Lake Christine Rollover

Accident Investigation

Bureau of Land Management
Colorado Northwest District
Silt, Colorado

July 19, 2018

Post rollover; Dozer 2 (left) securing Dozer 1 (right).

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Leader's Intent

On July 10, 2018, the Bureau of Land Management (BLM) Colorado Northwest District Manager issued a Delegation of Authority for a team to review a crawler tractor (commonly known as a "dozer") rollover incident that occurred on the Lake Christine Fire on July 7, 2018.

Learning from unintended outcomes provide a valuable opportunity for the entire wildfire community to both reflect and learn from non-fatal events. These reviews exemplify the learning culture of our fire community, the value we place on learning from incidents, and the constant focus placed on the safety and well-being of everyone. Key objectives of the team process include:

- Supporting an interdisciplinary and interagency collaborative process in gathering, assessing and sharing factual information related to the incident, and
- Providing specific suggested recommendations and actions for federal agency follow-up.

Review teams may be asked to complete a final written report of their findings. As requested by the District Manager, this document includes the following items:

- The facts and a chronological narrative of the event;
- The underlying reasons for success or unintended outcomes;
- What was learned and what should/could be done differently in the future;
- Recommendations that could prevent future similar occurrences.

We appreciate the time, information and insights that the Incident Management Team (IMT), those involved in the incident, and our cooperators have shared to help us all learn from this incident, and reduce the likelihood of a similar event occurring again.

Executive Summary

On July 7, 2018, during extended attack, a local high track D5M LGP (Low Ground Pressure) dozer, referred to hereafter as Dozer 1, was following a local low track D6K XL dozer, refereed to hereafter as Dozer 2, on the Lake Christine Fire near Basalt, Colorado. The dozers were tracking across the fire area along the upper edge of the black with the assistance of a heavy equipment boss (HEQB) and a HEQB trainee (HEQB(t)). While descending a rocky slope (approximately 40 percent grade), Dozer 1 rolled over two times sideways before coming to a rest in the upright position. The operator lost consciousness during the rollover, and the dozer continued to track downhill in reverse across the black. It was successfully disabled by Dozer 2's operator shortly after. Once Dozer 1 was disabled, the HEQB (t) secured the idling motor.

Nearby fire crews provided medical care to Dozer 1's operator and initiated medical evacuation via helicopter (air ambulance) to a local hospital. The operator, having regained consciousness, was able to walk from the dozer site to the air ambulance and was later released from the hospital with minor injuries. Dozer 1 sustained some visible damage. Once Dozer 1's operator was successfully transported to the hospital, the rollover site was immediately secured and documented by the IMT Safety Officer. After the review team's full assessment of the rollover site, the owner of the dozer recovered Dozer 1 and moved it off the mountain under its own power.

Review team site visit.

Review Process

The review process is intended to support a transparent, critical learning culture in an open, non-punitive manner for the benefit of the greater fire community.

In accordance with the Interagency Standards for Fire and Fire Aviation Operations (Red Book), Chapter 18, Reviews and Investigations, a multi-agency seven person team was assembled to visit the rollover site and complete the review process.

Team members included a facilitator and subject matter experts (in this case, contracting, equipment operation and operational fire experience). The team also included a line officer, Colorado Department of Fire Prevention and Control liaison, and a writer/editor/GIS Specialist. The team in-briefed at 0830 on July 10, 2018, at the BLM Northwest District Office in Silt, Colorado. The briefing included a verbal summary of the rollover, list of preliminary contacts, Incident Action Plan (IAP) and witness statements.

After a site visit with those familiar with the rollover, team members paired up to gather facts through in-person conversations with over one dozen key members of the IMT (fire crews, staff, Agency Administrators and cooperators). A second site visit occurred to verify key locations and collect relevant documents, photos, field notes and logs from before, during, and immediately after the event.

The team's assessment process, conducted on July 10th – 12th included thorough reviews of documents, corroboration of facts, and verification of site details through photos and geospatial data collection. A collaborative process was used to verbally share and prioritize both relevant and collateral findings, and identify key lessons learned and recommendations based on an assessment of the most pertinent findings.

