
**WSDOT NPDES Municipal Stormwater Permit
Highway Monitoring Status Report
Water Year 2022**

October 2023

Prepared by

Stormwater Monitoring and Research Program
Environmental Services Office
Washington State Department of Transportation



**Washington State
Department of Transportation**

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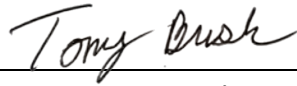
Stormwater Monitoring Report (Highway)

Water Year 2022

Approved by:

I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for willful violations.

Signature: _____



Date: _____

Tony Bush, Stormwater Branch Manager
WSDOT Environmental Services Office

Signatures are not available on the Internet version.
WSDOT = Washington State Department of Transportation

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1 Introduction

1.1 Permit Overview

On March 6, 2019, the Washington State Department of Ecology (Ecology) reissued a National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge Municipal Stormwater General Permit (permit) (Ecology 2019) to the Washington State Department of Transportation (WSDOT), effective April 5, 2019, to April 5, 2024. Under Special Condition S7.D. of the permit, WSDOT must begin new highway and facilities effectiveness studies that are approximately the same level of monitoring effort and cost as the previous studies that were reported on in October 2019.

Stormwater monitoring provides feedback to WSDOT for inclusion in its Highway Runoff Manual (HRM) (WSDOT, 2019). WSDOT's stormwater management approach utilizes BMPs to help meet the permit requirement to "reduce pollutants in discharges to the maximum extent practicable" (Ecology, 2019). The monitoring program evaluates performance of BMPs using guidance in the Technology Assessment Protocol – Ecology (TAPE) (Ecology, 2018) as required by S7.C of the permit.

Under Special Conditions S7.H and S8.B. of the permit, monitoring reports are required for information collected at the department's stormwater monitoring sites. The following report is meant to satisfy these requirements and provides a summary of monitoring activities completed in Water Year 2022 (WY22) from October 1, 2021, through September 30, 2022.

2 Monitoring Program Implementation

2.1 Study Overview

WSDOT, in consultation with Ecology, selected a biofiltration swale longevity study to fulfill the highway BMP effectiveness monitoring study requirements. The goal of the study is to determine if highway biofiltration swales provide treatment beyond their effective life, which is defined in the HRM as 5-20 years age. The results of this study are intended to inform future maintenance and replacement schedules of biofiltration swales. Program implementation during WY22 included hydraulic and chemistry stormwater sample, which are described below.

WSDOT selected two biofiltration swale study sites (Figure 1) based on the design guidelines listed below. An overview of the sites selected is given in Table 1. Additional site selection criteria for this study, accounting for characteristics of both monitoring locations, are:

Highway biofiltration swales:

1. Safely accessible for WSDOT staff and provide access that will not put the traveling public at undue risk.
2. Within the WSDOT right-of-way.
3. Biofiltration swale constructed prior to the year 2000.
4. Site characteristics, including shape, slope, soil composition representative of 1995 specifications for biofiltration swales.
5. At a location that regularly receives enough precipitation and subsequent stormwater runoff to maintain a reasonable monitoring timeline.
6. Inlet and outlet are monitorable for hydrology and chemistry without altering the function of the biofiltration swale and moving it beyond HRM specification.

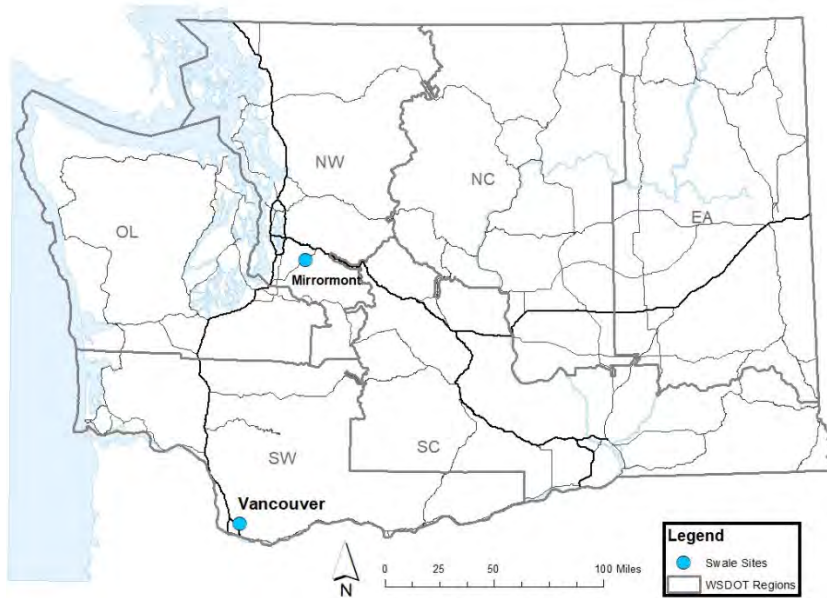


Figure 1. Highway Study Site Locations

Table 1. Highway BMP monitoring locations and Traffic/Roadway Conditions

Highway	Site Name	Highway Conditions	
		Annual Average Daily Traffic	Location Condition
SR 500/503 Interchange	Vancouver	503: 41,000	Intersection with Traffic Light
		500: 20,000	
SR 18	Mirrormont	27,000	Suburban Highway with Off Ramp

Vancouver

The Vancouver biofiltration swale is located at milepost 7.00 on State Route (SR) 500 and treats stormwater from the intersection of SR 500 and SR 503. The biofiltration swale was built for Clark County in 1999 and came under WSDOT ownership in 2005 when Padden Park Way became SR 500.

The biofiltration swale is located northeast of the intersection and receives runoff from a 1-acre drainage area. The stormwater conveyance system is highlighted in Figure 2. The drainage area was ground-checked through multiple site observations during storm events, including heavy rain events. The biofiltration swale does not receive water from local roads or any non-WSDOT property.



