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Memorandum

To:	Anne Roderer and David Ashwood, JHU
From:	Shandor Szalay
Date:	October 26, 2012
Re:	Homewood Campus SWM as-built requirements
cc:	Wendy Ciemiewicz File#51143.0001

The Johns Hopkins University (JHU) requires as-built documentation following construction of campus build-out projects to update the 2012 Stormwater Management Master Plan (SWMMP) geographic information system (GIS) and for internal and regulatory reporting. As-built documentation requires an as-built survey performed by a licensed surveyor in the State of Maryland who may or may not be the Lead Design Professional responsible for the final project design. This memorandum provides guidance for the as-built survey information required for updating the JHU stormwater geodatabase. The as-built survey shall include the following tasks and deliverables, which are described in more detail within the body of this memorandum:

- Perform field survey of as-built conditions;
- Create digital computer-aided design (CAD) files representing as-built survey;
- Create digital tabular data files associated with features depicted in the as-built CAD files based on the templates provided; and
- Complete supporting documentation checklist and create and provide required files.

The as-built surveyor and JHU PM should discuss any items included in the memorandum that are omitted from the as-built survey scope of work to ensure complete information. If the as-built survey is performed by the Lead Design Professional responsible for the final project design, additional documentation of compliance with stormwater designs should have been provided to the JHU PM at various stages of the design and construction process (e.g., site development submission, final design submission, construction inspections, etc.).

Based on campus expansion plans and approved stormwater treatment measures, no structural practices (as defined by Maryland Environmental Site Design [ESD] program) were required by the SWMMP. Guidance concerning the collection of as-built data for structural practices is not provided in this memorandum. Additional guidance will be provided in the event that structural practices are constructed for stormwater management.

The JHU Project Manager (PM) shall provide information to the as-built surveyor to ensure that the data collected is complete. The surveyor shall request the following information prior to performing the as-built survey if it is not provided by the JHU PM:

- The boundary/extent of the as-built survey;
- The boundaries of each JHU Project included in the as-built survey assignment;
- The unique JHU Project identification (ID) code and Project Name for each project;
- The JHU Building Name and Code associated with each project;
- Additional requirements of the as-built surveyor requested by the JHU PM to fulfill requests made by Baltimore City or as a result of information deficiencies identified during construction and post-construction inspections (e.g., verification of soil media depth, infiltration rate, etc.).

A. AS-BUILT SURVEY

The as-built survey shall include collection of project area, BMP, land cover, and infrastructure data that will be used to create as-built CAD files (Section B) and tabular data files (Section C). The surveyor shall complete the as-built survey according to the following guidelines.

DATUM AND PROJECTION REQUIREMENTS

- Horizontal survey data shall be collected in NAD 1983 State Plane Maryland FIPS 1990; and
- Vertical survey data shall be collected in Baltimore City Datum.

DATA ACCURACY AND UNIT REQUIREMENTS

- The as-built survey shall be completed with survey instrumentation that provides vertical and horizontal accuracy to hundredths of a foot;
- All vertical and horizontal measurements shall be measured computed to hundredths of a foot; and
- All dimensions shall be measured to the hundredths of a foot.

SURVEY DATA COLLECTION

The as-built surveyor shall collect the following minimum survey data points, measurements, and observations. Each survey data point shall include both horizontal and vertical measurements. Appendix A defines the range of acceptable entries to be used when identifying feature types (e.g., rain garden, sidewalk, manhole, etc.) and documenting categorical observations (e.g., pipe material).

PROJECT DATA

- Points delineating the spatial extent of the project boundary.

BMP DATA

- Points delineating the spatial extent (e.g. footprint) of each BMP (i.e., micro-bioretention, green roof, pervious pavement, etc.);
- Points delineating the spatial extent of the drainage area to each BMP;
- Points delineating the boundary of the floor area of depressional storage BMPs (i.e., micro-bioretention, rain garden, swale, and submerged gravel wetland);
- Points at all BMP overflow inverts;
- BMP type (see Table A1);
- Average vertical elevations of the BMP floor; and
- BMP model ID, as applicable (e.g., cisterns).

LAND COVER DATA

- Points delineating the spatial extent of impervious surfaces within the project boundary by land cover type (see Table A.2); and
- Points delineating the spatial extent of pervious surfaces within the project boundary by land cover type (see Table A.3) and hydrologic condition (see Table A.4).

The hydrologic condition of all pervious areas shall be determined by a licensed professional engineer in the State of Maryland.

