# TABLE OF CONTENTS

## VOLUME 1

### CONCURRENT SESSION THREE: REHABILITATION CASE HISTORIES FOR HISTORIES FOR HISTORIC INFRASTRUCTURE

**Rehabilitation of the 100 Year Old Farnham Reservoir Dam** .......................................................... 1  
*Michael Malenfant, Martha Monserrate, Bruce Collingwood, Doug Gove*

**Pymatuning Dam Gatehouse - New Life for an Enduring Landmark** ........................................ 13  
*John Harrison, Kortney Brown, Edward Raptosh*

### CONCURRENT SESSION FOUR: FROM THE DAM SECURITY EXPERTS: RECENT ADVANCES

**Public Safety and Security at Dams - Are Not Mutually Exclusive** ............................................. 23  
*William F. Foss, Frank Calcagno, Paul G. Schweiger*

**An Integrated Approach for Physical and Cyber Security Risk Assessment: The USACE Common Risk Model for Dams** ................................................................. 33  
*Yazmin Seda-Sanabria, James D. Morgeson, Jason A. Dechant*

### CONCURRENT SESSION FIVE: EXTREME EVENTS

**How Many Times Did 2,100 Watershed Dams in Oklahoma Experience Auxiliary Spillway Flows in 67 Years?** ........................................................................................................... 52  
*Larry Caldwell, Ray Riley, Jim Henley*

**Preliminary Observations of Levee Performance and Damage Following the 2015-16 Midwest Floods in Missouri and Illinois** ................................................................. 86  
*Leslie F. Harder, Cassandra J. Rutherford, Michelle L. Bernhardt, Joseph Gamez, Adam Lobbestael, Behdad Mofarraj, Michael Musgrove, Nicolas Pinter, Brent Rosenblad, Rafael O. Tinoco, Minh D. Uong*

### CONCURRENT SESSION SIX: OWNERS, REGULATORS

**Standard of Care in a Regulatory Environment** .................................................................................. 171  
*Douglas L. Johnson*

**Kingsley Dam Functional Exercise** ..................................................................................................... 183  
*Kevin M. Boyd*

### CONCURRENT SESSION SEVEN: GEOTECHNICAL ISSUES

**A Comparison of Methods for Managing Seepage Through Embankment Dams** ............................................................ 189  
*Joseph R. Kula, John W. France, G. Richard Bird, Robert D. Pinciotti*

**Nepal Hydro Project Post-Earthquake Evaluation** ............................................................................. 212  
*Ray E. Martin, Binod Tiwari*

**Clear Creek Dam: Collaborative Risk Analysis - A Powerful Tool for Evaluating Aging Dams** ........ 222  
*Darrin Harris, Steven Anselmo, Mark Perry, Greg Zamensky*
CONCURRENT SESSION NINE: CASE HISTORIES

TROUBLE IN THREESS - TECHNOLOGY AND TEAMWORK TAKE ON MOTHER NATURE AT SPEEDWELL FORGE
Gary Horninger, Lisa Ciampitti, Greg Paxson, Jerry Woomer

CONCURRENT SESSION TEN: EXTREME PRECIPITATION

THE SOUTH CAROLINA EXTREME RAINFALL ANALYSIS-UNDERSTANDING THE STORM AND IMPLICATIONS FOR DAM SAFETY
Bill Kappel, Doug Hultstrand, Joe Bellini, Dennis Johnson, Petr Masopust

ALTERNATIVE LOCAL PMP DESIGN STORM FOR ARIZONA EFFECTS OF PMP DEPTH- DURATIONS AND TEMPORAL PATTERNS ON PMF FLOOD DISCHARGES
Michael Johnson, Thomas Loomis, Bill Kappel

ADVANCES IN EXTREME PRECIPITATION METHODOLOGIES
T. Parzybok, R. Jason Caldwell, K. Laro, M. Schaefer, G. Taylor, E. Tomlinson

CONCURRENT SESSION ELEVEN: THIS SESSION IS ALL MY FAULT

RISK CHARACTERIZATION AND DAM SAFETY MODIFICATIONS TO ADDRESS ACTIVE FAULT RUPTURE BENEATH AN EMBANKMENT DAM
David C. Serafini, Keith I. Kelson, Henri V. Mulder

