Risk Management Through Engineering and Operational Controls

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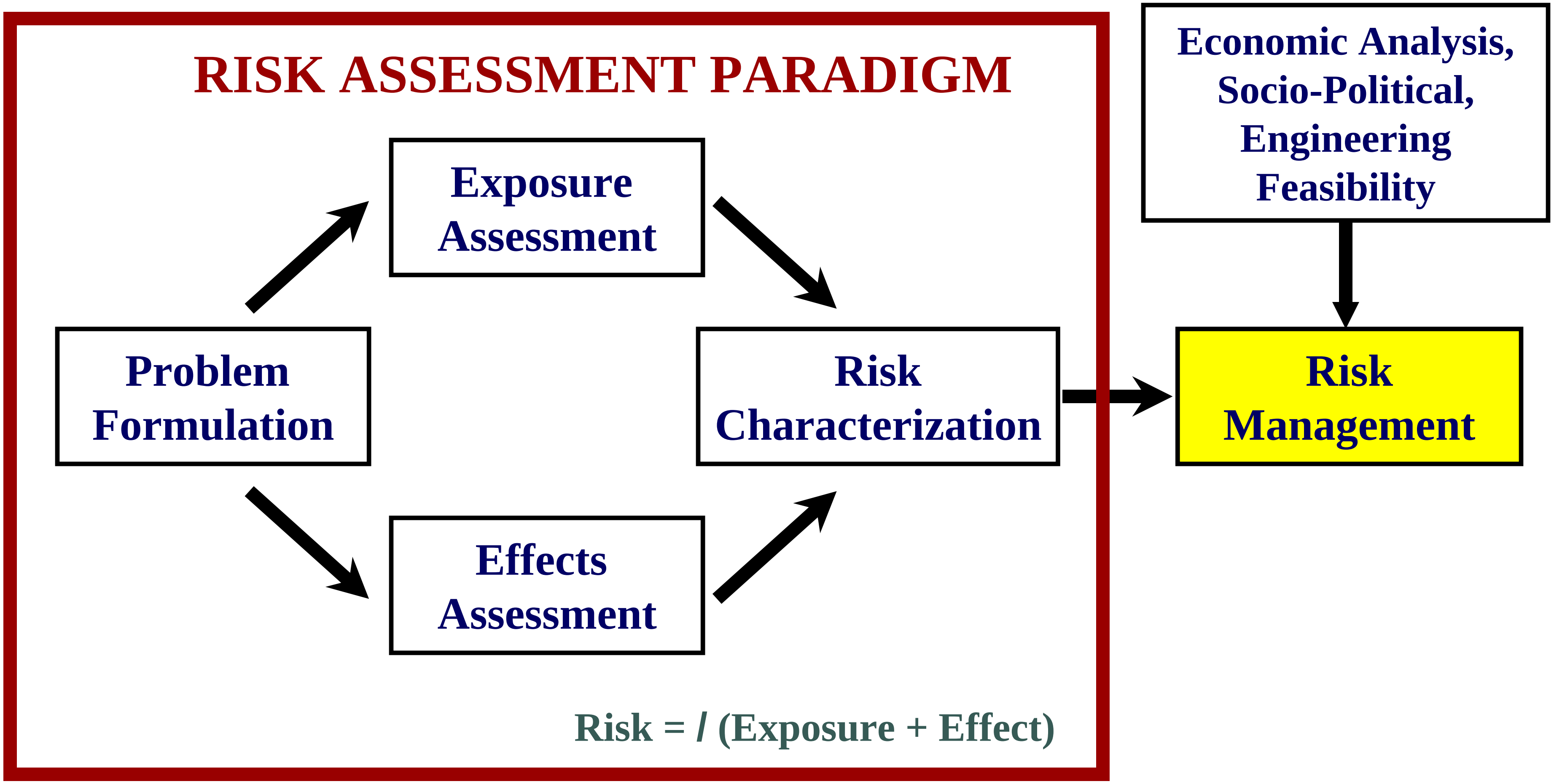
Engineer Research and Development Center

RISK FRAMEWORK



Presentation Objective

Risk Management –

Reduce sediment resuspension risks (where unacceptable) to acceptable levels by use of engineering controls, and/or use of operational controls.

Concept

- **Risk is managed by managing the exposure.**
- **Exposure can be managed by controls that:**
  - reduce the source concentration,
  - alter the source location,
  - reduce total mass of sediment resuspended in the water column,
  - alter transport of resuspended sediment,
  - increase settling.

Engineering Control

Definition: Requires a physical construction technology or modification of the physical dredge plant to cause the desired change in conditions.

Source: Geotechnical Supply Inc

Operational Control

Definition: Action that can be undertaken by dredge operator to reduce unacceptable risks of the dredging operations.

If it is determined that unacceptable risk(s) exist

Engineering and/or operational controls must be evaluated for effectiveness for the site-specific conditions.

Control Applications

Changes in dredging equipment and/or operations can modify:

- the resuspended sediment concentration at source,
- total mass of sediment resuspended in the water column,
- the release points,
- transport of resuspended material.

Control Applications

But changes in dredging equipment and/or operations involves tradeoffs:

- **dredge production rates,**
- **project duration,**
- **costs,**
- **etc.**

Tradeoffs

- Are involved with the use of engineering and operational controls as risk reduction solutions.

  - Big hopper dredges can cost REALLY APPROXIMATELY $85K/day.

  - Big cutterheads can cost REALLY APPROXIMATELY $45K-$55K/day.

