Mitigation Categories 3 and 4
September 1, 2009

OHIO EPA
STREAM MITIGATION PROTOCOL

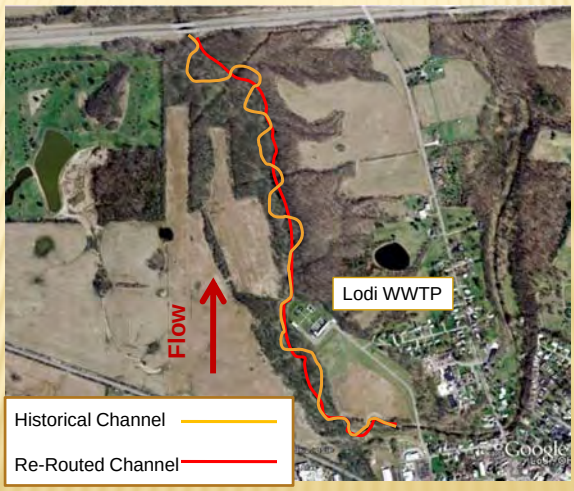
PREFACE

- Reminders:
  - Mitigation Category 3
    - WWH – GHQW
    - CWH – Inland Trout Streams
    - Class III PHWH
  - Mitigation Category 4
    - EWH
    - WWH – SHQW, OSW
    - CWH – Native Fauna

PREFACE

- Mitigation Category 3 and 4:
  - All three debit-credit categories for adjusted area apply:
    - Aquatic habitat
    - Flood Prone Area
    - Vegetated Riparian Buffer
  - The currency for debits and credits is in acres
  - Areas are adjusted based upon:
    - Areas (acres) in comparison to drainage area adjusted targets
    - Quality of the resource

CASE STUDY: EAST FORK EAST BRANCH BLACK RIVER



CASE STUDY:
EAST FORK EAST BRANCH BLACK RIVER

- Straightening of the stream channel resulted in channel incision
  - Result: stream disconnected from it's floodplain
- The Lodi WWTP also caused problems: NH_3-N toxicity
- In 2002, a stream restoration project was conducted to improve the stream geomorphology
  - ~$1.7 million WRRSP Project

CASE STUDY:
EAST FORK EAST BRANCH BLACK RIVER

- Caveats:
  - This is an example!
    - Data collection during the post-construction monitoring period was not designed for this exercise
    - Data placed into the model was interpolated where necessary
  - Strength of data as follows:
    - Aquatic Habitat – Excellent
    - Flood Prone Area – Good
    - Vegetated Buffer - Fair

CASE STUDY:
EAST FORK EAST BRANCH BLACK RIVER

Post-Construction, 2003

UPSTREAM LODI WWTP:
FLOODPLAIN CREATION + BANK STABILIZATION

- Design:
  - Floodplain creation
  - Bank stabilization to protect a utility right of way
  - Use of structures to maintain channel pattern

UPSTREAM LODI WWTP – GRADE CONTROL

- Constructed grade control structure upstream of the Lodi WWTP
  - Used to restore connectivity to the flood plain
  - Addresses incision of the channel

DOWNSTREAM LODI WWTP: "PASSIVE RESTORATION"

- The section of the East Fork downstream of the Lodi WWTP is moderately entrenched, but has an intact woody riparian corridor
- Habitat restoration in this reach is "passive" in that upstream actions were anticipated to have downstream benefit.

DOWNSTREAM LODI WWTP

BIOLOGICAL SURVEYS

Conducted in 2001 (before work)
2003 (year 1)
2006 (year 4)

CASE STUDY: EAST FORK EAST BRANCH BLACK RIVER

Species List

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River Code: **20-014**	Stream: **East Fork East Branch Black River**	Sample Date: **2006**
River Mile: **1.60**	Location: dst. Lodi WWTP	Date Range: 06/28/2006
Time Fished: 6243 sec	Drainage: 14.4 sq mi	Thru: 10/04/2006
Dist Fished: 0.42 km	Basin: Black River No of Passes: 2	Sampler Type: E