Figure 2. Vancouver biofiltration swale monitoring site and associated drainage features

Construction and installation of monitoring equipment took place during water year 21. Supply chain and other covid-19 related delays pushed the sample start date to October 28, 2021.



Figure 3. Vancouver bioswale effluent

Mirrormont

The Mirrormont biofiltration swale is located at milepost 20.48 on SR 18 and treats stormwater from SR 18 mainline lanes. The Mirrormont biofiltration swale was built to 1995 HRM standards in 1999.

The biofiltration swale is located on an offramp north of mainline SR 18 and receives runoff from a 3.5-acre impervious drainage area. The stormwater conveyance system is highlighted in Figure 4. The drainage area was ground-checked through multiple site observations during storm events, including heavy rain events. The biofiltration swale does not receive water from local roads or any non-WSDOT property.



Figure 4. Mirrormont biofiltration swale monitoring site and associated drainage features

Construction and installation of monitoring equipment took place during water year 21. Influent monitoring equipment is shown in Figure 5. Supply chain and other covid-19 related delays pushed the sample start date to October 28, 2021.



Figure 5. Mirrormont influent monitoring equipment

2.2 Highway Study Results

WSDOT initiated hydrological, chemical, and meteorological data collection at the highway sites in 2022. WSDOT mobilized 30 times for attempted storms chemistry and hydrology sampling. WSDOT successfully sampled 10 storms. This data will be used to inform WSDOT Maintenance and WSDOT HRM on the life expectancy of swales and the treatment capacity of bioswales older than 20 years (longest HRM life expectancy).

Tables 2 and 3 contain the list of all storm sampling event attempts and outcomes. Appendices A and B contain the storm reports and chemistry data associated with successful sampling events.

Table 2. Mirrormont Sample Attempts

Date	Influent	Effluent
2/14/2021	Less Volume Than Expected	Low Volume
2/21/2021	Accepted	Equipment Failure
2/27/2022	More Volume Than Expected	Equipment Failure
3/13/2022	Less Volume Than Expected	No volume
3/19/2022	No Effluent	No volume
4/18/2022	Less Volume Than Expected	No volume
4/13/2022	Accepted	No volume

4/30/2022	Equipment Failure	No volume
5/5/2022	Less Volume Than Expected	No volume
5/10/2022	Less Volume Than Expected	No volume
5/12/2022	Rainfall Inadequate	Rainfall Inadequate
6/5/2022	Accepted	No volume
6/10/2022	Equipment Failure	Accepted

Table 3. Vancouver Sample Attempts

Date	Influent	Effluent
2/14/2022	Rainfall Inadequate	Rainfall Inadequate
2/27/2022	Accepted	No Flow
3/13/2022	Rainfall Inadequate	Rainfall Inadequate
3/18/2022	No Effluent	No flow
3/20/2022	Less Volume Than Expected	Less Volume Than Expected
4/17/2022	Accepted	Accepted
4/18/2022	Less Volume Than Expected	Less Volume Than Expected
4/19/2022	Accepted	Accepted
4/20/2022	<75% Hydrograph Collected	<75% Hydrograph Collected
4/30/2022	Accepted	Accepted
5/5/2022	Accepted	Accepted
5/14/2022	Accepted	Accepted
5/28/2022	Less Volume Than Expected	Less Volume Than Expected
6/5/2022	Accepted	Accepted
6/10/2022	Accepted	Accepted

Literature Cited

Ecology. 2018. *Technical Guidance Manual for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE)*. September 2018 Revision. Washington State Department of Ecology, Olympia, WA. Publication no. 18-10-039.

Ecology. 2019. *Washington State Department of Transportation National Pollutant Elimination System and State Waste Discharge Municipal Stormwater General Permit*. Washington State Department of Ecology. Olympia, Washington. Permit No. WAR043000A. Issuance Date April 5, 2019.

WSDOT. 2019. *Highway Runoff Manual*. Washington State Department of Transportation. Olympia, WA. Publication Number M 31-16.05.

Appendix A Chemistry Data

Location	Date	Sample Point	Parameter	Result
Mirrormont	6/8/2022	Influent	TSS	33 R
Vancouver	4/19/2022	Influent	TSS	72
Vancouver	4/19/2022	Effluent	TSS	26 R
Vancouver	4/30/2022	Influent	TSS	20
Vancouver	4/30/2022	Effluent	TSS	7
Vancouver	5/5/2022	Influent	TSS	35
Vancouver	5/5/2022	Effluent	TSS	11
Vancouver	5/16/2022	Influent	TSS	25
Vancouver	5/16/2022	Effluent	TSS	6
Vancouver	6/13/2023	Influent	TSS	1 R

All data is preliminary needing to go through 3rd party validation.

R=Rejected

Appendix B Storm Reports

Download 22 Mirrormont In

Lat: 47.436421N Long: -121.974058W

Drainage Area (acres):

Precipitation				
Total (in)	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Antecedent Dry (hrs)
1.02	06/04/2022 18:55	06/06/2022 01:15	30.33	16.66

Aliquots								Water Temp	
Sample Point (m)	Sample Point Name	Aliquots Collected	First Aliquot Time (Pacific)	Last Aliquot Time (Pacific)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (°C)	Max (°C)
1	MIR-In	35	06/04/2022 20:30	06/06/2022 00:00	27.50	250	8,750	13.40	17.50

