Watershed Science and Technical Conference

September 14, 2012

Application of a Culvert Assessment Procedure for Determining Compliance with USACE Nationwide and New York Regional Permit Conditions for Aquatic Life Movement and Management of Water Flows

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What you will hear…

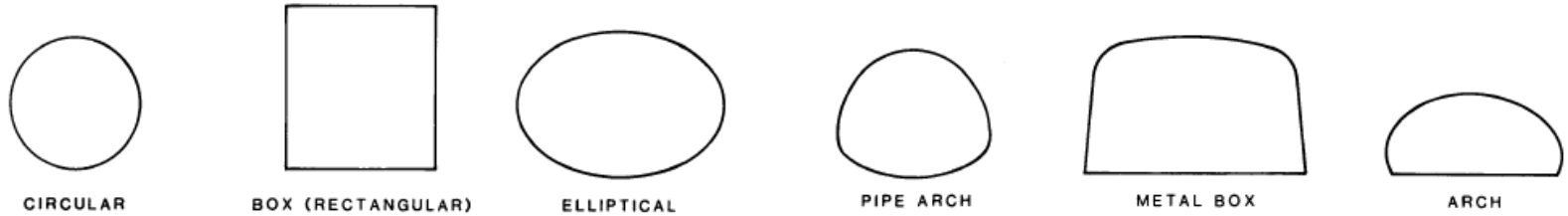
- Culverts 101
- Describe regional permit conditions for culvert projects in NY
- Case Study
- Implications
- Lessons learned

Definitions

- **NYSDOT Culvert definition:**

  A culvert is usually a **closed conduit**, **a pipe)**, but may be an **open conduit (e.g., an arch)**, installed to **convey runoff** collected in road (e.g. side channels, and natural channels such as streams, underneath an embankment. Generally, a culvert is open at both ends and is not connected to a drainage structure. Any single structure with a **span greater than 20 ft. is a bridge.**

- **Culvert shapes**



Some perspective for NY…

- **NYSDOT**
  - Approximately 8,000 large culverts between 5 feet and 20 feet span (diameter)
  - Roughly 80,000 small culverts less than 5 feet in span (dia.)
- **Cornell**
  - There are an estimated 50,000 large (>5’ span) culverts
  - There are an estimated 1,000,000 small culverts on the State, County and Local system excluding private structures.

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Culvert Issues

- Structural concerns and public safety
- Erosion and sediment deposition leading to unstable stream reaches
- Flooding
- Impediments to fish passage
- Vermont - Hurricane Irene damaged about 2,000 culverts

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Blockages can be real problematic…

How can these issues be addressed?

- U.S. Army Corps of Engineers Section 10 and 404 permits
  - Work in a navigable water or Water of the U.S. requires an individual or general permit
  - Nationwide Permit Program
- NYS Department of Environmental Conservation permits

Corps Nationwide Permit Program (2012-2017)

- 52 General Permits: Linear Transportation Projects (NWP14) and Maintenance (NWP3)
- 31 General Conditions related to:
  - Pre-construction Notification – *When do I notify the Corps?*
  - Compensatory Wetland and Stream Mitigation
  - Archeological and Threatened/Endangered Species
  - **Aquatic Life Movement (General Condition #2)**
  - **Management of Water Flows (General Condition #9)**
- NY General Regional Conditions for all Nationwide Permits (2012-2017)
  - Construction Best Management Practices for culverts (Sections II.A.11 and Section II.A.12)
    - **New or Replacement**
    - **Rehabilitation**

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USACE-NY General Requirements

- Appropriate engineering required – sized appropriately
- Assessment of stream slope, channel material, stream type
- Evaluate impacts on downstream flooding, upstream/downstream habitat including wetlands
- Promote safe passage of fish and other indigenous aquatic organisms
- No altering of stream dimension, pattern, and profile

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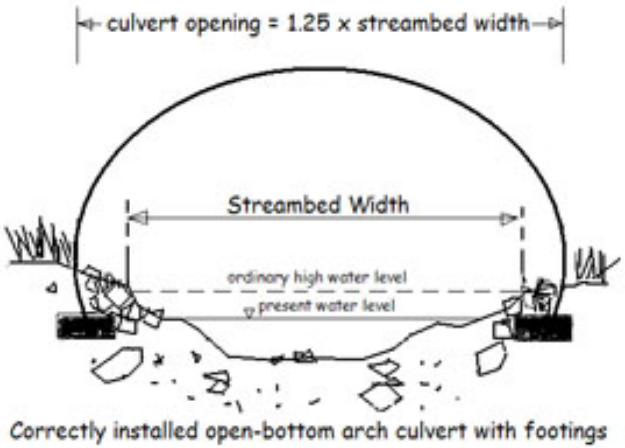
USACE-NY Pre-construction Notification Requirements



New or Replacement Culvert

Install Bottomless Culvert or Bridge ?

Yes

Culvert width at least 1.25 times the stream bankfull width ?

