Association of State Dam Safety Officials Annual Conference (Dam Safety 2022)

Baltimore, Maryland, USA 18 – 22 September 2022

ISBN: 978-1-7138-6742-5

Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2022) by Association of State Dam Safety Officials All rights reserved.

Printed with permission by Curran Associates, Inc. (2023)

For permission requests, please contact Association of State Dam Safety Officials at the address below.

Association of State Dam Safety Officials 239 S. Limestone Lexington, Kentucky 40508 USA

Phone: 859/550-2788

info@damsafety.org

Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA Phone: 845-758-0400 Fax: 845-758-2633 Email: curran@proceedings.com Web: www.proceedings.com

Table of Contents

MONDAY, SEPTEMBER 19

Opening General Session – 50th Anniversary of the Buffalo Creek Dam Failure

ASDSO Welcome Charles Thompson, P.E., Dam Safety Bureau, NM Office of the State Engineer

Maryland Welcome

Re-examination of the Failure of Buffalo Creek Dam, West Virginia on February 26, 1972 Keith Ferguson, P.E., D.GE. D.WRE, and Christopher Krivanec, P.E., G.E., HDR

Buffalo Creek Dam Failure of 1972 – Policy Outcomes from the Failure 34 Jonathan Pittman, Schnabel Engineering

Consequences and Lawsuit from the Buffalo Creek Disaster N/A Nathaniel Gee, Tennessee Valley Authority

Concurrent Session 1 – Decade Dam Failures Series Part I

Human and Social Impacts of the Lawn Lake Dam Failure of 1982 Dylan Hoehn and Clint Brown, Engineering Analytics, Inc.; Mark Baker, DamCrest Consulting; and Alan 35 Pearson

50th Anniversary of the 1972 Black Hills Flood and Subsequent Canyon Lake Dam Failure – A Disaster of 36 PMP-level Proportions

Keil Neff, P.E., Ph.D., Stantec Consulting Services, Inc.; Abbas Dorostkar, Ph.D., P.E., Pacific Gas & Electric Company; Greg Richards, P.E., CFM, Gannett Fleming, Inc.; and Lee Mauney, P.E., CFM, HDR

1802 Failure of Puentes II Dam 52 A. Tom MacDougall and Diego Saldaña Arce, Ph.D., RJH Consultants, Inc.; and Seth Thompson, P.E., Gannett Fleming, Inc.

Concurrent Session 2 – Understanding Seepage

Large Scale Permeameter Tests for Internal Erosion Assessment of Widely Graded Materials in 53 Embankment Dams

Maoxin Li, Ph.D., P.Eng, and Li Yan, P.Eng., Ph.D., BC Hydro; Sasi Sasitharan, P.Eng., Ph.D., and Emily Tham, MSc., P.Eng, Powertech Labs Inc.

Erosion Resistance and the Impact of Water Content 62 Peter Irey, P.E., and Ted Howard, P.E., Bureau of Reclamation

A Mooseload of Piezometers: Investigation and Remediation of Seepage at Upper Dam 68 Gillian M. Williams, P.E., and Lee Wooten, P.E., GEI; Chris Karam, P.E., Brookfield Renewable; and Steve Rabasca, P.E., Soil Metrics, LLC

Concurrent Session 3 - What's New in Roller Compacted Concrete

 Using Cool New Tools to Reduce Risks at Comanche Dam
 89

 Steve Jamieson, P.E., and Christine Mugele, P.E., W.W. Wheeler & Associates, Inc.; David Hibbs, P.E., and Brad Iarossi, P.E. (Retired), US Fish & Wildlife Service; and Jesse Wullenwaber, P.E., Schnabel Engineering

 Lessons Learned or Should Have Learned – RCC Design and Construction
 101

 Randall P. Bass, Schnabel Engineering
 101

 I dare you to knock this off! Physical model testing of crest caps on RCC overlays
 102

 Tony L. Wahl and Bryan J. Heiner, P.E., Bureau of Reclamation
 102

Concurrent Session 4 – High-tech Hydrology

Hydrologic vs Hydraulic Rainfall-Runoff Modeling 103 Michael Horst, Ph.D., P.E., The College of New Jersey

Appyling Stochastic Weather Generation and Continuous Hydrologic Simulation for Critical Infrastructure 117 Design

Joe Bellini and Dennis Johnson, Ph.D., Aterra Solutions; and Bill Kappel, Applied Weather Associates