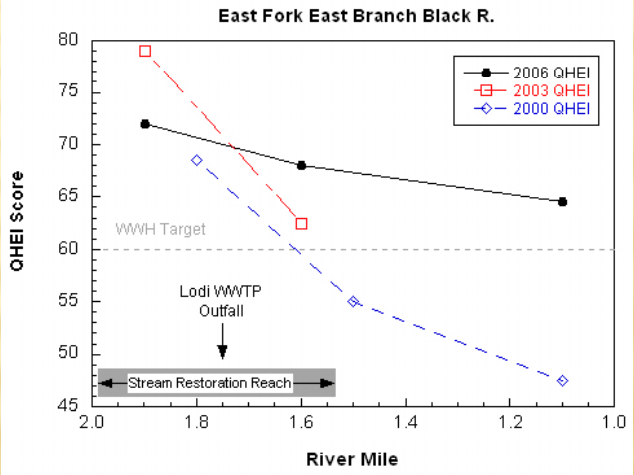
Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Northern Hog Sucker	R	I	S	M	16	11.43	1.36			
White Sucker	W	O	S	T	71	50.71	6.05			
Western Blacknose Dace	N	G	S	T	30	21.43	2.56			
Creek Chub	N	G	N	T	227	162.14	19.35			
Common Shiner	N	I	S		9	6.43	0.77			
Silverjaw Minnow	N	I	M		56	40.00	4.77			
Bluntnose Minnow	N	O	C	T	110	78.57	9.38			
Central Stoneroller	N	H	N		322	230.00	27.45			
Yellow Bullhead		I	C	T	1	0.71	0.09			
Rock Bass	S	C	C		2	1.43	0.17			
Largemouth Bass	F	C	C		3	2.14	0.26			
Green Sunfish	S	I	C	T	24	17.14	2.05			
Bluegill Sunfish	S	I	C	P	43	30.71	3.67			
Pumpkinseed Sunfish	S	I	C	P	2	1.43	0.17			
Blackside Darter	D	I	S		7	5.00	0.60			
Johnny Darter	D	I	C		15	10.71	1.28			
Greenside Darter	D	I	S	M	40	28.57	3.41			
Fantail Darter	D	I	C		7	5.00	0.60			
Mottled Sculpin		I	C		188	134.29	16.03			
	Mile Total				1,173	837.86				
	Number of Species				19					
	Number of Hybrids				0					

CASE STUDY: EAST FORK EAST BRANCH BLACK RIVER

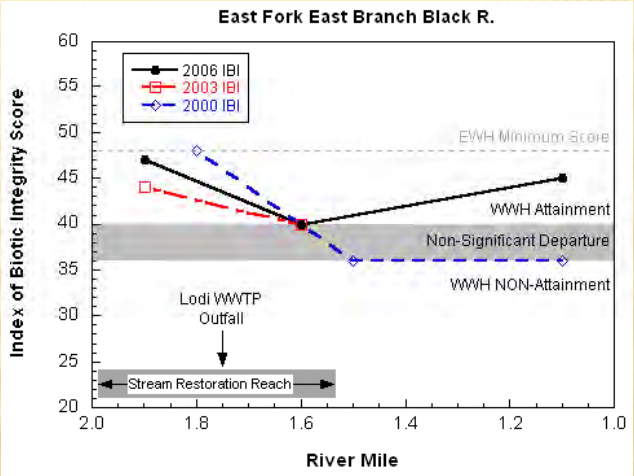
East Fork of East Branch Black River IBI scores.

				Number of						Percent of Individuals						
River Mile	Type	Date	Drainage area (sq mi)	Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
E Fk E Br Black R. - (20-014)																
Year: 2006																
1.90	E	09/18/2006	14.4	20(5)	8(5)	4(5)	4(3)	5(5)	7(5)	52(3)	22(3)	42(3)	34(3)	0.0(5)	459(3)	48
1.90	E	07/24/2006	14.4	21(5)	8(5)	3(3)	4(3)	5(5)	6(3)	44(3)	11(5)	40(3)	30(3)	0.0(5)	702(3)	46
1.60	E	06/28/2006	14.4	19(5)	6(3)	3(3)	2(1)	5(5)	6(3)	37(3)	19(3)	34(3)	36(3)	0.0(5)	513(3)	40
1.60	E	10/04/2006	14.4	14(3)	6(3)	3(3)	2(1)	5(5)	6(3)	42(3)	12(5)	40(3)	33(3)	0.0(5)	502(3)	40
1.10	E	06/27/2006	14.5	18(5)	7(5)	3(3)	2(1)	4(3)	4(3)	48(3)	4(5)	41(3)	41(3)	0.0(5)	330(3)	42
1.10	E	10/04/2006	14.5	17(5)	7(5)	4(5)	3(3)	5(5)	7(5)	42(3)	9(5)	33(3)	31(3)	0.3(3)	507(3)	48
Year: 2003																
1.90	E	10/03/2003	14.4	21(5)	10(5)	4(5)	3(3)	4(3)	6(3)	48(3)	23(3)	53(3)	45(3)	0.2(5)	482(3)	44
1.60	E	10/03/2003	14.4	17(5)	8(5)	4(5)	2(1)	4(3)	5(3)	61(1)	19(3)	42(3)	31(3)	0.0(5)	470(3)	40
Year: 2000																
1.70	E	09/28/2000	14.4	17(5)	6(3)	5(5)	3(3)	4(3)	6(3)	52(3)	7(5)	26(5)	30(3)	0.1(5)	857(5)	48
1.50	E	09/28/2000	14.4	15(3)	5(3)	3(3)	1(1)	4(3)	4(3)	41(3)	17(5)	14(5)	46(3)	4.3(1)	600(3)	36
1.10	E	09/28/2000	14.5	13(3)	5(3)	3(3)	1(1)	4(3)	4(3)	64(1)	10(5)	34(3)	25(3)	0.0(5)	718(3)	36

