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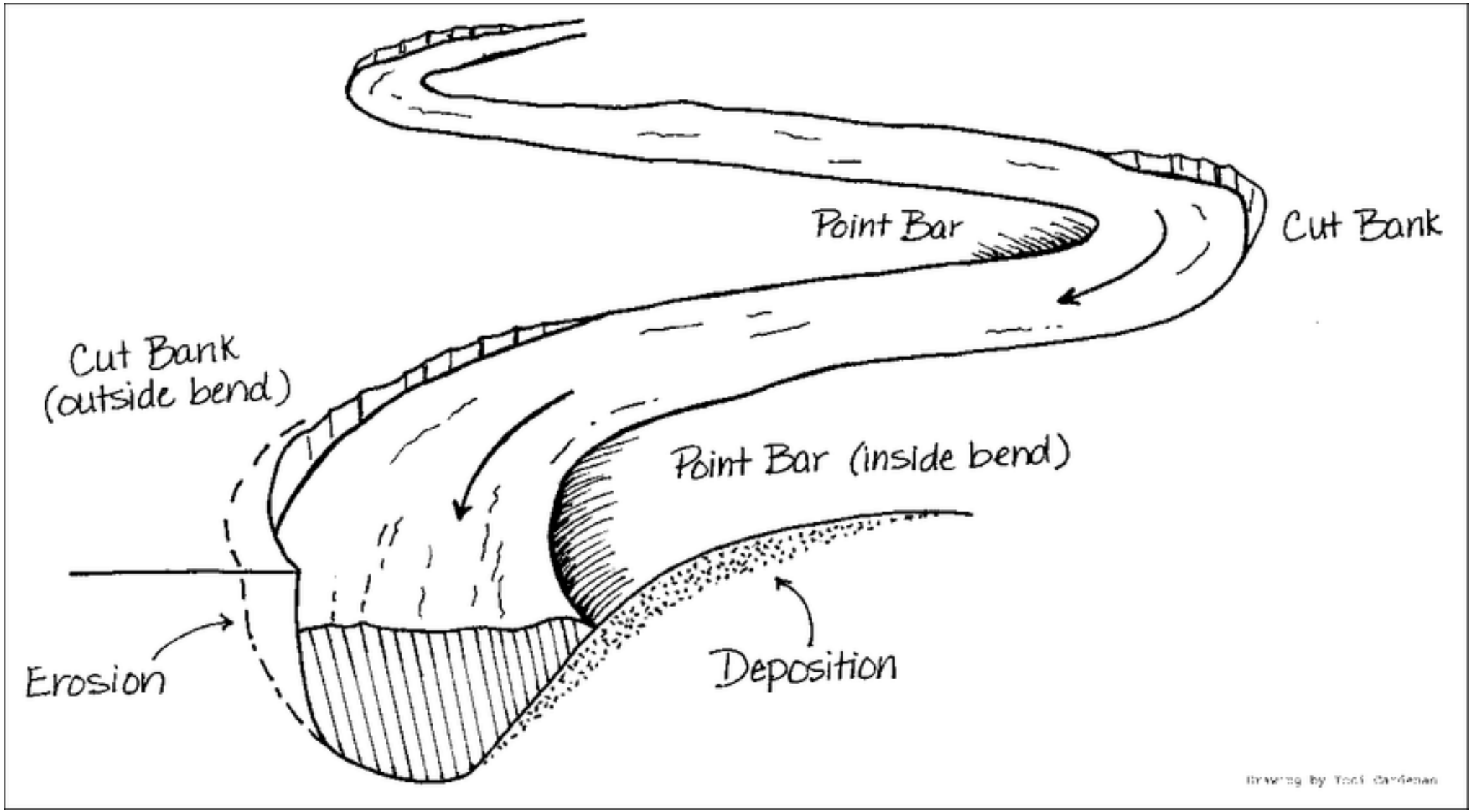
PRP STREAM BANK RESTORATION

WHAT YOU NEED TO KNOW

JOHNNA ZONA

Streams

- Streams form a continuous system of pools, riffles, bars and curves to absorb the energy of the flow
- They are rarely perfectly straight. Water naturally meanders from one side of a channel to the other, and soil, sand and gravel are washed away from the areas where the current is fastest and deposited where the water moves more slowly
- Adjustments a stream makes creates a balance between the amount of water flowing in the channel, the amount of sediment it is transporting through the channel, and the changing slope and size of the channel

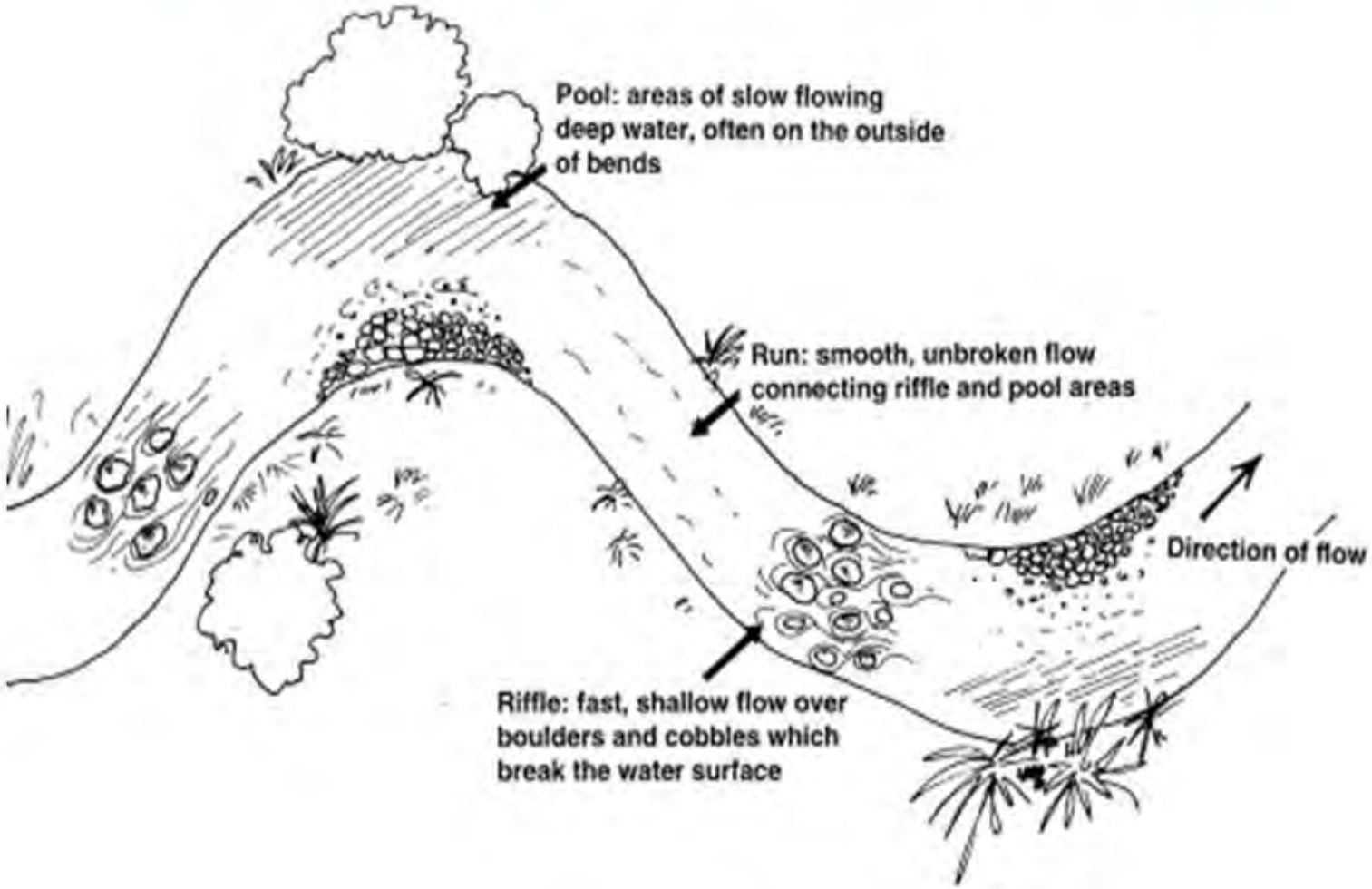


https://www.youtube.com/watch?v=HDjcT8-xsXk

Fish and Wildlife Habitat Values of Streams

- A healthy aquatic population in a stream depends on a variety of suitable habitats, adequate food supply and clean water
- Fish and organism need a mixture of habitats such as fast flowing riffles, deep pools and cool water, rocks, snags and overhanging vegetation
- Streamside vegetation is important as it provides a food supply, shade to cool the water and cover for roosting, resting/nesting and protection

Different Velocity/Depth Regimes
= Different Stream Habitats



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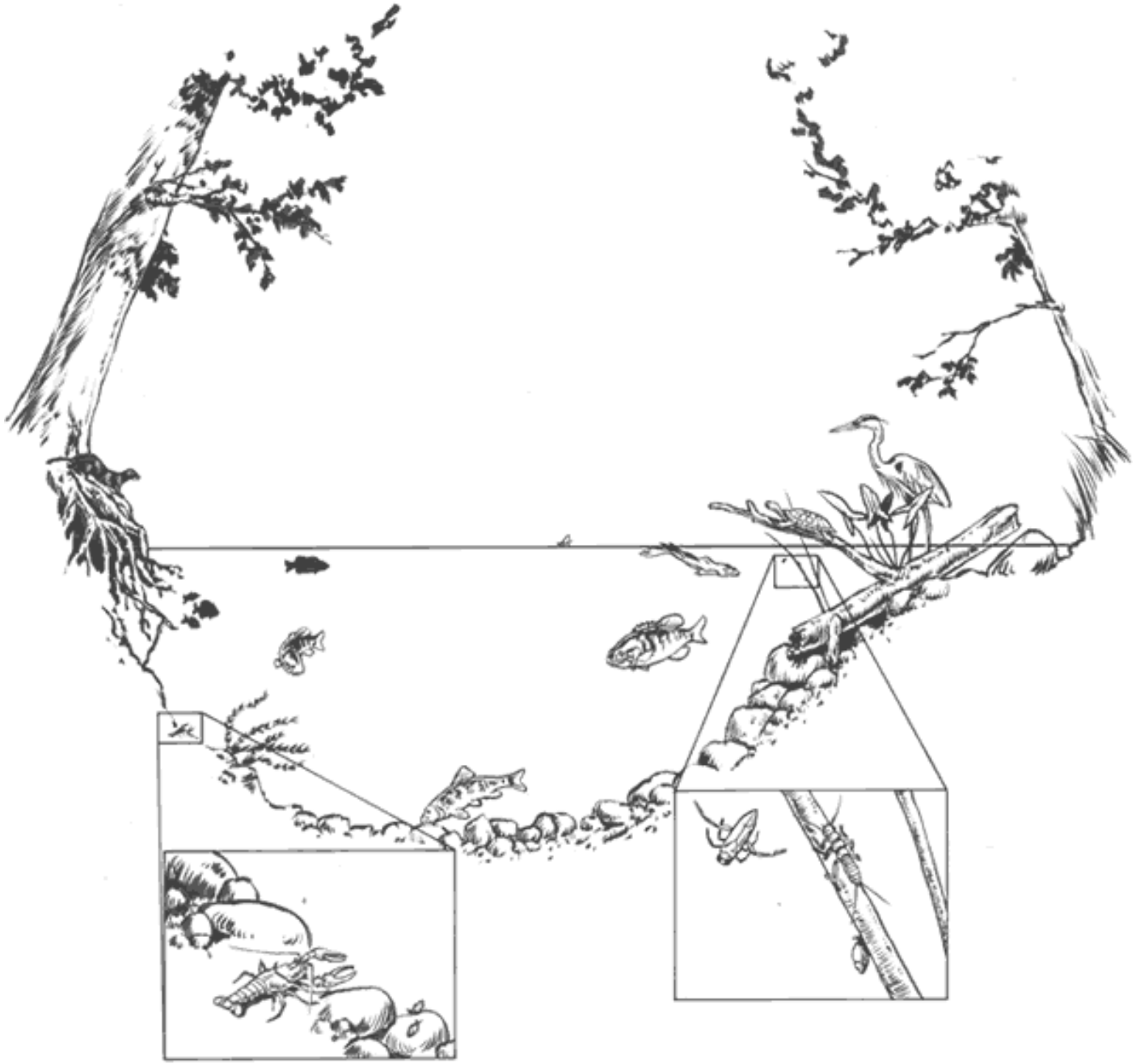

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Stream Blockages

- Debris jams, log, tires, construction materials and things like shopping carts can cause streambank erosion by deflecting flows off of banks.
- Municipalities and homeowners can help remove the obstructions and reduce potential bank erosion problems and increase the capacity of the stream channel to carry flows without over topping

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Stream Blockages

- Removal of debris from a channel should be done without altering the stream or banks, including vegetation.
- If it can be removed from the side by "picking" it out without entering the stream, a permit is not required.
  - Also applies to debris that has accumulated in and around a structure (bridge, culvert)
  - 50 feet upstream and 50 feet downstream of a structure. Gravel and flood debris may be removed from around structures according to your permit

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Why Cant We Dredge?

https://www.youtube.com/watch?v=OAZ_BuyM41s

Why Are Restoration Projects Needed?

- Streambank erosion is a natural process but land use changes and/or natural disturbances can alter the frequency and magnitude of water forces.
- Loss of streamside vegetation can also reduce resisting forces, making the streambanks more susceptible to erosion.
- Channel realignment can increase stream power and cause the banks to erode.

Why Are Restoration Projects Needed?

- Major impacts include
  - Increased sediment and turbidity
  - Destroys stream habitat
  - Damages property and structures

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Pollution Reduction Plans

- DEP prepared MS4 Requirements Table for impaired watersheds
- Calculate existing sediment loading for your impaired areas
- 10% sediment reduction, 5% nutrients
- Previously installed BMPs can not be counted as credit but if functioning properly and being maintained, you can claim credit in the form of reduced exiting loading
- BMP effectiveness values contained within DEP's BMP Effectiveness Values document

Pollution Reduction Plans

- For stream restoration, the effectiveness values contained the Expert Panel Report is what is to be used.
- DEP provided simplified method which was calculated using Chesapeake Bay loading rates
- Must identify responsible parties for Operation and Maintenance of BMPs and a monitoring schedule
  - Identify the activities in the Annual MS4 Report

Pollution Reduction Plans

- Projects that are NOT eligible for crediting regarding
  - Riparian fencing projects to keep livestock out of streams
  - Projects that seek to restore streams damaged by Acid Mine Drainage
  - Enhancement projects where the stream is in fair to good condition, but habitat features are added to increase fish population
  - Outfall stabilization projects

Pollution Reduction Plans

- Under PAG-13 General Permit, the permittee must achieve the required pollutant load reductions within 5 years following DEP's approval of coverage under the GP, and must submit a report demonstrating compliance with the minimum pollutant load reductions as an attachment to the first Annual MS4 Status Report that is due following the completion of the 5th year of GP coverage.

Site of Stream Restoration Project

> Must document existing streambank erosion prior to restoration

> Performed on 1st-3rd order streams

> 100 linear feet of channel must be addressed as well as both sides of stream.

