394 Firebreak Design Procedures

1. PURPOSE

A firebreak is a permanent or temporary strip of bare or vegetated land planned to contain prescribed fire. This practice applies on all land uses where prescribed burning is applied in Indiana.

2. SELECTING FIREBREAK TYPE(S)

It is important to account for the location and type of fuel in the area to be burned when selecting the appropriate firebreak type(s). Five types of firebreaks and their uses in prescribed burns are presented below.

> Note: A combination of firebreak types and firing techniques may be used at the same time. A **Backing Fire (or backfiring)** is a firing technique often used to establish a wide control line and can be used in conjunction with other firebreak types to achieve the minimum firebreak width required. Backing fire used to supplement a firebreak width will be planned in a Prescribed Burn Plan meeting the Indiana (IN) Field Office Technical Guide (FOTG) Standard (338) Prescribed Burning. The details of the backing fire are typically described in the fire sequence section of the burn plan.

A. Natural/Man-made Firebreaks

Natural firebreaks utilize existing terrain features. Any terrain feature, such as cropland, rivers, roads, rock outcrops or other areas devoid of fuels can serve as a firebreak. Man-made firebreaks such as existing roads and trails can be used for implementing low-intensity backfires in non-volatile fuels. Both natural and man-made features should be augmented to achieve the minimum width recommendations for the type of fuels being burned.

New roads shall be constructed in a location to provide adequate access to the area for long-term fire protection. Water control devices will be installed on slopes where damage to the road from soil erosion could occur. Ridge tops are excellent locations for access roads and make good firebreaks. Refer to IN FOTG Standards (655) Forest Trails and Landings and (560) Access Road for construction details.

Water bars are used along with constructed firebreaks on steep slopes and access road/skid trails to divert water from side ditches and road or trail surfaces in highly erosive areas. Water bars are excavated channels with a berm constructed across an access road or skid trail. They are best suited for roads that receive little use for extended periods of time because they are difficult to drive over and easily eroded when subjected to heavy traffic. Water bars should be installed at the top of any sloping road or trail (10% or greater). Space additional water bars as needed. See IN FOTG (655) Forest Trails and Landings or the Indiana Logging and Forestry Best Management Practice (BMP Field Guide, 2005, Indiana Department of Natural Resources, Division of Forestry) for water bar design.

B. Constructed Firebreaks

A constructed firebreak can be permanent or semi-permanent and must be built so that it can be traversed by fire suppression vehicles. All flammable material will be removed or covered with soil by machinery on a strip of land wide enough to contain the fire. Constructed firebreaks are commonly used in combination with other firebreaks or firing techniques (such as a back firing) for a total width that will contain the prescribed burn. Disks, graders, plows, and bulldozers can be used to construct the firebreaks. Heavy equipment, such as a bulldozer, may be needed to remove thick brush or large trees in rocky areas, creek crossings, and on steep slopes. Debris will either be stacked outside the burned area, or burned prior to the prescribed burn when the surrounding fuel source is either too green to burn, covered with snow, or is too wet to burn.

Areas with thick vegetative cover may need to be disked several times to expose bare soil. If a large amount of thatch is still present that could burn across the break, disk the area again. Make sure there are no fuel connections across the firebreak. If disking in cop fields, caution should be taken to not just turn the crop stubble over into furrows. If stubble is concentrated in a furrow it can ignite and burn the entire length of the furrow, even when lightly covered with soil. All stubble should be well incorporated into the soil. Patrolling the disked line during the prescribed burn is critical, particularly on the downwind side of the burn.

The constructed firebreak and the combination with other firebreaks or firing techniques to complete the total firebreak must meet the minimum width criteria listed in Table 2 (and footnotes).

Firebreaks in Forestland Areas typically use leaf blowers or rakes to remove leaves, duff and small branches from existing or newly created firebreaks to bare mineral soil. This can be done in areas where the ground cover is sparse or easy to remove (e.g. leaf litter, and possibly ag. residue).

Construct forestland firebreaks to a minimum width of 2X the height of the tallest vegetation to be burned or 4 feet, whichever is greater. In forestland, the total combined width of firebreaks or firing techniques will still need to be a minimum of 15 feet or 3 times the height of the available fuel, whichever is greater. These firebreaks are often combined with a back fire in order to get a black line established. Make sure the black line is sufficiently wide before setting flank/head fires. (See below information on backing fire)

Rake fuel away from dead or hollow trees within 100 feet of firebreaks to prevent dead or hollow trees from igniting or falling across firebreaks.

