Tailwater Ponds for Water Quality, Habitat and Farmland Benefits

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Background

Tailwater ponds, especially those of two stage design, are changing how row crop farmers manage runoff water in Yolo County. While ponds built over the last decade may not have shared the same objectives, their cumulative success demonstrates the excellent multi-purpose benefits from well designed tailwater ponds. Not only do ponds offer solutions to widely-recognized surface water quality problems, they provide valuable wildlife habitat and enhance ground water recharge.

Without intervention, irrigation water turns into unrestricted runoff, thus bringing about a series of problems. Irrigated row crop fields that drain to one or several main low spots often empty into an initial drainage system that then dumps into a main water conveyance channel (canal or slough). Silt-laden runoff results both from summer irrigation and, even more so, from winter storms. Runoff not only removes topsoil from farmland but deposits this resource downstream, at unwanted places throughout the watershed and beyond.

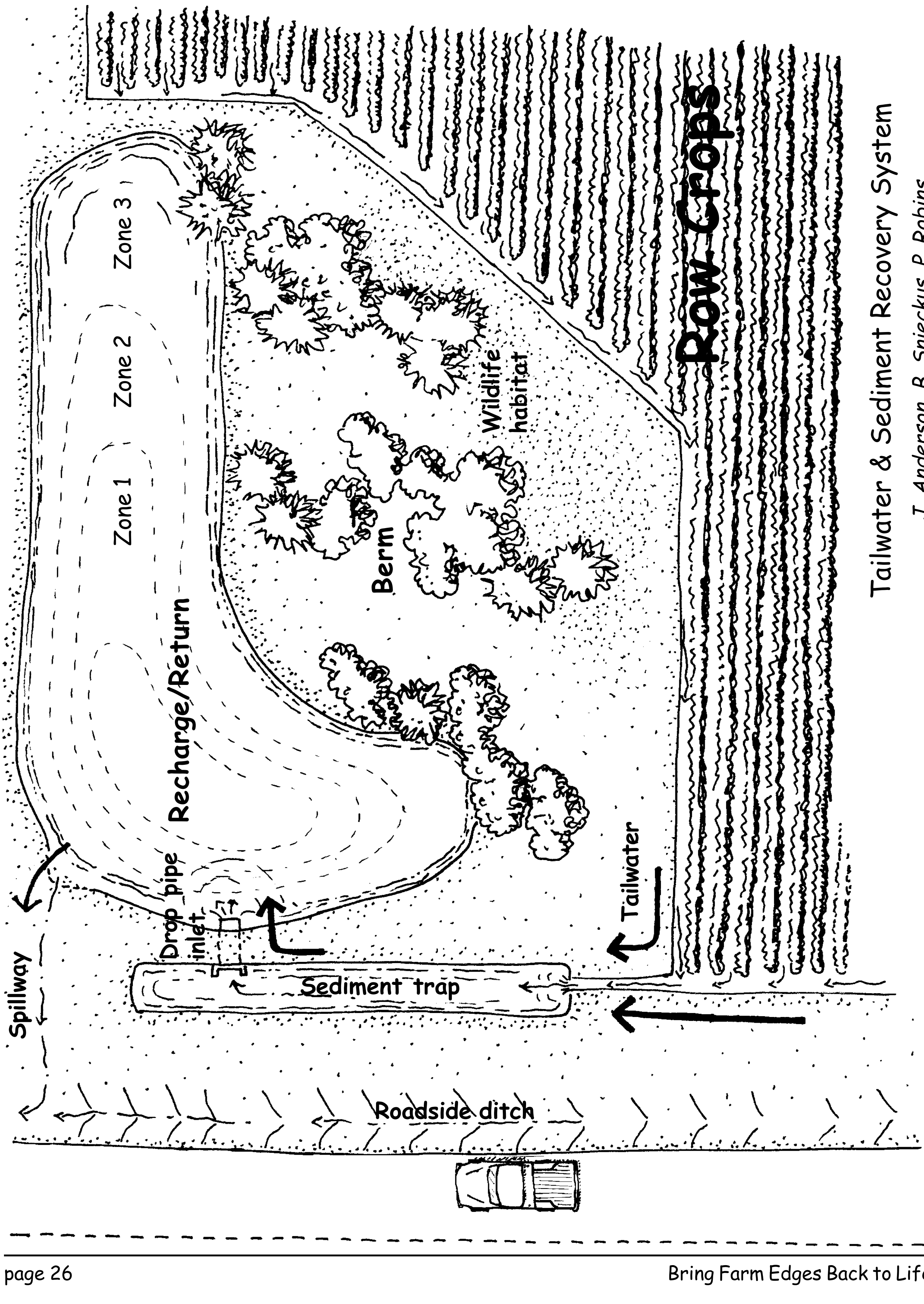
Ditch maintenance is perhaps the most visible impact of this sediment-laden run-off, but not the only one. First, public works crews must constantly remove silt from roadside ditches. Sloughs and canals also need periodic expensive excavation. Furthermore, water quality flowing into the Sacramento River, Delta, and Bay is seriously degraded, thus adding to non-point source pollution. A third result of unrestricted runoff is the loss of the water itself. For Yolo farmers, it makes much more sense to recapture this lost resource and re-use it or return it to our groundwater storage systems.

