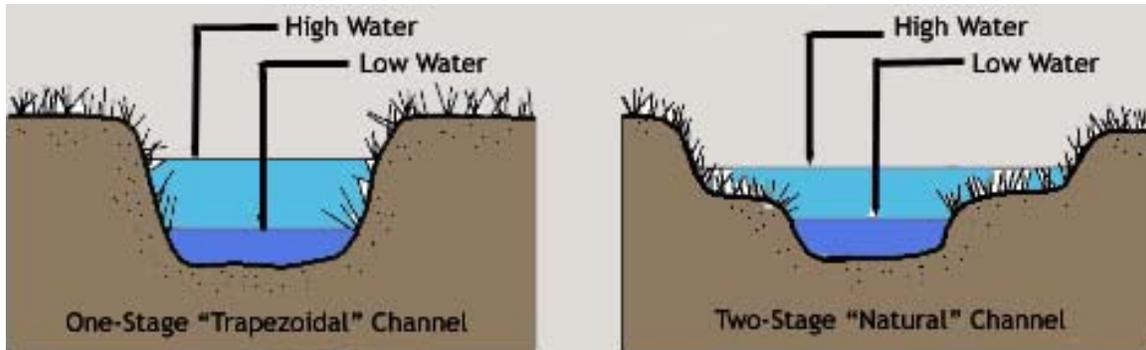


2 Stage Ditch Design

Definition

A two-stage ditch consists of a natural base flow channel with floodplain “benches” which are adjacent to the base flow channel within a drainage ditch.



Purpose

This practice can be applied as a management system for one or more of these purposes:

- Provide a larger water holding capacity at high flows which can reduce downstream flooding while providing drainage
- Promote fine sediment deposition on the bench areas during high flows, which will improve habitat for aquatic communities and reduce instream sediment loads
- Increase vegetative uptake of nutrients (e.g. by grasses) which buffers downstream nutrient export
- Reduce bank erosion and failure, which can decrease the frequency of ditch maintenance activities especially in combination with bench sediment deposition
- Increase the surface area where denitrification can occur, which increases permanent removal of nitrogen to the atmosphere, thus reducing downstream nitrogen export and eutrophication

Conditions where the Practice Applies

This practice applies if the following conditions exist:

1. Headwater streams in manipulated ditches
2. Bank slumping
3. High nutrient concentrations and export
4. High sedimentation loading and export in the ditch
5. High frequency of ditch maintenance (e.g. bottom dipping)

Basic Design Features

- Benches meet the minimum of 2X the width of the inset channel (current water width)
- One-sided bench construction also follows the 2X channel width criteria.
- Side slopes will vary and depend on the current slope and soil type.
- Design side slopes to be stable, for most designs a 2:1 will be appropriate.
- Bench height will depend on the ditch's drainage area and flashiness, and will be determined by using a regional runoff curve that is calculated for the area.

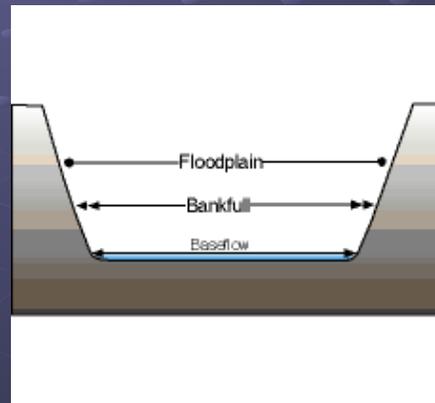
Answers to the question?

● Conventional Ditch

- $Q = A * v$, where $A =$
 ft^2 and $v = \text{ft/s}$

A is 175 ft^2 , v is 0.35 ft/s

$Q = 61.25 \text{ ft}^3/\text{s}$



Answers to the question

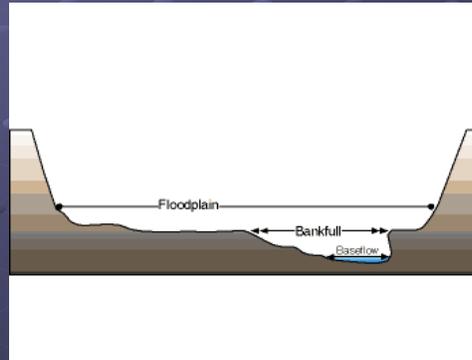
● 2-Stage Ditch

- $Q = A * v$, where $A = \text{ft}^2$
and $v = \text{ft/s}$

A is 266 ft^2 (65% increase)
 v is 0.25 ft/s (30% decrease)

$Q = 66.5 \text{ ft}^3/\text{s}$

This demonstrates that the 2-stage is more appropriately designed to handle high flows than a conventional ditch.



Outlet concerns and erosion control specific to the Tippecanoe River 2 Stage Ditch Project.

An insight into possible erosion control measure that can be used

Each tile outlet will be repaired and will outlet onto the newly formed benches. These areas will have a rip rapped pad that the tile water will drop onto as a preventative measure for any erosion that could potentially take place on the benches.

4' geo jute, or other erosion control blanket, will be applied to the entire stretch and will be placed on the lower 4' of the side slope toe to ensure maximum stability

Straw blanket or blown straw to be placed on exposed soil areas to minimize impacts from precipitation hitting the bare soil, and help to encourage vegetation to grow.

Vegetation

Native vegetation to be planted on bench areas, side slopes, and any other disturbed surfaces. Disturbed areas should be re-vegetated as soon as is reasonable post-construction to decrease erosion and protect the integrity of the constructed areas.

Planting rate and species:

Seeding rates are based on 10 pounds per acre mix.

Example seeding mix – this is the mix we used on the Tippecanoe 2 Stage Ditch

Site	Species	Common Name	Lbs. actual
upland	Schizachyrium scoparium	LITTLE BLUESTEM GRASS	9
upland	Elymus canadensis	CANADA WILD RYE	20
upland	Rudbeckia hirta	BLACK-EYED SUSAN	0.2
upland	Petalostemum purpureum	PURPLE PRAIRIE CLOVER	1.6
upland	Solidago rigida	STIFF GOLDENROD	0.6

	Species		lbs
bench	Carex frankii	BRISTLY CATTAIL SEDGE	3
bench	Carex lurida	BOTTLEBRUSH SEDGE	2.5
bench	Carex trichocarpa	HAIRY-FRUITED LAKE SEDGE	2.3
bench	Juncus effusus	COMMON RUSH	0.05
bench	Eupatorium perfoliatum	COMMON BONESET	1

Seed amount based on 2 acres of upland and 2 acres of bench area.

Other Site Considerations

- Consideration should be paid to the depth and width of the existing ditch channel during site selection process to minimize the amount of soil that must be moved to create the floodplain “benches”. This amount of removal will be critical for bidding out the excavation work.
- Make plans for the excavated bench soil, such as spreading in adjacent fields or trucked off site.
- Identify potential adjacent wetlands to ensure that there is no impact, secure appropriate permits to perform the work.
- Obtain appropriate native seeding mixes to meet the site condition (i.e. a wet mix should be used on the bench areas and dry seed mixes can be used on the adjacent uplands and side slope areas as appropriate).
- Existing site vegetation in the buffer zone of the ditch should also be considered when selecting a site, as it is not as advantageous to remove a higher quality forested buffer to create a 2-stage ditch.