South Red Bird Project

Soil & Water Report

Prepared by:

Mac A. Cherry
Hydrologist
&
Dr. Claudia Cotton
Soil Scientist

for:

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Daniel Boone National Forest

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Introduction

This report describes the soil and water analysis for the proposed South Red Bird Project on the Daniel Boone National Forest (DBNF). Forested watersheds are a key component of the landscape because they supply high-quality water used for public drinking, agriculture, recreation, and aquatic organism habitat. The biological, chemical, and physical characteristics of forest soils influence the quality and quantity of water that is delivered to forest streams and downstream areas. Forest soils support a high abundance and diversity of micro-and macro-faunas, help reduce flooding, and filter contaminates (Neary et al., 2009).

Beginning in 2010, 12-digit hydrologic unit code (HUC) (sub watersheds) on National Forest System (NFS) lands, including the DBNF, were classified with a nationally-consistent, science-based approach (USFS, 2011a). The watershed condition classification (WCC) approach places sub watersheds in discrete classes that reflect the level of watershed health or integrity. The Forest Service WCC Technical Guide (USFS, 2011a) uses three classes to describe watershed condition:

Class 1: Functioning Properly: watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.

Class 2: Functioning at Risk: watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.

Class 3: Impaired Function: watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.

An interdisciplinary team also rated 12 watershed condition indicators (Table 1). A properly functioning watershed contains terrestrial, riparian, aquatic, and wetland habitats that function in a way to support diverse populations of native species.

Table 1. Description of the 12 national core watershed condition indicators (USFS, 2011a).

Aquatic Physical Indicators	
1. Water Quality	This indicator addresses the expressed alteration of physical, chemical, and biological components of water quality.
2. Water Quantity	This indicator addresses changes to the natural flow regime with respect to the magnitude, duration, or timing of the natural stream flow hydrograph.
3. Aquatic Habitat	This indicator addresses aquatic habitat condition with respect to habitat fragmentation, large woody debris, and channel shape and function.
Aquatic Biological Indicators	
4. Aquatic Biota	This indicator addresses the distribution, structure, and density of native and introduced aquatic fauna.
5. Riparian/Wetland Vegetation	This indicator addresses the function and condition of riparian vegetation along streams, water bodies, and wetlands.
Terrestrial Physical Indicators	
6. Roads and Trails	This indicator addresses changes to the hydrologic and sediment regimes due to the density, location, distribution, and maintenance of the road and trail network.
7. Soils	This indicator addresses alteration to the natural soil condition, including productivity, erosion, and chemical contamination.
Terrestrial Biological Indicators	

8. Fire Regime or Wildfire	This indicator addresses the potential for altered hydrologic and sediment regimes due to departures from historical ranges of variability in vegetation, fuel composition, fire frequency, fire severity, and fire pattern.
9. Forest Cover	This indicator addresses the potential for altered hydrologic and sediment regimes due to the loss of forest cover on forestland.
10. Rangeland Vegetation	This indicator addresses impacts to soil and water relative to the vegetative health of rangelands.
11. Terrestrial Invasive Species	This indicator addresses potential impacts to soil, vegetation, and water resources due to terrestrial invasive species (including vertebrates, invertebrates, and plants).
12. Forest Health	This indicator addresses forest mortality impacts to hydrologic and soil function due to major invasive and native forest pest insect and disease outbreaks and air pollution.

Existing conditions

The spatial bounds for the soil and water analyses are displayed in Figure 1 and 2, respectively. Temporal bounds is typically three years, or the time it takes for soil that has been disturbed to become completely re-vegetated. Research reports, field reconnaissance, NRCS soil surveys, NASIS reports, and GIS analysis were utilized to determine existing soil resources and condition in the South Red Bird Project area. Actions that can potentially disturb the soil from this project include heavy equipment use, road and trail maintenance and construction, herbicide use, and prescribed burning.

Table 2 describes the sub watersheds analyzed for soil and water, including the WCC score and class. The southern-most sub watershed, Lick Fork-Red Bird River, does not include NFS land, but was considered for cumulative effects. All of the sub watersheds are in the Kentucky River 8-digit HUC sub basin.

Table 2. Descriptions of the 12-digit HUC sub watersheds analyzed for soil and water, South Red Bird Project, Daniel Boone National Forest, Red Bird Ranger District. HUC, Hydrologic Unit Code; %, percent; ND, no data; *, computed with GIS and accuracy

Sub watershed name	12-digit HUC	Total watershed acres	NFS-owned land, in % of total	WCC score	WCC Class
Lick Fork – Red Bird River	051002030201	ND	0	ND	ND
Phillips Fork – Red Bird River	051002030202	13,695	7,203	2.1	2. Functioning at Risk
Bowen Creek – Red Bird River	051002030203	19,851	16,087	2.1	2. Functioning at Risk
Elisha Creek – Red Bird River	051002030204	11,147	8,973	1.7	2. Functioning at Risk

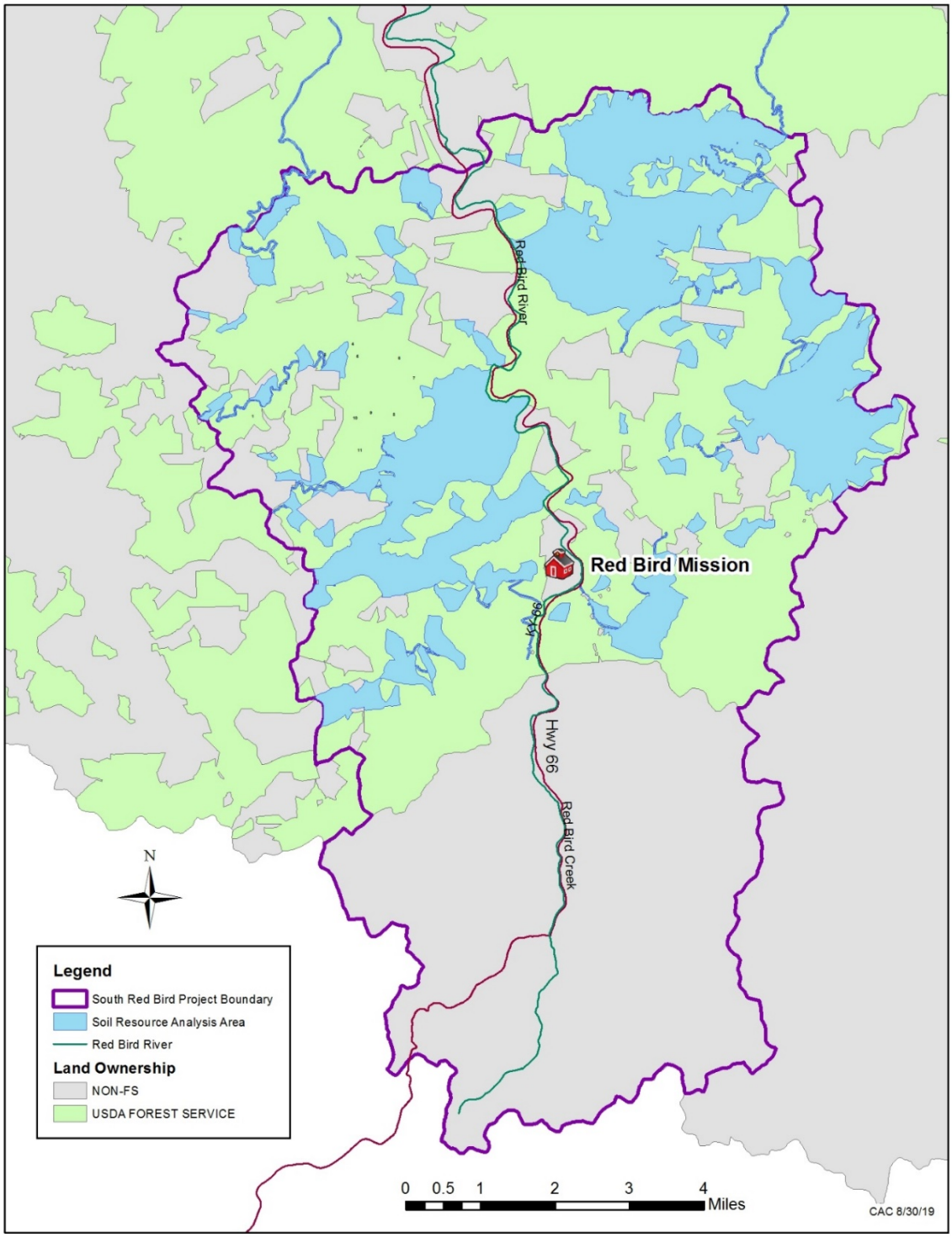

Figure 1. Spatial bounds of the South Red Bird Project analyzed for soil, Redbird Ranger District, Daniel Boone National Forest.

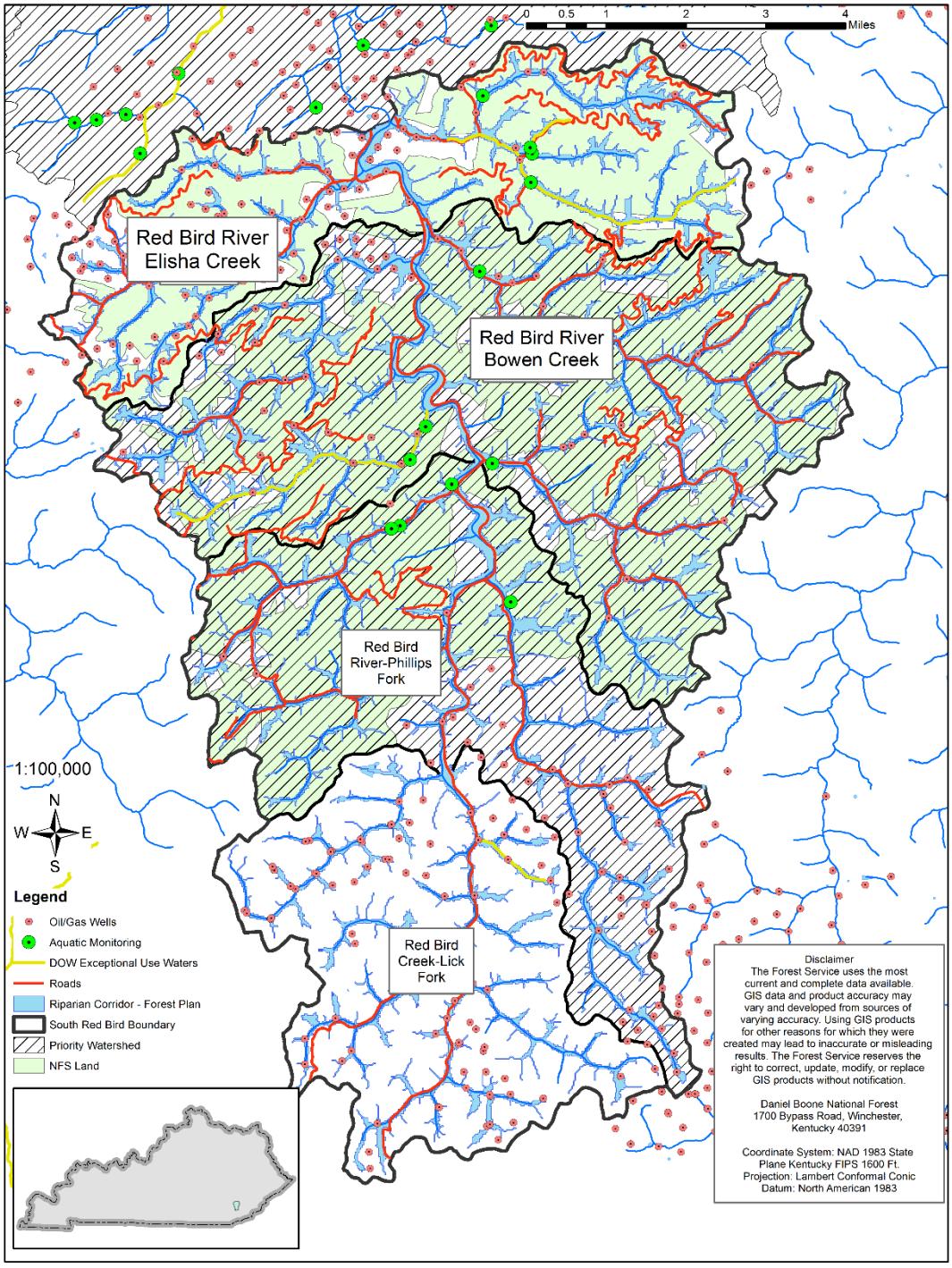

Figure 2. Spatial bounds of the South Red Bird Project analyzed for water, including HUCs, roads, monitoring sites, oil and gas wells, and priority watersheds, Redbird Ranger District, Daniel Boone National Forest.

