

# Presentation To Inland Waterways Users Board

## OLMSTED LOCKS & DAM – Construction Status, L/Ds 52/53 Risk Assessment, PACR, Construction Methodology, Funding Alternatives

**MR. RICHARD HANCOCK, P.E.**

**DIRECTOR, Regional Business Directorate**

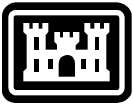
**Great Lakes & Ohio River Division**

**19 Dec 2012**



**US Army Corps of Engineers**  
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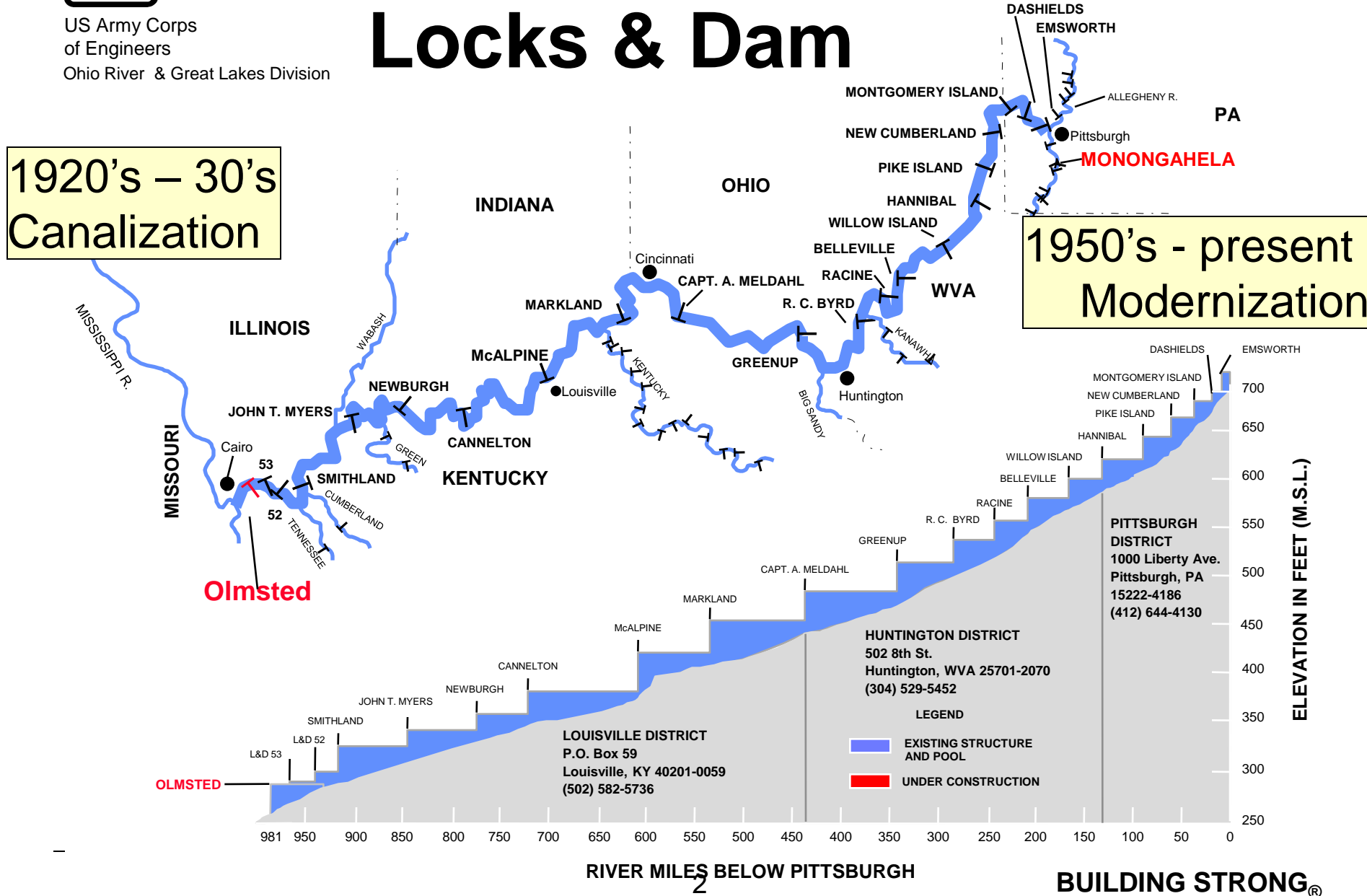


