DIRECT SURVIVAL AND INJURY OF YEARLING CHINOOK SALMON PASSING McNARY SPILLBAYS WITH AND WITHOUT TEMPORARY SPILLWAY WEIRS (TSW'S), MARCH-APRIL 2007

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Objectives

- Compare the condition (survival and injury rates) of fish after passage through two types of TSW's versus conventional spillbays (with guide walls)
- Provide the Corps with an indirect comparison between the two TSW designs, which were not tested concurrently
- Estimate survival and injury rates to be within 0.05, 95% of the time
- Determine type, severity and possible cause of passage induced injuries

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Experimental Conditions

- **Dates:** 15-26 March and 7-9 April 2007
- **Study Locations:** TSW2 installed in Bay 20
  Conventional Spillbays 21 and 22
  TSW1 installed in Bay 22 (April)
- **Rel. Locations:** Pipes positioned so fish passed 1.5 ft and 6.5 ft above TSW crests
  Pipes positioned so fish passed 3 ft and 8 ft above spillbay crests
- **Flow Volume:** TSW's were 9.5 kcfs and conventional spillbays were 10.4 kcfs
- **Water Temp:** 5.5-7.5°C
- **Specimens:** Yearling chinook salmon (mean=141 mm)

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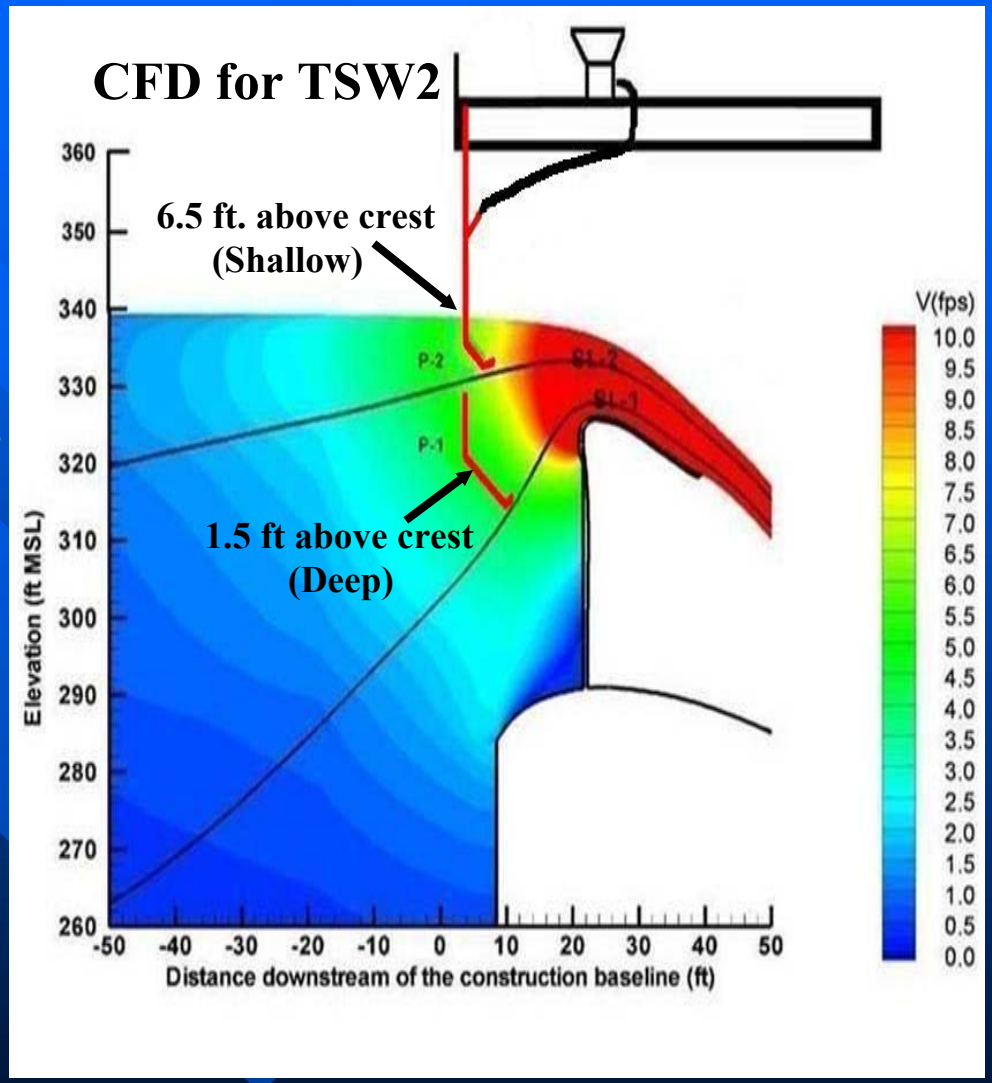
Pipe Release Locations for TSW's