The following key findings, recommendations, and commendations cover a range of human, equipment, environmental, communications, risk, and process factors. After analysis and much deliberation, the review team agreed that no single factor resulted in the accident, but concluded the rollover was likely the result of many small factors aligning at the right time, under the right conditions (e.g. 'swiss cheese' model). This accident investigation will focus on those smaller factors and submit recommendations capable of reducing the likelihood of a similar incident occurring in the future.

Background

The Lake Christine Fire investigation cites the source of ignition as "human caused," beginning around 1815 on July 3rd, near Basalt, Colorado. The fire grew significantly on July 4th, driven by strong outflow winds, dry fuels, and single digit relative humidity. The extreme fire behavior on July 4th necessitated evacuations of approximately 1,800 residents from 664 homes by the Eagle County Sheriff's Office. Local crews worked through the night, saving hundreds of homes and losing as few as three to the blaze. By July 7th, approximately 782 evacuees from 279 residences were able to return home.

This multi-jurisdictional fire included private and state lands in Eagle County, as well as lands managed by the BLM and the U.S. Forest Service (USFS). The fuels are consistent with a mountain brush fuel model, comprised of heavy stands of drought cured gambel oak with mixed conifer at higher elevations. The elevation range of the fire was between 6,500 feet to 9,700 feet.

Daytime temperatures on July 7th were hovering in the upper 80's to low 90's – with relative humidity ranging in the teens.

A local fire management organization had command of the fire from the onset, until the morning of July 5th at 0600. At that time, a pre-positioned Type 2 IMT assumed command. Fire behavior greatly intensified throughout the evening and burned actively into the night. By the next morning, the fire made a downhill run toward the community of El Jebel and outlying neighborhoods.

The focus for firefighting efforts was to contain the portion of the fire impacting state and private lands; BLM and USFS lands had lower values at risk. No resources were committed to the north end of the fire on July 6.

The operational day began at 0700 on the morning of July 7th. The fire was divided into four divisions and two structure groups. Division Romeo was assigned the northwest portion of the fire – extending north and east to Division Gulf. Resources assigned to Division Romeo consisted of five Type 2 crews, two engines, two local dozers, and a task force leader (TFLD). Late in the previous shift (July 6th), a Type 1 interagency hotshot crew (IHC) arrived on the division. They were also assigned to Division Romeo on July 7, but were not identified on the July 7th IAP.

The plan for the day in Division Romeo was to continue constructing direct line where possible and develop a plan to hook the northwest corner of the fire to prevent it from advancing west. The IHC crew supervisor and the Division Group Supervisor (DIVS R) took an orientation flight of the division while IHC crew members scouted the line from the ground. It was determined that the IHC could work safely and effectively on the portion of the division they were assigned to. The fire was "hung up" in an area that had been previously treated with prescribed fire three to five years ago. It was mentioned several times during the review process that the prescribed fire was successful in slowing the progression and the intensity of the fire. The predominant fuel type was three to four foot gambel oak across the broad west aspect of the division.

Lake Christine Fire

Narrative

On the morning of July 7th, the two dozers assigned to Division Romeo did not have a HEQB assigned to them. The IHC was asked if they could supply a HEQB for the dozers so they could be utilized during the shift. The IHC crew supervisor was reluctant at first because he did not want the crew split up across the division. A plan was devised that would supply the dozers with a HEQB and a HEQB(t) from the IHC with the dozers working in tandem and in close proximity to the rest of the IHC's location. There were three objectives for the dozers during the shift:

1. Open an old road to utilize as an access/fuel break.
2. Construct line, working down from the black, and tie into the top of a scree slope.
3. Work on clearing the right-of-way (ROW) for a large power line that ran through the division.

Accomplishing the objectives would allow the fuel break to hook the northwest portion of Division Romeo. Upon completion of tying the line into the scree slope, the dozers worked their way across a ridge to find a place where they could track down to the power line, allowing the dozers to be in place for the following day shift. The dozers and the HEQB(t) worked their way to the south to find a safe route to the power lines. At approximately 1730, the dozer operators arrived at a point they believed safe to track downhill to the black and power lines. The operators got out of their dozers to inspect the route, and observed it to be a 40 percent downhill slope, spanning approximately 100 yards through three to four foot tall unburned oak.

