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Introduction

The Burned Area Emergency Response (BAER) treatments catalog presents, instructions, monitoring tools, and references that BAER assessment and implementation teams use to identify appropriate treatments in a BAER emergency. The target audience for this publication is any Federal land management agency BAER assessment and implementation team. The publication is written as instructions to the team. However, other readers with an interest in emergency rehabilitation of fire areas will benefit from this information.

BAER treatments for land, channels, roads/trails, and protection and safety are discussed in the catalog. Readers will learn the primary treatment use, the purpose and objective of the treatment, suitable locations for treatment implementation, and cost factors. Available treatment effectiveness information is provided to share known benefits and limitations of the treatments, although such information may be limited or anecdotal. BAER teams should validate specific treatment effectiveness in the affected area prior to recommending its use.

BAER implementation team members can familiarize themselves with project design and implementation information as they review design considerations, tools and equipment, construction specifications, and safety considerations.

Implementation and effectiveness monitoring recommendations for each treatment are included. Photographs and drawings illustrate the treatments and provide information to facilitate contracting. A draft contract with specifications for each treatment is in the appendix.

Although the BAER catalog provides current comprehensive guidance on BAER treatments numerous variations exist for each treatment. BAER teams must consider the local conditions, climate, resources, geography, vegetation response, storm intensity, and values at risk when prescribing a treatment. A treatment that is highly effective in Washington may not be as effective in Arizona. BAER teams should use the catalog as general guidance for treatment selection and implementation, and work closely with local resource specialists and regional BAER coordinators to ensure that the correct treatment is prescribed and implemented.

Starting the BAER Assessment Process

BAER assessment team composition is determined both by the size of each fire and the nature of values potentially threatened by post-fire effects. Generally, specialists in soils, hydrology, geology, engineering, wildlife, botany, and archeology assess the fire's effects and predict the post-fire effects. Each resource specialist brings a unique perspective to the BAER process, to help the team rapidly determine whether the post-fire effects constitute urgent threats to human life, safety, property, or critical natural and cultural resources and to produce an integrated plan to respond to those threats (FSM 2500-2523).

Areas to Review

The assessment of a burned area includes a review of existing resource documents. Prior to conducting field reviews, the forest supervisor or district ranger briefs the BAER team regarding the fire and known values at risk (FSM 2500-2523). Forest maps are used to identify structures and infrastructure within and downstream of the burned area. Each BAER team member consults appropriate references (such as databases, maps, and inventories) to identify additional values at risk.

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Soil-resource and ecological-unit inventories provide baseline information on soil characteristics, including erosion potential, slope class, soil texture, and management limitations. Review of hydrologic records--including historic records of magnitude and duration of events, frequency curves, flood history, and records of past wildfires--help the hydrologist understand a watershed's response to fire. The access and travel management plan and road management objectives, which are products of the roads analysis process, provide information on roads including jurisdiction, maintenance level, and resource concerns.

Next, the field review focuses on the fire's effect (i.e., changes in vegetation cover and watershed response) and identifies potential values at risk. The BAER team specialists look at:

- Amount and distribution of high- and moderate-burn severity within each watershed.
- Presence and extent of water-repellent soils.
- Presence and extent of effective soil cover.
- Potential needle-cast from existing vegetation.
- Vegetative recovery timeframe and potential for noxious and invasive plant spread.
- Flood-prone areas and downstream effects.
- Debris-prone areas and downstream effects.
- Flood-source areas and downstream effects.
- Potential for stream diversion at trail and road crossings.
- Channel stability and riparian vegetation conditions.
- Potential for increased erosion or sedimentation.
- Potential for water quality deterioration.
- Barriers to natural water flow (e.g., fencing, stockponds, dams).
- Physical hazards at campgrounds, trailheads, and facilities.
- Capacity and condition of structures at stream crossings.
- Condition of road infrastructure including signs, guardrails, and road delineators.
- Potential hazardous materials contamination created or exposed by the fire.
- Downstream values outside the fire perimeter that may be at risk.
- Potential impacts on road and trail prisms to increased erosion and runoff from adjacent hillslopes.
- Access needs on routes throughout the burned area to facilities, residences, and campgrounds.

