Downstream DefenderÒ Report Sections

from

Final Report
for Onondaga Lake Nonpoint
Source Environmental Benefit Project

November 2002

Submitted by
Moffa and Associates
A Unit of Brown and Caldwell
East Syracuse, NY

Moffa & Associates
A UNIT OF BROWN AND CALDWELL

November 6, 2002

Pamela J. Deahl
Hydro International
94 Hutchins Drive
Portland, ME 04102

Re: Onondaga Lake Nonpoint Source Environmental Benefit Project

Dear Ms. Deahl,

As part of the above referenced project, Moffa and Associate, *a unit of Brown and Caldwell*, evaluated a four-foot diameter Downstream Defender® in Syracuse, NY.

Please find attached an electronic copy of the final report sections that pertain only to the Downstream Defender®. This version is not a complete final report. The Executive Summary is included in full to provide the reader an appreciation of the scope of the entire project.

It is our understanding that you will use these sections for marketing purposes as confirmation of a third party evaluation.

If you have any questions, please do not hesitate to call.

Very truly yours,

John J. LaGorga
Project Manager

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1 EXECUTIVE SUMMARY

1.1 Background

Nonpoint source (NPS) pollution is unlike industrial and municipal pollution; it comes from diffuse sources and is the result of rainfall or snowmelt moving over and through the ground. NPS pollution is usually associated with land use activities such as agricultural, construction and urbanization and include pollutants such as fertilizers, herbicides, pesticides, insecticides, sediment, bacteria, nutrients, oils and grease and toxic chemicals.

The objective of the Onondaga Lake Nonpoint Source Environmental Benefit Project (EBP) was to implement nonpoint source controls and management strategies to reduce nutrient inflow to Onondaga Lake from agricultural and urban practices and to evaluate the effectiveness of these controls and management strategies.

Onondaga Lake is located immediately northwest of the City of Syracuse in Onondaga County, New York. The Onondaga Lake drainage basin encompasses approximately 247 mi^2 (642 km^2) and, with the exception of 0.75 mi^2 (2 km^2) in Cortland County, lies almost entirely in the Onondaga County drainage basin. The basin includes six natural subbasins: Nine Mile Creek, Harbor Brook, Onondaga Creek, Ley Creek, Bloody Brook and Saw Mill Creek. The City of Syracuse is the region's major metropolitan center, encompassing approximately 20 square miles. The City of Syracuse together with the adjacent towns and villages have been designated an urban area by the State of New York, and thus fall under the Phase II stormwater regulations. The urban area including the City of Syracuse is approximately 100 square miles. The non-urban areas of the Onondaga Lake watershed include mostly forest and agricultural lands. The Onondaga County Soil and Water Conservation District estimated a total of 107 active farms including 67 active dairy farms in 1992. The land use attributed with these farms 37,181 cropland acres including 3,721 acres of pastureland. The current estimate of total farms is 98.

The selected agricultural sites were chosen to represent the prominent agricultural trends in New York State. Specifically, the Rohe Farm represents a typical family-owned, 100-head dairy farm that plans to continue operations as usual. The Guptill Farm is a family-owned farm that recently made the transition from dairy farming to beef cattle and heifer-livestock handling. The Leubner Farm is also a family-owned dairy farm but has expanded from a 150-head operation to more than 400-head operation.

The selected urban sites were chosen to represent typical municipal urban runoff. A stormwater vegetative filter strip was installed at the Burnet Park Zoo to treat and control runoff from a typical urban parking lot. A stormwater vortex unit was installed on East Seneca Turnpike to treat runoff from a major city street.

There were three major elements of work for the EBP: 1) *BMP design and implementation*, 2) *water quality monitoring* and 3) *effectiveness evaluation*.

BMP design and implementation included BMP identification and selection and design and construction. Working with the farmers and municipal representatives was especially important during this phase of work in order to ensure their commitment to the operation and maintenance of the BMPs. BMP design and implementation started in June 1999 and continued until November 2001.

Water quality monitoring for the agricultural sites was conducted from May 1999 to May 2000 for pre-BMP period and November 2000 to November 2001 for post-BMP period. During each period, water quality samples were collected in the receiving water adjacent to the farmstead. The intent of this sampling was to monitor the reduction of pollutants in the receiving water as a result of the group of BMPs installed on the farmstead. Water quality sampling for the urban BMPs effort began during the spring of 2001 after the BMPs were installed. For the urban BMPs, influent and effluent samples were taken during actual wet-weather events to define removal efficiency.

Effectiveness evaluation began immediately following implementation of the BMPs beginning in November 2000 and continued until March 2002. The effectiveness evaluation included site visits, farmer interviews and analysis of water quality data.

1.2 BMP Design and Implementation

The agricultural BMP selection and design process used a combination of newly established approaches and efforts that were customized to fit the nature of the project. Under this project, Tier I and II Assessments from the Agricultural Environmental Management (AEM) guide for New York State were completed to identify water quality risks and suitable BMPs. Tiers III to V Assessments were not completed since the objectives differed from those of the Soil and Water Conservation District; the EBP project was confined to farmstead-scale problems and remedies and not geared towards long-term soil management efforts. The Tier I and II Assessments led to the design and construction of BMPs, and efforts were made to have all BMPs comply with Natural Resources Conservation Service (NRCS) specifications. Based on the assessments, it was decided during the early stages of the project that targeting manure handling practices and animal pasturing adjacent to receiving waters would provide the greatest return on the investment in terms of nutrient reductions. Most of manure handling improvements were made through reengineering the manure handling stations and providing training to the farmer on proper operation. Creating a buffer zone between the receiving waters and active livestock areas and manure handling stations also provide a relatively inexpensive benefit to water quality. A simple principle was maintained throughout design and construction of BMPs: keep the clean runoff clean and divert the contaminated runoff to a treatment area.

The selected urban BMP were chosen to represent treatment for typical municipal urban runoff. A stormwater vortex unit was installed at 134 East Seneca Turnpike for the purpose of removing suspended solids and associated nutrients from the stormwater before discharge to Onondaga Creek. The catchment area serviced by this unit primarily encompasses a 1,000-feet length of East Seneca Turnpike and is approximately 1.2 acres in size. The unit is a 4-foot diameter Hydro International Downstream Defender® with a design flow of 0.75 cfs and a maximum capacity of 3.0 cfs. A stormwater vegetative filter strip was installed at the Onondaga County Burnet Park Zoo for the purpose of controlling and treating runoff from a parking lot. The original stormwater structure for this parking lot was a cobblestone-lined ditch, which was constructed around 1985 and no longer effectively conveyed stormwater. The vegetative filter strip was installed to replace the cobblestone-lined ditch. The vegetative BMP is a 160-foot long swale, which collects and conveys runoff from the parking lot. The ditch was reshaped to convey flow at rates that minimize erosion. The area was seeded with a mixture of grasses. These grasses were selected to be resilient against invading species, to grow well in a wet and dry environment and to only grow to approximately two feet tall.

1.3 Water Quality Monitoring

The EBP water quality sampling program provided data that were intended to provide only a first order approximation of farmstead and urban runoff pollutant concentrations and effectiveness of BMPs. Prior to this sampling program there were no site-specific data for urban and farmstead runoff available for the City of Syracuse and surrounding agricultural land. This sampling approach was consistent with budgetary constraints, which allocated 85% of the budget for BMP implementation and the remaining 15% for sampling and monitoring, laboratory analyses, data analyses, meetings and reporting.

Water quality analyses following USEPA approved methods were performed for Soluble Reactive Phosphorus (Ortho-Phosphorus), Total Phosphorus (Total-P), Total Kjeldahl Nitrogen (TKN), and Total Suspended Solids.

Water quality samples for the agricultural BMPs were collected in the receiving water adjacent to the farmstead once per month for one year before and after BMP implementation. Instantaneous flow measurements were taken at the same time as the water quality data. The intent of this sampling was to monitor the reduction of pollutants in the receiving water as a result of the group of BMPs installed on the farmstead. Using the water quality concentrations and the flow measurements, pounds (i.e. loads) of pollutants discharged from the farmsteads were estimated. These loads were used to identify pre- and post-BMP load reductions as well as for estimating relative loads discharging from such farmstead in the receiving waters of Onondaga Lake.

Water quality sampling for the urban BMPs effort began during the spring of 2001 after the

BMPs were installed. For the urban BMPs, influent and effluent samples were taken during actual wet-weather events to define removal efficiency. Six wet-weather events were sampled for each the vortex unit and the vegetative strip.

