GUIDELINES FOR ENGINEERING ANALYSIS FOR FLOODPLAIN PERMITTING

Jerry Bishoff, P.E., CFM
Senior Civil Engineer
Illinois Department of Natural Resources
Office of Water Resources

Agenda

- Background Information about regulatory program
- Challenges in implementation of regulations
  - Technical Obstacles
  - Political / Legal Obstacles
- Technical Guidelines Document
  - Introduction
  - Review Procedures
  - Determination of Jurisdiction
  - Floodway Construction
  - Levees and Floodwalls
  - Bridges and Culverts
  - Hydrology
  - Hydraulics

Floodway Construction Rules

- **Administered under Rivers, Lakes and Streams Act (615 ILCS 5)**
  - **Part 3700 Rules – Downstate**
  - **Part 3708 Rules – 6-county Chicago Area**

The purpose of this Part is to protect the rights, safety and welfare of private and public landowners by the regulation of floodway development. Construction activities which restrict a stream's capacity to carry flood flows may result in channel instability and increased flood damages to neighboring properties.

Floodway Construction Rules

- Standards for permitting:
  - 0.1 ft raise in water surface in urban areas
  - 0.5 ft raise in water surface in rural areas
  - Covers flood events up to 100-year
  - Must consider cumulative impacts

- Bridges and culverts
  - 0.5 ft raise in water surface in urban areas
  - 1.0 ft raise in water surface in rural areas
  - Flood events up to 100-year

- Levees and floodwalls
  - Same criteria as for floodplain development but with 500-year flood as upper regulatory limit (proposed revision in progress)

How do we know the standard is met?

- Statewide Permits
- General Permits
- Formal Permits
  - Judgment Call – no hydraulic analysis needed
  - Worst-Case Analysis – applicant has an engineer demonstrate quantitatively that permitting thresholds are met

What is a Worst-Case Analysis?

How do engineers show that they meet the permit criteria?

"Worst-case Analysis" – The calculation of the maximum increases in flood heights, velocities and damages a project would cause due to conveyance and storage losses considering both the project alone and the combined effects of other existing construction and reasonably anticipated equally obstructive construction on other similarly situated properties in the locality. Flood events up to and including the flood which has a 1% annual chance of exceedence shall be used in this analysis (see Section 3700.75 for exception).

Straightforward? Or not?

What is a Worst-Case Analysis?

For Engineers…

- **Can mean different things for different engineering backgrounds**
  - **Civil / Site Designers – Rational Method and Manning's Equation**
  - **Bridge / Highway Engineers – FEMA Flood Study and Backwater Model (HEC-RAS)**
  - **Water Resources Engineers – Full Watershed Study with 2-D Backwater Modeling or Unsteady Flow Hydraulic Model**

What is a Worst-Case Analysis?

For Regulators…

- **Can also mean different things for different types of projects**
  - **Culverts / Small Developments – Regression Equations and Simple Backwater Model**
  - **Flood Control Projects – Routing Model – Single Watershed Model with Rating Curve**
  - **Large Riverine Levees – Gage Data and Detailed Unsteady Flow Models**

What is a Worst-Case Analysis?

- Acceptable analysis methods also change over time
  - Up to 1960s – Historic accounts of flooding with hand calculations for flow depths – very simple technical analysis; physical models
  - 1970s and 1980s – Regression Equations, HEC-1 and HEC-2
  - 1990s and 2000s – FEMA Flood Insurance Studies, HEC-HMS, HEC-RAS, UNET
  - 2010s – LiDAR, Finite Elements, 2D & 3D models are available