- Based on CFD models
- Positioned to pass fish 1.5 ft (Deep) and 6.5 ft (Shallow) above the crest of the TSW's
- Ends of release pipes positioned where ambient water velocity was approximately 5–7 ft/sec



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Pipe Release Designs for TSW's – Very Complex

- End of pipes bent to align with trajectory of ambient flow past release points
- Release hose extended approximately ½ ft beyond end of steel support pipe

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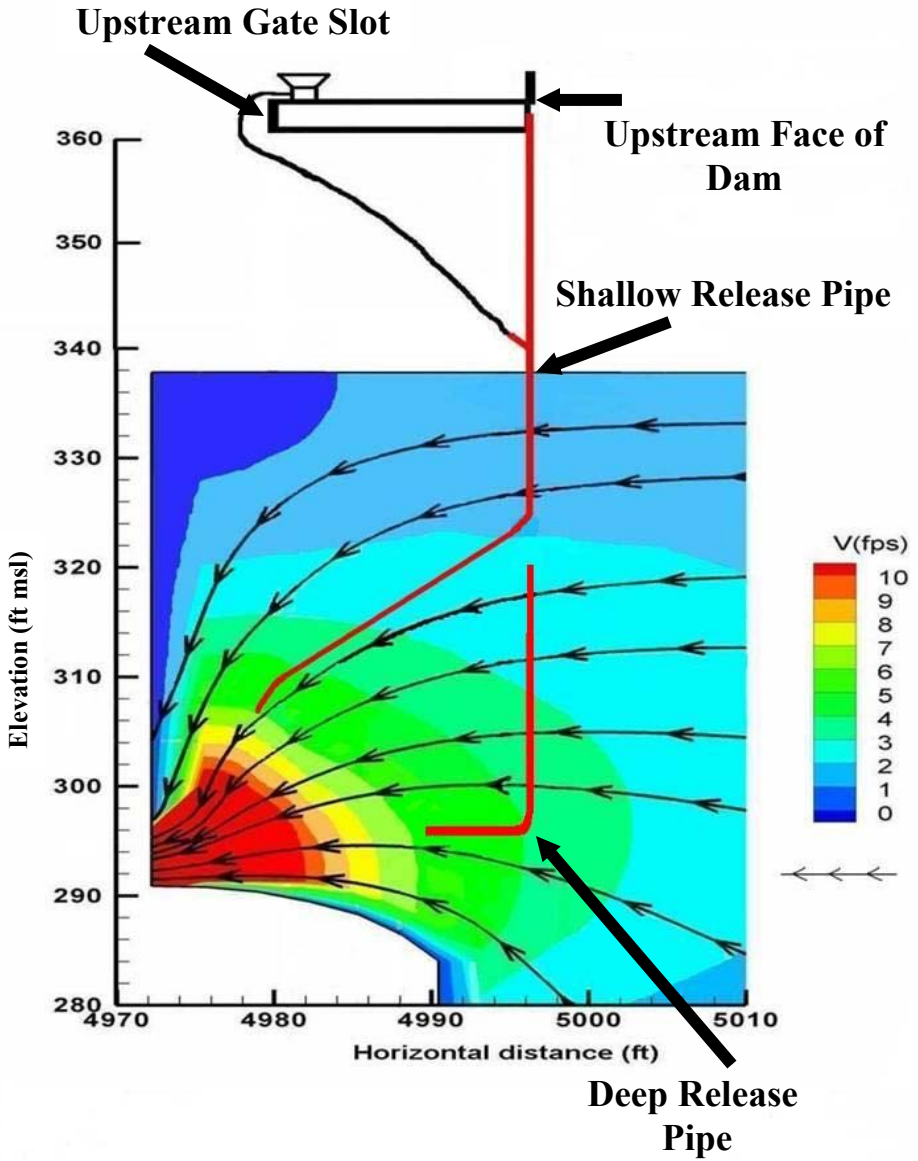
Pipe Release Locations for Conventional Spillbays



