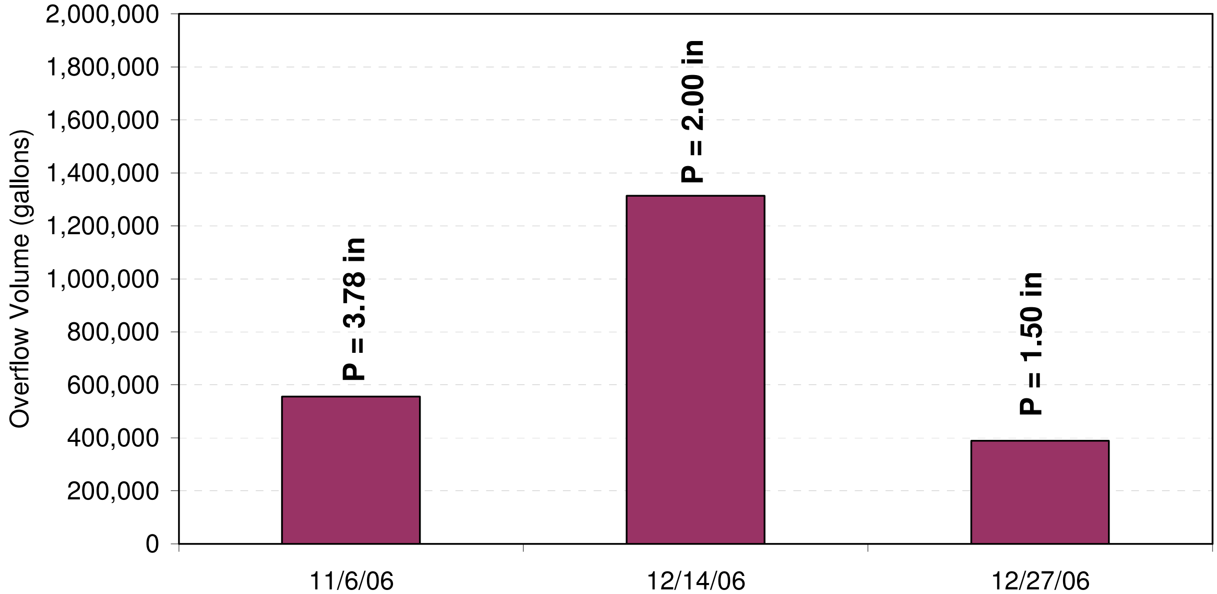

Figure 4. Overflow Structure 38 – Estimated CSO Volumes

A CSO control volume was not estimated for NPDES #38 outfall. Less than one year of monitoring data was available for evaluation since the overflow structure was renovated and CSO Basin 39 flows were redirected to NPDES #38 outfall.

4.4 CSO Basin 40

In late 2002, NPDES #40A outfall was renamed to NPDES #40 outfall.

Flows from CSO Basin 40 discharge to 8- and 12-inch-diameter pipelines, enter MH (maintenance hole) 059-490, and pass through a hydrobrake, continuing downstream to CSO Basin 41B. When the flow rate discharging to MH 059-490 exceeds the hydraulic capacity of the hydrobrake, combined sewer backs up in the upstream conveyance system, which includes an 84-inch-diameter inline storage pipeline. A sluice gate is also located in MH 059-490 that can be used to regulate flow and initiate storage in the inline storage pipe prior to exceeding the capacity of the hydrobrake. MH 059-491 is located at the downstream end of the inline storage pipe and has an elevated, flow-through storm channel (shown in Figure 5). When combined sewer rises in the inline storage pipe to the

[5] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

top of the storm channel, combined sewer overflows to the storm system (as shown by red arrows in Figure 5), and the CSO is conveyed to NPDES #40 outfall. A schematic diagram of the overflow structure (MH 059-491), inline storage pipe, and hydrobrake is shown in Figure A.1 (Appendix A).

Figure 5. MH 059-491: Flow-through Storm Channel[6]

4.4.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 9 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix C.1.

Table 9. Overflow Structure 40 - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir Double-sided
Sensor-to-Weir Height	87.6 inches
Weir Length	240 inches

[6] The red arrows in Figure 5 indicate the direction of overflow, and the green arrows indicate the direction of dry weather flow.

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 240 inches; 240 inches is the approximate weir length (based on record drawings and doubling of ADS's weir length measurement) assuming a double-sided weir. Generally, it appears that both Geotivity and ADS have installed sensors in the invert of channels for measurements based on available field photographs. However, it cannot be confirmed whether or not the Geotivity sensors were moved during the monitoring period (location-wise or height-wise). ADS currently uses a sensor-to-weir height of 87.63 inches to estimate overflow volumes, and it was assumed that the sensor-to-weir height during Geotivity monitoring was the same for Estimated CSO Volumes.

ADS monitoring data from the 12/3/07 CSO event was also reviewed to determine if the largest CSO events may be outlet-controlled (submerged condition). If the CSO events are outlet-controlled at larger overflow rates, then the actual CSO volumes are lower than the reported CSO volumes (overflow rate estimates would be less in a submerged versus free-flowing condition). The reported CSO volume for this event was estimated using the broad-crested weir equation. Figure 6 displays the measured depth during the 12/3/07 storm. The maximum measured depth was approximately 92 inches, which is approximately 4.5 inches above the crest of the weir. This depth corresponds to a maximum flow rate of approximately 5,800 gpm (8.4 mgd) for a double-sided weir. Of the 5 reported CSO events (between 2001 and 2006), the estimated flow rate for the 3/22/03 CSO event (using assumptions presented in Table 9) resulted in a maximum flow rate of approximately 6,500 gpm (9.4 mgd), which is larger than the maximum 12/3/07 overflow rate. Thus, it may be possible that the pipeline may have inadequate capacity for this CSO event at the larger overflow rates (see Appendix C.1 for details). Thus, using an unsubmerged broad-crested weir equation may be inadequate to estimate some overflow volumes. The possibility of the broad-crested weir being submerged during this CSO event (3/22/03) was not accounted for in the Estimated CSO Volumes.

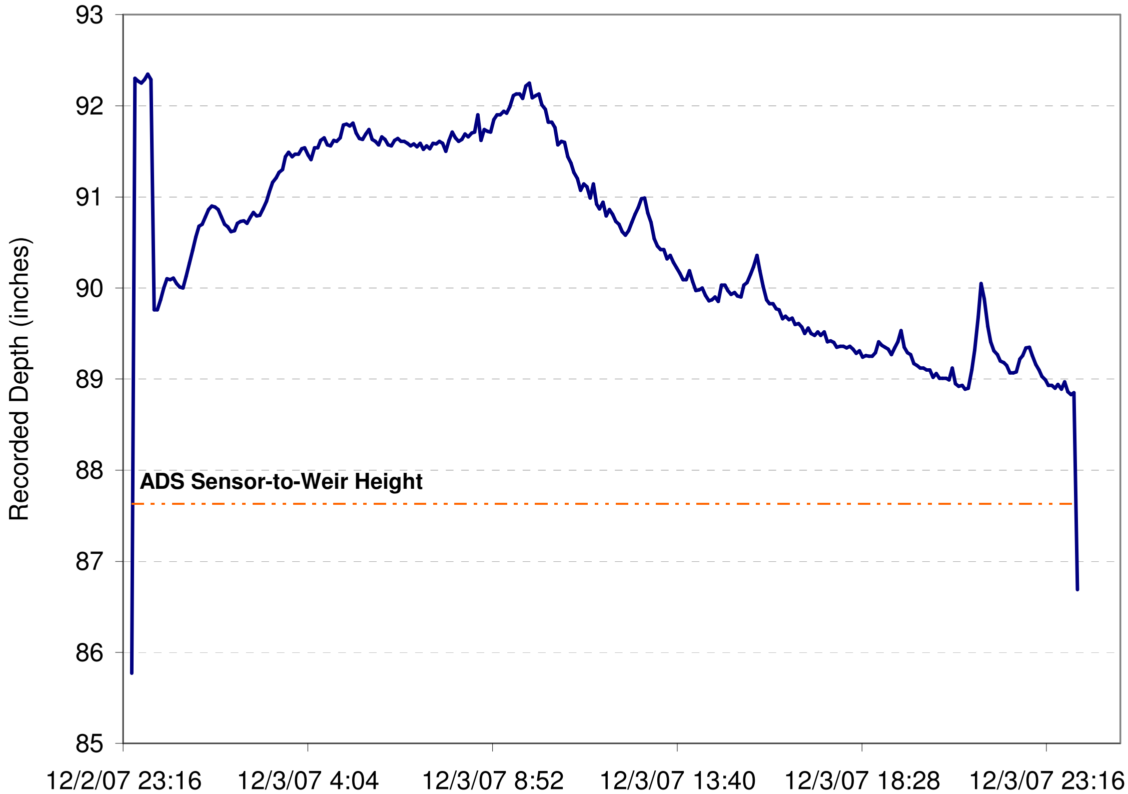

Figure 6. Recorded Depth during 12/3/2007 CSO Event (Overflow Structure 40)

4.4.2 Initial CSO Control Volume

Geotivity monitoring data is available from 12/19/01 through 12/30/06. Within this time period, six CSO events were documented, but the equipment was not operating during one of the CSO events (12/16/01). The Estimated CSO Volumes as well as the recorded precipitation depths (P)[7] are shown for the five CSO events in Figure 7 below. The 12/14/02 CSO event was approximated for the Estimated CSO Volume due to unavailable data during the monitoring period. The overflow volume for this event was approximated based on the average percent difference between reported (CSO volumes that were reported to Ecology) and Estimated CSO Volumes for the January 2003 CSO events. In other words, the Estimated CSO Volume was calculated by multiplying the reported CSO volume (CSO volume that was reported to Ecology) by the average percent difference between the reported CSO volume and Estimated CSO Volumes for other CSO events in which monitoring data is available and appears adequate.

[7] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

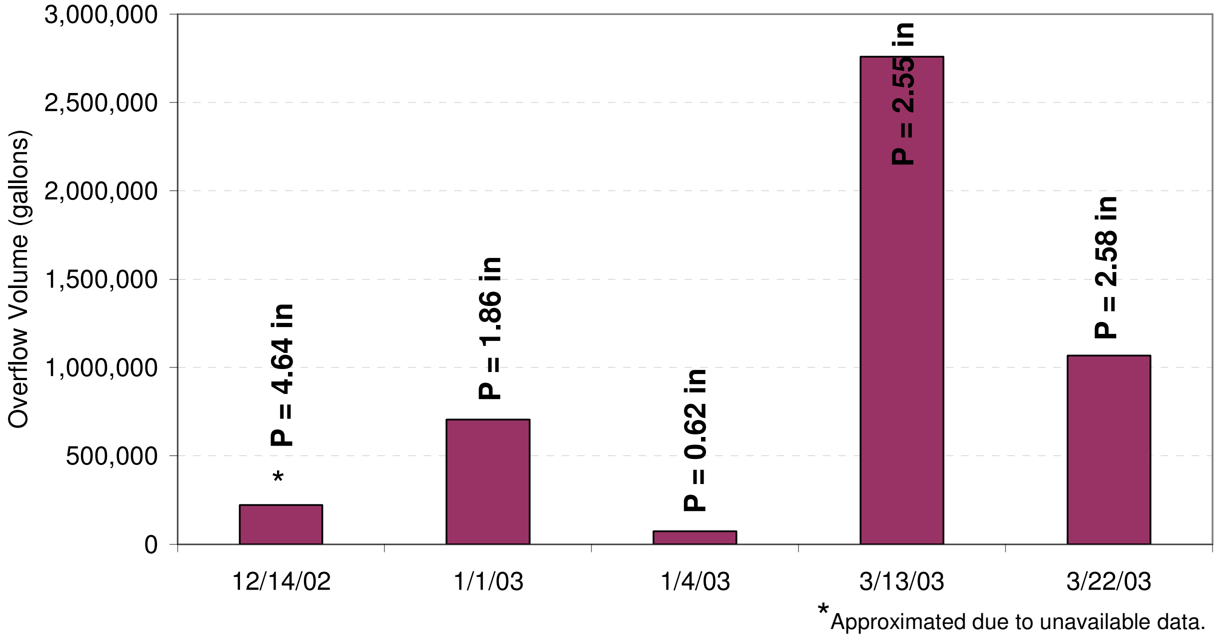

Figure 7. Overflow Structure 40 – Estimated CSO Volumes

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume is based on the Estimated CSO Volume that corresponds to the 1/4/03 CSO event. Initial CSO Control Volume for Overflow Structure 40 is presented in Table 10.

Table 10. Overflow Structure 40 – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	70,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 10 received a confidence rating of 2 for the following reasons:

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. For these reasons, and because of the possibility that the sensor was moved during the monitoring periods, the sensor-to-weir height was assumed based on engineering judgment from existing data and information available at the time this report was written.

- No monitoring data was available for the CSO event reported on 12/14/02; thus, a CSO volume could not be directly estimated for this event. This Estimated CSO Volume was included when estimating the Initial CSO Control Volume for Overflow Structure 40.
- The weir length of the double-sided weir that was used for Estimated CSO Volumes was based on record drawings.
- It may be possible that the overflow pipeline had inadequate capacity for larger overflow rates during the 3/22/03 CSO event. The possibility of the broad-crested weir being submerged during the CSO event was not accounted for in the Estimated CSO Volumes.

4.5 CSO Basin 41

CSO Basin 41 contains two overflow structures: Overflow Structure 41A (MH 059-434) and Overflow Structure 41B (MH 059-406). Initial CSO Control Volumes were estimated for both overflow structures (described in Sections 4.5.1 and 4.5.2, respectively), and the Initial CSO Control Volume for the NPDES #41 outfall is presented in Section 4.5.3.

4.5.1 Overflow Structure 41A

Flows from CSO Basin 41A are conveyed to Pump Station No. 5 via a 15-inch-diameter mainline. When the mainline capacity is exceeded, combined sewer backs up and overflows across a side-cast weir in MH 059-434 (shown in Figure 8), and the CSO is conveyed to NPDES #41 outfall. A schematic diagram of the overflow structure (MH 059-434) is shown in Figure A.2 (Appendix A).

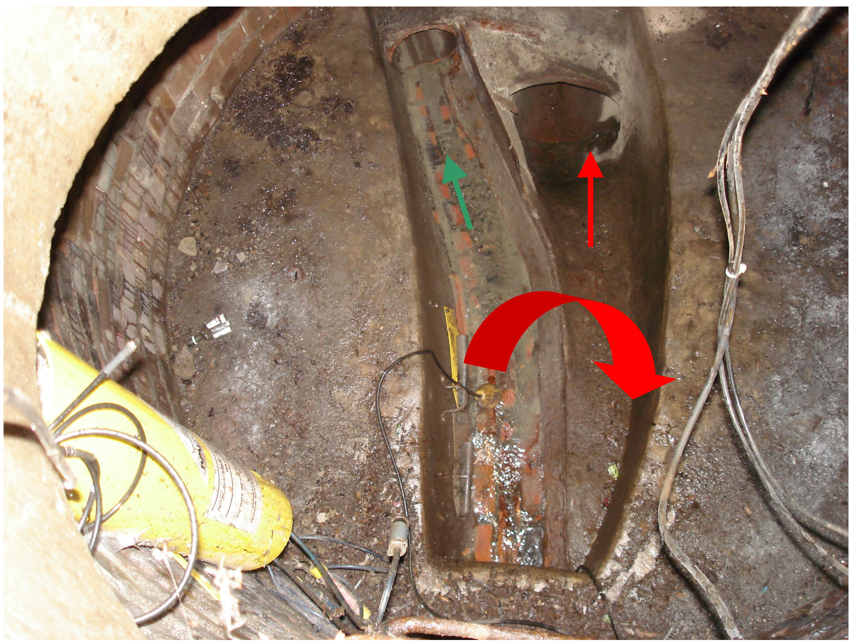

Figure 8. MH 059-434: Side-cast weir[8]

[8] The red arrows in Figure 8 indicate the direction of overflow, and the green arrows indicate the direction of dry weather flow.

4.5.1.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 11 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix D.1.

Table 11. Overflow Structure 41A - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Sharp-crested weir
Sensor-to-Weir Height	5.4 inches
Weir Length	60 inches

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 60 inches (dimension indicated on Geotivity Site Investigation Form). The ADS Site Report indicated weir heights of 5.38 inches (right side), 5.5 inches (center), and 8.25 inches (left side). The slope of the channel results in varying weir heights, making it difficult to determine when an overflow occurs since the location of the sensor is unknown. After reviewing the depth versus time plots of the reported CSO events (sample of plots presented in Appendix D.2), it was difficult to determine the sensor-to-weir height that would be sufficient for estimating CSO volumes. Generally, it appears that both Geotivity and ADS have installed sensors in the invert of channels for measurements based on available field photographs. For these reasons, the weir heights indicated on the ADS Site Report were assumed as the sensor-to-weir heights for the Estimated CSO Volumes.

4.5.1.2 Initial CSO Control Volume (Overflow Structure 41A)

Geotivity monitoring data is available from 2/29/00 through 12/30/06. Within this time period, six CSO events were reported. The Estimated CSO Volumes as well as the recorded precipitation depths (P) [9] are shown for the six CSO events in Figure 9 below. The 1/3/02 CSO event was approximated for the Estimated CSO Volume due to inadequate data during the monitoring period[10]. The overflow volume for this event was approximated based on the average percent difference between reported (CSO volumes that were reported to Ecology) and Estimated CSO Volumes from other CSO events. In other words, the Estimated CSO Volume was calculated by multiplying the reported CSO volume (CSO volume that was reported to Ecology) by the average percent difference between the reported CSO volume and Estimated CSO Volumes for other CSO events in which monitoring data is available and appears adequate.

[9] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).
[10] See Appendix D.2 for stage versus time plot of 1/3/02 CSO event. Depth measurements are less than 5 inches (weir height indicated on Geotivity Site Investigation Form) for the duration of the CSO event.

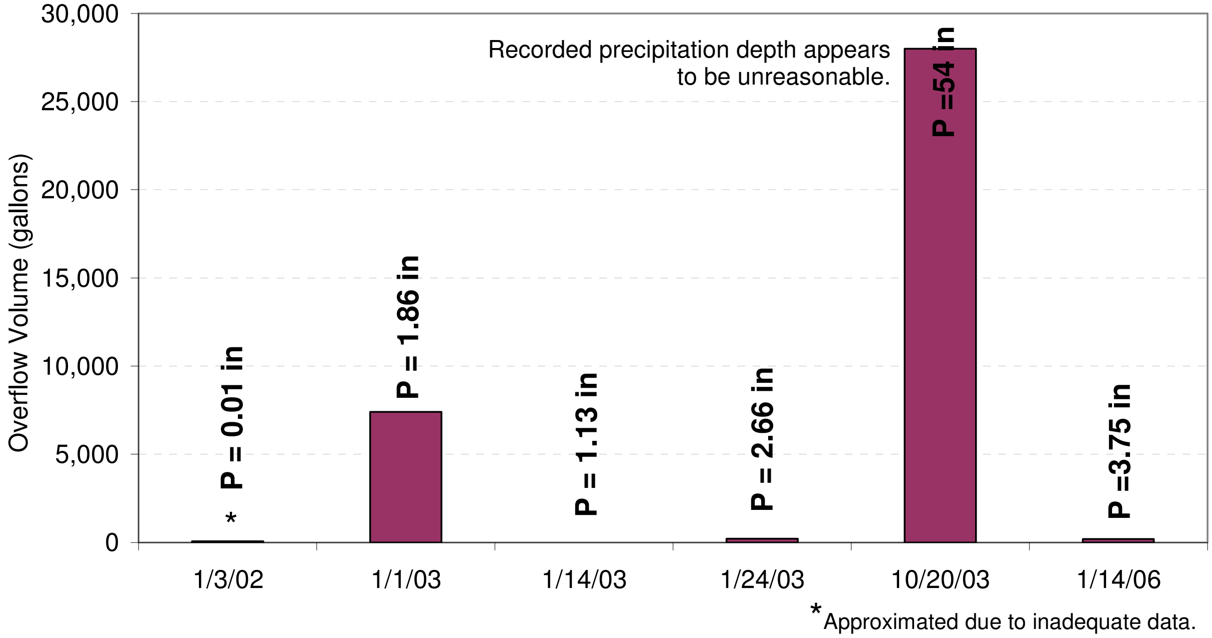

Figure 9. Overflow Structure 41A – Estimated CSO Volumes

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume is based on the Estimated CSO Volume that corresponds to the 1/14/03 CSO event. The Initial CSO Control Volume for Overflow Structure 41A is presented in Table 12.

Table 12. Overflow Structure 41A – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	0 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 12 received a confidence rating of 1 for the following reasons:

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. For these reasons, and because of the possibility that the sensor was moved during the monitoring periods, the sensor-to-weir height was assumed based on engineering judgment and on existing data and information available at the time this report was written.
- It is difficult to accurately estimate the overflow volume using a weir equation for this overflow structure, particularly since the weir is very shallow and the slope of the

channel impacts the "head" over the crest of the weir. It is also likely that the flow does not uniformly flow over the full length of the weir.

Since completion of Geotivity monitoring, a depth and velocity sensor was installed in the overflow pipe to estimate overflow volumes using the continuity equation, Q = AV (Q = flow rate in cfs; A = flow area in square feet; V = velocity in feet per second [fps]). This methodology seems to be a more reasonable method for estimating CSO volumes for this overflow structure.

- There appears to be inadequate data for the 1/3/02 CSO event (see Appendix D.2); thus, a CSO volume could not be directly estimated for this event. This Estimated CSO Volume was included when estimating the Initial CSO Control Volume for Overflow Structure 41A.

4.5.2 Overflow Structure 41B

In late 2002, NPDES #40B outfall was renamed to NPDES #41B outfall.

Flows from CSO Basin 41B discharge to 15- and 21-inch-diameter mainlines that convey flows to Pump Station No. 5. When the capacity of the downstream conveyance system is exceeded, combined sewer backs up in the upstream conveyance system. When combined sewer rises in MH 059-406 to the height of the weir/orifice (shown in Figure 10), an overflow occurs, and the CSO is conveyed to NPDES #41 outfall. A schematic diagram of the overflow structure (MH 059-406) is shown in Figure A.3 (Appendix A).

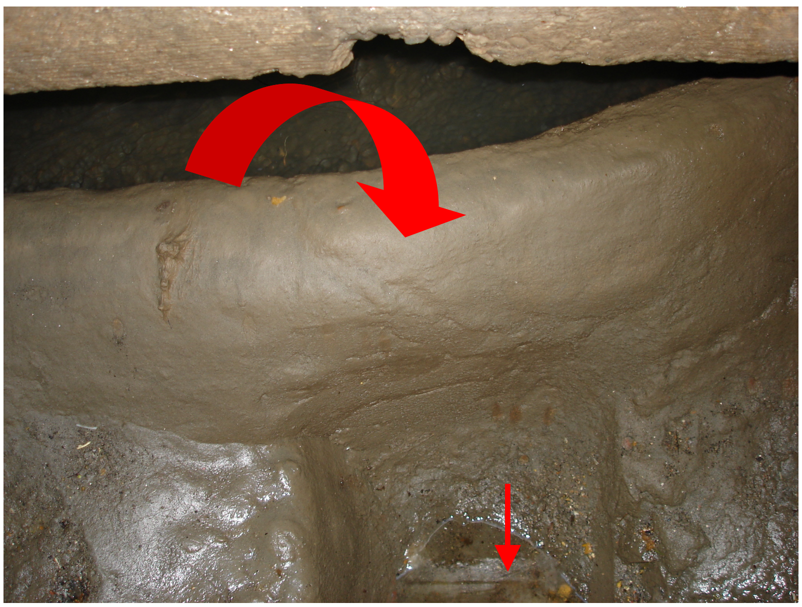

Figure 10. MH 059-406: Weir/Orifice[11]

4.5.2.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 13 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix D.3.

[11] The red arrows in Figure 10 indicate the direction of overflow.

Table 13. Overflow Structure 41B - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Outlet-controlled (submerged condition) 550 gpm during CSO event
Sensor-to-Weir Height	9 to 14 inches
Weir Length	70 inches

Estimated CSO Volumes were determined by reviewing ADS monitoring data from the 12/3/07 CSO event. The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of the outfall. The reported CSO volume for this event was based on the depth and velocity in the overflow pipe. Figure 11 displays the overflow rates estimated during the 12/3/07 CSO event, and the maximum flow rate was approximately 520 gpm (0.75 mgd). Another significant historical storm event is the 12/14/06 CSO event. The estimated flow rate (calculated assuming sharp-crested weir and free-flowing conditions) is shown in Figure 12, resulting in a maximum flow rate of approximately 28,000 gpm (40 mgd), which is significantly larger than the maximum 12/3/07 overflow rate. Based on this observation and reported observations by Earth Tech personnel during the 11/6/06 storm, it was assumed that this overflow structure was outlet-controlled during the 10 largest reported CSO events. Thus, for conservative purposes, a flow rate of 550 gpm was assumed during each CSO event. For the purposes of these Estimated CSO Volumes, a CSO event occurs when the water level rises above the crest of the weir/orifice.

For Estimated CSO Volumes, the height of the weir/orifice was assumed to range between 9 and 14 inches. Sensor-to-weir height of 9 to 10 inches was assumed for CSO events that occurred prior to February 2005; 9 inches is the weighted average weir height based on weir length from dimensions indicated on the Geotivity Site Investigation Form (7.5-inch weir height in center sag and 10-inch weir height on the right and left sides of the weir). Sensor-to-weir height of 14 inches (indicated on the ADS Site Report, 12/12/06) was assumed for CSO events that occurred after the weir sag was filled in February 2005.

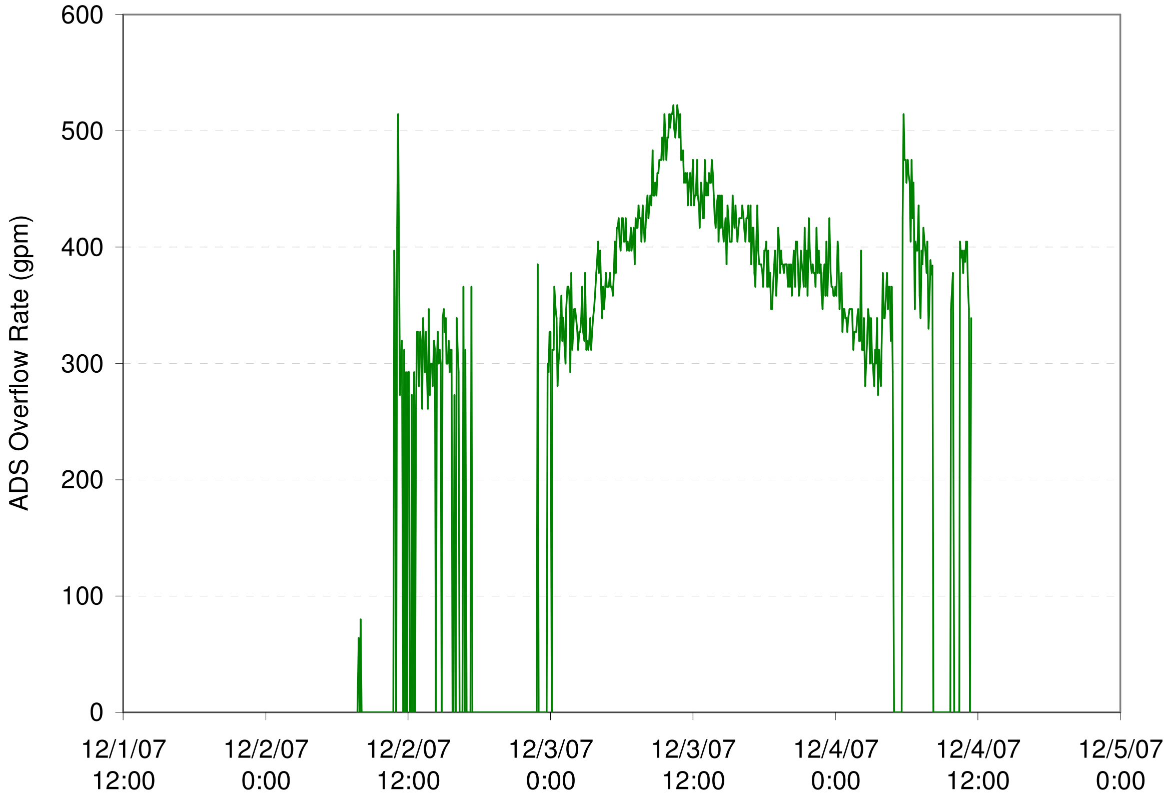

Figure 11. Estimated Overflow Rate - 12/3/07 CSO Event (Overflow Structure 41B)

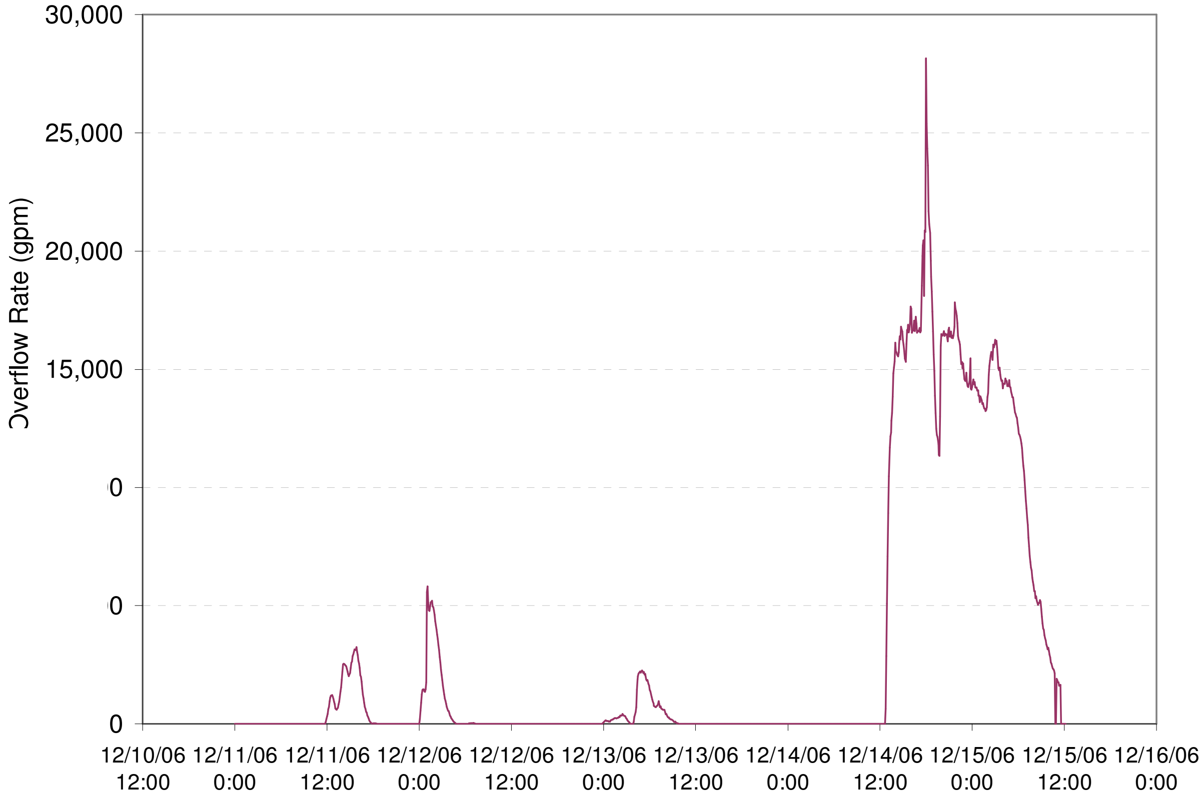

Figure 12. Estimated Overflow Rate - 12/14/06 CSO Event (Overflow Structure 41B)

4.5.2.2 Initial CSO Control Volume (Overflow Structure 41B)

Geotivity monitoring data is available from 6/13/00 through 12/31/06. Within this time period, approximately 79 CSO events were reported. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[12] are shown in Figure 13 below for the 10 largest CSO events. The 10/17/03 and 10/21/03 CSO events were approximated for the Estimated CSO Volume due to inadequate data for the monitoring periods[13]. The overflow volumes for these events were approximated based on the average percent difference between reported (CSO volumes that were reported to Ecology) and Estimated CSO Volumes for other 2003 CSO events. In other words, the Estimated CSO Volume was calculated by multiplying the reported CSO volume (CSO volume that was reported to Ecology) by the average percent difference between the reported CSO volume and Estimated CSO Volumes for other CSO events in which monitoring data is available and appears adequate. The 2002 CSO Annual Report indicated that the 12/10/02 CSO event may have been due to a partial system blockage.

[12] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).
[13] See Appendix D.4 for stage versus time plots of 10/17/03 and 10/21/03 CSO events. Multiple depth measurements are approximately 10 to 12 feet above the crown of the maintenance hole (surface elevation).

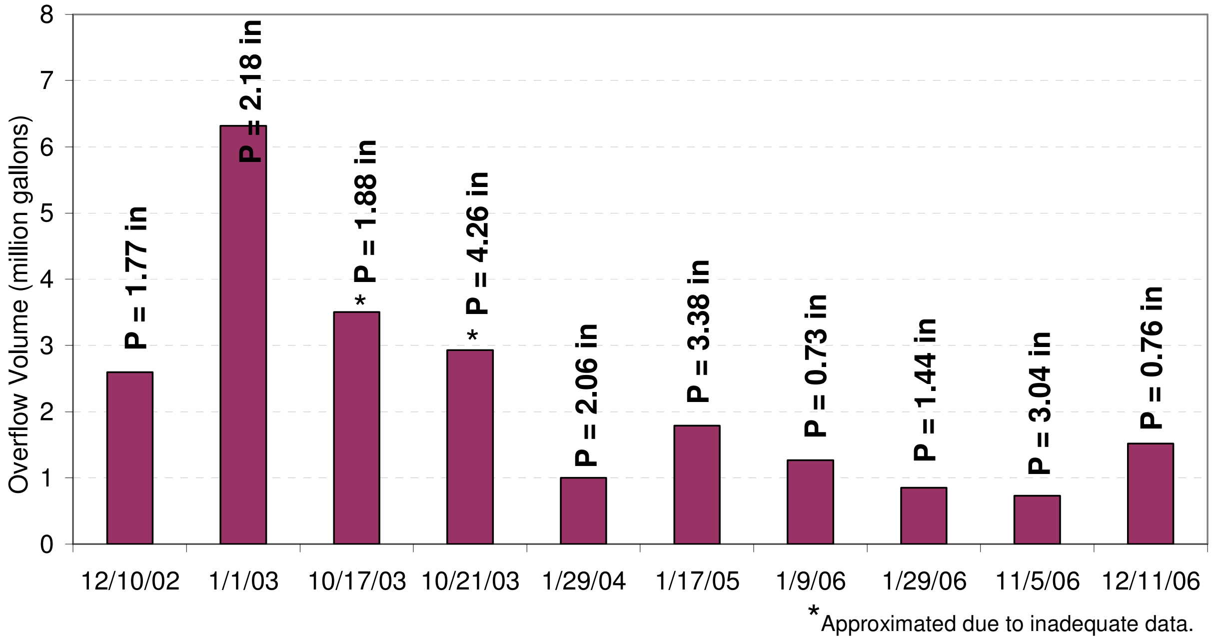

Figure 13. Overflow Structure 41B - Estimated CSO Volumes

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume is based on the Estimated CSO Volume that corresponds to the 1/9/06 CSO event. The Initial CSO Control Volume for Overflow Structure 41B is presented in Table 14.

Table 14. Overflow Structure 41B – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	1,270,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 14 received a confidence rating of 1 for the following reasons:

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. For these reasons, and because of the possibility that the sensor was moved during the monitoring periods, the sensor-to-weir height was assumed based on engineering judgment and existing data and information available at the time this report was written. The sensor-to-weir height was used to determine the time duration of the CSO event.

- The outfall structure (downstream of the weir) does not appear to have adequate capacity for flow rates predicted by using the weir equation for the largest reported CSO events. It was assumed that Overflow Structure 41B was outlet-controlled, and the overflow rate during the CSO event was 550 gpm (maximum flow rate during 12/3/07 storm). The actual overflow rate could not be estimated because the location of Geotivity sensors could not be verified.
- There appears to be inadequate data for the 10/17/03 and 10/21/03 CSO events (see Appendix D.4); thus, CSO volumes could not be directly estimated for these events. These Estimated CSO Volumes were included when estimating the Initial CSO Control Volume for Overflow Structure 41B.

4.5.3 Initial CSO Control Volume (NPDES #41 Outfall)

During the 7th largest reported CSO event for Overflow Structure 41B (1/9/06, recurrence interval of 1.02 years), no CSO was reported for Overflow Structure 41A. Thus, the Initial CSO Control Volume is the Estimated CSO Volume of Overflow Structure 41B for the reported 1/9/06 CSO event. Table 15 lists the Initial CSO Control Volume for NPDES #41 outfall.

Table 15. NPDES #41 Outfall – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	1,270,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

4.6 CSO Basin 42

Flows from CSO Basin 42 pass through a hydrobrake (located in MH 060W-052) and discharge to a 15-inch-diameter mainline that conveys flow to Pump Station No. 5. When the flow rate discharging to MH 060W-052 exceeds the hydraulic capacity of the hydrobrake, combined sewer backs up and begins to rise in the upstream conveyance system. When combined sewer rises above the weir in MH 060W-045, combined sewer overflows into the parallel off-line storage pipelines. When combined sewer rises above the overflow weir in MH 060W-052 (shown in Figure 14), the CSO is conveyed to NPDES #42 outfall. A schematic diagram of the overflow structure (MH 060W-052), offline storage pipes, and hydrobrake is shown in Figure A.4 (Appendix A).

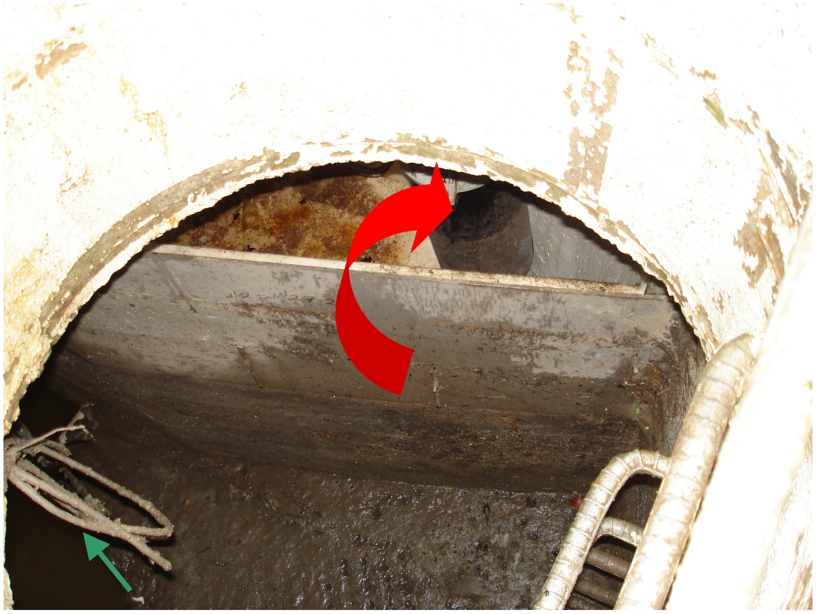

Figure 14. MH 060W-052: Overflow Weir[14]

4.6.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 16 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix E.1.

Table 16. Overflow Structure 42 - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Sharp-crested weir
Sensor-to-Weir Height	48 to 63 inches
Weir Length	88 inches

Estimated CSO Volumes were determined by applying a sharp-crested weir equation to estimate overflow rates with a weir length of 88 inches (dimension indicated on ADS Site Report). However, in late summer of 2005, the overflow weir was raised by approximately 10 inches, and on 1/9/08, the ADS Site Report indicated weir heights of 65.5 inches (right side), 62.75 inches (center), and 61 inches (left side). Depth versus time plots of the reported CSO events (prior to weir renovation in 2005) indicate that the sensor-to-weir height could vary between 48 and 53 inches (see Appendix E.2 for sample of depth versus time plots). After the weir renovation in 2005, the sensor-to-weir height was assumed as 63 inches (average of the three reported weir measurements indicated on

[14] The red arrows in Figure 14 indicate the direction of overflow, and the green arrows indicate the direction of dry weather flow.

the ADS Site Report) for the Estimated CSO Volumes. Generally, it appears that both Geotivity and ADS have installed sensors in the invert of channels for measurements based on available field photographs, and one Geotivity Site Investigation Form is available for this overflow structure (prior to weir renovation in 2005); thus, ADS measurements were used to determine the sensor-to-weir height for Estimated CSO Volumes.

4.6.2 Initial CSO Control Volume

Geotivity monitoring data is available from 12/19/01 through 12/31/06. Within this time period, 22 CSO events were reported (16 of the 22 events were reported since the overflow weir was raised). The Estimated CSO Volumes as well as the recorded precipitation depths (P)[15] are shown for the 10 largest CSO events in Figure 15 below.

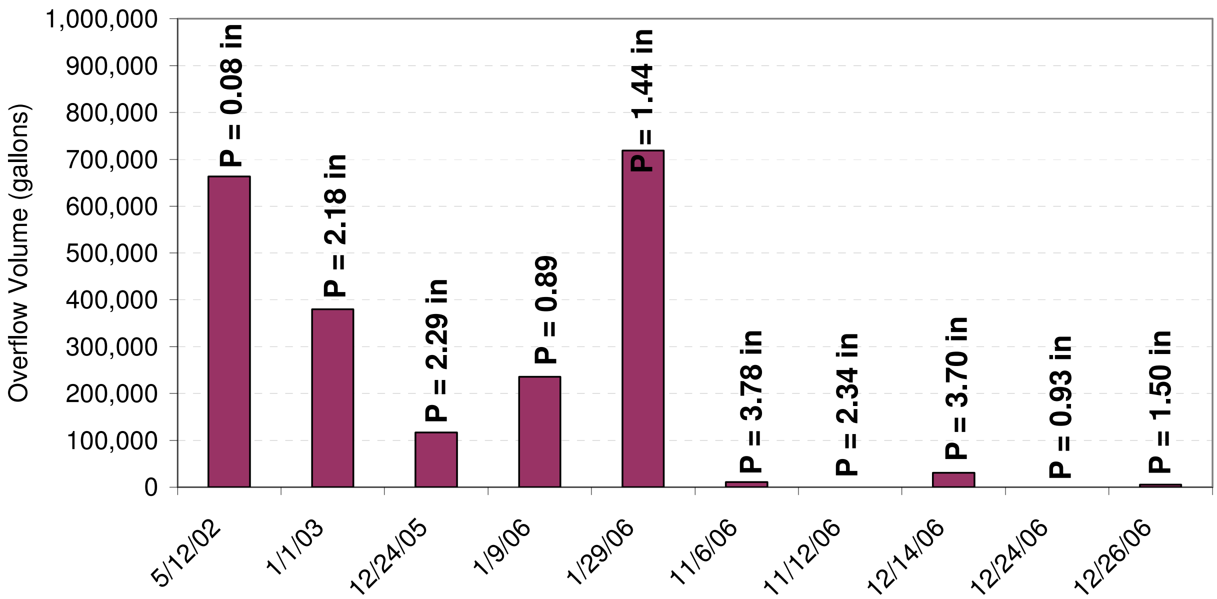

Figure 15. Overflow Structure 42 – Estimated CSO Volumes

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume is based on the Estimated CSO Volume that corresponds to the 1/29/06 CSO event. The Initial CSO Control Volume for Overflow Structure 42 is presented in Table 17.

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15 Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

Table 17. Overflow Structure 42 – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	720,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 17 received a confidence rating of 2 for the following reasons:

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. For these reasons, and because of the possibility that the sensor was moved during the monitoring periods, the sensor-to-weir height was assumed based on engineering judgment and from existing data and information available at the time this report was written.
- Flow monitoring data was available only for approximately one year after the weir wall was raised approximately 10 inches.

4.7 CSO Basin 43

Flows from CSO Basin 43 enter MH 060W-049, pass through a hydrobrake (located in MH downstream of inline storage pipe), and discharge to a 12-inch-diameter mainline. When the flow rate discharging to the MH exceeds the hydraulic capacity of the hydrobrake, combined sewer backs up and begins to rise in the inline storage pipeline. When combined sewer rises above the weir in MH 060W-049 (shown in Figure 16), the CSO is conveyed to NPDES #43 outfall. A schematic diagram of the overflow structure (MH 060W-049) is shown in Figure A.5 (Appendix A).

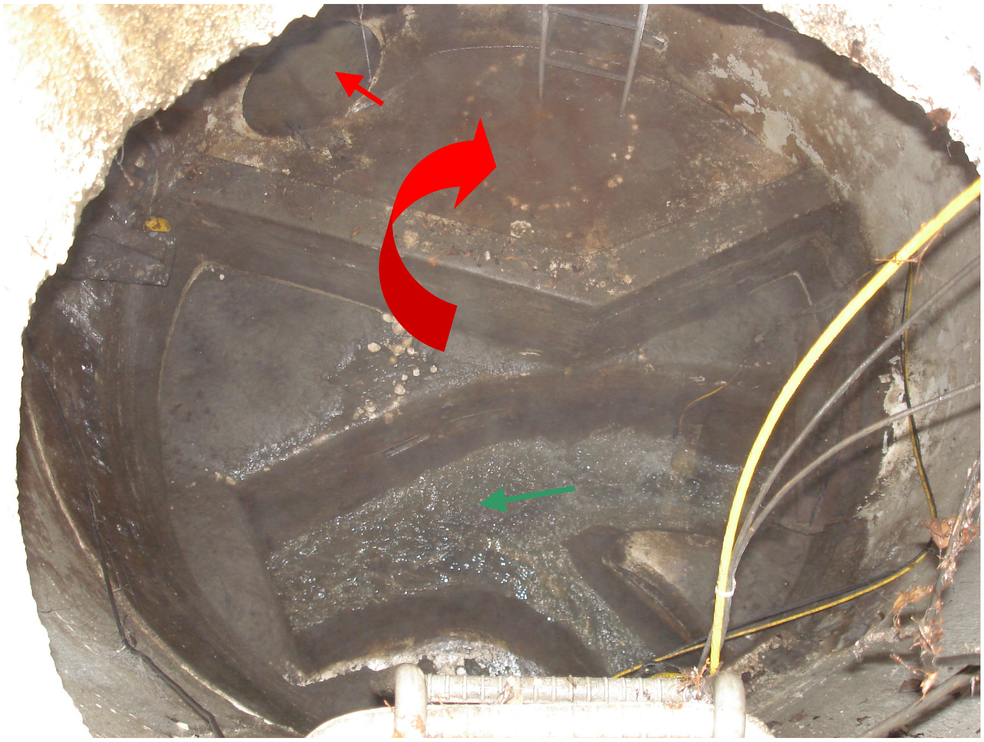

Figure 16. MH 060W-049: Overflow Weir[16]

4.7.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 18 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix F.1.

Table 18. Overflow Structure 43 - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir
Sensor-to-Weir Height	36 to 49 inches
Weir Length	92 inches

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 92 inches (dimension indicated on ADS Site Report). On 12/12/06, the ADS Site Report indicated weir heights of 48.25 inches (right side), 48.63 inches (center), and 50 inches (left side). Depth versus time plots of the reported CSO events indicate that the sensor-to-weir height could vary between 36 and 49 inches (see Appendix F.2 for sample of depth versus time plots). Thus, the sensor-to-weir height ranged between 36 and 49 inches for Estimated CSO Volumes.

[16] The red arrows in Figure 16 indicate the direction of overflow, and the green arrows indicate the direction of dry weather flow.

ADS monitoring data from the 12/3/07 CSO event was also reviewed to determine if the largest CSO events may be outlet-controlled (submerged condition). The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of the outfall. If the CSO events are outlet-controlled, then the actual CSO volumes are lower than the CSO volumes calculated (overflow rate estimates would be less in a submerged versus free-flowing condition). The reported CSO volume for this event was estimated by ADS using the broad-crested weir equation. Figure 17 displays the measured depth during the 12/3/07 storm. The maximum measured depth was approximately 63 inches, which is approximately 14 inches above the crest of the weir. This depth corresponds to a maximum flow rate of approximately 11,460 gpm (16.5 mgd). Of the 10 largest reported CSO events (between 2001 and 2006), the estimated flow rate (using assumptions presented in Table 18) resulted in maximum flow rates less than 16.5 mgd, except for the 12/14/06 CSO event. It appears that the depth meter was malfunctioning; the depth measurement that corresponds to the maximum flow rate increased by 15 inches within 5 minutes, and decreased by 10 inches within the next 5 minutes. Thus, it appears that the overflow pipeline has adequate capacity for the largest CSO events (at least the largest 9 CSO events), and that the overflow structure is not outlet-controlled for the largest CSO events within this monitoring period.

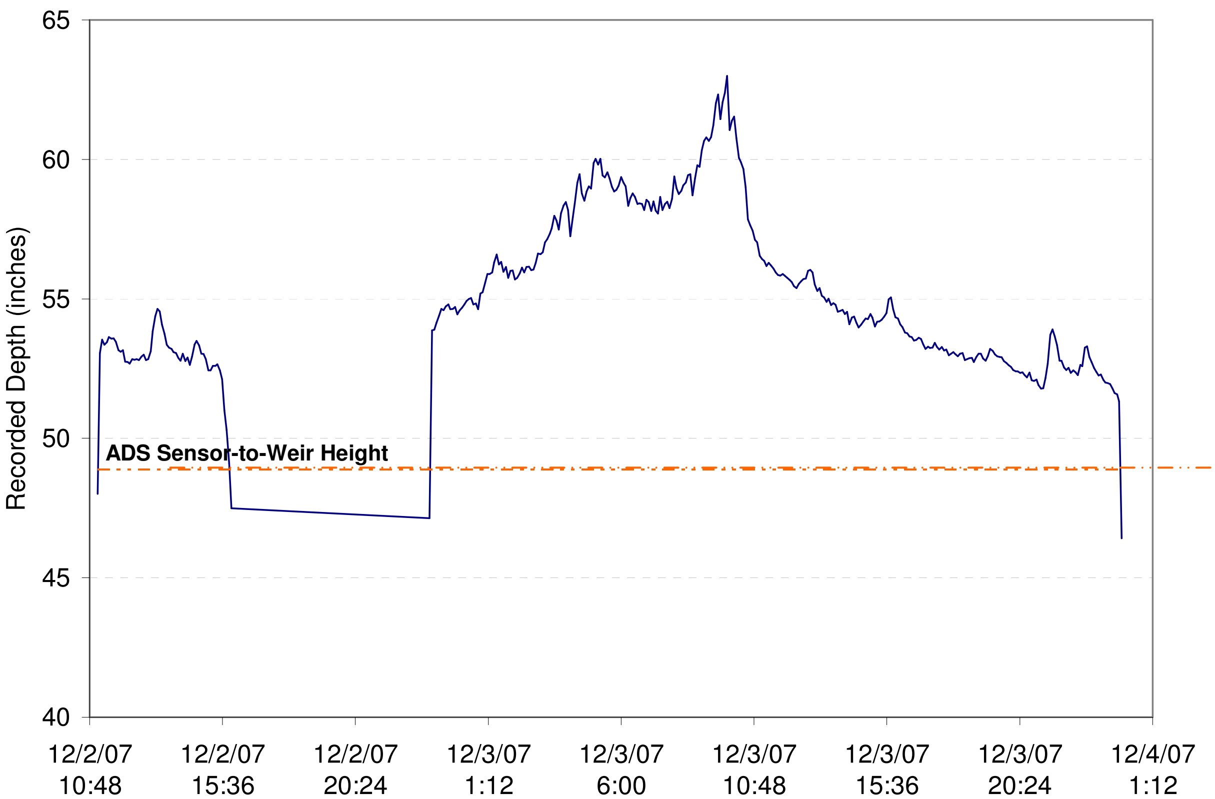

Figure 17. Recorded Depth - 12/3/07 CSO Event (Overflow Structure 43)

4.7.2 Initial CSO Control Volume

Geotivity monitoring data is available from 12/19/01 through 12/30/06. Within this time period, 26 CSO events were reported. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[17] are shown in Figure 18 below for the 10 largest CSO events. The following should be noted regarding the CSO volume comparisons:

- The 1/29/04 CSO event was approximated for the Estimated CSO Volume due to unavailable data during the monitoring period. The overflow volume for this event was approximated based on the median percent difference between reported (CSO volumes that were reported to Ecology) and Estimated CSO Volumes for other reported CSO events. In other words, the Estimated CSO Volume was calculated by multiplying the reported CSO volume (CSO volume that was reported to Ecology) by the median percent difference between the reported CSO volume and Estimated CSO Volumes for other CSO events in which monitoring data is available and appears adequate.
- It appears that the IETs for the 12/14/02 and 1/1/03 CSO volumes are greater than 24 hours (see Appendix F.2 for depth versus time plots of these events).

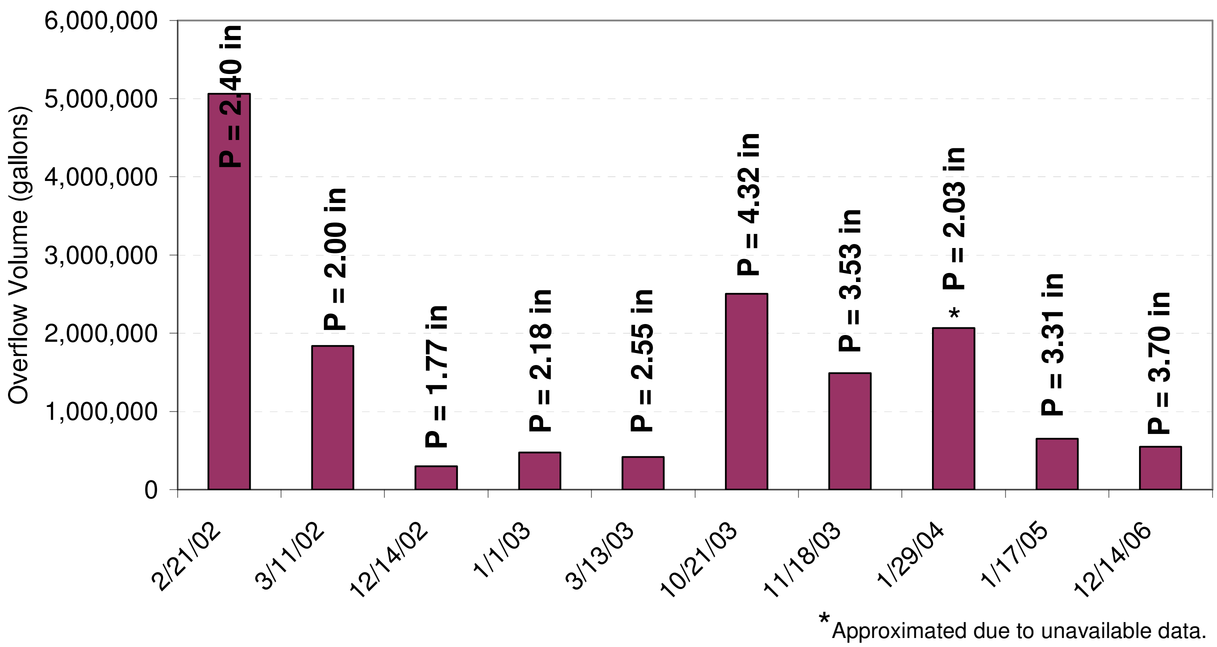

Figure 18. Overflow Structure 43 – Estimated CSO Volumes

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume is based on the Estimated CSO Volume that corresponds to the 11/18/03 CSO event. The Initial CSO Control Volume for Overflow Structure 43 is presented in Table 19.

[17] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

Table 19. Overflow Structure 43 – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	1,490,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 19 received a confidence rating of 1 for the following reasons:

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. It also appears that the sensors may have been moved during the monitoring period (possible sensor-to-weir height may range between 36 and 52 inches). For these reasons, the sensor-to-weir height was assumed based on engineering judgment and existing data and information available at the time this report was written.
- No monitoring data was available for the CSO event reported on 1/29/04; thus, a CSO volume could not be directly estimated for this event. This Estimated CSO Volume was included when estimating the Initial CSO Control Volume for Overflow Structure 43.

4.8 CSO Basin 165

Flows from CSO Basin 165 enter MH 067W-078 and discharge to an 8-inch-diameter mainline that conveys flows to Pump Station No. 6. When the capacity of the downstream conveyance system is exceeded, combined sewer backs up in the upstream conveyance system. When combined sewer rises in MH 067W-078 to the height of the weir (shown in Figure 19), an overflow occurs, and the CSO is conveyed to NPDES #165 outfall. A schematic diagram of the overflow structure (MH 067W-078) is shown in Figure A.6 (Appendix A).

Figure 19. MH 067W-078: Overflow Weir[18]

4.8.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 20 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix G.1.

Table 20. Overflow Structure 165 - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir
Sensor-to-Weir Height	2 to 10 inches
Weir Length	45 inches

The Geotivity Site Investigation Form indicated that the height from the invert (bottom) of the channel to the crest of the weir is 10 inches. With the information provided, it was difficult to determine adequate assumptions to estimate CSO volumes for 6 of the 10 largest reported CSO events. Some examples of possible issues that made it difficult to determine adequate assumptions are listed below.

- The sensor-to-weir height could not be determined within a reasonable value (based on available data); see Figure 20 for an example (1/22/03 CSO event).

[18] The red arrows in Figure 19 indicate the direction of overflow, and the green arrows indicate the direction of dry weather flow.

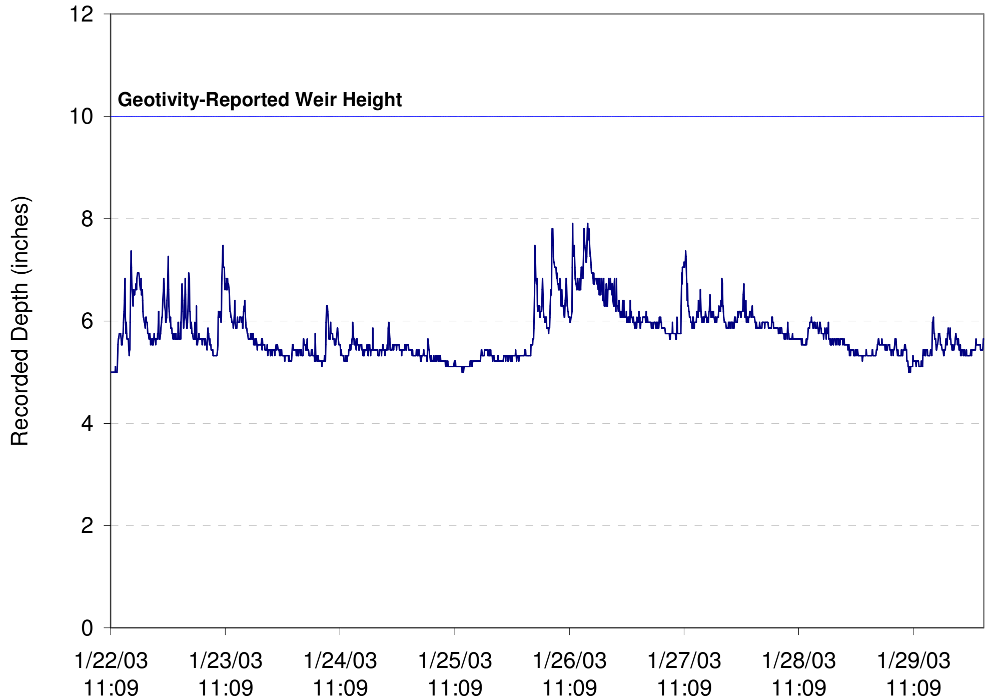

Figure 20. Depth versus Time – 1/22/03 CSO Event (Overflow Structure 165)

- CSO volumes were reported to Ecology for events with major water depth fluctuations; see Figure 21 for an example (6/3/02 CSO event).

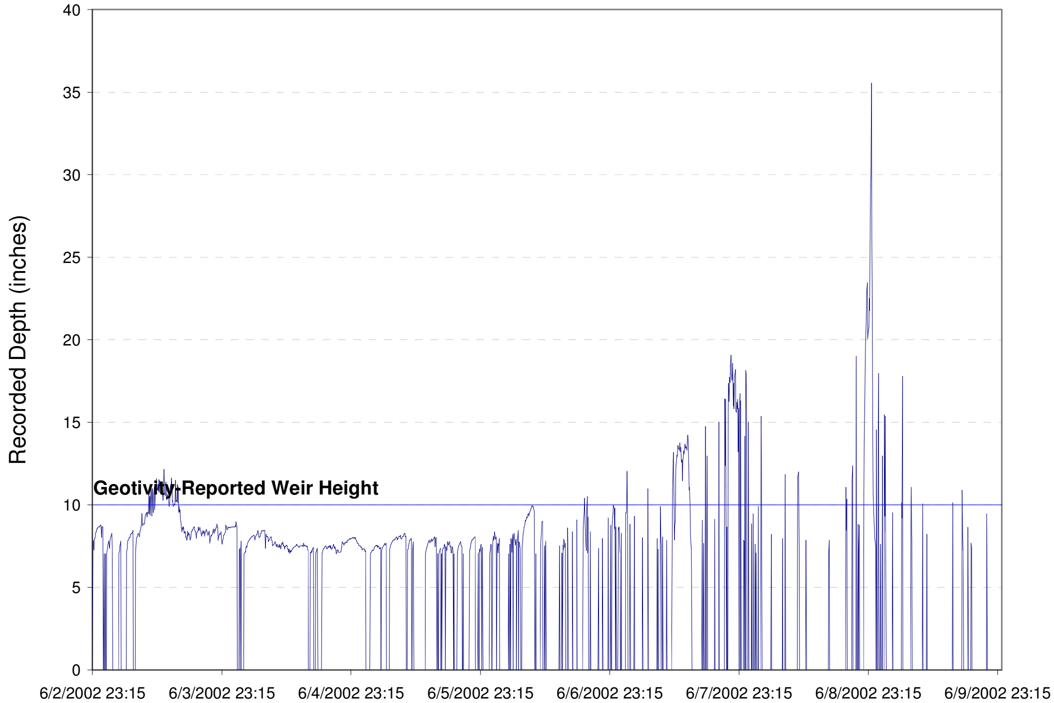

Figure 21. Depth versus Time – 6/3/02 CSO Event (Overflow Structure 165)

- CSO volumes were reported to Ecology for events with unreasonable depth measurements; see Figure 22 for an example (11/4/06 CSO event).

