



NATIONAL HIGHWAY INSTITUTE

Training Solutions for Transportation Excellence

NHI 135081

Introduction to Highway Hydraulics Software

Roger Kilgore (Hydraulic
Engineer Expert)

A presentation to the AASHTO Task Force
on Hydrology and Hydraulics

Indianapolis, Indiana

May 15, 2003

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and Management**







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Course Goal



Enable participants to *select* and *effectively apply* software tools available to the engineer and designer for hydrology and hydraulics.

Learning Objectives



1. Choose appropriate software for the design situation.
2. Identify data needs for the tools.
3. Input data into the software tools.
4. Apply H&H software tools.
5. Interpret results.

Agenda



| <i>Lesson</i> | <i>Subject</i> | <i>Time (hrs)</i> |
|---------------|---------------------|-------------------|
| | Introduction | 0.5 |
| 1 | WMS Introduction | 1.0 |
| 2 | Hydrology | 3.5 |
| 3 | Channels | 1.0 |
| 4 | Culverts | 6.0 |
| 5 | Inlets/Storm Drains | 5.0 |
| 6 | Detention Basins | 1.5 |
| | Summary/Closing | 0.5 |
| | <i>Total</i> | 19 |

Target Audience



- ❖ Highway engineers and designers responsible for H&H aspects of designing storm drains, culverts, detention basins, and channels.
- ❖ Good, intelligent folks.

Pre-training competencies



- ❖ Overall knowledge of H&H.
- ❖ Course is focused on hands-on. Theory is reviewed, but it is considered a refresher.

