Assessing Performance Characteristics of Sediment Basins Constructed in Franklin County

Summary Report of ALDOT Project 930-791

By Xing Fang, Wesley C. Zech, Christopher P. Logan, and T. Prabhakar Clement

1. Introduction

The objective of the study was to monitor and document the performance of newly designed sediment basins that were constructed for the 502 project in Franklin County. The following tasks were proposed by the research team to achieve the objective:

Task 1 – Assess performance characteristics of sediment basins on the 502 project

Task 2 – Collect cost data and perform a literature review

Task 3 – Survey of the current state-of-the-practice

Task 4 – Prepare final project reports documenting the findings.

For Task 1, originally five sediment basins were planned to be constructed on the 502 project. Basins 2, 3, and 5 were omitted by ALDOT due to unfavorable site conditions. Sediment basin 1 was constructed in March and April of 2011, but wet weather conditions at the location where the basin was constructed prevented researchers from properly installing the data collection equipment after the basin was initially built; therefore basin 1 was not monitored. All data collection for Task 1 was performed on sediment basin 4 at the 502 construction project in Franklin County.

2. Sediment Basin 4

The basin 4 was located in a fill section between 919+00 and 921+00. The size of basin 4 (Fig. 1) was originally designed to accommodate 670 yd^3 (18,090 ft^3) of stormwater. The bottom length and width of the basin were designed as 76 ft and 23 ft. The side slopes of the basin were designed as 3:1 (H:V), and the basin depth was designed as 5 ft. A minor field adjustment during construction added an extra 1.5 ft of depth (i.e., sediment and dead storage) – adding 97 yd^3 (2,622 ft^3) of additional volume of storage to the basin. The dead storage was a 1.5 ft deep rectangular basin that had original design bottom length and width (76 ft by 23 ft). Using these dimensions, the total computed storage volume equals 751.4 yd^3 (20,287 ft^3) which is larger than the originally designed storage of 670 yd^3 for the basin.

Considering the total contributing watershed area, 9.2 acres, intended to drain into the sediment basin, the storage provided by the basin was calculated to be approximately 2,203 ft^3/acre. Discounting the 97 yd^3 additional storage added during construction, the original sediment basin design provided 1,918 ft^3/acre of storage. Based on these calculations, the sediment basin was originally designed and sized using the out-of-date minimum sediment basin storage design standard to provide 1,800 ft^3/acre of contributing area draining into the basin.

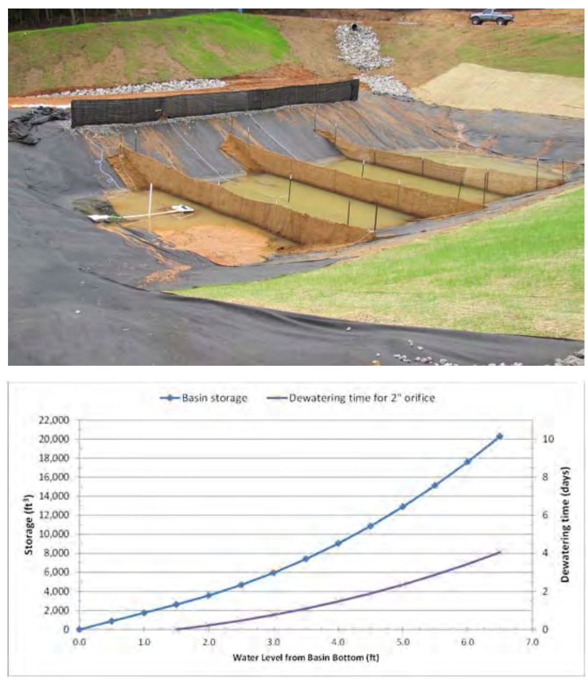


Figure 1. Sediment basin 4 with a 2.5 in. Faircloth skimmer after construction (top) and storage and dewatering time at different water levels (bottom).