Lick Fork – Red Bird Creek sub watershed (051002030201)

Lick Fork – Red Bird River sub watershed does not include any NFS land, and the total acreage has not been determined (Figure 2). The Red Bird River originates here and flows north through the three other sub watersheds in the South Red Bird Project boundary (Figure 2). The Lick Fork – Red Bird River sub watershed includes Red Bird Creek (6th order) and its tributaries: Lick Fork (5th order), Lawson Creek (5th order), Spruce Branch (5th order), and Cow Fork (4th order). An unbranched stream that does not receive another stream is considered 1st order; a 2nd order stream receives two or more 1st order streams; a 3rd order stream receives two or more 2nd order streams, and so forth (Horton, 1945). Eighty-two oil and gas wells have been documented in the sub watershed (Figure 2). Spruce Branch is listed as Category 2 stream, meaning all uses are "Fully Supporting, but not all designated uses assessed" (KDEP, 2016a) and the same reach is also designated as Exceptional Use waters (KAR, 2019; Figure 2). Lawson Creek is impaired because of Escherichia coli (*E. coli*) from agriculture (KDEP, 2016a; 2016b). Large portions of the sub watershed contain permitted coal mines (Figure 3).

WCC was not assessed at Lick Fork – Red Bird River sub watershed.

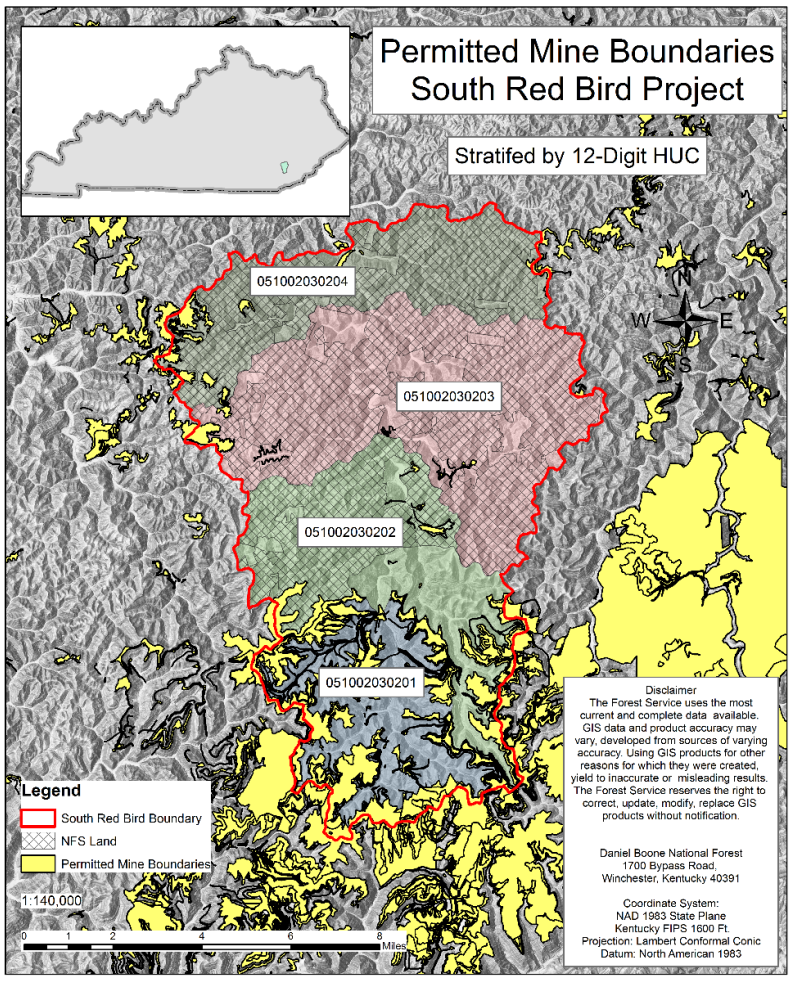

Figure 3. Map of Permitted Mine Boundaries, Redbird Ranger District, Daniel Boone National Forest.

Phillips Fork – Red Bird River sub watershed (051002030202)

Phillips Fork – Red Bird River sub watershed is 13,695 acres, of which 7,203 acres are NFS land (Figure 2). Red Bird Creek (6th order) and Phillips Fork (5th order) flow north through the sub watershed and converge to form Red Bird River (6th order). Upper Bear Creek (5th order) and Blue Hole Creek (5th order) are tributaries to Red Bird River. The entire reach of Red Bird River that flows through the sub watershed is impaired because of elevated lead and specific conductance from coal mining and *E. coli* from agriculture (KDEP, 2016b). Phillips Fork is listed as Category 2, "Fully Supporting, but not all designated

uses assessed" (KDEP, 2016a). Approximately 43 oil and gas wells have been documented in the sub watershed (Figure 2). Aquatic organisms are monitored at four sites in the sub watershed (Figure 2). There are permitted coal mines in the sub watershed (Figure 3). Phillips Fork – Red Bird River sub watershed is considered a priority watershed after the WCC assessment (USFS, 2011b). Priority watersheds are "a subset of watersheds, equivalent to a 5 year plan of work, where the Forest plans to concentrate watershed restoration activities to show improvement in watershed condition" (USFS, 2011c).

Phillips Fork – Red Bird River WCC score was 2.1 and classified as "functioning at risk" (USFS, 2011b). Two of the watershed condition indicators (Table 1) were ranked poor: Aquatic Habitat and Roads and Trails. Soil Erosion and Soil Productivity were ranked fair and good, respectively.

Bowen Creek – Red Bird River sub watershed (051002030203)

Bowen Creek – Red Bird River sub watershed is 19,851 acres, of which 16,087 acres are NFS land (Figure 2). Upper Jacks Creek (6th order) converges with Red Bird River (6th order) at the southern end of the sub watershed to make Red Bird River 7th order. Red Bird River (7th order) flows north through the Bowen Creek – Red Bird River sub watershed; its major tributaries are Spring Creek (5th order), Bowen Creek (5th order), and Katies Creek (4th order). Bowen Creek is listed as impaired, but the pollutant and source are unknown. The entire reach of Red Bird River that flows through the sub watershed is impaired because of elevated lead and specific conductance from coal mining and E. coli from agriculture (KDEP, 2016b). About half of Upper Jacks Creek (beginning at the mouth) is impaired because of *E. coli* from agriculture and improper treatment of waste water (KDEP, 2016b). Approximately 47 oil and gas wells have been documented in the sub watershed (Figure 1). Five aquatic organism monitoring sites are located in the sub watershed (Figure 2). Bowen Creek – Red Bird River sub watershed is considered a priority watershed after being assessed with WCC. There is a small amount of permitted coal mines in the sub watershed (Figure 3).

Bowen Creek – Red Bird River WCC score was 2.1 and classified as "functioning at risk" (USFS, 2011b). Two of the watershed condition indicators (Table 1) were ranked poor: Aquatic Habitat and Roads and Trails. Soil Erosion and Soil Productivity were ranked fair.

Elisha Creek – Red Bird River sub watershed (051002030204)

Elisha Creek – Red Bird River sub watershed is 11,147 acres, of which 8,973 acres are NFS land (Figure 2). Red Bird River (7th order) flows north through the Elisha Creek – Red Bird River sub watershed; its major tributaries are Flat Creek (5th order), and Elisha Creek (6th order). The entire reach of Red Bird River that flows through the sub watershed is impaired because of elevated lead and specific conductance from coal mining and E. coli from agriculture (KDEP, 2016b). Portions of Elisha Creek and Left Fork Elisha Creek are Exceptional Use waters (KAR, 2019). Approximately 85 oil and gas wells have been documented in the sub watershed (Figure 1). Four aquatic organism monitoring sites are located in the sub watershed (Figure 1). There is a small amount of permitted coal mines in the sub watershed (Figure 2).

Elisha Creek – Red Bird River WCC score was 1.7 and classified as "functioning at risk" (USFS, 2011b). None of the watershed condition indicators (Table 1) were ranked poor. Soil erosion was ranked fair. Soil productivity was ranked fair.

Climate

The climate of the South Red Bird Project is humid oceanic and locally influenced by entrenched river valleys and elevation (Taylor et al., 1997). Mean annual temperature averages approximately 53°F. Daily

minimum temperature averages approximately 21°F and daily maximum temperature averages approximately 86°F. Precipitation is distributed fairly evenly throughout the year with fall generally receiving the lowest average amount. Average annual precipitation equals 53 inches.

Hydrology

All sub watershed in Figure 2 have impaired streams from *E. coli* (KDEP, 2016b). Two waterways are designated as Exceptional Use waters: Spruce Branch and Elisha Creek (Figure 1). The quality of Exceptional Use waters exceeds what is necessary to support the propagation of fish, shellfish, and wildlife and recreation (KDEP, 2016a). Two of the sub watersheds, Phillips Fork – Red Bird River and Bowen Creek – Red Bird River, are priority watersheds (USFS, 2011c). No karst topography has been documented in any of the sub watersheds.

Soils

Soils within the South Red Bird Project area are derived from sedimentary rock, mostly sandstone and shale, with lesser amounts of limestone, siltstone, and coal. The parent rock includes lower to middle Pennsylvanian-aged rocks from the Breathitt Formation. Coal beds are numerous and common in this part of the Breathitt.

The diversity of parent material produces soils that differ in rock content, erodibility, and depths (Table 3 and 4). Woodland soils are often mapped as complexes or associations. These consist of two or more dissimilar components occurring in a regularly repeating pattern (Soil Survey Division Staff, 1993). The project area crosses two soil survey areas, KY051 Clay County and KY633 Leslie and Perry Counties. Approximately 40% of the project activities occur in Clay County and the remaining occur in Leslie County.

Table 3. Soil mapping units and characteristics within the project area for Soil Survey Area KY051 (Clay County), found in the project area, South Red Bird Project, Redbird Ranger District, Daniel Boone National Forest.

Mapping Units in KY051 Clay County	Depth (cm)	Drainage[1]	Erosion Rating	Parent Material[2]	Landscape Position	Acres Covered	Percent of Acres Covered in Soil Survey Area
Shelocta-Highsplint-Gilpin complex, 20-70% slopes, very stony	150	Well drained	Moderate to Severe	Fine-loamy colluvium derived from sandstone and shale	Ridge tops, side slopes, shoulders	1,534	12.9
Shelocta-Kimper-Cloverlick complex, 20-80% slopes, very stony	150	Well drained	Moderate to Severe	Fine-loamy colluvium derived from sandstone and shale over clayey residuum weathered from shale and siltstone	Ridge tops, side slopes, shoulders	1,524	12.8
Gilpin-Rayne-Sequoia complex, 25-55% slopes, very stony	71	Well drained	Severe	Fine-loamy residuum weathered from sandstone and shale	Ridge tops	1,520	12.8
Gilpin-Shelocta complex, 20-35% slopes, eroded	84	Well drained	Moderate to Severe	Fine-loamy residuum weathered from sandstone and shale	Side slopes	76	0.6

Mapping Units in KY051 Clay County	Depth (cm)	Drainage[1]	Erosion Rating	Parent Material[2]	Landscape Position	Acres Covered	Percent of Acres Covered in Soil Survey Area
Pope fine sandy loam, occasionally flooded	>200	Well drained	Slight	Coarse-loamy alluvium derived from sandstone and shale	Flood plains	41.9	0.4
Craigsville-Philo complex, 0 to 3% slopes, rarely flooded	>200	Well drained	Slight	Loamy-skeletal alluvium derived from sandstone and shale	Flood plains	36	0.3
Mine dumps and tailings	>200	Well drained	Not rated		Flood plains	4	0.0
Fairpoint and Bethesda soils, 20-79%, stony	>200	Well drained	Severe	Loamy-skeletal coal extraction derived from sandstone and shale	Side slopes	2.5	0.0
Gilpin-Shelocta complex, 12-20% slopes, eroded	76	Well drained	Slight to Moderate	Fine-loamy residuum weathered from sandstone and shale	Shoulders and ridge tops	0.9	0.0
				Totals for Soil Survey Area KY051		**4739**	**40**

[1]Drainage refers to the relative wetness of the soil under natural conditions as it pertains to wetness due to the water table (Soil Survey Staff, 1993).
[2]Residuum refers to a soil that has weathered in place above the parent geology; colluvium refers to a soil that has moved away from its original parent geology by the force of gravity; alluvium is a soil that has moved away from its original parent geology by the force of water.