Application of a 21-year radar rainfall record to assess changing probability of extreme rainfall in the mid-Atlantic region Andrew J. Miller, UMBC: James A. Smith and Mary Lynn Baeck, Princeton University: and Elijah Claggett

Andrew J. Miller, UMBC; James A. Smith and Mary Lynn Baeck, Princeton University; and Elijah Claggett, Kyushu University

Concurrent Session 5 – Warning and Consequences

Improved Monitoring at Upper Highline Dam to meet Colorado's Early Warning System Program 119 Requirements

Lee Mauney, P.E., CFM, Loring Crowley, P.E., HDR; and Eric Eisinger, P.E, Colorado Parks and Wildlife

Bureau of Indian Affairs Safety of Dams – Early Warning System Challenges and Advancements 129 Michele Minihane, Katharine Anderson, Kevin Humphreys, and Tim Pauls, Managed Business Solutions (MBS), a Sealaska Company

Estimating Dam Failure Life-Loss Consequences to Motorists, Recreationalists, and Pedestrians for 131 Hazard Potential Classification of Dams

Chad Krofta, David Jackson, P.E., and Christopher Clopper, P.E., Managed Business Solutions (Contractor to Bureau of Indian Affairs); and Matt Young, P.E., CFM, Bureau of Indian Affairs

Concurrent Session 6 – Improving Inspections

Risk-Based Dam Inspection Guidelines – Montana Learns from the Oroville Dam Incident 132 Amanda J. Hess, Greg Richards, P.E., CFM, and Patrick Campana, Gannett Fleming, Inc.; and Michele Lemieux, P.E., MT Department of Natural Resources and Conservation

A Lot of Dam Data! Using ESRI's Survey123 and Field Maps Applications To Efficiently Collect Data and 139 Standardize Quarterly Inspection Packages for 30 Dams Meron Wolde-Tensae, P.E., Hazen and Sawyer; and Brandon K. Harris, P.E., Gwinnett County Government, Department of Water Resources *Together is Better – Complimenting Assessments Utilizing Rope Access and Unmanned Aerial Vehicles* 140 Kenny Dosanjh, P.E., SPRAT III, Matt Lynch, Eduard Egov, P.E., SPRAT III, and Michael Buga, P.G., C.E.G, SPRAT I, HDR

Concurrent Session 7 – Potpourri Grab N Go

Articulating Concrete Block (ACB Design Practice Update 158 Christopher I. Thornton, Colorado State University-Fort Collins; Jim Nadeau, Ferguson Waterworks; Jon Fripp and Karl Visser, USDA – NRCS; and Dennis Zeveney, US Army Corps of Engineers

The Tale of Two Spillways 159 Joseph Bell, James Murphy, and Paul Schweiger, P.E., Gannett Fleming, Inc.; and Constantine Pappas US Fish & Wildlife Service

How Latest CFD and 2-D Modeling Capabilities Support Dam Rehabilitations 160 Ahintha Kandamby, Michelle Bowen, Chamil Perera, and Mathew Lunemann, WSP

Cyclic and Static Liquefaction Study for a New Earth Dam in Colorado 175 Todd Street, P.E., and Amin Ghorbanpour, Ph.D., P.E., W. W. Wheeler and Associates, Inc.

Caldor Fire Emergency Repairs 183 Amy Deakyne, GHD, Inc.

Concurrent Session 8 - It's Maryland, Hon

Brighton Dam: Working Together to Repair Unanticipated Damage and Deterioration to Tainter Gates 184 Brad Zelonis, P.E., Kleinschmidt Associates; Richard F Walker, Jr., P.E., Scott Jones, P.E., Ph.D., Robert Pinciotti, P.E., and Eric Wenz, P.E., AECOM; and Claude Modise, P.E., and Karen A. Wright, WSSC Water

Goldilocks and the Three EAPs: Working with EAP Templates and Inundation Mapping Guidelines to196Ensure They are "Just Right" for your Dam196Kate Naughton, Jeffery Powers, and Jeremy Hise, Hazen and Sawyer; and Nancy Hausrath, William196Luhn, and Kellen Douglas, City of Hagerstown196

Historic Ellicott City, Maryland Flooding: Safe and Sound Mitigation Plan 197 Mark S. Richmond, Howard County Stormwater Management Division

TUESDAY, SEPTEMBER 20

General Session 2 – Dam Safety 3.0 – Changing Our Paradigm (presentation only) Federal Lawmakers, Uncommon Dialogue, and FEMA. Reimagining Dam Safety.