A 2.5 inches (in.) Faircloth skimmer®, which had a maximum 2.5 in. orifice size, was used as a primary dewatering or outflow control device for the basin. The skimmer was positioned 1.5 ft above the basin bottom (or just above the dead storage) when the basin was empty. The stormwater in the basin flows through the skimmer orifice to a 2.5 in. short pipe section (19 in. long), then to a 1.5 in. PVC long pipe (70 in. long), followed by a 4 in. short pipe section, and finally flows through a 6 in. pipe for outflow (Fig. 1). Therefore, the effective orifice opening for 2.5 in. Faircloth skimmer was unknown due to the flow restriction of 1.5 in. of PVC pipe. The flow rate from the skimmer was measured in the field using a bucket that holds 1.281 gallons of water when full, and the average fill time was 3.397 seconds from repeating to fill the bucket for 10 times. The outflow rate calculated for the skimmer was 22.6 gpm or 0.05 ft^3/s, which is almost equivalent to flow rate of a 2 in. orifice opening using standard equations provided by skimmer manufacturer J.W. Faircloth & Son Inc. Figure 1 shows dewatering time of the basin 4 at different water levels, and the dewatering time varies with the water level inside the basin. When the basin is full (6.5 ft depth), the dewatering time is 4.1 days (or 97.3 hours) to discharge a total of 17,655 ft^3 or 754.3 yd^3 (excluding dead storage) stormwater runoff from the basin.

3. Highlights of Literature Review

A few major parameters must be carefully considered when designing a sediment basin. One such parameter is the size of the basin. The usual methods of regulating sediment basins are through performance standards, which specify effluent concentrations, and/or hydraulic design standards (Millen et al. 1997). According to hydraulic standards, sufficient volume must be provided to store sediment-laden runoff water so that the suspended sediment has time to settle from the water (Millen et al. 1997; Bidelspach et al. 2004). In the 2006 edition of the Alabama Handbook (ASWCC 2006), a sediment basin should be designed to capture at least 0.5 in. of runoff per acre of drainage area, which is equivalent to capturing 1,800 ft^3/acre of stormwater from the contributing drainage area and was adopted from NCDOT design standards (NCDOT 2006). A new design standard (ASWCC 2009), adopted by the state of Alabama, required capturing 3,600 ft^3/acre of stormwater from the contributing drainage area (ADEM 2011), or 1.0 inch of runoff per acre of disturbed area for sediment basins that serve an area with 10 or more disturbed acres at one time (Kalainesan et al. 2008). US EPA's Construction General Permit (CGP) requires a sediment basin to provide storage for either: (1) the calculated volume of runoff from 2-yr, 24-hr storm or (2) 3,600 cubic feet per acre drained.

Different rainfall depths falling on contributing areas with different antecedent moisture contents, surface covers, and soil types could produce the one inch of runoff from disturbed areas. Therefore, sizing sediment basins based on either 1,800 ft^3/acre or 3,600 ft^3/acre of disturbed area does not give designers and stormwater managers any idea of the risk the sediment basin would have for not providing adequate storage during the lifespan of the basin under various rainfall events.

To size a basin properly, one must determine the particular local design storm event that is being considered for the site. The most common storm event that is factored into sediment basin design is a 2-yr, 24-hr event for the basin and 10-yr, 24-hr event for the emergency spillway. For any hydrologic design, the probability *R*, called risk, that a *T*-year design storm will be equaled or exceeded at least once in *n* successive years, is defined by equation (1) (Viessman and Lewis 2003).

$$R = 1 - \left(1 - \frac{1}{T}\right)^n \quad (1)$$

In Franklin County, AL, a 2-yr, 24-hr and 10-yr 24-hr storms have a rainfall depth of **3.9 and 5.6 inches**, respectively. If a sediment basin is designed using 3.9 in. rainfall depth, the risk that the basin will be overflowed for the next 2 year (*n* = 2) is 75% based on the equation (1).

To properly calculate the runoff volume for the design storm, it is necessary to select or use appropriate methods to compute effective rainfall depth after considering various rainfall losses. There are many factors affecting rainfall losses for converting rainfall into runoff. The major factors affecting runoff generated from a rain event are rainfall, antecedent moisture content, surface cover, and soils (Pitt et al. 2007).

For the first step in sizing a sediment basin, an estimate of runoff volume in mm or inches is needed. Volumetric runoff coefficient R_v (Pitt et al. 2007; Dhakal et al. 2012) and NRCS curve number (CN) (NRCS 1986) can be used to compute runoff or effective rainfall for small watersheds such as construction sites. Pitt et al. (2007) recommends use of the SCS (NRCS) TR-55 method for construction site hydrology evaluations. The runoff depth in TR-55 is calculated using Equation (2) as (NRCS 1986):