1.4 Effectiveness Evaluation

In the agricultural setting, pollutant concentratio ns significantly decreased from the pre-BMP sampling period to the post-BMP sampling period at all three farms. Pollutant concentrations from each sampling event were ranked using the Wilcoxson Rank-Sum Test. This comparison approach (alpha = 0.05, 95% confidence) indicated a significant reduction in concentration from the pre-BMP sampling to the post-BMP sampling period. Presumably the only changes at the farm were the implementation of the BMPs, which suggests the BMPs successfully reduced the concentration of pollutants discharging from the farms.

The following table provides pounds of pollutants discharged during the pre- and post-BMP periods and percent removals.

	Pre-BMP (pounds)	Post-BMP (pounds)	Percent Removal
Rohe Farm			
Total Phosphorous	865	265	70%
Total Kjeldahl Nitrogen	2,830	900	68%
Guptill Farm			
Total Phosphorous	1,700	684	61%
Total Kjeldahl Nitrogen	10,400	2,174	79%
Leubner Farm			
Total Phosphorous	799	359	55%
Total Kjeldahl Nitrogen	5,837	2,922	50%

There are approximately 50 active farms within the Onondaga Lake watershed without BMPs. If it is assumed that the three farms studied during this project are representative of the 50, than the findings from this project equate to approximately 20,000 to 50,000 pounds per year of potential total phosphorus reduction and approximately 45,000 to 410,000 pounds per year of potential TKN reduction within the watershed. Assuming that 50% of the TKN is ammonia-N, than there is approximately 22,500 to 205,000 pounds per year of potential ammonia-N reduction.

As a frame of reference, based on current Metropolitan Sewage Treatment Plant (METRO) upgrade plans, the potential total phosphorus reduction at METRO is 66,500 pounds per year and the potential ammonia-N reduction is 550,000 pounds per year.

The cost of BMP construction and implementation on each farm was approximately $45,000. This equates to approximately $45 to $112 per pound of total phosphorus removed per year and $10 to $100 per pound of ammonia-N removed per year. As a frame of reference, Onondaga County is investing approximately $125 million (1997) at METRO for phosphorus and ammonia removal during the period from 1996 to 2015. This equates to approximately $1,900 per pound of total phosphorus removed per year and $230 per pound of ammonia per year.

The stormwater vortex unit was monitored for just over a one-year period from March 2001 until May 2002, during which time approximately 40 inches of rain fell during the non-winter months. This equated to approximately 730,000 gallons of stormwater processed by the vortex unit. Also during this time approximately 100 cubic feet of material was removed from the vortex unit weighing an estimated 4,500 lbs. This equated to approximately 0.14 cubic feet or 6 lbs of material removed per 1,000 gallons of stormwater processed. Most of the material removed from the vortex unit was sand and grit and organic material such as leaves and twigs. Relatively little nutrients were removed, which was likely due to the low influent concentrations of nitrogen and phosphorus. Additionally, relatively little trash was collected as a result of the grated catchbasins, which prevent trash from entering the stormwater conveyance system. The sediment storage sump of the vortex unit is approximately 12 cubic feet; maintenance is key to the successful operation of such equipment because once the unit's sump is full, a reduction in removal efficacy is possible due to the increased risk of re-entrainment of solids deposited within the zone above the shielded sediment storage sump.

The vegetative filter strip was monitored for roughly five months from June 2001 until October 2001, during which time approximately 16.5 inches of rain fell. This equated to approximately 40,000 gallons of stormwater processed by the 160-foot long vegetative filter strip. Water quality sampling was conducted on six storm events beginning in June of 2001 and ending in October of 2001. For half the events sampled, the vegetative filter strip absorbed the stormwater and no effluent flow was apparent. During the other three sampling events, rainfall and the resulting parking lot runoff were great enough to cause flow through the vegetative filter strip. It appears that the strip could absorb about one inch of rain before effluent flow was apparent; this is equivalent to approximately 3,000 gallons of stormwater. The vegetative filter strip appeared to be effective at removing solids during a flow through condition. However, concentrations of solids were relatively low. It also appeared that the vegetative filter strip was acting as a nutrient exporter; releasing nutrients when stormwater flowed through the strip. Again, the nitrogen and phosphorus concentration in both the influent and effluent was very low. The source of the nutrient reservoir was likely from the compost bedding established for seeding.

2 URBAN BMP SELECTION AND DESIGN

Two urban BMPs were selected for this project; namely a stormwater vortex unit and a vegetative filter strip. These BMPs represent a structural and nonstructural approach, respectively.

A stormwater vortex unit was selected to represent a structural approach to controlling and treating urban stormwater.

A stormwater vortex unit is a device designed to capture settleable solids (solids such as grit and sand that settle in quiescent flow), floatables, oils and grease and incidental nutrients from stormwater runoff. The stormwater vortex unit consists of a concrete cylindrical vessel that can be installed in place of an existing catchbasin. Stormwater enters tangentially into the cylindrical vessel, which creates a circular flow path (i.e. vortex). This circular flow path minimizes turbulence and allows solids to settle into an isolated storage zone (depending on configuration) and not become re-entrained. Stormwater vortex units are generally baffled to enhance floatable and oil and grease collection. These units collect and store pollutants in the cylindrical vessel during a stormwater event, and the pollutants are removed from the unit after the stormwater event has ended.

Several companies that manufacture stormwater type vortex units provided information. This information was provided to the City of Syracuse engineers and the project team, with the approval from the city engineers, selected the Downstream Defender® manufactured by H.I.L. Technologies (Hydro International).

The City of Syracuse engineers originally recommended two sites for the stormwater vortex unit:

1. 205 Hopper Road, Syracuse, NY 13207

2. 201 East Seneca Turnpike, Syracuse, NY 13205

The site on East Seneca Turnpike was selected. After field reconnaissance the actual location of the unit was moved approximately 150 feet to the west to 134 East Seneca Turnpike. This area is depicted in Figure 7.

Due to budget constraints and sampling objectives, a 4-ft diameter Downstream Defender® with a design flow rate of 0.75 cfs was purchased for installation at the East Seneca Turnpike site, which has a catchment area of approximately 1.2 acres. Hydro International recommends a conservative approach to sizing the Downstream Defender® if no regulatory guidelines are available as in New York State. It is typically recommended to size the installation so that the design flow of the unit is greater than or equal to the peak runoff rate from a 1-year, 24-hour storm event as a minimum, with a 2-year, 24-hour storm event desirable. This conservative approach is taken because of the variability related to the first flush and TSS size distributions and particle densities.

For this project, the project team sized the Downstream Defender® much more aggressively than recommended by Hydro International. The sizing rationale for this site was based on exceeding the design flow rate of 0.75 cfs at least once or twice a month. This approach was taken in order to increase the likelihood that the site would generate flows at or above the design flow and thereby generate performance data at and beyond the unit's design flow.

Once the Downstream Defender® was located and designed, applications were submitted to the City Common Council for approval. The council adopted Ordinance No. 327 on July 10, 2000, which granted permission for the project team to construct and install the Downstream Defender®. Additionally, during field reconnaissance several residents stopped to discuss the purpose of the work and the potential impacts to their street.

3 URBAN BMP IMPLEMETATION

A stormwater vortex unit was installed at 134 East Seneca Turnpike for the purpose of removing suspended solids and associated nutrients from the stormwater before discharge to Onondaga Creek. The catchment area serviced by this unit primarily encompasses a 1,000-feet length of East Seneca Turnpike and is approximately 1.2 acres in size. The unit is a 4-foot diameter Hydro International Downstream Defender® with a design flow of 0.75 cfs and a maximum capacity of 3.0 cfs. Figure 30 shows a portion of the catchment area and Figure 31 shows the unit during installation.

Installation of the Downstream Defender® was fairly simple, considering that the location of the stormwater sewer was on the edge of a busy city street. As a result of the location of the sewer, the unit was installed off-line instead of directly in-line with the sewer. This required removing a three-foot section of the sewer and replacing it with a diversion manhole. The diversion manhole was constructed with a weir wall that diverts flow out of the stormwater sewer and into the unit. Once the flow is processed through the unit it is piped back into the diversion manhole on the other side of the weir wall where it flows back into the stormwater sewer.

In general, construction of the Downstream Defender® proceeded as planned. However, pre-cast concrete components of both the Downstream Defender® and the diversion manhole were not cast to the specified dimensions. These components were not rejected but modified in the field to meet the specifications.

