Engineering Natural Streams within the Built Environment

– How the Greater Peoria Sanitary District Weathered

Mother Nature

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Presented by:

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Introduction

- Project Background
- Site History & Urbanization
- RESEARCH!
- Benefits of Past Efforts
- Site Conditions and Repairs
- Permitting/Early Coordination

Project Background

- Greater Peoria Sanitary District (GPSD) Sewer Rehab. and Erosion Control
- Significant erosion around sanitary sewer facilities
- Correct existing damage and protect assets against future degradation.
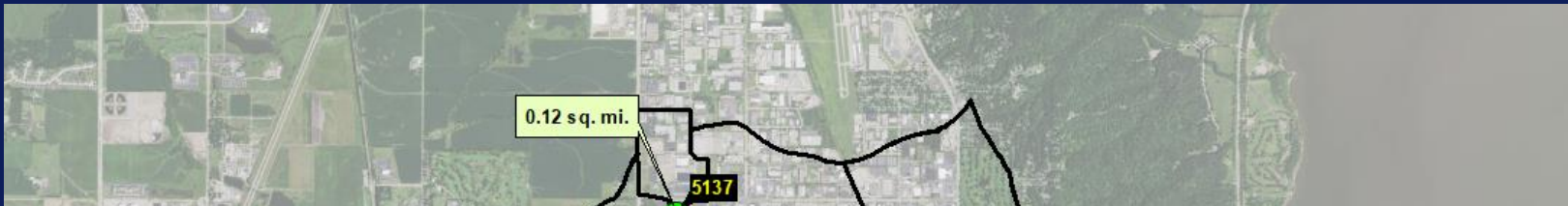- Extensive site assessments
- 2 Phase Approach

- COORDINATION!

Site History & Urbanization

- Site Conditions
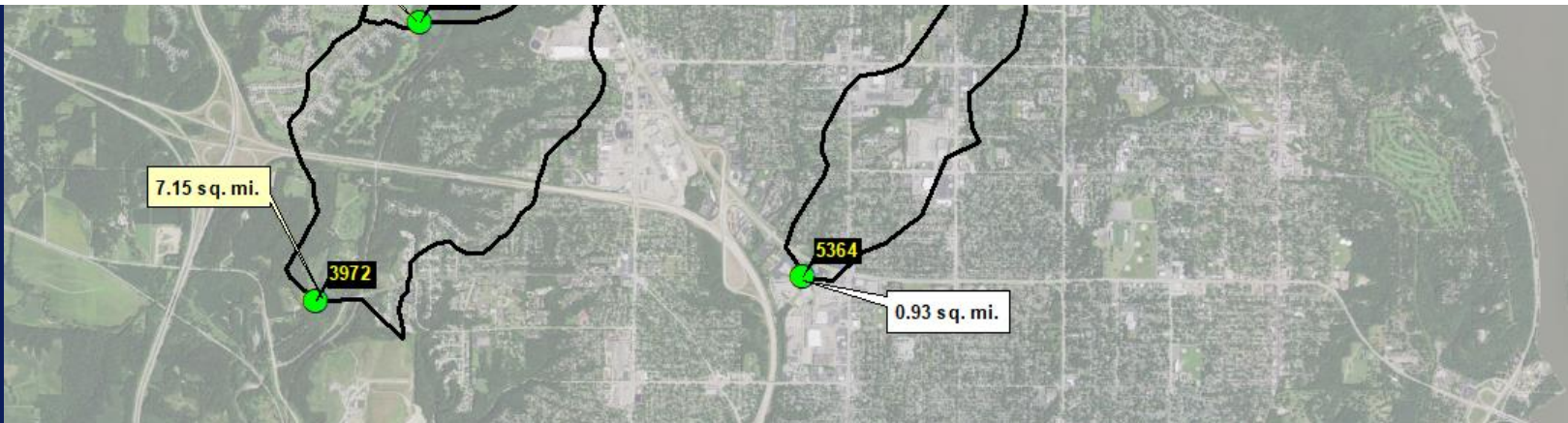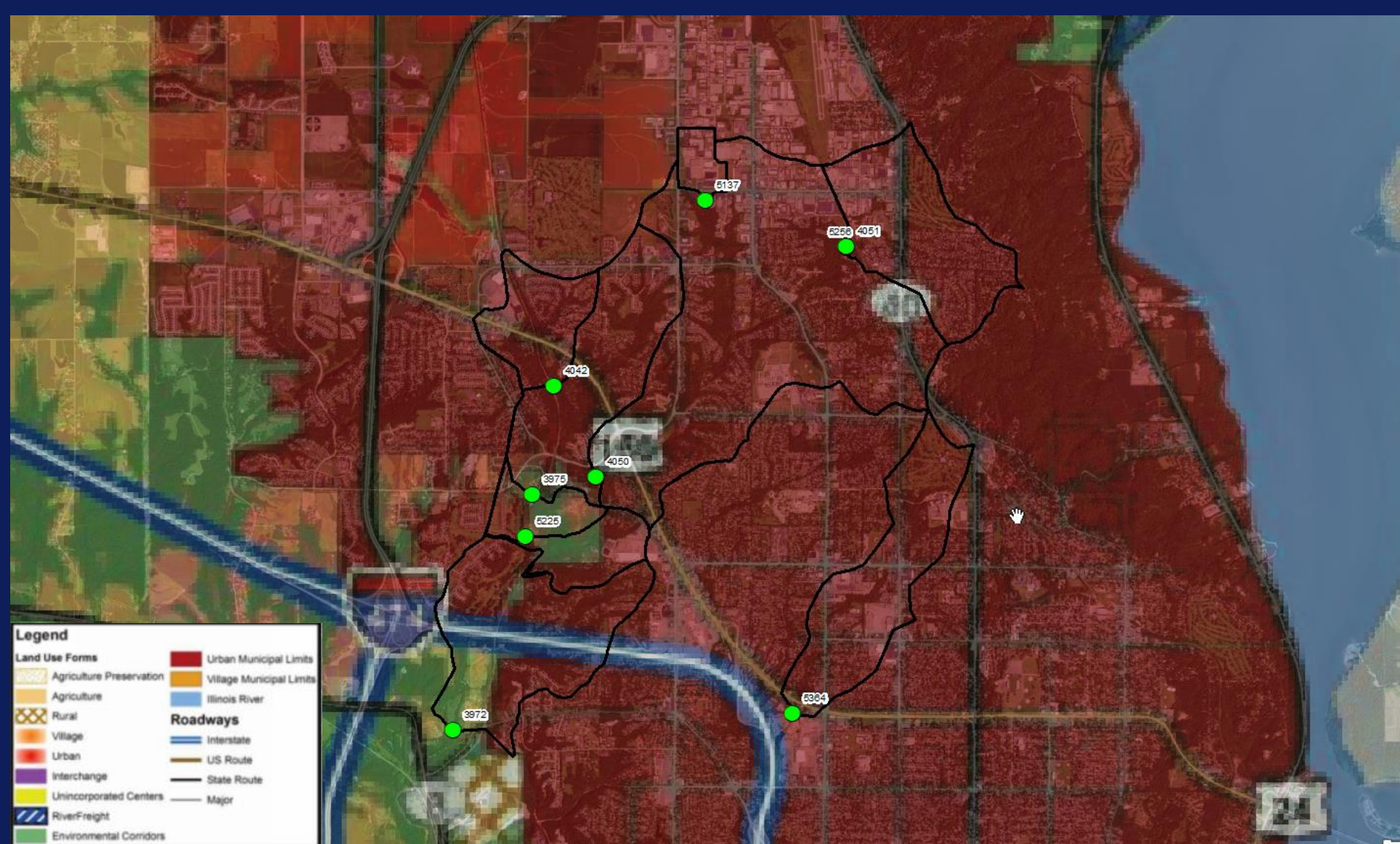- Age of infrastructure
- Peoria Growth