INFRASTRUCTURE DATA

- Points sufficient to locate all pre-existing and newly constructed stormwater infrastructure features (see Table A5-A10).
- BMP ID of BMP associated with the feature, if applicable;
- Point to locate rim or top of feature;
- Point to locate sump (i.e. feature bottom);
- Points to locate pipe inverts;
- Material (see Table A11) of the feature, and if applicable, of its cap;
- Model ID, if applicable;
- Dimensions of the feature, and if applicable, of its cap; (see Section C. Tabular Data Requirements for dimensions required for each infrastructure feature category)
- Presence/absence of a sump (see Table A12);
- Shape of all roof leaders (see Table A13);
- Shape of feature caps if applicable (see Table A14);
- Feature condition (see Table A15);
- Feature status (see Table A16);
- Weir type (see Table A17) for junction and control structure features;
- Number of pipes associated with each junction, cleanout, outfall, and control structure feature;
- Feature IDs of all pipes associated with each junction, cleanout, outfall, and control structure feature;
- Wing wall angle (see Table A18) and type of erosion protection (see Table A19) for outfall features;
- Accessibility rating for cleanout, junction, and control structure features (see Table A20);
- One photograph depicting the feature and labeled using the following naming convention: PHOTO_[Feature ID], where "Feature ID" is the unique infrastructure feature ID (described in Section B under Layer Specifications section); "YY" is a 2-digit integer assigned consecutively beginning with "01" for each infrastructure feature (see naming conventions in Table 1). Photographs should depict the interior of a feature when applicable (e.g., junctions, cleanouts, etc.); and
- Photo-documentation of major observed issues (e.g., cracks, collapses, undermining, etc.). Photos should be labeled using the following naming convention: PHOTO_[Feature ID]_YY, where "Feature ID" is the unique infrastructure feature ID; "YY" is a 2-digit integer assigned consecutively beginning with "01" for each infrastructure feature.

In situations where the end points of a pipe cannot be verified via access through vertical features such as manholes, subsurface utility locating services (using sonar or ground penetrating radar) will be required. In some situations such as an inaccessible manhole, the need for these services will not be apparent until the survey is underway. In these cases, a change of scope will be required for the as-built survey. In other instances, the need for electronic subsurface survey can be anticipated and shall be included in the

scope of work. An example of this situation is a distribution pipe or under drain with only one access point, which would prevent verification of the pipe's horizontal extent.

B. AS-BUILT CAD FILES

The as-built surveyor shall prepare georeferenced CAD files to provide location data for the surveyed features. These digital files shall be provided according to the specifications provided below.

DATUM AND PROJECTION REQUIREMENTS

- Horizontal survey data shall be provided in NAD 1983 State Plane Maryland FIPS 1990; and
- Vertical survey data shall be provided in Baltimore City Datum.

FILE FORMAT REQUIREMENTS

- CAD files shall be georeferenced and provided in AutoCAD 2011 or more recent; and
- Any externally referenced files (e.g., existing conditions, base map, etc.) shall be provided with the as-built survey files;

LAYER SPECIFICATIONS

The as-built surveyor shall provide CAD files containing features on specified layers to facilitate accurate migration of data from CAD to GIS. Features shall be located, as appropriate, on one of 15 CAD layers, which are summarized in the text below. Individual features (e.g., project boundaries, inlets, sidewalk boundaries, BMP boundaries, etc.) shall be assigned to layers by feature category. The as-built surveyor shall use CAD object types including coordinate geometry (COGO) points, 2D polylines and 2D closed polylines to draw surveyed features, as specified below. Each CAD layer shall be limited to a single CAD object type, and shall correspond to a MS Excel worksheet (see the "Tabular Data Entry" template file) with the same name. Each feature shall be labeled on a corresponding CAD text layer, as specified below.

The following CAD layers shall be provided:

- Projects closed polylines layer (1): "Projects"
- Projects text layer (1): "Projects_txt"
- BMP closed polylines layers (2): "BMP" and "BMPDA"
- BMP text layer (1): "BMP_txt
- Cover closed polylines layers (2): "Cover_PA" and "Cover_IA"
- Cover text layer (1): "Cover_txt"
- Infrastructure COGO layers (5): "Infra_Junction", "Infra_Cleanout", Infra_Outfall", "Infra_ControlStructure", and "Infra_RoofLeader".
- Infrastructure polyline layer (1): "Infra_Pipe"
- Infrastructure text layer (1): "Infra_txt"

PROJECT LAYERS

The as-built surveyor shall provide two (2) project boundary CAD layers named:

- "Project"
- "Project_txt"

The "Project" layer shall include only the project boundaries defined by the JHU PM. Features in this CAD layer shall be closed polylines. Project boundary features shall be named with a unique Project identifier (ID) according to internal JHU naming conventions. Each project boundary polygon shall be labeled on the "Project_txt" layer according to its Project ID. The JHU PM shall provide the Project ID to the as-built surveyor with the survey assignment. The project boundary IDs will be provided in this format: C.170.07.9999.

