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Successful Approaches to Change-MaineDOT's Experience (2015 State of the Bay Presentation)

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Successful Approaches to Change: MaineDOT's Experience

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presented at

Our Changing Bay 2015

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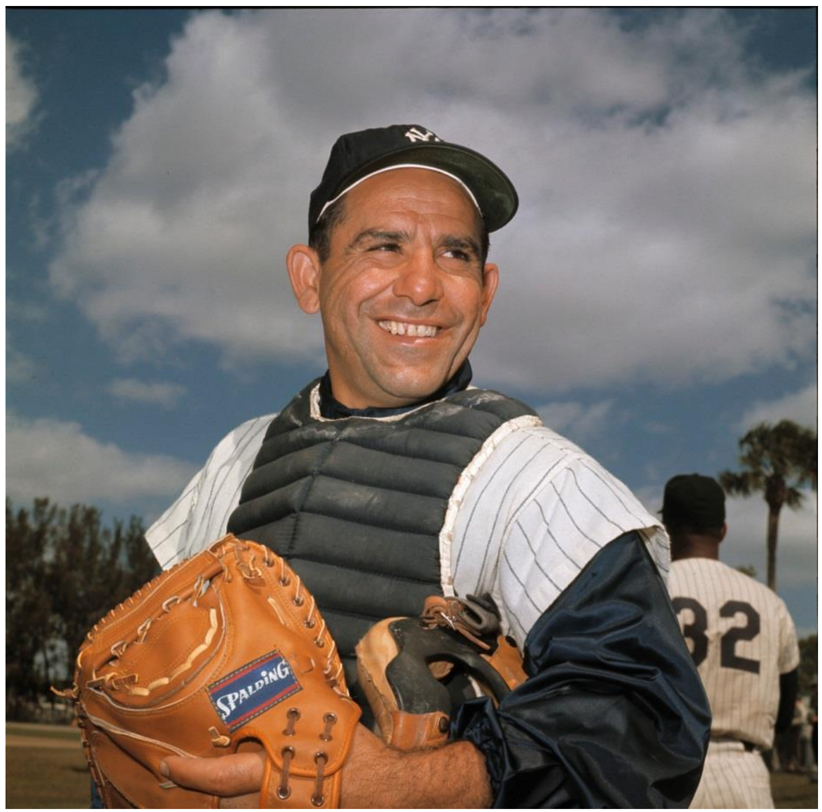
As a famous climate scientist once said …

The future ain’t what it used to be.



Some DOT Challenges
Hydraulic Structures

- Assets:
  - Thousands of bridges (span S > = 10 ft)
  - Thousands of large culverts (5 <= S < 10 ft)
  - Many thousands of cross-culverts (S < 5 ft)
- Exposures:
  - Coastal: seal-level rise (SLR)
  - Inland: riverine runoff peak flow events
- Projects:
  - Individual assets
  - Corridor reconstruction
- Design Life of New Structures
  - 100 YRS +

Some Very Simplistic *Starting* Assumptions

- Bridges: they are generally big, climate change not a worry
- Culverts: existing structures tend to be undersized by current standard
- Sea Level Rise: elevation is the issue, not capacity
- Inland Peak Flows: asset capacity is the primary issue
- Asset Replacement:
  - Due to poor condition or chronic hydrologoc failure
  - Not according to some *prediction* of future failure

MaineDOT Efforts

* Data & Engineering Methods
  * Cooperative projects with USGS
  * Internal design policy
* Planning, Research & Pilot Studies
  * FHWA sponsorship
  * Catalysis & GEI projects (Sam Merrill & collaborators)
  * Decision Support Tool for Enhanced Early Project Scoping and Program / Project Risk Identification

Major Change to MaineDOT Culvert Design Standard

* Cross Culverts (S < 5 ft)
  * Design Flow Q_{50}
  * Allowable Headwater $H_w/D <= 1.5$
  * *(former standard for all culverts)*
* Large Culverts (5 ≤ S < 10)
  * Design Flow Q_{100}
    * Q_{100} 20% > Q_{50}
  * Allowable Headwater $H_w/D <= 1$
  * ***Result: bigger structures***

- Complemented by environmental "bankfull sizing" for fish passage.
- Protection against Q_{100}++ .
- Relatively few culverts on "real streams" sized purely for hydraulic capacity.

