DRAFT

Kitsap County Public Works

Suquamish Wastewater Collection Facilities I&I Analysis

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RH2 Engineering, Inc.
22722 29th Drive SE, Suite 210
Bothell, WA 98021

Kitsap County Public Works

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The information contained in this report was prepared by and under the direct supervision of the undersigned.

Richard H. Harbert, P.E.
President

John D. Hendron, P.E.
Project Manager

Ryan Withers, P.E.
Project Engineer

Kitsap County Public Works
Suquamish Wastewater Facilities I&I Analysis

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Kitsap County Public Works
Suquamish Wastewater Facilities I&I Analyses

EXECUTIVE SUMMARY

This analysis evaluates the sources of infiltration and inflow (I&I) throughout Kitsap County Public Works (County) Suquamish wastewater collection system. This analysis is based on review of in-stream flow monitoring and flow isolation data, and review of video and visual inspections of the sewer mains and manholes. The analysis evaluates the I&I contribution to the collection system of four basins:

- Prospect and Division Basin;
- Park and Center Basin;
- Harris and Angeline Basin; and
- Beach Basin.

Video inspection of the collection system's sewer mains was performed in spring 2011 by County personnel, and video inspection of 30 side sewers (between the sewer main and each house) was performed by Pipe Experts, LLC, (Pipe Experts) in January and February 2012.

In-stream flow monitoring was performed at five locations by the County in November and December 2009. Additional in-stream flow monitoring was performed between September 2011 and March 2012 at seven manholes throughout the Suquamish wastewater collection system. Two of the locations were monitored by County meters, and the other five locations were monitored by ADS Environmental Services (ADS). A temporary tipping-bucket rain gauge was installed at Suquamish Elementary School to record rainfall intensity in Suquamish concurrently with in-stream flow monitoring.

Flow isolations were performed by ADS during nighttime hours to measure low-flow areas. The influents of 22 manholes were isolated during three nights of monitoring.

Data loggers were installed on the County's two lift stations and at the Suquamish Wastewater treatment plant to record the influent flows at each facility. An evaluation of the flows from the Suquamish Casino wastewater pump station and the flows through the Beach Basin compared with the Puget Sound tide elevation was also performed.

Proposed improvements were identified to eliminate significant I&I contributions for each basin, and the improvements were prioritized to most efficiently correct the most deficiencies. The implementation schedule and the cost of the proposed improvements is shown in **Table ES-1**.

Table ES-1. Proposed Improvements Implementation Schedule

Phase	Basin	Description	Estimated Cost (2012 $)	Planned Year of Project and Estimated Cost in 2012 $						
				2012	2013	2014	2015	2016	2017	2030+
1	Prospect & Division	Predesign and design engineering; permitting	$222,500	$222,500						
	Prospect & Division	Construction and remaining engineering	$2,000,500		$2,000,500					
2	Park & Center	Predesign and design engineering; permitting	$150,000		$150,000					
	Park & Center	Construction and remaining engineering	$1,347,000			$1,347,000				
3	Harris & Angeline	Design and Construction	$305,000				$305,000			
4 - Alt 1	Beach	Design and Construction	$1,729,000							$1,729,000
4 - Alt 2	Beach	Predesign and design engineering; permitting	$90,500					$90,500		
	Beach	Construction and remaining engineering	$542,500						$542,500	
Total Estimated Costs of Improvements (Including Beach Alternative 1)			**$5,754,000**	**$222,500**	**$2,150,500**	**$1,347,000**	**$305,000**	**$0**	**$0**	**$1,729,000**
Total Estimated Costs of Improvements (Including Beach Alternative 2)			**$4,658,000**	**$222,500**	**$2,150,500**	**$1,347,000**	**$305,000**	**$90,500**	**$542,500**	**$0**

The anticipated I&I reduction for each basin and the estimated cost per gallon of I&I removed from the collection system is shown in **Table ES-2**. The Prospect and Division Basin has the largest I&I contribution to the collection system, and can be reduced with the lowest estimated cost per gallon per minute of I&I removed from the basin. The other basins have a smaller I&I contribution and a higher estimated cost per gallon per minute of I&I removed from each basin. Therefore, replacement and rehabilitation of the collection system infrastructure in these basins is recommended to take place following improvements to the Park and Center Basin.

Table ES-2. Estimated Cost of I&I Reduction by Basin

Basin	I&I Observed During Storm Events (gpm)	I&I to be Elimiated with Proposed Improvements (gpm)	Estimated Total Project Cost of Improvements	Estimated Cost per gpm of I&I Removed from Basin
Prospect & Division	340	255	$2,223,000	$8,718
Park & Center	75	56	$1,497,000	$26,613
Harris & Angeline	25	19	$305,000	$16,267
Beach (Alternative 1)	5	4	$1,729,000	$461,067
Beach (Alternative 2)			$633,000	$168,800

INTRODUCTION

The objective of this report is to document the sources of infiltration and inflow (I&I) throughout the Kitsap County Public Works (County) Suquamish wastewater collection system. The analysis includes review of in-stream flow monitoring and flow isolation data, and review of video and visual inspections of the sewer mains and manholes. A prioritized construction approach to replace or upgrade the components of the collection system is included as part of this report.

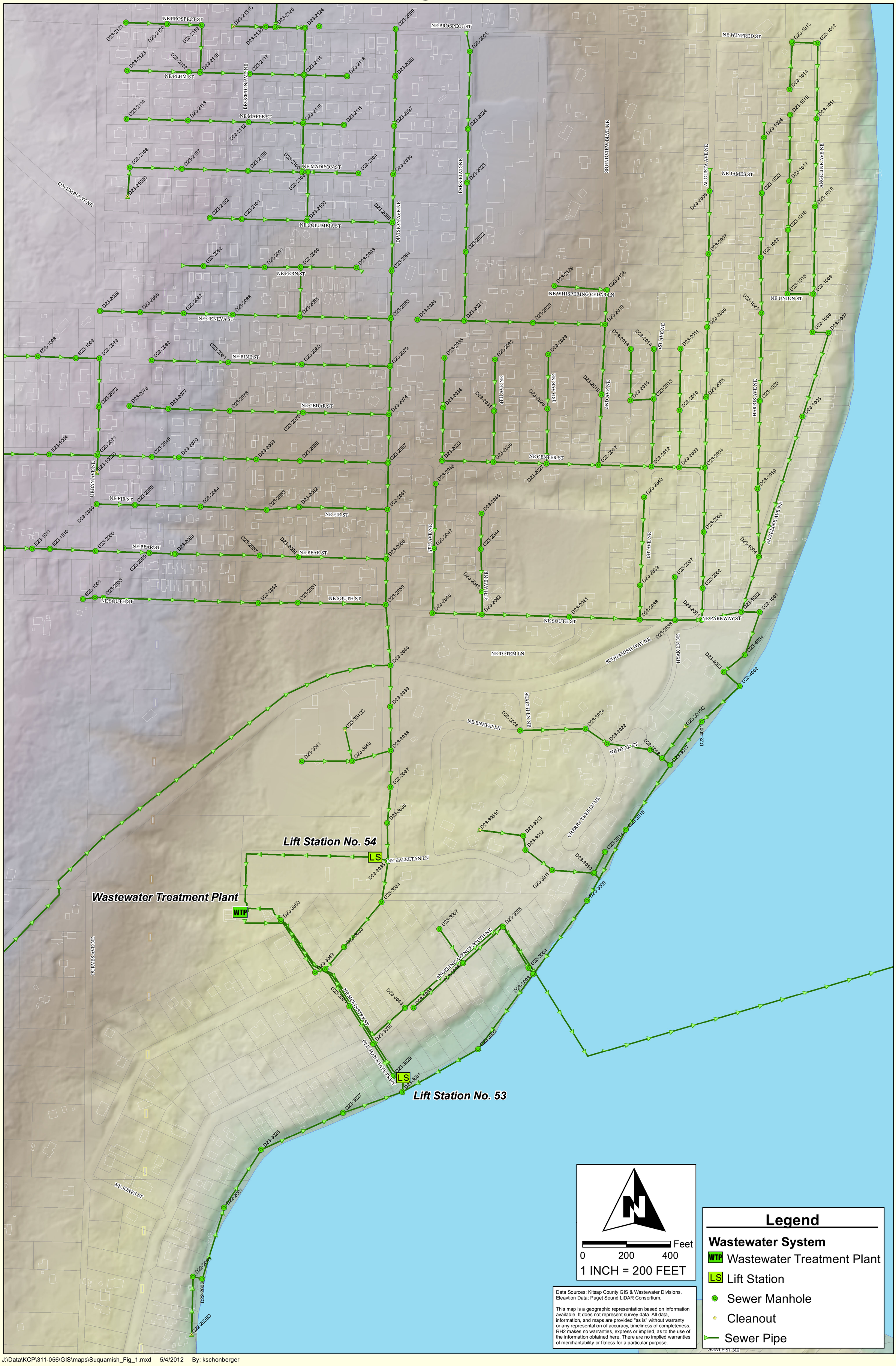
Background

The County's wastewater collection system serving the Suquamish area experiences excessive I&I, which limits the hydraulic capacity of the Suquamish wastewater treatment plant. The County performed diagnostic work to determine the magnitude of the problem and the sources of the I&I, including in-stream flow monitoring, smoke testing and video inspection of the mains. The County authorized RH2 Engineering, Inc., (RH2) in July 2011 to refine the I&I analysis started by the County to more accurately locate the sources of I&I, evaluate alternative solutions and recommend repairs or replacements. The Suquamish wastewater collection system is shown in **Figure 1**.

Kitsap County Public Works Wastewater Division

Suquamish Collection System

Figure 1



Data Sources: Kitsap County GIS & Wastewater Divisions.
Eleavtion Data: Puget Sound LiDAR Consortium.

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Purpose

The purpose of this study is to refine I&I analyses performed by the County and to recommend repair to or replacement of parts of the existing Suquamish wastewater collection system to increase the hydraulic capacity of the Suquamish. As part of this analysis, previous work performed by the County was evaluated, and additional in-stream flow monitoring, flow isolations, side sewer inspections, and a tide analysis were performed. The results of these evaluations will be utilized by the County to determine ways to decrease the volume of I&I throughout the Suquamish wastewater collection system.

Description of Analyses

Video Inspection

Video inspections throughout areas suspected to have high I&I in the Suquamish wastewater collection system were performed in the spring of 2011. Pipeline video inspection hardcopy data recorded during these inspections are shown in **Figure 2** for the following areas:

- Suquamish northwest quadrant, approximately bound by NE Prospect Street to the north, Division Avenue NE to the east, NE Columbia Street to the south, and Brockton Avenue NE to the west;
- Harris Avenue NE and Angeline Avenue NE, which includes sewer main located within easements between the two streets; and
- Suquamish beach, including all sewer main located along the beach south of the dock and boat launch at the intersection of Augusta Avenue NE Suquamish Way NE.

The pipeline inspection videos were also reviewed to determine existing main conditions and characteristics such as type of taps, leaks, cracks, root intrusions, joint separations, corrosion, mineral deposits, and bellies. In addition to the sewer main video inspections performed by County personnel, video inspections of 30 side sewers (between the sewer main and each house) were performed by Pipe Experts in January and February of 2012. These 30 side sewers were randomly distributed among all three of the focus areas listed above.

In-stream Flow Monitoring

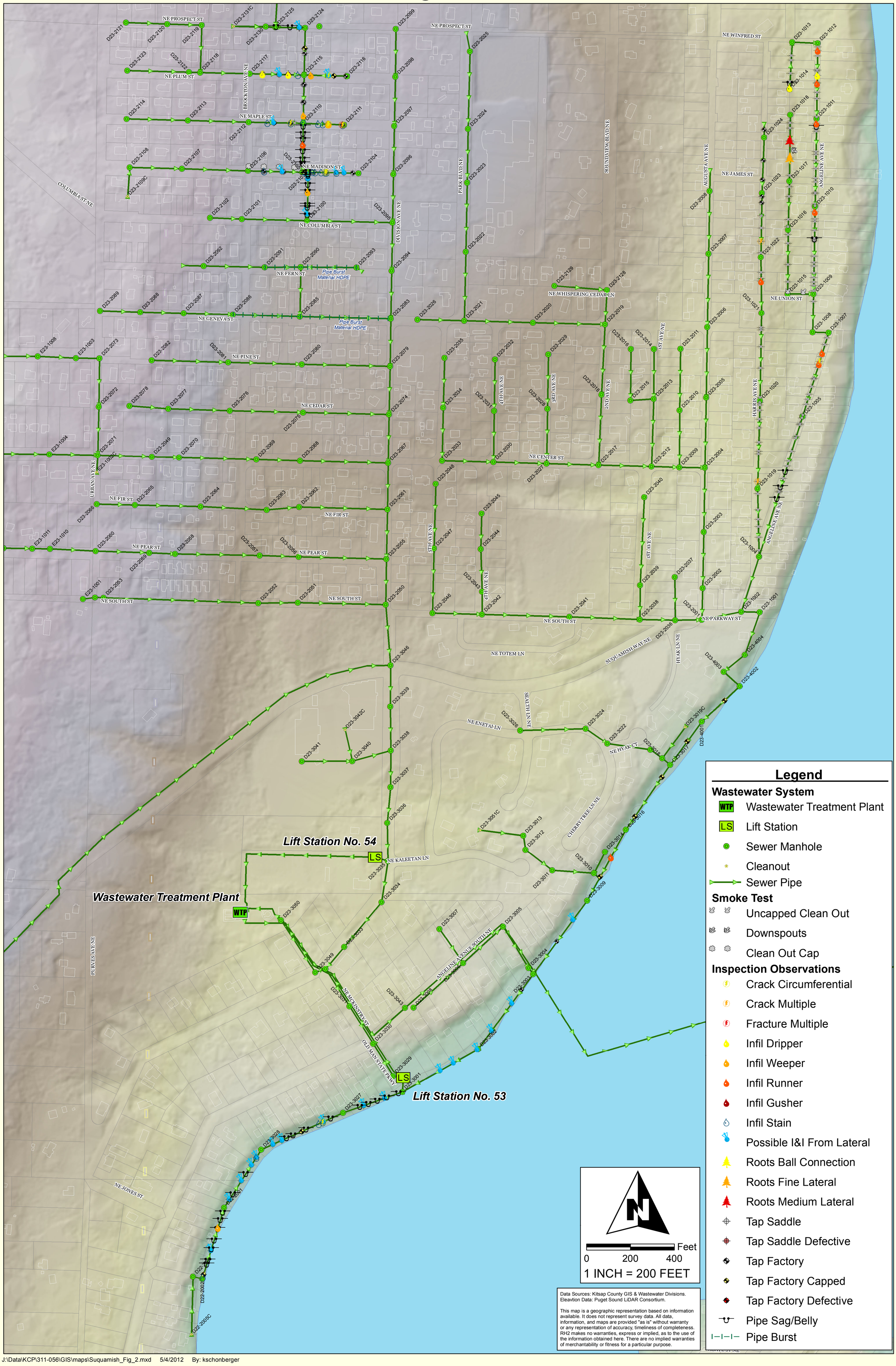
The County performed in-stream flow monitoring at five locations in November and December of 2009. Additional in-stream flow monitoring was performed between September 2011 and March 2012 at seven manholes throughout the Suquamish wastewater collection system, as shown in **Figure 3**. Two of the locations were monitored by County meters, and the other five locations were monitored by ADS. Data was downloaded and reviewed throughout the monitoring period and the locations of the ADS flow monitoring locations were adjusted accordingly; therefore, flow monitoring data does not exist for the duration of the monitoring period for all meters. ADS installed a temporary tipping-bucket rain gauge at Suquamish Elementary School to record rainfall in Suquamish concurrently with in-stream flow monitoring. Detailed results from the ADS analyses are presented in the Suquamish Sanitary Sewer Flow Monitoring & Flow Isolation Report, included as **Appendix A** of this report.

In addition to the in-stream flow monitors, monitoring also took place at the Suquamish wastewater treatment plant and lift stations 53 and 54. The wastewater treatment plant's influent flow monitor was equipped with a data logger to record the influent flow rate at 3-minute intervals. HOBO data

Kitsap County Public Works Wastewater Division

Suquamish System Defect Video Inspections

Figure 2



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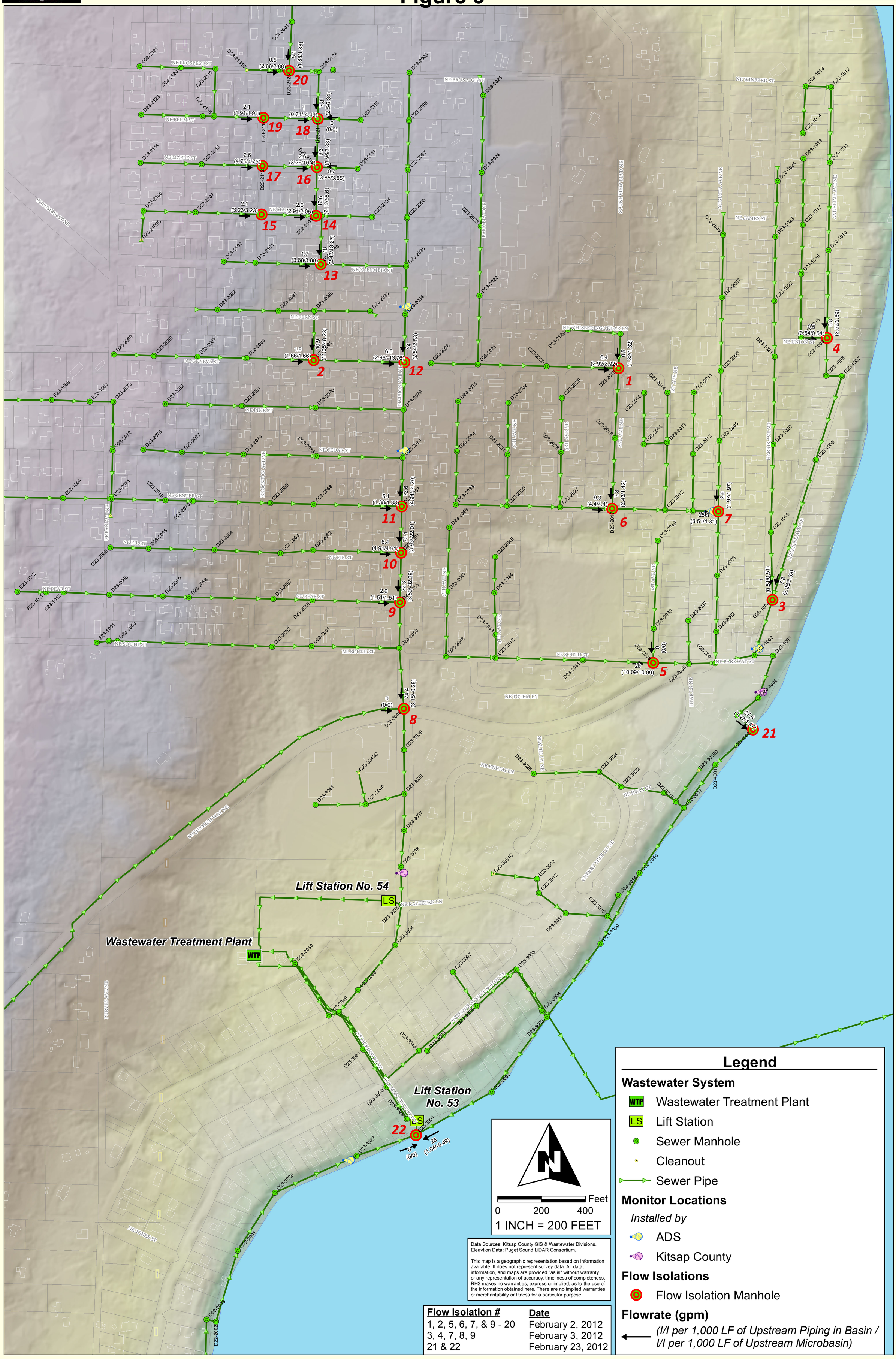
Kitsap County Public Works Wastewater Division

Suquamish Instream Flow Monitoring and Flow Isolation Locations

Figure 3



Legend

Wastewater System

- WTP — Wastewater Treatment Plant
- LS — Lift Station
- Sewer Manhole
- Cleanout
- Sewer Pipe

Monitor Locations

Installed by

- ADS
- Kitsap County

Flow Isolations

- Flow Isolation Manhole

Flowrate (gpm)

- *(I/I per 1,000 LF of Upstream Piping in Basin / I/I per 1,000 LF of Upstream Microbasin)*

Feet
0 200 400
1 INCH = 200 FEET

Data Sources: Kitsap County GIS & Wastewater Divisions.
Eleavtion Data: Puget Sound LiDAR Consortium.

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Flow Isolation #	Date
1, 2, 5, 6, 7, & 9 - 20	February 2, 2012
3, 4, 7, 8, 9	February 3, 2012
21 & 22	February 23, 2012

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loggers were installed at lift stations 53 and 54 to record the date and time each pump was turned on and off throughout the monitoring period.

Flow Isolations

Flow isolations were performed by ADS during nighttime hours to measure low-flow areas. Flow isolation analysis involves entering a manhole and measuring the instantaneous flowrate using a portable weir that fastens to the manholes influent main(s). The influents of 22 manholes were isolated during three nights of monitoring. By monitoring these locations between midnight and 6:00 AM, it is expected that the flows measured are predominately a result of I&I, as the land use throughout the Suquamish area is nearly all residential and should not be contributing substantial flows to the collection system during these times. The results of these isolations are shown graphically in **Figure 3**, and in tabular form in Appendix B of the ADS report, which is attached as **Appendix A.**

ANALYSES AND RESULTS

Video Inspection

The video inspections indicate that the Suquamish northwest quadrant has the highest number of defects per lineal foot (LF) of sewer main. These defects include approximately nine instances of cracks or main fractures, eight instances of visible infiltration occurring at varying rates, and more than a dozen instances of visible stains on the interior of the piping due to I&I, as shown in **Figure 2**.

The sewer main in Harris Avenue NE and Angeline Avenue NE has substantially fewer defects per lineal foot of sewer main than the northwest quadrant. The defects in Harris and Angeline avenues include three cracks or main fractures, nine instances of visible infiltration occurring at varying rates, and two locations with tree roots protruding through side sewers, as shown in **Figure 2**.

The Suquamish beach has the fewest defects, which include one circumferential crack in the sewer main, and two instances of visible infiltration occurring at varying rates. Although the sewer main has few defects, 16 side sewers were observed for possible contribution of I&I to the collection system, as shown in **Figure 2**. However, the volume of the I&I contribution appears to be insignificant; this will discussed later in this report.

The Pipe Experts video inspection of 30 side sewers indicates that 29 of the side sewers consist of 6-inch-diameter concrete pipe from the sewer main to the property line. At the property line, side-sewers almost universally transitioned to 4-inch diameter PVC pipe that appeared to be in good condition upon inspection. Based on the results of these inspections, replacement or rehabilitation of the laterals (the portion from the main to the right-of-way) is recommended, but the PVC side sewers on private property should not require replacement or rehabilitation. The WINCAN reports for each of these video inspections are included in **Appendix B**.

In-stream Flow Monitoring

In-stream flow monitoring was performed at seven manholes throughout the Suquamish wastewater collection system between September 14, 2011, and March 16, 2012. Data measured during this period was recorded at 5-minute intervals and was downloaded by the County and ADS on a monthly basis. Dry weather throughout September and October 2011 provided a baseline domestic

flow pattern for four of the seven monitoring locations. Two major storm events occurred during the monitoring period that illustrate the I&I contribution in each basin. The first event occurred on November 22, 2011, and November 23, 2011, when more than 5 inches of rainfall was recorded by the rain gauge at Suquamish Elementary School. The second event occurred between January 18 and 22, 2012, during which heavy snowfall was observed, followed by more than 2 inches of rainfall, resulting in a combination of snowmelt runoff and rainfall occurring throughout the collection system. Charts showing the full record of flows between September 2011 through March 2012 from the flow monitoring for each basin is included in **Appendix C**.

The following is a discussion of observations made in the various basins monitored.

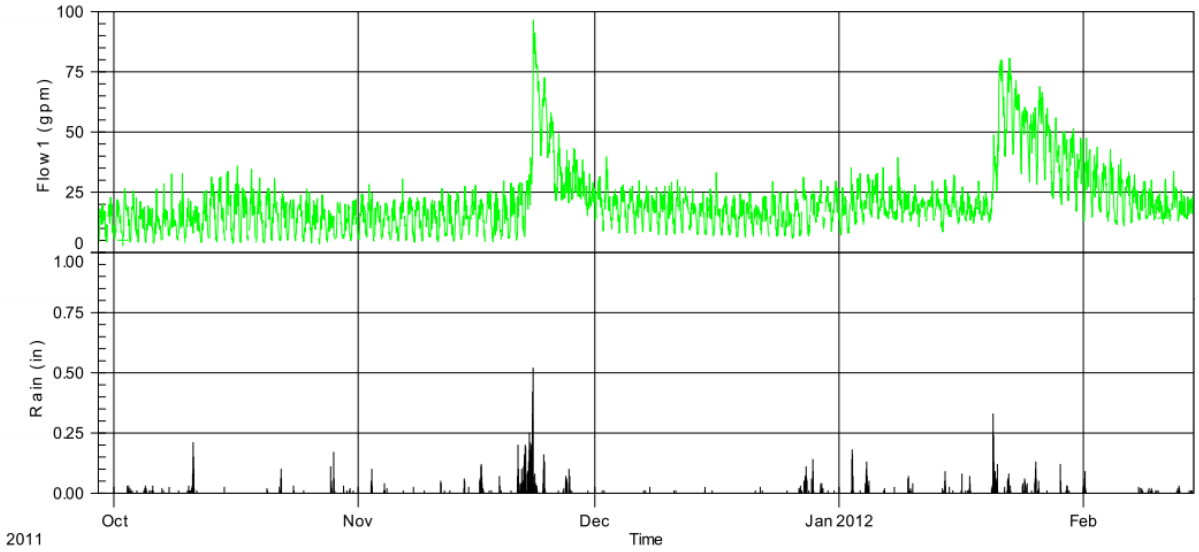
Park and Center Basin (MH D23-2004)

ADS installed an in-stream flow monitor in the western inlet of manhole D23-2004, at the intersection of Augusta Avenue NE and NE Center Street, on September 22, 2011 and monitored the flow through February 14, 2012. The basin upstream of this flow monitor is approximately bound to the east by Augusta Avenue NE, to the south by NE Center Street, to the west by 5th Avenue NE and Park Boulevard NE, and to the north by NE Prospect Street.

During dry weather, the nighttime minimum flow was approximately 5 gpm and the daytime maximum flow was approximately 25 gpm, as shown in **Chart 1**. During the November storm event, the flow in this basin increased to approximately 100 gpm at night, when the domestic contribution to the system was minimal. These increased flows were measured for 3 days before returning to baseline levels. Baseline flows continued to be measured throughout much of December 2011, during which minimal rainfall was measured. During the January storm event, flow in the basin increased to approximately 80 gpm, including a nighttime maximum of approximately 40 gpm, and remained at elevated levels for approximately 3 weeks. The time required for flows to return to baseline levels following rain events is indicative of infiltration occurring throughout this basin. The rapid response to storm events is indicative of inflow also occurring within this basin.

During the peak flow measured in the basin, which took place during the November storm event, the I&I measured in the basin was approximately 75 gpm when compared to daytime baseline flows. Based on the total length of sewer main in the basin (approximately 7,220 LF), the peak I&I in the basin is 10.4 gpm per 1,000 LF, and the peak I&I per acre served in the basin (approximately 29.0 acres) is 2.6 gpm per acre. These peak I&I rates reported above (and hereafter in the individual basin discussions) are for peak, 20-minute average flows.

Chart 1. Park and Center Basin (MH D23-2004) Flowrates



It should be noted that the Park and Center Basin was not considered a problem area at the beginning of this study. This basin was chosen for monitoring to verify that it was not a basin contributing I&I. Results show otherwise and we recommend video inspection and flow-isolation analyses to more accurately locate the sources of I&I in this area.

Prospect and Division Basin (MH D23-2074)

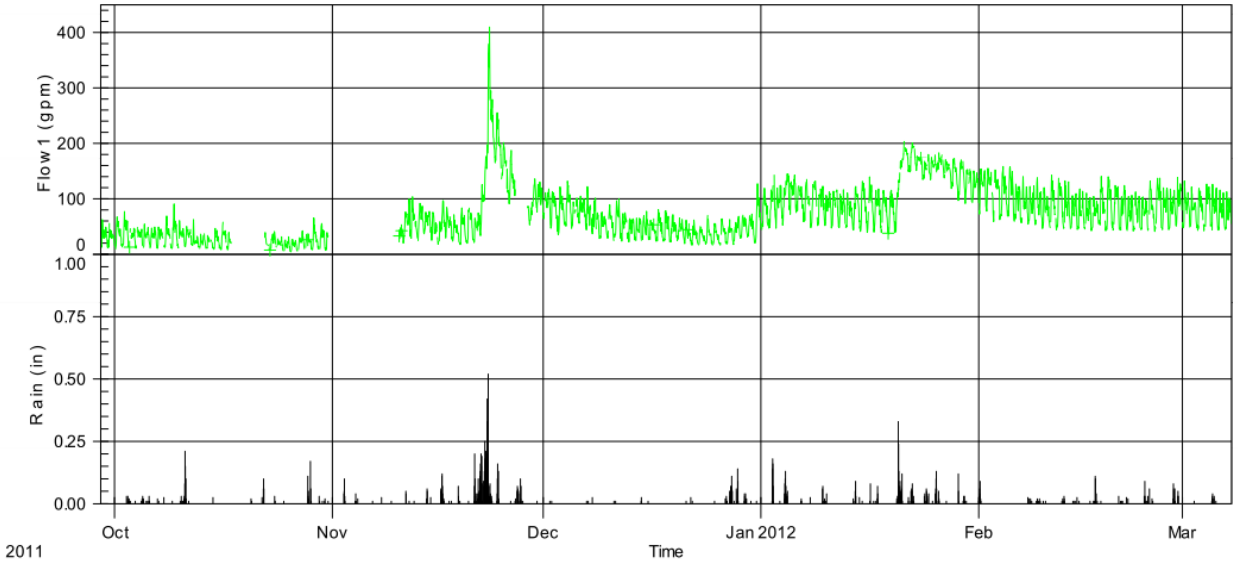
ADS installed an in-stream flow monitor in the northern inlet of manhole D23-2074, at the intersection of Division Avenue NE and NE Cedar Street, on September 28, 2011 and monitored the flow through March 7, 2012. The basin upstream of this flow monitor is approximately bound to the east by Division Avenue NE, to the south by NE Cedar Street, to the west by Urban Avenue NE, and to the north by NE Prospect Street.

During the dry weather, the nighttime minimum flow was approximately 5 gpm and the daytime maximum flow was approximately 60 gpm, as shown in **Chart 2**. During the November storm event, the flow in this basin increased to approximately 400 gpm. The data in **Chart 2** has been smoothed. At times, peaks up to 470 gpm occurred and were sustained for about 20 minutes. Increased flows were measured for 3 days before returning to baseline (dry weather) levels. Baseline flows continued to be measured throughout much of December 2011, during which minimal rainfall was measured. During the January storm event, flow in the basin increased to approximately 200 gpm and remained at elevated levels for approximately 2 weeks before returning to wet season baseline levels, which are approximately 50 gpm greater than the dry season baseline levels. The time required for flows to return to baseline levels following rain events is indicative of infiltration occurring throughout this basin. The rapid response to storm events is indicative of inflow also occurring within this basin. Both extraneous flow components exist in substantial quantities.

During the peak flow measured in the basin, which took place during the November storm event, the I&I measured in the basin was approximately 340 gpm when compared to daytime baseline flows. Based on the total length of sewer main in the basin (approximately 13,600 LF), the peak I&I

in the basin is 25.0 gpm per 1,000 LF, and the peak I&I per acre served in the basin (approximately 61.8 acres) is 5.5 gpm per acre.

Chart 2. Prospect and Division Basin (MH D23-2074) Flowrates



Northeast Basin (MH D23-4004)

The County installed an in-stream flow monitor in the northwestern inlet of manhole D23-4004, south of the dock and boat launch near the intersection of Augusta Avenue NE and Suquamish Way, on September 14, 2011, and monitored the flow through March 16, 2012. The basin upstream of this flow monitor is approximately bound to the west by Division Avenue NE and to the south by NE South Street.

During dry weather, the nighttime minimum flow was approximately 10 gallons per minute (gpm) and the daytime maximum flow was approximately 45 gpm, as shown in **Appendix C**. During the November storm event, the flow in this basin increased to approximately 800 gpm. Increased flows were measured for three days before returning to baseline levels. Baseline flows continued to be measured throughout much of December 2011, during which minimal rainfall was measured. During the January storm event, flow in the basin increased to approximately 2,000 gpm and remained at elevated levels for approximately 5 weeks.

Beginning in mid-December 2011 and continuing through the duration of monitoring, the flows measured by this in-stream flow monitor were inconsistent with other in-stream flow monitors and the data loggers at the Suquamish wastewater treatment plant and lift station 53. The flows from manholes D23-2004 and D23-2074 should be approximately equal to the flows measured at manhole D23-4004. However, during the last three months of the monitoring period, the flows measured at manhole D23-4004 were approximately 200 to 400 gpm more than anticipated.

Flow from manhole D23-4004 is conveyed along the beach and enters the lift station 53 wet well, where it is pumped to the Suquamish wastewater treatment plant. During the last 3 months of the monitoring period, the flows measured at manhole D23-4004 were approximately 500 to 700 gpm more than the influent flows calculated at lift station 53. Additionally, during the same period, the

flows measured at manhole D23-4004 were routinely more than 200 gpm more than the influent flows measured at the Suquamish Wastewater treatment plant, and as much as 1,200 gpm more than the treatment plant influent during the January storm event. As a result of these inconsistent flow measurements, data measured by this in-stream flow meter was not considered as part of the final recommendations and conclusions described in the deficiencies and capital improvements sections this report.

West Basin (MH D23-3036)

The County installed an in-stream flow monitor in the northern inlet of manhole D23-3036, located one manhole north of lift station 54 wet well in Division Avenue NE, on September 20, 2011, and monitored the flow through March 16, 2012. The basin upstream of this flow monitor is approximately bound to the east by Division Avenue NE and to the south by NE Kaleetan Lane. The basin also includes the Suquamish Clearwater Casino Resort.

During dry weather, the nighttime minimum flow was approximately 10 gpm and the daytime maximum flow was approximately 50 to 80 gpm, as shown in **Appendix C**. During the November storm event, the flow in this basin increased to approximately 210 gpm. Increased flows were measured for 7 days before returning to baseline levels. Baseline flows continued to be measured throughout much of December 2011, during which minimal rainfall was measured. During the January storm event, flow in the basin increased to approximately 220 gpm and remained at elevated levels throughout the duration of the monitoring period.

Throughout the duration of monitoring, the flows measured by this in-stream flow monitor are inconsistent with other in-stream flow monitors and the data loggers at lift station 54. The flows in manhole D23-3036 should be approximately equivalent to the influent flows calculated at lift station 54. However, the flows measured at manhole D23-3036 were approximately 80 to 150 gpm less than those at lift station 54.

Flow from the Prospect and Division Basin (MH D23-2074) is conveyed south in Division Avenue NE as additional neighborhoods west of Division Avenue NE connect to the collection system. The flows measured at manhole D23-2074, which is upstream of manhole D23-3036, were approximately 50 gpm more than the flows measured at manhole D23-3036. As a result of these inconsistent flow measurements, data measured by this in-stream flow meter was not considered as part of the final recommendations and conclusions described in the deficiencies and capital improvements sections this report.

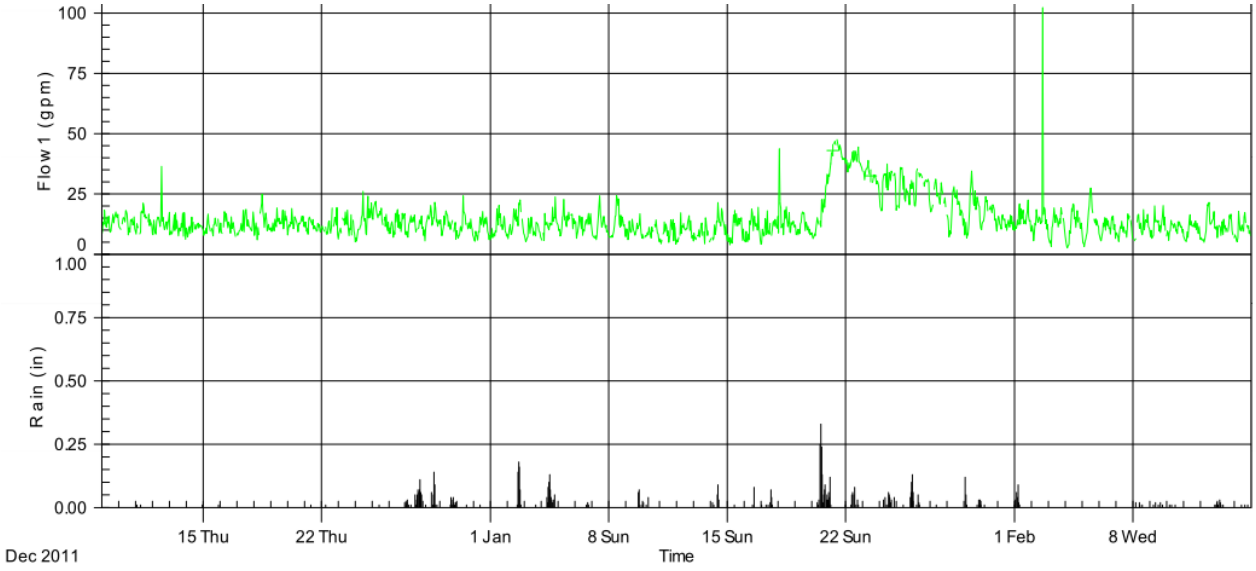
Harris and Angeline Basin (MH D23-1002)

The County installed an in-stream flow monitor in the northeastern inlet of manhole D23-1002, located at the intersection of Angeline Avenue NE and NE Parkway Street, on September 20, 2011. The basin upstream of this flow monitor includes the collection system within and tributary to Harris Avenue NE and Angeline Avenue NE. During review of the data downloaded from this monitor on October 20, 2011, it was apparent the flows in this basin were too low to be measured accurately by the County's in-stream flow monitor. The County authorized ADS to install an in-stream flow monitor in the same location, and monitoring began on December 9, 2011.

As a result of the relatively dry weather throughout December 2011, baseline flows for the basin were measured to range between approximately 5 to 10 gpm at night and 20 gpm during the daytime, as shown in **Chart 3**. Measurements during the November storm event are not available, but the flows increased to 45 gpm during the January storm event and remained elevated from the baseline flows for approximately 2 weeks. The time required for flows to return to baseline levels following rain events is indicative of infiltration occurring throughout this basin.