ESTIMATING GROUND MOTIONS FOR LEVEES FOUNDED UPON SOFT SOILS
Yi Tyan Tsai, Scott J. Brandenberg, Jonathan P. Stewart

SEISMIC MODIFICATION OF THE MORMON ISLAND AUXILIARY DAM
Greg Eddy, M. Jonathan Harris, Caleb Rudkin

CONCURRENT SESSION THIRTEEN: CONSTRUCTION: THE CONSISTENT AND IMPORTANT NATURE OF TEMPORARY ISSUES

CONSIDERATIONS FOR DEWATERING DURING DAM CONSTRUCTION
John W. France

CONTINENTAL DAM SPILLWAY: MANAGING UNEXPECTED FOUNDATION CONDITIONS DURING CONSTRUCTION
Scott L. Jones, Joe Owen, Henrik Forsling

CONCURRENT SESSION FOURTEEN: EMERGENCY MANAGEMENT TOOLS: FROM PREPAREDNESS TO RESPONSE

FROM RAINDROP TO EVACUATE - HOW MODELING, GIS AND OTHER TOOLS ARE USED TO RESPOND TO FLOOD RELATED EMERGENCIES
Stephanie Gerlach, Thomas R. Loomis

SOUTH CAROLINA FLOODING AND DAM FAILURES
Emily Reed, Katile Poston, Lucas Muñásque, Dan Vandenberg, Alfred Kalyanapu

CONCURRENT SESSION FIFTEEN: UNIQUE FAILURE MODES

ICE: A FAILURE MODE!
Richard Rudolph

THE ABCS OF ACBS PART III ACB ARMORING FAILURE MODES AT DAM EMBANKMENTS AND SPILLWAYS
Paul Schweiger, Darin Shaffer, Jim Nadeau

WHY EMBANKMENTS CRACK AND HOW TO FIX THEM - 50 YEARS OF NRCS EXPERIENCE
Benjamin C. Doerge
CONCURRENT SESSION SIXTEEN: DECADE DAM FAILURES PART 1

UPRIVER DAM FAILURE, SPOKANE RIVER, 1986 ........................................................................................................... 449
  Douglas L. Johnson
THE MEADOW POND DAM TRAGEDY - HUMAN AND PHYSICAL FAILURES ................................................................. 460
  R. Lee Wooten, James W. Gallagher

CONCURRENT SESSION SEVENTEEN: SEEPAGE AND FILTERS

FILTER DESIGN: THE WHY, WHEN, AND WHERE ........................................................................................................... 474
  Chuck Redlinger, Bryant Robbins, Mark Pabst
INNOVATIVE APPROACHES TO ADDRESS HISTORIC DAM SEEPAGE .................................................................... 489
  Edwin Friend, Darren Brinker, Jeff Martin, Douglas Raitt
ANALYSIS OF INTERNAL EROSION AT INLAND LAKE DAM .................................................................................... 505
  Michael C. Canino, Jian Hu, Lawrence H. Roth

CONCURRENT SESSION EIGHTEEN: SOMETHING FOR EVERYONE – THE 2016 GRAB-N-GO TALKS

ROBERT STREET DAM REMOVAL - RESTORING MIGRATORY FISH PASSAGE ON THE RARITAN RIVER, NEW JERSEY ........................................................................................................... 526
  John W. Jengo, Gene Meyer
COMPREHENSIVE REHABILITATION IMPROVEMENTS AT CEDAR CREEK RESERVOIR DAM AND SPILLWAY ............................................................................................................................... 551
  Marc T. Miller, Louis Verreault
COUPLED DAM SAFETY ANALYSIS USING WINDAM ................................................................................................... 562
  Mitchell L. Neilsen, Ronald D. Tejral, Karl Visser, Sherry L. Hunt
DESIGN AND CONSTRUCTION OF THE UPSTREAM GEOMEMBRANE FACING SYSTEM FOR GRINDSTONE CANYON RCC DAM ........................................................................................................... 573
  Bob Waddell, Debi Lee, John Wilkes, Eric Schlosser, Robert Blankinship