$$Q = \frac{[P - 0.2(1000 / CN - 10)]^2}{P + 0.8(1000 / CN - 10)} \quad (2)$$

where Q is the runoff depth in inches, P is the gross rainfall depth of a design storm, and CN is curve number as function of land use, hydrologic soil group, and antecedent soil moisture conditions (NRCS 1986; Viessman and Lewis 2003). For example, newly graded construction areas (no vegetation) with soils of the hydrologic soil group C have a curve number CN = 91 (NRCS 1986; Pitt et al. 2007). For 3.9 in. and 5.6 in. design storms in Franklin County, the runoff depths are 2.9 in. and 4.6 in., respectively, when CN = 91 is used. Therefore, sizing a basin solely on the 1,800 or 3,600 ft^3/acre (*i.e.* 0.5 or 1 in. of stormwater runoff) standard procedures most likely results in insufficient basin volume leading to frequent overflow through the basin's emergency spillway that can result in a large amount of eroded sediments being discharged to downstream receiving waters.

4. Results of State-of-the-Practice Survey

The objective of the survey was to establish the state-of-the-practice nationwide in regards to how state highway agencies (SHAs) in the U.S. are using sediment basins on highway construction projects. The survey consisted of 68 possible questions in six categories: *A. Background and Experience, B. Design, C. Construction, D. Maintenance of Sediment Basins during Construction, E. Inspection and Monitoring, and F. Lessons Learned.* Most of the questions were structured in a multiple-choice format. Several of the multiple choice questions allowed respondents to check more than one answer if it applied to their agency, therefore the sum of some percentages may exceed 100%. Comment boxes were included on some questions to allow respondents to further explain or clarify individual responses. The survey was electronically distributed via Qualtrics® survey software in August of 2011. A total of 37 responses (74% response rate) were received from 50 SHAs.

Though a majority of the responding SHAs use sediment basins as a sediment control measure, there is a wide variety in practices being used for the construction, maintenance, and inspection of sediment basins, each showing different levels of experience with successes and limitations to overcome. Often considered to be a leader in the industry, NCDOT has been referred to as the agency for being on the cutting edge of erosion and sediment control practices. However, not all states can directly benefit from NCDOT research and technology by copying the NCDOT protocol, as soil types, topography, and geographic considerations play a large role in decision making for sediment basin designs and applications. Therefore, many states use different systems of erosion and sediment control Best Management Practices (BMPs) that best suit the conditions typically experienced in that state. In addition to soil types, some of the different practices may be attributed to rainfall intensity and frequency, and ROW availability.

Significant findings from the survey show that the typical design life of a sediment basin for a construction site is between 6 months and 2 years. The generally accepted minimum storage volumes among most agencies is 3,600 ft^3/acre of disturbed area draining to the basin, and most agencies do not have a limit on the maximum watershed area for sediment basin design. In addition, most states use a minimum 2:1 length to width ratio in basin design but do not have a standard maximum length to width ratio. Seventy-five to eighty percent of all responding agencies did not specify a minimum or maximum value for inflow channel slope. Perforated risers are the most commonly used dewatering device, though it has been proven to be inefficient due to the fact that it dewaters the entire water column at once. Thirteen agencies (39%) out of the 37 responding agencies having experience with sediment basins use flocculant additives to enhance the basin's efficiency. The use of baffles within sediment basin is split among the responding agencies, however most agencies that do use baffles do not require contractors to maintain or replace them during the active use of the basin.

All responding agencies with sediment basin experience recommended that basin maintenance should be performed, and 85% of those recommend that basin cleanout should occur when the sediment basin loses 50% or less of its sediment storage capacity. Most importantly, it is notable that few agencies actually monitor or collect data from sediment basins. For agencies to improve upon current sediment basin designs and functionality, it will be important to monitor and collect basin data to gain an in-depth understanding of overall sediment basin performance and effectiveness.

5. Methods of Data Collection

A data collection plan was developed and implemented in the sediment basin 4 for collecting various data to assess the performance of the basin. Five ISCO 6712 portable automatic stormwater samplers (*i.e.*, samplers A, B, C, D, and E in Fig. 2) were used to take stormwater samples at the following locations: inflow (samplers A and B), within the sediment basin (samplers D and E), and outflow (sampler C). Sampler C was connected to an ISCO tipping bucket rain gauge (Fig. 2) to monitor the rain events on-site, giving accurate time stamped information regarding rainfall amounts and intensity.

