Virginia Stormwater Best Management Practice (BMP)
Clearinghouse Committee Meeting

Virginia Department of Forestry Building, Training Room
Charlottesville, VA
October 22, 2012

Meeting minutes by Jane Walker

Committee Members Present

Joe Battiata, Center for Watershed Protection
Dean Bork, Department of Landscape Architecture, Virginia Tech
Scott Crafton, Virginia Department of Conservation and Recreation (DCR), Committee Chair
Joanna Curran, Department of Civil & Environmental Engineering, University of Virginia
Jacob Dorman, City of Lynchburg
Ryan Janoch, Stormwater Equipment Manufacturers Association (SWEMA) / Terraphase Engineering, Inc.
Greg Johnson, City of Virginia Beach
Chris Kuhn, Williamsburg Environmental Group (WEG)
Craig Moore, Virginia Department of Transportation (VDOT)
David Powers, WEG
Colleen Rizzi, Loudon Water
David Sample, Biological Systems Engineering and Occoquan Watershed Monitoring Laboratory, Virginia Tech
Joe Wilder, Frederick County Department of Public Works

State Agency Personnel Present

Robert Bennett, DCR
Dave Dowling, DCR
Matt Gooch, Office of the Attorney General, Counsel to DCR
Ginny Snead, DCR

Virginia Water Resources Research Center (VWRRC) Staff Present

Jane Walker, VWRRC

Others Present

Derek Berg, Contech
Nick Burns, Hydro International
Chris French, Filterra
Tom Grizzard, Department of Civil Engineering, Virginia Tech
Randy Hardman, Hanover County Department of Public Works
Lee Hill, Joyce Engineering
Richard Jacobs, Culpeper Soil and Water Conservation District
Whitney Katchmark, Hampton Roads Planning District Commission, alternate for Jenny Tribo
Edward Kay, Imbrium Systems, alternate for Scott Perry
Marc Lelong, Kristar

Bill Nell, Thristy Duck
Norman Rainer, Dynaphore, Inc./Cleanway Environmental Partners
James Rakestraw, Stafford County, alternate for Rishi Baral
James Rice, Prince William County, alternate for Madan Mohan
Steve Rossi, Concrete Specialties, Inc.
Corey Simonpietri, ACF Environmental
Terry Siviter, Rotondo Environmental Solutions LLC.
Mark Williams, Luck Stone Corp.

Introductions

Scott Crafton of DCR, Clearinghouse Committee chair, called the meeting to order and introduced Robert Bennett, Director of the Division of Stormwater Management at DCR. Robert Bennett thanked all members for their hard work. He highlighted the importance of the work by the Clearinghouse Committee and provided background history, stating that DCR realized the need for a new Stormwater Management Handbook (Handbook) and a need for how to incorporate new stormwater BMPs into the Handbook as the science develops. He believes the efforts of the committee will make a big difference in stormwater management in Virginia.

Following Robert Bennett's introduction, everyone introduced himself or herself and his or her represented affiliation.

Minutes of the Previous Meeting

Scott Crafton announced that draft minutes of the Clearinghouse Committee meeting held on July 23, 2012 were distributed prior to the meeting and asked if there were any corrections or additions to the minutes. There were not any comments pertaining to the minutes. A representative of a stormwater manufacturer stated that he did not receive the minutes and requested a copy.

DCR Policy Decisions about VTAP

Scott Crafton explained some of the policy decisions by DCR that have resulted in changes to the Virginia Technology Assessment Protocol (VTAP).

Regulatory Process

Scott Crafton began by offering that DCR's stormwater management believes the VTAP process meets the definition of a regulation. Once adopted by the Clearinghouse Committee and the Soil and Water Conservation Board, DCR plans to make the VTAP part of the regulations through a fast-track regulatory process. Given the years of stakeholder input from the public and those affected by the protocol, DCR believes the protocol is eligible for the fast-track process, meaning it should take six to nine months instead of 18 to 24 months to become regulations. The DCR hopes the process can occur even quicker than a typical fast-track process. If the regulatory action is filed in December 2012 as expected, the application process could begin shortly after the beginning of the new year, and the actual testing process could begin in late spring or summer of 2013.

Fees

DCR believes that it has the authority to establish fees through a regulatory action. It is likely that until the regulation is in place, that fee payments will be deferred until the end of the application review process. Someone asked what the fees would cover. In reply, Dave Dowling of DCR reported that the Agency would need to establish contracts to have the applications, status reports, and other items reviewed by professional scientists. Scott Crafton added that DCR has a contract with the VWRRC for administrative assistance and website development of the Clearinghouse. The Agency needs to have a way to pay these contractors.

A placeholder fee of $10,000 was suggested by DCR management, citing that DCR believes a fee at that level would provide the operating funds to establish the program. Dave Dowling added that should such a fee be added into the regulations, we would likely revisit the fee structure in two years so the fee could be adjusted up or down depending on the actual costs to administer the program. Scott Crafton requested feedback from the vendors as to the appropriateness of this initially proposed level. Representatives of two manufacturers present reported they would find a $10,000 application fee acceptable. A representative of a manufactured treatment device (MTD) stated that his company would be more comfortable with fees established following a cost-benefit analysis. Another representative of a MTD manufacturer asked: If the place-holders fees are set too high, would DCR repay companies that paid the higher fee? Scott Crafton offered to look into this as he was unsure if the Agency has a way to pay rebates.

Limitation of Installations

DCR management decided not to limit the number of installations allowed once the testing period starts. As defined in the VTAP, the testing period begins once the first Quality Assurance Project Plan (QAPP) is approved. Because of the new policy – whereby installations are not limited during testing – and to help even the playing field, the DCR decided that a guidance document to address MTDs listed in the 1999 Handbook is not needed.

Regulations vs. Guidance Document

The structure of the current VTAP document includes both policy and technical aspects. The VTAP needs to be divided into two documents: one document will become the regulations and the other document will be the guidance referenced in the regulations. The VTAP adoption motion by the Clearinghouse Committee will therefore need to allow DCR staff the flexibility to separate the document into regulations and technical guidance documents.

Voting on the VTAP

Scott Crafton explained that according to the Clearinghouse Committee Charter, 60% of the members of the Clearinghouse Committee must be present at a meeting to have a quorum. Scott announced that the meeting is shy of reaching a quorum by one member so unless someone else arrives, a vote would not be taken at the meeting. Scott added that according to the charter, a member may send a representative to the meeting, but the alternate cannot vote. A member asked if votes could be established by proxy. DCR staff replied that they would look into the matter.

November 13, 2012 was suggested as a possible meeting date to vote, but another date may be needed if a quorum is not possible on November 13th. A member noted that the committee will become a working committee where a quorum would be needed at each meeting in order to allow for votes in establishing the use designations and pollutant removal credits. It would be a disservice to the applicants if there was not a quorum at each meeting. Without a quorum, all votes would need to be pushed off to the next meeting. Scott Crafton added that the Charter may need to be altered.

Other Topics Discussed

Scott Crafton clarified that the current stormwater regulations will not go into effect until July 1, 2014 so the six MTDs listed in the Handbook and Technical Bulletin #6 can continue to be installed until that date. Establishing the assessment process as quickly as possible is therefore of greatest importance to those MTDs not currently listed in the Handbook or Technical Bulletin. A representative of the company associated with Technical Bulletin #6 stated that DCR plans to revoke the bulletin once the company is approved for testing through the VTAP. DCR staff explained that the Agency plans to revoke the bulletin following the Board meeting in December 2012, but the rescindment would not become effective until a later date. The representative of the company requested that DCR provide an illustration of how the process would work with established target dates so the company can be assured that the transition will be seamless.

A committee member requested clarification that products not listed in the current Handbook could be installed if approved by the local government. Scott Crafton agreed with the interpretation but noted that local governments look to DCR for assurance that the product works before approving it. Thus, manufacturers of products not listed in the Handbook have a much harder time convincing local governments to approve their use. The member requested that DCR publish a policy statement that MTDs listed in the Handbook are there because they existed at the time of publication of the Handbook and have not been tested by DCR or received an endorsement by DCR. He further suggested that DCR announce that it is in the process of establishing an assessment program and that no products have gone through the process to date. He noted that many are confused about the Clearinghouse and the status of some MTDs. Scott Crafton offered that DCR would consider this request and possibly develop a policy statement that could be published on the Clearinghouse website.

A representative of a device used for flow control offered to submit an application for a test run of the VTAP process. The product would not need a phosphorus removal credit, but he would like to be listed on the Clearinghouse website. DCR staff explained that to get the process moving forward, the VTAP protocol was altered to focus on phosphorus so the latest edition of the VTAP has removed the text related to peak rate control. Scott Crafton stated that he was unsure how to answer the request at this time. The individual related that he is being told by localities that he needs to gain VDOT approval and be listed on the Clearinghouse website. Scott believes that after July 1, 2014, the product would need approval by the agency director and be posted on the Clearinghouse website but not until then. A member of the Clearinghouse Committee suggested that the committee could evaluate such products without going through the formal VTAP process.

Review of the VTAP

David Sample, the Clearinghouse Committee member who headed a panel of academic experts that helped write the VTAP, and Jane Walker of the VWRRC went through the most recent version of the VTAP in an attempt to explain where and why changes were made to the document. In addition to making changes that reflect the DCR policy decisions, changes were made following input from the public. A document that lists the questions and comments in reference to the VTAP as received from the public and the DCR responses to the submissions was distributed prior to the meeting (Appendix A). Two versions of the VTAP document were also distributed prior to the meeting: one version shows where changes were made and the other "clean" copy incorporates all of the suggested changes. Jane and David went through the version with markups (Appendix B). Text associated with questions posed by the public are indicated with comments on the side. Most text that has been altered was done so using MSWord's "track changes." When this feature was not used for additions to the VTAP, the text is highlighted. Highlighting is also used to call attention to changes. Jane Walker stated that she attempted to remove redundant statements within the document and reorganized parts of the document so there appear to be more changes than there are.

DCR staff requested that the Board approval date be removed from the cover until the VTAP is actually approved. Dave Dowling stated that the language throughout the document may be tweaked by DCR to be sure the VTAP conforms to other state standards; however, these changes are not expected to affect the functionality of the process.

As a general comment, a committee member requested that instead of using the word "should" use the phrase "it is recommended." Dave Dowling prefers the term "shall" instead of "must" because the VTAP will be part of the regulations. Dave offered that the use of "shall" and "may" would be helpful.

Section 1-- Introduction

Jane Walker summarized the changes made to this section of the VTAP prior to the meeting:

- Approval is only for MTDs (not all BMPs) – A representative of a MTD manufacturer noted he was disappointed that non-proprietary BMPs would not be assessed at this time. Scott Crafton noted that DCR will consider addressing the testing of non-proprietary BMPs, but given some of the differences that apply to them, there is insufficient time to do that adequately as part of this VTAP approval process.
- A definition for MTD was added.
- The document is only for evaluating MTDs that control phosphorus.
- The role of the Board was added to **Section 1.4 -- Roles and Responsibilities**.
- Proponents of the technology must only notify the Agency of installations made in Virginia during the testing period.
- Language was added regarding how confidential information will be handled.

The following additional changes were requested at the meeting:

- Because approvals will be made by the director of DCR, refer to the Agency director title once and from then on, simply refer to the "Director."
- List the agency name, DCR, once and from that point forward, refer to it as the "Agency."

- Add text to **Section 1.5 -- Protocol Limitations, Release of Liability, and Disclosure** stating that if DCR contracts with another entity, it will establish a confidentiality agreement with the contracted entity prior to sharing confidential information.

<u>Section 2 -- BMP Certification Designations</u>
The changes to Section 2 prior to the meeting included the following:

- The number of installations allowed in Virginia will not be limited during the test period, but the testing period for the pilot use designation (PUD) and conditional use designation (CUD) is limited to 24 months from the date the first QAPP is approved (the Agency may grant extensions to the testing period, if needed).
- Table 2.1 (summary of the testing requirements) was updated to include only one field study that focused on total phosphorus (TP) to obtain a CUD.
- To receive a general use designation (GUD), the test sites must represent urban stormwater conditions expected in Virginia; conditions representative of those in Virginia are recommended to receive a PUD or CUD but are not required.

Discussions pertaining to Section 2 of the VTAP focused on the following topics:

Table 2.1
Much of the discussion focused on the accepted protocols that could be used to receive the CUD and/or GUD. Some representatives of MTD manufacturers were vocal in their support to allow the use of the Technology Acceptance Reciprocity Partnership (TARP) to earn the CUD, provided the testing focused on TP removal. Dave Dowling offered to determine if dates are required or not for the specific protocols although he suggested that it is likely that they are necessary. A representative of a MTD noted that the TARP reference should be the 2003 version, not the New Jersey Department of Environmental Protection's 2009 document (which consists of New Jersey-centric amendments to the TARP). Committee members and representatives of MTD manufacturers discussed the costs and benefits of requiring two field tests that followed the VTAP to receive a GUD.

The committee recommended the following changes:

- Update the CUD status in Table 2.1 to allow the use of TARP when the testing monitored TP, i.e., cite "VTAP, TARP, TAPE and other protocols accepted by the Agency."
- Update the GUD status in Table 2.1 – 2 field; TP; and "At least one test site must follow VTAP."

To reflect the updates in Table 2.1, the following sections also need to be updated: **2.1 -- PUD**, **2.2 -- CUD**, **2.3 -- GUD,** and **2.4 -- Applying for the Appropriate Use Designation**. In addition, the pollutant removal credit may not exceed 30% for the PUD.

Table 2.2 (urban stormwater test conditions for approval in Virginia)
One of the public comments suggested listing a range of influent phosphorus concentrations expected for urban stormwater in Virginia. The committee heard input from the manufacturers present at the meeting on this topic. Following several minutes of discussion, Scott Crafton proposed that Table 2.2 not be updated to include a range or ranges of typical TP concentrations

required for test conditions. There appeared to be general agreement with this proposal because influent characterization is very site-specific.

Special Issues
An alternate asked if the VTAP has provisions for how to handle special issues such as high water tables. In reply, David Sample offered that the proponent is told to list site requirements and limitations of the MTD in the application. Scott Crafton added that testing is not being required for different types of sites. A committee member offered that it is the responsibility of the proponent to provide the necessary information, and it is the responsibility of the locality to review the provided information before deciding whether or not to allow MTDs to be used within that locality. The VTAP is not designed to cover all circumstances; it is just an attempt to level the playing field.

Locality Responsibilities
A plan reviewer and approver in attendance at the meeting asked what affect the Agency's stance of not requiring the removal of MTDs found to be underperforming would have on localities. Would localities need to require that such MTDs be removed and replaced with other BMPs in order to meet the desired performance standard? DCR staff explained that when the plan approval process is being performed under the general construction permit, and the BMP is designed and installed as the Agency specifies, the stormwater management (SWM) rules have been satisfied from a compliance point of view. The Agency will assume that the load meets the 0.41 pounds per acre per year load of phosphorus. If the locality is a MS4 (Municipal Separate Storm Sewer System) and especially if it is under an individual permit, the U.S. Environmental Protection Agency (EPA) may require additional performance verification. Some compensation may be needed, but at this time, no one knows what that might be. Localities have the option to allow or disallow the use of MTDs within the locality and have the ability to place conditions on installed MTDs.

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Note: The meeting broke for lunch, and following the break, the discussion concerning updates to the VTAP continued.

<u>Section 3 -- Assessment Process</u>
Jane Walker noted that text was added to clarify when suspensions and cancellations of use designations would be needed.

Dave Dowling stated that the required deadlines will be articulated in the regulations. Jane Walker explained that because the Agency director will be the person to establish use designations and pollutant removal credits, more time was added to the estimated time for the approval process, i.e., extended from 15 days to 45 days following the recommendation by the Clearinghouse Committee. The flow chart was updated to show this change and was altered to illustrate that the testing period begins once the Agency approves the first QAPP.

A member of the committee asked for clarification that DCR would begin to review completed applications in the order that they were received. The committee did not request changes to Section 3 of the VTAP.

Section 4 -- Field Monitoring and Data Evaluation

David Sample explained that the panel of academics that originally proposed the field methodology was asked by DCR to review the submitted questions and suggestions posed by the public regarding the VTAP. He explained that the panel met three times to discuss how best to address these questions. David summarized the updates made to this section of the VTAP following the meetings of the panel.

Section 4.2 -- QAPP and Documentation

David Sample stated that the panel had requested additional input on acceptable methods for determining peak flow rate. The input David received indicated that the use of the calculation in Virginia's Handbook is a good approach. A representative of a MTD manufacturer clarified that the Virginia approach is different than that taken by New Jersey. Several representatives of MTD manufacturers suggested removing text that other methodologies could be used with approval by the DCR.

David Sample explained that the panel felt that the use of accredited laboratories is important to provide an assurance of standardization. To comply with Virginia regulations, accreditation or certification through the Virginia Environmental Laboratory Accreditation Program (VELAP) is required. However, if a constituent does not have a VELAP-certified procedure, it will be reviewed on a case-by-case basis as part of the QAPP. A representative of a MTD manufacturer stated that he believes VELAP, National Environmental Laboratory Accreditation Program (NELAP), and any state accreditation program, such as California, should be allowed to be used. He suggested that DCR should talk to the Department of Environmental Quality's (DEQ's) quality assurance officer, James Beckley; Jane Walker noted that she had talked to James Beckley about this issue previously. The individual suggested that DCR obtain written response from DEQ on this matter. As an alternative approach, it was suggested that the Division of Consolidated Laboratory Service (DCLS) laboratories could be used, but others explained that these labs could not be used for commercial purposes.

David Sample commented that QAPPs not only need to address the general requirements in the QAPP section of the VTAP (Section 4.2) but also specific requirements requested in **Sections 4.3 -- Monitoring Program Design** and **Section 4.5 -- Sample Collection, Analysis, and Quality Control**.

Section 4.3 -- Monitoring Program Design

David Sample explained that Figure 4.1 (sample effort needed for paired testing) was removed from the VTAP. It had previously been included to help explain the reason for monitoring sequential storms but was being removed because it raised several questions from the public thereby causing more confusion than clarification. He added that only 18 qualifying storms are needed if the confidence level exceeds 50% and if approved by DCR; otherwise 24 qualifying storms must be sampled. David Sample noted that the VTAP has relaxed the "ten consecutive storm" requirement to five paired storms (for a total of ten events), which consist of back-to-back events. It was suggested to add the term "qualifying storms" to the sentence describing the minimal number of back-to-back storms.

Two representatives of stormwater MTD manufacturers voiced a preference for the updated version of the VTAP that requires one storm with more than 1-inch of rainfall and three storms with more than 0.5-inches of rainfall. They were not concerned with leaving in or taking out the 15-inch minimal total of all storms, stating that meeting such a goal would be easy if monitoring 24 storms and meeting the other requirements. A third representative of a MTD manufacturer stated that he prefers to eliminate the 15-inch minimal requirement.

Section 4.4 -- Monitoring System Design and Installation
A change in the VTAP allows for the use of area-velocity (AV) meters to monitor flow. David Sample clarified that if AV meters are used, the devices must be calibrated according to the equipment manufacturers' guidelines and an estimate of its accuracy of flow at the given site must be provided (estimate that the equipment will range within plus or minus [±] a given amount). A representative of a manufacturer requested that DCR consider listing a threshold over which the device should not be used. Scott Crafton clarified that the commenter is looking to minimize subjectivity as much as possible. David Sample commented that these issues will be sorted out prior to testing in the QAPP approval process.

Section 4.5 -- Sample Collection, Analysis, and Quality Control
A representative of a MTD manufacturer requested that the document be clarified to differentiate between flow that was diverted from entering the MTD (i.e., external bypass) and flow that entered the MTD but was not treated (i.e., internal bypass). David Sample agreed that DCR should modify the language of the VTAP to meet this request. The language was intended to avoid cases that may affect the mass balance of the system; diversions before flow measurements do not affect the mass balance.

David Sample stated that one of the public comments indicated that measuring more than TP for each sample is "overkill." He reminded those in attendance that the Clearinghouse Committee decided at a previous meeting that the following parameters in addition to TP need to be measured: total soluble phosphorus (TSP), total suspended solids (TSS), suspended sediment concentration (SSC), and particle size distribution (PSD) for all MTDS and soluble reactive phosphorus (SRP) when the MTD uses sorption.

David Sample offered that following the suggestion from a public comment, the panel decided to make the measurement of specific gravity a required parameter for accumulated sediment as well as for stormwater.

David Sample explained that to date, there are no National Environmental Laboratory Accreditation Conference (NELAC) methods for measuring SSC, PSD, and specific gravity. Jane Walker stated that the VTAP now clarifies that if a parameter does not have a NELAC certified method, it does not need to be performed in a VELAP accredited or certified laboratory.

David Sample stated that one comment from the public seemed to recommend limiting the methodology for measuring PSD to wet sieving. The panel did not think this was necessary because laser diffraction is an acceptable method of measuring PSD and is less labor intensive to perform and less expensive to analyze once the instrument is purchased. A representative of a MTD manufacturer noted that measuring PSD using the different methods would give different results, and David Sample agreed that the specific method chosen needs to be used throughout the entire testing period.

David Sample explained that the panel attempted to clarify that there are numerous ways to calibrate flow metering systems and thus added more examples of methods that could be used.

David Sample stated that the term "decontamination" was removed from the document following the objection to its use by a reviewer. He explained that decontamination has a specific meaning in the hazardous waste field and noted this meaning was not intended in the VTAP. Therefore, the term "decontamination" was replaced with "equipment cleaning or maintenance."

A representative of a MTD manufacturer asked if there are criteria related to the results associated with field blanks. David Sample replied that the QAPP should address what the researchers intend to do if the field blanks are above the reporting limit. The DCR evaluator will carefully review this aspect of the QAPP and work with each proponent to ensure an acceptable process. David Sample commented that **Appendix D -- Laboratory Methods** has been updated to include the table in the *Technology Assessment Protocol – Ecology* (TAPE) 2011 version (no longer using the table cited in the TAPE 2008 version). The reporting limit for TP is thus now 0.01 mg/L (instead of 0.001 mg/L as listed in TAPE 2008).

A committee member asked if the VTAP could provide more flexibility on the use of VELAP certified labs by allowing testing to begin prior to VELAP accreditation/certification. David Sample and another member of the committee stated that the proponent would be at risk in doing it that way. In the event that their methodology needed to be altered, their past monitoring results would be called into question (and thus would not meet the VTAP requirement of using a VELAP accredited/certified laboratory). A representative of a MTD manufacturer stated that to his knowledge DEQ still uses data collected prior to when the VELAP regulations came into being. Several members suggested that the VELAP reference in **Section 4.5.8 -- Laboratory QA/QC Procedures** could be removed because it was redundant to earlier statements in **Section 4.2.1 -- Preparation of a QAPP**. Scott Crafton offered that the part about needing at least 180 days to gain VELAP certification could be added to the earlier statements. Jane Walker offered to update the VTAP to ensure it covers all the VELAP information provided in this version (October 19, 2012) while removing redundancies.

David Sample requested input on the method of using half the detection limit for statistical analysis of non-detects. A representative of a manufacturer stated that he liked the approach so was glad to see it stated in the protocol. A member suggested that it should be half the reporting limit (not detection limit of the instrument). He noted that different labs have different confidence levels in their methodology so it should be half the limit of the lab's reporting limit. David Sample offered to research it further and provide a response to this request in writing.

Section 4.6 -- Data Verification, Validation, and Certification
David Sample called attention to a modified statement: "Data validation is based on the verified data and data validation records, and it needs to be performed by person(s) independent of the activity which is being validated." Jane Walker explained that the VTAP used to specify that the proponent's technical advisor would be the one to validate the data, but in the instance where the proponent's technical advisor performs the testing, it should be validated by an independent person or entity.

A member asked why "efficiency" was replaced by "pollutant removal (PR) credit." Scott Crafton explained that DCR was trying to make the VTAP compatible with the Handbook and other DCR documents by using the same terminology in all.

<u>Section 5 -- Application and Reporting</u>
An alternate expressed concern with the proposed deletion of nitrogen from the description of the MTD design and sizing section of the Technology Evaluation Report (TER). A representative of a MTD manufacturer asked if additional nitrogen data could be submitted and reviewed. Scott Crafton explained that to keep the process moving forward, the VTAP is only focusing on phosphorus at this time. In the future, approvals for nitrogen removal may be awarded. A member asked: If there is a TMDL for nitrogen or bacteria, would the locality be able to use the Clearinghouse to identify MTDs that remove these pollutants? Scott Crafton replied, "Not at this time." Scott added that DCR may be able to develop another way for the director to approve and list such MTDs on the Clearinghouse website. David Sample stated that in theory, if the committee could agree on how samples are collected and if labs are VELAP accredited or certified for nitrogen then evaluating the MTDs for nitrogen removal should be possible. Another alternate noted there is nothing stopping the proponent from measuring parameters other than those listed in the VTAP. Dave Dowling suggested that with nutrient trading underway, there may be a need to include a credit for nitrogen removal. It was suggested to include the collection of nitrogen data as an option.

The group began considering the removal of other parameters such as metals, oil, and bacteria and started discussing how easy or difficult it would be to establish protocols to evaluate MTDs on the removal of these pollutants. Scott Crafton added that if the group could easily reach a consensus, then the VTAP could be updated to include these parameters, and MTDs could be evaluated for removal of these pollutants. A member suggested that the other data could simply be verified at this time but not necessarily awarded removal credit. Thus, when protocols are established for evaluating these pollutants, the data have already been verified and can be used for statistical analysis. There was general agreement with this approach, and David Sample offered to propose language for this section to provide for that.

<u>Appendices</u>
Dave Dowling suggested that all forms be removed from the VTAP appendices. The committee members appeared to be in support of removing the forms because it would increase the flexibility of the process.

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A representative of a MTD manufacturer asked what he should do if he has questions as he reviews the document more carefully. In reply, Scott Crafton requested that committee members and others with questions or comments submit them to him by Friday, October 26, 2012 if possible.

Virginia MTD Registry Update

Scott Crafton stated that the purpose of the MTD Registry was to allow MTD manufacturers the opportunity to post information about their product on the Clearinghouse website prior to the start of the evaluation process. Given that the evaluation process would soon be opened, Scott wondered if there was a need to continue with developing the MTD Registry. A representative of a MTD manufacturer stated that the MTD Registry would only benefit the manufacturer if consultants would use it to learn about the various products. A member of the committee who has worked as a consultant stated that she would likely recommend a product that has already been approved or one she has used in the past and found to be effective. She wants to be sure she has substantive data prior to recommending a product, so she would probably not use the MTD Registry. A member stated that localities might easily fall into a misconception that a product's listing in the MTD Registry constitutes an "approved" BMP listed on the Clearinghouse website, which is not what DCR intends to convey. He believes the MTD Registry would provide a false start and would not help in the long run. Another member thought that part of the purpose of the MTD Registry was to have a way to promote hydrodynamic devices that would not be going through the VTAP protocol.

Evaluation of Pretreatment Devices

Scott Crafton stated that one of the public comments regarding the VTAP was to develop a pretreatment category for such devices as hydrodynamic separators that would not attempt to gain phosphorus removal credits. This category was not included in the VTAP. DCR envisions that manufacturers of such devices would apply as a pretreatment device and submit their TARP data for TSS removal. Several individuals began offering suggestions for what the pretreatment protocol could include. One person suggested that only field data should be recognized, and another suggested that parameters in addition to TSS, such as gross solids and the removal of organic material, be allowed for consideration. Scott Crafton offered that this discussion should be continued at another meeting. A representative of a MTD manufacturer asked if there was a timeline for when development of the pretreatment protocol and evaluation of pretreatment devices would begin. Scott Crafton stated that this has not been discussed. Scott noted his sense that some basic requirements could be developed for recognizing pre-treatment devices, based on their testing under the TARP, and that a separate Virginia testing protocol would not be necessary. He suggested that continuing this discussion could be part of the January Clearinghouse Committee meeting.

Next Meeting

Scott Crafton offered that a confirmation on the special meeting to vote on the VTAP would be provided soon. A member asked if DCR would check into the possibility of members voting by proxy. A representative of a MTD manufacturer asked if the special meeting would be "public noticed," and Scott Crafton replied that it would be listed on the Town Hall website just like all other Clearinghouse Committee meetings.

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With no further business, the meeting was adjourned.

Appendix A

PUBLIC COMMENTS AND AGENCY RESPONSES PERTAINING TO DCR's PROPOSED VTAP DOCUMENT

1. Contention that VTAP is an improperly developed regulation: **COMMENT:** It is premature for DCR to finalize any guidance document related to VTAP at this time. Questions have been recently raised regarding whether the agency has properly implemented the required public engagement process through the Virginia Administrative Process Act (APA) for what appears to be a regulatory process. There does not appear to have been designated public comment periods when key decisions were made by the Committee and DCR. While this appears to have been handled by direct communication with committee members, it does not appear there has been a process in place for informing other stakeholders beyond oral statements made at Committee meetings. When asked on 26 March 2012 whether VTAP is considered regulatory in nature or simply a guidance document/process, DCR was unable to provide an answer. This matter should be resolved prior to any finalization of program guidance materials. Also, some manufacturers believe they have not had sufficient input into the process, and that there remain important aspects of the process that have not yet been clarified sufficiently, such as evaluation of data and who will perform this evaluation. *(Chris French, Filterra; Marc Lelong, KriStar)*

   The DCR Panel of Academic BMP Researchers advisory response: *The panel considered this issue to be entirely a policy question for DCR to resolve and, therefore, did not take a position on it.*

   DCR response: *It is important to note that DCR has a tradition of issuing various kinds of regulatory guidance to external entities and stakeholders, using a stakeholder participation and comment process that parallels that of the APA. The VTAP document has been developed with similar stakeholder involvement, and the modified Virginia Stormwater Management Regulations refer to procedures developed by the BMP Clearinghouse Committee for testing MTDs. (4 VAC 50-60 C).*

   However, DCR staff did confer with legal counsel from the Attorney General's office and determined that the VTAP does set forth requirements that meet the Virginia APA definition of a regulation. Therefore, following adoption of the VTAP as a guidance procedure by the BMP Clearinghouse Committee and, subsequently, by the Virginia Soil and Water Conservation Board, DCR staff will ask the Board to authorize a fast-track process to incorporate the VTAP document into the Virginia Stormwater Management Regulation.. This approach should keep the process moving forward so that manufacturers will be able to begin testing their MTDs sooner rather than later.

2. Lack of uniform application (Section 1.2, pg. 2, VTAP document): **COMMENT:** The VTAP document states the assessment will apply to new BMPs or the modification of existing BMPs, "manufactured or otherwise." The guidance document clearly excludes a listing of non-proprietary BMPs from the verification process. We submit that non-proprietary BMPs are modified each and every time they are installed. Conversely, a manufactured product is constructed in a controlled factory environment, assuring compliance with the original design parameters and expected performance. Despite the requirement to address pollutants of concern, particularly phosphorus, there is an extensive body of research questioning the efficacy of some non-proprietary BMPs. At a recent mid-Atlantic bioretention conference, such studies indicated as many as 65% of these systems are underperforming. They have not been vetted through the rigors of the pending VTAP testing and verification process and are being given an unfair free pass. DCR should add a provision to the VTAP

and this guidance document that states under what circumstances non-proprietary systems should have to use the VTAP.

All BMPs (non-proprietary and proprietary) need equivalent research from field studies with a level platform of monitoring in order to equally access performance. Some Washington state MS4 permittees are required to perform a TAPE compliant field study of proprietary or non-proprietary BMPs during the permit cycle. This could be one way to promote academic studies of non proprietary BMPs across the state. The same VTAP protocol should be used as a guide for all studies. Costs may be saved with academic studies by using in-house labs, but still following quality control plans to establish statistical significance. These would be good graduate projects to help develop water quality scientists in Virginia and for universities to become higher profile, regional centers of excellence.

We believe that any urban SWM grant program administered by DCR that includes installation of non-proprietary BMPs should be subject to VTAP requirements, since public dollars are used for the construction. This would provide DCR and its partners with a workable and reasonable process for eliminating this identified inequity for implementing VTAP. All BMPs should be held to the same process to ensure performance. *(Craig Beatty, Stormwater Equipment Manufacturers Association, Chris French, Filterra; Marc Lelong, KriStar; Scott Perry & Edward Kay, Imbrium Systems)*

The DCR Panel of Academic BMP Researchers advisory response: *The statement that "non-proprietary BMPs are modified each and every time they are installed," while "a manufactured product is constructed in a controlled factory environment, assuring compliance" is a gross oversimplification of the process. Many non-proprietary BMPs have a large history of performance research, several of which have been published and peer reviewed. We acknowledge gaps in this knowledge, particularly in agricultural and catchment-scale BMPs. The current Bay program's emphasis on implementation without sufficient verification does likely weaken its ability to achieve compliance. Verification is taking place in some jurisdictions, albeit under less than uniform conditions. However, this does not obviate the need for certification of proprietary practices, about which we know much, much less. Going to the core of the argument is the "fairness" of requiring testing. The panel does not feel that this argument holds water, no pun intended. No entity stands to gain from the certification of nonproprietary practices; whereas there are substantial potential rewards associated with certification of proprietary practices. Thus the risk and reward appear to be commensurate.*

DCR response: *DCR agrees with its panel of academic BMP researchers that there is no clear impulse driving the testing and evaluation of non-proprietary BMPs in Virginia or, for that matter, in any other specific state. Non-proprietary BMP research tends to occur at academic institutions or within local jurisdictions where there is specific interest and funding can be cobbled together to accomplish the research. Our understanding of the performance of non-proprietary BMPs is based on many monitoring projects for any specific BMP type (e.g., bioretention) conducted in many different states, as opposed to a few more focused tests typically applied to the same design of a specific MTD. Keep in mind that even if Virginia does develop recommended testing procedures for non-proprietary BMPs, there will be no compulsion for researchers in other states to follow those procedures. Therefore, the methods of evaluating their performance and effectiveness and improving their designs are likely to remain the same as they are today.*

DCR will give this issue further consideration to be sure that the "playing field" is fair and even and that, to the degree feasible, appropriate scientific rigor is applied to the evaluation of new or enhanced non-proprietary BMPs. However, in order to maintain focus on completing the current VTAP for MTDs and enabling their testing to begin as quickly as possible, DCR proposes that *development of appropriate testing and evaluation procedures for non-proprietary BMPs be delayed until after the VTAP for MTDs is completed.*

3. The fee structure is too high and without foundation (Section 4.1, pg. 14, VTAP document): **COMMENT:** We question whether DCR has the legal authority (Code of Virginia, Virginia Administrative Code, etc.) to charge fees for the VTAP applications and evaluations. Furthermore, the fee structure is quite high, particularly for products that will need to go through all 3 steps of the program. The cumulative cost of the fee structure would approach $100,000. This can be as much as 250% greater for most BMP manufacturers than any other such program in the U.S (10 times greater than fees charged by the Washington DOE for implementing their RAPE program). The fee structure as proposed threatens to discourage, in Virginia, the use and development of technological solutions to the vexing issue of stormwater pollution control, particularly as the emphasis in the reduction of phosphorous from stormwater from stormwater runoff is Virginia's top priority. We also note that the number of such programs in the U.S. is very limited, as reciprocity is the more common avenue for technology product review and approval. We strongly urge you to revisit the fees and base them on expected costs. Perhaps reaching out to the NJCAT and/or WA TAPE programs to discuss their experiences would help identify the appropriate fees. As it currently stands, the combination of the extensive testing costs and high fees is considered excessive and exclusionary, and we believe it is likely to significantly many companies from participating in this process, limiting the number of products submitted to the program and depriving local constituencies of proven methods for enhancing water quality.

   At a 26 March 2012 meeting with DCR and others, DCR stated the current fee structure in the VTAP document is considered filled with placeholders and not intended to be the final fees for program implementation. At a minimum, a statement reflecting this position should be placed in the guidance document and in an updated VTAP document, so there is full disclosure that this is DCR's intent. We believe the guidance document should not be finalized until there is a final fee structure established. *(Derek Berg, Contech; Craig Beatty, Stormwater Equipment Manufacturers Association; Chris French, Filterra; Marc Lelong, KriStar)*

   The DCR Panel of Academic BMP Researchers advisory response: *The panel feels that this is mainly a policy question, and takes no position on the matter. The panel does observe that since fees may discourage applicants from seeking certifications, the DCR will have removed this impediment from the process.*

   DCR response: *DCR staff has discussed this matter with counsel from the Attorney General's office to determine whether there is sufficient legal authority to charge the fees. The DCR Policy staff and legal counsel believe that there is legal authority in the Code of Virginia to charge fees for the VTAP process. However, DCR agrees that the fee schedule needs to be established in regulation and the fee amounts should reasonably reflect the work involved in implementing the VTAP program (e.g., reviewing applications, reports and test results and formulating recommendations pertaining to specific MTD tests, etc.). It is not clear yet how quickly that can be accomplished, so the testing program may have to begin without charging up-front fees.*

   The fee amounts stated in the VTAP document were intended to be placeholder values, with the final values yet to be determined. DCR is checking with the Washington DOE program and with NJDEP to determine the basis for the fees that are currently charged for the TAPE and TARP programs, respectively. Commenters should also understand that the Commonwealth already has a significant investment in development of this program, and the program may not be funded with General Fund *appropriations. So DCR will ultimately have to charge reasonable fees to cover the costs involved with administering the VTAP and the BMP Clearinghouse program.*

4. Committee representation: Historically, the Clearinghouse Committee composition has had a low ratio of manufacturers participate as committee members. At best, only two of the available positions were filled by this sector at any one time. The Committee has also been dominated by academics and consultants. The manufacturers of MTDs should have more of a presence on the Committee, to offset this imbalance. The Stormwater Equipment Manufacturers Association (SWEMA) should also have a representative on the Committee. *(Marc Lelong, KriStar; Chris French, Filterra)*

The DCR Panel of Academic BMP Researchers advisory response: *While this is mainly a policy question, the panel would like to weigh in. First, we would like to point out two corrections: (1) there is manufacturer representation from the trade association, and local government and VDOT are also represented. We do not feel that the current committee is out of balance. The Committee should be comprised primarily of members that do not have any stake in the outcome of Committee decisions; often academics and consultants fit these criteria. A Committee comprised of a significant number of MTD manufacturers, which do have a stake in outcomes, could be problematic and result in severe conflict of interest, particularly if they vote on each other's work.*

DCR response: *This is a DCR policy decision, not a VTAP document issue. The make-up of the Committee membership is addressed in the Clearinghouse Committee Charter. DCR has recently appointed a representative of the Stormwater Equipment Manufacturers Association (SWEMA) to a Committee seat. However, DCR intentionally set up the Clearinghouse Committee to be composed, primarily, of the range of stormwater management program stakeholders that would typically be involved in regulatory advisory committees and who represent ultimate users of MTDs as well as academicians who understand water quality monitoring and BMP testing. MTD manufacturers were included on the committee in order to solicit their practical insights to the process, and additional vendors have been welcomed to attend Committee meetings and to engage in discussion of issues. However, the number of manufacturer representatives sitting ON the committee at any one time was intentionally limited because, ultimately, the Committee's job is to evaluate products produced by these and other manufacturers. Manufacturers sitting on the committee are likely to have to recuse themselves from votes pertaining to product approvals, since they either will have produced the MTD being considered, or their products compete with that MTD. In that vein, it would not be prudent to have a Committee loaded with manufacturer representatives. Furthermore, as particular manufacturer representatives have rotated off the Committee, DCR has intentionally tried to replace them with representatives of different companies, in order to give all manufacturers the opportunity to, at some point, have an official seat at the table.*

5. Add definitions and/or a glossary of terms to the document (Section 5.3.2.4, pg. 28, VTAP document): **COMMENT:** This would clarify the terminology used. For example, "paired sampling" can mean both paired influent and effluent samples and paired samples between two different monitoring sites.