Concurrent Session 9 – Explaining Environmental Justice

 Mapping Maryland's Inundation Zones
 198

 John Roche and William Ashby, MD Department of the Environment
 199

 What should we protect? Consequence Analysis that reflects communities' unique assets and vulnerabilities.
 199

 Katherine Sharpe and Kayla Briggs, Gannett Fleming, Inc.
 199

 Concurrent Session 10 – ASDSO Resources Making an Impact

 ASDSO's Technical Knowledge Base – A New Online Resource for the Dam Safety Industry Greg Richards, Gannett Fleming, Inc.; and Jeremy Franz, CO Division of Water Resources
 200

Debris, Fire, and Ice – Unusual Hydrologic Conditions and their Impact on Dams and Floods (Recent Highlights from DamFailures.org

Greg Richards, P.E., CFM, Gannett Fleming, Inc.; Bill Johnstone, Ph.D., P.E., Spatial Vision Group Inc.; 201 Doug Johnson, P.E., Federal Energy Regulatory Commission; Everett Taylor, P.E., UT Divison of Water Rights; John Atkins, P.E., Eagle Creek Renewable Energy; and Nathaniel Gee, P.E., Tennessee Valley Authority

Concurrent Session 11 – Focus on Seismic Issues

Considerations for Subsurface Investigations for Seismic Analysis of Embankment Dams and Levees 205 Khaled Chowdhury, Ph.D., P.E., G.E., Ethan Dawson, Ph.D., Georgette Hlepas, Ph.D. P.E., Michael Arles, P.G., and Olivia F. Finlay, GIT, US Army Corps of Engineers; Zia Zafir, Ph.D., P.E., G.E., Kleinfelder; and Raymond B. Seed, Ph.D., Professor Emeritus, University of California, Berkley

Framework for Seismic Risk Analysis of Embankment Dams 257 Glenn J. Rix, Ph.D., P.E., Geosyntec Consultants; and Martin W. McCann, Jr., Jack R. Benjamin and Associates, Inc.

How do you perform a DSHA for a distributed seismicity source? 269 Christie Hale, Ph.D., Glenn J. Rix, Ph.D., P.E., and E. Onur Tastan, Ph.D., P.E., Geosyntec Consultants

Concurrent Session 12 – Small But Dangerous. A Programmatic View of Low Head Dams

A Tool to Identify Dangerous Conditions at Low-Head Dams 279 Tony L. Wahl and Connie D. Svoboda, P.E., Bureau of Reclamation

Machine Learning for locating low head dams280Salvador Augusto Vinay Mollinedo and Rollin H. Hotchkiss, Brigham Young University

Stream Slope Map to Predict Drowning Potential at Low-head Dams282Jason Poff and Rollin Hotchkiss, Ph.D., P.E., D.WRE, Brigham Young University

Concurrent Session 13 – Spillway Hydraulics

Case Study: 2D and 3D/CFD Modeling along Stepped-Chute Spillways with Stilling Basin and Tailwater 293 Weir Joe Bellini, Dennis Johnson, Ph.D., and Tom Saldutti, Aterra Solutions, LLC Is that a hydraulic jump basin or a roller bucket? Physical modeling of the Gross Dam Spillway Stilling 294 Basin Greg Glunz, P.E., and Frank Lan, Ph.D., P.E., AECOM; Chris Thornton, Ph.D., P.E., Colorado State University; Felipe Garcia, P.E., Stantec Consulting Services, Inc.; and Casey Dick, P.E., Denver Water To step or not to step, that is the question! – Using SpillwayPro to evaluate increased discharge or design 305 head Bryan J. Heiner and Tony L. Wahl, Bureau of Reclamation Concurrent Session 14 – Decade Dam Failures Series Part II 307 Christmas Catastrophe: Crisis Averted At Adams Lake Dam Robert C. Hatton, P.E., and Jon Keeling, P.E., CFM, Stantec Consulting Services, Inc. Edgewick Railroad Fill Failure, Washington State, 1932 312 Douglas L. Johnson, P.E., Federal Energy Regulatory Commission 1952 Failure of Frenchman Creek Dam 317

Greg Paxson, P.E., D.WRE, Schnabel Engineering; and Chadrick Hill, MT DNRC Dam Safety Program

10th Anniversary of the Percy Quinn Dam Incident – Two Slides, Two States, One Big Mess!325Dusty Myers and Johnathon Atkins, P.E., Eagle Creek Renewable Energy325

