Evaluation of Additional Papers on Passive Treatment Systems (PTS) for C&D ELG
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NAHB and URS have provided several comments to EPA on many of the papers discussing Passive Treatment Systems (PTS), and how the results cited in these papers do not support a numeric limit of 200 NTU for sites using PTS, either as an enforcement limit or an action level. We recognize that PTS can be an effective tool that can be utilized at difficult sites. However, we believe that when taken as a whole, these reports support the NAHB proposed action level of 1000 NTU as being more representative of the performance of these PTS BMPs under a variety of adverse site and rain event conditions. While results less than 200 NTU had sometimes been attained for some data points at some of the sites described in these papers, they do not consistently support a 200 NTU limit primarily for the following general reasons:

- There has been no formal statistical assessment of the limited data presented. For ELGs, EPA has formally calculated daily maximum limits based on the 99th percentile of the data.
- Several of the PTSs described in the papers in fact frequently exhibited discharges well in excess of 200 NTU, and sometimes averaged well over 1000 NTU, even when the PTS remained intact. This would indicate that 200 NTU, either as an action level or a compliance limit, is far too low to be universally applicable to all sites and rain events.
- There has been frequent deterioration of the passive systems reported in many of the papers during rain events that have often resulted in turbidity values much greater than 200 NTU. These deteriorations include the covering of PAM logs with sediment and channelization of water around the PAM logs. In the comment exhibits supplied by NRDC in support of a 200 NTU limit, these numerous events and the resultant turbidities have been discarded in the final analysis, under the assumption that these instances all could have been avoided by timely repairs or sufficient foresight by the operator. If these events had been included in the analysis, the overall turbidity values would have frequently exceeded 200 NTU, and in many cases exceeded 1000 NTU. However, the frequency of these disruptions to the PTS operation (approximately 25% of all tests in Exhibit 10, for example) would indicate that these problems are common and inherent to the PTS under certain site and rain conditions, and that they cannot be avoided even with due diligence on the part of the operator.
- Though frequent inspections, repairs and adjustments by qualified personnel are acknowledged as necessary in the papers, there is no consideration as to the practicality or safety of making these repairs or adjustments to the PTS in the middle of a heavy rain event or thunderstorms, in order to avoid a violation for that event.
- The data are sometimes presented without reference to influent turbidity or percent removal. Where influent turbidity data are available, often the lowest effluent turbidities cited in the papers occur when the influent turbidity is also very low; less than 1000 NTU, and sometimes less than 200 NTU. Some tests also used simulated influent where the initial turbidity was limited to a low range, in some instances as low as 250 NTU prior to treatment.

Since the comment period closed, several additional papers regarding passive treatment systems have been placed in the docket. The first four pages of this evaluation give a brief commentary on these additional reports from an industry perspective. These are then followed by excerpts from previous NAHB comments already presented to EPA that address specific papers on PTS. These come from the initial NAHB comments to the proposed rule, or as comments submitted in response to the NRDC proposed 200 NTU compliance limit for all sites less than 30 acres, based on use of PTS technologies.

New Comments by URS on Additional PTS Papers Available After the Comment Period Closed

Paper—"Water Quality Improvements using Modified Sediment Control Systems on Construction Sites" (Docket ID EPA-HQ-OW-2008-0465-0984.3) This paper obtained "storm weighted average (SWA)" turbidity data on treated discharges using automated samplers at 11 different treatment systems over 26 rain events. The systems that used passive polyacrylamide treatment had SWA turbidity of 990 NTU in their treated effluent, with a peak SWA turbidity of 1590 NTU. It is difficult to reconcile these results with a 200 NTU limit. In fact, this paper provides evidence that even the NAHB proposed 1000 NTU action level may be difficult to achieve at some sites.

The only evidence that turbidities less than 200 NTU might sometimes be attainable comes from a statement in the abstract: "When one of the latter systems was at optimal function, however, turbidity was reduced to below the receiving stream water levels (<100 NTU)." Presumably, these instances were included in the calculation of the SWA of 990 NTU. However, these were rare occasions, and the low turbidity could easily be the result of the changes in construction activity, and the size and intensity of the rain event as opposed to modifications to the PTS. The paper states as much for modifications attempted during the 2005 testing. On the bottom of page 16, lines 292-294, the report cautions: "Because the changes to the system coincided with changes in activity in the watershed, the differences in discharged water quality cannot be completely attributed to the basin configuration changes." URS reviewed the data from the various Tables presented in the paper to determine when the SWA for the final discharge was below 100 NTU, and found only the following instances:

- On page 16, Table 5, on 2/24/04, a final effluent turbidity of 94 NTU was achieved from the final basin. However, the influent to the final basin (exit from the "forebay", which also had PAM treatment) was only 195 NTU. The influent to the forebay was not reported. Two additional tests on the same dual forebay and basin PTS treatment conducted on 4/13/2004 and 6/14/04 yielded average NTUs of 146 (from an influent of only 260) and 3762 respectively. The percent removal in the final basin for all three of these tests was only 50%.
- On 3/8/05 (Table 7), a modified forebay/basin treatment which included a skimmer outlet achieved 63 NTU, but the untreated influent was only 116 NTU.
- On 3/16/05 (Table 7), an average discharge of 32 NTU was achieved, but the influent to the final basin (outlet from the forebay) was only 124 NTU. The untreated turbidity value was not reported.
- On 3/22/05 (Table 7), the final discharge was 54 NTU, while the untreated turbidity was 4360 NTU. This is a moderate influent turbidity. Values as high as 11,480 NTU were reported for untreated influent in this paper. This is the only example in the entire report (out of 26 trials) where the final turbidity of <100 NTU was achieved from a moderately high untreated turbidity value. This was achieved using basically the same two stage PTS treatment that in other trials conducted only a few weeks later (4/8/05 and 4/12/05) produced SWA turbidities in the discharge of 466 and 776 NTU respectively.

In summary, the PTS treatments in this paper produced a SWA turbidity of 990 NTU, with many storm events averaging more than 1000 NTU. On the relatively few rain events where turbidity less than 200

NTU was achieved, these results could not be entirely isolated from random changes in construction, and rain event size and intensity. Rather than support a numeric limit of 200 NTU, this paper actually lends support to the proposed NAHB action level of 1000 NTU, as being a more appropriate universal level for the wide range of sites, soils, and rain events that can occur.

"Energy Dissipation and Chemical Treatment to Improve Stilling Basin Performance" (Docket ID EPA-HQ-OW-2008-0465-0984.5) This is another McLaughlin paper that uses a synthetically generated influent at the SECREF facility, similar to those described in Docket ID EPA-HQ-OW-2008-0465-0984.9, as discussed previously in the original NAHB comments submitted prior to the 02/28/09 deadline. The purpose of these papers is to compare different BMP configurations under as close to identical situations as possible, which in part requires simulated rain events. For this paper, the simulated influent (before treatment) stormwater had turbidities ranging from 250 to 400 NTU. These values are far lower than what is often encountered under actual field conditions at construction sites. As such, the results of this paper, though usable as a guide to the comparative effectiveness of different BMP configurations, are not useful in assessing an absolute NTU limit.

ASABE paper: "Polyacrylamide Blocks for Turbidity Control on Construction Sites" (Docket ID EPA-HQ-OW-2008-0465-0984.7) Again, the experiments in this paper were performed at the SECREF facility using simulated runoff water that ranged from 400 to 600 NTU before treatment. These data are useful for comparison relative to other tests performed under similar conditions, but the influent NTU is far lower than can occur at actual sites during a heavy rain. This paper is therefore not useful in determining a numeric turbidity limit.

Warner Study (note: the brief summary of the monitoring data for Big Creek was provided by E. H. Pechan Associates): "Erosion Protection and Sediment Control Computer Modeling Project" (Docket ID EPA-HQ-OW-2008-0465-0264[1]) (hereafter, the Warner Study) This long study (239 pages) covered multiple subjects, including complex computer modeling regarding BMP optimization and cost effectiveness. In the sections most relevant to NTU limits (Chapter 5), the Warner Study compiled monitoring data for the Big Creek school construction project in Fulton County, Georgia. This site represented a demonstration project that represents "state of practice" erosion prevention and sediment control measures. The study reports monitoring data for two watershed basins (one for two storm events; the other for three storm events). The study reports the following <u>**peak**</u> turbidity values:

75 NTU (Basin 2 for 1.04" rain event)
330 NTU (Basin 1 for 4.7" rain event)
520 NTU (Basin 2 for 2.96" rain event)
620 NTU (Basin 2 for 3.7" rain event)
1,920 NTU (Basin 1 for 1.04" rain event – report notes that peak flow is higher than expected for this example "most likely due to a high head over the sand" which may have resulted from a valve being fully open on the discharge barrel of the small perforated riser principal spillway).

The report also provides a figure (5-34) showing turbidity levels measured 9 to ~14 hours after onset of the 4.7" rain event experienced in Basin 1. This figure shows great variability in turbidity with the peak 330 NTU occurring 9 hours from onset of rainfall, with lowest measured turbidity (~ 50 NTU) occurring a little more than 13 hours after rainfall onset.

These data demonstrate the large variability of turbidity from individual sites (slopes/soils), storm events, and measurement time.

The Warner study also used the Sediment Erosion Discharge by Computer Aided Design version 4 (SEDCAD 4.0) to estimate performance and cost of a numerous set of passive sediment controls. One aspect of the modeling was to attempt to project resultant turbidity in the runoff. This model was fairly accurate at predicting turbidity results for rain events at the Big Creek site, but this was a real site for which a great deal of detailed information was available. This report then used this software to model hypothetical sites for a large number of cost and effectiveness parameters, including projections of resultant turbidity. These results varied, but for some models, the average turbidity was predicted to be quite low. However, these models were based on hypothetical sites with inputs that 1) may not include all the pertinent variables, especially as would exist at individual sites, and 2) cannot have accurate historical inputs (one of the input categories), since the sites don't actually exist. It is easier to get more accurate predictions of future stormwater runoff turbidity if the model can be adjusted for actual site data from past monitoring activities. Again, NAHB believes these models have some use on a comparative basis with other like-generated models, but not for setting absolute numeric NTU limits.