HABITAT RESPONSE



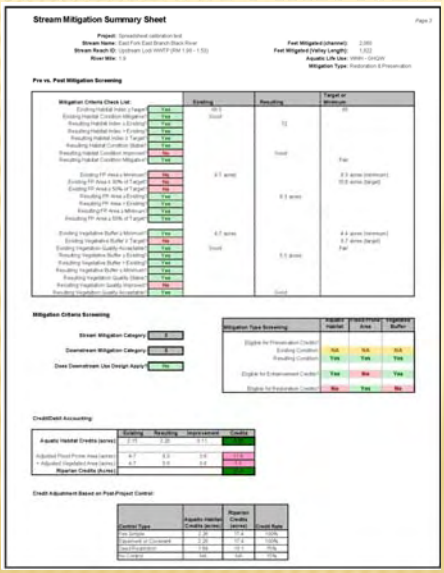
FISH COMMUNITY RESPONSE



MITIGATION MODEL OUTCOME

- The reach of the East Fork affected by the restoration project was divided into two sections for analysis
  - Upstream Lodi WWTP (RM 1.98-1.53)
    - Restoration activities
      - Creation of low flood prone area
      - Bank stabilization
      - Installation of grade control to address channel incision
  - Downstream Lodi WWTP (RM 1.53 – 1.10)
    - No direct activity – benefits from upstream actions

UPSTREAM LODI WWTP – MODEL OUTPUT


Stream Mitigation Summary Sheet

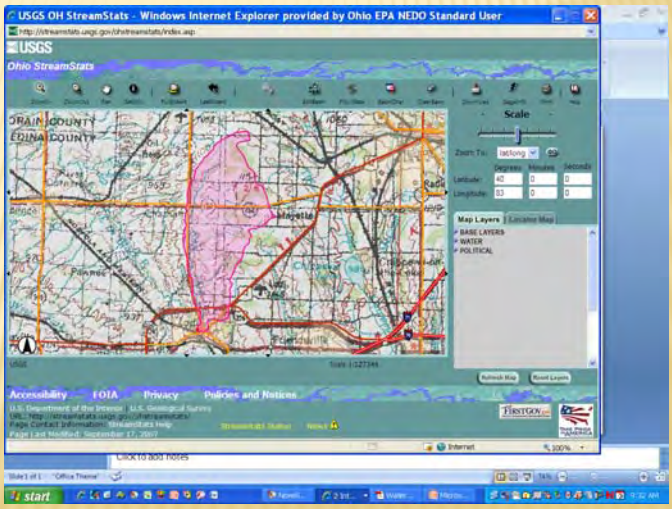
- The site falls into Mitigation Category 3 (WWH).
- All three acreage metrics apply:
  - Aquatic Habitat
  - Flood Prone Area
  - Vegetated Riparian Area
- Applicability for credits and credit allocation is based upon:
  - Final condition
  - Comparison to initial condition
  - Comparison to the targets

DESKTOP TOOLS: STREAMSTATS

http://water.usgs.gov/osw/streamstats/ohio.html

Upstream Lodi WWTP watershed delineation

Watershed area = 13.8 mi^2 (8,832 acres)



UPSTREAM LODI WWTP– DESIGN TARGETS

Stream Condition Targets for Mitigation

Page 2

Blue Cells are for Data Input

Red Cells are Auto-Calculated

Project: Spreadsheet calibration test
Stream Name: East Fork East Branch Black River
Stream Reach ID: Upstream Lodi WWTP (RM 1.98 - 1.53)
River Mile: 1.9

Aquatic Life Use: WWH - GHOW
Margin of Safety: 1.5

HABITAT TARGETS

Site-Specific QHEI Target Applicable?:	Yes / No

See text. Based on reference reach.
Values less than default target with Ohio EPA Permission only

Site-Specific QHEI Target:	65.0
Site-Specific QHEI Max:	80.0

See Text. Base on Regional Data

FLOODPLAIN COMPARISON WIDTHS

Reference Zones:	Width (ft):	Area (ac)
Target Streamway Width:	398	16.6
Intermediate Zone:	199	8.3
Core Zone:	120	5.0
Vegetated Riparian Buffer Target:	208	8.7
Minimum Vegetated Riparian Buffer:	104	4.4

Vegetated Riparian Buffer Required?	Yes
Minimum Frequently Flooded (%):	50%
Minimum Frequently Flooded (acres):	8.3

CALCULATED VALUES:

EXISTING CONDITION

W_{BKF} = Bankfull Width (ft):	39.8
L = Channel Length (ft):	2,060
C = (W_{BKF} * L)/43,560 = Channel Area (acres):	1.88
Default Target QHEI:	60
Design Target QHEI:	66