The DCR Panel of Academic BMP Researchers advisory response: *The panel does not object to creation of such a document; however it would like to review said document (or definitions).*

DCR response: *The term "paired sampling" is the only term that has been questioned to date. Rather than lengthening the document by adding a glossary, DCR prefers to clarify the meaning of that term within the text where it appears.*

6. Objection to requirement that VELAP-certified labs be used (Sections 5.5.4 and 5.5.8, pp. 40 and 44, VTAP document): **COMMENT:** There are concerns about the use of the VELAP program within the context of VTAP. We recommend that DCR move away from requiring VELAP certified laboratories as part of the VTAP. We believe that this requirement is an overextension of DCR's regulatory authority, as that program is administered by the Department of General Services, Division of Consolidated Laboratory Services, through a MOU with DEQ. The VELAP regulations resulted in program exemptions for data generated by citizen scientists and academics, who in turn share their data with the DEQ. *(Chris French, Filterra)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel notes that there is a legislative requirement for environmental laboratories in Virginia doing work in support of the State Water Control Law to have VELAP* ***accreditation (as opposed to certification)****. From DCLS:*

> *"These regulations directed the Virginia Division of Consolidated Laboratory Services (DCLS) to establish a program to certify or accredit environmental laboratories that perform tests, analyses, measurements, or monitoring required pursuant to the Commonwealth's air, waste, and water laws and regulations. As of January 1, 2012, environmental laboratories must become certified or accredited by DCLS before any analyses can be used for the purposes of the Virginia Air Pollution Control Law, the Virginia Waste Management Act, or the State Water Control Law."*

It is clear that MTD performance certified under the auspices of Virginia DCR will fall under these regulations, at the very least in determining compliance with the Chesapeake Bay TMDL. There are, of course, laboratories, particularly those in universities, which have a long history of performing environmental and treatment process studies. The requirement to acquire accreditation in compliance with VELAP will certainly create a burden. The panelists, all being academicians, are cognizant of this burden. One of the panelists recently achieved such accreditation in Florida and did not find it to be insurmountable. In Virginia, at least one state university laboratory has already been awarded VELAP accreditation, and two others are in progress. We believe that this requirement is driven by regulation, that no exception should be created for academic laboratories, and that such a requirement, while taxing, is not an undue burden on such laboratories.

DCR response: *DCR disagrees that specifying the use of VELAP-accredited labs in the VTAP document is an overextension of DCR's regulatory authority. Whether or not DCR was initially involved in or ultimately responsible for the VELAP regulations, DCR (and other agencies, for that matter) can refer to and/or require VELAP accreditation for appropriate applications related to DCR legislative and regulatory authorities. This is no different than DCR requiring in its SWM regulations that a professional licensed by the Virginia State Corporation Commission's Division of Professional and Occupational Regulation seal site plans and calculations associated with stormwater management plans. In this case, DCR's panel of academic BMP researchers who drafted the VTAP document felt it important that samples collected from MTD product tests be analyzed in certified labs using certified equipment, in order to assure consistency of results across tests by numerous companies on various devices.*

Jane Walker, of the Virginia Water Resource Research Center, which provides staff support to DCR for administration of the BMP Clearinghouse, had a recent conversation with staff of the VELAP program, which is implemented by the Virginia Division of Consolidated Laboratory Services (DCLS), part of the Department of General Services. The VELAP staff stated that VELAP certified labs are required for any monitoring involved with meeting requirements of the Virginia State Water Control Law They stated their opinion that VELAP certification should be required for labs analyzing test data to assign pollution removal efficiencies for products that could then be used to meet TMDL *and other regulatory water quality requirements. DCR water quality requirements fall under separate laws. DCR checked with the Virginia DEQ about this. DEQ's position is that any data used for purposes of complying with the Air, Waste or Water Control Laws must be VELAP certified. This would include compliance with TMDL requirements, such as the Bay TMDL. See Section 2.2-1105 B of the Code of Virginia.*

Jane Walker also determined that there are numerous VELAP-certified laboratories in Virginia and elsewhere, in order to ensure that sufficient laboratory services are available to vendors testing their products under VTAP. A list of VELAP-certified labs is provided on the following DCLS webpage:

http://www.dgs.state.va.us/DivisionofConsolidatedLaboratoryServices/Services/EnvironmentalLaboratoryCertification/tabid/1059/Default.aspx

The labs are listed in the PDF or Excel files entitled: "VELAP Accredited Commercial Laboratories WITH FIELD OF ACCREDITATION (FOA) DETAIL" (updated 7/25/2012). We counted about 70 commercial labs that are certified for TP analysis at this time, and many of them are located outside of Virginia. Similarly, about 30 non-commercial labs have VELAP certification for TP.

It is important to note that it is common for university researchers to be involved in testing the performance of various kinds of BMPs. However, most university laboratories do not have VELAP or NELAC certifications. One consideration is that, since other (out-of-state) testing protocols are allowed in order to obtain CUD certification from Virginia, we probably do not need to require VELAP certified labs for the PUD and CUD certifications. But either VELAP or NELAC certified labs should be required for gaining a GUD certification, provided we want to be able to use the assigned and sediment reductions toward meeting TMDL targets or to meet any other requirements of the State Water Control Law. If the vendors are not interested in having their products used to meet such water quality requirements, then the labs they use would not have to be VELAP/NELAC certified. However, such a distinction would have to be made clear in DCR recognition of a MTD.

7. Out-of-state certification of labs (Sections 5.5.4 and 5.5.8, pp. 40 and 44, VTAP document)? **COMMENT:** North Carolina labs are consistent with EPA methods and lab analysis requirements. The VTAP should provide some "equivalence" language that would qualify labs used in testing out-of-state at labs obviously not certified in Virginia by the VELAP process. *(Dr. Bill Hunt and grad student Andrew Anderson, N. C. State University)*

The DCR Panel of Academic BMP Researchers advisory response: *The comment confuses EPA methods with laboratory accreditation. These are separate issues. "EPA methods", while essential for VTAP, are reviewed as part of the QAPP and are not the same as laboratory accreditation. There should be an equivalent path for out-of-state certification (under NELAC). It appears that NC does not have such a laboratory accreditation program. Despite this, there are at least 9 commercial laboratories (Chapter 46) in North Carolina which have been accredited by VELAP. If for some peculiar reason, a NC lab decided not to acquire Virginia accreditation, we should probably allow for acceptance from a lab with accreditation that adheres to the requirements of the NELAC Standard, such as Washington State or New Jersey's accreditation programs. The panel points out that there are on no available EPA methods for some constituents, such as SSC and PSD, but there are a variety of standards and procedures (USGS, TAPE, and ASTM) for these.* ***There should be some wording that allows for such analyses to be conducted without accreditation.***

DCR response: *This is a good point. There was strong support for the use of certified labs in order to provide for consistent results, and the VELAP accreditation process was considered appropriate, accessible and sufficiently rigorous. However, the Virginia process does allow manufacturers to* *submit results from testing under other protocols in other states, where the labs may not have been VELAP-certified. DCR agrees that to date the VTAP document is silent about this. However, DCR should include some type of equivalence provision, if legally permissible. The VELAP staff informed us that out-of-state commercial laboratories that have their primary accreditations under TNI (The NELAC Institute) or from their own state government can apply for secondary accreditation in Virginia. To obtain secondary accreditation, the out-of-state lab needs to pay the VELAP lab fees and cover the travel expenses for an inspector from VELAP to perform an on-site inspection. The process of obtaining primary or secondary VELAP certification should be expected to take about six months to complete. North Carolina does not offer primary accreditation (only Virginia and Pennsylvania do in this region of the U.S.). As well, the VTAP should provide flexibility for monitoring constituents for which there are no established procedural standards.*

8. Recognition of research protocols other than TARP (Section 1.2, pg. 2, VTAP document): **COMMENT:** The VTAP states that DCR and the Clearinghouse Committee support TARP, but no other protocol is specifically cited as being supported. While it appears that field testing under TAPE will be accepted for Conditional Use Designation (CUD), it is unclear to what extent. Both TAPE and TARP data should be specifically cited as valid testing methods and supported by DCR and the Committee. *(Marc Lelong, KriStar)*

   The DCR Panel of Academic BMP Researchers advisory response: *TAPE is specifically recognized. The other state programs that we have reviewed (Georgia, Wisconsin) are voluntary and are not the same level as VTAP, TARP, or TAPE, and therefore were not included.*

   DCR response: *In the early discussions of the VTAP, DCR clearly expressed that previous testing under any of the existing MTD testing protocols would be accepted and considered when evaluating MTD for a use level designation in Virginia. This would include TARP and TAPE, but not the Georgia Technology Assessment Protocol (GTAP) and the Wisconsin program, which are voluntary and have much less rigorous procedural requirements.* ***Clarifying language has been added to the VTAP document.***

9. Clarification of the numbers and types of field studies necessary to achieve GUD status (Section 3.3, Table 3.1, and Appendix E, pp. 12-13 and 85, VTAP document): **COMMENT:** Provide clarification as to the number of field studies that will be required to achieve GUD, because there has been confusion over this issue. This was an issue Contech had raised at multiple meetings while Lee Hill was chairing the committee, and there was a lot of back and forth from one meeting to the next. Things would be discussed and seemingly agreed to, but never committed to writing so that by the next meeting we would be rehashing the same ground. I reviewed my notes from the January and April 2011 meetings, when a number of proposals were discussed. I had a note indicating that there seemed to be agreement that if a technology had two TARP or TAPE compliant studies *that included phosphorus data*, then the technology would only be required to complete 1 additional VTAP compliant field study as long as TARP/TAPE compliant studies were also available and resulted in a CUD. If two such studies were not available, then 2 VTAP compliant studies would be required to achieve GUD certification. Other combinations were discussed including requiring only 1 study to achieve CUD and then 1 additional VTAP studies for GUD as well as requiring 2 existing for CUD and 2 more VTAP for GUD, which is how things are currently written. If this is correct, we suggest clearly noting this in the process and other relevant VTAP guidance. One issue that was not raised during this discussion was how closely the existing studies must comply with the TARP and/or TAPE requirements to achieve CUD. There are a number of studies out there marketed as TARP or TAPE that do not actually appear to meet all of the requirements and would not be acceptable to NJ or WA. It would probably be a good idea to require the manufacturer claiming certifications in another state provide confirmation by referencing a link to the other state's website where the certification is noted.

Also, now that there are newer versions of some of the other state testing protocols, manufacturers should refer to the specific versions under which they performed testing (e.g., TARP I vs. TARP II, TAPE vs. TAPE 2011, etc.)

Also, given that technologies will be required to conduct or submit data from two testing studies, how should the result of the two studies be compiled into a single pollution removal rating for the MTD? This should be defined in the VTAP document, so the method can be applied consistently to all technologies. *(Derek Berg, Contech)*

The DCR Panel of Academic BMP Researchers advisory response: *The current VTAP (has been changing) requires 1 field test site to achieve CUD status, and another to achieve GUD status, with a rigorous review of the QAPP beforehand. The commenter has raised an interesting point. By requiring 2 tests, how will they be treated when coming up with a recommendation upon final approval? This is going to have to be a case by case recommendation. As an example, an initial testing result in Washington State under TAPE yields an overall pollutant removal of 60% followed by a VTAP result of 49%, most of us would agree that he latter test should take precedence. In the case of 2 VTAP test results of differing %, given no other information; we would need to average them. It is likely that some information however, will be found that would favor one set over the other.*

DCR response: *DCR staff has reviewed the minutes from the January 24 and April 18, 2011 Clearinghouse Committee meetings to reconstruct the conversations about the required numbers of field testing sites. Furthermore, in light of the comments received, staff has had further discussions regarding the applicable requirements. Language was added to note that testing performed under other approved protocols may be accepted by DCR if it is acceptable to (and recommended by) DCR's technical evaluator. DCR interprets that this provision could include the technical evaluator's consideration of the rigor of earlier studies. That is, if two field studies testing for TP et al have already been completed at a level of rigor comparable or equivalent to the VTAP, then consideration could be given to accepting one or both of those studies toward the requirement for GUD certification. The GUD row in the table was changed to require two field studies that must measure for TP and must follow the VTAP. It is important to note that agreement had already been reached that the field sites do not necessarily have to be located within Virginia, but they must provide rainfall and site conditions that are representative of typical conditions found in Virginia. A summary of these changes was discussed at the July 25, 2011 meeting. Also, Table 2.1 (formerly Table 3.1) has been changed to require only one field study for consideration of CUD status. To determine the level of performance credit assigned to each MTD following testing, the technical evaluator should consider the earlier testing data and results.*

10. Relevant sites of previous field studies (Section 3.0, pg. 9, VTAP document): **COMMENT:** Data obtained through field testing should be accepted from anywhere in the country and for any rainfall distribution in order to obtain a CUD. The field test data provide performance curves for the MTD, which can then be used for sizing the system based on parameters in Virginia. Just because testing is performed in areas outside Virginia does not make that test data invalid. This fact makes it imperative to clarify how the data will be evaluated and applied to sites in Virginia. *(Marc Lelong, KriStar)*

The DCR Panel of Academic BMP Researchers advisory response: *VTAP does allow other sites to be "credited"; we do not understand the comment. There was initial discussion of differences in rainfall and physiography, i.e., Washington State; even within Virginia, there are mainly Type II distributions, with Type III along the coast. These differences can be addressed in the "weighting" (response to comment #9).*

DCR response: *There was early discussion about the field testing sites needing to be representative of Virginia conditions (soils, rainfall regime, etc.). DCR had concerns about tests done under very different rainfall distributions (e.g., the Type I distribution in western Washington state versus the Type II distribution in most of Virginia). Devices tested under conditions where rainfall is very light (even if more continual) are likely to react very differently (much less likely to bypass, may be effective with smaller sizing, etc.) than for the more flashy, intense, and larger storms of Virginia. However, Section 3.0 of the VTAP states clearly that the field sites do not necessarily have to be located within Virginia, as long as they provide rainfall and site conditions that are representative of typical conditions found in Virginia.*

11. The "technical evaluator" should be an internal DCR staff position: **COMMENT:** The evaluator position should be created as an internal DCR staff position, versus contracting to an outside entity for that service. An evaluator position at DCR could be responsible for coordinating a panel of experts or a research group responsible for reviewing VTAP applications. This would allow for a streamlined review process, greater public accountability, and long-term cost savings to the state, given that an outside contractor will typically have indirect costs associated with their fees. Also, if the VTAP evaluator is ultimately a contracted position, we feel it would be best to exclude any individuals and entities who have participated previously in the BMP Clearinghouse Committee, in order to avoid any conflicts-of-interest. *(Chris French, Filterra)*

The DCR Panel of Academic BMP Researchers advisory response: *We disagree that the Evaluator needs to be a DCR staff position. The evaluator should be an independent entity, such as an academic researcher or consultant. Membership on the Clearinghouse is not disqualifying; however, a recent business relationship with any vendor should be. We would suggest that vendors should be specifically prohibited from serving in a yea/nay role in approving devices if they are allowed on the committee. We do not agree that the Evaluator should be excluded from voting on the BMP Clearinghouse; however, we acknowledge this is really DCR's policy decision to make.*

In commenting on this response, the panel notes that one of its members, David Sample, has submitted a proposal to perform the technical evaluator services for VDCR for a trial period of one year. We understand DCR has accepted this proposal. We support this work, and feel that David can provide unbiased reviews and evaluations for the BMP Clearinghouse and DCR.

DCR response: *This is a DCR policy decision, not a VTAP document issue. DCR staff agrees that having the technical evaluator position as a DCR classified staff person could be an effective solution. However, that assumes that DCR (1) has a vacant position that can be assigned to this function; (2) that DCR management agrees with such assignment; (3) that DCR either has sufficient sustained and competitive funding or can successfully procure such funding from the General Assembly to pay for the position over time; and (4) that DCR is able to attract a truly qualified person to accept such a position. At the current time, only the first of these conditions exists. The longer DCR might take to obtain the approvals and funding for such a position, the greater the delay in beginning to consider the performance of MTDs submitted for evaluation.*

The alternative is to contract for the services. This can be done more quickly. DCR could ultimately consider having time-and-service contracts with more than one contractor to perform these evaluations, given that the contractors are likely to have other responsibilities as well. DCR suspects that the likely competitors for such contracts would be staff of certified analytic laboratories and/or academic researchers with appropriate water quality monitoring backgrounds. Assuming that neither of these categories of competitors are developing and submitting products for testing, it is difficult to imagine how they might present conflicts-of-interest, even if they may have previously been involved with the Clearinghouse Committee. The one caution that would need to be applied is that the *evaluator should not be someone who is currently contracted by one or more vendors as a "technical advisor." This would indeed present a conflict of interest.*

12. Exemption of previously approved MTDs from VTAP: **COMMENT:** Clarify how MTD manufacturers who have already received BMP approval status under the current SWM program will be considered within the scope of VTAP. The following statement is found on page 3 of the draft guidance document under ***Field Monitoring and Evaluation***: *"It* (the field monitoring protocol) *is to be used in the assessment of new BMPs, manufactured or otherwise."* Filterra is currently an approved BMP under existing Virginia Stormwater guidelines (via Technical Bulletin 6) and has not undergone modifications. As a result, our standard BMP does not qualify as a new BMP or modified BMP under the condition stated above. As a result we believe that Filterra is exempt from this criterion. **[NOTE: This is Filterra's position. DCR's position is that the device received an *interim conditional approval* based on conditions that were subsequently not met.]** Filterra is prepared to undergo the necessary VTAP protocols for any new products we develop, but we believe we have already done our due diligence in regards to monitoring our product in Virginia.

Our concern is that Filterra would be expected to undergo additional testing in order to meet the new VTAP protocol after we have spent considerable financial resources towards meeting TARP. It is inequitable for any manufacturer to be forced to meet the VTAP protocols after they have dedicated considerable time and resources to meet and achieve the TARP testing protocol. It is Filterra's position that all existing MTDs currently approved by DCR should be "grandfathered," since they have undergone the previously established testing protocol under TARP.

Contech Engineered Solutions also provided comments about this issue. As a manufacturer with several technologies included in the 1999 Virginia Stormwater Management Handbook (The Stormwater Management StormFilter® and the Vortechs® System), Contech also has a vested interest in this subject. They have stated that they "feel strongly that any evaluation process for innovative stormwater technologies should serve the dual purpose of establishing a level playing field for all manufacturers/technologies as well as establishing performance expectations for each technology in order to ensure water quality goals will be achieved. Since only a limited number of technologies were included in the 1999 handbook prior to this review process being suspended, and the evaluation process applied to those technologies is not consistent with the new stormwater regulations/VTAP criteria, neither of those goals is currently being met. We believe firmly that all technologies must be evaluated in the same manner. We feel that all stormwater technologies must be reevaluated in accordance with the VTAP. We have participate in just about every MTD evaluation program in North America including TAPE, TARP and ETV, and can't emphasize enough the importance of holding all technologies to the same standards. Failure to do so will ultimately result in frustration for all parties involved. The VTAP is a much higher standard of evaluation than anything that existed prior to its creation, so grandfathering would mean some technologies would be held to a lower standard. VADCR would then be subject to extensive protest by manufacturers not given the luxury of grandfathering. VADCR would also potentially compromise water quality by grandfathering technologies that were evaluated via a less robust process. We know that BMP monitoring is expensive and fully support allowing any past performance data that fully complies with the VTAP to be resubmitted for evaluation. However, to be used in awarding a General Use Designation, data must be fully compliant with all aspects of the VTAP. Data that does not fully meet VTAP criteria, but meets other standards such as TARP or TAPE should be applicable for achieving Conditional Use Designation as noted in the VTAP. We expect the VTAP will represent the new gold standard in BMP evaluation, but if a level playing field is not maintained for all technologies, the program will be compromised and is likely to collapse. Since the VTAP process is not yet fully functional and field monitoring will take 12-18 months on average, we would support the continued recognition of technologies currently in the 1999 manual for a maximum of 24 months after the VTAP process is officially launched. This would allow ample time to monitor said technologies and submit the resulting data for evaluation. . . .” *(Chris French, Filterra; Derek Berg, Contech)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel supports VDCR’s policy of eliminating grandfathering by a phased process that also requires timely VTAP submission and approval. Allowing unrestricted grandfathering for a small number of MTDs would destroy the basic intent of VTAP and reduce the value of the Commonwealth’s investment in the VTAP development over the past 3 years.*

DCR response: *Manufacturers following the BMP Clearinghouse process have asked DCR to consider allowing MTDs covered under Minimum Standard 3.15 in the 1999 Stormwater Management Handbook and Technical Bulletin 6 (a 2002 addendum to the Handbook providing design information for the Filterra devices) to continue to be grandfathered or, at least, to be used for a period of 24 months from the official initiation of the VTAP process. Their position is that it will take 18-24 months from the start of VTAP testing to complete a study, and that it is reasonable to continue to allow the use of these devices until further Virginia-based testing data is completed. Other manufacturers have asked DCR to allow their devices that meet the criteria in Minimum Standard 3.15 to receive the same consideration, even though they may not yet have been previously approved by DCR or the Virginia Soil & Water Conservation Board (SWCB) for use in Virginia.*

DCR began to prepare a guidance document to address the status of MTDs represented in Minimum Standard 3.15 in the 1999 Virginia SWM Handbook. However, in light of several subsequent policy decisions made by DCR management and reflected in the changes to the VTAP document, DCR decided to NOT develop that guidance document. In effect, DCR anticipates beginning to accept applications for testing shortly after the beginning of next year (2013). Once accepted into the testing process, the MTDs will be allowed to market their devices without limitation. Therefore, we will not have a situation where there will be no MTDs available in the marketplace either prior to or immediately after July 1, 2014.

It is important to point out that most of the MTDs for which limited specifications are provided in the old Handbook do not provide specific water quality performance expectations, and only a few are intended to capture nutrients. In addition, the design specifications for these practices are very limited, as compared to the new design specifications for non-proprietary BMPs on the Clearinghouse website. Also, previously issued DCR Technical Bulletins were considered interim guidance documents and did not necessarily constitute a permanent approval of whatever they addressed. Finally, when these earlier MTD specifications that were included in the old Handbook were developed, there were no existing testing protocols in place anywhere in the U.S. Even TARP, the first such testing protocol developed, examined only TSS removal. The VTAP specifically aims at testing for phosphorus removal (total phosphorus is the basis for the Virginia stormwater quality protection regulatory requirements).

In view of these realities, DCR still believes there is good reason for reevaluation or further consideration of earlier performance claims and, hopefully, subsequent test results, particularly since many of the devices tested for TSS removals established claims of TP removals by association with the fine sediments removed through filtering or settling, not be direct testing of the TP removal. This is not to say that a company may have to start over completely. Local governments – many of which must now answer to the USEPA regarding accomplishment of local Chesapeake Bay TMDL nutrient and sediment removals – expect DCR to certify MTDs providing confidence that they will function consistently with their claims. In view of that reality, it is prudent that those reevaluations and further considerations should be thorough. As well, as noted above, several MTD manufacturers have indicated that it is very important for DCR to treat all manufacturers’ products the same and not *make special exceptions. They have stated that such special considerations have undermined confidence in similar processes in the states of New Jersey and Washington.*

13. Concern about limitation of installed devices for previously approved MTDs (Section 3.0, Table 3.2, pg. 10, VTAP document): **COMMENT:** VTAP only allows a certain number of manufactured treatment devices (MTDs) to be installed if they have received PUD and CUD status (see VTAP Table 3.2 located on page 10 of the protocol). Filterra is concerned that MTDs currently approved under existing state protocols will be limited by the allowable number of devices they can install if they do not have GUD status. If this provision is enforced under the VTAP structure, then it will potentially create an unfair economic burden on manufacturers that have an established market in Virginia. The VTAP should not produce any negative economic impact to companies that have approved BMP practices in Virginia under existing protocols and regulations. *(Chris French, Filterra)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel understands that this restriction has been removed (see #12), and has no comment.*

DCR response: *DCR originally proposed sales limitations during testing because the agencies and Virginia localities are concerned about the risk of installing an unlimited number of any particular MTD and finding later, through testing results, that the MTD does not perform as claimed. This is especially true if there is no subsequent requirement for the manufacturer to have to uninstall the device and/or provide additional treatment to compensate for the lack of performance. In fact, many Virginia communities will be held accountable by both DCR and the USEPA for long-term BMP performance under their MS4 permits or through reported pollutant load reductions pursuant to the Chesapeake Bay (or other local) TMDL(s). The limitation on the number of devices a manufacturer may sell during VTAP testing was set by consensus among the manufacturers participating in the Clearinghouse Committee's discussion of this issue at the time. They agreed among themselves that if they could sell 20 devices under PUD-certification or 40 devices under CUD certification, they should be able to generate enough income to pay the costs of their testing. These were not arbitrary limitations dictated by DCR.*

However, in subsequent discussions among DCR's senior management and policy staff, the agency has decided to NOT impose any limitations on sales during the testing process. If the testing process takes longer than two years, the manufacturer will have to explain the need for more time and request an extension. Based on the data collected by that time, DCR will consider whether to continue allowing unlimited sales of the device or, alternatively, place a sales limitation pending completion of the testing process.

14. Need to clarify roles and responsibilities and clearly explain how the various aspects of the performance verification process will work (Section 1.4, pg. 4, VTAP document): **COMMENT:** Clearly identify the roles and responsibilities of all those involved in screening applications, reviewing results, and awarding approval status (e.g., DCR staff, Clearinghouse Committee members, the Soil and Water Conservation Board, the DCR Director, the DCR technical evaluator, manufacturers, etc.). The VTAP document should also note how potential issues *not* covered in the protocol will be handled. NJDEP is currently working on a process document for their program, and this could be a model, once it is completed later this summer. *(Derek Berg, Contech)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel feels that this is mainly a policy question; however, it does seem to be fair and reasonable for DCR to do so.*

***DCR response**: The roles and responsibilities of the various participants in the process are described in Section 1.4 on pages 4-5 of the VTAP document. However, the document will be clearer about the fact that the DCR Director has final authority for decisions regarding product approvals and assigned performance credits (4 VAC 50-60-65 C).*

15. Need to clearly communicate criteria and expectations upon which approvals are based: **COMMENT:** Clearly identify/define all the critical elements that will be included with each approval letter/document. For example, it is important that these letters clearly identify the appropriate hydraulic loading rate/operating rate for each model, media type/depth, mass loading capacity, expected longevity, required sump volume, etc. Ultimately, each BMP must be sized consistently with the tested unit. In other words, sizing must be consistent with the tested unit or results will not be relevant. We suggest reaching out to NJCAT/NJDEP and/or WA DOE to discuss their experience with issuing approval letters/reports. There was a steep learning curve for those programs, and Virginia DCR may prevent considerable frustration by avoiding the mistakes they made. *(Derek Berg, Contech)*

***The DCR Panel of Academic BMP Researchers advisory response:** The panel agrees with this comment, and finds VDCR's response acceptable in addressing it.*

***DCR response**: This is a DCR process issue, and does not need to be addressed in the VTAP document. However, this is an excellent suggestion. DCR understands this request to mean that when DCR issues approvals, the approval statement should not just provide a blanket approval of the product, but should also connect the approval to the specific design features, hydraulic capacity, etc., of the tested device. DCR agrees that this is a useful proposal and also that it will be useful to confer with other testing protocol entities (Washington DOE, NJCAT, NJ-DEP, etc.) about how they communicate approvals, in order to benefit from their experience with this matter.*

16. Need for improved and more consistent communications by DCR and the Committee: **COMMENTS:** KriStar, at least, has received inconsistent communication from DCR and the Clearinghouse Committee regarding scheduled meetings and postings of meeting minutes. KriStar representatives on the "email list" will receive some notices and not others. Updates to the website have been sporadic and not done in a timely manner. More consistent and timely communication is needed between the public and the Committee. This could be remedied by posting meeting minutes and other relevant information to the Virginia Regulatory Town Hall website, the Clearinghouse website, and via a stakeholder contact list maintained by the VWRRC. Ideally, draft meeting minutes should be made available through one of these mechanisms in a timely fashion, so there is an opportunity for timely review and feedback prior to their becoming finalized. *(Marc Lelong, KriStar; Chris French, Filterra)*

***The DCR Panel of Academic BMP Researchers advisory response:** The panel feels that this is mainly a policy question, but the time lags pointed out in the comment have impacted participation. Remedying this can be achieved by DCR management direction.*

***DCR response**: This is a DCR process issue, and does not need to be addressed in the VTAP document. DCR will attempt to improve on communications regarding Clearinghouse business, decisions and information, in order to provide timely information to those interested in the Committee's activities and the VTAP process. DCR acknowledges that the meeting minutes have been taking an unusually long time to be approved by DCR senior management, which must happen before they can be posted on the Regulatory Town Hall or other websites as final meeting minutes. However, DCR staff has made efforts to clear the backlog of previous meeting minutes in order to have the posted on the Virginia Regulatory Town Hall website. DCR staff will also explore whether we may* *post DRAFT minutes on the Clearinghouse website pending their final approvals by DCR senior management.*

17. Guidance on analytes is a bit muddled and comes off as overkill. Does DCR really need to evaluate full speciation of phosphorus when regulation is based only on TP? Does DCR firmly intend to require testing for both TSS and SSC? It is harder to find SSC-certified labs (Section 3.0, Table 3.1, and Section 5.5.1.1, pp. 9 and 38, VTAP document). **COMMENT:** Table 3.1 **[NOTE: now Table 2.1]** clearly says certification is based on TP *or* TSS *or* SSC (depending on the level of use requested). Requiring the full speciation of phosphorous, when permitting is based on TP, appears to be unnecessary. While complete speciation may provide greater insight, it should not be a requirement.

Nor does the protocol explain the disconnect between Table 3.1 and the need for full phosphorus speciation (pg. 38) in monitoring. Again, full speciation seems like a luxury. Similarly, Table 3.1, **[NOTE: now Table 2.1]** when appropriate, says TSS *"or"* SSC. But the minimum analysis on page 38 requires both TSS *"and"* SSC. Again, this feels like asking the proponents to participate in a research project for no obviously good reason. Since sediment loads are ultimately wanted simply to better understand impacts on phosphate transport, either TSS or SSC would seem appropriate. The difference is whether a subset of the sample (TSS) or the entire sample (SSC) is analyzed. Expected sediment concentrations will impact how much water needs to be analyzed for accurate measurements. *(Dr. Teresa Culver, U. Va.; Dr. Bill Hunt and grad student Andrew Anderson, N. C. State University)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel believes that the requirements should be left in place, because they will inform the development of future performance standards. The requirement is similar to the Information Collection Rule (ICR) required by EPA for certain constituents in water treatment plants and distributions systems. One of the purposes of the testing is to fully evaluate the unit being tested, i.e., to determine how it operates and functions. In this process, it is very likely each unit will treat specific constituents differently, i.e., DP, SRP, etc. TSS must be used due to the regulation, and it is a relatively inexpensive test. One drawback of TSS is its negative bias. SSC was desired from most of the vendors due to its general applicability. For comparison, we recommend including both. We would go further than the comment about SSC accreditation; there are* ***no*** *laboratories accredited for this constituent, because such a standard does not presently exist. SSC, like PSD, involve analyses that are being requested that do not have a current EPA method; and thus, no accreditation exists for them.* ***Appropriate wording that allows for such analyses to be conducted without accreditation should be added to VTAP.***

DCR response: *Table 3.1* **[NOTE: now Table 2.1]** *has been changed to indicate that there is some choice regarding testing for TSS or SSC at the PUD level only, and reference to the period between the present and July 1, 2014 has been removed. TP data must be submitted for consideration of designation at the CUD level. Full speciation is required for GUD testing. This allows one to understand more clearly what is occurring within the BMP and what pollutant forms are being treated well versus not at all. DCR and the Clearinghouse Committee consider it appropriate to continue to test for TSS because it is the key parameter tested for in the other major protocols (W-TAPE, TARP, etc.), and Virginia is a TARP cooperator. So we need to capture that data in order to allow for state certification reciprocity to be possible. However, TSS has a pretty gross scale of the constituents being measured and, by definition, a very wide range of qualifying particle sizes. Furthermore, EPA has been considering moving to the more discrete SSC parameter. Since we were developing the VTAP during the discussion of TSS vs. SSC (with no consensus in sight among the key decision makers), the Clearinghouse Committee agreed we should require both in our testing protocol. DCR still agrees with this decision.*

18. Distinctions should be made in the TP removal credit that can be credited to MTDs in pursuit of PUD or CUD status, depending upon whether initial data provided for the devices is based on TSS or SSC testing or on actual TP removal testing (Sections 3.0, 3.1 and 3.2, and Table 3.2, pp. 9-12, VTAP document). **COMMENT:** It is possible to show high levels of solids removals without actually achieving comparable levels of TP removals. Perhaps impose a maximum TP removal credit of ~ 20% when only TSS/SSC data is available, but a higher removal credit (~ 40%?) if early testing data shows reasonable TP removals.

Another suggestion is that a consistent level of performance credit be assigned to devices pending completion of VTAP testing, based on the level and rigor of their earlier testing and certifications elsewhere. For example, to achieve PUD certification with prior derived TSS data only, a limit of 20% TP removal could be granted to match 1999 bluebook figures for hydrodynamic devices. To achieve CUD certification, (1) the BMP should have been monitored previously for a minimum of 10 storms with phosphorus data, following TAPE, TARP or a similar protocol, with no TP limit OR (2) the BMP should have been monitored for a minimum of 10 storms with TSS data, following TAPE, TARP or similar a protocol and, during GUD testing be granted either (a) a maximum of 50% TP removal to match the 1999 bluebook TP credit for filtering devices OR (b) higher removals credited from earlier tests, if the sizing in those test was appropriate and the data is compelling enough. Finally, to achieve GUD certification, the BMP monitoring should have followed the VTAP protocol, to the maximum extent practicable, with just one study. The GUD should represent the final field study, following VTAP protocols. *(Derek Berg, Contech; Edward Kay, Imbrium Systems)*

The DCR Panel of Academic BMP Researchers advisory response: *The basis for this comment is a concern that devices that only remove heavy sediment (i.e., hydrodynamic separators) not be given too high a credit. We would suggest DCR take away any P certification that exists without testing; and alternatively create a pretreatment certification (see response to question #35). This would eliminate this problem. The panel points out that while the sediment fraction generates much of the TP mass in source areas, the sediment is also more labile than the suspended fraction. Any credit that is ultimately given should thus depend heavily upon the frequency of maintenance.*

DCR response: *The Clearinghouse Committee and DCR may certainly consider modifying the credits assigned, as suggested in the comment above and subject to recommendations of the DCR Technical Evaluator. DCR is considering a way, outside of the VTAP, to provide an opportunity to qualify a device as a pre-treatment MTD, based on TSS testing elsewhere through the TARP protocol.*

19. What does the VTAP document mean by "five paired storms?" And the requirement to monitor 10 back-to-back storms "in sequence" is considered extreme. Why require back-to-back storms at all (Section 5.3.2.4, pp. 28-29, VTAP document)? **COMMENT:** It is my professional opinion that managing to collect 10 *consecutive* storm events at a remote monitoring location (such as Fayetteville, which is a 1.25-hour drive from North Carolina State University) is extremely unlikely. It is usually very difficult to capture good data from more than three storms back-to-back. Very rarely can one rely on collecting five or even four consecutive events, due to factors out of the researcher's control, including equipment malfunction, spatial heterogeneity of rainfall, site disturbance by passersby, and events simply too small for sufficient amounts of water quality data to be collected. In my entire peer-reviewed publication history (which of 50 journal articles, includes 40 that are based on water quality monitoring), my research group has only managed to sample three or four consecutive storms a handful of times. Please note that if you meant 10 consecutive events for hydrology (and not water quality), this goal becomes more attainable. It is possible that I have misinterpreted what was intended. There are no data analysis measures discussed in the protocol

specific to understanding the significance of series of events. Was this statement put in place to avoid studies selecting only events with good performance? This could be avoided by requiring inclusion in analysis of qualifying events with sufficient data.

Assuming that paired storms means storm events monitored in sequence (no intervening rain events), Imbrium Systems agrees that there should be a goal to monitor as many sequential storms as possible, with suitable explanation and comment for events that are missed or not monitored. Imbrium proposes that there be a target of 75% of the number of storms monitored to be sequential pairs or three events in sequence (triplicates). For example, out of 24 events, 18 should be in groups of sequential storms – either 9 paired storms, or 6 triplicate storms. Imbrium also believes that any BMP that uses detention, volume or infiltration as part of the mechanism, (as opposed to flow through devices) should be required to monitor at least 6 triplicate storm sequences, as performance impacts need to be reviewed. *(Dr. Bill Hunt and grad student Andrew Anderson, N. C. State University; position also supported by John Lenith, Herrera Env. Consultants; Mindy Ruby, Filterra; Dr. Teresa Culver, U. Va.; Scott Perry & Edward Kay, Imbrium Systems)*

The DCR Panel of Academic BMP Researchers advisory response: *The panelists support the idea of 5 paired storms (10 total, each with inflow and outflow) to evaluate event interdependence. Some devices such as hydrodynamic separators are not expected to have any event interdependence. However, others will. Part of the rationale for the requirement is an attempt to boost the confidence level from 50% (calculated in the report) based upon 24 events. See response to comment #20. The panelists recommend that events that produce no runoff be included in the results (as being very effective), but for counting purposes, the 24 be actual sampled (inflow and outflow) events. The next sample after a 100% runoff event would be very interesting, and is one of the reasons for requesting sequential sampling, (i.e., the runoff from the device may actually integrate several storms). In practice, for most MTDs, 100% runoff reduction is not expected.*

DCR response: *The reason for requiring back-to-back storms has to do with providing the ability to observe and account for the effects of between-storm conditions and changes within the BMP during those inter-storm periods. For example, soil saturation between two closely spaced storms may generate surface runoff quicker. What goes on between storms from a water chemistry perspective often has a substantial impact on long-term nutrient removal. A prime example is anaerobic conditions leading to the transformation and leaching of previously captured pollutants.*

The term "paired storms" was intended to mean back-to-back storms in the VTAP document. The original intent was that there would have to be one sequence of 10 back-to-back storms, plus five pairs of back-to-back storms, plus four additional storms, to make up the required total of 24 storms sampled. DCR believes the panel recommendation noted above reasonably addresses the concerns expressed in the comment and proposes to make this change in the VTAP document.