"Evaluation of Erosion Control Products with and without Added Polyacrylamide (PAM)" (Brown and McLaughlin, Docket ID EPA-HQ-OW-2008-0465-0984.8) This paper describes the applications of polyacryalamide to soil, mulch, and other ground cover erosion control features to prevent sediment from getting into the stormwater runoff. As such, this paper does not directly address PTS as discussed elsewhere by EPA and others. Systems described as "PTS" by EPA are systems that help remove sediment already suspended by passively injecting coagulant chemicals or causing running water to pass over PAM blocks or logs so that settling in ponds is enhanced. The study did show that turbidity could significantly reduce turbidity in runoff on slopes of 10 or 20 percent. However, the turbidity values measured were not of final discharge from the property, but only from the slope containing the test ground cover. Turbidity values for the various test events ranged from 74 to 614 NTU, with most values being in the 300 to 500 NTU range. This technology is not directly applicable to the turbidity of the final discharge, but the range and variety of values does indicate that an Action Level is more appropriate rather than a compliance limit, and that this limit would seem to be closer to 1000 NTU rather than the 200 NTU proposed by NRDC.

Papers Previously Reviewed by URS/NAHB in the NAHB Comments, and Previously Submitted to EPA (with a few minor comments added where indicated for clarity)

DCN 43082, R.A. McLaughlin, "The Potential for Substantial Improvements in Sediment and Turbidity Control" (2003) (Docket ID EPA-HQ-OW-2008-0465-0984.9) This paper describes a series of experiments conducted at the Sediment and Erosion Control Research and Education Facility (SECREF) in Raleigh, NC, which were intended to determine the effectiveness of design innovations for various sediment and erosion controls, among them being PAM logs, settling pond baffles, and rock and skimmer outlets. The SECREF facility allows the staging of simulated rain events, and can be setup with different configurations of BMPs. It should be noted that the conclusions of the paper appear to be valid, but the focus is always on *relative* performance of the BMPs under simulated conditions that are attempted to be made as *similar as possible* for the various trials. There was no attempt to test the absolute NTU values under differing conditions, and at no point does the author even consider numeric compliance limits.

In the proposal, EPA focused on one series of three laboratory trials using PAM logs as evidence that a numeric limit could be met, because two of the three trials had a discharge turbidity of <100 NTU. This series of trials involved what had been determined to be the optimum configuration of PAM logs (logs located in a conduit upstream from entrance into the pond to provide for optimum polymer mixing) and a rock outlet to the settling pond, both of which remained constant for all three laboratory trials. The variable BMP for the three trials was settling pond baffles: one trial had no baffles, one had Jute/coconut baffles, and one had silt fence/weir baffles. Therefore, the main focus for comparison for this series of three trials was the use of baffles in the settling pond. The resultant average NTU (weighted by volume) for the three trials were 51, 71, and 151 NTU, corresponding to the no baffle, the coconut/jute baffle, and the silt fence/weir baffle trials respectively. The following comments can be made from this series of experiments as related to applicability to numeric compliance limits:

- These were simulated experiments that did not cover any of the potential variables from different sites, soils, rain events, etc. In fact, one point of the experiments was to control the variables, and make each trial (within a series) as similar as the last, except for the BMP parameter being tested. **For example, where it was *possible* to attain a 50 NTU effluent using PAM logs (the author made no claim as to consistently meeting this value), one of the conditions was that the simulated influent was within the range of 400 to 800 NTU.** ***(Added Note not in original NAHB comments:*** *This turbidity is much lower than would frequently occur at actual construction sites during heavy rain events. Turbidity at influent to treatment is most often greater than 1000 NTU, and can sometimes exceed 10,000 NTU.)*
- While it is clear that PAM logs, especially when arranged in the configuration used in the experiment series focused on by EPA, do show significantly greater removal of NTU under the test conditions, the results continue to show great variability. Of the three tests, the two average turbidity results of 51 and 71 NTU are not considered significantly different statistically by the author. However, if there were a numeric limit of say 60 NTU, this would be very significant. The third result of 151 NTU was considered significantly different.
- Not only were these results variable, but variable in a surprising way, in that the test with no baffles was significantly better than the two tests that had baffles. In many other experiments, the pond baffles appeared to be at least somewhat effective. There certainly is no logical reason why the presence of baffles, even if ineffective, should be the cause of *higher* NTU values.

Therefore, the variable results seen in this series of tests may likely be a function of variable performance of the PAM logs.