PROPOSED CONDITION

W_{BKF} = Bankfull Width (ft):	39.8
L = Channel Length (ft):	2,060
A = (W_{BKF} * L)/43,560 = Channel Area (acres):	1.88

UPSTREAM LODI WWTP – AQUATIC HABITAT

- The Aquatic Habitat acreage is calculated based upon the following equation:

  QR * CF * C

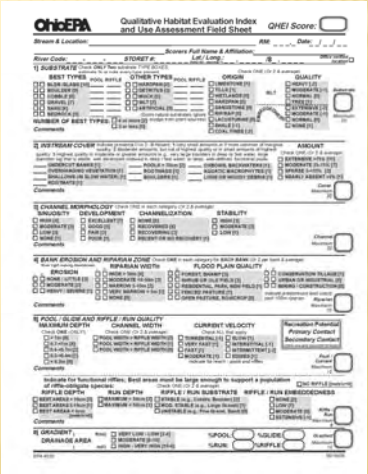
  Where:

  QR = QHEI Ratio, the ratio of the existing or resulting habitat index score to Q_{ref} (QHEI or HHEI)

  Q_{ref} = reference habitat index score (QHEI in this example) = 60

  CF = condition factor based upon the number of Modified Warmwater Habitat attributes

  C = area of the channel (in acres) = $(W_{Bkf} * L) / 43{,}560$
  Bankfull width * channel length (in feet)



AQUATIC HABITAT – CONDITION FACTOR

- CF (condition factor) is based upon the number of High Influence (HI) and Moderate Influence (MI) QHEI attributes present:

≥ 2 HI	= Poor	= 0.4
HI + MI > 4	= Fair	= 0.8
0 HI + 3 or 4 MI	= Good	= 1.0
0 HI + ≤ 2 MI	= Excellent	= 1.2

- The Condition Factor categories are derived from the QHEI methodology (Rankin, 1989; Ohio EPA, 2006)
  - Same categories used in habitat TMDL's in Ohio

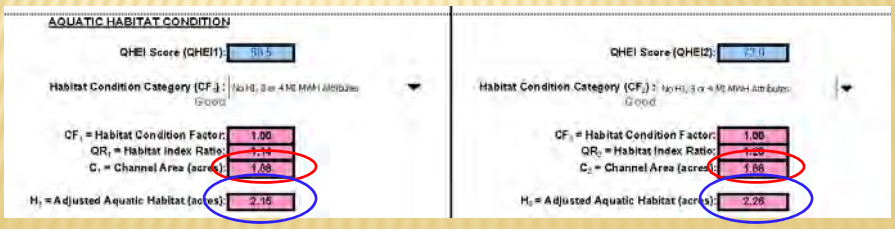
UPSTREAM LODI WWTP – AQUATIC HABITAT

Measurement	Before	After	Target or Threshold
QHEI Score	68.5	72	60
HI – MWH Attributes	1	1	≤ 1
MI – MWH Attributes	3	3	
HI + MI Attributes	4	4	>4
Condition (Narrative)	Good	Good	Fair
Condition Factor	1.0	1.0	

- Notes on habitat:
  - The existing (pre-construction) habitat score was attaining the target
    - only credits for habitat enhancement or preservation would apply
  - The resulting habitat score was higher by only 3.5 points
    - within the range of observational error?
  - The condition factor did not change and meets the criteria: "Good" better than "Fair"

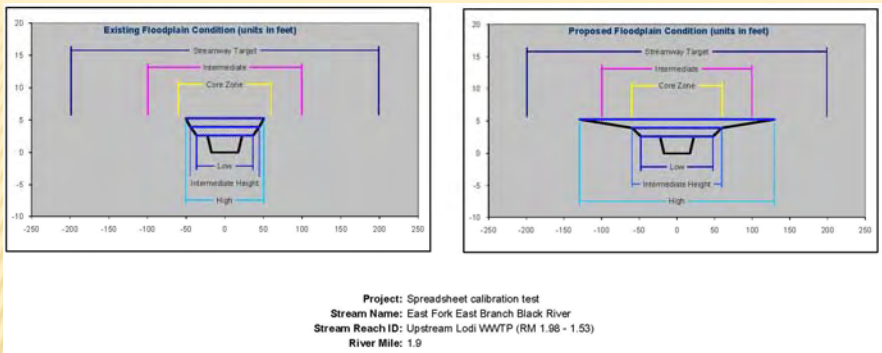
UPSTREAM LODI WWTP – AQUATIC HABITAT

- Final Aquatic Habitat Acreage calculation:
  - No increase in channel length or actual area of channel
  - Adjusted habitat acreage calculation increases by 0.11 acres based upon an increase in the QHEI score
  - Eligible for enhancement credits?
    - In this case, the decision should be based upon site-specific analysis



