Oak Grove Road over Unnamed Tributary to Lawrence Creek: Confluences, Urbanization, and Permitting

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1) Project Background
2) Project Need
3) Hydrologic Methodology
4) Hydraulic Methodology
5) Design Criteria
6) County Stormwater Management Permit
7) Wetland Permitting
8) Lessons Learned
**Client:** McHenry County Division of Transportation

**Project Location**
- Oak Grove Road at Unnamed Tributary to Lawrence Creek
- Chemung Township – Unincorporated McHenry County

**Project Improvements**
- Bridge replacement (22’ Bridge to Triple 10’x7’ Culverts)
- Roadway widening
- Installation of Guardrail
- Ditch re-grading

**Funding**
- 80% Federal
- 20% Local (MCDOT)
Stream Crossing

Located approx. 2 miles north of Harvard, IL

Source: Google Earth
2 stream branches converge into single stream approx. 70’ upstream of bridge crossing

Approx. 1,700’ downstream of bridge crossing the stream flows into Lawrence Creek
Project Need

- Existing superstructure of bridge is structurally deficient
- Benefits of project include:
  - Safer movement of vehicular traffic
  - Reduced risk of flooding
  - Improvement in ride quality
  - Reduction of future maintenance costs
Project Need

- Phase I (2015) Scope to Determine:
  - Structure Type
  - Waterway Opening
  - Geometric Deficiencies
  - Cost
  - Required R.O.W.
  - Permitting Need

Phase I ➔ Phase II ➔ Construction
Project Need

- Phase II (2017) Scope:
  - Detailed Design
  - Permitting
    - Issuance of Stormwater Management Permit / Approval of Hydraulics
    - County DOT
    - IDOT BLRS
    - USACE
StreamStats
- Used to determine discharges (Rural Regression Equations)
- No regulatory data available
- Separate analyses for each reach upstream of the bridge

Source: USGS StreamStats
Hydrologic Methodology

StreamStats

Separate StreamStats for stream downstream of confluence and upstream of bridge

Source: USGS StreamStats
Hydrologic Methodology

FEMA FIRM

- Zone A Floodplain immediately downstream
- No designated floodplain upstream
XS 7, 8: +66 cfs added to these sections

XS 10, 11: -66 cfs subtracted from these sections

- XS 7 & 8 shared ground points with XS 10 & 11
- Iterative process to obtain matching Water Surface Elevations
**Hydrologic Methodology**

**HEC-RAS Flow Calibration – Iterative Process**

<table>
<thead>
<tr>
<th>Reach 1</th>
<th>Reach 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Profile (ft)</strong></td>
<td><strong>Flow (cfs)</strong></td>
</tr>
<tr>
<td>10</td>
<td>347</td>
</tr>
<tr>
<td>20</td>
<td>370</td>
</tr>
<tr>
<td>100</td>
<td>505</td>
</tr>
<tr>
<td>200</td>
<td>597</td>
</tr>
<tr>
<td>500</td>
<td>673</td>
</tr>
<tr>
<td>1000</td>
<td>1000</td>
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</tbody>
</table>

- **Reach 1**
  - approx. 66 cfs added: 10yr: 247 cfs  ➔ 313 cfs
- **Reach 2**
  - approx. 66 cfs subtracted: 10yr: 239 cfs  ➔ 177 cfs
Urbanization

- Account for existing urbanized/developments in the watershed
- Urban Technique to convert rural regression eqn’s (StreamStats) to urbanized flows
- 0.024 sq.mi. out of 1.01 sq.mi for 2.4%

Existing Urbanized Area (approx. 2.4%)
### Hydrologic Methodology

**Percent Imperviousness within urbanized area – 12.5%**

- 9 residential units within 0.024 sq.mi. urbanized area, which is 375 residential units per sq.mi.
- 375 residential units per sq.mi. equates to 12.5% imperviousness within urbanized area

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Figure 4-101.02b – IDOT Drainage Manual

**Graph:**
- Relationship between Percentage of Imperviousness and Housing Density.
- From Water-Resources Investigations 79-38²
  - "Effects of Urbanization on the Magnitude and Frequency of Floods in Northeastern Illinois"
  - Pg 19
  - Figure 4-101.02b
Hydrologic Methodology

Ratio of Flood Magnitudes for Flood Frequency

- 2.23 for 2-yr flood
- 1.78 for 10-yr flood
- 1.67 for 25-yr flood
- 1.60 for 50-yr flood
- 1.55 for 100-yr flood
Hydrologic Methodology