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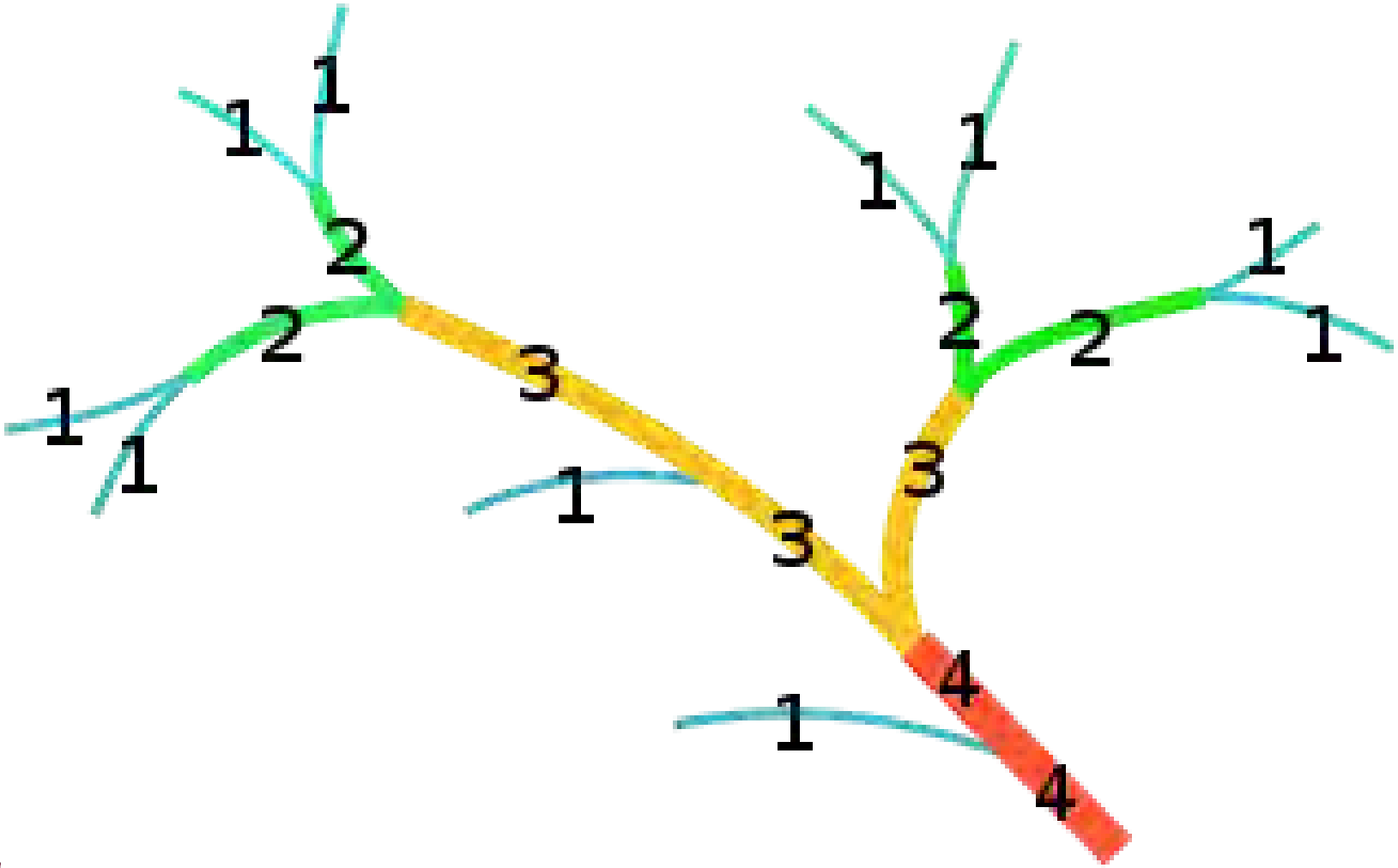
Site of Stream Restoration Project



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Site of Stream Restoration Project

- Can use a mixture of techniques appropriate to the site
- Armoring can be used, but will not be "counted" in the load reduction calculations
- Projects should maximize floodplain reconnection
- Permanent 35' minimum riparian buffer

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Technique

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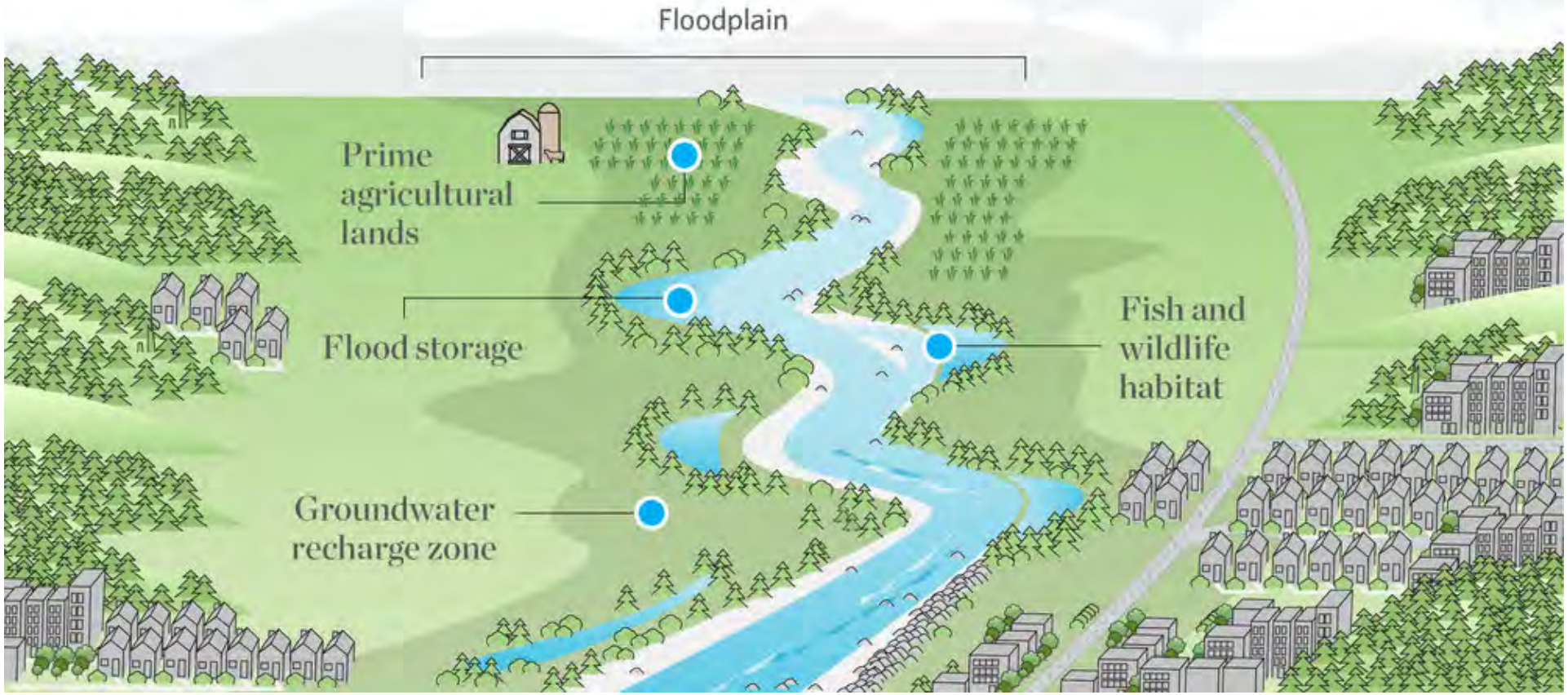
A floodplain is an area of flat, low-lying land near rivers or coasts that has the potential to flood due to rain, tidal surges or other storm events.

When a river has room to roam within its floodplain it provides multiple benefits, making communities safer from flooding and helping both people and nature thrive.



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Floodplains

Area of land on either side of a stream or river that will experience occasional flooding. It holds excess water allowing it to be slowly released into the river system and/or infiltrate into the ground.

Flood plains support wildlife habitats and give time for sediment to settle out of floodwaters.

First Steps – Goals and Objectives

- Meeting requirement for MS4 PRP
- 10% sediment reduction
- Provide habitat enhancement for native species
- Prevent streambank erosion
- Protect property and infrastructure
- Restore hydrologic function
- Improve water quality

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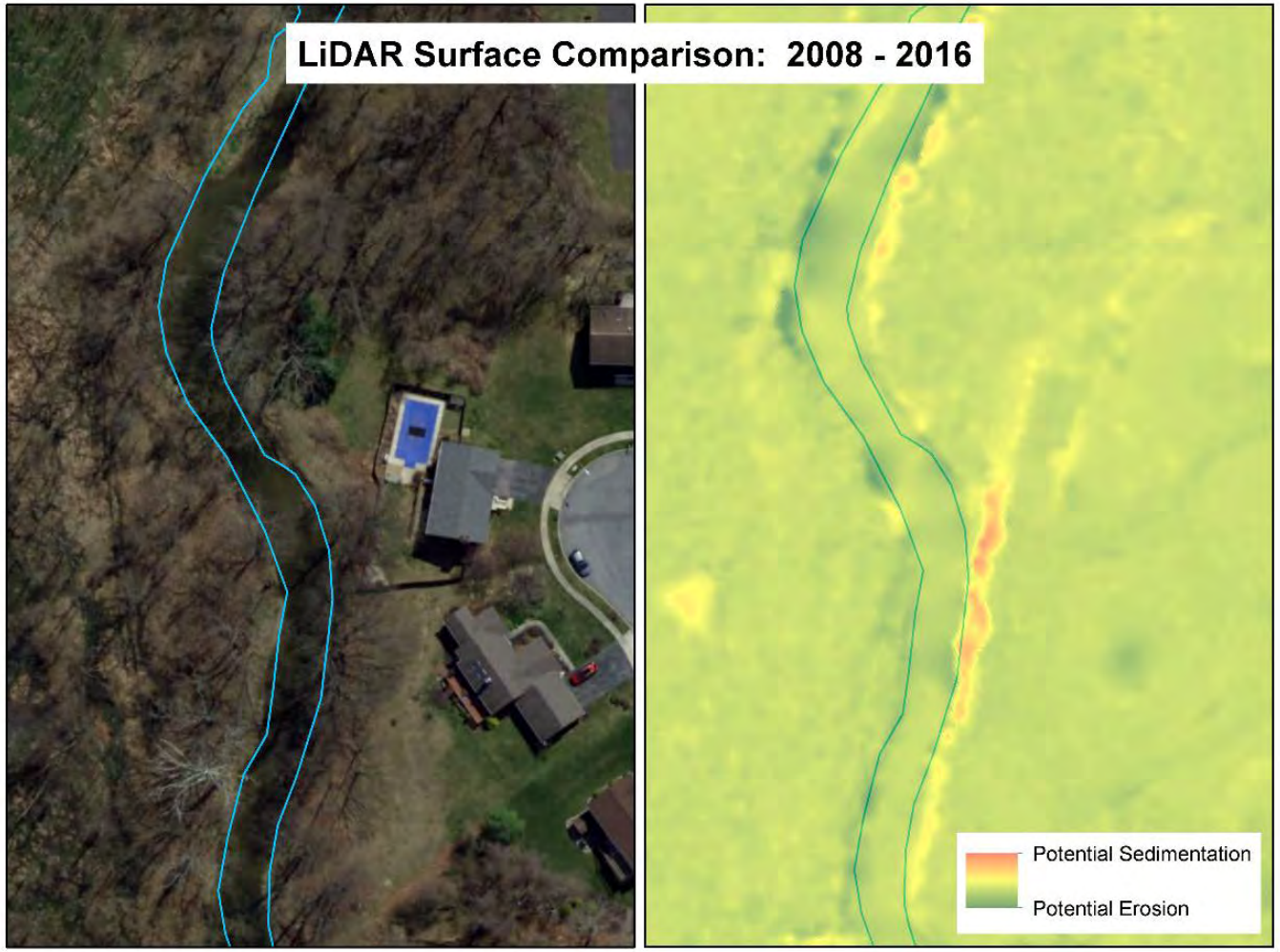
First Steps – GIS Data Gathering

- Can analyze stream system
- Show stream characteristics during rain events using elevation data
- Can store information such as stream flow, water diversion and water quality data, biological inventories, aerial imagery and elevation data



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First Steps – Historical Information

- Climate records
- Land uses records and historic maps
- Historic aerial imaging
- How the stream has changed over time
  - Channel modification
  - Soil and vegetation patterns
  - Infrastructure removal/addition

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First Steps – Preliminary Field Assessment

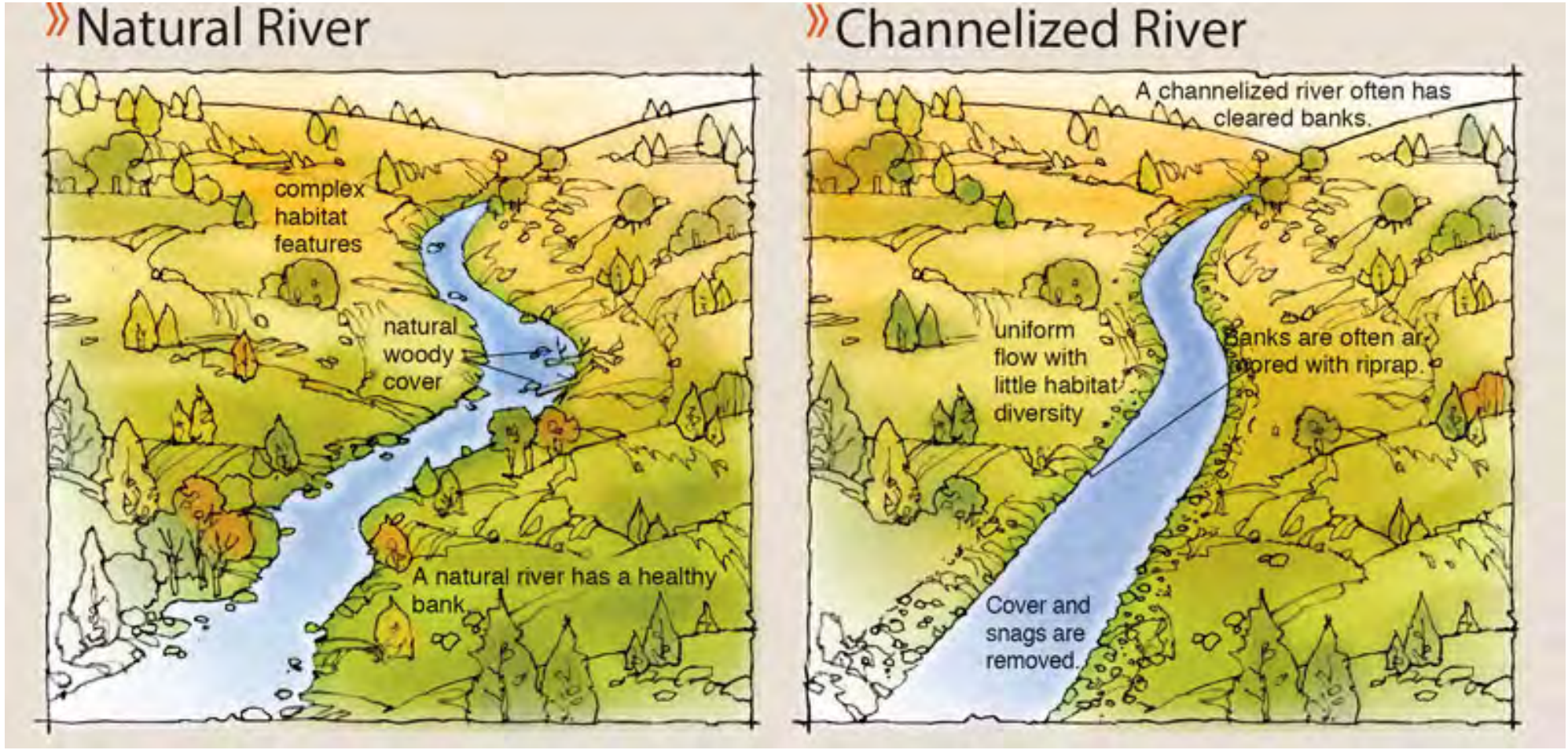
- Consultants with experience can analyze the system independent of bias and can use expertise to understand the system to make an appropriate solution

- Impairments that are considered:

First Steps – Preliminary Field Assessment

- Excessive bank erosion

First Steps – Preliminary Field Assessment



➢Channel straightening and incision

First Steps – Preliminary Field Assessment

- Water quality impairments
  - Mining
  - Agricultural

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First Steps – Preliminary Field Assessment

- Lack of deep pools
- Insufficient riparian vegetation
- No cover or shading
- Excessive fine sediment

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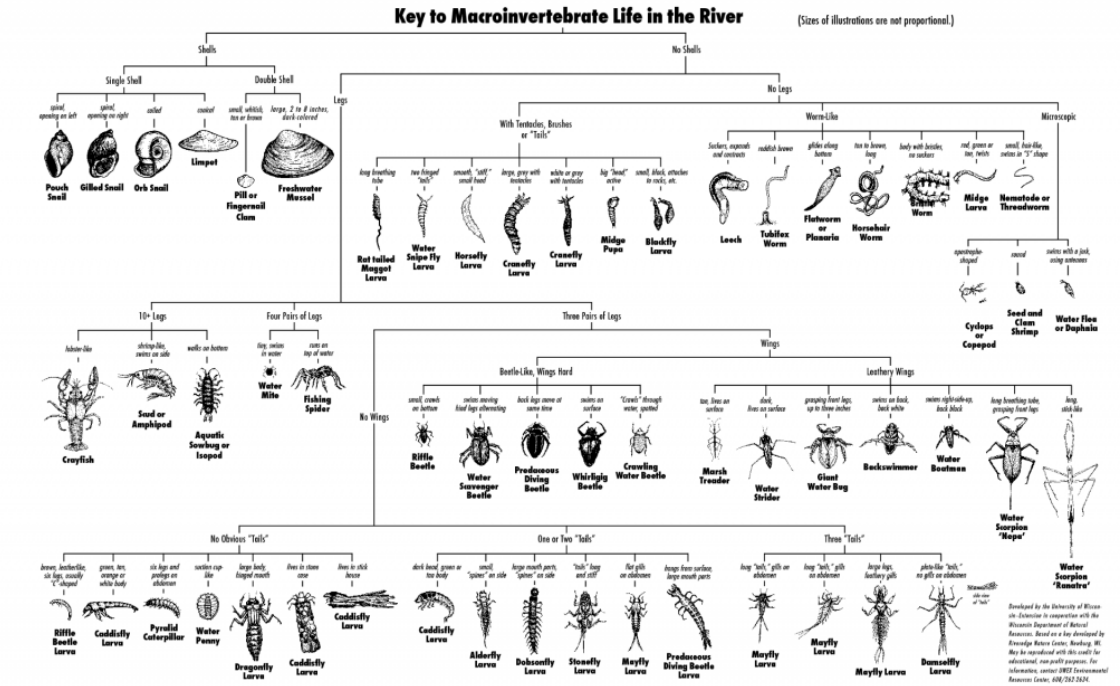
Field Data Collection

