# SR 520 SDEIS Technical Work Session

Museum of History and Industry

September 16, 2008

# Agenda

- Welcome and Meeting Overview
- Cost Estimate Validation Process
- Endangered Species Act and Stormwater Update
- Project Impact Plan
- Lid Leads Report Out
- West Side Outreach
- Acoustics Expert Review Panel Report Out
- Next Steps

# Cost Estimate Validation Process: Building Success and Minimizing Surprises - Helping Avoid Cost / Schedule Overrun

SR 520 SDEIS Technical Work Session for Mediation Participants

John Stout, Senior Economist, HDR

# Definition of Terms

- CRA – Cost Risk Analysis:
  - Applies to projects 25 million to 100 million.
  - Internal subject matter experts may be used.
  - Held as needed.

- Cost Estimation Validation Process (CEVP®):
  - Applies to projects greater 100 million.
  - External subject matter experts required.
  - Typically held once every six to 12 months or as needed.

# What is CEVP?

- What is CEVP?
  - Estimating tool that considers cost, schedule, risks, opportunities and uncertainties.

- Why CEVP?
  - More realistic projections of probable cost and schedule.
  - Better decision-making and risk management for projects and programs.

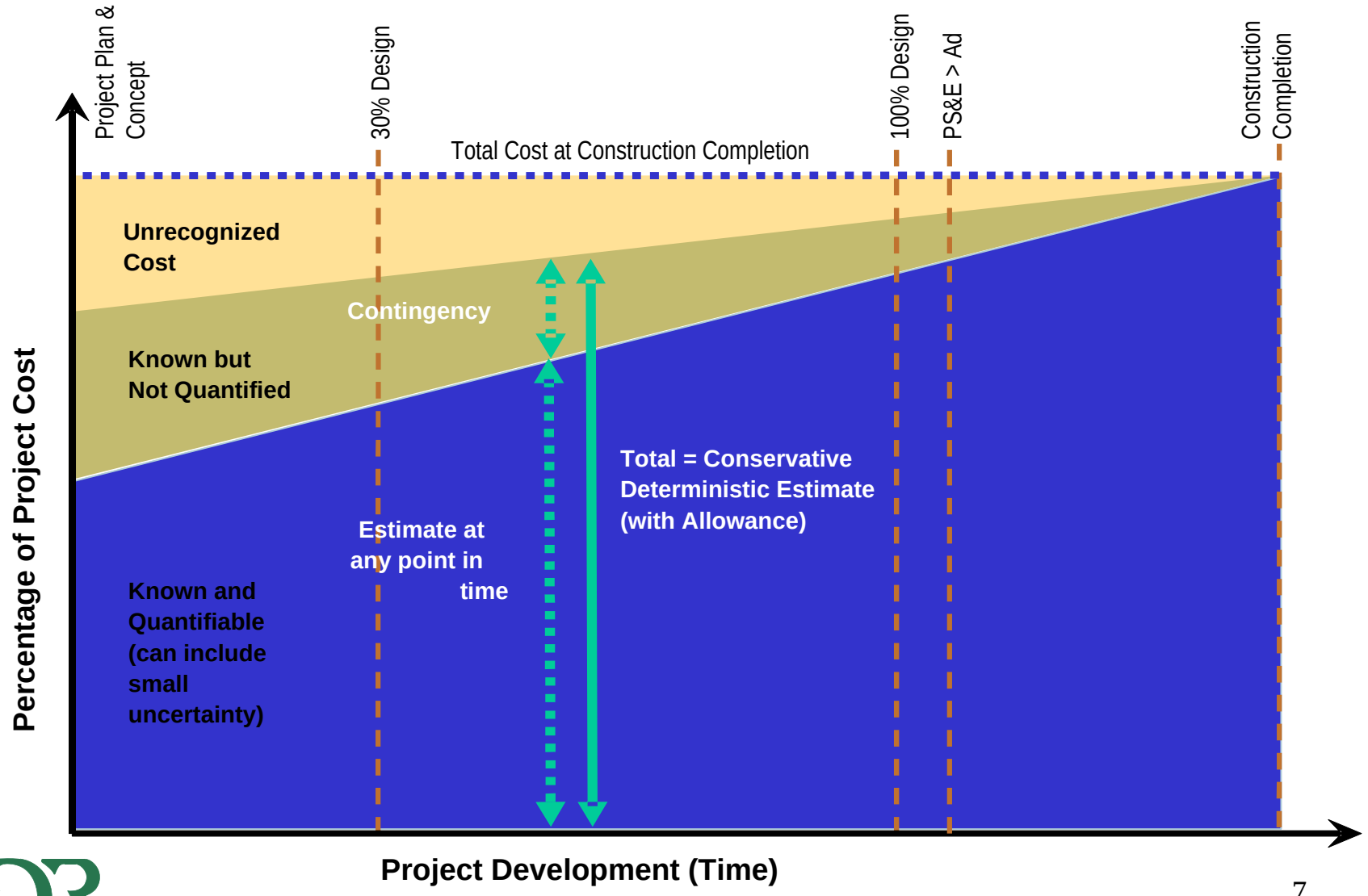
# Why Risk Assessment?

Risk Assessment provides significant value by:

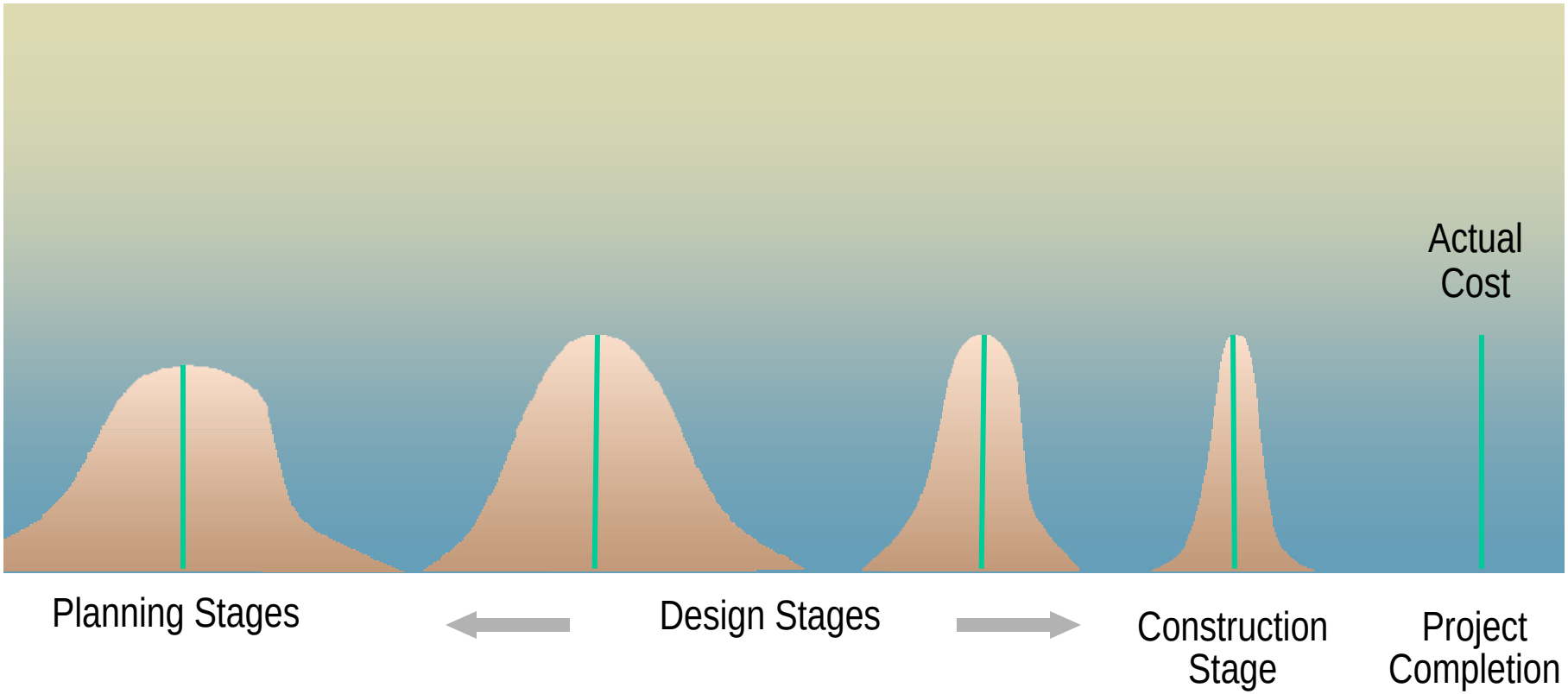
1. Encouraging pro-activity and early planning within the project team to shift odds in their favor.
2. Providing the collaborative environment to develop mitigation strategies for all anticipated threats.
3. Building confidence and credibility in project's plans and estimates.
4. Ensuring transparency and integrity throughout the life-cycle of the project.
5. Providing the project's sponsor with better cost and schedule forecasts for planning, budgeting, and bonding.

HDR

# Project Life Cycle

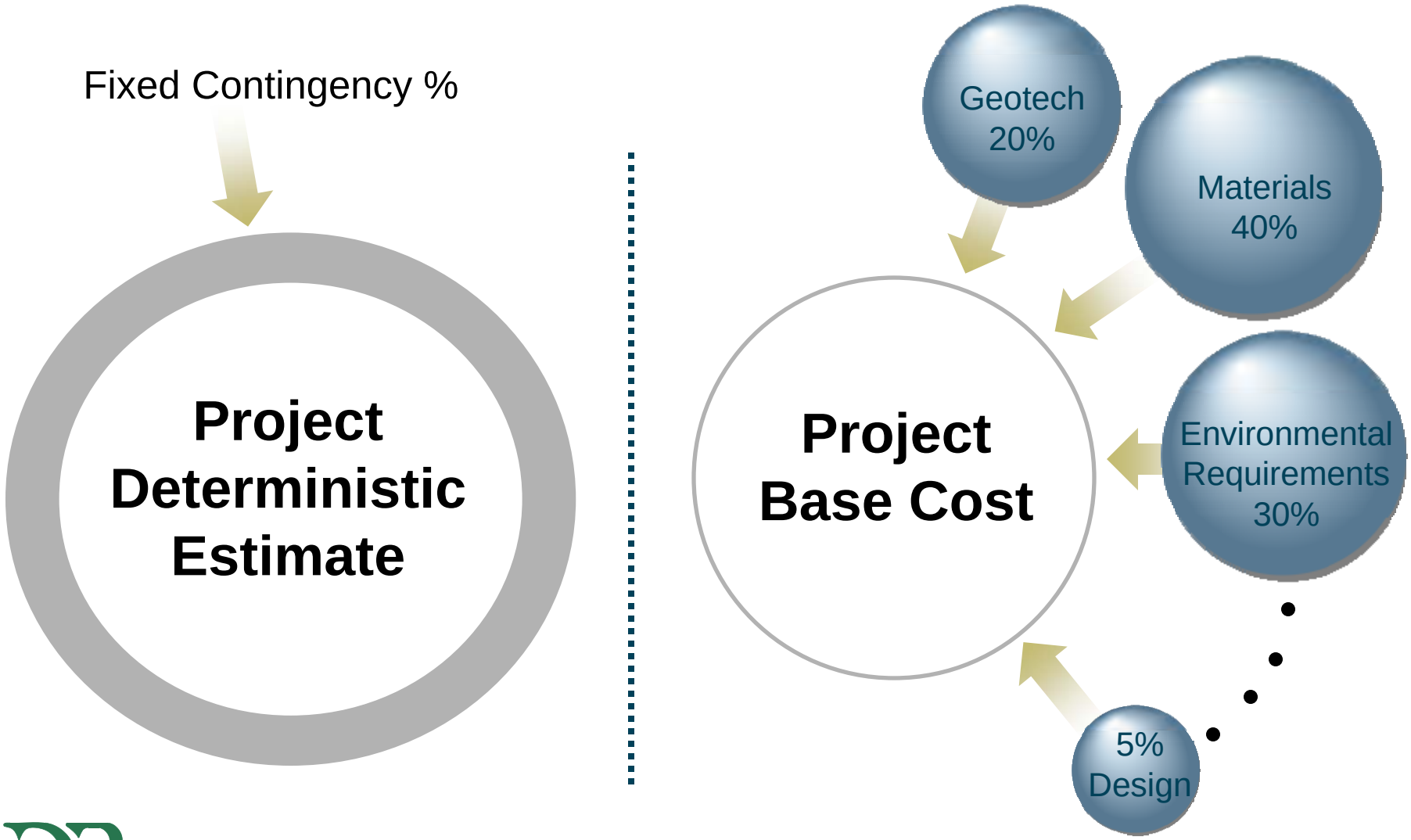


# Uncertainty and the Project Delivery Process



# Cost Estimation Process

## Traditional vs. Risk-Based Approach



# Type of Risks

- Budget Risks
  - Risk that budget elements will deviate from the estimate.
  - Examples: deviations in unit prices, deviations in quantities.

- Event Risks
  - Risk of internal or external events that force the project team to work beyond the estimate just to meet the Project Scope and SOW.
  - Examples: Extreme weather, contractor non-performance.

- Scope Risks
  - Risk of significant changes to project scope due to external pressures.
  - Examples: community pressures for changes in alignment or station location.

