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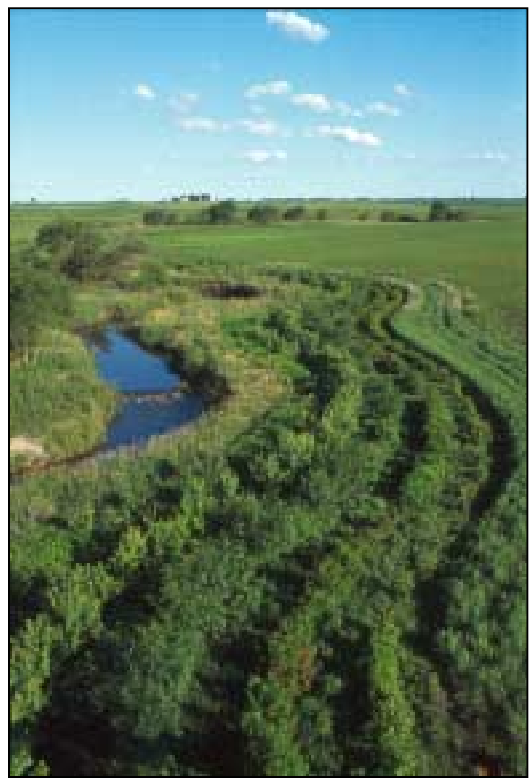
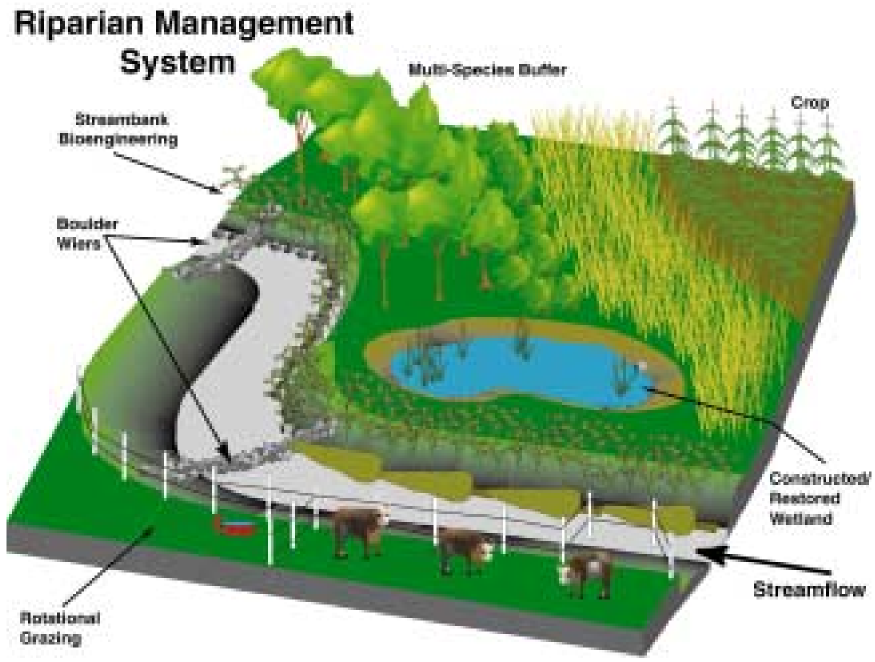
What does riparian mean?

There are numerous definitions for a riparian area.



The USDA Forest Service defines it as: *"the aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment. This includes streams, rivers, lakes, and bays and their adjacent side channels, flood plain, and wetlands. In specific cases, the riparian area may also include a portion of the hillslope that directly serves as streamside habitats for wildlife."* Lowrance, Leonard, and Sheridan defined that riparian ecosystem as: *"a complex assemblage of plants and other organisms in an environment adjacent to water. Without definite boundaries, it may include streambanks, flood plain, and wetlands, ... forming a transitional zone between upland and aquatic habitat. Mainly linear in shape and extent, they are characterized by laterally flowing water that rises and falls at least once within a growing season."* The Coastal Zone Management Handbook defines riparian areas as: *"vegetated ecosystems along a waterbody through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent waterbody. These systems encompass wetlands, uplands, or some combination of these two land forms. They will not in all cases have all the characteristics necessary for them to be classified as wetlands."* The common threads between these and other definitions are that a riparian area is: 1) adjacent to a body of water; 2) has no clearly defined boundaries; 3) a transition between aquatic and upland environments, and 4) linear in nature.

