Performance Standards for Target Hydrology and Target Vegetation

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March 8, 2017
Performance Standards (PS)

- Observable or measurable physical, chemical and/or biological attributes used to determine if a compensatory mitigation project meets its objectives (Federal Mitigation Rule (§ 332.2))
- Must be based on best available science that can be measured or assessed in a practicable manner (§ 332.5)
- Must be enforceable “shall”

Why Important: Compensatory wetland mitigation involves millions of dollars and thousands of acres nationwide. This mitigation needs to be objectively evaluated in striving for the goal of replacing wetland functions and services lost due to authorized impacts.
Goals for Compensation Sites

- **Target Hydrology**: the hydrology necessary to achieve the goals/objectives of a compensation site

- **Target Vegetation**: the specific wetland plant communities to be established at a compensation site

- **Goal**: match target hydrology with target vegetation to achieve a higher degree of success at wetland compensation sites

A compensation site that meets performance standards for both target hydrology and target vegetation is typically on the correct trajectory for meeting goals/objectives.
History (MN/WI)

- By 2005, seed mixes and performance standards for target vegetation had advanced significantly.

- However, performance standards for target hydrology often consisted of a one size fits all, minimum for wetland hydrology – the driest condition that would minimally meet wetland criteria.

- The goal is not to establish the minimum wetland hydrology, but rather to establish the optimum hydrology for targeted wetland plant communities and associated functions and services.
Minimum (driest) condition that meets wetland hydrology is not suitable for establishing most target wetland plant communities.

From Eggers and Reed (2015)
Target Hydrology Performance Standards (PS) for MN/WI

Deep Marshes
Shallow Marshes
Sedge Meadows
Fresh (Wet) Meadows
Wet to Wet-Mesic Prairies
Calcareous Fens
Open Bogs
Coniferous Bogs
Shrub-Carrs
Alder Thickets
Hardwood Swamps
Coniferous Swamps
Floodplain Forests
Seasonally Flooded Basins

Target hydrology PS developed for specific plant communities based on monitoring well data, field observations, scientific literature and other sources.

Plant communities based on: *Wetland Plants and Plant Communities of MN and WI*, Version 3.2

http://cdm16021.contentdm.oclc.org/cdm/compoundobject/collection/p266001coll1/id/2801/rec/1
Components of Target Hydrology PS for Specific Wetland Plant Communities

- Specify minimums and maximums for depth, duration and frequency of inundation and/or a water table ≤12 inches below the soil surface
- During the growing season
- In the context of antecedent precipitation
- Use monitoring wells/dataloggers to confirm whether PS are met
- Regionalized to account for different plant communities, climatic conditions, etc.
Components of Target Hydrology PS for Specific Wetland Plant Communities

- During the growing season
  - Growing season is determined in accordance with the regional supplements to the 1987 *Corps of Engineers Wetlands Delineation Manual* (e.g., the “green up” indicator)
Components of Target Hydrology PS for Specific Wetland Plant Communities

- In the context of antecedent precipitation
  - PS specify the antecedent conditions under which inundation and/or a water table ≤12 inches below the soil surface is required
  - Many types of wetlands are naturally dry during late summer or during periods of below normal precipitation
  - Thus, it would not be reasonable nor prudent to require inundation, or a water table ≤12 inches below the soil surface, for 100 percent of the growing season every year
  - Inundation and/or a water table ≤12 inches below the soil surface is not required for certain wetland plant communities during monitoring periods that are “drier than normal”
Defining Antecedent Precipitation Terminology Used in the PS

- References for categorizing antecedent precipitation as normal, wetter than normal, and drier than normal
  - Accessing and Using Meteorological Data to Evaluate Wetland Hydrology (Sprecher and Warne 2000)
    http://el.erdc.usace.army.mil/elpubs/pdf/wrap00-1.pdf
Figure 1 – Example of 30-day Rolling Totals

- Range of Normal Precipitation (based on 30-year period of record)

Recommended approach for presenting precipitation data in monitoring reports

Source: Stantec
Components of Target Hydrology PS for Specific Wetland Plant Communities

- **Monitoring Wells/Dataloggers**
  - PS are based on a consecutive number of days of inundation and/or a water table <12 inches below the soil surface.
  - Once weekly, twice weekly, etc., readings are not suitable because they do not confirm whether the consecutive day requirement is met.
  - Recommended approach is installation of monitoring wells/dataloggers set for multiple readings/day.

