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**HIGHWAY 267
FILTER FABRIC SAND TRAP
PILOT STUDY**

2004-2005 INTERIM REPORT

FEBRUARY 2006

CALIFORNIA DEPARTMENT OF TRANSPORTATION
DIVISION OF ENVIRONMENTAL ANALYSIS
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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
Caltrans	California Department of Transportation
cm	Centimeter
COC	Chain-of-Custody
EMC	Event Mean Concentration
ft, ft ² , ft ³	Feet, Square Feet, Cubic Feet
in	Inch
LRWQCB	Lahontan Regional Water Quality Control Board
m, m ² , m ³	Meter, Square Meter, Cubic Meter
mg/L	Milligrams per liter
mL	Milliliter
MOP	Monitoring and Operations Plan
NTU	Nephelometric Turbidity Unit
Pilot Study	Highway 267 Full-Scale Filter Fabric Sand Trap Pilot Study
QA/QC	Quality Assurance/Quality Control
TSS	Total Suspended Solids
TRPA	Tahoe Regional Planning Agency

TABLE OF CONTENTS

	Page
ACRONYMNS AND ABBREVIATIONS.....	i
EXECUTIVE SUMMARY	v
1.0 INTRODUCTION.....	1-1
1.1 BACKGROUND	1-1
1.2 PROJECT OVERVIEW AND OBJECTIVES	1-1
1.2.1 BMP Effectiveness Evaluation.....	1-3
1.2.2 BMP Operational Monitoring.....	1-3
2.0 MONITORING SITE CHARACTERISTICS	2-1
2.1 SITE LOCATIONS.....	2-1
2.2 SITE CHARACTERISTICS.....	2-1
2.3 SAND TRAP #1.....	2-1
2.4 SAND TRAP #2.....	2-4
3.0 MONITORING METHODOLOGY	3-1
3.1 HIGHWAY RUNOFF SAMPLING METHODS	3-1
3.2 HIGHWAY RUNOFF ANALYTICAL METHODS.....	3-4
3.3 OPERATIONAL MONITORING METHODS.....	3-6
3.3.1 Field Crew Mobilization.....	3-6
3.3.2 Pre-Event Setup Activities	3-6
3.3.3 Monitoring Event Activities	3-6
3.3.4 Post-Event Activities	3-7
3.3.5 Special Considerations for Cold Weather and Snowmelt Monitoring.....	3-7
4.0 MONITORING RESULTS	4-1
4.1 ANALYTICAL MONITORING STORM EVENT DESCRIPTIONS.....	4-1
4.2 OPERATIONAL MONITORING RESULTS	4-5
4.3 ANALYTICAL RESULTS	4-10
5.0 SAND TRAP PERFORMANCE	5-1
5.1 SAND TRAP CONSTITUENT REMOVAL PERFORMANCE.....	5-1
5.2 SAND TRAP-TO-SAND TRAP COMPARISON	5-6
6.0 CONCLUSIONS	6-1
7.0 REFERENCES.....	7-1

TABLES

Table 2-1	Summary of Monitoring Site Characteristics and Monitoring Equipment
Table 3-1	Highway Runoff Monitoring
Table 4-1	Summary of Monitoring Events for All Sites

Table 4-2	Sand Trap Standing Water and Overflows
Table 4-3	Effluent Flow Rates
Table 4-4	Summary of Analytical Results from Sand Trap #1
Table 4-5	Summary of Analytical Results from Sand Trap #2
Table 5-1	Summary Statistics for Sand Trap #1 and #2 Stations
Table 5-2	Comparison of Sand Trap-to-Sand Trap Mean Concentrations and Percent Removal

FIGURES

Figure 1-1	Site Location
Figure 2-1	Sand Trap #1
Figure 2-2	Sand Trap #2
Figure 3-1	Runoff Sampling Equipment Configuration, Drain Inlet to Sedimentation Chamber
Figure 5-1	Total Suspended Solids
Figure 5-2	Turbidity

PHOTOGRAPHS

Photo 1	View of Sand Trap #2 and lower infiltration basin along Highway 267
Photo 2	Filter chamber in Sand Trap #1
Photo 3	Outlet drainage from Sand Trap #1 to lower infiltration basin
Photo 4	Filter chamber in Sand Trap #2
Photo 5	Standard flow monitoring equipment consists of an autosampler, flow meter, and a battery housed in an enclosure
Photo 6	Snow accumulation at Sand Trap #2

APPENDICES

Appendix A	Operational Monitoring Inspection Forms
Appendix B	Photo-Monitoring Logs and Photographs
Appendix C	Hydrographs
Appendix D	Quality Assurance/Quality Control Data Tables

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EXECUTIVE SUMMARY

This report presents results of the Highway 267 Full-Scale Filter Fabric Sand Trap Pilot Study (Pilot Study) conducted by the California Department of Transportation (Caltrans) in the Tahoe Basin. This report presents data from the first year of this study, collected during the wet season from December 2004 through May 2005. This Pilot Study will be conducted for 3 years through the 2006-2007 wet season.

The Pilot Study is designed to provide data to support the Caltrans Storm Water Management Program and to comply with regulatory requirements. This Pilot Study was designed to evaluate the treatment effectiveness of two innovative Best Management Practice (BMP) facilities designed to provide enhanced treatment of highway runoff with a combination of settling of coarse material and filtration through nonwoven geotextile filter fabric. A Basis of Design report will be prepared during the second year of this Pilot Study and will present information regarding siting criteria, conceptual and final design, and construction of these BMPs. The BMPs are identified in this Pilot Study as Sand Trap #1 and Sand Trap #2. Monitoring was also performed to assess operational and maintenance requirements of each sand trap.

To assess the quality of storm water entering and discharging from the sand traps, runoff samples were collected from each influent and effluent monitoring station. Collected runoff samples were analyzed for total suspended solids (TSS) and turbidity.

The findings of the 2004-2005 wet season water quality monitoring are as follows:

- The filter fabric did not clog. No obvious decrease in effluent flow rates was observed. In addition, runoff did not overflow from the filter chamber to the outlet.
- The sand traps are more effective at treating higher influent TSS concentrations. The sand traps are not effective at decreasing the runoff turbidity below the surface water discharge limit of 20 nephelometric turbidity units (NTUs) established by the Lahontan Regional Water Quality Control Board (LRWQCB). In addition, the filter fabric does not consistently decrease the runoff turbidity below the infiltration discharge limit of 200 NTUs established by the LRWQCB. The mean effluent TSS concentrations of the runoff from both sand traps were below the surface water discharge limit of 250 milligrams per liter established by the Tahoe Regional Planning Agency.
- The first year of monitoring was insufficient to assess the treatment life of the filter fabric.

Based on results of operational monitoring conducted during the 2004-2005 wet season, the following recommendations should be incorporated into the Pilot Study:

- Each sand trap should be cleaned of construction debris and accumulated sediment prior to installation of the filter fabric and use.
- Periodic snow removal is needed for site access.
- Several maintenance issues should be corrected during the summer construction season including: replacing the slotted dewatering pipe with a louvered pipe in the sedimentation chamber; adjusting the slope of the effluent pipe to reduce backwater conditions; repairing the downhill slope of each sand trap; removing coarse sediment from the upstream drainage inlet of Sand Trap #2; and repairing the asphalt dike on the south side of Highway 267 above Sand Trap #2.

1.0 INTRODUCTION

1.1 BACKGROUND

This report presents results of the Highway 267 Full-Scale Filter Fabric Sand Trap Pilot Study (Pilot Study) conducted by the California Department of Transportation (Caltrans) in the Tahoe Basin. This report presents data from the first year of this study, collected during the wet season from December 2004 through May 2005. This Pilot Study will be conducted for 3 years through the 2006-2007 wet season.

Data collected during this Pilot Study will be used to support the Caltrans Storm Water Management Program. This Pilot Study was designed to evaluate the treatment effectiveness of two innovative Best Management Practice (BMP) facilities (identified as Sand Trap #1 and Sand Trap #2). Each sand trap was designed to provide enhanced treatment of highway runoff by using a two-stage treatment process consisting of settling followed by filtration through a fabric filter. A Basis of Design report will be prepared during the second year of this Pilot Study and will present information regarding siting criteria, conceptual and final design, and construction of these BMPs.



Photo 1: View of Sand Trap #2 and lower infiltration basin along Highway 267.

1.2 PROJECT OVERVIEW AND OBJECTIVES

As part of a roadway drainage water quality improvement project along Highway 267 in Placer County near the town of Kings Beach, California, Caltrans District 3 installed a series of earthen infiltration basins to treat runoff from the highway. Two of these basin sites were selected for pilot testing the Filter Fabric Sand Traps that use a two-stage treatment process consisting of settling followed by filtration through filter fabric. These sites were selected for the Pilot Study because they met the spatial and hydraulic head requirements of the devices and the design and construction schedule matched the needs of the study. The location of each sand trap is identified on Figure 1-1.

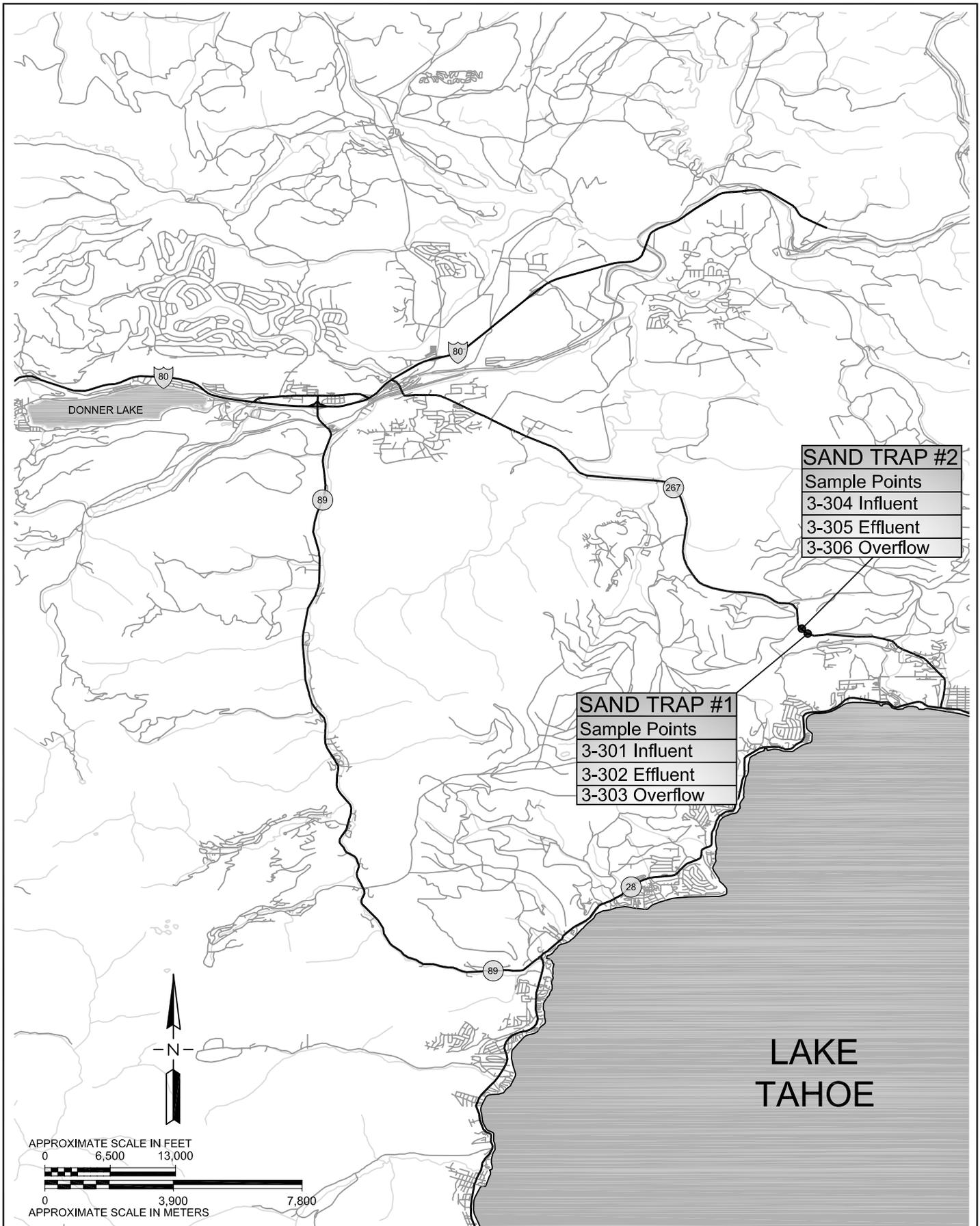


FIGURE 1-1
SITE LOCATION
 Caltrans Tahoe Basin Highway 267 Sand Trap with Filter Fabric BMP Pilot Study
 Tahoe Basin, El Dorado County, California

The primary goals of the Pilot Study are:

1. Evaluate the treatment effectiveness of two sand traps for reducing total suspended solids (TSS) and turbidity from storm water runoff.
2. Assess operation and maintenance requirements at the two sand traps under the various environmental conditions that occur in the Tahoe Basin.

The specific objectives that were associated with these goals are given as follows.

1.2.1 BMP Effectiveness Evaluation

Monitoring was performed to assess the treatment effectiveness of each sand trap based on:

1. Reduction in effluent TSS concentrations and turbidity levels relative to influent concentration, and
2. Ability to meet storm water effluent discharge requirements established by the Lahontan Regional Water Quality Control Board (LRWQCB) and the Tahoe Regional Planning Agency (TRPA).

1.2.2 BMP Operational Monitoring

During the study period, monitoring was performed to assess the operational and maintenance requirements of each sand trap based on:

1. Frequency, duration, and volume of overflows from the sand traps.
2. Accumulation of fine materials in the filter media and their impact on the rate of flow through the sand traps.
3. Duration that filter fabric remains hydraulically effective (unclogged).
4. Sediment accumulation and its impact on the operations of the sand traps.

2.0 MONITORING SITE CHARACTERISTICS

Based on the study goals and objectives discussed in Section 1, a monitoring program was developed for the two Filter Fabric Sand Traps installed in the summer of 2004 along Highway 267. The monitoring considerations applied to each of the devices included:

- Safe access for field crews; and
- Accessibility to the influent and effluent to allow for obtaining representative runoff samples.

2.1 SITE LOCATIONS

The two sand traps are located adjacent to Highway 267 in the Tahoe Basin within the Caltrans right-of-way. Site locations are shown on Figure 1-1.

2.2 SITE CHARACTERISTICS

Table 2-1 presents a summary of the monitoring characteristics of each site. Each sand trap is set up to monitor influent flow, effluent flow, and overflow that occurs from the filter chamber to the outlet. Automatic samplers were employed to collect representative runoff samples of the influent and effluent. The monitoring equipment was located in an equipment housing vault that was incorporated into the designs of Sand Trap #1 and Sand Trap #2.

2.3 SAND TRAP #1

Sand Trap #1 receives runoff from a paved highway drainage area of approximately 2,000 square meters (m^2) (21,600 square feet [ft^2]). At this location, Highway 267 is a two-lane road with bike lanes and asphalt concrete dikes along each side of the highway. The dikes convey runoff to three drainage inlets located along the sides of the road. The drainage inlets are designed with sump bottoms that allow coarse sands to settle out and provide temporary storage volume for the runoff before it is conveyed through underground pipes to the sand trap. Although the total storage volume of the three inlets is unknown, it is small with respect to the drainage area. The location of upstream drainage inlets at this site during the Pilot Test was unavoidable. However, this BMP would not be constructed with upstream drainage inlets during large-scale deployment.



Photo 2: Filter chamber in Sand Trap #1.

TABLE 2-1

**SUMMARY OF MONITORING SITE
CHARACTERISTICS AND MONITORING EQUIPMENT¹**

Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

Site Characteristics	Monitoring Site and Station ID Numbers	
	Sand Trap #1	Sand Trap #2
	Influent: 3-301 Effluent: 3-302 Overflow: 3-303	Influent: 3-304 Effluent: 3-305 Overflow: 3-306
Caltrans District	3	3
Lahontan Regional Board Area	Region 6a	Region 6a
Highway	267	267
Installation Date	Summer/Fall 2004	Summer/Fall 2004
Post Mile	6.87	6.78
Longitude	120.06855	120.06970
Latitude	39.25848	39.25920
Elevation	2,165 meters (7,103 feet)	2,171 meters (7,123 feet)
Catchment Area	2,000 m ² (21,600 ft ²)	1,000 m ² (11,300 ft ²)
Drainage Type	Rural Highway	Rural Highway
Average Annual Daily Traffic ²	8,350	8,350
BMP Type	Enhanced sedimentation/ filtration	Enhanced sedimentation/ filtration
Filter Configuration	Lined rectangular chamber	Two lined perforated riser pipes
Filter Type	nonwoven geotextile	nonwoven geotextile
Tensile Strength (kN)	1.73	1.73
Apparent Opening Size	0.150 mm (5.9 x 10 ⁻³ in)	0.150 mm (5.9 x 10 ⁻³ in)
Permeability	0.20 cm/sec (7.8 x 10 ⁻² in/sec)	0.20 cm/sec (7.8 x 10 ⁻² in/sec)
Thickness (mils)	115	115
Flow Rate (L/min/m ²)	2,037	2,037
Filter Fabric Area	50 m ² (538 ft ²)	8 m ² (86 ft ²)
Layers of Fabric	3	3
Sedimentation Chamber Sand Storage Volume	23 m ³ (800 ft ³)	12 m ³ (400 ft ³)
Receiving Water Type	Intermittent	Intermittent
Rain Gauge	No	No
Flow Measurement Equipment	Bubbler Tube	Bubbler Tube

1. m² = square meters; ft² = square feet; BMP = Best Management Practice; kN = kilonewtons; mm = millimeters;
in = inches; cm/sec = centimeters per second; in/sec = inches per second; L/min/m² = liters per minute
per square meter; m³ = cubic meters; ft³ = cubic feet.

2. www.dot.ca.gov/hq/traffops/saferesr/trafdata/2004all/r221275i.htm (Caltrans, 2004).

Upon entering the sand trap, runoff flows into a sedimentation chamber where it is detained for a short period to allow the coarse-grained sediments to settle out. The sedimentation chamber has a sand storage capacity of 23 cubic meters (m^3) (800 cubic feet [ft^3]). When this capacity is reached, the flow will spill over a weir (height of 1.8 meters [m] [6.0 feet (ft)]) and into the filter chamber. In most conditions, the sedimentation chamber storage volume will not be exceeded and a louvered pipe in the sedimentation chamber conveys water to the filter chamber. This louvered pipe allows the sedimentation chamber to drain completely after influent flow has stopped. The filter chamber has a volume of 19 m^3 (670 ft^3) and is lined with a triple layer of non-woven geotextile. Upon entering the filter chamber, the runoff passes through the fabric and is collected in an underdrain piping system beneath the filter fabric. The effluent is then discharged to the surface. In addition, there is an emergency overflow weir (height of 1.7 m [5.6 ft]) located within the filter chamber to prevent backup if the filter fabric becomes completely clogged. Runoff flowing over this weir will bypass the filter fabric and will discharge to the surface. See Figure 2-1 for details.



Photo 3: Outlet drainage from Sand Trap #1 to lower infiltration basin.

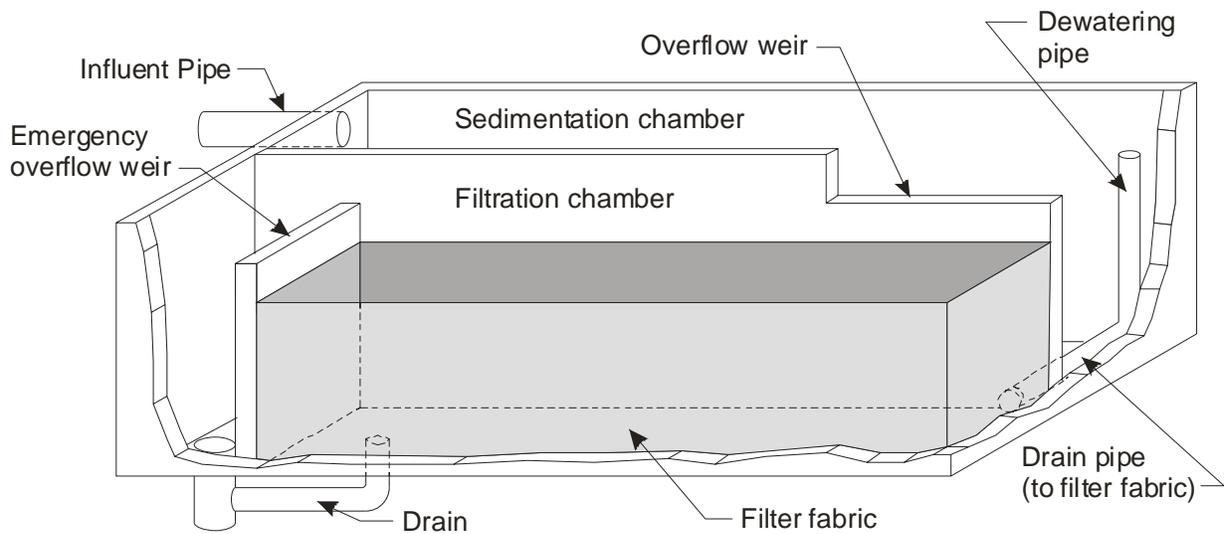


Figure 2-1. Sand Trap #1

2.4 SAND TRAP #2

Sand Trap #2 receives runoff from a paved highway drainage area of approximately 1,000 m² (11,300 ft²). At this location, Highway 267 is a two-lane road with bike lanes and asphalt concrete dikes along each side of the highway. The dikes convey runoff to two drainage inlets where flow enters a culvert that discharges to the BMP via an inlet pipe. The drainage inlets are designed with sump bottoms that allow coarse sands to settle out and provide temporary storage volume for the runoff before it is conveyed through underground pipes to the sand trap. Although the total storage volume of the two inlets is unknown, it is small with respect to the drainage area. The location of upstream drainage inlets at this site during the Pilot Test was unavoidable. However, this BMP would not be constructed with upstream drainage inlets during large-scale deployment.

Upon entering the sand trap, runoff flows into a sedimentation chamber where it is detained for a short period to allow the coarse grained sediments to settle out. The sedimentation chamber has a sand storage capacity of 12 m³ (400 ft³). When this capacity is reached, the flow will spill over a weir (height of 1.8 m [6.0 ft]) and into the filter chamber. In most conditions, the sedimentation chamber storage volume will not be exceeded and a louvered



Photo 4: Filter chamber in Sand Trap #2.

pipe in the sedimentation chamber conveys the runoff to the filter chamber. This louvered pipe allows the sedimentation chamber to drain completely after influent flow has stopped. The filter chamber has a volume of 8 m³ (280 ft³) equipped with two perforated riser pipes covered with a triple layer of non-woven geotextile. Upon entering the filter chamber, the runoff passes through the fabric and is collected in an underdrain piping system beneath the filter fabric. The effluent is then discharged to the surface. In addition, there is an overflow weir (height of 1.6 m [5.2 ft]) located within the filter chamber to prevent backup if the filter fabric becomes completely clogged. Runoff flowing over this weir will bypass the filter fabric and will discharge to the surface. See Figure 2-2 for details.

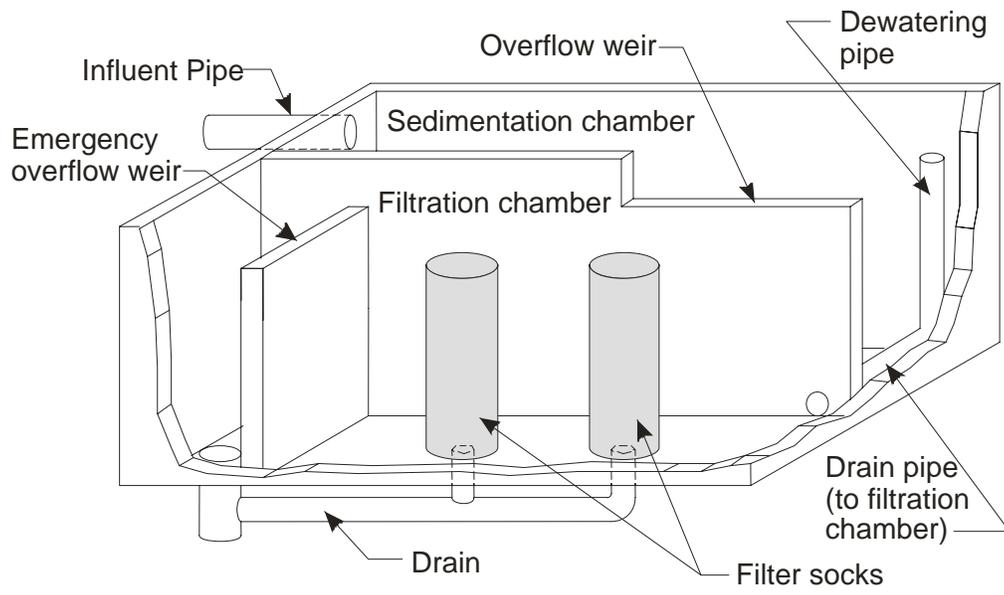


Figure 2-2. Sand Trap #2

3.0 MONITORING METHODOLOGY

This section summarizes the monitoring methods used to collect and analyze samples of highway runoff, and conduct operational monitoring activities at the Pilot Study sites. Monitoring methods follow the Caltrans Comprehensive Protocols Guidance Manual (Caltrans, 2003), and are presented in detail in the Caltrans Tahoe Basin Highway 267 Full-Scale BMP Pilot Study Monitoring Season 2004-2005 Monitoring and Operations Plan (MOP; Caltrans, 2005a). The MOP describes the analytical constituents, equipment, and procedures for monitoring storm water and snowmelt runoff, as well as operational monitoring requirements.

3.1 HIGHWAY RUNOFF SAMPLING METHODS

The runoff water quality monitoring was designed to provide an estimate of the mean concentration of constituents for a specific runoff event. This concentration is referred to as the event mean concentration (EMC). To generate an approximation of the EMC, a series of discrete 250-milliliter (mL) aliquots were collected by autosamplers on a flow-weighted basis over the course of each runoff event and combined into a single 10-liter sample bottle.

Flow-weighted composite samples were collected as discrete aliquots after a pre-determined volume of runoff passed the flow measurement device. This volume remained constant for the entire event and is known as the trigger volume. For example, if the trigger volume was set at 100,000 liters, a discrete 250-mL aliquot was collected every time 100,000 liters of flow was recorded by the measurement device.

The monitoring sites were equipped with autosamplers, continuously-recording flow meters, and a 12-volt power source, as shown in the photograph on the right. Due to site constraints, no rain gages were set up at either sand trap. Monitoring equipment was housed in the equipment vault. The vaults are described in Section 2.

Flow rates for the influent and effluent were calculated by use of the Manning Equation. This method involves measuring the depth of flow with a bubbler tube mounted on the inside of the pipe, and using the pipe diameter, slope, and roughness to



Photo 5: Standard flow monitoring equipment consists of an autosampler (front), flow meter (top rear), and a battery (bottom rear) housed in an enclosure.

estimate the flow rate. This method was selected because site constraints did not allow for installation of a flume or other primary flow measurement devices. The Manning's roughness coefficient of 0.011 was determined from literature values for the smooth-walled plastic pipe. Flow rates were calibrated by measuring flows manually and adjusting the depth measurement on the flow meter to match the measured rate. Figure 3-1 illustrates typical flow measurement configurations.

Effluent pipes were installed with positive slopes that resulted in a slight backwater condition to occur in both pipes. The primary purpose of the flow data is to pace the autosamplers for the collection of flow-weighted composite samples.

The monitoring system was configured to measure flow rates at the overflow weir between the filter chamber and outlet by using a weir equation. A bubbler was installed to measure the height of flow above the overflow weir. However, as previously mentioned, overflow from the filter chamber to the outlet did not occur during the 2004-2005 monitoring season.

Each monitoring station was equipped with three data loggers that were programmed to record flow depth in a pipe or over an overflow weir, calculate flow measurements, and record sampling times.

Before the start of a targeted runoff event, each autosampler was equipped with a single 10-liter polyethylene sample bottle and the flow meter was programmed with a site-specific trigger volume. When signaled by the flow meter, each autosampler collected a 250-mL aliquot. Based on this configuration, approximately 40 discrete aliquots could be collected before the bottle filled and had to be replaced with a clean empty bottle. Bottle change-out times were anticipated by observing weather patterns and runoff during the storms.

Automatic shutoff devices were installed in the autosamplers. This equipment consists of a float switch positioned at the top of the 10-liter sample bottles. The autosamplers were set to a continuous operation mode to allow for the collection of runoff aliquots until the sample bottles were filled. The continuous mode programming provided more flexibility for sampling runoff events with highly variable volumes.

