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ANCHOR QEA

Memorandum

September 30, 2020

To: Greg Wendt and Donna Hutchinson, Benton County Planning Department

From: Ben Floyd, White Bluffs Consulting; John Small, Anchor QEA, LLC

cc: Nikole Stout, Anchor QEA, LLC

Re: Proposed Riparian Buffers within the Benton County Critical Areas Code Update

Introduction and Purpose

The purpose of this memorandum is to demonstrate how the best available science (BAS) was incorporated in the development of policies and regulations to protect Benton County critical areas outside of shoreline jurisdiction (per Revised Code of Washington 36.70A.172) but based on standards consistent with the County's Shoreline Master Program (SMP). Specifically, this memorandum summarizes how the BAS was used to support the riparian buffers proposed within Benton County's draft update to the Critical Areas Ordinance (CAO), Title 15 Benton County Code (BCC). This memorandum begins with a summary of recent, relevant, peer-reviewed literature on riparian ecological functions, along with associated recommendations for buffer widths or ranges for protecting ecological functions. This information is followed by proposed riparian buffers for the applicable stream types. Attachment 1 includes the *Riparian Buffer Analysis Summary Memorandum* (AC Geospatial, LLC 2020).

This memorandum was written to meet the requirements of Washington Administrative Code (WAC) 365-195-905 (criteria for determining which information is the "best available science") under the Growth Management Act. BAS is required to be included in CAO updates. To "include" BAS means to substantively consider BAS in developing regulations (Whidbey Environmental Action Network v. Island County 2004). In 2012, the Division II Court of Appeals held that "including" BAS does not impose a duty on local governments to describe each step of their deliberative process but rather the local government is required to address on the record the relevant sources of BAS included in their decision-making (Olympic Stewardship Foundation v. Western Washington Growth Management Hearings Board 2012).

As noted, this memorandum focuses on the BAS information for the streams and topographic lows and their associated riparian areas in the unincorporated areas in the County that are outside of shoreline jurisdiction, and that are largely privately owned (Figure 1). Ecological conditions and riparian buffers associated with shorelines of the state have been addressed as part of the Benton County SMP, which includes regulations based on a Shoreline Analysis Report for Shorelines in Benton County: Yakima and Columbia Rivers, developed in 2013.