4 URBAN BMP WATER QUALITY MONITORING

During a sampling event, stormwater was sampled from the influent and effluent of the Downstream Defender® at the locations illustrated in Figure 38. During the first five events, these samples were taken with a US DH-81A sampler, which was specifically designed for sampling sediment in flowing water. A photo of the US DH-81A sampler is illustrated in Figure 39. Because there was some concern that the US DH-81A sampler was not taking representative samples of the sediment load, a Van Dorn sampler was used to sample during the last event. The Van Dorn sampler is illustrated in Figure 40. Grab samples from each location were taken at approximately 15-minute intervals throughout a rain event and attempts were made to collect the first flush of stormwater from each rain event. For each pair of influent and effluent samples, the influent sample was taken first and the effluent sample was taken second with approximately 1-2 minutes between the samples.

During the first four events, each influent and effluent grab sample was analyzed for TSS, phosphorus and nitrogen. During the last two events, only TSS was analyzed because there was no clear indication of nutrient removal, and the data from the first four events provided adequate information regarding nutrient runoff in this urban stormwater. Furthermore, during the last two events the laboratory procedures for TSS were changed to reflect the industry's new understanding of laboratory bias (USGS, 2000) with respect to heavy solids and the TSS analysis. In general, the original TSS analysis allowed the laboratory to spilt the primary sample for the purpose of performing the analysis with a single filter of size 24 or 42 mm. Research has shown that splitting stormwater samples that contain solids larger than 62 micron can bias the TSS results downward by as much 50% (USGS, 2000). The new TSS method (also known as ASTM 3977 Suspended Sediment Concentration) required the laboratory to filter the entire sample and not take a split or sub-sample.

The changes made to the sampling method and solids analysis appeared to increase the concentration of solids measured. It is likely that the data collected from the first five events were biased low due to the type of sampler used and the analysis method. Further more the influent samples were likely biased more than the effluent samples because of the higher percentage of coarse grit in the influent. Based on field observations, the effects of changing the sampling method were greater than the effects of changing the solids analysis. Due to time and budget constraints, comparative sampling was not completed. As a result influent versus effluent comparisons were made only for the sixth event when both the Van Doran sampler was used and the ASTM 3977 solids analysis were used.

Flow was measured continuously in the effluent pipe of the Downstream Defender® using a

Marsh McBirney depth/velocity flow meter and data logger, Model 260C. Rain was measured continuously with a tipping rain bucket with data logger. The rain gauge was installed on the roof of St. James School approximately 200 feet from the Downstream Defender®.

5 URBAN BMP DATA ANALYSIS

The stormwater vortex unit was monitored for just over a one-year period from March 2001 until May 2002, during which time approximately 40 inches of rain fell during the non-winter months. This equated to approximately 730,000 gallons of stormwater processed by the vortex unit. Also during this time approximately 100 cubic feet of material was removed from the vortex unit weighing an estimated 4,500 lbs. This equates to approximately 0.14 cubic feet, or 6 lbs of material captured per 1,000 gallons of stormwater processed. Most of the material removed from the vortex unit was sand and grit and organic material such as leaves and twigs. Relatively little trash was collected as a result of the grated catchbasins, which prevent trash from entering the stormwater conveyance system.

The vortex stormwater unit was installed in October of 2000. Only visual inspections were made from October 2000 to March of 2001 when the first cleaning occurred. Cleaning of the unit occurred after March 2001 on an as needed basis. Table 10 shows the dates of the cleanings, the amount of stormwater volume processed between cleanings and the amount of material removed from the unit.

Water quality sampling was conducted on six storm events beginning in July of 2001 and ending in April of 2002. However, due to non-representative sampling procedures and laboratory methods only samples collected during the sixth event are considered appropriate for influent versus effluent comparisons. During events 1 through 5 samples were taken with a US DH-81A sampler, which was specifically designed for sampling sediment in flowing water. Because there was some concern that the US DH-81A sampler was not taking representative samples of the sediment load, a Van Dorn sampler was used to sample during the last event. The amount and type of material collected during the sixth event with the Van Dorn sampler appeared to be significantly different than that collected with the US DH-81A during the first five events. A photo of the solids collected with the Van Dorn sampler from the influent during event six is presented in Figure 90. Coarse, medium and fine grit (3 to 0.075 mm) were apparent in the influent while mostly fine grit (< 0.2 mm) and silt material were apparent in the effluent. In addition, the solids concentrations measured during the sixth event were the highest observed throughout the sampling effort thus suggesting that the Van Dorn sampler was collecting more solids in the sample than the US DH-81A sampler.

Figures 84 through 89 show the hyetographs and hydrographs from each of the six sampled storm events. Peak flows by event ranged from 0.3 cfs to 1.9 cfs. The peak flow of 1.9 cfs was generated from approximately 0.35 inches of rain falling in a 15 minute time period. This equates to a rain intensity of 1.4 inches per hours, which is equivalent to approximately one-half the intensity of the 1-year return frequency storm for the City of Syracuse. As a frame of reference the 4-ft diameter Downstream Defender® design flow rate is 0.75 cfs and the maximum capacity is 3.0 cfs. The design flow of 0.75 cfs was exceeded during three of the six sampled storm events. As discussed in Section 4.3.1, a 4-ft diameter unit was installed so that the design flow would be exceeded approximately once or twice a month for the purposes of sampling the unit while it operated at or near the design conditions.

Figure 89 shows the hyetograph and hydrograph for event six as well as the influent and effluent solids concentrations observed for the samples taken during this event. Flows began at approximately 9:15 am on April 25, 2002. Sampling equipment was prepared and ready for sampling in advance. Three influent/effluent sample pairs were taken at flow rates ranging from 0.4 to 0.75 cfs. As the first flows were observed, the first pair of samples were taken. As the flow rate peaked to near the design flow (0.75 cfs) the second pair of samples were taken. The third samples were taken on the falling limb of the hydrograph. Percent removal ranged from 26% to 93%. The first sample appeared to be representative of a first flush; solids concentrations in the influent were the highest observed throughout the entire sampling program. The corresponding percent removal was on the order of 93%. High percent removals are often associated with the first flush because this flush conveys waters laden with heavy solids and associated pollutants.

During events five and six floatable material (trash) was seeded into the influent. The floatable material consisted of cigarette butts, food wrappers, Styrofoam cups and milk cartons. The vortex unit was effective at removing this material; no seeded material was observed in the effluent. During the cleanings that followed events five and six all the seeded material except for the cigarette butts were recovered. This should not necessarily indicate that the unit is ineffective at capturing cigarette butts. In fact, based on field observations, the unit does capture cigarette butts, but because of their size finding cigarette butts during cleaning proved difficult.

On August 21, 2001 and September 3, 2002 solids were sampled from the sediment storage sump of the Downstream Defender®. Nine percent of the material in the sump was characterized as course sand, 53% of the material was characterized as medium sand and 38% characterized was as fine sand, silt and clay. This suggests that the majority of the material influent to this particular installation is medium sand and smaller and the material captured by this particular unit ranges from coarse to fine sized sand and smaller. This is not to say this units captures 100% of any particular size material, but rather based on the contents of the storage sump it has the ability to capture coarse to fine sized sand and smaller material. Figure 90 illustrates the type and size of material found in both the influent and effluent of the unit during testing.

Also on September 3, 2002 samples from the sediment storage sump were collected and analyzed for metals and phosphorus. These results are presented in Table 11. These results show that there are pollutants such as metals and phosphorous associated with the types of solids that the Downstream Defender® successfully captured. Pounds of associated pollutants were calculated based on the total quantity of material (solids) captured by Downstream Defender® throughout the duration of this study period and based on the assumption that this one sample was representative of the total mass of material captured. Of particular interest was chromium, cooper, lead and total phosphorus. Pounds of these pollutant removed during this study period were estimated to be:

- Chromium: 0.29 lbs
- Copper: 0.14 lbs
- Lead: 0.76 lbs
- Phosphorus: 0.95 lbs *

It is likely that the mass of phosphorus captured by the Downstream Defender® was significantly greater than 0.95 pounds. This is based on the fact that this sample represented solids captured during the summer months when nutrient concentrations are assumed to be low. It is expected that nutrient concentrations would be significantly higher if the sample were collected after the heavy autumn leaf load. During cleaning after the fall seasons, heavy layers of leaf litter were apparent.

Maintenance is key to success with any structural BMP designed to remove solids from stormwater. Onondaga County removed the solids from the unit on an as needed basis. It was a very simple operation with the vactor truck. Cleanout of the diversion manhole and the unit itself took approximately 15 minutes, which included maneuvering the truck into position near the unit, drawing material up with the suction pipe of the vactor truck and pressure washing the solids from the bottom and sides.

6 URBAN BMP LESSONS LEARNED

In the urban setting, specifically with regards to the stormwater vortex unit, measuring solids presented challenges in terms of both sampling and laboratory analysis.