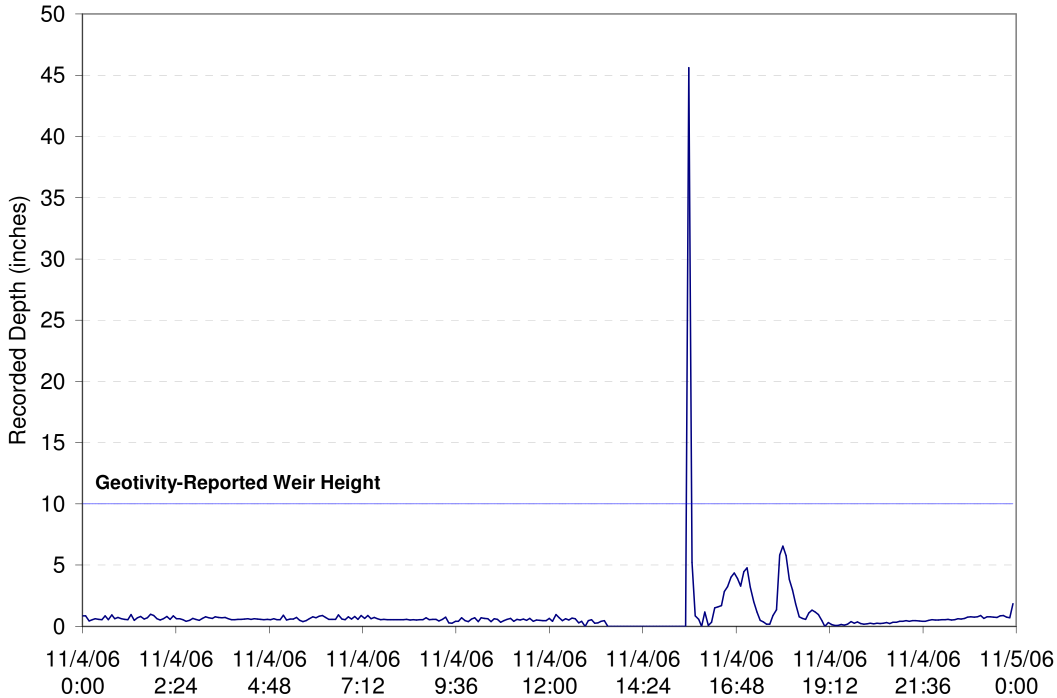

Figure 22. Depth versus Time – 11/4/06 CSO Event (Overflow Structure 165)

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 45 inches (dimension indicated on Geotivity Site Investigation Form). The actual sensor-to-weir height was unable to be determined due to limited documentation. On 12/12/06, the ADS Site Report indicated weir heights of 10.5 inches (right side), 10.5 inches (center), and 10.0 inches (left side). Depth versus time plots of the reported CSO events indicate that the sensor-to-weir height could vary between 2 and 10 inches.

4.8.2 Initial CSO Control Volume

Geotivity monitoring data is available from 3/1/00 through 12/31/06. Within this time period, approximately 39 CSO events were reported to Ecology. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[19] are shown in Figure 23 below for the 10 largest CSO events. The following should be noted:

- With the information provided, it was difficult to determine adequate assumptions to estimate CSO volumes for the following six CSO events: 6/2/01, 6/11/01, 11/12/02, 1/4/03, 1/22/03, and 1/30/03. See Appendix G.1 for details regarding the reasons why the reported CSO volumes could not be determined.
- The 12/24/05 and 11/4/06 CSO events were estimated by not including data that appeared to be inadequate (see Appendix G.2 for depth versus time plots that show unreasonable increases in depth measurements).

[19] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

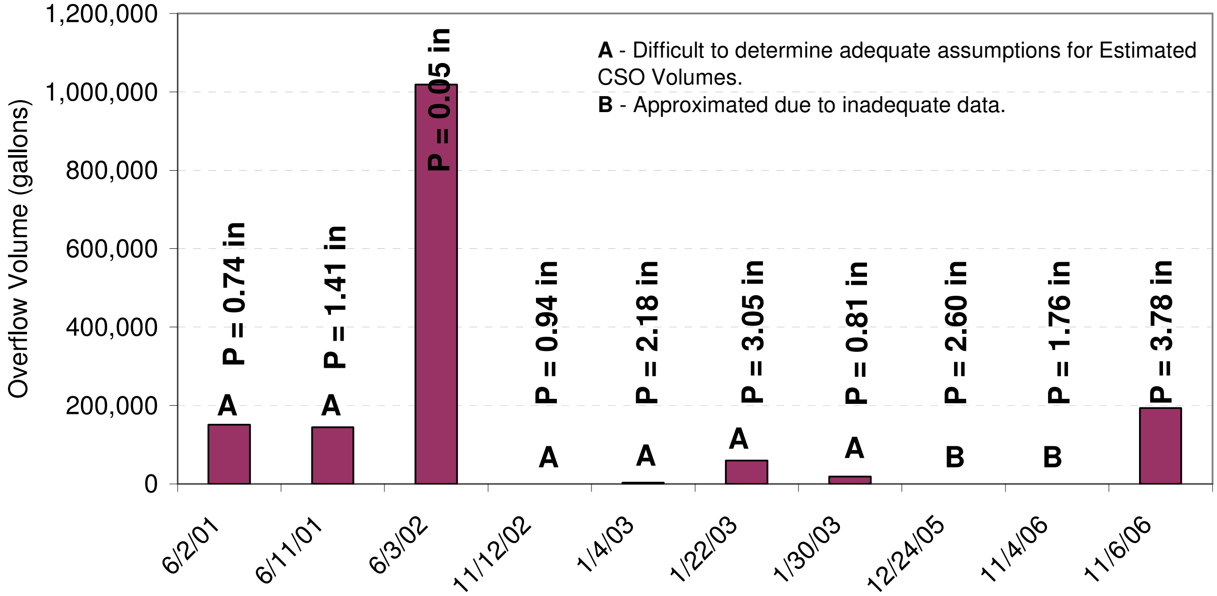

Figure 23. Overflow Structure 165 – Estimated CSO Volumes

A CSO control volume was not estimated for NPDES #165 outfall. With the information provided, it was difficult to determine adequate assumptions to calculate Estimated CSO Volumes for 6 of the largest 10 reported CSO events, and there appears to be inadequate data for some of the monitoring periods.

5.0 Henderson Basin – Findings

The Henderson Basin consists of seven CSO basins corresponding to NPDES outfalls designated by NPDES 44, 45, 46, 47, 48, 49, and 171. The Henderson Basin, NPDES outfalls, and CSO basins are shown in Figure 24.

Recent CSO reporting to Ecology indicates that CSO Basins 46 and 48 are in compliance. CSO Basins 44, 45, 47, 49, and 171 currently appear to exceed an average of one untreated CSO per outfall per year.

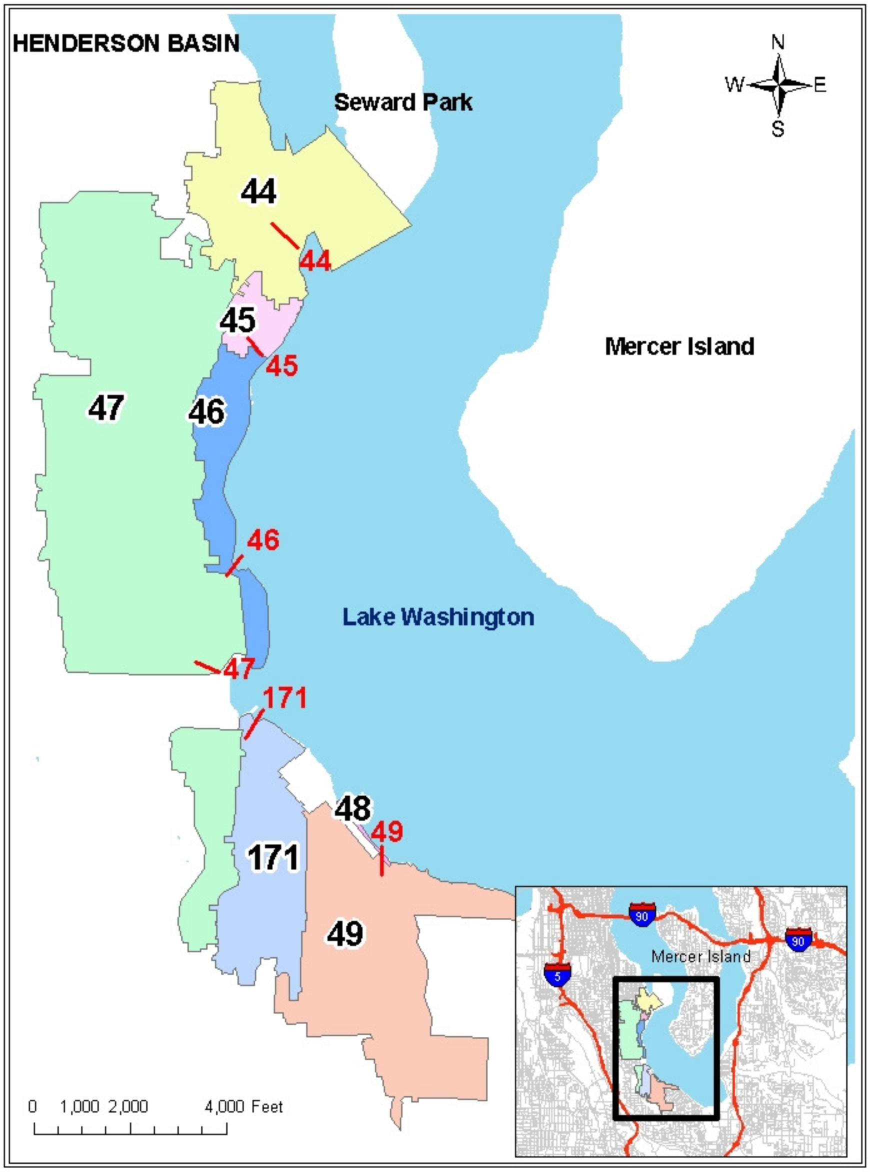

Figure 24. Henderson Basin

5.1 Summary of Initial CSO Control Volume

Table 21 and Figure 25 display the Initial CSO Control Volumes for Henderson Basin NPDES outfalls that were estimated following the methodology presented in Section 3.0 (the Initial CSO Control Volume for NPDES #47 is for CSO Basin 47 North only and does not include CSO Basin 47 South). Sections 5.2 through 5.8 describe the specific assumptions used to estimate Initial CSO Control Volumes for each NPDES outfall. NPDES #48 outfall is currently in compliance. A CSO control volume was not estimated for NDPES #45 outfall, NPDES #46 outfall, or Overflow Structure 47B (CSO Basin 47 South); justification described in Sections 5.3, 5.4, and 5.6.1.2, respectively.

Table 21. Initial CSO Control Volumes for Henderson Basin per NPDES Outfall

NPDES Outfall	Initial CSO Control Volume (Gallons)*	Confidence Rating
44	5,660,000	3
45	Not estimated	NA
46	Not estimated	NA
47 (CSO Basin 47 North)	1,410,000	2
48	0	NA
49	2,730,000	2
171	16,500,000	2
47 (CSO Basin 47 South)	Not estimated	NA

NA = Not Applicable

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

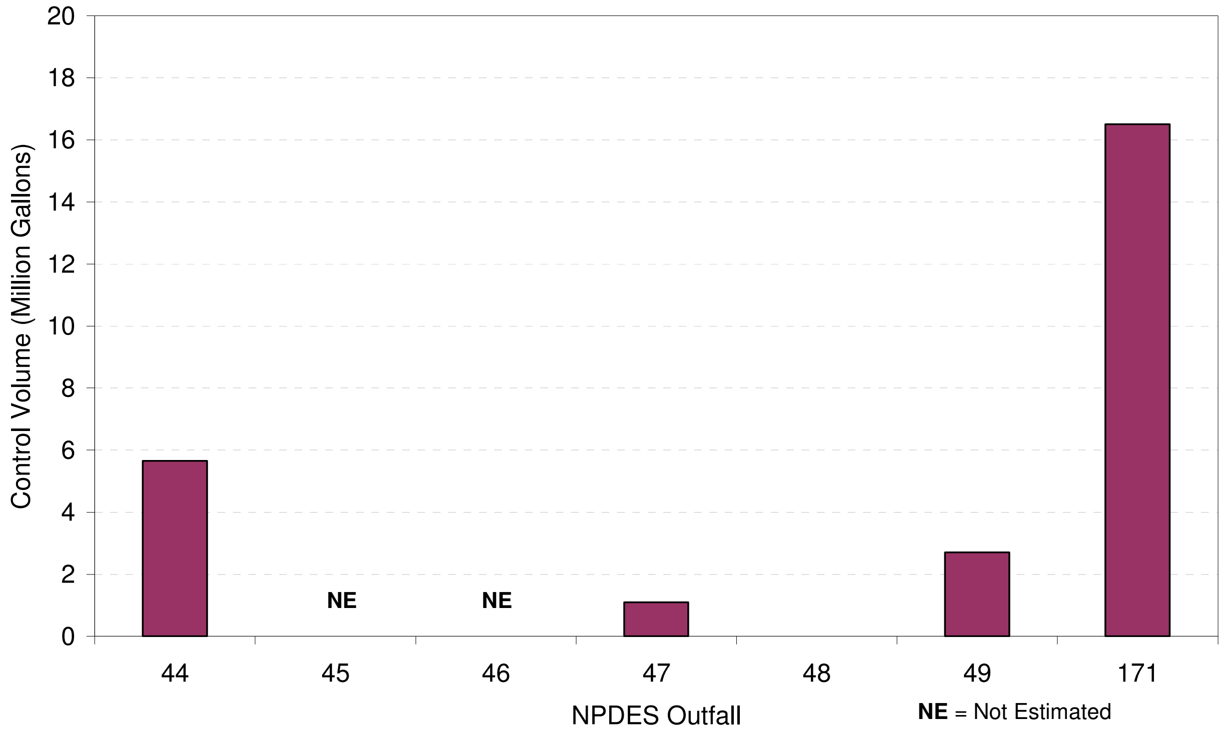

Figure 25. Initial CSO Control Volumes for Henderson Basin per NPDES Outfall

5.2 CSO Basin 44

CSO Basin 44 contains two overflow structures: Overflow Structure 44A (MH 067-274) and Overflow Structure 44B (MH 067-261). Initial CSO Control Volumes were estimated for both overflow structures (described in Sections 5.2.1 and 5.2.2, respectively), and the Initial CSO Control Volume for NPDES #44 outfall is presented in Section 5.2.3.

5.2.1 Overflow Structure 44A

Flows from CSO Basin 44A are conveyed south through a 30-inch-diameter pipe, enter MH 067-272, and pass through a hydrobrake, continuing downstream through CSO Basin 44B. When the flow rate discharging to MH 067-272 exceeds the hydraulic capacity of the hydrobrake, combined sewer backs up in the upstream conveyance system. When combined sewer rises in MH 067-272 and flows over the weir, flow discharges to Overflow Structure 44A (MH 067-274) and is conveyed to CSO Control Facility #8. CSO Control Facility #8 is an offline storage pipeline that contains 100 feet of 84-inch-diameter pipe and 169 feet of 72-inch-diameter pipe, providing approximately 64,000 gallons of storage. Once CSO Control Facility #8 reaches full capacity, excess flow is conveyed over the long, horseshoe weir (located in MH 067-274) to NPDES #44 outfall (overflow weir shown in Figure 26). A schematic diagram of the overflow structure (MH 067-274) is shown in Figure A.7 (Appendix A).

Figure 26. MH 067-274: Overflow Weir

5.2.1.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 22 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix H.1.

Table 22. Overflow Structure 44A - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir
Sensor-to-Weir Height	62.5 inches
Weir Length	145 inches

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 145 inches (dimension indicated on ADS Site Report). Based on a depth meter located on the overflow side of the weir and the Geotivity-installed float switch, the sensor-to-weir height was assumed to be 62.5 inches for the 10 largest reported CSO events. See Appendix H.2 for a sample of depth versus time plots.

5.2.1.2 Initial CSO Control Volume (Overflow Structure 44A)

Geotivity monitoring data is available from 12/19/01 through 12/31/06. Within this time period, 59 CSO events were reported. The eight largest Estimated CSO Volumes as well as the recorded precipitation depths (P)[20] are shown in Figure 27 below. The 2/21/02, 1/22/03, and 12/19/06 CSO events were approximated due to inadequate data during the monitoring periods. The overflow volumes for these events were approximated based on the average percent difference between reported (CSO volumes that were reported to Ecology) and Estimated CSO Volumes from other CSO events. In other words, the Estimated CSO Volume was calculated by multiplying the reported CSO volume (CSO volume that was reported to Ecology) by the average percent difference between the reported CSO volume and Estimated CSO Volumes for other CSO events in which monitoring data is available and appears adequate.

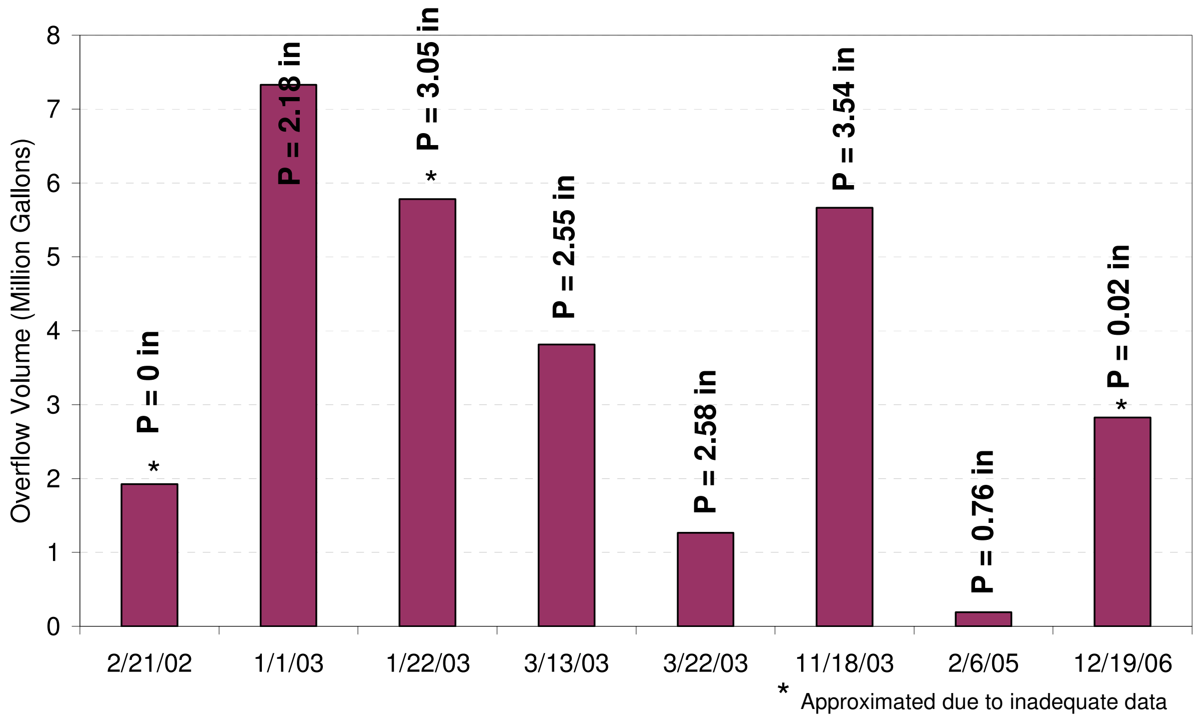

Figure 27. Overflow Structure 44A – Estimated CSO Volumes

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume should be based on the Estimated CSO Volume that corresponds to the 12/19/06 CSO event; however, the data for the 12/19/06 CSO event indicated that the meter may have malfunctioned because depth measurements of 282 inches were recorded. This depth measurement seems unreasonable, particularly since the maintenance hole is only 9 feet (108 inches) deep. For this reason, the Initial CSO Control Volume was based on the 11/18/03 CSO event (instead of the 12/19/06 CSO event) because it is one event larger by volume than 12/19/06. The Initial CSO Control Volume for Overflow Structure 44A is presented in Table 23.

[20] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

Table 23. Overflow Structure 44A – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	5,660,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 23 received a confidence rating of 3 for the following reasons:

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. For these reasons, and because of the possibility that the sensor was moved during the monitoring periods, the sensor-to-weir height was assumed based on engineering judgment and existing data and information available at the time this report was written.
- Record drawings and more recent measurements of weir dimensions differ from the measurements indicated on the Geotivity Site Investigation Form. Record drawings show weir height from the invert of the channel as 78 inches. The ADS Site Report indicates the height of the weir as 62.5 inches (right and left sides of the weir) and 63.5 inches (center of weir); however, the ADS Site Report does not indicate the reference point for these measurements.
- It is difficult to accurately estimate the overflow volume using a weir equation for this overflow structure due to the shape of the weir (see Figure 26). It is also likely that the flow does not uniformly flow over the full length of the weir.
- There appears to be inadequate data for the 2/21/02, 1/22/03, and 12/19/06 CSO events; thus, CSO volumes could not be directly estimated for these events. These Estimated CSO Volumes were included when estimating the Initial CSO Control Volume for Overflow Structure 44A.
- An area-velocity meter and depth meter is currently installed in the inlet pipe to Overflow Structure 44A to indicate when the water surface level is above the crest of the weir. This method should provide a more accurate representation of the overflow volume occurring at Overflow Structure 44A than using a weir equation.

5.2.2 Overflow Structure 44B

Flows from CSO Basin 44B are conveyed through a 15-inch-diameter pipe to MH 067-261, where combined sewer continues downstream to CSO Basin 45. When the capacity of the downstream conveyance system is exceeded, combined sewer backs up in the upstream conveyance system. When combined sewer rises in MH 067-261 to the height of the weir (shown in Figure 28), an overflow occurs, and the CSO is conveyed to NPDES #44 outfall. A schematic diagram of the overflow structure (MH 067-261) is shown in Figure A.7 (Appendix A).

Figure 28. MH 067-261: Overflow Weir

5.2.2.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 24 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix H.3.

Table 24. Overflow Structure 44B - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir
Sensor-to-Weir Height	27.5 inches
Weir Length	75 inches

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 75 inches (dimension indicated on the ADS Site Report). The sensor-to-weir height was assumed as 27.5 inches; this dimension was obtained from a spreadsheet (provided by SPU) titled *Weir Heights June 2002.xls* (presented in Appendix H.3). The dimensions indicated on this spreadsheet did not provide useful information for all structures. An additional depth meter that was assumed to be located on the overflow side of the weir and Geotivity-installed float switch confirmed that an overflow occurred when the depth was approximately 27.5 inches on the upstream side of the weir (sensor-to-weir height). The assumed 27.5-inch-sensor-to-weir height is further confirmed by the ADS Site Report and the sample of depth versus time plots (see Appendix H.4), which indicate that the weir height ranges between 26.5 to 30.5 inches for the Estimated CSO Volumes.

ADS monitoring data from the 12/3/07 CSO event was also reviewed to determine if the largest CSO events may be outlet-controlled (submerged condition). The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of the outfall. If the CSO events are outlet-controlled, then the actual CSO volumes are lower than the CSO volumes calculated (overflow rate estimates would be less in a submerged versus free-flowing condition). The reported CSO volume for this event by ADS was based on the broad-crested weir equation. Figure 29 displays the overflow rates estimated during the 12/3/07 CSO event, and the maximum flow rate was approximately 1,790 gpm (2.6 mgd). Five of the 10 largest reported CSO events (between 2001 and 2006) have estimated maximum flow rates (calculated assuming broad-crested weir and free-flowing conditions) greater than 2.6 mgd (12/3/07 maximum overflow rate); see Appendix H.3 for details. Thus, it may be possible that the pipeline may have inadequate capacity for these CSO events at the larger overflow rates. Thus, using an unsubmerged broad-crested weir equation may be inadequate to estimate some overflow volumes. The possibility of the broad-crested weir being submerged during these CSO events was not accounted for in the Estimated CSO Volumes.

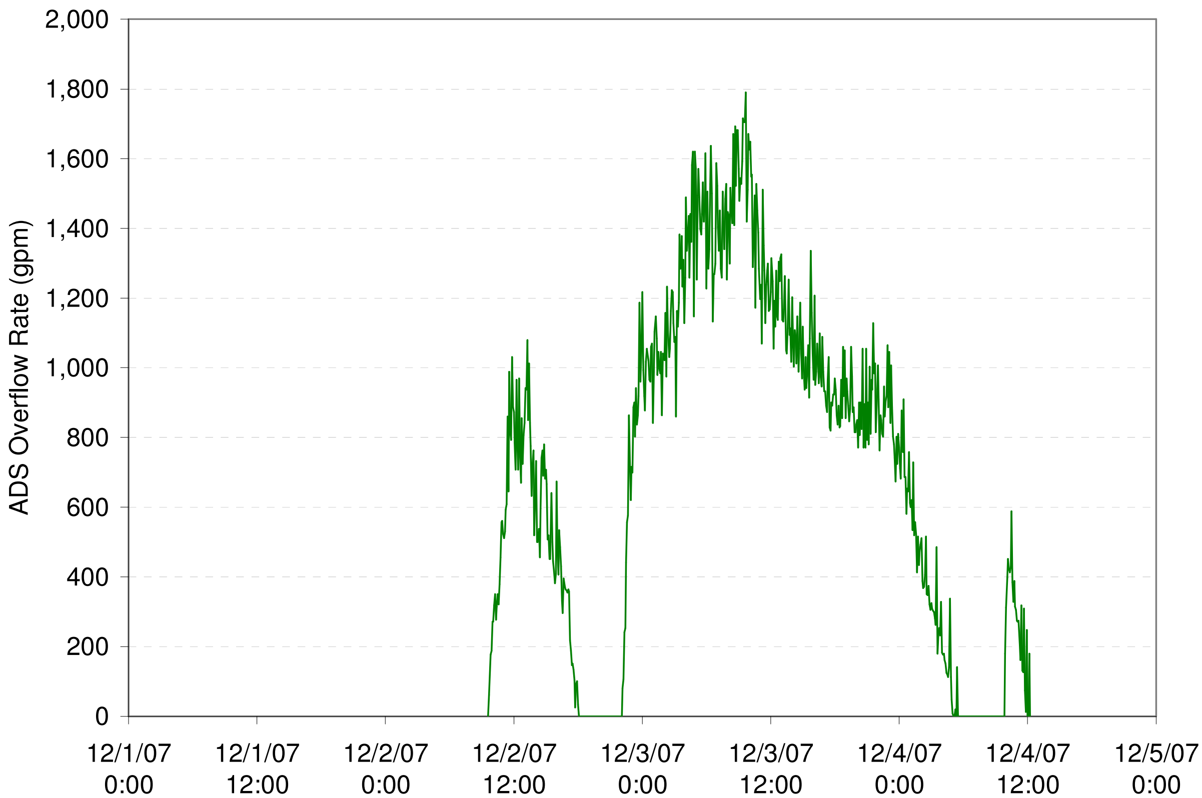

Figure 29. Estimated Overflow Rate - 12/3/07 CSO Event (Overflow Structure 44B)

5.2.2.2 Initial CSO Control Volume (Overflow Structure 44B)

Geotivity monitoring data is available from 1/01/01 through 12/31/06. Within this time period, 111 CSO events were reported. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[21] are shown in Figure 30 below.

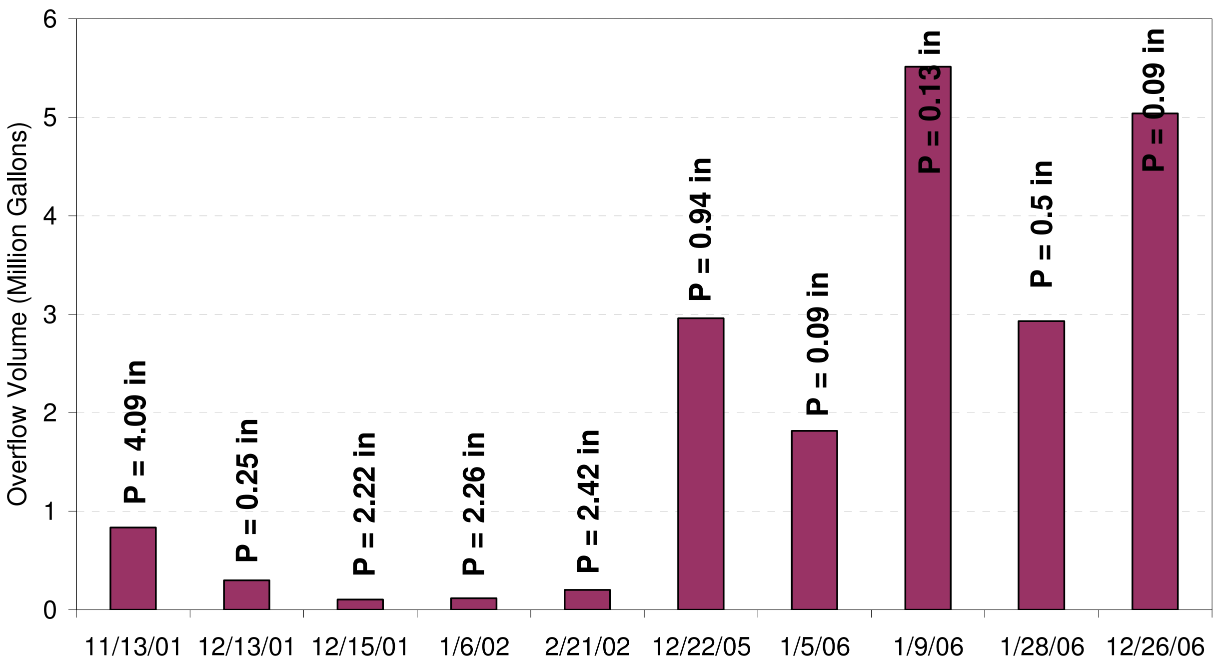

Figure 30. Overflow Structure 44B – Estimated CSO Volumes

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume is based on the Estimated CSO Volume that corresponds to the 11/13/01 CSO event. The Initial CSO Control Volume for Overflow Structure 44B is presented in Table 25.

Table 25. Overflow Structure 44B – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	830,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 25 received a confidence rating of 3 for the following reasons:

[21] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. For these reasons, and because of the possibility that the sensor was moved during the monitoring periods, the sensor-to-weir height was assumed based on engineering judgment and existing data and information available at the time this report was written.
- Record drawings and more recent measurements of weir dimensions differ from the measurements indicated on the Geotivity Site Investigation Form. Record drawings indicate weir height from the invert of the channel as 32.6 inches. The ADS Site Report indicates the height of the weir to be 30.5 inches and 29.5 (right and left sides of the weir, respectively) and 26.5 inches (center of weir); however, the ADS Site Report does not indicate the reference point for these measurements.
- It may be possible that the overflow pipeline had inadequate capacity for larger overflow rates during 5 of the largest 10 reported CSO events (see Appendix H.3 for details). The possibility of the broad-crested weir being submerged during the CSO events was not accounted for in the Estimated CSO Volumes.

5.2.3 Initial CSO Control Volume (NPDES #44 Outfall)

Table 26 lists the Initial CSO Control Volume based on the Estimated CSO Volume that corresponds to the 12/26/06 CSO event. This estimate was determined by adding the Estimated CSO Volumes for the 12/26/06 CSO event at Overflow Structure 44A and Overflow Structure 44B.

Table 26. NPDES #44 Outfall – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	5,040,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

5.3 CSO Basin 45

CSO Basin 45 contains two overflow structures: Overflow Structure 45A (MH 074-153) and Overflow Structure 45B (MH 074-167), and one hydrobrake in MH 074-159. Pump Station No. 10 conveys flow south from CSO Basin 45 to CSO Basin 46. A schematic diagram of the overflow structures (MH 074-153 and MH074-152) is shown in Figure A.8 (Appendix A).

From 2001 to 2006 there were a total of 9 reported CSO events from Overflow Structure 45A. The 6 largest CSOs at Overflow Structure 45A occurred prior to 2003. The hydrographs for this monitoring period do not confirm that these CSOs occurred because the hydrographs show no increase in flow during the rainfall events. The other 3 CSOs occurred in 2005; Geotivity monitoring data from 2005 indicates there were possibly more than 3 CSOs based on the assumed sensor-to-weir height used in the Estimated CSO Volumes. The available monitoring data and information appears to be too incomplete to estimate an Initial CSO Control Volume.

From 2001 to 2006, there were a total of 11 reported CSO events at Overflow Structure 45B. The Geotivity Site Investigation Form indicated that the monitor was located in

Overflow Structure 44A (MH 067-274) in CSO Basin 44. However, photographs show that the monitor was possibly located in MH 074-159; MH 074-159 is unrelated to the NPDES #45 outfall. Because the location of this monitor was unknown, an Initial CSO Control Volume could not be estimated.

5.4 CSO Basin 46

CSO Basin 46 contains one overflow structure, which is located in MH 081-062. CSO Basin 46 conveys flow from CSO Basin 45 and Pritchard Island. A schematic diagram of the overflow structures (MH 081-062) is shown in Figure A.9 (Appendix A).

From 2001 to 2006 there were 4 reported CSO events at Overflow Structure 46. The data for the largest reported CSO event (1/29/04) was unavailable; therefore, this CSO volume could not be confirmed. The second largest reported CSO event (5/8/01) had data indicating that a malfunction occurred in the meter with unreasonable depth fluctuations recorded (e.g., depth jumped from 0 to 203 to 0 inches within a 15-minute period).

Further investigation into the Geotivity data for 2005 showed that there were possibly 9 CSOs that occurred and were not reported (using the assumed sensor-to-weir height). The reason for this discrepancy is unknown. Because of the inconsistencies in the CSO annual reporting and insufficient data for historical CSOs, there is insufficient information to estimate an Initial CSO Control Volume for NPDES #46 outfall.

5.5 CSO Basin 47 North

CSO Basin 47 North contains three overflow structures: Overflow Structure 47C (MH 081-330), Overflow Structure 47D (MH 080-298), and Overflow Structure 47E (MH 080-480). Initial CSO Control Volumes were estimated for all three overflow structures (described in Sections 5.5.1, 5.5.2, and 5.5.3, respectively), and the Initial CSO Control Volume for CSO Basin 47 North is presented in Section 5.5.4.

Flows from CSO Basin 47 North are conveyed to the King County Trunk Sewer. During rain storm events, when combined sewer within each overflow structure rises above the corresponding overflow weir, overflows from all three structures are conveyed to an 84-inch-diameter storm drain. This storm drain is used for stormwater flow and is referred to as NPDES #47 outfall. Schematic diagrams of CSO Basin 47 North are shown in Figures A.10 through A.13 (Appendix A).

5.5.1 Overflow Structure 47C

Overflow Structure 47C is located in MH 081-330. This structure contains an overflow weir and is located downstream from a 78-inch-diameter inline storage pipe. Once the inline storage pipe reaches capacity, the combined sewer will rise until the flow goes over the overflow weir. The CSO is conveyed to the NPDES #47 outfall. See Figure A.10 for a schematic diagram of Overflow Structure 47 C (Appendix A).

5.5.1.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 27 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix I.1.

Table 27. Overflow Structure 47C - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir
Sensor-to-Weir Height	51 inches
Weir Length	364 inches

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 364 inches (dimension indicated on ADS Site Report) and weir height of 51 inches (dimension indicated on Geotivity Site Investigation Form, 6/26/02). It was assumed that the sensor was installed in the invert of the channel (sensor-to-weir height = weir height from invert of channel). The Geotivity-installed float switch was used to confirm the assumed sensor-to-weir height for the Estimated CSO Volumes. See Appendix I.2 for sample of depth versus time plots of reported CSO events.

5.5.1.2 Initial CSO Control Volume (Overflow Structure 47C)

Geotivity monitoring data is available from 6/6/02 through 12/31/06. Within this time period, 15 CSO events were reported. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[22] are shown in Figure 31 below for the 10 largest reported CSO events. The 11/14/01 and 12/13/01 CSO events were approximated for the Estimated CSO Volume because these CSO events occurred before Geotivity meters were installed. The overflow volumes for these events were approximated based on the average percent difference between reported (CSO volumes that were reported to Ecology) and Estimated CSO Volumes from other CSO events. In other words, the Estimated CSO Volume was calculated by multiplying the reported CSO volume (CSO volume that was reported to Ecology) by the average percent difference between the reported CSO volume and Estimated CSO Volumes for other CSO events in which monitoring data is available and appears adequate.

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[22] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

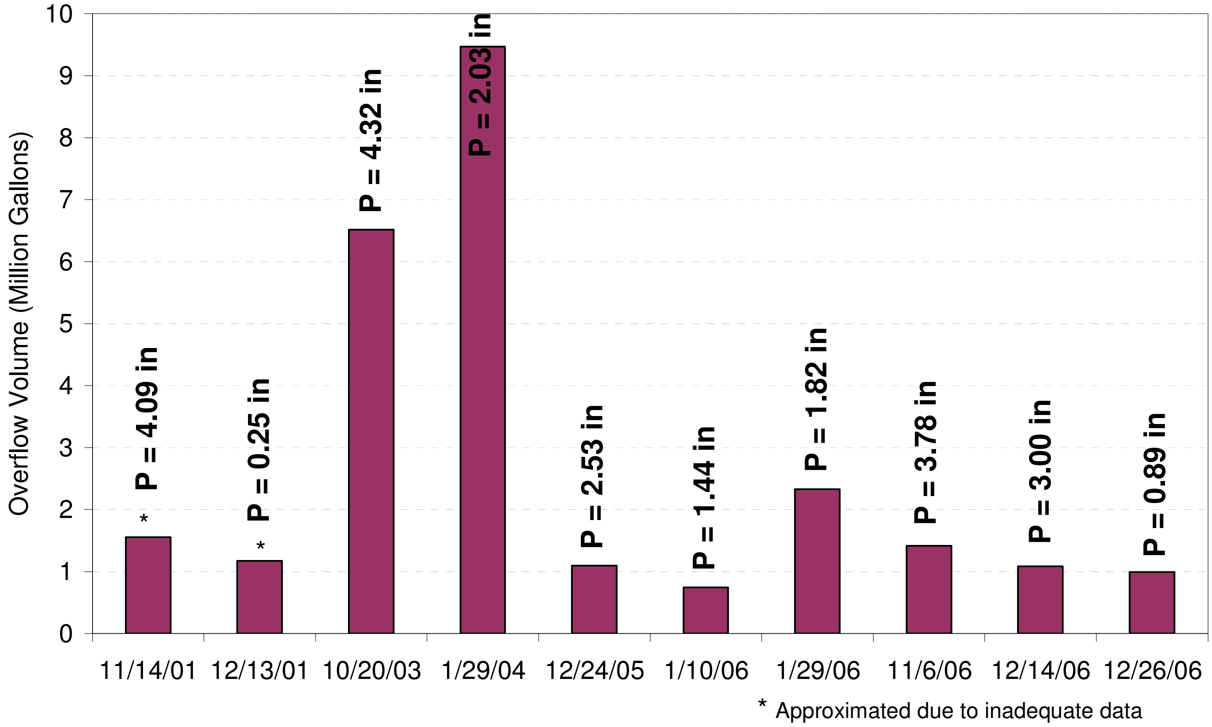


Figure 31. Overflow Structure 47C – Estimated CSO Volumes

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume is based on the Estimated CSO Volume that corresponds to the 11/6/06 CSO event. The Initial CSO Control Volume for Overflow Structure 47C is presented in Table 28.

Table 28. Overflow Structure 47C – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	1,410,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 28 received a confidence rating of 2 for the following reasons:

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. For these reasons, and because of the possibility that the sensor was moved during the monitoring periods, the sensor-to-weir height was assumed based on engineering judgment and existing data and information available at the time this report was written.

- It is difficult to accurately estimate the overflow volume using a weir equation for this overflow structure due to the shape and length of the weir. It is also likely that the flow does not uniformly flow over the full length of the weir.

5.5.2 Overflow Structure 47D

5.5.2.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 29 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix I.3.

Table 29. Overflow Structure 47D - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir
Sensor-to-Weir Height	10 inches
Weir Length	50 inches

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 50 inches and weir height of 10 inches (dimensions indicated on Geotivity Site Investigation Form, 12/19/01). It was assumed that the sensor was installed in the invert of the channel (sensor-to-weir height = weir height from invert of channel). The Geotivity-installed float switch was used to confirm the assumed sensor-to-weir height for the Estimated CSO Volumes.

5.5.2.2 Initial CSO Control Volume (Overflow Structure 47D)

Geotivity monitoring data is available from 12/19/02 through 12/31/06. Within this time period, 4 CSO events were reported. Thus, a CSO control volume is not required for Overflow Structure 47D based on historical Geotivity monitoring data. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[23] are shown in Figure 32 below.

[23] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

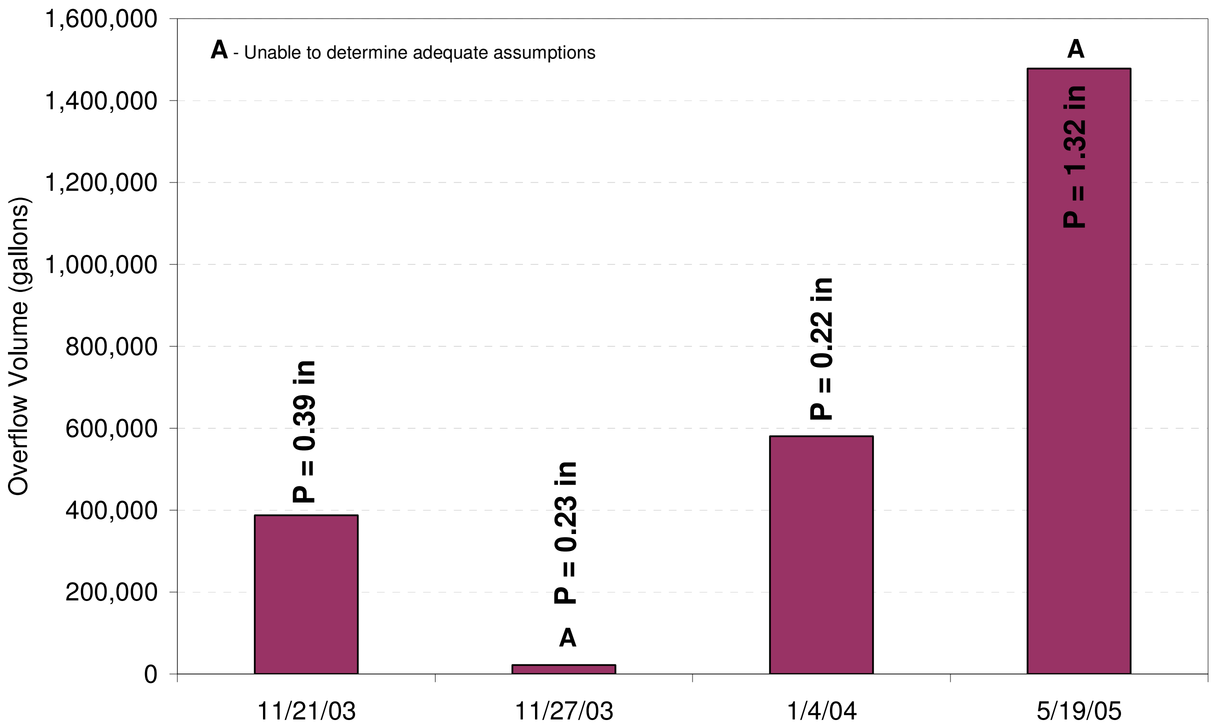


Figure 32. Overflow Structure 47D – Estimated CSO Volumes

The volume for the reported 5/19/05 CSO event could not be confirmed using the historical Geotivity data because the actual sensor-to-weir height was unknown. The confidence in the Estimated CSO Volume for this event is very low because there is no additional information available.

5.5.3 Overflow Structure 47E

One reported CSO event occurred at Overflow Structure 47E from 12/19/2001 to 12/31/2006. Thus, a CSO control volume is not required for Overflow Structure 47E based on historical Geotivity monitoring data.

5.5.4 Initial CSO Control Volume (CSO Basin 47 North)

Table 30 lists the Initial CSO Control Volume based on the Estimated CSO Volume that corresponds to the 11/6/06 CSO event. This estimate was determined by adding the Estimated CSO Volumes for the 11/6/06 CSO event at Overflow Structure 47C (1,410,000 gallons), Overflow Structure 47D (0 gallons), and Overflow Structure 47E (0 gallons).

Table 30. CSO Basin 47 North – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	1,410,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

5.6 CSO Basin 47 South and CSO Basin 171

CSO Basin 47 South and CSO Basin 171 have been included in the same section because Overflow Structure 47B and Overflow Structure 171 are hydraulically linked (schematic diagram is shown in Figure A.14, Appendix A). CSO Control Facility #5 lies between Overflow Structure 47B and Overflow Structure 171. The facility contains 900 feet of 24-inch-diameter pipe and 240 feet of 72-inch-diameter pipe, providing approximately 72,000 gallons of storage. A hydrobrake located in Overflow Structure 171 (MH 081-231) controls flow to the King County Henderson Pump Station.

5.6.1 Overflow Structure 47B

Overflow Structure 47B, located in MH 081-224, is a historically active site with 68 reported CSO events from 2001 to 2006.

5.6.1.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 31 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix I.4.

Table 31. Overflow Structure 47B - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir
Sensor-to-Weir Height	118 inches
Weir Length	27.25 inches

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 118 inches and weir height of 27.25 inches (dimensions indicated on the ADS Site Report, 12/19/06). Figure 33 indicates that the depth sensor may have been located in the invert of the channel during Geotivity monitoring; thus, it was assumed that the sensor was installed in the invert of the channel (sensor-to-weir height = weir height from invert of channel). The Geotivity-installed float switch was used to confirm the assumed sensor-to-weir height for the Estimated CSO Volumes. See Appendix I.5 for a sample of depth versus time plots of reported CSO events.

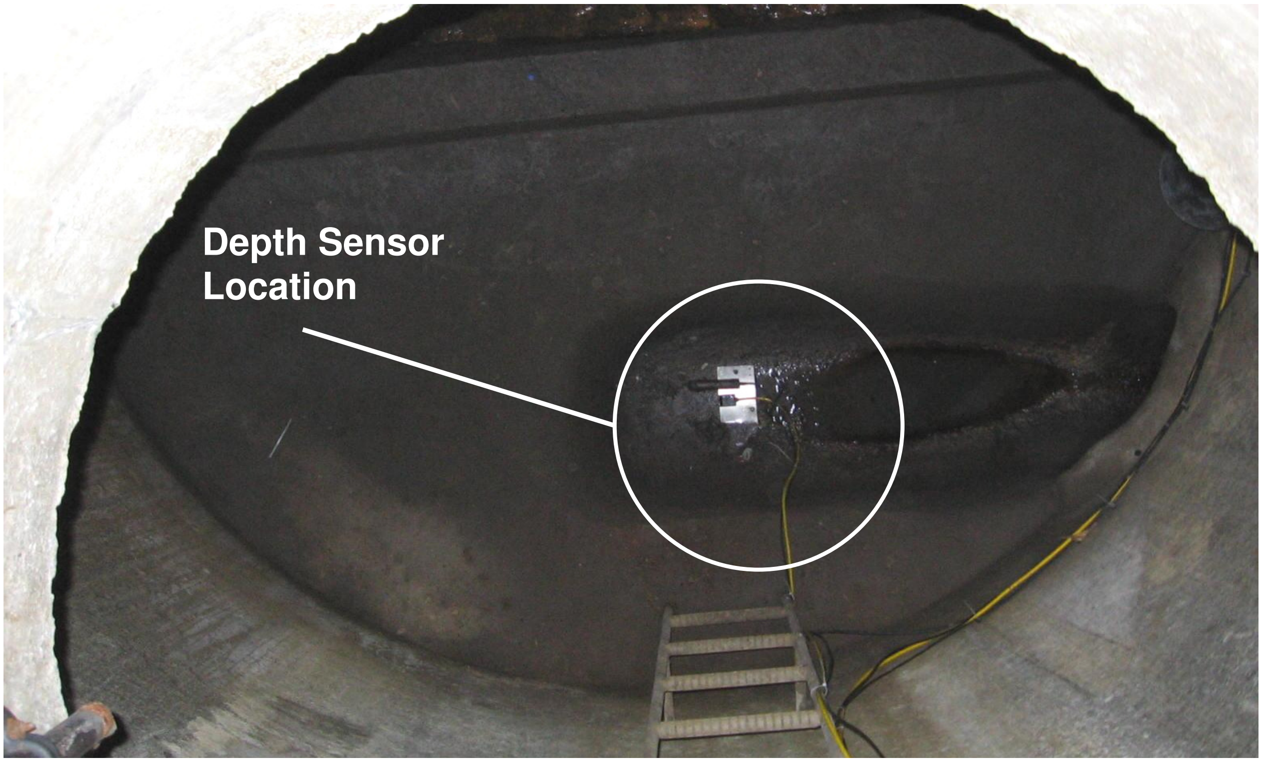


Figure 33. Overflow Structure 47B

5.6.1.2 Initial CSO Control Volume (Overflow Structure 47B)

Geotivity monitoring data is available from 12/19/01 through 12/31/06. Within this time period, 68 CSO events were reported. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[24] are shown in Figure 34 below for the 10 largest reported CSO events.

[24] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

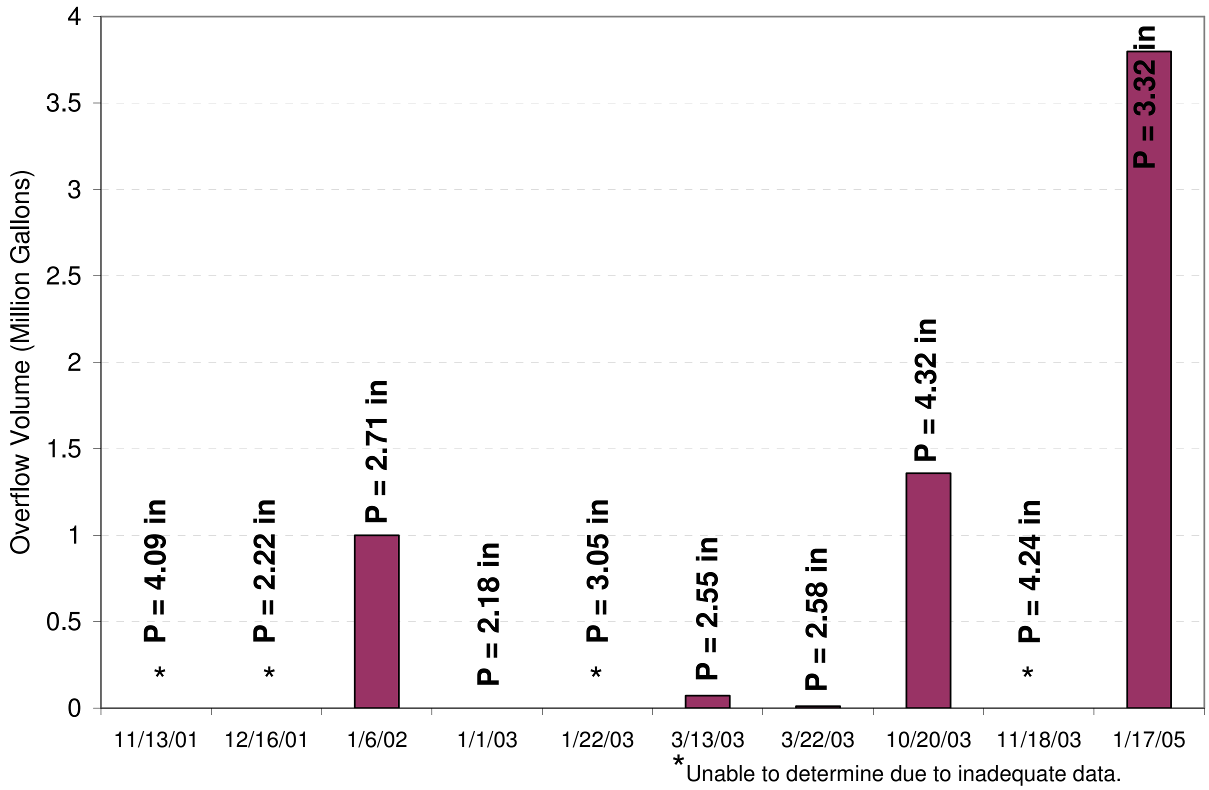


Figure 34. Overflow Structure 47B – Estimated CSO Volumes

Questionable monitoring data is associated with several of the reported CSO events. The depth data for the CSO events in 1/1/03 and 1/22/03 did not confirm that a CSO event occurred based on the assumed sensor-to-weir height; for this reason, the estimate for these events is 0 gallons. The data for the event dated 11/18/03 indicated that the meter was malfunctioning because the depth data showed a head of 36 inches over the weir (based on assumed sensor-to-weir height), which appears to be unreasonable. For these reasons, an Initial CSO Control Volume was not estimated for Overflow Structure 47B.

5.6.2 Overflow Structure 171

Overflow Structure 171, located in MH 081-231, is hydraulically linked to Overflow Structure 47B by CSO Control Facility #5 (see Figure A.14, Appendix A). Overflow Structure 171 is historically active with 56 reported CSO events from 2001 through 2006. Table(3) of the 2006 CSO Annual Report (see Attachment 1) indicates that the 5-year moving average for this site was in compliance with Ecology requirements. Further investigation suggests that the site has a 5-year moving average of approximately 9 CSO events.

5.6.2.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 32 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix J.1.

Table 32. Overflow Structure 171 Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir Overflow rate = 16 mgd
Sensor-to-Weir Height	81 inches
Weir Length	118 inches

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 118 inches and weir height of 81 inches (dimensions indicated on ADS Site Report, 12/19/06). Figure 36 indicates that the depth meter is located in the invert of the channel; thus, it was assumed that the sensor was installed in the invert of the channel (sensor-to-weir height = weir height from invert of channel). The Geotivity-installed float switch was used to confirm the assumed sensor-to-weir height for the Estimated CSO Volumes. See Appendix J.2 for a sample of depth versus time plots of reported CSO events.

For further verification, ADS monitoring data from the 12/3/07 CSO event was reviewed. The 12/3/07 storm was greater than a 100-year return event and could be used to determine the maximum capacity of the outfall. The reported CSO volume for this event was based on the depth and velocity in the overflow pipe. From measurements of the 12/3/07 CSO event, the maximum flow rate was approximately 16 mgd. Another reported CSO event occurred on 1/16/06. The estimated flow rate (sharp-crested weir, free-flowing conditions) is shown in Figure 35, resulting in a maximum flow rate of approximately 47 mgd, which is significantly larger than the maximum 12/3/07 overflow rate. Based on this observation, it was assumed that this overflow structure was outlet-controlled during the 10 largest reported CSO events. A broad-crested weir equation (capped to 16 mgd) was used to calculate Estimated CSO Volumes for each CSO event. For the purposes of these overflow estimates, a CSO event occurs when the water level rises above the crest of the weir.

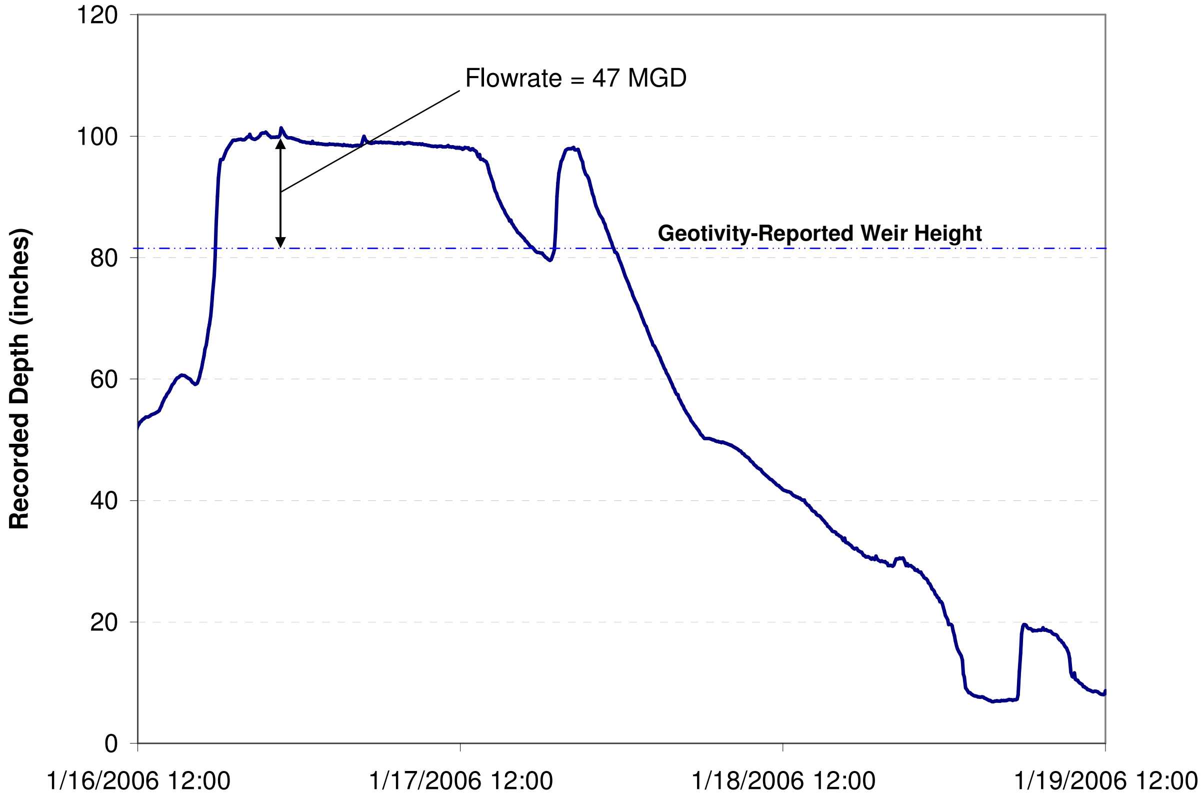


Figure 35. Estimated Overflow Rate (Sharp-Crested Weir) – 1/16/06 CSO Event (Overflow Structure 171)

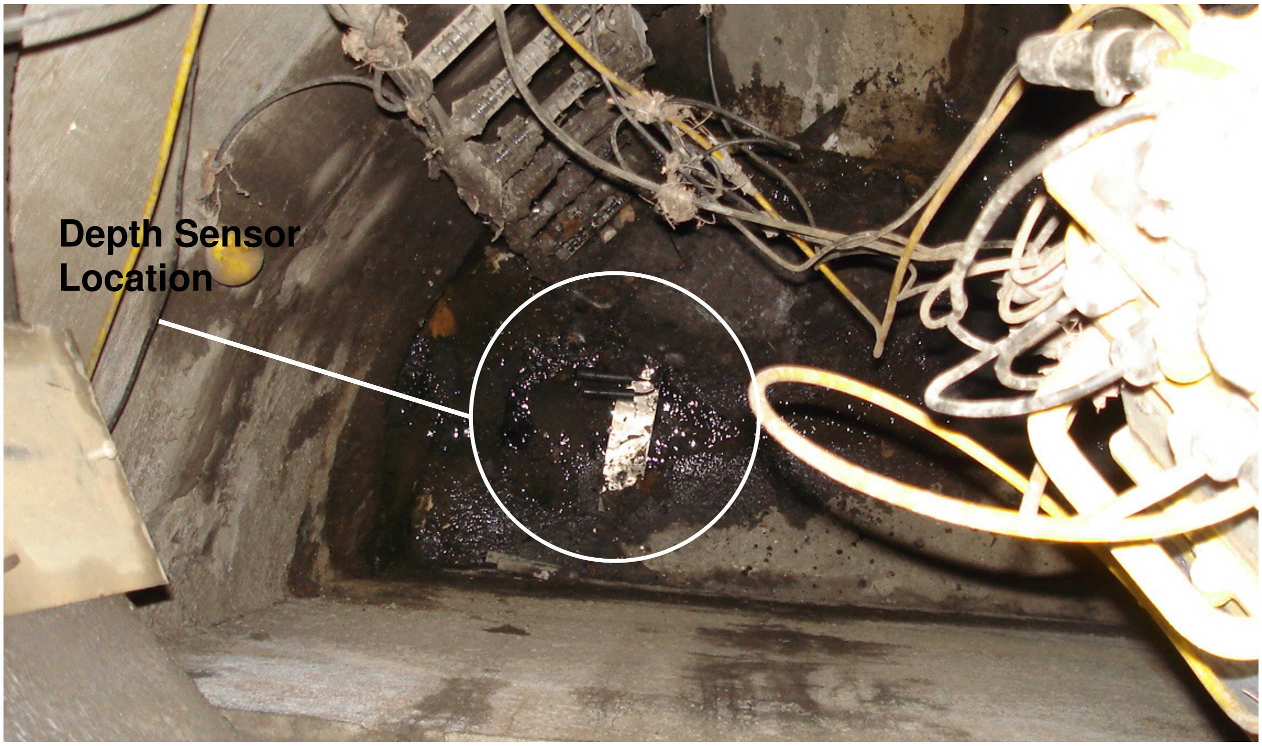


Figure 36. Overflow Structure 171

5.6.2.2 Initial CSO Control Volume (Overflow Structure 171)

Geotivity monitoring data is available from 2/22/02 through 12/31/06. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[25] are shown in Figure 37 below for the 11 largest CSO events.

