Inflow and Infiltration Update Report

Prepared for

City of Sweet Home, Oregon

September 24, 2013

I/I Update Report

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REGESTERED PROFESSIONAL
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FINAL

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Table of Contents

List of Figures

List of Tables

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List of Abbreviations

AV	area-velocity
BC	Brown and Caldwell
CAPE	Capacity Assurance Planning Environment modeling platform
CCTV	closed-circuit television
cfs	cubic feet per second
CIPP	cured-in-place pipe
City	City of Sweet Home
CMOM	Capacity, Management, Operation, and Maintenance
DEQ	Oregon Department of Environmental Quality
DWF	dry weather flow
FOG	fats, oil, and grease
gpad	gallons per acre per day
gpm	gallons per minute
I/I	infiltration/inflow
LPIII	Log Pearson Type III
MAO	Mutual Agreement and Order
mgd	million gallons per day
NASSCO	National Association of Sewer Service Companies
NOAA	National Oceanic and Atmospheric Administration
LF	linear feet
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
QA/QC	quality assurance/quality control
R&R	rehabilitation and replacement
RDII	rainfall-derived infiltration/inflow
ROW	right-of-way
SFE	SFE Global
SSO	sanitary sewer overflow
SWII	Stanford Watershed Infiltration/Inflow model
USEPA	U.S. Environmental Protection Agency
WWF	wet weather flow
WWTP	wastewater treatment plant

Executive Summary

The City of Sweet Home (City) retained Brown and Caldwell (BC) in 2002 to analyze sewer system infiltration/inflow (I/I) rates, evaluate system capacity deficiencies, make preliminary recommendations on how to comply with the Oregon Department of Environmental Quality (DEQ) requirement to pass without overflow the 5-year, peak-hour flow in the winter and the 10-year, peak-hour flow in the summer. Through the course of this work with the City, four rehabilitation and replacement (R&R) projects have been completed on portions of the collection system in an effort to reduce I/I. From recent collection system flow monitoring and modeling studies and a hydraulic capacity evaluation, BC concludes the R&R projects have been effective in reducing peak I/I flow rates and the City is moving toward compliance with DEQ regulations.

This report presents the results of the modeling efforts and the demonstrated effectiveness of the four R&R projects.

Findings

The City has invested over $15 million in planning and construction of the first four phases of R&R work in the collection system. The construction costs for each phase are listed in Table ES-1.

Table ES-1. Summary of R&R Costs by Phase

Construction phase	Capital cost, millions of dollars
Phase 1	1.3
Phase 2	1.7
Phase 3	3.1
Phase 4	6.0

Approximately 35 percent of the main line sewers and 30 percent of the laterals in Sweet Home have been rehabilitated using a variety of techniques. Service laterals have been rehabilitated to varying degrees. Due to access constraints, funding requirements, and budget limitations, not all service laterals have been fully rehabilitated all the way to the building. This variable level of rehabilitation should be considered when evaluating the I/I reduction effectiveness results and when planning future R&R work within the City's collection system.

Figure ES-1 shows the extent of rehabilitation for the first four phases of R&R work.

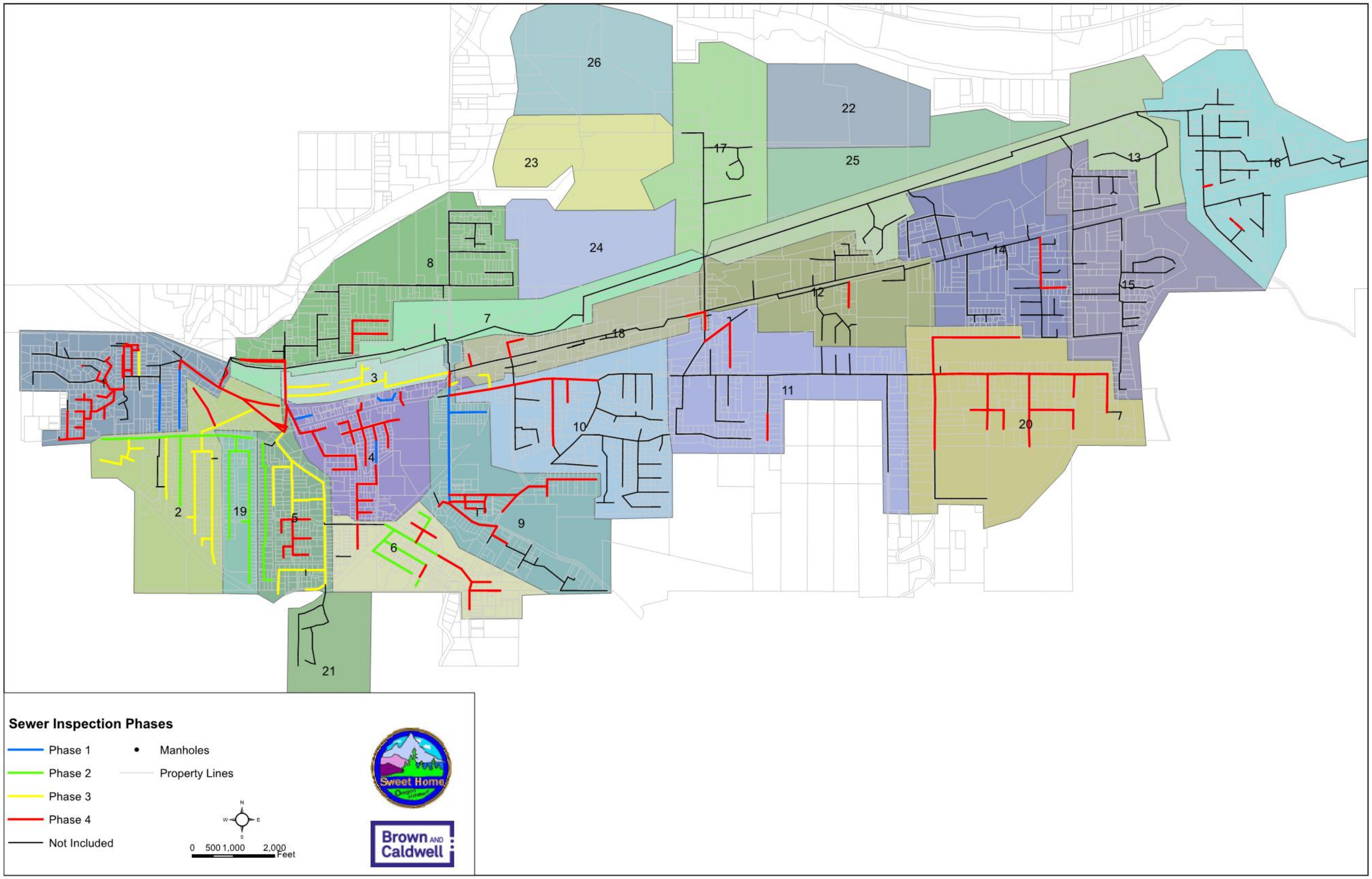

Figure ES-1. Phases 1, 2, 3, and 4 R&R work

Hydrologic Modeling Efforts

As part of the *Sanitary Sewer Master Plan* (BC, 2002), a hydrologic model was developed to simulate the maximum-hour, 1-in-5 year flows. Modeling was conducted under two scenarios: 1) using the existing population; and 2) using future population and also assuming future expansion of the City's wastewater service area.

Flow monitoring data, collected by the City from December 2000 to February 2002 at eight locations, was used to calibrate the model. As a result of the modeling effort, the peak-hour flow with a 5-year recurrence under existing population projections was modeled to be 22.0 mgd, while the peak-hour 5-year flow under future population projections was modeled to be 25.1 mgd.

After completion of the Phases 1 and 2 rehabilitation projects, a more comprehensive flow monitoring effort was conducted. The model was recalibrated using these flow data. The model projected that, under current population and service area conditions, the maximum-hour flow with a 5-year recurrence was 15.3 mgd with a system peaking factor of 15, or a 6.7 mgd reduction in peak-hour flow from the modeling effort conducted in 2002. BC postulates that this dramatic decrease in peak flow was the result of the Phases 1 and 2 projects as well as the more refined flow data leading to a more precise calibration of the model.

The metering/modeling results were also used to determine the most cost-effective methodology for rehabilitation and to focus the capital investments on the leakiest basins. Basins that underwent rehabilitation of the mains and laterals appeared to have the greatest reduction in I/I by a significant margin, as listed in Table ES-2.

Table ES-2. Post-Phase 1 and Phase 2 Rehabilitation Effectiveness Summary

I/I reduction method	Effectiveness at reducing I/I, percent
Sewer mains and manholes	11 to 16
Laterals only	7 to 11
Sewer mains, manholes, and laterals to building	60 to 88

Based on the understanding of the need to address the sewer system holistically in each basin, Phase 3 was designed and constructed with the goal of completing rehabilitation in areas that were only partially rehabilitated previously as well as adding full basins to the scope. After completion of the Phase 3 rehabilitation project, additional flow monitoring was conducted during the winter of 2008/2009 at eight locations to gauge the effectiveness of the Phase 3 work. The projected peak-hour flow with a 5-year recurrence, under existing population and service area conditions, was 13.6 mgd, or a 1.7 mgd reduction in peak flow from the 2006 modeling effort.

Phase 4 was aimed at continuing the holistic rehabilitation efforts. After completion of the Phase 4 rehabilitation project, additional flow monitoring was conducted during the winter of 2012-2013 at 15 locations to gauge the effectiveness of the Phase 4 work and project the future peak-hour flows to the Sweet Home Wastewater Treatment Plant (WWTP). The projected peak-hour flow with a 5-year recurrence, under existing population and service area conditions, is 11.5 mgd, or a 2.1 mgd reduction in peak flow from the 2009 modeling effort.

This reduction was less than expected during the predesign efforts of Phase 4; however there are two main contributing factors. First, the funding for Phase 4 had unacceptable constraints for any work conducted on private property, so many laterals that were slated for full rehabilitation were addressed either at the connection only or to the edge of the public right-of-way. Secondly, some rerouting and upsizing was added to Phase 4 to reduce the occurrences of overflows upstream in the system, particularly at the upstream end of the Ames Creek siphon. While this upsizing reduces overflows in the collection system, it has the consequence of allowing additional I/I that was previously restricted from entering the system because of hydraulically restricted pipes.

In total for all four phases, 10.5 mgd of peak-hour I/I has been removed from the system under existing conditions and nearly 11.8 mgd under future conditions. Table ES-3 summarizes modeling results for the phases.

Table ES-3. Modeling Results

Model run	Peak-hour flow, existing conditions, mgd	Peaking factor	Peak-hour flow, future conditions, mgd
Pre-Phase 1 and 2	22.0	22	25.11[a]
Post-Phase 1 and 2	15.3	15	17.92[b]
Post-Phase 3	13.6	14	15.42[b]
Post-Phase 4	11.5	12	13.32[b]
Total Flow Removed	10.5	-	11.8

[a]Based on future population (2027) of 10,525 with no expansion of the City's wastewater service area (WWFP, 2002).

[b]Based on future population (2025) of 15,633 with expansion of the City's wastewater service area (WWFP, 2002).

Figure ES-2 shows these predicted peak-hour flows after each modeling effort in graphical format.

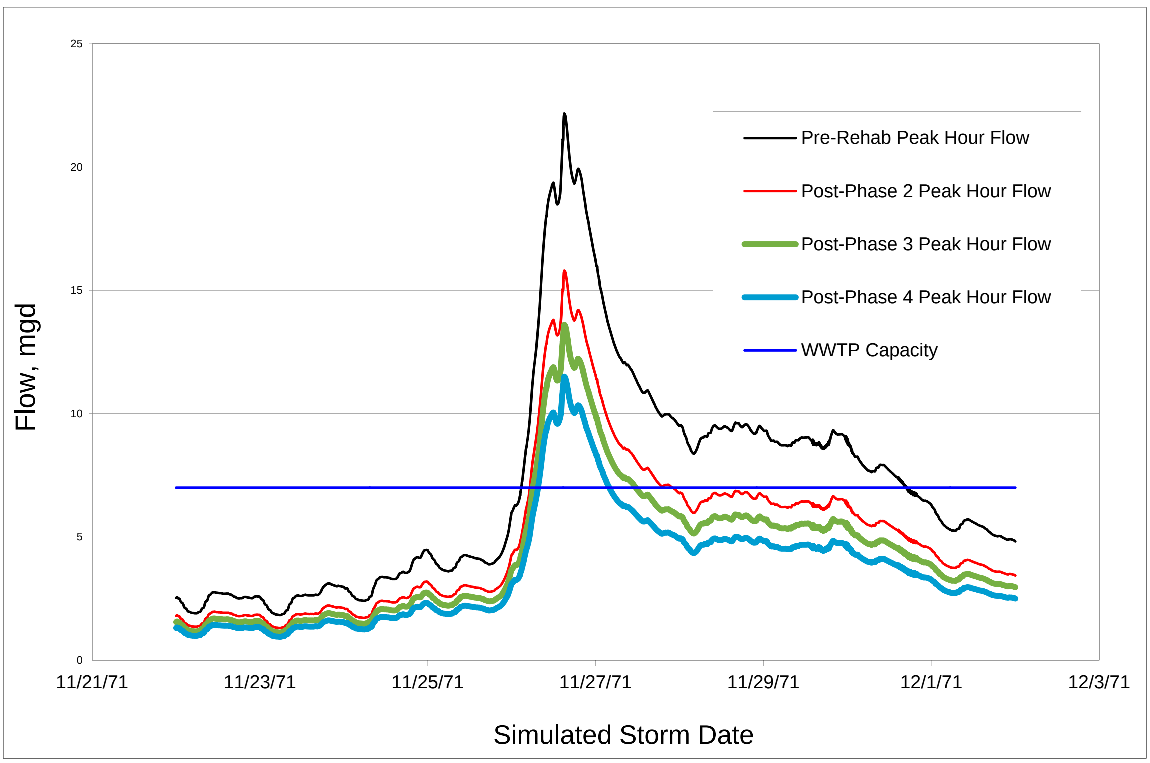

Figure ES-2 Predicted 1-in-5 peak-hour flow

Future R&R work in the collection system should continue for the City, either to maintain the level of RDII entering the system or to further target RDII reductions while making structural improvements to the unaddressed sewers that are aging and deteriorating. However, the highest priority basins identified throughout the course of the I/I Abatement Program have been largely addressed and there is a diminishing rate of return on the dollars invested in the collection system. Table ES-4 lists the estimated rehabilitation costs for future R&R work, with the expected reduction in peak RDII.

Table ES-4. Future R&R Work Cost Effectiveness

Sanitary Basin(s)[a]	Type of R&R	Cost of remaining R&R work, dollars	Peak RDII removed[b], mgd	Cost-effectiveness, dollars per mgd RDII removed	Rank
1	Full rehabilitation, complete uppers	1,620,000	0.18	9,000,000	12
2, 19	Complete uppers	310,000	0.17	1,800,000	1
3	R&R work complete	0	0	0	NA
4	Complete uppers	820,000	0.14	5,700,000	7
5, 6, 21	Complete uppers	970,000	0.39	2,500,000	2
7,13,14,17	Full rehabilitation	7,350,000	1.55	4,700,000	6
8	Full rehabilitation, complete uppers	2,720,000	0.28	9,900,000	13
9	Full rehabilitation, complete uppers	910,000	0.29	3,100,000	4
10	Full rehabilitation, complete uppers	2,990,000	0.42	7,100,000	11
11,12	Full rehabilitation	3,770,000	0.53	7,100,000	10
15	Full rehabilitation	2,130,000	0.31	6,800,000	8
16	Full rehabilitation	2,520,000	0.58	4,400,000	5
18	Full rehabilitation	1,130,000	0.37	3,100,000	3
20	Complete uppers	630,000	0.09	7,000,000	9
	Total	27,900,000	5.30		

[a]*Basins grouped together due to flow monitoring locations and model calibration* methodology.
[b]*Assumes 65 percent reduction in RDII for full rehabilitation, 30 percent reduction for completing uppers.*

An estimated $28 million in construction costs would be required to remove an additional 5.3 mgd. Since $12 million was spent on the first four phases with over 10 mgd removed, the diminishing cost-effectiveness is apparent. However, future R&R work should focus on completing the upper laterals, particularly on Phase 4 sewers, with full rehabilitation efforts directed in Sanitary Basins 18, 9, and 16, in that order of priority.

Hydraulic Modeling Efforts

A hydraulic model was developed to determine the collection system's response to peak flows under the 5-year wet-weather condition event. Flows input into the hydraulic model were the current population dry weather flow as well as projected rainfall-derived I/I (RDII) peak-hour flows under the 1-in-5 year 24-hour event. Only the major trunk lines were modeled hydraulically and are shown in Figure ES-3. The scenario assumes no hydraulic restrictions or flow limitations at the Sweet Home WWTP, meaning the WWTP will be expanded to convey the peak 5-year flows. The scenario also assumes the pipes are maintained properly and are capable of reaching their hydraulic capacity.

Figure ES-3. Hydraulic modeling network

The hydraulic modeling effort reveals a number of locations where the collection system either surcharges or overflows. Figure ES-4 summarizes the hydraulic modeling results from the 1-in-5 year event under existing conditions. Red manholes indicate locations of projected overflows, yellow manholes indicate locations of surcharging between 0 to 3 feet below grade, and green manholes indicate either no surcharging or surcharging between 3 and 10 feet below grade. A number of locations where overflows were identified in the Post-Phase 3 modeling effort, particularly along the main trunk that parallels the railroad, are now projected not to overflow based on the rehabilitation work conducted as part of Phase 4. Under existing conditions, a single manhole at Long and 18th Streets is predicted to overflow in the 1-in-5 year event. The manhole and associated pipe segments were rehabilitated in Phase 4, but this location was not identified as a potential overflow location. It is possible that the slight reduction in inside diameter from the Phase 4 reconstruction work as well as refined flow data and model calibration since the 2009 modeling effort is contributing to the predicted overflows.

Figure ES-4. Hydraulic modeling results, projected surcharge and overflow locations under existing conditions

Figure ES-5 shows locations where the model predicts potential severe surcharging or overflows under future conditions. Under future conditions, three additional overflow locations on the east-west 24-inch

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trunk paralleling the railroad tracks are anticipated. However, raising or sealing these manholes will prevent overflows without creating additional overflow points anywhere else in the City.

Figure ES-5. Hydraulic modeling results, projected surcharge and overflow locations under future conditions

Conclusions

The following summarizes the conclusions BC has made based on modeling and hydraulic capacity evaluation.

- Post-rehabilitation and reconstruction flow monitoring and hydrologic modeling demonstrate that basin-wide work can remove approximately 65 percent of the projected 1-in-5 year event peak-hour RDII flow in that basin.
- Focusing efforts on rehabilitating sewer mains, manholes, and laterals to the private building has been found to be the most effective at removing peak-hour RDII. Focusing only on specific components such as mains or laterals offers some reduction but at a much lower cost-effectiveness.
- To date, over 50 percent of the peak-hour RDII has been removed from the system over four phases of R&R work.
- Approximately an additional 4.5 mgd of RDII will need to be removed or accommodated at the WWTP to pass the 1-in-5 peak-hour flow under existing conditions, and approximately 6.3 mgd will need to be removed to handle future conditions. These are conservative estimates based on the modeling work.
- Under existing conditions, a single manhole at Long and 18th streets is predicted to overflow in the 1-in-5 year event. The manhole and associated pipe segments were rehabilitated in Phase 4 but this manhole was not identified as a potential overflow location. It is possible that the slight reduction in inside diameter from the Phase 4 reconstruction work and refined flow data and model calibration since the 2009 modeling effort are contributing to the predicted overflows.
- The benefits of R&R work in select basins have not been realized fully due to partial lateral rehabilitation caused by funding agency constraints related to work on private property without a permanent easement and/or owner unwillingness to allow for the work to be completed. Completing the rehabilitation work on the uppers in these partially completed basins (see Table 8-2) is the most cost-effective way to remove additional RDII.
- Full replacement of sanitary basins 18 and 9 have the most cost-effective R&R remaining in the City, with an approximate cost of $2.04 million (2010 R&R costs) to remove approximately 0.66 mgd of

peak-hour RDII. Sanitary Basin 8, conversely, has an approximately $2.7 million R&R cost to remove an estimated 0.28 mgd of peak-hour RDII.

- Upsizing and rerouting of flows from Sanitary Basins 5 and 6 toward Sanitary Basin 2 has significantly reduced the potential for overflows at the upstream of the siphon under Ames Creek, but may have resulted in the negative effect of allowing previously restricted I/I to now enter the system.
- A number of locations where overflows were identified as overflow points in the Post-Phase 3 modeling effort, particularly along the 18- to 24-inch main trunk that parallels the railroad, are now no longer projected to overflow based on the rehabilitation work conducted as part of Phase 4.
- Whereas the *Sanitary Sewer Master Plan* identified approximately $1.4 million in upsizing pipes to pass the 1-in-5 peak-hour flows (2012 dollars), the R&R work under the last four phases has essentially eliminated the need for upsizing of pipes. This assumes that the rate of RDII does not increase over time and that the City finds surcharging up to the manhole rim but not overflowing acceptable during the 1-in-5 year event. The City should continue to address RDII in the system on an annual basis. Under existing conditions, there is one manhole in Sweet Home that is predicted to overflow during the 1-in-5 year peak-hour flow event.
- Under future conditions, there are three additional manholes that are predicted to overflow during the 1-in-5 peak-hour flow. Several additional manholes on or immediately adjacent to the 24-inch main trunk line just upstream of the WWTP experience increased surcharging to within 3 feet of the manhole rim.

Recommendations

BC recommends the City take the following steps to continue to manage I/I in the system with the goal of regulatory compliance:

- Closely monitor the single manhole at the downstream end of Sanitary Basin 10 on Long Street that is predicted to overflow during the 1-in-5 year peak-hour flow. Due to margin-of-error and compounding conservative assumptions within any modeling effort, it is possible the predicted overflow may be overly conservative. Therefore as a precaution, the City should clean and monitor this section of pipe annually and also prior to anticipated large wet-weather events. In addition, there is a significant portion of Sanitary Basin 10 that has not been addressed by the first four phases of the program. R&R work in Sanitary Basin 10 will likely greatly reduce the overflow potential, both in existing as well as future conditions. Additional flow monitoring at monitoring location 9.1 to validate the modeling predicted peak flows is also recommended.
- Evaluate sealing or raising the three manholes just east of 9th Avenue on the east-west 24-inch trunk paralleling the railroad tracks. These manholes are predicted to overflow under future conditions but sealing or raising these manholes will prevent overflows while also not creating any adverse affect elsewhere in the City's collection system.
- Prepare an update to the City's Wastewater Facility Plan to determine the feasibility and cost of an upgrade to the Sweet Home WWTP to accommodate additional flows and determine the break-even point between WWTP upgrades and RDII reduction through future R&R work. As part of this update, re-evaluate the future growth projections and timing of expansion of the City's wastewater service areas.
- Prioritize completion of the rehabilitation work on upper laterals to complete the holistic basin approach, per Table 8-2. Further R&R work in the collection system aimed at reducing peak-hour RDII has diminishing returns. **However, at a minimum the City must continue with additional R&R work to maintain the current level of RDII in the system.** Sanitary Basins 18 and 9 are the next

highest priority basins with the largest predicted RDII removal rates. Look for opportunities to remove I/I while also addressing the pipes with the worst structural ratings.

- Explore implementing a lateral rehabilitation program that can address the private laterals without the constraints of acquiring permanent easements.
- Update sewer condition maps that document the structural and operational condition of sewers. The last comprehensive update of sewer condition was completed in 2006.
- Evaluate the cost and feasibility for addressing Grade 5 sewers (as defined in Section 6 of the main report). Many Grade 5 sewers are likely rated so severely due to isolated point defects rather than full pipe issues. However, failure of point defects are as problematic as full length failures and the City should plan for the rehabilitation of these Grade 5 sewers.
- Begin preparing for and implementing a formal Capacity, Management, Operations, and Maintenance (CMOM) Program, in accordance with U.S. Environmental Protection Agency guidelines. The Oregon Department of Environmental Quality has guidance documents that indicate cities with compliant CMOM plans in place will receive greater leniency in cases of non-compliance (e.g., overflows during events less than the 1-in-5 year storm, see Appendix B).
- Install flow meters and increase the monitoring resolution in Sanitary Basins 7, 13, 14, and 17 to further delineate flows and determine if full basin rehabilitation would be effective. The City's post-Phase 4 flow monitoring was extremely successful, and the City can utilize their flow monitoring equipment and experience to identify and prioritize areas of additional RDII reduction.

Section 1

Introduction

1.1 Background

The City of Sweet Home (City) is located along the west slope of the Cascade Mountains at the edge of the Willamette Valley. The City limits encompass an area of approximately 6.5 square miles and the urban growth boundary is coincident with the city limits. The current population is 9,025, with the population expecting to increase to 9,800 in 2020 and 10,550 in 2027.

The South Santiam River runs east to west along the northern edge of the city and functions as the base of the watershed in which the city lies. Groundwater in the area is generally shallow and ranges from 8 to 25 feet below ground surface. Soils in the area are comprised of fluvial gravels near the Santiam River with silty clay and loam in the upland areas.

The City wastewater collection system is comprised of approximately 275,000 linear feet (LF) of sanitary sewers. Construction of the collection system began as early as 1910. The sewer pipe ranges from 6 to 24 inches in diameter with over 80 percent of the pipe sized at 8 inches. The majority of pipes are constructed of non-reinforced concrete pipe in 3-1/2 foot sections. Other pipe materials include reinforced concrete, cast iron, and poly-vinyl chloride. The collection system transports wastewater by gravity flow to the Sweet Home Wastewater Treatment Plant (WWTP) adjacent to the South Santiam River. The WWTP treats an average dry weather flow of 1 million gallons per day (mgd) with a treatment capacity of up to 7 mgd. Figure 1-1 shows an overview of City's collection system and location of the WWTP.

The City's sanitary sewer collection system experiences high levels of infiltration/inflow (I/I) during wet weather that can lead to overflows at the WWTP and within the collection system. For the past several years, the City has been under a Mutual Agreement and Order (MAO) from the Oregon Department of Environmental Quality (DEQ) to eliminate sanitary sewer overflows in accordance with Oregon Administrative Rule 341-041-0120. More specifically, the MAO requires the elimination of any overflows caused by less than the 1-in-5 year recurrence, 24-hour-duration storm during the winter (November 1 to May 21) and the 1-in-10 year, 24-hour storm during the summer (May 22 to October 31).

To meet DEQ requirements, the City had the choice in 2002 of either reducing I/I within the collection system at an estimated cost of $30 million or increasing capacity of the WWTP at an estimated cost of $17 million. Even though I/I reduction was more costly, the City recognized that its collection system was aging and not addressing the deterioration would likely lead to future problems and potentially higher I/I. The City decided to conduct an aggressive I/I abatement program.

This report summarizes the results of the multi-phased program to reduce I/I within the collection system between 2003 and 2012.

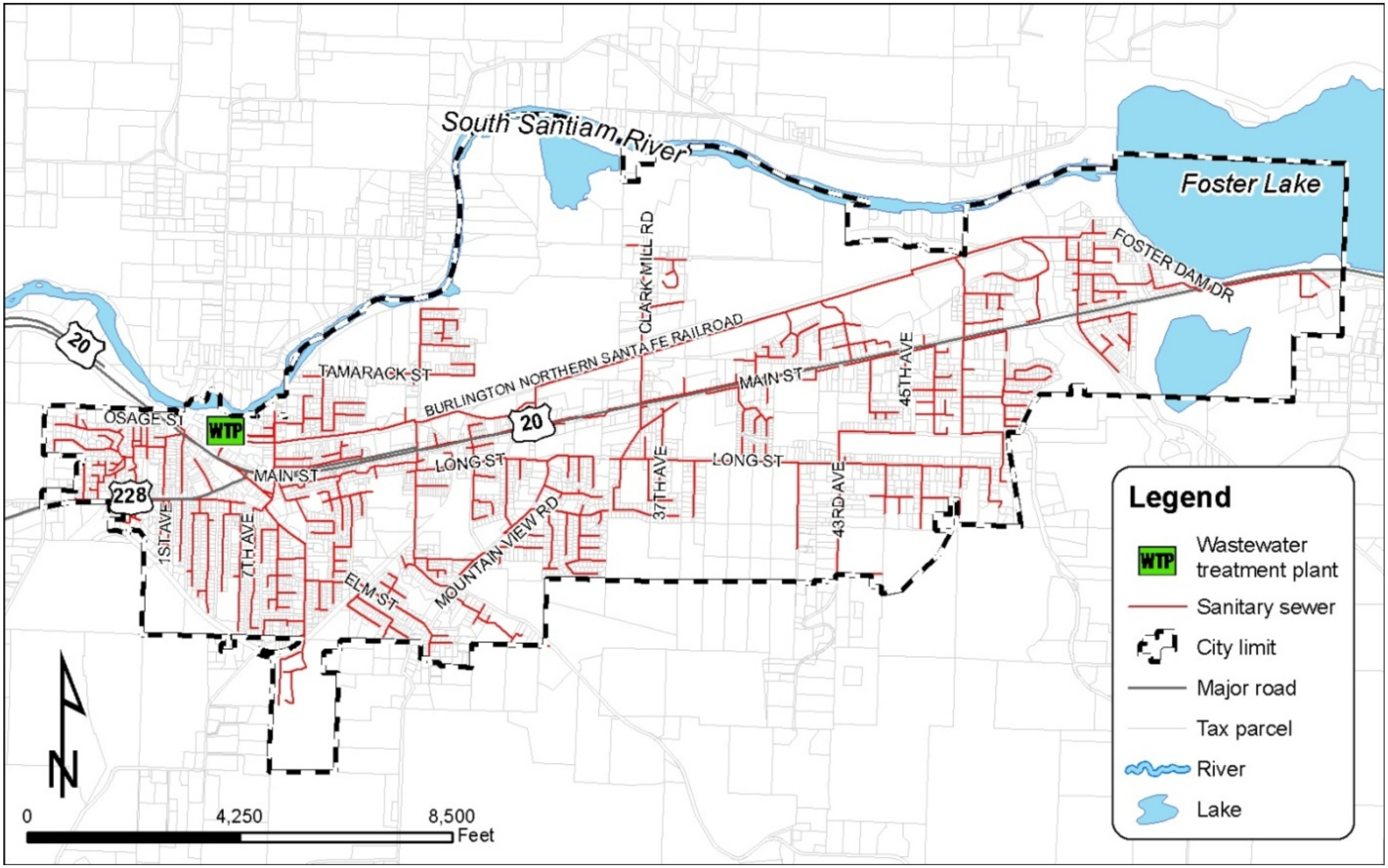

Figure 1-1. Overview of the City's collection system

1.2 Summary of Rehabilitation Work

The I/I abatement program has consisted of multiple phases. In 2003 and 2004, two separate I/I reduction demonstration projects (Phases 1 and 2), as well as pre- and post-rehabilitation flow monitoring and modeling were conducted in some of the leakiest basins to help determine the most cost-effective approach to I/I removal. Holistic basin-wide rehabilitation addressing manholes, sewer main, and laterals up to the private building was determined to be the most cost-effective method of removing I/I.

In 2007, Phase 3 addressed basins that did not yet complete this holistic approach and added other basins. Post-rehabilitation flow monitoring and modeling were conducted to measure results and target areas for future rehabilitation. In 2012, Phase 4 was completed and post-rehabilitation flow monitoring followed in the winter of 2012/2013 and the City's hydrologic and hydraulic models were recalibrated.

Work was focused either in entire City sanitary basins or smaller subbasins. Sweet Home is divided into 27 sanitary basins, 19 of which have residents within their boundaries connected to the public sewer system. Figure 1-2 shows a map of the City's sanitary basins.

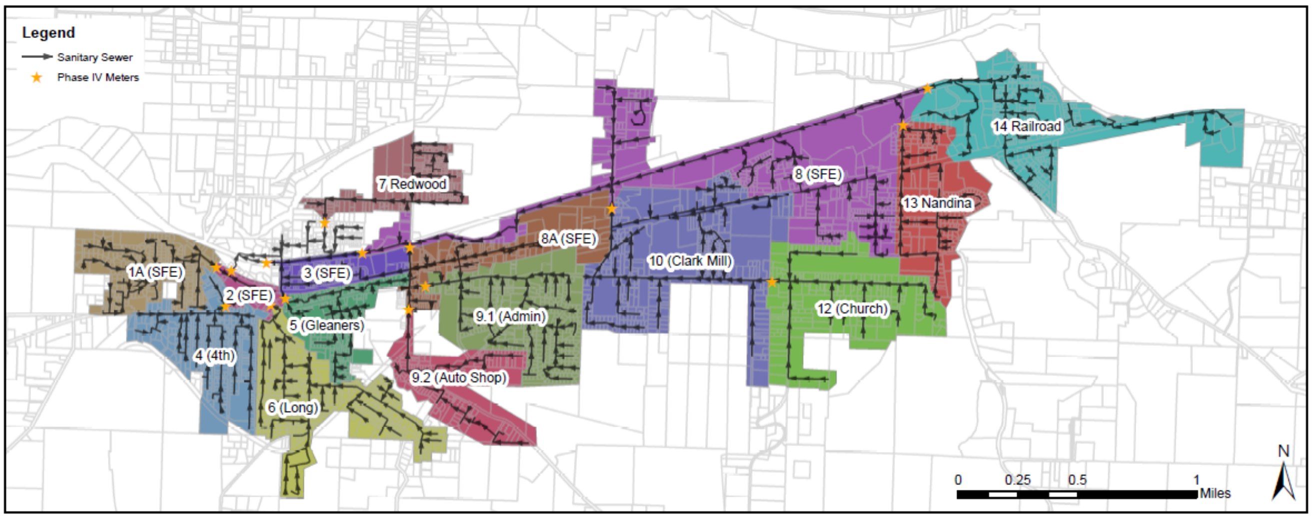

Figure 1-2. City's monitoring basins

1.2.1 Phases 1 and 2

Phase 1 work was performed in 2003 and focused predominately on the southern part of the city, in Sanitary Basins 1, 4, 5, 6, and 9. Phase 2 was performed in 2004 and focused on the southwestern portion of the city, with a focus on Sanitary Basins 1, 2, 5, and 19. Approximately $3 million was spent on these two phases, which included the rehabilitation or reconstruction of 18,500 LF of sewer main and 300 laterals. During Phases 1 and 2, rehabilitation technologies were separated into three categories to determine the most effect rehabilitation plan. In some basins, only sewer mains and manholes were addressed with existing laterals being reconnected to the new sewer main. In other basins, only service laterals were rehabilitated to the edge of the public right-of-way (ROW) while in other areas, service laterals on private property were rehabilitated with the goal of attempting to rehabilitate the lateral as close to the private building as possible. Lastly, some areas had a more holistic approach, with rehabilitation efforts focusing on sewer mains, manholes, and laterals up to the private building. Inactive lateral connections were plugged and cleanouts were installed on all active laterals.

The extent of the work in each Sanitary Basin is shown in Figure 1-4.

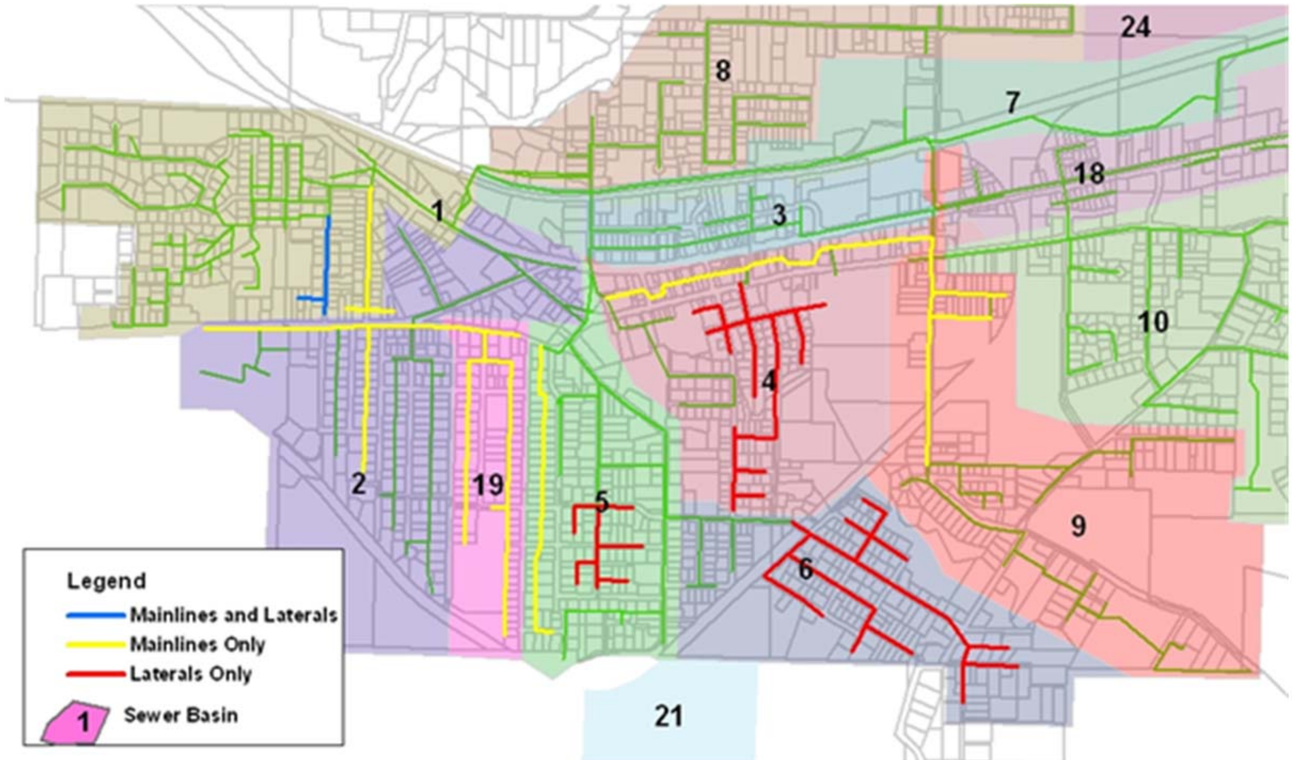

Figure 1-3. Phases 1 and 2 project extents

1.2.2 Post-Phases 1 and 2 Flow Monitoring and Modeling

After completion of Phases 1 and 2 construction, flow monitoring and modeling were conducted to quantify the benefits of the rehabilitation program and allow accurate I/I reduction estimates to be made. These estimates were used to determine the most cost-effective methodology for rehabilitation and to focus the capital investments on the leakiest basins. Basins that underwent rehabilitation of both mains and laterals have the greatest reduction in I/I by a significant margin, as listed in Table 1-1.

Table 1-1. Post-Phase 1 and Phase 2 Rehabilitation Effectiveness Summary	
I/I reduction method	Effectiveness at reducing I/I, percent
Sewer mains and manholes	11 to 16
Laterals only	7 to 11
Sewer mains, manholes, and laterals to building	60 to 88

A more detailed discussion of the rehabilitation effectiveness analysis is described in Section 2.

1.2.3 Phase 3

Phase 3 work was performed in 2007 and focused on Sanitary Basins 1, 2, 3, and 5. Approximately $3 million was spent on Phase 3 work, which included the rehabilitation or reconstruction of 17,000 LF of sewer main and 415 laterals. After the Phases 1 and 2 post-rehabilitation I/I removal effectiveness analysis, Phase 3 focused on completing only those basins in Phases 1 and 2 that were partially completed and holistic rehabilitation in previously unaddressed high-priority basins.

The extent of the Phase 3 project is shown in Figure 1-4.

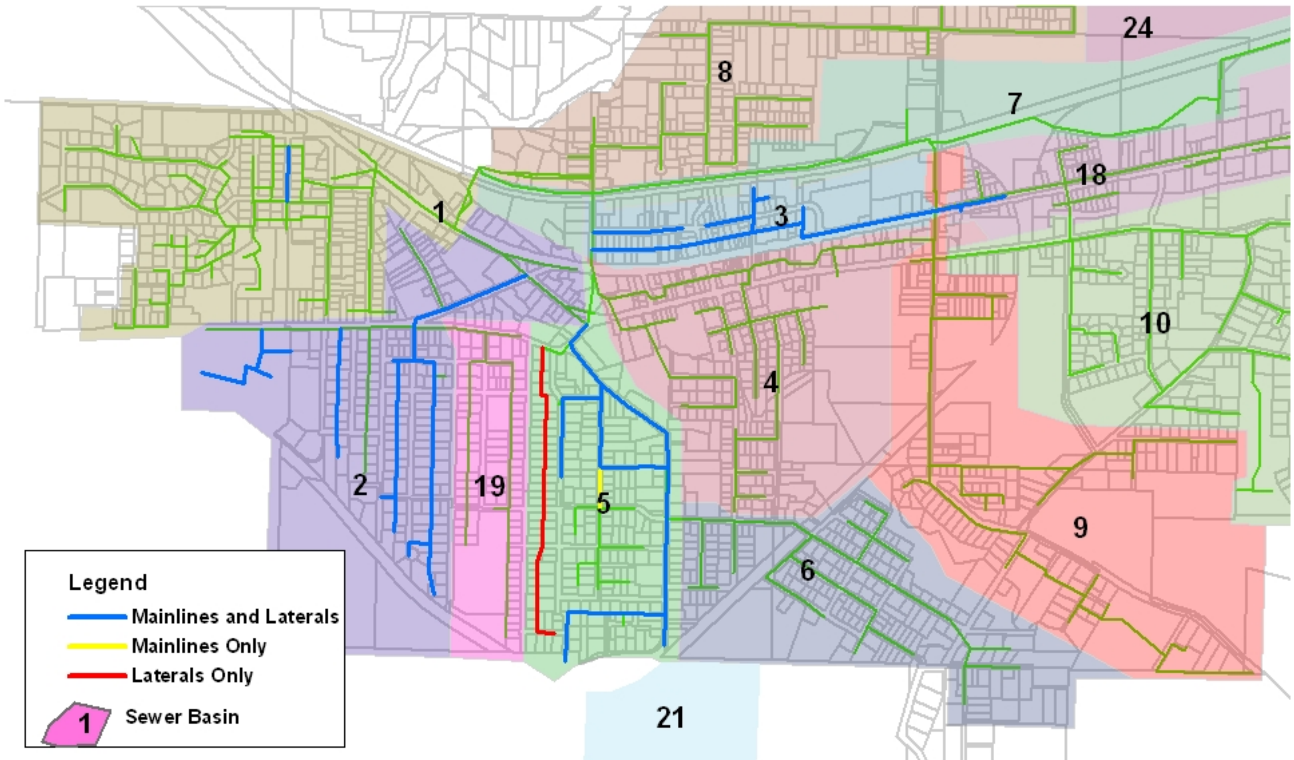

Figure 1-4. Phase 3 project extents

Combined, the first three phases have addressed 36,000 LF of sewer main, or approximately 15 percent of the sewers in the city. Approximately 700 laterals have been rehabilitated or replaced (R&R), or 20 percent of the laterals in the city. Figure 1-5 shows the extents of all R&R work from Phases 1, 2, and 3.

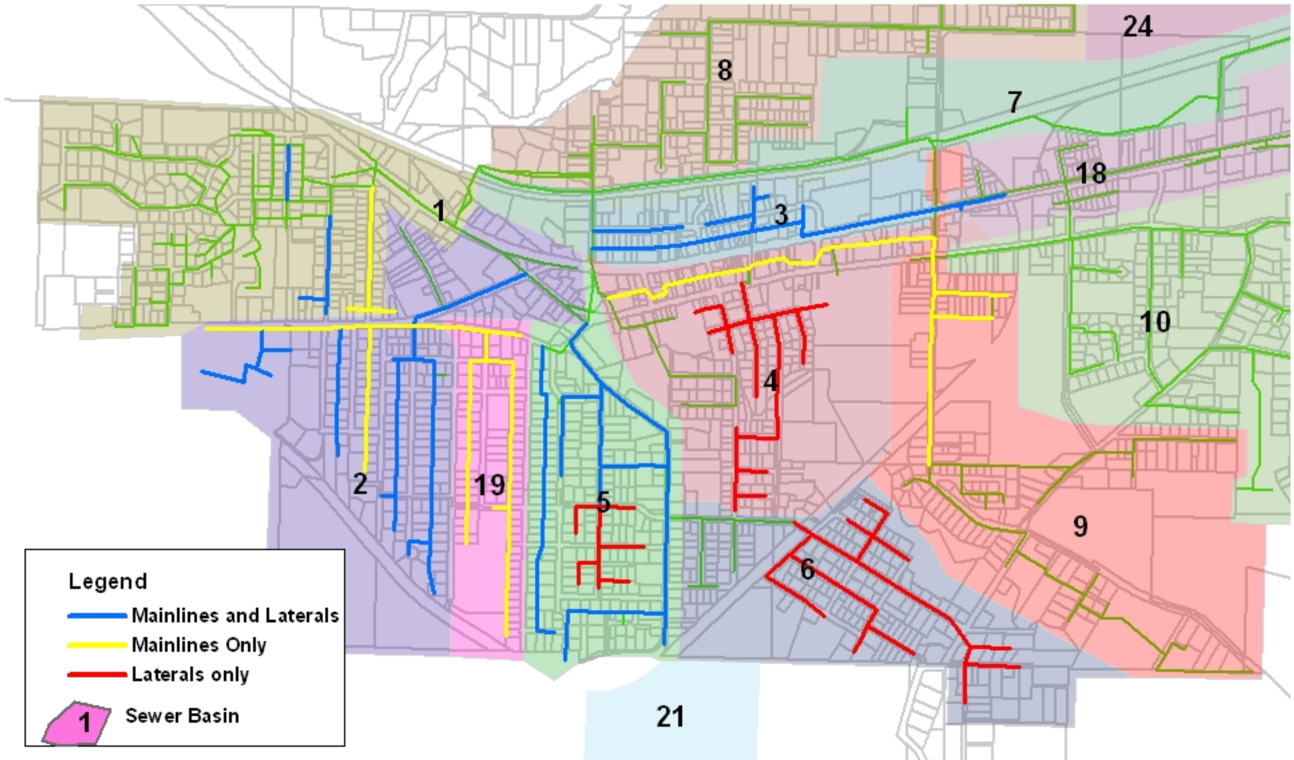

Figure 1-5. Phases 1, 2, and 3 R&R work

1.2.4 Phase 4

Phase 4, the largest of the four I/I abatement projects, was completed in 2012. The $6 million project covered 11 basins and was designed to rehabilitate or reconstruct 51,500 LF of sewer and 700 laterals. While all the sewer mains and manholes were addressed, the funding for Phase 4 had unacceptable conditions for any work conducted on private property. Many laterals slated for full rehabilitation were addressed either at the connection only or to the edge of the public ROW. Only 577 laterals were reconstructed, with most lateral rehabilitation being done in the public ROW. Upper laterals were inspected using closed-circuit television and only those that were clearly structurally deficient or actively leaking were rehabilitated. In addition, some rerouting and upsizing was conducted to reduce the occurrences of overflows upstream in the system, particularly at the upstream end of the Ames Creek siphon. The City also elected to have some additional grouting (non-structural) work performed to augment the RDII reductions. Figure 1-6 shows the extent of the Phase 4 project.

In total, the City's I/I abatement program has addressed 92,500 LF of sewer main, or approximately 35 percent of the sewers in the city. Approximately 1,250 laterals have been rehabilitated or replaced, or 30 percent of the laterals in the city. Table 1-2 shows the breakdown of existing sewers and rehabilitated sewers by sewer basin.

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Table 1-2. Post-Phase 4 Summary of Work by Sewer Basin					
Sanitary Basin	Total pipe, LF	Rehabilitated pipe in Phases 1, 2, and 3, LF	Rehabilitated pipe in Phase 4, LF	Total rehabilitated pipe, lf	Remaining non-rehabilitated pipe, lf
1	17,920	2,053	7,320	9,373	8,547
2	14,030	10,821	2,851	13,672	358
3	5,220	4,444	719	5,163	57
4	12,500	1,325	8,434	9,759	2,741
5	13,500	9,405	2,280	11,685	1,815
6	9,700	3,567	3,500	7,067	2,633
7	9,400	0	0	0	9,400
8	17,600	0	2,550	2,550	15,050
9	12,230	2,053	5,558	7,611	4,619
10	21,350	0	4,167	4,167	17,183
11	16,000	0	1,768	1,768	14,232
12	12,700	0	438	438	12,262
13	14,150	0	0	0	14,150
14	14,050	0	1,314	1,314	12,736
15	15,100	0	0	0	15,100
16	19,400	0	367	367	19,033
17	5,300	0	0	0	5,300
18	8,800	0	763	763	8,037
19	5,436	5,144	0	5,144	292
20	15,220	0	11,757	11,757	3,463
21	3,200	0	0	0	3,200

Figure 1-7 shows the extent of all work from Phases 1, 2, 3, and 4.

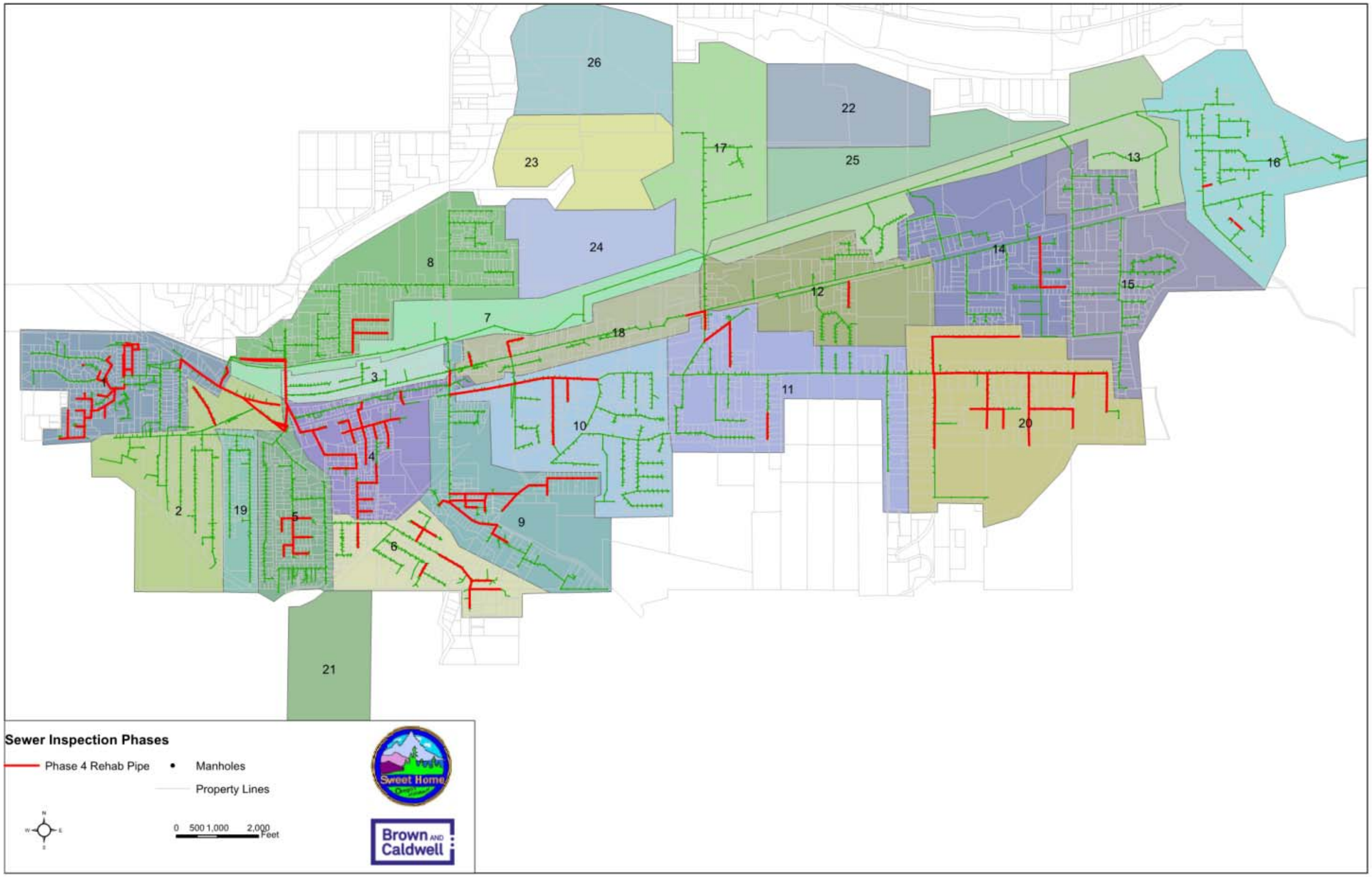

Figure 1-6. Phase 4 project extents

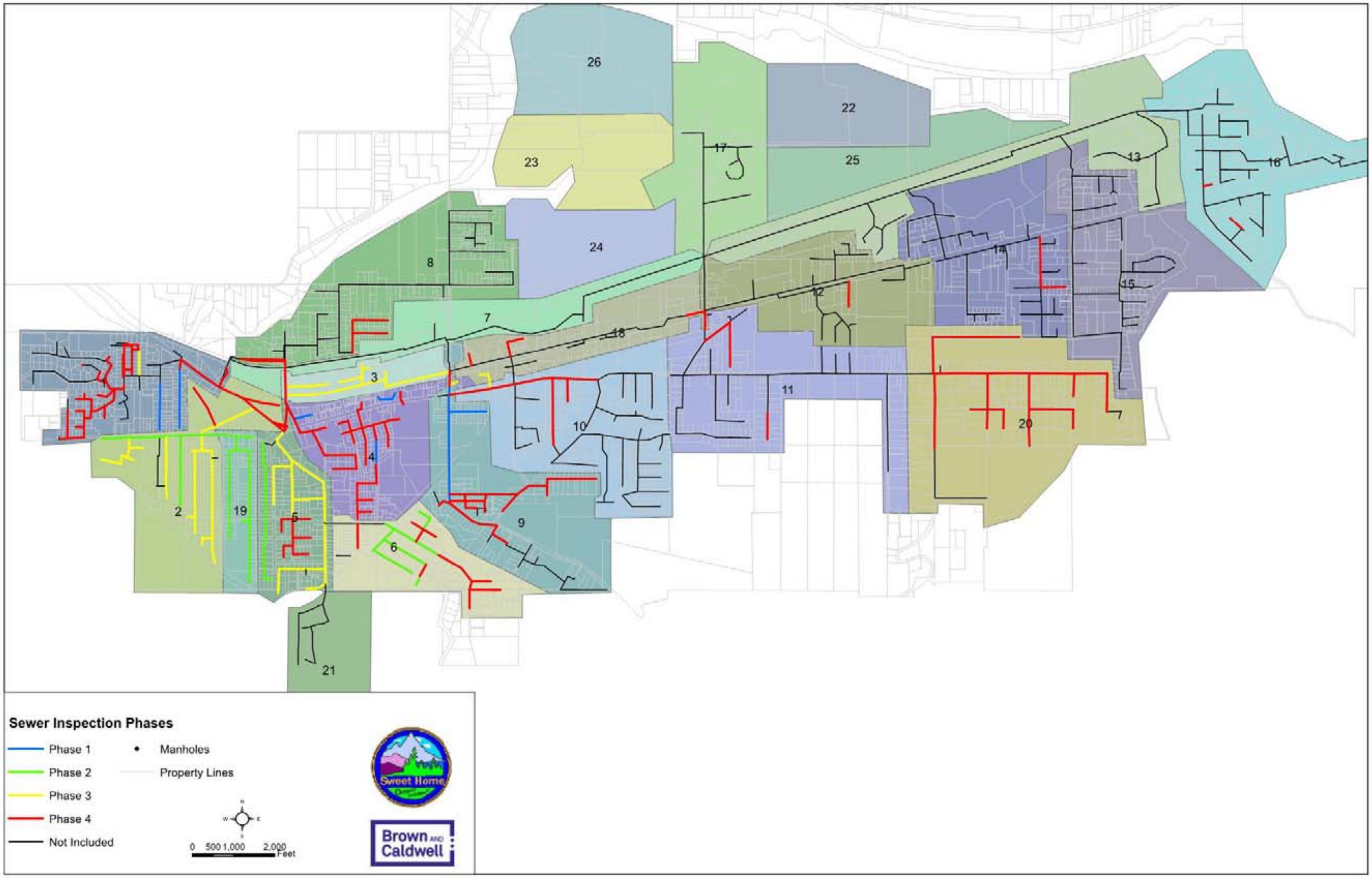

Figure 1-7. Phases 1, 2, 3, and 4 R&R work

Section 2

Rehabilitation Effectiveness

This section describes the hydrologic and hydraulic modeling effort undertaken in Phase 4 to represent the hydrologic response of the collection system to rainfall and to identify areas of limited conveyance capacity.

After completion of Phases 1 and 2 construction, flow monitoring and modeling were conducted to quantify the benefits of the rehabilitation program and allow accurate infiltration/inflow (I/I) reduction estimates to be made. These estimates were used to determine the most cost-effective methodology for rehabilitation and to focus the capital investments on the leakiest basins. Sanitary basins that underwent rehabilitation of both the mains and laterals have the greatest reduction in I/I.

2.1 I/I Reduction from Mainline Rehabilitation

In Phases 1 and 2, sewer mainlines only were rehabilitated in six smaller subbasins. However, only three subbasins had both pre-rehabilitation flow data and post-rehabilitation data of sufficient quality to assess the effectiveness of the work.

I/I reduction resulting from mainline rehabilitation ranges from 11 to 16 percent. This minimal reduction can be attributed to many factors including lateral connection quality, condition of laterals, manhole connection quality, and incomplete rehabilitation. A leaky sewer system can depress the groundwater in the surrounding area. When only mainlines are rehabilitated, the groundwater table rises and enters the sewer system at a higher defect. Figures 2-1 and 2-2 include a comparison of the Log-Pearson Type III plots for pre- and post-rehabilitation of the sewer mainlines in Sanitary Basins 2, 5, and 19.

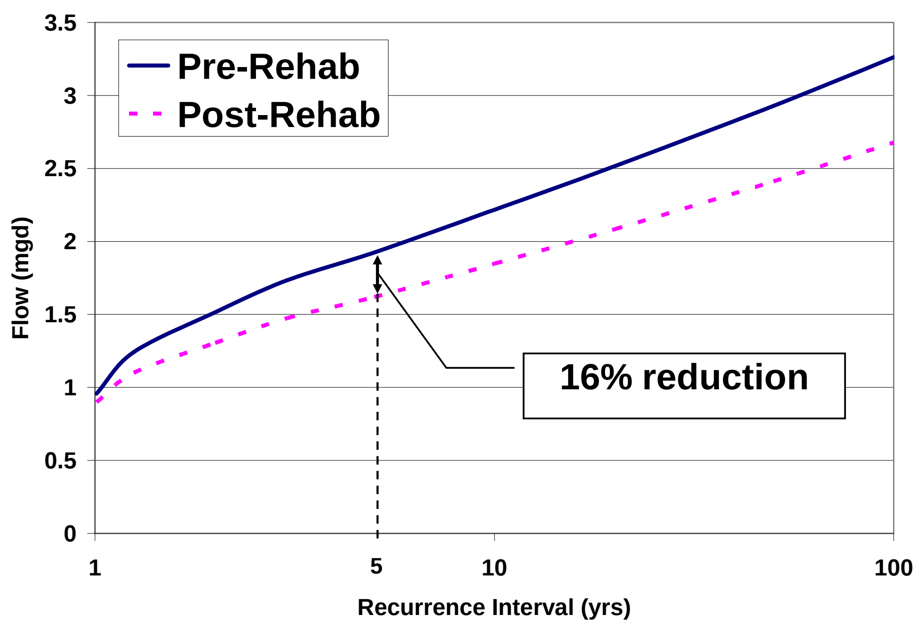

Figure 2-1. Pre- and Post- rehabilitation flow rates for portions of Sanitary Basins 2 and 19

(60 percent of mainlines rehabilitated)

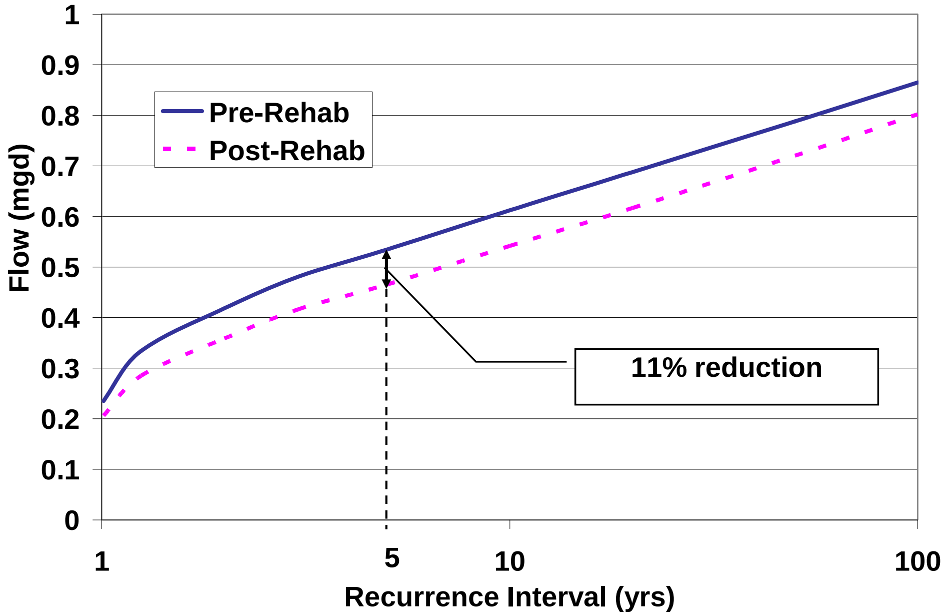

Figure 2-2. Pre- and post-rehabilitation flow rates for portions of Sanitary Basin 5

(100 percent of mainlines rehabilitated)

2.2 I/I Reduction from Lateral Rehabilitation

Service laterals were rehabilitated in Sanitary Basins 4, 5, and 6. In these basins, the work varied from complete lateral replacement to only the upper or only the lower laterals, depending on previous work, existing lateral condition, and property access. Lateral rehabilitation included 70 to 83 percent of laterals within any given subbasin.

Pre- and post-rehabilitation flows from Sanitary Basins 4, 5, and 6 are shown in Figures 2-3, 2-4, and 2-5, respectively. It can be seen that I/I reduction ranges from 7 to 40 percent.