- Positioned to pass fish 3 ft (deep) and 8 ft (shallow) above crest of spillbays
- Ends of release pipes positioned where ambient water velocity was 5–7 ft/sec

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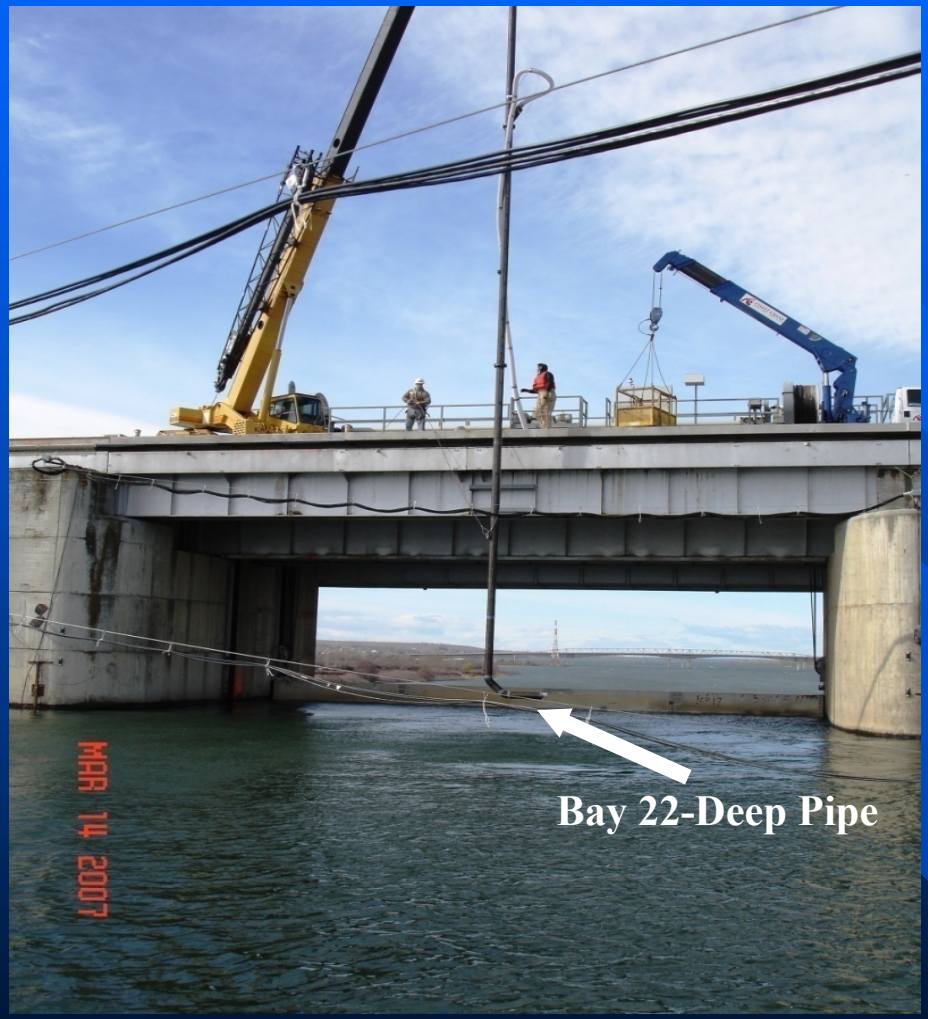
Pipe Release Designs for Spillbays