Where is the most effective location for buffers in a watershed? ***Continuously on both sides of the channel in the upper portion of the watershed.***



The function of buffers is to intercept nonpoint source pollutants from upland agricultural systems. To be most effective streams that are in closest contact with the uplands should be buffered. In any landscape there are ridges and valleys. In the agricultural landscape water, sediment and chemicals can move as surface runoff to the valleys. Where the slope distance (distance between the ridge and the channel) is the shortest the valley probably contains an ephemeral channel or gully (one that only carries water during a rain event and has no contact with the local water table). That ephemeral channel or gully may actually not exist because a grass waterway has been installed as a best management practice. As the slope distance increases the valley will contain intermittent (runs only during the wet season of the year) and perennial (runs year round) channels. These channels are in contact with the water table that are the first actual stream channels to receive sediment and chemicals from the upland. On a watershed basis, these small (first - third order) streams are included in the zone of sediment and nutrient production and these are the channels that should be buffered first. Larger streams function primarily as transport channels for the flow that has been collected by the smaller streams. The volume of water and sediment supplied directly from their adjacent uplands is small compared to the volume of water that is contributed from upstream. Randomly locating buffers along streams with little continuity can provide effective field-level reductions of NPS pollutants but will have little measurable effect on stream water quality. While any buffer has value they are most effective for stream water quality improvement when they are installed using a watershed approach.

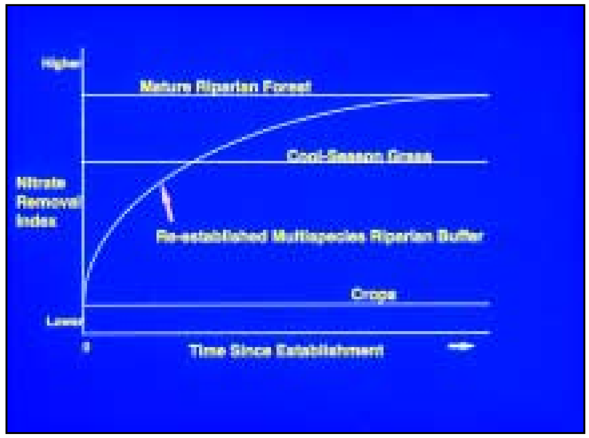
How long does it take for a buffer to reach its maximum efficiency? ***10-15 years*.**

Present research comparing the established buffers along Bear Creek with other native riparian plant communities suggests that chemical processing of nonpoint source (NPS) pollutants may take 10-15 years to reach maximum efficiency. This is mostly due to the time required for the perennial plant community to occupy the site and for soil quality parameters to reach optimum levels. Sediment trapping by the native grass component of the buffer may reach optimal efficiency in as little as five years.

Do buffers really reduce nitrogen and other chemicals loadings to streams? ***Yes***. Nitrate concentrations are 90% lower and atrazine concentrations 70% lower in the soil water of the unsaturated zone (rooting zone) under the riparian buffers along Bear Creek than under adjacent crop fields. This may not mean that the buffer has removed all of that nitrogen or atrazine from the soil solution but it does represent a zone where nitrogen and atrazine have not been directly applied to the soil. Similarly, nitrate concentrations in the shallow groundwater are reduced by as much as 90% within the buffers, though this is very much influenced by site geology. Where the shallow groundwater moves in a narrow zone near the surface, significant reductions may be expected but where it lies in a wider zone and moves well below the rooting zone significantly less reduction can occur. Understanding site geology is very important to understanding buffer function. In some agricultural regions, agricultural drainage tiles bring water from distant upland portions of the watershed directly to the stream channel, short-circuiting the buffer. In some regions this tile water may provide the major baseflow for the stream. In that case buffers themselves are ineffective at removing pollutant chemicals from the tile water. The Multispecies Riparian Buffer Management System provides an integrated management approach by including constructed wetlands that can be designed to intercept and treat tile water and therefore improve stream water quality.

