Common Terminology and Definitions

The discipline of stream restoration has spawned many different terms; therefore, the panels agreed on the following definitions and acronyms that appear within this document.

Bank armoring: Armoring involves the placement of hard structures along the stream channel for the express purpose of limiting the movement of a stream along its horizontal and/or vertical dimensions. Engineers use bank armoring to protect and fix streams within constrained urban stream corridors so they will not move or erode at design flow rates and shear stress. For purposes of Protocol 1, individual bank armoring techniques are classified as being creditable, creditable with limits or non-creditable.

Bank Assessment for Non-point Source Consequences of Sediment (BANCS) is a method to estimate sediment and nutrient load reductions associated with stream restoration developed by Dave Rosgen (2001). Field measurements of near bank stress and bank erosion hazard in the project reach are used to predict streambank erosion rates using empirically-based regional bank erodibility curves.

Bank erosion rate monitoring: Refers to techniques to measure the overall rate bank retreat in a project reach before and after a channel is restored, which are a key input into the prevented sediment protocol. Acceptable bank erosion rate monitoring techniques include: digital elevation model differencing, bank pin monitoring, permanent cross-sections, bank profile measurement and BANCS assessment.

Base-level control: Base-level control features consist of channel features, such as bedrock and existing infrastructure that are anticipated to withstand expected channel erosion processes. Confluence locations, an existing stable condition downstream, or the downstream limits of proposed bed stabilization features can be used as base level controls in cases where no hard point controls are present within the channel**.**

Bank Erosion Hazard Index (BEHI) is a field method to estimate bank erodibility potential along a project reach that measures bank parameters such as top of bank, bank full height, rooting depth, root density, bank angle, bank composition and material stratification, among other factors. BEHI is a key parameter in the BANCS method to predict stream bank erosion at the project reach level.

Bulk density*:* Bulk density is the mass of soil for a given volume and is used as a measure of soil compaction in Protocol 1. A bulk density soil sample should be taken from each soil horizon present within the restoration reach and weighted according to the relative abundance of each horizon layer. The samples should be collected from undisturbed soils using a core and analyzed in the lab using undisturbed sampling methods. Average bulk density values are then input into Protocol 1.

Channel conditions: the current or future potential for erosion of the channel bed or banks to subsequently deliver sediment and other pollutants downstream.

Chesapeake Assessment and Scenario Tool (CAST). This tool is used to evaluate the sediment and nutrient reduction potential of a variety of urban, agricultural and forestry best management practices (BMPs) installed at various locations in the Chesapeake Bay watershed. The CAST tool relies on loading rates, BMP efficiencies and watershed delivery factors simulated by the most current version of the CBWM. CAST can be used to determine how the reductions for individual stream restoration projects are adjusted to account for delivery of sediment as it travels through the stream and river network of the Bay watershed to the estuary.

Chesapeake Bay Watershed Model (CBWM). This watershed simulation model is used as the primary accounting tool to track sediment and nutrient load reductions across the 64,000 square mile Chesapeake Bay watershed. The current version of the model (Phase 6) has been extensively calibrated to hundreds of stream and river monitoring stations, and is the regulatory tool used to track Bay-state compliance with the 2010 Chesapeake total maximum daily load.

Dry channel regenerative stormwater conveyance (RSC) involves restoration of ephemeral streams or eroding gullies using a combination of step pools, sand seepage wetlands, and native plants. The receiving channels are located above the water table and only carry water during and immediately after storms. Protocol 4 is used to define pollutant reduction achieved by this stormwater retrofit treatment practice.

Ephemeral stream: A stream that flows briefly and only in direct response to local precipitation and whose channel is always above the water table.

Equilibrium slope is the ground surface slope wherein channel bed and bank slopes within the hydrologic regime and erosion substantially decreases or ceases, and is determined by slope stability analysis.

Equilibrium bank angle is the angle at which a channel or stream bank reaches a stable condition, thereby minimizing or eliminating bank erosion within the hydrological regime.