4. Soil mapping units and characteristics within the project area for Soil Survey Area KY633 (Leslie and Perry Counties), South Red Bird Project, Redbird Ranger District, Daniel Boone National Forest.

Mapping Units in KY633 Leslie and Perry Counties	Depth (feet)	Drainage[1]	Erosion Rating	Parent Material[3]	Landscape Position	Acres Covered	Percent of Acres Covered in Soil Survey Area
Matewan-Marrowbone-Latham complex, 20-80% sloeps, very rocky	70	Well drained	Moderate to Severe	Loamy-skeletal residuum weathered from sandstone	Ridge tops	2,734	22.9
Shelocta-Cutshin-Gilpin complex, 20-75% slopes, very stony	150	Well drained	Moderate to Severe	Fine-loamy colluvium derived from sandstone and shale over clayey residuum weathered from shale and siltstone	Side slopes and foot slopes	2,130	17.9
Shelocta-Highsplint-Gilpin complex, 20-70% slopes, very stony	150	Well drained	Moderate to Severe	Fine-loamy colluvium derived from sandstone and shale	Ridge tops, side slopes, shoulders	2,118	17.8
Fairpoint and Bethesda soils, 2-70% slopes, benched, stony	>200	Well drained	Severe	Loamy-skeletal coal extraction mine spoil derived from sandstone and shale	Side slopes	125	1.0

Mapping Units in KY633 Leslie and Perry Counties	Depth (feet)	Drainage[1]	Erosion Rating	Parent Material[3]	Landscape Position	Acres Covered	Percent of Acres Covered in Soil Survey Area
Grigsby fine sandy loam, 0-3% slopes, frequently flooded	>200	Well drained	Slight	Coarse-loamy alluvium derived from sedimentary rock	Flood plains	55	0.5
Fairpoint soils, undulating	>200	Well drained	Slight to Moderate	Loamy-skeletal coal extraction mine spoil derived from interbedded sedimentary rock	Ridge tops	14	0.1
					Totals for Soil Survey Area KY633	**7,175**	**60**
					Totals for Project Area	**11,914**	**100**

[1]Drainage refers to the relative wetness of the soil under natural conditions as it pertains to wetness due to the water table (Soil Survey Staff, 1993).
[2]Residuum refers to a soil that has weathered in place above the parent geology; colluvium refers to a soil that has moved away from its original parent geology by the force of gravity; alluvium is a soil that has moved away from its original parent geology by the force of water.

Soils in the project area are silt and sandy loams that cover a wide range of landscape positions. Gilpin, Rayne, and Latham may be found in the highest landscape positions, such as ridge tops and shoulders. Sideslopes are covered with a variety of well-draining and deeper soils such as Shelocta, Sequoia, and Gilpin, which are good for vegetative growth. Kimper and Cutshin are representative soil series found on lower slope positions, and the floodplains are mapped with Philo, Grigsby, Pope, and Craigsville alluvial soils.

Erosion

The Natural Resource Conservation Service (NRCS) provides soil interpretation ratings in National Soil Information System (NASIS) for all the soil mapping units in the project area. The erosion ratings found in Table 3 indicate the hazard or risk of soil loss from areas after disturbance activities that expose the soil surface. Ratings assume a 50 to 75% exposed, roughened mineral surface layer. Ratings are defined as follows:

Slight - Erosion is unlikely under ordinary climatic conditions.

Moderate - Some erosion is likely; control measures may be needed.

Severe - Erosion is very likely; control measures for vegetation re-establishment on bare areas and structural measures are advised.

The erosion hazard for unsurfaced roads or trails in the project area ranges from slight to severe, with the most common soil series having moderate to severe erosion potential, influenced by slope, rock content, and soil texture (Soil Survey Staff, 2019). The remaining soils, including complexes that include Rigley and Cranston, have severe erosion potential for unsurfaced roads and trails. This rating reflects erosion that may occur from a road or trail without any cover or water control structures. These roads and trails require frequent maintenance, and erosion-control measures are needed. Slopes within the project area range between 0-60% gradient (Table 5). The mean slope in the project area is 23%.

Table 5. Slope classes within the South Red Bird Project area, Redbird Ranger District, Daniel Boone National Forest.

Slope %	0 – 10%	10 – 20%	20 – 30%	30 – 40%	>40%
Project Area %	9.5	23.1	48.6	17.5	1.3

BMP Monitoring

Required annual BMP monitoring (USFS, 2012) of timber sale landings, skid trails, prescribed burn fire lines, and trail improvements by DBNF Watershed staff indicate that BMPs have been implemented and continue to be effective at limiting the amount of erosion on projects across the forest (Table 6). This data is available in the project record. Annual monitoring of timber sales and other activities indicates that erosion is being managed within these limits, with few exceptions.

Table 6. Summary of BMP Monitoring results for random and various ground-disturbing activities on the Daniel Boone National Forest, South Red Bird Project, Redbird Ranger District, Daniel Boone National Forest.

Monitoring Activity	Site	Date	Implementa-tion	Effectiveness	Composite	Notes
Prescribed Fire	Walker Branch London RD	9/24/14	Marginal	Effective	Good	One fireline needed more waterbars but there was no evidence of erosion; recommended because line ended in a creek
Completed construction or re-routing of motorized or non-motorized trails	Trail 631 Stearns RD	9/09/14	Fully	Effective	Excellent	Erosion occurred when track-hoe was installing bridge. Soil revegetated after implementation.
Prescribed Fire	Prewitt	9/21/15	Fully	Effective	Excellent	
Motorized or non-motorized trail operation and maintenance	Bark Camp Trail 413 London RD	9/6/15	Fully	Effective	Excellent	
Ground-based skidding and harvesting	Middle Fork Unit 6 London RD	9/24/15	Fully	Effective	Excellent	
Ground-based skidding and harvesting	Buffalo Unit 2 Stearns RD	8/11/16	Fully	Effective	Excellent	
Ground-based skidding and harvesting	Freeman Fork Unit 2 Stearns RD	8/31/16	Mostly	Effective	Excellent	Landing needed additional seeding and ripping

Monitoring Activity	Site	Date	Implementa-tion	Effectiveness	Composite	Notes
Completed construction or re-routing of motorized or non-motorized trails	Limestone Trail 109 Cumberland RD	8/03/17	Fully	Effective	Excellent	
Motorized or non-motorized trail operation and maintenance	Sheltowee Trace Stearns RD	8/2/17	Fully	Effective	Excellent	
Mechanical site treatments	Wildcat Reforestatio n London RD	6/16/17	Fully	Effective	Excellent	
Prescribed Fire	BearWallow London RD	9/4/18	Fully	Effective	Excellent	
Completed construction of motorized or non-motorized trails	Twin Branch Trail 406 London RD	9/27/18	Mostly	Effective	Excellent	Erosion from new tread
Motorized or non-motorized trail operation and maintenance	Bark Camp Trail Steps London RD	9/12/18	Fully	Effective	Excellent	

One large exception occurred in a nearby sub watershed within the last 2 years: Granny's Branch. A full-bench skid road was constructed on slopes that exceeded 35%. The soil scientist was not informed until after the sale was finished. Repairs were made using soil and water funding. Erosion occurred in this location but it was arrested once the area was seeded and mulched. Communication could have kept this from happening, and the leadership, staff, and district all understand that Granny's Branch was an unacceptable situation. That is not expected to happen again.

319 Grant Work

In 2010 the DBNF initiated a project in the Red Bird River Watershed that culminated in a Watershed-Based Management Plan (WBP). This involved multiple local citizens, non-profits, and government agencies. Using the WBP, the forest applied for an EPA 319(h) grant, which was awarded in 2016. The Kentucky Division of Water administrates these federal grants.

The grants are awarded to address non-point source pollution in impaired waters, such as the Redbird River and its tributaries. The WBP included water quality monitoring results that revealed the primary pollutants in the river and watershed. *E. coli* was the most pressing issue in the water to be addressed. We also focus on reducing sediment within the watershed through trail and road work.

With the grant funds we have been able to install 16 septic systems in target sub watersheds, clean up 50 acres of trash, hire a local Watershed Coordinator, educate numerous children and adults on the importance of clean water, and conduct water control work on approximately 20 miles of the Red Bird Crest Trail. This grant is going to be extended for another 3 years with the same objectives.

Environmental Consequences

Existing Condition

All the sub watersheds in the South Red Bird Project boundary, except Lick Fork – Red Bird River, are "functioning at risk". If the Proposed Actions do not take place, erosion and stream sedimentation will remain at current levels. If the Proposed Actions do not take place, there will be no change to water quality from prescribed fire or herbicide application.

The Proposed Action

Under the Proposed Actions, approximately 2,300 acres of young forest will be created from commercial timber harvests, cut-surface site preparation, and thinning (commercial and non-commercial). Commercial thinning will be used to salvage 600 acres of timber. Approximately 3.7 miles of temporary roads and logging skid roads and trails would be rehabilitated after timber harvests to reduce erosion and sedimentation. Approximately 30 miles of existing roads will be rehabilitated and 1.8 miles of new roads will be constructed. Commercial thinning is proposed on approximately 45 miles of existing roads. Non-commercial midstory removal treatments and prescribed burning will allow approximately 2,400 acres of dense midstory canopy to be removed for oak reproduction and recruitment. Approximately 1,900 acres will receive non-commercial, cut-surface crop tree release treatments. Existing barriers (creeks, roads, and trails) will be used for approximately 62 miles of control lines and an additional 8 miles of newly created control lines will be used for the 7,500 acres (maximum) of prescribed burns that are proposed. Approximately 19.1 miles of the Redbird Crest Trail will be created to re-route the public from roads that are currently being used by motorized vehicles. Approximately 2.17 miles of disconnected sections of old mining roads will be connected and designated as NFSR 1750, Steel Trap Road.

Direct and Indirect Effects

Stream sedimentation

Proposed activities, such as commercial timber harvests, prescribed fire, hiking trail construction, and construction of new roads have the potential to increase stream sedimentation from current levels. Proposed Actions may include a combination of these activities.

Proposed commercial timber harvest actions will likely lead to increases in stream sedimentation from the current levels. The time frame is approximately 3 years for each harvest. Research and local experience has shown following timber harvest, soil that becomes exposed are completely covered by regrowth in three years (Fulton and West, 2002) and sedimentation impacts to streams were reduced to pre-harvest levels in three years (Patric, 1976; Macdonald et al., 2003; Karwan et al., 2007). Best Management Practices (BMPs) and Forest Plan standards will reduce the probability of sediment actually being delivered to the streams (Stringer et al., 1998; USFS, 2004, 2012). Research has proven BMPs are effective at reducing stream sedimentation and maintaining applicable water quality standards (Swift, 1988; Fulton and West, 2002; Witt et al., 2013). Haul roads, skid trails, and landings will likely generate the most erosion (Patric 1976; Yoho, 1980; Swift 1984a, 1984b, 1988; Binkley and Brown, 1993), so it is particularly important for them to be excluded from Riparian Corridors.

Short-lived indirect effects (e.g. increases in turbidity and suspended sediment) will likely result from the commercial timber harvest activities, but should be limited to precipitation events and will return to pre-storm conditions within days. Long-lived indirect effects (stream channel elevation increases) are not expected. Non-commercial timber harvests will not use heavy equipment, so stream sedimentation is not expected.