CONCURRENT SESSION TWENTY: 3 MILLION TO 6.5 BILLION REASONS TO ATTEND THE SESSION ON EMBANKMENT DAMS

PRICELESS: THE VALUE OF PROJECT-FOCUSED GEOTECHNICAL AND HYDROLOGIC DATA ......................................................... 593
  Greg Paxson, Scott Raschke, Edward Raptosh
RAPID DRAWDOWN AT EMBANKMENT DAMS, IS IT A REAL CONCERN? ................................................................ 610
  Cari Beenenga, Andy Deichert, Robert Saber
DEVELOPMENT OF LA ROMAINE COMPLEX IN NORTHERN QUÉBEC, CANADA; BEHAVIOR OF ASPHALT CORE ROCKFILL DAMS ........................................................................................................... 618
  Vlad Alicescu, Jean Pierre, Redha Kara, Dan Rosculet

CONCURRENT SESSION TWENTY-ONE: HIGH FLOW RISK MANAGEMENT

BREAKING NEWS - TROPICAL STORM HITS OKLAHOMA, AGAIN! UNIQUE REPAIR CHALLENGES AT CADDIO CREEK SITE 27 ........................................................................................................... 636
  J. Chris Stoner, Valerie Glasgow, Gregg Hudson
FLOOD RISKS FROM SPILLWAYS: MODELING AND COMMUNICATING NON-DAM-FAILURE IMPACTS TO NATIVE AMERICAN TRIBES ........................................................................................................... 645
  Rinda Tisdale, Matthew Young
MANAGING FLOOD RISK INFRASTRUCTURE IN THE NEW MILLENNIA ................................................................. 650
  Jason Vazquez
CONCURRENT SESSION TWENTY-TWO: DAM REMOVALS

REMOVAL OF MAIN STREET DAM: CREATING A THRIVING ECOSYSTEM FROM A DEGRADED AND IMPOUNDED RIVER IN URBAN DOWNTOWN STAMFORD, CONNECTICUT ................................................................. 684
Adam W. Burnett, Siamac Vaghar

THE INVESTIGATION AND DESIGN OF THE PROPOSED LARGEST DAM REMOVAL IN NJ ................................. 693
Geoffrey M. Goll, Mary Paist-Goldman

CREATIVE APPROACH TO DAM BREACH SEDIMENT MANAGEMENT .............................................................................. 696
Gary B. Emmanuel, Stephen M. Szewczak

VOLUME 2

CONCURRENT SESSION TWENTY-THREE: UPLIFT CONSIDERATIONS FOR CONCRETE DAMS

UPLIFT CONSIDERATIONS FOR CONCRETE GRAVITY DAMS .................................................................................. 705
Scott L. Jones, Larry K. Nuss, Amanda Lopez

CONCURRENT SESSION TWENTY-FOUR: EMERGENCY RESPONSE TO GEOTECHNICAL INCIDENTS

TURBID DISCHARGE, THE SKIRMISH AT CANNONSVILLE DAM INCIDENT, RESPONSE AND RECOVERY ........................................................................................................ 713
John Vickers, Thomas Dejohn

SEEPAGE CONCERNS AT LAKE WHITE DAM PROMPTS EMERGENCY RESPONSE ......................................................... 738
Robert J. Kirkbride, Jeremy M. Wonner, Richard L. Williams

BOONE DAM - INITIAL RESPONSE, SITE CHARACTERIZATION AND DEVELOPMENT OF A LONG-TERM MITIGATION STRATEGY ................................................................................. 752
James M. Bryant, Daniel A. Gilbert, Scottie L. Barrentine

CONCURRENT SESSION TWENTY-FIVE: LEVEES: LESSONS LEARNED

ENVIRONMENTAL IMPACTS OF LEVEES AND THEIR MITIGATION ........................................................................... 764
Andrew J. Orlosky

THE USE OF SLAG CEMENT IN CB SEEPAGE CUTOFF WALLS FOR LEVEES ............................................................. 771
Khaled Chowdhury, Michael Kynett, Richard Millet, Rob Nixon, Francke Walberg, Nichole Tollefson

CONCURRENT SESSION TWENTY-SIX: DAM INSPECTIONS AND IDENTIFYING POTENTIAL PROBLEMS

COMPREHENSIVE DAM SAFETY EVALUATIONS: COLORADO EXPANDS RISK CONSIDERATIONS IN ITS DAM SAFETY PROGRAM .................................................................................. 788
John Hunyadi, Mark Perry, Jennifer L. Williams, John France

ALBERTA ENERGY REGULATOR DAM SAFETY PROGRAM .............................................................................................. 801
Tim Eaton, Santiago Paz