In conclusion, this report demonstrates that improvements in turbidity removal can be obtained using PAM logs and also a few other types of BMP technology *relative* to discharges that do not use these BMPs. (The word relative is extremely important, because numeric compliance limits are absolute, not relative.) However, at the same time, the report demonstrates that in the discharge, the average NTU values in absolute terms are also quite variable and not always predictable, even under the controlled simulations used for these laboratory experiments. It is therefore very likely that this variability would greatly increase when real world variability from rain event intensity and duration, different soil types and topography, etc. are included into the mix. Rather than providing proof that numeric compliance limits can be achieved through these technologies as EPA suggests, a close look at the experiments suggests otherwise.

C. Discussion of the Auckland Regional Council (ARC) Papers (DCNs 4111, 4112, and others)

The Auckland Regional Council is the regulatory agency for storm water issues in that portion of New Zealand. It is unusual that they should be cited in the proposal, because in many ways they are the antithesis of what is represented in the C&D proposal. The Auckland Regional Council (ARC) follows a best practicable option approach in terms of regulating construction sites, whereby erosion and sediment control devices found to work best in their local region are required, designed, constructed and maintained in accordance with their guideline document (**Technical Publication 90**), and then assumed to achieve a satisfactory level of sediment removal. Therefore, the way ARC administers stormwater regulations is vastly different than what EPA is attempting in this proposed rule:

- The ARC is a (relatively) local agency that uses a BMP approach. Their technical document includes a series of Best Management Practices that have a track record of working best within their region. EPA, with this rule, is attempting a one size/type fits all sort of regulation without regard to local conditions.
- The ARC recognizes that different sites, rain events, etc. make the application of a single numeric limit impractical. They do not impose numeric compliance limits, and to the best knowledge of the URS New Zealand office, they do not require continuous monitoring even for "benchmark" values. Contrary to the ARC approach the EPA appears to want to impose a single extremely low numeric limit across the country, even for stages of construction without significant land disturbance, and without consideration of background turbidity levels in the receiving streams.
- ARC is relatively flexible (in comparison to the proposed EPA rule), in that they add new technologies to their guidance once they are demonstrated to work at certain types of sites in their area. EPA has cited **DCN 41111**, where passive flocculation techniques are proposed (the document has not yet been adopted into the ARC Tech Publication 90) to be required at certain sites. However, this technology has actually been tested at sites in their region, and this document provides exceptions for sites where the characteristics have demonstrated that this approach is either less effective, or unnecessary.

DCN 41112 is the ARC Draft Technical Publication 227 **(TP227)** from June, 2004, titled, "The Use of Flocculants and Coagulants to Aid the Settlement of Suspended Sediment in Earthworks Runoff: Trials, Methodology and Design". This paper was used as part of the basis for ARC to consider passive coagulation as a possible addition to Technical Publication 90. Although the passive flocculation treatment has not been officially adopted into Technical Publication 90, URS New Zealand reports that ARC now considers the passive treatment to be most appropriate for certain types of sites as described in DCN 41111 (see above).

DCN 41112 describes the stormwater runoff from construction sites in the Auckland region as being something approaching worst case conditions. The topography is steep, the fine soil of volcanic origin is both highly erosable and very poor for unaided settling, and the type of rain events in the area are very often of high energy, with great amounts of rain falling within a short period of time. It would therefore appear that this unusual combination of characteristics serves in part to make the passive flocculation systems more attractive for use in this local region. However, the systems described in ARC TP 227 have their own set of problems and issues that EPA perhaps did not fully consider.

- In the proposed rule, on pages 72581 to 72582, EPA compares the high removal percentages using alum and PAC in the ALPURT trials to the very low percent removals for untreated water (10% in the alum trial, 4% and 12% in the PAC trials), and therefore appears to imply that this removal is the best that can be obtained through traditional settling (without chemical enhancement) from a properly sized pond with adequate retention time. However, a reading of the paper reveals that all samples in the ALPURT trials were taken after **only one hour of settling**. This therefore confirms that settling occurs much faster in the chemically treated water, but it is not an indication of overall performance for water allowed to fully settle without chemical addition. For comparison the proposed rule suggests that there should be a minimum of 72 hours of settling. The comparisons from the July, 2008 ARC paper discussed below are more appropriate for this purpose.
- One of the unfortunate conclusions from TP 227 was that alum and polyaluminum chloride (PAC) performed significantly better than Polymer Blocks (similar to PAM logs). The passive treatment systems designed for the TP 227 report, were triggered by rain events to automatically release acidic liquid chemicals containing dissolved aluminum into the stormwater stream. Dissolved aluminum is toxic to Daphnia at levels significantly lower than 1 mg/L, yet the trials frequently added doses that equaled more than 12 mg/L as aluminum. At very low doses, the natural alkalinity of the water will cause most of the aluminum to precipitate, and in fact, this charged precipitate is what creates the floc. Alum and PAC are acidic liquids, and if dosed high enough, will lower the pH of the water, and cause some of the aluminum to remain dissolved. Alum is more acidic than PAC, and this is one of the reasons most of the later trials used PAC. The dissolved aluminum was monitored for all of the trials, and at least for the PAC, the dissolved aluminum remained below the level of acute toxicity. However, as admitted in the report, this level of aluminum is dependent on the natural alkalinity present in the water to be treated. Since this is initially rain water, most of the alkalinity likely resides in the suspended sediment. If PAC were used at other sites with different soils, it is most likely that toxic amounts of dissolved aluminum and/or or water with too low a pH could be discharged. For this reason, aluminum based chemicals are only infrequently used in the US.
- URS chemists also noticed the claim in the report that "dissolved" aluminum was actually lower in most of the treated waters than it was in the waters receiving no chemical treatment. This