  - Big mechanical dredges can cost REALLY APPROXIMATELY $25K-$30K/day.

Controls

- **Controls should only be applied when conditions clearly indicate that they are needed.**
- **Should not be set as a requirement solely because they can be applied.**
- **Improperly used can have direct negative impacts on project and environment.**

Selection of Dredging Equipment

- Physical characteristics of material to be dredged
- Quantities of material to be dredged,
- Dredging depth,
- Distance to disposal area,
- Physical environment of the dredging and disposal areas,
- Contamination level of sediments,
- Method of disposal,
- Production required,
- Type of dredges available
- Cost.

Factors Influencing Sediment Resuspension

Mechanical versus hydraulic issues.

- **Magnitude of resuspension,**
- **Location of resuspension in water column,**
- **Strength of resuspension,**
- **Continuous or intermittent.**

Relative performance is a function of site specific conditions.

Engineering Controls
Type of Dredge

- **Empirical Solids Releases**

Resuspension of fine-grained mass of dredged sediment to water column

- ➢ Mechanical dredges
  - – Open or watertight ➔ 0.2 to 9%, typically 0.5 to 2%
  - – Environmental ➔ 0.1 to 5%, typically 0.3 to 1%
- ➢ Hydraulic dredges ➔ 0.01 to 4%, typically 0.2 to 0.8%

Engineering Controls
Size Matters

- **As size increases:**

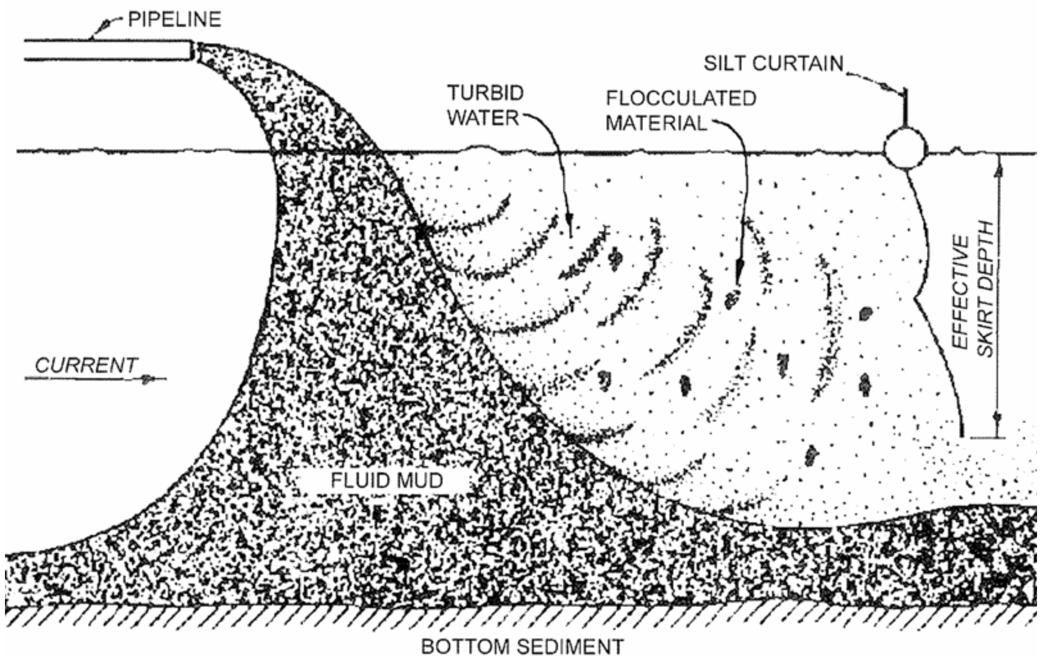
  - Production rate increases,

  - Resuspension rate and therefore strength (concentration) of resuspended sediment increases,

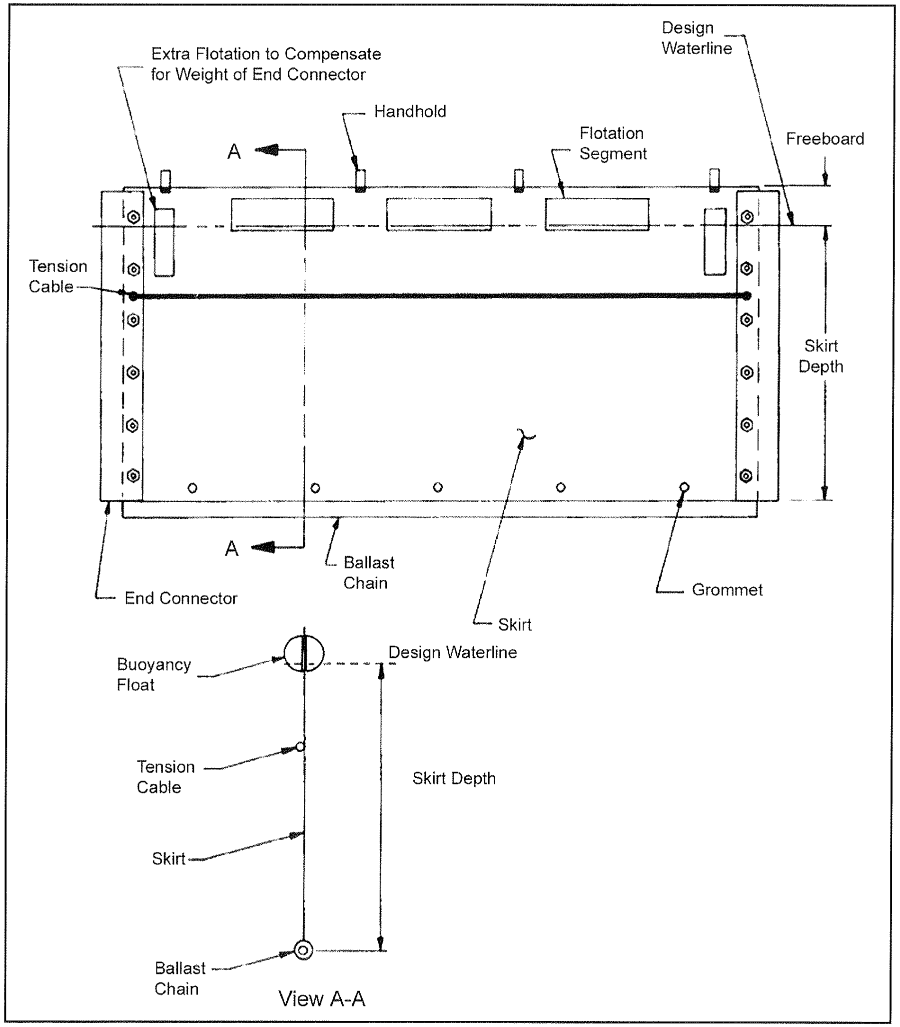
  But, exposure time is decreased because the dredge is operated for a shorter amount of time and total mass of sediment resuspended is decreased.