[25] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

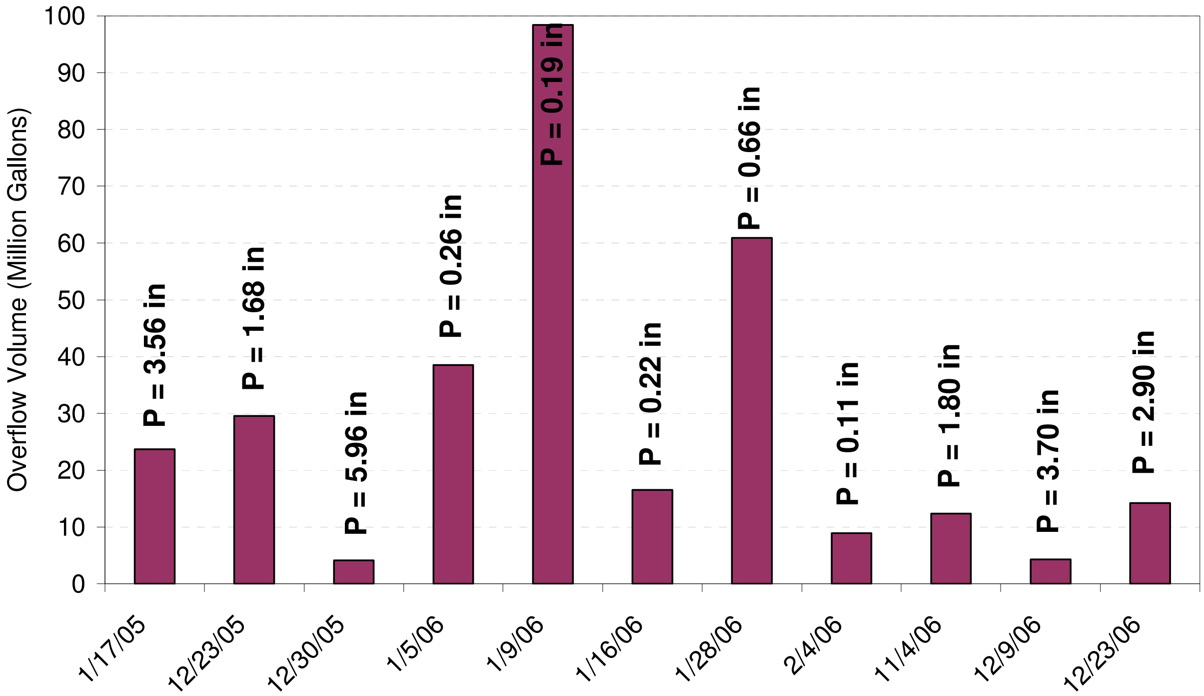


Figure 37. Overflow Structure 171 – Estimated CSO Volumes

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume is based on the Estimated CSO Volume that corresponds to the 1/16/06 CSO event. The Initial CSO Control Volume for Overflow Structure 171 is presented in Table 33.

Table 33. Overflow Structure 171 – Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	16,500,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 33 received a confidence rating of 2 for the following reasons:

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. For these reasons, and because of the possibility that the sensor was moved during the monitoring periods, the sensor-to-weir height was assumed based on engineering judgment and existing data and information available at the time this report was written.

- Hydraulics of CSO Control Facility #5 are not completely understood. Overflow Structure 171 has a weir approximately 4 inches higher than Overflow Structure 47B according to the 2001 Earth Tech Basin Group A Model Development Report. This would imply that the largest CSOs at Overflow Structure 171 are also the largest CSOs at Overflow Structure 47B. The data and reported volumes do not reflect this observation.

  Overflow Structures 171 and 47B have recently been surveyed to verify elevations and determine the hydraulics of CSO Control Facility #5. The hydraulics have not been evaluated yet based on this recent survey data.
- The outfall pipe (downstream of the weir) does not appear to have adequate capacity for flow rates predicted using the weir equation for the largest reported CSO events. The use of another method other than a weir equation is recommended to determine the CSO volumes at this structure.

5.7 CSO Basin 48

NPDES #38 outfall is currently in compliance, with no CSO events reported to Ecology from 2001 through 2006. Thus, a CSO control volume is not required for CSO Basin 48 based on historical Geotivity monitoring data.

5.8 CSO Basin 49

Overflow Structure 49 is located in MH 306-437 (see Figure 38). CSO Control Facility #4 is located between MH 306-437 and MH 306-428 and is approximately 190 feet of 72-inch-diameter pipe and 980 feet of 84-inch-diameter pipe. The offline storage pipe (CSO Control Facility #4) provides approximately 322,000 gallons of storage. A schematic diagram of the overflow structure (MH 306-437) is shown in Figure A.15 (Appendix A).

5.8.1 Assumptions

The assumptions used to calculate the Estimated CSO Volumes are presented in Table 34 and are based on the information provided (described in Section 3.0, Step #4). Details of the assumptions, equations, and sources used to calculate Estimated CSO Volumes for reported CSO events are presented in Appendix K.1.

Table 34. Overflow Structure 49 - Assumptions

	Estimated CSO Volume Assumptions
Weir Type	Broad-crested weir
Sensor-to-Weir Height	68.5 inches
Weir Length	326 inches

Estimated CSO Volumes were determined by applying a broad-crested weir equation to estimate overflow rates with a weir length of 326 inches and weir height of 68.5 inches (dimensions indicated on Geotivity Site Investigation Form, 12/18/01). It was assumed that the sensor was installed in the invert of the channel (sensor-to-weir height = weir height from invert of channel) for the Estimated CSO Volumes. See Appendix K.2 for a sample of depth versus time plots of reported CSO events.

Figure 38. Overflow Structure 49

5.8.2 Initial CSO Control Volume

Geotivity monitoring data is available from 12/18/01 through 12/31/06. Within this time period, 16 CSO events were reported. The Estimated CSO Volumes as well as the recorded precipitation depths (P)[26] are shown in Figure 39 below for the 10 largest CSO events.

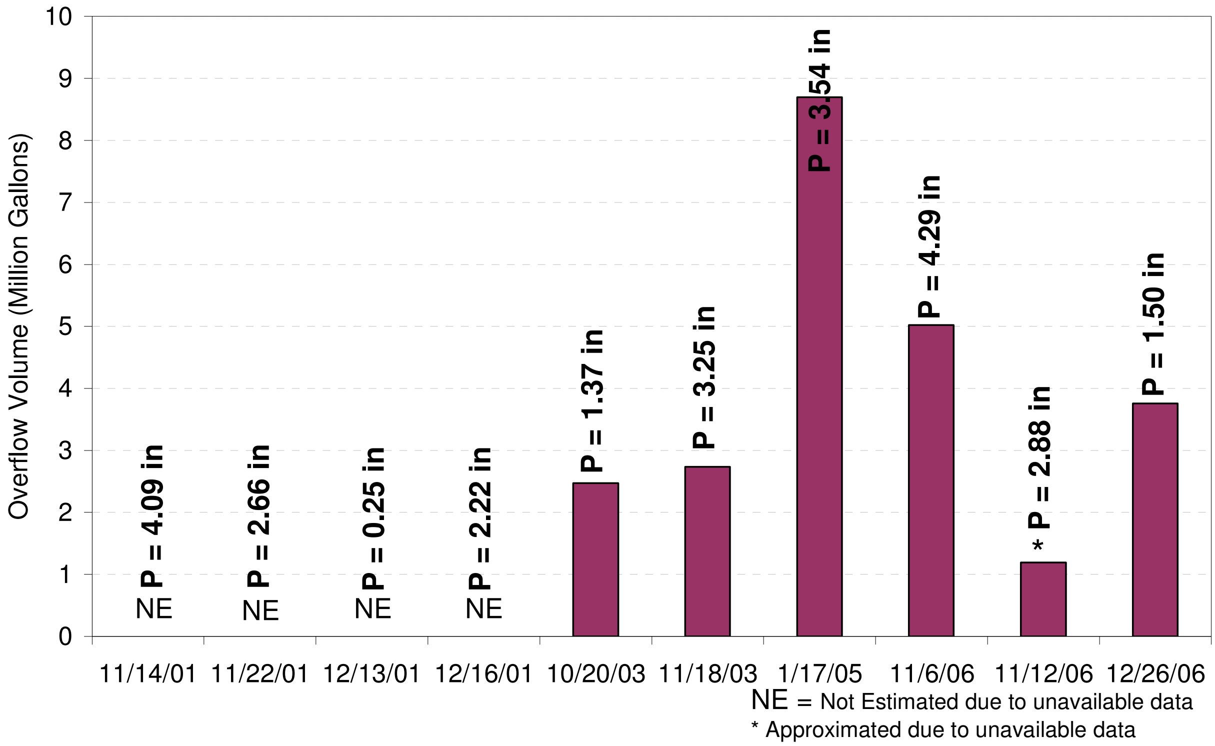


Figure 39. Overflow Structure 49 – Estimated CSO Volumes

The reported CSO events prior to 12/18/01 could not be confirmed because the Geotivity meter was not installed until this date.

After ranking the Estimated CSO Volumes, the recurrence interval for each CSO event was calculated. The CSO event with a recurrence interval of at least one year was selected, and the corresponding CSO volume was documented as the Initial CSO Control Volume. The Initial CSO Control Volume is based on the Estimated CSO Volume that corresponds to the 11/18/03 CSO event. The Initial CSO Control Volume for Overflow Structure 49 is presented in Table 35.

[26] Precipitation depths (total precipitation recorded during CSO events) came from supporting files used to report CSO events to Ecology (see Attachment 1).

Table 35. Overflow Structure 49 - Initial CSO Control Volume

Description	Quantity
Initial CSO Control Volume*	2,730,000 gallons

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

The Initial CSO Control Volume listed in Table 35 received a confidence rating of 2 for the following reasons:

- The actual sensor-to-weir height used during the corresponding monitoring period was not found in the documentation provided and cannot be confirmed because Geotivity sensors are no longer installed. For these reasons, and because of the possibility that the sensor were moved during the monitoring periods, the sensor-to-weir height was assumed based on engineering judgment and existing data and information available at the time this report was written.
- No monitoring data was available for the CSO events prior to 12/18/01.
- Discrepancies exist in weir length measurements. The recent ADS Site Report indicates a weir length of 153 inches, while the Geotivity Site Investigation Form indicates a weir length of 326 inches. ADS is currently confirming the weir measurements.
- It is difficult to accurately estimate overflow volume using a weir equation for this overflow structure because the weir shape is rectangular. The rectangular shape affects the nappe of the flow at the corners, resulting in an inaccurate measurement of flow rate over the weir (if using weir equation to estimate overflow rate). It is also likely that the flow does not uniformly flow over the full length of the weir.

6.0 Combined Sewer Overflow Reduction Plan Amendment (2001)

The Combined Sewer Overflow Reduction Plan Amendment (December 2001) (CSO Plan) presents baseline CSO reductions (referred to as “Reported CSO Control Volumes” in this report), model calibration/validation and rainfall analysis, and CSO reduction alternative analyses for six study areas. Two of the study areas are South Lake Washington/South Genesee Street Area and South Lake Washington/South Henderson Street Area, which correspond to the Genesee and Henderson Basins, respectively. A comparison of the Initial CSO Control Volumes with these Reported CSO Control Volumes in the CSO Plan is summarized in Section 6.4.

6.1 CSO Plan Model Application

SPU used InfoWorks, version 3.00 (June 2000) to model study areas. Infoworks is a modeling package for analyzing urban drainage and wastewater systems. SPU’s Geographic Information Systems (GIS) was used as the basis for system data in the model, and accuracy was confirmed by reviews of record drawings, field investigations, and interviews with City staff.

The models were calibrated using flow data from in-system flow monitoring during both wet and dry seasons. The calibrated models were validated by simulating the precipitation events that induced known overflow from 1998 and 1999.

The performance of the existing system was simulated using precipitation data recorded at the City’s seventeen rain gauges from 1995 through 1999. This five-year period had the most storm events exceeding a 1-year return period in the 60-year historical record. The sixth largest overflow event by volume, occurring during the five-year period, was identified for each basin and selected as the minimum volume that would need to be controlled to reduce overflows to an average of one per year per outfall, averaged over five years. If CSO control facilities were designed to contain the sixth largest overflow volume during a five-year period, there would only be five larger events during that same five years that would result in overflows (resulting in an average of one overflow per year).

6.2 Genesee Basin: Reported CSO Control Volumes

Basins 39 and 41 were shown to have less than one CSO per year on average and are, therefore, in compliance. Table 36 summarizes the estimated Reported CSO Control Volume for the other basins: 39, 40, 41, 42, 43, and 165. The Reported CSO Control Volumes (referred to as “Estimated Baseline CSO Reduction under Existing Conditions” in the CSO Plan) came from Table 7-2 of the CSO Plan.

Table 36. Genesee Basin Reported CSO Control Volumes

CSO Basin	Reported CSO Control Volume (gallons)
39	0
40	1,720,000
41	0
42	290,000
43	445,000
165	97,000

6.3 Henderson Basin: Reported CSO Control Volumes

Basins 47D, 47E, and 48 were shown to have fewer than one CSO per year and are, therefore, in compliance. Table 37 summarizes the Reported CSO Control Volumes for the other basins: 44, 45, 46, 47C, 47D, 47E, 47B, 171, 48, and 49. The Reported CSO Control Volumes (referred to as "Estimated Baseline CSO Reduction under Existing Conditions" in the CSO Plan) came from Table 7-2 of the CSO Plan.

Table 37. Henderson Basin Reported CSO Control Volume

CSO Basin	Reported CSO Control Volume (gallons)
44	2,581,000
45	420,000
46	943,000
Subtotal:	**3,944,000**
47C	871,000
47D	0
47E	0
Subtotal:	**871,000**
47B	184,000
171	353,000
Subtotal:	**537,000**
48	0
49	1,143,000
Subtotal:	**1,143,000**

6.4 Comparison of Reported and Initial CSO Control Volumes

Table 38 and Table 39 present the Reported and Initial CSO Control Volumes for the Genesee and Henderson Basins, respectively. These control volumes differ for the following reasons:

- Different methodologies were used to estimate Reported and Initial CSO Control Volumes. Reported CSO Control Volumes were estimated based on modeling efforts and precipitation data from 1995 - 1999 as described in the CSO Plan (see Section 6.1 for more details). Initial CSO Control Volumes were estimated based on overflow measurements at overflow structures from approximately 2000 – 2001 to 2006 (start dates vary according to overflow structure).
- Some overflow structures were hydraulically modified since the Reported CSO Control Volumes were estimated.
- Calibration of model for Reported CSO Control Volumes is based on precipitation data from 1995 – 1999. Initial CSO Control Volumes were based on flow monitoring data from approximately 2000 – 2001 to 2006 (start dates vary according to overflow structure).
- Confidence ratings assigned to Initial CSO Control Volumes are low. A confidence rating between 0 and 5 (lowest to highest) was assigned to each Initial CSO Control Volume to provide a degree of confidence that the Initial CSO Control Volume would adequately reduce the untreated CSO events to an average of one event per outfall per year. Confidence ratings of Initial CSO Control Volumes are low for the following reasons:
    - The volume of some CSO flows could be restricted due to pipeline capacity during CSO events; thus, a possibility exists that not all the flow discharges through the outfall pipe (e.g., sewer backups).
    - CSO volumes were not estimated in all cases due to insufficient data (e.g., inconsistent depth measurements).
    - The actual locations of the depth sensors (and corresponding sensor-to-weir heights) for the Geotivity monitoring periods are unknown and could not be confirmed. The sensor-to-weir height highly influences CSO volume calculations using weir equations.
    - Potential outlet control and submerged conditions should be incorporated into CSO volume estimates when applicable.
    - CSO volumes may not have been estimated for depth measurements when the meter was potentially malfunctioning (e.g., reading depths higher than surface elevation). In some instances, a CSO volume may have been associated with these depth readings.

Table 38. Reported and Initial CSO Control Volumes for Genesee Basin per NPDES Outfall

NPDES Outfall	Reported CSO Control Volume (Gallons)	Initial CSO Control Volume (Gallons)*	Confidence Rating for Initial CSO Control Volume
37	Not estimated	0	NA
38	Not estimated	Not estimated	NA
40	1,720,000	70,000	2
41	0	1,270,000	1
42	290,000	720,000	2
43	445,000	1,490,000	1
165	97,000	Not estimated	NA

NA = Not Applicable

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

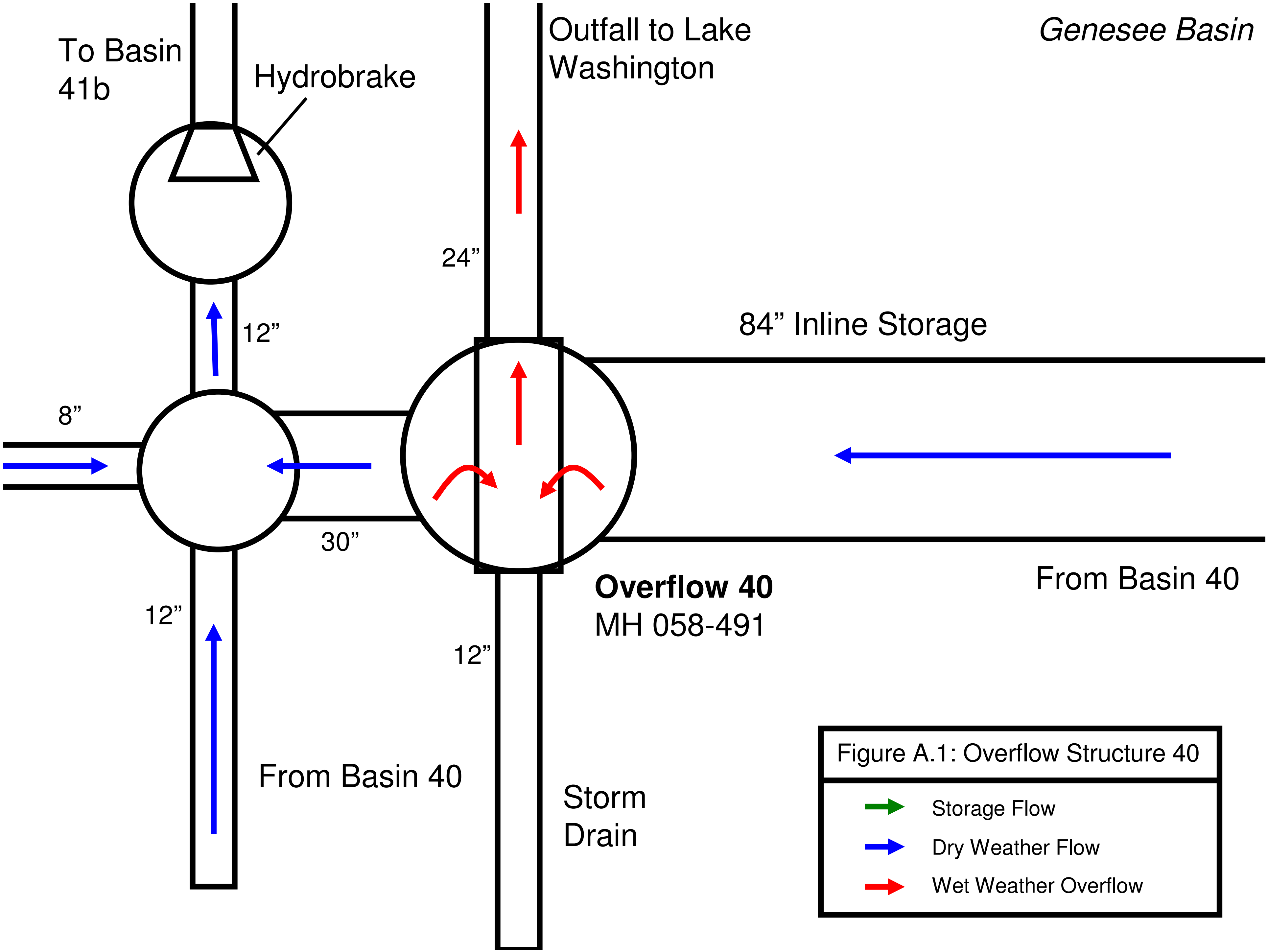
Table 39. Reported and Initial CSO Control Volumes for Henderson Basin per NPDES Outfall

NPDES Outfall	Reported CSO Control Volume (Gallons)	Initial CSO Control Volume (Gallons)*	Confidence Rating for Initial CSO Control Volume
44	2,581,000	5,660,000	3
45	420,000	Not estimated	NA
46	943,000	Not estimated	NA
47 (CSO Basin 47 North)	871,000	1,410,000	2
47 (CSO Basin 47 South)	184,000	Not estimated	NA
48	0	0	NA
49	1,143,000	2,730,000	2
171	353,000	16,500,000	2

NA = Not Applicable

* Initial CSO Control Volume is the quantity (volume) of CSO that would need to be controlled (i.e., not allowed to overflow) during each CSO event such that overall CSO frequency is reduced to one overflow per year per outfall.

Appendix A – Schematic Flow Diagrams


Genesee Basin
To Basin 41b
Hydrobrake
Outfall to Lake Washington
24”
12”
8”
30”
84” Inline Storage
Overflow 40
MH 058-491
From Basin 40
12”
12”
From Basin 40
Storm Drain
Figure A.1: Overflow Structure 40
Storage Flow
Dry Weather Flow
Wet Weather Overflow

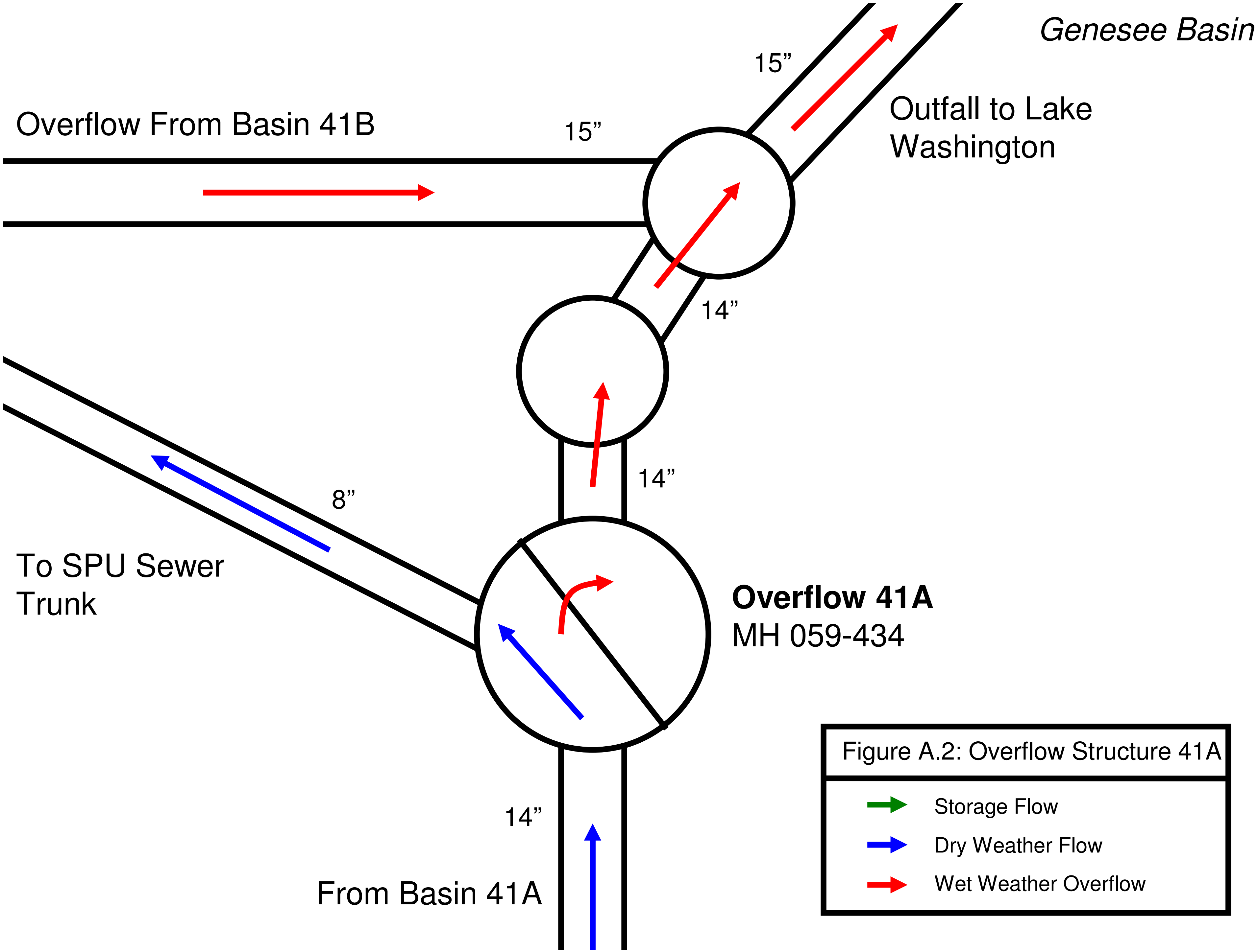


Figure A.2: Overflow Structure 41A

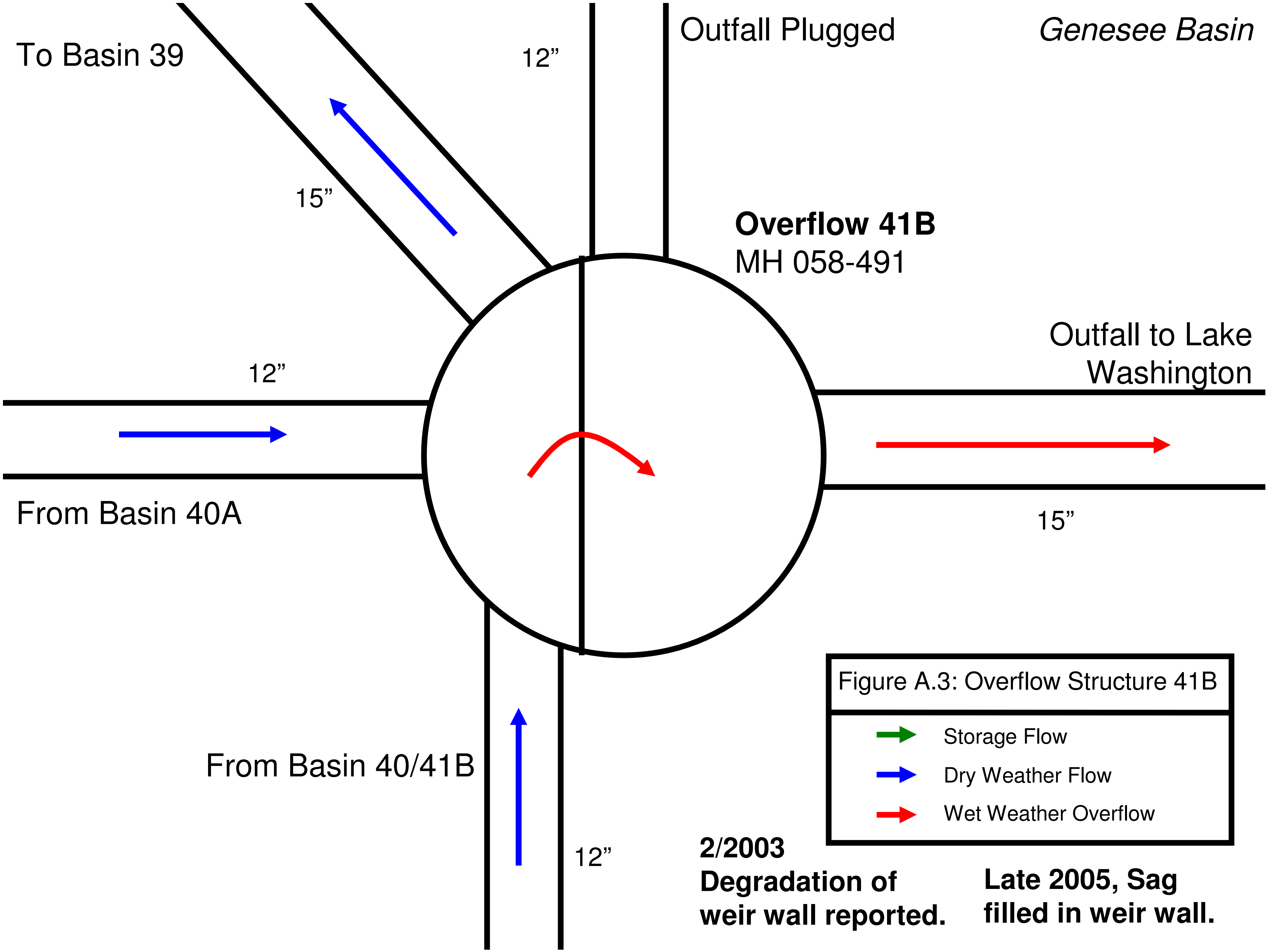


Figure A.3: Overflow Structure 41B

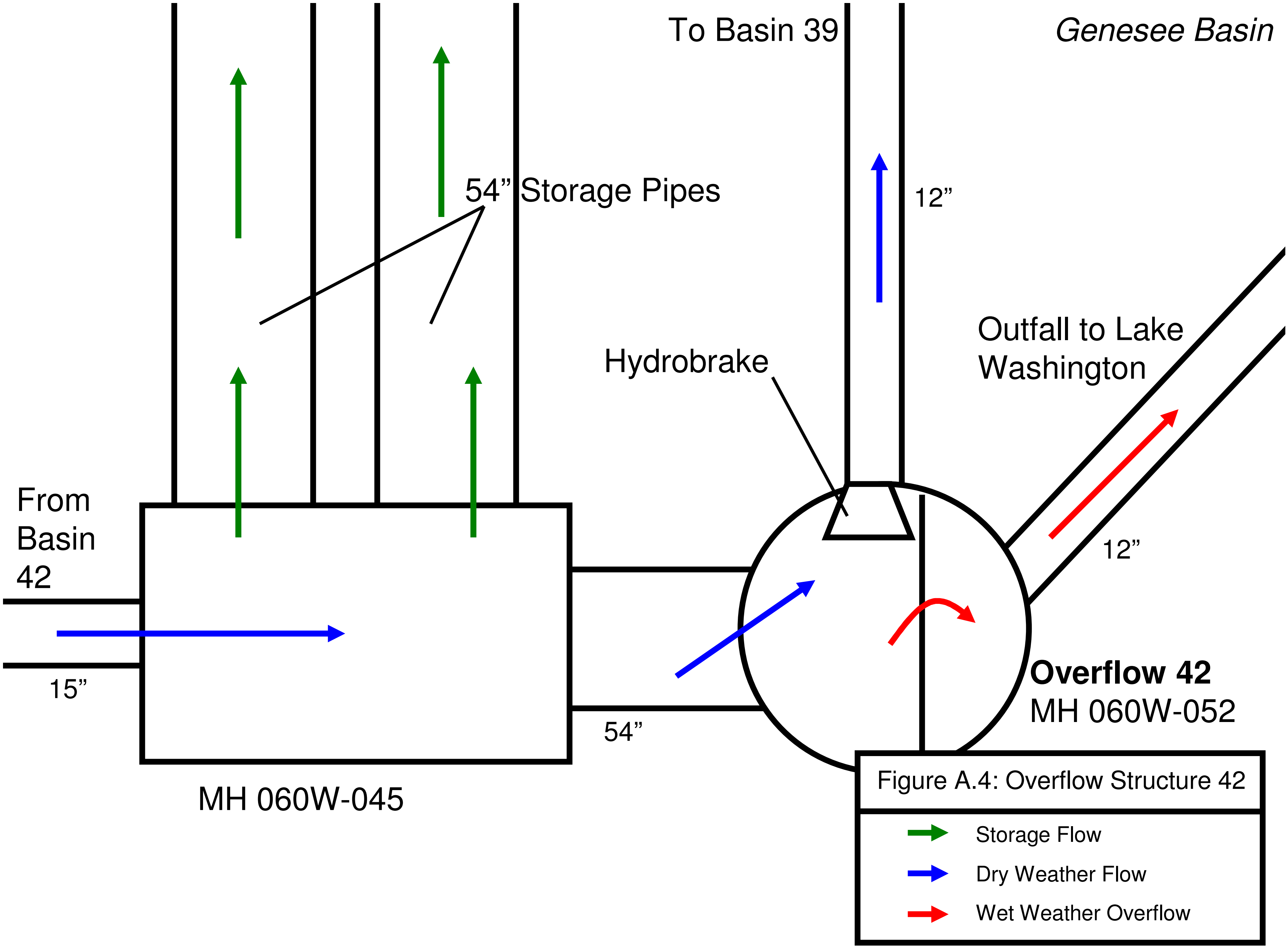


Figure A.4: Overflow Structure 42

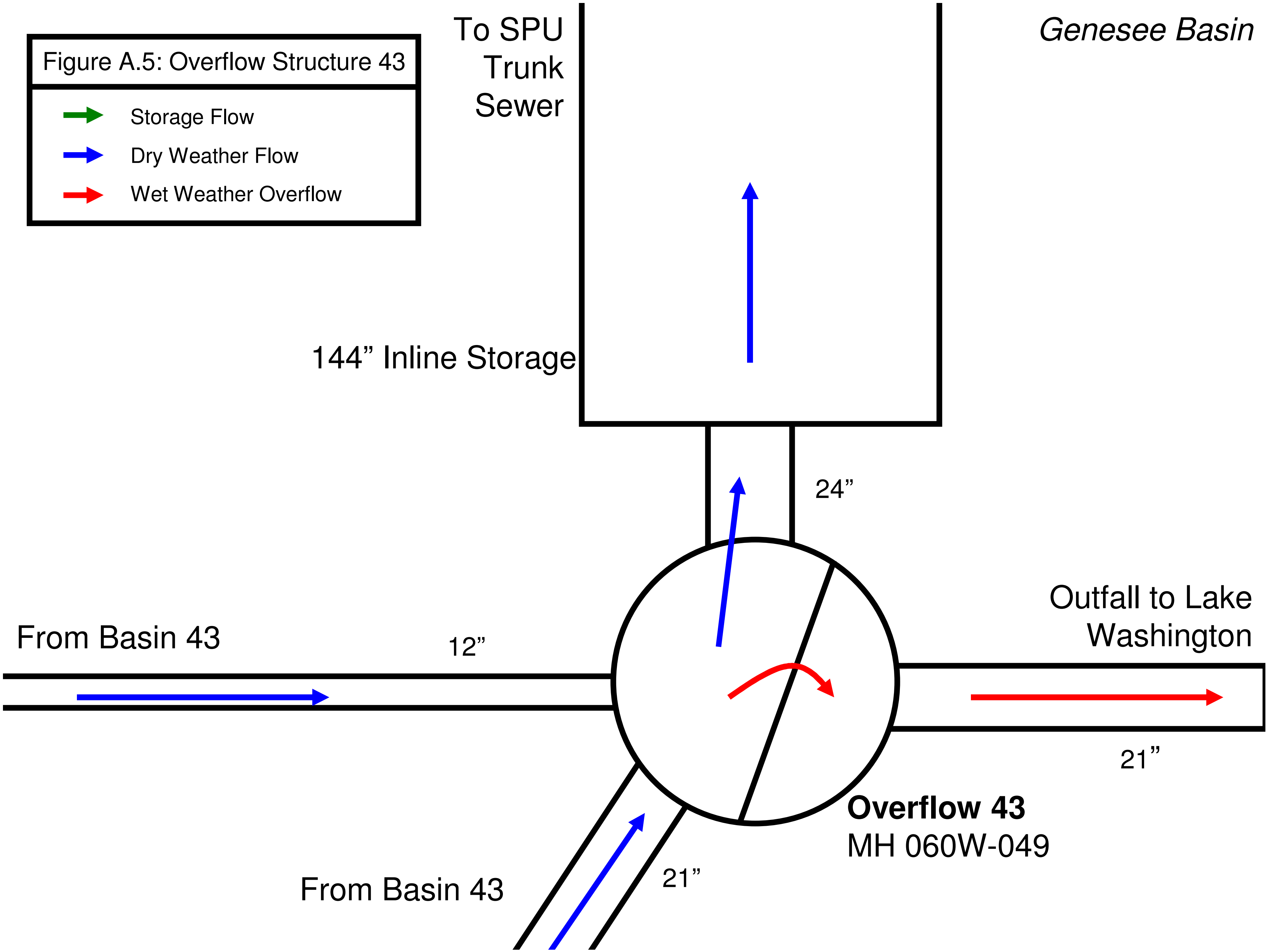


Figure A.5: Overflow Structure 43
Storage Flow
Dry Weather Flow
Wet Weather Overflow
To SPU Trunk Sewer
Genesee Basin
144" Inline Storage
24"
Outfall to Lake Washington
From Basin 43
12"
21"
Overflow 43
MH 060W-049
From Basin 43
21"

Genesee Basin

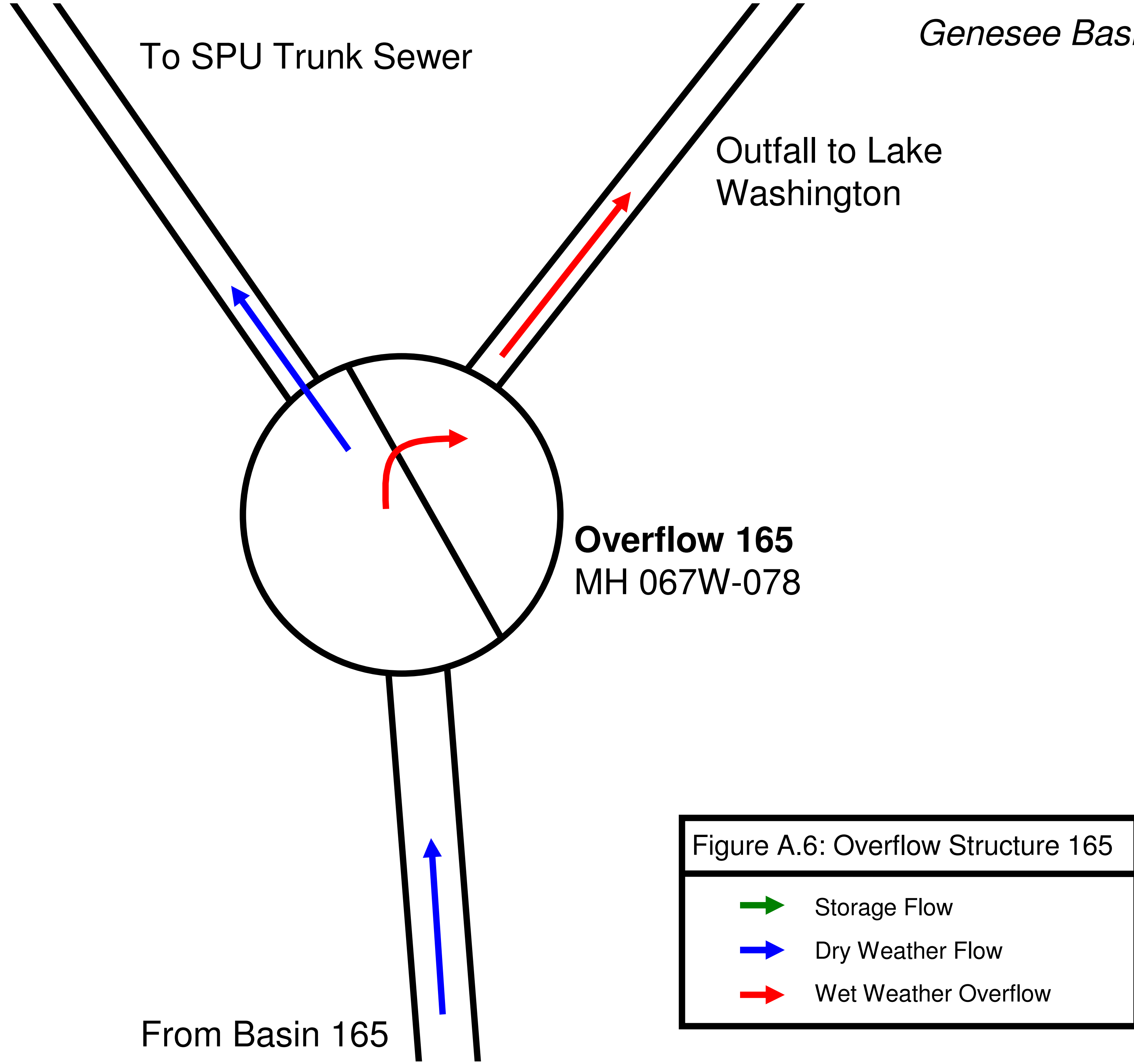


Figure A.6: Overflow Structure 165

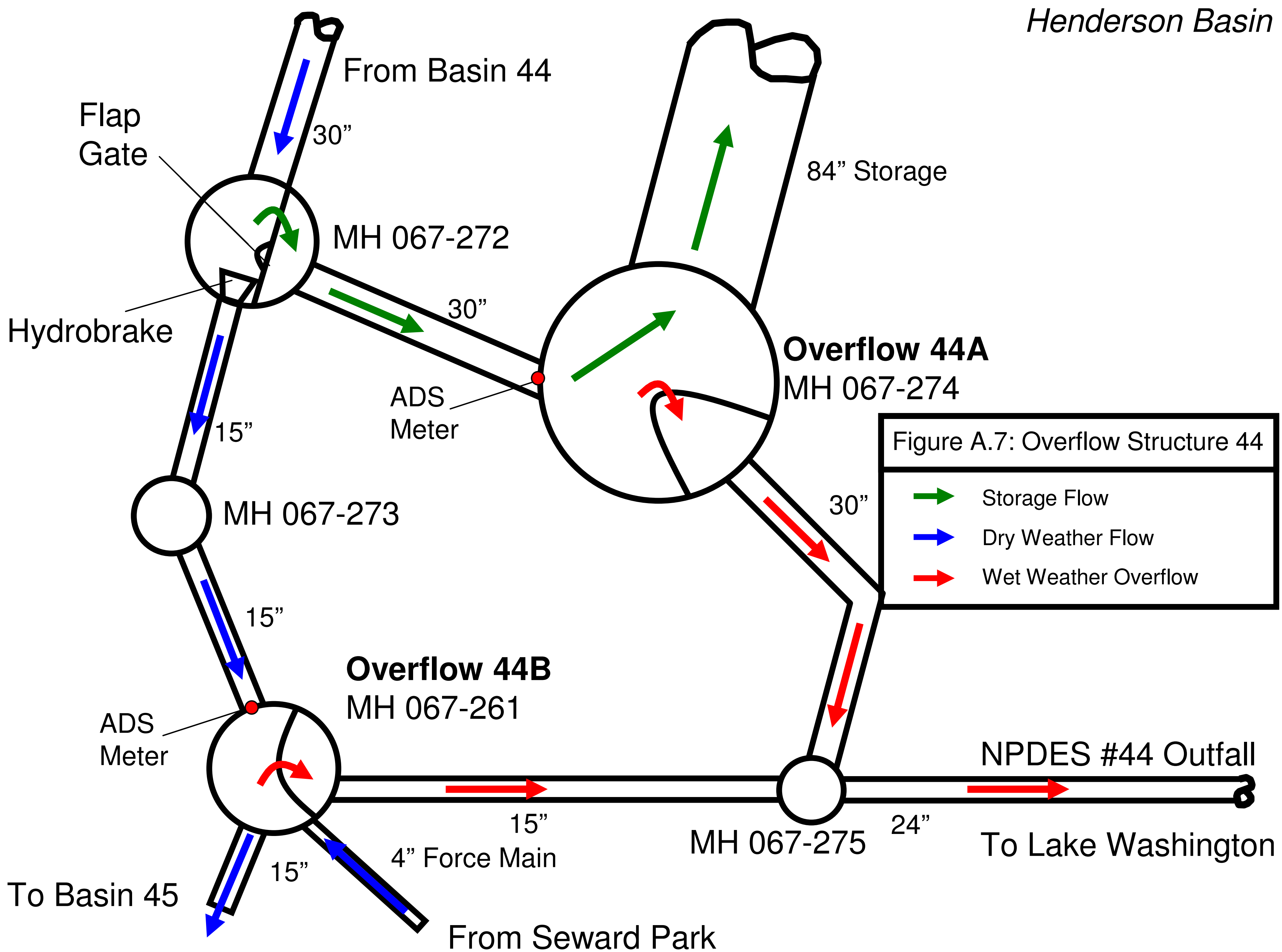


Figure A.7: Overflow Structure 44

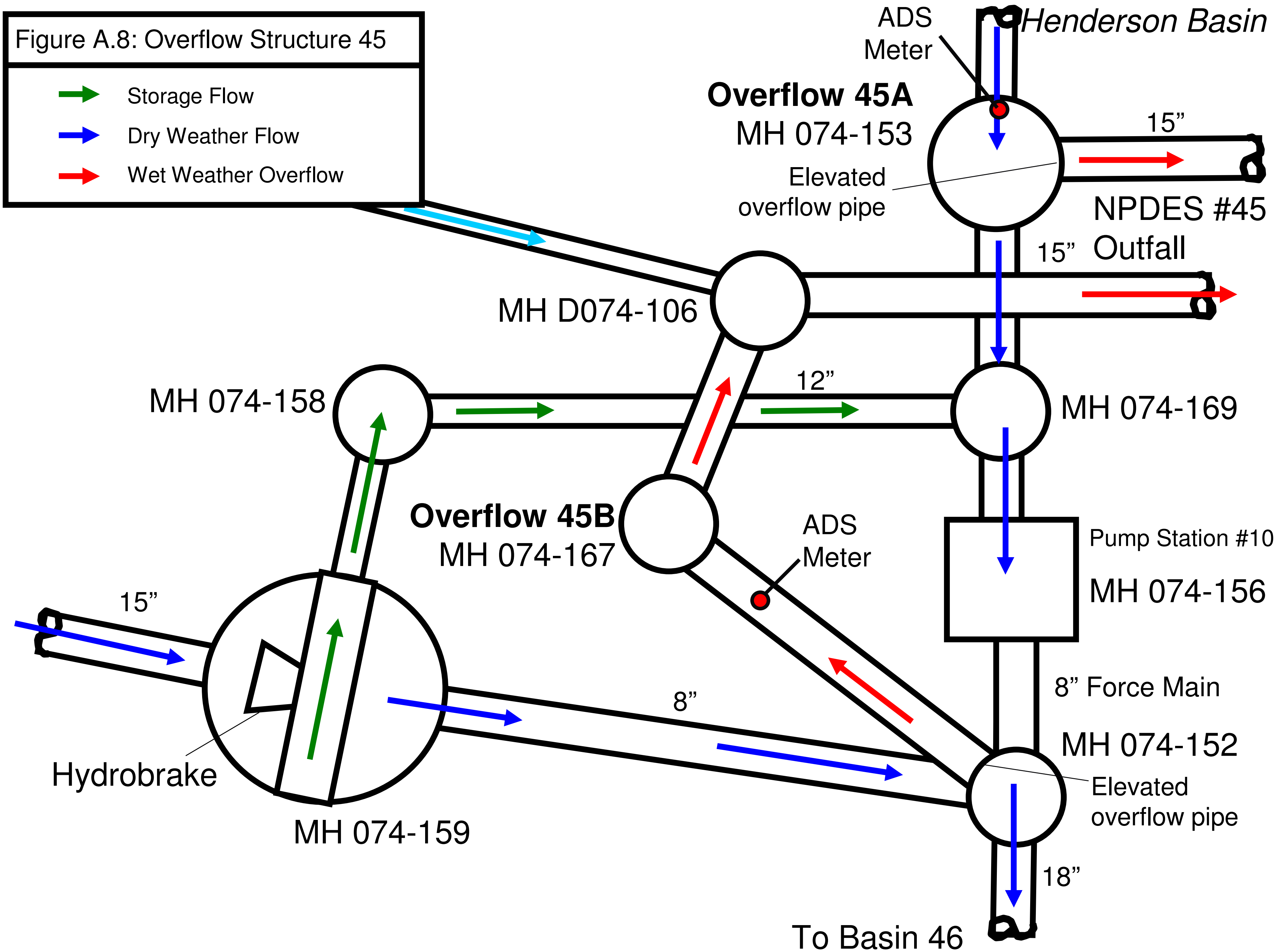


Figure A.8: Overflow Structure 45
Storage Flow
Dry Weather Flow
Wet Weather Overflow
ADS
Meter
Henderson Basin
Overflow 45A
MH 074-153
15”
Elevated
overflow pipe
NPDES #45
Outfall
15”
MH D074-106
12”
MH 074-158
MH 074-169
Overflow 45B
MH 074-167
ADS
Meter
Pump Station #10
MH 074-156
15”
8” Force Main
8”
MH 074-152
Elevated
overflow pipe
Hydrobrake
MH 074-159
18”
To Basin 46

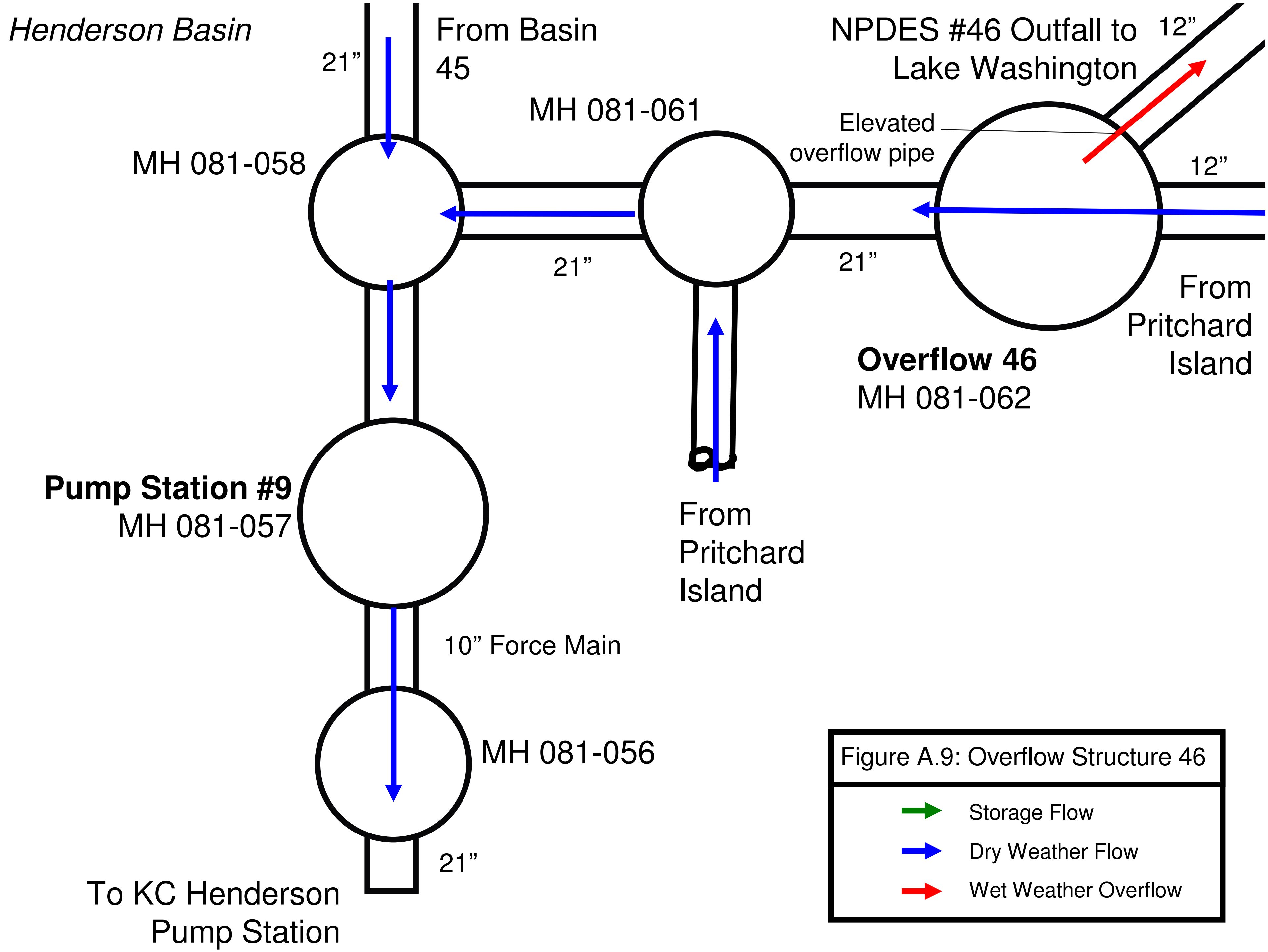
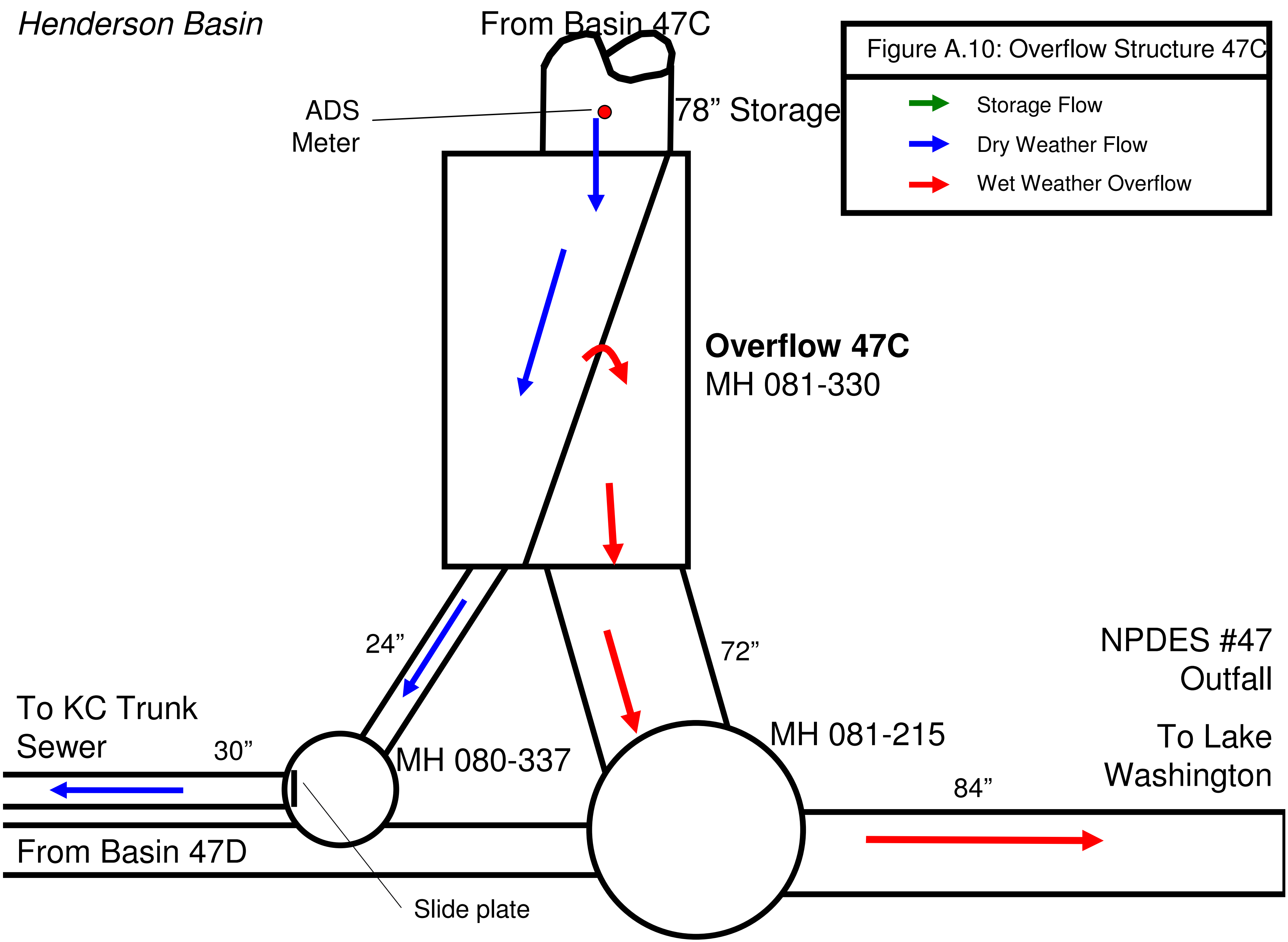
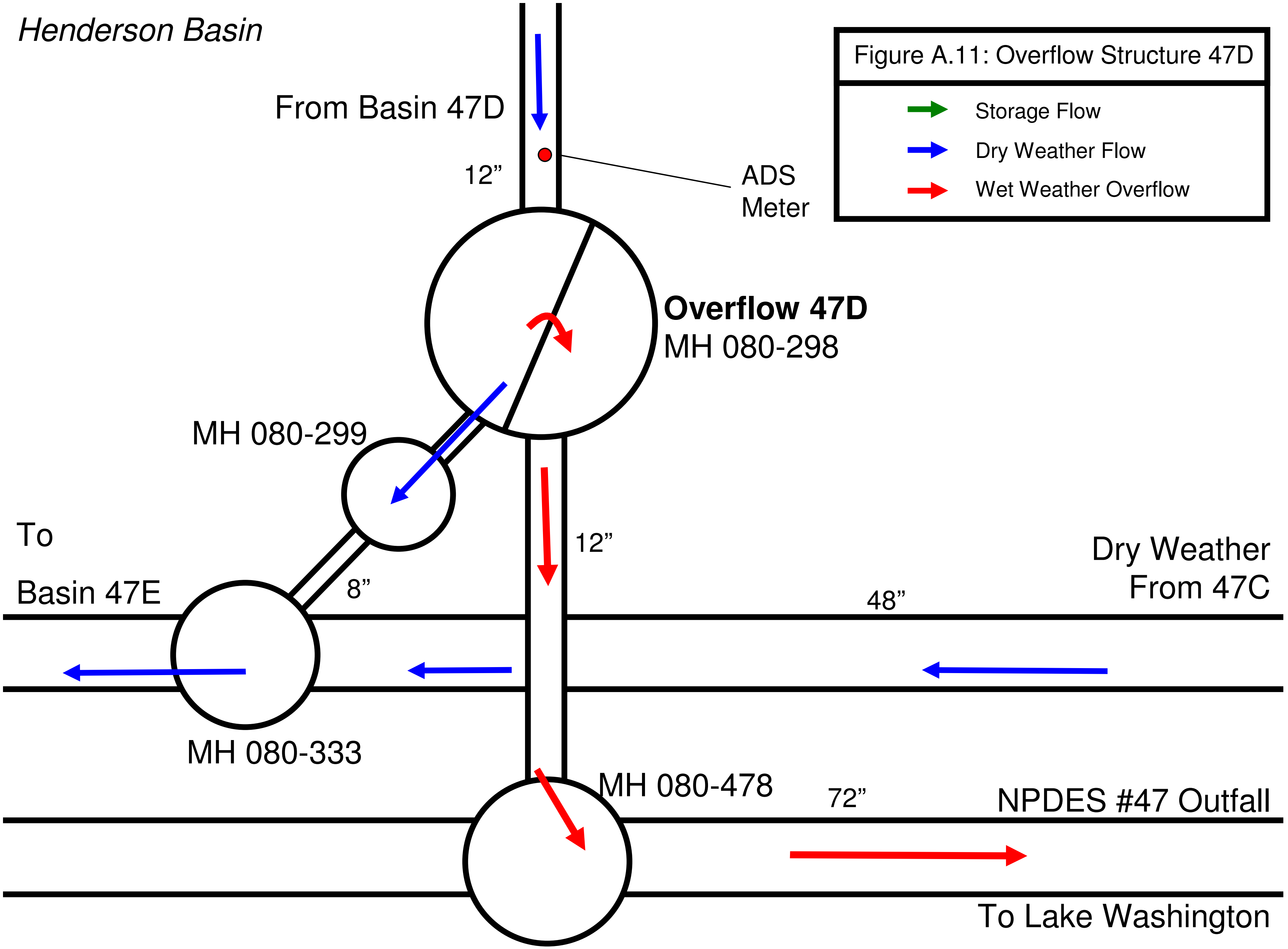


Figure A.9: Overflow Structure 46


Henderson Basin
From Basin 47C
Figure A.10: Overflow Structure 47C
Storage Flow
Dry Weather Flow
Wet Weather Overflow
ADS
Meter
78” Storage
Overflow 47C
MH 081-330
24”
72”
NPDES #47
Outfall
To KC Trunk
Sewer
30”
MH 080-337
MH 081-215
To Lake
Washington
84”
From Basin 47D
Slide plate



Henderson Basin
Figure A.11: Overflow Structure 47D
Storage Flow
Dry Weather Flow
Wet Weather Overflow
From Basin 47D
12”
ADS
Meter
Overflow 47D
MH 080-298
MH 080-299
12”
To
Basin 47E
8”
Dry Weather
From 47C
48”
MH 080-333
MH 080-478
72”
NPDES #47 Outfall
To Lake Washington

