Appendix D: Clarifying the definition of "Efficiency" to estimate TN, TP and TSS reductions as applied to wetland BMPs in the Phase 6 CBWM

Editor's note: this was originally a handout provided to the panel prior to its April 2019 conference call. Only minor edits (e.g., table/figure numbers) were made when updating it for the panel's report as Appendix D.

The panel will have an opportunity to review and provide input on efficiency values for the TN, TP and TSS reduction values (as percent values) for the three wetland BMPs within our scope/panel charge (creation, rehabilitation and enhancement[1]) at our April 12th meeting. These percent values reduce the estimated nutrient and sediment loads from upland areas such as cropland. One conceptual difficulty is how to quantify and differentiate the BMP-condition from a baseline condition to determine these efficiency values. Additional load reductions are gained for land use change BMPs, such a wetland creation. More details are provided later in this document.

To date the panel has considered and applied different definitions of the term "efficiency." For example, the term has been used to define the post -construction pollutant removal or effectiveness of a practice (i.e., difference between input and output loads in that post-construction condition) but, has also referred to a net efficiency that considers the baseline, or pre-treatment condition of the project site and post-construction conditions. The purpose of this memo is to resolve the differences in interpretations of the term "efficiency" and to agree on the best interpretation to apply to the panel recommendations for the three BMPs. For example, a post-construction efficiency would be calculated based on the difference in input and output loads shown in Figure . A net efficiency is defined by the difference in the output loads pre- and post-treatment, respectively, as depicted in Figures D-1 and D-2.

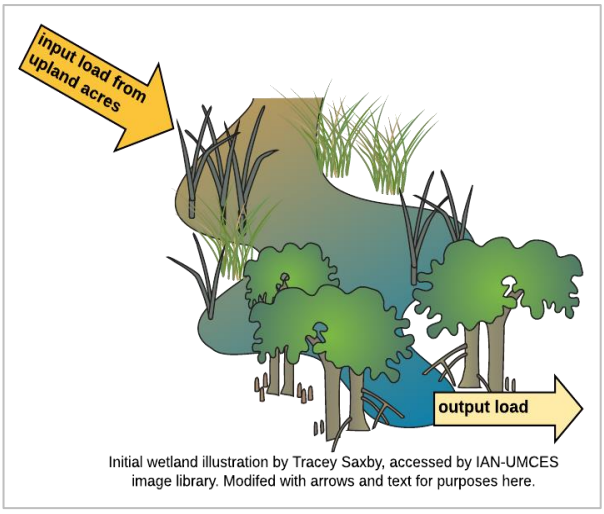

Figure D-1. Baseline or pre-treatment condition, with wetland present but conditions are degraded.

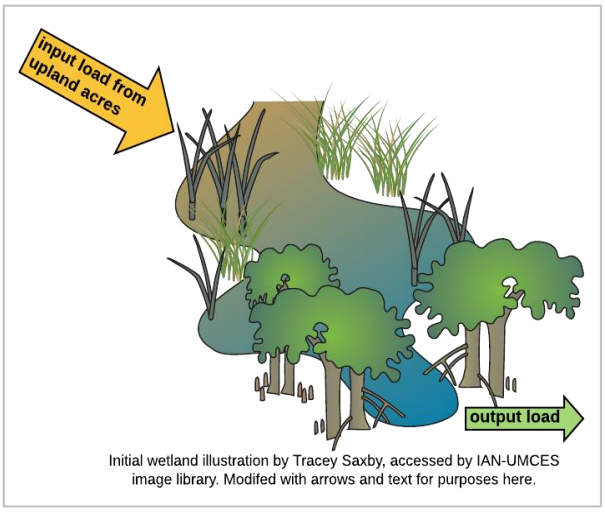

Figure D-2. Post-treatment, or desired outcome for a degraded wetland to repair functions to natural or historic functions (e.g. rehabilitated).

[1] Recommendations are forthcoming to determine if wetland enhancement BMPs are eligible for credit.