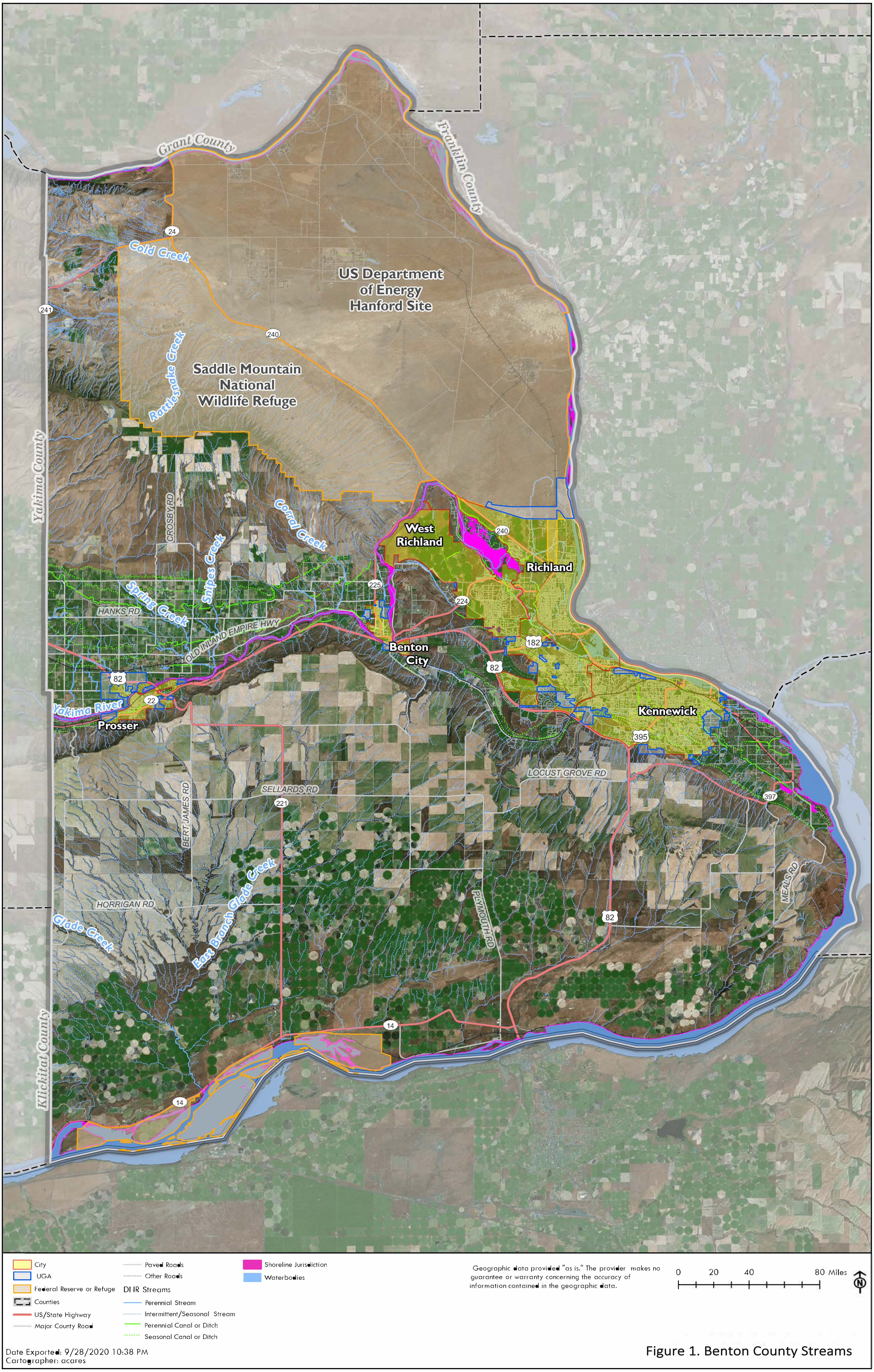

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Figure 1. Benton County Streams

Benton County Regional Conditions

Benton County is located in southeastern Washington and encompasses approximately 1,715 square miles. The Columbia River borders the north, east, and south sides of the County and the Yakima River intersects the middle of the County, flowing from Prosser to its confluence with the Columbia River at Richland. The County contains portions of three Water Resource Inventory Areas (WRIAs), including the eastern portion of the Lower Yakima Watershed (WRIA 37), the Rock-Glade Watershed (WRIA 31), and the Alkali-Squilchuck Watershed (WRIA 40).

Benton County is a cold desert climate, mean annual rainfall is generally 10 inches or less per year (Best Places 2020). Most of the drainage of the Columbia River falls as snow in the Rocky Mountains and in the Cascade Range. It is important to note that the 21 dams built on the Columbia and Snake Rivers since 1933 have substantially altered the Columbia River hydrograph. Annual peak discharges for local east slope drainages occur in the late spring (typically in June) and generally results from snowmelt in the interior subbasin. Peak flows are lower and winter flows higher than under natural conditions due to dam and reservoir operations. Mainstem Columbia River flows are primarily determined by fish runs and hydropower.

General Conditions

Benton County has an arid to semi-arid climate, and this is reflected in the dominant habitat cover. Shrub-steppe is the predominant upland native habitat type in Benton County. However, conversion of shrub-steppe habitats to cropland and grazing has left only about 5% of the historical habitat in relatively undisturbed condition. A larger proportion of the remaining native habitat is moderately disturbed by grazing, off-road vehicle use, and other land uses. These areas still provide cover, food, and nesting habitat for many species of wildlife, particularly during winter months when cultivated fields provide no vegetative cover.

Riparian areas exist along the rivers and streams in the County. These water bodies include large river systems, perennial streams with flow enhanced by surface water irrigation and shallow groundwater, and intermittent streams and topographic lows, also often enhanced by upland irrigation. With average rainfall in Benton County at less than 10 inches per year, irrigation water is the primary determinant in stream flow and associated riparian areas based on irrigation operations and upland irrigation areas and practices. The Columbia and Yakima rivers are the largest river systems in Benton County, and the riparian areas associated with their shorelines are regulated under the SMP. All 13 Endangered Species Act (ESA)-listed evolutionary significant units (ESUs) of salmon (*Oncorhynchus spp.*) and steelhead (*O. mykiss*) in the Columbia basin use the mainstem Columbia River for migration to and from freshwater natal areas to the Pacific Ocean (NMFS 2016). Most of the ESA-listed species spawn and incubate in tributaries, but some populations of fall Chinook and chum salmon spawn in the mainstem itself. Summer and fall Chinook salmon spawn in the mainstem Yakima River, and spring Chinook salmon use the mainstem for rearing (WDFW 2020). Generally, Chinook salmon are the dominant salmonid during the spring period. Non-native fish species that compete with native fish are also present in the Yakima and Columbia Rivers. Generally, riparian buffer widths may influence critical habitat function for endangered salmon and steelhead.