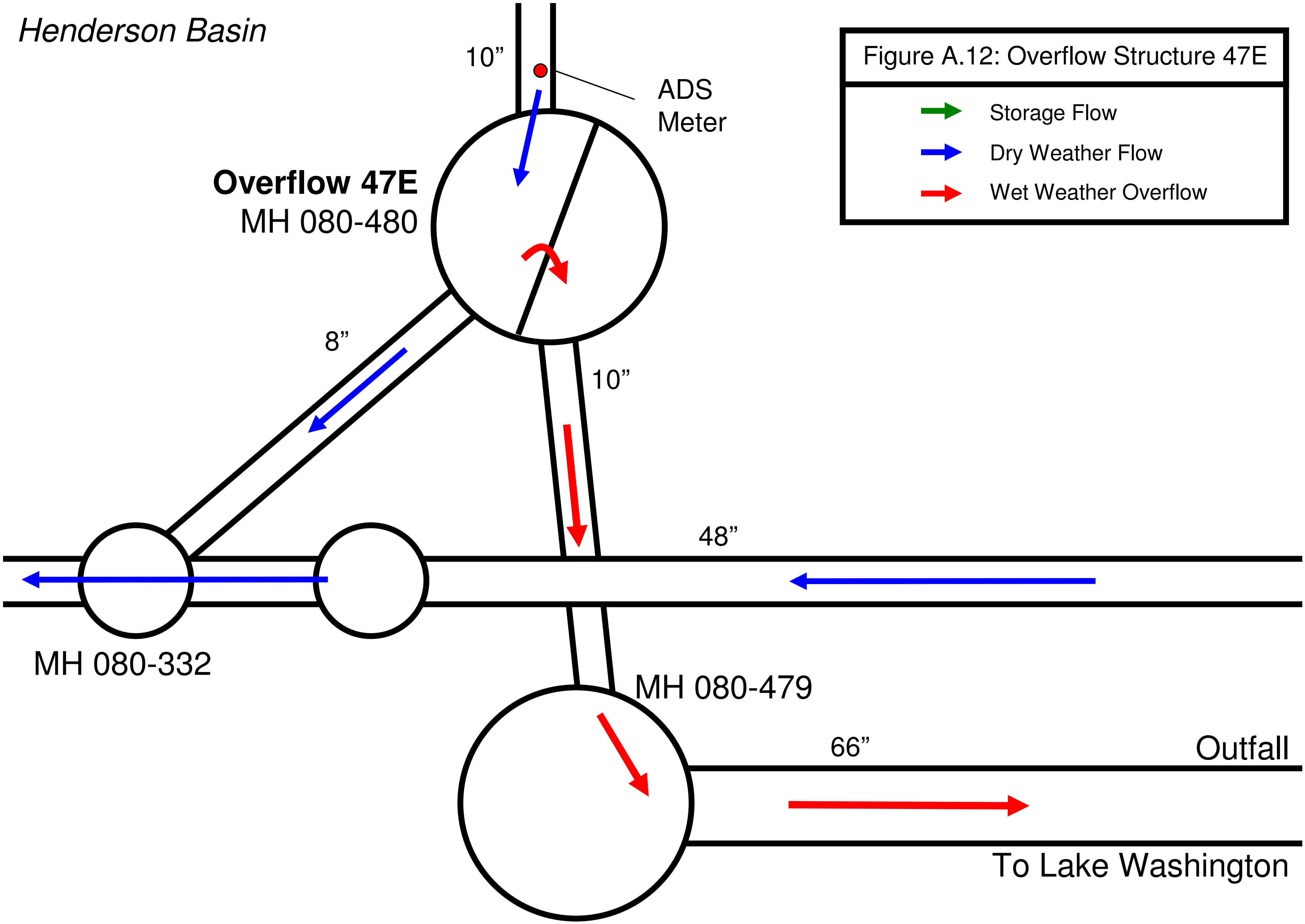
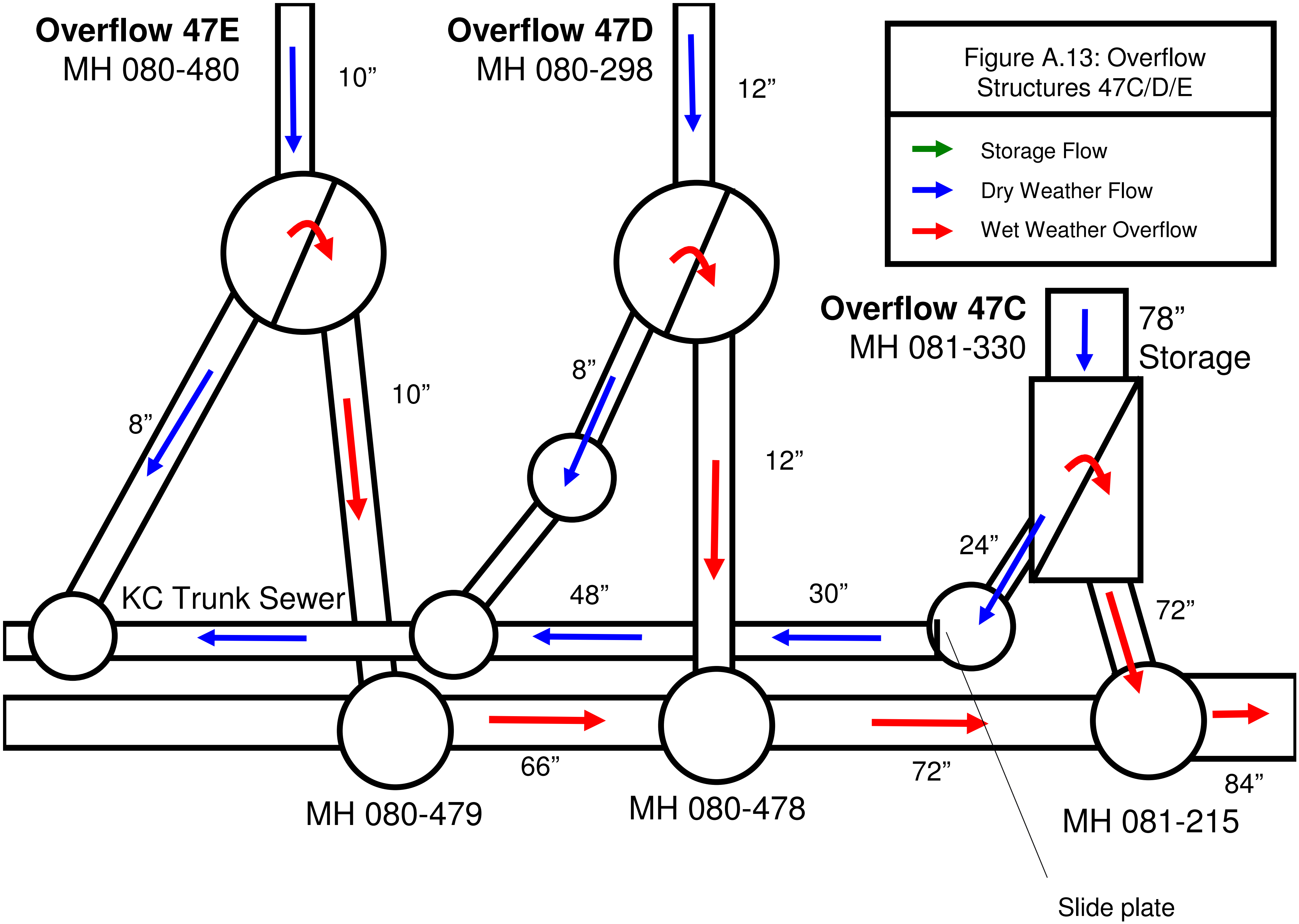


Figure A.12: Overflow Structure 47E



Henderson Basin

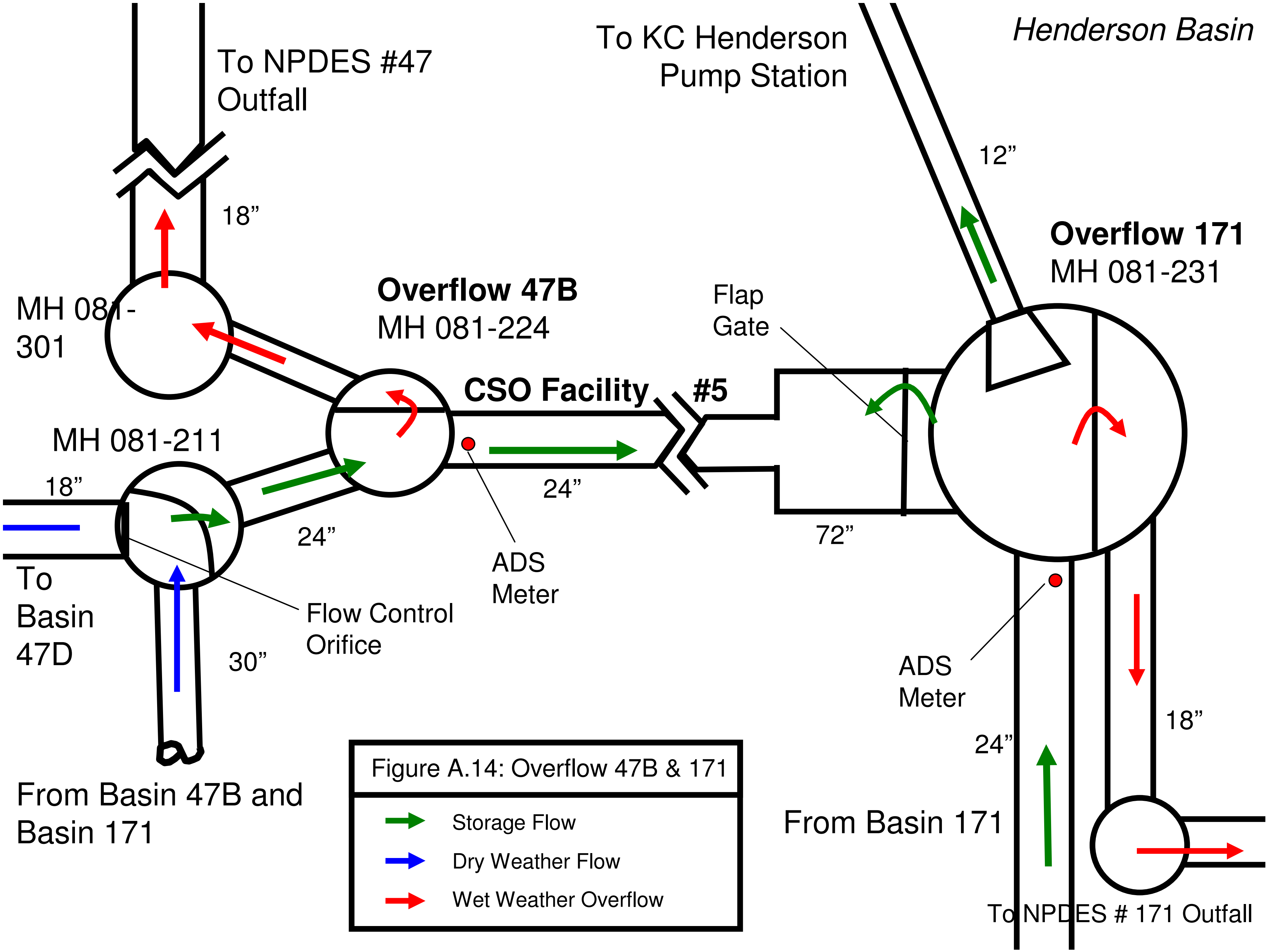


Figure A.14: Overflow 47B & 171

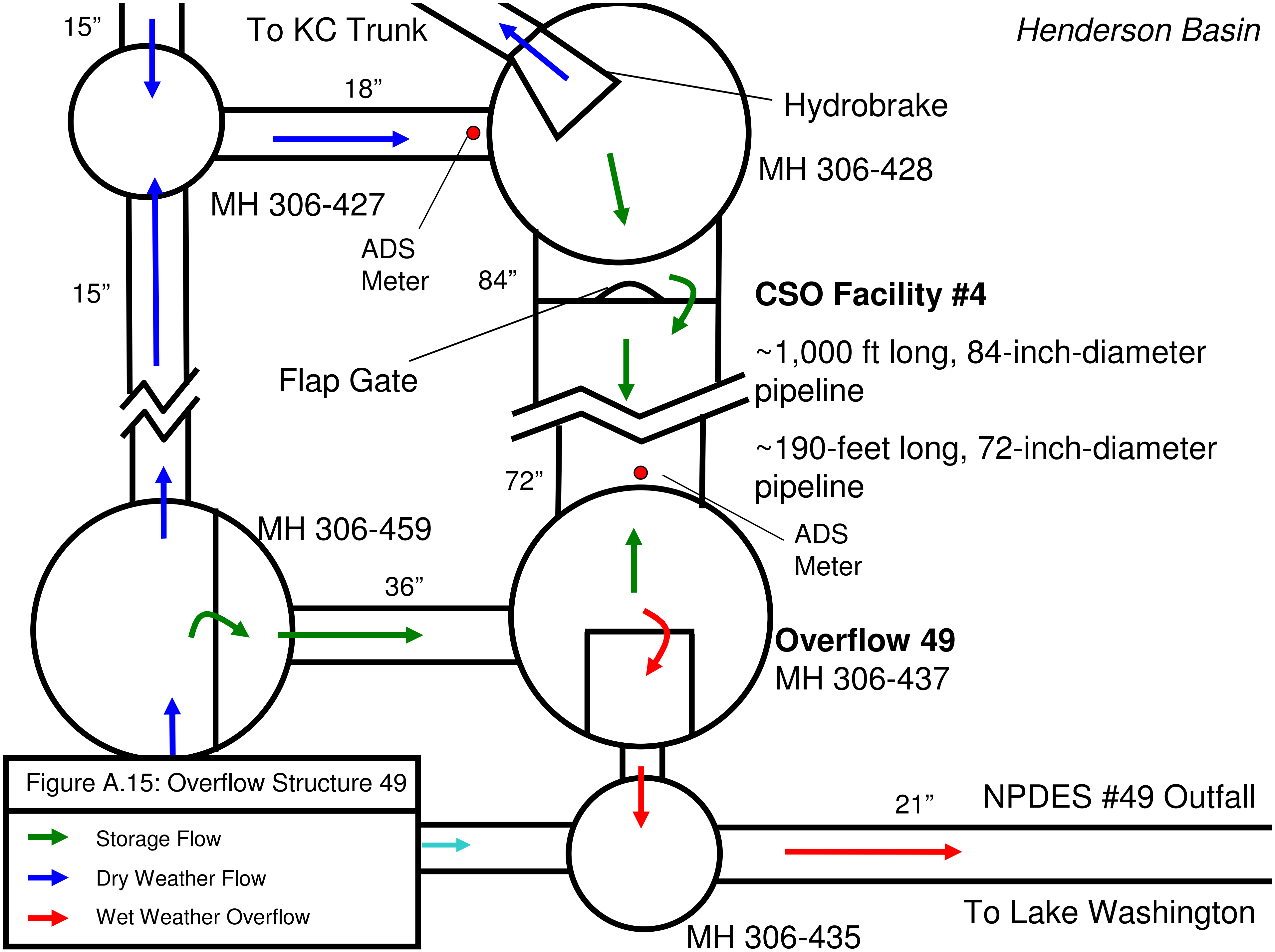


Figure A.15: Overflow Structure 49

Appendix B – CSO Basin 38/39

Appendix B.1 – CSO Basin 38/39

Summary of Assumptions

NPDES Basin 38 - Matching Recorded Volumes

MH059-451

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006
Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 16 inches Weir length = 200 inches Weir width = 12 inches
ADS Site Report (12/12/2006)	Weir length = 96 inches Weir width = 6 inches Lower weir (outfall weir) wall - height = 17.25 inches (left); 17 inches (center); 17.25 inches (right) Higher weir wall - height = 24.5 inches (left); 24.5 inches (center); 24.25 inches (right) Crest of weir to face of ultra 9.5 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
1	12/14/2006	Broad-crested weir equation will be used in HDR estimation (ADS Site Report states weir width = 6 inches). Unable to determine actual weir height from sensor to overflow weir; ADS currently estimates 32.5 inches (measured distance from shelf to weir) + ~10 inches (approximate distance - not measured - of invert of channel to shelf). Will estimate volume with possible weir heights and assume weir length of 96 inches (ADS Site Report). Location of Geotivity depth sensor needs to be determined to verify volume. Photographs indicate that the sensor was located at the invert of the channel. In October 2005, NPDES 38 overflow structure was renovated. Dimensions reported on Geotivity Site Investigation Form are assumed to no longer apply.	Method A: P = 40 inches (matches reported CSO volume) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 8 ft (96 in) H = Depth of water over crest of weir (feet) P = Height of weir = 40 in Volume calculations: Simpson's Rule	3,127,158	
			Method B: P = 42.3 inches (estimated height from 11/6/2006 CSO event) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 8 ft (96 in) H = Depth of water over crest of weir (feet) P = Height of weir = 42.3 in Volume calculations: Simpson's Rule	1,313,941	X

NPDES Basin 38 - Matching Recorded Volumes

MH059-451

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity
Site Investigation Form
(12/19/2001)

Weir height = 16 inches
Weir length = 200 inches
Weir width = 12 inches

ADS
Site Report (12/12/2006)

Weir length = 96 inches
Weir width = 6 inches
Lower weir (outfall weir) wall - height = 17.25 inches (left); 17 inches (center); 17.25 inches (right)
Higher weir wall - height = 24.5 inches (left); 24.5 inches (center); 24.25 inches (right)
Crest of weir to face of ultra 9.5 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
2	11/6/2006	Broad-crested weir equation will be used in HDR estimation (ADS Site Report states weir width = 6 inches). Unable to determine actual weir height from sensor to overflow weir; ADS currently estimates 32.5 inches (measured distance from shelf to weir) + ~10 inches (approximate distance - not measured - of invert of channel to shelf). Will estimate volume with possible weir heights and assume weir length of 96 inches (ADS Site Report). Location of Geotivity depth sensor needs to be determined to verify volume. Photographs indicate that the sensor was located at the invert of the channel. In October 2005, NPDES 38 overflow structure was renovated. Dimensions reported on Geotivity Site Investigation Form are assumed to no longer apply.	Method A: P = 42.3 inches (matches reported CSO volume) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 8 ft (96 in) H = Depth of water over crest of weir (feet) P = Height of weir = 42.3 in Volume calculations: Simpson's Rule	555,446	X
			Method B: P = 42.7 inches (estimated height from 12/27/2006 CSO event) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 8 ft (96 in) H = Depth of water over crest of weir (feet) P = Height of weir = 42.7 in Volume calculations: Simpson's Rule	445,543	

NPDES Basin 38 - Matching Recorded Volumes

MH059-451

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 16 inches Weir length = 200 inches Weir width = 12 inches
ADS Site Report (12/12/2006)	Weir length = 96 inches Weir width = 6 inches Lower weir (outfall weir) wall - height = 17.25 inches (left); 17 inches (center); 17.25 inches (right) Higher weir wall - height = 24.5 inches (left); 24.5 inches (center); 24.25 inches (right) Crest of weir to face of ultra 9.5 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
3	12/27/2006	Broad-crested weir equation will be used in HDR estimation (ADS Site Report states weir width = 6 inches). Unable to determine actual weir height from sensor to overflow weir; ADS currently estimates 32.5 inches (measured distance from shelf to weir) + ~10 inches (approximate distance - not measured - of invert of channel to shelf). Will estimate volume with possible weir heights and assume weir length of 96 inches (ADS Site Report). Location of Geotivity depth sensor needs to be determined to verify volume. Photographs indicate that the sensor was located at the invert of the channel. In October 2005, NPDES 38 overflow structure was renovated. Dimensions reported on Geotivity Site Investigation Form are assumed to no longer apply.	Method A: P = 42.7 inches (matches reported CSO volume) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 8 ft (96 in) H = Depth of water over crest of weir (feet) P = Height of weir = 42.7 in Volume calculations: Simpson's Rule	283,291	
			Method B: P = 42.3 inches (estimated height from 11/6/2006 CSO event) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 8 ft (96 in) H = Depth of water over crest of weir (feet) P = Height of weir = 42.3 in Volume calculations: Simpson's Rule	389,329	X
4	11/14/2001	No data available for time period of reported CSO event.	No data available for time period of reported CSO event.	No data available for time period of reported CSO event.	
5	12/16/2001	No data available for time period of reported CSO event.	No data available for time period of reported CSO event.	No data available for time period of reported CSO event.	
6	12/13/2001	No data available for time period of reported CSO event.	No data available for time period of reported CSO event.	No data available for time period of reported CSO event.	

NPDES Basin 38 - Matching Recorded Volumes

MH059-451

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity
Site Investigation Form
(12/19/2001)

Weir height = 16 inches
Weir length = 200 inches
Weir width = 12 inches

ADS
Site Report (12/12/2006)

Weir length = 96 inches
Weir width = 6 inches
Lower weir (outfall weir) wall - height = 17.25 inches (left); 17 inches (center); 17.25 inches (right)
Higher weir wall - height = 24.5 inches (left); 24.5 inches (center); 24.25 inches (right)
Crest of weir to face of ultra 9.5 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
7	10/20/2003	Broad-crested weir equation will be used in HDR estimation (Geotivity Site Investigation form states width = 12 inches). Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir height and assume weir length of 200 inches (Geotivity Investigation Form). Location of Geotivity depth sensor needs to be determined to verify volume.	Method A: P = 16 inches (Geotivity Site Investigation Form) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 16.67 ft (200 in) H = Depth of water over crest of weir (feet) P = Height of weir = 16 in Volume calculations: Basic Integration (summation of Q * dt)	10,431
8	12/24/2005	Broad-crested weir equation will be used in HDR estimation (ADS Site Report states weir width = 6 inches). Unable to determine actual weir height from sensor to overflow weir; ADS currently estimates 32.5 inches (measured distance from shelf to weir) + ~10 inches (approximate distance - not measured - of invert of channel to shelf). Will estimate volume with possible weir heights and assume weir length of 96 inches (ADS Site Report). Location of Geotivity depth sensor needs to be determined to verify volume. Photographs indicate that the sensor was located at the invert of the channel. In October 2005, NPDES 38 overflow structure was renovated. Dimensions reported on Geotivity Site Investigation Form are assumed to no longer apply.	Method A: P = 40 - 43 inches (matches reported 2006 CSO volumes) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 8 ft (96 in) H = Depth of water over crest of weir (feet) P = Height of weir = Possible ranges between 40 and 43 inches (see 2006 CSO volume estimates). Volume calculations: Simpson's Rule	0

NPDES Basin 38 - Matching Recorded Volumes

MH059-451

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006
Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 16 inches Weir length = 200 inches Weir width = 12 inches
ADS Site Report (12/12/2006)	Weir length = 96 inches Weir width = 6 inches Lower weir (outfall weir) wall - height = 17.25 inches (left); 17 inches (center); 17.25 inches (right) Higher weir wall - height = 24.5 inches (left); 24.5 inches (center); 24.25 inches (right) Crest of weir to face of ultra 9.5 inches.

<table>
<tr><th>Rank</th><th>Reported Overflow Date</th><th>Comments</th><th>Estimated CSO Volume Methodology</th><th>Estimated CSO Volume (gal)</th><th></th></tr>
<tr><td rowspan="2">9</td><td rowspan="2">10/1/2005</td><td rowspan="2">Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir height and assume weir length of 200 inches (Geotivity Investigation Form).

Location of Geotivity depth sensor needs to be determined to verify volume.

In October 2005, NPDES 38 overflow structure was renovated. Dimensions reported on Geotivity Site Investigation Form no longer apply.</td><td>Method A: P = 16 inches (Geotivity Site Investigation Form)

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 16.67 ft (200 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 16 in

Volume calculations:
Basic Integration (summation of Q * dt)</td><td>8,212</td><td>X</td></tr>
<tr><td>Method B: P = 16.8 inches (match as that reported)

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 16.67 ft (200 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 16.8 in

Volume calculations:
Simpson's Rule</td><td>491</td><td></td></tr>
</table>

Following information reviewed in CSO Annual Reports:

Report	Description
2001	When reporting frequency, City was using the 3-hour inter-event time (IET) from January 2001 until March 2001. Beginning April 5, 2001, City began using the 24-hr IET per Ecology.
2005	In October 2005, overflow structure was renovated with two weirs, baffle, hydraulic regulating device and 23,700 gallons of additional storage. NPDES 39 was abandoned and routed to NPDES 38/39 in January 2005. Monitoring data prior to October 2005 may be considered irrelevant since the outfall has a new configuration.

Determine weir height:

Height (in)	Source
16	Geotivity Site Investigation Form - old configuration (12/01)
27.84	Overflow & Diversion Structure Drawing, height from invert of structure to outfall overflow weir.
48.00	CSO Reduction Program 2005 Retrofit Project (March 2005)
17	ADS Site Report (center height) - invert of channel? (12/06)
42.5	ADS reported (via e-mail) height of 32.5 inches from shelf to weir (measured) and approximately 10 inches from invert of channel to shelf (not measured). (2/08)

Determine weir length:

Length (in)	Source
200	Geotivity Site Investigation Form (12/19/01)
96	ADS Site Report (12/12/06)

Determine flow rate estimate:

Assumption	Reasoning
Broad-crested weir	Reported as 6-inch weir width in ADS Site Report.
Broad-crested weir	Reported as 12-inch weir width in Geotivity Site Investigation Form. Old configuration

Conclusion based on available information:

Broad-crested weir equation was assumed in estimations.

S-Doc Site Investigation Form
Site Name: Npdes039

Project	0054852
SN#	1030966

*Note**
This form contains information measured in the field environment, and is subject to change depending on recent site conditions including but not limited to physical erosion, site hydraulics, pipe corrosion and siltation

LOCATION INFORMATION

Field Book Number:	N/A	**Address:**	Lake Washington Blvd. & 46th
MH#	MH059-456	**GPS Coordinates**	Latitude: N 47.57010 Longitude: W 122.27711
Install Date:	2001-01-01 00:00	***Intrinsically Safe Sticker Number***	none
Thomas Brothers Map Pg	N/A	**Traffic Conditions**	3rd Man Required

Location Map

Image Not Available

Landmarks:

Image Not Available

MONITOR:

Type:	QTrek V2		**SN:**	1030966		**SIM**	8931 0380 2020 2332 2059
Sensors:	Depth 1	Depth 2	Battery	Float Switch	-	-	**Signal** -85
	-	-	-	-	-	-	**Server IP**

GAS:

O2	0	**H2S**	0	**Confined Space Entry notes***
LEL	0	**CO2**	0	

CHANNEL

Type:	Irregular	
Cond.	Deteriorating	
Flow:	Cracked pipe	
Material:	Ductile iron	
Height:	0	in
Width:	0	in
Other:	Sheet #	
Ground:	0	ft (bench)

OVERFLOW

Type:	Irregular	
Cond.	Deteriorating	
Length:	47.99	in
Width:	3.98	in
Height:	26	in

Other Information:

old serial CUS1002448

Image Not Available
Image Not Available

note* all dimensions referenced from invert (bottom) of channel

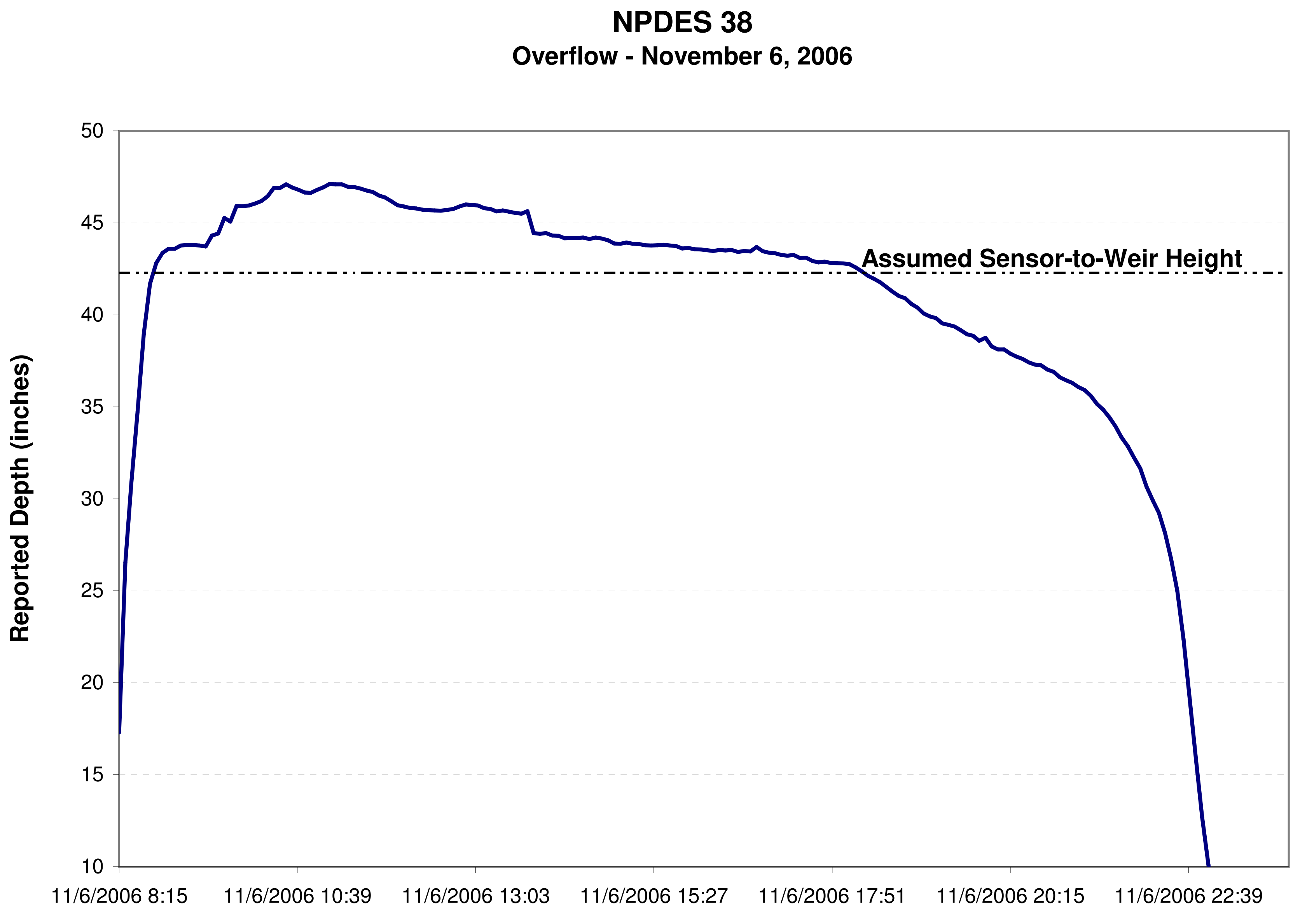
SIF Type = Sewer
Site Pictures
Format: All pictures are RGB 640 by 480 pix. Resolution.

Manhole Cover With #

Monitor In Hole

Appendix B.2 – CSO Basin 38/39

Sample of Depth versus Time Plots for Reported CSO Events



NPDES 38
Overflow - November 6, 2006
Reported Depth (inches)
50
45
40
35
30
25
20
15
10
Assumed Sensor-to-Weir Height
11/6/2006 8:15
11/6/2006 10:39
11/6/2006 13:03
11/6/2006 15:27
11/6/2006 17:51
11/6/2006 20:15
11/6/2006 22:39

Appendix C – CSO Basin 40

Appendix C.1 – CSO Basin 40

Summary of Assumptions

NPDES Basin 40 - Matching Recorded Volumes

MH059-491

8/20/2002: Site renamed from NPDES 040A to NPDES 40
Duration of Geotivity Metering: December 19, 2001 - December 30, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form (12/19/2001)	Weir height = 90 inches Weir length = 130 inches Weir width = 9 inches
ADS Site Report (12/12/2006)	Weir length = 119.5 inches Weir width = Not provided Weir height = 71.88 inches (left), 87.75 inches (center); 72.5 inches (right) Manhole depth = 14'-6"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
1	3/13/2003	Assumed a double-sided broad-crested weir. Used ADS's measured height as the height to the weir in calculations.	Method A - Assume ADS measurement is adequate and double-sided broad-crested weir. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 20 ft (240 in) H = Depth of water over crest of weir (feet) P = Height of weir = 87.63 in Volume calculations: Simpson's Rule	2,757,769
2	1/1/2003	Assumed a double-sided broad-crested weir. Used ADS's measured height as the height to the weir in calculations.	Method A - Assume ADS measurement is adequate and double-sided broad-crested weir. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 20 ft (240 in) H = Depth of water over crest of weir (feet) P = Height of weir = 87.63 in Volume calculations: Simpson's Rule	706,964
3	3/22/2003	Assumed a double-sided broad-crested weir. Used ADS's measured height as the height to the weir in calculations.	Method A - Assume ADS measurement is adequate and double-sided broad-crested weir. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 20 ft (240 in) H = Depth of water over crest of weir (feet) P = Height of weir = 87.63 in Volume calculations: Simpson's Rule	1,066,840
4	12/14/2002	Data unavailable for this reported CSO event.	Data unavailable for this reported CSO event.	Data unavailable for this reported CSO event.

NPDES Basin 40 - Matching Recorded Volumes

MH059-491

8/20/2002: Site renamed from NPDES 040A to NPDES 40
Duration of Geotivity Metering: December 19, 2001 - December 30, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form (12/19/2001)	Weir height = 90 inches Weir length = 130 inches Weir width = 9 inches
ADS Site Report (12/12/2006)	Weir length = 119.5 inches Weir width = Not provided Weir height = 71.88 inches (left), 87.75 inches (center); 72.5 inches (right) Manhole depth = 14'-6"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
5	1/4/2003	Assumed a double-sided broad-crested weir. Used ADS's measured height as the height to the weir in calculations.	Method A - Assume ADS measurement is adequate and double-sided broad-crested weir. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 20 ft (240 in) H = Depth of water over crest of weir (feet) P = Height of weir = 87.63 in Volume calculations: Simpson's Rule	72,499

Following information reviewed in CSO Annual Reports:

Report	Description
2001	When reporting frequency, City was using the 3-hour inter-event time (IET) from January 2001 until March 2001. Beginning April 5, 2001, City began using the 24-hr IET per Ecology.
2002	Prior to 2002, NPDES 40 was referred to as NPDES 40A.

Determine weir height:

Height (in)	Source
90	Geotivity Site Investigation Form (12/19/2001)
87.63	ADS - currently uses in calculations.
87.75	ADS Site Report (center height), 12/12/2006
87.6	Overflow structure drawing

Determine weir length:

Length (in)	Source
130	Geotivity Site Investigation Form (12/19/2001)
119.5	ADS Site Report (12/12/2006)
240	As-built drawings (measured with scale), double-sided weir.

Determine flow rate estimate:

Assumption	Reasoning
Double-sided broad-crested weir	Reported as 9-inch weir width in Geotivity Site Investigation Form.

Conclusion based on available information:

Weir height ranges between 87.6 and 90 inches (from invert of the channel) from available documentation. Assumed double-sided broad-crested weir in estimated CSO volume.

Pipe Capacity Estimations (Overflow Structure 40)

Downstream pipe capacities (for overflow and outfall pipes) were calculated to determine if pipes may be outlet-controlled at larger overflow rates during CSO events for Overflow Structure 40. If the CSO events are outlet-controlled at larger overflow rates, then the actual CSO volumes are lower than the CSO volumes calculated (overflow rate estimates would be less in a submerged versus free-flowing condition).

The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of the outfall. The assumed maximum overflow rate for the 12/3/07 storm is shown in Table A in bold for Overflow Structure 40.

Maximum pipe capacities were also calculated using the Manning equation and available Geographic Information Systems (GIS) data. Invert elevations of maintenance holes and pipe lengths and diameters (as indicated in GIS) were used to estimate full pipe capacity (also shown in Table A). However, these capacities should not be considered the maximum pipe capacities due to GIS data discrepancies and because the GIS data was not compared to record drawings or available survey data for verification.

Table B presents the maximum estimated overflow rates for the reported CSO events that were calculated using the broad-crested weir equation (unsubmerged). Of the 5 reported CSO events (between 2001 and 2006), the estimated flow rate for the 3/22/03 CSO event resulted in a maximum flow rate of approximately 6,500 gpm (9.4 mgd), which is larger than the maximum 12/3/07 overflow rate. Thus, it may be possible that the pipeline may have inadequate capacity for this CSO event at the larger overflow rates.

Table A. Estimated Pipe Capacities for Overflow Structure 40

Source	Maximum Pipe Capacity	Details and Assumptions
ADS Monitoring Data, 12/3/07 storm	**8.4 mgd**	Overflow rates estimated from depth meter and broad-crested weir equation, assuming double-sided weir.
Seattle Public Utilities Geographic Information Systems (GIS) layers for sewer mainlines and manholes	4.3 mgd	Upstream and downstream manholes for pipe segment: MH 059-491 to MH D059-272. Capacity calculated using Manning equation (d = 12 inches; n = 0.013; s = 0.0347 ft/ft). GIS discrepancy: GIS indicates that overflow pipe is 12 inches while other sources indicate 24 inches in diameter. Invert elevation of D059-272 is indicated in GIS as 31.1 and 30.1 inches.
	31.8 mgd	Upstream and downstream manholes for pipe segment: MH D059-272 to MH D059-271. Capacity calculated using Manning equation

Source	Maximum Pipe Capacity	Details and Assumptions
		(d = 24 inches; n = 0.013; s = 0.047 ft/ft). GIS discrepancy: Invert elevation of D059-272 is indicated in GIS as 31.1 and 30.1 inches.
	25.1 mgd	Upstream and downstream manholes for pipe segment: MH D059-271 to D059-245. Capacity calculated using Manning equation (d = 24 inches; n = 0.013; s = 0.0294 ft/ft)
	0.18 mgd	Upstream and downstream manholes for pipe segment: MH D059-245 to MH D059-244. Capacity calculated using Manning equation (d = 24 inches; n = 0.013; s = 0.0095 ft/ft)

Table B. Maximum Estimated Overflow Rates for Reported CSO Events (2000 – 2006), Overflow Structure 40

Reported Overflow Date	Maximum Estimated Overflow Rate	Details and Assumptions
3/13/03	6.39 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged), assuming double-sided weir.
1/1/03	3.59 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged), assuming double-sided weir.
3/22/03	9.36 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged), assuming double-sided weir.
12/14/02	Data unavailable for this reported CSO event.	
1/4/03	2.30 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged), assuming double-sided weir.

GEOTIVITY

S–Doc Site Investigation Form

Site Name: Npdes040

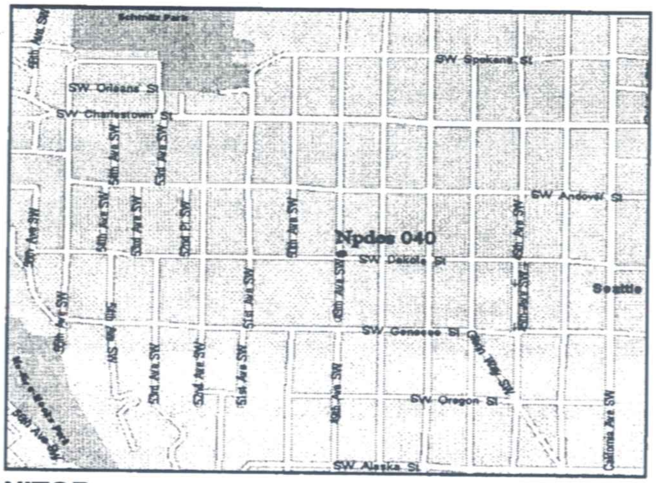
Project	0054852
SN#	1031668

*Note**
This form contains information measured in the field environment, and is subject to change depending on recent site conditions including but not limited to physical erosion, site hydraulics, pipe corrosion and siltation

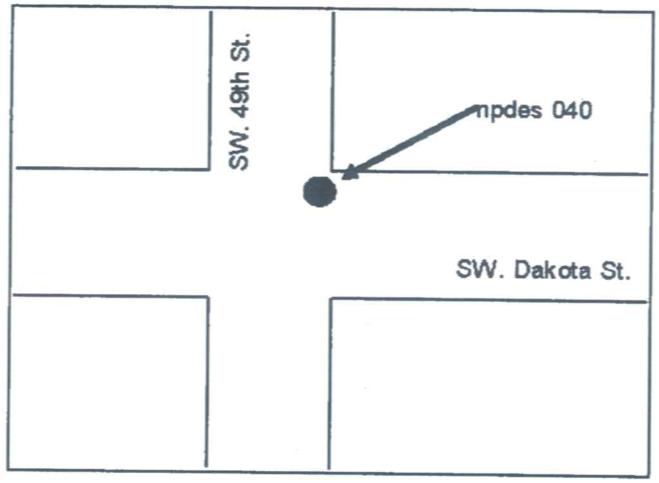
LOCATION INFORMATION

Field Book Number:	N/A	**Address:**	S Dakota St & 49th Ave S
MH#	MH059–491	**GPS Coordinates**	Latitude: N 47.02184 Longitude: W 122.54816
Install Date:	2001–12–19 00:00	***Intrinsically Safe Sticker Number***	none
Thomas Brothers Map Pg	N/A	**Traffic Conditions**	Slow Traffic

Location Map



Landmarks:



MONITOR:

Type:	QTrek V2		**SN:**	1031668			**SIM**	8931 0380 2020 2331 8123
Sensors:	HRS Depth 1	HRS Depth 2	Battery	Float Switch	–	–	**Signal**	–97
	–	–	–	–	–	–	**Server IP**	

GAS:

O2	20.9	**H2S**	0	**Confined Space Entry notes***	
LEL	0	**CO2**	0		

CHANNEL

Type:	Circular	
Cond.	Good	
Flow:	Smooth	
Material:	Concrete	
Height:	17	in
Width:	24	in
Other:	Sheet #	
Ground:	9	ft (bench)

OVERFLOW

Type:	Irregular	
Cond.	Deteriorating	
Length:	130	in
Width:	9	in
Height:	90	in

Other Information:

8/20/02 Site renamed from NPDES40a to NPDES040

Image Not Available
Image Not Available

note* all dimensions referenced from invert (bottom) of channel

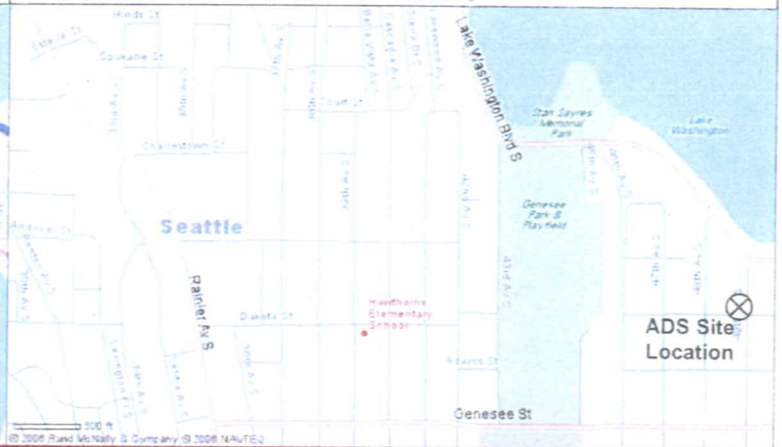
SIF Type = Sewer
Site Pictures
Format: All pictures are RGB 640 by 480 pix. Resolution.

ADS ENVIRONMENTAL SERVICES®

ADS Site Report

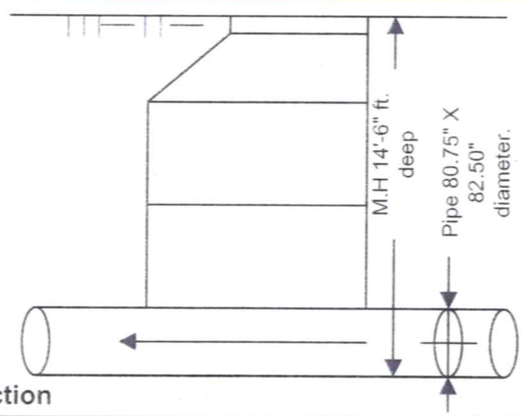
Quality Form

Project Name: Seattle - CSO	City / State: Seattle, WA		FM Initials: SS
Site Name: NPDES 40/SEA_059491:D059279	Monitor Series:	Monitor S/N: 5000 AG	26117
'dress/Location: 4102 S. Dakota Street @ 49 Av. S.		Manhole #	059-491
		Thomas Bros Map Page:	595 E4
		Pipe Height:	80.75"
Access: Drive	Type of System: Sanitary [ ] Storm [ ] Combined [X]	Pipe Width:	82.50"
		IP Address:	166.219.19.48

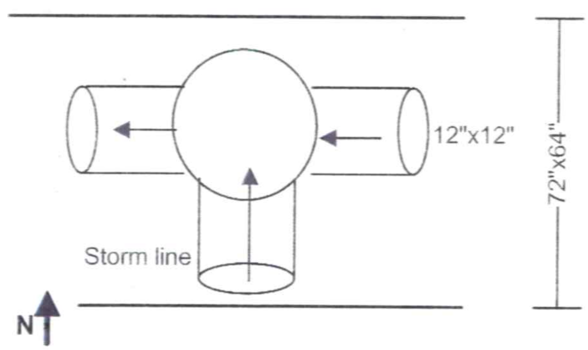


Investigation Information:		Manhole Information:	
Date/Time of Investigation:	12/12/2006 14:00	Manhole Depth:	14' - 6"
Site Hydraulics:	Fast flow	Manhole Material / Condition	Concrete / Good
Upstream Input: (L/S, P/S)		Pipe Material / Condition:	Concrete / Good
Upstream Manhole:	DNI	Mini System Character:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Downstream Manhole:	DNI	Telephone Information:	
Depth of Flow:	2.75" +/- 0.25"	Access Pole #:	
Range (Air DOF):	Pending further info. +/- 0.25"	Distance From Manhole:	Feet
Peak Velocity:	4.05 fps	Road Cut Length:	Feet
Silt:	0.00 Inches	Trench Length:	Feet

Other Information:



Cross Section



Planar N

Installation Information		Backup	Yes	No	?	Distance
Installation Type:	Special	Trunk	[ ]	[ ]	[ ]	
Sensors Devices:	Ultra / Pressure / Velocity	Lift / Pump Station	[ ]	[ ]	[ ]	
Surcharge Height:	0.00" Feet	WWTP	[ ]	[ ]	[ ]	
Rain Guage Zone:		Other	[ ]	[ ]	[ ]	

Additional Site Information / Comments:

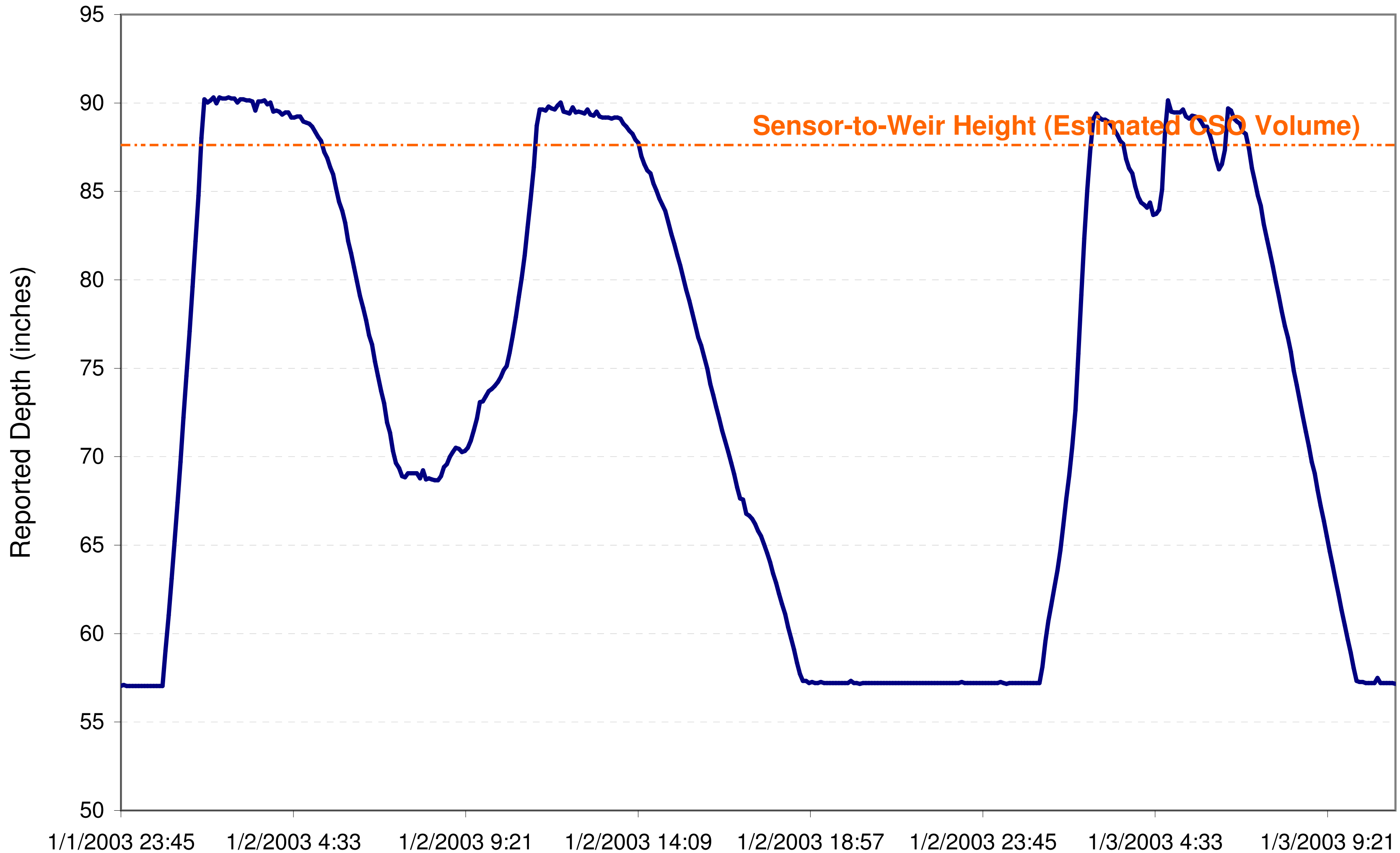
Weir Measurements: Length 119.50". Height: Left 71.88", Center 87.75", Right 72.50"

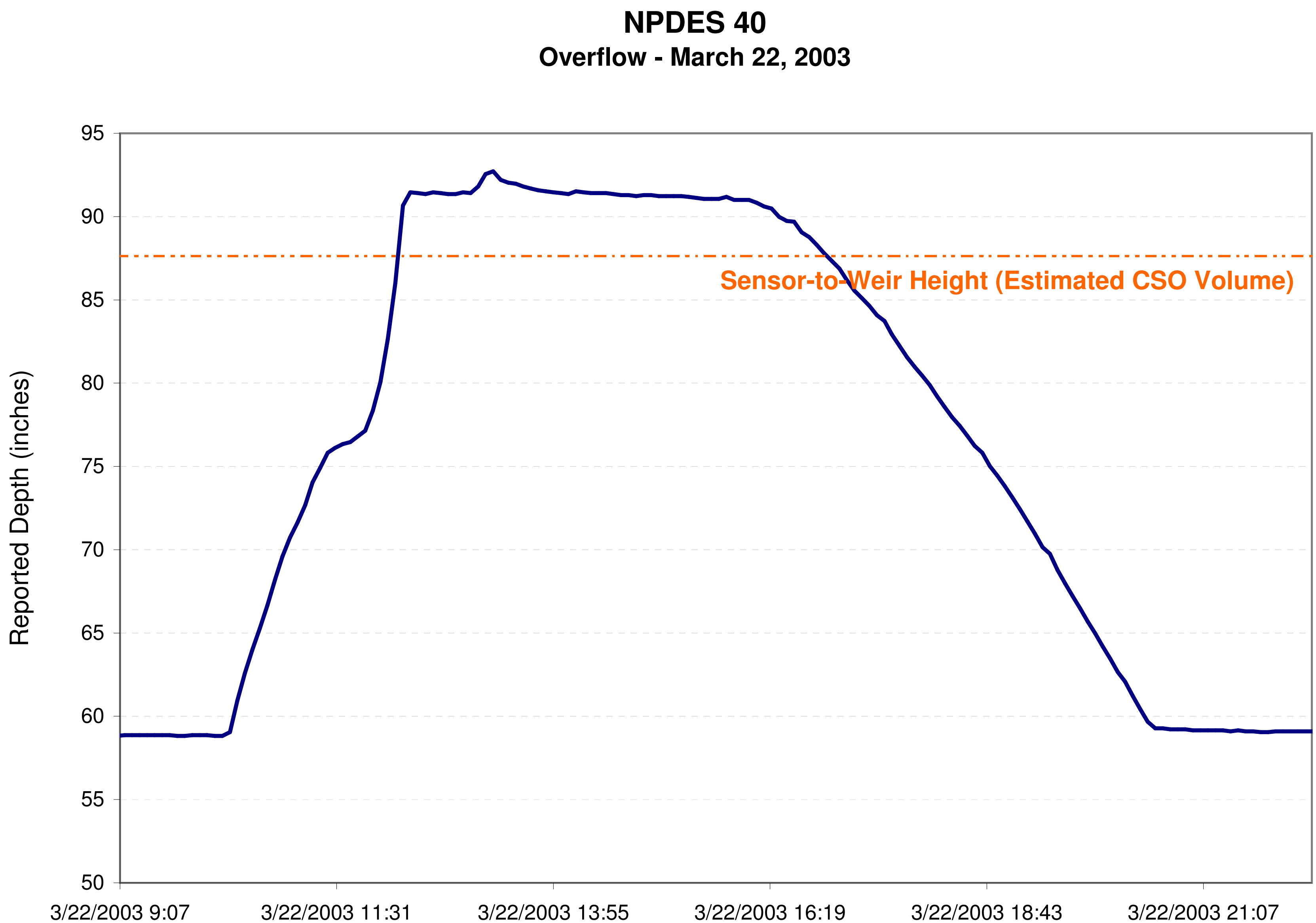
Appendix C.2 – CSO Basin 40

Sample of Depth versus Time Plots for Reported CSO Events

NPDES 40

Overflow - January 1, 2003




NPDES 40
Overflow - March 22, 2003
Reported Depth (inches)
95
90
85
80
75
70
65
60
55
50
Sensor-to-Weir Height (Estimated CSO Volume)
3/22/2003 9:07
3/22/2003 11:31
3/22/2003 13:55
3/22/2003 16:19
3/22/2003 18:43
3/22/2003 21:07

Appendix D – CSO Basin 41

Appendix D.1 – CSO Basin 41A

Summary of Assumptions

NPDES Basin 41A - Matching Recorded Volumes

MH059-434

8/20/2002 = Site renamed from NPDES 041 to NPDES 41A
Duration of Geotivity Metering: February 29, 2000 - December 30, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form (1/1/2001)	Weir height = 5 inches Weir length = 60 inches Weir width = 3 inches
ADS Site Report (12/12/2006)	Weir length = Not provided Weir width = Not provided Weir height = 8.25 inches (left), 5.5 inches (center); 5.38 inches (right) Manhole depth = 8'-4"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
1	1/24/2003	Depth data appears to be unreasonable (inadequate) during 1/24/03 22:35 - 22:50. Depth data jumps from 2 inches to 16 inches back to 4 inches. Majority of estimated volume is within this time frame. Will not include this volume in estimation. Depth of water during this CSO event ranges between 5 and 5.65 inches (removing "inadequate" data.) Thus, water would likely only be going over a portion of the weir wall (portion of the length) - not the entire 60 inches. However, to be conservative, will maintain 60-inch length. Will use ADS measured weir height (right) since lowest height.	Method A - Assume ADS measurement (right side) is adequate. Flow calculations: $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 5 ft (60 in) H = Depth of water over crest of weir (feet) P = Height of weir = 5.38 in Volume calculations: Simpson's Rule	216
2	10/20/2003	Depth of water during this CSO event ranges between 5 and 7.3 inches; thus, water would be overflowing along the right side and center of the weir. Used average weir height of right and center side of the weir (amounts to 5.44 inches) based on ADS measurements.	Method A - Assume ADS measurement (right and center) is adequate and use average. Flow calculations: $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 5 ft (60 in) H = Depth of water over crest of weir (feet) P = Height of weir = 5.44 in Volume calculations: Simpson's Rule	27,994

NPDES Basin 41A - Matching Recorded Volumes

MH059-434

8/20/2002 = Site renamed from NPDES 041 to NPDES 41A
Duration of Geotivity Metering: February 29, 2000 - December 30, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form (1/1/2001)	Weir height = 5 inches Weir length = 60 inches Weir width = 3 inches
ADS Site Report (12/12/2006)	Weir length = Not provided Weir width = Not provided Weir height = 8.25 inches (left), 5.5 inches (center); 5.38 inches (right) Manhole depth = 8'-4"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
3	1/14/2006	Depth of water during this CSO event ranges between 5 and 5.64 inches; thus, water would be overflowing along the right side and center of the weir. Used average weir height of right and center side of the weir (amounts to 5.44 inches) based on ADS measurements.	Method A - Assume ADS measurement (right and center) is adequate and use average. Flow calculations: $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 5 ft (60 in) H = Depth of water over crest of weir (feet) P = Height of weir = 5.44 in Volume calculations: Simpson's Rule	191
4	1/1/2003	Depth of water during this CSO event ranges between 5 and 6.32 inches; thus, water would be overflowing along the right side and center of the weir. Used average weir height of right and center side of the weir (amounts to 5.44 inches) based on ADS measurements.	Method A - Assume ADS measurement (right and center) is adequate and use average. Flow calculations: $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 5 ft (60 in) H = Depth of water over crest of weir (feet) P = Height of weir = 5.44 in Volume calculations: Simpson's Rule	7,400
5	1/3/2002	Inadequate data available for this CSO event.	Inadequate data available for this CSO event.	Inadequate data available for this CSO event.
6	1/14/2003	Depth of water during this CSO event ranges between 5 and 5.33 inches; thus, water would be overflowing along the right side of the weir. However, based on ADS measurements, the right side of the weir is 5.38 inches. No CSO event would have occurred using these assumptions.	Method A - Assume ADS measurement (right side) is adequate. Flow calculations: $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 5 ft (60 in) H = Depth of water over crest of weir (feet) P = Height of weir = 5.38 in Volume calculations: Simpson's Rule	0

Following information reviewed in CSO Annual Reports:

Report	Description
2001	When reporting frequency, City was using the 3-hour inter-event time (IET) from January 2001 until March 2001. Beginning April 5, 2001, City began using the 24-hr IET per Ecology.
2002	Prior to 2002, NPDES 41A was referred to as NPDES 41.

Determine weir height:

Height (in)	Source
5	Geotivity Site Investigation Form (1/1/2001)
5.04	Charlestown Street Trunk Sewer, etc. (drawing)
5.5	ADS Site Report (center height), 12/12/2006

Determine weir length:

Length (in)	Source
60	Geotivity Site Investigation Form (1/1/2001)

Determine flow rate estimate:

Assumption	Reasoning
Sharp-crested weir	Reported as 3-inch weir width in Geotivity Site Investigation Form.

Conclusion based on available information:

Reported weir height ranges between 5 and 8.25 inches.

S–Doc Site Investigation Form

Site Name: Npdes041A

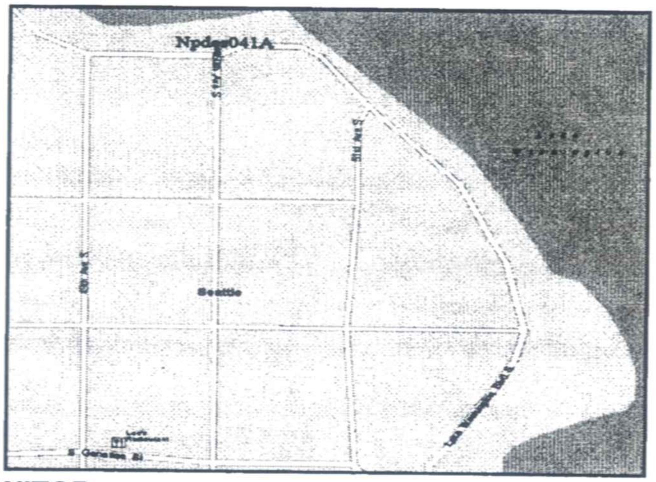
Project 0054852
SN# 1021744

Note This form contains information measured in the field environment, and is subject to change depending on recent site conditions including but not limited to physical erosion, site hydraulics, pipe corrosion and siltation*

LOCATION INFORMATION

Field Book Number:	N/A	**Address:**	50th Ave & Lake Washington Blvd. S
MH#	MH059-434	**GPS Coordinates**	Latitude: N47.034043 Longitude: W 122.10244
Install Date:	2001–01–01 00:00	***Intrinsically Safe Sticker Number***	none
Thomas Brothers Map Pg	N/A	**Traffic Conditions**	3rd Man Required

Location Map



Landmarks:

Image Not Available

MONITOR:

Type:	QTrek V2	**SN:**	1021744			**SIM**	8931 0380 1010 2106 0259
Sensors:	HRS Depth 1	HRS Depth 2	Battery	Float Switch	–	–	
	–	–	–	–	–	–	
Signal	-95						
Server IP							

GAS:

O2	20.9	**H2S**	0	**Confined Space Entry notes***	
LEL	0	**CO2**	0		

CHANNEL

Type:	Circular	
Cond.	Good	
Flow:	Smooth	
Material:	Concrete	
Height:	14	in
Width:	14	in
Other:	Sheet #	
Ground:	8	ft (bench)

OVERFLOW

Type:	Manhole	
Cond.	Good	
Length:	60	in
Width:	3	in
Height:	5	in

Other Information:

8/20/02 Site renamed from NPDES041 to NPDES041a.

Image Not Available
Image Not Available

note* all dimensions referenced from invert (bottom) of channel

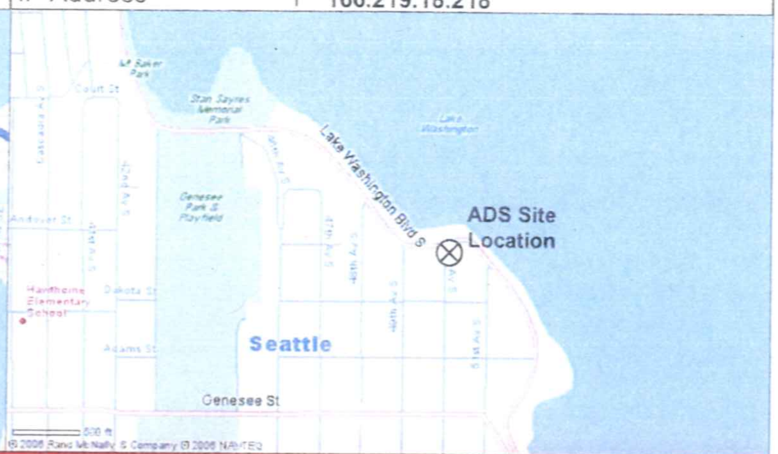
SIF Type = Sewer
Site Pictures
Format: All pictures are RGB 640 by 480 pix. Resolution.