Haven't nitrate levels always been high in Iowa and other Midwestern states surface waters? ***No.***

"Always" is the key word in this question. A paper by Keeney and Deluca (J.E.Q. 22:267-272 (1993)) indicates that nitrate levels in the Des Moines river today are not much different today than they were in 1945. However, the authors use this evidence to suggest that row crop agriculture, in general, and not just nitrogen fertilizer application are the reasons for the high nitrate concentrations. When soils are cultivated and left bare for a good part of the year mineralization (changing organic forms of nitrogen to inorganic forms) is increased and soluble nitrate is produced. Under native plant ecosystems (prairie or forest) this process is slower and the nitrate that is present is rapidly immobilized by plant uptake or microbial activity. Thus, native ecosystems are said to have a closed or tight nitrogen cycle while present-day agricultural ecosystems are open and leaky. Thus, the Iowa landscape has been leaking nitrogen to surface waters since the native prairie and native forests were cleared and replaced by cultivated fields, roads and urban areas. Buffers provide a small, strategically located perennial plant community which can accept a given amount of the leaking chemical load of the rest of the landscape and process it before it reaches the surface and ground waters. The research challenge is to identify the size of the buffer community that is needed to accept and reduce to an acceptable level the NPS pollutants from the unbuffered portion of watersheds.



Do trees and shrubs really stabilize streambanks? ***Yes.***

Woody roots have been shown to increase the strength of the soil. In many agricultural areas streams have been deeply incised creating deep channels with steep vertical banks. Along such streams, tree and shrub roots provide the strength needed to hold them in place. Nothing can completely stop bank erosion as it is a natural process so in time trees will fall into the stream. However, with proper buffer management trees can be harvested before that happens. Grasses may be planted along stream edges but cool-season grass roots seldom grow deeper than 18 inches while native warm-season grass roots may grow as deep as 3-6 feet depending on soils. Grass roots are small and non-woody and many die each year providing little long-term structural strength for the soil. If stream banks are sloped at a ratio of 3:1 or more native grasses may effectively hold them in place. On steeper banks dense stands of small willow cuttings are very effective at holding banks in place. Sandbar willow is especially effective because this species root sprouts developing a dense web or spreading roots that help stabilize banks. Where banks are more than 6 ft in height above base flow levels even woody roots may not be effective, and bank shaping and soil bioengineering approaches are necessary.

In addition to stabilizing banks, trees and shrubs are also very effective at slowing flood waters and trapping flood debris which keeps it out of the farm fields. The trapped debris decomposes on the site and provides carbon for soil development and microbial processes. Slowing flood flows in tributary streams can reduce the peak flows in larger streams and thus reduce the severity of flooding of downstream urban areas.

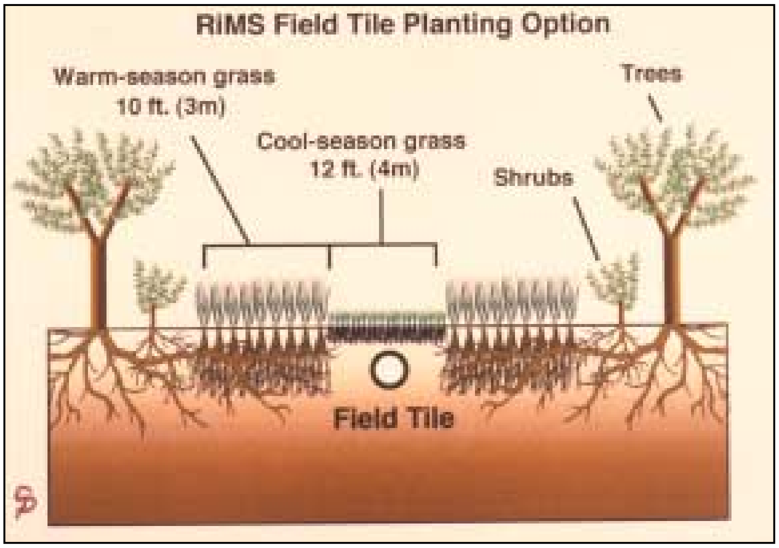
Can grasses be planted first right along the bank to minimize trees falling into the channel? ***Yes if conditions permit***.

Buffer design should be very flexible not only to fit the biological and physical constraints of the site but also to meet the objectives of the landowner/farmer and the cost-share programs that might be used. As a result any combination of trees, shrubs or grasses is possible. However, Where banks are vertical and unstable it is best to plant woody plants as close to the bank as possible. If there is concern of trees falling into the channel then shrubs can be planted first. A typical design that we often use consists of a row of shubs right next to the creek followed by rows of trees and then rows of shrubs. In either case a cover of grasses is also desired if the area was in row crop agriculture or the woody plants should be planted into existing pasture grasses using herbicides to control a narrow strip where the woody plants will be planted. If banks are sloped at 2:1 or better than grasses, preferably a mixture of native grasses and forbs, can be planted. If cool-season grasses are planted a waterway mix can be used.