The originally proposed sampling procedure relied on the use of a submersible pump to draw stormwater from the sewer to the street level where sample bottles could be filled. When selecting the pump, factors such as pumping power and transport velocity were considered. It is important that the pumping power provide a transport velocity sufficient enough to keep solids in suspension, otherwise the solids in the stormwater will not be drawn with the water to the sampling location. An additional concern with pumping stormwater for the purpose of solids sampling is the issue of solids maceration; submersible pumps can break large solids apart and bias the analytical results. After discussions with the stormwater vortex manufacturer, it was decided not to use the pumps, but instead use a US DH-81A sampler, which was specifically designed for sampling sediment in flowing water. A photo of the US DH-81A sampler is illustrated in Figure 39.

The US DH-81A sampler was used during the first five events, but concerns developed regarding the representativeness of the samples. The US DH-81A sampler is essentially a sample bottle with a specially designed nozzle that allows the bottle to be oriented in a horizontal position without losing the sample. Both the bottom of the sample bottle and the nozzle create increased flow pressure, which results in water flowing around the sample bottle and not into the bottle. As a result of the concern that the US DH-81A sampler was not taking representative samples of the sediment load, a Van Dorn sampler was used to sample during the last event. The Van Dorn sampler is illustrated in Figure 40.

The Van Dorn sampler is essentially an open tube that has two end caps that can close instantaneously. When using in a storm sewer, the end caps are in the opened position allowing water to flow freely through the tube. The end caps are then closed, trapping a sample of water within the tube. This appears to have an advantage over a sample bottle because significant pressure increases are not induced. In comparison to the submersible sampling pumps, transport velocity and solids maceration are no longer issues.

The originally proposed solids analysis was Total Suspended Solids (USEPA 160.3). However this analysis was changed to reflect the industry's new understanding of laboratory bias (USGS, 2000) with respect to heavy solids and the TSS analysis. In general, the original TSS analysis allowed the laboratory to spilt the primary sample for the purpose of performing the analysis with a single filter of size 24 or 42 mm. Research has shown that splitting stormwater samples with heavy solids can bias the TSS results downward by as much 50% (USGS, 2000). The new TSS method (also know as ASTM 3977 Suspended Sediment Concentration) required the laboratory to filter the entire sample and not take a split or sub-sample. It appears that the ASTM 3977 Suspended Sediment Concentration has an advantage over the USEPA 160.3 Total Suspended Solids method because it eliminates sampling splitting; in general the less a sample is handled and manipulated the more representative it is. Because federal and state effluent discharge permits are written to include USEPA 160.3 Total Suspended Solids, both of these analyses should be run simultaneously until enough data are collected to the presence or absence of laboratory bias.

7 URBAN BMP CONCLUSIONS

The costs of the urban stormwater vortex unit and vegetative filter strip were $34,000 and $6,000, respectively. The cost difference reflects the degree of capital improvements involved.

The urban BMPs were effective at removing solids from stormwater, but not at removing nutrients. This is likely due to the low concentration of nutrients influent to these BMPs. This may suggest that in certain urban environments, such as parking lots and city streets, nutrient runoff is not a priority pollutant.

The stormwater vortex unit worked as expected; it was easy to maintain and it collected coarse, medium and fine sized grit (4.75 mm to .075 mm) and trash. The stormwater vortex unit removed approximately 0.14 cubic feet and 6 lbs of material per 1,000 gallons of stormwater processed. The water quality-sampling program had limitations because the original sampling equipment and laboratory analysis were not appropriate for stormwater with coarse and medium sized grit content (> 0.15 mm).

The vegetative filter strip generally worked as expected; it was easy to maintain and it absorbed much of the runoff from the parking lot. However, it was a source (i.e., exporter) of nutrients. The source of the nutrients was likely the compost used to fertilize and establish vegetation. In light of the fact that the effluent nutrient concentrations were low as compared local receiving water concentrations, the increase in nutrients from influent to effluent was likely apparent because of the very low influent concentrations. The vegetative filter strip, which was approximately 150 square yards could absorb approximately 1.0 inch of rain before runoff exceeded its infiltration capacity.

8 URBAN BMP RECOMMENDATIONS

Stormwater vortex units should be installed at selected points in the urban setting to capture solids and trash. Nutrient capture may be limited due to the relatively low concentrations in the runoff from parking lots and city streets.

Consideration should be given to maximizing the size of vortex sediment storage sump to maximize storage and thereby reduce maintenance frequency. A cost analysis should be performed comparing the expense of deepening the sump versus the costs incurred by additional maintenance time.

Retrofitting a vegetative filter strip into an existing urban setting may prove difficult to site. However, constructing strips in new developments may provide many advantages including increasing green space and reducing stormwater volume through infiltration.

Measuring solids in stormwater samples presented some challenges both in terms of sampling and in analytical procedures. In the future, when heavy solids in stormwater are an issue it is recommended that a volume sampler (e.g. Van Dorn sampler) be used. Analytical procedures should also be appropriate to quantify the heavy solids.

9 REFERENCES

USGS, 2000. Comparability of Suspended-Sediment Concentration and Total Suspended Solids Data By John R. Gray, G. Douglas Glysson, Lisa M. Turcios, and Gregory E. Schwarz. Water-Resources Investigation Report 00-4191.

Date of Cleaning	Volume of Stormwater Processed (gallons)	Volume of Material Removed (cubic feet)	Notes
March 1, 2001	NA	20	Not cleaned since installation. Filled beyond capacity. Obvious layer of leaf liter from fall foliage. Influent diversion manhole filled with heavy grit and effluent diversion manhole filled with fine silty material.
June 25, 2001	227,899	19	Unit filled to near capacity. Influent diversion manhole filled with heavy grit and effluent diversion manhole filled with fine silty material.
August 21, 2001	95,757	17	Unit filled to near capacity. Influent diversion manhole full. Effluent diversion manhole relatively clean.
November 30, 2001	184,998	19	Unit filled to near capacity. Influent diversion manhole filled with heavy grit and effluent diversion manhole filled with fine silty material.
March 13, 2002	7,965	20	Filled beyond capacity because of winter build-up of road sand. Influent diversion manhole filled with heavy grit and effluent diversion manhole filled with fine silty material.
April 8, 2002	53,219	15	Unit filled to near capacity. Influent diversion manhole full. Effluent diversion manhole relatively clean.
June 5, 2002	167,802	17	Unit filled to near capacity. Influent diversion manhole full. Effluent diversion manhole relatively clean.
Total	**737,640**	**107**	

Notes: March 1, 2001 not included in totals. Evaluation started on March 1, 2001.

The mass of the material captured (4,500 lbs) was estimated based on volume removed and specific gravity of material.

During the period from November 30, 2001 and March 13, 2002 the unit processed stormwater derived from, which was not included in the 7,965 gallons.

During this period approximately 50 inches of snow fell with a water equivalence of 3.8 inches.

Percent Passing Sieve	
#4	98
#10	91
#30	53
#40	38
#60	18
#100	9
#200	4

Parameter	Result (mg/kg)	Mass of Pollutant* (lbs)
Arsenic	2.1	0.01
Barium	30	0.13
Cadmium	2	0.01
Chromium	65	0.29
Copper	31	0.14
Lead	170	0.76
Mercury	0.2	0.00
Nickel	9	0.04
Selenium	0.8	0.00
Silver	2	0.01
Zinc	180	0.81
Total Phos	210	0.94

Note: * Mass Pollutant Captured based on 4,500 lbs total Solids Captured During Study Period