US Army Corps  
of Engineers  
Ohio River & Great Lakes Division

# Ohio River Main Stem Locks & Dam

1920's - 30's  
Canalization

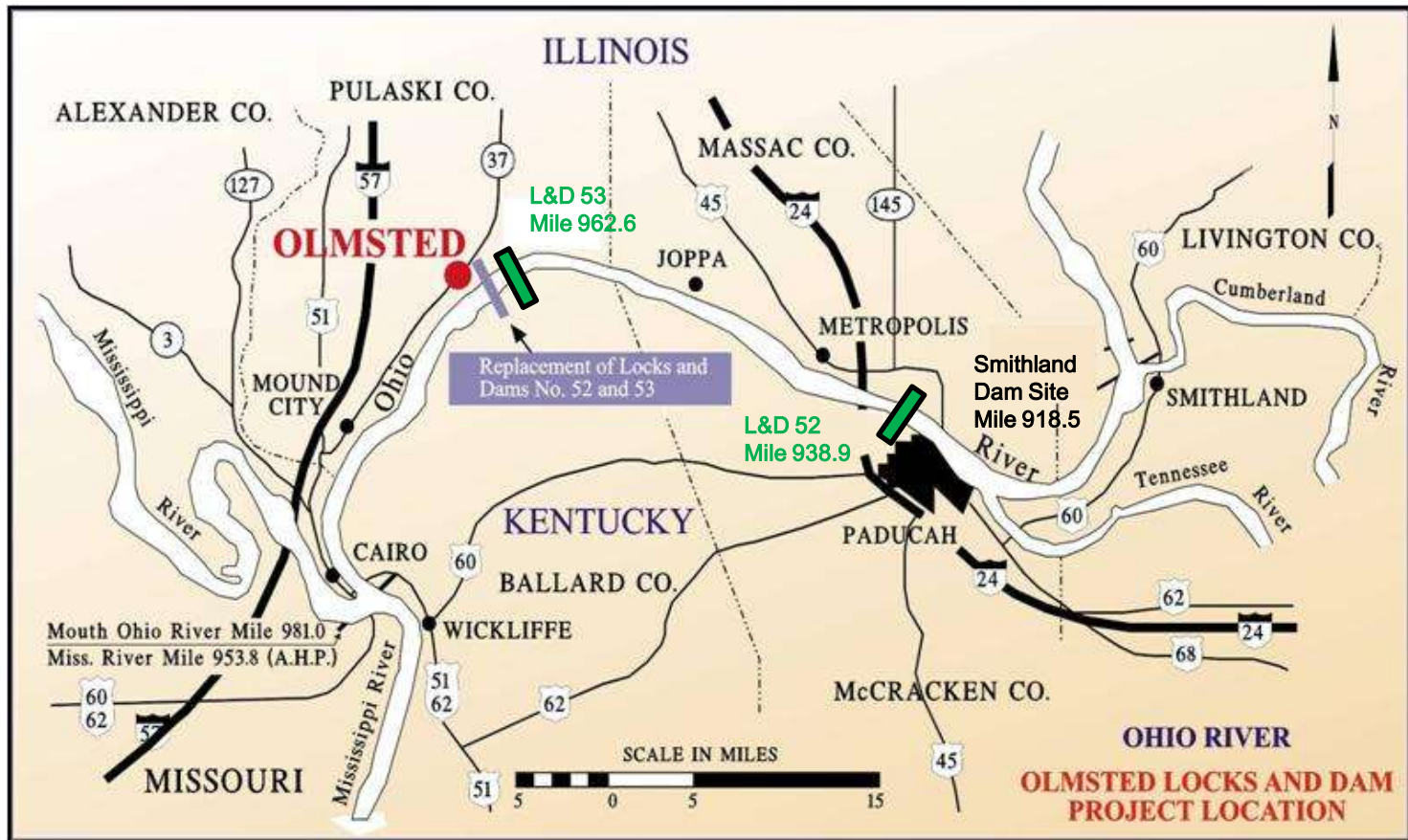
1950's - present  
Modernization



RIVER MILES BELOW PITTSBURGH

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# Olmsted Locks & Dam Project



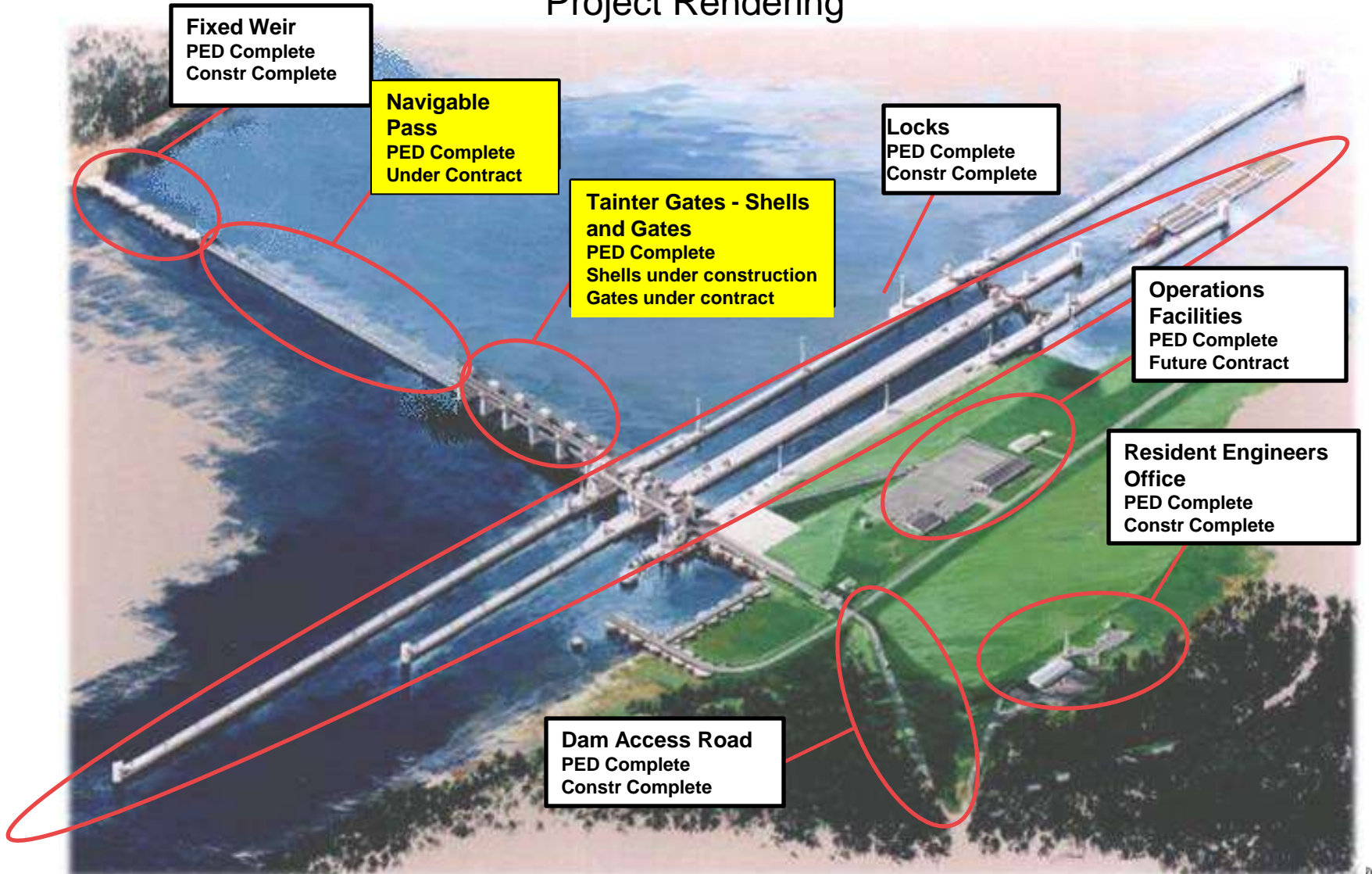
- 1928/1929: L&D 52 & 53 in service
- 1949-1957: Miscellaneous studies
- 1969: L&D 52 1,200-ft Chamber operational (temporary chamber)
- 1977: Recon Report for Major Rehab L&D 52 & 53
- 1980: L&D 53 1,200-ft Chamber operational (temporary chamber)
- 1985: Feasibility Report
- 1988: Authorization



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# Olmsted Locks & Dam Project

## Project Rendering



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# 29 Aug IWUB Actions

1. Endorsed increase to 902 limit to \$2.918 B
2. Revalidated support of Capital Projects Business Plan priorities - Olmsted as the Highest priority project in the IMTS
3. Revalidated support for funding the highest priorities efficiently
4. Acknowledged the Corps as the experts to make ITW vs. ITD decision



