Keys to LLWW for Inland Wetlands of the Western United States

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INTRODUCTION

Wetlands occur in a wide variety of landscape settings across the western United States. The geomorphic setting of a wetland, its proximity to other wetlands and waterbodies, and the dominant water source and flow path all influence the functions a wetland can perform (Brinson 1993; Tiner 2014). The national standard for wetland classification in the United States is the U.S. Fish and Wildlife Service (USFWS)'s *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979), which emphasizes vegetation structure, hydroperiod, and certain natural and human modifications (e.g., beaver-influence, excavation, impoundment, partial drainage, and farming). This classification has been used by the USFWS National Wetland Inventory (NWI)[1] since the 1970s to map wetlands across the conterminous U.S. and many outlying areas. The NWI Program now provides a seamless digital dataset of wetlands for nearly the entire nation. The Cowardin classification has proven very effective at characterizing diverse wetlands types for mapping purposes and for natural resource management. However, this classification does not include properties essential for estimating likely wetland functions.

In the early 1990s, Mark Brinson created the hydrogeomorphic (HGM) classification system to assess wetland function (Brinson 1993). The HGM classification system groups wetlands based on geomorphic position and hydrologic characteristics, such as water source and hydrodynamics. Recognizing a need to bridge NWI's Cowardin classification and Brinson's HGM classification, the NWI program developed an HGM-like coding system complimentary to the national wetlands classification system. This new classification system describes wetlands based on Landscape Position, Landform, Water Flow Path and Waterbody Type and is referred to by the acronym LLWW (Tiner 1995; USFWS 2008). The LLWW codes and modifiers for wetlands can be easily correlated with the primary HGM classes, but also include a level of detail beyond HGM. To assist with the application of the LLWW classification, NWI's Ralph Tiner developed a series of dichotomous keys for LLWW codes (Tiner 2003; Tiner 2011; Tiner 2014) and these keys have been used for landscape-scale assessments of potential wetland functions in several states (e.g., Tiner & Bergquist 2003; Tiner et al. 2013; Stark et al. 2016).

The LLWW classification was originally developed in the eastern United States and has primarily been applied to wetlands east of the Great Plains. Wetlands in the western United States differ from

[1] See the NWI website for more information: https://www.fws.gov/wetlands/index.html

eastern wetlands in many respects, due to differences in climate, geography, and common landscape stressors. The following keys are intended to guide the application of the LLWW classification to existing or newly created NWI data throughout the inland portion of the western United States[2] following basic principles outlined in Tiner (2014). These keys do not apply to marine or estuarine wetlands. Specific aspects of these keys and associated codes are different from those presented in Tiner (2014) to better represent the Western landscape, including wetland types unique to arid and semi-arid climates, and to simplify the application of the classification.

How to Use These Keys

This document focuses on clear definitions for the major components of the LLWW coding system, along with specific modifiers that can be added to further refine the data. The basic structure of the LLWW code presented in this document is two letters for Landscape Position, two letters for wetland Landform OR Waterbody Type, and two letters for Water Flow Path. Modifiers are applied at the end of the code as a string, separated with commas if the user desires. The resulting code is a minimum of six characters for the base code with any number of modifiers at the end (**Figure 1**).

All modifiers within this document are optional and can be added through visual inspection or overlays of ancillary data sources. Modifiers are grouped into four main categories: 1) natural characteristics, 2) human-influenced characteristics, 3) hydrologic characteristics, and 4) landscape characteristics. Use of modifiers are at the user's discretion. For detailed datasets, any and all potential modifiers may be used. For more rapid application of the classification, fewer modifiers may be used. Some modifiers duplicate information in the base code and users can decide if they should be applied or if a simpler code is preferred. For instance, all Lotic polygons are by default on the geomorphic floodplain (*gf*). Users can decide if all Lotic polygons should receive the *gf* modifier (along with all TE and LE polygons also in the geomorphic floodplain). If the *gf* modifier is applied to Lotic polygons, it can serve as a single queryable code component for all polygons on the geomorphic floodplain; however, the resulting Lotic codes will be longer (e.g, LOFPTHgf). If the *gf* modifier is not applied to Lotic polygons, queries for polygons on the geomorphic floodplains will be more complex, but the Lotic codes will be shorter (e.g., LOFPTH).

In a Geographic Information System (GIS) database table, it may be helpful to users of this key to assign each component of the code separately in its own field. A typical table structure may contain fields for:

1. Landscape Position
2. Waterbody Type
3. Landform (optionally, Landform can be combined with Waterbody Type, as the two fields are mutually exclusive; a polygon will either receive a Landform or Waterbody Type code)
4. Flow Path
5. Modifiers (either one field for all modifiers or, preferably, a series of fields for each individual modifier)

[2] These keys apply to all inland wetlands within the states of AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, and WY.

Once all components have been assigned individually, a concatenated field can be populated to show the code as a single string. Alternatively, one field could be used for all the components of an LLWW code (Landscape Position, Landform/Waterbody Type, Water Flow Path, and modifiers). For example, TEBAVRbv for Terrene, Basin, Vertical Flow, beaver-influenced wetland.

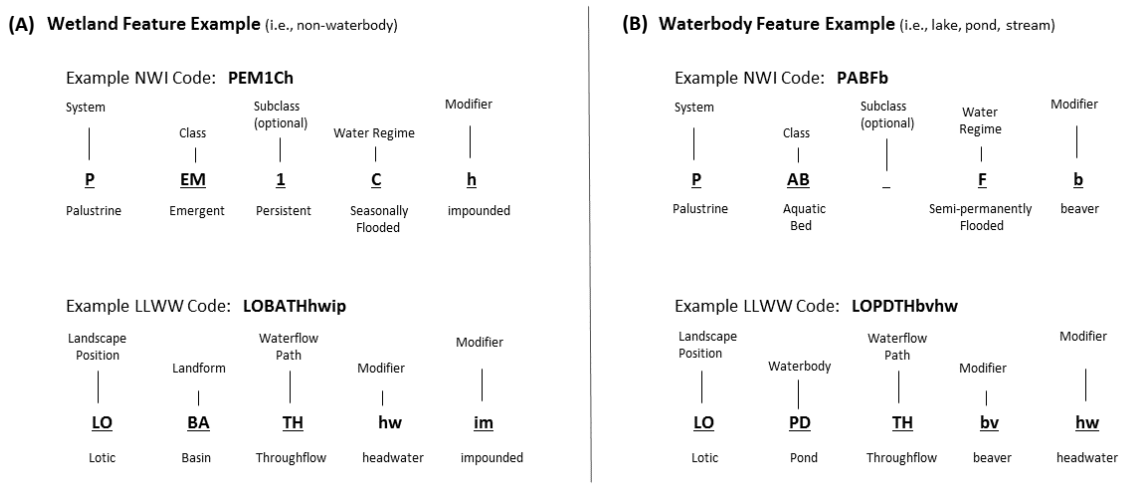

Figure 1. Example LLWW codes for (A) wetland and (B) waterbody features.

When applying the LLWW classification with these keys, it is useful to assign codes to all waterbodies first, since wetland Landscape Position is directly related to proximity and connection to waterbodies. **Key A** includes all components of waterbody codes. Unlike wetlands, waterbodies are coded first by Waterbody Type, then by Landscape Position and Water Flow Path. The definition of a waterbody in LLWW is different than the definitions of Lacustrine or Riverine within the Cowardin classification; therefore *it is important* to fully read **Key A** before applying any codes. See **Figure 1B** for an example of a waterbody code. Starting with **Key B,** the remaining keys focus on wetlands. **Key B** is a key to wetland Landscape Position, **Key C** is a key to Landforms and Water Flow Paths for Lotic wetlands, **Key D** is a key to Landforms and Water Flow Paths for Lentic wetlands, and **Key E** is a key to Landforms and Water Flow Paths for Terrene wetlands. See **Figure 1A** for an example of a wetland code. Modifiers for natural and human-influenced characteristics are specified throughout the keys under the Waterbody Types and Landforms to which they are primarily applied. Modifiers for hydrologic characteristics and landscape characteristics are listed separately in **Key F**.

Appendix A includes several important notes on applying the LLWW keys in particular situations. **Appendix B** includes an alphabetical list of all modifiers and rules for their application. Please review all modifiers in the Appendix, as not every potential modifier is incorporated into the main keys. **Appendix C** includes illustrations of common LLWW codes. Throughout the keys, NWI attribute rules provide guidance on the logical relationships between NWI and LLWW. However, most LLWW codes are not a direct crosswalk from NWI and additional considerations may be required. Within the NWI attribute rules and elsewhere in the document, the percent symbol (%) is used as a wild card signifying that any character could occupy that space in the attribute or code.

For the most part, LLWW codes should be applied to NWI mapping without further dividing NWI polygons. However, there are times when it may make sense to split NWI polygon so that multiple LLWW codes could be applied to separate areas of one polygon. Before making that decision, the following points should be considered: 1) first and foremost, the resulting data will not be compliant with NWI data standards (i.e., adjacent polygons will have the same NWI attribute); 2) this could likely have significant effect on the scope of the mapping effort by requiring additional time to split individual polygons; 3) there are many situations where the scale of the split is unrealistic to produce (e.g., separating narrow features along edge of a stream to separate Fringe Landforms from Floodplain Landforms). The decision to split NWI polygons rests with the photo-interpreter, who is presumably knowledgeable about wetlands within a project area and the proposed use of the LLWW data. While we caution against splitting NWI polygons, it may be desirable in some instances.

Crosswalk of LLWW Codes to Primary HGM Classes

One goal of producing this regionalized and simplified set of LLWW keys was to make the crosswalk between LLWW and HGM Class more straight-forward. There are only 10 Landscape Position/Landform code combinations for wetlands resulting from these keys. Those 10 codes are listed below with their crosswalk to primary HGM Classes (**Table 1**). HGM subclasses, which are generally defined by region, can often be derived based on LLWW modifiers and ancillary data sources. One advantage of LLWW is that it includes code combinations that indicate characteristics of more than one HGM Class. For instance, Lotic Basin (LOBA) describes depressions on a floodplain, which have characteristics of both Riverine and Depressional HGM Classes. Another example is Terrene Slope wetlands that occur within a geomorphic floodplain (TESL%gf). These wetland have characteristics of both Riverine and Slope HGM Classes and have been called "Sliverine" wetlands by some practitioners.

Table 1. Base LLWW Codes and Primary HGM Class.

