Appendix 3-G

SWM AND BMP CONSTRUCTION INSPECTIONS

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APPENDIX SECTION HEADINGS

3-G.1.0. INTRODUCTION

The purpose of construction inspections and an as-built survey is to verify that constructed Stormwater Management (SWM) facilities and associated conveyance systems have been built in accordance with the approved plan and design specifications. An as-built survey, including construction inspection logs, should be provided prior to final site approval and release of the performance guarantee. This is in the best interest of the owner as well as the local program, since long term maintenance costs can increase significantly, if the facility is not built correctly. Furthermore, the owner and locality want assurance that the facilities are constructed properly and will provide the quantitative and/or qualitative control prescribed by the approved plan. Liability issues arise if a downstream property owner is adversely affected and can prove that the facility does not conform to the approved plan.

3-G.1.1 Construction Inspections

Adequate construction inspection of stormwater BMPs will usually require an on-site inspector to verify that the materials, methods, and placement, are in accordance with the approved plans and specifications. Critical components of the design; such as the anti-seep collar or filter and drainage diaphragm on the outlet conduit, the embankment foundation, riser footing, and other sub-surface components, must be examined for compliance to the design prior to being backfilled with the earthen embankment. The use of an on-site inspector will help to avoid delays by allowing the contractor to proceed with the earthwork rather than waiting for a scheduled (or non scheduled) inspection of a critical component.

Localities will usually provide regular inspections of SWM facilities under construction. The frequency of these inspections will vary based on the workload represented by active projects and the number of inspectors on staff. These inspections should verify that the contractor and on-site inspector are documenting the construction inspections in order to adequately substantiate the as-built certification. In the case of a local program requirement of inspections at critical points during construction, a signed inspection log by a qualified individual (other than the contractor) should be acceptable. Otherwise, the locality should establish a construction inspection schedule with the contractor prior to construction. All inspection logs and other related information should be incorporated into a file for each individual project. The BMP Design and Plan Review Checklists in **Appendix 8-A of Chapter 8** can also be used for construction inspections.

3-G.1.2. As-Built Survey and Plan

Some as-built documentation must be obtained *during* the construction process, since some vital components are hidden in the final product. Therefore, construction inspections and inspection records are included in the as-built survey, which is the responsibility of the owner/permittee. For purposes of discussion, an as-built survey may be broken down into three components. These components are *earthwork specifications*, *material specifications* (other than earthwork) and a *dimensions and elevations survey*. The items noted within these components should be checked, and documentation be retained as needed to substantiate that the SWM BMP has been constructed in accordance with the approved plan and specifications. The following provides a discussion of the components of an as-built survey.

3-G.1.2.1 Earthwork Specifications

The acceptable completion of earthwork in the construction of a SWM facility is crucial in assuring that a facility is structurally sound. This category covers all aspects pertaining to the completion of earthwork for a facility. It is essential that specific elements of the construction inspection, as well as the pre-construction feasibility analysis of the soils, be documented. This may include compaction tests, inspections of the removal of unsuitable materials under and adjacent to the embankment foundation, construction of the cut off trench and other seepage control measures, compaction around the barrel, riser structure footing, and any other element that is hidden in the final condition. All work should be completed under supervision of a licensed geotechnical engineer. The inspection logs and test results should be included in the final as-built survey.

3-G.1.2.1.1. Geotechnical/Geophysical Testing

The examination of existing underlying strata indicates the composition of that strata and if that strata will support a SWM facility. For example, the presence of bedrock at the natural ground surface or in “cut” provides a plane of weakness that water may follow or exfiltrate to. This is especially critical in areas of karst. Also, the presence of organics or other unsuitable materials under the embankment and embankment footing may require additional excavation. This must be documented as having been completed.

Normally, in non-karst terrain (east of the Blue Ridge), simple geotechnical logs taken at the SWM site will provide adequate interpretative results. However, in karst environments it is extremely useful that the testing be expanded to geophysical (seismic) evaluation. These tests provide images of underlying strata and indicate the presence of anomalies. This is critical since limestone geology exhibits extensive caves and cavities where ponding of runoff may exacerbate collapse of underlying cavities, which ultimately results in extremely expensive repairs.

3-G.1.2.1.2. Fill Classification

The geotechnical portion of the approved plan should provide a listing of soil classification types that are suitable for use at the project infill. Specialized criteria may also specify the classification of impermeable soil to be used for clay liners in areas of sandy soils or karst. Fill soils containing such materials as excessive or large rock, organic material or “fatty clay” (CH) classification are not acceptable due to the inability to achieve proper compaction or because of their shrink-swell properties. Verification must also be provided that the specifications for materials to be used in the construction of drainage and filter diaphragms have been complied with.

3-G.1.2.1.3. Compaction

The application of "lifts" in proper thickness and density is essential in attaining a stable SWM structure. The compaction of dam embankment to a percentage at or above the percent compaction specified in the approved plan and within the optimal range of moisture content assures that there will not be adverse settlement of the embankment. Careful compaction in areas adjacent to the barrel and seepage control measures is critical to eliminate excessive "void space" along the outlet barrel where the potential for embankment failure is high. Sufficient test results should be retained to document uniform compaction of the dam embankment and density/permeability of **existing soil formation and/or soils to be** used for liners (where applicable), in accordance with the approved plan.