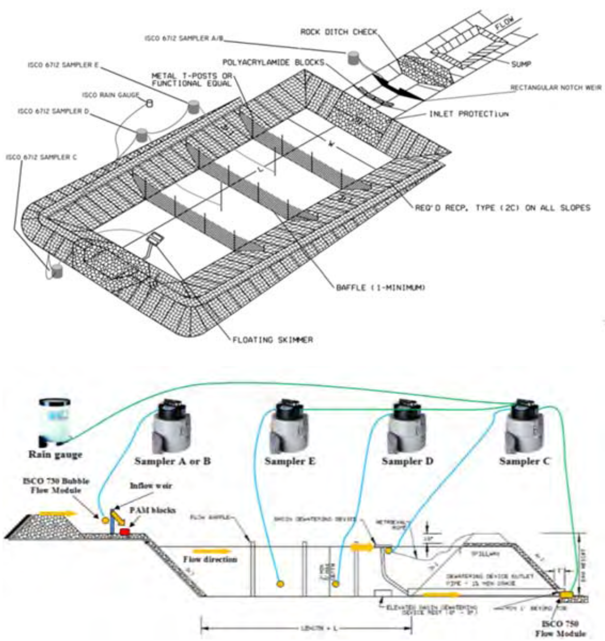


Figure 2. Data collection equipment setup used for the basin 4: (A) isometric view and (B) profile view.

The ISCO 730 Bubbler Flow Module was used to collect necessary data to determine inflow discharge and volume. Upstream of the sediment basin and following the rock ditch check dam, a rectangular notched weir was installed in each channel to gauge inflow into the basin (Fig. 2). An ISCO 750 Area Velocity Flow Module, mounted with a spring ring inside a 6-inch outflow pipe connected to a Faircloth Skimmer, was used to monitor the outflow.

Inflow sampler A took a 0.25L sample for every 50 ft^3 of inflow passing over the weir in the secondary inflow channel, and inflow sampler B took a 0.25L sample for every 150 ft^3 of inflow passing over the weir in primary inflow channel, because inflow volume is typically much larger from the primary inflow channel than from the secondary inflow channel. For each inflow sampler (A and B), four 0.25L were collected in a single 1L container to create a composite stormwater sample to provide a measure of incoming water quality over the course of a rainfall event. Sampler C (Fig. 2) was activated once 0.002 ft^3/s of outflow was detected by the flow module inserted into the outlet pipe of the skimmer and pulled a stormwater sample from just below the intake orifice of the Faircloth skimmer. Sampler C collected a total of 24, 1L stormwater samples when the program was completely finished over 23 hours. Two other ISCO 6712 sampler units (Sampler D and Sampler E) were positioned within the sediment basin to collect water quality samples from the minimum water depth of 1.5 ft from the bottom of the basin. Samplers D and E were connected directly to Sampler C via a special made "Y-cable", therefore, Sampler D and Sampler E were triggered to draw a stormwater sample in sequential order after Sampler C had completed each sampling cycle.

An initial, pre-evaluation survey of the basin 4 was performed by ALDOT surveyors immediately after basin construction and prior to the deployment of ISCO sampling units to establish a baseline volume for the sediment basin. A post-evaluation survey was conducted at the end of the monitoring period for the basin to establish the amount of sediment captured. To obtain data on sediment deposited in the basin, samples were taken in the middle of each bay, with respect to length of the basin. Total 12 sediment samples were collected in the basin (3 samples in each bay separated by three baffles).

Using the stormwater samples collected by the ISCO 6712 samplers, an evaluation of turbidity in NTU was performed in the laboratory using the HACH 2100Q Portable Turbidimeter according to instructions given in the "Sample Dilution" section. Total suspended solids (TSS) (mg/L) of each sample was determined using vacuum filtration according to the "Determining Total Suspended Solids" section of HACH Method 8366.

6. Results of Data Analysis

The overall data collection effort for the sediment basin 4 in Franklin County was divided into two phases. In Phase 1, a single inflow channel (called the secondary inflow channel during Phase 2) was constructed to carry stormwater into the sediment basin, and in Phase 2, there were two inflow channels with the newly added inflow channel acting as the primary inflow channel. Automatic ISCO 6712 samplers collected 10 sets of inflow data (4 sets were incomplete or may not be accurate due to weir installation issues) and 21 sets of stormwater samples inside the basin and at the outflow that provide valuable information for the data analyses and support recommendations for the study. Retained sediment volume for the basin 4 was 62.9 yd^3 (1,698 ft^3) that was resulted from sediment-laden runoff generated from rainfall events from 9/13/2011 to 4/26/2012.

