The International Journal Of Engineering And Science (IJES)
||Volume||2 ||Issue|| 4 ||Pages|| 17-22||2013||
ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

Turbidity Study of Siphon Sediment Basin

Moayyad M. Al-Nasra
Department of Engineering Technology, West Virginia University Institute of Technology

Abstract

Erosion and sedimentation best management practice, BMP, did not address the turbidity issues effectively. Several measures were proposed, and in many cases erosion and sedimentation measures are enforceable. In this study, an effective turbidity contol sediment basin called siphon sediment basin will be introduced. Turbidy will be investigated using the siphon sediment basin. Several experimental readings will be presented. New design of the siphon basin will also be covered in this study. Because pollutant-removal efficiency depends on the detention time, sediment basin efficiency becomes critical issue. Comparison with existing sedimentation measures will be discussed in terms of effectiveness and cost. Site maintenance is also a major issue when it comes to turbidity control. Effective and simple erosion and sedimentation measure addressing the turbidy in water will be presented.

Keywords *– sediment basin, turbidity, siphon, erosion, pollutant, detention*

Date Of Submission: 15 April 2013 Date Of Publication:30,April.2013

I. INTRODUCTION

A siphon can be a pipe connecting an upstream and high level pool of water to a downstream and lower level pool. The difference in elevation is called the hudraulic head. The weight of the water above the lower pool has the potential energy that can be used to cause the water to flow from the upper pool to the lower pool. The water in the pipe can reach a higher elevation than the higher pool. The energy in the water can be used to increase the velocity of flow in the pipe and thereby increase the rate of flow over that obtainable by letting the water free fall into a receiving channel or pipe. Chen et al [1] studied the high turbidity in raw water. Barrier board was used to extend the flowing route and to change the overflow level for carrying out the pre –treatment of high-turbidity raw water through the channel of varied flow rate in order to study the changes and removal rate of the turbidity for the influent and effluent. Their experimental results indicated that the turbidity of high-turbidity water can be reduced by means of intertia restrained flow, extending the flowing route, anf heightening the overflow level.Liu et al [2], studied the tubidity measurement using the Poly (N-isopropylacrylamide) shading agent systems containing Hydrophlilic Vinyl Compounds addiitives. The tubidity measures were used to study the temperature sensitive behavior and the phase behavior of linear Poly (N-isopropylacrylamide) in water-additive systems. Polutant removal is a major issue that has been addresses by many researchers. Hidayah and Karnaningroem [3] studied the implementation of hydrodynamics model in water treatment to estimate turbidity removal. Mathematical model was constructed from two hydrodynamic equations, namely the continuity equation and momentum equation. Their research aimed to study mathematical models of settling flocs patterns in rectangular sedimentation tanks based on a specified hydrodynamic model mathematical formulation. Lewis [4] also studied the sediment load estimation. The study covered an automated procedure for measuring turbidity and sampling suspended sediment.

The basic equipment consists of a programmable data logger, an in situ turbidimeter, a pumping sampler, and stage-measuring device. The data logger program employs turbidity to govern sample collection during each transport event. To reduce turbidity in sediment basins, baffles can be used to increase the water pathway[5]. Sediment traps and basins at construction sites, agricultural operations, and other unsettled areas provide temporary pools for runoff that allow sediment to settle before the water is discharged into a river, stream, or landscape. They prevent erosion and trap sediment and other coarse material. They are most effective in sandy soils and less effective in clayey soils. Unfortunately, these traps and basins are not efficient when the swift, turbulent water moves along a straight-line flow that takes runoff quickly to the basin’s outlet. This short-circuits interaction with the entire basin. Using baffles to slow, calm, and distribute the water can help solve this problem. Baffles can lengthen the flow path and distribute the flow more widely.

They significantly increase the amount of sediment captured and also trap much smaller particles than open basins. A simple way to lengthen the flow path is to install solid baffles that force the water to move from side to side in the basin. These may be made of sturdy plywood or similar materials, usually with a notch or weir cut into the top at opposite ends to create a long, back-and-forth flow path. Silt fencing (or geotextile) has also been used because the material is sturdy, inexpensive and easy to install, and it is commonly available on construction sites. The geotextile is essentially impermeable for the kinds of flows expected in the basin [5].Hoechst [6] studied the efficiency of skimmers in comparison with perforated risers, and concluded that the effluent sediment concentrations were highest at the start of each run and then declined exponentially. There was no statistical interaction between outlet and soil type therefore the basin retention efficiency was not influenced by any particular combination of outlet and soil type. Shorter dewatering times may have less of an impact on retention efficiency when the skimmer is utilized than when the perforated riser is used thereby possibly requiring smaller sedimentation basin sizes.