Basins

Site #	Drainage Name	TDA mi²	MCS ft/mi	BL mi	Q_{100} cfs	Comment	$1mi^2 < A < 10\ mi^2$	$A > 10\ mi^2$	$A < 1\ mi^2$
4050	Big Hollow Creek	4.03	38.91	3.19	2,597	Rural or Urban Watershed?	IDNR Determination		
3975	Big Hollow Creek	5.47	38.01	3.82	3,261	Rural or Urban Watershed?	IDNR Determination		
5225 & 5471	Big Hollow Creek	5.69	39.75	4.19	3,370	Rural or Urban Watershed?	IDNR Determination		
3972	Big Hollow Creek	7.15	40.19	5.60	3,835	Rural or Urban Watershed?	IDNR Determination		
5383	Kickapoo Creek (near outfall)	306.04	6.94	25.24	27,134			Jurisdictional	
5137	Big Hollow- North Fork Tributary	0.12	20.00	0.50	163				Non-Jurisdictional
4042	Big Hollow- North Tributary	0.45	80.52	0.98	792				Non-Jurisdictional
5364	Dry Run Creek C	0.93	73.01	4.19	993				Non-Jurisdictional
4051 & 5256	Big Hollow Creek	0.94	37.19	1.61	904				Non-Jurisdictional

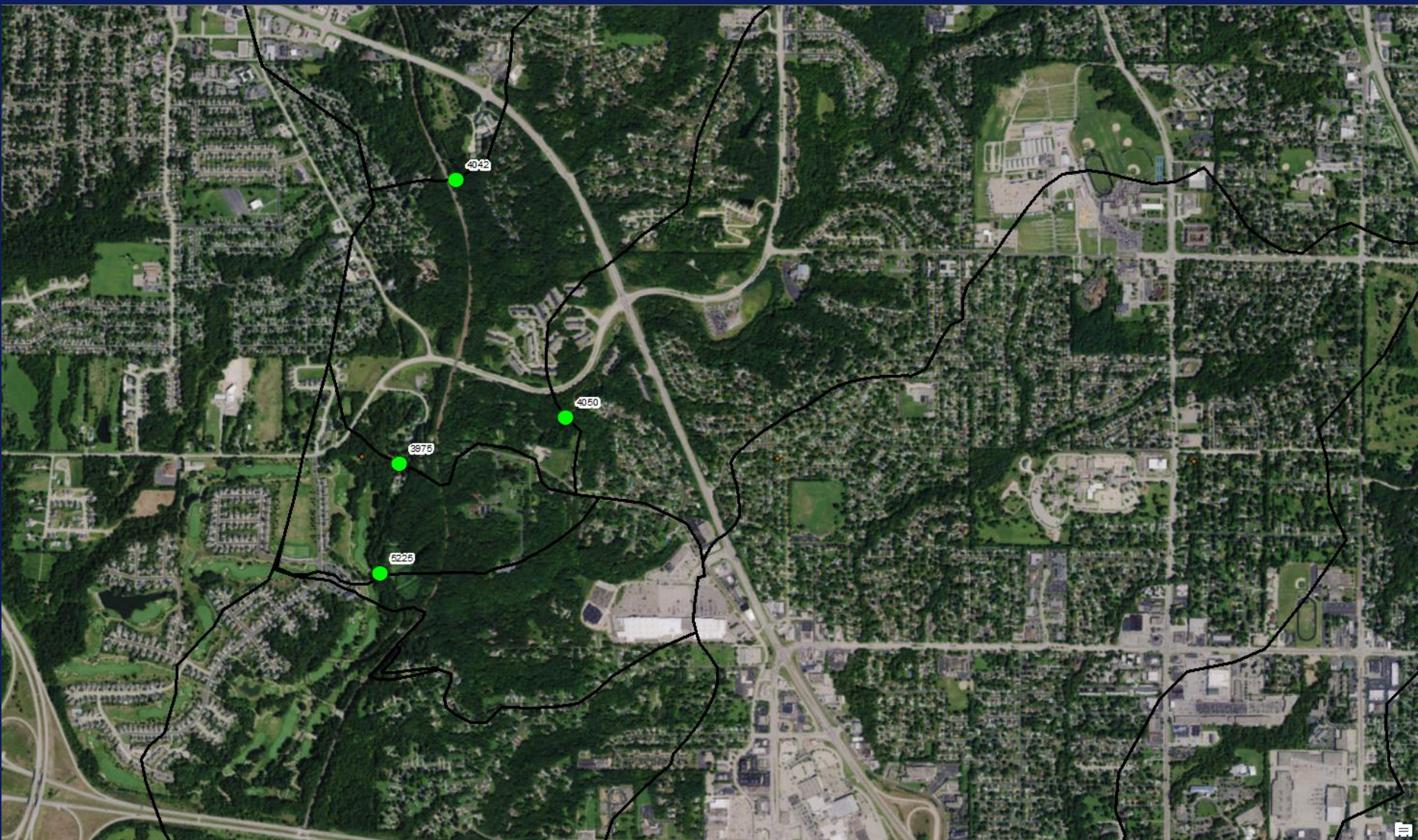Rural or Urban

Age of Infrastructure & Peoria Growth

Urbanization

Erosion Control Measures

- Typical
  - Ripra
  - Turf   lankets
  - Vege
  - River
  - Grad   ure)
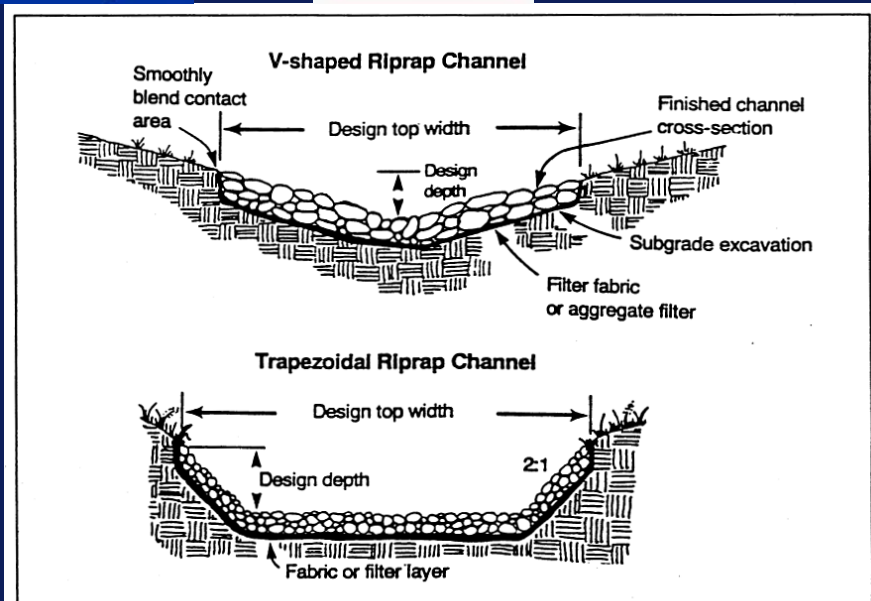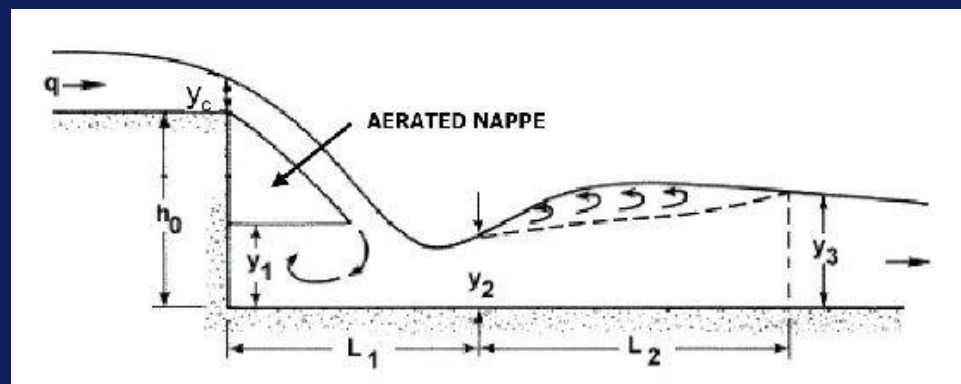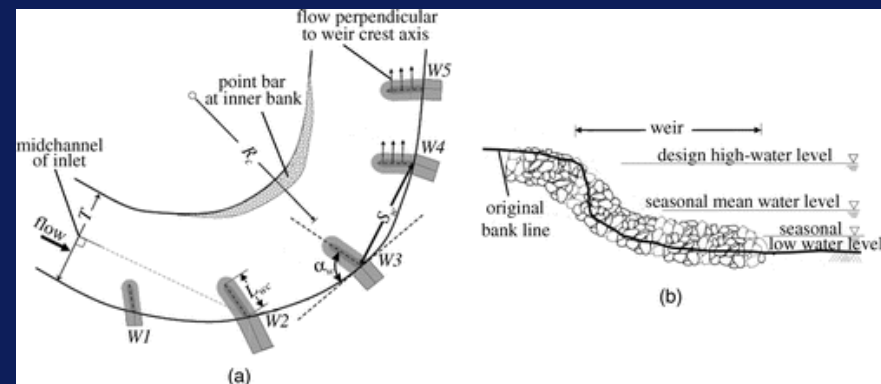- Customized to each site

RESEARCH!

