ATTACHMENT C

City of Boulder
Planning and Development Services

Wetland and Stream Buffers: A Review of the Science and Regulatory Approaches to Protection

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Developed by:

City of Boulder
Planning and Development Services

and

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I. Introduction

PURPOSE AND BACKGROUND

The purpose of this report is provide the Planning Board, City Council and the Boulder community with information on the value of wetland and stream buffers and a review of regulatory approaches to buffer protection across the U.S. The information in this report will be used to compare Boulder's Wetlands Protection Ordinance (Boulder Revised Code, Section 9-3-9, "Wetlands Protection") with other regulatory approaches to wetland[1] protection throughout the country and to determine the scope and direction of potential revisions to the city's code.

In conducting a public process to update the city's official wetlands maps, issues with the wetlands ordinance in general and the regulatory buffer area in particular were raised by property owners and the Planning Board. Some of the issues that were raised with the current ordinance concerned: 1) the methodology for establishing buffer widths; 2) the appropriate size of buffer areas to protect the wetland functions; and 3) the lack of specific standards in the review process.

This report addresses some of the issues that were raised with the ordinance by reviewing the current thinking about and approaches to buffer area protection across the country. The goal of the study is to provide background information that will guide the development of options for updating the city's wetlands protection program and ordinance. The following questions are addressed in this report:

1) **What does recent science tell us about the purpose and importance of wetland buffers? What are the recommended widths to protect different wetland functions?**

2) **What are the various approaches used in other U.S. counties and municipalities to regulate activities in buffer areas?**

3) **What are the elements of an effective wetland buffer ordinance and how does that compare to Boulder's Wetlands Protection Ordinance?**

STRUCTURE OF REPORT

The information in this report is presented in four sections. Section I provides background on the role of local governments in regulating wetland and stream buffers. Section II reviews the purpose and functions of buffers and the science-supported buffer widths needed to protect the ecological functions of streams and wetlands. Section III is a discussion and analysis of various approaches to buffer protection among several local jurisdictions across the country. Section IV presents a conclusion to the report and recommendations for change to Boulder's ordinance.

[1] For the purposes of this report, use of the term *wetland* refers to both wetlands and streams.

ROLE OF LOCAL GOVERNMENT IN WETLAND BUFFER AREA PROTECTION

Regulatory and policy approaches to wetland protection exist on all government levels including federal, state, regional, county, and municipal. Section 404 of the federal Clean Water Act establishes a program administered by the U.S. Army Corps of Engineers to regulate the discharge of dredged or fill material into waters of the U.S., including wetlands, through a permitting process. The landward extent of the federal jurisdictional authority, however, is defined by the boundaries of the wetland as defined in federal rules.

Although much attention has been placed on wetland regulation at the federal level over the past few decades, there is a limitation to the role that the federal government plays in regulating activities in and around wetlands. For example, the ability of the federal government to regulate and administer the protection of smaller wetlands and streams through a case-by-case permitting system is limited by the lack of federal control over water rights (which is regulated through the states) and land use (which is regulated primarily on the county and municipal level). In addition, the federal government places little authority over non-wetland habitat around a wetland despite the fact that the U.S. Army Corps of Engineers and the federal courts have established that the areas outside jurisdictional wetlands may be vital to the processes on which functioning wetlands depend.

The role of local governments in protecting wetlands and other natural resources is becoming more evident as political pressures at the federal level result in continuing changes to the scope and effectiveness of Section 404. Minimum thresholds and types of activities that are within the scope of the federal law constantly change with political administrations, court challenges, and periodic re-issuance of general permits.

Over the last two decades, local governments have come to realize the critical role they play in protecting and restoring wetlands. Buffer area protection is not uncommon in ordinances or statutes designed to protect wetlands, streams or rivers. In fact, the use of buffers is very common and becoming more of the normal approach to wetland protection across the country on the municipal and county levels. Numerous states, counties, and municipalities have enacted laws and ordinances over the past 20 years to provide stronger protection to wetlands. As of 2006, it is estimated that approximately 5,000 to 6,000 counties, cities and towns across the U.S. have adopted specific wetland protection regulations[2]. Local wetland regulations fill the gaps in federal and state protection by providing regulatory approaches that cater to local conditions, provide more effective enforcement, and emphasize landowner education. In particular, local governments can provide better protection of the land areas adjacent to sensitive resources which are typically outside the purview of federal and state governments.

BOULDER’S WETLANDS PROTECTION ORDINANCE

Boulder’s Wetlands Protection Ordinance was first adopted in December 1992 and went into effect in January of 1993. The ordinance is part of the land use section of the city's municipal

[2] See Kusler, 2006.

code and requires a landowner to obtain a permit for certain activities within a wetland or its buffer area. The ordinance regulates activities in a mapped wetland or stream channel and within a 25 foot or 50 foot buffer area from the edges of the wetland or stream channel (or top of the bank). For the most part, general development activities such as the placement of fill, structures or impervious surfaces; major regrading; or the removal of a significant amount of vegetation are currently regulated under the ordinance.

The city's ordinance was developed with an approach to the regulation of activities similar to the federal law (e.g. the placement of fill, removal of vegetation, alteration of drainage, and placement of structures) but was expanded in scope to regulate these activities in more wetlands and in a buffer area beyond the wetland boundary. Similar to the individual permit system of the federal law, Boulder applies the standards of "avoidance", "minimization", and/or "mitigation" of impacts through a discretionary review of permit applications. Most land use activities, then, are not strictly prohibited within a wetland or its buffer. Under the standards of the code, regulated activities may be permitted if the standards of avoidance, minimization and/or mitigation can be shown.

II. The Science of Wetland Buffers

INTRODUCTION TO WETLAND BUFFERS

Wetland protection depends not only on managing wetlands themselves, but on managing the surrounding water sources and landscape, above all in buffer areas. An abundance of scientific research published since the 1970s documents the value of establishing, maintaining, and enhancing vegetated buffers along wetlands. Wetland buffers provide important benefits including water quality improvement, streambank stabilization, flood control, wildlife habitat, and groundwater recharge (USDA, 2003; Castelle et al., 1992; EOR, 2001; Wenger, 2000; Correll, 1996). Wetland buffers also provide significant social and economic benefits by improving aesthetics and increasing property values (Lovell and Sullivan, 2005; Qui et al., 2006).

Wetland buffers are located along the edges of streams, and ponds, as well as on hill slopes and in depressions (Figure 1). Water bodies and adjacent lands are generally divided into three zones – the aquatic zone includes the area below the high water mark; the riparian zone is between the high water mark and the upland area; and upland areas are adjacent to the riparian zones with distinctly different vegetation and soils. Because they are not wetlands, buffers generally have unsaturated soils that did not develop under saturated conditions and vegetation communities with few if any plant species that require saturated soils. A wetland buffer is the vegetated transition zone between an upland area and the aquatic ecosystem, and depending on the definition, the buffer may include portions of both riparian and upland zones. This unique position in the landscape enables buffers to mitigate certain impacts of upland land use on adjacent wetlands. In the absence of wetland buffers, these impacts are typically magnified and become more damaging.

Width, length, and vegetation composition of buffer areas are key features that enhance many functions essential to establishing and maintaining healthy wetlands. Wetland buffers vary in size based on factors such as adjacent land use, land ownership, topography, wetland area, and ecological functions. Generally speaking, buffers that are wider, longer, and more densely vegetated with herbaceous, shrub, and tree layers provide more benefits than buffers that are narrower, shorter, and sparsely vegetated with only herbaceous species.

Figure 1. Example of vegetated wetland buffer along Bear Canyon Creek in Boulder, CO.

In riparian areas adjacent to active stream channels, buffers provide important hydrological and ecological "rights-of-way". Stream buffers maintain lateral connectivity between the streams and adjacent floodplains and uplands, as well as longitudinal connectivity up and down stream.

FUNCTIONS AND BENEFITS OF BUFFERS

This subsection summarizes major wetland buffer functions including water quality protection, streambank stabilization, floodflow alteration and storage, groundwater recharge, and habitat protection. Vegetated wetland buffers also provide an array of sociological and economic benefits to communities which are only briefly noted here.

Water Quality Protection – *Wetland buffers improve water quality by trapping and/or transforming pollutants such as sediments, nutrients, pathogens, and pesticides in surface water and groundwater* (Pearsell and Mulamoottil, 1996; numerous articles cited in Correll, 1996 including Mitsch et al., 1979; Peterjohn and Correll, 1984; Lowrance et al., 1988; Klarer and Millie, 1989; Chesair et al., 1991; Parsons et al., 1995). Surface runoff is slowed by buffer vegetation, causing larger sediment particles and pollutants adsorbed to sediment particles to settle out (Lee et al., 2003; Correll, 1996). This filtering function is greatly enhanced as the density of ground layer vegetation and the width of a buffer increase. Further removal and/or transformation of smaller sediments, nutrients, pathogens, and pesticides can occur through groundwater filtration, uptake by vegetation, biogeochemical processes, and microbial processes in the shallow soil profile (Lee et al., 2003; Correll, 1996; USEPA 2005b). For certain pollutants, such as bacterial pathogens, drier, unsaturated buffer soils will be more effective at reducing concentrations than saturated wetland soils (Pearsell and Mulamoottil et al., 1996). Elevated nitrate levels can be reduced where groundwater contacts roots of vegetation and denitrifying microbes in soils in buffer areas, thereby reducing growth of excess aquatic vegetation such as algae blooms (Lee et al., 2003). Heavy metals may be precipitated in the soil and removed from groundwater or may be transformed such that they become immobile or less toxic or otherwise less biologically active.

Without mature, densely vegetated buffers, common urban runoff pollutants such as pesticides and fertilizers easily find their way into and degrade receiving waters (Miltner et al., 2004; CWP, 1995; Meyer et al., 2005). It is important to note, however, that the filtering function that wetland buffers can provide depends largely on the proportion of surface runoff traversing the buffer via sheet flow. If runoff in an area is mostly channelized or routed into storm sewers, the filtering function would be greatly reduced.

Streambank Stabilization – *Vegetated riparian buffers stabilize streambanks and therefore help to protect infrastructure, improve safety, and reduce sediment loading.* The strong, thick roots of trees and/or shrubs growing along the edge of a stream channel greatly increase the stability of the stream banks and can effectively dampen energy in stream water, slow water velocities, and promote infiltration. Plant roots increase the effective size and cohesiveness of soil particles, thereby protecting soil in stream banks from the erosive forces of water, reducing the amounts of streambank erosion.

Channel and shoreline erosion occur as a result of fast-moving and turbulent flows contacting unstable stream banks (Figure 2). In urban and suburban settings, accelerated erosion is typically associated with increased and uncontrolled stormwater runoff (Dunne and Leopold, 1978; Wohl, 2001). Hardened and compacted land surfaces contribute to increased volumes and higher velocities of runoff by reducing the degree of stormwater infiltration and increasing the rate of runoff. Where streambank erosion occurs, landowners can lose property, infrastructure may become undermined, and wildlife habitat can be destroyed. Furthermore, as the energy of the water in a stream diminishes following a storm, eroded materials are deposited in the stream channel. These depositional areas can cause channel widening, reduce flood storage capacity, block fish movement, and smother aquatic habitats (Jacobson et al., 2001; also Waters, 1995 in Jacobson et al., 2001 and Burton and Pitt, 2002 in Sprague et al., 2006).