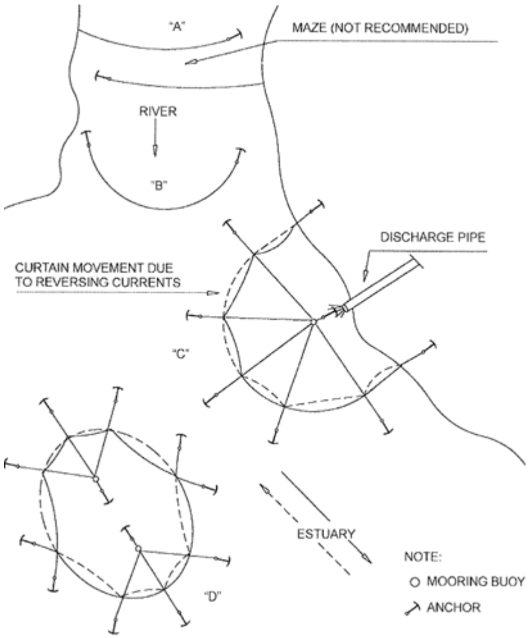
Engineering Controls
Silt Curtains

Silt curtains are devices designed to control suspended solids and turbidity in the water column generated by dredging and disposal of dredged material.

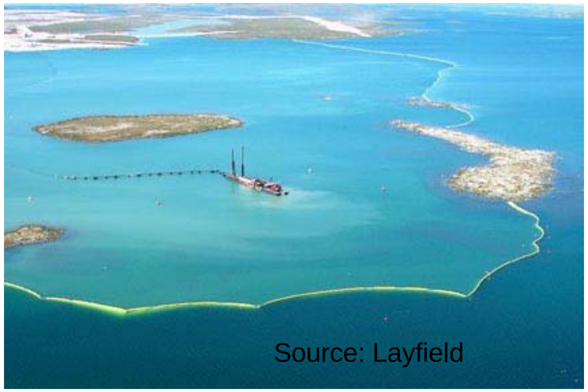


Components of a Silt Curtain





Effectiveness of Silt Curtains


Source: Layfield

Depends on:

- Nature of operation,
- Quantity and type of material in suspension,
- Characteristics, construction, and conditions,
- Method of deployment,
- Hydrodynamics.

Silt Curtains “Lessons Learned”

- Used at various sites with various degrees of success.
- Should not be considered a “one-solution-fits-all” type of BMP.
- Are highly specialized, temporary-use devices that should be selected only after careful evaluation.
- Requires knowledge and practical experience for successful applications.

Silt Curtain "Lessons Learned"

- Deploying in currents > 1 to 1 ½ knots problematic.
- Low current/high current conundrum.
- In general, should be used in slow to moderate currents, stable water levels, and relatively shallow water depths.
- Selection/use is extremely site-specific (not a silver bullet).

http://el.erdc.usace.army.mil/dots/doer/pdf/doere21.pdf

Operational Controls

Operational Controls
Slow Down

- Slowing operation can decrease strength but may increase total mass of resuspension.
- Slowing operation would change exposures - turbidity,
  - net deposition,
  - deposition rate
  - and potential dose.

Operational Controls Mechanical Dredges

- Varying the bucket descent speed
- Varying the bucket ascent speed
- Varying the slewing speed
- Barge overflow/no overflow

Operational Controls
Mechanical Dredges

Varying Bucket Speeds

Mechanical Dredge Bucket Size yd3 (m3)	Bucket Cycle Time sec	Bucket Ascent & (Descent) Velocity m/s (m/s)	Instantaneous Production Rate m^3/hr	Mass Resuspension Rate g/s	Percent Resuspension	Project Duration Days*
4.0 (3.0)	50	1.06 (0.8)	184	217	0.72	27
4.0 (3.0)	75	0.5 (0.37)	122	142	0.71	39
4.0 (3.0)	100	0.32 (0.24)	92	123	0.81	50
30.0 (23.0)	50	1.06 (0.8)	1408	1432	0.61	4
30.0 (23.0)	75	0.5 (0.37)	938	977	0.63	5
30.0 (23.0)	100	0.32 (0.24)	704	843	0.73	6