Runoff monitoring targeted two types of runoff events: mixed rain/snow events and snowmelt events. However, one monitoring event was conducted in May 2005 that consisted only of rainfall runoff. Monitoring procedures were adjusted as needed throughout the study period to

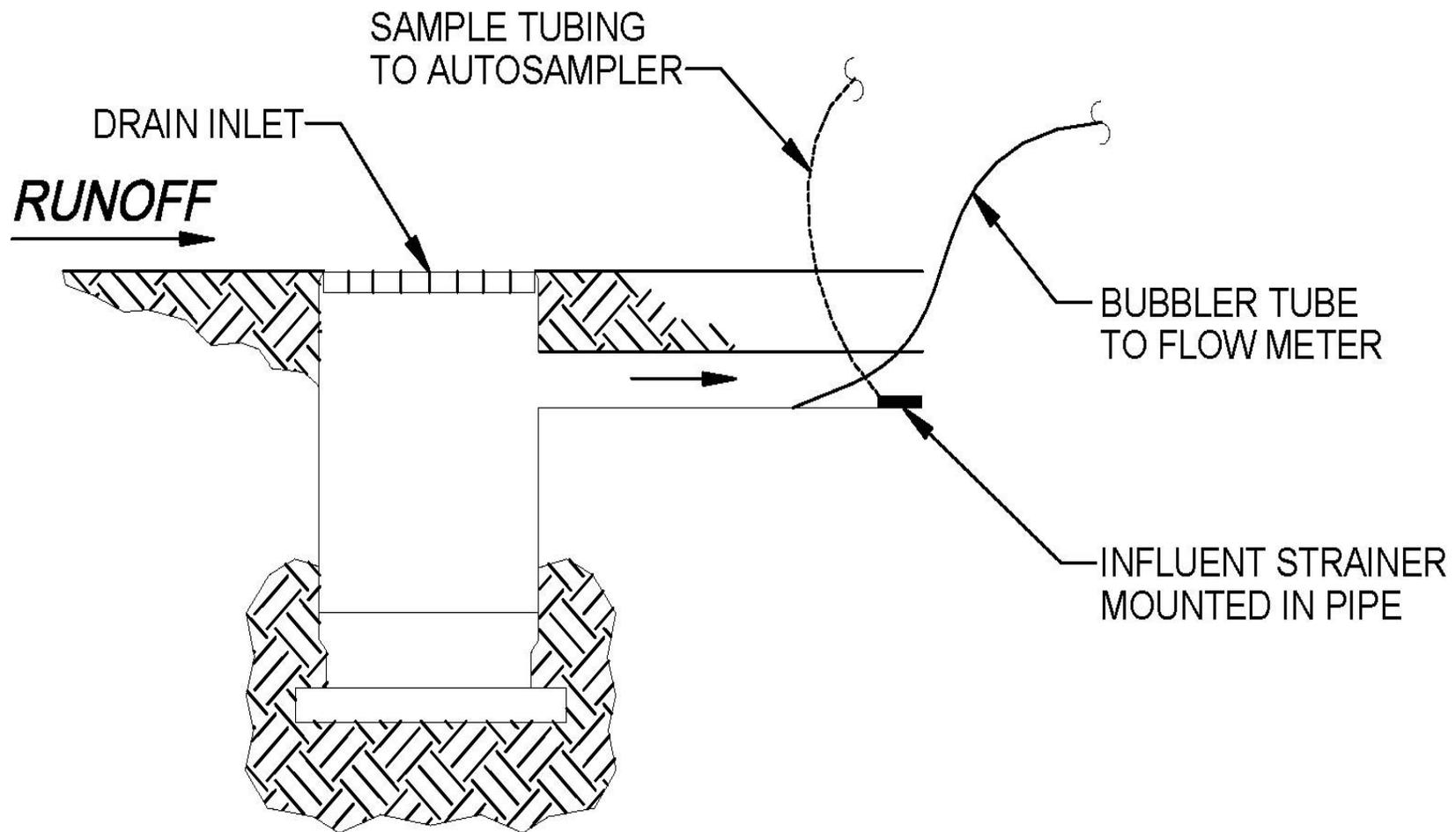


FIGURE 3-1
 RUNOFF SAMPLING EQUIPMENT CONFIGURATION, DRAIN INLET TO SEDIMENTATION CHAMBER
 Highway 267 Filter Fabric Sand Trap Pilot Study
 Tahoe Basin, El Dorado County, California

collect runoff samples under the highly variable environmental conditions that occurred during each event. These conditions are described below:

Rain/Snow Mix Events. Rain/snowmelt mix events occur when rain changes over to snow due to a drop in temperature or when snow changes over to rain when temperatures increase. These events occurred throughout the wet season (October – June), depending on the nature and timing of the weather system that produced the precipitation.

Cold weather sampling activities were hampered by snow accumulation. Regular snow removal around the monitoring sites was required to maintain site access.

Snowmelt Events. Snowmelt events occur when temperatures rise above freezing and the accumulated snow melts in sufficient quantities to produce runoff. Snowmelt runoff monitoring differs fundamentally from rainfall/runoff and rain/snow monitoring in that sampling was initiated in response to runoff flow in the absence of precipitation. Once substantial snowfall occurred, field crews tracked weather conditions for the possibility of significant snowmelt. When the desired conditions occurred (warming temperatures after a period of snow accumulation or when salt was applied to melt snow accumulated on roads), field crews



Photo 6: Snow accumulation at Sand Trap #2.

programmed the automated equipment to collect flow-weighted composite samples of the snowmelt runoff. The main challenge for snowmelt sampling was measuring and sampling low flows.

3.2 HIGHWAY RUNOFF ANALYTICAL METHODS

Following the collection of each sample, the sample bottle label was completed, the sample kept on ice, the chain-of-custody (COC) form filled out, and the sample packaged for shipment to the laboratory. The sample date, location, and analyses requested were included on the COC forms.

Composite runoff samples were analyzed by Pat-Chem Laboratories of Moorpark, California, for the constituents listed in Table 3-1

TABLE 3-1

HIGHWAY RUNOFF MONITORING

Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

Constituent	Sample Type	EPA Method¹	Bottle²	Target Reporting Limit³	Volume⁴	Preservative⁵	Holding Time
Total suspended solids	Flow-based composite sample	160.2	HDPE	1 mg/L	1000 mL	40 °C	7 days
Turbidity	Flow-based composite sample	180.1	HDPE	0.05 NTU	50 mL	40 °C	48 hours

1. EPA = U.S. Environmental Protection Agency.
2. HDPE = high density polyethylene.
3. mg/L = milligrams per liter. NTU = nephelometric turbidity unit.
4. mL = milliliters.
5. °C = degrees Celsius.

3.3 OPERATIONAL MONITORING METHODS

This section summarizes the procedures followed for operational monitoring of the BMPs (full details are given in the MOP; Caltrans 2005a). The specific activities discussed in the following sections include:

- Field crew mobilization,
- Pre-event setup activities,
- Monitoring event activities,
- Post-event activities, and
- Special considerations for cold weather and snowmelt monitoring.

Operational monitoring inspection forms are included in Appendix A.

3.3.1 Field Crew Mobilization

When a candidate storm approached or when a snowmelt event was forecast, the monitoring task manager alerted the field crew. The field crew then mobilized prior to the precipitation or snowmelt event.

Upon arriving at the site, a brief site check was conducted to assess health and safety issues. Equipment inspection and necessary maintenance activities were also conducted to ensure accurate measurements.

3.3.2 Pre-Event Setup Activities

Prior to each operational monitoring event, possession of required equipment and forms was verified, digital camera battery power and the date and time were checked, and appropriate clothing was worn after checking the weather.

3.3.3 Monitoring Event Activities

Storm water monitoring event activities are described as follows:

Photographic Monitoring. Photographic monitoring during and immediately after selected storm events was conducted as part of the operational monitoring. Digital photographs were taken from seven pre-established locations, and were accompanied by a Photograph Log recording site conditions (Appendix B).

Flow Monitoring. Continuous flow measurements were recorded using flow meters equipped with bubbler tubes. Flow monitoring activities included downloading data from the data logger, maintaining a field record of flow and site conditions in the Operation Monitoring Inspection Form, and keeping flow sensors clear of obstruction.

Depth of Standing Water. Water level sensors were located on the filter chamber. Continuous-depth measurements were recorded using a bubbler, and downloaded from the data logger. Water depth and site conditions were recorded during each Operational Monitoring Inspection.

Depth of Accumulated Sediment. Visual documentation of the depth and location of sediment accumulation within the sedimentation and filter chambers and site conditions were recorded on the Operational Monitoring Inspection Form.

3.3.4 Post-Event Activities

Each site was secured prior to leaving and all waste was removed from the location. Completed field forms were brought back to the office; pictures and data were uploaded to the project database; and photographs and raw data files were labeled with the time, date, and photo point location.

3.3.5 Special Considerations for Cold Weather and Snowmelt Monitoring

Cold weather sampling activities were hampered by snow accumulation that was not present in moderate and warm weather. Snow accumulation prevented access to monitoring equipment. To alleviate this problem, snow was removed from the monitoring equipment on a regular basis after every snowfall.

4.0 MONITORING RESULTS

4.1 ANALYTICAL MONITORING STORM EVENT DESCRIPTIONS

Storm events were monitored throughout the 2004-2005 monitoring season. A storm event summary for each monitoring site is included in Table 4-1. Hydrographs for each storm event from which a sample was collected are included in Appendix C. Hydrographs show flow and sample collection information. Flow rates were recorded directly by the flow meter. Rainfall intensity is not shown on the hydrographs because rain gages were not installed at either sand trap. The estimated percent capture for each monitoring event was calculated by the Caltrans Hydrologic Utility Tool (Caltrans, 2003). Samples were not collected from the overflow monitoring stations because overflow conditions did not occur during the 2004-2005 monitoring season. The following paragraphs present descriptions of each monitored runoff event during the 2004-2005 monitoring season.

On December 6 and 7, 2004, a storm system from the Pacific generated moderate snow over the sites. The snowfall elevation was approximately 1,400 m (4,590 ft) for this event. The snowfall depth was approximately 30 centimeters (cm) (12 inches [in]) at the sites. The snow water equivalent for this event was approximately 1.5 cm (0.6 in). On December 8, 2004, a storm system from the Pacific generated moderate rain and snow over the sites. The snow level began at approximately 1,800 m (5,910 ft) and rose to 2,400 m (7,870 ft) for this event. The snowfall total was approximately 20 cm (7.9 in) at the sites before precipitation began falling as rain at 9:00 A.M on December 8, 2004. The precipitation total for this event was approximately 3.0 cm (1.2 in) at the sites.

Both sand traps were setup for sampling as a test run for this storm event to calibrate the equipment. Flow-weighted composite runoff samples were successfully collected at each of the four sampling sites. These samples were not analyzed because it was evident that construction debris, such as concrete dust and dirt from construction, remained in the sand traps and would likely impact the effluent water quality.

From January 7 through 9, 2005, a strong storm system from the Pacific generated snow over the sites. The snow elevation was approximately 1,500 m (4,920 ft) for this event. The snowfall depth was approximately 150 cm (59 in) at the sites.

TABLE 4-1

SUMMARY OF MONITORING EVENTS FOR ALL SITES

Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

Event Number	Event Type	Dates	Paired Event¹	Flow Start	Flow End	Flow Duration (hours)	Percent Capture²
SAND TRAP #1 INFLUENT STATION (3-301)							
2004-01	Snowmelt	01/17/05	Yes	01/17/05 11:20	01/17/05 17:00	5.7	100
2004-02	Snowmelt	01/18/05	Yes	01/18/05 11:25	01/18/05 17:45	6.3	99
2004-03	Snowmelt	01/20/05	Yes	01/20/05 10:55	01/20/05 22:50	11.9	71
2004-04	Mixed	01/25/05-01/26/05	Yes	01/25/05 09:05	01/26/05 17:50	32.8	97
2004-05	Snowmelt	01/27/05	Yes	01/27/05 11:10	01/27/05 15:15	4.1	88
2004-06	Snowmelt	02/02/05	Yes	02/02/05 10:55	02/02/05 23:30	12.6	98
2004-07	Mixed	02/07/05	Yes	02/07/05 11:40	02/07/05 21:25	9.8	96
2004-08	Mixed	02/15/05-02/16/05	Yes	02/15/05 14:25	02/16/05 15:40	25.3	98
2004-09	Mixed	02/21/05-02/22/05	Yes	02/21/05 11:50	02/22/05 17:00	29.2	96
2004-10	Snowmelt	02/23/05	Yes	02/23/05 10:20	02/23/05 14:00	3.7	100
SAND TRAP #1 EFFLUENT STATION (3-302)							
2004-01	Snowmelt	01/17/05-01/18/05	Yes	01/17/05 11:10	01/18/05 08:40	21.5	96
2004-02	Snowmelt	01/18/05-01/19/05	Yes	01/18/05 12:20	01/19/05 08:05	19.8	100
2004-03	Snowmelt	01/20/05-01/21/05	Yes	01/20/05 10:00	01/21/05 07:35	21.6	98
2004-04	Mixed	01/24/05-01/27/05	Yes	01/24/05 22:00	01/27/05 00:30	50.5	97
2004-05	Snowmelt	01/27/05-01/28/05	Yes	01/27/05 11:30	01/28/05 08:40	21.2	100
2004-06	Snowmelt	02/02/05-02/03/05	Yes	02/02/05 10:55	02/03/05 03:05	16.2	99
2004-07	Mixed	02/07/05-02/08/05	Yes	02/07/05 11:48	02/08/05 03:16	15.5	94
2004-08	Mixed	02/15/05-02/17/05	Yes	02/15/05 12:00	02/17/05 21:00	57.0	90
2004-09	Mixed	02/21/05-02/23/05	Yes	02/21/05 11:50	02/23/05 05:40	41.8	94
2004-10	Snowmelt	02/23/05-02/24/05	Yes	02/23/05 11:30	02/24/05 10:10	22.7	100

TABLE 4-1

SUMMARY OF MONITORING EVENTS FOR ALL SITES

Event Number	Event Type	Dates	Paired Event¹	Flow Start	Flow End	Flow Duration (hours)	Percent Capture²
SAND TRAP #2 INFLUENT STATION (3-304)							
2004-01	Snowmelt	01/17/05	Yes	01/17/05 11:45	01/17/05 17:00	5.3	92
2004-02	Snowmelt	01/19/05	Yes	01/19/05 09:45	01/19/05 17:00	7.3	67
2004-03	Mixed	01/25/05-01/26/05	Yes	01/25/05 09:15	01/26/05 21:00	35.8	100
2004-04	Snowmelt	02/02/05	Yes	02/02/05 10:15	02/02/05 17:05	6.8	89
2004-05	Snowmelt	02/03/05-02/04/05	Yes	02/03/05 08:55	02/04/05 09:20	24.4	99
2004-06	Mixed	02/14/05-02/17/05	Yes	02/14/05 08:55	02/17/05 00:00	63.1	88
2004-07	Mixed	02/21/05-02/22/05	Yes	02/21/05 09:45	02/22/05 21:30	35.8	89
2004-08	Snowmelt	02/23/05	Yes	02/23/05 10:00	02/23/05 20:00	10.0	81
2004-09	Rainfall	05/04/05-05/06/05	Yes	05/04/05 13:40	05/06/05 09:35	43.9	98
SAND TRAP #2 EFFLUENT STATION (3-305)							
2004-01	Snowmelt	01/17/05-01/18/05	Yes	01/17/05 12:20	01/18/05 09:25	21.1	100
2004-02	Snowmelt	01/19/05-01/20/05	Yes	01/19/05 09:30	01/20/05 08:25	22.9	92
2004-03	Mixed	01/25/05-01/27/05	Yes	01/25/05 09:55	01/27/05 05:00	43.1	100
2004-04	Snowmelt	02/02/05-02/03/05	Yes	02/02/05 10:55	02/03/05 08:50	21.9	97
2004-05	Snowmelt	02/03/05-02/04/05	Yes	02/03/05 11:15	02/04/05 07:05	19.8	100
2004-06	Mixed	02/14/05-02/17/05	Yes	02/14/05 08:55	02/17/05 04:00	67.1	99
2004-07	Mixed	02/21/05-02/23/05	Yes	02/21/05 10:30	02/23/05 05:40	43.2	100
2004-08	Snowmelt	02/23/05-02/24/05	Yes	02/23/05 10:40	02/24/05 06:10	19.5	100
2004-09	Rainfall	05/04/05-05/06/05	Yes	05/04/05 13:50	05/06/05 09:25	43.6	99

1. A paired event is when an influent and effluent sample were successfully collected and analyzed per storm event.

2. The percentage of the total rainfall runoff captured during each storm event was calculated by the Caltrans Hydrologic Utility Tool.

Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #1 on January 17, 18, and 19, 2005, and the corresponding effluent on January 18, 19, and 21, 2005. Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #2 on January 17 and 20, 2005, and the corresponding effluent on January 18 and 20, 2005.

On January 25 and 26, 2005, a storm system from the Pacific generated rain and snow over the sites. The snow elevation was approximately 2,000 m (6,560 ft) for this event. The snowfall depth was approximately 10 cm (4 in) at the sites. Runoff from this storm event began on January 25, 2005, and was generated from the rain/snow mix as it landed in the drainage areas.

Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #1 on January 26 and 27, 2005, and the corresponding effluent on January 27 and 28, 2005. Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #2 on January 26, 2005, and the corresponding effluent on January 27, 2005.

On January 28, 2005, a storm system from the Pacific generated rain and snow over the sites. The snow elevation was approximately 1,500 m (4,920 ft) for this event. The snowfall depth was approximately 20 cm (7.9 in) at the sites.

On February 2, 2005, temperatures warmed to induce snow melt in the drainage areas. Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #1 on February 2, 2005, and the corresponding effluent on February 3, 2005. Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #2 on February 2 through 4, 2005, and the corresponding effluent on February 3 and 4, 2005.

On February 7, 2005, a storm system from the Pacific generated snow over the sites. The snow elevation was approximately 1,500 m (4,920 ft) for this event. The snowfall depth was approximately 1 cm (0.4 in) at the sites. During intermittent snowfall, temperatures induced the snow to melt in the drainage area of Sand Trap #1.

Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #1 on February 7, 2005, and the corresponding effluent on February 8, 2005. Flow-weighted composite runoff samples were not collected at Sand Trap #2.

On February 14 and 15, 2005, a storm system from the Pacific generated snow over the sites. The snow elevation was approximately 1,500–2,000 m (4,920–6,560 ft) for this event. The

snowfall depth was approximately 10 cm (4 in) at the sites. The snow water equivalent was approximately 1 cm (0.4 in). During intermittent snowfall, temperatures induced snow to melt off the roadway in the drainage area of both sand traps.

Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #1 on February 16, 2005, and the corresponding effluent on February 17, 2005. Flow-weighted composite runoff samples were successfully collected at the influent and the corresponding effluent of Sand Trap #2 on February 17, 2005.

On February 21 and 22, 2005, a storm system from the Pacific generated snow over the sites. The snow elevation was approximately 1,500–2,000 m (4,920–6,560 ft) for this event. The snowfall depth was approximately 15 cm (5.9 in) at the sites. The snow water equivalent was approximately 1.5 cm (0.6 in). During intermittent snowfall, temperatures induced snow to melt off the roadway in the drainage areas.

Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #1 on February 22 and 23, 2005, and the corresponding effluent on February 23 and 24, 2005. Flow-weighted composite runoff samples were successfully collected at the influent of Sand Trap #2 on February 22 and 23, 2005, and the corresponding effluent on February 23 and 24, 2005.

On May 4 through 6, 2005, a storm system from the Pacific generated rain over the sites. The snow elevation was approximately 2,300 m (7,550 ft) for this event. The precipitation depth was approximately 0.6 cm (0.24 in) at the sites. The Sand Trap #1 influent and effluent stations (3-301, 3-302) were not set-up for sampling because the required number of rainfall and snowmelt events at Sand Trap #1 had been met. Sand Trap # 2 was setup for sampling for this runoff event.

Flow-weighted composite runoff samples were successfully collected at the influent and the corresponding effluent of Sand Trap #2 on May 6, 2005.

4.2 OPERATIONAL MONITORING RESULTS

Since the completion of the sand traps in November 2004, operational monitoring inspections were conducted during individual rainfall and snowmelt runoff events. General observational monitoring was also performed during each site visit. Operational monitoring inspection results are summarized in three Operational Monitoring Reports (Caltrans, 2005b, 2005c, and

2005d). Operational monitoring inspection forms and photograph-monitoring logs are included in Appendices A and B, respectively.

Sand Trap Overflows and Standing Water. Overflow has not occurred from either sand trap since operations began on December 7, 2004.

The maximum depth of standing water observed in the sand traps is illustrated in Table 4-2. Sand Trap #1 experienced the greatest recorded depth measurement at 37 cm (14.6 in) in the sedimentation chamber during high spring runoff flows. Sand Trap #2 had standing water depths up to 10 and 16 cm (4 and 6.3 in, respectively), in the sedimentation chamber and the filter chamber, respectively. These depth readings are recorded during high flow and typically decrease rapidly as the inflow decreases.

Permanent standing water of approximately 2.5 cm (1 in) has been observed in both sedimentation chambers. The cause of this is likely due to the construction of the piping system between the sedimentation and filter chambers in the sand traps, when slotted pipes were installed in lieu of the specified louvered pipes. Slotted pipes may be more susceptible to clogging from the sand. Also, the lowest slot in the pipe is approximately 2.5 cm (1 in) above the sand trap floors. Standing water also is observed in both sand traps in the effluent pipe under the filter due to negative slopes.

During this monitoring period, a bubbler was used to measure effluent flow rates. The negative slope in the effluent pipe created a backwater condition, which caused noisy and imprecise flow readings.

Sediment Accumulation. Sediment accumulation refers to the accumulation of materials that are coarse enough to settle out of the storm water runoff by gravity. Sediment accumulations in the sedimentation and filter chambers were monitored to assess maintenance requirements of each sand trap. Most of the sediment accumulation was in the sedimentation chamber. The sediment accumulations were measured by visual observations and by taking measurements of sediment depth at representative locations in the sand traps. Sediment accumulation was also observed in the filtration chamber but not at a measurable depth. Both sand traps have shown a moderate accumulation (approximately 3-6 cm [1.2-2.4 in]) of sediment on the bottom of the sedimentation chambers.

TABLE 4-2

SAND TRAP STANDING WATER AND OVERFLOWS¹

Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

	Sand Trap #1		Sand Trap #2	
	Sedimentation Chamber	Filter Chamber	Sedimentation Chamber	Filter Chamber
Overflow Events	0	0	0	0
Peak Level of Standing Water in centimeters (and inches)	37 (14.6)	1 (0.4)	10 (4)	16 (6.3)
Duration at peak level (in minutes)	<1 hour	na	<1 hour	100
Peak Level of Standing Water in centimeters (and inches) from March 10 through 31, 2005	37 (14.6)	1 (0.4)	10 (4)	16 (6.3)
Duration at peak level (in minutes)	<1 hour	na	<1 hour	100
Overflow Elevation in centimeters (and inches) above bottom of sand trap	180 (70.8)	169 (66.5)	250 (98.4)	160 (62.9)

1. < = less than. na = not available.

Fines Accumulation. Fines accumulation refers to accumulation of materials by filtration as the storm water runoff flows through the filter fabric. Accumulation of fines within the filter chamber is assumed to cause a decrease in flow rates at the discharge point coupled with an increase in standing water level and duration in the filter chamber. In Table 4-3, maximum and average event effluent flow rates are given. This summary is designed to assess clogging of the filter fabric, as indicated by effluent flow decrease corresponding with greater depth and longer duration of standing water level.

Effluent flow rates were continuously monitored at both sand traps. No obvious decrease in these flow rates occurred. While variations in both the maximum and average flow rates were observed from event to event, these variations were apparently caused by variations in the inflow rates, not from accumulated fine sediments clogging the filters.

Maintenance Activities and Other Issues.

Unstable Slopes

A finished slope at Sand Trap #2 experienced sloughing between March 31 and April 1, 2005. These slopes were constructed with a 1.5-to-1 (horizontal-to-vertical) grade. During March 2005 storms, the snow covered the slopes to a depth of over 0.6 m (2 ft).

The sloughing soil has partially blocked the effluent discharge into the infiltration basins, causing a slight backwater condition. This backwater condition is well downstream of any treatment processes and will not affect the treatment performance of either sand trap.

Caltrans landscaping crews repaired some of the sloughs in the area but the slopes immediately below both sand traps were not addressed. The material was mostly mulch and loose soil that was installed for revegetation. The structural fill stabilizing the sand traps and the roadway did not appear to be a part of the sloughed material.

Coarse Sediment Accumulation

The immediate upstream drainage inlet at Sand Trap #2 has filled with sediment. The coarse sediment is now reaching the sedimentation chamber, which will greatly increase the rate of sediment accumulation. On March 4, 2005, sediment covered the influent flow-monitoring device, resulting in erroneous flow measurement. A custom mesh screen upstream of the influent bubbler has been tested as the means to correct this problem, although it does not

TABLE 4-3**EFFLUENT FLOW RATES**

Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

Event Date	Event Type	Maximum Flow (lps¹)	Average Flow (lps)
Sand Trap #1 (3-302) Effluent			
01/17/05	Snowmelt	0.577	0.165
01/18/05	Snowmelt	0.669	0.247
01/20/05	Snowmelt	1.657	0.473
01/25/05 - 01/27/05	Mixed	1.106	0.183
01/27/05	Snowmelt	0.281	0.107
02/02/05	Snowmelt	1.813	0.489
02/07/05	Mixed	0.298 ²	0.189 ²
02/15/05 - 02/17/05	Mixed	0.493	0.047
02/21/05 - 02/23/05	Mixed	0.249	0.055
02/24/05	Snowmelt	0.249	0.050
Sand Trap #2 (3-305) Effluent			
01/17/05	Snowmelt	0.208	0.070
01/19/05	Snowmelt	0.149	0.042
01/25/05 - 01/27/05	Mixed	0.513	0.213
02/02/05	Snowmelt	0.357	0.095
02/03/05	Snowmelt	0.872	0.146
02/15/05 - 02/17/05	Mixed	0.661	0.084
02/21/05 - 02/23/05	Mixed	0.401	0.128
02/24/05	Snowmelt	0.448	0.237
05/04/05 - 05/06/05	Rainfall	2.175	0.437

1. lps = liters per second.

2. Flow data could not be downloaded from equipment. Maximum and average flow estimated from hydrograph.

appear that this will be the permanent solution. Sediment interference and flow rates should continue to be monitored.

Drainage Failure

The asphalt dike on the south side of Highway 267 above Sand Trap #2 was damaged by snow removal activities. This breach allowed highway runoff to bypass the drainage inlets and flow down the hillside. This diverted flow is eroding the hillside.

Snow removal activities frequently damage asphalt concrete berms along Tahoe Basin highways and Caltrans makes repairs annually to address these problems. Temporary repairs using sand bags or other materials will be made during subsequent monitoring seasons as appropriate.

4.3 ANALYTICAL RESULTS

Analytical results for Sand Trap #1 and Sand Trap #2 are summarized in Tables 4-4 and 4-5, respectively. Results were compiled to determine the quality of influent and effluent at the sites and evaluate the performance of each sand trap. Storm water samples were analyzed for the constituents listed in Table 3-1. Turbidity and TSS concentrations from samples collected from the influent and effluent of Sand Trap #2 during the rainfall event in May 2005 are lower than snowmelt or mixed events. This is attributed to Caltrans not applying sand or salt to the roads during rainfall events.

Quality assurance/quality control (QA/QC) procedures were implemented in accordance with the MOP, including using Caltrans Automated Data Validation Version 3.1 software during the data validation process. Laboratory analytical results for QA/QC samples collected during the 2004-2005 monitoring season are included in Appendix D.

TABLE 4-4**SUMMARY OF ANALYTICAL RESULTS
FROM SAND TRAP #1**Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

Sample Information						Laboratory Analytes			
Event ID	Sample Date		Event Type	Sample Type ¹	PSTM Number ²	Turbidity (NTU) ³		TSS (mg/L) ⁴	
	3-301	3-302				3-301	3-302	3-301	3-302
2004-01	01/17/05	01/18/05	Snowmelt	C	PSTM 2	239	160	111	76
2004-02	01/18/05	01/19/05	Snowmelt	C	PSTM 3	234	218 J	167	92
2004-03	01/20/05	01/21/05	Snowmelt	C	PSTM 5	184	145	72	45
2004-04	01/26/05	01/27/05	Mixed	C	PSTM 6	2,245	1,206	1,027	407
2004-05	01/27/05	01/28/05	Snowmelt	C	PSTM 7	256 J	134 J	234	74
2004-06	02/02/05	02/03/05	Snowmelt	C	PSTM 8	265	249	114	116
2004-07	02/07/05	02/08/05	Mixed	C	PSTM 10	285	91	238	23
2004-08	02/16/05	02/17/05	Mixed	C	PSTM 11	2,480	159	1,409	102
2004-09	02/22/05	02/23/05	Mixed	C	PSTM 12	320	35 J	267	33
2004-10	02/23/05	02/24/05	Snowmelt	C	PSTM 13	1,220	108	326	636

1. C = composite sample.
2. PSTM = post-storm technical memorandum.
3. NTU = nephelometric turbidity units. J = estimated concentration, sample was not analyzed within recommended holding time.
4. TSS = total suspended solids. mg/L = milligrams per liter.

TABLE 4-5**SUMMARY OF ANALYTICAL RESULTS
FROM SAND TRAP #2**Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

Sample Information						Laboratory Analytes			
Event ID	Sample Date		Event Type	Sample Type ¹	PSTM Number ²	Turbidity (NTU) ³		TSS (mg/L) ⁴	
	3-304	3-305				3-304	3-305	3-304	3-305
2004-01	01/17/05	01/18/05	Snowmelt	C	PSTM 2	1,150	259	605	116
2004-02	01/20/05	01/20/05	Snowmelt	C	PSTM 4	1,090	173 J	549	52
2004-03	01/26/05	01/27/05	Mixed	C	PSTM 6	1,879	943	1,399	480
2004-04	02/02/05	02/03/05	Snowmelt	C	PSTM 8	320	185	280	70
2004-05	02/04/05	02/04/05	Snowmelt	C	PSTM 9	396 J	291 J	482	117
2004-06	02/17/05	02/17/05	Mixed	C	PSTM 11	1,099	298	1,118	270
2004-07	02/22/05	02/23/05	Mixed	C	PSTM 12	292	103 J	438	99
2004-08	02/23/05	02/24/05	Snowmelt	C	PSTM 13	1,100	438	1,925	293
2004-09	05/06/05	05/06/05	Rainfall	C	PSTM 14	79	63	115	41

1. C = composite sample.
2. PSTM = post-storm technical memorandum.
3. NTU = nephelometric turbidity units. J = estimated concentration, sample was not analyzed within recommended holding time.
4. TSS = total suspended solids. mg/L = milligrams per liter.