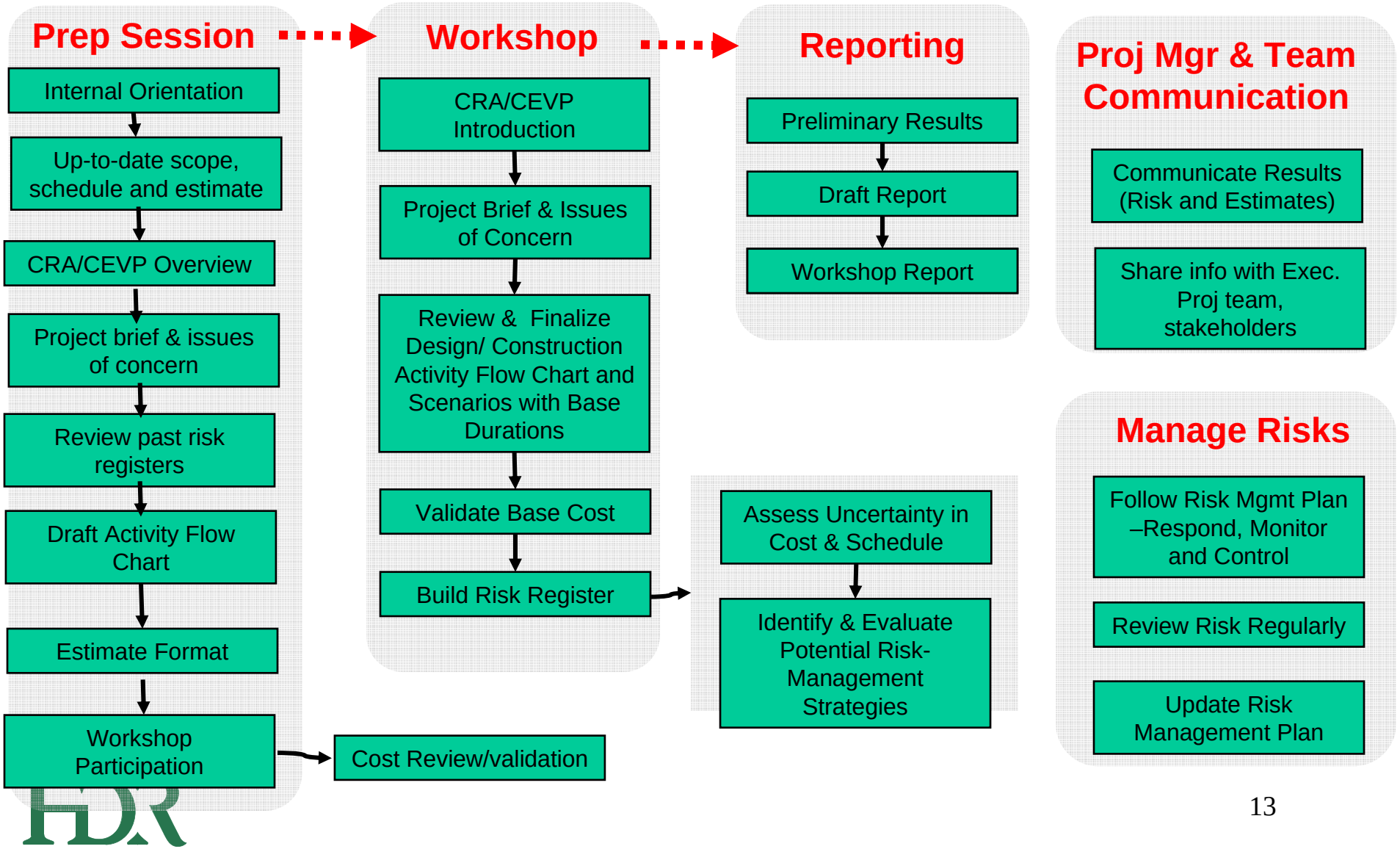
# Principles of the Risk Assessment Approach

- Collaborative, team approach.
- Looks at design, right of way and construction.
- Defines threats and opportunities individually (to the extent possible).
- Provide broad flexibility to represent uncertainty and correlation.
- Identifies risk management strategies.

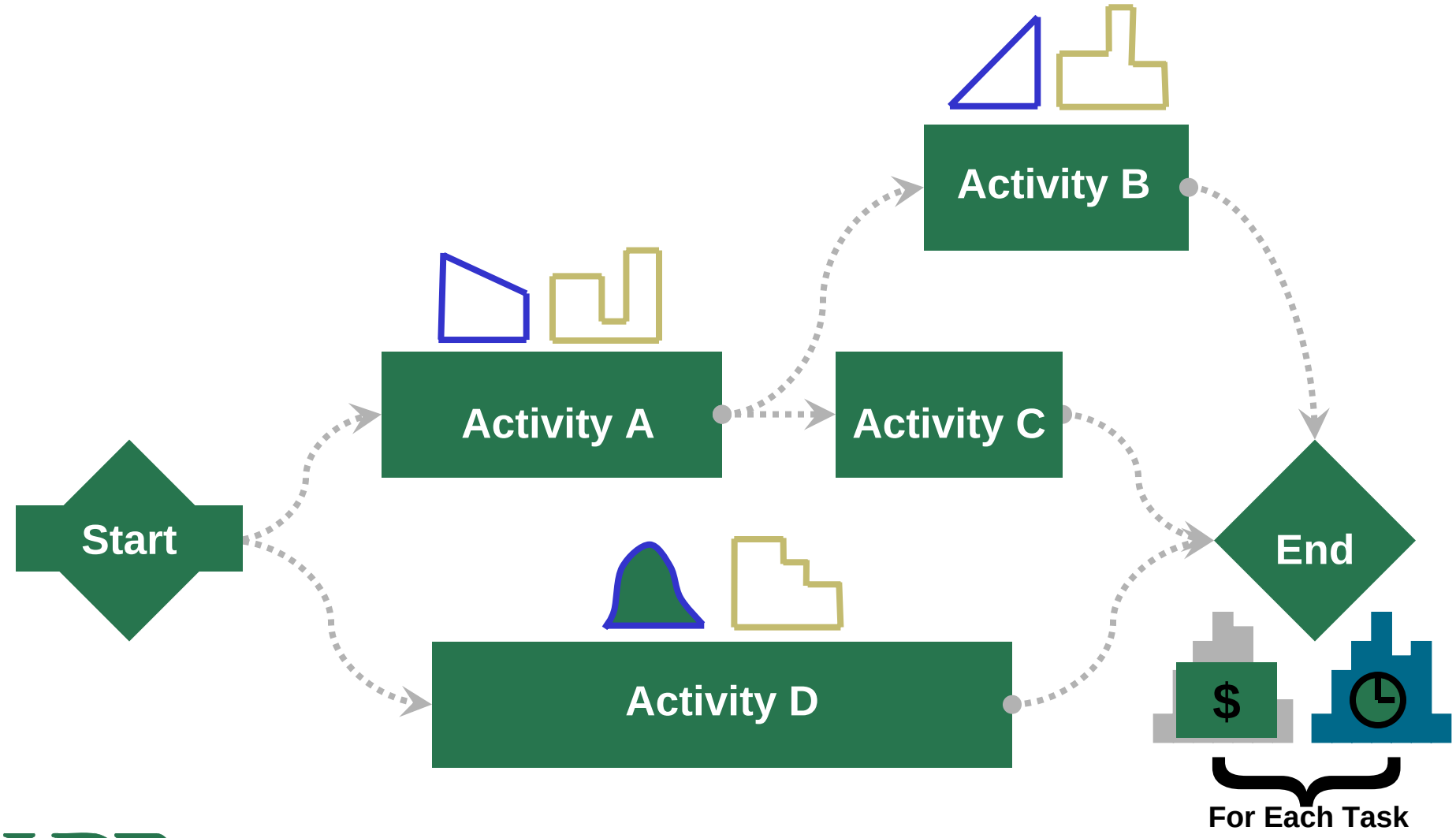
# Cost Estimate Validation Process Key Steps

- ***Step 1:***
  - ***Preparation Session*** with the project team to educate, plan, set the stage, and build expectation with the project team.
- ***Step 2:***
  - ***Workshop*** to elicit project characteristics and develop understanding, solicit inputs, develop ranges, identify and quantify risk factors, identify opportunities, and develop mitigation strategies.
- ***Step 3:***
  - ***Modeling and reporting*** to summarize all the project aspects in terms of risk as applied to budget, schedule, and management plan.