The much higher reduction achieved in Sanitary Basin 6 was most likely due to the mainline rehabilitation work performed by the City of Sweet Home (City) in 1999 on the lower portion of this basin. In general, since groundwater levels influence when and how much I/I will enter a defect, if an upstream defect is repaired, the groundwater will simply enter a defect at a lower elevation in the same basin. However, since the mainlines at the bottom of the basin already had been rehabilitated, there were fewer defects for the I/I to enter, thus the significantly higher removal rate of I/I.

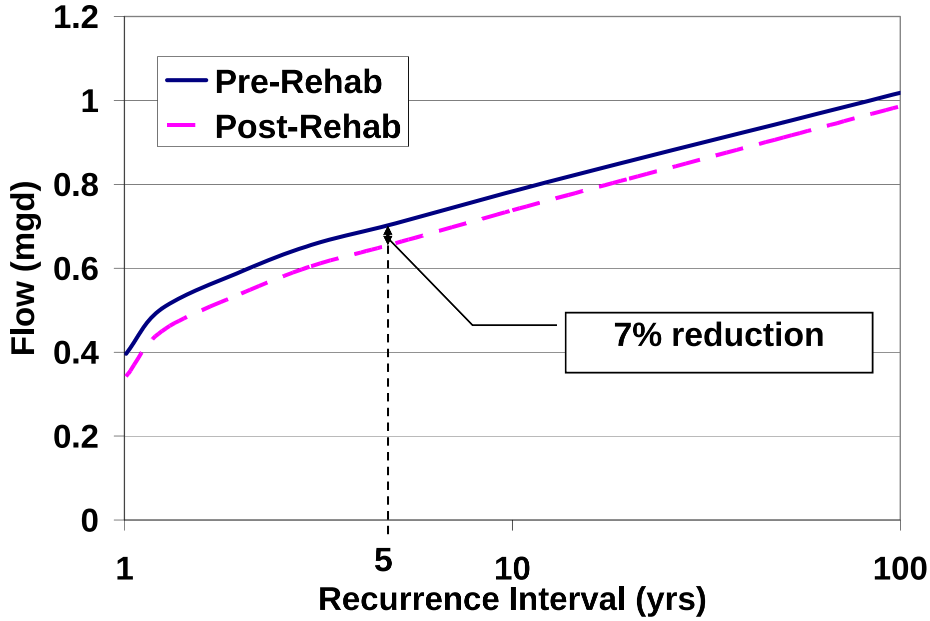

Figure 2-3. Pre- and post-rehabilitation flow rates for laterals in Sanitary Basin 4

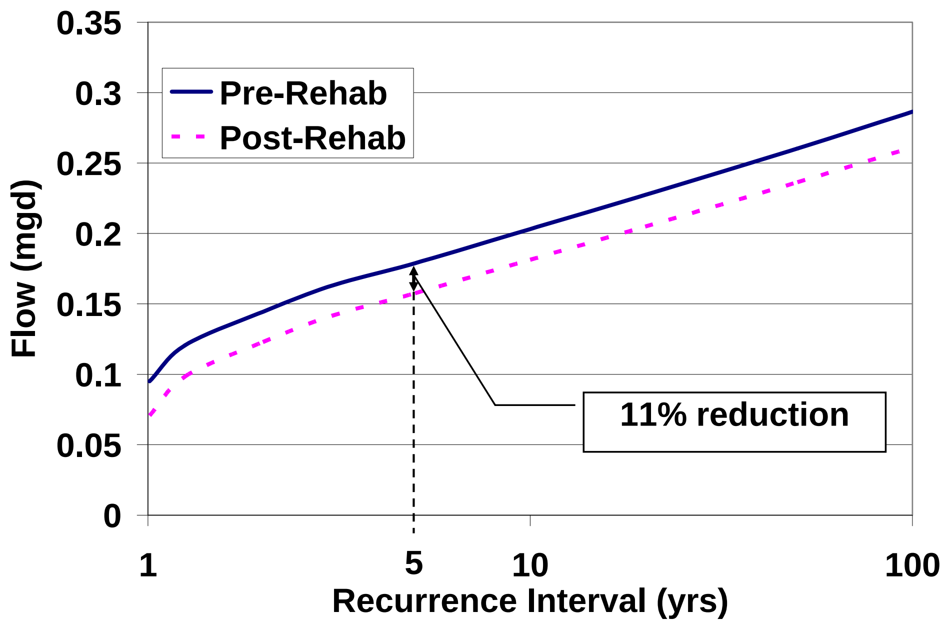

Figure 2-4. Pre- and post-rehabilitation flow rates for laterals in Sanitary Basin 5

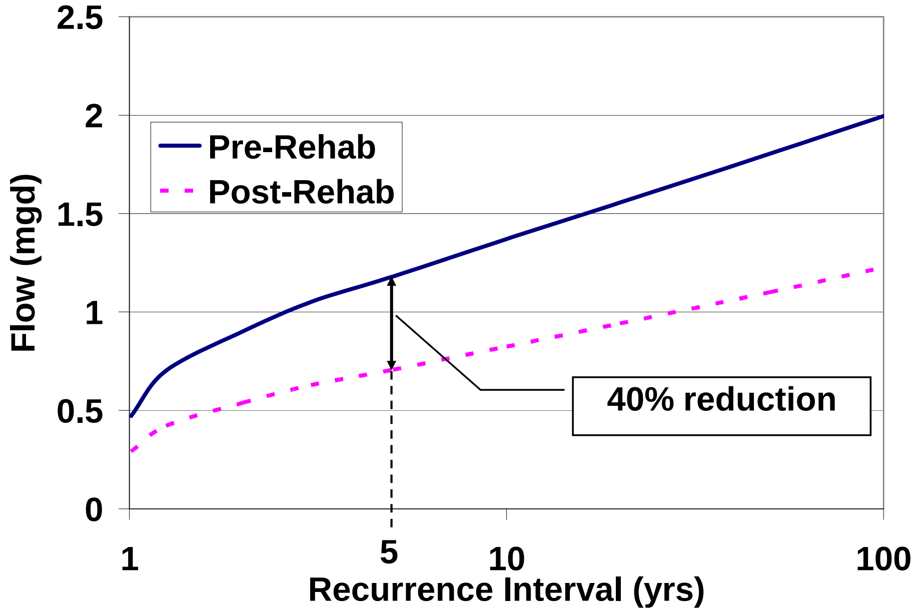

Figure 2-5. Pre- and post-rehabilitation flow rates for laterals in Sanitary Basin 6

2.3 I/I Reduction from Full (Sewer Mains and Laterals) Rehabilitation

Full rehabilitation of mains and laterals was completed in a subbasin in Sanitary Basin 1. Pre- and post-rehabilitation flows are shown in Figure 2-6. It can be seen that approximately 88 percent of the peak I/I was removed through 100 percent rehabilitation of the mains and nearly 95 percent rehabilitation of the laterals.

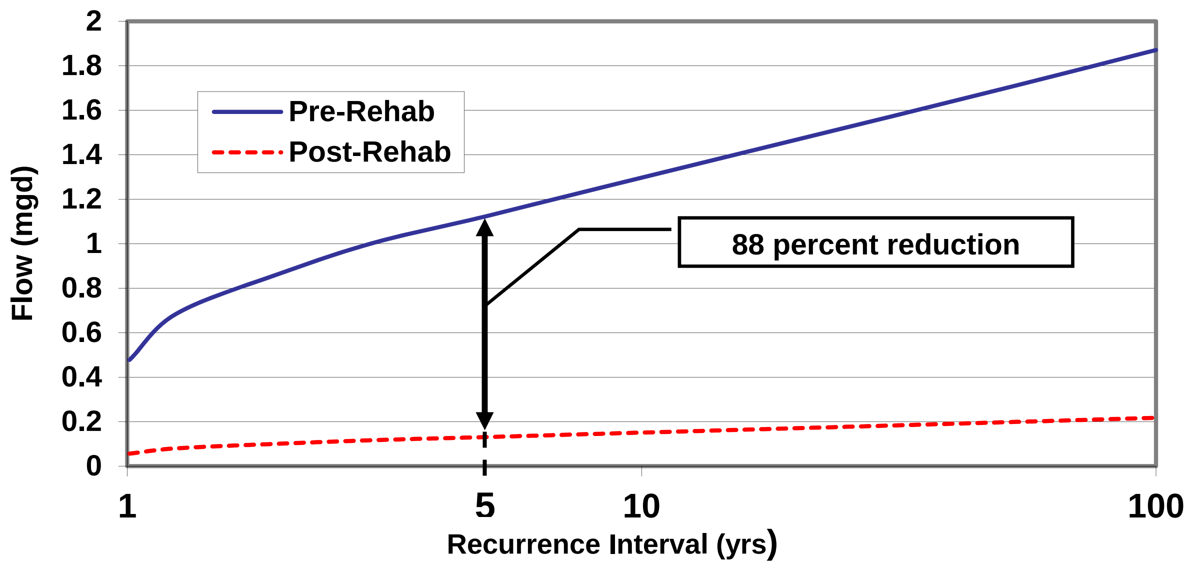

Figure 2-6. Pre- and post-rehabilitation flow rates after full rehabilitation in Sanitary Basin 1

2.4 Cost-Effectiveness of Rehabilitation Strategies

The bottom line for many communities is how much money they have to spend to achieve the desired level of I/I reduction. The cost-effectiveness of the 2003 and 2004 rehabilitation projects in Sweet Home is summarized in Table 2-1. Items such as mobilization, bypass pumping, and traffic control were evenly distributed between rehabilitation basins without weighting for basin size or type of work performed. Construction costs were escalated to approximate 2008 costs. It can be seen that rehabilitating an entire basin (mains and laterals) was, in these examples, 60 to 70 times more effective than doing either mains or laterals alone.

Table 2-1. Cost-Effectiveness of Various Rehabilitation Strategies

Rehabilitation method	Footage or quantity	Construction cost, dollars	I/I reduction, gallons	Dollars per gallons removed
Full rehabilitation	1,200 linear feet (LF) and 15 laterals	398,308	970,000	0.41
Mainlines only	20,000 LF	1,000,502	36,000	27.79
Laterals only	330	1,425,718	54,000	26.40

Prior to this analysis, City policy was to work on the public portion of the sewers and service laterals only. As a result of the rehabilitation effectiveness analysis, holistic rehabilitation efforts were targeted in Phases 3 and 4.

Section 3

Flow Monitoring

The City has engaged in pre- and post-rehabilitation flow monitoring for each phase of its infiltration/inflow (I/I) reduction improvements over the last decade. The purpose of the flow monitoring is to collect flow data from isolated sanitary basins that could then be used to calibrate a hydrologic model. The hydrologic and hydraulic modeling effort then aims to predict theoretical peak-hour flows, determine collection system capacity, and ultimately identify future improvements needed.

3.1 Past Monitoring Efforts

City-owned Isco Model No. 2150 flow monitors were used for the pre-rehabilitation flow monitoring studies in the winters of 2001/2002 through 2004/2005. Isco 2150 flow monitors use continuous wave Doppler technology to measure mean velocity. The sensor transmits a continuous ultrasonic wave, and then measures the frequency shift of returned echoes reflected by air bubbles or particles in the flow. Additional flow monitoring was performed in additional years before and after additional rehabilitation and replacement projects. Figure 3-1 shows the location of the monitors used between 2001 and 2005.

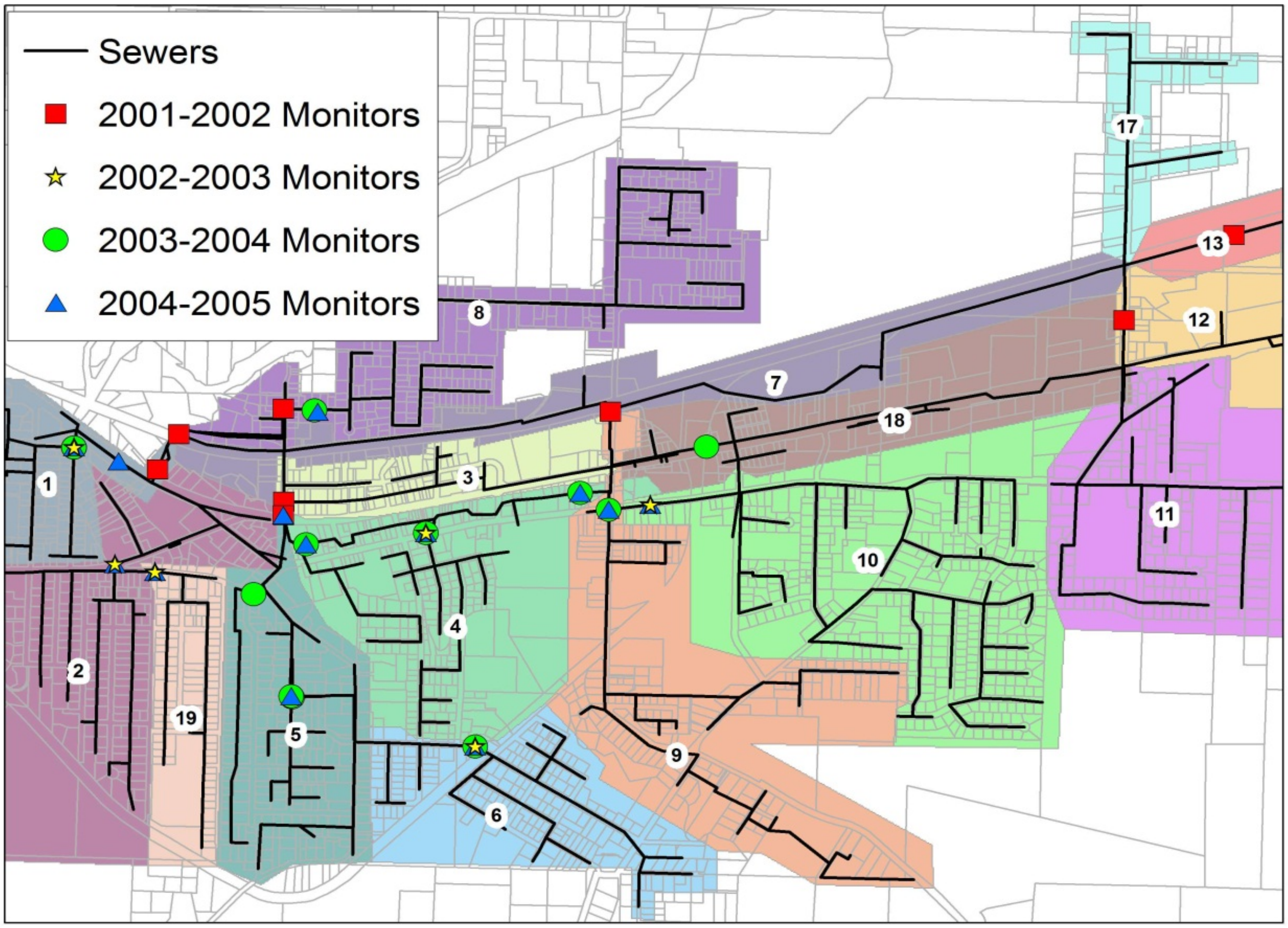

Figure 3-1. Locations of flow monitors from 2001 to 2005

The 2005/2006 winter flow monitoring was performed by SFE Global (SFE), a flow monitoring company based out of British Columbia, Canada. SFE was responsible for installation, download, maintenance, and removal of the flow monitors. Brown and Caldwell (BC) provided oversight, assistance with site and flow monitor selections, and data quality assurance and quality control (QA/QC). Two different types of flow monitors were employed by SFE. The first was a custom compound, sharp-crested weir manufactured by SFE with an Isco Model No. 2150 providing backup flow measurement. The depth of water behind each weir was measured by the Isco 2150 and a custom rating table was used to translate the water depth into a flow rate for each site. The second type of flow monitor was a Datagator® venturi flow meter, manufactured by Renaissance Instruments. These meters combine a modified Venturi flow tube design with pressure transducers at the inlet, throat, and outlet to measure flow under all conditions, including transitional periods between open channel and full pipe. The Datagators translate pressure directly into flow using the continuity and Bernoulli equations. A total of 22 meters were installed by SFE, 11 weirs and 11 Datagators.

Eight of these meters monitored flows from sanitary basins that were rehabilitated in 2003 and 2004 as part of Phases 1 and 2 projects. The other 14 were installed in strategic locations around the collection system to allow a comparison of all major basins in the system and to help guide future I/I rehabilitation work. The locations of all of the monitors and basins are shown in Figure 3-2.

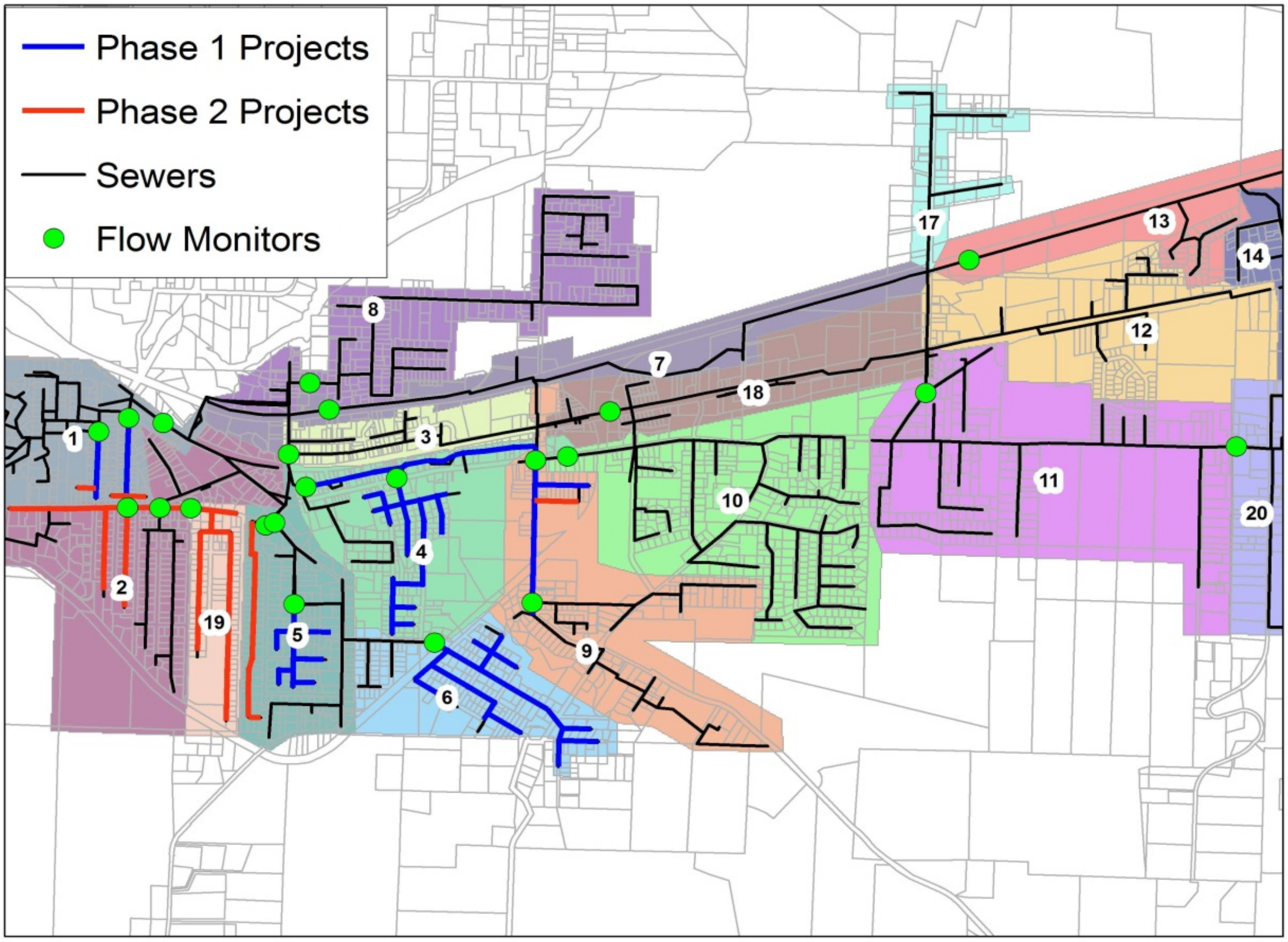

Figure 3-2. Location of 2005-2006 flow monitors

After Phase 3 was constructed, additional flow monitoring was conducted in the winter of 2008/2009 to determine the impact of prior projects and to recalibrate the model. SFE was retained again to conduct the flow monitoring using custom weir flow monitors. The location of the additional eight flow monitors is shown in Figure 3-3.

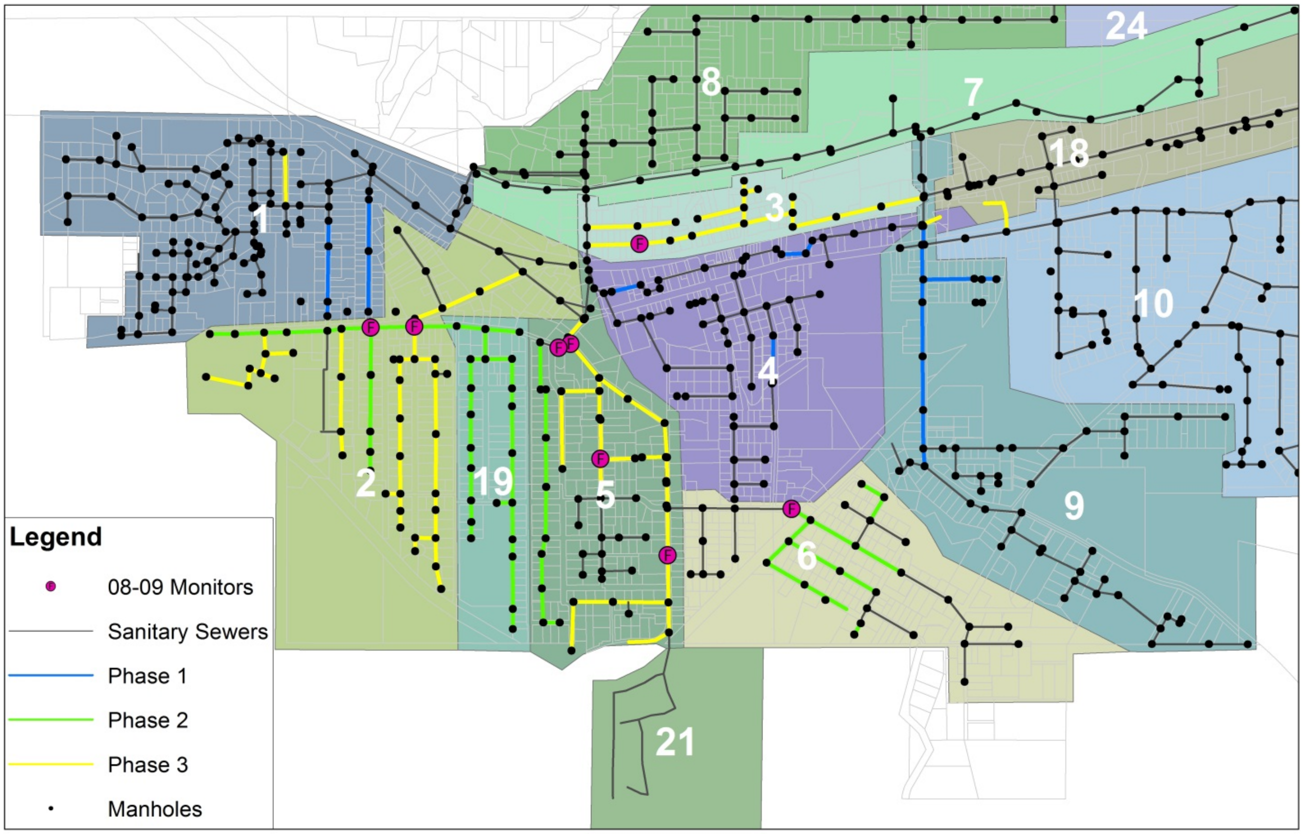

Figure 3-3. Location of 2008/2009 flow monitors

After the conclusion of Phase 4 construction, the City engaged in a post-rehabilitation flow monitoring program during the wet season of 2012/2013. The flow monitoring period extended from November 2012 to March 2013. Monitoring sites were selected based on the ability to isolate portions of the sanitary sewer system for analysis. Site evaluation criteria included site hydraulics, surcharge potential, manhole invert configuration, and pipe diameter.

The flow monitoring was conducted using a combination of ten City-owned ISCO 2150 area-velocity (AV) meters and five SFE-owned weirs. City staff and SFE were each responsible for installation, weekly download and site maintenance, and removal of their respective flow monitors. In addition, effluent flow data from the Sweet Home Wastewater Treatment Plant (WWTP) were collected weekly by City staff. Rainfall data were obtained from the City's total weather station located at the WWTP until it experienced a maintenance failure in February 2013. SFE installed a rain gauge at the City's maintenance yard and continued to collect rainfall data in March.

Figure 3-4 and Table 3-1 highlight the meters used in the post-Phase 4 flow monitoring effort.

Table 3-1. Phase 4 Post-Rehabilitation Flow Monitoring Locations				
Monitoring basin	Location of flow monitor	Meter type and owner	Upstream basins	Corresponding Sanitary basins
All	Sweet Home WWTP		2,3,7	
1A	4th and Main Street	Weir - SFE		1
2	490 Main Street	Weir - SFE	1A, 4, 6	19 (partial)
3	8th Avenue West of 9th Avenue	Weir - SFE	5,8	3, 8 (partial)
4	4th Street	AV – City		2, 19 (partial)
5	Gleaners	AV – City		4
6	Long	AV – City		5, 6, 21
7	Redwood	AV – City		8 (partial)
8	15th Avenue	Weir - SFE	8A, 10, 13, 14	7, 12, 14, 17
8A	18th Avenue at Rail Road	Weir - SFE	9.1, 9.2	18
9.1	Admin	AV – City		10
9.2	Auto Shop	AV – City		9
10	Clark Mill	AV – City	12	11
12	Church	AV – City		20
13	Nandina	AV – City		15
14	Rail Road	AV – City		16

3.1.1 Quality Control Oversight

As part of the post-Phase 4 monitoring, BC provided oversight, assistance with site and flow monitor selections, and QA/QC. Raw data and field maintenance notes from each site were sent weekly in electronic format from both City staff and SFE to BC for validation and verification. Field notes accompanying the data exchange included a digital photograph of each installation, all observations, field verifications, calibrations, and adjustments for each site.

At different times throughout all of the flow monitoring periods, short gaps and inconsistencies in the data were observed due to lost power, faulty calibration, debris, computer malfunction, limitations of the flow monitor, etc. Appendix A contains a detailed analysis of all flow monitoring data collected during the monitoring period.

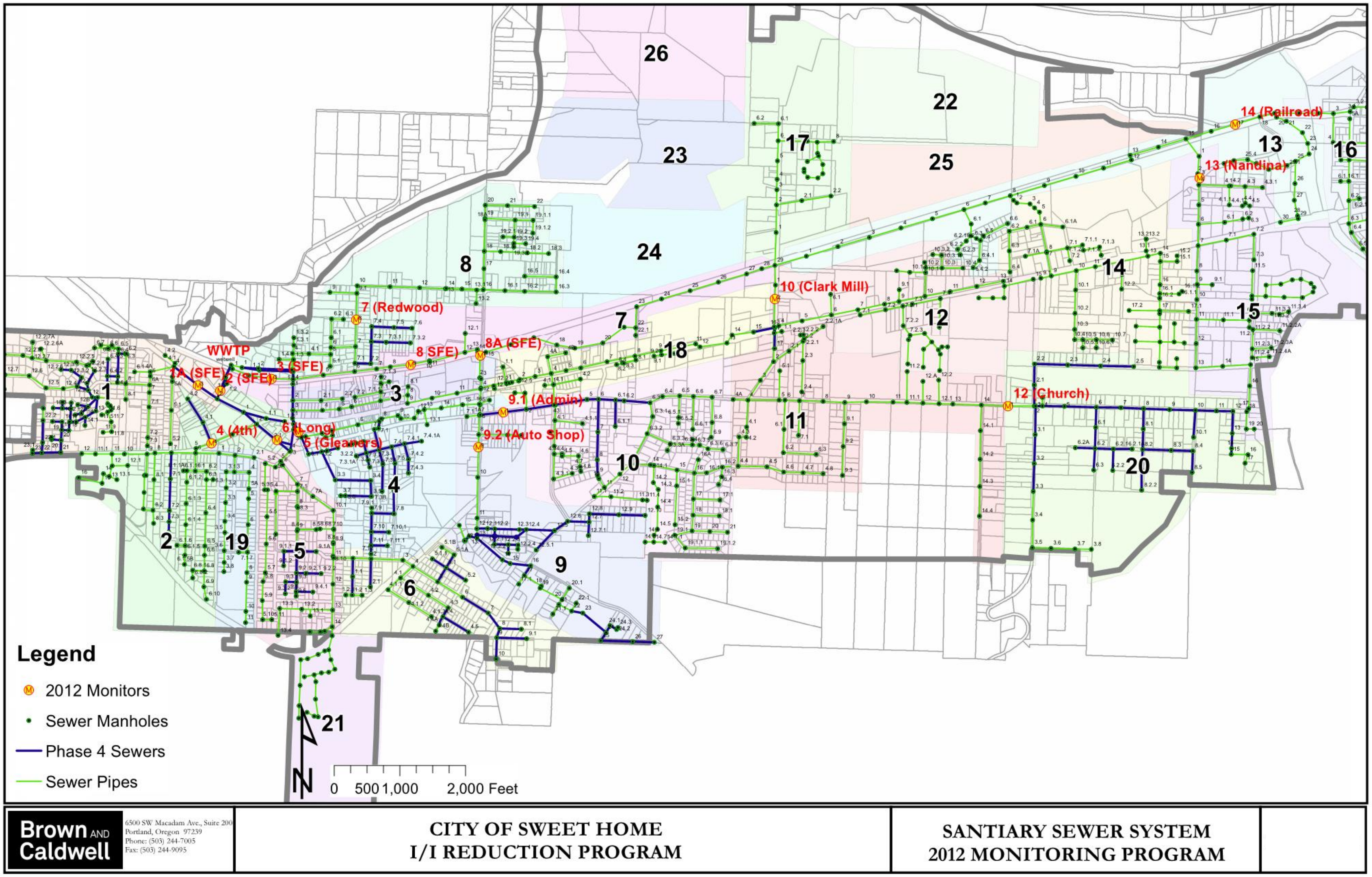

Figure 3-4. Location of 2012/2013 flow monitors

Section 4

Modeling

This section describes the hydrologic and hydraulic modeling effort undertaken in Phase 4 to represent the hydrologic response of the collection system to rainfall, evaluate the effectiveness of infiltration and inflow reduction projects, and to identify areas of limited conveyance capacity and system flooding.

4.1 Hydrologic Modeling

As part of the *Sanitary Sewer Master Plan* (Brown and Caldwell [BC], 2002), hydrologic models were developed in BC's modeling platform, Capacity Assurance Planning Environment (CAPE), to simulate the peak–hour, 5-year recurrence flows at each flow meter in the Sweet Home collection system. The hydrologic engine selected to simulate rainfall-derived infiltration/inflow (RDII) at each flow meter is the Stanford Watershed I/I (SWII) model, which simulates impervious runoff as well as subsurface rapid and long-term infiltration. Throughout the four phases of sewer system rehabilitation, flow monitoring data have been collected to calibrate the SWII models.. As a result of the modeling efforts, the 5-year peak-hour flow under existing and future population projections can be estimated at each point in the rehabilitation process and the effectiveness of sewer rehabilitation projects can be quantified between rehabilitation phases.

4.1.1 Hydrologic Data Sources

The following subsections describe the inputs to the hydrologic models necessary for model calibration ands long-term simulations for recurrence statistics.

4.1.1.1 Basin Delineations

Sweet Home is divided into 27 sanitary basins that do not necessarily share the same borders as the flow monitoring basins. Phase 4 flow monitoring generally was coarser spatially than flow monitoring efforts in previous phases. Some flow monitoring basins, such as Monitoring Basin 6, used to have multiple flow monitors installed for purposes of refining I/I abatement activities. Now, these areas are represented by a single flow monitor. Because of this, the monitoring basins had to be delineated before the hydrologic models could be set up because the basin area tributary to each flow meter is a necessary model input. Some basins, such as Sanitary Basin 12 (Church) were unchanged from previous monitoring efforts (apart from the meter ID). Figure 4-1 shows the delineated monitoring basins for the Phase 4 meters. The area of these basins were calculated using ArcGIS 10.1.

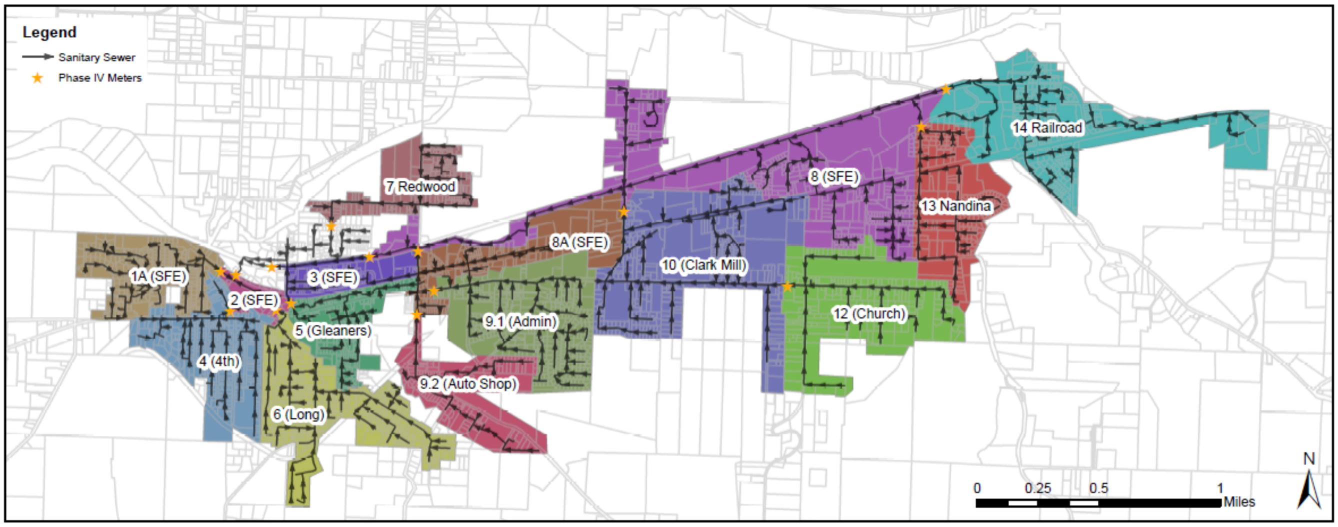

Figure 4-1. Phase 4 monitoring basins

4.1.1.2 Local Rainfall

A local representative rainfall dataset is necessary to calibrate the hydrologic models to the observed flow data. The closer in proximity the rain gauge is to the flow meters, the more likely the rainfall data will be representative of the rainfall that fell on the monitoring basins when the flow was monitored. The City operates a rain gauge at the Sweet Home Wastewater Treatment Plant (WWTP) that collects rainfall at a 15 minute interval. The City's gauge failed twice during the Phase 4 monitoring period, which created gaps in the record. These gaps were patched to create a complete rainfall record that was used to maintain the water balance of the hydrologic models through the wet season and to appropriately match late season storms.

To patch the rainfall record, data from weather stations in Sweet Home available on WeatherUnderground.com were analyzed for correlation to the WWTP rain gauge during concurrent periods. A National Oceanic and Atmospheric Administration (NOAA)/National Weather Service weather station located at Foster Dam on the eastern edge of town collects rainfall data; however, at the time of this analysis, finalized rainfall data were not available for the Foster Dam gauge operated by NOAA, so it was not considered for record patching. Four available gauges within Sweet Home were analyzed for daily rainfall totals as they compared to daily totals at the WWTP gauge. The flow monitoring firm retained by Brown and Caldwell (BC) installed a rain gauge, KORSWEET4, at the City's Maintenance Yard. The gauge KORSWEET4 correlated best and was selected to be used in patching the local rainfall record. As the calibration process began, it was noted that the models consistently over-predicted flows on the March 19th event. The WeatherUnderground gauges showed lower rainfall totals for the storm than the WWTP gauge read, so the WWTP rainfall data were replaced with KORSWEET4 data for the March 19th event.

Table 4-4 summarizes the rainfall sources used to create a composite local rainfall record for use in calibrating the 15 hydrologic models.

Table 4-1. Local Rainfall Record Sources			
Source	Start date	End date	Reason
WWTP	10/14/2012 00:00	12/26/2012 12:15	WWTP rainfall available
KORSWEET4	12/26/2012 12:30	01/02/2013 15:00	WWTP rainfall data gap
WWTP	01/02/2013 15:15	01/31/2013 13:45	WWTP rainfall available
KORSWEET4	01/31/2013 14:00	03/06/2013 04:00	WWTP rainfall data gap
WWTP	03/06/2013 04:15	03/19/2013 15:45	WWTP rainfall available
KORSWEET4	03/19/2013 16:00	03/21/2013 00:00	WWTP rainfall not representative
WWTP	03/21/2013 00:15	03/27/2013 08:00	WWTP rainfall available

The local rainfall dataset, shown in green in Figure 4-2, is plotted against the flow monitoring data for meter 8. As the graph shows, the high flows correspond to periods of rainfall.

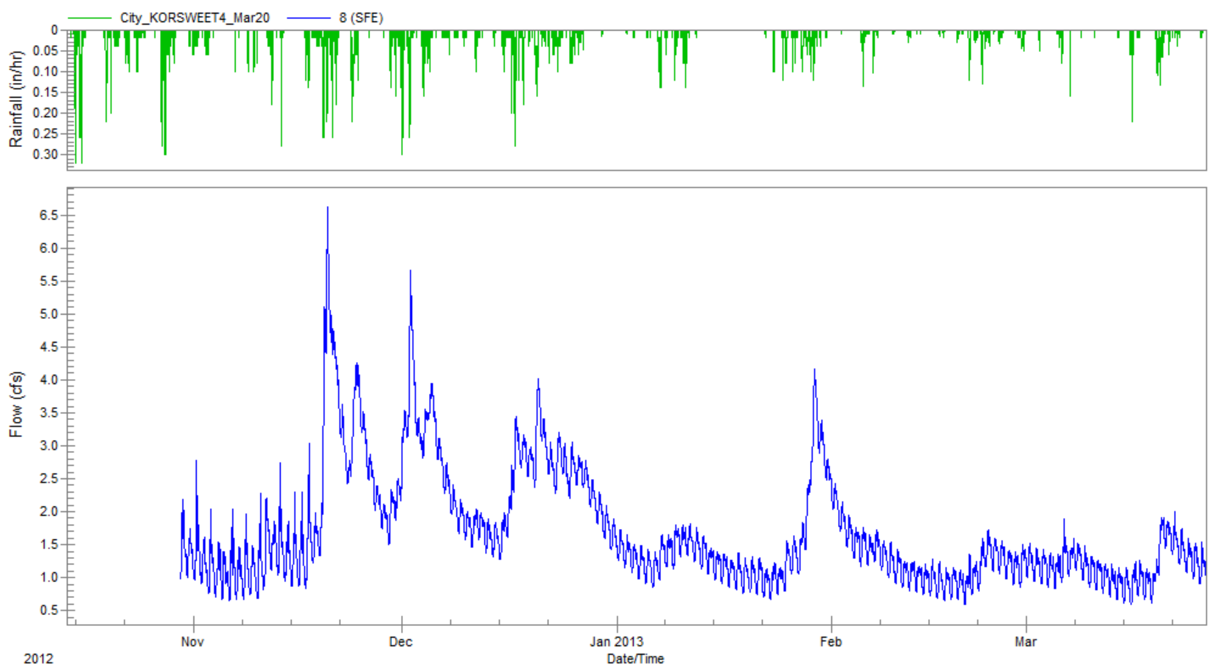

Figure 4-2. Local rainfall plot

4.1.1.3 Long-Term Rainfall

Long-term rainfall datasets allow hydrologic models to be run over the course of many years. The predicted long-term flow datasets are used to calculate recurrence statistics on peak flows by looking into the large events of the past which were not monitored. The City's gauge at the WWTP has not been in service long enough to run the hydrologic models for a period sufficient to calculate recurrence statistics.

The rain gauge at Foster Dam (operated by NOAA) on the eastern edge of Sweet Home has been in service since November 1969, collecting rainfall at an hourly interval. In previous analyses of RDII rehabilitation effectiveness for the City, BC has used the rainfall record from Foster Dam that spans from

November 1, 1969 through April 14, 2009. For consistency, we have used this same long-term rainfall dataset in Phase 4 modeling for long-term simulations. This provides an apples-to-apples comparison of post-Phase 3 and post-Phase 4 model statistics to determine the change in the 5-year peak-hour RDII flow due to rehabilitation alone. Figure 4-3 shows the spatial relationship of the Foster Dam gauge to the gauges used in creation of the local record.

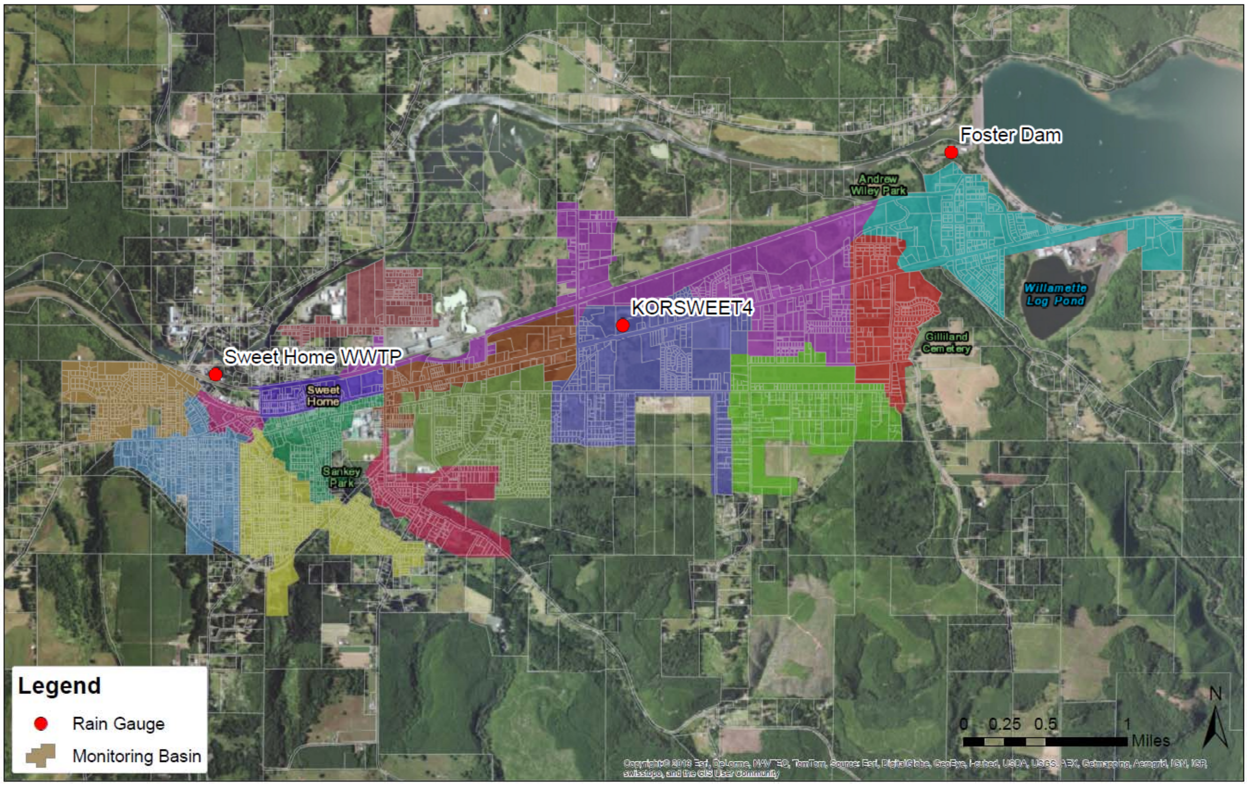

Figure 4-3. Rain gauge spatial relationship

At the time of this analysis, finalized Foster Dam rainfall data were not available for the period concurrent with the monitoring data. However, NOAA did provide raw rainfall data that had not yet been put through the agency's internal QC process. A comparison of the raw Foster Dam rainfall data to the local record was made to determine how well the two gauges likely correlate each other. Event separation was performed on the local gauge using a 24-hour event duration with an additional 6 hours of duration on each side of the event. Rainfall from the two gauges were summed for the events and plotted against each other. Figure 4-4 shows points with a linear best fit line in blue. The red line is the 1:1 plot upon which the points would lie if the gauges correlated perfectly.

The best fit line equation was forced through the origin to prevent a Y intercept from being calculated as both gauges should read zero rainfall on a dry day. The slope of 0.75 indicates that the local gauge may tend to read lower total rainfall for concurrent events than does the Foster Dam Gauge by approximately 25 percent. Although the Foster Dam rainfall data are not finalized, this analysis suggests that the long-term rainfall record may produce more water in the hydrologic models than the calibration with the local gauge would intend. The consequence of this additional rainfall is an element of conservatism in the magnitudes of estimated flows from long-term simulations.

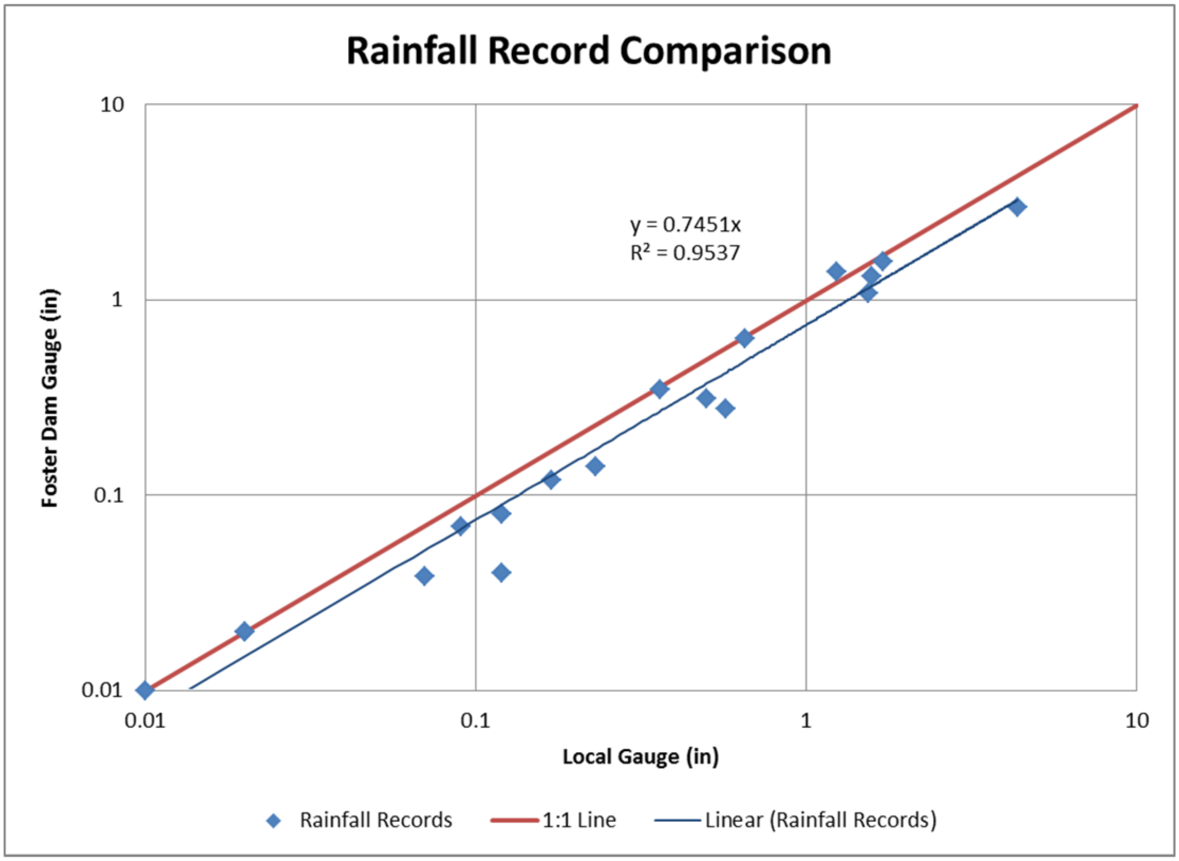

Figure 4-4. Local gauge to Foster dam gauge comparison

4.1.2 Model Calibration and Long-Term Simulation

A hydrologic model was constructed for each of the 15 flow meters deployed in the winter of 2012/2013 as part of Phase 4 rehabilitation monitoring. Calibration to observed flow data was first performed on the most upstream basins which did not have any flow inputs (meters 1A, 4, 6, 7, 9.1, 9.2, 12, 13, and 14). Upon calibration of the models, model flows were input into downstream basin models, which were then calibrated to the downstream meters (meters 2, 3, 8A, and 10). The following sections describe the dry and wet weather flow calibration.

4.1.2.1 Dry Weather Flow (DWF) Calibration

DWF refers to the flow in the sewer system independent of rainfall. It is the wastewater flow produced from household discharges. Over time, a diurnal pattern can be seen due to periods of high and low water use throughout the day. Calibration to this flow is necessary to capture the wastewater component of sewer flow which is not subject to rainfall.

DWF calibration was performed in PCSWMM, using built in tools to develop the factors and flow magnitudes necessary to replicate the observed dry weather diurnal flows in the model. Figure 4-5 shows an example of a DWF calibration for the flow meter for Monitoring Basin 2 flow meter. The red line is the calculated diurnal pattern for the observed (blue) flow monitoring data. The pattern was calculated from the mostly dry period (as there was not a completely dry period in the monitoring record) between November 4 and November 9, 2012. Pattern development periods are chosen on a meter specific basis and the dates used reflect periods where the flows appear to be uninfluenced by rainfall or meter error.

The magnitude of the flow as well as the factors for each hour produced by PCSWMM were then entered into CAPE to produce the diurnal flow pattern in the hydrologic model.

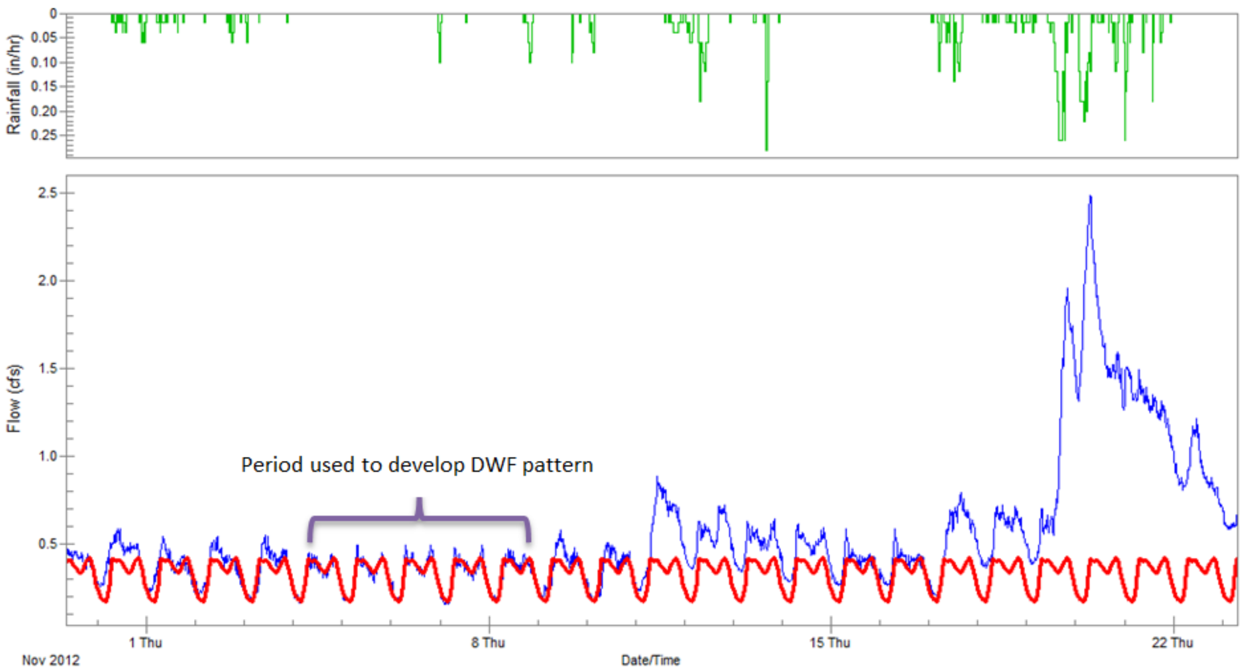

Figure 4-5. DWF pattern development

For the most upstream basins, the calculated DWF magnitude was placed directly into CAPE (as there are no upstream basins contributing to the DWF observed at the meter. The DWF value entered into the CAPE models for downstream basins is calculated as the difference between the calculated magnitude for the downstream meter and the magnitude for the upstream meter (or meters). For example, if the calculated DWF magnitude for meter 12 (upstream) is 0.03 million gallons per day (mgd) and the calculated magnitude for meter 10 (downstream) is 0.2 cubic feet per second (cfs), then the value entered into the CAPE for the Monitoring Basin 10 model is 0.17 mgd (the difference between the two). This contributing flow represents the DWF produced by the downstream basin alone independent of any upstream basins.

The lower most Phase IV flow monitors in the City (2, 3, and 7) were sufficiently upstream from the WWTP that about 7600 feet of pipe went unmonitored. To account for this, scaling factors based on pipe length for monitoring basins 2, 3, and 7 were developed based on the fractional difference in monitored to unmonitored pipe length and are shown in Table 4-2. These factors are necessary to scale flows that are likely created in the unmonitored areas to estimate the full contribution of the City's collection system to the WWTP.

Table 4-2. Unmonitored Area Adjustment Factors

Monitoring Basin	Monitored Pipe Length (ft)	Unmonitored Pipe Length	Factor
2 (SFE)	3,125	450	1.14
3 (SFE)	7,768	680	1.09
7 (SFE)	10,538	6433	1.61

Brown AND Caldwell

Table 4-3 summarizes the DWF values calculated from the observed flow data and the contributing DWF values entered into the hydrology models. The total calculated DWF to the Sweet Home Wastewater Treatment Plant (WWTP) is 1.22 mgd. This number appears to be high compared to anecdotal information about summer time dry weather flows which have been recorded near 0.7 to 0.8 mgd. This high estimation is likely due to the fact that flow meters were not deployed until November, when groundwater is likely to begin infiltrating the sewers and elevating the average low flows. The consequence of this high DWF estimation is that the future growth scenarios will be inherently conservative analyses as this number is used to extrapolate out future DWFs for a larger population.

Table 4-3. DWF Calibration

Flow meter	DWF magnitude, mgd	Upstream basins	Contributing DWF, mgd
1A (SFE)	0.080	N/A	0.080
2 (SFE)	0.217	1A, 4, 6	0.011
3 (SFE)	0.871	5, 8, 8A, 9.1, 9.2, 10, 12, 13, 14	0.217
4 (4th)	0.032	N/A	0.032
5 (Gleaners)	0.075	N/A	0.075
6 (Long)	0.095	N/A	0.095
7 (Redwood)	0.069	N/A	0.069
8 (SFE)	0.597	8A, 9.1, 9.2, 10, 12, 13, 14	0.111
8A (SFE)	0.215	9.1, 9.2	0.089
9.1 (Admin)	0.078	N/A	0.078
9.2 (Auto Shop)	0.048	N/A	0.048
10 (Clark Mill)	0.197	12	0.197
12 (Church)	0.030	N/A	0.030
13 (Nandina)	0.052	N/A	0.052
14 (Railroad)	0.040	N/A	0.04
Total			1.22

4.1.2.2 Wet Weather Flow (WWF) Calibration

WWF calibration is an iterative process of hydrologic model parameter adjustment which seeks to isolate parameters that force the model to respond to rainfall volumes and intensities with the same hydrologic behavior seen in the observed flow dataset. In the case of the SWII model, four main components of the model need to be calibrated to represent the different components of the hydrograph of each monitoring basin accurately. When calibrated correctly, these four components work in tandem to represent directly-connected impervious area, rapid infiltration, interflow infiltration, and long-term groundwater infiltration.

Figure 4-6 shows the four different components of the Monitoring Basin 9.1 calibrated model for three large storms of the calibration period (rainfall is not shown for figure clarity). This model shows that during these storms, long-term groundwater accounted for approximately 0.03 mgd of the total flow. Interflow infiltration was the largest component of the flow with well-defined peaks and a majority of the total RDII volume. Virtual inflow (rapid infiltration) as well as direct inflow (connected impervious area) accounted for moderate portions of the peaks. The sum of the component flows creates the RDII time series.

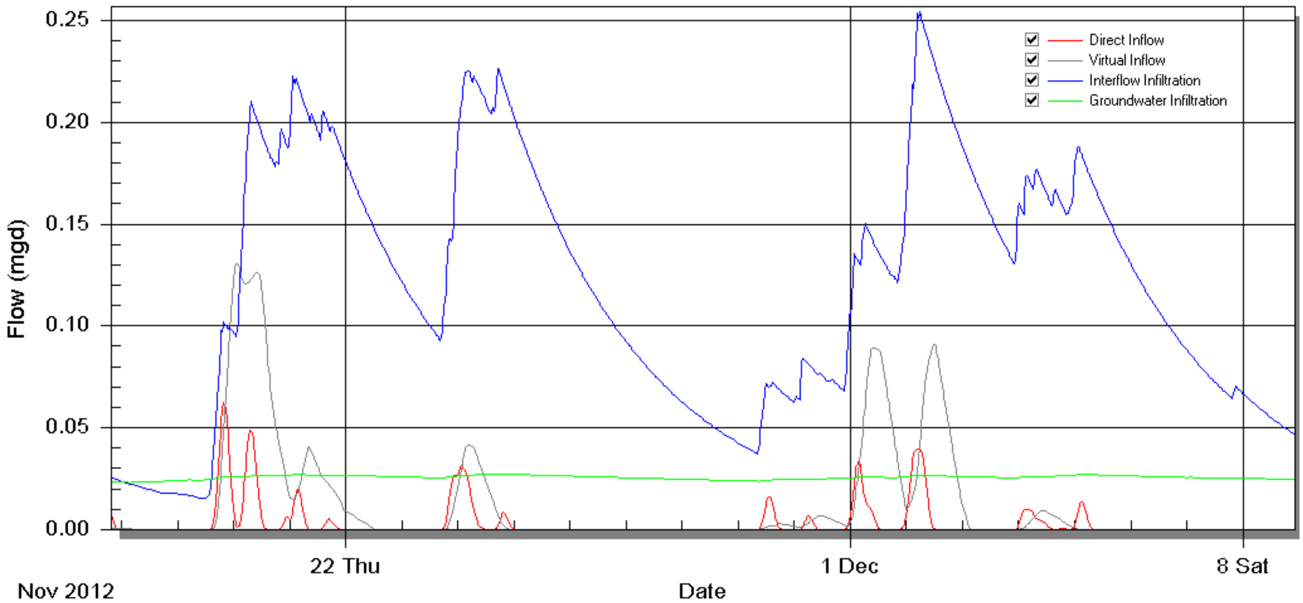

Figure 4-6. Monitoring Basin 9.1 Component RDII Flows

The sum of the RDII and the DWF creates the total flow, which can be seen plotted in red against the observed flow monitoring data (blue) in Figure 4-7. This figure is taken from the calibrated monitoring Basin 9.1 model. A model is determined to be calibrated when further adjustments of the model parameters no longer produce a better fit of the model flows to the observed flow data. In general, a calibrated model will do an accurate job of matching peak flows, rising and falling limbs, and long-term infiltration. A calibrated determination is fundamentally a subjective one because the model will never match observed flow data perfectly (as can be seen in the figure).

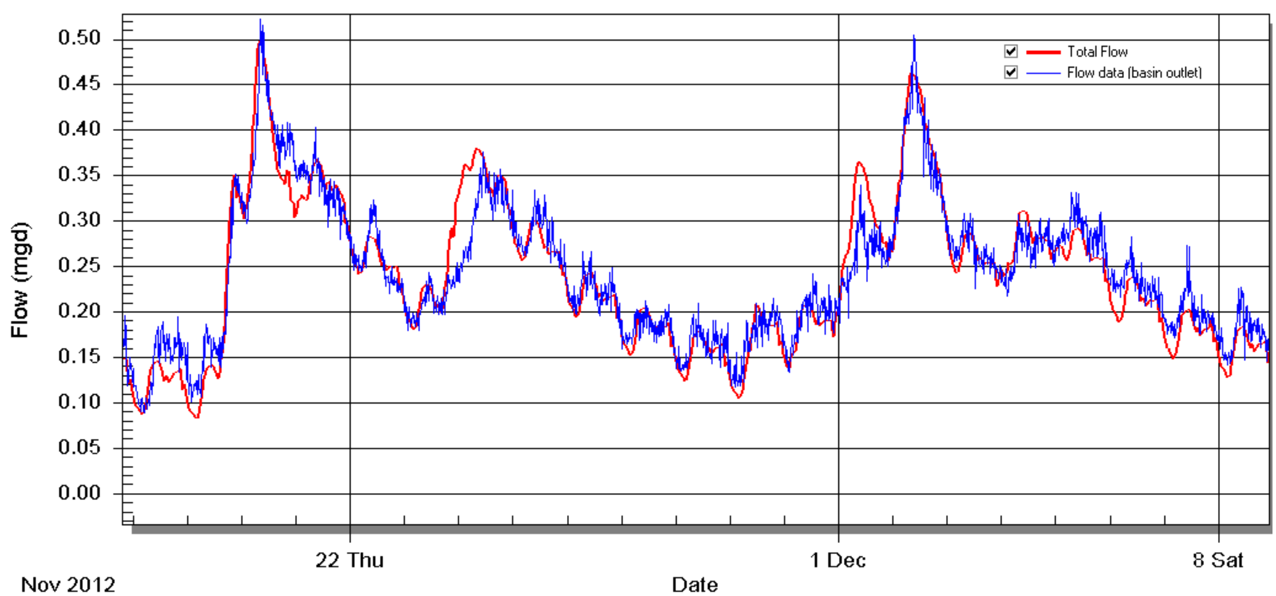

Figure 4-7. Monitoring Basin 9.1 peak storm calibration plot

Zoomed out with the local rainfall data visible (green), the calibrated model can be seen rising and falling along with the flow meter 9.1 monitoring data, as shown in Figure 4-8. The calibration rainfall data (green) is shown for reference.