Figure 6. Typical riprap-lined channel cross-sections. (Source: Ref. 1)
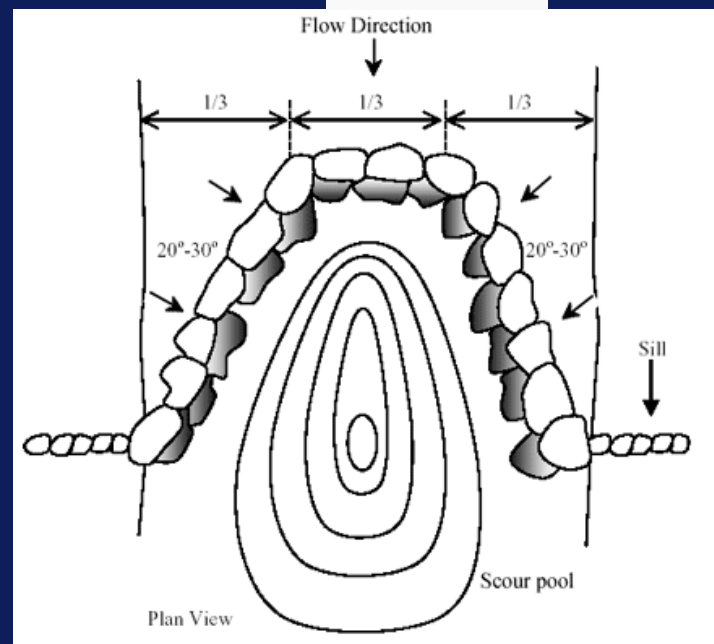
Benefits of Past Repairs

- Research = Bench Scale
- Past Repairs = Field Experience
  - Riprap
  - ACB
  - Gabion Baskets
  - Concrete Blocks

Site Conditions and Repairs

- Steep Channels & limited workspace/accessibility
    - Velocity/Shear!
- Sustainability and a long term approach
- Predicting future conditions
- Impacts to the natural environment
- Significant Presence of Debris
- Modeling, Assumptions, and Design

Goals

- Promote Trapezoidal Channel Shape
- Imitate Nature
- Energy Dissipation
- Reduce Erosion

- Cost
- Design Frequency
- Resiliency

Hydraulic Analysis

- Utilize U.S. Army Corps of Engineers' HEC-RAS computer program
- Develop a 1D model of the channel reach
- Define hydraulic parameters at the site
    - *Velocity*
    - *Shear Stress*
- Evaluate final design and quantify hydraulic impacts
- Early Opportunity to use HEC-RAS 2D

15.0
10.0
8.0
6.0
4.0
2.0
0.0
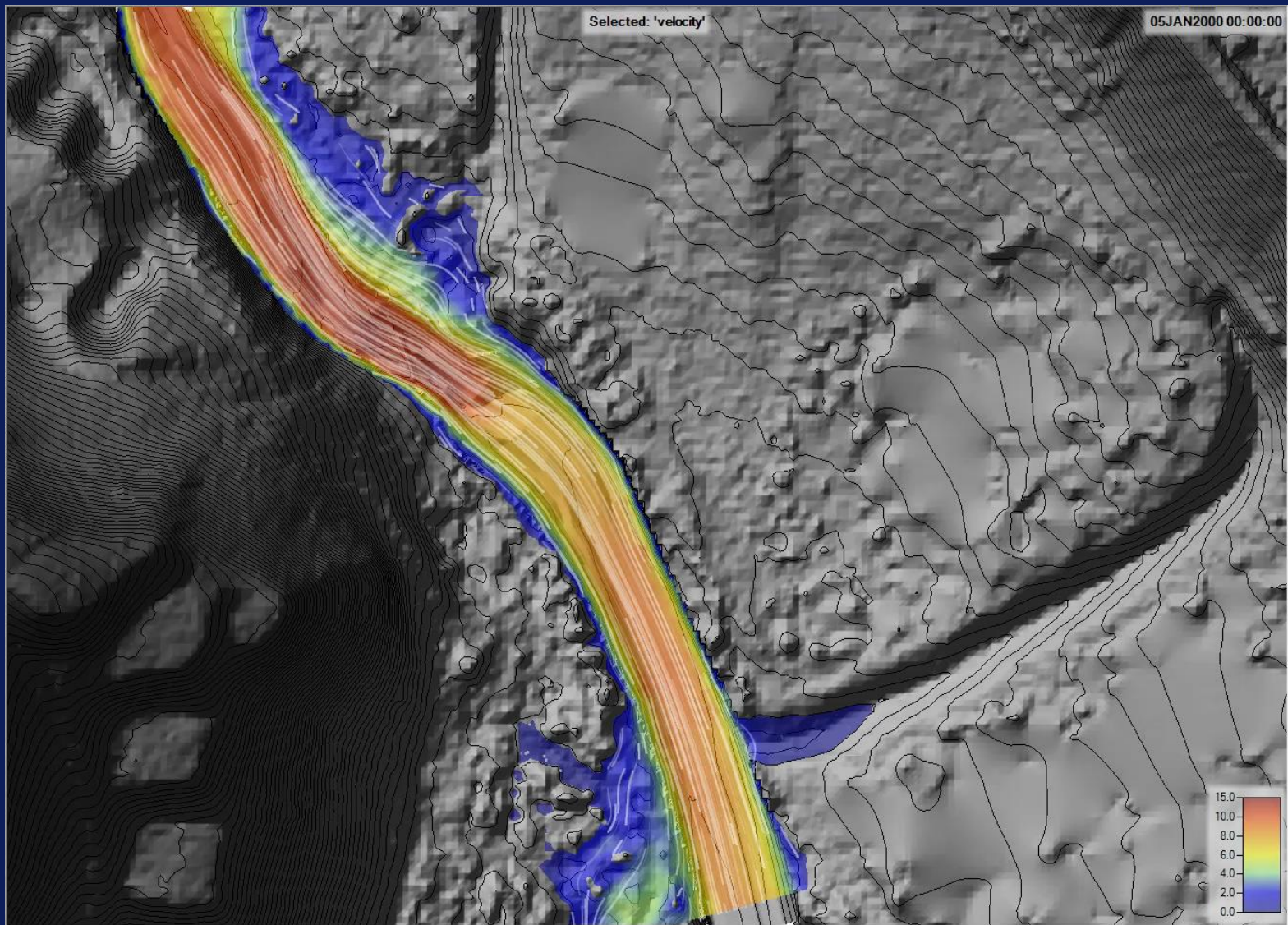
Applicability of Available Research

- Difficult to apply lab equations to natural environment
  - Limitations of study source data
- Multiple Methodologies
  - Try them all
  - Develop a conservative solution with good engineering judgement
- Develop unique approaches

Site Repairs

5383 – Kickapoo Creek near Mouth

- Familiar with reach
  - 2D modeling just upstream of project site
  - Upstream failure of ACB
- Multiple Approaches
  - Move Berm
  - Restore and Armor natural alignment
- Restoration of "natural conditions"
  - Is natural still sustainable
  - Minimize encroachment
  - Don't further degrade bank

