Nevada Division of Water Resources | Nevada Department of Conservation & Natural Resources

EAPs in Nevada 101

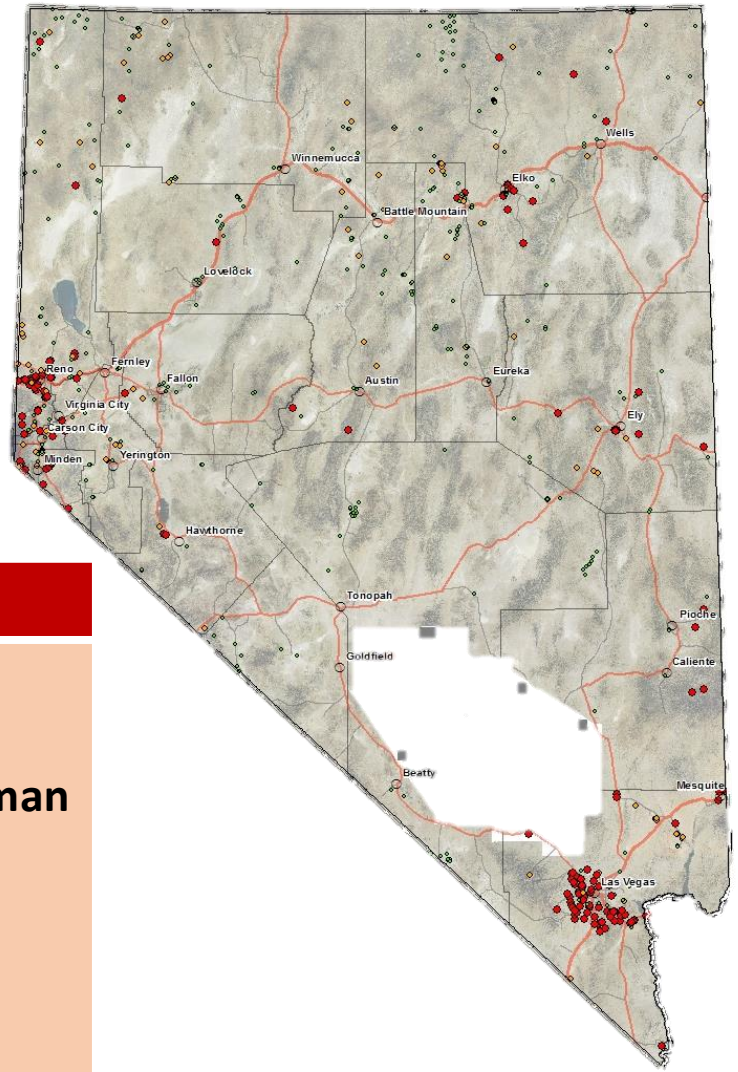
Danny Larson, Water Resource Specialist
NDWR, Dam Safety Program
And
Keith Johnson, P.E., Staff Engineer II
NDWR, Dam Safety Program

Hazard Classification

≈ 653 Dams in inventory (including tailings dams)

- 156 High Hazard (Red)
- 89 Significant Hazard (Orange)
- 407 Low Hazard (Green)

The Hazard Classification is based solely on the downstream condition of a dam.



NAC 535.140 Hazard classifications. (NRS 532.120, 535.030, 535.040)

Low Hazard	Significant Hazard	High Hazard
(1) Very low probability of causing a loss of human life; and (2) Reasonable probability of causing little, if any, economic loss or disruption in a lifeline.	(1) Reasonable probability of causing a loss of human life; or (2) High probability of causing extensive economic loss or disruption in a lifeline.	High probability of causing a loss of human life.

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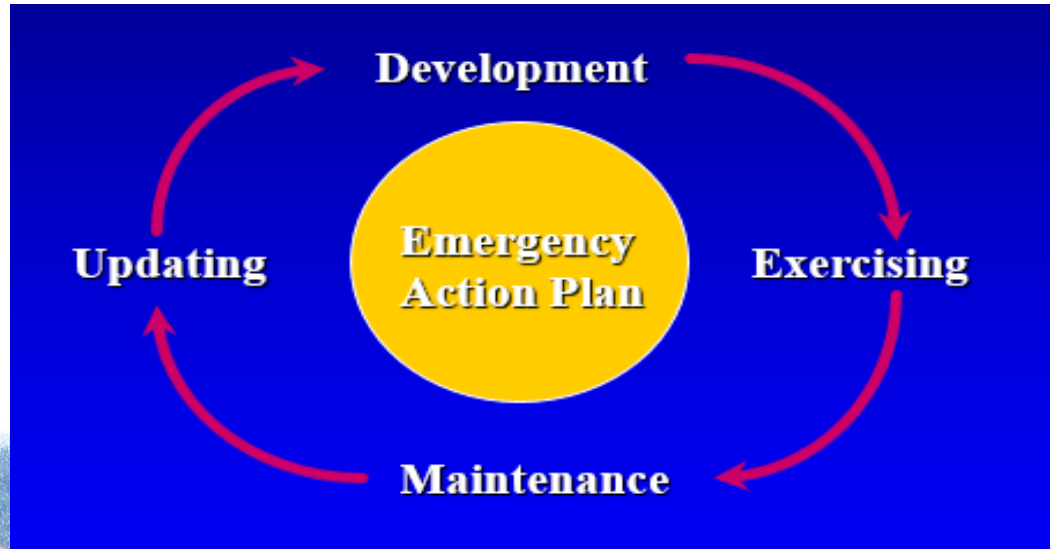
Dam Emergency Action Plans

The dams within State of Nevada Jurisdiction:

- Emergency Action Plans (EAPs) are required for Significant & High Hazard Dams.
- All 156 High Hazard Dams have an EAP, not all are up to date.
- For Significant Hazard dams there are approximately 73 EAPs complete of 89 at this time.
- 16 Low Hazard dams have EAPs even though they are not required to have an EAP.



Requirements for Dam EAPs

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NAC 535.320 Emergency action plan. (NRS 532.120)

1. To obtain an approval to impound, including a temporary approval to impound, an owner or operator of a dam classified as high hazard or significant hazard must submit to the State Engineer an emergency action plan for the dam.

2. An owner or operator of a dam classified as high hazard or significant hazard for which an approval to impound has been granted as of October 24, 2014, or that otherwise is impounding water or is capable of impounding water as of October 24, 2014, shall submit to the State Engineer an emergency action plan for the dam.

3. An emergency action plan submitted pursuant to this section must:

(a) Follow the format presented by the Federal Emergency Management Agency in the Federal Guidelines for Dam Safety: Emergency Action Planning for Dams (FEMA Publication No. P-64) or an equivalent format approved by the State Engineer;

(b) For those sections requiring numeric analysis, calculations or mapping, be prepared under the direction of a professional engineer;

(c) Include a detailed response for each foreseeable emergency; and

(d) Include one or more inundation maps.

4. An owner or operator subject to this section shall:

(a) Perform periodic exercises under the plan;

(b) Update the plan as necessary to keep it current and incorporate lessons learned from the exercises; and

(c) Submit any updates to the plan to the State Engineer.