II. TURBIDITY

Turbidity is the cloudness or haziness of a fluid caused by individual particales, suspended solids, that are generally invisivle to the naked eye, similar to smoke in air. One of the key tests of water quality is tubidity. Water can contain suspended solids matters of different particles sizes. The large and heavy particles settle faster than the little and light particles. The very small particles will settle very slowly, and in some cases will not settle at all if the water is regularly agitated or the particles are colloidal. These small solid particles cause the water to apear turbid.

There are sveral ways to measure the water quality. The most direct way is to measure the attenuation of light as it passes through a sample column of water. The suspended particles, in turn will scatter a light beam, which used as a measure of turbidity in water. The units of turbidity is called Nephelometric Turbidity Unit, NTU. There is a direct correlation between the turbidity and the total disolved solids in water. Figure (1) shows different turbidity measurements of water. Turbidity in open water is caused by growth of phytoplankton. Land disturbance due to urbanization , mining, and agricultural projects is one of the cause of turbidity in water. Turbidity can be used as a measure of water polution which can be considered as health hazard. In addition, in water bodies such as lakes rivers and reservoirs, high turbidity levels reduce the amount of light reaching lower depths afecting the growth of submerged aquatic plants and marine life.

Figure 1: Jars of different turbidity values 0, 250, and 1100 NTU from left to right

III. EXPERIMENTAL TURBIDITY MEASUREMENT

Several turbidity measurement were taked at a sidiment basin in the state of West Virginia. The reading were taked right after a storm of high intensity filling the experimenal sediment basin up to it 85% capacity. Three sets of reading were taken at different time focusing on the turbidity values of water at different water depths. The first set is taken at the top of the sediment basin, the scond set is at the middle of the sidement basin about 2 feet from the top surface, and the third set of readings is taken at about 6 inched from the bottom of the sediment basin, which is about four feet from the top of the basin. Figure (2) shows new tool used to collect water sample at different water depth. Figure (3) shows the decrease of the turbidity measurement with time. The values reflect the settlement rate of the suspended particles with time.

As can be seen from Figure (3) that the turbidity decreases at the top surface at a fster rate than the middle and the bottom layer of water in the sediment basin. This rate depends on several factor including the characteristics of the suspendend particles, the water flow, and water temperature.

Figure 2: New built-up tools used to sample water at different water depth

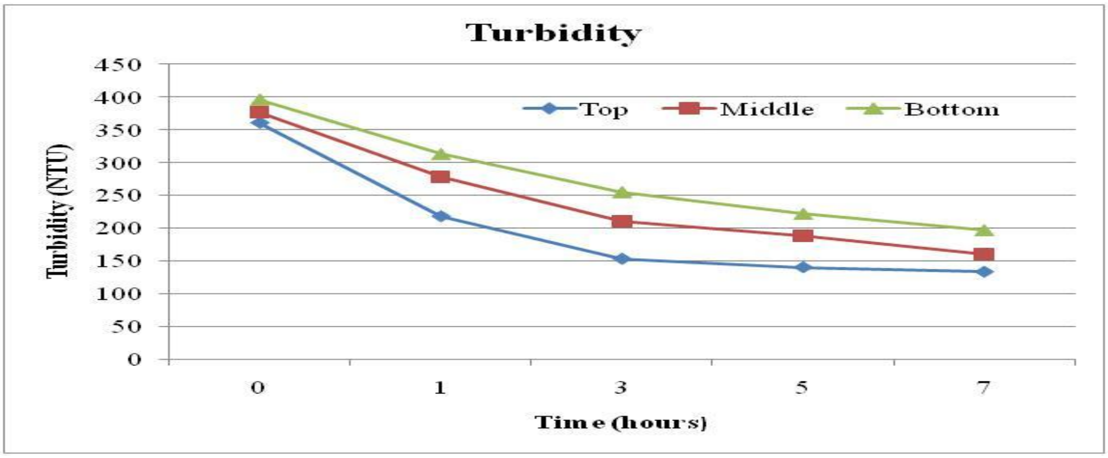

Figure 3: Turbidity measured at different water levels in a sediment basin

Figure (4) shows the turbidity values of the same sediment basin at the levels; top, middle and bottom. The measurement in this figure is taken over longer period of time to study the long term effect of water turbidity. It also can give an indication of the most appropriate settling time that can be allowed to better control water turbidity. Eventhough the turbidity reduction rate depends mostly on the charateristics of the suspendid particles, but for this particular basin Figure (4) shows that the turbidity will reduce substantially in 24 hours in an expoential form.