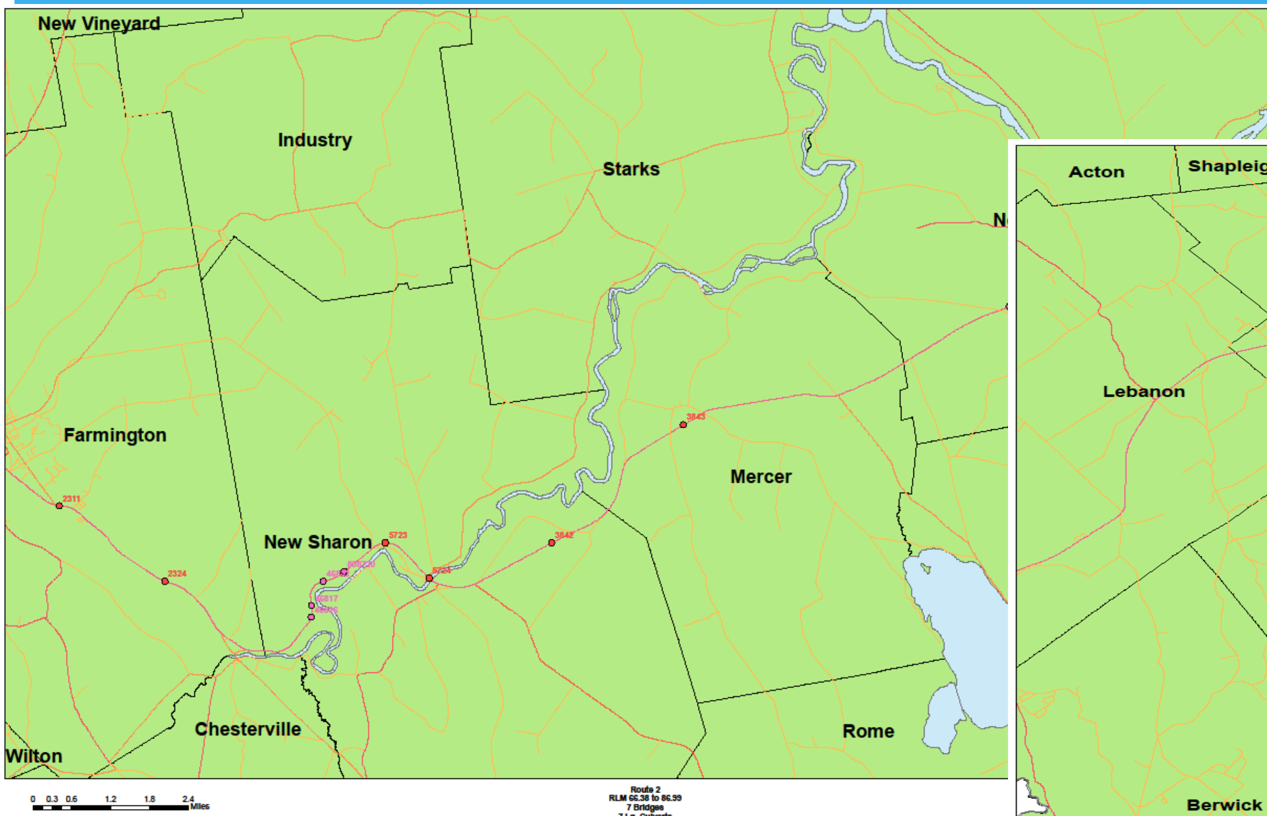
Benefits of New Standard

* Enhanced protection of assets
  * Protection against increased flows due to climate change
  * Design for Q_{100} now, get Q_{50} protection 50 – 100 yrs from now
* Most useful, biggest impact on "production work"
  * Smaller structures, routine work – lots of them!
* Improved fish passage
  * Reducing & eliminating undersized culverts
* "We're doing something!"
* Better than interim standard – strong first step - but not final story
  * Ideally – still need to capture future climate expectations
    * Which change scenario plays out?
    * Uncertainty in predictions within that scenario
  * Address MaineDOT *system* in some fashion

Some Ideas

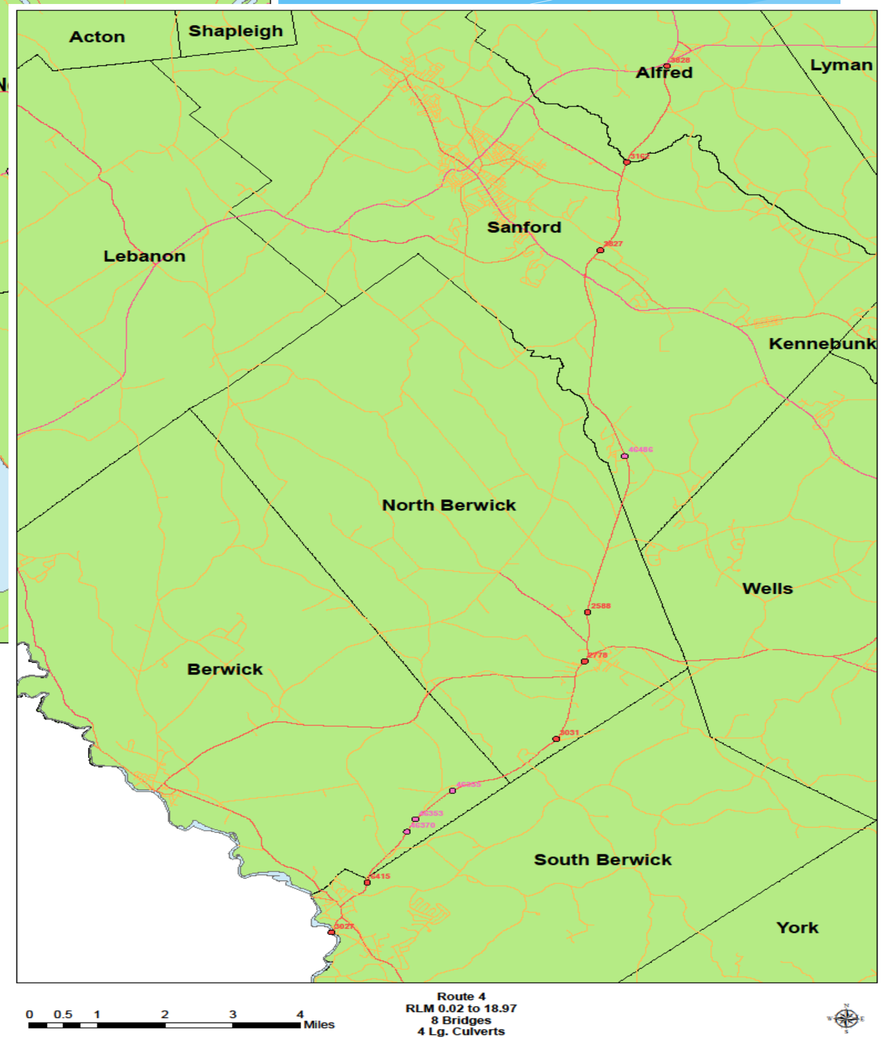
- Total DOT asset base too big for meaningful assessment
  - Break it up into digestible portions
  - Corridors
  - Vulnerable geographic settings
  - Leverage local experience and staff knowledge
    - Efficient, effective screening
- Risk-Based Design *(vs current Frequency-Based Design)*
  - ***Goal: Balance Underdesign against Overdesign in a Rational Manner***
  - Minimize total expected project cost over asset lifetime
  - Challenges & Limitations:
    - Data
    - Models