Figure 2 .Example of eroded stream banks. Buffer area lacks sufficient vegetation to provide stabilization. Erosive force of water cuts the banks and sediments degrade water quality.

Floodflow Alteration and Flood Storage – *Wetland buffers provide space for flood water to spread laterally once it leaves a channel; thereby slowing flood water velocity and unsaturated soils help provide additional temporary storage for flood water.* Flooding is a natural event that is essential to maintaining sediment transport and deposition, biodiversity (e.g., by seed dispersal and creation of spatially heterogeneous habitat), and contaminant removal (Naiman at al., 2005; Briggs, 1996). Wetland buffers that are undeveloped and vegetated with trees and shrubs in floodplains help to slow, store, and gradually release flood waters. Dense vegetation in a wetland buffer increases surface roughness of a floodplain and slows the velocity of overland flow while promoting shallow groundwater recharge, depressional surface storage, and subsequent uptake of water by vegetation. The reduced velocity and volume of flood water results in reduced flood peaks (Leopold, 1994) and improved base flows due to subsequent slow release of water stored in floodplain soils. Wetland buffers play a key role in reducing property damage associated with flooding while at the same time maintaining natural processes necessary for the health of stream and river systems. Limiting development in wetland buffers means that flooding does not threaten structures in the portion of the floodplain covered by the wetland buffer.

Development activities associated with urbanization increase the proportion of impervious surfaces in a watershed and reduce infiltration of precipitation. Greater impervious surface increases the volume of surface runoff and the speed with which it reaches a stream (both via direct overland flows and indirect flows routed into storm sewers). This leads to an increase in the occurrence and severity of floods and increased property damage (Wohl, 2001; Briggs, 1996; Wenger and Fowler, 2000; Sprague et al., 2006 and numerous citations therein including McMahon et al. 2003, Poff et al. 1997, and USEPA 1997a).

Groundwater Recharge – *During long, dry periods, the water in streams and wetlands may come solely from groundwater which is recharged in upland buffers.* Vegetated wetland buffer areas help to slow surface runoff and promote infiltration thereby helping to maintain groundwater levels. Elevated groundwater then discharges into streams to provide baseflow (EOR, 2001). Elevated soil moisture also provides a source of water for riparian vegetation (Naiman et al., 2005; Poff and Allan, 1997, Pearsell and Mulamoottil, 1996). In addition, water quality benefits arise from the interaction of surface water and groundwater. Groundwater discharge into streams also helps moderate temperature fluctuations (Sprague et al., 2006).

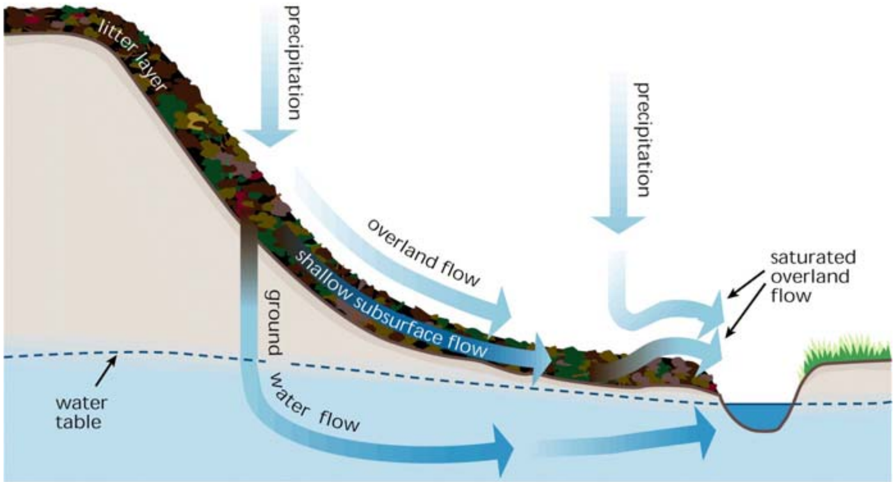


Figure 3 Groundwater and surface water interactions.
Adapted from: Stream Corridor Restoration: Principles, Processes, and Practices (10/98) Interagency Stream Restoration Working Group.

In the absence of wetland buffers, the groundwater table can decline because of the reduced infiltration of precipitation. Reduction in groundwater discharge to a stream and attendant reduction in baseflow can negatively impact aquatic life during low flow periods by reducing available habitat and causing stream temperatures to increase. Groundwater decline can also negatively impact riparian vegetation when the plant roots are unable to reach saturated soils (Briggs, 1996). If riparian trees and shrubs die as a result of water table decline, a stream channel can become unstable with an increase in streambank erosion and downcutting. Loss of riparian shrubs and trees could lead to reduced leaf fall into a stream. Leaves from riparian plants are a primary energy source for aquatic food chains (Naiman et al., 2005).

Habitat Protection & Food Chain Support – *Riparian areas make up only 1% of the landscape but support 80% of all vertebrate wildlife and more bird species than any other habitat area in the southwest* (NRCS, 1996; Miller et al. 1995). Buffers provide critical habitat for a wide range of aquatic and terrestrial species living in and around wetlands (Semlitsch and Bodie, 2003; Naiman et al., 2005). Wetland buffer vegetation provides three critical functions for aquatic systems. First, leaves and twigs from trees and shrubs, and to a lesser extent, herbaceous species, provide energy for aquatic food webs. Leaves in the stream are colonized by algae and microscopic invertebrates. The algae are eaten and the leaves are shredded by aquatic organisms (e.g., caddis fly larvae). These invertebrates are, in turn, eaten by fish. Studies have shown loss of riparian vegetation causes reduced growth of aquatic insects that rely on leaves from trees and shrubs for food (Johnson et al., 2003). Second, riparian trees and shrubs shade streams and help moderate water temperatures. This is especially important for cold-water (as opposed to warm-water) aquatic life such a trout. Streams and ponds with overhanging vegetation will have lower water temperatures than those that lack overhanging vegetation (Westchester County, 2007). Stream water temperatures are also influenced by direct surface runoff from nearby impervious surfaces. These thermal impacts can be mitigated by directing the surface runoff as sheet flow to vegetated buffers, allowing it to infiltrate and slowly return to the receiving water as shallow groundwater flows. Third, tree trunks and large limbs that fall across a stream channel create small dams that help prevent channel downcutting (Wohl, 2001; Naiman, et al., 2005); although, this is less relevant to urban areas because city and urban drainage agencies generally have a policy of keeping drainageways free of debris to prevent potential flood hazards.

The location of wetland buffers makes them ideal links between aquatic and upland ecosystems. As a result of the presence of water, buffers provide habitat for a broad range of birds, small mammals, reptiles, insects, and amphibians that require both upland and wetland areas to complete their life cycles (numerous articles cited in Semlitsch and Bodie, 2003). Deciduous shrublands and forests found in wetland buffers in semi-arid landscapes are vital for many bird species. For example, numerous migratory bird species use wetland buffers in the spring and fall as they travel through Boulder.

Wetland buffers provide habitat corridors, as shown in Figure 4, which facilitate wildlife movement between habitat patches (Hilty, 2006). In urban areas, these important corridors often become fragmented, significantly limiting the movement of key species and facilitating the colonization of opportunistic invasive and predator species (Schaefer, et al., 2006; Lineham et al., 2006). Establishing wetland buffers in urban and suburban areas can reduce this fragmentation and help maintain important floral and faunal populations on a local scale (Lovell and Sullivan, 2006; Miltner et al., 2004; Johnson et al., 2003; Peak and Thompson, 2006).

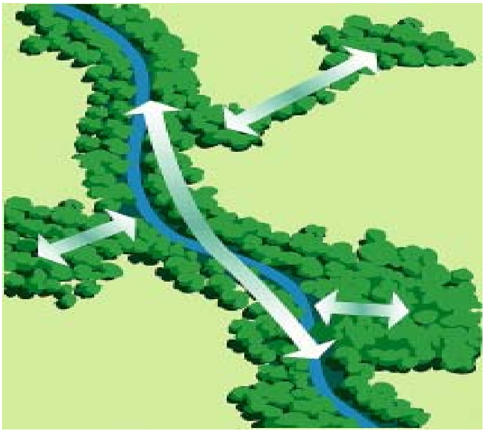


Figure 4. Schematic showing important wildlife corridors provided by wetland buffers (Source http://www.rivercare.org/wildlink/wl_corridors.php)

Other Benefits – Recreation, Aesthetic, Education, and Economic - *Wetland buffers offer recreational, aesthetic, economic, and educational opportunities for neighborhoods and schools, promoting healthy lifestyles and enhanced community stewardship and relationships (Lovell and Sullivan, 2006).* For example, the wetland buffers along Bear Canyon Creek provide an educational opportunity for students at Beak Creek Elementary School in south Boulder. It should be noted, however, that recreation can also degrade wetlands if it occurs at high levels and in an unmanaged setting.

In addition to the ecosystem services and benefits previously noted, communities and property owners that establish and implement wetland buffers typically benefit from increased property values due to the aesthetic appeal of open space. (Qiu et al., 2006). Development near streams, lakes, or wetlands is often able to sustain premium sale prices. Where aquatic resources lack buffers, communities and property owners often are faced with mitigation and repair costs to protect infrastructure and property being impacted by erosion, sediment deposition and floods. Wetland buffers can provide cost-effective and reliable human health and safety services such as flood control, erosion control, water quality protection and enhancement, and recreational opportunities that would otherwise cost communities significant amounts of money to provide through highly engineered structures and systems.

FUNCTIONS OF WETLAND BUFFERS IN RELATION TO LOCATION, DIMENSIONS, AND VEGETATION

The effectiveness of wetland buffers varies by function and depends on a number of factors including vegetation, width, length, and landscape setting, but generally speaking, the wider the buffer, the more effective it will be. Vegetation composition can have a significant effect on the health, function, maintenance and effectiveness of a buffer. Vegetation composition can vary widely across a wetland buffer –as illustrated in Figure 5. Examples of buffer benefits provided by grasses, shrubs, and trees are provided in Table 1. Note that increased benefits are generally associated with deciduous trees and shrubs in a wetland buffer.

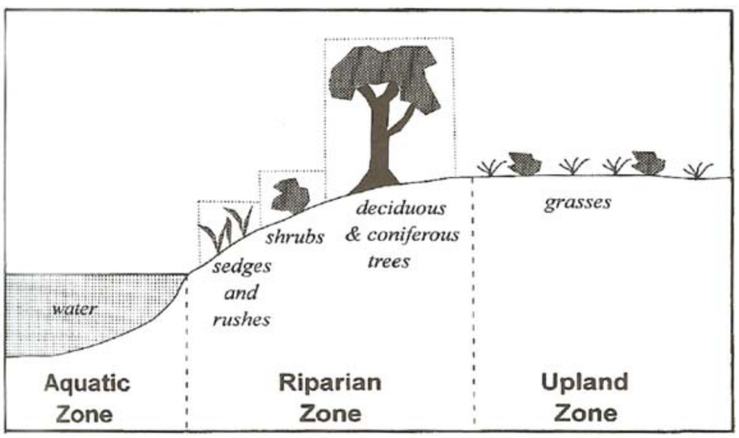


Figure 5 Cross section of riparian zones.
Adapted from: Wohl, 2001, after R.J. Smith 1979, Mountain grazing on riparian ecosystems to benefit wildlife in Cope., ed. Forum – grazing and riparian/Stream ecosystems. Tro Unlimited. Inc. Fig. 1.