What should be planted if all or part of the riparian zone is in reed canary grass?
The best response may be to leave the reed canary grass.

Reed canary grass is a very aggressive grass that has a high demand for nitrogen. It is one of the deeper rooted cool-season grasses but does not root as deeply as native grasses. It is very difficult to kill a dense stand of reed canary grass. It often takes multiple applications of herbicide to kill it completely. If it is not killed completely it will rapidly spread and out compete most any plants that are planted in its space. Because it is a rather effective riparian grass the best advice may be leave it. It often has good control over surface runoff and does provide some nutrient uptake from the soil solution.

Don't trees plug tiles? ***Yes trees do plug tiles***



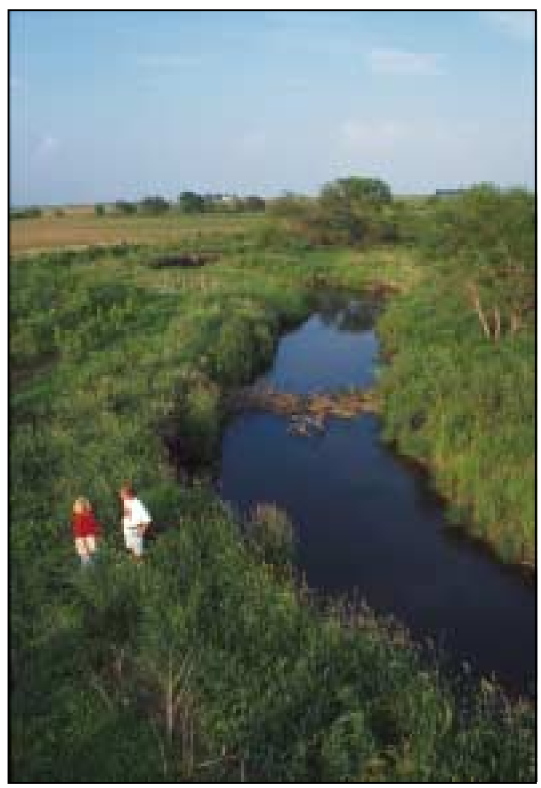
There are two solutions to the problem. The first is to replace the perforated or clay tile with solid tile through the buffer. The second is to modify the planting design over the tile. This design would include a 6 foot wide zone of cool season grass centered directly over the tile. On either side of that is a 12 foot strip of native grasses followed by shrubs and trees. While native grass roots grow to great depths they have few lateral roots so backing them off 3 feet from the tile will keep them from plugging it. The key to shrub and tree placement is to keep them as far away from the tile as the mature tree height, as this is the distance their roots will grow.

What are the shallowest rooted trees and shrubs that can planted so they can be removed at a later date if necessary? ***Most riparian species.***

Most riparian tree and shrub species tend to have shallow root systems and include such species as willow, cottonwood, silver maple and green ash. However, any tree species growing over a shallow water table will tend to have a shallow root system. On the other hand, it is important to remember that root systems of most woody plants will also go as deep in the soil profile as good aeration will allow. Along many of our deeply incised streams the water table has been dropped to averages of more than 3-5 feet during the growing season allowing deeper rooting. As a result upland as well as riparian species can be successfully planted. This question has been asked by people who consider converting the buffer back to row crops after the CRP contract has expired.

Can direct seeding or natural regeneration be used to establish a buffer? ***Yes.***

There is no reason that these two methods of establishment couldn't be successful if done correctly. Both methods create a more natural stand of woody plants. This may better meet the objectives of the landowner. However, it may create problems because buffers are managed systems whose major function is to intercept and reduce NPS pollutants. As a result they require more maintenance than a native stand and random spacing may create problems for access during more frequent harvesting, etc. Natural regeneration may be difficult to obtain in many agricultural areas because the natural source of seed or propagules may be miles from the buffer site.