5383 – Kickapoo Creek near Mouth
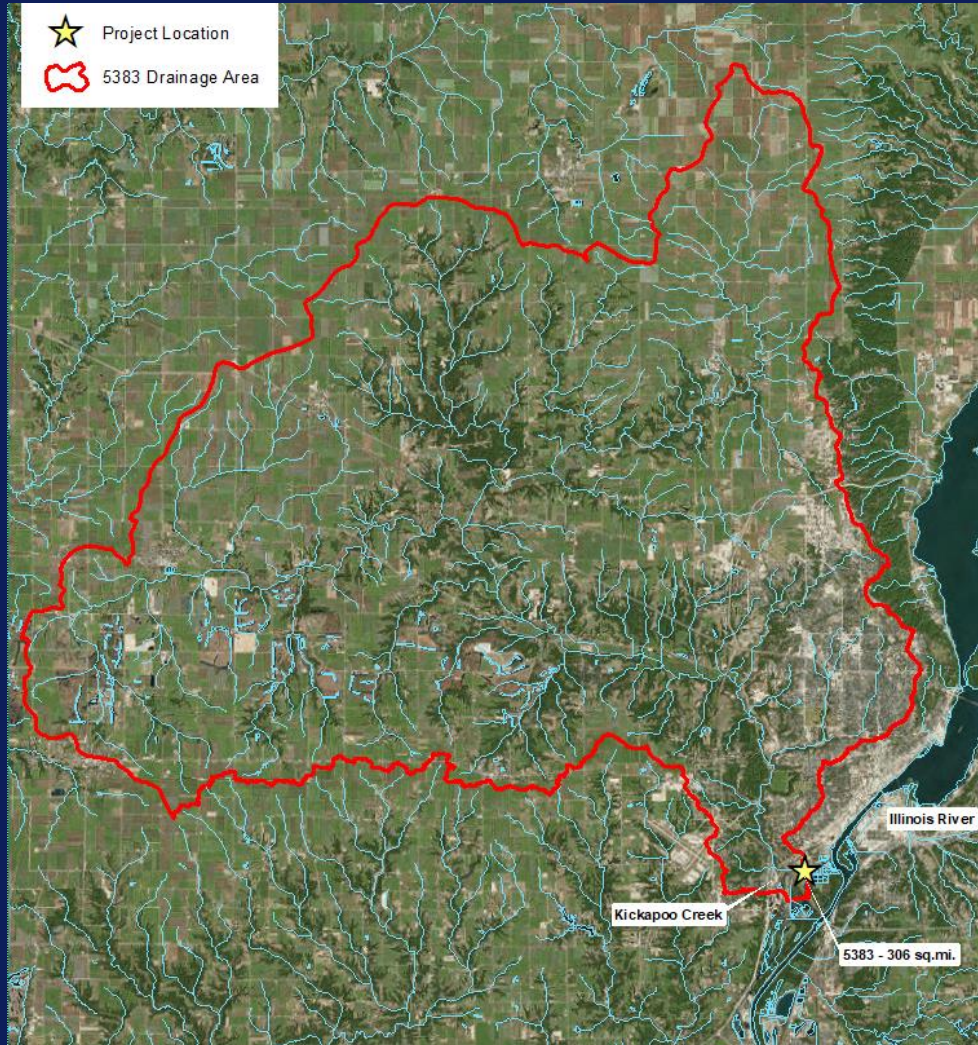
History of Channel Migration
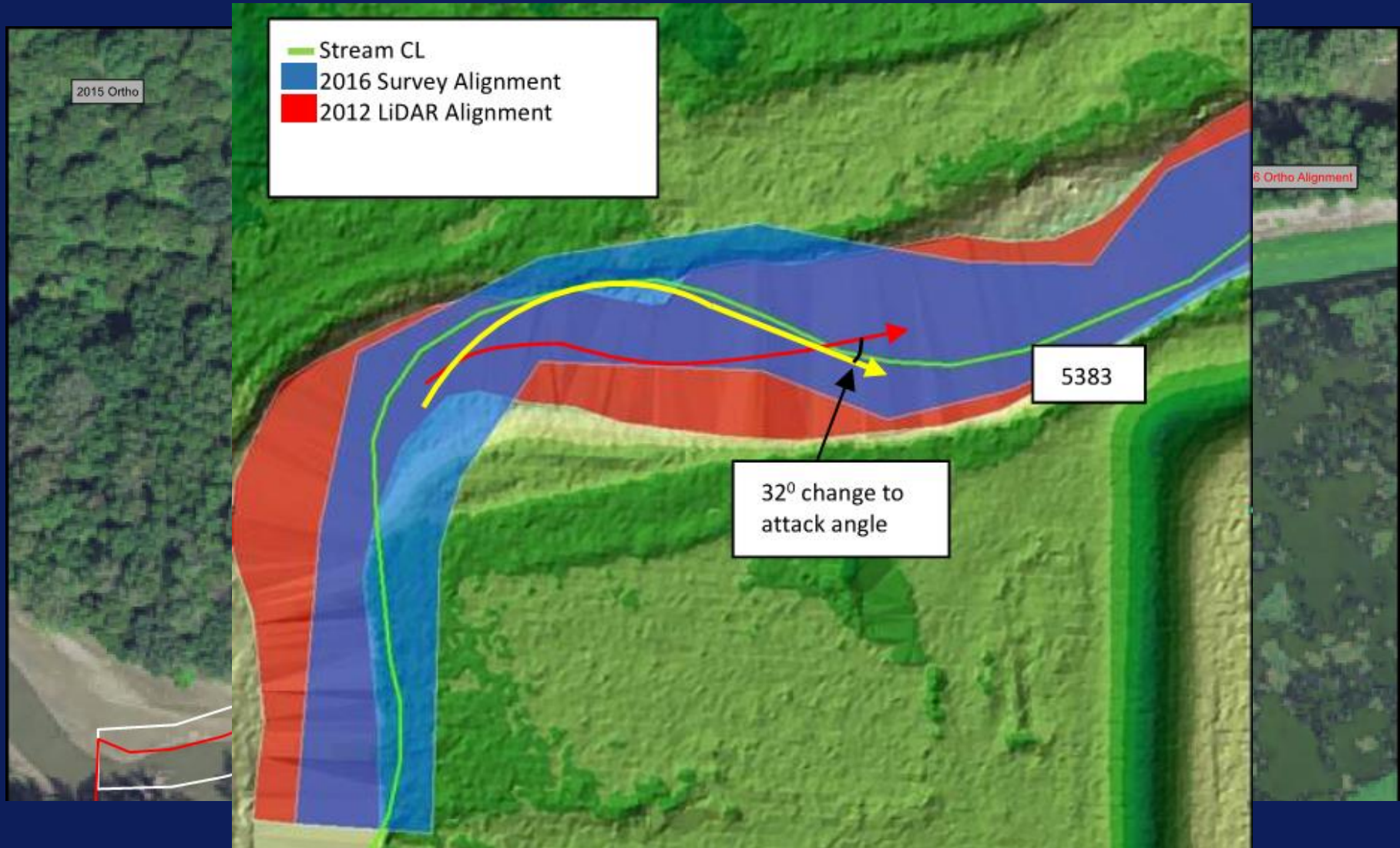
Debris Induced?