Design

A straightforward, cost-effective solution to all these widespread problems is the construction of a small double-pond system that catches and stores at least part of the runoff water. The double-pond design works efficiently by making the first, small pond work as a sediment trap, engineered for easy excavation of silt that is easily replaced on the field during fall groundwork. The second, larger pond serves many other purposes: water storage, ground water recharge, water return systems, and plant and wildlife habitat (see illustration).

The larger pond can be designed with a natural shape rather than the usual long, narrow trench of some return systems. The curved 'L' shape in the accompanying illustration is easy to construct with standard scrapers. A gradual 3:1 or 4:1 slope (meaning for every 3 or 4 feet of distance there is 1 foot of fall)- with a deep center portion is preferable. For stability purposes, no slopes should be steeper than 1:1. The pond should also not be less than 5 feet deep, to minimize the encroachment of unwanted weeds. As water percolates or evaporates, the pond surface simply decreases in circumference. Wildlife will continue to use it even when it turns into a puddle. The gradual slope also creates several moist soil planting zones for the establishment of wetland species that can compete against unwanted weeds.

The overall size of your pond could vary greatly, depending on whether it will be used to capture and hold tailwater for wildlife only or to also recirculate that water for irrigation. If you are planning a tailwater recirculating system (tailwater return system), pond and pump sizing will depend strongly on how you manage crop irrigations. Factors to consider in the design of the pond and the sizing of the pump and flashboard risers are the amount of irrigation water you will be running, (measured in cubic feet per second (cfs) or gal./min.), whether you will be running half or full sets, and the amount of runoff. For pond design purposes runoff is usually considered to be approximately 25% of the amount of water applied in a surface irrigation. Another important factor is whether you will be returning the water to the upper end of the same field or sending it downstream to another field. With such a variety of scenarios for recirculating systems, it is important to consult with someone that has experience in pond design, such as your local NRCS engineer or a private consultant.


Row Crops
Tailwater & Sediment Recovery System
J. Anderson, B. Snieckus, P. Robins
Zone 3
Zone 2
Zone 1
Wildlife habitat
Berm
Recharge/Return
Tailwater
Drop pipe inlet
Sediment trap
Spillway
Roadside ditch

If you plan to have your pond simply capture and retain irrigation runoff, sizing and design becomes simpler. The deciding factors may simply be how much space you have or how much land you are willing to take out of production. A common size would be a 1-acre area in a 100 acre field, usually in the lowest corner. Half of the 1-acre pond site would be occupied by the pond, and the other half by a landscaped mound created by excavation spoil. The mound provides structural diversity to the landscape which will in turn encourage the establishment of a wider variety of plants and animals. The mound also reduces the expense of moving the dirt during excavation. However, in order to maintain slope stability, any berms or mounds created from the pond spoils should not be closer than 12 feet from the pond edge. If you want to minimize the loss of farmable acres, the pond spoils could also be redistributed over the field.

Water control structures, such as drop pipes, flashboard risers, or weir boxes, are important for controlling water movement and water levels in the sediment trap and pond. A flashboard riser, for example, should be used as the entry point from the sediment trap to the pond and should also be used at the pond outlet. The pipe barrel should not be less than 12 inches in diameter to reduce clogging from debris. The riser, or upright part of the structure, is always larger (approx. 1.5 x barrel diameter) and is based on the maximum water expected to come through the structure during a given storm or irrigation event. Riser heights are standard at three or four feet and up, but it should always be high enough to see in order to avoid equipment damage. A steel stake can be a good marker.