Determination of Urbanized Flow

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<tr>
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</thead>
<tbody>
<tr>
<td>2-yr</td>
<td>101</td>
<td>2</td>
<td>2.23</td>
<td>5</td>
<td>99</td>
<td>104</td>
<td>3</td>
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<tr>
<td>10-yr</td>
<td>239</td>
<td>6</td>
<td>1.78</td>
<td>10</td>
<td>233</td>
<td>243</td>
<td>4</td>
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<tr>
<td>20-yr</td>
<td>296</td>
<td>7</td>
<td>N/A.</td>
<td>N/A.</td>
<td>289</td>
<td>300 *</td>
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<tr>
<td>25-yr</td>
<td>314</td>
<td>8</td>
<td>1.67</td>
<td>13</td>
<td>306</td>
<td>319</td>
<td>5</td>
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<tr>
<td>50-yr</td>
<td>373</td>
<td>9</td>
<td>1.60</td>
<td>14</td>
<td>364</td>
<td>378</td>
<td>5</td>
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<tr>
<td>100-yr</td>
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<td>1.55</td>
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<td>419</td>
<td>435</td>
<td>6</td>
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<tr>
<td>200-yr</td>
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<td>N/A.</td>
<td>476</td>
<td>500 *</td>
<td>12</td>
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10-yr: 4 cfs added to original StreamStats rural flow

100-yr: 6 cfs added to original StreamStats rural flow

Source: Google
Hydraulic Methodology

HEC-RAS used for Hydraulics

- Existing, Natural, and Proposed Conditions Modeled
- Proposed Conditions: 1’ Embedment and 2’ weir walls
- No HEC-18 scour analysis required

Weir Wall

1’ Embedment
Hydraulic Methodology

HEC-RAS used for Hydraulics

- Weir walls modeled using Depth Blocked function
- Manning’s roughness \( (n) \) for natural bottom
- Weir walls conform to stream geometry at overbanks


Assessment of Sensitive Flood Receptors

Upstream homes assessed for flooding due to backwater

No homes in danger of flooding

Bridge not source of flood damage, as certified by Chemung Township

Source: Google Earth
Design Criteria

Hydraulics

- No More Restrictive than Existing
- Proposed Triple 10’x7’ Box Culverts
- Waterway Opening Greater than or Equal to Existing
- Created Head - 0.1’ over Existing
- 20-year Design Event

- No Freeboard – Local Road
- No Clearance - Culvert
Will this project require a Floodway Construction Permit?

Non-designated floodway

- IDOT will not issue Floodway Construction Permit

Watershed classified as rural and less than 10 sq mi.

- IDNR does not have jurisdiction, therefore Construction Permit is not needed

McHenry County Dept. of Planning and Development review

- Issue County Stormwater Management Permit
McHenry County Department of Planning & Development

- Compensatory Storage required for fill within the floodplain
- Insufficient Compensatory Storage for 10-yr to 100-yr
- A Request for Waiver from compensatory storage requirement for 10-100 yr floodplain cut
- Waiver request granted by McHenry County
Permanent Impacts to Waters of the U.S.

- Impacts to wetlands
- Permanent Impacts to WOUS = 0.06 acres
- Compensatory mitigation not required (USACE) since < 0.10 acres
- IDOT required mitigation, which was done through wetland banking
Minimize impacts by:

- Maintaining alignment of channel with proposed culverts
- Embedment of culvert – low flow fish passage (bridge to culvert)
- RP3 (Transportation Projects) and RP7 (Temporary Construction Activities) of the Regional Permit Program by USACE

Source: Google
Wetland Permitting

National Wetlands Inventory Map vs Delineated Wetlands
Wetland Banking

- Mitigation Agreement between Sybaquay Council Wetland Mitigation Bank and McHenry County Division of Transportation

- County purchased 0.05 credits for impacted 0.03 ac of wetlands
  - Based on 1.5:1 ratio
Wetland Permitting

Wetland Banking in McHenry County

McHenry County Wetland Restoration Fund
- Isolated wetlands within Fox River Watershed
- Review matrix for eligibility of potential projects
- Total fund availability for all projects is up to $198,490
- Info available at: https://www.co.mchenry.il.us/country-government/departments-j-z/planning-development/divisions/water-resources

Source: Google
Lessons Learned

- Flow Optimization required to accurately model 2 reaches and a confluence
- Urbanization (existing land use) of the watershed required;
  - Current StreamStats incorporates urban regression equations
- Open communication is needed, especially when coordinating with multiple agencies
  - IDOT BLRS
  - McHenry County DOT
  - McHenry County P&D
  - USACE

Source: Google
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