20. Is the requirement for the dataset to include 24 storms firm (Section 5.3.2.4, pp. 28-29, VTAP document)? **COMMENT:** Having 24 events (required by VTAP) will result in enough seasonal and temporal variation to have a very strong data set at the end of the study. In fact, provided that the storms are seasonally distributed and reflect long-term precipitation trends, as few as 18 water quality events should be sufficient for an adequate analysis. The absolute minimum number of storms should be 15, but 20-25 provides much better statistical significance for the data. *(Dr. Bill Hunt and grad student Andrew Anderson, N. C. State University; Dr. Jim Bachhuber, AECOM)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel recommended 24 after reviewing sample statistics, which depend upon a multitude of factors, including the variability* *of runoff quality and estimates of error. While error will be managed, it should be pointed out that 100% compliance with all QA/QC cannot be expected with every sampled event. While it is not possible to predict all of these variables, our best estimate is a minimum of 24 samples to achieve a minimum level of confidence. Perhaps some flexibility should be offered to accommodate improvement in accuracy in the field and reductions in covariance. As an alternative, we suggest using 18 as an absolute minimum, but also request that in the applicants evaluation, that they demonstrate the sampling programs statistics, with a the confidence level exceeding 60%.*

DCR response: *The requirement of 24 total storms is a compromise between achieving statistical confidence in the data and keeping testing costs within reason. DCR's panel of academic BMP researchers felt that this number was important, because, even with that many storm events sampled, the statistical confidence in the data is still only about 50%. Fewer sampling events lowers that statistical confidence. It has been pointed out that the TAPE testing protocol in Washington state requires that only 15 rainfall events be monitored. However, the TAPE protocol also requires a certain level of statistical confidence for the data and, typically, additional storm events – sometimes exceeding a total of 24 – must be monitored to achieve that statistical confidence. DCR is open to the panel's suggestion that some flexibility might be provided regarding the total number of sampled storm events required, subject to supportive documentation (e.g., improved COV factors, etc.) that demonstrates that at least a 50% statistical level of confidence can be achieved, and also subject to the agreement and recommendation of DCR's Technical Evaluator.*

21. Actually defining the real drainage area to the BMP is trickier than anticipated (Section 6.4.7.2, 2nd bullet, pg. 60, VTAP document): **COMMENT:** Drainage boundaries *can change* during a storm, depending on rainfall intensity, time of year, and other factors. It would be prudent for the VTAP document to provide some guidance regarding this dynamic. *(Dr. Jim Bachhuber, AECOM)*

The DCR Panel of Academic BMP Researchers advisory response: *The comment is a good one when sites are located in flat areas, where actually estimating the drainage area can be difficult and may change by storm event. This said, it should be the responsibility of the submitter to verify the drainage area in order to be able to generalize results to other sites, which serves the interest of the vendor.*

DCR response: *The specified drainage area is typically an estimate. DCR understands that storms of different intensities might alter the drainage pattern somewhat. DCR agrees with the panel response, that the investigator must verify the drainage area. However, the VTAP document allows the investigator to explain any variations from the stated norms or testing requirements, subject to a recommendation from the DCR Technical Evaluator.*

22. Is the VTAP event monitoring event rainfall threshold of a minimum 0.1" firm (Section 5.3.2.1, pg. 27, VTAP document)? **COMMENT:** Such a small storm may not generate runoff, so this threshold may not be practical and could result in monitoring/testing studies taking a longer time to capture sufficient qualifying events. The 0.1 inch threshold for an official "storm event" has been cited frequently in the literature, mostly for historical analysis purposes. However, being able to collect enough runoff for water quality testing at this threshold can be problematic, especially when long periods of dry, hot weather results in an asphalt surface that has a higher moisture deficit than a pre-soaked pavement, as does frequently occur during Mid-Atlantic summers. A threshold of 0.3 inches or more of rainfall may be more reasonable to ensure enough volume is collected. This is considered to be a more reliable rainfall depth, especially for monitoring sites located at some distance. The issue is not collecting a sample; it is collecting enough samples for analysis purposes.

It seems that the event size should be defined relative to meteorology and not design capacity. Is capacity based only on storm depth? Intensity? Many BMPs are designed to ensure a maximum flow (or volume), with the remainder of the storm bypassing. Thus, bigger and bigger storms do not necessarily demonstrate a lot more about the BMP, and they may be difficult to capture. The sampling plan (including the range of events anticipated) should be included in the monitoring plan. One would think that the distribution of events captured should be statistically similar to the range of events anticipated, unless proposers can justify accepting a different range.

Also, is it feasible that there could also be guidance provided about whether good samples resulting from storms smaller than the stipulated event threshold can be used, or must they be discarded. *(Dr. Bill Hunt and grad student Andrew Anderson, N. C. State University; Dr. Teresa Culver, U. Va.; Derek Berg, Contech)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel feels that 0.1 inches is a reasonable threshold, and it is the same value contained in TAPE and TARP. The commenter's point is acknowledged in that runoff may not be produced at this threshold for all sites. We do not see how this harms the process. Raising the threshold to 0.3 inches would result in a much more restrictive protocol. Therefore, we recommend keeping the 0.1 inch threshold.*

DCR response: *The intent of setting the threshold at 0.1" of rainfall was (1) to be reasonably consistent with the other existing testing protocols (TARP = 0.1"; TAPE = 0.15"), and (2) to help save the manufacturers some testing costs by avoiding having to count storms too small to generate useful runoff or limiting them to significantly larger events, which are likely to occur much less frequently. Rainfall frequency analyses done in Virginia indicate that at least 80% of storms are likely to generate at least 0.1" of rainfall. Raising the threshold to 0.3" would result in only about 50% of storm events being eligible for testing. This means the testing period would probably be longer, resulting in higher costs. Therefore, DCR is comfortable using this qualifying event threshold.*

As an alternative to the panel's response to this comment, the Clearinghouse Committee may consider that if data is generated from a storm that doesn't qualify (e.g., 0.09"), the investigator could (1) just report it but not analyze it, or (2) report it, providing as much supporting justification as possible, and request the DCR technical evaluator to consider including the data (i.e., qualifying the storm).

23. What is the justification for requiring monitored events to total a minimum of 15 inches of precipitation (Section 5.3.2.4, pg. 29, VTAP document)? **COMMENT:** This is also included in the TARP protocol as a measure of at least 50% of the total annual rainfall. However, it seems that this value should vary, depending on the selected monitoring location. Sampling 50% of the total annual rainfall in a single monitoring year is a requirement that has no statistical significance, and it can also be challenging to achieve. Fifty percent of Virginia's average annual rainfall would be approximately 22 inches. With a goal of 24 storms captured, this would severely skew the monitoring toward large storm events that are atypical and harder to forecast and monitor effectively (i.e., storm length to sample timing intervals) Also, data would be less representative of when most pollutants are transported. Our recommendation is that 15 inches of total rainfall volume be the minimum to be used as a target for flow-through BMPs, with a minimum of 10 inches as a drop dead requirement. For runoff reduction BMPs, 25 inches of total rainfall volume could be used as a target minimum, with a minimum of 20 inches as a drop dead requirement. *(John Lenith, Herrera Environmental Consultants; Scott Perry & Edward Kay, Imbrium Systems)*

The DCR Panel of Academic BMP Researchers advisory response: *We acknowledge this point. Earlier, 50% of the annual rainfall was required (stems from TAPE). This was later relaxed to 15* *inches of rainfall. The intent of this criterion was to ensure a distribution of events. Previously we had requested that specific storms be included in the 24. These did not make it into the final VTAP. We recommend the following events be included:*

- *At least one measured event must be rainfall > 1 inch.*
- *At least 3 events must be > 0.5 inch.*

If 24 storms are sampled, and the above events are captured, we feel that the events will have both seasonal variability and be sufficiently robust for further generalization. Therefore, if the above recommendation is accepted, we recommend dropping the criterion requiring 15 inches of total rainfall sampled.

***DCR response**: DCR concurs with the panel's recommendation and has edited the VTAP document accordingly.*

24. The VTAP document states that "graphical plots developed by Burton and Pitt (2002) can be used to estimate sample size (Section 5.3.2.4, pg. 28, VTAP document): **COMMENT:** It is good that the protocol indicates that Figure 5.1 "may" be used, but is not required. These power analysis plots assume a normal distribution of the data, which is often not the case in water quality monitoring. Other statistical approaches are available.. A much more robust and statistically valid approach is presented in the 2011 update of the TAPE protocol (Washington Department of Ecology). The overall distribution (Figure 5.5) is important. Analysts should have some freedom for selecting the statistical technique that fits their dataset; Figure 5.1 is not a one-size-fits-all technique. *(Dr. Teresa Culver, U. Va.; John Lenith, Herrera Environmental Consultants)*

***The DCR Panel of Academic BMP Researchers advisory response:** Normality is a typical assumption made when you are discussing a hypothetical problem. Figure 5.1 is used as an example to demonstrate that very large sample sizes are required for sample populations that can be highly variable, such as rainfall/runoff. Values from this figure are not used to set VTAP policy, but are merely given as an example. We would agree that in the data analysis, normality should not be assumed, and that other distributions (i.e., log-normal, or no distribution, i.e., nonparametric tests) should be explored; these are the responsibility of the applicant. An excellent tool for doing this (albeit at a 95% confidence level), is a bootstrap tool developed by the Washington Stormwater Center (http://www.wastormwatercenter.org/tape-program).*

***DCR response**: DCR agrees with the panel that Figure 5.1 is provided in the VTAP document as an example and does not preclude consideration of other, more applicable distributions, as selected and proposed by the investigator.*

25. Reporting "Non-Detect" values: **COMMENT:** It is common for some samples collected during a study to be deemed *non-detect* by the lab. This does not mean the concentration of the pollutant in question is 0, since labs are not able to confidently measure values below certain thresholds for many pollutants. It would be helpful if guidance is provided on what numeric value should be used for reporting/calculating performance when non-detect values occur. The most conservative approach is to use the detection limit as the numeric input. The least conservative is to enter a value of 0 in place of non-detects. Some entities split the difference and request that a value equal to half of the detection limit be used. The choice can have a big impact on results when influent concentrations are also low. For example, if the influent TP concentration is 0.04 mg/l and the detection limit is 0.02 mg/l (which is common), then the results would be 50% removal if 0.02 is used as the effluent value, but performance would jump to 100% removal if a value of 0 was used for the effluent. The appropriate value should be clearly stated and consistently applied to all. *(Derek Berg, Contech)*

The DCR Panel of Academic BMP Researchers advisory response: *First, we must point out we are assuming this is not simply a result of a high threshold, i.e., a laboratory with too high a detection limit. We agree that the values should neither be discarded nor assumed to be zero. The detection limits for each parameter reported should be provided in the QAPP. In reviewing the QAPP, the Technical Evaluator will assess the appropriateness of the reporting limits proposed. Analytical values less than the detection limit should be statistically evaluated as one-half of the detection limit. If both input and output values are below the detection limit, the storm event should be noted in the report, but results should be excluded from the statistical evaluation. The new textbook by Helsel ("Statistics of Censored Data") illustrates some new ways of dealing with such datasets.*

However, given the likely limitation of proponents in dealing with such tools, we'd suggest staying (for now) with 0.5 of the PQL (practical quantification limit, or 5x the method). It is a conservative approach. Perhaps we could leave open the option for a proponent to use the "better" statistical tools, but to justify their use in the report.

DCR response: *DCR concurs with the recommendations of the panel, as noted above. The detection limits for each parameter reported should be provided in the QAPP. In reviewing the QAPP, the Technical Evaluator will assess the appropriateness of the reporting limits proposed. Analytical values less than the detection limit should be statistically evaluated as one-half of the detection limit. If both input and output values are below the detection limit, the storm event should be noted in the report, but results should be excluded from the statistical evaluation.*

26. Typical Influent Concentrations (Section 3.0, Table 3.3, and Section 5.1, pp. 10 and 21): **COMMENT:** The VTAP document states: "*Sites should provide influent concentrations typical of stormwater for those land-use types using a consistent sampling methodology and homogenous land use*." We recommend that DCR establish a range of acceptable concentrations for key pollutants and guidance detailing how to address results falling outside of this range. While occasionally we have encountered sites that have excessively high concentrations of various pollutants that can lead to higher than expected performance it is more common to encounter very low concentrations. Very low concentration can make a BMP appear to have limited effectiveness when results are presented as percent removal. For example if the detection limit is 0.02 mg/l (and is used for reporting) and the influent concentration is 0.04 mg/l or less, then the highest possible percent removal is 50%. Some agencies have taken steps to assess performance differently when low concentrations are prevalent. Two common approaches include moving the monitoring to an alternate location or setting the detection limit as the ideal performance benchmark when influent concentrations drop below an established threshold. It should also be noted that new improved techniques of sampling (such as full sample capture for mass/balance) provide different concentration values than older TSS protocol samples using only automatic samplers. Field sites and pollutant loading inherently vary, but sampling with a typical intended land use (e.g., roadway or parking lot), quality controlled data will provide good results. When data is presented that may fall outside of the target ranges, the manufacturer can provide an explanation, and the quality of the data could be determined by DCR's Technical Evaluator using best available science. *(Derek Berg, Contech; Scott Perry & Edward Kay, Imbrium Systems)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel agrees that this is difficult because there is such variability in runoff quality. However, characterizing the site in relationship with expected values is being done so we can assume that the site is "representative." That is, we are only testing one or two of the sites where the vendor's BMP will be installed. TARP requires this of applicants. We are aware that this poses a risk to the vendor. However, in their defense, this is something that will be learned early in the process.*

***DCR response**: The VTAP process will be flexible enough that vendors will be able to submit their best estimates of expected runoff (influent) quality. As early data is accumulated, the initial characterization can be adjusted to reflect what is actually showing up in the runoff sampled. The VTAP document allows the investigator to explain any variations from the stated norms or testing requirements.*

27. Appendix D Particle Size Distribution (PSD) Analysis (Section 5.5.1.1 and Appendix D, pp. 38 and 73, VTAP document): **COMMENT:** PSD characterization provides data that is useful to help understand processes of a BMP. However, PSD data should be encouraged, not required. The 2008 TAPE method (Washington Department of Ecology) for PSD analysis – which provided the basis for the method set forth in Appendix of the VTAP document – has been found to provide inaccurate estimates of median grain sizes. The 2011 TAPE protocol provides an updated method that is essentially an expanded SSC method and is considered more accurate. Also, it is critical that monitoring include a particle size analysis of both the raw AND treated stormwater. This provides a wealth of information regarding BMP performance.

However, evaluating PSD for every event may be more than should be expected. Depending on the site and BMP, larger volumes of samples may be needed for some sites, and capturing 70% of the storm volume for PSD for every storm may be difficult to calculate. The guidance is vague as to whether PSD is intended for every event. This should be clarified. Furthermore, the protocol also requests "specific gravity," without specifying whether the intent is to determine the specific gravity of the sediment sample or the stormwater sample. The final TP removal will provide the correct data/approval, and remove irresolvable arguments about the minutiae of PSD vs phosphorus removal of each storm monitored. *(John Lenith, Herrera Environmental Consultants; Dr. Jim Bachhuber, AECOM; Dr. Teresa Culver, U. Va.; Scott Perry & Edward Kay, Imbrium Systems)*

***The DCR Panel of Academic BMP Researchers advisory response:** This comment is not sufficiently specific, i.e., the TAPE 2011 Technical Guidance does not contain a specific procedure for PSD. We have assumed that the commenter has a specific issue with one of the PSD methods, and that frames our response. The panel contends that there is, at this time, no universal standard for PSD. Both wet sieving and laser diffraction methods have been reported in the literature for urban stormwater. At the present time, there is no NELAC-approved method for PSD. The 2008 version was mentioned previously as a reference. The panel feels that any procedure that is referenced should not exclude PSD by laser diffraction analysis (LDA) methods. LDA is an inexpensive method, and has become generally accepted for determining particle sizes in aqueous samples. Wet sieving is also a generally accepted method, but is more labor intensive. Understanding the distribution of particle size is important since the predominance of P mass is associated with sediment, and the higher P concentrations are associated with finer PM. Each fraction of the gradation is important to manage, but for different reasons; large PM can become a leaching and maintenance issue, and finer particles present mobility and bio-availability issues. Therefore we recommend requesting PSD measurements with each of the TSS/SSC samples. However we feel that the applicant should be allowed the flexibility of using the less expensive LDA method.*

***DCR response**: DCR concurs with the panel recommendation that PSD measurements be submitted with each TSS/SSC sample, and investigators will be allowed to use the less expensive LDA method of PSD analysis.*

28. Flow Balance (Sections 5.3.2.3, 5.5.1 and 5.9, pp. 28, 37 and 49, VTAP document): **COMMENT:** The VTAP requires that a "flow balance" be achieved between inflow and outflow. Past ETV, TARP and TAPE studies have shown that flow balance can be very difficult to document to within 10% as required by the VTAP. Inflow certainly needs to be measured to allow sizing limits to be implemented. However, some vaults may not be perfectly water tight allowing flow to enter or exit the vault, and common flow meters such as area velocity meters are often not precise enough to measure flow balance to within 10%. Historically this issue has been addressed by measuring flow at the influent only and assuming that flow in = flow out when calculating pollutant loads. This approach could be applied to flow-through devices without infiltration capacity. However, if a device is intended to infiltrate flow, it would be important to still document the amount of effluent flow leaving the system.

Another point-of-view is that it is critical that *ALL* runoff is monitored (raw stormwater runoff, treated runoff, and bypassed flow). Outflow data helps determine load reductions. Not measuring outflow is likely to result in recording lower BMP pollutant removal numbers than may actually occur. Overflow/bypass must be monitored to understand the behavior/performance aspects of a BMP. If not measured, rainfall can be assumed and modeled to match inflow, which varying intensities will disprove. How a BMP functions for one storm will vary when compared with another similar storm the next week. Therefore, bypass data is important to assess performance over the whole study period. *(Derek Berg, Contech; Dr. Jim Bachhuber, AECOM; Scott Perry & Edward Kay, Imbrium Systems)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel suggests that understanding the flow balance is critical, and it is the responsibility of the applicant to suggest sites and appropriate monitoring technology so that all mass is accounted for to the level specified. Not all metering technology will work with all sites or treatment modalities; the applicant should carefully consider this when submitting an application. One of the commenters suggests reinforcing the requirement to account for ALL bypasses. We agree, to the extent feasible, all water should be accounted for.*

DCR response: *DCR concurs with the recommendation of the panel that, to the extent feasible, all water should be accounted for in the monitoring process. The VTAP document allows the investigator to explain any variations from the stated norms or testing requirements.*

29. Flow Measurement (Sections 5.4.1 and 5.4.2, pp. 33-37, VTAP document): **COMMENT:** The VTAP currently requires primary flow measurement devices, such as flumes or weirs, to be used in addition to secondary measures like AV sensors, bubblers, etc. Keep in mind that many of these projects will be executed on privately owned sites with previously designed stormwater infrastructure. The use of weirs and/or flumes in these instances will often not be possible due to their potential impact on site hydraulics and/or infrastructure. We suggest allowing the use of AV sensors or similar when site conditions are not conducive to the installation of a weir or flume for flow measurement. These types of flow measurement device have been utilized for the majority of TARP/TAPE and ETV studies. *(Derek Berg, Contech)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel prefers weirs and flumes due to their simplicity of operation and lower cost. However, other flow measurement technologies such as area velocity (AV) sensors may be acceptable, depending upon the specific site. The accuracy, precision, and applicability of the flow measurement technology selected for a site will be reviewed in the QAPP.*

Suggested DCR response: *DCR agrees that AV sensors are valid choices for measuring flow. However, they are more expensive, more sensitive to certain kinds of errors and, therefore, require more frequent maintenance and a greater level of expertise to analyze the data correctly. All these factors result in higher monitoring costs. However, the commenter is correct that there may be some* *monitoring situations where weirs and flumes are difficult to place or other reasons why a manufacturer may desire to use AV sensors. The VTAP document will be clarified to provide that option.*

30. Verifying flume flow rates over the entire range of flows (Sections 5.5.5.6.1, bullet 2, pg. 42, VTAP document): **COMMENT:** Flume flow functions are approximations for which one always expects errors, especially at the upper and lower ranges. What exactly is the protocol suggesting to be done to eliminate this flow bias? For the accuracies required for stormwater management, especially if a large set of events are monitored at the same location, this seems unnecessary. In fact, errors in the built-in routines used to perform automated, volume-based sample collection are a down-side of doing extensive compositing in the field. If biases in flow measurements are found, one can correct for these if doing manual compositing. However, it is unclear as to how to address this with an automated sampler. *(Dr. Teresa Culver, U. Va.)*

The DCR Panel of Academic BMP Researchers advisory response: *Flow measurement bias can occur with any primary device (weir, flume, etc.) due to deviation from the standards of installation, or deformation of the device. One practical method for verifying the rating relationship is comparing with other measurements (tracer dilution, "bucket rating" for small flows, or velocity-area measurements in the field). The means of assuring accurate rating relationships should be an element of the QAPP, which will be reviewed by the DCR Technical Evaluator. This approach places the onus on the proponent, rather than VTAP to prescribe a long and inevitably inconclusive list of approved methods.*

DCR response: *DCR concurs with the panel observation. Flume flow rating and verification is an important element of the monitoring process. Various methods are available to the proponent for doing this. DCR expects the proponent to propose the most appropriate method for the setting in the QAPP. Further discussions may result from the Technical Evaluator's review of the QAPP, but this should result in an acceptably negotiated path forward for testing.*

31. Establishing a Standard Water Quality Treatment Flow (Section 3, Table 3.3, pg. 10, VTAP document): **COMMENT:** Many jurisdictions specify in their BMP manuals or elsewhere a *methodology that defines how the required water quality volume should be converted to a water quality treatment flow rate for flow-through systems*. Many agencies use a TR-55 based method to convert volume to a treatment rate including, MD, CT, NY, RI, GA and more. The following is a link detailing the method:

http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/MarylandStormwaterDesignManual/Documents/www.mde.state.md.us/assets/document/sedimentstormwater/Appnd_D10.pdf

It is *also important* when issuing product ratings for flow-through BMPs *to establish the appropriate hydraulic loading rate to be maintained during the peak treatment rate*. This is typically tied to the product testing. For example, if the tested BMP was sized not to exceed 1 gpm/ft^2 of filter surface area during the peak treatment flow, then it must not exceed this rate at future installations in order to keep performance consistent. It is also critical that all technologies be sized for the same water quality flow, hence the need for a standard. *(Derek Berg, Contech)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel does not disagree with this statement. However, the BMP Clearinghouse Committee should weigh in on what the event should be.*

DCR response: *DCR agrees with this comment. However, some additional discussion will be needed to determine the criteria needed in the VTAP document.*

32. "Decontamination" and Field Blanks (Sections 5.5.6.2, 5.5.7.1 and 5.5.9, pp. 42, 43 and 45, VTAP document): **COMMENT:** These expectations seem unreasonable for phosphate monitoring. Decontamination between every event is overkill and doesn't seem reasonable in a field setting. The "decontamination" term is not even used in the EPA/Wright Water Engineers' Stormwater Manual often referenced in the VTAP. The field blank protocols described were recommended in the EPA/Wright Water Engineers' guidance for sampling in the parts per billion range. Accuracy at the resolution of parts per billion is not needed for sediments and TP. *(Dr. Teresa Culver, U. Va.)*

The DCR Panel of Academic BMP Researchers advisory response: *The commenter argues first that we should be using the EPA/Wright Water document when referring to decontamination, then argues against it for the level of field blanks. It is not common procedure to clean sampling equipment after each event; VTAP states "as needed," which is determined the field. Field blanks, however, are common, and are a means of quantifying the error associated with sampling equipment. The level of accuracy is something that should be stated in the QAPP and reviewed by the DCR Technical Evaluator.*

DCR response: *The issue is this: how clean do the field blanks need to be? The VTAP document doesn't stipulate a parts per billion resolution. In fact, the actual language requires decontamination between monitoring events "as necessary." This is a judgment call by the investigator and, in DCR's opinion, the VTAP document provides sufficient flexibility.*

33. A proponent shall monitor a minimum of two events that exceed 75% of the design capacity (Section 5.3.2.4, pg. 29, VTAP document): **COMMENT:** It is important to target a range of storm intensities and treatment design capacity to assess performance up to peak sizing. Monitoring only one outlier at the maximum storm size needs more support, so this target (guidance) is reasonable. However, when developing the revised TAPE protocol (Washington Department of Ecology), it was found that by sizing a treatment system appropriately for a particular site (i.e., not under-sizing the system), it may be difficult to capture the higher flow rates through a treatment system. The TAPE protocol includes a provision for discrete sampling to target treatment performance at higher flow rates or allows supplemental laboratory testing if a proponent is unable to measure these higher flow rates in the field. Also, given this criterion, more information should be provided regarding how to determine if an event exceeds 75% of the design capacity, when sampling occurs over many flow rates during the event. *(Scott Perry & Edward Kay, Imbrium Systems; John Lenith, Herrera Environmental Consultants)*

The DCR Panel of Academic BMP Researchers advisory response: *The intent of this provision is to ensure that a device is sized appropriately for the site. This language was taken directly from TAPE, albeit without the discrete sampling provision. We are not opposed to including this provision; however, laboratory studies may not be directly applicable. The determination of design capacity will be done initially in the application, by the vendor, and in the TER, again by the Vendor, and will be reviewed by the DCR Technical Evaluator. The panel asserts that determining capacity is a design issue and is mainly the vendor's responsibility.*

DCR response: *DCR concurs with the panel's observation that device's sizing should be appropriate for the site, which is a design issue that is the proponent's responsibility. The VTAP document states the requirement, and DCR expects the proponent to specify this information in application and TER, subject to review by the DCR Technical Evaluator.*

34. Extremely high expectations for sampling equipment (Section 5.4.2, pg. 36, VTAP document): **COMMENT:** Sampling equipment is quite expensive and not all of these expensive samplers have every advanced feature. On my last project, I spent approximately $70,000 to purchase and install equipment at the inlet and outlet of a single BMP. Yet, this equipment still would not have all of the features specified in the protocol. Two sources of power will greatly limit site options. If the proponents are willing to risk losing a storm due to power failure, that should be their risk. It is not reasonable to assume that equipment that can be remotely controlled is also a cool feature, but for many samplers and/or locations. It is not reasonable to assume that equipment, once purchased, can readily be moved to another location, since each site may require different kinds of equipment due to layout, BMP type, and stormwater concentrations. Furthermore, the protocol seems to imply – by the section on determining flow volumes in irregular cross-sections – that this can be done in real time and linked to the sampler. Most of these expensive automated samplers will only do real-time volume-based sampling in a small subset of settings, even after all the appropriate attachments and extras have been purchased and installed. If you can't do real-time, automated, volume-based sampling, then a much higher density of point samples must be taken to create the necessary composited samples in the lab. (Teresa Culver, U. Va.)

The DCR Panel of Academic BMP Researchers advisory response: *We disagree with this comment, particularly regarding the cost of equipment. With a flow measuring device (weir, flume), samplers, rain gauge, enclosures, and ancillary equipment, the expected cost should be <$20K. One of the panelists just instrumented 3 new sites for $16K each. Additional economies can be realized because the equipment is reusable. VTAP does not proscribe the power source, i.e., battery, solar, direct-wired, etc., or the telemetry; this is for the vendor to decide based upon their labor and equipment budget. For example, refrigerated samplers cost more money, but allow longer sample collection times (important for phosphorus collection).*

DCR response: *DCR is told by other researchers that equipment sufficient to meet the VTAP requirements can be purchased for considerably less ($5,000-20,000). Also, some of the necessary equipment is now available with solar power, eliminating the need for external or backup power. DCR sees no need to make changes to the VTAP document regarding this stated concern.*

35. Suggest that consideration be given to creating a Pre-treatment category of devices that are not subjected to the full VTAP criteria: **COMMENT:** There are several technologies included in the 1999 Virginia Stormwater Management Handbook that are classified as hydrodynamic structures. These types of technologies are most effective at removing coarse particulate and are often deployed as pre-treatment to more effective BMPs, such as infiltration or filtration systems, that are sensitive to solids loading and clogging. It is unlikely that these types of technologies will achieve appreciable phosphorus load reductions, so most manufacturers will likely forego evaluating hydrodynamic separators in accordance with the VTAP. If VADCR sees a role for these types of devices as pretreatment for certain retrofit applications, consideration should be given to an alternative evaluation process intended to establish basic sizing and sediment capture capabilities for this class of technologies. The process for approval should be based on TSS alone, and Virginia could consider providing reciprocal TARP certification based on NJDEP's lab testing for 50% TSS removal, or TAPE or TARP studies already completed that show similar or better performance. Of course, any manufacturer wishing to pursue a phosphorus rating for a hydrodynamic structure could still participate in the VTAP process.*(Derek Berg, Contech; Scott Perry & Edward Kay, Imbrium Systems)*

The DCR Panel of Academic BMP Researchers advisory response: *The panel suggests that there is real value to a pretreatment provision. Why not just use the TARP, which Virginia participates in as* *the standard? If it is TARP certified, that is the TSS removal credit it gets. We suggest no P removal credit unless they then go through VTAP. Nitrogen or other constituents are a different issue and specific protocols will need to be developed; TAPE is possibly a good starting point regarding other pollutants.*

DCR response: *DCR agrees that this is a good idea and will consider how to best accomplish this – perhaps, as the panel suggests, simply by reciprocal recognition of TARP certification. However, DCR is reluctant to allow consideration of this issue to delay completion of the VTAP document and product testing process.*

Additional Technical Issues considered by DCR's Panel of Academic BMP Researchers (UPDATED 10/8/2012)

1. Definition of MTD

   "Manufactured treatment devices (MTDs) are pre-fabricated BMPs used to ~~1) reduce the volume of stormwater runoff, 2) control the peak rate of stormwater runoff, or 3)~~ remove pollutants from stormwater runoff; MTDs include structures with proprietary components or processes."

   Note: In the DCR Panel of Academic BMP Researchers' meeting on September 24, 2012, it was agreed to delete control of runoff volume and peak discharge. The wording has been clarified to only refer the testing to MTDs for pollutant removal.

   From the changes on 10/2/12, DCR wants to exclusively use "MTD" and not "BMP" when discussing BMPs

   The panel supports this definition and use.

2. DCR is not "certifying", but is "approving".

   The panel has no comment.

3. "efficiency removal rating" and/or "pollutant removal rating" and other terms will be stricken, and replaced with "pollutant removal credit"

   The panel prefers this term as well.

4. "standards and specifications" to be replaced with "design specifications"

   No objection from the panel.

5. Other policy items:
   a. Updated roles to include SWCB and expanded roles of other participants
   b. Modified some times in timeline (takes longer to gain director's approval)
   c. To get a CUD, monitor at 1 field site, using TP, and VTAP or TAPE (TARP does not use TP); it does not need to be tested under VA conditions.
   d. MTDs will be assigned provisional PUD/CUD until 1st QAPP is approved (Becomes official once 1st QAPP approved)
   e. Official PUD/CUD is assigned a temporary pollutant removal credit for TP (<50%)

f. Official approval at the PUD and CUD levels is for 24 months. If not finished testing, proponents must request an extension.
g. Proponents may sell as many MTDs as can during 24-month testing period. We cannot limit "marketing," only the "installation" so updated the text to reflect this.
h. Added draft Confidentiality and Non-Disclosure Agreement from DCR.

The panel has no comment on these changes beyond what we have stated in response to the specific comments above.

6. Pretreatment section to be added.

   The panel supports this addition.

7. Design and Sizing Bulleted list (review)

   This will vary extensively depending upon particular technology; the list does reflect site data well. The panel suggests using it as guidance, as in "not limited to…"

8. Additional quick questions (responses in italics):
   a. Just double checking that a QAPP is needed for each site where testing is to occur.

      The panel believes a QAPP should be required for every site where testing is to occur.

   b. Under the description for the siting location: says, "Depth to water table." Is "depth to water table" a requirement or is that really a minimal depth from the water table? I propose changing this to "minimum depth needed from water table." Does that make sense or am I confused?

      In the application, the applicant should state what the buffer between the bottom of their device and the water table is. In some locations, it may be necessary to verify what the groundwater table is using a monitoring well, such as in in coastal location. This will have to be reviewed case by case. The panel supports the clarification that follows.

      Changed to say:
      "Address any and all site installation requirements and likely impacts resulting from the installation of the MTD. As a guide, be sure to consider at least the following: • Siting location – Contributing drainage area, upstream controls (non-structural and structural), available space needed, soil characteristics, hydraulic grade requirements, hydraulic capacity, minimum depth needed from water table, pretreatment requirements, etc."

   c. Under the operation and maintenance section, I think there is a punctuation error. Should there by a semi-colon after "mileage" instead of a comma? In other words, does mobilization and mileage refer to the costs associated with equipment? If not, what does mobilization and mileage refer to?

      Currently says •"Projected operational and maintenance (O&M) costs. Maintenance service contract availability. Include information about items that affect O&M costs: equipment rental, mobilization and mileage, solids/spent media disposal, etc."

The panel believes that mileage should be removed. This will vary depending upon location of the maintenance personnel. Instead, quantify the number of visits, the amount of time, and quantity of personnel.

d. Under system longevity, are these two separate thoughts instead of a "or" situation? "If applicable, does the filter medium decompose? Is the filter medium subject to slime/bacteria growth?"

   Currently says: "If applicable, does the filter medium decompose or is it subject to slime/bacteria growth?"

   The panel agrees. Add a question mark after decompose. Strike "or", begin new sentence at "is".

Appendix B

Virginia Technology Assessment Protocol
October 19, 2012 Version With Mark Ups

Guidance for Evaluating Stormwater Manufacture Treatment Devices

Virginia Technology Assessment Protocol (VTAP)

Prepared by:

Virginia Department of Conservation and Recreation

in cooperation with:

Virginia Stormwater Best Management Practice Clearinghouse Committee

You can print or download this document from DCR's website at:
http://www.dcr.virginia.gov

or from the Virginia Stormwater BMP Clearinghouse website at:
http://www.vwrrc.vt.edu/swc

For more information contact:
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Comment [WJ1]: Dave Dowling – Best address to use?

Approved by:
Virginia Soil and Water Conservation Board
December 11, 2012

Contents

Comment [WJ2]: Update once all changes are incorporated

Comment [WJ3]: Yellow high lighting often means this is new text. May sometimes be used to call attention

Comment [WJ4]: May remove this appendix from VTAP.

List of Figures

List of Tables

Acronyms and Abbreviations Used in this Document

APHA – American Public Health Association
ASCE – American Society of Civil Engineers
ASME – American Society of Mechanical Engineers
ASTM – American Society for Testing and Materials
AWWA – American Water Works Association
BMP – best management practice
BOD – biochemical oxygen demand
C – Celsius
CAD – computer-aided design
CD – compact disc
cfs – cubic feet per second
Clearinghouse – Virginia Stormwater BMP Clearinghouse
COD – chemical oxygen demand
CUD – Conditional Use Designation
D_{50} – mass median particle diameter (μm)
DCLS – Division of Consolidated Laboratory Services
DCR – Virginia Department of Conservation and Recreation
DGS -- Department of General Services
DQA – data quality assessment
DQI – data quality indicator
DQO – data quality objective
e.g. – Latin *exempli gratia*, "for example"
EMC – event mean concentration
EPA – United States Environmental Protection Agency
ER – efficiency ratio
etc. – Latin *et cetera*, "and so forth"
ETV – Environmental Technology Verification
ft./sec. – feet per second
$ft.^3$ – cubic feet
$ft.^3$/sec. – cubic feet per second
GIS – geographic information system
gpm/ft^2 – gallons per minute per square foot
GUD – General Use Designation
GULD – General Use Level Designation
HASP – health and safety plan
HDPE – high-density polyethylene
ICP/MS – inductively coupled plasma/mass spectrometry
i.e. – Latin *id est*, "that is"
in. – inches
in./hr. – inches per hour
Inc. – Incorporated
IR – infrared
mg – milligram (one thousandth of a gram)
mg/kg – milligrams per kilogram
mg/L – milligrams per liter

mL – milliliter (one thousandth of a liter)
mm/L – millimeter per liter
MQO – measurement quality objective
MS/MSD – matrix spike/matrix spike duplicate
MTD – manufactured treatment device
µm – micron or micrometer (one millionth of a meter)
N – nitrogen
NA – not applicable
NELAC – National Environmental Laboratory Accreditation Conference
NELAP – National Environmental Laboratory Accreditation Program
NJ – New Jersey
NJCAT – New Jersey Corporation for Advanced Technology
NJDEP – New Jersey Department of Environmental Protection
NOAA – National Oceanic and Atmospheric Administration
NPDES – National Pollutant Discharge Elimination System
NRCS – Natural Resources Conservation Service
NSQD – National Stormwater Quality Database
NTIS – National Technical Information Service
NWTPH-Dx – Northwest Total Petroleum Hydrocarbons-Motor Oil and Diesel fractions
O&M – operation and maintenance
PAH – polycyclic aromatic hydrocarbons
PE – professional engineer
PLD – Pilot Level Designation
PM – particulate matter
PP – particulate phosphorus
PR – pollutant removal
PSD – particle-size distribution
PSEP – Puget Sound Estuary Program
PUD – Pilot Use Designation
QA – quality assurance
QAPP – quality assurance project plan
QC – quality control
SOL – summation of loads
SM – Standard Methods
SRP – soluble reactive phosphorus
SSC – suspended sediment concentration
SUP – soluble unreactive phosphorus
SW – Solid Waste
TAPE – Technology Assessment Protocol – Ecology
TARP – Technology Acceptance Reciprocity Partnership
TDS – total dissolved solids
TER – technology evaluation report
TKN – total Kjeldahl nitrogen
TMDL – Total Maximum Daily Load
TN – total nitrogen
TNI – The NELAC Institute
TOC – total organic carbon
TP – total phosphorus
TPH – total petroleum hydrocarbons
TRC – Technical Review Committee
TSP – total soluble phosphorus

TSS – total suspended solids
U.S. EPA – United States Environmental Protection Agency
USGS – United States Geological Survey
VELAP – Virginia Environmental Laboratory Accreditation Program
$V_E t_v$ – Equal Volume – Variable Time
VSMP – Virginia Stormwater Management Program
VTAP – Virginia Technology Assessment Protocol
$V_V t_V$ – Variable Volume – Variable Time
VWRRC – Virginia Water Resources Research Center
WA – Washington
WEF – Water Environment Federation
WQV – water quality volume
WSDOE – Washington State Department of Ecology

1 -- Introduction

This document, the *Virginia Technology Assessment Protocol* (VTAP), describes the assessment process for listing stormwater manufactured treatment devices (MTDs) on the Virginia Stormwater Best Management Practice (BMP) Clearinghouse website: http://www.vwrrc.vt.edu/swc. For this document, MTDs refer to pre-fabricated BMPs used to remove pollutants from stormwater runoff; MTD designs may involve proprietary components or processes. MTDs may not be installed in Virginia for the treatment of stormwater runoff quality control credit (i.e., phosphorus removal) unless approved by the DCR through the VTAP process and listed on the Clearinghouse website. This process was developed by the Virginia Department of Conservation and Recreation (DCR) in collaboration with the Virginia Stormwater ~~Best Management Practice (~~BMP~~)~~ Clearinghouse Committee (Clearinghouse Committee) and approved by the Virginia Soil and Water Conservation Board. ~~has established a process for evaluating post construction, proprietary/manufactured stormwater BMPs for certification in Virginia. BMPs under consideration or approved by the DCR for use in Virginia are listed on the Virginia Stormwater BMP Clearinghouse website: http://www.vwrrc.vt.edu/swc. This document, the *Virginia Technology Assessment Protocol* (VTAP) describe the assessment process for listing stormwater BMPs on the Clearinghouse website.~~

Comment [WJ5]: Addressing Public Comment #2.