Consolidating our terminology: wetland BMPs and illustrations

For the purposes of crediting in the Chesapeake Bay Watershed Model, the overall **effectiveness** of a BMP is the difference between a **baseline** condition (no BMP or a natural, degraded wetland) and the post-implementation condition or **BMP condition**. This is consistent with other BMP credit methods. For example, an urban BMP retrofit practice is provided a 'bump-up' credit based on the difference between the pre-treatment (existing BMP, like a dry pond) and the post-treatment (retrofit) conditions.

To merge the terms and discussions so far, recall the four BMP categories as described in WEP 2016 (see Table D-1). A key distinction to remember is the resulting gains from the practices: **restoration and creation yield acreage and functional gains from wetlands**, **while rehabilitation and enhancement only represent functional gains**.

Table D-1 - CBP Wetland BMP definitions

Wetland BMP Definitions		
Wetland type	CBP Definition	Operational Definitions
Restoration	The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland	• No wetland currently exists, • Gain in wetland acreage • Hydric soils present • "Prior converted"
Creation	The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist at a site.	• No wetland currently exists • Gain in wetland acreage • Hydric soils not present
Rehabilitation	The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded wetland.	• Wetland present • Gain in wetland function • Wetland conditions/functions degraded
Enhancement	The manipulation of the physical, chemical, or biological characteristics of a wetland to heighten, intensify, or improve a specific function(s).	• Wetland present • Gain in wetland function • Some functions may be suboptimal

The distinction between acreage gain BMPs and functional gain BMPs is vital for determining the BMPs' effectiveness, as it informs an understanding of the possible baseline and BMP conditions. The panel has discussed the starting conditions in detail, but for simplicity we will assume two general possibilities: 1) no wetland is present, with or without hydric soils) or, 2) a wetland is present and degraded.

The post-implementation performance of the site (BMP condition) will vary, but the general concept is to improve upon existing site conditions that either restores or repairs to a natural or historic wetland condition; creates a wetland where one did not historically exist; or improves one or more functions of an existing wetland. The actual performance and function of the wetland will vary based on the type of BMP and the specific actions/techniques applied on the site. However, we are lumping them into one diagram for this basic illustration (Figure). The question remains: how should the panel quantify and define its recommended efficiency values?

Baseline Conditions

This section will revisit the concept of the baseline condition for wetland BMPs, focusing on restoration (for reference to the previous WEP), creation and rehabilitation. The Panel may apply this to wetland enhancement BMPs pending the discussion of recommendations.

Recall the conceptual baseline condition for Restoration or Creation in Figure D-3. In that case, the baseline consists of agriculture land – let's assume marginal cropland.

The previous WEP established its efficiency values for Restoration based on the literature, which generally reflects the reduction from inputs to outputs of a wetland. If we assume that the baseline condition (ag land) provides near zero retention or removal of loads from upland loads, then we can understand why the WEP went with the literature values (i.e., typically representative of post-construction loads).

For creation, therefore, we could make a similar assumption for the baseline condition - that it provides no retention or removal benefits for upland loads, but the established wetland will – thereby an efficiency value based on the post-construction condition will suffice.

Figure D-4 illustrates how wetland creation will be simulated in the Model as a land use change BMP with additional upland treatment. The wetland restoration BMP works the same way, but potentially with a different upland efficiency value or upland acre ratio, depending on the recommendations from this current panel.

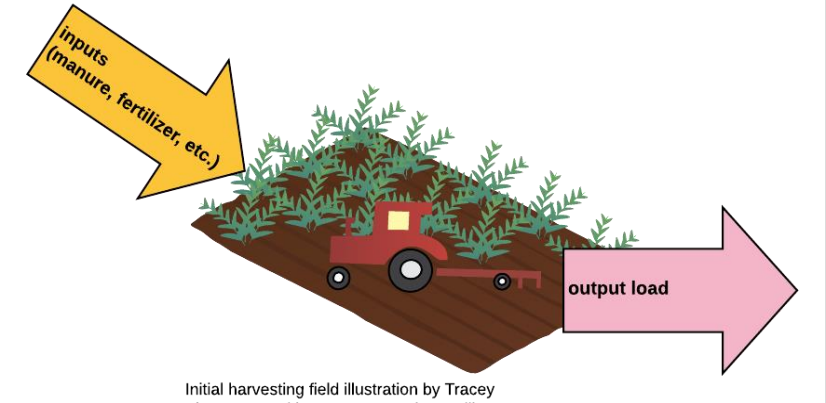

Figure D-3. Possible starting condition, with no wetland present. The site may be (A) prior-converted site with hydric soils present (restoration), or (B) hydric soils may not be present (creation). Hydric soils not illustrated.

