

# Dam Safety & Planning: Examples of Collaboration and Lessons Learned

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US Army Corps of Engineers  
**PLANNING SMART**  
**BUILDING STRONG®**



# Topics

- BLUF
- Dam Safety and Planning
- Dam Safety Program
- Lessons Learned from Isabella Dam Safety Modification Study



# BLUF

- Dam Safety Modification Studies and Reports
  - Joint projects and products
  - Six-step planning process
  - SMART Planning concepts
  - Revised ER forthcoming w/additional webinars
  - Developing training in FY14
  - MCX (matrixed) Planner – Jay Aya-ay (LRH)



# Planning and Dam Safety: We're Not So Different

- ER 1110-2-1156
  - ID dam safety issues/opportunities
  - Estimate existing and future without risk conditions
  - Formulate plans
  - Evaluate plans
  - Compare plans
  - Select a plan
- ER 1105-2-100
  - ID problems and opportunities
  - Inventory and Forecast
  - Formulate plans
  - Evaluate plans
  - Compare plans
  - Select a plan



# Planning and Dam Safety: Where We're Different

- Life Safety focus
- Tolerable Risk Guidelines
  - Life Risk (individual and societal)
  - Probability of Failure
  - As low as reasonably practicable (ALARP)
- Risk analysis and how it is used



# Link to Roles and Scope of Work

## What

### HAZARD

(What can cause harm?)

### PERFORMANCE

(How will the system react?)

### EXPOSURE

(Who and What can be harmed?)

### VULNERABILITY

(How susceptible to harm?)

### CONSEQUENCE

(How much harm?)

## Who

H&H, Coastal CoPs, RMC.....

Geotech, Structural, RMC.....

Econ, Enviro, Cultural Resources,  
MMC, ...

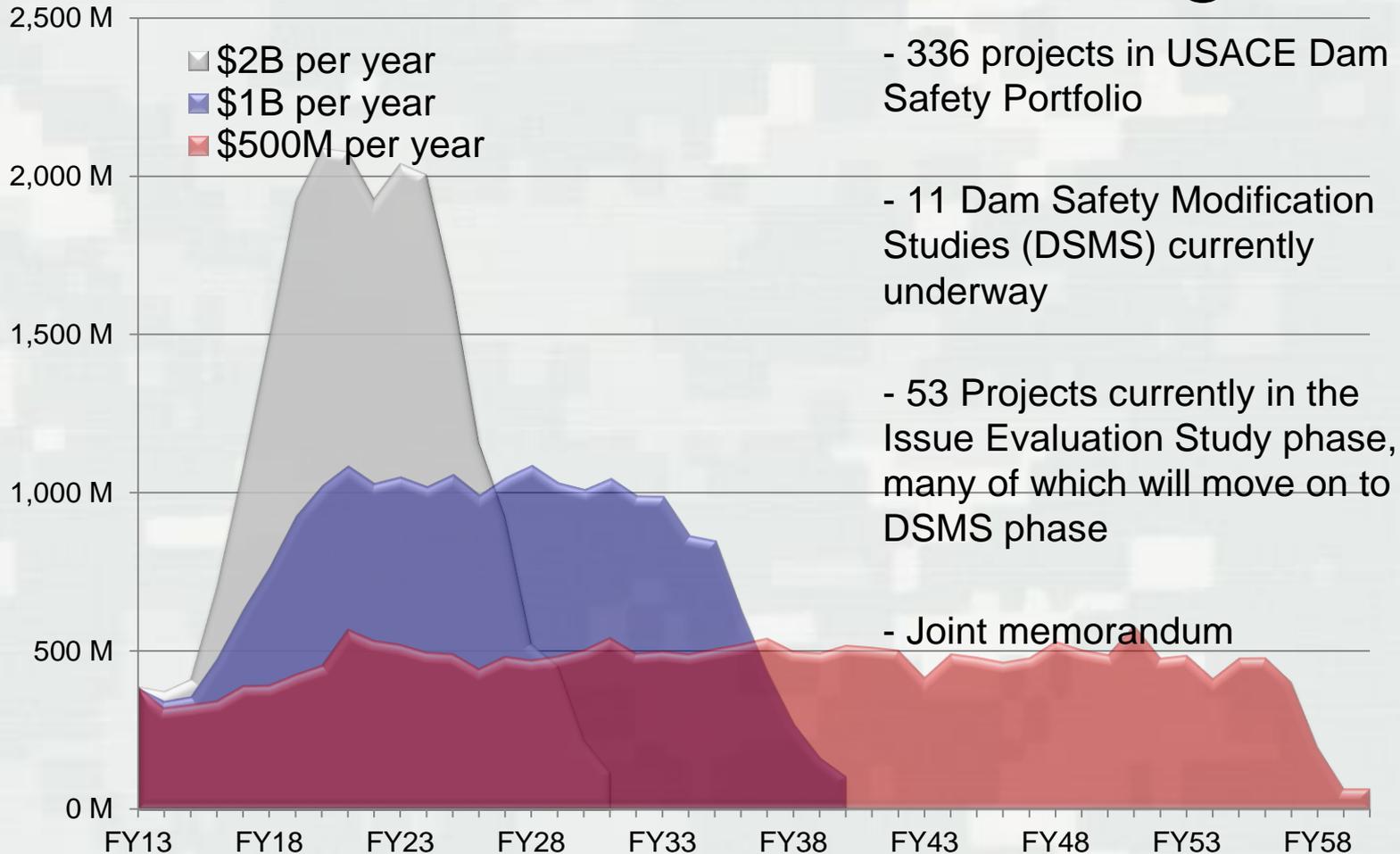
Econ, Enviro, Cultural, MMC....