Solution

- Moving wastewater berm was not feasible
  - Cost
  - Permitting
  - Reduction in Storage
- Stabilizing Bank
  - Minimize fill
  - Launching Stone
  - Key
  - Remove accumulated debris

PROPOSED SITE PLAN
SCALE: 1"=30'
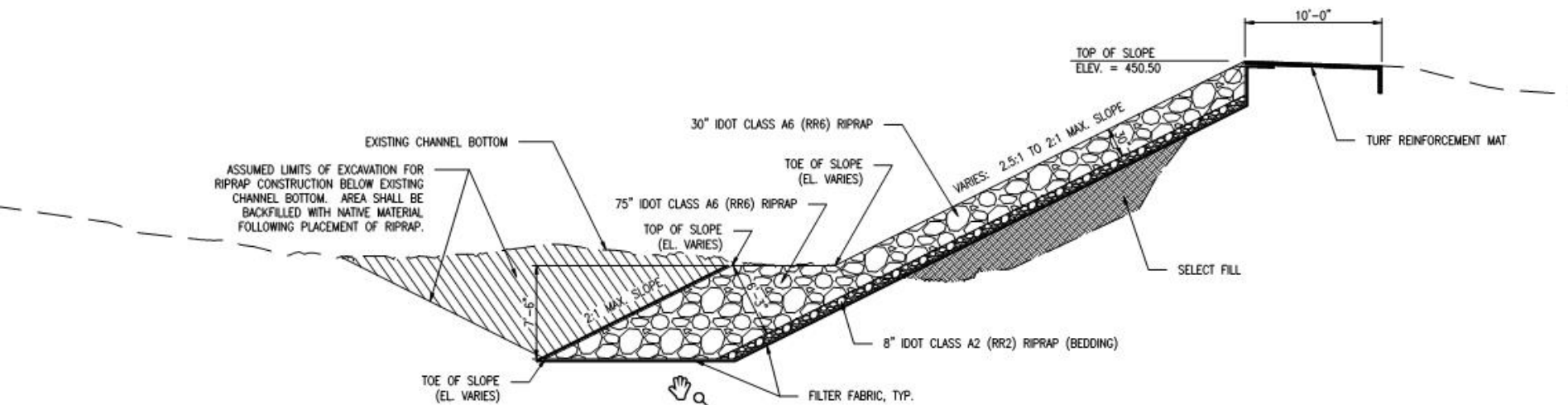
TYPICAL BANK STABILITZATION – CROSS SECTION
SCALE: NONE

5225/5471 – Big Hollow Creek Headcut
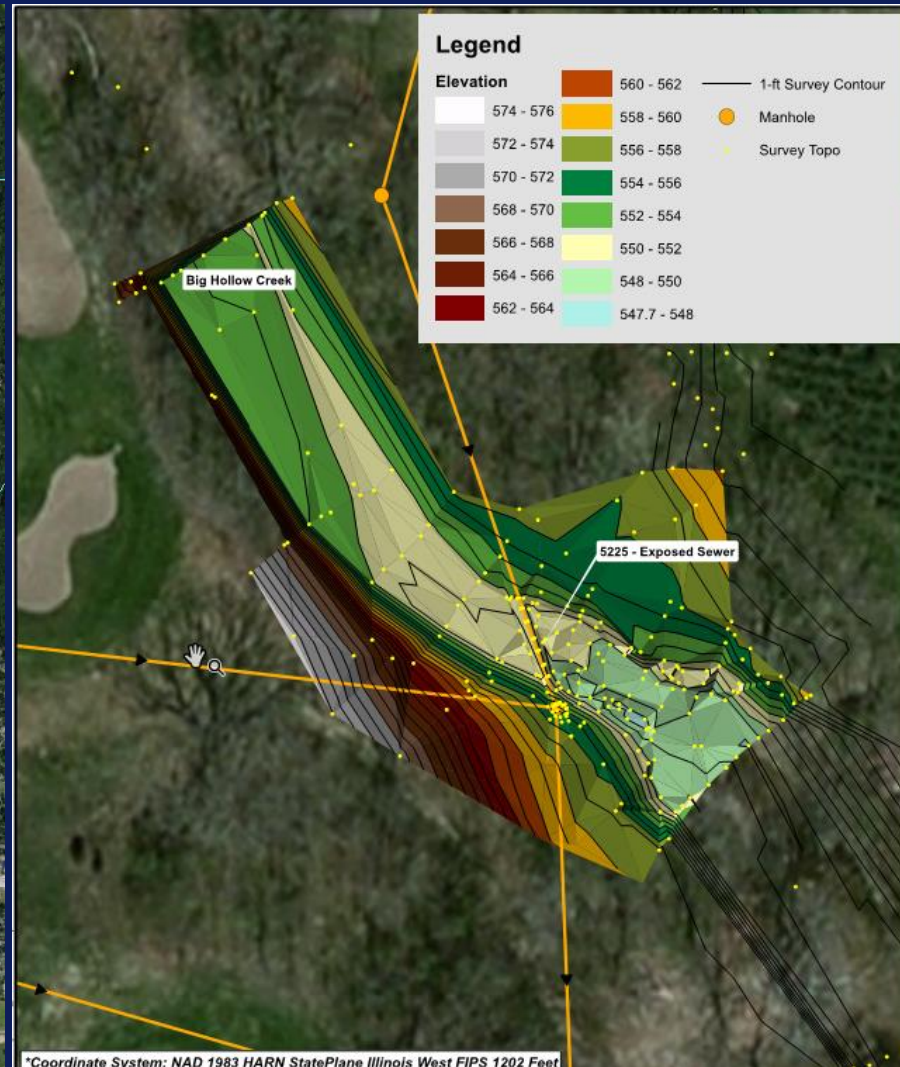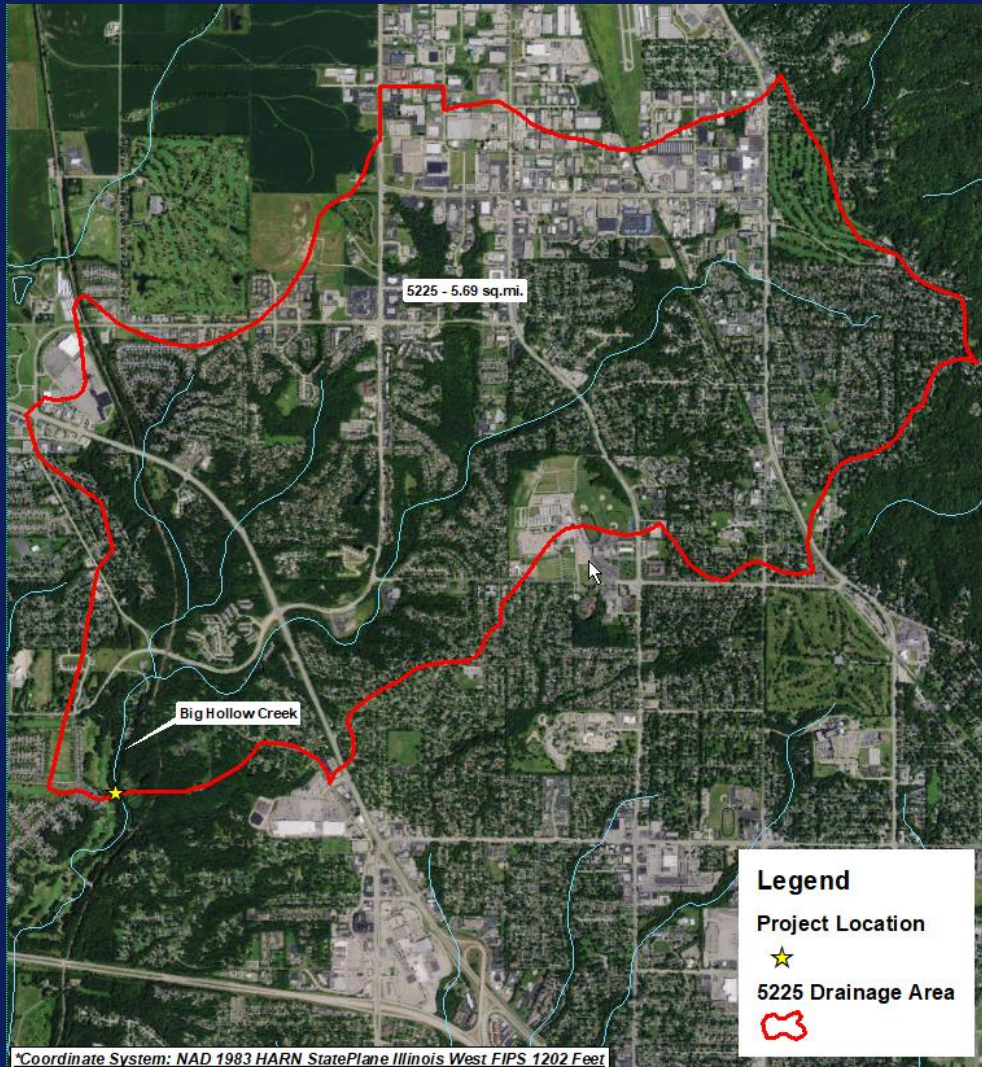
Site History