1912 Collapse of the Nashville City Reservoir: From Failure to Fortress Jonathan Pittman, P.E., Schnabel Engineering; and Dawning Wu, EIT, HDR

1992 Fairfax Lake Dam Piping Incident and Repair 333 Natalie Orbesen, Zachary Hollandsworth, P.E., and Cecil Bearden, P.E., Oklahoma Water Resources Board

Concurrent Session 15 – Dam Removal Part I

Multi-benefit Dam Removal Projects for Dam Safety—Dam Removal as a Dam Safety Solution 334 Katherine Schmidt, Serena McClain, Jessie Thomas-Blate, and Brian Graber, American Rivers

Happy Hour is here again! – Long Draught Branch Dam Removal and Stream Restoration 335 Justin Lennon, Kyle Spendiff, and Michael Coco, P.E., WSP; and Dana Havlik, P.E., MD State Highway Administration

Federal Actors in Dam Removal Policy: Legal and Bureaucratic Influences in the Decommissioning of
Powered and Non-Powered Dams in the United States336Arianna Drechsler, Marquette UniversityArianna Drechsler, Marquette UniversityArianna Drechsler, Marquette University

Concurrent Session 16 - State Perspectives on Portfolio Risk Analysis

Evaluating and Prioritizing Risk for a Portfolio of Dam Assets 348 Nicolette Schluter, EIT, Jeff Blass, P.E., and G. Michael McIntyre, P.E., AECOM; Spyridon Papadimas, P.E., MD Department of General Services; Perry Otwell, P.E., MD Department of Natural Resources; and John Roche, P.E., MD Department of the Environment

Where to Focus: Benefits of a Portfolio-Level Risk Analysis 361 Aaron J. Fricke, P.E., Christopher B. Burke Engineering, LLC; and Moumita Mukherjee, Ph.D., P.E., IN Department of Natural Resources

Integrating Risk into the NC State Dam Safety Program 367 Tony Grubbs, Freese & Nichols; and William E. Toby Vinson, NC Department of Environmental Quality

Concurrent Session 17 – Innovations In Monitoring Methods

Acoustic Methods to Detect Anomalies in an Embankment Dam – A Comparison With Other Geophysical 368 Methods Sam Johansson, Ph.D., HydroResearch AB; Ingvar Ekström, M.Sc., Sweco AB; and Mats Persson, Vattenfall Vattenkraft, M.Sc.

Use of InSAR to Support Dam Health Monitoring Programs 385 Cyrus D. Garner, Ph.D., P.E., Jordan Keeney, P.E., and Mike Davis, P.Eng., Stantec Consulting Services, Inc.

Concurrent Session 18 – Modifying Low Head Dams

Dam Good Fishing without the Snags – Fish Passage at a Low Head Dam 393 Carmen Lepsch and John Harrison, P.E., Schnabel Engineering; and Brian Crookston, Ph.D., P.E., Utah State University

Willow River Dam - Innovative Conversion to Compound Rock Arch Rapids 405 Jessica Olson, P.E., and Peter Hinck, P.E., Barr; and Crystal Payment, MN Department of Natural Resources

Simple Design of a Safer Low Head Dam 413 Paul A. Cocca. P.E., CFM, and Daniel A. Bennett, US Army Corps of Engineers; and Marta Lopez-Egea, Golder Associates

Concurrent Session 19 – Spotlight on State Programs

Inundation Studies and Downstream Hazard Determination Guidance for Ohio Dams 424 Matt Marquis, P.E., OH Department of Natural Resources

Use of Rapid Categorization of Assets Tool (RCAT for Gap Analysis of Physical Security Measures for 434 Flood Management Facilities in California

Rajat Saha, John J. Rizzardo, P.E., Jon Ericson, P.E., and John Paasch, P.E., M. Eng., CA Department of Water Resources; and James L. Strife, CPP, PCI, CHPA, Gannett Fleming, Inc.