All of the above



# Dam Safety Investments...

## a Future for Planners & Engineers



- 336 projects in USACE Dam Safety Portfolio

- 11 Dam Safety Modification Studies (DSMS) currently underway

- 53 Projects currently in the Issue Evaluation Study phase, many of which will move on to DSMS phase

- Joint memorandum

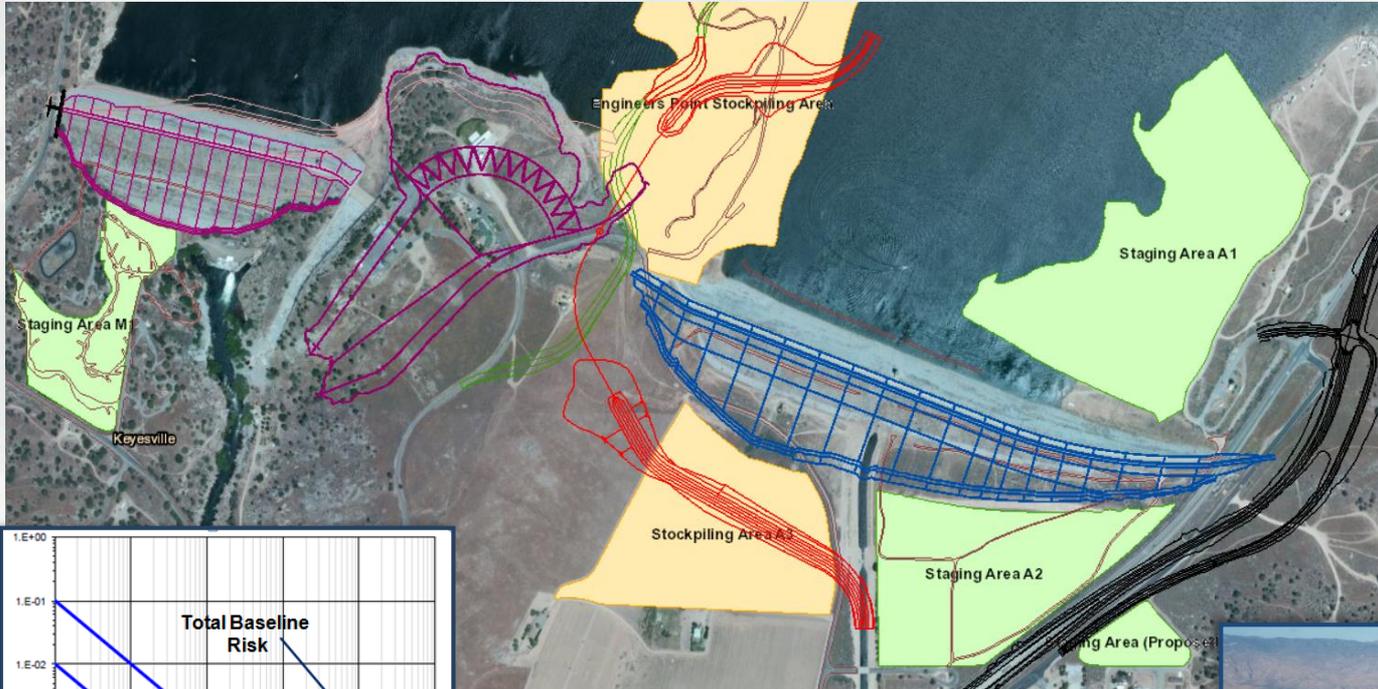
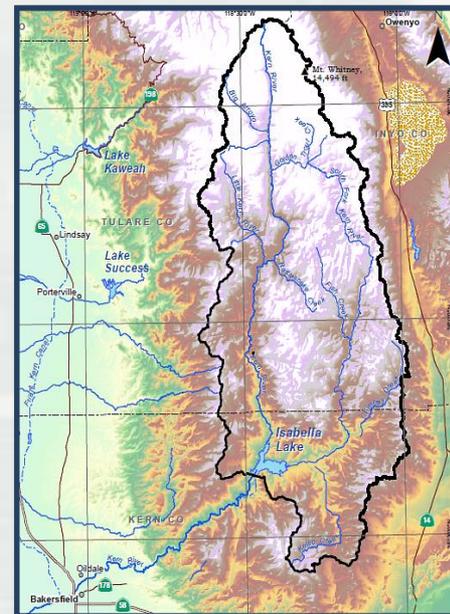