Soil erosion control structures (such as water bars) may be needed on slopes exceeding 10 percent when not seeded to vegetation. (see also Natural/Man-made Firebreaks)

C. Burned Firebreaks (blacklining)

Burned firebreaks are semi-permanent or temporary firebreaks installed in combination with other types of firebreaks, such as constructed firebreaks, where mowing, disking, or dozing is used to meet the minimum widths required. Burned firebreak construction is also called black-lining and the specifications will be described in a prescribed burn management plan. Blacklines are not fire proof and will not be used as stand-alone burn lines.

The burned firebreak consists of two parallel 10-foot wide lines of bare soil or mowed vegetation with a center area of at least 15 feet between the parallel lines. Then the untouched center area will be pre-burned to create a blackline. The burned firebreak combined with other techniques must meet the minimum width criteria listed in Table 2 (and footnotes). Before burning the center strip, remove large flammable material, such as logs, limbs, standing cedar, or discarded fence posts. Burn the area between the strips to complete the firebreak following the guidelines outlined in the prescribed burn management plan.

Burned firebreaks or black-lines can be constructed well before the planned date of a prescribed burn, when weather conditions are safe. Early green-up of vegetation in the burned strip retards the spread of fire and can be an effective anchor for prescribed burn ignition. Blacklines can provide safe areas for moving personnel and equipment during the prescribed burn.

A "backing fire" is similar to blacklines, however a backing fire is a type of firing technique done during the prescribed burn as described in the prescribed burn plan. The backing fire is the most common firing technique used and should always be the first line of fire set in any prescribed burning sequence. A backing fire is always started along a firebreak or other barrier at the most leeward (downwind) edge of the burn area and allowed to back into the wind. When used with other firing techniques, the backing fire is set first and allowed to burn an area at least equal in width to the expected average flame length, prior to setting any other fires. This helps ensure that any fire moving in a windward direction as a result of additional fires ignited upwind will be contained within the blackened area created behind the backing fire. In general, backing fires should be allowed to burn windward a distance of at least 15 feet from the leeward control line before employing other firing techniques to complete the prescribed burn.

D. Perennial Vegetation Firebreaks

Perennial vegetation firebreaks are planted and managed to ensure that non-volatile vegetation is present

during the prescribed burn. These firebreaks are planted with low growing cool season grasses or other cool season plants to reduce future maintenance costs and prevent soil erosion. Suitable species are identified in Table 1 below. Refer to IN FOTG Standard (327) Conservation Cover practice for information on seedbed preparation, seeding dates, equipment and other factors related to establishment of perennial vegetation. The vegetation within the firebreak must be established and functioning well in advance of the prescribed burn. The vegetative firebreak and combination with other firebreaks or firing techniques to complete the total firebreak must meet the minimum width criteria listed in Table 2.

Mow, disk, or graze vegetative firebreaks to avoid a build-up of excess litter and to control weeds. Perennial vegetation firebreaks shall not be grazed until the vegetation is established and in an approved conservation plan.

Species and Seeding rates will be selected using the firebreak option in the IN NRCS Seeding Calculator.

E. Mowed Wet-lines

The mowed wet-line is a temporary firebreak used in herbaceous fuels and often with other firebreaks (such as disked or vegetated) and done immediately before a prescribed fire. Mowed firebreaks using wet-lines can be used if adequate personnel, equipment, and water supplies are available to safely conduct the procedure. Mowed wet-lines combined with other techniques shall meet requirements in Table 2. The mowed height should be no more than 4 inches. Cuttings shall be raked outside of the area to be burned or removed from the area if vegetation is excessive.

Water is sprayed on the mowed vegetation to create a wet-line immediately in advance of ignition of the fire. Typically, a lead engine or ATV with a tank sprayer will lay down a wetline closely followed by the igniter who lights the unit side of the wetline behind the lead engine (usually no more than 20 feet behind the lead engine). The igniter is followed by a flapper (or other appropriate hand tools), engine or ATV with a tank sprayer, to ensure that the flames do not cross the original wetline. While engines are preferable, a tandem team of all-terrain vehicles with mounted sprayers may be used where the fuel load allows and water re-supply sources are available.

This type of firebreak requires strict observation during the burn as fire can dry the wetted vegetation and creep across the wetline. Follow-up personnel with hand tools or patrolling ATV's with sprayers must be available to immediately extinguish fire that attempts to escape through the firebreak.