UNCOVERING AND ADDRESSING A HISTORY OF SIGNIFICANT INCIDENTS AFTER AN ANNUAL DAM SAFETY INSPECTION ........................................................................................................ 813
Steven Davidheiser, Robert A. Kline, Amanda Lothes

CONCURRENT SESSION TWENTY-SEVEN: FULL SCALE TESTING

LARGE-SCALE SHEAR BOX TESTS TO DETERMINE ROCKFILL PARAMETERS ........................................................................... 828
Ingvar Ekström, Magnus Ljunggren, Carl-Anders Andersson, Qi Jia, Jan Laue

FIELD ROLLING TRIALS TO INVESTIGATE COMPACTED GNEISS/SCHIST ROCKFILL PROPERTIES .............................. 847
Magnus Ljunggren, Ingvar Ekström, Carl-Anders Andersson
MONITORING OF A FULL-SCALE DAM FAILURE TEST ................................................................. 860
Shi-Jun Wang, Yan-Chang Gu, Hong Wang, Hai-Bing Huang, Ji-Hao Yan, Qiong Pang
FULL SCALE TEST FILL SUPPORTS EMERGING RESEARCH INTO EXIT GRADIENTS ................. 870
Robert J. Huzjak, James A. Olsen, Bryant A. Robbins

CONCURRENT SESSION TWENTY-EIGHT: RISK INFORMED DECISION MAKING – WHAT’S
ACCEPTABLE AND HOW DO WE GET THERE?

10E-3 / 10E-4 TWENTY YEARS LATER A REVIEW OF THE TOLERABILITY OF RISK
TWENTY YEARS LATER ........................................................................................................... 885
Patrick J. Regan
A REGULATORY PERSPECTIVE ON IMPLEMENTING RISK-INFORMED DECISION
MAKING IN DAM SAFETY .................................................................................................. 945
Douglas Boyer, William Allerton
APPLICATION OF ALARP PRINCIPLES FOR THE EVALUATION OF TOLERABLE RISK
FOR FERC REGULATED DAMS .......................................................................................... 957
Daniel W Osmun, Douglas D Boyer

CONCURRENT SESSION TWENTY-NINE: OPERATIONS AND MAINTENANCE

BENEFITTING NOT BURDENING: DEVELOPING INTERACTIVE RESOURCES FOR DAM
OWNERS AND OPERATORS ............................................................................................... 970
Kate E. Aulenbach, Paul Schweiger, Tony Fernandes
WHAT’S IN YOUR PIEZOMETER? EVALUATING AND MAINTAINING PIEZOMETERS,
RELIEF WELLS, AND DRAINS ....................................................................................... 981
Charles N. Easton, Russell G. Springer

CONCURRENT SESSION THIRTY: DECADE DAM FAILURES PART II

TENTH ANNIVERSARY OF THE LAKE NEEDWOOD DAM INCIDENT ..................................... 1009
Steve Durgin, Allin Stahl

CONCURRENT SESSION THIRTY-ONE: FLOOD HYDROLOGY AND METEOROLOGY

METHODS TO ESTIMATE THE ANNUAL EXCEEDANCE PROBABILITY (AEP) OF THE 1-
DAY PROBABLE MAXIMUM PRECIPITATION .................................................................. 1013
Douglas M. Hultstrand, Bill D. Kappel
GARRISON DAM PALEOFLOOD HYDROLOGY DISCHARGE ESTIMATION ANALYSIS .......... 1027
Brian M. Hall, Nicholas Koutsounis, Christina Leonard, Keith Kelson
DEALING WITH UNCERTAINTY IN HYDROLOGIC MODELING - JUST BETWEEN US .......... 1040
Amanda J. Hess, Paul G. Schweiger, Yan Wang

CONCURRENT SESSION THIRTY-TWO: CONSTRUCTION MANAGEMENT

BUCKEYE FRS NO. 1 DESIGN AND CONSTRUCTION OF A CENTRAL FILTER ON 7 MILES
OF DRY DAM IN THE DESERT SOUTHWEST ..................................................................... 1051
Douglas Lantz, Gregory Jones
EARLY CONTRACTOR INVOLVEMENT FOR A SEEPAGE BARRIER - THE
OWNER/ENGINEER PERSPECTIVE ................................................................................... 1094
Jon Ausdemore, Rachel Leier
CONCURRENT SESSION THIRTY-THREE: HYDROLOGY AND RISK STANDARDS