Table 1 Effectiveness of Different Vegetation Types for Specific Buffer Benefits

BENEFITS	**Grass**	**Shrubs**	**Trees**
Stabilize streambanks	Low	High	High
Filter sediment & the nutrients, pesticides & pathogens bound to it	High	Moderate	High
Filter nutrients, pesticides, & microbes from surface water	Moderate	Low	Moderate
Protect groundwater and drinking water supplies	Low	Moderate	High
Improve overall aquatic habitat	Low	Moderate	High
Improve wildlife habitat for field animals	High	Moderate	Low
Improve wildlife habitat for forest animals	Low	Moderate	High
Moderation of water temperatures	Low	Moderate	High
Provide visual interest	Moderate	Moderate	High
Protect against flooding	Low	Moderate	High

Low | Moderate | High

Adapted from: Connecticut River Joint Commissions, 2000. *Riparian Buffers for the Connecticut River Watershed: No. 8 Planting Riparian Buffers (and Plant List).*

There is not one optimal width for a wetland buffer. Instead, widths depend on the desired wetland functions and local conditions such as topography (see Figures 6-9). A substantial body of research exists that correlates wetland buffer widths with function (NRCS, 2003; USACE, 2000; CWP &USEPA, 2005; USEPA, 2005b); there is a wide range of recommended widths for different functions as shown in Table 2 and Figure 10. While much of the literature has investigated buffer widths in more humid or agricultural settings, the information is still pertinent and can be used to infer applicability to semi-arid and urban settings, because the underlying physical and biological mechanisms are the same. For example, regardless of the climate or contaminant, the pathway of sheet flow as opposed to channelized flow across a wetland buffer is the key variable influencing the effectiveness of capturing sediment and increasing infiltration.

Figure 6. Wetland along lower Four Mile Canyon Creek , northwest of Pleasantview soccer fields.

Figure 7. Riparian corridor along South Boulder Creek.

Figure 8. Upstream reach on Bear Canyon Creek ,west of Lehigh.

Figure 9. Upstream reach on Four Mile Canvon Creek .west of Broadwav.

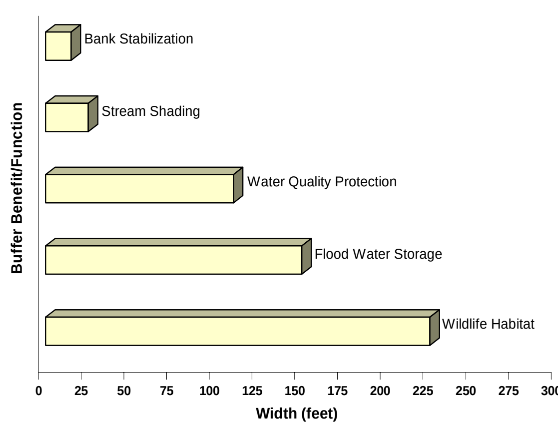
For aquatic habitat purposes, the USEPA has established methods for evaluating the condition of streams and rivers using a rapid bioassessment protocol which includes criteria for riparian vegetative zone width (Barbour et al., 1999). In the aquatic habitat assessment method, vegetated riparian zone greater than 18 meters (i.e., 56 ft on each side) is considered optimal; 12-18 meters is considered suboptimal; 6-12 meter zones are considered marginal, and less than 6 meters is categorized as poor. These categories are very general and do not strictly apply in all situations. For example, in some topographic settings, high-quality buffers may consist of only a narrow strip of riparian vegetation surrounded by extensive native upland (e.g., along Four Mile Creek where it crosses Open Space west of Broadway).

Table 2 Buffer Widths Recommended by USEPA for Various Wetland Functions

Function	Special Features	Recommended Minimum Width (feet)
Sediment reduction	Steep slopes (5-15%) and/or functionally valuable wetland	100
	Shallow slopes (<5%) or low quality wetland	50
	Slopes over 15%	Consider buffer width additions with each 1% increase of slope (e.g., 10 feet for each 1% of slope greater than 15%)
Phosphorus reduction	Steep slope	100
	Shallow slope	50
Nitrogen (nitrate) reduction	Focus on shallow groundwater flow	100
Biological contaminant and pesticide reduction	N/A	50
Wildlife habitat and corridor protection	Unthreatened species	100
	Rare, threatened, and endangered species	200-300
	Maintenance of species diversity	50 in rural area 100 in urban area
Flood control	N/A	Variable, depending on elevation of flood waters and potential damages
Source: Center for Watershed Protection and United States Environmental Protection Agency. 2005. *Wetlands and Watersheds: Adapting Watershed Tools to Protect Wetlands.*		

Figure 10

Aquatic Buffer Width Correlated to Ecological Function



Adapted from USDA Natural Resources Conservation Service. *Where the Land and Water Meet: A Guide for Protection and Restoration of Riparian Areas First Edition.* USDA NRCS, September 2003.

Terrestrial habitat widths have an even wider range than aquatic habitat. One literature survey reported that most of the current municipal buffer programs are not wide enough to protect the life cycle activities of many reptile and amphibians (Semlitsch and Bodie, 2003). In their study, Semlitsch and Bodie (2003) summarized data on the use of terrestrial habitat by numerous amphibians and reptiles. They found for example, that certain species can migrate within a core habitat area of 200-600 meters, and the range of core habitats for amphibians was 159-290 meters. While protection of buffer distances of this size is difficult to achieve in urban settings, they highlight the need for large buffers where possible to protect wildlife habitat.

> ***"Our data clearly indicate that the 15-30 meters used to protect wetland species in many states, are inadequate for amphibian and reptiles. Further, we emphasize that our estimates are derived from the core terrestrial habitats used by amphibians and reptiles and therefore are not buffers per se but necessary habitat." (Semlitsch and Bodie, 2003)***

Riparian buffer widths also have been found to be a factor influencing effectiveness of water quality improvements such as nitrogen removal. USEPA conducted an extensive review of the current science and regulations pertaining to buffer width, vegetation cover, and nitrogen removal (USEPA, 2005b). Buffer vegetative cover was not found to play a major role in nitrogen removal efficiencies. Although variations occur due to soil type, loading, and organic carbon, in general, the wider the buffer the more effective nitrogen removal. "Wider buffers (>50m) more consistently removed significant portions of nitrogen entering a riparian zone" (USEPA, 2005b).

For erosion and sediment control purposes, the Colorado Office of the Natural Resources Conservation Service (NRCS) provides multiple technical guidances that relate to buffer conditions and width. Most of these have been developed for agricultural settings, but they also have some applicability to urban and suburban settings along the Front Range (Jim Sharkoff, NRCS State Agronomist, pers. comm.). The Contour Buffer Strip code (NRCS, Code 332) states that the buffer should be 30 feet (10 meters) wide or greater in order to reduce erosion and sediment loading and enhance wildlife habitat. The Riparian Forest Buffer code (NRCS Code 391) suggests buffer widths by zones-- where the first zone starts at the high water line and extends 10 feet out; zone 2 extends from the edge of zone 1 a minimum of 20 feet (or 30% of the floodplain width not less than 35 feet) and zone 3 is variable depending on the drainage are and surrounding land us. However, NRCS Colorado field office staff note that the forest buffer code is not directly applicable to Colorado conditions and to consider instead the Filter Strip code (NRCS Code 393). The filter strip size recommendations in Code 393 are based on the ratio of the drainage area to the filter strip area (approximately 70:1) as well as considerations of slope and annual sheet and rill erosion rates above the filter strip.

CONSIDERATIONS OF WETLAND BUFFERS IN SEMI-ARID SETTINGS

In the semi-arid western U.S., there is generally a greater difference between the biota in wetlands buffers compared to the adjacent upland than there is the more humid eastern U.S. (Baker et al., 2004). In the west, the riparian vegetation is typically more diverse and more abundant and is easily distinguished from that in adjacent uplands. This reflects the steeper gradient in the availability of water as one moves away from a wetland in the western U.S. compared to the eastern U.S. The presence of steep topography and the presence of dry-south-facing slopes accentuate the differences in soil moisture as one moves away from a stream in the west. Generally speaking, riparian community characteristics also follow a longitudinal gradient that parallels the increase in elevation and precipitation that occurs from lowland prairies to mountains (Mutel and Emerick, 1992).

Many streams in the semi-arid west are intermittent and therefore sometimes mistakenly considered to provide little functional value. However, intermittent streams play a critical role in maintaining wetlands. Despite ephemeral flows, floodplains and stream banks along even small intermittent streams nonetheless provide opportunities for increased native vegetation and the associated benefits as described below.

Physical, Chemical, and Biological Linkages. *There are physical, chemical, and biological linkages or interrelationships that are unique to and focused in semi-arid wetland buffers that do not occur to the same degree in surrounding areas.* Unlike humid areas where plant production is relatively uniform over a wide geographic area, in semi-arid regions the limited availability of water causes native plant production to be concentrated in and around wetland and riparian areas. Organic matter in buffer soils can therefore be higher and help promote water quality benefits such as denitrification (USEPA, 2005).

Additionally, unlike humid areas where the temporal distribution of precipitation patterns may be more evenly distributed, the timing (frequency and duration) of precipitation events in the semi-arid west supports a number of species that are adapted to capitalize on specific hydrologic conditions. Plains cottonwood is the dominant native tree species found along riparian areas in Boulder, and cottonwood regeneration is specially adapted for establishment in floodplains through a variety of recruitment pathways, particularly following high streamflow events in early summer (Cooper et al., 2003; numerous references in Rood et al. 2003). The interconnected linkages between hydrology, geomorphology, chemistry, and biology are critical aspects of wetland ecosystems, and buffer areas are focal points for many of these interconnected processes (Baker et al., 2004).

Deciduous Woody Species. *Probably the most important characteristic of semi-arid wetlands and their buffers is the increased diversity and productivity of native deciduous trees and shrubs as compared to surrounding semi-arid grasslands (Rood et al., 2003, Wohl, 2001).* Riparian areas tend to be one of the few locations in semi-arid landscapes that possess dense, multi-layered strata including trees, shrubs, and herbaceous species which provide important cover for terrestrial wildlife. Abundant leaf litter from the cottonwoods and other woody species provides food for aquatic insects. Cottonwoods shade streams and provide large woody debris that supplies cover for fish.

Extensive roots from the woody species, such as large cottonwood trees and native willows, also provide major streambank stabilization benefits. While some non-native species such as Siberian elm and crack willow also provide streambank stabilization benefits, other impacts may result from the replacement of native species with non-natives. For example, the increased amount and size of large woody debris from a crack willow could affect channel morphology by increasing channel braiding which in turn may alter pool formations, sedimentation, and ultimately aquatic habitat.

Biodiversity. *Wildlife use is disproportionately high in riparian areas in semi-arid settings such as the Colorado Front Range* (Hilty, 2006, Wohl, 2001, Baker et al., 2004, and numerous references in Leal et al., 1995). The combination of water and diverse and abundant vegetation provides attractive habitat conditions for a wide array of terrestrial and aquatic species. For example, semi-arid riparian habitats have some of the highest bird diversity and breeding bird densities in the country (Carothers et al., 1974). Interestingly, the Colorado Breeding Bird Atlas shows the Boulder quadrangle as having the highest number of breeding birds of any of the surveyed blocks in the state (Kingery, 1998). This probably reflects, in part, the riparian areas that are present in the Boulder quadrangle.