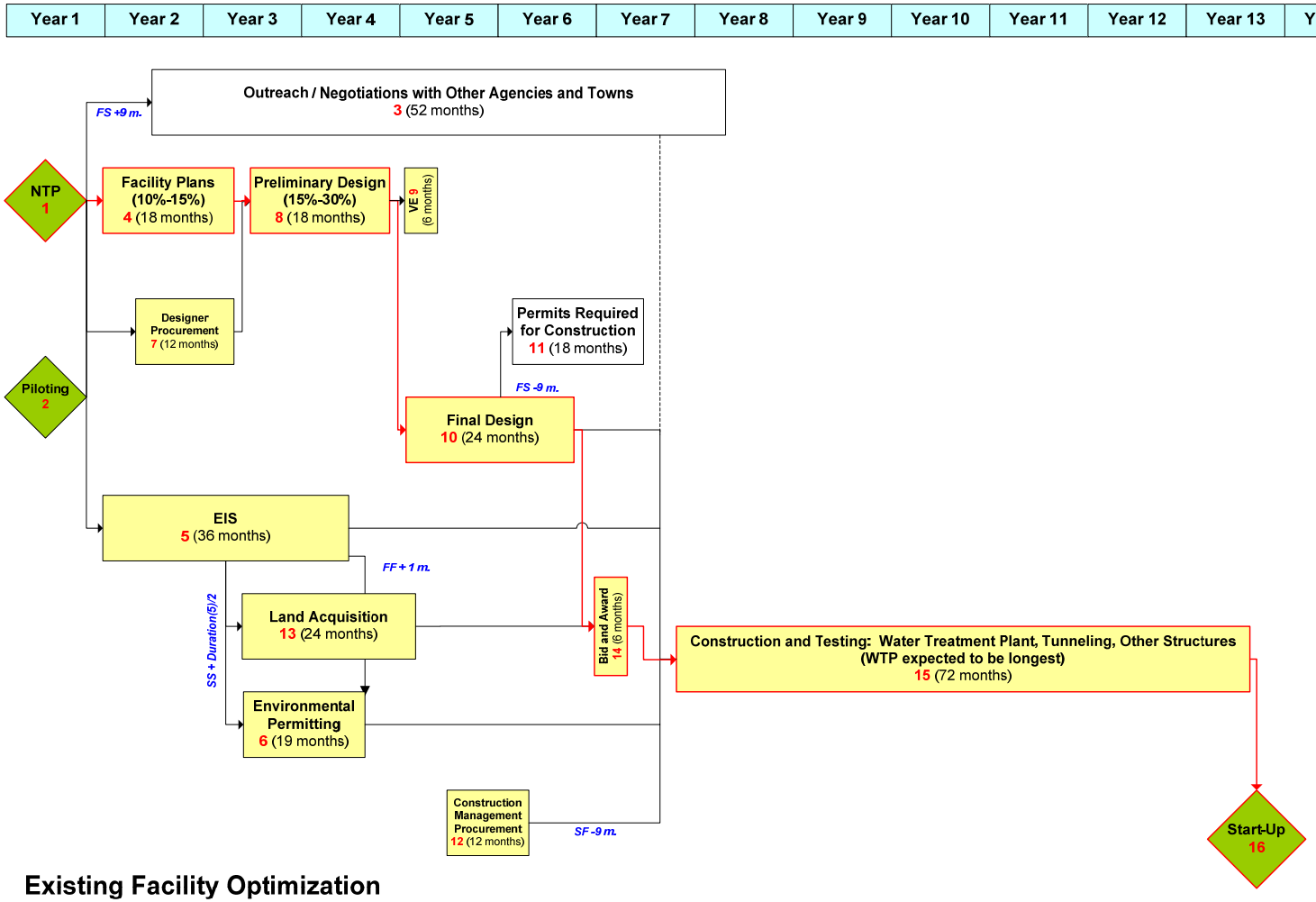
# The CEVP Process



# Building the Risk Analysis Backbone

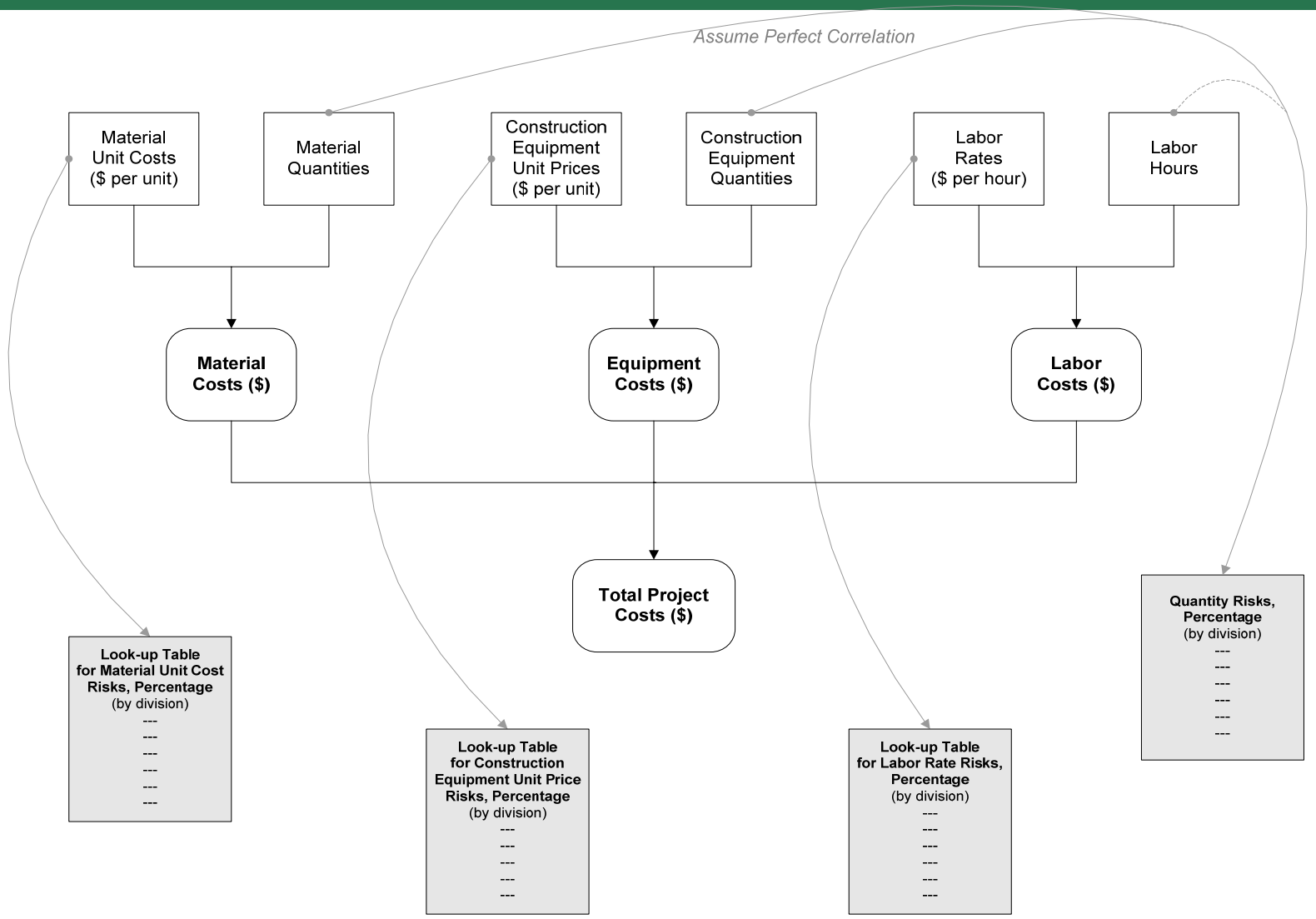


# Flowchart Diagram




**Existing Facility Optimization**
EF-03d
New Croton Aqueduct
200 mgd capacity pressurization

# Assess Base Cost



# Baseline Cost Uncertainty

Preliminary Engineering & Environmental

Final Design

Construction Management

Right of Way

Subgrade Construction

Track Construction

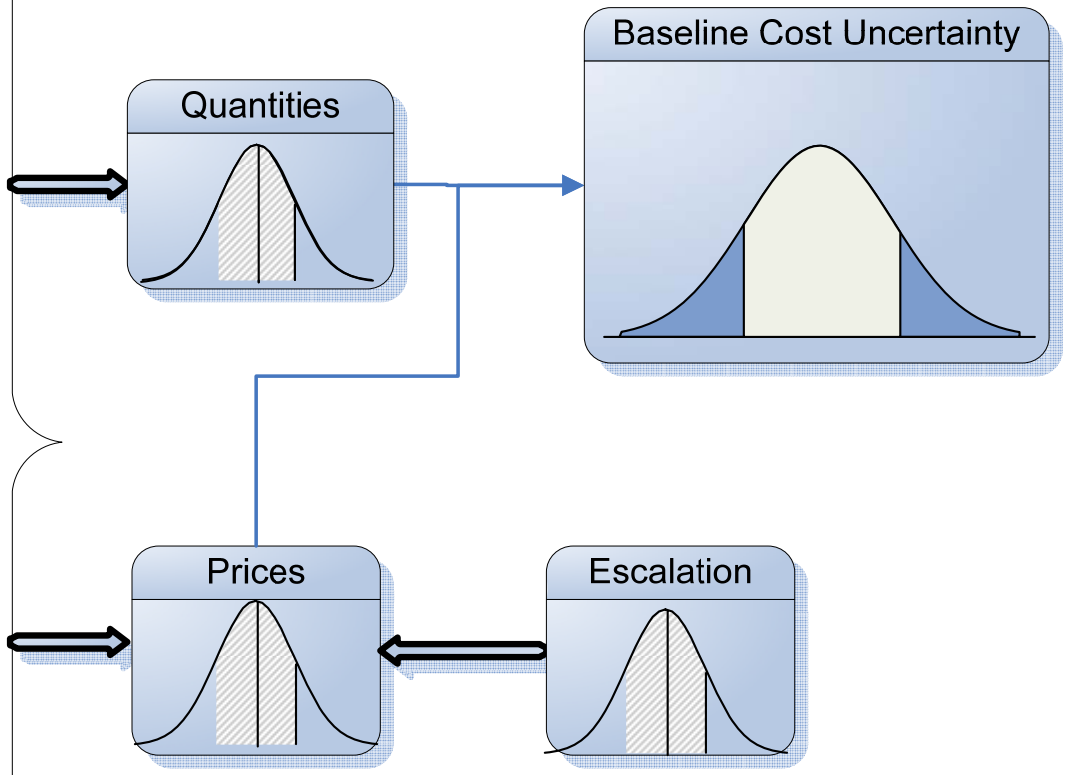
Separate Access Road

Bridges/Structures

Signals/Communications/Dispatch

Buildings/Shops

Environmental



# Involvement of Project Team and Experts in a Consensus-Based Forum

- A risk analysis workshop is held to:
  - Review and validate cost estimates.
  - Identify and quantify potential risks.
  - Develop mitigation strategies.
- Expert panel consists of project team leads representing expertise such as:
  - Environmental
  - Right of Way
  - Geotechnical
  - Utilities
  - Construction
  - Political and Public Relations

# Risk Factors

## Risk Checklist

Project Feasibility
- ☐ Technical feasibility
- ☐ Long-term viability
- ☐ Political circumstances

Funding
- ☐ Sources of funding
- ☐ Inflation and growth rates
- ☐ Accuracy of cost and conti
- ☐ Cash flow
- ☐ Exchange rates
- ☐ Appropriation

Planning
- ☐ Scope
- ☐ Complexity of the project
- ☐ Technical Constraints
- ☐ Sole source material or se
- ☐ Constructability
- ☐ Milestones (schedule)
- ☐ Tune to complete (schedul
- ☐ Synchronization of work ar

Engineering
- ☐ Design and performance S
- ☐ Unreliable data
- ☐ Complexity
- ☐ Completeness of design
- ☐ Accountability for design
- ☐ System integration

Type of Contract
- ☐ Lump sum
- ☐ Unit price
- ☐ Cost Plus
- ☐ Guaranteed Maximum

Contracting Arrangement
- ☐ Design-build
- ☐ Joint venture
- ☐ Single prime contractor
- ☐ Several prime contract
- ☐ Innovative procuremen

Regional and Local Business C
- ☐ Number of bidders
- ☐ Unemployment rate in
- ☐ Workload of regional c

Contractor Reliability
- ☐ Capability
- ☐ Capacity
- ☐ Credit Worthiness
- ☐ Personnel experience

## Risk Checklist, cont.

Ability to Perform
- ☐ Familiarity with type work
- ☐ Availability and qualifications of key personnel
- ☐ Knowledge of area
- ☐ Completeness of design
- ☐ Quality of design
- ☐ Timeliness of design
- ☐ Complexity, constructability of design
- ☐ Requirements for new technology
- ☐ Competing activity on site
- ☐ Availability of access to work when required
- ☐ Need for work or fire permits

Time Factors
- ☐ Deadlines and milestones
- ☐ Available normal works days
- ☐ Potential for stoppages by other parties or situations

Owner Factors
- ☐ Financial stability
- ☐ Construction management sophistication
- ☐ Interferences
- ☐ Quality expectations
- ☐ Interpretation of contract
- ☐ Ability/willingness to meet obligations
- ☐ Change management policies

Contractor-Furnished Materials Factors
- ☐ Quantity variations
- ☐ Quality
- ☐ Price
- ☐ Availability

HDR

# Identify, Quantify, and Mitigate…

| Activity Impacted | Identitfication | | | | | |
|---|---|---|---|---|---|---|
| | Risk ID | Functional Assignment | Threat / Opportunity Events | Additional Description | Panelists Comments | Type of Risk |
| c3 | c4 | c5 | c7 | c8 | c9 | c10 |
| 29 | DES1a | Design, Permitting, Reviews, etc. | Lack of project support by SAM, Corp, Commission RMM & Site Demo | Impacts all design activities. Cost impact based on $350K per month. | High probability due to impending decision on project developer. | Cost & Schedule |
| 33 | DES1b | | | | | |
| 11, 13 | DES1c | | | | | |

**Quantitative Analysis**

| Prob. | Cost Impact ($) | | | | Schedule Impact (Months) | | | |
|---|---|---|---|---|---|---|---|---|
| | Distribution | V1 | V2 (L) | V3 (H) | Distribution | V1 | V2 (L) | V3 (H) |
| c11 | c12 | c13 | c14 | c15 | c19 | c20 | c21 | c22 |
| 50% | Discrete | | $500,000 | $2,000,000 | Uniform | | 6.0 | 12.0 |

| Response | | Mtgtd Prob. | Mitigated Cost Impacts | | | Mitigated Schedule Impacts | | |
|---|---|---|---|---|---|---|---|---|
| Strategy | Response Actions including Advantages & Disadvantages | | V1 | V2 (L) | V3 (H) | V1 | V2 (L) | V3 (H) |
| c26 | c27 | c29 | c30 | c31 | c32 | c33 | c34 | c35 |
| Transference | Business case disclosure; allocation of benefits and costs (Public Private Partnership). Memorandum. Goal is to develop a better partnership with the rental car companies and help project move forward | 5% | $0 | | | 1.0 | | |
| Mitigation | Business case disclosure; allocation of benefits and costs (Public Private Partnership). Memorandum. Goal is to develop a better partnership with the rental car companies and help project move forward. | 25% | | $500,000 | $2,000,000 | | 6.0 | 12.0 |
| Acceptance | Business case disclosure; allocation of benefits and costs (Public Private Partnership). Memorandum. Goal is to develop a better partnership with the rental car companies and help project move forward. | 25% | | $500,000 | $2,000,000 | | 6.0 | 12.0 |

# Risk Register:
## Risk Identification

| Activities Impacted | ID | Functional Assignment | Threat / Opportunity Events | Type of Risk | SMART Column | Additional Panelists' Comments |
|---|---|---|---|---|---|---|
| 20 | C1 | Construction | Force Majure | Schedule | Major delays from storms, earthquakes or other unavoidable natural disasters | |
| 13 | D1 | Design or Scope Changes | Relative level of implementation of sustainable design features | Cost and Schedule | Achieving specific LEED Ratings for buildings, etc. | |
| 12 | D2 | Design or Scope Changes | Using unproven technology to implement sustainable design features | Cost and Schedule | | |
| 12,13, 14, 15 | D3 | Design or Scope Changes | Scope Creep | Cost and Schedule | Quantifying bridges of this type and how well they stay on schedule | |
| 14 | D4 | Design or Scope Changes | Any Caltrans or Federal Highways requirements | Cost and | | |
| All | E1 | Economy/Market Conditions | Impact of adjacent planned transportation projects (i.e. POLA Southern California Intermodal Gateway Project, I-710 Widening Project) | Cost | | |
| All Construction | E2 | Economy/Market Conditions | steel prices) | | | |
| 22 | Ev1 | Environmental | Fotential environmental contamination in existing rail yard and North Harbor Area (asbestos, hydrocarbons, solvents, heavy metals, lead-based paint) | Cost and Schedule | | |
| 13 | Ev2 | Environmental | Any environmental impacts that would affect schedule | Schedule | If there are falcons on the bridge, any water wildlife that might be affected by operations | |
| All Construction | L1 | Market or Labor | Risk of escalating labor costs | Cost | | |
| All Construction | L2 | Operations Work Windows | Any shipping changes required by the work, meaning if ships have to be delayed, or repositioned or if work on the bridge has to be delayed to allow particular ships to pass. | Schedule | | |
| 12 | P1 | Permitting & Stakeholder | Fotential delays in environmental permitting schedule for programmatic EIR for Port Rail Program | Schedule | | |
| 12 | P2 | Permitting & Stakeholder | Impact to port clients in the areas where the bridge could affect their storage | Cost | | Likely & impacts, maybe schedule |
| All Construction | Fo1 | Political | Risk of shut down due to environmental protests and political fall out (similar to the Foothill South Toll road in Orange County), primarily schedule risk that leads to cost risk. | Cost and Schedule | | |
| All | Fo2 | Political | Risks of changes to environmental requirements due to pending or expected issues around the ports (note media discussions of higher cancer risk at and around the ports) | Cost and Schedule | | |
| All Construction | Fr1 | Procurement | Material procurement and management (owner procurements vs. contractor procurement) | Cost | | |
| 21-25 | U1 | Utilities | Any delays caused by utilities in the existing bridge or in the area of abutments, etc. that might need to be relocated | Schedule | | |

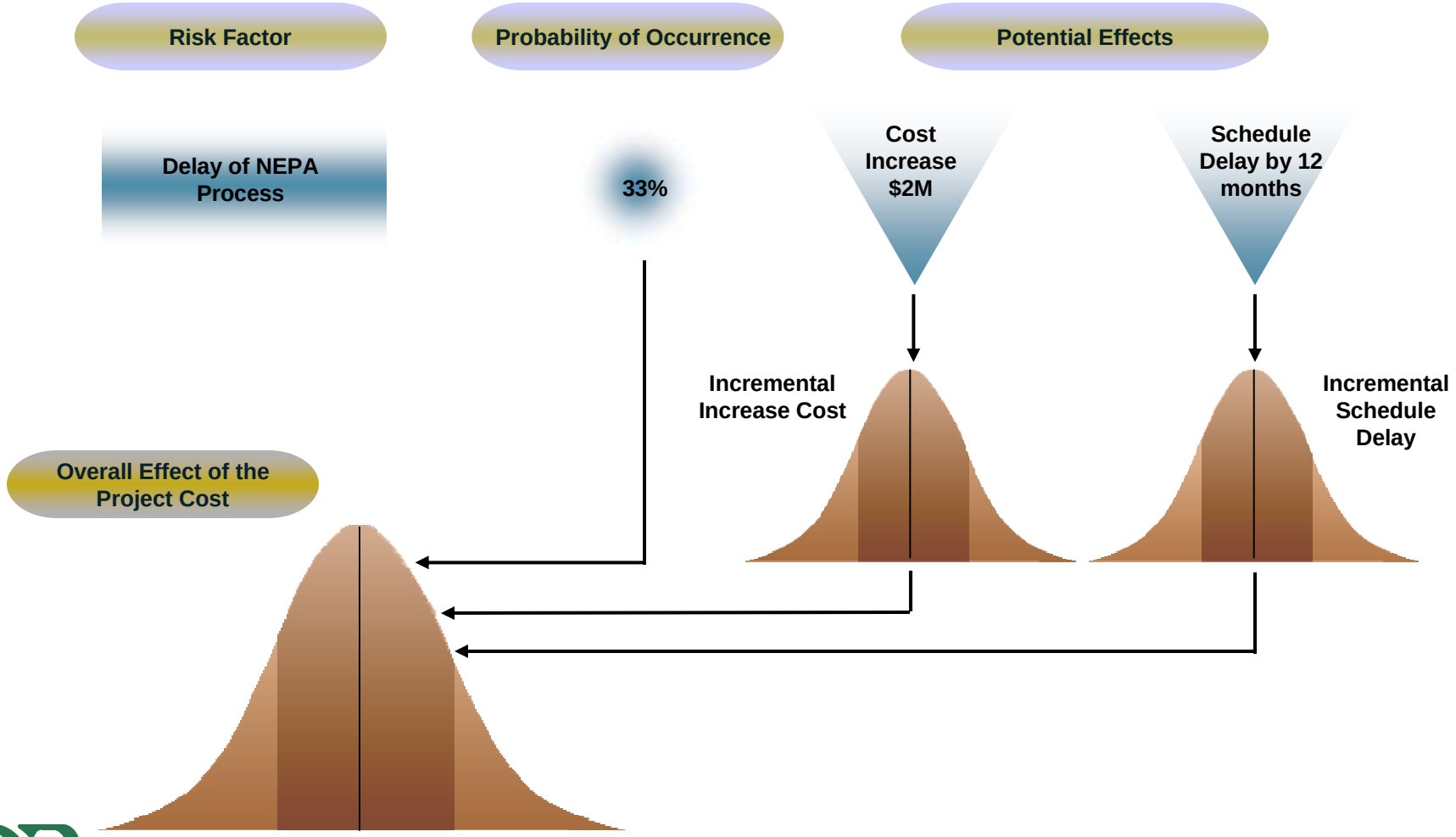
# Risk Register:
## Risk Quantification

| Prob. | NON MITIGATED Cost Impact ($) | | | | Schedule Impacts (months) | | | |
|---|---|---|---|---|---|---|---|---|
| | Distribution | Median | Low | High | Distribution | Median | Low | High |
| 10% | | $10,000,000 | $8,000,000 | $25,000,000 | Trigen | 5.0 | 2.0 | 10.0 |
| 15% | Trigen | $1,000,000 | $250,000 | $10,000,000 | Trigen | 4.0 | 2.0 | 6.0 |
| 80% | Trigen | $7,500,000 | $250,000 | $10,000,000 | Trigen | 2.0 | 1.0 | 3.0 |
| 50% | Trigen | $15,000,000 | $10,000,000 | $20,000,000 | Trigen | 4.0 | 2.0 | 6.0 |
| 15% | Trigen | $7,500,000 | $250,000 | $10,000,000 | Trigen | 2.0 | 1.0 | 3.0 |
| 0% | Trigen | | | | | | | |
| 75% | Trigen | $7,500,000 | $250,000 | $10,000,000 | | | | |
| 10% | Trigen | $1,000,000 | $250,000 | $10,000,000 | Trigen | 2.0 | 1.0 | 3.0 |
| 20% | | | | | Trigen | 4.0 | 2.0 | 6.0 |
| 80% | Trigen | $8,000,000 | $5,000,000 | $12,000,000 | | | | |
| 25% | | | | | Trigen | 2.0 | 1.0 | 3.0 |
| 15% | | | | | Trigen | 4.0 | 2.0 | 6.0 |
| 0% | Trigen | $7,500,000 | $250,000 | $10,000,000 | | | | |
| 15% | Trigen | $1,000,000 | $250,000 | $10,000,000 | Trigen | 2.0 | 1.0 | 3.0 |
| 30% | Trigen | $5,000,000 | $2,000,000 | $20,000,000 | Trigen | 4.0 | 2.0 | 6.0 |
| 5% | Trigen | $500,000 | $250,000 | $750,000 | | | | |
| 40% | | | | | Trigen | 4.0 | 2.0 | 6.0 |