The acceptable methods for today may be obsolete in the future

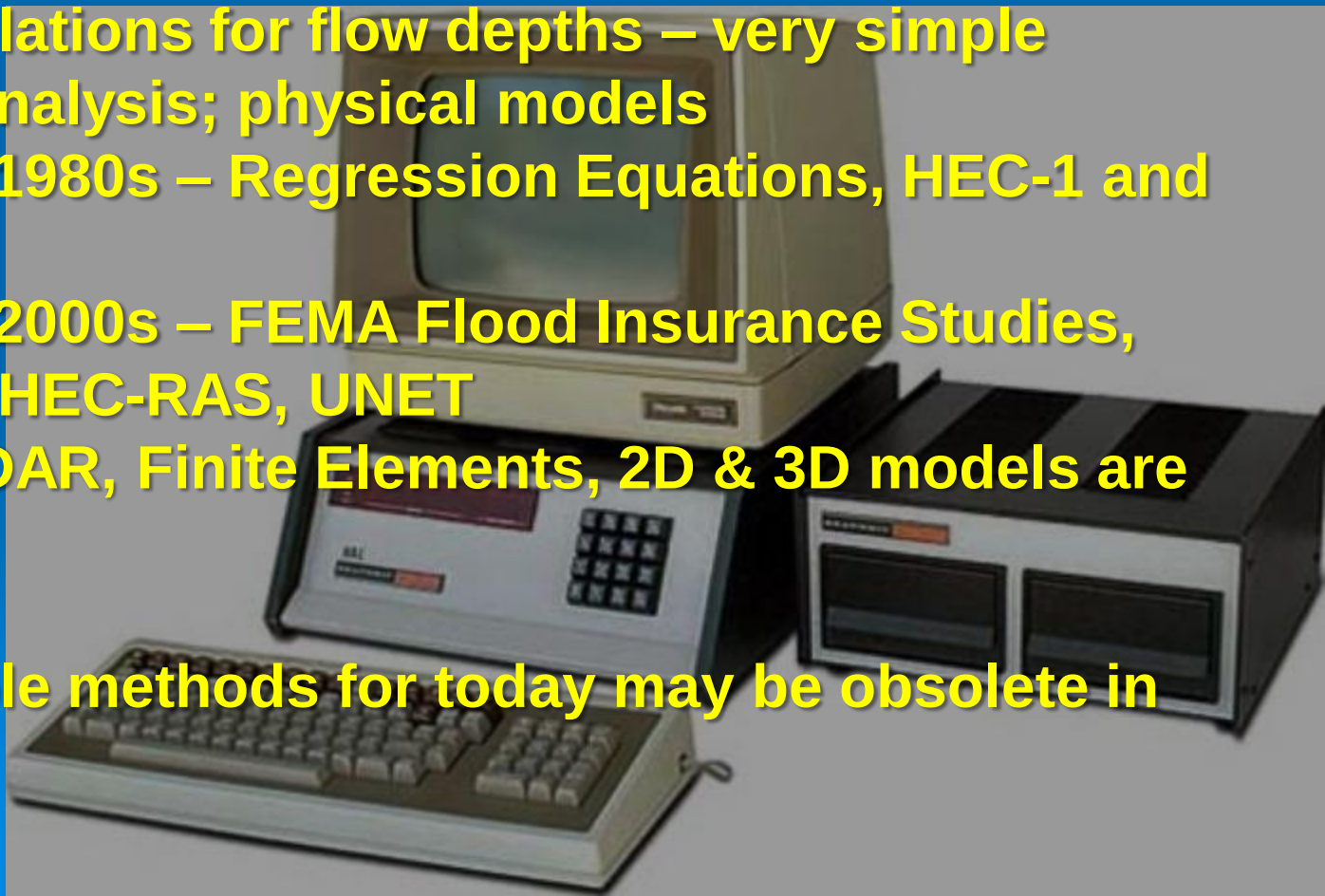


Illustration: Dissipation of Backwater Increases

in urban areas, the water surface profile increase would not exceed 0.5 feet at the structure, nor 0.1 foot at a point 1000 feet upstream of the structure as determined by the horizontal projection of the increase and the slope of the hydraulic grade line; or

in rural areas, the water surface profile increase would not exceed 1.0 foot at the structure, nor 0.5 feet at a point 1000 feet upstream of the structure as determined by the horizontal projection of the increase and the slope of the hydraulic grade line; and

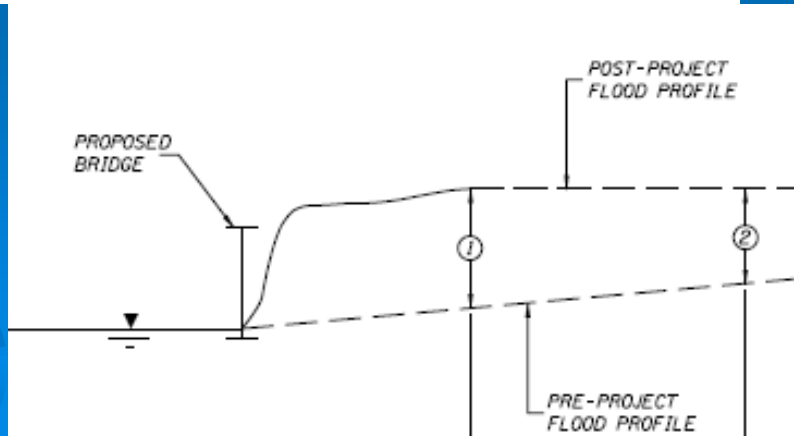
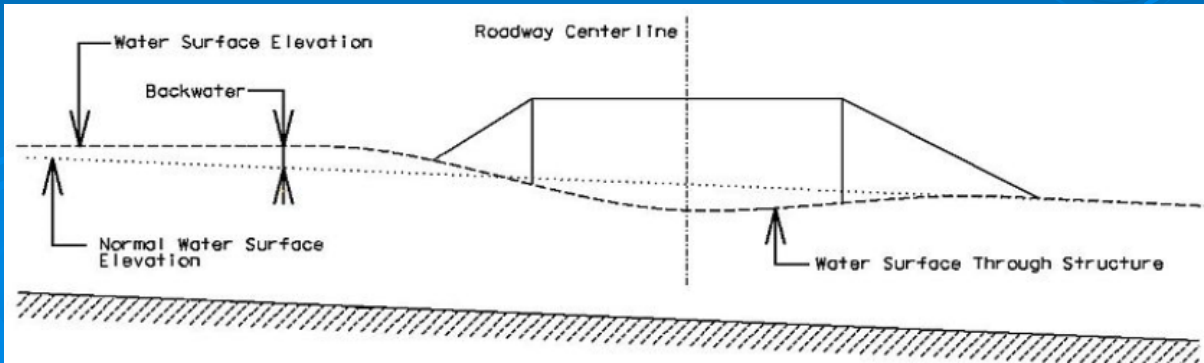


Illustration: Dissipation of Backwater Increases

- Modeling of multiple upstream cross-sections was not always feasible (before HEC-2 and HEC-RAS were more widespread)

- Standard was written based on level pool backwater
  - Does not consider actual water surface
  - Standard is confusing and less accurate considering today's technology and engineering analysis standards
  - Proposed revision to this standard is in progress



What is a Worst-Case Analysis?

- What do we know about the answer to this question?
  - Engineers may have differing interpretations depending on their background
  - Regulators may have differing interpretations depending on the nature and extent of any given project
  - The “correct” interpretation can vary over time

Why is this problematic?