Base LLWW Code	***Primary HGM Class***	***Secondary HGM Class***
Lotic Basin (LOBA)	Riverine	Depressional
Lotic Floodplain (LOFP)	Riverine	
Lotic Fringe (LOFR)	Riverine	
Lentic Basin (LEBA)	Lacustrine Fringe	Depressional
Lentic Floodplain (LEFP)	Lacustrine Fringe	
Lentic Fringe (LEFR)	Lacustrine Fringe	
Terrene Basin (TEBA)	Depressional	
Terrene Flats (TEFL)	Flats (Mineral or Organic)	
Terrene Fringe (TEFR)	Depressional	
Terrene Slope (TESL)	Slope	Riverine (if given the *gf* modifier)

TABLE OF CONTENTS FOR THE KEYS

KEY A: WATERBODIES

Key A begins by assigning Waterbody Type because waterbodies are often the easiest features to map (and automate in mapping), and the waterbody codes subsequently help determine Landscape Position, wetland Landform, and Water Flow Paths. The definition of a waterbody in LLWW is different than the definitions of the Lacustrine or Riverine System within the Cowardin classification; therefore *it is important* to fully read **Key A** before applying any codes. Please note that Waterbody Type occupies the same position in the LLWW code as Landform for wetlands and can be populated in its own field in GIS or joined with wetland Landform in one field.

A-1: Waterbody Types

1a. Waterbody has predominantly flowing water (when present) in a channel with defined bed and banks, and is a linear or polygonal feature on a U.S. Geological Survey (USGS) map (1:24,000) or within the National Hydrography Dataset (NHD) ..... **Stream (ST)**

*See **Appendix A** for **NOTE 1** on LLWW Rivers and Streams.*

Optional distinction between streams and rivers; if not differentiated, use Stream (ST) for all:

i. Waterbody is a polygonal feature (width >10 m or 33 ft) on a U.S. Geological Survey (USGS) map (1:24,000) or within the National Hydrography Dataset (NHD) ..... **River (RV)**

NWI Attribute Rules: R1%, R2%, R3% (restricted to F, G, H water regimes), AND the feature is a polygon within NHD.

ii. Waterbody is a linear or polygonal feature on USGS maps or in NHD ..... **Stream (ST)**

*Go to **Key A-2** for River/Stream Flow Duration and Modifiers, **Key A-5** for Waterbody Landscape Position, then **Key A-6** for Waterbody Flow Paths.*

1b. Waterbody has predominantly standing water **2**

2a. Waterbody is permanently flooded and either large in size (>8 ha or 20 acres) or deep even at low water (≥2.5 m or 8.2 ft deep) ..... **Lake (LK)**

NWI Attribute Rules: L1%, L2UB%, L2AB% (restricted to F, G, H, K water regimes).

*See **Appendix A** for **NOTE 2** on NWI Lacustrine System vs. LLWW Lakes.*

*Go to **Key A-3** for Lake Modifiers, **Key A-5** for Waterbody Landscape Position, then **Key A-6** for Waterbody Flow Paths*

2b. Waterbody is small (<8 ha or 20 acres) and shallow (<2.5 m or 8.2 ft) ..... **Pond (PD)**

NWI Attribute Rules: PUB%, PAB% (restricted to F, G, H, K water regimes).

*Go to **Key A-4** for Pond Modifiers, **Key A-5** for Waterbody Landscape Position, then **Key A-6** for Waterbody Flow Paths*

A-2: River/Stream Flow Duration

Rivers and streams within the LLWW classification are refined by flow duration, an ecologically important characteristic that affects their ability to support fish and other aquatic life, along with riparian vegetation and terrestrial wildlife. See **Appendix A** for **NOTE 1** on LLWW Rivers and Streams.

1a. Natural flowing water feature (including features that have flow alteration due to dams and other impoundments, as well as streams and rivers that have been channelized) **2**

1b. Flowing water feature (usually a linear and narrow shape) created solely for the purpose of water conveyance and built in an otherwise upland landscape ..... **Artificial Canal or Ditch (R5/S5)**

NWI Attribute Rules: Most R%x features, but check for channelized natural streams.
Also check for vegetated ditches and canals mapped at PEM%x or PSS%x.
*See **Appendix A** for **NOTE 3** about artificial ditches vs. excavated and channelized streams*

2a. Water flow is generally year-round ..... **Perennial Flow (R1/S1)**

NWI Attribute Rules: R(1,2,3)UB%, generally with no 'x' but check for channelized natural streams.

2b. Water flow is not year-round, generally only streams **3**

3a. Water flow occurs for prolonged periods (usually more than a few weeks) and is generally seasonal in nature, lasting for much of the growing season ..... **Seasonal Intermittent Flow (S2)**

NWI Attribute Rules: R4SBC, generally with no 'x' but check for channelized natural streams.
Also check for vegetated channels mapped at PEM% or PSS%.

3b. Water flow is less than a few weeks, generally only streams **4**

4a. Water flow occurs for briefer periods (from a few days to a few weeks) during the growing season ..... **Temporary Intermittent Flow (S3)**

NWI Attribute Rules: R4SBA, generally with no 'x' but check for channelized natural streams.
Also check for vegetated channels mapped at PEM% or PSS%.

4b. Water flows for brief periods (usually less than a few days) and is tied to precipitation events; flow duration may extend beyond a few days during extremely wet years in arid regions ..... **Ephemeral Flow (S4)**

NWI Attribute Rules: R4SBJ, generally with no 'x' but check for channelized natural streams.
Also check for vegetated channels mapped at PEM% or PSS%.

Further classification of LLWW Rivers and Streams is attributed with optional modifiers. More than one modifier may be applied, if appropriate. Modifiers below are divided into those that define natural characteristics and those that define human-influence characteristics. A polygon could have modifiers from both categories, as well as from Hydrology and Landscape modifiers listed in **Key F**.

Natural modifiers:

- **i.** Temporary or ephemeral stream in an arid region *(ST4 and ST3 only);* often used with the flashy hydrology modifier (fs)..... *arroyo (ay)*
- **ii.** River or stream influenced by beaver activity .....*beaver influenced (bv)*
- **iii.** River or stream located within a geomorphic floodplain *(all RV and ST features should receive this modifier)* .....*geomorphic floodplain (gf)*

Human-influence modifiers:

- **i.** Stream or canal used for agriculture purposes, such as crop production (including hay) or livestock watering.....*agricultural (ag)*
- **ii.** Natural stream that has been artificially straightened, redirected, or deeply incised from excess erosion..... *channelized (ch)*
- **iii.** Excavated channel, either natural or artificially dug into the upland landscape.....*excavated (ex)*
- **iv.** River or stream affected by dam used for hydropower .....*hydropower (hy)*
- **v.** Channelized river with a series of locks and dams to aid navigation *(ST1 only)* .....*lock and dammed (ld)*
- **vi.** River or stream affected by logging .....*logged (lg)*
- **vii.** River or stream affected my mining.....*mining (mn)*
- **viii.** River or stream modified by known restoration or enhancement activities (e.g., earthwork, planting, vegetation removal, beaver re-introduction, etc.) .....*restoration site (re)*
- **ix.** River or stream section with low dam(s) allowing flow during high water periods; often used for low-head hydropower generation or irrigation diversion(s) *(ST1 and ST2 only)* .....*run of river dammed (rr)*

You've completed the River/Stream Flow Duration Key.
*Now go to **Key A-5** for Waterbody Landscape Position.*
*All Rivers and Streams are generally given a Throughflow (**TH**) Water Flow Path.*
*See **Key F** for Hydrology and Landscape Modifiers.*

A-3: Lakes

In this version of LLWW keys, all lakes receive the same code (**LK**). See **Appendix A** for **NOTE 2** discussing the difference between the NWI Lacustrine System and LLWW Lakes. Further classification of LLWW Lakes is attributed with optional modifiers. More than one modifier may be applied, if appropriate. Modifiers below are divided into those that define natural characteristics and those that define human-influence characteristics. A polygon could have modifiers from both categories, as well as from Hydrology and Landscape modifiers listed in **Key F**. Modifiers for ponds (see next page) may also be used for lakes, if applicable. Also see **Appendix B** for additional modifiers that may be possible for lakes.

Natural modifiers

Most appropriate for the following NWI Attributes: L1%, L2UB%, L2AB% (restricted to F, G, H water regimes) with no modifier.

- **i.** Lake influenced by beaver activity ..... *beaver influenced (bv)*
- **ii.** Lake located within a geomorphic floodplain (up to the approximate 100-year floodplain boundary) ..... *geomorphic floodplain (gf)*
- **iii.** Lake formed from an oxbow channel on a floodplain ..... *oxbow (ox)*
- **iv.** Shallow lake, often saline, with fluctuating water levels depending on local precipitation patterns and extent of groundwater connection; typically with no natural outlet ..... *playa (pl)*
- **v.** Lake located within the formerly glaciated Prairie Pothole region; water sources include direct precipitation, runoff from surrounding areas, and groundwater; generally associated with Quaternary glacial deposits such as moraines, glacial valleys, and outwash plains .. *prairie pothole (pp)*
- **vi.** Lake dominated by inputs from surface runoff, groundwater seepage and precipitation; may be subject to seasonal water level fluctuation; typically with no natural inlet or outlet..... *seepage lake (sl)*

Human-influence modifiers

Most appropriate for the following NWI Attributes: L1%, L2UB%, L2AB% (restricted to F, G, H, K water regimes) with 'h', 'm', or 'x' modifier.

- **i.** Lake excavated or impounded for mining of sand or gravel ..... *gravel (gr)*
- **ii.** Lake is excavated or impounded ..... *impounded (im) or excavated (ex)*
- **iii.** Dammed lake used for hydropower ..... *hydropower (hy)*
- **iv.** Lake excavated or impounded for coal or hard rock mining, either a quarry lake or lake to capture mining waste ..... *mining (mn)*
- **v.** Water levels are managed for wildlife (e.g., waterfowl habitat) ..... *wildlife management (wm)*

*You've completed the **Lakes Key**.*
*Now go to **Key A-5** for Waterbody Landscape Position,*
*then **Key A-6** for Waterbody Flow Paths.*

A-4: Pond Subtypes

In this version of LLWW keys, all ponds receive the same code (**PD**). Further classification of LLWW Ponds is attributed with optional modifiers. More than one modifier may be applied, if appropriate. Modifiers below are divided into those that define natural characteristics and those that define human-influence characteristics. A polygon could have modifiers from both categories, as well as from Hydrology and Landscape modifiers listed in **Key F**. Modifiers for lakes (see preceding page) may also be used for lakes, if applicable. Also see **Appendix B** for additional modifiers.

Natural modifiers

Most appropriate for the following NWI Attributes: PUB %, PAB% (restricted to F, G, H water regimes) with no modifiers, except beaver (b).