- Aquatic Organisms
  - Habitat improvement for aquatic organisms is a measureable goal for stream restoration projects
  - Sampling macroinvertebrates can be a valuable took for assessing status of your stream



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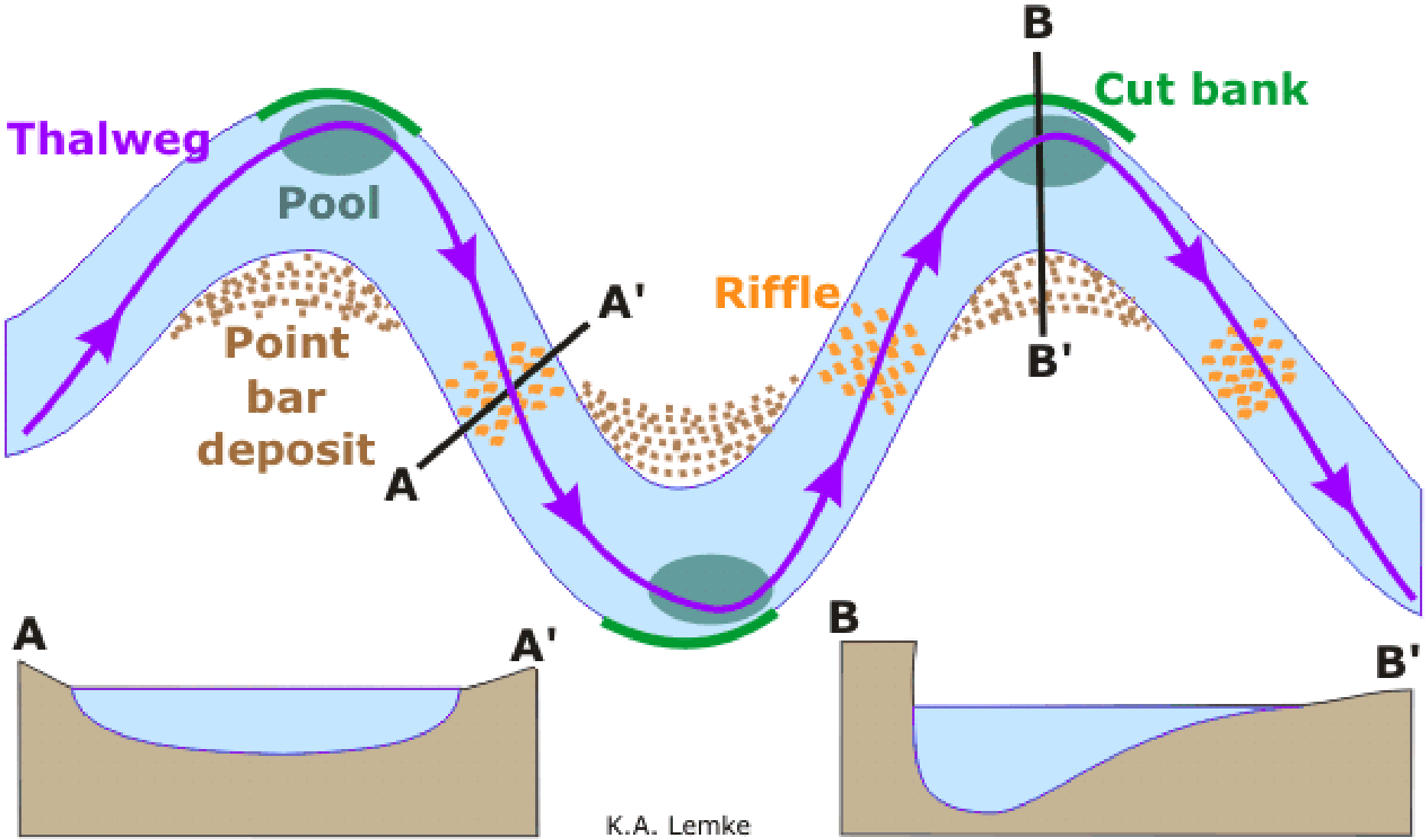
Field Data Collection

- Topographic Survey Data
  - Survey grade GPS collects accurate data points that can then be uploaded into the GIS system to create accurate descriptions of landforms.
  - Can be placed into CADD and utilized for construction layouts.
  - Limited capabilities in areas of heavy vegetation canopy
  - Minimum collection points should include the thalweg, bankfull longitudinal profiles and cross sections

Field Data Collection



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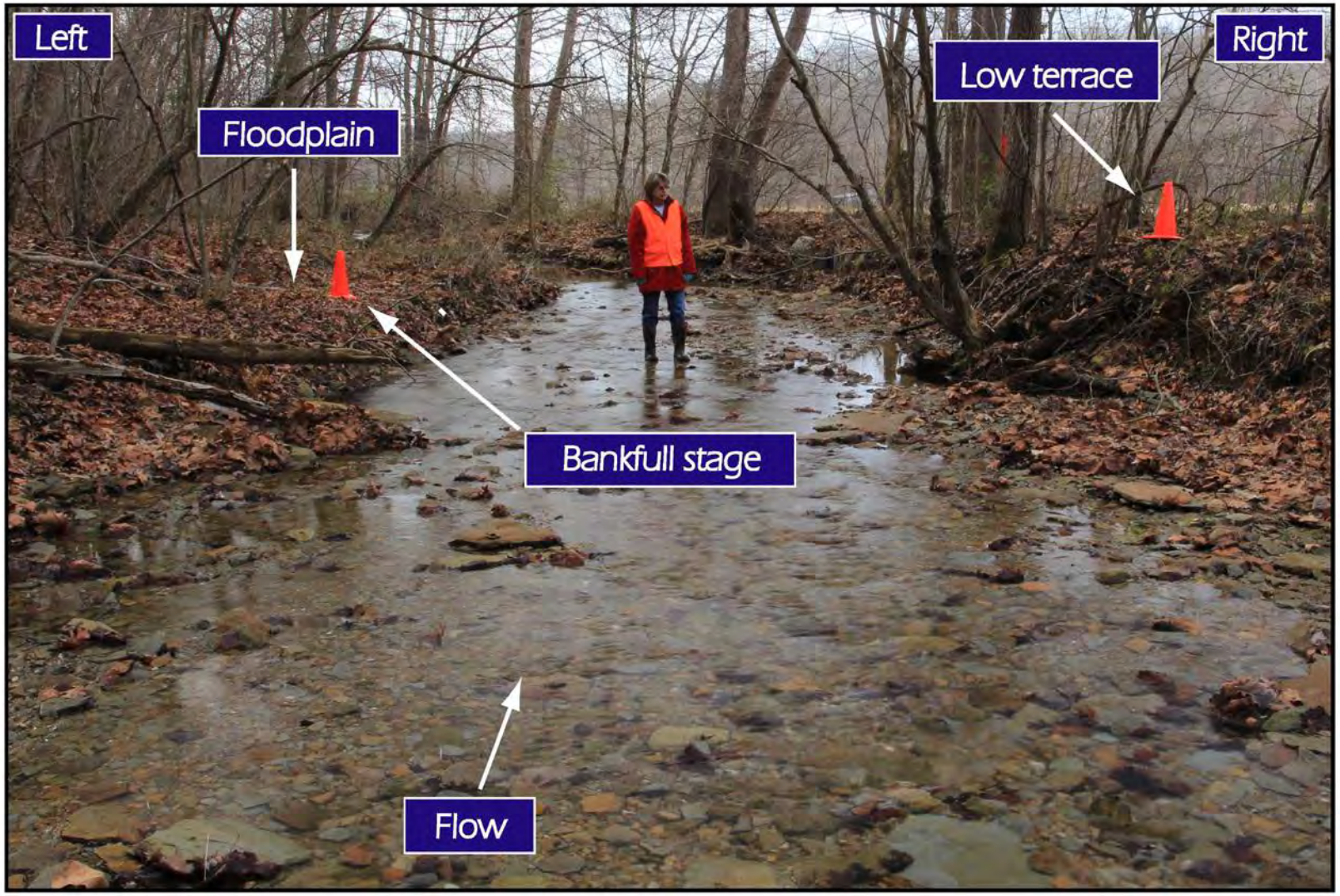
Field Data Collection

- Bankfull Stage Identification
  - The water level, or stage, at which a stream is at the top of its banks and any further rise would result in water moving into the floodplain.



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Field Data Collection

- Water Quality Sampling
- Bed Material Sampling
- Sediment Transport Measurements

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How Are We Going To "Fix" The Stream?

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3 Steps: Streambank Restoration

- Reshaping the floodplain
- Building in-stream structures
- Protecting the banks

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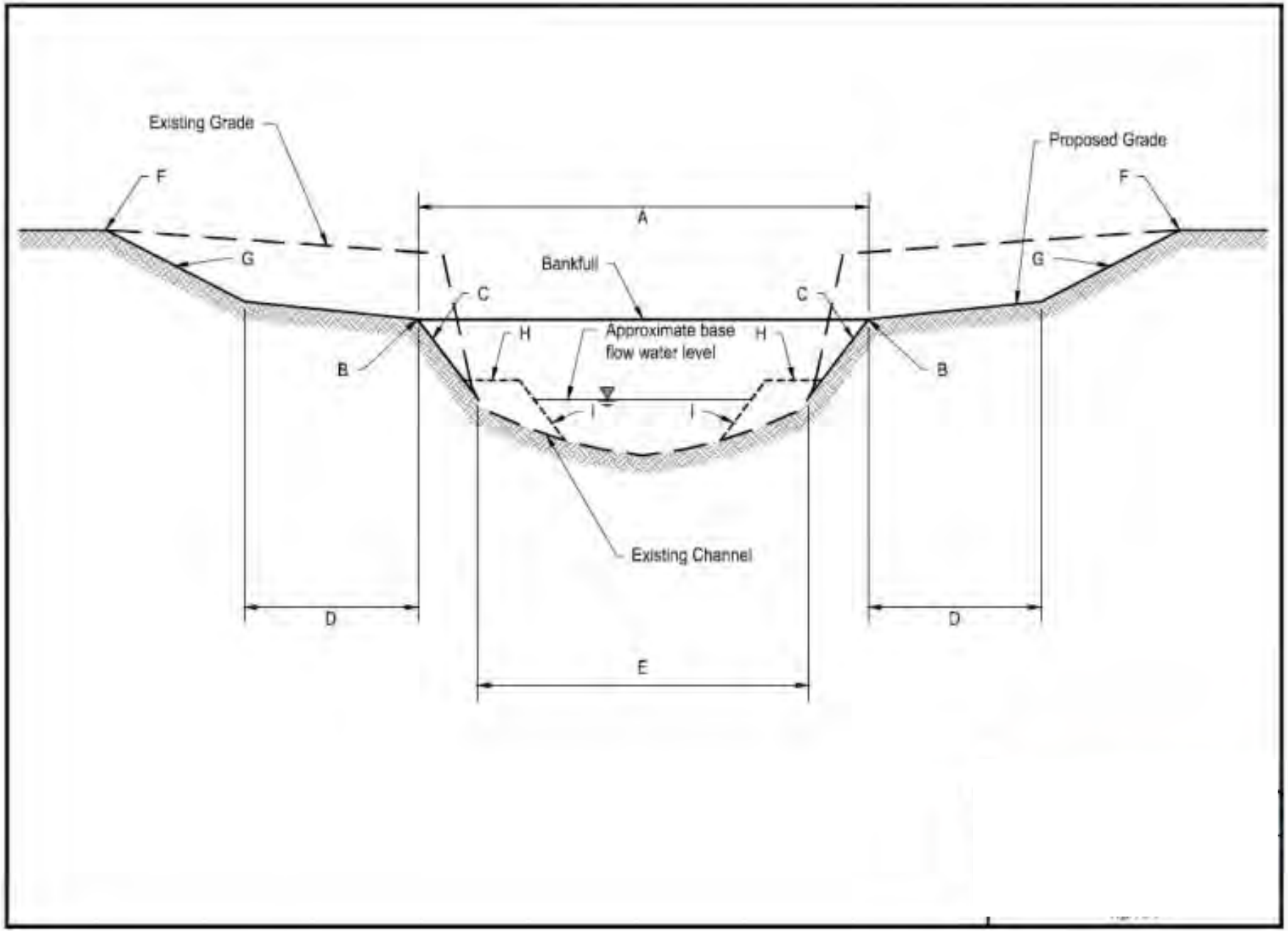
Bank Shaping

- Grading the streambank so that it can sustain vegetation and maintain stability.
- Vegetation growth on the newly shaped bank is essential to prevent erosion after construction



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Dimension	Name	Description
A	Bankfull Width	The channel width at bankfull stage, where discharge has filled the channel to the top of its bans and water begins to overflow onto a floodplain
B	Bankfull Elevation	Maximum water level before flood water rises above the bankfull channel and begins to overflow onto a floodplain
C	Stream Bank Slope	Grade of stream bank from the inner berm elevation to the bankfull bench elevation
D	Bankfull Bench	Flat vegetated area at bankfull elevation where flood water can spread during flood events
E	Bankfull Channel Bottom Width	The bottom width of the bankfull channel
F	Floodplain Elevation	Maximum water level above bankfull elevation that is prone to flood water
G	Upper Channel Bank Slope	Grade of channel bank from the bankfull bench to the floodplain
H	Inner Berm Elevation	Located slightly above the base/low flow water level and formed by sediment deposition
I	Inner Berm Channel Bank Slope	Grade from the channel bottom to the inner berm elevation

Bank Shaping

- Materials:
  - Seed mix and vegetation
  - Engineered soil if existing soil is not suitable for bank stability or vegetation growth
- Equipment:
  - Excavator
  - Tools for planting
- Sequence:
  - Remove loose soil from face of slop, excavate banks to appropriate elevation, re-spread spoils in approved location, seed and plant vegetation, protect slopes with temporary erosion control measures

Bank Shaping

- Maintenance:
  - During and following construction, bank slopes are vulnerable to erosion. Establishing vegetation as soon as possible will help prevent the newly formed banks from erosion. Maintenance will be needed as sediment settles within the channel. Plants may not live and will need to be replaced.

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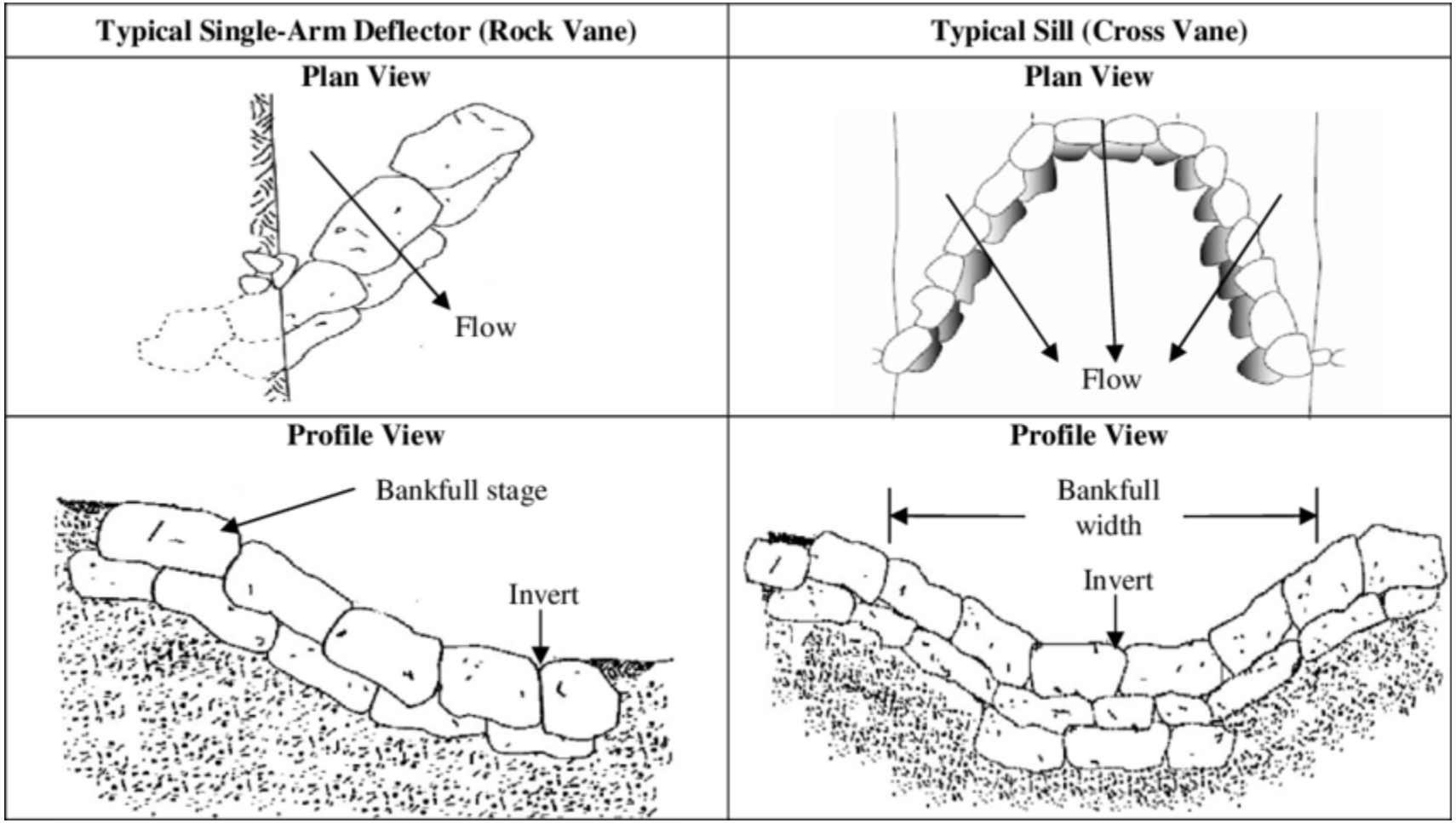
In-Stream Structures