Phase 1 data collection was performed from 9/26/2011 to 12/29/2011, shortly after construction of the sediment basin with a single inflow channel. Two conditions (Table 1) were observed during the Phase 1 data collection effort: (1) correct PAM placement in the inflow channel, and (2) incorrect (*i.e.*, wrong type) PAM placement in the inflow channel. Inflow turbidity was as high as 10,656 NTU (average of 5,855 NTU, Table 1) for the rainfall event on 11/16/2011 when there was little vegetation or ground cover (*i.e.*, approximately 10%) at the early phase of the construction. Inflow turbidity was only up to 2,724 NTU (average of 1,989 NTU, Table 1) for the rainfall event on 12/05/2011 when ground cover was about 25% after some vegetative growth. When the correct PAM was used, it took about 20 hours (Table 2) for basin turbidity resulted from the event on 11/16/2011 to reach 280 NTU. When the wrong PAM was used by contractor, it took up to 45 hours (Table 2) for basin turbidity resulted from the event on 12/05/2011 to reach 280 NTU.

Table 1: Phase 1 inflow data for different PAM treatment types.

Date	Number of data	Turbidity (NTU)				TSS (mg/L)			
		Max	Min	Avg.	Std. Dev.	Max	Min	Avg.	Std. Dev.
11/16/2011 [1]	23	10,656	1,030	5,855	2,582	10,545	790	5,430	2,689
12/05/2011 [2]	21	2,724	878	1,989	446	1,950	465	1,305	380

Note: [1] – *With PAM* in the inflow channels, [2] – with *wrong PAM* in the inflow channels.

Table 2: Phase 1 sediment basin performance comparison of *w/PAM* and *w/wrong PAM* conditions using elapsed time from peak turbidity to 280 NTU.

Location/ Parameters	PAM Conditions					
	w/PAM			*w/wrong PAM*		
	Max. Turbidity[1]	Ending Turbidity[2]	Time (hr.) to 280 NTU[3]	Max. Turbidity[1]	Ending Turbidity[2]	Time (hr.) to 280 NTU[3]
Bay 2	5,592	235	19.0	1,642	590	32.6
Bay 3	3,856	247	20.4	1,552	615	36.0
Outflow	1,646	239	**19.0**	1,112	593	**45.3**

Note: [1] – Maximum measured turbidity (NTU) from stormwater samples collected (for some cases, it may not be the real maximum turbidity during or immediately after the rain event),

[2] – Turbidity at the end of data collection (typically about 24 hours) for single rain event or minimum turbidity just before turbidity had a large increase due to the second rain event,

[3] – Time in hours from the maximum turbidity occurred and elapsed time is either interpolated from measured turbidity distribution if measured ending turbidity is less than 280 NTU or predicted from exponential reduction equation if measured ending turbidity is higher than 280 NTU.

The event mean concentration (EMC in mg/L) is defined using equation (3) when the event load for a specific contaminant (e.g., TSS for current study) and the event stormwater volume are measured (Wanielista and Yousef 1993).

$$EMC = \frac{L}{R} \quad \textbf{(3)}$$

where L = sediment loading per event (mg); R = volume of runoff per event (liter). The loading for an event is determined by summing the loadings during each sampling period, provided that flow rate (or volume) data are available for the period. The equation (4) is used for computing loading L:

$$L = \sum_{i=1}^{n} R_i C_i \quad \textbf{(4)}$$

where R_i = volume (L) proportional to flow rate at time interval i, C_i = average concentration (mg/L) over the interval i, n = total number of samples during a single storm event. The EMC values of TSS were determined for inflow and outflow for two events, and the removal efficiency of sediments for the basin 4 was 97.9% by load (kg) for the event on 11/16/2011 with correct PAM, and 83.7% for the event on 12/05/2011 with wrong PAM. Figure 3 shows time series of inflow turbidity and flow rate for two rainfall events (discharge was up to 3.4 cfs on 11/16/2011). Rainfall intensity was up to 1.1 in./hr for the event on 12/05/2011.

Table 3: EMC for TSS and turbidity and removal efficiency for two rain events.