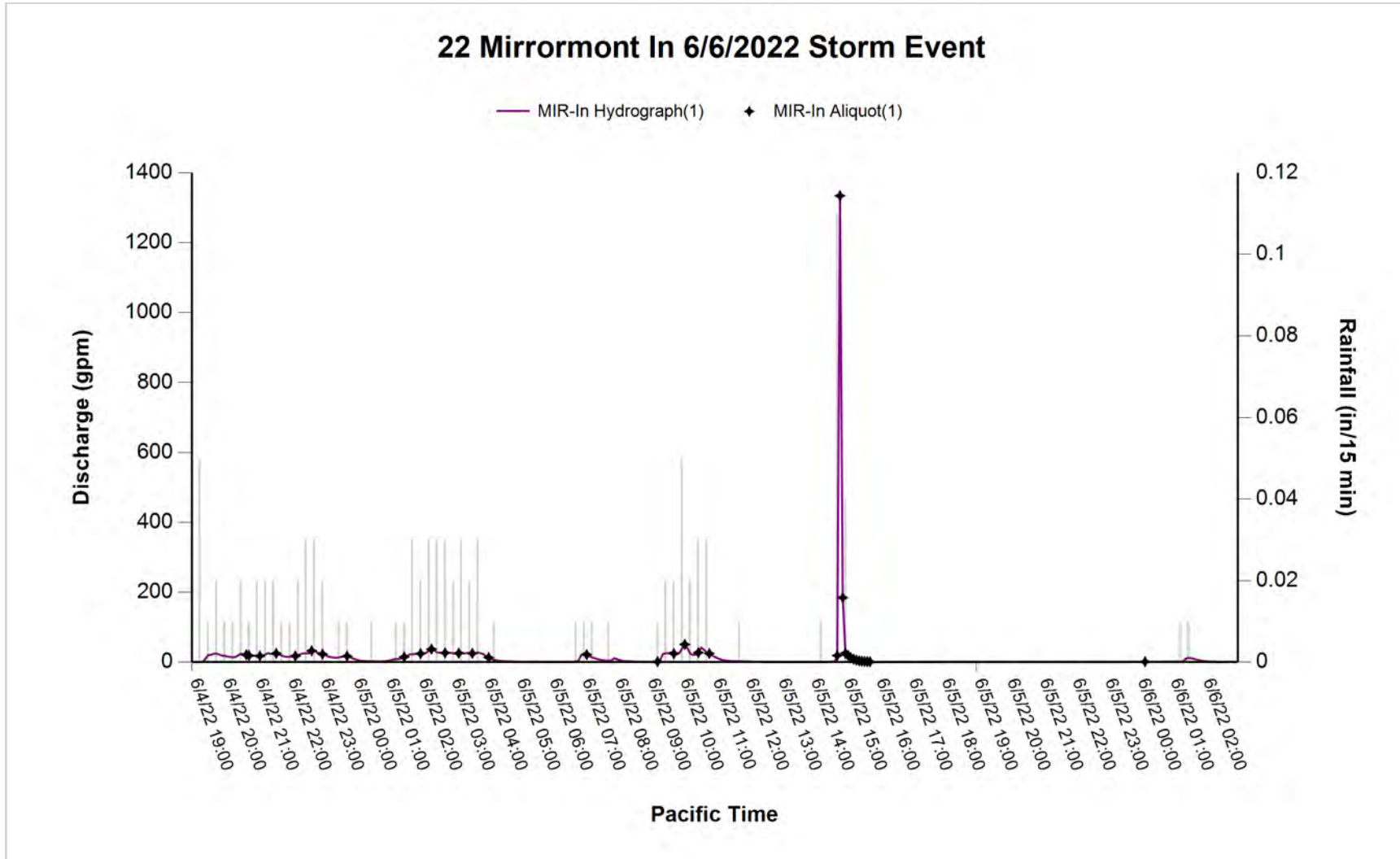
Runoff / Discharge														
		Runoff Time			Volume			Sampled		Flow			Stage	
Sample Point (m)	Sample Point Name	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)	Hydrology Validation Code
1	MIR-In	06/04/2022 19:10	06/06/2022 02:40	31.50	23,610.1	749.5	23,556.7	23,116.1	98.10	1333.96	0.39	12.43	0.500	

No comments added for this event

Download 22 Mirrmont In

Lat: 47.436421N Long: -121.974058W

Drainage Area (acres):



Download 22 Mirrormont In

Lat: 47.436421N Long: -121.974058W

Drainage Area (acres):

Precipitation				
Total (in)	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Antecedent Dry (hrs)
1.15	03/12/2023 16:25	03/14/2023 01:25	33.00	36.25

Aliquots								Water Temp	
Sample Point (m)	Sample Point Name	Aliquots Collected	First Aliquot Time (Pacific)	Last Aliquot Time (Pacific)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (°C)	Max (°C)
1	MIR-In	26	03/12/2023 19:15	03/14/2023 04:00	32.75	250	6,500	5.50	7.20