- **i.** Pond formed by beaver activity ..... *beaver (bv)*
- **ii.** Pond located within a peatland matrix (bog if precipitation-dominated or fen if groundwater-dominated) ..... *bog (bg) or fen (fn)*
- **iii.** Pond contains a floating mat of vegetation ..... *floating mat (fm)*
- **iv.** Pond located within a geomorphic floodplain (within the approximate 100-year floodplain) ..... *geomorphic floodplain (gf)*
- **v.** Pond located within a dune field ..... *interdunal (id)*
- **vi.** Pond located within a formerly glaciated landscape (but not in the Prairie Pothole region) and formed by ice blocks left by retreating glaciers ..... *kettle (kt)*
- **vii.** Pond formed from an oxbow channel on a floodplain ..... *oxbow (ox)*
- **viii.** Shallow pond, often saline, with fluctuating water levels depending on local precipitation patterns and extent of groundwater connection ..... *playa (pl)*
- **ix.** Pond located within the formerly glaciated Prairie Pothole region; water sources include direct precipitation, runoff from surrounding areas, and groundwater; generally associated with Quaternary glacial deposits such as moraines, glacial valleys, and outwash plains .. *prairie pothole (pp)*

Human-influence modifiers

Most appropriate for the following NWI Attributes: PUB%, PAB% (restricted to F, G, H, K water regimes) with 'h', 'm', or 'x' modifier.

- **i.** Pond used for agriculture or livestock watering ..... *agricultural (ag)*
- **ii.** Pond used for aquaculture ..... *aquaculture (aq)*
- **iii.** Pond is excavated or impounded ..... *impounded (im) or excavated (ex)*
- **iv.** Pond situated within a golf course ..... *golf (gf)*
- **v.** Pond is excavated or impounded for mining of sand or gravel ..... *gravel (gr)*
- **vi.** Pond is excavated or impounded for mining of coal or hard rock, either a quarry pond or a pond to capture mining waste ..... *mining (mn)*
- **vii.** Pond is used to detain or retain stormwater runoff ..... *stormwater (sw)*
- **viii.** Pond is used for wastewater retention and/or treatment (e.g., oil and gas, domestic) *wastewater (ww)*
- **ix.** Water levels are managed for wildlife (e.g., waterfowl habitat) ..... *wildlife management (wm)*

*You've completed the **Ponds Key**.*
*Now go to **Key A-5** for Waterbody Landscape Position,*
*then **Key A-6** for Waterbody Flow Paths.*

A-5: Waterbody Landscape Position

This key characterizes waterbodies based on their proximity to other waterbodies or in relative isolation. Please consider these rules:

- River and streams are generally classified within the Lotic (**LO**) Landscape Position and are not discussed in the key. However, Artificial Canals (**S5**) can be classified as Terrene (**TE**) at the discretion of the user.
- Lakes can be classified as either Lotic (**LO**) or Terrene (**TE**) based on proximity to the stream network. Please note that lakes are ***not*** classified as Lentic (**LE**), even though they create the Lentic Landscape Position for associated ponds and wetlands.
- Ponds can be classified as Lotic (**LO**), Lentic (**LE**), or Terrene (**TE**) based on proximity to the stream network or to a large lake.

1a. Lake or pond is adjacent to, within the banks of, or on the *active* (approximately 1-5 year recurrence interval) channel or floodplain of a natural river or stream ***and*** is periodically flooded by the river or stream or strongly influenced by the alluvial aquifer. This includes reservoirs and other impounded lakes formed within a stream channel, oxbows and other floodplain ponds, and it includes ponds formed by natural depressions or artificial impoundments on ephemeral channels that are flooded when the channel flows and receive no major inputs other than flooding when the channel flows ..... **Lotic (LO)**

1b. Lake or pond is not as described.....**2**

2a. Pond is located within the basin formed and influenced by a large lake or reservoir ***and*** experiences rising and falling water levels as a direct result of the lake or reservoir .... **Lentic (LE)**

2b. Lake or pond is surrounded by upland (non-hydric soils or filled lands that are now upland), or is located within the geomorphic floodplain of a river or stream ***but*** is not subject to frequent overbank flow (e.g., lake or pond in a headwater position feeding the stream, at a toe-of-slope on the edge of a stream valley, or on a disconnected upper floodplain terrace); hydrology is maintained primarily by groundwater discharge, surface runoff, precipitation and/or irrigation..... **Terrene (TE)**

The following are optional ways to differentiate the Terrene landscape position; they may be applied if additional data are available. Alternatively, the same information can be conveyed through modifiers, with T1 = hw, T2 = gf, and T3 = no modifier.

i. Lake or pond occurs in a headwater position (*see **Appendix A** for **NOTE 9** for a potential method of classifying headwaters*).....Terrene Headwater **(T1)**

ii. Lake or pond is located within the boundary of the geomorphic (approximately 100-year) floodplain of a river or stream, but is fed primarily by groundwater, surface runoff, and precipitation rather than overbank flow.....Terrene Riparian **(T2)**

iii. Lake or pond occurs in an upland area, and not in a geomorphic floodplain ....Terrene Non-riparian **(T3)**

*You've completed the **Waterbody Landscape Position Key**.*
*Now go to **Key A-6** for Waterbody Flow Paths.*

A-6: Waterbody Flow Paths

This key characterizes the primary surface Water Flow Path of waterbodies based on their proximity to a waterbody, in a drainageway, or in relative isolation. Please consider these rules:

- River and streams are automatically classified with the Throughflow (**TH**) flow path, even if the stream is ephemeral or the initiation point of a flow network. Rivers and streams are not discussed in the key.
- Lakes and ponds can be classified by several flow paths, however, please note that *only lakes* can receive the Throughflow-Bidirectional (**TB**) flow path.
- For small ponds embedded within wetland complexes, consider the flow path of the entire complex and not the internal paths within the complex.

1a. There is an observable perennial or seasonal surface water channel connecting the lake or pond with other waters either upstream or downstream; water may flow out of, into, or through the waterbody. This applies to ponds within natural depressions or artificial impoundments on intermittent channels that are flooded when the channel flows and receive no other major inputs, ***but*** this does not apply to ponds on floodplains that are not flooded, but connected through shallow alluvial groundwater **2**

1b. There are no observable perennial or seasonal surface water channels connecting the lake or pond with other waters upstream or downstream; surface water does not pass through the waterbody to other waters except through temporary (**S3**) or ephemeral (**S4**) drainages. Sources of water include non-channelized inputs of snowmelt, precipitation, local surface runoff, groundwater discharge, or shallow alluvial groundwater that is not connected via surface water channels **5**

2a Waterbody receives surface water from a waterbody at a higher elevation ***and*** surface water passes through it to another waterbody at a lower elevation **3**

2b. Surface water flows ***either*** out of the waterbody to waters at a lower elevation ***or*** into the waterbody from waters at higher elevation; water does not flow through waterbody 4

3a. Water flows through the waterbody, even if interrupted by small impoundments (e.g., impounded ponds along a stream channel); waterbody is not a lake with periodic raising or lowering of lake levels ..... **Throughflow (TH)**

3b. Water flow is through a lake where residence time of water is generally longer and accompanied by periodic raising or lowering of lake levels; this often occurs in large dammed or excavated lakes or lakes situated in historic floodplains that are now separated by man-made or natural levees ..... **Throughflow-Bidirectional (TB)**

4a. Water flows out of the waterbody via a river, stream, or ditch, with little or no observable surface water inflow (inflow could be from ephemeral drainages, non-channelized inputs of snowmelt, precipitation, local surface runoff, or groundwater discharge); waterbody serves as a source for surface water ..... **Outflow (OU)**

4b. Water flow enters via a river, stream, ditch, or is pumped in, but does not exit the pond, lake or reservoir (outflow could be through ephemeral drainages or groundwater discharge); waterbody serves as a sink for surface water ..... **Inflow (IN)**

5a. Waterbody is a large isolated lake and water levels fluctuate due to both rising and falling lake levels and wind-driven wave action ..... **Bidirectional (BI)**

5b. Waterbody is a pond or small isolated lake; water levels rise as the pond or lake fills with precipitation, surface runoff, and/or groundwater discharge and lowers as water is evaporated or lost to groundwater seepage; wave action is rare or nonexistent. This can apply to Lotic or Lentic Ponds that lack a dominant surface water connection with a stream or lake but are driven by fluctuation in the aquifer ..... **Vertical Flow (VR)**

*You've completed the **Waterbody Flow Path Key**.*
*Now go to **Key F** for Hydrology and Landscape Modifiers*

KEY B: WETLAND LANDSCAPE POSITION

This key allows characterization of wetlands based on their location in or along a waterbody, in a drainageway, or in relative isolation. Wetland Landscape Position should be attributed by analyzing the proximity of each wetland polygon to waterbodies. See **Appendix A** for **NOTES 4 & 5** for more information on distinguishing Landscape Position.

1a. Wetland is adjacent to, within the banks of, or on the *active* (approximately 1-5 year recurrence interval) channel or floodplain of a natural river or stream ***and*** is periodically flooded by the river or stream or strongly influenced by the alluvial aquifer. This also includes wetlands formed by natural depressions or artificial impoundments on ephemeral channels that receive no major inputs other than flooding when the channel flows ..... **Lotic (LO)**

*See **Appendix A** for **NOTE 4** on Lotic vs. Lentic Landscape Position.*
*See **Appendix A** for **NOTE 5** on Lotic vs. Terrene Landscape Position.*

*Go to **Key C-1** for Lotic Landforms*
*Optionally, use **Key A-2** to add a River and Stream Duration numeral to the Lotic Landscape Position.*

1b. Wetland is not as described **2**

2a. Wetland is located along the shore of a lake or reservoir, within the basin formed by a lake or reservoir, or along a stream flowing through a lake basin ***and*** wetland experiences rising and falling water levels as a direct result of the lake or reservoir..... **Lentic (LE)**

*Go to **Key D-1** for Lentic Landforms*

2b. Wetland or wetland complex is surrounded by upland (non-hydric soils or filled lands that are now upland), **or** is located within the geomorphic floodplain of a river or stream ***but*** is not subject to frequent overbank flow (e.g., wetland is in a headwater position feeding the stream, at a toe-of-slope on the edge of a stream valley, or on a disconnected upper floodplain terrace); hydrology is maintained primarily by groundwater discharge, surface runoff, precipitation and/or irrigation..... **Terrene (TE)**

The following are optional ways to differentiate the Terrene landscape position; they may be applied if additional data are available. Alternatively, the same information can be conveyed through modifiers, with T1 = hw, T2 = gf, and T3 = no modifier.

i. Wetland occurs in a headwater position (*see **Appendix A** for **NOTE 9** on a potential method of classifying headwaters*) ..... **Terrene Headwater (T1)**

ii. Wetland is located within the boundary of the geomorphic (approximately 100-year) floodplain of a river or stream, but is fed primarily by groundwater, surface runoff, and precipitation rather than overbank flow..... **Terrene Riparian (T2)**

iii. Wetland occurs in an upland area, and not in a geomorphic floodplain..... ..... **Terrene Non-riparian (T3)**

*Go to **Key E-1** for Terrene Landforms*

KEY C: LOTIC LANDFORMS AND WATER FLOW PATHS

Lotic wetlands are primarily driven by streamflow, overbank flooding, and rising and falling alluvial groundwater. **Key C-1** defines the classification of Lotic Landforms and includes most commonly used modifiers. **Key C-2** defines the classification of Lotic Water Flow Paths. More than one modifier may be applied, in addition to Hydrology and Landscape modifiers listed in **Key F**. All Lotic polygons could receive the geomorphic floodplain *(gf)* modifier by default, if the user desires. Also see **Appendix B** for additional modifiers that may be possible for Lotic Landforms.