Monitoring Well Design for Wetland Hydrology Determinations
Depth, Duration & Frequency of Inundation and/or the Water Table

- Starting point is the wetland hydrology technical standard for interpreting monitoring well data ([Technical Standard for Water-Table Monitoring of Potential Wetland Sites][U.S. Army Corps of Engineers 2005]) [http://el.erdc.usace.army.mil/elpubs/pdf/tnwrap05-2.pdf]

Inundation and/or a water table ≤12 inches below the soil surface for ≥14 consecutive days during the growing season in most years (≥50 percent probability)

- Use reference standard wetlands when feasible

- Build PS based on best available science: (1) scientific literature; (2) hydrological data collected by watershed districts, for research projects, monitoring of previously constructed compensation sites, etc.; (3) stream gauge data; and (4) consultation with regional wetland experts.
The wetland hydrology tech standard uses depth to the water table; therefore, the PS use depth to the water table.

Depth to saturated soils is problematic for purposes of the PS and is not used for that reason.

Upper limit of soil saturation due to the capillary fringe* can be difficult to measure in the field and is not practical for daily hydrologic monitoring.

Monitoring wells measure depth to the water table – cannot measure saturation due to capillary fringe.

Depth to the water table can be monitored readily and consistently using monitoring wells.

* Tension-saturated zone
Reference Standard Wetlands

- Least altered wetlands in the least altered landscapes that are of the same type as that proposed for the compensation site
- Located on-site or as close as possible to the compensation site
- Data from monitoring wells/dataloggers in reference standard wetland are then compared to that from the restored/enhanced/created wetland of the compensation site
- This approach is the ideal; however, finding and instrumenting reference standard wetlands in proximity to a compensation site is often not practicable
Example: A compensation site plan proposes restoration of a depressional (HGM class), hardwood swamp community on Histosols (organic soils)

A reference standard depressional, hardwood swamp community on Histosols and in proximity to the compensation site is instrumented with monitoring wells/dataloggers

Monitoring well data are then compared between restored and reference standard hardwood swamp communities contemporaneously

Set criteria for acceptable range of differences in inundation and/or depth to the water table (e.g., plus or minus 20%)
Example: Characteristic hydrograph for certain wetland plant communities in MN/WI is inundation and/or a water table \( \leq 12 \) inches below the soil surface for 4-6 weeks during the early growing season (April-May-June) followed by a water table more than 12 inches below the soil surface for the remainder of the growing season ("seasonal wetlands")
Example – WET PRAIRIES

- General Description: Herbaceous communities dominated by native, hydrophytic grasses and forbs associated with prairies; growing on hydric mineral soils with a seasonal high water table; periodically inundated for brief duration following snowmelt and heavy precipitation events.*

* From Eggers and Reed (2015)

* Cowardin et al. (1979) hydrologic regime “saturated”

FIGURE 6 - Generalized Cross Section of a Meadow-Marsh-Open Water Complex
Example: **Target Hydrology PS for WET PRAIRIES**

- **(Seasonal High Water Table)** *Hydrology shall consist of a water table 12 inches or less below the soil surface for a minimum of 28 consecutive days during the growing season under normal to wetter than normal hydrological conditions.*

**Comments:** This PS is based on wet prairies that exhibit a water table ≤12 inches below the soil surface for 4-6 weeks early in the growing season followed by a decline in the water table below 12 inches. Thus, *4 consecutive weeks (28 days)* is applied as the minimum duration of a water table ≤12 inches below the soil surface.

Reference standard wet prairies are typically dry during drier than normal conditions so it is not a negative if the compensation site wet prairie community lacks a water table ≤12 inches below the soil surface during drier than normal conditions. But it also does not inform us of whether the required water table depth/duration would be met during normal and wetter than normal conditions. Answer: continue monitoring.

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Example – FLOODPLAIN FORESTS

- **General Description:** Forested communities dominated by hydrophytic, deciduous hardwoods growing on alluvial soils associated with riverine systems. *Inundated during flood events but relatively well-drained for much of the growing season.*

*Cowardin et al. (1979) hydrologic regime “temporarily flooded”*
Example: Target Hydrology PS for FLOODPLAIN FORESTS*

- Hydrology shall consist of inundation for a minimum of 14 consecutive days during the growing season at the following annual frequencies:
  - Elevations below 700: >90%
  - Elevations 700-701: >70%
  - Elevations 701-702: >50%

- Duration of inundation during the growing season shall not exceed ___ consecutive days.