Corridor Selections

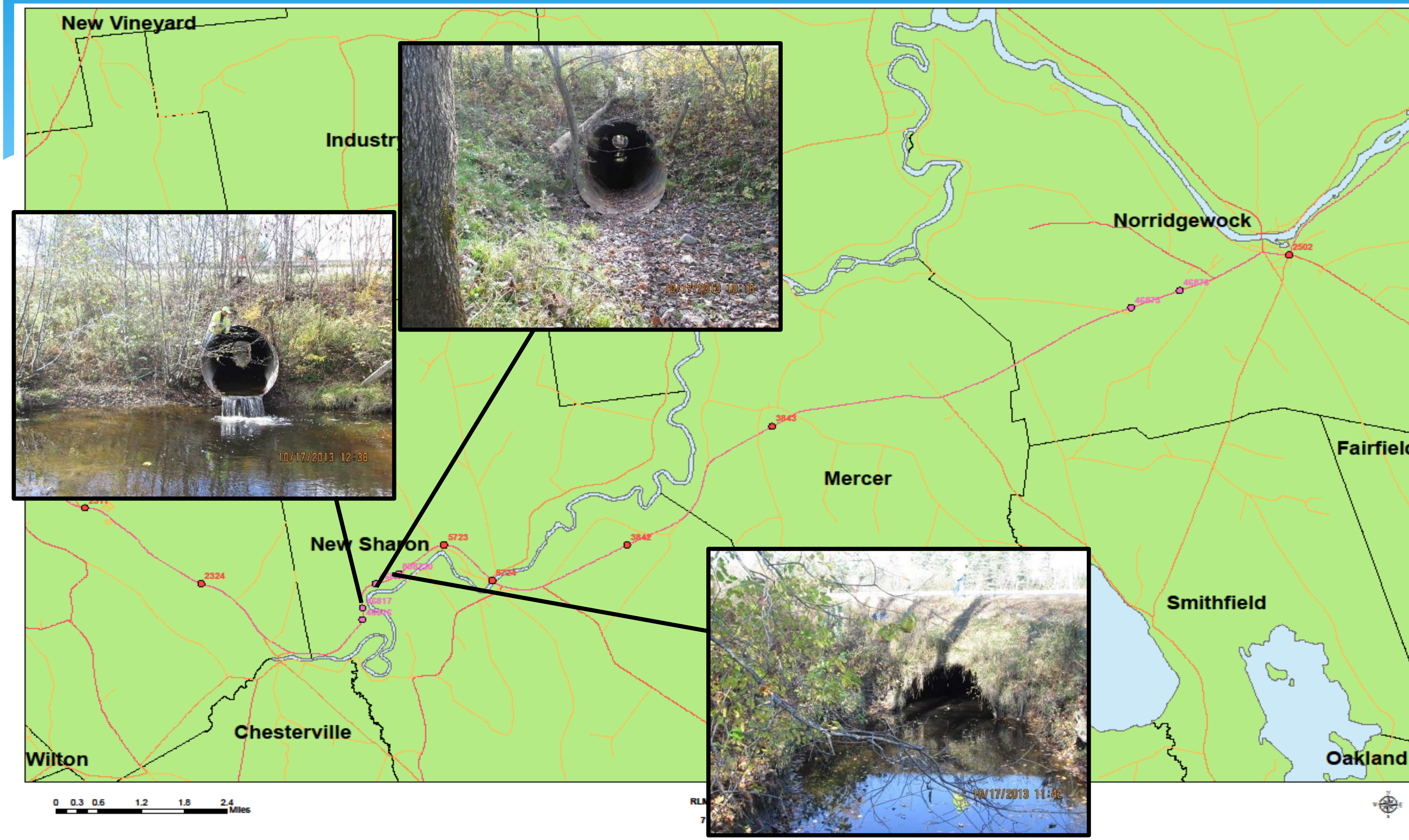


Route 2 - Mercer

Courtesy of Sam Merrill

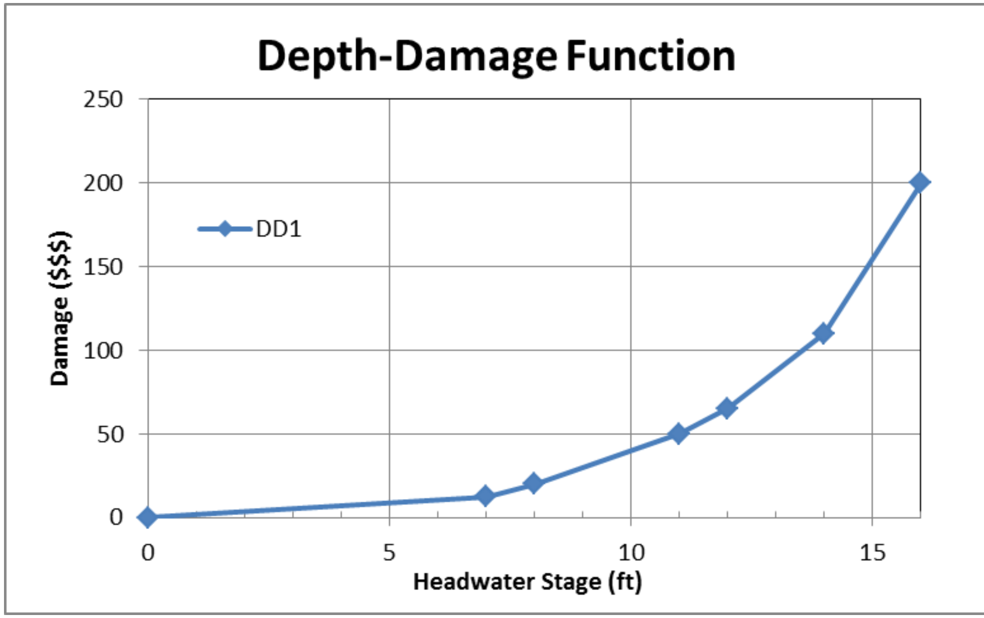


Route 4 - Berwicks

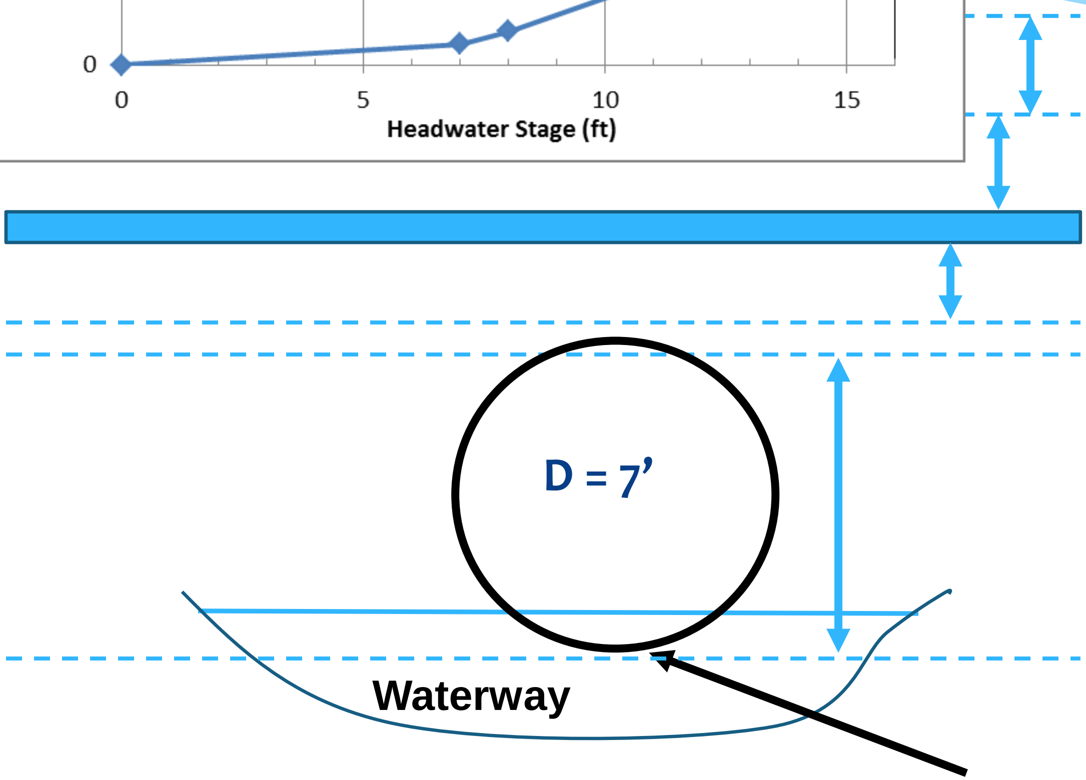


Courtesy of Sam Merrill