Trampas Canyon Dam Enlargement 435 Rick Draeger, P.E., and Ashley Gobel, P.E., CA Department of Water Resources, Division of Safety of Dams

Concurrent Session 20 – Dam Removal Part II

Assessing the Pre-Dam Removal Ecological Functions of Blackwater Creek, 90 Years after the Construction of College Lake Dam: A High Hazard Dam Brandon Alderman, AECOM; and Erin Hawkins, City of Lynchburg

Dam Removal using a Pilot Channel for Sediment Management448Maren Hancock, P.E., Jonathon Kusa, P.E., and Marty Melchior, Inter-Fluve, Inc.; Suzannah Deneau,P.E., Wightman and Associates; and Jeff Dunlap, City of Niles, Michigan

Breaching and Environmental Impacts of Woodlands Lake Dam a High Hazard Dam 457 Ivan Gomez and Beth Ann Smith, GHD; Nadia Savage, Westchester County Department of Public Works and Transportation; and David DeLucia, Westchester County Department of Parks, Recreation and Conservation

Concurrent Session 21 – Rehabilitation Methods and Materials

Researching Grout Mix Performance in the Presence of Low Velocity Crossflow Using Large Scale 471 Laboratory Testing for Logan Martin Dam Joshua Anderson, Alden Research Laboratory; and Eric Manning, P.E., Southern Company

Performance of a Test Levee Slope using Bio-Engineered Stabilization on High Plasticity Clay 472 Amber Spears, P.E., Avipriyo Chakraborty, Omer Alzeghoul, Mohammad Sadik Khan, Ph.D., P.E., and Robert W. Whalin, Ph.D., P.E., Jackson State University

Performance of the Boone Dam during Reservoir Filling following Remediation480John Barrett, Geosyntec Consultants; and Chris Saucier, P.E., Tennessee Valley Authority

Concurrent Session 22 – Developing Your Risk Toolbox

Leveraging PFMA to Address Unexpected Foundation Conditions during Active Rehabilitation on a Spillway Chute Andrea Jacobs, P.E., Scott Jones, P.E., Ph.D., and David Bianco, AECOM; and Chad Knutti, P.E., Brookfield Renewable

Risk Informed Decision Making for Construction, Repair, and Maintenance Projects 493 Lewis Rounds, P.E., Ballard Marine Construction

Potential Failure Mode Screening Analyses501Martin W. McCann, Ph.D., Jack R. Benjamin and Associates; Glenn J. Rix, Geosyntec Consultants; and
Thomas Westover, Cornforth Consultants, Inc.,

Concurrent Session 23 – Advancements In Inundation Mapping

Painless Mapping Using New Mexico OSE Dam Inundation Mapbook Processing Toolset511Hui-Ming (Max) Shih, Ph.D., P.E., CFM, Allison Wagner, Joseph Machala, P.E., CDM Smith; and CharlesN. Thompson, P.E., and David Heber, P.E., NM Office of the State Engineer

The Use of Dam Failure Inundation Maps in Exercises519Richard Kusmierczyk, P.E., Tennessee Valley Authority

The Domino Effect – A Look Into Cascading Dam Failures 522 Luke Trumble, MI Department of the Environment, Great Lakes, and Energy; Bill Kussman, P.E., Hatch; Mark Forest, P.E., CFM, and Lee Mauney, P.E., CFM, HDR; and Mark Baker, P.E., DamCrest Consulting, LLC

WEDNESDAY, SEPTEMBER 21

Concurrent Session 24 – Levee Management

Reverse Water Loadings for Levee Systems – A Lesson from Hurricane Ida 524 Will McRae, Noah Vroman, P.E., and Jennifer Stephens, P.G., US Army Corps of Engineers

Common Levee O&M Pitfalls – Keeping Sponsors Above Water 525 Vicki Twerdochlib, P.E., CFM, and Brice Stafne, P.E., HDR; and George Parizek, P.E., City of Omaha, Nebraska

Inspecting Levees within Multiple Jurisdictions 534 Randy Bushey, Jacobs

The Benefits of Active Levee Sponsor Engagement in the Inspection Process535Kimberly Lukas, P.E., CPESC and Daniel Teak, P.E., HDR535

Concurrent Session 25 – Geo Tech Case Studies

Stiles Reservoir Dam – No More Patches 539 J. Matthew Bellisle, P.E., and David R. Caouette, P.E., Pare Corporation

Anchoring Down in the Peach State 561 Nate Witter, P.E., Nicholson Construction Company; and Nick Ciomei, P.E., Kleinschmidt Group

Run-Of-River Dam Construction: A Team Approach to Navigating Changing Waters 562 James Guistina, Bergmann; and Caroline Wheadon, Labella Associates

Leon Hurse Dam – Characterization and Construction Approval of a Five Million Cubic Yard Borrow Area 563 Mark Ickert and Russ Springer, P.E., Freese and Nichols, Inc.; and Adam McKnight, Upper Trinity Regional Water District

Concurrent Session 26 – Assessing Spillway Conditions

Flow Rates Through Joints and Cracks in Spillway Chutes 576 Tony L. Wahl and Bryan J. Heiner, P.E., Bureau of Reclamation

A New Cloud-Based Tool For Assessment Of Rock Scour Incidents During Floods At High-Head Dams 577 Erik F.R. Bollaert, C. Eng., Ph.D., AquaVision Engineering Llc *Condition assessment of an urban spillway designed and built in three phases spanning 45 years* 590 Jeffrey R. Keaton, Ph.D., P.E., P.G., Wood; and Stewart S. Vaghti, P.E., Gannett Fleming, Inc.