Vegetation

The plant species incorporated into a tailwater pond system influence its functional and biological value. A pond initially established with the right plant materials becomes a self-sustaining, weed-free system. The planting areas within a system include the deep water that rarely goes dry (zone 1), a moist soil area that is intermittently under water (zones 2 and 3), edges adjacent to the high water level, and dryland areas with or without mounds. Dryland areas with mounds have slope and exposure zones. The three zones in the moist soil area will vary considerably depending on permeability of the soil and how often the pond is filled during the irrigation season. The accompanying plant list names some of the species that can be established and managed.

Water Quality and Storage Benefits

The degree of ground water recharge in these systems will vary according to soil permeability. One pond alone is probably not significant, but one pond for every hundred acres increases recharge range. Out of the volume of water that a single small pond holds, perhaps half of this water may return to the ground every time the pond is filled either from winter storms or irrigation. If this happened six times in a season and there were ten 1 acre-foot ponds on 1000 acres, 30 acre feet of water would recharge into the ground.

By acting as biological filters, as vegetation absorbs excess chemical nutrients, ponds help improve water quality. This has become a high priority mandate for the ’90s. Agricultural practices have been identified by the EPA as a leading cause of poor water quality in the Sacramento-San Joaquin River systems. In short, the installation of tailwater ponds has excellent potential to improve the quality of ag water runoff while at the same time enhancing wildlife and recharging ground water.

The Yolo County RCD promotes this land stewardship practice and we encourage farmers and land owners to consider installation of these valuable systems. Cost-sharing is available through Natural Resources Conservation Service (NRCS) conservation programs. Technical assistance is also available through the NRCS office.

Suggested Plant Materials for Tailwater Ponds

Moist Soil Vegetation Zone 1 and 2

Spikerush (*Eleocharis macrostachya*)
Sedges (*Cyperus* species)
Rushes (*Scirpus americanus, Juncus effusus and J. balticus*)

(Establishing short-statured rushes and sedges will keep out unwanted species such as cattails and bulrushes which will dominate a small wetland if allowed to proliferate.)

Moist Soil Vegetation Zone 3

Species listed in Zones 1 and 2
White-root sedge (*Carex barbarae*)
Clustered field sedge (*C. praegracilis)*
Meadow barley (*Hordeum brachyantherum*)
Hairgrass (*Deschampsia caespitosa*)
Bentgrass (*Agrostis exarata*)

Pond Edge

Meadow barley
Bentgrass (*Agrostis exerata*)
Hairgrass
Slender wheatgrass (*Elymus trachycaulus majus*)
Creeping wildrye (*Leymus triticoides*)
Clustered field sedge
White-root Sedge

Dryland Native Grass Mixture

Blue wildrye (*Elymus glaucus*)
Purple needlegrass (*Nassella pulchra*)
Oniongrass (*Melica californica*)
Pine bluegrass (*Poa secunda*)

Trees

Willows (*Salix* spp.)
Valley Oak (*Quercus lobata*)
Sycamore (*Platanus racemosa*)
Black Walnut (*Juglans californica* var. *hindsii*)
Cottonwood (*Populus fremontii*)
Interior Live Oak (*Quercus wislizenii*)
Buckeye *(Aesculus californica*)

Shrubs

Button Willow (*Cephalanthus occidentalis)*
Coyote Brush (*Baccharis pilularis*)
Wild Rose (*Rosa californica*)
California Lilac (*Ceanothus* spp.)
Mulefat (*Baccharis viminea*)
Elderberry (*Sambucus mexicana*)
Toyon (*Heteromeles arbutifolia*)
Redbud (*Cercis occidentalis*)

Note: The grass, tree, and shrub species listed are all commercially available. Many of the wetland sedges and rushes are also commercially available but can be otherwise obtained by transplanting from natural stands. Vendors are listed at the end of this book as potential commercial sources.