# Future IWUB Actions

1. Help LRD prioritize our O&M investments to pay for addressing failure modes on L/D 52/53 (what will not get done?)
2. Develop Long Term sustainable strategy for the IWTF
3. Discussion/Coordination of Slow down plan for the 902 limit



# Construction Status

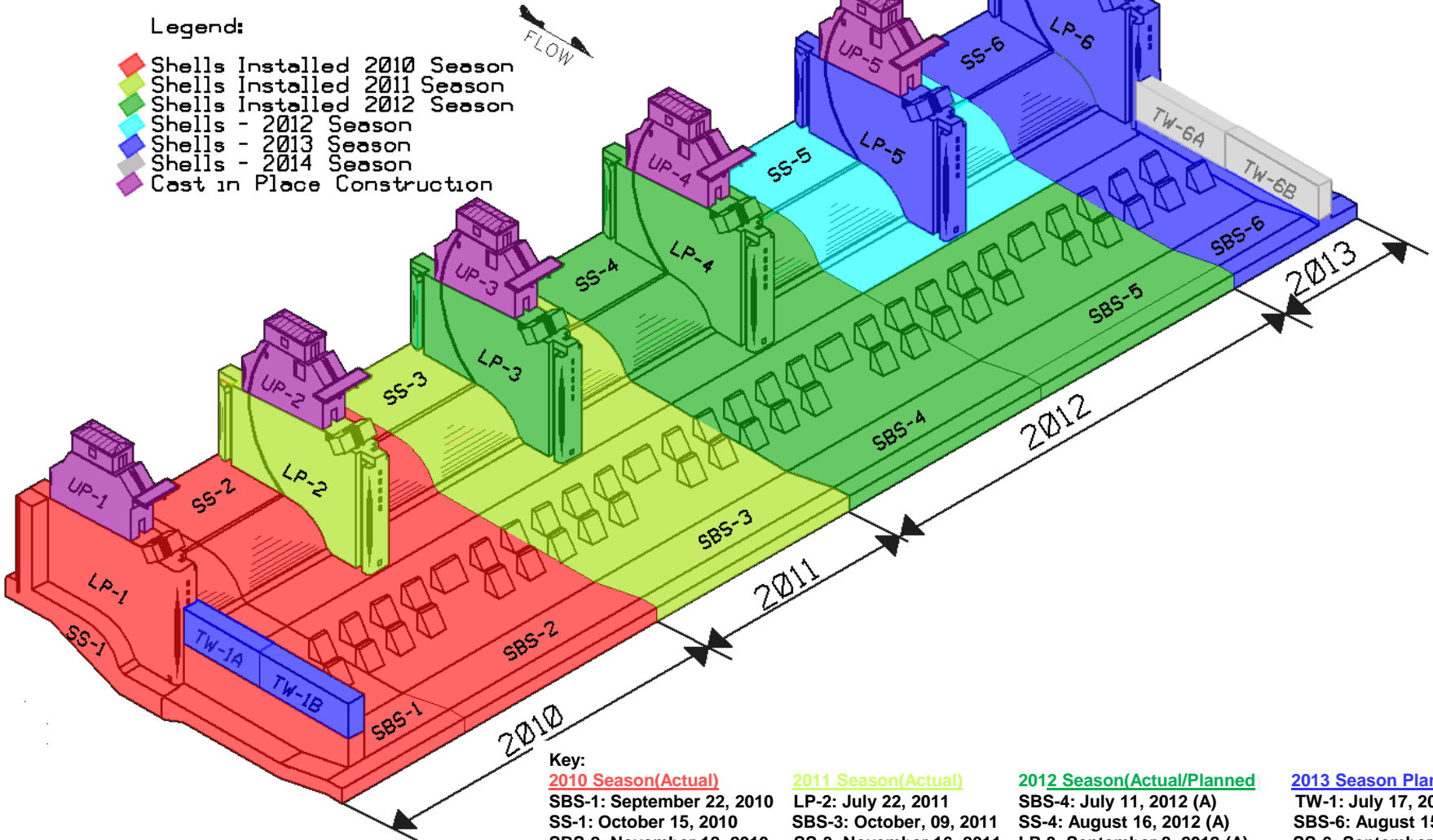
- Constructing Tainter Gate section of Dam. Components include 18 concrete shells, 5 gates.
- Total of 8 shells placed in 2010 and 2011.
- Four shells scheduled for 2012. Ahead of schedule. Five placed to date in 2012 (SBS4, SS4, LP3, LP4, SBS5).
- Stretch goal - place 6 shells in the 2012 construction season, on schedule.
- SS5 scheduled for 7 Jan 2013.



# Precast Yard / Shell Work

## Legend:

- Shells Installed 2010 Season
- Shells Installed 2011 Season
- Shells Installed 2012 Season
- Shells - 2012 Season
- Shells - 2013 Season
- Shells - 2014 Season
- Cast in Place Construction



### Key:

#### 2010 Season(Actual)

- SBS-1: September 22, 2010
- SS-1: October 15, 2010
- SBS-2: November 18, 2010
- SS-2: January 02, 2011
- LP-1: February 16, 2011

#### 2011 Season(Actual)

- LP-2: July 22, 2011
- SBS-3: October, 09, 2011
- SS-3: November 16, 2011

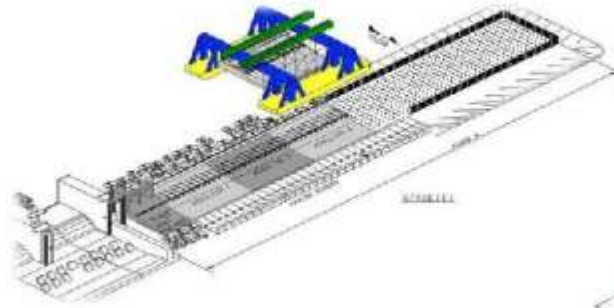
#### 2012 Season(Actual/Planned)

- SBS-4: July 11, 2012 (A)
- SS-4: August 16, 2012 (A)
- LP-3: September 8, 2012 (A)
- LP-4: September 16, 2012 (A)
- SBS-5: November 17, 2012 (A)
- SS-5: January 7, 2013

#### 2013 Season Planned

- TW-1: July 17, 2013
- SBS-6: August 15, 2013
- SS-6: September 17, 2013
- LP-5: October 11, 2013
- LP-6: October 24, 2013
- TW-6: November 7, 2013

# Navigable Pass Shell Installation using Cat Barge



FLOW

LEFT BOAT ABUTMENT

NAVIGABLE PASS SHELLS (TYPICAL)

RIGHT BOAT ABUTMENT

PAYING BLOCKS

**Key:**

2014 Season (Planned)

- RBA: September 17, 2014
- PB-1: August 25, 2014
- NP-1: October 11, 2014
- PB-2: September 8, 2014
- NP-2: November 8, 2014