UPSTREAM LODI WWTP– FLOOD PRONE AREA

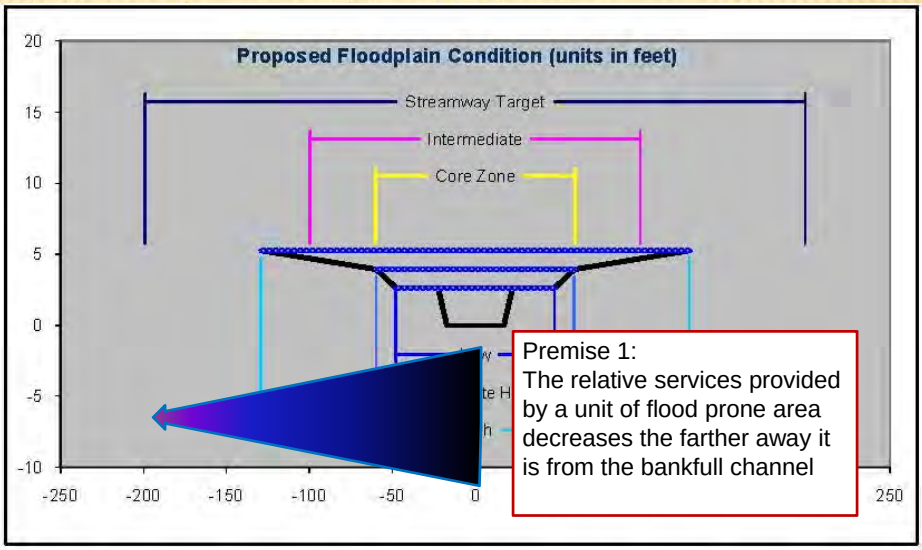
- Areas adjacent to outside bends terraced to provide floodplain
- Spoil piles from past dredging removed
- Degree of excavation possible limited by presence of clay deposits



- Restoration design based upon a Rosgen type "C" channel
- Cobble – gravel substrates
- Bankfull width ranging from 50 – 60 ft
- Bankfull velocities from 3 – 4 fps at 300 cfs
- Stream banks range from 3-12 ft in height
- Stream gradient = 16.95 ft/mi = 0.0032%

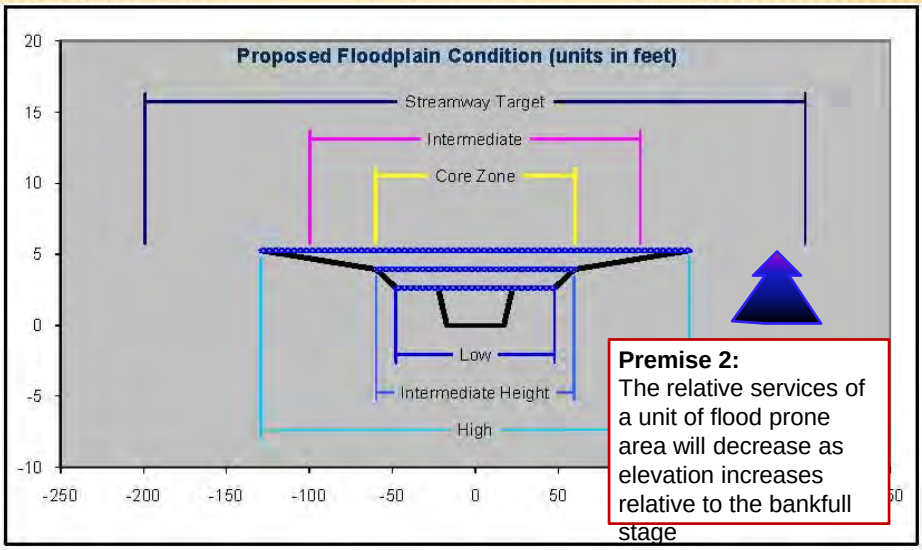
UPSTREAM LODI WWTP– FLOOD PRONE AREA

FLOOD PRONE AREA ADJUSTMENT



Premise 1:
The relative services provided by a unit of flood prone area decreases the farther away it is from the bankfull channel