During the peak flow measured in the basin, which took place during the January storm event, the I&I measured in the basin was approximately 45 gpm when compared to daytime baseline flows. Based on the total length of sewer main in the basin (approximately 5,900 LF), the peak I&I in the basin is 3.4 gpm per 1,000 LF, and the peak I&I per acre served in the basin (approximately 26.6 acres) is 0.8 gpm per acre.

Chart 3. Harris and Angeline Basin (MH D23-1002) Flowrates



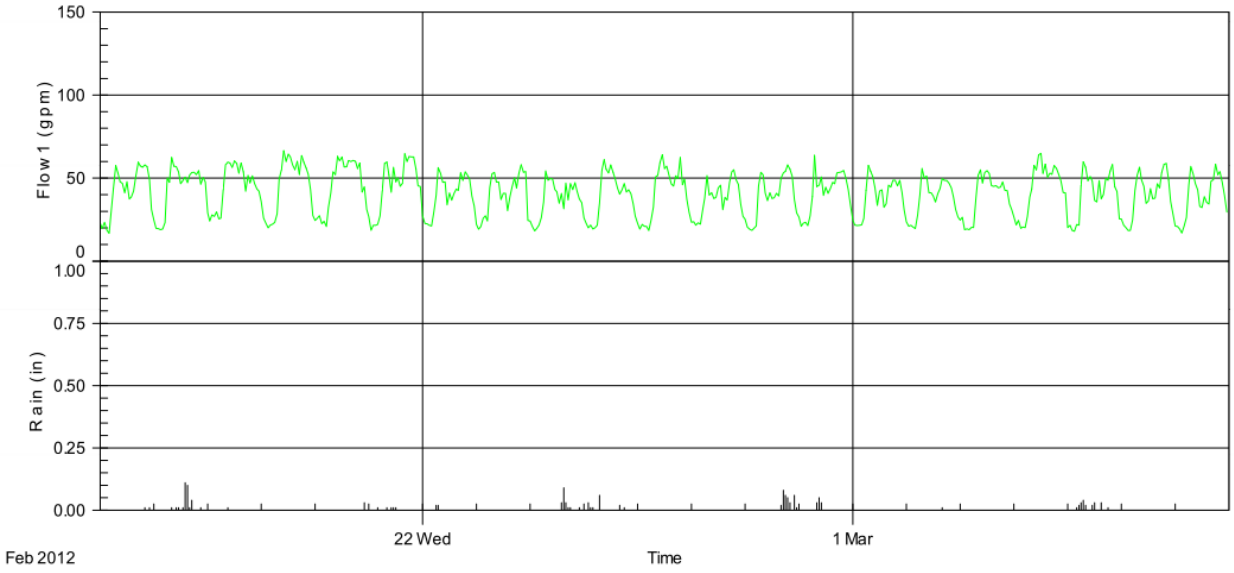
Division and Fern Basin (MH D23-2094)

ADS installed an in-stream flow monitor in the northern inlet of manhole D23-2094, at the intersection of Division Avenue NE and NE Fern Street, on February 16, 2012, and monitored the flow through March 7, 2012. The basin upstream of this flow monitor is approximately bound to the east by Division Avenue NE, to the south by NE Columbia Street, to the west by Urban Avenue NE, and to the north by NE Prospect Street.

This location was selected for in-stream flow monitoring in early February 2012 following the review of the flow isolation measurements, which identified a large contribution to the collection system in Division Avenue between NE Geneva Street and NE Center Street. Manhole D23-2094 was selected to provide supplementary data to the manhole D23-2074 flow monitor to more accurately determine the location of I&I in this area of the collection system. The results of the flow isolation measurements are discussed in detail in the **Flow Isolation** section of this report.

Based on the nighttime monitoring, the flow at manhole D23-2094 was approximately 20 gpm less than the flow at manhole D23-2074 every night of the monitoring period, as shown in **Chart 4**. The nighttime flow at these manholes is expected to be equal because the domestic contribution to the flow is minimal. The repeated difference between the flows observed at these two manholes represents infiltration occurring in the collection system piping between these two manholes. Based on the total length of sewer main in the basin between manholes D23-2094 and D23-2074 (approximately 4,050 LF), the peak I&I in the basin is 4.9 gpm per 1,000 LF, and the peak I&I per acre served in the basin (approximately 18.4 acres) is 1.1 gpm per acre.

Chart 4. Division and Fern Basin (MH D23-2094) Flowrates



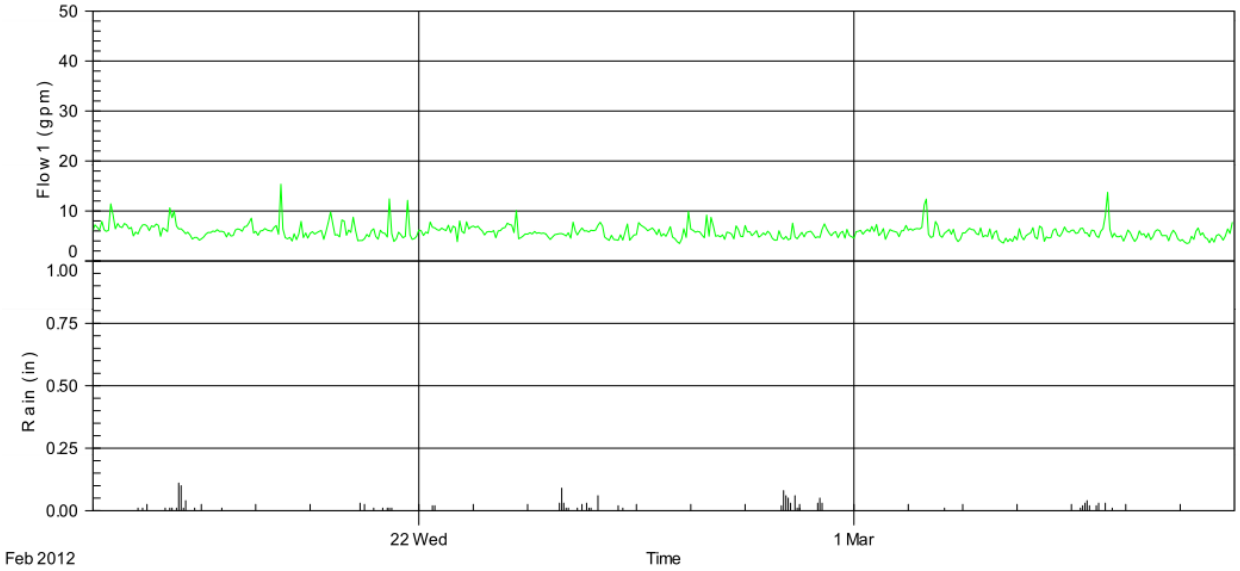
South Beach Basin (MH D23-3027)

ADS installed an in-stream flow monitor in the southwestern inlet of manhole D23-3027, located southwest of the lift station 53 wet well on the beach, on February 16, 2012, and monitored the flow through March 7, 2012. The basin upstream of this flow monitor includes all piping and services south of this location. The sewer main in this location is located along the beach and becomes submerged regularly during high tide events.

This location was selected for in-stream flow monitoring in early February 2012 to quantify the volume of I&I along this portion of the beach sewer main and to analyze the real-time correlation of the tide elevation with I&I.

Based on the monitoring, the flow at manhole D23-3027 was less than 10 gpm for nearly the entire duration of the monitoring period, as shown in **Chart 5**. Periodic flow increases up to 15 gpm occurred in multiple instances throughout the monitoring period, but were not successive. The repeated low flow measured at this manhole is indicative of little to no rainfall induced I&I occurring in the basin. In addition, flows are so low in this basin that the low flow conditions cannot be reliably measured. For this reason, an I&I rate for this basin is not reported. However, significant I&I contributions from this basin were not observed.

Chart 5. South Beach Basin (MH D23-3027) Flowrates



Lift Station 53

A HOBO data logger was installed on September 14, 2012, at lift station 53, which pumps wastewater from the Northeast and Beach basins to the Suquamish wastewater treatment plant. The influent flow was calculated from the pump runtimes measured by the HOBO data logger and the known wetwell volume between the pump on and pump off setpoints. This volume was calculated from field measurements performed by the County. The average pump 1 flowrate is calculated to be 239 gpm, and the average pump 2 flowrate is calculated to be 399 gpm.

The dry weather flows observed in September and October 2011 ranged from approximately 50 gpm during the day to approximately 25 gpm at night. The maximum influent flow calculated at the lift station was approximately 220 gpm, which occurred during both the November 22 and 23, 2011, and the January 18 through 22, 2012, storm events. A chart showing the results of the September 2011 through March 2012 influent flows to lift station 53 is included in **Appendix C**

During the peak flow measured in the basin, the I&I measured in the basin was approximately 170 gpm when compared to daytime baseline flows. Based on the total length of sewer main in the basin (approximately 24,300 LF), the peak I&I in the basin is 7.0 gpm per 1,000 LF, and the peak I&I per acre served in the basin (approximately 100 acres) is 1.7 gpm per acre.

Lift Station 54

A HOBO data logger was installed on September 14, 2012, at lift station 54, which pumps wastewater from the West Basin to the Suquamish wastewater treatment plant. The influent flow was calculated from the pump runtimes measured by the HOBO data logger and the known wetwell volume between the pump on and pump off setpoints. This volume was calculated from field measurements performed by the County. The average pump 1 flowrate is calculated to be 263 gpm, and the average pump 2 flowrate is calculated to be 289 gpm.

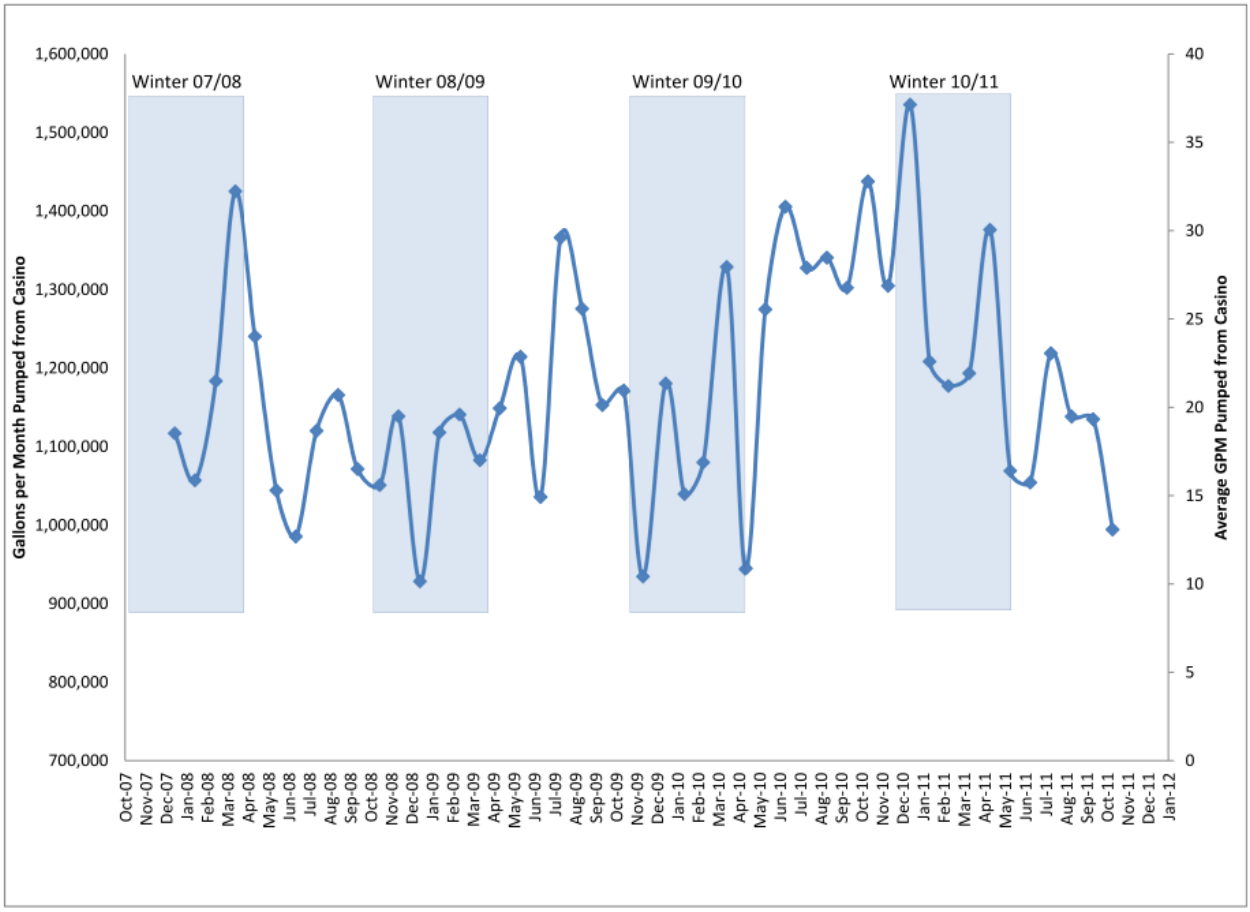
The dry weather flows observed in September and October 2011 ranged from approximately 160 gpm during the day to approximately 25 gpm at night. The maximum influent flow calculated at the lift station was approximately 280 gpm, which occurred during the November 22 and 23, 2011, storm event. Approximately 260 gpm of influent flow was calculated during the January 18 through 22, 2012, storm event. A chart showing the results of the September 2011 through March 2012 influent flows to lift station 54 is included in **Appendix C**.

During the peak flow measured in the basin, the I&I measured in the basin was approximately 120 gpm when compared to daytime baseline flows. Based on the total length of sewer main in the basin (approximately 32,800 LF), the peak I&I in the basin is 3.7 gpm per 1,000 LF and the peak I&I per acre served in the basin (approximately 133 acres) is 0.9 gpm per acre. These calculations are skewed by the 1.5 miles of dedicated sewer main connecting the Suquamish Clearwater Casino Resort (Casino) to the collection system. Based on a review of the condition of this sewer main and the Casino's flow patterns compared to the influent flows at lift station 54, the sewer main is in satisfactory condition and minimal I&I is believed to be contributing to the wastewater collection system in this sewer main. If the 1.5 miles of sewer main connecting the Casino to the collection system is not included, the peak I&I per 1,000 LF of main in the basin is 4.7 gpm.

Suquamish Casino

All flows from the Casino pass through the Casino's wastewater pump station and are conveyed to the Suquamish wastewater treatment plant via lift station 54. The Casino's pump station run-time meter allows accurate monitoring of flows from the Casino, which are shown in **Chart 6** from October 2007 to October 2011. What is notable about this figure is that high flows do not correlate with the rainy season as is the case in a system with I&I. This stands to reason as the collection system for the Casino is less than 10 years old and was built to municipal standards using modern construction materials. Peaks from the Casino appear to correlate to high attendance and not wet weather.

Chart 6. Suquamish Casino Flows



Suquamish Wastewater Treatment Plant

A HOBO data logger was installed on September 22, 2012, at the Suquamish wastewater treatment plant to record the influent flow rate at 3-minute intervals. The dry weather flows observed in September and October 2011 ranged from approximately 270 gpm during the day to approximately 70 gpm during the night. The maximum influent flow measured was approximately 1,000 gpm, which occurred during both the November 22 and 23, 2011, and the January 18 through 22, 2012, storm events. A chart showing the results of the September 2011 through March 2012 influent flows to the Suquamish wastewater treatment plant is included in **Appendix C**.

During the peak flow measured at the Suquamish wastewater treatment plant, the I&I measured in the basin was approximately 730 gpm when compared to daytime baseline flows. Based on the total length of sewer main in the collection system (approximately 57,100 LF), the peak I&I in the basin is 12.8 gpm per 1,000 LF, and the peak I&I per acre served (approximately 233 acres) is 3.1 gpm per acre. Although the sum of the lift station flows should be equivalent to the Suquamish wastewater treatment plant flows, the difference is the result of the measurements at the lift stations only including pump start and stop times. The lift station flowrate calculations are based on the assumed fixed pumping rates of the pumps and the time between pump starts and stops. Once the pump stations surcharge during high flow events and the static heads on the pumps are reduced, the

pumps deliver higher flowrates. Our analysis did account for this; hence the pump station flow rates tend to under-report the magnitude of influent flows. The pump stations also store and attenuate surges in wastewater flows. The pump stations do not include influent flow readings, and as a result, are less than the instantaneous influent flows measured at the Suquamish wastewater treatment plant.

Flow Isolations

Flow isolations were performed by ADS during the nights of February 2 and 3, 2012, and February 23, 2012. There was no rainfall these nights, and as a result, the magnitude of the inflow component of I&I was not able to be measured. However, the groundwater table was elevated during following the November and January storm events, and the magnitude of the infiltration component of I&I was measured during the flow isolations.

The flow isolations in the northwest quadrant of the collection system were consistent with the video inspection and in-stream flow monitoring results in this area. A combined flow of 5.6 gpm was measured flowing into the northwest quadrant at manhole D23-2125, located just east of the intersection of NE Prospect Street and Brockton Avenue NE, and labeled as Flow Isolation Manhole (FIM) 20 in **Figure 3**. A flow of 18.0 gpm was measured flowing into manhole D23-2100, located on NE Columbia Street and shown as FIM 13 in **Figure 3**. The 13 gpm difference between the northwest quadrant inlet and outlet manholes represents the infiltration occurring throughout this basin during night of the flow isolations.

The flow isolations performed on NE Geneva Street, shown as FIMs 2 and 12 in **Figure 3**, represented high levels of infiltration in the basins upstream of each manhole. The flow measured in the north inlet of FIM 2 of 10.9 gpm is high considering the limited length of main in the upstream basin. The 6.8 gpm measured in the west inlet of FIM 12, although lower than the flows measured at FIM 2 due to pulsing flows, is also high considering the length of main in the upstream basin.

In Division Avenue NE, between NE Geneva Street (FIM 12) and NE Center Street (FIM 11), more than 40 gpm of infiltration was measured. The flow isolation measurement in the north inlet of FIM 12 was 24 gpm, which is consistent with the nighttime flow readings from the upstream manhole D23-2094. The flow isolation measurement in the north inlet of FIM 11 was 72.6 gpm. This measurement was confirmed by the measurements in the two downstream manholes, FIMs 10 and 9, with 73.1 gpm and 72.3 gpm measured in the north inlet of these manholes, respectively.

Flow isolations at the intersection Harris Avenue NE and Angeline Avenue NE basin showed only 1 gpm of infiltration from Harris Avenue NE, and 7.8 gpm of infiltration from Angeline Avenue, as measured at FIM 3, shown in **Figure 3**. The 7.8 gpm of infiltration from Angeline Avenue NE appears to occur uniformly throughout the upstream basin, as a combined flow of 4.3 gpm was measured in the middle of the basin at FIM 4. Based on the total length of main in the Angeline Avenue NE basin and the uniform nature of the infiltration, the 7.8 gpm of infiltration is considered minimal.

Flow isolations upstream of the Park and Center Basin, including FIMs 1, 6, and 7 as shown in **Figure 3**, indicate high levels of infiltration occurring throughout the basin. Specifically, 9.3 gpm was measured in the west inlet of FIM 6, located at the intersection of 2nd Avenue NE and NE Center Street, which is a high flowrate considering the short length of main in the upstream basin.

The difference between the total influent flow to FIM 6 and the western inlet flow to FIM 7, located at the intersection of Augusta Avenue NE and NE Center Street, is 8.2 gpm. Similar to the flow west of FIM 6, the difference in flows between FIMs 6 and 7 is high considering the short length of main between these two manholes. The flow upstream of the north inlet to FIM 6 is relatively small considering the long length of main in this basin.

The flow isolations performed on the beach during low tide indicate that I&I in this location is minimal. The flow measured on the north side of the beach, in the northwest inlet of manhole D23-4002 (FIM 21 in **Figure 3**), was 27.6 gpm, and the flow measured near the south side of the beach, in the northeast inlet of manhole D23-3001 (FIM 22 in **Figure 3**), was 25 gpm. The flow measured at the downstream manhole is less than the flows measured upstream because of the slight change in flow patterns during the 45-minute time difference between the measurements at each manhole. The nearly identical flows measured at these two manholes represents negligible I&I between these two manholes during low tide conditions. A flow isolation was performed on the southwest inlet of manhole D23-3001 (FIM 22 in **Figure 3**) to measure the I&I in the South Beach Basin. The ADS field crew waited 6 minutes for flow to accumulate behind the weir, and no flow was measured at this location, representing negligible I&I in this basin.

Visual Inspection

Manholes in the northwest quadrant, Park and Center Basin, and Harris and Angeline Basin were opened to observe the wastewater flows throughout each basin. The visual observations occurred on March 15 and 29, 2012 during periods of heavy rain. Manholes at the downstream end of each basin were opened first, with the upstream manholes opened sequentially to determine if substantial flow increases occurred, indicating sections of sewer main with high I&I contributions to the collection system.

Large volumes of clear wastewater were observed throughout NE Fern Street and NE Geneva Street, increasing between manholes D23-2090 and D23-2085, and manholes D23-2085 and D23-2083. Although these observations took place during the daytime, the flows observed were greater than the expected domestic flows, and the clear color of the wastewater is indicative of I&I. No significant wastewater flow increase was observed in Division Avenue NE between manholes D23-2083 and D23-2074 (NE Geneva Street and NE Cedar Street), or in NE Pine Street or NE Cedar Street.

Inflow via manhole lid pick-holes was observed at low points in the street during these rainfall events in the northwest quadrant of the Suquamish system.

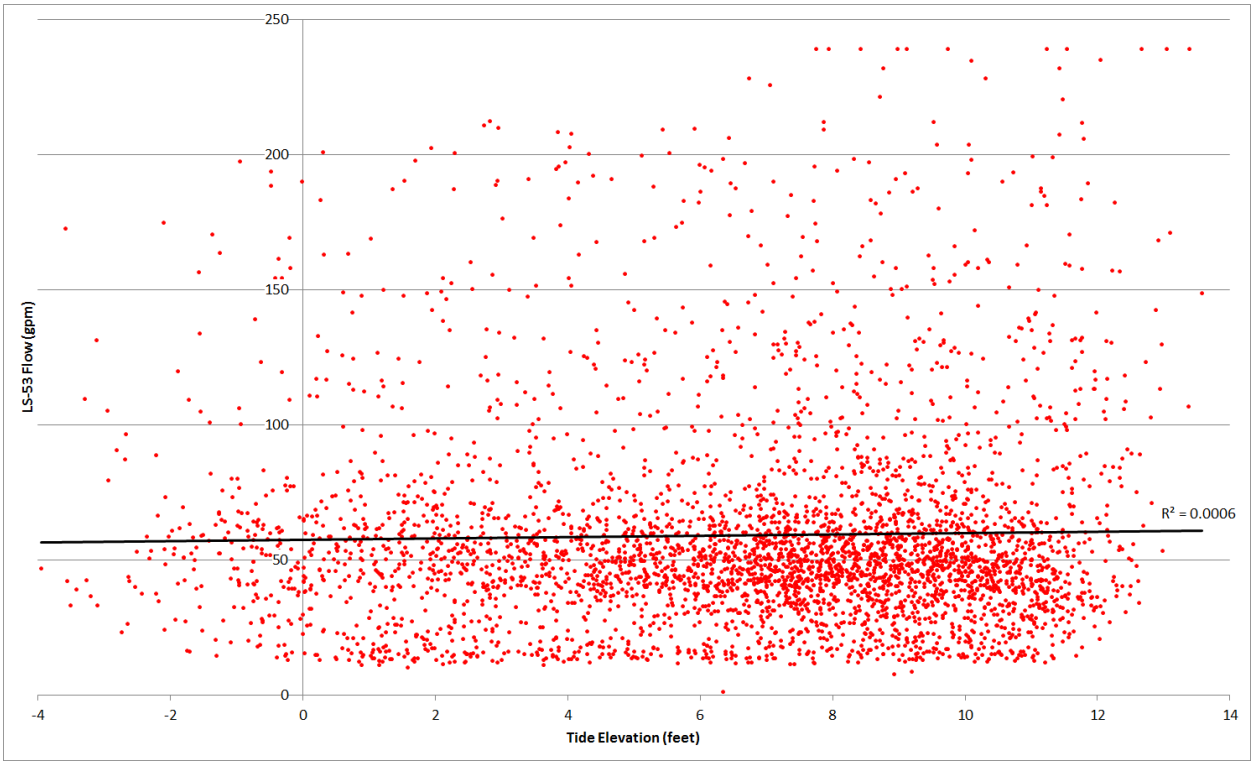
A small increase in wastewater flow was observed in the Park and Center Basin between manholes D23-2027 and D23-2017. South of this basin, on NE South Street, manholes D23-2041 and D23-2038 were observed to have no significant wastewater flow increase between them.

Manhole D23-1002, located at the downstream end of the Harris and Angeline Basin, was observed to have no significant increase of flows based on previous visual inspections at this manhole during rain events.

Tide Analysis

A comparative analysis of the flows measured at lift station 53 and the tide elevation was performed to determine if I&I increases at high tide. The manholes along the beach are exposed during low tides and become submerged during high tides. Tide elevation data from September 14, 2011, to February 29, 2012, for Puget Sound in Seattle, Wash., was provided by the National Oceanic and Atmospheric Administration. The tide analysis indicates that there is no correlation between the tide elevation and the flows in lift station 53. The resulting scatter plot, shown as **Chart 7**, has an R-squared value of 0.0006, which corresponds to a poor trend between the lift station 53 flow data and the tide elevation data. An R-squared value near 1.0 would represent a strong trend between the data. Further analysis of the data indicates repeated occurrences of high tide elevations and low flow at lift station 53, as well as low tide elevations and high flow at lift station 53.

Chart 7. Lift Station 53 and Tide Elevation Analysis



Summary of Deficiencies

The Prospect and Division Basin (MH D23-2074), also termed the northwest quadrant, has the most deficiencies of the basins analyzed in the Suquamish wastewater collection system. Video inspection revealed this basin has the most sewer main deficiencies of the basins inspected, the in-stream flow monitoring determination of I&I per 1,000 LF of sewer main and I&I per acre is the largest in the collection system, and the flow isolation measurements indicate large infiltration flowrates contributing to the collection system in this basin. Visual inspection of the manholes in the basin indicate no significant I&I entering the main in Division Avenue NE. The coincidence of a high number of deficiencies found during video inspections, high flows during in-stream flow

monitoring and flow isolations analyses, and high flows seen during visual observations makes this basin the most in need of restoration.

The Park and Center Basin (MH D23-2004) has the second most deficiencies of the basins analyzed in the Suquamish wastewater collection system. This area was not perceived to be contributing significant I&I at the beginning of this analysis and was therefore not included in the scope of work, and review of video inspections from this area was not performed. Although this review has not occurred throughout this basin, the in-stream flow monitoring determined the I&I per 1,000 LF of sewer main and the I&I per acre is the second largest in the collection system and the flow isolation measurements indicate large I&I flowrates contributing to the collection system in this basin. Visual inspection of the manholes in the basin indicates I&I may be occurring in NE Center Street.

The basin between manholes D23-2094 and D23-2074, approximately between NE Fern Street and NE Cedar Street, has the third most deficiencies of the basins analyzed in the Suquamish wastewater collection system. The in-stream flow monitoring determined 20 gpm of infiltration is occurring throughout this basin based on the nighttime flows at manholes D23-2094 and D23-2074. The I&I per 1,000 LF of sewer main and the I&I per acre in this basin is the third largest in the collection system. The flow isolations measurements indicate large I&I flowrates contributing to the collection system in this basin. Visual inspection of the manholes in the basin indicate significant I&I occurring in and between NE Fern Street and NE Geneva Street. I&I was not suspected in the area at the beginning of this study because the collection mains and services had been replaced by pipe bursting in 1996; some manholes were replaced and others were rehabilitated at that time. Prior to performing improvements for this area, it is recommended that video inspections be performed to narrow the location of the I&I sources. Spot repairs should be all that are required given that much of the material is relatively new. RH2 contacted the contractor that performed the sewer restoration work in 1996. He stated that he suspected leakage at the flexible couplings used to join the HDPE service lines to the fusion saddle at the main. Further video inspection, preferably after and during heavy rain, should be performed to determine the rehabilitation strategy.

The sewer main video inspection of the Harris and Angeline Basin (MH D23-1002) revealed that the basin has substantially fewer defects per lineal foot of sewer main than the northwest quadrant. The in-stream flow monitoring determined the peak I&I in the basin is only 20 gpm, and the I&I per 1,000 LF of sewer main and the I&I per acre is approximately 30 percent of that measured in the Park and Center Basin, and approximately 13 percent of that measured in the Prospect and Division Basin. The flow isolation measurements indicate minimal I&I occurring throughout this basin based on the total length of pipe in the Angeline Avenue NE basin and the uniform nature of the infiltration. Visual inspection of the manholes during heavy rain at the downstream end of this basin indicates no significant I&I increase based on previous observations by the County.

The sewer main video inspection of the Suquamish beach main revealed a minimal number of defects in the existing sewer main, although 16 side sewers were observed to be contributing small amounts of I&I to the collection system. The in-stream flow monitoring of the South Beach Basin determined that the I&I in this basin is minimal, and the flow isolations determined that the I&I in this basin, and along the entire beach, is negligible. Visual inspection of manholes in this basin did not take place. The physical condition of the beach main was observed to be good from review of video inspections. There were no signs of corrosion or serious structural defects to indicate imminent failure. Casting and ladder rungs have sustained some rust and corrosion; however, the focus of this project is I&I reduction. These features can be replaced out of yearly maintenance

budgets as needed. It is our opinion that the structural condition of the beach lines is sufficient to provide another 20 to 25 years of service life from the mains with normal maintenance.

REMEDIATION OF DEFICIENCIES

Replacement and Rehabilitation Methods

Multiple open-cut and trenchless methods can be used to replace or rehabilitate existing wastewater collection systems. Different methods can be used for the sewer main, laterals (between the sewer main and property line), and side sewers (between the property line and each house). The following is a description of replacement and rehabilitation techniques for each section of the collection system.

Sewer Main Replacement and Rehabilitation

The sewer main can be replaced or rehabilitated by open-cut, pipe bursting, or cured-in-place pipe (CIPP) methods. Open-cut replacement is most applicable when short distances (20 feet or fewer) of sewer main needs replacement, or where sags and bellies in the sewer main exist. Open-cut sewer main involves the replacement of the existing sewer main with new sewer main. Open-cut installation provides the highest quality end product of the sewer main replacement and rehabilitation methods, and inspection of the installation is the easiest. However, open-cutting is the most expensive and most disruptive construction method.

Pipe bursting is the most applicable rehabilitation method for sewer main with leaks at joints and cracks. Pipe bursting rehabilitation involves an excavation on the upstream and downstream sides of the existing sewer to launch and receive a pipe bursting head, which bursts the existing sewer main and drags the new main into the void created by bursting the existing sewer. Pipe bursting is advantageous in areas with extensive surface restoration requirements as it reduces surface disruption and provides a high-quality product. However, sags and bellies cannot be eliminated with pipe bursting and the lateral connections to the sewer main require excavation at each service to be reinstated.

Similar to pipe bursting, CIPP is an applicable rehabilitation method for sewer main with leaks at joints and cracks and in areas with extensive surface restoration requirements. CIPP can be installed using existing manholes as launching and receiving points, eliminating the need for excavations at each end of the sewer main. CIPP rehabilitation involves inserting a liner between two manholes, expanding the liner with air or water pressure such that it lines the entire interior of the existing sewer main, and curing the liner with steam or hot water to attach seamlessly the existing sewer main. As with pipe bursting, CIPP rehabilitation does not eliminate sags and bellies, and the long-term durability of the liner is unknown since this rehabilitation technology has only been practiced in the Puget Sound area since the 1990s.

Lateral and Side Sewer Replacement and Rehabilitation

Replacement and rehabilitation of laterals and side sewers can be accomplished with the same methods as the sewer main, although there are distinct differences for each rehabilitation method. Open-cut replacement of laterals and side sewers is appropriate for distances of fewer than 20 feet.

For distances greater than 20 feet, the surface restoration costs and inconvenience to customers due to the disruptive nature of the construction, make open-cut replacement a less ideal option.

Pipe bursting laterals and side sewers provides a high-quality product at a reasonable cost, but it requires excavation for launching and receiving pits. Because this construction is not completely trenchless, only a limited number of contractors are qualified to perform this work and possess the specialized equipment.

CIPP lining for laterals and side sewers is completely trenchless, minimizing surface disruption. However, the liners are ambient-cured and can cure both prematurely or not at all, and few contractors are qualified for this construction method. CIPP lining for laterals and side sewers is currently considered a less reliable construction method.

Connection of Lateral to Main

The preferred construction method for connecting the sewer lateral to the main varies depending on the replacement or rehabilitation method for each of the sewer main, lateral, and side sewer. Installation of a new tee provides the highest quality connection and is the preferred method if the sewer main is replaced with open-cut construction and an excellent choice if lined with CIPP.

The lateral connection to the main can be hole-cut through HDPE pipe or CIPP lining to connect with a fusion fitting or Inserta-tee, respectively. Another option for connecting to a CIPP-lined main is a strapped saddle (such as the Romac CB-Saddle). All of these methods require excavation at the lateral connection to the main. The fusion fitting provides a better joint than the Inserta-tee, and the required hole for the Inserta-tee must be cut with precision to match the location of the lateral. The Inserta-tee joint can leak when the tee is deflected with earth loads; therefore it is not preferred unless there is a substantial pipe wall section to resist twisting. The lateral can also be reinstated with a completely trenchless method, which involves a tractor-mounted router that travels within the pipe and joint grouting. This method utilizes the existing tee and installs grout around the lateral connection to the sewer main to eliminate any leaks from joints or cracks at this location, and from the annular space between the host pipe and the CIPP. The grout has a 5- to 10-year design life and is a good short-term, low cost solution. If the grout is kept wet year-round, as is the case on the beach, grout life can be longer. As with pipe bursting and CIPP lining, there are few qualified grouting contractors that can perform this work.

Inflow Reduction Methods

During construction of the replacement and rehabilitation of the sewer mains and services, tests should be performed to determine sources of inflow from each side sewer service. Video inspection of each lateral and side sewer should be performed during the construction phase to determine the condition of the sewer main. If replacement or rehabilitation of the lateral and side sewer is necessary, the construction method will be determined based on the pipe condition as determined from the video inspection. Dye testing for each house should also be performed during construction of the replacement and rehabilitation of the sewer main to determine if existing roof downspouts, yard drains, or other unapproved connections to the wastewater collection system exist.

Stormwater Management

The flows in the stormwater collection system will increase following the completion of improvements to reduce the contribution of I&I to the wastewater collection system. Uncompleted projects described in the County's 1999 Suquamish Regional Storm Water Improvements Project Draft Report and supplemental 2008 through 2013 list of proposed improvements should be coordinated with the proposed wastewater collection system improvements in the same area. The sizing of the proposed stormwater improvements should be reevaluated during the design phase to include the additional projected flows resulting from the reduction of I&I in the wastewater collection system.

CAPITAL IMPROVEMENT PROGRAM

This section presents the proposed improvements to the Suquamish wastewater collection system that are necessary to resolve the existing system deficiencies. The improvements were identified from an evaluation of the **Analyses and Results** section of this report. The following improvements will decrease the I&I contribution to the Suquamish wastewater collection system and will be ranked by anticipated effectiveness in the following section of this report.

Recommended Improvements

Prospect and Division Basin

This section presents the proposed improvements in the Prospect and Division Basin, which is also termed the northwest quadrant. Based the analyses and results, the I&I in this basin is large, peaking at approximately 340 gpm during winter storm events. To reduce approximately 255 gpm (75 percent of 340 gpm) of this I&I, replacement of approximately 3,350 LF of existing 8-inch sewer main and rehabilitation of approximately 77 laterals is recommended, as shown in **Figure 4**. The recommended construction method for the improvements can be open-cut replacement and/or pipe bursting rehabilitation of approximately 3,350 LF of 8-inch sewer main located in the County right-of-way utility easements. The estimated cost of the project as constructed either way is approximately the same. The option of open-cut or pipe bursting construction should be given to the bidders in order to receive the most competitive bids. The construction plans and specifications would have detail to allow the contractor to choose bursting or open-cut methods (or a combination) as project conditions require. The laterals and side sewers can be open-cut or pipe burst, depending on the condition of the existing pipe and length of the lateral and side sewer. Each tee connecting the lateral to the sewer main should be replaced. A determination of the appropriate construction method for each lateral should take place during the construction phase of the project. Rehabilitation of side sewers on private property will be considered on a case-by-case basis during construction based on the results of dye testing and video inspection performed by the contractor. In addition to the piping improvements, 16 manholes located adjacent to the sewer main improvements should be replaced. Five additional manholes, located in NE Fern Street and NE Geneva Street, should also be evaluated for replacement. Budget cost estimates to replace these items have been provided.

The scope of these improvements in NE Fern Street and NE Geneva Street may be reduced following video inspection and additional in-stream flow monitoring or flow isolations during the design phase to determine a more precise location of the I&I contribution to the wastewater

Kitsap County Public Works Wastewater Division

Proposed Suquamish System Improvements

Figure 4

Phase 1

Phase 2

Phase 3

Phase 4

Lift Station No. 54

Wastewater Treatment Plant

Lift Station No. 53

Legend

Existing Infrastructure

- Suquamish Wastewater Treatment Plant
- Lift Station
- Manhole
- Cleanout
- Sewer Main

Phase 1- Proposed Infrastructure

- Manhole
- Open Cut or Pipe Burst Sewer Replacement
- Proposed Lateral Replacement Parcel

Phase 2 - Proposed Infrastructure

- Manhole
- Open Cut or Pipe Burst Sewer Replacement
- Proposed Lateral Replacement Parcel

Phase 3 - Proposed Infrastructure

- CIPP Liner Sewer Rehabilitation

Phase 4 - Proposed Infrastructure

- Sewer Main to be Sliplined
- Proposed Lateral Replacement Parcel

Feet

0 200 400

1 INCH = 200 FEET

Data Sources: Kitsap County GIS & Wastewater Divisions.
Eleavtion Data: Puget Sound LiDAR Consortium.

This map is a geographic representation based on information available. It does not represent survey data. All data, information, and maps are provided "as is" without warranty or any representation of accuracy, timeliness of completeness. RH2 makes no warranties, express or implied, as to the use of the information obtained here. There are no implied warranties of merchantability or fitness for a particular purpose.

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collection system in this area. The sewer main, laterals, and side sewers were rehabilitated by pipe bursting in the mid-1990s and may not require rehabilitation. Following construction of all improvements in the Prospect and Division Basin, a full street overlay will be required to restore the street in areas disturbed by the sewer main and lateral construction.

Park and Center Basin

Based the analyses and results, I&I in this basin peaks at approximately 75 gpm during winter storm events. Although significantly less than the total I&I measured in the northwest quadrant, the I&I per 1,000 LF of sewer main and the I&I per acre in this basin is the second largest in the Suquamish wastewater collection system. Based on the flow isolation results, replacing or rehabilitating approximately 6,300 LF of sewer main and 86 laterals, and replacing 29 manholes, as shown in **Figure 4**, could eliminate 56 gpm (75 percent of 75 gpm) of I&I observed during storm events. Because this area was not perceived to be contributing significant I&I at the beginning of this analysis, a thorough evaluation was not performed throughout this basin. Following review of video inspections and completion of flow isolations throughout this basin, it is estimated that the 75 gpm of I&I observed during storm events can be eliminated by completing half of the improvements described above and shown in **Figure 4**.