Dozer 2 tracked down the slope to the black with Dozer 1 following a distance behind on BLM administered land. Near the bottom of the descent, Dozer 1's blade dislodged a boulder causing the dozer to drive over it on the right side. This caused the left edge of the blade to strike a boulder, violently pivoting the dozer downhill to the right. The downhill momentum of the dozer caused it to roll two complete times, and in the process render the operator unconscious.

Landing on its tracks with the rear of the dozer facing downhill to the northwest, Dozer 1 began to track in reverse at a downhill angle, while the operators remained unresponsive. Dozer 2's operator immediately noticed that the operator was unresponsive and no longer in control of Dozer 1. Dozer 2's operator quickly turned his

Route taken; rock dislodged.

Dozer 2 securing Dozer 1; rocks that led to the rollover.

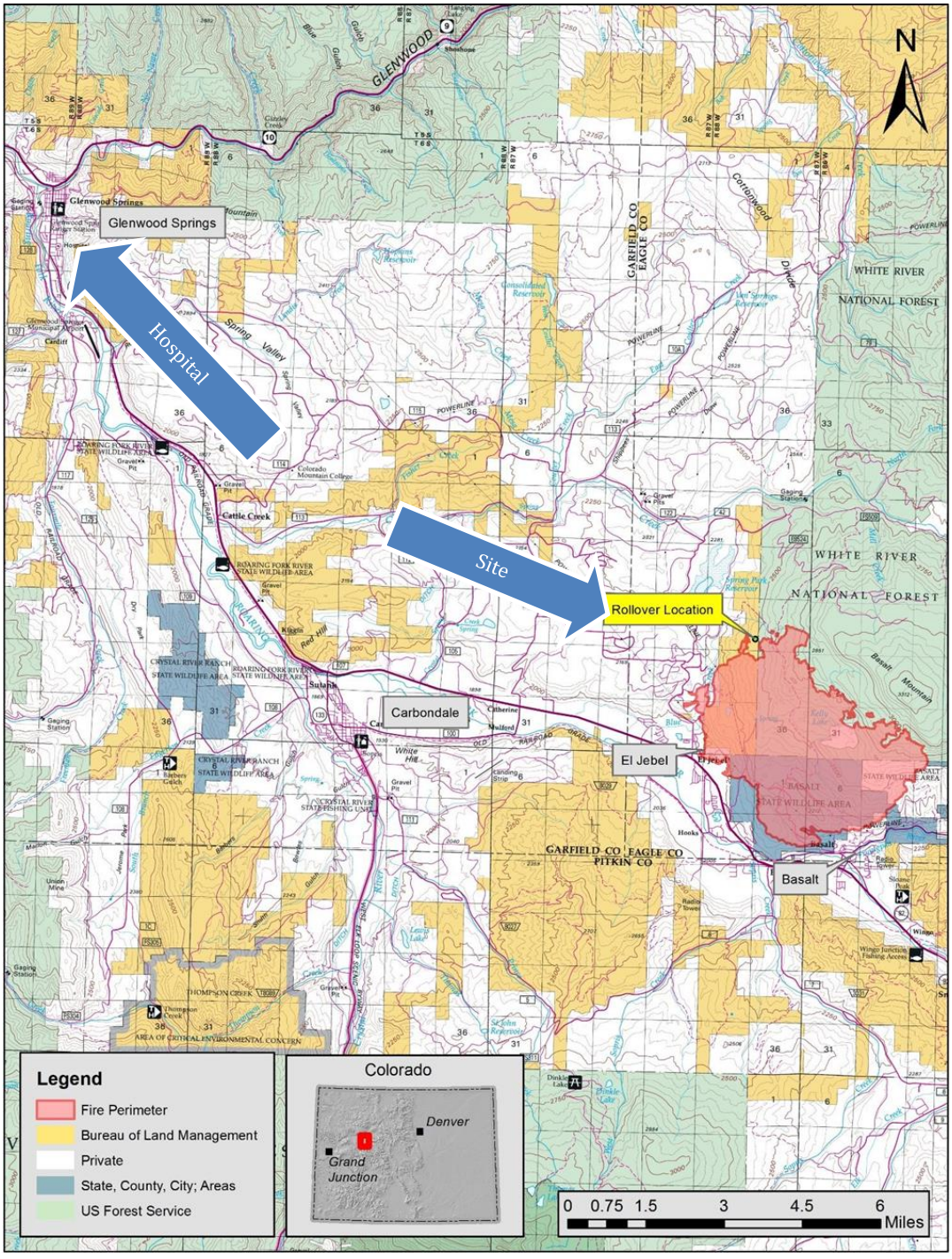
dozer around and used his dozer blade to stop the downhill descent of Dozer 1. After a couple of attempts, Dozer 2's operator was able to push Dozer 1 into an uphill angle and wedge his blade into the right-hand track of Dozer 1 – which effectively secured Dozer 1 in place. With the machine secured, the HEQB(t) immediately jumped onto Dozer 1 and shut it down. The operator of Dozer 1 became responsive at this time.