ADS ENVIRONMENTAL SERVICES

ADS Site Report

Quality Form

Project Name: Seattle - CSO	City / State: Seattle, WA	FM Initials: SS	
Site Name: NPDES 41A/SEA_059434	Monitor Series: 5000 BG	Monitor S/N:	19025
Address/Location: 3971 50th Av. S. @ S. Lake Wash. BLVD		Manhole #	059-434
		Thomas Bros Map Page:	595 F4
		Pipe Height:	MP1 14.5 / MP2 15.13
Access: Drive	Type of System: Sanitary [ ] Storm [ ] Combined [X]	Pipe Width:	MP1 14.13 / MP2 15.5
		IP Address	166.219.18.218



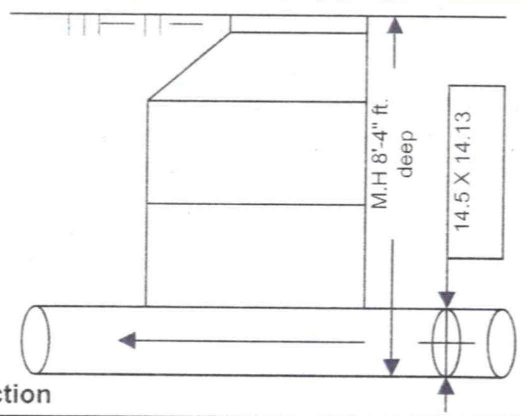
Investigation Information:

Date/Time of Investigation:	12/12/2006 14:45
Site Hydraulics:	Pending further info.
Upstream Input: (L/S, P/S)	
Upstream Manhole:	DNI
Downstream Manhole:	DNI
Depth of Flow:	0.38" +/- 0.25"
Range (Air DOF):	Pending further info. +/- 0.25"
Peak Velocity:	Pending further info. fps
Silt:	0.00 Inches

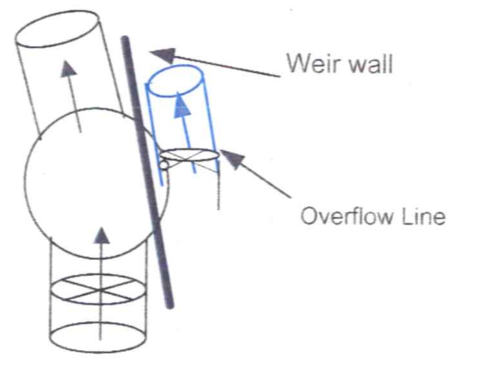
Manhole Information:

Manhole Depth:	8' - 4"
Manhole Material / Condition	Bridk / Good
Pipe Material / Condition:	Clay / Fair
Mini System Character:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Telephone Information:	
Access Pole #:	
Distance From Manhole:	Feet
Road Cut Length:	Feet
Trench Length:	Feet

Other Information:



Cross Section



Planar N

Installation Information

Installation Type:	Standard and reverse in overflow
Sensors Devices:	Ultra / Pressure / Velocity
Surcharge Height:	0.00" Feet
Rain Guage Zone:	

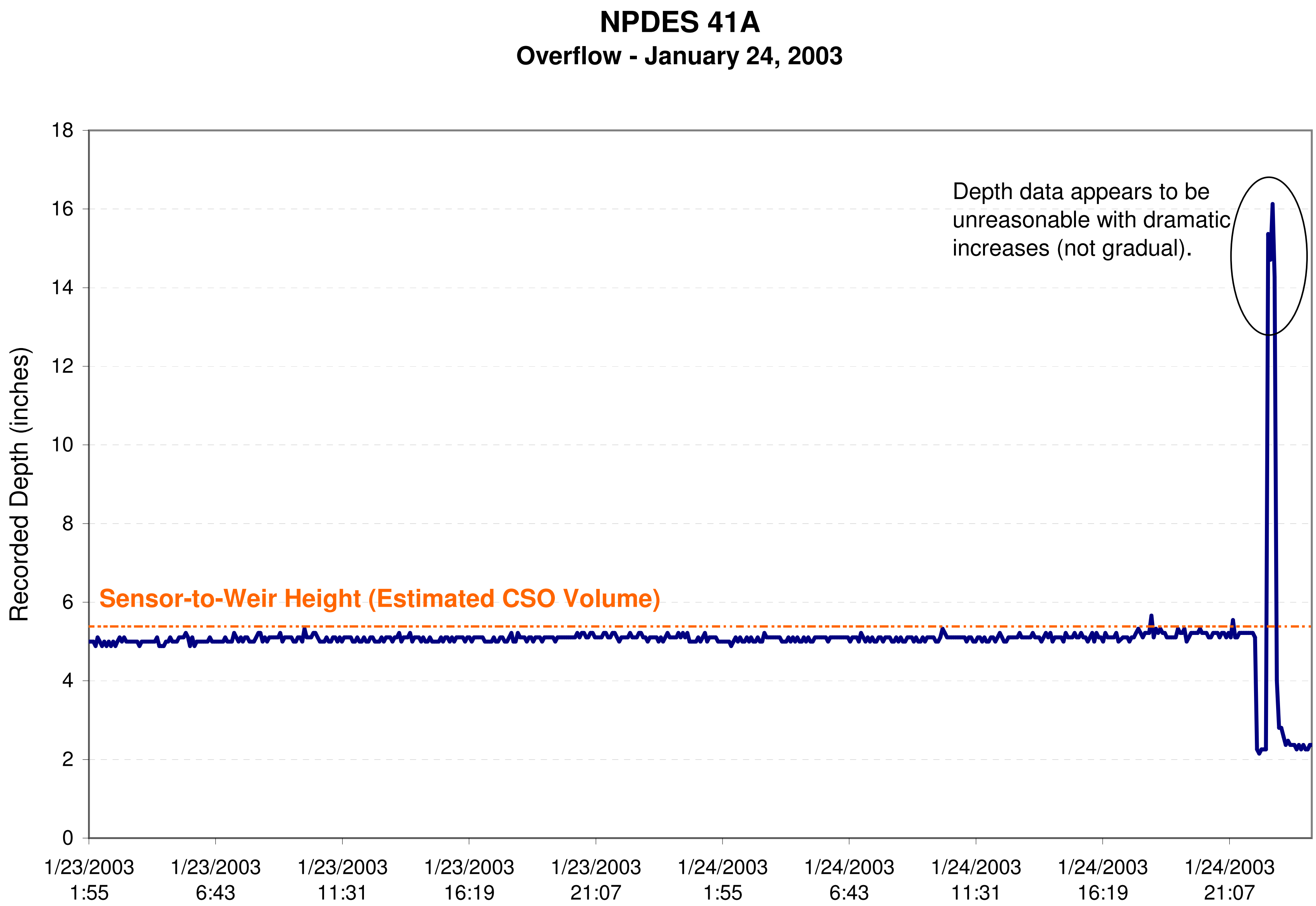
Backup	Yes	No	?	Distance
Trunk	[ ]	[ ]	[ ]	
Lift / Pump Station	[ ]	[ ]	[ ]	
WWTP	[ ]	[ ]	[ ]	
Other	[ ]	[ ]	[ ]	

Additional Site Information / Comments:

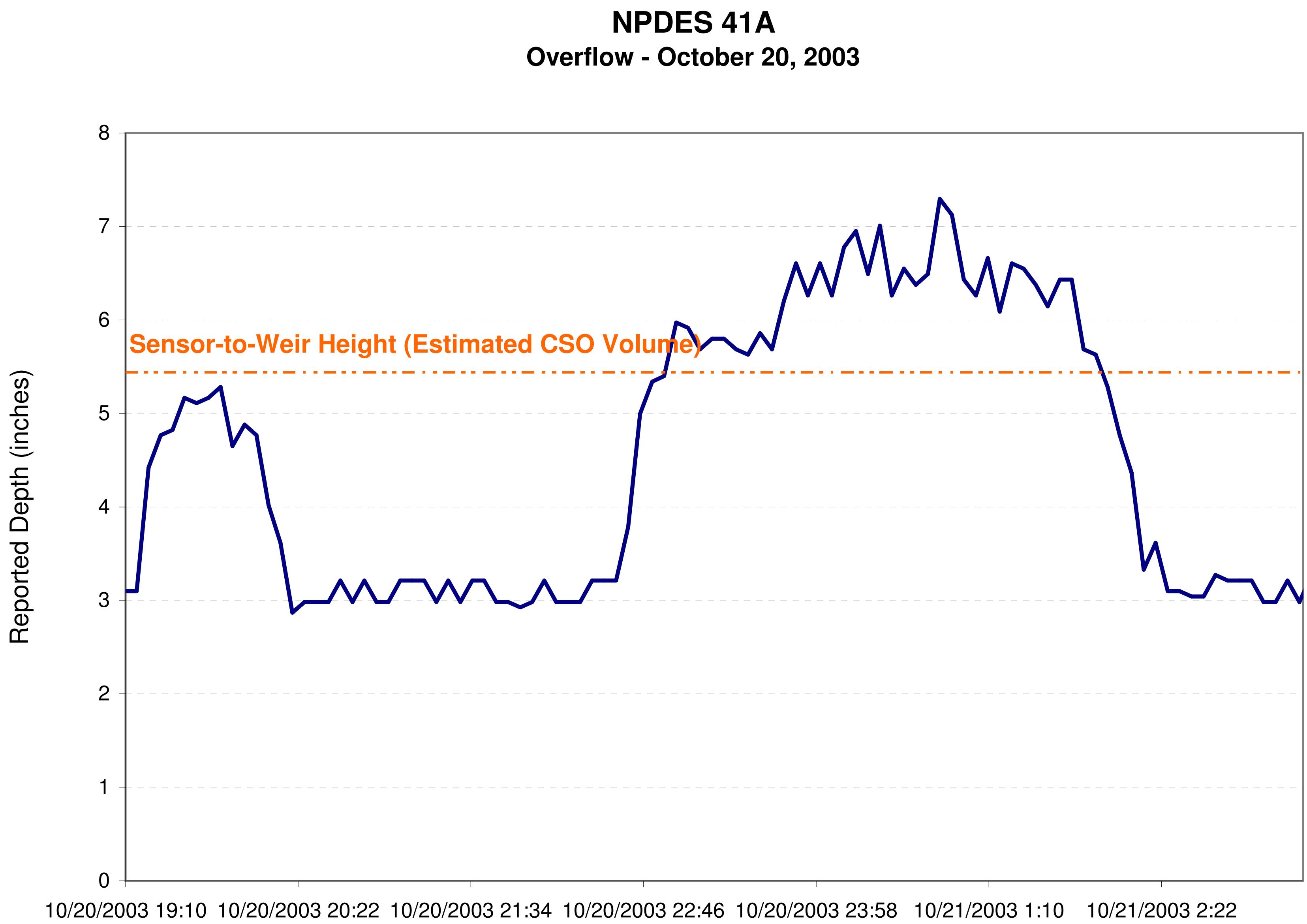
Weir wall: Rt side 5.38 center: 5.5 Lt side: 8.25

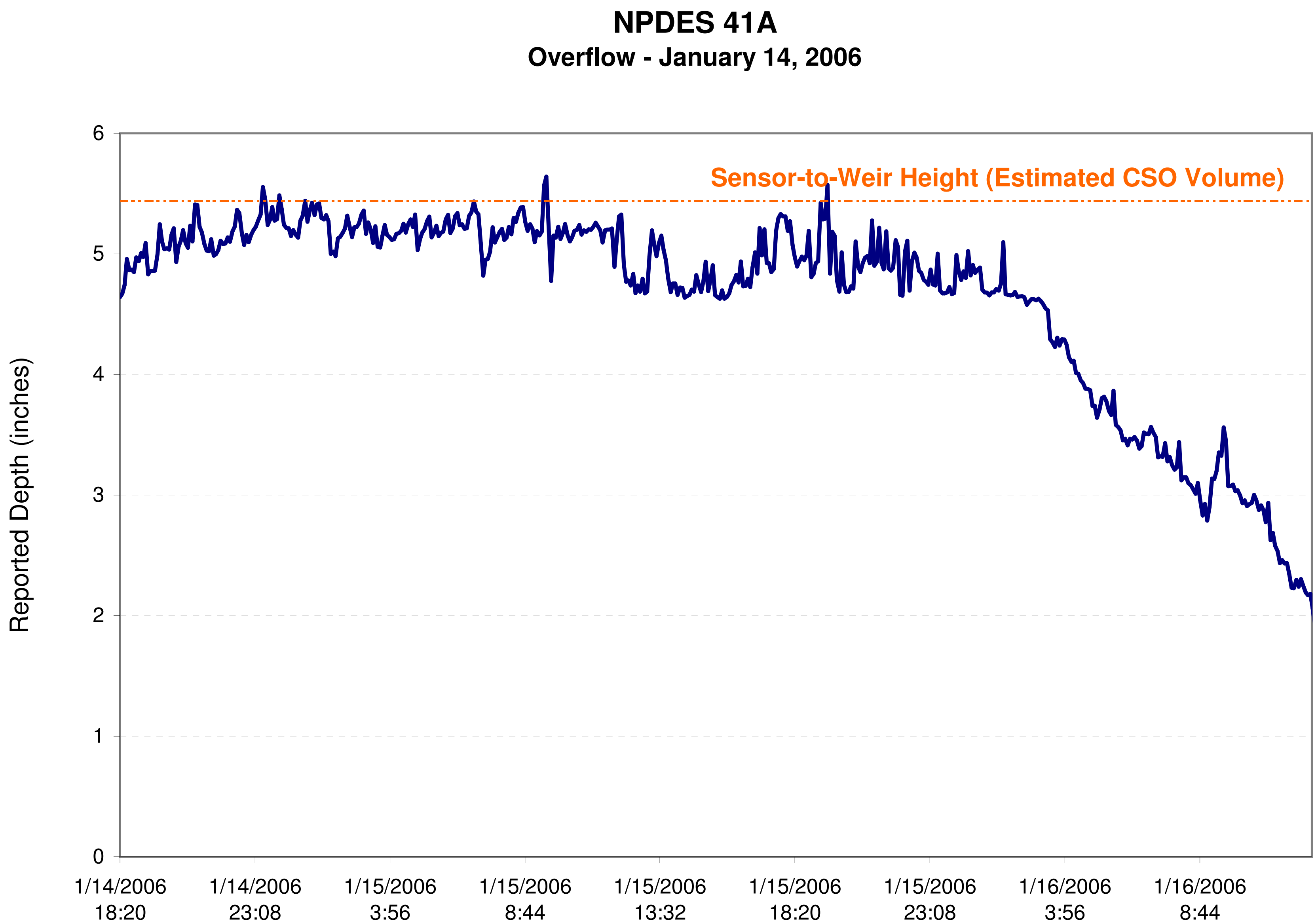
Appendix D.2 – CSO Basin 41A

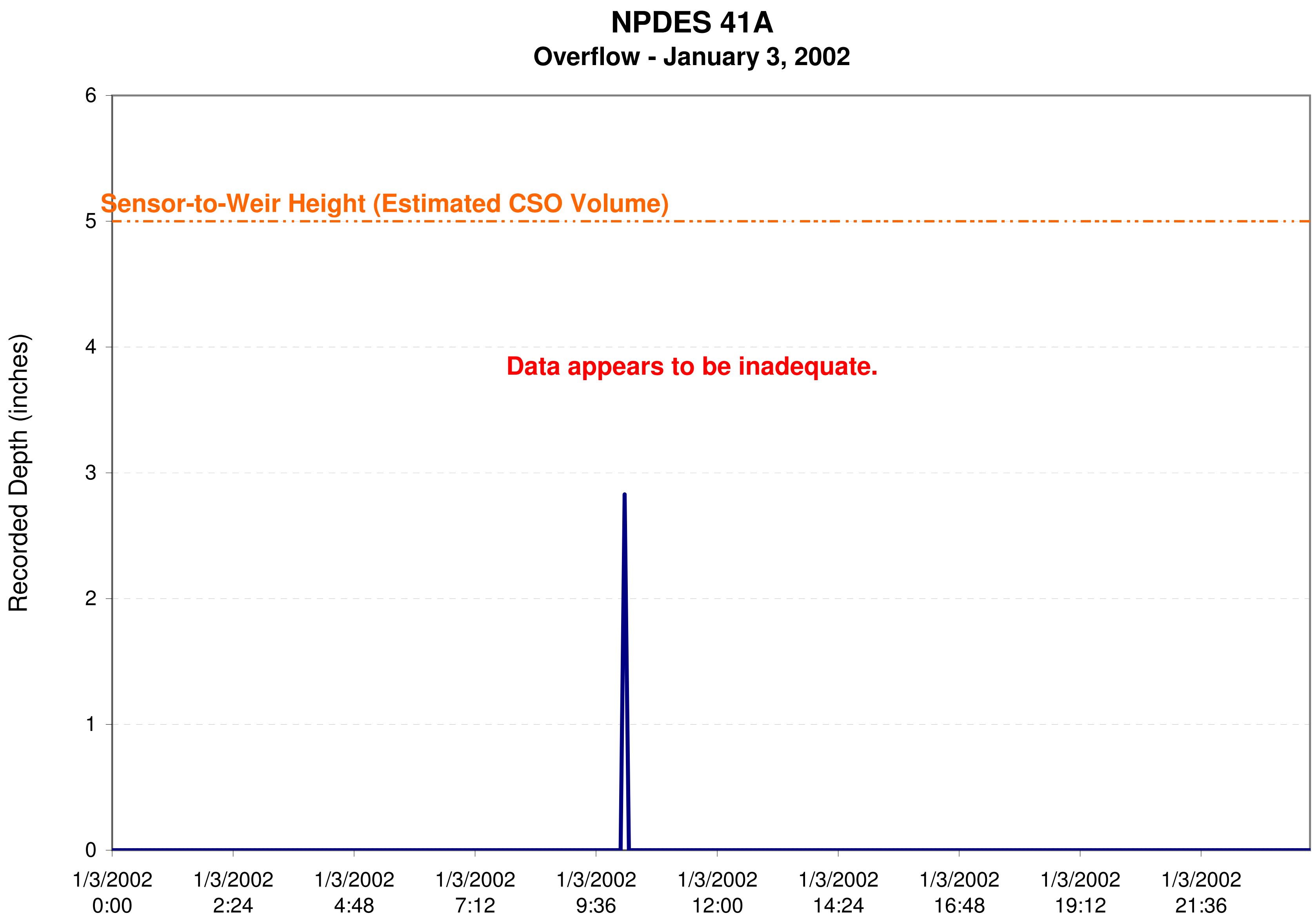
Sample of Depth versus Time Plots for Reported CSO Events



NPDES 41A
Overflow - January 24, 2003
Recorded Depth (inches)
0
2
4
6
8
10
12
14
16
18
Sensor-to-Weir Height (Estimated CSO Volume)
Depth data appears to be unreasonable with dramatic increases (not gradual).
1/23/2003 1:55
1/23/2003 6:43
1/23/2003 11:31
1/23/2003 16:19
1/23/2003 21:07
1/24/2003 1:55
1/24/2003 6:43
1/24/2003 11:31
1/24/2003 16:19
1/24/2003 21:07


NPDES 41A
Overflow - October 20, 2003
Sensor-to-Weir Height (Estimated CSO Volume)
Reported Depth (inches)
0
1
2
3
4
5
6
7
8
10/20/2003 19:10
10/20/2003 20:22
10/20/2003 21:34
10/20/2003 22:46
10/20/2003 23:58
10/21/2003 1:10
10/21/2003 2:22


NPDES 41A
Overflow - January 14, 2006
Sensor-to-Weir Height (Estimated CSO Volume)
Reported Depth (inches)
0
1
2
3
4
5
6
1/14/2006 18:20
1/14/2006 23:08
1/15/2006 3:56
1/15/2006 8:44
1/15/2006 13:32
1/15/2006 18:20
1/15/2006 23:08
1/16/2006 3:56
1/16/2006 8:44



NPDES 41A
Overflow - January 3, 2002
Sensor-to-Weir Height (Estimated CSO Volume)
Data appears to be inadequate.
Recorded Depth (inches)
0
1
2
3
4
5
6
1/3/2002 0:00
1/3/2002 2:24
1/3/2002 4:48
1/3/2002 7:12
1/3/2002 9:36
1/3/2002 12:00
1/3/2002 14:24
1/3/2002 16:48
1/3/2002 19:12
1/3/2002 21:36

Appendix D.3 – CSO Basin 41B

Summary of Assumptions

NPDES Basin 41B - Matching Recorded Volumes

MH059-406

Used to be called 40B (prior to 2002)
Retrofit in 2005 - Sag in weir was filled (February 2005).
Duration of Geotivity Metering: June 13, 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form	February 5, 2003 - due to degradation of weir wall, weir wall height is 7.5 inches. March 4, 2005 - weir height 10" Weir length = 71 inches Weir width = 8.5 inches
ADS Site Report (12/12/2006)	Weir length = 70 inches Weir width = 6 inches Weir height = 13.75 inches (left), 14 inches (center); 14.25 inches (right) Manhole depth = 4'-8"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
1	1/1/2003	2/5/2003 - Geotivity reported degradation of the wall and have now set the float to 7.5 inches. Thus, there is a possibility that the overflow volumes are greater than reported. Based on CSO Retrofit 2005 drawing, it appears that degradation of weir wall occurs in the center of the weir for 2 feet. It is likely that the center portion of the weir is 7.5 inches while the other portions of the weir are closer to that reported by Geotivity (10 inches). December 3, 2007 storm - ADS measured flow rate by applying continuity equation (Q = A * V) using a depth and velocity meter. Maximum flow rate during storm was approximately 522 gpm. Assuming combination of broad-crested weir and free-flowing orifice (unsubmerged), estimated flow rates are higher than 522 gpm when the height above the weir is approximately 2 inches. Thus, it is highly likely that the outlet is restricting flow rate (need to look at upstream impacts). For HDR estimation, assumed 550 gpm for the time duration in which the CSO event is assumed (assumued duration occurs when water depth is above assumed weir height).	Method A - Assume 550 gpm for duration of CSO event. P = Height of weir = 10 in Volume calculations: Simpson's Rule	6,314,000	X
			Method B - Assume 550 gpm for duration of CSO event. P = Height of weir = 9 in (weighted average of weir height - 7.5"/10") Volume calculations: Simpson's Rule	12,226,500	

NPDES Basin 41B - Matching Recorded Volumes

MH059-406

Used to be called 40B (prior to 2002)
Retrofit in 2005 - Sag in weir was filled (February 2005).
Duration of Geotivity Metering: June 13, 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form	February 5, 2003 - due to degradation of weir wall, weir wall height is 7.5 inches. March 4, 2005 - weir height 10" Weir length = 71 inches Weir width = 8.5 inches
ADS Site Report (12/12/2006)	Weir length = 70 inches Weir width = 6 inches Weir height = 13.75 inches (left), 14 inches (center); 14.25 inches (right) Manhole depth = 4'-8"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
2	1/17/2005	2/5/2003 - Geotivity reported degradation of the wall and have now set the float to 7.5 inches. Thus, there is a possibility that the overflow volumes are greater than reported. Based on CSO Retrofit 2005 drawing, it appears that degradation of weir wall occurs in the center of the weir for 2 feet. It is likely that the center portion of the weir is 7.5 inches while the other portions of the weir are closer to that reported by Geotivity (10 inches). December 3, 2007 storm - ADS measured flow rate by applying continuity equation (Q = A * V) using a depth and velocity meter. Maximum flow rate during storm was approximately 522 gpm. Assuming combination of broad-crested weir and free-flowing orifice (unsubmerged), estimated flow rates are higher than 522 gpm when the height above the weir is approximately 2 inches. Thus, it is highly likely that the outlet is restricting flow rate (need to look at upstream impacts). For HDR estimation, assumed 550 gpm for the time duration in which the CSO event is assumed (assumued duration occurs when water depth is above assumed weir height).	Method A - Assume 550 gpm for duration of CSO event. P = Height of weir = 7.5 in Volume calculations: Simpson's Rule	2,516,250	
			Method B - Assume 550 gpm for duration of CSO event. P = Height of weir = 9 in (weighted average of weir height - 7.5"/10") Volume calculations: Simpson's Rule	1,790,250	X

NPDES Basin 41B - Matching Recorded Volumes

MH059-406

Used to be called 40B (prior to 2002)
Retrofit in 2005 - Sag in weir was filled (February 2005).
Duration of Geotivity Metering: June 13, 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form	February 5, 2003 - due to degradation of weir wall, weir wall height is 7.5 inches. March 4, 2005 - weir height 10" Weir length = 71 inches Weir width = 8.5 inches
ADS Site Report (12/12/2006)	Weir length = 70 inches Weir width = 6 inches Weir height = 13.75 inches (left), 14 inches (center); 14.25 inches (right) Manhole depth = 4'-8"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
3	12/10/2002	2/5/2003 - Geotivity reported degradation of the wall and have now set the float to 7.5 inches. Thus, there is a possibility that the overflow volumes are greater than reported. Based on CSO Retrofit 2005 drawing, it appears that degradation of weir wall occurs in the center of the weir for 2 feet. It is likely that the center portion of the weir is 7.5 inches while the other portions of the weir are closer to that reported by Geotivity (10 inches). 12/16/2002 15:10 and 15:15, measured depths reported from 26.5 inches to 110.9 inches/118.35 inches back to 8.56 inches (amounts to approximately 2,277,991 gallons). Assumed inadequate depth readings. In estimations, applied depth of 26.5 inches to level out readings. December 3, 2007 storm - ADS measured flow rate by applying continuity equation (Q = A * V) using a depth and velocity meter. Maximum flow rate during storm was approximately 522 gpm. Assuming combination of broad-crested weir and free-flowing orifice (unsubmerged), estimated flow rates are higher than 522 gpm when the height above the weir is approximately 2 inches. Thus, it highly likely that the outlet is restricting flow rate (need to look at upstream impacts). For HDR estimation, assumed 550 gpm for the time duration in which the CSO event is assumed (assumued duration occurs when water depth is above assumed weir height).	Method A - Assume 550 gpm for duration of CSO event. P = Height of weir = 10 in Volume calculations: Simpson's Rule	2,596,000	X
			Method B - Assume 550 gpm for duration of CSO event. P = Height of weir = 9 in (weighted average of weir height - 7.5"/10") Volume calculations: Simpson's Rule	3,181,750	

NPDES Basin 41B - Matching Recorded Volumes

MH059-406

Used to be called 40B (prior to 2002)
Retrofit in 2005 - Sag in weir was filled (February 2005).
Duration of Geotivity Metering: June 13, 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form	February 5, 2003 - due to degradation of weir wall, weir wall height is 7.5 inches. March 4, 2005 - weir height 10" Weir length = 71 inches Weir width = 8.5 inches
ADS Site Report (12/12/2006)	Weir length = 70 inches Weir width = 6 inches Weir height = 13.75 inches (left), 14 inches (center); 14.25 inches (right) Manhole depth = 4'-8"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
4	12/11/2006	Reported in 2005 CSO Report - construction of weir modifications at NPDES #41B was completed in February 2005 to eliminate dry weather overflows and lake-water intrustion. December 3, 2007 storm - ADS measured flow rate by applying continuity equation (Q = A * V) using a depth and velocity meter. Maximum flow rate during storm was approximately 522 gpm. Assuming combination of broad-crested weir and free-flowing orifice (unsubmerged), estimated flow rates are higher than 522 gpm when the height above the weir is approximately 2 inches. Thus, it is highly likely that the outlet is restricting flow rate (need to look at upstream impacts). For HDR estimation, assumed 550 gpm for the time duration in which the CSO event is assumed (assumued duration occurs when water depth is above assumed weir height).	Method B - Assume 550 gpm for duration of CSO event. P = Height of weir = 14 in Volume calculations: Simpson's Rule	1,518,000	X

NPDES Basin 41B - Matching Recorded Volumes

MH059-406

Used to be called 40B (prior to 2002)
Retrofit in 2005 - Sag in weir was filled (February 2005).
Duration of Geotivity Metering: June 13, 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form	February 5, 2003 - due to degradation of weir wall, weir wall height is 7.5 inches. March 4, 2005 - weir height 10" Weir length = 71 inches Weir width = 8.5 inches
ADS Site Report (12/12/2006)	Weir length = 70 inches Weir width = 6 inches Weir height = 13.75 inches (left), 14 inches (center); 14.25 inches (right) Manhole depth = 4'-8"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
5	1/29/2006	Reported in 2005 CSO Report - construction of weir modifications at NPDES #41B was completed in February 2005 to eliminate dry weather overflows and lake-water intrustion. December 3, 2007 storm - ADS measured flow rate by applying continuity equation (Q = A * V) using a depth and velocity meter. Maximum flow rate during storm was approximately 522 gpm. Assuming combination of broad-crested weir and free-flowing orifice (unsubmerged), estimated flow rates are higher than 522 gpm when the height above the weir is approximately 2 inches. Thus, it is highly likely that the outlet is restricting flow rate (need to look at upstream impacts). For HDR estimation, assumed 550 gpm for the time duration in which the CSO event is assumed (assumued duration occurs when water depth is above assumed weir height).	Method B - Assume 550 gpm for duration of CSO event. P = Height of weir = 14 in Volume calculations: Simpson's Rule	849,750

NPDES Basin 41B - Matching Recorded Volumes

MH059-406

Used to be called 40B (prior to 2002)
Retrofit in 2005 - Sag in weir was filled (February 2005).
Duration of Geotivity Metering: June 13, 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form	February 5, 2003 - due to degradation of weir wall, weir wall height is 7.5 inches. March 4, 2005 - weir height 10" Weir length = 71 inches Weir width = 8.5 inches
ADS Site Report (12/12/2006)	Weir length = 70 inches Weir width = 6 inches Weir height = 13.75 inches (left), 14 inches (center); 14.25 inches (right) Manhole depth = 4'-8"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
6	1/29/2004	2/5/2003 - Geotivity reported degradation of the wall and have now set the float to 7.5 inches. Thus, there is a possibility that the overflow volumes are greater than reported. Based on CSO Retrofit 2005 drawing, it appears that degradation of weir wall occurs in the center of the weir for 2 feet. It is likely that the center portion of the weir is 7.5 inches while the other portions of the weir are closer to that reported by Geotivity (10 inches). December 3, 2007 storm - ADS measured flow rate by applying continuity equation (Q = A * V) using a depth and velocity meter. Maximum flow rate during storm was approximately 522 gpm. Assuming combination of broad-crested weir and free-flowing orifice (unsubmerged), estimated flow rates are higher than 522 gpm when the height above the weir is approximately 2 inches. Thus, it is highly likely that the outlet is restricting flow rate (need to look at upstream impacts). For HDR estimation, assumed 550 gpm for the time duration in which the CSO event is assumed (assumued duration occurs when water depth is above assumed weir height).	Method A - Assume 550 gpm for duration of CSO event. P = Height of weir = 10 in Volume calculations: Simpson's Rule	984,500	
			Method B - Assume 550 gpm for duration of CSO event. P = Height of weir = 9 in (weighted average of weir height - 7.5"/10") Volume calculations: Simpson's Rule	1,003,750	X

NPDES Basin 41B - Matching Recorded Volumes

MH059-406

Used to be called 40B (prior to 2002)
Retrofit in 2005 - Sag in weir was filled (February 2005).
Duration of Geotivity Metering: June 13, 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity — Site Investigation Form
February 5, 2003 - due to degradation of weir wall, weir wall height is 7.5 inches.
March 4, 2005 - weir height 10"
Weir length = 71 inches
Weir width = 8.5 inches

ADS — Site Report (12/12/2006)
Weir length = 70 inches
Weir width = 6 inches
Weir height = 13.75 inches (left), 14 inches (center); 14.25 inches (right)
Manhole depth = 4'-8"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
7	1/9/2006	Reported in 2005 CSO Report - construction of weir modifications at NPDES #41B was completed in February 2005 to eliminate dry weather overflows and lake-water intrustion. December 3, 2007 storm - ADS measured flow rate by applying continuity equation (Q = A * V) using a depth and velocity meter. Maximum flow rate during storm was approximately 522 gpm. Assuming combination of broad-crested weir and free-flowing orifice (unsubmerged), estimated flow rates are higher than 522 gpm when the height above the weir is approximately 2 inches. Thus, it is highly likely that the outlet is restricting flow rate (need to look at upstream impacts). For HDR estimation, assumed 550 gpm for the time duration in which the CSO event is assumed (assumued duration occurs when water depth is above assumed weir height).	Method A - Assume 550 gpm for duration of CSO event. P = Height of weir = 14 in Volume calculations: Simpson's Rule	1,267,750	X
8	10/17/2003	Inadequate data available for this CSO event.	Inadequate data available for this CSO event.	Inadequate data available for this CSO event.	
9	10/21/2003	Inadequate data available for this CSO event.	Inadequate data available for this CSO event.	Inadequate data available for this CSO event.	

NPDES Basin 41B - Matching Recorded Volumes

MH059-406

Used to be called 40B (prior to 2002)
Retrofit in 2005 - Sag in weir was filled (February 2005).
Duration of Geotivity Metering: June 13, 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred

Geotivity Site Investigation Form	February 5, 2003 - due to degradation of weir wall, weir wall height is 7.5 inches. March 4, 2005 - weir height 10" Weir length = 71 inches Weir width = 8.5 inches
ADS Site Report (12/12/2006)	Weir length = 70 inches Weir width = 6 inches Weir height = 13.75 inches (left), 14 inches (center); 14.25 inches (right) Manhole depth = 4'-8"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
10	11/5/2006	Reported in 2005 CSO Report - construction of weir modifications at NPDES #41B was completed in February 2005 to eliminate dry weather overflows and lake-water intrustion. December 3, 2007 storm - ADS measured flow rate by applying continuity equation (Q = A * V) using a depth and velocity meter. Maximum flow rate during storm was approximately 522 gpm. Assuming combination of broad-crested weir and free-flowing orifice (unsubmerged), estimated flow rates are higher than 522 gpm when the height above the weir is approximately 2 inches. Thus, it is highly likely that the outlet is restricting flow rate (need to look at upstream impacts). For HDR estimation, assumed 550 gpm for the time duration in which the CSO event is assumed (assumued duration occurs when water depth is above assumed weir height).	Method A - Assume 550 gpm for duration of CSO event. P = Height of weir = 14 in Volume calculations: Simpson's Rule	728,750	X

Following information reviewed in CSO Annual Reports:

Report	Description
2001	When reporting frequency, City was using the 3-hour inter-event time (IET) from January 2001 until March 2001. Beginning April 5, 2001, City began using the 24-hr IET per Ecology.
2002	Prior to 2002, NPDES 41B was referred to as NPDES 40B.
2002	12/10/02 – Geotivity reported that this CSO event may be due to a partial blockage.
2003	It was documented (1/1/2003 thru 2/21/2004) that site investigations revealed that the site is prone to frequent lake water intrusion and most of the recorded data are in fact, lake water flowing into the City's CSS.
2005	Construction of weir modifications at NPDES #41B was completed in February 2005 to eliminate dry weather overflows and lake-water intrusion.

Determine weir height:

Height (in)	Source
10	Geotivity Site Investigation Form (1/1/2001)
7.5	Geotivity Site Investigation Form (1/1/2001), degradation of weir wall was documented (2/5/03).
12.12	Evans - Plan View Retrofit (12/29/2004) - with sag
16.44	Evans - Plan View Retrofit (12/29/2004) - sag filled
14	ADS Site Report (center height), 12/12/2006

Determine weir length:

Length (in)	Source
71	Geotivity Site Investigation Form (1/1/2001)
70	ADS Site Report (12/12/2006)

Determine flow rate estimate:

Assumption	Reasoning
Broad-crested weir	Reported as 6-inch weir width in ADS Site Report.
Broad-crested weir	Reported as 8.5-inch weir width in Geotivity Site Investigation Form.

Pipe Capacity Estimations (Overflow Structure 41B)

Downstream pipe capacities (for overflow and outfall pipes) were calculated to determine if pipes may be outlet-controlled at larger overflow rates during CSO events for Overflow Structure 41B. If the CSO events are outlet-controlled at larger overflow rates, then the actual CSO volumes are lower than the CSO volumes calculated (overflow rate estimates would be less in a submerged versus free-flowing condition).

The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of the outfall. The assumed maximum overflow rate for the 12/3/07 storm is shown in Table A in bold for Overflow Structure 41B.

Maximum pipe capacities were also calculated using the Manning equation and available Geographic Information Systems (GIS) data. Invert elevations of maintenance holes and pipe lengths and diameters (as indicated in GIS) were used to estimate full pipe capacity (also shown in Table A). However, these capacities should not be considered the maximum pipe capacities due to GIS data discrepancies and because the GIS data was not compared to record drawings or available survey data for verification.

Table B presents the maximum estimated overflow rate from the 12/11/06 CSO event that was calculated using the sharp-crested weir equation (unsubmerged). The estimated flow rate for the 12/11/06 CSO event (the fourth largest reported CSO event between 2000 to 2006) resulted in a maximum flow rate of approximately 40 mgd, which is larger than the maximum 12/3/07 overflow rate. Thus, it may be possible that the pipeline may have inadequate capacity for this CSO event at the larger overflow rates.

Table A. Estimated Pipe Capacities for Overflow Structure 41B

Source	Maximum Pipe Capacity	Details and Assumptions
ADS Monitoring Data, 12/3/07 storm	**0.75 mgd**	Overflow rates estimated from depth and velocity meters in overflow pipe.
Seattle Public Utilities Geographic Information Systems (GIS) layers for sewer mainlines and manholes	Not estimated	Upstream and downstream manholes for pipe segment: MH 059-406 to MH 059-429. Capacity could not be calculated using Manning equation because the slope was indicated as negative in GIS.
	1.81 mgd	Upstream and downstream manholes for pipe segment: MH 059-429 to MH 059-432. Capacity calculated using Manning equation (d = 15 inches; n = 0.013; s = 0.0019 ft/ft).
	5.22 mgd	Upstream and downstream manholes for pipe segment: MH 059-432 to MH 059-431. Capacity calculated using Manning equation (d = 14 inches; n = 0.013; s = 0.0225 ft/ft)

Table B. Maximum Estimated Overflow Rates for 12/14/06 CSO Event, Overflow Structure 41B

Reported Overflow Date	Maximum Estimated Overflow Rate	Details and Assumptions
12/14/2006	40 mgd	Overflow rates calculated using sharp-crested weir equation (unsubmerged).

S–Doc Site Investigation Form

Site Name: Npdes041B

GEOTIVITY

Project	0054852
SN#	1031657

*Note**
This form contains information measured in the field environment, and is subject to change depending on recent site conditions including but not limited to physical erosion, site hydraulics, pipe corrosion and siltation

LOCATION INFORMATION

Field Book Number:	N/A	**Address:**	Lake Washington Blvd and 49th
MH#	MH059–406	**GPS Coordinates**	Latitude: N 47.56769 Longitude: W 122.27191
Install Date:	2001–01–01 00:00	***Intrinsically Safe Sticker Number***	none
Thomas Brothers Map Pg	N/A	**Traffic Conditions**	Slow Traffic

Location Map

Image Not Available

Landmarks:

Image Not Available

MONITOR:

Type:	QTrek V2		**SN:**	1031657		**SIM**	8931 0380 2020 2332 1036
Sensors:	HRS Depth 1	HRS Depth 2	Battery	Float Switch	–	–	**Signal**	–85
	–	–	–	–	–	–	**Server IP**	

GAS:

O2	20.9	**H2S**	0	**Confined Space Entry notes***	Weir wall deteriorating. Heavy sediment
LEL	0	**CO2**	0		

CHANNEL

Type:	Circular	
Cond.	Fair	
Flow:	Smooth	
Material:	Concrete	
Height:	0	in
Width:	0	in
Other:	Sheet #	
Ground:	5	ft (bench)

OVERFLOW

Type:	Irregular	
Cond.	Good	
Length:	71	in
Width:	8.5	in
Height:	10	in

Other Information:

Weir wall deteriorating. Heavy sediment 03 Feb 05 Weir Wall Height would be 275 mm if weir wall was intact. due to degradation weir wall height is now 7.5\\\" , float is set at 7.5\\\" Feb 14 2005 Site made inactive because it is no longer in the ground. AV Feb 18th 2005 Re–Installed unit API March 4 weir hieght 10"

Image Not Available
Image Not Available

note* all dimensions referenced from invert (bottom) of channel

SIF Type = Sewer
Site Pictures
Format: All pictures are RGB 640 by 480 pix. Resolution.

Manhole Cover With #

Upstream Flow

ADS ENVIRONMENTAL SERVICES®

ADS Site Report

Quality Form

Project Name:	Seattle - CSO	City / State:	Seattle, WA	FM Initials:	SS

Site Name: NPDES 41B/SEA_059406	Monitor Series: 5000 BG	Monitor S/N:	19003
Address/Location:	4002 49th Av. S. @ Lake Washington BLVD S.	Manhole #:	059-406
		Thomas Bros Map Page:	595 F4
		Pipe Height:	MP 1: 12.00" MP 2: 15.00"
Access: Drive	Type of System: Sanitary [ ] Storm [ ] Combined [X]	Pipe Width:	MP 1: 12.00" MP 2: 15.00"
		IP Address:	166.219.18.242

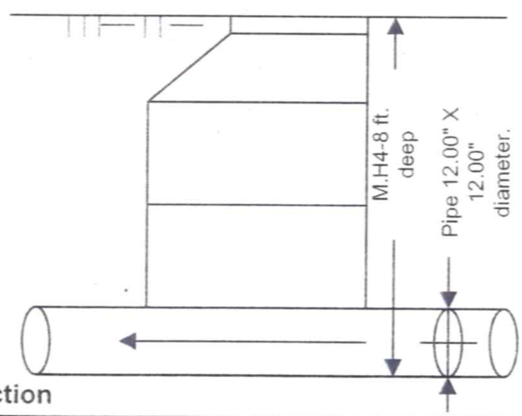
Investigation Information:

Date/Time of Investigation:	12/12/2006 13:19
Site Hydraulics:	Steady smooth flow
Upstream Input: (L/S, P/S)	
Upstream Manhole:	DNI
Downstream Manhole:	DNI
Depth of Flow:	9.13"+/- 0.25"
Range (Air DOF):	+/-
Peak Velocity:	1.73 fps
Silt:	2.00 Inches

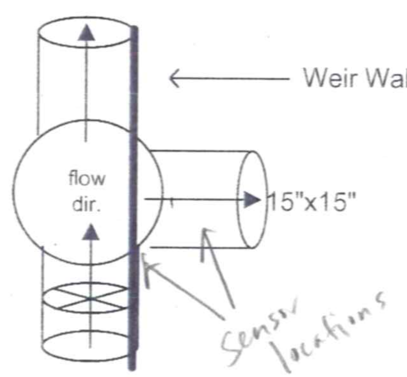
Manhole Information:

Manhole Depth:	4' - 8"
Manhole Material / Condition	Brick / Good
Pipe Material / Condition:	Clay / Good
Mini System Character:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Telephone Information:	
Access Pole #:	
Distance From Manhole:	Feet
Road Cut Length:	Feet
Trench Length:	Feet

Other Information:



Cross Section



Planar N

Installation Information	
Installation Type:	Regular
Sensors Devices:	Ultra / Pressure / Velocity
Surcharge Height:	0.00" Feet
Rain Guage Zone:	

Backup	Yes	No	?	Distance
Trunk	[ ]	[ ]	[ ]	
Lift / Pump Station	[ ]	[ ]	[ ]	
WWTP	[ ]	[ ]	[ ]	
Other	[ ]	[ ]	[ ]	

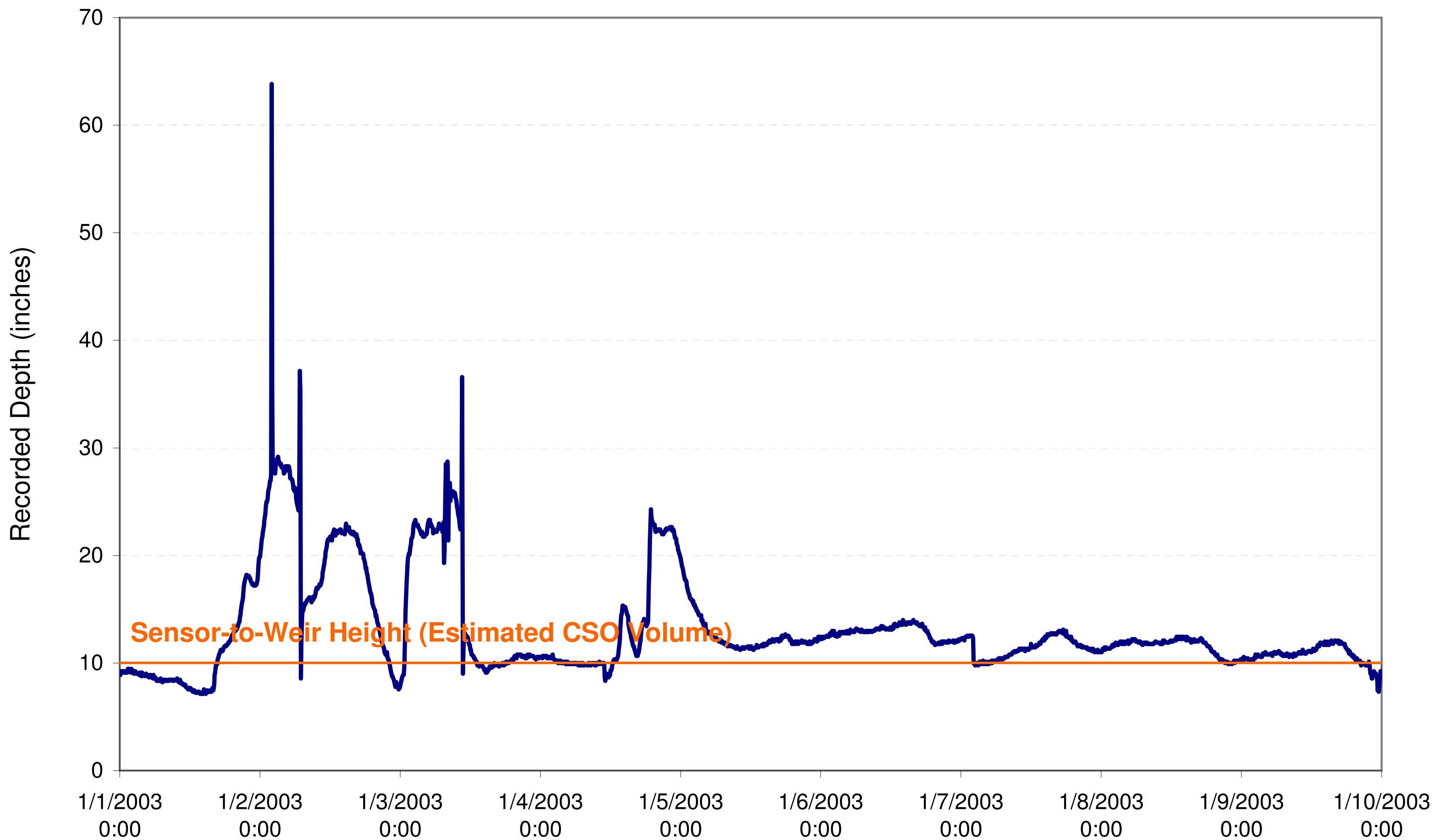
Additional Site Information / Comments:

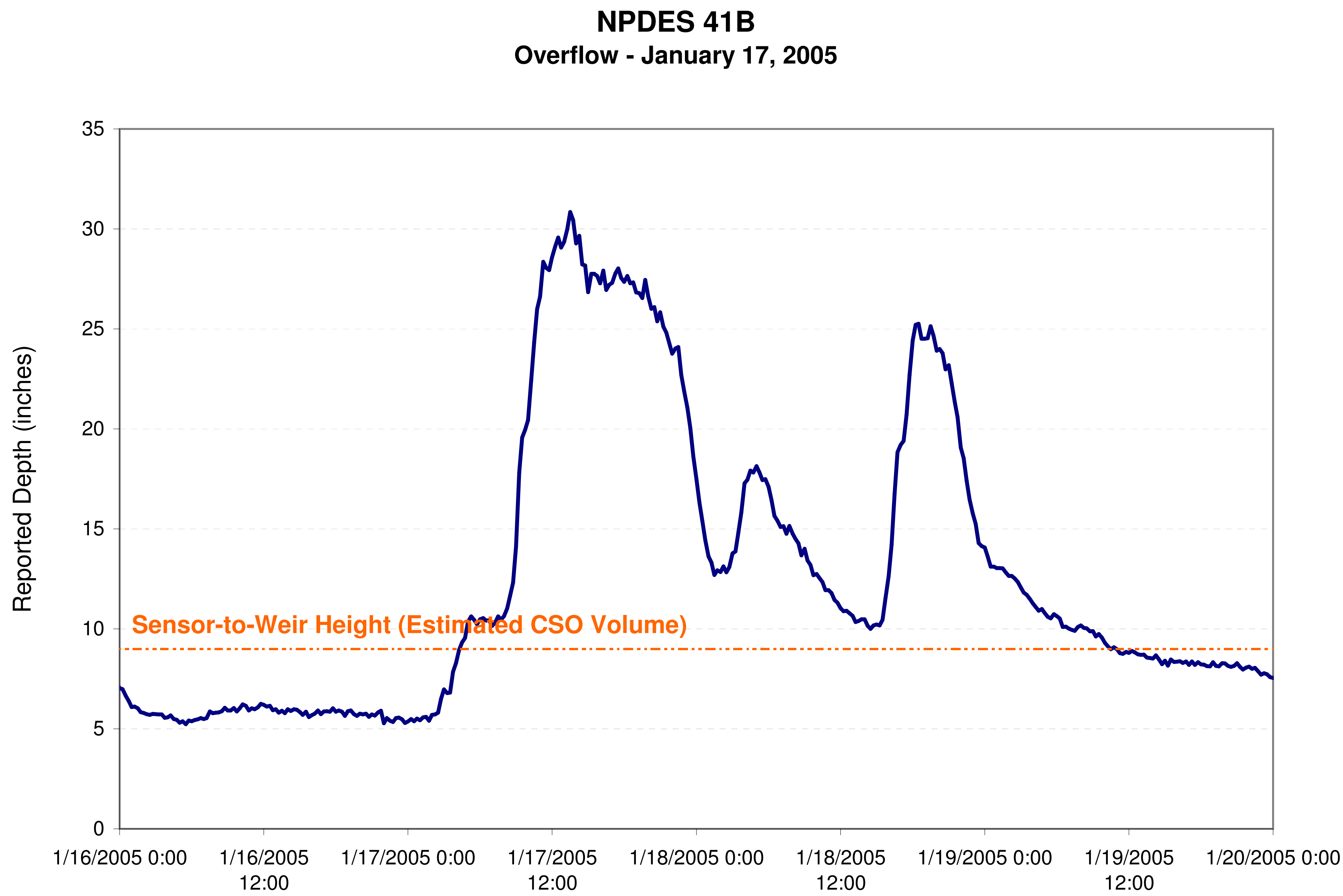
Weir Measurements; Length 70.00", Width 6.00". Height: Left 13.75", Center 14.00", Right 14.25".
Overflow quantification - MP1 - Broad crested Weir, MP2 continuity

Appendix D.4 – CSO Basin 41B

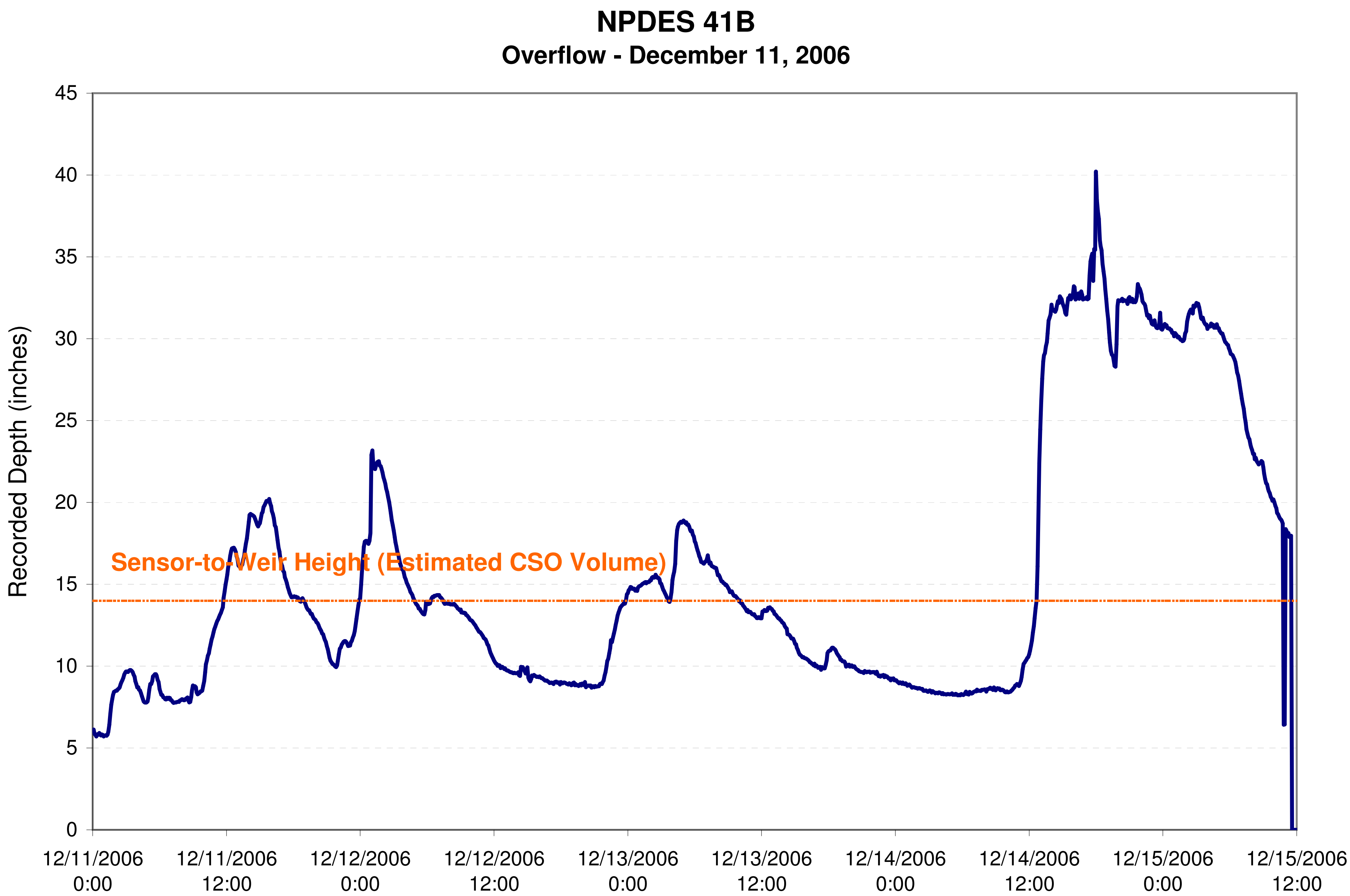
Sample of Depth versus Time Plots for Reported CSO Events

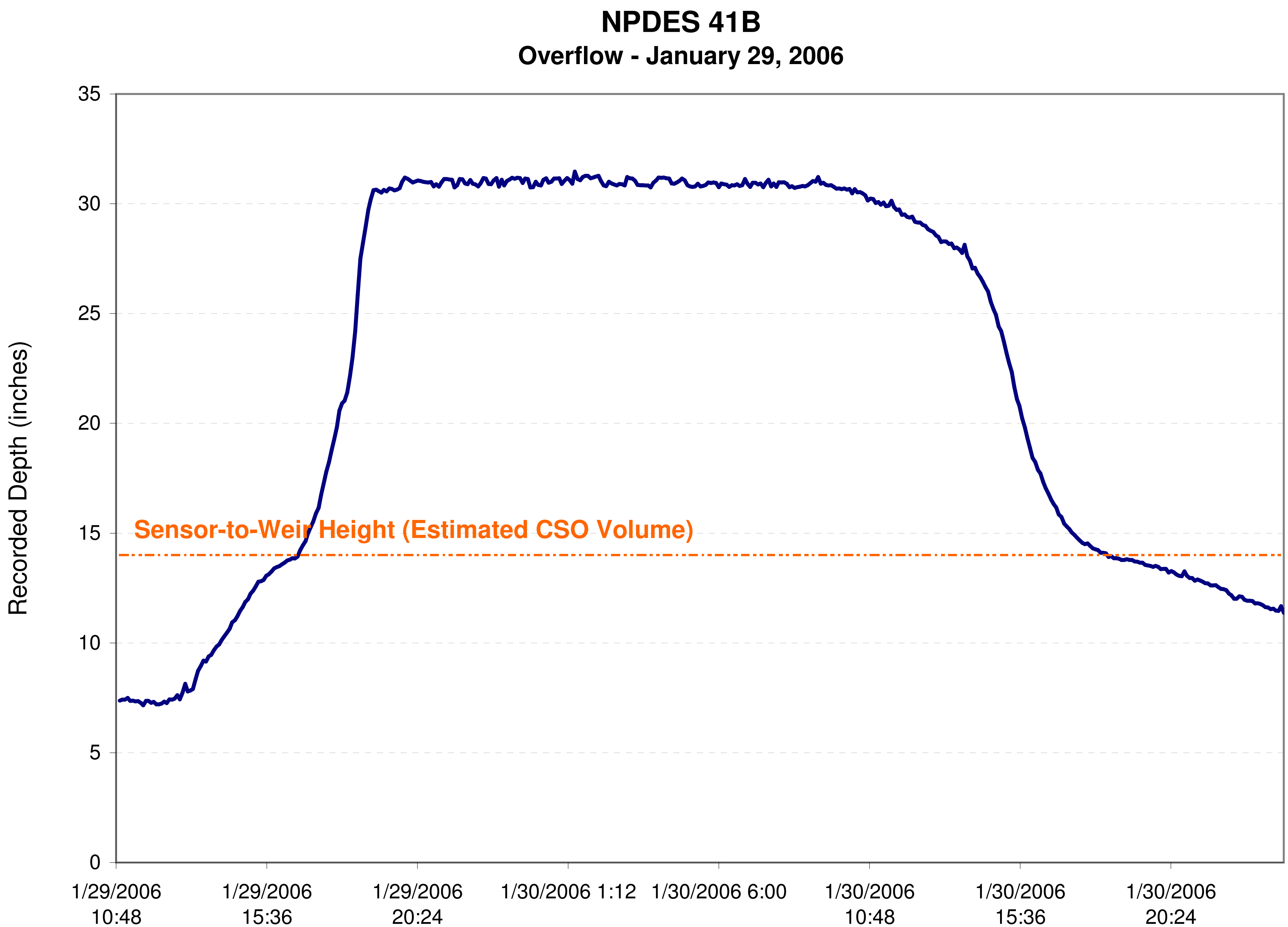
NPDES 41B
Overflow - January 1, 2003



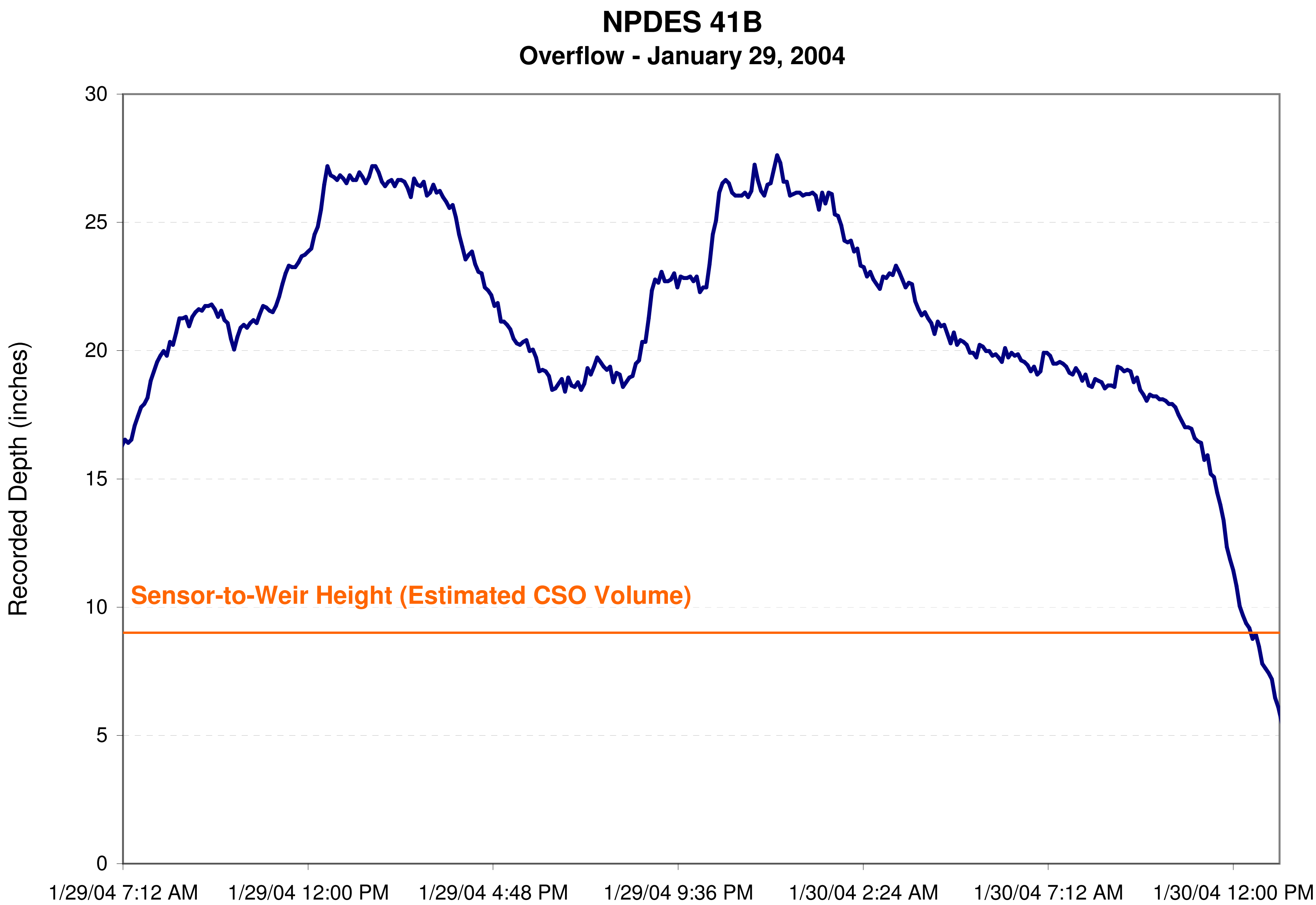


NPDES 41B
Overflow - January 17, 2005
Reported Depth (inches)
35
30
25
20
15
10
5
0
Sensor-to-Weir Height (Estimated CSO Volume)
1/16/2005 0:00
1/16/2005 12:00
1/17/2005 0:00
1/17/2005 12:00
1/18/2005 0:00
1/18/2005 12:00
1/19/2005 0:00
1/19/2005 12:00
1/20/2005 0:00

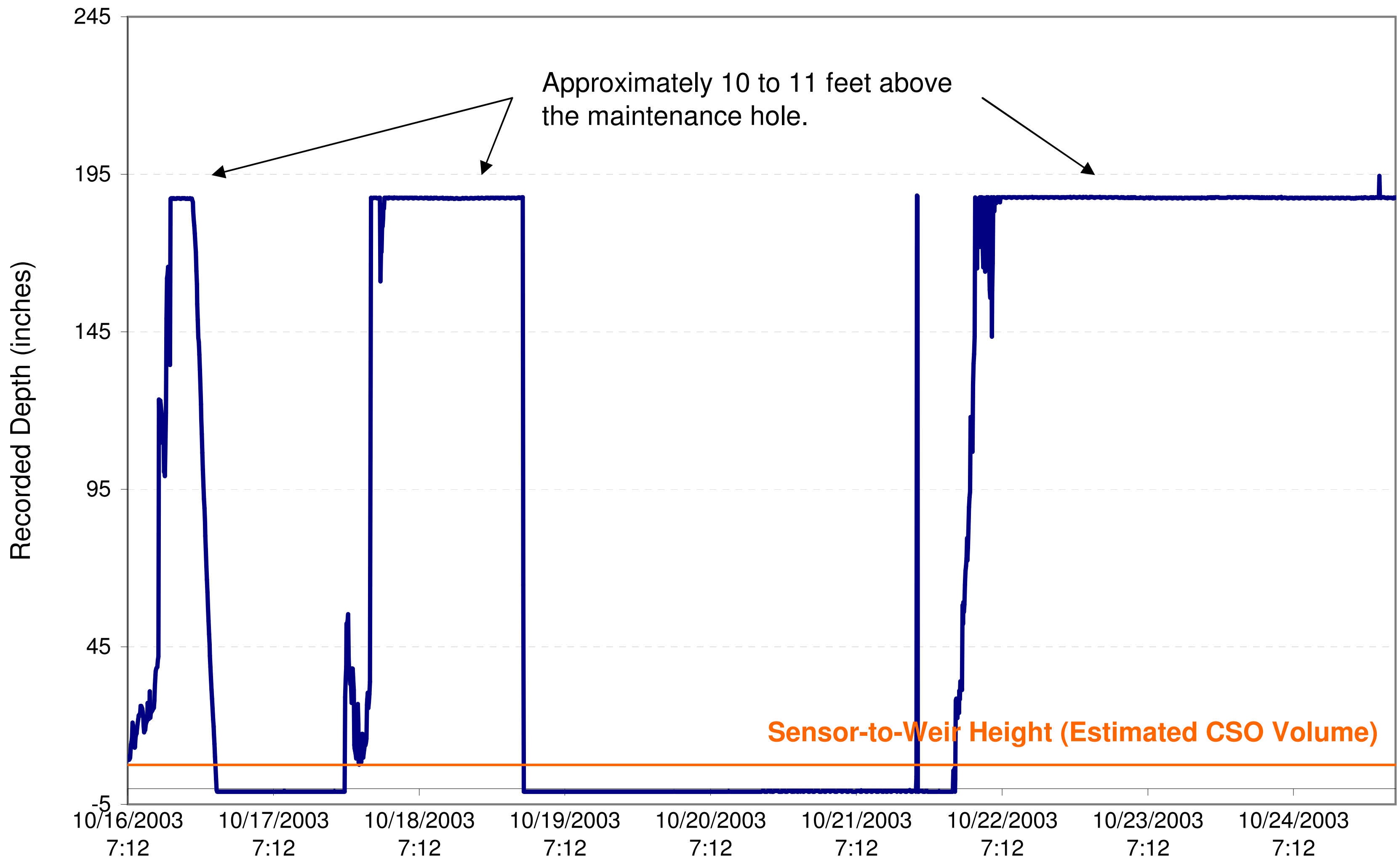

NPDES 41B
Overflow - December 11, 2006
Recorded Depth (inches)
45
40
35
30
25
20
15
10
5
0
Sensor-to-Weir Height (Estimated CSO Volume)
12/11/2006 0:00
12/11/2006 12:00
12/12/2006 0:00
12/12/2006 12:00
12/13/2006 0:00
12/13/2006 12:00
12/14/2006 0:00
12/14/2006 12:00
12/15/2006 0:00
12/15/2006 12:00



NPDES 41B
Overflow - January 29, 2006
Recorded Depth (inches)
35
30
25
20
15
10
5
0
Sensor-to-Weir Height (Estimated CSO Volume)
1/29/2006 10:48
1/29/2006 15:36
1/29/2006 20:24
1/30/2006 1:12
1/30/2006 6:00
1/30/2006 10:48
1/30/2006 15:36
1/30/2006 20:24


NPDES 41B
Overflow - January 29, 2004
Recorded Depth (inches)
30
25
20
15
10
5
0
Sensor-to-Weir Height (Estimated CSO Volume)
1/29/04 7:12 AM
1/29/04 12:00 PM
1/29/04 4:48 PM
1/29/04 9:36 PM
1/30/04 2:24 AM
1/30/04 7:12 AM
1/30/04 12:00 PM

NPDES 41B
Overflows - October 17 and 21, 2006



Appendix E – CSO Basin 42

Appendix E.1 – CSO Basin 42

Summary of Assumptions

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006
Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

<table>
<tr><th>Rank</th><th>Reported Overflow Date</th><th>Comments</th><th>Estimated CSO Volume Methodology</th><th>Estimated CSO Volume (gal)</th><th></th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">1/29/2006</td><td rowspan="2">Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches.

Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.</td><td>Method A - Assume dimension change in Sept. 2005.

Flow calculations (Sept. 2005 - Dec. 2006):
$Q = 3.33LH^{3/2}$ (sharp-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.33 ft (88 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 63 in (average weir height from ADS)

Volume calculations:
Simpson's Rule</td><td>718,207</td><td>X</td></tr>
<tr><td>Method B - Assume Geotivity dimensions from Dec. 2001 - Dec. 2006.

Flow calculations (Dec. 2001 - Sept. 2005):
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.5 ft (90 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 51 in

Volume calculations:
Simpson's Rule</td><td>10,593,839</td><td></td></tr>
</table>

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
2	12/14/2006	Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches. Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.	Method A - Assume dimension change in Sept. 2005. Flow calculations (Sept. 2005 - Dec. 2006): $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 7.33 ft (88 in) H = Depth of water over crest of weir (feet) P = Height of weir = 63 in (average weir height from ADS) Volume calculations: Simpson's Rule	30,096	X
			Method B - Assume Geotivity dimensions from Dec. 2001 - Dec. 2006. Flow calculations (Dec. 2001 - Sept. 2005): $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.5 ft (90 in) H = Depth of water over crest of weir (feet) P = Height of weir = 51 in Volume calculations: Simpson's Rule	6,963,061	

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
3	12/26/2006	Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches. Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.	Method A - Assume dimension change in Sept. 2005. Flow calculations (Sept. 2005 - Dec. 2006): $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 7.33 ft (88 in) H = Depth of water over crest of weir (feet) P = Height of weir = 63 in (average weir height from ADS) Volume calculations: Simpson's Rule	5,413	X
			Method B - Assume Geotivity dimensions from Dec. 2001 - Dec. 2006. Flow calculations (Dec. 2001 - Sept. 2005): $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.5 ft (90 in) H = Depth of water over crest of weir (feet) P = Height of weir = 51 in Volume calculations: Simpson's Rule	6,127,777	

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

<table>
<tr><th>Rank</th><th>Reported Overflow Date</th><th>Comments</th><th>Estimated CSO Volume Methodology</th><th>Estimated CSO Volume (gal)</th><th></th></tr>
<tr><td rowspan="2">4</td><td rowspan="2">1/9/2006</td><td rowspan="2">Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches.

Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.</td><td>Method A - Assume dimension change in Sept. 2005.

Flow calculations (Sept. 2005 - Dec. 2006):
$Q = 3.33LH^{3/2}$ (sharp-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.33 ft (88 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 63 in (average weir height from ADS)

Volume calculations:
Simpson's Rule</td><td>235,599</td><td>X</td></tr>
<tr><td>Method B - Assume Geotivity dimensions from Dec. 2001 - Dec. 2006.

Flow calculations (Dec. 2001 - Sept. 2005):
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.5 ft (90 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 51 in

Volume calculations:
Simpson's Rule</td><td>5,959,424</td><td></td></tr>
</table>

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006
Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
5	11/6/2006	Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches. Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.	Method A - Assume dimension change in Sept. 2005. Flow calculations (Sept. 2005 - Dec. 2006): $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 7.33 ft (88 in) H = Depth of water over crest of weir (feet) P = Height of weir = 63 in (average weir height from ADS) Volume calculations: Simpson's Rule	10,900	X
			Method B - Assume Geotivity dimensions from Dec. 2001 - Dec. 2006. Flow calculations (Dec. 2001 - Sept. 2005): $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.5 ft (90 in) H = Depth of water over crest of weir (feet) P = Height of weir = 51 in Volume calculations: Simpson's Rule	4,679,501	

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
6	12/24/2005	Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches. Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.	Method A - Assume dimension change in Sept. 2005. Flow calculations (Sept. 2005 - Dec. 2006): $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 7.33 ft (88 in) H = Depth of water over crest of weir (feet) P = Height of weir = 63 in (average weir height from ADS) Volume calculations: Simpson's Rule	116,318	X
			Method B - Assume Geotivity dimensions from Dec. 2001 - Dec. 2006. Flow calculations (Dec. 2001 - Sept. 2005): $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.5 ft (90 in) H = Depth of water over crest of weir (feet) P = Height of weir = 51 in Volume calculations: Simpson's Rule	3,905,427	

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
7	11/12/2006	Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches. Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.	Method A - Assume dimension change in Sept. 2005. Flow calculations (Sept. 2005 - Dec. 2006): $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 7.33 ft (88 in) H = Depth of water over crest of weir (feet) P = Height of weir = 63 in (average weir height from ADS) Volume calculations: Simpson's Rule	0	X
			Method B - Assume Geotivity dimensions from Dec. 2001 - Dec. 2006. Flow calculations (Dec. 2001 - Sept. 2005): $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.5 ft (90 in) H = Depth of water over crest of weir (feet) P = Height of weir = 51 in Volume calculations: Simpson's Rule	2,314,515	

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
8	12/24/2006	Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches. Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.	Method A - Assume dimension change in Sept. 2005. Flow calculations (Sept. 2005 - Dec. 2006): $Q = 3.33LH^{3/2}$ (sharp-crested weir) Q = flow in cfs L = Weir length (feet) = 7.33 ft (88 in) H = Depth of water over crest of weir (feet) P = Height of weir = 63 in (average weir height from ADS) Volume calculations: Simpson's Rule	0	X
			Method B - Assume Geotivity dimensions from Dec. 2001 - Dec. 2006. Flow calculations (Dec. 2001 - Sept. 2005): $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.5 ft (90 in) H = Depth of water over crest of weir (feet) P = Height of weir = 51 in Volume calculations: Simpson's Rule	909,183	

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006
Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

<table>
<tr><th>Rank</th><th>Reported Overflow Date</th><th>Comments</th><th>Estimated CSO Volume Methodology</th><th>Estimated CSO Volume (gal)</th><th></th></tr>
<tr><td rowspan="2">9</td><td rowspan="2">5/12/2002</td><td rowspan="2">Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches.

Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.</td><td>Method A - Assume Geotivity Dimensions.

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.5 ft (90 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 51 in

Volume calculations:
Simpson's Rule</td><td>3,286,095</td><td></td></tr>
<tr><td>Method B - Assume "Matched" Dimensions from Geotivity and Weir Length from ADS.

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.33 ft (88 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 52.7 in

Volume calculations:
Simpson's Rule</td><td>663,333</td><td>X</td></tr>
</table>

NPDES Basin 42 - Matching Recorded Volumes

MH060W-052

Duration of Geotivity Metering: December 19, 2001 - December 31, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form	Weir height = 51 inches Weir length = 90 inches Weir width = 7 inches Reported condition of weir as deteriorating
ADS Site Report (12/12/2006)	Weir length = 88 inches Weir width = 0.50 inches Weir height = 64.75 inches (left), 64.13 inches (center); 49.13 inches (right) Distance of ultra to top of weir = 19.50 inches Manhole depth = 9.5 feet
Measurement Verification (1/9/2008)	Weir height = 61 inches (left), 62.75 inches (center); 65.5 inches (right) Alarm set at 64.38 inches.

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
10	1/1/2003	Overflow weir wall may have been modified in late summer of 2005. It appears that Geotivity used the same reported (12/01) dimensions from 2004 until 2006 and did not modify volume calculations. Broad-crested weir equation will be used when width = 7 inches and sharp-crested weir equation will be used when width = 0.5 inches. Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined.	Method A - Assume Geotivity Dimensions. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.5 ft (90 in) H = Depth of water over crest of weir (feet) P = Height of weir = 51 in Volume calculations: Simpson's Rule	50,648	
			Method B - Assume "Matched" Dimensions from Geotivity and Weir Length from ADS. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.33 ft (88 in) H = Depth of water over crest of weir (feet) P = Height of weir = 48.2 in Volume calculations: Simpson's Rule	379,506	X

Following information reviewed in CSO Annual Reports:

Report	Description
2001	When reporting frequency, City was using the 3-hour inter-event time (IET) from January 2001 until March 2001. Beginning April 5, 2001, City began using the 24-hr IET per Ecology.
2005	In late summer 2005, a project for NPDES 42 was completed to include installation of a weir wall (raised the weir).

Determine weir height:

Height (in)	Source
51	Geotivity Site Investigation Form (12/19/01)
51.48	As-built drawing (1985)
64.38	ADS Current Calculations (HH alarm)
64.13	ADS Site Report (center height) - 12/12/2006
62.75	ADS Site Report (center height) - 1/9/2008

Determine weir length:

Length (in)	Source
90	Geotivity Site Investigation Form (12/19/01)
88	ADS Site Report (12/12/2006)

Determine flow rate estimate:

Assumption	Reasoning
Sharp-crested weir	Reported as 0.5-inch weir width in ADS Site Report.
Broad-crested weir	Reported as 7-inch weir width in Geotivity Site Investigation Form and as-built drawing.

Conclusion based on available information:

It appears that the overflow weir wall may have been modified in late summer of 2005. Thus, it would seem that this modification may explain the difference between the dimensions provided by Geotivity in Dec. 2001 versus ADS in Dec. 2006.

It appears that the dimensions reported in Dec. 2001 from 2004 through Dec. 2006 were used to estimate reported CSO volumes, meaning that when the overflow weir was modified in 2005, the new modifications may not have been accounted for in reported CSO volumes.

S–Doc Site Investigation Form

Site Name: Npdes042

GEOTIVITY

Project	0054852
SN#	1031669

*Note**
This form contains information measured in the field environment, and is subject to change depending on recent site conditions including but not limited to physical erosion, site hydraulics, pipe corrosion and siltation

LOCATION INFORMATION

Field Book Number:	N/A	**Address:**	4603 Lake Washington Blvd
MH#	MH060W–052	**GPS Coordinates**	Latitude: N 47.38918 Longitude: W 122.20503
Install Date:	2001–12–19 00:00	***Intrinsically Safe Sticker Number***	none
Thomas Brothers Map Pg	N/A	**Traffic Conditions**	Field

Location Map

Image Not Available

Landmarks:

Image Not Available

MONITOR:

Type:	QTrek V2		**SN:**	1031669			**SIM**	
Sensors:	HRS Depth 1	HRS Depth 2	Battery	Float Switch	–	–	**Signal**	–97
	–	–	–	–	–	–	**Server IP**	

GAS:

O2	20.9	**H2S**	0	**Confined Space Entry notes***
LEL	0	**CO2**	0	

CHANNEL

Type:	Circular	
Cond.	Good	
Flow:	Rough	
Material:	Concrete	
Height:	15	in
Width:	15	in
Other:	Sheet #	
Ground:	8	ft (bench)

OVERFLOW

Type:	Irregular	
Cond.	Deteriorating	
Length:	90	in
Width:	7	in
Height:	51	in

Other Information:

Image Not Available
Image Not Available

note* all dimensions referenced from invert (bottom) of channel

SIF Type = Sewer
Site Pictures
Format: All pictures are RGB 640 by 480 pix. Resolution.

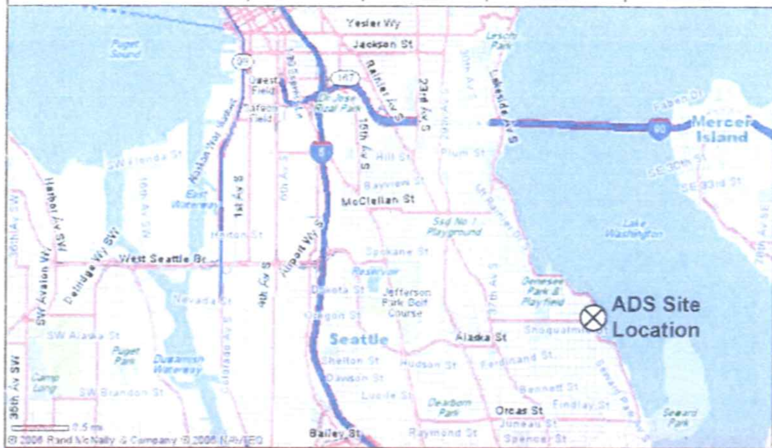
Manhole Cover With # **Landmark**

ADS ENVIRONMENTAL SERVICES

ADS Site Report

Quality Form

Project Name: Seattle - CSO	City / State: Seattle, WA	FM Initials:	SS
Site Name: NPDES 42/SEA_060W052	Monitor Series: 5000 AL	Monitor S/N:	15084
'dress/Location: 4603 Lake Washington BLVD Nearest cross street, S. Snoqualmie St.		Manhole #	060W-052
		Thomas Bros Map Page:	595 G5
		Pipe Height:	11.88"
Access: Drive	Type of System: Sanitary [ ] Storm [ ] Combined [X]	Pipe Width:	16.50"
		IP Address:	166.219.19.49



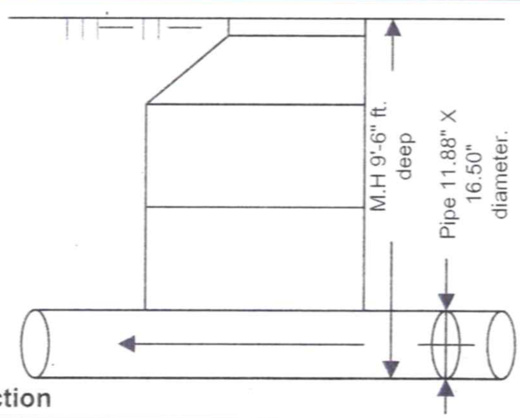
Investigation Information:

Date/Time of Investigation:	12/12/2006	15:24
Site Hydraulics:	Further info. pending	
Upstream Input: (L/S, P/S)		
'Ipstream Manhole:	DNI	
Jownstream Manhole:	DNI	
Depth of Flow:	6.50" +/- 0.25"	
Range (Air DOF):	Further info. pending +/- 0.25"	
Peak Velocity:	0.45 fps	
Silt:	2.50 Inches	

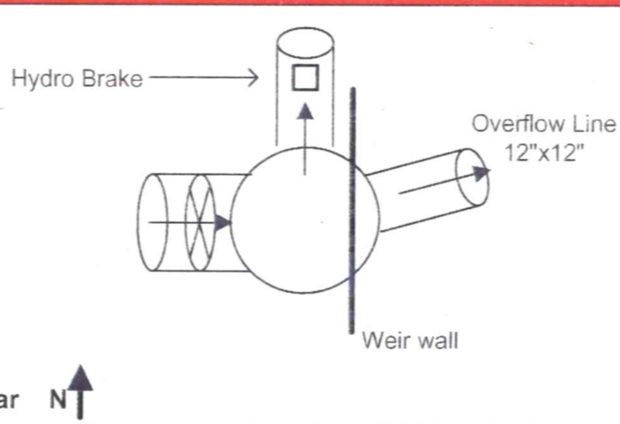
Manhole Information:

Manhole Depth:	9' - 6"
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	Concrete / Good
Mini System Character:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Telephone Information:	
Access Pole #:	
Distance From Manhole:	Feet
Road Cut Length:	Feet
Trench Length:	Feet

Other Information:



Cross Section



Planar N

Installation Information	
Installation Type:	Regular
Sensors Devices:	Ultra / Pressure / Velocity
Surcharge Height:	0.00" Feet
Guage Zone:	

Backup	Yes	No	?	Distance
Trunk	[ ]	[ ]	[ ]	
Lift / Pump Station	[ ]	[ ]	[ ]	
WWTP	[ ]	[ ]	[ ]	
Other	[ ]	[ ]	[ ]	

Additional Site Information / Comments:

Weir Measurements: Length 88.0", Width 0.50". Height: Left ~~64.75~~", Center ~~64.13~~", Right ~~49.13~~". 1/9/2007
Distance of ultra to top of weir 19.50".
61 62.75 65.5

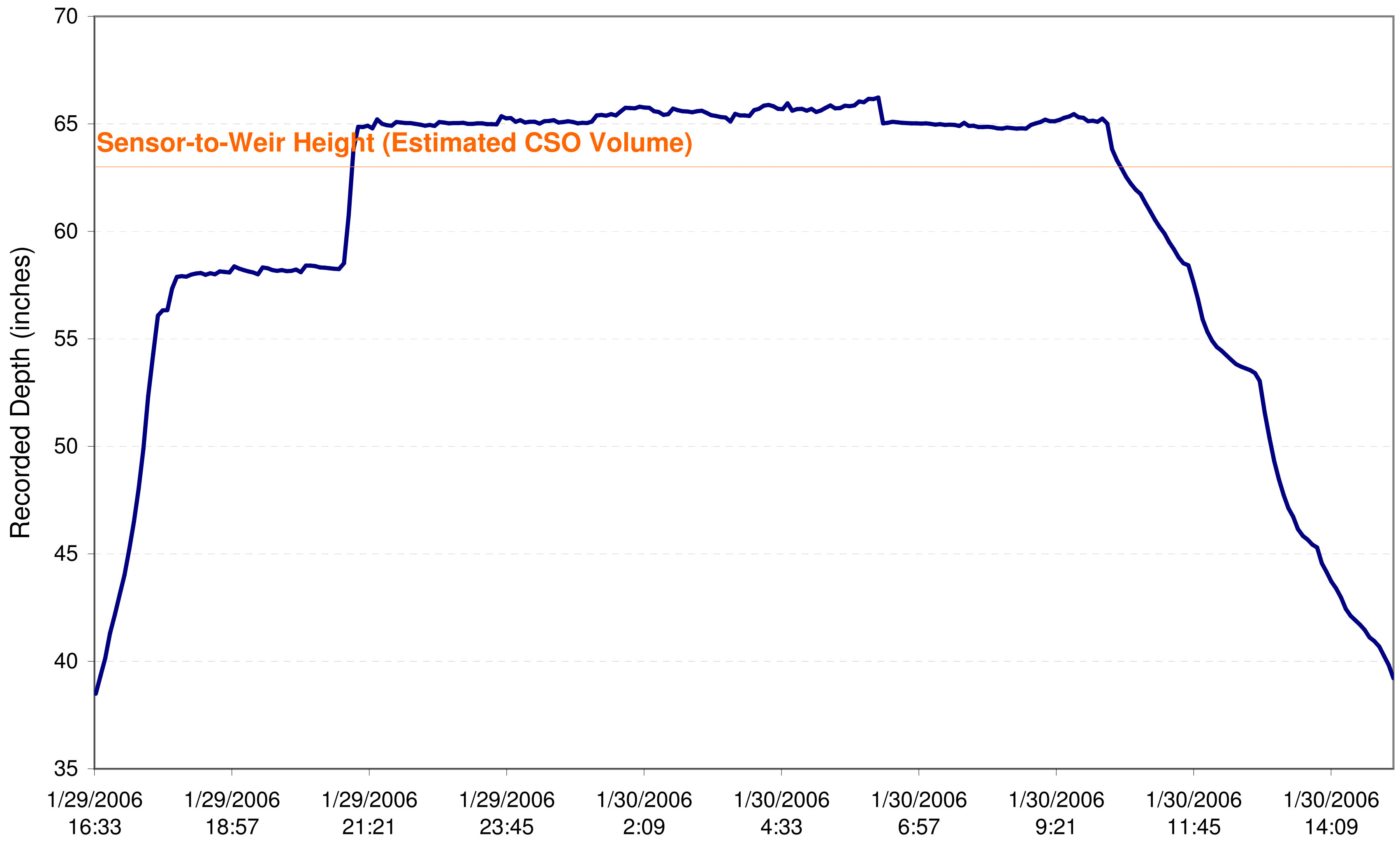
alarm: 64.38"

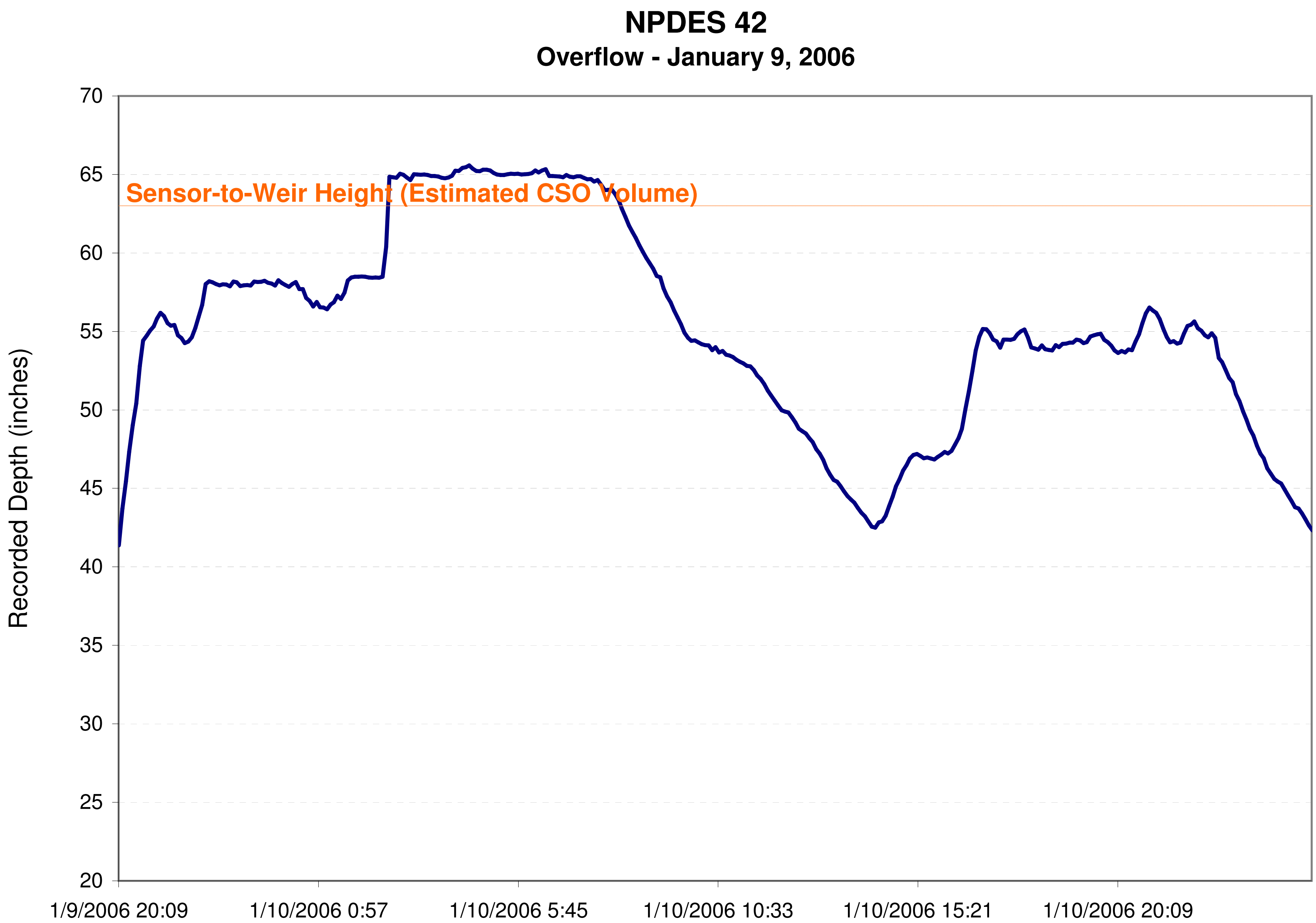
Appendix E.2 – CSO Basin 42

Sample of Depth versus Time Plots for Reported CSO Events

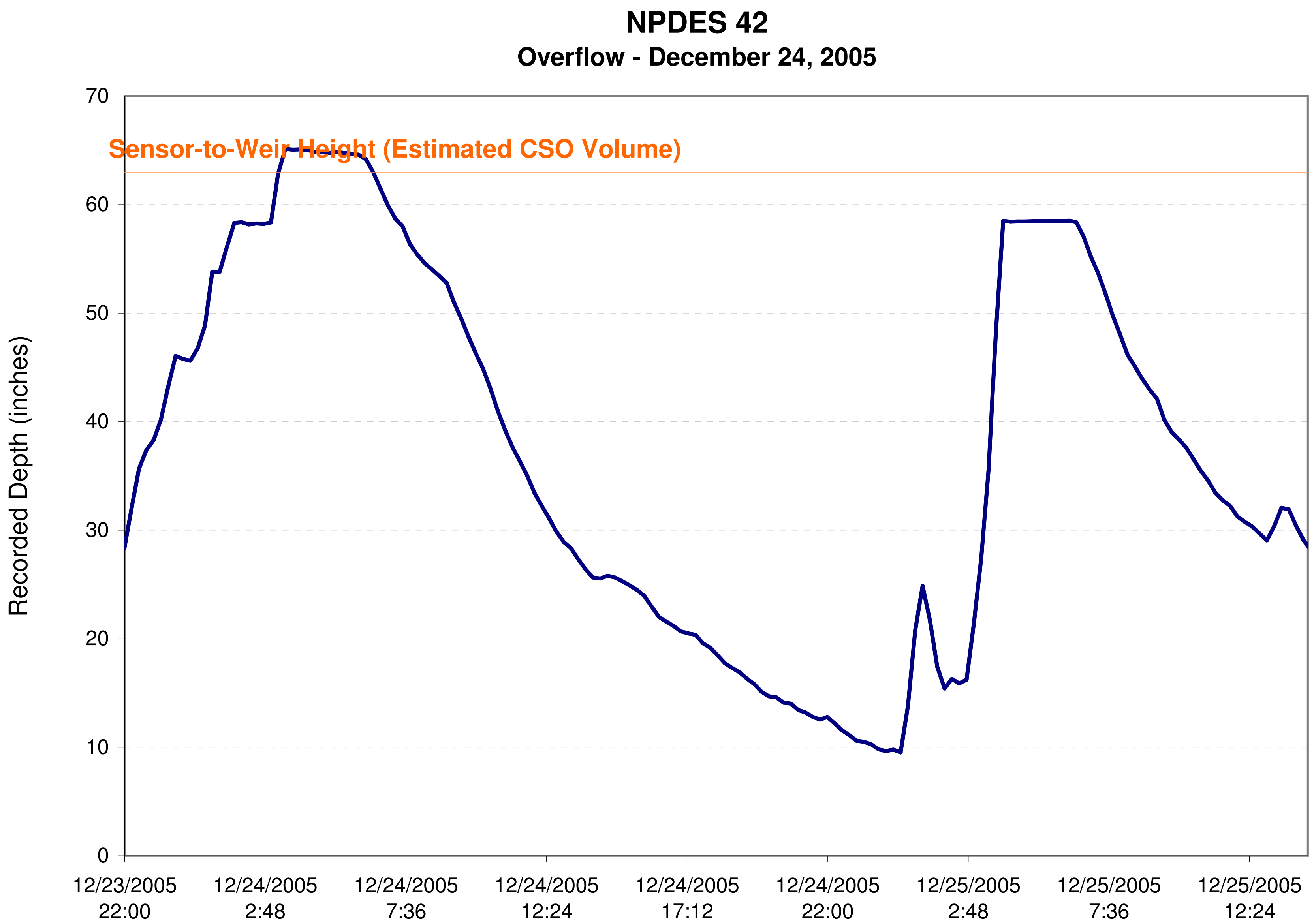
NPDES 42

Overflow - January 29, 2006

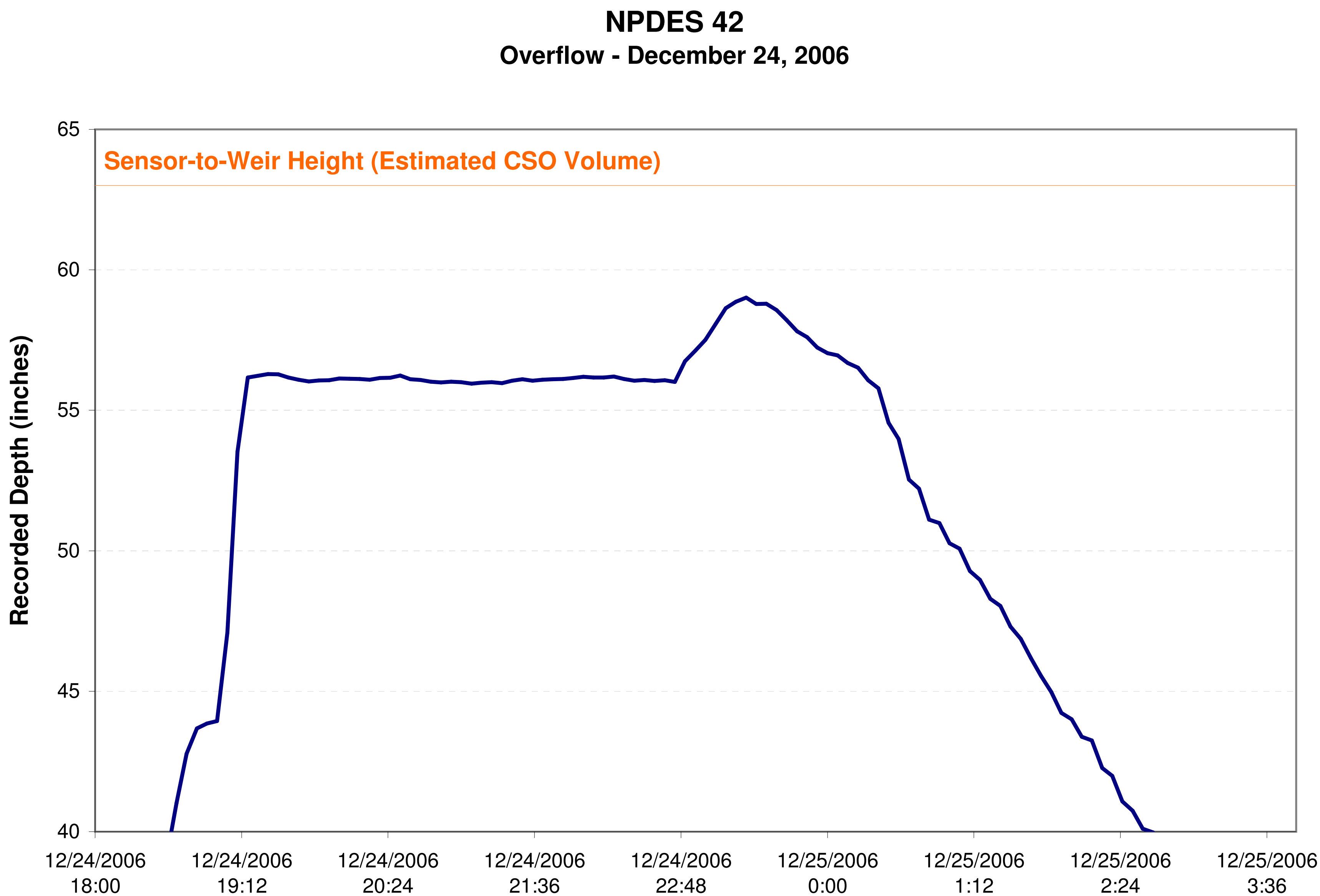


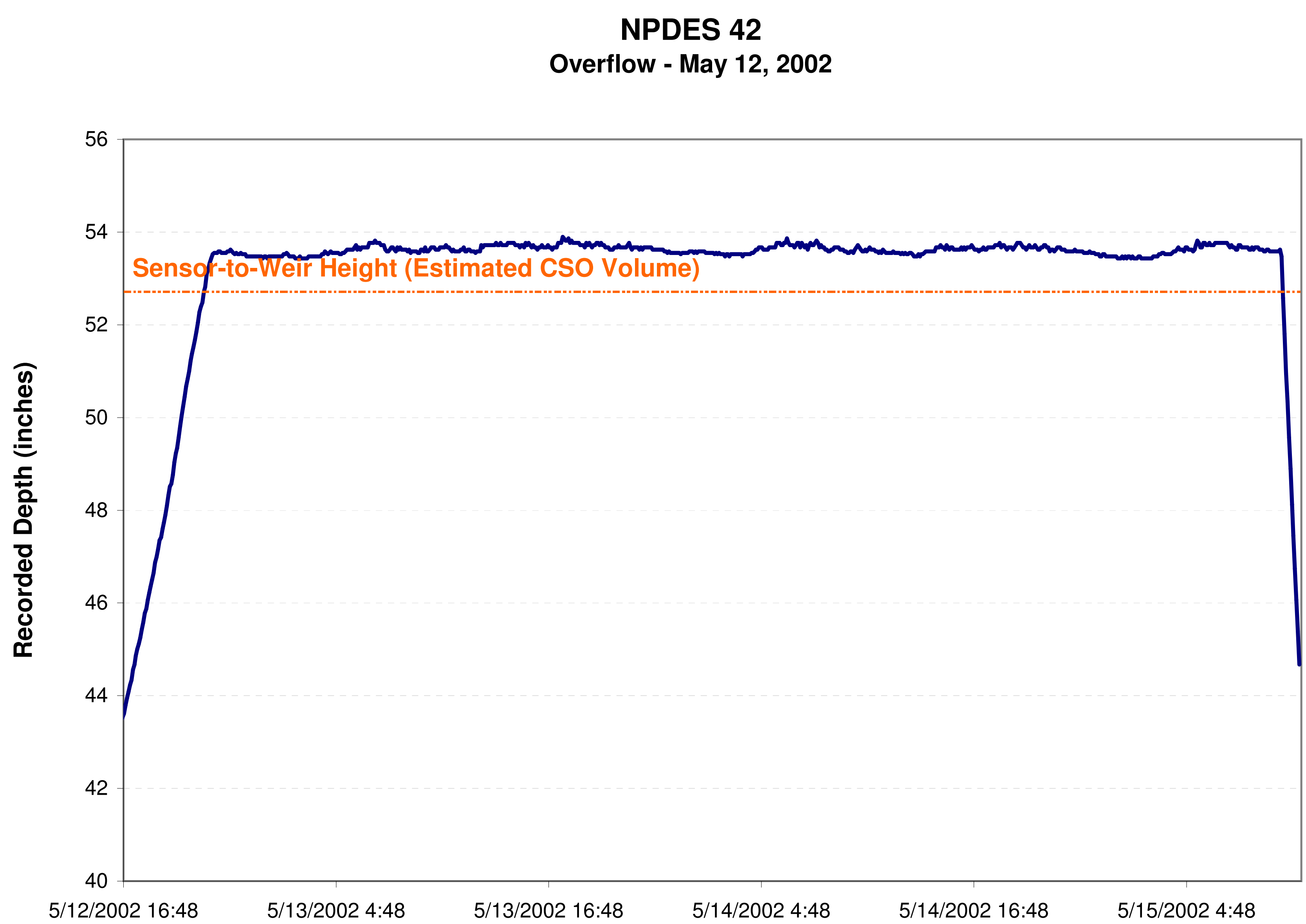


NPDES 42
Overflow - January 9, 2006
Sensor-to-Weir Height (Estimated CSO Volume)
Recorded Depth (inches)
70
65
60
55
50
45
40
35
30
25
20
1/9/2006 20:09
1/10/2006 0:57
1/10/2006 5:45
1/10/2006 10:33
1/10/2006 15:21
1/10/2006 20:09



NPDES 42
Overflow - December 24, 2005
Sensor-to-Weir Height (Estimated CSO Volume)
Recorded Depth (inches)
0
10
20
30
40
50
60
70
12/23/2005 22:00
12/24/2005 2:48
12/24/2005 7:36
12/24/2005 12:24
12/24/2005 17:12
12/24/2005 22:00
12/25/2005 2:48
12/25/2005 7:36
12/25/2005 12:24


NPDES 42
Overflow - December 24, 2006
Sensor-to-Weir Height (Estimated CSO Volume)
Recorded Depth (inches)
65
60
55
50
45
40
12/24/2006 18:00
12/24/2006 19:12
12/24/2006 20:24
12/24/2006 21:36
12/24/2006 22:48
12/25/2006 0:00
12/25/2006 1:12
12/25/2006 2:24
12/25/2006 3:36


NPDES 42
Overflow - May 12, 2002
Recorded Depth (inches)
56
54
52
50
48
46
44
42
40
Sensor-to-Weir Height (Estimated CSO Volume)
5/12/2002 16:48
5/13/2002 4:48
5/13/2002 16:48
5/14/2002 4:48
5/14/2002 16:48
5/15/2002 4:48

Appendix F – CSO Basin 43

Appendix F.1 – CSO Basin 43

Summary of Assumptions

NPDES Basin 43 - Matching Recorded Volumes

MH060W-049

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 48.58 inches Weir length = 93.1 inches Weir width = 6.3 inches
ADS Site Report (12/12/2006)	Weir length = 92 inches Weir width = 6.38 inches Weir height = 50 inches (left), 48.63 inches (center); 48.25 inches (right) Manhole depth = 14'-7"

<table>
<tr><th>Rank</th><th>Reported Overflow Date</th><th>Comments</th><th>Estimated CSO Volume Methodology</th><th>Estimated CSO Volume (gal)</th><th></th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">2/21/2002</td><td rowspan="2">Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir heights and assume weir length of 92 inches (ADS Site Report).

Location of Geotivity depth sensor needs to be determined to verify volume.

Reviewing graph for CSO event, P = 48.88 inches appears to be more reasonable than P = 41 inches. To be conservative, use P = 41 inches.</td><td>Method A: P = 41 inches (matches reported CSO volume)

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.67 ft (92 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 41 in

Volume calculations:
Simpson's Rule</td><td>5,060,480</td><td>X</td></tr>
<tr><td>Method B: P = 48.88 inches (current height used by ADS)

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.67 ft (92 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 48.88 in

Volume calculations:
Simpson's Rule</td><td>669,885</td><td></td></tr>
</table>

NPDES Basin 43 - Matching Recorded Volumes

MH060W-049

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006
Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 48.58 inches Weir length = 93.1 inches Weir width = 6.3 inches
ADS Site Report (12/12/2006)	Weir length = 92 inches Weir width = 6.38 inches Weir height = 50 inches (left), 48.63 inches (center); 48.25 inches (right) Manhole depth = 14'-7"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
2	10/21/2003	Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir heights and assume weir length of 92 inches (ADS Site Report). Location of Geotivity depth sensor needs to be determined to verify volume.	Method A: P = 48.58 inches (matches reported CSO volume) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 48.58 in Volume calculations: Simpson's Rule	2,506,329	X
			Method B: P = 48.88 inches (current height used by ADS) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 48.88 in Volume calculations: Simpson's Rule	2,262,589	
3	1/29/2004	No data available for time period of reported CSO event.	No data available for time period of reported CSO event.	No data available for time period of reported CSO event.	

NPDES Basin 43 - Matching Recorded Volumes

MH060W-049

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 48.58 inches Weir length = 93.1 inches Weir width = 6.3 inches
ADS Site Report (12/12/2006)	Weir length = 92 inches Weir width = 6.38 inches Weir height = 50 inches (left), 48.63 inches (center); 48.25 inches (right) Manhole depth = 14'-7"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
4	3/11/2002	Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir heights and assume weir length of 92 inches (ADS Site Report). Based on monitoring data, it appears that the sensor is above the invert of elevation due to "0" readings for depth. Location of Geotivity depth sensor needs to be determined to verify volume. Due to the "0" readings, it seems possible that depth sensor would be above invert of channel (possibly somewhere in between 43 and 48.88 inches).	Method A: P = 43 inches (matches reported CSO volume) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 43 in Volume calculations: Simpson's Rule	1,835,469	X
			Method B: P = 48.88 inches (current height used by ADS) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 48.88 in Volume calculations: Simpson's Rule	314,313	

NPDES Basin 43 - Matching Recorded Volumes

MH060W-049

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006
Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 48.58 inches Weir length = 93.1 inches Weir width = 6.3 inches
ADS Site Report (12/12/2006)	Weir length = 92 inches Weir width = 6.38 inches Weir height = 50 inches (left), 48.63 inches (center); 48.25 inches (right) Manhole depth = 14'-7"

<table>
<tr><th>Rank</th><th>Reported Overflow Date</th><th>Comments</th><th>Estimated CSO Volume Methodology</th><th>Estimated CSO Volume (gal)</th><th></th></tr>
<tr><td rowspan="2">5</td><td rowspan="2">11/18/2003</td><td rowspan="2">Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir heights and assume weir length of 92 inches (ADS Site Report).

Location of Geotivity depth sensor needs to be determined to verify volume.</td><td>Method A: P = 48.58 inches (matches reported CSO volume)

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.67 ft (92 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 48.58 in

Volume calculations:
Simpson's Rule</td><td>1,488,247</td><td>X</td></tr>
<tr><td>Method B: P = 48.88 inches (current height used by ADS)

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.67 ft (92 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 48.88 in

Volume calculations:
Simpson's Rule</td><td>1,294,173</td><td></td></tr>
</table>

NPDES Basin 43 - Matching Recorded Volumes

MH060W-049

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 48.58 inches Weir length = 93.1 inches Weir width = 6.3 inches
ADS Site Report (12/12/2006)	Weir length = 92 inches Weir width = 6.38 inches Weir height = 50 inches (left), 48.63 inches (center); 48.25 inches (right) Manhole depth = 14'-7"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
6	1/17/2005	Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir heights and assume weir length of 92 inches (ADS Site Report). Location of Geotivity depth sensor needs to be determined to verify volume.	Method A: P = 44.3 inches (matches reported CSO volume) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 44.3 in Volume calculations: Simpson's Rule	650,814	X
			Method B: P = 48.88 inches (current height used by ADS) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 48.88 in Volume calculations: Simpson's Rule	0	

NPDES Basin 43 - Matching Recorded Volumes

MH060W-049

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 48.58 inches Weir length = 93.1 inches Weir width = 6.3 inches
ADS Site Report (12/12/2006)	Weir length = 92 inches Weir width = 6.38 inches Weir height = 50 inches (left), 48.63 inches (center); 48.25 inches (right) Manhole depth = 14'-7"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
7	12/14/2002	Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir heights and assume weir length of 92 inches (ADS Site Report). Location of Geotivity depth sensor needs to be determined to verify volume. It appears that Geotivity counted two CSO events (12/14 and 12/16) as one CSO event, but more than 24 hours occurred between each event. HDR estimate will only estimate volume associated with one CSO event (12/14 is the greater volume).	Method A: P = 36 inches (matches reported CSO volume) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 36 in Volume calculations: Simpson's Rule	298,884	X
			Method B: P = 48.88 inches (current height used by ADS) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 48.88 in Volume calculations: Simpson's Rule	0	

NPDES Basin 43 - Matching Recorded Volumes

MH060W-049

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006
Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 48.58 inches Weir length = 93.1 inches Weir width = 6.3 inches
ADS Site Report (12/12/2006)	Weir length = 92 inches Weir width = 6.38 inches Weir height = 50 inches (left), 48.63 inches (center); 48.25 inches (right) Manhole depth = 14'-7"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
8	1/1/2003	Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir heights and assume weir length of 92 inches (ADS Site Report). Location of Geotivity depth sensor needs to be determined to verify volume. It appears that Geotivity counted two CSO events (1/1 and 1/4) as one CSO event, but more than 24 hours occurred between each event. HDR estimate will only estimate volume associated with one CSO event (1/1 is the greater volume).	Method A: P = 36 inches (matches reported CSO volume) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 36 in Volume calculations: Simpson's Rule	474,686	X
			Method B: P = 48.88 inches (current height used by ADS) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 48.88 in Volume calculations: Simpson's Rule	0	

NPDES Basin 43 - Matching Recorded Volumes

MH060W-049

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006
Unable to determine how much degradation of weir wall occurred.

Geotivity
Site Investigation Form
(12/19/2001)

Weir height = 48.58 inches
Weir length = 93.1 inches
Weir width = 6.3 inches

ADS
Site Report (12/12/2006)

Weir length = 92 inches
Weir width = 6.38 inches
Weir height = 50 inches (left), 48.63 inches (center); 48.25 inches (right)
Manhole depth = 14'-7"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)	
9	3/13/2003	Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir heights and assume weir length of 92 inches (ADS Site Report). Location of Geotivity depth sensor needs to be determined to verify volume.	Method A: P = 48.58 inches (matches reported CSO volume) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 48.58 in Volume calculations: Simpson's Rule	416,525	X
			Method B: P = 48.88 inches (current height used by ADS) Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 7.67 ft (92 in) H = Depth of water over crest of weir (feet) P = Height of weir = 48.88 in Volume calculations: Simpson's Rule	324,311	

NPDES Basin 43 - Matching Recorded Volumes

MH060W-049

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Unable to determine how much degradation of weir wall occurred.

Geotivity Site Investigation Form (12/19/2001)	Weir height = 48.58 inches Weir length = 93.1 inches Weir width = 6.3 inches
ADS Site Report (12/12/2006)	Weir length = 92 inches Weir width = 6.38 inches Weir height = 50 inches (left), 48.63 inches (center); 48.25 inches (right) Manhole depth = 14'-7"

<table>
<tr><th>Rank</th><th>Reported Overflow Date</th><th>Comments</th><th>Estimated CSO Volume Methodology</th><th>Estimated CSO Volume (gal)</th><th></th></tr>
<tr><td rowspan="2">10</td><td rowspan="2">12/14/2006</td><td rowspan="2">Broad-crested weir equation will be used in HDR estimation. Unable to determine actual weir height from sensor to overflow weir. Will estimate volume with possible weir heights and assume weir length of 92 inches (ADS Site Report).

Location of Geotivity depth sensor needs to be determined to verify volume.

Based on graph, it appears that weir height may be lower than indicated.</td><td>Method A: P = 51.6 inches (matches reported CSO volume)

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.67 ft (92 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 51.6 in

Volume calculations:
Simpson's Rule</td><td>162,541</td><td></td></tr>
<tr><td>Method B: P = 48.88 inches (current height used by ADS)

Flow calculations:
$Q = 2.62LH^{3/2}$ (broad-crested weir)

Q = flow in cfs
L = Weir length (feet) = 7.67 ft (92 in)
H = Depth of water over crest of weir (feet)

P = Height of weir = 48.88 in

Volume calculations:
Simpson's Rule</td><td>547,460</td><td>X</td></tr>
</table>

Following information reviewed in CSO Annual Reports:

Report	Description
2001	When reporting frequency, City was using the 3-hour inter-event time (IET) from January 2001 until March 2001. Beginning April 5, 2001, City began using the 24-hr IET per Ecology.

Determine weir height:

Height (in)	Source
48.58	Geotivity Site Investigation Form (12/19/01)
52.44	Basin 43 Control Structure Drawing
10.80	Schematic of Wastewater Flow, Discharge Serial No. 043
48.88	ADS Current Calculations
48.63	ADS Site Report (center height), (12/12/06)

Determine weir length:

Length (in)	Source
93.1	Geotivity Site Investigation Form (12/19/01)
92	ADS Site Report (12/12/06)

Determine flow rate estimate:

Assumption	Reasoning
Broad-crested weir	Reported as 6.38-inch weir width in ADS Site Report.
Broad-crested weir	Reported as 6.3-inch weir width in Geotivity Site Investigation Form.
Broad-crested weir	Reported as 6-inch weir width on Basin 43 Control Structure Drawing.

Conclusion based on available information:

Broad-crested weir equation was used to estimate CSO volumes.

Pipe Capacity Estimations (Overflow Structure 43)

Downstream pipe capacities (for overflow and outfall pipes) were calculated to determine if pipes may be outlet-controlled at larger overflow rates during CSO events for Overflow Structure 43. If the CSO events are outlet-controlled at larger overflow rates, then the actual CSO volumes are lower than the CSO volumes calculated (overflow rate estimates would be less in a submerged versus free-flowing condition).

The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of the outfall. The assumed maximum overflow rate for the 12/3/07 storm is shown in Table A in bold for Overflow Structure 43.

Maximum pipe capacities were also calculated using the Manning equation and available Geographic Information Systems (GIS) data. Invert elevations of maintenance holes and pipe lengths and diameters (as indicated in GIS) were used to estimate full pipe capacity (also shown in Table A). However, these capacities should not be considered the maximum pipe capacities due to GIS data discrepancies and because the GIS data was not compared to record drawings or available survey data for verification.

Table B presents the maximum estimated overflow rates for the largest 10 reported CSO events that were calculated using the broad-crested weir equation (unsubmerged). Of the 10 largest reported CSO events (between 2001 and 2006), the estimated flow rates resulted in maximum flow rates less than 16.5 mgd, except for the 12/14/06 CSO event. It appears that the depth meter was malfunctioning; the depth measurement that corresponds to the maximum flow rate increased by 15 inches within 5 minutes, and decreased by 10 inches within the next 5 minutes. Thus, it appears that the overflow pipeline has adequate capacity for the largest CSO events (at least the largest 9 CSO events), and that the overflow structure is not outlet-controlled for the largest CSO events within this monitoring period.

Table A. Estimated Pipe Capacities for Overflow Structure 43

Source	Maximum Pipe Capacity	Details and Assumptions
ADS Monitoring Data, 12/3/07 storm	**16.5 mgd**	Overflow rates estimated from depth meter and broad-crested weir equation.
Seattle Public Utilities Geographic Information Systems (GIS) layers for sewer mainlines and manholes	32.1 mgd	Upstream and downstream manholes for pipe segment: MH 060W-049 to MH 060W-023. Capacity calculated using Manning equation (d = 21 inches; n = 0.013; s = 0.0979 ft/ft).
	31.0 mgd	Upstream and downstream manholes for pipe segment: MH 060W-023 to MH D060W-020. Capacity calculated using Manning equation (d = 21 inches; n = 0.013; s = 0.0911 ft/ft).
	31.8 mgd	Upstream and downstream manholes for pipe segment: MH D060W-020 to D060W-021. Capacity calculated using Manning equation (d = 21 inches; n = 0.013; s = 0.0956 ft/ft)

Table B. Maximum Estimated Overflow Rates for Reported CSO Events (2000 – 2006), Overflow Structure 43

Reported Overflow Date	Maximum Estimated Overflow Rate	Details and Assumptions
2/21/02	11.0 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
10/21/03	6.30 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
1/29/04	Data unavailable for this reported CSO event.	Overflow rates calculated using broad-crested weir equation (unsubmerged).
3/11/02	9.13 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
11/18/03	3.41 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
1/17/05	2.09 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
12/14/02	3.85 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
1/1/03	4.51 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
3/13/03	1.54 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
12/14/06	20.18 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).

S-Doc **Site Investigation Form**

Site Name: **Npdes043**

Project	0054852
SN#	1026466

*Note**
This form contains information measured in the field environment, and is subject to change depending on recent site conditions including but not limited to physical erosion, site hydraulics, pipe corrosion and siltation

LOCATION INFORMATION

Field Book Number:	N/A	**Address:**	S Alaska St & 54th Ave S
MH#	MH060W-049	**GPS Coordinates**	Latitude: N 47.56056 Longitude: W 122.26567
Install Date:	2001-12-19 00:00	***Intrinsically Safe Sticker Number***	none
Thomas Brothers Map Pg	N/A	**Traffic Conditions**	Curb Lane

Location Map ***Landmarks:***

Image Not Available

Image Not Available

MONITOR:

Type:	QTrek V2	**SN:**	1026466			**SIM**	8931 0380 1010 6630 7201
Sensors:	HRS Depth 1	HRS Depth 2	Battery	Float Switch	-	-	**Signal**	-93
	-	-	-	-	-	-	**Server IP**	

GAS:

O2	20.9	**H2S**	0	**Confined Space Entry notes***
LEL	0	**CO2**	0	

CHANNEL

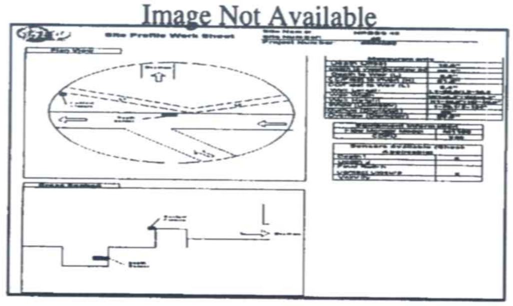
Type:	Circular	
Cond.	Good	
Flow:	Smooth	
Material:	Concrete	
Height:	24	in
Width:	24	in
Other:	Sheet #	
Ground:	22	ft (bench)

OVERFLOW

Type:	Circular	
Cond.	Deteriorating	
Length:	93.1	in
Width:	6.3	in
Height:	48.58	in

Other Information:

Image Not Available



note* all dimensions referenced from invert (bottom) of channel

SIF Type = Sewer
Site Pictures
Format: All pictures are RGB 640 by 480 pix. Resolution.