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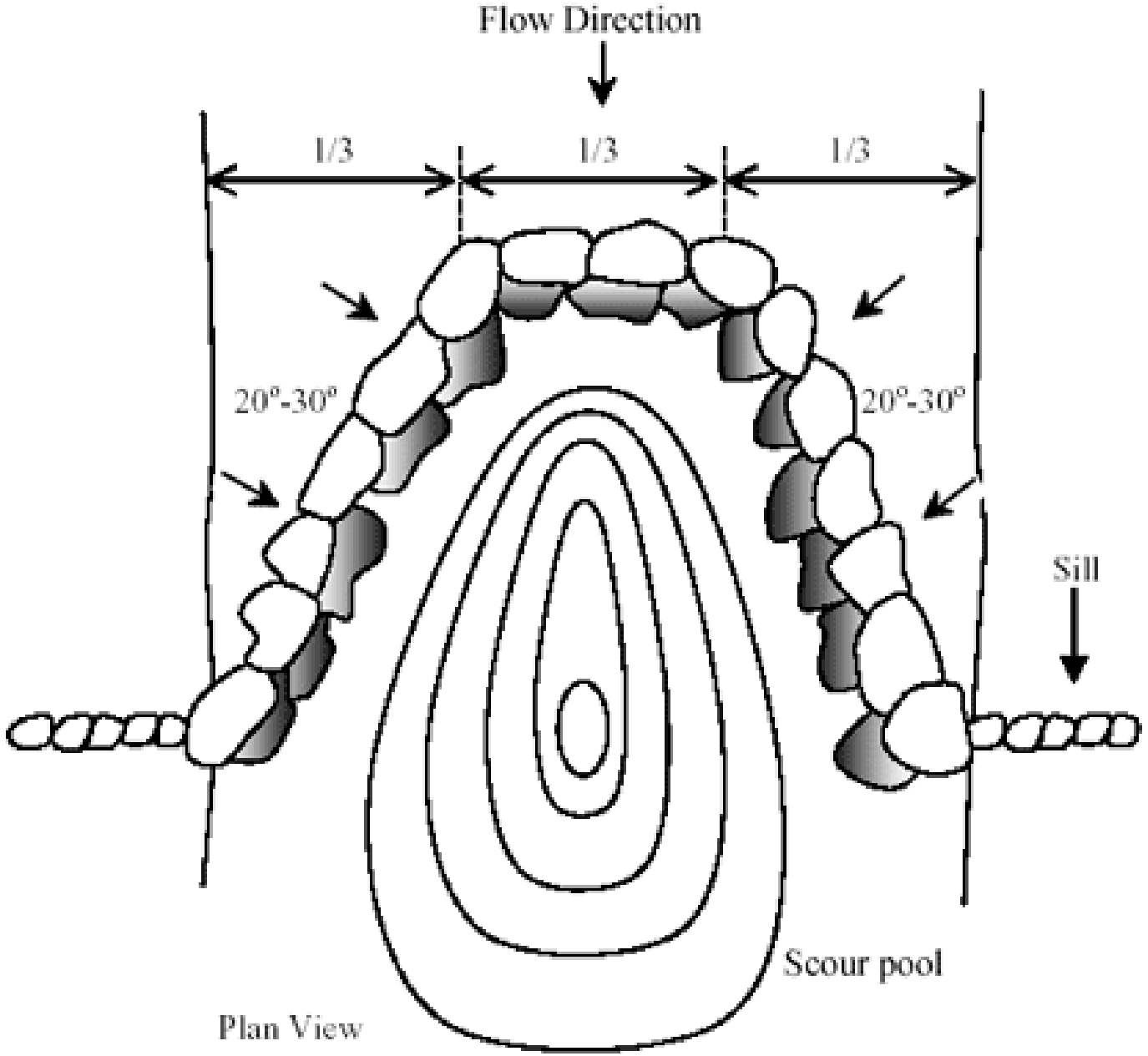
Cross Veins

- Protect the banks from erosion
- Large rocks shaped in “v” structure 20-30 degree angle
- 2-5 degree elevation change
- Deflects flow away from the banks of the stream
- Flow is diverted over the rock walls and concentrated down the center of the channel
- Scouring associated with high flow velocities in the center of the channel and the “waterfalling” over the structure itself creates a deep pool

Cross Veins



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Cross Veins

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Cross Veins

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Cross Veins

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Cross Veins

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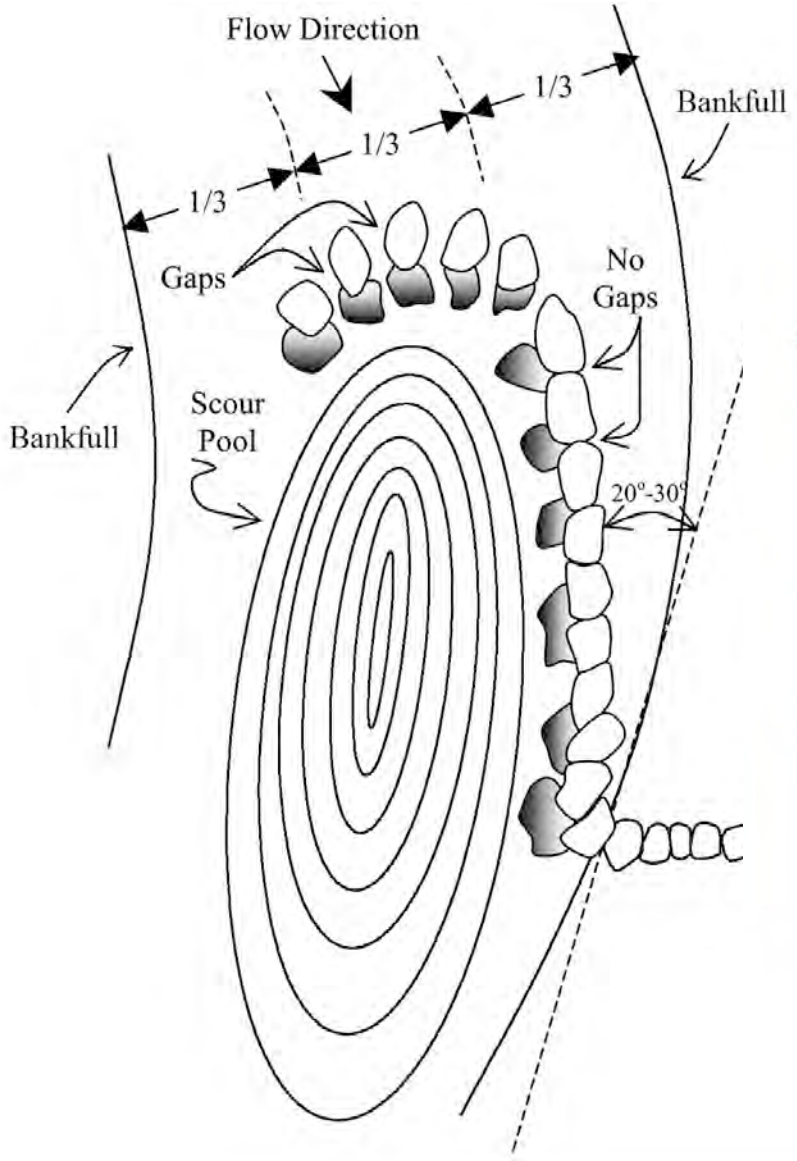
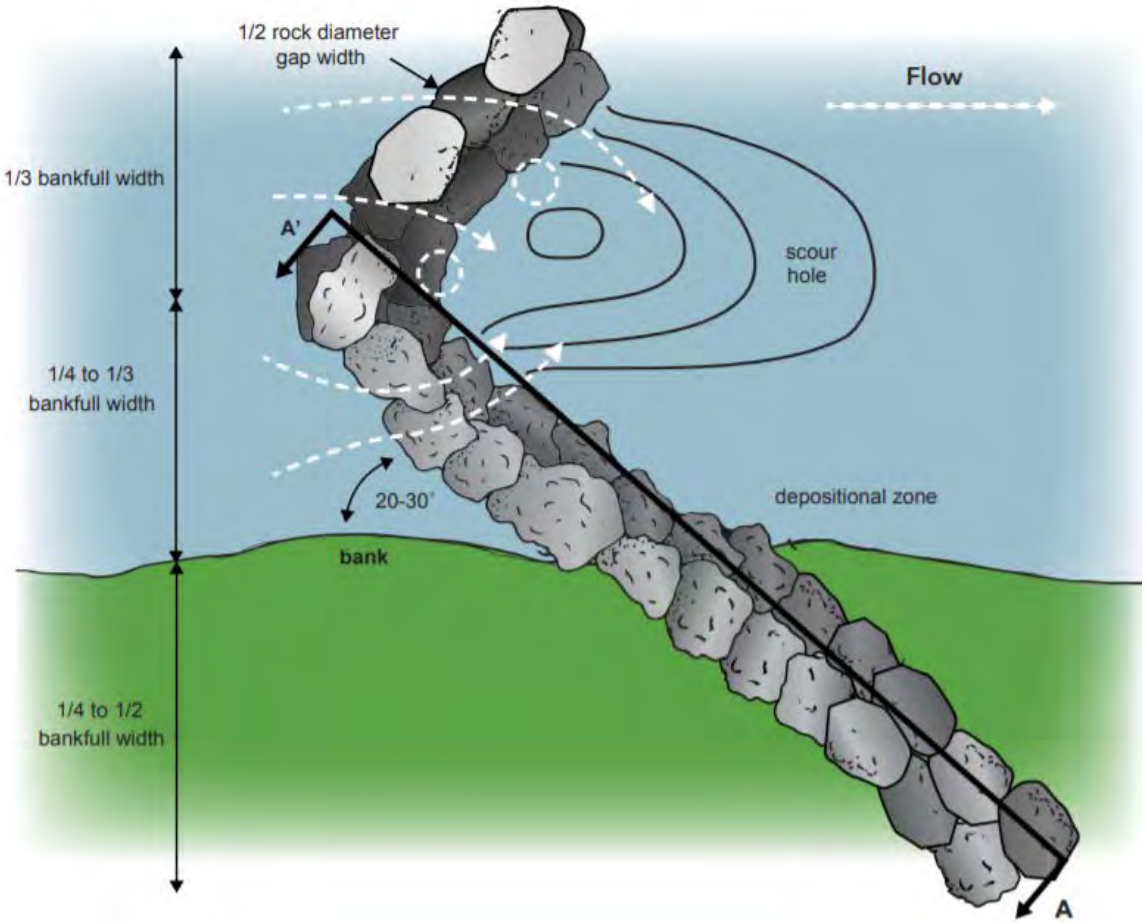
J Hooks

- Grade control and deflect water from banks
- Moves water away from one bank, instead of both
- Slight slope, can be made of rocks or logs
- Needs to be tied in to the stream bank
- Creates a deep pool for habitat and protection/spawning for aquatic life

J Hooks





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J Hooks

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J Hooks

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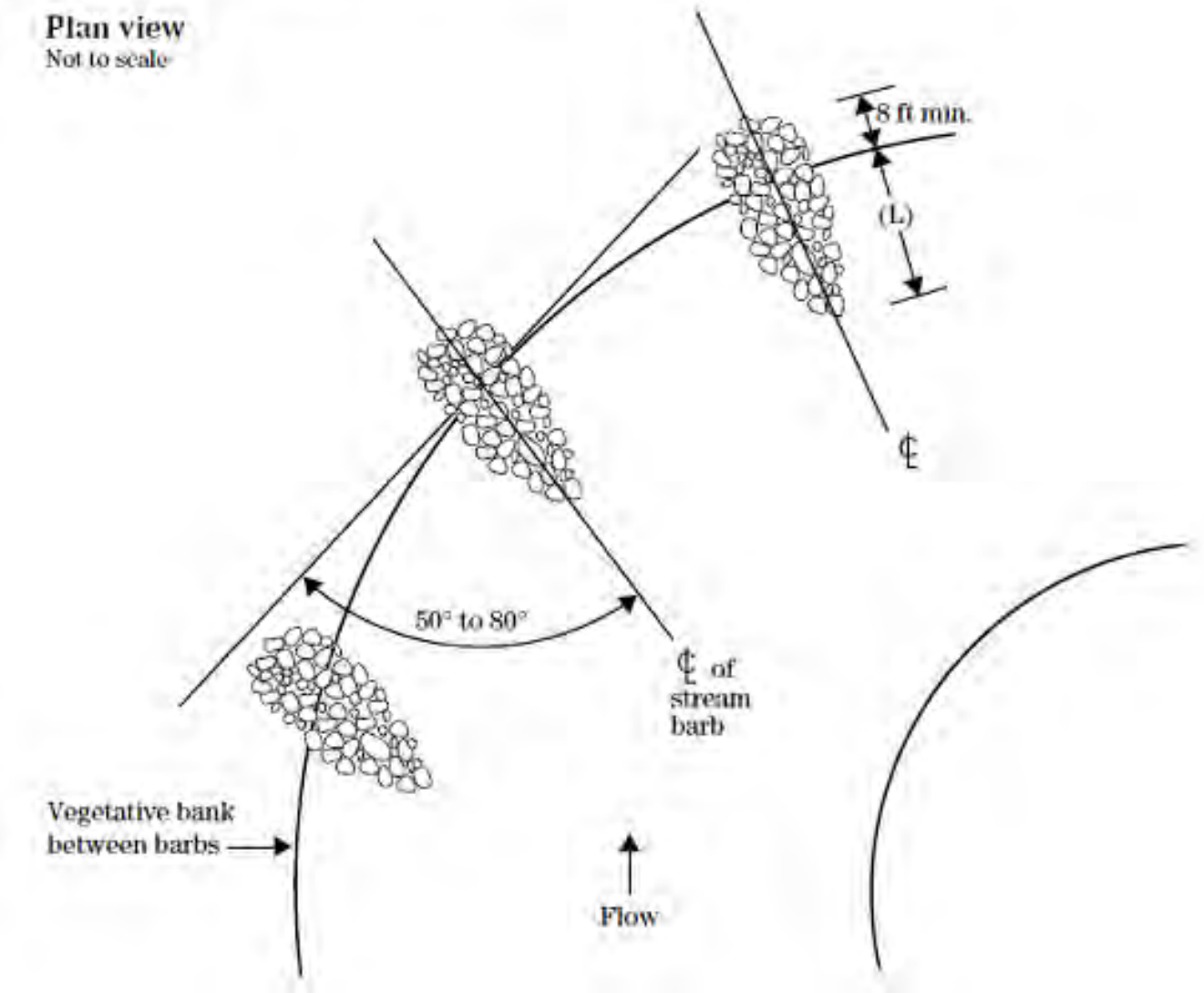
Barbs

- Rock structures that extend into the stream flow to modify flow patterns and bed topography
- Larger rivers where J hooks aren't practical because there is too much energy
- Barbs use the same type of technology
- Moves water up slope and then back to middle of stream to keep flow away from banks