Fit with other H&H NHI Courses



Practical Highway
Hydrology

Introduction to
Highway Hydraulics

Urban Drainage
Design

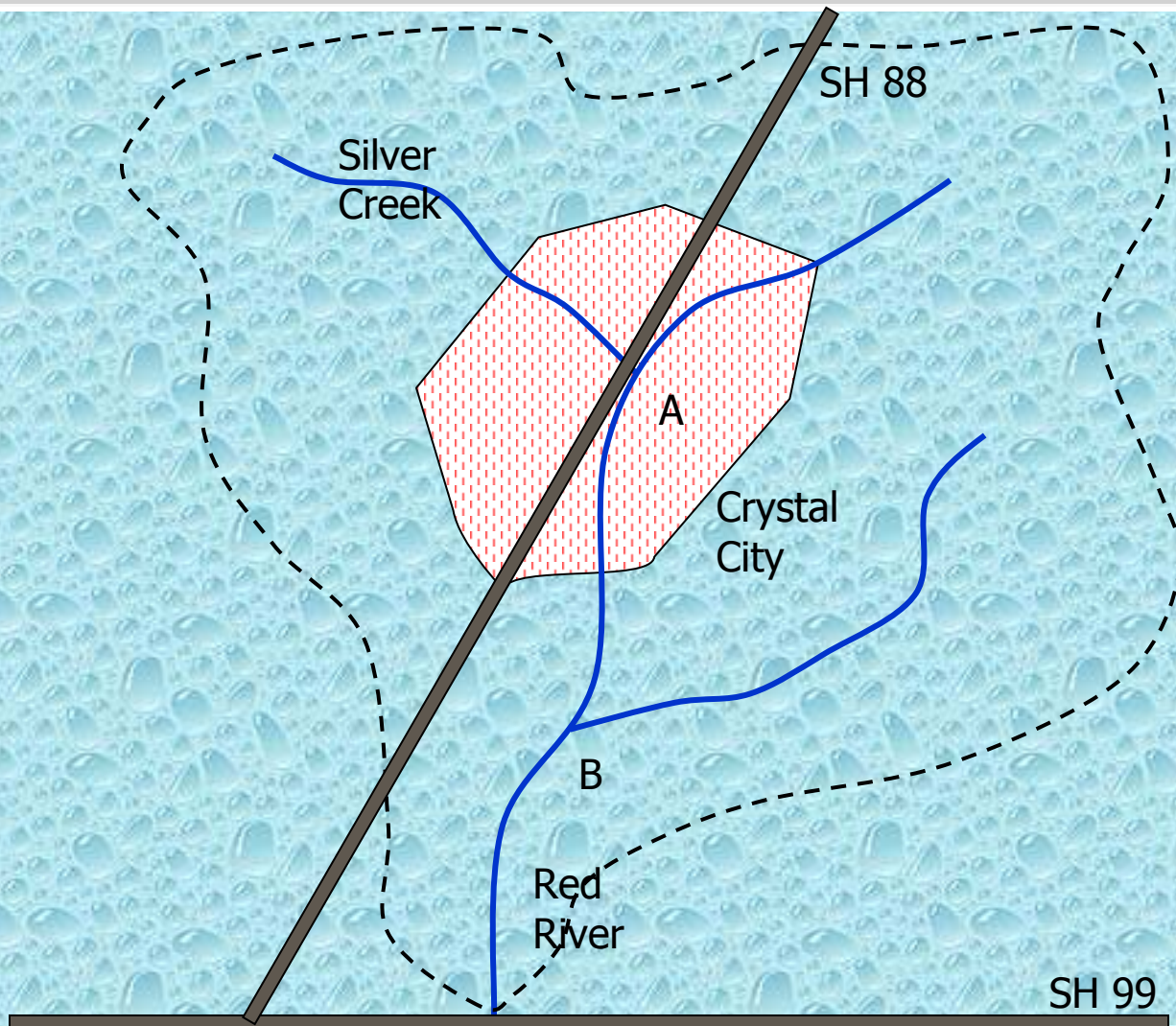
Culvert Design

Highway Hydraulics
Software

Hydrologic Modeling
with WMS