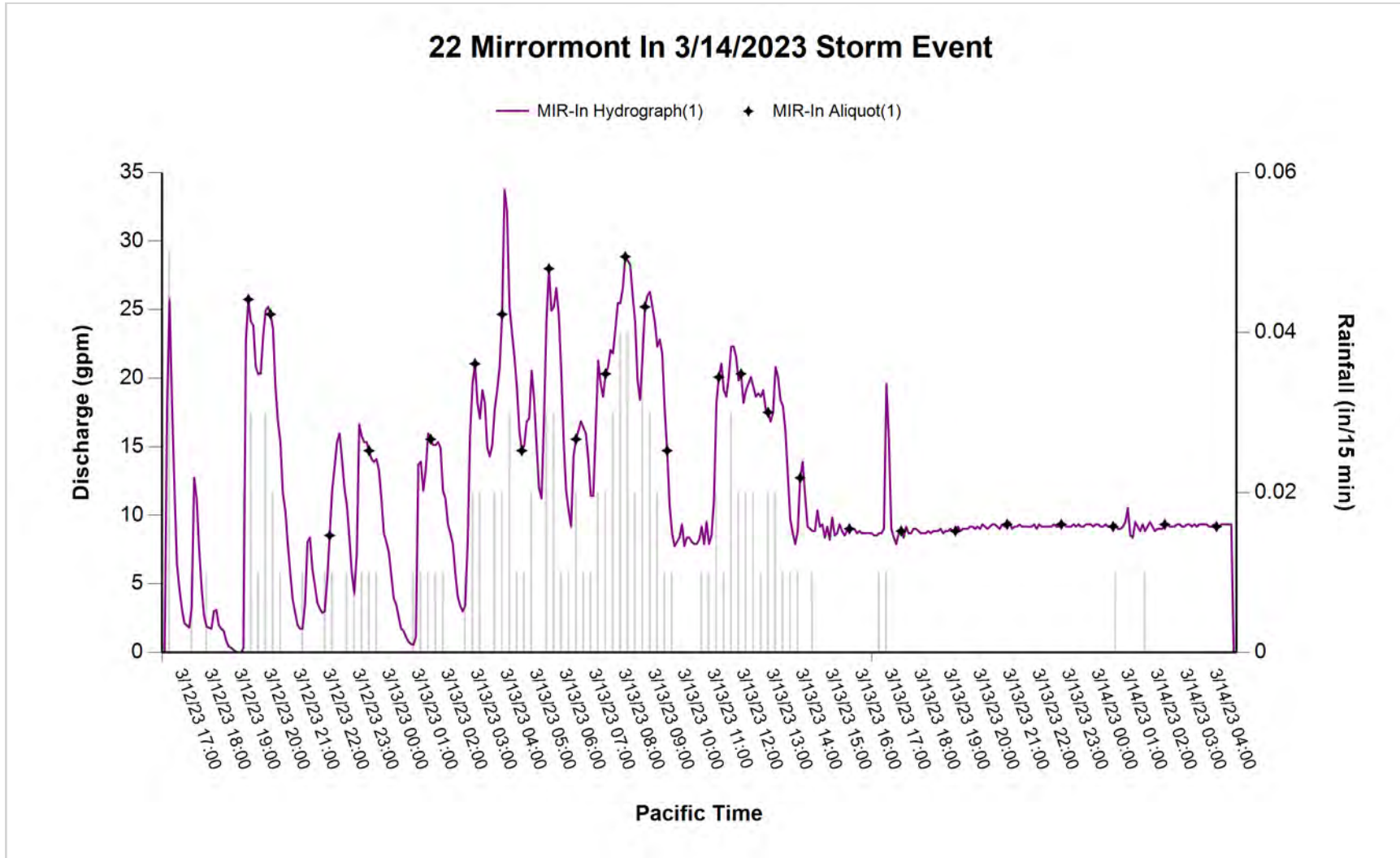
Runoff / Discharge														
		Runoff Time			Volume			Sampled		Flow			Stage	
Sample Point (m)	Sample Point Name	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)	Hydrology Validation Code
1	MIR-In	03/12/2023 16:30	03/14/2023 04:30	36.00	25,709.7	714.2	22,895.0	25,430.3	100.00	33.73	0.05	11.88	0.207	

No comments added for this event

Download 22 Mirrmont In

Lat: 47.436421N Long: -121.974058W

Drainage Area (acres):



Download 22 Vancouver

Lat: 45.682453N Long: -122.551595W

Drainage Area (acres):

Precipitation				
Total (in)	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Antecedent Dry (hrs)
0.30	02/26/2022 16:20	02/27/2022 08:35	16.25	53.25

Aliquots								Water Temp	
Sample Point (m)	Sample Point Name	Aliquots Collected	First Aliquot Time (Pacific)	Last Aliquot Time (Pacific)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (°C)	Max (°C)
1	VAN-In	7	02/26/2022 17:05	02/27/2022 03:35	10.50	250	1,750	5.40	7.10

Runoff / Discharge														
		Runoff Time			Volume			Sampled		Flow			Stage	
Sample Point (m)	Sample Point Name	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)	Hydrology Validation Code
1	VAN-In	02/26/2022 16:25	02/27/2022 09:05	16.67	1,554.8	93.3	1,554.8	1,480.9	95.20	10.95	0.01	1.98	0.130	

No comments added for this event

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Lat: 45.682453N Long: -122.551595W

Drainage Area (acres):



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Drainage Area (acres):

Precipitation				
Total (in)	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Antecedent Dry (hrs)
0.39	04/18/2022 12:05	04/18/2022 17:10	5.08	143.75

Aliquots								Water Temp	
Sample Point (m)	Sample Point Name	Aliquots Collected	First Aliquot Time (Pacific)	Last Aliquot Time (Pacific)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (°C)	Max (°C)
1	VAN-In	15	04/18/2022 12:30	04/18/2022 17:20	4.83	250	3,750	11.20	12.10
2	VAN-Out	5	04/18/2022 15:45	04/18/2022 16:35	0.83	250	1,250	11.30	11.70