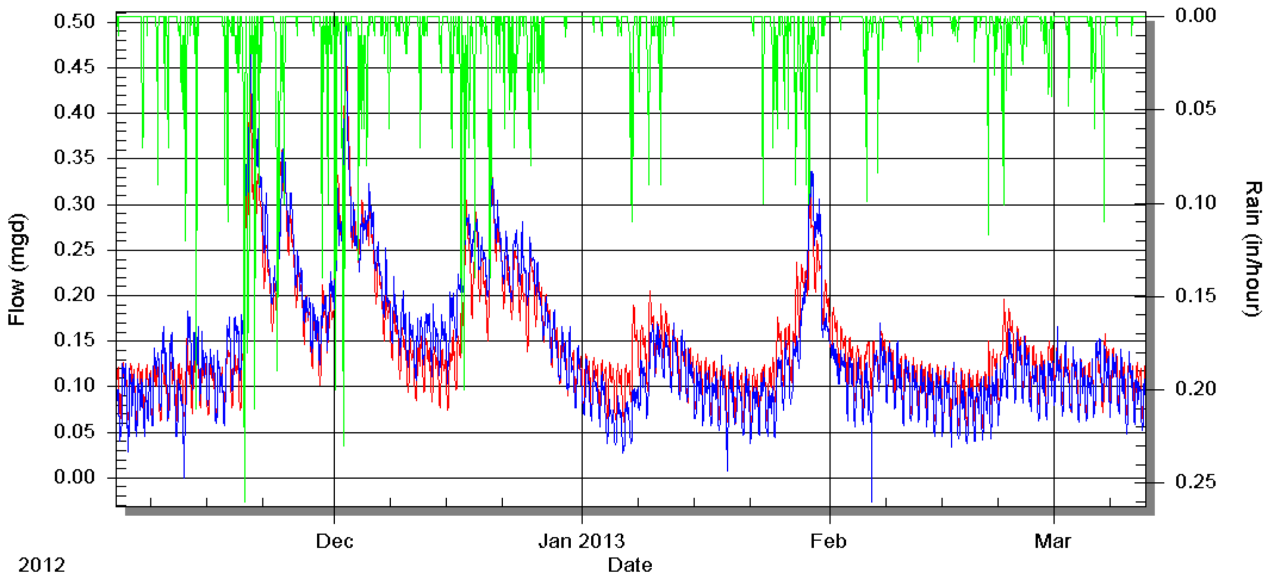

Figure 4-8. Monitoring Basin 9.1 seasonal calibration plot

Once calibrated, the model can be used with the long-term rainfall record to simulate RDII and total flows for 39 years. The long-term flow record can be used to generate flow statistics that describe the hydrologic performance of the basin over time.

4.1.2.3 Long-Term Simulation Statistics

After the model is run through the 39-year Foster Dam rainfall record, the peak hourly RDII discharge values for each year of the record are extracted to create the annual maxima series. The annual maxima series is fit to a Log Pearson Type III (LPIII) distribution to allow for estimation of the peak hourly RDII for any desired return period (also referred to as recurrence interval). This analysis is necessary to estimate the 5-year peak-hourly RDII between rehabilitation phases, which is the statistic used in calculating rehabilitation effectiveness. Figure 4-9 below shows the RDII annual maxima series (points) for monitoring basin 1A plotted on top of the fitted LPIII curve (black). To the right are the estimated flow magnitudes at different recurrence intervals. For monitoring basin 1A, the 5-Year peak hourly RDII is estimated at being 0.57 cfs (0.37 mgd).

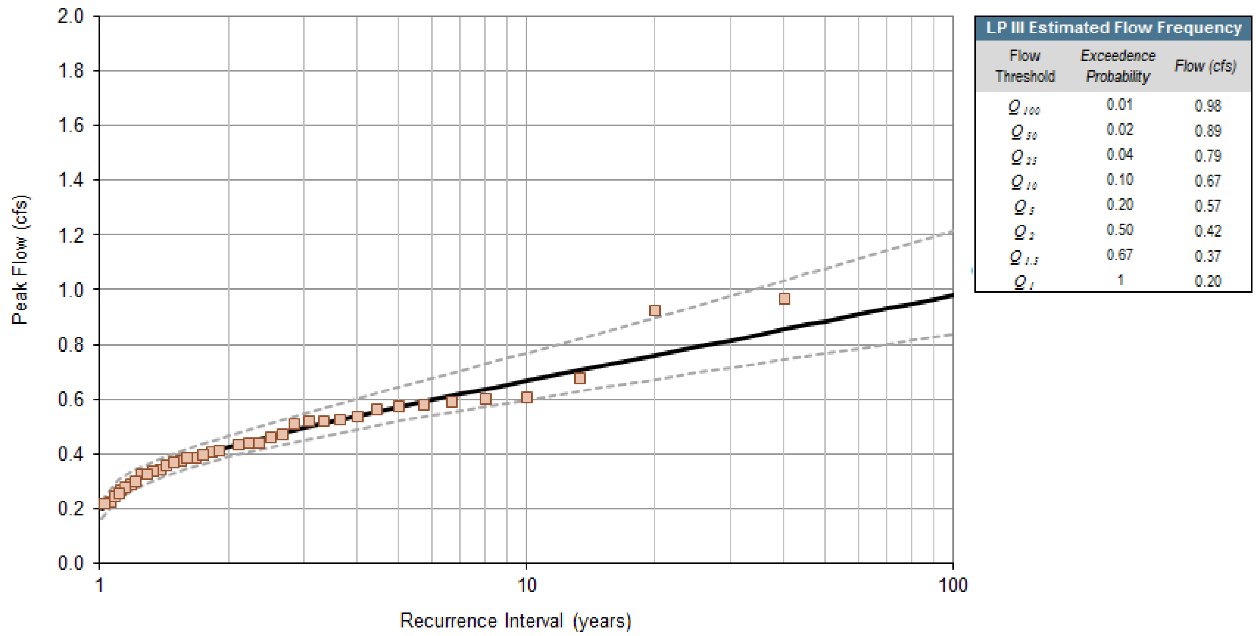

Figure 4-9. Fitted LPIII Curve with 90% Confidence Bounds

Table 4-4 provides the 5-year peak-hour RDII for each of the 15 Phase 4 monitoring basins.

Table 4-4. Post Phase 4 5-Year Peak-Hour RDII			
Flow meter	RDII, mgd	Unit area, gpad[a]	Pipe length, gpm[b] per foot
1A (SFE)	0.37	3,647	0.015
2 (SFE)	0.05	2,682	0.007
3 (SFE)	0.66	13,998	0.051
4 (4th)	0.52	4,047	0.020
5 (Gleaners)	0.49	7,006	0.029
6 (Long)	1.32	8,403	0.034
7 (Redwood)	0.35	4,644	0.022
8 (SFE)	2.07	21,148	0.113
8A (SFE)	0.58	1,750	0.011
9.1 (Admin)	0.86	5,124	0.027
9.2 (Auto Shop)	0.59	5,629	0.037
10 (Clark Mill)	0.84	3,156	0.020
12 (Church)	0.31	1,616	0.014
13 (Nandina)	0.49	3,891	0.023
14 (Railroad)	1.09	5,160	0.032

[a] *gpad = gallons per acre per day*

[b] *gpm = gallons per minute*

The model results show that the highest RDII after completion of Phase 4 is being monitored by meter 8. The next highest RDII rates are being monitored by meter 3. Another way to interpret the results is to show the 1-in-5 peak-hour RDII being contributed by each sanitary basin, as shown in Table 4-4.

The highest RDII contributions are coming from sanitary basins 7, 13, 14, and 17, followed by sanitary basin 8.

Table 4-5. Post Phase 4 5-Year Peak-Hour RDII

Sanitary Basin	RDII, mgd
1	0.36
2, 19	0.57
3	0.46
4	0.48
5, 6, 21	1.30
7, 13, 14, 17	2.38
8	0.55
9	0.58
10	0.84
11, 12	0.82
15	0.48
16	0.89
18	0.57
20	0.30

4.1.3 Rehabilitation Effectiveness

As discussed in Section 2, post-Phase 1/2 modeling revealed a marked decrease in predicted peak RDII when holistic basin rehabilitation is employed. Phase 3 post-construction modeling validated the need for full basin rehabilitation.

As part of the post-Phase 4 flow monitoring effort, five of the 15 flow monitors deployed in the winter of 2012/2013 measured flow from basins which had been rehabilitated as part of Phase 4. Rehabilitation effectiveness for this project is measured by the change in the 5-year peak-hour RDII flow between the pre-retrofit model (post-Phase 3 model) and the post-retrofit model (post-Phase 4 model). The following sections describe how the recurrence statistics are calculated, the calculation method for each rehabilitated basin, and a summary of the RDII removal effectiveness for Phase 4.

4.1.3.1 Phase 4 to Phase 3 Monitoring Basin Crosswalk

The flow meters deployed in Phase 4 below the rehabilitated basins were not always in the exact same location as the meters deployed during Phase 3 monitoring. Furthermore, there may have been multiple Phase 3 meters within the Phase 4 basin, in which case the sum of the RDII time series is necessary. Phase 4 meters 1A, 9.1, and 12 were placed in the same location as their Phase 3 counterparts. Thus, the long-term simulation results from the post-Phase 3 and post-Phase 4 models can be compared without alteration. For meters 5 and 9.2, the Phase 4 meter locations were adjusted from their original Phase 3 locations. Thus, an adjustment to the post-Phase 3 RDII time series was necessary to account for the additional or decreased tributary area upstream of the meter. A factor based on the change in upstream pipe length was applied to the RDII time series of the post-Phase 3 RDII time series so that it can be comparable to the post-Phase 4 RDII. Table 4-6 summarizes Phase 4 to Phase 3 meter crosswalk.

Table 4-6. Phase 4 to Phase 3 Monitoring Basin Crosswalk

Phase 4		Phase 3		Phase 3 RDII scaling factor
Monitoring basin	Total upstream pipe length, feet	Monitoring basin(s)	Total upstream pipe length, feet	
1A	16,747	1, 2, 3	16,747	1.00
5	11,567	9, 10	8,947	1.29
9.1	20,998	19	20,998	1.00
9.2	10,690	17, 18	12,643	0.85
12	14,818	23	14,818	1.00

4.1.3.2 Monitoring Basin 1A (Sanitary Basin 1)

Monitoring Basin 1A monitored the flows from Sanitary Basin 1. Approximately 9,400 linear feet (LF) or 52 percent of the sewers or were addressed in Sanitary Basin 1 since the inception of the program. Since a majority of the rehabilitation took place during Phase 4, the laterals were addressed on an as-needed basis only.

Figure 4-10 shows the extent of rehabilitation and replacement (R&R) work done since the beginning of the I/I Abatement Program.

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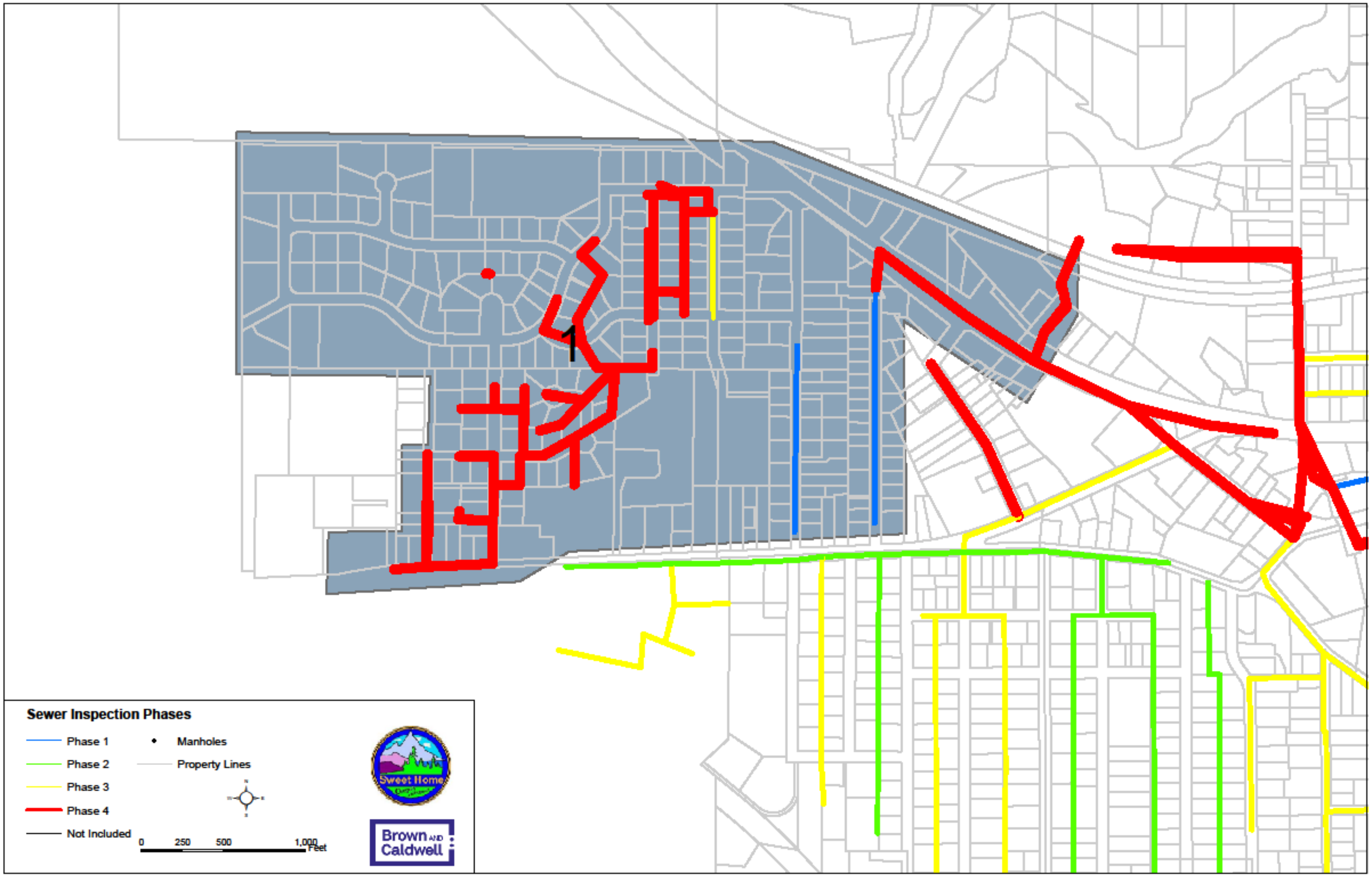


Figure 4-10. Extent of R&R work in Sanitary Basin 1

Phase 3 meters 1, 2, and 3 sum together to comprise the flow seen at the Phase 4 meter 1A, which was metering the flows coming from Sanitary Basin 1. Phase 3 meter 3 is located in the same manhole as Phase 4 meter 1A, thus, no scaling is necessary. The change in the LPIII curve between the two phases can be seen in Figure 4-11. The total reduction in 5-year peak hourly RDII is 0.78 mgd, which represents a 68 percent reduction in RDII since Phase 3. This large reduction in RDII indicates the rehabilitation within this monitoring basin was highly effective in reducing peak flows.

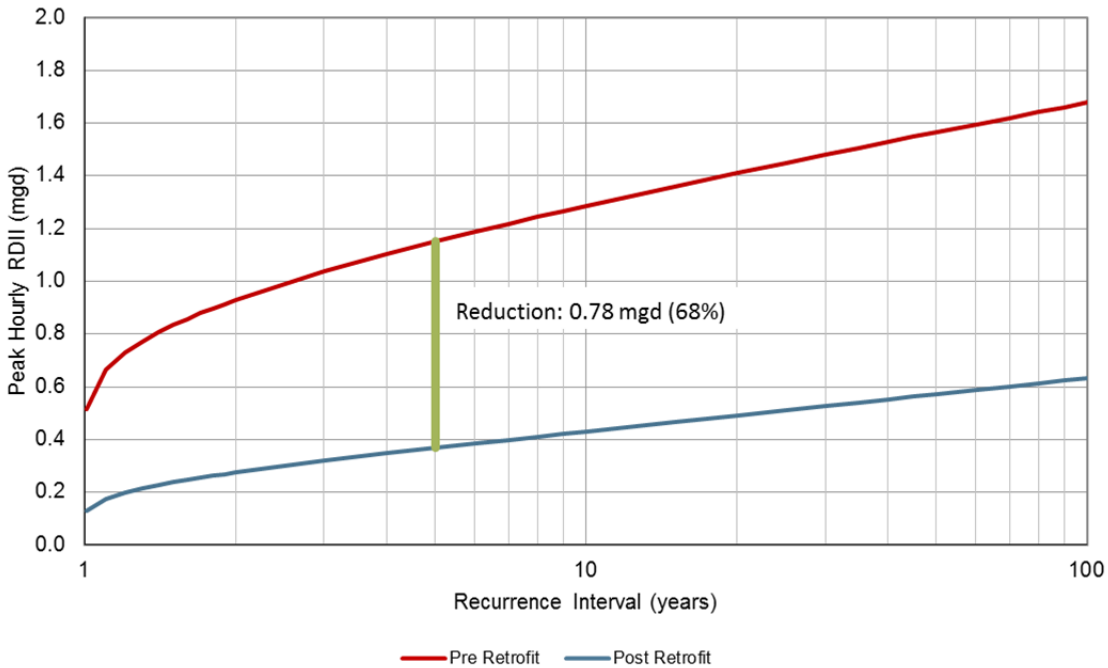


Figure 4-11. Phase 4 monitoring Basin 1A LPIII analysis

4.1.3.3 Monitoring Basin 5 (Sanitary Basins 4 and 6)

Monitoring Basin 5 monitored the flows from Sanitary Basins 4 and 6. Approximately 16,800 LF or 75 percent of the sewers were rehabilitated since the inception of the I/I Abatement Program.

Figure 4-12 shows the extent of work completed in the first four phases.

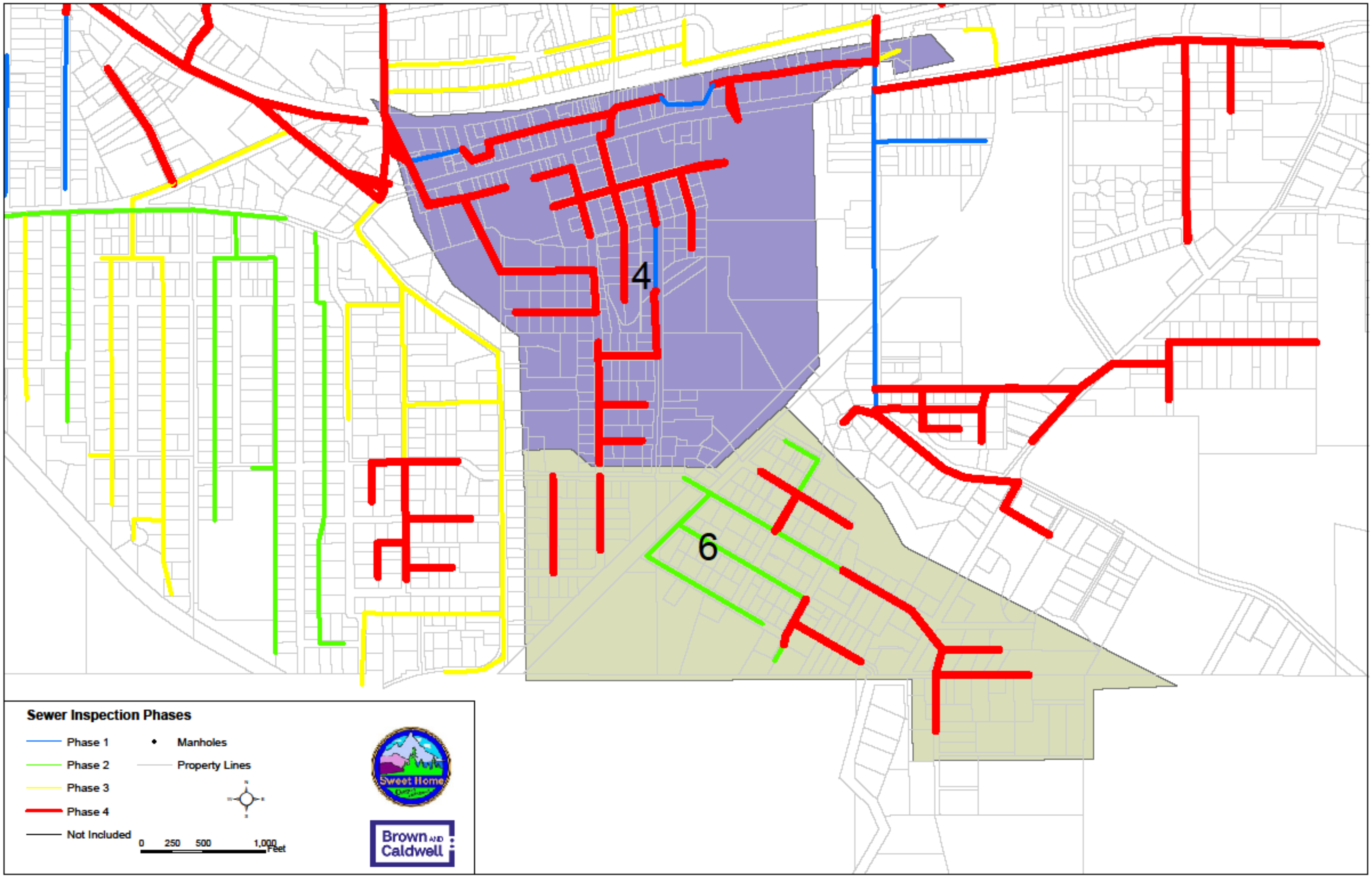


Figure 4-12. Extent of R&R work in Sanitary Basins 4 and 6

Phase 3 monitors 9 and 10 monitored 77 percent of the total pipe length monitored by Phase 4 meter 5. To account for the missing pipe lengths in Phase 3 that were monitored in Phase 4, the sum of the RDII time series from the two Phase 3 meters were scaled by 1.29 to be more comparable with Phase 4 meter 5. The total reduction in 5-year peak-hour RDII is 1.16 mgd, which represents a 70 percent reduction in RDII, as shown in Figure 4-13.

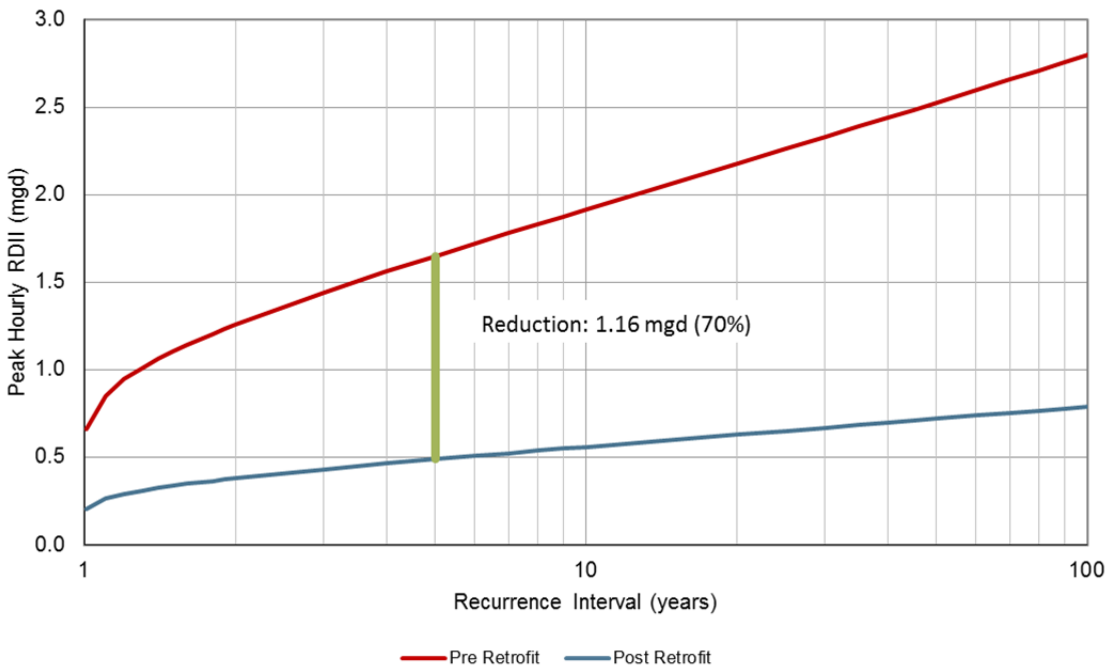


Figure 4-13. Phase 4 monitoring Basin 5 LPIII analysis

4.1.3.4 Monitoring Basin 9.1 (Sanitary Basin 10)

Monitoring Basin 9.1 monitored flows from Sanitary Basin 10. Phase 4 was the only phase to conduct work in this basin. Input from the City's engineering and maintenance staff indicated some localized issues along Long Street, and due to budget restrictions and lower predicted I/I removal rates, the scope of the work was limited to these areas. Approximately 4,200 LF or 20 percent of the sewers were addressed since the inception of the I/I Abatement Program.

Figure 4-14 shows the extent of work completed in the first four phases.

Phase 3 meter 19 was located in the same manhole as Phase 4 meter 9.1; therefore, no scaling was necessary to make the two time series comparable. The change in 5-year peak-hour RDII between the two models is negative, indicating the peak-hour RDII may have increased between phases. Closer inspection of the Phase 3 meter 19 flow data indicates that the meter may have had trouble accurately measuring peak flows, which in turn would make peak calibration difficult to achieve. The peaks in the blue observed time series shown in Figure 4-15 appear to be cropped at a relatively consistent value of around 0.55 to 0.6 mgd. These cropped peaks may indicate that the meter likely was unable to measure flow values greater than the 0.55- to 0.6-mgd threshold. The model calibrated to these flow data is likely underrepresenting peak flows, which would underestimate the post-Phase 3, 5-year peak-hour RDII. In other words, the pre-Phase 4 model likely underreported peak-hour flows due to underreported flows from the pre-Phase 4 monitoring effort.

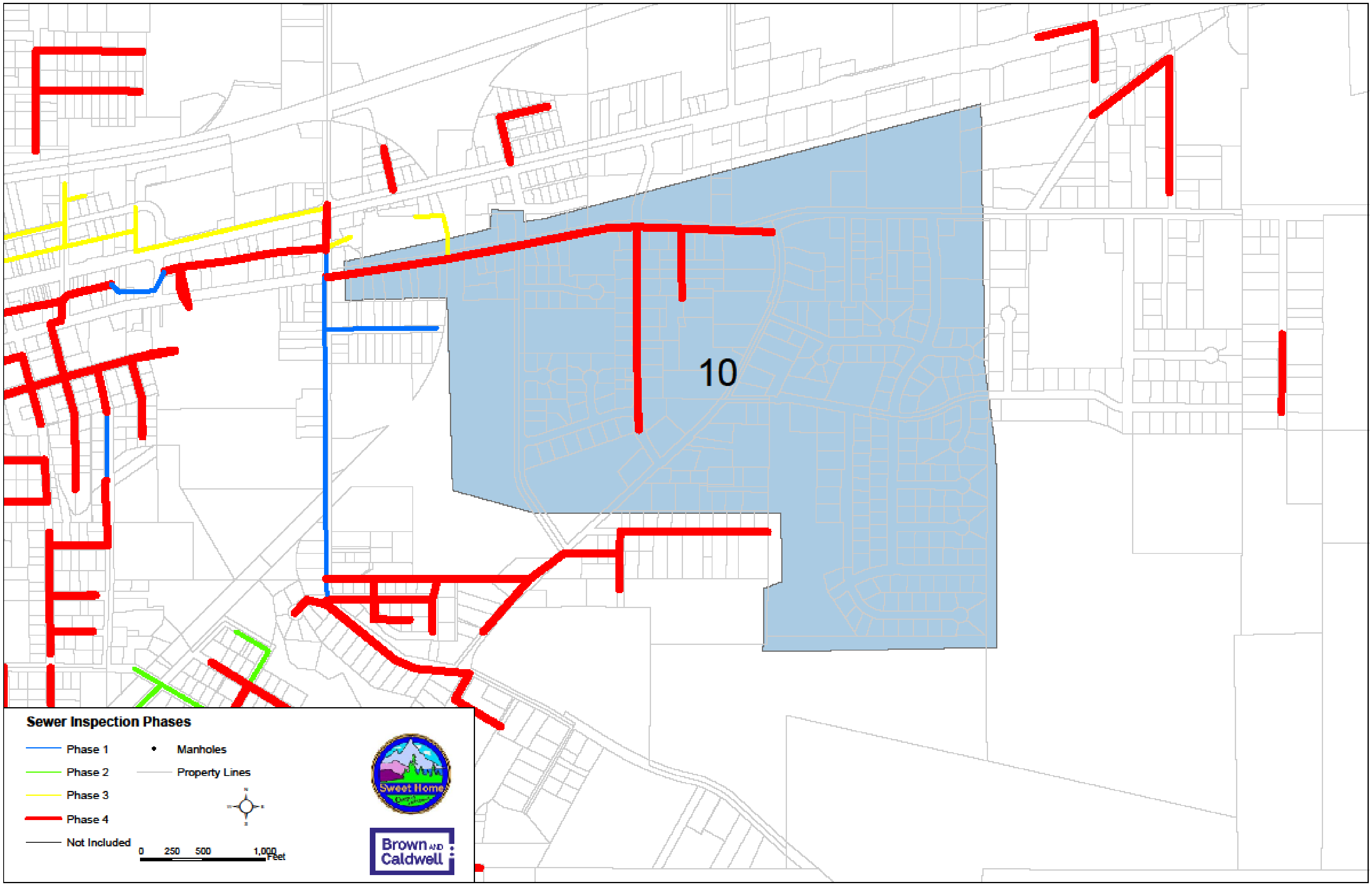


Figure 4-14. Extent of R&R work in Sanitary Basin 10

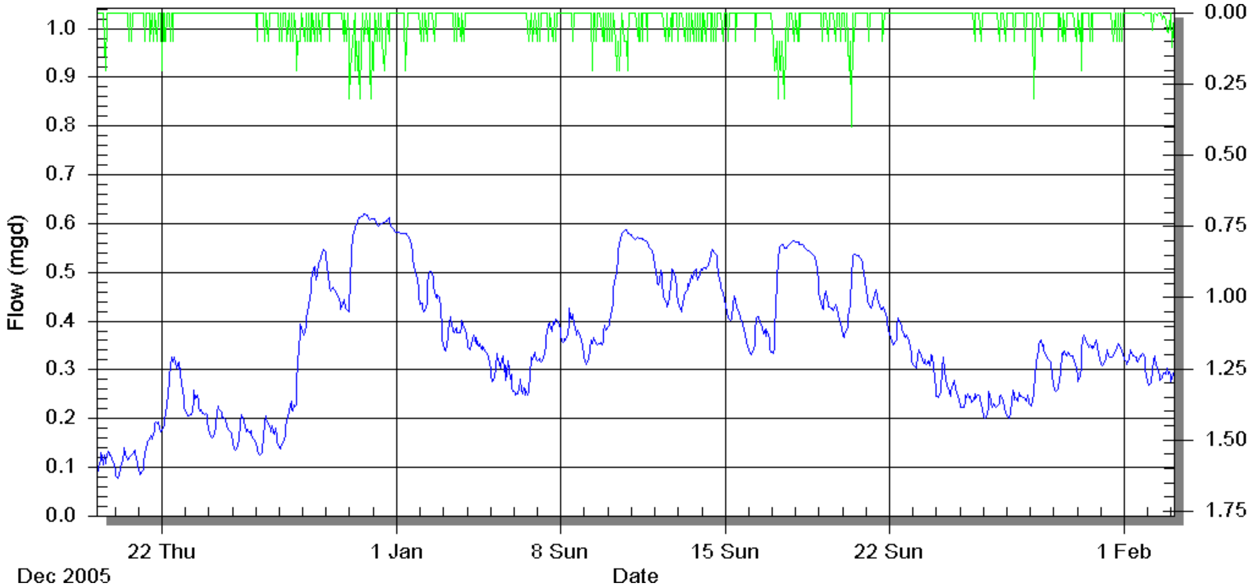


Figure 4-15. Cropped peaks in pre-Phase 3 flow monitoring data

Figure 4-16 presents the LPIII curves for both phases.

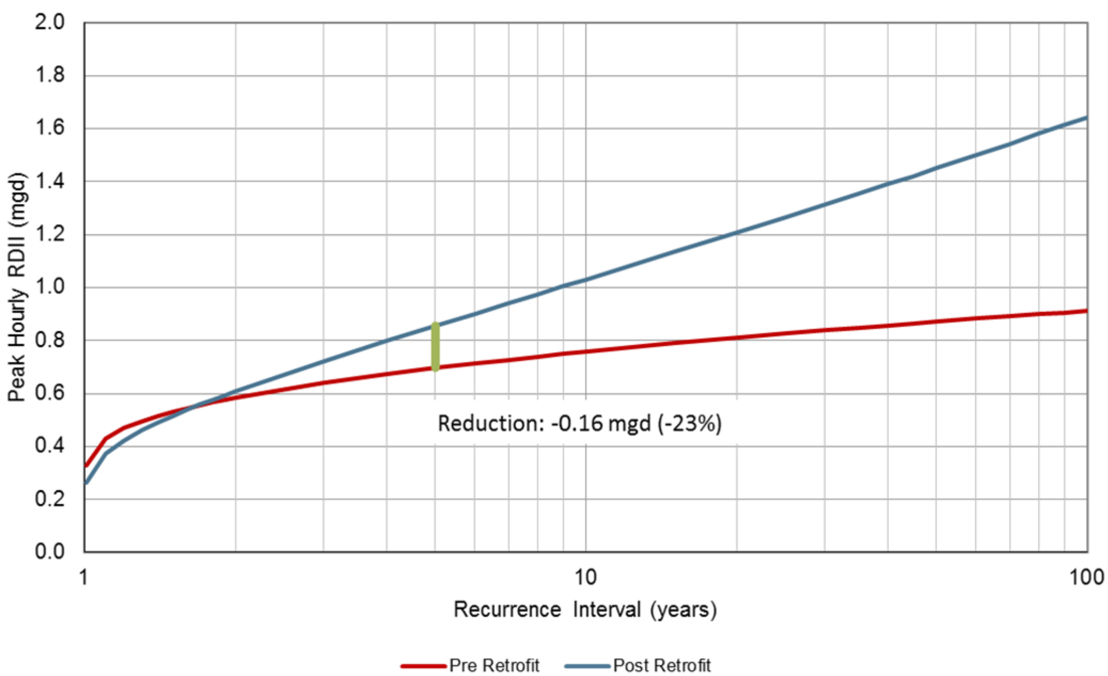


Figure 4-16. Phase 4 Monitoring Basin 9.1 LPIII analysis

4.1.3.5 Monitoring Basin 9.2 (Sanitary Basin 9)

Monitoring Basin 9.2 monitored flows from Sanitary Basin 9. Approximately 7,600 LF or 62 percent of the sewers have been addressed in this basin since the inception of the I/I Abatement Program. Figure 4-17 shows the extent of work completed in the first four phases.

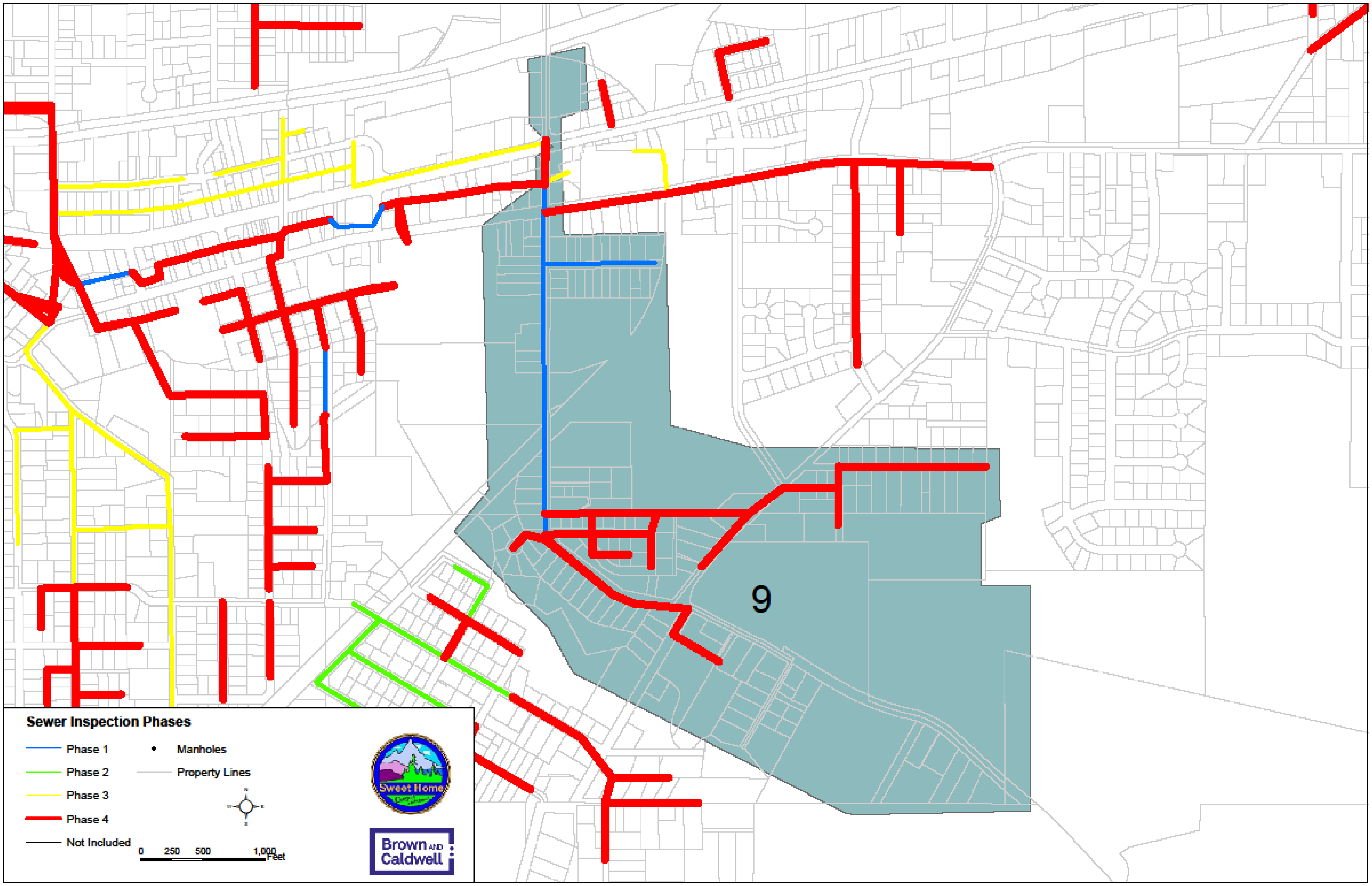


Figure 4-17. Extent of R&R work in Sanitary Basin 9

Phase 3 meters 17 and 18 monitored slightly more pipes than Phase 4 meter 9.2. Phase 3 meter 17, which is the downstream of the two meters, was prone to surcharge conditions during Phase 3 monitoring. To prevent the monitoring issues surrounding surcharge conditions, the meter was moved upstream to the Phase 4 meter 9.2 location. To account for this loss of monitored pipe, a factor of 0.85 was applied to the sum of the RDII time series of the Phase 3 basin 17 and 18 models to be comparable with the RDII time series of the Phase 4 Basin 9.2 model. Figure 4-18 shows the reduction of peak-hour RDII flows since the completion of Phase 3 in this basin. Overall, the reductions are consistent with what is expected in a basin where a portion of the mains and manholes have been rehabilitated but the laterals have been partially addressed.

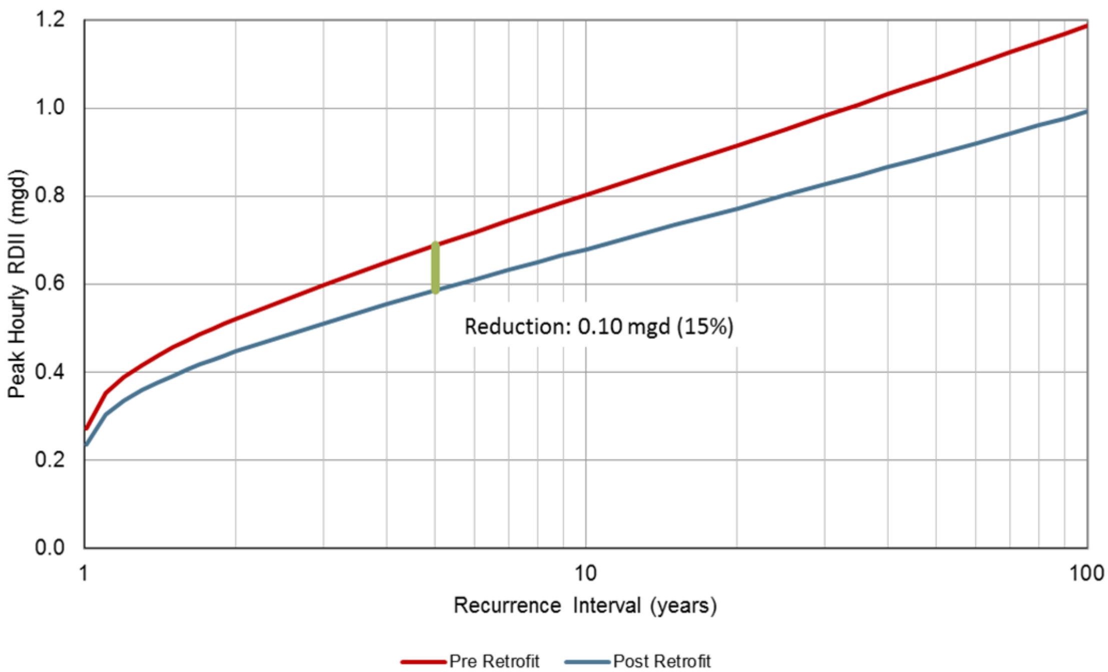


Figure 4-18. Phase 4 Monitoring Basin 9.2 LPIII analysis

4.1.3.6 Monitoring Basin 12 (Sanitary Basin 20)

Monitoring Basin 12 monitored flows from Sanitary Basin 20. Approximately 11,800 LF or 77 percent of the sewers have been addressed in this basin since the inception of the I/I Abatement Program, all in Phase 4. As discussed previously, Phase 4 funding constraints limited the amount of lateral work that could be done on private property, so laterals have not been addressed to the extent recommended for maximum I/I reduction. Figure 4-19 shows the extent of work completed in this basin.

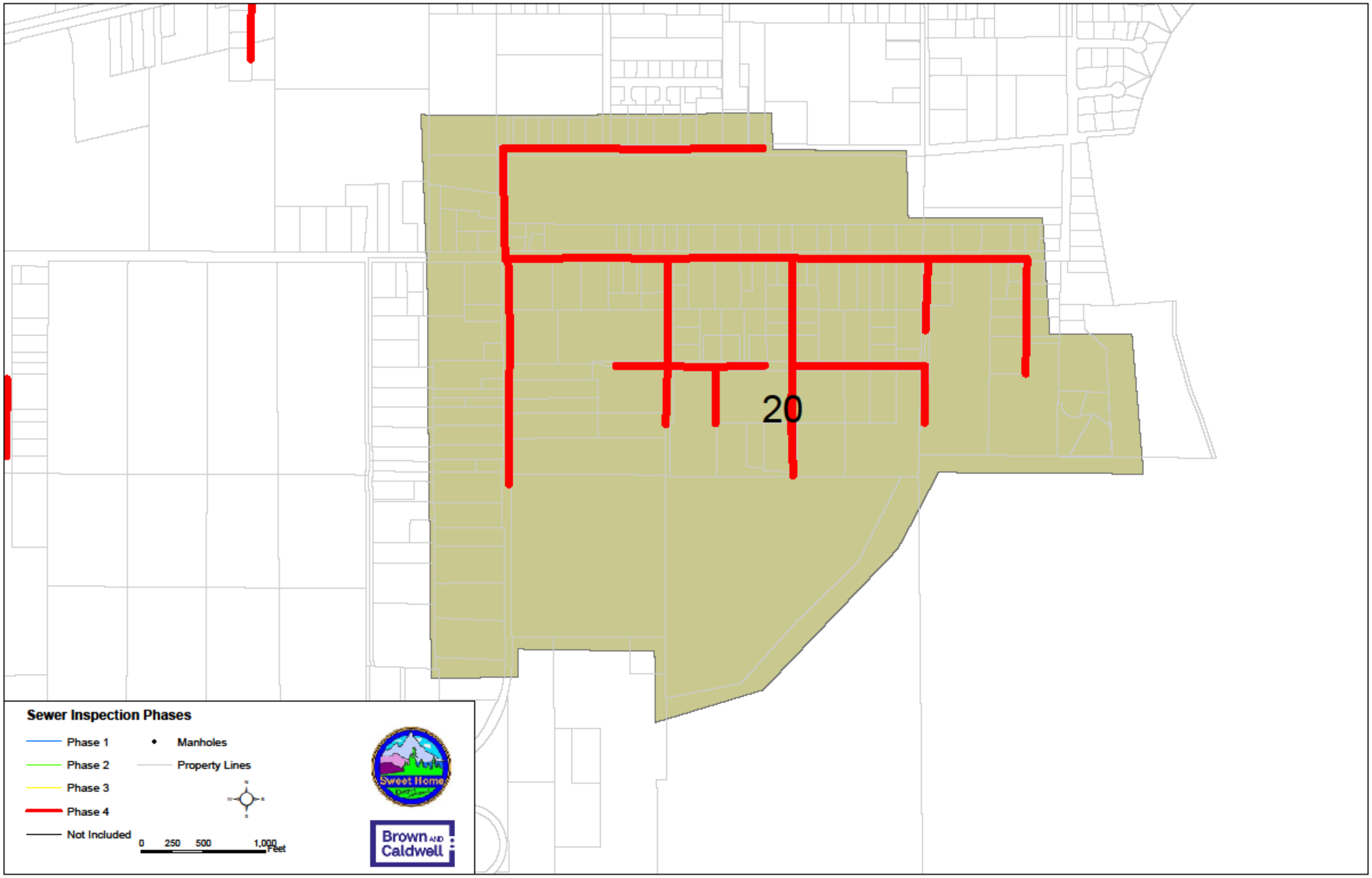


Figure 4-19. Extent of R&R work in Sanitary Basin 20

Phase 3 meter 23 was located in the same manhole as Phase 4 meter 12, allowing for a direct comparison of the RDII time series from each basin's calibrated models. The change in 5-year peak-hour RDII between the two phases is 0.16 mgd, representing a 35 percent change in RDII, as shown in Figure 4-20. Inspection of the LPIII curves indicates that the rehabilitation was most effective between the 2-year and 7-year return periods as the difference between the two curves is the greatest. Above approximately the 7-year return period, the effectiveness is reduced as the post-retrofit curve climbs steeply toward the pre-retrofit curve. This indicates that for low-frequency high-magnitude storms, the rehabilitation has less of an impact on RDII removal. For the more frequent low-magnitude storms, the rehabilitation appears to be more effective. One possible reason is that the unaddressed laterals at slightly higher elevation are contributing more RDII during those high-magnitude storms when the ground is extremely saturated and the groundwater table is temporarily elevated. Overall, the reductions are consistent with what is expected for a basin where mains and manholes have been rehabilitated but the laterals have been partially addressed.

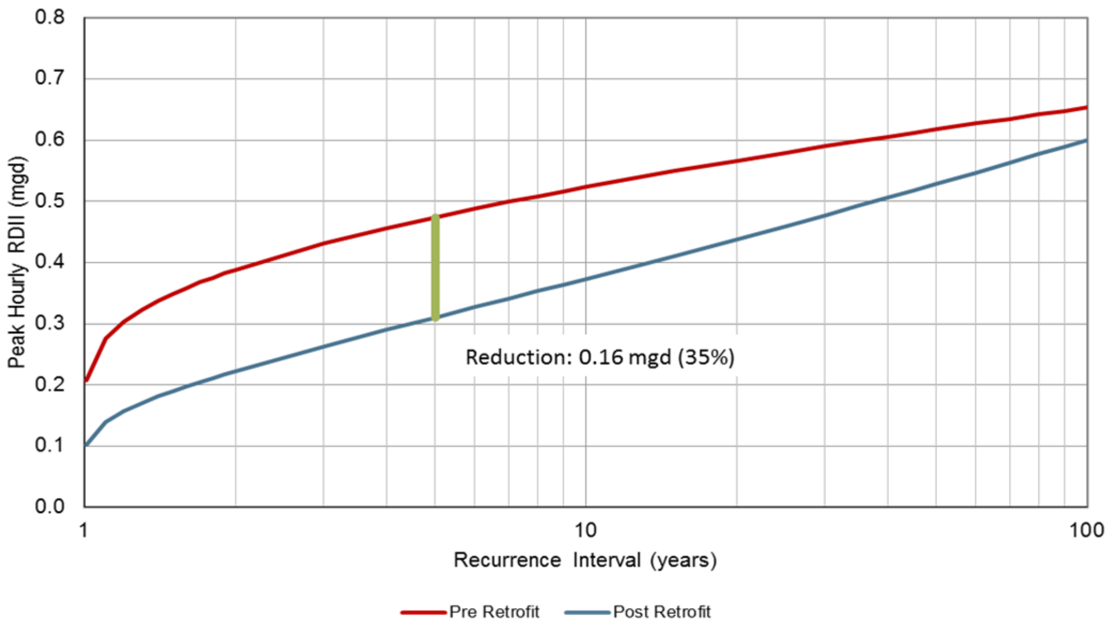


Figure 4-20. Phase 4 Monitoring Basin 12 LPIII analysis

4.1.3.7 Summary and Conclusions

Table 4-7 summarizes the RDII removal for the Phase 4 monitoring basins.

Table 4-7. Post Phase 4 5-Year Peak Hourly RDII				
Monitoring basin	Post-Phase 3 5-year peak-hour RDII, mgd	Post Phase 4 5-year peak-hour RDII, mgd	RDII removed, mgd	Percent reduction
1A (SFE)	1.15	0.37	0.78	68
5 (Gleaners)	1.65	0.49	1.16	70
9.1 (Admin)	0.70	0.86	-0.16	-23
9.2 (Auto Shop)	0.69	0.59	0.10	15
12 (Church)	0.47	0.31	0.16	35
Total	4.66	2.61	2.05	44

The total RDII removed during Phase 4 is at least 2.05 mgd in these five basins, representing a 44 percent reduction in available RDII. Considering the modeling complications associated with the post-Phase 3 model of Monitoring Basin 9.1 and recognizing additional rehabilitation work in spot areas outside of the basins, the actual Phase 4 RDII removal is likely higher than 2.05 mgd.

4.1.4 Future Conditions

The following subsections describe the methods used to model future sanitary system hydrologic conditions for Sweet Home.

4.1.4.1 Future Service Areas and Population

Sweet Home is divided into 27 sanitary basins that do not necessarily share the same borders as the flow monitoring basins. Currently, 19 of the sanitary basins have residents living within their boundaries. The remaining eight basins are not yet developed.

Figure 4-21 shows the existing and future sewer service areas.

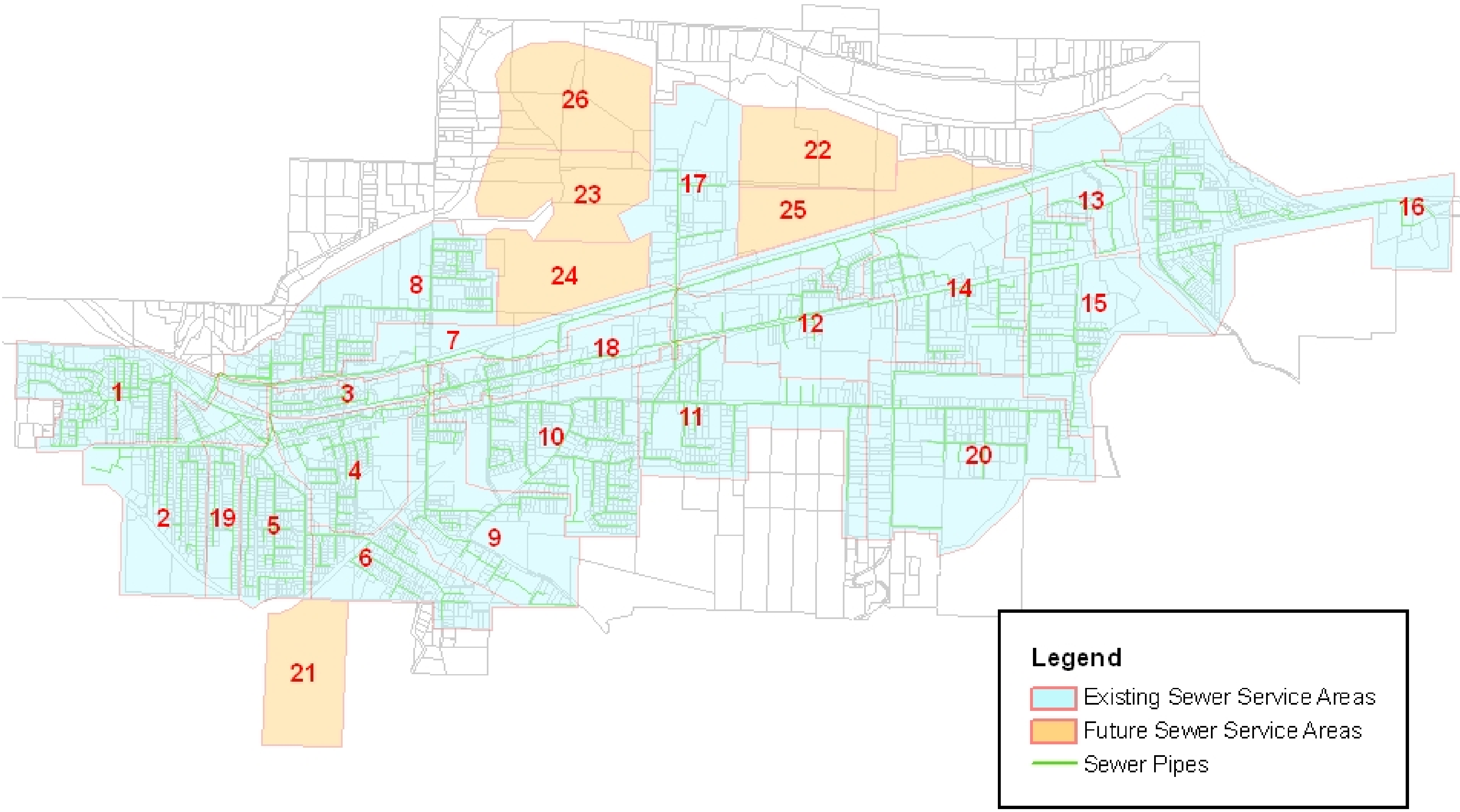


Figure 4-21. Existing and future service areas

Service area and population expansion data for the year 2025 as developed in the Sweet Home Wastewater Facility Plan were used to project wastewater and RDII loads in Sweet Home. The data provided are listed in Table 4-8.

Table 4-8. Future Service Areas and Populations

Sanitary basin	Existing service areas		Additional future (2025) service areas	
	Area, acres	Population	Area, acres	Population
1	118	687	0	0
2	108	690	33	162
3	36	258	0	0
4	103	637	0	0
5	78	605	0	0
6	77	505	13	81
7	94	475	0	0
8	159	778	0	0
9	124	444	33	54
10	166	858	0	54
11	100	673	75	81
12	82	259	49	216
13	115	177	42	81
14	104	390	49	189
15	111	400	56	162
16	230	430	16	135
17	0	0	74	81
18	65	227	12	81
19	40	272	0	0
20	170	356	65	405
21	0	0	85	637
22	0	0	94	448
23	0	0	105	1,215
24	0	0	97	0
25	0	0	108	810
26	0	0	122	270
27	0	0	100	1,350
Total	2,080	9,121	1,228	6,512

4.1.4.2 Future DWF

By 2025, an additional 6,512 people are predicted to live in Sweet Home. Current demand patterns can provide an estimate of what the demand patterns of the future may be. To estimate the wastewater demand of the future population, the current DWF of 1.22 mgd (see Section 4.1.2.1) was divided by the current population to give a per capita wastewater demand. This per capita demand was multiplied by projected future additional populations to estimate the future additional wastewater demand of each sanitary basin.

To estimate the DWF pattern of the future areas, a representative DWF pattern was created by averaging the DWF patterns of all 15 monitoring basins created during hydrologic modeling. This average DWF pattern, as shown in Figure 4-22 is the best guess of what the DWF pattern of any future population in Sweet Home may look like.

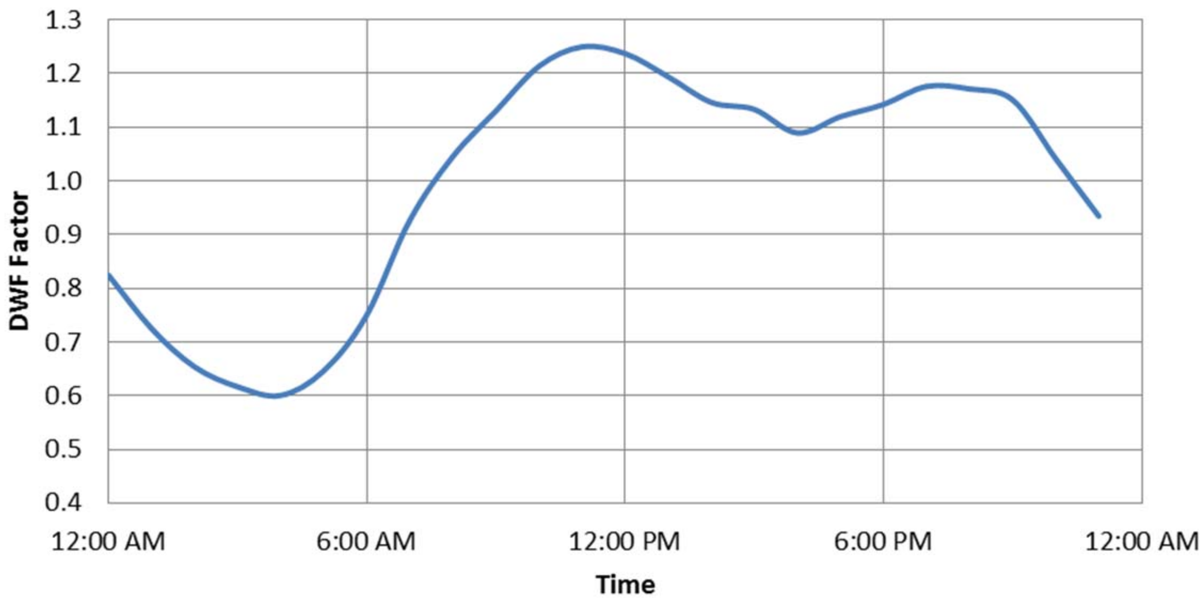


Figure 4-22. Sweet Home average DWF pattern

4.1.4.3 Future WWF

WWF projections were also performed on a sanitary basin basis. Projections for wet weather flow are based on basin size instead of basin population. For each sanitary basin, a peak RDII was calculated using an assumption of 1,500 gpad (Earth Tech Team, 2005), which is lower than the 2,000 gpad maximum allowable groundwater infiltration rate dictated by OAR 340 Division 52. To load these peak flows into the model, a similar approach to that which was taken in DWF projections was applied to WWFs. A characteristic RDII curve was created by taking the area weighted average (monitoring basin area) of the January 1976 event from the 15 calibrated model RDII time series. This average time series was scaled such that the peak-hour RDII would be equal to 1 mgd. When loaded into the hydraulic model, a factor could be applied to scale this characteristic RDII curve which in turn will produce the desired peak-hour RDII for a given sanitary basin. For example, Sanitary Basin 2 will have 33 additional acres of area in the future. Using the 1,500 gpad assumption, the projected future peak-hour RDII for this basin is 0.0495 mgd. Using a factor of 0.0495 on the characteristic RDII curve will produce a peak of 0.0495 mgd in the hydraulic model from this sanitary basin. .

The characteristic RDII time series is shown in Figure 4-23. Note that the peak RDII is 1 mgd.

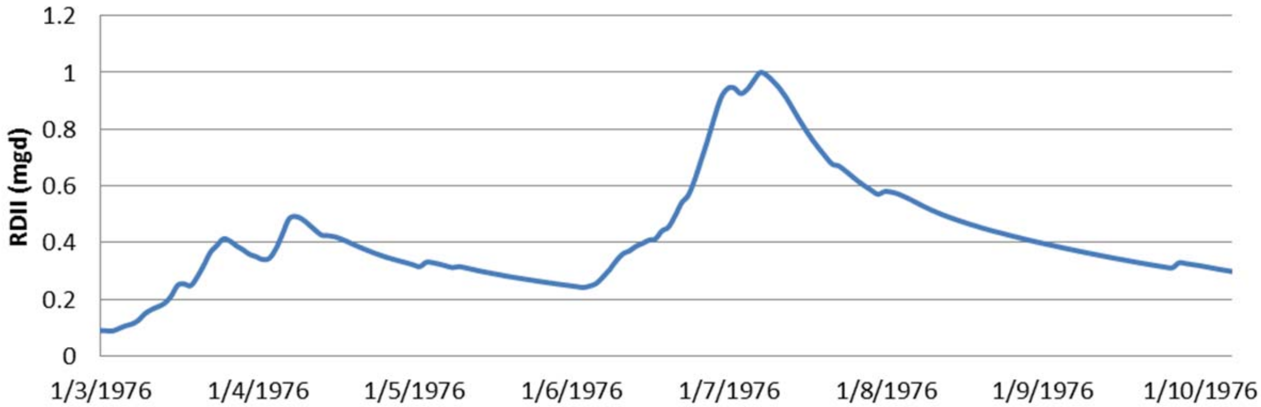


Figure 4-23. Characteristic RDII time series

4.1.4.4 Summary of Future Flow Inputs

Table 4-9 summarizes the future flow projections. These flows will be loaded into the hydraulic model based on their respective sanitary basins' outlet. For future sanitary basins not currently serviced by a sewer line, the closest existing node was chosen as the loading point.