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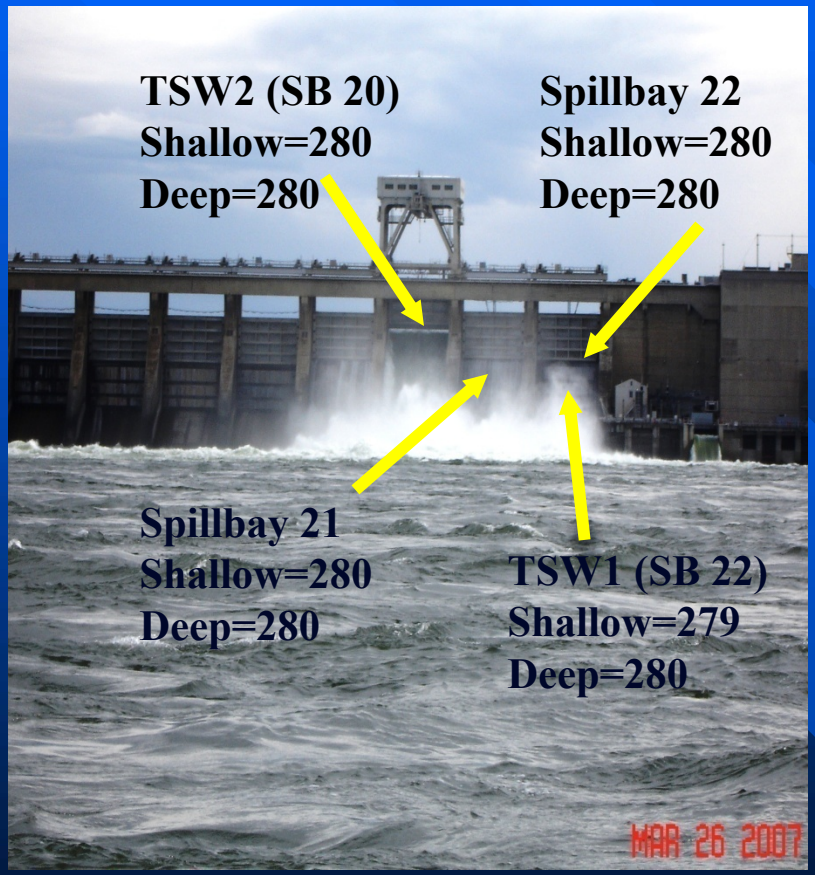
Treatment and Control Release Locations and Sample Size



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Analysis

- Statistical analyses were performed by Drs. John R. Skalski and Richard L. Townsend, University of Washington, Seattle, Washington
- The analysis assessed the effect of two passage depths for TSW1 and TSW2, and conventional Spillbays 21 and 22 at a spill volume of approximately 9.5-10.4 kcfs

Metrics Used

- ***Direct survival*** **(1 h and 48 h)**
- ***Conditional probability*** **of fish being malady-free given alive at 48 h**
- ***Joint probability*** **of 48 h survival and being malady free**
- ***Malady*** **defined as a fish with a visible injury, scale loss >20% per side and/or loss of equilibrium**

Visible Injury Examination

- All recaptured fish examined for injury type, severity and probable cause

Results: Recapture Rates

- Recapture rates ranged from 98.6–99.6% of treatment fish and 100% of control fish
- Virtually all fish recaptured were alive

	TSW1 (SB 22)	TSW2 (SB 20)	Spillbay 21	Spillbay 22
		Treatment		
Shallow	99.6	98.6	98.9	99.3
Deep	99.6	99.7	99.3	98.9
		Control		
		100%		

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Results:48 h Survival

- Estimated survival ≥0.982 (range 0.982–0.993)
- Highest survival (0.993) both shallow and deep for TSW1
- Precision (ε) was ≤ ±0.016, 95% of time and met the study criteria; precision in (parenthesis)
- No significant differences (P>0.10) between release depth, passage route or interaction between release depth and passage route

			Without TSW	
	TSW1 (SB 22)	TSW2 (SB 20)	Bay 21	Bay 22
Shallow	0.993 (±0.010)	0.982 (±0.016)	0.982 (±0.016)	0.989 (±0.012)
Deep	0.993 (±0.010)	0.989 (±0.012)	0.989 (±0.012)	0.989 (±0.012)

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Malady/Injury Rate Cause and Severity