Don't trees attract beavers and don't they hinder water movement? ***Yes.***

Trees do attract beavers but beavers can have a very positive influence on water movement. Most Iowa streams have become incised into a deep channel and no longer use their floodplain as a natural river does. In the process the water velocity of these streams has increased and with it the erosive potential of the water. This means that the steep bare banks are more subject to undercutting and collapse. Grade control structures such as boulder weirs or low-head dams that are less than 1 m in height can be used to slow the water and reduce its velocity. In addition, these structures raise the base flow level of the water and reduce the height of the exposed stream bank which reduces bank collapse. Beaver dams can function in the same manner as these structures. However, beavers cannot be told where to build their dams and they may locate them so that their dam impoundments back water up drainage tiles. If, however, a buffer is between 100 and 150 ft in width it would be rare that beaver impoundments would actually back up water in the tiles as far back as the crop fields. If beaver become a nuisance, landowners can get permission to have them trapped outside of the regular trapping season.

Do buffers attract undesirable wildlife species (e.g. coyotes, deer, rodents, insects)? ***Buffers attract wildlife.***

Buffers provide habitat that wildlife will utilize. Controlling the design of the buffer can have some influence on the kind of wildlife that will inhabit it. Cool-season grass filters provide the least complex habitat so will have relatively few species and these will tend to be smaller in size. Changing the design to a native prairie mixture of warm-season grasses and forbs greatly increases the habitat and the wildlife species. The most complex buffer in terms of habitat is the riparian forest buffer that includes combinations of trees and shrubs as well as a native prairie plant community. In a recent song bird survey in the Bear Creek Watershed, 9 species were consistently found in the narrow cool-season grass and weed strips typically left along unbuffered streams. In a 10 year old riparian forest buffer 43 species were found. Game species such as pheasants have are present in large numbers making the buffers prime hunting areas. In the same riparian zones another survey showed an increase in small mammals in the 10 year old buffer. Buffers are narrow corridors and as such will attract primarily edge species. In many landscapes the buffers provide the only consistent habitat around and therefore may concentrate many species, which in some cases, makes them more susceptible to predation. Buffers are being studied as possible refugees for beneficial birds and insects that prey on crop pests. The only way to control specific wildlife species is to simplify the buffer design to a point that habitat for the key species does not exist. Frequently that simplification also brings with it a loss in buffer function for reducing non-point source pollutants.

Don't buffers act as sources of seed for noxious weeds? ***No.***

Well managed buffers are not sources of noxious weeds. Most noxious weeds are introduced annuals that do not compete well in a native grass or forest setting. During the first two years of native grass establishment the potential for noxious weeds is present but through judicious mowing and controlled burning the weeds can be controlled before producing seed. After the native community is established periodic burning or harvesting will assure that weed species are not a problem. Noxious weeds can also be a component of the establishing woody plants. Planting a perennial cover crop of cool-season grasses such as rye and timothy and applying herbicides for the first three year within the rows will keep the weeds out until the woody plants have closed their canopies over the site.

Isn't there a problem with the buffers ponding water as a result of levee formation along their edge and/or sediment trapping? Or how do you keep concentrated flow channels from developing through the buffer? ***No, if the buffer and adjacent upland are managed properly.***

Buffers, like any conservation practice, require management to maintain their functionality. There are two possible ways for ponding to develop in the buffer. The first is the development of a ridge along the field/native grass border as a result of cultivation. As this ridge develops, water may pond in the field at the edge of the buffer or run along the ridge before creating a breach of concentrated flow through the ridge and buffer. Proper management of the field-buffer edge is the key to minimizing the potential of concentrated flow across the buffer. A dense stand of switchgrass that is at least 5-7 m wide will halt the development of concentrated flow on most sites with slopes up to 14%. In areas with slopes of 0-2% switchgrass along the edge may be replaced by other native grasses and forbs. Switchgrass is used because it has less of a tendency to grow in bunches than most of the other native warm-season grasses that are used. Managing the edge to minimize the development of a ridge can be done using careful field cultivation. Should a ridge develop and lead to channelized flow, the edge of the buffer can be reworked by dragging the sediment back into the field and replanting the edge of the buffer.

The other cause of ponding may be the development of a levee along the streambank that results from deposition of sediment when the stream comes out of its banks. As flood water comes out of its banks its velocity slows quickly and the heavier suspended particles are dropped. As the levee builds water can be trapped in the buffer behind the levee and may have difficulty getting back into the stream. This is a natural phenomena and is most prevalent on outside bends.