2015 Season (Planned)

- PB-3: September 17, 2015
- NP-3: October 16, 2015
- PB-4: September 25, 2015
- NP-4: November 14, 2015
- PB-5: October 3, 2015
- NP-5: December 14, 2015

2016 Season (Planned)

- PB-6: September 16, 2016
- NP-6: October 18, 2016
- PB-7: September 24, 2016
- NP-7: November 17, 2016
- PB-8: October 04, 2016
- NP-8: December 18, 2016

2017 Season Planned

- PB-9: October 6, 2017
- NP-9: November 5, 2017
- PB-10: October 16, 2017
- NP-10: December 5, 2017
- PB-11: October 24, 2017
- NP-11: January 4, 2018

2018 Season (Planned)

- PB-12: June 21, 2018
- NP-12: August 27, 2018
- NP-12A: September 18, 2018
- LBA-1:
- LBA-2:
- LBA-3:

# Duration of Shell Movement

- It takes approximately a 3 week duration to:
  - ▶ Set shell onto the Cradle
  - ▶ Lift with the Cat Barge
  - ▶ Haul and Set at It's Final Position
  - ▶ Fill with Tremie Concrete
  - ▶ Return to Pick another Shell



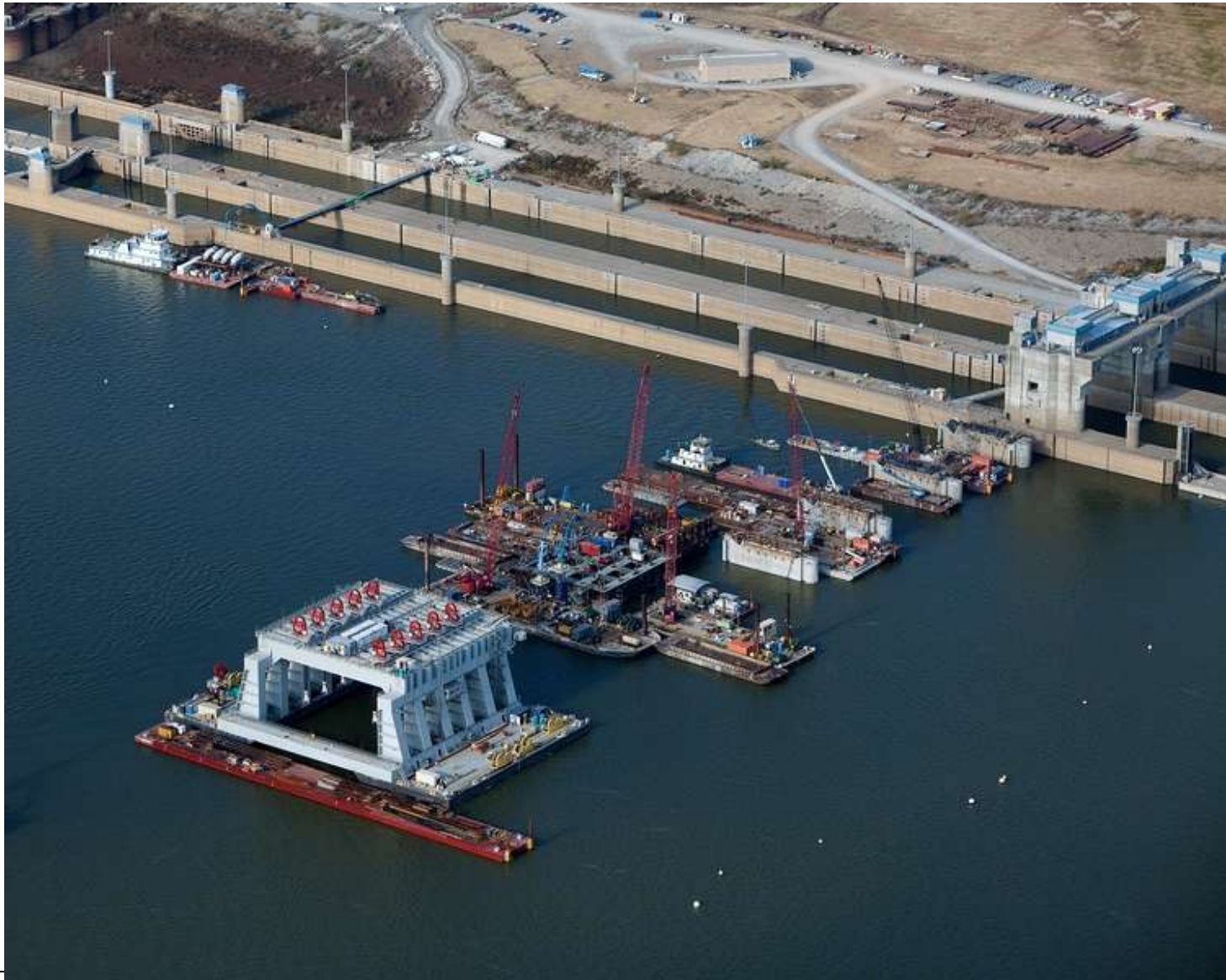
# November 2012 Status



# December 2012 Status



# SBS- 5 set



# Pier Infill & Trunnion Anchorage



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# SS-5 Outfitting



# Casting Yard Operations



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# L/Ds 52/53 Qualitative Risk Assessment - Summary

- A Risk Assessment was performed to determine credible Failure Modes (FMs) and Rough Order of Magnitude (ROM) cost estimates to address the credible (or likely) FMs in a 10, 20, and 30 year timeframe.
- The team defined “Failure” as an event that caused delays to navigation of more than 24 hours, loss of 2(+) feet of pool, or loss of life.
- 39 Potential failure modes were identified based on expert judgment and review of the original feasibility investigation, Operational Condition Assessment inspections, Periodic Inspection Reports, SPRA inspections, etc...



# L/Ds 52/53 Qualitative Risk Assessment - Summary (cont)

- Of the 39 potential FMs, 11 were identified as significant for L/D 52 and 12 for L/D 53 in a 10 year period.
- A ROM estimate was prepared to “band-aide” the FMs. The technical team was very clear that these measures do not “correct” the issue, just mitigate risk.
- The cost to proactively address these FMs in a 10 year period is ~\$96 million (\$53 m for 52 and \$43 m for 53). We would like to perform the work to address this right now but funding is not available. Therefore, the work will be planned/executed over the next 5 or 6 years.