BMP LAYERS

The as-built surveyor shall provide three (3) BMP-related CAD layers named:

- "BMP"
- "BMPDA"
- "BMP_txt"

The "BMP" layer includes the footprint of each BMP. The floor area of each BMP shall be calculated and provided as numeric field in the corresponding tabular data table (see Section C), but shall not be represented in the CAD layers. The "BMPDA" layer includes the delineated drainage area to each BMP. Features in the BMP layers shall be closed polylines. Each BMP and its corresponding drainage area shall be assigned the same unique BMP ID. BMP ID shall be assigned using the following naming convention: ProjectID_B_XXX, where "ProjectID" is the unique project ID within which the BMP is located; "B" indicates the feature is part of the BMP layers; and "XXX" is a 3-digit whole number assigned consecutively from 001 for each BMP and its associated drainage area within a project boundary. Each BMP and BMP drainage area polygon shall be labeled according to its BMP ID on a text layer named: "BMP_txt".

LAND COVER LAYERS

The as-built surveyor shall provide three (3) land cover-related CAD layers named:

- "Cover_PA"
- "Cover_IA"
- "Cover_txt"

Features within the "Cover_PA" and "Cover_IA" layers shall delineate all land cover within the project boundary using closed polylines according to the land cover metrics (provided in section A and Appendix A) for pervious land cover and impervious land cover, respectively. Land cover ID shall be assigned using the following naming convention: ProjectID_C_XXXX, where "ProjectID" is the unique project ID within which the land cover is located; "C" indicates the feature is part of the land cover layers; and "XXXX" is a 4-digit number assigned consecutively from 0001 within a project boundary. Each land cover polygon shall be labeled on a text layer named: "Cover_txt" according to its Land Cover ID. The polylines of adjacent closed polylines shall be snapped to provide coverage free of overlapping features or 'empty' space. When a cover area is defined by an inner and outer boundary where the inner polyline defines a new cover type (e.g., turf center of a traffic circle, etc.), the inner boundary shall be drawn on both the appropriate cover layer for its type, and as the defining internal boundary on the additional cover layer as necessary.

INFRASTRUCTURE LAYERS

The as-built surveyor shall provide six (6) stormwater infrastructure-related CAD layers. Different infrastructure feature categories shall be reported on each specified layer. The layer names and specific layers for each feature category are as follows:

- “Infra_Junction”
- “Infra_Pipe”
- “Infra_Cleanout”
- “Infra_Outfall”
- “Infra_ControlStructure”
- “Infra_RoofLeader”
- “Infra_txt”

Features within the stormwater infrastructure layer “Infra_Pipe” shall be polylines; all other stormwater infrastructure features shall be COGO points. Each stormwater infrastructure feature shall be assigned a unique Feature ID. Feature ID shall be assigned using the following naming convention: ProjectID_I_XXXX, where “ProjectID” is the unique project ID within which the feature is located; “I” indicates the feature is part of the stormwater infrastructure layers; and “XXXX” is a 4-digit number assigned consecutively from 0001 within a project boundary. Each stormwater infrastructure feature shall be labeled in CAD on a text layer named “Infra_txt” according to its Feature ID.

If the as-built surveyor encounters stormwater infrastructure features which cannot be classified using the range of acceptable entries provided in the appropriate Appendix A table, the as-built surveyor shall assign the feature a type of “other” within the most appropriate infrastructure feature category (cleanouts, control structures, junctions, outfalls, roof leaders, or pipes), and provide a description of the feature in the “Comments” field. If the feature cannot be classified using the infrastructure feature categories, the as-built surveyor shall contact the GIS Coordinator to resolve the issue.