CONTRACT DRAWINGS

ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

EAST SENECA TURNPIKE DOWNSTREAM DEFENDER
ONONDAGA COUNTY, NEW YORK

CENTRAL NEW YORK
REGIONAL PLANNING AND DEVELOPMENT BOARD

INDEX OF DRAWINGS

DD-1 AREA MAP (TITLE SHEET)
DD-2 LAYOUT DETAILS
DD-3 MANHOLE DIVERSION DETAILS
DD-4 GENERAL ARRANGEMENT DETAILS

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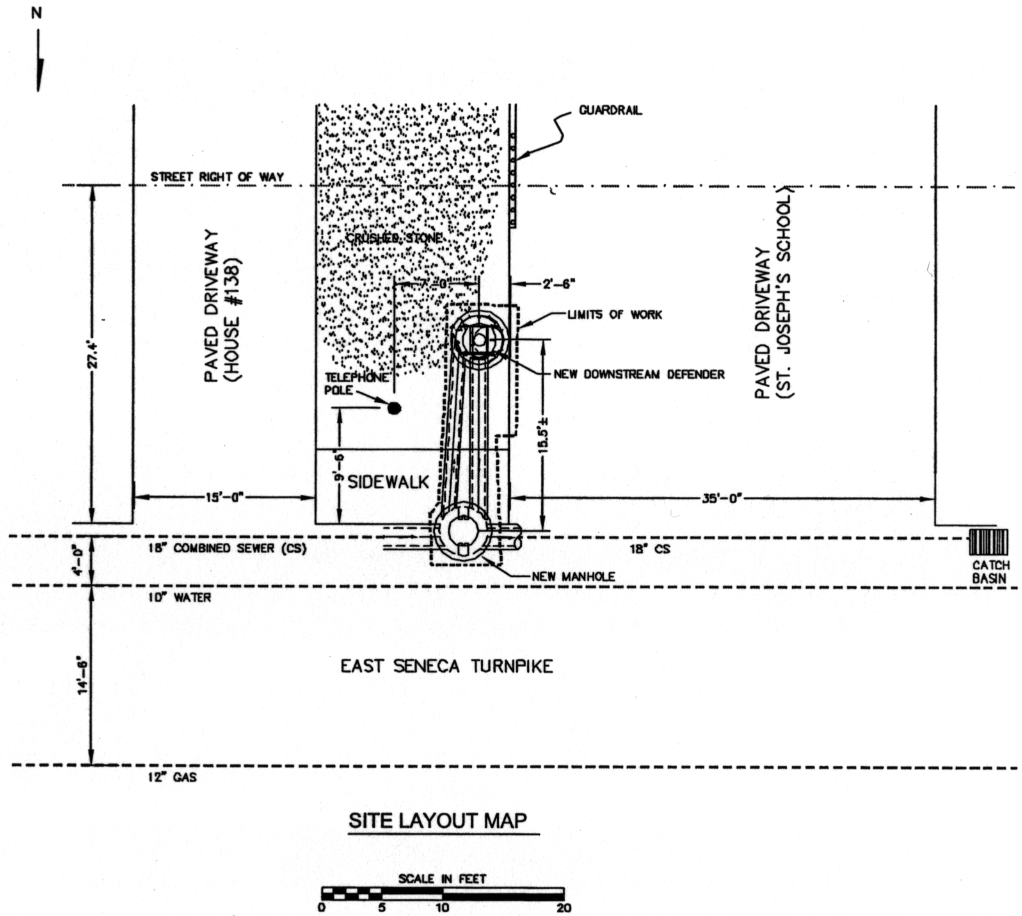


Moffa & Associates
A unit of BROWN AND CALDWELL

Onondaga Lake Watershed, Nonpoint Source EBP
East Seneca Turnpike and Downstream Defender Location

Figure 7

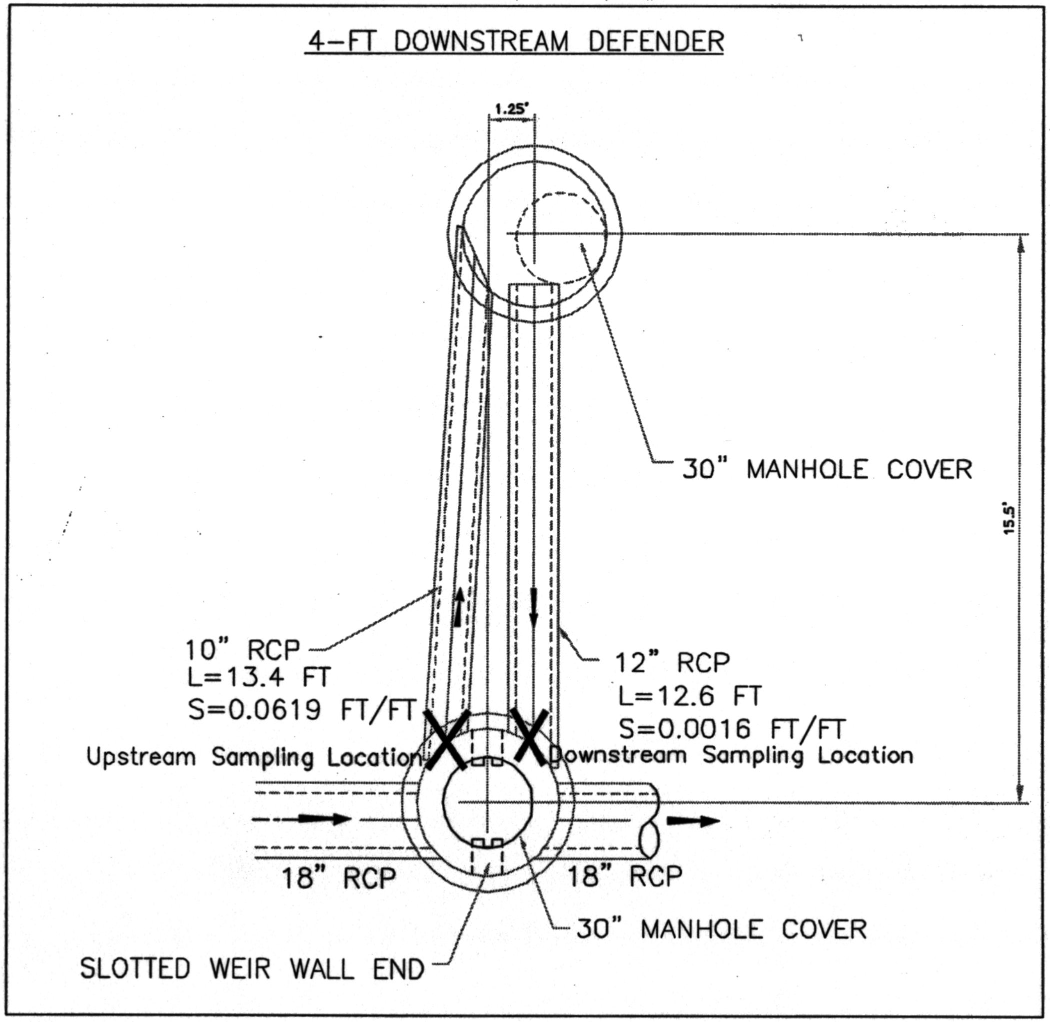
Stormwater Vortex Unit Catchment Area

Stormwater Vortex Unit Installation

Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Stormwater Vortex Unit Catchment Area and Unit Installation