1.1 -- Authority

Virginia's stormwater management programs are implemented according to the Virginia Stormwater Management Law and Virginia Stormwater Management Regulations. The law is codified at Title 10.1, Chapter 6, Article 1.1 of the *Code of Virginia,* and the regulations are found at Section 4 VAC 50-60 of the *Virginia Administrative Code*. The Law provides authority for the Virginia Soil and Water Conservation Board to *". . . establish minimum design criteria for measures to control nonpoint source pollution and localized flooding . . . ."* (§10.1-603.4 2) and to *". . . [delegate to the Department (sic DCR)] . . . any of the powers and duties vested in it by [the law] . . . ."* (§10.1-603.2:1.2). The Virginia Soil and Water Conservation Board and the DCR thus maintain the authority to establish, approve, and update design specifications of BMPs that may be used within Virginia to control stormwater runoff.

The *Virginia Administrative Code* states that BMPs not listed in 4 VAC 50-60-65 (water quality compliance) "shall be reviewed and approved by the director [of DCR] in accordance with procedures established by the BMP Clearinghouse Committee and approved by the board [Virginia Soil and Water Conservation Board]." Accordingly, this guidance document sets forth procedures established by the Clearinghouse Committee and was approved by the Virginia Soil and Water Conservation Board.

Comment [WJ6]: Yellow highlighting used to bring text to your attention or text that was added/altered but done so without using "track changes."

1.2 -- Purpose of Virginia Technology Assessment Protocol (VTAP)

The purpose of the VTAP is to define the ~~structure and~~ procedures to follow for approving and listing ~~stormwater BMP~~MTDs on the Virginia Stormwater BMP Clearinghouse website. Because the water-quality regulatory criterion in the Virginia Stormwater Management Program (4 VAC 50-60-63) is aimed at removal of total phosphorus (TP), TP removal provides the basis for water-quality testing in Virginia. This document is, therefore, for the purpose of assessing MTDs that remove phosphorus from post-construction stormwater runoff.

Approved MTDs assessed for phosphorus removal through the VTAP process will be listed on the BMP Clearinghouse website and will be assigned pollutant removal (PR) credits for TP. The PR credits approved through the VTAP and listed on the Clearinghouse website ~~removal efficiencies~~ will be the ones that state agencies and local stormwater management programs will recognize ~~and approve~~ when the approved MTDs ~~BMPs~~ are ~~used~~included in ~~specific~~ stormwater management plans in Virginia.

Local governments statewide can apply the use~~-level~~ designations listed on the Clearinghouse website to evaluate the suitability of these BMPs for use in their communities. ~~I~~Furthermore, information acquired during testing may also be useful for the development and implementation of Total Maximum Daily Loads (TMDLs).

~~The VTAP defines the Virginia testing protocol and process for evaluating and reporting on the performance and appropriate uses of manufactured BMPs that address post-construction stormwater runoff. Documents that support the Technology Acceptance Reciprocity Partnership (TARP)(TARP 2003; NJDEP 2009) and Technology Assessment Protocol – Ecology (TAPE) (WSDOE 2008, 2011) were used in developing the VTAP. The VTAP, however, is specific to Virginia, which has established total phosphorus load limits in the water quality protection section of the Virginia Stormwater Management Regulations (4 VAC 50-60-65). Therefore, use of the TARP, TAPE, or any other established protocol does not eliminate state review or approval of projects proposing to use stormwater management technologies approved in other states, nor does it require Virginia to "rubber stamp" the approval or certification of another state. Those seeking reciprocal certification from Virginia of practices and methods previously certified by another state must demonstrate consistency with the procedures articulated in this document.~~

~~By obtaining accurate and relevant data, evaluators can assess performance claims and make informed decisions whether or not to approve BMPs for use in Virginia. Information acquired during testing may also be useful for the development and implementation of Total Maximum Daily Loads (TMDLs). Local governments statewide can apply the use level designations listed on the Clearinghouse website to evaluate the suitability of these BMPs for use in their communities.~~

1.3 -- Applicability

This protocol is intended for use in assessing ~~post-construction, proprietary/manufactured BMPs~~MTDs for use in Virginia to treat post-construction, stormwater runoff. The testing protocol is intended for volume-based and flow-rate based ~~detention, flow-based (volume and peak rate)~~ stormwater ~~BMPs~~ MTDs and may not be suitable for all stormwater treatment practices. Th~~e~~is testing protocol does NOT apply to non-proprietary BMPs, and the protocol is NOT for use in the evaluation of erosion and sediment control technologies or products.

Although documents that support the Technology Acceptance Reciprocity Partnership (TARP) (TARP 2003, NJDEP 2009) and the Technology Assessment Protocol – Ecology (TAPE) (WSDOE 2008, 2011) were used in developing this guidance, the VTAP is specific to Virginia.

Comment [WJ7]: Incorporated into the applicability section below.

Comment [WJ8]: Incorporated into paragraph above.

Comment [WJ9]: Addressing Public Comment #8

Approvals obtained through ~~Use of the~~ TARP, TAPE, or ~~any~~ other established protocols do~~es~~ not eliminate the need for review and approval in Virginia. ~~state review or approval of projects proposing to use stormwater management technologies approved in other states, nor does it require Virginia to “rubber stamp” the approval or certification of another state.~~ Those seeking ~~reciprocal certification~~ approval ~~from~~in Virginia for MTDs ~~of practices and methods~~ previously ~~certified~~ approved by another state must demonstrate consistency with the procedures articulated in this document.

1.4 -- Roles and Responsibilities

1.4.1 – Virginia Soil and Water Conservation Board

According to the *Virginia Administrative Code* (4 VAC 50-60-65) (see **Section 1.1 -- Authority**), the Virginia Soil and Conservation Board shall establish procedures for reviewing and approving stormwater management BMPs. Thus, the Board has approved this protocol (VTAP), which is to be used to approve MTDs for use in Virginia for treating phosphorus in post-construction, stormwater runoff.

1.4.2 -- Virginia Department of Conservation and Recreation (DCR)

The Virginia Department of Conservation and Recreation is responsible for ~~the~~ Stormwater Management Programs in Virginia (see **Section 1.1 -- Authority**). For this reason, the DCR may obtain recommendations from outside evaluators and the Clearinghouse Committee, but the DCR director is ultimately responsible for granting or denying use designations and establishing PR credits for MTDs.

Comment [WJ10]: Addressing Public Comment #14

The Department of Conservation and Recreation:

- Chairs the Virginia Stormwater BMP Clearinghouse Committee;
- Grants use~~-level~~ designations and assigns PR credits;
- Approves changes made to use~~-level~~ designations and PR credits;
- Approves or denies requested exceptions to the VTAP,
- Reviews and approves Quality Assurance Project Plans (QAPPs);
- Reviews and approves changes to approved QAPPs;
- Provides oversight and analysis of all submittals to ensure consistency with the DCR’s stormwater management requirements;
- Provides responses regarding public comments received on Technology Evaluation Reports posted on the Clearinghouse website;
- Assumes the duties of the ~~contracted~~ DCR’s evaluator(s) (see below) when necessary; and
- Reviews new information and updates the VTAP as needed.

1.4.3 -- DCR’s Evaluator(s)

The DCR may contract with a qualified and independent individual or entity or may use internal staff to assist with the assessment process.

Comment [WJ11]: Public Comment #11

DCR's evaluator(s):

- Review submitted applications for completeness;
- Provide recommendations to the DCR regarding technical questions posed by the agency;
- Review ~~Quality Assurance Project Plans (~~QAPPs~~)~~ ~~;~~ and p~~P~~rovide recommendations to the DCR for approval or denial of QAPPs;
- May p~~P~~eriodically inspect laboratory testing and/or field testing;
- Provide secondary check of ~~Validate monitoring data and write~~ data validation ~~reports~~;
- ~~Review technology evaluation reports (TERs) for completeness and conformance with Clearinghouse procedures and protocols;~~
- Provide recommendations to the Clearinghouse Committee and the DCR regarding the need for additional testing (if necessary) and limitations of ~~the~~evaluated ~~technology~~MTDs~~.~~;
- Provide recommendations ~~and assessments~~ to the Clearinghouse Committee and the DCR's director regarding ~~pollution removal efficiencies~~ PR credits to assign to ~~BMPs~~ MTDs and whether or not to ~~certify/~~approve ~~BMP~~MTDs at requested use ~~-~~designation levels; ~~and~~
- Provide draft responses to the DCR regarding public comments received on Technology Evaluation Reports posted on the Clearinghouse website; and
- Work in collaboration with the proponent to develop information for the Clearinghouse website regarding approved MTDs.

1.4.4 -- Clearinghouse Committee

Members of the~~The~~ Virginia Stormwater BMP Clearinghouse Committee that have experience with stormwater BMPs but are not affiliated with the proponent of the MTD being assessed or other stormwater MTD manufacturers/vendors will review applications ~~and TERs~~ and provide recommendations to the DCR. Members of the committee will also have the opportunity to comment on quality assurance project plans (QAPPs). ~~The committee members that provide review of the assessments represent both academics and practitioners that have experience with stormwater BMPs but are not affiliated with the proponent of the technology or other stormwater BMP manufacturers/vendors.~~

The Clearinghouse Committee:

- Establishes procedures (i.e., VTAP) for approving MTDs in Virginia;
- Meets quarterly to provide oversight review of use-~~level~~ designation applications; ~~and technology engineering reports; and~~
- Provides recommendations ~~and assessments~~ to the DCR and the proponent regarding ~~pollution removal efficiencies~~ PR credits to assign to ~~BMPs~~ MTDs and whether or not to ~~certify/~~approve ~~BMPs~~ MTDs at requested use ~~-~~designation levels;
- Interacts with the DCR staff to assess how well the VTAP process satisfies the DCR's stormwater treatment BMP selection objectives~~;~~.

1.4.5 -- Virginia Water Resources Research Center

The Virginia Water Resources Research Center facilitates the VTAP review process by coordinating with the DCR and the Clearinghouse Committee.

The Virginia Water Resources Research Center:

- Develops and maintains the Virginia Stormwater BMP Clearinghouse website under the direction of the DCR and the Clearinghouse Committee; and
- May facilitate outside research and evaluations, when requested, by coordinating with stormwater BMP designers, manufacturers, researchers, and regulators regarding the scientific review of existing BMP test data or new monitoring and testing.

1.4.6 -- Proponent of Technology

The proponent of the technology refers to the person/company that is promoting the project through the VTAP process. The proponent can be the manufacturer, the ~~product~~ MTD vendor, consultant, etc.

The proponent:

- Submits the use-~~level~~ designation application to the DCR;
- Submits status reports to the DCR;
- Submits QAPP~~s~~ to the DCR for each ~~all laboratory and~~ field test~~ing~~ site;
- Submits requests to change approved QAPPs, if applicable, to the DCR;
- Notifies the DCR of all installations made in Virginia during the testing period~~Submits the technical evaluation report (TER)~~; and
- Works in collaboration with the DCR's evaluator(s) to develop information for the Clearinghouse website regarding approved MTDs.~~.~~

1.4.7 -- Proponent's Technical Advisor(s)

The proponent's technical advisor provides oversight of performance testing. The DCR requires the use of a technical advisor at the onset of testing. This technical advisor is paid for by the proponent of the technology and is not provided by the DCR, the DCR's contracted evaluator(s), the Clearinghouse Committee, or the VWRRC.

At a minimum, the technical advisor:

- Reviews and approves the QAPPs for all testing ~~(laboratory and field)~~; and
- Provides oversight of QAPP implementation by periodically providing inspections of test/site conditions, sampling equipment, sample handling, etc.~~; and~~
- ~~Validates monitoring data and writes validation report.~~

1.5 -- Protocol Limitations, Release of Liability, and Disclosure

This protocol has been published for ~~the purpose of evaluating or generating performance claim data for best management practices for certification~~ listing manufactured treatment devices on the Virginia Stormwater BMP Clearinghouse website and for assigning pollutant removal credits for phosphorus for use in Virginia ~~for stormwater management~~. Neither the DCR; its contracted partners, including ~~the VWRRC~~the DCR's contracted evaluator(s) and the VWRRC; nor the Clearinghouse Committee accept responsibility or liability for performance of stormwater technologies being evaluated using the VTAP. Whereas DCR authorizes the installation of approved MTDs, the jurisdiction operating a local Virginia Stormwater Management Program will have full responsibility for the decision to allow MTDs to be used in the jurisdiction. The DCR and the jurisdiction will have the ability to place conditions upon installations of approved MTDs.

Proprietary information that is not to be made public should NOT be included in the application but instead should be submitted separately to the DCR along with a completed Confidentiality and Non-Disclosure Agreement (see **Appendix A;** confidential information should NOT be sent to the DCR via e-mail). The DCR's regulatory manager or designee will evaluate the confidentially and either: 1) sign the agreement and return a copy of the signed agreement to the proponent, or 2) deny the request. If the agreement is signed, the information will be considered as part of the application by DCR staff, including the DCR director, and may be shared with DCR's contractors associated with implementing the VTAP process. If the request is denied, the DCR will notify the proponent of the reason for denial and return the information to the proponent. Furthermore, if the confidentiality request is denied, the DCR's director will not have access to the information so cannot consider it in his or her evaluation of the MTD.

Comment [WJ12]: May replace with process described in 4VAC50-60-340. Confidentiality of information

Comment [WJ13]: Addressing Public Comment #14

Comment [WJ14]: Should they submit 2 signed agreements so that both parties can have an original? Or just 1 original and the proponent gets a copy?

Comment [WJ15]: DCR will need to obtain signed confidentiality agreements from its contractors too.

Comment [WJ16]: Assume this is by mail? Is that an OK when to return proprietary information?

2 -- ~~BMP~~ MTD ~~Certification~~ Use Designations

There are three use designations for assessed stormwater MTD~~BMP~~s in Virginia: **Pilot Use Designation** (**PUD**), **Conditional Use Designation** (**CUD**), and **General Use Designation** (**GUD**). The goal for the proponent is to obtain a **GUD**~~,~~. ~~whereby the technology may be marketed throughout Virginia, subject to conditions that the DCR may apply as a result of the testing and assessment of the practice.~~

Table 2.1 summarizes the testing requirements that must be met to receive each use designation for phosphorus removal. ~~Technologies~~ MTDs with limited data will only be evaluated for the **PUD**. The DCR will not consider an application for a **CUD** or a **GUD** unless the application includes sufficient field performance data that clearly demonstrate acceptable feasibility and the likelihood that the ~~BMP~~ MTD will achieve desired performance levels using the manufacturer's recommended sizing criteria, pretreatment requirements, and maintenance schedule, etc.

Table 2.1. Summary of the testing requirements for phosphorus removal by stormwater manufactured treatment devices to receive Pilot Use Designation (PUD), Conditional Use Designation (CUD), and General Use Designation (GUD) in Virginia

Comment [WJ17]: Addressing Public Comment #9.and #13

Use Designation	Minimum Testing Required to Receive Designation	Test Parameter Required to Receive TP Approval	Accepted Protocols
PUD	1 Full-scale Lab or Field	TP or TSS or SSC	Lab: NJCAT (http://www.njcat.org/; NJDEP 2003) or other protocol accepted by DCR Field: VTAP, NJ TARP (NJDEP 2009), TAPE (WSDOE 2011) ~~-~~or other protocol accepted by DCR
CUD	1~~2~~ Field	TP ~~or TSS or SSC (TSS or SSC accepted only until July 1, 2014)~~	VTAP, ~~NJ TARP (NJDEP 2009),~~ TAPE (WSDOE 2011), or other protocol accepted by DCR
GUD	2 Field	TP	VTAP

Comment [WJ18]: Addressing Public Comment #10

MTDs may not be installed in Virginia for PR credit (i.e., phosphorus removal) for the treatment of post-construction stormwater runoff ~~quality control credit (i.e., phosphorus removal)~~ unless the DCR grants it the official status of PUD, CUD, or GUD (This rule does not apply to post-construction, non-proprietary BMPs). To gain official approval for the **PUD** or **CUD**, the DCR's regulatory manager or designee must approve a QAPP for at least one field test site. A DCR-approved QAPP is required for each field test site, and performance monitoring methods must follow the approved QAPP.

Comment [WJ19]: Public Comment #`14

Once granted an official **PUD, CUD**, or **GUD**, MTDs will be assigned a PR credit for phosphorus removal. The PR credit is temporary for the **PUD** and **CUD**. The PR ~~rating~~ credit will be calculated from the direct measurement of TP loads into and out of the MTD. Summed with the total phosphorus load from the bypassed annual discharge volume (untreated), the total phosphorus load reduction for the drainage area may be determined and used to assess compliance with the DCR average annual phosphorus load limit.

For the purpose of awarding a use designation and establishing ~~BMP efficiencies~~PR credits for MTDs, the DCR will allow the use of test data collected in states other than Virginia. However, any field data used ~~to be included~~ to receive a **GUD**~~in the assessment process~~ *must* be derived from testing sites representative of urban stormwater conditions expected in Virginia, and field data used to receive a **PUD** or **CUD** *should* be derived from testing sites representative of urban stormwater conditions expected in Virginia (Table 2.2). For example, any ~~product~~ MTD verification in a rainfall distribution other than Type II, such as those approved in Washington's TAPE program, must address the influence of the rainfall intensity, duration, peak flow, etc. in order to be used to receive a **CUD.** Thus, in this example, a flow-based system that is designed to treat the water quality flow rate would have to be sized for the Type II intensity – rather than the much lower Type IA of the Pacific Northwest. Information provided in the use-designation application and/or~~,~~ QAPP~~, and/or TER~~ about the demonstration site will be used to help assess how well the site represents conditions in Virginia.

Comment [WJ20]: Addressing Public Comment #18

Comment [WJ21]: Public Comment#10

Table 2.2. Urban stormwater test conditions for ~~certification~~ approval in Virginia.

Condition Influencing Stormwater	Test Conditions
Precipitation	Type II Distribution (Distribution obtained at NOAA Atlas 14)
Temperature	26.0°F-86.1°F Long-term Monthly Average 44.6 °F-66.7°F Long-term Annual Average (From Virginia State Climatology Office: http://climate.virginia.edu/virginia_climate.htm)

2.1 -- Pilot Use Designation (PUD)

The ~~**Pilot Use Designation**~~ ~~(~~**PUD**~~)~~ is for the purpose of collecting field performance data according to the VTAP when the performance data do not meet the standards of applying for a **CUD** or **GUD**. The DCR will grant a **PUD** ~~certification~~ if it believes the practice has merit and should have field performance testing conducted.

A **PUD** approved for phosphorus treatment may be granted for MTDs that were tested for TSS or SSC removal in the laboratory at full-scale size using Sil-Co-Sil 106 or from field testing. To receive a **PUD**, laboratory testing needs to follow the NJCAT protocol (http://www.njcat.org/; NJDEP 2003) or other laboratory protocol accepted by the DCR. To receive a **PUD**, data from field testing needs to follow the VTAP, NJ TARP (NJDEP 2009), TAPE (WSDOE 2011) or other established protocol accepted by the DCR (Table 2.1).

~~BMPs~~ MTDs with an official **PUD** ~~certification~~ from the DCR will be listed as such on the Clearinghouse website and granted a temporary pollutant removal (PR) credit for TP (not to exceed 50%). These MTDs may be installed in Virginia subject to approval by the jurisdiction operating the local Virginia Stormwater Management Program and conditions that the DCR or the jurisdiction may impose. ~~These BMPs may be installed in Virginia while field testing occurs,~~

~~but the DCR may impose conditions for installations in Virginia. In addition, t~~The proponent of the ~~technology~~ MTD must notify the DCR of all installations made in Virginia during the testing period. The **PUD** ~~certification~~ expires after 24 months from the time the first QAPP is approved by the DCR unless the DCR grants an extension of the testing period. Testing is required at ~~two~~one field site~~s~~ to move to the **CUD** level and at two field sites to move to the **GUD** level. ~~either the **CUD** or **GUD** levels.~~

If a MTD approved at the **PUD** level is found to perform poorly, the DCR will not require the removal of the MTDs installed in Virginia for testing purposes or otherwise installed during the testing period. ~~The proponent of a poor performing **PUD** technology is not required to remove BMPs installed in Virginia.~~

2.2 -- Conditional Use Designation (CUD)

The **Conditional Use Designation** (**CUD**) is for ~~BMPs~~ MTDs that have undergone rigorous field testing in at least ~~two~~one location~~s with urban stormwater conditions representative of those in Virginia (Table 2.1)~~ using a DCR-approved protocol for testing the removal of TP from post-construction stormwater runoff. The test protocol used could be the VTAP, TAPE (WSDOE 2011), or other protocol with phosphorus testing that is accepted by the DCR (Table 2.1). ~~The **CUD** certification should be sought when the data were collected according to an established protocol, but the protocol does not need to be consistent with the VTAP.~~ The DCR will grant a **CUD** ~~certification~~ if it believes the practice has merit and should have more field performance testing conducted.

~~Technologies~~ MTDs with an official **CUD** ~~certification~~ from the DCR will be listed as such on the Clearinghouse website and granted a temporary pollutant removal credit for TP (not to exceed 50%). These MTDs may be installed in Virginia subject to approval by the jurisdiction operating the local Virginia Stormwater Management Program and conditions that the DCR or the jurisdiction may impose. ~~These BMPs may be installed in Virginia while field testing occurs, but the DCR may impose conditions for installations in Virginia. In addition, t~~The proponent of the ~~technology~~ MTD must notify DCR of all installations made in Virginia during the testing period. The **CUD** ~~certification~~ expires after 24 months from the time the first QAPP is approved by the DCR unless the DCR grants an extension of the testing period. Testing that follows the VTAP ~~protocol~~ is required at two distinct field sites for ~~certification~~ approval at the **GUD** level.

If a MTD approved at the **CUD** level is found to perform poorly, the DCR will not require the removal of the MTDs installed in Virginia for testing purposes or otherwise installed during the testing period. ~~The proponent of a poor performing **CUD** technology is not required to remove BMPs installed in Virginia.~~

2.3 -- General Use Designation (GUD)

The **General Use Designation** (**GUD**) confers a general acceptance for the stormwater ~~BMP~~ MTD based on MTD performance of phosphorus removal and factors that influence the performance~~validated field performance claims~~. ~~BMPs~~ MTDs seeking a **GUD** ~~certification~~ must have been field tested in at least two field sites and must conform to the requirements in this

VTAP document (Table 2.1). Furthermore, the test sites must be representative of urban stormwater runoff in Virginia (Table 2.2).

~~BMPs~~ MTDs with a **GUD** ~~certification~~ will be listed as such on the Clearinghouse website and awarded a pollutant removal credit based on the test results. ~~Technologies~~ MTDs with a **GUD** ~~certification~~ from the DCR may be used anywhere in Virginia, subject to ~~conditions~~ approval by the jurisdiction operating the local Virginia Stormwater Management Program and conditions that the DCR or the jurisdiction may impose. ~~the DCR may apply as a result of the testing and evaluation of the practice. Technologies~~ MTDs that receive a **GUD** ~~certification~~ have no expiration date.

If at a later date, it is discovered that a MTD with a **GUD** ~~certified technology~~ is not performing at the ~~certified level~~assigned pollutant removal credit, the evidence for lack of performance and other relevant information would be submitted to the Clearinghouse Committee for review and recommendation. The DCR director would make any final approvals/disapprovals. During this review process, the practice would be removed from the Clearinghouse website until the PR credit is changed~~certified performance level is corrected~~, the design criteria are improved to achieve the listed performance, or the matter is otherwise resolved.

Comment [WJ22]: Public Comment #14

2.4 – Applying for the Appropriate Use Designation

In deciding for which use designation ~~level~~ to apply ~~for~~, the proponent will need to ask a fundamental question:

> **Does the ~~technology~~ MTD have field performance data ~~that represent urban stormwater conditions in Virginia~~, and do these data meet the VTAP requirements?**

To determine the answer to this question, the proponent of the ~~technology~~ MTD must be familiar with the information in this ~~the~~ VTAP ~~as described in this~~ document.

The following guidance is intended to be helpful in selecting the most appropriate use designation ~~level~~ for which to apply:

- Proponents of ~~BMPs~~ MTDs with full-scale laboratory performance data for TP, TSS, or SSC and no, or limited, field testing data should submit a **PUD** application.
- Proponents of ~~BMPs~~ MTDs with field performance data that meet the following criteria should submit a **CUD** application:
  (a) The TP removal data were collected from at least ~~two~~ one field site, ~~s representing urban stormwater conditions in Virginia,~~ and
  (b) The testing procedures conform to an established protocol, such as ~~-~~ the VTAP, ~~TARP (NJDEP 2009) or~~ TAPE (WSDOE 2011)~~,~~ or other protocol with phosphorus testing that is accepted by the DCR~~'s evaluator(s)~~.
- Proponents of ~~BMPs~~ MTDs with field performance data that meet the following criteria should submit a **GUD** application:
  (a) The TP removal data were collected from at least two field sites representing urban stormwater conditions in Virginia, and
  (b) The testing procedures conform to the VTAP.

3 -- Assessment Process

The Virginia Stormwater BMP Clearinghouse will maintain a list of approved ~~BMPs~~ MTDs on the Clearinghouse website to assist local jurisdictions in identifying stormwater technologies ~~and products~~. ~~Technologies~~ MTDs undergoing testing to meet criteria of the **General Use Designation** (**GUD**) may be listed on the Clearinghouse website with either a **Pilot Use Designation** (**PUD**) or a **Conditional Use Designation** (**CUD**; ~~(~~refer to **Section 2 -- ~~BMP~~ MTD ~~Certification~~ Use Designations**).

3.1 -- Overview of Virginia Technology Assessment Protocol and Timeline

The assessment process for approving MTDs for the treatment of phosphorus in post-construction, stormwater runoff in Virginia is explained in the steps below and illustrated in Figure 3.1. Required deadlines are shown in bold-faced type. The other times listed are guidelines for the amount of time expected for a given step in the process. The evaluators will review submittals as quickly as possible and will communicate with the proponent of the MTD if delays or problems arise.

Failure to submit progress reports or failure to demonstrate satisfactory progress during the testing period risks suspension or cancellation of the use designation and possible removal from the Clearinghouse website. A MTD with a suspended **PUD** or suspended **CUD** cannot be installed in Virginia during the suspension period. Suspensions granted because of a lack of progress will be removed when the proponent demonstrates satisfactory progress in completing the required component. Furthermore, if undesirable trends become evident during the testing phase, the DCR can call for the suspension of the approved **PUD** or **CUD**, in which case, the MTD may not be installed in Virginia until the problem is found and corrected. If the undesirable trends are serious enough, the DCR can issue a cancellation, whereby the MTD will be removed from the Clearinghouse website and cannot continue to be installed in Virginia. The proponent of a cancelled MTD must resubmit an application after the issue(s) have been addressed in order to have the MTD re-evaluated.

The PUD or CUD will expire after 24 months from the time the first QAPP is approved by the DCR unless the DCR grants an extension of the testing period. A MTD with an expired **PUD** or expired **CUD** will be removed from the Clearinghouse website and cannot continue to be installed in Virginia. The proponent of an expired MTD ~~ation requires the proponent~~ must ~~to re~~submit an application (assumedly at a higher use designation) in order to have the MTD evaluated. ~~-~~In an effort to prevent the expiration of a **PUD** or **CUD**, the proponent of a MTD may submit a request to the DCR for an extension of the testing period; the DCR's regulatory manager or designee must approve this request in order for the proponent to gain additional testing time and to continue installing the MTD in Virginia.~~The other times listed are guidelines for the amount of time expected for a given step in the process. The evaluators will review submittals as quickly as possible and will communicate with the proponent of the technology if delays or problems arise.~~

1. The assessment process in Virginia begins when the proponent submits a **PUD**, **CUD**, or **GUD** application to the DCR.

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Comment [WJ23]: Public Comment #14

2. Submitted applications are reviewed for completeness by the DCR's evaluator(s) within 15 calendar days.
3. If the application is complete, the DCR's evaluator(s) will assess the application and recommend a use designation and PR credit within 60 calendar days.
4. If recommended by DCR's evaluator(s), the technical evaluation report (TER), submitted as part of the application, will be included on the Clearinghouse website for ~~peer review and~~public comment for 30 calendar days.
5. The DCR~~'s evaluator(s)~~ will respond to the public comments within 30 calendar days; and will provide the~~ir recommendation~~ responses to the Clearinghouse Committee~~.~~
6. The Clearinghouse Committee will review the application, recommendations made by DCR's evaluator(s), ~~and~~ public comments, and responses to the comments. The Clearinghouse Committee will develop a use-designation recommendation and a PR credit recommendation. The Clearinghouse Committee will notify the proponent and the DCR of its~~the~~ recommendations. The Clearinghouse Committee meets quarterly and will review applications in the order they were received. Depending on the number of applications ~~and TERs~~ to be reviewed, the submitted application will be assessed at the earliest possible Clearinghouse Committee meeting.
7. The DCR's director will review all recommendations and determine an appropriate use designation (i.e., no use designation, provisional **PUD**, provisional **CUD**, or **GUD**) and ~~efficiency rating~~PR credit within ~~1~~45 calendar days.

~~BMPs~~ MTDs approved at the **GUD** level are listed on the Clearinghouse website. If a ~~BMP~~ MTD is not awarded any type of ~~certification~~approval, ~~it~~thes proponent of the MTD will need to reapply once the identified issues have been addressed. For ~~BMPs~~ MTDs with provisional approval at the **PUD** or **CUD** levels, the process continues as described below:

8. Proponents of ~~technologies~~ MTDs with ~~certifications~~ approvals at either the provisional **PUD** or provisional **CUD** level must begin to provide quarterly status reports to the DCR. Reporting time begins once granted the provisional ~~certification~~approval. **Quarterly status reports are due to DCR for the preceding ~~three~~3-month period, specifically:**
   - **May 1st for the period January 1 – March 31;**
   - **August 1st for the period April 1 – June 30;**
   - **November 1st for the period July 1 – September 30; and**
   - **February 1st for the period October 1 – December 31**.

   The proponent must continue to submit quarterly progress reports to the DCR until submission of the ~~they submit the~~ application for a higher use designation at the conclusion of the testing period~~TER~~.
9. ~~Proponents with provisional certification must submit to DCR a~~ A QAPP that ~~for each field test site. The QAPP must~~ meets the VTAP's requirements, including that the proponent's technical advisor must, at least, review and approve the QAPP, is required for each field test site.
10. The DCR's evaluator(s) will review each QAPP within 60 calendar days, and members of the Clearinghouse Committee will have the opportunity to comment on the QAPP during this time.
11. The DCR's regulatory manager or designee will review all comments and recommendations received for each QAPP and will approve or disapprove each QAPP. If the QAPP is disapproved by the DCR, the proponent must modify and resubmit the plan. Once the ~~first~~ QAPP for the first test site is approved by the DCR, the agency changes the provisional status of the **PUD** or **CUD** to an official ~~certification~~approval. Furthermore, once the DCR officially ~~certifies~~ approves the ~~BMP~~ MTD at the **PUD** or **CUD** level, the ~~DCR~~ VWRRC lists the ~~BMP~~ MTD on the Clearinghouse website within

Comment [WJ24]: Public Comment #14

~~7~~15 days.~~,~~ The DCR then allows for the ~~BMP~~ MTD to be ~~market~~installed in Virginia, consents to field performance testing at the QAPP-approved site(s), and starts the clock on the 24-month test time.

12. The proponent conducts field testing according to the procedures outlined in the approved QAPP. The proponent notifies the DCR of all locations of the ~~technology~~ MTD installed in Virginia during the testing period. **If field testing is not completed with 24 months (or other time period specified by the DCR), the proponent of the ~~BMP~~ MTD must submit to the DCR a request for an extension of the testing period, and the DCR must approve this request in order for additional testing to occur and for the ~~BMP~~ MTD ~~marketing~~ to continue to be installed in Virginia~~to occur~~.**
13. At the end of the testing period, the proponent of a stormwater ~~BMP~~ MTD submits an ~~updated~~ application for a higher use designation ~~, including a TER,~~ to DCR.
14. Submitted applications are reviewed for completeness by the DCR's evaluator(s) within 15 calendar days.
15. If the application is complete, the DCR's evaluator(s) will assess the application and recommend a use designation and a PR credit within 60 calendar days.
16. If recommended by DCR's evaluator(s), the ~~technical evaluation report (~~TER~~)~~, submitted as part of the application, will be included on the Clearinghouse website for ~~peer review and~~public comment for 30 calendar days.
17. The DCR~~'s evaluator(s)~~ will respond to the public comments within 30 calendar days~~;~~ and will provide the~~ir~~ responses~~ommendation~~ to the Clearinghouse Committee.
18. The Clearinghouse Committee will review the application, recommendations made by DCR's evaluator(s), ~~and~~ public comments, and responses to the public comments. The Clearinghouse Committee will develop a use-designation recommendation and PR credit recommendation. The Clearinghouse Committee will notify the proponent and the DCR of its~~the~~ recommendations. The Clearinghouse Committee meets quarterly and will review applications in the order they were received. Depending on the number of applications ~~and TERs~~ to be reviewed, the submitted application will be assessed at the earliest possible Clearinghouse Committee meeting.
19. Once reviewed by the Clearinghouse Committee, the DCR's director will review all recommendations and comments and make a decision within ~~14~~45 days. ~~-~~The DCR director will decide to issue a higher use~~-level~~ designation (i.e., provisional **CUD** or **GUD**), revoke the current use~~-level~~ designation, or grant an extension of the testing period for a specifi~~c~~ed time. ~~Technologies~~ MTDs approved at the **GUD** level will be listed on the Clearinghouse website by the VWRRC within 15 days. ~~Technologies~~ MTDs granted a provisional **CUD** will need to follow the steps outlined above, beginning at step 8. If the current use~~-level~~ designation is revoked, the proponent will be notified of the DCR's decision and reason for it. If the testing period is extended, the proponent will need to follow the steps above, beginning at step 12, and using the test time specified by the DCR's director.

Comment [WJ25]: Public Comment #14

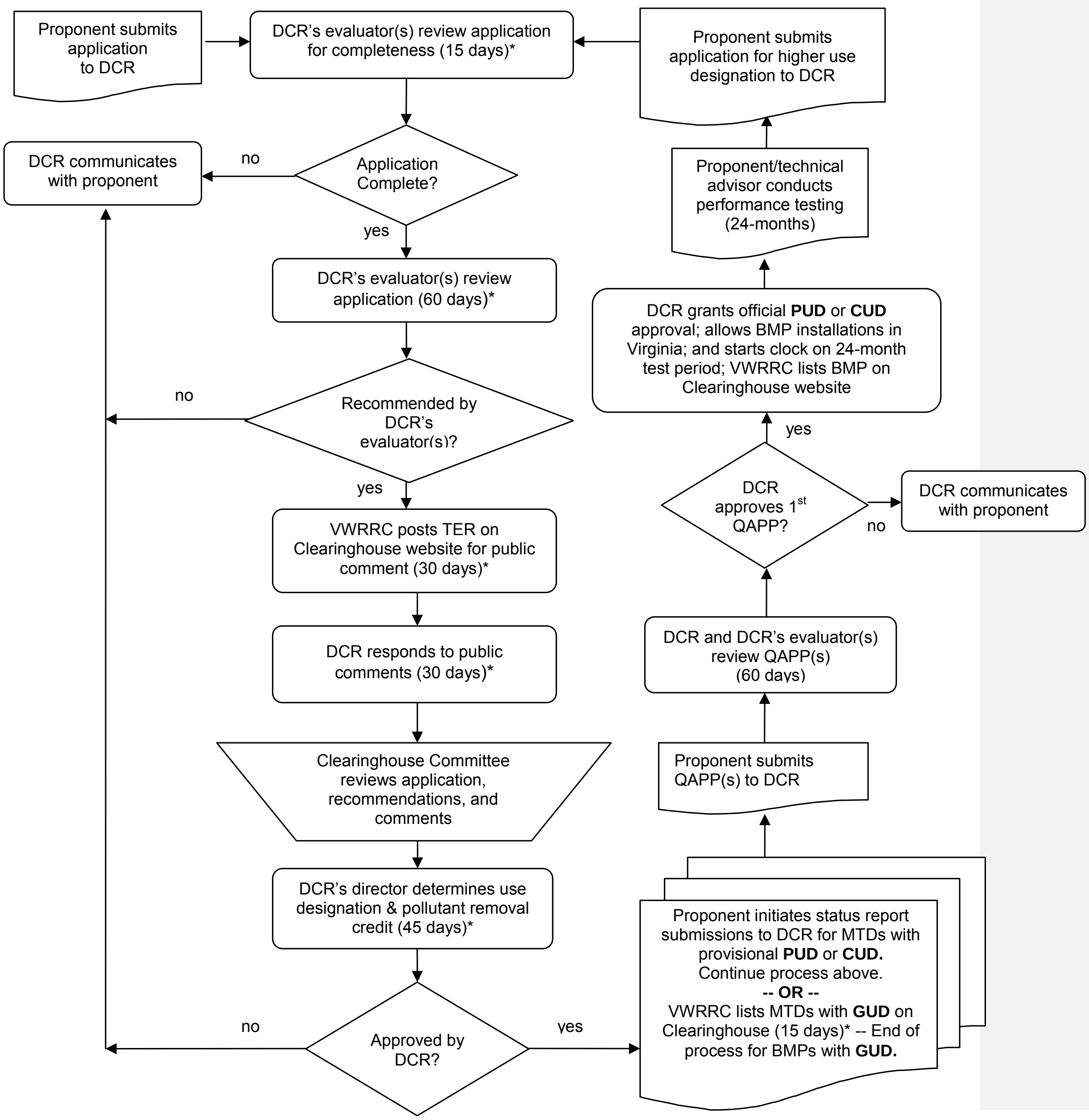


Figure 3.1. Flow chart illustrating the approval process in Virginia for stormwater manufactured treatment devices.