5.0 SAND TRAP PERFORMANCE

Influent and effluent storm water quality was assessed from collected analytical data. Sand trap performance for reducing TSS and turbidity was evaluated by comparing influent and effluent EMCs. In addition, the effluent concentrations of constituents of concern were compared to discharge limits established by the LRWQCB and the TRPA. A basin-to-basin comparison of influent and effluent mean concentrations was also performed. The data set collected from the first year of the Pilot Study is too small for further statistical analysis.

5.1 SAND TRAP CONSTITUENT REMOVAL PERFORMANCE

Sand trap performance for reducing the TSS and turbidity was assessed by comparing mean EMCs in samples collected at influent and effluent monitoring stations. These data can be found in Table 5-1, which contains computed means and other summary statistics for the individual monitoring stations.

The following sections summarize TSS and turbidity analytical results, the results of calculations of percent removal based on mean values of paired (influent and effluent) data, and plots of effluent concentrations against influent concentrations. In the plots, results for both sand traps are shown on the same figure. On each plot a “No Treatment” line showing the influent concentration plotted against itself is shown as a guide for seeing whether effluent concentrations (plotted as symbols) are greater or less than influent concentrations. In addition, effluent limits established by the LRWQCB and the TRPA are shown.

Total Suspended Solids. Effluent TSS concentrations are plotted against influent concentrations on Figure 5-1. Data are plotted for runoff events for which both influent and effluent samples were collected. For the paired storm events, the mean values and percent removal are shown in Table 5-2. The TRPA effluent limit for surface water discharge is 250 milligrams per liter (mg/L). Figure 5-1 indicates the sand traps are more effective (in terms of average percent removal) at treating higher influent TSS concentrations.

Turbidity. For those storm events which produced paired influent and effluent data, the mean values and percent removal are shown in Table 5-2. The LRWQCB effluent limit for surface water discharge is 20 nephelometric turbidity units (NTU) and the effluent discharge limit for infiltration is 200 NTU. Figure 5-2 indicates the sand traps are not effective at decreasing the runoff turbidity below the surface water discharge limit of 20 NTU. In addition, the sand traps

TABLE 5-1**SUMMARY STATISTICS FOR SAND TRAP #1 AND #2 STATIONS¹**

Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

Station	Constituent ²	Units ³	Number of Samples Collected	Percent Detection	Range		Mean	Median	Standard Deviation	CV ⁴
					Min	Max				
3-301	Turbidity	NTU	10	100%	184	2,480	772.8	275	923.5	1.19
	TSS	mg/L	10	100%	72	1,409	396.5	236	478.9	1.21
3-302	Turbidity	NTU	10	100%	35	1,206	250.5	152	446.1	1.78
	TSS	mg/L	10	100%	23	636	160.4	84	217.4	1.36
3-304	Turbidity	NTU	9	100%	79.2	1,879	822.8	1,090	598.7	0.73
	TSS	mg/L	9	100%	115	1,925	767.9	549	614.3	0.80
3-305	Turbidity	NTU	9	100%	62.6	943	305.9	259	301.6	0.99
	TSS	mg/L	9	100%	41	480	170.9	116	155.4	0.91

1. Analytical results for snowmelt, rain, and mixed events from November 2004 through June 2005.
2. TSS = total suspended solids.
3. NTU = nephelometric turbidity units. mg/L = milligrams per liter.
4. CV = coefficient of variance, which is the standard deviation divided by the mean.

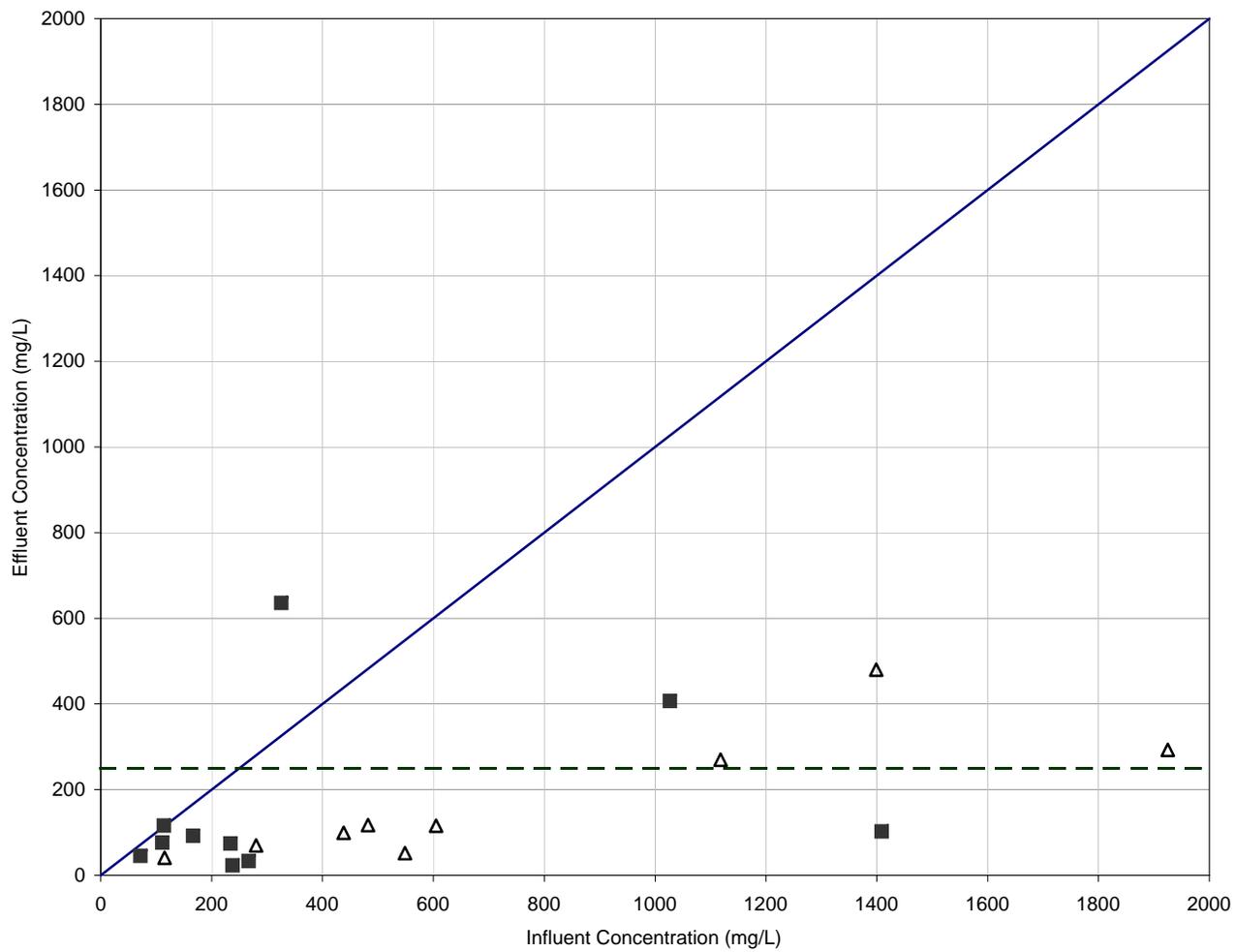
TABLE 5-2

**COMPARISON OF SAND TRAP-TO-SAND TRAP
MEAN CONCENTRATIONS AND PERCENT REMOVAL¹**

Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

	Units ²	Mean Influent Concentration		Mean Effluent Concentration		Percent Removal ³	
		3-301	3-304	3-302	3-305	Sand Trap #1	Sand Trap #2
Turbidity	NTU	773	823	251	306	68	63
Total Suspended Solids	mg/L	397	768	160	171	60	78

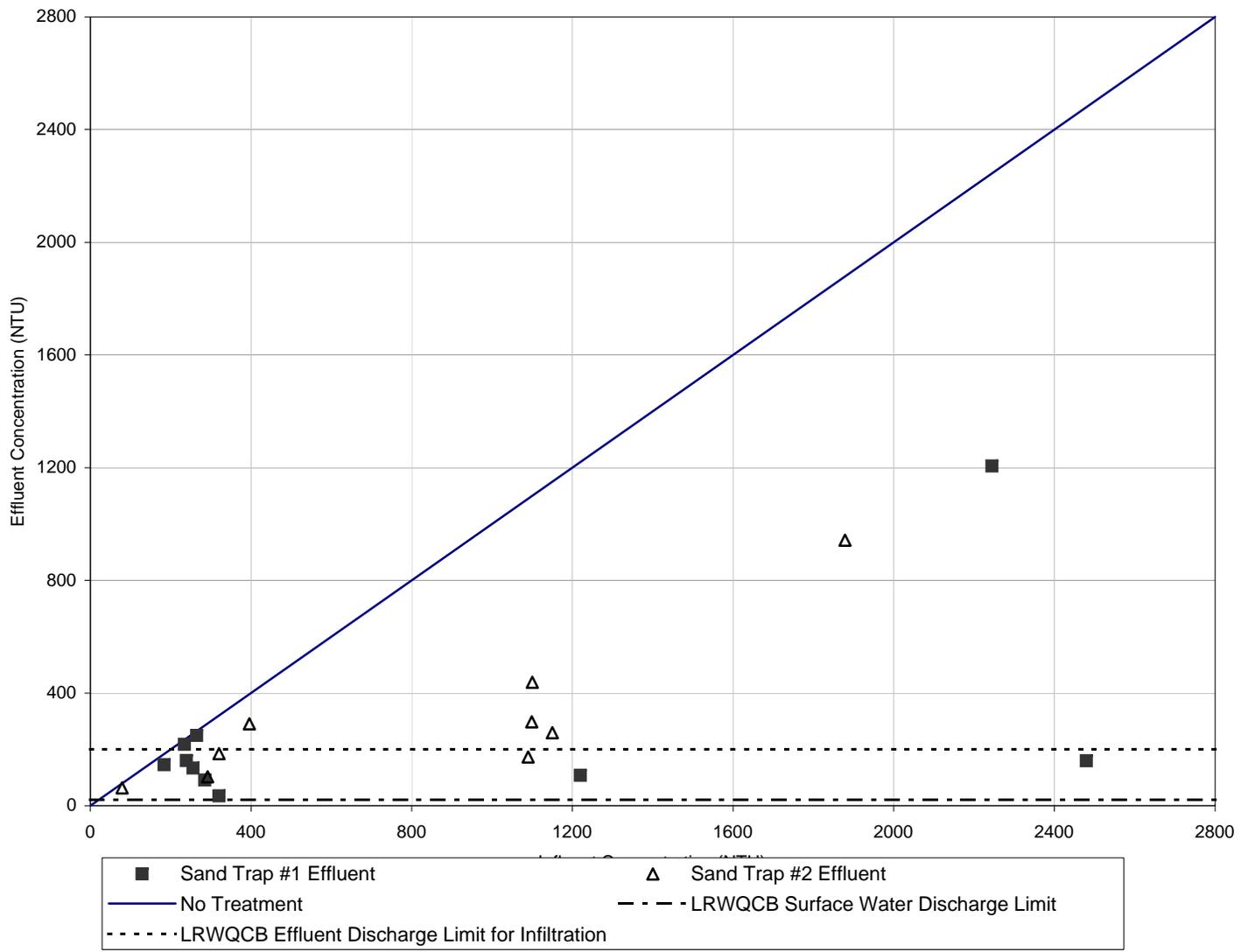
1. Mean values of paired (influent and effluent) data are calculated using the Caltrans Data Analysis Tool.
2. NTU = nephelometric turbidity units. mg/L = milligrams per liter.
3. Percent removal is calculated based on mean values of paired (influent and effluent) data.



Sand Trap #1 Effluent
 Sand Trap #2 Effluent
 No Treatment
 TRPA Surface Water Discharge Limit

Note: No treatment line is the hypothetical line of effluent = influent. TRPA = Tahoe Regional Planning Agency.

FIGURE 5-1
 TREATMENT OF TOTAL SUSPENDED SOLIDS
 Highway 267 Filter Fabric Sand Trap Pilot Study
 Tahoe Basin, El Dorado County, California



Note: No treatment line is the hypothetical line of effluent = influent. LRWQCB = Lahontan Regional Water Quality Control Board

FIGURE 5-2
 TURBIDITY
 Highway 267 Filter Fabric Sand Trap Pilot Study
 Tahoe Basin, El Dorado County, California

do not consistently decrease the runoff turbidity below the infiltration discharge limit of 200 NTU.

5.2 SAND TRAP-TO-SAND TRAP COMPARISON

Table 5-2 presents an intra-basin comparison of mean values of paired (influent and effluent) data and percent removal. These data indicated the mean influent concentrations of TSS and turbidity were greater for Sand Trap #2. The mean percent removal of TSS from Sand Trap #2 was greater than that of Sand Trap #1, while the mean percent removal of turbidity for both sand traps were similar. The mean effluent concentrations for TSS for both sand traps were less than the TRPA effluent limit for surface water discharge of 250 mg/L. The mean effluent concentration for turbidity for both sand traps were above the LRWQCB effluent limit for surface water discharge of 20 NTU and the infiltration discharge limitation of 200 NTU.

6.0 CONCLUSIONS

Storm water analytical data were collected during the 2004-2005 monitoring season along Highway 267 in the Tahoe Basin from two innovative sand traps consisting of settling followed by filtration through a fabric filter. These data were used to evaluate the treatment effectiveness of the two sand traps in reducing TSS and turbidity from storm water runoff. In addition, inspections of the BMP were conducted in order to characterize operation and maintenance requirements under the various environmental conditions that occur in the Tahoe Basin.

The findings of the 2004-2005 wet season water quality monitoring are as follows:

- The filter fabric did not clog. No obvious decrease in effluent flow rates was observed. In addition, runoff did not overflow from the filter chamber to the outlet.
- The sand traps are more effective at treating higher influent TSS concentrations. The sand traps are not effective at decreasing the runoff turbidity below the surface water discharge limit of 20 NTUs established by the LRWQCB. In addition, the filter fabric does not consistently decrease the runoff turbidity below the infiltration discharge limit of 200 NTUs established by the LRWQCB. The mean effluent TSS concentrations of the runoff from both sand traps were below the surface water discharge limit of 250 mg/L established by the Tahoe Regional Planning Agency.
- The first year of monitoring was insufficient to assess the treatment life of the filter fabric.

Based on results of operational monitoring conducted during the 2004-2005 wet season, the following recommendations should be incorporated into the Pilot Study:

- Each sand trap should be cleaned of construction debris and accumulated sediment prior to installation of the filter fabric and use.
- Periodic snow removal is needed for site access.
- Several maintenance issues should be corrected during the summer construction season including: replacing the slotted dewatering pipe with a louvered pipe in the sedimentation chamber; adjusting the slope of the effluent pipe to reduce backwater conditions; repairing the downhill slope of each sand trap; removing coarse sediment from the upstream drainage inlet of Sand Trap #2; and repairing the asphalt dike on the south side of Highway 267 above Sand Trap #2.

7.0 REFERENCES

California Department of Transportation, 2003, Caltrans Comprehensive Protocols Guidance Manual (CTSW-RT-03-105.51.42), November (Caltrans, 2003).

California Department of Transportation,
<http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/2004all/r221275i.htm>, (Caltrans, 2004).

California Department of Transportation, 2005, Monitoring Operations Plan (CTSW-PL-05-129-03.2), February (Caltrans, 2005a).

California Department of Transportation, 2005, Operational Monitoring Report No. 1 (CTSW-RT-05-129.03.3), June (Caltrans, 2005b).

California Department of Transportation, 2005, Operational Monitoring Report No. 2 (CTSW-RT-05-129.03.4), June (Caltrans, 2005c).

California Department of Transportation, 2005, Operational Monitoring Report No. 3 (CTSW-RT-05-129.03.5), June (Caltrans, 2005d).

APPENDIX A

Operational Monitoring Inspection Forms

**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #1 Operational Monitoring Inspection Form**

Name: T. Rynders

Date	Time ¹	Standing Water Level	Sediment Accumulation (Describe areal extent and average depth of sediment accumulations, use back of page for sketch if necessary)	Comments
12/22/04	13:30	1 cm (0.4 in)	Some sediment accumulating in the sedimentation chamber (1-2 cm [0.4-0.8 in]). Some appears to be dust and debris from construction.	Slopes failing from snow weight and moisture saturation. Slotted pipe possibly clogging from sediments, must keep checking standing water depths. Lots of debris in the pipe network, especially in the effluent pipe from the filter chamber into the overflow chamber.
cm = centimeters; in = inches				

1. Pacific Time

**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #2 Operational Monitoring Inspection Form**

Name: T. Rynders

Date	Time ¹	Standing Water Level	Sediment Accumulation (Describe areal extent and average depth of sediment accumulations, use back of page for sketch if necessary)	Comments
12/22/04	13:45	1 cm (0.4 in)	Some sediment accumulating in the sedimentation chamber (1-2 cm [0.4-0.8 in]). Some appears to be dust and debris from construction.	Slope failing near the sand trap. Slotted pipe possibly clogging from sediments, must keep checking standing water depths. Lots of debris in the pipe network, especially in the effluent pipe from the filter chamber into the overflow chamber.

cm = centimeters; in = inches

1. Pacific Time

**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #1 Operational Monitoring Inspection Form**

Name: N. Batchelder

Date	Time ¹	Standing Water Level (cm)	Sediment Accumulation (Describe areal extent and average depth of sediment accumulations, use back of page for sketch if necessary)	Comments
03/09/05	14:30	2-3 cm (0.8-1.2 in) in the sedimentation chamber. 7.5-10 cm (3-4 in) standing water at the discharge of the effluent pipe.	2-5 cm (0.8-2 in) of sediment on the bottom of the sedimentation chamber. <1 cm (0.4 in) on the filter fabric on the influent half of the filter chamber. DI on sand trap side of roadway full of sediment. DI on opposite side of roadway has approximately 0.6 m (2 ft) of available sediment storage.	Slopes continue failing from snow weight and moisture saturation. Construction debris beginning to flush out of system.

cm = centimeters; in = inches; m = meters; ft = feet

DI = drainage inlet

1. Pacific Time

**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #2 Operational Monitoring Inspection Form**

Name: C. Eklund

Date	Time ¹	Standing Water Level (cm)	Sediment Accumulation (Describe areal extent and average depth of sediment accumulations, use back of page for sketch if necessary)	Comments
03/09/05	13:15	7.5-10 cm (3-4 in) in filter chamber (shortly after runoff). 2 cm (0.8 in) in sedimentation chamber (shortly after runoff).	1-2 cm (0.4-0.8 in) of sediment around bubbler and intake strainer in influent pipe. Upstream DI's full of sediment. 2-4 cm (0.8-1.6 in) of fine and coarse sediment on the floor of the sedimentation chamber. 1-2 cm (0.4-0.8 in) of fine sediment accumulation around the bottom of the riser pipes.	Slopes have continued to fail.

cm = centimeters; in = inches

DI = drainage inlet

1. Pacific Time

**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #1 Operational Monitoring Inspection Form**

Name: T. Rynders

Date	Time ¹	Standing Water Level (cm)	Sediment Accumulation (Describe areal extent and average depth of sediment accumulations, use back of page for sketch if necessary)	Comments
03/31/05	15:15	37 cm (14.6 in) in the sedimentation chamber (during runoff) 0-1 cm (0-0.4 in) in filter chamber 7.5-10 cm (3-4 in) standing water at the discharge of the effluent pipe	DI on sand trap side of roadway full of sediment. DI on opposite side of roadway has approximately 0.3 m (1 ft) of available sediment storage. Fine sediment (approximately 1 cm [0.4 in]) beginning to build up across entire floor surface of filter fabric. Coarse sediment depth (approximately 4-10 cm [1.6-4 in]) at influent side of sedimentation chamber. Does not appear to be distributed equally across the sand trap.	Standing water level in sedimentation chamber is due to high flows (max approximately 4 lps). The dewatering pipe is apparently the flow limiting device in this sand trap. Depth of sediment layer in down gradient portion of sedimentation chamber is unknown during this inspection period because of frequent submersion.

cm = centimeters; in = inches; m = meters; ft = feet

DI = drainage inlet

lps = liters per second

1. Pacific Time

**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #2 Operational Monitoring Inspection Form**

Name: T. Rynders

Date	Time ¹	Standing Water Level (cm)	Sediment Accumulation (Describe areal extent and average depth of sediment accumulations, use back of page for sketch if necessary)	Comments
03/31/05	15:00	16 cm (6.3 in) in filter chamber (shortly after runoff peak) 10 cm (4 in) in sedimentation chamber (during runoff)	1-2 cm (0.4-0.8 in) of sediment around bubbler and intake strainer in influent pipe. Upstream DI full of sediment. 3-6 cm (1.2-2.4 in) of fine and coarse sediment on the floor of the sedimentation chamber. 2-3 cm (0.8-1.2 in) of fine sediment accumulation around the bottom of the riser pipes. 1 cm (0.4 in) of fine silt accumulation in the effluent pipe at effluent intake location.	Slope failed between March 31 and April 1, 2005. Filter fabric (filter chamber) is the flow-limiting device in this sand trap. Fine sediment/silt building up in negatively sloped effluent pipe is likely to be causing an increase in turbidity. Picture illustrates that the effluent intake is sucking in fine sediment that has accumulated at the strainer.

cm = centimeters; in = inches

DI = drainage inlet

1. Pacific Time

APPENDIX B

Photo-Monitoring Logs and Photographs

**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #1 Photo Log**

Name: T. Rynders

Site ID	Photo Point ID	Date	Time¹	Comments²
Sand Trap #1	1	12/14/04	10:23	View of slopes sloughing into infiltration basins below the sand trap.
	2	12/14/04	10:16	Shows slopes that did not slough, looking up towards Brockway Summit.
	3	12/22/04	13:49	Influent pipe shows mortar work for proper flow reading and little-to-no sediment accumulation in the pipe. Pipe was cleaned at date of install.
	4	12/22/04	13:44	Photo of sedimentation chamber. Approximately 1 cm (0.4 in) of sand has accumulated.
	6	12/07/04	12:32	Look into effluent pipe with piece of concrete and other debris sitting in the elbow.
	7	12/22/04	13:48	This is the effluent discharge into the infiltration basins. Outfall of pipe obstructed by sloughing slopes. Notice the large amount of debris and sediment in the effluent pipe.

1. Pacific time.

2. cm = centimeters; in = inches

Photo Point #1 12/14/04



Photo Point #2 12/14/04



Photo Point #3 12/22/04



Photo Point #4 12/22/04



Photo Point #6 12/07/04

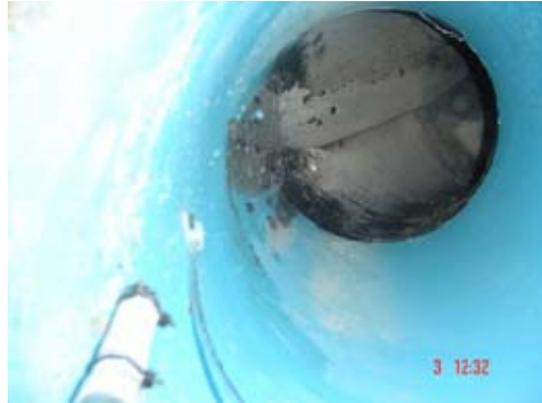


Photo Point #7 12/22/04



**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #2 Photo Log**

Name: T. Rynders

Site ID	Photo Point ID	Date	Time¹	Comments²
Sand Trap #2	1	12/14/04	10:25	Sloughing of slope into infiltration basins beneath sand trap.
	2	12/20/04	12:52	Shows slope remained in place above the sand trap, along the maintenance access road.
	3	12/22/04	13:31	Shows influent pipe. Slight buildup of fine sediment since installation, pipe has very small slope, will be prone to sediment buildup.
	4	12/22/04	13:32	Shows accumulation of approximately 1-2 cm (0.4-0.8 in) of sand and water in sedimentation chamber.
	5	12/22/04	13:31	View into effluent piping, shows debris in overflow chamber and effluent pipe.
	5	12/22/04	13:31	Filter chamber shows no sediment buildup or standing water present.

1. Pacific time.

2. cm = centimeters; in = inches

Photo Point #1 12/14/04



Photo Point#2 12/20/04



Photo Point #3 12/22/04



Photo Point #4 12/22/04



Photo Point #5 12/22/04



Photo Point #5 12/22/04



**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #1 Photo Log**

Name: T. Rynders

Site ID	Photo Point ID	Date	Time ¹	Comments ²
Sand Trap #1	1	03/09/05	14:30	View of slopes continuing to slough into infiltration basins below the sand trap.
	2	02/07/05	07:50	Drainage area, looking towards Brockway Summit.
	3	03/09/05	14:25	Influent pipe shows no coarse sediment accumulation in the pipe. Also, approximately 1-2 cm (0.4-0.8 in) accumulation of coarse and fine sediment on the bottom of the sedimentation chamber.
	5	02/07/05	14:51	Look into filter chamber, shows accumulation of fines on fabric in beginning of February.
	5	03/09/05	14:27	Shows continued accumulation of fines on filter fabric of a month duration. Fines covering approximately 5 m (16.4 ft) along the bottom of the 10 m (32.8 ft) long fabric bag.
	7	03/09/05	14:20	Blockage of effluent pipe discharge into the infiltration basins.

1. Pacific Time

2. cm = centimeters; in = inches; m = meters; ft = feet

Photo Point #1 03/09/05



Photo Point #2 02/07/05



Photo Point #3 03/09/05



Photo Point #5 03/09/05



Photo Point #5 03/09/05



Photo Point #7 03/09/05



**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #2 Photo Log**

Name: T. Rynders

Site ID	Photo Point ID	Date	Time ¹	Comments ²
Sand Trap #2	1	02/07/05	10:25	Sloughing of slope into infiltration basins beneath sand trap.
	2	02/07/05	12:52	Shows slope remained in place above the sand trap, along the maintenance access road.
	3	03/09/05	13:31	Shows influent pipe. Slight build up of fine sediment since installation, pipe has very small slope, will be prone to sediment build-up.
	4	02/07/05	13:32	Shows accumulation of approximately 1-2 cm (0.4-0.8 in) sand and water in sedimentation chamber.
	5	02/07/05	13:31	View into filter chamber.
	7	03/09/05	13:30	Backwater condition in effluent pipe.

1. Pacific Time

2. cm = centimeters; in = inches

Photo Point #1 02/07/05



Photo Point#2 02/07/05



Photo Point #3 03/09/05



Photo Point #4 02/07/05



Photo Point #5 02/07/05



Photo Point #7 03/09/05



**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #1 Photo Log**

Name: T. Rynders

Site ID	Photo Point ID	Date	Time ¹	Comments ²
Sand Trap #1	1	03/31/05	12:11	Slopes buried under 0.6 m (2 ft) of new snow.
	2	03/22/05	13:15	Heavy March snow in drainage area.
	3	03/31/05	16:10	Highest level of flow observed (about 2 lps in picture). Very clean snowmelt and groundwater seepage are the contributors to this clear runoff.
	4	03/31/05	16:30	Staff gage shows water at high-level mark in sedimentation chamber (at 0.4 m [1.2 ft]).
	5	03/31/05	16:00	Upstream half of filter fabric totally covered with sediment. Flow now reaching downstream end of filter fabric.
	5	03/31/05	16:05	Flow reaching the end of the filter fabric, although it is not backing up to any measurable depth.

1. Pacific Time

2. m = meters; ft = feet; lps = liters per second

Photo Point #1 03/31/05



Photo Point #2 03/22/05



Photo Point #3 03/31/05



Photo Point #4 03/31/05



Photo Point #5 03/31/05



Photo Point #5 03/31/05



**Highway 267 Filter Fabric Sand Trap Pilot Study
Sand Trap #2 Photo Log**

Name: T. Rynders

Site ID	Photo Point ID	Date	Time ¹	Comments ²
Sand Trap #2	1	04/04/05	14:06	Sloughing of slope into infiltration basin beneath sand trap.
	2	03/31/05	11:15	Drainage area illustrating new snowfall and snow covering slopes.
	3	03/31/05	11:45	Influent pipe with a piece of mesh screen blocking bubbler line. Sediment intermittently disrupts flow readings.
	4	03/31/05	15:38	Staff gage shows water level near 0.09 m (0.3 ft) of depth in sedimentation chamber (approximately 10 cm [4 in]). This photo was taken during high flows.
	5	03/31/05	15:37	View into filter chamber. Picture shows that the water has backed up into the dewatering pipe leading into the sedimentation chamber. Water level is 16 cm (6.3 in).
	6	03/31/05	10:36	Silt accumulating in effluent pipe. Intake able to pull it in through the strainer.