- Engineers may not automatically know what type of analysis is required
- Regulators may have different requirements of different projects based on type of work
  - If it is not explained how we review applications, this can be frustrating to applicants

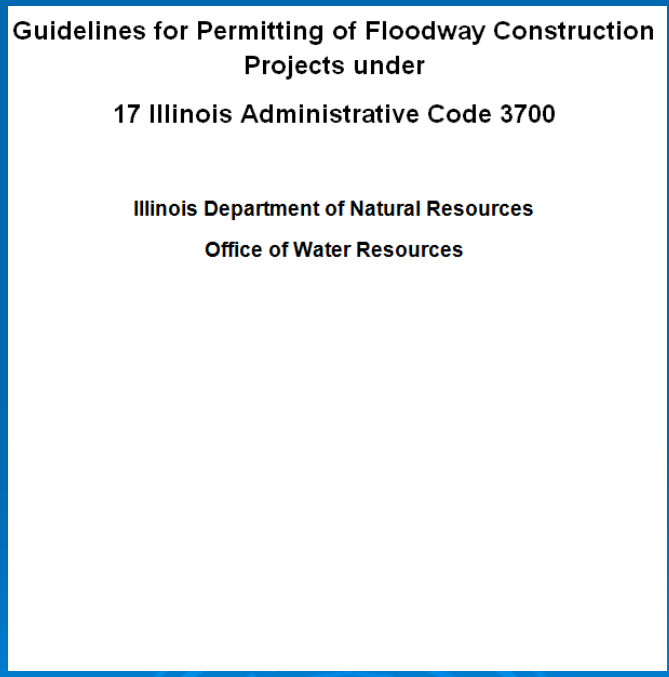
What could be done about it?

- Option 1 – Define in more detail in administrative rules
  - Disadvantage – cannot change very easily if technology changes and cannot adapt very easily to updated study information
  - It is very time-consuming and difficult to change administrative rules

- Option 2 – Keep internal policies on how to review permit applications
  - Disadvantages - lacks transparency
    - Consumes more time making revisions when engineers are unsure of requirements

Proposed Solution: Guidelines Document

- Release a document outlining review policies for floodway construction permitting
- Informal document – gives regulators flexibility to update as data, technology, and standards change


Guidelines for Permitting of Floodway Construction Projects under

17 Illinois Administrative Code 3700

Illinois Department of Natural Resources

Office of Water Resources

Major Sections of the Document

- Introduction
- Review Procedures
- Determination of Jurisdiction
- Floodway Construction
- Levees and Floodwalls
- Bridges and Culverts
- Hydrology
- Hydraulics

Introduction

- General purpose of Floodway Construction Rules
  - To protect others from flooding caused by others construction
- Intent to make more transparent and efficient permitting process
- Disclaimer that other regulations could also be applicable
- Disclaimer that information is for guidance and does not provide rigid instruction

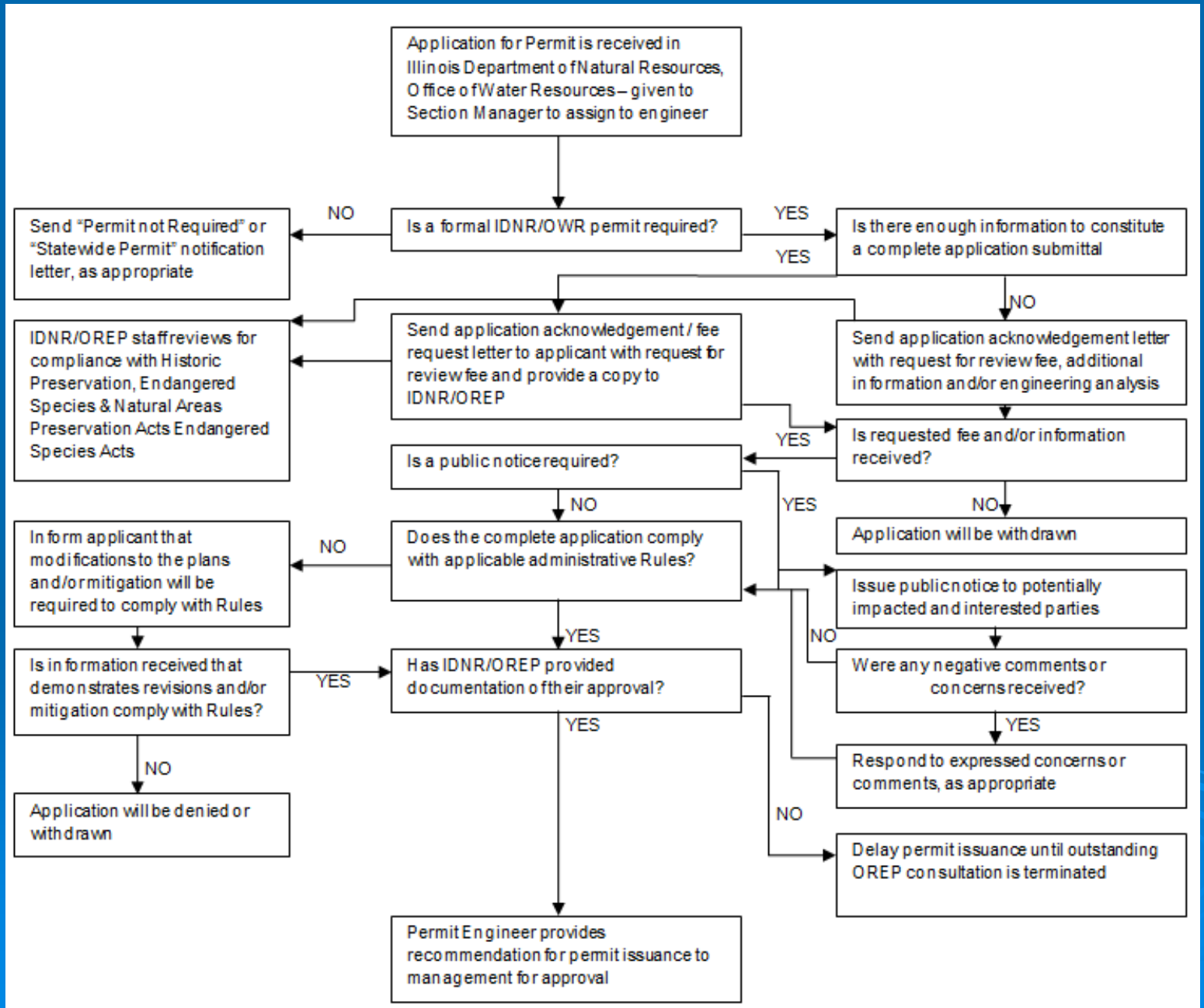
Review Procedures

- Explains Types of Permits
  - Statewide
  - General
  - Individual

- When and What to Submit
  - Joint Application Form
  - Plans and Project Description
  - Worst-Case Analysis (if required)
  - Permit Review Fee