Defining the Emergency

The BAER assessment team integrates the information collected from engineering, hydrology, soils, and other resource areas to determine whether the post-fire effects will threaten life, safety, or property, or cause unacceptable degradation to natural or cultural resources. They also determine whether the burned area requires emergency treatments to minimize identified threats. The assessment team identifies the threat or emergency type, location, duration, and extent prior to determining appropriate emergency treatments (Veenis 2000; FSM 2500-2523).

Treatment Selection

Once a BAER team determines that a fire created an urgent need to implement emergency stabilization measures, the treatment selection process begins. The BAER assessment team identifies appropriate treatments and measures that best respond to the potential threats or hazards using reliable and proven land, channel, road/trail, and

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protection/safety methods (FSM 2520-2523). Often several treatments are recommended to reduce or mitigate the effect of the threats in a burned area. The BAER team considers numerous treatment-selection factors in consultation with the forest supervisor and leadership team including:

- Nature of downstream values at risk.
- Effectiveness of treatment.
- Treatment combinations (land, channel, road/trail, protection/safety) to reduce risks.
- Timeframe for implementation.
- Personnel and resources available for implementation and monitoring.
- Hazards associated with treatment implementation.
- Ease of treatment implementation.
- Cost effectiveness of treatments.
- Coordination with other Federal, State, and local agencies.

Generally, a combination of land, channel, road/trail, and protection/safety treatments are selected. The synergy of treatments often provides the most effective set of stabilizing factors. Not all treatments are as effective at obtaining the emergency stabilization objectives. A treatment selection tool is provided (table 1) to assist BAER teams in selecting treatments that achieve stabilization objectives. Treatments are ranked 1, 2 or 3 to identify the degree by which they meet the stabilization objective. If the box is blank the treatment does not address the objective. Use table 1 to ensure the appropriate treatment is selected. A brief summary of the considerations and use of the treatments within each category follows.

Land Treatments

Land treatments stabilize burned areas by preventing or reducing fire's adverse effects. They foster recovery by providing soil cover and reducing erosion, trapping sediment and reducing sedimentation, and/or reducing water repellency and improving infiltration. They also maintain ecosystem integrity by preventing expansion of unwanted species.

Mulching

Mulching provides immediate ground cover and protects soils from erosion and nutrient capital loss. Mulching can reduce downstream peak flows by absorbing rainfall and allowing water repellency to breakdown. Mulch helps to secure seeds that are either stored in the soil or applied as an emergency treatment by maintaining a favorable moisture and temperature regime for seed germination and growth. Mulching methods include aerial and ground application using straw, woodchips, or fiber materials.

Erosion barriers

Erosion barriers reduce the slope's length, slow overland runoff, trap sediment, and improve infiltration by installing logs, fiber rolls, or sandbags. Knowing storm type and erosion potential, trapping capacity of each structure, and implementation production rates are critical factors for selecting appropriate erosion barriers.

Scarification

Scarification increases infiltration and reduces runoff and erosion. Teams need to evaluate the persistence, depth, and pervasiveness of water repellency when recommending scarification methods, such as tilling, ripping, and raking. Teams recommend this treatment with seeding as a tool for seedbed preparation. Hazards to crews implementing this treatment should be considered fully.