Barbs

Figure 16–40 Stream barb details



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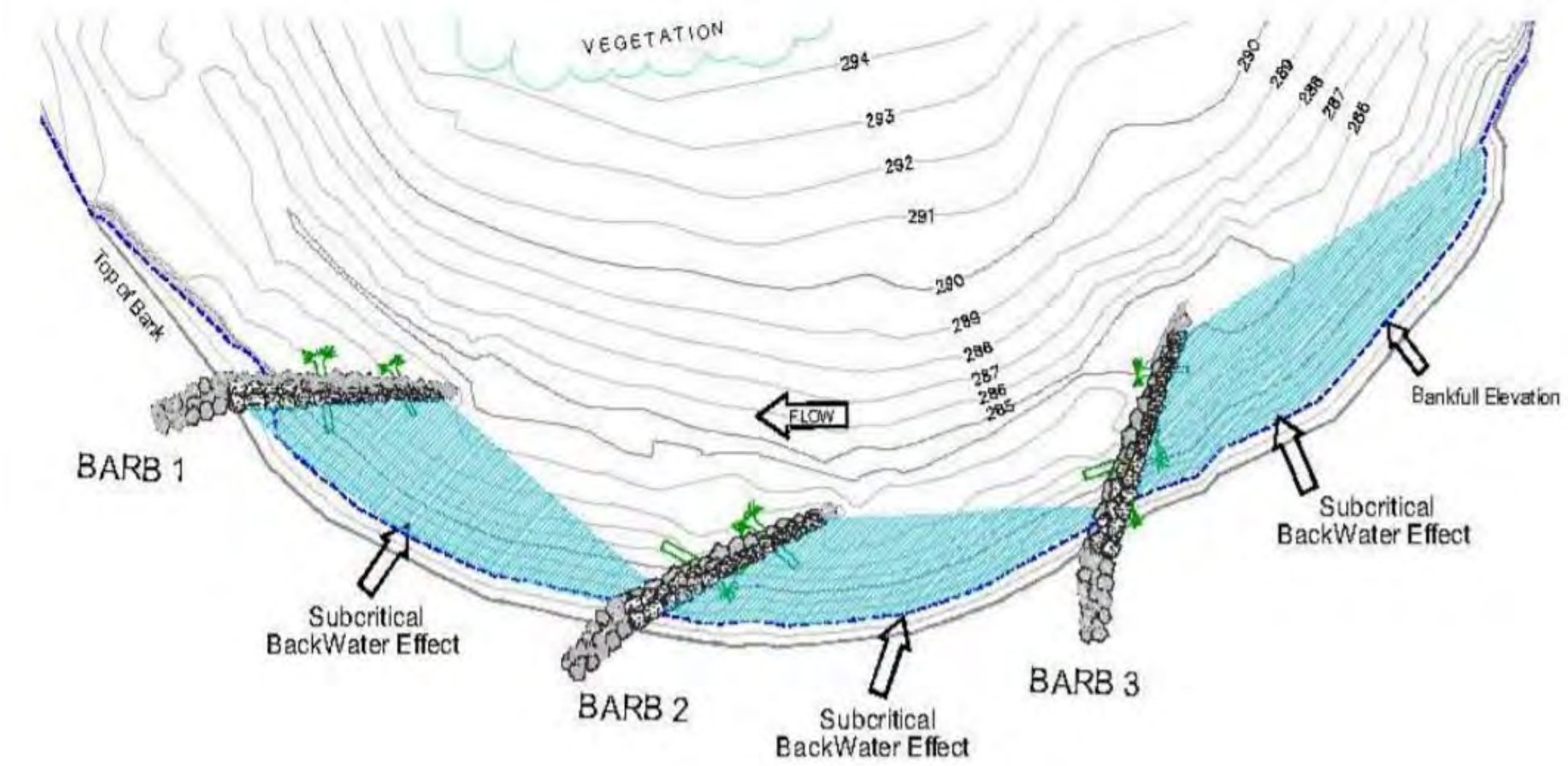
Barbs



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Barbs

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Barbs

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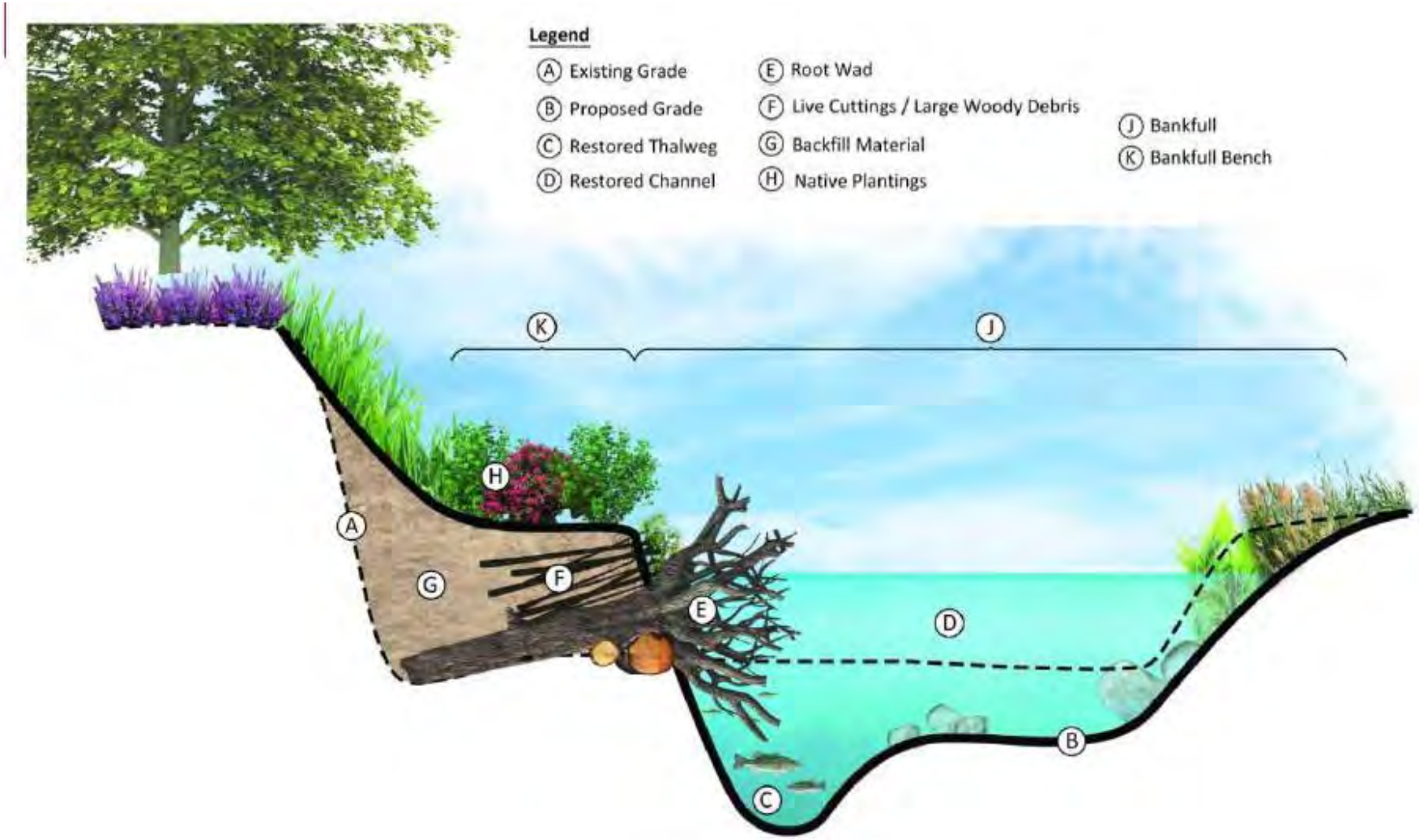
Toe Wood

- Great for stabilizing outer edge of stream
- Logs, sticks and brush that is buried 6-8 feet
- Provides habitat
- Sticks will degrade, but live plants are also used to create a tree line along the bank creating stabilization

Toe Wood

- Ideally should be 10-24 inch base diameter
- Trunk length should be 10 to 15 feet long
- Installation
  - Drive-point: track hoe with hydraulic thumb to insert the root wad directly into the bank. Sharpen end of long with chainsaw and drive it into bank.
  - Trenching: excavate a trench for the long portion and install a footer long underneath the root wad. Root wad is then placed on top of the footer. Backfill the trench and rebuild the bank with transplants and sod mats

Toe Wood



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Toe Wood/Root Wad

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Now that you decided what type of project fits your site's needs, what is the next step?

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Outreach

- Keep residents “in the loop” so there are no surprises when construction starts
- Let them be a part of the project by helping plant the vegetation
- Opportunity to obtain MS4 credits

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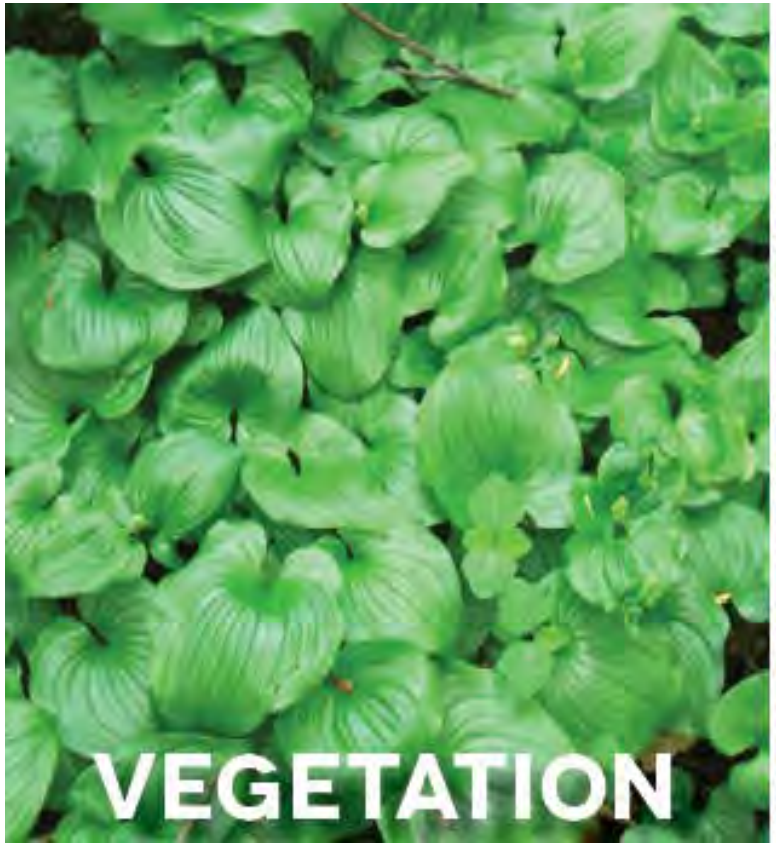
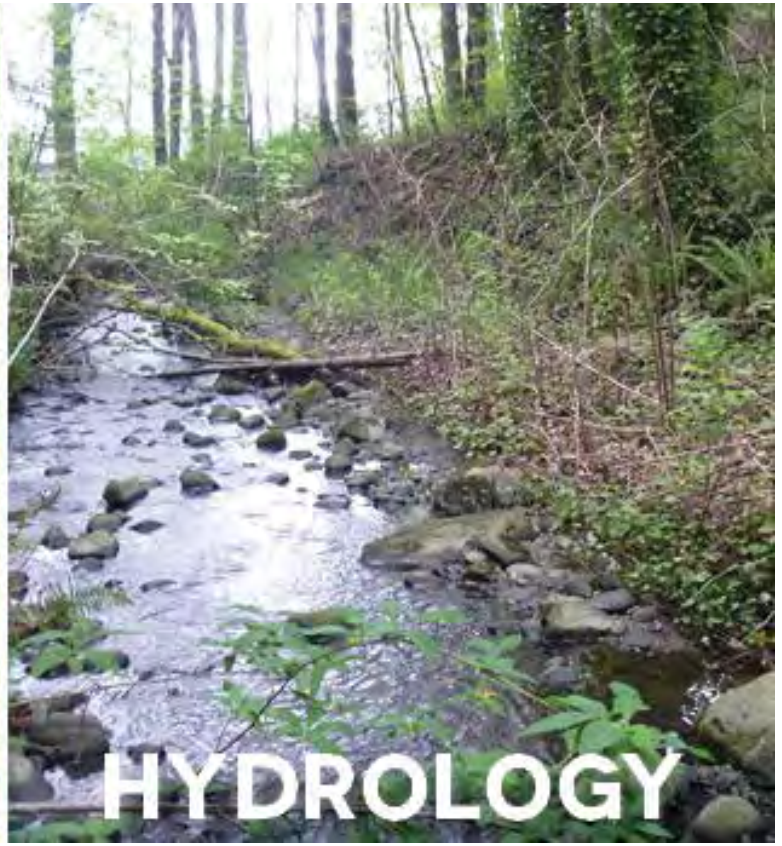
Wetland Delineation





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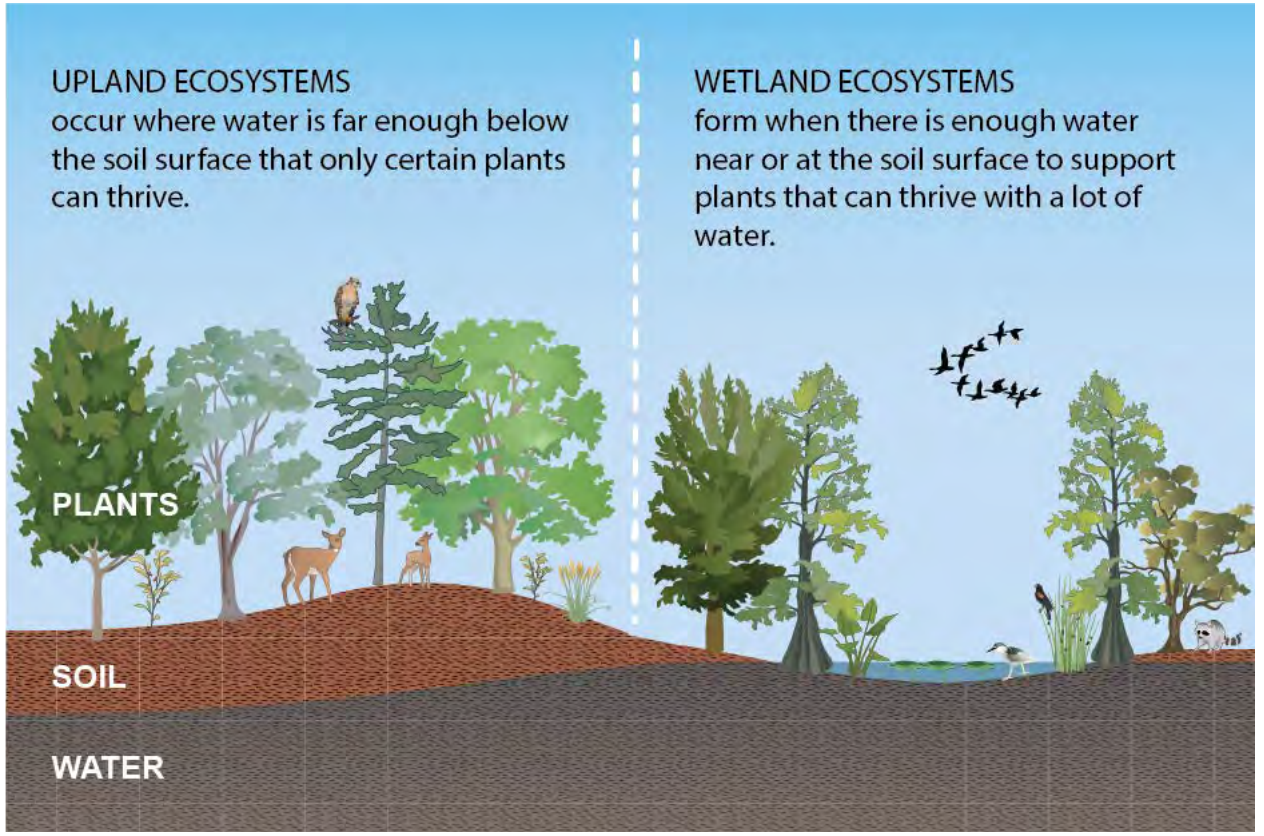
Wetlands are defined as…

Wetlands are areas that are periodically or permanently inundated by surface or ground water and support vegetation adapted for life in saturated soil.

Wetlands include swamps, marshes, bogs and similar areas.



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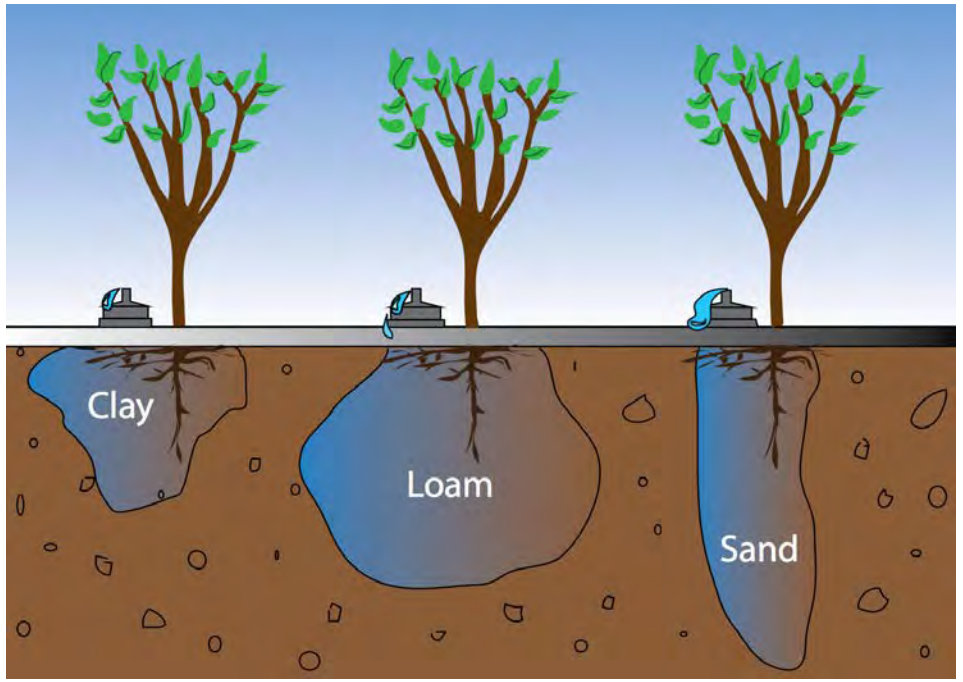
So basically we need…

- Hydrology – A source of water
- Hydric Soils – Inundated soils
- Hydrophytic Vegetation – Vegetation that grow can grow in a wetter type of environment

Soils…

1. Sandy soils
   - Have good drainage and aeration
   - Does not store water well
   - Is not suitable for most plants

2. Silt soils
   - Soils made from minerals
   - Granule sizes are between sandy and clay.
   - Very fine texture seen after storm runoff events



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Soils continued…

3. Clay soils
   - Holds water very well (i.e. does not drain water easily)
   - Do not have space for air
   - Is not suitable for most plants

4. Loam soils
   - Soils that contain an equal amount of sand, silt, and clay
   - The mixture of sand, clay and silt make loam soils an optimal place for plants to grow.
   - Are able to hold water and air.