Road improvements, such as culvert installation or replacement, will be made on approximately 30 miles of existing infrastructure and 1.8 miles of roads will be newly constructed to implement the Proposed Actions. There will likely be stream sedimentation when culverts are installed; however, that will be short-lived, and improvements to soil and water resources from the culverts will be long-lived. There will be stream sedimentation when new roads are constructed, but the impacts will be mitigated by BMPS (Stringer et al., 1998) and Forest Plan standards (USFS, 2004). Unauthorized use of OHVs on access roads and skid trails are a threat to soil and water resources, so control structures will be installed to deter OHV use in these areas after the roads and skid trails are no longer needed for timber extraction. The existing road segments through the Steel Trap mine are currently excluded from maintenance by the DBNF. By designating them as a National Forest System Road, it will be maintained by the DBNF, which will benefit soil and water resources over the current levels.

In order to re-route the Red Bird Crest Trail off existing portions of motorized roads, 14.05 miles of new trails will be constructed in the Bowen Creek – Red Bird River and Elisha Creek – Red Bird River sub watersheds. There will likely be short-lived stream sedimentation above the current levels when the new trails are constructed. The trails will be laid out according to Forest Plan standards (USFS, 2004) and will be designed for the designated uses, which will mitigate stream sedimentation after their establishment.

Fire crews will follow Forest Plan Standards (page 2-27) to avoid upland erosion and stream sedimentation when installing fire lines and backing fires into riparian areas (USFS, 2004). The severity of previous prescribed fires on the DBNF have shown to be light, which reduces the probability of stream sedimentation.

Elisha Creek – Red Bird River, Phillips Fork – Red Bird River, and Bowen Creek – Red Bird River sub watersheds are all classified as “functioning at risk”. The Aquatic Habitat and Roads and Trails Condition are watershed condition indicators at Phillips Fork – Red Bird River and Bowen Creek – Red Bird River sub watershed are ranked poor (Table 2). The Proposed Actions will likely cause short-term increases in stream sedimentation from the current levels, and new roads and trails will likely cause a small increase over the current levels, but it is not expected to cause a measurable change in the WCC or affect the Exceptional Use designations where applicable (Table 2).

Changes to water quality from herbicide and prescribed fire

Fire in forested ecosystems can lead to altered nutrient transformation rates and bioavailability in soils (Knoepp and Swank, 1993; Fulton and West, 2002) and changes in nutrient concentrations in surface waters if the burn is severe (Carignan et al., 2000). Walker and Chalfant (1996) examined the impacts of prescribed fire on soils and riparian areas on the DBNF and found that low-intensity fires only consumed the upper-most layer of leaf litter and often extinguished when backed into the riparian areas. In the southeastern U.S., the best available science has reported no noticeable effects to water quality from nutrient runoff associated with low-intensity prescribed fire (Douglas & Van Lear, 1983; Vose et al., 1999; Kolka, 2012). Others have concluded little or no impact to biological or drinking water resources from nutrient movement associated with prescribed fire (Vose et al. 2005).

The changes to nutrient concentrations in streams following prescribed fire from the Proposed Actions should be similar to the previously mentioned studies because appropriate measures will be used by the fire crews to control fire severity. The fire crews will follow standards set in the Forest Plan (USFS, 2004), so there should not be a direct effect to nutrient concentrations in streams following prescribed burns in the Proposed Action.

When applied incorrectly, herbicides can reach streams via direct application, surface runoff, or subsurface flow from forestry activities (Fulton and West, 2002). Relevant science concludes that surface

waters are more likely to be contaminated from aerial applications of herbicides compared to stem injection or cut surface applications and streamside management zones greatly reduce the risk of contamination from herbicides (Micheal and Neary, 1993; Fulton and West, 2002). Standards set in the Forest Plan (pages 2-24 to 26) will be followed when herbicides are applied (USFS, 2004), so there should not be a direct or indirect effect to streams from the Proposed Action.

Erosion

The primary soil concern for this project is erosion, driven by the fine-loamy textures, rock content, and slopes of the area. The NRCS erosion rating for the soil mapping units ranges from moderate to severe (Soil Survey Staff, 2019).

Heavy equipment use including skidding, decking, and transportation of logs can affect soil resources. Soil erodes when rainstorms occur on sites where the ground cover has been removed. Ground-disturbing activities associated with the proposed actions may directly impact soil erosion by removing the vegetation and exposing it to erosive forces. Erosion will occur in the short-term with these activities until the ground cover is re-established. During operations when there is no ground cover, off-site effects of erosion are minimized by adhering to BMP's, such as maintaining stream-side management zones and installing water bars and lead-out ditches on roads and trails. Mulching and seeding of exposed areas after use reduces erosion.

A full analysis of proposed herbicides was completed on 01/15/2015 (Cotton and Walker, 2015). Please refer to that document in the Project File for soil and water effects from herbicide.

Other soil stabilizing activities, including the management and improvements to road and trail systems, allow for the use of techniques to improve stream crossings, culvert function, and other indirect effects associated with roads and trails in the project area. The Red Bird Crest Trail re-route construction will directly and temporarily affect soil erosion but long-term it will improve the situation by removing an eroding section of trail.

Temporary roads will have design criteria to ensure erosion and soil disturbance is mitigated. Engineers and the hydrologist will assist during layout. If designed properly, these routes are relatively stable and will be completely restored after use. Improving the structure, stability and drainage of haul roads is expected to mitigate most of the erosion potential.

There exists a Forest Plan standard (page 2-12) that requires no more than 10% of a harvest area to be in landings, skid roads, or exposed soil (USFS, 2004). The project proposes to commercially harvest approximately 3,925 acres of forest. To be in compliance with the Forest Plan, no more than 392.5 acres of soil may be exposed from landings and skid roads. The project proposes to create 1.8 miles of new access road and 4.7 miles of temporary access road. Assuming the roads are 14 feet wide would result in 12 acres of soil being exposed.

Twelve acres of new access road (exposed soil) is 0.31% of the harvest area, which is well within the Forest Plan standard of 10%. This leaves approximately 380 acres that may be exposed through landings or skid roads to stay within compliance of the Forest Plan. Assuming 150 landings at 1.5 acres each results in 225 acres alone. To put the remaining acreage into context, the remaining 155 acres converts to 91 miles of 14-foot wide skid trails that may be established in the harvest units. These numbers are totals for the entire project. One must consider that the proposed actions will be spread out over time so effects will be considerably less on an annual basis.

Prescribed fires have the ability to affect soil erosion by burning too hot and removing the vegetation cover. Design criteria are included in the project to offset effects from these activities, such as the rehabilitation of fire lines and ridgetop ignition. Igniting these burns off of the ridge allows the flame front to slowly move down the hill and maintain temperatures that do not negatively affect soil. The flame front eventually gets extinguished in the riparian area due to the increased moisture and canopy cover.

Cumulative Effects

Past, present, and reasonably foreseeable future actions in the South Red Bird Project boundary are considered for cumulative effects (Figure 1). Actions that have the ability to cumulatively affect soil and water resources include oil and gas well roads, mining on private land, the Spring Creek Sale on NFS land, and historic subsistence farming.

Changes in land use over the last 200 years have increased stream sedimentation in the South Red Bird Project boundary. A majority of these changes have been the conversion of land from forest to roads, low density urban use, and mining. Future sources of stream sedimentation may include wildlife opening maintenance, research, and timber cutting on Forest Service and private lands.

Improvements to stream crossings and control structures used to deter OHV use from the Proposed Actions will offset stream sedimentation from oil and gas wells access roads. Oil and gas wells are widespread throughout the South Red Bird Project boundary on private land (Figure 1), and their access roads have the potential to cause stream sedimentation. In total, 15.8 miles of oil and gas road have been inventoried within the project area, with an additional 3.0 miles of probable road awaiting ground inspection. These are not Forest Service roads, so they are not scheduled to be maintained by the DBNF. Road attributes vary, but it is possible to make some generalizations:

- Road surfaces are typically native materials.
- Roads are about 6 feet wide, and are travelled by UTV.
- Average slope is about 13%, but ranges widely from 0-40%.
- Tree canopy cover was generally high. Ground cover during the fall season was highly variable.
- Uncontrolled water flow on many roads is causing some degree of erosion, but about half of the inventoried road segments were rated at 1 or 2 (low erosion).
- NNIS are widespread on oil and gas roads, and often more abundant near well pads. Kudzu is not widespread, but small populations are present on some road segments.
- Several oil and gas roads had been recently maintained and most would benefit from maintenance. Narrow road widths may limit maintenance options.

The Forest Service has to grant reasonable access to mineral rights holders. District personnel are working with the gas companies to improve the construction and maintenance on the roads they use. The exposed soil created by this activity calculates to approximately 14 acres. This cumulative effect must be considered when planning and calculating access roads, landings, and skid roads.

Figure 3 shows the places that have been mined for coal in the affected environment, and there has been some degree of coal mining in every sub watershed. Lick Fork – Red Bird Creek sub watershed, which contains no NFS land, contains the most permitted mines, and is upstream of the other sub watersheds. The impacts of mining is evident; the Red Bird River is listed as impaired because of elevated lead and specific conductance associated with mining. The Proposed Actions will not impact the lead or specific conductance of Red Bird River, or any other waterway in the South Red Bird Project boundary. None of the waterways in the South Red Bird Project boundary are impaired because of sediment, but coal mining can increase stream sedimentation, particularly during rain events.

Stream sedimentation from the proposed Actions will likely contribute to what is being delivered from coal mines, the Spring Creek Sale, and oil and gas roads; however, the changes in stream sedimentation will not change the WCC. Soils within the South Red Bird Project area will have short-term direct, indirect, and cumulative effects from the proposed activities. However, if design criteria are followed, those effects should be minimal, fall within standards in the Forest Plan, and not cause a change in WCC. Since the direct or indirect changes to water quality from herbicide runoff are unlikely, there would be no additional cumulative effects.

In 2007, restoration efforts began on portions of Left Fork Elisha Creek (Figure 5). The restoration is now complete and approximately 6,200 linear feet of stream has been restored. The restoration has reduced peak flows, in-stream erosion, and sediment suspended in stream flow and improved aquatic habitat. The benefits from the restoration help offset some of the stream sedimentation generated in other areas of the South Red Bird Project boundary.

Several of the waterways in the South Red Bird Project boundary are impaired because of *E. coli* , including most of the Red Bird River. *E. coli* indicates pathogens from fecal contamination and many of the sources are from inadequate septic systems or lack of septic systems (straight pipes). None of the Proposed Actions will contribute *E. coli* to the streams. The 319 grant work in the area, including repairing and replacing septic systems, will improve fecal contamination into the future.