HEC-RAS

Integrated Case Study





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Lesson 1 (1 hr)

WMS Introduction

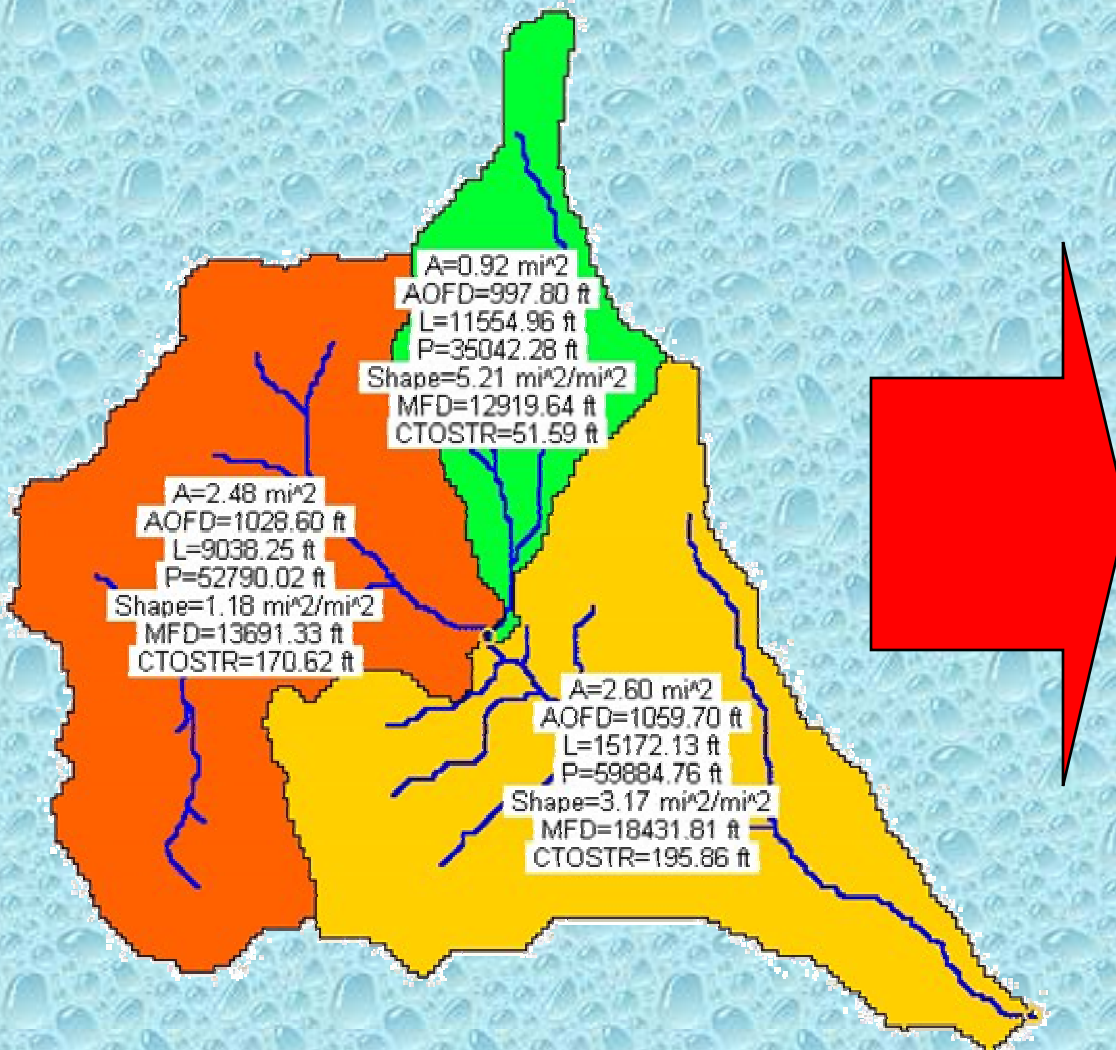
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WMS Functions