- Flow Chart for Review Process

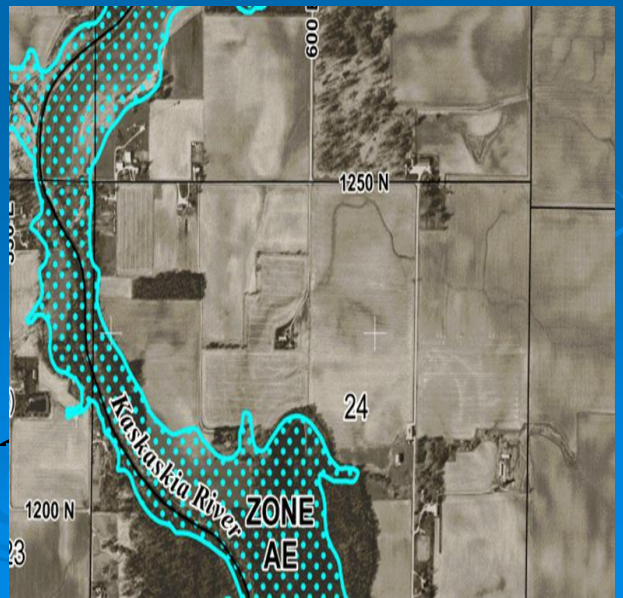
Review Procedures



Determination of Jurisdiction

- Drainage Area Thresholds
  - 10 square miles – Rural
  - 1 square mile – Urban
  - Urban versus Rural is better clarified

- Floodway Information
  - Mapping Sources (i.e. FEMA maps)
  - What to do if:
    - There is no floodway map
    - Floodplain but no Floodway is Delineated
    - Levees forming Floodway Boundaries

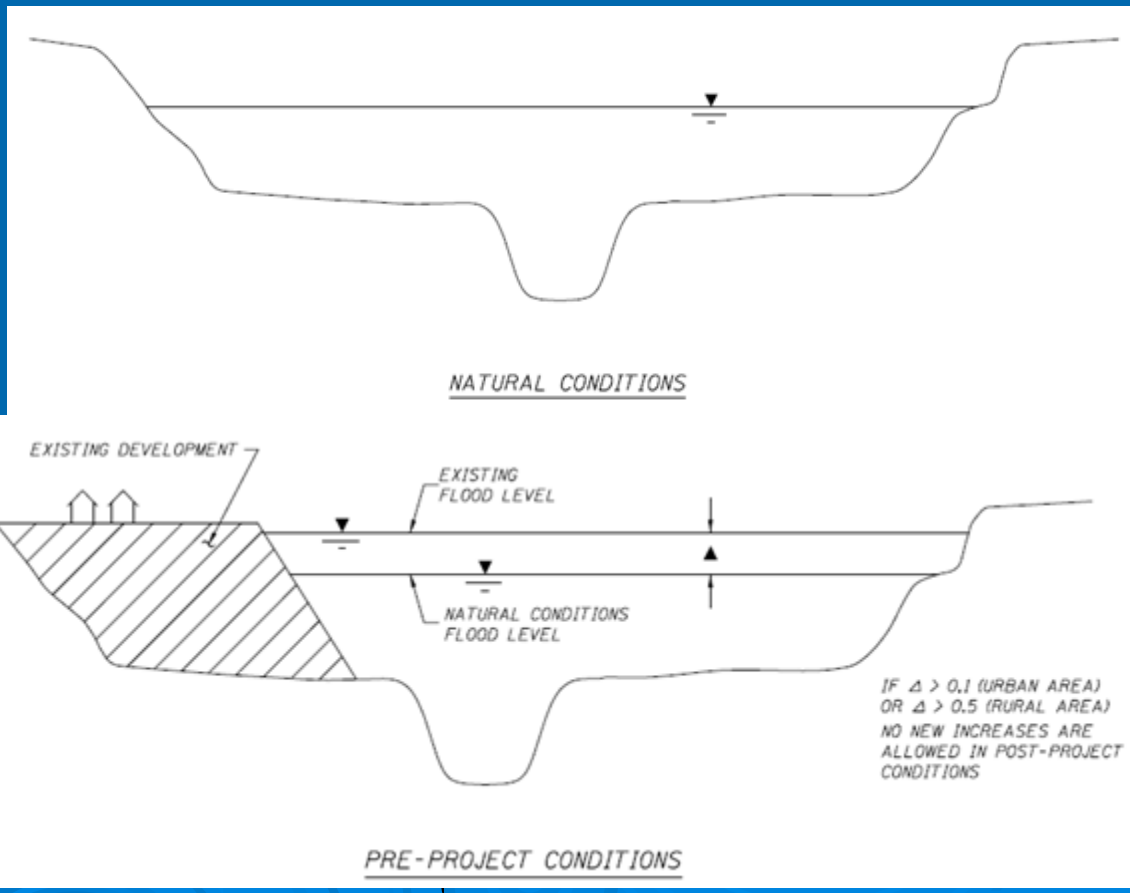


Determination of Jurisdiction

- **Exempted Activities Listed**
  - **Maintenance**
  - **Irrigation**
  - **Field Tile**
  - **RURAL Fences**
  - **Bridge Deck Widening**
  - **Short Culvert Extensions**