Similar to the recommended improvements in the Prospect and Division Basin, the option of open-cut or pipe bursting construction should be deferred to the contractor in order to receive competitive bids. To reduce the scope of these improvements, a detailed review of the video inspections in this basin could be performed, as well as additional flow monitoring or flow isolations during heavy rain events to more accurately identify the sources of I&I in this basin. Following construction of any improvements, a full street overlay will be required to restore the street in areas disturbed by the sewer main and lateral construction.

Harris and Angeline Basin

Based the analyses and results, I&I in this basin peaks at approximately 25 gpm during winter storm events. Based on the small amount of I&I in this basin, minimal improvements are recommended to eliminate 19 gpm (75 percent of 25 gpm) of the I&I observed during storm events, and include CIPP lining of three sections of sewer main. The three sections of sewer main include the approximately 1,050 LF of existing 8-inch concrete sewer main between manholes D23-1012 and D23-1001, manholes D23-1007 and D23-1005, and manholes D23-1018 and D23-1017, as shown in **Figure 4**. During the sewer main construction, dye testing should be performed to determine if any unapproved connections to the wastewater collection system exist and video inspection of each lateral and side sewer should be performed to determine if replacement or rehabilitation is necessary. Based on the results of the video inspection of the sewer main in these areas, rehabilitation of the laterals and side sewers is not anticipated.

Beach Sewer Main (Including South Beach Basin)

Based on the analyses and results, there is no significant I&I contribution to the Suquamish wastewater collection system in this basin. No improvements are necessary at this time along the beach sewer main or for any of the side sewer or laterals connected to this sewer main. However, two alternative upgrade plans for the collection system on the beach are recommended in the future

when the existing infrastructure reaches the end of its design life. Based on the observed condition of the beach lines, there should be at least another 25 to 30 years of useful life remaining.

The preferred alternative to replacing the beach sewer main involves sliplining the existing beach sewer main, which would include four large excavations (20 feet long x 6 feet wide x 7 feet deep) and approximately 50 small excavations (4 feet x 4 feet x 7 feet deep) on the beach to rehabilitate the existing sewer main and side sewers, as shown in **Figure 4**. Approximately 50 small excavations would be required in the backyard of each beachfront home. This alternative would require an upland temporary collection system above the mean high water level and temporary above-ground piping in the beachfront backyards to convey wastewater flows to the sewer main during side sewer rehabilitation. This alternative has substantial environmental impacts but would provide the greatest long-term reliability of the beach collection system.

The second rehabilitation alternative involves no rehabilitation of the existing beach sewer main or excavations in the beach. Rehabilitation of the side sewers would be performed with CIPP liner installed from small excavations would be required in the backyard of each of the approximately 50 beachfront homes, as shown in **Figure 4**. During low tides, grout injection equipment would be inserted into the beach manholes to inject chemical grout in the main at every side sewer connection to seal existing leaks where laterals connect to the main. The grout would flow into the soil surrounding the existing pipe to form a gelatinous mass to stop leaks.

The second alternative should be undertaken if, in the future, in-stream flow monitoring data shows significant extraneous flow. The first alternative should be performed if video inspections show corrosion and structural failures. Currently, neither is occurring and RH2 recommends that these improvements be deferred until these lines show structural defects and I&I.

Priority Ranking Criteria

The four basins and their deficiencies were prioritized based on the basin-by-basin evaluation criteria to schedule projects that will correct the most deficiencies and meet the greatest need for improvement prior to projects correcting fewer deficiencies. **Table 1** lists criteria that were established for prioritizing the improvements. The criteria encompass four categories, with a weight factor assigned to each category, and include the magnitude of I&I flowrates measured by the flow monitoring and flow isolations analyses; the number of defects observed by the video inspection; and the flowrate increases observed between manholes during the visual observations. The criterion given the most weight was the magnitude of I&I flowrates measured by the flow monitoring.

Table 1. Sewer Main Improvements Priority Ranking Criteria

Points	Category	Weight Factor	Weighted Points
	Flow Monitoring		
3	High I&I Flowrates Measured	4	12
2	Medium I&I Flowrates Measured	4	8
1	Minimal I&I Flowrates Measured	4	4
	Video Inspection		
3	High Number of Defects Observed	3	9
2	Medium Number of Defects Observed	3	6
1	Minimal Number of Defects Observed	3	3
	Flow Isolations		
3	High I&I Flowrates Measured per LF of Main in Upstream Basin	2	6
2	Medium I&I Flowrates Measured per LF of Main in Upstream Basin	2	4
1	Minimal I&I Flowrates Measured per LF of Main in Upstream Basin	2	2
	Visual Observations		
3	Large Flowrate Increase Between Manholes	1	3
2	Medium Flowrate Increase Between Manholes	1	2
1	Minimal Flowrate Increase Between Manholes	1	1

The sewer main improvements priority ranking criteria were applied to each of the four basins and the weighted point totals are shown in **Table 2**.

Table 2. Sewer Main Improvements Weighted Point Totals

Criteria	Park & Center Basin	Prospect & Division Basin	Harris & Angeline Basin	Beach Basin
	Points			
Flow Monitoring	2	3	1	1
Video Inspection	2	3	2	1
Flow Isolations	1	3	2	1
Visual Observations	2	3	1	1
	Weighted Points			
Flow Monitoring	8	9	2	1
Video Inspection	8	9	4	1
Flow Isolations	4	9	4	1
Visual Observations	8	9	2	1
Total	**28**	**36**	**12**	**4**

The results of the analyses indicate that the basin with the most deficiencies is Prospect and Division Basin. Improvements to resolve the deficiencies in this basin should be completed prior to the construction of improvements in the other basins. The analyses indicate that Park and Center Basin has the second most deficiencies, followed by Harris and Angeline Basin, and, lastly, Beach Basin.

Preliminary Cost Estimates

All cost estimates shown in the tables are presented in 2012 dollars. These cost estimates will need to be adjusted to account for inflation and changing construction market conditions to determine future costs at the actual time of project implementation. Future costs can be estimated using the Engineering News Record (ENR) Construction Cost Index for the Puget Sound area or by applying an estimated rate of inflation that reflects the current and anticipated future market conditions.

Prospect and Division Basin

Project costs related to the proposed Prospect and Division Basin improvements were estimated based on costs of similar sewer projects in the Puget Sound area and are presented in 2012 dollars in **Table 3**. The costs shown in **Table 3** include the cost for open-cut construction and the applicable surface restoration costs. Also included in the costs are the replacement or rehabilitation of all laterals in the basin, including those on NE Fern Street and NE Geneva Street. As described in the **Recommended Improvements** section of this report, the scope of the improvements on these streets may be reduced following additional video inspection and land surveying during the design phase.

Table 3. Proposed Prospect and Division Basin Improvements Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
1	Mobilization, Demobilization, Site Preparation, and Cleanup	LS	1	$129,400	$129,400
2	Traffic Control	LS	1	$23,100	$23,100
3	Shoring and Trench Safety System	LF	3,350	$2	$6,700
4	Temporary Erosion and Sedimentation Control	LS	1	$20,000	$20,000
5	Landscape, Mitigation, and Miscellaneous Restoration	LS	1	$50,000	$50,000
6	Trench Dewatering	LS	1	$10,000	$10,000
7	8-inch SDR 35 PVC Sewer Pipe - Open Cut or Pipe Bursting	LF	3,350	$75	$251,250
8	48-inch Manhole w/CL Frame & Cover 8-foot Depth w/GU Liner	EA	26	$5,000	$130,000
9	Open Cut or Pipe Bursting of Residential Lateral	EA	77	$5,000	$385,000
10	12-inch Layer Crushed Rock Compacted Trench Backfill	LF	14,740	$10	$147,400
11	2-inch HMA Patch w/ 4-inch Crushed Rock Base	SY	3,900	$25	$97,500
12	HMA Grind & Overlay	SY	10,200	$15	$153,000
13	Dye Testing and Video Inspection for Sewer Services	EA	77	$250	$19,250
	Subtotal Construction Costs				**$1,423,000**
	Construction Cost Contingency	15%			$214,000
	Washington State Sales Tax	8.6%			$141,000
	Total Capital Construction Cost				**$1,778,000**
	Indirect Costs (includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting, and inspections)	25.0%			$445,000
	Total Project Cost				**$2,223,000**

Park and Center Basin

Project costs related to the proposed Park and Center Basin improvements were estimated based on costs of similar sewer projects in the Puget Sound area and are presented in 2012 dollars in **Table 4**.

The costs shown in **Table 4** include the cost for open-cut construction and the applicable surface restoration costs. As described in the **Recommended Improvements** section, following a review of video inspections and flow isolations in this basin, it is estimated that half of the replacement and rehabilitation improvements shown in Figure **4** will eliminate 56 gpm (75 percent of 75 gpm) of I&I observed during storm events. The quantities and unit prices shown in **Table 4** represent half of the improvements shown in **Figure 4**.

Table 4. Proposed Park and Center Basin Improvements Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
1	Mobilization, Demobilization, Site Preparation, and Cleanup	LS	1	$91,200	$45,600
2	Traffic Control	LS	1	$0	$0
3	Shoring and Trench Safety System	LF	3,150	$2	$6,300
4	Temporary Erosion and Sedimentation Control	LS	1	$20,000	$10,000
5	Landscape, Mitigation, and Miscellaneous Restoration	LS	1	$50,000	$25,000
6	Trench Dewatering	LS	1	$10,000	$5,000
7	8-inch SDR 35 PVC Sewer Pipe - Open Cut or Pipe Bursting	LF	3,150	$75	$236,250
8	48-inch Manhole w/CL Frame & Cover 8-foot Depth w/GU Liner	EA	15	$5,000	$72,500
9	Open Cut or Pipe Bursting of Residential Lateral	EA	43	$5,000	$215,000
10	12-inch Layer Crushed Rock Compacted Trench Backfill	LF	13,860	$10	$138,600
11	2-inch HMA Patch w/ 4-inch Crushed Rock Base	SY	3,500	$25	$87,500
12	HMA Grind & Overlay	SY	7,000	$15	$105,000
13	Dye Testing and Video Inspection for Sewer Services	EA	43	$250	$10,750
	Subtotal Construction Costs				**$958,000**
	Construction Cost Contingency	15%			$144,000
	Washington State Sales Tax	8.6%			$95,000
	Total Capital Construction Cost				**$1,197,000**
	Indirect Costs (includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting, and inspections)	25.0%			$300,000
	Total Project Cost				**$1,497,000**

The estimated costs shown in **Table 4** include replacing or rehabilitating approximately 3,150 LF of sewer main and 43 laterals and side sewers in the Park and Center Basin. However, as described in the **Recommended Improvements** section of this report, the scope of these improvements may be revised following additional in-steam flow monitoring, flow isolations, and review of the video inspections if the location of the source or sources of I&I in this basin can be more accurately identified.

Harris and Angeline Basin

Project costs related to the proposed Harris and Angeline Basin improvements were estimated based on costs of similar sewer projects in the Puget Sound area and are presented in 2012 dollars in **Table 5**.

Table 5. Proposed Harris and Angeline Basin Improvements Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
1	Mobilization, Demobilization, Site Preparation, and Cleanup	LS	1	$9,100	$9,100
2	Traffic Control	LS	1	$2,000	$2,000
3	Temporary Erosion and Sedimentation Control	LS	1	$3,000	$3,000
4	Landscape, Mitigation, and Miscellaneous Restoration	LS	1	$12,000	$12,000
5	CIPP Lining 8-inch Concrete Pipe	LF	1,050	$70	$73,500
6	Video Inspection	LS	1	$5,000	$10,000
7	Open Cut of Pipe Busting of Residential Lateral	EA	4	$7,000	$84,000
	Subtotal Construction Costs				**$194,000**
	Construction Cost Contingency	15%			$30,000
	Washington State Sales Tax	8.6%			$20,000
	Total Capital Construction Cost				**$244,000**
	Indirect Costs (includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting, and inspections)	25.0%			$61,000
	Total Project Cost				**$305,000**

Beach Basin

Project costs related to the proposed Beach Basin improvements were estimated based on costs of similar sewer projects in the Puget Sound area and are presented in 2012 dollars in **Table 6** and **Table 7**. **Table 6** shows the project costs for Alternative 1, which includes sliplining the existing beach sewer main and pipe bursting approximately 50 side sewers. **Table 7** shows the project costs for Alternative 2, which includes CIPP lining approximately 50 side sewers and injecting chemical grout in the main at every side sewer connection to seal existing leaks. A memo/report describing the permitting considerations and regulatory approvals for the construction alternatives on the beach is included as **Appendix D**.

Table 6. Proposed Beach Basin Alternative 1 Improvements Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
1	Mobilization, Demobilization, Site Preparation, and Cleanup	LS	1	$89,800	$89,800
2	Temporary Erosion and Sedimentation Control	LS	1	$50,000	$50,000
3	Landscape, Mitigation, and Miscellaneous Restoration	LS	1	$50,000	$50,000
4	Trench Dewatering	LS	1	$50,000	$50,000
5	Slipline 18-inch Conc. with 12-inch HDPE	LF	2,500	$75	$187,500
6	Slipline 12-inch Conc. with 8-inch HDPE	LF	1,400	$70	$98,000
7	48-inch Manhole w/CL Frame & Cover 8-foot Depth w/GU Liner	EA	14	$5,000	$70,000
8	Pull and Launch Pits	EA	4	$20,000	$80,000
9	Temporary Wastewater Collection System	LS	1	$50,000	$50,000
10	Pipe Bursting of Residential Lateral and Side Sewer	EA	50	$5,000	$250,000
11	Dye Testing and Video Inspection for Sewer Services	EA	50	$250	$12,500
	Subtotal Construction Costs				**$988,000**
	Construction Cost Contingency	15%			$149,000
	Washington State Sales Tax	8.6%			$98,000
	Total Capital Construction Cost				**$1,235,000**
	Indirect Costs (includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting, and inspections)	40.0%			$494,000
	Total Project Cost				**$1,729,000**

Table 7. Proposed Beach Basin Alternative 2 Improvements Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
1	Mobilization, Demobilization, Site Preparation, and Cleanup	LS	1	$32,800	$32,800
2	Temporary Erosion and Sedimentation Control	LS	1	$25,000	$25,000
3	Landscape, Mitigation, and Miscellaneous Restoration	LS	1	$25,000	$25,000
4	Trench Dewatering	LS	1	$5,000	$5,000
5	Inject Chemical Grout at Side Sewer Connection	EA	50	$200	$10,000
6	CIPP Lining of Residential Lateral and Side Sewer	EA	50	$5,000	$250,000
7	Dye Testing and Video Inspection for Sewer Services	EA	50	$250	$12,500
	Subtotal Construction Costs				**$361,000**
	Construction Cost Contingency	15%			$55,000
	Washington State Sales Tax	8.6%			$36,000
	Total Capital Construction Cost				**$452,000**
	Indirect Costs (includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting, and inspections)	40.0%			$181,000
	Total Project Cost				**$633,000**

Schedule of Improvements

The results of prioritizing the improvements were used to assist in establishing an implementation schedule to reduce the I&I in the Suquamish wastewater collection system. The implementation schedule for the proposed improvements is shown in **Table 8**. RH2 recommends that in-stream flow monitoring and flow isolations be performed each year to determine the magnitude of the I&I reductions afforded by the replacements. **Table 8** assumes replacement of a conservative amount of pipe to reduce the I&I in the Suquamish collection system. RH2 anticipates that the estimated quantities of main can be substantially reduced with further analysis, particularly in Phase 2.

Table 8. Proposed Improvements Implementation Schedule

Phase	Basin	Description	Estimated Cost (2012 $)	Planned Year of Project and Estimated Cost in 2012 $						
				2012	2013	2014	2015	2016	2017	2030+
1	Prospect & Division	Predesign and design engineering; permitting	$222,500	$222,500						
	Prospect & Division	Construction and remaining engineering	$2,000,500		$2,000,500					
2	Park & Center	Predesign and design engineering; permitting	$150,000		$150,000					
	Park & Center	Construction and remaining engineering	$1,347,000			$1,347,000				
3	Harris & Angeline	Design and Construction	$305,000				$305,000			
4 - Alt 1	Beach	Design and Construction	$1,729,000							$1,729,000
4 - Alt 2	Beach	Predesign and design engineering; permitting	$90,500					$90,500		
	Beach	Construction and remaining engineering	$542,500						$542,500	
Total Estimated Costs of Improvements (Including Beach Alternative 1)			**$5,754,000**	**$222,500**	**$2,150,500**	**$1,347,000**	**$305,000**	**$0**	**$0**	**$1,729,000**
Total Estimated Costs of Improvements (Including Beach Alternative 2)			**$4,658,000**	**$222,500**	**$2,150,500**	**$1,347,000**	**$305,000**	**$90,500**	**$542,500**	**$0**

Table 9 summarizes the anticipated I&I reduction for each basin and the estimated cost per gallon of I&I removed from the collection system. As shown in **Table 9**, the I&I reduction project with the best value is the rehabilitation of main in the Prospect and Division basin. Other projects, such as the beach improvements, warrant deferral as their anticipated benefits are small. Project costs for 2012, 2013, and 2015 have been estimated with a reasonable level of certainty. Costs for 2014 have been estimated conservatively and, as stated above, may be reduced by a more accurate determination of the sources of the I&I in this basin.

Table 9. Estimated Cost of I&I Reduction by Basin

Basin	I&I Observed During Storm Events (gpm)	I&I to be Elimiated with Proposed Improvements (gpm)	Estimated Total Project Cost of Improvements	Estimated Cost per gpm of I&I Removed from Basin
Prospect & Division	340	255	$2,223,000	$8,718
Park & Center	75	56	$1,497,000	$26,613
Harris & Angeline	25	19	$305,000	$16,267
Beach (Alternative 1)	5	4	$1,729,000	$461,067
Beach (Alternative 2)			$633,000	$168,800

Recommended Near Term Course of Action

Pursuing pipeline replacements in the Prospect and Division basin will achieve the greatest I&I reductions. We recommend that the County begin with these replacements immediately. Compliance with wetland permitting requirements is the most uncertain and potentially time consuming task in the preparation of a construction contract for this work. A discussion of site observations and potential permit requirements for the Prospect and Division basin can be found in **Appendix D.** Work should begin as soon as possible, and no later than October 1st of this year in to allow completion of a permitted bid set by the end of February 2013. This would allow construction to proceed during the dry season of 2012. The following is a schedule outlining Phase 1 of the project (Prospect and Division basin replacements).

During the winter of 2012 and, video inspection should be performed in the Park and Center Street Basin to locate sources of I&I. We recommend that the County purchase a set of portable weirs to enable it to perform its own flow isolation measurements. The County will be able to responsively measure peak flows during extreme peak events. The logistics of scheduling a contractor to perform these measurements on short notice was problematic over the 2011/2012 winter. Therefore, having portable weirs in the possession of County staff will enable us to reliably capture flowrates during extreme rainfall events. A set of portable weirs for pipes 6 to18 inches in diameter costs approximately $2,000.

Overall effectiveness of the I&I reduction projects can be evaluated by flows received at the wastewater treatment plant. Hourly data is now available at the plant with the installation of the HOBO data logger at the plant. In addition to these data, we recommend supplementing with flow isolation analyses in pipe segments that are suspected to have high I&I rates. Over the winter of 2013/2014, we recommend installation of in-stream flow monitoring to assess the effectiveness of the Phase 1 improvements. Within 4 years, this approach should effectively locate I&I sources and allow replacements to reduce the current I&I levels by 75percent.

APPENDICES

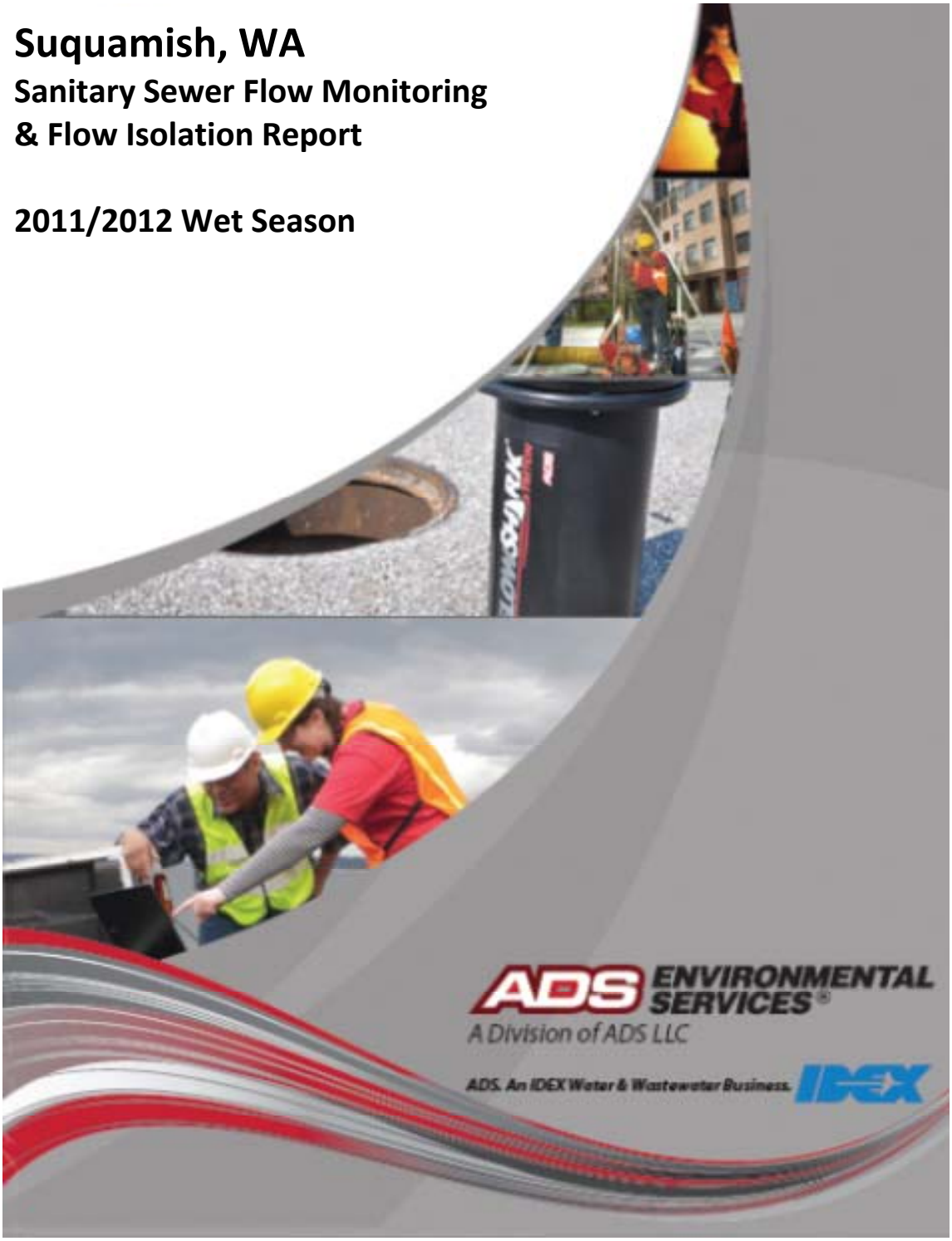
APPENDIX A

Suquamish Sanitary Sewer Flow Monitoring and Flow Isolation Report by ADS, 2011/2012 Wet Season

Suquamish, WA

Sanitary Sewer Flow Monitoring & Flow Isolation Report

2011/2012 Wet Season



4455 South 134 Place • Tukwila, WA 98168
Phone: 206.762.5070 • Fax: 206.762.5077
www.adsenv.com

April 23, 2012

Mr. John D. Hendron, P.E.
Project Manager
RH2 Engineering Inc.
12100 NE 195th St, Suite 100
Bothell, WA 98011
T 425.951.5326
jhendron@rh2.com

Re: Temporary Flow Monitoring & Flow Isolation Services - Suquamish, WA

Dear Mr. Hendron,

On behalf of ADS, thank you for the opportunity to complete the flow monitoring and flow isolation tasks in Suquamish, WA in Kitsap County during the 2011/2012 wet season. Please find attached the electronic report summarizing the observations and results based on the investigative studies undertaken in the Squamish sanitary sewer system.

John, we certainly look forward to other opportunities to work with RH2 and the County on wastewater and water projects as they arise. If you have any questions regarding the content of this report, please do not hesitate to call me at (206) 255 6904.

Thank you for your time.

Sincerely,

Gillian Woodward P.E.
Business Development Manager
(206) 255-6904

ADS Environmental Services
gwoodward@idexcorp.com
Enclosure

Table of Contents

Section 1 - Introduction

1.1 Background

RH2 Engineering Inc. (RH2) contracted ADS Environmental Services to conduct flow monitoring at multiple locations in Suquamish, WA. The objective of this study was to measure rainfall, depth and velocity and to quantify sewer flows to enable RH2 to isolate areas of the system contributing Rain Dependent Inflow/Infiltration (RDI/I). Section 2 of this report outlines the flow quantification methods, equipment type, and installation procedures for the flow monitoring equipment. Section 3 outlines the meter data evaluation and presentation procedures and format. Section 4 summarizes the flow isolation methodology. Finally, Appendix A of this report contains site information and graphical flow data from the ADS flow metering location and Appendix B a table of the flow isolation measurements.

1.2 Flow Monitoring Project Scope

The scope of this study involved using temporary flow monitors to quantify wastewater flow at multiple locations for various duration summarized in Table 1.

Site Name	Address	Flow Monitoring Duration
SUQ_D23-1002	7234 NE Parkway	12/9/2011 – 2/14/2012
SUQ_D23-2004	18593 Augusta Ave NE	9/29/2011 – 2/14/2012
SUQ_D23-2074	18678 Division Ave	9/29/2011 – 3/7/2012
SUQ_D23-2094	NE Fern St and Division Ave	2/16/2012 – 3/7/2012
SUQ_D23-3027	Down on the beach	2/16/2012 – 3/7/2012
SUQ_RG	18950 Park Boulevard NE	9/29/2011 – 3/7/2012

Specifically, the study included the following key components.

- Investigation of the proposed flow-monitoring site for adequate hydraulic conditions;
- Flow monitor installation;
- Flow monitor data collection and confirmations;
- Data analysis;
- Reporting.

Section 2 - Equipment and Methodology

2.1 Flow Quantification Methods

There are two main equations used to measure open channel flow; the Continuity Equation and the Manning Equation. The Continuity Equation, can be used if both depth of flow and velocity are available. In cases where velocity measurements are not available or not practical to obtain, the Manning Equation can be used to estimate velocity from the depth data based on certain physical characteristics of the pipe (i.e. the slope and roughness of the pipe being measured). However, the Manning equation assumes uniform, steady flow hydraulic conditions with non-varying roughnesses, which are typically invalid assumptions in most sanitary sewers.

Continuity Equation

The Continuity Equation simply states that the flow quantity (Q) is equal to the wetted area (A) multiplied by the average velocity (V) of the flow.

Q = A * V

This equation is applicable in a variety of conditions including backwater, surcharge, and reverse flow. Most modern flow monitoring equipment, including ADS models measure both depth and velocity and therefore are capable of using the Continuity Equation to calculate flow quantities.

2.2 Flow Monitoring Equipment

The monitor selected for this project was the ADS Model FlowShark™ flow monitor. This flow monitor is an area-velocity flow monitor.

The ADS Model FlowShark™ flow monitor consists of data acquisition sensors and a battery- powered microcomputer. The microcomputer includes a processor unit, data storage, and an on-board clock to control and synchronize the sensor recordings. The monitor was programmed to acquire and store depth of flow and velocity readings at 5-minute intervals.

Three types of data acquisition sensors are available for Model FlowShark™ flow monitor. The primary depth measurement device is the ADS quad-redundant ultrasonic level sensor. This sensor uses four independent ultrasonic transceivers in pairs to measure the distance from the face of the transceiver housing to the water surface (air range) with up to four of the available transceiver pair's active at one time. The elapsed time between transmitting and receiving the ultrasonic waves is used to calculate the air range between the sensor and flow surface based on the speed of sound in air. Sensors in the transceiver housing measure temperature, which is used to compensate the ultrasonic signal travel time. The speed of sound will vary with temperature. Since the ultrasonic level sensor is mounted out of the flow, it creates no disturbance to normal flow patterns and does not affect site hydraulics.

Redundant flow depth data can be provided by a pressure depth sensor, and is independent from the ultrasonic level sensor. This sensor uses a piezo-resistive crystal to determine the difference between hydrostatic and atmospheric pressure. The pressure sensor is temperature compensated and vented to the atmosphere through a desiccant filled breather tube. Its streamlined shape minimizes flow distortion.

Velocity is measured using the ADS V-3 digital Doppler velocity sensor. This sensor measures velocity in the cross-sectional area of flow. An ultrasonic carrier is transmitted upstream into the flow, and is reflected by suspended particles, air bubbles, or organic matter with a frequency shift proportional to the velocity of the reflecting objects. The reflected signal is received by the sensor and processed using digital spectrum analysis to determine the peak flow velocity. Collected peak velocity information is

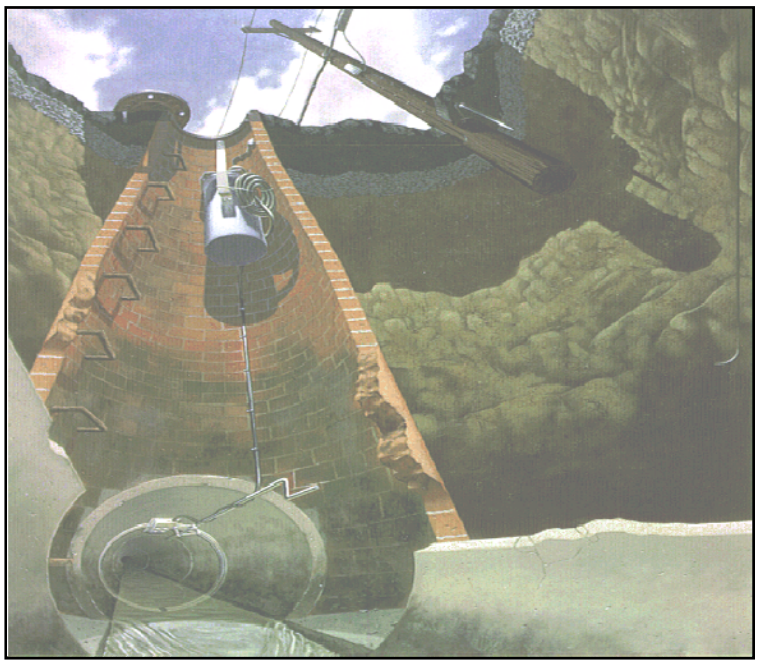
filtered and processed using field calibration information and proprietary software to determine the average velocity, which is used to calculate flow quantities. The sensor's small profile, measuring 1.5 inches by 1.15 inches by 0.50 inches thick, minimizes the effects on the site hydraulics.

2.3 Installation

Installation of flow monitoring equipment typically proceeds in four steps. First, the site is investigated for safety and to determine physical and hydraulic suitability for the flow monitoring equipment. Second, the equipment is physically installed at the selected location. Third, the monitor is tested to assure proper operation of the velocity and depth of flow sensors and verify that the monitor clock is operational and synchronized to the master computer clock. Fourth, the depth and velocity sensors are validated and line confirmations are performed. A typical ADS flow monitor installation is shown in Figure 2.1.

The installations depicted in Figure 2.1 are typical for circular or oval pipes up to approximately 104-inches in diameter or height. In installations into pipes 42-inches or less in diameter, depth and velocity sensors are mounted on an expandable stainless steel ring and installed one to two pipe diameters upstream of the pipe/manhole connection in the incoming sewer pipe. This reduces the affects of turbulence and backwater caused by the connection. In pipes larger than 42 inches in diameter, a similar installation is made using two sections of the ring installed one to two feet upstream of the pipe/manhole connection; one bolted to the crown of the pipe for the depth sensor, and the other bolted to the bottom of the pipe (bolts usually placed just above the water line) to hold the velocity sensor.

Figure 2.1 Typical Installation



2.4 Data Collection, Confirmation, and Quality Assurance

During the monitoring period, field crews visit each monitoring location to verify proper monitor operation and document field conditions. Data are collected remotely by a data analyst where wireless connectivity to the flow meter is possible.

The following quality assurance steps are taken to assure the integrity of the data collected:

- **Measure Power Supply:** The monitor is powered by a dry cell battery pack. Power levels are recorded and battery packs replaced, if necessary. A separate battery provides back-up power to memory, which allows the primary battery to be replaced without the loss of data.
- **Perform Pipe Line Confirmations and Validate Depth and Velocity:** Once equipment and sensor installation is accomplished, a member of the field crew descends into the manhole to perform a field measurement of flow rate, depth and velocity to confirm they are in agreement with the monitor. Since the ADS V-3 velocity sensor measures peak velocity in the wetted cross-sectional area of flow, velocity profiles may be taken to develop a relationship between peak and average velocity in lines that meet the hydraulic criteria.
- **Measure Silt Level:** During site confirmation, a member of the field crew descends into the manhole and measures and records the depth of silt at the bottom of the pipe. This data is used to accurately compute the wetted area of flow.
- **Confirm Monitor Synchronization:** The field crew checks the flow monitor's clock for accuracy.
- **Upload and Review Data:** Data collected by the monitor is uploaded and reviewed for comparison with previous data. All readings are checked for consistency and screened for deviations in the flow patterns, which indicate system anomalies or equipment failure.

Section 3 - Data Analysis and Presentation

3.1 Data Analysis

A flow monitor is programmed to collect data at 5-minute intervals throughout the monitoring period unless circumstances dictate a more frequent sample rate (e.g. rapidly changing flows due to pump station influence). The monitor stores raw data consisting of (1) the air range (distance from sensor to top of flow) for each active ultrasonic depth sensor pair and (2) the peak velocity. If the monitor is equipped with a pressure sensor, then a depth reading from this sensor may also be stored. When the data is collected, the air range is converted to depth data based on the pipe height and physical offset (distance from the top of the pipe to the surface of the ultrasonic sensor). The data is examined by a data analyst to verify its integrity. The data analyst also reviews field reports and site visit records to identify conditions that may affect the collected data.

Velocity profiles and line confirmation data developed by the field personnel are reviewed by the data analyst to identify inconsistencies and verify data integrity. Velocity profiles are reviewed and an average to peak velocity ratio is calculated for the site. This ratio is used in converting the peak velocity measured by the sensor to the average velocity used in the Continuity equation.

The data analyst selects which ultrasonic pairs and/or depth sensor entity will be used to calculate the final depth information. Any silt levels present at each site visit are reviewed and representative silt levels established.

Selections for the above parameters can be constant or can change during the monitoring period. While the data analysis process is described in a linear manner, it often requires an iterative approach to accurately complete.

3.2 Data Presentation

This type of flow monitoring project generates a large volume of data. To facilitate review of the data, results have been provided in a graphical format in Appendix A. The flow data is presented graphically in the form of scattergraphs and hydrographs. The following explanation of terms may aid in interpretation of the scattergraphs and hydrographs:

DFINAL – Final calculated depth measurement (in inches)

VFINAL – Final calculated flow velocity (in feet per second)

QFINAL -- Final calculated flow rate (in gpm)

AVERAGE – The average depth, velocity, and flow observed over the period indicated. Based on an average of all valid 5-minute data points.

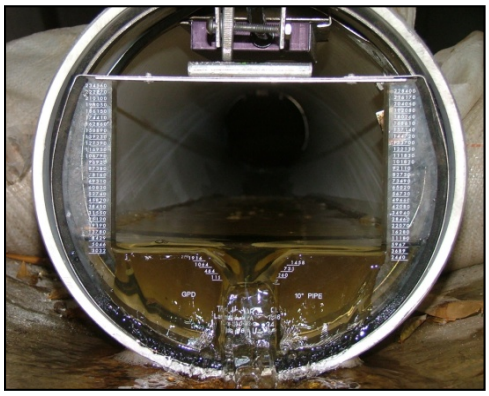
MINIMUM -- The minimum depth, velocity, and flow observed over the period indicated. Derived from 5-minute interval data points.

MAXIMUM -- The maximum depth, velocity, and flow observed over the period indicated. Derived from 5-minute interval data points.

Section 4 - Flow Isolations

Flow isolations are used to obtain night time flow values in the system where the flow volume may be too small to be reliably measured by a flow meter. Flow isolation work consisted of night time entry into the manhole, setup of quick insert weir equipment, and data collection from each location.

Figure 4.1 A Quick Insert Weir



RH2 determined the location of the flow isolation manholes utilizing the County provided GIS files. The initial Squamish flow isolations were completed early morning on February 2 and 3, 2012 for a total of twenty manhole locations encompassing forty measurements. On February 23, 2012 two additional flow isolations were taken. The results from the flow isolations are provided in Appendix B.

All sewage collection systems will have a certain amount of infiltration. The joint ASCE-WEF (1982) design guidelines for gravity sewers gives a table of guidelines used by various municipalities for the infiltration that should be used in capacity calculations for a sewer system approaching the end of its design life. These guidelines are expressed in terms of gallons per day per inch diameter mile (gpd/IDM) and in terms of gpd/mile (assuming 8-inch pipes) and are presented in Table 4.1.

Table 4.1 ASCE-WEF Infiltration Guidelines

Number and Percent Of Cities Reporting	I&I Allowance (gpd/IDM)	Total I&I Allowance (gpd/mile)
4 (3.1%)	1500	12,000
4 (3.1%)	1000	8,000
1 (0.8%)	800	6,400
2 (1.6%)	700	5,600
1 (0.8%)	600	4,800
63 (49.2%)	500	4,000
11 (8.6%)	450 to 300	3,000
16 (12.5%)	250 to 150	1,600
21 (16.4%)	100	800

Number and Percent Of Cities Reporting	I&I Allowance (gpd/IDM)	Total I&I Allowance (gpd/mile)
5 (3.9%)	50	400
Total Cities = 128	Weighted Avg. = 422	Weighted Avg. = 3,200

Upstream flows were subtracted to provide net flows for each micro basin and provided to RH2 to complete the normalized analysis. In some cases the flow isolation results yielded negative net flows. This can occur when there is a pump station influence upstream (resulting in pulses being detected at different times for the upstream and downstream locations), the weir does not fit in the pipe well or silt is evident. Notes have been provided in Appendix B where there were issues obtaining accurate flow isolations.