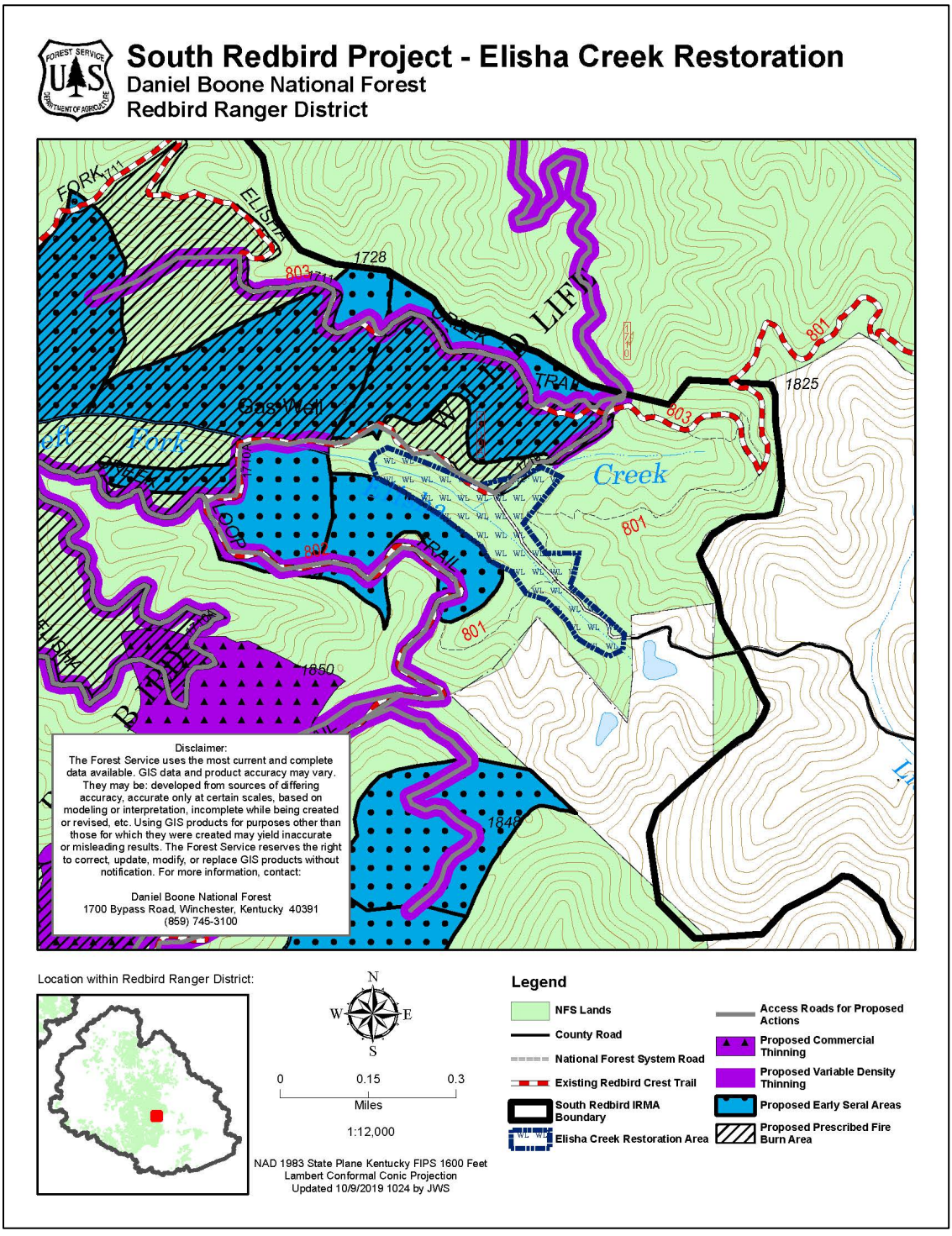

Figure 4. Left Fork Elisha Creek restoration boundary (approximate) and Proposed Actions.

Design Criteria

- The Riparian Corridor is a Forest Plan Prescription Area (p. 3-9) and is generally unsuitable for timber production unless to attain Desired Future Condition (USFS, 2004). In some of the planning GIS layers (Figure 4), it appears there are relatively large proportions of Riparian Corridor in some of commercial timber harvest units. The figure displays unit boundaries, not operation boundaries. Operations will adhere to all BMPs and Forest Plan Standards.

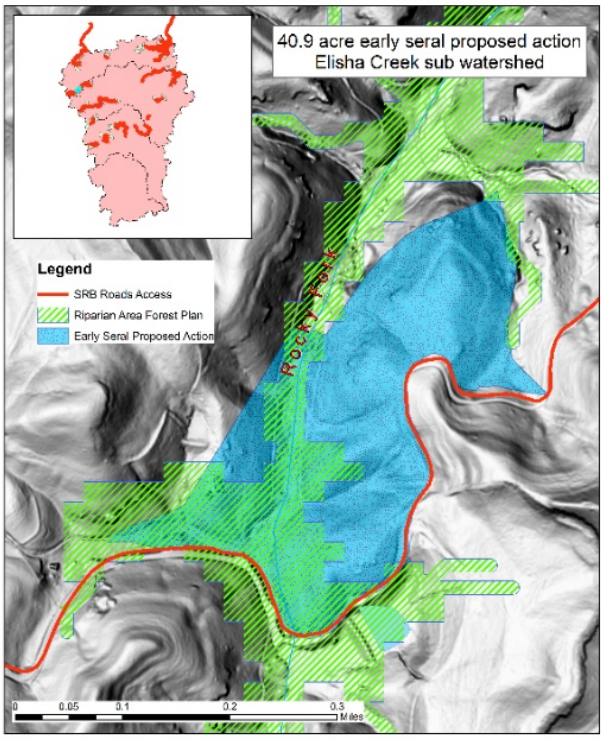

Figure 5. An example of a proposed commercial timber unit with a high proportion of Riparian Corridor.

- Figure 5 shows approximate boundaries of the Left Fork Elisha Creek stream restoration in the South Red Bird Project boundary. Restoration activities began in 2007 and have since been completed. The restoration was funded through the Kentucky Wetland and Stream Mitigation Fund trust for the purpose of restoring, creating or enhancing wetlands and streams in the Commonwealth. Continued protection of the Left Fork Elisha Creek stream restoration is critical. The Forest Service will work with all stakeholders to follow guidance in 33 C.F.R. §332 to avoid incompatible uses (USACE, 2008).

- Soil exposed by projects would be revegetated with either annual cereal grasses (wheat, rye, oats, or barley alone or in mixture) for temporary cover, or with a combination of annual cereal grasses for temporary cover, and native species when seeding directly for permanent vegetation.

- Execute ignition into or facing the wind along dominate ridges or along a controlled perimeter; allowing fire to back down slope will normally keep flame lengths below 3 feet. An ignition strategy using backing fires is more protective of soils, as such fires have lower heat intensity and shorter flame lengths, although with a relatively longer residence time.

- Stabilize all fire control lines as soon as possible following their use.

- Rehabilitate, close, and decommission temporary roads as soon as possible following their use.

- When planning out skid roads and landings in harvest units, calculations of exposed soil must consider the additional 31.7 acres of soil-exposing activities from gas well roads and Spring Creek sales activities.

- Sales must be spread out in time and space to mitigate the direct, indirect, and cumulative effects to soil and water discussed in this report.

- Skid trails or roads should not cross over the Fire Clay or Fire Clay Rider coal seams when the slope gradient exceeds 35%.

- Mulch the following areas as the operator finishes with a harvest unit: exposed landings, 3 feet above the waterbars, and the entire waterbar. Seed as soon as conditions allow for germination, pursuant to the sale contract.

- It is recommended to either change the operations in the Little Flat Creek harvest unit to non-commercial or drop it altogether, due to the Fireclay coal seam cutting diagonally across the unit. As of 1/24/20, the District Ranger decided to drop the unit.

- In areas where slopes exceed 35%, install more waterbars on skid trails than prescribed in KY BMPs (Stringer et al., 2018).

Regulatory Framework

Compliance with Land and Resource Management Plan, Federal, State, and Local Law

Project is consistent the DBNF Forest Plan. This work also complies with Kentucky water productivity regulations (401 KAR) and the Clean Water Act.

Municipal Watersheds

There are no Source Water Protection Zones in the South Red Bird Project boundary.

Executive Orders

Wetlands (Executive Order 11990)

Other than an occasional farm pond or artificial pond on the DBNF, there are very few wetlands in the project area. With Forest Plan Riparian Prescription Area standards and low intensity backing fires near the shoreline, these anthropogenic wetlands would be unaffected and the intent of Executive Order 11990 would be met.

Floodplains (Executive Order 11988)

Numerous floodplains exist throughout the project area, but these areas should not have adverse effects from the project since they are protected by Forest Plan Riparian Prescription Area standards. They are also not likely to burn due to backing fires and increased soil moisture (Walker and Chalfant, 1996). The intent of Executive Order 11988 would be met.

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Addendum to SRB Soil and Water Specialist Report

Response to Heartwood Comments on South Red Bird Wildlife Habitat Enhancement Project

Claudia Cotton, PhD, DBNF Soil Scientist
Mac Cherry, DBNF Forest Hydrologist

January 28, 2020

Additional response may be found in the response to comments by the District Biologist. This addendum addresses the soil and water comments of the HW letter.

Section 1: Soil and Water Resources

"I. Logging activities can cause significant erosion and sedimentation" (KY Heartwood, p. 1)

When effects to soil and water resources were analyzed for the South Red Bird (SRB) project, it was determined there will not be impacts to water chemistry (including nutrients), streamflow, or water temperature from the proposed activities. The SRB Soil and Water Specialist Report (Cherry and Cotton, 2020) (S&W report) acknowledged there will likely be short-term increases in stream sedimentation (direct effects), resulting in increases in turbidity and suspended sediment (indirect effects), from the commercial timber harvests (p. 14). Stream sedimentation mostly will be in response to precipitation events. Based on relevant research, it was determined that because of vegetation regrowth, the levels of stream sedimentation will return to current levels in less than 3 years following commercial timber harvest (Patric, 1976; Macdonald et al., 2003; Karwan et al., 2007; Fulton and West, 2012).

The Forest Service – Daniel Boone National Forest (DBNF) will follow state and federal Best Management Practices (BMPs) and The Land and Resource Management Plan for the Daniel Boone National Forest (Forest Plan) standards during proposed timber harvest actions. These include streamside management zones (SMZs) to trap erosion before it reaches streams and proper placement of skid trails and landings to avoid landslides and erosion from reaching streams. Because state and federal BMPs and Forest Plan standards will be used, there will be no changes to the current (existing) conditions of streams in the SRB project watersheds from the increases in stream sedimentation, nor any indirect effects from the SRB project. The existing conditions of the SRB project watersheds can be found in the S&W report, page 4.

The "Edwards et al., 2016" reference on page 2 could not be found in the footnotes. Without a title or source, that reference could not be obtained, which made it not possible to consider that comment.

Section 1: Soil and Water Resources

"II. Erosion and sedimentation can have significant, adverse impacts to aquatic species" (KY Heartwood, p. 2)

Sedimentation and siltation are the cause of over half of the identified stream impairments for aquatic life in Kentucky (KDEP, 2018). Streams all over Kentucky, including the narrow valley bottoms of the SRB watersheds, were straightened and channelized to allow more land for agriculture and roads (Parola et al., 2005a, 2005b, 2007). Land-use changes over the last 200 years have had the most profound impact to stream sedimentation in the SRB project boundary, and by using state and federal BMPs and Forest Plan Standards, stream sedimentation from the SRB project will be lessened to the point that no changes to the existing conditions are expected. Research has proven BMPs (e.g., streamside management zones, water bars, seeding and mulching) are effective at reducing stream sedimentation and maintaining applicable water quality standards (Cristan et al., 2016; Swift, 1988; Fulton and West, 2002; Witt et al., 2013).

Because of rapid vegetation regrowth, impacts to stream sedimentation for each harvest is not expected to last more than 3 years, and increases in turbidity and suspended sediment from stream sedimentation are only expected in response to storm events and will return to pre-storm conditions in days. The duration of stream sedimentation from the proposed actions is not long enough to deposit enough sediment to change aquatic habitat from the current conditions.

Stream sedimentation, in response to precipitation events, occurs in undisturbed, as well as disturbed, forests (Binkley and Brown, 1993; Fulton and West, 2012), mostly from in-channel erosion (Edward and Glysson, 1999). In-channel erosion may increase slightly from current levels during timber harvests, but the increases will likely be limited to growing seasons when harvested watersheds have reduced evapotranspiration (Hewlett and Helvey, 1970; Anderson et al., 1976; Wynn et al., 2000). Siltation of fine spaces between rocks are not expected because the fine sediment particles that can fill in crevices will be transported downstream with stormflow. Excessive deposition of large sediment particles, which can increase streambed elevations and impact aquatic habitat, are not expected because those particles are transported by sheet erosion (Edward and Glysson, 1999) and will be filtered by the SMZs.

Large woody debris and leaves typically fall into stream channels from the trees that grow in the riparian areas, alongside streams. Retention of trees in the riparian corridor is a state BMP (BMP3, p. 12; Stringer et al., 2018) and Forest Plan standard (1.E, p. 3-9; USFS, 2004), and the Riparian Corridor (Forest Plan) Standard (1.E-VEG-5, p. 3-16) specifically restricts the removal of large woody debris in the riparian corridor, unless it poses a threat to public safety or water quality. Because of the state BMPs and Forest Plan standards that protect the natural addition of large woody debris and leaf litter to streams, the SRB proposed actions will not adversely impact the food source that large woody debris and leaves provide to the aquatic food web.

The commercial method of timber harvests will be shelterwood with reserves, not clearcutting, and conversion of hardwoods to pine plantations is not a part of any proposed action for the SRB project.