Table 1. Naming Convention for Unique Identifiers

Object description	Applicable CAD layers	Tabular attribute field	Naming convention
Project boundaries	Project	Project_ID	Provided by JHU on a by product basis
BMP and drainage areas	BMP; BMPDA	BMP_ID	[Project_ID]_B_XXX
Cover type areas	Cover_PA; Cover_IA	Cover_ID	[Project_ID]_C_XXXX
Infrastructure features	Infra_Junction; Infra_Pipe; Infra_Cleanout; Infra_Outfall; Infra_ControlStructure; Infra_RoofLeader	FEAT_ID	[Project_ID]_I_XXXX
Photos of features	Infra_Junction; Infra_Pipe; Infra_Cleanout; Infra_Outfall; Infra_ControlStructure; Infra_RoofLeader	PHOTO_NAME	PHOTO_[FEAT_ID]
Photos of problem areas	Infra_Junction; Infra_Pipe; Infra_Cleanout; Infra_Outfall; Infra_ControlStructure; Infra_RoofLeader	COMMENTS	PHOTO_[FEAT_ID]_YY

C. TABULAR DATA FILES

The as-built survey shall include tabular data files with attribute data (e.g., feature types, measurements, observations, etc.) for the surveyed features. These digital files shall be provided in MS Excel according to the specifications provided below. MS Excel templates for all tabular data are provided in the corresponding digital appendix "Tabular Data Entry." This single template file includes separate worksheets for each required CAD layer and a "validation fields" worksheet that contain domains that restrict the valid content of specified attribute fields within the other worksheets.

FILE FORMAT REQUIREMENTS

- Tabular data associated with surveyed features shall be provided in a single MS Excel 2010 file;
- Within the single Excel file, separate worksheets of tabular data shall be provided for each CAD layer;
- Worksheets shall be named according to the CAD layer (see above, "Layer Specifications"); and
- All entered data must follow the nomenclature and formats provided in the layer specifications and the minimum data requirements sections below and in the "validation field" worksheet of the digital appendix "Tabular Data Entry."

DATA ACCURACY REQUIREMENTS

- All area measurements and calculations shall be reported to the nearest square foot; and
- All dimensions and elevations shall be reported to the hundredth of a foot.

DATA REQUIREMENTS FOR TABULAR DATA

The as-built surveyor shall provide all tabular data for surveyed features in accordance with the following requirements:

PROJECT

The as-built surveyor shall provide one (1) project data table. Project boundary tabular data (see "Project" worksheet in MS Excel template) shall include the following:

- PROJECT_ID: Unique project identifier (see Table 1 for naming convention)
- PROJECT_NAME: Name of project
- ASBUILT_COMPANY: Lead firm responsible for as-built survey
- ASBUILT_DATE: Date of as-built survey completion
- PROJECT_AREA: Area within project boundary (square feet)
- JHU_BUILDING_NAME: Name of nearest JHU building
- JHU_BUILDING_CODE: Building code associated with nearest JHU building

BMP

The as-built surveyor shall provide two (2) BMP data tables; one for the BMP boundaries and another for the delineated drainage area to each BMP.

BMP tabular data (see "BMP" worksheet in MS Excel template) shall include the following information for each BMP feature:

- PROJECT_ID: Project ID of project in which BMP is located

- BMP_ID: Unique BMP identifier (see Table 1 for naming convention)
- BMP_TYPE: Type of BMP
- BMP_MODEL: Model ID or name of BMP feature, as applicable
- BMP_FOOTPRINT: Area within the highest defining contour of the BMP/BMP extent (square feet)
- BMP_FLOOR_AREA: Area within the lowest defining 1-ft. contour of the BMP (square feet)
- BMP_FLOOR_ELEV: Average floor elevation of depressional storage BMPs (feet)
- BMP_TOP_ELEV: Elevation of overflow pipe invert (feet)
- COMMENTS: Any relevant comments

BMPDA tabular data (see "BMPDA" worksheet in MS Excel template) shall include the following information for each BMP drainage area feature:

- PROJECT_ID: Project ID of project in which BMP is located
- BMP_ID: Unique identifier of the associated BMP (see Table 1 for naming convention)
- DA_ FOOTPRINT: Total area within the BMP drainage area (square feet)
- DA_IA: Impervious area within the BMP drainage area (square feet)
- COMMENTS: Any relevant comments

LAND COVER

The as-built surveyor shall produce two (2) land cover data tables of attribute data; one for pervious features and another for impervious features.