appears illogical, and URS chemists speculate that this is an artifact of the method used to prepare samples for dissolved metals measurement, which is to filter the sample through a 0.45 um filter. The report shows that the untreated water contained significantly more sediment. A significant portion of this sediment could consist of fine clay particles, capable of passing through the 0.45 um filter. Clay particles also have significant aluminum content. Treated samples had less solids overall, so less clay particles were available to pass through the filter. Therefore, it appeared that the untreated water contained disproportionately more "dissolved aluminum, which in fact was most likely from fine clay particles that passed through the filter.

The unnumbered ARC article titled, "Performance of a Sediment Retention Pond Receiving Chemical Treatment" dated July 2008 is intended as a follow-up report to ARC TP 227. (*Note: This ARC paper was not cited by EPA, and was not included in the EPA docket at the time of the proposal. URS obtained this document through the URS office in Auckland, NZ.*) This paper is important to the above discussion because 1) it compares actual performance of an untreated pond with a pond receiving chemical treatment, using actual design settling times for each pond (as opposed to one hour in the ALPURT trials), and 2) the effects of different sized rain events are examined using the same two ponds (one treated, the other untreated). In these tests, percent removal was based on total sediment in vs. total sediment out from each pond, treated and untreated. This was calculated by a series of TSS and flow measurements taken during the rain events. There were seven different rain events sampled for this part of the study.

- Percent removals for untreated ponds ranged from 25.8 to 91.0% (for one extreme event, percent removal could not be calculated, due to problems in the influent sampling). For treated ponds, the percent removals ranged from 47.5 to 92.3 percent removal. The report also points out that the treated water not only had overall better percent removal, but also had significantly higher removal during the more intense higher volume rain events, when retention time in the ponds was significantly reduced. These events produced much more total sediment, so that there was significantly more total sediment removed in the treated ponds. On the other hand, it should be noted that in TP 90, the standard ARC size requirement for settling ponds is 200 cubic meters per hectare, which calculates out to only 2429 cubic feet per acre. These ponds are therefore significantly smaller than those proposed for Option 1 of the EPA proposed rule (3600 cubic feet plus 1000 cubic feet solids storage per acre).
- This test also compares the differing performance due to rain events. These differences are dramatic. Discharge sediment loadings from the untreated pond ranged from 9.15 kg up to 5286 kg over the seven rain events. The treated pond discharge ranged from 2.05 kg up to 1235 kg over the seven rain events. The discharge from these ponds varied more than 500 fold, with the only variable being different rain events. Charts tracking TSS for these same events were similar, ranging from less than 10 mg/L up to, in one instance, over 11,000 mg/L (in the treated pond!). There is no more conclusive evidence that conventional treatments, and even passive flocculation treatments, are far too subject to variation not only in rain events, but also all the other potential variables discussed in these comments, for a single numeric compliance limit to be at all practicable.

Evaluation of Reports Submitted in the Comments by NRDC in Support of a PTS Limit for 200 NTU, and NAHB Comments in Support of 1000 NTU Limit

Paper: NRDC Exhibit 10, "Target Turbidity Limits for Passive Treatment Systems" by McLaughlin, (Docket ID EPA-HQ-OW-2008-0465-1370[1].10, and also submitted as Docket ID EPA-HQ-OW-2008-0465-0984.6)

Exhibit 10 is actually the earlier of the cited McLaughlin papers, so it is discussed first here. The greater part of the data used to justify a 200 NTU limit from PTS treatment comes from this paper. When McLaughlin states that a 200 NTU limit (benchmark) would be feasible, he specifically applied this statement to sites that properly employed passive flocculation systems termed Passive Treatment Systems (PTS). The following is a direct quote summary of the points made in McLaughlin Exhibit 10 concerning the 200 NTU limit, that deal with the proper installation and operation of PTS. Note that these appear to require considerable on staff expertise and a "great deal of diligence" to operate properly.

- Erosion and sediment control systems need to be designed to include PTS from the beginning.
- Successful PTS requires sufficient training of construction site staff, primarily those involved in grading and utility installation, in PTS functions and problems to avoid. It is likely a person trained in PTS will be needed on staff, or as a contractor.
- In most cases, the key factor in successful PTS use is routing all water from disturbed areas into the water conveyance with PTS installed. Bypass flows of untreated runoff is often the cause of turbidity spikes.
- The area immediately around the sediment basins needs to be stabilized at all times so as to not contribute untreated, turbid runoff into the basin.
- A great deal of diligence will be required to avoid spikes above any target turbidity level.
- One suggested strategy for LID projects is to site the sediment basins just outside the construction envelope to avoid compromising the basin functions during construction activities. While this will disturb a slightly larger area (5-10%), the benefits will likely be substantial.