In addition to the Columbia and Yakima rivers, unincorporated Benton County also has Glade, Spring, Snipes, Corral, and Dead Canyon creeks, along with several other unnamed perennial and intermittent streams or topographic lows with regular or occasional surface water flow. Spring, Snipes and Corral Creeks are tributaries to the Yakima and have documented usage by steelhead, fall Chinook salmon, and Coho salmon in the lower reaches of the streams. Additionally, Snipes also has spring Chinook salmon documented usage. Snipes Creek documented fish presence is in the lower 3.7 miles, Corral in the lower 1.7 miles and Spring in the lower 1.0 mile. Flows in each of these streams is annually regulated by irrigation system operations, including spill and/or return flows. Additionally, periodic high precipitation events can also temporarily influence flows.

Glade Creek and Dead Canyon, tributary to the Columbia River, have documented historical usage for Glade by Coho salmon (lower approximate 2.5 miles) and steelhead rearing for Dead Canyon (lower 1.4 miles) (WDFW 2020). Shallow groundwater from upland irrigation and pool elevations in the Columbia River John Day reservoir affect flows in these streams. Additionally, periodic high precipitation events can also temporarily influence flows.

Riparian Ecological Functions in the Semi-arid Environment

Riparian ecosystems in semi-arid regions appear as dense vegetative patches and corridors in a landscape otherwise dominated by shrub-steppe communities (Photo 1). "Riparian systems are therefore uncommon ecosystems in semi-arid regions, making up no more than 3% of the landscape, but are linked hydrologically to the rest of the landscape" (Naiman and Decamps 1997 as cited in Patten 1998).

Photo 1
Typical Shrub-Steppe Riparian Stream Buffer Conditions

The width of the riparian vegetation community can vary from a few feet to a few hundred feet (when associated wetlands also exist). Topography, specifically the depth to groundwater associated with the stream, strongly controls that distance. In areas without wetlands, where subsurface water or wet soils are limited, the riparian vegetation typically does not extend more than 20 feet from the ordinary high water mark of the associated waterbody. Exceptions occur where an upland irrigation source provides surface runoff or shallow ground water return to supplement the stream hydrology and when topography is extremely flat and hyporheic (e.g. subsurface) flows extend laterally from the stream maintaining the alluvial aquifer which the riparian vegetation depend on.

In Benton County, riparian buffer characteristics were summarized for 29 stream segments outside of SMP jurisdiction (F, Np, and Ns streams) (AC Geospatial, LLC 2020**). The average, minimum, and maximum values for each stream segment were calculated from the measurement points that fall along that segment. Overall, the measured streams had an average vegetated buffer width**

of 20 feet per side. The average stream channel width was 7 feet, and the average cumulative width of the stream and riparian vegetation was 47 feet (, average channel width 7 feet). The Riparian buffer data for each stream segment is summarized in Table 1 and described in greater detail in Table 3 of the Riparian Buffer Analysis Summary Memorandum (Attachment 1).

Table 1
Non-Shoreline Stream Riparian Widths

Stream Name	Max Width for Stream and Riparian Areas	Minimum Width for Stream and Riparian Areas	Max Average Riparian Width Per Side	Minimum Average Riparian Width Per Side
Corral Creek	126	26	41	33
East Branch Glade Creek	87	25	33	33
Glade Creek	132	30	32	21
Snipes Creek	102	27	25	16
Spring Creek	64	9	14	5
Unnamed Perennial Stream Segments	115	8	28	7
Dead Canyon	34	39	26	26
Bing Canyon	34	38	27	27
Switzler Canyon	34	39	31	31
Fourmile Canyon	34	16	21	15

Source: (AC Geospatial, LLC 2020)

Wood Recruitment and Organic Inputs

Instream wood provides habitat and hydrology function, especially for rearing fish and other aquatic fauna. Large woody material that creates pools and provides channel complexity is sparse in Benton County, where riparian areas are dominated by shrub and herb species. This vegetation still provides key organic inputs to the stream ecosystems.