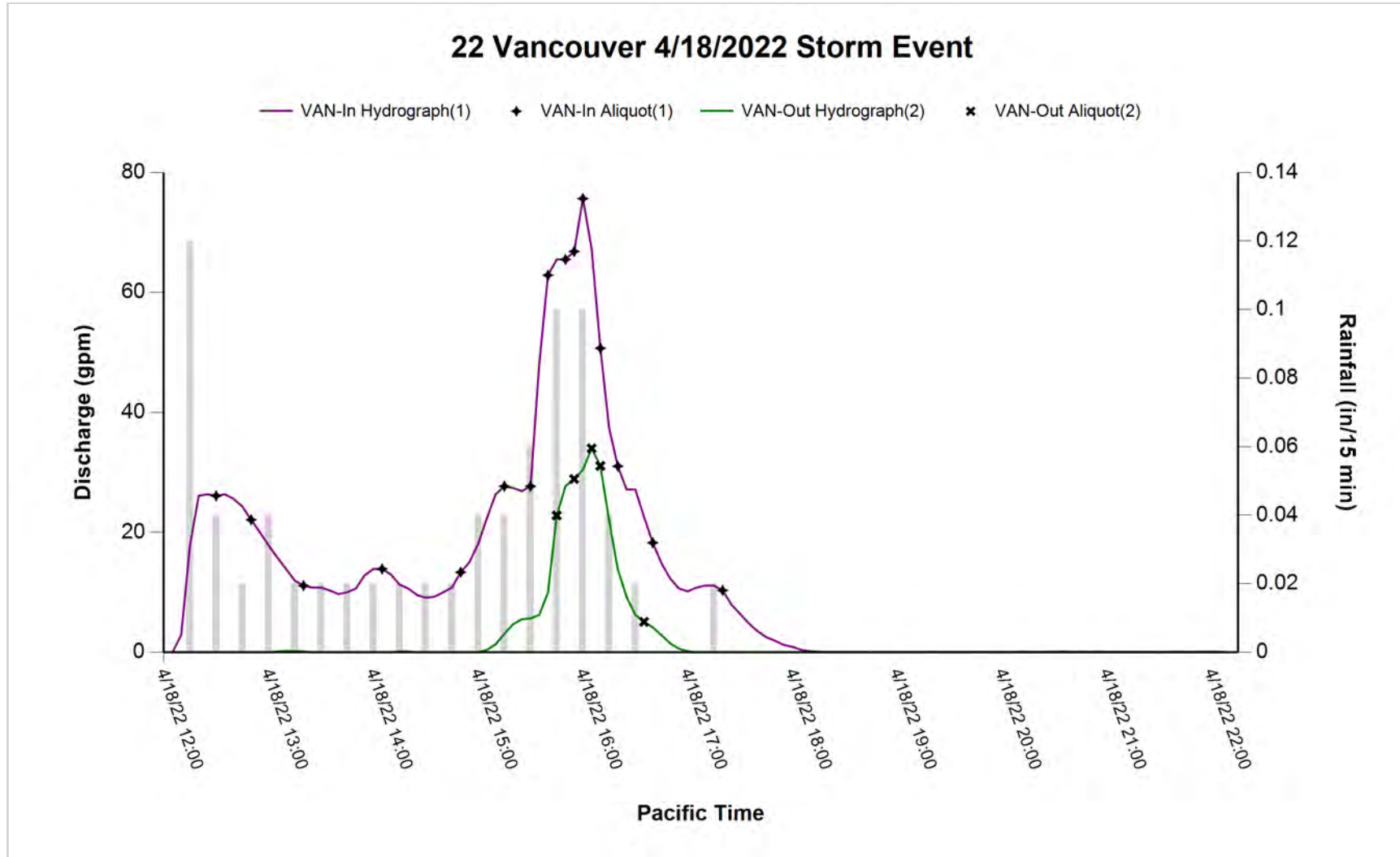
Runoff / Discharge														
		Runoff Time			Volume			Sampled		Flow			Stage	
Sample Point (m)	Sample Point Name	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)	Hydrology Validation Code
1	VAN-In	04/18/2022 12:10	04/18/2022 22:05	9.92	7,348.6	740.8	7,348.6	7,182.0	97.70	75.64	0.04	12.25	0.337	
2	VAN-Out	04/18/2022 13:05	04/18/2022 17:00	3.92	1,391.0	354.9	1,391.0	1,344.9	96.70	34.00	0.13	9.27	0.187	

No comments added for this event

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Lat: 45.682453N Long: -122.551595W

Drainage Area (acres):



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Lat: 45.682453N Long: -122.551595W

Drainage Area (acres):

Precipitation				
Total (in)	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Antecedent Dry (hrs)
0.76	04/29/2022 20:40	04/30/2022 06:45	10.08	16.66

Aliquots								Water Temp	
Sample Point (m)	Sample Point Name	Aliquots Collected	First Aliquot Time (Pacific)	Last Aliquot Time (Pacific)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (°C)	Max (°C)
1	VAN-In	27	04/29/2022 21:00	04/30/2022 06:50	9.83	250	6,750	11.40	13.50
2	VAN-Out	21	04/29/2022 21:35	04/30/2022 09:50	12.25	250	5,250	11.40	14.50

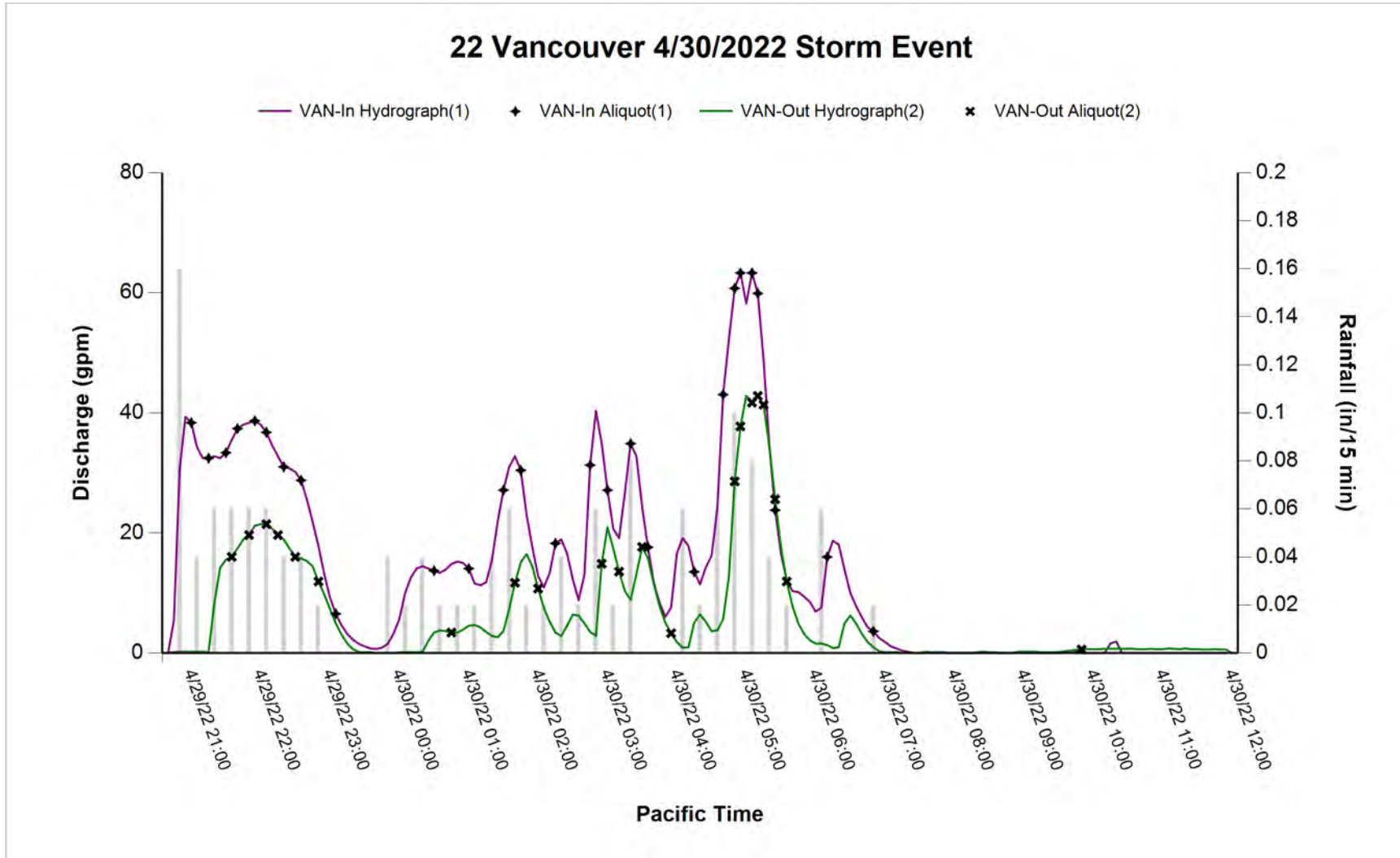
Runoff / Discharge														
		Runoff Time			Volume			Sampled		Flow			Stage	
Sample Point (m)	Sample Point Name	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)	Hydrology Validation Code
1	VAN-In	04/29/2022 20:45	04/30/2022 10:20	13.58	12,909.5	950.6	12,909.5	12,852.5	99.60	63.31	0.01	17.81	0.310	
2	VAN-Out	04/29/2022 20:45	04/30/2022 11:55	15.17	5,631.4	371.2	5,631.4	5,549.0	98.50	42.82	0.13	6.74	0.212	