Do buffers require maintenance? ***Yes.***

Properly functioning buffers require maintenance during their establishment and also long-term. During the establishment phase weed competition must be controlled. This can be done through mowing and burning of the native prairie plants, mowing between the rows of trees and using herbicides over the tree seedlings. This intensive maintenance is required for the first 3-5 years if a healthy buffer is to be established. Buffers are designed to reduce the non-point source pollutant load the moves through them. As such there are larger loads of materials flowing into these systems than into other natural systems. A healthy, well established prairie, forest or wetland ecosystem can act as storage sinks for nutrients. However, there is a finite capacity to those sinks unless some of the plant material and the associated chemicals are removed from the site. As a result, buffer management requires periodic harvesting of the above ground biomass to remove the chemicals that are stored in the plants. This may come in the form of a tree harvest or cutting and baling or burning of the grasses. Trees along streambanks should be monitored and cut if they are about to fall into the stream. The cropfield-buffer edge should be monitored and reworked if a ridge of soil begins to develop which causes lateral concentrated flow along the buffer border. Any concentrated flow areas that develop into the buffer should be treated quickly. This usually requires upslope best management practices such as grass waterways.

Can buffers be grazed for short periods? ***Theoretically, buffers could be grazed for short periods of time.***

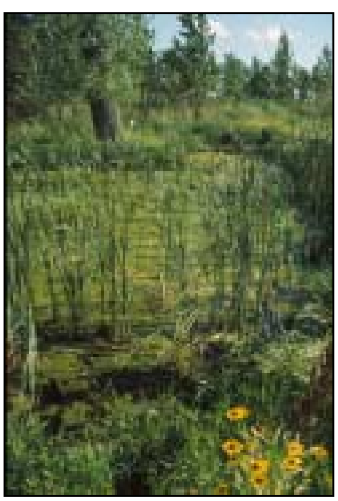
The plant community of buffer serves as a nutrient storage sink removing and immobilizing NPS pollutants in the plant biomass. If all of the plant material is returned to the soil upon death and decomposition the plant sink will have a finite ability to immobilize NPS pollutants. As a result plant materials should be removed from the buffers from time to time. Trees can be harvested and prairies are burned on a regular cycle. However, careful rotational grazing could also accomplish this removal. However, if not carefully managed cattle can put significant pressure on tree saplings and shrub. Cattle can also put extreme pressure on stream banks and with poor management can do extensive damage to the buffer area through compaction. Overgrazed pastures have some of the slowest soil infiltration rates and some of the highest stream bank instability problems of any riparian land-use management practices. There is also concern that grazed riparian pastures may be a source of phosphorus pollution stemming from the manure and from the collapse of banks. The Agroecology and Animal Management Issue Teams of the Leopold Center for Sustainable Agriculture are conducting a series of studies in cooperation with the Iowa Cattleman's Association and the Iowa Department of Natural Resources to determine the impact of riparian grazing on streams and to develop grazing best management practices that will allow careful grazing of riparian zones.

What provisions can be made for livestock access to water? *Direct access and pasture pumps*.

There are two basic ways that livestock access to water can be provided in a buffer system. The first is to provide direct access to the stream through controlled access points. These points can be fenced and armored with rock to harden the channel and to discourage loitering. Ideally, access points should restrict the access to just a portion of the channel.

This can be done by using adjustable fences as shown in the adjacent pictures. Restricting access to the banks by fencing narrow strips along the channel can stimulate rapid bank revegetaion and stability. Fencing at the access points can be removed after the grazing season is ended and replaced after the spring floods. The second method of providing water to riparian pastures is to provide remote water sources using manually operated pasture pumps, solar or wind pumps, or electrically powered pumps that provide water to strategically located troughs. Pasture pumps are inexpensive and can satisfy up to 20 cows per pump, and lift water 7.5 m vertically over a horizontal distance of about 40 m.

Are wetlands really effective in reducing nitrate and other chemicals? *Yes.*



Wetlands are extremely effective at reducing nitrate and other chemicals if properly designed and managed. The rates of some biological processes in wetlands are known and this area is the subject of ongoing research by the Wetlands Research Group at Iowa State University. Using this information, ratios of wetland area to cropland drained can be estimated based on a desired processing efficiency. The major questions addressing the efficacy of wetlands for treatment of NPS pollutants relate to siting wetlands at the watershed level to maximize efficiency and providing the incentives and cost-shares required to effect implementation. In some midwestern streams baseflow consists primarily of water from field drainage tiles. These tiles by-pass riparian buffers carrying water rapidly from the uplands under the buffers and into the stream. In assessing the upper third of the Bear Creek Watershed over 100 tiles were found entering the creek. Of these 8 were large tiles that contributed over 80% of the tile flow to the creek. The present strategy is to construct large wetlands to intercept the largest of the large tiles to have an impact on reducing nutrient loading from the tiles.