THIRTY YEARS OF SPILLWAY RECONSTRUCTION: IMPACTS OF MOVING TO A RISK BASED SPILLWAY STANDARD ......................................................... 1101
Michele Lemieux, Robert Kingery

CONCURRENT SESSION THIRTY-FOUR: ROLLER COMPACT CONCRETE

THERE'S SOMETHING IN THE AIR - ADVANCING GROUT ENRICHED CONCRETE FACING FOR RCC DAMS ................................................................. 1113
Jeremy R. Young, Eric S. Musselman, George J. Zimmer

POST-CONSTRUCTION CORING EVALUATION FOR RCC AT THE SAN VICENTE DAM RAISE PROJECT ............................................................... 1125
M. Rogers, A. Oleksyn, G. Tarbox, T. Reynolds, J. Reed, W. Griffis, J. Zhou, J. Stiady

CONCURRENT SESSION THIRTY-FIVE: EXTREME INSPECTION TECHNIQUES

YOUR RUSTY PIPES - REPAIR OR REPLACE THE THOMSON CONDUIT STORY ................................................................. 1139
Michael Carpenter, Kevin Roell, William Walton, Chris Rousseau

INSPECTION OF UPSTREAM SLOPE PROTECTION MATERIAL USING REMOTE SENSING ...................................................... 1148
Michael P. McGuire, Travis Shoemaker, Guillaume Roussel

THE INTEGRATION OF UNMANNED AIRCRAFT SYSTEMS (UASS) AND 3D MODELING SOFTWARE FOR BASELINE ASSET MANAGEMENT MONITORING (BAMM) OF DAMS ................................................................. 1159
D. Strachan, T. Barr, A. Mbah, E. Weech

POSTER PAPERS

IS IT TIME TO GO UPSTREAM? A GUIDE FOR UPSTREAM CONSTRUCTION AT HIGH HAZARD COAL REFUSE AND COAL ASH DISPOSAL DAMS ................................................................. 1174
Roger W. Cecil

A RETROSPECT OF THOSE OFTEN OVERLOOKED DAMS - DETENTION BASINS ................................................................. 1183
Clay Emerson, Kelsey Stanton

SEEPAGE DISTRESS AND REPAIRS ON THE CALIFORNIA AQUEDUCT ............................................................................ 1189
Leslie F. Harder, Jeanne Kattel, Joseph Rayer, Timothy Wehling, Joseph Burke, Robert Black, Michael Driller, Christina Kashiwada, Rob Barry, Raphael A. Torres

MAINTAINING EMBANKMENT SAFETY WITH COMPREHENSIVE INVESTIGATION AND ANALYSIS ................................................................. 1245
Dennis J. Hogan

CONVECTIVE HEAT TRANSFER ANALYSIS OF A DAM OVER PERMAFROST ........................................................................ 1252
Gokhan Inci, Ekin B. Bayrak

NAHTZILLEE DAM FAILURE OF 1996 (20 YEAR ANNIVERSARY) ........................................................................ 1265
Lee Mauney

RECONSTRUCTION OF A LOCAL DAM AS A REAL-WORLD LEARNING EXPERIENCE ................................................................. 1275
Andrew T. Rose

EXPANDING FLORIDA’S DAM INVENTORY USING GIS AND REMOTE SENSING ........................................................................ 1281
Dan Schmutz, Danny Goodding, Valerie A. Hrabal, Art Sengupta

ATLAS DAM REMOVAL MINIMIZING SEDIMENT DISPOSAL COSTS ........................................................................ 1283
Bill Weihbrecht

109 YEAR OLD DAM; 4 YEARS OF EXPERIENCE: DEVELOPING YOUNG PROFESSIONALS WITHIN DAM AND LEVEE SAFETY ........................................................................ 1292
Meghann Wygonik, Joe Goldstein

DAM SAFETY INSTRUMENTATION DATA ACQUISITION, MONITORING, AND DATA VISUALIZATION IMPROVEMENTS AT THE ROCKY MOUNTAIN HYDROELECTRIC PLANT ........................................................................ 1303
Peter Zimmerman, Daryl Jordan, Vani Newell

Author Index