



United States Department of the Interior

BUREAU OF RECLAMATION

P.O. Box 25007

Denver, CO 80225-0007

IN REPLY REFER TO:

86-68560
ADM-12.00

VIA ELECTRONIC MAIL ONLY

MEMORANDUM

To: Kelly Titensor, Acting Program Manager
Native American and International Affairs Office

Through: Thomas A. Luebke
Director, Technical Service Center

From: Mr. Tony L. Wahl, P.E., Hydraulic Engineer
Hydraulic Investigations and Laboratory Services, Technical Service Center

Subject: Control Number 18-225, International Trip report for Aussois, France

1. **Location:** Aussois, France
2. **Dates of Travel:** December 9-15, 2017
3. **Attendee:** Tony Wahl
4. **Purpose of Trip:** To participate in two workshops on the subject of erosion problems associated with overtopping flow at dams.
5. **Synopsis:** I traveled by air from Denver to Paris overnight, beginning on December 9. On December 10 I traveled by train and taxi to the meeting location at Aussois. The workshops took place on December 11-12 (embankment dams) and December 13-14 (concrete dams and unlined spillways). On the evening of December 14 I traveled by train to Geneva, Switzerland and returned to Denver by air on December 15.

The two workshops I attended were sponsored by the European Commission on Large Dams (EURCOLD) and the French Committee on Dams and Reservoirs (CFBR), and hosted by Electricité de France (EDF), the major producer, distributor and marketer of electricity in France. EDF has considerable hydropower assets and has been a long-time collaborator with Reclamation's hydraulics laboratory on research related to embankment dam breach modeling, with much of that research coordinated through the CEATI-DSIG (Centre for Energy Advancement through Technological Innovation-Dam Safety Interest Group). EDF provided full funding for my attendance at the workshops. An agenda for the workshops and attendee list is attached.

The first workshop on Monday and Tuesday focused on erosion problems associated with overtopping of embankment dams and dikes (including river and sea levees). On Monday I

presented a summary of the final report of the CEATI-DSIG project on evaluation of computational dam breach models. On Tuesday I gave an impromptu presentation on recent embankment breach tests performed in the summer of 2017 in Reclamation's hydraulics laboratory. One of these tests was of a zoned embankment with a downstream zone composed of well-graded gravel. This was provided to complement a presentation by Dr. Miguel Angel Toledo (Spain) on testing of zoned rockfill dams composed of more uniformly graded gravel.

On Wednesday and Thursday the second workshop was focused on erosion associated with overtopping of concrete dams, and also included several presentations related to rock erosion in unlined spillway chutes. I presented Reclamation's past experience with overtopping flow at Gibson Dam (Montana, 1964) and analysis of potential overtopping flows and abutment armoring needs for other Reclamation dams. I highlighted our interest in the use of photogrammetry to map rock joints and determine changes in rock profiles after significant flow events. Very interesting presentations were made by other workshop participants on recent research related to the hydraulic stream power characteristics of impinging and plunging jet flows, high velocity flow and erosion in unlined spillway chutes, and the forensic investigation of the Oroville Dam spillway chute failure.

Each workshop concluded with open discussions of research needs and potential collaborative research opportunities. I discussed Reclamation research funded for FY2018 on erodibility measurement methods for cohesive embankment soils and high-velocity flow over joints in concrete spillway chutes.

6. **Trip Agenda:** The workshop agendas and a list of attendees are attached.

7. **Benefit to Reclamation:** The workshops provided an opportunity for Reclamation to learn about state-of-the-art techniques for modeling erosion that occurs during overtopping of embankment dams and during high-velocity flows in unlined (rock) spillway chutes. Reclamation research projects will benefit from awareness of and collaboration with other research programs. Two specific opportunities are a collaboration with Belgian researchers developing a large-scale submerged jet erosion test device, and a collaboration with French and British researchers who wish to apply next-generation computational dam breach models to Reclamation's recent zoned embankment breach tests.

8. **Benefit to Traveler:** The traveler gained significant knowledge about new developments in the measurement and prediction of soil erodibility and the modeling of erosion affecting embankments and rock chutes.

9. **Conclusions and Recommendations:** There are numerous organizations in Europe, Australia, and North America that have common interests with Reclamation related to erosion caused by overtopping flow at dams. Communication with workshop attendees should be maintained so that Reclamation's research in these areas can address leading edge problems with a full awareness of accomplishments coming from other countries.