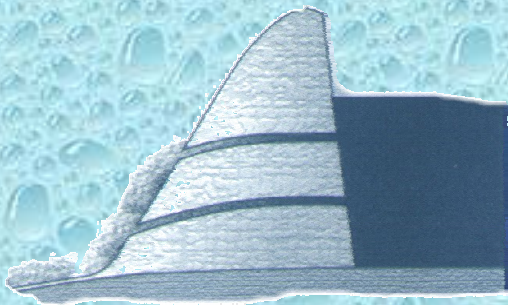
- ❖ Extract hydrologic model input data from computerized maps
- ❖ GUI for hydrologic models
- ❖ GUI for various hydraulic calculators
- ❖ Present model output in a form that is convenient for post-processing and report generation

Hydrologic Models

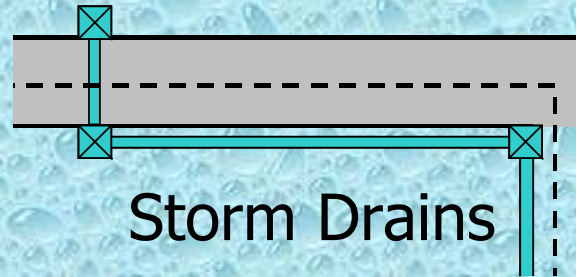


HEC-1
TR-20
TR-55
Rational
NFF
HSPF

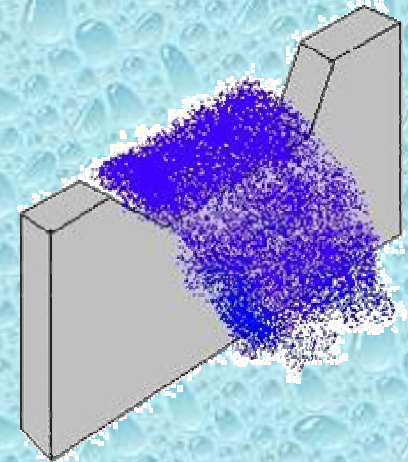
FHWA Calculators



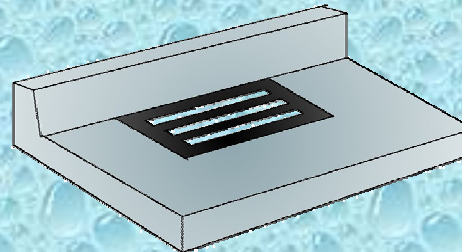
Detention Basins



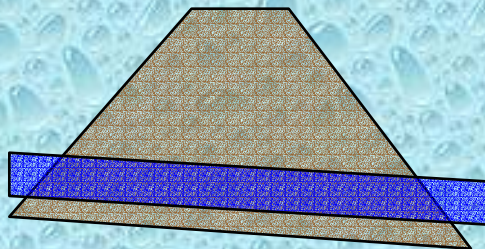
Storm Drains



Weir Flow



Curb & Gutter



Culvert Hydraulics



Channel Hydraulics



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Lesson 2 (3.5 h)

Hydrology

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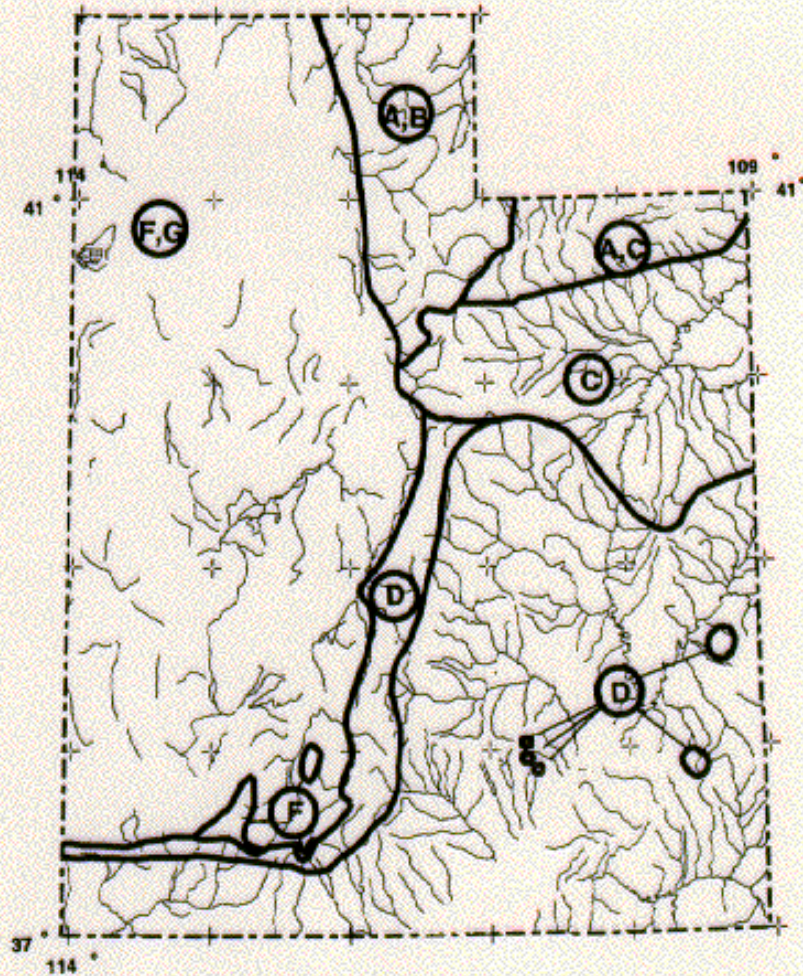
Peak Flow Methods



- ❖ Regression Equations (Newest version of NFF in WMS 7.0)*
- ❖ SCS*
- ❖ Rational
- ❖ Log Pearson III

*Workshops include applications of these methods.