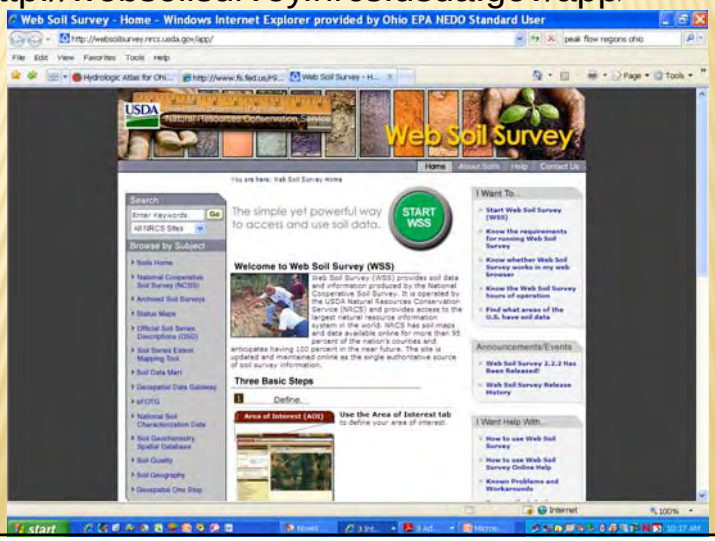
FLOOD PRONE AREA ADJUSTMENT



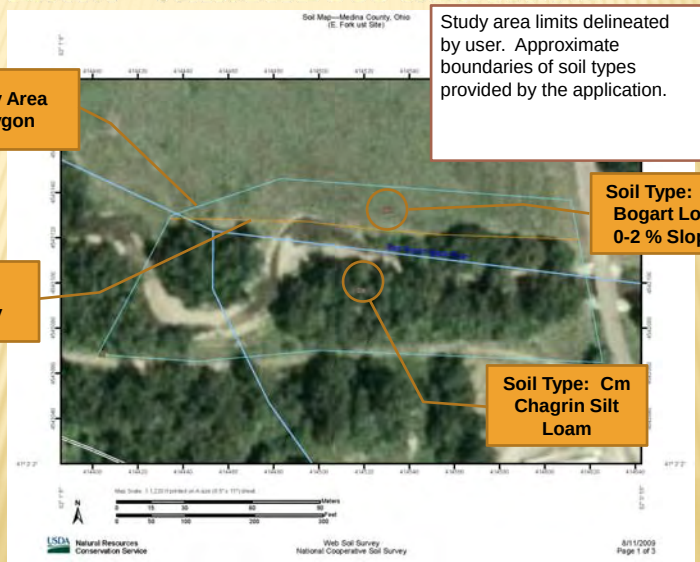
Premise 2:
The relative services of a unit of flood prone area will decrease as elevation increases relative to the bankfull stage

DESKTOP TOOLS: WEB SOIL SURVEY

http://websoilsurvey.nrcs.usda.gov/app/



EAST FORK: UPSTREAM SEGMENT



SOIL QUALITY FACTOR

Quality Factor (scoring value)	Permeability (µm/sec)	Permeability (inches/hr)	Percent Organic Matter
Excellent (1.2)	≥ 9.2	≥ 1.3	≥ 3%
Good (1.0)	5.6 - <9.2	0.8 - <1.3	2% - <3%
Fair (0.8)	3.5 - <5.6	0.5 - <0.8	1% - <2%
Poor (0.4)	<3.5	<0.5	<1%

- The highest quality factor for either permeability or percent organic matter is used for determining the soils quality factor.

EAST FORK: UPSTREAM SEGMENT

Physical Soil Properties–Medina County, Ohio E. Fork ust Site

Report—Physical Soil Properties

Physical Soil Properties– Medina County, Ohio

symbol oil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors Kw	Kf	T	Wind erodibility group	
	In	Pct	Pct	Pct	g/cc	micro m/sec	In/in	Pct	Pct					
Bogart loam, 0 to 2 percent slopes														
Bogart	0-9	-44-	-41-	7-16- 24	1.30-1.50	4.23-42.34	0.12-0.16	0.0-2.9	2.0-3.0	.32	.37	4	5	56
	9-18	-37-	-37-	18-27- 30	1.20-1.60	4.23-42.34	0.09-0.12	0.0-2.9	0.5-1.0	.32	.55			
	18-36	-66-	-15-	8-19- 30	1.20-1.60	14.11-42.34	0.04-0.10	0.0-2.9	0.2-0.5	.32	.64			
	36-60	-86-	- 4-	4-10- 16	1.20-1.80	42.34-141.14	0.03-0.07	0.0-2.9	0.1-0.3	.10	.24			
Cm—Chagrin silt loam														
Chagrin	0-8	-27-	-54-	10-19- 27	1.20-1.40	4.23-14.11	0.17-0.21	0.0-2.9	2.0-4.0	.32	.32	5	5	56
	8-38	-24-	-52-	18-24- 30	1.20-1.50	4.23-14.11	0.11-0.19	0.0-2.9	0.5-1.0	.32	.37			
	38-60	-30-	-55-	5-15- 25	1.20-1.40	4.23-42.34	0.13-0.17	0.0-2.9	0.3-1.0	.32	.43			
Ju—Jimtown-Urban land complex														
Jimtown	0-9	-43-	-40-	10-17- 24	1.30-1.50	4.23-14.11	0.13-0.17	0.0-2.9	2.0-3.0	.32	.37	5	5	56
	9-29	-63-	-19-	18-18- 27	1.25-1.60	4.23-14.11	0.12-0.16	0.0-2.9	0.5-1.0	.32	.43			
	29-60	-69-	- 6-	20-25- 30	1.25-1.65	4.23-42.34	0.10-0.14	0.0-2.9	0.1-0.3	.10	.24			
Urban land	—	—	—	—	—	—	—	—	—					

