Beneficial Uses of Dredged Material

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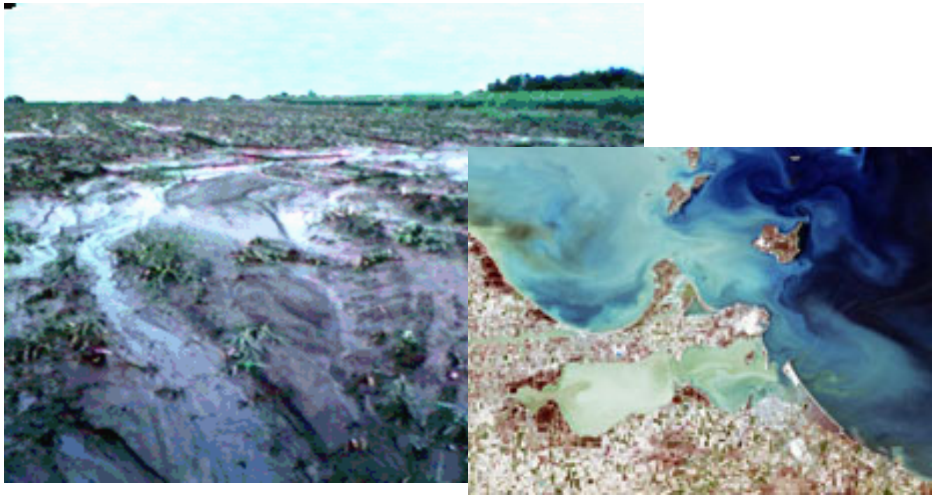
Dredging Quick Facts

- **USACE is not responsible for agricultural, industrial and urban discharges of soil and their associated contaminants.**
- **USACE is responsible for maintaining navigation depths in the federal channel and dredge/fill permits**
- **Watershed erosion, left unabated, will remain the main contributor for the need to dredge**

Sources of origin and contamination



Beneficial Use

- **What is it?**

Regional Sediment Management

- **The use of sediment resources removed in dredging operations for shoreline habitat or structure, land development or as raw material in construction and soil material products.**

Keeping a productive resource in the watershed system

Two Paths for BU

- **Beneficial use is part of the dredging and placement process**
  - ***Regional Sediment Management***
    - ***Keeping sediment in the system***
- **Beneficial use is part of the CDF recovery process**
  - ***Mining CDFs to reclaim capacity***
  - ***Design CDFs for placement & processing***

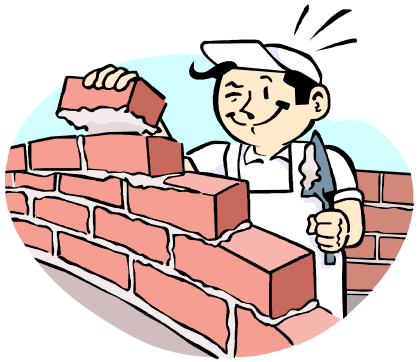
Where Did it Go - 2008?

- "Of the 300 million cubic yards of sediment the USACE dredges annually to facilitate navigation, an estimated 5 to 10 percent is contaminated." NRC, Committee on Contaminated Marine Sediments, National Academy Press. 1997.

- ~ 40% was used beneficially in 2008

Disposal Type	Cubic yds	% of Total
Beach Nourishment	4,833,125	3.3
Confined	12,565,711	8.6
Underwater Confined	2,926,000	2.0
Mixed Types	5,186,694	3.5
Overboard & Open Water	50,050,381	34.2
Open & Upland	3,435,000	2.3
Beach & Upland	929,000	0.6
Upland	3,897,019	2.7
Wetland Nourishment	49,075,000	33.5
Undefined	13,385,700	9.2

Beneficial Uses



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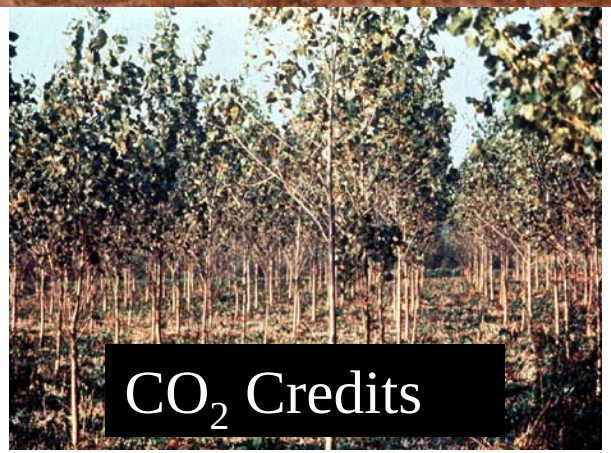
Dredged Material Assessment and Management Seminar
15-17 September 2009, Detroit, MI