Yes

No need to notify Corps, unless required by other NWP condition

No

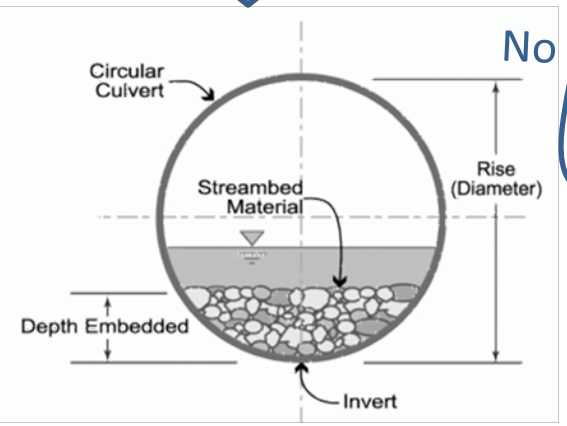
Notify Corps

No

Can the culvert be embedded below streambed grade to a minimum depth of 20% of the culvert vertical rise ?

Yes

No



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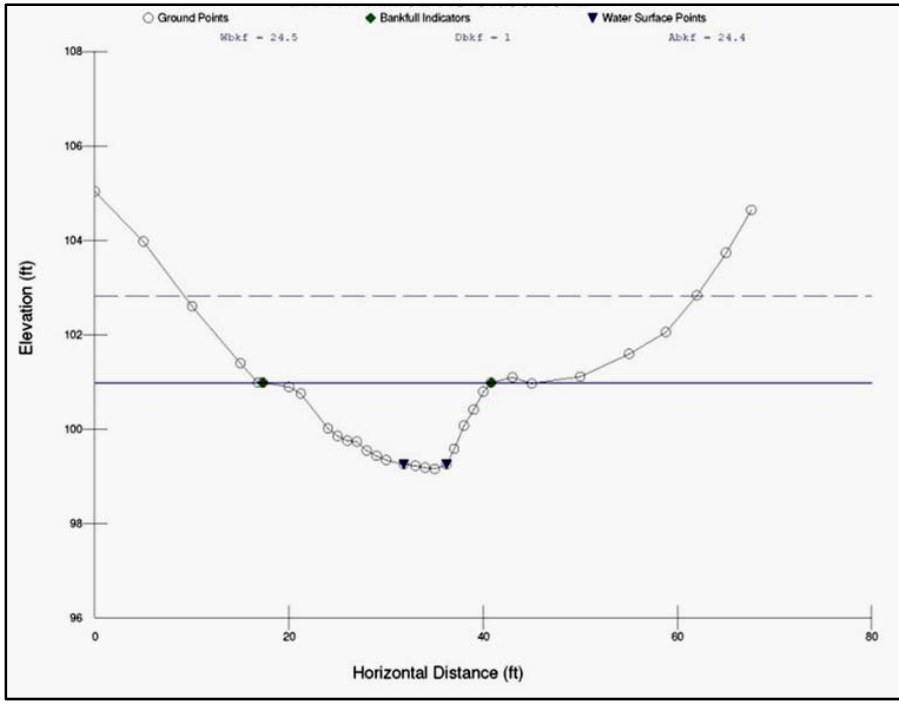
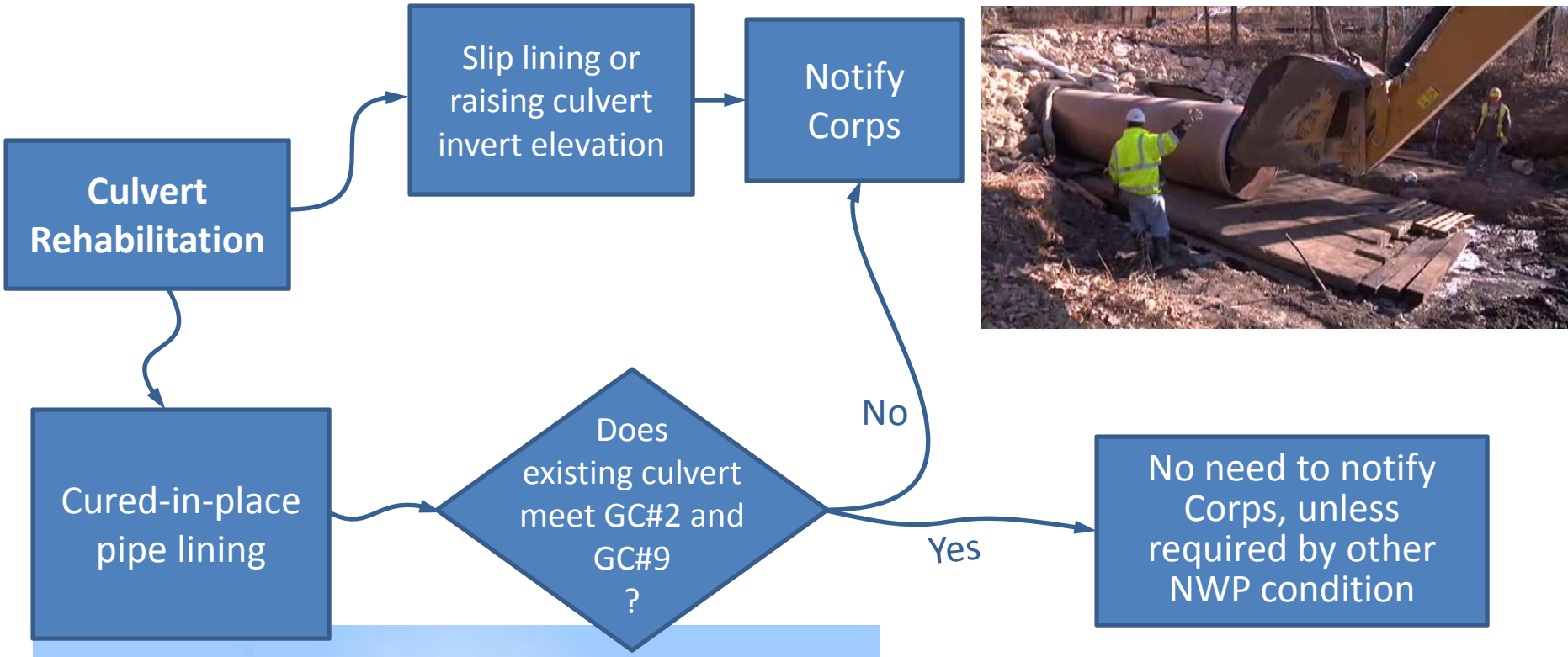
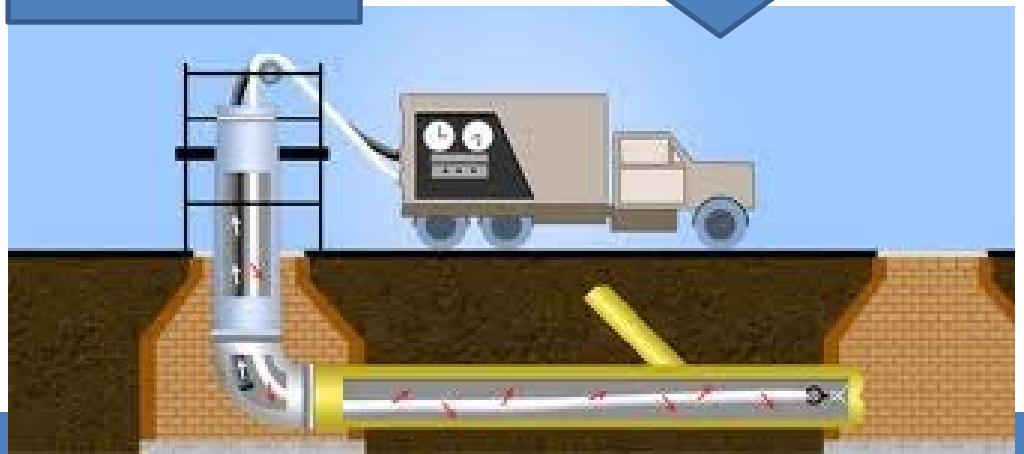
USACE-NY Pre-construction Notification Requirements