Section 1: Soil and Water Resources

"IV. The Draft EA Fails to Meaningfully Consider the Impacts of Logging on the KAD and Snuffbox Mussel" (KY Heartwood, p. 8)

Two sources of data were used to determine erosion ratings: Web Soil Survey and the National Soil Information System Database (NASIS). Erosion ratings within the SRB project harvest units are based on soil mapping units as delineated by NRCS (Soil Survey Staff, 2019), as well as updated erosion ratings available in NASIS. Soil mapping units, especially in forested locations, often contain multiple soil series referred to as complexes. All of the soil mapping units found within the soil analysis area for the SRB project are complexes (e.g., Shelocta-Highsplint-Gilpin complex, 20-70% slopes, very stony), with the exception of Fairpoint. Interpretative ratings, such as erosion, vary within FS unit boundaries when the soil mapping unit is a complex because the ratings are based on multiple soil series that make up the complex (Appendix 1).

In response to KY Heartwood's comment (p. 9), erosion ratings have been updated in the SRB S&W report to reflect the range of erosion potentials. There is no combined map of the erosion ratings by harvest unit because the data comes from two sources; however, Appendix 1 includes maps of the soil mapping units in the harvest units, and those can be cross-referenced with the erosion ratings in the specialist report.

Median slope gradient by operating area within each unit is found in the maps of Appendix 2.

Section 1: Soil and Water Resources

"V. Implementation of Group One Project Demonstrates Inadequacy of BMPs and Forest Plan Standards" (KY Heartwood, p. 10)

Conditions on the Ground

In consideration of the comments regarding soil and water issues in the Group One Project area, on January 9, 2020, DBNF personnel visited Unit 18 of the Granny's Branch Sale within the Group One Project (Harvest Unit 18). This harvest unit closed 9/28/18. We confirmed the landslide mentioned on p. 11 of the KY Heartwood comment letter (KHW letter). The location of the landslide was approximately 37º11'26", -83º34'45". The landslide appeared to be a rotational slump (Figure 1) since most of the loose soil was still on site and adjacent to an unmapped intermittent stream. The landslide was not recent because vegetation was growing on the spoil. It was approximately 50 feet wide by 60 feet long. The out fill of the skid trail

appeared to be the origin of the slide. Median slope of the unit was 60%. Slope gradient at the landslide was 61%.

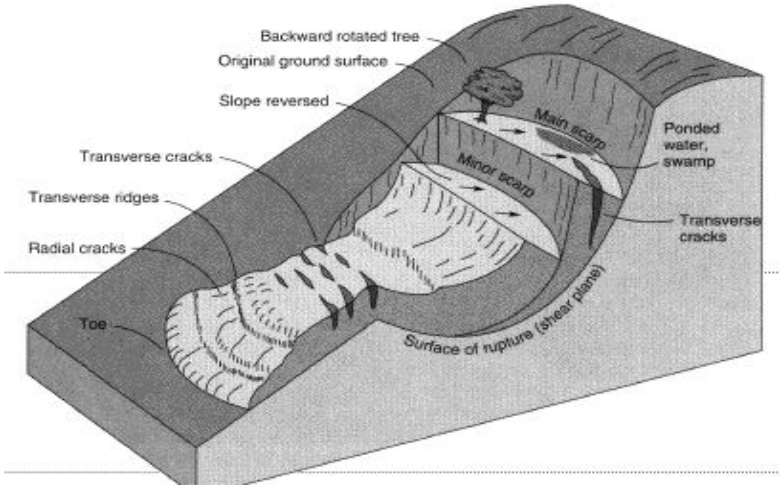

Figure 6. Diagram of a rotational slump, a form of landslide (http://bynumbruce.com/wp-admin/8-slump-mass -wasting).

On January 7, 2020, we visited Unit 14 (Harvest Unit 14) of the Granny's Branch Sale within the Group One Project. This harvest unit closed on March 29, 2017. Three-year-old tree saplings were established in the skid trails (Figure 2). The area of the landslide mentioned on p. 11 of the HW letter was on a strip mine bench that had an un-reclaimed highwall. The area had soil exposure but erosion was limited because the vegetation was becoming re-established (Figure 3). Waterbars were properly spaced, vegetated, and working as prescribed in the BMPs (Figure 4). Research indicates that vegetated waterbars are an effective mitigation measure to preventing stream sedimentation originating on forest roads (Cristan et al., 2016).

It was hard to determine if a landslide had actually occurred in Unit 14 but it was possible due to the presence of the Fireclay coal seam. This was the original coal seam that was mined out. Median slope of the unit was 61%.

Figure 7. Three-year-old tree saplings growing in the skid trail of Harvest Unit 14, Granny's Branch Sale of the Group One Project, Redbird Ranger District, Daniel Boone National Forest. For reference, DBNF employee is 6 feet tall.

Figure 8. Vegetation becoming re-established in Harvest Unit 14, Granny's Branch Sale of the Group One Project, Redbird Ranger District, Daniel Boone National Forest.

Figure 9. Waterbars working as prescribed in Harvest Unit 14, Granny's Branch Sale of the Group One Project, Redbird Ranger District, Daniel Boone National Forest.

Why Did It Happen?

Upon closer review of the geology of Harvest Units 14 and 18, there occurred two coal seams known as Fireclay and Fireclay Rider. Both coal seams are known to be underlain by rooted clays that act as a restricting layer to normal soil water percolation, allowing groundwater to potentially perch (KGS, 2010). Analysis indicates these coal seams are lower in the slope profile, occurring anywhere from 80 to 280 feet above the stream. In both harvest units, skid trails crossed the Fireclay coal seam.

The catalyst of the landslides in Harvest Unit 18 and potential landslide in Unit 14 appeared to be a combination of increased precipitation, slope, geology, and skid road placement.

When the dozer operator was improving the skid trail that failed in Harvest Unit 18, it bumped up against bedrock and had to move closer to the intermittent stream. This bedrock was the Fireclay coal seam. As the perched water continued to accumulate, it saturated the soil beneath the skid trail.

Precipitation was higher in 2018 and 2019 in this area compared to the preceding eight years (Table 1). This likely resulted in more accumulated water in the soil profile, and could have exacerbated the weight of the saturated soil, increasing the probability for a landslide.

Table 1. Annual total precipitation from the Owsley County Mesonet Station (BNVL) from 2010 to 2019. Owsley County is one county north of Harvest Units 14 and 18.

Year	Precipitation Amount (in)	Year	Precipitation Amount (in)
2019	56.35	**2014**	50.97
2018	61.54	**2013**	51.54
2017	47.77	**2012**	52.78
2016	49.65	**2011**	43.52
2015	50.97	**2010**	58.62

BMPs and the Forest Plan in Harvest Unit 18

DBNF personnel walked the entire length of the unmapped intermittent stream to the confluence of Lower Jacks Branch to observe for changes in channel morphology and sediment due to the landslide. There were no changes to suspended sediment levels or streambed conditions of Lower Jacks Branch, upstream or downstream of the confluence of the unmapped intermittent stream.

In Harvest Unit 18, measurements of the distance between the skid trail and the intermittent stream ranged between 50-65 horizontal feet. The Forest Plan specifies that riparian corridors on intermittent streams have a width of 50 feet on each side. The DBNF follows applicable Kentucky BMPs as well. At the time this harvest unit was logged, it was held to BMPs listed in the 1998 version of the state manual for forest practices (Stringer et al., 1998), which required a minimum distance of 65 feet (for slopes 40% or higher) between a skid trail and intermittent stream. A footnote to this table states, "Where minimum distances are not possible, (then) roads, trails, and landings can be located at less than the recommended distances, but they should be constructed to protect water quality." Initially, extra water bars were installed to overcome this exception and the water bars were vegetated during our site visit.

Soil Exposure in Unit 18 of Granny's Branch Sale of the Group One Project

The Group One Project was originally analyzed by a former DBNF Soil Scientist who is now retired. Forest Plan standard DB-VEG-26 states, "No more than 10% of a harvest area should be in landings, skid roads, or exposed soil." It was unclear in the original Soil and Water specialist report if he based the 10% soil exposure on the harvest unit or sale level. At the harvest unit level with field validation, we estimated 14.4% soil exposure using NAIP and Bing imagery. At the sale unit level (average of all units in the sale) the soil exposure was 11%. The purchaser for that sale used bigger equipment than usual. The widest areas of soil exposure were landings and skid road turns, which had a 25' turn radius in some areas. Geological obstacles were encountered in these units and equipment had to continually adjust track, an action that exposed soil.

How Will We Keep this From Happening Again?

Design criteria may be found in the S&W report for the SRB project, and in Appendix A of the project's EA. Kentucky State BMPs for logging were recently updated and now require a 100-foot streamside management zone for both perennial and intermittent streams with slopes greater than 15% (Stringer et al., 2018). These updated BMPs will be implemented for all harvest units in the SRB project, providing additional protections for soil and water.

Each harvest unit in the SRB project was examined for interactions between slope and the Fireclay and Fireclay Rider coal seams. Out of 77 units, eight contained the Fireclay and/or the Fireclay Rider coal seam. Other coal seams occur in the units but are not as susceptible to landslides as the Fireclay and Fireclay Rider.

Maps of each harvest unit that depict median unit slope, Fireclay and Fireclay Rider coal seams, and the SMZ, revealed that most of the Fireclay and Fireclay Rider coal seams fall within the SMZ (Appendix 2). When the Fireclay and Fireclay Rider fall into the SMZ, equipment should not cross over either coal seam when the slope is greater than 35%, which should minimize the potential for a landslide. Thirty-five percent was chosen as a slope threshold because Forest Plan standard DB-VEG-2 references that slope as a maximum limit for mechanical site preparation (p. 2-24). The presence of a Fireclay or Fireclay Rider coal seams does not preclude management around the seam, but skid trails should not cross these seams to minimize the potential of landslides.

In addition to known geologic hazards, DBNF personnel will mark off soil protection zones in each harvest unit that exclude heavy equipment due to slope, erodible soils, and/or the presence of Fireclay (Appendix 2). The SMZ will serve to protect soil and water within the riparian zone, and the soil protection areas will serve to protect soil and water on upland slope positions when the slope or other landform precludes safe equipment operation.

Only one unit in the Little Flat Creek area has the Fireclay coal seam crossing the main portion of the harvest unit, Stand 2701-0023 (Figure 12, harvest unit farthest to the left). It is recommended that either non-commercial actions take place in this harvest unit, therefore excluding skid trails, or that the unit be dropped altogether to reduce the potential of landslides.

For the SRB project we will mulch the following areas as the operator finishes with a harvest unit: exposed landings, 3 feet above the waterbars, and the entire waterbar. Seed as soon as conditions allow for germination, pursuant to the sale contract. Literature and observations on the ground indicate that generally, at the end of three years, exposed soil has some cover of litter and/or vegetation. In the interim before ground cover is established, waterbars serve to protect soil and water resources within the harvest unit, and continue to do so until the soil surface is covered. Waterbars will be installed at a higher density than BMP recommendations, and will be seeded and mulched as soon as conditions allow for germination. This will reduce the potential for exposed soil and erosion.

Page 12 of the KHW letter refers to the S&W report as stating "as many as 91 miles of skid roads may be developed…" This is true; however, the context behind the statement is important. One of the requirements of NEPA is to put effects into context. Page 16 of the S&W report has been updated to the following: "To put the remaining acreage into context, the remaining 155 acres converts to 91 miles of 14-foot wide skid trail." This does not mean we are bound to 155 acres or 91 miles of exposed soil, it simply defines the allowable maximum in different terms.

The median slope gradient and geology are different in the units of SRB versus Group One. In the SRB Project area the maximum median harvest unit slope is not as steep, and the Fireclay and Fireclay Rider coal seams are lower in the profile. If maximum median harvest unit slopes are not as steep, and the Fireclay and Fireclay Rider coal seams are mostly in the SMZ (lower on the landscape) than they were for the Group One project area, then the potential for landslides should be less in the SRB project area.

Design Criteria to be added to the EA:

1. Skid trails or roads should not cross over the Fire Clay or Fire Clay Rider coal seams when the slope gradient exceeds 35%.
2. Mulch the following areas as the operator finishes with a harvest unit: exposed landings, 3 feet above the waterbars, and the entire waterbar. Seed as soon as conditions allow for germination, pursuant to the sale contract.
3. It is recommended to either change the operations in the Little Flat Creek harvest unit to non-commercial or drop it altogether, due to the Fireclay coal seam cutting diagonally across the unit. As of 1/24/20, the District Ranger decided to drop the unit.
4. In areas where slopes exceed 35%, install more waterbars on skid trails than prescribed in KY BMPs (Stringer et al., 2018).