Beach Nourishment

Construction Fill

Agriculture/Forestry

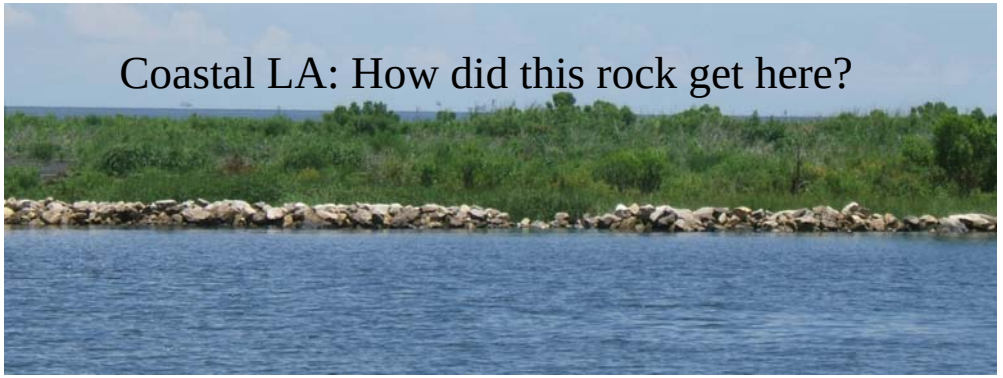


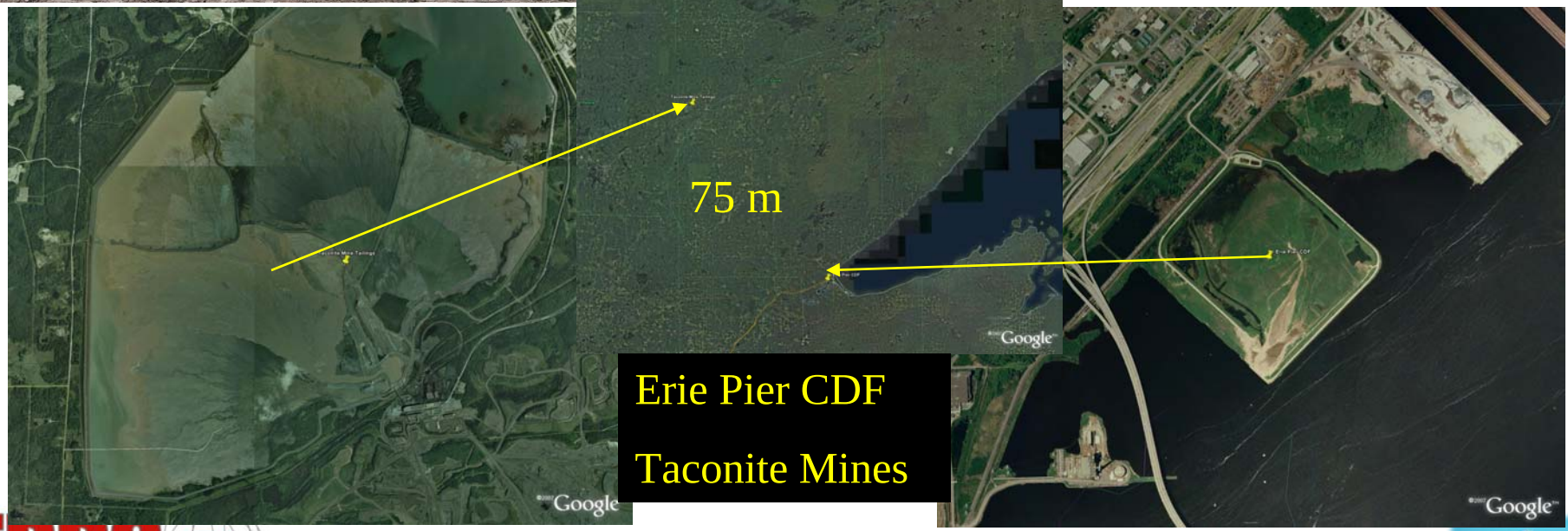
Recreation

Wetland Habitat and Shoreline Protection

Island Habitat

Mineland Reclamation



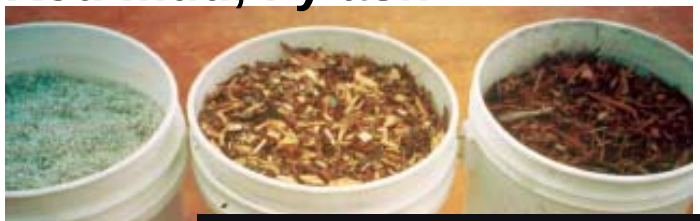


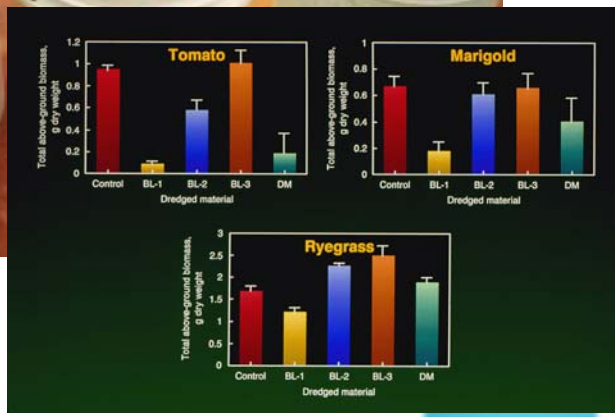
Dredged Material Recycling

Construction Materials

Blending to Meet Needs

- **Cellulose**
  - Yard wastes, paper wastes
- **Biosolids**
  - Sewage sludge, animal wastes
- **Industrial by-products**
  - Red mud, fly ash





Dredged Material to Landscapes

Grand Haven, MI

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So, What is the Problem?