WMS/NFF Computer Demo



Peak Method Selection



| METHOD | URBAN/RURAL | DRAINAGE AREA SIZE | COMMENTS |
|-----------------|---------------------------|---------------------------|--|
| LP3 Gaged flows | Generally Rural | "near" gage locations | Need minimum record length; homogeneous period |
| Rational | Urban (extended to rural) | <80 ha (200 ac) | t_c = storm duration |
| SCS Graphical | Rural (extended to urban) | $0.1 < t_c < 10$ h | Homogeneous basin/ 24-h storm |
| Regression | Rural (extended to urban) | Limited by equation | Drainage parameters within equation range |

WMS/HEC-1 Applications

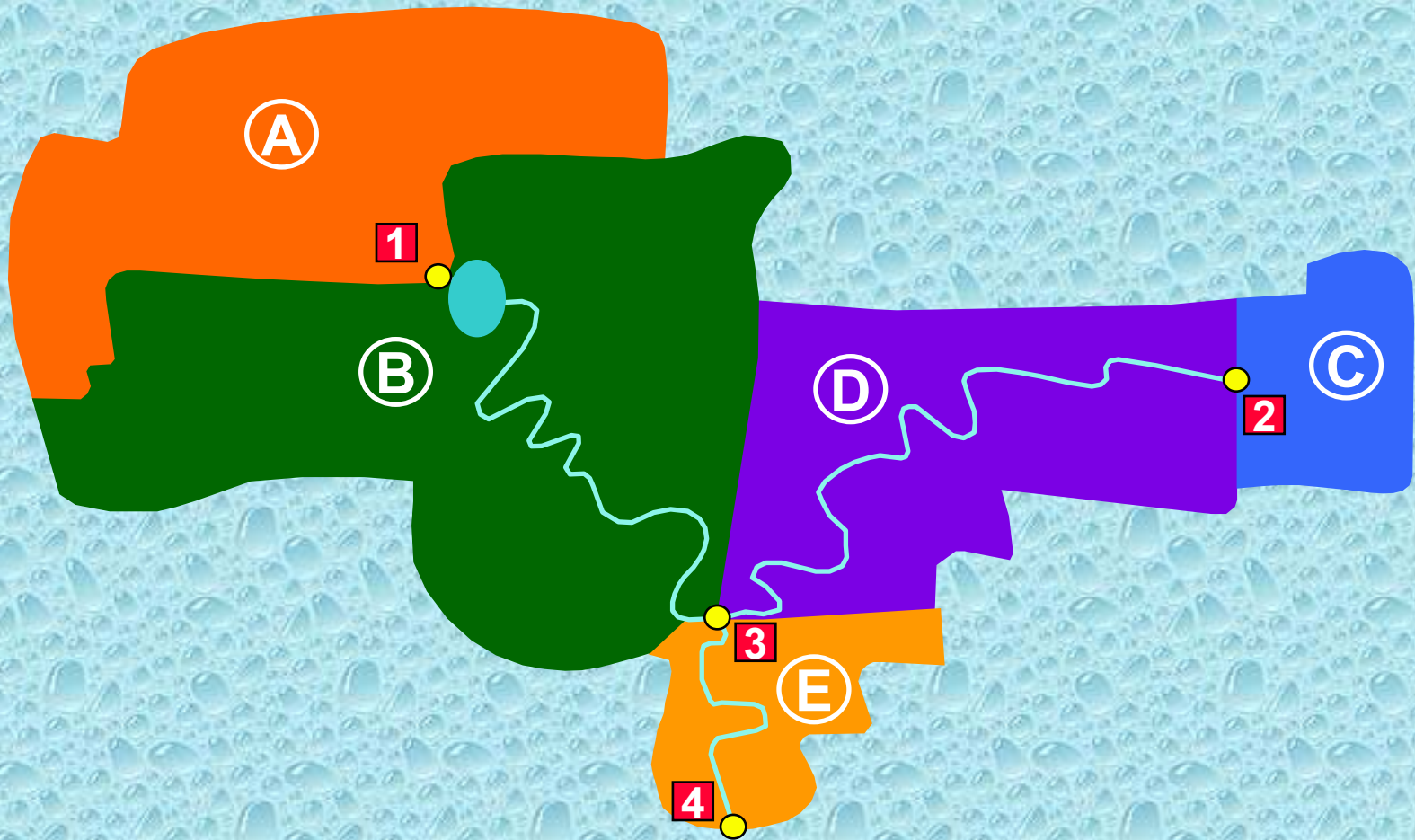


- ❖ Heterogeneous land uses
- ❖ Significant storage/storage routing
- ❖ Channel routing
- ❖ More detail justified
- ❖ Historical storm events