1. Pacific Time

2. m = meters; ft = feet; cm = centimeters; in = inches

Photo Point #1 04/04/05



Photo Point #2 03/31/05



Photo Point #3 03/31/05



Photo Point #4 03/31/05



Photo Point #5 03/31/05



Photo Point #6 03/31/05

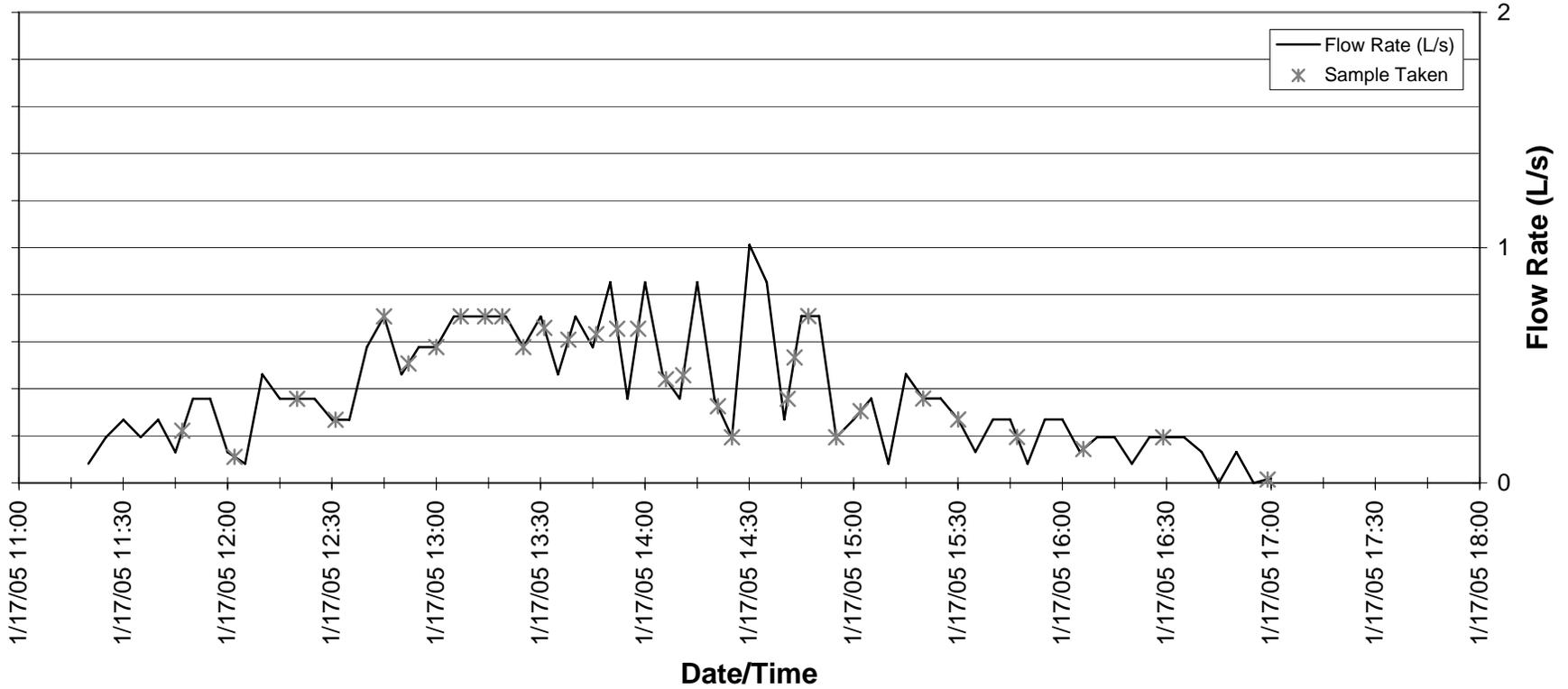


APPENDIX C

Hydrographs

Event Summary

Site: Sand Trap #1 Influent - HWY 267 (3-301)
 Event: 2004-01



Runoff Data

Start Date/Time: 01/17/05 11:20
 Stop Date/Time: 01/17/05 17:00
 Total Flow Volume (L): 7743
 Peak Flow (L/s): 1.01

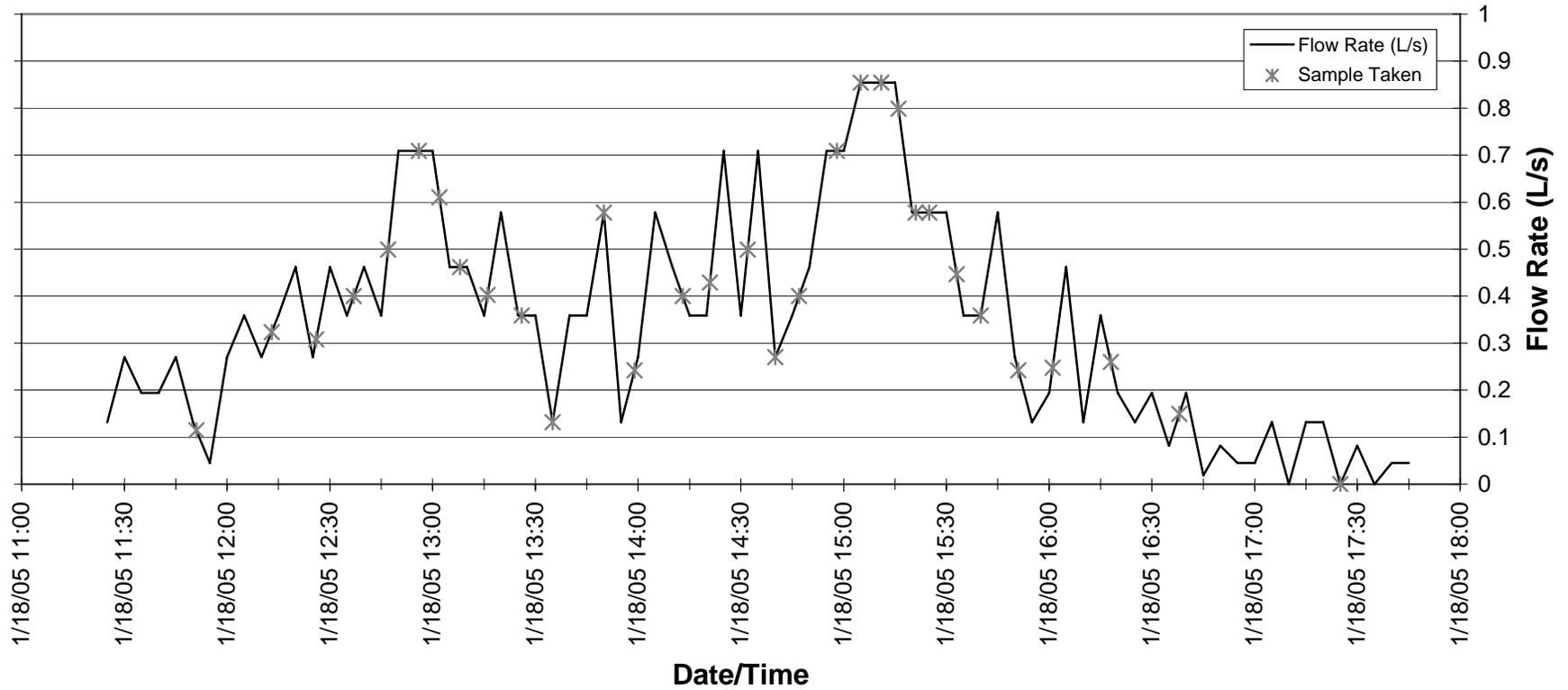
Sample Data

Start Date/Time: 01/17/05 11:20
 Stop Date/Time: 01/17/05 16:59
 Estimated Percent Capture: 100%
 Successful Aliquots: 31

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Influent - HWY 267 (3-301)
 Event: 2004-02



Runoff Data

Start Date/Time: 01/18/05 11:25
 Stop Date/Time: 01/18/05 17:45
 Total Flow Volume (L): 7817
 Peak Flow (L/s): 0.85

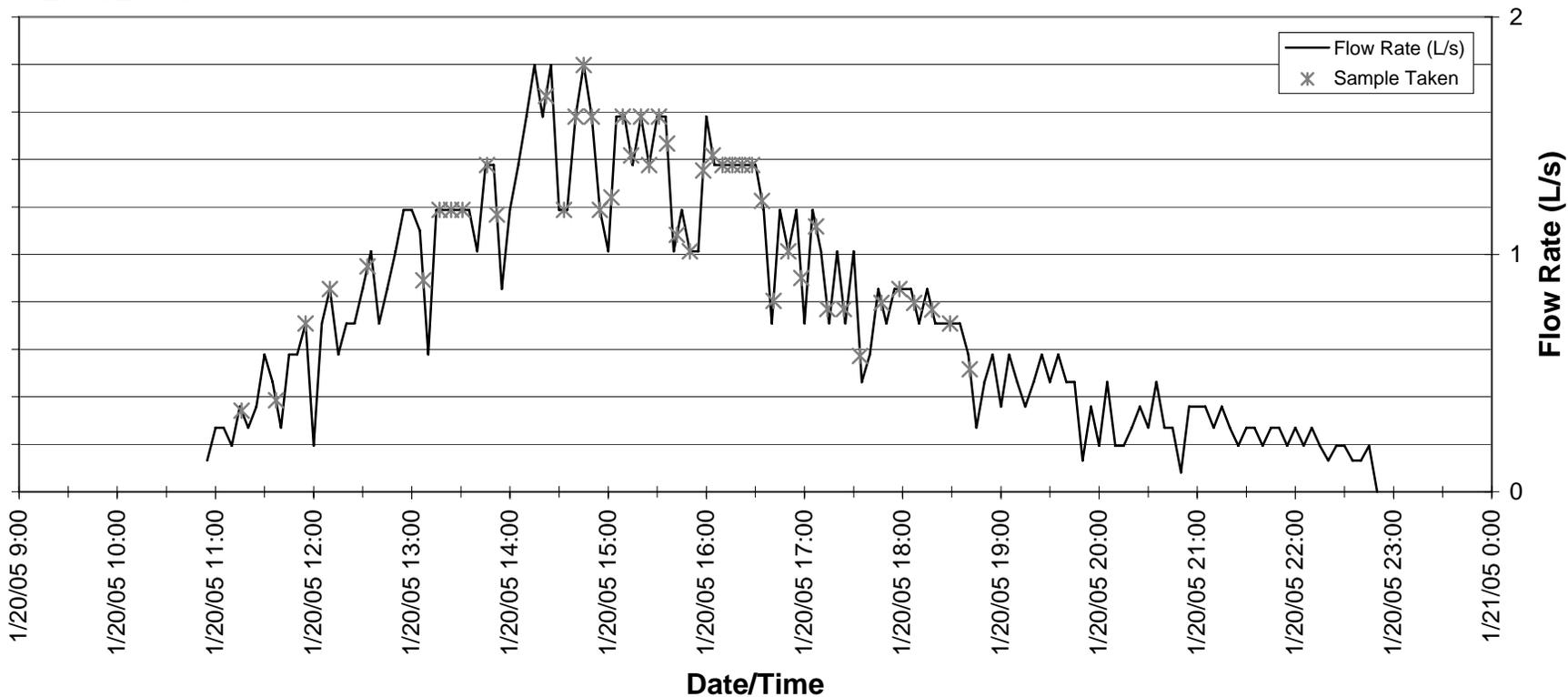
Sample Data

Start Date/Time: 01/18/05 11:25
 Stop Date/Time: 01/18/05 17:25
 Estimated Percent Capture: 99%
 Successful Aliquots: 31

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Influent (3-301)
Event: 2004-03



Runoff Data

Start Date/Time: 01/20/05 10:55
 Stop Date/Time: 01/20/05 22:50
 Total Flow Volume (L): 32472
 Peak Flow (L/s): 1.80

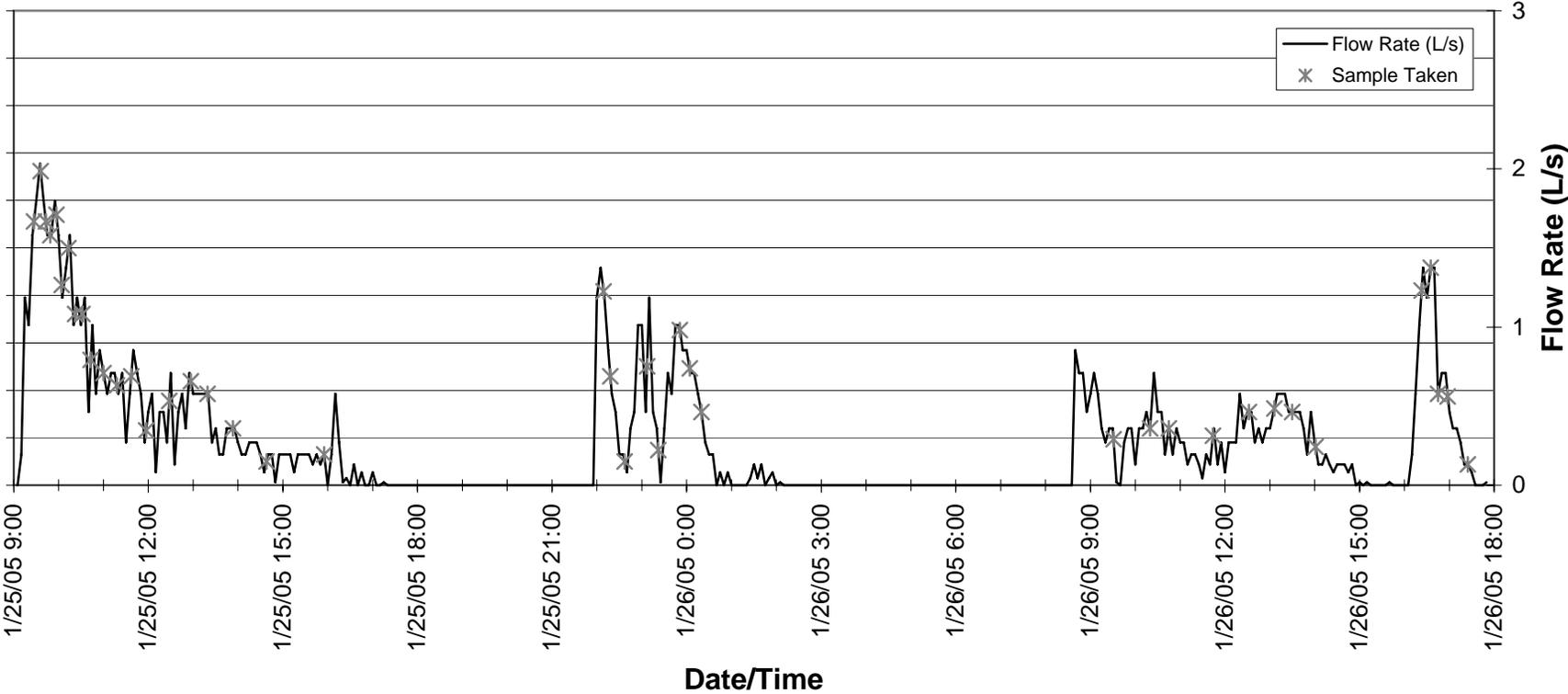
Sample Data

Start Date/Time: 01/20/05 10:55
 Stop Date/Time: 01/20/05 18:41
 Estimated Percent Capture: 71%
 Successful Aliquots: 46

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Influent - HWY 267 (3-301)
 Event: 2004-04



Runoff Data

Start Date/Time: 01/25/05 09:05
 Stop Date/Time: 01/26/05 17:50
 Total Flow Volume (L): 32155
 Peak Flow (L/s): 2.03

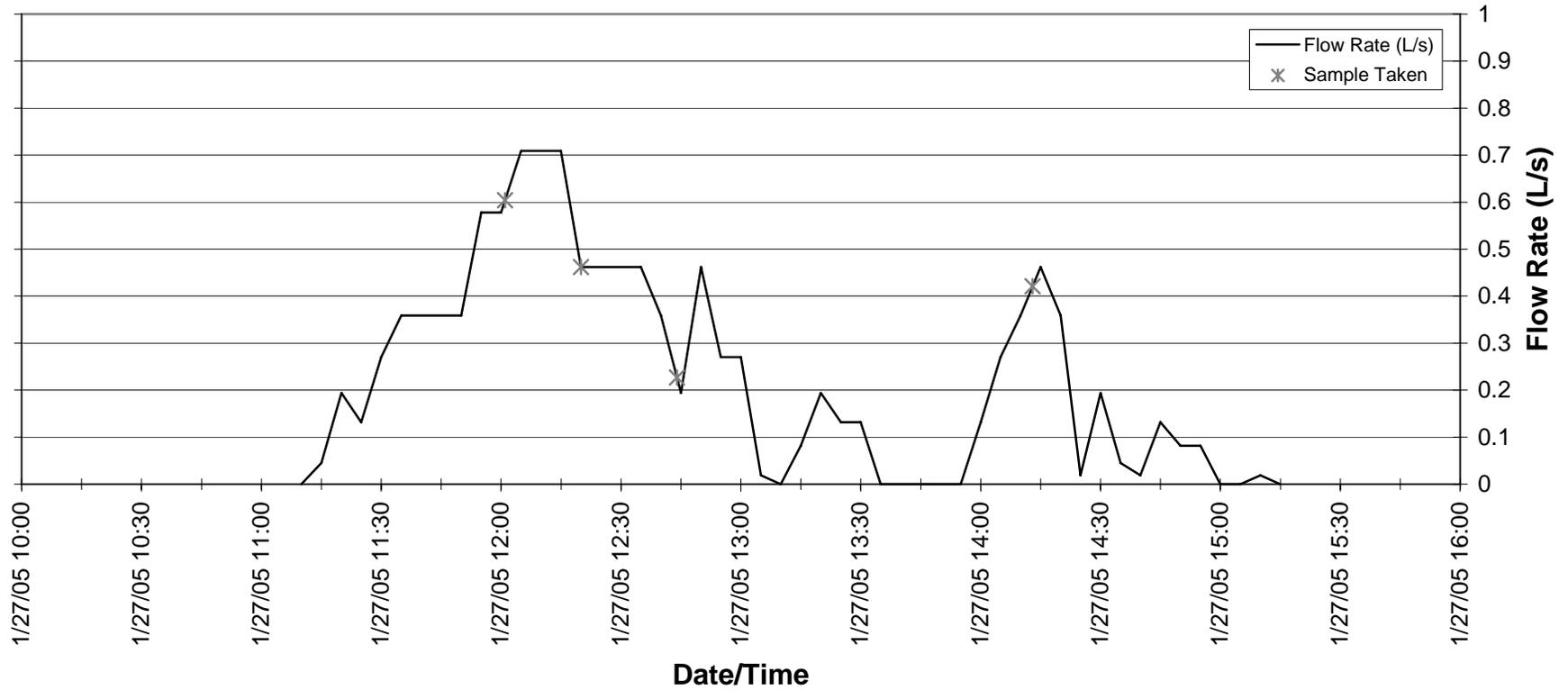
Sample Data

Start Date/Time: 01/25/05 09:05
 Stop Date/Time: 01/26/05 17:25
 Estimated Percent Capture: 97%
 Successful Aliquots: 41

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #1 Influent - HWY 267 (3-301)
Event: 2004-05



Runoff Data

Start Date/Time: 01/27/05 11:10
 Stop Date/Time: 01/27/05 15:15
 Total Flow Volume (L): 3449
 Peak Flow (L/s): 0.71

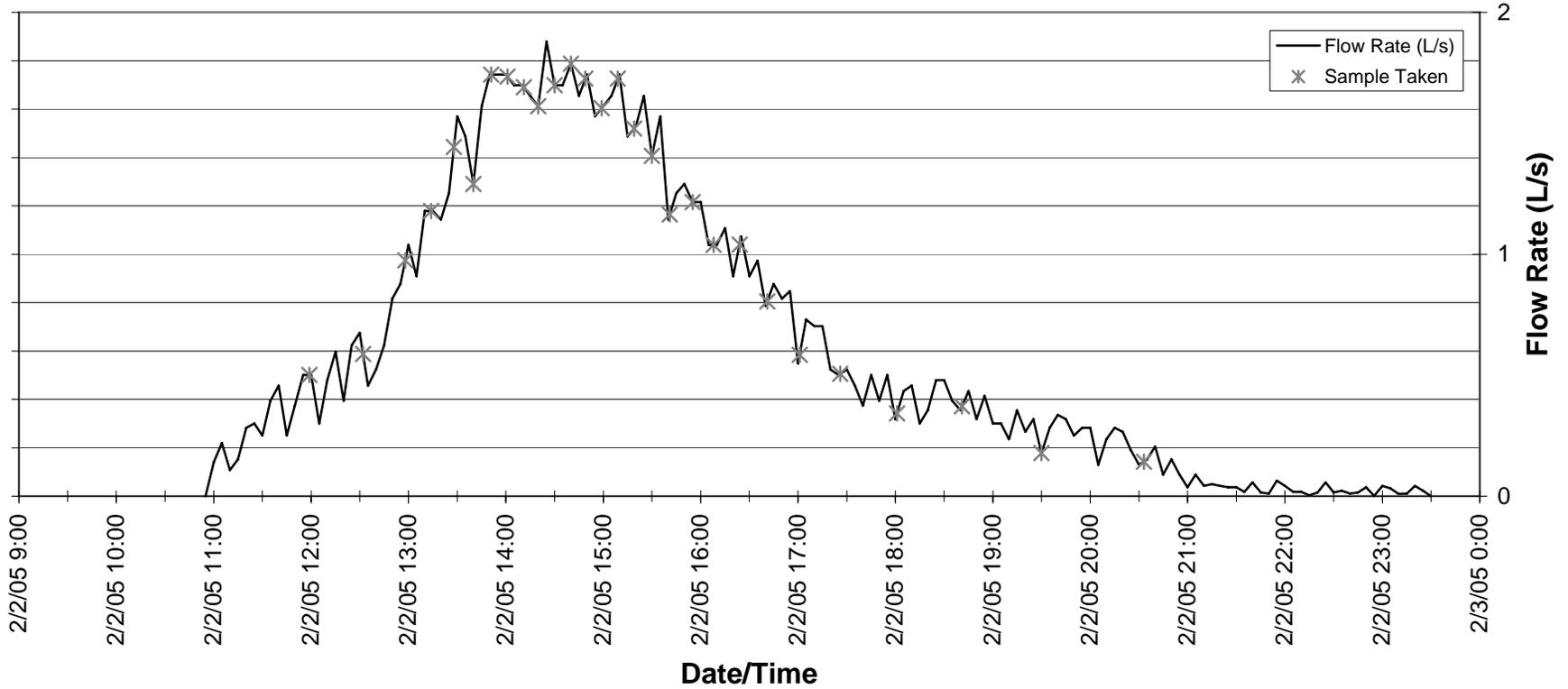
Sample Data

Start Date/Time: 01/27/05 11:10
 Stop Date/Time: 01/27/05 14:13
 Estimated Percent Capture: 88%
 Successful Aliquots: 4

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Influent - HWY 267 (3-301)
 Event: 2004-06



Runoff Data

Start Date/Time: 02/02/05 10:55
 Stop Date/Time: 02/02/05 23:30
 Total Flow Volume (L): 28132
 Peak Flow (L/s): 1.88

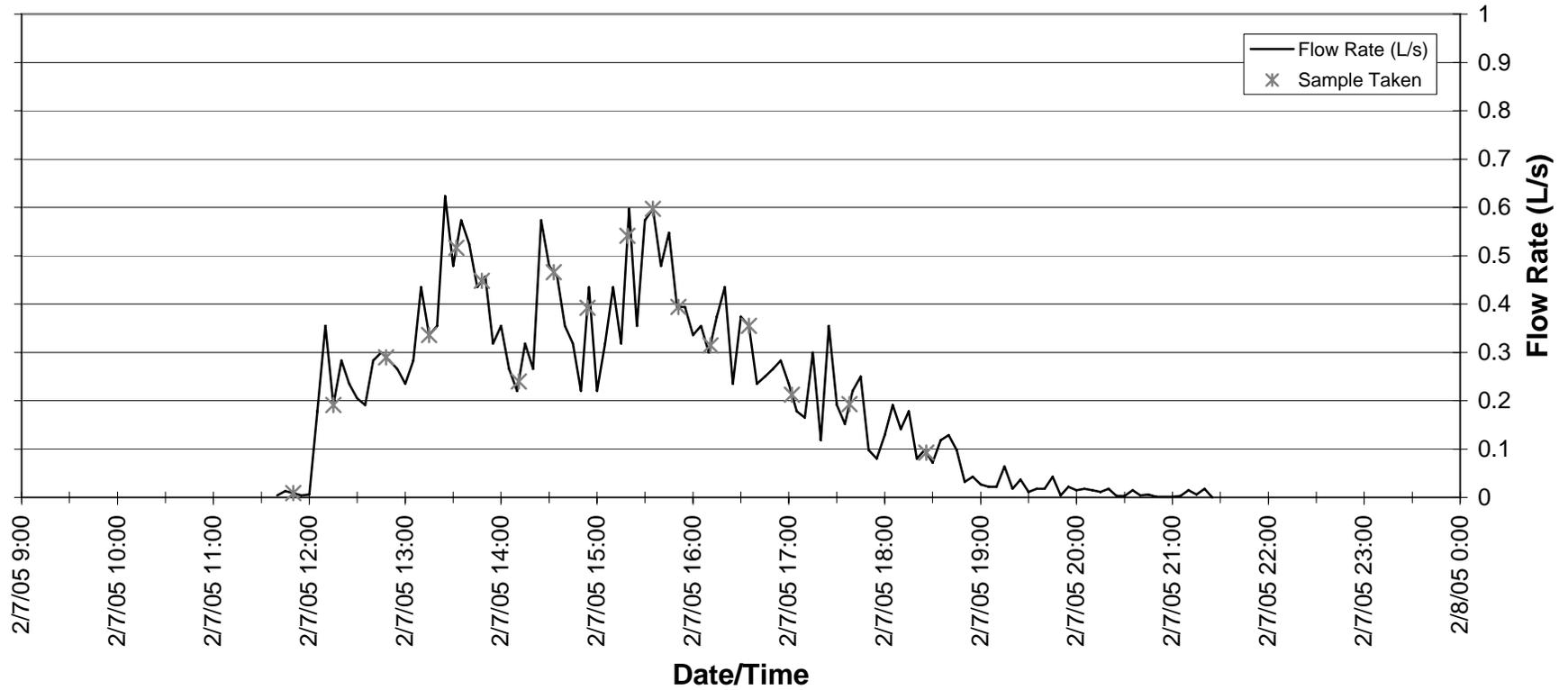
Sample Data

Start Date/Time: 02/02/05 10:55
 Stop Date/Time: 02/02/05 20:33
 Estimated Percent Capture: 98%
 Successful Aliquots: 28

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Influent - HWY 267 (3-301)
 Event: 2004-07



Runoff Data

Start Date/Time: 02/07/05 11:40
 Stop Date/Time: 02/07/05 21:25
 Total Flow Volume (L): 7577
 Peak Flow (L/s): 0.62

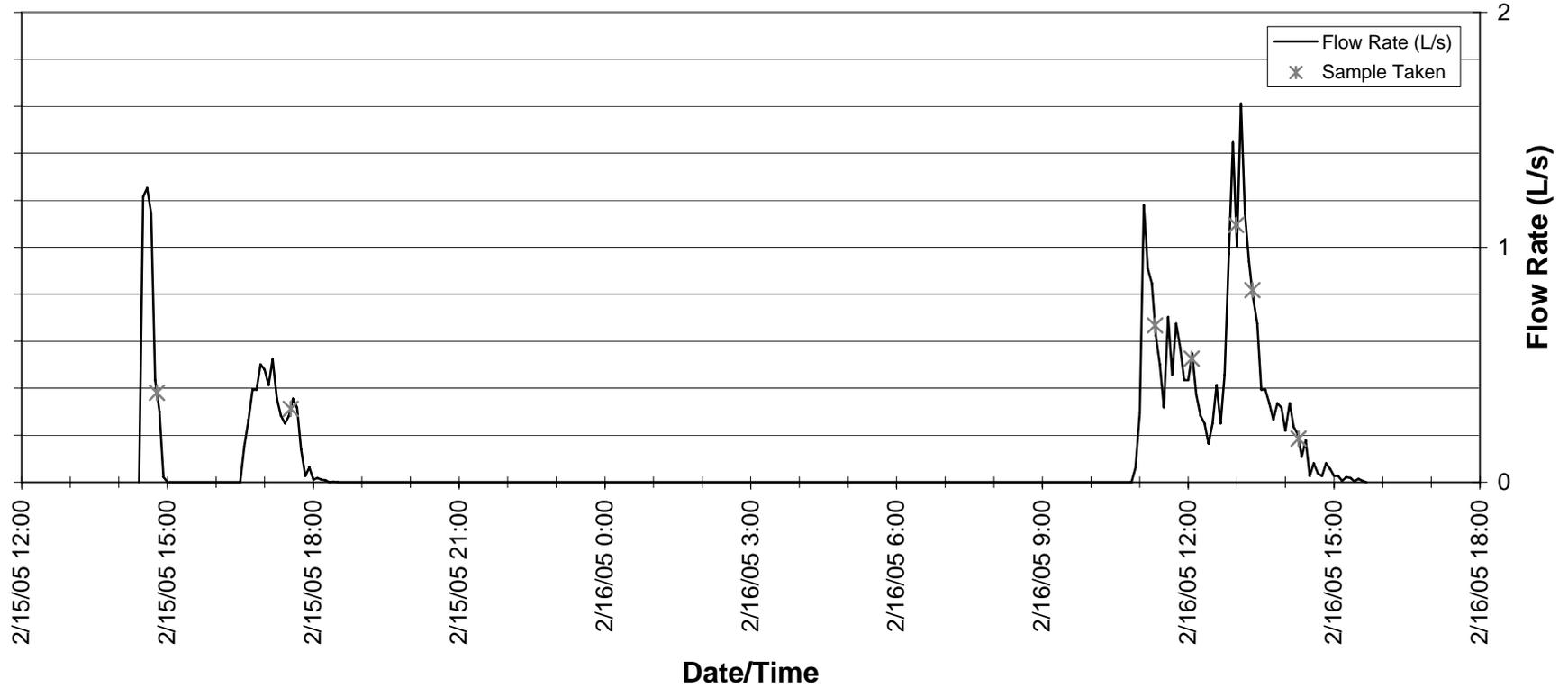
Sample Data

Start Date/Time: 02/07/05 11:40
 Stop Date/Time: 02/07/05 18:26
 Estimated Percent Capture: 96%
 Successful Aliquots: 17

Note Storm-Snowmelt Event.