Soils by Comparison

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Wetland Plants…

Plants in wetlands are categorized according to their ability to grow in water or hydric soils.

Obligate Wetland (OBL) Plants

These types of plants are found in wetlands 99% of the time

Narrow Leaf Cat-tail

Arrow-leaf Tearthumb

Skunk Cabbage

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Facultative Wetland (FACW) Plants

Usually live in wetlands (67-99%) but are sometimes found in non-wetlands

Sensitive Fern

Spotted Touch-Me-Not

Lamp Rush

Facultative (FAC) Plants

Are found in wetlands (34-66%) and uplands

Deer-Tongue Rosette Grass

Red Maple

Poison Ivy

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Facultative Upland (FACU) Plants

Usually live in non-wetlands (67-99%) but are sometimes found in wetlands

Tall Goldenrod

White Clover

Common Plantain

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Upland (UPL) Plants

These plants are found in uplands 99% of the time.

Queen Anne's Lace

Oxeye daisy

Allegheny Blackberry

So why are wetlands important?

- Wetlands serve many roles in our ecosystems. A few of these roles are:
  - Filtering water (removes things like pollutants and sediment)
  - Protect uplands from floods by temporarily storing some of the water
  - Provide sources of food
  - Wildlife habitats
  - Creates healthier watersheds by removing particles from runoff before it reaches the streams.
  - Prevent erosion when on banks of streams, rivers, and lakes – riparian buffers

Three types of wetlands in Pennsylvania

- Forested
- Scrub-shrub
- Emergent Wetlands

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Forested Wetlands

- Dominant plants are woody, mature plants
  - Tall trees are over 20 ft tall
  - Soils drain slowly; rich in nutrients
  - Red and Silver Maples
  - Willows

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Scrub-shrub wetlands

- Dominant Plants include scrub and shrub species
  - Trees less than 20 ft tall
  - Spicebushes
  - Alders
  - Willows

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Emergent Wetlands

- Marshy areas
  - Plants are rooted in the soils
  - Contain plants such as rushes, sedges and grasses

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Wetlands Provide…

- Habitat
  - More than 500 plant species in PA
  - Amphibians – Roughly 80% of the states amphibians (approximately 200 species) live in and around wetlands
  - Wild ducks and geese, bitterns
  - Threatened and Endangered (T&E) species as well

- Food in wetlands , from bacteria to plants, provides for the higher order food chain

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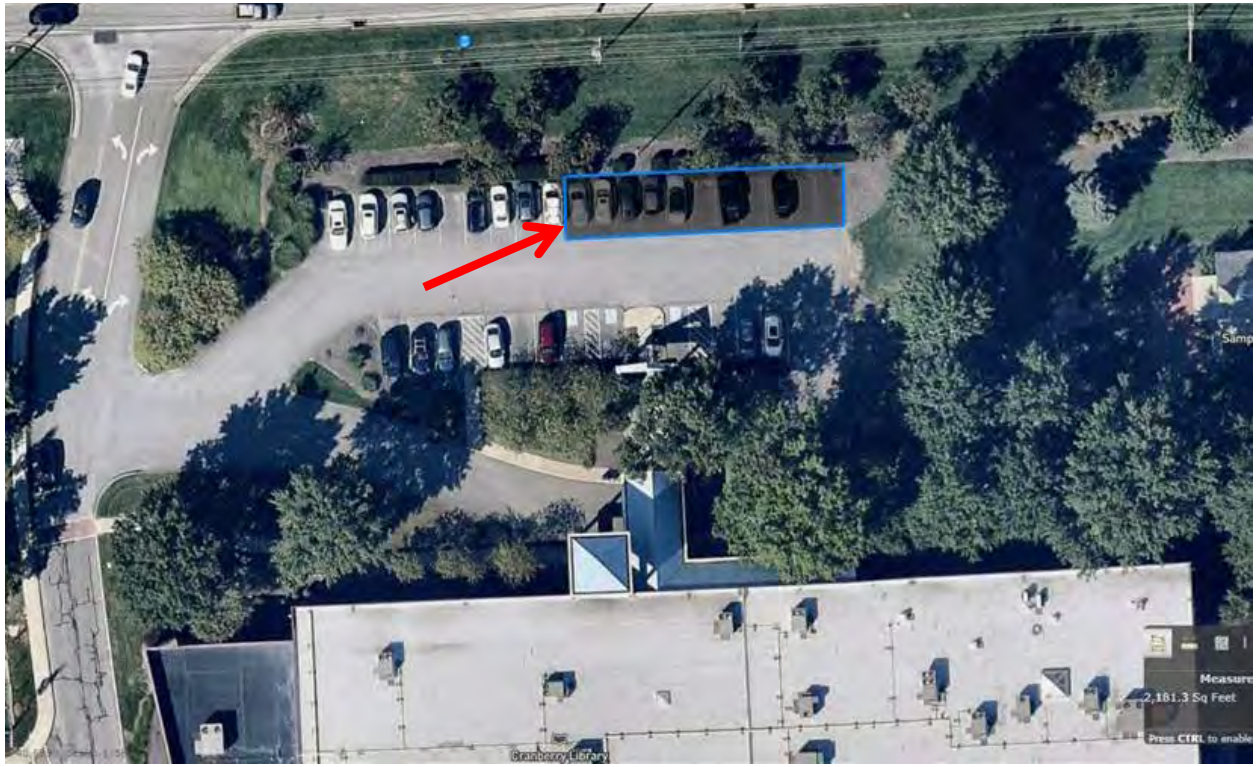
When wetlands are impacted, what happens?

- When wetlands are impacted, the opportunity exists for:
  - Increased floods
  - Water quality problems
  - Population decrease in plants and animals that live in wetlands

That magic number…

> The Pennsylvania Department of Environmental Protection limit for wetland impacts without mitigation is **0.05 acres** (2,178 sq. ft.) OR…



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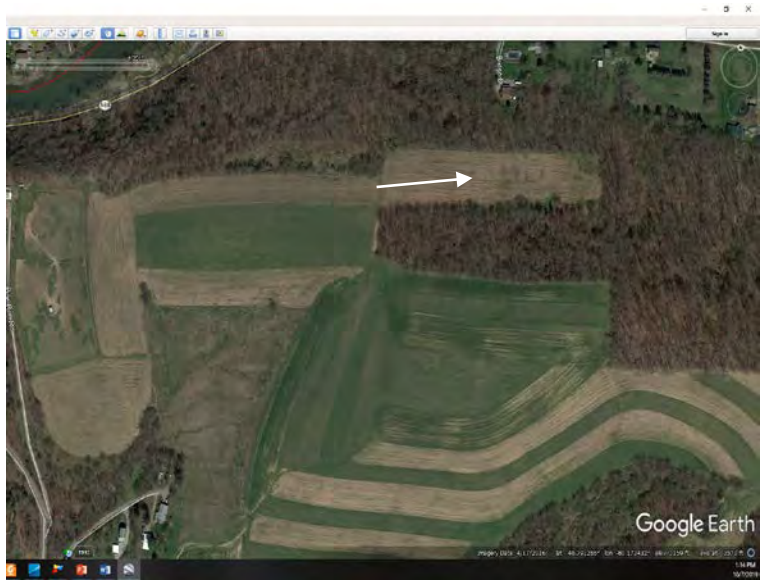
Game Plan

Prior to heading out to the field to delineate

> Historic aerials – usually GoogleEarth historical images are useable

2016



2005

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Game Plan continued…

> Check the Web Soil Survey for hydric soils in the area that you'll be investigating (https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm)

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Game Plan continued…

National Wetland Inventory Mapping – Not always accurate but they could give some insight

https://www.fws.gov/wetlands/Data/Mapper.html

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What Qualifies as an Impact?

- Direct impacts include filling, grading, removal of vegetation, building construction and changes in water levels and drainage patterns.
- Any person or entity (including PennDOT) who impact wetlands must obtain authorization from both the USACE and DEP.

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Park

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Park Improvements

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Wetlands located within Best Management Practices

- Constructed/Designed wetlands to improve water quality
- Sediment may need removed after accumulating
- Trash and debris removal
- Invasive species need removed
- May need replanted per the plan
- Mowing to be performed annually
- Follow maintenance schedule on site plan

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Naturally Occurring Wetlands

> Remove invasive species by hand (shovel). Plan native species on bare soil to prevent invasives from establishing

> Add logs or large rocks to standing pools of water to provide basking habitat for turtles and reptiles

> Add native plants

- Natural Regeneration – Allowing the site to revegetate on its own through natural process of plant succession
- Active Revegetation – Establishing vegetation by physically placing seed, seedlings or cuttings on a site.
- Planting trees could alter the wetland, and not for the better

Why Do We Care?

> Help manage water flows

> Provide natural filtration, improving downstream water quality

> Balances groundwater levels and supports flood control

> Supports ecosystems of plants and wildlife



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When in doubt…

When in doubt if your activity may have impacts to wetlands or streams, give the regulatory agencies a call!

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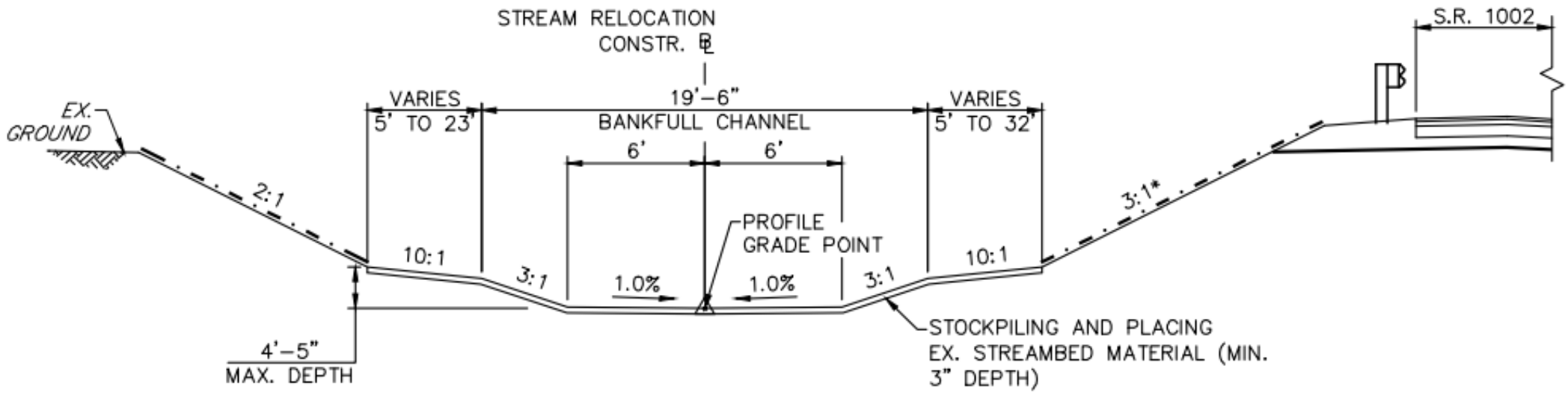

STREAM RELOCATION

STA 0+00 TO STA 2+48

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Permitting

- NPDES Permit reviewed by the Conservation District
- Chapter 105 GP-3 Bank Rehabilitation, Bank Protection and Gravel Bar Removal
- Projects exceeding 500 feet in length is required to submit a Joint Permit with the US Army Corps of Engineers

Permitting

- Under Section 105.12(a)(16) it is possible to obtain a permit waiver:
  - **Restoration activities undertaken and conducted pursuant to a restoration plan which has been approved, in writing, by the Department.**
- Still need to provide to DEP and receive approval:
  - GIF, application fees, copies and proof of receipt, cultural resource notice, GP reporting criteria checklist, PNDI search, site plans, cross sectional drawings, profiles, location map, project description narrative, color photographs with map location, environmental assessment form

Pre-Application Meeting

- Invite the permitting agencies to review the site selection
- This should help expedite the permit process and save time and money for the applicant
- Permitting agencies can provide guidance on permittability of the project and offer alternatives if applicable
- Provide during meeting: location, waterway, delineation information, impacts, proposed improvements, concept plans

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Permitting

SECTION F. APPLICATION COMPLETENESS CHECKLIST

Applicant must place an entry - Y = Yes, N = No, N/A = Not Applicable - in each left side column space. See Section 105.13 for additional details. If you are applying under the Small Projects Application format, place an entry in only those comments prefixed by an asterisk (*).

REQUIREMENT	Applicant Entry	DEP Use Only
a. GIF and permit application properly signed, sealed and witnessed	*Y	
b. Application Fee & Worksheet enclosed (see Section G.)	*Y	
c. Copies and proof of receipt - Act 14 notification - Acts 67/68/127	*Y	
d. Cultural Resource Notice (Notice, return receipt and PHMC review letter, as appropriate)	*Y	
e. PASPGP-5 Reporting Criteria Checklist	*Y	
f. Bog Turtle Habitat Screening (copy of "No Effect" determination from the Army Corps of Engineers OR copy of documented clearance from the US Fish and Wildlife Service)	*Y	
g. Pennsylvania Natural Diversity Inventory (signed PNDI Receipt showing Avoidance Measures or Potential Impacts and proof of delivery to the appropriate jurisdictional agency(ies) where further coordination is required, as appropriate)	*Y	
h. Plans (site plan including cross sections and profiles for Subsections 151, 191, 231, 261)	*Y	
i. Location map	Y	
j. Project description narrative including PNDI avoidance measures (if applicable) AND Aquatic Resource Impact Table	*Y *Y	
k. Color photographs with map showing location taken	*Y	
l. Environmental Assessment form	*Y	
m. Erosion and Sediment Control Plan and approval letter	Y	
n. Hydrologic and hydraulic analysis	Y	
o. Stormwater Management Analysis with consistency letter	Y	
p. Floodplain Management Analysis with consistency letter	Y	
q. Risk Assessment	Y	
r. Professional engineer's seal and certification	Y	
s. Alternative analysis	Y	
t. Mitigation plan	Y	