C-1: Lotic Landforms

1a. Wetland occurs within or along the banks of a river or stream (often below the bankfull elevation), on the margin of an island in the streams, or on the shore of a pond embedded within a Lotic landscape ***and*** is either vegetated and semi-permanently flooded or permanently saturated due to this location ***or*** a non-vegetated shore that is temporarily flooded or wetter (e.g., gravel and sand bars)..... **Fringe (FR)**

NWI Attribute Rules: P(EM,SS,FO)(F,D) or PUS(A or wetter) or R%US(A or wetter) and adjacent to a Stream/River (RV/ST) or Lotic Pond (LOPD)
*See **Appendix A** for **NOTE 6** on Fringe and Island Landforms.*

- **i.** Wetland formed along the shore of an island within the stream or river channel.....*island (il)*
- **ii.** Wetland formed along the shore of a pond within an active floodplain .....*pond fringe (pd)*

1b. Wetland does not occur within or along the banks of a river or stream, along an island in the stream, or on the shore of a Lotic pond.....**2**

2a. Wetland formed in a distinct depression within the floodplain, either a natural depression, such as an abandoned oxbow, or an excavated or impounded depression .....**Basin (BA)**

- **i.** Wetland occurs in a distinct depression along a river or stream, including recently active oxbows and meander scars.....*oxbow (ox)*
- **ii.** Depression formed by beaver activity, may be fully vegetated (PEM1Fb) or recently blown out (PUSCb)..... *beaver pond (bv)*
- **iii.** Excavated or impounded depression within a floodplain or along a stream channel .... *impounded (im) or excavated (ex)*

2b. Wetland forms the matrix vegetation on a (approximate) 100-yr floodplain above the bankfull elevation and is fed primarily by overbank flow and alluvial groundwater. This includes narrow vegetated bands along small streams, even if the stream corridor only has a narrow floodplain..... **Floodplain (FP)**

*See **Appendix A NOTE 7** on Floodplain Landforms.*

- **i.** Wetland is influenced by beaver activity ..... *beaver-influenced (bv)*
- **ii.** Wetland formed along the shore of an island within the stream or river channel.....*island (il)*

*Go to **Key C-2** for Lotic Flow Paths*

C-2: Lotic Water Flow Paths

1a. Hydrology within the wetland is dominated by surface water inputs from a stream or wetland associated with a stream through overbank flooding or through the alluvial aquifer and surface water outflow is to a stream, wetland, or other waterbody at a lower elevation. By default, all Lotic (LO) Fringe and Floodplain wetlands receive this flow path ..... **Throughflow (TH)**

1b. Wetland lacks a dominant surface water connection with a stream or river; hydrology is driven by fluctuation in the alluvial aquifer in most years, and closely tied to stream or river stage. This flow path is generally reserved for Lotic Basins..... **Vertical Flow (VR)**

*You've completed the **Lotic Landform and Flow Path Keys**.*
*Now go to **Key F** for Hydrology and Landscape Modifiers*

KEY D: LENTIC LANDFORMS AND WATER FLOW PATHS

Lentic wetlands are primarily driven by rising and falling lake levels. **Key D-1** defines the classification of Lentic Landforms and includes most commonly used modifiers. **Key D-2** defines the classification of Lentic Water Flow Paths. More than one modifier below may be applied, in addition to Hydrology and Landscape modifiers listed in **Key F**. Also see **Appendix B** for additional modifiers that may be possible for Lentic Landforms.

D-1: Lentic Landforms

1a. Wetland occurs along the shores of a lake, an island in a lake, or a pond embedded within a Lentic landscape ***and*** is either vegetated and permanently inundated, semi-permanently flooded or permanently saturated due to this location ***or*** a non-vegetated shore that is temporarily flooded or wetter ..... **Fringe (FR)**

NWI Attribute Rules: P(EM,SS,FO)(F,D) or PUS(A or wetter) or L2US%(A or wetter) and adjacent to a Lake (LK) or Lentic Pond (TEPD)

*See **Appendix A** for **NOTE 6** on Fringe and Island Landforms.*

- **i.** Wetland formed along the margin of an island within a lake..... *island (il)*
- **ii.** Wetland formed along the outer margin of a Lentic pond..... *pond fringe (pd)*

1b. Wetland does not occur along a shore..... **2**

2a. Wetland occurs in a distinct depression within a Lentic landscape..... **Basin (BA)**

NWI Attribute Rules: Many code combinations could fall within the Landform, but they are generally wetter water regimes.

- **i.** Depression formed by beaver activity, may be fully vegetated (PEM1Fb) or recently blown out (PUSCb)..... *beaver pond (bv)*
- **ii.** Excavated or impounded depression within a floodplain or along a stream channel .... *impounded (im) or excavated (ex)*

2b. Wetland exists in a nearly flat area within a Lentic landscape..... **Floodplain (FP)**

NWI Attribute Rules: Many code combinations could fall within the Landform, but they are generally drier water regimes.

*See **Appendix A** for **NOTE 7** on Floodplain Landforms.*

- **i.** Wetland formed along the margin of an island within a lake..... *island (il)*

*Go to **Key D-2** for Lentic Flow Paths*

D-2: Lentic Water Flow Paths

1a. Wetland is associated with a river or stream flowing through the lake basin and is influenced by lake levels, such as wetlands along streams at the delta of a reservoir with fluctuating water levels.....**Throughflow-Bidirectional (TB)**

1b. Wetland is not associated with a river or stream flowing through the lake basin.....**2**

2a. Water levels fluctuate due to both rising and falling lake levels and wind-driven wave action ..... **Bidirectional (BI)**

2b. Water levels rise as the lake fills and lowers as water is evaporated or lost to groundwater seepage; water levels lack a surface water connection to the lake in most years; hydrology is driven by groundwater fluctuations closely tied to lake levels.....**Vertical Flow (VR)**

*You've completed the **Lentic Landform and Flow Path Keys**.*
*Now go to **Key F** for Hydrology and Landscape Modifiers*

KEY E: TERRENE LANDFORMS AND WATER FLOW PATHS

Terrene wetlands are primarily driven by precipitation, overland flow, or groundwater discharge. They include wetlands fed by overland flow from the direct application of irrigation water, from excess irrigation run-off, and subsurface seepage from irrigation up-gradient, such as from a field or canal. They can be located far from a waterbody ***or*** adjacent to a waterbody, but with a separate water source. The water regime of a wetland identified in the NWI code can be useful in separating Terrene Landforms, but visual examination and ancillary data are often needed. **Key E-1** defines the classification of Terrene Landforms and includes most commonly used modifiers. **Key E-2** defines the classification of Terrene Water Flow Paths. More than one modifier may be applied, in addition to Hydrology and Landscape modifiers listed in **Key F**. Also see **Appendix B** for additional modifiers that may be possible for Terrene Landforms.

E-1: Terrene Landforms

1a. Wetland occurs along the outer margin of a pond or the margin of an island within a pond embedded within a Terrene landscape and is either vegetated and semi-permanently flooded or permanently saturated due to this location ***or*** a non-vegetated shore that is temporarily flooded or wetter ..... **Fringe (FR)**

Attributes: P(EM,SS,FO)(D,F) or PUS(A or wetter) and adjacent to or within a Terrene Pond (TEPD)
*See **Appendix A** for **NOTE 6** on Fringe and Island Landforms.*

- **ii.** Wetland formed along the margin of an island within a pond ..... *island fringe (il)*
- **iii.** Wetland formed along the outer margin of a pond..... *pond fringe (pd)*

1b. Wetland does not occur along the outer margin of a pond or the margin of a pond island **2**

2a. Wetland occurs in a distinct depression, typically round or oblong in shape, and collects water from the surrounding landscape in multiple directions ..... **Basin (BA)**

- **i.** Wetland is a floating mat of vegetation extending into or over open water..... *floating mat (fm)*
- **ii.** Wetland is peat-accumulating, and has the minimum required organic soil depth (40 cm in the upper 80 cm) to qualify as a bog (precipitation-dominated) or fen (groundwater-dominated) ..... *bog (bg)* or *fen (fn)*
- **iii.** Wetland within the formerly glaciated Prairie Pothole region; water sources include direct precipitation, runoff from surrounding areas, and groundwater; generally associated with Quaternary glacial deposits such as moraines, glacial valleys, and outwash plains .... *prairie pothole (pp)*
- **iv.** Shallow wetland, often saline, with fluctuating water levels depending on local precipitation patterns and extent of groundwater connection ..... *playa (pl)*
- **x.** Wetland located within a dune field ..... *interdunal (id)*

2b. Wetland does not occur in a distinct depression **3**

3a. Wetland occurs on a slope (typically >2%, but not always) ***and*** hydrology is largely influenced by groundwater discharging to the surface (including seepage of irrigation water), groundwater flowing laterally subsurface, or surface water flowing laterally across the site from snowmelt or overland flow (including the direct application of irrigation water) ..... **Slope (SL)**

NWI Attribute Rules: P(EM, SS, FO)(restricted to A, B, C, D, or E water regimes)

- **i.** Wetland is peat-accumulating, and has the minimum required organic soil depth (40 cm in the upper 80 cm) to qualify as a bog (precipitation-dominated) or fen (groundwater-dominated) ..... *bog (bg)* or *fen (fn)*
- **ii.** Wetland has accumulation of peat, but not of sufficient depth to qualify as a bog or fen; often interspersed with, or along the margins of a bog or fen ..... *mire (mr)*
- **iii.** Wetland is managed as a hay field and/or pasture with grass cover ..... *hayfield (hf)*
- **iv.** Wetland is located on a geomorphic (approximately 100-year) floodplain, often at the edge or in some cases filling a narrow valley ..... *geomorphic floodplain (gf)*
- **v.** Wetland is located in a narrow valley ..... *stream valley (sv)*
- **vi.** Wetland is located at the base of a hill or slope ..... *toe-of-slope (ts)*

3b. Wetland exists in a nearly flat area (<2% slope) ***and*** is fed primarily by precipitation **Flat (FL)**

- **i.** Wetland occurs on saline soil, often with obvious salt crust visible ..... *saline (sa)*
- **ii.** Wetland is comprised of mineral soils ..... *mineral (ml)*
- **iii.** Wetland is peat-accumulating, and has the minimum required organic soil depth (40 cm in the upper 80 cm) to qualify as a bog (precipitation-dominated) or fen (groundwater-dominated) ..... *bog (bg)* or *fen (fn)*

*Go to **Key E-2** for Terrene Flow Paths*

E-2: Terrene Water Flow Paths

1a. There is an observable perennial or seasonal surface water channel connecting the wetland with waterbodies either upstream or downstream; surface water may flow out of the wetland, into the wetland, ***or*** through it.....**2**