Impervious land cover tabular attribute data (see "Cover_IA" worksheet in MS Excel template) shall include the following information for each impervious land cover feature:

- PROJECT_ID: Project ID for project in which cover is located
- COVER_ID: Unique cover shape identifier (see Table 1 for naming convention)
- COVER_IA_TYPE: Impervious cover type
- COMMENTS: Any relevant comments

The pervious land cover tabular data (see "Cover_PA" worksheet in MS Excel template) shall include the following information for each pervious land cover polyline:

- PROJECT_ID: Project ID for project in which cover is located
- COVER_ID: Unique cover shape identifier (see Table 1 for naming convention)
- COVER_PA_TYPE: Pervious cover type
- HYDRO_COND: The hydrologic condition associated with each land cover polygon
- COMMENTS: Any relevant comments

INFRASTRUCTURE

The as-built survey shall produce six (6) infrastructure data tables: junctions, pipes, cleanouts, outfalls, control structures, and roof leaders.

Junction tabular data (see "Infra_Junction" worksheet in MS Excel template) shall include the following information for each junction feature:

- BMP_ID: BMP ID of BMP associated with junction feature, if any
- FEAT_ID: Unique stormwater infrastructure feature identifier
- FEAT_JUNCT_TYPE: Type of junction
- FEAT_MODEL: Model ID or name of feature, as applicable
- FEAT_MAT: Feature material
- FEAT_COND: Structural condition of feature
- PHOTO_NAME: File name for interior photo (see Table 1 for naming convention)
- RIM_ELEV: Rim elevation (feet)
- CAP_MAT: Feature cap material
- CAP_SHP: Feature cap shape
- CAP_LEN: Feature cap length, if rectangular (feet)
- CAP_WID: Feature cap width, if rectangular (feet)
- CAP_DIA: Feature cap, if circular (feet)
- CAP_ACCESS: Whether or not the cap could be lifted and the interior accessed
- SUMP: Whether or not a sump was observed within the interior
- SUMP_ELEV: Sump (bottom of interior) elevation (feet)
- NUM_PIPES: Number of pipes observed within feature
- PIPE1_FEAT_ID: Feature ID for pipe 1
- PIPE1_ELEV: Elevation of pipe 1 invert (feet)
- PIPE2_FEAT_ID: Feature ID for pipe 2
- PIPE2_ELEV: Elevation of pipe 2 invert (feet)
- PIPE3_FEAT_ID: Feature ID for pipe 3
- PIPE3_ELEV: Elevation of pipe 3 invert (feet)
- PIPE4_FEAT_ID: Feature ID for pipe 4
- PIPE4_ELEV: Elevation of pipe 4 invert (feet)
- WEIR_TYPE : Weir type
- COMMENTS: Additional comments; include photo names if additional issue photos were taken
- STATUS: Status of junction feature (e.g., in use, abandoned, etc.)
- X_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements
- Y_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements

Pipe tabular data table (see "Infra_Pipe" worksheet in MS Excel template) shall include the following information for each pipe feature:

- BMP_ID: BMP ID of BMP associated with pipe feature, if any
- FEAT_ID: Unique stormwater infrastructure feature identifier
- FEAT_PIPE_TYPE: Pipe type
- FEAT_MODEL: Model ID or name of pipe feature, as applicable
- FEAT_MAT: Pipe material
- FEAT_DIAM: Pipe diameter (feet)
- FEAT_COND: Structural condition of feature
- PHOTO_NAME: File name for photo or CCTV file (see Table 1 for naming convention)
- INVERT_UPSTREAM: The upstream invert elevation (feet), also the PIPE_ELEV field for the junction feature ("Infra_junction" worksheet) located at the upstream end of the pipe
- INVERT_DOWNSTREAM: The downstream invert elevation (feet), also the PIPE_ELEV field for the junction feature ("Infra_junction" worksheet) located at the downstream end of the pipe
- COMMENTS: Additional comments; include photo names if additional issue photos were taken
- STATUS: Status of pipe (e.g., in use, abandoned, etc.)
- X_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements
- Y_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements

Cleanout tabular data table (see "Infra_Cleanout" worksheet in MS Excel template) shall include the following information for each cleanout feature:

- BMP_ID: BMP ID of BMP associated with cleanout, if any
- FEAT_ID: Unique stormwater infrastructure feature identifier
- FEAT_CO_ TYPE: Cleanout feature type
- FEAT_MODEL: Model ID or name of cleanout, as applicable
- FEAT_MAT: Feature material
- FEAT_DIAM: Feature diameter (feet)
- FEAT_COND: Structural condition of feature
- PHOTO_NAME: File name for feature interior photo (see Table 1 for naming convention)
- RIM_ELEV: Rim elevation (feet)
- CAP_MAT: Feature cover material
- CAP_SHP: Feature cover shape
- CAP_LEN: Feature cover length, if rectangular (feet)
- CAP_WID: Feature cover width, if rectangular (feet)