Rainfall event	Inflow (weir)			Outflow (skimmer)			Removal Efficiency		
	EMC TSS (mg/L)	EMC Turbidity (NTU)	TSS Load (kg)	EMC TSS (mg/L)	EMC Turbidity (NTU)	TSS Load (kg)	by TSS	by NTU	by Load
11/16/2011	6519.6	6830	1197.7	221.5	478	25.3	96.6%	93.0%	97.9%
12/5/2011	1331.2	2024	224.0	319.6	793	36.6	76.0%	60.8%	83.7%

Phase 2 of the data collection was performed during a more mature stage of site construction: road bed excavation was nearing completion, such that the entire design contributing watershed area of 9.2 acres emptied into the sediment basin. The data collected during the phase 2 was divided into two conditions based on site flow characteristics: (1) '*No PAM*', and (2) '*W/Limited PAM*'. The inflow weir of the primary channel that was not correctly installed by the contractor was reconstructed on 1/24/2012, and the research team missed some opportunities to collect necessary inflow data, but stormwater samples inside the basin 4 were collected for most of the rainfall events during Phase 2 to understand the basin performance. The rainfall event on 1/17/2012 lasted 2 hours with the maximum 5-minute intensity of 3.5 in./hr and resulted in large inflow (up to 11.4 ft^3/s) that created upset condition (inflow overflowed and washed out the channel). Time series of rainfall and turbidity (NTU) data from 1/7 through 1/12/2012 is given in Fig. 4 as example results: turbidity inside basin was reduced from about 2,600 NTU to less than 280 NTU after above three days retention.

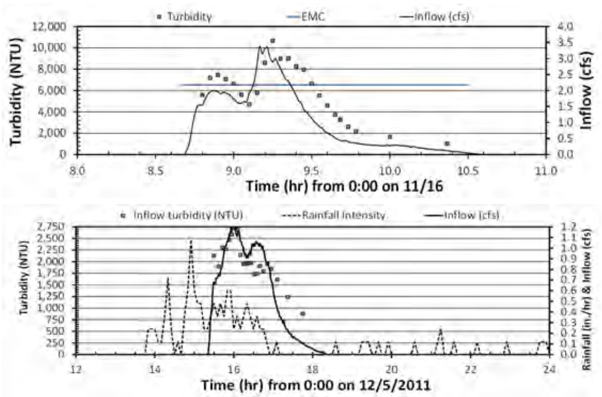


Figure 3. Time series of inflow turbidity and flow rate for rainfall events on 11/16 (top) and 12/5/2011 (bottom). Measured 5-minute rainfall intensity was included for the event on 12/5/2012.

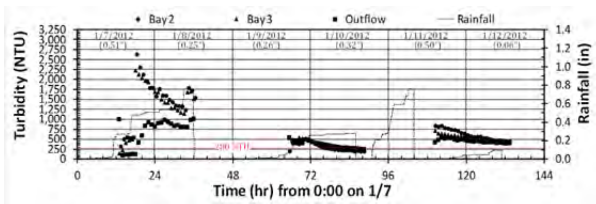


Figure 4. In-basin and outflow turbidity and rainfall data for 1/7 through 1/12/2012.

The second category of data collected during Phase 2, '*w/Limited PAM*', spanned six rain events. Due to the nature of the rainfall events, continuous monitoring of the sediment basin, and overall performance of the sediment basin, data analyses of samples collected with limited PAM were categorized by 4 rain events: (1) 1/26/2012, (2) 2/1/2012(a), (3) 2/1/2012(b), and (4) 2/4/2012, as shown in Fig. 5. The 1/26/2012 inflow had much lower observed turbidity (up to 785 NTU) and TSS values due to light rain and low inflow rates during the time that samples were being taken. The first rain event on 2/1/2012(a) produced enough inflow that the sampler collected all inflow samples for that rain event and had the maximum turbidity of 3,688 NTU, but in-basin turbidity was only up to 1,552 NTU (Fig. 5). Since the sampler had completed its sampling program during the inflow from the first rain event on 2/1/2012(a) in the morning, no inflow samples were collected for the subsequent rain event occurring on 2/1/2012(b) in the evening (7:40 pm) that lasted 25 minutes. Turbidity in Bay 2 was reduced from 1,552 NTU to 811 NTU after about 10 hours retention and then increased to 2,996 NTU (Fig. 5) due to the second rainfall event, which brought additional sediments into the basin and most likely resuspended bottom sediments inside the basin also. The same situation occurred at the rainfall event on 2/4/2012 (Fig. 5): turbidity in Bay 2 increased from 579 NTU to 1,988 NTU.