Depth Damage Functions for Each Candidate Structure

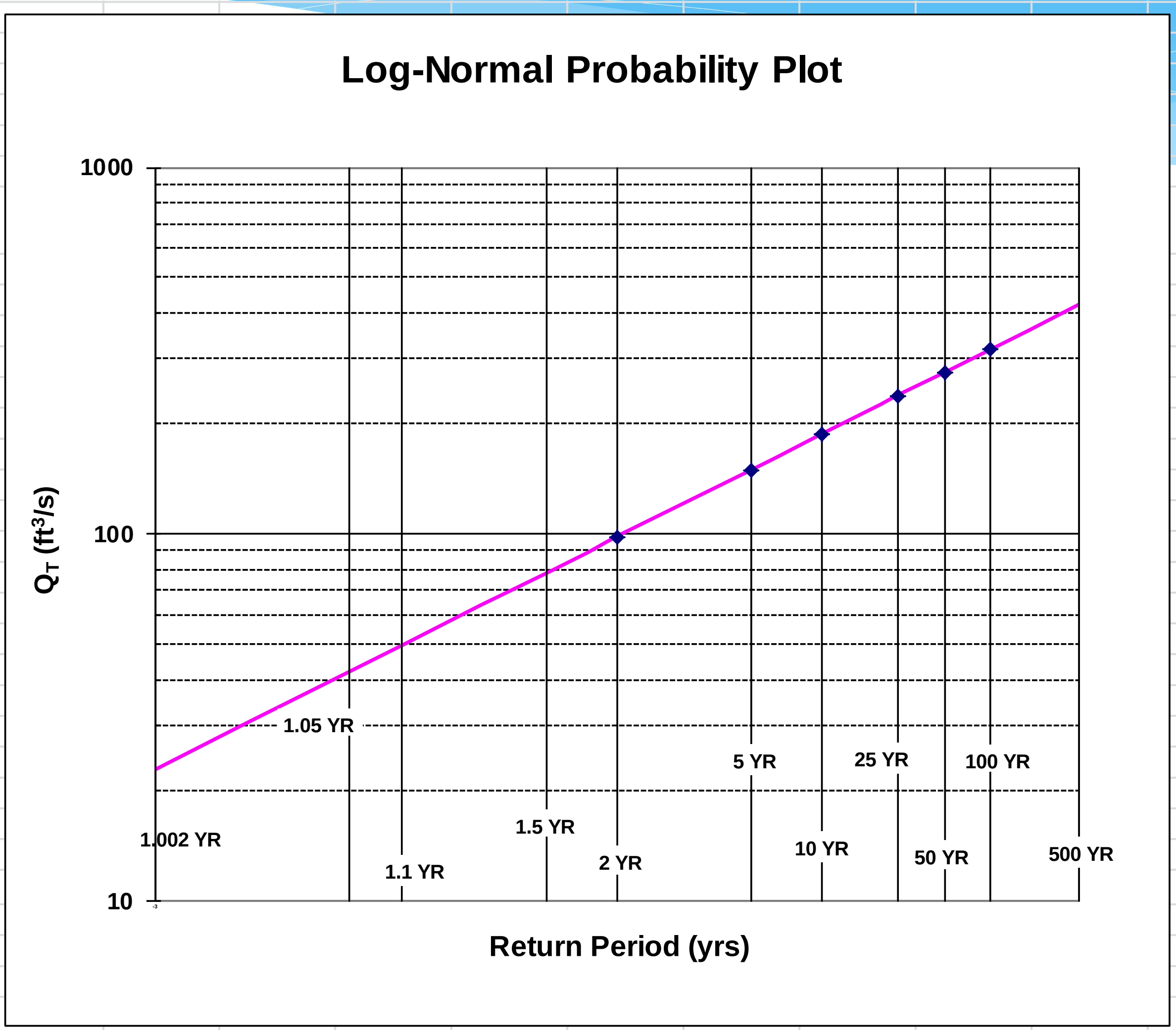


Elev.	Damage	Cost
14-16’	Extreme	= $E/event
12-14’	Severe	= $E/event
11-12’	Serious	= $D/event
8-11’	Moderate	= $C/event
7-8’	Slight	= $B/event
0-7’	Negligible	= $A/event