- Past Repairs
  - Gabions
  - Encasement
  - Riprap (at grade)
- Presence of debris and large diameter rock
- Headcut
- Upstream infrastructure

5137 - North Fork Trib

- Similar to 5225

5364 - Dry Run Creek

- Similar to 5225

Solution

- **Grade Control**
  - Log Drop
    - Long Term Outlook
  - Concrete Block Weir
- **Riprap**
- **Preformed Scour**
  - Staged Drops in Grade
  - 2-ft max
  - Dissipate Energy

PLAN – NOTCHED LOG DROPS
SCALE: NONE

SECTION A-A
SCALE: NONE

Top of diagram (plan view):

23.25'
DISSIPATER POOL

11.5'
APRON

23.25'
DISSIPATER POOL

11.5'
APRON

2'x2'x4' CONCRETE BLOCK (TYP.)

RIPRAP SLOPE STABILIZATION

MAX. 1.5:1

Middle diagram:

TOP OF SIDESLOPE EL. = 749.00

CONCRETE BLOCK GRADE CONTROL STRUCTURE #1 (SEE DETAILS)

CONCRETE BLOCK GRADE CONTROL STRUCTURE #2 (SEE DETAILS)

CONCRETE BLOCK GRADE CONTROL STRUCTURE #3 (SEE DETAILS)

CONCRETE BLOCK GRADE CONTROL STRUCTURE #4 (SEE DETAILS)

CONCRETE BLOCK GRADE CONTROL STRUCTURE #5 (SEE DETAILS)

FLOW

9'
DISSIPATOR POOL
7'-6"
1'-6"
EL. 746.17

9'
DISSIPATOR POOL
7'-6"
1'-6"
EL. 745.75

DISSIPATOR POOL
7'-6"
1'-6"
EL. 745.33

9'
DISSIPATOR POOL
7'-6"
1'-6"
EL. 744.9

EL. 742.87
24"
7'-6"
1'-6"
DISSIPATOR POOL

16" IDOT CLASS A4 (RR-4) RIPRAP
6" IDOT CLASS A1 (RR-1) RIPRAP BEDDING
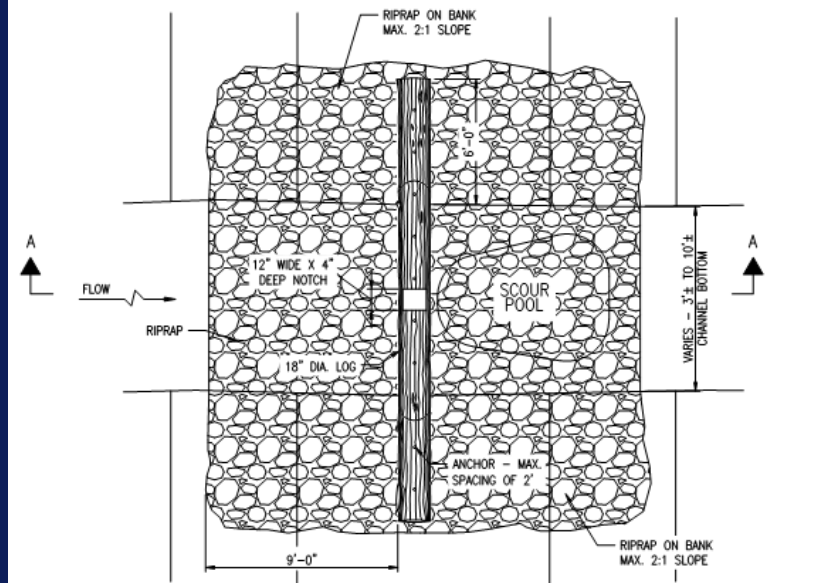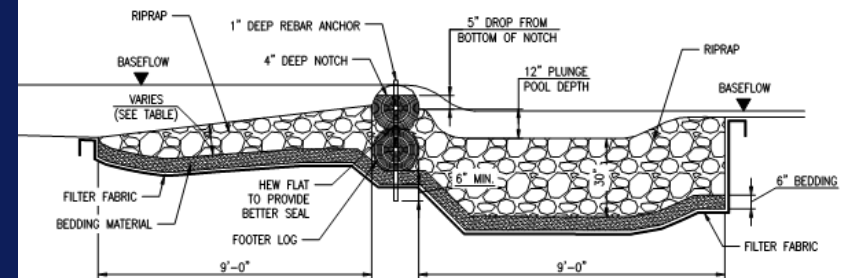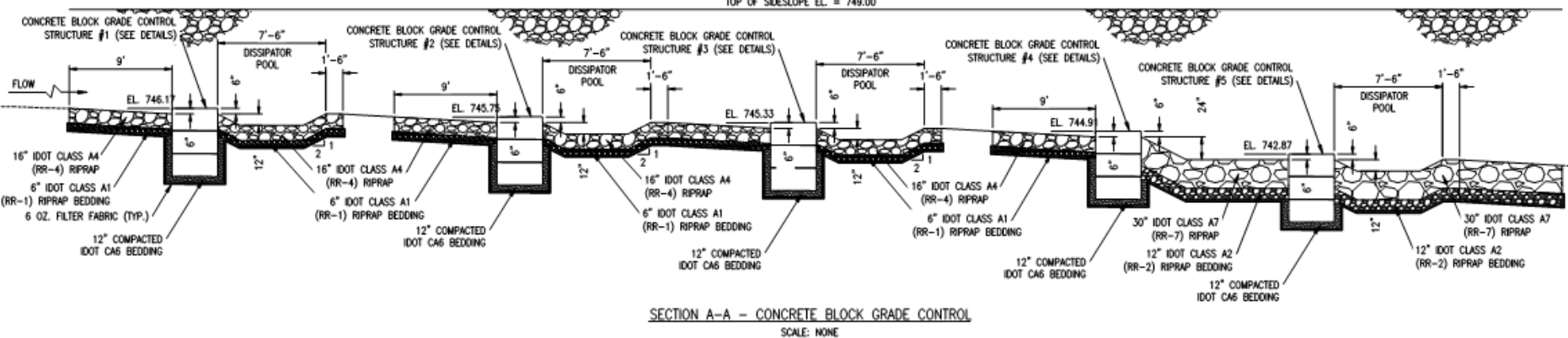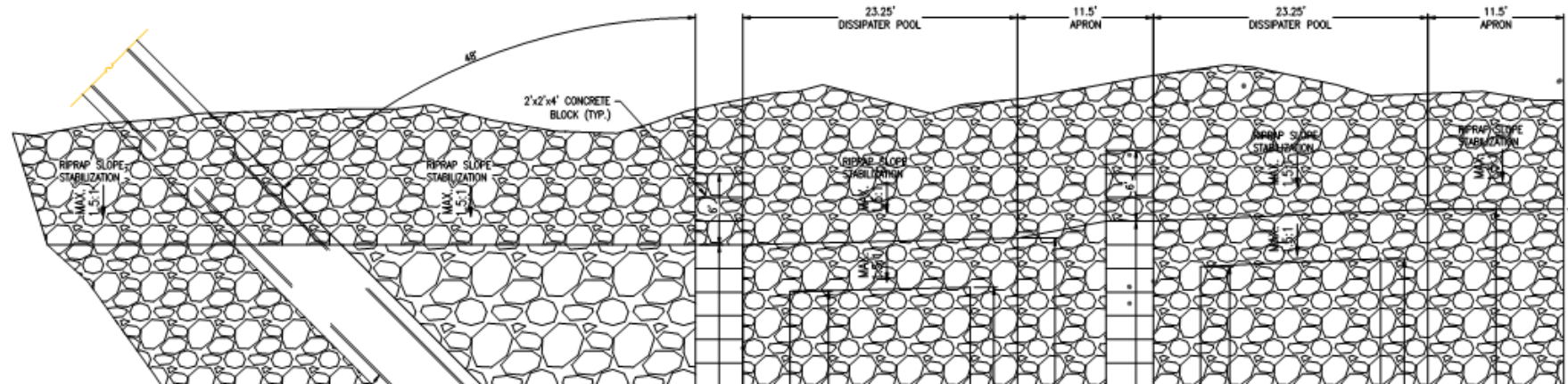6 OZ. FILTER FABRIC (TYP.)
12" COMPACTED IDOT CA6 BEDDING