# Locks & Dams 52 & 53

## Qualitative Risk Assessment

- Examples of L&D 52/53 Credible Failure Modes
  - Failure of pile foundation for dam due to earthquake
  - Failure of wickets due to barge impact
  - Failure of pile foundation for dam due to piping
  - Failure of miter gate anchorage
  - Cell failure due to loss of structural integrity
  - Failure of wicket dam causing loss of maneuver boat while dam is being set



# Locks & Dams 52 & 53

## Qualitative Risk Assessment

- L&D 52/53 Credible and Significant Failure Modes
  - Considering things such as available workarounds, impacts to navigation, impacts to the community, cost to repair and life safety, the team applied engineering judgment and trimmed the Credible list down to a list of Significant failure modes.
  - The Significant failure modes were those considered necessary to address in a repair strategy to allow for continued operation of the locks and dam for the next 10 yrs.
  - The team identified 11 Significant failure modes for L&D 52 and 12 for L&D 53
  - The team determined best repair alternatives, repair costs and impacts to navigation in terms of days of lock closure



# Locks & Dams 52 & 53

## Qualitative Risk Assessment

### L&D 52 REPAIR STRATEGY 10 YEAR TIME PERIOD

PFM#	PFM Description	Repair Cost	Impacts to Nav (days) Scheduled
22/28/31	Wicket Failure	\$10,400,000	0
29	Wicket Embedded Hardware	\$13,000,000	0
1/3/5	Chamber Cell Failure	\$11,000,000	14 day closure
6	Miter Gate Anchorage	\$4,000,000	12 day closure
9A	Failure of Pile Foundation (Scour)	\$2,000,000	0
9B	Failure of Pile Foundation (Piping)	\$5,000,000	0
25	Guide Wall Failure	\$8,000,000	Three 7 day closures



# Locks & Dams 52 & 53

## Qualitative Risk Assessment

### L&D 53 REPAIR STRATEGY 10 YEAR TIME PERIOD

PFM#	PFM Description	Repair Cost	Impacts to Nav (days) Scheduled
22/28/31	Wicket Failure	\$14,000,000	0
29	Wicket Embedded Hardware	\$10,000,000	0
1/3/5	Chamber Cell Failure	\$5,000,000	14 day closure
6	Miter Gate Anchorage	\$4,000,000	12 day closure
9A	Failure of Pile Foundation (Scour)	\$2,000,000	0
9B	Failure of Pile Foundation (Piping)	\$5,000,000	0
25	Guide Wall Failure	\$3,000,000	7 day closure
26	Guide Wall Beam Failure	\$250,000	3 day closure



# Locks & Dams 52 & 53

## Qualitative Risk Assessment

### ■ KEY POINTS / SUMMARY

- Both projects contain numerous critical components that are likely to fail without investment beyond normal O&M.
- Eleven failure modes at L&D 52 and twelve at L&D 53 were identified that represent significant risk to property and economic benefit.
- Some failure modes represent risk to life and limb.
- The assessment team has laid out a repair strategy that if implemented should allow for continued operation.
- Current conditions represent a high level of risk.
- From an overall project standpoint, the investment strategy will not appreciably reduce the level of risk.



# Locks & Dams 52 & 53

## Qualitative Risk Assessment

- KEY POINTS / SUMMARY (cont)
  - LRD recommends that proactive measures be taken to address the credible and significant failure modes at L/D 52/53 over the next 10 year period. Cost is ~\$96 million. QUESTION: What options are available to get these additional funds? Project funds from Olmsted cannot be used and our O&M funds are already very limited.
  - Will discuss and coordinate with the IWUB to prioritize what maintenance does not get accomplished elsewhere in LRD. We will schedule a meeting in Jan 2013 with industry representatives to discuss our maintenance plan.



# Post Authorization Change Report (PACR)

- Recommend Authorization Increase to: \$2.918 B
- Current Section 902b Limit: \$1.7 B (will hit in 2<sup>nd</sup> qtr of FY14)
- BCR for authorization at 4% discount rate: 9.9
- BCR for budget development at 7% discount (OMB): 3.7
- Estimated Lock and Dam Operational: FY 2020
- Estimated Dam Construction Complete: FY 2021
- Estimated Project Complete: FY 2024



# PACR Recommendation

- Olmsted is the #1 priority project in the IMTS inventory, producing significantly more benefits than the #2 priority, even if optimistic assumptions are made concerning the reliability of L/Ds 52 and 53.
- A slowdown of Olmsted is being discussed for late in FY13 or early in FY14. QUESTION: What are the chances of getting an authorization increase by mid-year, 2013?



# In-The-Dry Alternative

- Developed design basis for constructing the Olmsted Dam Navigable Pass In-The-Dry
- Utilizes conventional construction techniques within two-phases of cofferdam construction
- Similar but less detailed than a Feasibility Study
- Prepared a cost estimate for the In-The-Dry construction
- Prepared a cost estimate for the current contract with the Navigable Pass work deleted
- Prepared a construction schedule
- Determined economic benefits based on schedule