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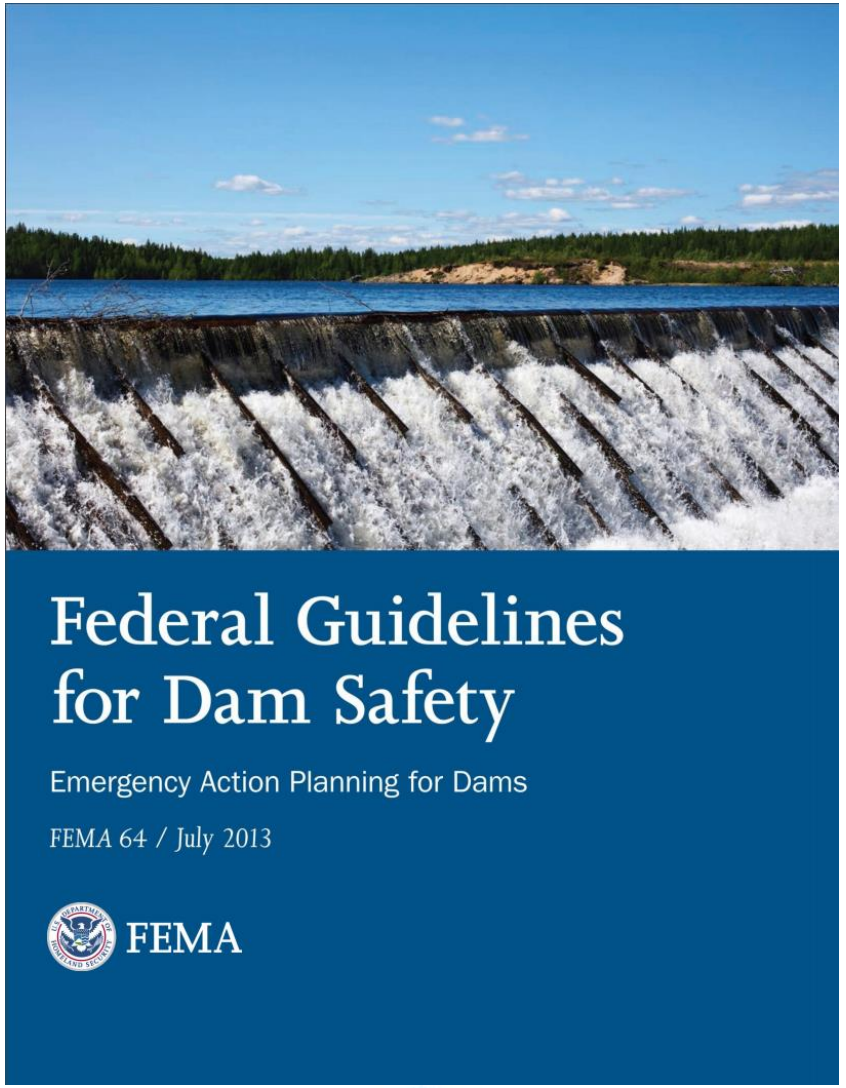
- Require that dam owners have an EAP and Inundation Map created to FEMA P-64 Guidelines.
- Review submitted EAPs and Inundation Maps to ensure they are in accordance to the guidelines.
- Require that dam owners keep the plan and maps up to date.
- Require the dam owners to send their EAP to their County/City Emergency Managers, NWS, NDEM.
- Require notification when an EAP is implemented.
- Require dam owners to update their EAPs every 5 years.



Hazard Creep

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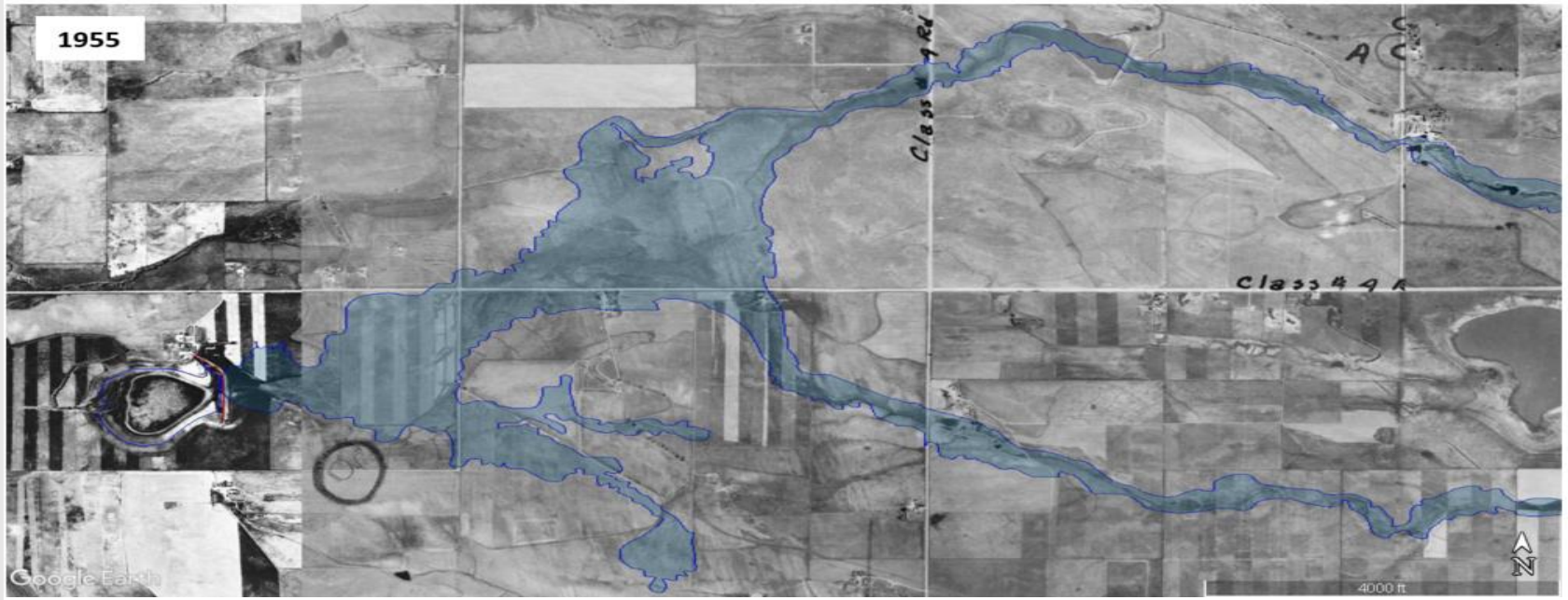

Aerial imagery comparison (1955 vs. 1999) showing infrastructure development within the current dam breach inundation limits downstream of a High hazard dam in southwest Denver, Colorado.

(Photo Source: Google Earth, 2019)
ASDSO
Damfailures.org

Hazard Creep

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Aerial imagery comparison (1955 vs. 1999) showing infrastructure development within the current dam breach inundation limits downstream of a High hazard dam in southwest Denver, Colorado.

(Photo Source: Google Earth, 2019)
ASDSO Damfailures.org

Hazard Creep – Pittman Anthem Detention Basin

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Hazard Creep – Pittman Anthem Detention Basin

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Hazard Creep – Chester Dam

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Structure of a Dam EAP

- **Designated Roles and Responsibilities -** Who is going to do what?

- **The Five Step EAP Process:**

  1. Detection - Identifying the hazard and/or emergency.

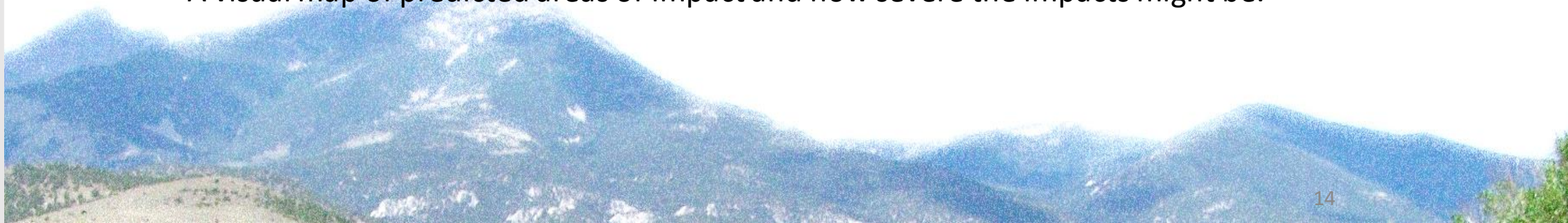
  2. Determination - Determine how critical the hazard is.

  3. Notification and Communication - Current contact information listed and who calls who instructions.

  4. Pre-planned Action - Executing actions based on level of emergency.

  5. Termination and Follow-up – Determine when an emergency is over and actions to end it.

- **Inundation Mapping**
  - A visual map of predicted areas of impact and how severe the impacts might be.