# **LESSONS LEARNED FROM ISABELLA DAM SAFETY MODIFICATION STUDY**

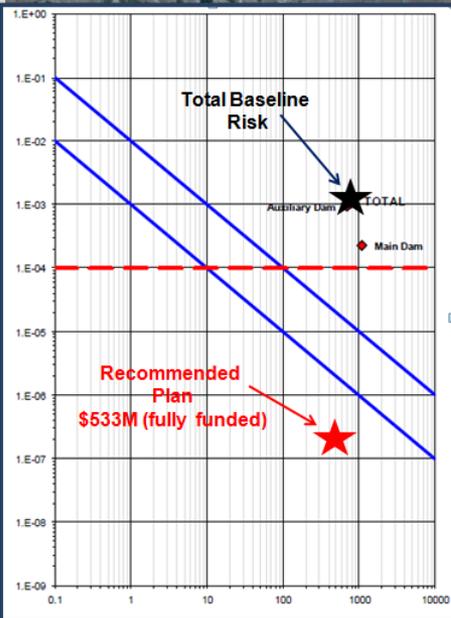


# ISABELLA LAKE, Kern River, California

DSAC I – Approved Dam Safety Modification Report (Dec 2012)  
 Environmental Impact Statement & Real Estate Design Memo



- Authorized by FCA 1944
- Constructed 1948-53
- Flood Control (79%)
- Irrigation (21%)
- Reservoir Capacity = 568K Ac-Ft



## Failure Modes (Dam Safety Issues)

- Hydrologic Overtopping
- Internal Erosion of the Auxiliary Dam Foundation
- Fault Rupture at the Auxiliary Dam
- Internal Erosion along Borel Conduit/Deformation and Structural Stability
- Transverse Cracking at the Main Dam



Risk Condition	Failure Risk (APF)	Life Loss Risk (ALL)	Annualized Damages
Baseline	1.17E-03	9.04E-01	\$12,321,235
Recommendation	3.20E-07	1.56E-04	\$2,269

# Isabella Dam Safety Modification Study (DSMS) Lessons Learned

- Collaboration to produce joint product
- Decision Framework
  - Tolerable Risk Guidelines (TRG)/ER 1110-2-1156
- Formulation and Evaluation
  - Understanding what makes up the failure mode and what is driving risk
  - Understand consequences breakdown
  - Risk reduction
- NEPA Lessons Learned