*Based on 100,000 m^3 project

Operational Controls
Cutterhead Dredges

- Using different cutterhead rotation speeds
- Using different swing speeds
- Varying the suction velocity
- Varying the cut height and step length
- Varying the direction of cut

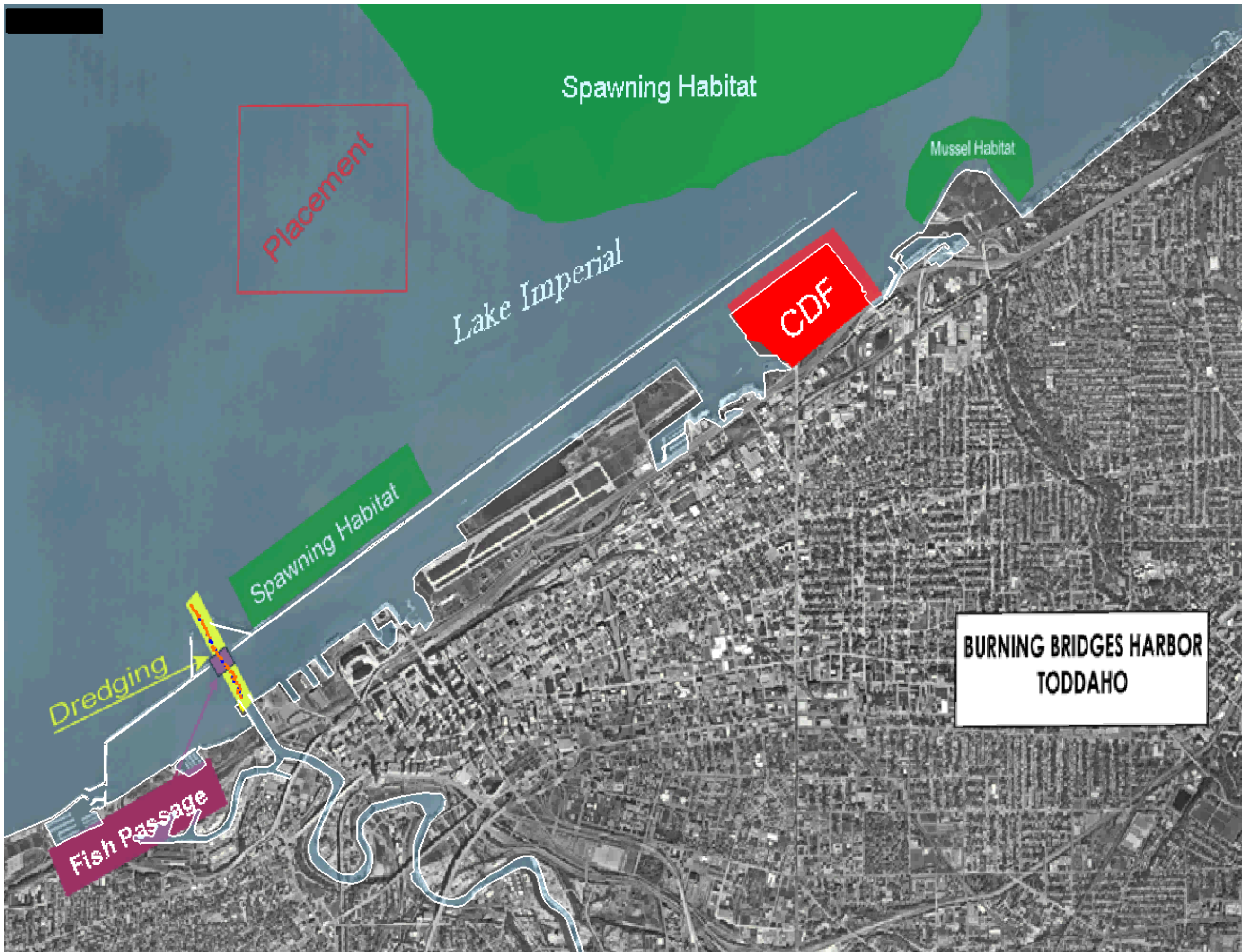
Operational Controls
Hopper Dredges

- Changing the suction pipe velocity
- Varying the trailing speed
- Loading with one suction pipe instead of two
- Allowing overflow, not allowing overflow
- Vary draghead operation