Table 4-9. Future Service Areas and Populations

Sanitary basin	Additional DWF, mgd	Additional RDII, mgd	Hydraulic model loading node
1	0.000	0.000	1-4
2	0.022	0.050	2-4
3	0.000	0.000	3-3
4	0.000	0.000	4-1
5	0.000	0.000	5-3
6	0.011	0.020	6-1
7	0.000	0.000	7-1
8	0.000	0.000	8-3
9	0.007	0.050	9-7
10	0.007	0.000	10-1
11	0.011	0.113	11-2
12	0.0297	0.074	12-1
13	0.011	0.063	13-2
14	0.025	0.074	13-2
15	0.022	0.084	13-2
16	0.018	0.024	13-2
17	0.011	0.111	7-29
18	0.011	0.018	18-1

Table 4-9. Future Service Areas and Populations			
Sanitary basin	Additional DWF, mgd	Additional RDII, mgd	Hydraulic model loading node
19	0.000	0.000	19-1
20	0.054	0.098	20-2
21	0.085	0.128	5-14
22	0.060	0.141	13-2
23	0.162	0.158	7-23
24	0.000	0.146	7-23
25	0.108	0.162	13-2
26	0.036	0.183	7-23
27	0.18	0.150	13-2
Total	0.870	1.842	n/a

By the year 2025, an additional 0.87 mgd of DWF is projected year-round. An additional 1.84 mgd of peak-hour RDII is projected during the 5-year storm.

4.1.4.5 Hydraulic Modeling Results Summary

Table 4-10 provides a historical look at the 5-year peak-hour existing and future flow rates to the WWTP through the four phases of rehabilitation.

Table 4-10. Hydraulic Modeling Results			
Model phase	Existing 5-year peak-hour flow, mgd	Peaking factor	Future 5-year peak-hour flow, mgd
Pre-Phases 1 and 2	22.0	22	25.1[a]
Post-Phases 1 and 2	15.3	15	17.9[b]
Post-Phase 3	13.6	14	15.4[b]
Post-Phase 4	11.5	12	13.3[b]

[a]*Based on future population (2027) of 10,525 with no expansion of the City's wastewater service area.*

[b]*Based on future population (2025) of 15,633 with expansion of the City's wastewater service area.*

Figure 4-24 shows these predicted peak-hour flows after each modeling effort in graphical format.

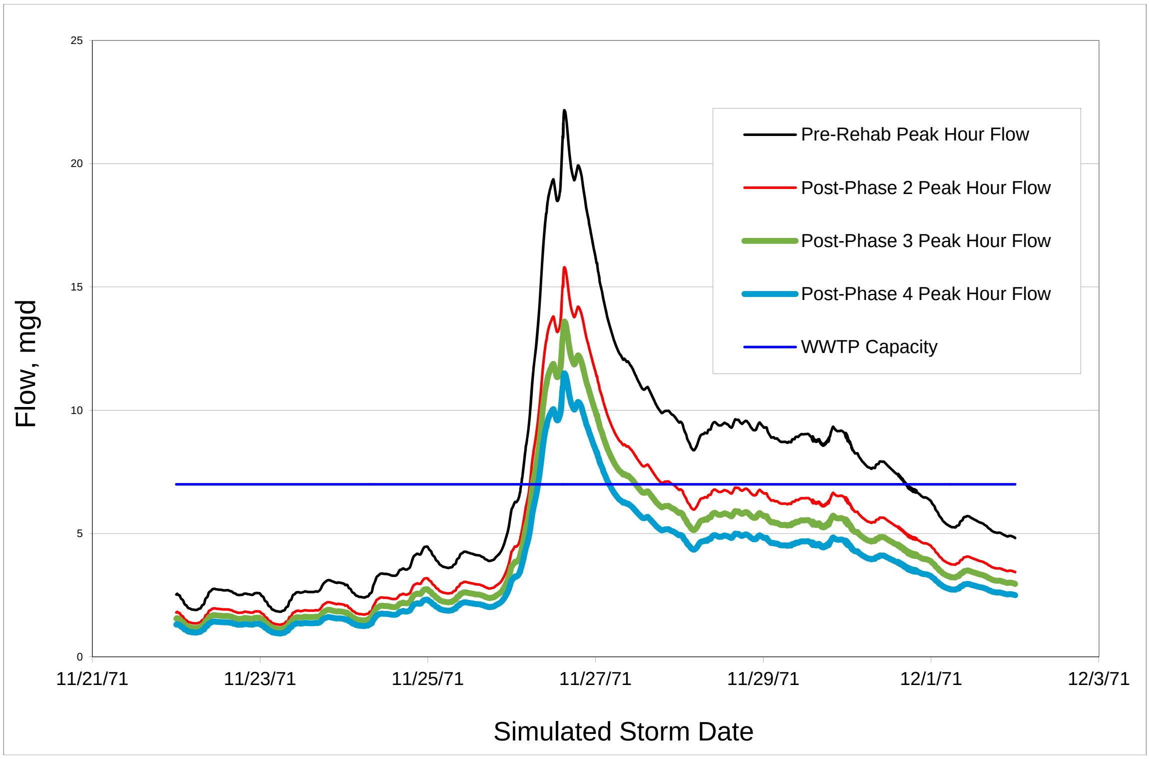


Figure 4-24. Predicted 1-in-5 peak-hour flow

Section 5

Capacity Evaluation

A hydraulic model was developed to determine the collection system's response to peak flows under the 5-year wet-weather event. The hydraulic model platform chosen was MIKE URBAN, a product of DHI, Inc. When the hydraulic model was originally developed, only the major trunk lines were included below the upper most monitoring basin outlets (meter locations). The purpose of the hydraulic model is to assess areas of capacity limitations within the collection system as well as prediction of the peak flow to the Sweet Home WWTP. This section describes hydraulic model modifications, flow loading, and results.

5.1.1 Model Modifications

As-built surveys created during Phase 4 rehabilitation guided the updating of the hydraulic model. In some locations, invert elevations, rim elevations, and pipe diameters needed to be updated. Hydraulic retrofits constructed during the Phase 4 rehabilitation needed to be reflected in the hydraulic model to reflect changes to the flow paths in the collection system accurately.

Three of the Phase 4 flow meters (meters 1A, 4, and 6) in the southwest portion of the city were placed farther down the collection system than their Phase 3 counterparts. This provides a more coarse view of the flows coming from these basins. Because the hydrologic models were built to reflect the flows at points farther downstream (where the existing conditions flows are loaded), the pipes upstream of these meters are not to be analyzed for surcharging because they do not see any flow in the existing condition model. Although the pipes remained in the model, their results are not presented here because they do not provide any useful information. Figure 5-1 shows the extents of the hydraulic model with reportable results.

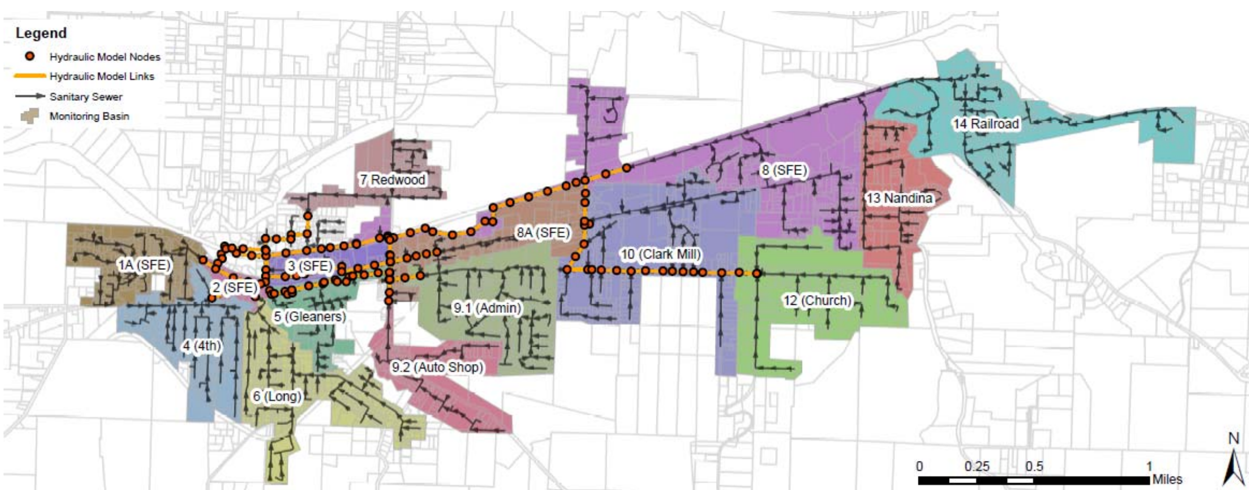


Figure 5-1. Hydraulic modeling network

Phase 4 flow meters 13 and 14 were placed in the far northeast corner of the city. These two meters break up Phase 3 Monitoring Basin 21 into smaller portions, giving a closer look at the contributions of flow from this part of the collection system. An attempt was made to extend the hydraulic model trunk line to this part of the city along the railroad tracks. The geographic information system data available to build this extension of the model were in error and prevented the extension from being built. Because of this, flows from Monitoring Basins 13 and 14 were loaded at the most northeastern node of the hydraulic model.

The meter for Phase 4 monitoring Basin 7 was located four manholes upstream of its Phase 3 counterpart. To account for the increased travel distance, the hydraulic model was updated to include these four additional links and nodes.

5.1.2 5 Year Recurrence Event Selection

An additional purpose of long term simulations is to isolate a 5-year storm to be routed through the hydraulic model. To identify this storm, the total flow timeseries of all 15 basin models were summed together, the annual maxima series of this summed data was extracted, and that series was fit to an LPIII distribution. The sum of the individual total flow timeseries is a quick way to simulate the total flow to the WWTP without having to route all 15 timeseries through the hydraulic model. The limitation of this method is that it does not take into account routing delays associated with flow conveyance from different points in the collection system. However, at an hourly timestep, these conveyance delays have a minimal effect on the analysis.

The LPIII curve provides an approximate 5-year peak-hourly total flow rate to the WWTP which can be used to select a storm in the long term simulation record that comes close to matching that peak value. The January 1976 storm used in previous (i.e. Phase 3) analyses for this project still ranks at nearly a 5-year peak-hourly flow recurrence. Therefore, this storm was chosen again for routing through the hydraulic model. Because the sum of the 15 individual total flow timeseries does not account for unmetered areas near the WWTP, the estimated 5-Year peak hourly total flow is considered an underestimate of the actual 5-year peak hourly total flow and is therefore not reported in this section. This underestimation is not a concern in selecting a 5-year storm since accounting for unmonitored area would not alter the ranking of storms against each other, which in turn would not affect the determination of a 5-year storm. This analysis is primarily intended to isolate a storm with a shape characteristic of a 5-year storm as the storm hydrograph will be scaled on a monitoring basin by basin basis. A discussion of this scaling can be found in Section 5.1.3.2.

5.1.3 Flow Loading

The following subsections describe the loading of flows into the hydraulic model.

5.1.3.1 Dry Weather Flow (DWF)

In all cases, loading DWF is done by giving the hydraulic model an average DWF magnitude and an associated diurnal pattern by which to scale the average values over time. For the 15 existing conditions monitoring basin models, 15 different DWF patterns were entered in the model and were associated with their respective average flow magnitudes (See Section 4.1.4.2) to provide 1.16 million gallons per day (mgd) to the WWTP. For consistency, these existing conditions DWFs were loaded into the hydraulic model at the same nodes that the flow meters used to calibrate the DWFs was placed within. For monitoring basins 2, 3, and 7, scaling factors were applied to the average DWF value to account for unmonitored downstream areas.

Future DWFs were loaded in much the same way except only one diurnal pattern was used for all additional DWF loads. Future DWFs were loaded with respect to sanitary basin loading points. These locations can be found in Section 4.

5.1.3.2 Wet Weather Flow (WWF)

Depending on the characteristics of the rainfall for a given storm, different subbasins basins will react in different ways due to factors such as soil condition, pipe condition, land surface conditions, etc. To illustrate this, consider two identically sized and sloped subbasins where subbasin A is entirely impervious and subbasin B has no impervious area. Subbasin A will be most sensitive to rainfall intensities as impervious surfaces wash off rainfall nearly immediately and have little initial abstractions to fill. Subbasin B will be more sensitive to total rainfall volume and duration as initial abstractions will need to be filled and the effects of subsurface interflow and groundwater buildup can add additional peak discharge later in high volume storms. The sum of the discharges from the subbasins will rank at some recurrence interval for each storm. However, since the two subbasins have dissimilar hydrologies, the recurrence interval for the sum of the two discharges will not be necessarily indicative of the recurrence interval of the flows from the individual subbasins. This is the same situation as can be found in Sweet Home. A rainfall event that produces a 5-year peak flow to the WWTP does not guarantee that all upstream subbasins are discharging at their individual 5-year peak flows due to dissimilar hydrologic conditions throughout the city.

To accurately represent the hydraulic performance of the collection system to 5-year peak flows, the modeled RDII timeseries loaded into the hydraulic model for the January 1976 storm were scaled to statistical 5-year peak hourly values for each of the monitoring basins. This scaling exercise prevents some pipes from having to pass 25-year flows while others only need to pass 2-year flows (and in turn, this prevents the mislabeling of undersized pipes). This method allows each basin to flow at a 5-year recurrence and therefore provide representative information about capacity restrictions in the collection system during statistical 5-year frequency conditions. Table 5-1 provides the scaling factors used on the existing conditions RDII as well as calculated composite factors which take into account adjustments necessary for unmonitored pipe lengths.

Table 5-1. Existing Conditions RDII Factors

Monitoring Basin	January 1976 peak-hour RDII, mgd	5-year peak-hourly RDII, mgd	RDII factor	Unmonitored pipe length factor	Composite factor	Calculated peak-hour RDII, mgd
1A (SFE)	0.367	0.368	1.004	n/a	1.004	0.370
2 (SFE)	0.061	0.054	0.883	1.144	1.010	0.054
3 (SFE)	0.737	0.658	0.893	1.088	0.971	0.639
4 (4th)	0.465	0.522	1.123	n/a	1.123	0.586
5 (Gleaners)	0.556	0.490	0.882	n/a	0.882	0.432
6 (Long)	1.303	1.319	1.012	n/a	1.012	1.336
7 (Redwood)	0.405	0.348	0.860	1.610	1.385	0.482
8A (SFE)	0.590	0.579	0.982	n/a	0.982	0.569
8 (SFE)	1.732	2.073	1.196	n/a	1.196	2.480
9.1 (Admin)	0.959	0.856	0.893	n/a	0.893	0.764
9.2 (Auto Shop)	0.661	0.585	0.886	n/a	0.886	0.519
10 (Clark Mill)	0.926	0.839	0.907	n/a	0.907	0.761
12 (Church)	0.318	0.310	0.975	n/a	0.975	0.302
13 (Nandina)	0.492	0.486	0.989	n/a	0.989	0.481
14 (Railroad)	1.110	1.094	0.985	n/a	0.985	1.078

Future conditions wet weather flows were loaded into the model with respect to sanitary basin outlets and were routed through the hydraulic network along with the existing conditions dry and wet weather flows. For a discussion of future condition hydrology, see Section 5.1.4.2.

5.1.4 Hydraulic Model Results

The hydraulic modeling effort reveals a number of locations where the collection system either surcharges or overflows. The following sections present the results of four modeling scenarios to assess flooding nodes and hydraulic capacity limitations in both existing and future conditions. Figure 5-2 below shows the results of the hydraulic model results as it relates to manholes; red manholes indicate locations of projected overflows, yellow manholes indicate locations of surcharging from 0 to 3 feet below grade, and green manholes indicate either no surcharging or surcharging less than 3 feet below grade.

5.1.4.1 Existing Conditions

The locations of pipe with the highest surcharge potential result from Sanitary Basins 9 and 10. Due to flow data complications in Phase 3, the projected 5-year peak-hour flow rate from Sanitary Basin 10 (Monitoring Basin 9.1) is higher in the Phase 4 analysis than calculated in Phase 3. This results in the only flooding manhole predicted in the existing condition model. A few manholes at the west ends of Sanitary Basins 7 and 8 show high surcharge as well.

Figure 5-2. Hydraulic modeling results, projected surcharge, and overflow locations under existing conditions

To determine which pipes are hydraulically restricted, the hydraulic model was rerun with sealed manholes that prevent the manholes from overflowing. This change projects where the 5-year event peak flow results in a hydraulic grade line higher than the rim of manholes and ultimately demonstrates which pipe segments are undersized. The pipes in red indicate capacity limitations that cause surcharging above 3 feet of freeboard in the upstream manhole, as shown in Figure 5-3. However, the undersized pipes are based on the criterion that surcharging with less than 3 feet of freeboard is unacceptable during the 1-in-5 peak-hour flow; applying a less conservative criterion would result in fewer undersized segments.

Figure 5-3. Hydraulic modeling results and undersized pipes under existing conditions

5.1.4.2 Future Conditions

Future population and service area expansion adds additional DWF as well as projected RDII. This adds flow to a system that already is hydraulically restricted in some areas. Flooding risks appear to be elevated in a future flow scenario as three manholes near the WWTP along the railroad tracks are predicted to overflow as shown in Figure 5-4.

Figure 5-4. Hydraulic modeling results, projected surcharge, and overflow locations under future conditions

The hydraulic model was rerun with sealed manholes under future growth conditions to show where pipes are undersized. These results are shown in Figure 5-5. Only two additional links are determined to be capacity-limited between the existing and future conditions. Again, the undersized pipes are based on the criterion that surcharging with less than 3-feet of freeboard is unacceptable during the 1-in-5 peak-hour flow; applying a less conservative criterion would result in fewer undersized segments.

Figure 5-5. Hydraulic modeling results and undersized pipes under future conditions

Section 6

Condition Assessment

In 2005, the City conducted a closed-circuit television (CCTV) inspection and condition assessment on the entire publicly-owned collection system. The assessment was intended to supplement the flow metering and modeling data to increase the effectiveness of the Phases 3 and 4 Infiltration/Inflow (I/I) Abatement Projects. Approximately 221,000 linear feet (LF) or 88 percent of the sewer system was inspected, as shown in Figure 6-1. The project provided the City with baseline digital inspections, updated inspection software capable of digital inspections and consistent with nationally accepted condition assessment protocols, and condition assessment certification for the City's inspectors. The City adopted the standards developed by the National Association of Sewer Service Companies (NASSCO) for the sewer defect identification and defect rating system. The ratings are according to the NASSCO Pipeline Assessment Certification Program grading system.

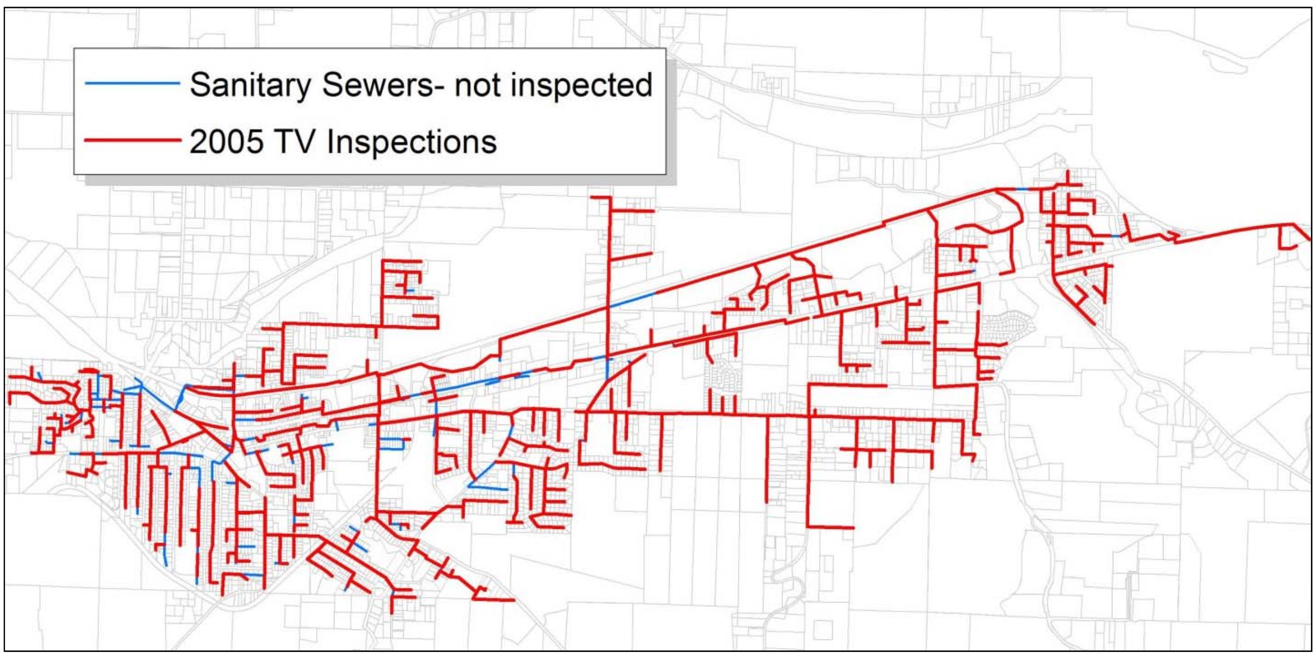


Figure 6-1. Extent of 2005 CCTV inspections

The 2005 results revealed the majority of the public sewer mains to be in fair to good condition with no apparent high risk structural (e.g., broken pipe) or operational (e.g., debris, roots) defects. Approximately 9 percent of pipe had structural defects requiring immediate attention (i.e. holes) and approximately 16 percent of pipe had defects that were recommended for monitoring that should be addressed in the next 5 to 10 years. A summary of the results is listed in Table 6-1.

Table 6-1. Summary of 2005 CCTV Inspections						
Condition grade	Structural		Operational		Structural and operational	
	LF	Percent of total inspections	LF	Percent of total inspections	LF	Percent of total inspections
5 (Failed)	14,714	6.7	7,883	3.6	20,411	9.3
4 (Poor)	27,729	12.6	13,738	6.2	35,733	16.2
3 (Fair)	51,170	23.2	16,443	7.5	47,653	21.6
2 (Good)	127,043	57.6	182,592	82.7	116,859	53.0
1 (Excellent)	0	0[a]	0	0[a]	0	0[a]

[a]*A structural or operational grade of 1 was reserved for new sewers only.*

6.1.1 Current Conditions

Since the 2005 inspections, approximately 69,000 LF of sewers have been rehabilitated as part of the Phases 3 and 4 I/I Abatement Projects. The main rehabilitation technologies included some cured-in-place pipe (CIPP and open-cut construction with a majority of pipe being rehabilitated using pipe bursting. Sewers that were addressed during Phases 3 and 4 had a decrease in the sewer structural/operational rating.

The condition improvement was based on the technology used for rehabilitation as listed in Table 6-2.

Table 6-2. Condition Grade Based on Rehabilitation Technology	
Rehabilitation technology	Condition grade
CIPP	2
Pipe bursting	1
Open-cut replacement	1

The 2005 inspections were conducted during the seasonally dry summer months when operational defects such as infiltration may not be visible. This should be considered when evaluating the operational condition of the sewers.

Figure 6-2 displays a map of the current structural ratings for the City's sewer system. Figure 6-3 displays a map of the current operational ratings for the City's sewer system.

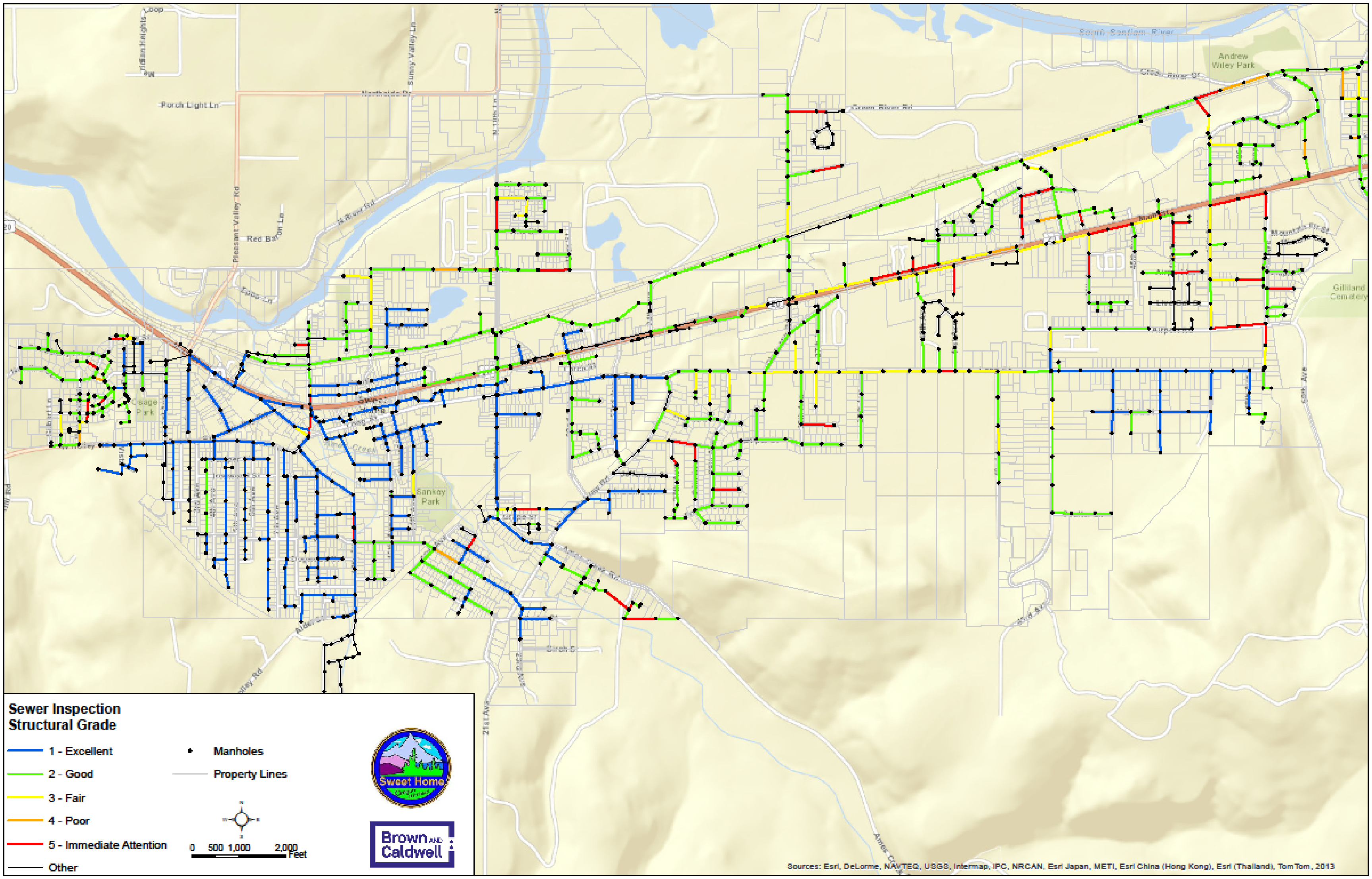


Figure 6-2. Post-Phase 4 Sewer Structural Condition Ratings

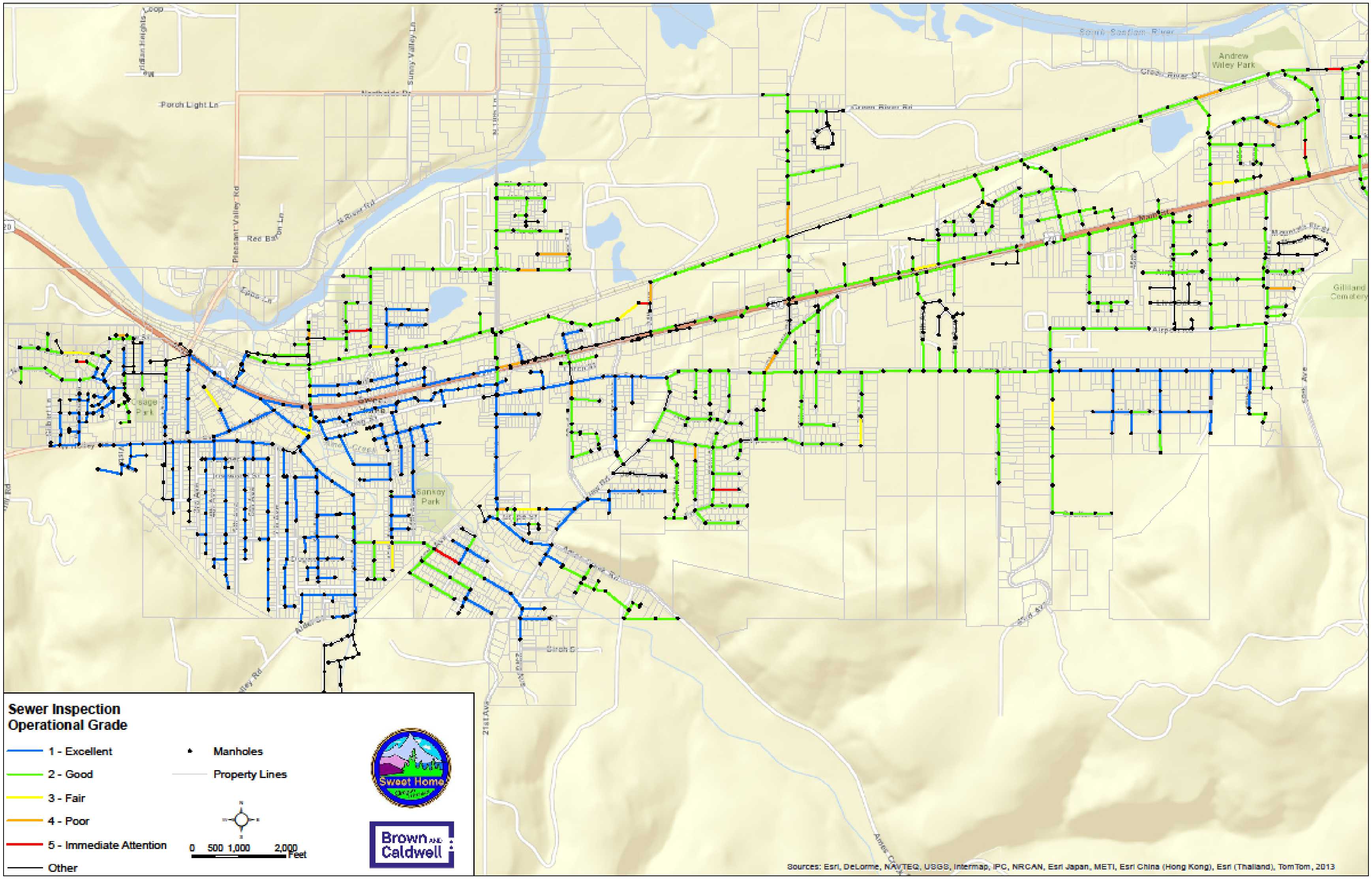


Figure 6-3. Post-Phase 4 Sewer Operational Condition Ratings

A summary of the condition grades following Phases 3 and 4 is listed in Table 6-3.

Table 6-3. Summary of Post-Phase 4 Condition Grades

Condition grade	Structural		Operational	
	LF	Percent of total inspections	LF	Percent of total inspections
5 (Failed)	16,968	7.4	2,086	0.9
4 (Poor)	3,930	1.7	4,607	2.0
3 (Fair)	26,436	11.5	5,542	2.4
2 (Good)	109,184	47.3	137,059	59.3
1 (Excellent)	74,187	32.1[a]	81,806	35.4[1]

[a]*A structural or operational grade of 1 was reserved for brand new sewers only.*

The amount of Grade 5 pipe has increased since the 2005 CCTV inspections. This is due to a conservative estimate that approximately 15 percent of pipes rated as Grade 4 back in 2005 and not addressed as part the Phases 3 or 4 projects have worsened to Grade 5 in the past 8 years. In many cases, the structural rating is attributed to a point defect rather than the entire pipe segment.

The Grades 3, 4, and 5 pipes shown in Figures 6-1 and 6-2 are based on the 2005 inspections, since any pipe rehabilitated as part of Phases 3 and 4 would have a grade of 1 or 2 structurally or operationally. However, since the City currently inspects its collection system on a regular cycle, City staff should update the summary of the overall structural and operational ratings of individual pipes as annual inspections are completed to ensure the most recent information is on file. The City should consider cataloging and addressing any grade 5 point defects prior to the full segment failing as a result.

Section 7

Capacity, Management, Operation and Maintenance (CMOM)

In 2001, the U.S. Environmental Protection Agency (USEPA) proposed legislation to reduce the number and volume of sanitary sewer overflows (SSOs) significantly throughout the U.S. The USEPA determined that such actions were required to improve water quality. The proposed requirements would affect nearly all aspects of sanitary sewer management and operation. As proposed, each permit holder would be required to develop a CMOM program. The USEPA's promulgation of the CMOM requirements has stalled; however, elements of the proposed requirements have made their way into National Pollutant Discharge Elimination System (NPDES) permits and compliance is considered when evaluating permit violations and fees associated with SSOs. Increasingly, cities in Oregon are implementing CMOM elements in anticipation of it becoming a regulatory minimum. An overview of the elements of a CMOM program are discussed below.

7.1 CMOM Program

CMOM activities are primarily a best management practice approach to controlling SSOs. CMOM programs generally are comprised of the eight primary elements described in Table 7-1. When implemented, each permit holder's CMOM program improves the performance of the collection system, resulting in much reduced number and volume of SSOs, fewer customer complaints, improved efficiency of operation and maintenance (O&M) activities, and increased longevity of the collection system's infrastructure.

Table 7-1. CMOM Program Elements

Element	Purpose	Description
Goals	To provide direction on all aspects of managing the collection system.	Goals should be specific, realistic, achievable, and measureable. • Determine linear footage of sewers to be inspected annually. • Determine number of manholes to be upgraded annually. • Upgrade maintenance management system. • Develop fats, oils, and grease (FOG) program. • Set limits on number of SSOs per year.
Organization	To structure the organization for efficient operation and management of the collection system.	• Write organization and governing body description. • Prepare organization chart. • Write job descriptions. • Define lines of communication.
Legal authority	To establish the legal authority allowing the permit holder to direct all critical aspects of sanitary sewer management.	The permit holder has the legal authority to do the following: • Control rates. • Regulate the volume and strength of discharges. • Manage FOG. • Maintain and replace service laterals.

Table 7-1. CMOM Program Elements		
Element	**Purpose**	**Description**
O&M activities	To operate and maintain the sanitary sewer collection system in a way that achieves optimum sewer performance.	• Identify the O&M activities required to maintain, sewers, manholes, pump stations, force mains, and service laterals. • Establish frequencies for performing the required activities that optimize sewer performance.
Design and performance provisions	To establish minimum requirements for collection system design, construction, inspection, and final acceptance.	• Determine minimum requirements for design. • Determine minimum requirements for construction materials. • Clearly define inspection requirements and train inspectors.
Overflow Emergency Response Plan	To establish response capabilities for responding to sewer emergencies.	• Clearly define emergency procedures. • Provide equipment and personnel training. • Install operating alarm system. • Create public notification plan.
Capacity assurance	To identify where hydraulic deficiencies may occur in the sanitary sewer collection system.	• Map collection system completely and accurately. • Model the collection system including sewers and pump stations. • Identify potential hydraulic deficiencies and create a plan for addressing the deficiencies. • Identify potential operational problem areas and create a schedule for cleaning affected sewers. • Create action plan for addressing areas with excessive I/I.
Annual self auditing	To evaluate where improvements are required in managing the sanitary collection system through annual auditing.	• Compare collection system performance with goals established to identify where improvements may be required. • Conduct annual self-evaluation and practice continuous improvement.

7.2 Current CMOM Practices and Improvements

The City of Sweet Home (City) has implemented several of the elements listed in Table 8-1 as part of the last 12 years of I/I abatement and as required by its past and present NPDES permits. Of the eight elements, those listed in Table 7-2 have been implemented/or currently practiced.

Table 7-2. CMOM Implemented Elements	
Element	**Current practice**
Goals	Determined linear footage of sewers to be inspected annually
Legal authority	Past NPDES permit required City to establish legal authority to control inflow
O&M activities	• City has a self-run inspection program • City has a cleaning program/cycle
Design and performance provisions	City has adopted Oregon Department of Transportation standard provisions for construction
Capacity assurance	• City has mapped and modeled the sewer system in its geographic information system • City has rehabilitated priority mains and laterals in priority basins to address excessive I/I and is undertaking a WWTP facility plan update to determine how to handle I/I that is not cost-effective to remove • City has identified locations with hydraulic deficiencies as outlined in this report • City knows of areas with frequent cleaning needs and has implemented a cleaning program to maintain capacity of problem areas • City has implemented plan to address areas of system with high levels of I/I as outlined in this report.

The current practices listed in Table 7-2 are good steps toward achieving the goals of a CMOM program, but additional efforts should be taken to ensure that all efforts and results (i.e., sewer inspections footage and updated condition, documentation of sewer cleaning, etc.) are properly measured and documented. Much of the O&M activities are run in-house. Without proper documentation, the City runs the risk of the USEPA not recognizing its efforts.

7.3 CMOM Program Recommendation

Table 8-1 identifies the eight proposed components of a well-structured CMOM program. The City has taken progressive steps toward achieving the CMOM program goals by implementing five of the program elements. Brown and Caldwell (BC) recommends that the City expand on the five elements currently in practice by addressing all the requirements listed in the description column of Table 7-1. In addition, BC recommends that the City review its current collection system O&M and management practices and compare them with CMOM program requirements. Missing or partially completed elements listed in Table 7-1 should be addressed. Doing so would reflect an aggressive and proactive approach by the City to achieve the goals of a CMOM program. Documentation of the City's efforts could result in greater leniency from the Oregon Department of Environmental Quality in cases of non-compliance (e.g., overflows during events less than the 1-in-5 year storm).

Section 8

Conclusions and Recommendations

The City has invested over $15 million in planning and construction during the first four phases of rehabilitation and replacement (R&R) work in the collection system. The construction costs for each phase are listed in Table 8-1.

Table 8-1. Summary of R&R Costs by Phase	
Construction phase	Capital cost, million dollars
1	1.3
2	1.7
3	3.1
4	6.0

The City's I/I Abatement Program has addressed approximately 92,000 linear feet or 35 percent of the main line sewers. Over 30 percent of the laterals in Sweet Home have been rehabilitated using a variety of techniques. The extent of service lateral rehabilitation has been completed to varying degrees. Due to access constraints, funding requirements, and budget limitations, not all service laterals have been fully rehabilitated to the private building. This variable level of rehabilitation should be considered when evaluating the rehabilitation effectiveness numbers and when planning future R&R work within the City's collection system.

8.1 Future R&R

Future R&R work in the collection system should continue for the City, either to maintain the level of RDII entering the system or to further target RDII reductions while making structural improvements to the unaddressed sewers that are aging and deteriorating. However, the highest priority basins identified throughout the course of the I/I Abatement Program have been largely addressed and there is a diminishing rate of return on the dollars invested in the collection system. Table 8-2 lists the estimated rehabilitation costs for future R&R work, with the expected reduction in peak RDII.

Table 8-2. Future R&R Work Cost Effectiveness					
Sanitary Basin(s)[a]	Type of R&R	Cost of remaining R&R work, dollars	Peak RDII removed[b], mgd	Cost-effectiveness, dollars per mgd RDII removed	Rank
1	Full rehabilitation, complete uppers	1,620,000	0.18	9,000,000	12
2, 19	Complete uppers	310,000	0.17	1,800,000	1
3	R&R work complete	0	0	0	NA
4	Complete uppers	820,000	0.14	5,700,000	7
5, 6, 21	Complete uppers	970,000	0.39	2,500,000	2

Table 8-2. Future R&R Work Cost Effectiveness					
Sanitary Basin(s)[a]	Type of R&R	Cost of remaining R&R work, dollars	Peak RDII removed[b], mgd	Cost-effectiveness, dollars per mgd RDII removed	Rank
7,13,14,17	Full rehabilitation	7,350,000	1.55	4,700,000	6
8	Full rehabilitation, complete uppers	2,720,000	0.28	9,900,000	13
9	Full rehabilitation, complete uppers	910,000	0.29	3,100,000	4
10	Full rehabilitation, complete uppers	2,990,000	0.42	7,100,000	11
11,12	Full rehabilitation	3,770,000	0.53	7,100,000	10
15	Full rehabilitation	2,130,000	0.31	6,800,000	8
16	Full rehabilitation	2,520,000	0.58	4,400,000	5
18	Full rehabilitation	1,130,000	0.37	3,100,000	3
20	Complete uppers	630,000	0.09	7,000,000	9
	Total	27,900,000	5.30		

[a]*Basins grouped together due to flow monitoring locations and model calibration* methodology.

[b]*Assumes 65 percent reduction in RDII for full rehabilitation, 30 percent reduction for completing uppers.*

An estimated $28 million in construction costs would be required to remove an additional 5.3 mgd. Since $12 million was spent on the first four phases with over 10 mgd removed, the diminishing cost-effectiveness is apparent. However, future R&R work should focus on completing the upper laterals, particularly on Phase 4 sewers, with full rehabilitation efforts directed in Sanitary Basins 18, 9, and 16.

8.2 Findings and Conclusions

The following summarizes the conclusions BC has made based on the modeling results and hydraulic capacity evaluation.

- Post-rehabilitation and reconstruction flow monitoring and hydrologic modeling demonstrate that basin-wide work can remove approximately 65 percent of the projected 1-in-5 year event peak-hour RDII flow in that basin.
- Focusing efforts on rehabilitating sewer mains, manholes, and laterals to the private building has been found to be the most effective at removing peak-hour RDII. Focusing only on specific components such as mains or laterals offers some reduction but at a much lower cost-effectiveness.
- To date, over 50 percent of the peak-hour RDII has been removed from the system over four phases of R&R work.
- Approximately an additional 4.5 mgd of RDII will need to be removed or accommodated at the WWTP to pass the 1-in-5 peak-hour flow under existing conditions, and approximately 6.3 mgd will need to be removed to handle future conditions. These are conservative estimates based on the modeling work.

- Under existing conditions, a single manhole at Long and 18th streets is predicted to overflow in the 1-in-5 year event. The manhole and associated pipe segments were rehabilitated in Phase 4 but this manhole was not identified as a potential overflow location. It is possible that the slight reduction in inside diameter from the Phase 4 reconstruction work and refined flow data and model calibration since the 2009 modeling effort are contributing to the predicted overflows.
- The benefits of R&R work in select basins have not been realized fully due to partial lateral rehabilitation caused by funding agency constraints related to work on private property without a permanent easement and/or owner unwillingness to allow for the work to be completed. Completing the rehabilitation work on the uppers in these partially completed basins (see Table 8-2) is the most cost-effective way to remove additional RDII.
- Full replacement of sanitary basins 18 and 9 have the most cost-effective R&R remaining in the City, with an approximate cost of $2.04 million (2010 R&R costs) to remove approximately 0.66 mgd of peak-hour RDII. Sanitary Basin 8, conversely, has an approximately $2.7 million R&R cost to remove an estimated 0.28 mgd of peak-hour RDII.
- Upsizing and rerouting of flows from Sanitary Basins 5 and 6 toward Sanitary Basin 2 has significantly reduced the potential for overflows at the upstream of the siphon under Ames Creek, but may have resulted in the negative effect of allowing previously restricted I/I to now enter the system.
- A number of locations where overflows were identified as overflow points in the Post-Phase 3 modeling effort, particularly along the 18- to 24-inch main trunk that parallels the railroad, are now no longer projected to overflow based on the rehabilitation work conducted as part of Phase 4.
- Whereas the *Sanitary Sewer Master Plan* identified approximately $1.4 million in upsizing pipes to pass the 1-in-5 peak-hour flows (2012 dollars), the R&R work under the last four phases has essentially eliminated the need for upsizing of pipes. This assumes that the rate of RDII does not increase over time and that the City finds surcharging up to the manhole rim but not overflowing acceptable during the 1-in-5 year event. The City should continue to address RDII in the system on an annual basis. Under existing conditions, there is one manhole in Sweet Home that is predicted to overflow during the 1-in-5 year peak-hour flow event.
- Under future conditions, there are three additional manholes that are predicted to overflow during the 1-in-5 peak-hour flow. Several additional manholes on or immediately adjacent to the 24-inch main trunk line just upstream of the WWTP experience increased surcharging to within 3 feet of the manhole rim.

8.3 Recommendations

BC recommends that the City takes the following steps to continue to manage the I/I in the system with the goal of regulatory compliance:

- Closely monitor the single manhole at the downstream end of Sanitary Basin 10 on Long Street that is predicted to overflow during the 1-in-5 year peak-hour flow. Due to margin-of-error and compounding conservative assumptions within any modeling effort, it is possible the predicted overflow may be overly conservative. Therefore as a precaution, the City should clean and monitor this section of pipe annually and also prior to anticipated large wet-weather events. In addition, there is a significant portion of Sanitary Basin 10 that has not been addressed by the first four phases of the program. R&R work in Sanitary Basin 10 will likely greatly reduce the overflow potential, both in existing as well as future conditions. Additional flow monitoring at monitoring location 9.1 to validate the modeling predicted peak flows is also recommended.
- Evaluate sealing or raising the three manholes just east of 9th Avenue on the east-west 24-inch trunk paralleling the railroad tracks. These manholes are predicted to overflow under future conditions but

sealing or raising these manholes will prevent overflows while also not creating any adverse affect elsewhere in the City's collection system.

- Prepare an update to the City's Wastewater Facility Plan to determine the feasibility and cost of an upgrade to the Sweet Home WWTP to accommodate additional flows and determine the break-even point between WWTP upgrades and RDII reduction through future R&R work. As part of this update, re-evaluate the future growth projections and timing of expansion of the City's wastewater service areas.
- Prioritize completion of the rehabilitation work on upper laterals to complete the holistic basin approach, per Table 8-2. Further R&R work in the collection system aimed at reducing peak-hour RDII has diminishing returns. **However, at a minimum the City must continue with additional R&R work to maintain the current level of RDII in the system.** Sanitary Basins 18 and 9 are the next highest priority basins with the largest predicted RDII removal rates. Look for opportunities to remove I/I while also addressing the pipes with the worst structural ratings.
- Explore implementing a lateral rehabilitation program that can address the private laterals without the constraints of acquiring permanent easements.
- Update sewer condition maps that document the structural and operational condition of sewers. The last comprehensive update of sewer condition was completed in 2006.
- Evaluate the cost and feasibility for addressing Grade 5 sewers (as defined in Section 6 of the main report). Many Grade 5 sewers are likely rated so severely due to isolated point defects rather than full pipe issues. However, failure of point defects are as problematic as full length failures and the City should plan for the rehabilitation of these Grade 5 sewers.
- Begin preparing for and implementing a formal Capacity, Management, Operations, and Maintenance (CMOM) Program, in accordance with U.S. Environmental Protection Agency guidelines. The Oregon Department of Environmental Quality has guidance documents that indicate cities with compliant CMOM plans in place will receive greater leniency in cases of non-compliance (e.g., overflows during events less than the 1-in-5 year storm, see Appendix B).
- Install flow meters and increase the monitoring resolution in Sanitary Basins 7, 13, 14, and 17 to further delineate flows and determine if full basin rehabilitation would be effective. The City's post-Phase 4 flow monitoring was extremely successful, and the City can utilize their flow monitoring equipment and experience to identify and prioritize areas of additional RDII reduction.

By continuing to monitor flows and completing rehabilitation projects, the City can expect to further quantify I/I problems, focus the I/I reduction program on priority areas, and quantify the impact of specific projects, all while focusing funds on the most cost-effective solutions. This further the goal of reducing peak wet weather flows and meeting regulatory compliance. By addressing I/I with a methodical and long-term approach, the City can expect to maximize effectiveness and minimize the financial burden of I/I reduction projects.

Section 9

Limitations

This document was prepared solely for City of Sweet Home, Oregon in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Sweet Home, Oregon and Brown and Caldwell dated January 21, 2010. This document is governed by the specific scope of work authorized by City of Sweet Home, Oregon; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Sweet Home, Oregon and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Section 10

References

Water Environment Research Foundation project report "Sanitary Sewer Overflow (SSO) Flow Prediction Technologies," Project 97-CTS-8, April 1999.

Earth Tech Team, *Regional Needs Assessment Report*, Regional Infiltration and Inflow Control Program, Appendix A5 Assumptions for Regional I/I Control Program, King County, 2005 (pg. 7)

City of Sweet Home Sanitary Sewer Master Plan, Brown and Caldwell, 2002.

City of Sweet Home Wastewater Facility Plan, Brown and Caldwell, 2002.

City of Sweet Home Sewer Inspection Project, Brown and Caldwell, 2006.

Appendix A: SFE Flow Monitoring Report, 2012-2013

Final Report for

City of Sweet Home
Oregon, USA

Attn: Ms. Corianne Hart P.E.
Brown and Caldwell

2012/2013 Sanitary Sewer Flow Monitoring

5 Flow Sites and 1 Rain Gauge

Prepared and submitted by:

SFE Global Inc.

1313 East Maple Street

Bellingham, Washington 98225

Toll Free: 1-866-332-9876

May 22, 2013

Ms. Corianne Hart P.E.
Brown and Caldwell Engineering
6500 South Macadam Ave
Portland, Oregon
97239

FINAL REPORT: SWEET HOME, OREGON
Sanitary Sewer Flow Monitoring
November 2012 to March 2013
(5 Flow Sites plus 1 Rain Gauge)

Dear Ms. Hart,

Please find enclosed SFE's Final Report for the above mentioned project. If you have any questions, comments or concerns, please do not hesitate to contact us at your earliest convenience.

Thank you for having SFE conduct this work on your behalf. We are appreciative of the opportunity to work with you and your team on this project. We look forward to working together again in the near future.

Sincerely,
SFE Global
SFE File #U12-118

Paul Loving
Operations Manager
(604) 992-6792
Paul.loving@sfeglobal.com
www.sfeonline.com

TABLE OF CONTENTS

1. Introduction

This report provides details of the sanitary sewer flow monitoring project conducted in the City of The Sweet Home, Oregon. SFE Global was retained by The Brown and Caldwell, under the direction of Ms. Corianne Hart. Mr. Paul Loving represented SFE Global as Project Manager during this project.

As requested, SFE installed (5) sanitary sewer flow monitors and (1) Tipping Bucket Rain Gauges to collect data for a Five (5) month period. The stations were installed by November, 2012 and removed April 1, 2013. The monitoring stations are as follows:

Site #	Location	Meter Utilized
U12-118-1A	4th Ave at Main Street	ISCO 2150 AV Flow Meter C/W SFE CCW Weir
U12-118-2	490 Main Street	ISCO 2150 AV Flow Meter C/W SFE CCW Weir
U12-118-3	8th Ave West of 9th Ave Intersection	ISCO 2150 AV Flow Meter C/W SFE CCW Weir
U12-118-8	Off 15th Ave in greasy area	ISCO 2150 AV Flow Meter C/W SFE CCW Weir
U12-118-8A	18th Ave at RR Tracks	ISCO 2150 AV Flow Meter C/W SFE CCW Weir
Rain Gauge	Public Works Yard	Isco 2105 Data logger with RG

2. Flow Monitoring Stations

Prior to installing flow monitoring stations, SFE performed detailed site assessments of each potential site to determine the appropriate monitoring method. Factors such as pipe size, channel condition, site location, site access, and flow hydraulics were all considered and documented while performing site assessments. See Appendix #2 of this report for site assessment details.

SFE installed the flow monitoring stations in accordance with the approved site assessment documentation. The meters were calibrated and set to log data at 5 minute intervals as per spec and standard SFE procedure . To ensure proper operation of the stations, a regular maintenance schedule was adhered to for the duration of the project. During each site maintenance inspection conducted by SFE, corresponding meter and field readings were obtained and recorded on the field maintenance sheet. These readings provided an indication of the accuracy and operation of the meter. See Appendix #3 of this report for the field report sheets detailing site inspection information, calibrations, and depth verifications.

U12-118 – Site 1 : 4th Avenue at Main Street

SFE installed an ISCO Area Velocity Meter to monitor level readings through the installed SFE Custom Compound Weir within the manhole to monitor flow from the 8 inch diameter pipe. Flow was calculated using the Head/Flow table entered into the flow meter's internal computer. Monitoring duration was from November 1 2012 to April 1, 2013. All equipment was removed from the site. There was a meter failure at this site January 15th 2013 that resulted in complete replacement of installed equipment. Data was edited from this point on due to level readings being recorded too high as per maintenance visits.

U12-118 – Site 2 : 490 Main Street

SFE installed an ISCO Area Velocity Meter to monitor level readings through the installed SFE Custom Compound Weir within the manhole to monitor flow from the 18 inch diameter pipe. Flow was calculated using the Head/Flow table entered into the flow meter's internal computer. Monitoring duration was from November 1 2012 to April 1, 2013. All equipment was removed from the site and no data issues were observed.

U12-118 – Site 3 : 8th Avenue West of 9th Avenue intersection

SFE installed an ISCO Area Velocity Meter to monitor level readings through the installed SFE Custom Compound Weir within the manhole to monitor flow from the 24 inch diameter pipe. Flow was calculated using the Head/Flow table entered into the flow meter's internal computer. Monitoring duration was from November 1 2012 to April 1, 2013. All equipment was removed from the site and no data issues were observed.

U12-118– Site 8 : 15th Avenue in Grassy Area

SFE installed an ISCO Area Velocity Meter to monitor level readings through the installed SFE Custom Compound Weir within the manhole to monitor flow from the 24 inch diameter pipe. Flow was calculated using the Head/Flow table entered into the flow meter's internal computer. Monitoring duration was from November 1 2012 to April 1, 2013. All equipment was removed from the site and no data issues were observed.

U12-118 – Site 8A : 18th Avenue at Railroad Tracks

SFE installed an ISCO Area Velocity Meter to monitor level readings through the installed SFE Custom Compound Weir within the manhole to monitor flow from the 10 inch diameter pipe. Flow was calculated using the Head/Flow table entered into the flow meter's internal computer. Monitoring duration was from November 1 2012 to April 1, 2013. All equipment was removed from the site and no data issues were observed.

U12-118 – Rain Gage 1 - Public Works Yard

A tipping bucket Rain Gage with an Isco 2105 Datalogger was utilized to collect Rainfall Data for the last 2 months of this project after City RG malfunctioned.

3. SFE Custom Compound Weir and Area Velocity Meter Sensors

See Appendix 1 of this report for technical information that provides details on the SFE Custom Compound Weir and Area Velocity Meter Sensors.

4. Site Maintenance

SFE conducted thorough site maintenance and field data verifications throughout the monitoring period. All field maintenance sheets are included as Appendix #3 of this report.

5. QA/QC and Safety Statement

SFE confirms that all flow monitoring stations were installed according to SFE's QA/QC methodology and protocol, and standard industry practice. All flow monitoring equipment has been removed from the site locations.

SFE has a comprehensive Company Safety Manual and can be reviewed upon request.

Confined space entry procedures and general site/traffic safety was adhered to during site installation and site maintenance. SFE utilizes an approved rescue system, a 2800 CFM air induction device and four-gas air quality monitors. All of our staff members are thoroughly trained and certified in confined space entry procedures. Certificates are available upon request.

A thorough traffic control plan was established and used by SFE Global crews where required.

6. Data

Data collected during this project has previously been submitted to Brown and Caldwell Eng, via web access. All data submitted is in RAW format and has not been altered.

Appendices

Appendix #1 Includes technical information on the SFE Weir and Area Velocity Meter Sensors

Appendix #2 Includes all site assessment sheets, site photos, field set-up reports and site maintenance sheets

Appendix #3 Data Summaries and Graphs

Report End
May 2013

SFE Global
File #U12-118

Appendix 1

Technical Information on the SFE Weir and Area Velocity Meter Sensors

SFE Custom Compound Weir - A Technical Discussion

SFE's Custom Compound Weir (CCW) Technology was first developed in 1983. This system consists of the following two components:

- *A customized primary device (Custom Compound Weir or CCW), which provides a predictable relationship of "head" versus "flow"*
- *A water level sensor and data logger*

Testing & Awards

The relationship between "head" and "flow" for the primary device was initially established in a hydraulics lab in conjunction with the Canadian Center for Inland Waterways (CCIW) and published in a report prepared for a local utility. In subsequent years the monitoring techniques were further refined and additional laboratory work was carried out for the primary device. The work was recognized in 1988 by the Association of Consulting Engineers with an Award of Merit at their annual national engineering awards program.

Any level sensing device may be used to reliably measure flows including ultrasonic level indicators, pressure transducers and floats. The system was designed to make it economically feasible for even small utilities to be able to operate a network of stations for a long duration - the low operating costs & high accuracy/reliability prevailing over other measurement systems.

Self-Cleaning

The primary device has a rectangular notch, which then flares out into a "V" section and then a rectangular upper portion. The notch and "V" section have chamfered 1 ½ inch thick "lips" which make them self cleaning and result in a very high weir flow coefficient.

The self-cleaning properties of these weirs have been amply field proven over the past 20 years at approximately 2200 such stations. Each of our Custom Compound Weirs is custom designed by an open channel hydraulics specialist, for the manhole, chamber or channel configuration it is to be used in.

Low Flow Accuracy

For sewers up to 21 inches in diameter the notch is typically 4 inches wide and 5 ½ inches deep. This results in a flow rate of roughly 0.25 GPM for a head of 1 inch. Since a 2.5 psi pressure transducer or narrow beam ultrasonic indicator is usually capable of measuring water levels within +/- ¼", flow rates down to 0.25 GPM can readily be measured (a special unit has previously been designed to measure pre-treated wastewater flow rates down to 0.025 GPM).

No Sewer Backups

The lower notch magnifies the variation of the water level with small changes in flow rate (e.g. for the base flow regime). The overall primary device or "weir" normally has an opening greater than the pipe cross sectional area and capacities greater than that of the sewer in which they are placed.

Any Size, Any Shape

SFE has installed custom compound weirs in sewers from 6 inch to 12 foot as well as in varying sizes of pond outlets, creeks, WWTP's, etc. Custom designing the primary device for the manhole or channel in which it will be placed means that you have considerable control over the final flow regime. This has allowed many difficult hydraulic situations to be handled including bends, junctions, slopes over 10%, drop connections, and drops in the main pipe invert.

Velocity Measurements Not Required

One of the major advantages of SFE's Custom Compound Weir is that it only requires a depth sensor and logger; a velocity sensor is not used. Many of the problems associated with sewer flow monitoring are related to the velocity sensor and the need to measure average velocity. Velocity sensors are prone to fouling with subsequent "drifting" of the signal whereas pressure sensors will still accurately register variations in water level even if they have debris on them.

No "In the flow" Probes

The use of SFE's Custom Compound Weir further improves the performance of pressure sensors since they no longer represent an effective obstruction in the flow (they are installed behind the weir). They will always have a reasonable "head" on them as the weir lip elevation maintains a minimum depth of 4 inches behind the weir. As pressure transducers are much less accurate when depths approach zero; this situation becomes a problem for Area-Velocity A-V) type meters in small pipes where base flow rates are low.

Less Expensive

"Level only" monitors such as those used with our Custom Compound Weir are less expensive than A-V meters and need less power to operate. Flow profiling is needed for conventional A-V meters to ensure that the velocity sensed at a point or across a band of flow is properly transformed into average velocity across the pipe section. Since the Custom Compound Weir does not use velocity, profiling becomes redundant.

High Accuracy

Dye dilution and full-scale lab comparisons have been conducted and the results have been excellent. In most cases +/- 5% over the full range of flows is readily achievable.

Temporary or Permanent

The Custom Compound Weir's (CCW's) are normally located in the manhole chamber about 12 inches from the downstream end.

Material	Life Expectancy	Uses
Lumber/Lexan	1 week to several years	Short Term (E.g. I/I Study)
Plywood	Up to 2 years	Temporary
Pressure Treated Lumber	5 years	Semi-Permanent
Lexan and 316 Stainless	50 Years	Permanent

No Surcharges

Is there a possibility of sewer surcharges causing basement flooding because of the use of such primary devices or weirs? The question has been raised many times and was addressed on a project when the Custom Compound Weir was first designed. The purpose of that first project was to determine the cause of persistent sewer related basement flooding. The client was very concerned that the study procedures did not create more flooding since two Custom Compound Weir stations were just downstream of the area receiving the flooding. The design and placement of the Custom Compound Weirs addressed this as follows:

Each CCW was located in a manhole, and not in the pipe, approximately 12 inches from the downstream end so that if the weir were to ever get blocked it could simply overflow safely. (This event has never occurred).

For manholes with a chamber larger than the pipe (i.e. 18 inch pipe in standard 42 inch manhole), the weir opening is greater than the pipe area. The flow over the weir is also at critical depth and therefore at a higher velocity than normally occurs in the pipe itself. As a result, the weir capacity is much greater than the pipe capacity in most installations.

A rating curve was provided for a demo weir that has the standard opening used in pipes up to 18 inches. The table below shows the flow capacity of this weir configuration at selected heads versus the full flow capacity of selected pipe sizes up to 18 inches at a 0.25 % grade. The comparison illustrates that the CCW capacity can be much greater than the pipe capacity.

Flow Capacity of Standard Small Pipe Configuration at Selected Heads (Custom Compound Weir range)		Full Flow Capacity of Selected Pipes @ 0.25 % Grade (Pipe range)	
Head (in.)	Flow (US GPM)	Pipe Diameter (in.)	Capacity (US GPM)
1	15.85	8	254
5.5	190	10	471
8	349	12	761
12.5	999	15	1388
20	2298	18	2267
24	3638		

Laboratory Tested

Hydraulic model testing conducted at the Canada Center for Inland Waters (CCIW), provided the opportunity of observing the pipe / weir / manhole performance as the flow rates in the system were increased to the point that it surcharged. As the system started to surcharge, the "control" shifted from the weir to the downstream pipe and there was essentially no drop in the water surface across the weir (under surcharge, the weir was not influencing the water levels upstream).

Custom Designs

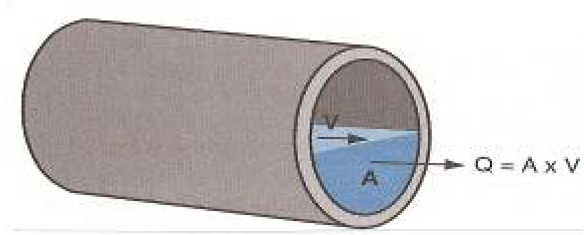
Every Custom Compound Weir is custom designed with a rectangular low flow notch and chamfered lips to give it a high weir flow coefficient. This means that it passes a greater flow for a given head than normal sharp crested weirs. Custom designed means specific concerns are addressed at specific sites.