The first example of a successful PTS in Exhibit 10 is a study of a gravel road improvement project in the North Carolina mountains (original paper: McLaughlin, R. A., S. E. King, and G. D. Jennings. 2009. Improving construction site runoff with fiber check dams and polyacrylamide. J. Soil and Water Cons. (accepted)). This test compared a PTS consisting of PAM logs plus a Fiber Check Dam (FCD) with "standard practices". The "standard practices" are described as small rock check dams (RCD) in ditches along steep terrain. Apparently there was no room for settling ponds on this backcountry road project. Not surprisingly, the areas of the site with standard RCD had discharges with very high turbidity. This problem contributed to the much better performance for the PTS + FCD treated areas, however it is still clear that many individual samples exceeded 200 NTU (see Table 1 from Exhibit 10).

Table 1

Site 1 (27 storms)			Site 2 (9 storms)	
Turbidity (NTU)	Standard Rock	FCD + PAM	Standard Rock	FCD + PAM
Average	3813	34	867	115
Median	2488	16	308	45
Single Sample High	14768	335	3419	533

Table 2 represents a selected number of the above tests where the FCD+PAM was "installed and properly functioning" for the two construction sites.

Table 2

	Average Site 1 (22 storms)	Average Site 2 (7 storms)
Number of Samples	12	15
Rainfall (in)	1.06	0.68
Turbidity (NTU)	20	81
Standard Deviation (NTU)	15	28
Maximum (NTU)	50	125

A couple of questions arise. The above Table indicates that something went wrong in 5 of 27 storm events at Site 1, and two of nine storm events at Site 2, and apparently during these rain events, the discharge turbidity would have frequently failed to meet a 200 NTU limit. This represents potential violations occurring in essentially one out of every five rain events, which is an intolerable condition for a compliance limit. EPA ELGs typically calculate Daily Maximum limits based on the 99th percentile of the available data (screened by EPA). A failure rate of one in five rain events is therefore not indicative of a numeric compliance limit. It may be more suited as an action level for the FCD+PAM technology. What happened to the FCD+PAM treatment? Was it unavoidable? Do the PAM logs and FCD require frequent maintenance or replacement during the actual storm events in order to meet the 200 NTU limit? In such rough terrain, it may not even be either feasible or safe to maintain or repair these BMPs during the active discharge of stormwater.

Exhibit 10 goes on to describe operations at several other construction sites, including a 3 acre LID site. These sites evidently had a traditional settling pond, however, there was no comparison to the discharge from the ponds with or without a PTS system. Table 3 shows the results for seven rainfall events where fully functional PTS are in place, but does not show the results for nine other storm events where the PTS was undermined by continual grading activity at the sites. Evidently, many or possibly all of these nine events were at an LID site, which required frequent soil grading activity. The results from the seven intact PTS sites are promising, although one of the seven rain events reported a maximum turbidity of 336 NTU, which would be a violation. Also, it is important to note that these seven tests did not include a single truly heavy rain event. Only three of the rain events were at or slightly over one inch; two of the rain events were less than 0.5 inches, which should not generate much sediment runoff even without a PTS. The fact remains that nine additional events, a majority, evidently did not at all consistently meet a 200 NTU limit. There is no information on the rain intensity or total rainfall for the nine "failed" events. Furthermore, with the LID site, it appears that most of the additional disturbances that undermined PTS effectiveness could not be avoided. The author suggested that this problem could be solved by installing an off-site pond. This solution would not be possible at most construction sites.

Table 3

Date	Rainfall (in.)	Average Turbidity	Std. Dev.	Maximum Turbidity
9/16/2008	1.15	167	93	339
11/4/2008	0.88	43	27	108
11/14/2008	1.17	50	19	98
11/25/2008	0.35	40	22	80
11/30/2008	1.01	37	8	48
12/25/2008	0.34	38	22	116
1/06/2009	0.68	11	12	46
	Averages	55	29	119

Finally, Table 4 of Exhibit 10 examines some simulated rain event experiments performed at the NC State Sediment and Erosion Control Research and Education Facility (SECREF). The experiment series looked at different pond outlets, both with and without PAM. The experiments showed that while the sediment capture rate was >97% for all tests, the PAM affected the average (weighted by volume) turbidity in the discharge to a much greater extent than the type of pond outlet. However, with the average turbidity as high as 162 NTU, the 200 NTU level would almost certainly have been exceeded for some grab samples.