- CAP_DIA: Feature cover, if circular (feet)
- CAP_ACCESS: Whether or not the cover could be lifted and the interior accessed
- NUM_PIPES: Number of pipes associated with the feature
- PIPE1_FEAT_ID: Feature ID of pipe 1
- PIPE1_ELEV: Elevation of pipe invert (feet)
- PIPE2_FEAT_ID: Feature ID of pipe 2
- PIPE2_ELEV: Elevation of pipe invert (feet)
- COMMENTS: Additional comments; include photo names if additional issue photos were taken
- STATUS: Status of cleanout feature (e.g., in use, abandoned, etc.)
- X_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements
- Y_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements

Outfall tabular data (see "Infra_Outfall" worksheet in MS Excel template) shall include the following information for each outfall feature:

- BMP_ID: BMP ID of BMP associated with outfall, if any
- FEAT_ID: Unique stormwater infrastructure feature identifier
- FEAT_OUT_TYPE: Outfall type
- FEAT_MODEL: Model ID or name of outfall, as applicable
- FEAT_MAT: Outfall material
- FEAT_LEN: Horizontal feature length (feet)
- TOPFEAT_ELEV: Elevation at top of feature (feet)
- WING: Wing wall angle (degrees)
- FEAT_PROT: Feature protection type
- FEAT_COND: Structural condition of feature
- PHOTO_NAME: File name for photo (see Table 1 for naming convention)
- NUM_PIPES: Number of pipes associated with feature
- PIPE1_FEAT_ID: Feature ID of pipe 1
- PIPE1_ELEV: Elevation of pipe invert (feet)
- PIPE2_FEAT_ID: Feature ID of pipe 2
- PIPE2_ELEV: Elevation of pipe invert (feet)
- COMMENTS: Additional comments; include photo names if additional issue photos were taken
- STATUS: Status of outfall (e.g., in use, abandoned, etc.)
- X_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements

- Y_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements

Control structure tabular data (see "Infra_ControlStructure" worksheet in MS Excel template) shall include the following information for each control structure feature:

- BMP_ID: BMP ID of BMP associated with feature, if any
- FEAT_ID: Unique object identification number
- FEAT_CONT_TYPE: Type of control structure
- FEAT_MODEL: Model ID or name of control structure, as applicable
- FEAT_MAT: Feature material
- FEAT_COND: Feature condition rating
- PHOTO_NAME: File name for photo (see Table 1 for naming convention)
- RIM_ELEV: Rim elevation (feet)
- CAP _MAT: Cap material
- CAP_SHP: Cap shape
- CAP_LEN: Cap length (feet)
- CAP_WID: Cap width (feet)
- CAP_DIA: Cap diameter (feet)
- CAP_ACCESS: Whether or not the cap could be lifted and the interior accessed
- SUMP: Whether or not a sump was observed within the feature
- SUMP_ELEV: Sump (bottom of feature) elevation (feet)
- NUM_PIPES: Number of pipes associated with feature
- PIPE1_FEAT_ID: Feature ID of pipe 1
- PIPE1_ELEV: Elevation of pipe invert (feet)
- PIPE2_FEAT_ID: Feature ID of pipe 2
- PIPE2_ELEV: Elevation of pipe invert (feet)
- WEIR_TYPE: Type of weir, if applicable
- COMMENTS: Additional comments; include photo names if additional issue photos were taken
- STATUS: Status of control structure (e.g., in use, abandoned, etc.)
- X_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements
- Y_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements

Roof leader tabular data (see "Infra_RoofLeader" worksheet in MS Excel template) shall include the following information for each roof leader feature:

- BMP_ID: BMP ID of BMP associated with roof leader, if any
- FEAT_ID: Unique object identification number
- FEAT_RLEAD_TYPE: Type of connection to storm sewer (internal/external, connected/disconnected)
- FEAT_MODEL: Model ID or name of roof leader, as applicable
- FEAT_MAT: Feature material
- FEAT_DIA: Feature diameter, if circular (feet)
- FEAT_COND: Structural condition of feature
- PHOTO_NAME: File name for photo (see Table 1 for naming convention)
- FEAT_SHP: Shape of feature
- FEAT_LEN: Measured length of feature opening, if rectangular (feet)
- FEAT_WID: Measured width of feature opening, if rectangular (feet)
- COMMENTS: Additional comments; include photo names if additional issue photos were taken
- STATUS: Status of roof leader (e.g., in use, abandoned, etc.)
- X_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements
- Y_COORDINATE: See Section B. As-built CAD Files – Datum and Projection Requirements