1b. There are no observable perennial or seasonal surface water channels connecting the wetland and other wetlands or waterbodies upstream or downstream; surface water does not pass through the wetland to other waters except through temporary (**ST3**) or ephemeral (**ST4**) drainages. Sources of water include inputs of snowmelt, precipitation, local surface runoff, or groundwater discharge (including irrigation seepage) and water is lost to evaporation or groundwater recharge. Water movement may not always be in a vertical direction, but this flow path captures all wetlands that are not part of the flowing surface water network ..... **Vertical Flow (VR)**

2a Wetland receives surface water from a stream, other waterbody, or wetland at higher elevation ***and*** surface water passes through the wetlands to a stream, other waterbody, or wetlands at a lower elevation; a flow-through system ..... **Throughflow (TH)**

*See **Appendix A** for **NOTE 8** on common uses of Terrene Throughflow wetlands.*

2b. Surface water flows ***either*** <u>out</u> of the wetland to waters at lower elevations ***or*** <u>into</u> the wetland from waters at higher elevations via a perennial or seasonal channel; water does not flow through the wetland.....**3**

3a. Surface water flows out of the wetland via a perennial or seasonal channel, with little or no observable surface water inflow (inflow could be from ephemeral drainages, non-channelized inputs of snowmelt, precipitation, local surface runoff, or groundwater discharge). Headwater slope wetland complexes that contribute to stream channel initiation are considered outflow systems in this key..... **Outflow (OU)**

3b. Surface water flows into the wetland via a perennial or seasonal channel, but does not exit the wetland (outflow could be through ephemeral drainages or groundwater recharge)..... ..... **Inflow (IN)**

*<u>You've completed the **Terrene Landform and Flow Path Keys**.</u>*
*<u>Now go to **Key F** for Hydrology and landscape Modifiers</u>*

KEY F: HYDROLOGY AND LANDSCAPE MODIFIERS

F-1: Hydrology Modifiers

The following codes are hydrology or flow path modifiers. More than one can be applied. They will occur at the end of the LLWW string along with all other modifiers. These may be applied if additional data are available and/or high resolution imagery and elevation data can allow for consistent interpretation of these features.

i. Hydrologic regime is artificial, typically through ditches or pumps, or for diked/impounded wetlands along streams where hydrologic connectivity is regulated by water control structures ..... *artificial flow (ar)*

ii. Hydrologic regime is augmented by large trans-mountain or trans-basin diversions of water *(does not apply to the TE landscape)* ..... *augmented flow (au)*

iii. Wetland contributes to streamflow (e.g., sloped wetland adjacent to the stream or within a stream valley) ..... *discharge to stream (ds)*

iv. Hydrologic regime is considered flashy, or surface-runoff dominated, with high variability in the occurrence and magnitude of peak flow events; levels are often rainfall-driven and unpredictable; includes waterbodies in catchments with shallow soil and/or bedrock that are prone to flash flooding, as well as urbanized catchments with a high amount of impervious surfaces ..... *flashy (fs)*

v. Hydrologic regime is primarily groundwater-driven, such that levels are predictable and dominated by stable groundwater inflow for most (if not all) of the year ..... *groundwater-driven (gw)*

vi. Hydrologic regime is strongly influenced by irrigation, either direct application or seepage or augmented water regime ..... *irrigation-influenced (ir)*

vii. Hydrologic regime is intermittent or ephemeral (including inflow driven by short duration precipitation event, including monsoonal events) ..... *temporary intermittent flow (it)*

x. Hydrologic regime is regulated by major dams or diversions upstream, such that the flow regime has been substantially altered in terms of the timing, frequency, magnitude, and duration of peak and low flows *(does not apply to the TE landscape)* ..... *regulated flow (rf)*

xi. Hydrologic regime, including mean annual flow and peak flows, is primarily driven by rainfall ..... *rainfall (rn)*

xii. Hydrologic regime, including mean annual flow and peak flows, is primarily driven by snowmelt ..... *snowmelt (sn)*

xiii. Hydrologic regime, including mean annual flow and peak flows, is driven by a mixture of snowmelt and rainfall ..... *snow + rain (sr)*

xiv. Waterbody or wetland is fed by a spring ..... *spring-fed (sf)*

F-2: Landscape Modifiers

i. Waterbody or wetland located above treeline ..... *alpine (al)*

i. Waterbody or wetland is located within a burn area perimeter ..... *burn area (ba)*

ii. Waterbody or wetland is located within a beetle kill area ..... *beetle killed forest (bk)*

iii. Waterbody or wetland is located within a historical or current glacial landscape... *glacial (gl)*

iv. Waterbody or wetland is located in the upper reaches of a watershed and often the source of a stream network (*see* ***Appendix A*** *for* ***NOTE 9*** *on a potential method of classifying headwaters*) ..... *headwaters (hw)*

v. Waterbody or wetland is located on permafrost..... *permafrost (pf)*

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APPENDIX A: NOTES ON APPLYING THE LLWW KEYS

NOTE 1: <u>LLWW Rivers and Streams.</u> Rivers and streams within the LLWW classification are refined by flow duration, an ecologically important characteristic that affects their ability to support fish and other aquatic life, along with riparian vegetation and terrestrial wildlife. This characteristic may be identified by 1:24,000 U.S. Geological Survey topographic maps, high-resolution National Hydrographic Data (NHD), locally specific hydrography data, high resolution aerial imagery, or field gauge data or observations. If applying LLWW to newly created NWI mapping, stream flow duration would be determined based on NWI codes. While NHD may be used to attribute the flow duration for rapid application of the classification, for detailed datasets the accuracy of NHD should be checked against streamflow data and/or aerial photography to ensure proper attribution. The terms within LLWW are intended to be consistent with NHD, but the resulting data may not be consistent with the NHD lines if the NHD class is not accurate for a given area. Also of note, most LLWW rivers and streams will be mapped as Riverine features in NWI; however, there may be vegetated stream channels mapped as PEM% or PSS%. These will be difficult to pull out in an automated application of LLWW, but can be attributed as streams if LLWW attribution is applied at the time of mapping. If these features are not caught as streams in LLWW attribution, they should generally be attributed as Lotic Floodplain wetlands.

NOTE 2: <u>NWI Lacustrine System vs. LLWW Lakes</u>. The LLWW Lake definition is narrower than the Cowardin Lacustrine System. The Cowardin Lacustrine System includes all open waterbodies >8 ha (20 acres), regardless of depth or water permanence, and smaller open waterbodies if the deepest part of the waterbody is >2.5 m deep and the shoreline is formed by wave action or bedrock (USFWS 2015). Within the LLWW classification, all Cowardin Lacustrine Limnetic (L1) features deeper than 2.5 m, and Cowardin Lacustrine Littoral Subsystem (L2) features with relatively permanent water (L2UB or L2AB classes with water regimes of F, G, H or K) are considered Lakes. Polygons with less permanent water (L2US class with water regimes of J, A, or C) are considered wetlands instead of Lakes within LLWW. For instance, L2US polygons on the margin or otherwise associated with a Lake within LLWW are considered Lentic Fringe wetlands. If Cowardin Lacustrine features occur as shallow waters that are not associated with a deeper or more permanent lake, they are considered either Terrene or Lotic wetlands depending on the proximity and influence of a stream. For example, a large, intermittently flooded playa lake mapped as Lacustrine Littoral Unconsolidated Shore Intermittently Flooded (L2USJ) in Cowardin would be considered a Terrene Basin rather than a Lake in LLWW.

NOTE 3: <u>Artificial Ditches vs. Excavated and Channelized Streams.</u> The NWI modifier of 'x' or excavated can be used on a variety of different channel, including ditches constructed within uplands, natural channels converted to ditches, and natural channels excavated or channelized for other purposes (to facilitate transportation or prevent erosion). If possible, these types of excavated system should be separated in LLWW. For ditches constructed with uplands, the LLWW code should be Lotic/Terrene Artificial Canal Throughflow (LOS5TH). For natural streams used as ditches, the code should be Lotic Stream (appropriate flow duration) Throughflow channelized irrigation-influenced (LOS%THchir). For natural stream channels that are excavated or channelized

for other purposes, the code should be Lotic Stream (appropriate flow duration) Throughflow channelized (LOS%ch). In addition, there can be stream that receive excess irrigation runoff, but are not excavated for water conveyance. Those features would be coded Lotic Stream (appropriate flow duration) Throughflow irrigation-influenced (LOS%THir) if the irrigation-influenced section is a discrete polygon.

NOTE 4: <u>Lotic vs. Lentic Landscape Position</u>. Lentic wetlands consist of all wetlands in a lake basin (i.e., the depression forming the lake) and influenced directly by lake levels, including ponds within lake basins, areas that are inundated during high lake levels, and lakeside wetlands intersected by streams emptying into the lake. The upstream limit of lentic wetlands is defined by the upstream influence of the lake, which is usually approximated by the limits of the basin within which the lake occurs. Wetlands contiguous to the lake but at higher elevations and not in the lake basin should not be classified as Lentic; these wetlands should be treated as Lotic wetlands if the lake is within a geomorphic floodplain or Terrene if the lake is isolated or in a headwaters position.

NOTE 5: <u>Lotic vs. Terrene Landscape Position</u>. This note includes guidance on three specific situations where defining the break between Lotic and Terrene (or Terrene Riparian) Landscape Positions can be challenging.

1) As a rule, wetlands fed by artificial drainageways (i.e., ditches, canals, or stormwater conveyance channels) are considered Terrene. This includes wetlands created by irrigation water that may be within or proximate to natural floodplains. Irrigation-fed wetlands should be coded as Terrene Slope Throughflow irrigation-influenced (TESLTHir) if the irrigation water returns directly to the stream or Terrene Slope Inflow irrigation-influenced (TESLINir) if there is not a clear surface water connection back to the stream. These wetlands may receive a hayfield modifier (*hf*) or a geomorphic floodplain modifier (*gf*), if appropriate.
2) In some stream valleys, wetlands can alternate between Lotic and Terrene depending on primary water source. Along headwater stream reaches, sloping groundwater-fed wetlands on the edges of the stream often contribute to baseflow. In many cases, these wetlands originate upslope of the geomorphic floodplain, but can extend to the edge of the stream channel. These groundwater-fed wetlands are often mapped with a B or D water regime in Cowardin, while polygons closer to the channel and flooded by the stream are mapped as C, A, or E water regimes. Wetlands located upslope of the floodplain and primarily fed by groundwater should be classified as Terrene Slope Outflow (TESLOU), even if other nearby wetlands are mapped as Lotic Floodplain Throughflow (LOFPTH). While most Terrene Slope wetlands receive an Outflow flow path, some Terrene Slope wetlands can actually fill the stream valley and have flow that is parallel to the valley. In many cases, these wetlands lack a defined channel, but are located in an obvious geomorphic valley and there can be a defined channel both above and below the wetland within the same valley. These Terrene Slope wetlands should receive a Throughflow flow path (TESLTH)
3) A separate challenging distinction is in dry landscapes dominated by ephemeral drainages. In general, this key does not consider temporary or ephemeral channels enough evidence to classify a wetlands as Lotic if there is another visible or potential water source

(groundwater discharge or overland flow). However, there can be many small impoundments along the ephemeral drainages created either to capture and retain water during floods or to control erosion. These impoundments are often mapped as PUSAh or PEMAh in Cowardin. If there is no visible or potential water source other than periodic flows of the ephemeral channel, they should be considered Lotic rather than Terrene. They are often classified as Lotic Basin Throughflow impounded temporary-intermittent (LOBATHimit).