No comments added for this event

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Drainage Area (acres):



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Drainage Area (acres):

Precipitation				
Total (in)	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Antecedent Dry (hrs)
0.57	05/05/2022 06:55	05/05/2022 16:50	9.92	69.25

Aliquots								Water Temp	
Sample Point (m)	Sample Point Name	Aliquots Collected	First Aliquot Time (Pacific)	Last Aliquot Time (Pacific)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (°C)	Max (°C)
1	VAN-In	15	05/05/2022 07:40	05/05/2022 14:30	6.83	250	3,750	12.30	14.70
2	VAN-Out	9	05/05/2022 08:25	05/05/2022 14:30	6.08	250	2,250	12.30	14.70

Runoff / Discharge														
		Runoff Time			Volume			Sampled		Flow			Stage	
Sample Point (m)	Sample Point Name	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)	Hydrology Validation Code
1	VAN-In	05/05/2022 07:00	05/05/2022 19:50	12.83	8,855.9	690.3	8,855.9	8,747.2	98.80	54.18	0.01	14.28	0.288	
2	VAN-Out	05/05/2022 07:00	05/05/2022 19:55	12.92	3,452.0	267.2	3,452.0	3,352.2	97.10	33.01	0.13	6.84	0.184	

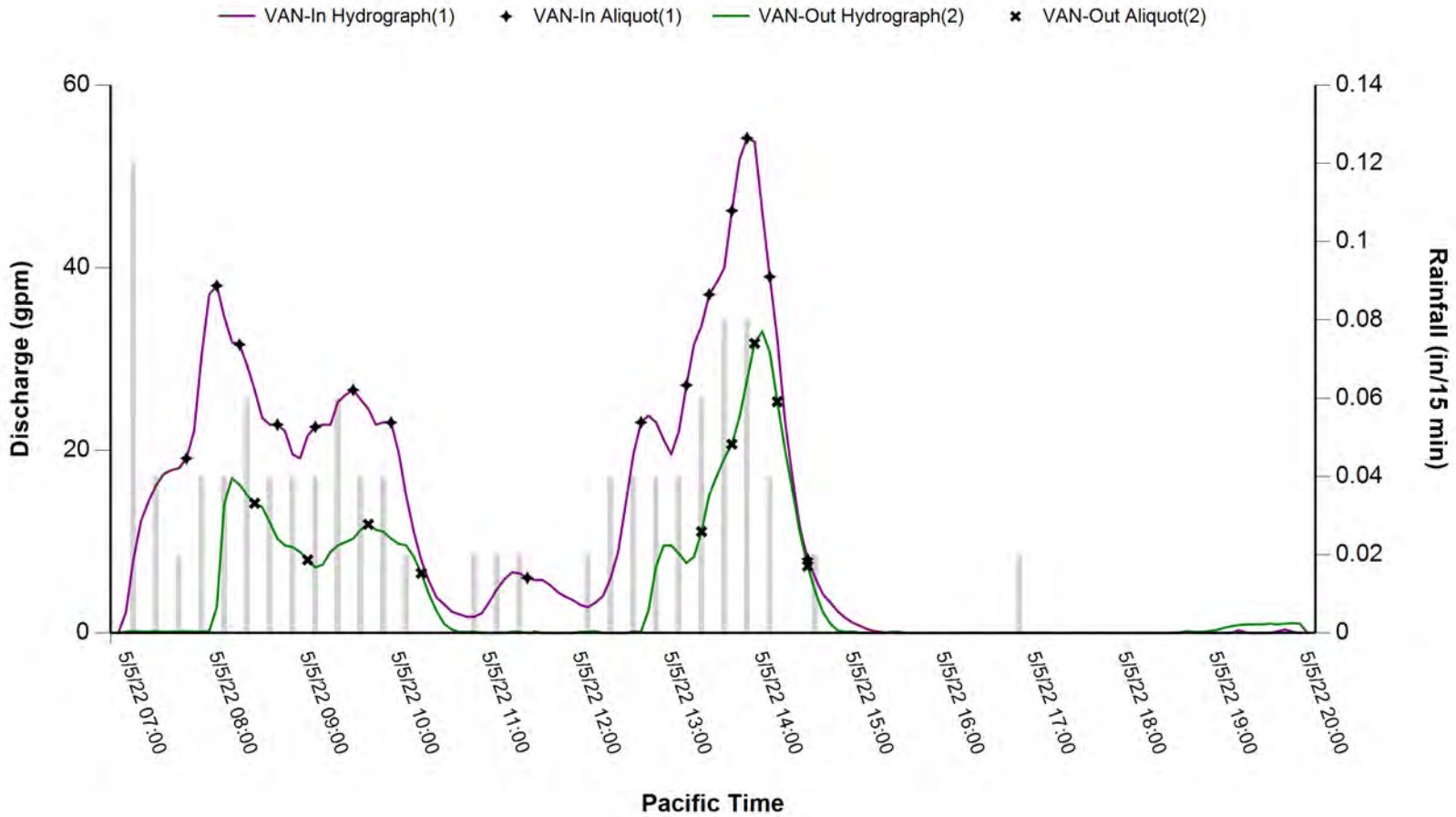
No comments added for this event