Effective Hyporheic Zone (EHZ): The area of restored channels and floodplain wetlands used to calculate nitrogen reduction credits using Protocol 2.

Fatal flaw is defined as a systematic problem discovered during an inspection of an individual stream restoration project that may not trigger failure now, but could potentially compromise the entire reach in the near future. Field crews that find a potential fatal flaw refer it to a qualified stream assessor to who conducts a more in-depth forensic inspection to determine what additional work is needed.

Floodplain Trapping Zone (FTZ) is where low energy conditions encourage trapping and filtering of sediments and organic matter in the floodplain during and shortly after storm events. Extends from the floodplain surface to one foot above the baseline floodplain elevation, unless a higher elevation is justified by local hydrologic and hydraulic modeling.

Floodplain – For flood hazard management purposes, floodplains have traditionally been defined as the extent of inundation associated with the 100-year flood, which is a flooding event that has a one-percent probability of being equaled or exceeded in any one year[1]. However, in the context of this document, floodplains are defined as relatively flat areas of land between the stream channel and the valley wall that will receive excess storm flows when the channel capacity is exceeded. Therefore, water accesses the floodplain thus defined much more frequently than what is typically considered a flooding event.

Floodplain restoration can be achieved using two basic techniques to reconnect incised streams to their floodplains.

Floodplain restoration: legacy sediment removal (FR-LSR) removes sediments to lower the floodplain surfaces, increasing out-of-bank flow and re-establishing the hyporheic exchange zone by reconnecting the floodplain with the hyporheic aquifer.

Floodplain restoration: raising the stream bed (FR-RSB) involves several techniques to raise the elevation of an incised stream channel and shallow groundwater, thereby increasing the volume of runoff diverted into the floodplain for treatment.

Floodplain Reconnection Volume (FRV) - This term quantifies the benefit that a given project may provide in terms of bringing streamflow in contact with the floodplain. The FRV is defined as the additional annual volume of stream runoff and base flow from an upstream subwatershed that is effectively diverted onto the available floodplain, riparian zone, or wetland complex, over the pre-project volume.

Functional uplift - A general term for the ability of a restoration project in a degraded stream to recover hydrologic, hydraulic, geomorphic, physiochemical, or biological indicators of healthy stream function.

Headwater channels are stream segments connected to open or closed channel segments within zero to first order channels where water first originates in a stream system. These channels can be ephemeral, intermittent, or perennial and often adjust to storm flows through gully and rill formation and therefore can produce significant vertical and lateral rates of erosion.

Headwater Transition Zone (HTZ): The zone connecting upland land uses and urban drainage (swales, ditches and storm drain pipes) discharging stormwater discharges into the perennial stream network. Slopes or channels within the zone typically lack perennial or seasonal flow. These zones experience higher rates of both

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[1] Floodplain management agencies use the term one-percent-annual chance to define this event, in part to dispel the misconception that the 100-year flood occurs once every 100 years. In this report, return periods instead of probabilities are used for convenience.

vertical and lateral erosion and are responsible for high sediment delivery to downstream reaches. Prevented sediment in the HTZ is usually calculated using Protocol 5.

Hyporheic – A zone located below and alongside a stream, occupied by a porous medium where there is an exchange and mixing of shallow groundwater and the surface water in the channel. The dimensions of the hyporheic zone are defined by the hydrology of the stream, substrate material, its surrounding environment, and local groundwater sources. This zone has a strong influence on stream ecology, biogeochemical cycling, and stream water temperatures.

Hyporheic Aquifer (HA): An aquifer within the HEZ with a high hydraulic conductivity that underlies a floodplain soil layer, and where shallow groundwater exchange with the surface water occurs.

Hyporheic box: A term introduced by the 2014 Stream Restoration Expert Panel intended to set the maximum boundaries for hyporheic exchange where denitrification could be expected and Protocol 2 applied. The default dimensions for the box extended five feet below the stream invert and five feet into both stream banks. Group 3 concluded that the fixed unit dimensions of the original hyporheic box needed to be replaced with an "effective hyporheic zone" or EHZ, as defined by actual site conditions.