* Time period may be modified based on information obtained in the state procurement process for the DCR's evaluator(s) or other reasons; days = calendar days

3.2 -- Requesting a Use Designation

The first step for a proponent wishing to ~~market~~ have ~~their~~a MTD listed on the Clearinghouse website ~~post-construction, proprietary/manufactured BMP~~will be to amass the ~~product~~ technology information and validated data to determine the use designation ~~level~~ for which to apply (see **Section 2.4 – Applying for the Appropriate Use Designation**).

Proponents seeking a use ~~level~~ designation by the DCR will need to submit an application to DCR (see **Section 5 -- Application and Reporting**). Submit an electronic version of the application, as a CD or E-mail attachment, to DCR~~. An electronic copy of quality assurance project plans, interim status reports, and other correspondences should also be provided to DCR.~~

~~CD submissions should be mailed to DCR~~ at the ~~following~~ address on the application form, and follow the instructions on the application form for paying the appropriate application fee.~~:~~
~~Virginia Department of Conservation and Recreation~~
~~Division of Stormwater Management~~
~~Stormwater Management BMP Clearinghouse~~
~~900 East Main Street, Suite 800~~
~~Richmond, VA 23219-3548~~

~~E-mail submissions should be sent to DCR at the following address:~~
~~SWMESquestions@dcr.virginia.gov~~

For assistance, please contact DCR's Virginia Stormwater Management Program.
E-mail: SWMESquestions@dcr.virginia.gov

Comment [WJ26]: Public Comment #3 – Stating that fees are needed but are not yet set…

3.3 -- Approval of a Quality Assurance Project Plan

Once provisional approval is granted for a specific use ~~level~~ designation (i.e., **PUD** or **CUD**), ***a quality assurance project plan (QAPP) must be submitted to the DCR and approved by the DCR's regulatory manager or designee for each field test site. At least one DCR-approved QAPP is required for official ~~certification~~ approval at the PUD or CUD levels in Virginia. Furthermore, DCR must approve ~~at least one~~the QAPP for the first test site before the proponent is able to ~~market~~ install the ~~technology~~ MTD in Virginia.*** Once the ~~first~~ QAPP for the first test site is approved by DCR, the 24-month testing period begins.

Development of QAPPs should be a collaborative effort between the proponent of the ~~BMP~~ MTD and the proponent's technical advisor (see **Section 1.4 -- Roles and Responsibilities and Section 4.2 – QAPP and Documentation**).

The DCR will identify evaluator(s) to review and provide recommendations concerning approval of QAPPs, and members of the Clearinghouse Committee will have the opportunity to comment on QAPPs. The DCR's regulatory manager or designee will make the final decision concerning QAPP approval.

The proponent should not begin performance testing until the QAPP is approved. Even when testing sites are located outside the state of Virginia, DCR-approved QAPPs are required for those sites in order to use them to receive a use designation in Virginia ~~certification~~. If the QAPP is NOT approved by the DCR, the proponent must modify and resubmit the plan.

When a change in procedure ~~to an approved QAPP~~is warranted for an approved QAPP, the author of the plan must seek approval from the DCR to use the amended ~~the~~ QAPP ~~to document the change and submit the revised plan to the DCR for approval of the amended QAPP~~. Proponents shall submit the updated QAPP to DCR along with a cover letter that explains what changes were made and why. The DCR's regulatory manager or designee will approve or disapprove the amended QAPP. Once approved by the DCR, the revised plan should be sent to all the individuals cited in the QAPP distribution list for implementation. Changes in key personnel associated with the project do not need to be approved by the DCR but must be reported to the DCR.

3.4 – Granting and Appealing ~~a~~ Use Designations

3.4.1 -- Granting a Use Designation

The DCR's director grants a use ~~level~~ designation and PR credit based on the information submitted, recommendations from DCR's evaluator(s) and the Clearinghouse Committee, comments received from the public and responses to those comments~~peer reviewers~~, and best professional judgment. The DCR's director will bases decisions on the system performance and factors that influence the performance (e.g., sizing, maintenance).

The DCR or local governments (4 VAC 50-60-65d) may place restrictions on the use of ~~the technologies~~ MTDs granted a **PUD**, **CUD**, or **GUD** (see **Section**. **1.5 -- Protocol Limitations, Release of Liability, and Disclosure**).

For approved ~~technologies~~MTDs, the proponent shall provide design ~~standards and~~ specifications and operation/maintenance specifications for the MTD~~technology~~ that are consistent with the accepted research findings. The proponent and the DCR's evaluator(s) will work in collaboration to develop information about the approved MTD for inclusion on the Clearinghouse website.

3.4.2—Appealing a Use Designation

Any owner aggrieved by an action taken by the DCR's director without hearing may demand in writing an informal fact-finding proceeding pursuant to § 2.2-4019 of the *Code of Virginia*.

4 -- Field Monitoring and Data Evaluation

The scope of the field monitoring and evaluation program consists of the following ten elements:

1. Monitoring Site Selection
2. Quality Assurance Project Plan (QAPP) and Documentation
3. Monitoring Program Design
4. Monitoring System Design and Installation
5. Sample Collection, Analysis, and Quality Control
6. Data Verification, Validation, and Certification
7. Data Management
8. Data Quality Assessment
9. Estimating Pollutant Removal
10. Preparation of the Technical Evaluation Report (see **Section 6.4 -- Technical Evaluation Report ~~(~~[TER]~~)~~**)

The specific activities and requirements associated with each of the program elements are described in the following subsections.

4.1 -- Monitoring Site Selection

The success of the field monitoring program will depend in large part on locating a suitable test site. The DCR requires field testing in Virginia or locations with similar field conditions in order to obtain a **GUD**; the burden of demonstrating the similarity of those conditions is on the applicant (refer to Table 2.2). Test sites should incorporate characteristics that are consistent with the intended applications and geographical locations for the MTD. Sites should provide influent concentrations typical of stormwater for those land-use types using a consistent sampling methodology and homogenous land use.

Prospective test sites shall initially be evaluated based on engineering and institutional concerns. Engineering concerns would include hydraulic loading, hydraulic grade, types of pollutants, and area and depth limitations. Institutional concerns would include site access, security, and existing permit requirements. The sites should be well-established with no on-going land development and/or disturbance activities. The following factors should also be considered when choosing a test site:

- The contributing (up-gradient) catchment should not be served by a combined sewer system, or if it is, steps must be taken to account for the possibility that stormwater samples would be contaminated by sanitary sewage.

- The storm drain system should be sufficiently well understood to allow a reliable delineation and description of the catchment area (e.g., geographic extent, topography, soils, land uses).

4.2 -- QAPP and Documentation

Once provisional approval is granted for a specific use designation (**PUD** or **CUD**), a quality assurance project plan (QAPP) *must be submitted to the DCR and approved by the DCR for each field test site* (see **Section 3.1 -- Overview of Virginia Technology Assessment Protocol and Timeline** and **Section 3.3 -- Approval of a Quality Assurance Project Plan**). Development of QAPPs should be a collaborative effort between the proponent of the MTD and the proponent's technical advisor (see **Section 1.4 -- Roles and Responsibilities**). Particular care must be taken to insure that field and laboratory QAPP elements are well-integrated.

4.2.1 -- Preparation of a QAPP

The QAPP must specify the procedures to be followed to ensure the validity of the test results and conclusions. A QAPP addresses the basic elements and will define and describe the following:

- Who will use the data.
- What the project goals/objectives/questions or issues are.
- What decision(s) will be made from the information obtained.
- How, when, and where project information will be acquired or generated.
- What possible problems may arise and what actions can be taken to mitigate their impact on the project.
- What type, quantity, and quality of data are specified.
- How the data will be analyzed, assessed, and reported.

The QAPP consists of four basic element groups:

- Project management.
- Data generation and acquisition.
- Assessment and oversight.
- Data validation and usability activities.

Each element group is subsequently divided into sub-elements addressing different topics. The plan must address all applicable elements found in *EPA Requirements for QA Project Plans* (EPA QA/R-5) (U.S. EPA 2001) (http://www.epa.gov/quality/qa_docs.html). If an element is not applicable, it must be so stated in the QAPP. When addressing the project management elements in *EPA Requirements for QA Project Plans* (EPA QA/R-5) (U.S. EPA 2001), be sure to:

- Include project manager, test site owner/manager, field personnel, consultant oversight participants if applicable, and analytical laboratory that will perform the sample analyses.
- Identify the proponent's technical advisor.
- Identify ~~each study participant's~~the roles and responsibilities of each study participant.
- Provide key personnel resumes.
- Include any acquired training or certifications needed to complete the project.
- Document any certifications received from a national or state agency regulating laboratory certification or accreditation programs for each laboratory participating in the project.
- Show certification by a professional engineer (P.E.) that the structural components of MTDs are proper.
- Provide a schedule documenting when the field-monitoring equipment is expected to be installed, the expected field testing start date, projected field sampling completion, and final project report submittal.

In general, proponents shall:

- Include the following information about each test site:
  - location of the test site (street, city, state, zip);
  - site map showing catchment area, drainage system layout, and MTD and sampling equipment locations;
  - test-site catchment area, tributary land uses, (roadway, commercial, high-use site, residential, industrial, etc.) and amount of impervious cover, topography, slope, geometry/planimetrics, and all anthropogenic/biogenic activities affecting the catchment;
  - potential pollutant sources in the catchment area (e.g., parking lots, roofs, landscaped areas, sediment sources, exterior storage, or process areas);
  - particle-size distribution of sediments in runoff (entire distribution, specify D_{50});
  - baseline-stormwater-quality information to characterize conditions at the site;
  - location of flow devices and samplers in relation to the inlets and outlets of the MTD (demonstrate that flow devices and samplers are installed and positioned properly to ensure that samples are representative of influent runoff and effluent runoff [i.e., sample the influent as close as possible to the inlet of the system and sample the total treated effluent]);
  - regional climate station for test site and its average number of storms per year, average annual precipitation (in.), and monthly average precipitation (in.);
  - ~~drainage area flow rates (i.e., water quality design flow, 2-year, 10-year, and 100-year peak flow rates) at 15-minute and 1-hour time steps as provided by an approved continuous runoff model~~;identify design maximum hydraulic loading rate (i.e., peak flow rate) using the calculation in Section 11.5.2.3 of Chapter 11 of the Virginia SWM Handbook and standard of 1-inch of rainfall; other methodologies may be used with approval from the DCR;
  - make, model, and capacity of the MTD;
  - evidence of matching unit operations, and hydraulic/volumetric capacity to watershed loads;
  - analysis of rainfall-frequency distributions and their anticipated effect on the treatment unit;
  - location and description of the closest receiving water body;
  - bypass flow rates and/or flow splitter designs necessary to accommodate the MTD (specify the bypass flow set point);
  - pretreatment system set-up and operational details, if required by site conditions or MTD operation;
  - potential adverse site conditions such as climate, tidal influence, high groundwater, rainfall pattern, steep slopes, erosion, high spill potential, illicit connections to stormwater catchment areas, and industrial runoff.

- Prepare and coordinate a QAPP and ensure that it includes:
  - data quality objectives (DQOs) (Test objectives should be clear, concise, quantitative, and unambiguous, such that standardized test methods and procedures can be applied. The entire range of MTD performance capabilities should be tested in order to demonstrate the full potential of the MTD.) (See *Guidance on Systematic Planning Using the Data Quality Objective Process* [EPA QA/G4] [U.S. EPA 2006c] available at: http://www.epa.gov/quality/qa_docs.html);
  - sampling equipment and procedures ~~(location and frequency)~~;
  - method of calibrating the flow metering system;

Comment [WJ27]: Public Comment #31? The panel requests input from the Clearinghouse Committee

- description of how any grab samples will be collected and at what intervals they will be collected during the storm event;
    - description of how composite samples will be collected (Samples collected as discrete flow composites may need to be manually composited following the sampling event. If samples will be manually composited, provide a description of the compositing procedures to prevent sample cross-contamination);
    - chain-of-custody procedures;
    - sample preservation/holding times;
    - quality control (QC) sample protocol (splits and composites; field, trip, equipment blanks; spikes; duplicates); and
    - sample equipment ~~decontamination~~cleaning and maintenance procedures.
- Have field sampling overseen by the technical advisor.
- Use standardized test methods and procedures, where applicable.
- Have all analyses conducted by an independent laboratory. **Use of a laboratory accredited/certified under 1 VAC 30 Chapter 45 or 1 VAC 30 Chapter 46 is required to receive a GUD.** Some constituents and procedures may not have a certification and/or accreditation; procedures for these tests will be reviewed on a case-by-case basis by the DCR's evaluator(s) and the DCR as part of the QAPP.
- Use equipment manufacturer's recommended instrument calibration/certification procedures.

In addition, the QAPP needs to address the requirements stated in the other sections of this document (particularly **Section 4.3 -- Monitoring Program Design** and **Section 4.5 -- Sample Collection, Analysis, and Quality Control**).

Standardized test methods and procedures shall be used to collect stormwater MTD data. Several sources of test plans, test methods, procedures, and standards are available for testing stormwater technologies. Some examples are provided below:

- *EPA Requirements for QA Project Plans* (EPA QA/R-5) (U.S. EPA 2001, available at http://www.epa.gov/quality/qa_docs.html).
- *National Field Manual for Collection of Water Quality Data, Techniques of Water Resources Investigations Book 9* (USGS, variously dated, available at http://water.usgs.gov/owq/FieldManual/).
- *National Water Quality Handbook* (NRCS 2003, available at http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17843.wba).
- *NPDES Storm Water Sampling Guidance Document* (EPA 833-B-92-001) (U.S. EPA 1992, available at http://www.epa.gov/npdes/pubs/owm0093.pdf).
- *Standard Methods for the Examination of Water &* Wastewater*: Centennial Edition* (American Public Health Association [APHA], the American Water Works Association [AWWA], and the Water Environment Federation [WEF] 2005).
- ~~U.S. Environmental Protection Agency (EPA) Test Methods (analytical measurements).~~
- American Society for Testing and Materials (ASTM) Standards (Website: http://www.astm.org/).
- The National Environmental Laboratory Accreditation Conference (NELAC) Institute (TNI) (Website: http://www.nelac-institute.org/).
- *Caltrans Comprehensive Protocols Guidance Manual* (Stormwater Quality Monitoring Protocols) (California Department of Transportation 2003, available at http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-03-105.pdf).

- *Guidance Manual for Monitoring Highway Runoff Water Quality* (FHWA-EP-01-022) (Federal Highway Administration 2001, available at http://www.fhwa.dot.gov/environment/h2o_runoff/index.htm).
- *Urban Stormwater BMP Performance Monitoring* (provides general advice on selecting monitoring methods and equipment, installing and using equipment, and implementing sampling approaches and techniques; prepared under support from U.S. Environmental Protection Agency, Water Environment Research Foundation, Federal Highway Administration, Environmental and Water Resources Institute of the American Society of Civil Engineers) (Geosyntec Consultants and Wright Water Engineers, Inc. 2009, available at http://www.bmpdatabase.org/MonitoringEval.htm).

DCR may allow flow-controlled field test sites. Flow-controlled field test sites use actual stormwater but control the flow through MTDs where it is demonstrated that the monitored water quality is not being impacted in a way that biases testing. Sampling plans for flow controlled field sites will include measures to estimate flow and mass flux in both the treated and bypass flows.

A QAPP is required for each test site for MTDs intended to be approved for use in Virginia,~~;~~ whether the test site is in Virginia or not.

An electronic version, CD or E-mail attachment, of the QAPP should be mailed to the ~~following~~ address on the application form.~~:~~

~~Virginia Department of Conservation and Recreation~~
~~Division of Stormwater Management~~
~~Stormwater Management BMP Clearinghouse~~
~~900 East Main Street, Suite 800~~
~~Richmond, VA 23219-3548~~

~~E-mail: SWMESquestions@dcr.virginia.gov~~

For assistance, please contact DCR's Virginia Stormwater Management Program.
E-mail: SWMESquestions@dcr.virginia.gov

The QAPP must be kept current and thus should be reviewed at least annually to determine if any changes are necessary. Refer to **Section 3.3 -- Approval of a Quality Assurance Project Plan** for ~~what to do~~instructions for when a change to an approved QAPP is warranted.

4.2.2 -- Preparation of Monitoring Documents and Forms

Depending on test conditions, the following monitoring documents and forms shall be submitted along with the QAPP:

- **Health and Safety Plan (HASP)**. A site-specific HASP must be developed for the test site(s), including confined space entry if applicable.

- **Work Permit for Confined Space**. If applicable, the field crew must fill out a "permit" for each confined space entry with names and qualifications of the personnel involved and the procedure that was followed.

- **MTD Inspection-Maintenance Log**. Following the inspection and maintenance procedures outlined in the MTD's Operation and Maintenance Manual, the field crew must record the accumulation of sediment, oil, and trash in the MTD. The recorded data will be used to establish the maintenance frequency of the MTD.

- **Stormwater Monitoring Equipment Maintenance Log**. The field crew uses this log when performing inspection and basic maintenance of the installed monitoring equipment.

- **Sampling Event Data Sheet**. The field crew enters information into this data sheet before and after each sampling event with a variety of information including sampler pacing, sample bottle replacement, samples collected, flows, storm volumes treated and bypassed, QA/QC performed, and sample identification.

- **Chain of Custody**. This sheet tracks the sample containers and specifies how the samples will be analyzed.

4.3 -- Monitoring Program Design

The monitoring program must be designed in accordance with the procedures described in the QAPP approved by the DCR. The monitoring program should reflect the intended applications of the MTD. Samples should be collected over a range of rainfall intensities encountered during the year.

In the event that changes in procedures are warranted, the QAPP must be amended to document the changes, and the amendments submitted to the DCR and approved by the DCR prior to implementing the revised plan. For more information, see **Section 3.3 -- Approval of a Quality Assurance Project Plan.**

4.3.1 -- MTD Sizing Methodology for Test Sites

Proponents need to verify that the MTD can treat the runoff of 1-inch of rainfall. The proponent must submit ~~a proposed~~ methodology for use in selecting the size of the MTD in the test system based upon standard design criteria for the MTD, including but not limited to peak flow rate or water-quality treatment volume, drainage area, and predicted performance. The facility sizing methodology should reflect the design basis of the MTD and be sufficiently generalized for all sites. The applicant should provide specific supporting calculations provided for the specific test site(s). Preliminary water quality data analysis obtained during characterization of the test site(s) can be part of the basis used for sizing the MTD.

4.3.2 -- Monitoring and Sampling Parameters

The following subsections provide the protocol for data collection. It is largely based on sections selected from the TAPE (WSDOE 2008, 2011) and TARP (TARP 2003, NJDEP 2009) programs. Although there are different approaches for collecting performance data, the following protocol is considered by the DCR to be necessary for obtaining scientifically valid data, particularly for field demonstrations.

4.3.2.1 -- Qualifying Storm Event Parameters

Current weather forecasts are available on http://weather.gov/ and should be consulted when evaluating forecasts for qualifying storm events. The following parameters must be used to define qualifying storm events:

- More than 0.1-inch of total rainfall. ~~If data is generated from a storm with less than 0.1-inch of rainfall that produce runoff, the proponent can (1) report the storm but not analyze it, or (2) report it, provide justification for its use, and submit a request to DCR for permission to include the data in analyses.~~ If a storm with more than 0.1-inch of rainfall has measurable runoff at the inflow of the MTD but produces no discharge, report the occurrence of the storm and record that the MTD effectively treated all runoff, but the storm will not count towards the minimum number of storms required for testing (see **Section 4.3.2.4 -- Minimum Number of Events Required to be Sampled**).
- Minimum inter-event period of 6 hours~~, where cessation of flow from the system begins the inter-event period (storms occurring within six hours of each other are considered to be one storm)~~.
- Flow-weighted composite samples covering a minimum of 70% of the total storm flow, including as much of the first 20% of the storm as ~~possible~~ feasible must be taken for all constituents on which ~~removal efficiencies~~PR credits are to be computed.
- A minimum of 10 aliquots (i.e., 10 influent and 10 effluent aliquots) should be collected per storm event. Exception: for short duration storms, those less than ~~one~~1-hour in duration, 6 aliquots are the minimum. One composite sample comprised of 10 aliquots (or 6 aliquots for short duration storms) equals a water quality sample minimum. It should be noted that use of programmable automatic samplers, which is recommended, can likely result in a larger number of aliquots being taken at a finer scale through methods which are explained in **Section 4.3.2.5 -- Sampling Methodology**. This larger number of aliquots, if planned appropriately, does not increase the sampling burden of the applicant.

4.3.2.2 -- Rainfall Monitoring

Rainfall must be recorded during each storm event at a measurement sensitivity of no greater than 0.01 inch, and a maximum intensity measurement capability of no less than 4 in./hr. Each event (defined by the measurement sensitivity) must be recorded. If the onsite rainfall monitoring equipment fails during a storm event, data from the next-closest, representative rain gauging station may be used to determine whether the event meets the qualifying storm event parameters. Clearly identify any deviations to the DCR. Nearby third-party rain gauges may be used only in the event of individual rain gauge failure and only for the period of failure. If nearby rain gauges are used to fill in missing data, a regression relationship must be established with the recorded rainfall at the monitoring site, and used to compute the local (monitoring site) rainfall.

4.3.2.3 -- Flow Monitoring

To the extent feasible, ~~a~~All flow (inflow, outflow and bypass) must be accounted for and monitored. Inflow to and outflow from the test unit must be measured and recorded on a

Comment [WJ28]: Panel suggests removing this option. See DCR response to Comment #22

Comment [WJ29]: Addressing Public Comment #19

Comment [WJ30]: Addressing Public Comment #28.

continuous basis over the duration of each sampling event. ~~The QAPP must address flow balance (e.g., for flow- through systems, provide justification if the inflow and outflow differ by more than 10%).~~ The appropriate flow measurement method depends on the nature of the test site and the conveyance system. For offline systems or those with bypasses, flows must be measured at the bypass as well as at the inlet and outlet. Flow measurement procedures must be fully described in the QAPP and evidence of calibration provided. The flow data recording interval should be appropriate to provide adequate definition of the inflow and outflow hydrograph, but in no case should flow be logged at an interval greater than 5 minutes.

Comment [WJ31]: Public Comment #28:

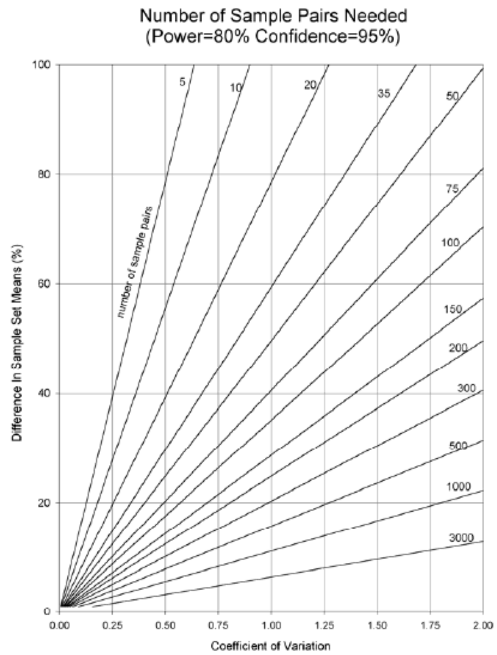
Comment [WJ32]: Gray highlighting refers to items to be included in the QAPP.

4.3.2.4 -- Minimum Number of Events Required to be Sampled

Statistical methods may be used to develop an estimate of the required sample size. There are a variety of methods for calculating sample size for various confidence levels (e.g., refer to Burton and Pitt 2002, Sample et al. 2012, Bootstrapping calculation tool at Washington Stormwater Center [http://www.wastormwatercenter.org/tape-program]) However, a critical assumption of the statistical method is that events are independent, i.e., the performance of the MTD is not impacted by previous events, nor does current performance impact later events. Because we know that behavior of the system is, in fact, related to what occurred during prior events (due to pollutant capture and buildup), understanding the behavior of the system and its response to these events becomes critical. This influence from previous storms becomes a strong argument for requiring an increased number of samples and ultimately for sampling a relatively long continuous sequence of storm events.

~~Graphical plots developed by Burton and Pitt (2002) can be used to estimate sample size. The graphical plots are based on a statistically-based process known as a power analysis. The graphical plot in Figure 4.1 may be used to estimate the sample effort needed for paired testing, (i.e.,~~ ~~for the purpose of the VTAP, comparing the influent and effluent loads of TP)testing back-to-back/sequential storm events)~~. ~~The methodology produces a minimum required number of samples necessary to meet a desired coefficient of variation on the order of magnitude of hundreds of storm events~~. ~~However, a critical assumption of the statistical method is that events are independent, i.e., the performance of the MTD is not impacted by previous events, nor does current performance impact later events. Because we know that behavior of the system is, in fact, related to what occurred during prior events (due to pollutant capture and buildup), understanding the behavior of the system and its response to these events becomes critical. This influence from previous storms becomes a strong argument for requiring an increased number of samples and ultimately for sampling a relatively long continuous sequence of storm events.~~

Comment [WJ33]: Public Comment #24 -



DELETE THIS ~~Figure 4.1. Sample Effort Needed for Paired Testing~~
~~(Power of 80% and Confidence of 95%) (source: Day, Pitt, and Parmer 1997)~~

For the purposes of MTD testing under this guidance, the minimum number of events required to be sampled is set at 18 qualifying storms with measurable inflow and outflow, provided the confidence level exceeds 50% and approval is granted by the DCR. Otherwise, 24 qualifying storms with measurable inflow and outflow is the minimum. A basis for this relationship is developed in more detail in **Appendix B -- Number of Tests**. If the testing period ~~24 events~~ does not cover the entire estimated maintenance cycle of the MTD, additional events must be sampled periodically until the maintenance cycle endpoint is established, and then at least one event immediately before and after maintenance must be monitored and reported.

Comment [WJ34]: Public Comment # 20

To best assess the performance of the MTD, proponents should establish a goal of ~~The best assessment of performance is obtained from~~ sampling a continuous sequence of qualifying events, or as close as possible to that goal. ~~At a minimum, 10 storms must be sampled in sequence, and five sets of back-to-back storms (five sets of two storms in sequence) must be sampled.~~ An assessment program designed in this manner will provide a more complete description of the behavior of the system by sampling the bulk of the mass flux through the system during each event and throughout the sampling campaign. At a minimum, five sets of back-to-back storms (five sets of two storms in sequence for a total of 10 storms) must be sampled.

Comment [WJ35]: Addressing Public Comment # 19:

At least one sampled rainfall event must be greater than 1 inch, and at least three sampled events must be greater than 0.5 inches. In addition, when feasible, a proponent should monitor a minimum of two events where peak flow rate exceeds 75% of the design capacity. ~~Also, a~~

Comment [WJ36]: Public Comment #23

Comment [WJ37]: Public Comment #33: Altered sentence (should)

~~minimum of 15 inches of precipitation is to be monitored.~~ The sampling and performance results for all sampled qualifying storms must be reported and included in all performance and maintenance interval computations.

Comment [WJ38]: Addressing Public Comment #23:

4.3.2.5 -- Sampling Methodology

Sampling protocols must be fully described in the QAPP, and the approved methods adhered to throughout the study program. This subsection provides a brief discussion of sampling methods that may be applicable to MTD performance measurements.

- **Grab samples** are discrete, individual samples taken within a short period of time (usually less than 15 minutes). Grab samples should only be used for certain constituents, in accordance with accepted standard sampling protocols, and never for the purpose of computing loads, except in cases where a sequence of grab samples is collected along the hydrograph. In such cases, if instantaneous flow data are available, loads may be computed as illustrated in the schematic of Figure 4.1~~2~~. Assuming that discrete samples were taken at each of the black dots situated along the hydrograph and subsequently analyzed (C_i), the total event load may be estimated as:

  $$\text{Total Load} = \sum_{i=1}^{9} C_i \Delta V_i$$

  $$\text{where } \Delta V_i = \text{incremental runoff volume, } L^3$$
  $$C_i = \text{constituent concentration } m/L^3$$

  The degree to which the total load estimated in the foregoing manner could be said to approach the "true" load would be increased by extracting (and analyzing) more samples at smaller (but not necessarily equal) increments of flow. Using such an approach should, in theory, eventually produce a very fine estimate of the true load of any constituent of interest if the number of samples collected was very high. There are, however, practical limits. For example, most automatic samplers have a total bottle limit of 24 to 28 samples. Using this as the upper limit of the number of samples that could be collected during an event, it may be seen that, even for constituents having modest unit analytical costs, load characterizations with the discrete sampling method could very quickly become cost-prohibitive.

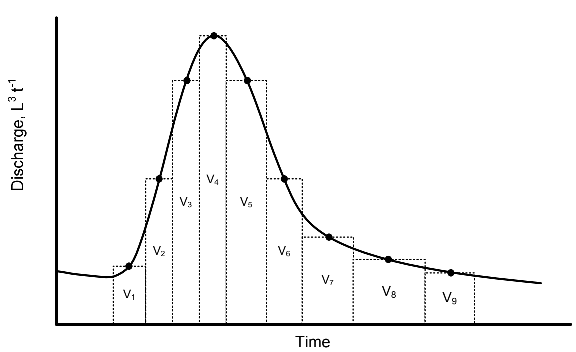


Figure 4.~~2~~1. Equal volume, variable time, flow-weighted composite (Graphic courtesy of T. Grizzard)

- **Composite samples** are more often better suited to the goals of stormwater sampling or BMP performance assessments that seek to develop a total mass load or an event mean concentration (EMC) for a constituent of interest in the runoff. In such cases, it may be more cost-effective to develop a sampling strategy around flow-weighted-composite samples of the entire runoff event. There are other strategies for constructing composite samples, but only flow-weighted composites should be considered for use. The potential for undue bias is simply too high with essentially all other methods. The flow-weighting approach is, generally, based on the premise that the volume of any sub-sample (or aliquot) in a composite is proportional to the flow increment that it represents. There are several methods for producing flow-weighted composites, but two of the most common are:
    - Variable Volume – Variable Time ($V_V t_V$)
    - Equal Volume – Variable Time ($V_E t_V$)

  Figure 4.~~2~~1 may again be used to illustrate the $V_V t_V$ compositing approach. Note that there are 9 samples and 9 volumes in Figure 4.1~~2~~. Assuming that V_1 is the smallest volume increment of the nine sub-samples taken, it may be used as the basis for calculating the aliquot volumes of the remaining eight sub-samples in the overall composite. For example, if the index aliquot for incremental volume V_1 is taken to be 100 mL, then the volume for the aliquot representing V_6 would be 100 x V_6/V_1. After all nine aliquots are placed in a single vessel with similarly computed sub-volumes, the resulting composite may be analyzed to determine the EMCs for constituents of interest. The caveats of the approach include insuring that the index volume is low enough to insure that there is enough sample for the maximum volume aliquot in the composite. In addition, great care must be taken in extracting aliquots for the composite from individual sample bottles in a quantitative manner. This is of paramount importance when substantial amounts of suspended matter are present. In fact, if the analytical protocols for suspended sediment concentration (SSC) are observed, the labor involved may make the method time- and cost-prohibitive.

  The compositing approach of choice is usually the $V_E t_V$ method illustrated in Figure 4.2~~3~~. The procedure requires the use of a somewhat more capable flow metering/sampling equipment suite, but initial costs are likely to be far outweighed by savings in staff time and analysis. As may be seen in the schematic, sub-samples of constant volume are withdrawn at equal increments of total stormwater flow volume. These sub-samples are deposited directly into the composite vessel in the field, and at the end of the event, the flow-weighted composite is complete and ready for retrieval and analysis. As may be inferred from Figure 4.2~~3~~, the total flow volume increment may be reduced to a point so that n is quite large, and the resulting composite represents the entire hydrograph at a very fine scale. An additional advantage of the method is that no post-storm effort is required in the laboratory to make up the composite. The entire composite is constructed in the field, and the measured concentrations in the vessel are representative of the EMCs for constituents of interest.

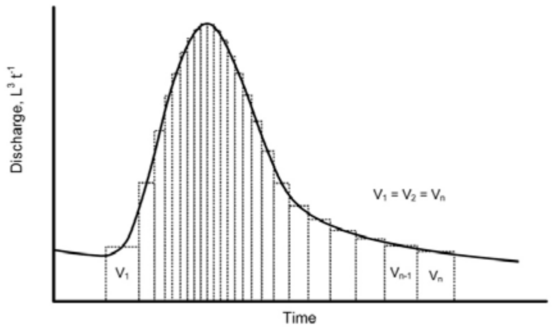


Figure 4.2~~3~~. Equal volume, variable time, flow-weighted composite (Graphic courtesy of T. Grizzard)

4.3.2.6 -- Maintenance Monitoring

When seeking a **GUD**, samples shall be collected past one maintenance cycle to verify maintenance requirements and to document how performance changes over time. To accomplish this goal, monitoring is required for the qualifying event just prior to and immediately after maintenance. If it can be shown that maintenance returns the MTD to its original condition (e.g., total replacement of treatment material), there is no need to show performance past one maintenance cycle (however, the requirement of meeting the minimum number of monitored storms must still be met [See **Section 5.3.2.4 -- Minimum Number of Events Required to be Sampled**]). ***For expected maintenance cycles greater than two years, the proponent must agree to conduct long-term periodic monitoring to show how performance varies over time and must monitor the qualifying events immediately before and after maintenance***.

4.3.3 -- Phosphorus Monitoring Overview

~~This VTAP field monitoring protocol provides guidelines for use by a proponent to obtain a **GUD**, and as applicable, to obtain either a **PUD** or **CUD**. Once granted an official **PUD** or **CUD**, MTDs will be awarded temporary efficiency ratingsPR credit, also referred to as a pollutant removal (PR) rating. Once awarded a **GUD**, the MTD will be assigned a PR rating credit that may be used in the DCR Runoff Reduction Method. For phosphorus removal, the PR credit rating will be calculated from the direct measurement of total phosphorus (TP) loads into and out of the MTD. Summed with the total phosphorus load from the bypassed annual discharge volume (untreated), the total phosphorus load reduction for the drainage area may be determined and used to assess compliance with the DCR average annual phosphorus load limit.~~

Comment [WJ39]: Edited this paragraph and moved it to section 2

A short description of the forms of phosphorus found in stormwater is provided here in order to gain an appreciation of their dynamic nature and relative treatability by different classes of BMPs. Phosphorus exists in aqueous systems in a variety of forms. For standardization of nomenclature and consistency of measurement, the following classifications are used: total phosphorus (TP), total soluble phosphorus (TSP), soluble reactive phosphorus (SRP), and particulate phosphorus (PP). TP, TSP, and SRP are directly measured in the laboratory, whereas PP is calculated by difference. The sum of all phosphorus components is termed total phosphorus (TP). TSP and PP are differentiated by whether or not they pass through a 0.45-µm membrane filter (TSP passes through the filter whereas PP does not).

Phosphorus speciation is site, watershed, land use, water chemistry, and time sensitive. Phosphorus fate will shift speciation as water chemistry (i.e., pH, alkalinity, temperature, redox potential, and concentration) naturally changes in stormwater runoff and treatment systems. These shifts in speciation may occur both during the transport and/or storage of PP within the conveyance and treatment structures, such as piping, detention/retention facilities, settling basins, and filtration/infiltration practices. Speciation shifts may result in PP re-solubilizing into TSP and becoming readily bio-available. Despite having been previously captured in the PP form, phosphorus that has transitioned to a soluble form has a high propensity to be carried downstream into a surface water body to feed algal growth.

The percentage of TP found in the TSP form may vary widely, as reflected in the National Stormwater Quality Database (Pitt 2008), which lists median TP and median TSP concentrations for a variety of land uses. Variations in phosphorus speciation may have a significant impact on BMP performance. BMPs using sedimentation and/or filtration processes can be effective for PP removal. However, unless they incorporate materials that utilize sorption or produce chemical reactions with TSP, they have limited effectiveness for TSP removal. Consequently, BMPs that target PP can potentially demonstrate TP removal at test sites where percent TSP is low, but may have poor TP removals at test sites where percent TSP is relatively high.

Additionally, some naturally-based materials and soil-based materials that have the ability to utilize sorption or produce chemical reactions with TSP may have a tendency to de-sorb or release TSP over time. Some waste materials may be successful with TSP capture but have proven to leach other toxic materials such as heavy metals or organics. ~~These potential negative performance parameters should be quantified upfront.~~

4.4 -- Monitoring System Design and Installation

The information provided in this section should be considered when designing the monitoring system for the collection of performance and maintenance data.

4.4.1 -- Monitoring System Design

The physical layout of the monitoring system may have direct impacts on MTD pollutant removal ~~efficiency~~. For example, upstream controls may have an important impact on the level of treatment observed. Likewise, if bypass and overflows are not considered, different results may be expected for overall MTD ~~efficiency~~effectiveness. Physical management of the system during the study period (e.g., adjustments to the height of an overflow/bypass weir or gate) may also impact the monitoring results. For this reason, all static and state variables of the MTD must be considered when designing the monitoring system.

When selecting flow monitoring stations, consider the following:

- For stations where flow is to be measured in open channels, the flow measurement facilities should be located where there is suitable primary hydraulic control to support the development of reliable rating curves (i.e., stage-discharge relationships). Suitable primary hydraulic controls for most MTDs will most often include a properly calibrated weir or flume. Selection of the control should be done carefully to avoid introducing bias into either water quantity or water quality measurements. If other flow measurement technologies are proposed in the study design (e.g., area-velocity meters), provision must similarly be made for adequate demonstration of precision and accuracy.