CONSIDERATIONS OF WETLAND BUFFERS IN URBAN SETTINGS

Protecting wetlands in urban settings is critical because they often occur in disturbed or degraded settings. At the same time, urban wetlands are located in areas where there is an increased need for the ecological services they can provide such as water quality improvements. The studies examining negative impacts that occur in wetland ecosystems from a variety of urban stressors are voluminous (Baker, et al., 2004; CWP & USEPA, 2006; Pearsell and Mulamoottil, 1996; Sprague et al,, 2006; Sheldon et al., 2005). Wetlands in urban areas are typically stressed by both direct and indirect threats including altered hydrology, increased erosion, channelization, pollutant loading, reduced size, and generally higher levels of human activity. Potential impacts and opportunities for improved protection through the establishment of buffers are briefly summarized below.

Hydrologic Balance and Flood Storage. *Wetland buffers in urban areas are particularly important in helping to moderate the impacts of altered hydrologic regimes and flooding.* In urban areas with abundant paved surfaces, increased volume and peak flows after precipitation events can increase the severity of flooding as well as channel destabilization. Vegetated buffers facilitate infiltration and storage in unsaturated soils and thereby reduce the impacts from flood damage.

Streambank Stability. *Roots from woody species in vegetated buffers help to reduce erosion associated with poorly located road and buildings in urban areas.* Protected streambanks also help to reduce scouring and sediment loading.

Water Quality. *The health of urban creeks and wetlands depends, in part, on the presence of wetland buffers to reduce the impacts from road runoff, pet and recreational usage, and commercial and industrial land uses that contribute to degraded water quality.* In the absence of buffers, pollutant loading is higher and human health risks may increase. Vegetated buffers can therefore function as a precautionary best management practice to “pre-treat” stormwater and protect wetland and water resources.

Biodiversity. *Urban wetlands vary widely in the quality of habitat they provide, but often wetlands and stream corridors are the only remaining undeveloped areas available for native plants, birds, amphibians, reptiles, and small mammals.* Habitat degradation leads to a decline in native plant and animal diversity. Protecting wetlands with buffers can increase habitat patch size, reduce edge effects, and reduce trampling. Perhaps most importantly, urban wetland buffers increase the connectivity between wetland areas within the city as well as providing important corridors and "stepping stones" between larger habitat patches at the edge or outside the city limits.

Often, it can be challenging to balance the ecologic and hydrologic benefits of buffer zones with the need for living spaces and urban infrastructure. Traditionally, engineered solutions have been pursued that allow for increased development intensity adjacent to wetlands. Unfortunately, these expensive structural solutions can have limited effectiveness, because they may only address one function rather than the multiple interconnected functions provided by the natural system. In fact, traditional engineering solutions can sometimes exacerbate undesirable conditions (such as habitat loss), and may simply transfer a problem to another location.

Fortunately, there are numerous opportunities for humans to reduce impacts to wetlands from urbanization through the establishment and maintenance of buffer areas. The Natural Resources Conservation Service, Urban Drainage and Flood Control District, and the City of Boulder Greenways Program are a few of the organizations that have developed guidelines to reduce impacts through installation of filter strips, best management practices, and trail designs. A common theme in all of these approaches is the importance of maintaining streamside vegetation.

III. Regulatory Approaches to Buffer Protection

INTRODUCTION

There are several regulatory and non-regulatory mechanisms that can be used to protect and manage wetlands and their buffer areas. Wetland and stream buffer protection programs can include: acquisition (fee simple or easement), comprehensive planning, incentives, floodplain management, education, technical assistance, or regulation and zoning. Boulder has adopted several of these types of plans and programs over the years which contribute to wetland protection in the city and in the Boulder Valley.

This chapter focuses primarily on regulatory approaches to wetland and buffer protection across the country. Municipal and county buffer ordinances were reviewed in terms of the location of the ordinance in the local code, the approach to establishing buffer widths; the process for review of proposed activities in buffers; and the approach to allowing variances. One non-regulatory approach, wetland and watershed planning, is reviewed in this chapter because it is an example of a planning approach used by a few communities to establish buffer widths that are adapted to localized conditions.

Methodology

City staff conducted the study by reviewing municipal and county codes and adopted plans throughout the country and developing a list of communities that regulate activities in wetlands and streams. Although several states have wetland protection laws, state-level law is typically less applicable to the municipal level and was not reviewed for this study. A general survey of municipal and county codes from the following categories was completed:

- Peer cities
- Front Range and Colorado cities and counties
- Major western cities
- Other western cities of similar size and density
- City and county codes cited in literature sources
- City and county codes cited by high profile agencies and organizations (USEPA, Center for Watershed Protection, and the Association of State Wetland Managers)
- Model ordinances promoted by high profile, nationally-based organizations

After compiling a list of communities with some level of wetland buffer protection, individual codes were examined to understand the different approaches used to regulate buffer areas in each jurisdiction (See Table 3). Although most of this report is based on the review of written code, limited interviews with staff from a few jurisdictions along the Front Range were conducted to determine the effectiveness of some individual ordinances. Staff, however, did not fully assess the success, actual costs, or support level of the approaches among all of the jurisdictions that were reviewed.

REGULATORY APPROACHES TO BUFFER AREA PROTECTION

Location of Buffer Ordinances in Local Codes

Buffer protection ordinances were found in the following three general areas of municipal and county codes throughout the country:

1) <u>Wetland or stream buffer restrictions as part of a land use or zoning code</u>
   This is Boulder's approach to buffer regulation and the most common approach on a local level. Typically, wetland buffers are identified or designated as an overlay or special district, resource conservation area, or sensitive lands on local zoning maps. Overlay or special zone restrictions are then included in the zoning regulations or land use code. An overlay zoning approach is considered more effective and expedient approach by several sources because it ties development restrictions in buffer areas more closely to the existing zoning of a property without requiring changes to a zoning map.

2) <u>Freestanding ordinances</u>
   Freestanding ordinance approaches are similar to land use code type restrictions but are found in other areas of the municipal code such as an environmental protection section. These types of ordinances are most common in jurisdictions that have limited zoning ordinances.

3) <u>Wetland/stream protection as part of other regulations</u>
   This approach incorporates some degree of wetland or stream protection into other regulations such as floodplain zoning, coastal zone management, tree protection regulations, stormwater management regulations, grading regulations. This approach was the least common among the codes that were reviewed.

Approaches to Establishing Buffer Area Widths

As discussed in Section II of this report, a considerable amount of research has been conducted over the past 30 years to provide a scientific basis for various buffer widths. Most regulatory approaches, however, seek to balance wetland protection with property rights in establishing local buffer widths. Regulatory buffer widths, consequently, vary among jurisdictions across the country. As a general rule, wider buffers are adopted in non-urban, agricultural areas, while narrower buffers are found in denser urban areas where pre-existing development likely influences the determination of the regulatory area.

Those jurisdictions that regulate wetland buffer areas have adopted one of three general approaches to establishing widths. The following are the general approaches used to establish buffer widths:

1) <u>Fixed-width buffer areas</u>
   Most jurisdictions that were reviewed regulate buffer areas by applying fixed or standard buffer widths to wetlands or streams. These approaches tend to simplify buffer regulations by applying a "one-size-fits-all" width to all wetlands regardless of the value of the waterbody or the existing land use conditions. Most jurisdictions adopt fixed

buffer widths because they are the simplest to apply and administer. Those jurisdictions typically have adopted a buffer width that balances property owner input with the minimum width to protect desired wetlands or stream functions. Some of these jurisdictions establish two, three, or four different fixed buffer widths based on various conditions such as stream or wetland value, size of wetland, location of the wetland or stream within a jurisdiction, or stream order.

Boulder uses a fixed-width approach. In the Boulder Revised Code (§9-3-9), a buffer area is "an area around a wetland or stream within which activities are likely to have an adverse impact upon wetland functions." The buffer area in the wetlands protection overlay district is a fixed width of either 50 feet "from each point on the wetland boundary" for significant wetlands and 25 feet "from each point on the wetland boundary" for all other wetlands.

The weakness of a fixed-width approach is that the buffer widths are not necessarily tailored to the specific conditions of and around the individual wetlands. Fixed-width buffers may not provide sufficient protection to ecologically sensitive areas or, conversely, may deprive landowners of areas more suited to development in ecological terms. Absent a detailed stream inventory and evaluation, standard buffer widths can appear excessive in some locations and insufficient in others.

2) <u>Variable-width buffer areas</u>
Variable-width buffer approaches allow buffer area widths to vary according to site-specific or reach-specific conditions such as slope, vegetative condition of the stream, or intensity of the existing land use. Typically with these approaches, a minimum buffer width is established that applies to all wetlands and then widths are widened based on site or reach specific conditions. The benefit of this approach is that the buffer area can incorporate protection for other sensitive natural features such as floodplains, wildlife habitat, and steep slopes.

Although a variable-width buffer approach tends to take into account localized conditions it can be more difficult and expensive for a jurisdiction to develop and administer. This approach, although more scientifically defensible, requires much more site evaluation since every stream reach, parcel and land use is different. Absent a comprehensive wetland or watershed plan, a variable-width approach also can place more burden on the landowner to provide detailed site analyses if buffer areas are established through site development applications. Other downsides of variable-width approaches are that they can be less easily understood by the public, they may strike some landowners as unfair, and they can result in continual disputes with landowners.

3) <u>Multi-zoned buffer areas</u>
A variation to the fixed or variable width system is the multi-zoned buffer area approach which is the recommended approach in the model ordinances promoted by both the USEPA and the Center for Watershed Protection. This approach establishes a buffer area that includes a strict setback in the area nearest a stream or wetland, a limited development zone beyond the setback, and a development zone along the far edge of the

buffer area. The objective of this approach is to provide strict protection of the riparian area and vegetation nearest the waterbody and to direct more intense uses away from the wetland area. Some multi-zoned approaches apply fixed widths to each zone, others allow variation according to stream and land use conditions.

The difficulty in applying a multi-zoned approach to urban streams is that existing development conditions may not provide enough undeveloped land area for a meaningful multi-zoned system. In addition, a multi-zoned system may be more difficult to administer in terms of educating landowners about the location of zones on individual properties and clarifying use restrictions in each zone. In some cases, a two-zoned system that provides a riparian setback and an outer limited development zone may be more applicable in an urban setting.

Table 3: Examples of Setback/Buffer Ordinances

JURISDICTION (POPULATION)	**BUFFER TYPE AND WIDTH**	**APPROACH TO REGULATING ACTIVITIES IN THE BUFFER**
Peer Cities		
Ann Arbor, Michigan (114,000)	No apparent buffer requirement.	N.A.
Berkeley, California (103,000)	Fixed widths (30 ft. from centerline)	Setback from centerline of creek. Permits for new construction allowed under certain conditions. Appeals to Zoning Adjustment Board.
Eugene, Oregon (142,000)	Fixed widths based on wetland value. 0 ft. – low value wetlands 25 – 50 ft. moderate value 50 - 100 ft. – high value	Setbacks with prohibited and allowed uses defined. Variances to setbacks and uses allowed by planning director.
Fort Collins, Colorado (128,000)	Fixed widths based specific stream corridor or size of wetland (50 - 300 ft.)	No development is allowed in the buffer zones. Buffer zones determined through site development plan.
Madison, Wisconsin (222,000)	No apparent buffer requirement.	N.A.
Norman, Oklahoma (96,000)	No apparent wetland or creek protection ordinance.	N.A.
Provo, Utah (106,000)	No apparent wetland or creek protection ordinance.	N.A.
Santa Barbara, California (93,000)	Fixed widths (25 ft.)	Discretionary review of permit applications with general standards.
Santa Cruz, California (55,000)	Variable widths/Three-zoned system based on category of stream reaches as specified in the city-wide creeks and wetlands management plan: Riparian corridor: 10-120 ft. Development Setback: 15-150 ft. Total Management Area: up to 175 ft.	Setbacks and use restrictions in inner zones. Development allowed in outer zone if defined standards are met. Variances allowed subject to Planning Commission approval if parcel is undevelopable with buffers.
Other Cities		
Aurora, Ohio	Fixed widths (25, 75 or 120 ft.) based	Setbacks.