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Roles During an Incident

Dam Owner/Operator

- If event is observed, report ASAP
- Determine Level
  - Level 1 – Unusual Event
  - Level 2 – Potential failure situation
  - Level 3 – Dam failure occurring or is imminent
- Notify agencies/people per EAP Notification Chart
- Provide updates on situation to incident commander.

Incident Commander

- Primary Contact Person
- Level 2 (failure potential)
  - Prepare Emergency personnel
- Level 3 (failure occurring)
  - Initiate evacuations and warnings
  - Notify emergency management services to evacuate people and close roads
- Decide when to terminate event
- Help prepare/update EAPs

Roles During an Incident

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Division of Water Resources

- Advise Dam Operator/Owner in determining EAP Action Level
- Advise Dam Operator/Owner of potential remedial actions, if time permits

Emergency Manager

- Maintain communication with media
- Level 2
  - Help Incident Commander with potential evacuation plan
- Level 3
  - Alert Public
  - Immediately close roads and evacuate people
- Participate in annual review and help update EAP

Five Steps Summarized

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EAP Overview

STEP 1: Event Detection

- Detect event

Step 2: Emergency Level Determination

- Assess situation determine emergency level
  - **Level 1** Unusual Event; Slowly Developing
  - **Level 2** Potential Dam Failure Situation; Rapidly Developing
  - **Level 3** Urgent; Dam Failure Appears to be Imminent or is in Progress

Step 3: Notification and Communication

- Level 1: **Notify** Level 1 Lists
- Level 2: **Notify** Level 2 Lists
- Level 3: **Notify** Level 3 Lists

Step 4: Expected Actions

- Level 1: **Monitor**
- Level 2: **Save dam** Protective Actions
- Level 3: **Save people** Evacuate

Step 5: Termination and Follow-up

- Termination and follow-up

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EXAMPLE - Step 1: Detection

This step describes the detection of an unusual or emergency event and provides information to assist the dam operator in determining the appropriate emergency level for the event.

Unusual or emergency events may be detected by:

- Observations at or near the dam by government personnel (local, state, or Federal), landowners, visitors to the dam, or the public
- Evaluation of instrumentation data
- Earthquakes felt or reported in the vicinity of the dam
- Forewarning of conditions that may cause an unusual event or emergency event at the dam (for example, a severe weather or flash flood forecast)

See *Guidance for Determining the Emergency Level* table for assistance in evaluating specific events to determine if they are unusual or potential emergency situations.

EXAMPLE - Step 2: Determination

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Guidance for Determining the Emergency Level

Event	Situation	Emergency level*
Earth spillway flow	Reservoir water surface elevation at auxiliary spillway crest or spillway is flowing with no active erosion	1
	Spillway flowing with active gully erosion	2
	Spillway flow that could result in flooding of people downstream if the reservoir level continues to rise	2
	Spillway flowing with an advancing head cut that is threatening the control section	3
	Spillway flow that is flooding people downstream	3
Embankment overtopping	Reservoir level is 1 foot below the top of the dam	2
	Water from the reservoir is flowing over the top of the dam	3
Seepage	New seepage areas in or near the dam	1
	New seepage areas with cloudy discharge or increasing flow rate	2
	Seepage with discharge greater than 10 gallons per minute	3
Sinkholes	Observation of new sinkhole in reservoir area or on embankment	2
	Rapidly enlarging sinkhole	3
Embankment cracking	New cracks in the embankment greater than ¼-inch wide without seepage	1
	Cracks in the embankment with seepage	2
Embankment movement	Visual movement/slippage of the embankment slope	1
	Sudden or rapidly proceeding slides of the embankment slopes	3
Instruments	Instrumentation readings beyond predetermined values	1
Earthquake	Measurable earthquake felt or reported on or within 50 miles of the dam	1
	Earthquake resulting in visible damage to the dam or appurtenances	2
	Earthquake resulting in uncontrolled release of water from the dam	3
Security threat	Verified bomb threat that, if carried out, could result in damage to the dam	2
	Detonated bomb that has resulted in damage to the dam or appurtenances	3
Sabotage/ vandalism	Damage to dam or appurtenance with no impacts to the functioning of the dam	1
	Modification to the dam or appurtenances that could adversely impact the functioning of the dam	1
	Damage to dam or appurtenances that has resulted in seepage flow	2
	Damage to dam or appurtenances that has resulted in uncontrolled water release	3

* Emergency Level 1: Nonemergency unusual event, slowly developing
* Emergency Level 2: Potential dam failure situation, rapidly developing
* Emergency Level 3: Urgent; dam failure appears imminent or is in progress

EXAMPLE - Step 3: Notification and Communication-FIX

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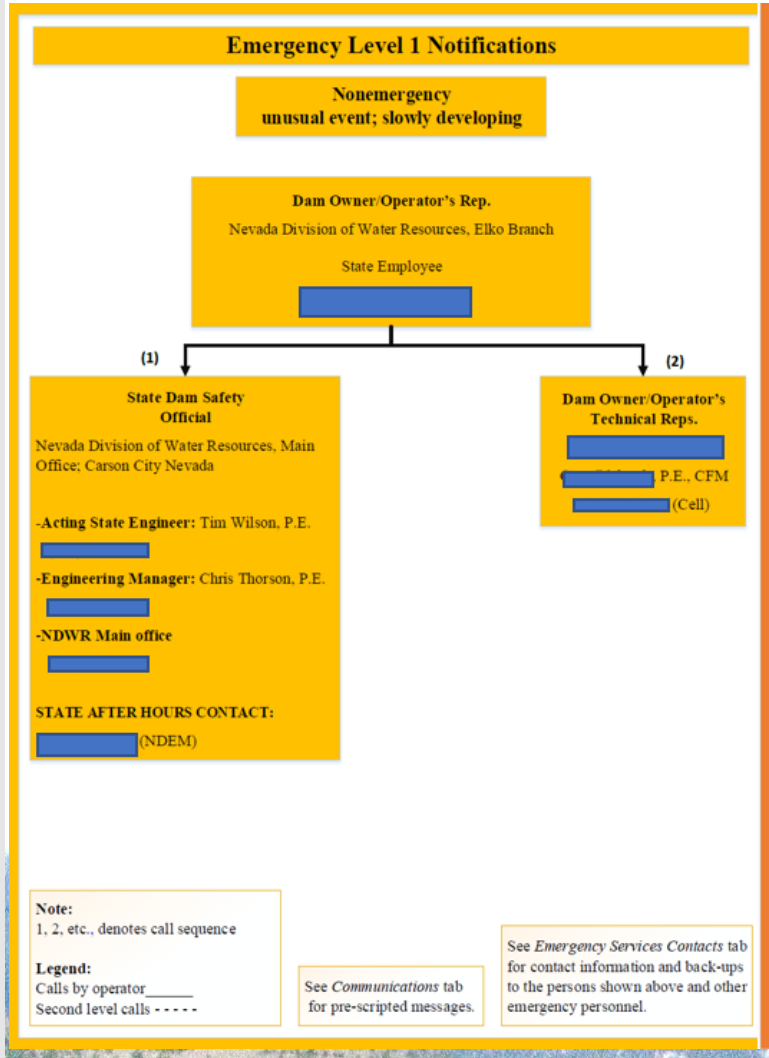