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Appendix 1. Soil mapping units in the SRB Project area (Soil Survey Staff, 2020).

Note: The map produced in Web Soil Survey was too small to see the harvest units so smaller screenshots are included here. Analysis area was based on commercial timber harvest units only due to the use of heavy equipment and increased soil disturbance compared to non-commercial activities, such as crop tree release.

Figure 10. Soil mapping units within the harvest units in the Bear Creek area of the SRB Project, Redbird Ranger District, Daniel Boone National Forest.

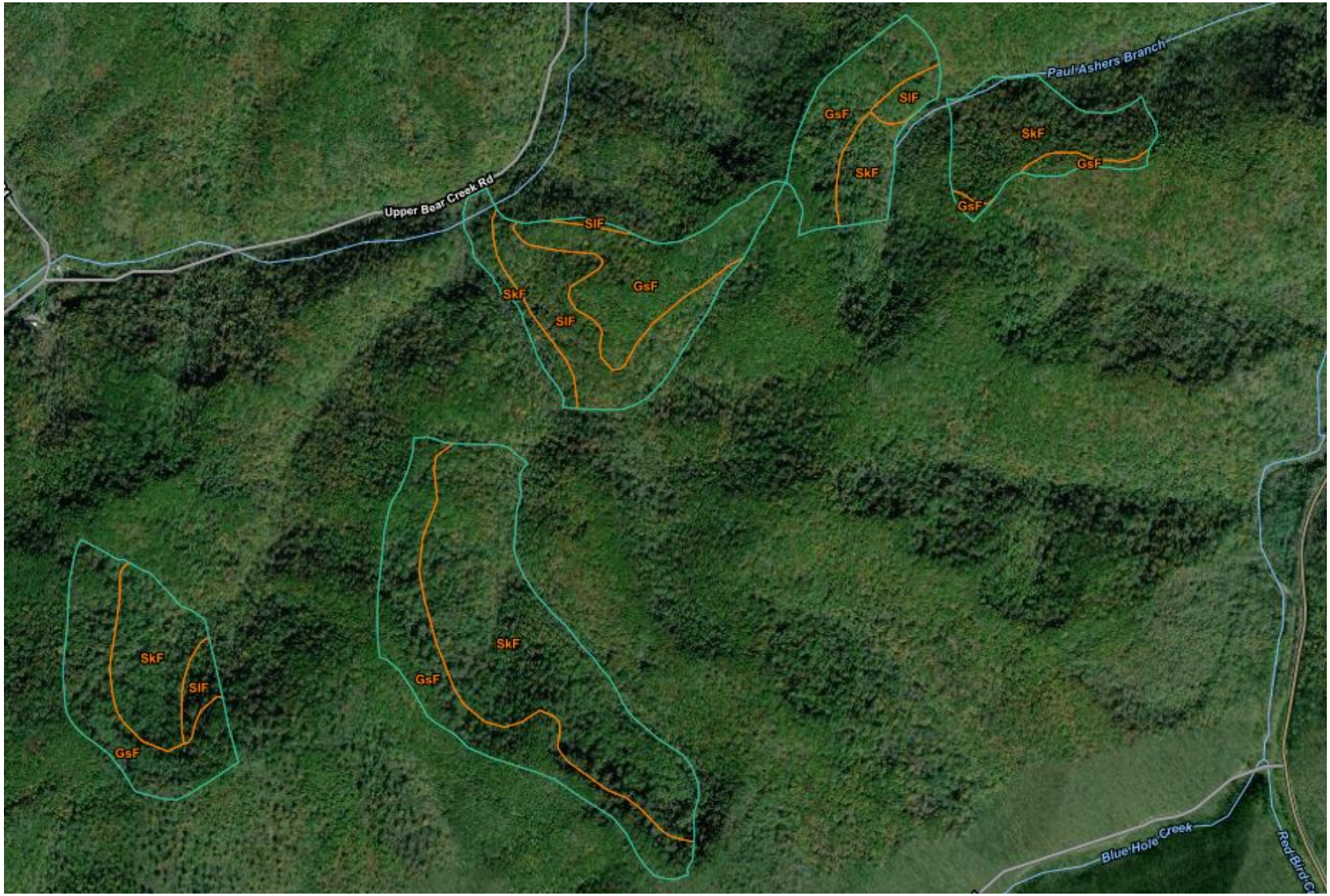


Figure 11. Soil mapping units within the harvest units in the Blue Hole area of the SRB Project, Redbird Ranger District, Daniel Boone National Forest.

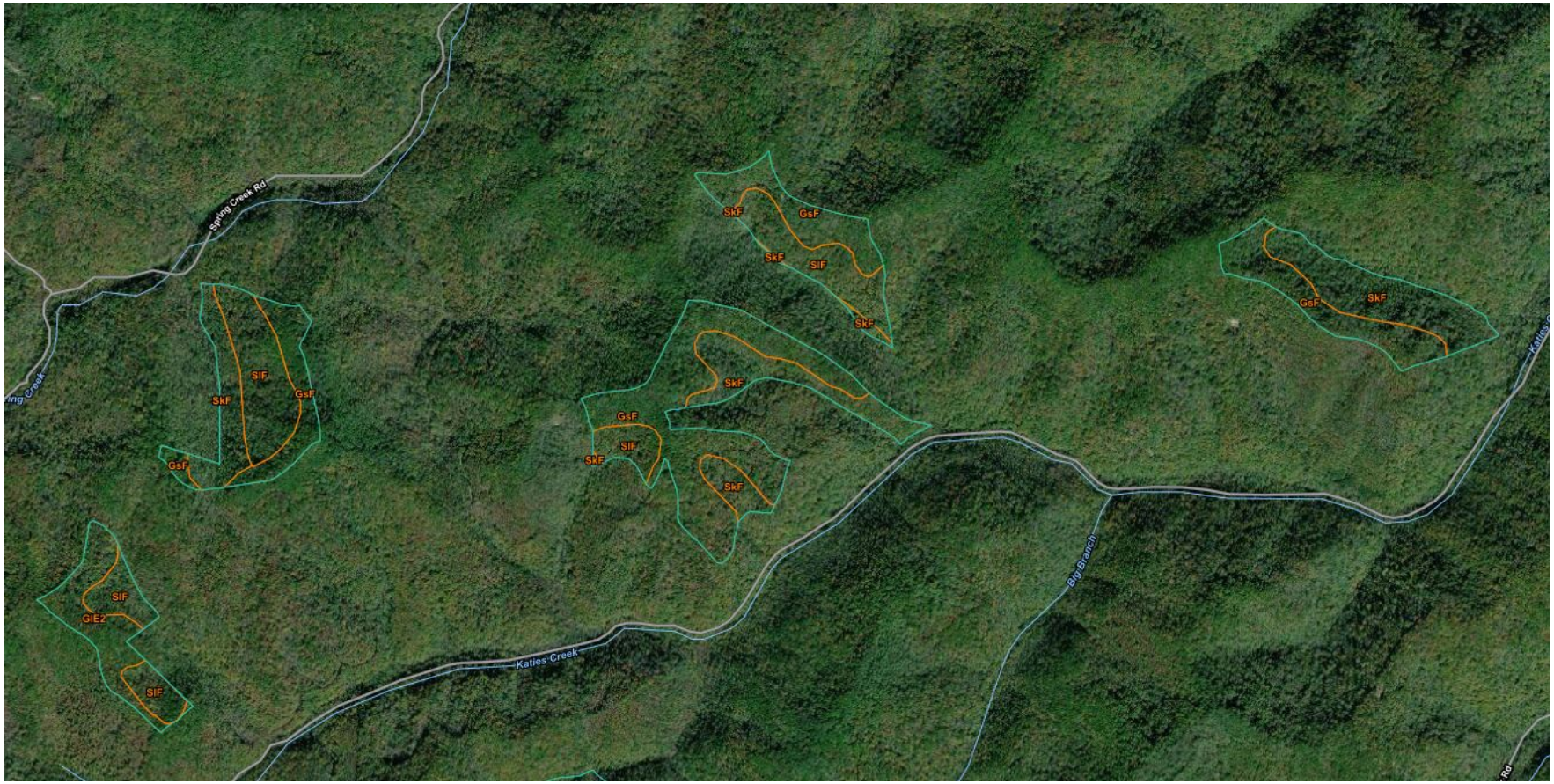


Figure 12. Soil mapping units within the harvest units in the Caney Knob area of the SRB Project, Redbird Ranger District, Daniel Boone National Forest.

Figure 13. Soil mapping units within the harvest units in the Bowens Creek area of the SRB Project, Redbird Ranger District, Daniel Boone National Forest.

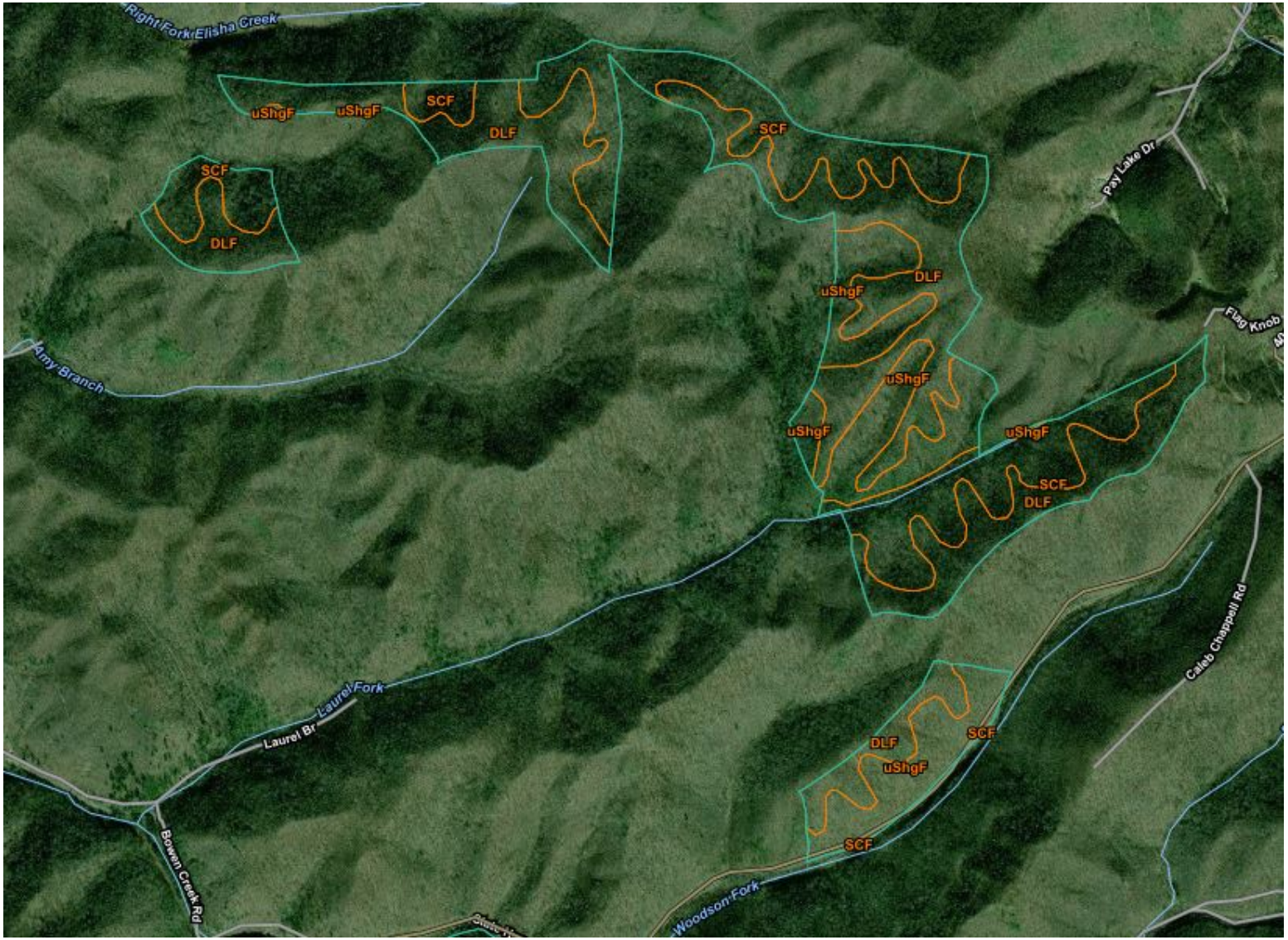


Figure 14. Soil mapping units within the harvest units in the Laurel Fork area of the SRB Project, Redbird Ranger District, Daniel Boone National Forest.