Hyporheic Exchange Zone (HEZ): Subsurface zone where nitrogen processing is highest and where denitrification credits are produced. The HEZ is where surface water and groundwater interact with the channel banks and the plant root zones in the floodplain soil layer. The HEZ occurs where a hyporheic aquifer underlays, and is in direct contact with the floodplain root zone, and the channel planform supports surface and groundwater exchange with the hyporheic aquifer. The HEZ will typically be shallow, often only 9 to 18 inches deep for most projects. Depths exceeding 12 inches would typically only occur in project reaches with large watersheds and/or large spring baseflows.

Intermittent stream: A stream in contact with the groundwater table that flows only at certain times of the year as when the groundwater table is high and/or when it receives water from springs or from some surface source (e.g., melting snow in mountainous areas). It ceases to flow above the stream bed when losses from evaporation or seepage exceed the available streamflow.

Legacy sediment - Sediment that (1) was eroded from uplands during several centuries of land clearing, agriculture and other intensive uses; (2) accumulated behind ubiquitous dams in slack-water environments, resulting in thick accumulations of cohesive clay, silt and sand, which distinguishes "legacy sediment" from fluvial deposits associated with meandering streams; (3) collected along stream corridors and within valley bottoms, effectively burying natural floodplains, streams and wetlands; (4)altered and continues to impair the morphologic, hydrologic biologic, riparian and other ecological services and functions of aquatic resources; (5) can also accumulate as coarser grained more poorly sorted colluvial deposits, usually at valley margins; (6) can contain varying amounts of nutrients that can generate nutrient export via bank erosion processes.

Widespread indicators of legacy sediment impairment include a history of damming, high banks and degree of channel incision, rapid bank erosion rates and high sediment loads. Other indicators include low channel pattern development, infrequent inundation of the riparian zone, diminished sediment storage capacity, habitat degradation, and lack of groundwater connection near the surface of the floodplain and/or riparian areas.

Legacy Sediment Removal (LSR) - A class of aquatic resource restoration that seeks to remove legacy sediments and restore the natural potential of aquatic resources including a combination of streams, floodplains, and palustrine wetlands. Although several LSR projects have been completed, the major experimental site was constructed in 2011 at Big Spring Run near Lancaster, PA.

Limited Erosion Control (LEC): refers to traditional methods to repair erosion problems at or near outfalls that involve regrading and placement of stone riprap to stabilize the eroding channel and temporarily protect the outfall. LEC often requires repeated application since the underlying channel stressors are generally not addressed and it is not considered to be a permanent engineering solution.

Natural Channel Design (NCD) - Application of fluvial geomorphology to create stable channels that maintain a state of dynamic equilibrium among water, sediment, and vegetation such that the channel does not aggrade or degrade over time. This class of stream restoration utilizes data on current channel morphology, including stream cross section, plan form, pattern, profile, and sediment characteristics for a stream classified according to the Rosgen (1996) classification scheme, but which may be modified to meet the unique constraints of urban streams

Near Bank Stress (NBS) is a field method to estimate bank stress associated with bank full flows along a project reach. The field crew estimates NBS based on channel pattern, depositional features, and the shape of the channel cross-section. NBS, along with BEHI, are key parameters in the BANCS method that are used to predict stream bank erosion at the project reach level.

Non-urban - A sub-watershed with less than 5% impervious cover, and is primarily composed of forest, agricultural or pasture land uses. Individual states may have alternative definitions.

Outfalls are the outlets, conveyances and discharge points from storm drain networks, often located at headwater stream systems or are direct connections to closed storm drain networks. Does not include outfalls that produce overflows from separate or combined sewer systems

Outfall and Gully Stabilization (OGS) Practices are an engineering approach to design a stable channel to dissipate energy that extends from the upland source to the stream channel. The new channel is designed and constructed to achieve an equilibrium or near-equilibrium state where future sediment loss is minimized or eliminated altogether. Acceptable OGSP practices provide a permanently stable connection between upland runoff sources and receiving streams by utilizing structural energy dissipation techniques such as grading, step-pools, cascades, and rock toe protection within the typically steep headwater transition zone. At highly constrained sites, other stable engineering solutions such as drop structures, extension of existing storm drain pipes or scour protection may be considered.