# Key Assumptions

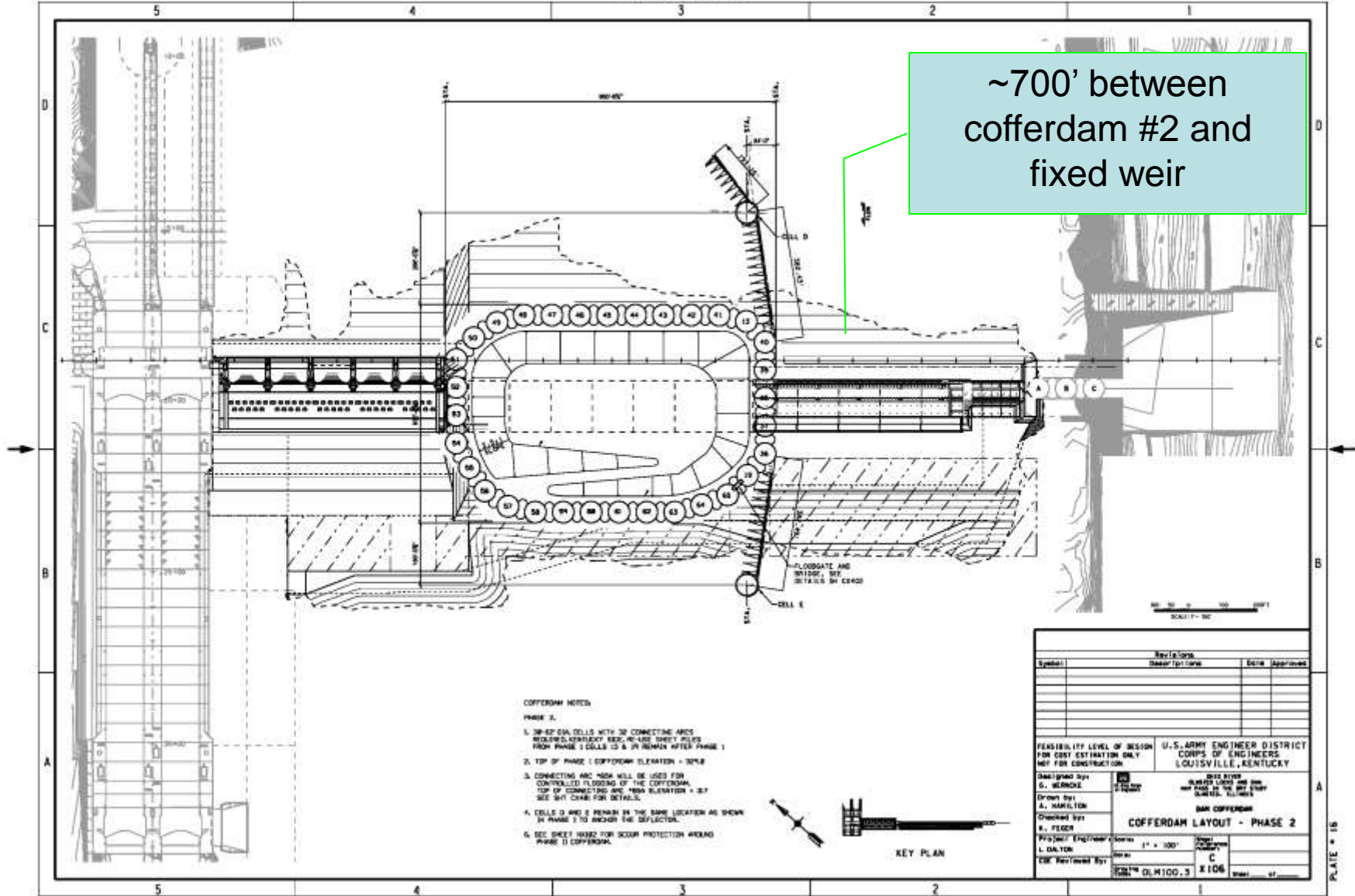
- No significant change in configuration of navigable pass
- Did not constrain the alternative study based on acquisition method or Incremental funding restrictions (this could be a significant issue)
- Assume continued funding at \$150 million per year
- Tainter Gate portion of Dam to be completed In-The-Wet
- Decision on In-The-Wet vs. In-The-Dry approach was made on 19 Nov 2012.





\*\*\* SAFETY PAYS \*\*\*

~700' between  
cofferdam #2 and  
fixed weir



- COFFERDAM NOTES  
PHASE 2.
1. 30'-00" DIA CELLS WITH 32 CONNECTING ARCS  
W/ 100 LB KATYDUR REB. #4 USE SHEET PILES  
FROM PHASE 1 COLLS 13 & 24 REMAIN AFTER PHASE 1
  2. TOP OF PHASE 1 COFFERDAM ELEVATION = 324.8
  3. CONNECTING ARC #25A WILL BE USED FOR  
CONTROLLED FLOODING OF THE COFFERDAM.  
TOP OF CONNECTING ARC #25A ELEVATION = 317  
SEE SHEET COAB FOR DETAILS.
  4. COLLS 13 AND 24 REMAIN IN THE SAME LOCATION AS SHOWN  
IN PHASE 1 TO PROTECT THE DEFLECTOR.
  5. SEE SHEET #025 FOR SCOUR PROTECTION AROUND  
PHASE 1 COFFERDAM.



Revisions		Date		Approved	
Symbol	Description	Date	Approved	Date	Approved

DESIGNED BY G. WENCKE	DATE 2/2/04	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS LOUISVILLE, KENTUCKY
DRAWN BY A. MARLTON	DATE 2/2/04	BAR COFFERDAM
CHECKED BY R. FEIGER	DATE 2/2/04	COFFERDAM LAYOUT - PHASE 2
PROJECT ENGINEER L. DALTON	DATE 2/2/04	SCALE 1" = 100'
DATE REVIEWED BY CSE	DATE 2/2/04	PROJECT NUMBER DLH100.3

\*\*\* SUPPORT VALUE ENGINEERING - IT PAYS \*\*\*

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# ITD Findings and Considerations

- Cost for ITD Construction using traditional cofferdams is estimated to be \$109 M less than ITW costs assuming no delays are experienced due to a supplemental EIS, acquisition changes, or Incremental funding restrictions.
- The Schedule for ITD Construction will cause an estimated delay of 2 years in completion of the Dam portion of the contract and realization of project benefits. The calculated benefits are \$875 million per year (over the 50-year period). However, actual benefits could range from less than \$30 million per year to well over \$1 billion, depending on the actual transportation impacts.



# ITD Findings and Considerations (cont)

- ITW construction did not meet the desired schedule in 2010 or 2011. However, we are ahead of schedule in 2012 and have reason to be confident we can complete the project on or ahead of schedule and within budget. We have incorporated learned lessons into the ITW construction method and have decreased man-hours required to fabricate the shells by over 30% since 2010. The new estimate was risk-based. Shell placement will get easier as we continue across the river. The nav pass shells are in shallower water, are slightly lighter, have smaller dimensions (less impacted by current) and only need to be aligned on one end. Based on these considerations, LRD supports ITW construction.



# ITW vs. ITD Decision

- In a Memo dated 19 Nov 2012, MG Walsh supported LRD's recommendation and directed LRD to proceed with ITW. This recommendation was based on current progress ahead of schedule in 2012, incorporation of lessons learned into the ITW process, reducing risk by eliminating the need and cost to terminate the existing contract and procure a new contract, reducing risk of protest, and an earlier completion schedule.
- Memo also directed monthly IPRs; development of improved Cost and Schedule metrics; completion of an independent review of ITD cost estimate by 30 Jan; by 15 Feb develop a contingency response plan if L/D 52 or 53 fails; and by 15 Feb develop an orderly shutdown plan if 902 isn't increased before limit is reached;





REPLY TO  
ATTENTION OF

DEPARTMENT OF THE ARMY  
U.S. ARMY CORPS OF ENGINEERS  
441 G STREET, NW  
WASHINGTON, DC 20314-1000

CECW-ZA

19 Nov 2012

MEMORANDUM FOR COMMANDER, GREAT LAKES AND OHIO RIVER DIVISION

SUBJECT: Olmsted Locks and Dam Project Direction and Guidance

1. References:

- a. Memorandum, CECW-ZA, 30 January 2012, subject as stated above
- b. Memorandum, CELRD-RB, 18 June 2012, subject as stated above
- c. Memorandum, CECW-ZA, 24 July 2012, subject as stated above
- d. Olmsted Post Authorization Change Report (PACR), November 2011, revised April 2012
- e. Inland Marine Transportation System Capital Project Business Model, 30 April 2010