Tool for complex watersheds

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Lesson 3 (1 h)

Channels

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WMS Channel Calculator

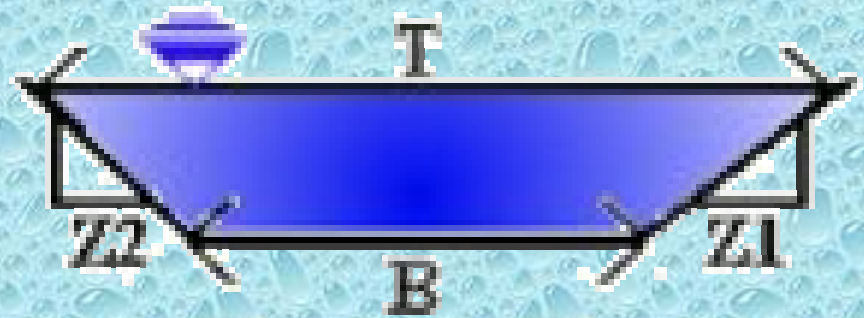


❖ Channel computations

- Normal depth, critical depth, water surface profiles.*

❖ Stable linings

- Tractive force



*Separate NHI course addresses HEC-RAS



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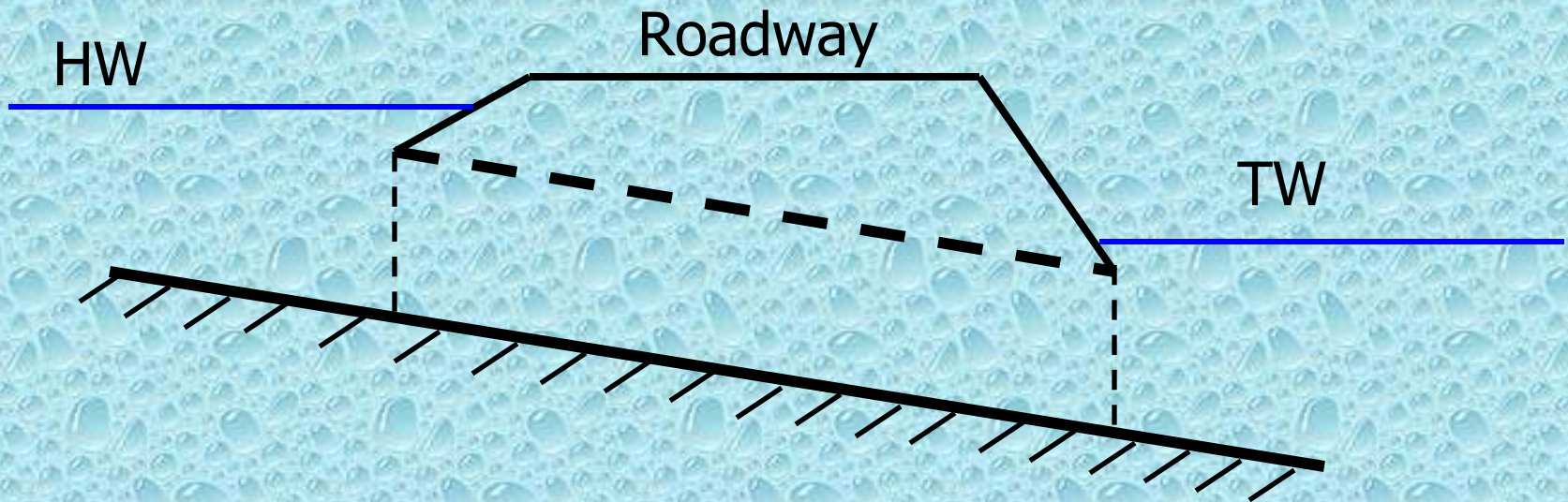
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Lesson 4 (6 h)

Culverts

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Culvert Hydraulics



Headwater is determined by the most limiting combination of tailwater, barrel characteristics, and inlet characteristics.