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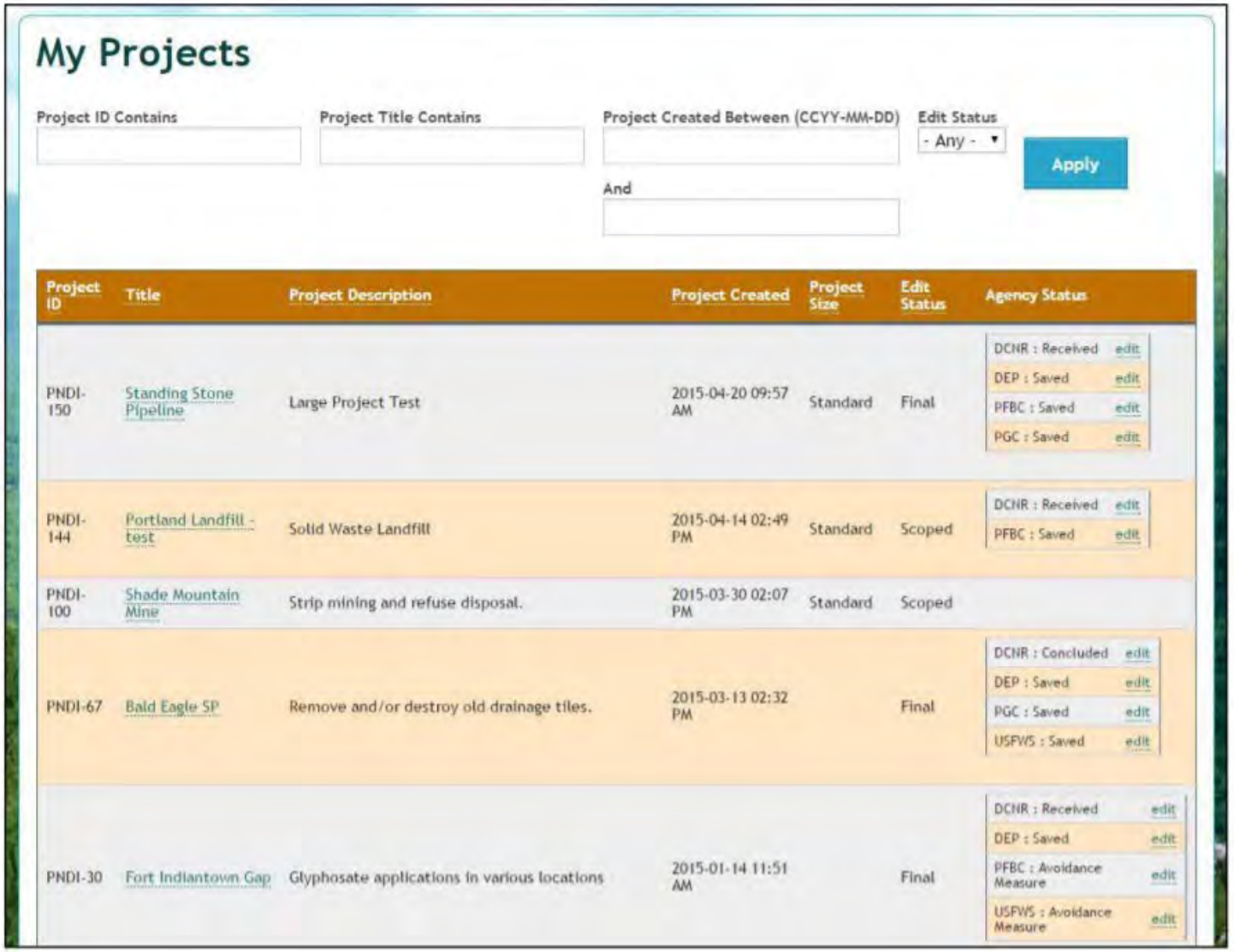
PNDI Environmental Review Process



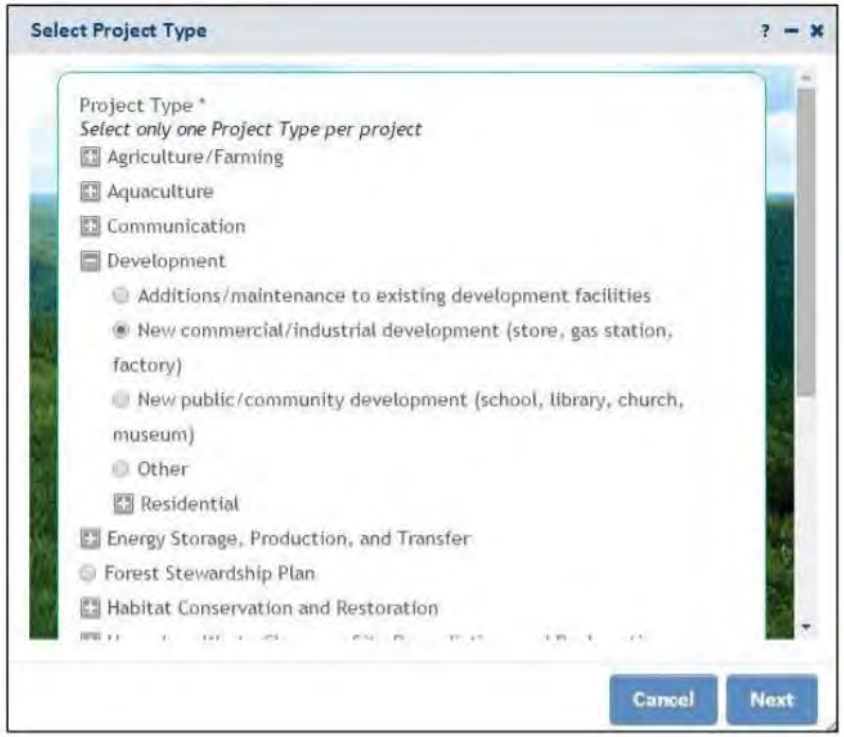
My Projects

Project ID Contains | Project Title Contains | Project Created Between (CCYY-MM-DD) | Edit Status | Apply

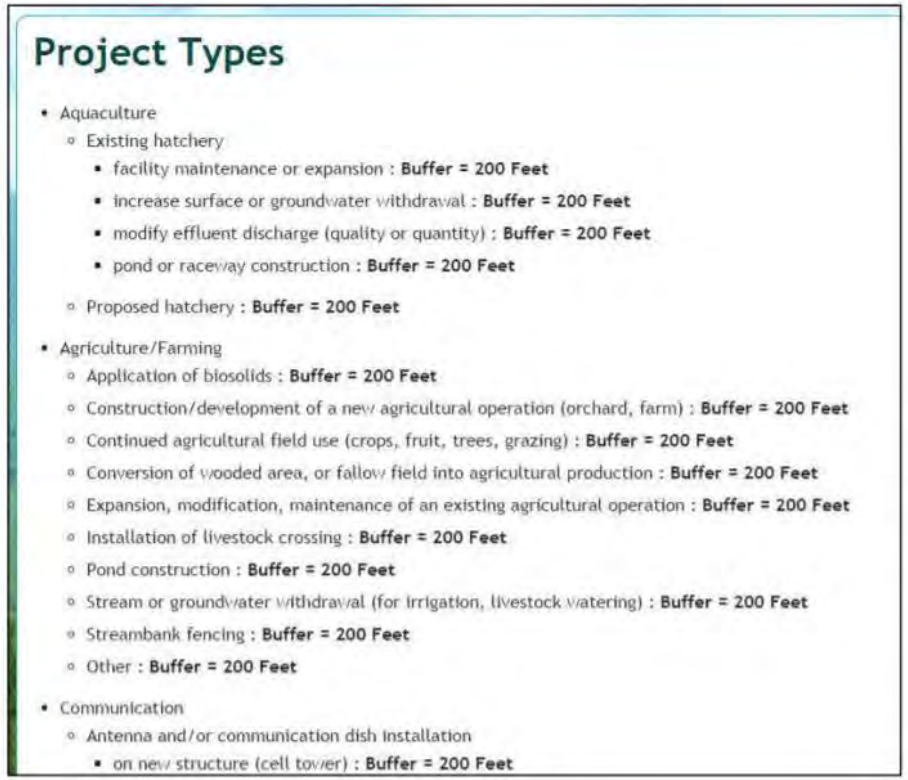
And

Project ID	Title	Project Description	Project Created	Project Size	Edit Status	Agency Status
PNDI-150	Standing Stone Pipeline	Large Project Test	2015-04-20 09:57 AM	Standard	Final	DCNR : Received edit DEP : Saved edit PFBC : Saved edit PGC : Saved edit
PNDI-144	Portland Landfill - test	Solid Waste Landfill	2015-04-14 02:49 PM	Standard	Scoped	DCNR : Received edit PFBC : Saved edit
PNDI-100	Shade Mountain Mine	Strip mining and refuse disposal.	2015-03-30 02:07 PM	Standard	Scoped	
PNDI-67	Bald Eagle SP	Remove and/or destroy old drainage tiles.	2015-03-13 02:32 PM		Final	DCNR : Concluded edit DEP : Saved edit PGC : Saved edit USFWS : Saved edit
PNDI-30	Fort Indiantown Gap	Glyphosate applications in various locations	2015-01-14 11:51 AM		Final	DCNR : Received edit DEP : Saved edit PFBC : Avoidance Measure edit USFWS : Avoidance Measure edit

PNDI Environmental Review Process



Step 3a. Select a project type and click "Next."



Step 3b. For a list of all project types and their corresponding screening area sizes (buffers), hover the mouse over the Help tab and click on "Project Types."

PNDI

Step 5c. Click on the "Show Preview Buffer" button in the Draw/Edit Toolbar to see the project footprint with the buffered screening area (outlined in red) and any overlapping environmental review polygons. Click "Accept."

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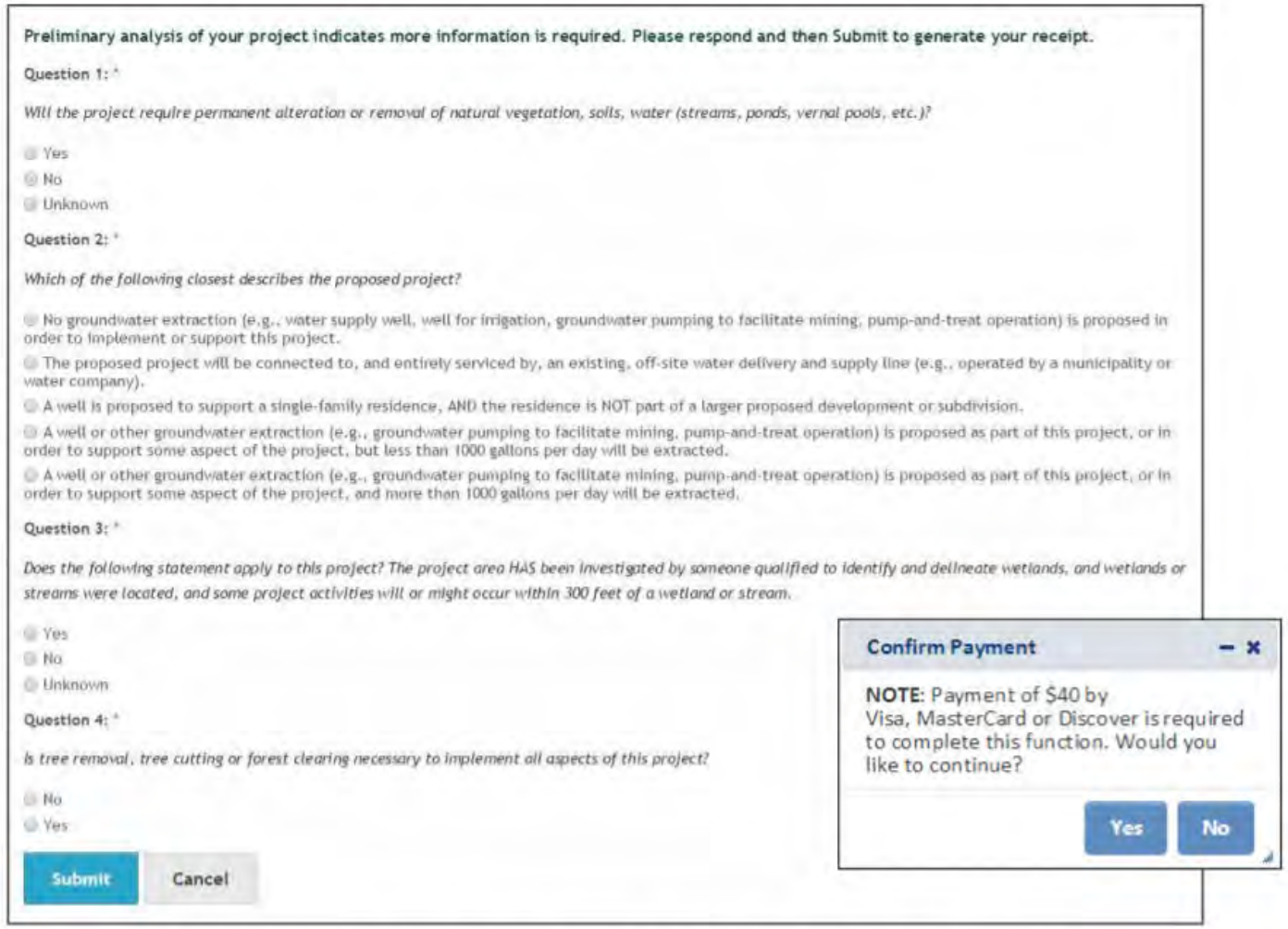
PNDI



Step 7. After submitting a project for pre-analysis, you may be asked questions if additional information is required. Answer them and click "Submit." You may be required to pay a fee for the first draft of the receipt. All subsequent revisions specific to the project are free of charge.

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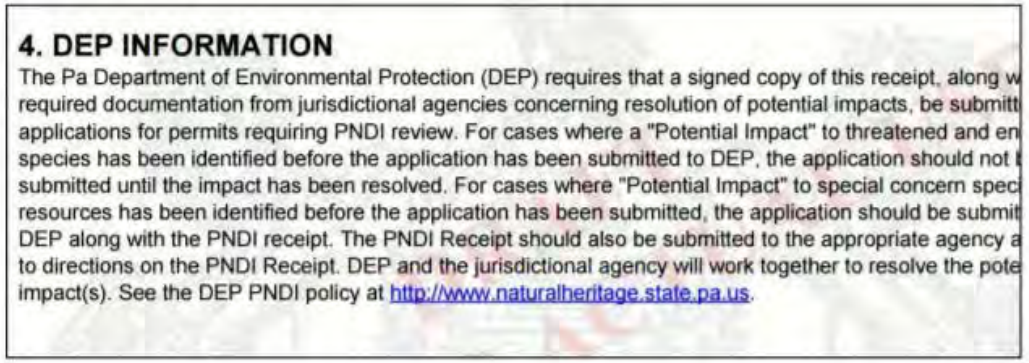
PNDI Environmental Review Process

Step 8. When the PNDI analysis is complete, an email message will be sent to you, prompting you to visit "My Projects" to view the receipt.

The receipt indicates if there are potential impacts, which agency(s) they are with, and it includes instructions on how to proceed.

The receipt is displayed by clicking on the Project Title and then the Receipt File pdf. Project summary information is displayed in the receipt followed by search results, location maps and agency-specific instructions. If the receipt is ready for agency review, click on the Edit Details/Finalize button. Upload any documents requested in the receipt (or click on the checkbox(s) if mailing documents or no further review is needed) using the Choose File button at the bottom of the page. Click on the Project Edit Status radio button indicating Final. Be sure to click Save when you are finished.

Note: Agency status information and downloadable zipped shapefiles are also accessible on the project page.



4. DEP INFORMATION

The Pa Department of Environmental Protection (DEP) requires that a signed copy of this receipt, along w
required documentation from jurisdictional agencies concerning resolution of potential impacts, be submitt
applications for permits requiring PNDI review. For cases where a "Potential Impact" to threatened and en
species has been identified before the application has been submitted to DEP, the application should not b
submitted until the impact has been resolved. For cases where "Potential Impact" to special concern speci
resources has been identified before the application has been submitted, the application should be submit
DEP along with the PNDI receipt. The PNDI Receipt should also be submitted to the appropriate agency a
to directions on the PNDI Receipt. DEP and the jurisdictional agency will work together to resolve the pote
impact(s). See the DEP PNDI policy at http://www.naturalheritage.state.pa.us.

Project Edit Status*
By selecting Final, I certify that this information provided accurately reflects the project activity.
Draft
Final

File attachments

Add a new file
Attach supporting documentation here. ***Please note:*** *This is a two-step process; first Choose the File and then Upload it to attach to the project. Files added to the project are not permanent until you save or submit this page.*
Choose File No file chosen
Upload
Files must be less than 10 MB.
Allowed file types: doc jpg jpeg gif png txt doc xls pdf ppt pps odt ods odp docx xlsx zip kml kmz.

I will mail my project documentation to the agencies requesting coordination on the PNDI receipt.
Check this box if you will NOT be uploading project documentation to DCNR, PGC or PFBC for environmental review.