Great Lakes Commission
des Grands Lacs

TOLEDO-LUCAS COUNTY
PORT AUTHORITY

CNN.com

Joe Public

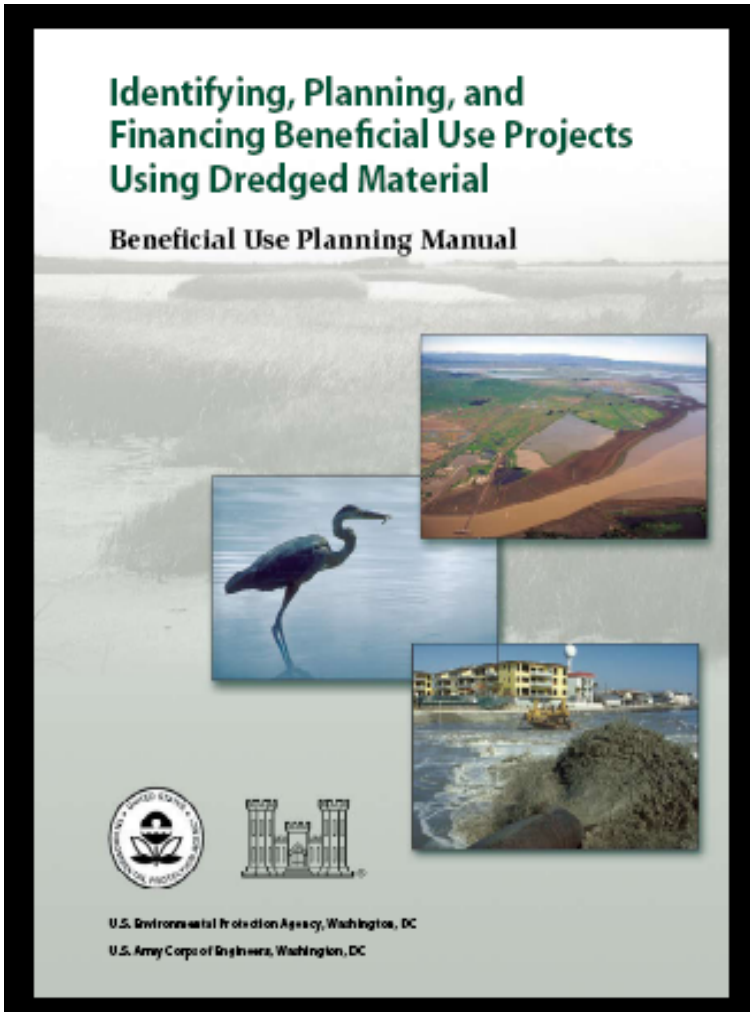
ISSUES

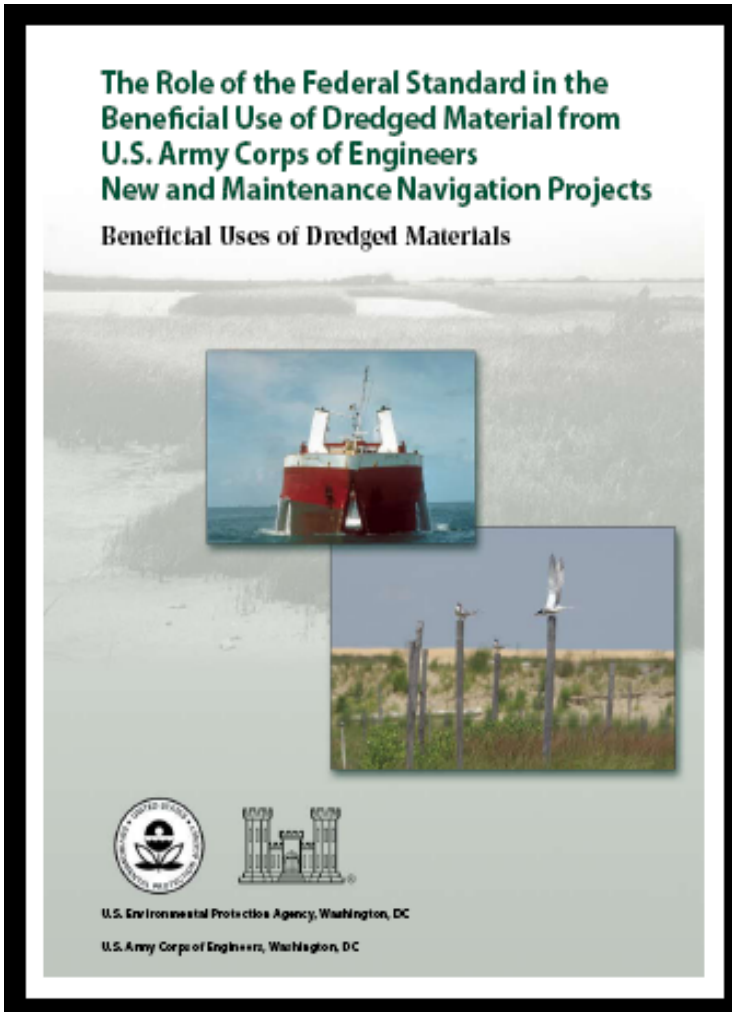
- Perceptions w/o scientific basis
- Lack of clear regulatory guidance
- Uncertainty dealing with contaminants
- Fear of product liability