- General condition waiver can be requested
- Pre-construction Notification must include:
  - Why the use of required measures are not practicable
  - Results of stream assessment
  - Stream channel cross-sections showing thalweg and bankfull elevations
  - Evaluation of impacts to aquatic life movement and water flows
  - Mitigation measures
- Waiver issued after Corps assessment of least environmentally damaging practicable alternative

USACE-NY Pre-construction Notification Requirements





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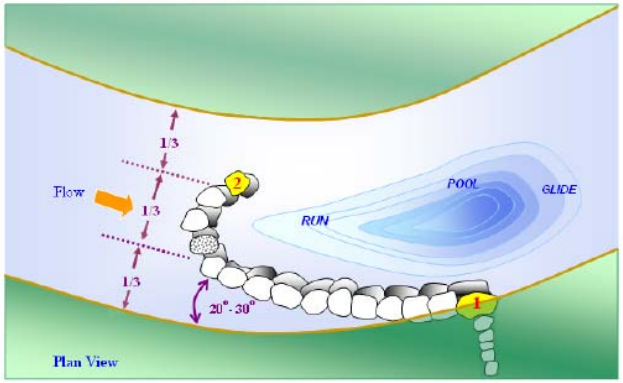
USACE-NY Pre-construction Notification Requirements

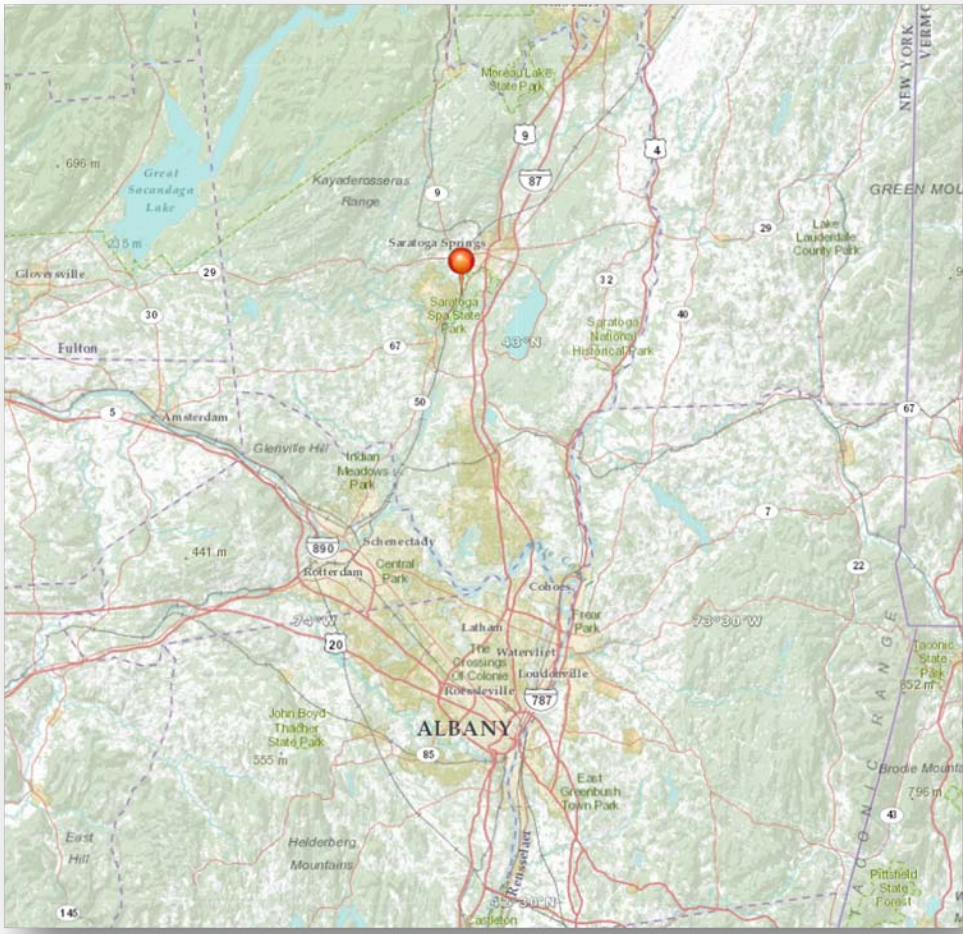
- Pre-construction Notification must include:
  - Evaluation of existing culvert and proposed condition for their effects on aquatic life movement and management of water flows (GC#2 and GC#9)
- Mitigation measures –
  - Fish Passage: baffles, weirs, roughened channels, grade control
  - Bankfull Flows: cross-vanes, j-hooks



CASE STUDY

Saratoga Springs, High Speed Rail Project

- NYSDOT/Canadian Pacific
- Installation of 2.5 mile second track just south of Saratoga yard
- Permit application filed with Pre-construction Notification for Nationwide Permit 14
- Proposed culvert extensions
- USACE considered this a rehabilitation project and requested assessment of existing and proposed culverts



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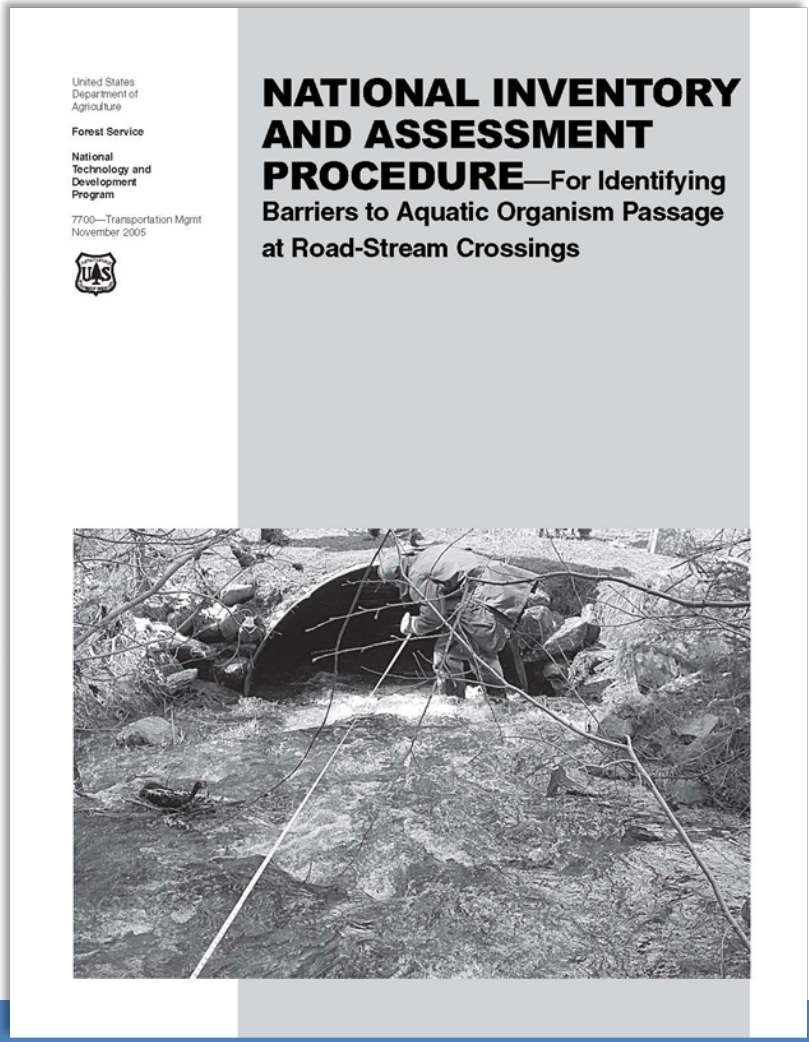
Saratoga Springs, High Speed Rail Project