Appendix A

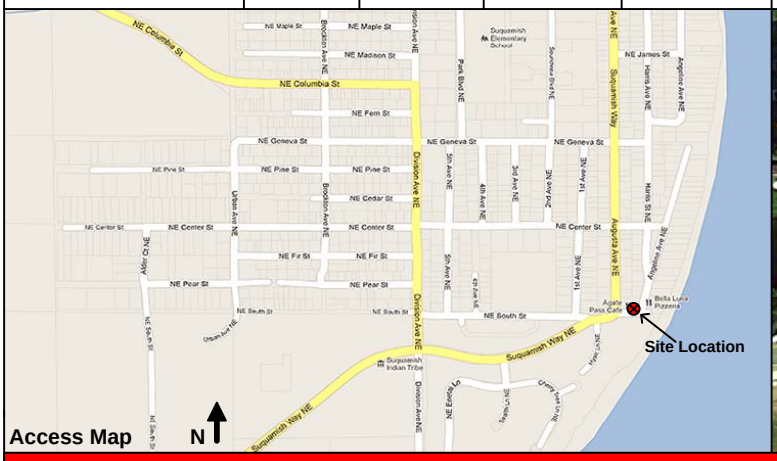
- Site Sheet
- Hydrograph
- Scattergraph
- Photo Collages

ADS Site Report

Quality Form

Project Name:	Suquamish.RH2.TFM.WA11	**City / State:**	Suquamish, WA	**FM Initials:**	SW
Site Name:	SUQ_D23-1002	**Monitor Series:**	FS 5000 AG		
Address/Location:	7234 NE Parkway (Dockside Bar and Grill)				
Access:	Drive	**Type of System:**	Sanitary [X] Storm [ ] Combined [ ]		

Monitor S/N:	26171
Manhole #	D23-1002
GPS Coordinates:	47°43'47.59"N 122°33'6.07"W
Pipe Height:	8.00"
Pipe Width:	7.88"
IP Address:	166.213.6.61



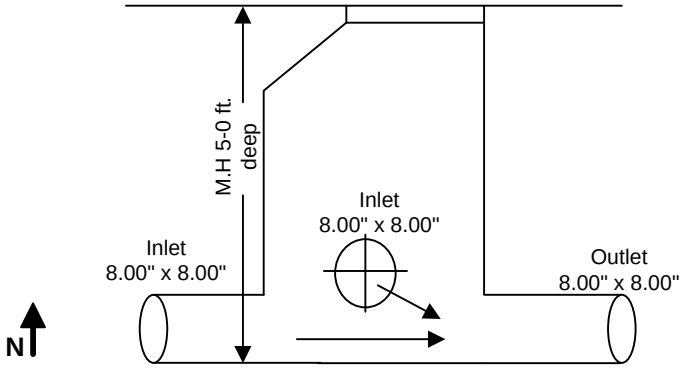
Investigation Information:

Date/Time of Investigation:	9/14/11 @ 12:30
Site Hydraulics:	Very low flow
Upstream Input: (L/S, P/S)	No influence
Upstream Manhole:	2 inlets / 1 outlet (Drop connection)
Downstream Manhole:	1 inlet / 1 outlet (90 degree bend)
Depth of Flow:	0.50" +/- 0.25"
Range (Air DOF):	7.50" +/- 0.25"
Peak Velocity:	2.00 fps
Silt:	0.00" Inches

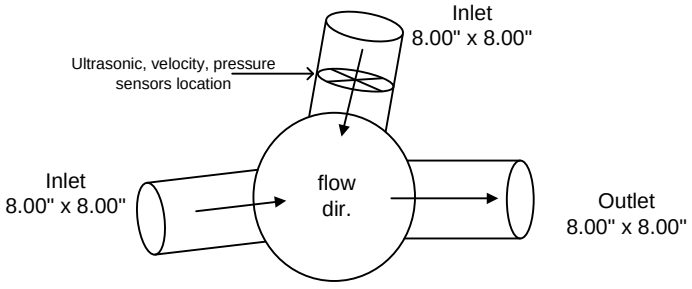
Manhole Information:

Manhole Depth:	5'				
Manhole Material / Condition	Concrete / Good				
Pipe Material / Condition:	Concrete / Good				
Mini System Character:	Residential [X]	Commercial [X]	Industrial [ ]	Trunk [ ]	
Telephone Information:	Doesn't apply				
Access Pole #:	Doesn't apply				
Distance From Manhole:	Doesn't apply	Feet			
Road Cut Length:	Doesn't apply	Feet			
Trench Length:	Doesn't apply	Feet			

Other Information:



Cross Section



Planar

Installation Information	
Installation Type:	Standard
Sensors Devices:	Ultra, Velocity, Pressure
Surcharge Height:	0 Feet
Rain Gage Zone:	SUQ_RG

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

Additional Site Information / Comments:

Pressure (5 PSI, accuracy +/- 0.25% for range of 0.25 – 11.5 ft.)

Flow Monitoring Site Safety Plan

Project Name: Suquamish.RH2.TFM.WA11	**Site ID:** SUQ_D23-1002	**Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	☐
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
Confined Space	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☐
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

No hazards found at this site

*** Site Classification**

	Class	Description
☐	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☒	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. *Must be approved by Corporate Safety Manager*

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

One flagger is needed for traffic control

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

- ☐ This worksite does NOT require a Traffic Control Plan
- ☒ Standard Traffic Control Plan TA-27 is to be used at this work site
- ☐ This site requires a special Traffic Control Plan which is attached

Approved		**Reviewed**	
Field Mgr Name:	Sean Winder	Project Mgr Name:	Mike Pina
Signature:	Signed copy can be obtained from ADS	Signature:	Signed copy can be obtained from ADS
Date:	9/15/11	Date:	9/15/11

Site Information

SUQ_D23-1002

Monitoring Period: 12/9/2011 – 2/14/2012
Measured Pipe Dimension: 8.00" x 7.88"
Finalized Silt: 0.00"

Overview

Metering point SUQ_D23-1002 was located at 7234 NE Parkway (see attached site report for details).

The hydrograph indicates a residential diurnal flow pattern. The scattergraph for this location indicates a repeatable data set.

The depth and velocity measurements recorded by the flow monitor were consistent with the field confirmations and supported the relative accuracy of the instrumentation at this location.

Due to the very shallow flow conditions the velocity sensor registered a high number of invalid zero readings. Because of this the derived Manning's equation was used to calculate the flow rate for the monitoring period except during the 2/2/2012 storm event.

The response to rainfall of the flow data calculated for this location appears to be associated more with infiltration (gradual recovery after storm events) than inflow (sharp response to storm events).

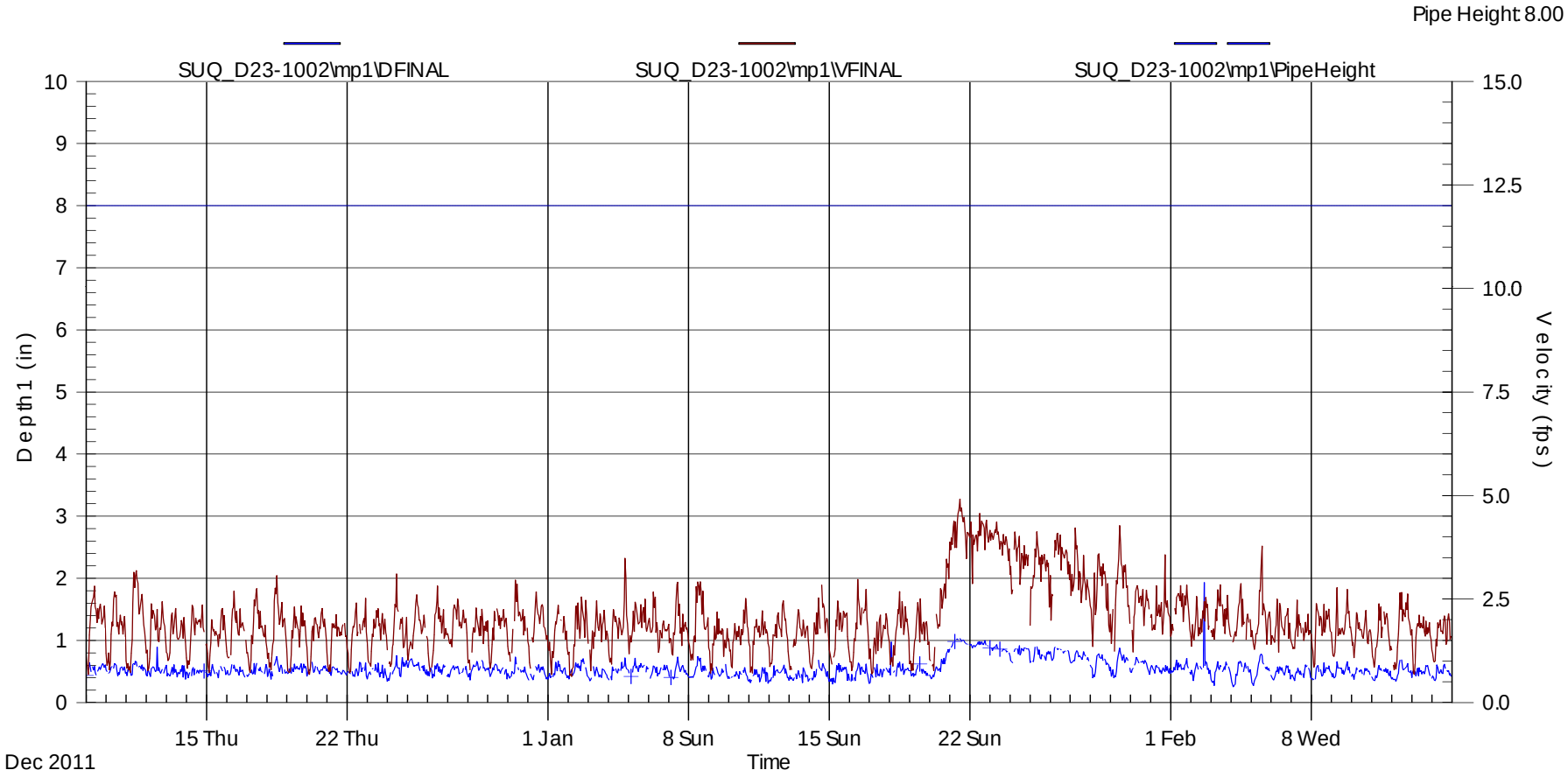
The average depth, velocity and flow rate values data for the monitoring period, along with the observed minimum and maximum data, are provided in the following table. The minimum and maximum rates recorded in the tables are based on 5-minute data intervals.

	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Average	0.51	1.72	12.02
Minimum	0.12	0.10	0.56
Maximum	1.21	4.71	65.32

Data uptime for the monitoring period (based on a 5 minute sample rate) is provided in the table below.

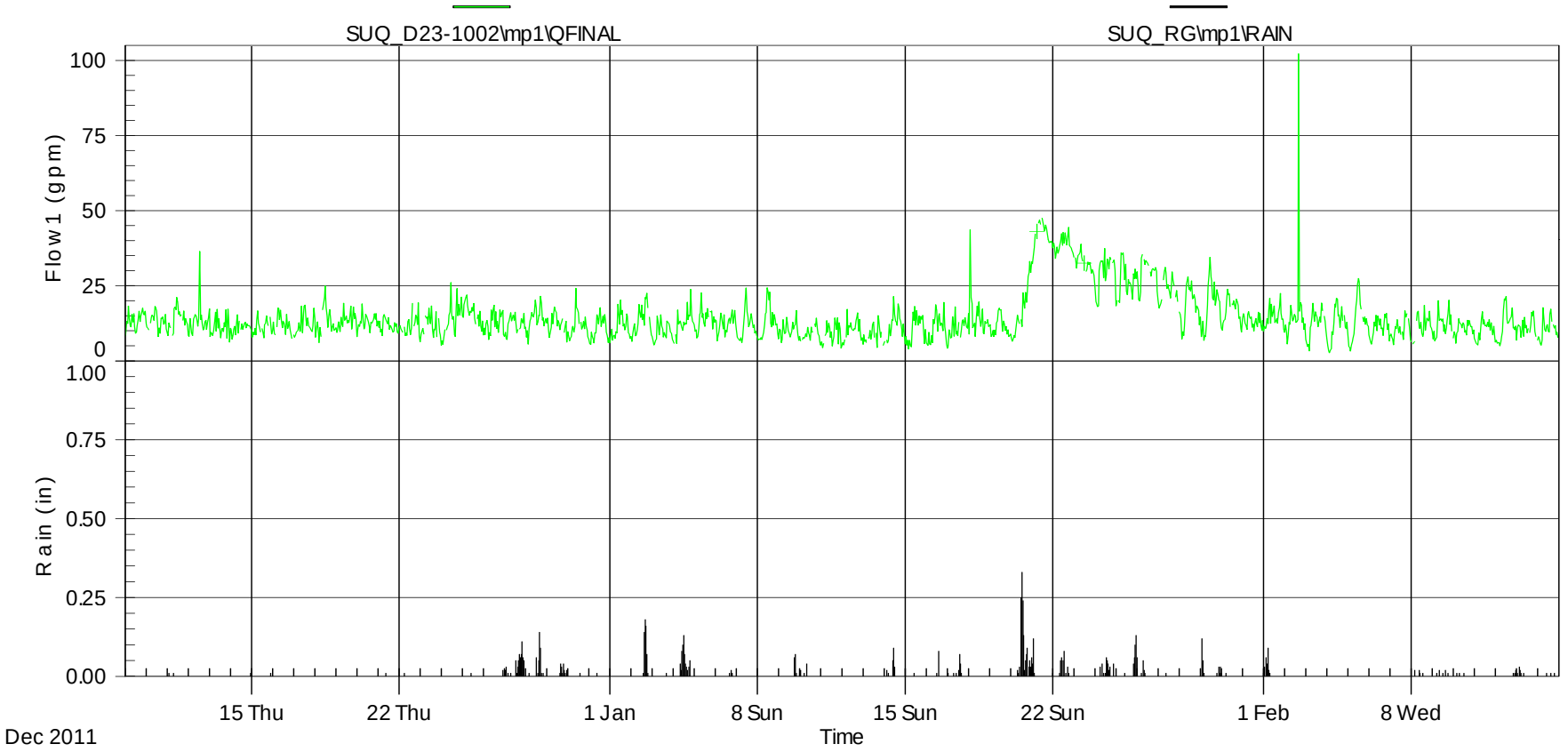
	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Raw	100%	100%	100%
Validated	100%	81%	100%

ADS Environmental Services



ADS Environmental Services

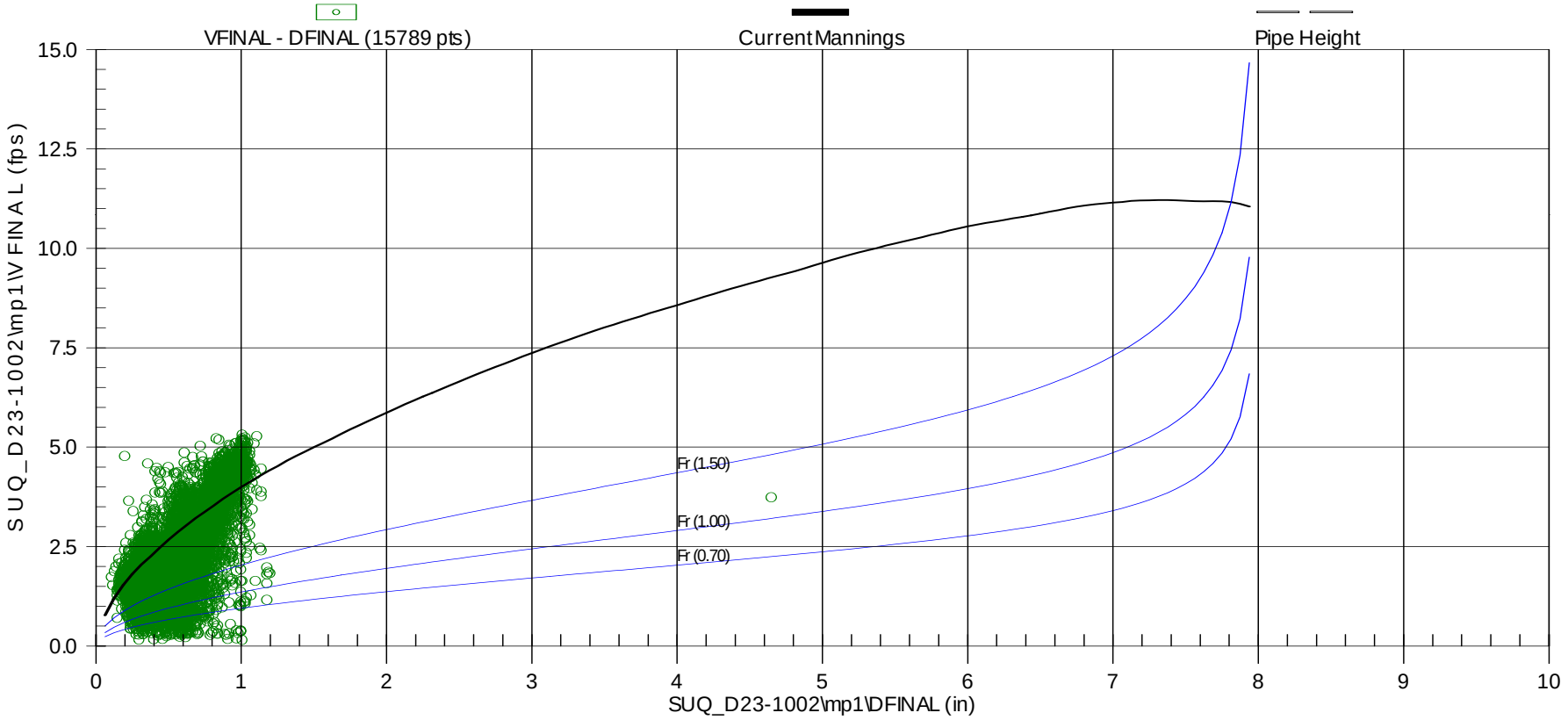
Pipe Height 8.00



ADS Environmental Services

12/9/2011 12:00:00 AM - 2/15/2012 12:00:00 AM

Pipe Height 8.00



SUQ_D23-1002

Site access

ADS ENVIRONMENTAL SERVICES®

Site access looking northwest

Photo taken
12.08.11 @ 12:58

SUQ_D23-1002

Site set up

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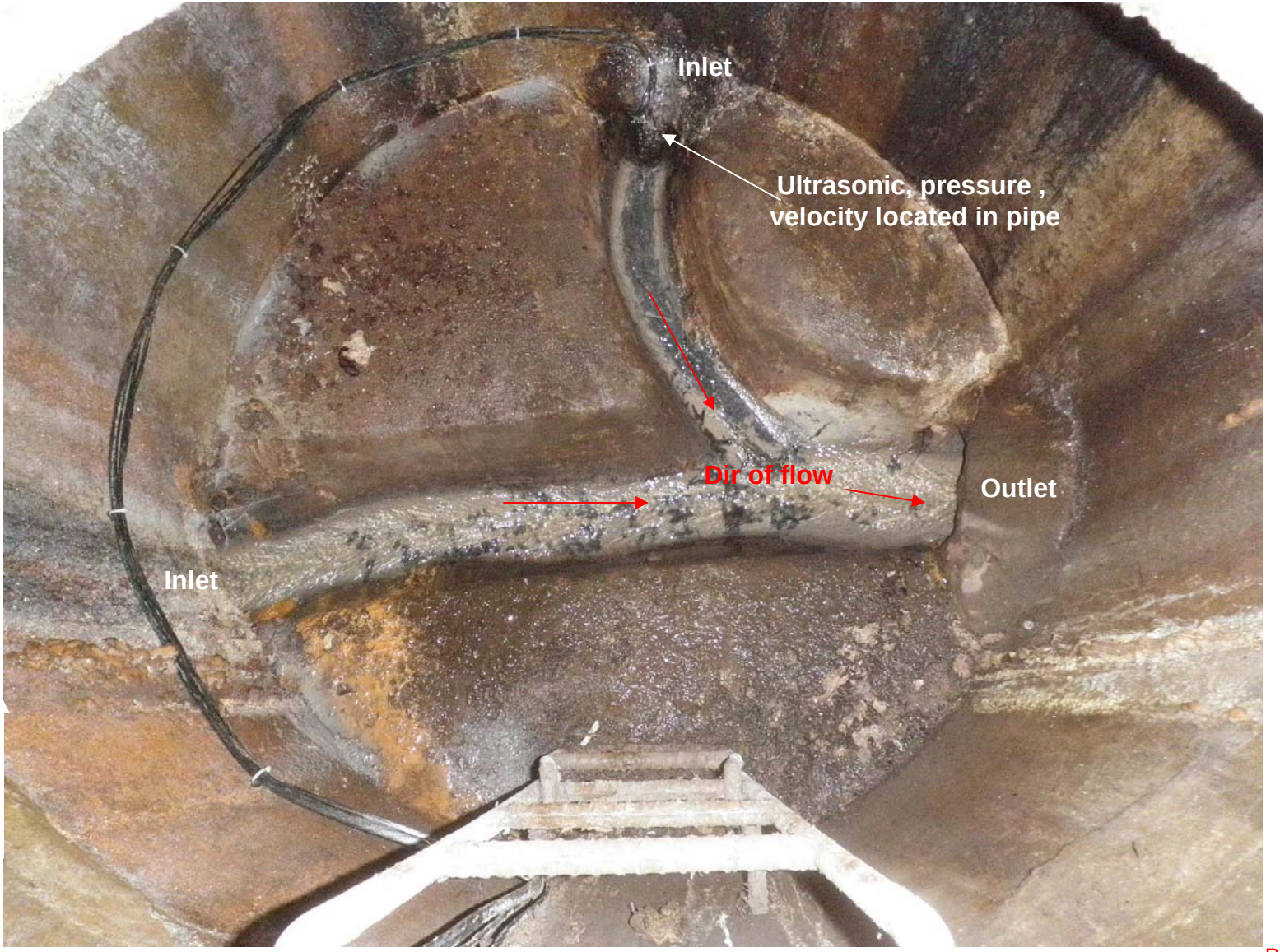


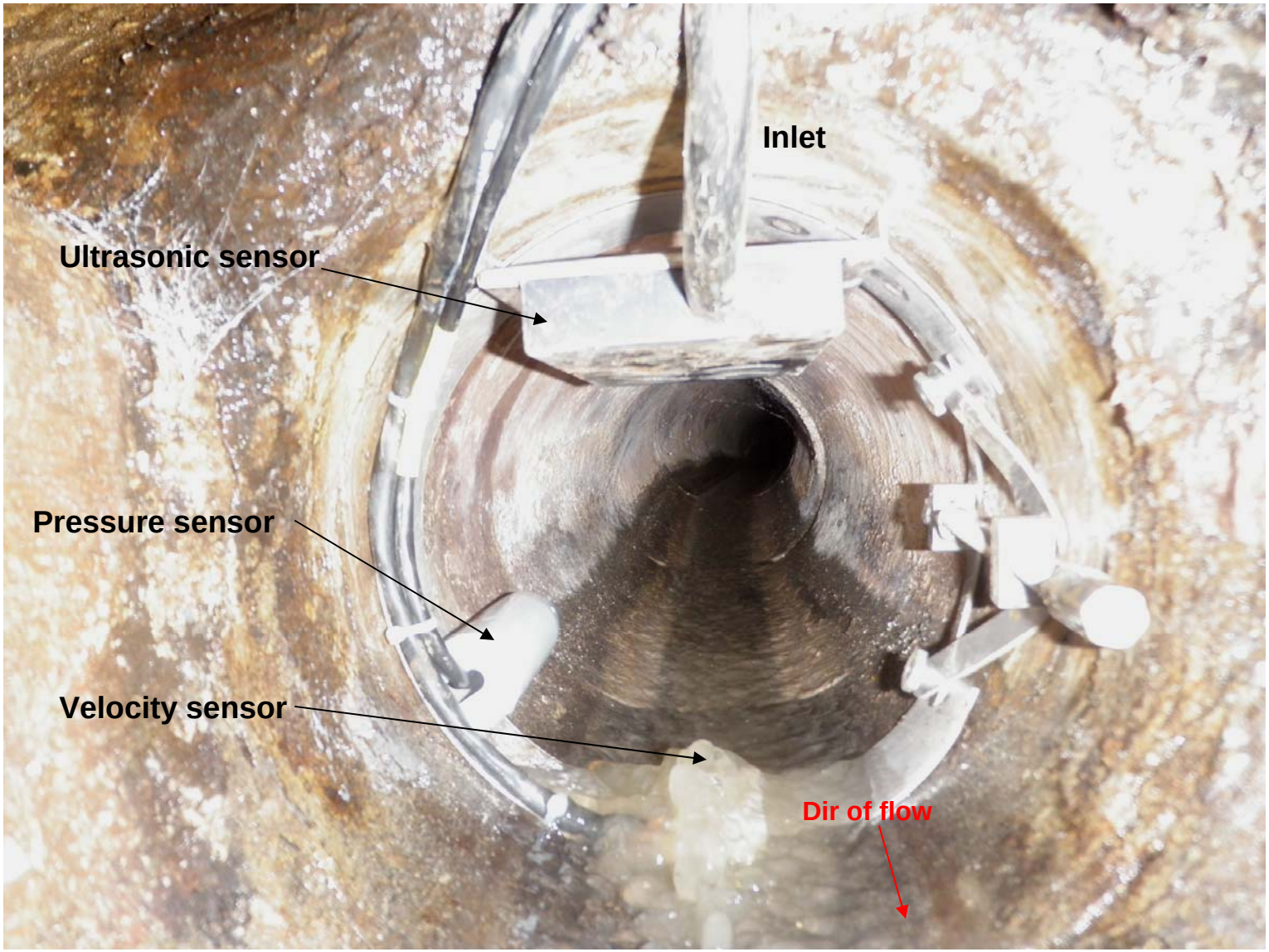
View down manhole looking north

Photo taken 12.08.11 @ 13:19

SUQ_D23-1002

Site set up

ADS ENVIRONMENTAL SERVICES®



View of sensor placement and site hydraulics

Photo taken
12.08.11 @ 13:01

SUQ_D23-1002
Site set up

ADS ENVIRONMENTAL SERVICES®

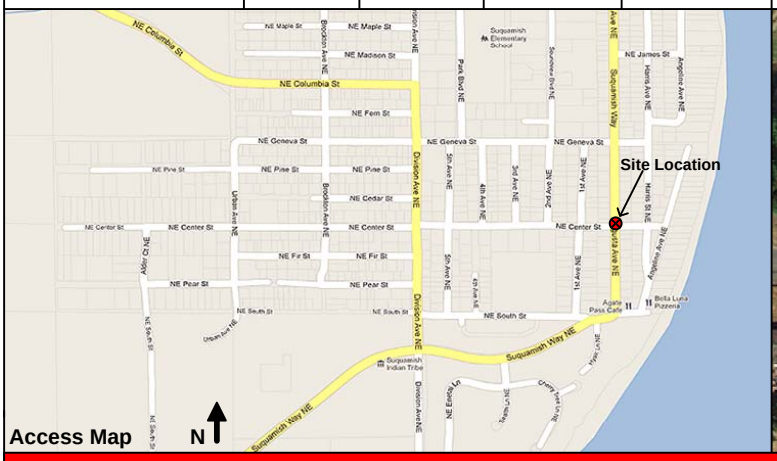
View of outlet and hydraulics

Photo taken
12.08.11 @ 13:03

ADS Site Report

Quality Form

Project Name:	Suquamish.RH2.TFM.WA11	**City / State:**	Suquamish, WA	**FM Initials:**	SW
Site Name:	SUQ_D23-2004	**Monitor Series:**	FS 5000 AG	**Monitor S/N:**	21781
Address/Location:	18593 Augusta Ave NE (Frame Station)			**Manhole #**	D23-2004
				GPS Coordinates:	47°43'53.91"N 122°33'8.75"W
				Pipe Height:	8.00"
Access:	Drive	**Type of System:**	Sanitary [X] Storm [ ] Combined [ ]	**Pipe Width:**	8.00"
				IP Address:	166.213.6.77



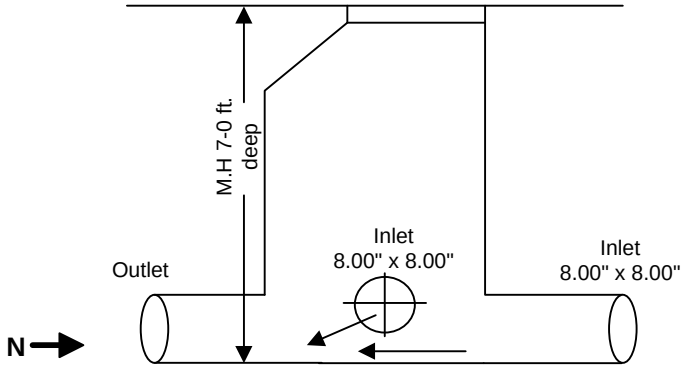
Investigation Information:

Date/Time of Investigation:	9/14/11 @ 11:14
Site Hydraulics:	Steady low depth flow with ripples
Upstream Input: (L/S, P/S)	No influence
Upstream Manhole:	2 inlets / 1 outlet (flow pulses)
Downstream Manhole:	1 inlets / 1 outlet
Depth of Flow:	1.13" +/- 0.25"
Range (Air DOF):	6.88" +/- 0.25"
Peak Velocity:	1.50 fps
Silt:	0.00" Inches

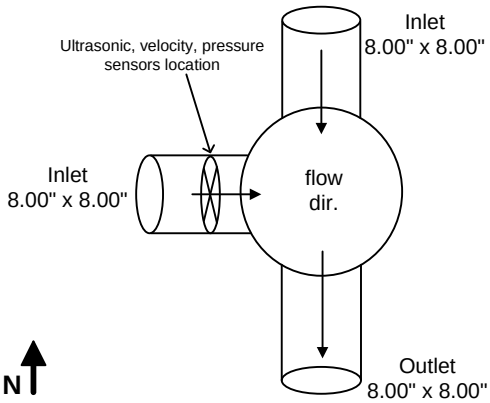
Manhole Information:

Manhole Depth:	7'				
Manhole Material / Condition	Concrete / Good				
Pipe Material / Condition:	Concrete / Good				
Mini System Character:	Residential [X]	Commercial [ ]	Industrial [ ]	Trunk [ ]	
Telephone Information:	Doesn't apply				
Access Pole #:	Doesn't apply				
Distance From Manhole:	Doesn't apply	Feet			
Road Cut Length:	Doesn't apply	Feet			
Trench Length:	Doesn't apply	Feet			

Other Information:



Cross Section



Planar

Installation Information	
Installation Type:	Standard
Sensors Devices:	Ultra, Velocity, Pressure
Surcharge Height:	0 Feet
Rain Gage Zone:	SUQ_RG

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

Additional Site Information / Comments:

Pressure (5 PSI, accuracy +/- 0.25% for range of 0.25 – 11.5 ft.)

Flow Monitoring Site Safety Plan

Project Name: Suquamish.RH2.TFM.WA11	**Site ID:** SUQ_D23-2004	**Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	X
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
Confined Space	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☐
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

Site is located in moderate volume intersection, there is ample room for vehicles to flow through work zone, follow TCP listed below

*** Site Classification**

	Class	Description
X	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☐	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. *Must be approved by Corporate Safety Manager*

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

No site specific hazards found

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

- ☐ This worksite does NOT require a Traffic Control Plan
- X Standard Traffic Control Plan TA-26 is to be used at this work site
- ☐ This site requires a special Traffic Control Plan which is attached

Approved		**Reviewed**	
Field Mgr Name:	Sean Winder	Project Mgr Name:	Mike Pina
Signature:	Signed copy can be obtained from ADS	Signature:	Signed copy can be obtained from ADS
Date:	9/15/11	Date:	9/15/11

Site Information

SUQ_D23-2004

Monitoring Period: 9/29/2011 – 2/14/2012
Pipe Dimension: 8.00" x 8.00"
Finalized Silt: 0.00"

Overview

Metering point SUQ_D23-2004 was located at 18593 Augusta Ave NE (see attached site report for details).

The hydrograph indicates a residential diurnal flow pattern. The scattergraph for this location indicates a repeatable data set.

The depth and velocity measurements recorded by the flow monitor were consistent with the field confirmations and supported the relative accuracy of the instrumentation at this location.

During the monitoring period the velocity sensor had a tendency to register invalid 0ft/s readings due to the very shallow flow conditions and these values were flagged. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate the flow rate for the monitoring period.

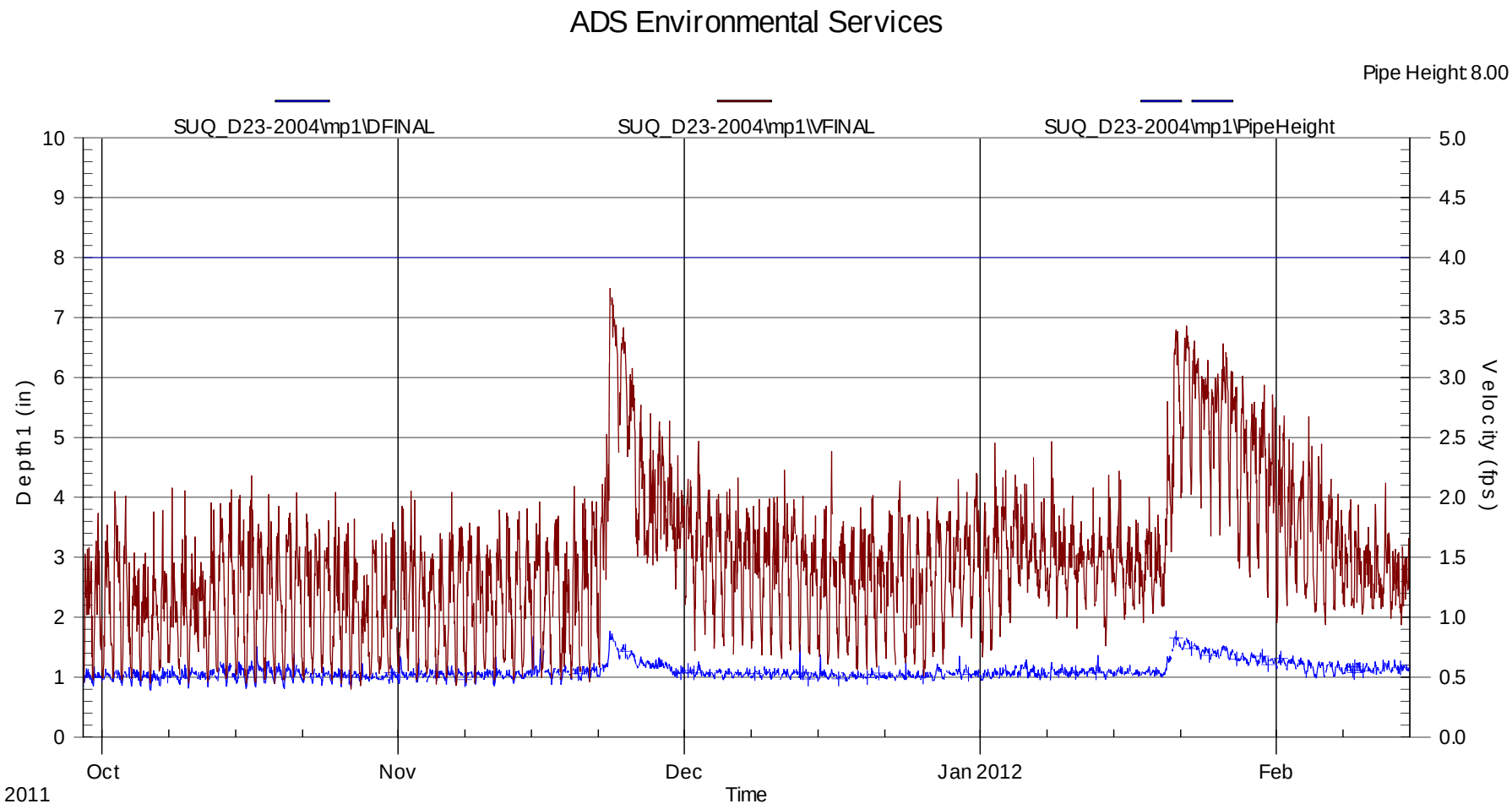
The response to rainfall of the flow data calculated for this location appears to be associated with inflow and infiltration (sharp response to storm events and gradual recovery after storm events).

The average depth, velocity and flow rate values data for the monitoring period, along with the observed minimum and maximum data, are provided in the following table. The minimum and maximum rates recorded in the tables are based on 5-minute data intervals.

	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Average	1.04	1.14	14.32
Minimum	0.59	0.12	1.44
Maximum	2.47	3.34	74.95

Data uptime for the monitoring period (based on a 5 minute sample rate) is provided in the table below.