# DAM SAFETY

**Lead  
Engineer**

**Project  
Manager**

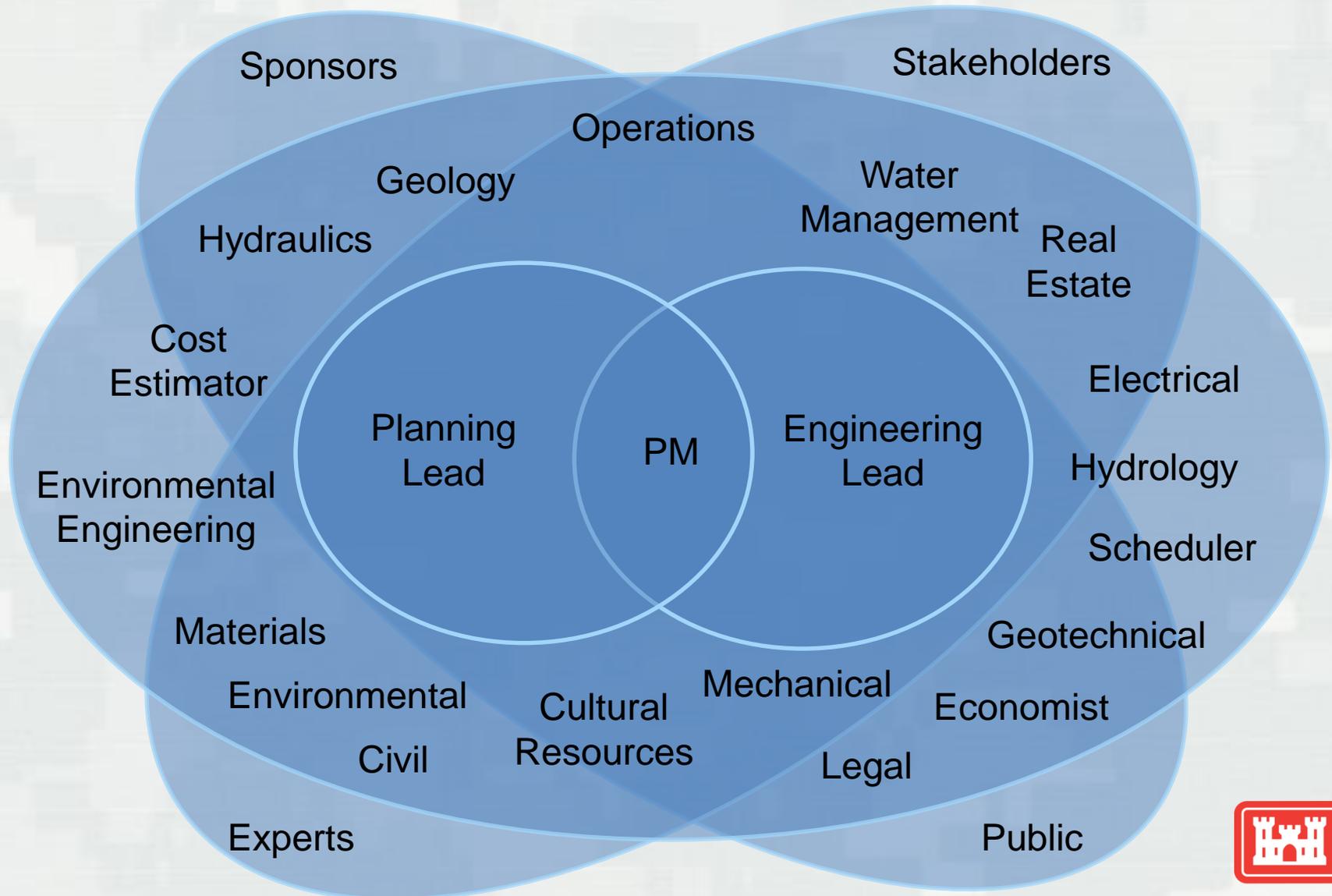
**Lead  
Planner**

Policy Compliance  
Public Involvement  
Risk Assessment  
Vertical Communication  
Congressional Interest  
Sponsor Relations

Schedule  
Alternative Development  
Budget  
Risk Reduction  
Environmental Compliance



# Team Collaboration



# Primary Screening Criteria

- Probability of Failure
- Life Safety Risk
  - Individual Risk
  - Societal Life Risk
- Economic Risk
- Environmental Risk

Critical to understand the primary risk drivers...