Floodway Construction

- Worst-Case Analysis
  - When it is necessary vs. when permit is made by judgment call
  - Modeling Required
    - Natural
    - Pre-Project
    - Proposed
  - Cumulative Effects



Floodway Construction

- Floodway Construction
  - When Increases are Allowed
  - When No-Rise is the Standard
  - Flood Easements
  - Compensatory Storage and Conveyance

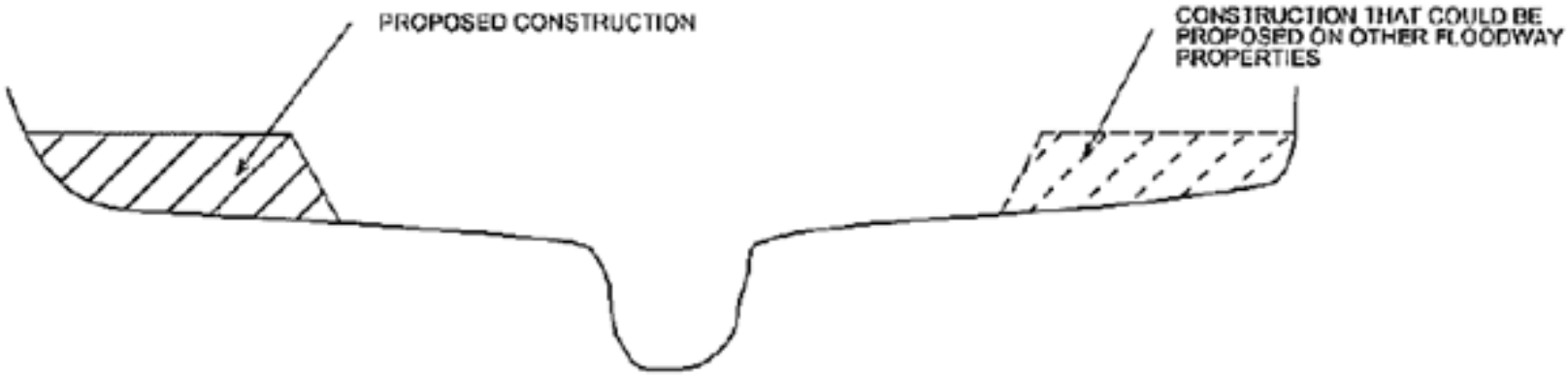


Figure 4.2: Illustration of cumulative impacts. Note the equally obstructive development that could be proposed, is modeled on the opposite side. These would also be considered on the upstream and downstream properties, as appropriate.

Floodway Construction

- **Compensatory Storage - Illustrated**

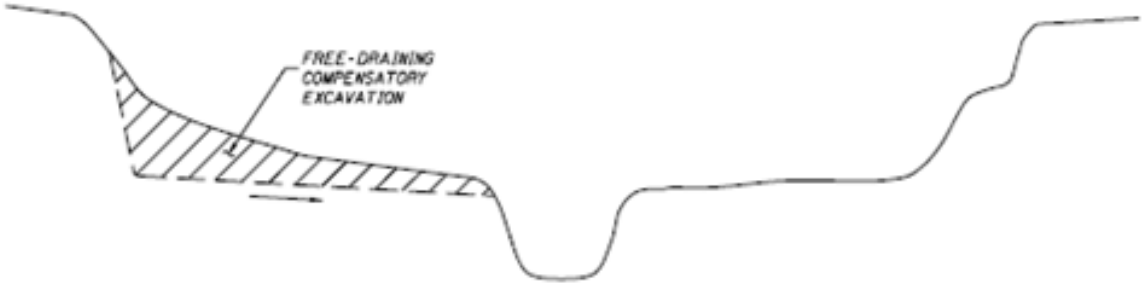


Figure 4.3(a): Cross-section of free draining compensatory excavation

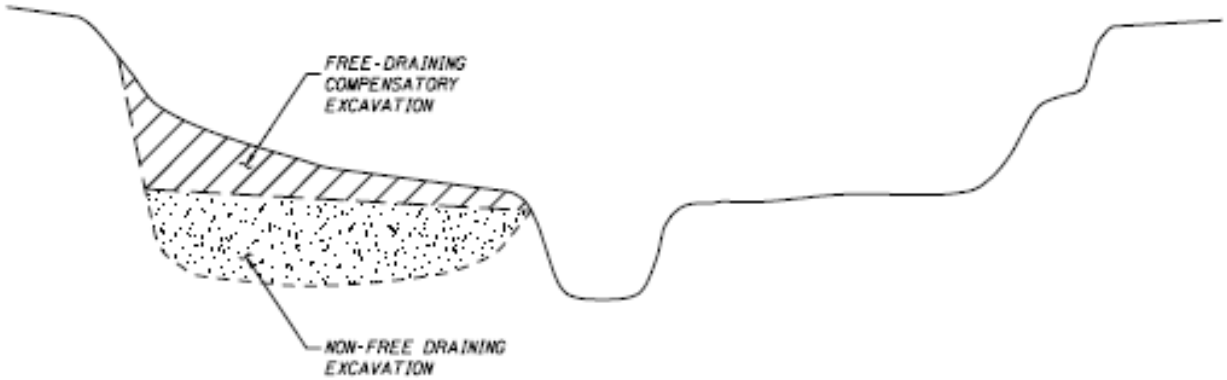


Figure 4.3(b): Cross-section of a compensatory excavation in which part of the area cannot be considered effective