Perennial stream: A stream that flows continuously throughout the year.

Pipe conditions: the current or future status of the discharge pipe associated with the given outfall and channel.

Predictive indicators (for severe erosion): Visible and measurable indicators that severe erosion is imminent in a bank face, bank toe, or channel bed in an outfall or headwater stream channel. These include indicators of fluvial erosional processes and mass failure mechanisms such as: a higher value of existing slope to equilibrium slope of greater than 25%, observations of tension cracks in a sediment profile upstream of a stream bed, knickpoints or head cuts greater than 6 inches in height, bulging of material at a headwater feature toe of slope indicative of planar/slab failures, rotational failures, or composite bank failures.

Prevented sediment - The annual mass of sediment and associated nutrients that are retained by a stable, restored stream bank or channel that would otherwise be eroded and delivered downstream in an actively enlarging or incising urban stream. The mass of prevented sediment for an individual stream restoration project using the field methods and Protocol 1.

Project failure: Field crews use numeric failure thresholds to determine the length of a project reach that may be compromised during field verification inspections. A second forensic investigation by a qualified stream restoration professional may be needed to confirm the diagnosis. Projects are assessed using visual indicators to determine if the degree of change is severe enough to warrant management action, relative to the original design. Stream restoration projects are classified as either functioning (pass) showing major compromise (action needed) or failing (fail, and lose credit).

Project reach - the length of an individual stream restoration project as measured by the valley length (expressed in units of linear feet). The project reach is defined as the specific work areas where stream restoration practices are installed.

Qualified stream professional are knowledgeable consultants, review agency staff, engineers, ecologists, biologists or other suitable experts. Person or teams serving in this role reviewed site conditions and project construction documents, provide quality control on rapid inspections done by field technicians, perform subsequent forensic investigations, and make final decision whether a project fails. The panels did not categorically define the qualifications for stream professionals, leaving the decision to the project owners/sponsors and their permit review authorities.

Regenerative Stormwater Conveyance (RSC) - Refers to two specific classes of stream restoration as defined in the technical guidance by Flores (2011) an An (2018) Anne Arundel County, Maryland. The RSC approach has also been referred to as coastal plain outfalls, regenerative step pool storm conveyance, base flow channel design, and other biofiltration conveyance. For purposes of this report, there are two classes of RSC: dry channel and wet channel.

Stream restoration refers to any natural channel design (NCD), regenerative stormwater conveyance (RSC), legacy sediment removal (LSR) or other restoration approach that meets the qualifying conditions for credits, including environmental limitations and stream functional improvements. No single design approach was considered superior, as any project can fail if it is poorly located, assessed, designed, constructed, or maintained.

Upland restoration - The implementation of best management practices (BMPs) outside the stream corridor to reduce runoff volumes and pollutant loads in order to restore the quality of streams and estuaries.

Verification: is required to ensure that any practice used for pollutant reduction credit in the Chesapeake Bay TMDL actually exists, is working as intended and are maintained properly over their design life. Each urban BMP has a defined credit duration, which can only be renewed when a field inspection of visual indicators confirms that the practice continues to function properly. The credit duration of stream restoration practices is five years.

Visual indicators are protocol-specific rapid field assessments that measure potential loss of pollutant reduction function in some or all of the project reach for dominant restoration crediting protocol. Visual indicators are used to quantify obvious departures from original design that appear to compromise project pollutant reduction functions.

Wet channel RSCs are located in intermittent streams or further down the perennial stream network and use instream weirs to spread storm flows across the floodplain at minor increases in the stream stage during smaller storm events. Wet channel RSC may also include sand seepage wetlands or other wetland types in the floodplain that increase floodplain connection, reconnection, or interactions with the stream. Wet channel RSC systems are classified as a stream restoration practice, and their pollutant removal rate can be estimated based on a combination of Protocol 1, 2 and 3.