NOTE 6: <u>Fringe Landform and the Island modifier</u>. Fringe wetlands are those occurring directly on the margins, shores, or banks of waterbodies and are directly and frequently influenced by the waterbody. They may also occur along the margins of islands within a waterbody. Vegetated Fringe wetlands must be very wet (see NWI Attribute Rules in the key) and border a permanent waterbody (e.g., floating mat vegetation, either rooted below the water surface or floating above the water surface, or emergent marsh vegetation along the shores of a lake or pond). Non-vegetated Fringe, such as sand bars, may occur along intermittent shores. Islands are any vegetated or non-vegetated feature completely surrounded by water within a river, stream, lake, or pond. In the original Tiner LLWW keys, islands were called out as a separate Landform, yet there are places where a polygon met the criteria for a Fringe Landform and was located on an island, complicating the attribution. For the purposes of this classification, island has been converted to a modifier and any polygon on any type of island (fully wetland or a mix of wetland and upland, Fringe or Floodplain Landforms) can receive the island (il) modifier, which simplifies the classification. Similarly, the key includes an optional pond modifier (pd) to signify that the Fringe is along the margin of a pond in any Landscape Position. No modifier is needed for Fringe Landforms directly on the shores of a lake (LEFR) or banks of a river or stream (LOFR) because the Landscape Position conveys this information. In addition, sections of marsh divided by ditching that are completely surrounded by water in the ditches are not considered Island for this classification, which is consistent with Tiner's keys.

NOTE 7: <u>Floodplain Landforms</u>. For the purpose of this classification, the term Floodplain is used for both Lotic and Lentic Landscape Positions. In both Landscape Positions, Floodplains represent the landform and associated vegetation that is influenced by streams or lakes, but is not on the immediate margins of the waterbody (Fringe) or within a distinct depression (Basin). In the original Tiner keys, the Flats Landform is used for Lentic landscapes. In this key, we have chosen to reserve the Flats Landform exclusively for the Terrene landscape to be most consistent with the HGM Class of Flats. Lotic Floodplain areas may be verified by consulting local and regional floodplain mapping, or using soil surveys and locating alluvial soils (e.g., Fluvaquents and Fluvents, or soils with Fluvaquentic subgroups). *While active floodplains are considered part of the Lotic landscape (LOFP), not all wetlands within the larger <u>geomorphic floodplain</u> are considered part of the Lotic landscape.* Terrene wetlands with a groundwater source that originates outside the active floodplain may occur along the edges of the floodplain or even fill a narrow stream valley. These would be considered Terrene with a geomorphic floodplain modifier (TE%gf) or Terrene Riparian (T2), if the Terrene subcodes are used. These wetlands may still experience flooding in extreme events, but their primary water source is not the stream or alluvial aquifer. In some cases, wetlands

on the historical geomorphic floodplain may be intentionally cut off from floodwater by dikes or levees.

NOTE 8: <u>Terrene Throughflow wetlands</u>. There are two common reasons for Terrene Throughflow wetlands. Also see **NOTE 5** above about distinguishing the Lotic vs. Terrene Landscape Position.

1) Irrigation-influenced wetlands, including flood irrigated hayfields, where water is diverted from a waterbody, typically a stream or reservoir, passes over the irrigated field, and returns to the stream in a contiguous surface flow path. In most instances, these sites would be classified as TESLTHgfhfir.
2) Groundwater-fed wetlands that occur within a narrow stream valley and are fully integrated within adjacent Lotic Floodplain wetlands would be classified as TESLTHsvgw.

NOTE 9: <u>Method for Classifying Headwater.</u> There is no precise definition for the word headwaters, as it is relative to the scale of watershed under consideration and how the stream network is classified and mapped. For the purpose of this key, we recommend the following method for classifying headwater waterbodies and wetlands, adapted form Vance et al. (2015). Intersect all NWI polygons by HUC10 watersheds. Calculate the mean elevation of each HUC10 watershed and of each intersected NWI polygon. All NWI polygons with a mean elevation greater than the mean elevation of their HUC10 watershed should be considered headwaters. In addition, a fixed elevation determined by latitude may also be used to classify headwater wetlands. In central Colorado, we classified all wetlands over 10,500 ft as headwaters in addition to the thresholds defined by HUC10 watersheds. One important note, this method does not differentiate headwater wetlands that drain into stream networks from those that have no apparent surface water connections to downstream waters. If that distinction is important, all Vertical Flow wetlands should be removed from the headwater definition.

APPENDIX B: LLWW MODIFIERS

Table B-1: List of all LLWW modifiers used within the Western U.S. LLWW Keys, arranged alphabetically. The most important modifiers are in **Bold**.

Code	*Name*	*Description*	*Category*
ag	*agricultural*	Waterbody or wetland used for agricultural purposes, such as crop production or livestock watering. (Can use along with hf to be comprehensive, or can assume all hf polygons are ag).	Human-Influence
al	*alpine*	Waterbody or wetland is located above treeline	Landscape
aq	*aquaculture*	Waterbody or wetland used for aquaculture	Human-Influence
ar	*artificial flow*	Hydrologic regime is artificial, typically controlled through ditches or pumps ***or*** hydrologic connectivity is regulated by water control structures (e.g., diked/impounded wetlands along streams)	Hydrology
au	*augmented flow*	Hydrologic regime is augmented by large trans-mountain or trans-basin diversions of water	Hydrology
ay	*arroyo*	Temporary or ephemeral stream in an arid region *(ST3 and ST4 only)*	Natural
ba	*burn area*	Waterbody or wetland is located within a burn area perimeter	Landscape
bg	*bog*	Wetland (or waterbody within a wetland) is peat-accumulating, has the minimum required organic soil depth to qualify as a peatland (40 cm in the upper 80), and saturation is maintained by precipitation	Natural
bk	*beetle killed forest*	Waterbody or wetland is located within a beetle kill area	Landscape
bv	***beaver***	**Waterbody or wetland formed or influenced by beaver activity**	**Natural**
ch	*channelized*	River or stream has been artificially straightened or redirected or deeply incised from excess erosion	Human-Influence
dr	***partially drained***	**Waterbody or wetland is partially drained**	**Human-Influence**
ds	*discharge to stream*	Wetland contributes to streamflow (e.g., sloped wetland adjacent to the stream or within a stream valley)	Hydrology
ex	***excavated***	**Waterbody or wetland is excavated**	**Human-Influence**
fm	*floating mat*	Floating mat of vegetation extending into or over open water; can be used for the vegetation itself and the waterbody containing the vegetation	Natural
fn	*fen*	Wetland (or waterbody within a wetland) is peat-accumulating, has the minimum required organic soil depth to qualify as a peatland (40 cm in the upper 80), and saturation is maintained by groundwater discharge	Natural
fs	*flashy*	Hydrologic regime is considered flashy, or surface-runoff dominated, with high variability in the occurrence and magnitude of peak flow events; levels are often rainfall-driven and unpredictable; includes waterbodies in catchments with shallow soil and/or bedrock that are prone to flash flooding, as well as urbanized catchments with a high amount of impervious surfaces	Hydrology

Code	Name	Description	Category
gf	***geomorphic floodplain***	**Waterbody or wetland is located within a geomorphic floodplain (up to the approximate 100-year floodplain boundary), even if fed by water sources outside the floodplain**	**Natural**
gl	*glacial*	Waterbody or wetland is located within a historical or current glacial landscape	Landscape
go	*golf*	Waterbody or wetland is located within a golf course	Human-Influence
gr	*gravel*	Waterbody or wetland is excavated or impounded for mining of sand or gravel	Human-Influence
gw	*groundwater-driven*	Hydrologic regime is primarily groundwater-driven, such that levels are predictable and dominated by stable groundwater inflow for most (if not all) of the year	Hydrology
gz	*grazed*	Wetland shows obvious signs of intensive grazing by livestock or native ungulates	Human-Influence
hf	*hayfield*	Wetland is managed as a hay field and/or pasture with grass cover	Human-Influence
hs	*hot-spring*	Waterbody or wetland is influenced by a geothermal spring (can be warm to hot)	Natural
hw	***headwater***	**Waterbody or wetland is located in the upper reaches of a watershed and often the source of a stream network**	**Landscape**
hy	*hydropower*	River, stream or lake is dammed for hydropower generation	Human-Influence
id	*interdunal*	Waterbody or wetland located within a dune field	Natural
il	*island*	Waterbody or wetland located on land completely surrounded by water within either a lake, pond, or stream (not formed by ditches that encircle the wetland)	Natural
im	***impounded***	**Waterbody or wetland is impounded**	**Human-Influence**
ir	***irrigation-influenced***	**Hydrologic regime is strongly influenced by irrigation, either direct application or seepage**	**Hydrology**
it	*temporary-intermittent flow*	Hydrologic regime is temporarily intermittent or ephemeral (including inflow driven by short duration precipitation event, including monsoonal events). Cowardin water regimes of A or J.	Hydrology
kt	*kettle*	Lake, pond, or wetland located within a formerly glaciated landscape (but not in the Prairie Pothole region) and formed by ice blocks left by retreating glaciers	Natural
ld	*lock and dammed*	Channelized river with a series of locks and dams to aid navigation *(ST1 and ST2 only)*	Human-Influence
lg	*logged*	Waterbody or wetland is subject to or within the perimeter of recent timber harvest area, particularly clear-cutting or other large-scale timber harvests	Human-Influence
ml	*mineral*	Wetland is comprised of mineral soils, within an emphasis on mineral soil flats rather than any mineral soil wetland	Natural
mn	*mining*	Waterbody or wetland is excavated or impounded for mining of coal or hard rock (e.g., quarry pond or pond to capture mining waste)	Human-Influence