Operational Controls

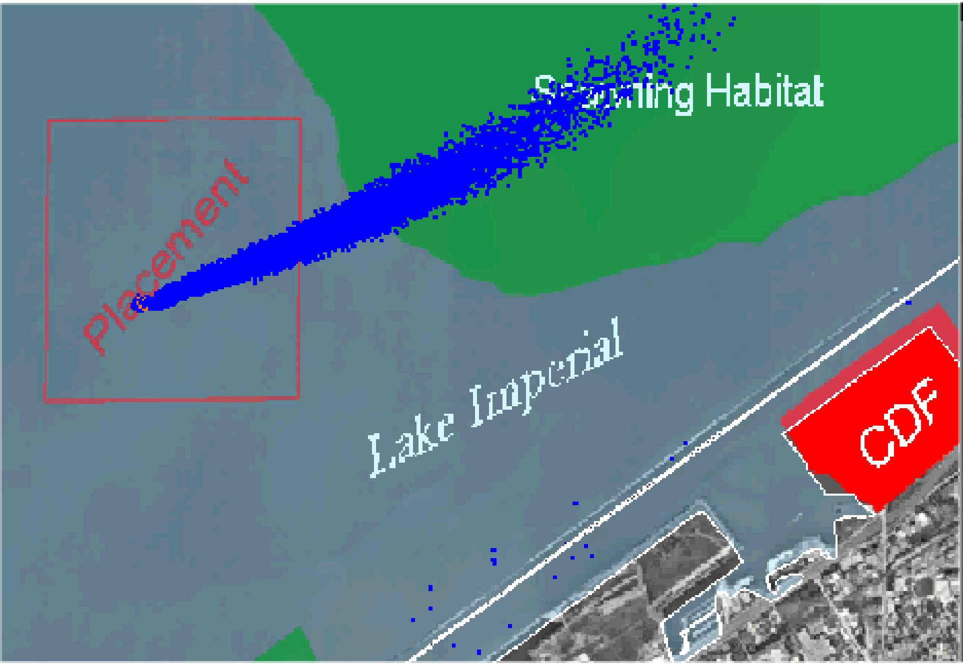
- These operational controls have been tested on a limited basis.
- Few data are available to support effectiveness of these controls in reducing resuspension.
- Experienced operators oft challenged to find optimal method and production rate.

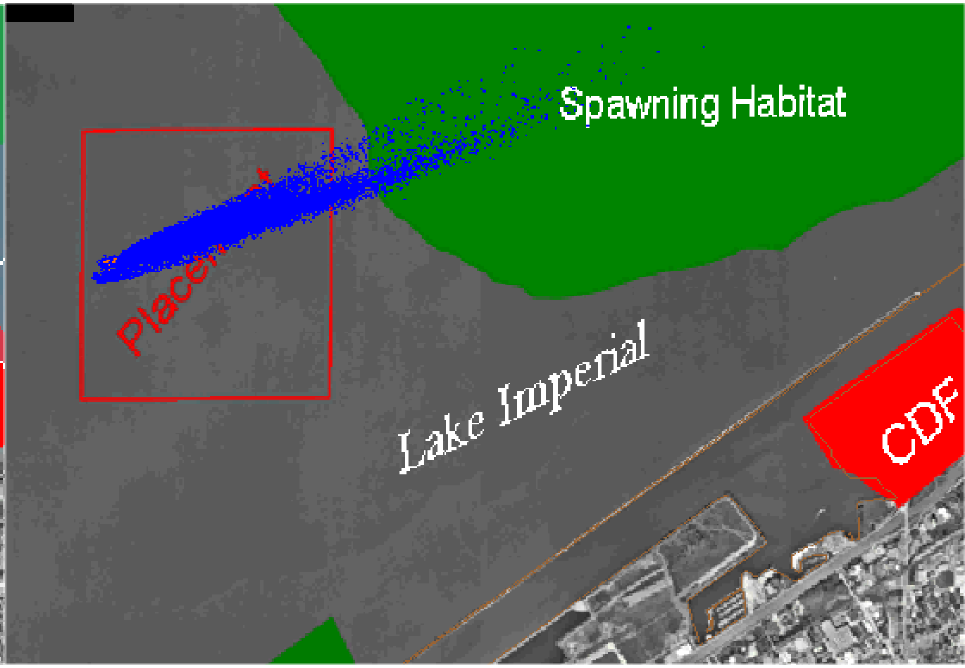
Hypothetical Example
Hopper Dredge & Open Water Placement