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Slash spreading	Slash spreading provides soil cover. Teams should identify the amount of soil cover necessary to reduce erosion. Using mechanized equipment, such as hydroax or mastication may provide more cover faster than using hand-held chain saws.
Seeding	Seeding provides a vegetative surface cover to minimize soil and wind erosion. Seeding methods include both aerial and hand application. Seeding may prevent the introduction and increase of noxious and invasive weeds. Because seeding may be ineffective until the second year, teams may recommend applying mulch for first-year effectiveness.
Invasive plants	If noxious and invasive plants were present prior to the fire, the assessment team may consider preventive treatments that include seeding of highly competitive desired species. Appropriate methods for removing or reducing noxious and invasive plants in the burned area (hand removal, and mechanical, biological, and chemical methods) depend on the extent of the population. Biological and chemical treatments can be implemented only if an environmental document is approved for both the area and biological or chemical agent identified (BAER Guidance Paper-Noxious and Invasive Weed Treatment).
Critical-habitat stabilization	Critical-habitat stabilization includes site-specific habitats, such as meadows, riparian areas, and other unique habitats. Methods to stabilize the site, foster recovery, and reduce adverse impacts to the values at risk depend on the habitat.
Hazardous-material stabilization	Hazardous-material stabilization includes methods to stabilize an identified hazardous material onsite. Measures may include rolled erosion control products to prevent erosion or reduce runoff onto or from the site (BAER Guidance Paper-Hazardous Materials).
Heritage-site stabilization	Heritage-site stabilization protects and maintains site integrity. Employing erosion control products, such as mulch, rolled erosion control products, and jute netting; establishing erosion barriers; and removing destabilized trees or other features help maintain site integrity (BAER Guidance Paper-Heritage Resources).
Channel Treatments	Use channel treatments to reduce or mitigate the effect to water quality, loss of water control, slow water velocity, trap sediment, and maintain channel characteristics. Channel treatments may reduce adverse impacts to downstream values at risk including property and critical natural or cultural resources.
Grade stabilizers	Grade stabilizers reduce channel downcutting by establishing grade control, decreasing water velocity, and maintaining width-to-depth ratio. When correctly implemented, grade stabilizers i.e., rocks, logs, or fiber-roll structures are most effective in small watersheds (ephemeral channels).
Checkdams	Checkdams temporarily store sediment and can attenuate peak flow as water is routed through several small basins. Careful hydrologic- and sediment-yield analysis is recommended before prescribing a checkdam of logs, strawbales, and rock/gabion structures.
Debris and sediment basins	Debris and sediment basins temporarily store sediment and can attenuate peak flows. Debris basins are expensive and time consuming to design and build to meet standards for dam construction. However, in areas of high

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values at risk, a debris basin may be the most effective treatment. BAER team members should consider size and amount of material to be moved as well as the long-term impacts of construction and maintenance.

Channel-debris clearing

Channel-debris clearing removes debris from the channel and flood-prone area that could dislodge and plug culverts downstream. Prescriptions to clear debris should consider channel and geomorphic processes, as well as fishery values within the system.

Stream-channel armoring

Stream-channel armoring reduces the potential impact from increased peak flows on stream reaches by placing rocks or suitable materials along the banks. Additional methods include rock vanes, in-channel felling, and stream deflectors. These methods reduce streambank erosion and protect both natural resources and property.

Road and Trail Treatments

Road and trail treatments mitigate the fire's effect on the transportation infrastructure and protect life, safety, property, and critical natural or cultural resources. These treatments work in conjunction with land, channel, and protection/safety treatments (BAER Guidance Paper-Roads and Trails Treatments).

Rolling dips and waterbars

Rolling dips and waterbars create additional drainage across roads or trails for anticipated increased runoff. Where the road prism alternates from insloped to outsloped, consider removing berms, and rolling the grade. Use armored dips for roads expecting all-season traffic. For roads with more than a 10-percent slope that can be closed to traffic, dig waterbars into the road and skew them properly to maintain their function.

Berm removal

Berm removal on the outside edges of roads allows water to sheet-flow off the road prism rather than being concentrated. Careful distribution of water minimizes its erosive power.

Outsloping

Outsloping prevents water concentration and channeling by dispersing runoff across the road. The cross-slope of an outsloped road varies from 3 to 5 percent and depends on road profile, maintenance level, and traffic service level.