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Drainage Area (acres):

22 Vancouver 5/5/2022 Storm Event



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Drainage Area (acres):

Precipitation				
Total (in)	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Antecedent Dry (hrs)
0.77	05/13/2022 19:15	05/14/2022 09:40	14.42	28.66

Aliquots								Water Temp	
Sample Point (m)	Sample Point Name	Aliquots Collected	First Aliquot Time (Pacific)	Last Aliquot Time (Pacific)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (°C)	Max (°C)
1	VAN-In	21	05/13/2022 20:00	05/14/2022 09:05	13.08	250	5,250	11.40	13.40
2	VAN-Out	19	05/13/2022 21:15	05/14/2022 09:00	11.75	250	4,750	11.40	12.80

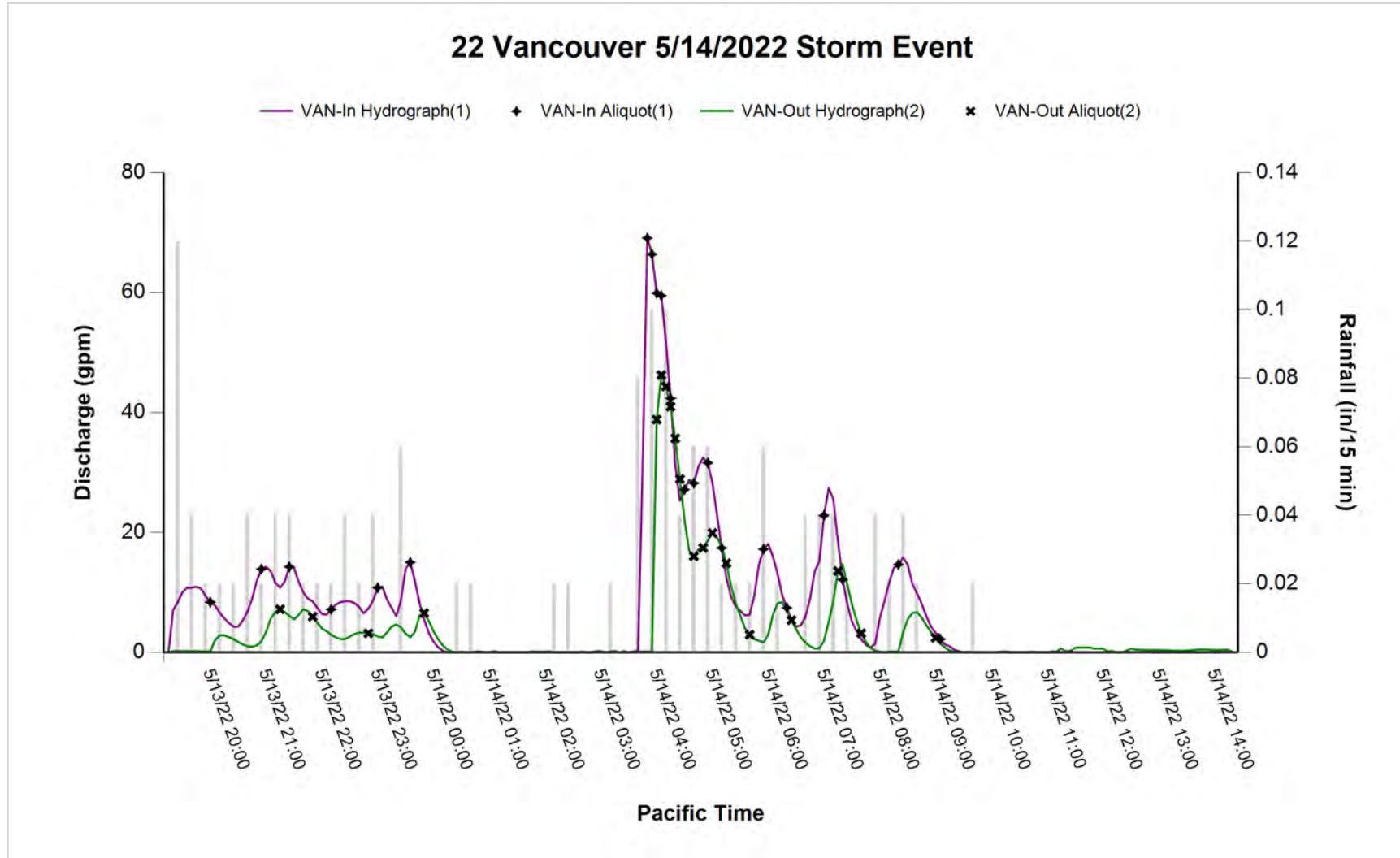
Runoff / Discharge														
		Runoff Time			Volume			Sampled		Flow			Stage	
Sample Point (m)	Sample Point Name	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)	Hydrology Validation Code
1	VAN-In	05/13/2022 19:20	05/14/2022 12:50	17.50	8,344.6	476.8	8,344.6	8,329.1	99.80	69.08	0.01	11.67	0.323	
2	VAN-Out	05/13/2022 19:20	05/14/2022 14:15	18.92	4,117.2	217.6	4,117.2	4,021.1	97.70	46.25	0.13	4.48	0.221	