10. **Actions Required:** I will maintain contact with several workshop attendees to share useful data and literature and to develop future research collaborations.



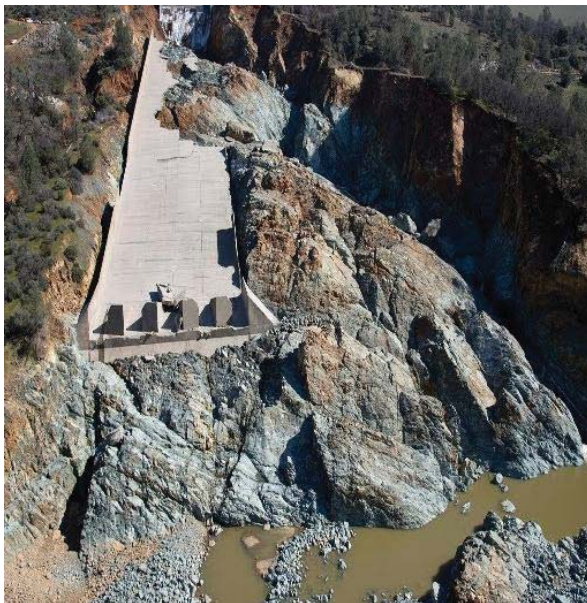
EURCOLD



International Workshop on overflowing erosion of dams and dikes

11 – 14th December 2017 - AUSSOIS, FRANCE

Programme and List of attendees



Supported by



International Workshop on overflowing erosion of dams and dikes

11-14 December 2017 – Aussois – France - Agenda

Part 1 – Embankment Dams and Dikes

Sunday 10th December

Taxi transfer from Modane railway station to Aussois resort

19:30: Dinner offered at the resort

Monday 11th December

07:30 – 08:15: Breakfast offered at the resort

08:40 – 08:50: Welcome address. J.-R. Courivaud

08:50 – 09:00: Goals of the workshop on embankment dams and dikes overtopping erosion. J.-R. Courivaud

09:00 – 15:30: Session 1: The Dam Owners' Perspectives: Issues and Engineering Needs

Moderator: Jean-Robert Courivaud

09:00 – 09:20: Hydro Quebec perspective (Annick Bigras/Judith Bouchard)

09:20 – 09:40: Environment Agency perspective (Christabel Mitchell)

09:40 – 10:00: EDF perspective (Jean-Robert Courivaud)

10:00 – 10:30: Coffee Break

10:30 – 10:50: CNR perspective (Christophe Picault)

10:50 – 11:10: USACE perspective (Scott Shewbridge)

11:10 – 11:30: Bavarian Environment Agency perspective (Stefan Raab)

11:30 – 11:50: Flanders agency perspective (Patrik Peeters)

11:50 – 12:10: SYMADREM perspective (Thibaut Mallet)

12:10 – 12:30: Rijkswaterstaat perspective, part 1 (Astrid Labrujere)

12:30 – 12:50: Rijkswaterstaat perspective, part 2 (Wim Kanning)

12:50 – 14:30: Lunch

14:30 – 15:00: UK dam owners' perspective (Alan Brown)

15:00 – 15:30: Synthesis of dam owners' perspectives. Jean-Robert Courivaud

Answering question n°1: What gaps need to be filled?

15:30: End of session 1

15:30 – 18:00: Session 2: State of the Art – Part 1

Moderator: Stephane Bonelli

15:30 – 16:00: Research performed at ARS-HERU Stillwater: Past, present and future developments (Sherry Hunt)

16:00 – 16:30: Coffee Break

16:30 – 17:00: DSIG project (Tony Wahl, USBR)

17:00 – 17:30: Overtopping erosion of coarse materials embankment dams, a literature review (Mark Morris)

17:30 – 18:00: USACE-ERDC research program (Maureen Corcoran/Johannes Wibowo)

18:00: End of the session 2

19:30: Dinner offered at the resort

Tuesday 12th December

07:30 – 08:15: Breakfast offered at the resort.