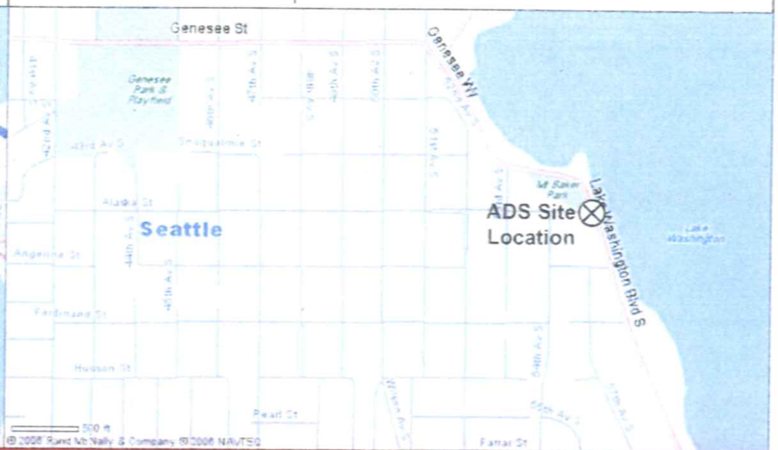
Landmark **Upstream Flow**

ADS ENVIRONMENTAL SERVICES®

ADS Site Report

Quality Form

Project Name: Seattle - CSO		City / State: Seattle, WA	FM Initials: SS
Site Name: NPDES 43/SEA_060W049	Monitor Series: 5000 BG	Monitor S/N:	19016
Address/Location: 5403 Alaska Street		Manhole #:	060W-049
		Thomas Bros Map Page:	595 G5
		Pipe Height:	24.38"
Access: Drive	Type of System: Sanitary [ ] Storm [ ] Combined [X]	Pipe Width:	24.13"
		IP Address:	166.219.19.32



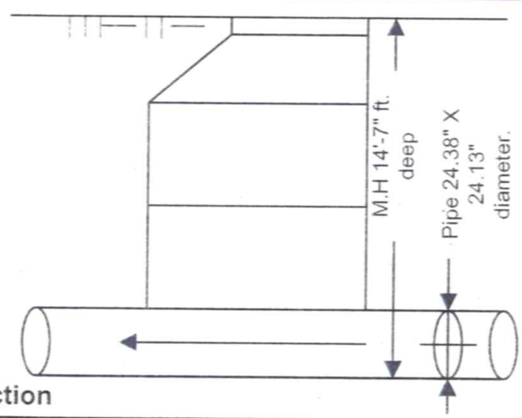
Investigation Information:

Date/Time of Investigation:	12/12/2006 16:11
Site Hydraulics:	Fast smooth flow (outgoing)
Upstream Input: (L/S, P/S)	
Upstream Manhole:	DNI
Downstream Manhole:	DNI
Depth of Flow:	2.13" +/- 0.25"
Range (Air DOF):	Further info. pending +/- 0.25"
Peak Velocity:	4.59 fps
Silt:	0.00 Inches

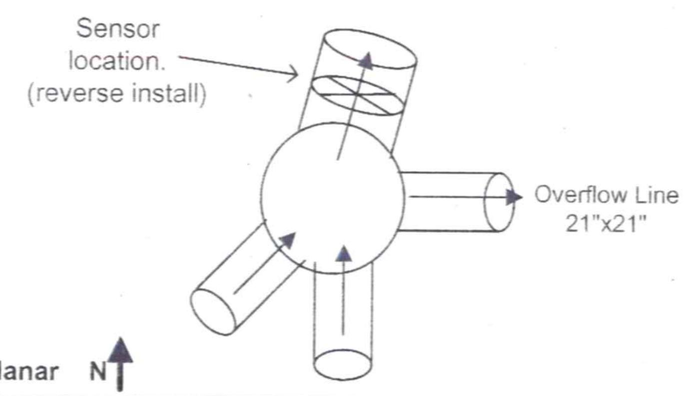
Manhole Information:

Manhole Depth:	14' - 7"
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	Concrete / Good
Mini System Character:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Telephone Information:	
Access Pole #:	
Distance From Manhole:	Feet
Road Cut Length:	Feet
Trench Length:	Feet

Other Information:



Cross Section



Planar N

Installation Information	
Installation Type:	Regular
Sensors Devices:	Ultra / Pressure / Velocity
Surcharge Height:	0.00" Feet
Guage Zone:	

Backup	Yes	No	?	Distance
Trunk	[ ]	[ ]	[ ]	
Lift / Pump Station	[ ]	[ ]	[ ]	
WWTP	[ ]	[ ]	[ ]	
Other	[ ]	[ ]	[ ]	

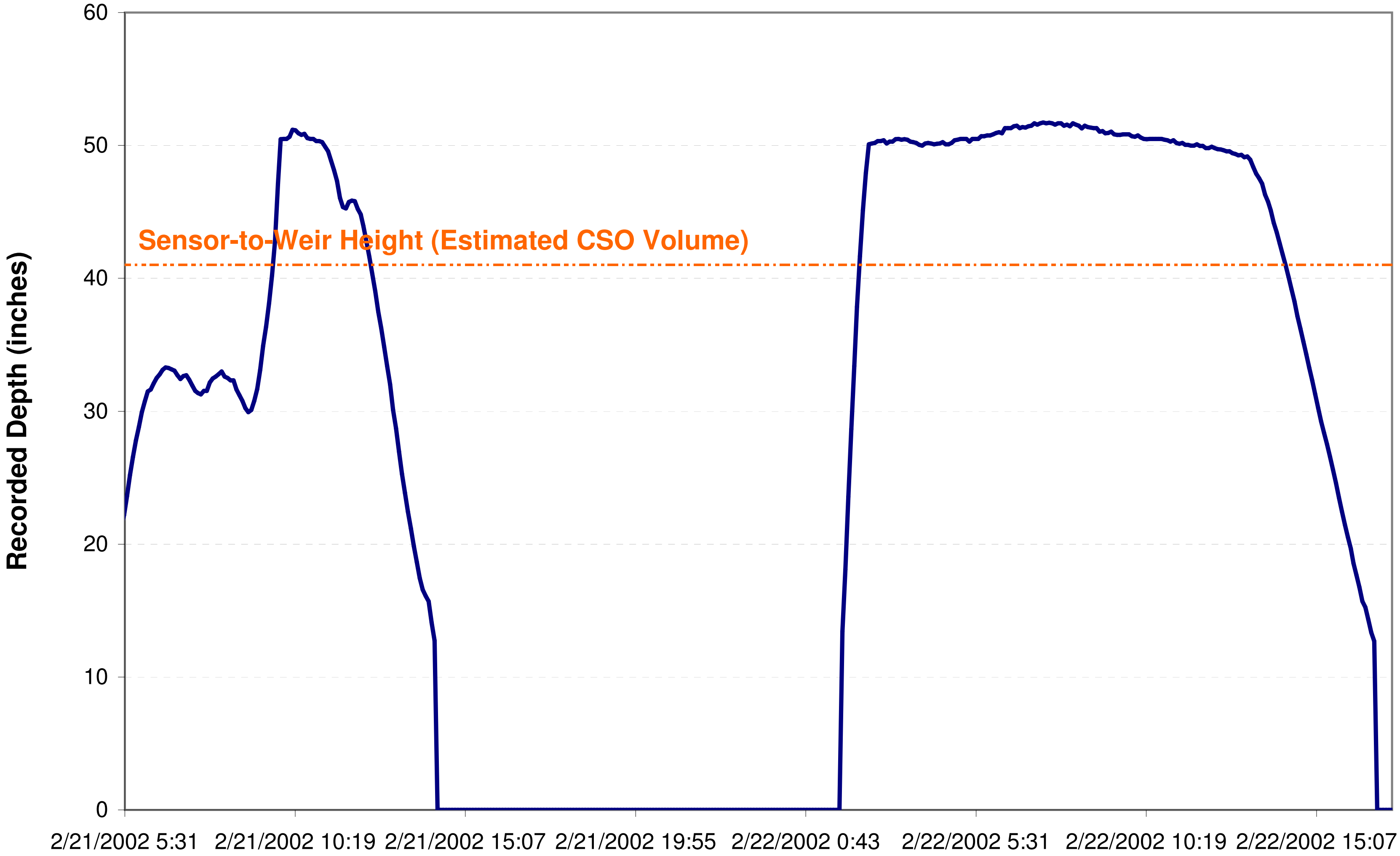
Additional Site Information / Comments:

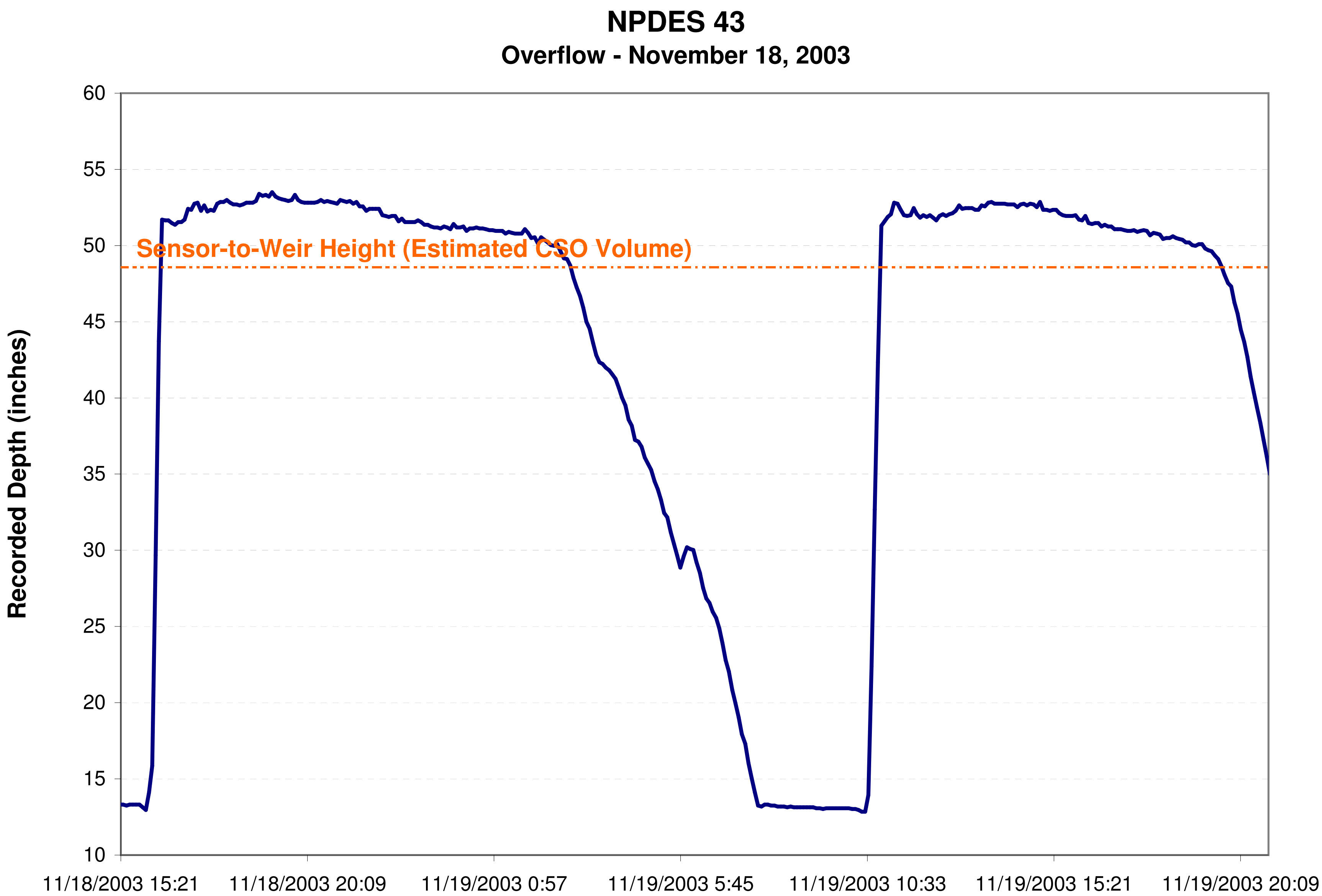
Weir Measurements: Length 92.00", Width 6.38". Height: Left 50.0", Center 48.63", Right 48.25"

Appendix F.2 – CSO Basin 43

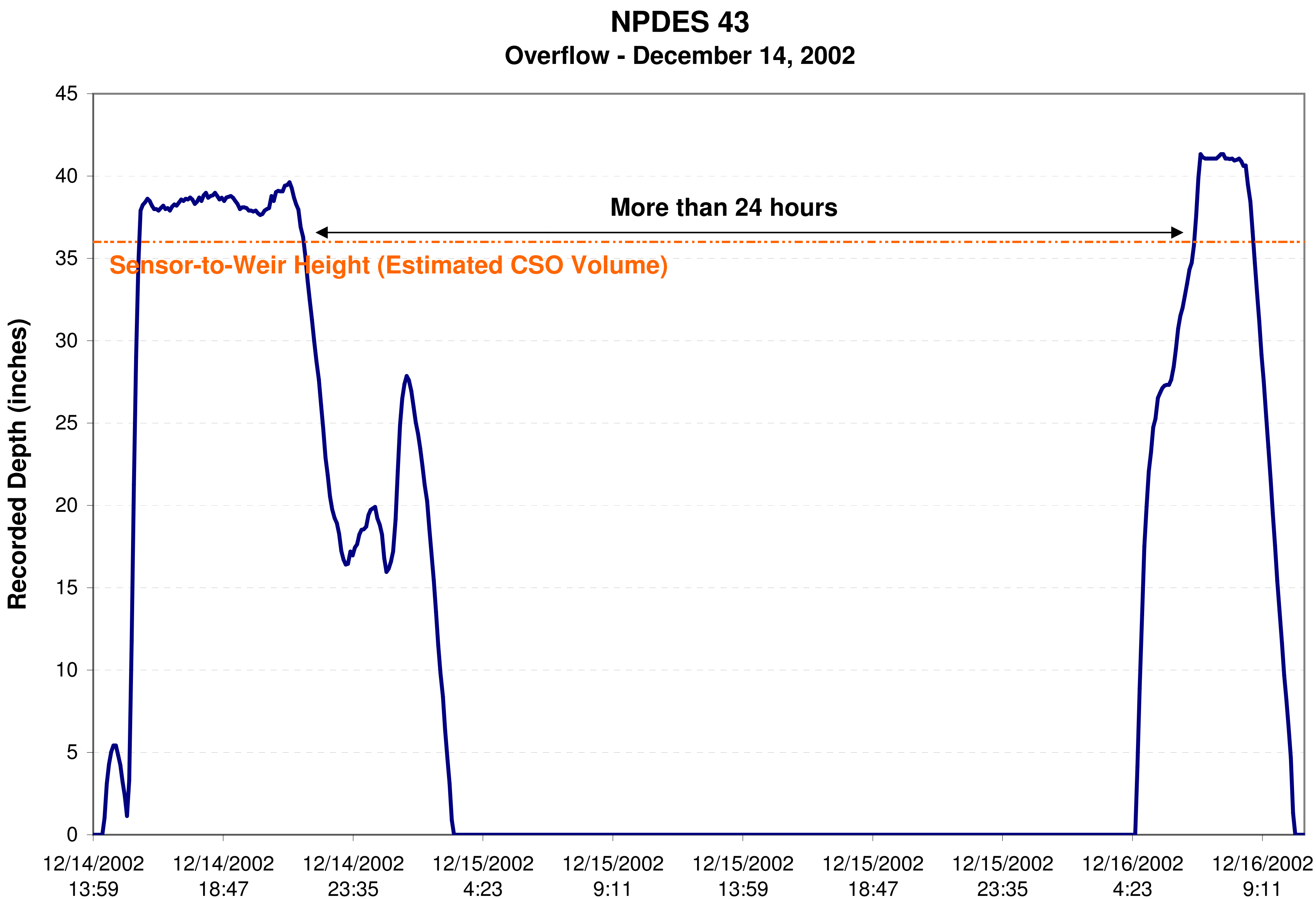
Sample of Depth versus Time Plots for Reported CSO Events

NPDES 43
Overflow - February 21, 2002

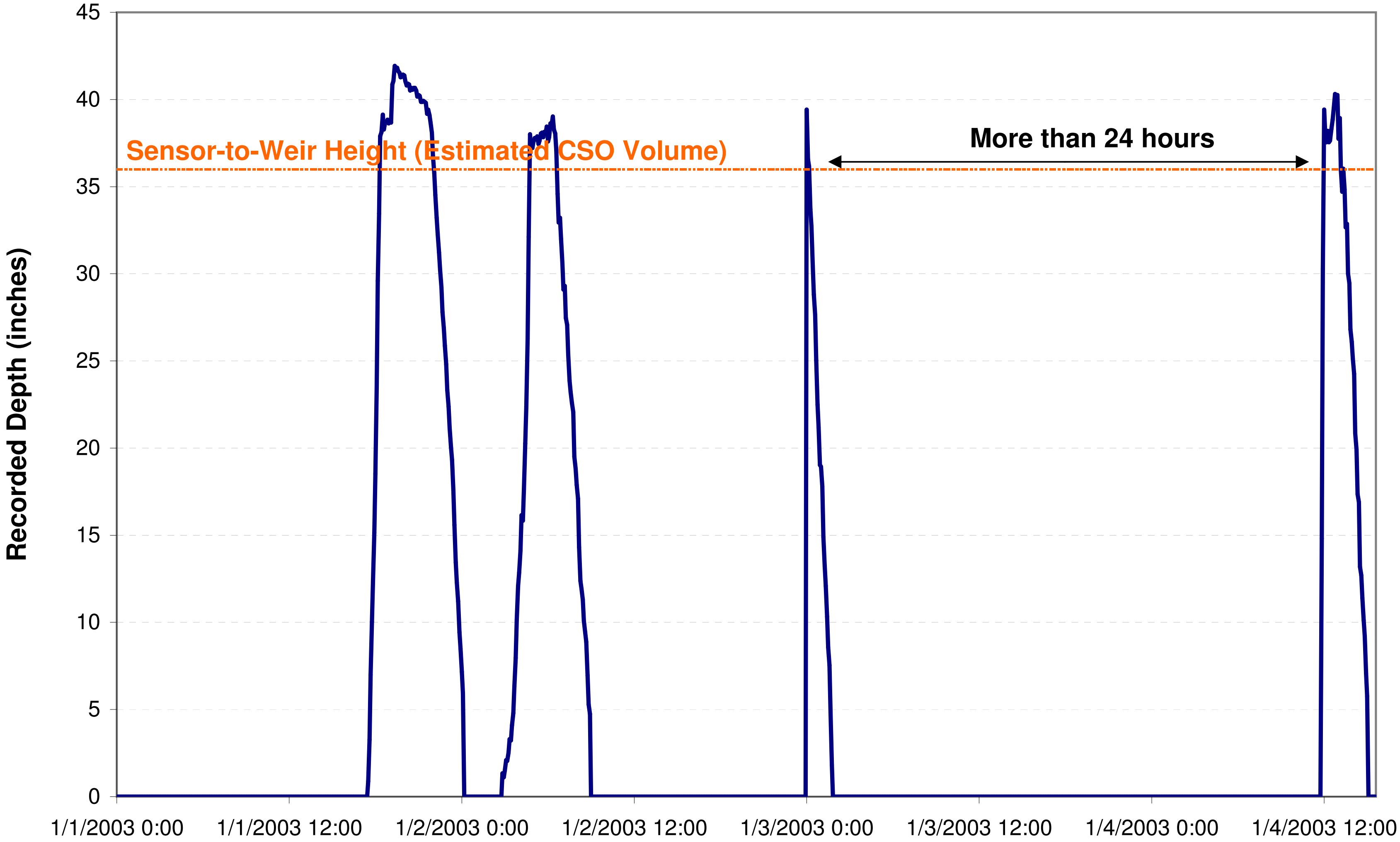




NPDES 43
Overflow - November 18, 2003
Sensor-to-Weir Height (Estimated CSO Volume)
Recorded Depth (inches)
60
55
50
45
40
35
30
25
20
15
10
11/18/2003 15:21
11/18/2003 20:09
11/19/2003 0:57
11/19/2003 5:45
11/19/2003 10:33
11/19/2003 15:21
11/19/2003 20:09


NPDES 43
Overflow - December 14, 2002
More than 24 hours
Sensor-to-Weir Height (Estimated CSO Volume)
Recorded Depth (inches)
45
40
35
30
25
20
15
10
5
0
12/14/2002 13:59
12/14/2002 18:47
12/14/2002 23:35
12/15/2002 4:23
12/15/2002 9:11
12/15/2002 13:59
12/15/2002 18:47
12/15/2002 23:35
12/16/2002 4:23
12/16/2002 9:11

NPDES 43
Overflow - January 1, 2003



Appendix G – CSO Basin 165

Appendix G.1 – CSO Basin 165

Summary of Assumptions

NPDES Basin 165 - Matching Recorded Volumes

MH067-078

Duration of Geotivity Metering: March 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred.
2004 CSO Annual Report - Monitoring equipment was removed in September 7 and reinstalled in October 11, 2004 for cleaning sewer pipes.

Geotivity Site Investigation Form (1/1/2001)	Weir length = 45 inches Weir width = 4 inches Weir height = 10 inches Deteoriating condition
ADS Site Report (12/19/2006)	Weir length = 33 inches Weir width = 4 inches Weir height = 10 inches (left), 10.5 inches (center); 10.5 inches (right) Manhole depth = 6' - 1"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
1	6/11/2001	Broad-crested weir equation will be used in estimations. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. No depth to sensor height makes sense with reported volume.	Method A - Determine weir height (P) by reviewing depth vs time plot. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 2 in (approximated by looking at where depth levels off) Volume calculations: Simpson's Rule	144,674
2	6/3/2002	Broad-crested weir equation will be used in estimations. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. Depth measurements jump around a lot during monitoring period (several "0 inches" readings). It appears that an IET of more than 24 hours was assumed for Geotivity estimate. Does not impact results significantly.	Method A - Assume Geotivity dimensions adequate. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 10 in Volume calculations: Simpson's Rule	1,018,281
3	6/2/2001	Broad-crested weir equation will be used in estimations. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. No depth to sensor height makes sense with reported volume.	Method A - Determine weir height (P) by reviewing depth vs time plot. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 2 in (approximated by looking at where depth levels off) Volume calculations: Simpson's Rule	150,937

NPDES Basin 165 - Matching Recorded Volumes

MH067-078

Duration of Geotivity Metering: March 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred.
2004 CSO Annual Report - Monitoring equipment was removed in September 7 and reinstalled in October 11, 2004 for cleaning sewer pipes.

Geotivity Site Investigation Form (1/1/2001)	Weir length = 45 inches Weir width = 4 inches Weir height = 10 inches Deteoriating condition
ADS Site Report (12/19/2006)	Weir length = 33 inches Weir width = 4 inches Weir height = 10 inches (left), 10.5 inches (center); 10.5 inches (right) Manhole depth = 6' - 1"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
4	11/6/2006	Broad-crested weir equation will be used in estimations. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. Depth measurements jump around a lot during monitoring period (several "0 inches" readings).	Method A - Assume Geotivity dimensions adequate. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 10 in Volume calculations: Simpson's Rule	193,036
5	1/4/2003	Broad-crested weir equation will be used in estimations. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. No depth to sensor height makes sense with reported volume.	Method A - Assume Geotivity dimensions adequate. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 10 in Volume calculations: Simpson's Rule	3,228
6	12/24/2005	Broad-crested weir equation will be used in estimations. Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. It appears that the depth sensor may be inadequate. Depth measurements jump from 7 inches to 28 inches to 2.6 inches within 15-min time periods. This volume estimate is not included in HDR estimate.	Method A - Assume Geotivity dimensions adequate. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 10 in Volume calculations: Simpson's Rule	0

NPDES Basin 165 - Matching Recorded Volumes

MH067-078

Duration of Geotivity Metering: March 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred.
2004 CSO Annual Report - Monitoring equipment was removed in September 7 and reinstalled in October 11, 2004 for cleaning sewer pipes.

Geotivity Site Investigation Form (1/1/2001)	Weir length = 45 inches Weir width = 4 inches Weir height = 10 inches Deteoriating condition
ADS Site Report (12/19/2006)	Weir length = 33 inches Weir width = 4 inches Weir height = 10 inches (left), 10.5 inches (center); 10.5 inches (right) Manhole depth = 6' - 1"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
7	11/4/2006	Broad-crested weir equation will be used in estimates. Needs to be confirmed before choosing which method. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. It appears that the depth sensor may be inadequate. Depth measurements jump from 0 inches to 47 inches to 5 inches within 5-min time periods.	Method A - Assume Geotivity dimensions adequate. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 10 in Volume calculations: Simpson's Rule	0
8	1/22/2003	Broad-crested weir equation will be used in estimations. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. No depth to sensor height makes sense with reported volume.	Method A - Assume Geotivity dimensions adequate. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 6.3 in Volume calculations: Simpson's Rule	59,715
9	11/12/2002	Broad-crested weir equation will be used in estimations. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. No depth to sensor height makes sense with reported volume.	Method A - Assume Geotivity dimensions adequate. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 10 in Volume calculations: Simpson's Rule	0

NPDES Basin 165 - Matching Recorded Volumes

MH067-078
Duration of Geotivity Metering: March 2000 - December 31, 2006
Unable to determine how much degradation of weir wall occurred.
2004 CSO Annual Report - Monitoring equipment was removed in September 7 and reinstalled in October 11, 2004 for cleaning sewer pipes.

Geotivity Site Investigation Form (1/1/2001)	Weir length = 45 inches Weir width = 4 inches Weir height = 10 inches Deteoriating condition
ADS Site Report (12/19/2006)	Weir length = 33 inches Weir width = 4 inches Weir height = 10 inches (left), 10.5 inches (center); 10.5 inches (right) Manhole depth = 6' - 1"

Rank	Reported Overflow Date	Comments	Estimated CSO Volume Methodology	Estimated CSO Volume (gal)
10	1/30/2003	Broad-crested weir equation will be used in estimations. Location of Geotivity depth sensor (and if it has ever been moved) needs to be determined. No depth to sensor height makes sense with reported volume.	Method A - Assume Geotivity dimensions adequate. Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 3.75 ft (45 in) H = Depth of water over crest of weir (feet) P = Height of weir = 6.3 in Volume calculations: Simpson's Rule	18,224

Following information reviewed in CSO Annual Reports:

Report	Description
2001	When reporting frequency, City was using the 3-hour inter-event time (IET) from January 2001 until March 2001. Beginning April 5, 2001, City began using the 24-hr IET per Ecology.
2001	Comparison of overflow volumes suggests site 165 is more sensitive than other sites to rainfall intensity and depth.
2004	Pipe cleaning projects along Lake Washington have been implemented at NPDES site #165 in summer 2004. Monitoring equipment was removed in September 2007 and reinstalled in October 11, 2004 for cleaning sewer pipes.

Determine weir height:

Height (in)	Source
10	Geotivity Site Investigation Form (1/1/01)
9.96	"Schematic of Wastewater Flow" drawing
10	ADS Current Calculations (HH alarm)
10.5	ADS Site Report (center height) - 12/12/2006

Determine weir length:

Length (in)	Source
45	Geotivity Site Investigation Form (1/1/01)
33	ADS Site Report (12/12/06)

Determine flow rate estimate:

Assumption	Reasoning
Broad-crested weir	Reported as 4-inch weir width in ADS Site Report.
Broad-crested weir	Reported as 4-inch weir width in Geotivity Site Investigation Form and as-built drawing.

S-Doc Site Investigation Form

Site Name: Npdes165

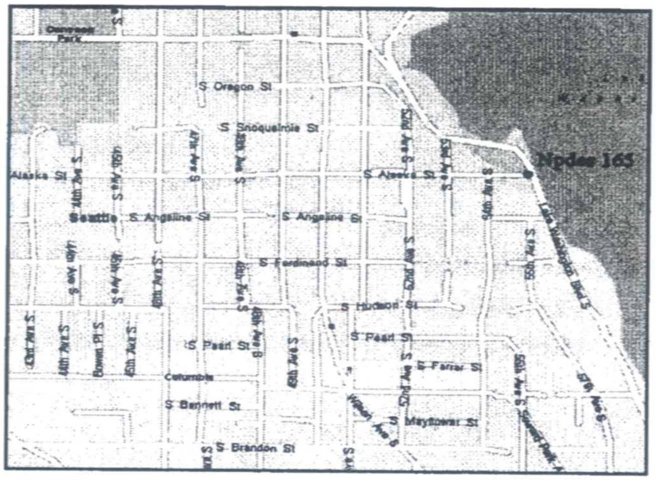
Project 0054852
SN# 1031667

*Note**
This form contains information measured in the field environment, and is subject to change depending on recent site conditions including but not limited to physical erosion, site hydraulics, pipe corrosion and siltation

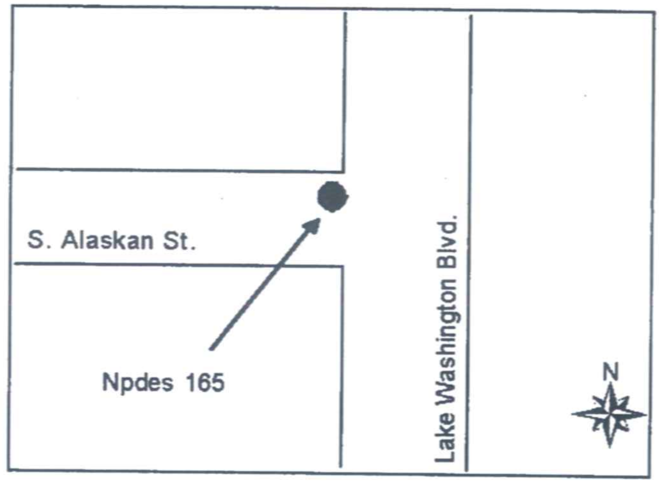
LOCATION INFORMATION

Field Book Number:	N/A	**Address:**	S Alaska St & LK Washington BLVD S
MH#	MH067-078	**GPS Coordinates**	Latitude: N 47.33621 Longitude: W 122.15875
Install Date:	2001-01-01 00:00	***Intrinsically Safe Sticker Number***	none
Thomas Brothers Map Pg	N/A	**Traffic Conditions**	Slow Traffic

Location Map



Landmarks:



MONITOR:

Type:	QTrek V2	**SN:**	1031667

Sensors:	HRS Depth 1	HRS Depth 2	Battery	Float Switch	–	–	**SIM**	8931 0380 20 20 2332 0988
	–	–	–	–	–	–	**Signal**	-87
							Server IP	204.191.12.227

GAS:

O2	20.9	**H2S**	0	**Confined Space Entry notes***
LEL	0	**CO2**	0	

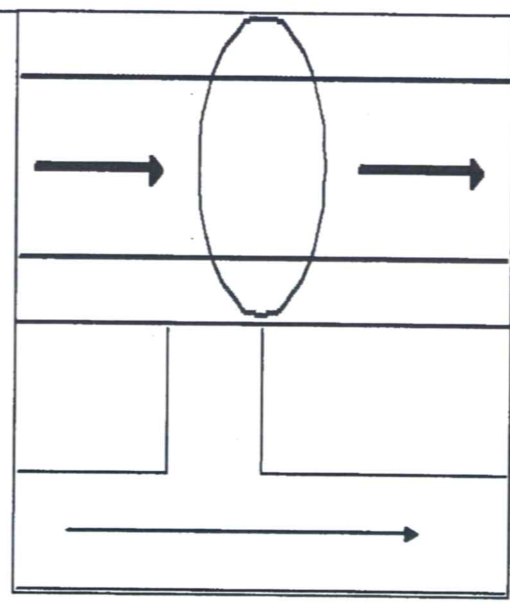
CHANNEL

Type:	Circular	
Cond.	Good	
Flow:	Smooth	
Material:	Concrete	
Height:	21	in
Width:	20	in
Other:	Sheet #	
Ground:	5.75	ft (bench)

OVERFLOW

Type:	Irregular	
Cond.	Deteriorating	
Length:	45	in
Width:	4	in
Height:	10	in

Other Information:



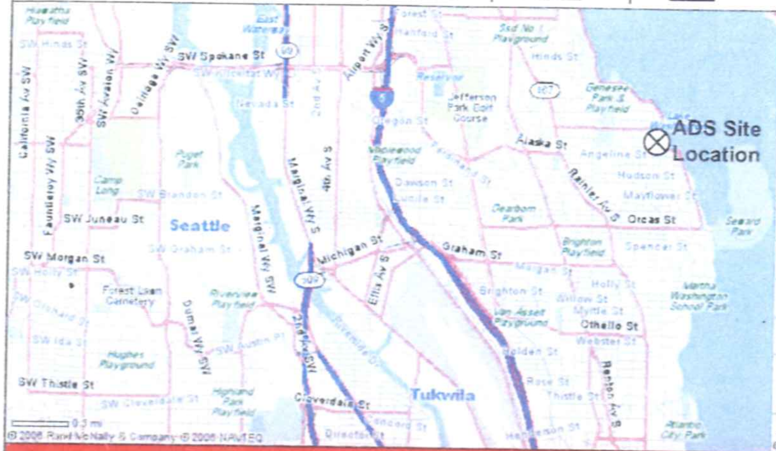
note* all dimensions referenced from invert (bottom) of channel

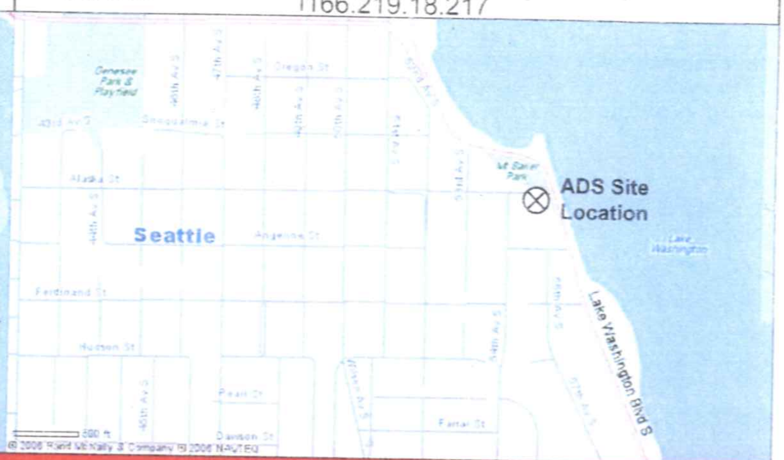
ADS ENVIRONMENTAL SERVICES

ADS Site Report

Quality Form

Project Name: Seattle - CSO	City / State: Seattle, WA	FM Initials: SS	
Site Name: 165/SEA_067078;D067152	Monitor Series: 5000 BG	Monitor S/N:	19019
Address/Location: SW corner of S. Alaska St. & Lake Washington BLVD (site located off street in grass)		Manhole #:	067-261
		Thomas Bros Map Page:	595 G5
		Pipe Height:	10.00 "
Access: Drive	Type of System: Sanitary [ ] Storm [ ] Combined [X]	Pipe Width:	10.13 "
		IP Address:	166.219.18.217





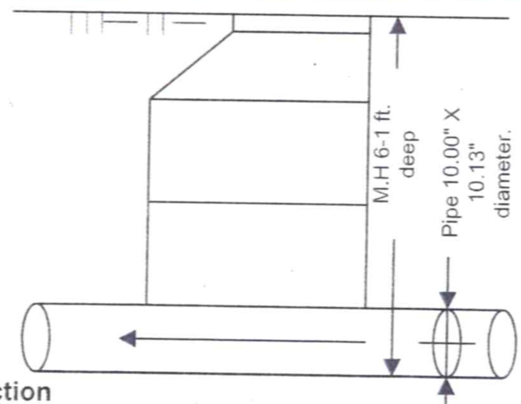
Investigation Information:

Date/Time of Investigation:	12/19/2006 08:22
Site Hydraulics:	Slow smooth flow Backup conditions, 1.50" of silt downstream
Upstream Input: (L/S, P/S)	
Upstream Manhole:	DNI
Downstream Manhole:	DNI
Depth of Flow:	2.25"+/- 0.25"
Range (Air DOF):	+/-
Peak Velocity:	1.55 fps
Silt:	0.50 Inches

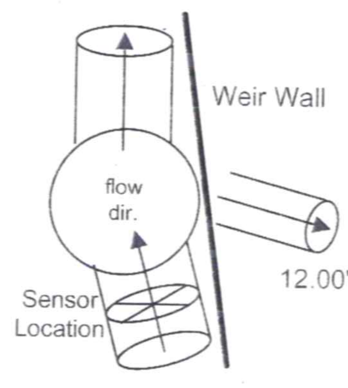
Manhole Information:

Manhole Depth:	6' - 1"
Manhole Material / Condition	Brick / Good
Pipe Material / Condition:	Concrete / Good
Mini System Character:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Telephone Information:	
Access Pole #:	
Distance From Manhole:	Feet
Road Cut Length:	Feet
Trench Length:	Feet

Other Information:



Cross Section



Planar N

Installation Information	
Installation Type:	Regular
Sensors Devices:	Ultra / Pressure / Velocity
Surcharge Height:	4'-00"
Rain Guage Zone:	

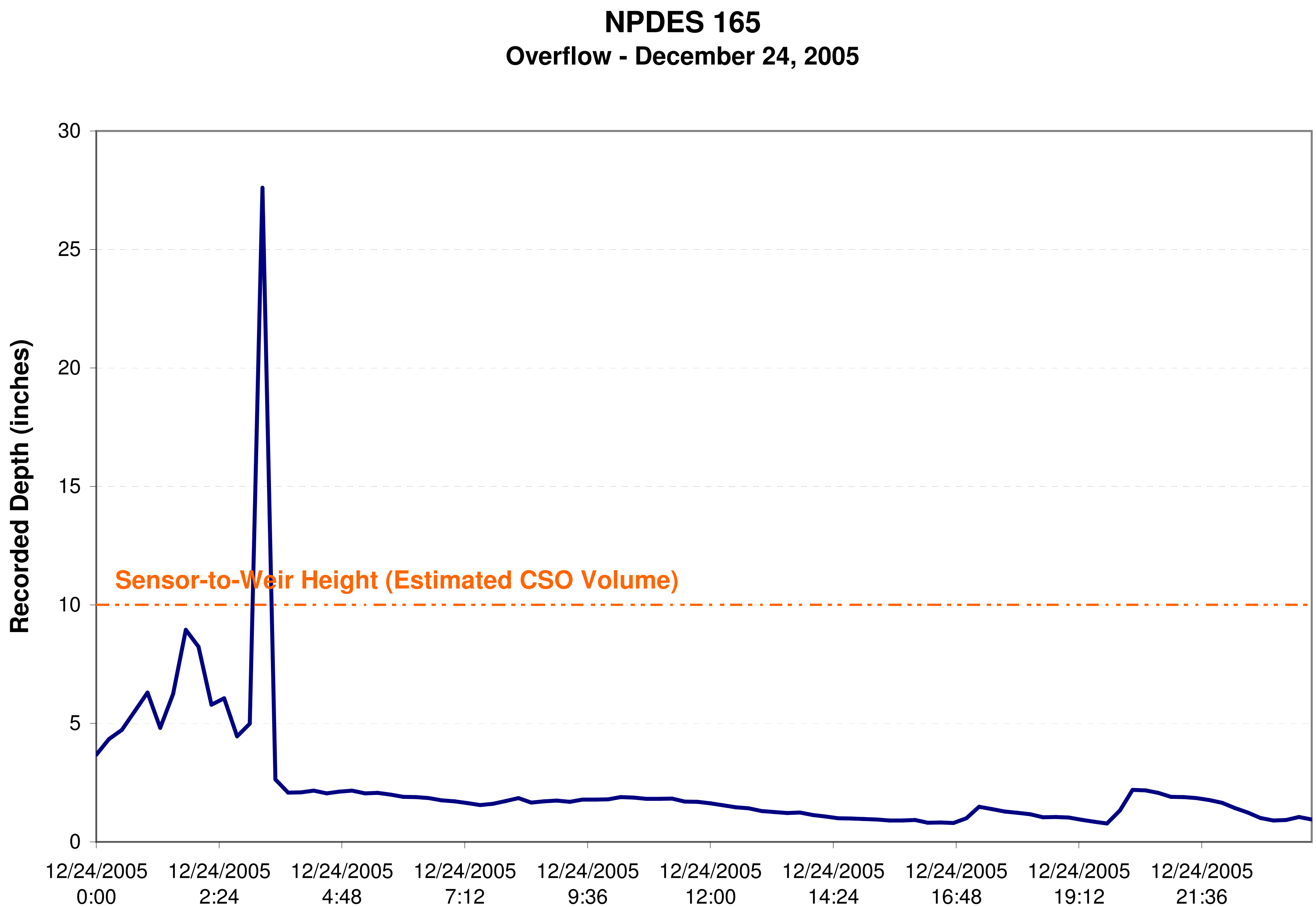
Backup	Yes	No	?	Distance
Trunk				
Lift / Pump Station				
WWTP				
Other				

Additional Site Information / Comments:

Weir Measurement: Length 33.00", Width 4.00". Height: Left 10.00", Center 10.50", Right 10.50". Ultra below crest of weir, distance between the two points is 1.75".

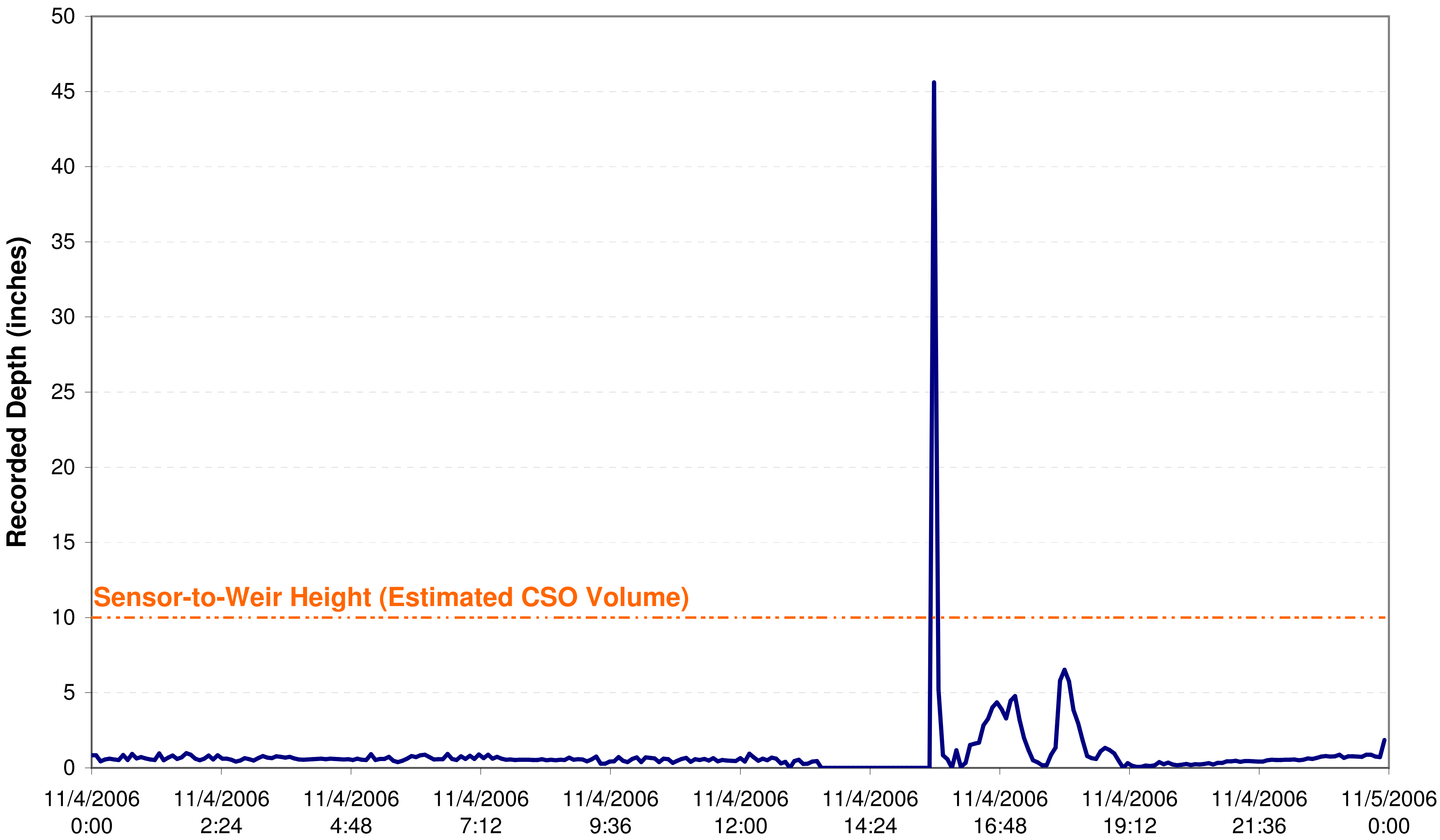
Appendix G.2 – CSO Basin 165

Sample of Depth versus Time Plots for Reported CSO Events


NPDES 165
Overflow - December 24, 2005
Recorded Depth (inches)
30
25
20
15
10
5
0
Sensor-to-Weir Height (Estimated CSO Volume)
12/24/2005 0:00
12/24/2005 2:24
12/24/2005 4:48
12/24/2005 7:12
12/24/2005 9:36
12/24/2005 12:00
12/24/2005 14:24
12/24/2005 16:48
12/24/2005 19:12
12/24/2005 21:36

NPDES 165

Overflow - November 4, 2006



Appendix H – CSO Basin 44

Appendix H.1 – CSO Basin 44A

Summary of Assumptions

NPDES Basin 44A - Matching Recorded Volumes

MH067-274

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Geotivity Site Investigation Form (12/19/2001)	Weir height = 48 inches Weir length = 77 inches Weir width = 6 inches
ADS Site Report (12/12/2006)	Weir length = 145 inches Weir width = Not provided Weir height = 62.5 inches (left), 63.5 inches (center); 62.5 inches (right) Manhole depth = 8'-6"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
1	1/22/2003	Data unavailable for this reported CSO event.	Estimated based on the average difference between other reported and HDR-estimated CSO events	5,782,719
2	1/1/2003		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 145 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 62.5 inches Volume calculations: $Q^*\Delta t$	7,328,239
3	11/18/2003		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 145 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 62.5 inches Volume calculations: $Q^*\Delta t$	5,663,992
4	3/13/2003		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 145 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 62.5 inches Volume calculations: $Q^*\Delta t$	3,813,527
5	12/19/2006	Data for this event indicates a malfunction in the meter. Depth data reaches a maximum value of 282 inches.	Estimated based on the average difference between other reported and HDR-estimated CSO events	2,827,814

NPDES Basin 44A - Matching Recorded Volumes

MH067-274

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Geotivity
Site Investigation Form
(12/19/2001)

Weir height = 48 inches
Weir length = 77 inches
Weir width = 6 inches

ADS
Site Report (12/12/2006)

Weir length = 145 inches
Weir width = Not provided
Weir height = 62.5 inches (left), 63.5 inches (center); 62.5 inches (right)
Manhole depth = 8'-6"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
6	2/6/2005		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 145 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 62.5 inches Volume calculations: $Q^*\Delta t$	192,140
7	3/22/2003		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 145 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 62.5 inches Volume calculations: $Q^*\Delta t$	1,266,388
8	2/21/2002	Data unavailable for this reported CSO event.	Estimated based on the average difference between other reported and HDR-estimated CSO events	1,928,592

Following information reviewed in CSO Annual Reports:

Report	Description

Determine weir height:

Height (in)	Source
48	Geotivity Site Investigation Form (12/19/2001)
64.75	ADS - currently uses in calculations.
63.5	ADS Site Report (center height), 12/12/2006
78	Overflow structure drawing

Determine weir length:

Length (in)	Source
77	Geotivity Site Investigation Form (12/19/2001)
145	ADS Site Report (12/12/2006)

Determine flow rate estimate:

Assumption	Reasoning
broad-crested weir	Reported as 6-inch weir width in Geotivity Site Investigation Form.

Conclusion based on available information:

Weir height is 62.5 from available documentation. In HDR estimations, will assume broad-crested weir.

Pipe Capacity Estimations (Overflow Structure 44A)

Downstream pipe capacities (for overflow and outfall pipes) were calculated to determine if pipes may be outlet-controlled at larger overflow rates during CSO events for Overflow Structure 44A. If the CSO events are outlet-controlled at larger overflow rates, then the actual CSO volumes are lower than the CSO volumes calculated (overflow rate estimates would be less in a submerged versus free-flowing condition).

The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of the outfall. The assumed maximum overflow rate for the 12/3/07 storm is shown in Table A in bold for Overflow Structure 44A.

Maximum pipe capacities were also calculated using the Manning equation and available Geographic Information Systems (GIS) data. Invert elevations of maintenance holes and pipe lengths and diameters (as indicated in GIS) were used to estimate full pipe capacity (also shown in Table A). However, these capacities should not be considered the maximum pipe capacities due to GIS data discrepancies and because the GIS data was not compared to record drawings or available survey data for verification.

Table B presents the maximum estimated overflow rates for the largest 8 reported CSO events that were calculated using the broad-crested weir equation (unsubmerged). Of the 8 largest reported CSO events (between 2001 and 2006), the estimated flow rates resulted in maximum flow rates less than 14.8 mgd, except for the 12/19/06 CSO event. It appears that the depth meter was malfunctioning; depth measurements of 282 inches were recorded. Thus, it appears that the overflow pipeline has adequate capacity for the largest CSO events, and that the overflow structure is not outlet-controlled for the largest CSO events within this monitoring period.

Table A. Estimated Pipe Capacities for Overflow Structure 44A

Source	Maximum Pipe Capacity	Details and Assumptions
ADS Monitoring Data, 12/3/07 storm	**14.8 mgd**	Overflow rates estimated from depth and velocity meters in overflow pipe.
Seattle Public Utilities Geographic Information Systems (GIS) layers for sewer mainlines and manholes	64.2 mgd	Upstream and downstream manholes for pipe segment: MH 067-274 to MH 067-275. Capacity calculated using Manning equation (d = 30 inches; n = 0.013; s = 0.0582 ft/ft).
	24.0 mgd	Upstream and downstream manholes for pipe segment: MH 067-275 to MH 067-197. Capacity calculated using Manning equation (d = 24 inches; n = 0.013; s = 0.0268 ft/ft).

Table B. Maximum Estimated Overflow Rates for Reported CSO Events (2000 – 2006), Overflow Structure 44A

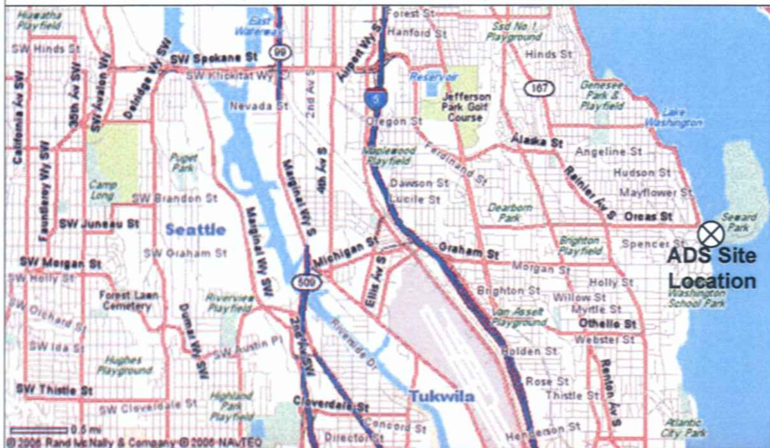
Reported Overflow Date	Maximum Estimated Overflow Rate	Details and Assumptions
1/22/03	Data unavailable for this reported CSO event.	Overflow rates calculated using broad-crested weir equation (unsubmerged).
1/1/03	13.1 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
11/18/03	13.3 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
3/13/03	7.9 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
12/19/06	1,608 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
2/6/05	1.8 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
3/22/03	8.5 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
2/21/02	Data unavailable for this reported CSO event.	Overflow rates calculated using broad-crested weir equation (unsubmerged).

ADS ENVIRONMENTAL SERVICES®

ADS Site Report

Quality Form

Project Name:	**Seattle - CSO**	**City / State:** Seattle, WA	**FM Initials:** SS
Site Name: NPDES 44A/SEA_067274	**Monitor Series:** 5000 AG	**Monitor S/N:**	15074
Address/Location:	Lake Washington BLVD S. s/o S. Juneau St. (n/o the tennis courts and parking lot)	**Manhole #**	067-274
		Thomas Bros Map Page:	595 H7
		Pipe Height:	30.00 "
Access: Drive	**Type of System:** Sanitary ☐ Storm ☐ Combined ☒	**Pipe Width:**	30.00 "
		IP Address:	166.219.19.27



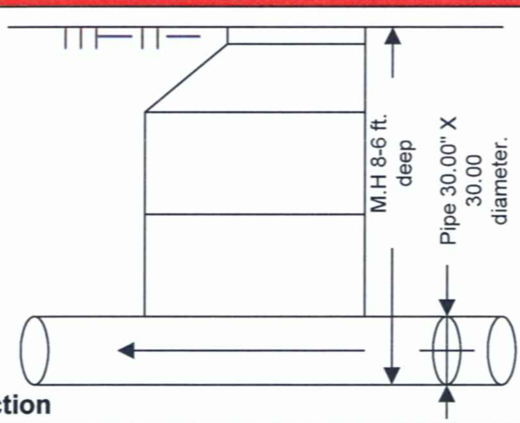
Investigation Information:

Date/Time of Investigation:	12/19/2006 08:52
Site Hydraulics:	Further info. pending
Upstream Input: (L/S, P/S)	
Upstream Manhole:	DNI
Downstream Manhole:	DNI
Depth of Flow:	Further info. pending +/- 0.25"
Range (Air DOF):	+/-
Peak Velocity:	Further info. pending fps
Silt:	0.00 Inches

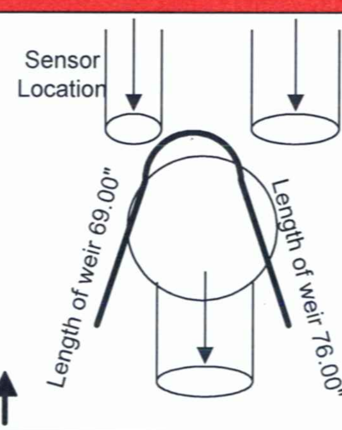
Manhole Information:

Manhole Depth:	8' - 6"
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	Concrete / Good
Mini System Character:	Residential ☒ Commercial ☐ Industrial ☐ Trunk ☐
Telephone Information:	
Access Pole #:	
Distance From Manhole:	Feet
Road Cut Length:	Feet
Trench Length:	Feet

Other Information:



Cross Section



Planar N

Installation Information	
Installation Type:	Regular
Sensors Devices:	Ultra / Pressure / Velocity
Surcharge Height:	0.00" Feet
Rain Guage Zone:	

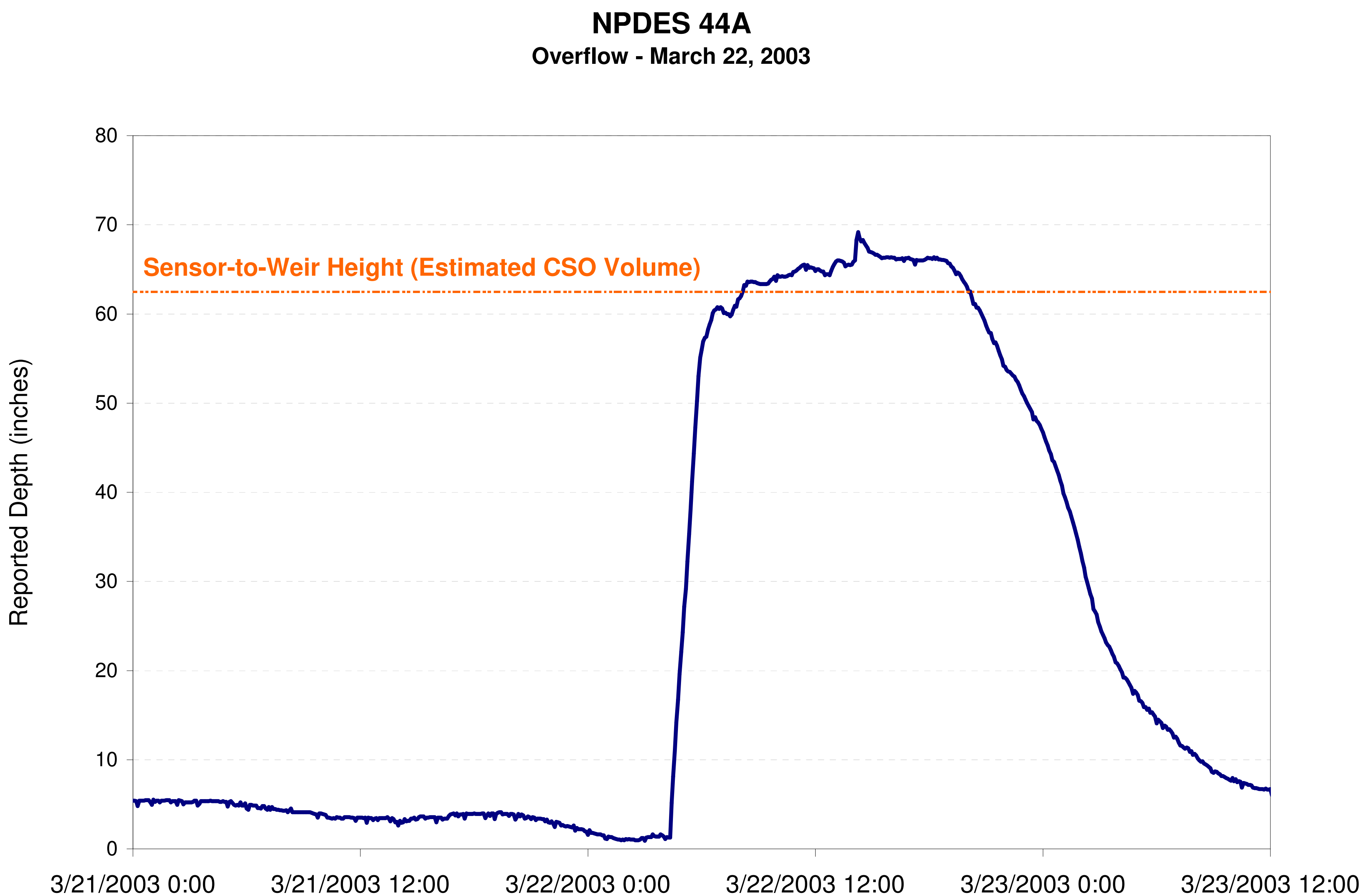
Backup	**Yes**	**No**	**?**	**Distance**
Trunk	☐	☐	☐	
Lift / Pump Station	☐	☐	☐	
WWTP	☐	☐	☐	
Other	☐	☐	☐	

Additional Site Information / Comments:

Weir Measurements: Length: Left side 69.00", Right side 76.00". Height: Left 62.50", Center 63.50", Right 62.50". Reverse install. 0-15 psi pressure.

Appendix H.2 – CSO Basin 44A

Sample of Depth versus Time Plots for Reported CSO Events


NPDES 44A
Overflow - March 22, 2003
Sensor-to-Weir Height (Estimated CSO Volume)
Reported Depth (inches)
80
70
60
50
40
30
20
10
0
3/21/2003 0:00
3/21/2003 12:00
3/22/2003 0:00
3/22/2003 12:00
3/23/2003 0:00
3/23/2003 12:00

Appendix H.3 – CSO Basin 44B

Summary of Assumptions

NPDES Basin 44B - Matching Recorded Volumes

MH067-261

Duration of Geotivity Metering: January 1, 2001 - December 30, 2006

Geotivity Site Investigation Form (1/1/2001)	Weir height = 18.11 inches Weir length = 38 inches Weir width = 3.5 inches
ADS Site Report (12/12/2006)	Weir length = 75 inches Weir width = Not provided Weir height = 29.5 inches (left), 26.5 inches (center); 30.5 inches (right) Manhole depth = 6'-6"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
1	1/9/2006		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: Q*Δt	5,512,404
2	12/22/2005		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: Q*Δt	2,961,886
3	1/28/2006		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: Q*Δt	2,930,661
4	2/21/2002		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: Q*Δt	200,794

NPDES Basin 44B - Matching Recorded Volumes

MH067-261

Duration of Geotivity Metering: January 1, 2001 - December 30, 2006

Geotivity
Site Investigation Form
(1/1/2001)

Weir height = 18.11 inches
Weir length = 38 inches
Weir width = 3.5 inches

ADS
Site Report (12/12/2006)

Weir length = 75 inches
Weir width = Not provided
Weir height = 29.5 inches (left), 26.5 inches (center); 30.5 inches (right)
Manhole depth = 6'-6"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
5	11/13/2001		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: Q*Δt	833,119
6	1/6/2002		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: Q*Δt	116,853
7	1/5/2006		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: Q*Δt	1,817,279
8	12/15/2001		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: Q*Δt	103,380

NPDES Basin 44B - Matching Recorded Volumes

MH067-261

Duration of Geotivity Metering: January 1, 2001 - December 30, 2006

Geotivity
Site Investigation Form
(1/1/2001)

Weir height = 18.11 inches
Weir length = 38 inches
Weir width = 3.5 inches

ADS
Site Report (12/12/2006)

Weir length = 75 inches
Weir width = Not provided
Weir height = 29.5 inches (left), 26.5 inches (center); 30.5 inches (right)
Manhole depth = 6'-6"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
9	12/26/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: $Q*\Delta t$	5,039,928
10	12/13/2001		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 75 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 27.5 inches (Weir Heights 2002 Spreadsheet) Volume calculations: $Q*\Delta t$	297,401

Following information reviewed in CSO Annual Reports:

Report	Description

Determine weir height:

Height (in)	Source
18.11	Geotivity Site Investigation Form (1/1/2001)
27.5	Geotivity Float & 2nd Depth Meter
28.5	ADS - currently uses in calculations.
26.5	ADS Site Report (center height), 12/12/2006

Determine weir length:

Length (in)	Source
72	Geotivity Site Investigation Form (1/1/2001)
75	ADS Site Report (12/12/2006)

Determine flow rate estimate:

Assumption	Reasoning
broad-crested weir	Reported as 3-inch weir width in Geotivity Site Investigation Form.

Conclusion based on available information:

Weir height is 27.5 from available documentation. In HDR estimations, will assume broad-crested weir.

Pipe Capacity Estimations (Overflow Structure 44B)

Downstream pipe capacities (for overflow and outfall pipes) were calculated to determine if pipes may be outlet-controlled at larger overflow rates during CSO events for Overflow Structure 44B. If the CSO events are outlet-controlled at larger overflow rates, then the actual CSO volumes are lower than the CSO volumes calculated (overflow rate estimates would be less in a submerged versus free-flowing condition).

The 12/3/07 storm was greater than a 100-year return storm event, and the maximum overflow rate is believed to represent the maximum capacity of the outfall. The assumed maximum overflow rate for the 12/3/07 storm is shown in Table A in bold for Overflow Structure 44B.

Maximum pipe capacities were also calculated using the Manning equation and available Geographic Information Systems (GIS) data. Invert elevations of maintenance holes and pipe lengths and diameters (as indicated in GIS) were used to estimate full pipe capacity (also shown in Table A). However, these capacities should not be considered the maximum pipe capacities due to GIS data discrepancies and because the GIS data was not compared to record drawings or available survey data for verification.

Table B presents the maximum estimated overflow rates for the largest 10 reported CSO events that were calculated using the broad-crested weir equation (unsubmerged). Five of the 10 largest reported CSO events (between 2001 and 2006) have estimated maximum flow rates greater than 2.6 mgd (12/3/07 maximum overflow rate). Thus, it may be possible that the pipeline may have inadequate capacity for these CSO events at the larger overflow rates. Thus, using an unsubmerged broad-crested weir equation may be inadequate to estimate some overflow volumes. The possibility of the broad-crested weir being submerged during these CSO events was not accounted for in the Estimated CSO Volumes.

Table A. Estimated Pipe Capacities for Overflow Structure 44B

Source	Maximum Pipe Capacity	Details and Assumptions
ADS Monitoring Data, 12/3/07 storm	**2.6 mgd**	Overflow rates calculated using broad-crested weir equation (unsubmerged).
Seattle Public Utilities Geographic Information Systems (GIS) layers for sewer mainlines and manholes	7.9 mgd	Upstream and downstream manholes for pipe segment: MH 067-261 to MH 067-275. Capacity calculated using Manning equation (d = 15 inches; n = 0.013; s = 0.0355 ft/ft).
	24.0 mgd	Upstream and downstream manholes for pipe segment: MH 067-275 to MH 067-197. Capacity calculated using Manning equation (d = 24 inches; n = 0.013; s = 0.0268 ft/ft).