Permeability GOOD - EXCELLENT

Organic Matter: EXCELLENT at shallow depths, POOR at deeper horizons

Overall Soil Condition = "Good"

USDA Natural Resources Conservation Service — Web Soil Survey, National Cooperative Soil Survey — 8/11/2009 Page 4 of 5

UPSTREAM LODI WWTP – FLOOD PRONE AREA

EXISTING

DESIGN

Project: Spreadsheet calibration test
Stream Name: East Fork East Branch Black River
Stream Reach ID: Upstream Lodi WWTP (RM 1.98 - 1.53)
River Mile: 1.9

UPSTREAM LODI WWTP – FLOOD PRONE AREA

Measurement	Before	After	Target or Threshold
Adjusted Flood Prone Area (acres)	4.7	8.3	8.3
Soils	Good	Good	Fair or Better

- Project meets the minimum required flood prone area (50% of the Streamway Target or 8.3 acres)
- Soil conditions adequate for riparian vegetation and stream function
- Clay deposits limit the ability to create floodplain through excavation
- Addition of grade control to raise the stream bed resulted in greater floodplain connectivity
- Outcome would be eligible for restoration credit
  - Went from acreage less than the minimum to equal to the minimum

VEGETATED RIPARIAN BUFFER

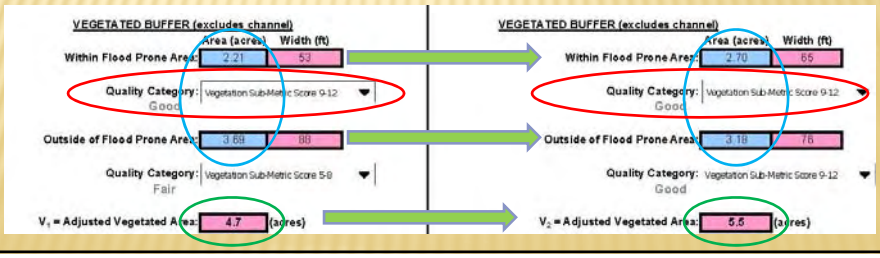
- Notes on vegetated buffer
  - Acreage for credits and debits limited to the calculated target based on drainage area
  - Vegetated areas within the flood prone area score higher than areas at higher elevation
  - Condition factor based upon a vegetation quality score adapted from the ORAM

UPSTREAM LODI WWTP – VEGETATED BUFFER

- Floodplain vegetation prior to project ranged from forest to row crop
- Invasive species were common in the wooded understory
- Extensive planting of the riparian area included in the project
- Values are estimates for illustration (based on project reports)

UPSTREAM LODI WWTP – VEGETATED BUFFER

- Note that the overall acreage did not change (~5.9 acres)
  - Before: 2.21 + 3.69 vs. After: 2.70 + 3.18
- The vegetation condition factor deemed to have improved from "Fair" to Good"
  - Control of invasives + planting along stream margin
- Acreages above and below the flood prone elevation changed
- Result is an overall increase in the adjusted flood prone acres (5.5 acres vs. 4.7 acres = 0.8 acre increase)
  - Improvement meets the criteria for enhancement



UPSTREAM LODI WWTP – WRAPPING IT UP!

Pre vs. Post Mitigation Screening

Mitigation Criteria Check List:		Existing	Resulting	Target or Minimum
Existing Habitat Index ≥ Target?	Yes	66.5		65
Existing Habitat Condition Mitigative?	Yes	Good		
Resulting Habitat Index ≥ Existing?	Yes		72	
Resulting Habitat Index > Existing?	Yes			
Resulting Habitat Index ≥ Target?	Yes			
Resulting Habitat Condition Stable?	Yes			
Resulting Habitat Condition Improved?	No		Good	
Resulting Habitat Condition Mitigative?	Yes			Fair
Existing FP Area ≥ Minimum?	No	4.7 acres		8.3 acres (minimum)
Existing FP Area ≥ 30% of Target?	No			16.6 acres (target)
Existing FP Area ≥ 50% of Target?	No			
Resulting FP Area ≥ Existing?	Yes		8.3 acres	
Resulting FP Area > Existing?	Yes			
Resulting FP Area ≥ Minimum?	Yes			
Resulting FP Area ≥ 50% of Target?	Yes			
Existing Vegetative Buffer ≥ Minimum?	Yes	4.7 acres		4.4 acres (minimum)
Existing Vegetative Buffer ≥ Target?	No			8.7 acres (target)
Existing Vegetation Quality Acceptable?	Yes	Good		Fair
Resulting Vegetative Buffer ≥ Existing?	Yes		5.5 acres	
Resulting Vegetative Buffer > Existing?	Yes			
Resulting Vegetative Buffer ≥ Minimum?	Yes			
Resulting Vegetation Quality Stable?	Yes			
Resulting Vegetation Quality Improved?	No			
Resulting Vegetation Quality Acceptable?	Yes		Good	

UPSTREAM LODI WWTP – WRAPPING IT UP!