2. Decision and Rationale: Based on your recommendations and the recommendations of the HQUSACE Chief of Engineering and Construction, I concur that the most appropriate course of action with respect to completing the Olmsted Lock and Dam project is to continue in-the-wet (ITW) construction operations with the existing contract and the existing Cost Plus Award Fee (CPAF) compensation method. My decision is based on the following:

a. The estimated cost savings associated with changing construction of the navigable pass section to the more traditional in-the-dry (ITD) method (\$109M) will be offset by lost benefits due to project delays (\$640M in net annual benefits) and termination costs (as high as \$70M).

b. Any change in the compensation method to the existing CPAF contract would likely be considered a cardinal change requiring sole-source justification at the Secretary of the Army level. A change from CPAF to a Firm Fixed Price (FFP) contract would transfer all of the cost risk to the contractor. This could result in an increase in project cost.

c. A new FFP contract to complete the dam construction may result in a protest further delaying project completion and would require congressional authorization to use a continuing contracts clause or would require full funding.

d. The Inland Waterways Users Board (IWUB) supports completion of Olmsted in the most expeditious manner.



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e. Olmsted benefits significantly outweigh any benefits that would be realized by diversion of funds to other inland navigation projects identified in reference 1.e.

f. The current Cost Performance Index (CPI) for the construction of the dam is favorable. And, the current calculated completion date for the dam, based on the contractor's most recent updated schedule, is well ahead of the risk-adjusted schedule contained in reference 1.d. This current status reflects positive learning from past operations.

g. ITW productivity has improved this construction season compared to last season and is expected to improve further when the less complex navigable pass sections are constructed in shallower water beginning in 2014.

h. CELRD Chief of the Regional Business Directorate will continue to be actively engaged in the oversight of the project.

3. Recommendation and Direction:

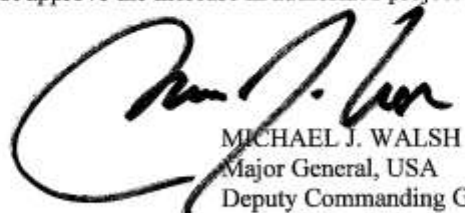
a. By 20 December 2012, in coordination with HQ Engineering and Construction Division, develop budget and schedule performance metrics and standard briefing charts for regular in-progress reviews (IPRs).

b. Schedule and conduct monthly IPRs with HQUSACE senior leaders beginning on 20 December 2012.

c. By 30 January 2013, complete an independent review of your ITD study pursuant to the recommendations of congressional staff. Include the Department of Defense, Cost Assessment and Program Evaluation Office as a participant in the process.

d. By 15 February 2013, develop and submit for my approval, a time-phased contingency plan to maintain or restore navigation on the river in the event of a loss of pool due to catastrophic failure at Locks and Dams 52/53.

e. By 15 February 2013, develop a plan for an orderly shutdown of the Olmsted project in the event congress does not approve the increase in authorized project cost as presented in reference 1.d.



MICHAEL J. WALSH  
Major General, USA  
Deputy Commanding General  
for Civil and Emergency Operations



## BENEFIT BY PROJECT FUNDING SCENARIO Alt. 4C – 6 Year Pause

- **Alternative 4C (pause 6yrs), Option 1 (divert funds to construction) would allow 1 construction project to be completed sooner.**
  - *Lower Monongahela phase 1 advanced 10 yrs from 2027 to 2017 operational (\$187.0M annual benefit).*
  
- **Alternative 4C (pause 6yrs), Option 2 (divert funds to rehabs) would allow 1 construction and 9 major rehab projects to be completed sooner.**
  - *High Island advanced 38 years from 2053 to 2015 operational (\$5.7M annual benefit).*
  - *LD 25 Upper MS rehab advanced 38 yrs from 2053 to 2015 operational (\$9.6M annual benefit).*
  - *Lagrange rehab advanced 49 yrs from 2064 to 2015 operational (\$10.2M annual benefit).*
  - *Lower Monumental rehab advanced 46 yrs from 2065 to 2019 operational (\$3.3M annual benefit).*
  - *O'Brien L/D rehab advanced 50 yrs from 2065 to 2015 operational (\$4.9M annual benefit).*
  - *Greenup L/D rehab advanced 60 yrs from 2079 to 2019 operational (\$19.0M annual benefit).*
  - *Myers rehab advanced 64 yrs from 2081 to 2017 operational (\$9.1M annual benefit).*
  - *Meldahl Dam rehab advanced 60 years from 2079 to 2019 operational (\$19.0M annual benefit)*
  - *Mel Price rehab advanced 69 yrs from 2086 to 2017 operational (\$7.6M annual benefit).*
  - *Marmet dam rehab advanced 71 yrs from 2090 to 2019 operational (\$11.3 annual benefit).*
  
- **Alternative 4C (pause 6yrs), Option 3 (divert to priority list) would allow 1 construction and 5 major rehab projects to be completed sooner.**
  - *Kentucky Lock addition advanced 22 years from 2041 to 2019 operational (\$66.1M annual benefit).*
  - *LD 25 Upper MS rehab advanced 38 yrs from 2053 to 2015 operational (\$9.6M annual benefit).*
  - *Lagrange rehab advanced 50 yrs from 2064 to 2014 operational (\$10.2M annual benefit).*
  - *Lower Monumental rehab advanced 46 yrs from 2065 to 2019 operational (\$3.3M annual benefit).*
  - *O'Brien L/D rehab advanced 50 yrs from 2065 to 2015 operational (\$4.9M annual benefit).*
  - *Myers rehab advanced 64 yrs from 2081 to 2017 operational (\$9.1M annual benefit).*



# Funding Alternatives and Impacts

- In addition to the 4 funding scenarios previously developed, we are developing 3 additional scenarios. One assumes full funding is available for Olmsted. The second is a “slow-down” of Olmsted. The third is proceeding with the current construction schedule and then stopping Olmsted.
- Full Funding Scenario: Removing the funding constraint of \$150 million per year would allow the existing contractor to increase the pace of construction and make more efficient material purchases (such as buying all 5 tainter gates in a single purchase instead of one per year). This would allow for completion of the dam 2 to 3 years earlier than in the current schedule and completion of the total project 4 years earlier (2020). The cost savings would be approximately \$250 million, assuming full funding is received in mid FY13.