Code	Name	Description	Category
mr	*mire*	Wetland has accumulation of peat, but not of sufficient depth to qualify as a bog or fen; often interspersed with, or along the margins of a bog or fen	Natural
ox	*oxbow*	Lake, pond, or wetland in located in a distinct depression within the floodplain of a river or stream, including recently active oxbows and meander scars	Natural
pd	*pond fringe*	Wetland formed along the shore of a pond	Natural
pf	*permafrost*	Waterbody or wetland is located on permafrost	Landscape
pl	*playa*	Shallow lake, pond, or wetland with fluctuating water levels depending on local precipitation patterns and extent of groundwater connection; typically with no natural outlet; can be saline or not	Natural
pp	*prairie pothole*	Lake, pond, or wetland located within the formerly glaciated Prairie Pothole region; water sources include direct precipitation, runoff from surrounding areas, and groundwater; generally associated with Quaternary glacial deposits such as moraines, glacial valleys, and outwash plains	Natural
re	*restoration site*	Waterbody or wetland has been modified by known restoration or enhancement activities (e.g., earthwork, planting, vegetation removal, beaver re-introductions, etc.); requires site-specific data to apply	Human-Influence
rf	*regulated flow*	Hydrologic regime is regulated by dam(s) or diversion(s) upstream, such that the flow regime has been substantially altered in terms of the timing, frequency, magnitude, and duration of peak and low flows (does not apply to the TE landscape)	Hydrology
rn	*rainfall*	Hydrologic regime, including mean annual flow and peak flows, is primarily driven by rainfall	Hydrology
rr	*run of river dammed*	River or stream section with low dam(s) allowing flow during high water periods; often used for low-head hydropower generation or irrigation diversion(s) *(ST1 and ST2 only)*	Human-Influence
sa	*saline*	Lake, pond, or wetland that occurs on saline soil, often with obvious salt crust visible	Natural
sf	*spring-fed*	Hydrologic regime includes inputs from a natural spring	Hydrology
sl	*seepage lake*	Lake dominated by inputs from surface runoff, groundwater seepage and precipitation; may be subject to seasonal water level fluctuation; typically with no natural inlet or outlet	Natural
sn	*snowmelt*	Hydrologic regime, including mean annual flow and peak flows, is primarily driven by snowmelt	Hydrology
sr	*snow + rain*	Hydrologic regime, including mean annual flow and peak flows, is driven by a mixture of snowmelt and rainfall	Hydrology
sv	*stream valley*	Slope wetland located in a narrow valley	Natural
sw	*stormwater*	Waterbody or wetland is used to detain or retain stormwater runoff	Human-Influence
ts	*toe-of-slope*	Slope wetland located at the base of a hill or slope	Natural

Code	Name	Description	Category
wm	*wildlife management*	Waterbody or wetland is managed for wildlife (e.g., waterfowl habitat); includes the management of water levels	Human-Influence
ww	*wastewater*	Waterbody or wetland is used for wastewater retention and/or treatment (e.g., oil and gas, domestic)	Human-Influence

Table B-2: Natural and human-influence modifiers and rules for their application with wetland polygons. X = common application, o = less common application, gray cells = not applicable.

Code	Name	Wetland Types (Landscape Position and Landform)									
		LOBA	LOFP	LOFR	LEBA	LEFP	LEFR	TEBA	TEFL	TEFR	TESL
Natural: Modifiers that further refine the classification based on natural characteristics											
ay	*arroyo*	X	X								
bg	*bog*				X	X	X	X	X	X	X
bv	*beaver*	X	X	X	X	X	X	X	X	X	X
fm	*floating mat*	X		X	X		X	X		X	
fn	*fen*	o	o	o	o	o	o	X	X	X	X
gf	*geomorphic floodplain*	X	X	X	X	X	X	X	X	X	X
hs	*hotspring*	o	o	o	o	o	o	X		X	X
id	*interdunal*				X	X	X	X		X	X
il	*island*	X	X	X	X	X	X	o		X	o
kt	*kettle*				X			X			
ml	*mineral*								X		
mr	*mire*	X	X	X	o	o	o	X	X	X	X
ox	*oxbow*	X		X				X		X	
pd	*pond fringe*			X			X			X	
pl	*playa*							X		X	
pp	*prairie pothole*				X	X	X	X		X	
sa	*saline*	o	o	o	X	X	X	X	X	X	X
sv	*stream valley*										X
ts	*toe-of-slope*										X
Human-Influence: Modifiers that further refine the classification based on human-derived characteristics											
ag	*agricultural*	X	o	o	X	o	o	X	X	X	X
aq	*aquacultural*	X		o	X		o	X		o	
ch	*channelized*	X	X	X							
ex	*excavated*	X	o	o	X	o	o	X	o	o	o
go	*golf*							X	X	X	X
gr	*gravel*	X	X	X	X	X	X	X	X	X	X
gz	*grazed*	X	X	X	X	X	X	X	X	X	X
hf	*hayfield*		X					X	X	X	X
im	*impounded*	X	X	X	X	X	X	X		X	
lg	*logged*	X	X	X	X	X	X	X	X	X	X
mn	*mining*	X	X	X	X	X	X	X	X	X	X
dr	*partially drained*	X	X		X	X		X	X	X	X
re	*restoration site*	X	X	X	X	X	X	X	X	X	X
sw	*stormwater*							X	X	X	X
ww	*wastewater*							X	X	o	o
wm	*wildlife management*	X	X	X	X	X	X	X	X	X	X

Table B-3: Natural and human-influence modifiers and rules for their application with waterbody polygons. X = common application, o = less common application, gray cells = not applicable.

Code	Name	Waterbodies						
		ST1	ST2	ST3	ST4	ST5	LK	PD
Natural: Modifiers that further refine the classification based on natural characteristics								
ay	*arroyo*			X	X			
bg	*bog*						X	X
bv	*beaver*	X	X	X	X	X	X	X
fm	*floating mat*						X	X
fn	*fen*						o	X
gf	*geomorphic floodplain*	X	X	X	X	X	X	X
hs	*hotspring*	o	o	o	o	o	o	X
id	*interdunal*						X	X
il	*island*							X
kt	*kettle*						X	X
mr	*mire*						o	X
ox	*oxbow*						X	X
pl	*playa*							X
pp	*prairie pothole*						X	X
sa	*saline*						X	X
Sl	*seepage lake*						X	
Human-Influence: Modifiers that further refine the classification based on human-derived characteristics								
ag	*agricultural*	o	o	o	o	X	o	X
aq	*aquacultural*					o	o	X
ch	*channelized*	X	X	X	X	X		
ex	*excavated*	o	o	o	o	X	X	X
go	*golf*						o	X
gr	*gravel*						X	X
hy	*hydropower*	X	X			X	X	X
im	*impounded*						X	X
ld	*lock and dammed*	X					X	
lg	*logged*	X	X	X	X	X	X	X
mn	*mining*	X	X	X	X	X	X	X
dr	*partially drained*						X	X
re	*restoration site*	X	X	X	X	X	X	X
rr	*run of river dammed*	X	X					
sw	*stormwater*					X		X
ww	*wastewater*							X
wm	*wildlife management*						X	X

Table B-4: Hydrology modifiers and rules for their application with waterbody and wetland polygons and by flow path. X = common application, o = less common application, gray cells = not applicable.

Code	Name	Wetland Polygons										Waterbody Polygons							Flow Path					
		LOTIC			LENTIC			TERRENE																
		BA	FP	FR	BA	FP	FR	BA	FL	FR	SL	ST1	ST2	ST3	ST4	ST5	LK	PD	BI	TB	TH	IN	OU	VR
Hydrology: Modifiers specific to hydrologic regime and flow path																								
ar	*artificial flow*	X	X	X	X	X	X	X		X	X					X	X	X		X	X	X	X	
au	*augmented flow*	X	X	X	X	X	X					X	X	X			X	X		X	X			
ds	*discharge to stream*							X		X	X					X	X	X			X		X	
fs	*flashy*	X	X	X				X		X			X	X	X			X			X			
gw	*groundwater-driven*	o	o	o	X	X	X	X		X	X		o	o			X	X	X		X		X	X
ir	*irrigation-influenced*	o	o	o	o	o	o	X		X	X							X			X	X		
it	*temporary intermittent flow*	X	X											X	X			X			X			
rf	*regulated flow*	X	X	X	X	X	X					X	X	X			X	X		X	X			
rn	*rainfall*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
sf	*spring-fed*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
sn	*snowmelt*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
sr	*snow + rain*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

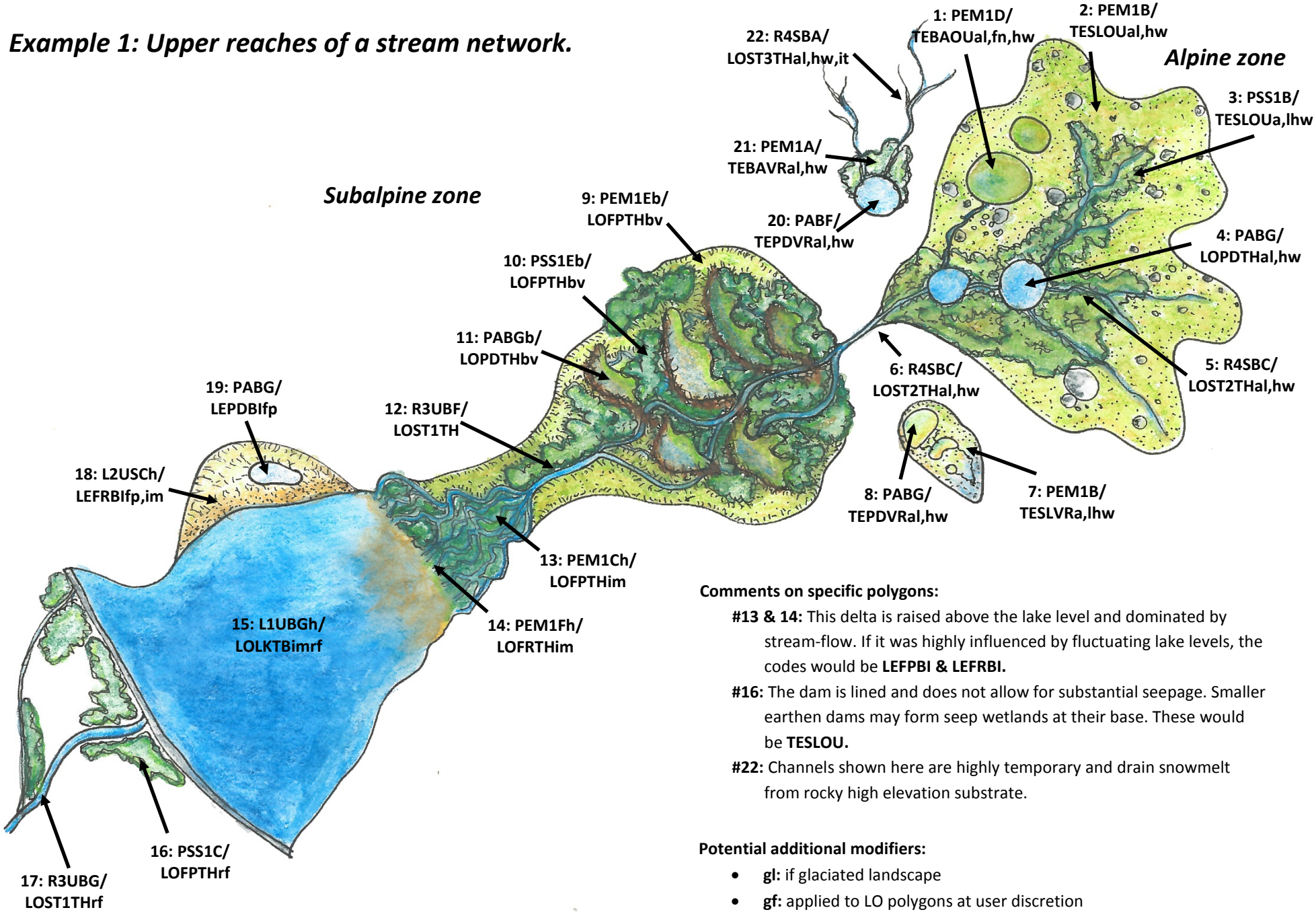
Table B-5: Landscape modifiers are applicable across all polygons.