Table B. Maximum Estimated Overflow Rates for Reported CSO Events (2000 – 2006), Overflow Structure 44B

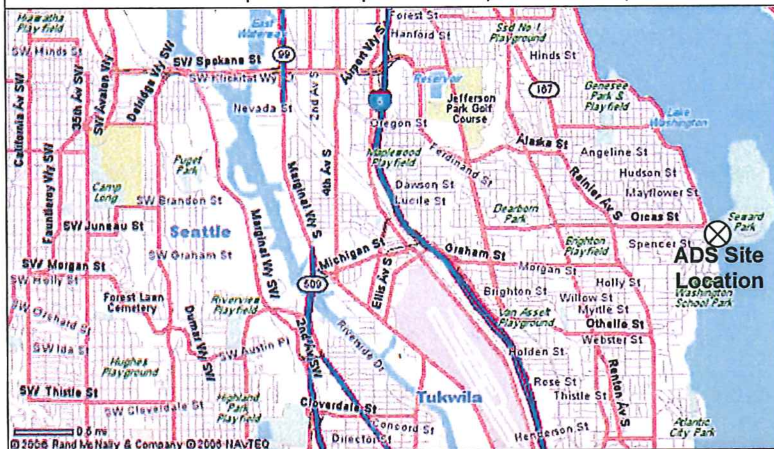
Reported Overflow Date	Maximum Estimated Overflow Rate	Details and Assumptions
1/9/06	10.7 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
12/22/05	2.2 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
1/28/06	3.2 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
2/21/02	0.5 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
11/13/01	4.6 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
1/6/02	0.4 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
1/5/06	2.6 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
12/15/01	0.5 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
12/26/06	6.2 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).
12/13/01	1.9 mgd	Overflow rates calculated using broad-crested weir equation (unsubmerged).

ADS ENVIRONMENTAL SERVICES®

ADS Site Report

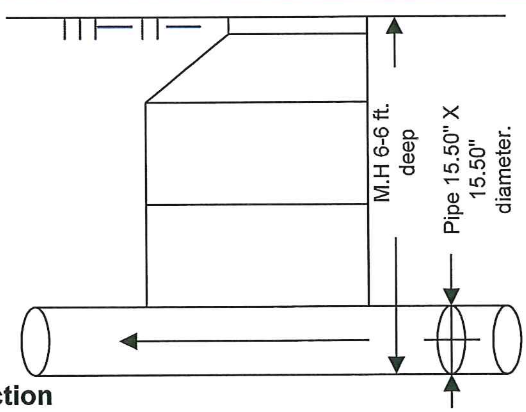
Quality Form

Project Name: Seattle - CSO	**City / State:** Seattle, WA	**FM Initials:** SS	
Site Name: NPDES 44B/SEA_067261	**Monitor Series:** 5000 AG	**Monitor S/N:**	26146
Address/Location: Lake Washington BLVD S. s/o S. Juneau St. (n/o the tennis courts and parking lot)		**Manhole #**	067-261
		Thomas Bros Map Page:	595 H7
		Pipe Height:	15.50 "
Access: Drive	**Type of System:** Sanitary [ ] Storm [ ] Combined [X]	**Pipe Width:**	14.50 "
		IP Address:	166.219.18.205

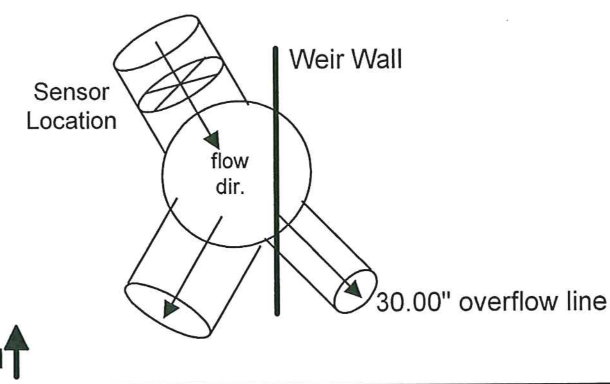


Investigation Information:		**Manhole Information:**				
Date/Time of Investigation:	12/19/2006	**Manhole Depth:**	6' - 6"			
Site Hydraulics:	Smooth flow	**Manhole Material / Condition**	Concrete / Good			
Upstream Input: (L/S, P/S)		**Pipe Material / Condition:**	Concrete / Good			
Upstream Manhole:	DNI	**Mini System Character:**	Residential [X]	Commercial [ ]	Industrial [ ]	Trunk [ ]
Downstream Manhole:	DNI	**Telephone Information:**				
Depth of Flow:	6.50"+/- 0.25"	**Access Pole #:**				
Range (Air DOF):	+/-	**Distance From Manhole:**	Feet			
Peak Velocity:	Further info. pending fps	**Road Cut Length:**	Feet			
Silt:	0.00 Inches	**Trench Length:**	Feet			

Other Information:



Cross Section



Planar

Installation Information		**Backup**	**Yes**	**No**	**?**	**Distance**
Installation Type:	Regular	Trunk	[ ]	[ ]	[ ]	
Sensors Devices:	Ultra / Pressure / Velocity	Lift / Pump Station	[ ]	[ ]	[ ]	
Surcharge Height:	0.00" Feet	WWTP	[ ]	[ ]	[ ]	
Rain Guage Zone:		Other	[ ]	[ ]	[ ]	

Additional Site Information / Comments:

Weir wall: Length: 75.00", Width: 4.00", Left side 29.50", Center 26.50", Right 30.50".
15 psi pressure used.

Weir Heights June 2002.xls

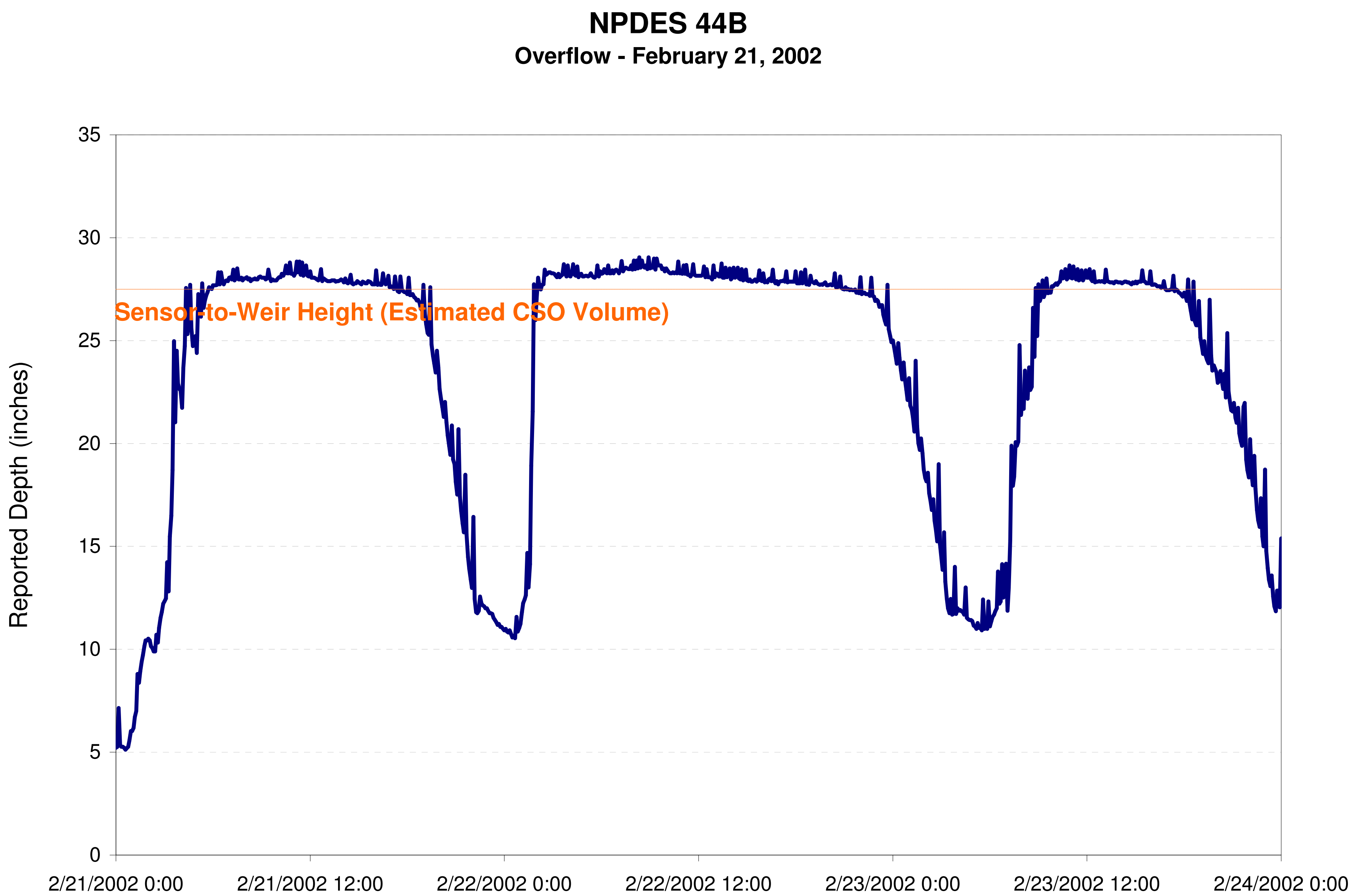
NPDES #	Manhole#	Inflow Pipe diameter (in)	Weir Height (in)
013A	MH017-253	49	72
013B	MH017-259	20	41
14	MH025-289	12	15
015A	MH025-373		69
018B		29 & 21	9
20	MH032-014		52
22	MH032-014		
25		50	37.75
26	MH038-081	12	8.5
27	MH042-269	22	24
28	MH042-275	12	7
29	MH042-303	8	10
30	MH042-324		21
31		8	8
32	MH046-157		14
33			39.76
34		15	18
35	MH046-138		22
36			7.5
37	MH059-489	18	24
38	MH059-451		61
39		21	19
40		12	7.5
040A	MH059-491		19
41		14	18
42	MH060-052		52
43	MH060-049	20.1 x 124	48.6
044A	MH067-274		48
044B	MH067-261	15	27.5
045A			35.25
045B	MH067-274		24.4
46			
047A	MH081-086		46
047B	MH081-224		27
047C	MH081-330		37
047D	MH080-298		10
047E	MH081-086		10
49	MH306-437		65
60		16 & 9 & 9	101
61	MH026-013	6	
62			53
63			8.75
068A	MH028.425	24	109
068B	MH028-431		68
069-1	MH039-521	47.24	88.98
069-2	MH039-521	47.24	50
070-1	MH039-519	11.81	86.81
070-2	MH039-519	11.81	21.65

Weir Heights June 2002.xls

NPDES #	Manhole#	Inflow Pipe diameter (in)	Weir Height (in)
071-1	MH039-528	35.83	61.81
071-2	MH039-528	35.83	11.42
072-1		17.52	80.31
072-2		17.52	1.93
85			42.75
95			3.54
99			91
107			64
111A	MH056-105		24
111B	MH056-520		23.5
111C	MH056-169		40
111D	MH057-253		19
111G	MH057-513		29.5
111H			147
116			47.5
125		24	9
128		42	32.5
130			18.3
132			5.60
135		18	4
138			53.4
139			43.86
140			19.50
141			50.25
144			
147A	MH022-187	30	18.5
147B			9.8
150-151	MH011-184	34	17
q150	MH011-184	34	17
152		46	27.43
164	MH034-523	41.9 x 17.9	20.08
165		10	10
168		12.60	35.24
169		36	381
170			46
171	MH081-231		77
172-1	MH043-006	12.6	35.2
174	MH021-052	48	21.3
175			21
179	MH005-157		23
180	MH005-154		

Appendix H.4 – CSO Basin 44B

Sample of Depth versus Time Plots for Reported CSO Events


NPDES 44B
Overflow - February 21, 2002
Reported Depth (inches)
35
30
25
20
15
10
5
0
Sensor-to-Weir Height (Estimated CSO Volume)
2/21/2002 0:00
2/21/2002 12:00
2/22/2002 0:00
2/22/2002 12:00
2/23/2002 0:00
2/23/2002 12:00
2/24/2002 0:00

Appendix I – CSO Basin 47

Appendix I.1 – CSO Basin 47C

Summary of Assumptions

NPDES Basin 47C - Matching Recorded Volumes

MH081-330

Duration of Geotivity Metering: June 6, 2002 - December 30, 2006

Geotivity Site Investigation Form (6/26/2002)	Weir height = 51 inches Weir length = 368 inches Weir width = 6.5 inches
ADS Site Report (12/12/2006)	Weir length = 364 inches Weir width = Not provided Weir height = 48 inches (left), 48.5 inches (center); 49 inches (right) Manhole depth = 5'-10"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
1	1/29/2004		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 364 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 51 inches Volume calculations: Q*Δt	9,466,693
2	10/20/2003		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 364 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 51 inches Volume calculations: Q*Δt	6,512,399
3	1/29/2006		Flow calculations: Q = 2.62LH$^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 364 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 51 inches Volume calculations: Q*Δt	2,328,196
4	11/14/2001	Data unavailable for this reported CSO event.	Estimated based on the average difference between other reported and HDR-estimated CSO events	1,552,416

NPDES Basin 47C - Matching Recorded Volumes

MH081-330

Duration of Geotivity Metering: June 6, 2002 - December 30, 2006

Geotivity Site Investigation Form (6/26/2002)	Weir height = 51 inches Weir length = 368 inches Weir width = 6.5 inches
ADS Site Report (12/12/2006)	Weir length = 364 inches Weir width = Not provided Weir height = 48 inches (left), 48.5 inches (center); 49 inches (right) Manhole depth = 5'-10"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
5	11/6/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 364 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 51 inches Volume calculations: $Q^*\Delta t$	1,413,495
6	12/13/2001	Data unavailable for this reported CSO event.	Estimated based on the average difference between other reported and HDR-estimated CSO events	1,172,103
7	12/24/2005		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 364 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 51 inches Volume calculations: $Q^*\Delta t$	1,093,648
8	12/14/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 364 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 51 inches Volume calculations: $Q^*\Delta t$	1,081,570

NPDES Basin 47C - Matching Recorded Volumes

MH081-330

Duration of Geotivity Metering: June 6, 2002 - December 30, 2006

Geotivity Site Investigation Form (6/26/2002)	Weir height = 51 inches Weir length = 368 inches Weir width = 6.5 inches
ADS Site Report (12/12/2006)	Weir length = 364 inches Weir width = Not provided Weir height = 48 inches (left), 48.5 inches (center); 49 inches (right) Manhole depth = 5'-10"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
9	12/26/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 364 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 51 inches Volume calculations: $Q^*\Delta t$	991,730

Following information reviewed in CSO Annual Reports:

Report	Description

Determine weir height:

Height (in)	Source
51	Geotivity Site Investigation Form (6/26/2002)
51	Geotivity Float
50.12	ADS - currently uses in calculations.
48.5	ADS Site Report (center height), 12/12/2006

Determine weir length:

Length (in)	Source
368	Geotivity Site Investigation Form (6/26/2002)
364	ADS Site Report (12/12/2006)

Determine flow rate estimate:

Assumption	Reasoning
broad-crested weir	Reported as 6.5-inch weir width in Geotivity Site Investigation Form.

Conclusion based on available information:

Weir height is 51 from available documentation. In HDR estimations, will assume broad-crested weir.

ADS ENVIRONMENTAL SERVICES®

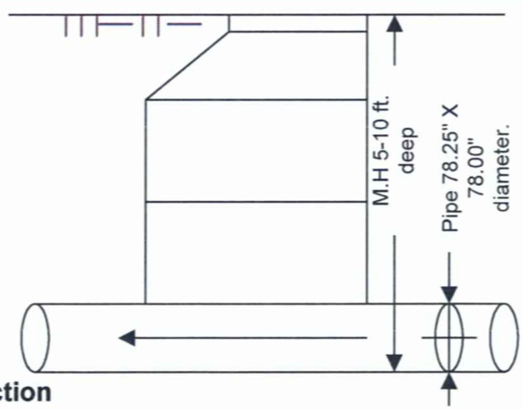
ADS Site Report

Quality Form

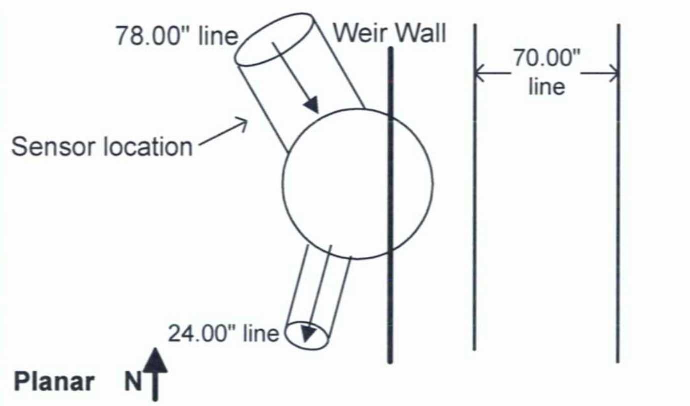
Project Name:	**Seattle - CSO**	**City / State:** Seattle, WA	**FM Initials:** SS
Site Name: NPDES 47C/SEA_081330	**Monitor Series:** 5000 AG	**Monitor S/N:**	15084
Address/Location:	9305 Rainier Av. S. @ 52^{nd} Av. S. (Northeast corner of intersection on sidewalk)	**Manhole #**	081-330
		Thomas Bros Map Page:	625 F4
		Pipe Height:	78.25"
Access: Drive	**Type of System:** Sanitary [ ] Storm [ ] Combined [X]	**Pipe Width:**	78.00"
		IP Address:	166.219.19.4

Investigation Information:			**Manhole Information:**	
Date/Time of Investigation:	1219/2006	09:32	**Manhole Depth:**	5' - 10"
Site Hydraulics:	Smooth flow		**Manhole Material / Condition**	Concrete / Good
Upstream Input: (L/S, P/S)			**Pipe Material / Condition:**	Concrete / Fair
Upstream Manhole:	DNI		**Mini System Character:**	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Downstream Manhole:	DNI		**Telephone Information:**	
Depth of Flow:	10.00+/- 0.25"		**Access Pole #:**	
Range (Air DOF):	+/-		**Distance From Manhole:**	Feet
Peak Velocity:	3.20 fps		**Road Cut Length:**	Feet
Silt:	0.00 Inches		**Trench Length:**	Feet

Other Information:



Cross Section



Planar N

Installation Information		**Backup**	**Yes**	**No**	**?**	**Distance**
Installation Type:	Regular	Trunk	[ ]	[ ]	[ ]	
Sensors Devices:	Ultra / Pressure / Velocity	Lift / Pump Station	[ ]	[ ]	[ ]	
Surcharge Height:	0.00" Feet	WWTP	[ ]	[ ]	[ ]	
Rain Guage Zone:		Other	[ ]	[ ]	[ ]	

Additional Site Information / Comments:

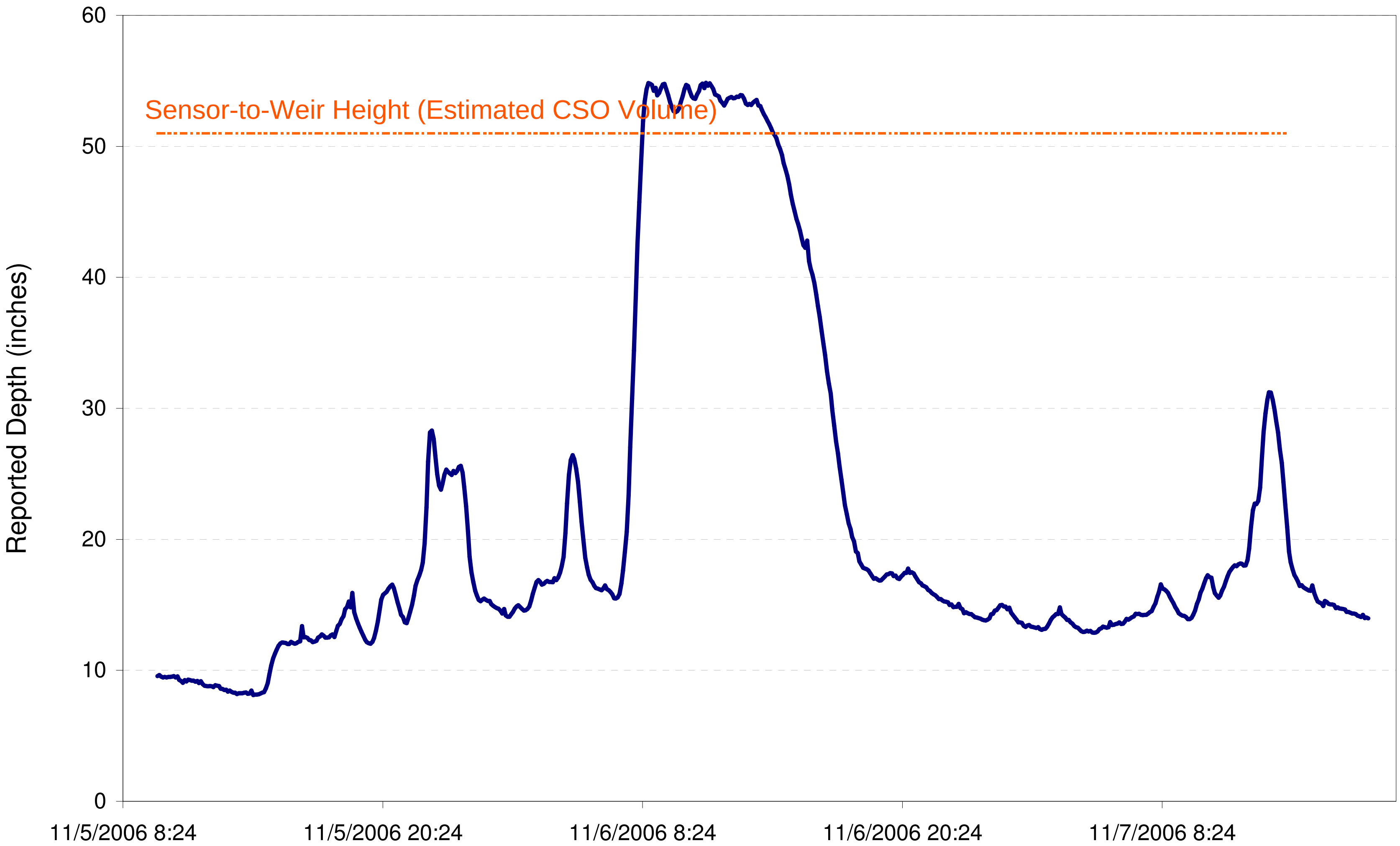
Weir Measurements: Length 364.00", Width 5.75". Height: Left 48.00", Center 48.50", Right 49.00". Face of ultra to crest of weir 26.63".

Appendix I.2 – CSO Basin 47C

Sample of Depth versus Time Plots for Reported CSO Events

NPDES 47C

Overflow - November 6, 2006



Appendix I.3 – CSO Basin 47D

Summary of Assumptions

NPDES Basin 47D - Matching Recorded Volumes

MH080-298

Duration of Geotivity Metering: December 19, 2002 - December 30, 2006

Geotivity Site Investigation Form (12/19/2001)	Weir height = 10 inches Weir length = 50 inches Weir width = 6 inches
ADS Site Report (12/12/2006)	Weir length = 49.5 inches Weir width = Not provided Weir height = 14.63 inches (left), 14.75 inches (center); 20 inches (right) Manhole depth = 11'-4"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
1	1/4/2004		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 50 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 10 inches Volume calculations: $Q*\Delta t$	580,117
2	11/21/2003		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 50 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 10 inches Volume calculations: $Q*\Delta t$	387,124
3	5/19/2005		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 50 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 10 inches Volume calculations: $Q*\Delta t$	1,478,528
4	11/27/2003		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) = 50 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 10 inches Volume calculations: $Q*\Delta t$	22,096

Following information reviewed in CSO Annual Reports:

Report	Description

Determine weir height:

Height (in)	Source
10	Geotivity Site Investigation Form (12/19/2001)
10	Geotivity Float
14.63	ADS - currently uses in calculations.
14.75	ADS Site Report (center height), 12/12/2006

Determine weir length:

Length (in)	Source
50	Geotivity Site Investigation Form (12/19/2001)
50	ADS Site Report (12/12/2006)

Determine flow rate estimate:

Assumption	Reasoning
broad-crested weir	Reported as 6-inch weir width in Geotivity Site Investigation Form.

Conclusion based on available information:

Weir height is 10 from available documentation. In HDR estimations, will assume broad-crested weir.

ADS ENVIRONMENTAL SERVICES®

ADS Site Report

Quality Form

Project Name: Seattle - CSO	**City / State:** Seattle, WA		**FM Initials:** SS
Site Name: NPDES 47D/SEA_080298	**Monitor Series:** 5000 AL	**Monitor S/N:**	15082
Address/Location: 4550 46th Av. S. @ S. Henderson St. (located NW corner of intersection)		**Manhole #**	080-298
		Thomas Bros Map Page:	625 F3
		Pipe Height:	12.00"
Access: Drive	**Type of System:** Sanitary [ ] Storm [ ] Combined [X]	**Pipe Width:**	11.75"
		IP Address:	166.219.19.42

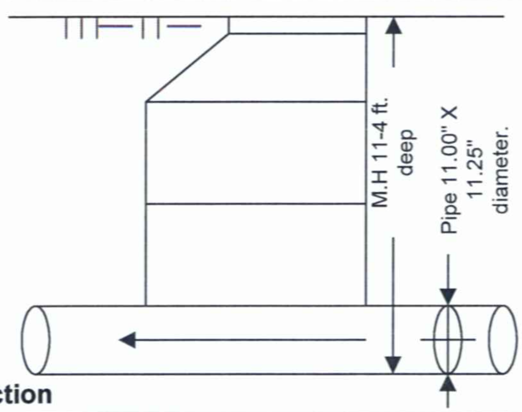
Investigation Information:

Date/Time of Investigation:	1219/2006	12:31
Site Hydraulics:	Fast smooth flow	
Upstream Input: (L/S, P/S)		
Upstream Manhole:	DNI	
Downstream Manhole:	DNI	
Depth of Flow:	2.25"+/- 0.25"	
Range (Air DOF):	+/-	
Peak Velocity:	3.30 fps	
Silt:	N/A Inches	

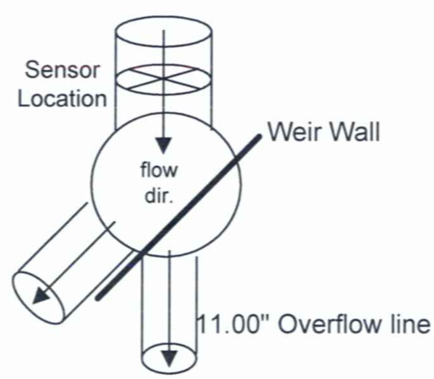
Manhole Information:

Manhole Depth:	11' - 4"
Manhole Material / Condition	Brick / Good
Pipe Material / Condition:	Clay / Fair
Mini System Character:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Telephone Information:	
Access Pole #:	
Distance From Manhole:	Feet
Road Cut Length:	Feet
Trench Length:	Feet

Other Information:



Cross Section



Planar

Installation Information	
Installation Type:	Regular
Sensors Devices:	Ultra / Pressure / Velocity
Surcharge Height:	0.00" Feet
Rain Guage Zone:	

Backup	Yes	No	?	Distance
Trunk	[ ]	[ ]	[ ]	
Lift / Pump Station	[ ]	[ ]	[ ]	
WWTP	[ ]	[ ]	[ ]	
Other	[ ]	[ ]	[ ]	

Additional Site Information / Comments:

Weir Measurements: Length 49.50", Width 6.00". Height: Left 14.63, Center 14.75", Right 20.00"

Appendix I.4 – CSO Basin 47B

Summary of Assumptions

NPDES Basin 47B - Matching Recorded Volumes

MH081-224

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Geotivity Site Investigation Form (12/19/2001)	Weir height = 27.5 inches Weir length = 118 inches Weir width = 0 inches
ADS Site Report (12/19/2006)	Weir length = 118 inches Weir width = Not provided Weir height = 26.75 inches (left), 27.75 inches (center); 27.25 inches (right) Manhole depth = 14'-7"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
1	1/17/2005		Flow calculations: Q = 2.62LH$^{3/2}$ (Broad-crested weir) Q = flow in cfs L = Weir length (feet) = 118 inches H = Depth of water over crest of weir (feet) P = Height of weir = 27.25 in Volume calculations: Q*Δt	3,797,345
2	11/13/2001	Data unavailable for this reported CSO event.	Data unavailable for this reported CSO event.	
3	3/13/2003		Flow calculations: Q = 2.62LH$^{3/2}$ (Broad-crested weir) Q = flow in cfs L = Weir length (feet) = 118 inches H = Depth of water over crest of weir (feet) P = Height of weir = 27.25 in Volume calculations: Q*Δt	70,955
4	3/22/2003		Flow calculations: Q = 2.62LH$^{3/2}$ (Broad-crested weir) Q = flow in cfs L = Weir length (feet) = 118 inches H = Depth of water over crest of weir (feet) P = Height of weir = 27.25 in Volume calculations: Q*Δt	9,567
5	1/22/2003	Data unavailable for this reported CSO event.	Data unavailable for this reported CSO event.	

NPDES Basin 47B - Matching Recorded Volumes

MH081-224

Duration of Geotivity Metering: December 19, 2001 - December 30, 2006

Geotivity Site Investigation Form (12/19/2001)	Weir height = 27.5 inches Weir length = 118 inches Weir width = 0 inches
ADS Site Report (12/19/2006)	Weir length = 118 inches Weir width = Not provided Weir height = 26.75 inches (left), 27.75 inches (center); 27.25 inches (right) Manhole depth = 14'-7"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
6	10/20/2003		Flow calculations: $Q = 2.62LH^{3/2}$ (Broad-crested weir) Q = flow in cfs L = Weir length (feet) = 118 inches H = Depth of water over crest of weir (feet) P = Height of weir = 27.25 in Volume calculations: $Q^*\Delta t$	1,357,054
7	1/6/2002		Flow calculations: $Q = 2.62LH^{3/2}$ (Broad-crested weir) Q = flow in cfs L = Weir length (feet) = 118 inches H = Depth of water over crest of weir (feet) P = Height of weir = 27.25 in Volume calculations: $Q^*\Delta t$	999,934
8	11/18/2003	Data unavailable for this reported CSO event.	Data unavailable for this reported CSO event.	
9	12/16/2001	Data unavailable for this reported CSO event.	Data unavailable for this reported CSO event.	
10	1/1/2003		Flow calculations: $Q = 2.62LH^{3/2}$ (Broad-crested weir) Q = flow in cfs L = Weir length (feet) = 118 inches H = Depth of water over crest of weir (feet) P = Height of weir = 27.25 in Volume calculations: $Q^*\Delta t$	0

Following information reviewed in CSO Annual Reports:

Report	Description

Determine weir height:

Height (in)	Source
27.5	Geotivity Site Investigation Form (12/19/2001)
28.5	ADS O/F Calculation
27.25	ADS Site Report (right height), 12/19/2006

Determine weir length:

Length (in)	Source
118	Geotivity Site Investigation Form (12/19/2001)
118	ADS Site Report (12/19/2006)

Determine flow rate estimate:

Assumption	Reasoning
broad-crested weir	

Conclusion based on available information:

Weir height is 27.25 from available documentation. In HDR estimations, will assume broad-crested weir.

ADS ENVIRONMENTAL SERVICES®

ADS Site Report

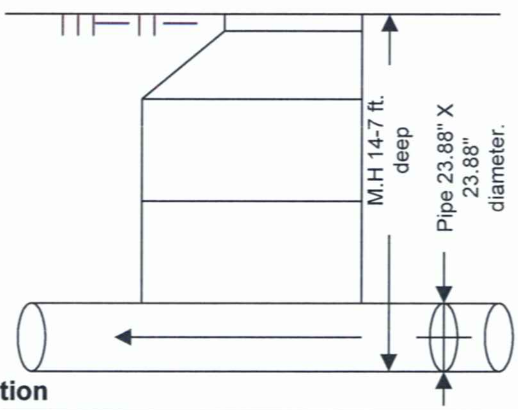
Quality Form

Project Name:	**Seattle - CSO**	**City / State:**	Seattle, WA	**FM Initials:**	SS

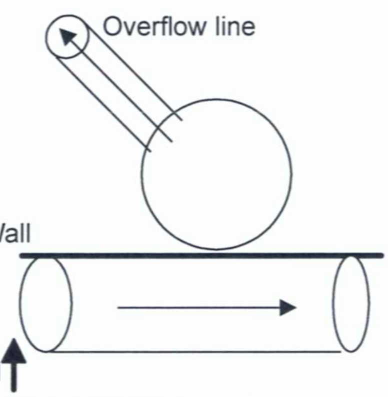
Site Name: NPDES 47B/SEA_081224	**Monitor Series:** 5000 AL	**Monitor S/N:**	15081
Address/Location:	9305 Rainier Av. S. @ 52nd Av. S. (Northeast corner of intersection on sidewalk)	**Manhole #**	081-224
		Thomas Bros Map Page:	625 G4
		Pipe Height:	23.88"
Access: Drive	**Type of System:** Sanitary [ ] Storm [ ] Combined [X]	**Pipe Width:**	23.88"
		IP Address:	166.219.19.47

Investigation Information:			**Manhole Information:**				
Date/Time of Investigation:	1219/2006	13:45	**Manhole Depth:**	14' - 7"			
Site Hydraulics:	Stagnate flow		**Manhole Material / Condition**	Concrete / Good			
Upstream Input: (L/S, P/S)			**Pipe Material / Condition:**	Concrete / Fair			
Upstream Manhole:	DNI		**Mini System Character:**	Residential [X]	Commercial [ ]	Industrial [ ]	Trunk [ ]
Downstream Manhole:	DNI		**Telephone Information:**				
Depth of Flow:	1.50"+/- 0.25"		**Access Pole #:**				
Range (Air DOF):	+/-		**Distance From Manhole:**	Feet			
Peak Velocity:	N/A fps		**Road Cut Length:**	Feet			
Silt:	0.00 Inches		**Trench Length:**	Feet			

Other Information:



Cross Section



Planar

Installation Information		**Backup**	**Yes**	**No**	**?**	**Distance**
Installation Type:	Regular	Trunk	[ ]	[ ]	[ ]	
Sensors Devices:	Ultra / Pressure / Velocity	Lift / Pump Station	[ ]	[ ]	[ ]	
Surcharge Height:	0.00" Feet	WWTP	[ ]	[ ]	[ ]	
Rain Guage Zone:		Other	[ ]	[ ]	[ ]	

Additional Site Information / Comments:

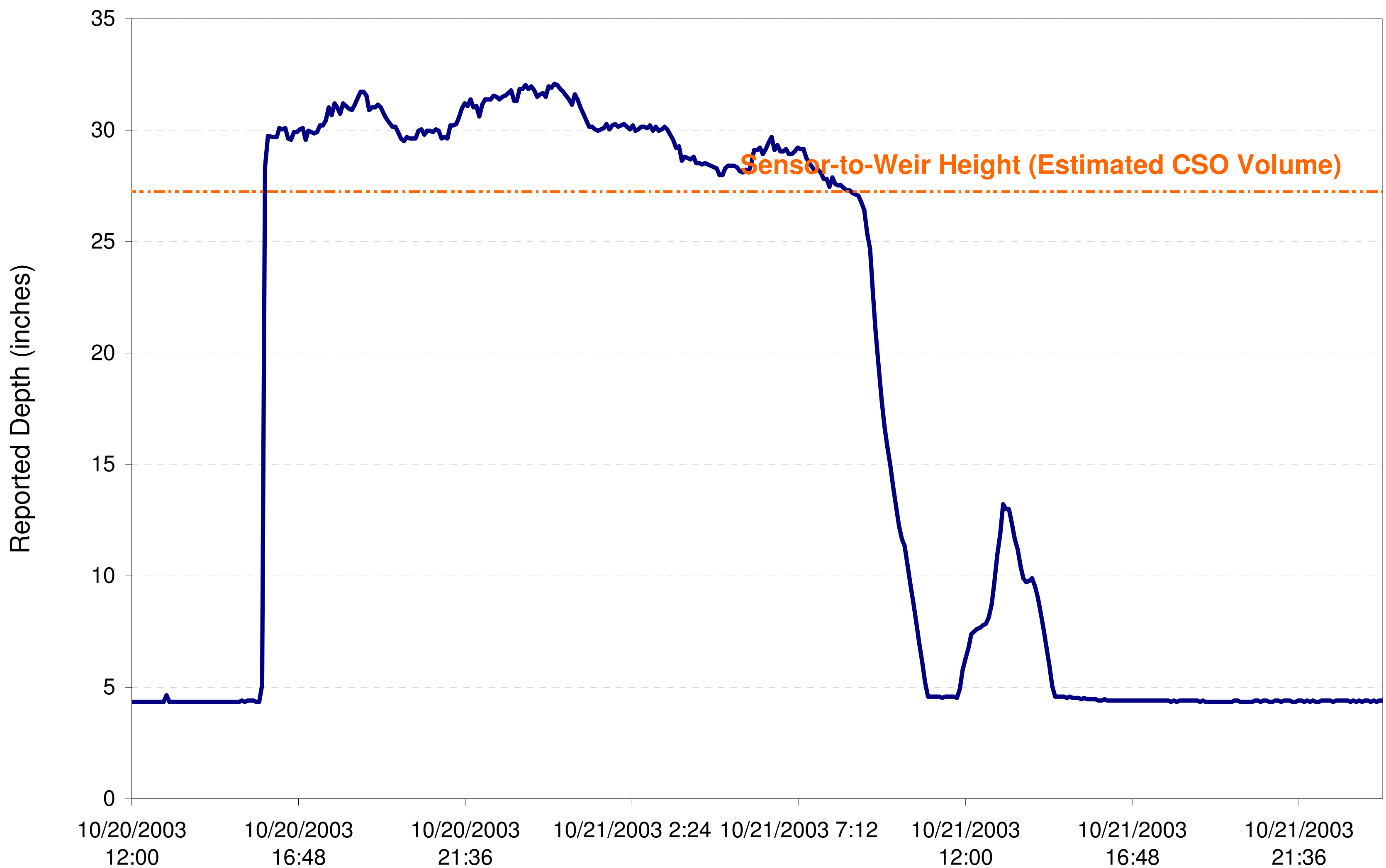
Weir Measurements: Length 118.00", Width 6.25", Height: Left 26.75", Center 27.75", Right 27.25"

Appendix I.5 – CSO Basin 47B

Sample of Depth versus Time Plots for Reported CSO Events

NPDES 47B

Overflow - October 20, 2003



Appendix J – CSO Basin 171

Appendix J.1 – CSO Basin 171

Summary of Assumptions

NPDES Basin 171 - Matching Recorded Volumes

MH081-231

Duration of Geotivity Metering: February 22, 2002 - December 30, 2006

Geotivity Site Investigation Form (2/22/2002)	Weir height = 84 inches Weir length = 118 inches Weir width = 6 inches
ADS Site Report (1/12/2007)	Weir length = 119 inches Weir width = Not provided Weir height = 89 inches (left), 85.25 inches (center); 81 inches (right) Manhole depth = 12'-7"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
1	1/9/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	98,402,850
2	1/28/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	60,899,156
3	1/5/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	38,524,955
4	12/23/2005		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	29,566,420

NPDES Basin 171 - Matching Recorded Volumes

MH081-231

Duration of Geotivity Metering: February 22, 2002 - December 30, 2006

Geotivity	Weir height = 84 inches
Site Investigation Form	Weir length = 118 inches
(2/22/2002)	Weir width = 6 inches

ADS	Weir length = 119 inches
Site Report (1/12/2007)	Weir width = Not provided
	Weir height = 89 inches (left), 85.25 inches (center); 81 inches (right)
	Manhole depth = 12'-7"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
5	1/16/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	16,526,548
6	1/17/2005		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	23,670,423
7	12/30/2005		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	4,098,165
8	12/9/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	4,318,780

NPDES Basin 171 - Matching Recorded Volumes

MH081-231

Duration of Geotivity Metering: February 22, 2002 - December 30, 2006

Geotivity Site Investigation Form (2/22/2002)	Weir height = 84 inches Weir length = 118 inches Weir width = 6 inches
ADS Site Report (1/12/2007)	Weir length = 119 inches Weir width = Not provided Weir height = 89 inches (left), 85.25 inches (center); 81 inches (right) Manhole depth = 12'-7"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
9	2/4/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	8,928,442
10	12/23/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	14,206,140
11	11/4/2006		Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Flowrate was capped to 16 MGD Based on ADS Measurements on December 3, 2007 Q = flow in cfs L = Weir length (feet) =118 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 81 inches Volume calculations: $Q^*\Delta t$	12,354,261

Following information reviewed in CSO Annual Reports:

Report	Description

Determine weir height:

Height (in)	Source
82	Geotivity Site Investigation Form (2/22/2002)
81	Geotivity Float
81	Photos and Record Drawings
81	ADS Site Report (right height), 1/12/2007

Determine weir length:

Length (in)	Source
118	Geotivity Site Investigation Form (2/22/2002)
119	ADS Site Report (1/12/2007)

Determine flow rate estimate:

Assumption	Reasoning
broad-crested weir	Reported as 6-inch weir width in Geotivity Site Investigation Form.

Conclusion based on available information:

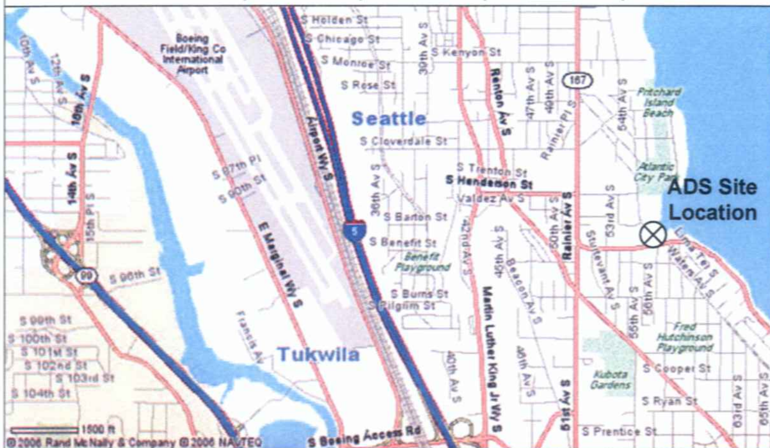
Weir height is 81 from available documentation. In HDR estimations, will assume broad-crested weir.

ADS ENVIRONMENTAL SERVICES®

ADS Site Report

Quality Form

Project Name: Seattle - CSO	**City / State:** Seattle, WA		**FM Initials:** SS
Site Name: NPDES 171/SEA_081231	**Monitor Series:** 5000 AG-M	**Monitor S/N:**	26168
Address/Location: Rainier Av. S. & Seward Park Av. S.		**Manhole #**	081-231
		Thomas Bros Map Page:	625 G4
		Pipe Height:	24.00 "
Access: Drive	**Type of System:** Sanitary [ ] Storm [ ] Combined [X]	**Pipe Width:**	24.00 "
		IP Address:	166.219.18.244



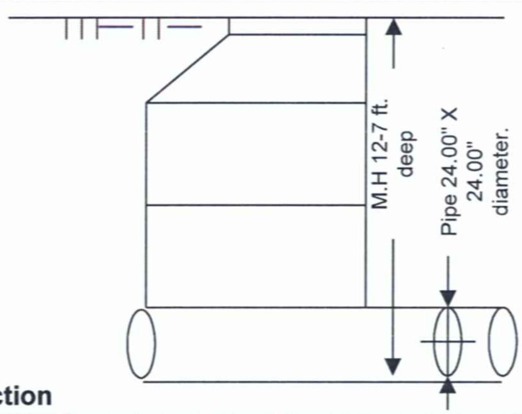
Investigation Information:

Date/Time of Investigation:	1/12/2007 03:36
Site Hydraulics:	Info. pending
Upstream Input: (L/S, P/S)	
Upstream Manhole:	DNI
Downstream Manhole:	DNI
Depth of Flow:	0.25"+/- 0.25"
Range (Air DOF):	+/-
Peak Velocity:	Info. pending fps
Silt:	0.00 Inches

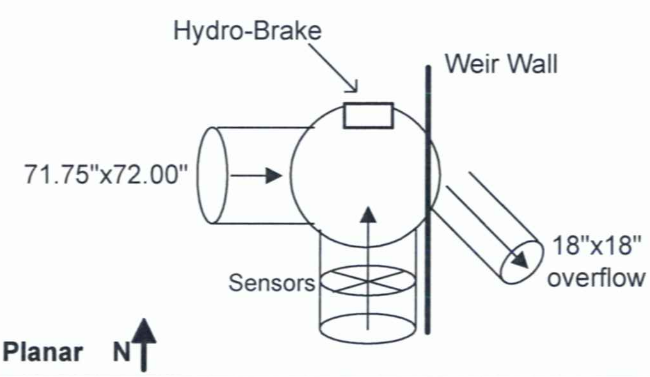
Manhole Information:

Manhole Depth:	12' - 7"
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	Concrete / Good
Mini System Character:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Telephone Information:	
Access Pole #:	
Distance From Manhole:	Feet
Road Cut Length:	Feet
Trench Length:	Feet

Other Information:



Cross Section



Planar

Installation Information	
Installation Type:	Regular
Sensors Devices:	Ultra / Pressure / Velocity
Surcharge Height:	0.00" Feet
Rain Guage Zone:	

Backup	Yes	No	?	Distance
Trunk	[ ]	[ ]	[ ]	
Lift / Pump Station	[ ]	[ ]	[ ]	
WWTP	[ ]	[ ]	[ ]	
Other	[ ]	[ ]	[ ]	

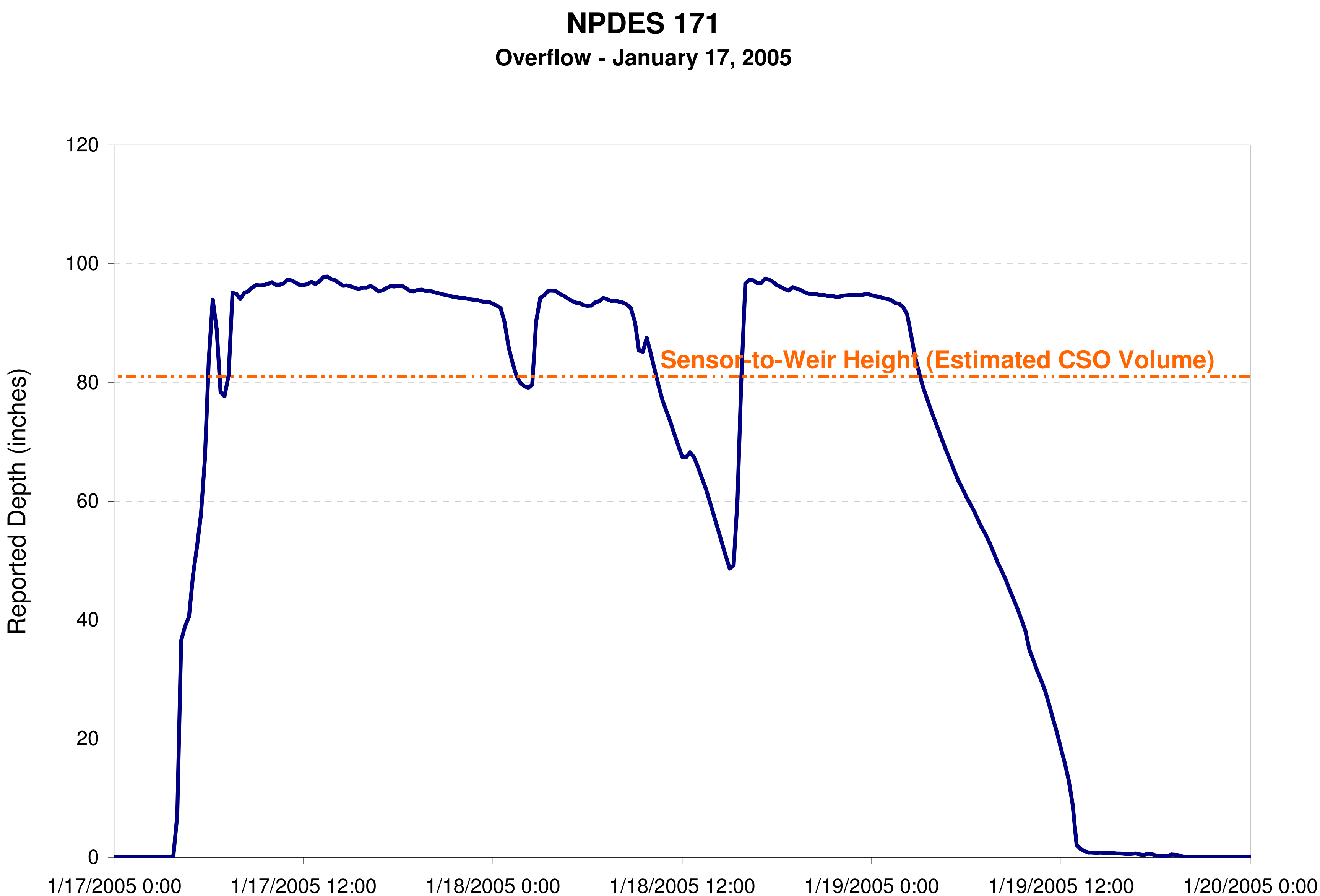
Additional Site Information / Comments:

Weir Measurements: Length 119.00", Width 6.25". Height: Left 89.00", Center 85,25", Right 81.00".

Night install

Appendix J.2 – CSO Basin 171

Sample of Depth versus Time Plots for Reported CSO Events


NPDES 171
Overflow - January 17, 2005
Sensor-to-Weir Height (Estimated CSO Volume)
Reported Depth (inches)
0
20
40
60
80
100
120
1/17/2005 0:00
1/17/2005 12:00
1/18/2005 0:00
1/18/2005 12:00
1/19/2005 0:00
1/19/2005 12:00
1/20/2005 0:00

Appendix K – CSO Basin 49

Appendix K.1 – CSO Basin 49

Summary of Assumptions

NPDES Basin 49 - Matching Recorded Volumes

MH306-437

Duration of Geotivity Metering: December 18, 2001 - December 30, 2006

Geotivity Site Investigation Form (12/18/2001)	Weir height = 68.5 inches Weir length = 326 inches Weir width = 0 inches
ADS Site Report (12/12/2006)	Weir length = 153 inches Weir width = Not provided Weir height = 69.25 inches (left), 69.25 inches (center); 68.38 inches (right) Manhole depth = 13'-0"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
1	1/17/2005	The site investigation form was the only reference to provide meaningful information.	Flow calculations: Q = 2.62L$H^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) =326 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 68.5 inches Volume calculations: Q*Δt	8,697,835
2	11/6/2006	The site investigation form was the only reference to provide meaningful information.	Flow calculations: Q = 2.62L$H^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) =326 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 68.5 inches Volume calculations: Q*Δt	5,018,162
3	11/14/2001	Data unavailable for this reported CSO event.		
4	12/26/2006	The site investigation form was the only reference to provide meaningful information.	Flow calculations: Q = 2.62L$H^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) =326 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 68.5 inches Volume calculations: Q*Δt	3,754,978
5	12/16/2001	Data unavailable for this reported CSO event.		

NPDES Basin 49 - Matching Recorded Volumes

MH306-437

Duration of Geotivity Metering: December 18, 2001 - December 30, 2006

Geotivity
Site Investigation Form
(12/18/2001)

Weir height = 68.5 inches
Weir length = 326 inches
Weir width = 0 inches

ADS
Site Report (12/12/2006)

Weir length = 153 inches
Weir width = Not provided
Weir height = 69.25 inches (left), 69.25 inches (center); 68.38 inches (right)
Manhole depth = 13'-0"

Rank	Reported Overflow Date	Comments	HDR Overflow Estimate Assumptions	Estimated Volume (gal)
6	11/18/2003	The site investigation form was the only reference to provide meaningful information.	Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) =326 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 68.5 inches Volume calculations: $Q^*\Delta t$	2,734,158
7	10/20/2003	The site investigation form was the only reference to provide meaningful information.	Flow calculations: $Q = 2.62LH^{3/2}$ (broad-crested weir) Q = flow in cfs L = Weir length (feet) =326 inches H = Depth of water over crest of weir (feet) P = Height of Weir = 68.5 inches Volume calculations: $Q^*\Delta t$	2,471,087
8	12/13/2001	Data unavailable for this reported CSO event.		
9	11/12/2006	Data unavailable for this reported CSO event.	The difference between the Reported CSO Volume and Estimated CSO volume is 78%.	1,192,066
10	11/22/2001	Data unavailable for this reported CSO event.		

Following information reviewed in CSO Annual Reports:

Report	Description

Determine weir height:

Height (in)	Source
68.5	Geotivity Site Investigation Form (12/18/2001)
69.25	ADS Site Report (center height), 12/12/2006

Determine weir length:

Length (in)	Source
326	Geotivity Site Investigation Form (12/18/2001)
153	ADS Site Report (12/12/2006)

Determine flow rate estimate:

Assumption	Reasoning
broad-crested weir	From Photos

Conclusion based on available information:

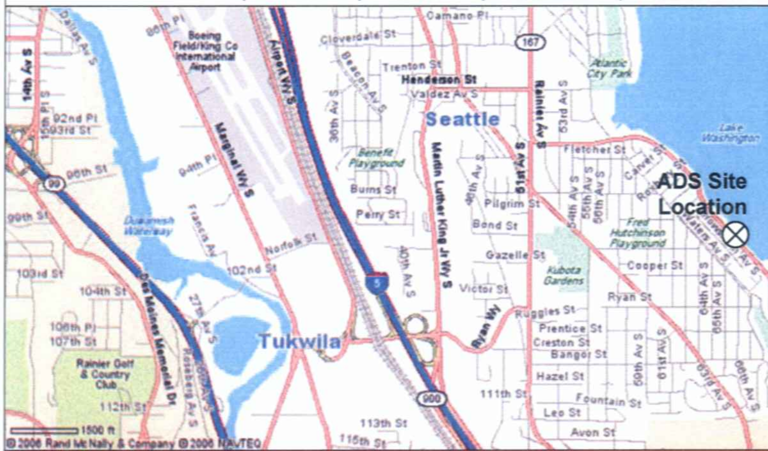
Weir height is 68.5 from available documentation. In HDR estimations, will assume broad-crested weir.

ADS ENVIRONMENTAL SERVICES®

ADS Site Report

Quality Form

Project Name: Seattle - CSO	**City / State:** Seattle, WA		**FM Initials:** SS
Site Name: NPDES 49/SEA_306437	**Monitor Series:** 5000 BG	**Monitor S/N:**	19027
Address/Location: 9860 Rainier Av. S. (on bike path)		**Manhole #**	306-437
		Thomas Bros Map Page:	625 H4/5
		Pipe Height:	72.00"
Access: Drive	**Type of System:** Sanitary [ ] Storm [ ] Combined [X]	**Pipe Width:**	71.63"
		IP Address:	166.219.19.55



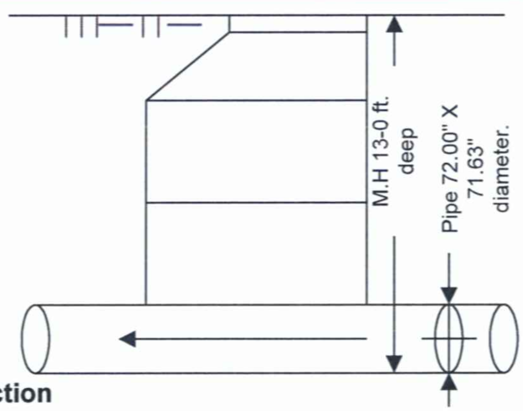
Investigation Information:

Date/Time of Investigation:	12/19/2006 14:30
Site Hydraulics:	No flow
Upstream Input: (L/S, P/S)	
Upstream Manhole:	DNI
Downstream Manhole:	DNI
Depth of Flow:	+/-
Range (Air DOF):	+/-
Peak Velocity:	fps
Silt:	0.00 Inches

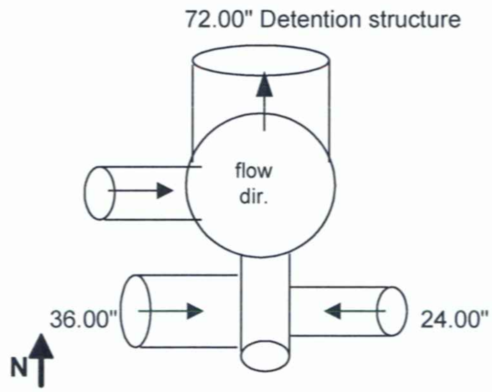
Manhole Information:

Manhole Depth:	13' - 0"
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	Concrete / Good
Mini System Character:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Telephone Information:	
Access Pole #:	
Distance From Manhole:	Feet
Road Cut Length:	Feet
Trench Length:	Feet

Other Information:



Cross Section



Planar

Installation Information	
Installation Type:	Regular
Sensors Devices:	Ultra / Pressure / Velocity
Surcharge Height:	0.00" Feet
Rain Guage Zone:	

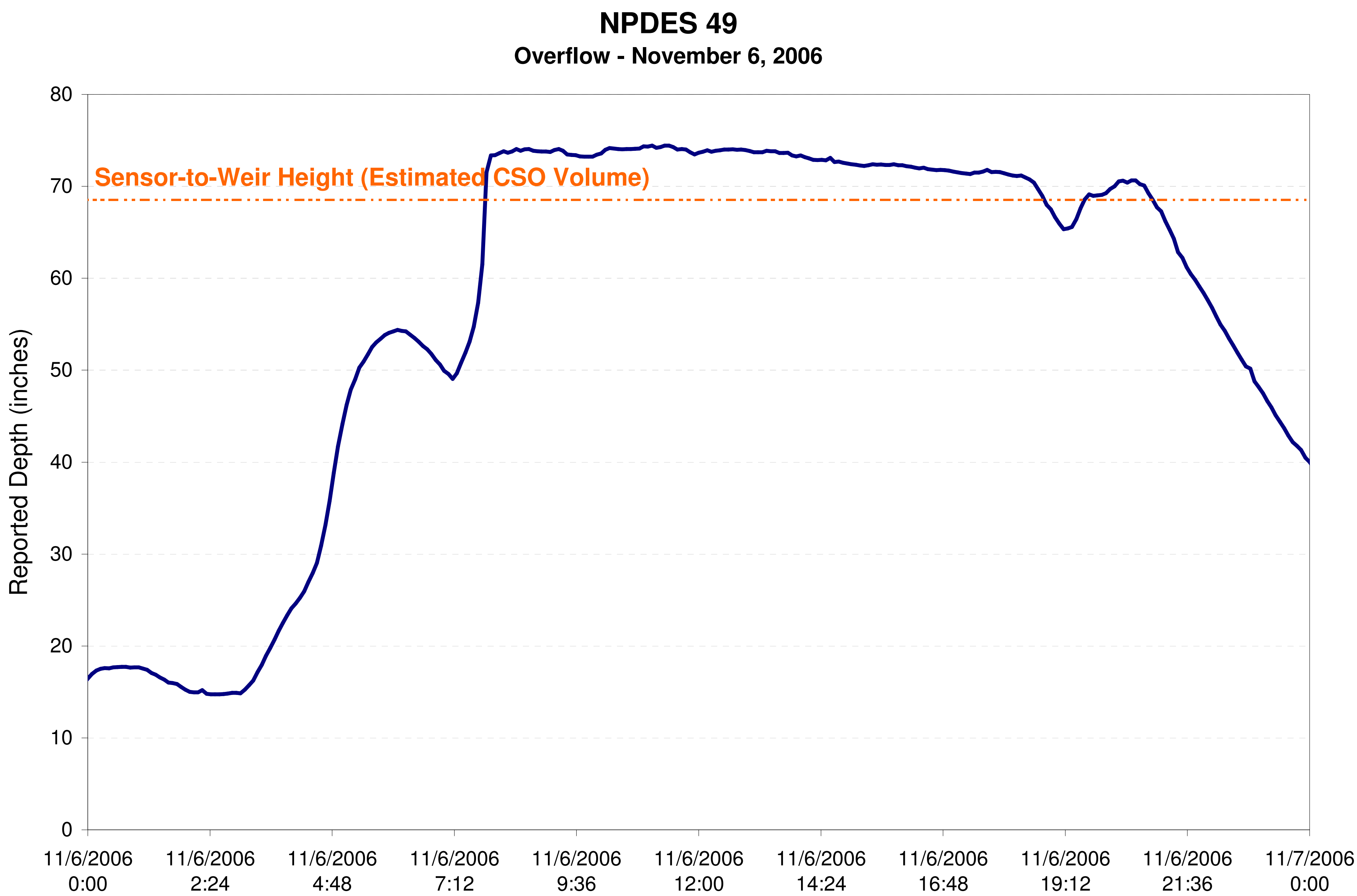
Backup	Yes	No	?	Distance
Trunk	[ ]	[ ]	[ ]	
Lift / Pump Station	[ ]	[ ]	[ ]	
WWTP	[ ]	[ ]	[ ]	
Other	[ ]	[ ]	[ ]	

Additional Site Information / Comments:

Weir Measurements: Length 153.00", Width 8.00". Height: Left 69.25", Center 69.25", Right 68.38"

Appendix K.2 – CSO Basin 49

Sample of Depth versus Time Plots for Reported CSO Events



NPDES 49
Overflow - November 6, 2006
Reported Depth (inches)
Sensor-to-Weir Height (Estimated CSO Volume)
80
70
60
50
40
30
20
10
0
11/6/2006 0:00
11/6/2006 2:24
11/6/2006 4:48
11/6/2006 7:12
11/6/2006 9:36
11/6/2006 12:00
11/6/2006 14:24
11/6/2006 16:48
11/6/2006 19:12
11/6/2006 21:36
11/7/2006 0:00