(14,000)	on wetland ranking.	Most new development activities (including disturbance of natural vegetation) are prohibited within the setback. Variances allowed subject to Planning Commission approval. Applicant must show hardship.
Bozeman, Montana (32,500)	Two-zoned system with overall fixed widths based on specific creek and adjacent wetlands. (50, 75 or 100 ft.) Zone 1 is 60% of required setback and closest to watercourse. Zone 2 is 40% of required setback.	Setbacks. No new development or impervious surfaces allowed in either zone. Trails, utility lines, street crossings and stormwater facilities may be permitted in Zone 2. Variances allowed through board appeal process.
Colorado Springs, Colorado (370,000)	Variable/Three-Zone System: based on stream characteristics Streamside zone: 15-30 ft. Middle zone: 40-60 ft. Outer zone: 15-30 ft.	Combination of setbacks and discretionary review depending on zone.
Croton-On-Hudson, New York (7,600)	Three-zoned system	Combination of setbacks and discretionary review depending on zone.
Davis, California (64,000)	Unclear setback requirements for watercourses and habitat areas.	N.A.
Napa, California (73,000)	Fixed: 50 ft. Buffer may be increased to mitigate development impacts.	Discretionary review of plans. Development allowed within riparian habitat buffer if it minimizes impacts to riparian habitat.
Portland, Oregon (556,000)	Fixed widths depending on designated protection zone (30 or 50 ft.)	Setbacks. Development review required.
Seattle, Washington (574,000)	Fixed widths based on size and value of wetland (0- 200 ft.) All watercourses have a 100 ft. riparian management area.	Setbacks. Development and vegetation removal is prohibited in wetland buffers and the riparian management area. Buffer reductions allowed with director approval.
Tuscan, Arizona (515,000)	Fixed widths (20 or 50 ft.)	Setbacks on watercourses.
Ventura, California (105,000)	Fixed widths (100 ft.)	Setbacks. Development in buffer must be consistent with comprehensive plan. Boundary adjustments may be made through comp plan change process.
County-Level		
Aspen/Pitkin County, Colorado (15,000)	Fixed widths (100 ft. standard may be modified to a minimum of 50 ft./25 ft. minimum for isolated wetlands)	Setbacks. Buffers may be reduced to a minimum of 50 ft. under certain conditions.

Athens-Clarke County, Georgia (104,000)	Fixed widths: 100 ft. (protected rivers) 150 ft. (protected streams in industrial zones) 75 ft. (all other protected streams) 25 ft. (lake, pond, state waters)	Setbacks with prohibited and allowed activities specifically defined (permits also required). Variances are not apparent.
Baltimore County, Maryland (754,000)	Fixed (25 – 100 ft.) based on stream order and location of floodplain.	Setbacks of 25-35 ft. based on type of use. Restricted development allowed in remaining buffer. Management requirements specific for setback.
Boulder County, Colorado (290,000)	No specific buffer requirement	Discretionary review of building and development permits. Exemption plat approval required.
Hillsborough County, Florida (1,147,000)	Fixed: 30 ft. for designated conservation areas. 50 ft. for designated preservation areas.	Setbacks. No filling, excavating, or placement of permanent structures or other impervious surfaces shall be allowed within a required setback.
King County, Washington (1,737,000)	Variable: based on habitat rating, proposed use, and proposed mitigation measure. (25 - 225 ft.)	Setback. No development allowed in the buffer area. Buffers may be modified on staff level based on defined standards.
Pima County, Arizona (1,000,000)	Variable: as defined on adopted riparian habitat classification maps.	Floodplain control section of code. Permit system with avoidance, minimization, mitigation standards. Variances to maps through board approval.
San Miguel County, Colorado (6,600)	Fixed width of 100 ft.	Permit with discretionary review standards.
Summit County, Colorado (23, 600)	Fixed for single family. (25 ft.) Variable for high quality wetlands. (50 – 300 ft.)	Setbacks. Variances to setbacks allowed with board approval.
Teton County, Wyoming (18,300)	Fixed based on the following categories: Rivers: 150 ft. Streams: 50 – 150 ft. Wetlands: 30 ft.	Setbacks. No development permitted. Permit required for agricultural use, flood protection, habitat enhancement or public pathways.

Review Processes and Standards

Generally, three different approaches to regulating activities in buffer areas can be found among the numerous municipal, county, and state wetland ordinances that were reviewed for this report:

1) Setback-based system with allowable and restricted uses clearly defined

   This is the most common approach to regulating activities in buffer areas found among the jurisdictions sampled for this report. Most jurisdictions have adopted buffer area overlay districts as part of their zoning codes which function as setbacks. With this approach, allowed and restricted activities are clearly defined for the buffer area.

   Although specific use restrictions vary from code to code, many communities specifically restrict most new development, grading, impervious surface, or clearing of vegetation within a defined setback and allow utility crossings, landscaping and limited path or trail development under certain conditions. If a prohibited use is proposed, a variance must be obtained through the local planning or zoning board. Staff-level variances are generally not allowed.

   Although a setback approach can be seen as more restrictive than a discretionary review approach, it provides much more clarity and certainty for the landowner and the local administrators of the code. Setbacks can also be more reflective of the science by clearly defining the buffer area that is needed to protect wetland functions. Since setbacks can be administered through existing development review processes, the additional expense to administer a permit system and additional permit fees for the landowner could be avoided.

2) Discretionary review of proposed activities

   A discretionary review approach requires that a landowner obtain a permit for a proposed activity if the activity falls within a set of regulated uses. With a discretionary approach, prohibited and allowed uses within a buffer area typically are not clearly outlined in the ordinance. In order for a permit to be issued, the city must find, at its discretion, that the proposed activity meets a set of performance standards or that the activity is designed to minimized impacts to a wetland and its buffer.

   Few examples of municipal codes were found that apply discretionary standards to proposed activities as in Boulder's ordinance. Wetland permit applications in Boulder are reviewed through a discretionary process where staff applies a general set of standards for review of proposed activities in either the wetland or the buffer area. In order for a permit to be issued under Boulder's ordinance, the applicant must demonstrate that: (1) adverse impacts to a wetland or its buffer were minimized through the design of the activity; (2) the project is in the public's interest; and (3) the unavoidable adverse impacts can be "successfully mitigated." These standards, however, are more easily applied to activities within the wetland itself than in those in the buffer area where it is often difficult to measure the level of indirect impact of an activity on an adjacent wetland.

Since the early 1990's when Boulder's code was adopted, some jurisdictions across the country have adopted a discretionary review process but with slightly more defined performance standards such as a maximum impervious surface coverage or a requirement to retain the natural vegetation in a buffer.

Similar to Boulder, Athens, Georgia requires a permit for certain activities in the buffer area. Although Athens strictly prohibits certain activities in the buffer area that are generally related to land development, it allows development of utility or transportation crossings, new single family homes, and vegetation clearing as long as very specific performance standards are met. Some of the performance standards for the construction of a new single family home include the following:

- the lot must be no smaller than two acres in size if adjacent to high value streams;
- development plans must conform to the topography of the site;
- septic tanks cannot be located in the riparian buffer;
- the impervious area footprint of the house and accessory structures must be less than 2,500 square feet;
- natural vegetation must be retained, protected and supplemented if possible; and
- the disturbed area and duration of exposure to erosive elements shall be kept to a practicable minimum.

3) <u>Combination</u>
A few communities have adopted ordinances with multi-zoned buffer area approaches and combine strict setback prohibitions in one zone with discretionary review standards and permit requirements in a second zone. Communities using this approach typically prohibit most new development within a streamside zone and limit development through performance standards (e.g. impervious surface cover limitations) in the outer zones. Although existing physical conditions in some urban areas may limit the practicality of a combined approach, this approach may be a more desirable way to balance the need for strict protection of the resource with landowner interests.

Variance Procedures
A variance or modification procedure is a permitted waiver or deviation from the land use regulations if a set of applicable criteria have been found to be met. Two general approaches to variances to wetland regulations were found among the sampled jurisdictions: 1) variances or appeals procedures for prohibited uses, and 2) variance procedures to modify adopted buffer widths.

Most jurisdictions generally prohibit activities in a setback area and provide for a variance procedure to the prohibited use or activity. Typically, an ordinance will outline a list of activities prohibited in the setback and require an appeal to the planning or zoning board to allow a prohibited activity. In order for a variance to be granted, a board must determine whether there is an unnecessary hardship, a physical constraint, or some unusual circumstance that would allow such an exemption.

The Berkeley, California zoning code provides a common example of a variance procedure for proposed activities in a setback. In general, construction in the 30 foot creek setback is prohibited and may be allowed only by appeal to the Zoning Adjustments Board for a variance. In the case of a single family home, an addition may be constructed through the issuance of a Conditional Use Permit if the Zoning Adjustments Board makes all of the following findings:

- all portions of the creek on the property are enclosed within a culvert;
- there is no open creek within 30 feet of the proposed construction;
- the single-family home is bisected by the creek such that "at least 30 percent of its footprint is located on both sides of the culverted creek";
- no portion of the addition is located directly above the culverted creek;
- there is no feasible alternative to development within the setback;
- the home has two or fewer bedrooms and is smaller than the median sized home within a 500 foot radius;
- the addition will not increase the size of the home to be larger than the median sized home within 500 feet;
- an independent structural engineer has concluded that the culvert is adequate to support the existing and proposed structure or will be made so; the addition will not adversely affect the creek; and
- the proposed addition will not be detrimental to the health, safety, peace, morals, comfort or general welfare of persons residing or working in the area or neighborhood of such proposed use, or be detrimental or injurious to property and improvements of the adjacent properties, the surrounding area or neighborhood or to the general welfare of the city.

Very few of the jurisdictions that were reviewed allow permanent variances to the buffer width such as in Boulder ordinance. Boulder's ordinance allows for permanent modifications to buffer widths if a landowner can demonstrate that the modified buffer is the area necessary to preserve the natural water source of the wetland or to protect the animal and plant habitat associated with the wetland. Since Boulder's ordinance is a discretionary review approach which allows an appeal of a permit decision to the Planning Board of a permit decision, a variance process for proposed activities is not necessary.

Modifications to the buffer area must be adopted by City Council ordinance after review and recommendation by the Planning Board. A problem with Boulder's current variance approach, however, is that, over time, buffer area boundaries could become irregular along certain stream widths and difficult to administer.

Model Ordinances

Several national and regional agencies and organizations have developed model buffer protection ordinances to provide guidance to jurisdictions wishing to develop a local law. The USEPA, the Association of State Wetland Managers, and the Center for Watershed Protection promote a similar model ordinance involving a multi-zoned buffer system (see <u>Appendix X</u>). In the USEPA's model ordinance, the basic structure of a stream buffer in an urban setting is broken up into the following three zones - each with different functions, width, vegetative targets, and allowed uses:

1) **Streamside zone** (minimum 25 ft. from the top of the bank). Allowable uses restricted to flood control, utilities, footpaths, road crossings.