At 1739 the IHC notified DIVS R of a dozer rollover. HEQB(t) and the operator from Dozer 1 were able to help the injured operator out from the dozer. Two EMTs from the IHC crew immediately provided patient care and assessment. The initial call from the Incident Commander (IC) on the 'incident within an incident' stated a priority red medical (from the 8-line Medical Incident Report), which means the evacuation need is immediate, in this case by air ambulance. The IC was not able to reach Communications Unit on command and utilized DIVS R as a human repeater to pass the Medical Incident Report (MIR) into the ICP.

At this time, an engine crewmember from the local area placed a call via phone and requested Classic Air, an air ambulance out of Glenwood Springs, respond to the incident. The IHC, who had identified a possible medevac site earlier in the shift, sent some of the crew to prep and cut a line down to the site and prepare it for a potential air medevac. A Type 2 crew working near the location of the rollover also assisted in preparing the site.

The injured operator was disoriented, nauseous, and had a laceration on the back of the head. A paramedic/engine boss from a local engine hiked into the rollover site and arrived at 1813. Intravenous Therapy (IV) was started and the medical personnel determined the injured operator

would be able to walk with assistance to the medevac site, approximately a quarter mile away. At 1835, they reached the medevac site. As the air ambulance approached the fire, communication issues prevented firefighters at the medevac site from communicating with the medevac. Weather conditions and visibility were also becoming factors, as outflow winds from nearby thunderstorms were blowing smoke, ash, and dust into the air – greatly impacting the visibility at the medevac site. The local engine crew that initially ordered the air ambulance was finally able to communicate with the helicopter and 15 minutes after the injured operator arrived at the medevac site, the air ambulance landed. The patient was loaded and the helicopter departed for Glenwood Springs with a 10 minute flight time.



Map of site and hospital locale.

Timeline

July 3	1815 - The Lake Christine Fire ignites one mile north of Basalt, Colorado Incident Command is assumed by the local fire district
July 4	Fire grows rapidly, forcing the evacuation of almost 1800 residents.
July 5	0600 - A pre-positioned Type 2 IMT assumes command of the Lake Christine Fire
July 7	1730 - Two local dozers, one HEQB and a HEQB(t) are tracking along a rocky ridge on a parcel of BLM land
July 7	1739 - A medical emergency (dozer rollover) is called in to Division Romeo Two on-site EMTs immediately begin patient care and assessment
July 7	1803 - Medevac site cleared 1813 - Ground-based paramedic arrives on scene
July 7	1817 - Patient is stable and responsive but dizzy, paramedic is still recommending air evacuation 1822 - Air ambulance is launched
July 7	1835 - Air ambulance radios to confirm coordinates; Patient walks to medevac site 1850 - Air ambulance lands and shuts down
July 7	1900 - Patient is loaded onto the air ambulance 1906 - Air ambulance launches to hospital in Glenwood Springs, Colorado
July 9	Patient is released from hospital

Rollover Incident

Finding 1: The route of travel the dozers selected was in challenging terrain.