Event Summary

Site: Sand Trap #1 Influent - HWY 267 (3-301)
 Event: 2004-08



Runoff Data

Start Date/Time:	02/15/05 14:25
Stop Date/Time:	02/16/05 15:40
Total Flow Volume (L):	9889
Peak Flow (L/s):	1.61

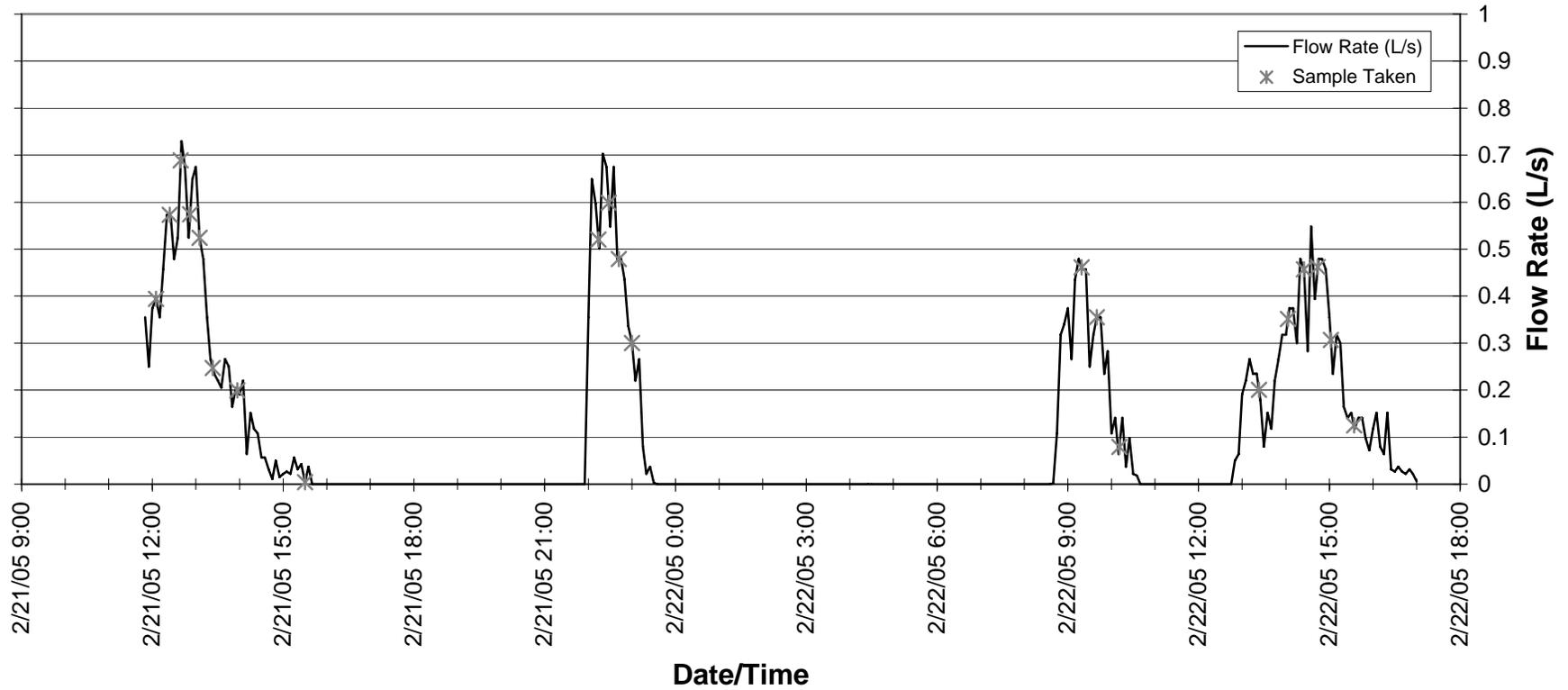
Sample Data

Start Date/Time:	02/15/05 14:25
Stop Date/Time:	02/16/05 14:16
Estimated Percent Capture:	98%
Successful Aliquots:	7

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #1 Influent - HWY 267 (3-301)
Event: 2004-09



Runoff Data

Start Date/Time: 02/21/05 11:50
Stop Date/Time: 02/22/05 17:00
Total Flow Volume (L): 10638
Peak Flow (L/s): 0.73

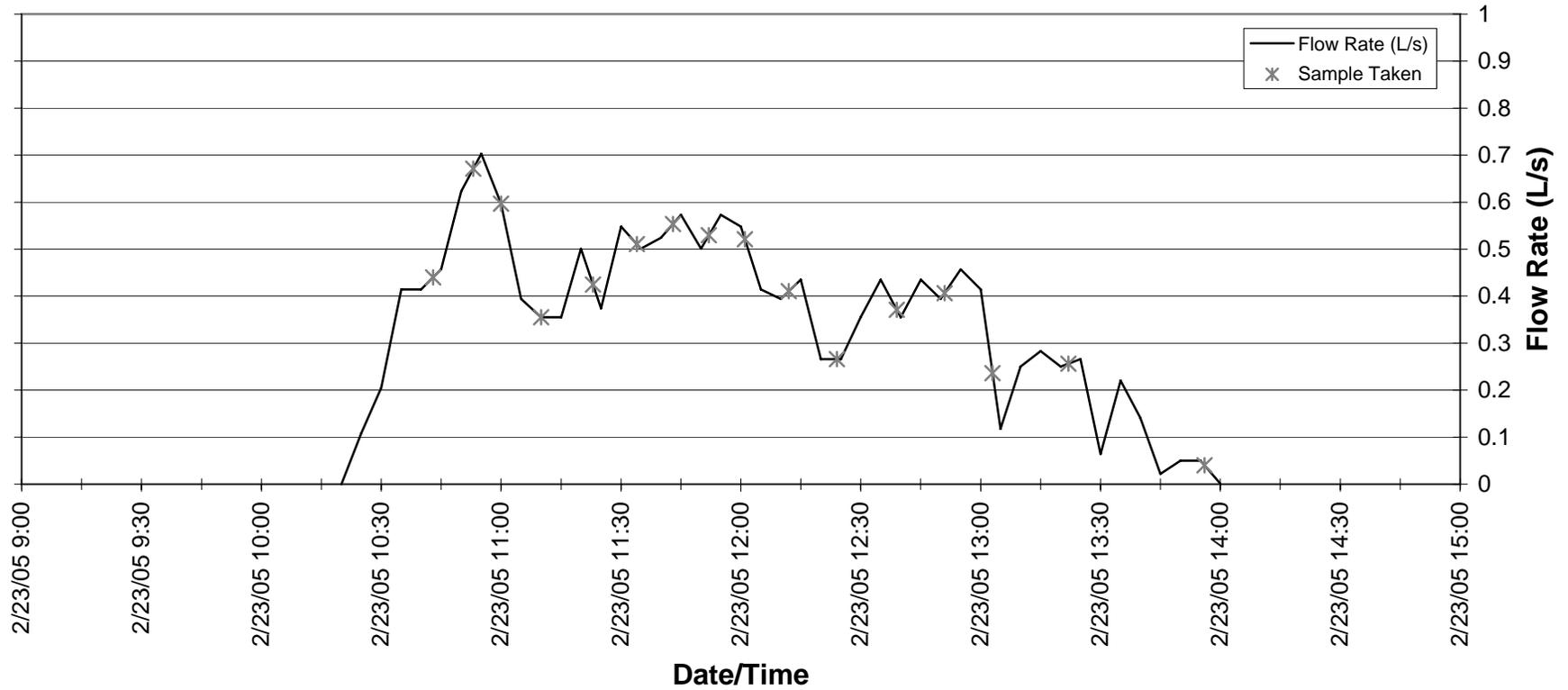
Sample Data

Start Date/Time: 02/21/05 11:50
Stop Date/Time: 02/22/05 15:34
Estimated Percent Capture: 96%
Successful Aliquots: 21

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #1 Influent - HWY 267 (3-301)
Event: 2004-10



Runoff Data

Start Date/Time: 02/23/05 10:20
 Stop Date/Time: 02/23/05 14:00
 Total Flow Volume (L): 4681
 Peak Flow (L/s): 0.70

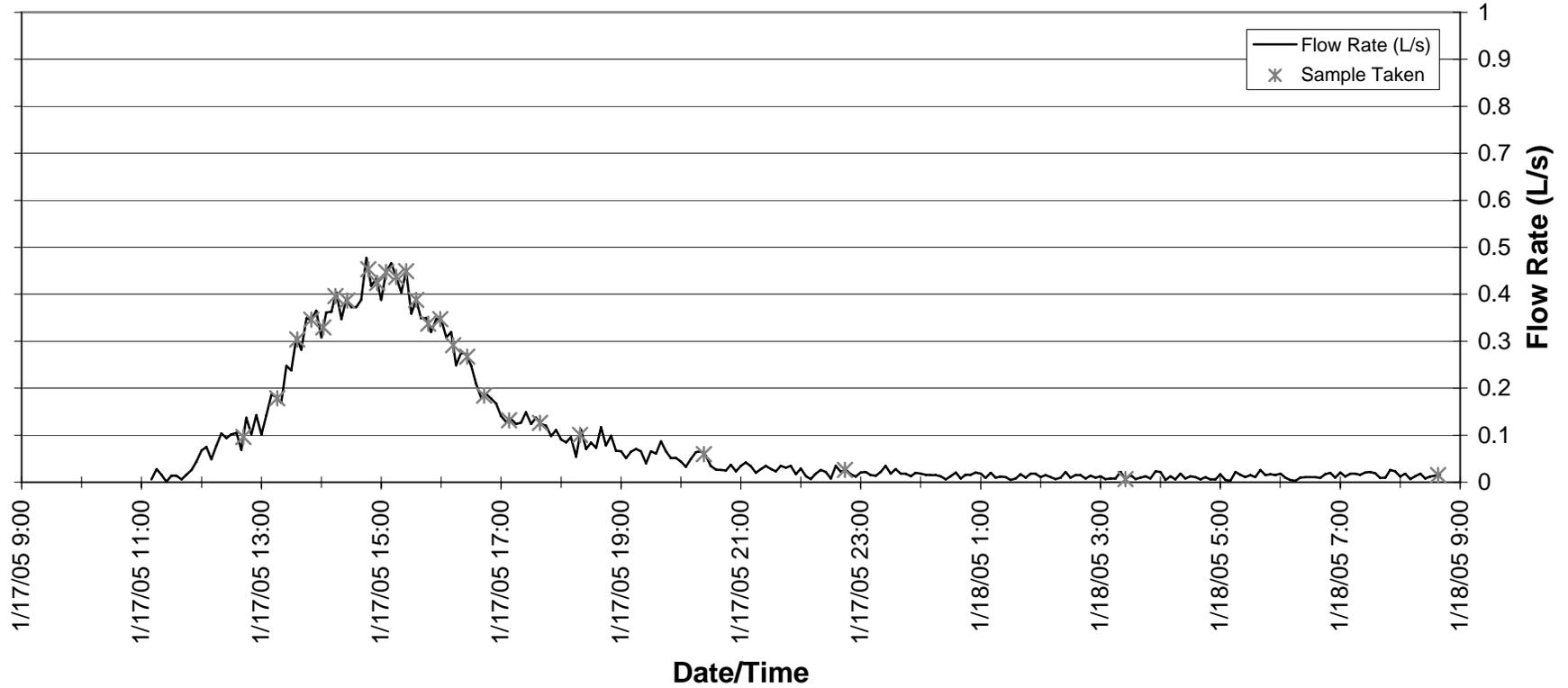
Sample Data

Start Date/Time: 02/23/05 10:20
 Stop Date/Time: 02/23/05 13:56
 Estimated Percent Capture: 100%
 Successful Aliquots: 16

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
 Event: 2004-01



Runoff Data

Start Date/Time: 01/17/05 11:10
 Stop Date/Time: 01/18/05 08:40
 Total Flow Volume (L): 6745
 Peak Flow (L/s): 0.48

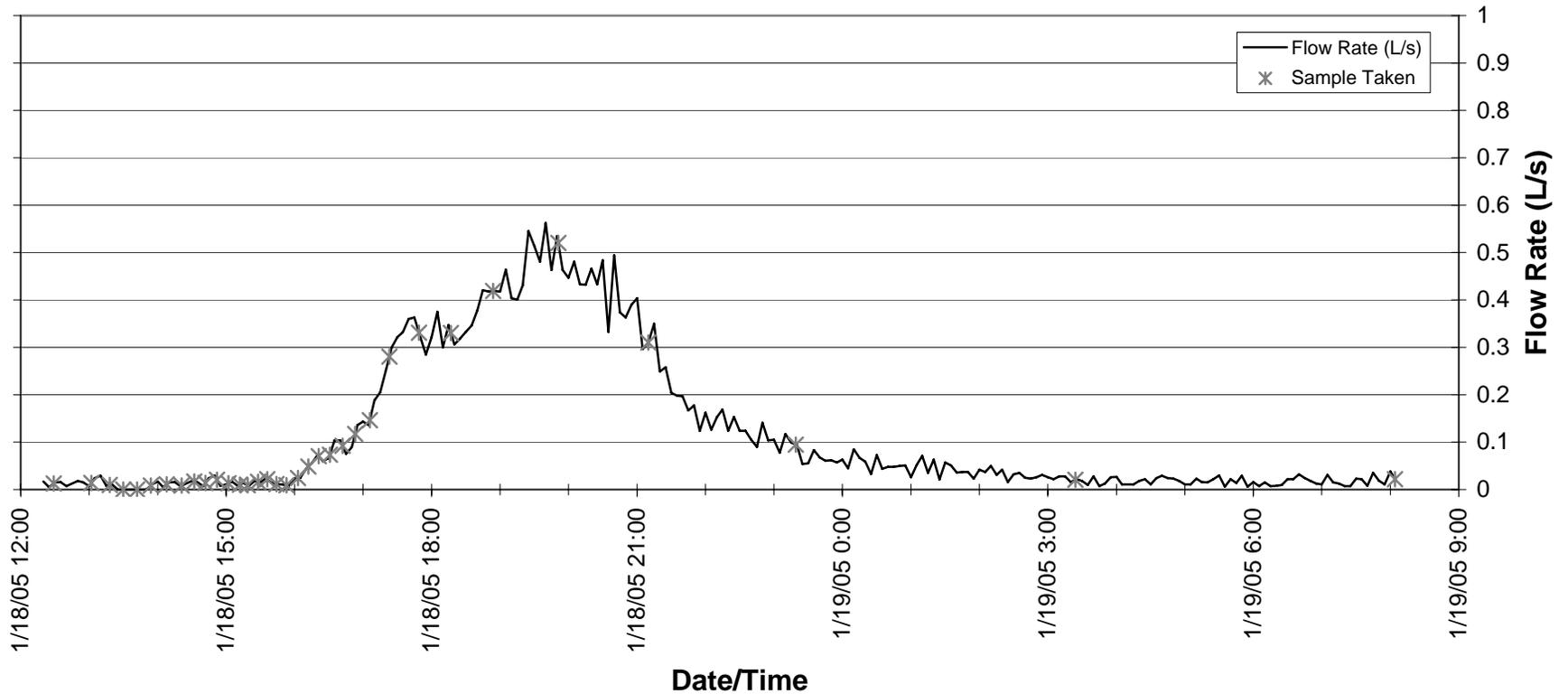
Sample Data

Start Date/Time: 01/17/05 11:10
 Stop Date/Time: 01/18/05 08:38
 Estimated Percent Capture: 96%
 Successful Aliquots: 25

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
 Event: 2004-02



Runoff Data

Start Date/Time: 01/18/05 12:20
 Stop Date/Time: 01/19/05 08:05
 Total Flow Volume (L): 8342
 Peak Flow (L/s): 0.56

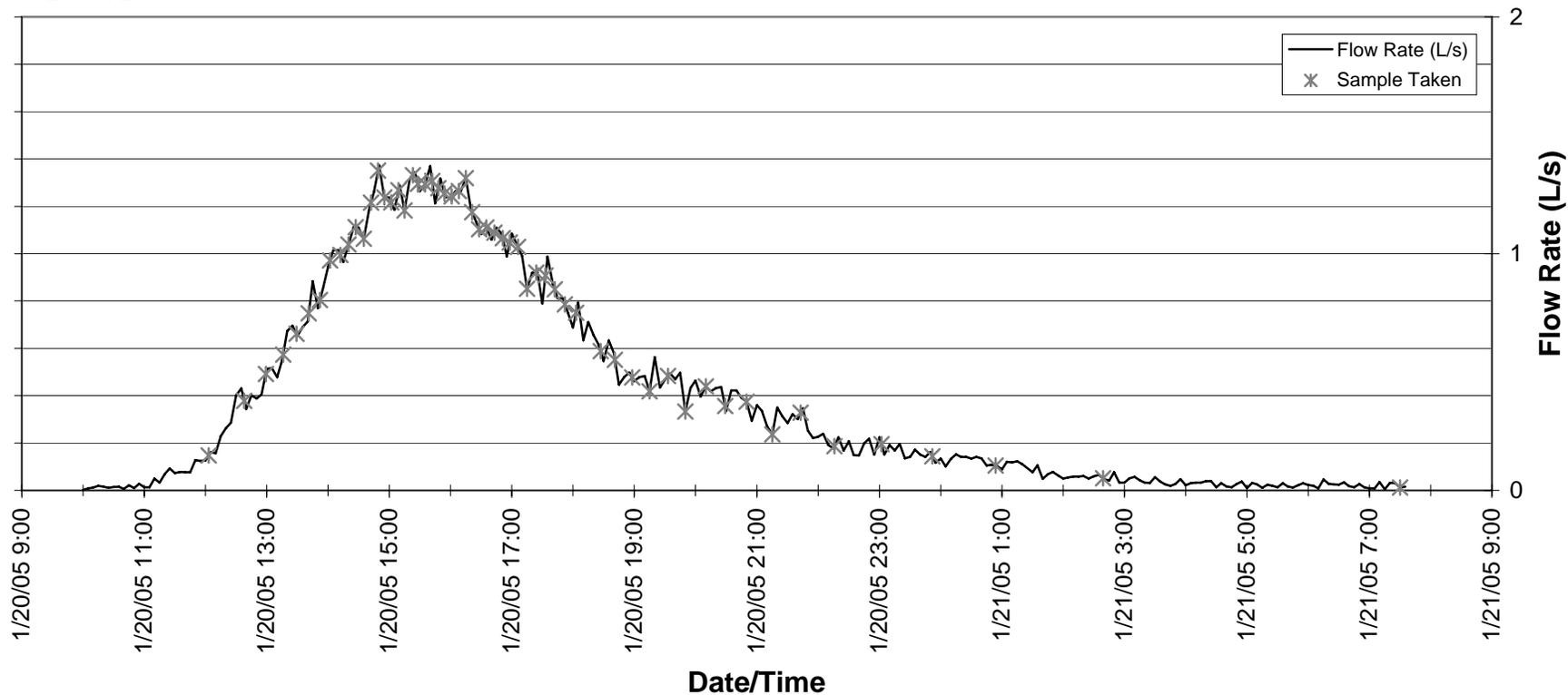
Sample Data

Start Date/Time: 01/18/05 12:20
 Stop Date/Time: 01/19/05 08:04
 Estimated Percent Capture: 100%
 Successful Aliquots: 34

Note Snowmelt Event. Flow readings before 13:25 on January 18, 2005 are estimated due to erroneous flow meter measurements.

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
 Event: 2004-03



Runoff Data

Start Date/Time: 01/20/05 10:00
 Stop Date/Time: 01/21/05 07:35
 Total Flow Volume (L): 28818
 Peak Flow (L/s): 1.37

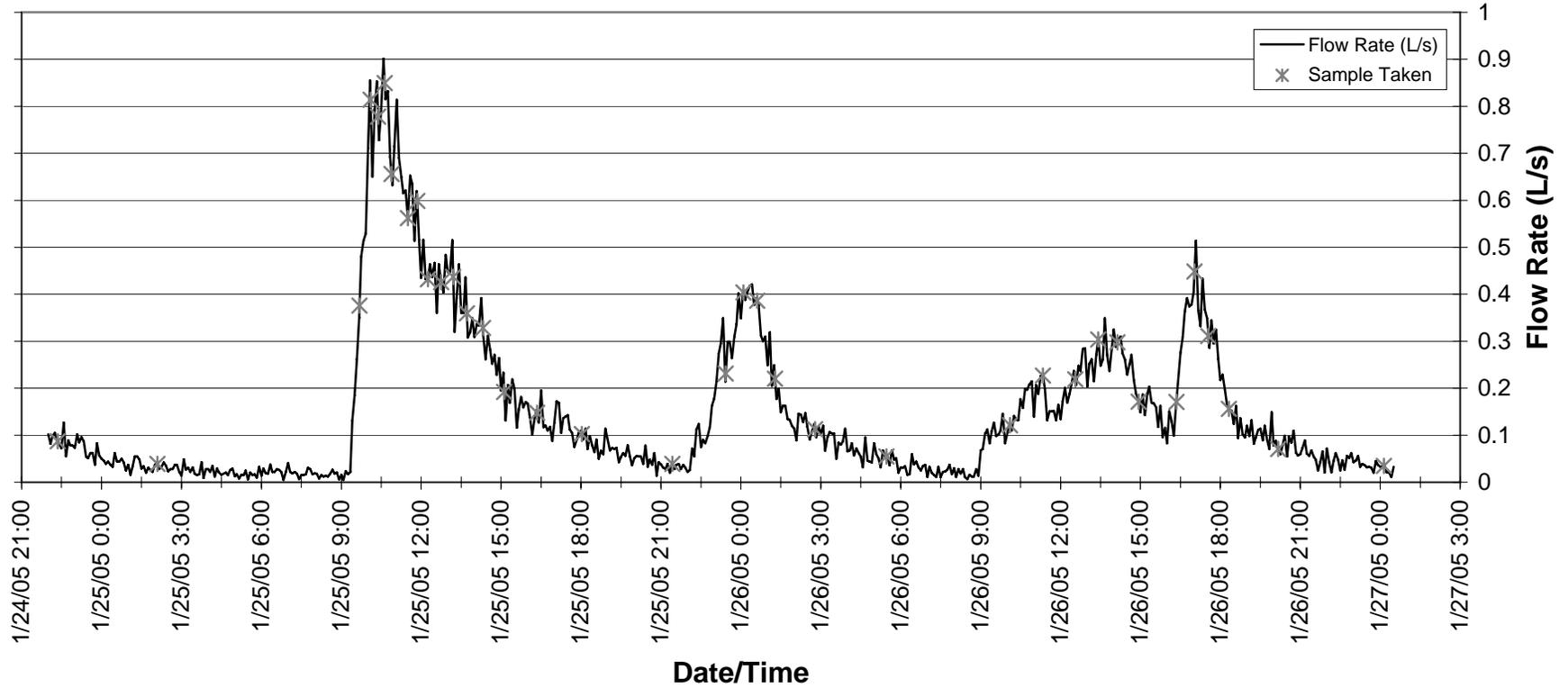
Sample Data

Start Date/Time: 01/20/05 10:00
 Stop Date/Time: 01/21/05 07:30
 Estimated Percent Capture: 98%
 Successful Aliquots: 57

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
 Event: 2004-04



Runoff Data

Start Date/Time: 01/24/05 22:00
 Stop Date/Time: 01/27/05 00:30
 Total Flow Volume (L): 27138
 Peak Flow (L/s): 0.90

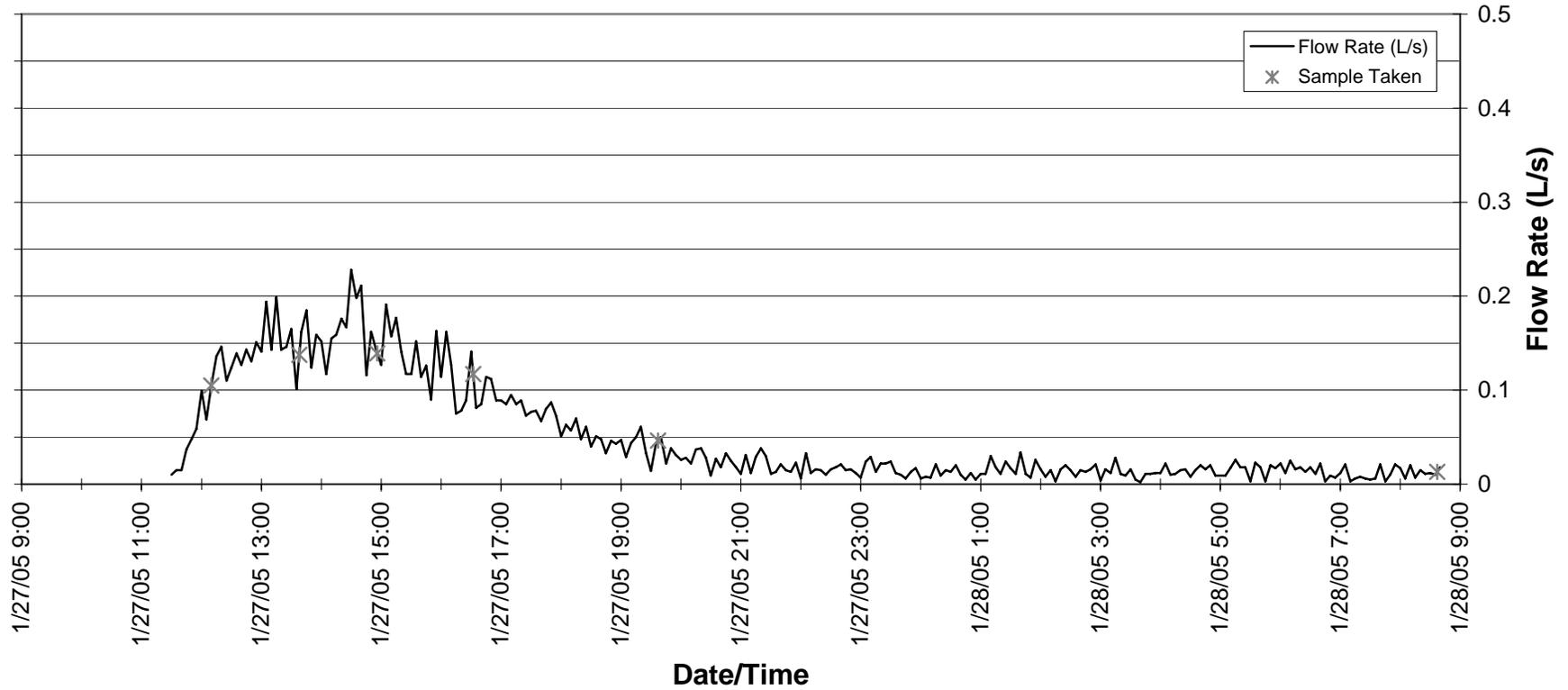
Sample Data

Start Date/Time: 01/24/05 22:00
 Stop Date/Time: 01/27/05 00:08
 Estimated Percent Capture: 97%
 Successful Aliquots: 36

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
 Event: 2004-05



Runoff Data

Start Date/Time: 01/27/05 11:30
 Stop Date/Time: 01/28/05 08:40
 Total Flow Volume (L): 3854
 Peak Flow (L/s): 0.23

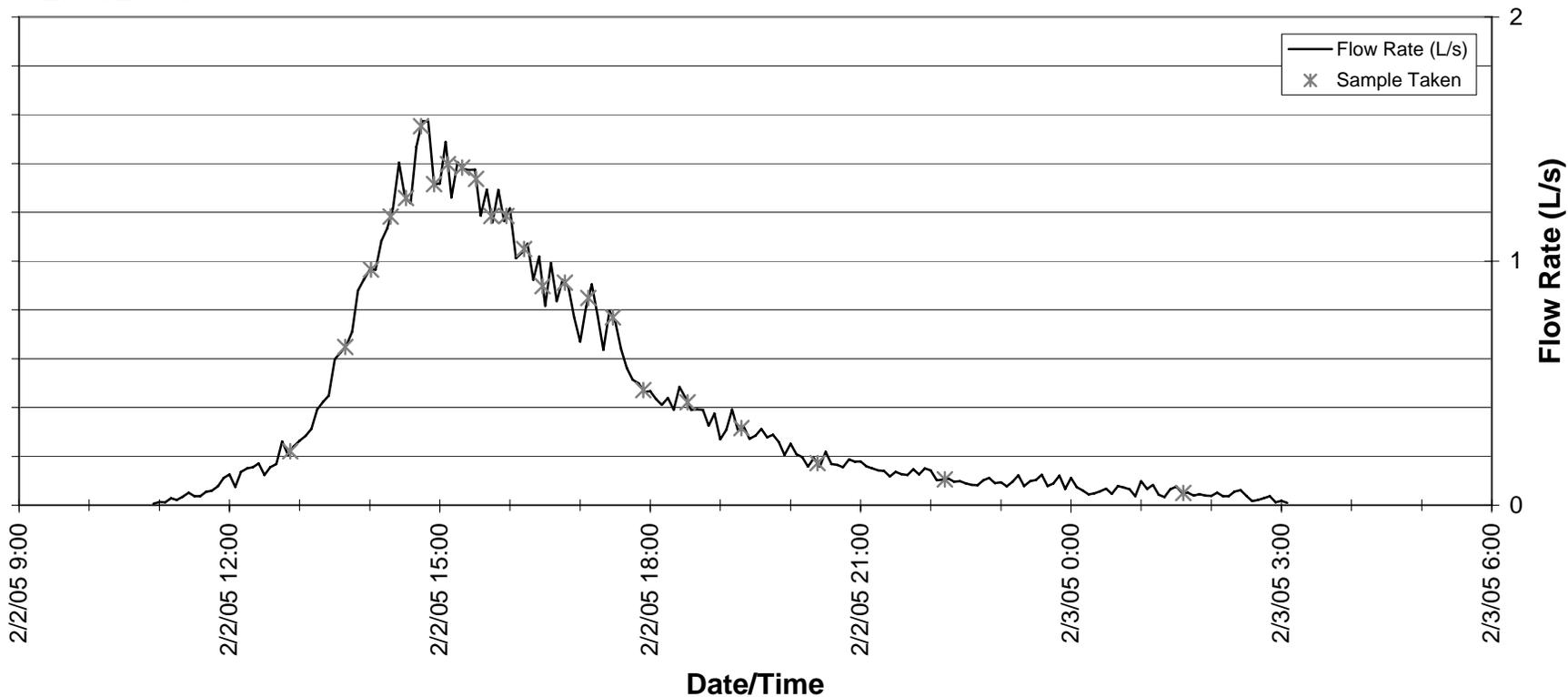
Sample Data

Start Date/Time: 01/27/05 11:30
 Stop Date/Time: 01/28/05 08:37
 Estimated Percent Capture: 100%
 Successful Aliquots: 6