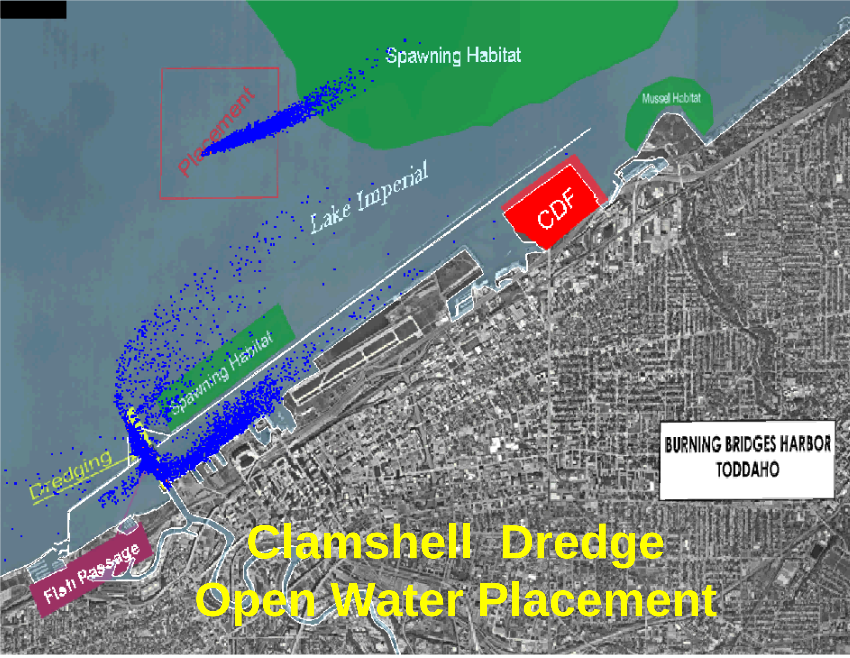


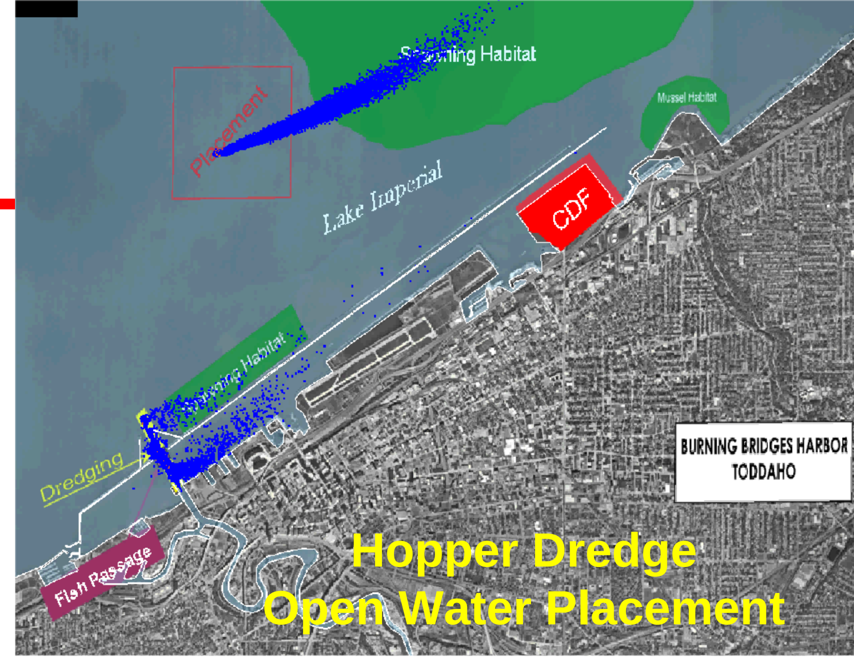
Hypothetical Example
Hopper Dredge & Open Water Placement