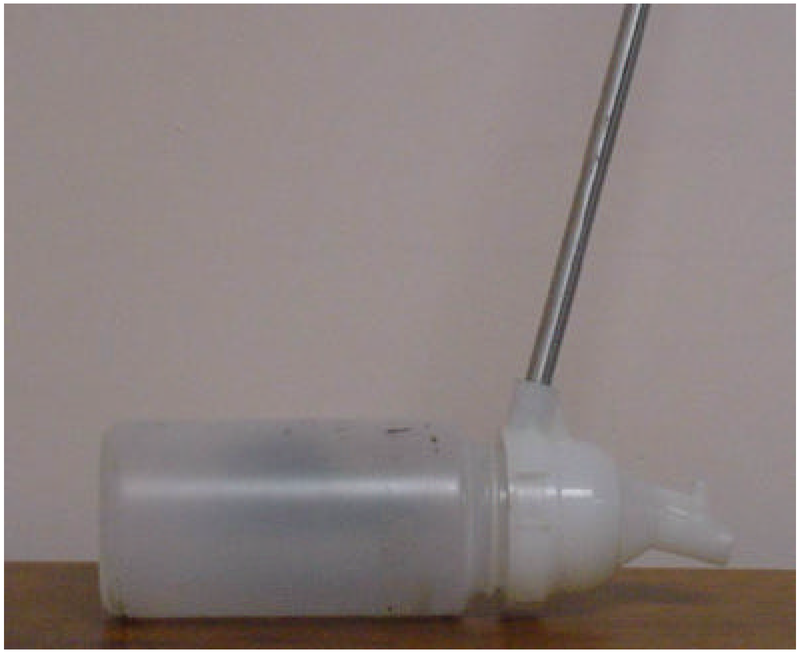
Figures 30 & 31



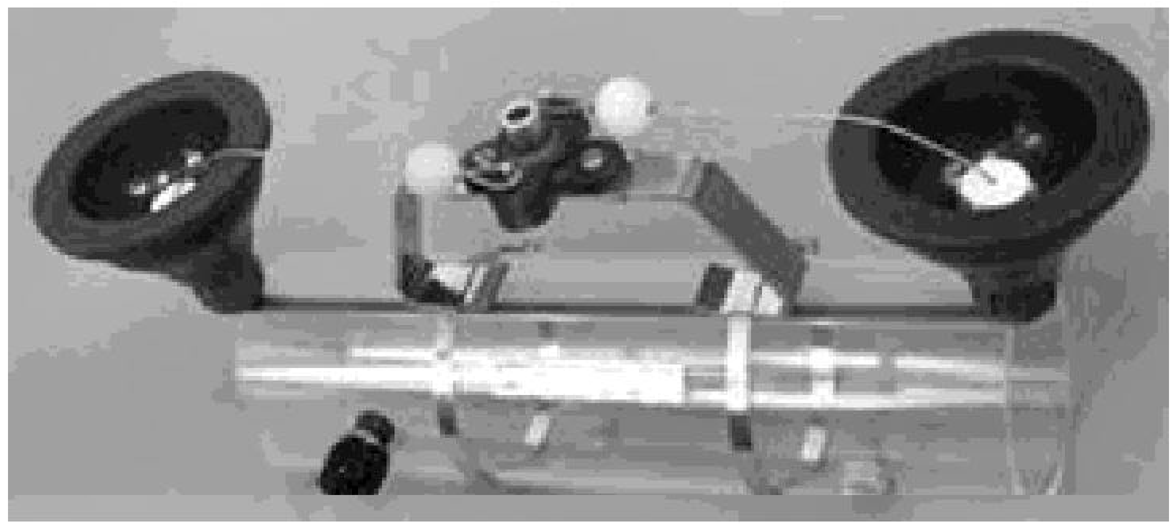
Moffa & Associates
A unit of BROWN AND CALDWELL

Onondaga Lake Watershed, Nonpoint Source EBP
Downstream Defender Layout with Sampling Locations

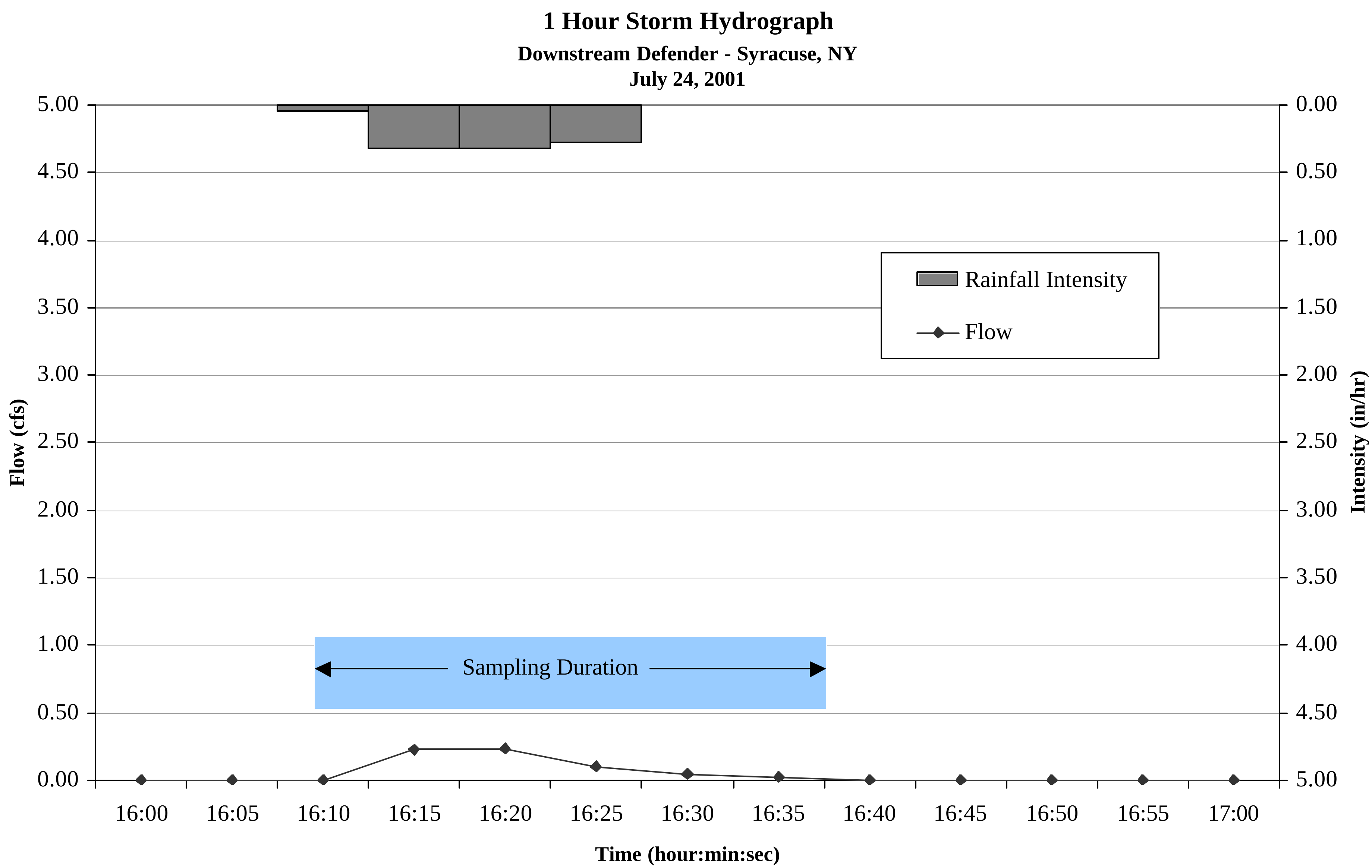
Figure 38



US DH-81A Sampler



Van Dorn Sampler



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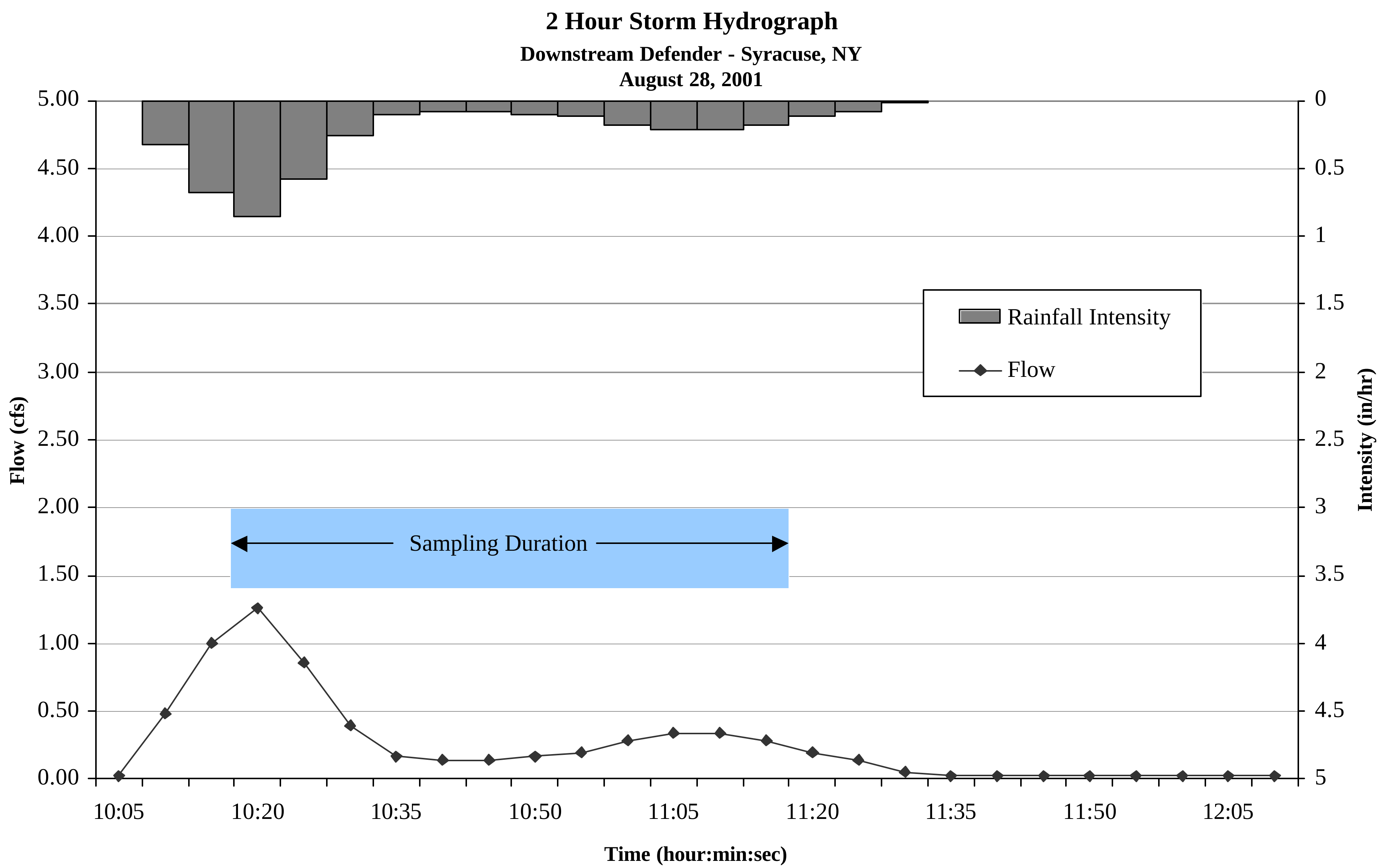
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
1 Hour Storm Hydrograph-Downstream Defender - July 24, 2001