Formula for Success

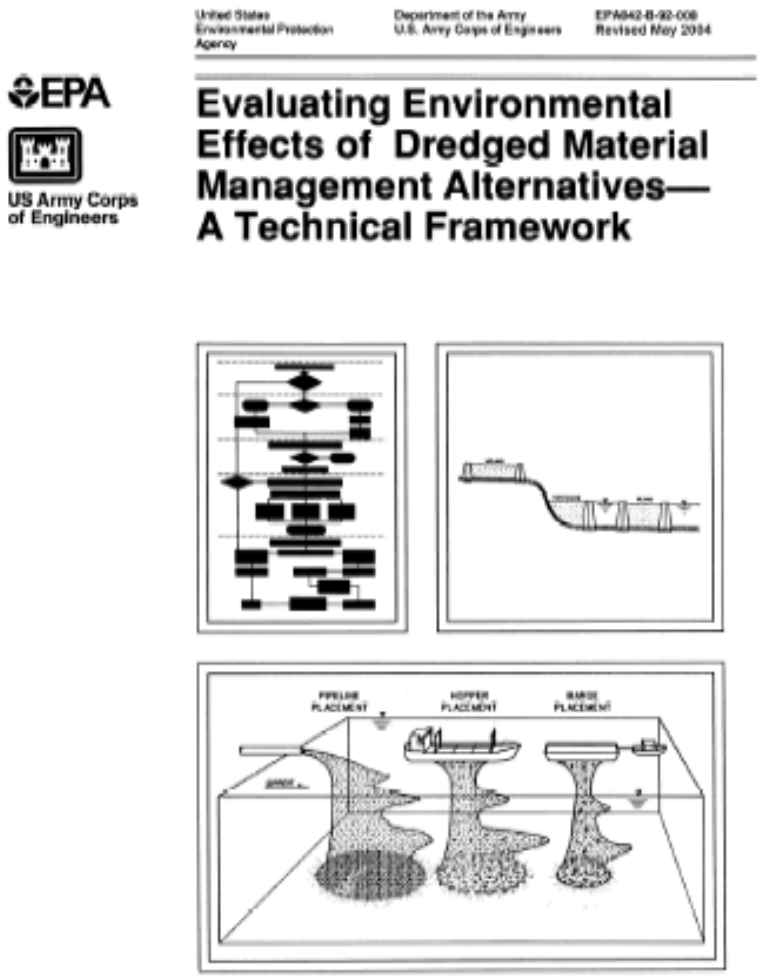
- A four-part formula is usually required for success
  - Technical feasibility
  - Legal / regulatory concerns
  - Public support
  - Economics (value added)

USEPA/USACE Planning/Authorities





EPA/CE Evaluation Framework



- BU opportunities
- Physical suitability
- Logistics & Mgt needs
- Environmental suitability – no testing methods specified
  - State/Fed screening criteria
  - Physical & biological tests

Regional Upland BU Guidance

Great Lakes Commission
des Grands Lacs

Great Lakes Dredging Team

September, 2004
Second Edition

With references to:
Upland Beneficial Use of Dredged Material Testing and Evaluation
Annotated Bibliography