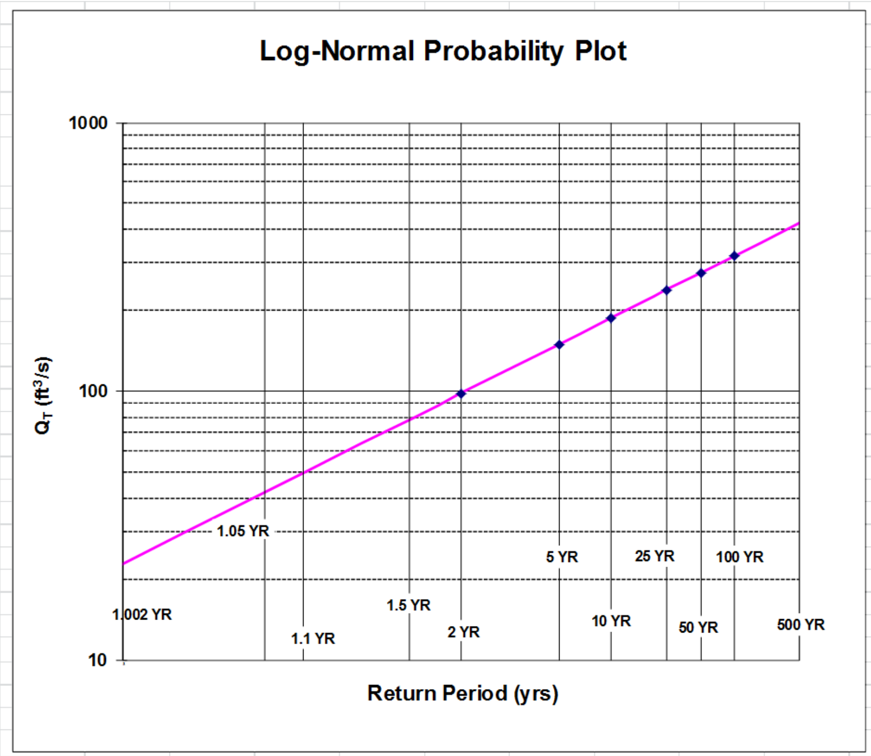
Courtesy of Sam Merrill

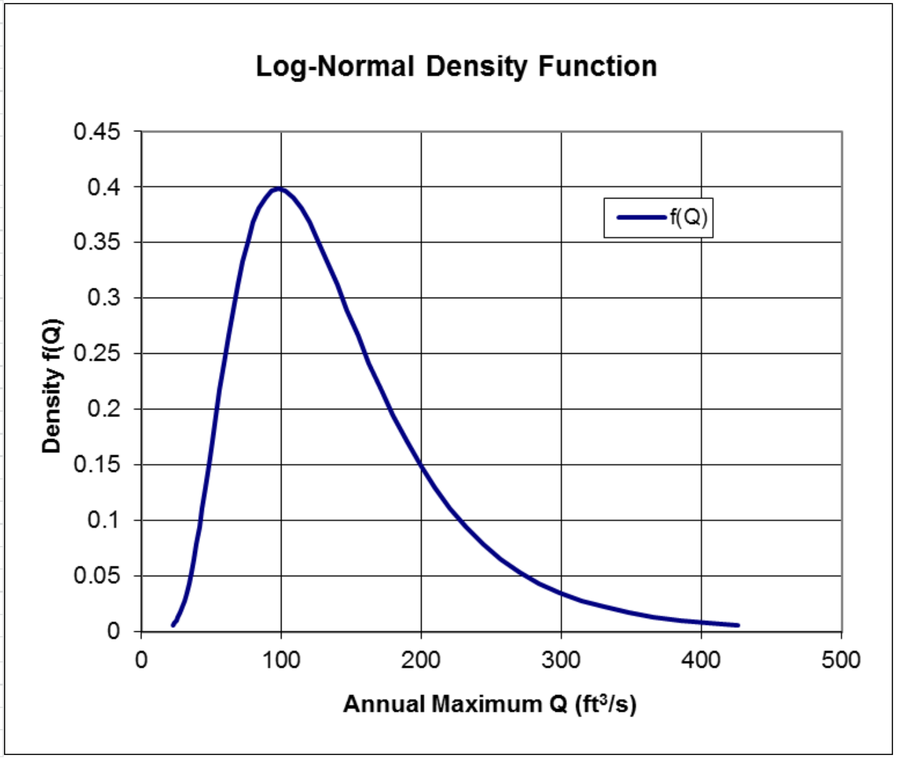
Transformation of Hydrologic Probabilities to Damage Probabilities



Sort of like the
Cumulative Distribution Fn – CDF
"showroom product"