2) **Middle zone** (minimum 50 ft. from streamside zone). Allowable uses restricted to biking paths, stormwater facilities, recreational uses, limited tree clearing.
3) **Outer zone** (Minimum of 25 ft. between middle zone and the nearest permanent structure). Restricts permanent structures or impervious cover with the exception of paths.

The USEPA's model ordinance provides suggested wording for a local regulation and is not meant to be adopted verbatim. Modification of the ordinance language is recommended in order to address specific local or regional conditions and concerns. The USEPA notes that consideration of political situations within a community may influence the final choice of buffer width, and flexibility in establishing stream buffer zones is important. While the wording and buffer widths of the USEPA's model ordinance may be flexible, several features are recommended for establishing the most effective ordinance possible:

- The establishment of a minimum stream buffer width. A width of at least 100 feet is recommended in order to recognize all the benefits that the stream buffer can provide.
- The creation of a three-zone buffer system with the functions, widths, vegetative targets and management schemes for each zone explained in detail.
- Language that creates the ability to expand the buffer to include the 100-year floodplain, steep slopes, and any adjacent delineated wetlands or critical habitats.
- A thorough explanation of the limits and uses of the stream buffer system and the requirements expected for any development plan during the entire development process--from initial plan review, through construction.
- A system to permanently mark the buffer, both physically on-site and in the land records should be enacted.
- A designated management system for the buffer, detailing permitted and restricted uses within the buffer, and an educational program that ensures that future residents know about the buffer.
- Any waivers or variances which may be granted regarding the buffer should be explained in detail to avoid legal challenges.
- Maintenance guidelines and enforcement procedures for buffer violations should be included.

WETLAND AND WATERSHED PLANNING

The USEPA and the Center for Watershed Protection promote a watershed-based approach to wetland and stream protection. A watershed, also called a drainage basin, is the area in which all water, sediments, and dissolved materials flow or drain from the land into a common river, lake, ocean, or other body of water. Wetlands are important elements of a watershed because they serve as the link between land and water resources.

Watersheds are significantly influenced by their wetlands. The capacity of wetlands to attenuate floods, absorb pollutants, recharge groundwater, provide wildlife habitat, and protect shorelines are important watershed functions. Despite performing these critical functions, wetlands are seldom integrated into local watershed plans. Instead, wetland managers regulate individual wetlands on a site-by-site basis. The site-by-site approach, however, often fails to consider cumulative wetland functions, and is often segregated along regulatory and jurisdictional lines.

A watershed-based approach to water and wetlands protection considers the whole system, including other resource management programs that address land, air, and water, to successfully manage problems for a given aquatic resource. Wetlands protection programs are most effective when coordinated with other surface and ground-water protection programs and with other resource management programs, such as flood control, water supply, protection of fish and wildlife, recreation, control of stormwater, and nonpoint source pollution. The watershed approach thus includes not only the water resource, but also the surrounding land from which the water drains. This area can be as large as the Mississippi River drainage basin or as small as a back yard.

Another benefit to a watershed-based approach is that the impacts of impervious surface on streams and water quality can be considered in a broader context. While maintaining protected riparian buffers helps to stabilize banks, protect riparian and wildlife habitat, and mitigate some of the effects of impervious surfaces, in many urban areas, most surface runoff is concentrated and routed through storm sewer systems before it reaches the stream buffer. Impervious surfaces result in the transfer of most precipitation into stormwater runoff, leading to increased surface and channel erosion, faster storm flows and elevated stream sediment levels. Flow from impervious surfaces carries pollutants directly to streams, bypassing natural filtration that would occur in undeveloped soils. In these cases, the buffers provide little service in intercepting sediments and other pollutants carried to the streams. Riparian buffers cannot fully protect streams if they are constantly scoured by high storm flows caused by runoff from impervious surfaces.

A few communities have addressed their water resource problems by taking a broader approach to protection of wetlands and streams and adopting comprehensive wetland protection plans. These plans generally consider the wetlands in a broader landscape context and establish conservation or protection areas based on extensive area by area habitat surveys and drainageway conditions (Santa Cruz, CA West Eugene, OR). The components of a watershed-based wetland protection plan as presented by the Center for Watershed Protection are as follows:

1) Compile wetland information on a watershed basis
2) Assess local wetland protection capacity
3) Identify wetland partners and roles
4) Define wetland goals and objectives for the watershed
5) Create an inventory of wetlands in the watershed
6) Screen wetlands for further assessment
7) Evaluate wetlands in the field
8) Adapt watershed tools to protect wetlands
9) Prioritize wetland recommendations
10) Coordinate implementation of wetland recommendations
11) Monitor progress toward wetland goals

West Eugene, Oregon was one of the first communities to take this approach to wetland protection in the early 1990s. The plan provided a survey and evaluation of wetlands in the community and designates protection areas, buffer sizes, and mitigation areas based on the location and value of each wetland in its broader watershed context.

The City Council of Santa Cruz, California adopted a “City-wide Creeks and Wetlands Management Plan” in February of 2006 which provides the scientific basis for its wetland and stream protection policies. The purposes of the plan are to: 1) identify and map watercourses and wetlands within the city limits; 2) identify appropriate development setbacks based on evaluation of habitat, stream and land use characteristics; 3) recommend management actions which promote the preservation of riparian and wetland resources, 4) define development guidelines and standards for areas where development adjacent to watercourses may be appropriate, and 5) provide a framework for permitting development adjacent to watercourses. The intent of the plan is to present a strategic approach to stream corridor management that is intended to result in better protection, enhancement, and management of the city’s riparian and wetland resources and water quality, while providing consistency and predictability of the city’s permitting process.

Watershed-based wetland plans can be a strong approach to establishing the most supportable buffer areas on a local level. Understanding the existing condition and larger context of streams and wetlands is key to applying the appropriate level of protection to individual sites. Comprehensive approaches are sometimes warranted in developed urban areas where existing land use conditions and political interests are complex. However, comprehensive studies and plans take time and expense to successfully develop and implement.

IV. CONCLUSIONS

Scientific literature provides extensive evidence that buffers are an important tool for achieving wetland protection. Characteristics of a good buffer depend on the individual wetland and the function being evaluated. For flood control benefits, a buffer should try to maximize available space in the floodplain so as to increase short term water storage, and vegetated banks should be present to stabilize streambanks. For water quality benefits, buffers need vegetation to slow runoff and for groundwater to pass through and undergo pollutant removal. For terrestrial habitat, it is desirable to have buffers with native vegetation in a variety of strata, providing connectivity to other patches, and with minimal disturbances. For overall stream ecology purposes, buffers are most effective when they provide leaf litter to supply the food chain, canopy for shade, large woody debris for in-stream cover, and a place for groundwater recharge which in turn supports baseflow in the stream.

There is not one optimal width for a wetland buffer. Instead, widths depend on the desired functions and local conditions such as topography. A substantial body of research exists that correlates wetland buffer widths with function; there is a wide range of recommended widths for different functions ranging from 50 feet to reduce sediment loading in streams to 300 feet for protection of certain types of wildlife habitat.

Protecting wetlands in urban settings is critical because they are at risk due to their location in disturbed or degraded settings. Furthermore, the protection of wetlands in urban and semi-arid settings is more necessary because of the scarcity of these ecosystems and the numerous ecological services they provide. The health of urban creeks and wetlands depends, in part, on the presence of wetland buffers to reduce the impacts from road runoff, pet and recreational usage, and commercial and industrial land uses that contribute to degraded water quality.

Buffer area protection is not uncommon in ordinances or statutes designed to protect wetlands, streams or rivers. In fact, the use of buffers is very common and becoming more of the normal approach to wetland and stream protection across the country on the municipal and county levels. However, regulatory approaches to stream and wetland buffer area protection differ widely throughout the country due to localized environmental, land use, and political conditions. There are, however, commonalities among municipal and county ordinances which can be summarized as follows:

1) <u>Location in code</u>
   The most common framework for buffer protection ordinances is an overlay zoning district within a land use code. This approach appears to be the more effective and expedient approach because it ties development restrictions in buffer areas more closely to the existing zoning of a property.
2) <u>Approach to establishing buffer widths</u>
   Most jurisdictions use fixed widths because they are simpler to develop, communicate and administer. Variable and multi-zoned buffer width approaches, although less common, are more adapted to site conditions, more scientifically based, and tend to balance landowner interests with resource protection.

3) Review process
   The majority of ordinances that were reviewed regulate uses with a setback approach with allowable and restricted uses specifically defined. Setback approaches provide more clarity to the landowner and tend to be simpler to administer than discretionary review approaches which require a permit review administration. The discretionary review approach of applying general performance standards to a proposed use in a buffer area is much less common.
4) Variances
   Jurisdictions that have adopted a setback approach provide for a variance procedure for activities that are generally prohibited. Typically, variance procedures require an appeal to the planning or zoning board to allow a prohibited activity under hardship conditions. Jurisdictions with a discretionary review approach do not provide for variances to proposed activities but typically allow for modifications to fixed buffer widths.

Because state and federal regulations do not adequately protect wetland buffers, local jurisdictions need to decide which buffer objectives and approaches to protection will work best within their regulatory framework. Under ideal circumstances, a watershed planning approach is recommended whereby individual wetlands and adjoining land uses are assessed for various functions and a reach-specific approach to buffer protection is developed and implemented. Nevertheless, most sources including the USEPA, the Association of State Wetland Managers, and the Center for Watershed Protection agree that the following basic objectives need to be met in a local wetland protection program for it to be effective:

1) Clearly define a minimum buffer width that balances resource protection with landowner interests and is sensitive to specific site and wetland conditions.
2) Provide clarity to the landowner in the uses and activities that are prohibited or allowed in the buffer area.
3) Balance landowner interest and resource protection in the regulation of activities and incorporate exceptions for existing land uses and activities that have minimal cumulative impact.
4) Provide flexibility to the landowner when there are physical site constraints, hardships or other unusual circumstances to necessitate variances.
5) Provide an on-going educational program that ensures that future residents know about the buffer, use restrictions, and recommended enhancements.

Like most other jurisdictions, Boulder regulates wetlands through an overlay zone district in the land use code and applies a fixed-width approach to establishing buffer areas. Unlike most other jurisdictions, however, Boulder uses a discretionary review approach and requires a permit for proposed activities in the buffer area. Boulder also allows a landowner to apply for a modification to the buffer width on an individual property if the landowner can show that the modified buffer includes the area adjacent to the wetland that is necessary to preserve the natural water source of the wetland or to protect the animal and plant habitat associated with the wetland.

The primary problem with Boulder's ordinance appears to be its discretionary review approach. The discretionary review approach results in a lack of clarity to the landowner in the uses that are permitted in the buffer area. The lack of concrete and clear standards in discretionary review can result in inconsistent application of performance standards and compromise both landowner expectations and resource protection. The discretionary review process has resulted in numerous permitted activities at various distances from wetlands, since there is no clear minimum buffer width. Finally, the city has not provided adequate, on-going education to ensure that landowners know about the buffer, use restrictions, and recommended enhancements.