Area Velocity Meter - Calibration & Verification of Monitor Sensors

Pipe Conduit Measurements

The measurement and condition of all sites were recorded during meter installation.

General Site Installation



Meter velocity was field calibrated according to the manufacturer's methodology and data was verified utilizing SFE Standard Protocol as outlined below.

Depth Verification

Depth verification was conducted at site and all data included on the field report. Five depth measurements from the meter and corresponding water depth are obtained simultaneously at sequential time intervals and recorded on the field worksheet. The lowest and highest measurements are discarded. The remaining three (3) measurements must be within 2.0 cm of each other. The averaged monitor reading must be within 5 % of the averaged field measurement to be acceptable.

Velocity Verification

Depth and velocity profiles were performed utilizing a Marsh McBirney Flow Mate point velocity meter. This instrument uses the Faraday principle to measure water velocity flowing over three electrodes. This allows an accurate velocity to be measured in a small area of the total flow.

SFE standard procedure is to use the 2-D method to determine average velocity. Numerous measurements are taken form the invert to water surface at the left, center and right thirds of the pipe. These measurements are averaged with the inclusion of readings taken from the upper left and right corner of flow.

SFE's alternate procedure when the pipe diameter is small or flow is sufficient is to use the .9-Vmax method. Point velocity readings are taken throughout the cross section of flow. The highest repeatable Velocity obtained is multiplied by 0.9 to determine average velocity. This average velocity is then correlated to the average velocity reading from the meter and must be within 10 %.

Velocity profiles were conducted and obtained for all sites.

Flow Monitoring Programs – SFE Technology Selection Approach

*SFE **does not** manufacture equipment - we select equipment and technology that in our experience will meet the project objectives in a cost effective and accurate manner.*

Our selection of a flow monitoring technology and the type of meter we use is based on these factors:

- ***A level of accuracy that is conducive to a high level of confidence in the project goals.***
- ***A high rate of recoverability and a focus on collecting as much "usable", un-modified, raw data as possible (greater than 95%).***
- ***The delivery of exceptional information in a timely manner.***

SFE focuses not only on the accuracy of the equipment; we also focus on the **best-suited** equipment and technology (i.e. Area Velocity versus Custom Compound Weirs) for each site. SFE views flow monitoring as matching the best technology to the prevalent "flow regime" at each site as opposed to selecting a specific flow meter. We may for example reject certain Area-Velocity (AV) flow meters as they are unable to provide acceptable combinations of redundant sensors; a combination we believe is imperative for flow monitoring programs in order to reduce the quantity and quality of poor data anticipated, particularly that due to low flow in small pipe (less than 18 inch). Other reasons for SFE to reject certain flow meters could be poor local service support, beta testing problems and QA/QC issue's, supply issues, etc. Conversely, we may accept and draw from any Area-Velocity (AV) meter deemed capable provided they are currently accurate to specification and suited for the project.

The approach described above was recently used at a regional sanitary sewer district; whereby the equipment and technology were evaluated versus an emphasis on evaluation of just the flow meter brand. The flow meters being considered did not have as much influence on accuracy as the type of technology used did. I.e. Several flow meter manufacturers installed various Area-Velocity (AV) meters while SFE also installed a Custom Compound Weir (CCW). The meters were all installed at the same manhole - all but one of the AV meters preformed to specifications, however, they were still not able to provide as much usable and reliable data at "this particular site" as the CCW did due to their inability to collect flow data during low flow, high velocity or turbulent conditions. The CCW collected reliable flow data over the full range of flows and was transmitted and monitored using CDPD wireless technology.

We found that in most cases, AV devices (meters) such as Isco, Sigma ADS, Geotivity, Marsh-McBirney, etc., have acceptable accuracies in terms of reading and reporting, however, it is the flow conditions or flow "regime" that exposes limitations.

For example, the scatter graph in ***Figure One*** below illustrates a flow-monitoring site that is exhibiting good flow characteristics relative to the use of an AV meter.

Figure One

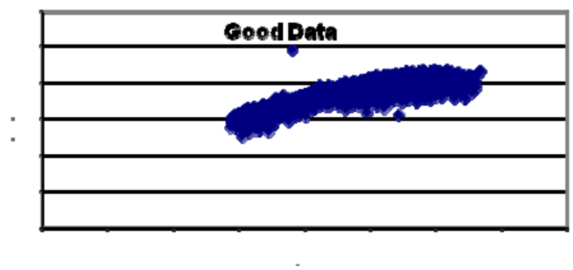


Figure Two

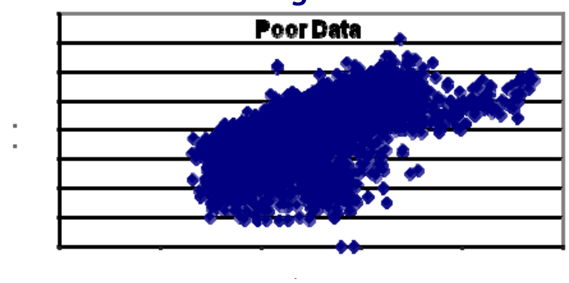
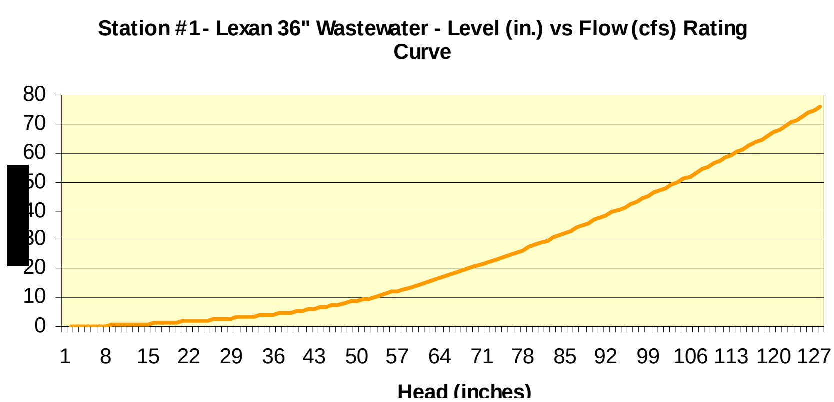


Figure Two illustrates a scatter graph from an AV flow-monitoring site that is not conducive to AV technology due to low flow and/or turbulence. In this case, while the AV meter is recording accurately, the flow characteristics (flow regime) of the site render less than 50% of the data as usable. Data modification and sub-analysis must be conducted in order to extract usable data.

Figure Three below by comparison, is a rating curve used with Custom Compound Weir Technology. Data scatter is eliminated, as there is a known relationship between velocity and depth, which eliminates the need to monitor velocity. The result is greater than 95% recoverability of usable data over the full range of flows at an accuracy of +/- 5% of full scale.

Figure Three



The case point is that while most of the Area-Velocity flow meters used preformed to specification, it is the addition of a primary flow-monitoring device (the Custom Compound Weir) that provided the basis for the collection of accurate data. The flow meters themselves become secondary devices. This does not mean that AV meters are not to be used – they have many suitable uses.

SFE has used CCW Technology at several thousand sites throughout North America and has received the "Order of Merit" by the Association of Professional Engineers.

CCW technology has the following benefits

- Reduces sub analysis and modified data resulting in increased "R-squared" confidence factors for producing I/I summaries
- Highly accurate over the full range of flows
- Highly accurate at low flows
- Highly accurate at high velocity
- Highly accurate at turbulence
- Eliminates data scatter and velocity reading requirements
- Self scouring

Our approach, therefore, is to assess each flow monitoring station and apply the best suited technology to that station. Sites could be AV or CCW, but will be dependant on the prevailing conditions at each location.

Appendix 2

Site Assessment Sheets, Site Photos, Field Set-up Reports and Site Maintenance Sheets

FIELD MAINTENANCE RECORD

NAME: Sweet Home
SFE SITE #: 1A
ADDRESS: 401 Main
GPS:
SENSOR TYPE: Av
PRIMARY DEVICE: 350 Weir

CONSTANTS		
D1 (in):	0.000	D1-lip to x-bar
TOM (in):	71.000	Raw Weir L - x-bar to water
METER #		DATE:
METER #		DATE:
METER #		DATE:

LEGEND	
DL - DOWNLOAD	**PC** - PROGRAM COMPLETE
CB - CHG BATTERY	**PM** - PROG. METER
V - VERIFY	**VIS** - VISUAL
LA - LEVEL ADJUST	**VP** - VELOCITY PROFILE
DO - DEPTH ONLY	**CD** - CHG DESICCANT

DATE M/D/YY	TIME HH:MM	METER TIME HH:MM	METER DEPTH in	FIELD DEPTH in	METER VEL fps	FIELD VEL-VIS fps	FLOW cfs	BATT V	SILT in	Raw Weir L in	Calc Weir L in	MTC BY (INIT.)	COMMENTS
10/17/12	10:56	9:51	2.132	2.5	*	*	0	12.32	0	na		JS	install
10/18/12	13:01	12:02	2.1	2.5	*	*	0	12.3	0	na		AM	
11/02/12	12:59	11:54	2.9	3	*	*	0	11	0	na		AM	
11/16/12	10:45	10:40	2.515	2.5	*	*	0	10.7	0	na		DC	confirm rating chart
11/29/12	15:44	15:40	2.646	3	*	*	0	10.4/12.4	0	na		DC	CB, FP
12/12/12	10:04	9:57	2.44	2.125	*	*	0	10.8	0	NA		AM	DL
01/03/12	9:12	9:05	1.24	1.75	*	*	0	12.2	0	NA		AM	DL CB
01/15/13	11:14	11:06	-0.814	2	*	*	0	11.5/12.2	0	NA		AM	DL CB install new sensor meter running neg
01/15/13	11:15	11:16	2.34	2.5	*	*	0	11.3	0	NA		AM	calibrate new sensor
02/05/13	10:58	10:51	5.2	5	*	*	0	10.7	0	NA		AM	month end down load
02/20/13	14:20	14:25	3.8	3.75	*	*	0	10.5	0	NA		AM	DL Clean site
03/06/13	14:36	14:36	2.39	2.75	*	*	0	12.2	0	N/a		AM	DL clean site CB
03/21/13	13:40	12:35	3.55	3.875	*	*	0	11.7	0	NA		AM	DL clean
04/04/13	7:46	6:43	2.12	2	*	*	1.63	10.2	0	NA		AM	DL and remove site

DATE:	NOTES:

Site Assessment

CLIENT FLOW MONITORING #:	**U12-118**	**SFE PROJECT #:**	**U12-118**
NAME:	**Sweethome, Oregon**	**SFE SITE #:**	**1A**
Date / Time:	Oct 17 2012		

Project Specific Information

Client Name:	Brown and Caldwell	
End User Name:	Same	
Project Name:	U12-118	
Client Contact:	Rob Lee	503-977-6625
Field Contact:	Adrian Marshall	509-312-0612
SFE PM Contact:	Paul Loving	604-992-6792

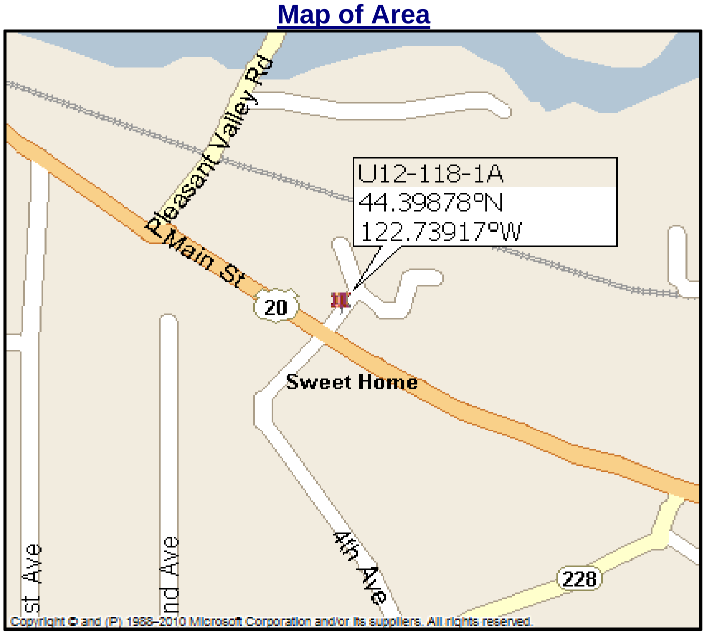
Site Equipment

Install / Remove Date:	Oct 17 2012
Meter Make & Model:	Isco 2150 AV
Level Type:	Pressure
Velocity Type:	NA
Primary Device:	SFE CCW
Wireless:	Yes
Redundancy:	Yes, additional AV in Pipe
Logging Rate:	5min

Site Location Information

Client Manhole #:	1A	
Address (Location):	4th Avenue at Main Street	
City, State:	Sweethome, Oregon	
GPS (North - West):	44.39878	-122.73917
Landmarks:		
Additional Information:	Drop pipe into MH above Weir lip need additional meter for redun.	

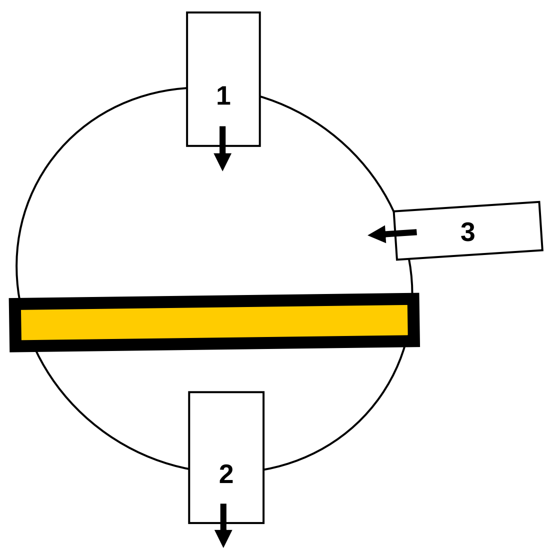
Map of Area



Site Profile

Pipe #1 Size:	8	Inches
Pipe #2 Size:	8	Inches
Pipe #3 Size:	6	Inches
Pipe #4 Size:	NA	Inches
Manhole Depth:	79	Inches
Laterals / Rungs:	Yes	
Additional Information:		

Manhole Layout



Traffic Control Requirements

Provider:	Third Party
Condition	Moderate traffic
Frequency:	Install/Removal
Speed Limit:	35
# of Lanes Effected:	1
Lane Configuration:	Center of 2 lane road
Additional Information:	

Site Hydraulics

Date & Time:	Oct 17 2012	13:30
Depth:	1.25	Inches
Velocity:	1	FPS
Turbulent:	No	
Surcharge:	Possible	
Silting:	No	
Solids:	Yes	

Notes

1
2

Notes

3
4

Site Pictures

CLIENT FLOW MONITORING #:	U12-118	SFE PROJECT #:	U12-118
NAME:	Sweethome, Oregon	SFE SITE #:	1A
Date / Time:	Oct 17 2012		

Picture 1

Picture 2

Picture 3

Picture 4

Picture 5

Picture 6

Notes

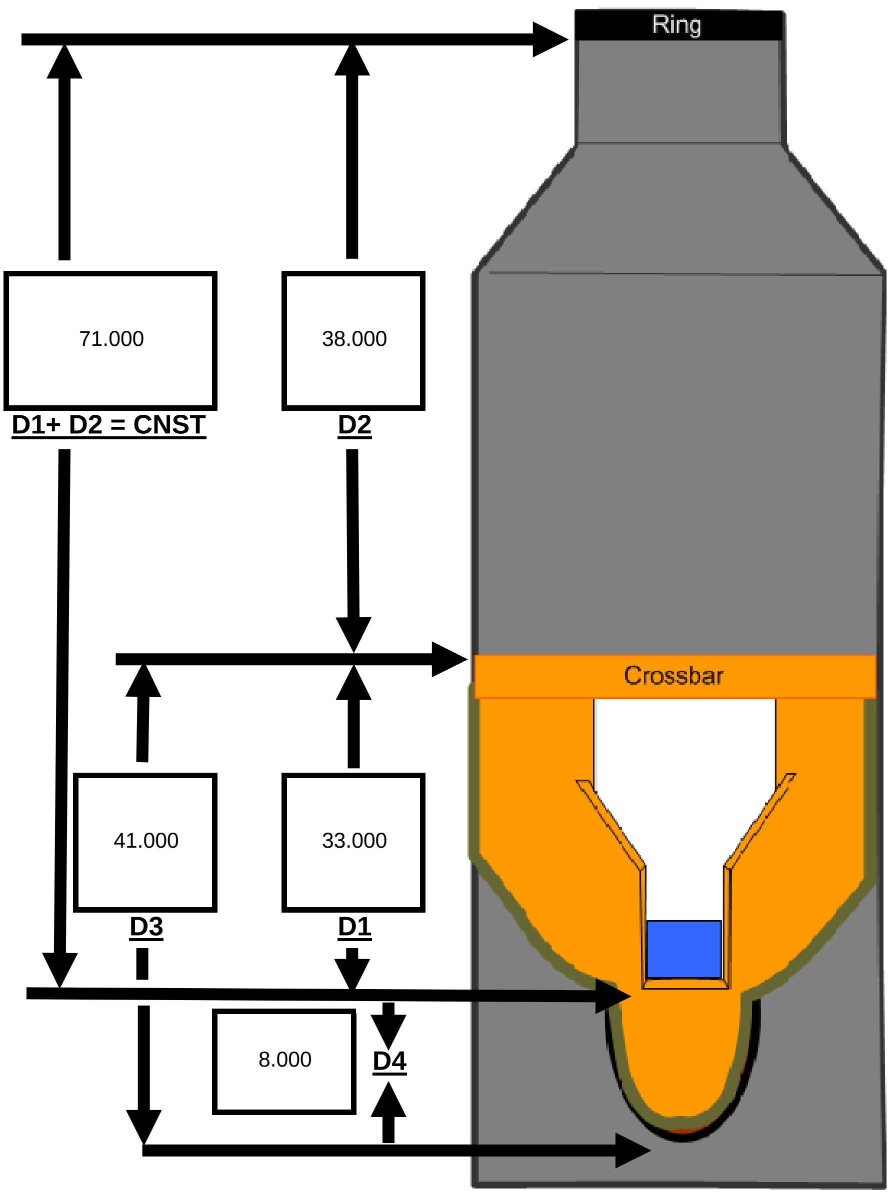
1
2
3

CLIENT FLOW MONITORING #: U12-118
NAME: Sweethome, Oregon
Date / Time: Oct 17 2012

SFE PROJECT #: U12-118
SFE SITE #: 1A
Technician 1: A Marshall 509-312-0612
Technician 2: Dylan Carvin

Meter Depth vs.. Field Depth Calibration / Verification

Reading Number	Date	Time	Field Meas (in.)	Meter Depth (in)	Comments (Zero Meter Level before Installation)
Initial	Oct 17 2012	14:40	2.500	2.45	Install
1	Oct 17 2012	14:42	2.500	2.53	
2	Oct 17 2012	14:45	2.500	2.59	
3	Oct 17 2012	14:50	2.500	2.51	
Average				.	



Constant Measurement (in)
Rim to Weir Lip
71.000

Pipe Diameters (in)

Pipe 1	8
Pipe 2	8
Pipe 3	6
Pipe 4	NA

D4=Invert to Weir Lip (D3-D1)
8.000

Obvert to Weir Lip
NA

Final Check-off Sheet

CLIENT FLOW MONITORING #:	**U12-118**	**SFE PROJECT #:**	**U12-118**
NAME:	**Sweethome, Oregon**	**SFE SITE #:**	**1A**
Date / Time:	Oct 17 2012		

Flow Meter Information

Meter Make:	Isco	Logging Rate:	5 Minute
Meter Model:	2150	Flow Units:	CFS
Sensor Type	AV	Velocity Units:	FPS
Meter Serial Number:	NA	Depth Units	Inches
Battery Volts:	12.2	Surcharge Meter (Y/N):	Yes

Site Physical Information

Silt Level:	0	Weather:	Sunny
Slope:	NA	Weir Size:	350
Uniform Flow (Y/N)	Y	Depth Only(DO)	NA
Debris in Flow (Y/N):	Y	or Look up Table(LT)	LT
Pipe Material:	Concrete	Comments	Drop pipe into manhole

Check Off List

	Yes	**No**
Time Set:	x	
Depth Calibrated:	x	
Velocity Profile:		x
Download Data:	x	
Meter Running:	x	
Pipe Size Verified:	x	
Photograph Taken:	x	
Site Cleaned:	x	
Site Secured:	x	

FIELD MAINTENANCE RECORD

NAME: Sweet Home
SFE SITE #: U12-118-2
ADDRESS: 490 Main
GPS:
SENSOR TYPE: Av
PRIMARY DEVICE: 600 Weir

CONSTANTS		
D1 (in):	0.000	D1-lip to x-bar
TOM (in):	75.750	Raw Weir L - x-bar to water
METER #		DATE:
METER #		DATE:
METER #		DATE:

LEGEND	
DL - DOWNLOAD	**PC** - PROGRAM COMPLETE
CB - CHG BATTERY	**PM** - PROG. METER
V - VERIFY	**VIS** - VISUAL
LA - LEVEL ADJUST	**VP** - VELOCITY PROFILE
DO - DEPTH ONLY	**CD** - CHG DESICCANT

DATE	TIME	METER TIME	METER DEPTH	FIELD DEPTH	METER VEL	FIELD VEL-VIS	FLOW	BATT	SILT	Raw Weir L	Calc Weir L	MTC BY	COMMENTS
M/D/YY	HH:MM	HH:MM	in	in	fps	fps	cfs	V	in	in	in	(INIT.)	
10/17/12	14:51	14:02	2.81	2.75	*	*	0.315	12.37	0			JS	install
10/18/12	12:46	11:50	3.1	2.75	*	*	0.428	12	0			AM	
11/02/12	11:49	11:00	3.75	3.772	*	*	0.485	11.7	0			JS	
11/02/12	11:53	11:07	3.5	3.588	*	*	0.457	11.7	0			JS	
11/16/12	8:13	8:24	3.686	3.75	*	*	0.467	10/12/04	0			DC	confirm pipe size, weir measurements, rating chart
11/29/12	16:11	16:21	4.767	4.75	*	*	0.561	10/12/04	0			DC	CB, FP
12/12/12	9:47	9:57	4.656	4.5	*	*	0.669	10.1/12.3	0			DC	CB
01/03/13	8:52	8:02	3.96	3.75	*	*	0.527	8.73/11.93	0			AM	DL, CB
01/15/13	10:20	10:24	4	3.75	*	*	0.551	10.07/12.1	0			AM	DL CB clean weir
02/04/13	16:32	16:41	3.9	3.75	*	*	0.52	12.2	0			AM	DL CB clean weir
02/20/13	15:44	15:44	3	3.25	*	*	0.35	12.2	0			AM	DL CB clean weir
03/06/13	16:10	16:12	4.1	4.25	*	*	0.573	9.8/12	0			AM	DL CB clean weir
03/21/13	13:27	12:36	4.8	5	*	8	4.88	9.9/12.2	0			Am	DL CB clean weir
04/04/13	11:50	11:01	3.37	3.25	*	*	0.391	10.2	0			AM	DL , check and remove

DATE:	NOTES:

Site Assessment

CLIENT FLOW MONITORING #: U12-118
NAME: Sweethome, Oregon
Date / Time: Oct 17 2012

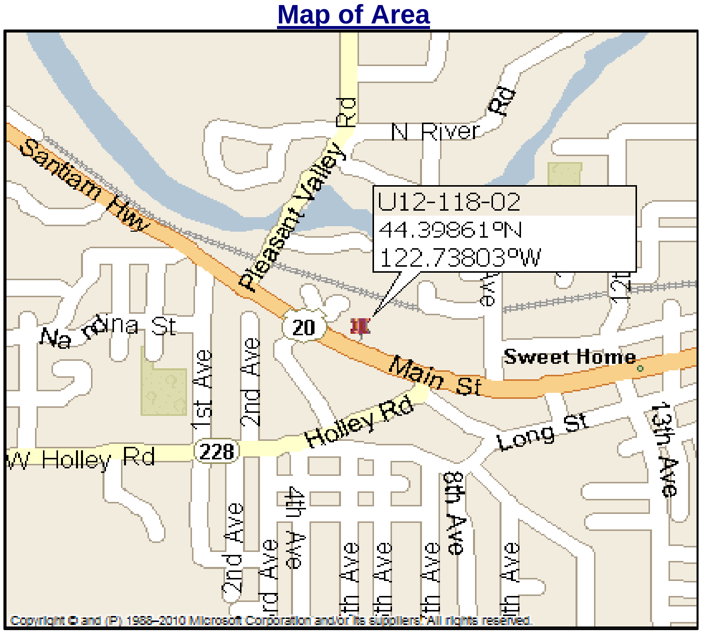
Project Specific Information

Client Name:	Brown and Caldwell	
End User Name:	Same	
Project Name:	U12-118	
Client Contact:	Rob Lee	503-977-6625
Field Contact:	Adrian Marshall	509-312-0612
SFE PM Contact:	Paul Loving	604-992-6792

Site Location Information

Client Manhole #:	2	
Address (Location):	490 Main Street	
City, State:	Sweethome, Oregon	
GPS (North - West):	44.39861	-122.73803
Landmarks:		
Additional Information:		

Map of Area



Traffic Control Requirements

Provider:	NA
Condition	NA
Frequency:	NA
Speed Limit:	NA
# of Lanes Effected:	NA
Lane Configuration:	
Additional Information:	

Notes
1
2

SFE PROJECT #: U12-118
SFE SITE #: 2

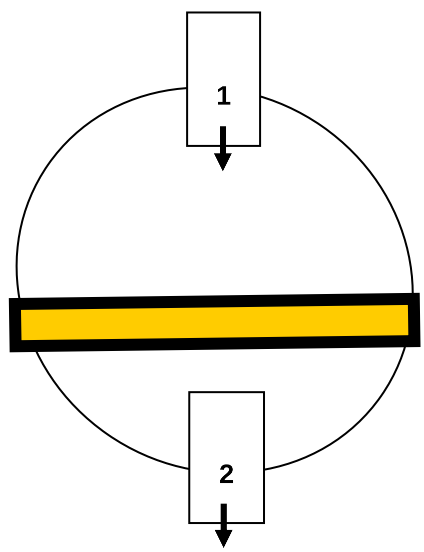
Site Equipment

Install / Remove Date:	Oct 17 2012
Meter Make & Model:	Isco 2150 AV
Level Type:	Pressure
Velocity Type:	NA
Primary Device:	SFE CCW
Wireless:	Yes
Redundancy:	Yes
Logging Rate:	5min

Site Profile

Pipe #1 Size:	18	Inches
Pipe #2 Size:	18	Inches
Pipe #3 Size:	NA	Inches
Pipe #4 Size:	NA	Inches
Manhole Depth:	83	Inches
Laterals / Rungs:	Yes	
Additional Information:		

Manhole Layout



Site Hydraulics

Date & Time:	Oct 17 2012	8:00
Depth:	2	Inches
Velocity:	1	FPS
Turbulent:	No	
Surcharge:	Possible	
Silting:	No	
Solids:	Yes	

Notes
3
4

CLIENT FLOW MONITORING #: U12-118
NAME: Sweethome, Oregon
Date / Time: Oct 17 2012

SFE PROJECT #: U12-118
SFE SITE #: 2

Picture 1

Picture 2

Picture 3

Picture 4

Picture 5

Picture 6

Notes

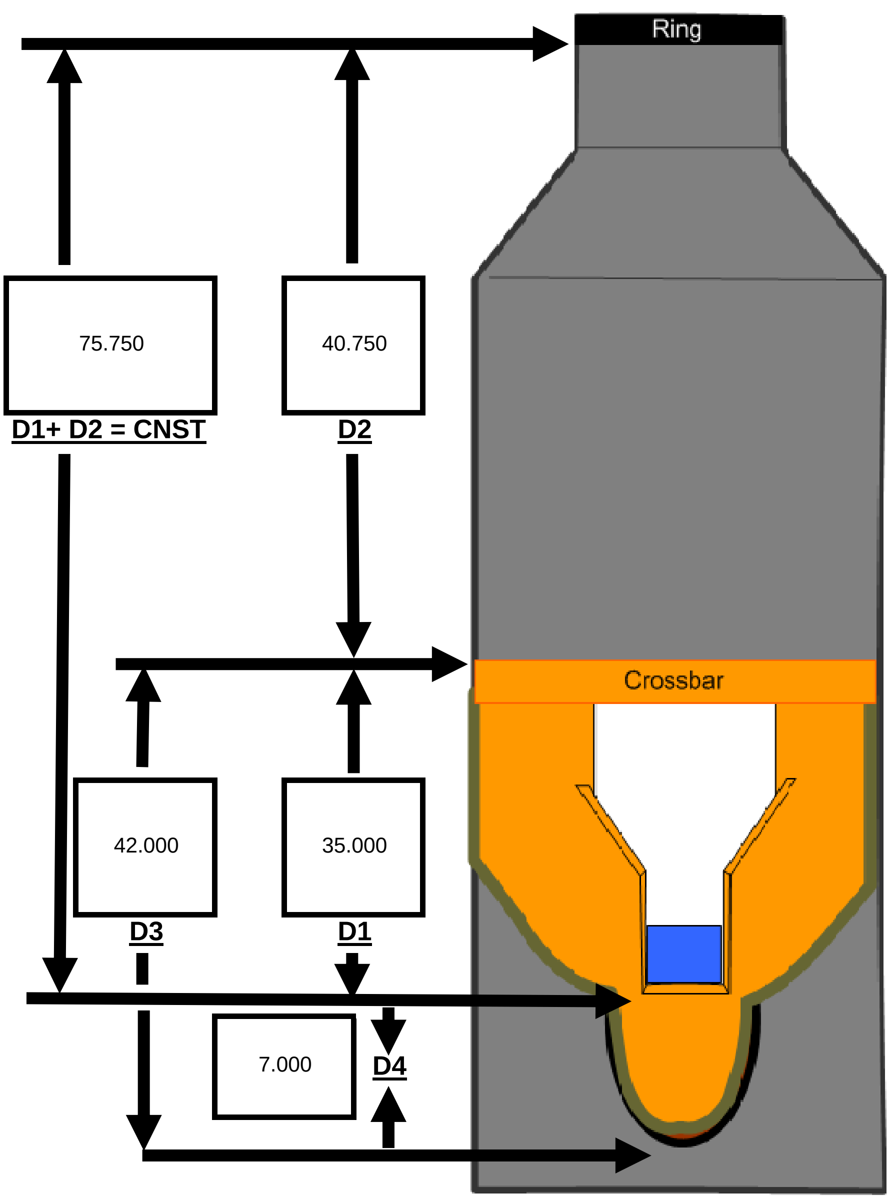
1
2
3

CCW Installation Form

CLIENT FLOW MONITORING #:	**U12-118**	**SFE PROJECT #:**	**U12-118**
NAME:	**Sweethome, Oregon**	**SFE SITE #:**	**2**
Date / Time:	Oct 17 2012	Technician 1:	A Marshall 509-312-0612
		Technician 2:	Dylan Carvin

Meter Depth vs.. Field Depth Calibration / Verification

Reading Number	Date	Time	Field Meas (in.)	Meter Depth (in)	Comments (Zero Meter Level before Installation)
Initial	Oct 17 2012	9:00	3.000	2.98	Install
1	Oct 17 2012	9:05	3.000	3.06	
2	Oct 17 2012	9:07	3.000	3.09	
3	Oct 17 2012	9:10	3.000	3.03	
Average				.	



Constant Measurement (in)
Rim to Weir Lip
75.750

Pipe Diameters (in)

Pipe 1	18
Pipe 2	18
Pipe 3	NA
Pipe 4	NA

D4=Invert to Weir Lip (D3-D1)
7.000

Obvert to Weir Lip
NA

Final Check-off Sheet

CLIENT FLOW MONITORING #:	**U12-118**	**SFE PROJECT #:**	**U12-118**
NAME:	**Sweethome, Oregon**	**SFE SITE #:**	**2**
Date / Time:	Oct 17 2012		

Flow Meter Information

Meter Make:	Isco	Logging Rate:	5 Minute
Meter Model:	2150	Flow Units:	CFS
Sensor Type	AV	Velocity Units:	FPS
Meter Serial Number:	NA	Depth Units	Inches
Battery Volts:	12.2	Surcharge Meter (Y/N):	Yes

Site Physical Information

Silt Level:	0	Weather:	Sunny
Slope:	NA	Weir Size:	600
Uniform Flow (Y/N)	Y	Depth Only(DO)	NA
Debris in Flow (Y/N):	Y	or Look up Table(LT)	LT
Pipe Material:	PVC	Comments	

Check Off List

	Yes	No
Time Set:	x	
Depth Calibrated:	x	
Velocity Profile:		x
Download Data:	x	
Meter Running:	x	
Pipe Size Verified:	x	
Photograph Taken:	x	
Site Cleaned:	x	
Site Secured:	x	

FIELD MAINTENANCE RECORD

NAME:	Sweet Home
SFE SITE #:	U12-118-3
ADDRESS:	110
GPS:	
SENSOR TYPE:	Av
PRIMARY DEVICE:	900 Weir

CONSTANTS			
D1 (in):	0.000	D1-lip to x-bar	
TOM (in):	138.000	Raw Weir L - x-bar to water	
METER #			DATE:
METER #			DATE:
METER #			DATE:

LEGEND	
DL - DOWNLOAD	**PC** - PROGRAM COMPLETE
CB - CHG BATTERY	**PM** - PROG. METER
V - VERIFY	**VIS** - VISUAL
LA - LEVEL ADJUST	**VP** - VELOCITY PROFILE
DO - DEPTH ONLY	**CD** - CHG DESICCANT

DATE	TIME	METER TIME	METER DEPTH	FIELD DEPTH	METER VEL	FIELD VEL-VIS	FLOW	BATT	SILT	Raw Weir L	Calc Weir L	MTC BY	COMMENTS
M/D/YY	HH:MM	HH:MM	in	in	fps	fps	cfs	V	in	in	in	(INIT.)	
10/18/12	10:29	9:28	5.257	5.25	*	*	1.612	12.276	0			JS	install
11/02/12	11:20	10:18	6.05	6.25	*	*	2.013	11.8	0			AM	
11/16/12	9:16	9:14	5.164	5.5	*	*	1.561	11.3	0			DC	confirm pipe size, weir measurements, rating chart
11/29/12	16:28	16:26	8.218	8	*	*	3.122	10.7/12.3	0			DC	CB, FP, attempt to regain wireless signal
12/12/12	9:11	9:09	7.77	7.25	*	*	2.84	11.5	0			AM	DC, check site, change ant.
01/03/13	8:30	8:35	6.04	5.5	*	*	1.97	10.8	0			AM	DL
01/15/13	10:03	10:00	6.01	5.75	*	*	2.06	11.1	0			AM	DLClean weir
02/04/13	16:20	16:17	6.67	6.7	*	*	2.29	11.1	0			AM	DL clean weir
02/20/13	15:23	15:23	5.2	5	*	*	1.56	11	0			AM	DL clean weir Data go
03/06/13	16:45	16:50	6.7	6.5	*	*	2.33	10.8	0			AM	DL clean weir CB
03/21/13	13:17	12:16	7.6	7.25	*	*	2.8	10.8	0			AM	DL clean weir
04/04/13	10:50	9:51	5.32	5	*	*	1.63	9.3	0			AM	DL Remove

DATE:	NOTES:

Site Assessment

CLIENT FLOW MONITORING #: **U12-118**
NAME: **Sweethome, Oregon**
Date / Time: Oct 17 2012

SFE PROJECT #: **U12-118**
SFE SITE #: **3**

Project Specific Information

Client Name:	Brown and Caldwell	
End User Name:	Same	
Project Name:	U12-118	
Client Contact:	Rob Lee	503-977-6625
Field Contact:	Adrian Marshall	509-312-0612
SFE PM Contact:	Paul Loving	604-992-6792

Site Equipment

Install / Remove Date:	Oct 17 2012
Meter Make & Model:	Isco 2150 AV
Level Type:	Pressure
Velocity Type:	NA
Primary Device:	SFE CCW
Wireless:	Yes
Redundancy:	Yes
Logging Rate:	5min

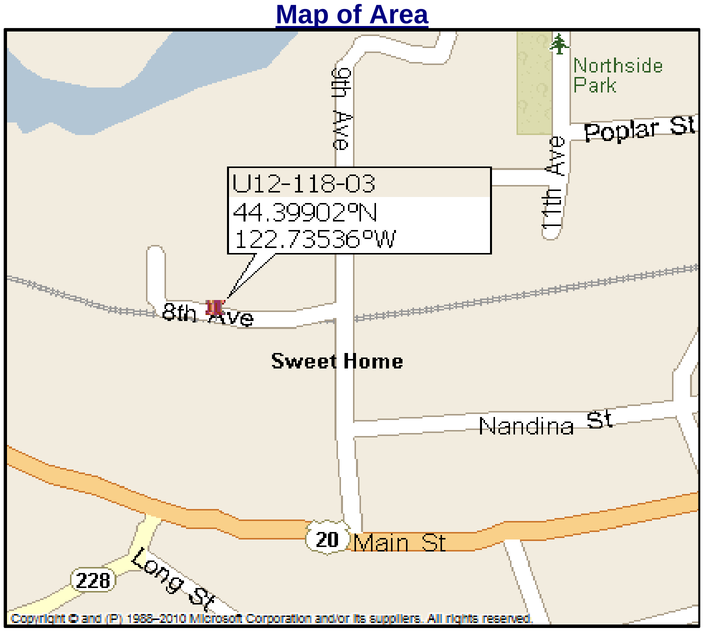
Site Location Information

Client Manhole #:	3	
Address (Location):	8th Avenue	
City, State:	Sweethome, Oregon	
GPS (North - West):	44.39902	-122.73536
Landmarks:		
Additional Information:		

Site Profile

Pipe #1 Size:	24	Inches
Pipe #2 Size:	24	Inches
Pipe #3 Size:	NA	Inches
Pipe #4 Size:	NA	Inches
Manhole Depth:	159	Inches
Laterals / Rungs:	Yes	
Additional Information:		

Map of Area



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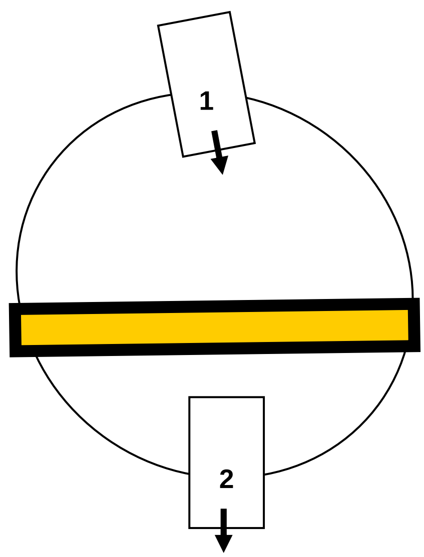
Manhole Layout



Traffic Control Requirements

Provider:	SFE
Condition	Gravel Lane
Frequency:	NA
Speed Limit:	NA
# of Lanes Effected:	1
Lane Configuration:	
Additional Information:	

Notes
1
2

Site Hydraulics

Date & Time:	Oct 17 2012	11:30
Depth:	1.25	Inches
Velocity:	1	FPS
Turbulent:	No	
Surcharge:	Possible	
Silting:	No	
Solids:	Yes	

Notes
3
4

Site Pictures

CLIENT FLOW MONITORING #:	U12-118	SFE PROJECT #:	U12-118
NAME:	Sweethome, Oregon	SFE SITE #:	3
Date / Time:	Oct 17 2012		

Picture 1

Picture 2

Picture 3

Picture 4

Picture 5

Picture 6

Notes

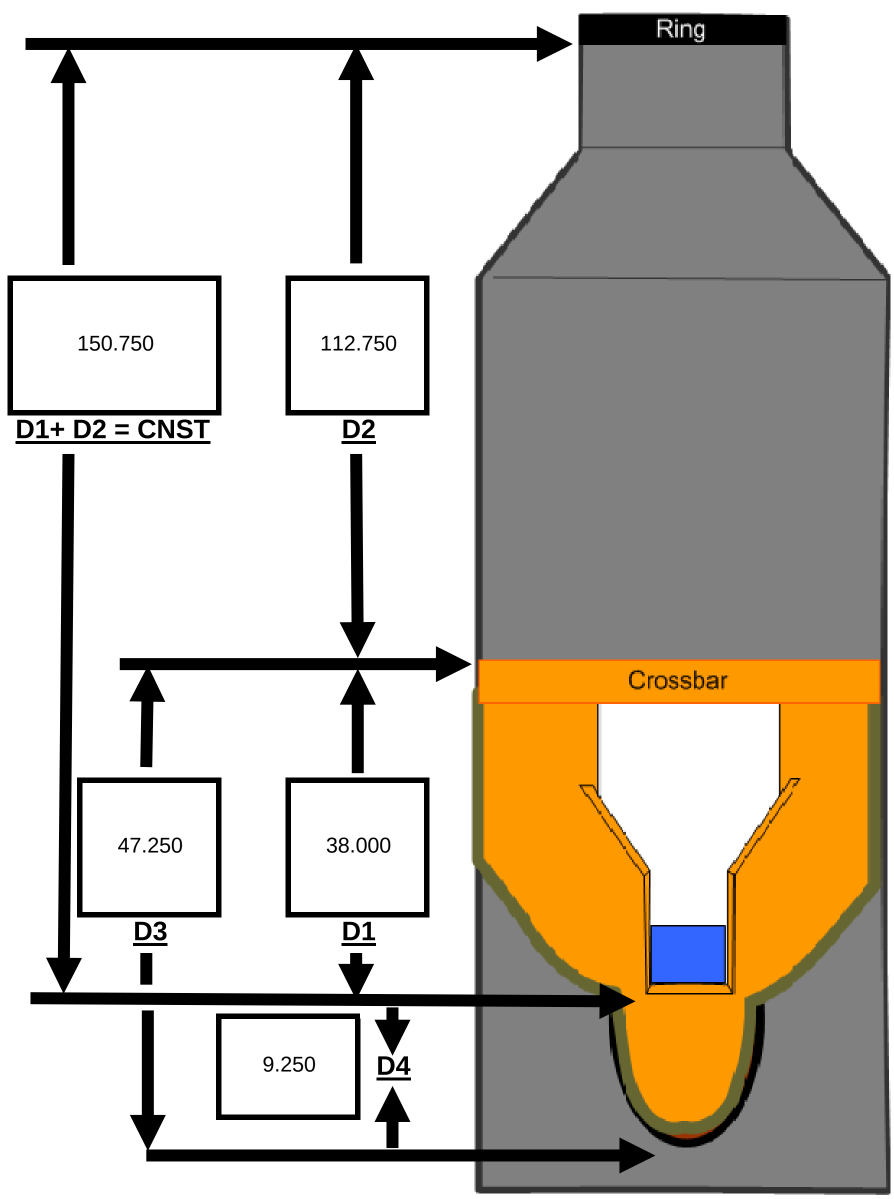
1
2
3

CCW Installation Form

CLIENT FLOW MONITORING #:	**U12-118**	**SFE PROJECT #:**	**U12-118**
NAME:	**Sweethome, Oregon**	**SFE SITE #:**	**3**
Date / Time:	Oct 17 2012	Technician 1:	A Marshall 509-312-0612
		Technician 2:	Dylan Carvin

Meter Depth vs.. Field Depth Calibration / Verification

Reading Number	Date	Time	Field Meas (in.)	Meter Depth (in)	Comments (Zero Meter Level before Installation)
Initial	Oct 17 2012	12:05	1.500	1.43	Install
1	Oct 17 2012	12:08	1.250	1.28	
2	Oct 17 2012	12:11	1.250	1.22	
3	Oct 17 2012	12:13	1.500	1.56	
Average				.	



Constant Measurement (in)
Rim to Weir Lip
150.750

Pipe Diameters (in)

Pipe 1	24
Pipe 2	24
Pipe 3	NA
Pipe 4	NA

D4=Invert to Weir Lip (D3-D1)
9.250

Obvert to Weir Lip
NA

Final Check-off Sheet

CLIENT FLOW MONITORING #: **U12-118**
NAME: **Sweethome, Oregon**
Date / Time: Oct 17 2012

SFE PROJECT #: **U12-118**
SFE SITE #: **3**

Flow Meter Information

Meter Make:	Isco	Logging Rate:	5 Minute
Meter Model:	2150	Flow Units:	CFS
Sensor Type	AV	Velocity Units:	FPS
Meter Serial Number:	NA	Depth Units	Inches
Battery Volts:	12.2	Surcharge Meter (Y/N):	Yes

Site Physical Information

Silt Level:	0	Weather:	Sunny
Slope:	NA	Weir Size:	900
Uniform Flow (Y/N)	Y	Depth Only(DO)	NA
Debris in Flow (Y/N):	Y	or Look up Table(LT)	LT
Pipe Material:	Concrete	Comments	

Check Off List

	Yes	No
Time Set:	x	
Depth Calibrated:	x	
Velocity Profile:		x
Download Data:	x	
Meter Running:	x	
Pipe Size Verified:	x	
Photograph Taken:	x	
Site Cleaned:	x	
Site Secured:	x	

FIELD MAINTENANCE RECORD

NAME: Sweet Home
SFE SITE #: U12-118-8
ADDRESS: 1400.5 NADD
GPS:
SENSOR TYPE: Av
PRIMARY DEVICE: 900 Weir

CONSTANTS			
D1 (in):	0.000	D1-lip to x-bar	
TOM (in):	83.500	Raw Weir L - x-bar to water	
METER #		DATE:	
METER #		DATE:	
METER #		DATE:	

LEGEND	
DL - DOWNLOAD	**PC** - PROGRAM COMPLETE
CB - CHG BATTERY	**PM** - PROG. METER
V - VERIFY	**VIS** - VISUAL
LA - LEVEL ADJUST	**VP** - VELOCITY PROFILE
DO - DEPTH ONLY	**CD** - CHG DESICCANT

DATE	TIME	METER TIME	METER DEPTH	FIELD DEPTH	METER VEL	FIELD VEL-VIS	FLOW	BATT	SILT	Raw Weir L	Calc Weir L	MTC BY	COMMENTS
M/D/YY	HH:MM	HH:MM	in	in	fps	fps	cfs	V	in	in	in	(INIT.)	
10/16/12	18:25	17:19	4.153	4.625	*	*		13.4	0			JS	install
10/17/12	11:00	9:59	4.41	4.5	*	*		12.4	0			AM	
11/02/12	10:45	9:50	4.761	4.75	*	*	1.392	11.5	0			JS	add cell unit
11/16/12	11:13	11:13	5.037	5	*	*	1.505	9.7/12.3	0			DC	CB, confirm pipe size, weir measurements and
X												X	rating chart
11/29/12	20:57	20:57	6.425	6	*	*	2.18	10.1/12.4	0			DC	CB, FP, attempt to regain wireless signal
12/12/12	8:48	8:46	5.935	6.25	*	*	1.919	10.2/12.2	0			DC	DL
01/03/13	8:22	8:22	4.63	4.75	*	*	1.32	8.7/12.2	0			AM	DL
01/15/13	9:39	9:37	4.74	4.5	*	*	1.378	10.03/12.02	0			AM	DL CB check weir & clean
02/05/13	16:09	16:04	5.26	5.5	*	*	1.607	9.4/12.02	0			AM	DL cb check level
02/20/13	15:07	15:05	3.8	4	*	*	0.988	9.6/118	0			DC	DL cean lite rag less than 1/8 in
03/06/13	15:33	15:32	4.83	4.75	*	*	1.46	7.6/12	0			AM	DL clean weir CB
03/21/13	12:23	11:22	5.8	6	*	*	1.9	9.8/12	0			AM	DL clean weir CB
04/04/13	10:21	9;20	3.9	4	*	*	1.06	9.6	0			AM	DL Remove and check

DATE:	NOTES:

Site Assessment

CLIENT FLOW MONITORING #:	**U12-118**	**SFE PROJECT #:**	**U12-118**
NAME:	**Sweethome, Oregon**	**SFE SITE #:**	**8**
Date / Time:	Oct 16 2012		

Project Specific Information

Client Name:	Brown and Caldwell	
End User Name:	Same	
Project Name:	U12-118	
Client Contact:	Rob Lee	503-977-6625
Field Contact:	Adrian Marshall	509-312-0612
SFE PM Contact:	Paul Loving	604-992-6792

Site Equipment

Install / Remove Date:	Oct 16 2012
Meter Make & Model:	Isco 2150 AV
Level Type:	Pressure
Velocity Type:	NA
Primary Device:	SFE CCW
Wireless:	Yes
Redundancy:	Yes
Logging Rate:	5min

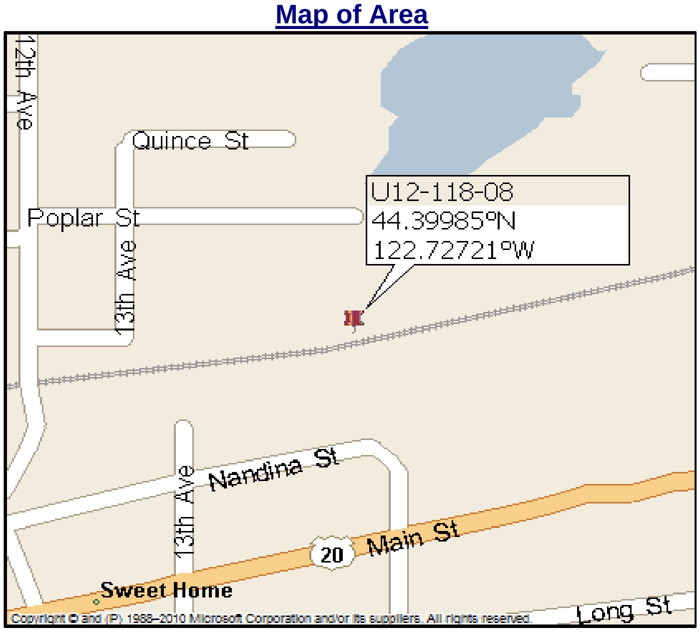
Site Location Information

Client Manhole #:	8	
Address (Location):	15th Avenue	
City, State:	Sweethome, Oregon	
GPS (North - West):	44.39985	-122.72721
Landmarks:		
Additional Information:		

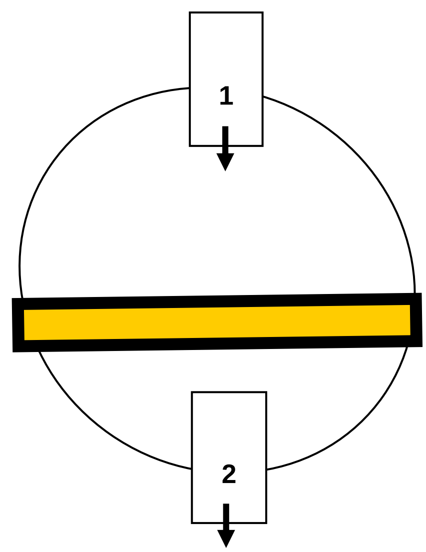
Site Profile

Pipe #1 Size:	24	Inches
Pipe #2 Size:	24	Inches
Pipe #3 Size:	NA	Inches
Pipe #4 Size:	NA	Inches
Manhole Depth:	91	Inches
Laterals / Rungs:	Yes	
Additional Information:		

Map of Area



Manhole Layout



Traffic Control Requirements

Provider:	NA
Condition	NA
Frequency:	NA
Speed Limit:	NA
# of Lanes Effected:	NA
Lane Configuration:	
Additional Information:	

Site Hydraulics

Date & Time:	Oct 16 2012	10:55
Depth:	2	Inches
Velocity:	1	FPS
Turbulent:	No	
Surcharge:	Possible	
Silting:	No	
Solids:	Yes	

Notes

1
2

Notes

3
4

Site Pictures

CLIENT FLOW MONITORING #:	U12-118	SFE PROJECT #:	U12-118
NAME:	Sweethome, Oregon	SFE SITE #:	8
Date / Time:	Oct 16 2012		

Picture 1

Picture 2

Picture 3

Picture 4

Picture 5

Picture 6

Notes

1
2
3

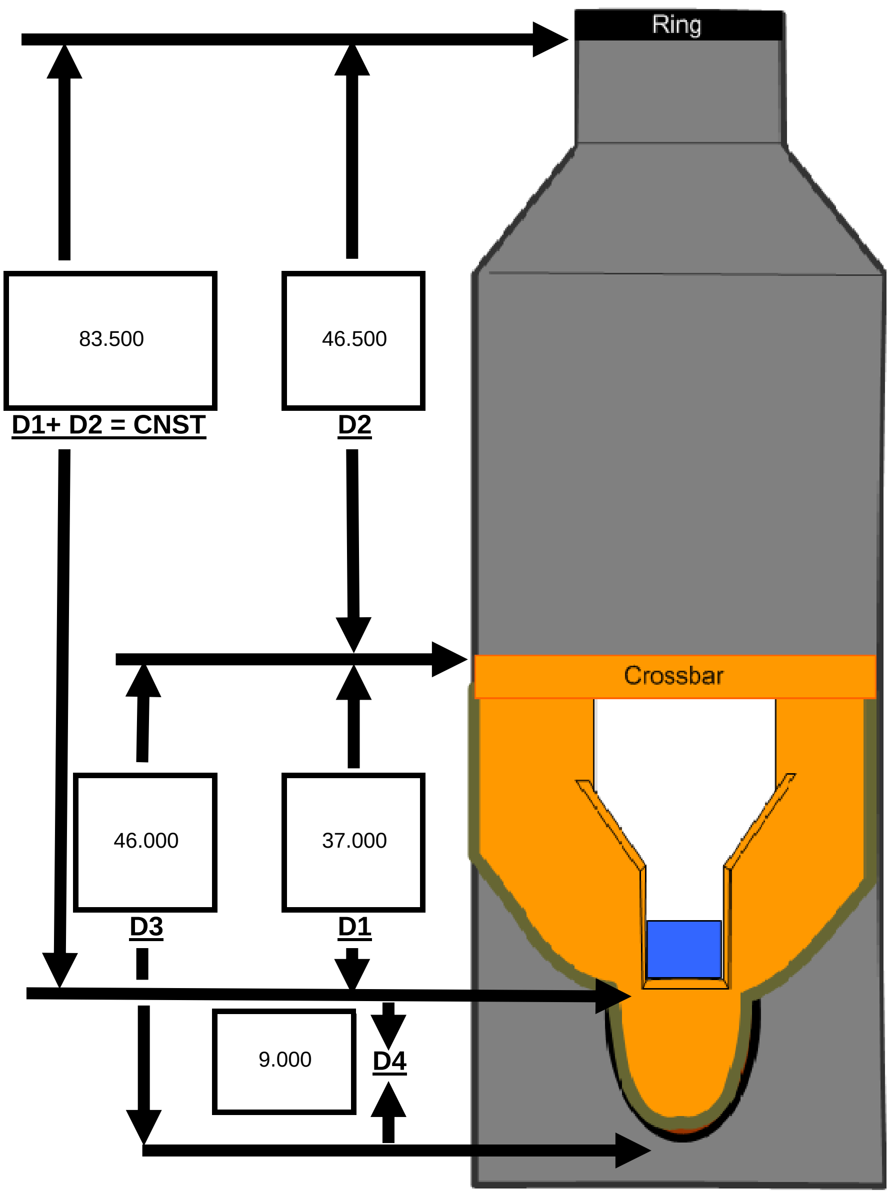
CCW Installation Form

CLIENT FLOW MONITORING #: **U12-118**
NAME: **Sweethome, Oregon**
Date / Time: Oct 16 2012

SFE PROJECT #: **U12-118**
SFE SITE #: **8**
Technician 1: A Marshall 509-312-0612
Technician 2: Dylan Carvin

Meter Depth vs.. Field Depth Calibration / Verification

Reading Number	Date	Time	Field Meas (in.)	Meter Depth (in)	Comments (Zero Meter Level before Installation)
Initial	Oct 16 2012	11:23	2.250	2.19	Install
1	Oct 16 2012	11:26	2.500	2.43	
2	Oct 16 2012	11:33	2.500	2.53	
3	Oct 16 2012	11:37	2.500	2.31	
Average				.	