Comment [WJ40]: Reflecting Public Comment #29,

- Where possible, stations should be located in reaches of a conveyance where flows tend to be relatively stable and uniform for some distance upstream (approximately 6 channel widths or 12 pipe diameters), in order to better approach "uniform" flow conditions. Steep channel slopes, changes in pipe diameter, conduit junctions, and areas of irregular channel shape (e.g., breaks, repairs, roots, debris, etc.) should all be avoided.

- ~~Stations should be located a sufficient distance downstream from inflows to the drainage system to favor uniform flow conditions.~~

- Monitoring sites in locations that may be affected by backwater and tidal action should be avoided because such conditions may adversely impact the reliable measurement of flow.

- Stations established in pipes, culverts, or tunnels should be located to avoid surcharging (pressure flow) over the normal range of precipitation.

- Sampling stations for the MTD should be located as close as possible to the MTD inlet and outlet in order to avoid potential sources of contamination that bias the study results (and the derived MTD pollutant removal ~~efficiency~~ data).

- Influent sampling stations should be located sufficiently downstream from inflows to the drainage system to better achieve well-mixed conditions across the channel.

- Sampling chambers designed to produce completely-mixed samples are preferable to sampling from pipe inverts.

- If an automated sampler with a peristaltic pump is to be used, and the access point is a manhole, the water surface elevation should not be excessively deep (i.e., it should be less than 6 meters, or 20 feet, below the elevation of the pump in the sampler, and preferably less than 4.5 meters or 15 feet deep). This is necessary to avoid unacceptable intake velocity reductions due to increased pump suction lift.

- Sampler intake locations should consider the expected velocity profile in the type of channel being used, see Figure 4.~~4~~3 from Chow (1959). Where possible, TSS measurements should be made on multiple flow-weighted cross-sectional samples at various flows and compared to the point intake TSS value to insure that intake location is not creating bias in sample results.

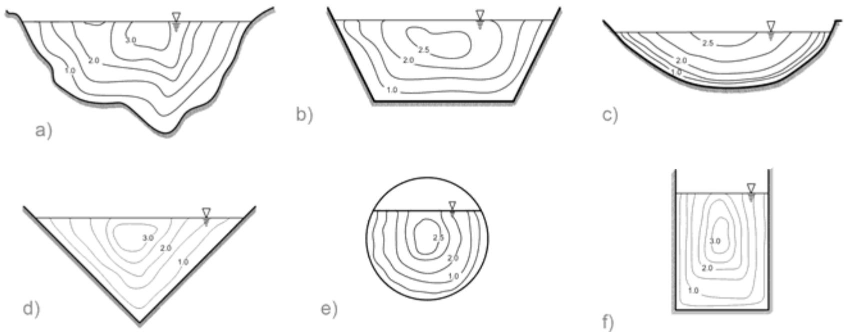


Figure 4.43. Typical velocity distributions (ft./sec.) for a) natural channel, b) trapezoidal channel, c) parabolic channel, d) triangular channel, e) pipe, f) rectangular channel. Modified from Chow (1959) (Graphic courtesy of T. Grizzard)

- In addition, evidence must be provided to insure that carry-over of compounds between samples (e.g., adherence to the sampling equipment surfaces) is not taking place.

- For systems that bypass runoff, the influent sampling station must ~~should~~ be directly upstream of the system and before the flow is split between the treatment system and the bypass. The outflow sampling location must ~~should~~ be located directly downstream of the treated flow (i.e., the MTD ~~or treatment system outlet~~) and after the effluent joins the bypass flow. If the treated effluent flow does not join the bypass, the bypass must be monitored after the split.

- ~~It should be noted that sampling points used for National Pollutant Discharge Elimination System (NPDES) permit compliance monitoring may not be appropriate for testing MTDs (e.g., in the situations where there is a contaminant source between the MTD and the outfall of a facility).~~

The following apply to all monitoring stations:

- Stations should be located where field personnel may safely access the equipment for construction, maintenance, and sample retrieval, e.g., ~~(i.e.,~~ where surface visibility is good and traffic hazards are minimal, and where monitoring personnel are unlikely to be exposed to explosive or toxic atmospheres~~)~~.

- If automated equipment is to be used, the monitoring system configuration should be such that confined space entry (for equipment installation, routine servicing, and operation) can be performed safely and in compliance with applicable regulations.

- Stations should be located where access and security are good, and vandalism of sampling equipment is unlikely.

- Stations should be located where the channel or storm drain is soundly constructed.

- Groundwater monitoring wells should be established if contamination of groundwater is suspected. Groundwater flow, direction and elevation as well as soil types should be established before monitoring stations are chosen. Monitoring stations should be located sufficiently down gradient from the MTD in order to intercept infiltrated water from the MTD.

Each candidate sampling station should be visited, preferably during or after a storm to observe the discharge. A wet-weather visit can provide valuable information regarding logistical constraints that may not be readily apparent during dry weather.

4.4.2 -- Minimum Monitoring Equipment Requirements

The following list of equipment is typically the minimum required to conduct field monitoring in conformance with field test protocol:

- **Rainfall Monitoring**: A rainfall monitoring station should be located at, or within ¼-mile of each test site. A tipping bucket rain gauge that measures rainfall volume in no greater than 0.01 inch increments and a maximum intensity measurement capability of no less than 4 in./hr. is required. The rain gauge should interface with a data acquisition system using the same electronic time base as flow measurements and sample event marks.

- **Inlet and Outlet Flow Monitoring**: Flow monitoring equipment should be located at both the MTD inlet and outlet. Use of both primary and secondary flow measurement devices are recommended whenever possible. Primary flow measurement devices include control sections such as weirs and flumes that create a known stage-discharge relationship. Secondary flow measurement devices include floats, ultrasonic transducers, pressure transducers, and bubblers that provide a means for sensing fluid level and either recording it or routing it to an external data acquisition/data logging device. Flow monitoring equipment should have the capability to measure discharge from near zero to full pipe (or cross-section) conditions. The sampling/monitoring sites should be carefully chosen to be consistent with the requirements of the primary devices selected. Generally, this means maintaining a free discharge (no backwater) through the control section. Designing and equipping a system to provide accurate flow measurements under backwater conditions adds unnecessary complexity, and often reduces reliability. Sites should be carefully evaluated for such conditions, and decisions to include them in the evaluation should only be taken after it has been demonstrated that the impacts on the quality of discharge measurements have been satisfactorily addressed.

- **Stage and Bypass Flow Monitoring**: MTDs using filter media should be equipped with sensors that provide data needed to monitor stage-discharge in the test unit. A variety of sensors (e.g., pressure and ultra-sonic) are available to measure water level (i.e., stage). The outlet flow monitor will measure discharge. Deviation from a baseline stage-discharge curve established during hydraulic testing prior to storm event monitoring should be used to assess clogging of the filter media and to determine when maintenance is needed. In addition, water level measurement inside the test unit should be used to determine when internal by-passes occur. The water level sensor should also be interfaced with a data acquisition system to record stage and discharge data under both normal and bypass conditions.

- **Inlet and Outlet Water Sampling**: Grab and composite samples may be collected either manually or by automatic sampler. However, automatic samplers controlled by a flow metering system should be used unless it is demonstrated that alternant methods are superior or that automatic sampling is infeasible. Automatic samplers should be located at the MTD inlet and outlet, and configured to be activated by the data acquisition/control system in accordance with the sampling scheme (discrete, composite) adopted for the study. Where possible, sampler intakes should be located in sampling chambers designed to provide well-mixed conditions. Otherwise sampler intakes should be mounted in a well-mixed section of the conduit close to the inlet and outlet of the test unit. The sampler intake tubing (and strainer, if any) must be selected to ensure the desired representativeness of the sample. The sampler intake tubing material must be selected to be consistent with the constituents to be analyzed. Sample aliquot collection should be initiated by signals from the data acquisition/control system.

- **In Situ Monitoring**: In situ monitoring equipment such as temperature probes and pH probes should be attached to internal surfaces where well-mixed conditions exist. The probes should also be interfaced with a data acquisition system to record relevant data.

- **Data Acquisition, Recording, and System Control**: The data acquisition system is often included in the same commercial package as the secondary device for flow measurement. Whether integrated or free-standing, the system should not only have multiple channels available to record both analog and digital data, but also have sufficient computing capacity to determine aliquot volumes for the compositing protocol being employed, and to route appropriate activation signals to automatic samplers. The data acquisition system should have a primary power source, a backup power source, and a means of being queried through an internal cellular or land-line telephone modem.

- **Weatherproof Shelter**: A weatherproof shelter or trailer should be provided to house the data acquisition system and automatic samplers, with adequate clearance for removal of samples and maintenance of equipment. The shelter should also be sized to permit maintenance activities during storm events without exposing equipment to the elements.

All monitoring equipment should be calibrated and maintained in accordance with the recommendations of the equipment providers.

4.5 -- Sample Collection, Analysis, and Quality Control

The following subsections detail the protocol for sample collection, analysis, and quality control.

4.5.1 -- Stormwater Sampling

All stormwater samples must be collected and analyzed in a manner that supports the construction of a mass-based assessment of MTD performance. Therefore, when feasible, all runoff (i.e., ~~raw~~ untreated ~~stormwater~~ runoff, treated ~~stormwater~~ runoff, bypassed flows, etc.) is to be monitored~~,~~. While the analytical work is generally undertaken at a laboratory remote from the sampling site(s), care should be taken that the sampling protocols in use at the site are consistent with the analyses contemplated.

~~4.5.1.1 -- Required Parameters for Phosphorus Monitoring of Stormwater~~

Comment [WJ41]: Public Comment #34 – "should" – not required

Comment [WJ42]: Addressing Public Comment #28

Required parameters for phosphorus monitoring of stormwater include, at a minimum:

- TP
- TSP
- SRP (if MTD uses sorption)
- TSS
- SSC
- PSD
- specific gravity.

Other parameters that influence phosphorus speciation, such as pH, alkalinity, temperature, turbidity, and redox potential should also be included in the analytical program, and may be monitored in situ or through sample collection, as appropriate.

~~To determine percent TP and TSP reduction, the samples must represent the cross-section (be a well-mixed or homogeneous sample) of the sampled water at both the inlet and outlet points of the MTD.~~

PP may be calculated by subtracting TSP from TP. The PP load in stormwater is related to the PSD. Generally, the finer fraction of suspended sediment contains the highest concentration of PP, which suggests that MTDs capable of removing the finer fraction will be more effective at reducing phosphorus load. Therefore, sampling for PSD from SSC samples at the inlet and outlet will provide important information relative to MTD effectiveness for reducing the PP load. Individual analysis of particle size ranges for PP, and the summation of PP load, can be used to corroborate the PP results taken from subtraction of TSP from TP.

Specific gravity provides additional useful information about the ability of a particular MTD to remove PP. In addition, settling velocities of solids are important and may be measured directly or calculated theoretically from specific gravity and PSD data. Settling velocities may give vital information for quantifying the amount of MTD sediment removal ~~efficiency~~ (Geosyntec Consultants and Wright Water Engineers, Inc. 2009) and, by extension, PP load reduction.

~~4.5.1.2 -- Other Parameters~~

~~When considering the analytical program, other parameters that support performance evaluation, including those listed in **Appendix C -- List of Parameters for Sampling** should be considered.~~

4.5.2 -- Accumulated Sediment Sampling

Where appropriate, the sediment accumulation rate in the MTD should be measured to help demonstrate facility performance and to design a maintenance plan. Practical measurement methods would suffice, such as measuring sump sediment depth immediately before sediment cleaning and following test completion. The following constituents shall be analyzed:

- TP
- PSD
- Percent total volatile solids
- specific gravity.

Comment [WJ43]: Public Comment #17 -- No VELAP procedure for SSC, PSD, and specific gravity at this time.

Comment [WJ44]: Public Comment #27:

Comment [WJ45]: This was stated in section 4.4.1 so deleted.

Comment [WJ46]: Public Comment #27

Use several grab samples (at least four) collected from various locations within the treatment system to create a composite sample of the sediment. This will ensure that the sample represents the total sediment volume in the treatment system. For QA/QC purposes, collect a field duplicate sample (see **Section 4.5.7 -- Field QA/QC Procedures**). Keep the sediment sample at 4°C during transport and storage prior to analysis. If possible, remove and weigh (or otherwise quantify) the sediment deposited in the system. Quantify or otherwise document gross solids (debris, litter, and other particles exceeding 4,750 microns in diameter). Use volumetric sediment measurements and analyses to help determine maintenance requirements; calculate a solids or TP mass balance; and determine if the sediment quality and quantity are typical for the application.

4.5.3 -- Sample Handling and Custody

Sample handling includes retrieval from the sampling device, packaging, shipment from the site, and storage at the laboratory. Documentation includes sample labels, custody forms, and sample-custody logs.

Sample container material, sample preservation, and holding time limits for the analyzed pollutants must be specified in the QAPP. Whether pre-cleaned sample bottles are obtained directly from the analytical laboratory, or bottles are to be obtained from another source, a detailed bottle-cleaning procedure must be included in the QAPP.

Provide preservation during sample collection, as well as during transport. Samples will be preserved in accordance with U.S. EPA-approved methods (U.S. EPA 1983) or *Standard Methods for the Examination of Water and Wastewater* (APHA, AWWA and WEF 2005). Automatic samplers will be cooled to maintain low temperatures throughout the sample collection period.

Samples must be labeled and tracked from collection through delivery to the analytical laboratory in order to insure sample integrity from time of collection to time of receipt in the laboratory. Whenever samples are removed from the flow, or retrieved from an automatic sampler, they must be placed in a cooled transportation case (e.g., a cooler) along with the chain-of-custody record form, pertinent field records, and analysis request forms, and transported to the laboratory. Temperature in the storage case should be recorded when the samples are introduced and when they are removed at the analytical laboratory. When performing composite sampling, the chain-of-custody form must include a column for entering the time and date of collection of each aliquot so that holding time limits may be determined.

Sample holding times should be assessed with respect to constituents being evaluated, and how long the “tail” of the hydrograph lasts. PSDs and PP/TSP may require holding times as short as 8-12 hours. One way around the short holding time can be collection of multiple composites.

When preparing samples for shipment to the laboratory, identify:

- Name of the analytical methodology.
- Approved method identifier.
- Sample matrix (aqueous or solid).
- Required method detection limit with appropriate units.

- Sample preservation technique(s) employed.
- Container type.
- Maximum holding time.

4.5.4 -- Analytical Methods

Proposed analytical methods must be included in the QAPP.

Laboratories accredited/certified under the Virginia Environmental Laboratory Accreditation Program (VELAP) must perform the analytical work for applicable constituents (e.g., measuring TP and TSS concentrations) in order to receive a **GUD.** VELAP accreditation/certification is not required of laboratories used by proponents seeking a **PUD** or **CUD**. Analyses that do not have a VELAP procedure do not need to be performed by a VELAP accredited/certified laboratory (see **Section 4.5.8 -- Laboratory QA/QC Procedures**).

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Comment [WJ47]: Added to meet Public Comment #6 and #17

4.5.4.1 -- Standardized Test Methods

Standardized test methods must be used to collect stormwater MTD data. Methods often used for analyses of samples from aquatic systems include:

- *Methods and Guidance for the Analysis of Water* (U.S. EPA 1999),
- *Standard Methods for the Examination of Water and Wastewater* (APHA, AWWA and WEF 2005), and
- American Society for Testing and Materials D5612-94(2008) (ASTM 2008).

Other nationally recognized organizations, such as the American Water Works Association (AWWA) and NSF International, have also published methods that may be used if more broadly applied standard methods are not available. Standardized test methods and procedures have the advantage of being prepared by technology-specific, expert subcommittees, and the methods typically incorporate a rigorous peer-reviewed data QA/QC.

4.5.4.2 – Analysis of Phosphorus

TP is largely defined on the basis of how much phosphorus in its various forms will be oxidized into orthophosphate by a strong chemical oxidant (i.e., digested). TSP is measured after filtering the sample with a 0.45-micron membrane filter and digesting the filtrate. SRP is measured on the same filtered sample, but without digestion, and represents the phosphorus directly available to participate in the color-producing reaction. While often taken as a surrogate for orthophosphate, SRP generally includes some additional material that is mobilized by the conditions of the test. The filter excludes most particulates, but some colloidal phosphorus may be present in the filtrate. The filtrate contains both organic and inorganic forms that are converted to orthophosphate by the digestion process. PP is defined as the sum of all the phosphorus retained on a 0.45-μm membrane filter during sample filtration and includes particulate and colloidal as well as inorganic and organic phosphorus. Sediment and stray leaf or plant remains that are captured on the filter are generally considered contaminants rather than normally-occurring portions of the TSP form. Different analytical tests used for digestion and analysis of phosphorus may change the amount of phosphorus reported. It is critically important that the laboratory not deviate from specified and approved analytical procedures.

4.5.4.3 – Analysis of Particle-Size Distributions

Due to the potential differences in precision among analytical procedures, the same analytical apparatus and procedures should be employed throughout each test program. PSDs shall be determined through an appropriate method or combination of methods:

- Sieve Analysis
- Coulter Counter
- Hydrometer
- Laser Diffraction

A PSD analytical procedure using laser diffraction instrumentation and sieve analysis is attached, **Appendix ~~D~~C – Particle-Size Distribution**.

4.5.5 -- Quality Control

One major function of quality control (QC) is to identify, quantify, and reduce both systematic and random error encountered in analytical processes, including variability due to sampling, storage, preparation, analysis, and data manipulations. A properly functioning QC program has the benefit of continuous feedback to the analytical system, and is a mainstay of the continuous quality improvement goal in analytical operations. More detailed information on assessing quality control is provided in the following sections: **4.5.6 -- Monitoring Equipment QA/QC Procedures**; **4.5.7 -- Field QA/QC Procedures**; and **4.5.8 -- Laboratory QA/QC Procedures.**

The QC plan should include:

- QC checks that will be followed for all project activities and the frequency each will occur.
- Control limits for each QC activity and the actions that will take place when these limits are exceeded.
- Applicable statistics that will be used to estimate sample bias and precision.
- Methodology for measurement of accuracy and precision, including the establishment of criteria based on the data quality objectives for the project.
- Methodology for use of blanks, the materials used, the frequency, the criteria for acceptable method blanks and the actions to be taken if criteria are not met.
- Procedure for determining samples to be analyzed in duplicate, the frequency and approximate number.

The QAPP shall provide a table listing all QC sample analyses being performed including the number and type of analyses for each batch of samples. QC activities must constitute no less than 10% of the samples being analyzed, with at least one of each QC procedure specified per sample batch.

4.5.6 -- Monitoring Equipment QA/QC Procedures

Quality assurance (QA) describes a process meant to prevent problems, such as the use of standardized methods, and ~~quality control (~~QC~~)~~ is a product-based approach used to detect problems that occur. QA and QC are largely interdependent and thus frequently described together.

The following subsections identify procedures that will help ensure monitoring equipment is operating as intended and ~~that~~ will help prevent cross-contamination of samples.

4.5.6.1 -- Instrument/Equipment Calibration and Frequency

- **Automated Samplers**. Automated samplers should be calibrated after installation to ensure that the correct volumes of liquid are being retrieved. The condition of the sampler pump and intake tubing, the vertical distance over which the sample must be lifted, and other factors can affect the volume drawn. Therefore, test the sampler after installation and adjust the sampler programming if necessary to be sure the system consistently draws the correct sample volume. Volume delivery takes on an added importance if the sampler is pumping against a variable suction lift.

- **Flow Metering Systems**. Primary devices (e.g., weirs, flume) are often deformed in some way during installation, and small changes in the geometry may have large impacts on the rating relationship. Upon installation, the primary device must be calibrated ~~over its entire measurement range~~ using methods such as tracer dilution studies, ~~or~~ velocity-area rating studies, or bucket rating. Such studies should be repeated periodically during the course of the field study to insure that changes have not taken place.

  Secondary devices such as bubblers, floats, or pressure transducers must similarly be calibrated and verified in the field. A stable datum for stage measurements should be established at the time the station is constructed and periodically referred to for subsequent calibrations and verifications. Most devices have well-developed procedures from the applicant, and these should be carefully followed.

- **Rain Gages**. Rain gages should be calibrated at the time of installation and periodically inspected/tested throughout the study to insure that operating characteristics have not changed. Tipping bucket rain gages should be located where they are not subject to the effects of wind eddy currents and turbulence. In general, obstructions (e.g., buildings, trees, etc.), should be no closer to the rain gage barrel than 4 times the height of the obstruction above the lip of the gage, and in no case may an obstruction be closer than twice the height of the obstruction above the lip of the gage. Rain gages must be carefully leveled, and periodically tested to insure that indicated rainfall is consistent with the depth of rain applied to the gage.

4.5.6.2 ~~--~~ Sampling Equipment ~~Decontamination~~Maintenance

Sampling equipment (sampler head and suction tubing) must be ~~decontaminated~~ cleaned and/or maintained between sampling events as necessary and specified under QA/QC procedures to prevent sample cross-contamination. Replace the suction tubing at least once during the test period and more frequently for highly contaminated runoff.

4.5.6.3 -- Inspection/Acceptance of Supplies and Consumables

The purpose of this element is to identify necessary supplies and how to make sure they are available when needed. Examples of supplies and consumables are reagent water, reference standards for calibrating instruments, and bottles of known cleanliness (such as for trace metal analysis).

Comment [WJ48]: Public Comment #30.

Comment [WJ49]: Addressing Public Comment #32

Comment [WJ50]: Public Comment #32: The “as necessary” addresses concerns about cleaning between every event

- Maintain a list of project supplies and consumables that may directly or indirectly affect the quality of the results.
- Identify individuals responsible for maintaining these supplies.
- Check products against acceptance criteria before using the product.

4.5.7 -- Field QA/QC Procedures

Field QA/QC procedures must be carefully integrated with laboratory QA/QC such that the overall program meets the project data quality objectives. When collecting samples from aquatic systems and transporting them to a remote analytical laboratory, several items normally considered as field quality control must be included:

4.5.7.1 -- Field Blanks

Field blanks are prepared after cleaning the equipment by sampling reagent-grade water with the equipment. Field blanks could include sources of contamination introduced by reagent water, sampling equipment, containers, handling, preservation, and analysis. In general, field blanks should be performed prior to sample collection. Because the field blank is an overall measure of all sources of contamination, it is used to determine if there are any blank problems. If problems are encountered with the field blank, then the other components of the sampling process should be evaluated by preparation of other blanks (e.g., method blanks, source solution blanks, bottle blanks, travel blanks, equipment blanks) in order to identify and eliminate the specific problem (see Geosyntec Consultants and Wright Water Engineers, Inc. [2009] for more information).

Field blanks will be used to verify the adequacy of the ~~decontamination~~ cleaning and/or maintenance process (i.e., to verify that the equipment is not a source of sample contamination). Collect field blanks at the inlet monitoring station where stormwater is expected to contain the highest contaminant concentrations. At a minimum, collect two separate field blanks during the initial equipment startup and testing and at least one additional blank midway through the sampling program. Collect more frequent blank samples if site conditions warrant (e.g., following an event with unusually high contaminant concentrations). Collect field blanks after decontaminating the equipment and after at least one storm event has been sampled (to “contaminate” the equipment). The field-blank sample should represent a volume of stormwater that will be collected during a typical sampling event.

Analyze field blanks as regular samples with all other appropriate quality control activities performed. The equipment-rinsate blanks should be below the accepted method detection limit for the constituent of interest. If contamination is observed above the practical quantitative limit for the constituent of interest, corrective actions must be taken (e.g., modifying ~~decontamination~~ equipment cleaning procedures, replacing suction tubing, etc.).

4.5.7.2 -- Field Duplicate Samples

A field duplicate sample is a second independent sample collected at the same location and with the same equipment. Duplicates are primarily used to assess the variation attributable to sample collection procedure and sample matrix effects. Duplicates for composite sampling may be obtained by splitting a composite sample of adequate volume into two separate samples, using an acceptable sample splitting technique. Duplicates for grab samples should be collected by filling two grab sample bottles at the same location. Field duplicate samples should be collected at a frequency of 5% or a minimum of one per event, whichever is greater. Field duplicate samples are used to provide a measure of the representativeness of the sampling and analysis procedures. Please note that splitting a previously collected composite sample does not assess sample collection procedures.

4.5.7.3 -- Field Sample Volumes

Sufficient sample volumes need to be collected to enable the required laboratory QA/QC analysis to be conducted. A table indicating what sample volumes are needed for regular sampling and for QA/QC sampling must be included in the QAPP.

4.5.7.4 -- Recordkeeping

Field logbooks must be maintained to record any relevant information noted at the collection time or during site visits. Notations about any activities or issues that could affect sample quality must be made (e.g., sample integrity, test site alterations, maintenance activities, and improperly functioning equipment). At a minimum, the field notebook must include the date and time, field staff names, weather conditions, number of samples collected, sample description and label information, field measurements, field QC sample identification, and sampling equipment condition. Records of sediment accumulation measurements are also appropriately entered into the field logbook. In particular, any conditions in the tributary basin that could affect sample quality must be noted (e.g., construction activities, reported spills, other pollutant sources). A field data form can be used in place of, or to supplement, the field logbook. If a field data form will be used, a sample form must be provided in the QAPP.

4.5.7.5 -- Chain of Custody

All sample custody and transfer procedures should be based on procedures outlined in *NPDES Storm Water Sampling Guidance Document* (EPA 833-B-92-001) (U.S. EPA 1992, available at http://www.epa.gov/npdes/pubs/owm0093.pdf). These procedures emphasize careful documentation of sample collection, labeling, and transfer, and storage procedures. Pre-formatted chain-of-custody forms should be used to document the transfer of samples to the laboratory and the analysis to be conducted on each bottle. A sample chain of custody form must be provided along with the QAPP.

4.5.8 -- Laboratory QA/QC Procedures

QA/QC procedures and standard operating procedures should be documented in the laboratory quality manual. Project requirements for laboratory QA/QC systems documented in the QAPP must include, but are not limited to, laboratory control samples, method blanks, matrix spike/matrix spike duplicates (MS/MSDs), laboratory duplicates, surrogates, and proficiency test samples or certified reference materials. Policies of corrective action, management audit, data integrity and ethics ~~are to~~should be outlined in the laboratory quality manual.

~~In general, whereas a **PUD** can be received based upon laboratory performance, laboratory studies cannot be used to obtain the **CUD** or **GUD** . Laboratory tests, however, are useful for testing aspects of MTDs under controlled conditions. In many cases, it will be necessary to document some aspects of MTD operational characteristics with laboratory data.~~

Laboratory work for submission under the MTD approval process at the **GUD** level must be performed by a VELAP accredited/certified environmental laboratory unless the particular constituent or circumstance does not have a VELAP procedure. Virginia regulations (1 VAC 30 Chapter 45 or 1 VAC 30 Chapter 46 in the Virginia Administrative Code) establish VELAP to meet Section 2.2-1105 of the *Code of Virginia*, which calls for "a program to certify environmental laboratories that perform tests, analyses, measurements or monitoring required pursuant to the Commonwealth's air, waste and water laws and regulations" (see http://www.dgs.state.va.us/DivisionofConsolidatedLaboratoryServices/Services/EnvironmentalLaboratoryCertification/tabid/1059/Default.aspx). Therefore, VELAP accreditation/certification is needed for laboratories analyzing test data to assign ~~pollution removal efficiencies~~PR credits for MTDs that could then be used to meet TMDL and other regulatory water quality requirements.

Comment [WJ51]: Addressing Public Comment #6

Additionally, 1 VAC 30-46-70 sets out the process that laboratories accredited by the National Environmental Laboratory Accreditation Program (NELAP) must use to receive accreditation/certification in Virginia. Of particular interest, "NELAP-accredited environmental laboratories shall submit an application to DGS-DCLS [Department of General Services-Division of Consolidated Laboratory Services] no later than 180 calendar days prior to initiating the provision of environmental laboratory services in Virginia." For more detailed information on laboratory QC, the applicant should consult VELAP at the Virginia Division of Consolidated Laboratory Services (http://www.dgs.virginia.gov/).

Comment [WJ52]: Addressing Public Comment #7

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4.5.9 -- Data Quality Indicators and Measurement Quality Objectives

The data quality indicators (DQIs) help define the quality and usefulness of the sample data, based on the factors that may impact the overall quality of the data. By defining the limits of the systematic and random errors that can impact data, the quality and usefulness of the data and impacts on decisions can be determined. The measurement quality objectives (MQOs) answer the question of how accurate the measurements need to be in order to get accurate data. For MTD effectiveness monitoring, individual measurement results are combined into data sets for statistical evaluation. The MQOs for accuracy, precision, bias, and required reporting limits must be presented in the QAPP. Reporting limits listed in **Appendix ~~E~~ D -- Laboratory Methods** should be met and should be provided in the QAPP. In some cases, a laboratory may need to reduce laboratory contamination sources to meet the reporting limits. Report any concentrations that are less than the detection limit as being one-half of the detection limit. If both input and output values are below the detection limit, the storm event should be noted in the report, but results should be excluded from the statistical evaluation.

Comment [WJ53]: Addressing Comment #32. Updated Appendix D with TAPE 2011 version, which lists TP reporting limit of 0.01 mg/L

Comment [WJ54]: Addressing Public Comment #25:

The following paragraphs define the DQIs and specify the methods used to evaluate them. Additional~~Further~~ detail on the use of these methods to evaluate the precision, accuracy, and completeness of data is provided in **Section 4.5.5.2 -- Field QA/QC Procedures** and **Section 4.5.5.3 -- Laboratory QA/QC Procedures**.

- **Precision** is a measure of the scatter in the data due to random error and is stated in terms of percent relative standard deviation or relative percent difference. The primary sources of random error are the sampling and analytical procedures. The total precision of results can be estimated from the results of field-duplicate samples. For laboratory analysis, precision is assessed using laboratory duplicates.

- **Bias** is a measure of the difference between the result for a parameter and the true value due to systematic errors. Bias is the difference between the mean of an infinite number of replicate results and the true value of the parameter being measured. Potential sources of bias include: (1) sample collection methods, (2) physical or chemical instability of samples, (3) interference effects, (4) inability to measure all forms of a parameter, (5) calibration of the measurement system, and (6) contamination.

  Previous studies pertaining to the sources of bias due to sampling have led to the recommended procedures currently in use. Thus, careful adherence to established procedures for collection, preservation, transportation, and storage of samples reduces or eliminates most sources of bias. Bias affecting laboratory measurement procedures are assessed by the use of matrix spike recovery, method blanks, and check samples in accordance with the laboratory QA plan. Analysis of split samples provides an estimate of overall sampling bias including variation in concentration due to sample heterogeneity. Matrix spikes are used to detect interference effects due to the sample matrix. An estimate of bias due to calibration is calculated from the difference between the check standard results and the true concentration.

- **Representativeness** is achieved by selecting sampling locations, sampler intakes, methods, and times so that the data describe the conditions that the project seeks to evaluate. The representativeness of project data is achieved by choosing the sampling sites using criteria specified in this document. Additionally, representativeness of the data is assured through definition of target storms and qualifying conditions, and through programming of the automated samplers to collect aliquots at appropriate intervals during the storm events.

- **Comparability** refers to the ability to compare the data from the project to other data sources. Data comparability is assured by selection of standardized procedures, adherence to this protocol, and by clearly stating any non-standard requirements.

- **Completeness** refers to the amount of useable data obtained during the project. Data completeness can be determined primarily by the success of flow data, rainfall data, and water quality sample collection during storm events.

4.6 -- Data Verification, Validation, and Certification

Guidance concerning the data verification and validation processes is presented in the following subsections. A detailed guidance of the data verification and validation process is available from EPA at: http://www.epa.gov/quality/qa_docs.html (*Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8) (EPA 2002a).

4.6.1 -- Data Verification and Certification

Data verification is the process after QA/QC in which the project's data records are reviewed for completeness, for actual content, and against project specifications. The goal of data verification is to ensure and document that the reported results reflect the work that was actually performed. Data verification applies to activities in the field as well as in the laboratory and is conducted during or at the culmination of data collection activities. Data verification includes checking the transference of data generated in the field via hard copies to digital datasets.

The project manager, field collectors, and/or lab personnel need to coordinate efforts to produce verified data and data verification records. These documents should be submitted to the ~~technical advisor for~~ data validator~~n~~.

Verified data have been carefully reviewed. Any changes in the data from that originally reported should be accompanied by an initialed/signed note of explanation from the field data collector, the laboratory, or the data verifier. The data verification records summarize the technical non-compliance issues or shortcomings of the data produced. Deficient data should be identified, and any corrective actions should be documented. When data are not available to perform verification, the data verification records should state that the data could not be verified. The data verification records should include checklists, handwritten notes, and data tables (electronic and/or hard copies). Definitions and supporting documentation for any laboratory qualifiers assigned should be documented. The data verification records also include a signed and dated certification statement from the verifier and project manager: "I, [verifier/project manager] acknowledge that the data associated with this project have been verified."

4.6.2 -- Data Validation and Certification

Data validation is used to determine the quality of a specific data set relative to the end use. Data validation criteria are based upon the measurement quality objectives (MQOs) developed in the QAPP. The goal of data validation is to evaluate whether the data quality goals established during the planning phase have been achieved. Data validation includes a determination, where possible, of the reasons for any failure to meet method, procedural, and an evaluation of the impact of such failure on the overall data set.

Data validation is based on the verified data and data verification records and needs to be performed by person(s) independent of the activity which is being validated. Validated data should be the same as the verified data with the addition of any data validation qualifiers that were assigned by the data validator. Any corrections or changes noted during the data validator's review of the verified data should be reflected in the validated data. Data that change as the result of validation must be re-verified.

The basic steps to validation are listed below:

1. Check that all requested analyses were performed and reported. Check that all requested QA/QC samples were analyzed and reported.
2. Check sample holding times to ensure that all samples were extracted and analyzed within the allowed sample holding times.
3. Check that the laboratory's performance objectives for accuracy and precision were achieved. This includes a check of method blanks, detection limits, laboratory duplicates, matrix spikes and matrix spike duplicates, laboratory control samples, and standard reference materials.
4. Check that field QA/QC was acceptable. This includes a check of equipment blanks, field duplicates, and chain-of-custody procedures.
5. Check that surrogate recoveries were within laboratory control limits.
6. Assign data qualifiers as needed to alert potential users of any uncertainties that should be considered during data interpretation.

If the field performance objectives were achieved, further data validation is not generally needed. Specifics of the instrument calibration, mass spectral information, and run logs are not usually recommended for review unless there is a suspected problem or the data are deemed critical. If performance objectives were not achieved (e.g., due to contaminated blanks, matrix interference, or other specific problems in laboratory performance), the resulting data should be qualified.

The data validation process should result in the following three outcomes: 1) validated data, 2) a data validation report, and 3) a certification statement. A data validation report is the primary means of communication between the data validator and the data user. The report should provide sufficient detail for the data user to have an overall idea of the quality of the data and how well the project needs were met. The report should be written in easy to read “lay language,” as much as is feasible, since it is likely to be read by decision makers that may not have the same level of technical understanding that is typically shared by the researchers and technical advisors. The report should include the following items:

- objectives for sampling and analysis;
- summary of the project record needs as assessed from the QAPP;
- field and laboratory data documentation (e.g., laboratory certification sheets, chain of custody forms);
- deficiencies encountered and the impact of deficiencies on the overall data quality;
- data validation qualifier definitions, assignments, and reasons for the assignments (also include these in the validated data set), and;
- updates and/or corrections to the verified data with explanations for the change.

The validator should sign and date a certification statement acknowledging that the data have been validated. “I, [data validator], acknowledge that the data associated with this project have been validated.” In addition, DCR and/or its evaluator(s) may ask the validator for clarifications and additional information at any time during the evaluation process.

4.7 -- Data Management

This element gives an overview for managing data generated throughout the project. Data management is an important component of field monitoring. You need to be able to store, retrieve, and transfer the diverse hard copy and electronic information generated by your monitoring program. Before beginning monitoring, establish the following data repositories:

- central file to accommodate and archive hard-copy information expected to be generated and practical dating and filing procedures to help ensure that superseded information is not confused with current information, and;
- database to accommodate digital information such as results of laboratory analyses, information recorded by data loggers (e.g., flow, precipitation, in-situ water quality measurements), maps in CAD or GIS, spreadsheets, etc.

After data from the field have been received, store the originals in the project file. Data reports should be reviewed for completeness as soon as they are received from the laboratory. Reports should be checked to ensure all requested analyses were performed and all required QA data are reported for each sample batch. If problems with reporting or laboratory performance are encountered, corrective actions (re-submittal of data sheets or sample re-analysis) should be performed prior to final data reporting or data analysis.

4.8 -- Data Quality Assessment

Data quality assessment (DQA) is the scientific and statistical evaluation of environmental data to determine if they meet the planning objectives of the project, and thus are of the right type, quality, and quantity to support their intended use. EPA's *Data Quality Assessment: A Reviewer's Guide* (EPA QA/G-9R) (U.S. EPA 2006a) is a non-technical guidance that describes broadly the statistical aspects of DQA in evaluating environmental data sets. A more detailed discussion about DQA graphical and statistical tools may be found in the companion guidance document, *Data Quality Assessment: Statistical Methods for Practitioners* (EPA QA/G-9S) (U.S. EPA 2006b). Both documents are available at http://www.epa.gov/quality/qa_docs.html. In general, DQA should follow the following steps:

- State well-defined project objectives and criteria.
- Provide the statistical hypotheses, including a null hypothesis as well as an alternative hypothesis. Alternatively, provide confidence intervals or tolerance intervals (e.g., 'We are 95% confident that at least 80% of the population is above the threshold value.').
- Describe the tolerance for uncertainty. For example, list the Type I error (false positive) and Type II error (false negative).
- Calculate basic descriptive statistics of the data and generate graphs of the data.
- Document the test statistical method used and the critical value or *p*-value.
- List the assumptions underlying the statistical method.
- Document the method used to verify each assumption together with the results from the investigations.
- Describe any corrective actions that were taken.
- Report the statistical results at the specified significance level.

An acceptable means of using direct measurements, modeling, and statistical analysis will be used to assess performance. For an in-depth discussion of appropriate statistical analysis procedures, including hypothesis driven techniques, refer to *Urban Stormwater BMP Performance Monitoring* (Geosyntec Consultants and Wright Water Engineers, Inc. [2009] for EPA and the American Society of Civil Engineers). In addition to the statistical characterization, it is desirable to advance further understanding of the physiochemical treatment processes used by the MTD, and be able to assess and predict how mass moves through the MTD during each event. Both statistical and mechanistic approaches are necessary to fully characterize performance and reliability of the MTD.