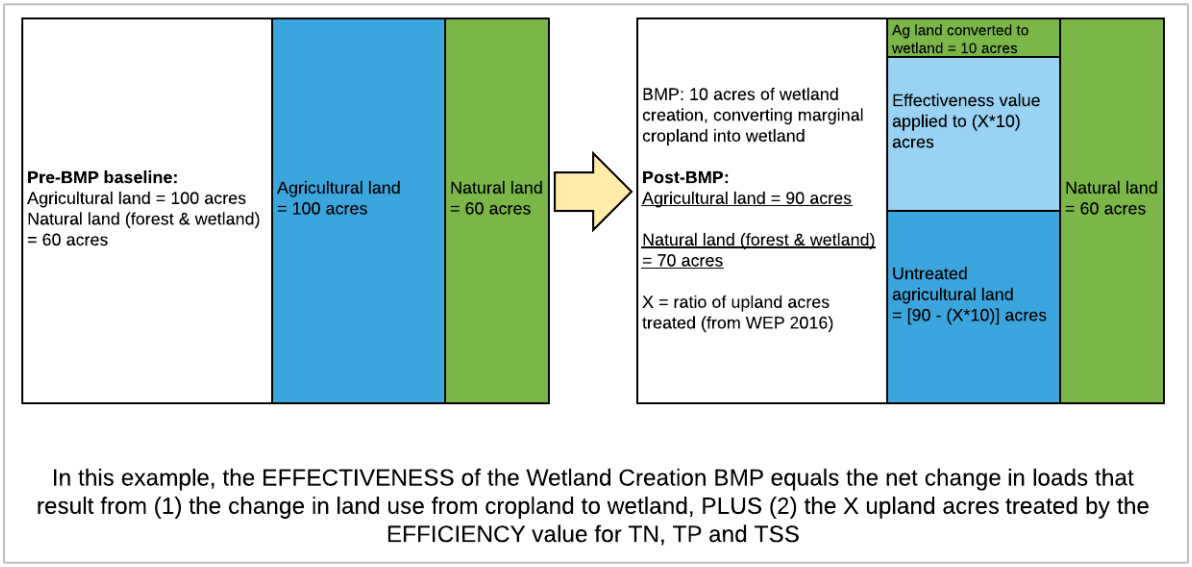

Figure D-4. Theoretic example of wetland creation in the Watershed Model.