Discussion: The terrain where the rollover occurred was close to a 40 percent slope with three to four foot green gambel oak and numerous large basalt rocks hidden by the brush. The dozer was travelling straight down slope at a slow rate of speed with the blade just above ground level and following another dozer. Both operators got out of their machines and looked at the proposed route of travel before going downhill. Weather and visibility did not appear to be a factor.

Recommendation: Proposed routes of travel should be thoroughly scouted, walked out, and evaluated for safety before attempting. HEQB and operators should evaluate and consider all possible routes before choosing a particular path.

Route Taken.

Finding 2: The dozer involved was not the best option for the terrain in which it was working.

Discussion: The dozer was a privately owned 1996-2002 Caterpillar D5M LGP based on the serial number 3CR01415. It was not inspected at the fire prior to the rollover incident. The track width was measured at 30 inches. A low ground pressure (LGP) machine is designed for use in soft, wet terrain and to provide for less soil compaction. The dozer was equipped with a factory Rollover Protective Structure (ROPS) that was extremely effective in protecting the operator and maintaining the structural integrity of the cab. LGP machines are not uncommon in the wildland fire environment, but their capability needs to be considered when operating in steep, rocky terrain (as with all dozers). All steel tracked equipment will slip on rock. The extra surface area of track on LGP dozers can lead to more steel on rock, which increases chances of slipping.

Dozer 1 secured in place.

Recommendation: Fire managers and HEQBs must evaluate equipment configurations and ensure they are appropriate for the mission or task. Fire managers and HEQBs should ensure that equipment being utilized on incidents meet the minimum safety requirements required by agency

policy or the agreement under which they were hired, as they may be different based on contract requirements.

Finding 3: A HEQB and HEQB(t) was assigned to the dozer.

Discussion: A qualified HEQB and HEQB(t) from the IHC crew assigned to the division were assigned to work with the dozers on the day of the rollover. There was good radio communication between the dozer and the HEQB and HEQB(t). Both the HEQB and HEQB(t) indicated there was no question as to the high level of skill of the operator.

Finding 4: Dozer 1's operator was familiar with the machine, highly skilled, and was wearing all required PPE. The operator met the minimum training requirements (RT-130 Annual Fireline Refresher) for a dozer operator based on agency standards for contract equipment operators.

Discussion: Upon an interview with Dozer 1's operator, his more than 50 years of experience operating heavy equipment in and out of the fire environment was explained, to include his comfort level in the terrain he was operating in (very comfortable). He also explained that he is a retired safety officer and firefighter for a local volunteer fire department. A pre-shift inspection on Dozer 1 was completed, to include washing the windows for better visibility. He was also wearing a hard hat while in the cab of the dozer, which got knocked off during the rollover. Contract dozer operators are not required to have an Incident Qualification Card (Red Card), the only requirement is RT-130 Annual Fireline Safety Refresher training.

"It was an incredible response by the IHC."
- Dozer 1's Operator

Medical Response

Finding 1: The patient received rapid initial care and assessment.

Discussion: The IHC crew was working in close proximity to the dozer when the rollover occurred. Two EMTs on the crew arrived to the patient very quickly and provided an initial patient assessment. The crew was thorough in following incident medical protocols utilizing the MIR. The crew previously identified a potential medevac site at the beginning of the shift. The IHC crew routinely performed scenario-based medical training, which significantly aided in their response to this incident.

Finding 2: An air ambulance was ordered directly by a local resource on Division Romeo.

Discussion: A local engine assigned to the division directly ordered the air ambulance without going through the incident chain of command. This resulted in the IMT ordering the same air ambulance a short time later and causing some confusion whether there were two incidents or one.

Recommendation: Incident personnel must adhere to standard ordering protocols in the incident medical plan when medical resources are needed so that all involved are informed and aware of resources committed to the medical evacuation.

Finding 3: The resources at the rollover scene were unable to communicate directly with air ambulance.