Fuel Reduction Lines

A high mowed area adjacent to a firebreak sometimes called a "fuel reduction line" is often used to reduce the herbaceous vegetation height and fire intensity in the interior, immediately adjacent to the firebreak. The addition of a mowed reduction line is an excellent addition to a firebreak when sensitive areas are nearby, fences are near the firebreak, fine fuel load is high, or crew members are inexperienced. Fuel reduction lines are not firebreaks and are not figured into the minimum width (see Table 2) requirement for a firebreak. If used, mowed width should be at least 10 feet at 1.5 - 3 tons / acre and 20 feet at > 3 tons / acre. Mow between an 8 - 12 inch stubble height.

3. DESIGNING FIREBREAKS TO CONTAIN PRESCRIBED BURNS

Excess volatile fuels (live and dead), will be removed from the firebreak prior to ignition. Width and length must equal or exceed NRCS or local fire district requirements whichever is greater. Minimum requirements for the firebreak depends upon the type of fuel present within the area to be burned.

A. FUEL TYPE DEFINITIONS

Fine fuel: Non-woody herbaceous materials, generally less than 0.25 inches in diameter, such as grasses. Fine fuel with fresh green growth and little dead plant residue or areas with a low amount of fine fuel will be more difficult to carry a prescribed burn.

Non-volatile herbaceous fuel are herbaceous fuels such as grasses that have low amounts of ether extractives. Examples include Big bluestem, Kentucky bluegrass and smooth brome. Fresh green growth is less volatile than dead plant residue and is not considered volatile if little or no dead plant material exists.

Volatile herbaceous fuel are herbaceous fuels that contain higher amounts of ether extractives, such as waxes, terpenes, oils, or resins. Examples of volatile herbaceous fuels include switchgrass, annual bromes, *Eragrostis* species such as weeping lovegrass, *Triden* species such as purpletop, and sericea lespedeza in a dried dormant condition. The dead plant residue is also considered volatile.

Non-volatile woody fuel are deciduous (hardwood) trees with low volatility, such as oaks, hickories, maples, elms, honey locust, etc. This group may also include invasive shrubs and woody vines, such as Asian bush honeysuckle, autumn and Russian olive, most sumac, grape, bittersweet, wintercreeper, etc.

Volatile woody fuel are coniferous (softwood) trees, such as eastern redcedar, ponderosa pine, fragrant sumac, and any species which contains volatile oils and have the ability to ignite when directly or indirectly exposed to intense heat.

B. DESIGNING WIDTH OF FIREBREAKS FOR PRESCRIBED BURNS

When designing the width of a firebreak around a burn unit, a good rule of thumb is 2 to 3 times as wide as the expected flame height. In general, flames should not reach more than half the width of the firebreak or into the black.

For designing a constructed and/or vegetated firebreak for Indiana NRCS FOTG Standard (394) Firebreak, the minimum width will be 15 feet or 3 times the height of the available fuel, whichever is greater. However, these minimums width around the burn unit may not be able to fully contain the fire, depending on the prescribed wind direction or fuel type. The type of fuel, its relative location to a proposed firebreak, and the minimum firebreak width required for implementing the burn as part of a prescribed burn plan are presented in Table 2.

For Firebreaks located downwind a factor of 10 times the height of the available fuel. For all other wind directions, firebreaks shall be at least 3 times the height of the available fuel or at a set minimum width based on factor in Table 2, ***whichever is greater***. (see Below).