Boulder's Wetlands Protection Ordinance was modeled on the Section 404 of the Clean Water Act by applying the standards of avoidance, minimization, and mitigation to activities within a wetland. It expanded upon the federal law by applying those same standards to the review of activities in wetland buffer areas. Over the past 10 to 15 years as more local jurisdictions have adopted wetland buffer area protection ordinances, regulatory approaches have evolved. Few of the current regulatory approaches require discretionary review of proposed activities or base approval of permits on a set of broad performance standards such as in Boulder's ordinance. While some jurisdictions require some level of review or permitting for activities within the actual wetland, many have adopted more straightforward buffer area setbacks where allowed and restricted activities within the buffer area are clearly specified.

Several changes to Boulder's wetlands protection program could help resolve regulatory issues and make it more effective. In reviewing more recent approaches taken by communities throughout the country, it appears that the city could benefit by looking at the following changes to the code:

1) **Develop a new approach to establishing buffer widths based on better science and more localized stream and wetland conditions**. (Consider a multi-zone approach)

2) **Consider a setback approach which more strictly defines allowable and restricted uses in at least a portion of the buffer area, creates a minimum buffer width, and provides more clarity to landowners.**

3) **Develop a procedure for allowing variances for restricted uses under clear conditions and standards.**

4) **Develop and implement an on-going educational program to keep new landowners informed about restrictions in buffer areas as well as about goals and expectations for land stewardship.**

Appendix A

Model Buffer Ordinance

(from the Center for Watershed Protection)

Section I. Background

Whereas, buffers adjacent to stream systems and coastal areas provide numerous environmental protection and resource management benefits which can include the following:

a) restoring and maintaining the chemical, physical and biological integrity of the water resources
b) removing pollutants delivered in urban stormwater
c) reducing erosion and controlling sedimentation
d) stabilizing stream banks
e) providing infiltration of stormwater runoff
f) maintaining base flow of streams
g) contributing the organic matter that is a source of food and energy for the aquatic ecosystem
h) providing tree canopy to shade streams and promote desirable aquatic organisms
i) providing riparian wildlife habitat
j) furnishing scenic value and recreational opportunity

It is the desire of the (Natural Resources or Planning Agency) to protect and maintain the native vegetation in riparian and wetland areas by implementing specifications for the establishment, protection and maintenance of vegetated along all stream systems and/or coastal zones within our jurisdictional authority.

Section II. Intent

The purpose of this ordinance is to establish minimal acceptable requirements for the design of buffers to protect the streams, wetlands and floodplains of (Jurisdiction); to protect the water quality of watercourses, reservoirs, lakes, and other significant water resources within (Jurisdiction); to protect (Jurisdiction's) riparian and aquatic ecosystems; and to provide for the environmentally sound use of (Jurisdiction's) land resources.

Section III. Definitions

Active Channel: The area of the stream channel that is subject to frequent flows (approximately once per one and a half years), and that includes the portion of the channel below where the floodplain flattens.

Best Management Practices (BMPs): Conservation practices or management measures which control soil loss and reduce water quality degradation caused by nutrients, animal wastes, toxins, sediment, and runoff.

Buffer: A vegetated area, including trees, shrubs and herbaceous vegetation, which exists or is established to protect a stream system, lake, reservoir or coastal estuarine area. Alteration of this natural area is strictly limited.

Development: 1) The improvement of property for any purpose involving building; 2) Subdivision, or the division of a tract or parcel of land in to 2 or more parcels; 3) the combination of any two or more lots, tracts, or parcels of property for any purpose; 4) the preparation of land for any of the above purposes.

Non-Tidal Wetland: Those areas not influenced by tidal fluctuations that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Non-point Source Pollution: Pollution which is generated by various land use activities rather than from an identifiable or discrete source, and is conveyed to waterways through natural processes, such as rainfall, storm runoff, or ground water seepage rather than direct discharge.

One Hundred Year Floodplain: The area of land adjacent to a stream that is subject to inundation during a storm event that has a recurrence interval of one hundred (100) years.

Pollution: Any contamination or alteration of the physical, chemical, or biological properties of any waters that will render the waters harmful or detrimental to: public health, safety or welfare; domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses; livestock, wild animals, or birds; fish or other aquatic life.

Stream Channel: Part of a water course either naturally or artificially created which contains an intermittent or perennial base flow of groundwater origin. Base flows of groundwater origin can be distinguished by any of the following physical indicators:

1) Hydrophytic vegetation, hydric soil or other hydrologic indicators in the area(s) where groundwater enters the stream channel, in the vicinity of the stream headwaters, channel bed or channel banks
2) Flowing water not directly related to a storm event
3) Historical records of a local high groundwater table, such as well and stream gauge records.

Stream Order: A classification system for streams based on stream hierarchy. The smaller the stream, the lower its numerical classification. For example, a first order stream does not have tributaries and normally originates from springs and/or seeps. At the confluence of two first order streams, a second order stream begins, and so on. (See Figure 1)

Stream System: A stream channel together with one or both of the following:

1) 100-year floodplain and/or
2) Hydrologically-related non-tidal wetlands

Streams: Perennial and intermittent watercourses identified through site inspection and USGS maps. Perennial streams are those which are depicted on a USGS map with a solid blue line. Intermittent streams are those which are depicted on a USGS map with a dotted blue line.

> *NOTE: Defining the term "stream" is perhaps the most contentious issue in the definition of stream buffers. This term determines the origin, and the length of the stream buffer. While some jurisdictions restrict the buffer to perennial or "blue line"*

streams, others include both perennial and intermittent streams in the stream buffer program. Some communities do not rely on USGS maps, and instead prepare local maps of all stream systems that require a buffer.

Water Pollution Hazard: A land use or activity that causes a relatively high risk of potential water pollution.

Section IV. Applications

A) This ordinance shall apply to all proposed development except for that development which meets waiver or variance criteria as outlined in Section IX of this regulation.
B) This ordinance shall apply to all timber harvesting activities, except those timber harvesting operations which are implementing a forest management plan which has been deemed to be in compliance with the regulations of the buffer ordinance and has received approval from . (*state forestry agency*).
C) This ordinance shall apply to all surface mining operations except that the design standards shall not apply to active surface mining operations which are operating in compliance with an approved (*state or federal agency*) surface mining permit.
D) The ordinance shall not apply to agricultural operations that are covered by an approved NRCS conservation plan that includes the application of best management practices.
E) Except as provided in Section IX, this ordinance shall apply to all parcels of land, structures and activities which are causing or contributing to:
    1) Pollution, including non-point pollution, of the waters of the jurisdiction adopting this ordinance.
    2) Erosion or sedimentation of stream channels
    3) Degradation of aquatic or riparian habitat

Section V. Plan Requirements

A) In accordance with section IV of this ordinance, a plan approved by the appropriate agency is required for all development, forest harvesting operations, surface mining operations, and agricultural operations.
B) The plan shall set forth an informative, conceptual and schematic representation of the proposed activity by means of maps, graphs, charts, or other written or drawn documents so as to enable the agency an opportunity to make a reasonably informed decision regarding the proposed activity.
C) The plan shall contain the following information:
    1) a location or vicinity map
    2) field delineated and surveyed streams, springs, seeps, bodies of water, and wetlands (include a minimum of two hundred (200) feet into adjacent properties).
    3) field delineated and surveyed forest buffers
    4) limits of the ultimate one hundred year floodplain
    5) hydric soils mapped in accordance with the NRCS soil survey of the site area
    6) steep slopes greater than fifteen (15) percent for areas adjacent to and within two hundred (200) feet of streams, wetlands, or other waterbodies.
    7) a narrative of the species and distribution of existing vegetation within the buffer

D) The buffer plan shall be submitted in conjunction with the required grading plan for any development, and the forest buffer should be clearly delineated on the final grading plan.
E) Permanent boundary markers, in the form of signage approved by (*Natural Resources or Planning Agency*), shall be installed prior to final approval of the required clearing and grading plan. Signs shall be placed at the edge of the Middle Zone (See Section VI.E).

Section VI: Design Standards for Forest Buffers

A) A forest buffer for a stream system shall consist of a forested strip of land extending along both sides of a stream and its adjacent wetlands, floodplains or slopes. The forest buffer width shall be adjusted to include contiguous sensitive areas, such as steep slopes or erodible soils, where development or disturbance may adversely affect water quality, streams, wetlands, or other waterbodies.
B) The forest buffer shall begin at the edge of the stream bank of the active channel.
C) The required width for all forest buffers (i.e., the base width) shall be a minimum of one hundred feet, with the requirement to expand the buffer depending on: stream order; percent slope; 100-year floodplain; wetlands or critical areas.
   1) In third order and higher streams, add twenty five feet to the base width.
   2) Forest Buffer width shall be modified if there are steep slopes which are within a close proximity to the stream and drain into the stream system. In those cases, the forest buffer width can be adjusted.

Several methods may be used to adjust buffer width for steep slopes. Two examples include:

Method A:

Percent Slope	Width of Buffer
15%-17%	add 10 feet
18%-20%	add 30 feet
21%-23%	add 50 feet
24%-25%	add 60 feet

Method B:

Percent Slope	Type of Stream Use	
	Water Contact Recreational Use	Sensitive Stream Habitat
0 to 14%	no change	add 50 feet
15 to 25%	add 25 feet	add 75 feet

Greater than 25%	add 50 feet	add 100 feet

3) Forest buffers shall be extended to encompass the entire 100 year floodplain and a zone with minimum width of 25 feet beyond the edge of the floodplain.
4) When wetland or critical areas extend beyond the edge of the required buffer width, the buffer shall be adjusted so that the buffer consists of the extent of the wetland plus a 25 foot zone extending beyond the wetland edge.

D) Water Pollution Hazards

The following land uses and/or activities are designated as potential water pollution hazards, and must be set back from any stream or waterbody by the distance indicated below:

1) storage of hazardous substances (150 feet)
2) above or below ground petroleum storage facilities (150 feet)
3) drainfields from on-site sewage disposal and treatment system (i.e., septic systems--100 feet)
4) raised septic systems (250 feet)
5) solid waste landfills or junkyards (300 feet)
6) confined animal feedlot operations (250 feet)
7) subsurface discharges from a wastewater treatment plant (100 feet)
8) land application of biosolids (100 feet)

For surface water supplies, the setbacks should be doubled.

E) The forest buffer shall be composed of three distinct zones, with each zone having its own set of allowable uses and vegetative targets as specified in this ordinance. (See Figure 2).

NOTE: Although a three-zone buffer system is highly recommended, the widths and specific uses allowed in each zone may vary between jurisdictions.

1) Zone 1 Streamside Zone
   a) The function of the streamside zone is to protect the physical and ecological integrity of the stream ecosystem.
   b) The streamside zone will begin at the edge of the stream bank of the active channel and extend a minimum of 25 feet from the top of the bank.
   c) Allowable uses within this zone are highly restricted to:
      i) flood control structures
      ii) utility rights of way
      iii) footpaths
      iv) road crossings, where permitted.
   d) The vegetative target for the streamside zone is undisturbed native vegetation.

2) Zone 2 Middle Zone
   a) The function of the middle zone is to protect key components of the stream and to provide distance between upland development and the streamside zone.

b) The middle zone will begin at the outer edge of the streamside zone and extend a minimum of 50 plus any additional buffer width as specified in Section VI C.
c) Allowable uses within the middle zone are restricted to:
    i) Biking or hiking paths
    ii) Stormwater management facilities, with the approval of (*Local agency responsible for stormwater).*
    iii) Recreational uses as approved by *(Planning Agency).*
    iv) Limited tree clearing with approval from (*Forestry agency or Planning Agency*).
d) The vegetative target for the middle zone is mature native vegetation adapted to the region.