3-G.1.2.2 Material Specifications

Construction materials may be classified as those items other than earthwork. A large number of component items needed for the construction of SWM facilities are grouped into this category. Some of these components must be inspected during installation. Materials would include, but not be limited to, concrete, reinforcing steel, concrete pipe, metal pipe, woodwork, masonry, and any other items that are applicable to the facility and satisfy all the requirements of the local program. The following provides a general discussion of some of the components of a SWM facility:

3-G.1.2.2.1 Riprap and Aggregate

The size distribution (diameter of aggregate), the amount of "fines" and integrity of rock may be factors, since aggregate sizing should be in accordance to the plan.

1. Aggregate sizing plays a role in two distinct areas. In underground reservoir use, the size of aggregate dictates the amount of void space available for infiltration or retention/detention of runoff. In riprap use, the minimum size is critical in maintaining stability during high velocity flow, while a size in great excess of the stone specified may be equally as detrimental in regards to aesthetics and/or proper placement.

2. The amount of fines contained within aggregate is generally a visual observation, although quarry delivery tags should bear out the specifications per VDOT specs. The percentage of fines generally is important where washed stone is to be utilized for an underground aggregate reservoir, or where the outlet protection of a facility is discharging into a stream or other sensitive area that is susceptible to turbidity.

3. Rock integrity and shape is generally the visual observation that the aggregate used will meet specifications without long term decay. For example, sandstone does not make good riprap since it may be expected to disintegrate over time. Slate usually exhibits cleavage planes and therefore lays flat. When used for outlet protection, insufficient surface roughness of the slate may not dissipate concentrated flow energy.

3-G.1.2.2.2. Control Structure

There are an infinite number of design configurations for a control structure. Whatever the design, there should be project specifications for dimensions, strength and specific materials in accordance with the specifications found in the particular BMP Design Specification and any other local requirements. Appropriate documentation from the manufacturer should be retained (as applicable) to document each component. For example, pre-cast concrete risers normally arrive with as-built shop drawings that indicate specifications of the item furnished. Where components are constructed at the site, such as a cast in-place riser footing, test information and/or delivery tags from the concrete plant should be retained, while rebar reinforcement and dimensional information is documented in the construction log. Other items normally applicable to the control structure include:

1. An outlet barrel, normally affixed to the control structure, is used to convey flow to an accepted discharge point. Items related to proper conduit installation include the procedure used in sealing joints of conduit together, the method of attachment to the control structure and the use of inlet and floor shaping (as applicable) within the control structure.

   There is also a need to inspect and document the existence, location and spacing of anti-seep collars, concrete cradles or other seepage control measures (at the outlet barrel) as specified in the approved plan. Documentation should include verification of critical dimensions, existence of reinforcement, and indication of concrete mix strength. In the case of filter diaphragms, both earthwork and materials need to be considered in the installation**.**

2. Trash racks of varying design and construction are normally affixed to a control structure and in some cases inlets which “feed” the SWM facility. Visual observation (with inspection log entry) should indicate bar size, spacing grate configuration, and proper attachment to the control structure, or inlet and the application of rust resistant coating to the same where applicable.

3-G.1.2.2.3 Geotextiles

Synthetic fabrics are frequently specified for application beneath various components, under riprap or individually in spillways or for low flow channels. Proper selection of a manufacturer’s product along with installation consistent with the plan and/or manufacture’s directives is necessary to assure the performance intended. The method of installation should be observed and a tag provided from the product that verifies compliance with the product specification given in the approved plan.

3-G.1.2.2.4 Conveyance System Components

One portion of a SWM design that is frequently overlooked in inspections is the collection of components comprising the drainage system for the site. It is obvious that if the system is not built as intended in the approved plan, then the facility may not function as expected. Critical items such as conveyance conduit diameter, slope, inlet and grate length/configuration are essential to insure that the required design storm (generated by the contributing drainage area) is adequately conveyed to the SWM facility for control and/or that runoff from other drainage areas is diverted away from SWM facilities.

3-G.1.2.3 Dimensions and Elevations Survey

The approved plan provides detailed information for specific elevations such as the inverts of the outlet conduits, control orifice and weir invert elevations, invert of emergency spillway, top of the dam, as well as pond bottom and slope of the same. Additional dimensional information exclusive of the control structure should also be provided. This could include the dimensions of the impoundment area at specific elevations and the top width and side slope of a dam embankment. The purpose of the as-built survey is to confirm that elevations and dimensions are consistent with the approved plan.

3-G.1.3. As-Built Submittal Requirements

As-built information should be documented and submitted as follows: (1) a copy of the applicant's inspection log book; (2) a red-line revision of the approved SWM plan sheets; and (3) certification by a qualified professional that the as-built plan conforms to the approved plan.

3-G.1.3.1. Inspection Log Book

A copy of the inspection log book should be kept at the project site. The log should document all aspects of the construction of the facility (with copies of applicable test results) to insure compliance with the approved plan. Any significant inconsistencies should immediately be reported to the engineer for evaluation and possible modification.

3-G.1.3.2. Red-Line Revision of Plans

Red-line revision plans should be submitted upon completion of the facility. The plans should indicate any changes to the approved plan. Items that differ from the original approved plans and computations should be shown in red on both the plans and computations as follows:

- A red check mark must be made beside design values where they agree with actual constructed values
- For changed values, "line out" the design value and enter the actual value in red
- Elevations to the nearest 0.1-foot are sufficient
- A stage-storage summary table, comparing the design values and the as-built values, should be provided for each facility with a storage volume

3-G.1.3.3. Certification Statement

The project owner should have those persons responsible for the inspection and implementation of the plan submit written certification that the SWM facility(s) and conveyance system have been built in accordance to the approved plan since this will cover underground facilities as well. Survey work during stake out and construction should be documented to verify underground volumes, elevations, pipe sizes, etc.