Key Functions

Organic Inputs. Riparian vegetation communities are the primary source of organic inputs in most streams and lakes in semi-arid regions. The mesic nature and higher biomass of the riparian community combined with the proximity to the water bodies makes it a crucial source of organic matter.

Large woody debris. The potential size of large wood recruited into streams east of the Cascade Divide is generally less than the size of these features on the west side of the region. Instream wood provides habitat for fish and other aquatic wildlife. Small and large wood both impact channel morphology through sediment capture, water retention, and create hydraulic complexity. Large wood provides pools and scour for fish-rearing habitat and organic matter storage, as well as shade and refuge for fish.

Key Findings

Sources. Bank erosion and tree mortality contribute the most to instream wood recruitment (Johnston et al. 2011; Murphy and Koski 1989). Litterfall including fallen woody debris can form debris dams that retain organic matter and sediment beneficial for habitat and/or as nutrients for aquatic species (Benke et al. 1985; Gregory et al. 1991; Prochazka et al. 1991; Speaker et al. 1984; Bisson et al. 1987 as cited in Tait et al. 1994). The limited water sources in semi-arid environments for tree and shrub vegetation in riparian habitats reduces the biomass of nutrients through organic input compared to riparian habitats in wetter climates.

Recruitment distances. Less wood is recruited as the distance from the channel increases. In Washington studies, 50% of wood recruited originated within 35 feet of the channel (McDade et al. 1990). Litterfall from shrubby vegetation is primarily input directly adjacent to the channel.

Recommendations

In semi-arid west environments, large woody vegetation can be rare and its presence decreases rapidly with increasing distance of the stream channel from flow patterns of the water table (Malanson 1993 as cited in Buffler 2005). Riparian buffer widths in Benton County on non-shoreline streams average 20 feet, with very limited tree cover as most of the habitat is shrub-steppe (Photo 2). Because most recruitment happens within the adjacent 49 feet of the stream, a buffer of 50 feet would be sufficient to provide wood recruitment in these conditions.

Photo 2
Benton County Non-Shoreline Stream Buffer Vegetation Example

Protection of existing functional riparian vegetation communities should be a priority and protective buffers should be developed based on the width of functional (undisturbed) riparian communities in the reach. In Benton County, the width of this area is typically less than 20 feet, so the recommended 50 feet is conservative.

Stream Temperature

Stream thermal conditions can vary with elevation, channel structure, landscape condition and land use, and the riparian ecosystem adjacent to the stream. The main source of heating in a stream is usual direct solar radiation, which is effectively reduced by the available shade given from vegetation.

Riparian vegetation has an important role in the food web system of streams (Cummins et al. 1989 as cited in Tait et al. 1994). Where it exists, overhanging vegetation can filter and absorb incident radiation, this affects periphyton primary productivity and, improves water temperatures (Lyford and Gregory 1975, Towns 1981, Bott 1983 as cited in Tait et al. 1998).

Riparian areas with tree cover are most efficient in reducing solar heating of stream water by shading, especially in low order streams (Brown and Krygier 1970). Riparian vegetation also provides cooling through evapotranspiration (Beschta 1984, Theuer et al. 1984, Sinokrot and Stefan 1993 as cited in Tabacchi et al. 1998). Stream temperature can also be moderated by cool groundwater upwellings from deep phreatic sources and from hyporheic zones near stream margins (Stanford et al. 1994 as cited in Tabacchi et al. 1998).

Similar to habitat corridor functions, tree and shrub vegetation canopies adjacent to the shoreline and overhanging the stream banks are required for optimal temperature function. As tree and shrub density decreases near the shoreline the function also decreases. In semi-arid west environments, tree and shrub vegetation is often limited not only through land use activity but also because of natural conditions such as streams in steep sloped ravines and valley systems which typically have limited tree cover. Severe topography dominates many of the smaller order stream systems in Benton County. Many of the riparian habitats in the county also include shrub vegetation with little or no tree cover. Shrub communities in semi-arid riparian habitats typically do not provide the height, density, and overhanging vegetation characteristics that shrub species in wetter environments provide and therefore provide a lesser temperature regulation function than in wetter environments. Herbaceous riparian vegetation provides little or no temperature functional value, except in low-order, low-energy systems that support reed beds and/or forb dominated vegetation.