08:30 - 15:00: Session 3: State of the Art – Part 2

Moderator: Mark Morris

08:30 – 09:00: Overtopping erosion of clay core zoned embankment dams: experimental and numerical modelling (Miguel Angel Toledo, University of Madrid)

09:00 – 09:30: CIMNE research (Antonia Larese)

09:30 – 10:00: Hydro Quebec research (Judith Bouchard)

10:00 – 10:30: Coffee Break

10:30 – 11:00: NTNU research (Leif Lia)

11:00 – 11:30: IRSTEA research (Stéphane Bonelli)

11:30 – 12:00: EDF/geophyConsult research (Rémi Béguin)

12:00 – 13:30: Lunch

14:00 – 15:00: Synthesis of the state of the art (Stéphane Bonelli, Mark Morris)

Answering question n°1: What gaps need to be filled?

Answering question n°2: Which are the main lines of an international research project to fill these gaps?

15:00: End of Session 3.

15:00 – 15:30: Coffee Break

15:30 – 18:00: Session 4: How Moving Forward?

Moderator: Jean-Robert Courivaud

Come back to question n°1: What gaps need to be filled?

Come back to question n°2: Which are the main lines of an international research project to fill these gaps?

Main focus on question n°3: Which dam owners would be ready to fund such a research project?

18:00 End of the **embankment dams and dikes overtopping erosion** workshop

19:30: Dinner offered at the resort

21:00 - 22:00 : Social event – Traditional country dance show from the Alps



International Workshop on overflowing erosion of dams and dikes

11-14 December 2017 – Aussois – France - Agenda

Part 2 – Concrete Dams

Wednesday 13rd December

07:15 – 08:00: Breakfast offered at the resort

08:00 – 08:15: Goals of the workshop on concrete dams overtopping erosion. Frédéric Laugier

08:15 – 14:30: Session 5: The Dam Owners' Perspectives: Issues and Engineering Needs

Moderator: Frederic Laugier

08:15 – 09:00: Key note - Lessons learnt from Oroville dam 2017 flood (John France)

09:00 – 09:15: Verbund perspective (Florian Landstorfer)

09:15 – 09:30: Alpiq perspective (Raphael Leroy)

09:30 – 09:45: EDP perspective (Irene Fernandes)

09:45 - 10:00: Questions

10:00 – 10:30: Coffee Break

10:30 – 10:45: SDEM perspective (G. Desperoux)

10:45 – 11:00 EDF perspective (Frederic Laugier)

11:00 – 11:15: Uniper and Swedish perspective perspective (Carl-Oscar Nilsson)

11:15 – 11:30: Norwegian perspective (Leif Lia)

11:30 – 11:45: British Dam Society perspective (Alan Brown)

11:45 - 12:00: Questions

12:00 – 12:15: Vietnamese perspective (Michel Ho Ta Khanh)

12:15 – 12:30: Hydro Quebec perspective (Marco Quirion)

12:30 – 12:45: USACE perspective (Maureen Corcoran)

12:45 – 13:00: USBR perspective (Tony Wahl)

13:00 - 13:15: Questions

13:15 – 14:30: Lunch

14:30 – 14:45: Synthesis of dam owner's perspectives. Frederic Laugier

14:45: End of session 5

14:45 – 17:45: Session 6: State of the Art – Part 1

Moderator: George Annandale

14:45 – 15:15: University of Pisa research (Stefano Pagliara)

15:15 – 15:45: University of Cartagena research. Paute Cardenillo and Toachi dams (Luis Castillo / Jose Carrillo)

15:45 – 16:15: EDF research – Hydraulics of nappe flow (Yvan Bercovitz)

16:15 – 16:45 : Coffee Break

16:45 – 17:15: USBR research – High velocity flows over spillway chutes (Tony Wahl)

17:15 – 17:45 : UQAC-Hydroquebec research – (Ali Saedi – Lamine Boumaiza)

17:45: End of Session 6 part 1

18:00 – 19:30 : Social event – Alpine Aperitif in a 19th century fort (warm cloths suitable!)

19:30: Dinner offered at the resort

Thursday 14th December

07:00 – 08:00: Breakfast offered at the resort

08:00 – 09:30: Session 6: State of the Art – Part 2

Moderator: George Annandale

08:00 – 08:30: USACE research - Unlined spillway erosion risk assessment toolbox (Johannes Wibowo)

08:30 – 09:00: EPFL research (Pedro Manso)

09:00 – 09:30: ARTELIA research (Lucie Alazard, Thierry Vincent)

09:30: End of session 6

09:30 – 10:00: Coffee Break

10:00 – 16:00: Session 7: State of the art - Key note lectures

Moderator: Anton Schleiss / George Annandale

10:00 – 11:00: Key note lecture – George Annandale

11:00 – 12:00: Key note lecture – Steven Pells

12:00 – 13:30: Lunch

13:30 – 14:30: Key note lecture – Michaël George

14:30 – 15:30: Key note lecture – Anton Schleiss

15:30: End of session 7

15:30 – 16:00: Coffee Break

16:00 – 18:00: Session 8: How Moving Forward?