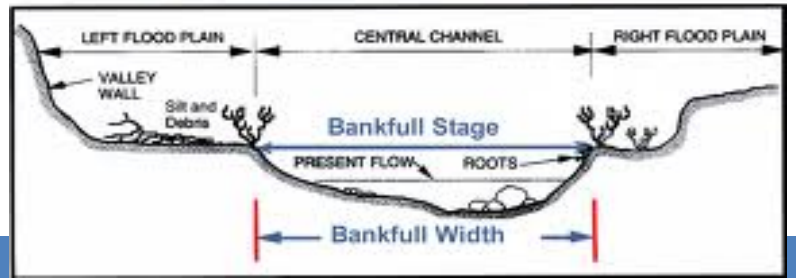
- U.S. Forest Service National Inventory and Assessment Procedure - For Identifying Barriers to Aquatic Organism Passage and Road- Stream Crossings (2005)
  - Intended to answer:
    - How and where does the crossing restrict Movement of aquatic life?
    - What aquatic species are affected and to what extent?
  - Also assesses flood conveyance capacity
  - FREE FishXing Software: http://stream.fs.fed.us/fishxing/

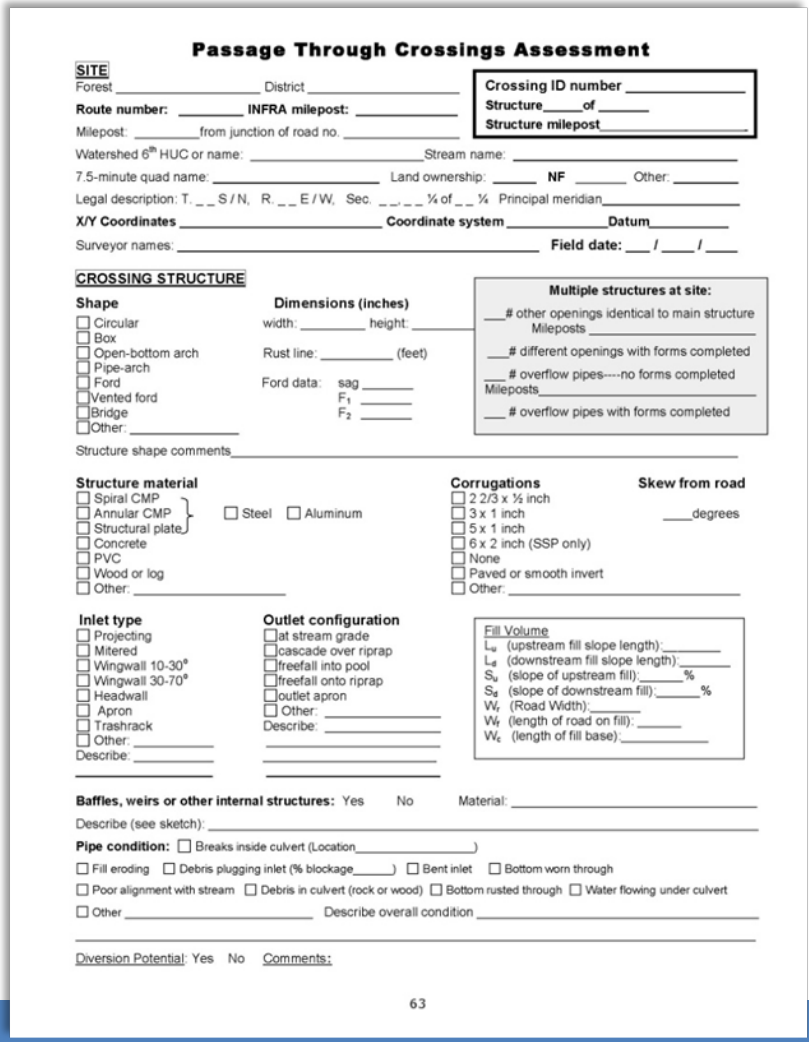


Saratoga Springs, High Speed Rail Project

Field assessment of:

- Crossing structure – shape, material, inlet type, condition
- Survey of critical points along reach longitudinal profile and cross section
- Streambed substrate in structure and dominant particle sizes
- Channel bankfull widths:
  - Bankfull flow – channel forming flow
  - Bankfull elevation – incipient point of flooding
  - U.S. Forest Service - *A Guide to Identification of Bankfull Stage in the Northeastern U.S.* – online training video





Passage Through Crossings Assessment

SITE
Forest _____ District _____
Route number: _____ **INFRA milepost:** _____
Milepost: _____ from junction of road no. _____
Watershed 6th HUC or name: _____ Stream name: _____
7.5-minute quad name: _____ Land ownership: _____ **NF** _____ Other: _____
Legal description: T. _ _ S / N, R. _ _ E / W, Sec. _ _, _ _ ¼ of _ _ ¼ Principal meridian _____
X/Y Coordinates _____ **Coordinate system** _____ **Datum** _____
Surveyor names: _____ **Field date:** ___ / ___ / ___

Crossing ID number _____
Structure ____ **of** ____
Structure milepost _____

CROSSING STRUCTURE

Shape
- ☐ Circular
- ☐ Box
- ☐ Open-bottom arch
- ☐ Pipe-arch
- ☐ Ford
- ☐ Vented ford
- ☐ Bridge
- ☐ Other: _____