Discussion: The medical plan in the IAP on the day of the rollover included air ambulance radio frequencies for ground personnel to communicate directly to the air ambulance. However, when

the air ambulance arrived on scene, personnel were unable to communicate (via radio) with the aircraft, with the exception of a local volunteer fire department engine assigned to the division. He was not located at the medevac site. This resulted in some difficulty getting the aircraft to the medevac site. Although available, an Air Tactical Group Supervisor (ATGS - Air Attack) was not requested to assist in the medical evacuation.

In Colorado, the standard medivac channel is VFIRE21, with a frequency of 154.280. That channel was listed in the Communications Plan within the IAP.

Recommendation: In addition to ensuring channels for medevac are included in the IAP, these channels and radio frequencies should be tested with air ambulance services before they are needed. Having an ATGS (Air Attack) aircraft on-scene can help with coordination and communication between ground and air resources.

Finding 4: Two separate medical incidents happened simultaneously on the fire, which caused confusion.

Discussion: Within two minutes, two separate medicals occurred on the fire; the dozer roll over and a knee injury. This caused some initial confusion at ICP, which was trying to determine if there was one or two incidents. The communication log clearly captures DIVS A (t) calling in a priority yellow medical at 1740. The communication log identifies DIVS R calling in a priority red medical at 1742. Although there was initial confusion regarding the two almost simultaneous medical events, it was quickly resolved. The use of the MIR prioritizes the severity of the medical and helps IMTs prioritize response in the event of two concurrent incidents.

> *"Everything worked the way it's supposed to. It would have been good to know the medevac capabilities of the onsite air resources."*
> - Hotshot Crew

Finding 5: The medical plan in the IAP identified three air ambulance aircraft for medical transport. No incident assigned aircraft were identified in the IAP for medical transport.

Discussion: Both the DIVS R and the IHC superintendent commented it would have been beneficial to be aware of available incident aircraft for medical transport; a helicopter assigned to the fire was identified for medical transport, this was not communicated in the July 7 IAP.

Recommendations: Available medical transport aircraft that are assigned to the incident must be communicated in the IAP. Identifying the air resources available for medical transport is important for on-scene personnel decision-making.

Contracting

Finding 1: At the time of the rollover, a written agreement was negotiated and agreed upon, however, the agreement was not yet signed.

Discussion: The dozer was used during Initial Attack (IA) on the fire when the Type 2 IMT assumed command on July 5th. It was listed on the IAP, under the operational control of incident personnel and operated on the fire on July 6th and 7th. On the morning of July 7th, when the operator of the dozer attended the morning briefing and checked in at ICP, the IMT recognized the dozer did not have a resource order or agreement in place.

At 0830 on July 7th, a general message was submitted from Operations to the Ordering Manager requesting two dozers and the transport or 'lowboy' be retained on the incident. The IMT placed a resource order and initiated a draft Emergency Equipment Rental Agreement (EERA). The

Procurement Unit Leader called the owner, negotiated pricing, and emailed the draft EERA to him. The IMT directed the dozers to continue working on the fire July 7th.

Recommendation: Track resources from IA to extended attack. This is critical to ensure privately owned equipment is under hire, and additionally ensures accountability after transition.

Additionally, establishing preseason competitive agreements, local Blanket Purchase Agreements (BPA) or other formal agreements for use of privately owned equipment is highly recommended. Agreements ensure equipment standards, rates and other requirements are in place when the need arises to use equipment. It also assists fire managers by knowing what resources are available, assists in quickly ordering these resources and ensures equipment is under hire when being used in fire suppression operations.

It may benefit local units of federal wildland management agencies to consider soliciting for heavy equipment using established interagency Incident Blanket Purchase Agreements (I-BPA) policies and procedures found at https://www.fs.fed.us/business/incident/vipr.php?tab=tab_d.

Review Team Observations

Observation: A timely after action review (AAR) including all participants was not conducted. While some IMT members participated in an AAR following the rollover, not all participants were involved. This left some individuals speculating about the details of the incident and fueled misinformation.