	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Raw	100%	100%	100%
Validated	100%	94%	94%


ADS Environmental Services
Pipe Height 8.00
SUQ_D23-2004\mp1\DFINAL
SUQ_D23-2004\mp1\VFINAL
SUQ_D23-2004\mp1\PipeHeight
Depth1 (in)
Velocity (fps)
10
9
8
7
6
5
4
3
2
1
0
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
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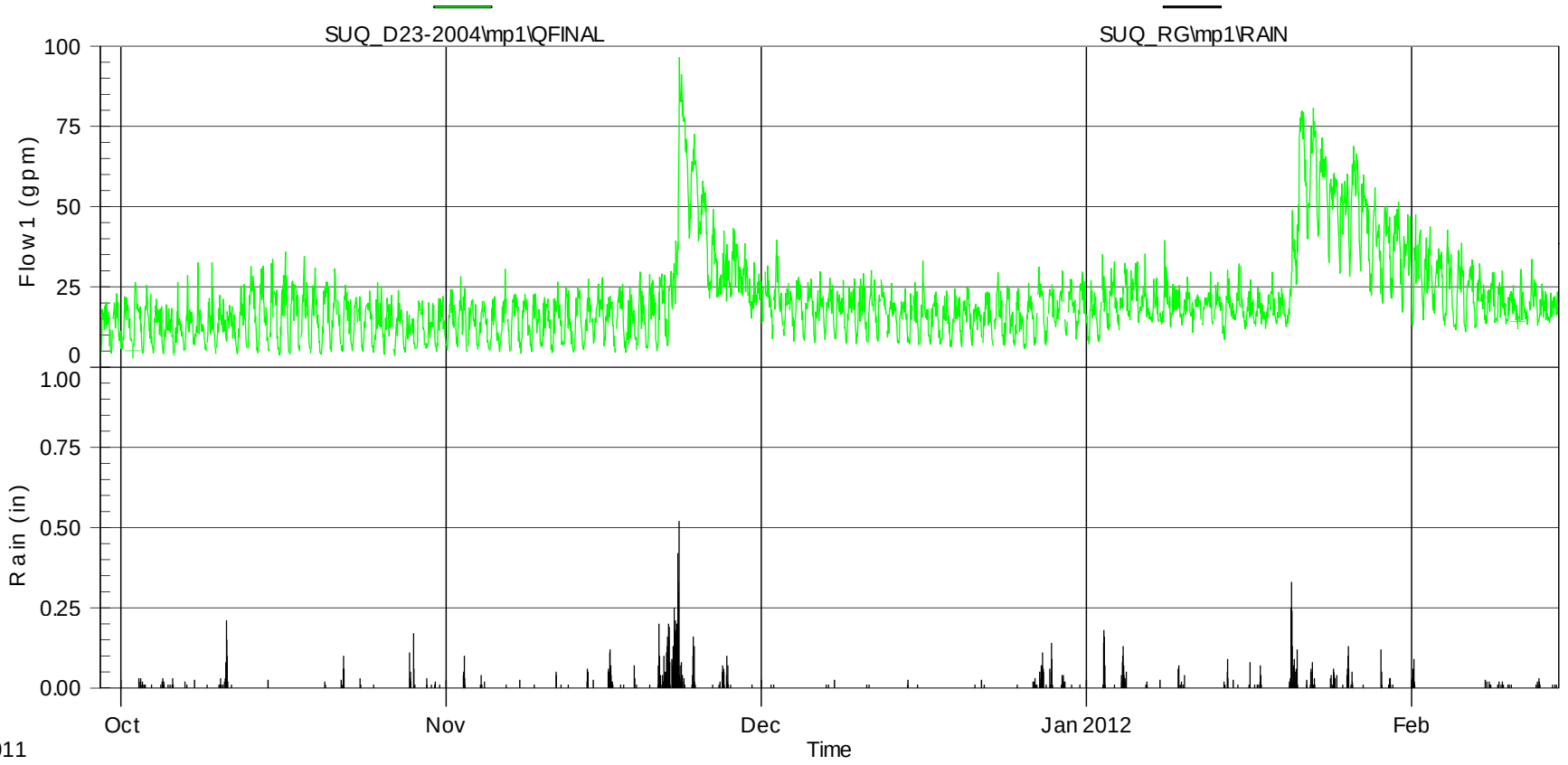
0.5
0.0
Oct
Nov
Dec
Jan 2012
Feb
2011
Time

ADS Environmental Services

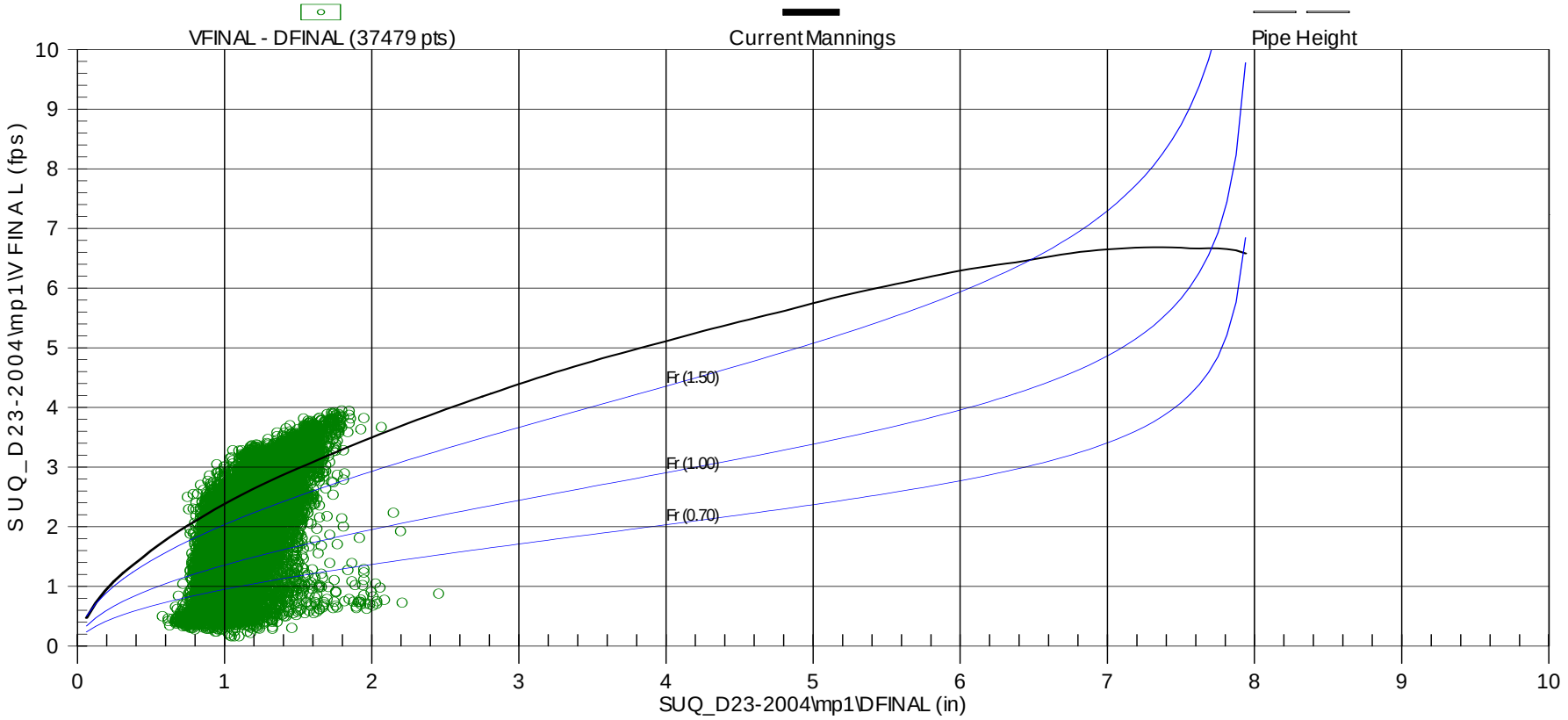
Pipe Height 8.00



ADS Environmental Services

9/29/2011 12:00:00 AM - 2/15/2012 12:00:00 AM

Pipe Height 8.00



SUQ_D23-2004

Site access

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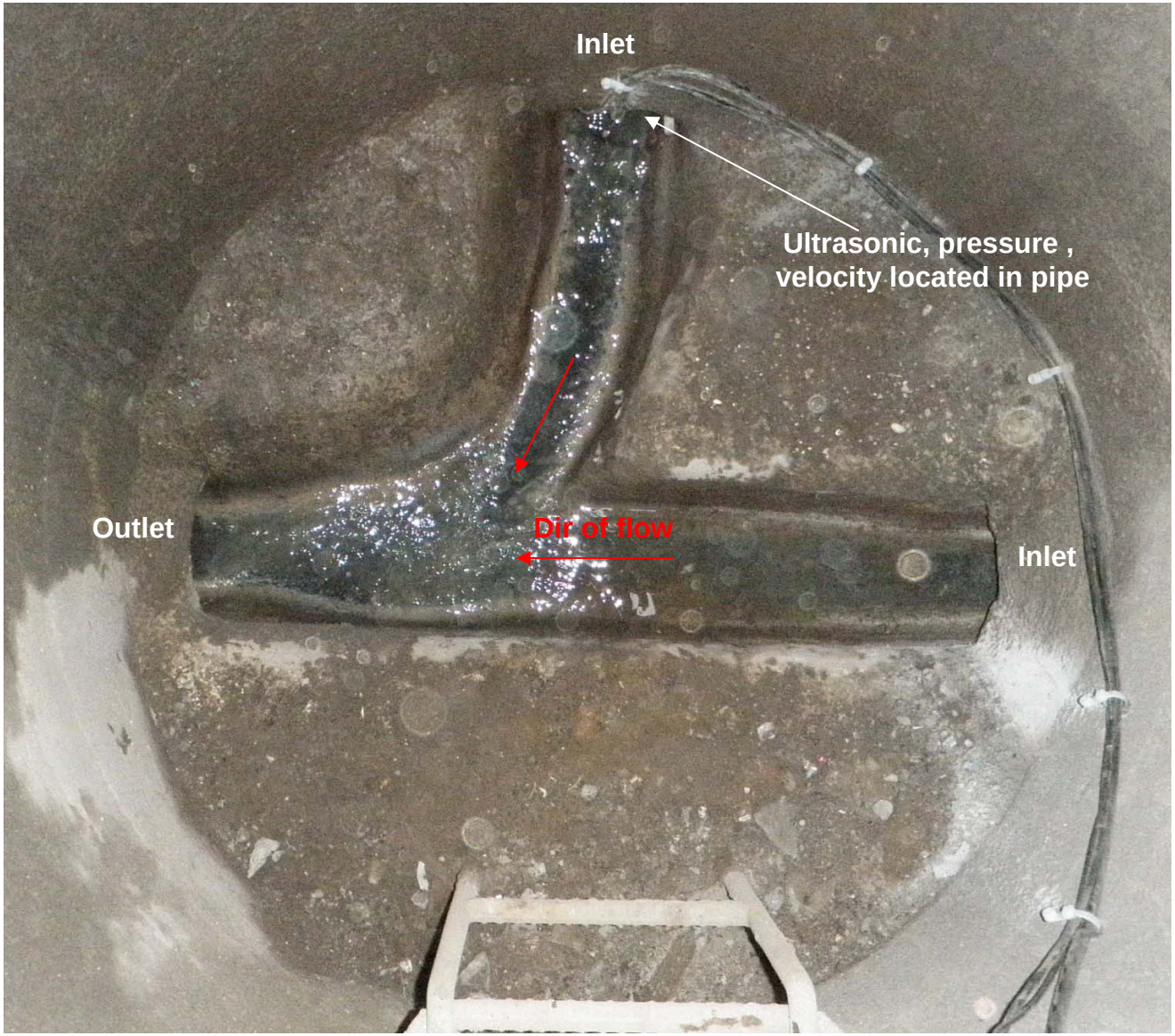
Site access looking south

Photo taken
09.22.11 @ 12:22

SUQ_D23-2004
Site set up

ADS ENVIRONMENTAL SERVICES®



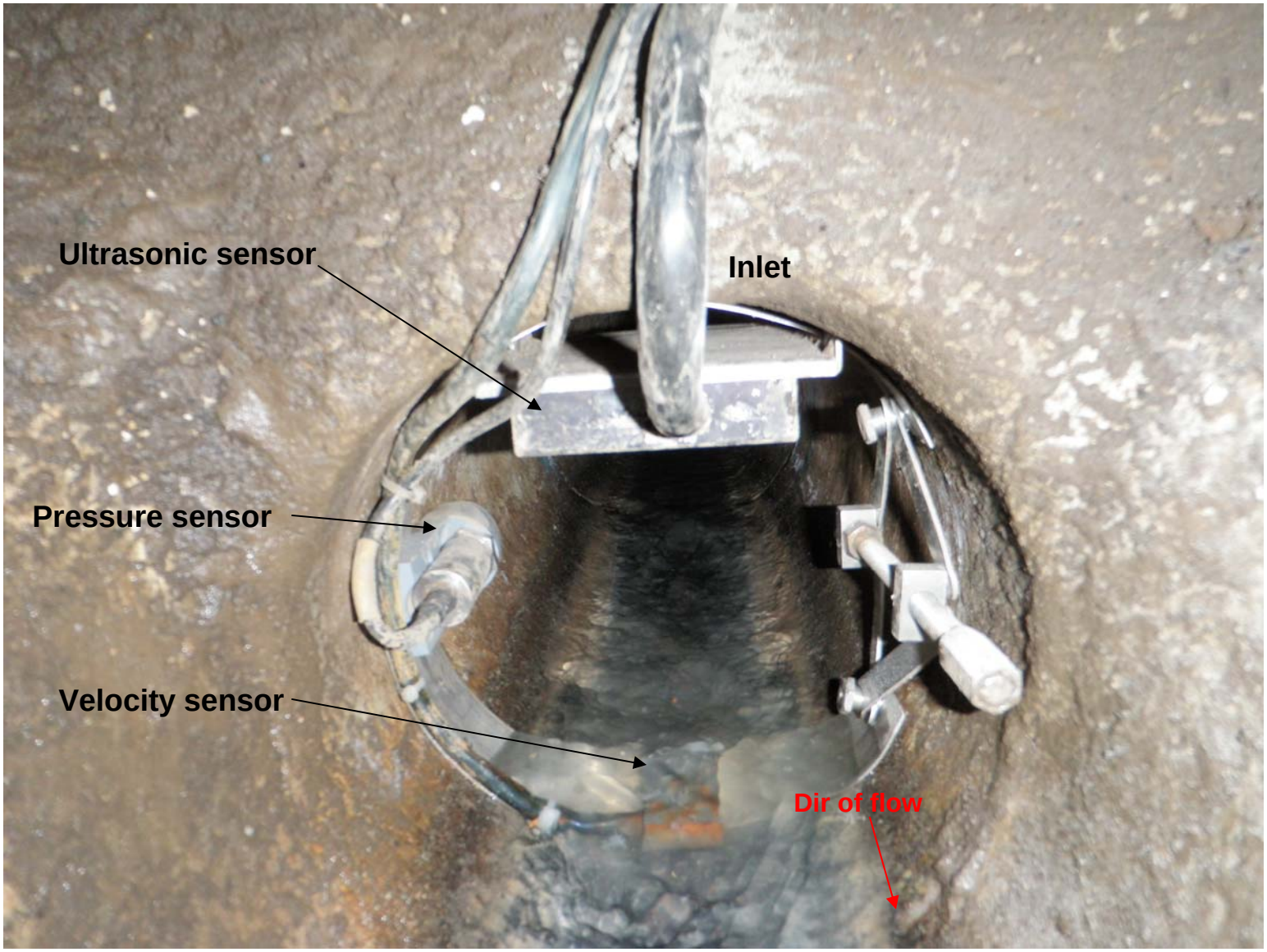
View down manhole looking west

Photo taken
09.22.11 @ 11:36

SUQ_D23-2004

Site set up

ADS ENVIRONMENTAL SERVICES®

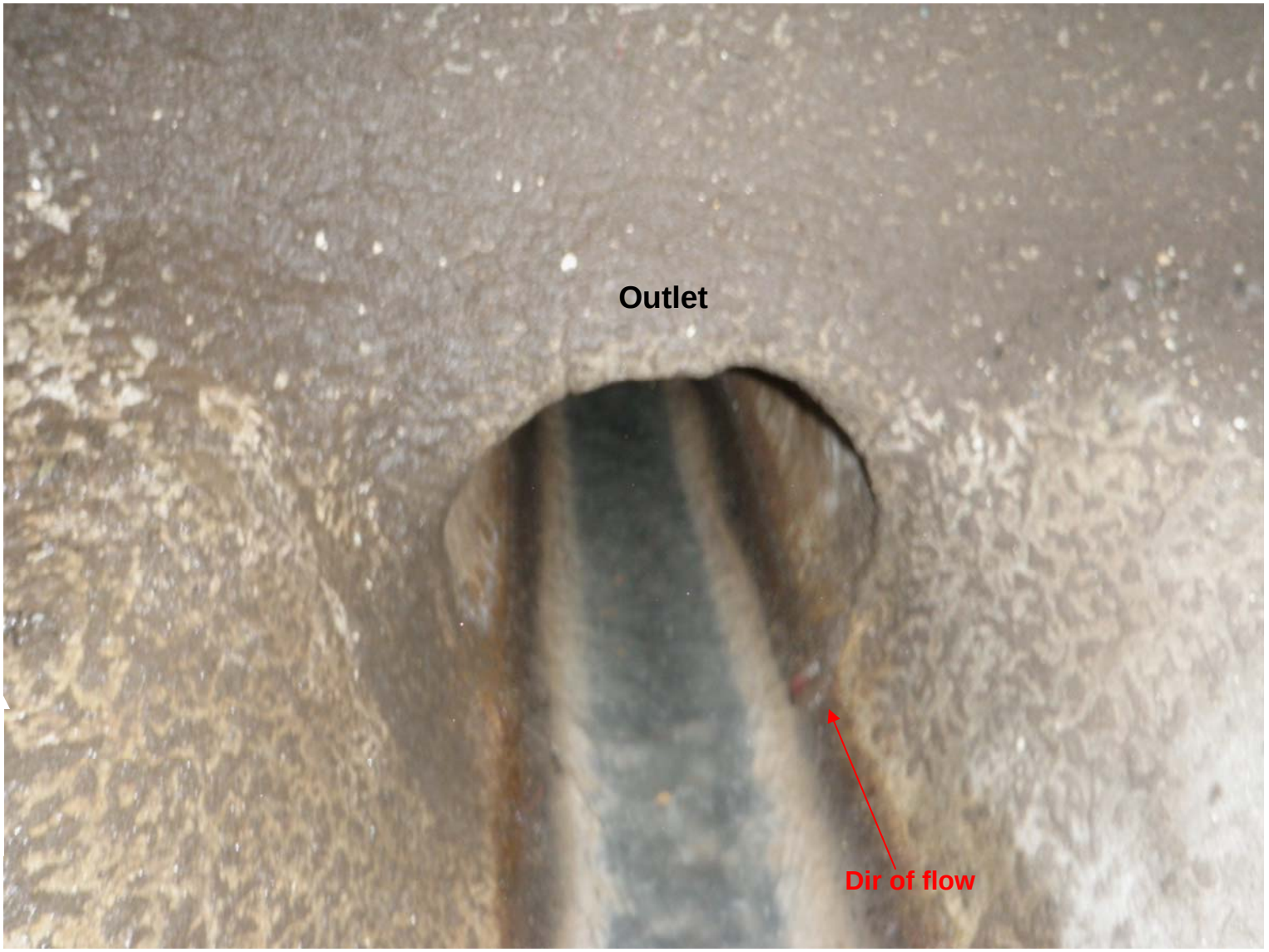


View of sensor placement and site hydraulics

Photo taken
09.22.11 @ 11:33

SUQ_D23-2004
Site set up

ADS ENVIRONMENTAL SERVICES®



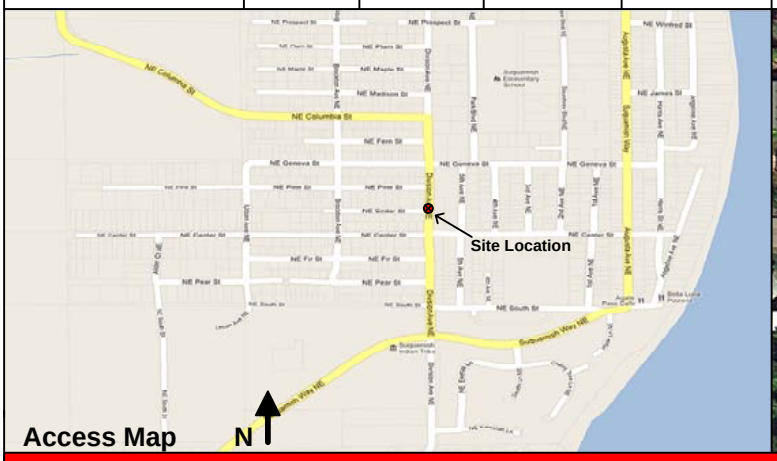
View of outlet and hydraulics

Photo taken
09.22.11 @ 10:38

ADS Site Report

Quality Form

Project Name:	Suquamish.RH2.TFM.WA11	**City / State:**	Suquamish, WA	**FM Initials:**	SW
Site Name:	SUQ_D23-2074	**Monitor Series:**	FS 5000 AG	**Monitor S/N:**	19082
Address/Location:	18678 Division Ave NE			**Manhole #**	D23-2074
				GPS Coordinates:	47°43'55.98"N 122°33'29.84"W
				Pipe Height:	8.00"
Access:	Drive	**Type of System:**	Sanitary [X] Storm [ ] Combined [ ]	**Pipe Width:**	8.00"
				IP Address:	166.213.6.76



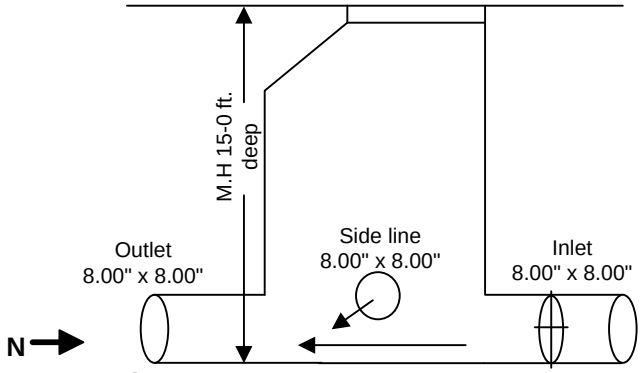
Investigation Information:

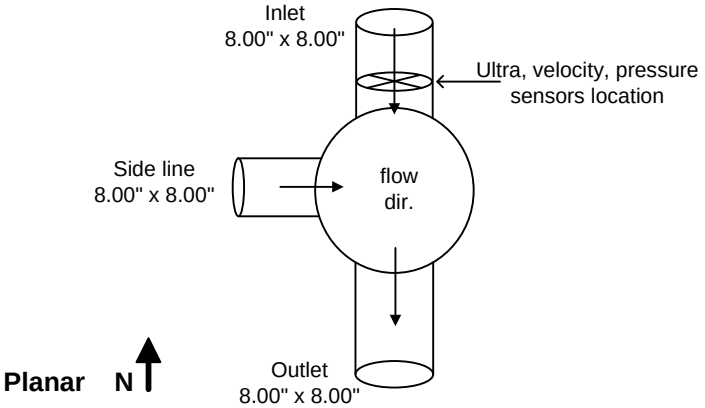
Date/Time of Investigation:	9/14/11 @ 09:48
Site Hydraulics:	Clear fast choppy flow
Upstream Input: (L/S, P/S)	No influence
Upstream Manhole:	2 inlets / 1 outlet
Downstream Manhole:	2 inlets 1 outlet
Depth of Flow:	1.00" +/- 0.25"
Range (Air DOF):	7.00" +/- 0.25"
Peak Velocity:	2.90 fps
Silt:	0.00" Inches

Manhole Information:

Manhole Depth:	15' - 0"				
Manhole Material / Condition	Concrete / Good				
Pipe Material / Condition:	Concrete / Good				
Mini System Character:	Residential [X]	Commercial [ ]	Industrial [ ]	Trunk [X]	
Telephone Information:	Doesn't apply				
Access Pole #:	Doesn't apply				
Distance From Manhole:	Doesn't apply	Feet			
Road Cut Length:	Doesn't apply	Feet			
Trench Length:	Doesn't apply	Feet			

Other Information:





Installation Information	
Installation Type:	Standard
Sensors Devices:	Ultra, Velocity, Pressure
Surcharge Height:	0 Feet
Rain Gage Zone:	SUQ_RG

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

Additional Site Information / Comments:

Pressure (15 PSI, accuracy +/- 0.25% for range of 0.25 – 23.5 ft.)

Flow Monitoring Site Safety Plan

Project Name: Suquamish.RH2.TFM.WA11	**Site ID:** SUQ_D23-2074	**Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	X
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
Confined Space	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☐
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

Site is located in low volume intersection, there is ample room for vehicles to flow through work zone, follow TCP listed below

*** Site Classification**

	Class	Description
X	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☐	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. *Must be approved by Corporate Safety Manager*

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

No site specific hazards found

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

- ☐ This worksite does NOT require a traffic control Plan
- X Standard Traffic Control Plan TA-15 is to be used at this work site
- ☐ This site requires a special Traffic Control Plan which is attached

Approved	**Reviewed**
Field Mgr Name: Sean Winder	Project Mgr Name: Mike Pina
Signature: Signed copy can be obtained from ADS	Signature: Signed copy can be obtained from ADS
Date: 9/15/11	Date: 9/15/11

Site Information

SUQ_D23-2074

Monitoring Period: 9/29/2011 – 3/7/2012
Pipe Dimension: 8.00" x 8.00"
Finalized Silt: 0.00"

Overview

Metering point SUQ_D23-2074 was located at 18678 Division Ave (see attached site report for details).

The hydrograph indicates a residential diurnal flow pattern. The scattergraph for this location indicates significant hydraulic shifting.

The depth and velocity measurements recorded by the flow monitor were consistent with the field confirmations and supported the relative accuracy of the instrumentation at this location.

The depth and velocity data from 10/17 - 22, 2011 were flagged as the data indicate there was a buildup of debris at or directly downstream of the monitoring location at this time (resulting in an invalid hydraulic shift). The data between 10/22/2011 – 11/10/2011 should be treated with caution as a field visit on 11/10/2011 found that the ADS equipment had been dislodged and the ultrasonic sensor damaged.

During the minimum flow period the velocity sensor had a tendency to register invalid 0ft/s readings at this site despite modifying the sensor parameters. For the period 11/27/2011 – 3/8/2012 the velocity drops were reconstituted using a best fit curve based on the remainder of the study period. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate the flow rate for the monitoring period.

The response to rainfall of the flow data calculated for this location appears to be associated with inflow and infiltration (sharp response to storm events and gradual recovery after storm events).

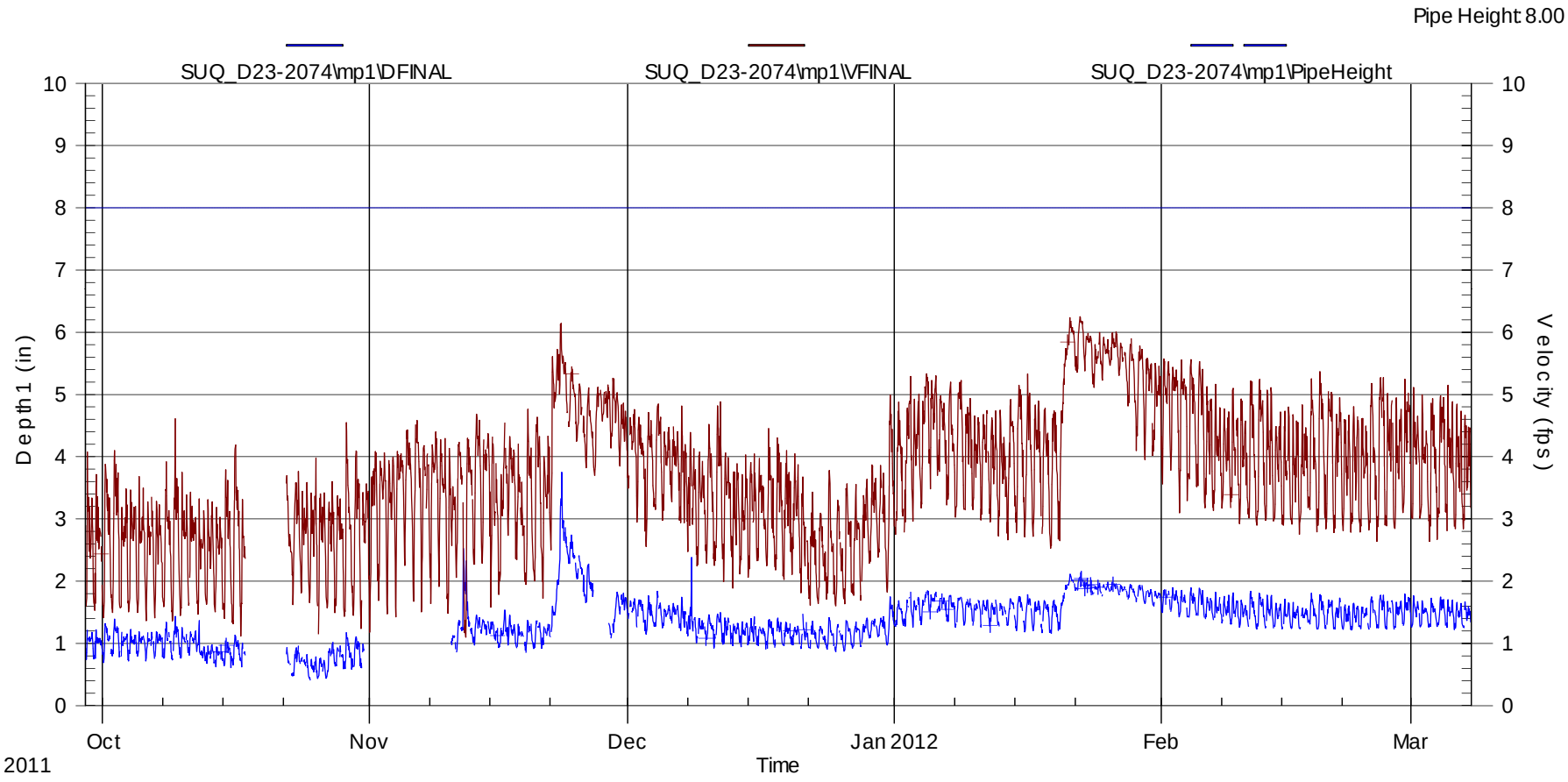
The average depth, velocity and flow rate values data for the monitoring period, along with the observed minimum and maximum data, are provided in the following table. The minimum and maximum rates recorded in the tables are based on 5-minute data intervals.

	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Average	1.37	3.7	75.02
Minimum	0.19	0.00	0.00
Maximum	5.81	6.54	469.80

Data uptime for the monitoring period (based on a 5 minute sample rate) is provided in the table below.

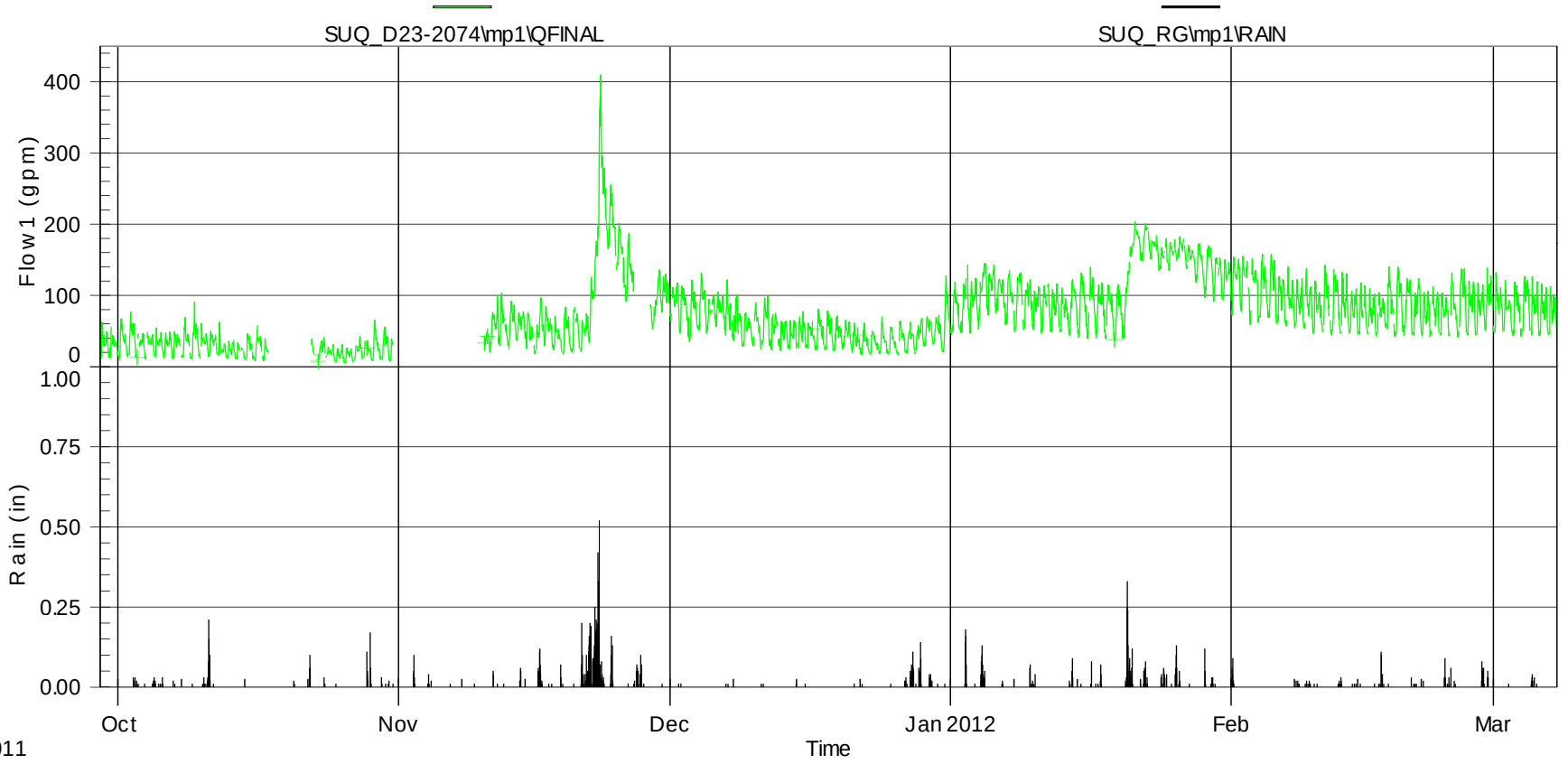
	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Raw	100%	100%	100%
Validated	89%	96%	89%