Constant Measurement (in)
Rim to Weir Lip
83.500

Pipe Diameters (in)

Pipe 1	24
Pipe 2	24
Pipe 3	NA
Pipe 4	NA

D4=Invert to Weir Lip (D3-D1)
9.000

Obvert to Weir Lip
NA

Final Check-off Sheet

CLIENT FLOW MONITORING #:	**U12-118**	**SFE PROJECT #:**	**U12-118**
NAME:	**Sweethome, Oregon**	**SFE SITE #:**	**8**
Date / Time:	Oct 16 2012		

Flow Meter Information

Meter Make:	Isco	Logging Rate:	5 Minute
Meter Model:	2150	Flow Units:	CFS
Sensor Type	AV	Velocity Units:	FPS
Meter Serial Number:	NA	Depth Units	Inches
Battery Volts:	12.2	Surcharge Meter (Y/N):	Yes

Site Physical Information

Silt Level:	0	Weather:	Sunny
Slope:	NA	Weir Size:	900
Uniform Flow (Y/N)	Y	Depth Only(DO)	NA
Debris in Flow (Y/N):	Y	or Look up Table(LT)	LT
Pipe Material:	Concrete	Comments	

Check Off List

	Yes	No
Time Set:	x	
Depth Calibrated:	x	
Velocity Profile:		x
Download Data:	x	
Meter Running:	x	
Pipe Size Verified:	x	
Photograph Taken:	x	
Site Cleaned:	x	
Site Secured:	x	

FIELD MAINTENANCE RECORD

NAME: Sweet Home
SFE SITE #: U12-118-8A
ADDRESS: 18th Ave & Train Tracks
GPS:
SENSOR TYPE: Av
PRIMARY DEVICE: 600 Weir

CONSTANTS			
D1 (in):	0.000	D1-lip to x-bar	
TOM (in):	93.250	Raw Weir L - x-bar to water	
METER #		DATE:	
METER #		DATE:	
METER #		DATE:	

LEGEND	
DL - DOWNLOAD	**PC** - PROGRAM COMPLETE
CB - CHG BATTERY	**PM** - PROG. METER
V - VERIFY	**VIS** - VISUAL
LA - LEVEL ADJUST	**VP** - VELOCITY PROFILE
DO - DEPTH ONLY	**CD** - CHG DESICCANT

DATE M/D/YY	TIME HH:MM	METER TIME HH:MM	METER DEPTH in	FIELD DEPTH in	METER VEL fps	FIELD VEL-VIS fps	FLOW cfs	BATT V	SILT in	Raw Weir L in	Calc Weir L in	MTC BY (INIT.)	COMMENTS
10/16/12	14:21	13:10	2.88	2.75	*	*	0.31	12.1	0			JS	install
10/18/12	11:16	10:11	2.977	2.75	*	*	0.337	11.8	0			AM	
11/01/12	10:21	9:15	4.128	4.25	*	*	0.445	11	0			AM	ragged
11/01/12	10:22	9:16	3.34	3.5	*	*	0.402	11	0			AM	Drop .75 in
11/16/12	11:47	11:42	3.946	4	*	*	0.526	10.7	0			DC	ragged, confirm pipe sizes and weir measurements
11/16/12	12:01	11:56	3.503	3.75	*	*	0.433	10.7	0			DC	Drop .25 in, confirm rating chart
11/29/12	17:15	17:19	4.88	4.75	*	*	0.712	10.6/12.4	0			DC	CB, FP
12/12/12	8:32	8:26	4.691	4.75	*	*	0.674	11.5	0			DC	DL
01/03/13	8:07	8:01	4.27	4.25	*	*	0.892	10.9	0			AM	DL
01/15/13	9:09	9:03	4.85	5	*	*	0.908	10.6	0			AM	DL clean weir all good
02/04/13	15:48	15:56	3.88	3.75	*	*	0.478	10.8	0			AM	Clean weir DL
02/20/13	14:55	14:56	3:25	3.25	*	*	0.397	10.5	0			DC	Lite Ragging .25 high
03/06/13	15:20	15:15	3.98	4.25	*	*	0.5	9.9/12.1	0			AM	DL clean weir CB
03/21/13	12:11	11:06	5.21	5	*	*	0.856	11.3	0			AM	DL CB
04/04/13	9:49	8:43	3.12	3.29	*	*	0.349	11.1	0			AM	DL CB Remove

DATE:	NOTES:

Site Assessment

CLIENT FLOW MONITORING #:	**U12-118**
NAME:	**Sweethome, Oregon**
Date / Time:	Oct 16 2012

SFE PROJECT #:	**U12-118**
SFE SITE #:	**8A**

Project Specific Information

Client Name:	Brown and Caldwell	
End User Name:	Same	
Project Name:	U12-118	
Client Contact:	Rob Lee	503-977-6625
Field Contact:	Adrian Marshall	509-312-0612
SFE PM Contact:	Paul Loving	604-992-6792

Site Equipment

Install / Remove Date:	Oct 16 2012
Meter Make & Model:	Isco 2150 AV
Level Type:	Pressure
Velocity Type:	NA
Primary Device:	SFE CCW
Wireless:	Yes
Redundancy:	Yes
Logging Rate:	5min

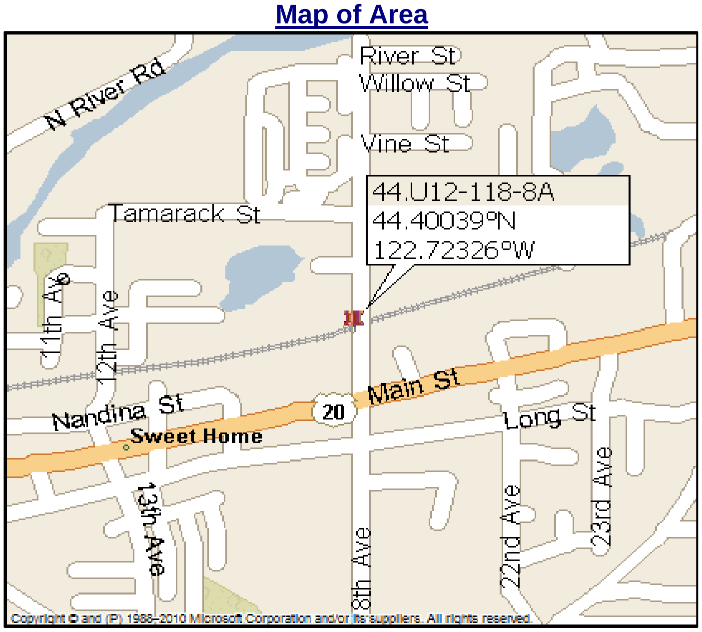
Site Location Information

Client Manhole #:	8A	
Address (Location):	18th Avenue	
City, State:	Sweethome, Oregon	
GPS (North - West):	44.40039	-122.72326
Landmarks:		
Additional Information:		

Site Profile

Pipe #1 Size:	10	Inches
Pipe #2 Size:	10	Inches
Pipe #3 Size:	NA	Inches
Pipe #4 Size:	NA	Inches
Manhole Depth:	101	Inches
Laterals / Rungs:	Yes	
Additional Information:		

Map of Area



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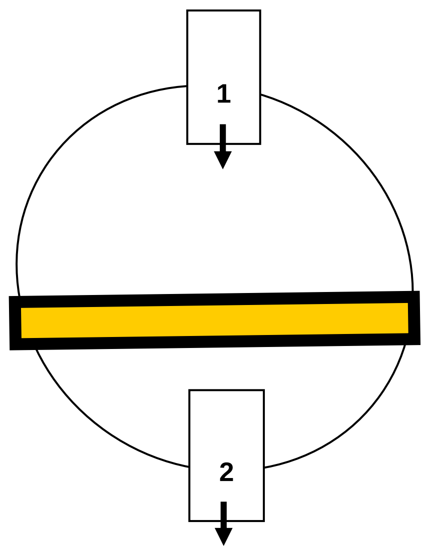
Manhole Layout



Traffic Control Requirements

Provider:	SFE
Condition	Local only
Frequency:	Never
Speed Limit:	NA
# of Lanes Effected:	NA
Lane Configuration:	
Additional Information:	

Notes
1
2

Site Hydraulics

Date & Time:	Oct 16 2012	13:10
Depth:	3	Inches
Velocity:	1	FPS
Turbulent:	No	
Surcharge:	Possible	
Silting:	No	
Solids:	Yes	

Notes
3
4

CLIENT FLOW MONITORING #: U12-118	SFE PROJECT #: U12-118
NAME: Sweethome, Oregon	SFE SITE #: 8A
Date / Time: Oct 16 2012	

Picture 1

Picture 2

Picture 3

Picture 4

Picture 5

Picture 6

Notes

1
2
3

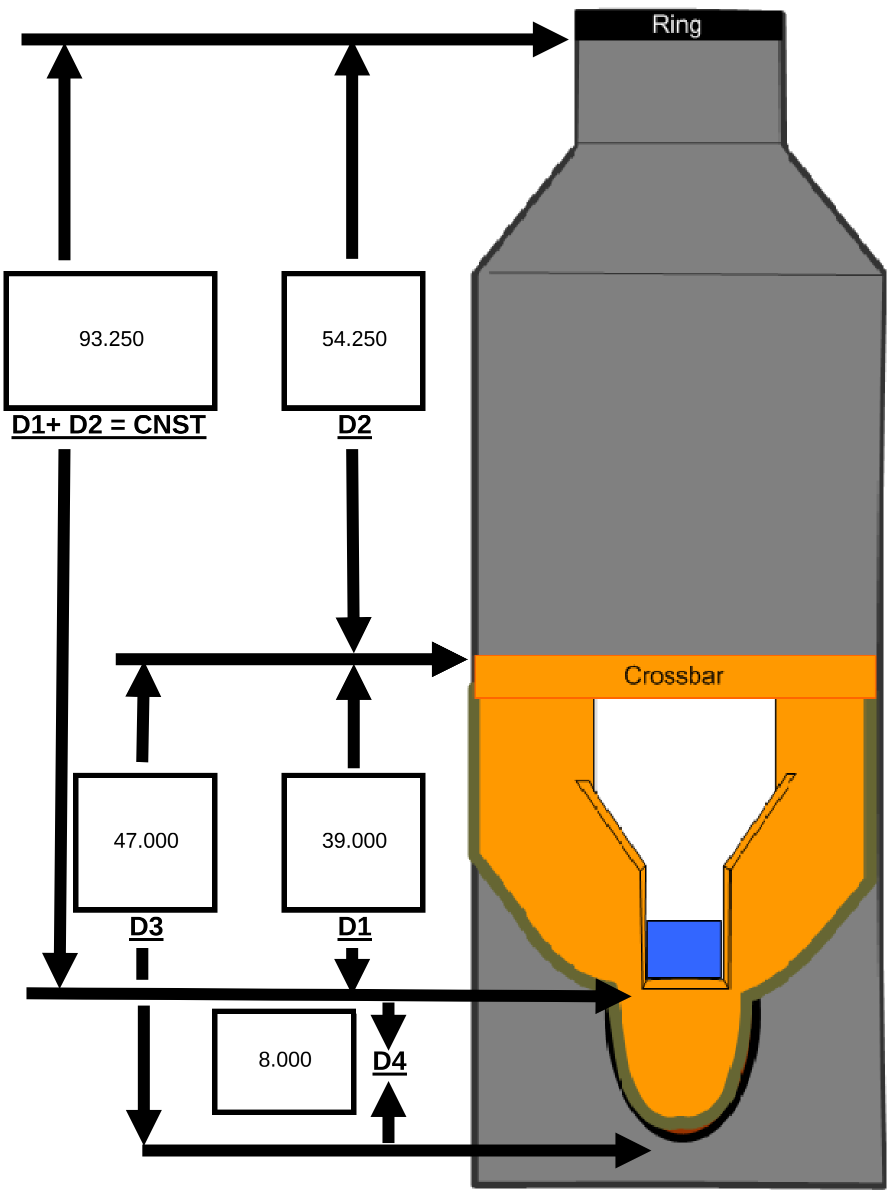
CCW Installation Form

CLIENT FLOW MONITORING #: **U12-118**
NAME: **Sweethome, Oregon**
Date / Time: Oct 16 2012

SFE PROJECT #: **U12-118**
SFE SITE #: **8A**
Technician 1: A Marshall 509-312-0612
Technician 2: Dylan Carvin

Meter Depth vs.. Field Depth Calibration / Verification

Reading Number	Date	Time	Field Meas (in.)	Meter Depth (in)	Comments (Zero Meter Level before Installation)
Initial	Oct 16 2012	14:10	3.250	3.28	Install
1	Oct 16 2012	14:13	3.000	3.04	
2	Oct 16 2012	14:16	3.000	3.10	
3	Oct 16 2012	14:20	3.000	2.96	
Average				.	



Constant Measurement (in)
Rim to Weir Lip
93.250

Pipe Diameters (in)
Pipe 1 10
Pipe 2 10
Pipe 3 NA
Pipe 4 NA

D4=Invert to Weir Lip (D3-D1)
8.000

Obvert to Weir Lip
NA

SFE Global

Final Check-off Sheet

CLIENT FLOW MONITORING #:	**U12-118**	**SFE PROJECT #:**	**U12-118**
NAME:	**Sweethome, Oregon**	**SFE SITE #:**	**8A**
Date / Time:	Oct 16 2012		

Flow Meter Information

Meter Make:	Isco	Logging Rate:	5 Minute
Meter Model:	2150	Flow Units:	CFS
Sensor Type	AV	Velocity Units:	FPS
Meter Serial Number:	NA	Depth Units	Inches
Battery Volts:	12.2	Surcharge Meter (Y/N):	Yes

Site Physical Information

Silt Level:	0	Weather:	Sunny
Slope:	NA	Weir Size:	600
Uniform Flow (Y/N)	Y	Depth Only(DO)	NA
Debris in Flow (Y/N):	Y	or Look up Table(LT)	LT
Pipe Material:	Concrete	Comments	

Check Off List

	Yes	No
Time Set:	x	
Depth Calibrated:	x	
Velocity Profile:		x
Download Data:	x	
Meter Running:	x	
Pipe Size Verified:	x	
Photograph Taken:	x	
Site Cleaned:	x	
Site Secured:	x	

Appendix 3

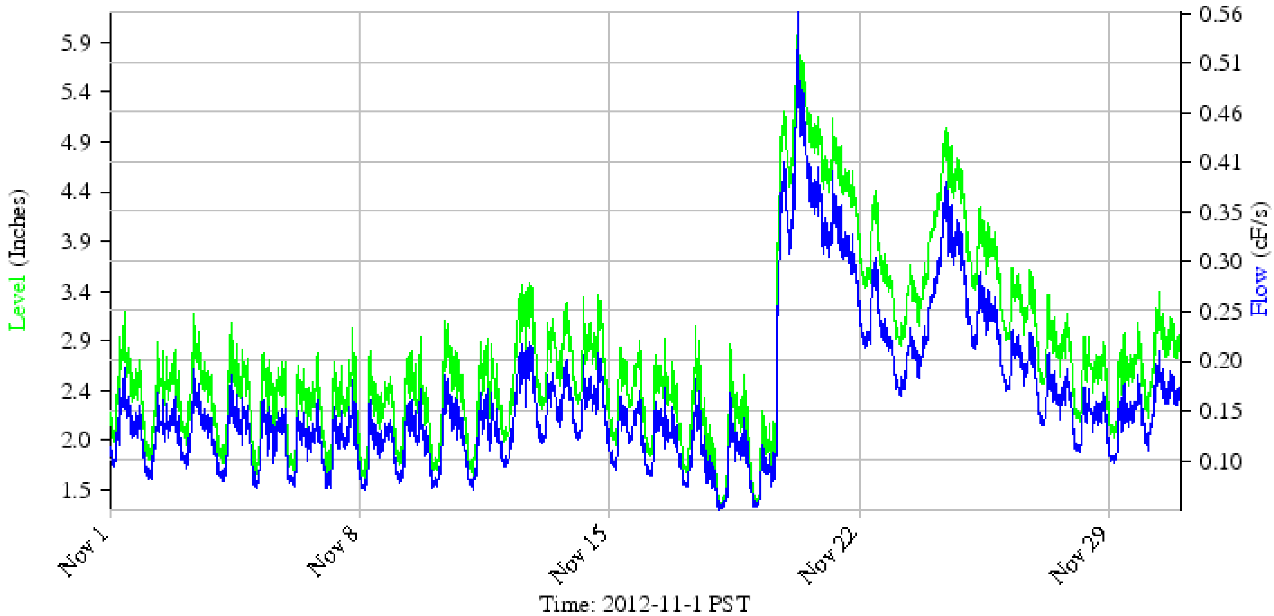
Data Summaries and Graphs

Site U12-118-1A

Summary Report - November, 2012

U12-118-1A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Nov	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.085	0.206	0.135	0.087
2	0.081	0.189	0.127	0.082
3	0.091	0.217	0.134	0.086
4	0.078	0.201	0.128	0.083
5	0.071	0.181	0.122	0.079
6	0.071	0.169	0.117	0.075
7	0.069	0.211	0.120	0.077
8	0.069	0.179	0.115	0.074
9	0.076	0.184	0.121	0.078
10	0.071	0.221	0.127	0.082
11	0.069	0.184	0.122	0.079
12	0.090	0.247	0.161	0.104
13	0.116	0.220	0.159	0.103
14	0.106	0.227	0.160	0.103
15	0.090	0.188	0.131	0.085
16	0.082	0.241	0.122	0.079
17	0.067	0.224	0.107	0.069
18	0.050	0.193	0.099	0.064
19	0.051	0.420	0.164	0.106
20	0.295	0.575	0.395	0.255
21	0.241	0.428	0.323	0.209
22	0.180	0.333	0.240	0.155
23	0.161	0.274	0.206	0.133
24	0.236	0.425	0.315	0.204
25	0.188	0.304	0.245	0.158
26	0.158	0.255	0.200	0.129
27	0.123	0.221	0.165	0.107
28	0.104	0.199	0.143	0.092
29	0.096	0.194	0.141	0.091
30	0.111	0.231	0.163	0.106
Mean	**0.113**	**0.251**	**0.167**	**0.108**
Maximum	**0.295**	**0.575**	**0.395**	**0.255**
Minimum	**0.050**	**0.169**	**0.099**	**0.064**
Total Flow (mg)		**3.234**		

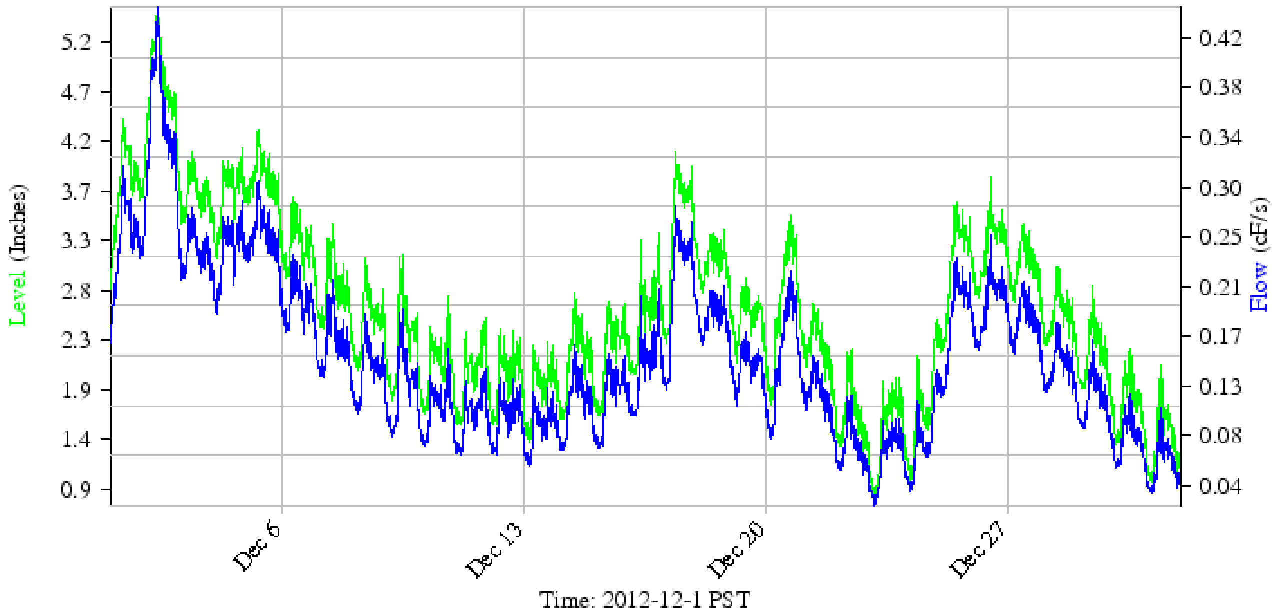
U12-118-1A
Levels with Flow



Summary Report - December, 2012

U12-118-1A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Dec	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.153	0.348	0.247	0.160
2	0.241	0.470	0.350	0.227
3	0.197	0.293	0.241	0.156
4	0.174	0.312	0.241	0.156
5	0.191	0.329	0.252	0.163
6	0.148	0.268	0.197	0.127
7	0.121	0.237	0.162	0.105
8	0.100	0.208	0.138	0.089
9	0.079	0.213	0.125	0.081
10	0.073	0.162	0.106	0.069
11	0.065	0.146	0.101	0.065
12	0.063	0.150	0.099	0.064
13	0.056	0.150	0.091	0.059
14	0.069	0.177	0.112	0.073
15	0.069	0.179	0.114	0.074
16	0.097	0.230	0.143	0.092
17	0.120	0.294	0.212	0.137
18	0.139	0.236	0.183	0.118
19	0.101	0.192	0.142	0.092
20	0.079	0.236	0.153	0.099
21	0.072	0.176	0.120	0.077
22	0.036	0.136	0.074	0.048
23	0.023	0.120	0.066	0.042
24	0.033	0.156	0.077	0.050
25	0.106	0.254	0.182	0.118
26	0.145	0.262	0.196	0.127
27	0.128	0.242	0.180	0.116
28	0.109	0.194	0.142	0.092
29	0.077	0.167	0.114	0.074
30	0.048	0.137	0.082	0.053
31	0.034	0.130	0.059	0.038
Mean	**0.101**	**0.219**	**0.152**	**0.098**
Maximum	**0.241**	**0.470**	**0.350**	**0.227**
Minimum	**0.023**	**0.120**	**0.059**	**0.038**
Total Flow (mg)		**3.039**		

U12-118-1A
Levels with Flow

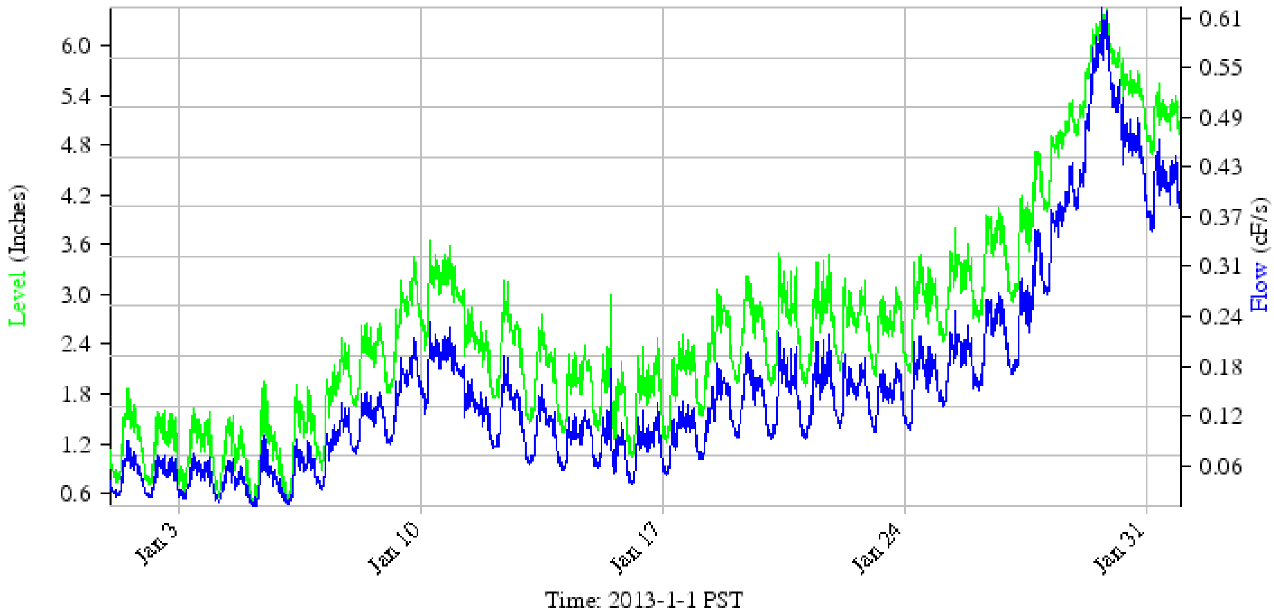


Summary Report - January, 2013

U12-118-1A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Jan	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.021	0.118	0.050	0.032
2	0.020	0.090	0.047	0.031
3	0.018	0.085	0.046	0.030
4	0.015	0.076	0.041	0.026
5	0.009	0.125	0.041	0.027
6	0.013	0.108	0.052	0.033
7	0.029	0.150	0.086	0.056
8	0.075	0.172	0.118	0.076
9	0.085	0.244	0.153	0.099
10	0.123	0.253	0.188	0.122
11	0.101	0.203	0.146	0.095
12	0.081	0.219	0.127	0.082
13	0.061	0.185	0.101	0.066
14	0.053	0.149	0.093	0.060
15	0.045	0.197	0.085	0.055
16	0.036	0.148	0.085	0.055
17	0.047	0.184	0.096	0.062
18	0.065	0.227	0.127	0.082
19	0.093	0.222	0.146	0.094
20	0.091	0.230	0.149	0.096
21	0.091	0.243	0.149	0.097
22	0.105	0.213	0.153	0.099
23	0.101	0.195	0.147	0.095
24	0.104	0.237	0.165	0.107
25	0.130	0.277	0.188	0.121
26	0.149	0.285	0.218	0.141
27	0.170	0.369	0.251	0.162
28	0.261	0.455	0.357	0.231
29	0.368	0.642	0.518	0.335
30	0.377	0.560	0.469	0.303
31	0.327	0.490	0.403	0.260
Mean	**0.105**	**0.237**	**0.161**	**0.104**
Maximum	**0.377**	**0.642**	**0.518**	**0.335**
Minimum	**0.009**	**0.076**	**0.041**	**0.026**
Total Flow (mg)	**3.229**			

U12-118-1A

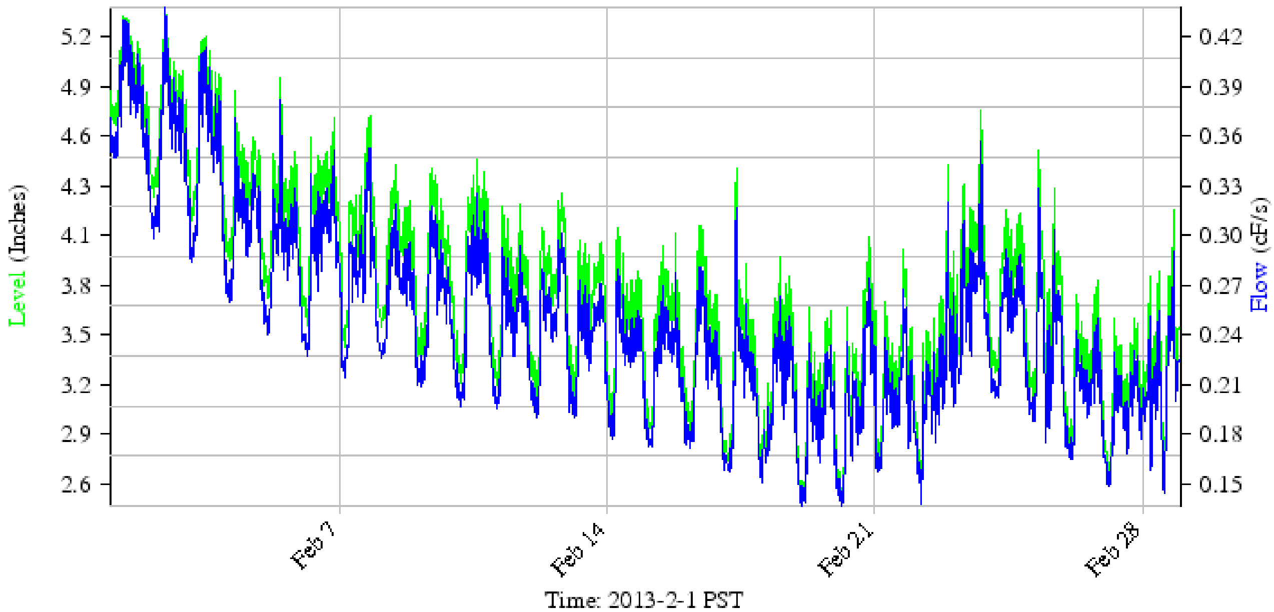
Levels with Flow



Summary Report - February, 2013

U12-118-1A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Feb	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.324	0.459	0.378	0.245
2	0.292	0.454	0.355	0.229
3	0.274	0.445	0.343	0.222
4	0.254	0.381	0.301	0.194
5	0.236	0.411	0.288	0.186
6	0.217	0.374	0.287	0.186
7	0.211	0.370	0.274	0.177
8	0.220	0.331	0.265	0.171
9	0.203	0.339	0.256	0.165
10	0.188	0.359	0.256	0.165
11	0.190	0.317	0.241	0.156
12	0.187	0.312	0.245	0.158
13	0.181	0.284	0.234	0.151
14	0.174	0.289	0.224	0.145
15	0.169	0.280	0.220	0.142
16	0.165	0.297	0.219	0.141
17	0.151	0.329	0.206	0.133
18	0.146	0.275	0.203	0.131
19	0.128	0.246	0.184	0.119
20	0.134	0.282	0.195	0.126
21	0.152	0.289	0.200	0.129
22	0.131	0.329	0.202	0.130
23	0.189	0.379	0.257	0.166
24	0.198	0.312	0.243	0.157
25	0.156	0.332	0.229	0.148
26	0.158	0.261	0.202	0.131
27	0.144	0.241	0.191	0.123
28	0.141	0.314	0.211	0.136
Mean	**0.190**	**0.332**	**0.247**	**0.159**
Maximum	**0.324**	**0.459**	**0.378**	**0.245**
Minimum	**0.128**	**0.241**	**0.184**	**0.119**
Total Flow (mg)		**4.464**		

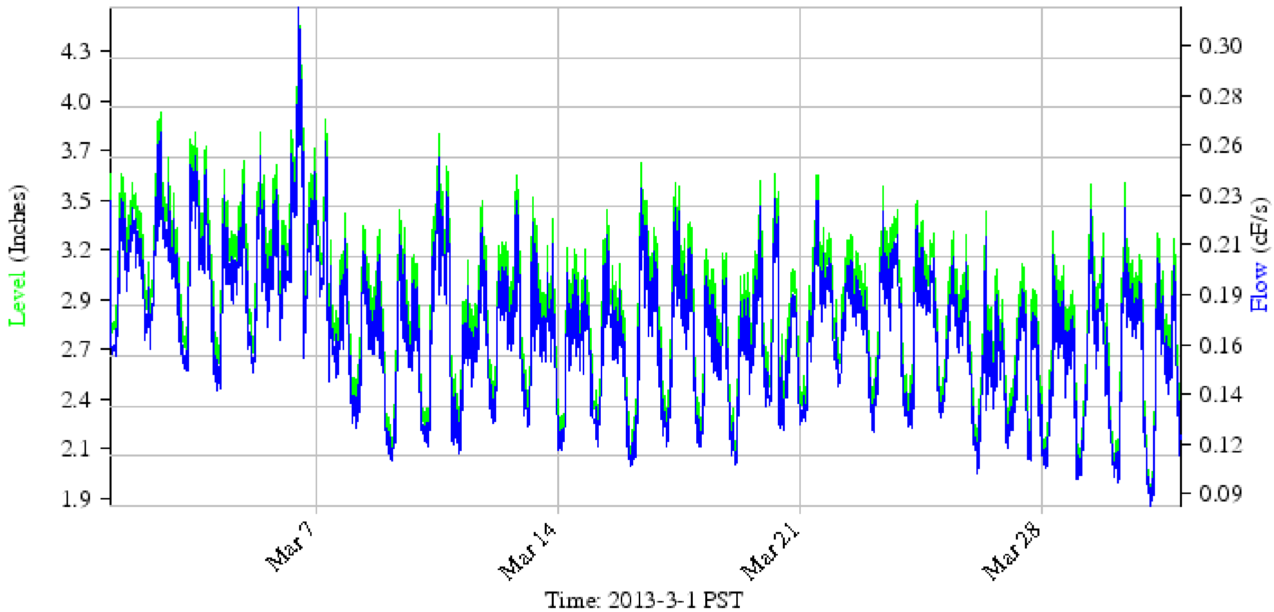
U12-118-1A
Levels with Flow



Summary Report - March, 2013

U12-118-1A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Mar	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.150	0.244	0.200	0.129
2	0.157	0.286	0.205	0.132
3	0.140	0.257	0.200	0.129
4	0.140	0.244	0.190	0.123
5	0.148	0.263	0.195	0.126
6	0.149	0.329	0.221	0.143
7	0.131	0.273	0.181	0.117
8	0.117	0.225	0.162	0.105
9	0.108	0.228	0.157	0.102
10	0.111	0.259	0.174	0.112
11	0.100	0.228	0.160	0.104
12	0.124	0.267	0.172	0.111
13	0.117	0.227	0.164	0.106
14	0.111	0.218	0.159	0.103
15	0.109	0.228	0.159	0.103
16	0.103	0.253	0.166	0.107
17	0.111	0.237	0.168	0.109
18	0.113	0.210	0.158	0.102
19	0.106	0.231	0.160	0.103
20	0.121	0.245	0.162	0.104
21	0.123	0.241	0.177	0.114
22	0.138	0.218	0.175	0.113
23	0.120	0.231	0.177	0.114
24	0.118	0.230	0.172	0.111
25	0.120	0.211	0.166	0.107
26	0.101	0.219	0.147	0.095
27	0.096	0.220	0.147	0.095
28	0.098	0.278	0.151	0.098
29	0.096	0.261	0.155	0.100
30	0.093	0.237	0.158	0.102
31	0.085	0.216	0.146	0.094
Mean	**0.118**	**0.242**	**0.170**	**0.110**
Maximum	**0.157**	**0.329**	**0.221**	**0.143**
Minimum	**0.085**	**0.210**	**0.146**	**0.094**
Total Flow (mg)		**3.414**		

U12-118-1A
Levels with Flow

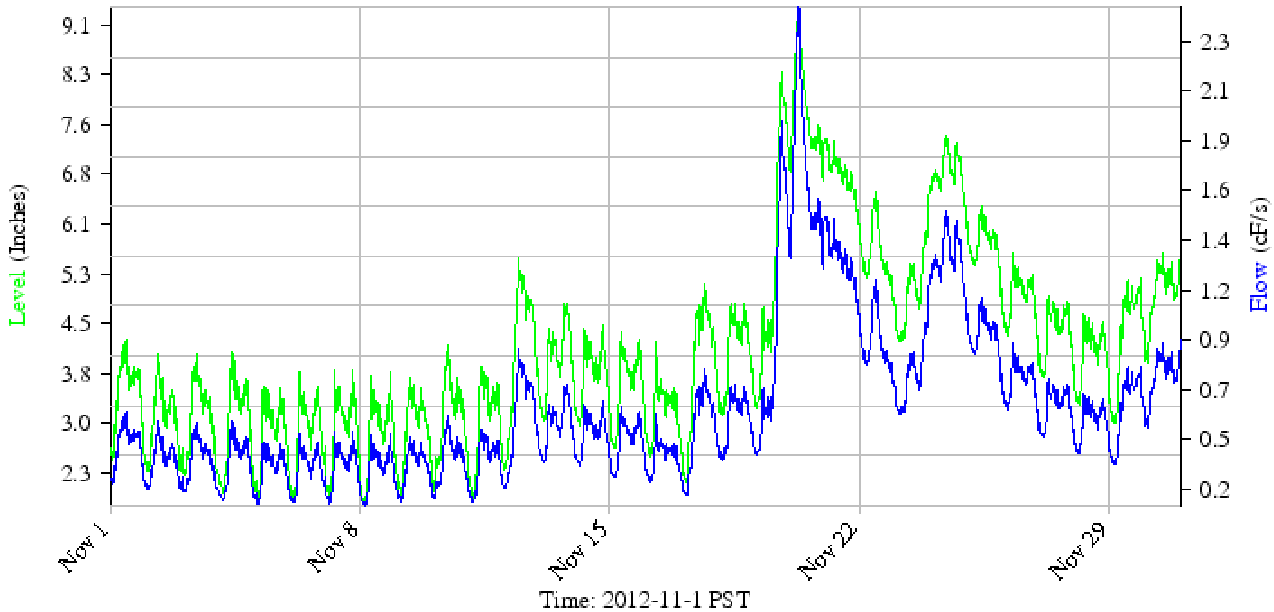


Site U12-118-2

Summary Report - November, 2012

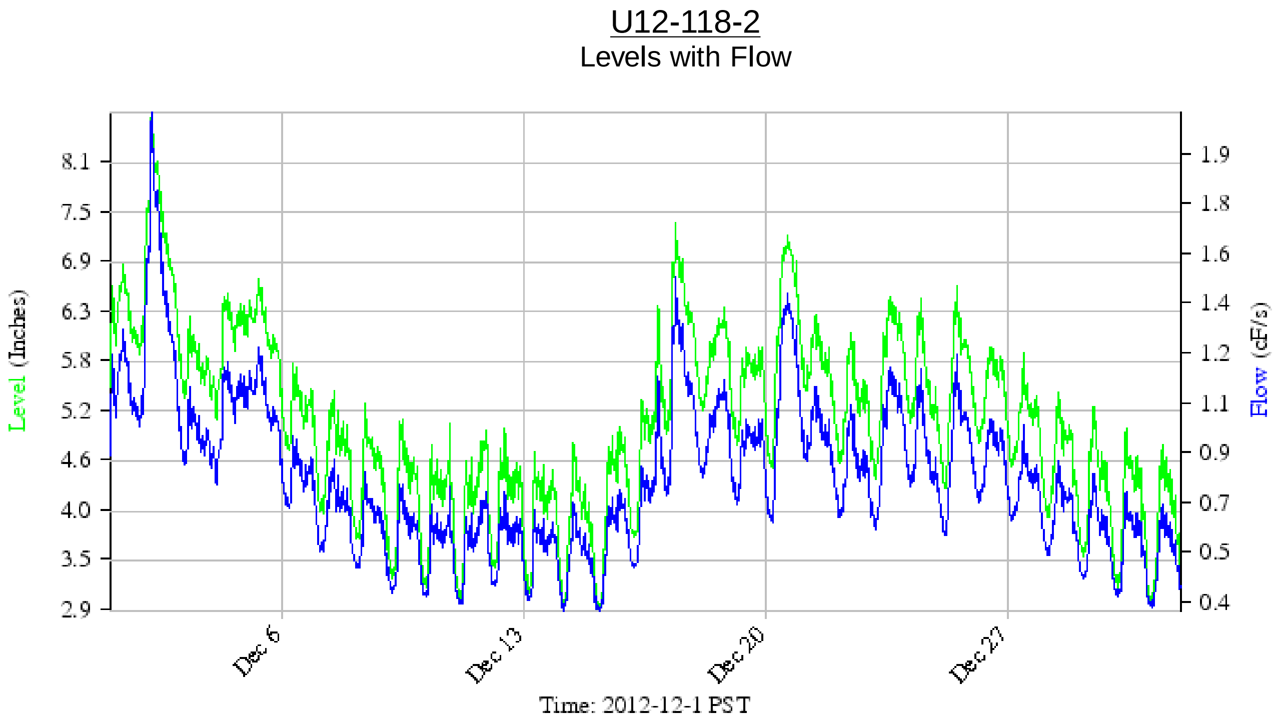
U12-118-2	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Nov	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.242	0.609	0.427	0.276
2	0.229	0.562	0.367	0.237
3	0.218	0.566	0.368	0.238
4	0.177	0.568	0.362	0.234
5	0.159	0.471	0.323	0.209
6	0.169	0.511	0.326	0.211
7	0.163	0.533	0.341	0.220
8	0.151	0.519	0.327	0.212
9	0.173	0.499	0.333	0.215
10	0.178	0.614	0.368	0.238
11	0.168	0.554	0.353	0.228
12	0.227	0.928	0.577	0.373
13	0.352	0.749	0.538	0.348
14	0.340	0.652	0.494	0.320
15	0.282	0.676	0.457	0.295
16	0.259	0.609	0.387	0.250
17	0.200	0.805	0.518	0.335
18	0.362	0.743	0.560	0.362
19	0.383	2.062	0.918	0.594
20	1.251	2.511	1.709	1.104
21	1.040	1.547	1.308	0.845
22	0.696	1.235	0.912	0.590
23	0.577	1.266	0.785	0.508
24	1.032	1.566	1.324	0.855
25	0.715	1.162	0.962	0.622
26	0.591	0.940	0.742	0.479
27	0.470	0.753	0.620	0.401
28	0.398	0.706	0.553	0.357
29	0.345	0.829	0.616	0.398
30	0.508	0.955	0.758	0.490
Mean	**0.402**	**0.890**	**0.621**	**0.401**
Maximum	**1.251**	**2.511**	**1.709**	**1.104**
Minimum	**0.151**	**0.471**	**0.323**	**0.209**
Total Flow (mg)	**12.044**			

U12-118-2
Levels with Flow



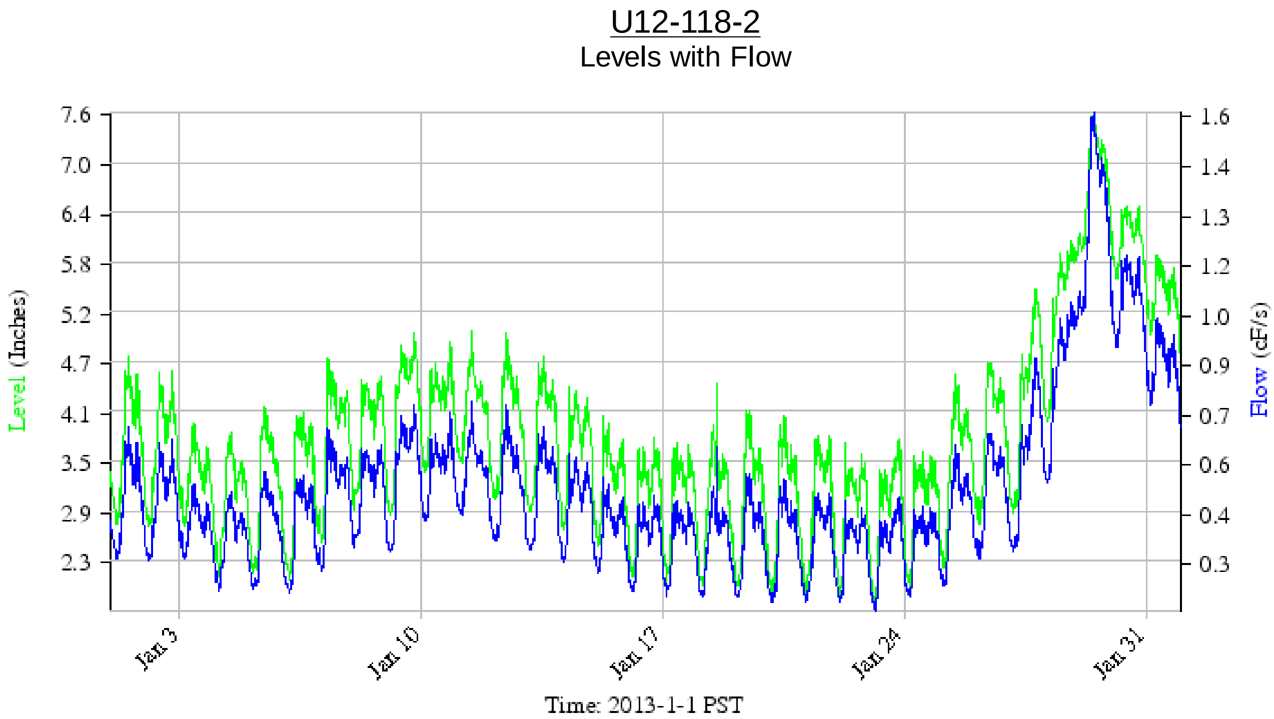
Summary Report - December, 2012

U12-118-2	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Dec	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.851	1.354	1.111	0.718
2	0.996	2.137	1.509	0.975
3	0.818	1.152	0.934	0.604
4	0.767	1.219	1.043	0.674
5	0.780	1.296	1.067	0.690
6	0.640	0.966	0.790	0.511
7	0.522	0.881	0.681	0.440
8	0.466	0.838	0.620	0.400
9	0.385	0.791	0.573	0.370
10	0.356	0.810	0.543	0.351
11	0.333	0.774	0.552	0.357
12	0.403	0.780	0.563	0.364
13	0.350	0.700	0.526	0.340
14	0.319	0.715	0.507	0.328
15	0.316	0.766	0.556	0.359
16	0.471	1.197	0.722	0.467
17	0.718	1.541	1.093	0.707
18	0.791	1.166	0.967	0.625
19	0.695	1.049	0.881	0.569
20	0.628	1.495	1.099	0.710
21	0.766	1.168	0.947	0.612
22	0.641	1.095	0.825	0.533
23	0.600	1.225	0.935	0.604
24	0.732	1.217	0.887	0.573
25	0.579	1.235	0.894	0.578
26	0.685	1.050	0.860	0.556
27	0.620	1.018	0.768	0.496
28	0.514	0.870	0.666	0.430
29	0.432	0.851	0.593	0.383
30	0.362	0.768	0.546	0.353
31	0.328	0.738	0.503	0.325
Mean	**0.576**	**1.060**	**0.799**	**0.516**
Maximum	**0.996**	**2.137**	**1.509**	**0.975**
Minimum	**0.316**	**0.700**	**0.503**	**0.325**
Total Flow (mg)		**16.003**		


U12-118-2
Levels with Flow
Level (Inches)
8.1
7.5
6.9
6.3
5.8
5.2
4.6
4.0
3.5
2.9
Flow (cF/s)
1.9
1.8
1.6
1.4
1.2
1.1
0.9
0.7
0.5
0.4
Dec 6
Dec 13
Dec 20
Dec 27
Time: 2012-12-1 PST

Summary Report - January, 2013

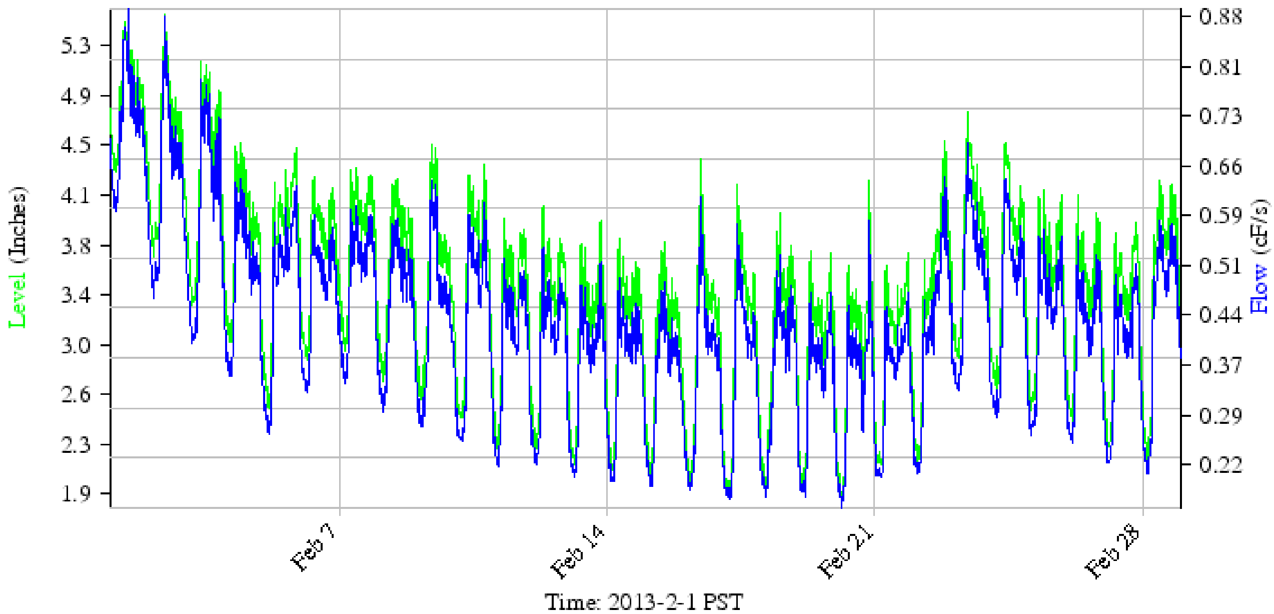
U12-118-2	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Jan	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.305	0.730	0.483	0.312
2	0.299	0.677	0.473	0.306
3	0.297	0.581	0.406	0.262
4	0.209	0.517	0.366	0.237
5	0.214	0.603	0.387	0.250
6	0.205	0.573	0.396	0.256
7	0.271	0.727	0.501	0.324
8	0.329	0.670	0.515	0.333
9	0.319	0.783	0.570	0.368
10	0.410	0.753	0.572	0.370
11	0.432	0.791	0.565	0.365
12	0.355	0.810	0.531	0.343
13	0.328	0.717	0.510	0.330
14	0.297	0.672	0.470	0.304
15	0.267	0.581	0.398	0.257
16	0.207	0.517	0.366	0.237
17	0.185	0.533	0.361	0.233
18	0.193	0.834	0.362	0.234
19	0.192	0.597	0.370	0.239
20	0.176	0.568	0.358	0.232
21	0.175	0.523	0.356	0.230
22	0.170	0.488	0.338	0.219
23	0.155	0.512	0.339	0.219
24	0.194	0.484	0.357	0.231
25	0.222	0.666	0.444	0.287
26	0.297	0.699	0.510	0.330
27	0.315	0.910	0.596	0.385
28	0.520	1.086	0.831	0.537
29	0.996	1.633	1.304	0.843
30	0.900	1.214	1.062	0.687
31	0.674	1.031	0.872	0.564
Mean	**0.326**	**0.725**	**0.515**	**0.333**
Maximum	**0.996**	**1.633**	**1.304**	**0.843**
Minimum	**0.155**	**0.484**	**0.338**	**0.219**
Total Flow (mg)		**10.322**		


U12-118-2
Levels with Flow
Level (Inches)
7.6
7.0
6.4
5.8
5.2
4.7
4.1
3.5
2.9
2.3
Flow (cF/s)
1.6
1.4
1.3
1.2
1.0
0.9
0.7
0.6
0.4
0.3
Jan 3
Jan 10
Jan 17
Jan 24
Jan 31
Time: 2013-1-1 PST

Summary Report - February, 2013

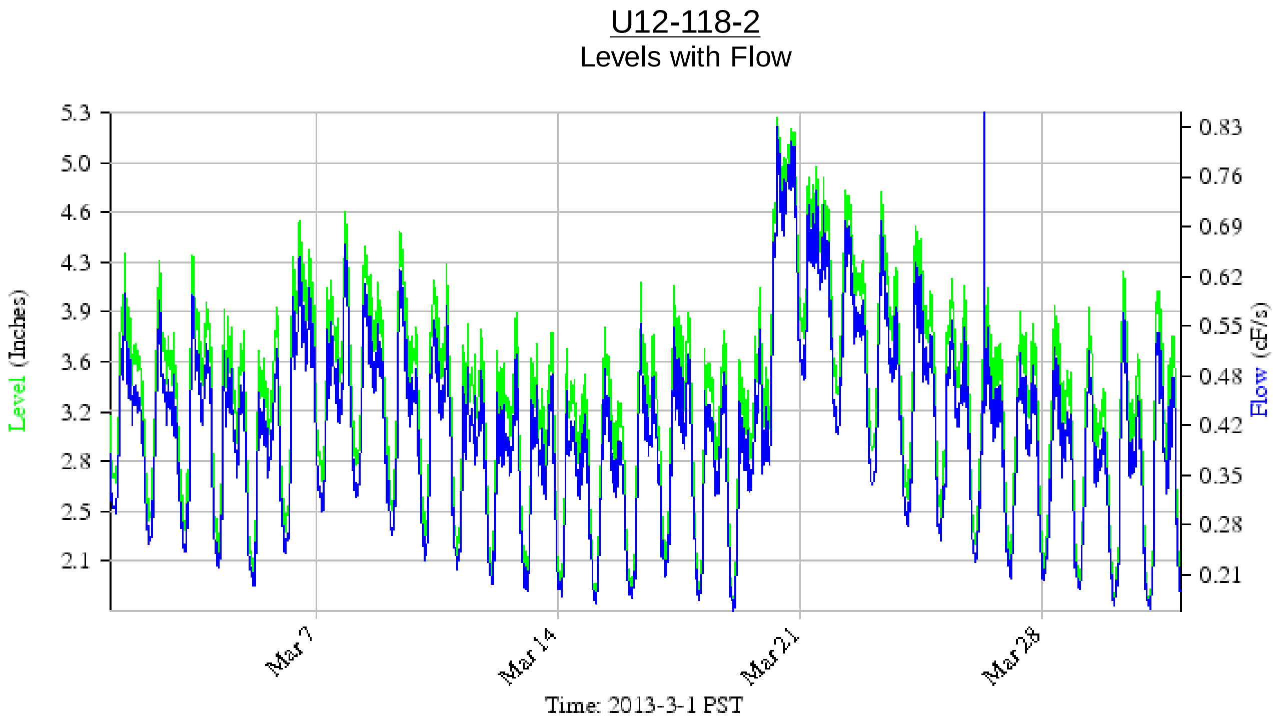
U12-118-2	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Feb	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.583	0.927	0.719	0.465
2	0.464	0.922	0.638	0.412
3	0.398	0.804	0.592	0.382
4	0.344	0.669	0.495	0.320
5	0.261	0.651	0.471	0.304
6	0.322	0.610	0.470	0.304
7	0.334	0.622	0.493	0.319
8	0.293	0.618	0.459	0.297
9	0.274	0.658	0.441	0.285
10	0.241	0.620	0.433	0.280
11	0.214	0.555	0.392	0.253
12	0.218	0.570	0.384	0.248
13	0.194	0.551	0.367	0.237
14	0.191	0.520	0.360	0.233
15	0.185	0.508	0.347	0.225
16	0.177	0.624	0.358	0.231
17	0.169	0.592	0.349	0.226
18	0.165	0.569	0.354	0.229
19	0.169	0.493	0.335	0.217
20	0.153	0.588	0.334	0.216
21	0.198	0.491	0.345	0.223
22	0.204	0.692	0.411	0.266
23	0.323	0.725	0.493	0.318
24	0.288	0.661	0.456	0.295
25	0.262	0.587	0.427	0.276
26	0.247	0.577	0.402	0.260
27	0.219	0.537	0.382	0.247
28	0.199	0.605	0.436	0.282
Mean	**0.260**	**0.627**	**0.434**	**0.280**
Maximum	**0.583**	**0.927**	**0.719**	**0.465**
Minimum	**0.153**	**0.491**	**0.334**	**0.216**
Total Flow (mg)	**7.848**			

U12-118-2
Levels with Flow



Summary Report - March, 2013

U12-118-2	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Mar	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.290	0.629	0.426	0.276
2	0.247	0.628	0.406	0.262
3	0.233	0.616	0.413	0.267
4	0.213	0.545	0.380	0.245
5	0.186	0.543	0.360	0.233
6	0.228	0.665	0.473	0.306
7	0.292	0.673	0.457	0.295
8	0.311	0.657	0.460	0.297
9	0.260	0.655	0.427	0.276
10	0.219	0.586	0.403	0.261
11	0.206	0.513	0.365	0.236
12	0.180	0.541	0.351	0.227
13	0.183	0.513	0.342	0.221
14	0.175	0.491	0.331	0.214
15	0.164	0.516	0.329	0.212
16	0.170	0.587	0.353	0.228
17	0.196	0.560	0.371	0.240
18	0.167	0.504	0.342	0.221
19	0.155	0.561	0.360	0.233
20	0.354	0.844	0.656	0.424
21	0.424	0.762	0.606	0.392
22	0.357	0.736	0.539	0.349
23	0.310	0.716	0.482	0.312
24	0.262	0.694	0.450	0.291
25	0.233	0.598	0.412	0.266
26	0.222	0.982	0.387	0.250
27	0.202	0.526	0.372	0.240
28	0.195	0.532	0.358	0.231
29	0.184	0.528	0.340	0.220
30	0.162	0.593	0.347	0.224
31	0.157	0.571	0.349	0.225
Mean	**0.230**	**0.615**	**0.408**	**0.264**
Maximum	**0.424**	**0.982**	**0.656**	**0.424**
Minimum	**0.155**	**0.491**	**0.329**	**0.212**
Total Flow (mg)		**8.174**		



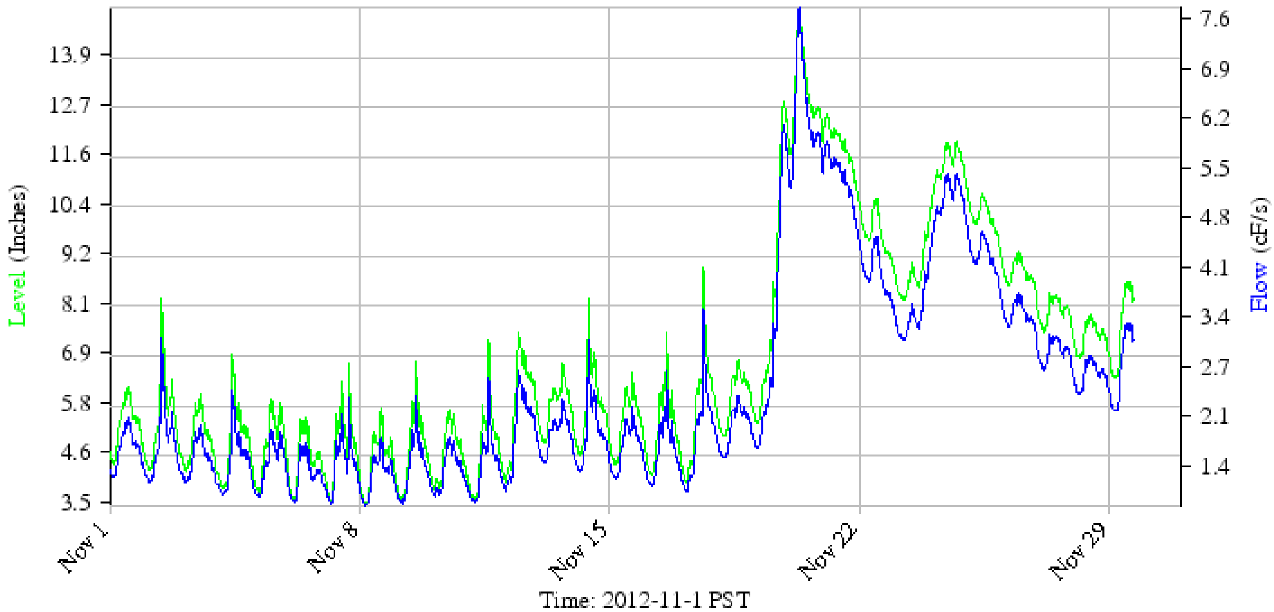
U12-118-2
Levels with Flow
Level (Inches)
Flow (cF/s)
5.3
5.0
4.6
4.3
3.9
3.6
3.2
2.8
2.5
2.1
0.83
0.76
0.69
0.62
0.55
0.48
0.42
0.35
0.28
0.21
Mar 7
Mar 14
Mar 21
Mar 28
Time: 2013-3-1 PST

Site U12-118-3

Summary Report - November, 2012

U12-118-3	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Nov	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	1.207	2.051	1.601	1.035
2	1.141	3.233	1.670	1.079
3	1.102	1.978	1.460	0.944
4	0.975	2.455	1.476	0.954
5	0.932	1.890	1.396	0.902
6	0.866	1.752	1.260	0.814
7	0.859	2.357	1.395	0.902
8	0.827	1.813	1.261	0.815
9	0.849	2.399	1.339	0.866
10	0.945	1.781	1.322	0.854
11	0.875	2.648	1.386	0.896
12	1.030	2.724	1.853	1.198
13	1.408	2.320	1.813	1.171
14	1.294	3.199	1.808	1.168
15	1.195	2.224	1.628	1.052
16	1.097	2.716	1.591	1.028
17	1.022	3.556	1.810	1.170
18	1.485	2.352	1.906	1.232
19	1.625	6.116	3.162	2.043
20	5.193	7.740	6.203	4.009
21	4.473	5.872	5.337	3.449
22	3.469	4.615	4.022	2.600
23	3.099	4.353	3.474	2.245
24	4.382	5.435	5.056	3.268
25	3.598	4.782	4.272	2.761
26	2.965	3.793	3.463	2.238
27	2.611	3.227	2.945	1.903
28	2.367	2.919	2.636	1.704
29	2.127	3.471	2.732	1.766
30	na	na	na	na
Mean	**1.897**	**3.302**	**2.458**	**1.589**
Maximum	**5.193**	**7.740**	**6.203**	**4.009**
Minimum	**0.827**	**1.752**	**1.260**	**0.814**
Total Flow (mg)	**46.067**			

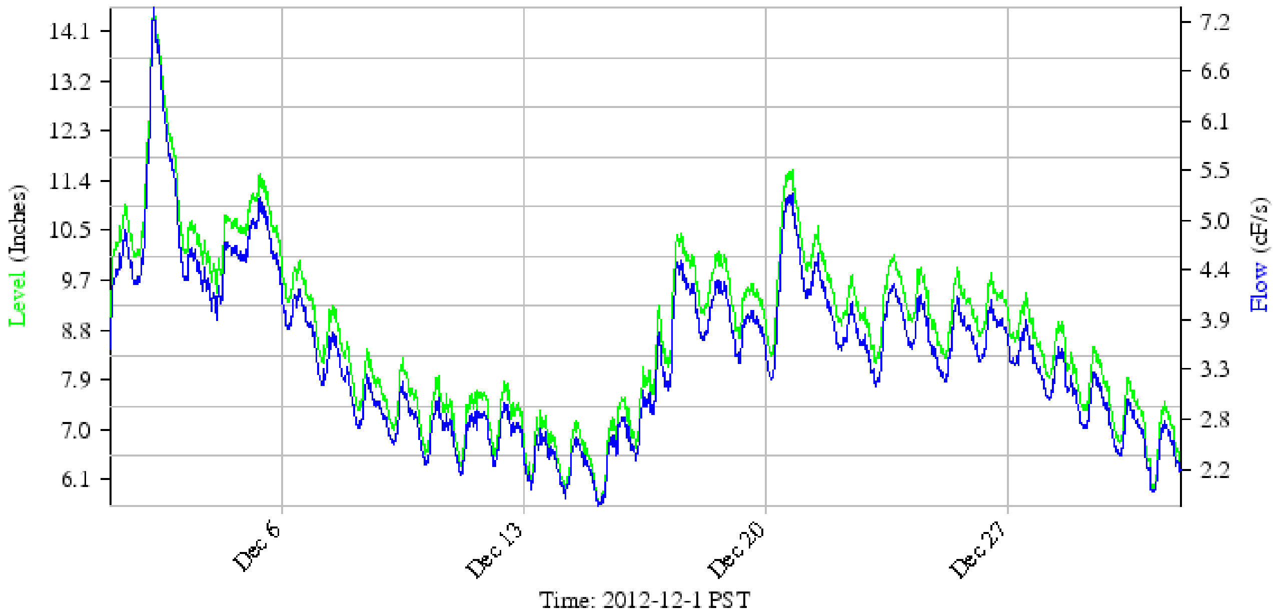
U12-118-3
Levels with Flow



Summary Report - December, 2012

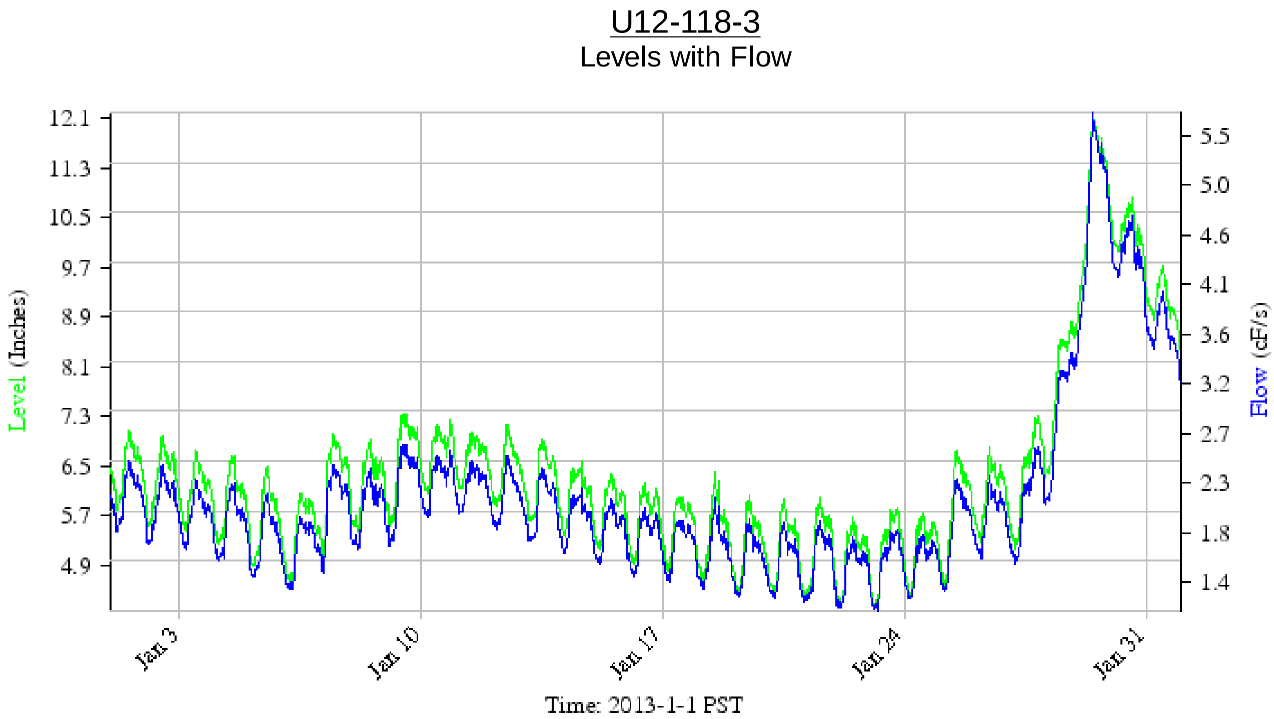
U12-118-3	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Dec	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	3.517	4.881	4.408	2.849
2	4.734	7.372	6.047	3.908
3	3.946	4.783	4.391	2.838
4	3.839	4.759	4.462	2.884
5	4.081	5.294	4.797	3.100
6	3.389	4.253	3.901	2.521
7	3.003	3.769	3.357	2.170
8	2.655	3.294	2.900	1.874
9	2.469	3.215	2.774	1.793
10	2.257	3.024	2.624	1.696
11	2.124	2.873	2.593	1.676
12	2.226	2.964	2.612	1.688
13	1.979	2.679	2.344	1.515
14	1.869	2.591	2.242	1.449
15	1.794	2.794	2.314	1.495
16	2.285	3.790	2.870	1.855
17	3.079	4.549	3.956	2.557
18	3.626	4.340	3.988	2.577
19	3.358	3.978	3.734	2.414
20	3.197	5.291	4.370	2.825
21	3.789	4.610	4.214	2.723
22	3.381	4.110	3.686	2.382
23	3.103	4.286	3.759	2.430
24	3.283	4.167	3.717	2.402
25	3.167	4.142	3.648	2.358
26	3.389	4.096	3.720	2.404
27	3.185	3.869	3.492	2.257
28	2.962	3.569	3.200	2.068
29	2.654	3.324	2.925	1.891
30	2.231	3.014	2.636	1.704
31	1.949	2.752	2.348	1.518
Mean	**2.985**	**3.949**	**3.485**	**2.252**
Maximum	**4.734**	**7.372**	**6.047**	**3.908**
Minimum	**1.794**	**2.591**	**2.242**	**1.449**
Total Flow (mg)		**69.821**		