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
 Event: 2004-06



Runoff Data

Start Date/Time: 02/02/05 10:55
 Stop Date/Time: 02/03/05 03:05
 Total Flow Volume (L): 22823
 Peak Flow (L/s): 1.57

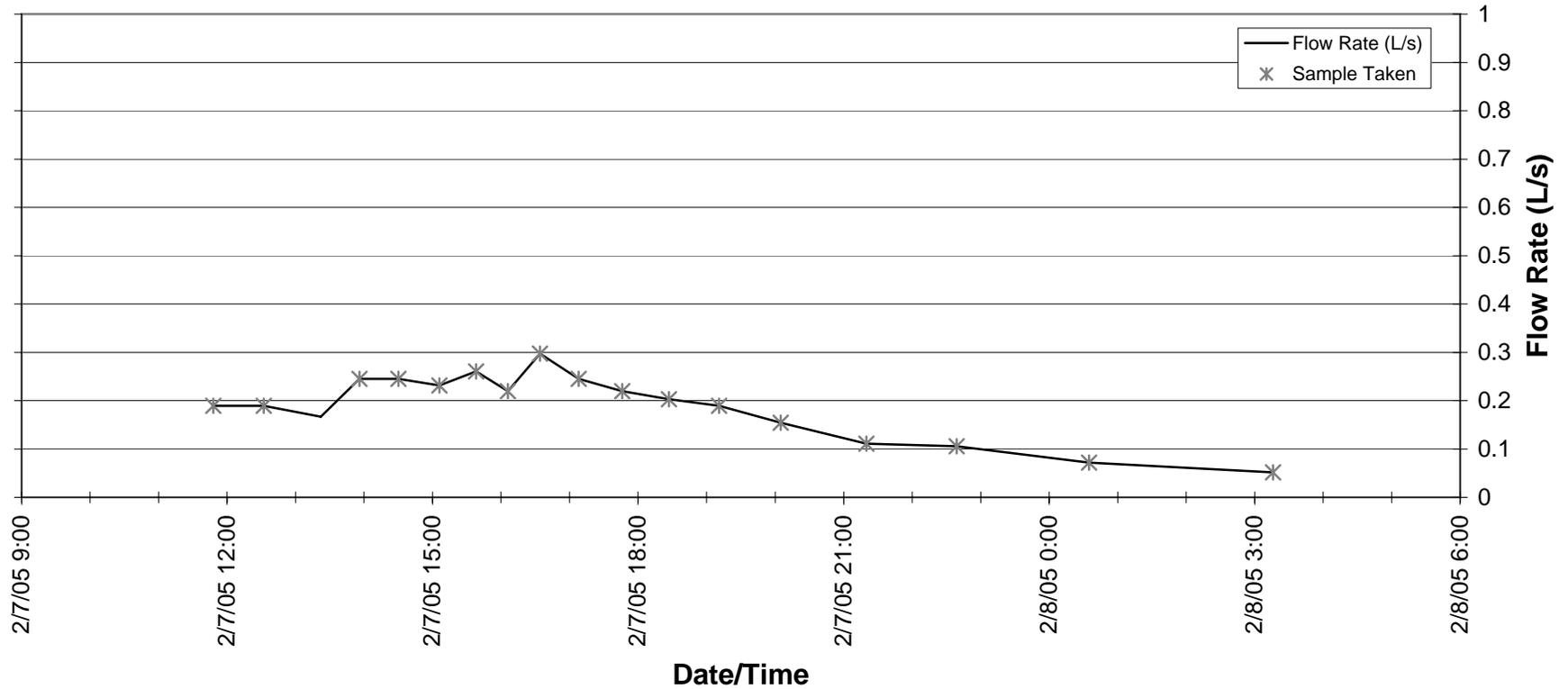
Sample Data

Start Date/Time: 02/02/05 10:55
 Stop Date/Time: 02/03/05 01:36
 Estimated Percent Capture: 99%
 Successful Aliquots: 23

Note Snowmelt Event

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
Event: 2004-07



Runoff Data

Start Date/Time: 02/07/05 11:48
Stop Date/Time: 02/08/05 03:16
Total Flow Volume (L): 8781
Peak Flow (L/s): 0.30

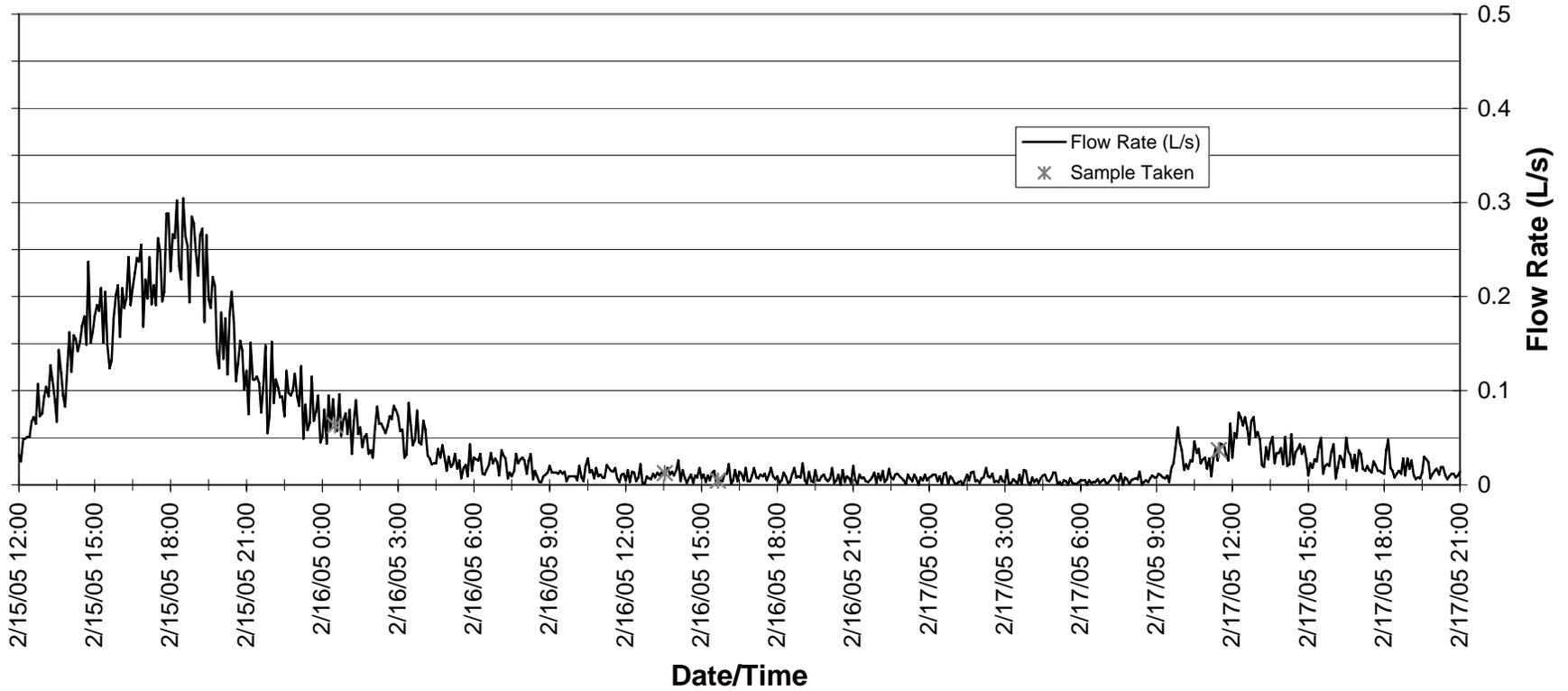
Sample Data

Start Date/Time: 02/07/05 11:48
Stop Date/Time: 02/08/05 03:16
Estimated Percent Capture: 94%
Successful Aliquots: 17

Note Storm-Snowmelt Event. The equipment appeared to be functioning normally, but flow data could not be down-loaded. Flow is estimated based on total flow recorded in the field and sample time.

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
 Event: 2004-08



Runoff Data

Start Date/Time: 02/15/05 12:00
 Stop Date/Time: 02/17/05 21:00
 Total Flow Volume (L): 9835
 Peak Flow (L/s): 0.30

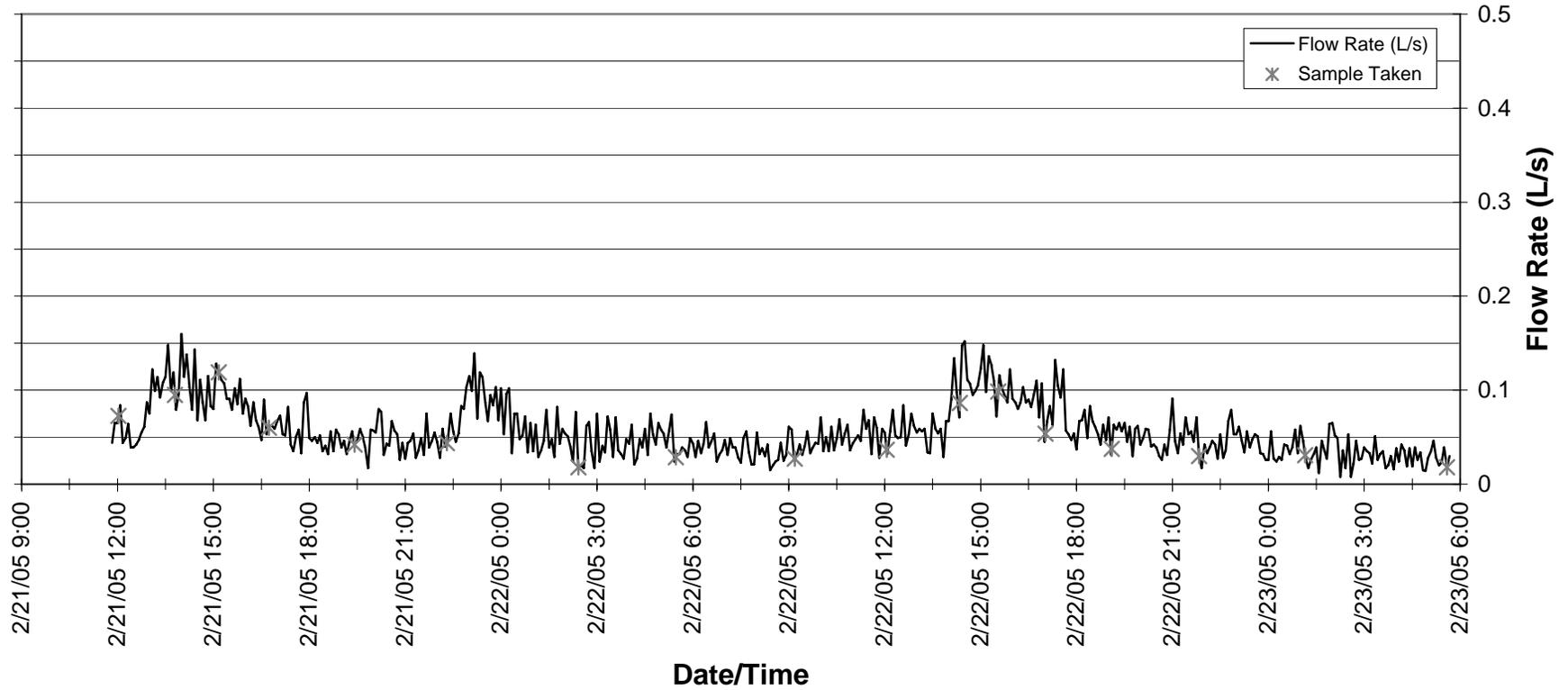
Sample Data

Start Date/Time: 02/15/05 12:00
 Stop Date/Time: 02/17/05 11:28
 Estimated Percent Capture: 90%
 Successful Aliquots: 4

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
Event: 2004-09



Runoff Data

Start Date/Time: 02/21/05 11:50
Stop Date/Time: 02/23/05 05:40
Total Flow Volume (L): 8545
Peak Flow (L/s): 0.16

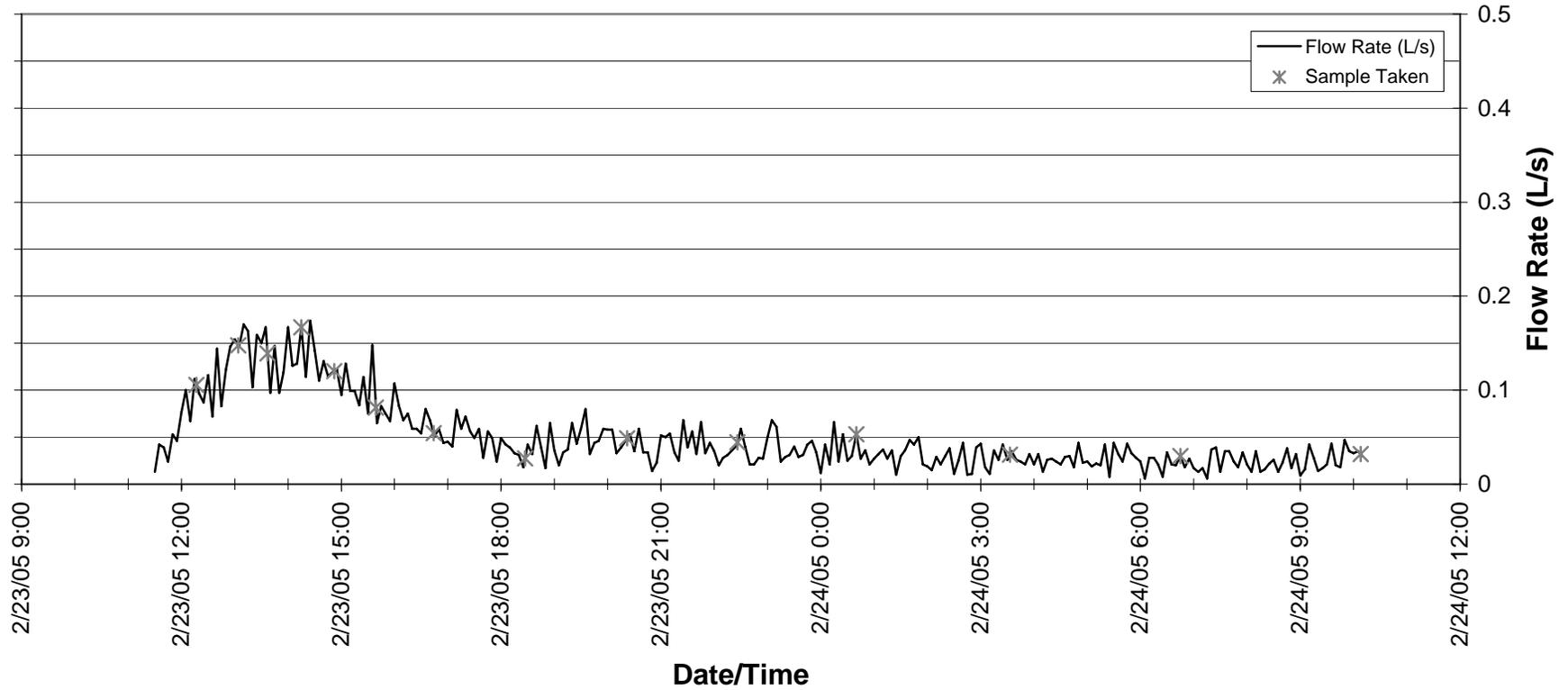
Sample Data

Start Date/Time: 02/21/05 11:50
Stop Date/Time: 02/23/05 05:35
Estimated Percent Capture: 94%
Successful Aliquots: 17

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #1 Effluent - HWY 267 (3-302)
 Event: 2004-10



Runoff Data

Start Date/Time: 02/23/05 11:30
 Stop Date/Time: 02/24/05 10:10
 Total Flow Volume (L): 4053
 Peak Flow (L/s): 0.17

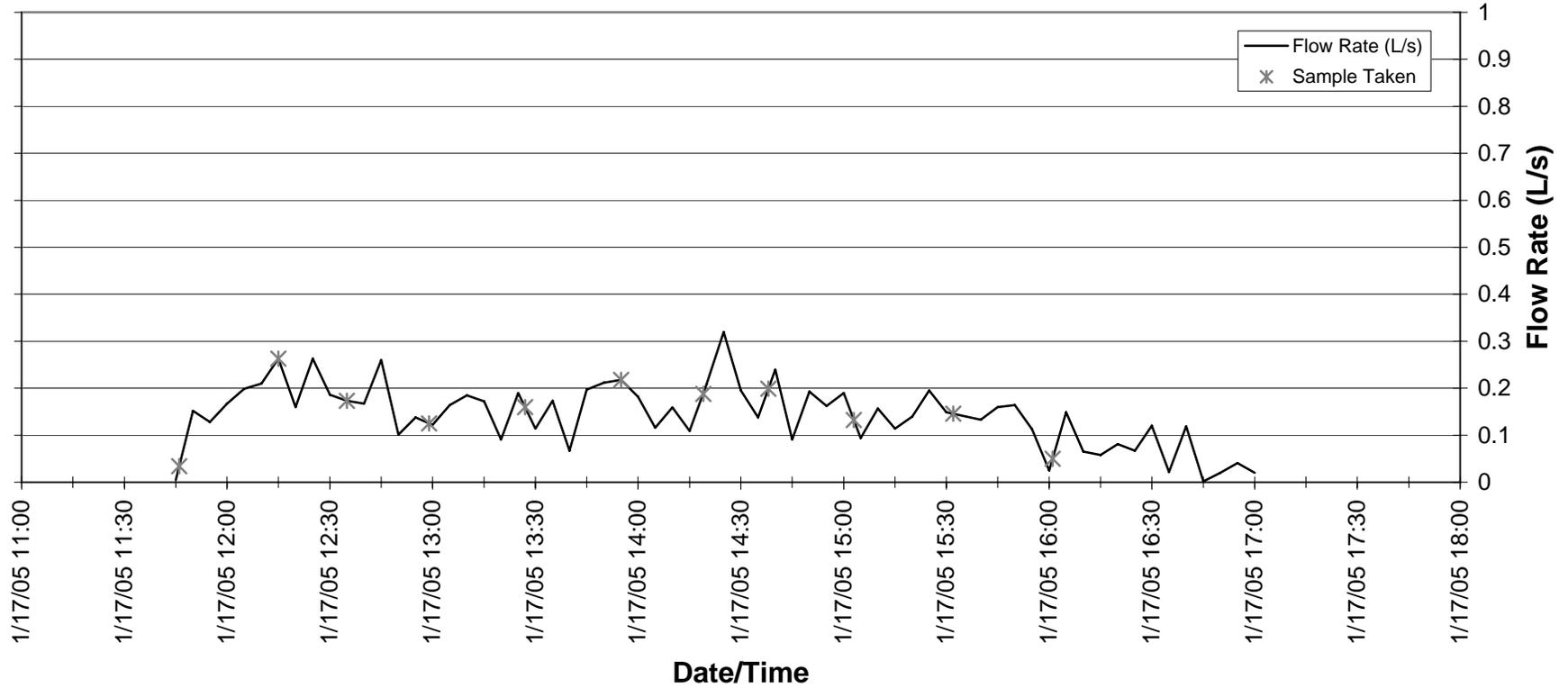
Sample Data

Start Date/Time: 02/23/05 11:30
 Stop Date/Time: 02/24/05 10:08
 Estimated Percent Capture: 100%
 Successful Aliquots: 14

Note Snowmelt Event

Event Summary

Site: Sand Trap #2 Influent - HWY 267 (3-304)
 Event: 2004-01



Runoff Data

Start Date/Time: 01/17/05 11:45
 Stop Date/Time: 01/17/05 17:00
 Total Flow Volume (L): 2735
 Peak Flow (L/s): 0.32

Sample Data

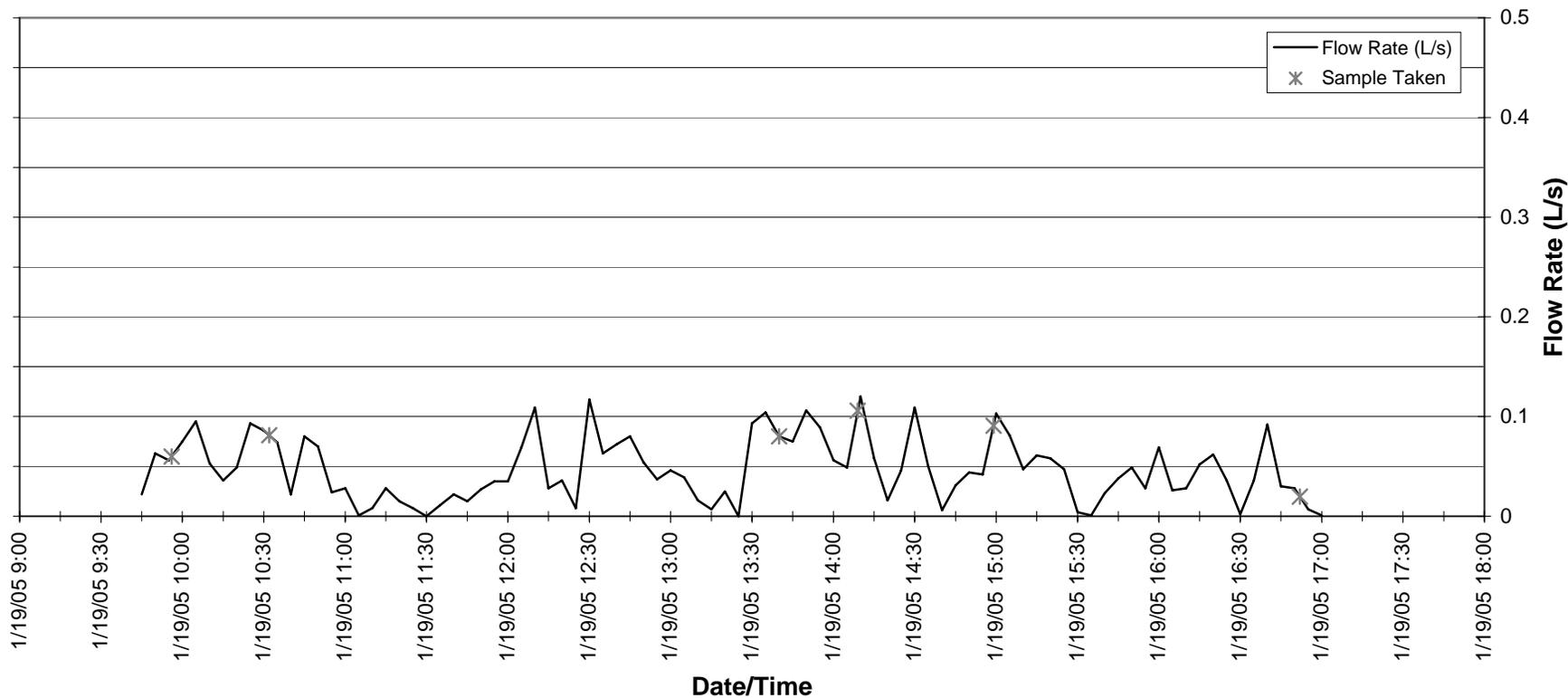
Start Date/Time: 01/17/05 11:45
 Stop Date/Time: 01/17/05 16:01
 Estimated Percent Capture: 92%
 Successful Aliquots: 11

Note Snowmelt Event

Event Summary

Site: Sand Trap #2 Influent - HWY 267 (3-304)

Event: 2004-02



Runoff Data

Start Date/Time: 01/19/05 09:45
 Stop Date/Time: 01/19/05 17:00
 Total Flow Volume (L): 1233
 Peak Flow (L/s): 0.12

Sample Data

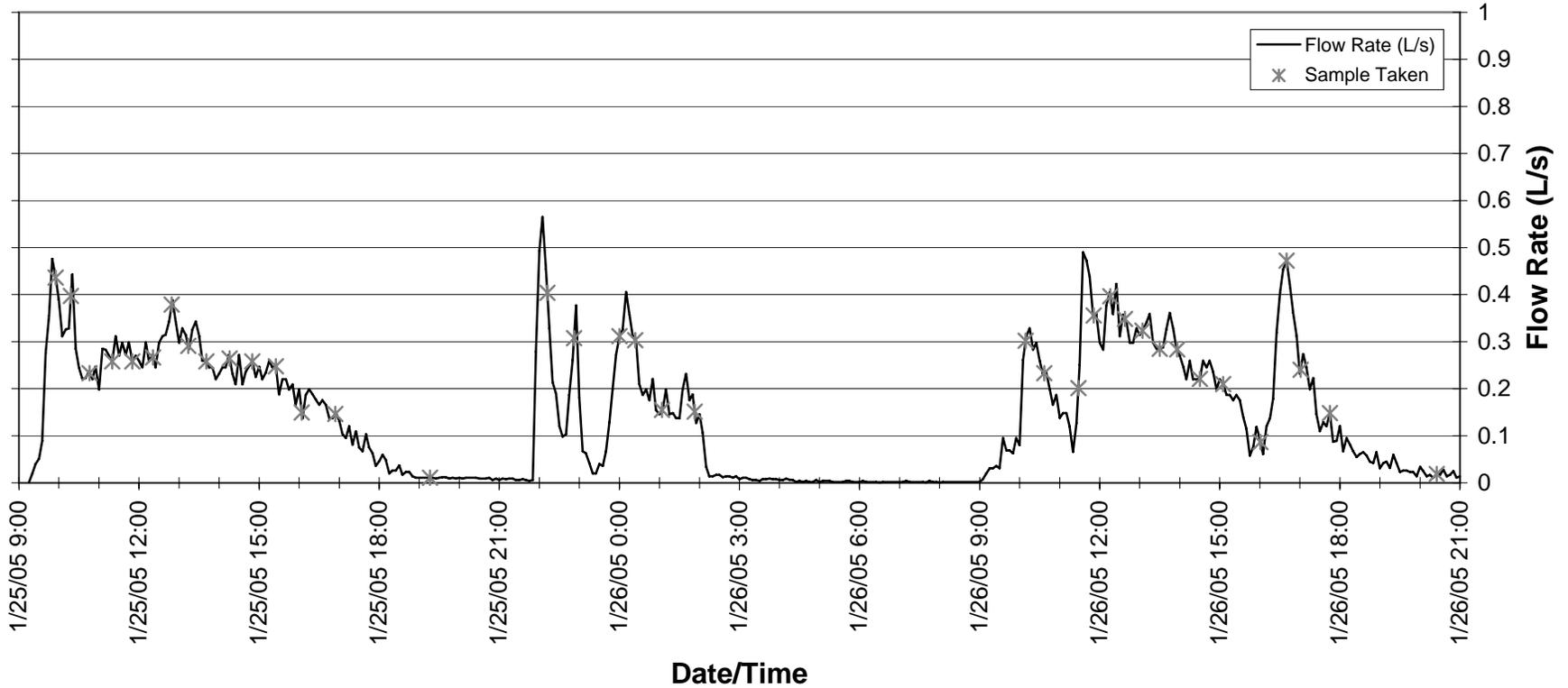
Start Date/Time: 01/19/05 09:45
 Stop Date/Time: 01/19/05 16:52
 Estimated Percent Capture: 67%
 Successful Aliquots: 6

Not

Snowmelt Event

Event Summary

Site: Sand Trap #2 Influent - HWY 267 (3-304)
Event: 2004-03



Runoff Data

Start Date/Time: 01/25/05 09:15
Stop Date/Time: 01/26/05 21:00
Total Flow Volume (L): 18388
Peak Flow (L/s): 0.57

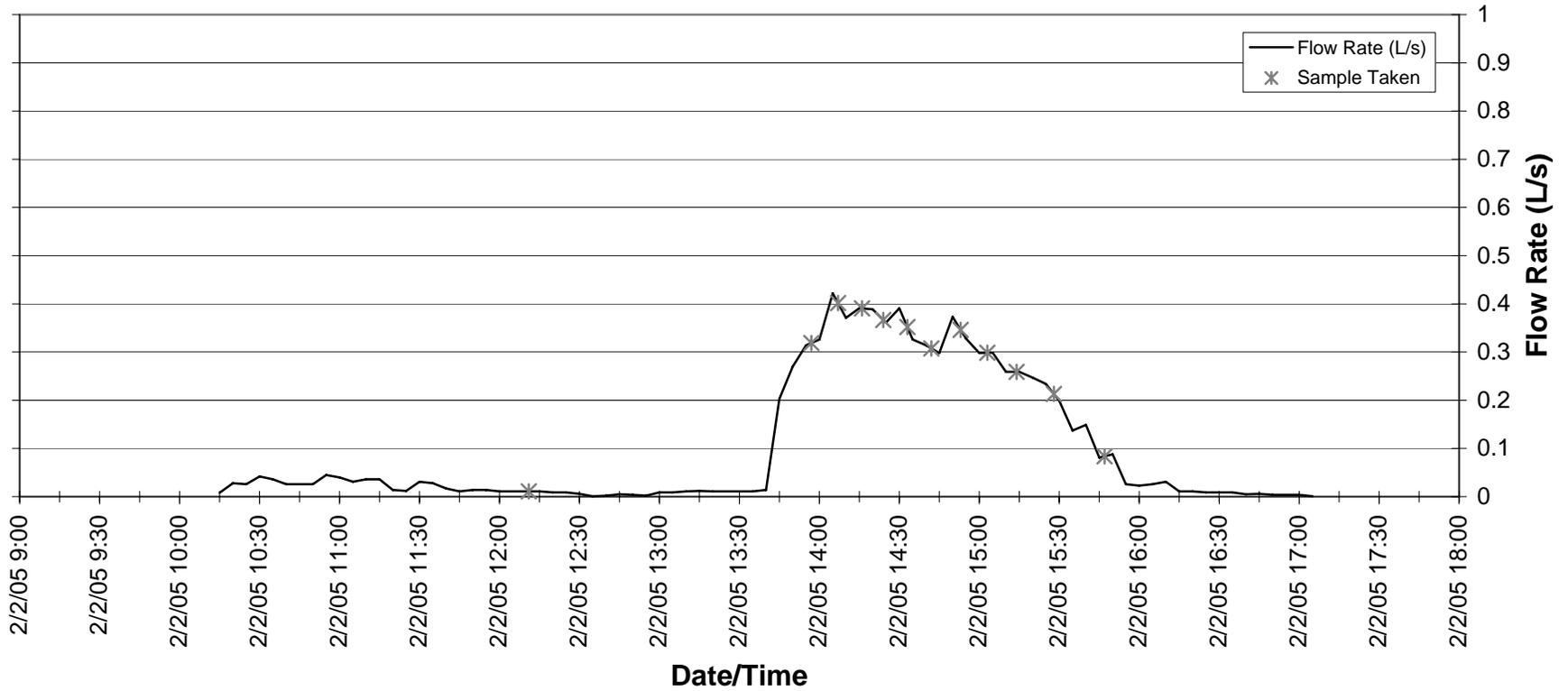
Sample Data

Start Date/Time: 01/25/05 09:15
Stop Date/Time: 01/26/05 20:25
Estimated Percent Capture: 100%
Successful Aliquots: 37