Concurrent Session 27 – Rainfall: High and Low Frequencies

High-Frequency Rainfall-Runoff Modeling for Dam Safety Decision-Making 596 Brent Zundel, P.E., CFM, and Anthony Moritz, EI, MT Department of Natural Resources and Conservation

Quantification of Uncertainty in Precipitation Frequency Estimates Considering Climate Change 601 Azin Al Kajbaf, Michelle Bensi, Ph.D., and Kaye L. Brubaker, Ph.D., University of Maryland

State of Statewide PMP – Where We've Been and What's Next 602 Bill Kappel, Applied Weather Associates

Concurrent Session 28 – Updates On The National Levee Safety Program

The National Levee Safety Program: Do We Need a Standard for all Levees in the Nation?603Michael Bachand, P.E., Jennifer Laux, and Phoebe Percell, P.E., US Army Corps of Engineers603

Concurrent Session 29 – Near Miss

Emergency Response at a High Hazard Dam Lasting Weeks 604 Mark W. Killgore, VA Department of Conservation and Recreation

Spillways, Sinkholes, and Slope Failures: Quick Thinking Saves Two Dams 605 Stephen Spink, P.E., and Timothy Blair, P.E., Weston & Sampson Engineers, Inc.

The 50-Year Anniversary of the Kingsley Dam Wave Erosion Incident608Tim Gokie, P.E., NE Department of Natural Resources; and Michael A. Drain, P.E., The Central NebraskaPublic Power and Irrigation District

Concurrent Session 30 – Advanced Geo Tech

Investigating and Addressing Seepage and Slope Stability Issues at Oroville Dam 619 Leslie F. Harder, Ph.D., P.E., G.E., Mark Stanley, P.E., G.E., Christopher Krivanec, P.E., G.E., and Sagar Raj Satyal, HDR; and Timothy Wehling, P.E., Christina Kashiwada, P.E., Daniel Cimini, P.E., Ashley Cousin, P.E., Ryan Abernathy, P.E., and David Sarkisian, P.E., CEG, CA Department of Water Resources

Estimating Maximum and Minimum Void Ratio from Index Parameters 678 Alex Pires-Sturm, Ph.D., P.E., and Robert Jaeger, Ph.D., P.E., CA Department of Water Resources, Division of Safety of Dams; and Jason DeJong, Ph.D., University of California, Davis

Experimental Overview of Static Liquefaction and Tips to Plan a Successful Laboratory Program 689 Amin Ghorbanpour, W. W. Wheeler and Associates

Concurrent Session 31 – CFD In Practice

To the Tune of a Piano-Key: Analysis of Alternatives for Curtis Dam and Hydraulic Design of a Piano-Key 690 Spillway Seth Thompson, Chad Hoover, P.E., and Paul Schweiger, P.E., Gannett Fleming, Inc.; Anthony Nokovich, P.E., Pennsylvania American Water Compan; and Brian Crookston, Ph.D., P.E., Utah State University

Designing or Evaluating a Spillway? Know the Controllers of the Control Section! 691 Benjamin Israel-Devadason and Paul Schweiger, Gannett Fleming, Inc.

A Dive into DeHart Dam: How PMP Studies and CFD Modeling Can Reshape a Dam's Rehabilitation 692 Alternatives

Wesley Hollenbach, P.E., CFM, Casey Robertson, Jeff Blass, P.E., and Scott Jones, P.E., Ph.D., AECOM

Concurrent Session 32 – The Best Of The Rest

Dam and Waterway Construction in the early 1900's – A Photographic Journey Through Time 702 Todd Mueller, P.E., Bergmann

Picture This: A 3-D Subsurface Model to Support Dam Design 703 Kyle Blakley, P.E., David Hayson, P.E., and Michael Bartosek, Stantec Consulting Services, Inc.