The findings from AC Geospatial 2020 show that the average width of riparian vegetation in Benton County is only 20 feet with a standard deviation of 9 feet. While this would be highly limiting in larger river systems in Benton County the average stream width was 7 feet, allowing for a large percentage of the stream to be shaded by relatively little vegetation. AC Geospatial (2020) also found that only about a third of reaches supported trees, which can provide shade to a stream even if growing away from the bank. Many riparian zones in Benton County are vegetated only with herbaceous species which provide shade only when very close to the streambank.

Stream water temperatures are also influenced by shallow groundwater inputs, primarily from upland irrigation practices. This groundwater is typically cooler than surface water, particularly in warmer months. Direct runoff from nearby impervious surfaces such as roads primarily occurs in the late fall and winter months when stream temperatures are lower. Thin stemmed vegetation like grasses and herbs tend to be more effective than trees or shrubs for collecting surface runoff to allow infiltration back into the groundwater prior to entering the streams (Hruby 2014).

Key Functions

Tree cover. Riparian areas with tree cover are most efficient in reducing solar heating of stream water by shading, especially in low order streams (Brown and Krygier 1970, as cited in Tabacchi et al. 1998). Riparian vegetation also provides cooling through evapotranspiration (Beschta et al. 1987, Theuer et al. 1984, Sinokrot and Stefan 1993, as cited in Tabacchi et al. 1998).

Groundwater. Stream temperature can also be moderated by cool groundwater upwellings from deep phreatic sources and from hyporheic zones near stream margins (Tabacchi et al. 1998).

Fish. Increasing stream temperatures are detrimental to fish, especially salmonids.

Key Findings

Shading. Shade from riparian cover maintains the cooler stream temperature, provided by groundwater inputs. Stream channel attributes like width, landscape position, flow, and groundwater table depth also influence stream temperatures. The type of riparian community (tree height and density) may have a larger impact on available shade than the width of riparian buffer (DeWalle 2010). Generally, cooler stream temperature is provided and maintained by irrigation spill and returns and the shallow groundwater table in the Yakima River tributaries.

Land use. Compaction can limit new vegetation growth and reduce shade from streambank riparian vegetation (Li et al. 1994), though riparian vegetation is able to recover after disturbance (Zoellick 2004).

In some studies, stream temperature was found to be more influenced by hyporheic exchange and width-to-depth ratio than by the riparian community type (forested or shrub-scrub) (Liquori and Jackson 2001; Maloney et al. 1999). Traditional stream temperature models are limited by the assumption that stream structure stays relatively stable because there is evidence of upslope land use and management affecting channel stability.

Recommendations

As stated in *Riparian Ecosystems, Volume 1* Section 7.4.2, "maximum recruitment distances for large wood will generally be either riparian zone width or site-potential tree height, whichever is smaller." This applies to shading function as well, as the more arid vegetation common in Benton County rarely exceeds a few feet in height. Cristea and Janisch (2007) found that shade on small streams 10 to 20 feet in channel width was 61% to 78% of undisturbed sites when only a 30-foot buffer was protected. Shorter shrub-steppe vegetation only a few feet in height will have the maximum function for shading closer to the stream.

Based on this, a buffer of 50 feet would be sufficient to support stream temperature function in undisturbed riparian areas. It should be noted that a buffer of 50 feet would likely be overprotective for shade functions in rural or developed areas, as shade function is severely limited or gone in these impacted areas. However, shade is not the only factor that influences stream temperature. The shallow groundwater table and irrigation practices in the county primarily influence stream temperatures for tributaries and topographic lows, as discussed above.

Pollutant Removal

Pollutant removal functions of riparian areas are only applicable in developed or rural areas where there is the potential for human activities that generate polluted runoff. The streams behind evaluated are outside of the more densely urban areas; however, agricultural activities and the occasional runoff from storm events in the rural areas have the potential to introduce pollutants and sediment into the stream.

Key Functions

Runoff. Riparian vegetation intercepts polluted runoff from upland areas and provides some filtration of the contaminants before they enter streams. Soil and hydrology are also large factors in determining how functional the riparian zone is for pollutant removal (WDFW 2018).

Vegetation type. Grass buffers can be as effective as dense forested buffers for pollutant removal function (Correll 1997; Hawes and Smith 2004; Dosskey et al. 2010). These grass filter strips are especially valuable in rural areas where forested areas are not present, like in Benton County.