Operational Control Changing Placement Location






Spawning Habitat
Mussel Habitat
Placement
Lake Imperial
CDF
Spawning Habitat
Dredging
Fish Passage
BURNING BRIDGES HARBOR
TODDAHO
Clamshell Dredge
Open Water Placement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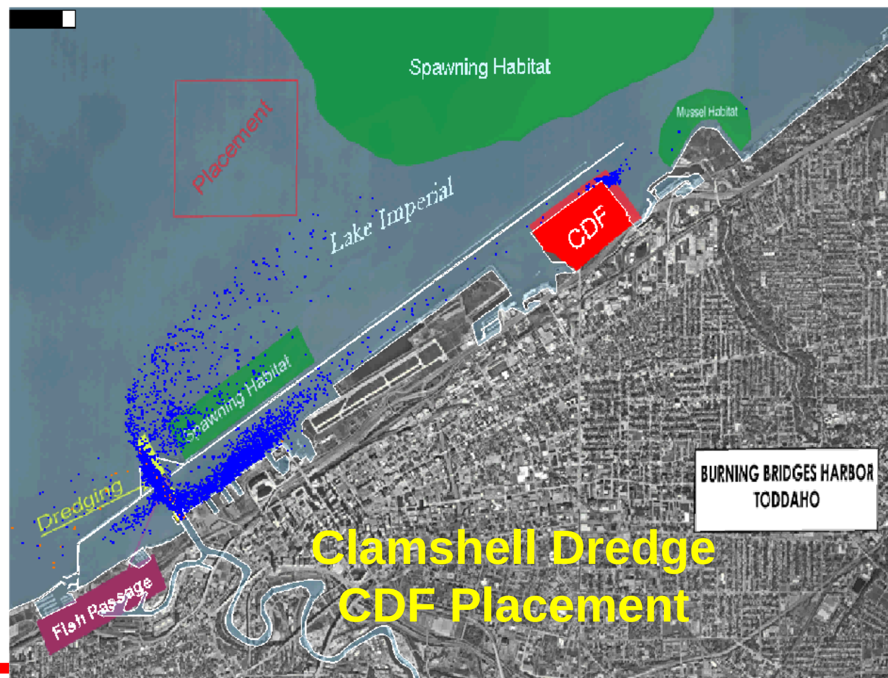
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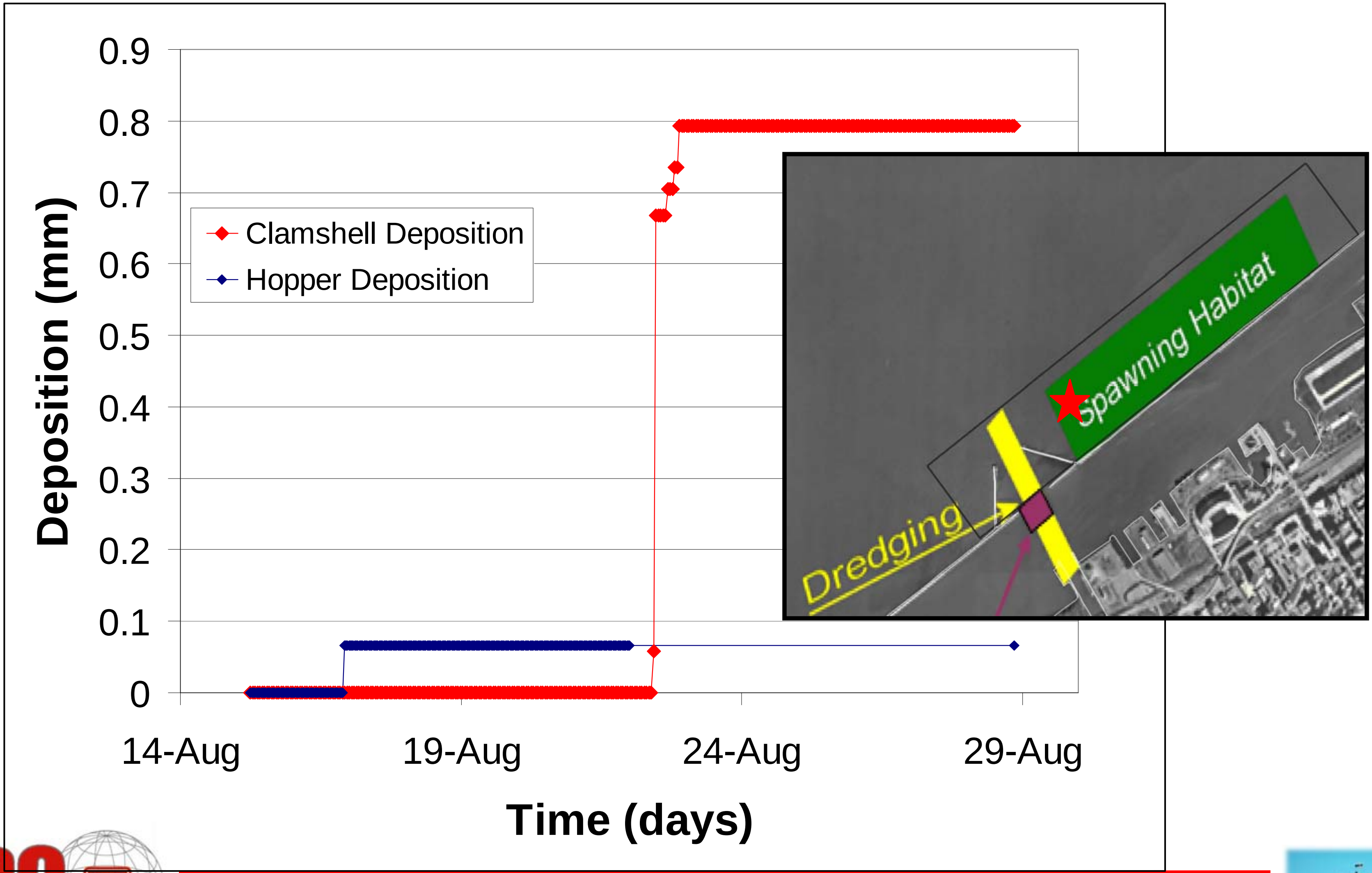
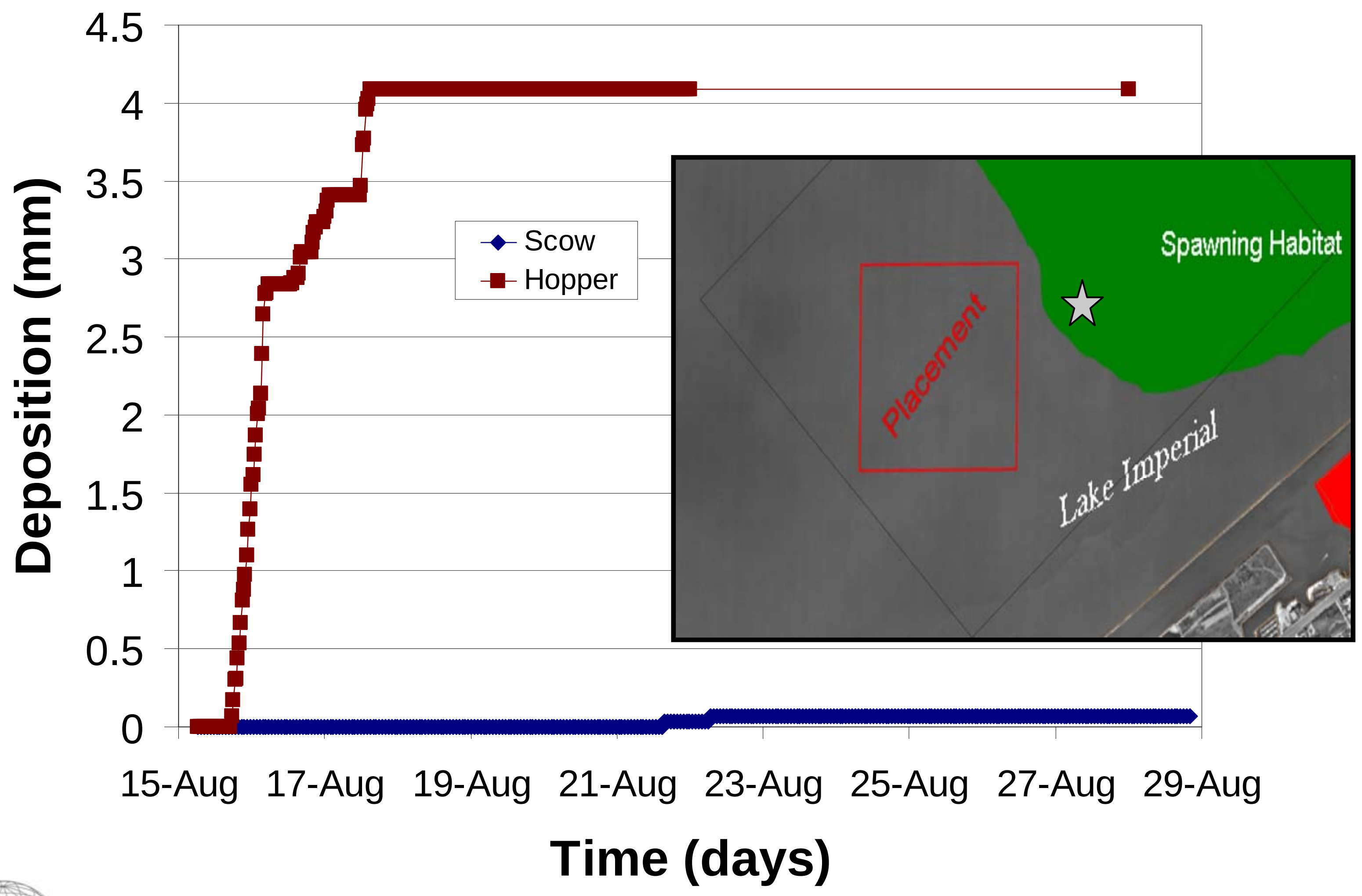
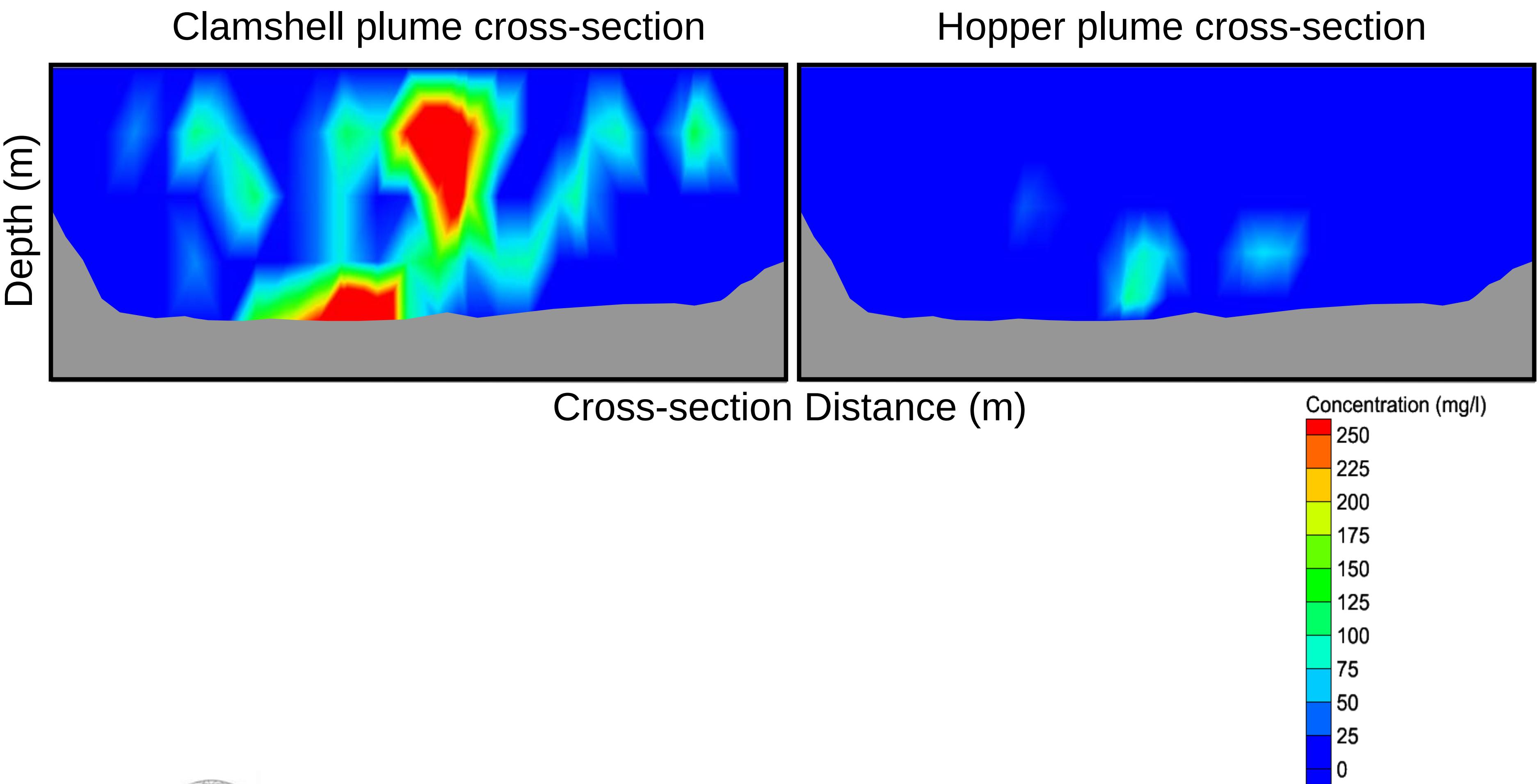
Time Series: Clamshell & Hopper Dredge Deposition



Time Series: Clamshell & Hopper Dredge Deposition



Engineering Controls to Reduce Fish Passage TSS Exposure



Hypothetical Example Dredging Scenarios

Dredging Scenario	Production Per Day	Dredging Duration (Days)	Approximate Project Dredging Cost*
Hopper Dredge with Open Water Placement	12,000 yd^3	4	$240,000
Clamshell Dredge with Open Water Placement	3,000 yd^3	16	$350,000
Clamshell Dredge with CDF Placement*	3,000 yd^3	16	$540,000

*Assume same clamshell bucket production as open water placement option, but requires additional barge and hydraulic unloader.

Questions?