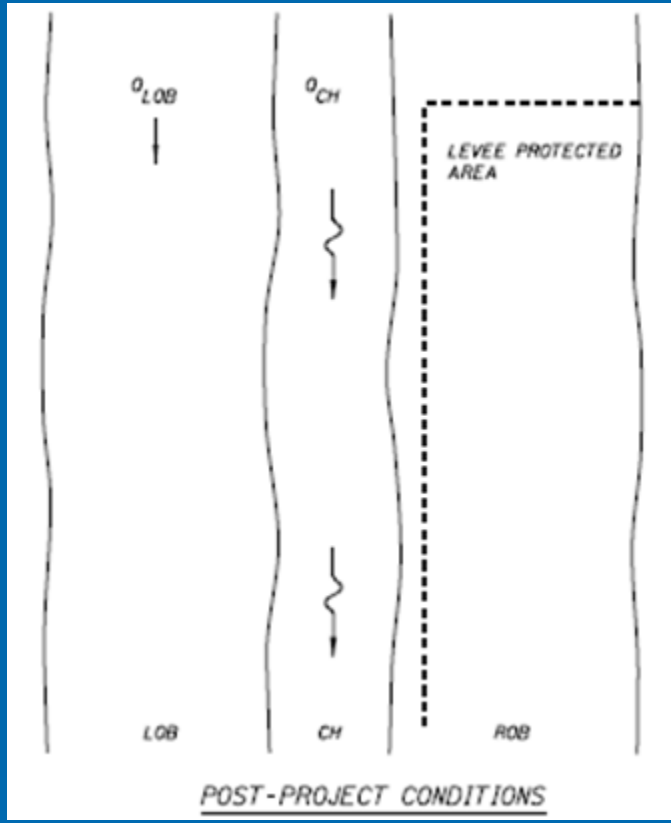
Floodway Construction

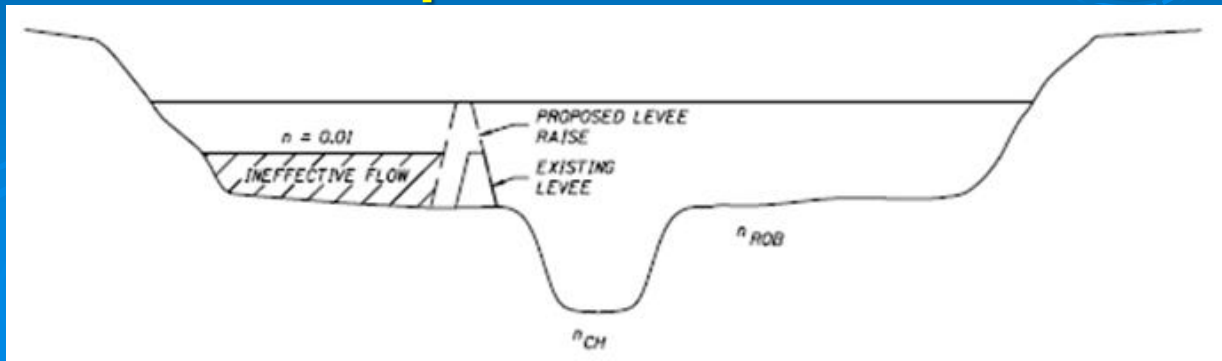
- Typical Floodway Construction Activities
  - Buildings
  - Excavation and/or Fill
  - Urban Fences
  - Material Storage
  - Temporary Construction
  - Water Intake Structures
  - Wetland Berms
  - Channel Modification
  - Channel and Bank Protection

Levees and Floodwalls

- Worst Case Analysis - Hydrology
  - Flood Discharges (up to 500-year event)
    - New proposed standard
  - Data Sources for discharges
  - DNR must concur with discharges

- Worst-Case Analysis – Hydraulics
  - Steady Flow Procedure
    - Loss of Storage
    - Loss of Conveyance
  - General Information about Corps 408 Program





Levees and Floodwalls

- Existing Levees
  - Proposed Levee Raises
  - Levee Re-Alignment
  - Flood Fighting
  - Maintenance / Repair
- Grandfather Date - 1985

Bridges and Culverts

- Worst-Case Analysis
  - Modeling for cumulative effects is somewhat different

- Crossing Features
  - Guardrails
  - Excavation for Larger Waterway Opening
  - Flow Transitions

Bridges and Culverts

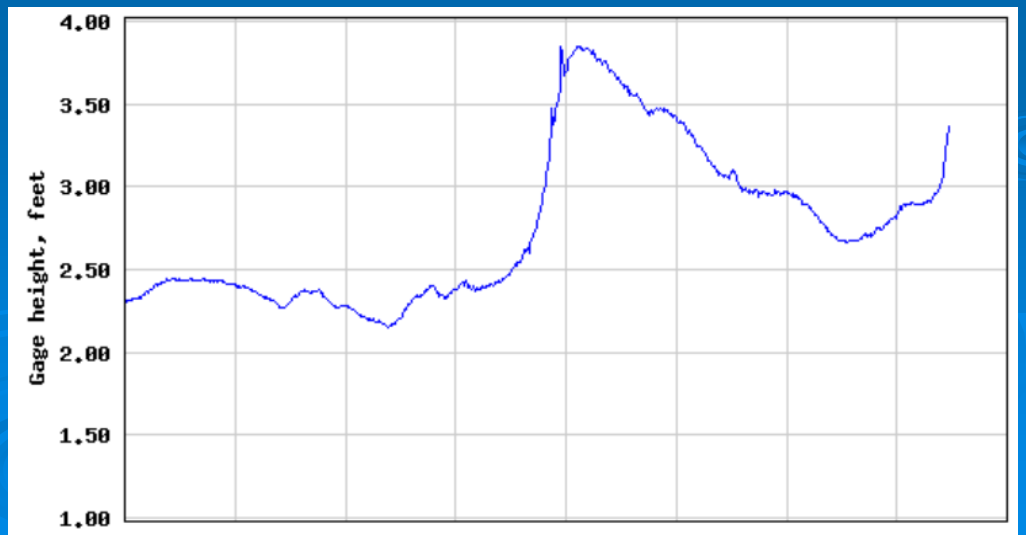
- Sensitive Flood Receptors
  - If there are homes and buildings in backwater
    - No-rise for new bridges
    - Replacements should be opened to “fullest practical extent”