Base duration on flood tolerances of the target vegetation

*Requires stream gauge data and 1-foot contour interval mapping of the compensation site
Example: **Target Hydrology PS for FLOODPLAIN FORESTS**

- Hydrology shall consist of inundation for a minimum of 14 consecutive days during the growing season at the following frequencies:
  - Elevations below 700: >90% of growing seasons
  - Elevations 700-701: >70% of growing seasons
  - Elevations 701-702: >50% of growing seasons

Note that 14 consecutive days of inundation would result in an additional number of days of a water table ≤12 inches below the soil surface depending on soil textures.
Example – DEEP MARSHES

- **General Description:** Vegetation comprised of aquatic emergent, floating, floating-leaved and submergent species. Depth of inundation during the growing season ranges from 6 inches to 36 inches except under drought conditions.*

*From Eggers and Reed (2015)

*Cowardin et al. (1979) hydrologic regimes “semi-permanently flooded” and “intermittently exposed”
Example: **Target Hydrology PS for DEEP MARSHES**

- Hydrology shall consist of inundation 6 inches to 36 inches in depth throughout the growing season with the exception of drought conditions.

To be enforceable, any technical term or phrase used in a PS must be specifically defined or have an accepted methodology.

So precisely what constitutes “drought conditions?”

Drought?
Example: “Drought Conditions”

Source: National Drought Mitigation Center
http://droughtmonitor.unl.edu/AboutUs/ClassificationScheme.aspx
Summary for Hydrology PS

- Develop target hydrology PS for specific plant communities based on reference sites and best available science
- Use site-specific data to tailor PS to achieve goals/objectives
- Confirm whether hydrology PS are met via monitoring wells/dataloggers
- Use 30-day rolling totals to characterize precipitation during each monitoring year
- Use best professional judgment and, when warranted, flexibility in applying hydrology PS
Components of Vegetation PS

- Relative Areal Cover by NNI Species versus InNN Species
- Species Richness/Diversity
- Relative Areal Cover by Hydrophytes
- Maximum Allowance for Unvegetated Areas
- Survival of Planted Woody Stock/Establishment of Woody Vegetation
- Floristic Quality Assessment

NNI = native, non-invasive species
InNN = invasive and/or non-native species
**PS for Target Vegetation**

**Areal cover:** a measure of the above ground portions of plants based on the percentage of the ground surface covered by stems and leaves when viewed from directly above. Two categories:

- **Absolute areal cover:** actual cover by an individual plant species, or group of plant species (e.g., hydrophytes), expressed as a percentage of a reference area or plot; sum of absolute areal cover within a reference area or plot can exceed 100 percent due to overlapping layers of vegetation

- **Relative areal cover:** the proportion (percentage) of the total absolute areal cover by an individual plant species, or group of plant species (e.g., hydrophytes), within a reference area or plot; sum of all proportions equals 100 percent

**Areal:** adjective of area  
**Aerial:** as in aerial photography
Relative Areal Cover

Determine proportion of areal cover by NNI species vs. InNN species

Relative Areal Cover by NNI = \[
\frac{\text{Sum of areal cover by NNI species}}{\text{Sum of areal cover by NNI and InNN species}} \times 100
\]

**Example Table**

<table>
<thead>
<tr>
<th>Plot</th>
<th>Absolute Areal Cover by NNI (%)</th>
<th>Absolute Areal Cover by InNN (%)</th>
<th>Total Veg. Areal Cover (%)</th>
<th>Relative Cover by NNI (%)</th>
<th>Relative Cover by InNN (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
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<td>20</td>
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<tr>
<td>F</td>
<td>380</td>
<td>20</td>
<td>400</td>
<td>95</td>
<td>5</td>
</tr>
</tbody>
</table>

NNI = native, non-invasive species; InNN = invasive and/or non-native species

PS: InNN species shall have ≤20% areal cover (Does that mean absolute areal cover or relative areal cover?)
### Tiered Approach to Vegetation PS

**Example:**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Areal Cover Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interim 1:</strong></td>
<td>≥50% relative areal cover by NNI species; &lt;50% relative areal cover by InNN species</td>
</tr>
<tr>
<td><strong>Interim 2:</strong></td>
<td>≥70% relative areal cover by NNI species; &lt;30% relative areal cover by InNN species for &gt;2 consecutive growing seasons after Interim 1 is met</td>
</tr>
<tr>
<td><strong>Final:</strong></td>
<td>≥85% relative areal cover by NNI species; &lt;15% relative areal cover by InNN species for &gt;1 growing season after Interim 2 is met</td>
</tr>
</tbody>
</table>

Applies to upland buffer communities as well as wetland communities.
Species Richness

- **Species richness** = number of plant species
- Varies widely among plant communities
- No formula developed to calculate
- Consider number of species in seed mix, what could be expected in the way of response by the native seedbank and seed rain from adjacent/upgradient areas
- Number of strata is a factor—herbaceous plant communities with a single stratum vs. forested communities with multiple strata

| Interim 1: None (vegetation is in initial stages of development) |
| Interim 2: >15 NNI species |
| Final: >20 NNI species |
Dominance/Diversity

Species richness alone is not sufficient (e.g., 25 NNI species are recorded but one species has 95% relative areal cover)

One solution is to specify a minimum number of species with a minimum areal cover

Example:

**Interim 1:** None (vegetation is in initial stages of development)

**Interim 2:** >5 species with >5% relative areal cover

**Final:** >8 species with >5% relative areal cover
Dominance by Hydrophytes

Minimum to meet hydrophytic vegetation is >50% of dominants are hydrophytes; or >50% relative areal cover by hydrophytes.