Key Findings

Sediment removal distances. Most sediment removal (up to 90%) happens in the first 10 to 40 feet of a riparian buffer (Leeds et al. 1994; Yuan et al. 2009). These findings are consistent with those of GEI Consultants, Inc. (2002), that reviewed riparian buffer efficiency in agricultural areas. In forested areas, 33 feet is enough of a buffer to reduce sediment transport to a stream (Clinton 2011); whereas in rural areas where quantity of overland flow could be greater, the buffer should be larger. Similarly, Sweeney and Newbold (2014) found that a 33-foot buffer is sufficient to remove approximately 65% of sediments. Zhang et al. (2010) analyzed pollutant removal and concluded that a 100-foot-wide riparian buffer with 10% slope could remove over 85% of pollutants.

This information indicates that to protect stream water quality from erosion a vegetative buffer of 40 to 50 feet should provide adequate protection. This achieves, for example, approximately 90% reduction in sediment for slopes up to 5%, and 80% reduction for slopes between 5 and 15%. This should be viewed as a conservative protection value, based upon the higher rainfall, intensity of rainfall and runoff potential in the geographic areas where most of the referenced studies were conducted. Semi-arid and arid areas experience significantly less precipitation (3 to 15 inches per year) than most of the study areas referenced (e.g., 20 inches [Nebraska] to 45 inches [Georgia]) per year. It is possible that at these lower precipitation levels and less frequent storm that less sediment overall can be transported. Verification of this assumption with additional information, particularly as it relates to storm intensities, is recommended.

Organics. USDA-NRCS (2000) recommends that pollutants like pesticides and organic compounds could be diffused between 35 and 65 feet.

Recommendations

A buffer of 50 feet would be sufficient to support a majority pollutant removal function in most riparian areas. A minimum buffer of 40 feet would effectively intercept pollutants and minimize sediment input from upland sources. In specific cases where slopes into the stream are greater than 10% and adjacent to cultivated agricultural ground. A buffer up to 100 feet would be needed, but these conditions are too atypical in the county to warrant applying this buffer in all cases.

Nutrient Dynamics

Transport of primary macronutrients between uplands and streams examined in riparian ecology include carbon, nitrogen, and phosphorus.

Riparian vegetation buffers trap and remove sediment and dissolved phosphorus, nitrogen, and other nutrients. Both particulate and dissolved matter can be retained by growing riparian vegetation and decomposing organic detritus. These biological processes reduce the potential for eutrophication (Horowitz 2009).

Riparian vegetation allows for suspended sediment removal, along with dissolved nutrients from surface runoff of stormwater (Peterjohn and Correll 1986, Chescheir et al. 1991, Klarer and Millie 1989, Lowrance et al. 1986, Mitsch et al. 1979, Parsons et al. 1994; as cited in Tabacchi et al. 1998) and flood waters entering (Brunet et al. 1994, Hart et al. 1987, Hupp and Morris 1990, Hupp et al. 1993, Johnston 1993, Kleiss et al. 1989; as cited in Tabacchi et al. 1998). Riparian vegetation facilitates the removal or storage of particulates. Increased friction with the soil surfaces can reduce water flow velocity and increase sedimentation of particulates. Riparian vegetation and organic detrital layers on the soil surfaces and bottom sediments are also very effective in slowing the velocity of the surface waters. The roots of the plants, which are on or near the surface, and the microbial communities on surfaces of soil, organic litter, and above ground vegetation can also assimilate dissolved nutrients from surface waters (Peterjohn and Correll 1986 as cited in Tabacchi et al. 1998).

In agricultural areas, dissolved phosphorus can be attached and exported in suspended sediments. Several studies have demonstrated the effectiveness of the riparian zones in controlling phosphorus inputs from agricultural lands to the aquatic systems (Omernik et al. 1981, Peterjohn and Correll 1986, Cooper and Gilliam 1987, as cited in Tabacchi et al. 1998) and produced equivocal results. Therefore, depending on the soil texture and the form of phosphorus, riparian forest soils can be considered “either as a source or a sink of phosphorus” (Fabre et al. 1996 as cited in Tabacchi et al. 1998).