ADS Environmental Services



ADS Environmental Services

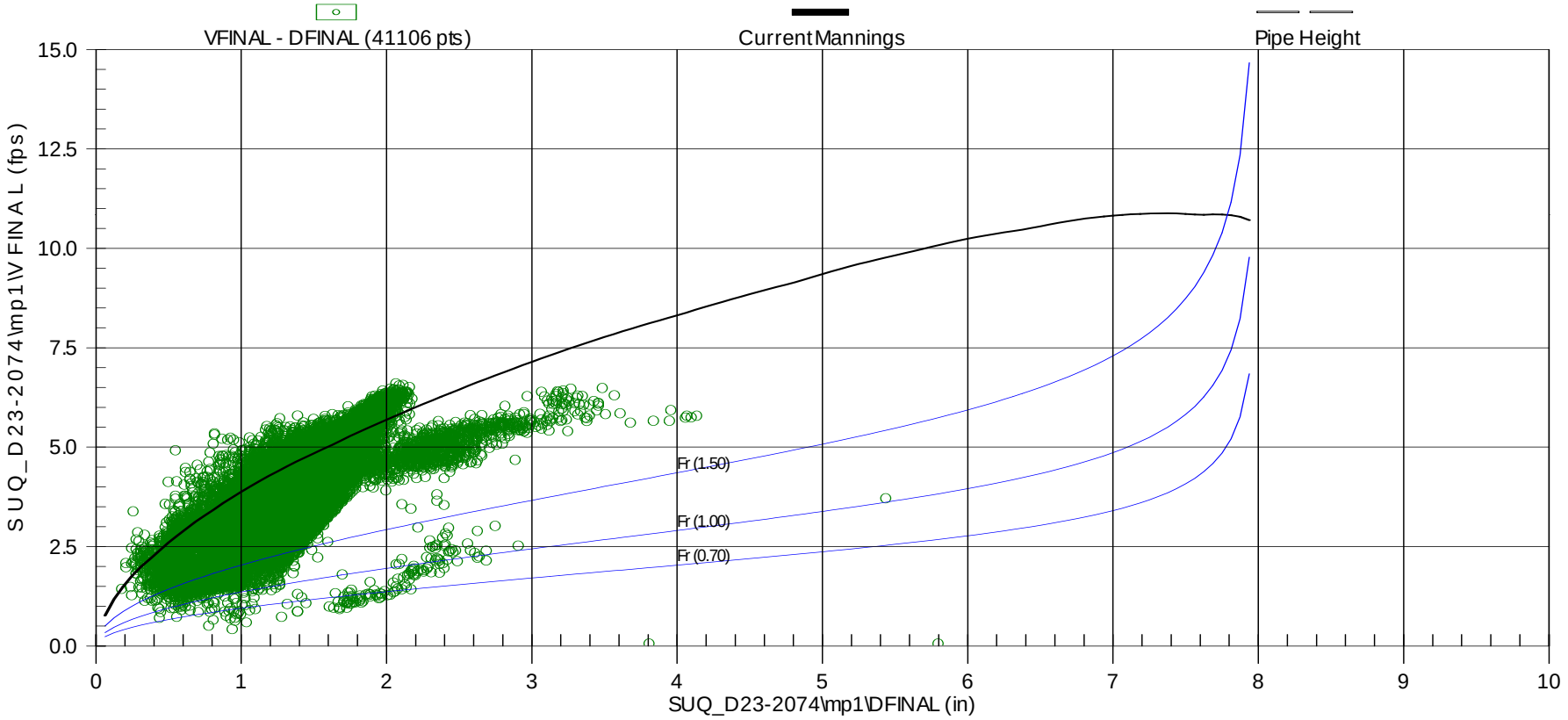
Pipe Height 8.00



ADS Environmental Services

9/29/2011 12:00:00 AM - 3/8/2012 12:00:00 AM

Pipe Height 8.00



SUQ_D23-2074

Site access

ADS ENVIRONMENTAL SERVICES®

Site access looking east

Photo taken
09.28.11 @ 11:38

SUQ_D23-2074
Site set up

ADS ENVIRONMENTAL SERVICES®

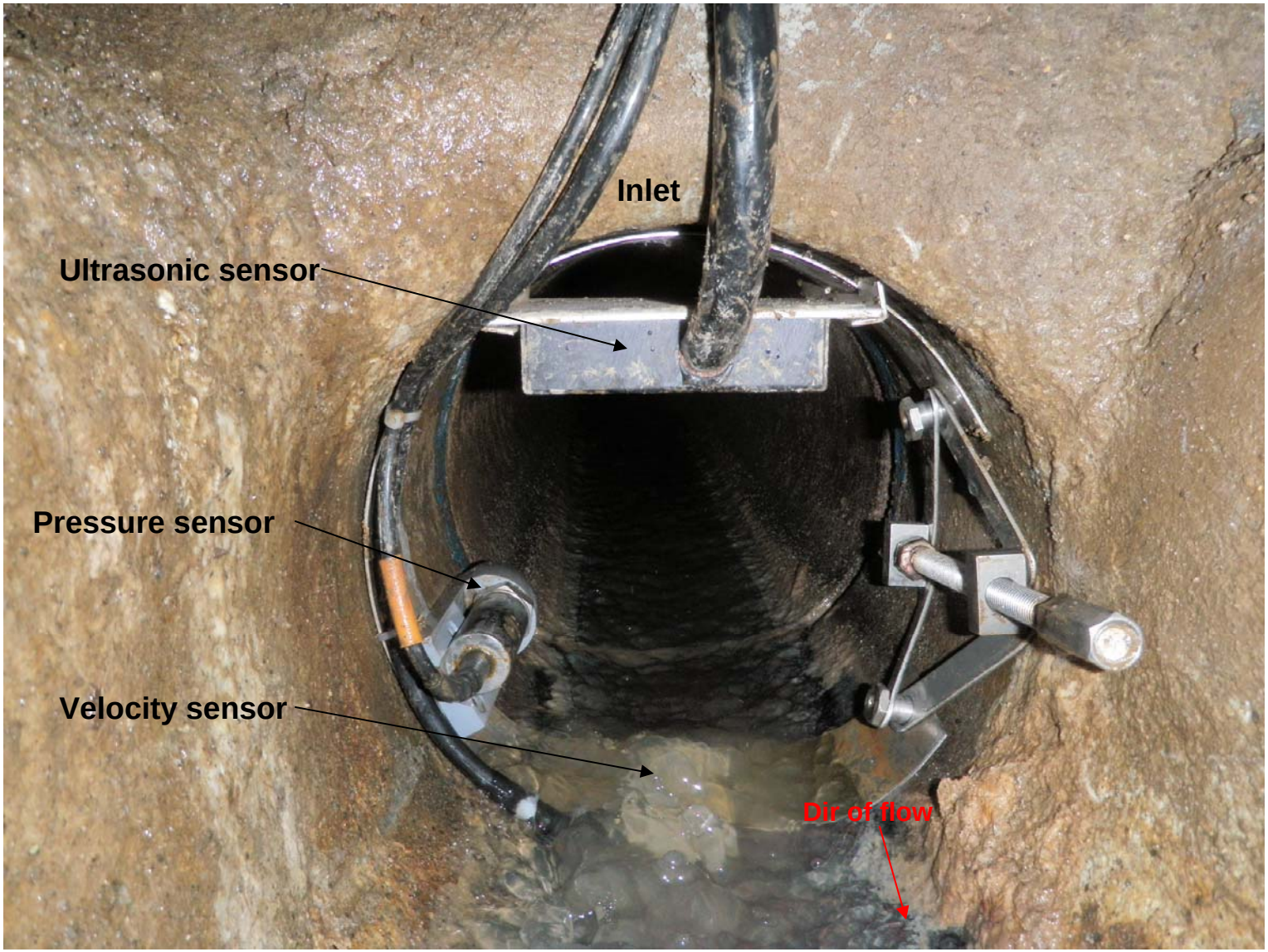
View down manhole looking west

Photo taken
09.28.11 @ 10:59

SUQ_D23-2074

Site set up

ADS ENVIRONMENTAL SERVICES®

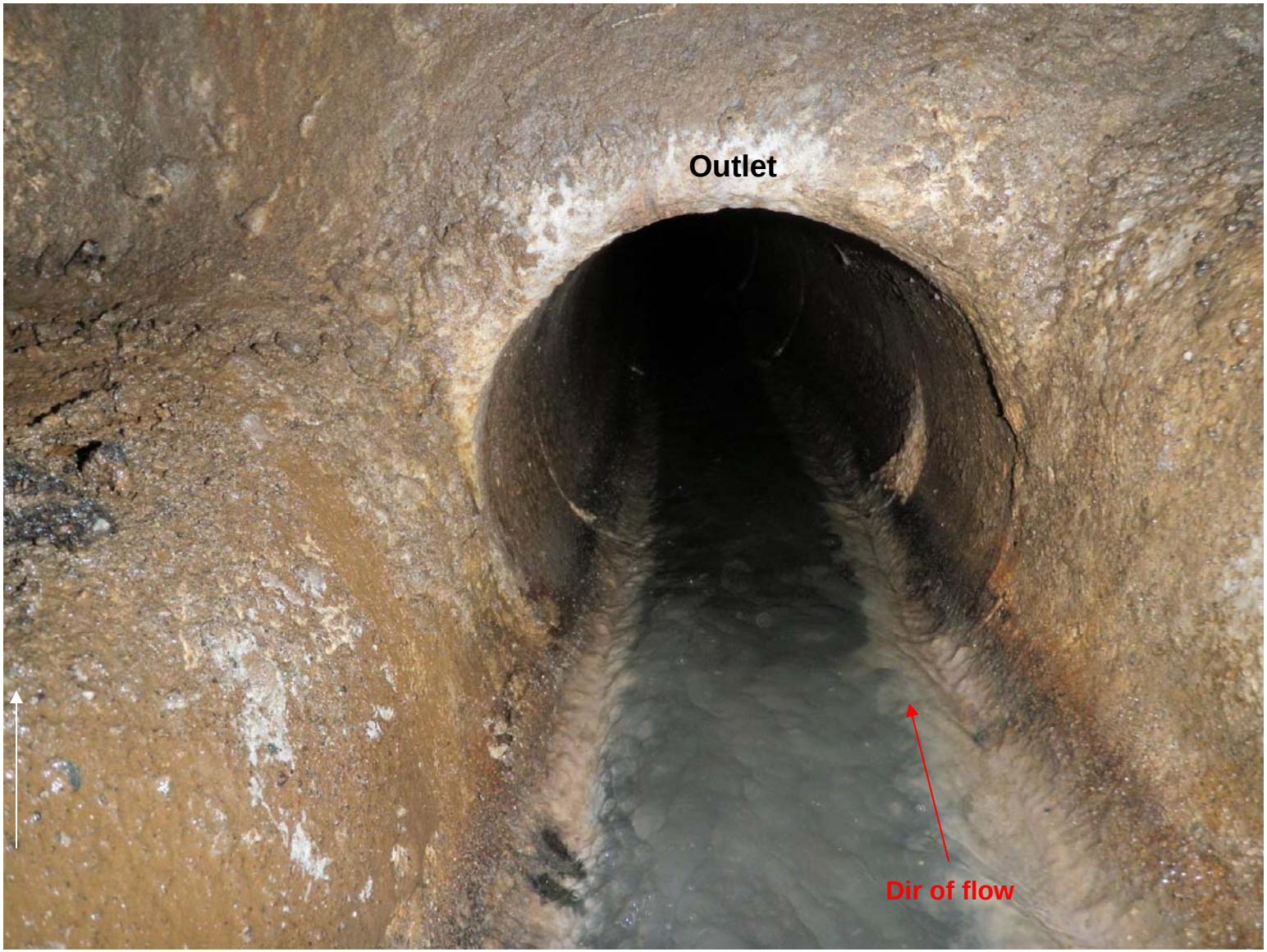


View of sensor placement and site hydraulics

Photo taken
09.28.11 @ 10:58

SUQ_D23-2074
Site set up

ADS ENVIRONMENTAL SERVICES®



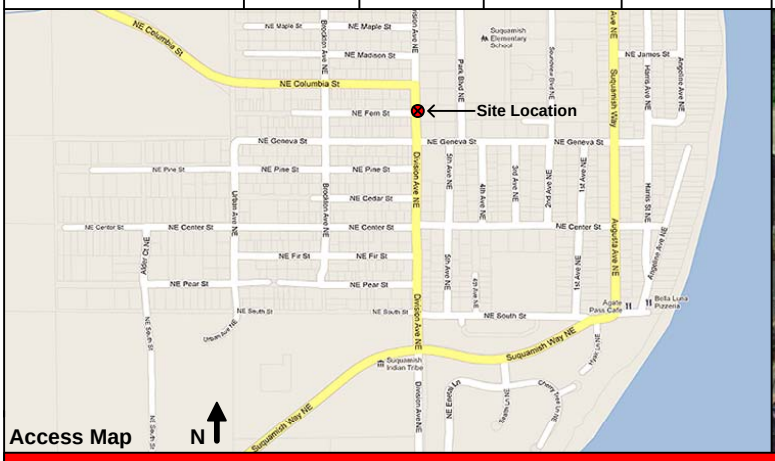
View of outlet and hydraulics

Photo taken
09.28.11 @ 11:00

ADS Site Report

Quality Form

Project Name:	Suquamish.RH2.TFM.WA11	**City / State:**	Suquamish, WA	**FM Initials:**	SW
Site Name:	SUQ_D23-2094	**Monitor Series:**	FS 5000 AG	**Monitor S/N:**	21781
Address/Location:	Intersection of NE Fern St and Division Ave NE			**Manhole #**	D23-2094
				GPS Coordinates:	47°44'2.42"N 122°33'29.98"W
				Pipe Height:	8.00"
Access:	Drive	**Type of System:**	Sanitary [X] Storm [ ] Combined [ ]	**Pipe Width:**	8.00"
				IP Address:	166.213.6.77



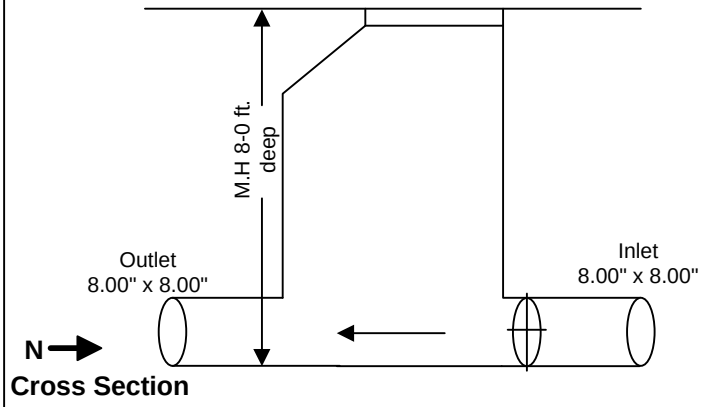
Investigation Information:

Date/Time of Investigation:	2/2/12 @ 11:53
Site Hydraulics:	Steady flow with small waves
Upstream Input: (L/S, P/S)	No influence
Upstream Manhole:	2 inlets / 1 outlet
Downstream Manhole:	2 inlets / 1 outlet (Drop connection)
Depth of Flow:	1.63" +/- 0.25"
Range (Air DOF):	6.38" +/- 0.25"
Peak Velocity:	1.62 fps
Silt:	0.00" Inches

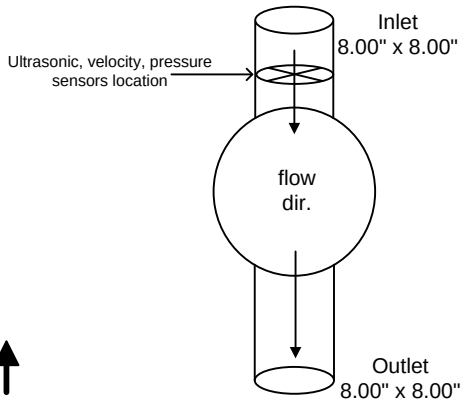
Manhole Information:

Manhole Depth:	8'					
Manhole Material / Condition	Concrete / Good					
Pipe Material / Condition:	Concrete / Good					
Mini System Character:	Residential [X]	Commercial [ ]	Industrial [ ]	Trunk [ ]		
Telephone Information:	Doesn't apply					
Access Pole #:	Doesn't apply					
Distance From Manhole:	Doesn't apply	Feet				
Road Cut Length:	Doesn't apply	Feet				
Trench Length:	Doesn't apply	Feet				

Other Information:



Cross Section



Installation Information		Backup	Yes	No	?	Distance
Installation Type:	Standard	Trunk	[ ]	[X]	[ ]	
Sensors Devices:	Ultra, Velocity, Pressure	Lift / Pump Station	[ ]	[X]	[ ]	
Surcharge Height:	0 Feet	WWTP	[ ]	[X]	[ ]	
Rain Gage Zone:	SUQ_RG	Other	[ ]	[X]	[ ]	

Additional Site Information / Comments:

Pressure (5 PSI, accuracy +/- 0.25% for range of 0.25 – 11.5 ft.)

Flow Monitoring Site Safety Plan

Project Name: Suquamish.RH2.TFM.WA11	**Site ID:** SUQ_D23-2094	**Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	X
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
Confined Space	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☐
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

Site is located in moderate volume intersection, follow TCP listed below and must use one flagger

*** Site Classification**

	Class	Description
☐	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
X	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. *Must be approved by Corporate Safety Manager*

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

One flagger is needed for traffic control

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

- ☐ This worksite does NOT require a Traffic Control Plan
- X Standard Traffic Control Plan TA-18 is to be used at this work site
- ☐ This site requires a special Traffic Control Plan which is attached

Approved		**Reviewed**	
Field Mgr Name:	Sean Winder	Project Mgr Name:	Mike Pina
Signature:	Signed copy can be obtained from ADS	Signature:	Signed copy can be obtained from ADS
Date:	2/8/12	Date:	2/8/12

Site Information

SUQ_D23-2094

Monitoring Period: 2/16/2012 – 3/7/2012
Pipe Dimension: 8.00" x 8.00"
Finalized Silt: 0.00"

Overview

Metering point SUQ_D23-2094 was located at the intersection of NE Fern St and Division Ave NE (see attached site report for details).

The hydrograph indicates a residential diurnal flow pattern. The scattergraph for this location indicates a fairly repeatable data set.

The depth and velocity measurements recorded by the flow monitor were consistent with the field confirmations and supported the relative accuracy of the instrumentation at this location.

During the minimum flow period the velocity sensor had a tendency to overstate the velocity readings due to the very shallow flow conditions. Based upon the quality and consistency of the observed flow depth and velocity data, the derived Manning's equation was used to calculate the flow rate for the monitoring period.

The response to rainfall of the flow data calculated for this location is minimal.

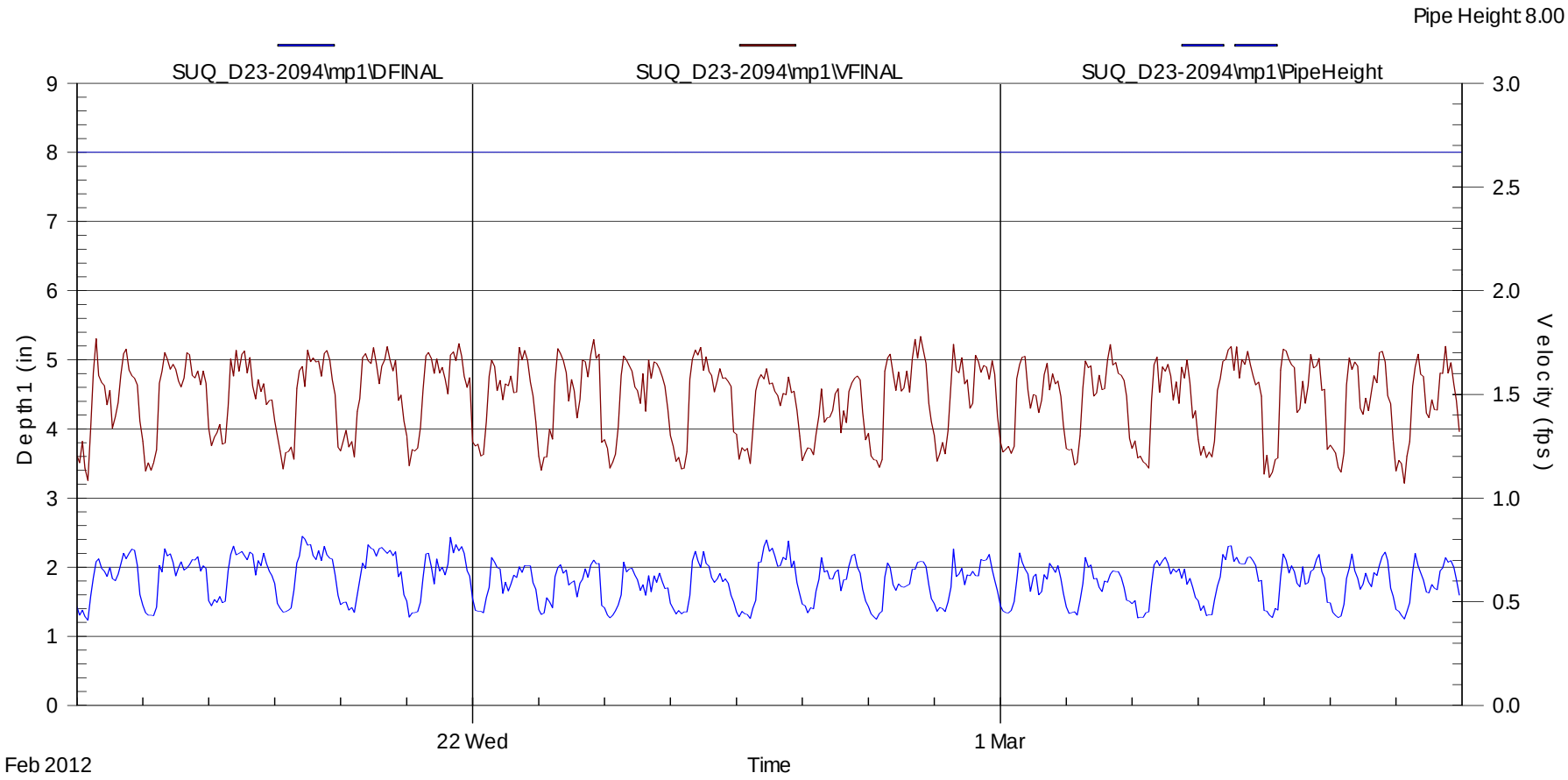
The average depth, velocity and flow rate values data for the monitoring period, along with the observed minimum and maximum data, are provided in the following table. The minimum and maximum rates recorded in the tables are based on 5-minute data intervals.

	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Average	1.81	1.48	40.83
Minimum	1.00	0.58	11.13
Maximum	3.01	2.01	91.00

Data uptime for the monitoring period (based on a 5 minute sample rate) is provided in the table below.

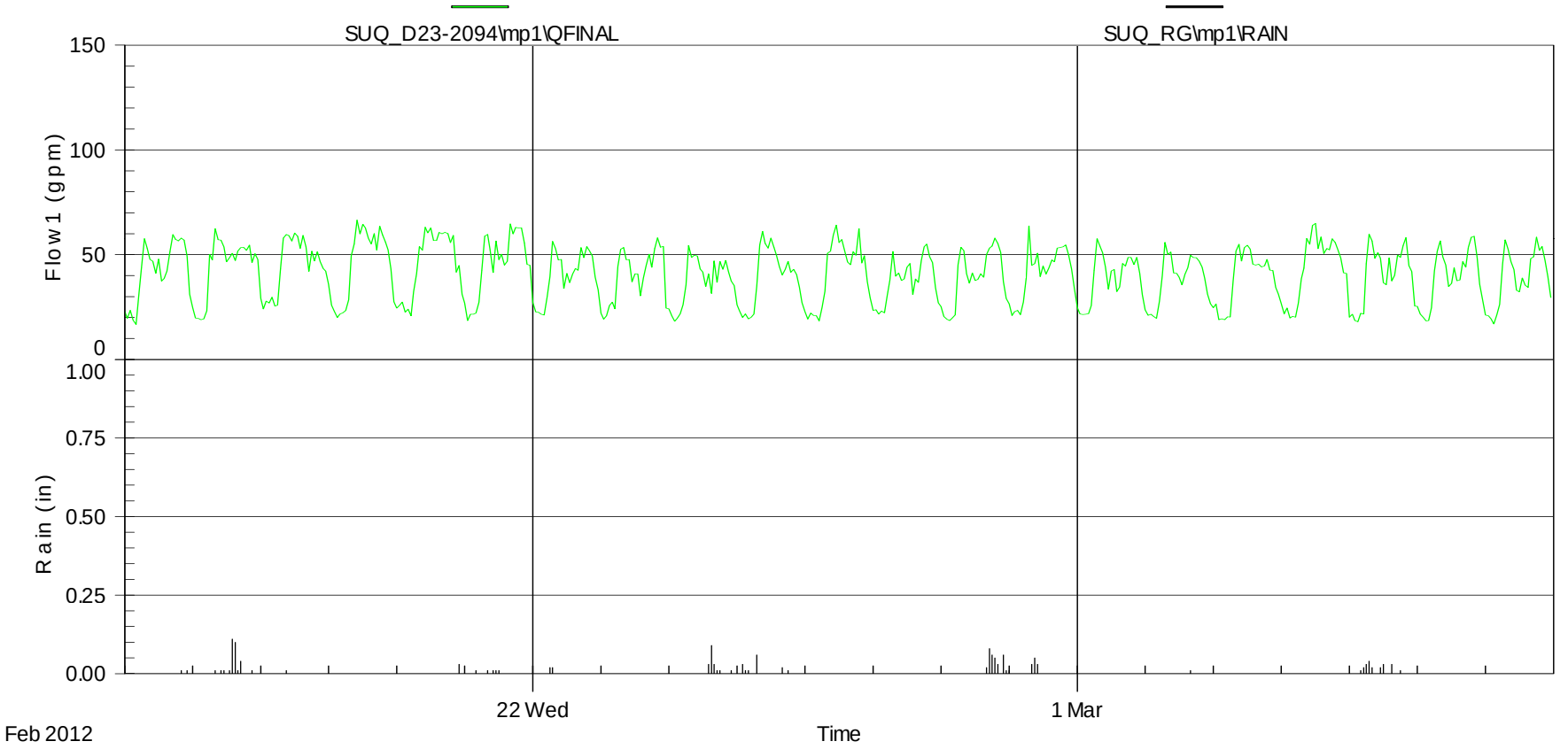
	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Raw	100%	100%	100%
Validated	100%	100%	100%

ADS Environmental Services



ADS Environmental Services

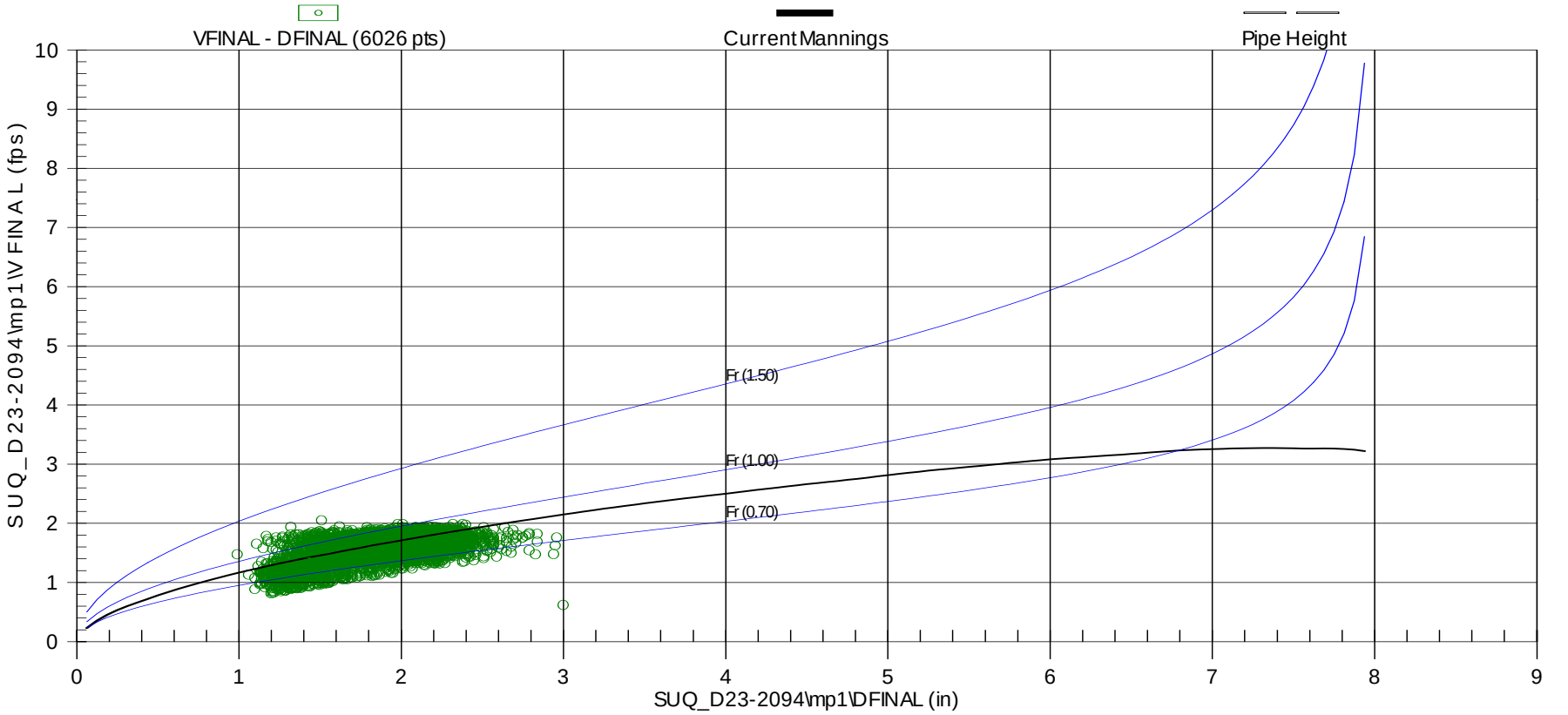
Pipe Height 8.00



ADS Environmental Services

2/16/2012 12:00:00 AM - 3/8/2012 12:00:00 AM

Pipe Height 8.00



SUQ_D23-2094

Site access

ADS ENVIRONMENTAL SERVICES®

Site access looking southwest

Photo taken
02.15.12 @ 12:19

SUQ_D23-2094

Site set up

ADS ENVIRONMENTAL SERVICES®

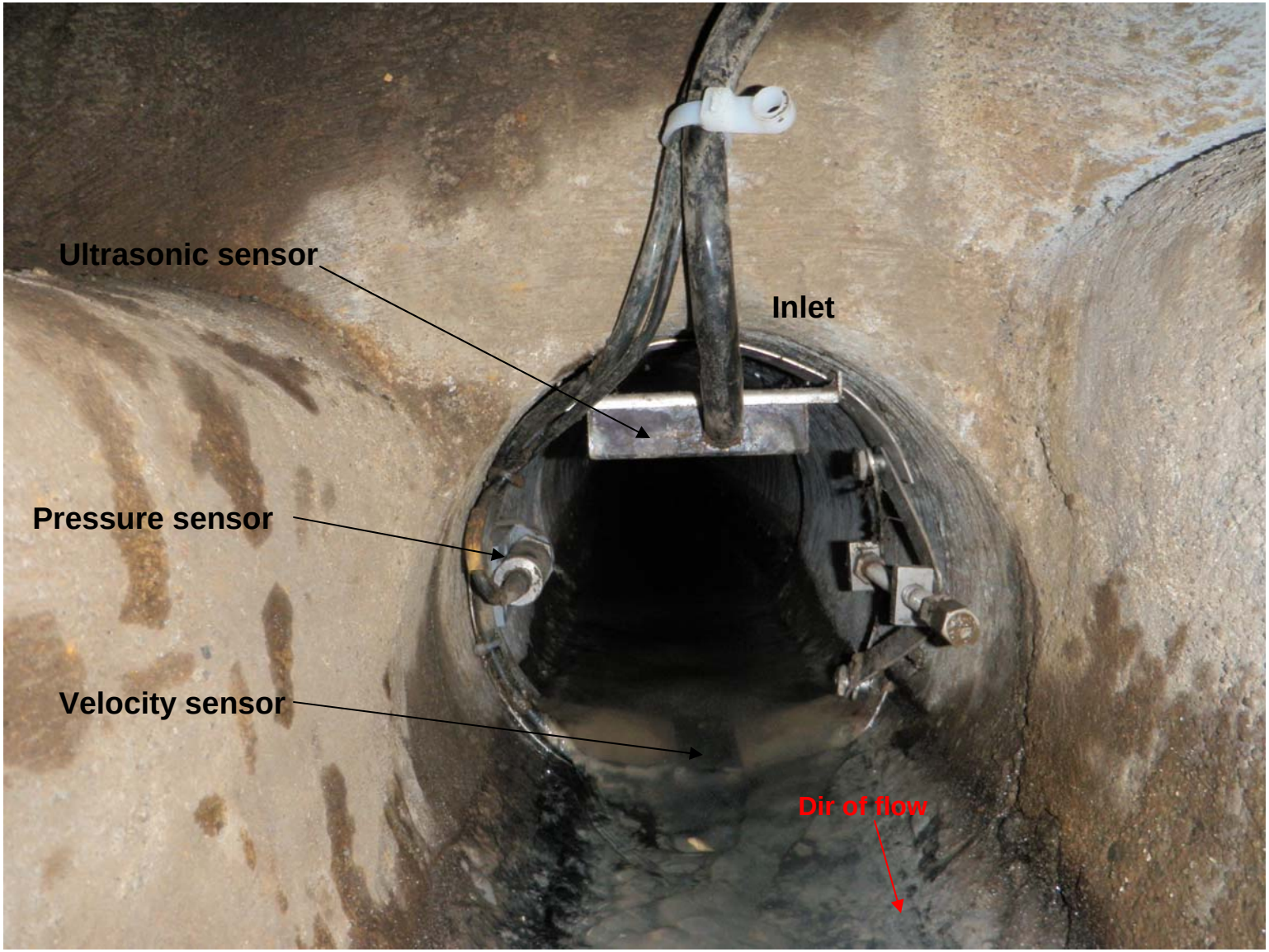
View down manhole looking west

Photo taken
02.15.12 @ 12:04

SUQ_D23-2094

Site set up

ADS ENVIRONMENTAL SERVICES®



View of sensor placement and site hydraulics

Photo taken
02.15.12 @ 11:51

SUQ_D23-2094
Site set up

ADS ENVIRONMENTAL SERVICES®

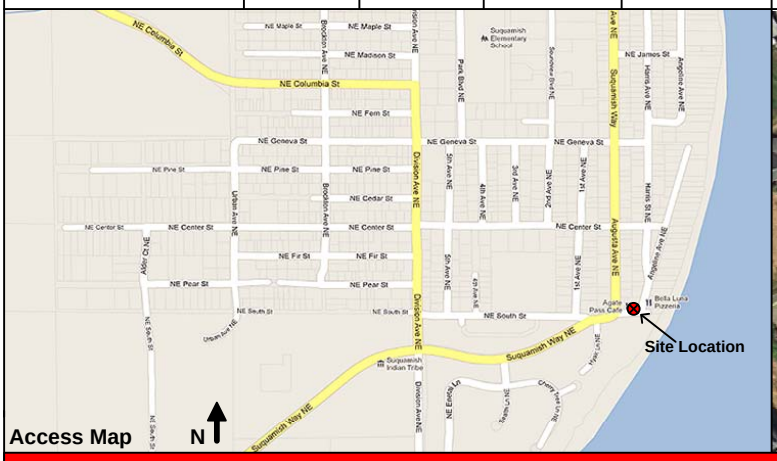
View of outlet and hydraulics

Photo taken
02.15.12 @ 11:52

ADS Site Report

Quality Form

Project Name:	Suquamish.RH2.TFM.WA11	**City / State:**	Suquamish, WA	**FM Initials:**	SW
Site Name:	SUQ_D23-3027	**Monitor Series:**	FS 5000 AG	**Monitor S/N:**	21507
Address/Location:	7234 NE Parkway (Dockside Bar and Grill)			**Manhole #**	D23-3027
				GPS Coordinates:	47°43'24.25"N 122°33'31.68"W
				Pipe Height:	12.00"
Access:	Drive	**Type of System:**	Sanitary [X] Storm [ ] Combined [ ]	**Pipe Width:**	12.13"
				IP Address:	166.213.6.61



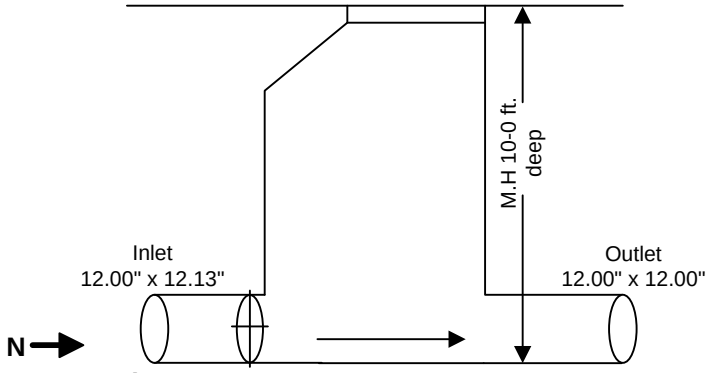
Investigation Information:

Date/Time of Investigation:	2/15/12 @ 14:03
Site Hydraulics:	Smooth and very slow flow
Upstream Input: (L/S, P/S)	No influence
Upstream Manhole:	1 inlet / 1 outlet
Downstream Manhole:	2 inlets / 1 outlet ("T" junction 90)
Depth of Flow:	1.13" +/- 0.25"
Range (Air DOF):	10.88" +/- 0.25"
Peak Velocity:	0.25 fps
Silt:	0.00" Inches

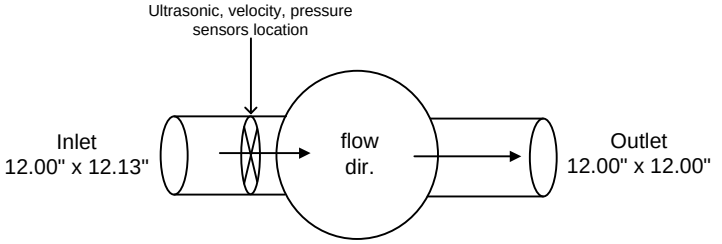
Manhole Information:

Manhole Depth:	10'				
Manhole Material / Condition	Concrete / Good				
Pipe Material / Condition:	Concrete / Good				
Mini System Character:	Residential [X]	Commercial [ ]	Industrial [ ]	Trunk [ ]	
Telephone Information:	Doesn't apply				
Access Pole #:	Doesn't apply				
Distance From Manhole:	Doesn't apply	Feet			
Road Cut Length:	Doesn't apply	Feet			
Trench Length:	Doesn't apply	Feet			

Other Information:



Cross Section



Planar N

Installation Information	
Installation Type:	Standard
Sensors Devices:	Ultra, Velocity, Pressure
Surcharge Height:	0 Feet
Rain Gage Zone:	SUQ_RG

Backup	Yes	No	?	Distance
Trunk	[ ]	[X]	[ ]	
Lift / Pump Station	[ ]	[ ]	[X]	D/S (~300')
WWTP	[ ]	[X]	[ ]	
Other	[ ]	[X]	[ ]	

Additional Site Information / Comments:

Pressure (5 PSI, accuracy +/- 0.25% for range of 0.25 – 11.5 ft.)
Can only access during low tide

Flow Monitoring Site Safety Plan

Project Name: Suquamish.RH2.TFM.WA11	**Site ID:** SUQ_D23-3027	**Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	☐
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☒
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
Confined Space	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☐
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

Site is located on Puget Sound shoreline and can only be accessed during low tides. Need to consult tide charts for access

*** Site Classification**

	Class	Description
☐	1	2-person crew. Standard procedures and equipment. No special requirements
☒	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☐	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. *Must be approved by Corporate Safety Manager*

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

Site can be only accessed during low tide, need to consult tide charts for access

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

☒ This worksite does NOT require a Traffic Control Plan
☐ Standard Traffic Control Plan is to be used at this work site
☐ This site requires a special Traffic Control Plan which is attached

Approved	**Reviewed**
Field Mgr Name: Sean Winder	Project Mgr Name: Mike Pina
Signature: Signed copy can be obtained from ADS	Signature: Signed copy can be obtained from ADS
Date: 2/15/12	Date: 2/15/12

Site Information

SUQ_D23-3027

Monitoring Period: 2/16/2012 – 3/7/2012
Pipe Dimension: 12.00" x 12.13"
Finalized Silt: 0.00"

Overview

Metering point SUQ_D23-3027 was located at 7234 NE Parkway (see attached site report for details).

The hydrograph indicates a residential diurnal flow pattern. The scattergraph for this location indicates a fairly repeatable data set.

The depth and velocity measurements recorded by the flow monitor were consistent with the field confirmations and supported the relative accuracy of the instrumentation at this location.

During the monitoring period the velocity sensor had a tendency to register invalid 0ft/s readings due to the very shallow flow conditions. These velocity drops were reconstituted using a best fit curve based on the derived Manning's equation. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate the flow rate for the monitoring period.

The response to rainfall of the flow data calculated for this location is minimal.

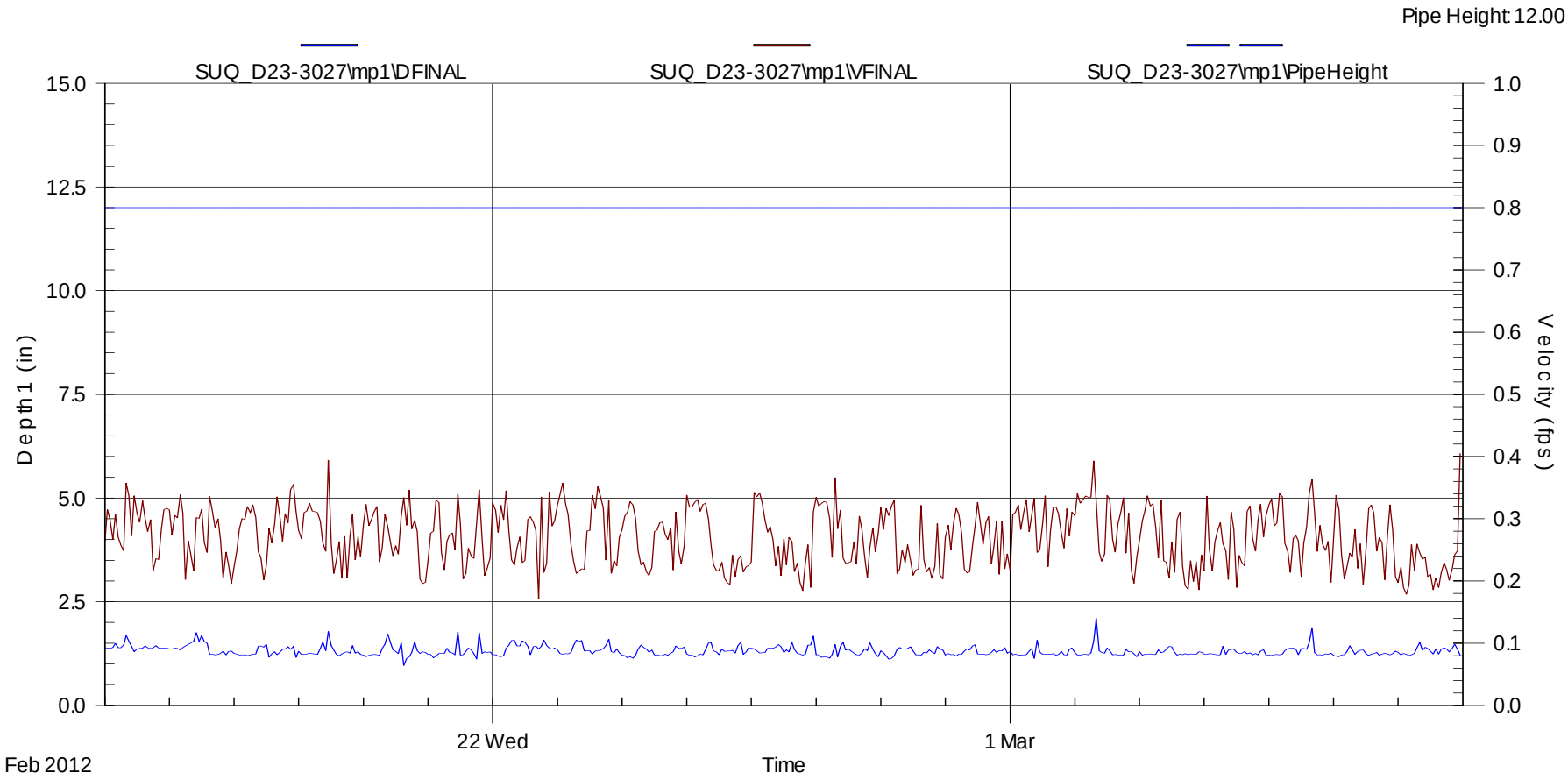
The average depth, velocity and flow rate values data for the monitoring period, along with the observed minimum and maximum data, are provided in the following table. The minimum and maximum rates recorded in the tables are based on 5-minute data intervals.

	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Average	1.31	0.27	5.78
Minimum	0.28	0.14	2.03
Maximum	3.61	0.61	36.74

Data uptime for the monitoring period (based on a 5 minute sample rate) is provided in the table below.