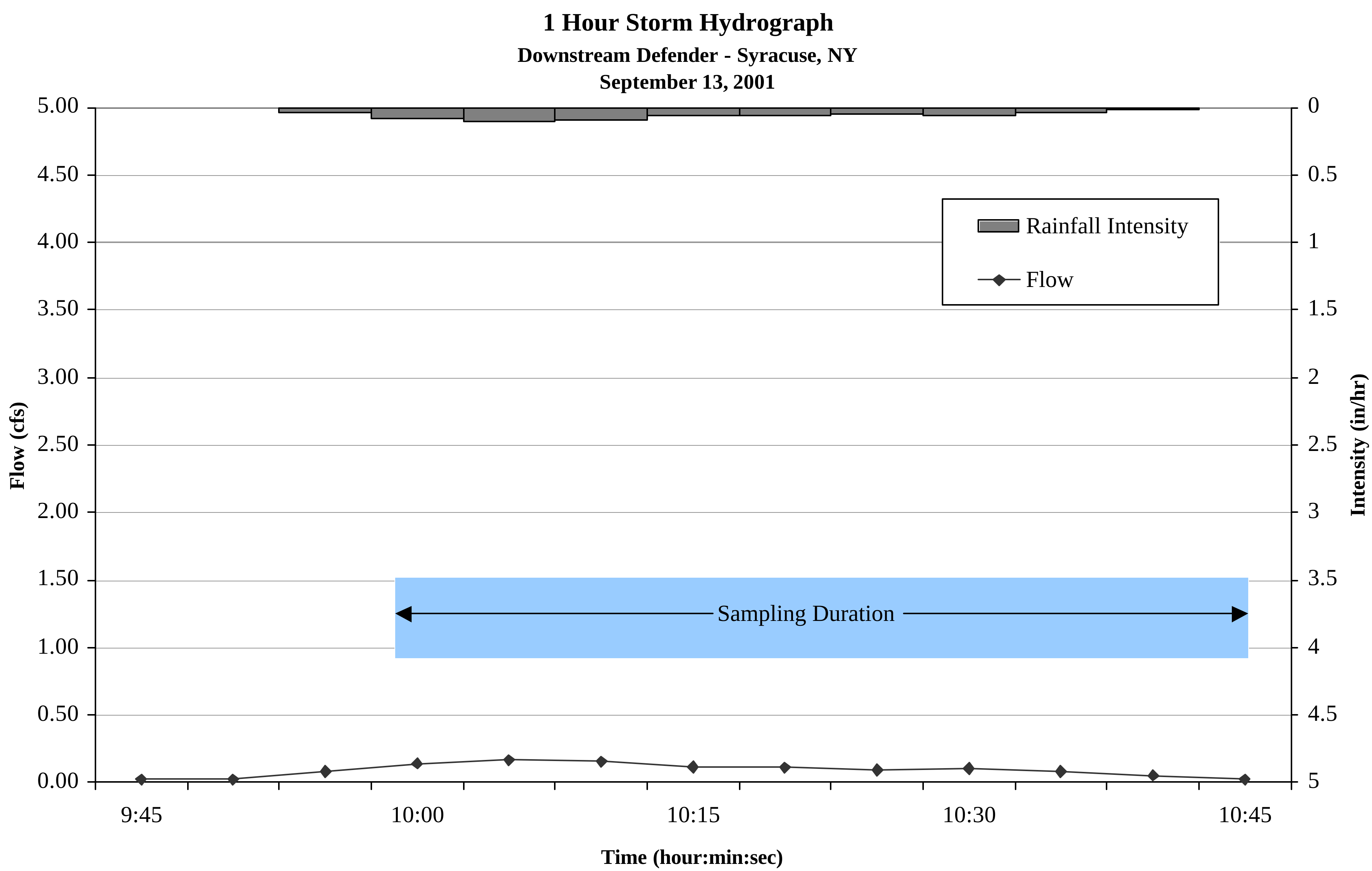
Figure 84



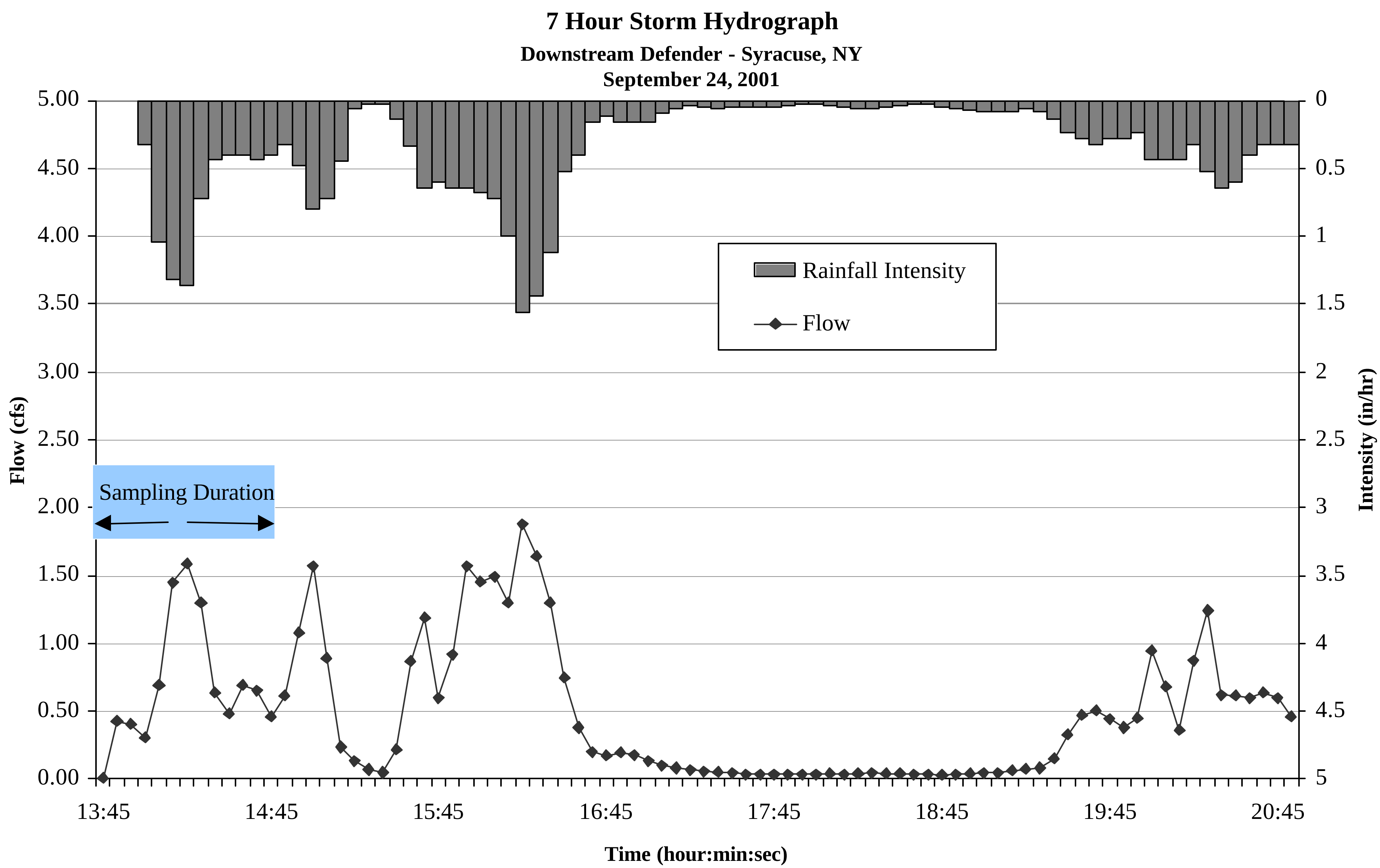
Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
2 Hour Storm Hydrograph-Downstream Defender -August 28, 2001