Overside drains

Overside drains are used to protect the fillslope from erosion where increased runoff is expected from the fire's effect. To prevent fill erosion, armor lead-out ditches with riprap. Corrugated metal downdrains can fail when installed on roads with earthen berms. Use culvert extensions and other downdrain structures to prevent erosion and release runoff onto stable areas.

Culverts

Culverts that are used for roadway drainage (ditch relief culverts) and channel crossings become a watershed emergency when they are damaged in a fire or when their hydraulic capacity is marginal. Stream diversion potential may exist along insloped roads with a continuous road grade. Post-fire sediment and debris flow in channels may plug culverts and increase the diversion-potential risk. Increased storm runoff due to the fire's effects can cause the failure of undersized culverts and lead to erosion of the road fill and deterioration of water quality. Potential treatments include:

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Culvert removal	Remove cross-drain culverts that are 24 inches or less and replace with outsloping or rolling dips. For channel-crossing culverts, evaluate whether a low-water stream crossing (unvented ford) would address the emergency and meet resource concerns (access, aquatic species, and water quality). If access is not needed, remove the culvert temporarily and replace after the emergency ceases. Place barricades as needed. Temporarily modifying culverts with risers or slotted drop inlets, adding elevated inlets, or armoring diversion dips below culverts can mitigate plugged culverts. To determine the appropriate modification, analyze each culvert for location, fill depth, access, sediment potential, and values at risk.
Debris structures	Installing structures above a culvert or bridge crossing can protect the facility and prevent plugging. Debris racks and deflectors require inspection and regular maintenance.
Replacement or upgrade	Fire damaged culverts should be replaced or upgraded if increased flow or debris is expected. Upgrades solely to protect the road or trail investment are used only when less costly than repairing damage.
Storm inspection and response	Typically, crews drive the roads during or immediately after storms, checking sediment and debris accumulations and performing thorough, rapid inspection of road-drainage features, culverts, and other structures. The crew is responsible for maintaining culvert function by opening culvert inlets and removing debris.
Trail stabilization	Trail stabilization reduces adverse effects of increased runoff and erosion from fire. Methods include waterbars (rock, log, or rubber), armored stream crossings, and rolling dips.
Road closure	Closing roads is the safest and most effective treatment when a threat to human life is identified. Roads can be closed where an alternative access exists. Closures are implemented with a signed forest order and must be enforced. Possible treatments include gates, jersey barriers, barricades, signs, and closure enforcement. Where closure is impossible, treatments may combine hazard removal, storm inspection and response, culverts modifications, dips, debris racks, warning signs, or flood-warning systems. The combination depends on the location, amount and type of access, and climatic conditions.
Protection and Safety Treatments	Treatments to protect life, safety, and critical natural and cultural resources include flood-warning systems, warning signs, barriers, facility safety work, enforcement protection, and hazard removal.
Flood-warning systems	Flood-warning systems are used when there is a direct and substantial threat to life and a high probability of significant storms capable of producing floods or mass failure. Flood-warning treatments include early-warning systems that are collaboratively identified with the local jurisdiction responsible for public safety (BAER Guidance Paper-Early Warning Systems).
Warning signs	Warning signs alert drivers and recreational users of existing or potentially hazardous conditions created by wildfire incidents. Warning signs use universal symbols and follow <i>Sign and Poster Guidelines for the Forest</i>

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Service (EM-7100-15). The signs identify the immediate threats to public safety or limit access to protect treated or recovering areas.

Protective fencing and barriers

Protective fencing and barriers limit public and/or livestock access to protect treated or recovering areas where emergency access is not necessary. Barriers also prevent access to hazardous areas (BAER Guidance Paper-Gates, Fences, and Barriers).

Protection enforcement

Protection enforcement is implemented through established patrol areas, signing, and enforcement actions and informs users of temporary changes in effect as a result of a fire.

Facility safety work

Facility safety work includes replacing minor warning or safety control facilities damaged or destroyed by the fire. Treatments are implemented rapidly where human health or safety is at risk and no other protection options exist (BAER Guidance Paper-Facility Replacement).