Caught Between the Ocean and a Watershed, Designing Climate Change Adaptations for Two Coastal 716 Water Supply Dams in Rhode Island Andrea Judge, P.E., Fuss & O'Neill, Inc.; Joseph Famely, Woods Hole Group; and Robert Schultz, Jr., City of Newport, Rhode Island

Dam, Analysis Modernization of Tools, Applications, Guidance, and Standardization (DAM-TAGS) Project 729 Sherry L. Hunt, Jarrett Wise, Michael Buser, and Kade Shelton, USDA – Agricultural Research Service Hydraulic Engineering Research Unit

Concurrent Session 33 – Federal Funding and Communications Initiatives

Conceptual Dam Safety Improvement Program Financed through Corps Water Infrastructure Financing 730 Program Robert Beduhn, Jeremy Cook, Derek Gardels, and Cris Parker, HDR; and Aaron Snyder and Nathan

Campbell, PMP, US Army Corps of Engineers

Shifting the Focus to Proactive Community Investments through Collaborative Technical Assistance: A 731 Western Maryland Case Study

Scott Bass, MD Department of the Environment; Preston Wilson, Federal Emergency Management Agency, National Dam Safety Program; and Rosemarie Bradley, Ph.D., Federal Emergency Management Agency, National Integration Center

| Case Study: A Small Hydroelectric Dam Navigating FEMA's Hazard Mitigation Program | 732 |
|---|------|
| Emily Campbell, John Barrett, P.E., and Matt Bardol, Geosyntec Consultants | . 02 |

Concurrent Session 34 – Challenges With Cutoff Wall Construction

| North Reservoir Dam Improvements – Rehabilitation of a High-Hazard Dam at Full Pool | 733 |
|--|-----|
| Pete Nix, Tetra Tech | |
| | |
| Design and Construction Challenges with a Multi-Level Seepage Cutoff Barrier | 758 |
| David Paiko, P.E., Jacobs Engineering; and Kevin Aubry, P.E., Terracon Consultants, Inc. | |

| East Branch Dam: Lessons Learned during Cutoff Wall Verification Drilling | 772 |
|---|-----|
| Sarah J. Missenda and Audrey Wingate, US Army Corps of Engineers | |

Concurrent Session 35 – Advancements In Inundation Mapping, Part II

| Probabilistic Dam Breach Analysis for Pennsylvania's Largest Dam Breach Inundation Limits Joseph Kudritz, Ed Kaminski, P.E., and Brian Afek, P.E., Michael Baker International | 773 |
|--|-----|
| Safe Zone Determination under the Dam Failure Condition John Dong, Nicolas Von Gersdorff, Matt Muto, Jeremy A Yager, and Douglas Raigosa, Southern California Edison; and Ziyad Duron, Harvey Mudd College | 774 |
| Replicating of Brumadinho Tailings Dam Failure: Using a Two-Phase Flow Model 78 Noemi Gonzalez Ramirez, Karen O'Brien, and Jimmy S. O'Brien, FLO-2D Software /Riada Engineeri | • |

Concurrent Session 36 – Decade Dam Failures Series Part III

Thomson Canal Embankment Failure of 2012785Eric Gross and Paul Kokoszka, Federal Energy Regulatory Commission, Federal Energy RegulatoryCommission

Santa Clara Dam: The hole problem 786 Everett Taylor, P.E., Utah Division of Water Rights

Concurrent Session 37 – Managing Rules And Regulations For Real Results

Is Enforcement Possible? An Ohio Success Story 787 Mia Kannik, Dena Barnhouse, and Cindy Frazzini, OH Department of Natural Resources

WAIT!, I own a dam? And Regulatory is Filing a Lawsuit?! 788 James Guistina, Bergmann

Incorporating Dam Inundation Risk within a FEMA RiskMAP Project: A Pilot Study 789 Tiffany Coleman, STARR II / Stantec Consulting Services, Inc.; and Thomas Song, Federal Emergency Management Agency

Concurrent Session 38 – Top Tips And Tools In Construction Management

Leveraging Construction Manager at Risk for Efficient Dam Safety Portfolio Delivery 790 Chad Davis, HDR; and Eric Shafer, P.E., Jacob Bench, P.E., and James Hilovsky, P.E., OH Department of Natural Resources

Reducing Risk, Schedule and Cost Via Construction Manager at Risk Delivery - Hargus Lake Dam795Pete Logsdon, P.E., and Chad Davis, P.E., HDR; Eric Shafer, P.E., OH Department of Natural795Resources; Brian Toombs, P.E., Schnabel Engineering; and Michael Garver, The Ruhlin Company795