Table 2. Minimum Firebreak Width for Prescribed Burns on Non-Forested Land

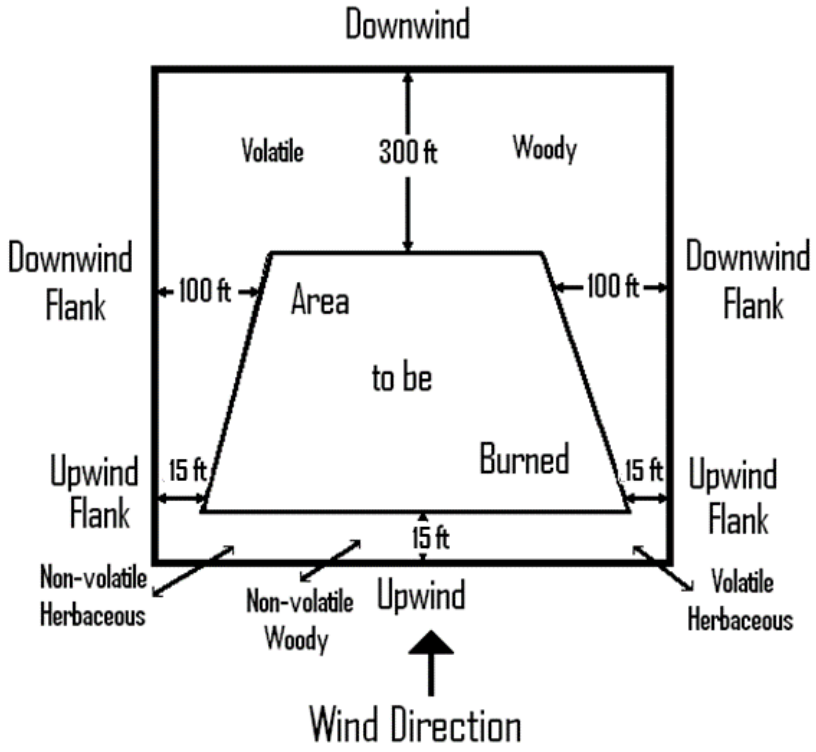
[1/] Type of Fuel	MINIMUM FIREBREAK WIDTH		
	Upwind Side Fire break located upwind of area to be burned	[2/] **Downwind Side** Firebreak located downwind of area to be burned	**Downwind Flank** Firebreak flanks (sides) are located downwind of area to be burned
Fine	15	15	15
Non-volatile Herbaceous	15	15	15
Volatile Herbaceous	15	40	30
Non-volatile Woody	15	60	50
Volatile Woody	50	300[3/]	100

[1/] Major consideration should be given to type of fuel directly adjacent to the firebreak and the most hazardous fuel in the burn area, i.e., Volatile Woody is significantly more hazardous than the other three fuel types; therefore, it requires greater firebreak widths on all sides. Post spotters downwind, especially when any volatile woody fuels exist that can send firebrands downwind.
[2/] Downwind Side: A factor of 10 times the height of the available fuel will be used as the minimum if greater than the corresponding width listed in this table.
[3/] In situations where topography or other restrictions beyond the planners control prohibit the minimum firebreak width, a reduced distance of no less than 150 feet can be written into the prescribed burn plan by designating additional spotters and positioning suppression resources on the downwind side of the burn unit. These exceptions must be documented and implemented only when absolutely necessary.

The firebreak will be included as part of a prescribed burn plan and will meet all requirements of IN FOTG Standard (338) Prescribed Burning. See Figure 1 for example schematic representation showing firebreak widths as related to location, fuel type and wind direction.

Patrolling will be used to maintain the integrity of the lines where necessary. If ATV's alone are used as support units, a careful evaluation of the fuel load, topography and wind direction will be conducted before initiating the burn.

Figure 1. Schematic of Firebreak Locations and Widths for an Area to be Burned that Contains Volatile Woody Fuel on the Downwind Side



Note: Diagram not drawn to scale; for illustration purposes only.
(NE FIREBREAK (394) DESIGN PROCEDURES, 2017)

C. LOCATION OF FIREBREAKS FOR PRESCRIBED BURNS

Firebreaks located along burn unit perimeters must be accessible by pickups, ATV's, UTV's or other fire suppression vehicles. Firebreak location will depend upon topography, fuel load and the presence and type of volatile woody fuels.

The planned location of a firebreak may need to be adjusted during the implementation phase to compensate for adjacent fuel load location and changing wind direction. Flexibility and attention to environmental details at the time of the prescribed burn are critical.

1. Firebreak Location in Relation to Topography

Firebreaks should be located on level to gently sloping ground if possible, and typically not on slopes greater than 10%. The exception to this will be pre-existing natural and/or manmade barriers such as county roads, crop fields etc. In situations where terrain is variable, short sections with slopes greater than 10% is allowable. Firebreaks located on steeper slopes below the unit run the risk of having flaming material roll across the break and out of the unit.

If the mowed line/wetline technique is used, the mowed line will be wider on the uphill side of the unit, and the wetline will be placed farther from the outside edge of the mowed line to allow for greater flame lengths and pre-drying of fuels due to the slope.

2. Firebreak Location in Relation to Fuel Load

Heavier fuel loads generate more heat, even on the upwind side of the unit. When fuel loads exceed 5,000 lb/ac, mowed lines will be wider, and wetline placement within the mowed line will be evaluated and adjusted accordingly.

3. Firebreak in relation to volatile woody species

All volatile woody species and volatile woody debris shall be removed from within a 300-foot distance of the burn perimeter on the downwind side of the unit, 100-foot distance on the downwind flanks, and 50-foot distance on the upwind side of the burn unit (Table 2).