HY8 InpGen Demo



- ❖ Analyze existing culvert
- ❖ InpGen/PCViewer

Capabilities of HY8



- ❖ Analysis and design of single and multiple culvert systems
- ❖ Analysis of roadway overtopping
- ❖ Steady state and routing analyses
- ❖ Energy dissipator design

HY8 components



- ❖ HY8 Engine
- ❖ InpGen (CU only)
- ❖ PCViewer
- ❖ HY8Energy (SI and CU)

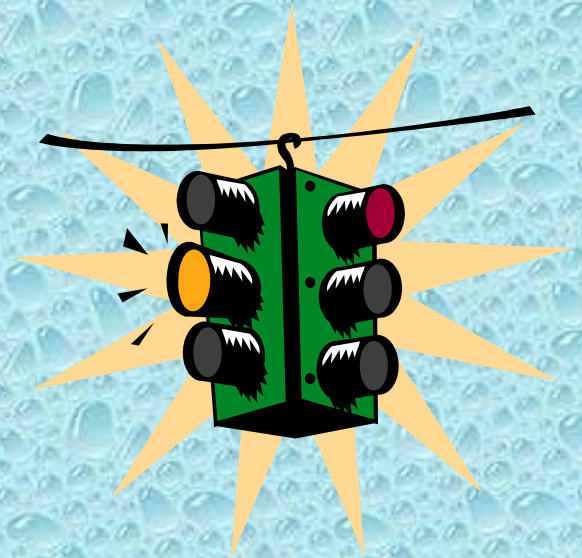
Other Culvert Design Tools



- ❖ WMS HY8 calculator
- ❖ Nomographs
- ❖ Chart Calculator
- ❖ DOS HY8

Energy Dissipation

- ❖ Erosive outlet velocities require mitigation
- ❖ Dissipation (velocity reduction) approaches
 - Forced hydraulic jump
 - Impact
 - Stilling



Dissipator Selection



- ❖ Froude Number
- ❖ Tailwater
- ❖ Debris
 - Silt/sand
 - Boulders
 - Floating
- ❖ Cost and constructability
- ❖ Aesthetics



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Lesson 5 (5 h)

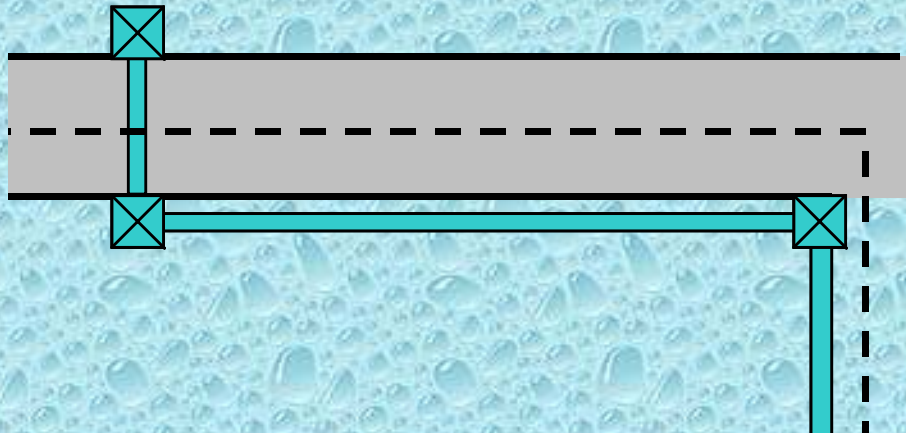
Inlets/Storm Drains

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WMS Storm Drain



- ❖ New GUI in version 7.0 of WMS (in beta testing now)
- ❖ Supersedes HYDRA (HYDRAIN)



Storm Drain Topics



- ❖ Defining storm drain networks.
- ❖ Designing and analyzing storm drain systems.
- ❖ Analyzing and designing inlets.
- ❖ Storage routing.
- ❖ Performance assessment with HGL and pressure flow analyses.