- Fullest Practical Extent
  - Analyze different opening alternatives
  - Flooding Cost, Construction Cost and Benefits (reduced flooding) associated with each alternative
  - Proposed must be less than existing and most economical

Hydrologic Computations

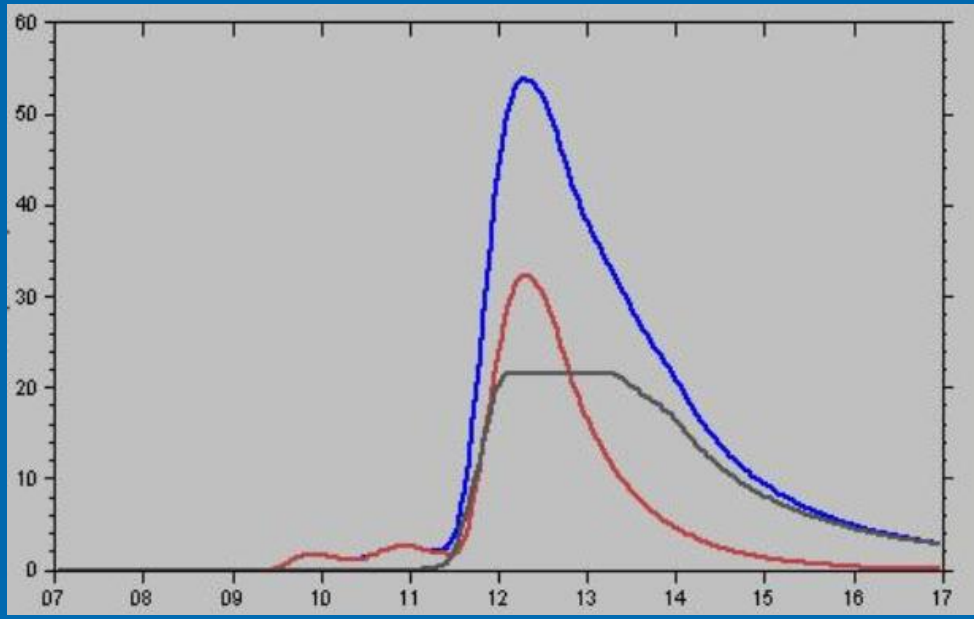
- Methods for Determination of Frequency Discharges (100-year or 500-year in particular)
  - Gage Data
  - FIS Studies
  - Regression Equations
  - Watershed Model (i.e. HEC-1 or HEC-HMS)

- How to judge the best available information and how to properly compute discharges using best available information



Hydrologic Computations

- Watershed Modeling
  - Sub-basin configuration
  - Time of concentration – Lag Time
  - Precipitation Modeling – critical duration
  - Precipitation Losses
  - Transformation – Precipitation to Runoff
    - Unit Hydrograph Methods



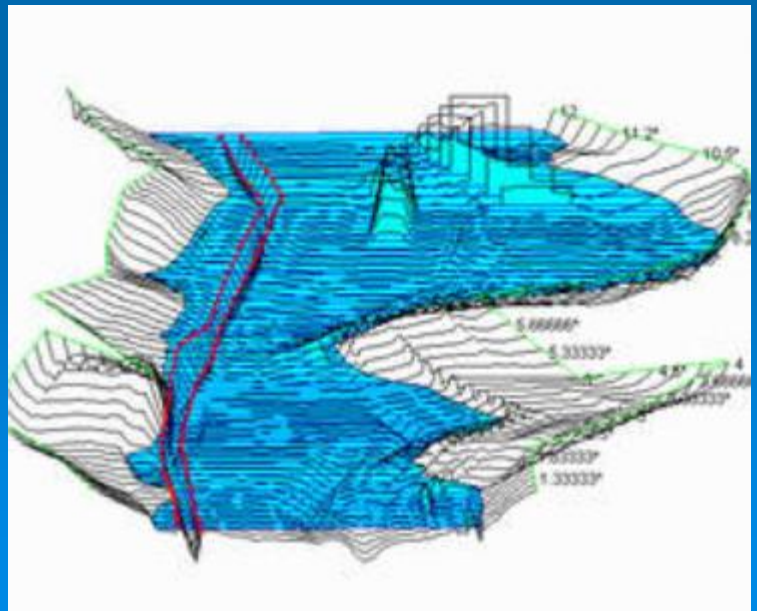
Hydrologic Computations

- Watershed Modeling
  - Some Tips on what is accepted practice
    - No restrictive bridges or culverts (those could someday be removed)
    - No detention storage considered unless it is a public (owned and maintained)