Hazard removal

Hazard removal includes prevention, control, or removal of contaminated or hazardous material created or exposed by the fire. In addition, hazard-tree and unstable-rock removal prevents risk to human life and property. Removing the hazard is prescribed when access to the area is not administratively controllable (BAER Guidance Paper-Hazardous Tree and Rock Removal).

Summary

The BAER assessment team conducts a rapid assessment of the fire area and downstream values at risk to determine whether the post-fire effects pose a threat to life or property or will cause unacceptable degradation to natural or cultural resources. The teams assess the nature of the threats and their potential impact to recommend appropriate emergency treatments.

BAER assessment and implementation teams can use this catalog in selecting and implementing appropriate treatments for the identified emergency. The following chapters describe land, channel, road and trail, and protection and safety treatments currently available to BAER teams.

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BAER Treatment Selection Tool

Land Treatments								
	Cover Treatments				Barrier Treatments			
	Straw mulch	Hydromulch	Slash spreading	Seeding	Contoured felled log erosion barrier	Fiber rolls	Silt fences	Scarification
Reduces Erosion	x1	x2	x2	x3	x2	x2	x2	x3
Increase Cover	x1	x2	x2	x2*				
Improve Moisture Retention	x1	x2	x3					
Reduce Slope Length					x2	x2	x1	
Slows Runoff Velocity								
Trap Sediment			x3		x2	x2	x1	
Increase Infiltration	x1	x2			x2	x2		x2
Provide a Seedbed	x2	x2						x2
Reduce Noxious Invasive Plant				x2				
Provide Surface Roughness	x1	x3	x2	x2				x2

1= Fully meets objective

2= Partially meets objective

3= Rarely or seldom meets objective

*= not effective in first year, partially effective year 2

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Channel Treatments									
	Checkdams			In-channel structures					
	Strawbale checkdams in ephemeral channels	Log checkdam	Rock checkdam	In-channel felling	Grade stabilizer rock	Grade stabilizer log	Streambank armoring	Channel deflectors	Debris and sediment basin
Trap Sediment Provides Grade Control Reduces Velocities	x1	x1	x1	x2					x1
Slows Sediment Delivery	x2	x2	x2		x1	x1			
Attenuates Peak Flow	x3	x2	x2						x1
Reduces Streambank Erosion						x2	x2	x2	
Durability of Structure	x2	x1	x1		x1	x2	x2	x2	x1
Maintenance Needs	moderate	moderate	low*	low	low	low	low	low	moderate

1= fully meets objective
 2= partially meets objective
 3= seldom or rarely meets objective

*low maintenance when structures are large

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Road and Trail Treatments													
		Road Prism Drainage						Culvert Modification					Trail Stabilization
	Storm inspection response	Outsloping	Dips	Armored dips	Rock armored overflow structure	Armored low water stream crossing	Metal overside drains	Debris racks deflectors	Risers	Culvert upgrades	Culvert cleanout	Metal end-sections	Trail stabilization
Improve Hydraulic Capacity			x1	x1		x1			x1	x1	x1	x1	x1
Shortens Flow Length		1x	1x										
Prevents Reduces Plugging of Culverts	x2			1x		x1		x1	x1	x1	x1	x2	
Prevents Reduces Diversion	x3	x1	x1	x1		x1							
Traps Debris								x2					
Reduces Road Erosion		x2		x1	x1	x2							x2
Disperses Flows		x1			x1								x2
Protects Road Fill		x3		x1	x1		x2		x1				

1= fully meets objective

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	Minor Facility Safety Work	Hazard Removal	Warning Signs	Protective Fencing and Barriers	Protection and Enforcement	Flood Warning Systems
Reduces Impacts to resources		x1		x2	x2	
Improves Public Safety	x1	x1	x1	x1	x2	x1

1= Fully meets objective

2= Partially meets objective

3= Rarely or seldom meets objective