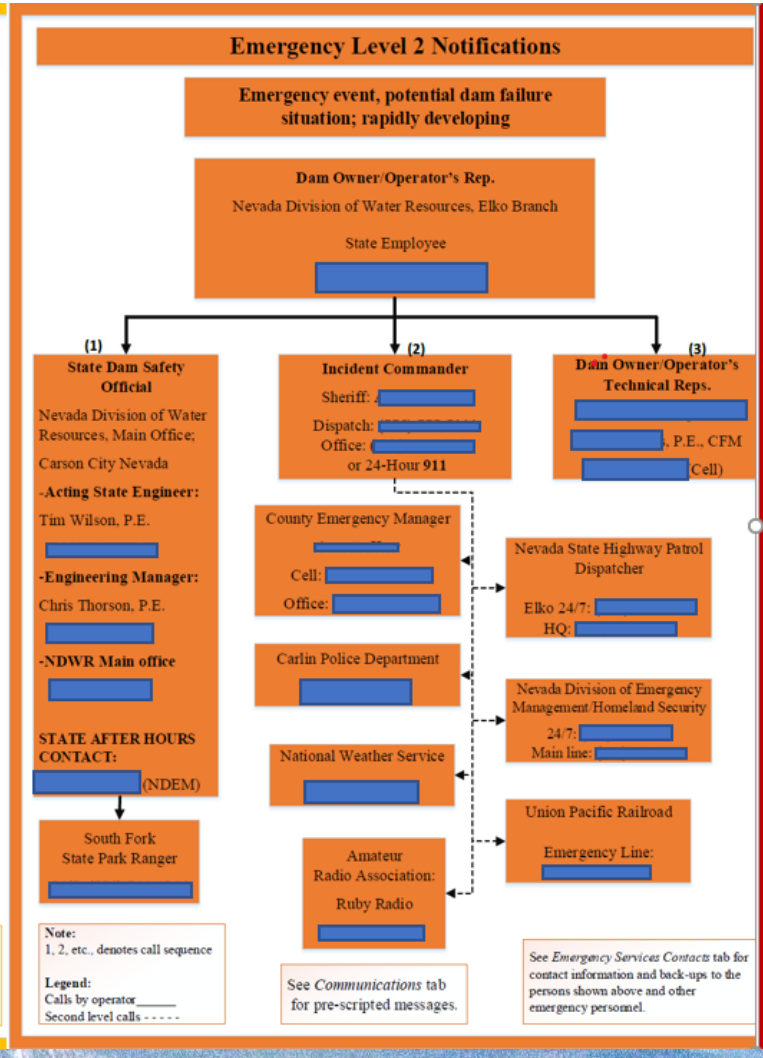

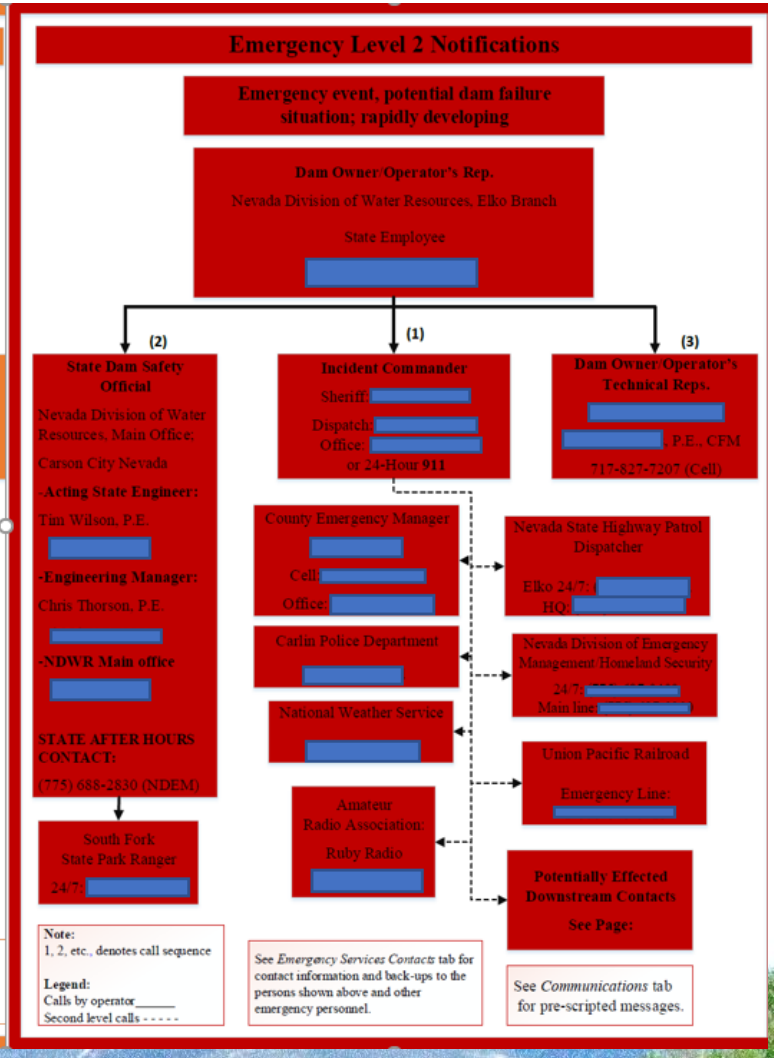

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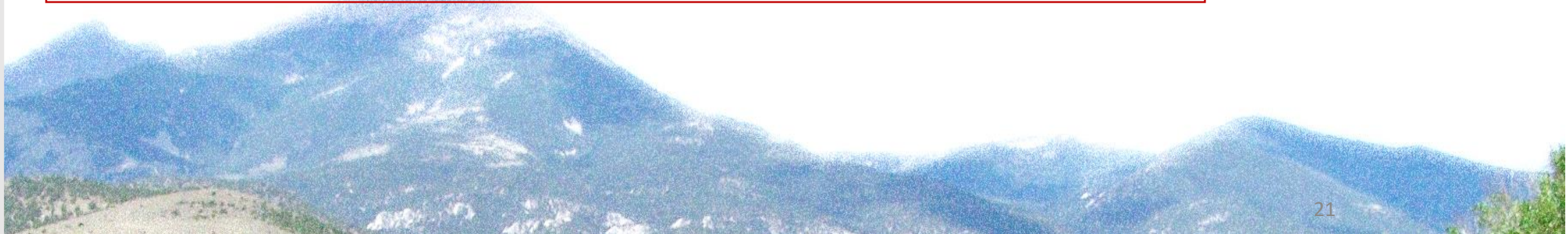
EXAMPLE - Step 4: Expected Actions

Emergency Level 1–Nonemergency, unusual event; slowly developing:
-The Dam Owner/Operator should inspect the dam.
-Contact their technical representatives & contact our office for advice.
-Record.

Emergency Level 2–Potential dam failure situation; rapidly developing:
-Contact their technical representatives & contact our office for advice.
-Inform 911, or IC to put EAP level 2 into effect.
-Provide updates to IC and do what they say and follow guided roles in EAP.
-If time permits; inspect the dam.
-Record.

Emergency Level 3–Urgent; Dam failure is imminent or in progress:
-Immediately inform 911, or IC to put EAP level 2 into effect.
-Provide updates to IC and do what they say and follow guided roles in EAP.
-Record and get to safe location.



EXAMPLE - Step 5: Termination & Follow-Up

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Step 5 Termination

Whenever the EAP has been activated, an emergency level has been declared, all EAP actions have been completed, and the emergency is over, the EAP operations must eventually be terminated and follow-up procedures completed.

Termination responsibilities

The Sheriff is responsible for terminating EAP operations and relaying this decision to the Dam Owner or Water Commissioner. It is then the responsibility of each person to notify the same group of contacts that were notified during the original event notification process to inform those people that the event has been terminated.

Prior to termination of an Emergency Level 3 event that has not caused actual dam failure, the State Dam Safety Officer will inspect the dam or require the inspection of the dam to determine whether any damage has occurred that could potentially result in loss of life, injury, or property damage. If it is determined that condition do not pose a threat to people or property, the Sheriff will be advised to terminate EAP operations as described above.

The Dam Owner or Water Commissioner shall assure that the *Dam Safety Emergency Situation Report* (Appendix A–3) is completed to document the emergency event and all actions that were taken. The Dam Owner or Water Commissioner shall distribute copies of the completed report to the Nevada Division of Water Resources.