Mitigation Type Screening:	Aquatic Habitat	Flood Prone Area	Vegetated Buffer
Eligible for Preservation Credits?			
Existing Condition:	NA	NA	NA
Resulting Condition:	Yes	Yes	Yes
Eligible for Enhancement Credits?	Yes	No	Yes
Eligible for Restoration Credits?	No	Yes	No

- Aquatic Habitat and Vegetated Buffer metrics eligible for enhancement credits, but not restoration credit
  - Both metrics met the minimum conditions for the use and setting
- The Flood Prone Area metric is eligible for restoration credits
  - The adjusted acreage and condition was improved from unacceptable to acceptable

UPSTREAM LODI WWTP – WRAPPING IT UP!

Credit/Debit Accounting: **Restoration and Preservation Credit Allocation**

	Existing	Resulting	Improvement	Credits
Aquatic Habitat Credits (acres):	2.15	2.26	0.11	2.26
Adjusted Flood Prone Area (acres):	4.7	8.3	3.6	11.9
+ Adjusted Vegetated Area (acres):	4.7	5.5	0.8	5.5
Riparian Credits (Acres):				17.4

Credit/Debit Accounting: **Restoration Credit Allocation with no Preservation**

	Existing	Resulting	Improvement	Credits
Aquatic Habitat Credits (acres):	2.15	2.26	0.11	0.11
Adjusted Flood Prone Area (acres):	4.7	8.3	3.6	8.3
+ Adjusted Vegetated Area (acres):	4.7	5.5	0.8	0.8
Riparian Credits (Acres):				9.1

UPSTREAM LODI WWTP – WRAPPING IT UP!

- The final piece to the evaluation is the post-project control proposed for the site.
- Fee simple ownership, easement, or covenant credited at 100%
- Deed restrictions (where allowed) credited at 75%
- Option for no post-project control is not applicable in this example – preservation credits are being applied
  - Note awarding of these credits is discretionary, is only allowed in conjunction with a primary project, and must be verified by monitoring

Credit Adjustment Based on Post-Project Control:

Note: this example assumes a preservation component

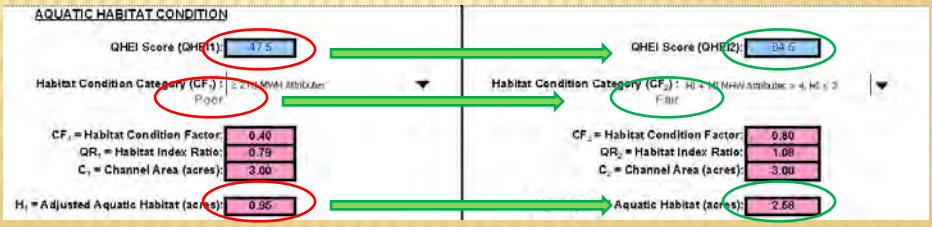
Control Type	Aquatic Habitat Credits (acres)	Riparian Credits (acres)	Credit Rate
Fee Simple	2.26	17.4	100%
Easement or Covenant	2.26	17.4	100%
Deed Restriction	1.69	13.1	75%
No Control	NA	NA	15%

EXAMPLE 2 – DOWNSTREAM LODI WWTP

- Restoration activities:
  - Constructed riffle and gravel bars to stabilize riffle-pool development
  - Old meander channel cleaned of debris to promote flood flow path
  - Spoil piles along the stream bank removed to improve connectivity
- Cross sectional data not available for analysis of changes to flood prone area
- Vegetation in the riparian area largely intact mature forest
- Changes in habitat quality evaluated for this example

EXAMPLE 2 – DOWNSTREAM LODI WWTP

- Habitat quality as measured with the QHEI significantly improved
- Condition factor based on MWH attributes also improved
- Targets for restoration credit met
- Adjusted Aquatic Habitat acreage increased by 271%



EXAMPLE 2 – DOWNSTREAM LODI WWTP

- To simplify the example, the downstream reach is assumed to have no preservation component
  - No legal instruments used to control site use
- Table demonstrates the discount to the credits available in these instances
  - This example, credits reduced by 85%
- Caution: for projects with spin-off effects, upstream and downstream <u>benefits</u> and <u>impacts</u> should be assessed

Credit Adjustment Based on Post-Project Control:

Control Type	Aquatic Habitat Credits (acres)	Riparian Credits (acres)	Credit Rate
Fee Simple	2.58	0.0	100%
Easement or Covenant	2.58	0.0	100%
Deed Restriction	1.93	0.0	75%
No Control	0.39	0.0	15%

ANY QUESTIONS ???

"Stream work ain't so tough, you just need a little know how!"