Do wetlands work during cold weather? ***Yes, but more slowlyr.***

Because the major processes for reducing chemical loads in wetlands are biological their rates are slower at colder temperatures. However, wetlands can be sized to account for these slower process rates and still provide the desired removal efficiency.   This is especially important in the early spring runoff events when cold conditions may be present during the first flush of chemicals from previously frozen soils.

How much land is going to be taken out of 'production' if buffers are installed? ***Suprisingly little.*** If a buffer is designed to meet the minimum width of 60 ft on one side of a channel as required in the 1995 Open Enrollment Component of the Conservation Reserve Program 7.3 acres will be used on one side (14.6 acres both sides) in one mile of channel length. If the buffer is 100 ft wide on one side, 12.1 (24.2 acres both sides) acres would be used along a mile of channel. At 150 ft of width 18.2 acres would be used on a side in one mile. While this land is usually taken out of grain crop production detailed evaluations in the Bear Creek watershed show that 1/2 of the acres that would be planted to buffers presently are not being cropped because of tight meanders in the channel that make it difficult for machinery to maneuver. Most of that area is in permanent grass/weeds or forests.

Wouldn't it be easier or better to straighten the stream and rip-rap the stream banks than leave it in its meandering form? ***No, this is one of the major sources of our present flooding problems.***

Channelizaton of streams has helped to produce the flashy runoff and flooding problems that face many parts of the country. It is estimated that nearly one half of the original stream miles in Iowa have been lost because of channelization. When a stream is channelized it is significantly shortened, which reduces channel storage capacity and increases velocity. When high flow events do occur water is accelerated because it moves through a straight channel and no longer is slowed by hitting meandering banks. Higher velocities also mean higher erosive potential which tends to downcut the channel. This reduces the ability of the channel to use its floodplain to slow the flow of water. Because the channel has been shortened, the same amount of water now flows in a shorter reach without access to its floodplain, resulting in high velocity water being delivered rapidly downstream producing potentially severe floods.

Using rip-rap on banks hardens the banks and often makes them smoother than when plant stems and roots provided a frictional surface. Unless properly applied rip-rap also may be undermined and collapse into the channel as often happens when broken portions of road construction debris are dumped along a bank. Rip-rap is significantly more expensive than bioengineering and is also aesthetically less pleasing. A combination of bioengineering using living woody plants and grasses along with properly applied hard-engineering, such as rip-rap is often the best solution to bank stabilization.

What kind of government incentives are available for establishing buffers? *Many.*

There are numerous government and non-government incentive programs. Some of these are aimed at specific watersheds while others are more general. The most effective program at the present time is the Continuous Sign-up for High Priority Practices of the Conservation Reserve Program. This program provides an annual payment consisting of an established land rental rate plus a twenty percent bonus for filter strips or riparian forest buffers on lands with a cropping or grazing history. The rental rate is based on values that are calculated for each county and based on specific soil types. The payments are provided annually for 10 or 15 years. At the present time there is also a signing bonus equivalent to $100 or $150 per acre depending if the buffer is enrolled for 10 or 15 years, respectively. The program also provides the equivalent of a 90% cost-share for installation of the buffer and provides some money for annual maintenance. Other cost-share programs also provide some funding. For example, in Iowa these include the USDA Stewardship Incentive program administered by the Iowa DNR and the Riparian Forest Buffer Practice of REAP (Resource Enhancement and Protection Program) administered by Iowa Department of Agriculture and Land Stewardship (IDALS) - Division of Soil Conservation and Soil and Water Conservation Districts. In addition, some parts of the practice may be funded by the Wetlands Reserve Program and Environmental Quality Incentives Program. Non-government organizations such as Pheasant’s Forever and Trees Forever may provide additional assistance under specific situations.

Are there products that can be derived from buffers? *Yes.*

Numerous market and non-market products can be derived from buffers. Some market products include wood fiber and timber products, harvested native plant seeds, baled hay and fruits, berries and nuts from shrubs. Hunting and nature appreciation, improved water quality, carbon sequestering and aquatic habitat improvement are examples of non-market products.