Similar to hydrology PS, the **minimum** is not the **optimum** for purposes of establishing wetland compensation sites.

Example:

| Interim 1: | None (vegetation is in initial stages of development) |
| Interim 2: | >60% relative areal cover by hydrophytes |
| Final:     | >75% relative areal cover by hydrophytes |

Why not require 100% relative areal cover by hydrophytes?
Wet meadows, sedge meadows, wet prairies vs. shallow and deep marshes

NNI FACU species are natural components of many native wetland plant communities.
Maximum Allowance for Unvegetated Areas

Adjust to specific plant communities. Should be very little unvegetated areas in wet meadow, sedge meadow, wet prairie and upland prairie after 2 growing seasons.

Conversely, some degree of unvegetated areas are natural components of shallow marshes, seasonally flooded basins, floodplain forests, vernal pools, etc.

Example:

- **Interim 1**: No unvegetated areas >400 sq. ft.
- **Interim 2**: No unvegetated areas >100 sq. ft.
- **Final**: No unvegetated areas >10 sq. ft.
Survival of Planted Woody Stock/Establishment of Woody Vegetation

**Metrics:**
- Survival of planted woody stock
- Number of live stems/acre
- Areal cover
- Basal diameter
Example: PS for restoration of a forested wetland given typical 10-year monitoring time frame:

Interim 1: >70% survival of planted tree seedlings; or, >200 live, NNI tree seedlings/acre for ≥3 growing seasons

Interim 2: >150 live, NNI tree seedlings/acre with a basal diameter of ≥1.0 inch for ≥3 growing seasons after Interim 1 is met

Final: >50% areal cover by ≥4 NNI tree species

General goal for forested restorations is 108 trees/acre (about 1 tree for each 20 x 20 foot area). Tree size (>3 inch dbh) may or may not be attained within limits of a 10-year monitoring period. Intent is to verify that the restoration is on the correct trajectory to establish the target forested community.
Floristic Quality Assessment

- Most useful metric for PS is weighted C-value ($wC$)

- Weighting C-values by percent areal cover of each plant species provides a simple yet comprehensive evaluation of that plant community (MPCA 2014*)

- The question for use in PS is what constitutes reasonable and appropriate targets for $wC$ in determining functional lift/credits generated

### Summary: Example Vegetation PS

#### Fresh (Wet) Meadows, Sedge Meadows and Wet to Wet-Mesic Prairie Communities

<table>
<thead>
<tr>
<th>Category</th>
<th>Interim 1 Description</th>
<th>Interim 2 Description</th>
<th>Final Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Areal Cover by NNI Species versus InNN Species</td>
<td>≥50% NNI; &lt;50% InNN</td>
<td>≥70% NNI; &lt;30% InNN*</td>
<td>≥85% NNI; &lt;15% InNN</td>
</tr>
<tr>
<td>Species Richness</td>
<td>N/A</td>
<td>&gt;15 NNI</td>
<td>&gt;20 NNI</td>
</tr>
<tr>
<td>Number of Species With ≥5% areal cover</td>
<td>N/A</td>
<td>&gt;8 NNI</td>
<td>&gt;10 NNI</td>
</tr>
<tr>
<td>Relative Areal Cover by Hydrophytes</td>
<td>N/A</td>
<td>&gt;60%</td>
<td>&gt;75%</td>
</tr>
<tr>
<td>Maximum Unvegetated Areas</td>
<td>&lt;400 ft²</td>
<td>&lt;100 ft²</td>
<td>&lt;10 ft²</td>
</tr>
<tr>
<td>Floristic Quality Assessment</td>
<td>N/A</td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>

N/A = none specified because vegetation is in initial stages of establishment. TBD = To be determined on a case-by-case basis as an optional PS.

* For ≥2 consecutive growing seasons after Interim 1 is met.

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#### For forested restorations:

| Establishment of Tree Species | >70% survival of planted woody stock; or >200 live, NNI seedlings/acre for ≥3 growing seasons | >150 live, NNI tree seedlings/acre with a basal diameter of ≥1.0 inch for ≥3 subsequent growing seasons | >50% relative areal cover by ≥4 NNI tree species |
Questions?

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