D. SUPPORTING DOCUMENTATION

In addition to the as-built survey and tabular data, supporting documentation pertaining to each project must also be compiled. Depending on how project work was allocated, the JHU PM may have received some of the required supporting documentation from contractors involved with earlier stages of the project (e.g., final design, construction, etc.). The JHU PM shall provide a check list of supporting documentation for which the as-built surveyor is responsible.

The JHU PM should provide the following checklist indicating for which documents the as-built surveyor is responsible. A description of each supporting document is included herein.

Supporting Documentation Checklist

Supporting Document	Required from as-built Surveyor	Provided by Other Source
Final engineering design plans (AutoCAD)		
Final engineering design plans (PDF)		
Final construction specification (PDF)		
Record drawings (PDF and/or AutoCAD)		
Stormwater management reports submitted to Baltimore City DPW—Site development phase		
Stormwater management reports submitted to Baltimore City DPW—Final design phase		
Regulatory approval(s) for plans		
Construction permit(s)		
Construction inspections		
Stormwater maintenance guidance agreement(s)		
Easement plat(s)		
Performance bond(s)		
Regulatory compliance comparison narrative and table		

SUPPORTING DOCUMENT DESCRIPTIONS

A description of the supporting documents is provided below.

FINAL ENGINEERING DESIGN PLANS

The final (100%) signed and sealed engineering design plans in both AutoCAD and PDF format.

FINAL CONSTRUCTION SPECIFICATIONS

The final (100%) design construction specifications associated with the design plans.

RECORD DRAWINGS

Design plans (PDF mark ups, scanned hard copy mark ups, or annotated AutoCAD files) showing mark-ups of field observations and changes completed during construction.

STORMWATER MANAGEMENT REPORTS

Stormwater management reports typically include a narrative, design calculations, and modeling outputs for stormwater faculties. These reports are submitted to Baltimore City Department of Public Works (DPW) for review and approval at stages of the design and permitting process. There should be one set for the site development phase and another for the final design phase.

REGULATORY APPROVALS

PDF files of official letters or statements of stormwater approval from Baltimore City DPW.

CONSTRUCTION PERMITS

PDF files of official grading and construction permit application and permits.

CONSTRUCTION INSPECTIONS

PDF files of official construction and post-construction inspections.

STORMWATER MAINTENANCE AGREEMENT/DECLARATION OF COVENANTS

PDF file of fully executed stormwater maintenance agreement between the owner of the stormwater facility and the City of Baltimore.

EASEMENT PLATS

PDF of official easement plats required for construction of stormwater facilities or for inspection and maintenance access of stormwater facilities.

PERFORMANCE BONDS

A surety or cash bond, irrevocable letter of credit, or other means of security acceptable to Baltimore City prior to the issuance of any building and/or grading permit for the construction of a development requiring a stormwater management facility. The amount of the security shall not be less than the total estimated construction cost of the stormwater management facility.

REGULATORY COMPLIANCE COMPARISON

Narrative description of how the detailed design differs from the SWMMP to include:

- A narrative description of deviations in stormwater management from the SWMMP with a rationale and statement of regulatory compliance based on modified design.
- A table showing the following information for each BMP presented in the SWMMP and final design (see Appendix B):
    - BMP ID;
    - Treatment Area (A_T);
    - Environmental Site Design Volume (ESD_V);
    - Recharge Volume (Re_V); and
    - Rainwater harvesting volume (RWH_V).

D. DATA TRANSFER

MS Excel and AutoCAD files shall be uploaded to an ftp/webfolder provided by the JHU PM. For each project, all corresponding files should be provided in a folder labeled with the project ID. Within this folder information should be saved within the following subfolders:

- CAD—Auto Cad file and any supporting external references;
- Tabular—tabular (MS Excel) data file;
- Images—image and CCTV (video) files, if applicable; and
- Supporting_Documents—supporting documents specified by the JHU PM.

The JHU PM shall review the uploaded files and return them to the as-built surveyor if they not meet the guidelines outlined in this memorandum.