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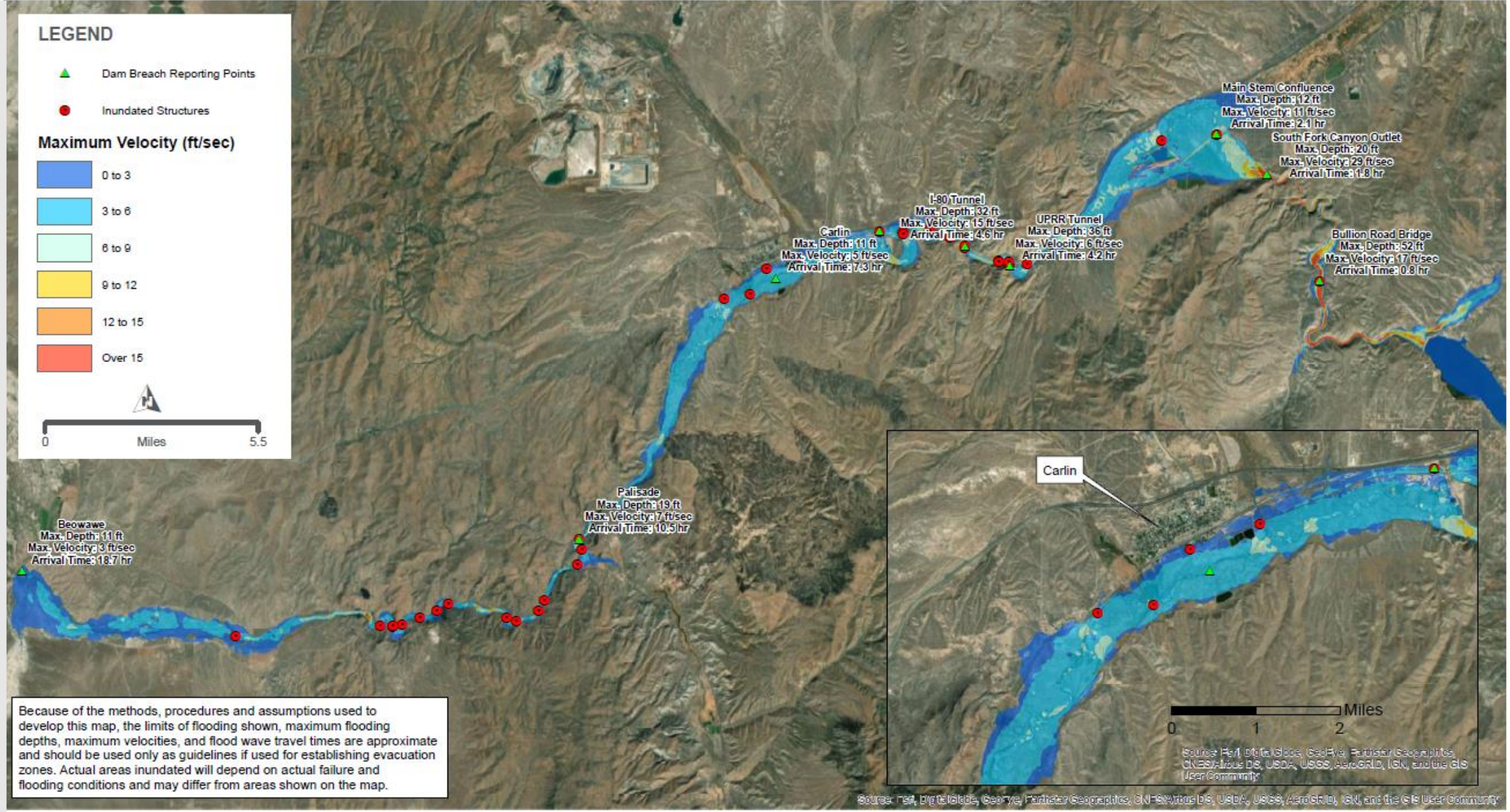

Because of the methods, procedures and assumptions used to develop this map, the limits of flooding shown, maximum flooding depths, maximum velocities, and flood wave travel times are approximate and should be used only as guidelines if used for establishing evacuation zones. Actual areas inundated will depend on actual failure and flooding conditions and may differ from areas shown on the map.

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HDR

SOUTH FORK DAM INUNDATION MAPPING

FIGURE 3 - MAIN DAM SUNNY DAY BREACH MAXIMUM VELOCITY RESULTS

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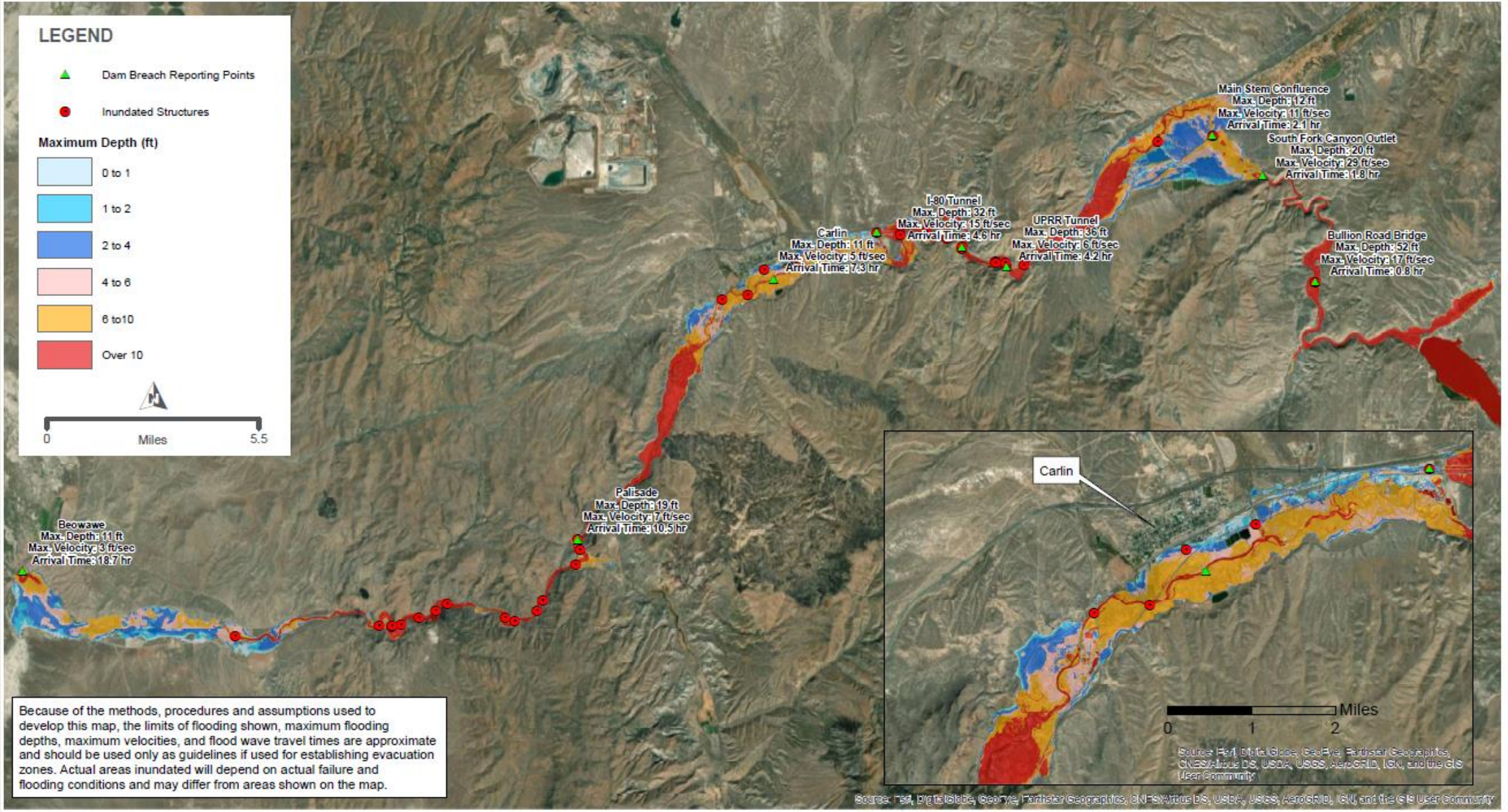

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SOUTH FORK DAM INUNDATION MAPPING