Recommendation: Conduct inclusive and appropriate AARs in a timely manner. AARs that include all participants are an effective means of gathering and sharing information and reflections, and can help individuals understand what has happened and what is being done currently in response.

Observation: The IHC crew was working in close proximity to the dozer when the rollover occurred. Two EMTs on the crew were able to get to the patient very quickly and do an initial patient assessment. The crew was thorough in following incident medical protocols utilizing the MIR. The crew had pre-identified a potential medevac site at the beginning of the shift. The IHC crew routinely performed scenario-based medical training, which significantly aided in their response to this incident.

Recommendation: Medical simulation training must be a priority for fire crews. It is an effective training tool and wildland fire programs should incorporate this type of training into pre-season.

Commendations

The review team noted several intelligent, effective, and brave actions that mitigated or avoided the potential for worse outcomes. The following list, while not inclusive, highlights the commendable actions.

During the Incident

1. The dozer operators were experienced. They pre-checked their equipment, wore appropriate PPE, knew how to navigate terrain, and scouted out route conditions.
2. The second dozer operator quickly and nimbly maneuvered his dozer to stop the righted, reversing dozer containing the unconscious operator.

Incident Response

1. The injured operator received rapid initial care and assessment by two IHC EMTs, and the IHC cleared a pre-identified medevac site.
2. The MIR was utilized efficiently, and local and IMT calls for the same air ambulance were reconciled quickly.

Prior to the Incident

1. A pre-positioned team in nearby Loveland, Colorado enabled a Type 2 team to quickly assume control under rapidly escalating circumstances.
2. The fire burned into an area previously treated with prescribed fire by the BLM and USFS. The treatment was successful in slowing the progression and the intensity of the fire.

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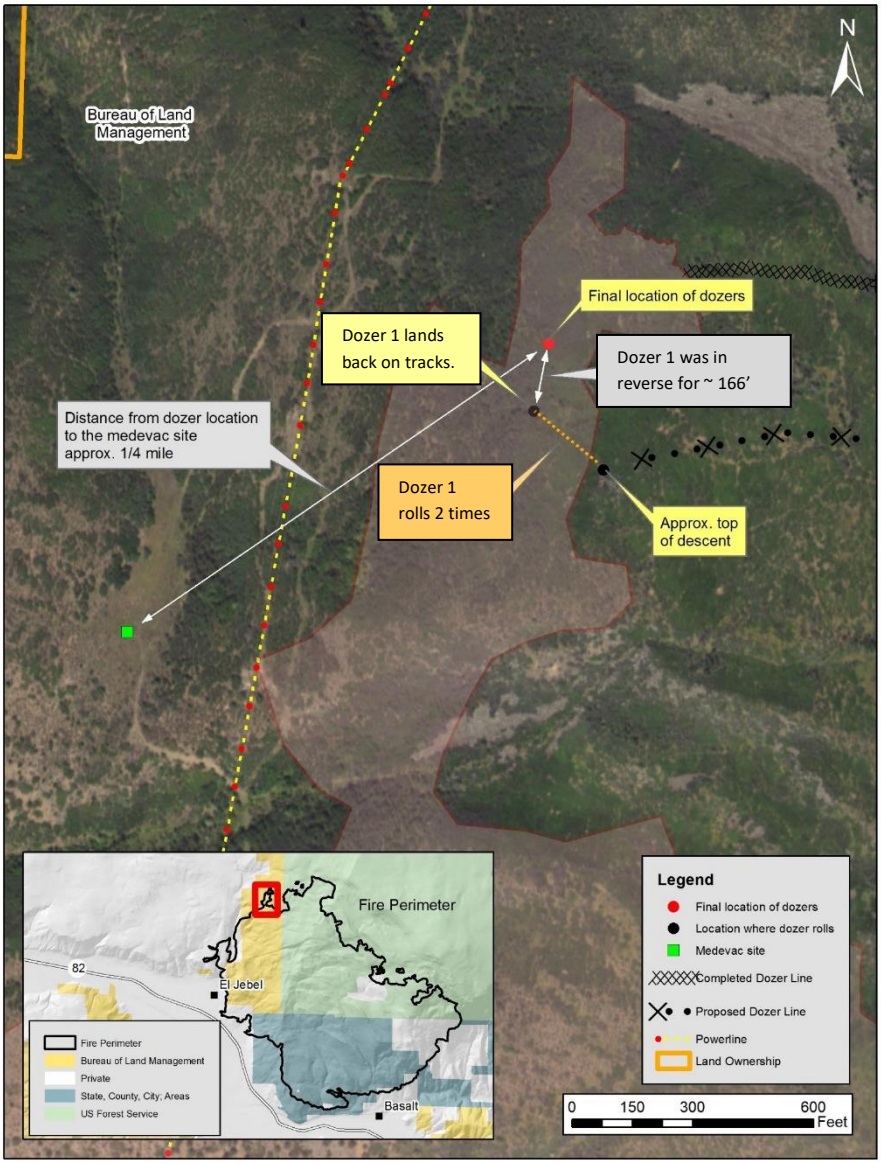
Photos and Maps