APPENDIX A: DEFINITION TABLES

Table A1. BMP definitions

Data Entry Code: BMP_TYPE

Green roof
Permeable pavement
Reinforced turf
Rooftop disconnection
Pavement disconnection
Sheetflow to conservation area
Rainwater harvesting
Submerged gravel wetland
Landscape infiltration
Dry well
Micro-bioretention
Rain garden
Swale
Other

Table A2. Impervious cover type definitions

Data Entry Code: COVER_IA_TYPE

Sidewalk, Pedestrian Way
Road, Vehicular Way
Gravel or Compacted Dirt
Building
Water
Other

Table A3. Pervious cover type definitions

Data Entry Code: COVER_PA_TYPE
Athletic Field
Forest
Landscaped Area
Lawn
Meadow
Brush, Shrub, or Thicket
Woods-Grass, Orchard
Pervious Pavement
Other

Table A4. Hydrologic condition definitions

Data Entry Code: HYDRO_COND
Poor (grass cover <50%)
Fair (grass cover 50% to 75%)
Good (grass cover >75%)

Table A5. Junction type definitions

Data Entry Code: FEAT_JUNCT_TYPE
Manhole
Curb inlet
Catchbasin inlet
Trench drain
Yard drain
Junction box
Other

Table A6. Pipe type definitions

Data Entry Code: FEAT_PIPE_TYPE
Stormwater main
Perforated distribution
Solid distribution
Perforated under drain
Solid under drain
Perforated lateral
Solid lateral
Culvert
Other

Table A7. Cleanout type definitions

Data Entry Code: FEAT_CO_TYPE
Under drain
Distribution pipe
Lateral pipe
Other

Table A8. Outfall type definitions

Data Entry Code: FEAT_OUT_TYPE
Headwall
Endwall
Flared end section
Other

Table A9. Control structure type definitions

Data Entry Code: FEAT_CONT_TYPE

Box
Stand pipe
Other

Table A10. Roof leader type definitions

Data Entry Code: FEAT_RLEAD_TYPE

Internal
External Connected
External Disconnected
Other

Table A11. Material type definitions

Data Entry Code: FEAT_MAT; CAP_MAT

Concrete
Reinforced Concrete
Brick
Stone/Masonry
Cast Iron
Ductile Iron
Ceramic
HDPE
PVC
Corrugated Metal
Steel
Aluminum
Rubber
Vitreous Clay
Terra Cotta
Other (see comment)
Could not be determined

Table A12. Sump presence definitions

Data Entry Code: SUMP

Yes
No
Not determined
Other

Table A13. Roof leader shape definitions

Data Entry Code: RFEAT_SHP

Circular
Rectangular
Oval
Other

Table A14. Cap shape definitions

Data Entry Code: CAP_SHP

Circular grate
Rectangular grate
Oval grate
Circular cover
Rectangular cover
Other

Table A15. Condition definitions

Data Entry Code: FEAT_COND

1-excellent condition, no maintenance
2-excellent condition, maintenance
3-functional, minor damage, no maintenance
4-functional, no damage, maintenance
5-functional, minor damage, maintenance
6-impaired, damage, no maintenance
7-impaired, no damage, maintenance
8-impaired, damage, maintenance
9-not functional due to damage
10-not functional due to maintenance needs
11-not functional due to damage and maintenance needs
12-condition could not be determined

Table A16. Status definitions

Data Entry Code: STATUS

Existing prior to redevelopment
New
Removed
Abandoned
Other

Table A17. Weir type definitions

Data Entry Code: WEIR_TYPE

None
Baffle
Rnotch
Vnotch
Other

Table A18. Wing angle definitions

Data Entry Code: WING

None
30 degrees
45 degrees
90 degrees
Other

Table A19. Outlet protection definitions

Data Entry Code: FEAT_PROT

None
Riprap apron
River stone
Articulated concrete
Concrete channel
Vegetation
Other

Table A20. Cap access definitions

Data Entry Code: CAP_ACCESS

Accessed
Inaccessible-sealed
Inaccessible-unable to lift
Inaccessible-blocked
Access not attempted
Not applicable

APPENDIX B: REGULATORY COMPLIANCE COMPARISON

Project	BMP	Corresponding Concept BMP	ESD_V (cf)		A_T (sf)		Re_V (cf)	
			Designed	Concept	Designed	Concept	Designed	Concept
Net Value for Stormwater Metrics								

ESD_V = Environmental Site Design Volume

A_T = Treatment Area

Re_V = Recharge Volume