16" IDOT CLASS A4 (RR-4) RIPRAP
6" IDOT CLASS A1 (RR-1) RIPRAP BEDDING
12" COMPACTED IDOT CA6 BEDDING

16" IDOT CLASS A4 (RR-4) RIPRAP
6" IDOT CLASS A1 (RR-1) RIPRAP BEDDING
12" COMPACTED IDOT CA6 BEDDING

16" IDOT CLASS A4 (RR-4) RIPRAP
6" IDOT CLASS A1 (RR-1) RIPRAP BEDDING

30" IDOT CLASS A7 (RR-7) RIPRAP
12" IDOT CLASS A2 (RR-2) RIPRAP BEDDING
12" COMPACTED IDOT CA6 BEDDING

30" IDOT CLASS A7 (RR-7) RIPRAP
12" IDOT CLASS A2 (RR-2) RIPRAP BEDDING

SECTION A-A - CONCRETE BLOCK GRADE CONTROL
SCALE: NONE

REPAIR 5225: PLAN - VERTICAL DROP STRUCTURES 2x2x4 CONCRETE BLOCK
SCALE: NONE

Bottom diagram:

TOP OF SIDESLOPE ELEV. VARIES

FLOW

EL. 552.00
EL. 549.02±

2'x2'x4' CONCRETE BLOCK (TYP.)
BLOCK TIE (TYP.)

23.25'
DISSIPATOR POOL
11.5'
APRON

23.25'
DISSIPATOR POOL
11.5'
APRON

3.2'
30"

3.2'
30"

RR-5 RIPRAP D$_{50}$=12"
BEDDING MATERIAL
EXIST. 54" RCP PIPE
CONCRETE CAP
RR-7 RIPRAP D$_{50}$=18"
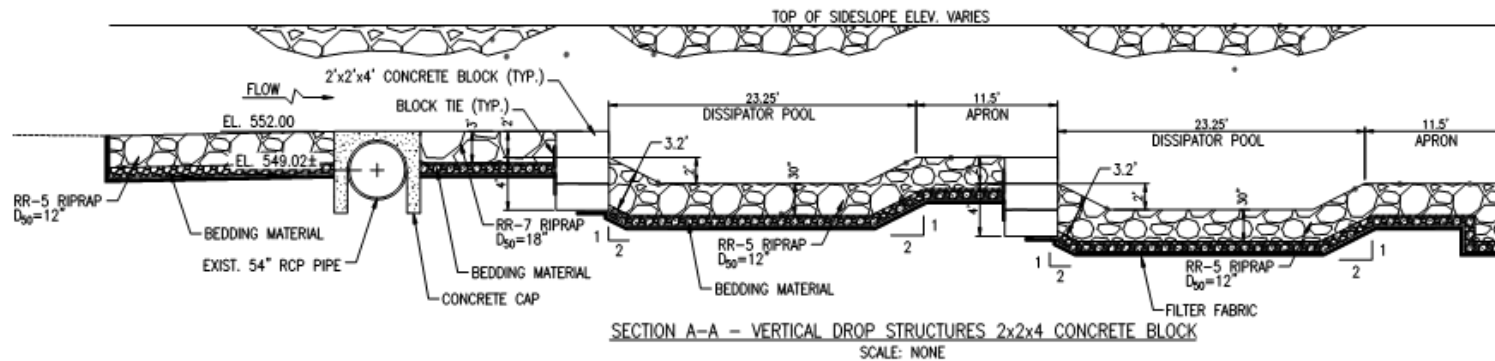BEDDING MATERIAL
RR-5 RIPRAP D$_{50}$=12"
FILTER FABRIC
RR-5 RIPRAP D$_{50}$=12"

SECTION A-A - VERTICAL DROP STRUCTURES 2x2x4 CONCRETE BLOCK
SCALE: NONE

Concrete Blocks

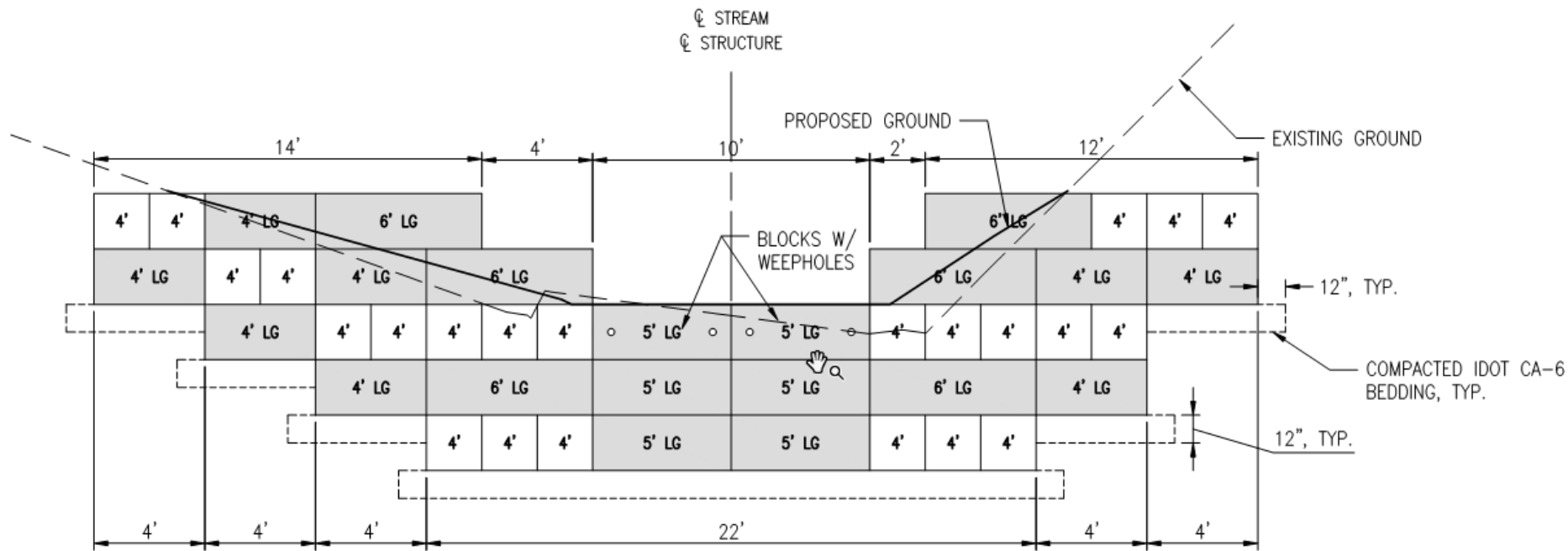- Design
  - Overturning/Moment Arms
  - Velocity/Shear
  - Earth Load
  - Saturated Soils
  - Exposure of DS Face

- History of use

Block Wall – Key In and Lock

4051/5256 – Big Hollow Creek

Drainage Area to
Demo of Manhole R08B017510 &
Bank Repair at Manhole R08B017523
(= 0.96 sq. mi.)