Dimensions (inches)
width: _____ height: _____
Rust line: _____ (feet)
Ford data: sag _____
F_1 _____
F_2 _____

Multiple structures at site:
___# other openings identical to main structure
Mileposts _____
___# different openings with forms completed
___# overflow pipes----no forms completed
Mileposts _____
___# overflow pipes with forms completed

Structure shape comments _____

Structure material
- ☐ Spiral CMP
- ☐ Annular CMP
- ☐ Structural plate
- ☐ Steel ☐ Aluminum
- ☐ Concrete
- ☐ PVC
- ☐ Wood or log
- ☐ Other: _____

Corrugations
- ☐ 2 2/3 x ½ inch
- ☐ 3 x 1 inch
- ☐ 5 x 1 inch
- ☐ 6 x 2 inch (SSP only)
- ☐ None
- ☐ Paved or smooth invert
- ☐ Other: _____

Skew from road
___degrees

Inlet type
- ☐ Projecting
- ☐ Mitered
- ☐ Wingwall 10-30°
- ☐ Wingwall 30-70°
- ☐ Headwall
- ☐ Apron
- ☐ Trashrack
- ☐ Other: _____

Describe: _____

Outlet configuration
- ☐ at stream grade
- ☐ cascade over riprap
- ☐ freefall into pool
- ☐ freefall onto riprap
- ☐ outlet apron
- ☐ Other: _____

Describe: _____

Fill Volume
L_u (upstream fill slope length): _____
L_d (downstream fill slope length): _____
S_u (slope of upstream fill): _____%
S_d (slope of downstream fill): _____%
W_r (Road Width): _____
W_f (length of road on fill): _____
W_c (length of fill base): _____

Baffles, weirs or other internal structures: Yes No Material: _____
Describe (see sketch): _____
Pipe condition: ☐ Breaks inside culvert (Location_____)
☐ Fill eroding ☐ Debris plugging inlet (% blockage_____) ☐ Bent inlet ☐ Bottom worn through
☐ Poor alignment with stream ☐ Debris in culvert (rock or wood) ☐ Bottom rusted through ☐ Water flowing under culvert
☐ Other _____ Describe overall condition _____

Diversion Potential: Yes No Comments:

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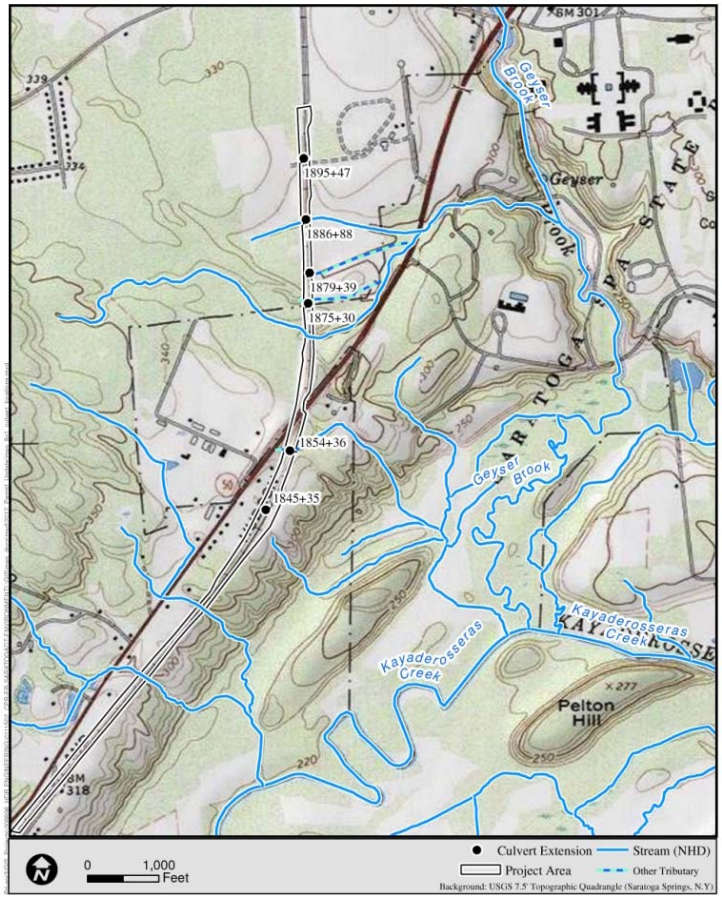
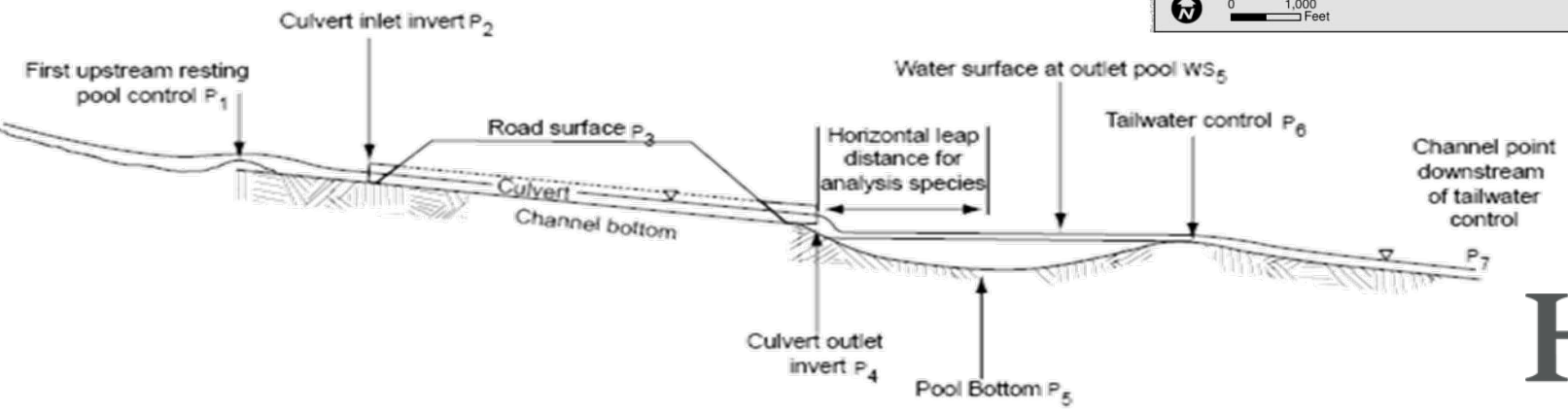
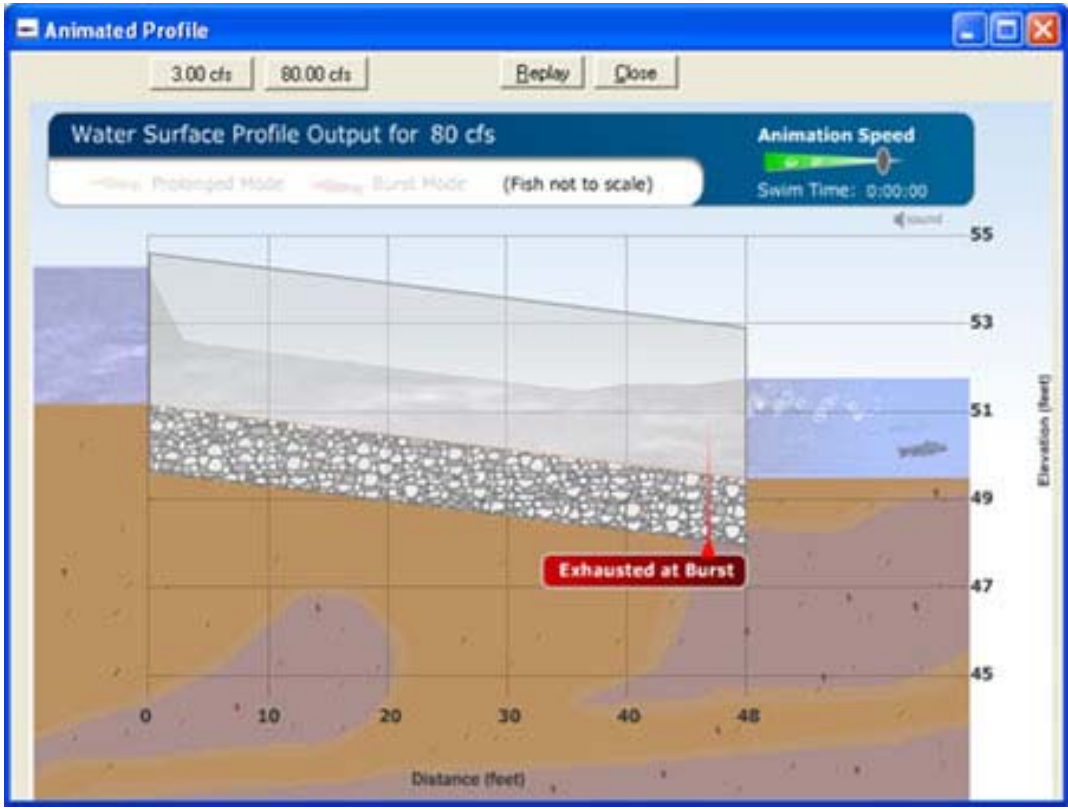

1895+47
1886+88
1879+39
1875+30
1854+36
1845+35
Geyser Brook
Geyser
Kayaderosseras Creek
Pelton Hill
0
1,000
Feet
Culvert Extension
Stream (NHD)
Project Area
Other Tributary
Background: USGS 7.5' Topographic Quadrangle (Saratoga Springs, N.Y.)