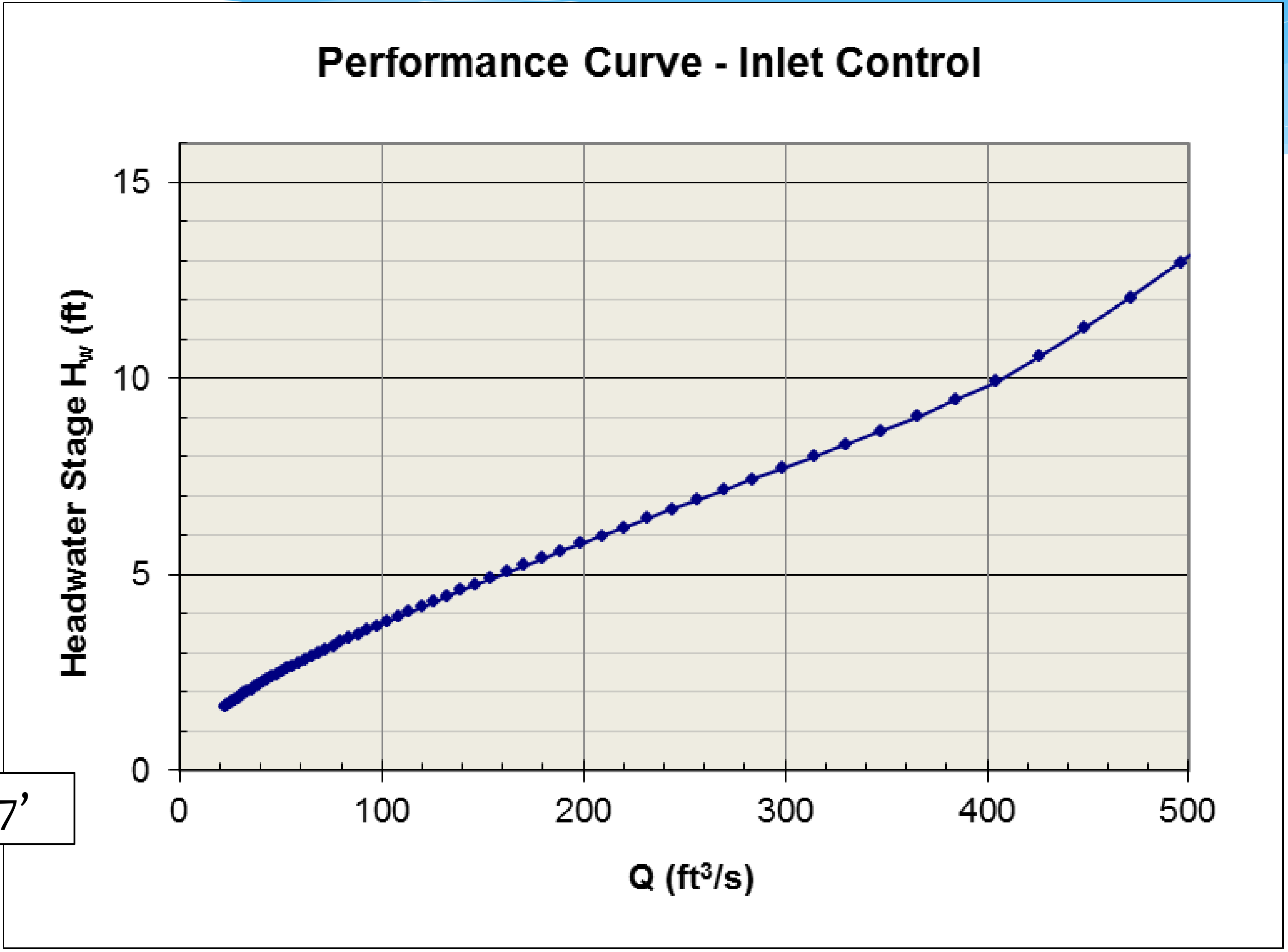
Probability Density Fn – PDF
"under the hood"