FIGURE 4 - MAIN DAM SUNNY DAY BREACH MAXIMUM DEPTH RESULTS

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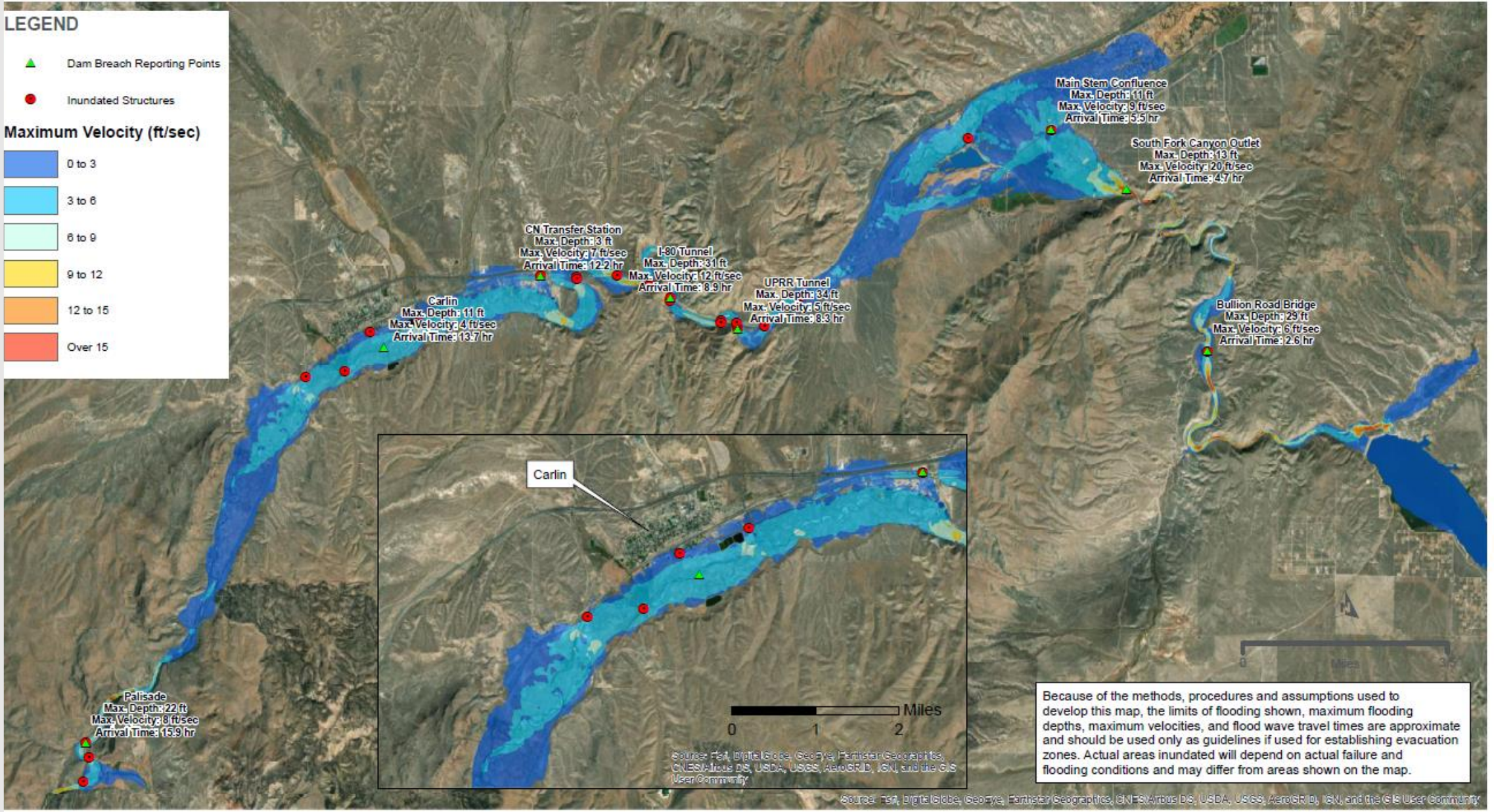

SOUTH FORK DAM INUNDATION MAPPING

FIGURE 6 - SADDLE DAM PMF BREACH MAXIMUM VELOCITY RESULTS

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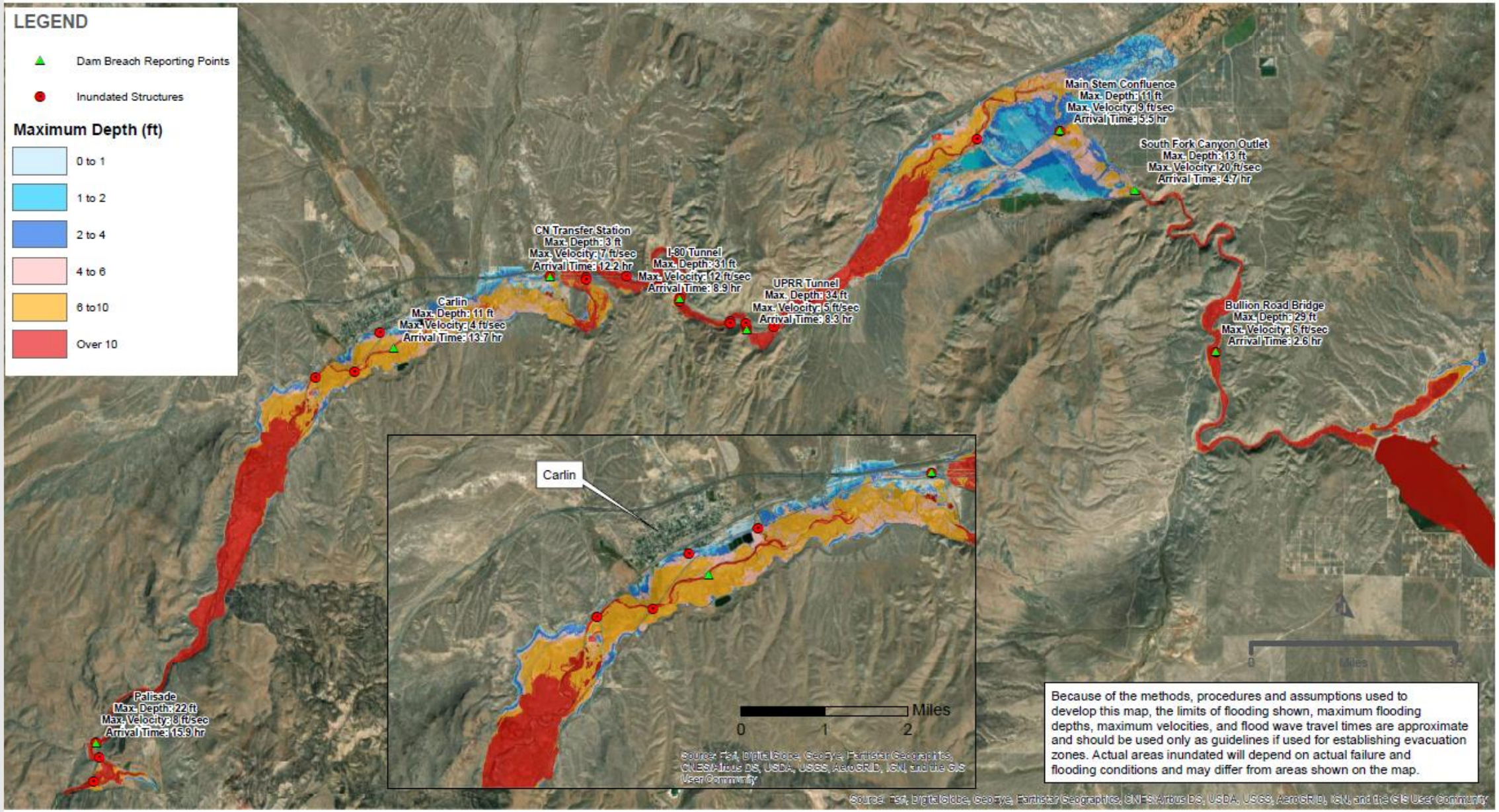