Drainage Area to
Relocated Manhole R08B017514 &
New Sewer Line R08B017514 - R08B017550
(= 1.2 sq. mi.)
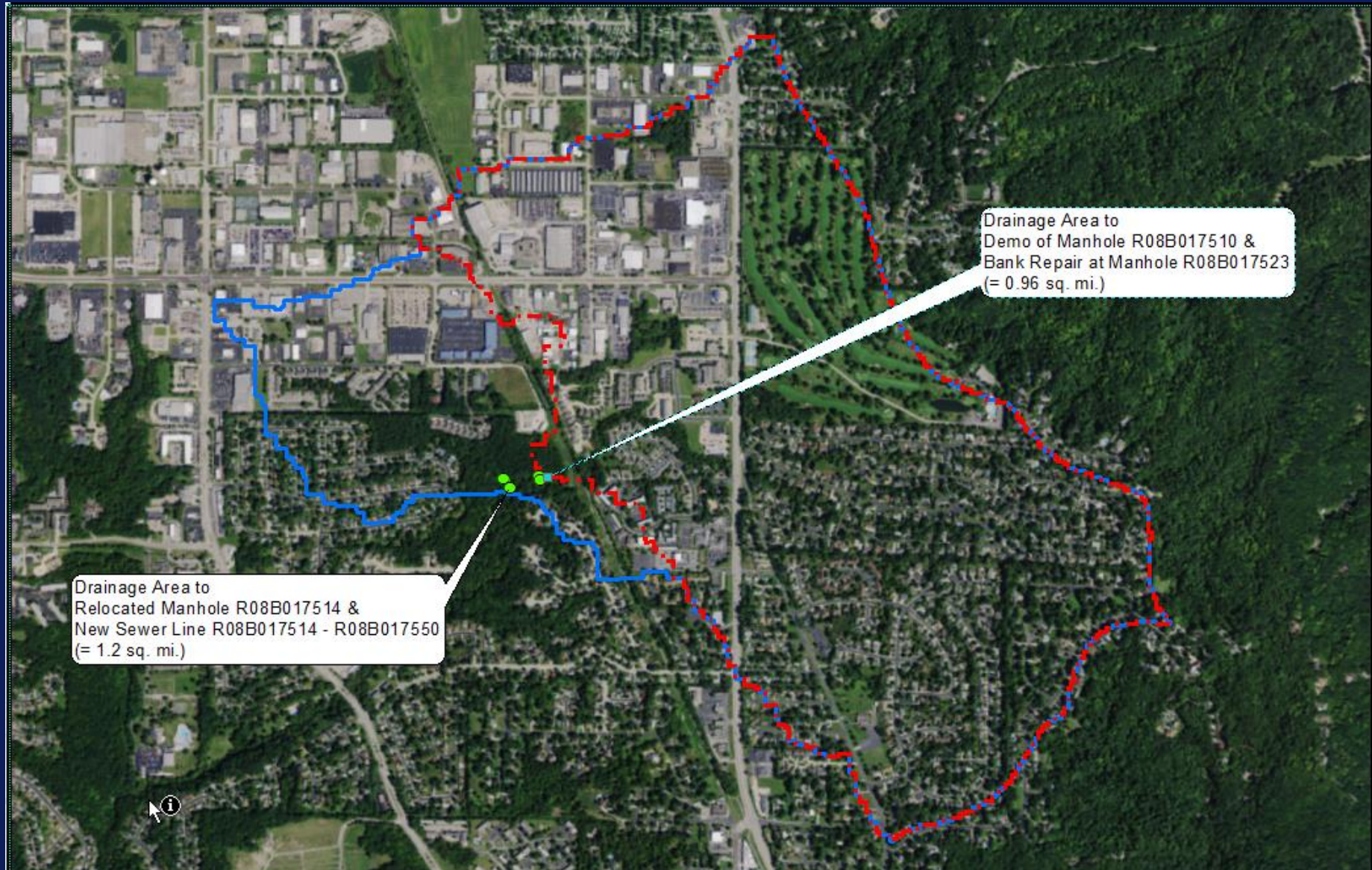
4051/5256 – Big Hollow Creek

- Highly Urbanized
- Channel Migration and Incision

Similar Sites

- 4050 - Big Hollow Creek
- 3972 – Big Hollow Creek
- 4042 – North Tributary to Big Hollow

4050

3972

4042

Solution

- Relocate Manhole/Line
- Cut/Fill to restore historic alignment
  - Smooth transitions
  - Imitate nature
- Promote Stable Channel Shape
- Armoring to protect infrastructure

REPAIR 5256 — LAYOUT DETAIL

REPAIR 5256
SECTION A-A — MANHOLE R08B017523
SCALE: NONE
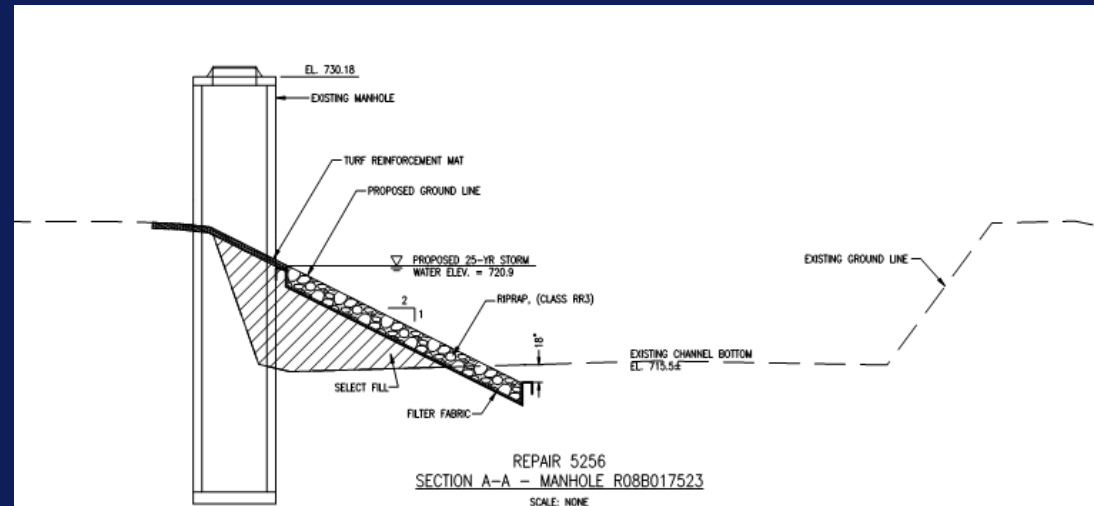
3975 – Big Hollow Creek

- Channel Meandering
  - Attack angle
  - Signficant Migration over 10-year period
- 80-ft of exposed 54-inch main
- Problem Starts Upstream

Problem Starts Upstream

Legend
- **Exposed Sewer Pipe** (red line)
- **Manhole Location from GPSD** (red dot)
- **Main Location from GPSD** (green line)
- **Stream Centerline (Existing)** (blue line)
- **Stream Centerline (Proposed)** (dashed green line)

BendwayWeirs
- **Key-in** (orange line)
- **Weir** (green line)

Solution

- River Training
  - Bendway Weirs
- Toe Protection
- Bank Restoration
  - Cut/Fill
  - Significant Length

TYPICAL SECTION OF SLOPE STABILIZATION

TYPICAL PROFILE, CENTERLINE OF BENDWAY WEIRS 5, 6 & 7
SCALE: NONE

TYPICAL BENDWAY WEIR SECTION
SCALE: NONE

Permitting

- [COORDINATION! – Early and Often](#)
- [USACE Individual and Nationwide](#)
- [IDNR Individual and Statewide](#)
- [IEPA](#)

Permitting

ROCK ISLAND DISTRICT

US Army Corps of Engineers

- **Individual Permit**
  The Corps will evaluate the probable impacts of the specific project as part of the public interest review.

- **Regional Permit**
  General permit issued by the district engineer after compliance with regulations. Procedure meeting authorized categories of the regulation.

- **Nationwide Permit**
  Series of General permits for minor projects that meet special conditions.

Permitting

- <u>Statewide Permit</u>
  #06 Minor non-obstructive floodway construction activities
  #07 Outfalls
  #08 Underground pipeline and utility crossings
  #09 Minor shoreline, stream bank, and channel protection activities
  #11 Authorizing minor maintenance dredging activities

- <u>Individual Permit</u>
  Construction in Floodways of Rivers, Lakes and Streams (that does not meet the special conditions of a Statewide Permit)

Monitor