No comments added for this event

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Drainage Area (acres):



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Lat: 45.682453N Long: -122.551595W

Drainage Area (acres):

Precipitation				
Total (in)	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Antecedent Dry (hrs)
0.49	06/04/2022 13:15	06/05/2022 05:00	15.75	39.66

Aliquots								Water Temp	
Sample Point (m)	Sample Point Name	Aliquots Collected	First Aliquot Time (Pacific)	Last Aliquot Time (Pacific)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (°C)	Max (°C)
1	VAN-In	8	06/04/2022 18:40	06/05/2022 02:30	7.83	250	2,000	16.40	18.50
2	VAN-Out	4	06/04/2022 19:25	06/05/2022 00:05	4.67	250	1,000	16.70	18.20

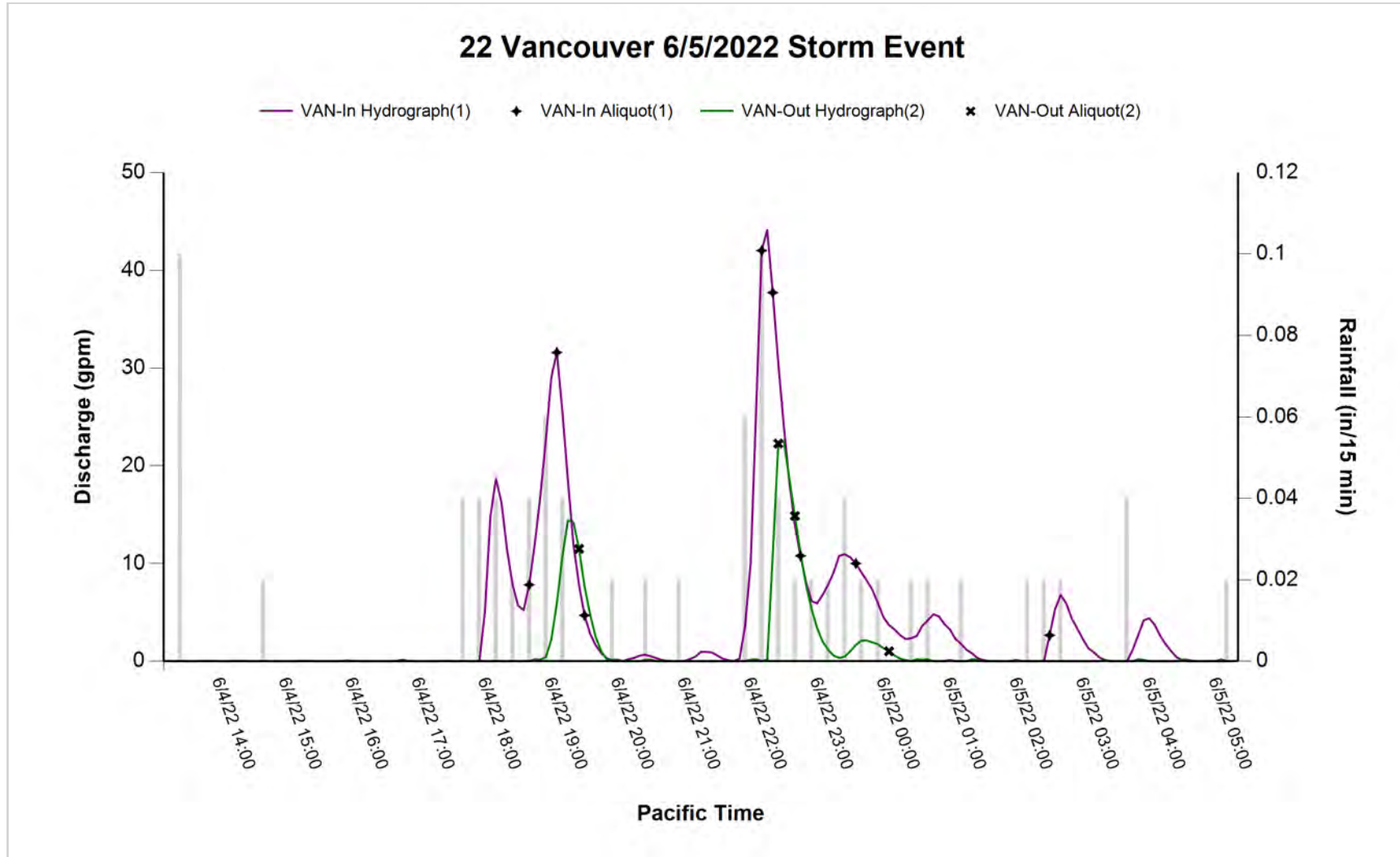
Runoff / Discharge														
		Runoff Time			Volume			Sampled		Flow			Stage	
Sample Point (m)	Sample Point Name	Start Time (Pacific)	End Time (Pacific)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)	Hydrology Validation Code
1	VAN-In	06/04/2022 13:45	06/05/2022 04:30	14.75	3,861.3	261.8	3,861.3	3,597.4	93.20	44.10	0.01	6.13	0.261	
2	VAN-Out	06/04/2022 18:45	06/05/2022 05:05	10.33	1,075.7	104.1	1,075.7	1,059.2	98.50	22.54	0.13	3.65	0.149	

No comments added for this event

Download 22 Vancouver

Lat: 45.682453N Long: -122.551595W

Drainage Area (acres):



*Event missing from storm report due to database error, data can be requested as soon as error is resolved.