Case Studies in Construction Quality Control / Quality Assurance Methods for Seepage Cutoff Walls 805 Conrad Ginther, P.E., Jamey Rosen, P.Geo; Fred Chandler, P.G., Joseph Kula, P.E., and John Barrett, P.E., Geosyntec Consultants; Hector Davila, Bauer Foundation Corp; and Veronica Barredo, P.E., Tennessee Valley Authority

Poster & Lightning Talks

Potential Pitfalls to Alternative Selection 821 Jason Boomer, P.E., and Jennifer Williams, P.E., AECOM; and Brian Francis, P.E., US Army Corps of Engineers Dam Resilience Decision Support Toolbox 822 Jenn Richkus, Sean Cavanaugh, Leah Balkin, Conor Lewellyn, Ph.D., P.E., and Ethan Robinson, The MITRE Corporation Project Execution Risk vs Infrastructure Performance Risk: A Critical Distinction for Dam Safety 829 Derek Morley, Geosyntec Consultants; and Brian Hubel, P.E., G.E., US Army Corps of Engineers Uncertainty in Predicting Emergency Action Plans from Dam Failure 830 Al Souid, Wood Remote Underwater Surveys and Inspections: Exceeding Regulatory Requirements for Safety of Water 831 Power Proiects Dusty Myers, Eagle Creek Renewable Energy; and Kristin Rotella, ASI Marine Gate Structures – Snatched from Failure: How Many Ways Can a Radial Gate See Single Sided Hosting? 832 Travis Ford, P.E., and Jarlene Ninive, EIT, HDR Dirty Job: Court Street Dam Gate Chamber Cleaning 838 Jeff Blass, P.E., G. Michael McIntyre, P.E., and Richard Walker, P.E., AECOM; and Roger Gural, PMP, New York Power Authority Modification of Howard Prairie Dam 849 Brandt Demars, Bureau of Reclamation Applicability of the Bayesian Dynamic Linear Model Method In Dam Behaviour Analysis and Comparison 850 With the HST Method Patrice Côté, Vincent Roy, Benjamin Miquel, and Arnaud Meynadier, Hydro-Québec Re-evaluating Dam Spillway Design Using Current Data and Methods 863 Mark Schwartz, P.E., Emrah Karakullukcu, and John Osterle, P.E., RIZZO Alternative Delivery Methods – Lyman Lake Spillway 876 Nick Sullivan, Phillips & Jordan, Inc. Leveraging Advanced Digital Modeling and AI Analytics for Arch Dam and Concrete Spillway Condition 877 Assessments Ryan Coppersmith, Niricson Software, Inc. Potential Applications of Forecast Informed Reservoir Operations (FIRO to Enhance Integrated Water 878 Management David Gutierrez, P.E., G.E., GEI Consultants Watershed Planning for the Rehabilitation of Beaver Creek 1: a Concerted Effort 879 J Ryan Collins, Schnabel Engineering; Mathew Lyons, P.E., USDA; and Victoria Fort, P.E., Rivanna Water and Sewer Authority

| Larger than Maryland: Site-Specific PMP & PMF for a 14,000-Square Mile River Basin880Patrick Miles, Freese and Nichols, Inc.; and Bill Kappel Applied Weather Associates | |
|--|-----|
| One Size Does Not Fit All – Evaluating Dam Breach Parameters for Small Urban Distribution Reservoirs Jason Zhou and Priyanka K. Jain, P.E., East Bay Municipal Utility District | 881 |
| Dam Breach Modeling and Fly Fishing Along the Trail of Lewis And Clark 893 Kevin Ruswick, Schnabel Engineering; and Dustin Kaste, P.E., North Western Energy | |
| Considerations for Addressing Floodplain Management for Dam Rehabilitation or Removal Projects Edward G. Beadenkopf and Diana Castro, P.E., CFM, Atkins North America | 894 |
| Flood Awareness Presentations for Seniors, Northern Virginia, 2015-2019895Charles E. Karpowicz, Water Resources Management of Virginia895 | |
| Flood detention reservoirs: A new wave of dam construction in the United Kingdom896Alan J. Brown, C.Eng, and Andy Courtnadge, C.Eng, Jacobs | |
| Recent Updates of the Web-based Decision Support System for Water Infrastructural Security (DSS- WISE Lite) Mohammad Al-Hamdan and Marcus McGrath – National Center for Computational Hydroscience and Engineering (NCCHE), University of Mississippi; and Paul Smith, Nuttita Pophet | 905 |
| | |