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #2 Influent - HWY 267 (3-304)
 Event: 2004-04



Runoff Data

Start Date/Time: 02/02/05 10:15
 Stop Date/Time: 02/02/05 17:05
 Total Flow Volume (L): 2469
 Peak Flow (L/s): 0.42

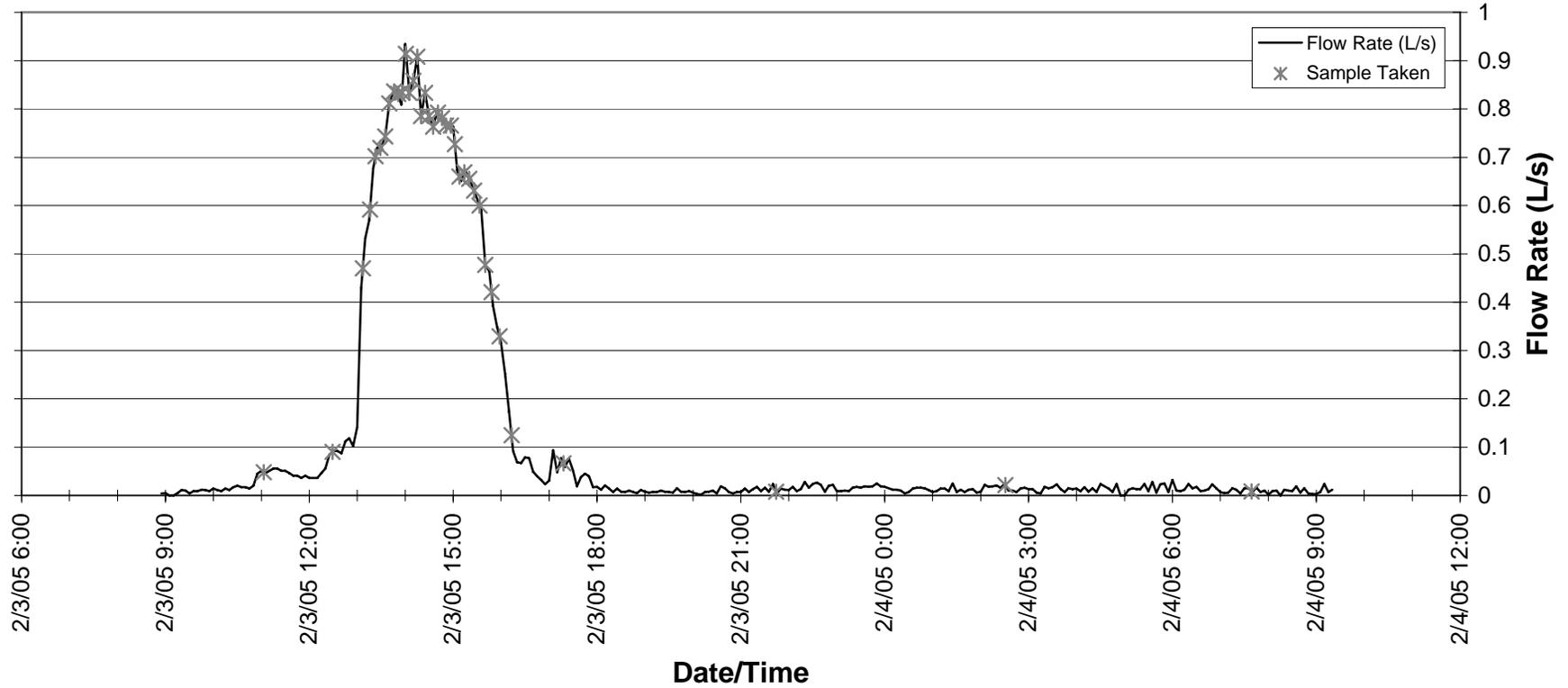
Sample Data

Start Date/Time: 02/02/05 10:15
 Stop Date/Time: 02/02/05 15:47
 Estimated Percent Capture: 89%
 Successful Aliquots: 12

Note Snowmelt Event

Event Summary

Site: Sand Trap #2 Influent - HWY 267 (3-304)
 Event: 2004-05



Runoff Data

Start Date/Time: 02/03/05 08:55
 Stop Date/Time: 02/04/05 09:20
 Total Flow Volume (L): 9145
 Peak Flow (L/s): 0.93

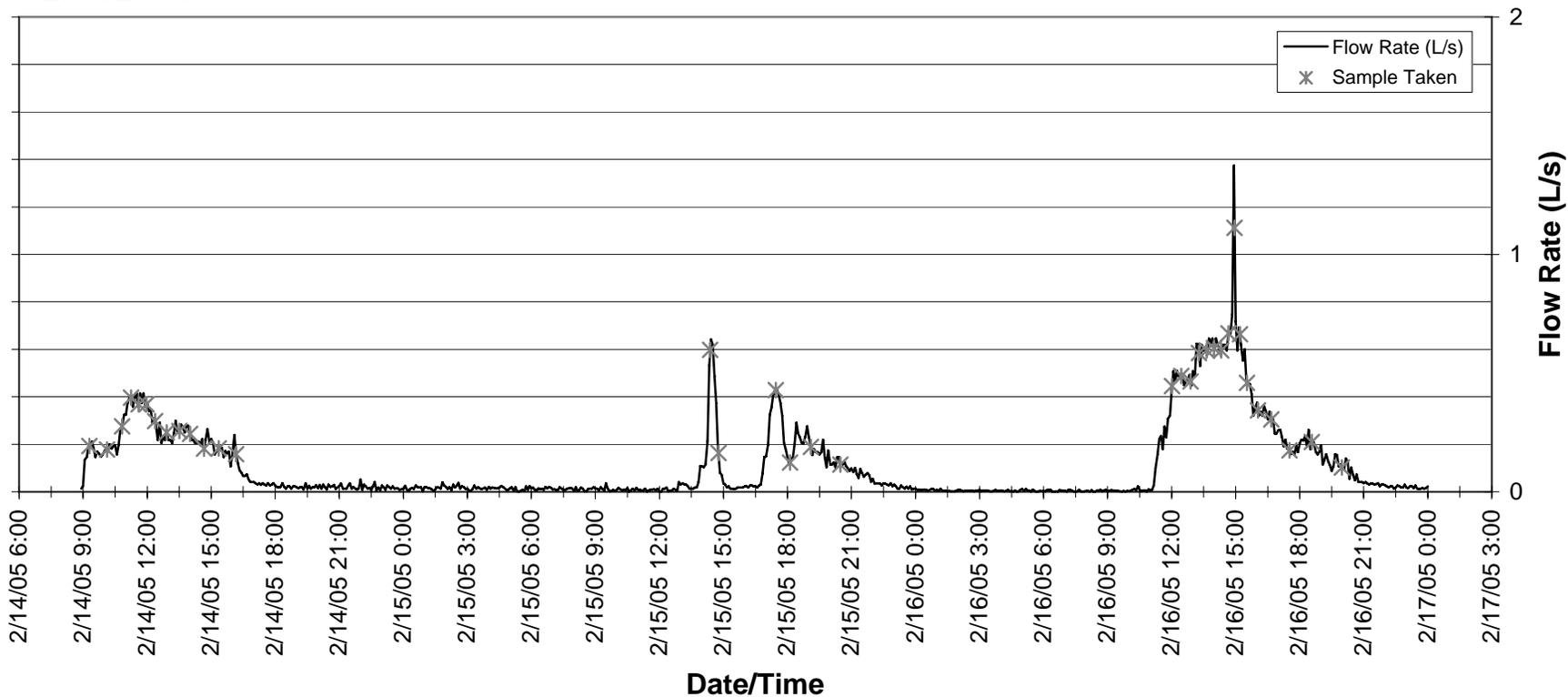
Sample Data

Start Date/Time: 02/03/05 08:55
 Stop Date/Time: 02/04/05 07:39
 Estimated Percent Capture: 99%
 Successful Aliquots: 37

Note Snowmelt Event

Event Summary

Site: Sand Trap #2 Influent - HWY 267 (3-304)
 Event: 2004-06



Runoff Data

Start Date/Time: 02/14/05 08:55
 Stop Date/Time: 02/17/05 00:00
 Total Flow Volume (L): 24930
 Peak Flow (L/s): 1.37

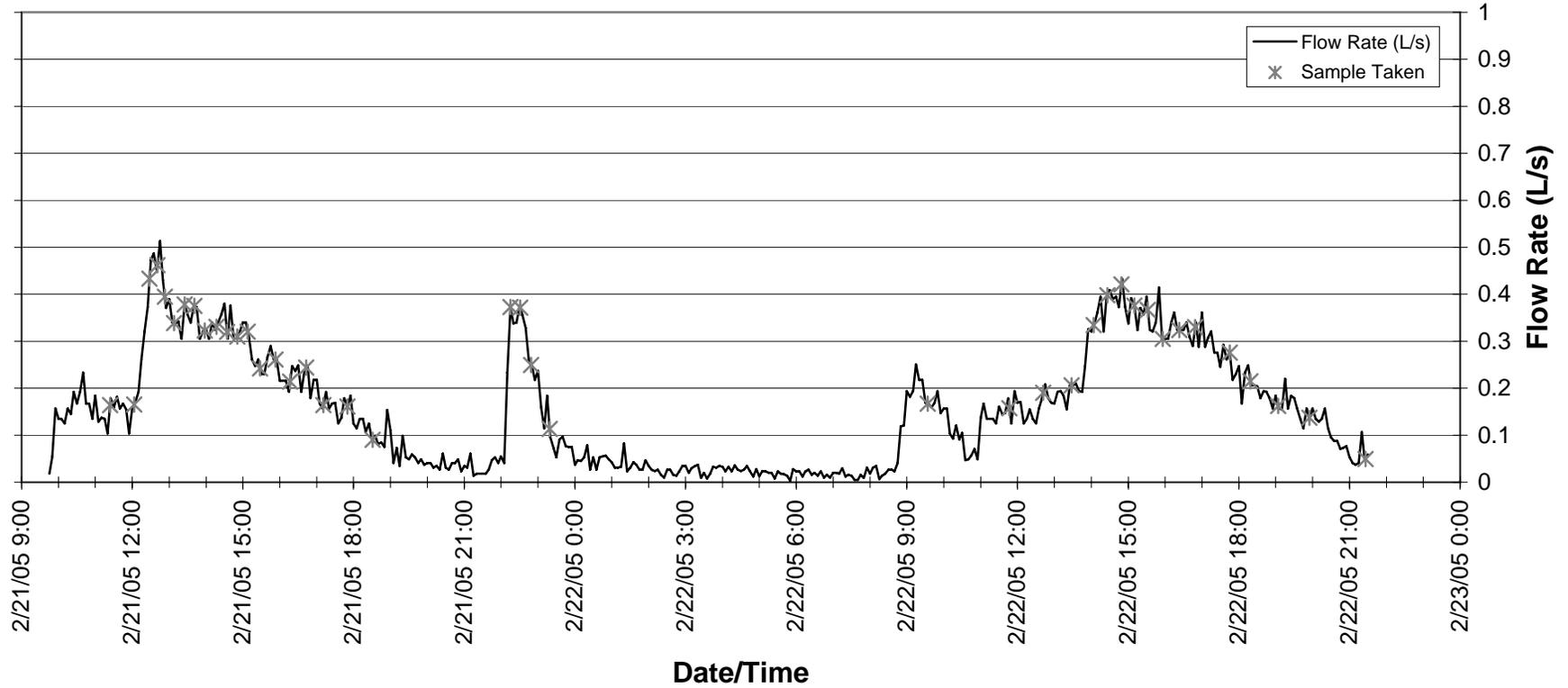
Sample Data

Start Date/Time: 02/14/05 08:55
 Stop Date/Time: 02/16/05 19:59
 Estimated Percent Capture: 88%
 Successful Aliquots: 35

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #2 Influent - HWY 267 (3-304)
Event: 2004-07



Runoff Data

Start Date/Time: 02/21/05 09:45
Stop Date/Time: 02/22/05 21:30
Total Flow Volume (L): 19856
Peak Flow (L/s): 0.51

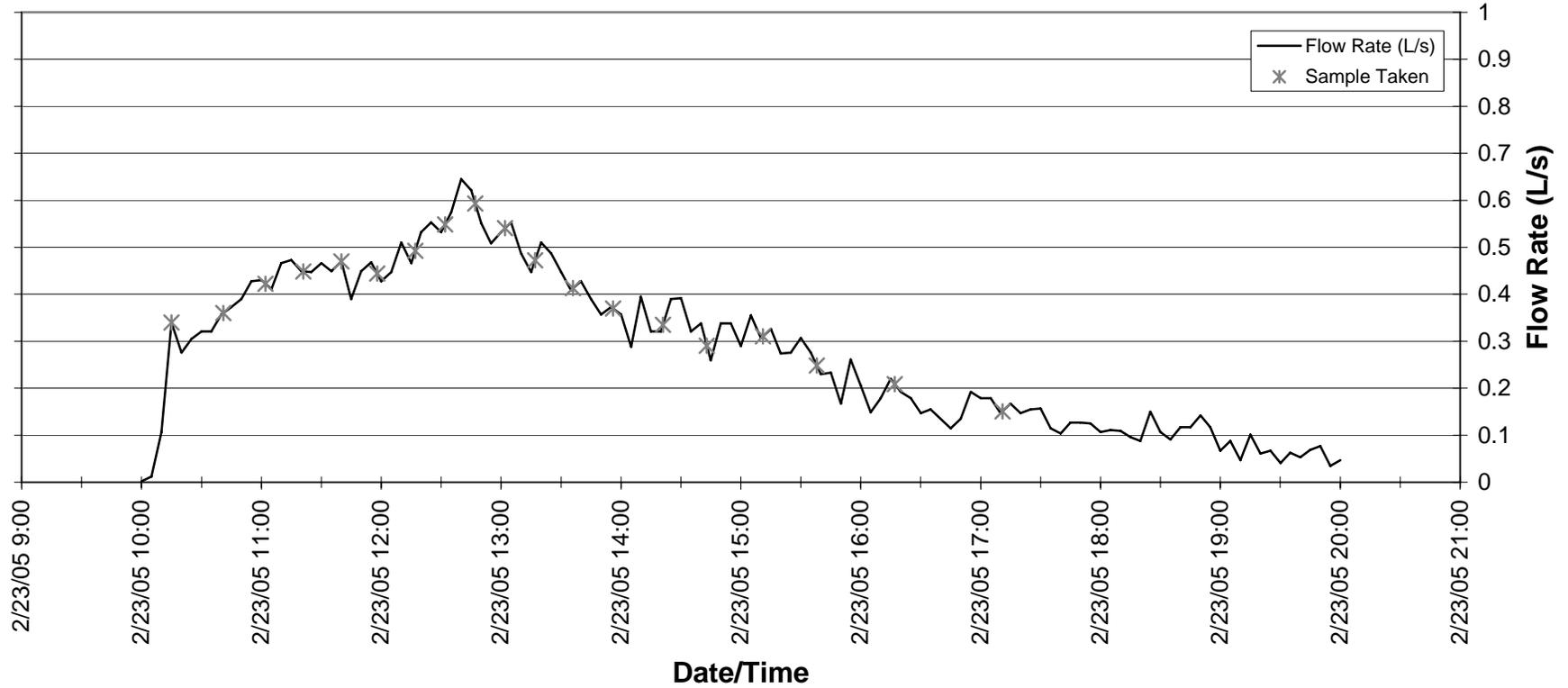
Sample Data

Start Date/Time: 02/21/05 09:45
Stop Date/Time: 02/22/05 21:26
Estimated Percent Capture: 89%
Successful Aliquots: 41

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #2 Influent - HWY 267 (3-304)
Event: 2004-08



Runoff Data

Start Date/Time: 02/23/05 10:00
 Stop Date/Time: 02/23/05 20:00
 Total Flow Volume (L): 10087
 Peak Flow (L/s): 0.65

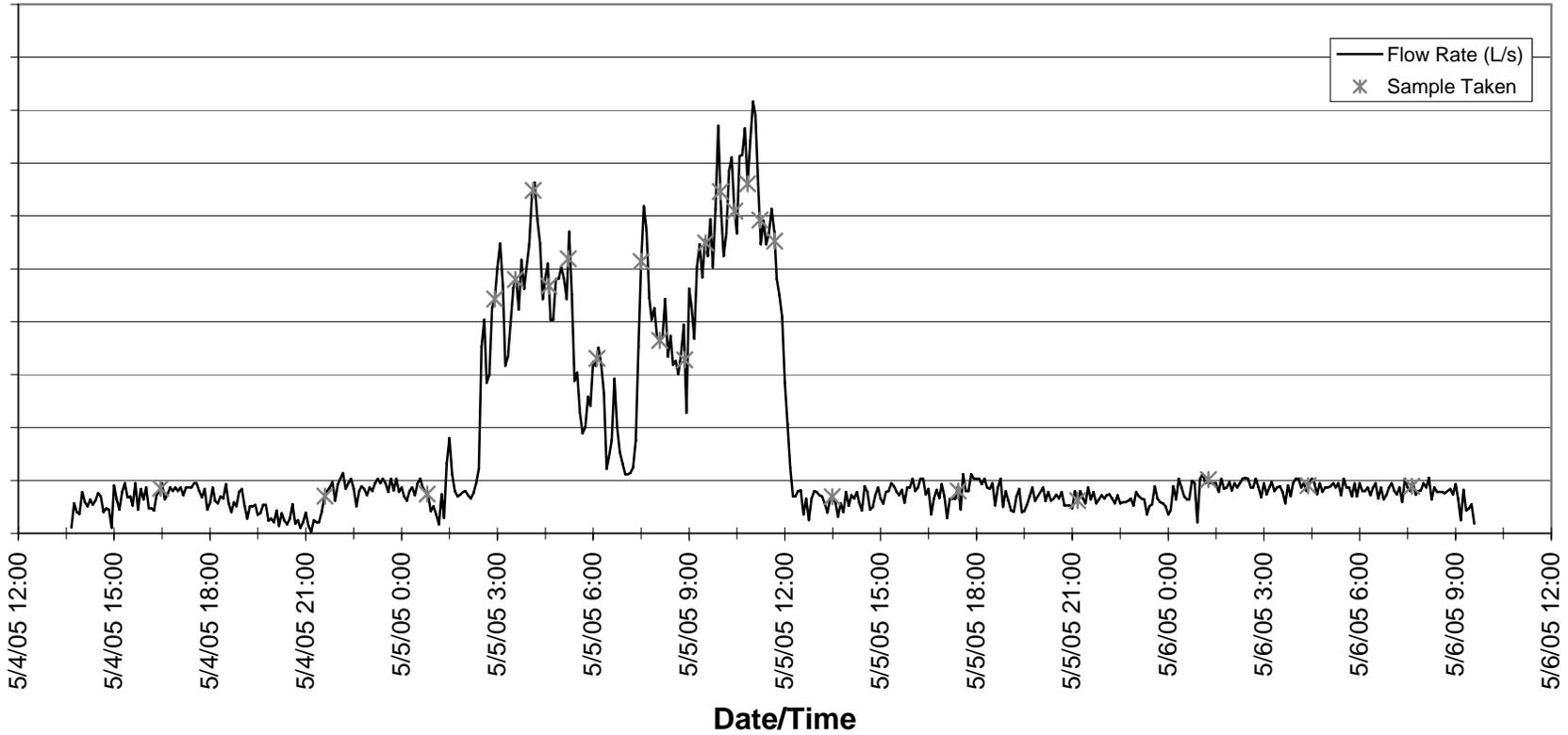
Sample Data

Start Date/Time: 02/23/05 10:00
 Stop Date/Time: 02/23/05 17:11
 Estimated Percent Capture: 81%
 Successful Aliquots: 19

Note Snowmelt Event

Event Summary

Site: Sand Trap #2 Influent - HWY 267 (3-304)
 Event: 2004-09



Runoff Data

Start Date/Time: 05/04/05 13:40
 Stop Date/Time: 05/06/05 09:35
 Total Flow Volume (L): 24119
 Peak Flow (L/s): 0.82

Sample Data

Start Date/Time: 05/04/05 13:40
 Stop Date/Time: 05/06/05 07:38
 Estimated Percent Capture: 98%
 Successful Aliquots: 24

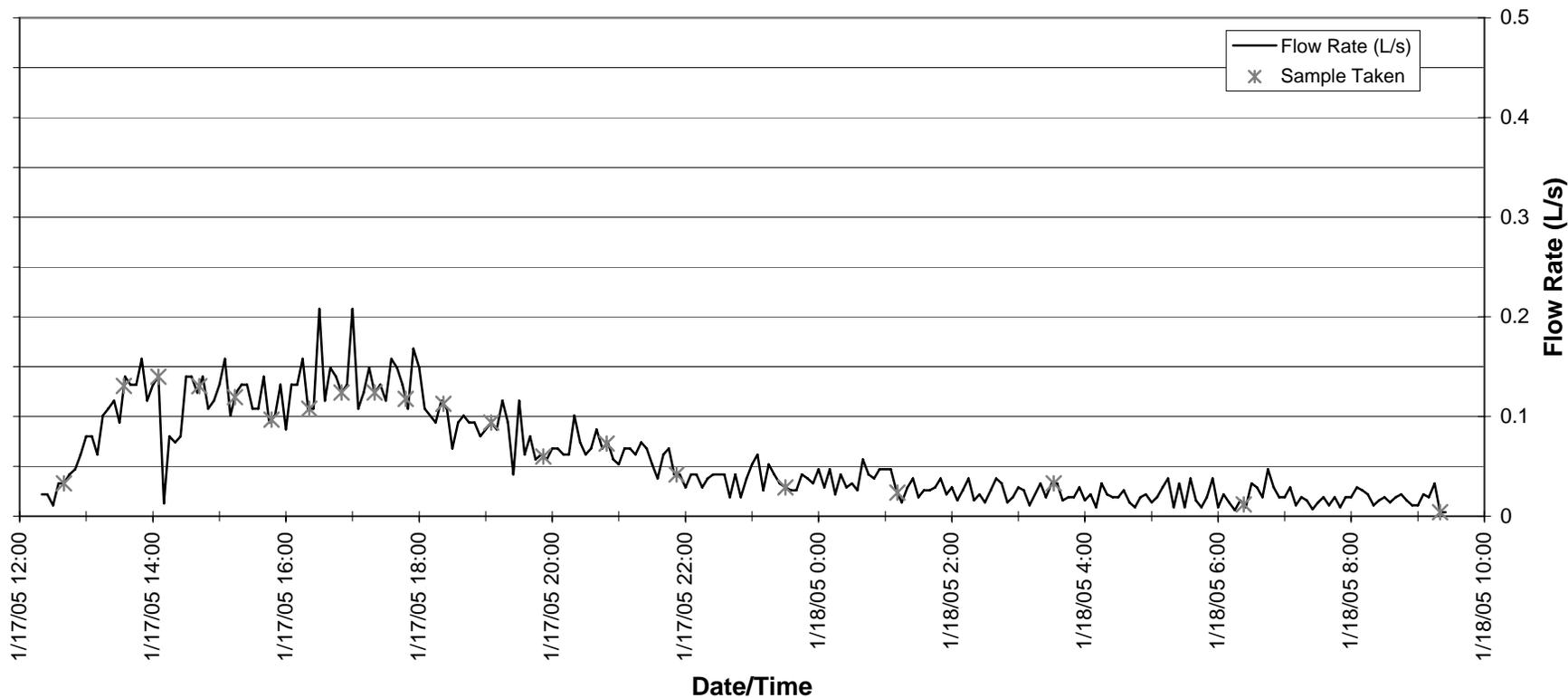
Note

Rainfall Event.

Event Summary

Site: Sand Trap #2 Effluent - HWY 267 (3-305)

Event: 2004-01



Runoff Data

Start Date/Time: 01/17/05 12:20
 Stop Date/Time: 01/18/05 09:25
 Total Flow Volume (L): 4456
 Peak Flow (L/s): 0.21

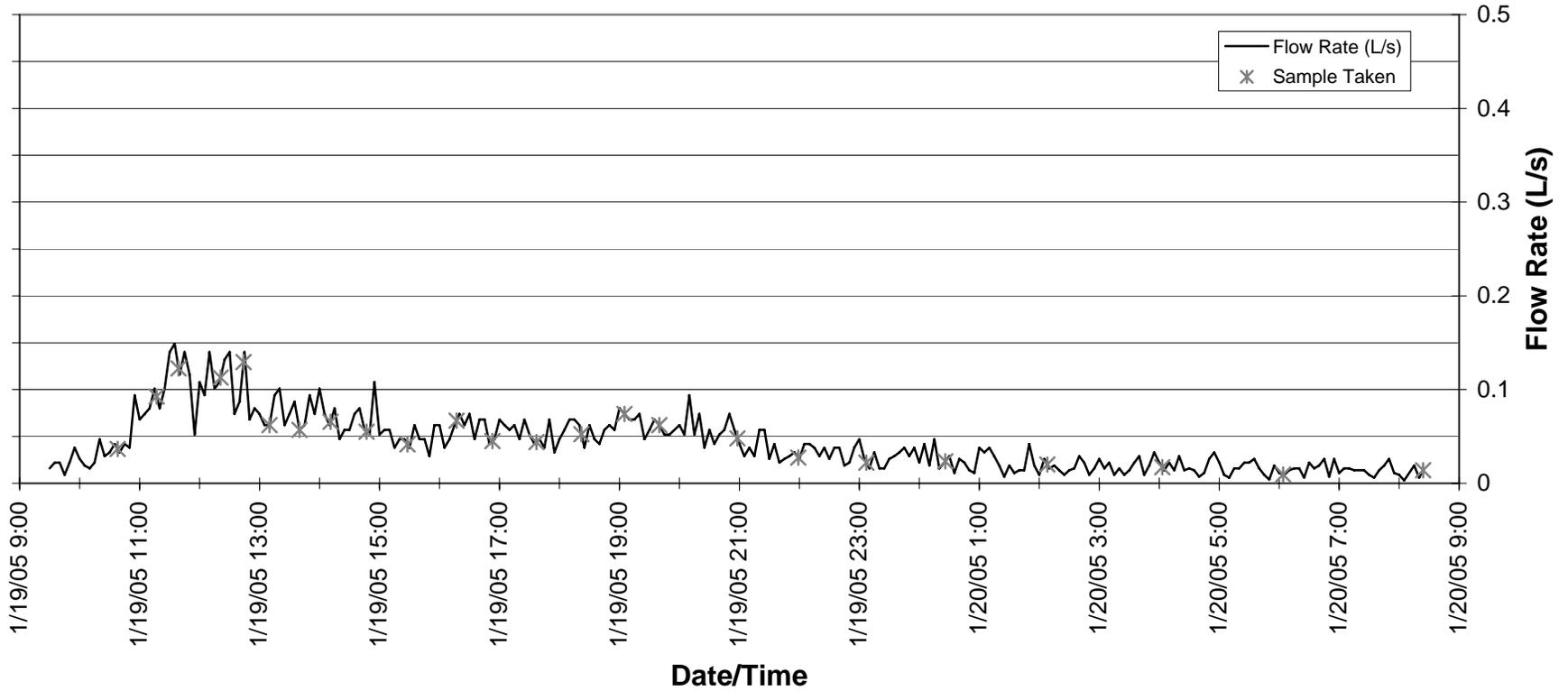
Sample Data

Start Date/Time: 01/17/05 12:20
 Stop Date/Time: 01/18/05 09:20
 Estimated Percent Capture: 100%
 Successful Aliquots: 20

Not Snowmelt Event

Event Summary

Site: Sand Trap #2 Effluent - HWY 267 (3-305)
 Event: 2004-02



Runoff Data

Start Date/Time: 01/19/05 09:30
 Stop Date/Time: 01/20/05 08:25
 Total Flow Volume (L): 3552
 Peak Flow (L/s): 0.15