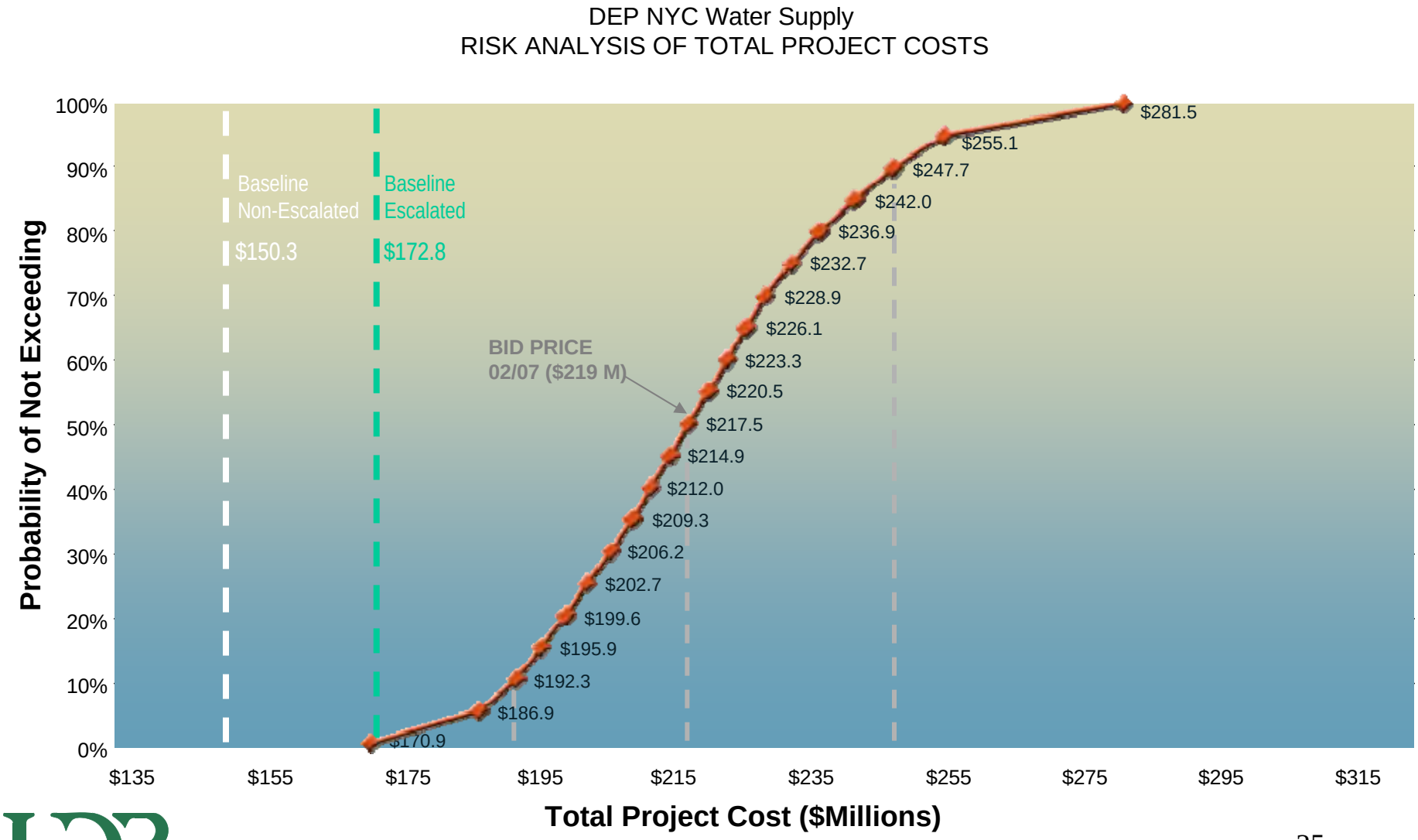
# Risk Register:
## Risk Mitigation

| Response | | Mitigated Prob. | Mitigated Cost Impacts | | | Mitigated Schedule Impacts | | |
|---|---|---|---|---|---|---|---|---|
| Strategy | Response Actions Including Advantages and Disadvantages | | v1 | v2 (L) | v3 (H) | v1 | v2 (L) | v3 (H) |
| Acceptance | | | | | | | | |
| Mitigation | Adjust design to account for higher level of sustainable design features | 10% | $500,000 | $125,000 | $5,000,000 | 2.00 | 1.00 | 3.00 |
| Acceptance | | | | | | | | |
| Acceptance | | | | | | | | |
| Mitigation | Communicate with Caltran during planning phase | 25% | $3,750,000 | $125,000 | $5,000,000 | 1.00 | 0.50 | 1.50 |
| Acceptance | | | | | | | | |
| Mitigation | Purchase materials early | 15% | $3,750,000 | $125,000 | $5,000,000 | 0.00 | 0.00 | 0.00 |
| Acceptance | | | | | | | | |
| Acceptance | | | | | | | | |
| Mitigation | Hire non-union labor | 15% | $4,000,000 | $2,500,000 | $6,000,000 | 0.00 | 0.00 | 0.00 |
| Acceptance | | | | | | | | |
| Acceptance | | | | | | | | |
| Mitigation | Research other area storge and inform current occupants of their options | 5% | $3,750,000 | $125,000 | $5,000,000 | 0.00 | 0.00 | 0.00 |
| Mitigation | Marketing | 75% | $5,000,000 | $125,000 | $5,000,000 | 1.00 | 0.50 | 1.50 |
| Mitigation | Marketing | 5% | $2,500,000 | $1,000,000 | $10,000,000 | 2.00 | 1.00 | 3.00 |
| Mitigation | Plan who is required to purchase materials | 10% | $250,000 | $125,000 | $375,000 | 0.00 | 0.00 | 0.00 |
| Acceptance | | | | | | | | |