3) Zone 3 Outer Zone
    a) The function of the outer zone is to prevent encroachment into the forest buffer and to filter runoff from residential and commercial development.
    b) The outer zone will begin at the outward edge of the middle zone and provide a minimum width of 25 feet between Zone 2 and the nearest permanent structure.
    c) There shall be no septic systems, permanent structures or impervious cover, with the exception of paths, within the outer zone.
    d) The vegetative target for the outer zone may vary, although the planting of native vegetation should be encouraged to increase the total width of the buffer.

Section VII. Buffer Management and Maintenance

A) The forest buffer, including wetlands and floodplains, shall be managed to enhance and maximize the unique value of these resources. Management includes specific limitations on alteration of the natural conditions of these resources. The following practices and activities are restricted within Zones 1 and 2 of the forest buffer, except with approval by (*Forestry, Planning or Natural Resources Agency)*:
    1) Clearing of existing vegetation.
    2) Soil disturbance by grading, stripping, or other practices.
    3) Filling or dumping.
    4) Drainage by ditching, underdrains, or other systems
    5) Use, storage, or application of pesticides, except for the spot spraying of noxious weeds or non-native species consistent with recommendations of .(*Forestry Agency*)
    6) Housing, grazing, or other maintenance of livestock.
    7) Storage or operation of motorized vehicles, except for maintenance and emergency use approved by .(*Forestry, Planning or Natural Resources Agency)*
B) The following structures, practices, and activities are permitted in the forest buffer, with specific design or maintenance features, subject to the review of (*Forestry, Planning or Natural Resources Agency)*:
    1) Roads, bridges, paths, and utilities:
        a) An analysis needs to be conducted to ensure that no economically feasible alternative is available.
        b) The right of way should be the minimum width needed to allow for maintenance access and installation.

c) The angle of the crossing shall be perpendicular to the stream or buffer in order to minimize clearing requirements
d) The minimum number of road crossings should be used within each subdivision, and no more than one fairway crossing is allowed for every 1,000 feet of buffer.

2) Stormwater management:
e) An analysis needs to be conducted to ensure that no economically feasible alternative is available, and that the project is either necessary for flood control, or significantly improves the water quality or habitat in the stream.
f) In new developments, on-site and non-structural alternatives will be preferred over larger facilities within the stream buffer.
g) When constructing stormwater management facilities (i.e., BMPs), the area cleared will be limited to the area required for construction, and adequate maintenance access, as outlined in the most recent edition of (*Refer to Stormwater Manual)*.
h) Material dredged or otherwise removed from a BMP shall be stored outside the buffer.

3) Stream restoration projects, facilities and activities approved by (*Forestry, Planning or Natural Resources Agency)* are permitted within the forest buffer.
4) Water quality monitoring and stream gauging are permitted within the forest buffer, as approved by (*Forestry, Planning or Natural Resources Agency)*:.
5) Individual trees within the forest buffer may be removed which are in danger of falling, causing damage to dwellings or other structures, or causing blockage of the stream.
6) Other timber cutting techniques approved by the agency may be undertaken within the forest buffer under the advice and guidance of (*State or Federal Forestry Agency*), if necessary to preserve the forest from extensive pest infestation, disease infestation, or threat from fire.

C) All plats prepared for recording and all right-of-way plats shall clearly:
1) Show the extent of any forest buffer on the subject property by metes and bounds
2) Label the forest buffer
3) Provide a note to reference any forest buffer stating: "There shall be no clearing, grading, construction or disturbance of vegetation except as permitted by the agency."
4) Provide a note to reference any protective covenants governing all forest buffers areas stating: "Any forest buffer shown hereon is subject to protective covenants which may be found in the land records and which restrict disturbance and use of these areas."

D) All forest buffer areas shall be maintained through a declaration of protective covenant, which is required to be submitted for approval by (*Planning Board or Agency*). The covenant shall be recorded in the land records and shall run with the land and continue in perpetuity.

E) All lease agreements must contain a notation regarding the presence and location of protective covenants for forest buffer areas, and which shall contain information on the management and maintenance requirements for the forest buffer for the new property owner.

F) An offer of dedication of a forest buffer area to the agency shall not be interpreted to mean that this automatically conveys to the general public the right of access to this area.

G) (*Responsible Individual or Group)* shall inspect the buffer annually and immediately following severe storms for evidence of sediment deposition, erosion, or concentrated flow channels and corrective actions taken to ensure the integrity and functions of the forest buffer.

H) Forest buffer areas may be allowed to grow into their vegetative target state naturally, but methods to enhance the successional process such as active reforestation may be used when deemed necessary by (*Natural Resources or Forestry Agency)* to ensure the preservation and propagation of the buffer area. Forest buffer areas may also be enhanced through reforestation or other growth techniques as a form of mitigation for achieving buffer preservation requirements.

Section VIII Enforcement Procedures

A) (Director of *Responsible Agency)* is authorized and empowered to enforce the requirements of this ordinance in accordance with the procedures of this section.

B) If, upon inspection or investigation, the director or his/her designee is of the opinion that any person has violated any provision of this ordinance, he/she shall with reasonable promptness issue a correction notice to the person. Each such notice shall be in writing and shall describe the nature of the violation, including a reference to the provision within this ordinance which has been violated. In addition, the notice shall set a reasonable time for the abatement and correction of the violation.

C) If it is determined that the violation or violations continue after the time fixed for abatement and correction has expired, the director shall issue a citation by certified mail to the person who is in violation. Each such notice shall be in writing and shall describe the nature of the violation, including a reference to the provision within this ordinance which has been violated, and what penalty, if any, is proposed to be assessed. The person charged has thirty (30) days within which to contest the citation or proposed assessment of penalty and to file a request for a hearing with the director or his designee. At the conclusion of this hearing, the director or his designee will issue a final order, subject to appeal to the appropriate authority. If, within thirty (30) days from the receipt of the citation issued by the director, the person fails to contest the citation or proposed assessment of penalty, the citation or proposed assessment of penalty shall be deemed the final order of the director.

D) Any person who violates any provision of this ordinance may be liable for any cost or expenses incurred as a result thereof by the agency.

E) Penalties which may be assessed for those deemed to be in violation may include:

   1) A civil penalty not to exceed one thousand dollars ($1,000.00) for each violation with each days continuance considered a separate violation.
   2) A criminal penalty in the form of a fine of not more than one thousand dollars ($1,000.00) for each violation or imprisonment for not more than ninety (90) days, or both. Every day that such violations shall continue will be considered a separate offense.
   3) Anyone who knowingly makes any false statements in any application, record, plat , or plan required by this ordinance shall upon conviction be punished by a fine of not more than one thousand dollars ($1,000.00) for each violation or imprisonment for not more than thirty (30) days, or both

F) In addition to any other sanctions listed in this ordinance, a person who fails to comply with the provisions of this buffer ordinance shall be liable to the agency in a civil action for damages in an amount equal to twice the cost of restoring the buffer. Damages that are recovered in accordance with this action shall be used for the restoration of buffer systems or for the administration of programs for the protection and restoration of water quality, streams, wetlands, and floodplains.

Section IX Waivers/Variances

A) This ordinance shall apply to all proposed development except for that development which prior to the effective date of this ordinance:
   1) Is covered by a valid, unexpired plat in accordance with development regulations
   2) Is covered by a current, executed public works agreement
   3) Is covered by a valid, unexpired building permit
   4) Has been accepted to apply for a building permit
   5) Has been granted a waiver in accordance with current development regulations.

B) The director of the agency may grant a variance for the following:
   1) Those projects or activities where it can be demonstrated that strict compliance with the ordinance would result in practical difficulty or financial hardship
   2) Those projects or activities serving a public need where no feasible alternative is available.
   3) The repair and maintenance of public improvements where avoidance and minimization of adverse impacts to nontidal wetlands and associated aquatic ecosystems have been addressed
   4) For those developments which have had buffers applied in conformance with previously issued requirements.

C) Waivers for development may also be granted in two additional forms, if deemed appropriate by the director:
   1) The buffer width made be relaxed and the buffer permitted to become narrower at some points as long as the average width of the buffer meets the minimum requirement. This averaging of the buffer may be used to allow for the presence of an existing structure or to recover a lost lot, as long as the streamside zone (Zone I) is not disturbed by the narrowing, and no new structures are built within the one hundred (100) year floodplain.
   2) (*Planning Agency*) may offer credit for additional density elsewhere on the site in compensation for the loss of developable land due to the requirements of this ordinance. This compensation may increase the total number of dwelling units on the site up to the amount permitted under the base zoning.

D) The applicant shall submit a written request for a variance to the director of the agency. The application shall include specific reasons justifying the variance and any other information necessary to evaluate the proposed variance request. The agency may require an alternatives analysis that clearly demonstrates that no other feasible alternatives exist and that minimal impact will occur as a result of the project or development.

E) In granting a request for a variance, the director of the agency may require site design, landscape planting, fencing, the placement of signs, and the establishment of water quality best management practices in order to reduce adverse impacts on water quality, streams, wetlands, and floodplains.

Section X. Conflict With Other Regulations

Where the standards and management requirements of this buffer ordinance are in conflict with other laws, regulations, and policies regarding streams, steep slopes, erodible soils, wetlands, floodplains, timber harvesting, land disturbance activities or other environmental protective measures, the more restrictive shall apply.

Appendix B

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Glossary of Terms

Adsorb – To accumulate gases, liquids, or solutes on the surface of a solid or liquid.

Alluvial – Relating to the sand, silt, clay, gravel, or other matter deposited by flowing water, as in a riverbed, floodplain, delta, or alluvial fan.

Aquatic bench – Shallow, flat zone along the edge of the permanent pool that is comprised of emergent wetland vegetation that acts as a biological filter.

Base flow – That portion of stream discharge derived from groundwater.

Biogeochemical – The relationship between the geochemistry of a given region and its flora and fauna, including the circulation of such elements as carbon and nitrogen between the environment and the cells of living organisms.

Contour buffer strips are defined in NRCS Code 332 as “narrow strips of permanent, herbaceous vegetative cover established across the slope and alternated down the slope with parallel wider cropped strips.

Filter strip is described in NRCS Code 393 as “A strip or area of herbaceous vegetation situated between cropland, grazing land or disturbed land (including forestland) and environmentally sensitive areas.”

Floodplain – The low-lying land adjoining a river that is sometimes flooded; generally covered by fine-grained sediments (silt and clay) deposited by the river at flood stage.

Hydrologic budget – An accounting of the inflow to, outflow from, and storage in, a hydrologic unit, such as a watershed, wetland, aquifer, or lake.

Natural capital – An extension of the economic notion of capital (manufactured means of production) to environmental 'goods and services'. It refers to a stock (e.g. a forest) which produces a flow of goods (e.g. new trees) and services (e.g. carbon sequestration, erosion control, and habitat).

Riparian – of or relating to or located on the banks of a river or stream.

Trophic state – Indication frequently associated with ponds and lakes of their biological productivity (i.e., the amount of living material supported, primarily in the form of algae). The least productive ponds and lakes are called ‘oligotrophic’. These are typically cool and clear, and have relatively low nutrient concentrations. The most productive lakes are called ‘eutrophic’ and are characterized by high nutrient concentrations, which result in algal growth, cloudy water, and low dissolved oxygen levels. Those lakes with a trophic status that falls along the continuum somewhere between oligotrophy and eutrophy are termed ‘mesotrophic’.