U12-118-3
Levels with Flow



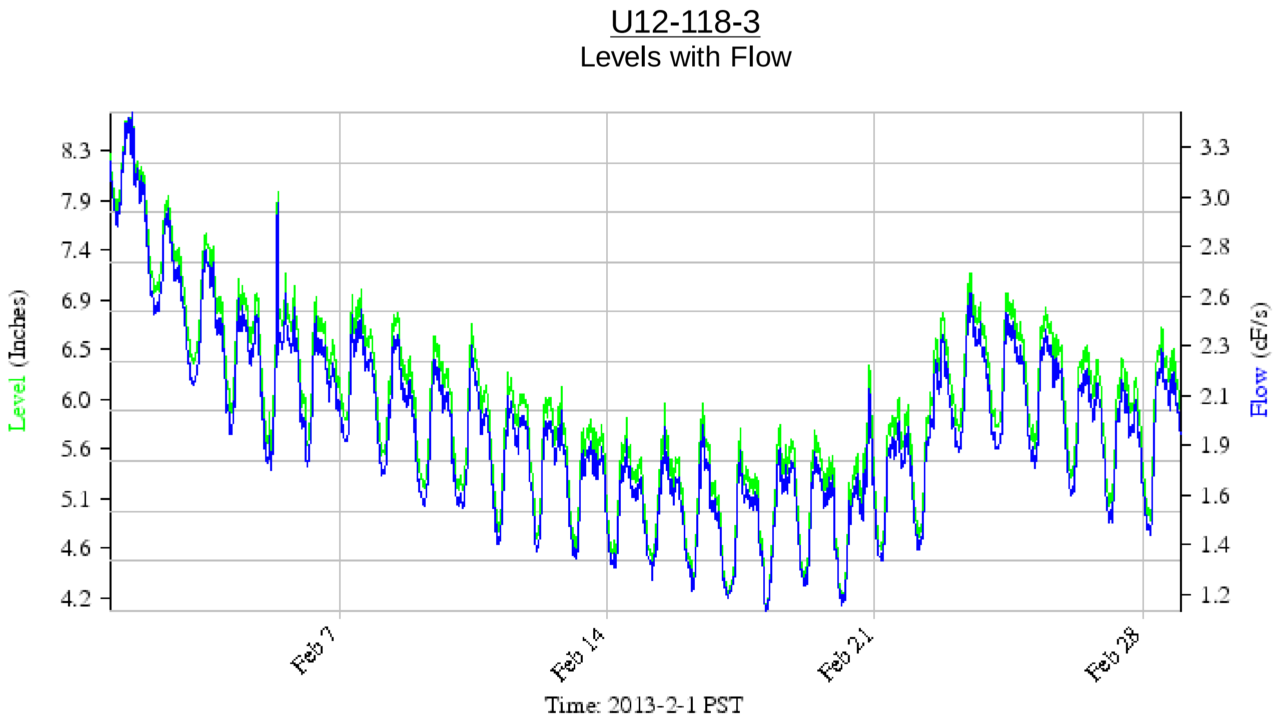
Summary Report - January, 2013

U12-118-3	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Jan	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	1.833	2.489	2.175	1.406
2	1.708	2.484	2.099	1.357
3	1.671	2.341	1.999	1.292
4	1.576	2.283	1.915	1.238
5	1.412	2.199	1.771	1.145
6	1.301	1.990	1.676	1.083
7	1.456	2.475	2.070	1.338
8	1.668	2.448	2.065	1.335
9	1.705	2.656	2.268	1.466
10	1.930	2.590	2.305	1.490
11	1.993	2.542	2.265	1.464
12	1.851	2.554	2.175	1.406
13	1.750	2.422	2.080	1.345
14	1.635	2.240	1.954	1.263
15	1.523	2.160	1.855	1.199
16	1.427	2.069	1.783	1.152
17	1.379	1.972	1.715	1.108
18	1.260	2.156	1.671	1.080
19	1.231	2.013	1.578	1.020
20	1.215	1.944	1.556	1.006
21	1.196	1.956	1.552	1.003
22	1.123	1.794	1.490	0.963
23	1.044	1.871	1.544	0.998
24	1.213	1.819	1.566	1.012
25	1.279	2.341	1.863	1.204
26	1.545	2.400	1.973	1.275
27	1.530	2.639	2.089	1.350
28	2.077	3.498	2.901	1.875
29	3.424	5.694	4.790	3.096
30	3.806	4.767	4.367	2.822
31	3.198	4.064	3.669	2.371
Mean	**1.708**	**2.544**	**2.154**	**1.392**
Maximum	**3.806**	**5.694**	**4.790**	**3.096**
Minimum	**1.044**	**1.794**	**1.490**	**0.963**
Total Flow (mg)		**43.161**		


U12-118-3
Levels with Flow
12.1
11.3
10.5
9.7
8.9
8.1
7.3
6.5
5.7
4.9
Level (Inches)
5.5
5.0
4.6
4.1
3.6
3.2
2.7
2.3
1.8
1.4
Flow (cF/s)
Jan 3
Jan 10
Jan 17
Jan 24
Jan 31
Time: 2013-1-1 PST

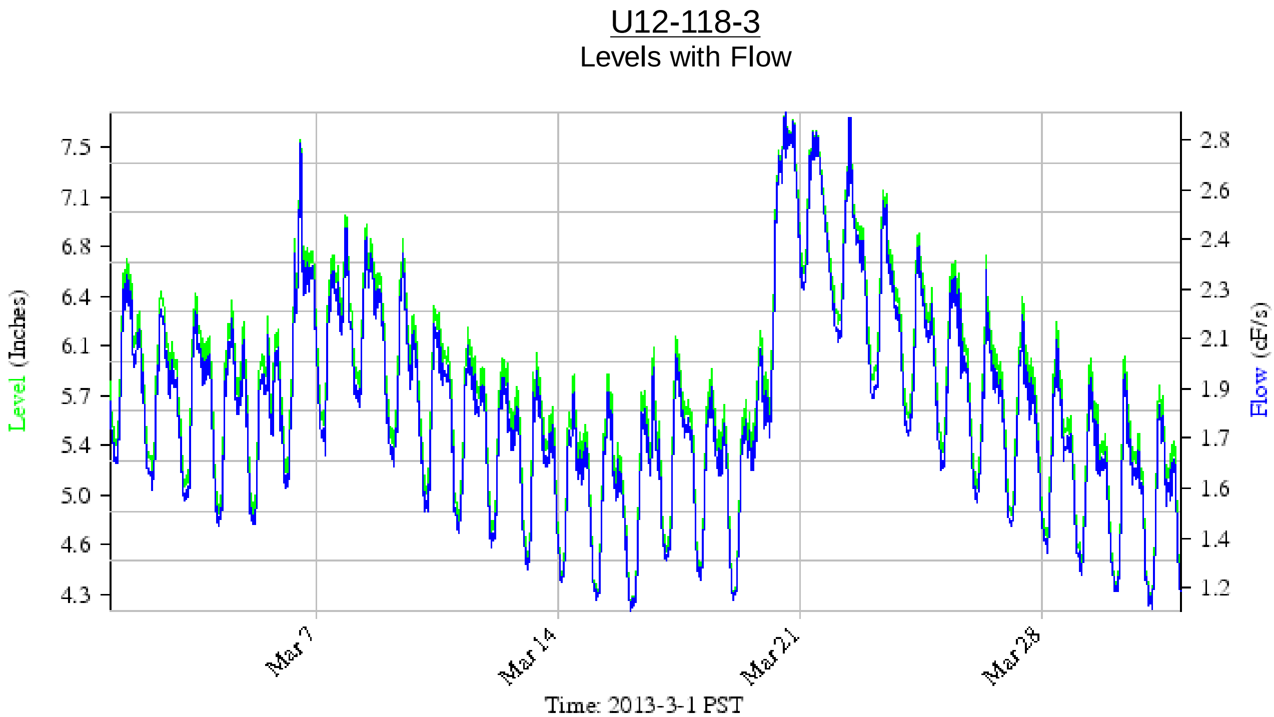
Summary Report - February, 2013

U12-118-3	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Feb	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	2.773	3.518	3.098	2.002
2	2.364	2.979	2.654	1.715
3	2.128	2.782	2.429	1.570
4	1.904	2.556	2.253	1.456
5	1.729	3.018	2.187	1.414
6	1.759	2.503	2.123	1.372
7	1.872	2.501	2.183	1.411
8	1.713	2.398	2.041	1.319
9	1.565	2.284	1.924	1.243
10	1.560	2.333	1.890	1.221
11	1.377	2.099	1.800	1.163
12	1.358	2.042	1.747	1.129
13	1.324	1.882	1.660	1.073
14	1.253	1.922	1.579	1.021
15	1.219	1.975	1.572	1.016
16	1.175	1.958	1.524	0.985
17	1.138	1.865	1.471	0.951
18	1.087	1.850	1.519	0.981
19	1.198	1.850	1.536	0.993
20	1.112	2.135	1.539	0.995
21	1.313	1.984	1.699	1.098
22	1.366	2.404	1.900	1.228
23	1.824	2.604	2.190	1.415
24	1.819	2.491	2.159	1.396
25	1.743	2.408	2.103	1.359
26	1.625	2.233	1.966	1.270
27	1.488	2.180	1.868	1.207
28	1.433	2.331	1.946	1.258
Mean	**1.579**	**2.325**	**1.949**	**1.259**
Maximum	**2.773**	**3.518**	**3.098**	**2.002**
Minimum	**1.087**	**1.850**	**1.471**	**0.951**
Total Flow (mg)	**35.263**			


U12-118-3
Levels with Flow
Level (Inches)
8.3
7.9
7.4
6.9
6.5
6.0
5.6
5.1
4.6
4.2
Flow (cF/s)
3.3
3.0
2.8
2.6
2.3
2.1
1.9
1.6
1.4
1.2
Feb 7
Feb 14
Feb 21
Feb 28
Time: 2013-2-1 PST

Summary Report - March, 2013

U12-118-3	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Mar	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	1.640	2.342	1.979	1.279
2	1.543	2.200	1.872	1.210
3	1.508	2.182	1.849	1.195
4	1.417	2.165	1.809	1.169
5	1.420	2.097	1.787	1.155
6	1.542	2.781	2.108	1.363
7	1.663	2.496	2.101	1.358
8	1.833	2.458	2.132	1.378
9	1.621	2.395	1.947	1.259
10	1.455	2.144	1.816	1.174
11	1.397	2.061	1.762	1.139
12	1.343	1.949	1.685	1.089
13	1.273	1.995	1.629	1.053
14	1.227	1.896	1.562	1.009
15	1.166	1.912	1.510	0.976
16	1.129	2.020	1.543	0.997
17	1.240	2.032	1.645	1.063
18	1.229	1.925	1.586	1.025
19	1.159	2.051	1.644	1.062
20	1.720	2.903	2.482	1.604
21	2.133	2.820	2.495	1.613
22	1.986	2.929	2.348	1.518
23	1.809	2.567	2.161	1.397
24	1.709	2.419	2.033	1.314
25	1.592	2.311	1.946	1.258
26	1.489	2.332	1.829	1.182
27	1.419	2.218	1.756	1.135
28	1.322	2.135	1.658	1.071
29	1.241	1.960	1.582	1.022
30	1.187	1.958	1.534	0.991
31	1.137	1.866	1.479	0.956
Mean	**1.469**	**2.243**	**1.847**	**1.194**
Maximum	**2.133**	**2.929**	**2.495**	**1.613**
Minimum	**1.129**	**1.866**	**1.479**	**0.956**
Total Flow (mg)		**37.014**		

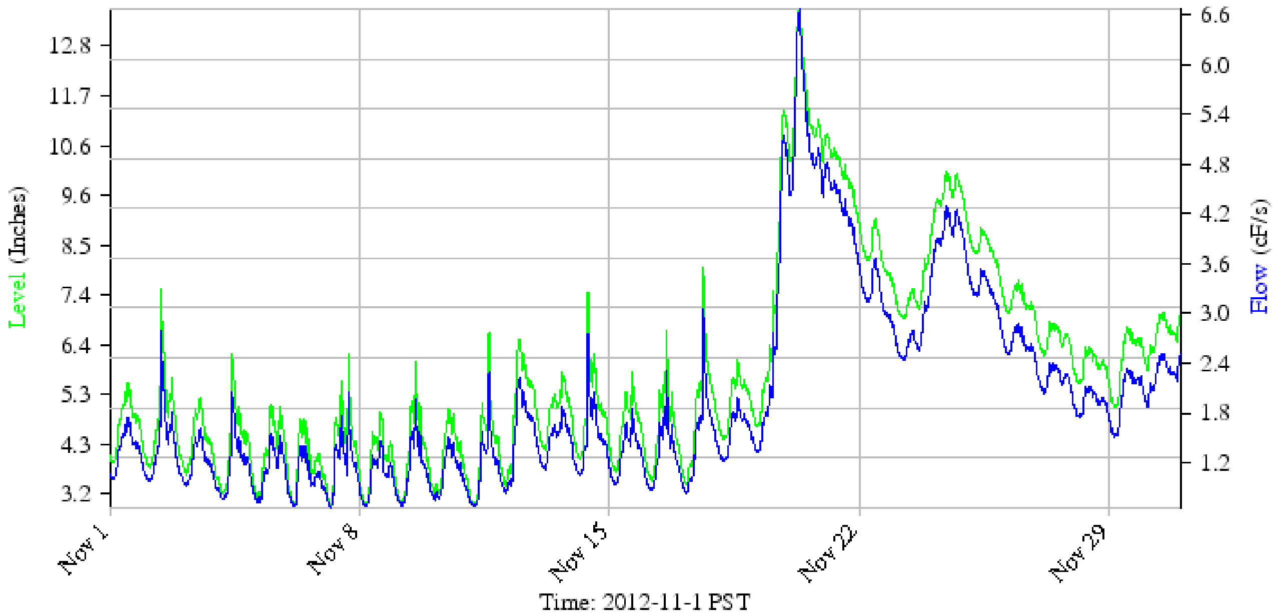

U12-118-3
Levels with Flow
Level (Inches)
7.5
7.1
6.8
6.4
6.1
5.7
5.4
5.0
4.6
4.3
Flow (cF/s)
2.8
2.6
2.4
2.3
2.1
1.9
1.7
1.6
1.4
1.2
Mar 7
Mar 14
Mar 21
Mar 28
Time: 2013-3-1 PST

Site U12-118-8

Summary Report - November, 2012

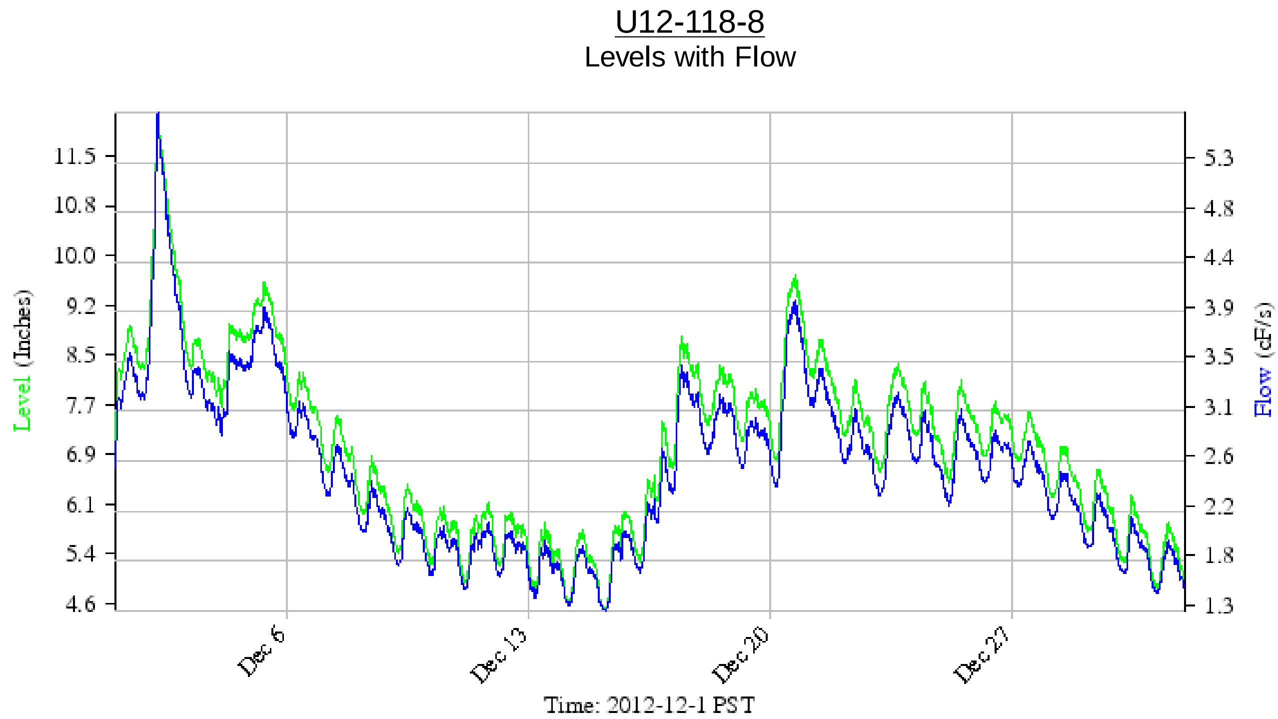
U12-118-8	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Nov	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.990	1.770	1.340	0.866
2	0.962	2.887	1.403	0.907
3	0.868	1.616	1.182	0.764
4	0.758	2.153	1.192	0.770
5	0.699	1.565	1.112	0.719
6	0.671	1.538	1.006	0.650
7	0.658	2.071	1.145	0.740
8	0.665	1.555	1.029	0.665
9	0.670	2.150	1.096	0.708
10	0.741	1.509	1.071	0.692
11	0.673	2.359	1.137	0.735
12	0.814	2.222	1.516	0.980
13	1.101	1.870	1.462	0.945
14	1.030	2.815	1.468	0.949
15	0.933	1.861	1.304	0.843
16	0.862	2.397	1.305	0.843
17	0.817	3.039	1.495	0.966
18	1.200	1.995	1.559	1.008
19	1.323	5.130	2.598	1.679
20	4.341	6.676	5.182	3.349
21	3.574	4.828	4.275	2.763
22	2.730	3.650	3.185	2.058
23	2.408	3.406	2.704	1.748
24	3.386	4.282	3.943	2.549
25	2.698	3.638	3.264	2.110
26	2.223	2.890	2.615	1.690
27	1.913	2.418	2.201	1.422
28	1.709	2.140	1.920	1.241
29	1.498	2.361	1.980	1.279
30	1.859	2.564	2.251	1.455
Mean	**1.492**	**2.712**	**1.965**	**1.270**
Maximum	**4.341**	**6.676**	**5.182**	**3.349**
Minimum	**0.658**	**1.509**	**1.006**	**0.650**
Total Flow (mg)		**38.095**		

U12-118-8
Levels with Flow



Summary Report - December, 2012

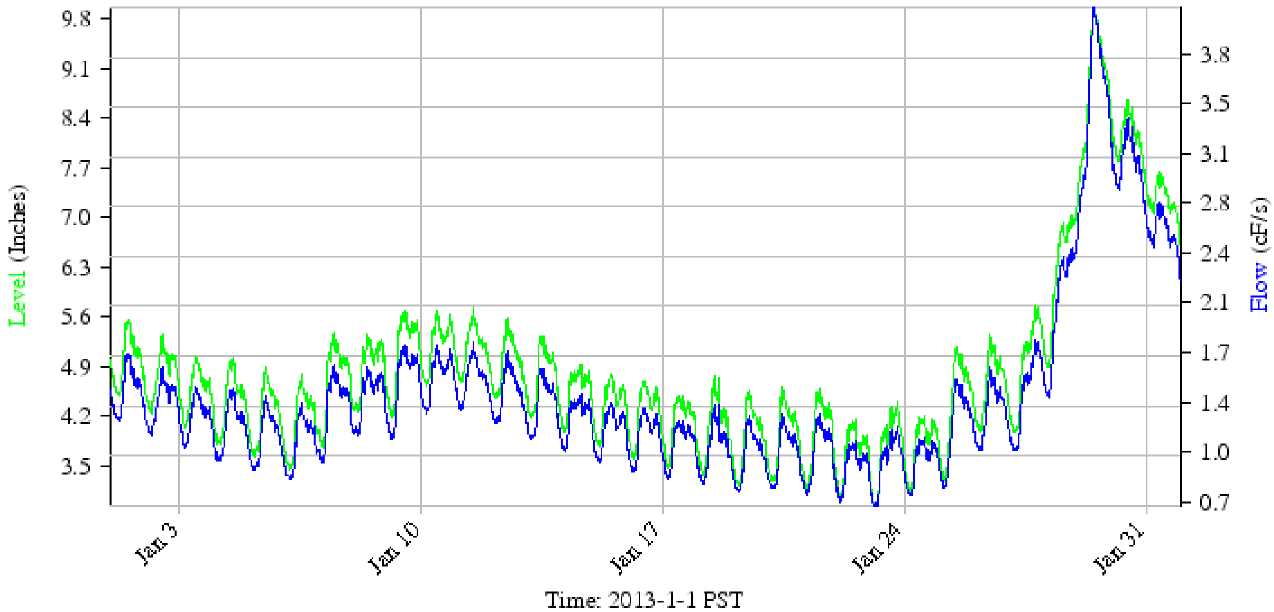
U12-118-8	Flow (cF/s)			
	Min	Max	Avg	Total
Dec	cF/s	cF/s	cF/s	mg/d
1	2.515	3.554	3.227	2.085
2	3.436	5.672	4.504	2.911
3	2.898	3.492	3.203	2.070
4	2.770	3.595	3.317	2.144
5	3.072	3.967	3.623	2.341
6	2.500	3.153	2.877	1.860
7	2.186	2.803	2.459	1.589
8	1.931	2.453	2.121	1.371
9	1.661	2.195	1.923	1.243
10	1.568	2.029	1.805	1.167
11	1.454	2.062	1.784	1.153
12	1.564	2.009	1.787	1.155
13	1.371	1.902	1.628	1.052
14	1.299	1.845	1.579	1.021
15	1.263	1.977	1.652	1.068
16	1.598	2.723	2.054	1.327
17	2.285	3.450	2.954	1.909
18	2.641	3.208	2.924	1.890
19	2.516	2.993	2.772	1.792
20	2.350	4.024	3.292	2.128
21	2.784	3.467	3.158	2.041
22	2.449	3.058	2.730	1.765
23	2.267	3.217	2.773	1.793
24	2.401	3.061	2.703	1.747
25	2.194	3.081	2.638	1.705
26	2.388	2.878	2.634	1.702
27	2.278	2.787	2.522	1.630
28	2.022	2.528	2.255	1.458
29	1.805	2.335	2.021	1.306
30	1.589	2.116	1.805	1.166
31	1.416	1.902	1.626	1.051
Mean	**2.144**	**2.888**	**2.527**	**1.634**
Maximum	**3.436**	**5.672**	**4.504**	**2.911**
Minimum	**1.263**	**1.845**	**1.579**	**1.021**
Total Flow (mg)		**50.639**		


U12-118-8
Levels with Flow
Level (Inches)
Flow (cF/s)
11.5
10.8
10.0
9.2
8.5
7.7
6.9
6.1
5.4
4.6
5.3
4.8
4.4
3.9
3.5
3.1
2.6
2.2
1.8
1.3
Dec 6
Dec 13
Dec 20
Dec 27
Time: 2012-12-1 PST

Summary Report - January, 2013

U12-118-8	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Jan	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	1.258	1.745	1.481	0.957
2	1.158	1.704	1.394	0.901
3	1.059	1.542	1.290	0.834
4	0.974	1.512	1.228	0.794
5	0.910	1.472	1.156	0.747
6	0.848	1.390	1.114	0.720
7	0.955	1.684	1.359	0.878
8	1.157	1.653	1.428	0.923
9	1.123	1.812	1.535	0.992
10	1.312	1.803	1.577	1.019
11	1.331	1.845	1.554	1.005
12	1.239	1.764	1.465	0.947
13	1.131	1.654	1.380	0.892
14	1.043	1.469	1.278	0.826
15	0.970	1.404	1.204	0.778
16	0.899	1.362	1.162	0.751
17	0.850	1.290	1.100	0.711
18	0.810	1.418	1.078	0.697
19	0.765	1.305	1.024	0.662
20	0.785	1.327	1.033	0.668
21	0.742	1.315	1.034	0.668
22	0.693	1.133	0.936	0.605
23	0.662	1.232	0.964	0.623
24	0.732	1.162	0.983	0.635
25	0.791	1.574	1.222	0.790
26	1.046	1.661	1.334	0.862
27	1.049	1.850	1.439	0.930
28	1.421	2.539	2.052	1.326
29	2.482	4.208	3.479	2.248
30	2.681	3.409	3.075	1.988
31	2.244	2.816	2.584	1.670
Mean	**1.133**	**1.744**	**1.450**	**0.937**
Maximum	**2.681**	**4.208**	**3.479**	**2.248**
Minimum	**0.662**	**1.133**	**0.936**	**0.605**
Total Flow (mg)		**29.047**		

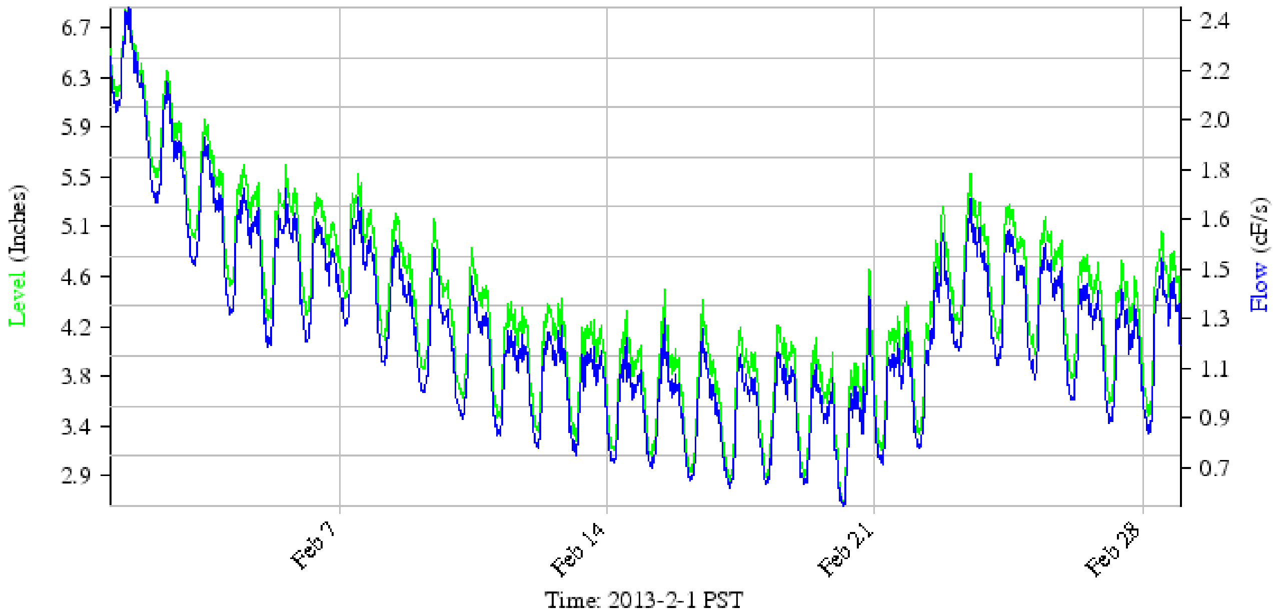
U12-118-8
Levels with Flow



Summary Report - February, 2013

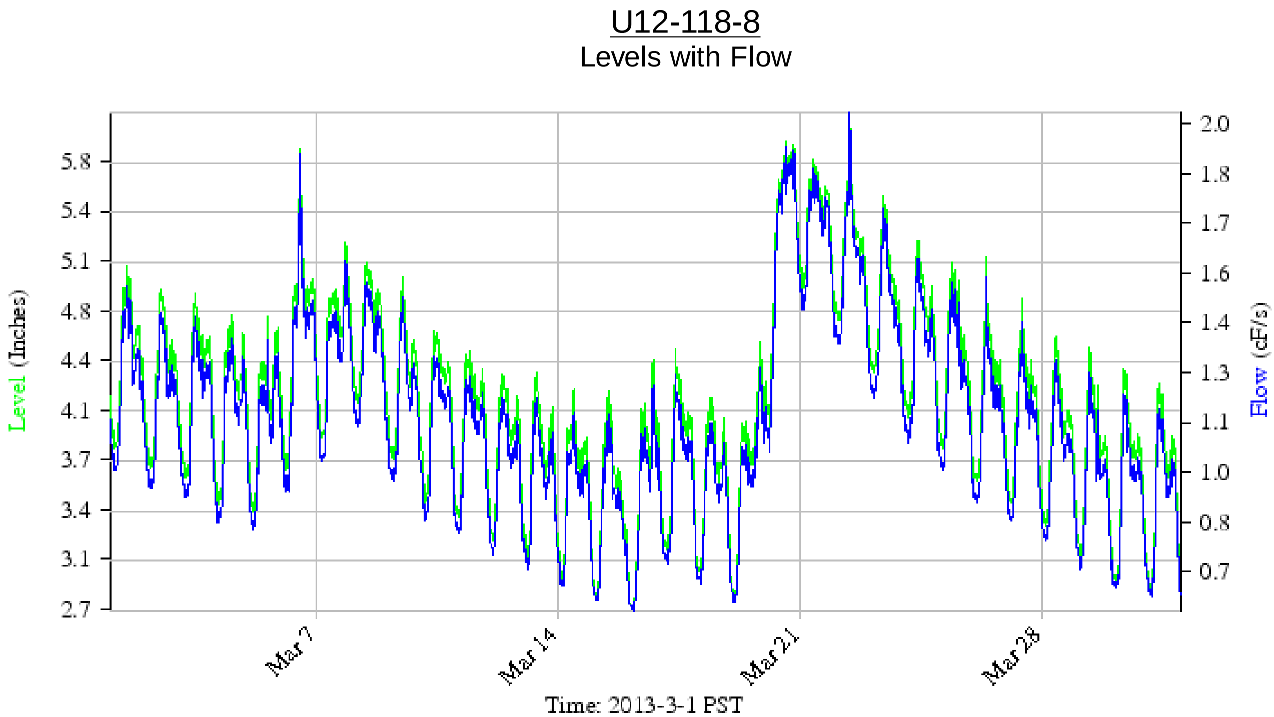
U12-118-8	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Feb	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	1.911	2.452	2.182	1.411
2	1.692	2.160	1.881	1.216
3	1.460	1.949	1.685	1.089
4	1.291	1.777	1.545	0.999
5	1.166	1.769	1.486	0.960
6	1.182	1.661	1.440	0.930
7	1.246	1.733	1.479	0.956
8	1.103	1.579	1.331	0.860
9	0.998	1.558	1.232	0.796
10	0.904	1.449	1.162	0.751
11	0.846	1.260	1.074	0.694
12	0.798	1.254	1.063	0.687
13	0.775	1.198	1.020	0.659
14	0.744	1.226	0.972	0.628
15	0.725	1.380	0.965	0.624
16	0.684	1.252	0.929	0.601
17	0.655	1.154	0.916	0.592
18	0.666	1.183	0.940	0.607
19	0.669	1.124	0.894	0.578
20	0.591	1.377	0.906	0.585
21	0.740	1.243	1.020	0.659
22	0.795	1.597	1.188	0.768
23	1.151	1.724	1.430	0.924
24	1.093	1.634	1.370	0.886
25	1.050	1.564	1.325	0.856
26	0.971	1.421	1.225	0.792
27	0.881	1.391	1.157	0.747
28	0.846	1.522	1.223	0.791
Mean	**0.987**	**1.521**	**1.251**	**0.809**
Maximum	**1.911**	**2.452**	**2.182**	**1.411**
Minimum	**0.591**	**1.124**	**0.894**	**0.578**
Total Flow (mg)		**22.646**		

U12-118-8
Levels with Flow



Summary Report - March, 2013

U12-118-8	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Mar	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.985	1.564	1.246	0.805
2	0.935	1.450	1.181	0.763
3	0.911	1.443	1.171	0.757
4	0.841	1.416	1.130	0.731
5	0.823	1.362	1.104	0.714
6	0.928	1.942	1.329	0.859
7	1.012	1.616	1.304	0.843
8	1.097	1.554	1.329	0.859
9	0.959	1.508	1.181	0.763
10	0.845	1.343	1.103	0.713
11	0.808	1.274	1.062	0.687
12	0.748	1.216	1.001	0.647
13	0.712	1.207	0.956	0.618
14	0.660	1.169	0.908	0.587
15	0.614	1.172	0.869	0.562
16	0.591	1.252	0.902	0.583
17	0.702	1.284	0.975	0.630
18	0.657	1.145	0.914	0.591
19	0.615	1.295	0.970	0.627
20	1.026	1.950	1.618	1.046
21	1.417	1.871	1.660	1.073
22	1.276	2.045	1.558	1.007
23	1.139	1.749	1.408	0.910
24	1.044	1.598	1.313	0.848
25	0.956	1.536	1.236	0.799
26	0.893	1.613	1.146	0.741
27	0.841	1.465	1.091	0.705
28	0.781	1.330	1.024	0.662
29	0.711	1.292	0.961	0.621
30	0.660	1.228	0.919	0.594
31	0.631	1.191	0.892	0.577
Mean	**0.865**	**1.454**	**1.144**	**0.739**
Maximum	**1.417**	**2.045**	**1.660**	**1.073**
Minimum	**0.591**	**1.145**	**0.869**	**0.562**
Total Flow (mg)		**22.919**		

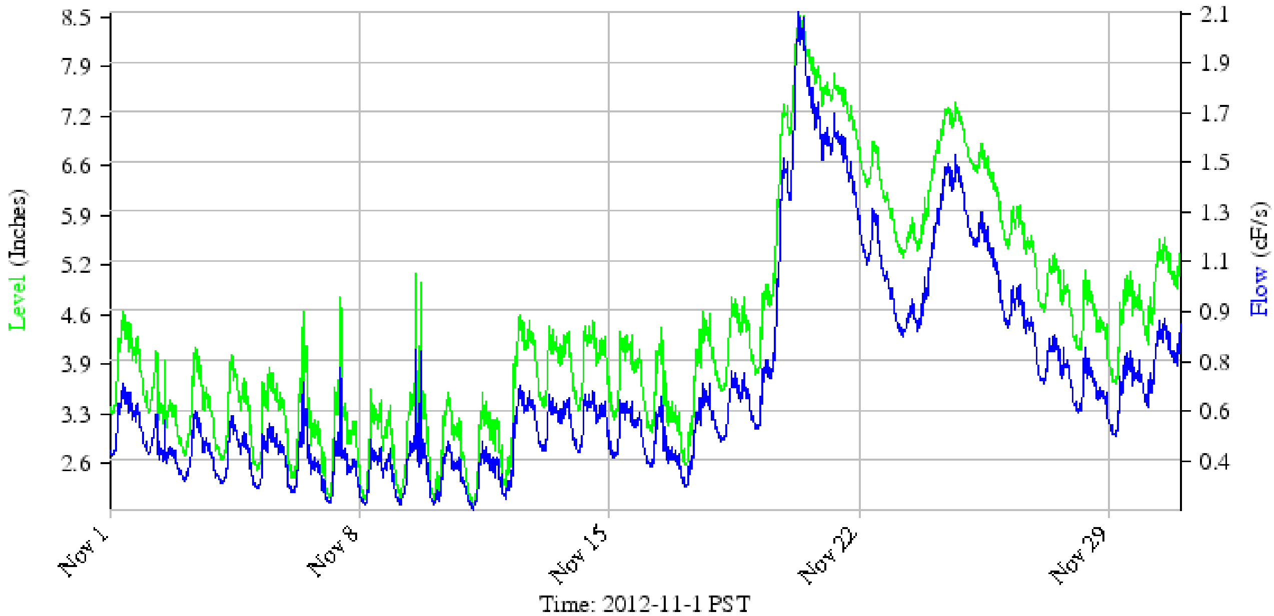

U12-118-8
Levels with Flow
Level (Inches)
Flow (cF/s)
5.8
5.4
5.1
4.8
4.4
4.1
3.7
3.4
3.1
2.7
2.0
1.8
1.7
1.6
1.4
1.3
1.1
1.0
0.8
0.7
Mar 7
Mar 14
Mar 21
Mar 28
Time: 2013-3-1 PST

Site U12-118-8A

Summary Report - November, 2012

U12-118-8A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Nov	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.391	0.690	0.529	0.342
2	0.320	0.608	0.416	0.269
3	0.295	0.589	0.412	0.266
4	0.288	0.584	0.410	0.265
5	0.264	0.555	0.391	0.253
6	0.250	0.814	0.369	0.239
7	0.210	0.917	0.347	0.224
8	0.208	0.474	0.333	0.216
9	0.209	1.032	0.356	0.230
10	0.207	0.460	0.322	0.208
11	0.188	0.466	0.317	0.205
12	0.228	0.675	0.485	0.313
13	0.405	0.637	0.525	0.339
14	0.401	0.663	0.530	0.342
15	0.375	0.628	0.498	0.322
16	0.320	0.664	0.423	0.274
17	0.277	0.694	0.478	0.309
18	0.446	0.726	0.584	0.377
19	0.489	1.530	0.866	0.560
20	1.346	2.133	1.738	1.123
21	1.278	1.714	1.522	0.984
22	0.924	1.352	1.143	0.739
23	0.838	1.144	0.931	0.602
24	1.093	1.545	1.378	0.891
25	0.953	1.352	1.187	0.767
26	0.732	1.078	0.921	0.595
27	0.600	0.874	0.737	0.477
28	0.511	0.810	0.635	0.411
29	0.464	0.817	0.638	0.412
30	0.572	0.947	0.770	0.498
Mean	**0.503**	**0.906**	**0.673**	**0.435**
Maximum	**1.346**	**2.133**	**1.738**	**1.123**
Minimum	**0.188**	**0.460**	**0.317**	**0.205**
Total Flow (mg)		**13.051**		

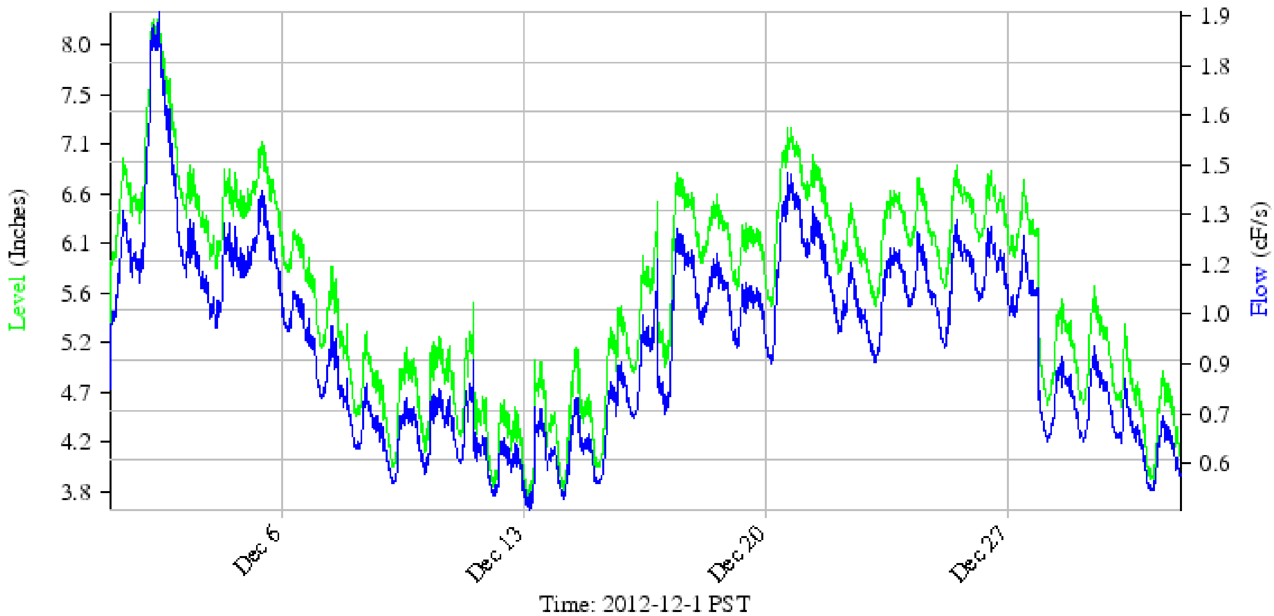
U12-118-8A
Levels with Flow



Summary Report - December, 2012

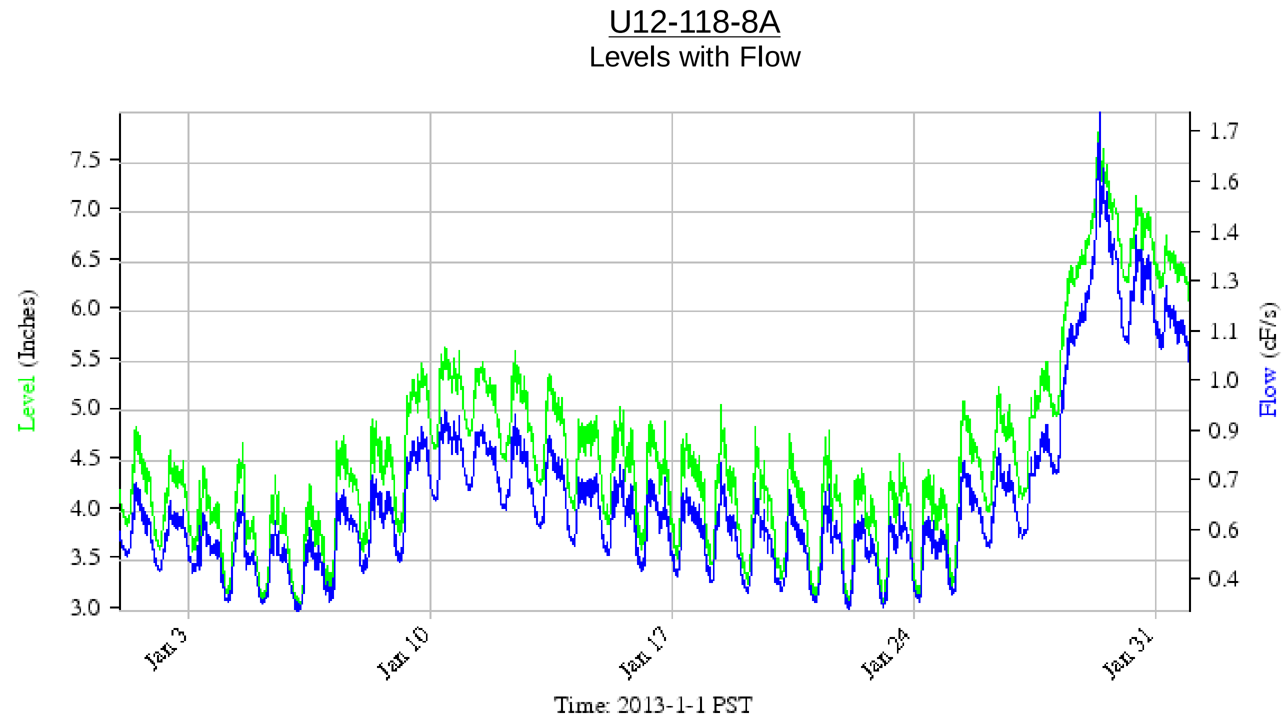
U12-118-8A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Dec	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.791	1.358	1.167	0.754
2	1.235	2.005	1.629	1.053
3	1.008	1.345	1.171	0.757
4	0.974	1.327	1.167	0.754
5	1.022	1.447	1.243	0.803
6	0.845	1.130	1.009	0.652
7	0.700	1.093	0.833	0.539
8	0.607	0.843	0.698	0.451
9	0.523	0.800	0.663	0.428
10	0.557	0.837	0.703	0.454
11	0.535	0.914	0.667	0.431
12	0.491	0.687	0.581	0.376
13	0.453	0.776	0.600	0.388
14	0.485	0.804	0.631	0.408
15	0.527	0.922	0.719	0.465
16	0.727	1.245	0.886	0.573
17	0.736	1.335	1.081	0.699
18	0.998	1.246	1.104	0.714
19	0.922	1.177	1.043	0.674
20	0.877	1.491	1.216	0.786
21	1.034	1.375	1.224	0.791
22	0.939	1.211	1.051	0.679
23	0.886	1.260	1.088	0.703
24	1.020	1.311	1.129	0.730
25	0.933	1.328	1.141	0.737
26	1.070	1.309	1.168	0.755
27	0.729	1.274	1.073	0.694
28	0.652	0.929	0.778	0.503
29	0.656	0.947	0.787	0.509
30	0.568	0.859	0.693	0.448
31	0.506	0.750	0.612	0.395
Mean	**0.774**	**1.140**	**0.953**	**0.616**
Maximum	**1.235**	**2.005**	**1.629**	**1.053**
Minimum	**0.453**	**0.687**	**0.581**	**0.376**
Total Flow (mg)		**19.103**		

U12-118-8A
Levels with Flow



Summary Report - January, 2013

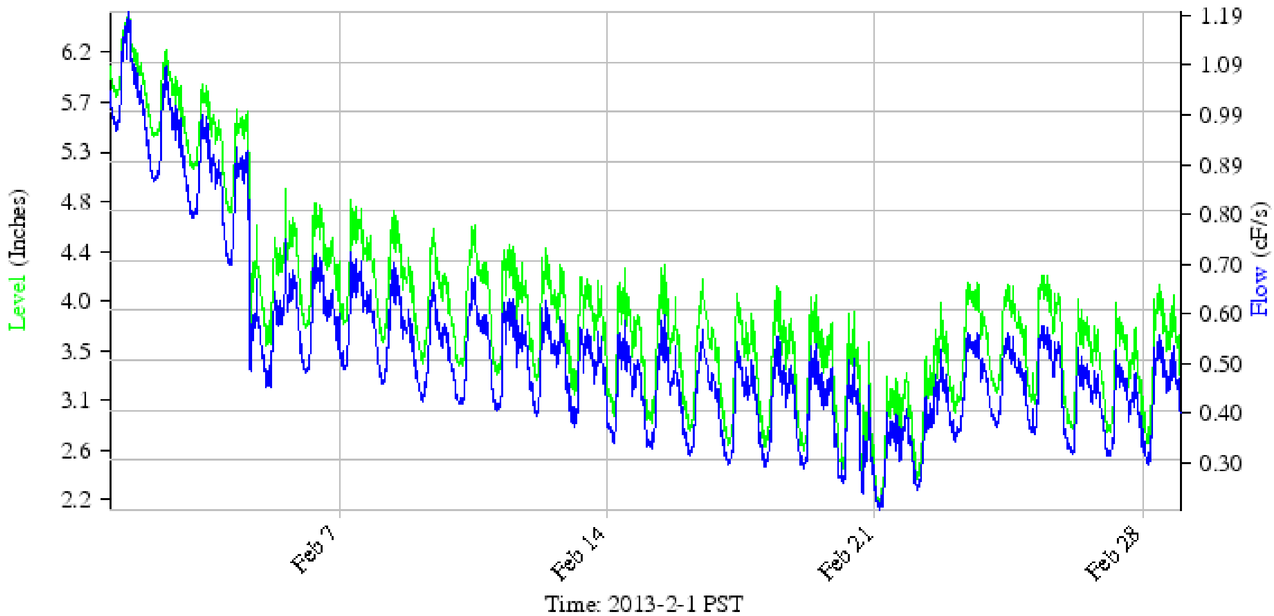
U12-118-8A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Jan	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.488	0.714	0.579	0.374
2	0.446	0.666	0.550	0.355
3	0.410	0.649	0.510	0.330
4	0.359	0.672	0.485	0.313
5	0.355	0.605	0.457	0.295
6	0.336	0.596	0.441	0.285
7	0.360	0.742	0.545	0.352
8	0.443	0.762	0.591	0.382
9	0.473	0.869	0.706	0.456
10	0.650	0.931	0.793	0.513
11	0.681	0.894	0.778	0.503
12	0.626	0.924	0.739	0.478
13	0.566	0.854	0.695	0.449
14	0.520	0.752	0.639	0.413
15	0.494	0.777	0.615	0.398
16	0.447	0.750	0.584	0.377
17	0.433	0.716	0.569	0.367
18	0.418	0.883	0.552	0.357
19	0.385	0.726	0.521	0.337
20	0.391	0.717	0.512	0.331
21	0.357	0.739	0.506	0.327
22	0.341	0.631	0.487	0.314
23	0.341	0.661	0.500	0.323
24	0.361	0.624	0.501	0.324
25	0.379	0.797	0.596	0.385
26	0.516	0.825	0.651	0.421
27	0.544	0.897	0.714	0.461
28	0.724	1.279	1.012	0.654
29	1.198	1.782	1.406	0.909
30	1.093	1.484	1.247	0.806
31	1.039	1.278	1.151	0.744
Mean	**0.522**	**0.845**	**0.666**	**0.430**
Maximum	**1.198**	**1.782**	**1.406**	**0.909**
Minimum	**0.336**	**0.596**	**0.441**	**0.285**
Total Flow (mg)		**13.336**		


U12-118-8A
Levels with Flow
Level (Inches)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
Flow (cF/s)
1.7
1.6
1.4
1.3
1.1
1.0
0.9
0.7
0.6
0.4
Jan 3
Jan 10
Jan 17
Jan 24
Jan 31
Time: 2013-1-1 PST

Summary Report - February, 2013

U12-118-8A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Feb	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.920	1.250	1.049	0.678
2	0.851	1.102	0.951	0.615
3	0.760	1.011	0.871	0.563
4	0.475	0.952	0.727	0.470
5	0.443	0.758	0.579	0.374
6	0.475	0.746	0.593	0.383
7	0.480	0.733	0.599	0.387
8	0.455	0.754	0.564	0.365
9	0.418	0.692	0.522	0.338
10	0.413	0.679	0.533	0.344
11	0.396	0.674	0.521	0.336
12	0.389	0.643	0.505	0.326
13	0.367	0.594	0.483	0.312
14	0.335	0.608	0.454	0.294
15	0.324	0.632	0.444	0.287
16	0.310	0.583	0.428	0.277
17	0.294	0.553	0.412	0.266
18	0.287	0.575	0.418	0.270
19	0.282	0.556	0.411	0.266
20	0.228	0.520	0.349	0.226
21	0.203	0.423	0.320	0.207
22	0.242	0.539	0.380	0.246
23	0.340	0.576	0.461	0.298
24	0.369	0.569	0.463	0.299
25	0.349	0.597	0.470	0.303
26	0.312	0.559	0.419	0.271
27	0.308	0.555	0.412	0.266
28	0.294	0.564	0.437	0.282
Mean	**0.404**	**0.678**	**0.528**	**0.341**
Maximum	**0.920**	**1.250**	**1.049**	**0.678**
Minimum	**0.203**	**0.423**	**0.320**	**0.207**
Total Flow (mg)		**9.548**		

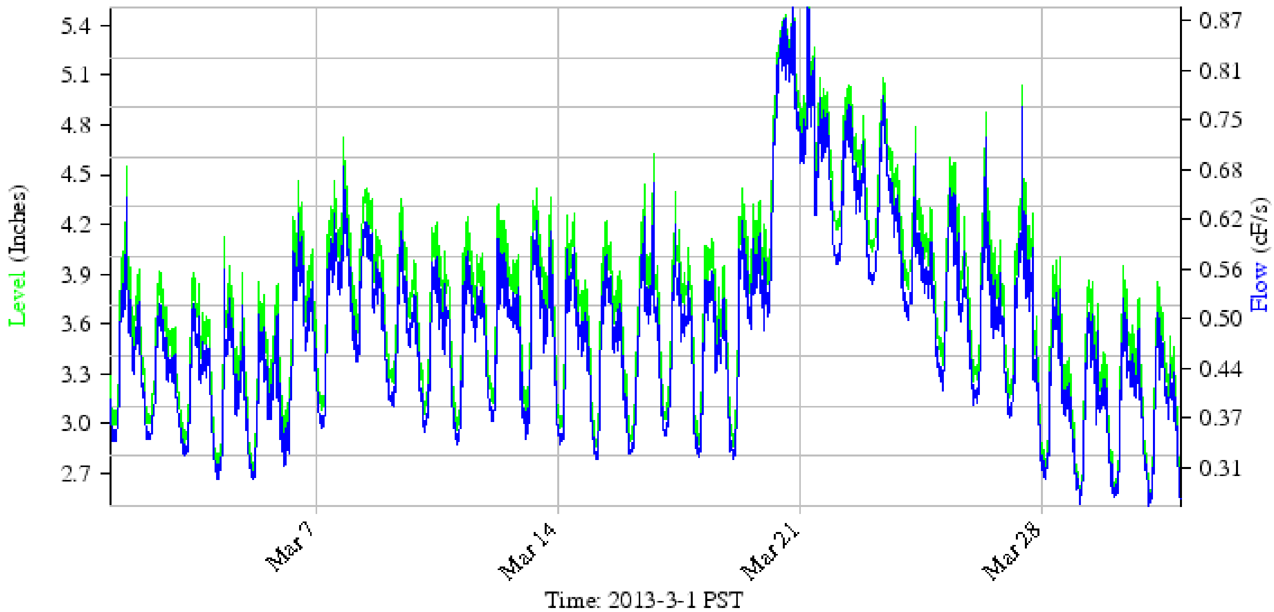
U12-118-8A
Levels with Flow



Summary Report - March, 2013

U12-118-8A	Flow (cF/s)			
	Min	**Max**	**Avg**	**Total**
Mar	**cF/s**	**cF/s**	**cF/s**	**mg/d**
1	0.343	0.730	0.450	0.291
2	0.344	0.540	0.423	0.273
3	0.322	0.523	0.415	0.268
4	0.294	0.570	0.406	0.263
5	0.294	0.509	0.396	0.256
6	0.310	0.649	0.474	0.306
7	0.358	0.690	0.518	0.335
8	0.434	0.661	0.532	0.344
9	0.386	0.625	0.475	0.307
10	0.353	0.591	0.460	0.297
11	0.337	0.602	0.473	0.306
12	0.359	0.628	0.481	0.311
13	0.344	0.630	0.487	0.315
14	0.338	0.617	0.463	0.299
15	0.316	0.602	0.455	0.294
16	0.325	0.703	0.467	0.302
17	0.332	0.635	0.459	0.297
18	0.321	0.585	0.455	0.294
19	0.320	0.641	0.509	0.329
20	0.485	0.902	0.750	0.485
21	0.571	0.923	0.720	0.465
22	0.545	0.786	0.655	0.423
23	0.516	0.796	0.630	0.407
24	0.421	0.718	0.544	0.352
25	0.394	0.753	0.521	0.336
26	0.385	0.738	0.498	0.322
27	0.316	0.789	0.479	0.310
28	0.283	0.556	0.396	0.256
29	0.264	0.628	0.385	0.249
30	0.273	0.537	0.393	0.254
31	0.263	0.514	0.377	0.244
Mean	**0.360**	**0.657**	**0.489**	**0.316**
Maximum	**0.571**	**0.923**	**0.750**	**0.485**
Minimum	**0.263**	**0.509**	**0.377**	**0.244**
Total Flow (mg)		**9.789**		

U12-118-8A
Levels with Flow



Appendix B: Oregon DEQ, Internal Management Directive on Sanitary Sewer Overflows, November 2010

Water Quality Division – Surface Water Management

Internal Management Directive
Sanitary Sewer Overflows (SSOs)

November 2010

State of Oregon
Department of Environmental Quality

Water Quality Division

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Last Updated: 12/01/10
By: Sonja Biorn-Hansen
DEQ10-HQ-0065-IMD
10-WQ-028
Version 1.0

Disclaimer

This internal management directive (IMD) represents the Department of Environmental Quality's (DEQ's) current directions to staff on how to take enforcement action when NPDES and WPCF permittees experience sanitary sewer overflows (SSOs). This IMD does not apply to combined sewer overflows (CSOs). This IMD is not final agency action and does not create any rights, duties, obligations, or defenses, implied or otherwise, in any third parties. This directive should not be construed as rule, although some of it describes existing state and federal laws.

The recommendations contained in this directive should not be construed as a requirement of rule or statute.

DEQ anticipates revising this document from time to time as conditions warrant.

Oregon Department of Environmental Quality
Water Quality Division
811 SW 6th Ave.
Portland, OR 97204
For more information:
Sonja Biorn-Hansen, (503) 229-5257

Alternative formats (Braille, large type) of this document can be made available. Contact DEQ's Office of Communications & Outreach, Portland, at (503) 229-5696, or toll-free in Oregon at 1-800-452-4011, ext. 5696.

Contents

SSO Enforcement Internal Management Directive

1. Introduction

Purpose of this IMD

The purpose of this IMD (Internal Management Directive) is to help DEQ permit staff respond efficiently and effectively to sanitary sewer overflow (SSO) events, in order to protect the health of the public and the environment. To this end, it covers the following:

- Measures that DEQ staff can advise permittees to take to prevent SSOs as well as how to respond appropriately when they occur,
- Reporting requirements, and
- When to take formal enforcement action.

References

The following sources of information were used in developing this IMD:

- DEQ's Enforcement Guidance
- EPA's Chapter 10 of the Enforcement Management System for the National Pollutant Discharge Elimination System: Setting Priorities for Addressing Discharges from Separate Sanitary Sewers, posted at: http://cfpub.epa.gov/npdes/docs.cfm?document_type_id=1&view=Policy%20and%20Guidance%20Documents&program_id=4&sort=name
- "What's in Your Water? The State of Public Notification in 11 States" by American Rivers, posted at: http://www.americanrivers.org/site/DocServer/arswg.all.8_16_07_opt.pdf?docID=6521

2. Preventing SSOs

A good Capacity, Management, Operation and Maintenance (CMOM) program will reduce the likelihood of SSO events, and permit staff should encourage permittees to adopt such programs. A detailed discussion of CMOM programs is beyond the scope of this document. Permit staff should instead familiarize themselves with and direct permittees to the following document developed by the EPA: "Guide for Evaluating Capacity, Management, Operation, and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems." This document may be accessed at: http://www.epa.gov/npdes/pubs/cmom_guide_for_collection_systems.pdf.

Other resources that may be helpful are as follows:

- EPA Region 4 Intro to Conducting Evaluations of CMOM Programs: http://www.epa.gov/region4/water/wpeb/momproject/documents/r4evalguide.pdf
- Wisconsin CMOM – see http://dnr.wi.gov/org/water/wm/ww/cmar/cmom.htm
- "Best Management Practices for SSO Reduction Strategies" from Central Valley and Bay Area Clean Water Agencies– see http://www.bacwa.org/Home.aspx

3. Reporting SSOs

Overview

Complete, consistent reporting of SSO events to Oregon Emergency Response System (OERS) and DEQ helps insure timely notification of affected parties. It also assists in the identification of collection system problem areas and long-term trends.

In light of this, NPDES permits require permittees to report SSOs (except those caused by blockages on privately-owned lines) within 24 hours of when the permittee becomes aware of them, whether or not they reach waters of the state. Permittees must provide follow-up written reports regarding SSOs within 5 days of becoming aware of the SSO, unless this requirement is waived by DEQ. The specific information that must be provided in written and oral reports is found in Schedule F, Section D.7 of NPDES permits. This language is reproduced in Appendix B.

The release of a small amount of sewage that may accompany the performance of a repair or maintenance project on the collection system is not considered by DEQ to be a reportable event, as long as maintenance staff maintain positive control when it occurs. However, any SSO occurring during repair or maintenance that reaches waters of the state or that otherwise threatens public health or the environment must be reported as an SSO.

3.1 2009 revised reporting requirements

Applicability

In 2009, the specific reporting requirements contained in the General Conditions of individual permits (hereinafter referred to as Schedule F) regarding SSOs were modified at the request of EPA. The new requirements are reproduced in Appendix B.

Reporting Process

A flow diagram summarizing the reporting requirements that apply to permits issued after August 20, 2009 is shown in Figure 1. Since all permits will eventually include these requirements, permit staff should encourage permittees to adhere to them regardless of when their permit was issued.

As shown in the flow diagram, permit holders may need to submit a five day written report on the SSO in the form of a letter to DEQ. On January 1st, 2011, DEQ will require permittees to use DEQ's SSO reporting form instead. The use of this form will help insure greater consistency in the information that is reported, and will enable better tracking of SSOs by DEQ. The form will be on DEQ's external website at http://www.deq.state.or.us/wq/wqpermit/sewer.htm.

To insure that permit holders use this form, permit writers should include the following permit language in Schedule B:

> Schedule B Model Permit Language Regarding Five Day Reporting of SSOs
> As per Schedule F, permit holders are required to submit five day written reports regarding SSO events. Such reports are to be developed using the form entitled "SSO Reporting Form" which is available on DEQ's external website. Permit holders may supplement this form with additional information such as copies of maintenance records. The Department may waive the submittal of the

five day written report on a case-by-case basis.

After filling out the form online, permit holders should print it out and mail it to the appropriate regional office.