State Regulations

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

RULES AND REGULATIONS FOR DREDGING AND THE MANAGEMENT OF DREDGED MATERIAL

February 2003

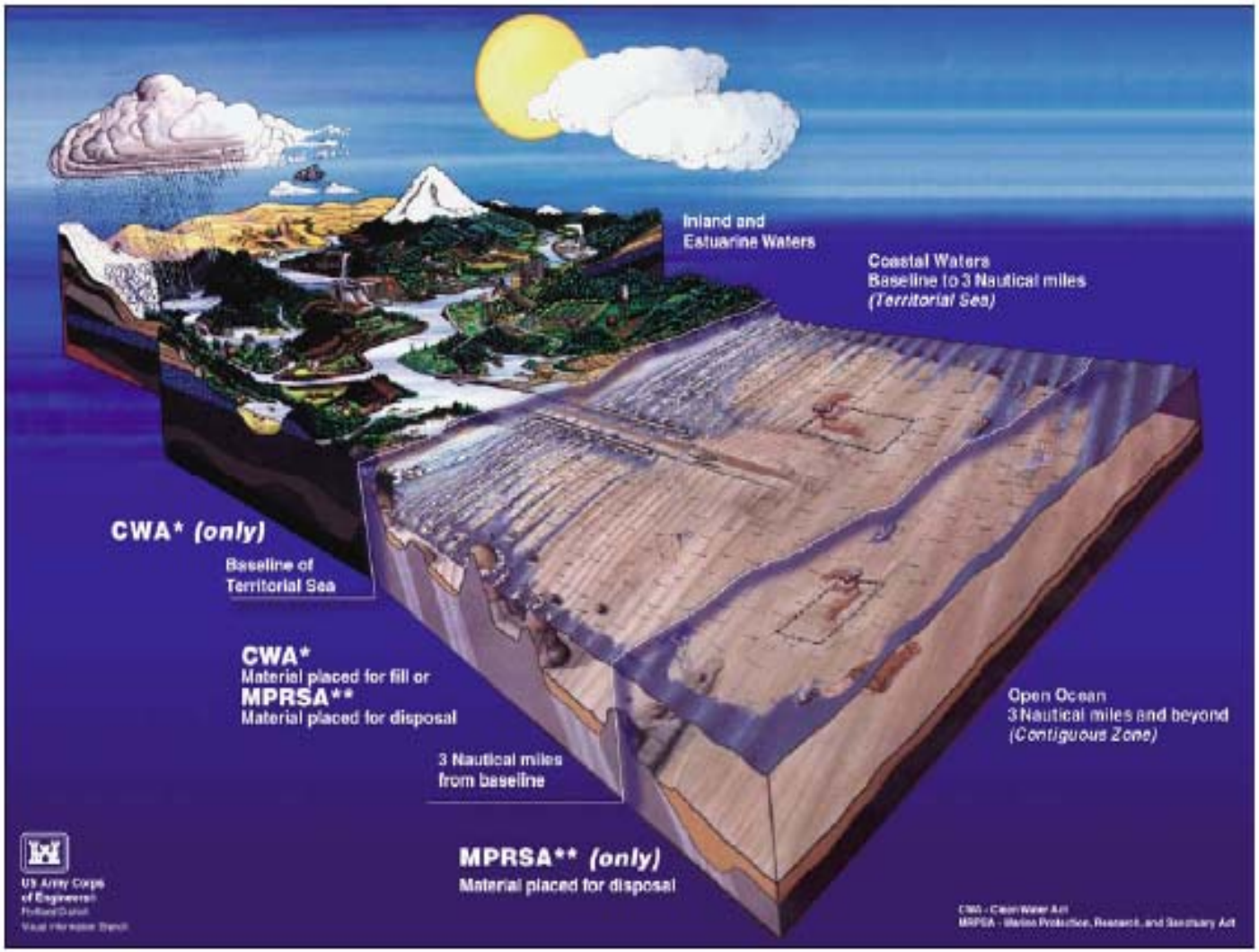
Regulation # DEM-OWR-DR-02-03

Regulatory Authority and BU

Disposal in coastal waters – MPRSA

Fill or discharge to coastal & inland waters – CWA

Upland – CWA if return flow and NEPA. Some states regulate as solid waste



Summary of Current Guidance

Suggested development of a Beneficial Uses Testing Manual

Testing Guidance for Dredged Material

- **Evaluation of Dredged Material Proposed for Ocean Disposal *(Ocean Testing Manual)* – *Evaluates suitability - BU***
  - **Sec. 103, Marine Protection, Research and Sanctuaries Act (1972)**
  - **Marine Water Quality Criteria**
  - **Biological Exposure/Effects**

- **Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual *(Inland Testing Manual)* – *Evaluates suitability - BU***
  - **Section 404 Clean Water Act (1977)**
  - **Fresh Water Quality Criteria**
  - **Biological Exposure/Effects**

- **Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual *(Upland Testing Manual)* - *Evaluates management needs***
  - **National Environmental Policy Act and CWA**
  - **Bioavailability and Transport of Contaminants**

Critical Need - Reclaim CDF Capacity

Issues

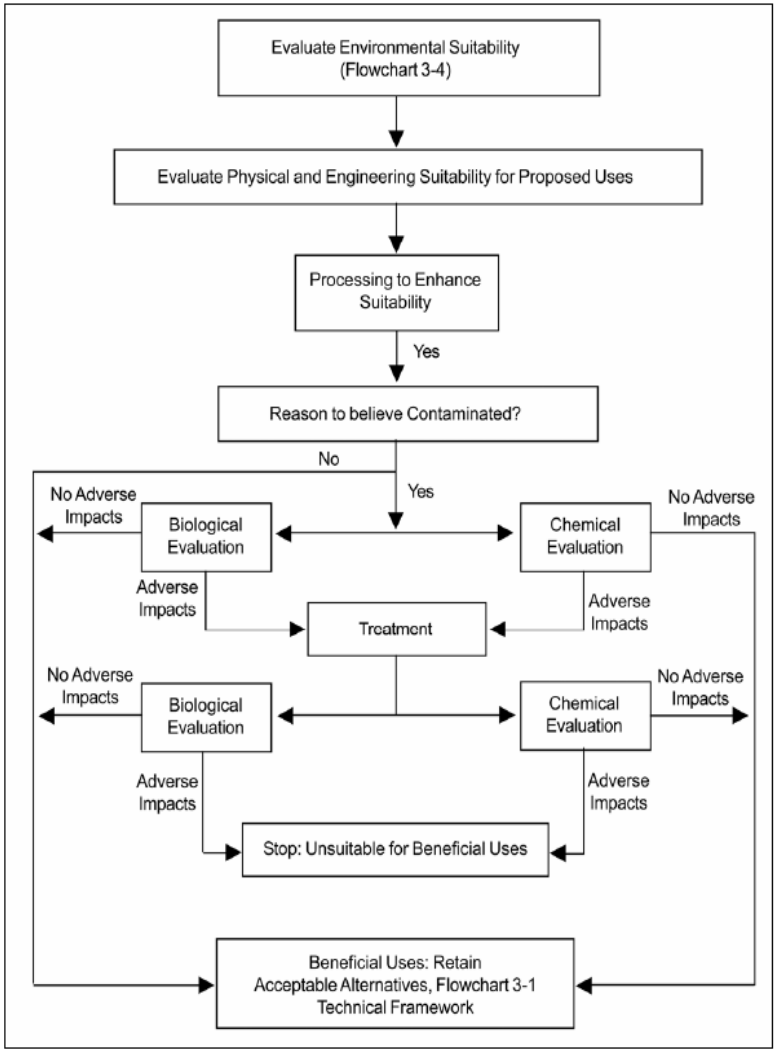
- **Material in CDFs assumed not suitable for open water disposal**
  - **Assumed to be contaminated**
- **Material from mixed dredging projects**
  - **Sampling and characterization – segregate, blend?**
- **Testing and evaluation procedures are not well established for upland beneficial uses - many**
  - **State regulatory requirements vary widely**
- **Testing guidance needed for Beneficial Uses**