SOUTH FORK DAM INUNDATION MAPPING

FIGURE 7 - SADDLE DAM PMF BREACH MAXIMUM DEPTH RESULTS

7. Inundation Mapping

	a	Does the inundation map include a north arrow and a bar scale?
	b	Are the inundation areas clearly delineated and labeled (this is especially important if there are multiple inundation scenario limits shown on the inundation maps)?
	c	Does the inundation map include a qualification stating that the inundation limits for an actual dam failure may vary in some ways from what is shown on the inundation map?
	d	Are local roads, drainages, and other landmarks clearly labeled on the base map?
	e	Are critical facilities identified on an inundation map?
	f	Is the downstream limit of the inundation mapping logical (e.g. at a major reservoir, river, or other water course)?
	g	Were channel cross sections taken at critical downstream locations (such as major road crossings, schools, population centers, etc.)?
	h	*Line out* flood inundation information provided at downstream cross sections: Peak flood stage; Flood wave arrival time; Maximum water surface elevation; Peak discharge; Other parameter (indicate)_____
	i	Notes:

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Common Mistakes

- Not submitted in a tabbed binder

- Confusing or insufficient notification chart
  - ❑ Overly Complex
  - ❑ Too many calls for certain individuals
  - ❑ Incorrect contact info/ wrong numbers

- Ineffective inundation map
  - ❑ outlined with no observation lines
  - ❑ Missing labels on important structures
  - ❑ Illogical ending to flow path

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Every EAP in Nevada Should Have:

1. Physical copy in a tabbed binder AND an electronic copy submitted
2. Clearly outlined emergency actions and preplanned responses to help with emergency level determination
3. Notification chart that is clear AND simple with verified contact information
4. Clean and detailed inundation map
5. Plans to update EAP in the future

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When to update the EAP

Nevada requires all Emergency Action plans to be updated every 5 years

Why?

- Changes in staffing and contact information
- Physical changes or alterations to the dam
- New development downstream

Emergency Action Plans are living documents and should be updated with any change as soon as possible.

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What are the five steps of any emergency?

A. Detection, delay, response, search & rescue, mitigation

B. Planning, preparedness, presence of mind, prayer, procrastination

C. Worry, worry more, call someone, panic, blame, call lawyer

D. Detection, decision making, notification, preventative actions, termination and follow-up

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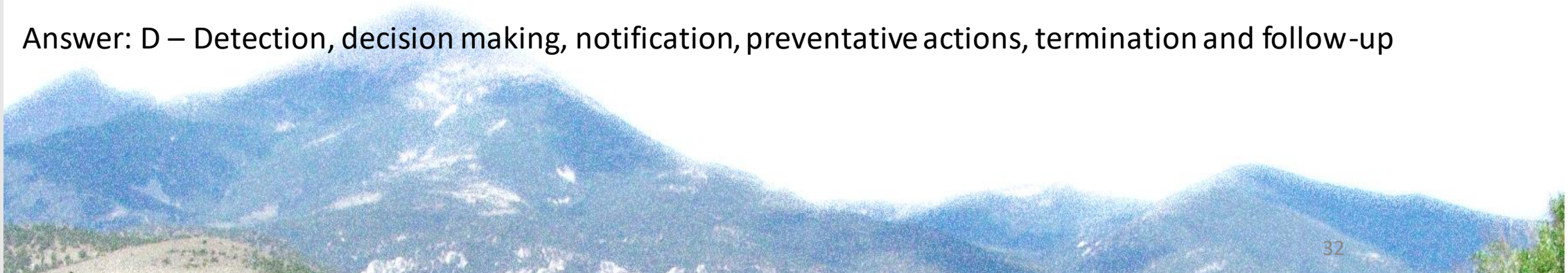
C. Worry, worry more, call someone, panic, blame, call lawyer

D. Detection, decision making, notification, preventative actions, termination and follow-up

Answer: D – Detection, decision making, notification, preventative actions, termination and follow-up



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If a dam fails, who is responsible for downstream warning and evacuation ?

A. The governor

B. The County Emergency Manager and law enforcement

C. The dam owner

D. NDWR Dam Safety Section

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If a dam fails, who is responsible for downstream warning and evacuation ?

A. The governor

B. The County Emergency Manager and law enforcement

C. The dam owner

D. NDWR Dam Safety Section

Answer: B – The County Emergency Manager in coordination with law enforcement

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Consequences of not having an EAP?

In the event of a dam failure

- Loss of life downstream
- Damage to property downstream (both public and private)
- Loss of dam and reservoir
- Years of litigation in civil court.
- Possible criminal charges

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Truckee Canal Failure (Nevada, 2008)

Damages estimated to be ~$50,000,000

Posted March 21, 2008 - 10:00pm

Rodent burrows blamed in canal failure

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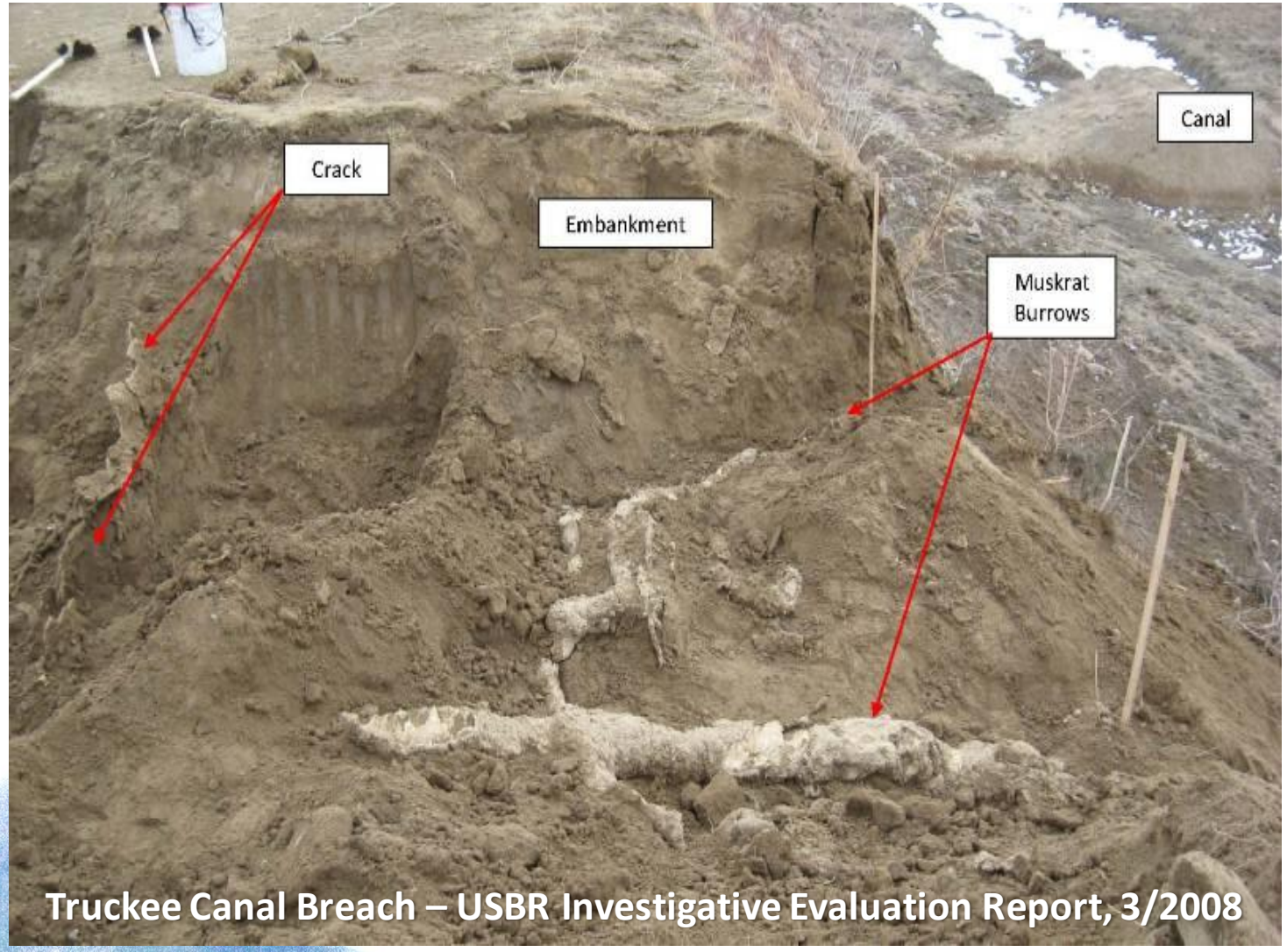
Polyurethane Foam Injected In Animal Burrows to Evaluate Extent of Damage …