Hydraulic Computations

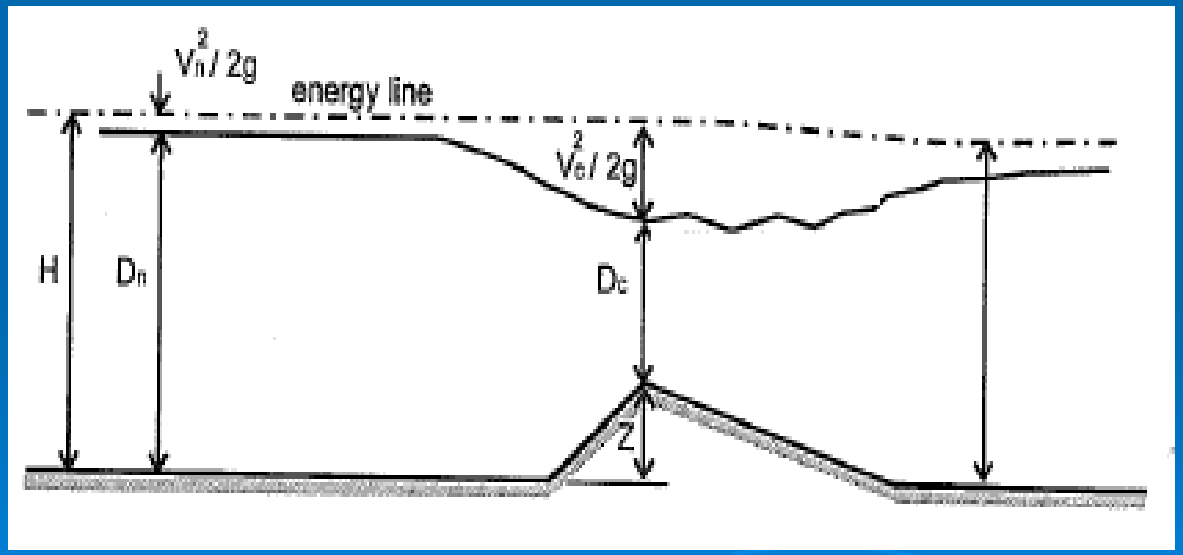
- Brief overview of hydraulic principles
  - Standard Step Methodology is Emphasized
  - Similar to HEC-RAS manual

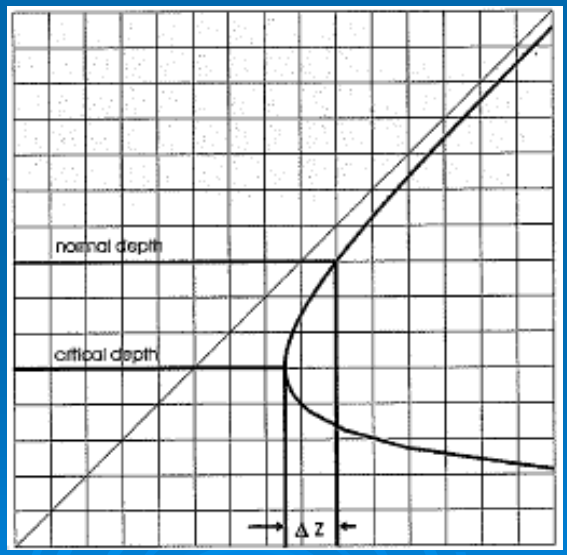
- Modeling Practices for Permitting
  - Consistency is Emphasized
    - ‘n’ value configuration
    - Number and placement of cross-sections



Hydraulic Computations

- Focus on Steady Flow Principles
- Simplified Methods
  - Sizing of Rock Riffles using Critical Depth Principles





Other Stuff – in Appendices

- Sample Restrictive Covenant
- Sample Flood Easement
- List of Statewide Permits
- List of General Permits

APPENDIX C: RESTRICTIVE COVENANT and FLOOD EASEMENT DOCUMENTS

C.1 Example Restrictive Covenant Document

WHEREAS, pursuant to the provisions of Rivers, Lakes and Streams Act, 615 ILCS 5 (insert permittee's name) applied for a permit from the State of Illinois, Department of Natural Resources, Office of Water Resources (hereinafter referred to as "OWR") to (insert project description and legal description of project site), County, Illinois ; and

WHEREAS, as a condition for issuance of Permit # (Permit # to be assigned by OWR upon receipt and approval of covenant), OWR requires that a certain restrictive covenant be obtained to maintain the flood conveyance and storage capacity of (insert stream name); and

WHEREAS, this covenant constitutes assurance of the preservation of such flood conveyance and storage; and

WHEREAS, (insert grantor's name) are the owners in fee simple of the premises upon which said conveyance and storage is to be maintained;

Now, THEREFORE, (insert grantor's names) do hereby agree as follows:

1. No additional channel straightening, filling, or dumping of dirt, refuse or any other material, or construction of any structure, shall occur within the floodplain/floodway of (insert stream name).

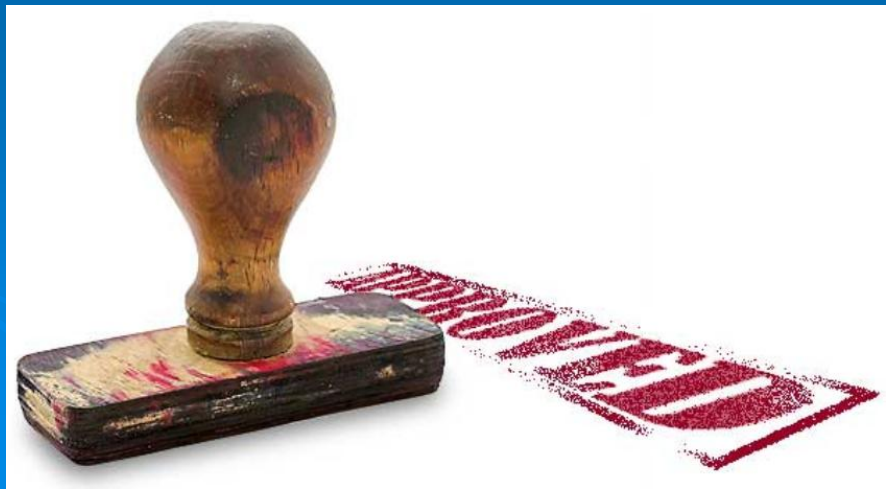
2. The above prohibition shall continue in perpetuity unless permission for a change is granted or waived by OWR.

3. This covenant shall run with the land and shall be binding upon the grantees, heirs, successors, divisees, legal representatives, and assigns of (insert grantor's names).

4. The above applies to the following described premises; (insert legal description of area).

Concluding Remarks

- Single Technical Reference for Permitting
- Better Transparency in IDNR/OWR Policies
- More Efficient for Applicants –
  - They will have a better idea of the requirements
- More Efficient for Regulators –
  - Less time will be spent asking for revisions



Questions?