Moderator: John France

16:00 – 16:30: Synthesis of the state of the art and current developments (Anton Schleiss, George Annandale)

16:30 – 18:00: Discussion

Question n°1: What gaps need to be filled?

Question n°2: Which are the main lines of an international research project to fill these gaps?

Question n°3: Which dam owners would be ready to fund such a research project?

18:00 End of the workshop

19:30: Dinner offered at the resort

Friday 15th December

07:30 – 08:30: Breakfast offered at the resort.

Taxi transfer from Modane railway station to Aussois resort



International Workshop on overflowing erosion of dams and dikes

11-14 December 2017 – Aussois – France - Agenda

List of Attendees

Name	Surname	Organization	Country	Arrival	Depart	Email
Toledo	Miguel Angel	Univ. of Madrid	Spain	10th Dec.	15th Dec.	matoledo@caminos.upm.es
Moran	Rafael	Univ. of Madrid	Spain	10th Dec.	15th Dec.	r.moran@upm.es
Castillo	Luis	Univ. of Cartagena	Spain	12th Dec.	15th Dec.	luis.castillo@upct.es
Carillo	Jose	Univ. of Cartagena	Spain	12th Dec.	15th Dec.	jose.carillo@upct.es
Larese	Antonia	Univ. of Barcelona	Spain	10th Dec.	13th Dec.	antonialdt@gmail.com
Morris	Mark	Samui	UK	10th Dec.	15th Dec.	mark.morris@samui.co.uk
Brown	Alan	Stillwater Associated Ltd	UK	10th Dec.	15th Dec.	alan.brown@stillwater-associated.co.uk
Mitchell	Christabel	Environment Agency	UK	10th Dec.	13th Dec.	christabel.mitchell@environment-agency.gov.uk
Shewbridge	Scott	USACE	USA	10th Dec.	15th Dec.	scott.E.shewbridge@usace.army.mil
Wibowo	Johannes	USACE	USA	10th Dec.	15th Dec.	johannes.L.Wibowo@usace.army.mil
Corcoran	Maureen	USACE	USA	10th Dec.	15th Dec.	maureen.K.Corcoran@usace.army.mil
Hunt	Sherry	USDA-ARS-HERU	USA	10th Dec.	14th Dec.	sherry.hunt@ars.usda.gov
France	John	AECOM	USA	10th Dec.	15th Dec.	john.france@aecom.com
Wahl	Tony	USBR	USA	10th Dec.	15th Dec.	twahl@usbr.gov
Annandale	George	Consultant	USA	10th Dec.	15th Dec.	george@GWAnnandale.com
George	Mike	BGC Engineering Inc.	USA	10th Dec.	15th Dec.	mgeorge@bgcengineering.ca
Lia	Leif	University of Trondheim	Norway	11th Dec.	14th Dec.	leif.lia@ntnu.no
Ravindra	Ganesh	University of Trondheim	Norway	11th Dec.	14th Dec.	
Douglas	Kurt	UNSW	Australia	10th Dec.	15th Dec.	k.douglas@unsw.edu.au
Pells	Steven	Pells Consulting	Australia	10th Dec.	15th Dec.	Steven.Pells@psm.com.au
Manso	Pedro	EPFL	Switzerland	13th Dec.	14th Dec.	pedro.manso@epfl.ch
Schleiss	Anton	EPFL	Switzerland	13th Dec.	14th Dec.	anton.schleiss@epfl.ch
Leroy	Raphael	Alpiq	Switzerland	12th Dec.	15th Dec.	raphael.leroy@alpiq.com
Peeters	Patrik	Flanders Agency	Belgium	10th Dec.	15th Dec.	patrik.peeters@mow.vlaanderen.be
Vercruysse	Jeroen	Flanders Agency	Belgium	10th Dec.	13th Dec.	jeroen.vercruysse@mow.vlaanderen.be