Truckee Canal Breach – USBR Investigative Evaluation Report, 3/2008

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2017 Flood Event

Eldorado Canyon Dam– Dayton, Nevada

Herman Dam– Reno, Nevada

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2017 Winter

Marlette Lake Spillway – Above Lake Tahoe, Nevada

Twenty-One Mile Dam Failure – Montello, Nevada

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Twenty-One Mile Dam Failure (Nevada, 2017)

<u>Approximate Dam Details</u>

- Hazard: Low
- Length: 600 ft
- Height: 47 ft
- Spill Width: 40 ft
- Structural Height: 47 ft
- Number of Outlets: 1
- Max Discharge: 100 CFS
- Normal Storage: 5500 AF
- Surface Area: 100 Acres
- Drainage Area: ~680 sq. mi.
- Construction Year: ~1915

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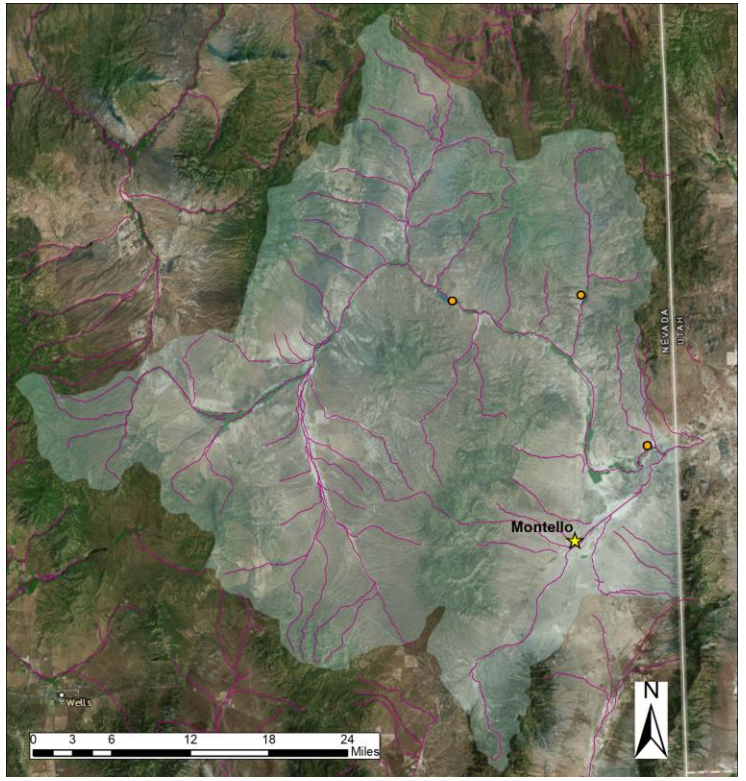
Twenty-One Mile Dam Failure (Nevada, 2017)

Upstream Watershed Area

- Twenty-One Miles Dam: ~680 square miles
- Crittenden Dam: ~60 square miles
- Dake Reservoir: over 800 square miles



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Twenty-One Mile Dam Failure (February 8, 2017)

- Center Breach area was about 50 feet wide and 40 feet deep.
- The Main Breach is located near the right abutment was about 120 feet wide and greater than 50 feet in depth.
- Over 1.5 inches of rain on top of snow that was melting. (Remember ~680 square mile watershed).

View from the news helicopter the day after the breach (2/9/17)

Twenty-One Mile Dam Investigation (April 25, 2019)






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Downstream of Twenty-One Mile Dam Failure

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Twenty-One Mile Dam – Highway 223 and UPRR

HWY 223 below Dake Reservoir

(photo credit Union Pacific Railroad)

UPRR Railroad downstream of HWY 223

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Echo Canyon Dam Spillway Incident (Nevada, 2019)

Approximate Dam Details

- Hazard: High
- Length: 1,500 ft
- Height: 60 ft
- Spill Width: 50 ft
- Number of Outlets: 1
- Max Discharge: 12,000 CFS
- Normal Storage: 1,500 AF
- Surface Area: 64 Acres
- Watershed Size: ~360 sq. mi.
- Construction Year: ~1970

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Echo Canyon Dam

- On March 6, 2019 excess snow melt above the reservoir caused the auxiliary spillway to run for the first time.
- Approximately 6” of water was flowing over the spillway and caused the spillway soil to erode.
- The water flowed over the spillway till approximately March 14th.
- The erosion stopped at one of the three rock cutoff walls installed in the spillway.
- Currently assessing repairs and associated cost.


PC: Nevada State Parks


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Washoe Lake Dam Incident (Nevada, June 2018)

Approximate Dam Details

- Hazard: High
- Length: 30 ft
- Height: 12 ft
- Spill Width: 24 ft
- Number of Outlets: 2
- Max Discharge: 200 CFS
- Normal Storage: 300 AF
- Surface Area: 45 Acres
- Watershed Size: ~80 sq. mi.
- Construction Year: ~1860
- Constructed out of Granite Blocks

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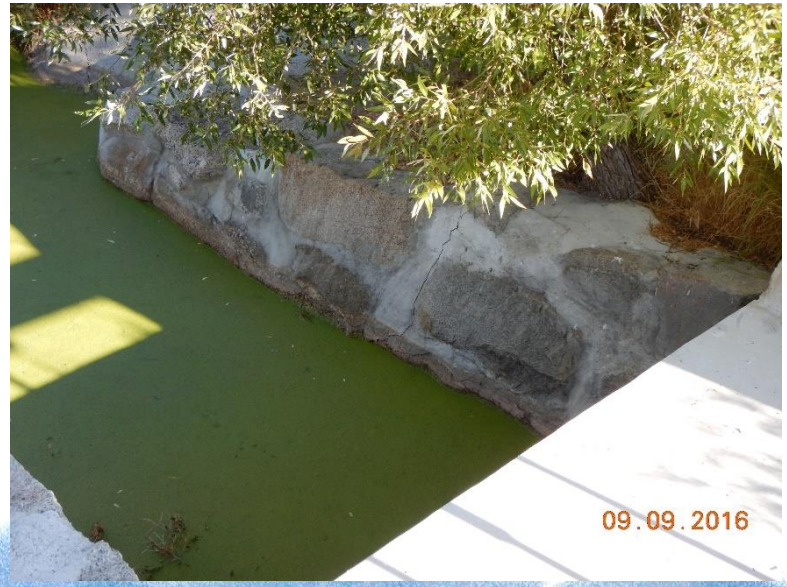
Washoe Lake Dam Incident (Nevada, June 2018)

- Vegetation was extremely thick on upstream and downstream side of the embankment.
- Large Russian olive tree located at toe of downstream embankment.



Right Downstream Toe

Right Upstream Toe

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Washoe Lake Dam Incident (Nevada, June 2018)

- Fisherman posted photo on Facebook the morning of June 18, 2018.
- At noon, our office received a phone call that water was flowing around Washoe Lake Dam.

Washoe Lake Dam Incident (Nevada, June 2018)

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Right Upstream Toe

Washoe Lake Dam Incident (Nevada, June 2018)

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References

- NRS 414.090 Local organization for emergency management; powers of political subdivision in event of emergency or disaster.
- NAC 535.320 Emergency action plan. (NRS 532.120)
- Federal Guidelines for Dam Safety, Emergency Action Planning for Dams, FEMA P-64, July, 2013
- Figures USBR (1988), Figure 1-4
- DSS-Wise Inundation Mapping Program for State Dam Safety Officials
- ASDSO website: damsafety.org
  Damfailures.org

Questions?

Contact

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