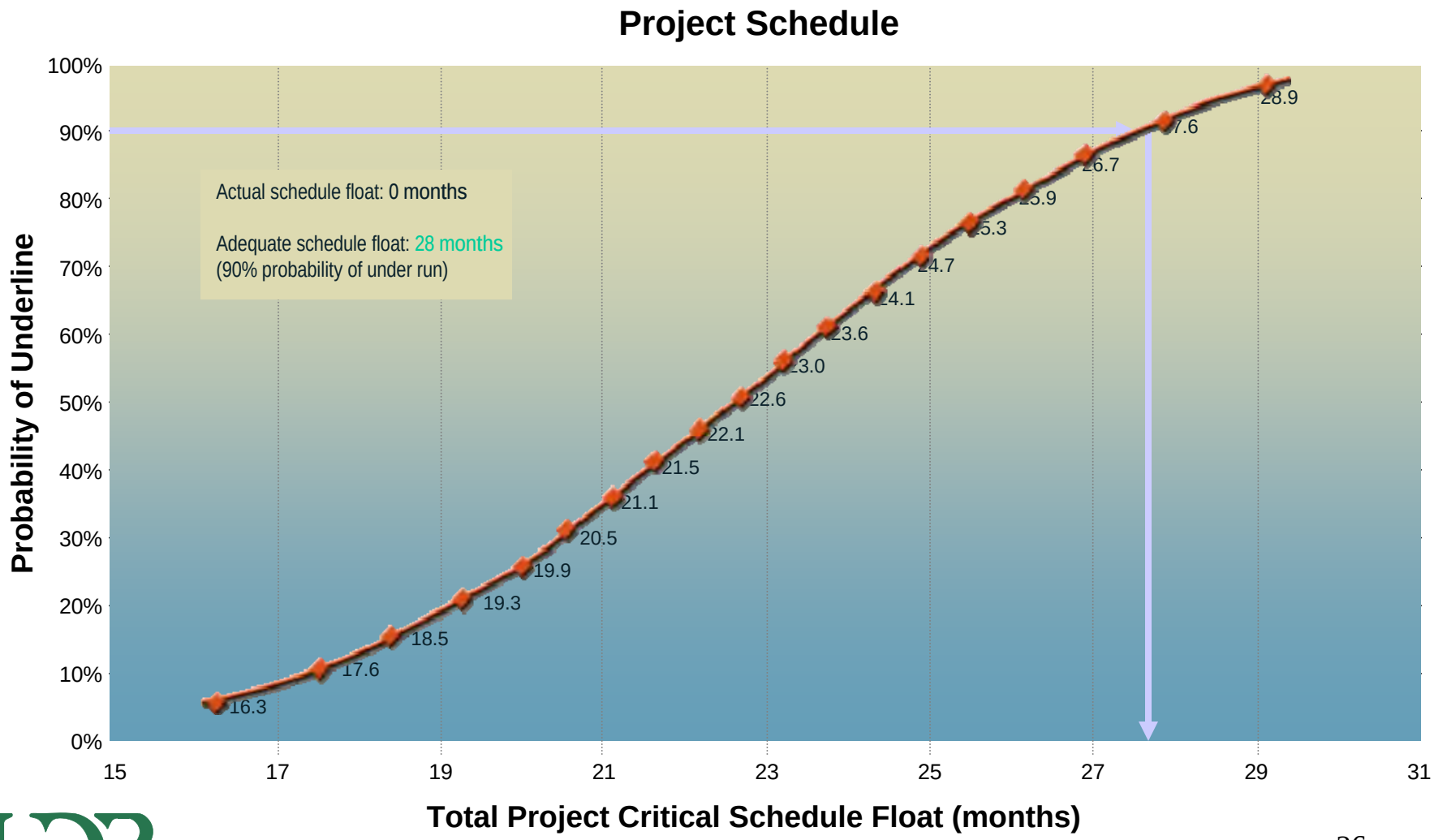
# Event Risk Assessment Process



# Risk Analysis to Better Forecast Costs (NYC Department of Environmental Protection)

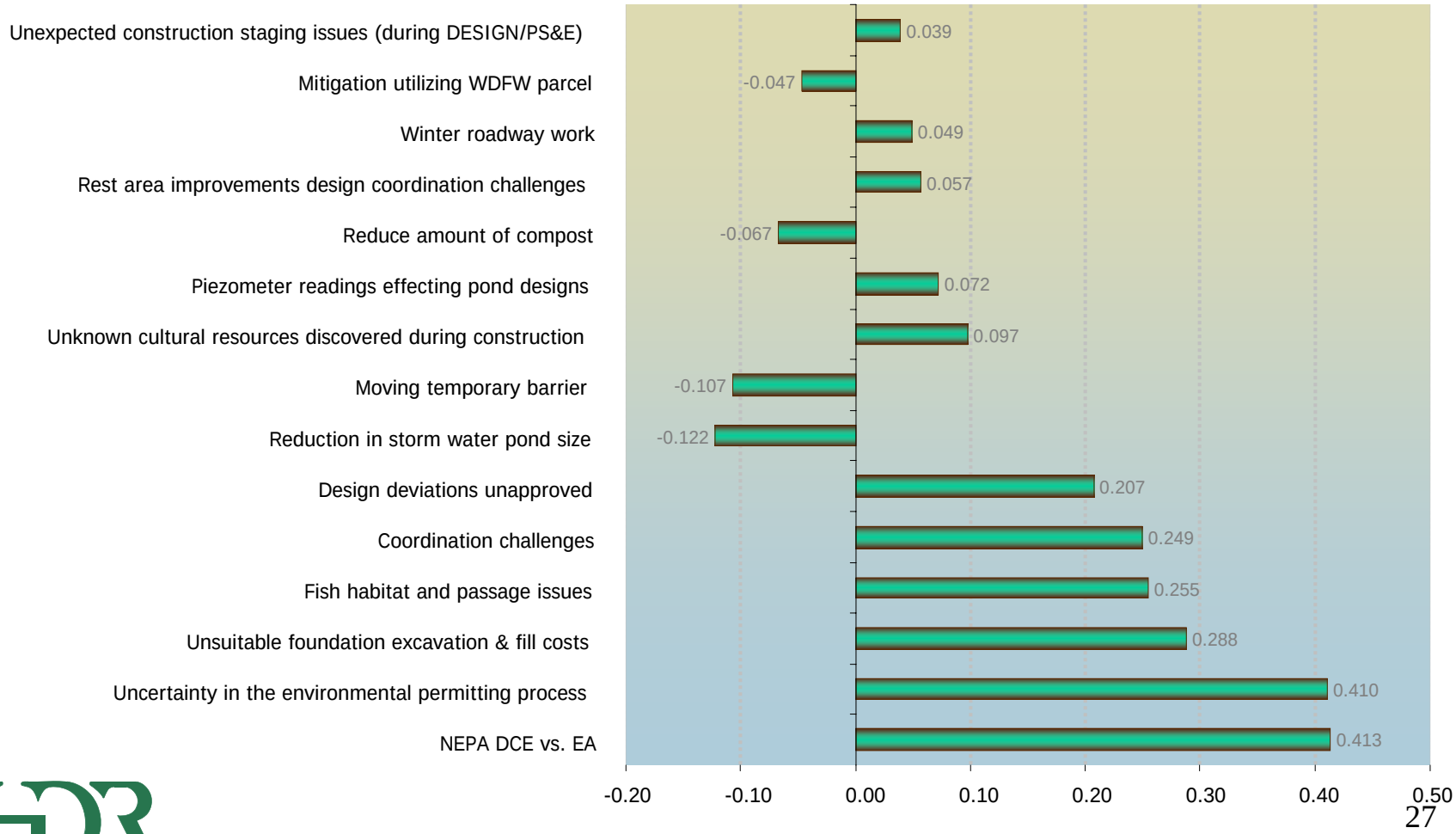


# Risk Analysis to Assess Schedule

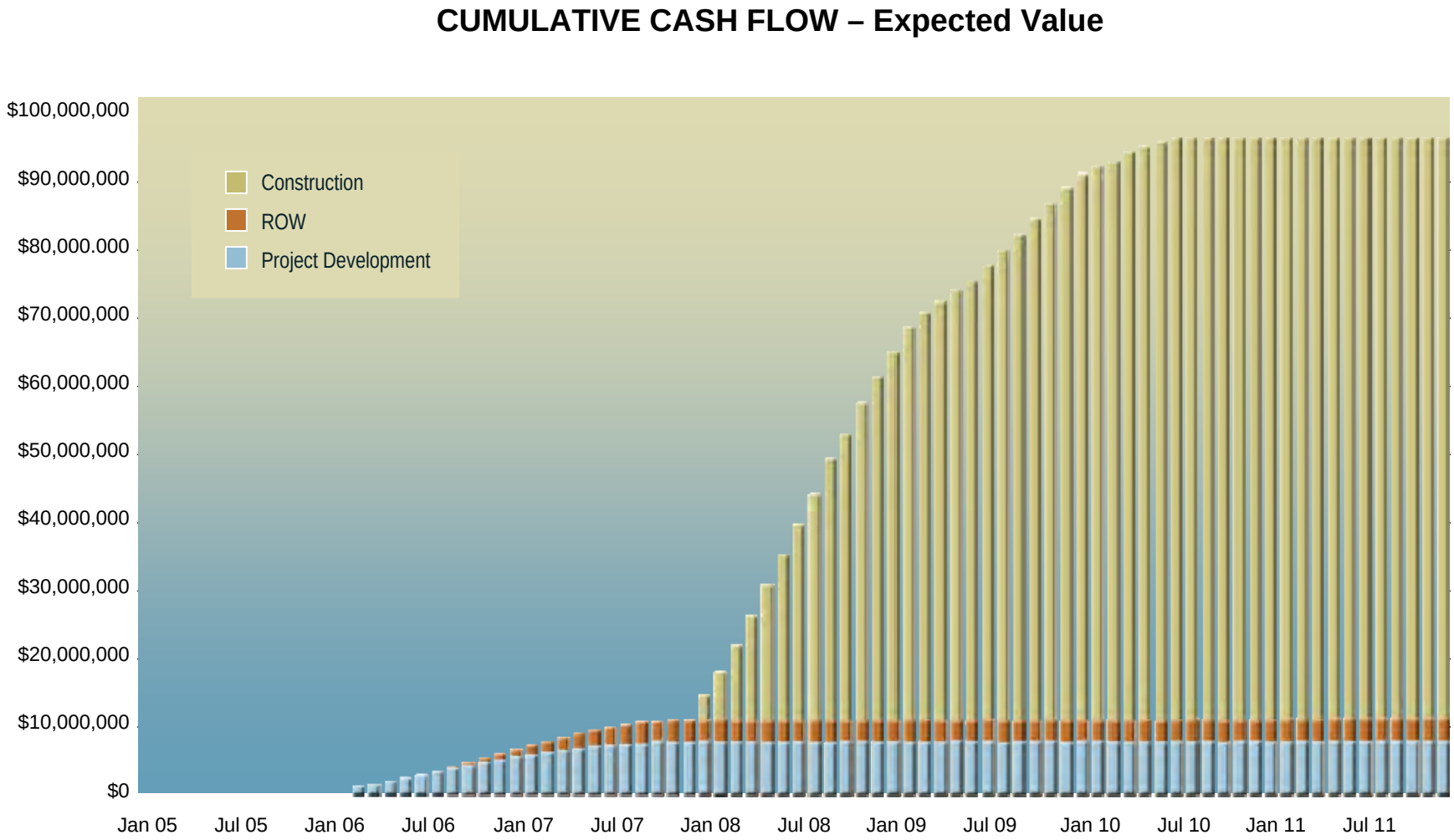


# Risk Analysis to Identify Key Risks

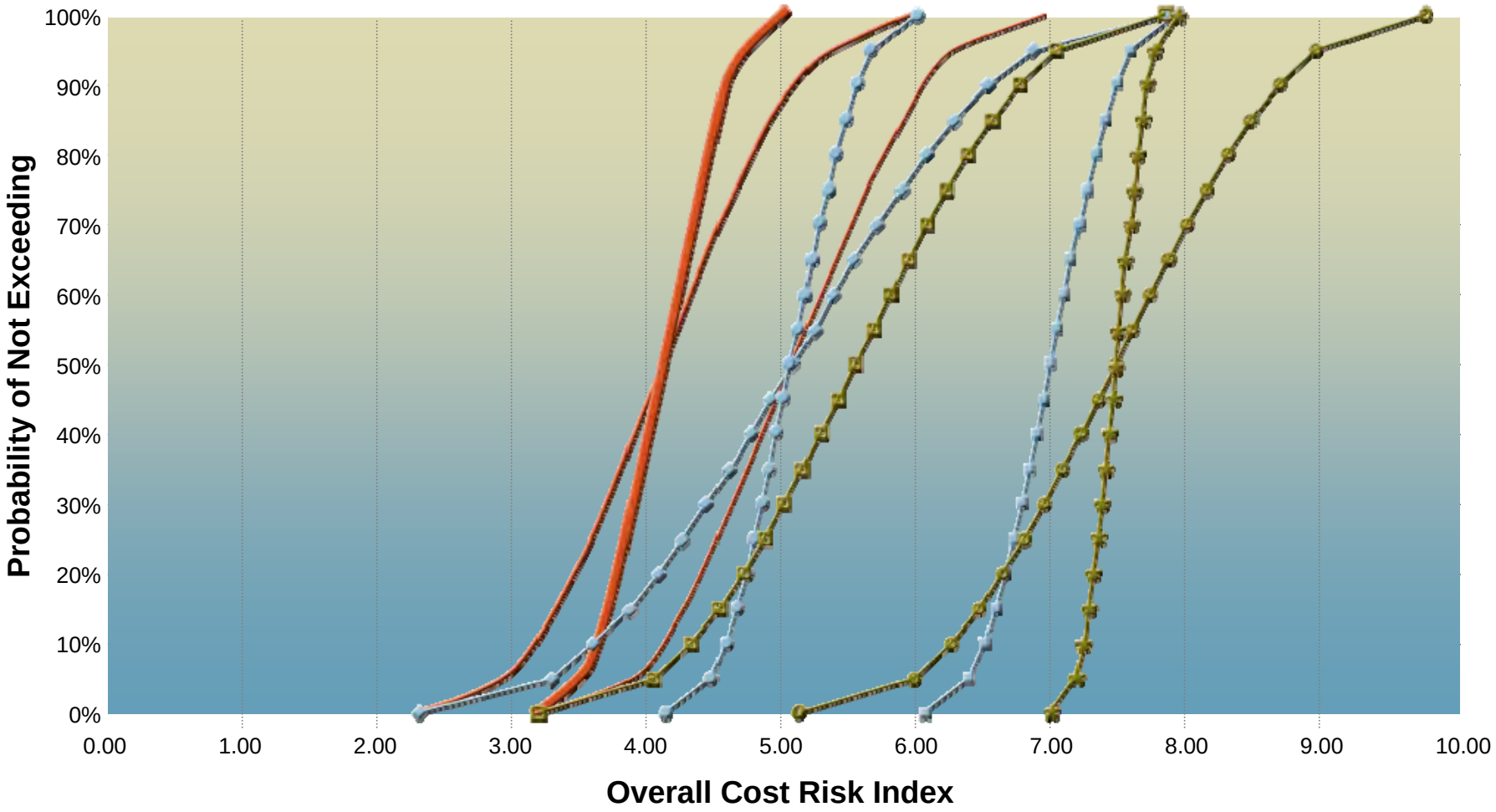
**Tornado Chart: Correlation with Total Project Cost**



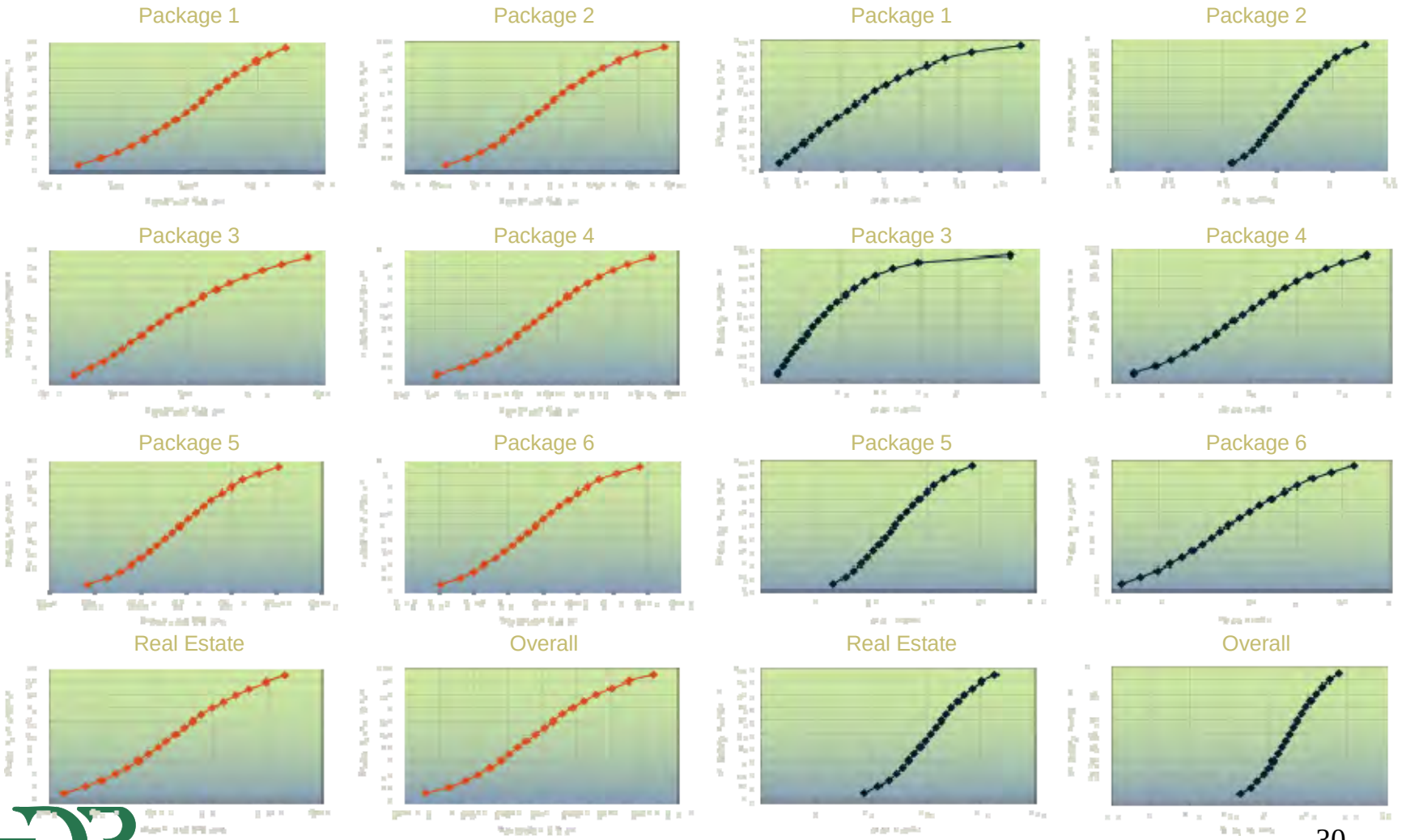
# Risk Analysis to Assess Impact on Cash Flow