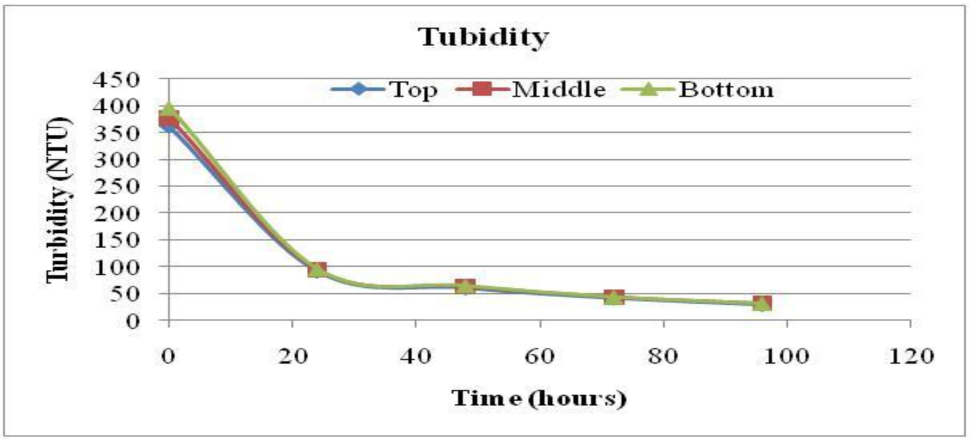

Figure 4: Turbidity measurement over longer period of time

IV. SIPHON SEDIMENT BASIN

Draining the sediment basin at the right time and the right location is a key to control water turbidity. Skimmers are used widely to drain the basin from the top water surface. At the top location the turbidity is at it lowest. But in many cases floating particles could be a problem. The skimmer is an expensive device, and difficult to maintain. This study introduces a new type of sediment basin called sipon sediment basin as shown in Figure (5). The siphon sediment basin is very inexpensive, composed maninly of PVC pipes than can be easly installed and maintained in minutes. In this figure one can see the the operational features of the siphon. The flow capacity as shown is related to the operating head. When the siphon is used as a stilling basin, it is appropriate to attenuate the detention time as as to decrease turbidity of the discharge. The controling operational judgement is determining the length of time to the next rainfall event.The siphon can be set low in the embankment, on top, or anywhere in between. The discharge pipe can be rotated to control the pool level and the rate of discharge. The siphon sediment basin also allows for draining the water at a designed elevation that can be varialbe depending on the particular need and the specific requirements of the sediment basin. Figure (6) shows details of the intake strainer design.