- Overall 45 of 2,222 (2.0%) of the recaptured treatment fish had maladies
- Of the 45 total treatment maladies, 26 (58%) were minor
- Maladies consisted primarily of visible injuries (37 fish)
- Common injuries were hemorrhaged eye(s), torn or folded operculum, and scrapes on head or body

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Malady/Injury Rate Cause and Severity-Continued

- The injuries were attributed to mechanical and shear forces, with shear related injuries being more common
- Total of 8 (0.4%) treatment fish exhibited loss of equilibrium exclusively, no recaptured fish had only scale loss
- The passage related visible injury rate was estimated at ≤2.9% for any treatment group
- Control fish exhibited no maladies

Visible Injury Types for Shallow Released fish

- Eye damage was the dominant injury type
- Spillbay 21 had the highest injury rate (2.2%)

			Without TSW'S	
	TSW1 (SB 22)	TSW2 (SB 20)	Bay 21	Bay 22
Eye Damage	1(0.4%)	2(0.7%)	3(1.1%)	0
Gill/Operculum	1(0.4%)	2(0.7%)	2(0.7%)	1(0.4%)
Bruise/Scrape	0	1(0.4%)	1(0.4%)	0
Internal	0	0	0	0
Number Injured	2(0.8%)	5(1.8%)	6(2.2%)	1(0.4%)

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Visible Injury Types for Deep Released fish

- *Some fish had multiple injury types
- Eye damage was the dominant injury type across all treatment groups
- Highest visible injury rate occurred at TSW2 (2.9%) followed by TSW1 (2.5%)

			Without TSW'S	
	TSW1 (SB 22)	TSW2 (SB 20)	Bay 21	Bay 22
Eye Damage	5(1.8%)	4(1.4%)	4(1.4%)	3(1.1%)
Gill/Operculum	3(1.1%)	2(0.7%)	0	1(0.4%)
Bruise/Scrape	1(0.4%)	1(0.4%)	0	1(0.4%)
Internal	0	1(0.4%)	0	0
Number Injured	7*(2.5%)	8(2.9%)	4(1.4%)	4*(1.4%)

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Results: Conditional Malady Free Estimates (CMFE)

- Highest TSW estimate was 0.993 at TSW1 Shallow release
- CMFE of TSW1 Deep and TSW2 Shallow were identical (0.971)
- Precision (ε) of CMFE's was ≤ ±0.020, 95% of the time and met study criteria; precision in (parentheses)
- Conventional spillbay CMFE ranged from 0.982 to 0.996
- CMFE's were not significantly different (P>0.119), and differed by 0.025 or less

			Without TSW	
	TSW1 (SB 22)	TSW2 (SB 20)	Bay 21	Bay 22
Shallow	0.993 (±0.010)	0.971 (±0.020)	0.982 (±0.016)	0.996 (±0.007)
Deep	0.971 (±0.020)	0.975 (±0.018)	0.986 (±0.014)	0.982 (±0.016)

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Results: Joint Probability of 48 h survival and being malady free

- Highest TSW estimate was 0.986 at TSW1 Shallow release
- Joint probability estimate of TSW1 and TSW2 Deep were identical (0.964)
- Conventional spillbay estimates ranged from 0.964 to 0.986
- Precision (ε) of estimates was ≤ ±0.025, 95% of the time and met study criteria; precision in (parentheses)
- Joint probability estimates were not significantly different (P>0.288)

			Without TSW	
	TSW1 (SB 22)	TSW2 (SB 20)	Bay 21	Bay 22
Shallow	0.986 (±0.014)	0.954 (±0.025)	0.964 (±0.022)	0.986 (±0.014)
Deep	0.964 (±0.022)	0.964 (±0.022)	0.975 (±0.018)	0.971 (±0.020)

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Conclusions

- 48 h survival was high for all treatment conditions (>0.982), (0.993) occurred at both TSW1 Deep and Shallow
- Desired precision (ε) $\leq \pm 0.05$; 95% of the time was met for all survival estimates
- Passage related maladies were low (2%)
- Slightly higher injury rates for deep released fish (1.4%-2.9%) than shallow released fish (0.8%-1.8%)
- Eye damage was the dominant injury type for most treatment conditions
- The three metrics were statistically similar between all treatments
- Direct survival and condition results indicated that both conventional spillbays (21 and 22) and the two TSW designs were relatively benign