# Risk Analysis to Assess Alternatives

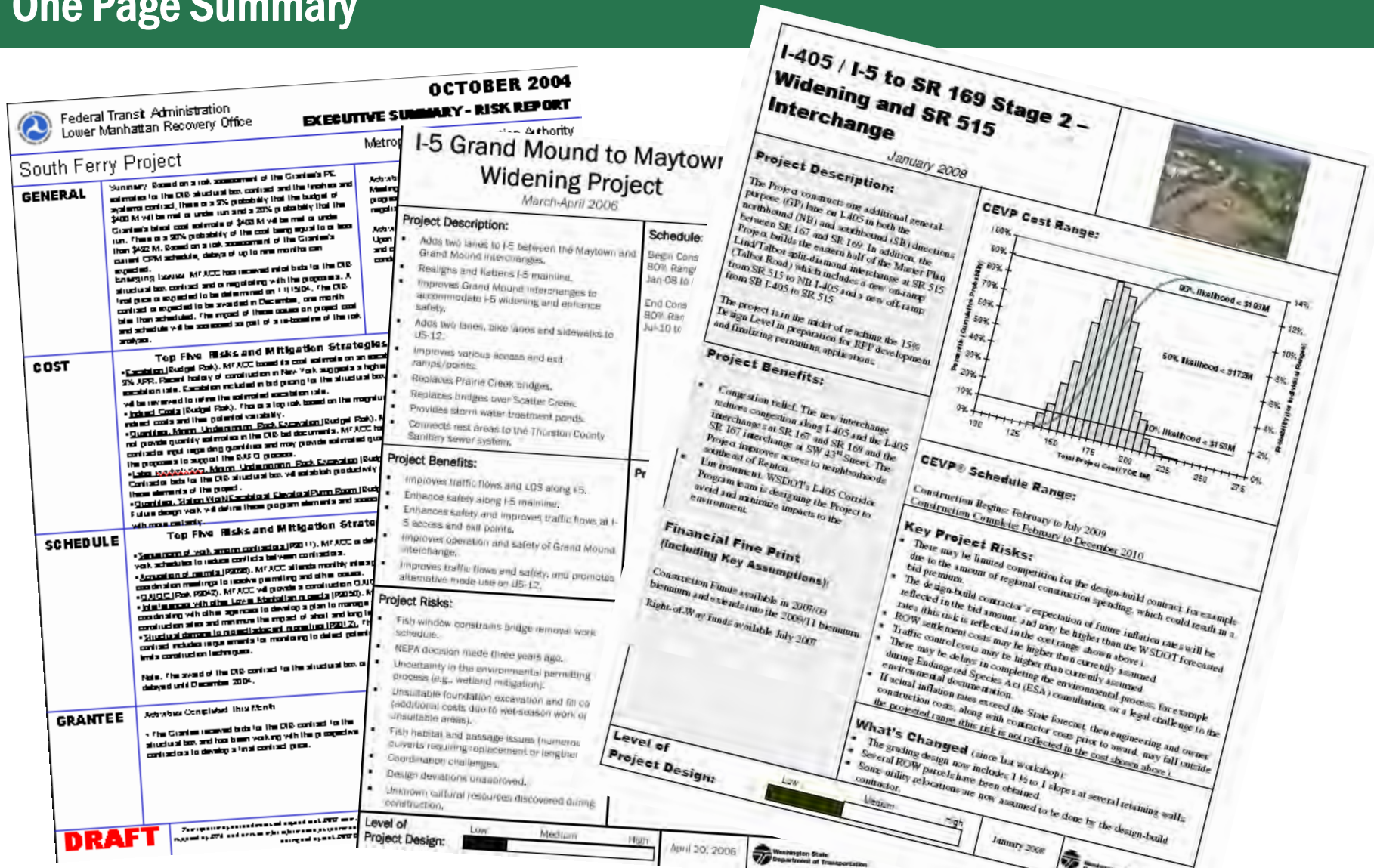


# Analysis at the Task or Sub-task Level (NYC-Lower Manhattan Rebuild Program)



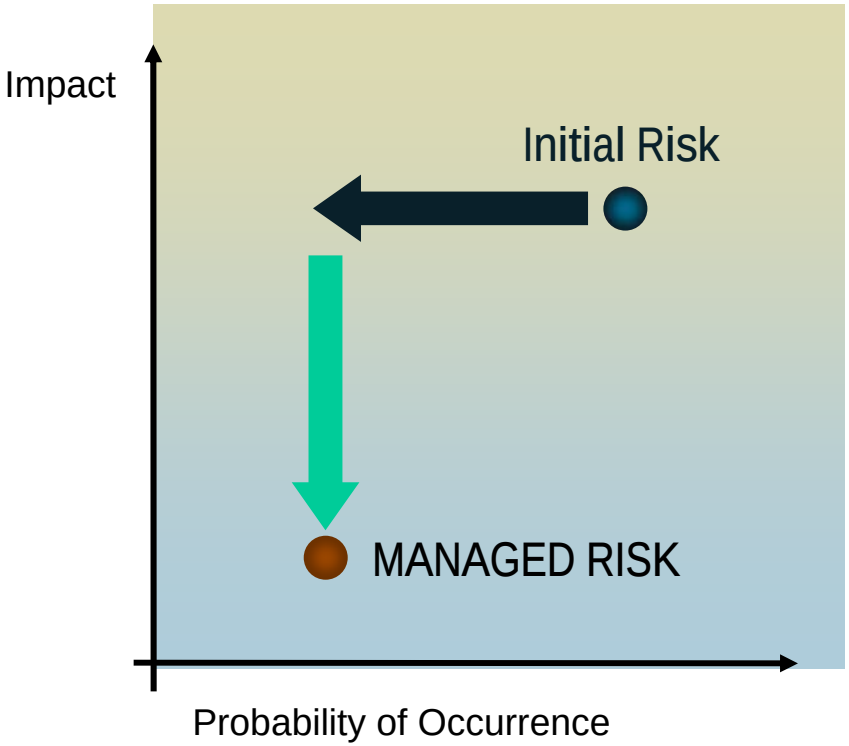
# Support the Decision Process

## One Page Summary



# Summary of the Project Value Added by CEVP

- Risk Assessment goal:
  - Assess potential impact of various scope, event, and budget risks on the project's cost and schedule.
- Risk Management goal:
  - Identify opportunities and mitigation strategies to reduce both the likelihood of an event occurrence and the potential effect if it occurs.

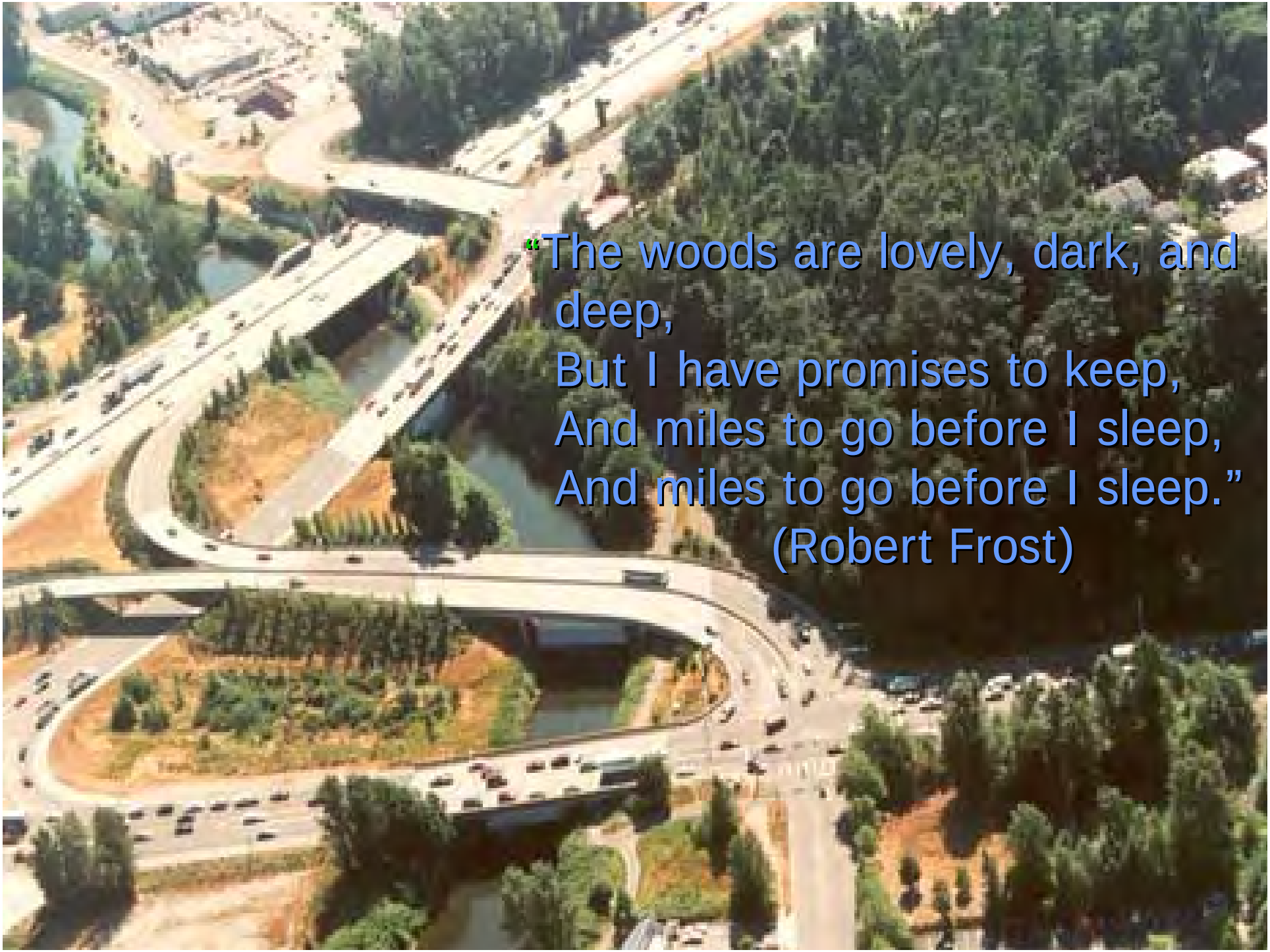


# Questions

# Biological Effects of Road Runoff: Applying Best Available Science in ESA Consultations

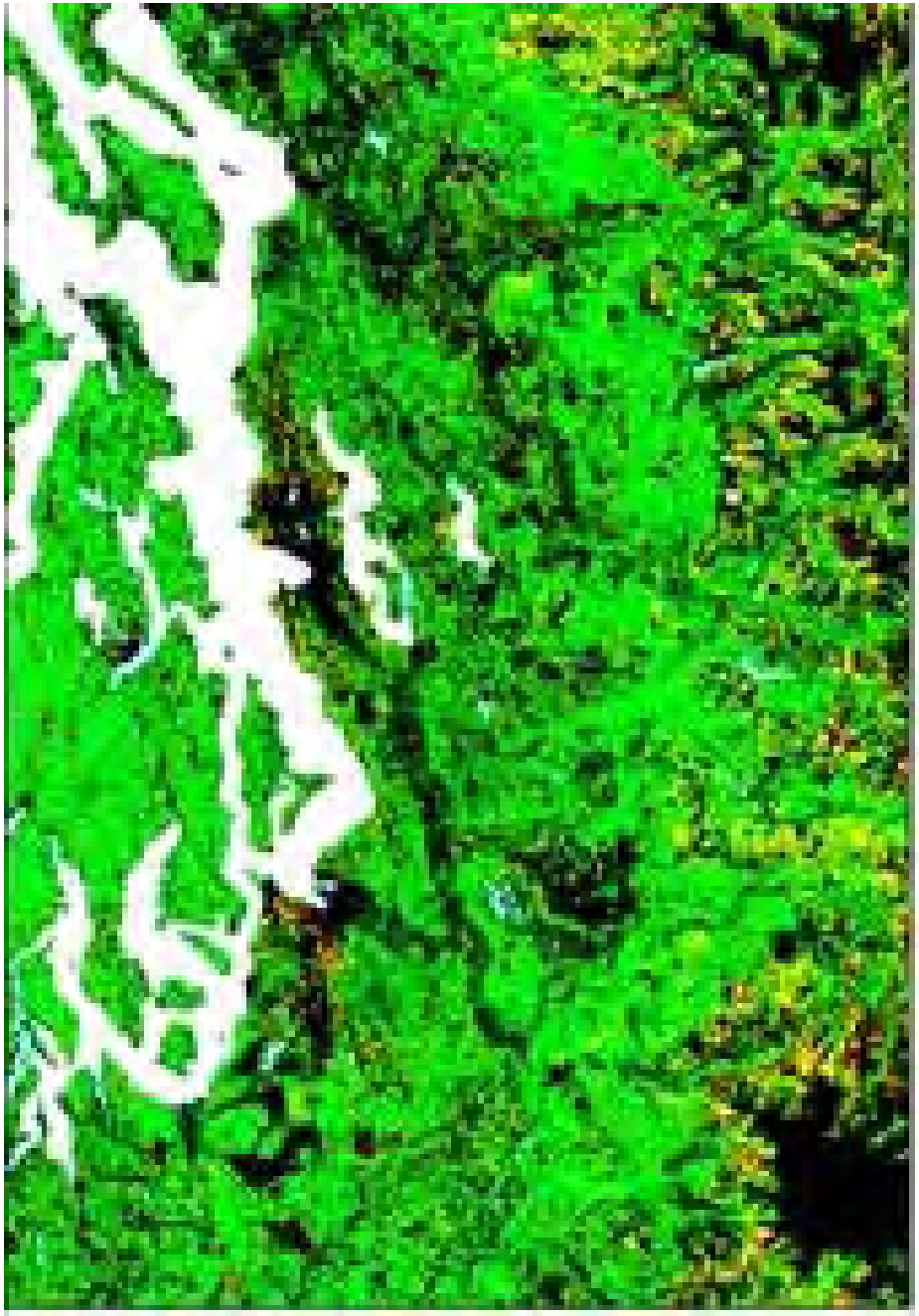
*Mitigation included

Michael Grady
NOAA Fisheries-Northwest
16 September 2008


"The woods are lovely, dark, and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep."
(Robert Frost)

# How do we keep our promises?

- Add 1 million people in 20 years
- Increase demand for rural lands
- Increase traffic volume by 30%
- Budget needs of over $20 Billion
- Declining fish and marine mammal species
- Preserve and enhance our quality of life

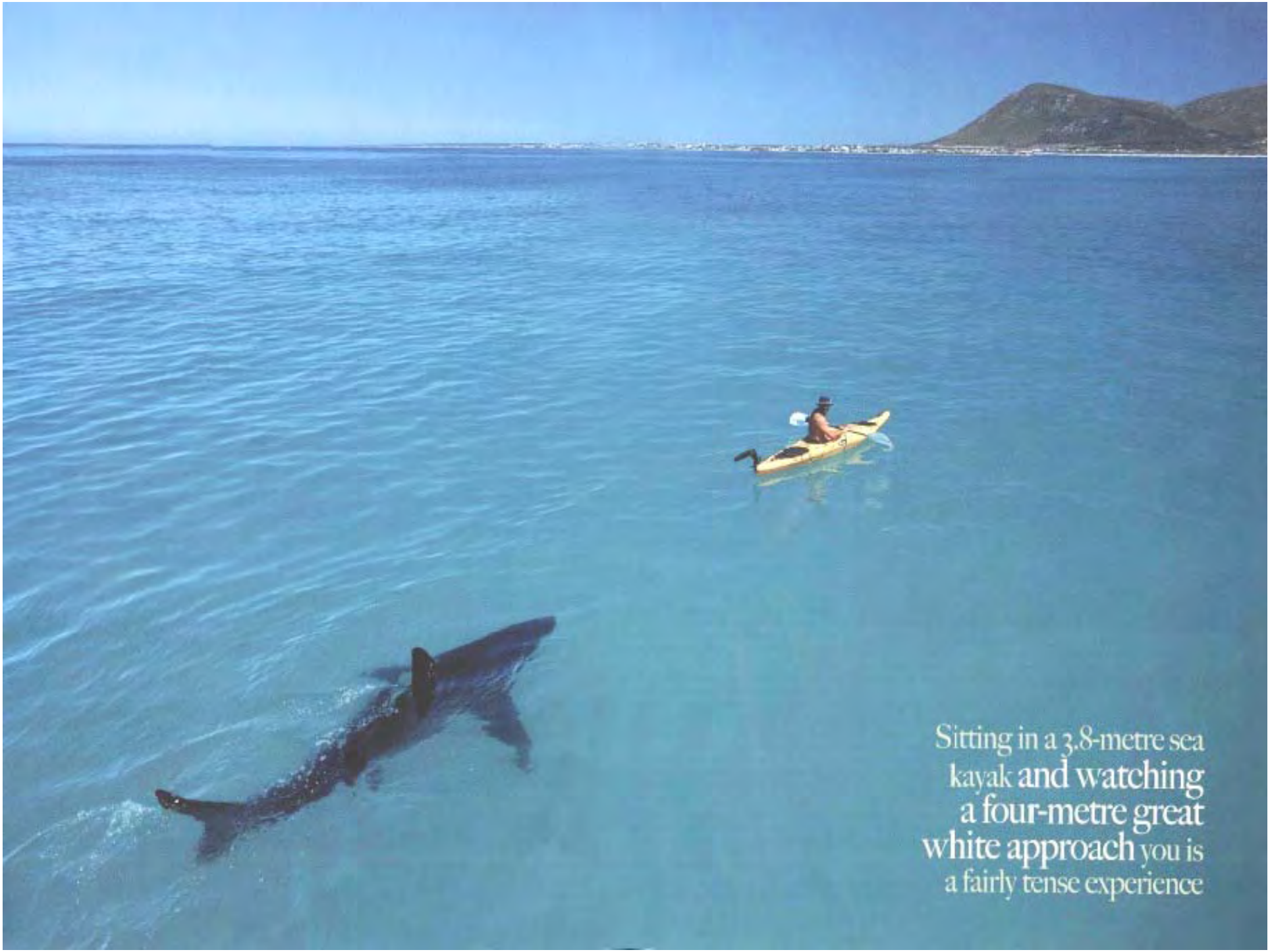


1970

1996


Photographed in 1941


Photographed in 2004


Sitting in a 3.8-metre sea
kayak and watching
a four-metre great
white approach you is
a fairly tense experience