Tailwater Pond Installation and Maintenance Costs (1999)

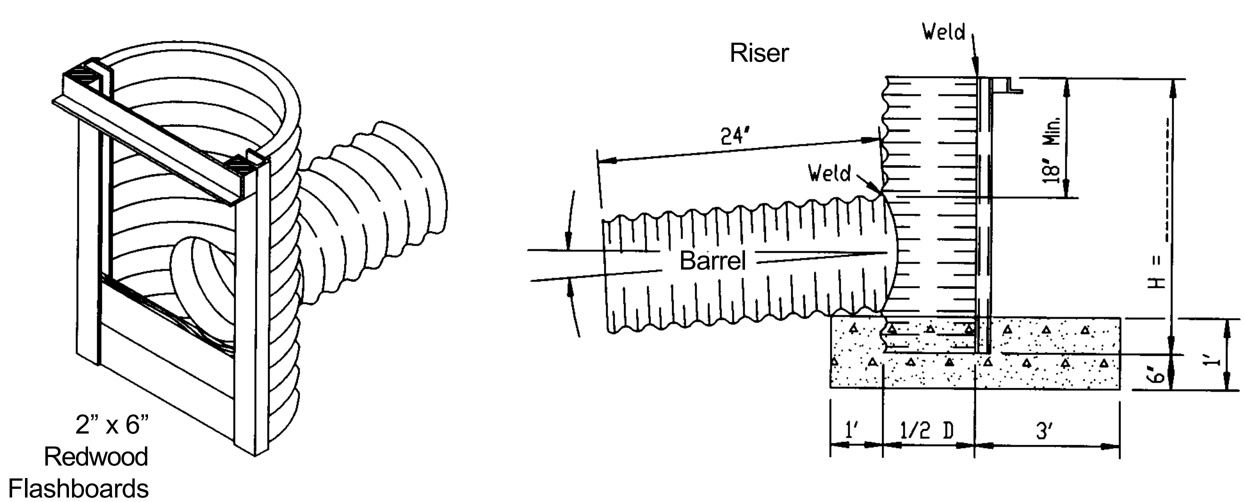
with return system and banks vegetated for wildlife benefit

Task	Cost/Unit in $ Low	Cost/Unit in $ High	Units Low	Units High	Total Cost in $ Low	Total Cost in $ High
Pond						
Planning/Engineering	50.00	50.00	10	10 hours	500.00	500.00
Pond Excavation & pipe install[1]	1.15	1.40	2500	7500 cu. yds.	2,875.00	10,500.00
Flashboard riser[2]	175.00	525.00	1	1 each	175.00	525.00
Pipe/Barrel extension[3]	9.00	15.00	20	100 feet	180.00	1,500.00
subtotal pond construction cost					*3,730.00*	*11,525.00*
Return System						
Lay pipe		2.00	1800	1800 feet	3,600.00	3,600.00
Return pipe materials[4]	1.25	1.35	1800	1800 feet	2,250.00	2,430.00
Pump installed[5]	4,000.00	10,000.00	1	1 each	4,000.00	10,000.00
subtotal return system construction					*9,850.00*	*16,030.00*
Vegetation Management						
Planning & design	50.00	50.00	2	6 hour	100.00	300.00
Bed preparation	50.00	50.00	1	2 hour	50.00	100.00
First weeds spray[6]	25.00	25.00	1	1 hour	25.00	25.00
Herbicide material	60.00	60.00	0.125	0.25 gallons	7.50	15.00
Seeding/incorporation	25.00	25.00	1	3 hours	25.00	75.00
Seed (20-30 #/ac. for 0.25 ac.)[7]	10.00	30.00	5	7.5 pounds	50.00	225.00
Winter weed mgmt.(spot spray)	10.00	10.00	1	2 hour	10.00	20.00
Broadleaf herbicide	22.00	22.00	0.125	0.25 gallons	2.75	5.50
Spring weed mgmt.(spot spray)	10.00	10.00	1	2 hour	10.00	20.00
Broadleaf herbicide	22.00	22.00	0.125	0.25 gallons	2.75	5.50
Mowing	40.00	40.00	1	2 hour	40.00	80.00
Spot weeding (hand crew)	10.00	10.00	15	35 hours	150.00	350.00
Irrigation Set-up (drip system)						
Small pump (for multiple sites)	300.00	800.00	1	1 each	300.00	800.00
Irrigation supplies	150.00	150.00	1	1 each	150.00	150.00
Installation labor	10.00	10.00	5	15 hours	50.00	150.00
Irrigation labor	10.00	10.00	5	20 hours	50.00	200.00
Additional plantings:						
Plants (Trees & shrubs)	1.50	2.50	25	50 starts	37.50	125.00
Waterline plants (rushes/sedges)	0.20	0.40	100	300 plugs	20.00	120.00
Labor	10.00	10.00	4	8 hours	40.00	80.00
subtotal vegetation cost					*1,120.50*	*2,846.00*
Total Installation Cost					**$14,700.50**	**$30,401.00**