Evaluating Terrestrial Beneficial Uses

- **Issues**
  - **Terrestrial use of dredged material complex**
  - **Risks may change depending on site selection**
    - **Wetland, upland**
  - **Risks affected by type of site use, potential receptors**
    - **Habitat, agronomic, recreational, industrial**
  - **Dredged material not regulated under MPRSA or CWA may be subject to Solid Waste Rules or other requirements**
    - **State requirements vary**
    - **Criteria mostly based on human health risks or groundwater protection**

Considerations for Suitability

- Considers processing to enhance physical suitability
  - Separation, washing, etc
- Considers dredged material as a component of a final product
  - May be blended with other materials to enhance performance
- Considers treatment options to eliminate or reduce risks
  - Chemical or biological treatment
- Final product subject to testing



Physical Suitability

Table 2. Suitability of dredged material for various BUs.

	Dredged Material Sediment Type				
Beneficial Use Options	**Rock**	**Gravel & Sand**	**Consolidated Clay**	**Silt/Soft Clay**	**Mixture**
Engineered Uses					
Land creation	X	X	X	X	X
Land improvement	X	X	X	X	X
Berm creation	X	X	X		X
Shore protection	X	X	X		
Replacement fill	X	X			X
Beach nourishment		X			
Capping		X	X		X
Agricultural/Product Uses					
Construction materials	X	X	X	X	X
Aquaculture			X	X	X
Topsoil				X	X
Environmental Enhancements					
Wildlife habitats	X	X	X	X	X
Fisheries improvement	X	X	X	X	X
Wetland restoration			X	X	X

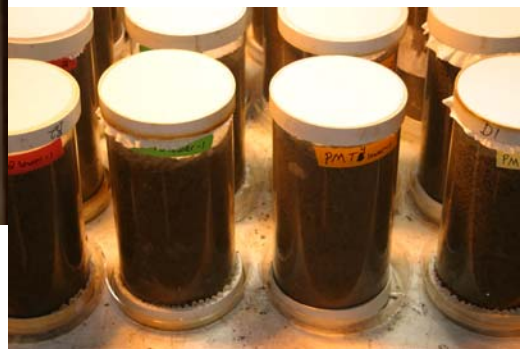
Source: http://el.erdc.usace.army.mil/dots/budm/types.html#mixture.

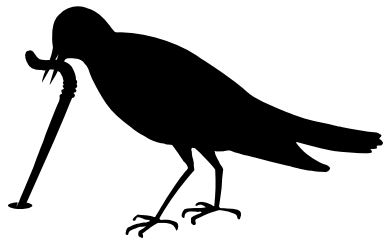
Physical Suitability

- **Issues**
  - **Considerations in habitat restoration, enhancement**
    - **Similar physical characteristics (particle size, geologic origin, salinity, etc)**
    - **Transport of invasive or detrimental biological components**

A concern as distance from source to use increases

Environmental Suitability





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Environmental Suitability

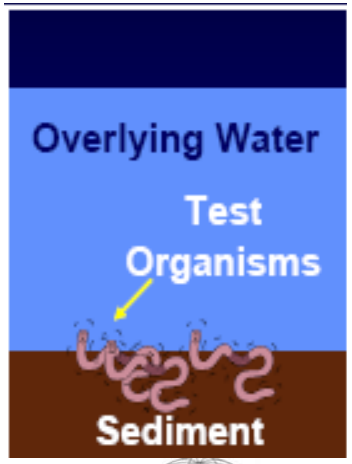
Contaminant pathways

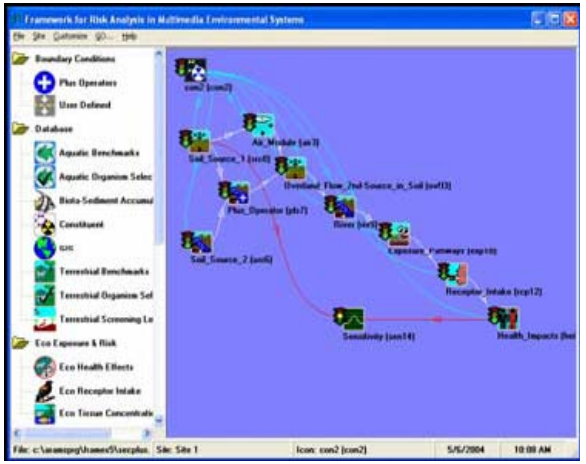
- **Soil**
  - **Direct contact, ingestion**
- **Water**
  - Water quality criteria (water column, effluent, surface runoff, leachate)
- **Plant**
  - Wetland and upland toxicity and bioaccumulation
- **Animal**
  - Water column toxicity / Benthic bioaccumulation
  - Soil invertebrate toxicity and bioaccumulation
- **Air**
  - Volatile emissions
  - Dust

Consider contaminant degradation/sequestering

Tiered Testing Approach

- Tier I – Existing info, material determined inert
- Tier II – Compare DM chemistry to screening level
  - Pass: no further contaminant evaluation
  - Fail: Further evaluation
- Tier III - Physical and biological tests for bioavailability
  - Biological exposure for bioavailability or site specific use
- Tier IV - Risk assessment





Comparison of State Criteria for Beneficial Use of Dredged Material Industrial Use