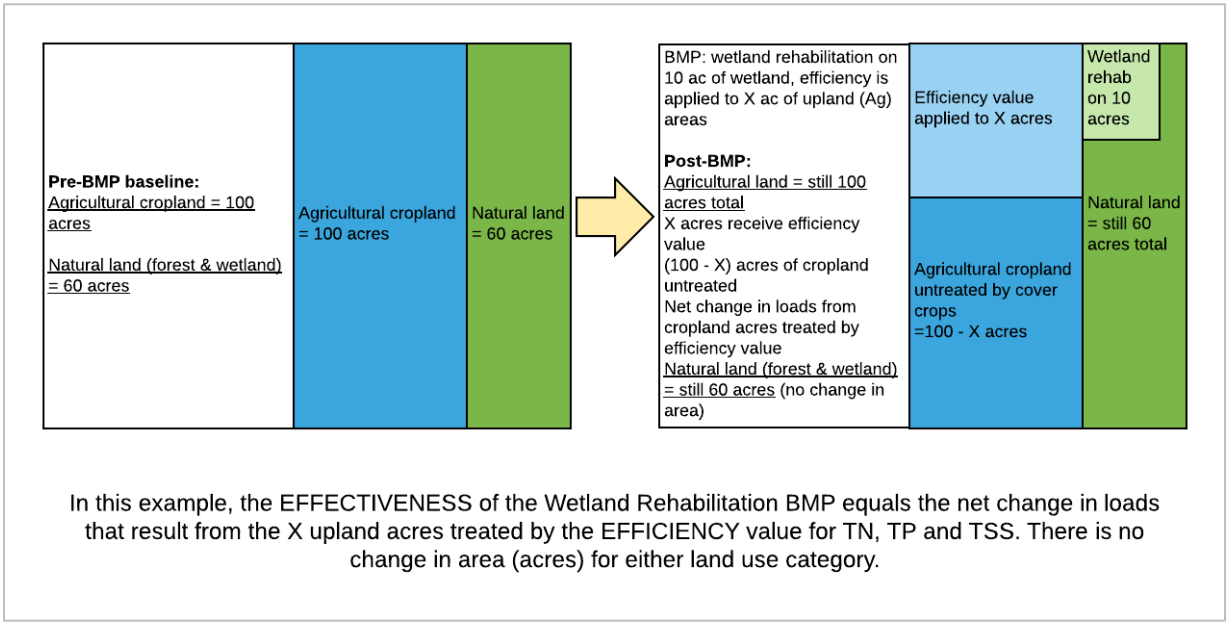

Figure D-5. Theoretical example of wetland rehabilitation in the Watershed Model.

Now let's consider rehabilitation, which is a functional gain practice (Figure D-5). This practice can only be applied on acres of wetlands in the model, but it can treat loads from upland load sources (presumably Ag, but the panel can broaden that to developed or natural sources with justification). In this case, consider the shift from Figure D-1 to Figure D-2; there is currently a wetland – whose effects are implicitly captured in the model – and the management action (rehabilitation) improves its ability to retain or transform nutrients and sediment, shifting us toward the condition in Figure D-2. In this case, our desired efficiency value is the net change between the baseline (existing wetland) and the BMP-condition. A rehabilitated wetland could theoretically perform as well as a restored or created wetland, but the recommended efficiency value applied to upland load sources would necessarily be lower to reflect the difference between baseline- and BMP-conditions.

Table D-2 builds on the simple concepts of baseline and the BMP-condition for the three wetland BMPs from the above discussion and figures, clarifying if literature removal rate values are logical as-is or if a net change value is needed.

Table D-2 - Summary of wetland BMPs and how to set respective efficiency values given baseline and BMP-conditions

Wetland BMP type	**Types of gains**	**Existing Representation in the P6 Model (pre-treatment)**	**Representation in the P6 Model Post treatment**	**How to set the efficiency value for treatment of upland loads** *(not including load reductions from land use changes)*
Wetland restoration	Gain in acres and function	The existing land use (ag, forest)	Change in land use to wetland and efficiency applied to upland treated acres	In this case the difference in baseline (no wetland, hydric soils) and the BMP-condition (restored wetland) is reasonably equal to the post-construction assumed to be represented by literature removal rates.
Wetland creation	Gain in acres and function	The existing land use (ag, forest)	Change in land use to wetland and efficiency applied to upland treated acres	In this case the difference in baseline (no wetland, no hydric soils) and the BMP-condition (created wetland) is reasonably equal to the post-construction assumed to be represented by the literature removal rates, perhaps adjusted in relation to restoration, using other lines of evidence like the Riparia database.
Wetland rehabilitation	Gain in function	Existing natural wetland (implicit assumption that all existing wetlands are represented in the model, their condition is not evaluated)	Efficiency applied to upland treated acres	In this case the difference in baseline (wetland, degraded function or conditions) and the BMP-condition (rehabilitated wetland) is the difference between the expected removal rates under the baseline and BMP-condition.
Wetland enhancement	Gain in function	Existing natural wetland (implicit assumption that all existing wetlands are represented in the model, their condition is not evaluated)	Efficiency applied to upland treated acres	TBD
Natural wetland (existing)	n/a	Wetland land use loading rate (equivalent to forested land use)	n/a	Land to water factors adjusts the loads….