Annual Management (First 3 years)						
2nd Fall pre-emergent[8]	0	75.00	0	1 treatment		75.00
Application labor	10.00	10.00	0	2 hours		20.00
Winter spot spraying	10.00	10.00	2	4 hours	20.00	40.00
Material	22.00	90.00	0.125	0.25 gallon	2.75	22.50
Spring mowing	40.00	40.00	1	2 hour	40.00	80.00
Irrigation for trees and shrubs (6x)	10.00	10.00	4	8 hours	40.00	80.00
Dredging of pond or sed. ditch	50.00	50.00	2	6 hours	100.00	300.00
Initial Annual Maintenance Costs					*202.75*	*617.50*
Perpetual Maintenance Costs (Beyond 3 years)						
Winter spot spraying[9]	10.00	10.00	0	4 hours		40.00
Material	22.00	90.00	0.125	0.25 gallon	2.75	22.50
Spring mowing	40.00	40.00	1	2 hour	40.00	80.00
Dredging pond or sed. ditch[10]	50.00	50.00	2	6 hours	100.00	300.00
T*otal Perpetual Annual Maintenance Costs*					*142.75*	*442.50*
Annual Cost of Project Averaged Over Ten Years					**$1,630.80**	**$ 3,535.10**
Annual savings on irrigation water with return system (for 100ac. tomatoes w/water cost of $15/ac.ft.):						**$2,000.00**

(*See endnotes on following page*)

Sample Drop Pipe Isometric & Elevation



Endnotes:

[1]This includes cutting the trench and setting in a flash board riser inlet. Cost per cubic yard of soil moved varies depending on the equipment required. A belly scraper type excavator and bulldozer may cost around $1.10 per cubic yard, while a bucket excavator is in the range of $1.40 per yard. A bucket excavator would be necessary in locations with shallow ground water. Often, as much as can be dug with bulldozer and scraper will be done until a bucket excavator is needed. This helps to reduce project cost/time.

[2]The size of the flash board riser depends on the peak flow anticipated through the pond. Your local NRCS field office can assist you in determining this. Risers are available in plastic and corrugated metal pipe (CMP). In corrosive soils, the NRCS requires (for cost share assistance) dipping CMP pipes and risers in hot asphalt, which adds about 25% to the item cost. Costs in this row reflect the range associated with item size and composition.

[3]This cost range reflects between 15" CMP (not dipped) and 18" CMP dipped in hot asphalt. Length of pipe depends on pond design.

[4]This estimate is for 8" or 10" PVC low-head pipe run underground to the top of a field with a 1/4 mile run. In a flat enough field, water could be returned to the head with a reverse ditch, but it moves slowly and will seep a lot of water unless it is lined. It also requires periodic cleaning and recutting.

[5]The range of installed pump costs is that between a 5 Hp submersible electric capable of 520 gpm with 20' of lift and a diesel motor, pump and suction line. The latter is much more costly, but it can be used at multiple sites.

[6]Mechanical means of weed control can substitute for the chemical means in this example. To minimize post-project weed pressure, the project site should be kept clean of weeds for at least one season before breaking ground. After the pond is built and ground prepared, it is best to let fall rains bring up the first weeds, kill them, and then plant.

[7]Prices for native grass seed vary greatly between species, from $5 to $50 per pound. The appropriate mix for a site dependends on pond design, soil, and climatic conditions. Broadcast seeding rates can also be varied, depending on the project goals, but under 20 pounds per acre is not recommended.

[8]If annual weed pressure is tremendous, application of a preemergence herbicide can offer relief to a young native grass stand. However, the herbicide will also suppress any germination of native grass seed produced in the first year.

[9]Spot treatment of weeds is necessary in order to suppress undesirable broadleaf and grass weeds. This example gives a range of costs from a common broadleaf herbicide to that of a glyphosate/oxyflourfen mix. Spot treatment can also be accomplished manually and/or mechanically, although at a greater labor expense.

[10]If a sediment ditch is successful in catching sediment, it must be dredged out periodically. Depending on the site, this could be multiple times per season or only once every year or two. This is typically accomplished with a bucket excavator to dig out the ditch and a scraper to pick up and distribute the soil once it has dried. A tailwater pond without a sediment ditch will require similar maintenance in order to remain functional. Because this poses a conflict with wildlife habitat goals for a pond, the RCD strongly recommends the two-pond system of a sediment trap and pond.