Contaminant	IL[a]	IN[b]	MI	MN[c]	NY[d]	OH[e]	PA	WI[f]
Arsenic	0.05*	20		25	14.5	41		0.042
Lead	0.0075*	230		700	150	300		50
Zinc	7,500	10000		70000	2,480	2,800		4,700
PCBs	1	5.3		8	10	--		--
Benzo(a)pyrene	0.8	1.5		4	0.061	--		0.0088
Benzene	0.03	0.67		4	0.06	--		--
Criteria Source	Cleanup – industrial	Cleanup – Industrial		Cleanup – Industrial	Reuse – Specific	Sludge rules		Reuse – general

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 industrial tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for an industrial soil.[74]

c: Minnesota criteria are based on SRV Tier 2 chronic industrial standards.[96]

d: New York metal criteria are based on Suggested Metals Limits for General Reuse Options,[97] category A; surficial use of contaminated material prohibited. Organic criteria based on DER TAGM 4046.[98]

e: Ohio values are based on monthly average limits contained in Ohio's sewage sludge rules.[22] There are additional limits for a single application and a total lifetime loading limit.

f: Wisconsin criteria are based on NR 538, Appendix 1, Table 1B. These criteria qualify the material as Category 1, allowing its application in nearly all beneficial uses. Less restrictive criteria may be applicable following evaluation by the WDNR.

Comparison of State Criteria for Beneficial Use of Dredged Material Compost or Topsoil, Unrestricted Use

Contaminant	IL[a]	IN[b]	MI[c]	MN[d]	NY[e]	OH[f]	PA	WI[g]
Arsenic	*0.05**	*3.9*	7.6	*10*	7.5	*41*		*0.042*
Lead	*0.0075**	*81*	400	*400*	Background	*300*		*50*
Zinc	*7,500*	*10000*	65	*1,242***	Background	*2,800*		*4,700*
PCBs	*1*	*1.8*	1.2	*1.2*	*1.0*	--		--
Benzo(a)pyrene	*0.09*	*0.5*	2	*1.0***	*0.061*	--		*0.0088*
Benzene	*0.03*	*0.034*	0.1	*0.034***	*0.06*	--		--
Criteria Source	Cleanup – Residential	Cleanup – Residential	Use-specific regulation	Cleanup – Residential	Specific reuse and general cleanup	Sludge rules		Reuse – General

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 residential tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for a residential soil.[74]

c: Michigan compost criteria are based on draft rules[183] for Part 115.[13]

d: Minnesota criteria are based on SRV Tier 2 chronic residential standards,[96] except for **, which are from SLV Tier 1 standards[194].

e: New York criteria are based on DER TAGM.[98] Background can be a site or regional background, as appropriate. Compost values in 6 NYCRR Part 360-5[16] may apply if the dredged material is used as a limited component.

f: Ohio values are based on monthly average limits contained in Ohio's sewage sludge rules[22]. There are additional limits for a single application and a total lifetime loading limit.

g: Wisconsin criteria are based on NR 538, Appendix 1, Table 1B. These criteria qualify the material as Category 1, allowing its application in nearly all beneficial uses.

USEPA Ecological Soil Screening Levels (Eco-SSLs)

Derived from standardized exposure/toxicity effects

Contaminant	Mammalian herbivore (vole)	Mammalian ground insectivore (shrew)	Mammalian carnivore (weasel)	Avian	Avian herbivore (dove)	Avian ground insectivore (woodcock)	Avian carnivore (hawk)
Antimony	10	0.27	4.9	NA	NA	NA	NA
Arsenic	170	46	170	43	61	43	1100
Barium	3200	2000	9100	NA	NA	NA	NA
Berryllium	21	34	90	NA	NA	NA	NA
Cadmium	73	0.36	84	0.77	28	0.77	630
Chromium	Cr III - 380 Cr VI - 1400	Cr III - 34 Cr VI - 130	Cr III - 180 Cr VI - 870	Cr III - 26 Cr VI - NA	78	26	780
Cobalt	2100	230	470	120	270	120	1300
Copper	1100	49	560	28	76	28	1600
Lead	1200	56	460	11	46	11	510
Manganese	5300	4000	6200	4300	4300	4300	65000
Nickel	340	NA	130	210	210	NA	2800
Selenium	2.7	0.63	2.8	1.2	2.2	1.2	83
Silver	1500	14	990	4.2	69	4.2	930
Vanadium	1300	280	580	7.8	13	7.8	140
Zinc	6800	79	10000	46	950	46	30000

Soil Chemistry:
Comparison of metals in dredged material to screening levels, mg kg^{-1}.

Metals	Island 18 CDF	10-B CDF	Lorain CDF	Ohio Criteria For Reuse	WI NR 538	Eco-SSL Plant to Avian	Eco-SSL Worm to Avian	Eco-SSL Worm to Mammal	Eco-SSL Plant to Mammal
As	13[1]	13	**12**	**12**	**0.042**	**61**	**43**	**46**	**170**
Cd	**2.6**	**2.6**	**5.4**	**10**	**7.8**	**28**	**0.77**	**0.36**	**73**
Cr	**20**	**20**	**33**	**218**	**14.5**	**78**	**26**	**34**	**380**
Cu	**39**	**39**	**47**	**1127**	**NA**	**76**	**28**	**49**	**1100**
Hg	**0.071**	**0.071**	**0.095**	**6.6**	**4.7**	**NA**	**NA**	**NA**	**NA**
Ni	**28**	**28**	**37**	**50**	**310**	**210**	**NA**	**NA**	**340**
Pb	**34**	**34**	**39**	**70**	**50**	**46**	**11**	**56**	**1200**
Ag	**0.7**	**<1**	**0.3**	**NA**	**9400**	**69**	**4.2**	**14**	**1500**
Zn	**186**	**186**	**189**	**200**	**4700**	**950**	**46**	**79**	**6800**

Plant Bioassays to Determine Bioavailability of Contaminants

Surrogate Receptor = Vole

Exposed Plant = Yellow Nutsedge

Soil - Plant - Mammal

Determine Acceptable Plant Conc.