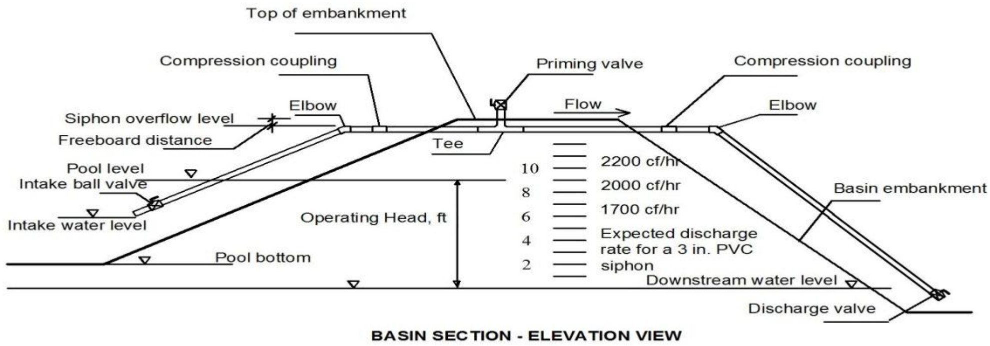

Figure 5: Siphon sediment basin

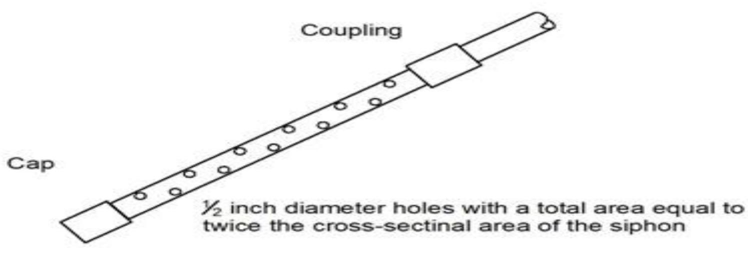

Figure 6: Intake strainer design

The siphon can be field operated. Siphon sediment basin allows preset functions and quantitative values be changed at will. The siphon is not a Best Management Practice (BMP) as presently prescribed in the local ordinance for soil erosion and sedimentation control. It is a device used in many applications such as sewer effluent dosing, water traps, commodes, and on large sewer outfalls. A possible and valuable use in erosion control is inabling the use of a detention basin as a stilling basin for reducing turbidity.When the pool level is above the siphon overflow level, the priming valve is closed, and intake and discharge valves are open, the siphon will automatically start (at an initail rate of approximately 2000 cubic feet of water per hour for a 3 inch pipe) and will continue to flow until the pool reaches the intake level. When the pool level is above the intake, the siphon may be started by priming. Priming requires the complete filling of the siphon using an open priming valve and closed intake and discharge valves. The siphon can then be started by closing the priming valve and then opeing the intake and discharge valves.

The siphon sediment basin can be designed based on the size of the watershed and the runnof. The siphon used in this study is design for 3.7 acres watershed, with 1 inch of runoff. The assigned percetage of drainage area dedicated to the basin is aprroximately 2% of the total area of 3.7 acrea, thus 13431 cubic feet of water will be the total runoff. The size of the basin is detemined as 3223 cubic feet (3.7x43560x2%), which will generate water depth of 4.2 feet (13431/3223). If the drawdown time is 48 hours, thus the rate of drawdown rate is 280 cubic feet per hour (13431/48). Then select the pipe size from the Table (1).

Table: Pipe size design table

Pipe size Diameter Inches	**Low range of flow Cubic feet per hour**	**High range of flow Cubic feet per hour**
1	80	160
1.25	140	300
1.5	200	500
2	380	800
3	800	2000
6	3200	8000

It is appropriate to emphasize that the siphon is controlable in the field. This is mainly accomplished by setting the size of the pipe and the overflow level of the siphon and thus predetermining the flow capacity and the pool level. The relative low cost of the siphon allows multiple siphons to be used for controllong the flow of a single basin unlike the other existing devices such as theBMP skimmers.

V. CONCLUSION

Turbidity has not been effectively controlled using the concepts of the existing best management practice, BMP. The turbidity decreases in a faster rate at the top of the sediment basin compared to the middel and the bottom of the basin. New and effective sediment basin is introduce called siphon sediment basin, which is not BMP device. Siphon sediment basin is relative inexpensive turbidity control device that can be field operated and can be easily maintained.

VI. ACKNOWLEDGEMENT

This study is conducted in memeory of David Lucas, who liked to be called public engineer, and practioner. He was my student at the age of 81, but I learned from him much more than what he learned from me. He was pationate about public health and safety. He lost his battle with cancer in 2010.

REFERENCES

[1] Chen, J, Chang, Y, Shem, Y., Chen, K., " Research on the Implementation and Analysis of High-turbidity Raw Water Pre-treatment with a Barrier Board,", Advanced Material Research, Vol 8, 2013, Page 1402- 1408. DOI: 10.4028/www.wcientific.net/AMR.610-613.1402.

[2] Liu, Y, Li, Y., Zhao, S., Yuan, K., Zou, G., Zhu, Y., "Tubidity measurement using the Poly (N-isopropylacrylamide) shading agent systems containing Hydrophlilic Vinyl Compounds addiitives,", Advanced Materials Research, Vol. 8, 2011, pages 2669-2673. DOI: 10.4028/www.scientific.net/ AMR.233-235-235.2669.

[3] Hidayah, E., Karnaningroem, N., "The implementation of hydrodynamic model in water treatment to estimate turbidity removal,", International Journal of Environmental Sciences and Research, Vol. 2, No. 1, 2012, pp. 129-133

[4] Lewis, J., "Turbidity threshold sampling for suspended sediment load estimation," Proceedings of the Seventh Federal Interagency Sedimentation Conference, March 25 to 29, 2001, Reno, Nevada.

[5] McLaughlin, R., "Using Baffles to Improve Sediment Basins", North Carolina Cooperative Extension,7/05-1M-JL/GM AG-439-59, 2005. ww.soil.ncsu.edu/publications/Soilfacts/AGW.../AGW_439_59.pd

[6] Hoechst, L., "Evaluating the Effectiveness of the Skimmer versus the Perforated Riser in SedimentationBasins," Master Thesis, Virginia Polytechnic Institute and State University, Biological Systems Engineering, December 4, 1997, Blacksburg, Virginia

BIOGRAPHY

Dr. Moayyad Al-Nasra, PhD, P.E. is the chair of the Engineering Technology Department at West Virginia University Institute of Technology. Dr. Al-Nasra has over 26 years of teaching, research and engineering practice experience. He has several publications in the area of civil engineering