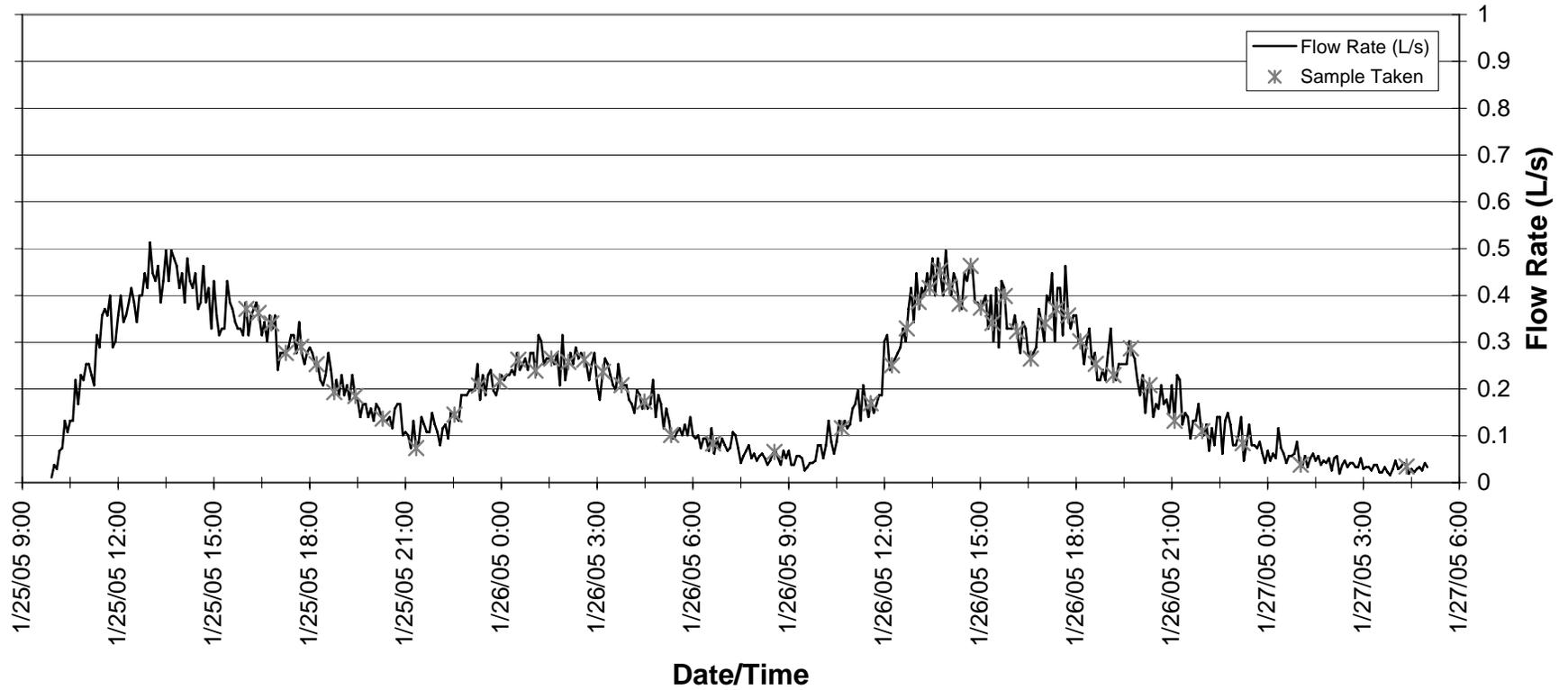
Sample Data

Start Date/Time: 01/19/05 09:30
 Stop Date/Time: 01/20/05 08:24
 Estimated Percent Capture: 92%
 Successful Aliquots: 24

Note Snowmelt Event

Event Summary

Site: Sand Trap #2 Effluent - HWY 267 (3-305)
 Event: 2004-03



Date/Time

Runoff Data

Start Date/Time: 01/25/05 09:55
 Stop Date/Time: 01/27/05 05:00
 Total Flow Volume (L): 32401
 Peak Flow (L/s): 0.51

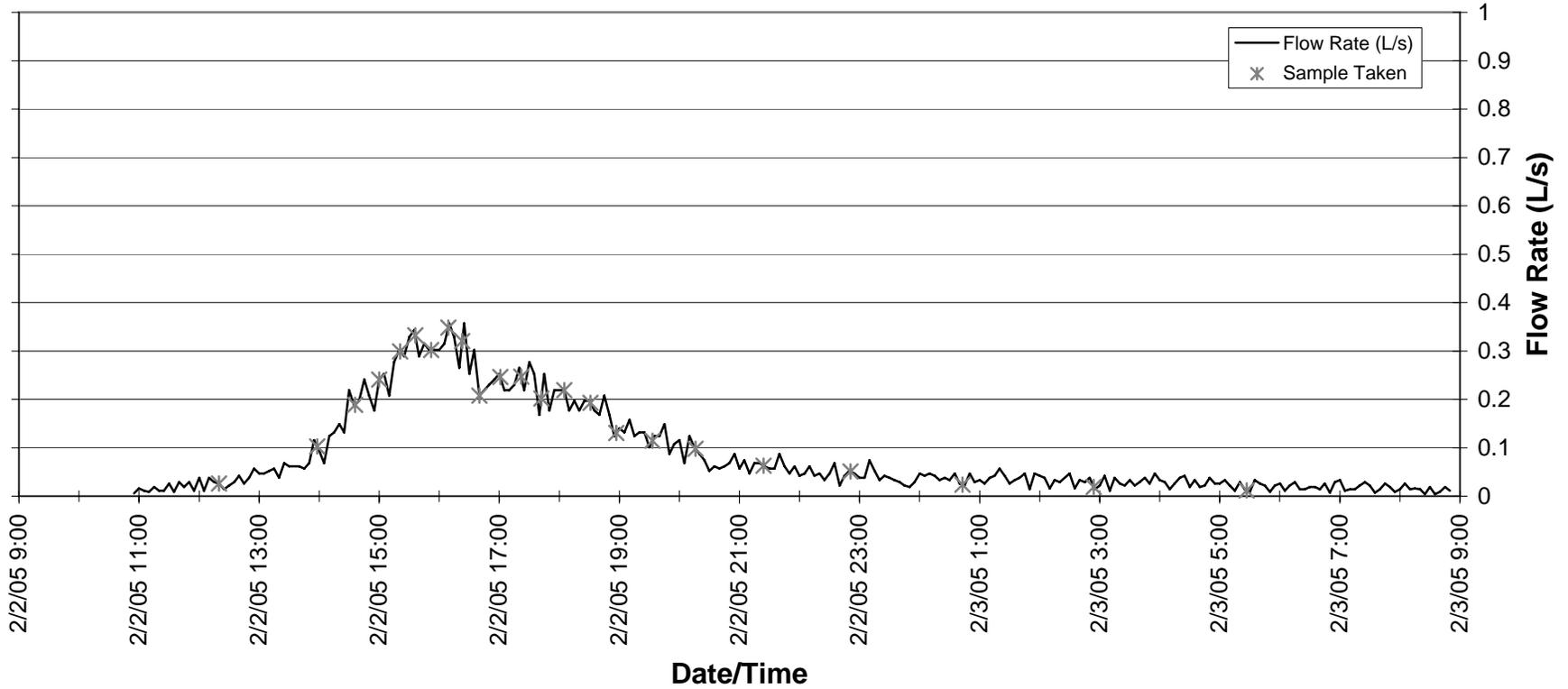
Sample Data

Start Date/Time: 01/25/05 09:55
 Stop Date/Time: 01/27/05 04:21
 Estimated Percent Capture: 100%
 Successful Aliquots: 52

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #2 Effluent - HWY 267 (3-305)
 Event: 2004-04



Runoff Data

Start Date/Time: 02/02/05 10:55
 Stop Date/Time: 02/03/05 08:50
 Total Flow Volume (L): 6622
 Peak Flow (L/s): 0.36

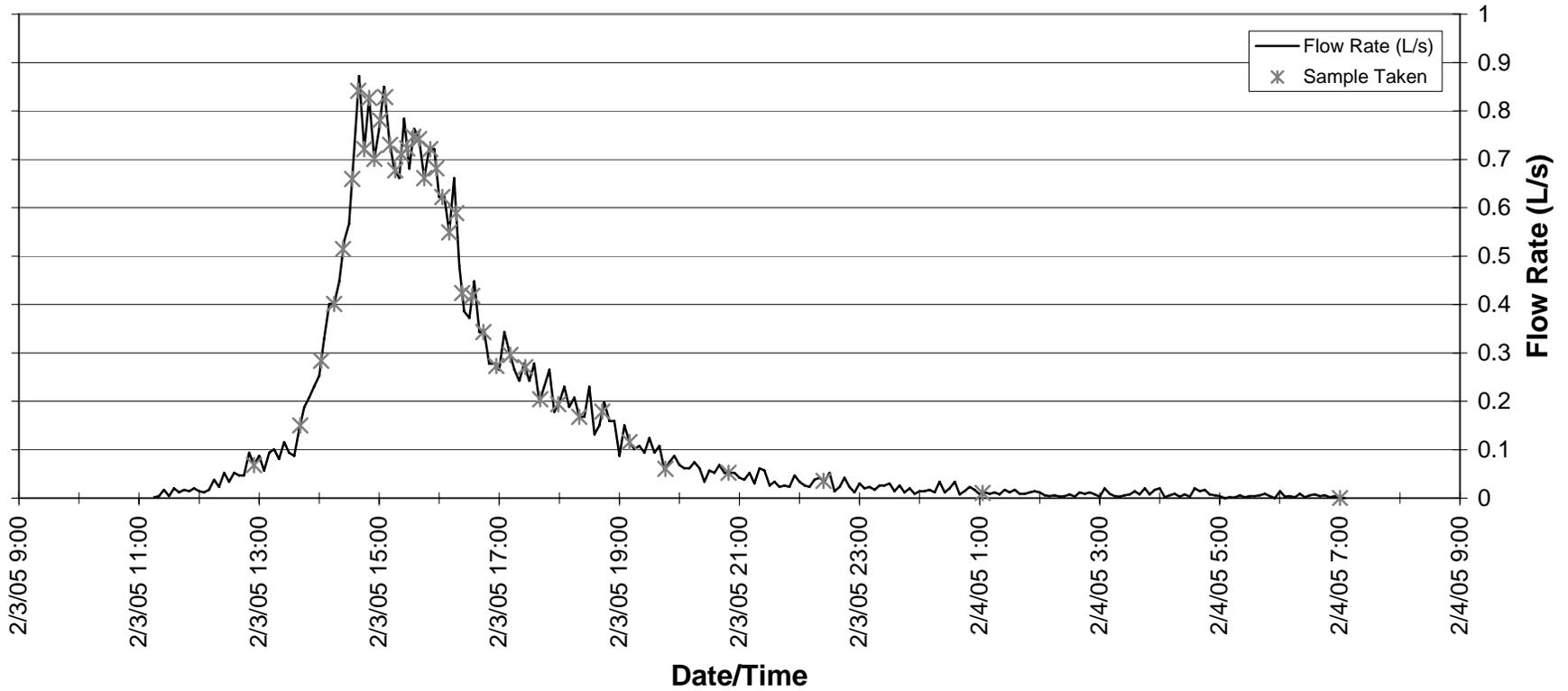
Sample Data

Start Date/Time: 02/02/05 10:55
 Stop Date/Time: 02/03/05 05:27
 Estimated Percent Capture: 97%
 Successful Aliquots: 23

Note Snowmelt Event

Event Summary

Site: Sand Trap #2 Effluent - HWY 267 (3-305)
 Event: 2004-05



Runoff Data

Start Date/Time: 02/03/05 11:15
 Stop Date/Time: 02/04/05 07:05
 Total Flow Volume (L): 9614
 Peak Flow (L/s): 0.87

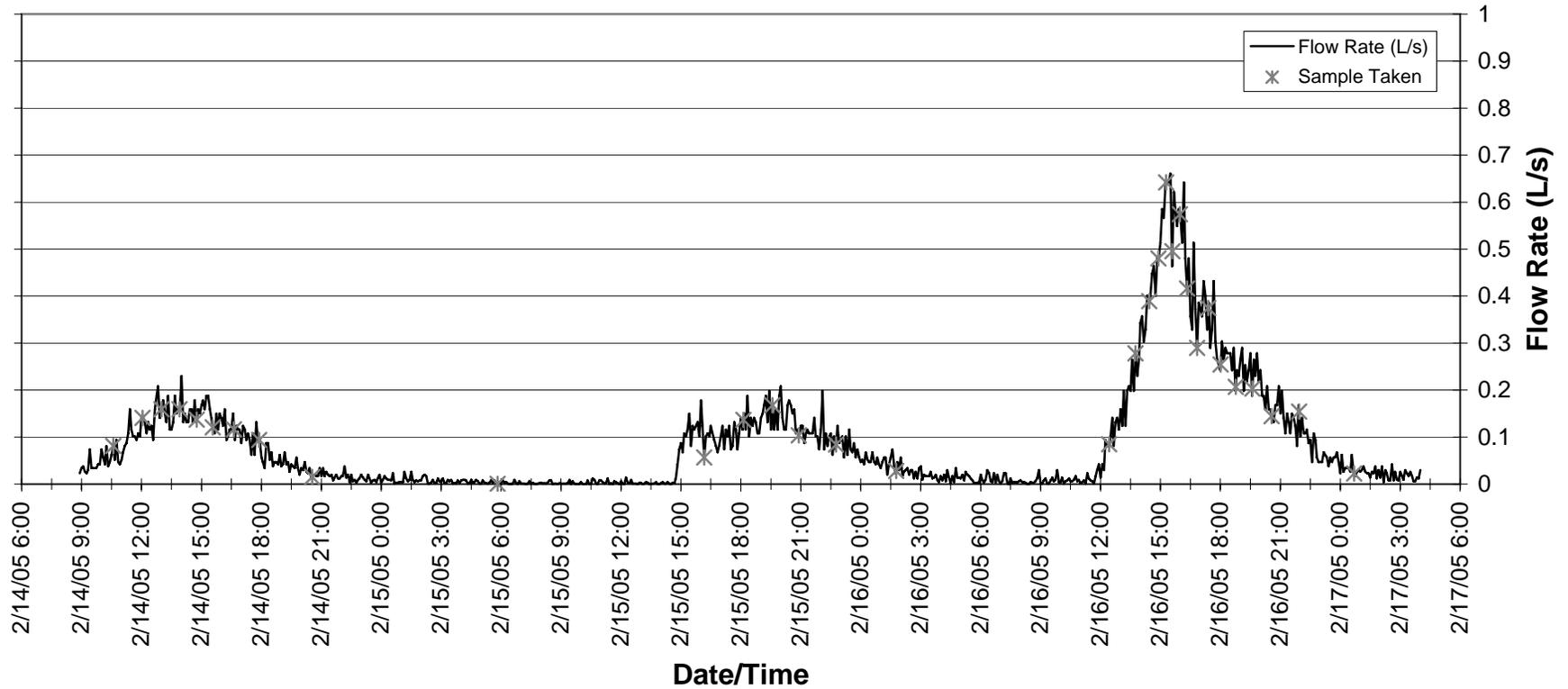
Sample Data

Start Date/Time: 02/03/05 11:15
 Stop Date/Time: 02/04/05 07:05
 Estimated Percent Capture: 100%
 Successful Aliquots: 40

Note Snowmelt Event

Event Summary

Site: Sand Trap #2 Effluent - HWY 267 (3-305)
 Event: 2004-06



Runoff Data

Start Date/Time: 02/14/05 08:55
 Stop Date/Time: 02/17/05 04:00
 Total Flow Volume (L): 20288
 Peak Flow (L/s): 0.66

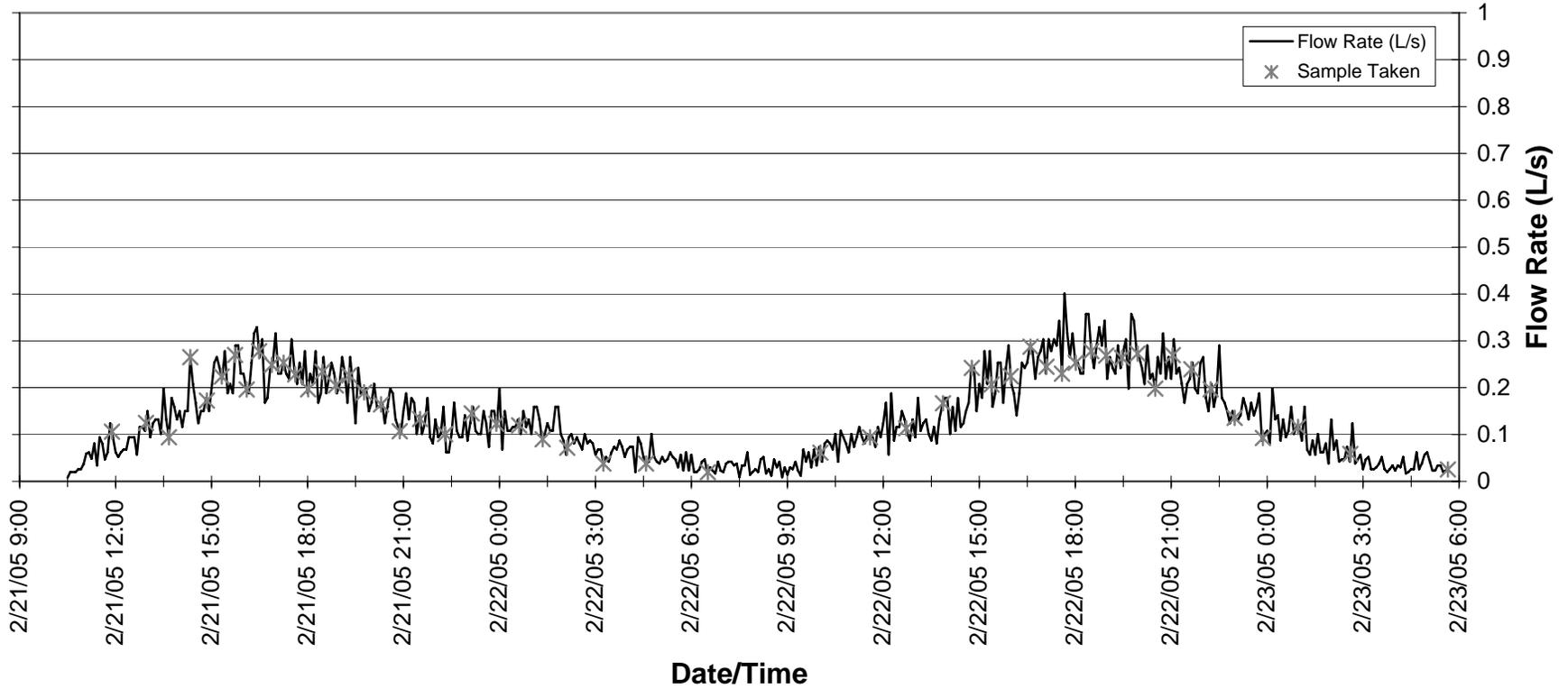
Sample Data

Start Date/Time: 02/14/05 08:55
 Stop Date/Time: 02/17/05 00:42
 Estimated Percent Capture: 99%
 Successful Aliquots: 32

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #2 Effluent - HWY 267 (3-305)
 Event: 2004-07



Runoff Data

Start Date/Time: 02/21/05 10:30
 Stop Date/Time: 02/23/05 05:40
 Total Flow Volume (L): 20918
 Peak Flow (L/s): 0.40

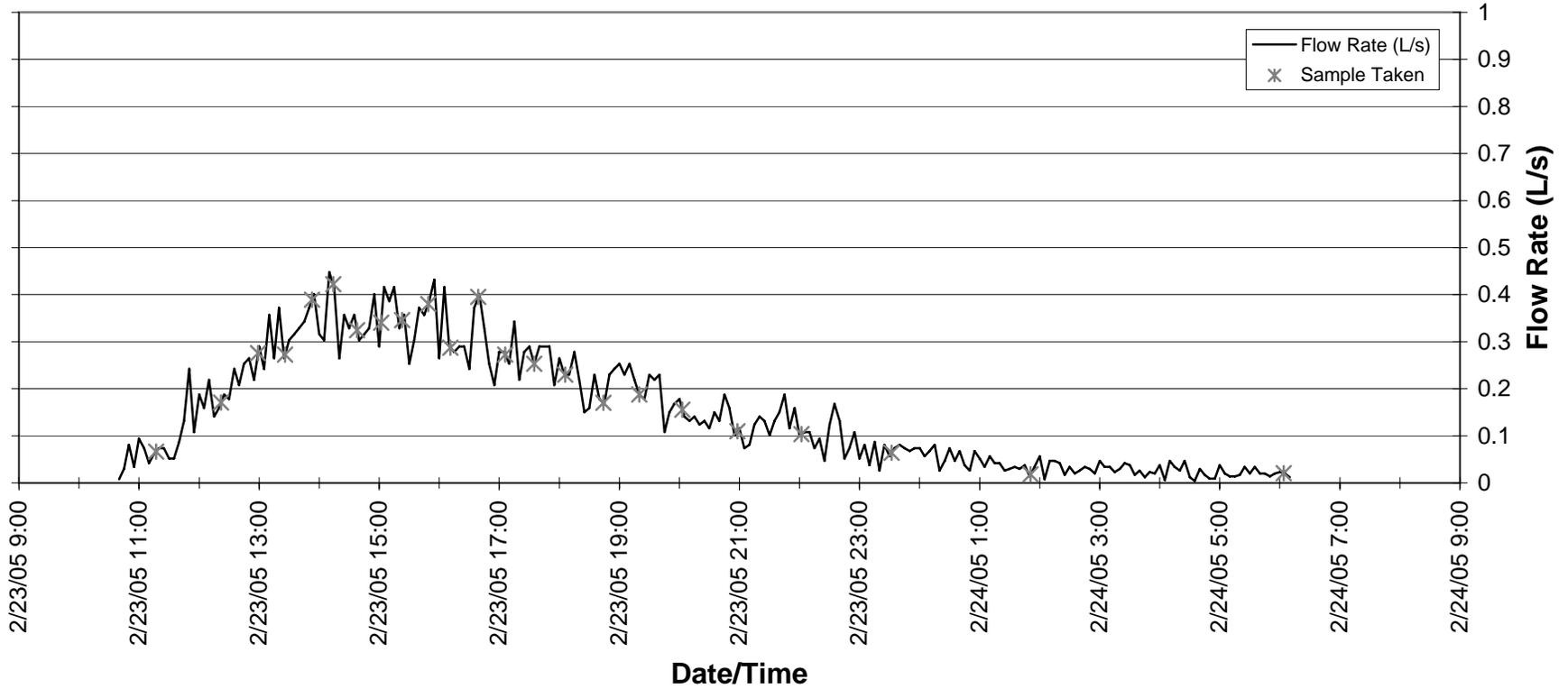
Sample Data

Start Date/Time: 02/21/05 10:30
 Stop Date/Time: 02/23/05 05:39
 Estimated Percent Capture: 100%
 Successful Aliquots: 53

Note Storm-Snowmelt Event

Event Summary

Site: Sand Trap #2 Effluent - HWY 267 (3-305)
 Event: 2004-08



Runoff Data

Start Date/Time: 02/23/05 10:40
 Stop Date/Time: 02/24/05 06:10
 Total Flow Volume (L): 10644
 Peak Flow (L/s): 0.45

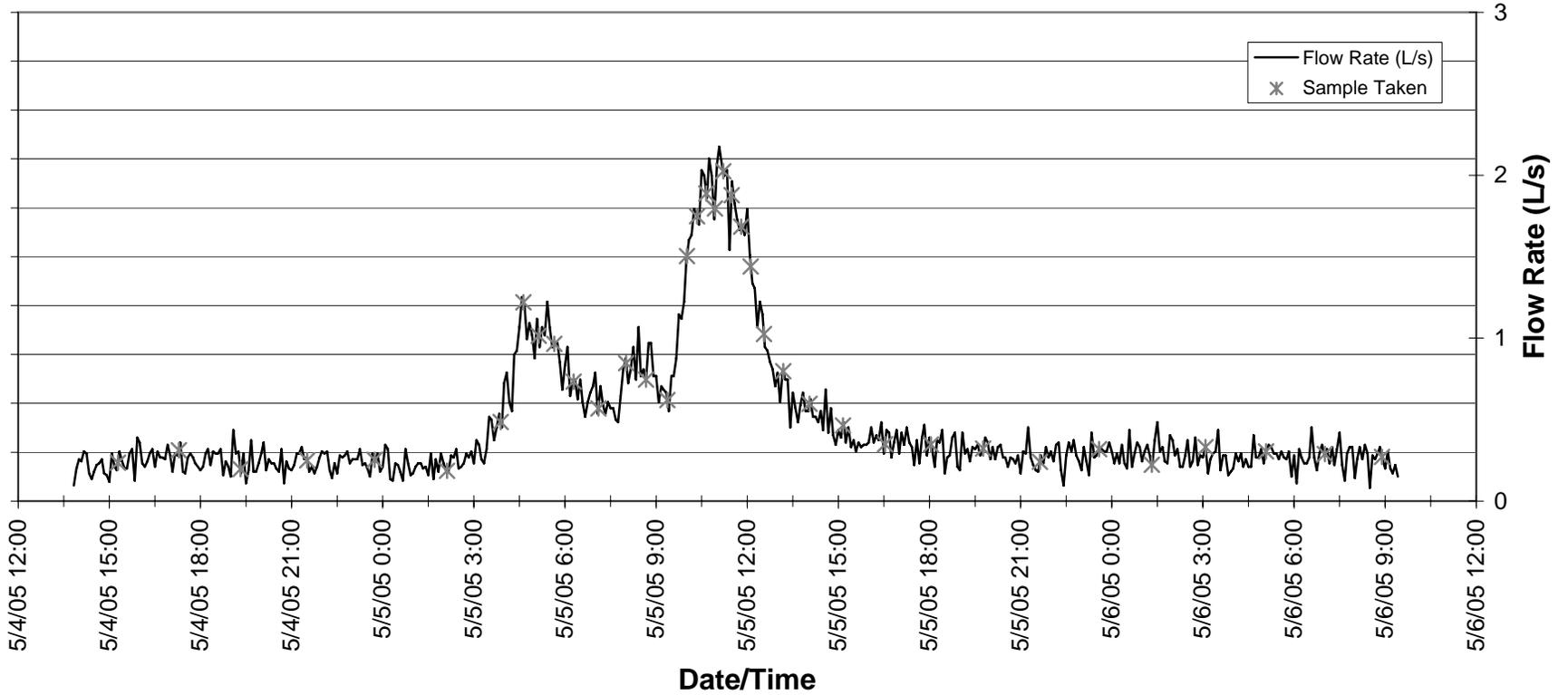
Sample Data

Start Date/Time: 02/23/05 10:40
 Stop Date/Time: 02/24/05 06:04
 Estimated Percent Capture: 100%
 Successful Aliquots: 23

Note Snowmelt Event

Event Summary

Site: Sand Trap #2 Effluent - HWY 267 (3-305)
Event: 2004-09



Runoff Data

Start Date/Time: 05/04/05 13:50
Stop Date/Time: 05/06/05 09:25
Total Flow Volume (L): 71418
Peak Flow (L/s): 2.18

Sample Data

Start Date/Time: 05/04/05 13:50
Stop Date/Time: 05/06/05 08:54
Estimated Percent Capture: 99%
Successful Aliquots: 37

Note Rainfall Event.

APPENDIX D

Quality Assurance/Quality Control Data Tables

TABLE D-1

**SUMMARY OF ANALYTICAL RESULTS
FROM FIELD DUPLICATES**

Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

Field Duplicate Information					Composite 01 Laboratory Results		Duplicate Laboratory Results	
Station Number	Sample	Sample Date	Sample Source	Sample Type ¹	Turbidity (NTU) ²	TSS (mg/L) ³	Turbidity (NTU)	TSS (mg/L)
3-301	Composite 01	02/23/05	Snowmelt	C	1,220	326	977	834
3-302	Composite 01	02/23/05	Snowmelt	C	108	636	70	56
3-304	Composite 01	02/21/05	Storm-Snowmelt	C	293	569	313	583
3-305	Composite 01	02/22/05	Storm-Snowmelt	C	120	118	149	94

1. C = composite sample.

2. NTU = nephelometric turbidity units.

3. TSS = total suspended solids, measured in milligrams per liter (mg/L).

TABLE D-2**LABORATORY DUPLICATE RESULTS¹**

Highway 267 Filter Fabric Sand Trap Pilot Study
Tahoe Basin, El Dorado County, California

Duplicate Source Station ID	Sample	Station Sampling Date	Laboratory Duplicate Analysis Date	Duplicate Results		Source Station Results		RPD	RPD Limit
				Turbidity ² (NTU)	TSS ² (mg/L)	Turbidity (NTU)	TSS (mg/L)		
3-301	Composite 01	01/20/05	01/22/05	183	na	184	na	0.5	20
3-301	Composite 01	01/26/05	01/27/05	2,700	na	2,700	na	0	20
3-301	Composite 01	02/02/05	02/04/05	264	na	265	na	0.4	20
3-302	Composite 01	01/26/05	01/27/05	1,040	na	1,040	na	0	20
3-304	Composite 01	02/04/05	02/07/05	395	na	396	na	0.3	20
3-301	Composite 01	02/07/05	02/09/05	285	na	285	na	0	20
3-304	Composite 01	01/26/05	01/27/05	1,590	na	1,590	na	0	20
3-304	Composite 03	02/17/05	02/18/05	1,160	na	1,160	na	0	20
3-304	Composite 01	02/21/05	02/23/05	293	na	293	na	0	20
3-304	Composite 01	02/23/05	02/25/05	1,100	na	1,100	na	0	20
3-304	Composite 01	02/02/05	02/07/05	na	283	na	280	1.1	20
3-304	Composite 01	02/04/05	02/08/05	na	484	na	482	0.4	20
3-304	Composite 03	02/17/05	02/22/05	na	1,160	na	1,153	0.6	20
3-305	Composite 01	02/23/05	02/28/05	na	100	na	83	18.6	20

1. NTU = nephelometric turbidity units, TSS = total suspended solids, mg/L = milligrams per liter, RPD = relative percent difference, na = not applicable.

2. Reporting limit for turbidity = 0.05 NTU, reporting limit for TSS = 1 mg/L.