Northwest Fisheries Science Center-Montlake

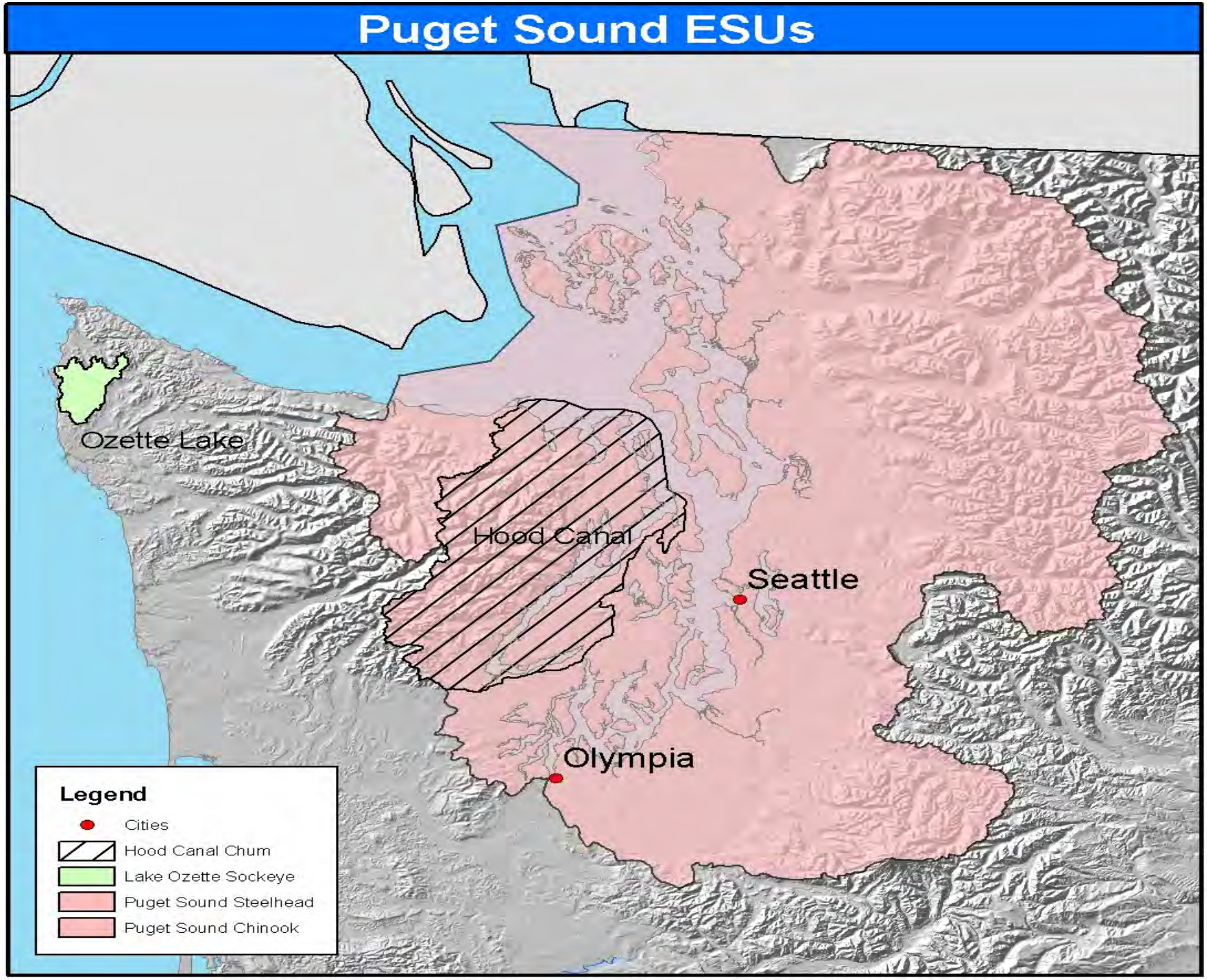
# NOAA's Statutory Guidelines

## Endangered Species Act

- Listing
- Recovery
- Avoid jeopardy
- Avoid adverse modification to critical habitat

## Tribal Treaty-Trust Responsibilities

## Magnuson-Stevens Fishery Conservation Act


Puget Sound ESUs
Ozette Lake
Hood Canal
Seattle
Olympia
Legend
Cities
Hood Canal Chum
Lake Ozette Sockeye
Puget Sound Steelhead
Puget Sound Chinook

# Recovery Plans

1. Developed at the local level
2. Based on science
3. Realistic roadmaps to recovery

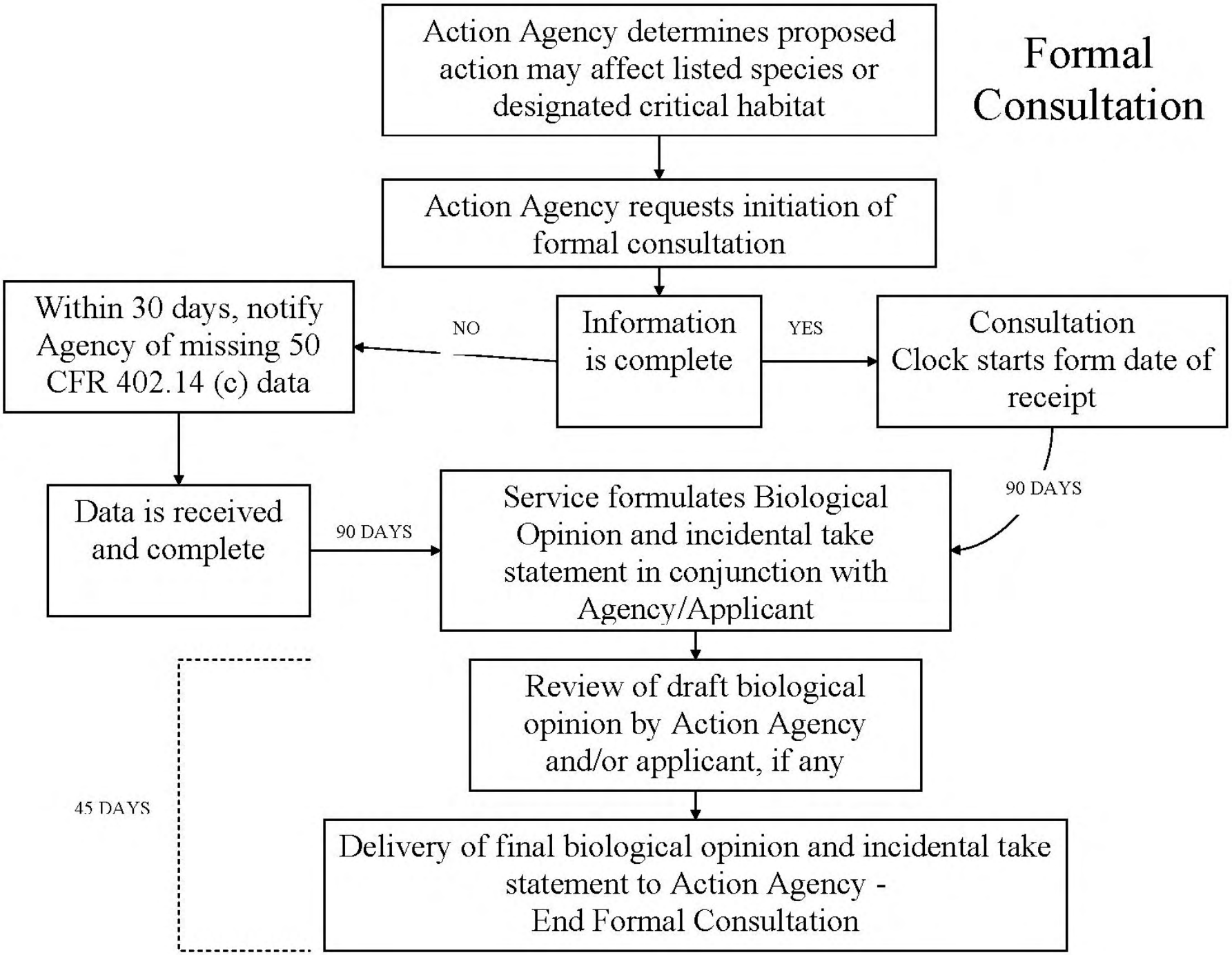
# How recovery plans will be used:

- Improved context for ESA decisions:
  - Consistent approach to all Hs in consultation
  - Expedite actions that implement recovery plans
- Setting priorities
  - Prioritize, sequence & coordinate actions in all H's to get to recovery
  - Match funding to priorities
  - Use plans as a guide in processing permits
  - Improve cost effectiveness and likelihood of success

# Section 7

- Federal agencies must ensure that any federal actions they authorize, fund, carry out are not likely to:
  - Jeopardize the continued existence of the species
  - Destroy or adversely modify designated critical habitat
- Linked to Recovery Plans (TRT data)

# Formal Consultation



# Debunking Conventional Wisdom

- Myth #1: Biological effects to listed species aren't measureable or significant
- Myth #2: Existing local (GMA), state (NPDES), and federal (CWA) laws are protective of listed species
- Myth #3: Stormwater treatment to biological thresholds is too costly

# Myth #1: Biological effects to listed species aren't measureable or significant

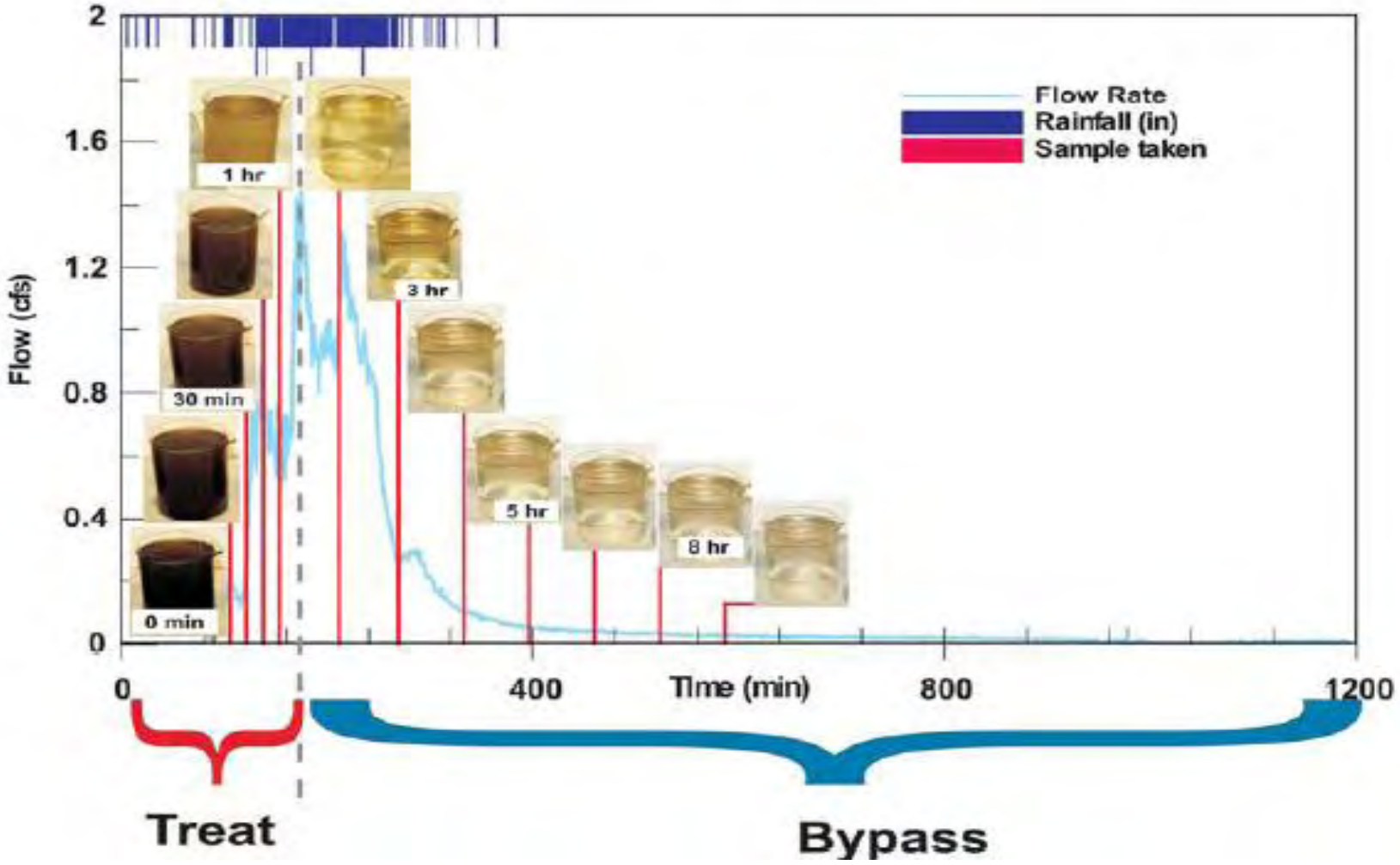
- Science Center Research
- Killer Whale cumulative impacts


DANGER
DO NOT PLAY
OR WALK ON
DRAINAGE
CULVERTS
NOAA


NOAA

# Road Runoff

## First Flush Phenomenon Characterization



# A Sensory System at the Interface between Urban Stormwater Runoff and Salmon Survival

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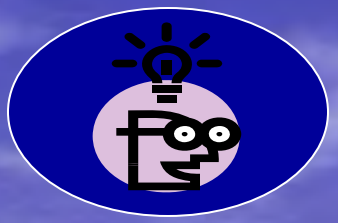
Motor vehicles are a major source of toxic contaminants such as copper, a metal that originates from vehicle exhaust and brake pad wear. Copper and other pollutants are deposited on roads and other impervious surfaces and then transported to aquatic habitats via stormwater runoff. In the western United States, exposure to non-point source pollutants such as copper is an emerging concern for many populations of threatened and endangered Pacific salmon (*Oncorhynchus* spp.) that spawn and rear in coastal watersheds and estuaries. To address this concern, we used conventional neurophysiological recordings to investigate the impact of ecologically relevant copper exposures (0−20 $\mu$g/L for 3 h) on the olfactory system of juvenile coho salmon (*O. kisutch*). These recordings were combined with computer-assisted video analyses of behavior to evaluate the sensitivity and responsiveness of copper-exposed coho to a chemical predation cue (conspecific alarm pheromone). The sensory physiology and predator avoidance behaviors of juvenile coho were both significantly impaired by copper at concentrations as low as 2 $\mu$g/L. Therefore, copper-containing stormwater runoff from urban landscapes has the potential to cause chemosensory deprivation and increased predation mortality in exposed salmon.



## Best Available Science

Sandahl JF, Baldwin DH, Jenkins JJ, Scholz NL. 2007. A sensory system at the interface between urban stormwater runoff and salmon survival. *Environmental Science and Technology* 41:2998-3004.

| Salmonid Sensory System | Behavioral Significance |
| --- | --- |
| **Olfaction** (smell)  | imprint, locate food, **detect** ***predators***, navigate migratory routes, participate in reproduction |
| Lateral Line (senses vibrational cues) | shoaling, rheotaxis, avoid predators |

# Pre-spawn Mortality

# Sources of Copper


# Myth #2: Existing local (GMA), state (NPDES), and federal (CWA) laws are protective of listed species

- GMA: Critical Area Ordinances and Development Regulations
- NPDES: water quality standards
- Clean Water Act: protection of beneficial uses-aquatic species

# Land Use Affects Water Quality and Quantity

# Growth Management

Growth Management Services
*Overview of the Growth Management Act*

## Description

In 1990 the Legislature found that "uncoordinated and unplanned growth, together with a lack of common goals… pose a threat to the environment, sustainable economic development, and the health, safety, and high quality of life enjoyed by residents of this state. It is in the public interest that citizens, communities, local governments, and the private sector cooperate and coordinate with one another in comprehensive land use planning." (RCW 36.70A.010) This is the foundation for the Growth Management Act (GMA).