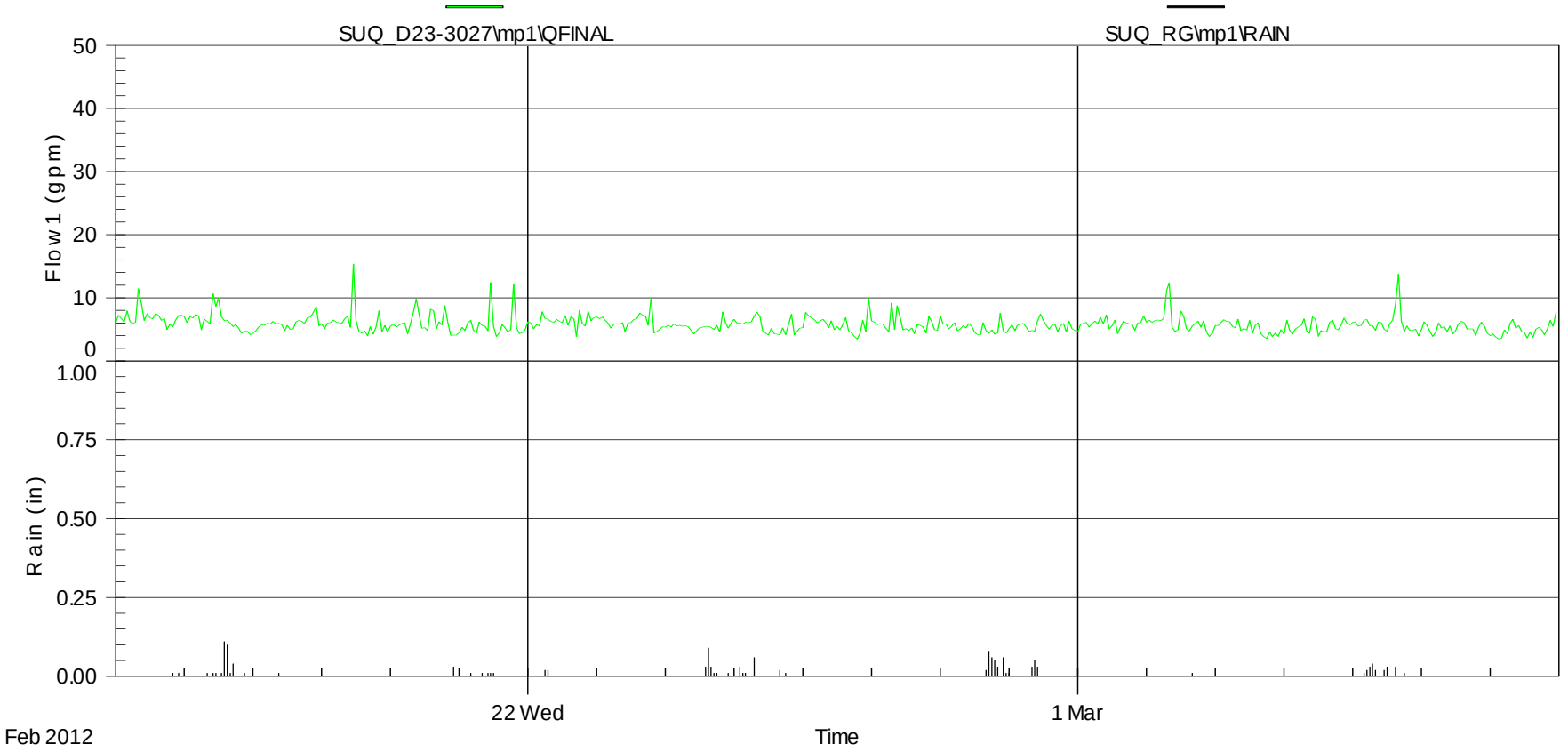
	Depth (in)	Velocity (ft/s)	Quantity (gpm)
Raw	100%	100%	100%
Validated	100%	99%	99%

ADS Environmental Services



ADS Environmental Services

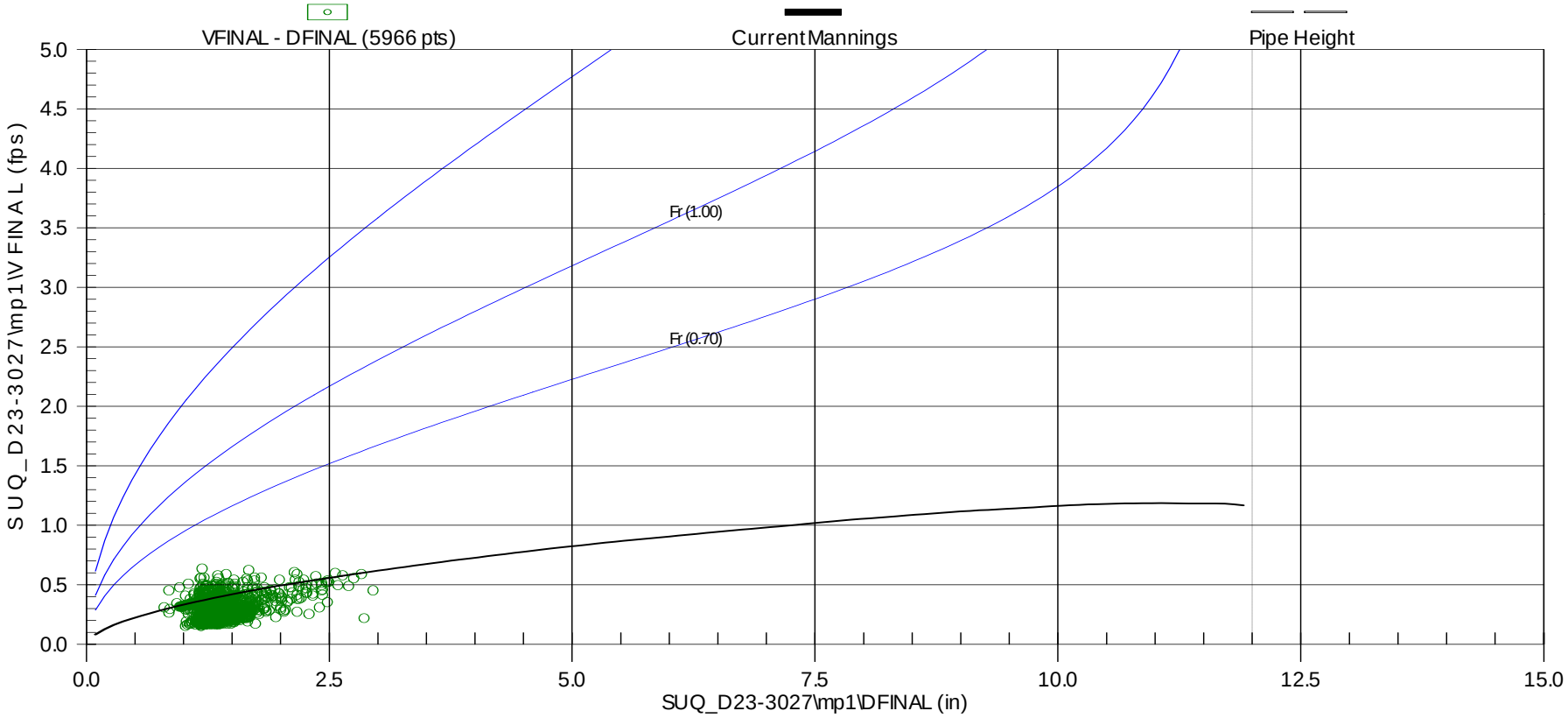
Pipe Height: 12.00



ADS Environmental Services

2/16/2012 12:00:00 AM - 3/8/2012 12:00:00 AM

Pipe Height 12.00



SUQ_D23-3027

Site access

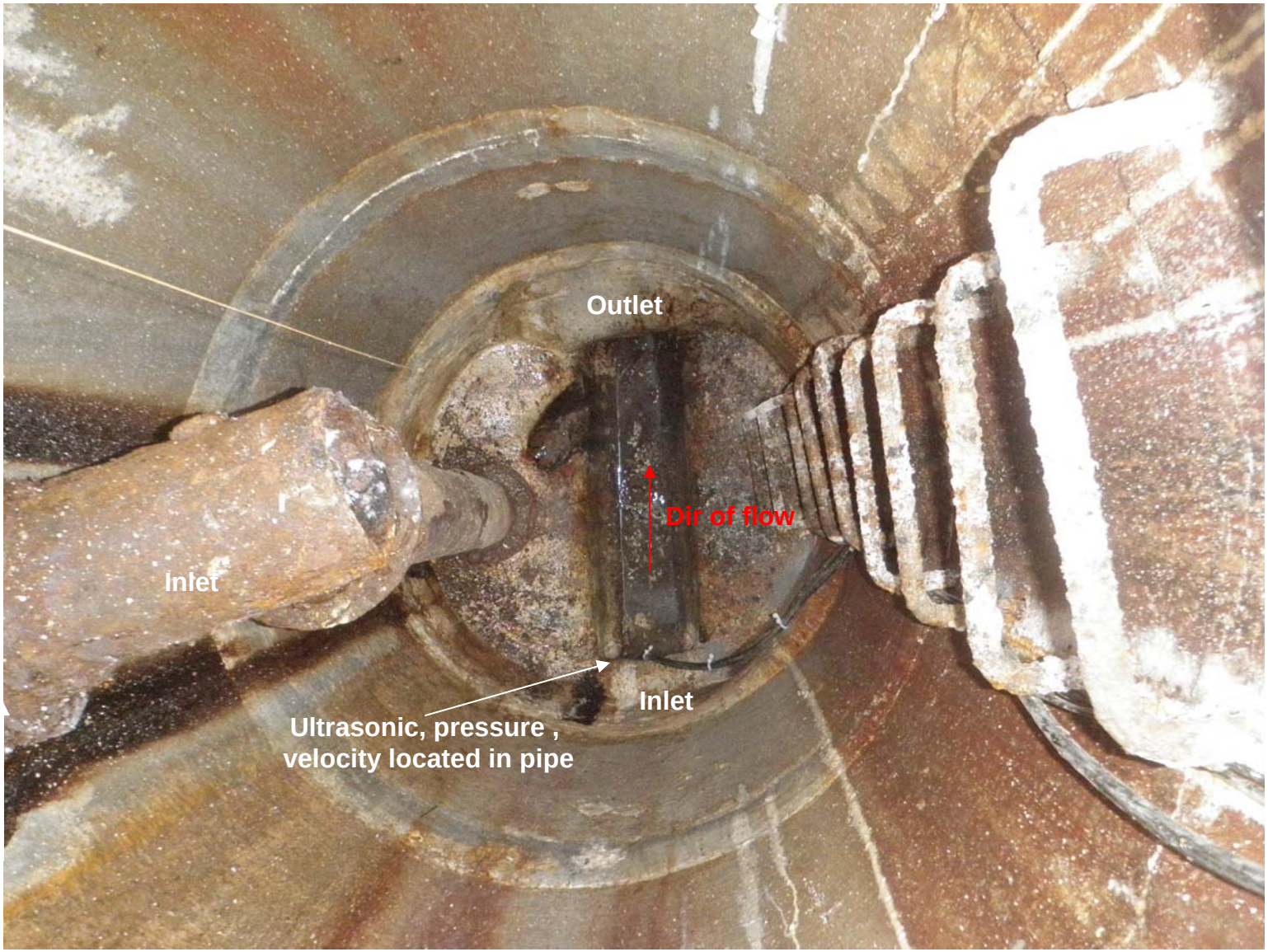
ADS ENVIRONMENTAL SERVICES®

Site access looking north

Photo taken
02.15.12 @ 14:26

SUQ_D23-3027
Site set up

ADS ENVIRONMENTAL SERVICES®



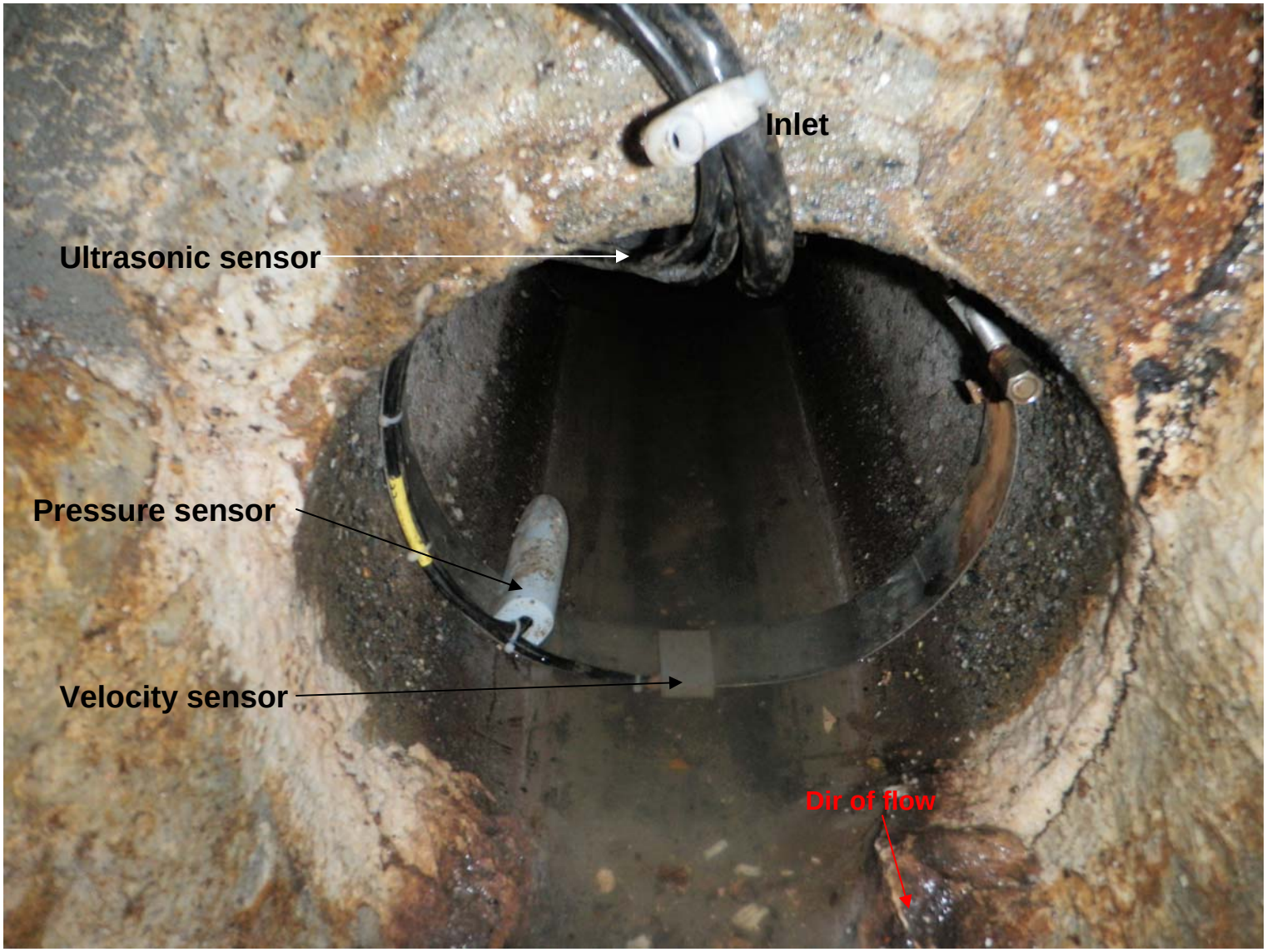
View down manhole looking north

Photo taken
02.15.12 @ 14:17

SUQ_D23-3027

Site set up

ADS ENVIRONMENTAL SERVICES®



View of sensor placement and site hydraulics

Photo taken
02.15.12 @ 14:13

SUQ_D23-3027
Site set up

ADS ENVIRONMENTAL SERVICES®

View of outlet and hydraulics

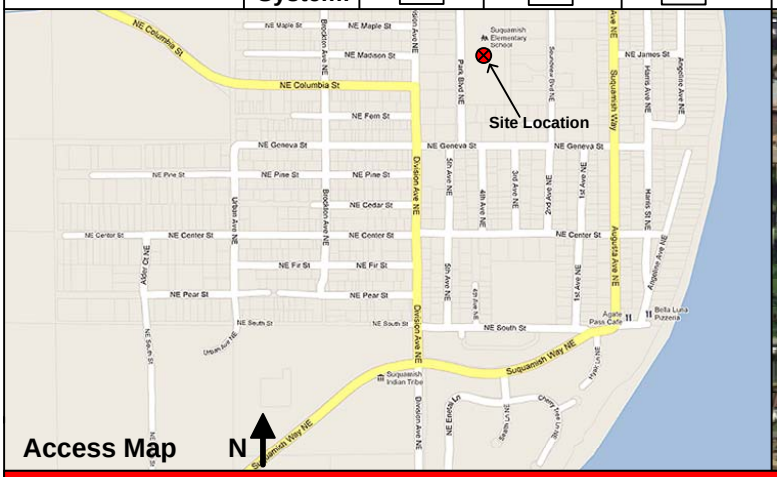
Photo taken
02.15.12 @ 14:13

ADS Site Report

Quality Form

Project Name:	Suquamish.RH2.TFM.WA11	**City / State:**	Suquamish, WA	**FM Initials:**	SW
Site Name:	SUQ_RG	**Monitor Series:**	FS 5000 AG		
Address/Location:	18950 Park Boulevard NE (Suquamish Elementary School)				
Access:	Drive	**Type of System:**	Sanitary [X] Storm [ ] Combined [ ]		

Monitor S/N:	14209
Rain Gauge S/N:	NA
GPS Coordinates:	47°44'7.58"N 122°33'22.85"W
Pipe Height:	Not applicable
Pipe Width:	8.00" diameter bucket
Phone Number:	166.219.6.84



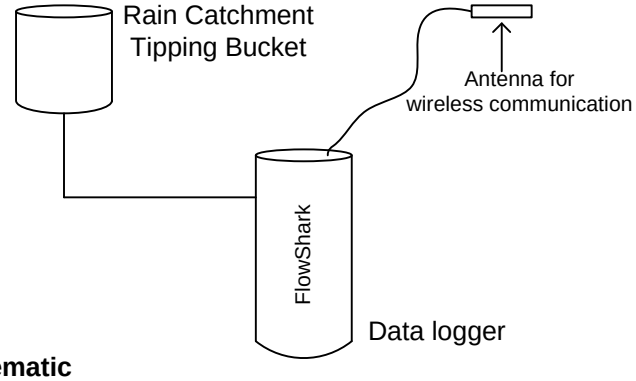
Investigation Information:

Activation Date and Time:	9/22/11 @ 14:30	**Initial Confirmation Date and Time:**	9/28/11 @ 11:50
GPS Lat / Long coordinates:	47°44'7.58"N	122°33'22.85"W	
Upstream Input: (L/S, P/S)	Doesn't apply		
Upstream Manhole:	Doesn't apply		
Downstream Manhole:	Doesn't apply		
Depth of Flow:	Doesn't apply		
Range (Air DOF):	Doesn't apply		
Peak Velocity:	Doesn't apply		
Silt:	Doesn't apply		

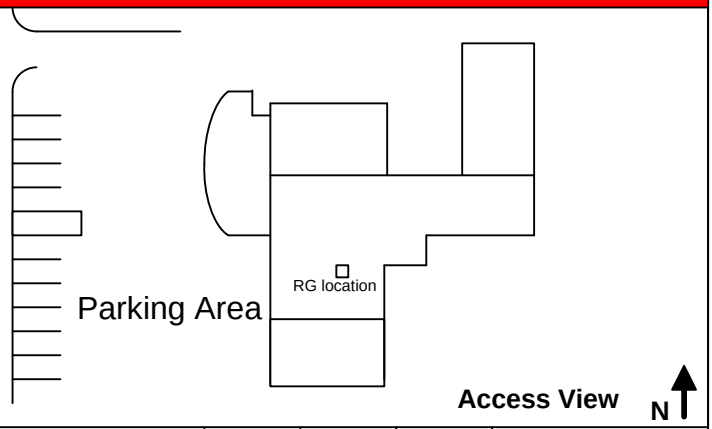
Manhole Information:

Manhole Depth:	Doesn't apply				
Manhole Material / Condition	Doesn't apply				
Pipe Material / Condition:	Doesn't apply				
Mini System Character:	Residential [X]	Commercial [X]	Industrial [ ]	Trunk [ ]	
Telephone Information:	Doesn't apply				
Access Pole #:	Doesn't apply				
Distance From Manhole:	Doesn't apply	Feet			
Road Cut Length:	Doesn't apply	Feet			
Trench Length:	Doesn't apply	Feet			

Other Information:



Schematic



Installation Information	
Installation Type:	Wireless
Sensors Devices:	Jarek tipping bucket
Surcharge Height:	Doesn't apply
Rain Guage Zone:	Suquamish

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

Additional Site Information / Comments:

Contact Chuck Whitmer at 360-394-2906 or cwhitmer@nkschools.org at least 24 hours in advance for access

Flow Monitoring Site Safety Plan

Project Name: Suquamish.RH2.TFM.WA11	**Site ID:** SUQ_RG	**Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	☐
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located ina high speed (>45MPH) or high density roadway roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
Confined Space	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☐
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

No Hazards found

*** Site Classification**

	Class	Description
☒	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☐	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. *Must be approved by Corporate Safety Manager*

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

No Site Specific Safety Requirements

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

☒ This worksite does NOT require a traffic control Plan
☐ Standard Traffic Control Plan is to be used at this work site
☐ This site requires a special Traffic Control Plan which is attached

Approved	**Reviewed**
Field Mgr Name: Sean Winder	Project Mgr Name: Mike Pina
Signature: Signed copy can be obtained from ADS	Signature: Signed copy can be obtained from ADS
Date: 9/15/11	Date: 9/15/11

Site Information

SUQ_RG

Monitoring Period: 9/29/2011 – 3/7/2012

Overview

Metering point SUQ_RG was located at 18950 Park Boulevard NE (see attached site report for details).

The rainfall observed during the monitoring period is provided in the following table.

	Rainfall (in)
September 2011 (partial)	0.00
October 2011	2.04
November 2011	8.51
December 2011	1.44
January 2012	5.33
February 2012	1.94
March 2012 (partial)	0.22

Data uptime for the monitoring period is provided in the table below.

	Rainfall (in)
Raw	100%
Validated	100%

SUQ_RG

Site set up

ADS ENVIRONMENTAL SERVICES®

View of tipping bucket looking north

Photo taken
09.22.11 @ 13:26

SUQ_RG

Site set up

ADS ENVIRONMENTAL SERVICES®

View of tipping bucket looking west

Photo taken
09.22.11 @ 13:26

SUQ_RG

Site set up

ADS ENVIRONMENTAL SERVICES®

View of tipping bucket looking east and monitor location

Photo taken
09.22.11 @ 13:26

SUQ_RG
Site set up

ADS ENVIRONMENTAL SERVICES®

View of tipping bucket looking south

Photo taken
09.22.11 @ 13:26

Appendix B

Flow Isolation Measurements

RH2 Delineation Number	MH ID	Upstream Sites that Delineate Basins	Net Flow Microbasin (% of gross)	Pipe Diameter (in)	Weir Gross Flow (gpd)	Net Flow Microbasin (gpd)	Type	Date	Time	Notes
1-N	D23-2019	None	NA	7.88"	735	735	Weir	2/2/2012	4:37	
1-W	D23-2019	None	NA	8.00"	9243	9243	Weir	2/2/2012	4:41	
2-N	D23-2085	None	NA	7.75"	15730	15730	Weir	2/2/2012	3:21	
2-W	D23-2085	None	NA	8.00"	2137	2137	PVD	2/2/2012	3:22	Pipe to narrow for weir to fit, flow deep at 2-W
3-N	D23-1003	None	NA	7.88"	1458	1458	Weir	2/3/2012	1:39	
3-NE	D23-1003	4	45%	8.00"	11290	5082	Weir	2/3/2012	1:42	
4-N	D23-1009	None	NA	8.00"	5473	5473	Weir	2/3/2012	1:12	
4-W	D23-1009	None	NA	8.00"	735	735	Weir	2/3/2012	1:12	
5-N	D23-2038	None	NA	8.00"	0	0		2/2/2012	5:48	Not enough flow to perform weir
5-W	D23-2038	None	NA	8.00"	28975	28975	PVD	2/2/2012	5:41	Pulsing flow, unstable readings
6-N	D23-2017	1	12%	8.13"	11290	1312	Weir	2/2/2012	5:24	Crack in invert of pipe, took photo and video
6-W	D23-2017	None	NA	8.00"	13460	13460	Weir	2/2/2012	5:14	Pulsing flow, unstable readings
7-N	D23-2004	None	NA	7.75"	3689	3689	Weir	2/3/2012	2:24	
7-W	D23-2004	1, 6	5%	8.00"	36432	1704	Flow Monitor	2/2/2012	5:30	Used raw data from meter
8-N	D23-3046	9	-2%	8.00"	107120	-2496	PVD	2/3/2012	3:25	Flow too fast for weir
8-W	D23-3046	None	NA	8.00"	0	0		2/3/2012	3:25	Couldn't access due to elbow in pipe
9-N	D23-2055	10	-14%	8.00"	100253	-14278	PVD	2/2/2012	4:25	Flow too fast for weir
9-N	D23-2055	10	NA	8.00"	104143	See 2/2	PVD	2/3/2012	3:00	Flow too fast for weir
9-W	D23-2055	None	NA	8.00"	3689	3689	Weir	2/2/2012	4:33	
9-W	D23-2055	None	NA	8.00"	5473	See 2/2	Weir	2/3/2012	2:56	
10-N	D23-2061	11	-6%	8.00"	105288	-6615	PVD	2/2/2012	4:05	Flow too fast for weir
10-W	D23-2061	None	NA	8.00"	9243	9243	Weir	2/2/2012	4:01	
11-N	D23-2067	12	58%	8.00"	104602	60259	PVD	2/2/2012	3:33	Flow too fast for weir
11-W	D23-2067	None	NA	8.00"	7301	7301	Weir	2/2/2012	3:30	
12-N	D23-2083	13	18%	8.00"	34490	6190	Weir	2/2/2012	4:00	Silt in pipe (food waste)
12-W	D23-2083	2	-81%	7.63"	9853	-8014	PVD	2/2/2012	4:01	Pipe to small for weir to fit, Silt in pipe (food waste)
13-N	D23-2100	14	16%	8.00"	25860	4061	Weir	2/2/2012	2:55	
13-W	D23-2100	None	NA	8.00"	2440	2440	Weir	2/2/2012	2:45	
14-N	D23-2105	16	-1%	8.13"	18110	-103	Weir	2/2/2012	2:52	
14-W	D23-2105	15-W	18%	8.00"	3689	657	Weir	2/2/2012	2:49	
15-W	D23-2106	None	NA	8.13"	3032	3032	Weir	2/2/2012	2:24	
16-N	D23-2110	18	5%	8.00"	13460	712	Weir	2/2/2012	1:50	
16-W	D23-2110	17-W	0%	8.13"	3689	0	Weir	2/2/2012	1:40	
16-E	D23-2110	None	NA	8.13"	1064	1064	Weir	2/2/2012	1:44	
17-W	D23-2112	None	NA	8.13"	3689	3689	Weir	2/2/2012	1:11	
18-N	D23-2115	20	29%	8.00"	11290	3254	Weir	2/2/2012	2:07	
18-W	D23-2115	19-W	-103%	8.00"	1458	-1504	Weir	2/2/2012	2:06	
18-E	D23-2115	None	NA	8.00"	0	0	None	2/2/2012	2:18	Not enough flow to perform weir
19-W	D23-2117	None	NA	8.00"	2962	2962	PVD	2/2/2012	1:42	Pipe had rough bottom and couldn't get weir to seal, pulsing present (velocity reading unreliable at 0.38" depth), Pulsing not present at 18-W
20-N	D23-2125	None	NA	8.00"	7301	7301	Weir	2/2/2012	1:13	
20-W	D23-2125	None	NA	7.50"	735	735	Weir	2/2/2012	1:27	
	D23-4002	-	-	12.00"	39830	-	Weir	2/23/2012	2:26	
NE	D23-3001	-	-	18.00"	36577	-	PVD	2/23/2012	1:41	
SW	D23-3001	-	-	12.00"	0	-	Weir	2/23/2012	1:54	Too little flow to measure even after waiting for 6 minutes to back flow up behind weir

APPENDIX B

WINCAN Reports for Video Inspections of Side Sewers

Rec 3/19/12

WinCan America Inc.

Pipe Experts L.L.C.
855 Trosper Rd. 108-190
Tumwater, WA 98512
Tel: (360) 943-5840, Fax: (360) 943-5865

INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
03/16/2012		Day, Rainy	J. Overton	26	
PRESENT:	**VEHICLE:**	**CAMERA:**	**PRESET:**	**CLEANED:**	**RATE:**
	Cues Van	LAMP		NO	0

STREET:	17548 & 17500 Angeline Ave	MAP #1:		MH:	D22-2002
CITY:	Suquamish	MAP #2:		MH:	D22-2001
LOCALE:	OTHER	TAPE #:	1	TV'D LGTH:	232.8 ft

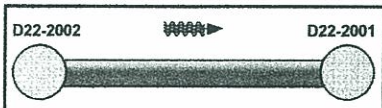
INSPECT REASON:	I/I Investigation	PIPE SIZE:	12"
SECTION TYPE:	WASTEWATER	MATERIAL:	CONCRETE JT LGTH:
AREA:		LINING:	NO RELINING
		RSRVD:	

REMARK:

1:575	DIST	OBSERVATION	RATE
D22-2002	0.00	inspection begins at upstream manhole	0
	132.00	service connection, at 10 o´clock	0
D22-2001	232.80	service connection, at 10 o´clock	0
	232.80	inspection ends	0

Pipe Experts L.L.C.
855 Trosper Rd. 108-190
Tumwater, WA 98512
Tel: (360) 943-5840, Fax: (360) 943-5865

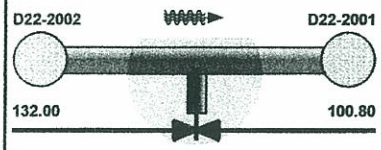
LATERAL REPORT



SECTION NR:	SECTION NAME:	TV'D LGTH:	MH:	MH:
26		232.8 FT	D22-2002	D22-2001

MATERIAL:	PIPE SIZE:	LINING:	SECTION TYPE:
CONCRETE	12"	NO RELINING	WASTEWATER

CITY:	STREET:	LOCALE:	TAPE #:
Suquamish	17548 & 17500 Angeline Ave	OTHER	1



DATE:	WEATHER:	CLEANED:	STREET:
03/16/2012	SUNNY, DRY	NO	

SECTION NAME:	DIST:	MATERIAL:	PIPE SIZE:
	132.00	CONCRETE	6"

OPERATOR:	VEHICLE:	CAMERA:	TAPE #:
J. Overton	Cues Van	OZ 2	

REMARK: 17500 Angeline Ave

1:125	DIST	OBSERVATION	VCR #	PH	RATE
	0.00	inspection begins at Main	00:00:00		0
	31.90	*Longitudinal Crack, at 07 o´clock*	*00:00:00*		*2*
	31.90	Infiltration Stain at 07 o´clock	00:00:00		3
	38.20	service connection, at 10 o´clock	00:00:00		0
	42.10	service connection, at 12 o´clock possible cleanout	00:00:00		0
	43.00	pipe material changes at this point to PVC	00:00:00		0
	46.40	inspection abandoned unable to push	00:00:00		0

WinCan America Inc.

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Tumwater, WA 98512
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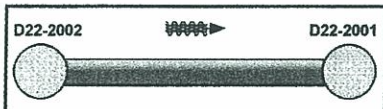
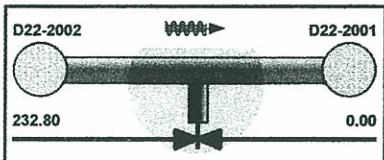
LATERAL REPORT



SECTION NR:	SECTION NAME:	TV'D LGTH:	MH:	MH:
26		232.8 FT	D22-2002	D22-2001

MATERIAL:	PIPE SIZE:	LINING:	SECTION TYPE:
CONCRETE	12"	NO RELINING	WASTEWATER

CITY:	STREET:	LOCALE:	TAPE #:
Suquamish	17548 & 17500 Angeline Ave	OTHER	1



DATE:	WEATHER:	CLEANED:	STREET:
03/16/2012	SUNNY, DRY	NO	

SECTION NAME:	DIST:	MATERIAL:	PIPE SIZE:
	232.80	CONCRETE	6"

OPERATOR:	VEHICLE:	CAMERA:	TAPE #:
J. Overton	Cues Van	OZ 2	

REMARK: 17548 Angeline Ave

1:125	DIST	OBSERVATION	VCR #	PH	RATE
	0.00	inspection begins at Main	00:00:00		0
	23.80	Infiltration Stain at 03 o´clock	00:00:00		3
	49.80	service connection, at 09 o´clock	00:00:00		0
	49.80	inspection abandoned unable to push	00:00:00		0

Pipe Experts L.L.C.
855 Trosper Rd. 108-190
Tumwater, WA 98512
Tel: (360) 943-5840, Fax: (360) 943-5865

INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
03/16/2012		**Day, Rainy**	**J. Overton**	**27**	
PRESENT:	VEHICLE:	CAMERA:	PRESET:	CLEANED:	RATE:
	Cues Van	**LAMP**		**NO**	**0**

STREET:	**17634 Angeline Ave**	MAP #1:		MH:	**D23-3028**
CITY:	**Suquamish**	MAP #2:		MH:	**D22-2001**
LOCALE:	**OTHER**	TAPE #:	**1**	TV'D LGTH:	**83 ft**

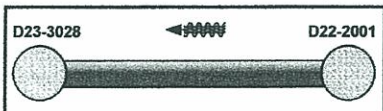
INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**12"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:225	DIST	OBSERVATION	RATE
D23-3028	0.00	inspection begins at downstream manhole	0
D22-2001	83.00	service connection, at 02 o´clock	0
	83.00	inspection ends	0

Pipe Experts L.L.C.
855 Trosper Rd. 108-190
Tumwater, WA 98512
Tel: (360) 943-5840, Fax: (360) 943-5865

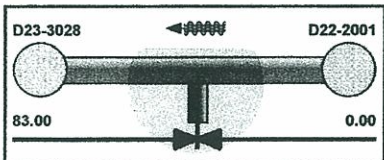
LATERAL REPORT



SECTION NR:	SECTION NAME:	TV'D LGTH:	MH:	MH:
27		83 FT	D23-3028	D22-2001

MATERIAL:	PIPE SIZE:	LINING:	SECTION TYPE:
CONCRETE	12"	NO RELINING	WASTEWATER

CITY:	STREET:	LOCALE:	TAPE #:
Suquamish	17634 Angeline Ave	OTHER	1



DATE:	WEATHER:	CLEANED:	STREET:
03/16/2012	SUNNY, DRY	NO	

SECTION NAME:	DIST:	MATERIAL:	PIPE SIZE:
	83.00	CONCRETE	6"

OPERATOR:	VEHICLE:	CAMERA:	TAPE #:
J. Overton	Cues Van	OZ 2	

REMARK: 17634 Angeline Ave

1:150	DIST	OBSERVATION	VCR #	PH	RATE
	0.00	inspection begins at Main	00:00:00		0
	18.60	*Infiltration Stain at 03 o'clock*	*00:00:00*		*0*
	48.50	service connection, at 12 o´clock possible cleanout	00:00:00		0
	49.70	pipe material changes at this point to PVC	00:00:00		0
	56.80	inspection abandoned end of cable	00:00:00		0

Pipe Experts L.L.C.
855 Trosper Rd. 108-190
Tumwater, WA 98512
Tel: (360) 943-5840, Fax: (360) 943-5865

INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
03/16/2012		**Day, Rainy**	**J. Overton**	**28**	
PRESENT:	VEHICLE:	CAMERA:	PRESET:	CLEANED:	RATE:
	Cues Van	**LAMP**		**NO**	**0**

STREET:	**17698 & 17724 Angeline Ave**	MAP #1:		MH:	**D23-3028**
CITY:	**Suquamish**	MAP #2:		MH:	**D23-3027**
LOCALE:	**OTHER**	TAPE #:	**1**	TV'D LGTH:	**303.8 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**12"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:750	DIST	OBSERVATION	RATE
D23-3028	0.00	inspection begins at upstream manhole	0
	59.00	service connection, at 10 o´clock	0
D23-3027	303.80	service connection, at 10 o´clock	0
	303.80	inspection ends	0

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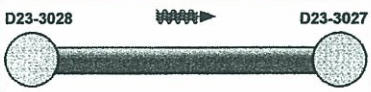
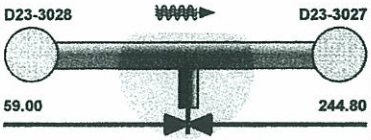
LATERAL REPORT



SECTION NR:	SECTION NAME:	TV'D LGTH:	MH:	MH:
28		303.8 FT	D23-3028	D23-3027

MATERIAL:	PIPE SIZE:	LINING:	SECTION TYPE:
CONCRETE	12"	NO RELINING	WASTEWATER

CITY:	STREET:	LOCALE:	TAPE #:
Suquamish	17698 & 17724 Angeline Ave	OTHER	1



DATE:	WEATHER:	CLEANED:	STREET:
03/16/2012	SUNNY, DRY	NO	

SECTION NAME:	DIST:	MATERIAL:	PIPE SIZE:
	59.00	CONCRETE	6"

OPERATOR:	VEHICLE:	CAMERA:	TAPE #:
J. Overton	Cues Van	OZ 2	

REMARK: 17698 Angeline Ave

1:100	DIST	OBSERVATION	VCR #	PH	RATE
	0.00	inspection begins at Main	00:00:00		0
	37.50	inspection abandoned unable to push due to bends and grade	00:00:00		0

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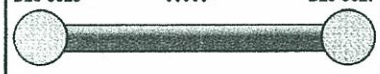
LATERAL REPORT



SECTION NR:	SECTION NAME:	TV'D LGTH:	MH:	MH:
28		303.8 FT	D23-3028	D23-3027

MATERIAL:	PIPE SIZE:	LINING:	SECTION TYPE:
CONCRETE	12"	NO RELINING	WASTEWATER

CITY:	STREET:	LOCALE:	TAPE #:
Suquamish	17698 & 17724 Angeline Ave	OTHER	1

DATE:	WEATHER:	CLEANED:	STREET:
03/16/2012	SUNNY, DRY	NO	

SECTION NAME:	DIST:	MATERIAL:	PIPE SIZE:
	303.80	CONCRETE	6"

OPERATOR:	VEHICLE:	CAMERA:	TAPE #:
J. Overton	Cues Van	OZ 2	

REMARK: 17724 Angeline Ave

1:75	DIST	OBSERVATION	VCR #	PH	RATE
	0.00	inspection begins at Main	00:00:00		0
	27.30	inspection abandoned due to grade and bends	00:00:00		0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
03/05/2012		**Day, Rainy**	**J. Overton**	**23**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**17914 Angeline Ave**	MAP #1:		MH:	**D23-3003**
CITY:	**Suquamish**	MAP #2:		MH:	**D23-3002**
LOCALE:	**OTHER**	TAPE #:	**1**	TV'D LGTH:	**158.1 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**18"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:400	DIST	OBSERVATION	RATE
D23-3003	0.00	inspection begins at upstream manhole	0
D23-3002	158.10	service connection, at 02 o´clock	0
	158.10	inspection ends at Lateral	0

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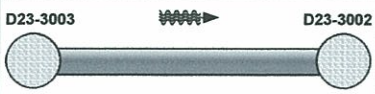
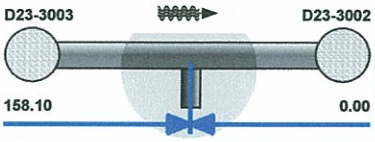
LATERAL REPORT