No further review is required.
Check this box if the draft PNDI receipt indicates no impacts to threatened, endangered and/or species of special concern are present ***and*** *(if applicable) you agree to comply with all avoidance measures listed on the receipt.*

Contact Information

Save Cancel

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Permitting - Reminder

- E&S Approval Letter
- H&H Report (Hydrology, Existing, Temporary, and Proposed Conditions, Scour Analysis)
- Municipal Stormwater Consistency Letter – Provided by Municipality
- Municipal Floodplain Consistency Letter – Provided by Municipality
- Risk Assessment
- Alternative Analysis
- Engineer's Seal
- Mitigation Plan
- Operation and Maintenance Plan

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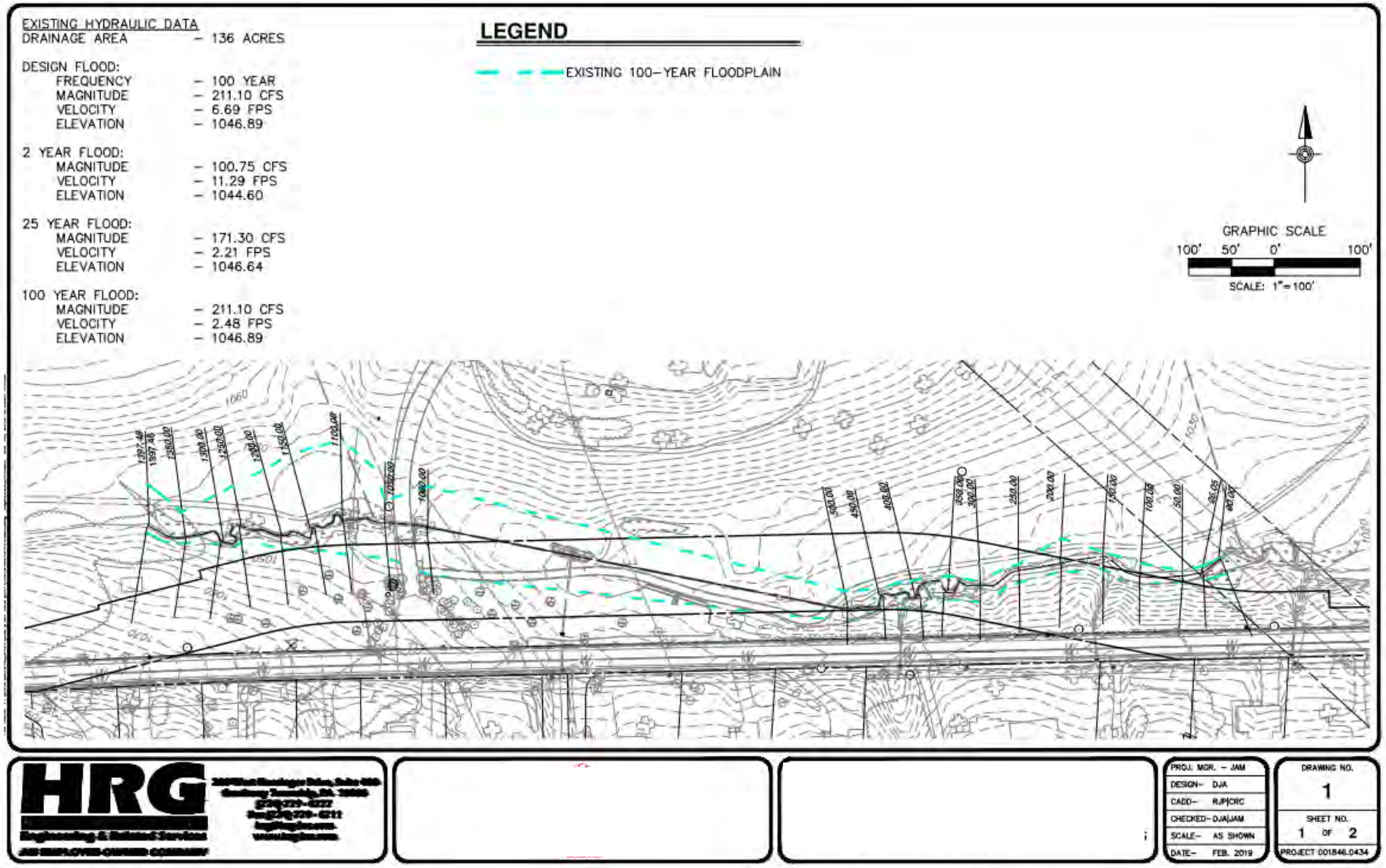
Hydrologic and Hydraulic Report

- Site inspection to assess the conditions of the stream
  - Basic measurements of stream
  - Site photos
  - Determination of general stream character
  - Overall bank conditions
  - Field view of the upstream watershed to confirm watershed boundaries

Hydrologic and Hydraulic Report



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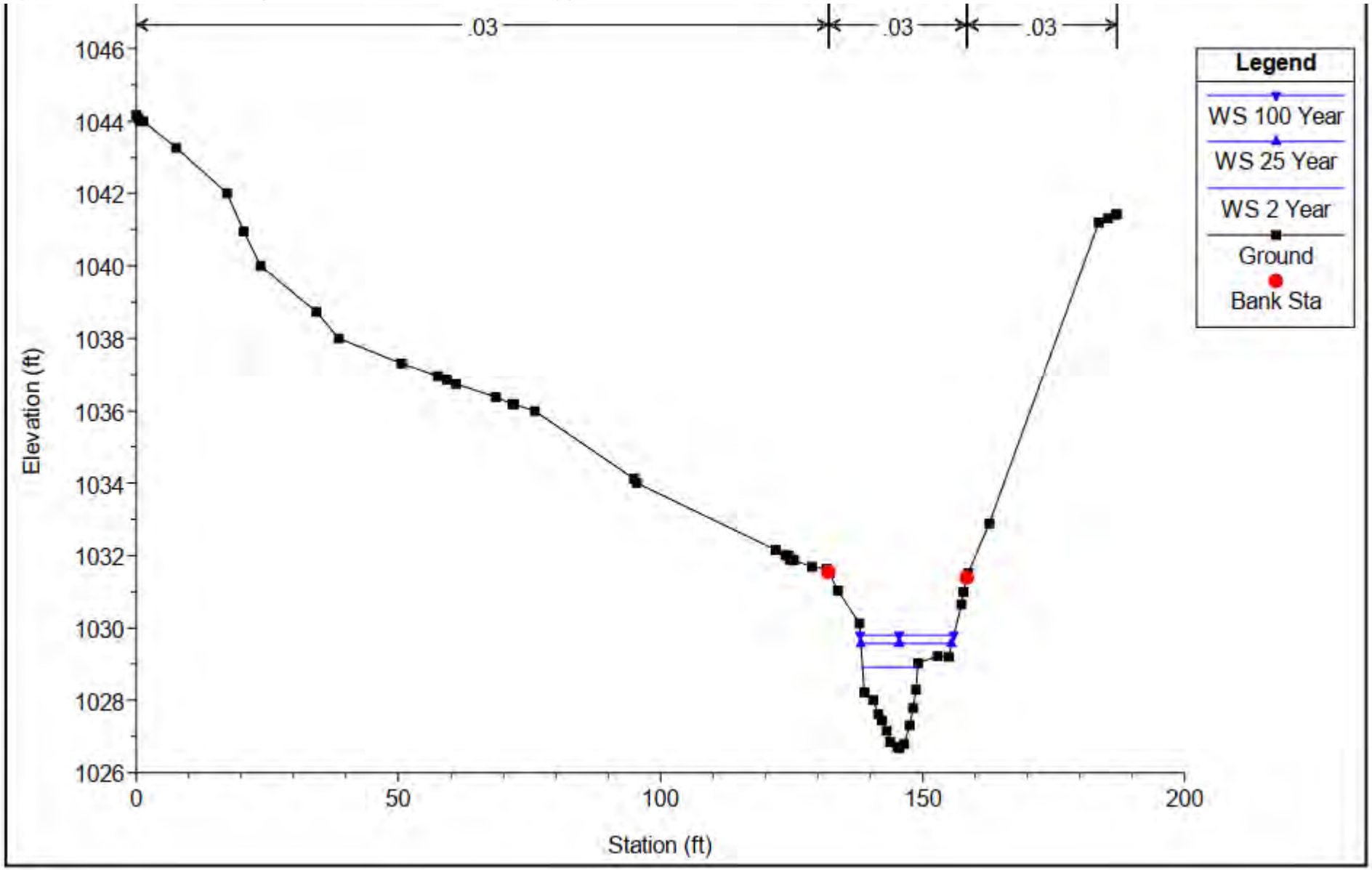
Hydrologic and Hydraulic Report

HEC-RAS Plan: EX River: Stream Reach: Stream

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Stream	1397.48	2 Year	100.75	1050.00	1050.64	1050.64	1050.90	0.016546	4.10	24.58	47.52	1.00
Stream	1397.48	25 Year	171.30	1050.00	1050.87	1050.87	1051.21	0.015144	4.69	36.53	53.93	1.00
Stream	1397.48	100 Year	211.10	1050.00	1050.98	1050.99	1051.36	0.014673	4.94	42.74	56.98	1.01
Stream	1350	2 Year	100.75	1048.00	1048.79	1049.04	1049.57	0.051386	7.08	14.23	28.31	1.76
Stream	1350	25 Year	171.30	1048.00	1049.03	1049.33	1049.99	0.046539	7.84	21.85	34.63	1.74
Stream	1350	100 Year	211.10	1048.00	1049.14	1049.47	1050.18	0.044865	8.16	25.87	37.53	1.73
Stream	1300	2 Year	100.75	1047.16	1048.63	1048.57	1048.83	0.011632	3.57	28.21	50.97	0.85
Stream	1300	25 Year	171.30	1047.16	1048.79	1048.79	1049.13	0.016041	4.70	36.47	55.60	1.02
Stream	1300	100 Year	211.10	1047.16	1048.94	1048.90	1049.28	0.013289	4.66	45.26	60.58	0.95
Stream	1250	2 Year	100.75	1045.59	1048.00	1048.00	1048.31	0.009625	4.80	25.28	43.08	0.83
Stream	1250	25 Year	171.30	1045.59	1048.51	1048.28	1048.71	0.004990	4.03	51.23	58.82	0.62
Stream	1250	100 Year	211.10	1045.59	1048.76		1048.93	0.003956	3.79	66.42	67.58	0.56
Stream	1200	2 Year	100.75	1045.07	1048.05	1047.21	1048.09	0.000731	1.80	71.21	67.43	0.24
Stream	1200	25 Year	171.30	1045.07	1048.55		1048.60	0.000663	2.03	109.88	86.85	0.24
Stream	1200	100 Year	211.10	1045.07	1048.78		1048.83	0.000641	2.13	130.65	95.79	0.24
Stream	1150	2 Year	100.75	1044.28	1048.05		1048.07	0.000183	1.15	122.55	106.21	0.13
Stream	1150	25 Year	171.30	1044.28	1048.56		1048.57	0.000181	1.30	178.84	116.24	0.14
Stream	1150	100 Year	211.10	1044.28	1048.79		1048.81	0.000183	1.38	205.92	120.88	0.14
Stream	1100	2 Year	100.75	1043.61	1048.03		1048.05	0.000232	1.33	97.54	98.40	0.15
Stream	1100	25 Year	171.30	1043.61	1048.54		1048.56	0.000240	1.53	154.65	125.84	0.16
Stream	1100	100 Year	211.10	1043.61	1048.77		1048.80	0.000240	1.60	184.51	134.74	0.16
Stream	1050	2 Year	100.75	1042.56	1047.59	1045.25	1047.90	0.001270	5.09	19.79	21.20	0.40

Hydrologic and Hydraulic Report



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Environmental Assessment

- Module S2: Resource Identification and Characterization
  - Natural Biological Functions (food chain production, general habitat and nesting, rearing and resting sites for aquatic or land species)

- Wetlands W-02, W-03, W-05, and W-07

Given the traits of wetlands W-02, W-03, W-05 and W-07 and surrounding landscape within the Project Area, the potential to function as general habitat, a nesting site and rearing and resting sites for various fauna which reside within and adjacent to the Project Area is available. This wetland also provides a limited, but functioning food source for the same fauna given the variety of species, which inhabit in the area. These wetlands have a lower potential to function as general habitat for wetland fauna given that the wetland is located in a fallow field and given the size and location of these wetlands, these functions are considered limited.

- Wetland W-04

With its location in the northwestern portion of the Project Area and proximity to streams S-03, S-04 and S-05. Wetland W-04, a former unmaintained sediment detention basin, contains the potential to function as general habitat, nesting sites and rearing / resting sites for various fauna which reside within and adjacent to the Project Area. These wetlands also provide a functioning food source for the same fauna given the variety of species, which inhabit in the area

Environmental Assessment

➢Module S2: Resource Identification and Characterization

➢Water quality/quality and floodflow alteration

- Wetlands W-02 and W-03

Wetlands W-02 and W-03 aid in maintaining natural drainage and sedimentation patterns as well as the natural water filtration process. Given these resources' location on a terrace near the top of the watershed adjacent to an existing highwall, it would capture runoff from the surrounding properties and allow it to filter through the soil prior to entering the groundwater table. This area would be able to contain water during runoff events and prevent additional water from erosion of the streambanks, thereby reducing the amount of sediment in the stream.

- Wetland W-04

Wetland W-04 is located within a former stormwater detention basin near the confluence of streams S-03, S-04 and S-05. This resource aids in in maintaining natural drainage and sedimentation patterns as well as the natural water filtration process. Given the resource's location in proximity to streams S-03, S-04 and S-05, this wetland would capture runoff from the surrounding properties and would allow it to filter through the soil prior to entering the groundwater table. In the portion of the wetland that abuts the stream, this area would be able to reduce flow during runoff events to catch sediment from upstream as well as prevent additional erosion from occurring within the project area.

Environmental Assessment

➢Module S3: Identification and Description of Potential Project Impacts

- Wetland W-02

Wetland W-02 (0.031 acres) will be completely impacted as a result of this project. Impacts to the natural biological functions of the wetland will be incorporated as part of the wetland mitigation proposed for this project.

Due to its size and location at the toe of slope of a highwall within a field of a historically disturbed site, it is anticipated that, the wetland's ability to serve as a source of food chain production, general habitat and nesting, rearing and resting sites for aquatic or land species are considered limited.

- Wetland W-03

Wetland W-03 (0.012 acres) will be completely impacted as a result of this project. Impacts to the natural biological functions of the wetland will be incorporated as part of the wetland mitigation proposed for this project.

Due to its size and location at the toe of slope of a highwall within a field of a historically disturbed site, it is anticipated that, the wetland's ability to serve as a source of food chain production, general habitat and nesting, rearing and resting sites for aquatic or land species are considered limited.

Construction of Project

- Choosing the right contractor can make all the difference
- Weather dependent, can be 6-9 months for completion
- Regular inspections of construction provides assurance that the engineered design is being effectively implemented by field contractor
- Can maximize credits by ensuring the project is built correctly and consistent monitoring to show results of sediment reduction. Could result in less projects being needed to meet MS4 requirements
- Prepare for the unknown

Restoration Evaluation and Monitoring

- Monitoring and Evaluation help determine if the goals have been met
- Help reveal the need for adjustments to design or stabilization methods

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Restoration Evaluation and Monitoring

- Pebble Counts
  - performed at permanent cross sections within each reach of the project
  - Include 100 pebbles collected from left bankfull to right bankfull
  - Record on a tally sheet and plot the data by size-class and frequency
  - Can be subjective and likely will have minimal changes

Restoration Evaluation and Monitoring

- Photo Documentation
  - Distinguish specific locations for photographs
  - Provide location points on map and give direction of views (northwest/downstream)
  - Photos should be taken throughout monitoring period
  - Compare to photos taken to ones taken previously
  - Photos can indicate the presence or absence of developing bars or bank erosion

Restoration Evaluation and Monitoring

- Vegetation
  - Direct counts along the entire corridor of restored stream should be completed
  - Survival of vegetation inside the riparian buffer can be documented through stem-counts and photographic documentation of the entire length of buffered corridor
  - Survival rates or density goals. If not achieved, plant supplemental vegetation

Restoration Evaluation and Monitoring

- Bank Stability Monitoring
  - Bank pins, bank profiles and permanent cross sections are all ways to monitor bank stability

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Restoration Evaluation and Monitoring

- Shading and Temperature
  - Monitor of water and air temperature will show if the vegetation is providing thermal stability in the riparian zones
  - Can measure temperature every year as vegetation and buffer plants grow
  - Take temperatures above and below the project area and compare. The project area should have lower temperatures

Restoration Evaluation and Monitoring

- Fish and Invertebrate Data
  - Macroinvertebrate populations can be counted to provide insight on the overall health of the stream

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Restoration Evaluation and Monitoring – Expert Panel Recommendations

- Maximum duration for credits is 5 years (permit term) but can be renewed indefinitely based on field performance inspections
  - Verify project still exists
  - Adequately maintained
  - Operating as designed
- Initial Verification of Performance
  - Municipality/consultant provides a post-construction certification that the project was installed properly, meets the restoration objectives, and is hydraulically and vegetatively stable

Restoration Evaluation and Monitoring – Expert Panel Recommendations

- Restoration Reporting to the State
  - Municipality/consultant must submit basic documentation to the appropriate state agency for each stream restoration project (should check with regional office on the specific data to report for the individual projects)
- Recommendations of Reporting Requirements
  - Type and length of restoration project, location coordinates, year of installation and maximum duration of credit, land uses and acres treated

Restoration Evaluation and Monitoring – Expert Panel Recommendations

- If a field inspection shows that the restoration project is not performing to original design, the municipality will have one year to correct it and bring back into compliance. If not remediated within the one year timeframe, the pollutant reduction for the project will be eliminated and must be reported to the state in the annual MS4 report

Funding the Project

- Stormwater Fee
  - Second Class Townships
  - Authorities
  - Home-ruled

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Funding the Project

- Stormwater Fee
  - Includes not-for-profit and tax exempt entities
  - Can bill in-house
  - Dedicated source of funds for projects
  - Credits can be offered
  - Incentive to reduce impervious surfaces

Funding the Project

- Grant Funding
  - County Conservation District
  - TreeVitalize
  - DCNR – Community Conservation Partnerships
  - DCED – PA Small Water and Sewer
  - H2O PA – Water Supply, Sanitary Sewer and Storm Water Projects

Funding the Project

- Infrastructure Bank (Butler County)
  - Low interest loan for a maximum term of 10 years
  - No match is required
- PENNVEST
  - Low-interest loans and grants for new construction or improvements
  - No Match