# Funding Alternatives and Impacts (cont)

- **Slow-Down Scenario:** In this scenario, construction expenditures in 2013 and 2014 would be reduced to ~\$70 million per year. This would allow us to remain below the 902 limit into FY15 and still maintain capability and progress on the project. The overall completion date would slip depending on when the 902 is increased. However, delays could be mitigated by “banking” the excess IWTF funds and then moving out at a more efficient pace when the 902 limit is increased. Another option is to divert the excess \$80+ million per year to other projects in FY13 and 14. If the 902 limit is not increased by FY15, the contract would be suspended or terminated. A Super Slow-Down variation to this option is also being considered to get thru FY15.



# Funding Alternatives and Impacts (cont)

- Continue At Current Pace And Then Stop Scenario:  
Construction would continue at \$150 million per year in anticipation of an increase to the 902 limit. If no increase is received in FY13, construction activity would stop in the 1<sup>st</sup> quarter of FY14 and the contract would be suspended or terminated. Enough funds would need to be retained to maintain the project in caretaker status until a future date when the project can proceed or a new contract awarded. The PRO of this scenario is no impact to the schedule or cost IF the 902 is increased by the 3<sup>rd</sup> quarter of FY13.
- THIS IS THE SCENARIO WE ARE CURRENTLY IMPLEMENTING.



# IWUB Key Messages

- The benefits of finishing Olmsted are compelling and make it the top priority in the IMTS even if we remove the assumption of a major failure early in the 50 year period for calculation of benefits.
- We need a fix to the IWTF as soon as possible. The current model is not sustainable and projects and national benefits are being impacted right now. A sustainable number for construction and rehabilitation is \$380 million per year per the Capital Projects Business Plan.



# IWUB Key Messages (cont)

- L/Ds 52 and 53 require significant proactive maintenance to address significant credible failure modes in the next 10 years. Our Intent is to address the 10 year failure modes, at a cost of \$96 million, and to finish Olmsted as fast as possible. Funding for these repairs has not be programmed or identified.



# IWUB Key Messages (cont)

- Full funding of Olmsted would save 2 to 3 years and ~\$250 million, if received by mid FY13. This could be done thru creative financing options (such as public-private partnerships) or thru a political fix. In the meantime, we are proceeding with construction in a manner that will complete the project and provide benefits to the nation asap given the current situation.



# Back-Up Slides



# Annual Benefits vs. Net Annual Benefits

- Stream of future benefits/costs discounted to present value, amortized to generate “Annual” estimates
- Discounting approximates “time value” of costs/benefits
  - A dollar today worth more than one 50 years from now
  - Performed using multiple “discount rates”
- Annual Benefits – Annual Costs = Net Annual Benefits

## Cost/Benefit Analysis – 7.0% Discount Rate

Annualized Benefits	
Transportation Benefits	\$823,272,341
Fuel Tax Revenues	\$19,976,006
Less WOPC Normal O&M	\$7,664,548
Less LD 52 Repairs	\$12,291,092
Less LD 53 Repairs	\$11,860,808
Incremental Annual Benefits	\$875,064,795
Annualized Costs	
Construction	\$211,450,732
Interest During Construction	\$19,093,734
Normal O&M	\$3,832,274
Main Chamber Maintenance	\$277,669
Aux Chamber Maintenance	\$314,605
Dam Maintenance	\$60,200
Incremental Annual Costs	\$235,029,214
Net Annual Project Benefits	\$640,035,580
<b>BENEFIT - COST RATIO</b>	<b>3.7</b>



# Benefit/Cost Categories

- Primary benefit categories:
  - Transportation rate savings
  - Locks and Dams 52 and 53 repair avoidance
  - O&M reductions
  - Fuel tax revenues
- Primary cost categories:
  - Construction cost (w/ IDC)
  - Olmsted future maintenance/repair cost



# Computation of Benefits

## Two New Scenarios

- Failure assumptions for L/Ds 52/53 were questioned. Therefore, alternate benefit calculation scenarios with different assumptions for L/Ds 52/53 were developed.
- Slipping the failure assumptions for L/Ds 52/53 in years 2021 thru 2026 by 20 years, and assuming no delays to navigation from 2021 thru 2026, the annual benefits reduce from \$875 million to \$513 million. This produces a BCR of 2.2 (based on total project cost)
- In another scenario, we removed the major failure assumptions in years 2021 thru 2026 completely and annual benefits dropped to \$445 million. This produces a BCR of 1.9 (based on total project cost)



Division	District	Project	Benefits	
			Average Annual	Source
LRD	LRL	Olmsted L/D Construction	\$ 875,064,795	Report
LRD	LRH	Greenup Dam Rehab PED and Const	\$ 18,960,343	Estimated
LRD	LRH	Meldahl Dam Rehab	\$ 18,960,343	Estimated
LRD	LRH	Willow Island Dam Rehab PED and Const	\$ 11,886,264	Estimated
LRD	LRH	Marmet Dam Rehab	\$ 11,344,108	Estimated
LRD	LRL	JT Myers Dam Major Rehab	\$ 9,142,532	Est*
LRD	LRN	Kentucky Lock Addition	\$ 66,057,052	Report
LRD	LRN	Chickamauga Replacement Lock	\$ 93,288,706	Est*
LRD	LRP	Lower Mon 2,3, & 4 Replacement **	\$ 220,032,000	Report
LRD	LRP	Montgomery Major Rehab	\$ 24,887,347	Estimated
MVD	MVN	Inner Harbor Lock Replacement	\$ 160,056,231	Est*
MVD	MVR	Lagrange 1200' Lock Addition	\$ 53,060,000	Report
MVD	MVR	L/D 22 Upper MS 1200' Lock Addition	\$ 45,799,413	Est*
MVD	MVR	Lagrange Major Rehab	\$ 10,178,239	Estimated
MVD	MVR	ILL WW Thomas O'Brien L/D Major Rehab	\$ 4,875,803	Estimated
MVD	MVS	L/D 25 Upper MS 1200' Lock Addition	\$ 54,854,226	Est*
MVD	MVS	L/D 24 Upper MS 1200' Lock Addition	\$ 49,869,093	Est*
MVD	MVS	L/D 25 Upper MS Dam Major Rehab	\$ 9,634,988	Estimated
MVD	MVS	Mel Price Upper MS Major Rehab	\$ 7,596,594	Estimated
NWD	NWW	Lower Monumental Major Rehab	\$ 3,304,068	Est*
SWD	SWG	High Island to Brazos River, TX	\$ 5,666,000	Report
SWD	SWL	No. 2 Lock AR Lock Wall/Bank Slope Rehab	\$ 22,685,480	Estimated

\* An analysis has been completed for this project, however, the benefit estimating procedure (3 x Av. Annual Equivalent Capability Cost) produced a higher value.

\*\* Lower Monongahela replacement benefits are phased.