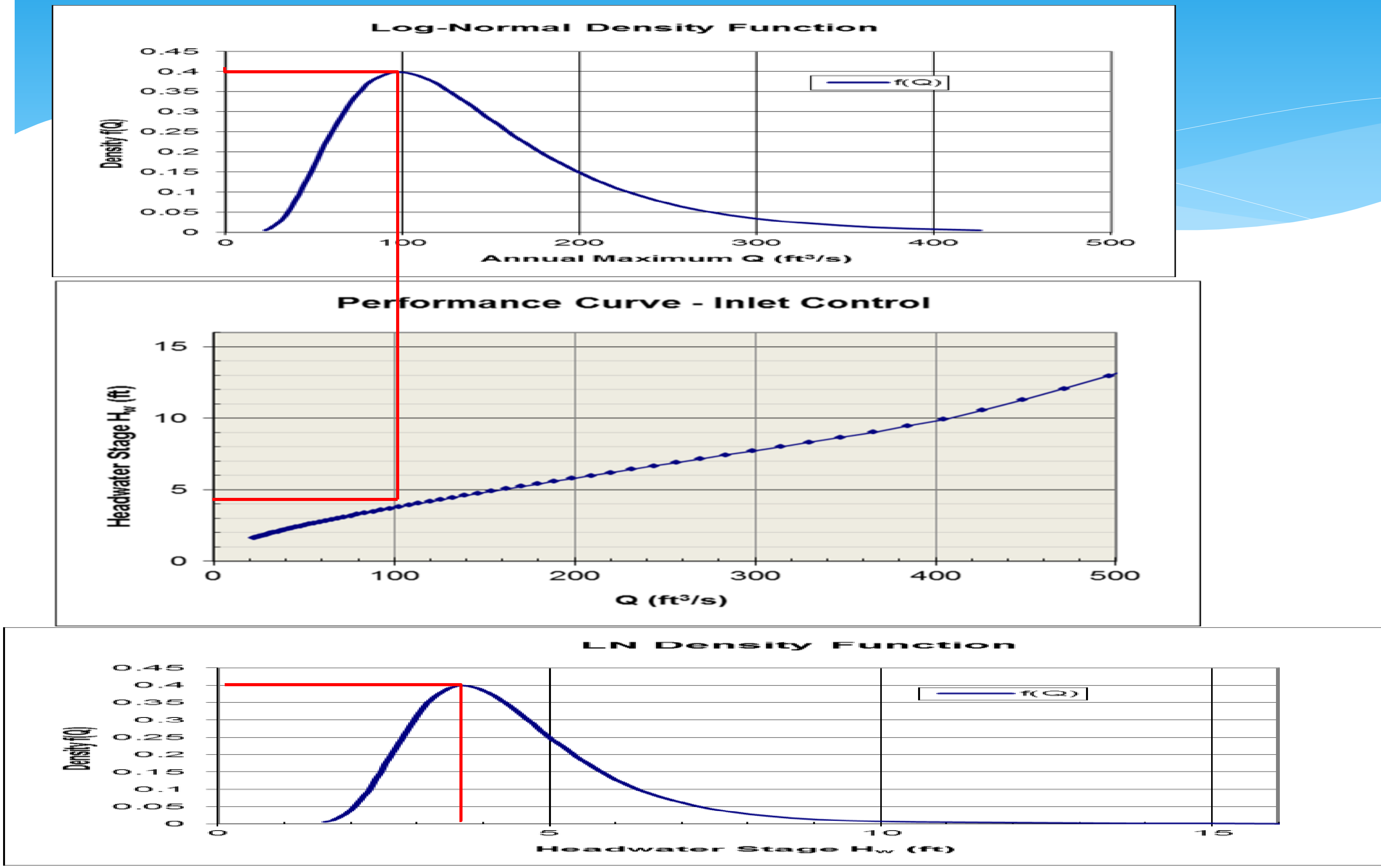
Alternative Representations of the Same Underlying Probability Function