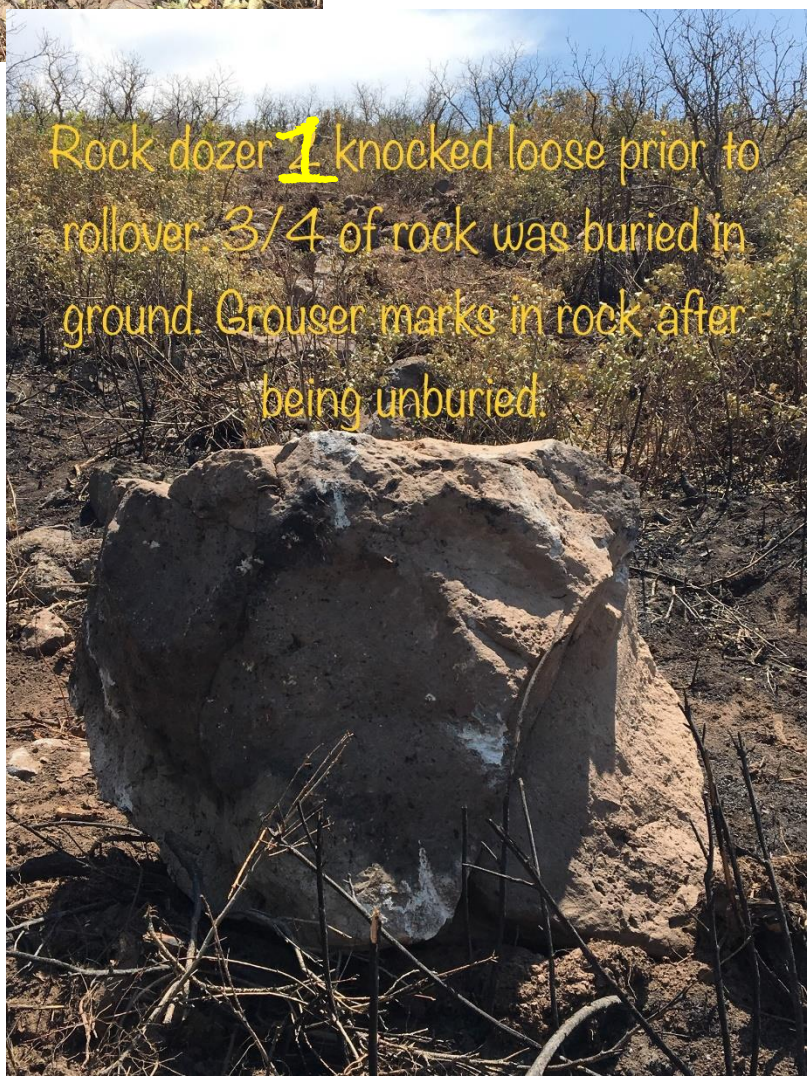


Map of accident site.

Aerial view of accident site.

Site visit by review team.

Person next to rock for size reference



Grouser mark ("grousers" are devices intended to increase track – traction.)

Dozer 1 damage and Dozer 2 actions to secure Dozer 1.