D. EXAMPLE FIRE BREAK WIDTH CALCULATIONS FOR PRESCRIBED BURNS

Example 1: Client wishes to perform a prescribed burn on a square 4-year-old native warm season grass and forb field (burn unit). Available fuel is 4 feet tall non-volatile herbaceous fuel. Forest surrounds the field on three sides and a crop field with stubble is on the downwind side. The client and burn boss wish to construct a disked firebreak around the perimeter. A Ring Fire technique (combining both a Flanking Fire and Head Fire) will be set with the head fire mowing towards the crop stubble field.

Firebreak Width Calculation:
Construct a 15ft. disked firebreak around all four sides of the field. (thus, meeting the 15 ft. minimum width).

Upwind Side: Using Table 2 the disked 15ft. width is sufficient. 15ft. is the minimum width (15ft is wider than 4ft fuel x 3)

Downwind Side: Start a **Backing Fire** first along the crop field on the downwind edge until it reaches a width of 25 ft. (40ft. minus 15ft.) (with 4ft fuel x 10 = 40' width).

Downwind Flank: Then start the **Flanking Fires** along the two edges parallel to the wind (width already minimum at 15ft.). Lastly, start the **Head Fire** along the windward edge so that the fire moves toward the crop field.

The Ring Fire technique should only be used by experienced personnel or where the downwind landscape is composed primarily of bare mineral soils, such as plowed crop fields. To properly employ the ring fire technique, at least two persons carrying their own ignition source, are needed to simultaneously set the fires round the perimeter.

Example 2: Client wishes to perform a prescribed burn on 5ft. tall non-volatile native grasses with an existing 10ft. wide mowed fescue/clover path around the entire perimeter. The client has a 12ft, disk which he can use to construct a disked firebreak.

Firebreak Width Calculation:
Construct a 12ft. disked firebreak around the perimeter (combined vegetated and disked = 22ft thus meeting minimum 15ft widths for Upwind and Downwind flanks)

Downwind: 50ft. is needed on the downwind side (5ft. veg. height x 10, see Table 2 footnotes) Either disk 4 strips (= 48ft.) on the interior side of the 10ft. path, or one disked strip (12ft.) on the interior side of the 10ft path and back burn 28ft. (10ft + 12ft +28ft = 50ft)

Example 3: Client wishes to perform a prescribed burn on native grasses that has been encroached by 15 ft. high eastern red cedar. Red cedar is located on the **downwind and flank** edges.

Firebreak Width Calculation:
Upwind Side: (non-volatile herbaceous fuel adjacent to firebreak) 15 ft. (from Table 2) = 15 ft. wide firebreak.

Downwind Side: (volatile woody fuel adjacent to firebreak) 300 ft. minimum width (from Table 2) Using the 10 X vegetation height rule alone would result in only a 150 ft. (15 ft. high fuels X 10) firebreak which would not meet

the minimum width required for volatile woody fuels. The client could use a combination of firebreaks to achieve the minimum 300 ft. firebreak width, including roads or trails, and the backburn of the prescribed fire itself. All red cedars need to be cleared from the firebreak and piled away from the fireline or moved offsite (50' from upwind edge; 100' from downwind flanks; 300' from downwind edge).

Downwind Flank: (volatile woody fuel adjacent to firebreak) 100 ft. (from Table 2) = 100 ft. wide firebreak. Red cedars will need to be cleared from the firebreak and piled away from the fireline or moved offsite (50' from upwind edge; 100' from downwind flanks; 300' from downwind edge).

Example 4: Client wishes to burn a CRP planting which has a mix of volatile and non-volatile native herbaceous fuels. Average fuel height is 6 ft. predominantly switchgrass and a minor component of big bluestem. A 20 ft. wide gravel road is adjacent to the downwind side of the proposed prescribed burn:

Firebreak Width Calculation:
Upwind Side: (volatile herbaceous vegetation) (from Table 2) = 18 ft. wide disked line (3 X 6ft. fuel height = 18ft.) (Note: 18ft. is wider than the 15 ft. minimum firebreak, thus 18 ft is used)

Downwind Flank: : (volatile herbaceous vegetation) (from Table 2) = 30 ft. disked wide firebreak

Downwind Side: = 40 ft. wide minimum disked firebreak. (6 ft. X 10 = 60 ft. from Table 2 footnotes minus the 20 ft. gravel road as part of the firebreak = 40ft).

Note: A backing burn is preferable for areas with volatile fuels. Only experienced personnel should conduct and write prescribed burn plans with significant amounts of volatile fuels.

Indiana NRCS employees are prohibited from writing or approving prescribed burn plans.