- *Cplant* = (*TRV* x *BW*)/(*F* x *CR*)
- Where: *TRV* = Toxicity Reference Value (mg dry weight/kg body weight per day), *BW* = the body weight of target receptor (kg), *F* = the fraction of vegetation consumed, *CR* = the consumption rate (kg dry weight plant per day)

- The toxicity reference value (TRV) provided for the surrogate receptor group (mammalian herbivore) for cadmium is 0.770 mg dry weight per kg of body weight per day (http://www.epa.gov/ecotox/ecossl/pdf/eco-ssl_cadmium.pdf). Using the surrogate species (vole) with a body weight of 25 g (0.025 kg) and assuming the diet is 100% plant tissue at a rate of 0.0875 kg plant/kg body weight (0.002188 kg/day) then we have the following:

- *Solving for Cd:*
  - ***Cplant* = (0.770 mg kg-1 x 0.025 kg) / (1 x 0.002188 kg) = 8.8 mg kg^{-1}**

Comparison of acceptable plant concentrations to dredged material plant concentrations.

CONTAMINANT	FOOD INGESTION RATE (KG DW/KG BW/D)	TOXICITY REFERENCE VALUE (MG DW/KG BW/D)	ACCEPTABLE PLANT CONC. MG/KG	LORAIN CDF	DIKE 10-B CDF	ISLAND 18 CDF
	Plant to Mammalian	Plant to Mammalian	Plant to Mammalian			
Arsenic	0.0875	1.04	11.8	0.543	<0.05	<0.5
Cadmium	0.0875	0.770	8.8	6.797	1.29	10.267*
Chromium (III)	0.0875	2.40	27.3	0.823	0.59	0.65
Copper	0.0875	5.82	66.1	10.057	8.13	11.75
Lead	0.0875	4.70	53.4	10.617	3.64	4.217
Nickel	0.0875	1.70	19.4	1.54	1.04	1.71
Silver	0.0875	6.02	68.8	<0.50	<0.50	<0.517

*Island 18 dredged material = 2.6 mg kg^{-1}, Eco-SSL =73 mg kg-1.

Sediment/Soil characteristics and plant available cadmium.

Location	Soil pH	Clay, %	Soil Cd[3]	Plant Cd[3]	BAF
Island 18	**7.5**	**38.3**	**2.6**	**10.267**	**3.95**
Toledo Reference	**6.4**	**42.5**	**2.2**	**1.450**	**0.66**
Dike 10-B	**6.8**	**9.2**	**2.6**	**1.29**	**0.50**
Cleveland Reference	**5.7**	**7.5**	**0.99**	**3.67**	**3.71**
Lorain CDF	**7.2**	**21.7**	**5.4**	**6.797**	**1.26**
Lorain Reference	**6.9**	**15.8**	**3.8**	**4.870**	**1.28**
Detroit River	**8.1**	**27.5**	**7.7**	**1.17**	**0.15**
Michigan City	**7.4**	**12.5**	**6.2**	**17.64**	**2.85**
Michigan City	**7.2**	**9.6**	**35.9**	**7.8**	**0.22**
Indiana Harbor	**7.6**	**5**	**16**	**6.34**	**0.40**
Indiana Harbor	**6.7**	**14.6**	**45.6**	**1.27**	**0.03**
Milwaukee Harbor	**7.7**	**25.9**	**7.8**	**1.84**	**0.24**
Menominee River	**6.4**	**8**	**0.1**	**1.44**	**14.40**
Menominee River	**7**	**6.5**	**9.3**	**9.57**	**1.03**

Summary

- Any dredged material can be used beneficially - $$ is the only limitation
- Environmental restoration offers greatest widespread use in volume
- Research continues to develop defensible screening criteria and more cost-effective testing procedures
- Potential risk associated with low to moderate contaminant levels best addressed by biological exposure testing – site/use specific
- Beneficial use is still evolving

Beneficial Uses of Dredged Material

U.S Army Corps of Engineers | Engineer Research and Development Center | U.S. Environmental Protection Agency

Introduction

Engineered Uses

Environmental Enhancement

Agricultural/ Product Uses

Most dredged material can be a valuable resource and should be considered for beneficial uses. The purpose of this site is to demonstrate potential beneficial uses of dredged material by presenting existing case studies as examples. Category descriptions, procedural outlines, and reference resources are also provided.

This site is a collaborative effort between
U.S. Environmental Protection Agency and U.S. Army Corps of Engineers

Web Resources

- **Dredging Operations Technical Support**
  http://el.erdc.usace.army.mil/dots/dots.html

- **Beneficial Uses of Dredged Material**
  http://el.erdc.usace.army.mil/dots/budm/budm.cfm

- **Dredging Operations and Environmental Research Program**
  http://el.erdc.usace.army.mil/dots/doer/doer.html