Pagliara	Stefano	University of Pisa	Italy	10th Dec.	15th Dec.	s.pagliara@ing.unipi.it
Raab	Stefan	Bavarian Environment Agency	Germany	10th Dec.	15th Dec.	stefan.raab@lfu.bayern.de
Stoelben	Ferdinand	Stoelben GmbH	Germany	10th Dec.	13th Dec.	stoelben@stoelben-gmbh.de
Eitner	Volker	Geopartner	Germany	10th Dec.	13th Dec.	volker.eitner@geopartner.lu
Labrujere	Astrid	Rijkswaterstaat	The Netherlands	10th Dec.	13th Dec.	astrid.labrujere@rws.nl
Kanning	Wim	Deltares	The Netherlands	10th Dec.	13th Dec.	wim.kanning@deltares.nl
Bigras	Annick	Hydro Quebec	Canada	10th Dec.	15th Dec.	bigras.annick@hydro.qc.ca
Quirion	Marco	Hydro Quebec	Canada	10th Dec.	15th Dec.	quirion.marco@hydro.qc.ca
Bouchard	Judith	Hydro Quebec	Canada	10th Dec.	15th Dec.	bouchard.judith@hydro.qc.ca
Saeidi	Ali	University of Quebec	Canada	11th Dec.	15th Dec.	Ali_Saeidi@uqac.ca
Boumaiza	Lamine	University of Quebec	Canada	11th Dec.	15th Dec.	
Nilsson	Carl-Oscar	UNIPER	Sweden			carl-oscar.nilsson@uniper.energy
Landstorfer	Florian	Verbund	Austria	10th Dec.	15th Dec.	florian.landstorfer@verbund.com
Fernandes	Irene	EDP	Portugal			irene.fernandes@edp.pt
Ho Ta Khanh	Michel	Consultant	France	10th Dec.	15th Dec.	mhotakhanh@yahoo.com
Bonelli	Stephane	IRSTEA	France	10th Dec.	13th Dec.	stephane.bonelli@irstea.fr
Mallet	Thibaut	SYMADREM	France	10th Dec.	12th Dec.	thibaut.mallet@symadrem.fr
Aigouy	Stephan	BETCGB	France	10th Dec.	14th Dec.	stephan.aigouy@developpement-durable.gouv.fr
Loudiere	Daniel	CTPBOH	France	10th Dec.	13th Dec.	daniel.loudiere@free.fr
Picault	Christophe	CNR	France	10th Dec.	12th Dec.	c.picault@cnr.tm.fr
Garandet	Aurelie	CNR	France	10th Dec.	12th Dec.	a.garandet@cnr.tm.fr
Deroo	Luc	ISL	France	11th Dec.	14th Dec.	deroo@isl.fr
Beguín	Remi	geophyConsult	France	11th Dec.	12th Dec.	remi.beguín@geophyconsult.com
Despeyroux	Guillaume	SHEM	France	12th Dec.	14th Dec.	guillaume.despeyroux@shem.engie.com
Vincent	Thierry	Artelia	France	12th Dec.	14th Dec.	thierry.vincent@arteliagroup.com
Alazard	Lucie	Artelia	France	12th Dec.	14th Dec.	lucie.alazard@arteliagroup.com
Creneau	Stanislas	EDF	France	12th Dec.	14th Dec.	stanislas.creneau@edf.fr
Rifai	Ismail	EDF	France	10th Dec.	13th Dec.	ismail.rifai@edf.fr
Bercowitz	Yvan	EDF	France	12th Dec.	14th Dec.	yvan.bercowitz@edf.fr
Fry	Jean-Jacques	EDF	France	13th Dec.	15th Dec.	jean-jacques.fry@edf.fr
Valley	Paul	EDF	France	13th Dec.	14th Dec.	paul.valley@edf.fr
Idelon	Cecile	EDF	France	13th Dec.	14th Dec.	cecile.idelon@edf.fr
Del Gatto	Laurent	EDF	France	10th Dec.	12th Dec.	laurent.delgatto@edf.fr
Laugier	Frederic	EDF	France	12th Dec.	15th Dec.	frederic.laugier@edf.fr
Courivaud	Jean-Robert	EDF	France	10th Dec.	15th Dec.	jean-robert.courivaud@edf.fr
Delorme	François	EDF	France	10th Dec.	15th Dec.	francois.delorme@edf.fr