Within the hyporheic zone riparian vegetation roots reduce subsurface pollution, particularly nitrogen (Peterjohn and Correll 1986). Nitrogen buffering in the riparian zone occurs through plant uptake and microbial denitrification. This buffering is most effective where the surface contact between riparian wetland and the adjacent agricultural land is maximized along low order streams (Haycock et al. 1993, Brinson 1990 as cited in Tabacchi et al. 1998). However, this function of regulating subsurface nitrogen is often limited by a riparian zone’s geomorphic character, which determine the groundwater flow path and thus influences transported nitrate availability. Thus the efficiency of the attenuation of nitrogen or other pollutants is dependent not only on the area of riparian vegetation but also on the area of length of hydrologic contact with vegetation in riparian areas. (Tabacchi et al. 1998).

In addition to their nutrient uptake properties, riparian areas also serve to reduce toxin inputs into aquatic environments. Since the character of vegetation corridors (width, density, type of vegetation) directly influence the amount of soil and sediment lost to the river this also influences the rate of immobilization of fertilizers, pesticides, and spilled contaminants found on the surface and subsurface of soils (Patten 1998).

Key Functions

Nutrient input. Riparian vegetation buffers trap and remove sediment and dissolved phosphorus, nitrogen, and other nutrients. Both particulate and dissolved matter can be retained by growing riparian vegetation and decomposing organic detritus. These biological processes reduce the potential for eutrophication (Horowitz 2009).

Riparian trees and other vegetation provide inputs of detrital particulate matter (e.g., leaves, pollen grains and terrestrial insects) to aquatic ecosystems. These organic materials comprise major sources of nutrients and energy source for food webs that sustain production of various consumers like fish and beaver (Tait et al. 1994).

Key Findings

Nitrogen removal. Nitrogen removal is most effective on wider bands of vegetation that allow for subsurface movement of water, from 80 to 150 feet wide (Sweeney et al. 2004; Mayer et al. 2007; Sweeney and Newbold 2014). Buffler et al. 2005 concluded that nitrogen “attenuation requires a buffer of as little as 30 feet to 60 feet in slopes up to 15%, and up to 100% removal of nitrogen with a buffer of 65 feet.”

Phosphorus retention. Phosphorus retention is influenced by hydrologic flow paths and soil structure more than by riparian area width (Hoffmann et al. 2009; Schechter et al. 2013).

Nutrient cycling. A riparian buffer width with a high function for nutrient cycling is 100 feet where there has been harvest or land use changes, and a 33-foot buffer would produce moderate function (Lecerf and Richardson 2010; Sweeney and Newbold 2014). Undisturbed areas would produce higher function with a smaller buffer width.

Recommendations

There are currently no Category 4 or 5 303(d) listing for nitrogen or phosphorus in the county (Ecology 2020). A buffer of 50 feet is sufficient to support nutrient dynamics function in riparian areas in Benton County.

Peak Flow Conveyance

Peak flow conveyance and channel migration is influenced by sediment supply, riparian vegetation, and transport capacity. Channel forms and varied substrates influence the quality of fish and wildlife habitat available in a stream system. Vegetation in the riparian zone strengthens the bank and contributes runoff to the stream. Inversely, channel morphology and hydrology affect the species composition and age structure of riparian vegetation.

Generally, streams in Benton County are controlled by irrigation practices, which also control peak flows. Because many of the streams are incised with severe topography, channel migration does not usually occur in the F, Ns and Np streams regulated under GMA.

Key Functions

Channel complexity. Channel forms are influenced by water flow, channel slope, sediment transport, and other factors the affect the stream shape and the quantity, quality, and type of habitat available to aquatic and terrestrial species using riparian areas (Leopold and Wolman 1957; Schumm 1977). These geomorphic processes contribute to the development of various stream habitats. Habitats useful to aquatic species, including shallow-water and off-channel refugia, gravel bars, pools, riffles, and the transport of organic material, including large woody debris.

Vegetation. Riparian vegetation slows flows during peak runoff events (greater than bankfull) and reduces peak discharge coming off of floods (Tabacchi et al. 2000). Vegetation along streambanks also traps and stores sediment from flow upslope (Naiman et al. 2010).

Key Findings

Sedimentation. For control of excessive sedimentation in rural or urban areas, Sweeney and Newbold (2014) concluded that a buffer of 100 feet is needed to remove approximately 85% of sediments from overland flow. A buffer of only 33 feet is needed to remove approximately 65% of excessive sediments. Buffler et al. 2005 found that a 3 to 10 meter-wide grass buffer was found to be sufficient to remove most particulates from overland flow.