4.9 ~~--~~– Methods for Estimating Pollutant Removal ~~and Efficiency Rating Methods~~

The following three types of data are particularly valuable for determining the performance of BMPs in removing water quality pollutants: 1) event mean concentrations (EMC); 2) summation of loads (SOL); and 3) Effluent Probability.

- **Event Mean Concentrations** -- The EMC is defined as the total constituent mass divided by the total runoff volume. It is used to represent the flow-proportional average concentration of a parameter during a storm event.

- **Summation of Loads** -- The SOL is determined from concentration and flow data. Loads are particularly important for meeting Virginia's stormwater management regulations and for meeting TMDL implementation plans. Annual loads of pollutants removed by the BMP and cited in the performance claim should be calculated, however, these values are only as accurate as the percent of storm flow captured by the MTD.

- **Effluent Probability** -- The effluent probability method provides a statistical view of the influent and effluent water quality. With this method, the data analyzer determines if the influent and effluent mean EMCs or loads are statistically different from one another and develops either a cumulative distribution function of influent and effluent quality or a standard parallel probability plot. For example, the ranked phosphorus EMC (log scale) can be plotted as a function of the probability. Improvements in water quality will be apparent from the differences in the input and output data. The ability of the MTD to meet a desired performance goal can be determined from this plot, as shown in Figure 4.4~~5~~, which is an example for suspended sediment reported by Geosyntec Consultants and Wright Water Engineers, Inc. (2009).

  The cumulative pollutant mass in and out should be calculated using all qualifying events and measuring all runoff, including the ~~raw~~ untreated ~~stormwater~~ runoff, treated runoff, and bypassed flows. The mass is calculated as the product of the EMC and the total volume for each event. The annual mass in and out is found by taking the measured cumulative mass values and multiplying them by the ratio of the expected annual rainfall depth, divided by the cumulative rainfall depth from the qualifying events.

Comment [WJ55]: Addressing Public Comment #28

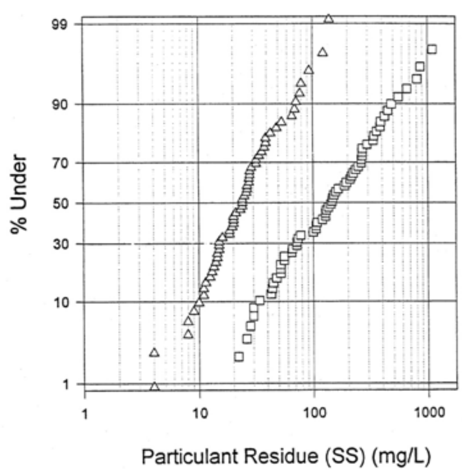

Figure 4.~~5~~4. Illustration of effluent probability method for assessing ~~efficiency~~ pollutant removal of stormwater manufactured treatment devices

Example Pollutant Removal ~~Efficiency~~ Calculation

The following equation is used to calculate load reduction ~~efficiencies~~ for TP:

% Total Phosphorus (TP) Load Reduction = 100 x (1-[C/D]) where:

C = Sum of Outlet TP Load = (Outlet TP EMC_1)(Flow $Volume_1$) + (Outlet TP EMC_2)(Flow $Volume_2$) + (Outlet TP EMC_n)(Flow $Volume_n$)

D = Sum of Inlet TP Load = (Inlet TP EMC_1)(Flow $Volume_1$) + (Inlet TP EMC_2)(Flow $Volume_2$) + (Inlet TP EMC_n)(Flow $Volume_n$)

EMC = event mean concentration (concentration of a flow-weighted composite sample)

n = number of qualified sampling events

SOL calculations are based on pollutant concentrations and flow volume. Each storm event will be characterized with respect to flow and pollutant concentrations (i.e., EMC) at the inlet and outlet of the test unit. The loads from each storm event are summed to provide an overall load reduction ~~efficiency~~ over the course of the monitoring program. Consistent with load limits for TP in the proposed Virginia stormwater regulations, and the load limits established for TMDL waters, the SOL approach calculates pollutant removal ~~efficiencies~~ based on data collected from a year, or more, of monitoring.

5 -- Application and Reporting

~~For efficient review of the application for a **PUD**, **CUD**, or **GUD**, c~~Complete all required components of the application before submitting it ~~the application~~ to the DCR. In addition to providing the information requested in this document, the DCR, the DCR's evaluator(s), and/or the Clearinghouse Committee may request additional information on a case-by-case basis.

At a minimum, an application *must* include:
- Completed Use-~~-~~Designation Application Form
- Technical Evaluation Report
- Certification Statement

Submit an electronic version, as a CD or E-mail attachment, to DCR at the address listed on the application form, and follow the instructions on the form for paying the appropriate application fee.~~:~~

~~Virginia Department of Conservation and Recreation~~
~~Division of Stormwater Management~~
~~Stormwater Management BMP Clearinghouse~~
~~900 East Main Street, Suite 800~~
~~Richmond, VA 23219-3548~~

~~E-mail: SWMESquestions@dcr.virginia.gov~~

For assistance, please contact DCR's Virginia Stormwater Management Program.
E-mail: SWMESquestions@dcr.virginia.gov

5.1 -- Use-~~-~~Designation Application Form

Complete the use-~~-~~designation application form available from the DCR. ~~in **Appendix F -- Use Designation Application Form.**~~

Develop a title for the technology assessment project and use this title in all submittals associated with the project (e.g., QAPP, Status Reports, and Technical Evaluation Report).

- Be sure to check the desired designation level for which the ~~technology~~ MTD is to be evaluated: **Pilot Use Designation**, **Conditional Use Designation**, or **General Use Designation** (see **Section 2 -- ~~BMP~~ MTD ~~Certification~~ Use Designations**).
- If either the **PUD** or the **CUD** has been ~~certified~~ approved previously by ~~Virginia~~ the DCR or approval has been granted in another state, indicate that this designation has been achieved~~,~~ and include the requested information~~date of approval~~.

5.2 -- Technical Evaluation Report (TER)

The Technical Evaluation Report (TER) is to be submitted to the DCR as part of the application for ~~technologies~~ MTDs seeking a **PUD**, **CUD**, or **GUD** ~~certification~~in Virginia. The TER is to be written ~~submitted~~ once performance testing is complete and the resulting data have been ~~verified~~ validated and analyzed.

If the MTD is recommended by the DCR's evaluator(s), the TER will be included on the Clearinghouse website for public review and comment. Thus, this component of the application should be completed with the understanding that the information will be included on the Clearinghouse website for review purposes. Proprietary information that is not to be made public should NOT be included in the TER but instead should be submitted separately to the DCR along with a completed non-disclosure form (see **Section 1.5 – Protocol Limitations, Release of Liability, and Disclosure** and **Appendix A**).
~~Modifications to the TER as outlined in this section are allowed, particularly for BMPs seeking **PUD** or **CUD** certification. Only applicable information should be submitted, but if the requested information does not apply to the BMP being assessed, it should be so stated within the TER.~~

~~Before submitting a TER for the General Use Designation, the proponent needs to be sure that:~~

~~(1) Field data were obtained that represent urban stormwater conditions expected in Virginia, and;~~

~~(2) The performance testing data meets the requirements in the approved QAPP (See **Section 5.2 -- QAPP and Documentation**).~~

~~The DCR will grant a **GUD** based on treatment performance testing and other factors.~~

5.2.1 -- TER -- Title Page

- Include: "Virginia Stormwater ~~BMP~~ MTD Technology Evaluation Report."
- List the title of the project. Give the same title as that used on the use~~-~~designation application form (**Appendix ~~F~~E**).
- Provide the month and year of report submittal.
- List the name of the manufacturer~~, if appropriate~~.
- Include the ~~name and~~ contact information, including E-mail addresses, of key contacts where questions and correspondences should be addressed.

5.2.2 -- TER -- Executive Summary

The executive summary should include the following items:

- ~~Technology~~ MTD name, function ~~(e.g., control hydrodynamics, TSS, TP, etc.)~~, and category (e.g., hydrodynamic separator, filter, etc.).
- Desired use designation ~~level~~ for which the MTD~~practice/product~~ is to be evaluated – (1) **Pilot Use Designation**, (2) **Conditional Use Designation**, or (3) **General Use Designation**.
- If either the **P~~ilot~~ U~~se~~ D~~esignation~~** or the **C~~onditional~~ U~~se~~ D~~esignation~~** has been ~~certified~~ approved previously by the DCR, the applicant shall indicate that this designation has been achieved, along with the date of approval.
- If ~~certification~~ approval ~~or verification~~ has been previously issued by another state, include the name of the granting agency, the level of ~~certification or verification~~approval,

the protocol version under which performance testing occurred (if applicable),~~-~~ date of award, and the link to the Web page where the award is listed (if applicable).

- ~~Based on field monitoring~~A brief~~, a~~ performance claim that identifies the ~~technology's~~ MTD's intended use and predicts the ~~technology's~~ MTD's capabilities to remove phosphorus ~~contaminants~~ and/or ~~control~~ reduce the quantity of stormwater runoff.
- A summary of the test results and conclusions.
- If basing the application upon testing performed in another state, indicate which, if any, stormwater conditions are not found in Virginia (see Table 2.2) ~~criteria in the VTAP have not been addressed~~ and provide an opinion of how relevant these differences ~~such omission(s)~~ may be ~~to~~for consideration of a Virginia ~~certification~~approval.
- If criteria in the VTAP have not been addressed, provide an opinion of how relevant such omission(s) may be for consideration of a Virginia approval.

5.2.3 -- TER -- Performance Claim

The performance claim will be used to evaluate the use designation. Performance claims should be objective, quantifiable, replicable, and defensible. Wherever possible, include information about anticipated performance in relation to ~~climate,~~ design, site conditions, storms and/or climate~~site conditions~~. Claims that are overstated should be avoided, as they may not be achievable and may result in rejection of the TER.

The performance claim should include the following descriptions:

- ~~List of pollutant constituents that will be used to evaluate performance.~~
- ~~Reduction of TP and other pollutants from stormwater runoff~~Removal of TP and sediment in stormwater runoff and what those reductions are based upon (e.g., reduction of the event mean concentration [EMC] through the ~~BMP's~~ MTD's treatment processes [See **Appendix ~~G~~F -- Pollutant Removal Calculation Methods~~Treatment Efficiency Calculation Methods~~**], reduction of runoff volume, a combination of both, etc.).
- The conditions under which th~~os~~e reductions were achieved; e.g., the specific influent and effluent concentrations of ~~pollutants~~ phosphorus in tests (mean/median/range), the particle-size distribution of sediments in tests (specify D_{50}), the flow volumes treated versus volumes that by-passed the ~~BMP~~MTD, etc.
- Application limitations of ~~technology~~ MTD if known to exist.
- The basis for sizing ~~of~~ the ~~technology~~ MTD (e.g., hydraulic loading at a specific head, concentration of influent, etc.).

5.2.4 -- TER -- Technology Description

~~Begin this section by listing the title of the practice and include a photograph of the BMP. Then provide a detailed description of the stormwater BMP. The description should ensure that the reader can understand completely how the technology works.~~

Design specifications for MTDs approved in Virginia at the **GUD** level will be included on the Clearinghouse website. Th~~us, th~~is section of the TER should ~~is to~~ be completed and organized so ~~in such a way~~ that the information can be directly lifted from the application for inclusion ~~and included~~ on the Clearinghouse website. ~~Thus,~~ This section of the TER ~~the application~~ should contain information that addresses as many of the elements described below ~~from the list below~~ as applicable. At a minimum, all topic headings should be addressed:

1. Description of Practice;
2. Performance Criteria;
3. Site Installation Requirements and Impacts;
4. Design and Sizing;
5. Material Specifications;
6. Construction Sequence and Inspection;
7. Operation and Maintenance;
8. System Longevity; and
9. References.

The ~~standard and~~ design specifications information for ~~non-proprietary,~~ post-construction, non-proprietary BMPs listed on the Clearinghouse website can be used as examples for the types of information to provide and the format to use in presenting the information (www.vwrrc.vt.edu/swc).

5.2.4.1 -- TER -- Description: Description of Practice

Begin the description with the name of the MTD and a photograph of it. ~~Provide a detailed description of how the stormwater BMP works and i~~Include the purpose of the ~~BMP~~MTD and cite the specific applications of the MTD. Provide detailed descriptions to ensure the reader can understand completely how the MTD works:

- Summarize the underlying scientific and engineering principles for the ~~technology~~MTD. Describe the physical, chemical, and/or biological treatment processes.
- Describe significant modifications and technical advancements in the ~~technology~~ MTD design.
- Include details on ~~the~~ relevant treatment mechanisms, such as those in Table 5.1.

Table 5.1. Measurements for various treatment mechanisms for manufactured treatment devices.

Mechanism	Measurement
Exchange Capacity / Sorption Capacity (dissolved pollutants)	Each medium or soil's anion or cation exchange capacity and target pollutant's overall removal capacity indicated by isotherms (mass/mass) and breakthrough (pollutant load per volume) analyses (capturing typical range of stormwater pollutant concentrations and hydraulic loading rates).
Sorption	Capacity -- Pollutant mass absorbed or adsorbed per mass (mass/mass). Absorbent type -- Each medium's percent organic matter or organic carbon.
Gravity Separation	Detention time, length to width ratio, hydraulic loading rate for design flow, removal efficiency versus flow rate, particle-size distribution, and specific gravity for each system type or size.

Filtration	Filter media grain size distribution, clean media hydraulic conductivity, hydraulic conductivity versus sediment loading (provide sediment grain size distribution and dry density used in analysis), provide typical and maximum operational hydraulic gradient.
Biological	Describe target pollutant's specific degradation mechanisms and estimated half-life versus temperature, provide estimated stormwater contact time (or detention time) for design flow, and provide target pollutant's estimated treatment efficiency versus flow rate.

5.2.4.2 -- TER -- Description: Performance Criteria

List the expected treatment performance capabilities. Describe the advantages of the ~~technology~~ MTD compared to conventional stormwater systems providing comparable stormwater control.

5.2.4.3 -- TER -- Description: Site Installation Requirements and Impacts

Describe the range of site installation characteristics. Address any and all site installation requirements and likely impacts resulting from the installation of the ~~technology~~MTD. As a guide, be sure to consider at least the following:

- **Siting location** – Contributing drainage area, upstream controls (non-structural and structural), available space needed, soil characteristics, hydraulic grade requirements, hydraulic capacity, minimum depth needed from ~~to~~ water table, pretreatment requirements, etc.

- **Land use** – Provide the applications that the manufacturer recommends for the ~~technology~~ MTD (e.g., land uses such as roadways, high-use sites, commercial, industrial, residential runoff areas). Give the rationale for the recommendations. List restrictions to installations within proximity of underground utilities, overhead wires, and hotspot land uses. Provide needed setbacks from buildings and vehicle loading allowances. Report any utility requirements.

- **Limitations** – Consider the physical constraints to installing the ~~BMP~~ MTD within karst terrain; steep terrain; flat terrain; tidal areas; sites with shallow groundwater tables; cold climates; types of soil; linear highway sites; and proximity to wells, septic systems and buildings, etc. Also include limitations associated with the ~~BMP's~~ MTD's weight and buoyancy, transportability, durability, energy requirements, consumable materials, etc. Describe whether the following safety considerations favor or limit the ~~technology's~~ MTD's use: facility depth limits for access and safety and hazardous materials spill risk. Describe how the limitation factors affect the ~~technology~~MTD.

- **Environmental impacts** – Describe likely impacts resulting from the construction, operation, and maintenance of the ~~technology~~MTD. Address community and environmental concerns, including safety risks and liability issues, local codes, winter operation, mosquitoes, aesthetics, etc.

5.2.4.4 -- TER -- Description: Design and Sizing

Divide this section into specific subsections that adequately describe design and sizing. The use of tables can be helpful to convey information. Table format should follow that in the ~~standard and~~ design specifications information for post-construction, non-proprietary BMPs listed on the Clearinghouse website (www.vwrrc.vt.edu/swc).

Include the following information as applicable:

- Design description and standard drawings (photographs may also be useful):
    - Schematic of the technology;
    - Diagram of the process and functions of the MTD;
    - Description of MTD's potential configurations;
    - Description of each treatment system component (engineering plans/diagrams of functional components, dimensions, description of each component's capacity, media or soil head-loss curves, etc.).
- Detailed description of the overall sizing methodology:
    - hydraulics (maximum treatment flow rate , by-pass flow, hydraulic grade line, scour velocities, etc.);
    - System sizing to meet performance standards and goals (e.g., to handle the water quality volume, rate of runoff, type of storm, or recharge requirements; include sizing chart);
    - Soil infiltration rate testing, specific media surface loading rate and specifications, etc.
- Siting and design specifications to achieve stated performance, include (but not limited to):
    - If applicable: T~~otal~~ P,SRP, PP, and sediment
    - ~~SRP, PP, if applicable~~
    - ~~Total N, Dissolved inorganic N, TKN, Nitrate, Nitrite, ammonia, if applicable~~
    - ~~Other pollutants such as metals or PAHs, if applicable~~
    - ~~Pollutants that should and could be addressed;~~
    - ~~Pollutants that will not be addressed;~~
    - Pollutants that may be increased;
    - Stormwater constituent limitations (pollutants and other constituents), including fouling factors;
    - Range of operating conditions for the MTD, including minimal, maximal, and optimal influent conditions to achieve the performance goals and standards, and for reliability of the MTD;
    - Pollutant removal at water quality design treatment flow rate at the water quality storm event (1-inch in 24 hours) and for representative stormwater characteristics;
    - Design residence time, vertical/horizontal velocities, surface overflow rate, and other parameters relevant to the process, if applicable;
    - Description of bypass process; and
    - Description of pretreatment and preconditioning of stormwater if appropriate to achieve stated performance of the MTD

5.2.4.5 -- TER -- Description: Material Specifications

When applicable, include a table that lists each construction material. For non-proprietary and patented materials, include specifications. Include raw material specifications for all non-proprietary treatment media.

5.2.4.6 -- TER -- Description: Construction Sequence and Inspection

List the steps to construction in chronological order. Begin with protection during site construction.

Describe the following:

- The role the ~~proponent~~ manufacturer/vendor takes in design and construction.
- ~~Technology~~ MTD availability (e.g., where do the major components come from and how much lead time is needed).
- Include estimate of typical installation time.
- Provisions for factors such as structural integrity, water tightness, and buoyancy.
- Types of problems that can occur/have occurred in designing and installing the ~~technology~~MTD.
- Methods for diagnosing and correcting potential problems; identify who is responsible to diagnose and correct problems.
- Impacts to the ~~technology's~~ MTD's effectiveness if problems are not corrected.

5.2.4.7 -- TER -- Description: Operation and Maintenance

Describe special operation instructions and maintenance needed to sustain performance, include:

- Date the manufacturer went into business. If applicant goes out of business or MTD model changes, describe how and where the facility owner will find needed parts, materials, and service.
- Whether the ~~technology~~ MTD can be damaged due to delayed maintenance, and if so, tell how it is restored.
- How inspections are performed and their frequency. Recommended maintenance schedule and basis for this estimated maintenance frequency. ~~Preventative maintenance procedures implemented during the course of the field test as well as long-term maintenance needs.~~
- How operations and maintenance are performed. Personnel and equipment needs to operate and maintain the ~~BMP~~MTD. Maintenance checklist. Availability of supplies, replacement materials and/or parts (e.g., filter media).
- Maintenance area accessibility by people and equipment; describe access ports, including dimensions. List special equipment or methods needed for access and identify any confined space entry areas or other safety issues.
- Generation, handling, removal, and disposal of discharges, emissions, and waste byproducts in terms of mass balance, maintenance requirements, and cost.
- Projected operational and maintenance (O&M) costs. Maintenance service contract availability. Include information about items that affect O&M costs: number of inspection/maintenance visits expected annually, equipment rental and mobilization, solids/spent media disposal, etc. ~~equipment rental, mobilization and mileage, solids/spent media disposal, etc.~~
- ~~The number of years the manufacturer has been in business. If applicant goes out of business or product model changes, describe how and where the facility owner will find needed parts, materials, and service.~~

Comment [WJ56]: Moved to 5.2.5

5.2.4.8 -- TER -- Description: System Longevity

Assuming the ~~BMP~~ MTD is designed, installed, and maintained correctly, what is the expected life of the ~~BMP~~MTD?

List factors that may cause the ~~BMP~~ MTD to not perform as designed by addressing the following questions:

- Is the ~~technology~~ MTD sensitive to heavy or fine sediment loadings, and is pretreatment required?
- Under what circumstances is the ~~technology~~ MTD likely to add, transform, or release accumulated pollutants?
- If applicable, how long will a soil-based or filter medium last if designed to capture dissolved pollutants?
- If applicable, does the filter medium decompose? Is ~~or is it~~ the filter medium subject to slime/bacteria growth?
- How is underperformance diagnosed and treated?

In addition answer the following questions:

- What is the warranty?
- What initial/ongoing user support is provided?
- Does the vendor charge for support?

5.2.4.9 -- TER -- Description: References

List any sources of published information, including ~~W~~websites, cited in the technology description section. List sources alphabetically. Follow the format style used for references included within the ~~standard and~~ design specifications information for post-construction, non-proprietary BMPs listed on the Clearinghouse website (www.vwrrc.vt.edu/swc).

5.2.5 -- TER -- Test Methods and Procedures Used

This section should include descriptions of how the assessment data were obtained. For all laboratory and field tests, the author of the TER shall provide the following information:

- Specifics of the MTD used in the assessment (model number if applicable, size).
- All procedures for obtaining data as described in the approved QAPPs, including a description of any deviations from this procedure during the assessment.
- Information on QA/QC as described in the approved QAPPs and followed during testing.
- Inspection protocols used to determine when maintenance was needed. All maintenance activities must be logged and included.
- Summary of the maintenance procedures implemented during the course of the performance testing.
- The method used to calculate performance.

For all MTDs seeking approval (at either the **PUD**, **CUD**, or **GUD** level), whether the testing occurred in the laboratory or in the field, include the requested information below when applicable:

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- Influent and effluent requirements of PSD, TSS, and SSC, including r~~. R~~epresentative PSDs and gravimetric TSS and SSC measurements to distribute the PSD % volume data for each sample of the influent and effluent.
- Representative method of sampling and sampling volume to generate a representative PSD; and suspended, settleable and sediment gravimetric fractions.

- Representative gravimetric measurement of the suspended fraction (1 to ~ 25 μm), settleable fraction (~ 25 to 75 μm) and sediment fraction (> 75 μm) for influent and effluent.
- Representative hydrologic, chemical and particulate matter loading rates.
- Representative QA/QC of the testing methods and analytical methods. For example, what does a mass balance result indicate?

For adsorptive-filtration media and soil-based treatment practices, the following information is mandatory at all approval levels (**PUD**, **CUD**, and **GUD**). When applicable, follow the instructions under **Section 1.5 – Protocol Limitations, Release of Liability, and Disclosure** for how to handle proprietary information that is to be kept confidential.

1. Granulometric media properties:
    a. Representative media size gradation, i.e., media size distribution and statistical indices;
    b. Representative media specific gravity; and
    c. Representative media specific surface area (not surface area of system, i.e., cartridge).
2. Representative mechanisms, i.e., filtration mechanisms that range from straining to physical-chemical phenomena.
3. Geometric and hydrodynamic properties of system including surface loading rates, contact time, and head-loss models. In this case, surface area is geometric surface area of the deployment system for the media, i.e., the area orthogonal to flow paths, as in Darcy's Law.
4. Chemical applications, such as coagulants and flocculants upstream of the filter, if used.
5. Backwash criteria based on hydraulics and backwash frequency, if using backwash.
6. Media stratification and inter-mixing.
7. Standardized isotherm, kinetics and breakthrough parameters.
8. Standardized desorption testing.

If field tests were performed, the author of the TER should characterize field sites by including the following information:

- General description of where the testing occurred (street, city, state, zip).
- Detailed site information including a site map. This information should include land-cover type, land-use activities, location of land-use activities, site conditions, site elevations and slopes, location of sampling equipment, location of on-site stormwater collection system, a description of any upstream BMPs, and the name of downstream receiving waters.
- Narrative that describes any special circumstances (e.g., pretreatment, bypass conditions, retention/detention facilities).
- The method used for sizing the MTD for the specific testing location.
- The time period that testing occurred for each test site., the sequence of storms, including missed events

If laboratory tests were performed for **PUD** approval, or included for supplemental information for a **CUD** or **GUD** approval, the author should include:

- Detailed test facility descriptions (photos, illustrations, process/flow diagrams).
- Treatment and hydraulic design flow.
- Loading rates on a unit basis.

- Dead storage/detention volumes.
- Media type/quantity/thickness.

If a less than full-scale setup (e.g., single cartridge testing) is tested in the laboratory and included for supplemental information, the author should describe the ratios to the full-scale device (sump capacity, flow paths, material differences, etc.).

5.2~~4~~.6 -- TER -- Test Equipment Used

List the equipment used to obtain data. If the equipment is standard monitoring equipment, giving the manufacturer's name and model number is appropriate. Show calibration results of flow metering systems.

5.~~4~~2.7 -- TER -- Data Verification and Validation

Include the certification statements certifying that the data have been verified and validated. These statements should be signed by the responsible personnel within the testing organization or as part of external data verification and validation. Also, include the data validation report, which is to be written by person(s) independent of the activity which is being validated.~~. and certification statement.~~ Refer to EPA's *Guidance on Environmental Data Verification and Data Validation* (U.S. EPA 2002a) for practical advice on implementing data verification and validation.

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5.~~4~~2.8 -- TER -- Data Summary

Provide summaries of ~~laboratory testing and~~ field testing and laboratory testing as described in the following subsections.

5.~~4~~2.8.1~~2~~ -- TER -- Data Summary: Field Testing

Report the number of storms monitored, longest continuous sequence of storms sampled, and the number of sets of back-to-back storms monitored. Using the validated data, complete the form in **Appendix G~~H~~ -- Stormwater ~~BMP~~ MTD Demonstration Site Summary** for each field test site. When reporting the PSD, include the entire distribution and specify D_{50}. The TER author should include additional data of value to understanding the performance results and/or quality control measures. ~~In the appendices of the TER i~~Include individual storm reports in the appendices of the TER (see **Section 5.2.11 – TER – Appendices**).

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Maintenance data are required and should include any summary data available about maintenance. Quantify the impact of maintenance activities or lack thereof on performance. The DCR suggests the use of a graphical representation of pollutant removal over time highlighting the times when and how maintenance was performed to verify maintenance cycles.

5.2~~4~~.8.2~~1~~ -- TER -- Data Summary: Laboratory Testing

Laboratory testing results ~~can be used to obtain a **PUD** so~~ should be included in the TER at the conclusion of performance testing. ~~Laboratory testing can only be used to supplement field testing for BMPs seeking the **GUD** or **CUD**.~~

Summarize the data obtained from laboratory testing in tables and graphs. Be sure to document data that are needed to prove the effectiveness of the practice in relation to the performance claim.

- Develop a table to summarize the characteristics of the ~~BMP~~ MTD including specifics related to sizing. Characteristics may include the model number, size, treatment capacity, storage capacity, etc.
- When a synthetic sediment product, such as Sil-Co-Sil 106, NJDEP particle-size distribution (NJDEP 2009), is used to test the performance of the ~~BMP~~MTD, include information about the particle-size distribution of the test material (entire distribution, specify D_{50}).
- Report the number of test runs.
- Summarize the specific settings of each test run, e.g., flow rate, run times, and loading rates.
- Include data to show pollutant removal ~~efficiencies~~ of ~~analytes~~ phosphorus and sediment~~included in the performance claim~~. If the ~~BMP~~ MTD performance was tested under different conditions (e.g., different flow rates, filter material, etc.), be sure to show data results for each tested condition. ~~If solids removal is part of the performance claim, d~~Determine the percent capture of the various sized particles under the performance claim conditions (e.g., flow rate).
- For ~~BMPs~~ MTDs considered for in-line (internal-bypass) use, determine the sediment effluent retention values and the various sized particles retained during higher flow conditions under the performance claim conditions (e.g., 200% the claimed flow rate).

5.~~4~~2.9 -- TER -- Data Quality Assessment

Submit statistical analyses (e.g., paired t-tests, Wilcoxon signed rank tests, sign tests, or effluent probability method) that were performed on the collected data to determine if pollutant concentrations and loadings are significantly lower in effluent samples relative to influent samples. Also submit additional analyses that may have been performed to examine how the ~~BMP~~ MTD performance varies with factors such as antecedent dry period, storm magnitude, and/or storm intensity. For flow through systems, address flow balance and provide justification for differences between the inflow and outflow.

Comment [WJ57]: Wording may need tweaking…

5.~~4~~2.10 -- TER -- Conclusions, Recommendations, and Limitations

All ~~BMPs~~ MTDs being assessed, either for a **PUD**, **CUD**, or **GUD,** must include the conclusions, recommendations, and limitations section in the TER. This section shall include the following information:

- All conclusions related to performance testing.

Expected ~~BMP~~ MTD performance for typical ~~the range of~~ land uses.~~characteristic of Virginia.~~

- concerning how best to site the ~~BMP~~ MTD relative to factors such as hydraulic grade and space constraints.
- Recommendations pertaining to the operation and maintenance (O&M) procedures of the ~~technology~~MTD.
- Frequency with which maintenance is needed.
- Special disposal requirements.
- Site limitations that would preclude the use of the ~~technology~~MTD.
- Limitations on the use or installation of the ~~technology~~MTD, including information about anticipated performance in relation to ~~climate,~~ design, site conditions, storms, and/or climate~~site conditions~~. List any pretreatment requirements.

If the sampling design is to be used again, either in a later phase of the current study or in a similar study, the proponent's technical advisor should evaluate the overall performance of the design. He or she should perform a statistical power analysis that describes the estimated power of the statistical test over the range of possible parameter values. Additional information on power curves (performance curves) is contained in EPA's *Guidance on Systematic Planning using the Data Quality Objectives Process* (EPA QA/G-4) (U.S. EPA 2006c) available at http://www.epa.gov/quality/qa_docs.html.

5.2.11 -- TER -- Appendices

Include individual storm reports. These reports compare data and provide a detailed description of each storm event monitored in an easy-to-read format. Individual storm reports should include:

- **General information** -- storm name, site location, system description, event date, date of last maintenance, antecedent conditions, unusual circumstances associated with the storm (e.g., a large storm that impacts the drainage area, etc.).
- **Hydrological information** -- total precipitation (in.); influent peak flow rate (ft.^{3}/sec.); effluent peak flow rate (ft.^{3}/sec.); bypass peak flow rate (ft.^{3}/sec.) if applicable; total influent runoff volume (ft.^{3}); total effluent runoff volume (ft.^{3}); total bypass runoff volume (ft.^{3}) if applicable. Include an event hydrograph with axes of time, flow, and precipitation: time on x-axis (date, time), flow on left-side y-axis (ft.^{3}/sec.); and precipitation on right-side y-axis (in./time). The event hydrograph should include a graph of precipitation, influent flow, effluent flow, and 75% of the design flow.
- **Pollutant information** -- number of influent aliquots, number of effluent aliquots, parameters monitored, influent mean concentrations, effluent mean concentrations, pollutant removal ~~efficiency~~ (calculated per **Appendix ~~G~~F -- Pollutant Removal Calculation Methods~~Treatment Efficiency Calculation Methods~~**), and reported detection limits.

Additional data may be provided in the TER appendices as well. Include any information requested by the evaluators in the appendices.

5.3~~5~~ -- Certification

In the use designation application, include both the signature of a company representative and date of certification. Use the following certification statement:

"I certify that all information submitted is true and correct. The information was accumulated using approved methods specified in the *Virginia Technology Assessment Protocol*, unless otherwise noted. I understand that any misrepresentation or misuse of information will result in immediate denial of the technology being demonstrated and may prohibit me or the company I represent from seeking future approvals."

5.4~~6~~ -- Status Reports

~~During the testing phase~~Once awarded an official **PUD** or official **CUD**, the proponent will need to submit quarterly status reports to DCR. Upon receiving an official **PUD** or official **CUD** and selecting a testing site, the proponent will need to develop a list of milestones and targeted dates of completion. The milestones should be developed from the DCR-approved QAPP and be based on expected achievements. Quarterly status reports are due to DCR for the preceding ~~three~~3-month period (see **Section 3.1 -- Overview of Virginia Technology Assessment Protocol and Timeline**)~~, specifically:~~

~~May 1st for the period January 1 – March 31;~~
~~August 1st for the period April 1 – June 30;~~
~~November 1st for the period July 1 – September 30; and~~
~~February 1st for the period October 1 – December 31.~~

Proponents should follow the milestone chart and highlight which achievements were expected to be met during the quarter. They should summarize the progress made during the ~~three~~3-month reporting period and report any setbacks encountered. The proponent should summarize the data obtained during the reporting period when available and describe any trends in the data.

The status reports will be used by the DCR to track progress. If undesirable trends become evident during the testing phase, the proponent~~s~~ should report ~~how they plan to~~ on the responsed~~d~~ to the assessment findings and begin identifying and implementing corrective actions if needed. If undesirable trends become evident, the DCR can call for the suspension or cancellation of the approval (see **Section 3.1 -- Overview of Virginia Technology Assessment Protocol and Timeline**). The DCR will make evaluations on a case-by-case basis.

Each status report should include:

- Title of the project
- Name of proponent submitting the report
- Date of the reporting period
- Location(s) of installments of the MTD in Virginia during the reporting period
- Location of field ~~T~~test site~~ location~~(s)
- Performance claim
- Summary of work accomplished during the reporting period
- Summary of findings, including data trends
- Summaries of contacts with representatives of the local community, public interest groups, or state/federal agencies
- Changes in key project personnel
- Projected work for the next reporting period

- Updated milestone chart

Submit an electronic version, as a CD or E-mail attachment, to DCR at the address listed on the application form. ~~:~~

~~Virginia Department of Conservation and Recreation~~
~~Division of Stormwater Management~~
~~Stormwater Management BMP Clearinghouse~~
~~900 East Main Street, Suite 800~~
~~Richmond, VA 23219-3548~~

~~E-mail: SWMESquestions@dcr.virginia.gov~~

For assistance, please contact DCR's Virginia Stormwater Management Program.
E-mail: SWMESquestions@dcr.virginia.gov

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Formatted: Justified

Appendix A – Form for Confidentiality and Non-Disclosure Agreement

This form is for informational purposes only.

To complete the official form, download it from the

Virginia Stormwater Best Management Practices Clearinghouse website:

www.vwrrc.vt.edu/swc

VTAP VERIFICATION ACCEPTANCE PROCESS

DRAFT CONFIDENTIALITY AND NON-DISCLOSURE AGREEMENT

Agreement

1. Effective ___/___/_____, the Proponent, ________________________________ ("________________") desires to disclose to the Recipient, the Virginia Department of Conservation and Recreation ("DCR" or "Recipient"), its staff or contractors associated with the VTAP process, staff or contractors of the Virginia Water Resources Research Center ("VWRRC") at Virginia Tech who are associated with the VTAP process, or members of the Virginia Stormwater BMP Clearinghouse Committee certain proprietary information which Recipient acknowledges to be of a certain confidential character, such information relating to ________________________________ developed by _______________________________ as described in DCR-VTAP File _______________________.

Definitions

a. *Proprietary Information* means any information relating directly or indirectly to a technology not generally known to the public provided to Recipient and conveyed in written, graphic, oral or physical form including, but not limited to, scientific knowledge, know-how, processes, inventions, techniques, formulae, products, business operations, customer requirements, data, plans or other records, biological materials, and/or software.

b. *Proponent* means the party disclosing the proprietary information.

c. *Recipient* means the DCR, including staff and contractors associated with the VTAP implementation process.

2. Recipient, on behalf of DCR, accepts this proprietary information for the sole purposes of evaluation and subsequent verification of the Proponent's technology or process and hereby agrees not to make use of the proprietary information except for such evaluation or verification or to disclose the same to any third party or parties without the written prior consent of Proponent. All such disclosures shall be in writing. All oral disclosures to Recipient are also covered by this Agreement and must be reduced to writing within thirty (30) days by Proponent. Recipient agrees to maintain the information in confidence to the extent permissible by law and protect it from further disclosure using the same degree of care, but no less than a reasonable degree of care, as the Recipient uses to protect its own confidential information.

3. If the period of evaluation or verification has expired, or the Recipient has notified Proponent in writing that such proprietary information is no longer required, then Recipient will promptly return to Proponent within thirty (30) days all proprietary information and copies thereof, including written documentation, drawings, photographs, models and specimens, less those specimens necessarily consumed in evaluation or verification, and may keep only those documents related to, but not containing any of, said proprietary information for the purposes of documenting the results of the evaluation or verification.

4. It is recognized that Recipient may be required to disclose such proprietary information to employees and/or contractors, staff or contractors of the VWRRC, or members of the Virginia Stormwater BMP Clearinghouse Committee for purposes of evaluation or verification. Recipient will exercise reasonable care in the selection of such individuals and will fully advise all such persons of the confidentiality of this proprietary information and shall secure the agreement of all such persons to comply with the terms and conditions of this Agreement. The number of such individuals will be limited to those who have a need to know for said evaluation or verification process.

5. Recipient shall have no obligation hereunder to refrain from disclosing or using the following information:

   a. Information which is already generally available to the public and/or known to the Recipient at the time of disclosure and/or delivery;

b. Information which is or becomes part of the public domain or publicly known or available not due to any unauthorized act or omission or other fault on the part of Recipient;

c. Information which thereafter is lawfully disclosed to the Recipient by a third party who is not obligated to retain such information in confidence; and

d. Information which has been independently developed at the Recipient by someone not privy to the confidential information, as demonstrated by competent evidence.

6. No license or other right under any United States or foreign patent, copyright or know-how is granted or implied by this Agreement.

7. The interpretation and validity of this Agreement and the rights of the parties shall be governed by the laws of the State of Virginia.

8. To the extent permitted by the Virginia Freedom of Information Act (FOIA) set forth in Virginia Code Section 2.2-3700 *et seq.*, the Recipient agrees to withhold from disclosure documents, communications, and information relating to the Proponent's application, or information that is subject to exemption from the FOIA disclosure requirements. Except as provided herein, nothing in this Agreement shall be construed to prevent any party from complying with the Virginia FOIA.

9. *Inadvertent Disclosure*. Any disclosure by a party that is inconsistent with this Agreement shall not waive the confidentiality of such documents, communications, or information.