Table 4

Sampling Position	No PAM (NTU)	PAM (NTU)
Basin In (untreated)	843a	847a
Rock Outlet	758ab	152b
Skimmer Outlet	353c	162b
Grass Buffer	498bc	70b
Forest Buffer	na	108b

Discussion of Exhibit 4 in Regards to a 200 NTU Limit and the NAHB Proposed 1000 NTU Action Level (Docket ID EPA-HQ-OW-2008-0465-1370[1].4)

This Exhibit is more recent, and formally endorses a numeric limit of 200 NTU for PTS systems, and supports the EPA 13 NTU limit for ATS systems. It is co-authored by Dr. McLaughlin and Alex Zimmerman; although it would appear that Zimmerman was the primary author of the sections on ATS, and McLaughlin was the primary source on PTS effectiveness, based on their biographical descriptions. Many of the claims in this exhibit are debated by NAHB in their comments. For example, the paper states in bullet form that the 13 NTU EPA limit can be met by ATS technology anywhere in the country, yet in the text, a site in North Carolina is reported to reduce turbidity from over 1000 NTU to "…<20 NTU in many cases." (Page 12, Exhibit 4.) Even though both statements support the effectiveness of ATS, this is am important discrepancy when discussing absolute numeric compliance limits. NAHB does not dispute that ATS treatment can be effective at reducing turbidity, but believes 1) the full costs have been underestimated, 2) it is impractical to implement as written in the EPA ELG, and 3) it removes turbidity far below natural turbidity levels in most receiving streams, making its use superfluous and not cost effective, and in some instances detrimental to natural biota and downstream bank stability. There are also documented cases from State agencies of flocculant overdose with detrimental effects.

As to the applicability of a specific 200 NTU numeric compliance limit, little new data over what was already in Exhibit 10 is presented, and this limit has not been subjected to a rigorous statistical evaluation. The data shows that 200 NTU or less can be met in a majority of cases, but this requires very significant, frequent, and immediate interventions on the part of trained personnel. Even then, there will be frequent instances at different sites or during certain rain events where the 200 NTU limit is exceeded through no fault or lack of attention on the part of the site operator. It would therefore appear that 200 NTU could possibly serve as an action level for PTS technology, requiring the initiation of corrective measures, but it is not suitable as a numeric compliance limit.

Recently, NAHB has proposed that an action level of 1000 NTU be implemented for all sites with greater than 30 acres of disturbed soils, that would otherwise have qualified for the EPA proposed Option 2. Exceedence of this action level would require an inspection and re-evaluation of the BMPs required in the SWPPP, as well as additional sampling to verify the problem has been corrected. A second consecutive exceedence would require notification of the appropriate regulatory agency.

This 1000 NTU action level, while high, should effectively target the few construction sites that contribute the majority of sediment to the discharges from construction sites. Many studies, including ones from the Auckland Regional Council (July 2008 paper, cited in previous 1000 NTU Action Level document), indicate that the greatest amount of sediment discharged from construction sites comes from a limited number of sites and rain events. High energy rain events create the greatest erosion and also the largest volume of runoff within a short time frame. The contributing factors that create sites that are at high risk for excessive sediment discharge could be regional in origin, or could be due to immediately local conditions. Sites with erosible soils and steep topography that are susceptible to sudden intense downpours represent the highest risk sites. These also are the sites most likely to exceed 1000 NTU in their discharge, even when conventional BMPs, including properly sized and designed settling basins are in place.

NAHB expects that exceedence of this proposed action level would be rare, but that it would occur at those sites most likely to contribute the most sediment discharge to US waters. Based on Washington State turbidity data for King County (greater Seattle), discharge from sites with conventional BMPs exceeds the 1000 NTU slightly more than one percent of the time. However, the action level could be exceeded more frequently in other parts of the country. In Exhibit 4 (page 7), McLaughlin discusses instances where even properly designed sediment basins can have average discharges of greater than 1000 NTU. McLaughlin-Zimmerman does not discuss whether better erosion control measures upstream from the basin could have reduced the discharge turbidity. However, NAHB is aware that conventional BMPs are not 100% effective at all sites. An action level of 1000 NTU would help identify the sites requiring additional BMPs and BMP technologies. The PTS treatments described by McLaughlin should not be required at every site, and may have varying effectiveness at sites where they are implemented. However, PTS should be included among the BMP options that could be implemented, in order to insure that the turbidity of the discharge does not exceed 1000 NTU in any future rain event.

More on Exhibits 4 and 10 from the NRDC Comments previously contained in NAHB Critique of NRDC Comments in Support of a 200 NTU Numeric Limit for PTS

Part 1A: Discussion of McLaughlin "200 NTU Limit" from Exhibit 10 (EPA-HQ-OW-2008-0465-1370[1].10, *Target Turbidity Limits for Passive Treatment Systems*, Richard A. McLaughlin, Ph.D.) and the McLaughlin/Zimmerman Exhibit 4 joint comments (EPA-HQ-OW-2008-0465-1370[1].4, *Critique of the Proposed Effluent Guideline for the Construction and Development Industry,* Alex Zimmerman and Rich McLaughlin, February 20, 2008) discussion in main NRDC comments starts on page 19 (EPA-HQ-OW-2008-0465-1370, NRDC/Waterkeepers Comments).