Recommendations

Peak flow conveyance and channel migration processes are site specific, as each system has a unique set of geomorphic controls and natural disturbance regime. For Benton County non-shoreline streams, flood events are less common and peak flows are controlled (Photo 3). A buffer of 33 feet would be sufficient to support peak flow conveyance and channel migration function in most streams, as vegetation becomes less effective at stabilizing the bank as distance from the bank increases (Roering et al. 2003; Sweeney and Newbold 2014). In geomorphically unstable reaches, with a history of channel migration would require additional setback. Development should generally be kept out of the historic channel migration zone in locations where channel migration has not been arrested by levees or revetments.

Photo 3
Typical Controlled Stream in Benton County

Summary of Recommendations

In reviewing the reference documents, much of the available technical information is geographically broadly based and does not provide site-specific details for identifying specific widths of riparian protections to maintain the various types of semi-arid riparian ecological functions found in Benton County. Caution must be used in applying or relating these prescriptions for wetland, riparian, and floodplain protection from other geographic areas to these features in the County. This caution is tied to the variability in riparian functions and the area in which these functions occur in a semi-arid environment. In many cases, the intent of the prescriptions found in the literature is to protect vegetation types that are relatively rare or absent within the greater Columbia Basin Plateau region, and that may or may not be applicable to the streams in Benton County addressed in this memorandum.

Tree and shrub vegetation adjacent to the shoreline and overhanging stream banks is necessary for optimally functioning aquatic habitat. Functional quality provided by herbaceous riparian habitat with no tree or shrub canopy generally provides less function in terms of food web support, thermal regulation, and soil stabilization. Riparian habitat in the semi-arid west can have limited or no tree or shrub vegetation due to both land use activities, natural environmental conditions, or both.

Table 2 summarizes the recommended buffer distances based on the conclusions drawn from sources reviewed in the section above. The recommended buffers include an additional 10 feet to provide for facilities maintenance and for consistency with the County’s draft SMP for similar functioning streams and associated habitat areas in the rural setting.

Table 2
Summary of Riparian Width to Provide Key Functions

Function	Minimum Distance Recommended by BAS (feet)	Type F Proposed Buffer in CAC	Type Np/Ns Proposed Buffer in CAC	Efficacy with Source from Above
Wood	20	50	50	Because most recruitment happens within the adjacent 49 feet of the stream, a buffer of 50 feet would be sufficient to provide wood recruitment in these conditions.
Stream Temperature	30	50	50	A buffer of 50 feet would be sufficient to support stream temperature function in undisturbed riparian areas. It should be noted that a buffer of 50 feet would be overprotective for shade functions in areas with moderate land use, as shade function is severely limited or gone in these impacted areas.
Pollutant Removal	40/100 (>10% slope)	40/100 (>10% slope)	50	A buffer of 40 feet would be sufficient to support pollutant removal function in riparian areas. 100 feet for areas with slope greater than 10% and significant ground disturbances directly upland.
Nutrient Dynamics	33	50	50	A buffer of 50 feet is sufficient to support nutrient dynamics function in riparian areas in Benton County.
Peak Flow Conveyance and Channel Migration	33	50	50	A buffer of 50 feet would be sufficient to support peak flow conveyance and channel migration function in most streams, as vegetation becomes less effective at stabilizing the bank as distance from the bank increases.

F: Fish
Np: Non-Fish
Ns: Non-Fish Seasonal

Table 3 provides the recommended riparian buffer widths for streams and topographic lows under the CAO. As a special consideration for anadromous species, the recommended buffer width for the documented anadromous fish-bearing streams is 75 feet.

Table 3
Recommended CAO Riparian Buffers

Stream Name, Type	Recommended Riparian Buffer
Corral Creek, F	75 feet
East Branch Glade Creek, Np	50 feet
Glade Creek, F	75 feet
Snipes Creek, F	75 feet
Spring Creek, F	75 feet
Unnamed Perennial Stream Segments, Np	50 feet
Dead Canyon, Ns	50 feet
Bing Canyon, Ns	50 feet
Switzler Canyon, Ns	50 feet
Fourmile Canyon, Ns	50 feet

References

AC Geospatial, LLC 2020. *Riparian Buffer Analysis Summary Memorandum.* Prepared for Benton County. May 2020.

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