# Other Examples of Screening Criteria

- ▶ Effectiveness of Risk Management (what is driving risk!)
- ▶ Do No Harm
- ▶ Verifiable QA/QC
- ▶ Constructability (Constructed Project)
- ▶ Robust/Flexible (Performance)
- ▶ Proven Acceptance
- ▶ Implementation Cost
- ▶ Environmental Impacts
- ▶ Material Availability
- ▶ Safety During Construction
- ▶ Schedule and Length of Construction Season
- ▶ Net Benefits



# Isabella Formulation Strategy

- Formulate plans to meet the minimum required alternatives in ER 1110-2-1156 in consideration of the formulation criteria
  - Effectiveness,
  - Efficiency,
  - Completeness, and
  - Acceptability
- Allowed for open thinking early on to develop the full array of alternative plans.
  - Low cost / low impact solutions
  - Largest risk reduction for the cost
  - Most robust solution
  - Staged implementations



# Isabella Evaluation Strategy

- Made decisions as a **PDT**, documented efforts, communicated vertically and moved on to next steps
- Focused alternative measure and plan development efforts on items that impacted comparison and selection of alternatives:
  - Identified and evaluated cost drivers
  - Understanding of selection and consideration factors
  - Understanding of environmental compliance



# Comparison and Selection of a Risk Management Plan

- Primary Selection Factors

- Life Safety Risk
  - Individual Life Risk
  - Societal Life Risk
- Probability of Failure Risk
- ALARP considerations

*Rank and Document!*

- Other Considerations

- Acceptability
- Effectiveness
- Completeness
- Efficiency
- Constructability
- Redundancy
- Resiliency
- Robustness
- Economic and Environmental Considerations
- Four Accounts (NED, RED, NER, OSE)
- Effects of Implementation (Beneficial and Adverse)
- Essential USACE Guidelines



# Comparison of Emergency Spillway Measures

Hydraulic Notation	1A/1B	3A	3D	4B	4C
Type	Labyrinth	Labyrinth	Labyrinth	Straight Crested Fusegate	Straight Crested Fusegate
Max PMF WSE above existing Dam Crest	No	Yes	Yes	Yes	No
Frequency of Use (AEP)	> 1/500	>1/4000	>1/4700	> 1/2400	>1/2400
Required Dam Raise (feet)	4	14	16	9	4
Peak Outflow (cfs)	481,000	514,000	511,000	599,000	564,000
Width (feet)	450	900	900	900	900
Total Weir Length (feet)	2,700	5,400	5,400	900	900
Height of Structure (feet)	30	19.26	19	21.5	24.5
Crest Elevation (NAVD88)	2618.26	2635.12	2637.26	2630.76	2630.76
Crest Elevation Relative to Existing Top of Dam	19-feet below	2.1-feet below	Same Elevation	7-feet below	7-feet below
<u>Incremental</u> Non-Breach ALL	0.795	0.0064	0.0011	0.0194	0.0268

# Comparison of Alternative Risk Management Plans

Parameter	No Action (Baseline)	Life Safety Plan 3	Life Safety Plan 4	DSAC Plan 2	Dam Replacement
Project Implementation Cost (\$M)	N/A	\$469.58	\$474.42	\$554.96	\$633.78
Annualized Probability of Failure (APF)	1.17E-03	1.87E-06	3.20E-07	8.68E-08	5.43E-08
Annual Life Loss-Failure (ALL)	9.04E-01	9.31E-04	1.56E-04	5.15E-05	5.11E-05
Tolerable Risk Guidelines (Failure)	No	Yes	Yes	Yes	Yes
Tolerable Risk Guidelines (Non-Failure)	No	No	Yes	Yes	Yes
Increases Incremental Non Failure ALL	N/A	Yes	No	No	No
Essential USACE Guidelines	No	No	Yes	Yes	Yes
Completeness	No	No	Yes	Yes	Yes
Acceptability	No	Yes	Yes	Yes	Yes
Effectiveness	No	Full	Full	Full	Full
Efficiency Ranking	8	6	1	2	3
Robustness	No	No	No	Yes	Yes
Redundancy	No	No	Yes	Yes	Yes
Resilience	No	No	No	Yes	Yes
Implementation (PED & Construction)	Immediate, No Action Required	PED ~ 2.5yrs Constr ~ 6yrs	PED ~ 2.5yrs Constr ~ 6yrs	PED ~ 2.5yrs Constr ~ 7.5yrs	PED ~ 3yrs Constr ~ 8yrs

# NEPA Compliance

## Environmental Impact Statement

- Engineering team members were a very important player in integrating the NEPA process to develop and adjust acceptable risk reduction measures based on environmental impacts
- Establish a good relationship with the public (ED, PD, PM, etc). The Isabella PDT built trust with the public by holding Public Information Meeting every 6 months before the NEPA process started.