Code	*Name*
Landscape: Modifiers that can be applied to large areas of the landscape using ancillary data sources	
al	*alpine*
bk	*beetle killed forest*
ba	*burn area*
gl	*glacial*
hw	*headwater*
pf	*permafrost*

APPENDIX C: ILLUSTRATED LLWW EXAMPLES

The following three illustrated examples provide LLWW codes and modifiers for common situations. Notes are provided to clarify difficult attribution. Additional modifiers are also listed that could be applied depending on ancillary data and user discretion; however, these should not be viewed as the only potential modifiers. More could be used if supported by ancillary data.

Example 1: Upper reaches of a stream network.



Comments on specific polygons:

#13 & 14: This delta is raised above the lake level and dominated by stream-flow. If it was highly influenced by fluctuating lake levels, the codes would be **LEFPBI & LEFRBI.**

#16: The dam is lined and does not allow for substantial seepage. Smaller earthen dams may form seep wetlands at their base. These would be **TESLOU.**

#22: Channels shown here are highly temporary and drain snowmelt from rocky high elevation substrate.

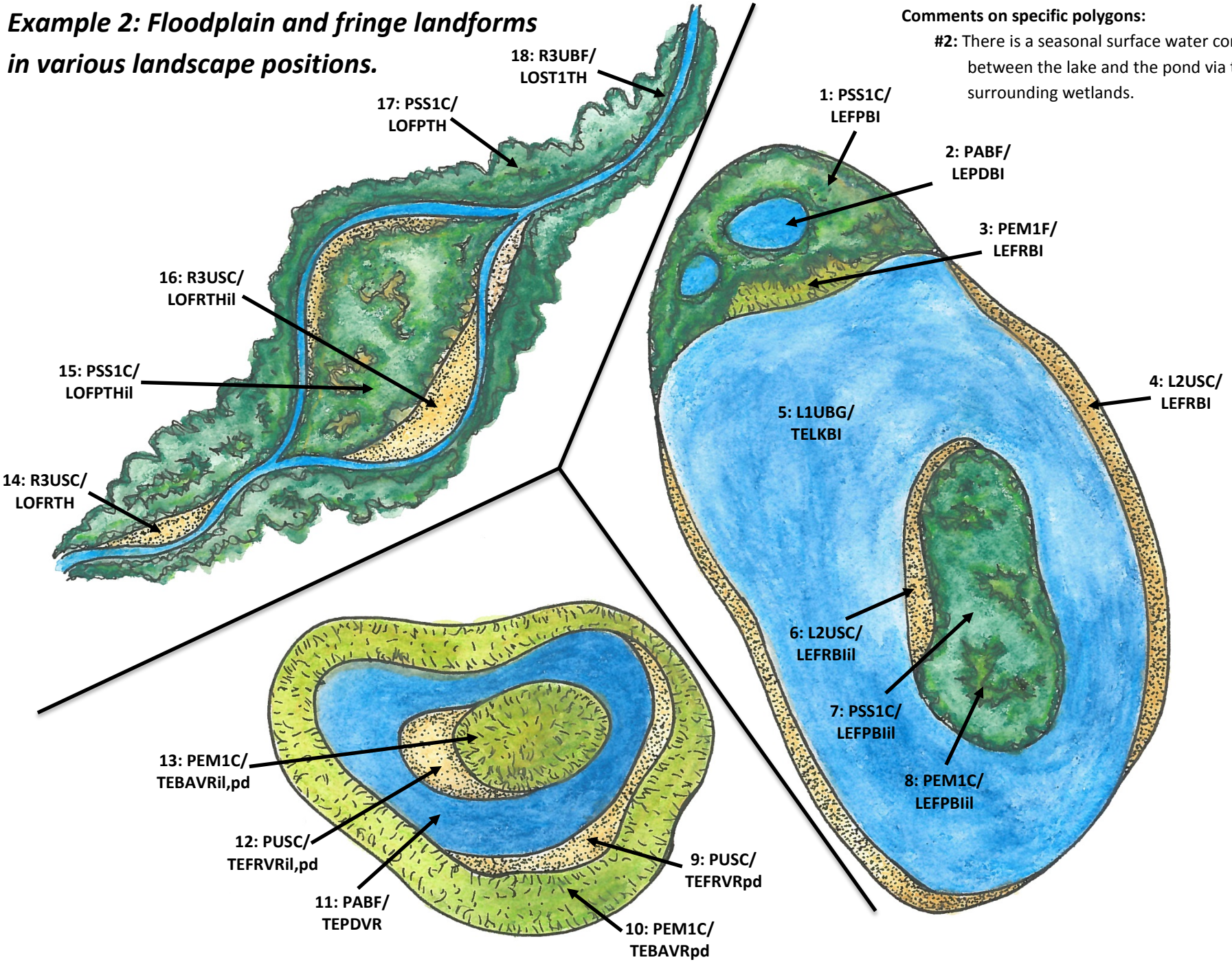
Potential additional modifiers:

- **gl:** if glaciated landscape
- **gf:** applied to LO polygons at user discretion
- **sn, sr, rn:** based on balance of snow vs. rain inputs

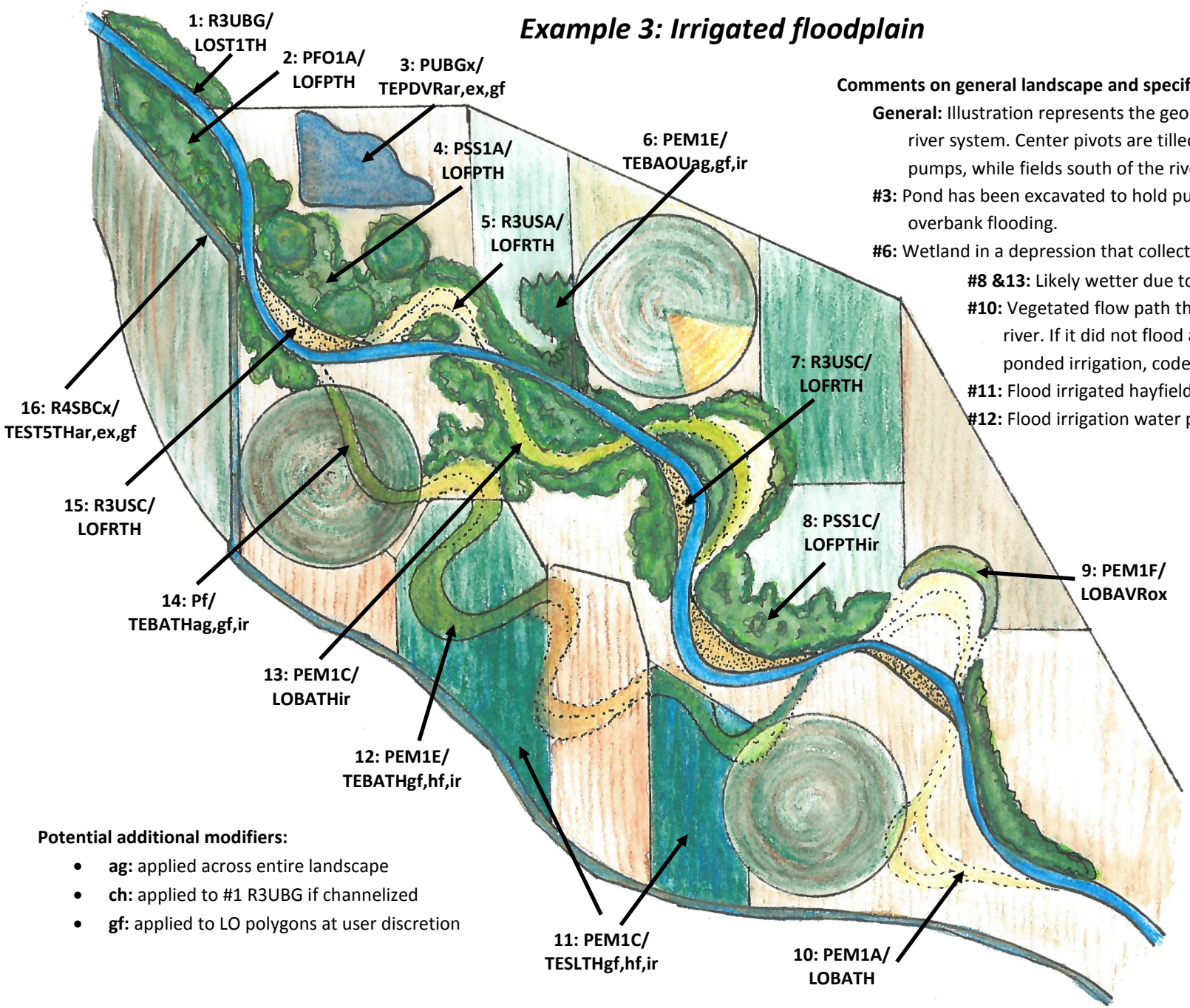
Example 2: Floodplain and fringe landforms in various landscape positions.

Comments on specific polygons:

#2: There is a seasonal surface water connection between the lake and the pond via the surrounding wetlands.



Example 3: Irrigated floodplain



Comments on general landscape and specific polygons:

General: Illustration represents the geomorphic floodplain of a modified, river system. Center pivots are tilled crops irrigated from groundwater pumps, while fields south of the river are flood irrigated hay.

#3: Pond has been excavated to hold pumped water and is not filled by overbank flooding.

#6: Wetland in a depression that collects excess irrigation from the pivot.

#8 &13: Likely wetter due to irrigation runoff.

#10: Vegetated flow path that is temporarily flooded by the river. If it did not flood and was supported only by ponded irrigation, code would then be **TEBAVRgf,ir**.

#11: Flood irrigated hayfields that show wetland signature.

#12: Flood irrigation water pools for longer in old flow path.

Potential additional modifiers:

- **ag:** applied across entire landscape
- **ch:** applied to #1 R3UBG if channelized
- **gf:** applied to LO polygons at user discretion