SECTION NR:	SECTION NAME:	TV'D LGTH:	MH:	MH:
23		158.1 FT	D23-3003	D23-3002

MATERIAL:	PIPE SIZE:	LINING:	SECTION TYPE:
CONCRETE	18"	NO RELINING	WASTEWATER

CITY:	STREET:	LOCALE:	TAPE #:
Suquamish	17914 Angeline Ave	OTHER	1



DATE:	WEATHER:	CLEANED:	STREET:
03/05/2012	SUNNY, DRY	NO	

SECTION NAME:	DIST:	MATERIAL:	PIPE SIZE:
	158.10	CONCRETE	6"

OPERATOR:	VEHICLE:	CAMERA:	TAPE #:
J. Overton	Cues Van	LAMP	

REMARK: 17914 Angeline Ave

1:150	DIST	OBSERVATION	VCR #	PH	RATE
	0.00	inspection begins at Main	00:00:00		0
	59.70	inspection ends End of cable	00:00:00		0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
03/05/2012		**Day, Rainy**	**J. Overton**	**24**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**17818 Angeline Ave**	MAP #1:		MH:	**D23-3001**
CITY:	**Suquamish**	MAP #2:		MH:	**D23-3002**
LOCALE:	**OTHER**	TAPE #:	**1**	TV'D LGTH:	**191 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**18"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:475	DIST	OBSERVATION	RATE
D23-3001	0.00	inspection begins at downstream manhole	0
D23-3002	191.00	service connection, at 10 o´clock	0
	191.00	inspection ends at Lateral	0

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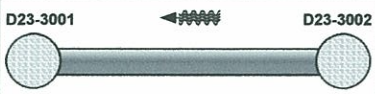
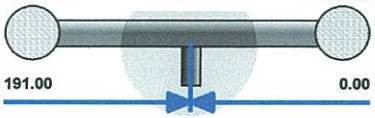
LATERAL REPORT



SECTION NR:	SECTION NAME:	TV'D LGTH:	MH:	MH:
24		191 FT	D23-3001	D23-3002

MATERIAL:	PIPE SIZE:	LINING:	SECTION TYPE:
CONCRETE	18"	NO RELINING	WASTEWATER

CITY:	STREET:	LOCALE:	TAPE #:
Suquamish	17818 Angeline Ave	OTHER	1



DATE:	WEATHER:	CLEANED:	STREET:
03/05/2012	SUNNY, DRY	NO	

SECTION NAME:	DIST:	MATERIAL:	PIPE SIZE:
	191.00	CONCRETE	6"

OPERATOR:	VEHICLE:	CAMERA:	TAPE #:
J. Overton	Cues Van	LAMP	

REMARK: 17818 Angeline Ave

1:100	DIST	OBSERVATION	VCR #	PH	RATE
	0.00	inspection begins at Main	00:00:00		0
	33.00	inspection ends Unable to push any further	00:00:00		0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
03/05/2012		**Day, Rainy**	**J. Overton**	**25**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**17762 Angeline Ave**	MAP #1:		MH:	**D23-3001**
CITY:	**Suquamish**	MAP #2:		MH:	**D23-3027**
LOCALE:	**OTHER**	TAPE #:	**1**	TV'D LGTH:	**184 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**12"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:450	DIST	OBSERVATION	RATE
D23-3001	0.00	inspection begins at downstream manhole	0
	184.00	service connection, at 02 o´clock	0
D23-3027	184.00	inspection ends at Lateral	0

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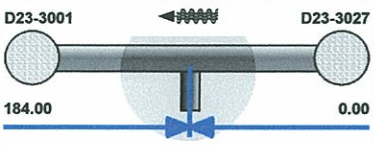
LATERAL REPORT

SECTION NR:	SECTION NAME:	TV'D LGTH:	MH:	MH:
25		184 FT	D23-3001	D23-3027

MATERIAL:	PIPE SIZE:	LINING:	SECTION TYPE:
CONCRETE	12"	NO RELINING	WASTEWATER

CITY:	STREET:	LOCALE:	TAPE #:
Suquamish	17762 Angeline Ave	OTHER	1



DATE:	WEATHER:	CLEANED:	STREET:
03/05/2012	SUNNY, DRY	NO	

SECTION NAME:	DIST:	MATERIAL:	PIPE SIZE:
	184.00	CONCRETE	6"

OPERATOR:	VEHICLE:	CAMERA:	TAPE #:
J. Overton	Cues Van	LAMP	

REMARK: 17762 Angeline Ave

1:100	DIST	OBSERVATION	VCR #	PH	RATE
	0.00	inspection begins at Main	00:00:00		0
	36.90	inspection ends Unable to push any farther	00:00:00		0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**8**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**18198 Cherry Tree Ln**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**63.8 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:175 DIST	OBSERVATION	RATE
0.00	inspection begins at Mainline	0
20.70	Cleanout	
21.40	pipe material changes at this point to PVC	0
21.40	pipe size decreases to 4"	0
63.80	inspection ends at end of cable	0

I seems PVC whole way

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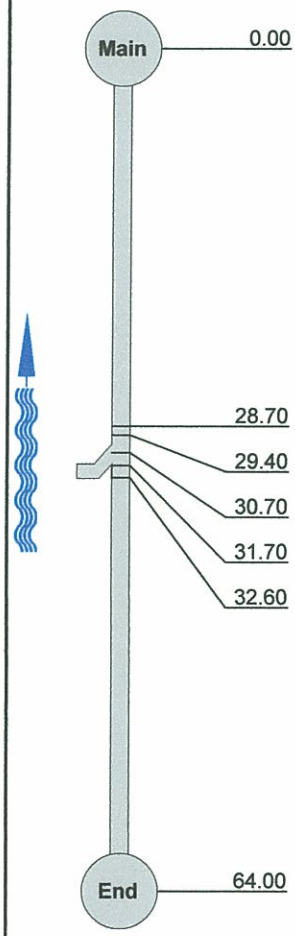
INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**3**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**6655 NE Plum St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**64 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:



1:175 DIST	OBSERVATION	RATE
0.00	inspection begins at Mainline	0
28.70	Cleanout	
29.40	pipe material changes at this point to PVC	0
30.70	service connection, at 03 o´clock	0
31.70	pipe size decreases to 4"	0
32.60	Cleanout	
64.00	inspection ends at end of cable	0

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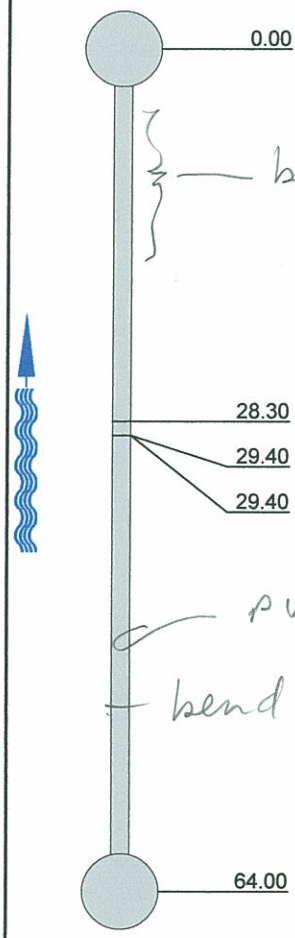
INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		Day, Rainy	J. Overton	4	
PRESENT:	**VEHICLE:**	**CAMERA:**	**PRESET:**	**CLEANED:**	**RATE:**
	Cues Van	LAMP		NO	0

STREET:	6725 NE Plum St	MAP #1:		MH:	
CITY:	Suquamish	MAP #2:		MH:	
LOCALE:	MAIN RESIDENTIAL STREET	TAPE #:	1	TV'D LGTH:	64 ft

INSPECT REASON:	I/I Investigation	PIPE SIZE:	6"
SECTION TYPE:	WASTEWATER	MATERIAL:	CONCRETE JT LGTH:
AREA:		LINING:	NO RELINING
		RSRVD:	

REMARK:



1:175	DIST	OBSERVATION	RATE
	0.00	inspection begins at Mainline	0
		steady flow of clear water (~ 5gpm)	
	28.30	Cleanout	
	29.40	pipe material changes at this point to PVC	0
	29.40	pipe size decreases to 4"	0
	64.00	inspection ends at end of cable	0

Service should be replaced.

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**7**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**6624 NE Maple St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**32.8 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:100	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
		standing water	
		relatively low I&I	
		conc.	
	32.10	Cleanout	
	32.80	pipe material changes at this point to PVC	0
	32.80	pipe size decreases 4"	0
	32.80	camera blocked, inspection abandoned, unable to bypass transition	0

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INSPECTION REPORT

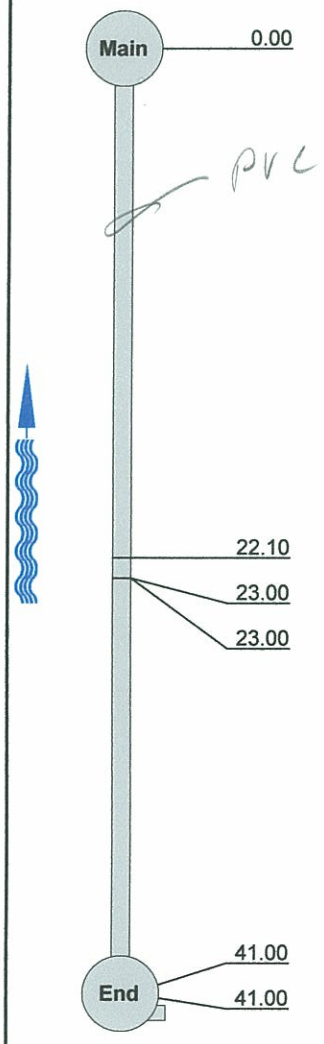
DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**9**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**6725 NE Maple**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**41 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

looks good. pipe not flowing anything



1:100 DIST	OBSERVATION	RATE
0.00	inspection begins at Mainline	0
22.10	Cleanout	
23.00	pipe material changes at this point to PVC	0
23.00	pipe size decreases to 4"	0
41.00	service connection, at 09 o´clock	0
41.00	inspection ends	0

wrong

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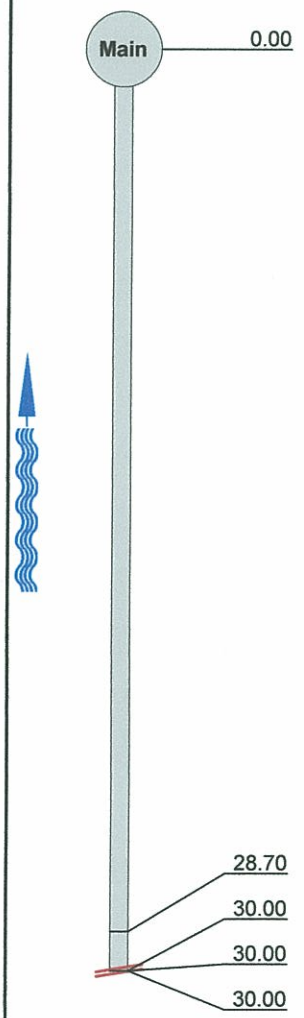
INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**10**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **150**

STREET:	**6720 NE Maple St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**30 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:



1:75 DIST	OBSERVATION	RATE
0.00	inspection begins at Mainline	0
28.70	Infiltration Running	1
30.00	pipe material changes at this point to PVC	0
30.00	pipe size decreases to 4"	0
30.00	camera blocked, inspection abandoned, unable to bypass transition	0

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INSPECTION REPORT

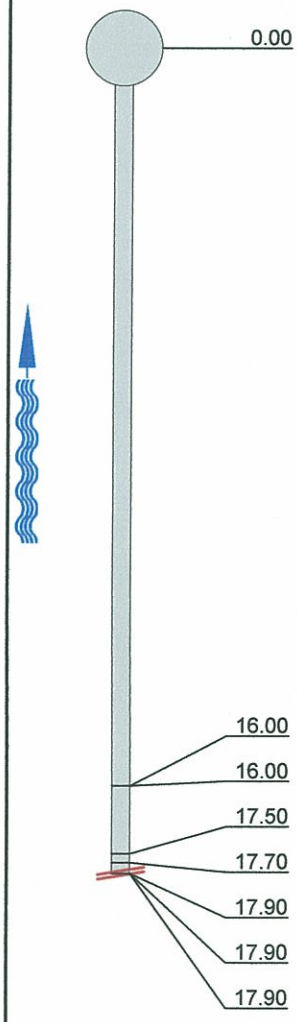
DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		Day, Rainy	J. Overton	5	
PRESENT:	VEHICLE:	CAMERA:	PRESET:	CLEANED:	RATE:
	Cues Van	LAMP		NO	430

STREET:	6633 NE Madison St	MAP #1:		MH:	
CITY:	Suquamish	MAP #2:		MH:	
LOCALE:	MAIN RESIDENTIAL STREET	TAPE #:	1	TV'D LGTH:	17.9 ft

INSPECT REASON:	I/I Investigation	PIPE SIZE:	6"
SECTION TYPE:	WASTEWATER	MATERIAL:	CONCRETE JT LGTH:
AREA:		LINING:	NO RELINING
		RSRVD:	

REMARK:

A lot of apparent I & I, 5 gpm?
Replace tee & lateral to PVC.



1:50 DIST	OBSERVATION	RATE
0.00	inspection begins at Mainline	0
16.00	Infiltration Running ✓	1
16.00	roots light ✓	1
17.50	Cleanout	
17.70	Infiltration Running	1
17.90	pipe material changes at this point to PVC	0
17.90	pipe size decreases to 4"	0
17.90	camera blocked, inspection abandoned unable to bypass transition	0

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855 Trosper Rd. 108-190
Tumwater, WA 98512
Tel: (360) 943-5840, Fax: (360) 943-5865

INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		Day, Rainy	J. Overton	11	
PRESENT:	VEHICLE:	CAMERA:	PRESET:	CLEANED:	RATE:
	Cues Van	LAMP		NO	0

STREET:	6720 NE MAdison St	MAP #1:		MH:	Main
CITY:	Suquamish	MAP #2:		MH:	End
LOCALE:	MAIN RESIDENTIAL STREET	TAPE #:	1	TV'D LGTH:	45.5 ft

INSPECT REASON:	I/I Investigation	PIPE SIZE:	6"
SECTION TYPE:	WASTEWATER	MATERIAL:	CONCRETE JT LGTH:
AREA:		LINING:	NO RELINING
		RSRVD:	

REMARK:

No I&I

1:125	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
		conc.	
		apparent branch @ 21' (double 55)	
	24.20	Cleanout	
	25.10	pipe material changes at this point to PVC	0
	25.10	pipe size decreases to 4"	0
End	45.10	service connection, at 09 o´clock	0
	45.50	inspection ends	0

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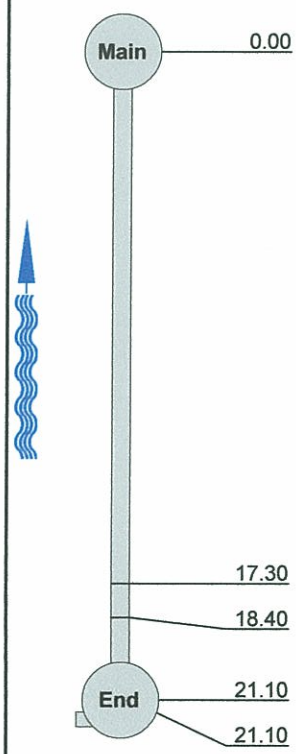
INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**12**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**6743 Ne Madison St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**21.1 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK: **6743 Madison has a shared connection with 6719 Madison**



1:75 DIST	OBSERVATION	RATE
0.00	inspection begins at Mainline	0
17.30	Cleanout	
18.40	pipe material changes at this point to PVC	0
21.10	service connection, at 03 o´clock, 6719 Madison	0
21.10	inspection ends	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**6**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**6690 NE Columbia St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**56.1 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:150	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
		conc some I&I	
	6.50	Cleanout	
	7.00	pipe material changes at this point to PVC	0
	7.00	pipe size decreases to 4"	0
		looks good. Replace lateral	
End	56.10	pipe material changes at this point to ABS	0
	56.10	pipe size decreases to 3"	0
	56.10	inspection ends	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**21**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**18868 Angeline St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**22.3 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:75	DIST	OBSERVATION	RATE
Main	0.00	inspection begins Mainline	0
	21.50	Cleanout	
	22.30	pipe material changes at this point to PVC	0
	22.30	pipe size decreases to 4"	0
	22.30	camera blocked, inspection abandoned, unable to bypass transition	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
02/02/2012		**Day, Rainy**	**J. Overton**	**22**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**18908 Angeline St**	MAP #1:		MH:	
CITY:	**Suquamish**	MAP #2:		MH:	
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**22.7 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:75 DIST	OBSERVATION	RATE
0.00	inspection begins at Mainline	0
21.60	Cleanout	
22.70	pipe material changes at this point to ABS	0
22.70	inspection ends	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**20**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**19022 Angeline St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**22.7 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:75	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
End	22.70	pipe material changes at this point to PVC	0
	22.70	Cleanout	
	22.70	inspection ends	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**18**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **150**

STREET:	**19082 Angeline St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**24.3 ft**

298 ft d/s of MH D23-1012

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:75	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
	0.00	Infiltration Running from 09 to 03 o´clock at pipe connection	1
		1-2 gpm. ↖ Replace tee.	
	24.30	pipe material changes at this point to PVC	0
	24.30	pipe size decreases to 4"	0
	24.30	Cleanout	
	24.30	camera blocked, inspection abandoned, unable to bypass transition	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**17**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **150**

STREET:	**19116 Angeline St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**23 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:75	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
	0.30	Possible Infiltration Running at 03 o´clock	1
	23.00	pipe material changes at this point to PVC	0
	23.00	Cleanout	
	23.00	pipe size decreases to 4"	0
	23.00	camera blocked, inspection abandoned, unable to bypass transition	0

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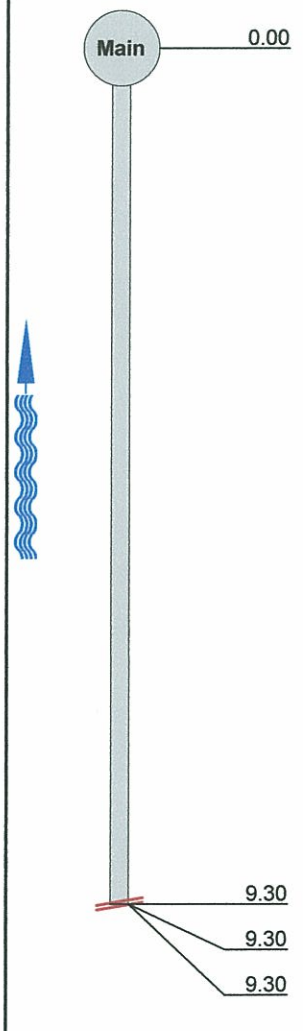
INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**19**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**19110 Harris St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**9.3 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:



1:25 DIST	OBSERVATION	RATE
0.00	inspection begins at Mainline	0
9.30	pipe material changes at this point to PVC	0
9.30	pipe size decreases 4"	0
9.30	camera blocked, inspection abandoned, unable to bypass transition	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**16**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**19056 Harris St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**7.8 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:25	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
	7.80	pipe material changes at this point to PVC	0
	7.80	pipe size decreases to 4"	0
	7.80	Cleanout	
	7.80	camera blocked, inspection abandoned, unable to bypass transition	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**14**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**18998 Harris St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**53 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

dry & tight

1:150	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
		PVC	
	8.90	Cleanout	
	10.00	pipe material changes at this point to CAST IRON	0
	40.00	service connection, at 09 o´clock	0
	42.80	pipe size decreases 3"	0
End	53.00	inspection ends	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012		**Day, Rainy**	**J. Overton**	**13**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**18850 Harris St**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**44.1 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:125	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
	7.30	pipe material changes at this point to PVC	0
	10.90	Cleanout	
	26.80	service connection, at 12 o´clock Possible Cleanout	0
End	44.10	inspection ends	0

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INSPECTION REPORT

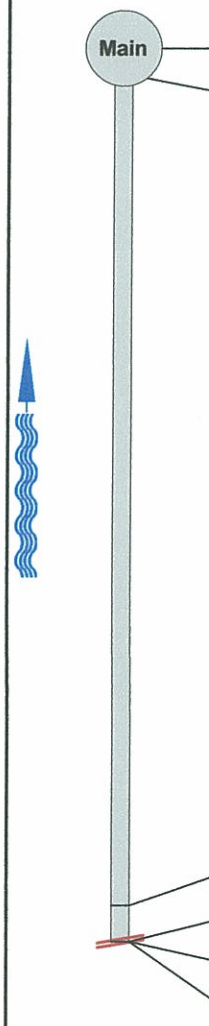
DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012				**2**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **150**

STREET:	**18813 Harris Ave**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**19.4 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:50	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
	0.60	Infiltration Running from 05 to 07 o clock	1
	18.60	Cleanout	
	19.40	pipe material changes at this point to PVC	0
	19.40	pipe size decreases to 4"	0
	19.40	camera blocked, inspection abandoned, unable to bypass transition	0



in conc. tee

substantial - 3 - 4 gpm

Tee should be removed & replaced.

Lateral & sidesewer not showing I & I.

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
01/26/2012				**1**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**18899 Harris Ave**	MAP #1:		MH:	**Main**
CITY:	**Suquamish**	MAP #2:		MH:	**End**
LOCALE:	**MAIN RESIDENTIAL STREET**	TAPE #:	**1**	TV'D LGTH:	**63.9 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**6"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:175	DIST	OBSERVATION	RATE
Main	0.00	inspection begins at Mainline	0
	11.90	Cleanout	
	12.90	pipe size decreases to 4"	0
	53.30	service connection, at 12 o´clock Possible cleanout	0
	54.40	pipe size decreases to 3"	0
	54.40	pipe material changes at this point to ABS	0
End	63.90	inspection ends at end of cable	0

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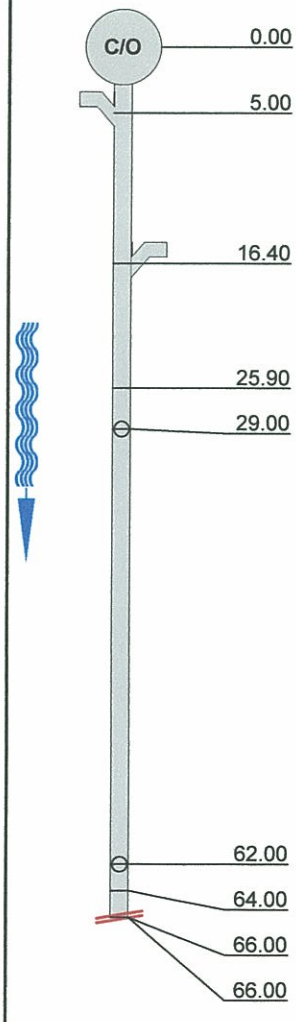
INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
04/18/2012		**Day, Rainy**	**J. Overton**	**29**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **250**

STREET:	**Angeline Ave**	MAP #1:		MH:	**C/O**
CITY:	**Suquamish**	MAP #2:		MH:	**Downstrm**
LOCALE:	**OTHER**	TAPE #:	**1**	TV'D LGTH:	**66 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**4"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**ABS** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK: **Line # 17**



1:175 DIST	OBSERVATION	RATE
0.00	inspection begins at upstream cleanout	0
5.00	service connection, at 02 o´clock	0
16.40	service connection, at 10 o´clock	0
25.90	pipe material changes at this point to PVC	0
29.00	service connection, at 12 o´clock, possible cleanout	0
62.00	service connection, at 12 o´clock, possible cleanout	0
64.00	pipe material changes at this point to CONCRETE	0
66.00	separated joint medium	2
66.00	camera blocked, inspection abandoned	0

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INSPECTION REPORT

DATE:	WORK ORDER:	WEATHER:	OPERATOR:	SECTION NR:	SECTION NAME:
04/19/2012		**Day, Rainy**	**P.Shepp**	**30**	
PRESENT:	VEHICLE: **Cues Van**	CAMERA: **LAMP**	PRESET:	CLEANED: **NO**	RATE: **0**

STREET:	**Angeline Ave**	MAP #1:		MH:	**D23-3004**
CITY:	**Suquamish**	MAP #2:		MH:	**D23-3009**
LOCALE:	**OTHER**	TAPE #:	**1**	TV'D LGTH:	**393.7 ft**

INSPECT REASON:	**I/I Investigation**	PIPE SIZE:	**18"**
SECTION TYPE:	**WASTEWATER**	MATERIAL:	**CONCRETE** JT LGTH:
AREA:		LINING:	**NO RELINING**
		RSRVD:	

REMARK:

1:975	DIST	OBSERVATION	RATE
D23-3004	0.00	inspection begins at downstream manhole	0
	105.30	service connection, at 10 o´clock	0
	222.00	service connection, at 10 o´clock	0
D23-3009	393.70	inspection ends at upstream manhole	0

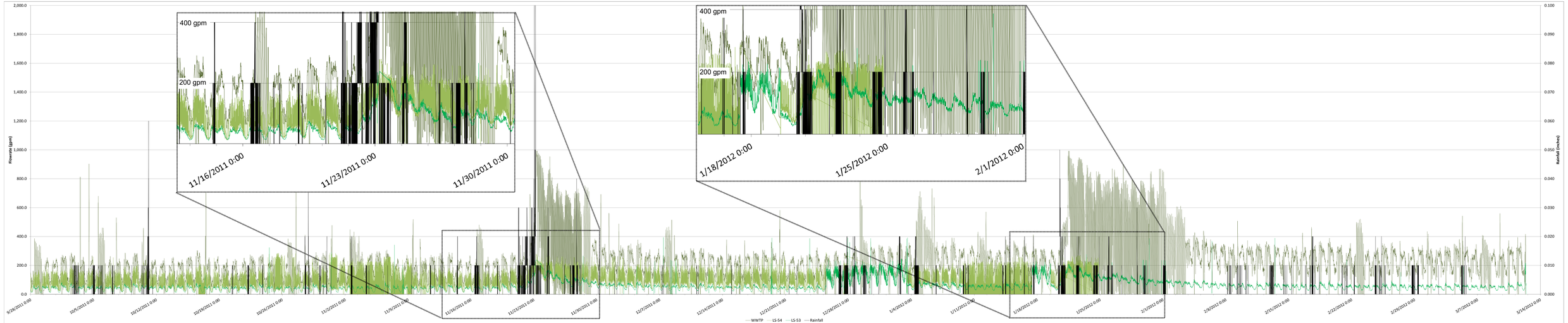
Project No	STREET_ADD	INSPECTION NOTES FROM 11/22/11	INSPECTION SUMMARY FROM 1/23-24/12
1	6655 NE PLUM ST	No C/O small vents	Inspected to end of cable (64'), shared lateral, no I/I
2	6725 NE PLUM ST	No C/O small vents	Inspected to end of cable (64'), no I/I
3	6624 NE MAPLE ST	No C/O small vents	Inspected to ROW, no I/I
4	6725 NE MAPLE ST	No C/O small vents	Inspected to house, no I/I observed
4	6720 NE MAPLE ST	No C/O small vents	Inspected to ROW, **I/I at 29'**
5	6633 NE MADISON ST	Not nice lady was told to leave	Inspected to ROW, **roots and I/I at 16'**
6	6720 NE MADISON ST	No C/O small vents	Inspected to ROW, no I/I
6	6719 NE MADISON ST	No C/O small vents	Shares connection with 6743 Madison St
7	6743 NE MADISON ST	Found but dirty	Inspected to shared connection, no I/I observed
8	6690 NE COLUMBIA ST	No C/O small vents	Inspected to house, no I/I observed
9	17500 ANGELINE AVENUE SOUTH NE	No C/O mainline on water side	
10	17548 ANGELINE AVENUE SOUTH NE	No C/O mainline on water side	
11	17634 ANGELINE AVENUE SOUTH NE	No C/O mainline on water side	
12	17698 ANGELINE AVENUE SOUTH NE	No C/O mainline on water side	
13	17724 ANGELINE AVENUE SOUTH NE	No C/O mainline on water side	
14	17762 S ANGELINE AVE NE	No C/O mainline on water side	
15	17818 ANGELINE AVENUE SOUTH NE	No C/O mainline on water side	
16	17914 S ANGELINE AVE NE	No C/O mainline on water side	
17	17978 ANGELINE AVENUE SOUTH NE	**Inspected c/o in basement**	
18	18198 CHERRY TREE LN	No C/O small vents	Inspected to end of cable (64'), no I/I
19	18868 ANGELINE AVE NE	No C/O small vents	Inspected to ROW, no I/I
20	18908 ANGELINE AVE NE	No C/O small vents	Inspected to ROW, no I/I
21	19022 ANGELINE AVE NE	No C/O small vents	Inspected to ROW, no I/I, **County says downspouts connected**
22	19082 ANGELINE AVE NE	No C/O small vents	Inspected to ROW, **I/I at mainline connection**
23	19116 ANGELINE AVE NE	No C/O small vents	Inspected to ROW, **I/I at mainline connection**
23	19116 ANGELINE AVE NE	No C/O small vents	**repeat**
24	19110 HARRIS AVE NE	No C/O small vents	Inspected to ROW, no I/I
24	19110 HARRIS AVE NE	No C/O small vents	**repeat**
25	19056 HARRIS AVE NE	No C/O small vents	Inspected to ROW, no I/I
26	19022 HARRIS AVE NE	No C/O small vents	Inspected to ROW, no I/I
27	18998 HARRIS AVE NE	No C/O small vents	Inspected to house, no I/I observed, 4" Cast Iron pipe
28	18850 HARRIS AVE NE	No C/O small vents	Inspected to house, no I/I observed
29	18813 HARRIS AVE NE	No C/O small vents	Inspected to ROW, **I/I at mainline connection**
30	18899 HARRIS AVE NE	No C/O small vents	Inspected to house, no I/I observed

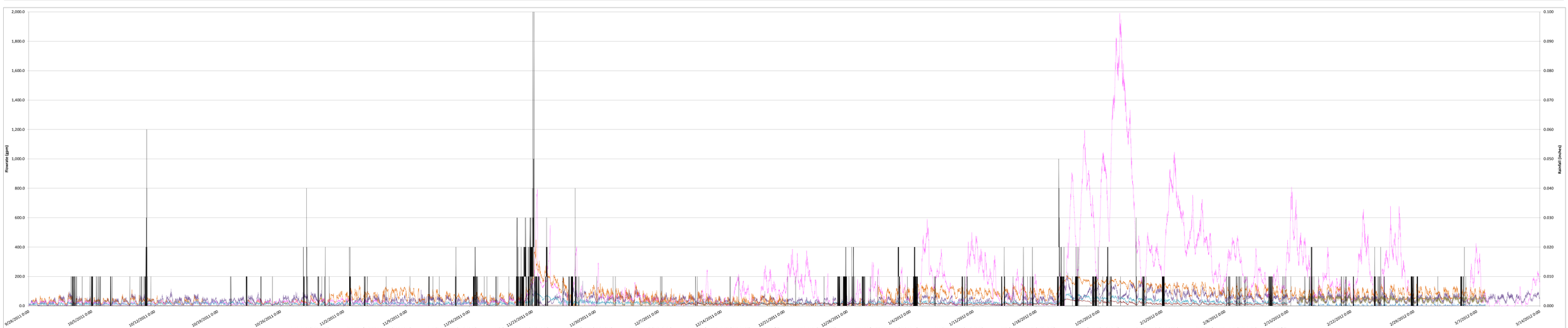
County reports that 6760 and 6720 Pine St suspected to have downspouts connected

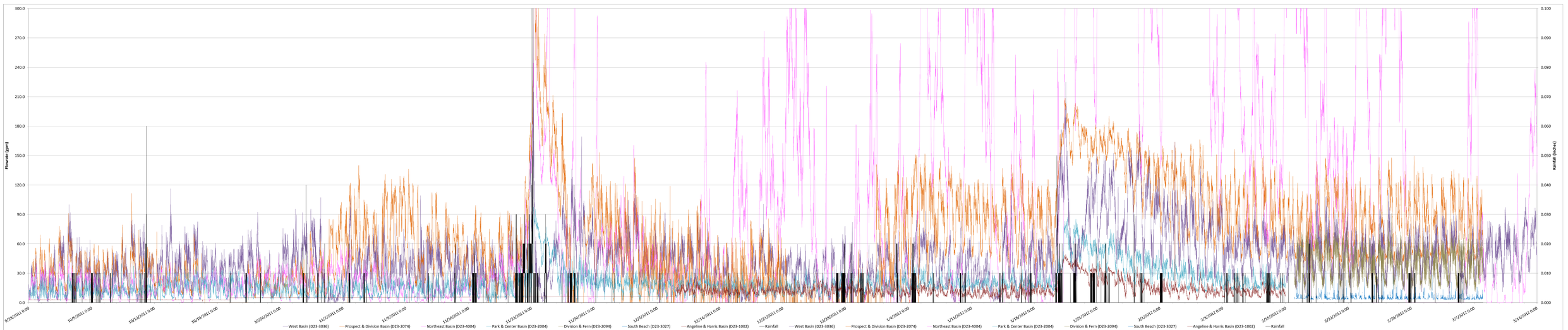
APPENDIX C

Full Record of Flows

September 2011 through March 2012


Flowrate (gpm)
Rainfall (inches)
400 gpm
200 gpm
11/16/2011 0:00
11/23/2011 0:00
11/30/2011 0:00
400 gpm
200 gpm
1/18/2012 0:00
1/25/2012 0:00
2/1/2012 0:00
WWTP
LS-54
LS-53
Rainfall


Flowrate (gpm)
Rainfall (inches)
West Basin (D23-3036)
Prospect & Division Basin (D23-2074)
Northeast Basin (D23-4004)
Park & Center Basin (D23-2004)
Division & Fern (D23-2094)
South Beach (D23-3027)
Angeline & Harris Basin (D23-1002)
Rainfall


Flowrate (gpm)
300.0
270.0
240.0
210.0
180.0
150.0
120.0
90.0
60.0
30.0
0.0
Rainfall (inches)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
9/28/2011 0:00
10/5/2011 0:00
10/12/2011 0:00
10/19/2011 0:00
10/26/2011 0:00
11/2/2011 0:00
11/9/2011 0:00
11/16/2011 0:00
11/23/2011 0:00
11/30/2011 0:00
12/7/2011 0:00
12/14/2011 0:00
12/21/2011 0:00
12/28/2011 0:00
1/4/2012 0:00
1/11/2012 0:00
1/18/2012 0:00
1/25/2012 0:00
2/1/2012 0:00
2/8/2012 0:00
2/15/2012 0:00
2/22/2012 0:00
2/29/2012 0:00
3/7/2012 0:00
3/14/2012 0:00
West Basin (D23-3036)
Prospect & Division Basin (D23-2074)
Northeast Basin (D23-4004)
Park & Center Basin (D23-2004)
Division & Fern (D23-2094)
South Beach (D23-3027)
Angeline & Harris Basin (D23-1002)
Rainfall
West Basin (D23-3036)
Prospect & Division Basin (D23-2074)
Northeast Basin (D23-4004)
Park & Center Basin (D23-2004)
Division & Fern (D23-2094)
South Beach (D23-3027)
Angeline & Harris Basin (D23-1002)
Rainfall

APPENDIX D

Wetland Reconnaissance: Permitting

Wetland Reconnaissance

A review of the WDFW SalmonScape interactive mapper, the WDFW PHS interactive mapper, the DNR Forest Practices interactive mapper, and the National Wetland Inventory interactive mapper yielded no wetland or stream habitat in the project footprint or its vicinity. An NWI wetland was mapped approximately 0.12 miles upslope and to the northwest of the project. The project is approximately 0.4 miles from Agate Pass of Puget Sound.

On May 15th, 2012, Nikki Olson, Environmental Scientist with RH2 Engineering, Inc., conducted an environmental reconnaissance of the project site for the Kitsap County Suquamish Collection System Upgrades project. Following is a summary of site observations and anticipated permits that will be necessary for the project.

- The weather was warm and sunny, and has been unseasonably warm and dry for most of this spring season.
- Drainage ditches line large portions of every street in the project area. Most of them were grass-lined and dry during the field visit. Many of the ditches appear to be mowed regularly. According to the definition of "wetlands" in the Kitsap County Code, wetlands do not include drainage ditches, grass-lined swales, or stormwater facilities (among others).
- Although the ditches convey stormwater for some portion of the year, water may not be present long enough to create wetland habitat. Soils, hydrology, and vegetation must be evaluated to conclusively determine whether wetlands occur in any of the ditches or other lands that may be disturbed during project construction.
- The existing sewer main that is proposed to be replaced for this project is within a natural sloping depression in the landscape. Consequently, there are several pockets of land along the alignment that exhibit potential wetland vegetation. During field reconnaissance, several forested areas were observed to have wetland plants. However, no obligate wetland species (i.e. plants that must live in standing water or saturated soils, like skunk cabbage) were observed. Facultative species such as red alder, salmonberry, and creeping buttercup were observed. Facultative species are equally likely to be observed in a wetland as they are in upland habitat; they are often a characteristic of wetland buffers. The presence of facultative wetland species does not necessarily indicate these areas are wetland. Wetland hydrology and hydric soils must also be present in these areas in order to classify as wetland habitat. It is recommended that these areas along the alignment be further investigated with respect to wetland soils, hydrology and vegetation.
- North of the alignment in NE Prospect Street there is a large pond with associated wetland habitat and a drainage that flows to the southeast (east of the alignment). The presence of water and clearly obligate plant species indicates this area will classify as a wetland. This area was not identified on the National Wetland Inventory or other critical areas data resources. Formal delineation and classification of this wetland was not completed as part of this reconnaissance. It is assumed that project work in NE Prospect Street can avoid this wetland. It is recommended that improvements remain within the developed roadway section to avoid

buffer habitat. If this is not possible, wetland buffer impacts would need to be mitigated for under the County's Critical Areas Code.

Preliminary Permitting Assessment

If some of the pockets or drainage ditches along the alignment are identified as wetlands, it may not be possible to avoid impacting them directly. In that scenario, Army Corps Section 404 and 401 approvals will be required; this will trigger NEPA. NEPA involves other approvals, such as Section 106 of the National Historic Preservation Act and Section 7 of the Endangered Species Act. Kitsap County is in the coastal zone for the Washington Coastal Zone Management Program; a federal nexus in the coastal zone triggers Coastal Zone Management approval by the Department of Ecology.

If the Army Corps takes jurisdiction over wetlands impacted by the project, or the project crosses a drainage that is classified by the County as a stream, a Hydraulic Project Approval will be required by WDFW.

The County will likely require a Site Development Activity Permit and Right-of-Way permit. The County will likely require a Critical Areas permit or approval, potentially with compensatory mitigation and monitoring related to impacts in wetlands or wetland buffers.

The project is outside of the shoreline and will not require a shoreline permit.

Although the project will qualify for the utility exemption under SEPA for 8" pipeline and under, if the project impacts critical areas, SEPA will be required.

If soil disturbance exceeds one acre, the project must obtain an NPDES Construction Stormwater Permit.