Culvert inlet invert P_2
First upstream resting pool control P_1
Road surface P_3
Culvert
Channel bottom
Horizontal leap distance for analysis species
Water surface at outlet pool WS_5
Tailwater control P_6
Channel point downstream of tailwater control
P_7
Culvert outlet invert P_4
Pool Bottom P_5

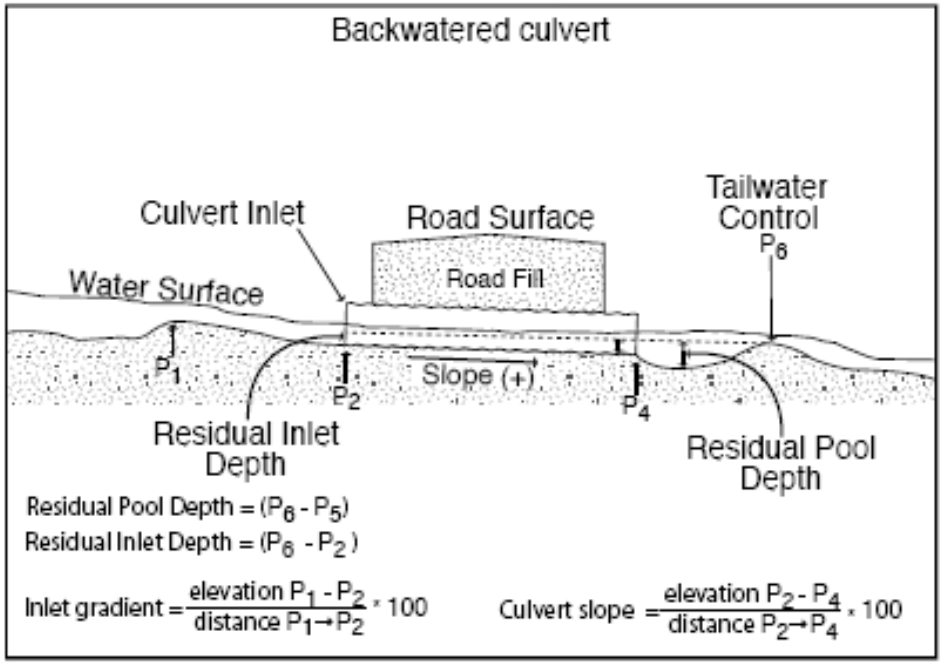
Data Analysis

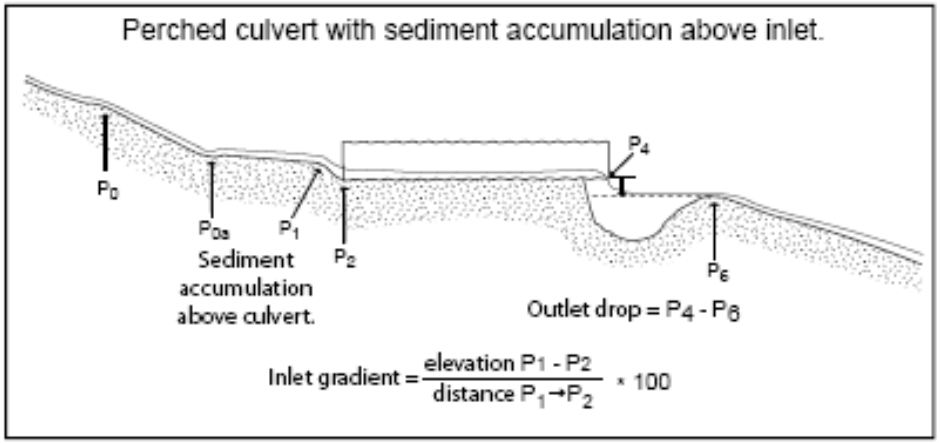


- Calculations
  - culvert slope
  - outlet drop
  - inlet gradient
  - residual inlet depth
  - residual pool depth
  - ratio of inlet width to channel width
  - substrate ratio
- "Analysis species" identified
- FishXing – input field assessment data, swim speeds for analysis species, and streamflows to model impediments resulting from velocity, shallow water depths, perched culvert outlet

Results

- Culvert Slope: 1.39%
- Outlet Drop: -1.4 ft
- Inlet gradient: 0.08%
- **Ratio of inlet width to channel width: 0.34**
- **Residual inlet depth: 0.74 ft**
- **Substrate ratio: 0.61**
- **Residual pool depth: 1.31 ft**
- FishXing software did not indicate any impediments





Back to the permitting…

- Results of assessment were submitted to Corps indicating:
  - All culverts meet general conditions for Aquatic Life Movement
  - Existing culverts do not meet general conditions for Management of Water Flows (i.e. bankfull widths)
- **No additional comments from Corps and permit issued!**

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Implications?

- Permitting – Some clarification provided, but additional work; Schedules dependant on regulatory triggers for Corps notification
- Cost – Larger, more complex structures are expensive, but can save money over long-term
- Design – Additional field assessment requirements
- Public Safety – Decreased chance of catastrophic failure
- Higher likelihood of stream maintaining stability and biological function

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Take home messages…

- Culverts are a critical part of NY infrastructure
- Poorly designed or installed culverts can lead to public safety concerns, destabilized stream channels, flooding, and act as biological impediments
- The U.S. Army Corps of Engineers has issued NY regional permit conditions for new, replacement, or rehabilitated culverts.
- An assessment of aquatic life movement and management of water flows should be completed at all proposed culvert projects.
- The U.S. Forest Service Assessment Method for Stream Crossings provides an efficient framework for completing the required assessment.
- Depending on the results of the assessment and the proposed design, you may be able to proceed with work without notifying the Corps.
- Be prepared to call on an interdisciplinary team of engineers, permitting specialists, biologists, geomorphologists, and hydrologists.

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QUESTIONS?