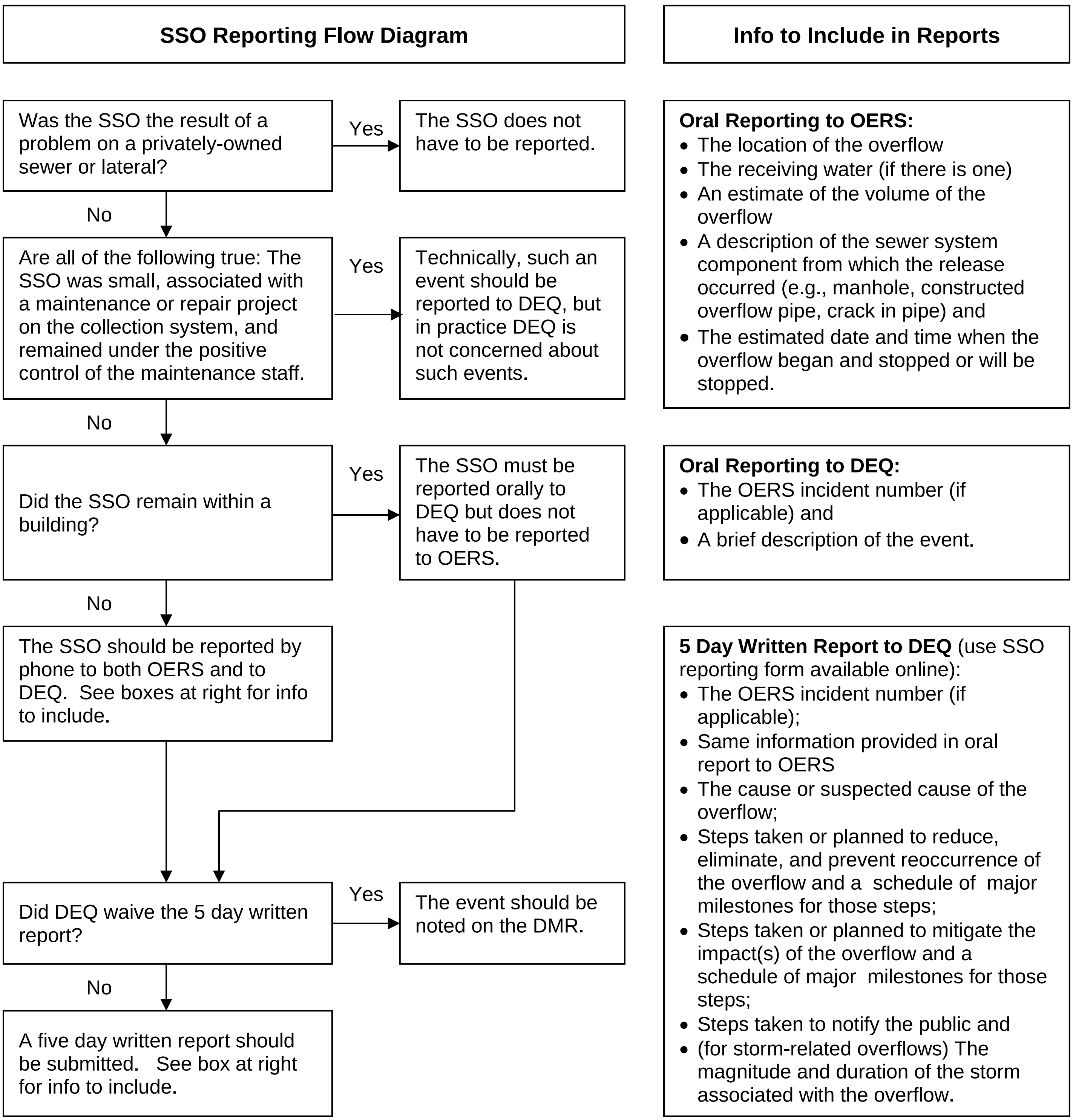

Figure 1. SSO Reporting Flow Diagram

3.2 SSO Reporting Follow-up

Process

Once the permittee has reported an SSO to OERS, OERS emails the report to DEQ headquarters and appropriate regional staff for the county the SSO occurred in. Regional staff should follow up with the permit holder as necessary.

As stated in Schedule F, basement backups (the term used to refer to any and all backups that remain inside buildings) only need to be reported to DEQ, not to OERS.

Again as indicated in Schedule F, regional staff may waive the five-day written report for SSOs that do not threaten public health or the environment, and that do not merit being tracked by DEQ. When it is not clear if public health or the environment is threatened, regional staff may contact headquarters staff for guidance.

When DEQ staff elect to waive the requirement to submit a 5 day written report, they should direct the permittee to note the event on their Discharge Monitoring Reports (DMRs).

After being received at the appropriate regional office, the form will be scanned and the information stored electronically on a Sharepoint site that has been set up for this purpose. DEQ staff will be able to retrieve SSO reports for individual permit holders as well as run various types of queries on the stored reports. Sharepoint is not accessible through DEQ's external website.

4. Responding to SSOs

4.1 Development of Emergency Response and Public Notification Plans

Reasons for developing a plan

NPDES Permits issued after August 20, 2009 contain a requirement to develop and implement Emergency Notification and Response Plans. This requirement is in Schedule F (General Conditions), Section B.7 and is reproduced in Appendix B. Permittees with Emergency Notification and Response Plans in place will be in a better position to respond adequately to SSO events as well as other types of emergencies. In the event that an SSO warrants an enforcement action by DEQ, a permittee's timely and appropriate response can serve to mitigate the penalty that may be associated with the event. Conversely, failure to take appropriate action can aggravate a penalty.

Process

Permit staff should direct permittees to develop and implement Emergency Notification and Response Plans. Permits issued after August 20, 2009 contain a requirement to develop such plans in Schedule F, Section B.8. However, all permittees should be encouraged to develop such plans as they can serve to reduce the civil penalty associated with an SSO.

Permit staff should encourage permittees to consult with appropriate authorities at the local, county and/or state level in developing these plans.

To insure that plans are developed on a timely basis, the permit writer may include the following in Schedule B of new and newly-issued permits:

> <u>Model Permit Language for Developing Emergency Response and Public Notification Plans</u>
> Emergency Response and Public Notification Plan. The permit holder is required to develop and maintain an Emergency Response and Public Notification Plan (the Plan) per Schedule F, Section B, and Conditions 7 & 8. The permit holder must develop the plan within six months of permit issuance and update the Plan annually to ensure that telephone and email contact information for applicable public agencies, [permit writer should include specific contacts here as needed] are current and accurate. An updated copy of the plan must be kept on file at the wastewater treatment facility for Department review. The latest plan revision date must be listed on the Plan cover along with the reviewer's initials or signature.

4.2 Responding to SSOs before a plan has been developed

Overview

Permittees that do not yet have Emergency Notification and Response Plans in place should be directed to the following measures for protecting the public. The measures listed below are not meant to be comprehensive, nor should they be considered a substitute for developing an Emergency Notification and Response Plan. They are meant to describe a minimal level of response for permittees that have not had sufficient time to develop more detailed plans. They may not be sufficient in all cases.

Moderate to Major Impact SSOs

Moderate SSOs are those events that have limited to moderate potential for public contact. These include SSOs where a small amount of sewage has reached a water body and the dilution is high, as well as SSOs on the ground that will not be cleaned up the same day.

Major SSOs are those events that do reach waters of the state or that may otherwise have moderate to significant potential for public contact. An example of a major SSO would be an event that impacts a drinking water intake, a recreation area or shellfish growing beds.
The expectations for the responding to SSOs, whether moderate or major, are as follows:

- Take immediate steps to stop the overflow.
- In the case of overland flow, cone or tape off the affected area, and post signs warning against contact.
- Call OERS within 24 hours.
- Call the appropriate DEQ office within 24 hours (or on the next business day if the SSO occurs on a weekend). Provide the OERS incident number along with a brief description of the event.
- (For major SSOs) Work with DEQ staff to identify potentially impacted drinking water intakes.

More information on tools available to permit staff to help protect drinking water supplies and public health is in Appendix G.

- (For major SSOs) Issue a press release as soon as possible to the local media (newspapers, radio, internet etc.) detailing area impacted by the SSO, and estimated duration of time to avoid contact.
- Submit a written incident report to the appropriate DEQ office, either via e-mail or hard copy within five (5) working days of when the permittee becomes aware of the SSO, unless the written report has been waived by the Department. If the written report has been waived, the SSO still needs to be noted on the monthly discharge monitoring reports (DMRs). If the written report has not been waived and must still be submitted, note that on January 1st, 2011 DEQ will require permittees to use the SSO reporting form on DEQ's external website.

5. When to Take Enforcement Action

Overview

This section contains 5 questions intended to guide permit compliance staff in determining what type of enforcement action is appropriate for a particular SSO event. The answers to the questions are based on the enforcement guidance developed by DEQ's OCE (Office of Compliance and Enforcement). Specifically, they are based on the Water Quality Violations section of Appendix O.

In general, the enforcement action taken in response to an SSO will depend on the following:

- Timeliness and adequacy of reporting (question 1)
- Whether the SSO was to land or surface water (question 2)
- The size of the SSO (question 2)
- Frequency (question 2)
- Whether or not the SSO was beyond the permit holder's reasonable control (question 3)
- The permit holder's response to the SSO (questions 4 and 5)

All of the questions need to be considered in order to perform a complete evaluation of a particular event.

A flowchart intended to supplement the questions is included at the end of this section.

Terms used in this section are defined below:

WL - Warning Letter. A Warning Letter is the minimum action DEQ takes when a violation is confirmed. It is not a formal enforcement action, and therefore is not appealable. Violations cited in a WL do not count as prior violations if the permittee is later issued a civil penalty. Multiple SSO violations may be consolidated into a single WL and sent on an interval not longer than semi-annually.

PEN - Pre-Enforcement Notice. A PEN simply notifies the violator they are being referred for formal enforcement action (civil penalty and/or compliance order). A PEN by itself is not formal enforcement, and is not appealable.

Refer – This is shorthand for the following: "Send a pre-enforcement notice to the permittee and submit an enforcement referral to the DEQ Office of Compliance and Enforcement." The Office of Compliance and Enforcement provides the formal enforcement response to the violations that are referred to them. Formal enforcement responses usually include civil penalty assessments and may also include a compliance order.

Question	Type of Violation and Enforcement Response	Requirements and Additional Guidance
1. Did the permittee report the SSO?	The permittee must report a SSOs as detailed in this IMD. Failure to follow these reporting requirements constitutes a violation of permit conditions and state environmental law. Failure to report within 24 hours is a Class I violation if the SSO reaches waters of the state (see OAR 340-012-0055(1)(e): "failing to comply with statute, rule, or permit requirements regarding notification of a SSO or upset condition, which results in a non-permitted discharge to public waters"). Send a PEN and refer. If the SSO does NOT reach waters of the state, failure to report within 24 hours is a Class II violation (see OAR 340-012-0055(2)(b) "failing to timely submit a report or plan as required by rule, permit, or license, unless otherwise classified"). Send a WL. Failure to submit a written report within 5 days is a Class II violation regardless of whether or not the SSO gets to public waters (see again OAR 340-012-0055(2)(b) "failing to timely submit a report or plan as required by rule, permit, or license, unless otherwise classified"). Send a WL.	Schedule F, Condition B.6 requires permittees to report all SSOs, except for those backups "caused solely by a blockage or other malfunction in a privately owned sewer or building lateral" within 24 hours, whether or not they reach waters of the state. The release of small amounts of sewage that may accompany the performance of maintenance and repair projects on the collection system is not considered by DEQ to be a reportable event, as long as maintenance staff maintains positive control when this happens and the sewage does not reach waters of the state. Any SSO occurring during repair or maintenance that escapes control measures (i.e., does not remain under positive control) and reaches waters of the state or otherwise threatens public health or the environment must be reported as an SSO. See Appendix B for complete Schedule F language pertaining to SSOs and 24-hour reporting. Schedule F, Section D.7 contains specific reporting requirements.

Question	Type of Violation and Enforcement Response	Requirements and Additional Guidance
2. Did the SSO reach waters of the state?	If yes, the SSO is a Class I violation. If the SSO was caused by "force majeure", no enforcement response is needed. Document only. Force majeure events are those events which can be neither anticipated nor controlled. They include war, sabotage, unusual vandalism, and extremes act of nature. If the SSO reached waters of the state, send a WL if either of the following are true: • The SSO was less than 40 gallons OR • The violation was beyond the permittee's reasonable control (see question 3). Otherwise send a PEN and refer. If the SSO did **not** reach waters of the state, send a WL if any of following are true: • The SSO was smaller than 400 gallons • The SSO was larger than 400 gallons, but was Beyond Reasonable Control • The SSO was larger than 400 gallons and was not Beyond Reasonable Control, however it was the first such event in 12 months. Otherwise, send a PEN and refer.	The Bacteria Rule prohibits the discharge of raw sewage (OAR 340-041-0009(2)). OAR 340-012-0055(1) defines the following as Class I violations, any or all of which may apply to a particular SSO: (a) Causing pollution of waters of the state; (b) Reducing the water quality of waters of the state below water quality standards; (c) Discharging any waste that enters waters of the state, either without a waste discharge permit or from a discharge point not authorized by a waste discharge permit. As a practical matter, it is easier to prove that raw sewage was discharged than it is to prove that it "caused pollution" or violated water quality standards, and so OAR 340-041-0009(2) of the Bacteria Rule is the violation most frequently cited in penalties involving SSOs. The Bacteria Rule does contain exceptions to the discharge prohibition. These exceptions are listed under question 3 on what constitutes "beyond reasonable control" of the permittee. Schedule F may or may not contain the exceptions in the Bacteria Rule depending on when the permit was issued. Permits issued before August 20, 2009 do contain them. Permits issued after August 20, 2009 do not, though the provisions may still be taken into account when considering whether or not the SSO was beyond the reasonable control of the permittee (see question 3). Regarding an SSO that does not reach waters of the state, this may be considered a Class II violation under OAR 340-012-0055(2)(c): "Causing any wastes to be placed in a location where such wastes are likely to be carried to waters of the state by any means".

<table>
<tr><th>Question</th><th>Type of Violation and Enforcement Response</th><th>Requirements and Additional Guidance</th></tr>
<tr><td>3. Was the event beyond the reasonable control of the permittee?</td><td>The answer to this question does not determine the class of violation; however along with the size and frequency of the event, it does determine whether the compliance specialist issues a WL or a PEN.

An SSO is be considered to be beyond reasonable control if Any of the following are true:
1. The event was caused by a force majeure event. Force majeure events are those events which can be neither anticipated nor controlled. They include war, sabotage, unusual vandalism, and extremes act of nature.
2. The SSO was caused by a storm event larger than what the system was designed to handle, as per OAR 340-041-0009(6) and (7).
3. The SSO was caused by hydrologic conditions that exceeded those described in a bacteria management plan approved by the EQC, as per OAR 340-041-0009(6) and (7).
4. The SSO was caused by an act of vandalism that could not have been reasonably anticipated or prevented by ordinary measures such as a padlock, cover or fence.
5. The SSO was the result of an act or omission of a third party not acting as an agent of the permittee.
6. The SSO occurred despite the fact that the permittee is implementing a good CMOM program. DEQ has not developed guidance on what constitutes a good CMOM program, and therefore permit staff are directed to EPA's guidance on the subject.

Alternatively, an SSO is considered to be beyond reasonable control if All of the following are true:
1. The system had an adequate level of redundancy against breakdowns and power failures. Appendix F lists examples of the level of redundancy that DEQ expects permittees to design for and maintain.
2. The SSO was not the result of an action or actions initiated by the permittee such as pipe cleaning, pipe repair or reservoir cleaning.
3. The SSO was not the result of an action or actions by contractors working for the permittee. Examples: pump-around failures or plugs left in lines. Such actions are avoidable.
4. The SSO was not the result of poor or lagging maintenance, or an unreasonable failure to inspect. Examples of such SSOs include SSOs caused by grease plugs, root intrusion or debris occurring in lines that have not been adequately inspected or cleaned.</td><td>Schedule F, Section B.1. requires permittees to properly operate and maintain facilities.

Guidelines for determining if an event is beyond reasonable control of the permit holder are based on Appendix O of DEQ's Enforcement Guidance for Field Staff, the provisions of the Bacteria Rule and input from regional staff.

The following excerpt from OCE's Spills Guidance may be helpful in establishing whether or not an event was beyond the reasonable control of the permit holder:
There is no easy black-and-white definition for the key word "reasonable." Evaluate the fact-specific situation to determine whether the violator could have reasonably prevented the violation. Consider the probability that the violation would occur and the gravity of the violation if it did occur. Reasonable people take more care to prevent more probable violations and those that would have more grave consequences.</td></tr>
</table>

Question	Type of Violation and Enforcement Response	Requirements and Additional Guidance
4. Did the permittee take steps to notify the public?	Failure to notify the public is a Class II violation, though the category of Class II violation depends on when the permit was issued. If the permit was issued before 2009, failure to take steps to notify the public is a Class II violation as defined in OAR 340-012-0053(2): Violating any otherwise unclassified requirement. The enforcement response depends on the severity and frequency of the violation as follows: (i)For first occurrence of violation, send PEN and refer if negative impact to beneficial uses (see examples at right). Otherwise, send WL. (ii) For repeated violations, for which a WL (or WL with opportunity to correct) has been sent (or self reporting has occurred), send PEN and refer upon the third violation within 36 months. Permits issued after August 20, 2009 require permittees to put together Emergency Response and Notification Plans. Failure to follow the plan is a Class II violation as defined in OAR 340-012-0055(2)(d): Violating any management, monitoring, or operational plan established pursuant to a waste discharge permit, unless otherwise classified. Send a WL with opportunity to correct. Send PEN and refer if not corrected by date specified in WL.	Schedule F, Section B.7. requires permittees to take such steps as are necessary to alert the public. NPDES Permits issued prior to 2009: Schedule F states that public notification will occur "upon request by the Department." Notifying the public may include but is not limited to: posting of the river at access points and other places, news releases, and paid announcements on radio or television. NPDES Permits issued after August 20, 2009: Under Schedule F, Section B.8., permittees are required to put together Emergency Response and Notification Plans and to follow these plans. Appendix D provides guidance to permit writers in reviewing these plans. Examples of a negative impact to beneficial uses include the following: closure of a beach, shellfish bed or drinking water intake, a fish kill, or a water quality standards violation. If there is no or insufficient water quality data available to demonstrate a standards violation, the likelihood of a water quality standards violation may be estimated based on available dilution.

Question	Type of Violation and Enforcement Response	Requirements and Additional Guidance
5. What steps did the permittee take to correct the violation or minimize the environmental impacts of the SSO?	A prohibited SSO is a violation regardless of whether the permittee takes steps to correct the violation or minimize the environmental impacts. However, the permittee's corrective steps can affect the amount of the civil penalty.	Schedule F, Section A.3. requires permittees, upon request by DEQ, to correct any adverse impact on the environment or human health resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge. Examples of corrective steps include, but are not limited to: being aware of the SSO as soon as possible and responding as quickly as possible, cleaning up areas affected by SSOs, posting the SSO area and/or fencing it off to prevent human contact, pumping out flooded basements, notifying public health agencies as necessary to prevent public contact, and/or adopting a rigorous CMOM program in order to avoid future SSOs

Summary The appropriate enforcement response to an SSO is determined by considering the cause, size, fate and frequency of the SSO, as well as the adequacy of the permit holder's reporting, emergency response and public notification efforts.

It is not practical to include all of these considerations into a single flowchart. A flowchart that takes into account cause, size, fate and frequency is provided below.

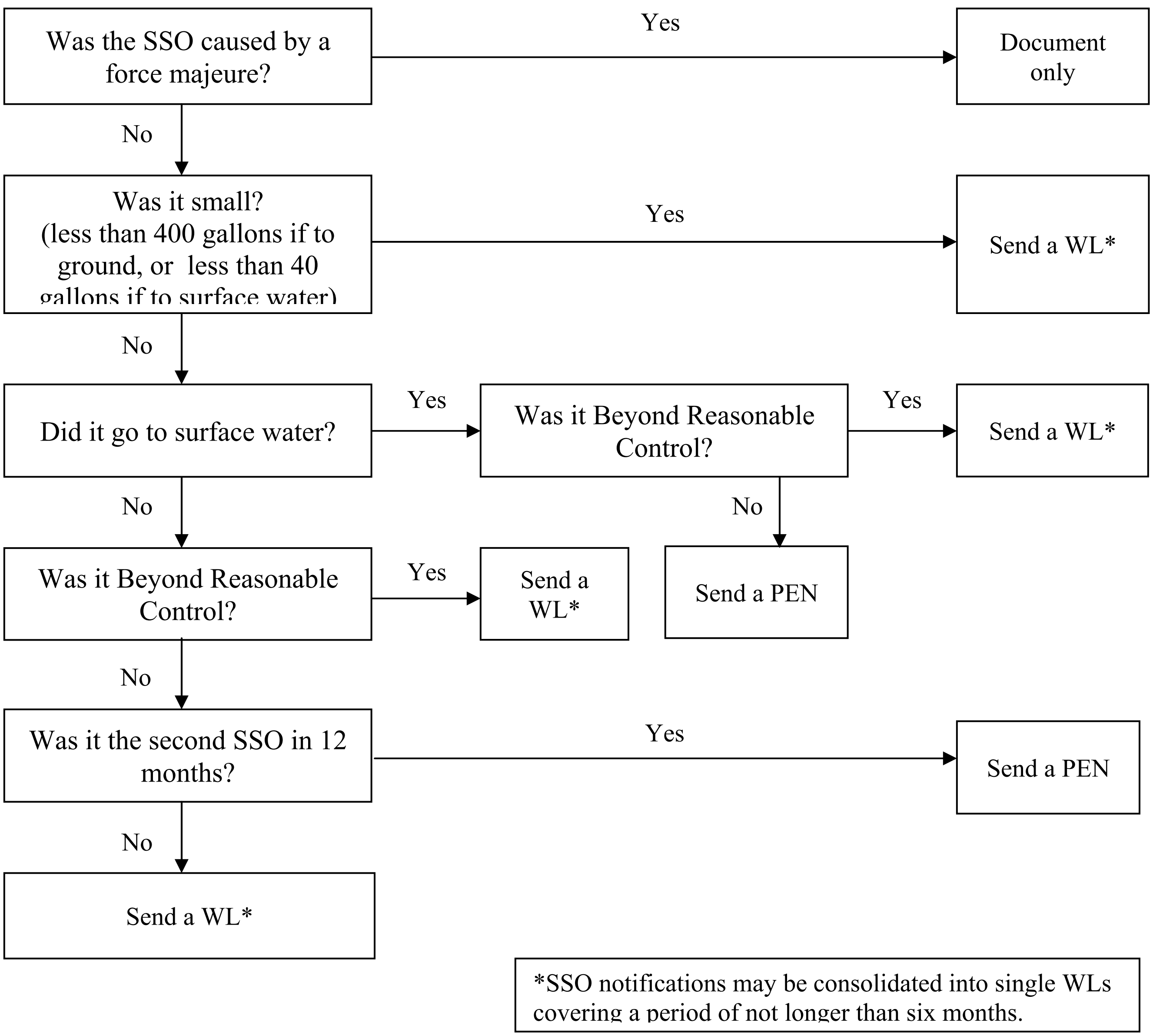

Figure 2. Flowchart for Determining Enforcement Response to an SSO Event (excludes reporting, emergency response and public notification considerations)

Sanitary Sewer Overflows IMD - November 2010

Appendix A: SSO Reporting Form

Sanitary Sewer Overflows IMD - November 2010

Oregon Department of Environmental Quality

SSO Reporting Form

This information must be submitted within 5 days of becoming aware of the overflow.
Please complete online and print for signature. Be sure to fill out all fields.

SSO

FACILITY/CONTACT INFORMATION		
Name of Permittee:		
Contact Name:		
Phone:	Email:	County:
DEQ Permit # (see permit face page):		
OERS Incident #:	Date Reported to OERS:	
Date Reported To DEQ:	Today's Date:	
Date SSO Started (if known):	Time Started (if known):	
Date SSO Stopped (if known):	Time Stopped (if known):	
SSO Location:		
SSO Nearest Address:		
City:	Zip Code:	
SSO Latitude (if known):	Longitude (if known):	
Estimate of Quantity Overflowed:	(Gallons)	Link to estimation method
Did the SSO discharge to surface water?		
Name of waterbody:		

PUBLIC NOTIFICATION
Notified downstream drinking water sources (List Below)?
Name of drinking water facility:
Signs Posted?
Media contacted?
Who?
List any other steps taken to notify the public or state/federal agencies:

CAUSES	
Cause or suspected cause of the overflow:	
Rainfall in the 24 hours prior to SSO (for storm-related overflows):	(inches)
Source of rainfall data:	
1-in-5 year 24 hour rainfall for the sewerage system area (if known): (in/24hr)	

EMERGENCY RESPONSE AND MIGRATION

List actions taken to stop and mitigate the impact of the SSO.

For overland flow:	Taped off affected area?
	Cleaned up affected area?
For SSO to surface water:	Bacteria samples taken to confirm impact?
	Follow up bacteria samples taken to confirm end of impact?
Describe monitoring and results:	
For SSOs that impact buildings:	Pumped out flooded buildings?
	Disinfected?

Other measures taken (describe):
Steps taken or planned to reduce, eliminate, and prevent the reoccurrence of the overflow and schedule for those steps:
COMMENTS

Signature: Date:

*You may attach additional information to this report before sending to DEQ as needed to explain the circumstances of the overflow. This information may include but is not limited to: maintenance records and bacteria monitoring results.

Upon completion, print out this form and send to the appropriate DEQ Address:

Portland-Permit Coordinator
2020 SW 4th Avenue, Suite 400
Portland, OR 97201
Phone: (503) 229-5263
TTY: (503) 229-5471
Hours: Mon-Fri, 8 a.m.-5 p.m.

Salem-Permit Coordinator
750 Front St NE, #120
Salem, OR 97301-1039
Phone: (503) 378-8240
Toll free in Oregon: (800) 349-7677
TTY: (503) 378-3684
Hours: Mon-Thurs: 8 a.m.-5 p.m.
Fri: 8 a.m.-12 p.m., 1 p.m.-5 p.m.

Pendleton-Permit Coordinator
700 SE Emigrant, #330
Pendleton, OR 97801
Phone: (541) 276-4063
Toll free in Oregon: (800) 304-3513
Hours: Mon-Fri,
8 a.m.-12 p.m., 1 p.m.-5 p.m.

Appendix B: Schedule F Language Regarding SSOs

The following language in Schedule F pertains to reporting of SSOs to DEQ and to notification of the public.

NPDES Permits issued prior to 2009:
Section B.6: Overflows from Wastewater Conveyance Systems and Associated Pump Stations

a. Definitions
  1) "Overflow" means the diversion and discharge of waste streams from any portion of the wastewater conveyance system including pump stations, through a designed overflow device or structure, other than discharges to the wastewater treatment facility.
  2) "Severe property damage" means substantial physical damage to property, damage to the conveyance system or pump station which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of an overflow.
  3) "Uncontrolled overflow" means the diversion of waste streams other than through a designed overflow device or structure, for example to overflowing manholes or overflowing into residences, commercial establishments, or industries that may be connected to a conveyance system.

b. Prohibition of storm related overflows. Storm related overflows of raw sewage are prohibited to waters of the State. However, the Environmental Quality Commission (EQC) recognizes that it is impossible to design and construct a conveyance system that will prevent overflows under all storm conditions. The State of Oregon has determined that all wastewater conveyance systems should be designed to transport storm events up to a specific size to the treatment facility. Therefore, such storm related overflows will not be considered a violation of this permit if:
  1) The permittee has conveyance and treatment facilities adequate to prevent overflows except during a storm event greater than the one-in-five-year, 24-hour duration storm from November 1 through May 21 and except during a storm event greater than the one-in-ten-year, 24-hour duration storm from May 22 through October 31. However, overflows during a storm event less than the one-in-five-year, 24-hour duration storm from November 1 through May 21 are also not permit violations if, the permittee had separate sanitary and storm sewers on January 10, 1996, had experienced sanitary sewer overflows due to inflow and infiltration problems, and has submitted an acceptable plan to the Department to address these sanitary sewer overflows by January 1, 2010;
  2) The permittee has provided the highest and best practicable treatment and/or control of wastes, activities, and flows and has properly operated the conveyance and treatment facilities in compliance with General Condition B.1.;
  3) The permittee has minimized the potential environmental and public health impacts from the overflow; and
  4) The permittee has properly maintained the capacity of the conveyance system.

c. Prohibition of other overflows. All overflows other than stormwater-related overflows (discussed in Schedule F, Section B, Condition 6.b.) are prohibited unless:
  1) Overflows were unavoidable to prevent an uncontrolled overflow, loss of life, personal injury, or severe property damage;
  2) There were no feasible alternatives to the overflows, such as the use of auxiliary pumping or conveyance systems, or maximization of conveyance system storage; and
  3) The overflows are the result of an upset as defined in General Condition B.4. and meeting all requirements of this condition.

d. Uncontrolled overflows are prohibited where wastewater is likely to escape or be carried into the waters of the State by any means.

e. Reporting required. Unless otherwise specified in writing by the Department, all overflows and uncontrolled overflows must be reported orally to the Department within 24 hours from the time the permittee becomes aware of the overflow. Reporting procedures are described in more detail in General Condition D.5. Reports concerning storm related overflows must include information about the amount and intensity of the rainfall event causing the overflow.

Section B.7:
Public Notification of Effluent Violation or Overflow
If effluent limitations specified in this permit are exceeded or an overflow occurs, upon request by the Department, the permittee must take such steps as are necessary to alert the public about the extent and nature of the discharge. Such steps may include, but are not limited to, posting of the river at access points and other places, news releases, and paid announcements on radio and television.

Section D.5:
Twenty-Four Hour Reporting
The permittee must report any noncompliance that may endanger health or the environment. Any information must be provided orally (by telephone) within 24 hours, unless otherwise specified in this permit, from the time the permittee becomes aware of the circumstances. During normal business hours, the Department's Regional office must be called. Outside of normal business hours, the Department must be contacted at 1-800-452-0311 (Oregon Emergency Response System).

A written submission must also be provided within 5 days of the time the permittee becomes aware of the circumstances. Pursuant to ORS 468.959 (3) (a), if the permittee is establishing an affirmative defense of upset or bypass to any offense under ORS 468.922 to 468.946, delivered written notice must be made to the Department or other agency with regulatory jurisdiction within 4 (four) calendar days of the time the permittee becomes aware of the circumstances. The written submission must contain:

a. A description of the noncompliance and its cause;
b. The period of noncompliance, including exact dates and times;
c. The estimated time noncompliance is expected to continue if it has not been corrected;
d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance; and
e. Public notification steps taken, pursuant to General Condition B.**7.**

The following must be included as information that must be reported within 24 hours under this paragraph:
a. Any unanticipated bypass that exceeds any effluent limitation in this permit;
b. Any upset that exceeds any effluent limitation in this permit;
c. Violation of maximum daily discharge limitation for any of the pollutants listed by the Department in this permit; and
d. Any noncompliance that may endanger human health or the environment.

The Department may waive the written report on a case-by-case basis if the oral report has been received within 24 hours.

NPDES Permits issued after August 20, 2009:
Section B.6.Overflows from Wastewater Conveyance Systems and Associated Pump Stations
a. Definitions
   1) "Overflow" means any spill, release or diversion of sewage, including:
      i. An overflow that results in a discharge to waters of the state; and

ii. An overflow of wastewater, including a wastewater backup into a building (other than a backup caused solely by a blockage or other malfunction in a privately owned sewer or building lateral), even if that overflow does not reach waters of the state.

b. Prohibition of overflows. Overflows are prohibited. The Department may exercise enforcement discretion regarding overflow events. In exercising its enforcement discretion, the Department may consider various factors, including the adequacy of the conveyance system's capacity and the magnitude, duration and return frequency of storm events.
c. Reporting required. All overflows must be reported orally to the Department within 24 hours from the time the permittee becomes aware of the overflow. Reporting procedures are described in more detail in General Condition D.5.

Section B.7:
Public Notification of Effluent Violation or Overflow
If effluent limitations specified in this permit are exceeded or an overflow occurs that threatens public health, the permittee must take such steps as are necessary to alert the public, health agencies and other affected entitles (e.g., public water systems) about the extent and nature of the discharge in accordance with the notification procedures developed in accordance with General Condition B.8. Such steps may include, but are not limited to, posting of the river at access points and other places, news releases, and paid announcements on radio and television.

Section B.8.:
Emergency Response and Public Notification Plan
The permittee must develop and implement an emergency response and public notification plan that identifies measures to protect public health from overflows, bypasses or upsets that may endanger public health. At a minimum the plan must include mechanisms to:

a. Ensure that the permittee is aware (to the greatest extent possible) of such events;
b. Ensure notification of appropriate personnel and ensure that they are immediately dispatched for investigation and response;
c. Ensure immediate notification to the public, health agencies, and other affected public entities (including public water systems). The overflow response plan must identify the public health and other officials who will receive immediate notification;
d. Ensure that appropriate personnel are aware of and follow the plan and are appropriately trained;
e. Provide emergency operations; and
f. Ensure that DEQ is notified of the public notification steps taken

Section D.5.:
24- Hour Reporting
The permittee must report any noncompliance that may endanger health or the environment. Any information must be provided orally (by telephone) to DEQ or to the Oregon Emergency Response System (1-800-452-0311) as specified below within 24 hours from the time the permittee becomes aware of the circumstances.

a. Overflows.
   1) Oral Reporting within 24 hours.
      i. For overflows other than basement backups, the following information must be reported to the Oregon Emergency Response System (OERS) at 1-800-452-0311. For basement backups, this information should be reported directly to DEQ and not to OERS.
      ii.
         (a) The location of the overflow;
         (b) The receiving water (if there is one);

(c) An estimate of the volume of the overflow;
(d) A description of the sewer system component from which the release occurred (e.g., manhole, constructed overflow pipe, crack in pipe); and
(e) The estimated date and time when the overflow began and stopped or will be stopped.

ii. The following information must be reported to the Department's Regional office within 24 hours, or during normal business hours, whichever is first:

(a) The OERS incident number along with a brief description of the event.

b. Written reporting within five days.

1) The following information must be provided in writing to the Department's Regional office within 5 days of the time the permittee becomes aware of the overflow:

i. The OERS incident number (if applicable);
ii. The cause or suspected cause of the overflow;
iii. Steps taken or planned to reduce, eliminate, and prevent recurrence of the overflow and a schedule of major milestones for those steps;
iv. Steps taken or planned to mitigate the impact(s) of the overflow and a schedule of major milestones for those steps;
v. Steps taken to notify the public; and
vi. (for storm-related overflows) The magnitude and duration of the storm associated with the overflow.

The Department may waive the written report on a case-by-case basis if the oral report has been received within 24 hours.

Appendix C: Determination of the Five-Year Storm Event

The bacteria standard (OAR 340-041-0009(6) and (7)) prohibits the discharge of raw sewage except during a winter storm event greater than the one-in-five-year, 24-hour duration storm.

When a permittee reports an SSO but fails to provide DEQ with information indicating whether or not the SSO occurred in response to a five-year event, DEQ can perform the determination using the information below. Permittees may also perform more site-specific determinations as to what constitutes the 5- and 10- year events for their systems, and are encouraged to provide this information to DEQ in advance of storm events.

Step 1: Determine the rainfall associated with the SSO event. As of this writing, the following websites provide rainfall data for Oregon. There may be others.

National Weather Service Advanced Hydrologic Prediction Service
This website has current as well as archived precipitation data for the whole country and is the most comprehensive of the sites listed. It is also a bit clumsy to use. Play with it.

Community Collaborative Rain, Hail and Snow Network
http://www.cocorahs.org/ViewData/StateDailyPrecipReports.aspx?state=OR
This website has data by volunteers from over 200 locations in Oregon. The data can be viewed in either table or (rather crude) map format.

MesoWest Surface Weather Maps
http://mesowest.utah.edu/cgi-bin/droman/mesomap.cgi?state=OR&address=&type=&noho=&rawsflag=3
This site is maintained by the University of Utah. This site is the most elegant of the three. To show 24-hour precipitation data for the whole state, make sure you have selected “All Networks” from the Network menu in the box entitled “Data Selection”, and “24hr Precip” from the Overlay 1 menu in the “Display” box. To get precipitation totals for the past 2, 5, 7 etc. days, select “Precipitation Summary” from the “Product” menu at the top of the screen. This summary also gives the number of days taken to achieve various precipitation levels.

Step 2: Determine whether or not the recorded rainfall corresponds to a one-in-five-year, 24-hour duration storm. This can be done by either contacting NOAA directly for to obtain rainfall data for a particular city, or by referring to the table below. The rainfall amounts in this table are taken from 1973 NOAA Atlas 2 entitled "Precipitation-Frequency Atlas of the Western United States, Volume X – Oregon". Specifically, they were interpolated from Figure 26 entitled "Isopluvials of 5-yr 24-hr precipitation in tenths of an inch". The Atlas can be obtained on line at http://hdsc.nws.noaa.gov/hdsc/pfds/other/or_pfds.html, however the file is very large. A scanned version of Figure 26 is available at: http://www.wrcc.dri.edu/pcpnfreq/or5y24.gif

Table 1: Rainfall Associated with Five Year Storm Events for Selected Cities in Oregon*

City	in/24 hr	City	in/24 hr	City	in/24 hr	City	in/24 hr
ADAIR VILLAGE	4	ESTACADA	4	MONMOUTH	4	SISTERS	2.25
ALBANY	3	EUGENE	4	MONROE	3	ST HELENS	2.5
AMITY	3	FALLS CITY	5.5	MOSIER	2	STANFIELD	1.2
ARCH CAPE	4.5	FLORENCE	5	MT ANGEL	3	STAYTON	3
ARLINGTON	1.4	FOREST GROVE	3.5	MT VERNON	1.6	SUTHERLIN	3.5
ASHLAND	3	GARIBALDI	4.5	MT. HOOD	3.5	SWEET HOME	3.5
ASTORIA	4.25	GERVAIS	3	MULTNOMAH FALLS	4	TANGENT	3
ATHENA	1.6	GLENDALE	4.5	MURPHY	3.5	THE DALLES	1.8
AUMSVILLE	3	GLENEDEN BEACH	4.5	MYRTLE CREEK	3	TIGARD	3
AURORA	3	GLIDE	4.5	MYRTLE POINT	5	TILLAMOOK	4.6
BAKER CITY	1.2	GOLD HILL	3	NEHALEM	4.5	TILLER	3.5
BANDON	5.5	GOSHEN	4	NESKOWIN	5.5	TOLEDO	4.5
BAY CITY	4.5	GOVERNMENT CAMP	5	NEWBERG	3	TRAIL	3
BIGGS	1.8	GRAND RONDE	5	NEWPORT	4	TROUTDALE	3.5
BIRKENFELD	4	GRANTS PASS	3.5	NORTH BEND	4.5	TWIN ROCKS	4.5
BORING	4	HALFWAY	2	NORTH POWDER	1.5	UMATILLA	1.2
BROOKINGS	6	HALSEY	3.5	NYSSA	1.4	UNION	1.6
BROOKS	3	HARRISBURG	3.5	OAKLAND	3.5	VENETA	4
BROWNSVILLE	4	HEBO	5.5	OAKRIDGE	3.5	VERNONIA	2.5
BUTTE FALLS	3.5	HEPPNER	1.5	OCEANSIDE	4	WALDPORT	5
CANBY	3	HERMISTON	1.4	ODELL	2.5	WALLOWA	1.8
CANNON BEACH	5	HILLSBORO	3	ONTARIO	1.4	WARRENTON	4
CANYONVILLE	3.5	HOOD RIVER	2.5	OREGON CITY	3.5	WELCHES	5
CARLTON	3	HUBBARD	3	OTTER CREST	4	WESTFIR	4
CASCADE LOCKS	4.5	HUNTINGTON	1.7	PACIFIC CITY	4.5	WESTON	2
CAVE JUNCTION	5.5	INDEPENDENCE	3.5	PARKDALE	3.5	WESTPORT	4
CENTRAL POINT	2.5	JEFFERSON	3	PENDLETON	1.2	WILLAMINA	3.5
CHILOQUIN	2	JOSEPH	1.6	PHILOMATH	4	WILSONVILLE	3
CLATSKANIE	4	JUNCTION CITY	3.5	PORT ORFORD	5.5	WINCHESTER BAY	4.5
CLOVERDALE	5.5	KEIZER	3	PORTLAND	3	WOODBURN	3
COOS BAY	4.5	KLAMATH FALLS	2	POWERS	5	YACHATS	5.5

Sanitary Sewer Overflows IMD - November 2010

Table 1: Rainfall Associated with Five Year Storm Events for Selected Cities in Oregon*

City	in/24 hr	City	in/24 hr	City	in/24 hr	City	in/24 hr
COQUILLE	5	LA GRANDE	1.6	PRINEVILLE	1.6	YAMHILL	3
CORVALLIS	3	LAFAYETTE	3	RAINIER	2.5	YONCALLA	4
COTTAGE GROVE	4	LAKE OSWEGO	3	REEDSPORT	5		
CRESWELL	4	LAKESIDE	4.5	RICE HILL	4		
DALLAS	4	LAKEVIEW	1.8	RIDDLE	4.5		
DAYTON	3	LEBANON	3.2	ROCKAWAY BEACH	4.5		
DAYVILLE	1.4	LINCOLN CITY	5	ROGUE RIVER	3		
DEPOE BAY	4	LONG CREEK	1.8	ROSEBURG	3		
DRAIN	4	LOWELL	4	SCAPPOOSE	3		
DUFUR	1.8	MAPLETON	6	SCIO	3.5		
DUNDEE	3	MAUPIN	1.6	SEASIDE	4		
ECHO	1.2	MCMINNVILLE	3	SHADY COVE	3		
ELGIN	2.2	MERLIN	3.5	SHERIDAN	3.5		
ENTERPRISE	1.5	MILWAUKIE	3	SILETZ	7.5		
ESTACADA	3.5	MOLALLA	3.5	SILVERTON	3		

The values in this table are generally conservative insofar as when a city was between two isopluvials, the higher rainfall value was selected as representing the 5- year, 24- hour event.

Contact information for NOAA is provided below.

Medford contact info is:

Medford Weather Forecast Office
4003 Cirrus Drive
Medford, OR 97504-4198
Tel: Charles Glaser at (541) 776-4303 or email Charles.Glaser@noaa.gov
Charles Glaswer

The Portland contact info is:

National Oceanic and Atmospheric Administration National Weather Service Portland Weather Forecast Office
5241 NE 122nd Avenue
Portland, OR 97230-1089
Tel: (503) 261-9246

The Pendleton contact info is:

National Oceanic and Atmospheric Administration National Weather Service Pendleton Weather Forecast Office
2001 NW 56th Drive
Pendleton, OR 97801
Tel: (541) 276-7832

Step 3: (Optional) Determine if the rainfall event corresponds to a one-in-five year (or greater) event lasting less than 24 hours (also known as the "cloudburst scenario"), or if the event may otherwise be viewed as extreme (such as rain-on-snow).

It should be noted that the bacteria rule only refers to 24- hour events, and it is up to DEQ's discretion (as reflected in the Enforcement Guidance) whether or not to take formal enforcement action as a result of SSOs that occur in response to five year events that last less than 24 hours. Furthermore, rainfall data is not always available on a less-than-24 hour basis, and adequate snowfall data may not be available either. In considering extreme events that may have been the cause of an SSO, permit staff are directed to consider that the bacteria rule was written with the understanding that SSOs should be rare occurrence, and it was not intended to reduce the incentive for addressing I/I. For this reason, it is not acceptable to accept the once-in-five year flow as a basis for exercising enforcement discretion regarding an SSO, though this flow may be used for sizing a POTW. The logic in using this flow as the basis for designing a POTW is that will result in a POTW that is able to handle flows all but once every five years, regardless of how quickly progress is made with reducing I/I.

If rainfall data is available, the determination of the size rainfall event may be determined by consulting Appendix A of ODOT's Hydraulics Manual. This may be found at: ftp://ftp.odot.state.or.us/techserv/Geo-Environmental/Hydraulics/Hydraulics%20Manual/Chapter_07/Chapter_07_appendix_A/CHAPTER_07_APPENDIX_A.pdf

Appendix D: Review of Emergency Response and Public Notification Plans

Overview

Domestic permits issued by DEQ after August 20, 2009 include a requirement to develop, implement and maintain plans for emergency response and public notification. The requirements for these plans may be found in General Conditions Section B.8., and are listed below in italics.

The purpose of these plans is to identify measures to protect public health from SSOs, bypasses or upsets that may endanger public health. As listed in Schedule F, Section B.8, these plans must include mechanisms to:

1. *Ensure that the permittee is aware (to the greatest extent possible) of such events;*
2. *Ensure notification of appropriate personnel and ensure that they are immediately dispatched for investigation and response;*
3. *Ensure immediate notification to the public, health agencies, and other affected public entities (including public water systems). The overflow response plan must identify the public health and other officials who will receive immediate notification;*
4. *Ensure that appropriate personnel are aware of and follow the plan and are appropriately trained;*
5. *Provide emergency operations; and*
6. *Ensure that DEQ is notified of the public notification steps taken.*

Permit staff should emphasize to permittees the importance of working with public health agencies and the local, county and/or state level in developing Emergency Response and Public Notification plans. Permit staff should advise permittees to have the final plans available for DEQ review during compliance inspections or upon request, and should include a requirement in the permit to develop such plans within six months of permit issuance.

Explanation of Requirements

Each of the requirements for emergency response and public notification plans is set forth and then explained below. The level of detail contained in a particular plan will vary with the size and complexity of the system.

1. *Ensure that the permittee is aware (to the greatest extent possible) of overflows, bypasses or upsets.*

   The plan should describe the measures that the permittee will take to ensure that maintenance staff is aware when events occur that may threaten public health. Measures permittees may elect to undertake may include (but are not limited to):

   - Insure that citizens know who to contact in the event of an SSO by making the phone number readily available. Ways to accomplish this include providing it in sewer bills, in the phone book and on the city's website.
   - Develop and maintain an inspection schedule for SSO points. The inspection schedule may be different for different SSO points. Areas vulnerable to overflowing generally only during major storm events may only need to be inspected during storm events. Areas vulnerable to the buildup of fats, oils and grease may need to be inspected during dry as well as wet weather times.
   - Develop and maintain a map or maps showing where SSOs have occurred in the last five years, as well as locations of potential public access and exposure. Examples of locations where public

exposure is a concern include residential areas, commercial or retail areas, parks, playgrounds, schoolyards, fishing access points and boat ramps.
- Install alarms, flow meters, cameras and/or other monitoring equipment at identified SSO points.

2. *Ensure notification of appropriate personnel and ensure that they are immediately dispatched for investigation and response.*

The plan should identify staff responsible for responding to SSOs on a 24-hour basis, and include appropriate contact information for those staff.

The plan should identify a goal for responding to reports of SSOs. The goal may vary from permittee to permittee, but it must be less than 24 hours. The plan should identify the response time that the permittee is aiming for, and list the notification and backup measures in place to ensure that it is met.

The plan should describe a process for achieving continuous improvement with respect to response time. When the time limit for a particular event is exceeded, staff should work to identify the cause of the delay as well as steps that will be taken to reduce the response time. The plan should be updated as necessary to reflect the outcome of this continuous improvement process.

3. *Ensure immediate notification to the public, health agencies, and other affected public entities (including public water systems). The overflow response plan must identify the public health and other officials who will receive immediate notification.*

The plan should describe the means by which the public will be notified of an SSO event. Such notification needs to happen in a timely manner, with the intent of reaching a broad audience. Depending on local circumstances, the permittee may notify the public directly or may notify other entities such as the local health authority to notify the public.

Several mechanisms may need to be employed to achieve this.

- The plan should state that all SSOs that may impact surface water or public health are to be reported to the Oregon Emergency Response System (OERS) at 1-800-452-0311.
- The plan should contain contact information for public water supplies with intakes located downstream of the permittee. This list should be accompanied by a description of the circumstances under which each public water supply would like to be contacted. Some entities located a significant distance away from the permittee may wish to be contacted regarding major SSOs only while others may wish to be contacted more frequently. DEQ permit staff can assist in determining who the potentially-impacted public water supplies are by consulting DEQ's outfall location data page and looking under the column entitled "Dwnstrm PWS". For security reasons, this web page is not accessible to the public.
- The notification list should include contact information for other downstream water users (livestock water, crop irrigation, etc.) as necessary, and regulatory and media contacts.
- The plan may also include set points (based on seasons, SSO volumes, locations, etc.) that would trigger issuance of a media release and a standard notice that can be sent out when needed.

Other measures that may be taken to ensure notification, and that should be described in the plan are as follows:
- Install warning signs in areas where the public is at risk for coming into contact with contaminated water. Areas of concern include parks, playgrounds, schoolyards, fishing access points and boat ramps. If the signs are to be installed on an as-needed basis, they should be made in advance so they will be available when needed. They should be in multiple languages

corresponding to the local population, or use universal warning symbols. Alternatively, lock up/lockdown-type signs may be installed on a permanent basis that contain warnings to the public to avoid contact with water during storm events.
- Have a phone number with a recorded message that can be updated as needed to notify the public about SSO events.
- Maintain a web page that citizens may access to find out the latest information regarding SSO events. Web pages could have an email notification option for citizens who would like to receive email notifications regarding SSO events.

4. *Ensure that appropriate personnel are aware of and follow the plan, and are appropriately trained.*

The plan should describe mechanisms for insuring that personnel are familiar with the plan and its implementation. These mechanisms may include but are not limited to:
- Locations where copies of the plan are to be kept. At a minimum, copies should be kept at the wastewater treatment plant, City Hall (or main agency office), and with the afterhours on-call staff.
- Regularly scheduled staff meetings or training sessions. The plan should describe the information to be disseminated at meetings or training sessions, and should include a schedule for when these meetings or training sessions are to take place.
- Development of a task list for insuring that the plan works as intended. The task list should identify positions/individuals associated with each task and their personal contact phone numbers. Individual tasks could include but are not limited to: insuring there is an adequate supply of signs and checking phone numbers of agencies during an SSO event to make sure the contact information is current.

5. *Provide emergency operations.*

The plan should describe, for a wide range of system failures, applicable corrective actions to halt and mitigate the impact of SSOs. Such actions may include but are not limited to containment, wash down and clean up procedures to be followed in the event of an emergency. The plan should also identify the staff and equipment available for handling emergencies. Regarding disinfection, desiccation by the sun is usually adequate for disinfection after clean up. However, if post-cleanup disinfection is desired, a dilute chlorine solution may be used on hard surfaces and lime may be use on dirt or gravel areas. If used, disinfection chemicals should not be allowed to discharge into creeks and streams, as they are toxic to aquatic life at very low concentrations. Areas that drain to storm drains and/or streams should be washed with water only.

When SSOs impact surface water, proper response to an SSO should include follow-up sampling and analysis for *E. coli* bacteria. The plan should define locations and frequencies of such monitoring. Monitoring results can be used by collection system and/or treatment staff to develop projections of when conditions are likely to return to safe levels.

The plan should state the circumstances under which a public notification or alert can be terminated. As described above, these circumstances can be determined by the results of sampling at predetermined locations and frequencies.

6. *Ensure that DEQ is notified of the public notification steps taken.*

The plan should include appropriate DEQ contact information and list the information that must be reported. As stated in the general conditions of the permit, a written report to DEQ is usually required within 5 days of the event unless this requirement has been waived by DEQ staff. To insure completeness and consistency in reporting, DEQ has developed an online SSO reporting form that will be accessible through DEQ's external website on January 1, 2011. Once the permit holder has filled out the form, it should be printed out and mailed to the appropriate regional office. Appendix A contains a copy of the form.

Appendix E: Template for Emergency Response and Public Notification Plans

All NPDES domestic permits issued by DEQ contain a requirement to notify the public regarding overflows. Permits issued after August 20, 2009 contain more specific requirements, and state that permit holders must develop and implement Emergency Notification and Response Plans. This requirement is in Schedule F of the General Conditions, Section B.7. All municipalities should be encouraged to develop such plans for the following reasons:

- Developing these plans can help define responsibilities, clarify roles and procedures, identify resources and result in complete, up-to-date contact information.
- In the event that an SSO warrants an enforcement action by DEQ, a municipality's timely and appropriate response can serve to mitigate the penalty that may be associated with the event. Conversely, failure to take appropriate action can aggravate a penalty. A good plan can help insure a timely and appropriate response to an SSO event.

In other words, all permit holders will benefit from developing Emergency Response and Public Notification plans regardless of when their permit was issued.

Emergency Response Plans should be written for the benefit of the staff that may use them, and not just to satisfy a regulatory requirement. It is recommended that they contain the following:

1. Introduction - the introduction should state why the plan is being developed and what it is intended to accomplish. The permit holder may wish to list permit requirements here.
2. Receipt of Information Regarding an SSO - this section should describe:
   a. How members of the public can report SSOs. A citizen who sees an SSO should know or be able to easily determine who to call to report the SSO.
   b. How a report of an SSO is received and assigned to the appropriate party for action. The anticipated turnaround time should be identified. Ideally it should be less than 24 hours.
3. Emergency Operations - this section should describe the steps that will be taken to contain and stop small, medium and large SSO events. It should describe available equipment and resources for responding. If the permit holder has arrangements with neighboring municipalities to borrow/share equipment, this is the place to describe. This section should also describe the circumstances under which private contractors may be called in to assist. Provisions for bacteria monitoring should also be included here.
4. Public Advisory Procedure - this section should contain the following:
   a. A list of Public Water Supplies that may need to be notified in the event of an SSO, and the particular circumstances under which each may wish to be notified. DEQ can help identify the Public Water Supplies located downstream from a permit holder. It is the responsibility of the permit holder to communicate with these entities to find out when they wish to be contacted. The results of these communications should be included in the Emergency Response and Public Notification Plan.
   b. A list of public health officials who may need to be notified in the event of an SSO.
   c. Information on when and where signs are to be installed when needed. This could include a map or list of areas where the public can be expected to come into contact with SSOs such as beaches and boat launches. Any information that staff might need in order to get the signs installed in a timely manner should be included as well.
   d. A standard press release that can be modified as needed when there is an SSO.

e. Other methods of notifying the public such as maintaining a phone with a pre-recorded message that can be updated on a regular basis, and/or a web page with regularly-updated information and an email notification option.
f. A description of monitoring procedures to follow to assess bacteria levels following an SSO to surface water.
g. A description of the circumstances under which public notification can be terminated. The results of bacteria monitoring can be used to establish this. Bacteria monitoring results collected over time can be used to establish general timeframes and make informed predictions.

5. Reporting to OERS and DEQ. This section should list the information that needs to be reported orally to OERS and to DEQ within 24 hours, and in writing within 5 days. It should contain the link to DEQ's online reporting form for SSOs.
6. Followup Process for Sewer System Overflows - this section should describe the extent and nature of cleanup actions to be carried out for SSOs that occur within buildings, outside buildings, to land and to surface water. Since the indiscriminate use of disinfectants can be harmful to aquatic and wildlife and desiccation by the sun is usually adequate for disinfection after cleanup, the circumstances under which they are needed should be described. This section should also describe the steps taken or planned to reduce, eliminate, and prevent the recurrence of the overflow and a schedule of those steps. The procedures for followup bacteria monitoring should be described here.
7. Distribution and Maintenance of Emergency Response and Public Notification Plan - this section should describe the process by which the plan will be made available and kept up-to-date.

Possible additional information to include in Emergency Response and Public Notification Plans:

1. Winter Storm Watch Sewer Overflow Manholes
2. Bypass Pump Inventory w. pumping capacity included - may be helpful to permittees in estimating the volume of particular overflows.
3. How to estimate the volume of an SSO. Appendix H of this IMD on SSOs contains several methods.

Appendix F: Pump Station Reliability/Redundancy

In determining whether an SSO from a pump station was beyond the reasonable control of the permit holder, DEQ staff should determine whether the pump station has an adequate level of reliability and redundancy. The following expectations for pump stations should be considered:

1. Back-up pumps: There should be a minimum of 2 pumps for each pump station, and the design flow must be handled with the largest pump out of service. The minimum design flow is the 5-year, 24-hour flow.
2. The following items should have telemetry for notifying appropriate personnel in the event of an emergency:
    a. High level alarm
    b. Overflow alarm
    c. Power fail alarm
    d. Generator fail alarm (if applicable)
3. There should be backup power as follows:
    a. Dedicated generator, mobile generator set or engine powered back-up pump, and
    b. Power supplied from independent grid.
4. Valves: each pump should have independent shut-off valves and check-valves.
5. Flood preparedness: the pump station controls and the top of slab should be at least 1 foot above the 100-year flood level (500-year flood for SRF jobs). The pump station and wet well should be designed so they do not float when soils become saturated.
6. Vandalism prevention: Pump stations should be secured to minimize the potential for vandalism. Security measures may be site-specific and adopted based on the general frequency of vandalism in the area. Such security measures may include but are not limited to: fences, locked gates and locked hatches.
7. The pump station must be designed so that a pump can be removed without taking the system off-line or dewatering the wet well.

If the pump station was built before these standards existed, the city needs to have a plan to upgrade the pump station. If they have a plan and they are following it, an SSO at an obsolete pump station will be considered to be Beyond Reasonable Control.

Sanitary Sewer Overflows IMD - November 2010

Appendix G: Drinking Water Protection Program Tools You Can Use

The Objective in developing these tools is to protect public health and drinking water supplies by:

- Creating a web-based tool for permit writers and permittees to easily identify drinking water source areas for public water system wells and intakes
- Encouraging communication between permit writers, permittees and downstream public water systems and
- Ensuring that permittees have contact information for downstream water systems in their Emergency Response and Public Notification Plans.

If a site is located within a drinking water source area, it does NOT mean we can't or shouldn't permit it…it just means that the public health implications need to be considered as BMPs, permit conditions and emergency notification plans are developed.

Web tool on QNet Permit Writers Page

- Most useful for identifying drinking water intakes downstream of the ~300 outfalls GPSed as part of the Effluent Outfall Project (which includes 90% of individual NPDES permits for domestic and industrial wastewater) - does not include drinking water source areas for wells or springs
- Find the permit in the permit record by common name, permit number, city, county, stream name, etc.
- Under "PWS" there will be a link to a report of PWSs (Public Water Systems) that have intakes downstream of the effluent outfall. (Note: only about 40% of the outfalls have a PWS intake identified downstream.)
- "PWS" report includes drinking water intakes between the effluent outfall and the 4^{th}-field watershed boundary (basin boundary) and link to DHS SDWIS for contact information.
- Report can be exported (.pdf, .doc, or. xls) - *RiverMile and LLID information is for internal DEQ use only and should not be released!*

DEQ Facility Profiler -- http://deq12.deq.state.or.us/fp20/

- Instructions on how to view source water areas using DEQ's Facility Profiler available at http://www.deq.state.or.us/wq/dwp/results.htm (Assessment Results/Maps) or http://www.deq.state.or.us/WQ/dwp/swrpts.asp
- Can be used to identify public groundwater and surface water drinking water source areas (for wells, springs and intakes – Can use PWS names (in light grey) in conjunction with DWP Website Tool
- Includes Drinking Water Source Areas for community water systems serving 25+people year-round (cities, towns, mobile home parks), other public water systems serving 25+ of the same people, > 6 months of the year (like work sites and schools), plus most groundwater systems serving transient population (like rest areas and campgrounds).
- Not included at this time: Surface water systems serving transient populations, state-regulated water systems serving 10 to 24 people daily (e.g. small mobile home parks), private wells or water supply.
- Limitations: Facility Profiler platform has limitations and is not necessarily user-friendly or intuitive. No "identify" tool for DWSAs, must look for light grey text. Can't identify specific

time-of-travel zones for groundwater DWSAs. Call DEQ Drinking Water Protection staff with any questions.

DWP Website Tools - http://www.deq.state.or.us/WQ/dwp/swrpts.asp

- Search by Public Water System Name or Subbasin for:
  - public access to list of downstream (and upstream) intakes,
  - Source Water Assessment Results (including identification of sensitive areas and potential sources of contamination to intake or well),
  - Link to DHS Data Online for Safe Drinking Water Information System (SDWIS) database:
    - basic system information (including PWS contact information),
    - data on coliform and chemical testing,
    - reports on violations, enforcements, and public notices
- Report can be exported (.pdf, .doc, .xls) for easy inclusion in plan

Additional resources available for Drinking Water Source Areas (DWSAs)

- Statewide and County scale maps of drinking water source areas available at http://www.deq.state.or.us/wq/dwp/results.htm
- Source Water Assessments for all PWSs (http://www.deq.state.or.us/wq/dwp/results.htm)
  - Drinking water source locations (intakes, wells and springs)
  - Delineation of the DWSA: the portion of a watershed or groundwater area that may contribute water (and, therefore, pollutants) to the drinking water supply
  - Identification of Sensitive Areas
  - Other risks and potential sources of contamination
- Best Management Practices (both voluntary and regulatory) for various potential sources of contamination within a watershed http://www.deq.state.or.us/WQ/dwp/dwp.htm
- DHS Data Online (http://oregon.gov/DHS/ph/dwp/index.shtml) for PWS contact information, data on coliform and chemical testing, and reports on violations, enforcements, and public notices.

Drinking Water Protection Program Contacts

http://www.deq.state.or.us/wq/dwp/dwp.htm

Technical Assistance:
Sheree Stewart, WQ Division, Drinking Water Protection Coordinator 503-229-5413
NWR: Julie Harvey, WQ Division 503-229-5664
WR: Jacqueline Fern, Regional Environmental Solutions, Eugene, 541-686-7898
ER: Julie or Jackie
Statewide DWP GIS: Steve Aalbers, HQ WQ Division, 503-229-6798
Non-point source: Josh Seeds, 503-229-5081

Appendix H: Ways to Estimate SSO Volume

Permit staff may suggest the following methods for estimating the volume of SSOs to permit holders.

1. Puddle Volume Method

The volume of a puddle caused by an SSO can be estimated using the following equation:

Volume in gallons = Π x (diameter/2) x (diameter/2) x average depth x 7.48

Where:

Π = 3.14
Diameter = diameter of the puddle in feet
Depth = average depth of the puddle in feet
7.48 = conversion factor from cubic feet to gallons

2. Houses Served Method

The volume of an SSO from a sewer main serving a residential area can be estimated from the number of houses served by the main as follows:

SSO volume in gallons = number of houses served x 240 gallons/household per day x duration of SSO event

3. Pump Rating Method

The volume of an SSO from a pump station can be estimated as follows:

SSO volume in gallons = GPM rating of pump that is out of service x no. of hours of outage x 60 minutes/hour

4. Bucket Fill Time Method

Measure or estimate how long it takes the SSO to fill a 5 gallon bucket, and use the following 2 equations (or table and 2nd equation) to estimate the volume of the SSO.

SSO flow rate, GPM = 5 x (60 seconds/minute) / (seconds to fill a 5 gallon bucket)

Time to Fill 5 gal. Bucket	GPM
3	100
5	60
10	30
20	15
30	10

SSO volume, gallons = GPM x no. of hours of flow x 60 minutes/hour

5. Visual Estimating Method

See Reference Sheet for Estimating Sewer Spills from Overflowing Sewer Manholes developed by the City of San Diego Metropolitan Wastewater Department. This is available online at: http://lgvsd.org/docs/SSMP%20Appendix%20A.pdf. See page 27.