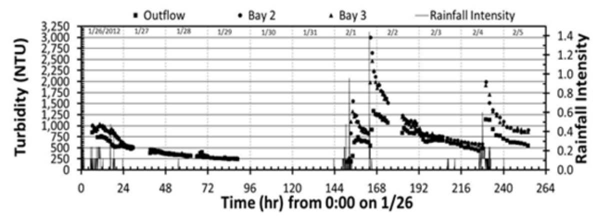


Figure 5. Phase 2 group-set of turbidity and rainfall data (from 1/26 to 2/5/2012).

Figure 6 shows example exponential reduction trends of in-basin turbidity after the event on 1/26 to 2/1/2012(b) excluding data after the event on 2/1/2012 (a) in the morning. Fitted coefficients of exponential reduction functions are displayed on graphs. Outflow turbidity resulted from the event on 1/26/2012 reduced from 750 NTU to 250 NTU after three days retention (Fig. 6). Outflow turbidity resulted from the event on 2/1/2012 reduced from 1,250 NTU to about 500 NTU after two days retention (Fig. 6), which ended before another rainfall event occurred on 2/4/2012 and increased turbidity again (Fig. 5).

Fitted exponential reduction functions were then used to predict the basin performance during and beyond the data collection period, assuming there was no additional rainfall event or runoff inflow to disturb the settling in the basin. Figure 7 shows two examples of observed and projected TSS reduction performance after two rainfall events. With three days (72 hours) retention, 100% and 69% of TSS reduction could be achieved after the rainfall event on 11/16/2011 with PAM and 2/1/2012(b) with limited PAM. Lower reduction rate after the second event may also be due to finer sediments brought by the storm runoff from the contributing area (after the construction is close to the completion) and suspended from the basin bottom because finer sediments take a longer time to settle.

There are strong linear corrections between TSS (mg/L) and turbidity (NTU) of all stormwater samples collected for the study (Fig. 8 as an example). For both phase 1 and 2 data collection, the ranges of TSS and turbidity after the rain events with correct PAM or limited PAM (open circles in Fig. 8) were always smaller than ones without PAM or with wrong PAM (filled squares in Fig. 8), which indicated PAM promoted settling of incoming sediments.

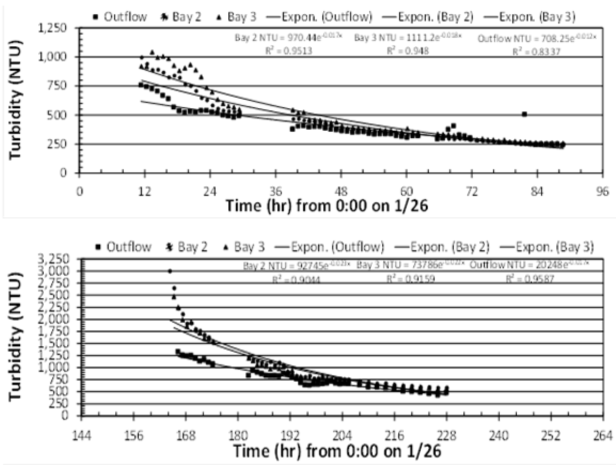
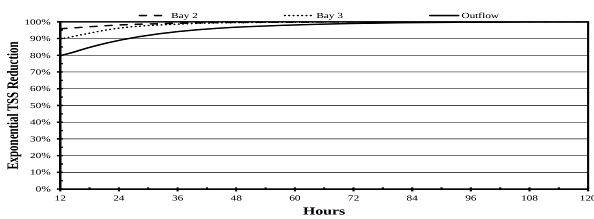
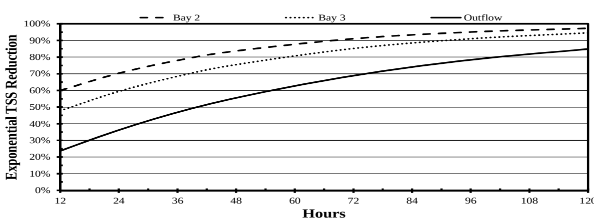


Figure 6. Phase 2 group-set turbidity reduction trends after the event on 1/26 to 2/1/2012(b).



11/16/2011 with PAM



2/1/2102(a) with limited PAM

Figure 7. Observed and projected in-basin TSS percent reduction performances after the event on 11/16/2011 and 2/1/2012(a).