Culvert Performance Curve
Flow – Depth Function

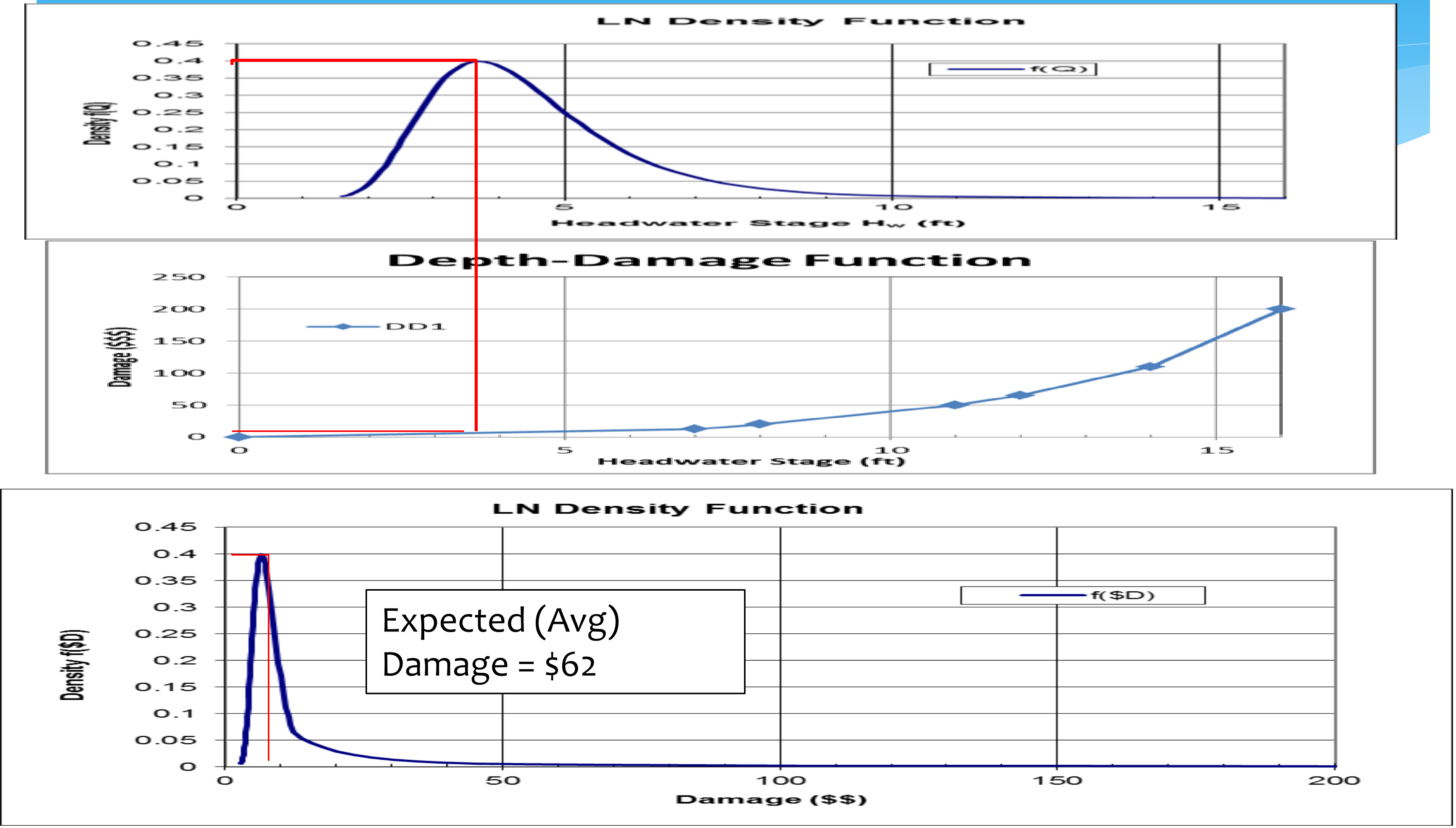


For D = 7’

Transform the Flow PDF to a Depth PDF



Transform Depth PDF to Damage PDF



Challenges to Application

- Models
  - Depth-damage functions
    - Identify ***ALL*** costs
    - Get good estimates (relative? absolute?)
  - Flood frequency curves
- Data
  - Basic asset data
    - Size (capacity)
    - Elevations
  - Real construction costs
  - Screen for vulnerable, at-risk assets