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Lesson 6 (1.5 h)

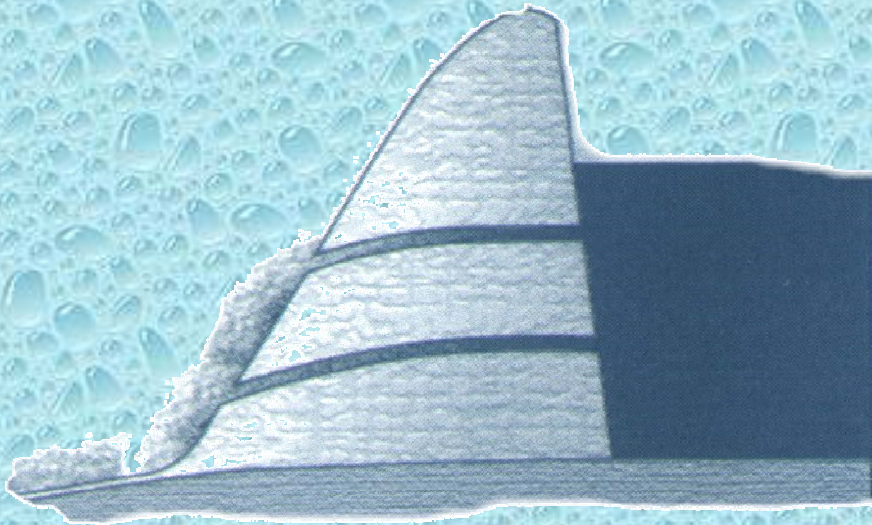
Detention Basins

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WMS Detention Basin Calculator



- ❖ Storage and outlet characteristics
- ❖ Level pool routing



Effectiveness Evaluation



- ❖ Workshops (hands-on) (dual units)
- ❖ Guided discussions
- ❖ Lesson quizzes
- ❖ Course pre- and post-testing?

Software Availability

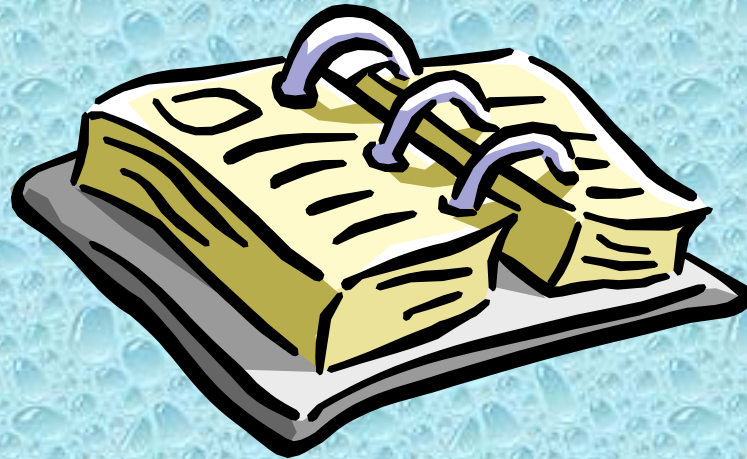


- ❖ Participants will be provided with CD containing all software used in the course.
- ❖ WMS 7.0
 - Full capabilities available to State/FHWA participants.
 - Limited time release for others

Development Schedule



- ❖ Pilot Presentation: August 2003*
- ❖ Course Available: October 2003



*Official release of WMS 7.0 Aug/Sept 2003

Comments?
Questions?
Suggestions?