Based on soil samples on the 502 project, Applied Polymer Systems, Inc. recommended using floc log type of 706B and having a reaction or contact time of 40–45 seconds. The recommended dosage rate should be 50–60 gpm flow per each floc log placed in a series or in a row. Therefore, four floc blocks showed in ALDOT design drawings and actually placed in the inflow channel of the basin 4 by the contractor (downstream of the rock ditch check) can only handle a maximum flow of 200 to 240 gpm or 0.446 to 0.535 cfs, which are much smaller than inflows experienced in basin 4 (Fig. 3).

When runoff from a rain event completely filled the basin, it was observed that the water level within the basin overtopped the baffles of the basin 4, creating a fully mixed condition within the basin, disabling the designed function of the baffles.

Resuspension of deposited sediments from previous events resulted from subsequent rainfall events was observed (Fig. 5). To more frequently remove deposited sediments may be necessary. USEPA recommends including sediment storage volume (e.g., 500–1000 ft^3/acre) and permanent pool volume for a sediment basin in addition to active water quality volume (detention volume), i.e., at least 3600 ft^3/acre drained.

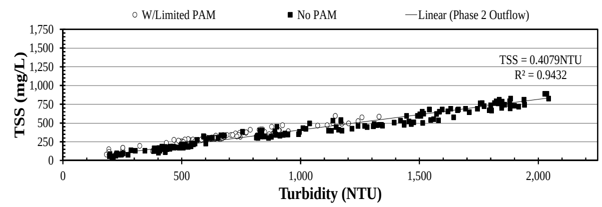


Figure 8. Phase 2 outflow TSS versus turbidity data correlations.

7. Conclusions and Recommendations

All tasks proposed have been completed. Through completing the study, the following conclusions have been developed:

- A field-scale data collection plan to monitor and evaluate in-field sediment basin performance at a construction site was developed and implemented using ISCO 6712 portable automatic stormwater samplers, flow modules, a rain gauge, and weirs.
- Sediment basin 4 on the 502 project did effectively remove sediments at the early stage of the construction when the basin's influent most likely contained relative large percent of large-size sediment particles. For example, sediment basin 4 removed 97.9% and 83.7% of sediments generated by rainfall events on 11/16/2011 and 12/5/2011.
- A floating skimmer allowed for effluent to be discharged uniformly and slowly, providing longer detention time for sediments to settle in the basin. Data analyses on decay (reduction) coefficients for total suspended solids (TSS) and turbidity allowed us to quantify the sediment-settling rate of soils on the 502 project in Franklin County, AL.
- Appropriate PAM (or floc log) added into inflow is crucial to aid sediment settling and to reduce

turbidity of effluent. For example, the performance of the basin 4 was superior for the rainfall event on 11/16/2011 when correct PAM was used in the inflow channel than the performance for the rainfall event on 12/5/2011 when wrong PAM was used.

• Rainfall events with subsequent high rainfall intensity impulses generated high turbidity inflows from the construction site and suddenly increased in-basin turbidity that could be several times higher than turbidity of water already in the basin.

• Resuspension of settled sediments significantly increased in-basin sediment concentration and turbidity when the basin has experienced a number of rainfall events with large amount of settled sediments inside the basin.

• An under-designed sediment basin (from a volumetric standpoint) more frequently allowed highly turbid sediment-laden runoff to directly flow over the emergency spillway to downstream receiving water body.

• Based upon the results of the data collected and observed site conditions throughout the research period, the following recommendations are provided to ALDOT to improve sediment basin design and installation to maximize performance efficiency and cost effectiveness:

• Use at least 3,600 ft^3/acre of runoff draining from the contributing area to size the sediment basin for the detention volume to capture and detain stormwater.

• Increase the number of PAM floc logs placed at the bottom of inflow channel to properly dose for the average flow rate of 2-yr, 24-hr runoff. The number of floc logs should be based on the manufacturer recommended dosage and the expected inflow rate of stormwater runoff.

• Consider increasing the number of floc logs placed on the sides of inflow channel to dose for the average flow rate of 10-yr 24-hr runoff. These storms will have higher water depths, resulting in a greater amount of inflow, therefore requiring a higher dosage of PAM.

• The height of the baffles, once installed, should match the full depth of the sediment basin and not be installed below the minimum elevation of the emergency spillway.

• Include a sediment storage volume (e.g., 500 ft^3/acre disturbed) into the design specifications of sediment basins and a requirement to remove the sediment when it reaches one third of the height of the sediment storage volume.

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