## Requirements for All Counties

The GMA requires all cities and counties in the state to:

- Designate and protect wetlands, frequently flooded areas and other critical areas.
- Designate farm lands, forest lands, and other natural resource areas.
- Determine that new residential subdivisions have appropriate provisions for public services and facilities.

## Requirements for Fully Planning Counties

In addition, 29 counties and the 218 cities within them are to plan for growth based on certain requirements. These jurisdictions represent the fastest-growing counties and the cities within them, as well as other counties, plus the cities inside their boundaries that chose to plan under the GMA.

Here are the basic steps that local governments fully planning under the GMA are to follow:

- Agree on county-wide planning policies to guide regional issues, for example, public facilities and affordable housing.
- Plan for urban growth within the urban growth areas that are adopted by each county, based on forecasts provided by the state Office of Financial Management (OFM).
- Adopt comprehensive plans with chapters that fit together.
- Identify lands useful for public purposes and essential public facilities, such as airports, educational facilities, and utility and transportation corridors.

# The Painful Cost of Booming Growth

**(Seattle Times May 11, 2008)**

Photo courtesy of Steve Ringman-Seattle Times May 11, 2008

# EPA's Review of Washington's Water Quality Criteria: An Evaluation of Whether Washington's Criteria Proposal Protects Stream Health and Designated Uses (October, 2003).

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Charles R. Horner, Esq.

## EXECUTIVE SUMMARY

Threatened Puget Sound chinook salmon and other imperiled anadromous and freshwater species continue to decline in Washington State due to the effects of diverse human actions. Recently, the Washington State Department of Ecology ("DOE") submitted revised water quality standards to the Environmental Protection Agency ("EPA") for federal approval. DOE's proposed criteria include traditional parameters such as dissolved oxygen, temperature, turbidity, and toxics. This juncture provides an opportunity to reflect on the adequacy of traditional water quality criteria to protect the designated uses of Washington's rivers and streams, which include salmon, trout and char spawning, rearing and migration, and meet the Clean Water Act's objectives. The National Wildlife Federation commissioned this review in order to evaluate the adequacy of Washington's water quality standards to meet these important goals.

# Dissolved Copper Thresholds
(in parts per billion-ppb)

- Biological Effects to Salmonids: 2.0 ppb
- State Water Quality Standards: 4.8 ppb (WSDOT* and Phase I and II NPDES)
- Industrial NPDES Permit: 20.0 ppb
- Boatyard NPDES permit: ??
- Aquatic Pesticides NPDES: 25.0 ppb

** WSDOT Guidance uses 2.0 ppb for Sec 7 only.*

# Myth #3: Stormwater treatment to biological thresholds is too costly

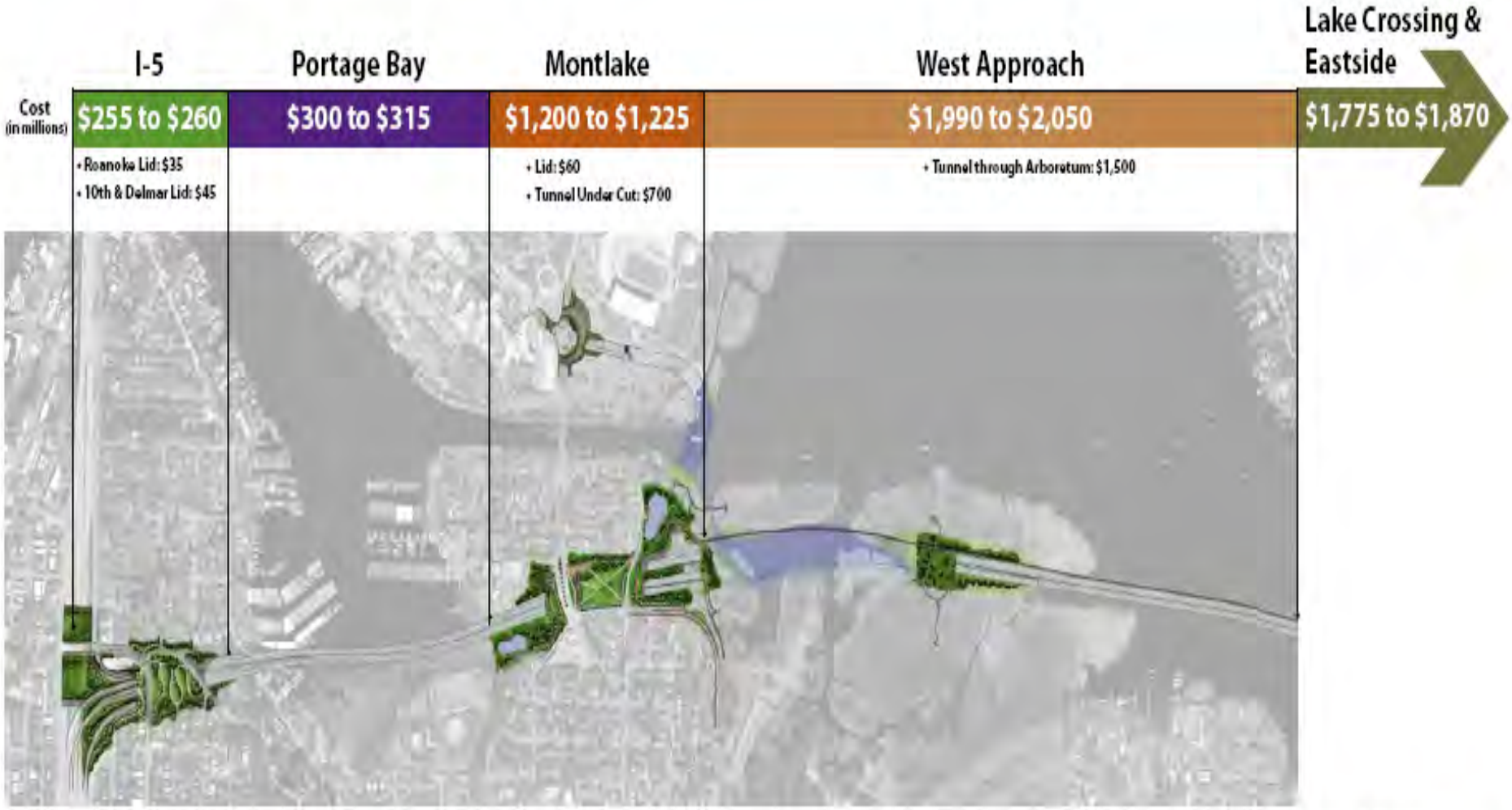
- High Efficiency Sweeping
- Bio-filtration systems
- Compost embankments
- Street-scape designs
- Low Impact Development
- Clean transportation options (DSM, ...)

# Looking for Treatment Solutions?

Washington State Department of Transportation

# SR 520 Bridge Replacement and HOV Project

PLANNING LEVEL COST OPINION FOR COMPARISON PURPOSES




## MEDIATION PROPOSAL K1

* Mitigation not determined.

**Total Cost** (in millions)

**$5,520 to $5,720**

# High-efficiency Sweeping

(photo courtesy of Seattle DOT)

# Bio-filtration embankments

(photo courtesy of SDOT)


11711

# Bio-retention Swales

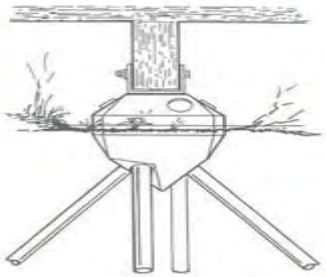
(photo courtesy of SDOT)

# Pervious v. Impervious

# Population growth

# LOW IMPACT DEVELOPMENT

## TECHNICAL GUIDANCE MANUAL FOR PUGET SOUND



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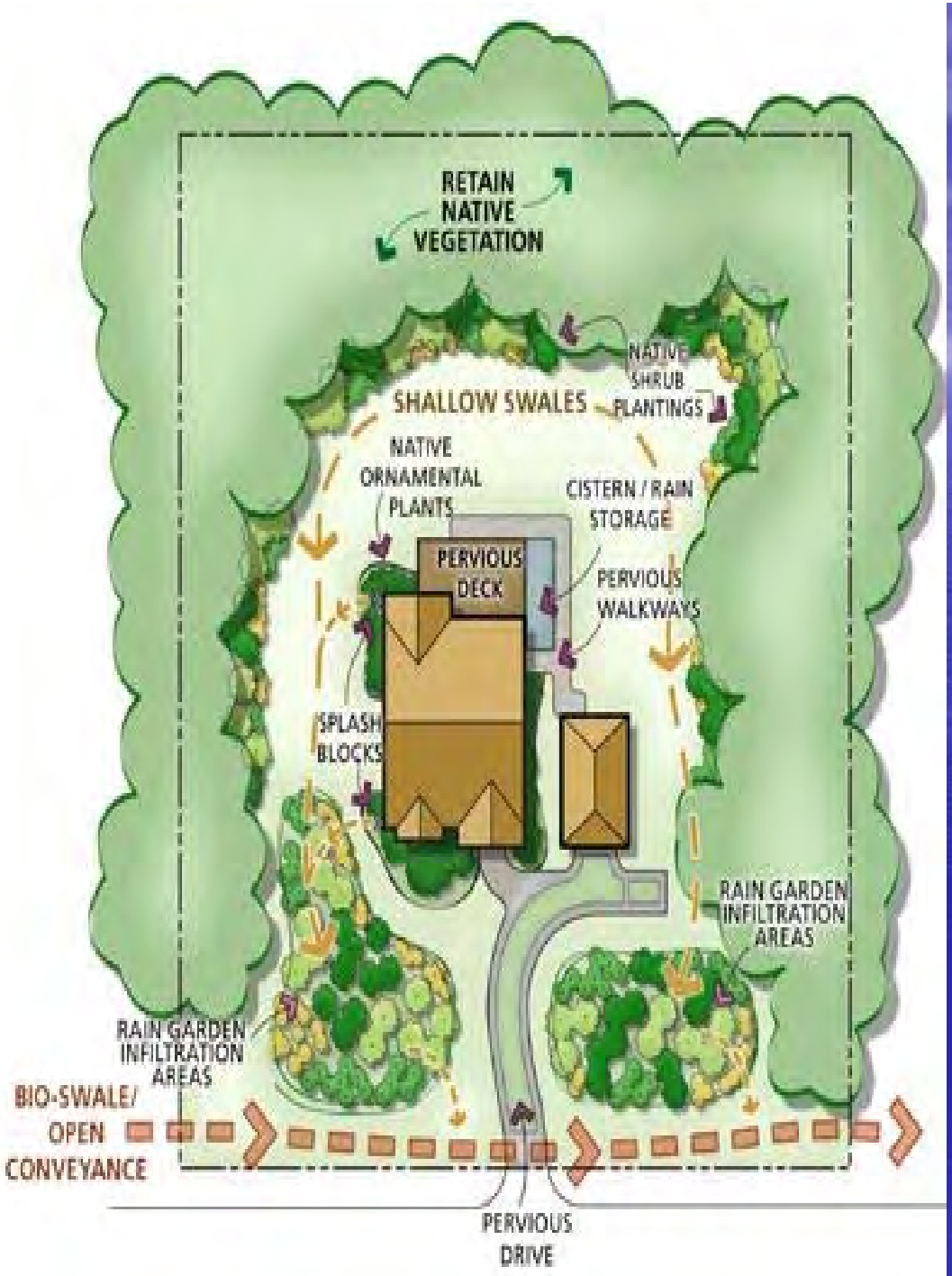

RETAIN
NATIVE
VEGETATION
NATIVE
SHRUB
PLANTINGS
SHALLOW SWALES
NATIVE
ORNAMENTAL
PLANTS
CISTERN / RAIN
STORAGE
PERVIOUS
DECK
PERVIOUS
WALKWAYS
SPLASH
BLOCKS
RAIN GARDEN
INFILTRATION
AREAS
RAIN GARDEN
INFILTRATION
AREAS
BIO-SWALE/
OPEN
CONVEYANCE
PERVIOUS
DRIVE

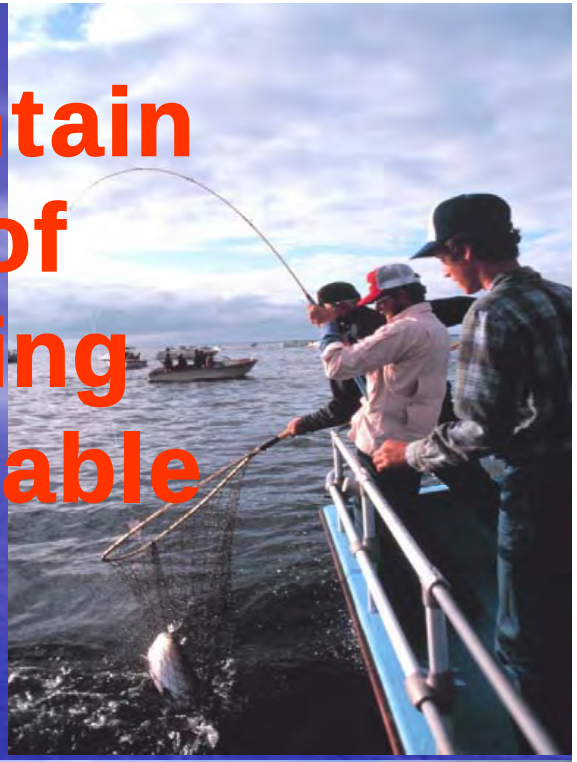
# Recommendations for the Future

- Biologically-based permits
- Address recovery plan limiting factors
- Watershed-scale mitigation
- Demand-side management (people and goods)
- Source control (brakes, oil-dependence)
- Climate change causal factors (carbon footprint)


LUFK
Chevron
5-11B SEC.33
100+ MPG
PLUG OK
CALCARS.ORG
THIS PLUG-IN HYBRID GETS 100+ MPG

# Impacts from Global Warming

# Recover and maintain an abundance of naturally spawning salmon at harvestable levels



# Useful Websites

United States Fish and Wildlife Service

http://endangered.fws.gov/

National Oceanic and Atmospheric Administration

http://www.nwr.noaa.gov

Michael.Grady@noaa.gov

*“Perfection of means and confusion of ends seems to characterize our age.” (Einstein)*

# Any Questions?

# Project Impact Plan

- Outline
- Schedule
- Question and answer

# Acoustics Expert Review Panel Report Out

# Next Steps