Figure 85



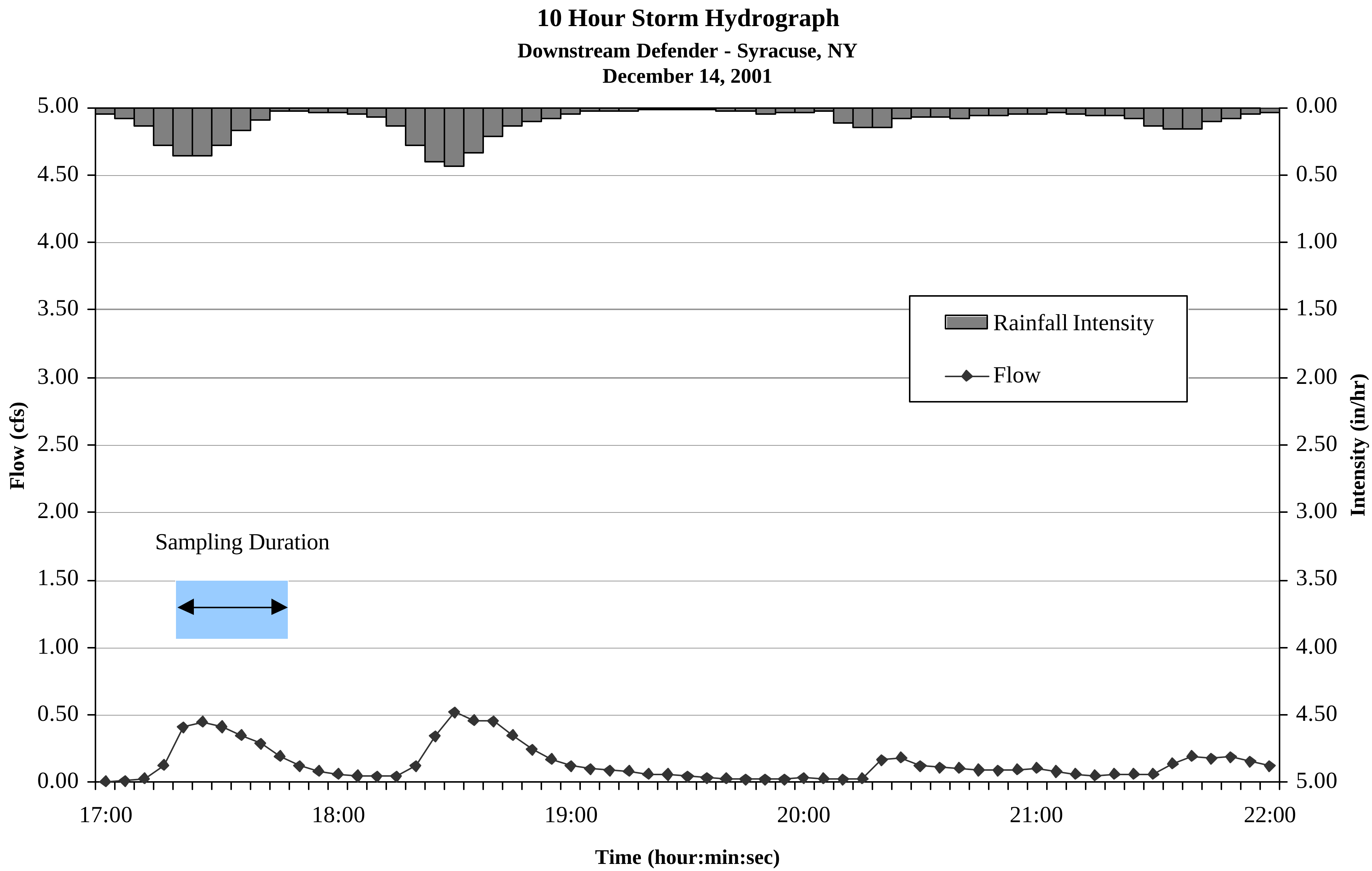
Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **1 Hour Storm Hydrograph-Downstream Defender-September 13, 2001**	**Figure 86**



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
7 Hour Storm Hydrograph-Downstream Defender-September 24, 2001

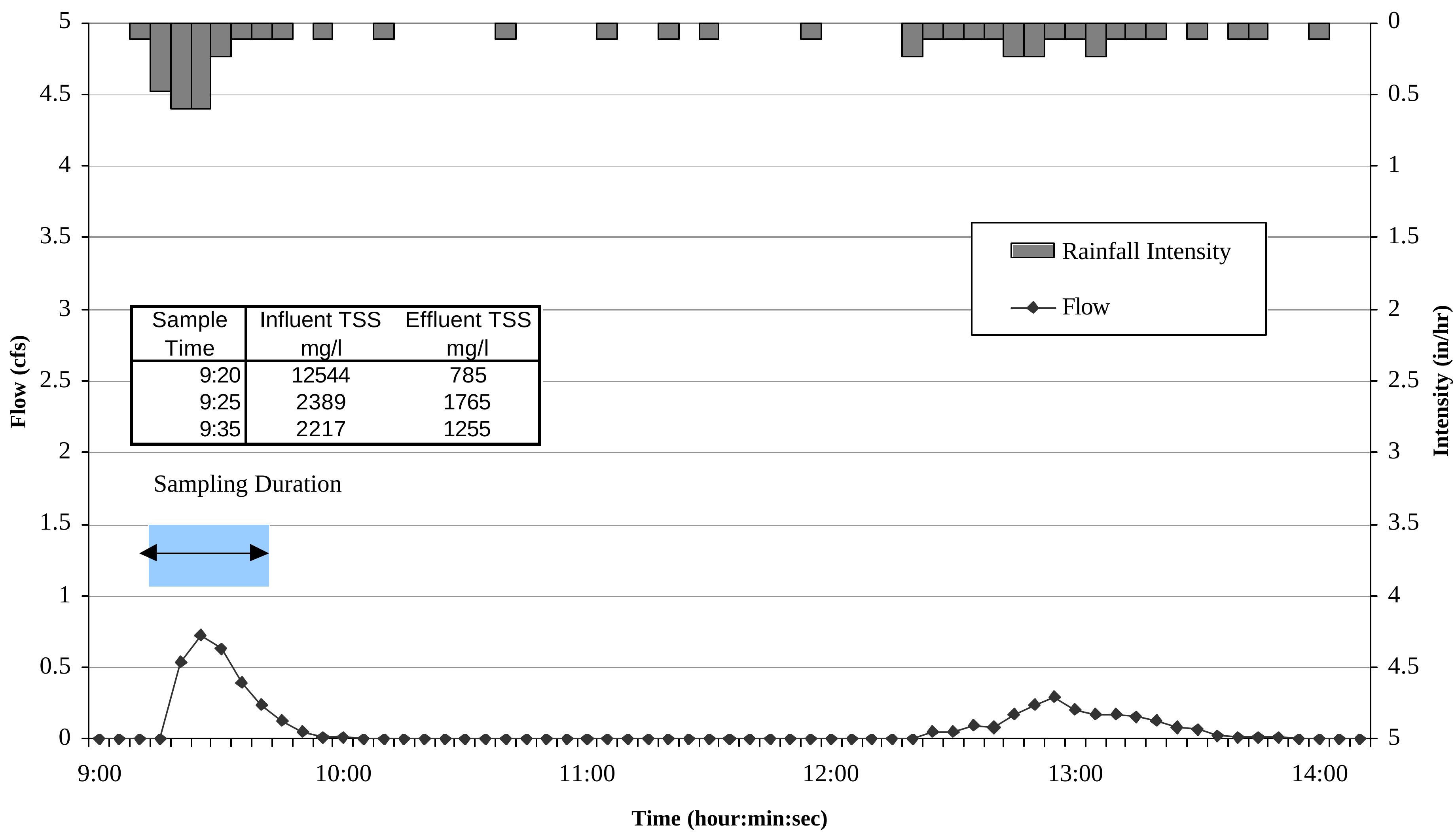
Figure 87



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
10 Hour Storm Hydrograph-Downstream Defender-December 14, 2001

Figure 88



Sample Time	Influent TSS mg/l	Effluent TSS mg/l
9:20	12544	785
9:25	2389	1765
9:35	2217	1255

Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
5 Hour Storm Hydrograph-Downstream Defender-April 25, 2002

Figure 89

Influent Stormwater Vortex Unit Solids Sample: Coarse to Medium Grit

Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **Influent and Effluent Solids - Downstream Defender-April 25, 2002**	**Figure 90**