This is a critique of comments about the NRDC 200 NTU proposed limit. NRDC has based its analysis entirely on the above referenced papers identified as Exhibits 10 and 4 in its comments. NAHB does not believe that these two papers on limited studies in North Carolina support the proposed 200 NTU level. If a *national* benchmark level is to be applied, it should be much higher to account for regional differences in soil, topography, rainfall, naturally occurring background NTU levels, and other regional parameters.

The NRDC/Waterkeepers coalition has taken the findings and opinions from several studies of Passive Treatment Systems conducted by Dr. McLaughlin (Exhibit 10, EPA-HQ-OW-2008-0465-1370[1].10) and McLaughlin/Zimmerman (Exhibit 4, EPA-HQ-OW-2008-0465-1370[1].4) and presented them in its comments as evidence that all sites greater than 1 acre can meet an absolute, instantaneous numeric turbidity compliance limit of 200 NTU. McLaughlin and Zimmerman do state in their joint paper (NRDC Exhibit 4) that a national "target" limit would seem to be the only way to persuade State agencies to accept new technologies that they believe are effective, most notably Passive Treatment Systems (PTS). The papers suggest a target limit (similar to a benchmark), not a numeric limit as stated by NRDC. However, their discussions also indicate that there are variances based on regions and rainfall events and that, although the systems are termed "passive" treatment, they require expert operators, timely maintenance, and coordination with construction activities to work effectively.

McLaughlin's paper, NRDC Exhibit 10, also discussed problems with small sites, especially those utilizing LID. This paper stated that the addition of an off-site pond may have proven beneficial for the three acre test site utilizing LID, but NAHB would submit that this remedy is simply not possible for the vast majority of construction sites. NAHB does not believe that a numeric limit is required to effectively control sediment runoff from construction sites, but if a numeric limit is imposed, it could only be practically used as a benchmark limit. In addition, a single numeric limit is not appropriate; it must be adjustable to various regions and site conditions. NAHB is opposed to any compliance limit for BMP technologies where the effectiveness can vary greatly from site to site. NAHB is not opposed to PTS; however, the Association believes it can be assimilated into the recommended BMPs on a regional basis without the use of numeric limits. The PTS requirements could be incorporated into the State BMPs during one of the CGP 5-year review cycles if evidence suggests it would be effective for regions of that state.

Text of 200 NTU limit comments:

Exhibit 10 is a brief paper summarizing several research projects by Dr. McLaughlin and associates that describe monitoring results of passive treatment systems installed by the author or by construction contractors under his supervision. These were primarily located at a few construction sites in North Carolina and operated and monitored during several rain events. The author believes that the use of passive treatment systems (PTS) can reduce turbidity dramatically. With properly trained staff, proper maintenance, and adjustments to the PTS in response to changing construction activities, Dr. McLaughlin believes that PTS can consistently provide turbidity <200 NTU. The author suggests that 200 NTU might be considered as a "target" limit. However, the paper also discusses many practical problems with the PTS systems. Problems noted by the author included: water that bypasses treatment increases the occurrence of high turbidity samples; changes in the construction activities require adjustments to ensure that any additional runoff is collected and directed towards the front end of the "treatment waffle"; and rain events can damage the PTS system, which must be frequently maintained by qualified personnel. The Exhibit 10 paper further states it is likely that a PTS trained individual would be required to be on staff or as a contractor. In Exhibit 4, the authors (Zimmerman and McLaughlin) also state that PTS operations require **continuous monitoring** to achieve optimum performance. Therefore, NAHB believes that these "passive systems" may not be as passive as the term implies.

NAHB is concerned that even the proponents of these PTSs concede that expert system operators must be on site during rain events, the turbidity must be continually monitored, and that many hands-on adjustments are apparently required during operation for optimum performance. These conditions would appear to be contrary to the authors' claim that PTS can cost less than conventional BMPs to maintain. It is not clear to NAHB whether the authors fully considered costs of labor for continuous monitoring and adjustments of the PTS during rain events. The NRDC and McLaughlin comments provide no specifics on costs.

Exhibit 10 is no more specific than to suggest that 200 NTU could be a "target" limit, which could be met with great care and proactive maintenance. In the McLaughlin/Zimmerman comments (NRDC Exhibit 4), this has evolved into a call for a national turbidity limit as the only means to provoke action from State regulators into adopting less traditional technologies. Even here, NAHB notes that the authors do not specify what type of limit they are advocating. It is also possible that the authors may be unfamiliar with the legal implications of a traditional ELG enforcement limit and with the legal requirements of the ELG process. The passive systems that the authors describe require considerable expertise to operate effectively and must be continually adapted to changing site conditions, so as to handle upcoming rain events for which the intensity and duration are uncertain. A significant amount of trial and error would continue to be part of the optimizing process for such systems.