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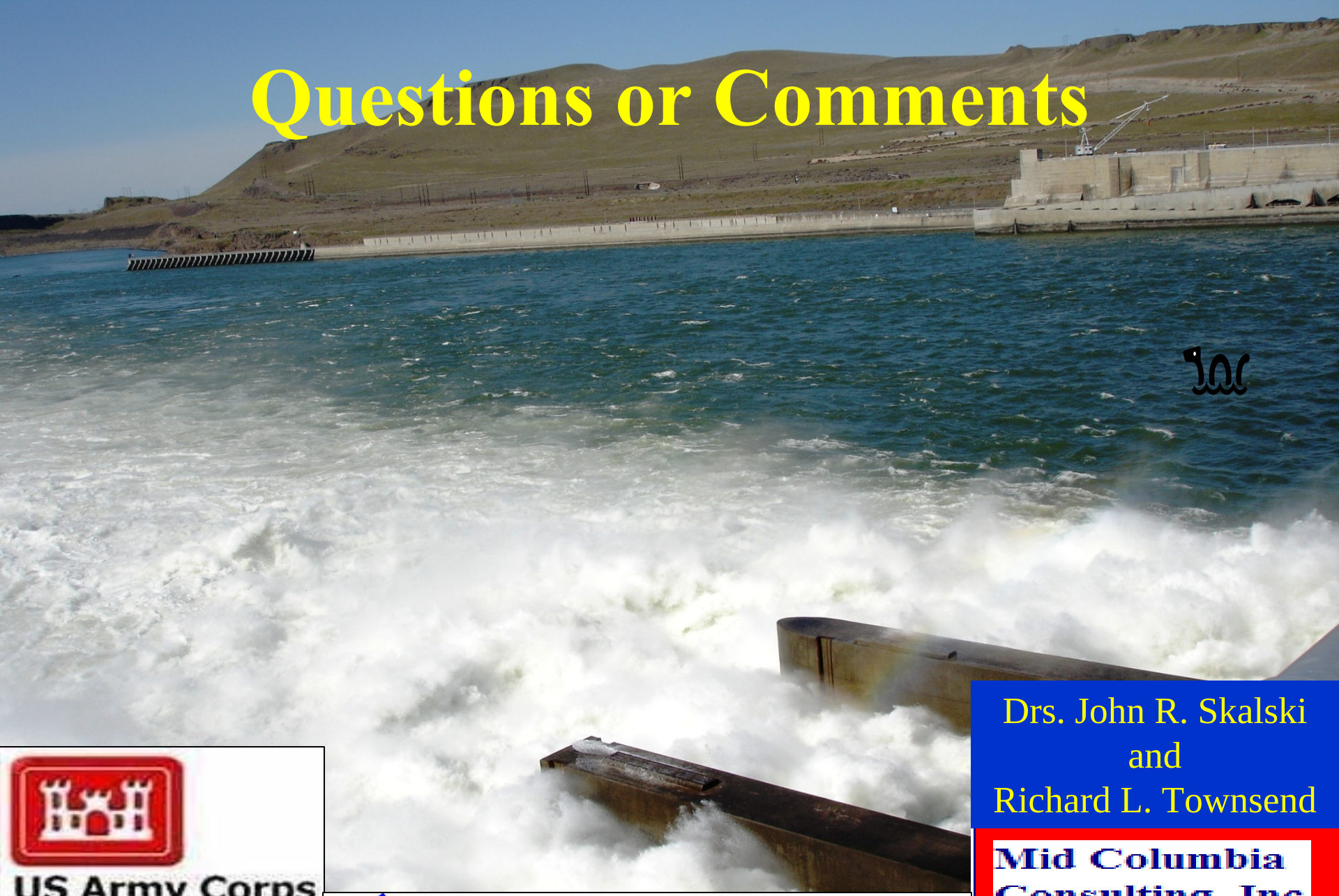
Questions or Comments



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