10. *Force and Effect*. The confidentiality obligations established by this Agreement shall remain in full force and effect, without regard to whether the Proponent's application is withdrawn and/or this Agreement is terminated.

11. *Termination*. Either party may terminate its participation in this Agreement by providing written notice to the other party at least thirty (30) days prior to the termination. However, the provisions of this Agreement shall continue to apply to all documents, communications, or information exchanged during the pendency of this Agreement. The terminating party shall return all copies of privileged documents provided pursuant to this Agreement within 30 days upon request by the party who provided the information.

12. *The period* of this Agreement is from the time of submittal of information to Recipient by the Proponent until three (3) years from the termination of evaluation or verification by Recipient. All obligations of the Recipient with respect to the use and disclosure of proprietary information hereunder shall terminate at the end of this period.

13. The above constitutes the full and complete Agreement in this matter by and between the parties.

IN WITNESS WHEREOF, RECIPIENT has executed this Agreement in duplicate originals by its duly authorized officer or representative.

______________________________	______________________________
Recipient	Proponent
______________________________	______________________________
Date	Date
______________________________	______________________________
Print Name	Print Name
______________________________	______________________________
Title	Title

Appendix B -- Number of Tests

Slightly Modified From:

Assessing Performance of Manufactured Treatment Devices:
State of the Science and Review of Proposed Virginia Testing Protocols

Expert Panel Report Prepared for:

Virginia Department of Conservation and Recreation

Prepared by:

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University of Florida

Submitted:

December 13, 2010

Number of Tests

Determining the number of samples required to evaluate the performance of a stormwater treatment device is not a trivial task. Both rainfall flows/volumes and water quality will vary significantly spatially and temporally. Several statistical expressions are available in the literature for estimating sample size requirements for experimental studies. These expressions require assumptions based on an assumed level of confidence, usually upfront estimates of means and/or standard deviation, assumptions of normality, and possibly other parameters.

Many of these inputs are not available or assumptions are not met during stormwater monitoring. Flows and input phosphorus concentrations are expected to be highly variable. They will range over an order of magnitude and will not be normally distributed. To this the performance of the device is overlain. The performance of the device is expected to be variable, depending on the concentration of phosphorus, the flow rate through the facility, and possibly other variables. As a result, a simple estimate of the number of samples required to evaluate performance is not available.

An example common expression is provided by Schneider and McCuen (2006):

$$n = \left[\frac{COV(t_\alpha)}{\varepsilon} \right]^2$$

where n is the number of samples needed for a statistically valid sample population. COV is the coefficient of variation for the data set, ε is the allowable relative error, α is the degree of confidence, and t is the appropriate t-statistic for the respective α.

The NPDES Phase I stormwater database has over 3000 measured values for Total Phosphorus (Pitt 2008). The COV for total phosphorus from all land uses is 1.5. For most engineering applications, the value of α is assumed as 0.05 (5%). For a sampling program, the error should be no more that 25% (0.25). Using a simple trial-and-error process to account for the degrees of freedom gives a required sample size of 100.

$$n = \left[\frac{1.5(1.661)}{0.25} \right]^2 = 100$$

A second, related equation is given by Pitt and has been applied to the NPDES Phase I database.

$$n = \left[\frac{COV(Z_{1-\alpha} + Z_{1-\beta})}{\varepsilon} \right]^2$$

Here, Z is the Z-score and β is the power. The other parameters are as defined as above.

A value of 0.8 is common for β. For α = 0.05, $Z_{0.05}$ = 1.645; $Z_{0.8}$ = 0.85. Based on these values and the phosphorus COV and relative error discussed above, the number of samples required is:

$$n = \left[\frac{1.5(1.645 + 0.85)}{0.25}\right]^2 = 224$$

Clearly, both of these values far exceed that which can be expected for an approval process. As a result, from a practical perspective, the number of events to be monitored is set at a minimum of 24, an average of one per month over a total 2-year timeframe.

Because rainfall depth and intensity vary and the treatment is expected to vary with these rainfall parameters, the sampling program should include some larger events.

As an example, a depth-duration frequency analysis for rainfall in Virginia is presented in Table B.1. The probability of rainfall events of various depths is provided.

Table B.1. Depth-~~D~~duration ~~T~~table ~~S~~showing ~~D~~distribution of 48,513 ~~E~~events in Virginia from 8 ~~W~~weather ~~S~~stations

Event	Rainfall Depth (in.)					Sum
	0.01-0.1	0.1-0.25	0.25-0.5	0.5-1	> 1	
0-2 hr	0.2799	0.0510	0.0302	0.0135	0.0050	0.3796
2-3 hr	0.0344	0.0225	0.0147	0.0078	0.0027	0.0821
3-4 hr	0.0218	0.0180	0.0133	0.0072	0.0031	0.0634
4-7 hr	0.0377	0.0431	0.0380	0.0226	0.0087	0.1502
7-13 hr	0.0149	0.0356	0.0500	0.0468	0.0218	0.1691
13-24 hr	0.0014	0.0086	0.0236	0.0422	0.0393	0.1151
>24 hr	0.0000	0.0004	0.0023	0.0102	0.0276	0.0405
Sum	0.3901	0.1791	0.1722	0.1502	0.1083	1

Based on these distributions, the following rainfall depths can be expected from various sample population sizes (Table B.2):

Table B.2. Distribution of a~~A~~verage ~~R~~rainfall ~~E~~event ~~D~~depth by s~~S~~ample s~~S~~ize[1]

Sample Size	Rainfall Depth (in.)[2]			
	0.1<X<0.25	0.25-0.5	0.5-1	> 1
15	3.4	3.9	4.2	3.5
18	3.9	4.7	5.3	4.2
20	4.3	5.0	5.9	4.7
24	5.2	6.2	6.6	6.0
30	6.5	7.5	8.3	7.6
60	12.7	15.5	15.8	14.8

[1] Table based upon methods adapted by Schneider and McCuen 2006, and Kreeb 2003, supplemented with data from Virginia and including a Monte Carlo model of the sampling program.
[2] Events less than 0.1 inches have been removed due to sampling program requirements. Events less than 0.1 inches constituted approximately 13-15% of events for each set.

Events will vary based upon when they are measured and collected due to climatic variability. Thus, these example depths are provided as a comparative assessment of how representative the submitted sampled regime actually was.

References:

Kreeb, L.B. 2003. *Hydrologic Efficiency and Design Sensitivity of Bioretention Facilities*. Honor's Research, Univ. of Maryland, College Park, MD.

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~~Appendix C -- List of Parameters for Sampling~~

Slightly Modified From

The Technology Acceptance Reciprocity Partnership

Protocol for

Stormwater Best Management Practice
Demonstrations

Updated: July 2003

Comment [WJ58]: Remove this appendix – No longer referred to in the VTAP

Table C.1. List of parameters for sampling

Pollutant	Target Pollutant	Incidental Pollutant	Not Addressed
SOLIDS			
• Floating solids and debris			
• 0.062 mm – 0.0250 mm			
• 0.250 mm – 1.0 mm			
• Larger than 1.0 mm			
• Total Suspended Solids			
• BOD, COD, TOC, TDS			
• Hydrocarbons			
• Oil & Grease			
• TPH by IR			
• Total PAH			
• Floating oil			
METALS			
• Copper (total/dissolved)			
• Lead (total/dissolved)			
• Zinc (total/dissolved)			
• Chromium (total/dissolved)			
• Cadmium (total/dissolved)			
• Other (*e.g.*, cyanide, nickel)_____________			
NUTRIENTS			
• Total Phosphorus			
• Total Soluble Phosphorus			
• Nitrate/nitrite			
• Ammonium			
• Total Kjeldahl nitrogen			
• Total nitrogen			
BACTERIA (*E. coli*, total coliform), Enterococci			
TEMPERATURE EFFECTS			

Appendix ~~D~~C – Particle-Size Distribution

Slightly modified from

Guidance for Evaluating Emerging

Stormwater Treatment Technologies

Technology Assessment Protocol – Ecology
(TAPE)

January 2008 Revision

Publication Number 02-10-037

Washington State Department of Ecology

Particle-Size Distribution

Wet sieve protocol and mass measurement

(Recommended by the Technical Review Committee [TRC] that serves in an advisory capacity to provide recommendations to Washington State Department of Ecology)

The intent of providing this protocol is to allow more analytical flexibility for vendors while setting reasonable expectations in terms of results. The purpose of requiring particle-size distribution (PSD) analysis in the TAPE protocols is to collect consistent information on particle size that will aid in evaluating system performance. PSD measurements will provide a frame of reference for comparing variability in performance between storms and between different sites. These measurements are an important tool with which to assess performance because performance is likely to be affected by particle size. For example, it is likely that performance will drop with a substantial increase in fine soil particles. Conversely, it is anticipated that performance will be high with sandy sediments.

This protocol is intended for use with the laser diffraction particle-size distribution (PSD) analysis. Laser diffraction methods are effective for particles smaller than 250 µm. Therefore, particles greater than 250 µm must be removed with a sieve prior to PSD analysis. These large-sized particles will be analyzed separately to determine the total mass of particulates greater than 250 µm. This protocol functions as a supplement to the existing protocols provided by the manufacturers of laser diffraction instruments such that the larger-sized particles in the sample can also be measured.

The mass measurement for the larger-sized particles will also separate out particles between 499 to 250 µm in order to be consistent with the *Guidance for Evaluating Emerging Stormwater Treatment Technologies* definition of TSS (total suspended particles <500 µm).

NOTE: The Technical Review Committee (TRC) recognizes the fact that applying a mathematical constant for density would provide a rough estimate of mass. However, there is concern that the potential error associated with the results due to different soil types and structure might be large.

Wet Sieving and Mass Measurement for Laser Diffraction Analysis

Wet sieving

Sample Collection/Handling
Samples should be collected in HDPE or Teflon containers and held at 4°C during the collection process. If organic compounds are being collected, the sample containers should be glass or Teflon.

Preservation/holding time
Samples should be stored at 4°C and must be analyzed within 7 days (U.S. EPA 1998). Samples may not be frozen or dried prior to analysis, as either process may change the particle-size distribution.

Sonication
Do not sonicate samples prior to analysis to preserve particle integrity and representativeness. Laboratories using laser diffraction will have to be notified not to sonicate these samples at any time during the analysis. This request is to be written on the chain-of-custody form that the analytical laboratory receives in order to assure that sonication is omitted.

Laboratory Procedures

Equipment

__ 2 L of stormwater sample water (total sample required for analysis [ASTM 1997, D 3977])
__ Drying oven (90°C ± 2 degrees)
__ Analytical balance (0.01 mg accuracy)
__ Desiccator (large enough diameter to accommodate sieve)
__ Standard sieves – larger than 2" diameter may be desirable
__ 500 µm (Tyler 32, US Standard 35)
__ 250 µm (Tyler 60, US Standard 60)
__ Beakers – plastic (HDPE)
__ Funnel (HDPE – Large enough diameter to accommodate sieve)
__ Wash bottle
__ Pre-measured reagent-grade water

Sample processing

- Dry 250 µm and 500 µm mesh sieves in a drying oven to a constant weight at 90 ± 2°C.
- Cool the sieves to room temperature in a desiccator.
- Weigh each sieve to the nearest 0.01 mg.
- Record the initial weight of each dry sieve.
- Measure the volume of sample water and record.
- Pour the sample through a nested sieve stack (the 500 µm sieve should be on the top and the sieve stack should be stabilized in a funnel and the funnel should be resting above/inside a collection beaker).
- Use some of the pre-measured reagent-grade water in wash bottle to thoroughly rinse all soil particles from sample container so that all soil particles are rinsed through the sieve.

- Thoroughly rinse the soil particles in the sieve using a pre-measured volume of reagent-grade water.
- The particles that pass through the sieve stack will be analyzed by laser diffraction particle-size distribution (PSD) analysis using the manufacturers recommended protocols (with the exception of no sonication).
- Particles retained on the sieve (>250 µm) will not be analyzed with the laser diffraction PSD.
- Dry each sieve (500 µm and 250 µm) with the material it retained in a drying oven to a constant weight at 90 ± 2°C. The drying temperature should be less than 100°C to prevent boiling and potential loss of sample (PSEP 1986).
- Cool the samples to room temperature in a desiccator.
- Weigh the cooled sample with each sieve to the nearest 0.01 mg.
- Subtract initial dry weight of each sieve from final dry weight of the sample and sieve together.
- Record weight of particles/debris separately for each size fraction (> 500 µm and 499 – 250 µm).
- Document the dominant types of particles/debris found in this each size fraction.

Laser diffraction (PSD)

PSD results are reported in mm/L for each particle-size range. Particle-size gradations should match the Wentworth grade scale (Wentworth 1922).

Mass Measurement

Equipment

__ Glass filter – 0.45 µm (pore size) glass fiber filter disk (ASTM 1997, D 3977) (larger diameter sized filter is preferable)
__ Drying oven (90°C ±2 degrees)
__ Analytical balance (0.01 mg accuracy)
__ Wash bottle
__ Reagent-grade water

Procedure

- Dry glass filter in drying oven at 90 ± 2°C to a constant weight.
- Cool the glass filter to room temperature in a desiccator.
- Weigh the 0.45 µm glass filter to the nearest 0.01mg.
- Record the initial weight of the glass filter.
- Slowly pour the laser diffraction sample water (after analysis) through the previously weighed 0.45 µm glass filter and discard the water.
- Use reagent-grade water in wash bottle to rinse particles adhering to the analysis container onto glass filter
- Dry glass filter with particles in a drying oven at 90 ± 2°C to a constant weight.
- Cool the glass filter and dried particles to room temperature in a desiccator.
- Weigh the glass filter and particles to the nearest 0.01mg.
- Subtract the initial glass filter weight from the final glass filter and particle sample weight.
- Record the final sample weight for particles <250 µm in size.

Quality Assurance

Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the particles will accumulate ambient moisture and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically, and, if necessary, the ground glass rims should be greased or the “O” rings should be replaced.
Handle sieves with clean gloves to avoid adding oils or other products that could increase the weight. The weighing room should not have fluctuating temperatures or changing humidity. Any conditions that could affect results such as doors opening and closing should be minimized as much as possible.

After the initial weight of the sieve is measured, the sieve should be kept covered and dust free. Duplicate samples should be analyzed on 10% of the samples for both wet sieving and mass measurements.

Reporting

Visual observations should be made on all wet sieved fractions and recorded. For example if the very coarse sand fraction (2,000-1,000 µm) is composed primarily of beauty bark, or cigarette butts, or other organic debris this should be noted. An option might also be for a Professional Geologist to record the geological composition of the sediment as well.

References

ASTM. 1997. *Standard Test Methods for Determining Sediment Concentration in Water Samples*. Method D 3977. American Society for Testing and Materials, Philadelphia, PA.

Puget Sound Estuary Program (PSEP). 1986. *Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound*. Prepared by Tetra Tech, Inc. for U.S. Environmental Protection Agency and Puget Sound Water Quality Authority. Tetra Tech Inc., Bellevue, WA.

U.S. EPA. 1998. *Analysis of Total Suspended Solids by EPA Method 160.2*. Region 9, Revision 1. SOP 462. 12 pp.

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Appendix ~~E~~ D -- Laboratory Methods

Slightly modified from

Technical Guidance Manual for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol – Ecology (TAPE)

August 2011 Revision of Publication Number 02-10-037

Publication Number 11-10-061

Laboratory Methods

Table E.1. Examples of analytical procedures and reporting limits used in stormwater monitoring

Comment [WJ59]: This appendix has been updated…Replaced table from that in TAPE 2008 with the one in TAPE 2011.

Category	Parameter	Method (in Sediment)	Reporting Limit Target [a,b]
Grain-size	Percent solids *Percent volatile solids* Grain size	SM 2540G SM 2540G Ecology Method Sieve and Pipet (PSEP 1997), ASTM F312-97, ASTMD422, or PSEP 1986/2003	NA 0.1% NA
Conventional	Total phosphorus	EPA Method 200.7, SW-6020	0.01 mg/kg
Metals	Total recoverable zinc	EPA Method 200.8 (ICP/MS), EPA Method 6160, EPA Method 6020, SM 3125 (ICP/MS), or EPA Method 200.7 (ICP)	5.0 mg/kg
	Total recoverable lead	EPA Method 200.8 (ICP/MS), EPA Method 6160, EPA Method 6020, or SM 3125 (ICP/MS)	0.1 mg/kg
	Total recoverable copper	EPA Method 200.8 (ICP/MS), EPA Method 6160, EPA Method 6020, or SM 3125 (ICP/MS)	0.1 mg/kg
	Total recoverable cadmium	EPA Method 200.8 (ICP/MS), EPA Method 6160, EPA Method 6020, or SM 3125 (ICP/MS)	0.1 mg/kg
Petroleum hydrocarbons	NWTPH-Dx	Ecology 1997 (Publication No. 97-602) or EPA SW-846 method 8015B	25.0-100.0 mg/kg

[a] Reporting limits may vary with each lab. To the extent possible, reporting limits for the laboratory selected by the proponent should be the same or below those given in the table.
[b] All results below reporting limits shall also be reported and identified as such. These results may be used in the statistical evaluations.
ICP/MS – Inductively Coupled Plasma/Mass Spectrometry
NA – not applicable
NWTPH-Dx – Northwest Total Petroleum Hydrocarbons-Motor Oil and Diesel fractions
PSEP – Puget Sound Estuary Program
SM – Standard Methods
SW – Solid Waste
mg/kg – milligrams per kilogram

Appendix ~~F~~E ~~--~~– Form for Use~~-~~-Designation Application ~~Form~~

Comment [WJ60]: Propose updating this and NOT including it in in the VTAP, which is to be part of the regulation—Part of the update should explain application fees….

Questions on the form are included within this document for informational purposes only.

To complete the official form, download it from the

Virginia Stormwater Best Management Practices Clearinghouse website:

www.vwrrc.vt.edu/swc

Use~~-~~ Designation Application Form

Project Title:

MTD Name: Today's Date:

1 Basic Technology Information

Proponent of the ~~BMP~~Manufactured Treatment Device (MTD)
Company name:
Address – Street: City: State: Zip:

Proponent Contact
Name (to whom questions should be addressed):
Address – Street: City: State: Zip:
Phone number:
Fax number:
E-mail address:

~~BMP~~ Technology
~~BMP~~ MTD common (marketing) name:
Specific size/capacity of ~~BMP~~ MTD assessed:
Range of drainage areas served by ~~BMP~~MTD:
Media used (if applicable):

2 Use Designation Currently Sought (check only one)

- ☐ Pilot Use (PUD)
- ☐ Conditional Use (CUD)
- ☐ General Use (GUD)

3 Treatment for which the Technology is Designed (check all that apply)

- ☐ Stormwater Runoff Volume Reduction
- ☐ Stormwater Runoff Peak Rate Control
- ☐ Stormwater Runoff Quality Control
- ☐ Other

4 Warranty Information (describe or attach details)

5 BMP History

How long has this specific model/design been on the market?

List several locations where one or more of this exact model/size is installed in Virginia if applicable (provide ~~town and~~ county or city and permitting authority. If known, provide latitude & longitude):

List several locations where one of more of this exact model/size is installed outside Virginia if applicable. ~~if testing was performed at the site (~~provide location, and if known, provide latitude & longitude):

6 Technology Intended Application (check all that apply)

☐ Pre-treatment for downgradient BMP
☐ Water quality treatment
☐ Flood control
☐ Channel protection
☐ Other:

7 Basis for Treatment (check all that apply and fill in blanks)

☐ **Volume-based Structure** – Specify the Treatment Volume (TV): cubic feet

Specify the range of size limitations among the different units available (smallest and largest, e.g., pipe diameter):

Discharge flow rate and basis of design:
Infiltration and, if so, percentage:

Comment [WJ61]: Altered wording to be more similar to the MTD Registry questionnaire.

☐ **Flow Rate-based Structure** (provides treatment up to a set rate of flow) – Specify treatment flow rates and hydrologic methods used. Specify the flow rates that are treated and provide documentation:

☐ **Hydrodynamic Structure**
Surface loading rate (flow rate per the primary filtration area), units are reported as gpm/ft^2:
Flow rate testing basis used which particle size gradation (e.g., NJDEP, OK 110, F-95, Sil-co-sil 106)?
Provide documentation for the treated flow:
Describe the overflow or bypass mechanisms and specify design features to prevent resuspension of captured particles/pollutants:
When testing for prevention of resuspension, what flow rate and particle size gradation ~~was tested~~ (e.g., NJDEP, OK 110, F-95, Sil-co-sil 106) were tested?
Any validation or verification of testing for prevention of resuspension?

☐ **Filtering Structure**
Filtering flux rate (flow rate per the primary filtration area), units are reported as gpm/ft^2:
Flow rate testing basis used which particle size gradation (e.g., NJDEP, OK 110, F-95, Sil-co-sil 106)?
Provide documentation for the treated flow:
Describe the overflow or bypass mechanisms and specify design features to prevent resuspension of captured particles/pollutants:
When testing for prevention of resuspension, what flow rate and particle size gradation ~~was tested~~ (e.g., NJDEP, OK 110, F-95, Sil-co-sil 106) were tested?
Any validation or verification of testing for prevention of resuspension?

☐ **Other** (describe):

8 Water Quality Treatment Mechanisms (check all that apply and provide brief description. Include pollutant(s) of interest.)

☐ Sedimentation/settling:
☐ Infiltration:
☐ Filtration (specify filter media):
☐ Adsorption/cation exchange:
☐ Chelation/precipitation:
☐ Chemical treatment:
☐ Biological uptake:
☐ Other (describe):

9 Design Features of Interest (answer each of the following questions.)

Pre-treatment/removal of particles larger than 63 microns achieved via which of the following?
☐ No pre-treatment
☐ Internal settling/sedimentation chamber
☐ Upgradient (separate) settling/sedimentation device
☐ Other (describe):

By-pass/diversion of larger flows (not designed for treatment) via which of the following?
☐ No by-pass/diversion
☐ Internal by-pass verified to prevent re-suspension captured particles/pollutants during larger flows
☐ Upgradient flow splitter used to divert water quality storm to device
☐ Other (describe):

10 Independent Performance ~~Certification~~ Approval (check all that apply)

Has the ~~BMP~~ MTD been "~~certified~~ approved~~or performance verified~~" by any of the organizations below?

☐ **No** (skip to next question)

☐ **Yes**; Continue below. For each approval~~, verification, or certification granted~~, indicate (1) the granting agency, (2) the protocol version under which performance testing occurred (if applicable), (3) the date of award, and (4) the link to the Web page where the award is listed, or attach award letter.

- ☐ **State Agency** (list):
  - Indicate the status of the ~~BMP~~MTD.
  - ☐ Approved (list state, protocol version, date approved, and award Web link/letter:)
  - ☐ Performance certified (list state, protocol version, date certified, and award Web link/letter:)
  - ☐ Status pending
  - ☐ Other (explain):
- ☐ **TARP** (list states[s]):
  - ☐ Lab tested (list state, protocol version, date awarded, and award Web link/letter:)
    - Particle size tested:
    - ☐ OK-110 PSD (50 to 250 microns) sands only
    - ☐ NJDEP PSD, (1 to 1,000 microns) silts and sands
    - ☐ Other PSD or test methodology (explain and provide details):
    - ☐ Approved for in-line use (scour prevention)
    - ☐ Approved for off-line use only
  - ☐ Field tested (list state, protocol version, date awarded, and award Web link/letter:)
  - ☐ Performance verified via NJCAT, etc. (list verifier, protocol version, date verified, and verification Web link/letter:)
  - ☐ Other (explain):
- ☐ **TAPE** (WA State only)
  - ☐ PULD - Pilot Use Level Designation (performance, i.e., basic, dissolved metals, phosphorus, oil, or pretreatment; protocol version; date awarded; and award Web link/letter:)
  - ☐ CULD - Conditional Use Level Designation (performance, i.e., basic, dissolved metals, phosphorus, oil, or pretreatment; protocol version; date awarded; and award Web link/letter:)
  - ☐ GULD - General Use Level Designation (performance, i.e., basic, dissolved metals, phosphorus, oil, or pretreatment; protocol version; date awarded; and award Web link/letter:)
  - ☐ Status pending
  - ☐ Other (explain):
- ☐ **Other** (provide documentation of testing protocol, status of ~~BMP~~ MTD and results of testing):

Comment [WJ62]: Addressing Public Comment # 9

11 Vendor-initiated Performance Testing (check all that apply):

Has the ~~BMP~~ MTD been tested and its performance reported?

☐ **Laboratory Tested**

- ☐ Manufacturer (directly tested)
- ☐ Contractor retained by manufacturer (Contact name and organization:)
- ☐ Tested by third party (e.g., not associated or tied financially to manufacturer) (Contact name and organization:)

☐ **Field Tested**

- ☐ Manufacturer (directly tested)
- ☐ Contractor retained by manufacturer (Contact name and organization:)
- ☐ Tested by third party (e.g., not associated or tied financially to manufacturer) (Contact name and organization:)

12 Results of Vendor-initiated Performance Testing

Has the ~~BMP~~ MTD been tested for pollutants of concern? (Check all that apply) **Note: Water-~~-~~quality approval~~certification~~ in Virginia is awarded only for TP removal at this time.**

☐ **Phosphorus**; please specify if lab or field results and then summarize the results:
Removal rates for phosphorus based upon measured:
- ☐ Total Phosphorus (TP)
  - ☐ Particulate Phosphorus (PP)
  - ☐ Total Soluble Phosphorus (TSP)
    - ☐ Soluble Reactive Phosphorus (SRP)
    - ☐ Soluble Unreactive Phosphorus (SUP)
  - ☐ Check here if reported % removal, load reduction, and/or effluent concentrations are provided over a range of influent concentrations, and list the range of influent concentrations:

Note: The information about the following pollutants will not be used to determine water-quality approval~~certification~~ in Virginia. Water-~~-~~quality approval~~certification~~ in Virginia is awarded only for TP removal at this time.

☐ **Sediment**; please specify if lab or field results and then summarize the results:
Removal rates for sediment based upon:
- ☐ Total Suspended Solids (TSS)
- ☐ Suspended Sediment Concentration (SSC)
  - ☐ Check here if reported % removal, load reduction, and/or effluent concentrations are provided over a range of influent concentrations, and list the range of influent concentrations:

☐ **Nitrogen**; please specify if lab or field results and then summarize the results:
Specify what form(s) of nitrogen the removal rates are based upon (e.g., Total Nitrogen [TN], Total Kjeldahl nitrogen [TKN], Total Ammonia-N, Nitrate-N, Nitrite-N, etc.):
- ☐ Check here if reported % removal, load reduction, and/or effluent concentrations are provided over a range of influent concentrations, and list the range of influent concentrations:

☐ **Oil/Grease**; please specify if lab or field results and then summarize the results:
- ☐ Check here if reported % removal, load reduction, and/or effluent concentrations are provided over a range of influent concentrations, and list the range of influent concentrations:

☐ **Heavy metals**; please specify if lab or field results and then summarize the results:
- ☐ Check here if reported % removal, load reduction, and/or effluent concentrations are provided over a range of influent concentrations, and list the range of influent concentrations:

☐ **Bacteria**; please specify if lab or field results and then summarize the results:
- ☐ Check here if reported % removal, load reduction, and/or effluent concentrations are provided over a range of influent concentrations, and list the range of influent concentrations:

☐ **Organic toxicants**; please specify if lab or field results and then summarize the results:
- ☐ Check here if reported % removal, load reduction, and/or effluent concentrations are provided over a range of influent concentrations, and list the range of influent concentrations:

☐ **Other**; please specify if lab or field results and then summarize the results:
- ☐ Check here if reported % removal, load reduction, and/or effluent concentrations are provided over a range of influent concentrations, and list the range of influent concentrations:

Comment [WJ63]: May need to alter this statement if allow for TSS/SSC pretreatment. **(Scott Crafton response) Prefer to address separate category of Pre-Treatment devices through separate guidance, not here. However, there may need to be a qualifying statement here that lays the groundwork for that other guidance and certification process.**

Comment [WJ64]: I propose deleting this question. The information will be in the TER for parameters being certified.

Comment [WJ65]: May need to alter this statement if allow for TSS/SSC pretreatment. **(Scott Crafton response) Prefer to address separate category of Pre-Treatment devices through separate guidance, not here. However, there may need to be a qualifying statement here that lays the groundwork for that other guidance and certification process.**

13 Particle-Size Distribution (PSD)

If laboratory test results are included and TSS/SSC results are reported, was Sil-Co-Sil 106 used in the test runs?
☐ Yes
☐ No -- If no, explain what was used instead:

If laboratory test results are included and TSS/SSC results are reported, was the NJDEP PSD (1 to 1,000 micron PSD) used in the test runs?
☐ Yes
☐ No -- If no, explain what was used instead:

What method and equipment were used to determine PSD?

If the method or equipment used to determine PSD differed for any lab test/storm where PSD was measured, provide the date of the test/storm and describe the change.

If laboratory test results are included, were the influent and effluent analyzed for PSD and reported for at least five (5) test runs?
☐ Yes
☐ No -- If no, explain why not:

If field test results are included, were the influent and effluent analyzed for PSD and reported for at least five (5) storms?
☐ Yes
☐ No -- If no, explain why not:

If field test results are included, did the PSD measurements that were reported include at least one storm that had 10 or more consecutive dry days before the storm?
☐ Yes
☐ No -- If no, explain why not:

If field test results are included, did the PSD measurements that were reported include at least one storm that had only 1-dry day before the storm?
☐ Yes
☐ No -- If no, explain why not:

Did the influent contain at least 50% of its particles in the 10-60 μm size range for lab tests/storms where PSD was measured?
☐ Yes – Provide the percentage of particles in the 10-60 μm size range:
☐ No -- Provide date(s) and characteristics of lab test/storms not meeting this target and list the percentage of particles in the 10-60 μm size range for the influent:

Did the effluent contain less than 10% of its particles between 10-60 μm in size for any lab tests/storms where PSD was measured?
☐ Yes – Provide the percentage of particles in the 10-60 μm size range:
☐ No -- Provide date(s) and characteristics of lab tests/storms not meeting this target and list the percentage of particles in the 10-60 μm size range for the effluent:

14 Maintenance Considerations (check all that apply and briefly explain maintenance procedures/standards)

What is the generic inspection and maintenance plan/procedure? (attach necessary documents):

Is there a maintenance track record/history that can be documented?
☐ No, no track record.
☐ Yes, track record exists; (provide list of local or regional ~~BMPs~~ MTDs currently in use and maintenance track record information):

What is the expected maintenance frequency, per year?
i. Total life expectancy of ~~BMP~~ MTD and, if relevant, life expectancy of media:
ii. For media or amendments functioning based on cation exchange or adsorption, how long will the media last before breakthrough (indicator capacity is nearly reached) occurs?
iii. For media or amendments functioning based on cation exchange or adsorption, how has the longevity of the media or amendments been quantified prior to breakthrough (attach necessary performance data or documents)?

Maintenance contract and associated costs offered by:
☐ Vendor – Provide current costs:
☐ Other commercial entities -- Provide range of current costs:

Is the maintenance procedure and/or are materials/components proprietary?
☐ Yes, proprietary;
- ☐ ~~BMP~~ MTD lends itself to competitive bidding for maintenance
- ☐ Recourse / options exist if the vendor goes out of business

☐ No, not proprietary;
- Are local contractors available who have been certified by the manufacturer?
  - ☐ Yes; provide a list of companies and cities where located.
  - ☐ No; local contactors are not available
- Does the ~~BMP~~ MTD lend itself to competitive bidding for maintenance?
  - ☐ Yes; provide a list of local, certified, maintenance companies and cities where located.
  - ☐ No; local competitive bidding not possible because only one maintenance company certified locally.

Maintenance complexity (Check all that apply):
☐ Confined space training required for maintenance
☐ Liquid pumping and transportation
- Specify method:
- Specify certified disposal locations:

☐ Solids removal and disposal
- Specify method:
- Specify certified disposal locations:

Other noteworthy maintenance parameter (describe):

15 Comments

Include any additional explanations or comments:

16 Certification – To be signed by the company president or responsible officer of the organization

☐ By selecting this box, "I certify that the information submitted is to the best of my knowledge and belief is true, accurate, and complete.

Name: ____

Title: ____

Date: ____

E-mail address: ____

Appendix ~~G~~F ~~-~~-– Pollutant Removal ~~Treatment Efficiency~~ Calculation Methods

Modified from

Center for Watershed Protection's

Tool 8: BMP Performance Verification Checklist Appendices
2008

~~Treatment Efficiency~~ Pollutant Removal Calculation Methods

The pollutant removal efficiency of a BMP refers to the pollutant reduction that is achieved by comparing the influent and effluent of a BMP or treatment train. To fully understand stormwater treatment, all of the runoff needs to be accounted for (~~.e~~.g., untreated runoff, treated runoff, and bypassed flows). Pollutant reduction can be determined on either a concentration or load/mass basis and is typically expressed as a percentage.

Comment [WJ66]: Addressing Public Comment # 28

Comment [WJ67]: For our purposes, is it only load?

Concentration-based methods use the ratio of pollutant concentrations or event mean concentrations (EMCs) at the outflow to pollutant concentrations or EMCs at the inflow as the basis for calculating BMP efficiency. As a general rule, concentration-based methods often result in slightly lower performance efficiencies than mass-based methods. This may be attributed to the fact that BMPs that reduce runoff volume are also reducing pollutant loads, but a concentration-in versus concentration-out study does not account for water losses that occur through infiltration and evapotranspiration, or storage within the BMP. For this reason, the pollutant removal efficiency of these types of BMPs may be under-reported using concentration-based methods.

Mass-based methods use pollutant loads as the basis for calculating BMP efficiency.
Pollutant load is the total amount of a pollutant conveyed over a specified duration. The pollutant loading from a given storm can be estimated using pollutant EMCs and flow data. Mass-based methods are influenced by the volume of water entering the BMP and water losses within the BMP (e.g., evapotranspiration and infiltration), so they are more accurate for BMPs that reduce runoff volume (Winer 2000).

The Efficiency Ratio method and the Summation of Loads methods are recommended for use by ASCE and EPA (2002) and the DCR (Table G.1). Use of either method should be supplemented with an appropriate statistical test indicating if the differences in mean EMCs between the outflow and inflow are statistically significant.

References

American Society of Civil Engineers (ASCE) and United States Environmental Protection Agency (EPA). 2002. *Urban Stormwater BMP Performance Monitoring: a Guidance Manual for Meeting the National Stormwater BMP Database Requirements*. EPA-821-B-02-001. Office of Water, U.S. Environmental Protection Agency, Washington DC. http://water.epa.gov/scitech/wastetech/guide/stormwater/monitor.cfm (accessed January 14, 2011).

Center for Watershed Protection (CWP). 2008. *Tool 8: BMP Performance Verification Checklist Appendices.* CWP, Ellicott City, MD. 20 pp. http://www.cwp.org (accessed January 14, 2011).

Winer, R. 2000. *National Pollutant Removal Database for Stormwater Treatment Practices*. Second edition. Center for Watershed Protection, Ellicott City, MD.

Table G.1. Methods to estimate pollutant removal credit ~~Methods to estimate BMP efficiency~~ (From Center for Watershed Protection 2008; compiled from ASCE and U.S. EPA 2002)

Method	Type of Method	Formula	Comments
Efficiency Ratio (ER)	**Concentration**	$ER = 1 - \frac{Average\ outlet\ EMC}{Average\ inlet\ EMC}$ Where the EMC = $\frac{\sum_{j=1}^{n} CiVi}{\sum_{j=1}^{n} Vi}$ Where: *Ci* = event inflow concentration; *Vi* = event inflow volume	• Most useful when loads are directly proportional to the storm volume. • Weights EMCs from all storms equally. • The accuracy varies with BMP type. • Minimizes impacts of smaller/cleaner storms on performance calculations. • Can apply log normalization to avoid equal weighting of events.
Summation of Loads (SOL)	**Mass**	$SOL = \frac{sum\ of\ outlet\ loads}{sum\ of\ inlet\ loads}$ Where the Load = C*i*V*i* *Ci = average concentration within period i; Vi = volume of flow during period i*	• Loads are calculated using concentration and flow volume and are summed for the number of events measured. • A small number of large storms can significantly influence results. • Removal of material is most relevant over entire period of analysis • Uses a mass balance approach. • Effluent concentration may still be high despite high removal efficiency

Appendix ~~H~~ G -- Stormwater ~~BMP~~ MTD Demonstration Site Summary

Modified From

The Technology Acceptance Reciprocity Partnership

Protocol for

Stormwater Best Management Practice
Demonstrations

Updated: July 2003

* * * * * *

Questions on the form are included within this document for informational purposes only.

To complete the official form, download it from the

Virginia Stormwater Best Management Practices Clearinghouse website:

www.vwrrc.vt.edu/swc

Stormwater ~~BMP~~ MTD Demonstration Site Summary

Download this form from the Virginia Stormwater Best Management Practices Clearinghouse website (www.vwrrc.vt.edu/swc), complete it for each testing site, and submit in electronic format as part of the Use- Designation Application.

~~Technology~~ Name of Manufactured Treatment Device (MTD) ~~Name~~
Category (e.g., Volume-based structure; Flow rate-based structure: Hydrodynamic or Filter)
Date

1. Contact Information

~~Vendor~~ Manufacturer: Name
Address (Street, City, State, Zip)
Proponent's Contact: Name
Address (Street, City, State, Zip)
Phone, Fax, E-mail Address

2. Test Site Information

Site Name
Address (Street, City, State, Zip)
Land Use: Commercial/Office, Residential, Industrial, Open, Other (Specify)
Total Contributing Drainage Area
~~Particle-Size Distribution of Sediments in Tests (Entire Distribution, Specify D_{50})~~

3. Watershed Information

Watershed Name
Total Watershed Area
Percent of Impervious Area in Watershed

4. Precipitation Information

Regional Climate Station
Average Number of Storms/ Year
Average Annual Rainfall (in.)
Monthly Average Rainfall at Test Site (During Testing) (in.)

5. ~~BMP~~ MTD Testing Information

Date System Installed

Insert tables that document the following information:

Number of storms monitored
Longest continuous sequence of storms sampled
Number of sets of back-to-back storms monitored
Dates ~~BMP~~ MTD Tested/Sampled
Storm Events Start and End Times (During Testing)
Testing Start and End Times (For Each Event)
Storm Precipitation (For Each Event) (in.)
Total Storm Flow Volume into ~~BMP~~ MTD (For Each Event) (ft.^{3})
Total Storm Flow Volume Bypassed (For Each Event) (ft.^{3})

Type of Samples Collected (e.g., Flow-weighted, Composite)
Parameters and Units Measured
Analysis Method