Figure 15. Soil mapping units within the harvest units in the Panther area of the SRB Project, Redbird Ranger District, Daniel Boone National Forest.

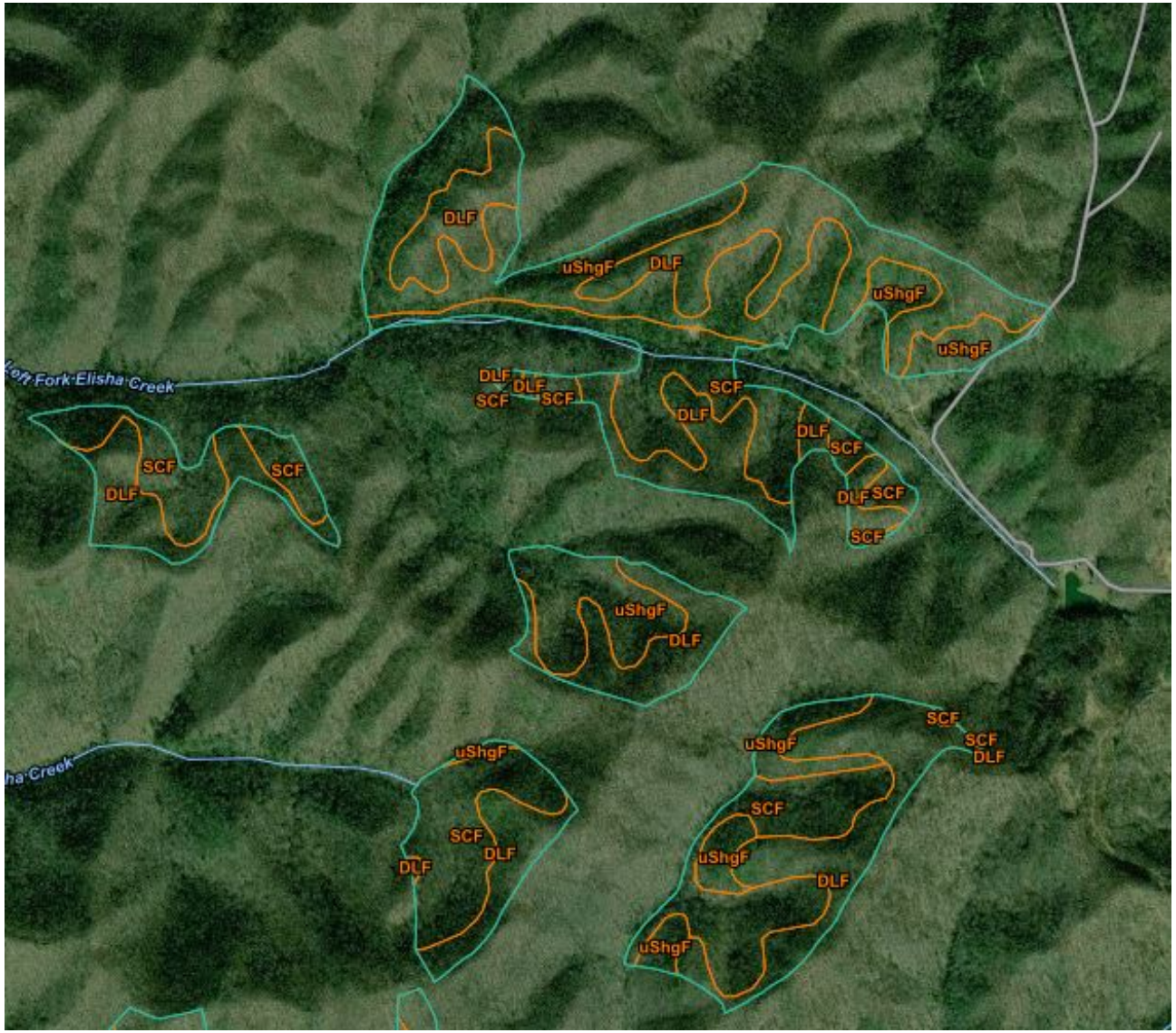


Figure 16. Soil mapping units within the harvest units in the Bear Creek area of the SRB Project, Redbird Ranger District, Daniel Boone National Forest.

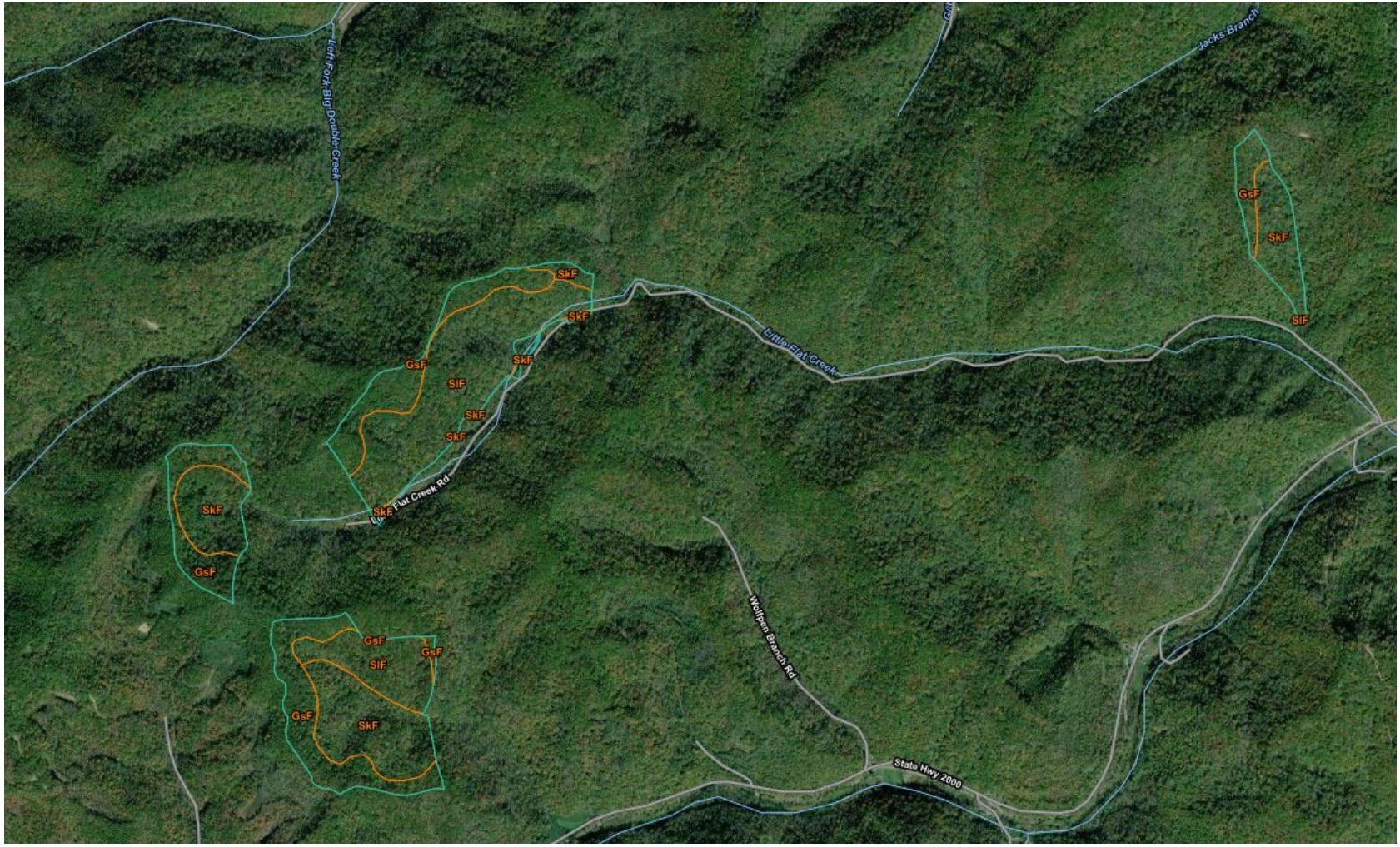


Figure 17. Soil mapping units within the harvest units in the Little Flat Creek area of the SRB Project, Redbird Ranger District.

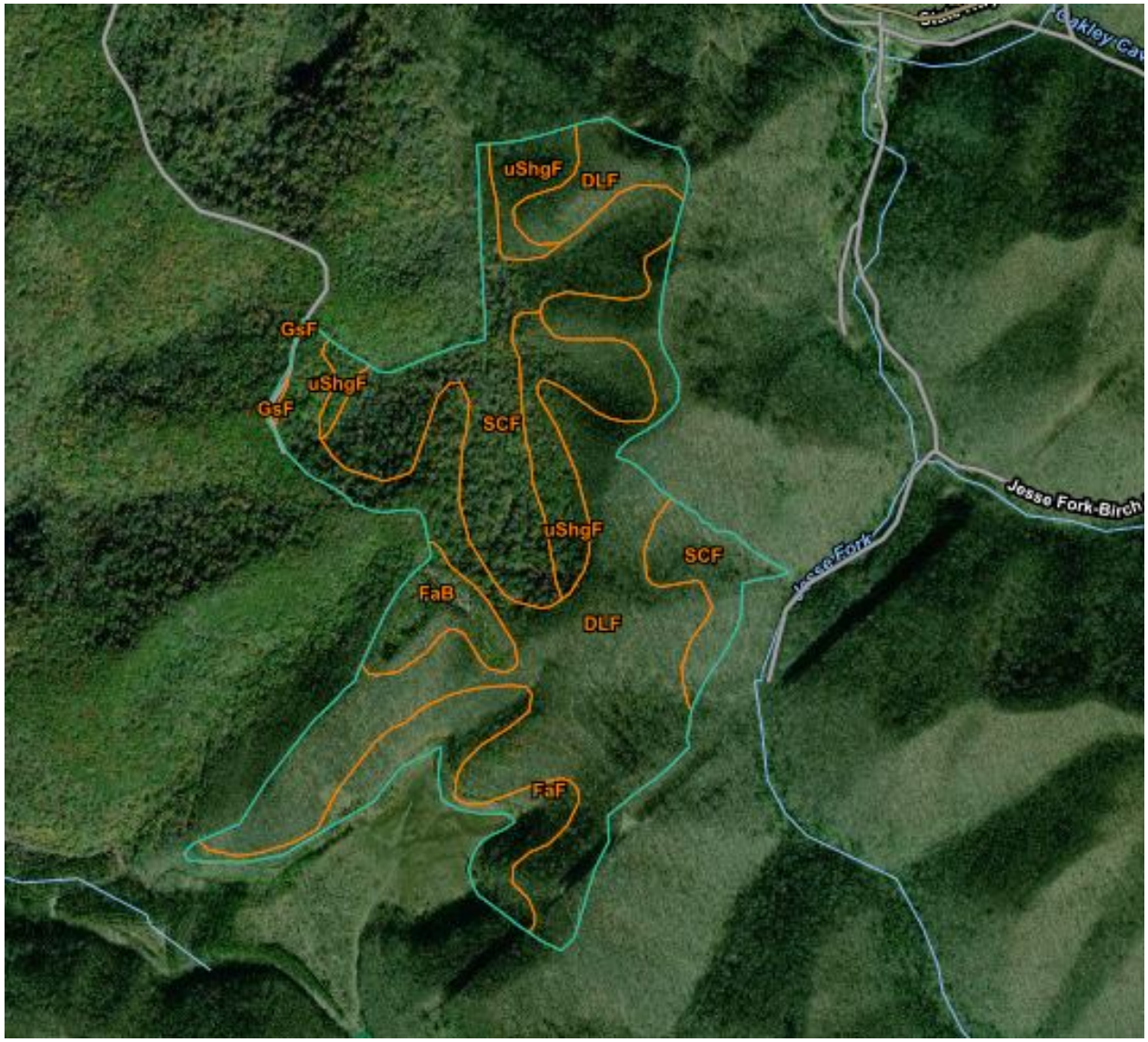


Figure 18. Soil mapping units within the harvest units in the Steel Trap area of the SRB Project, Redbird Ranger District, Daniel Boone National Forest.

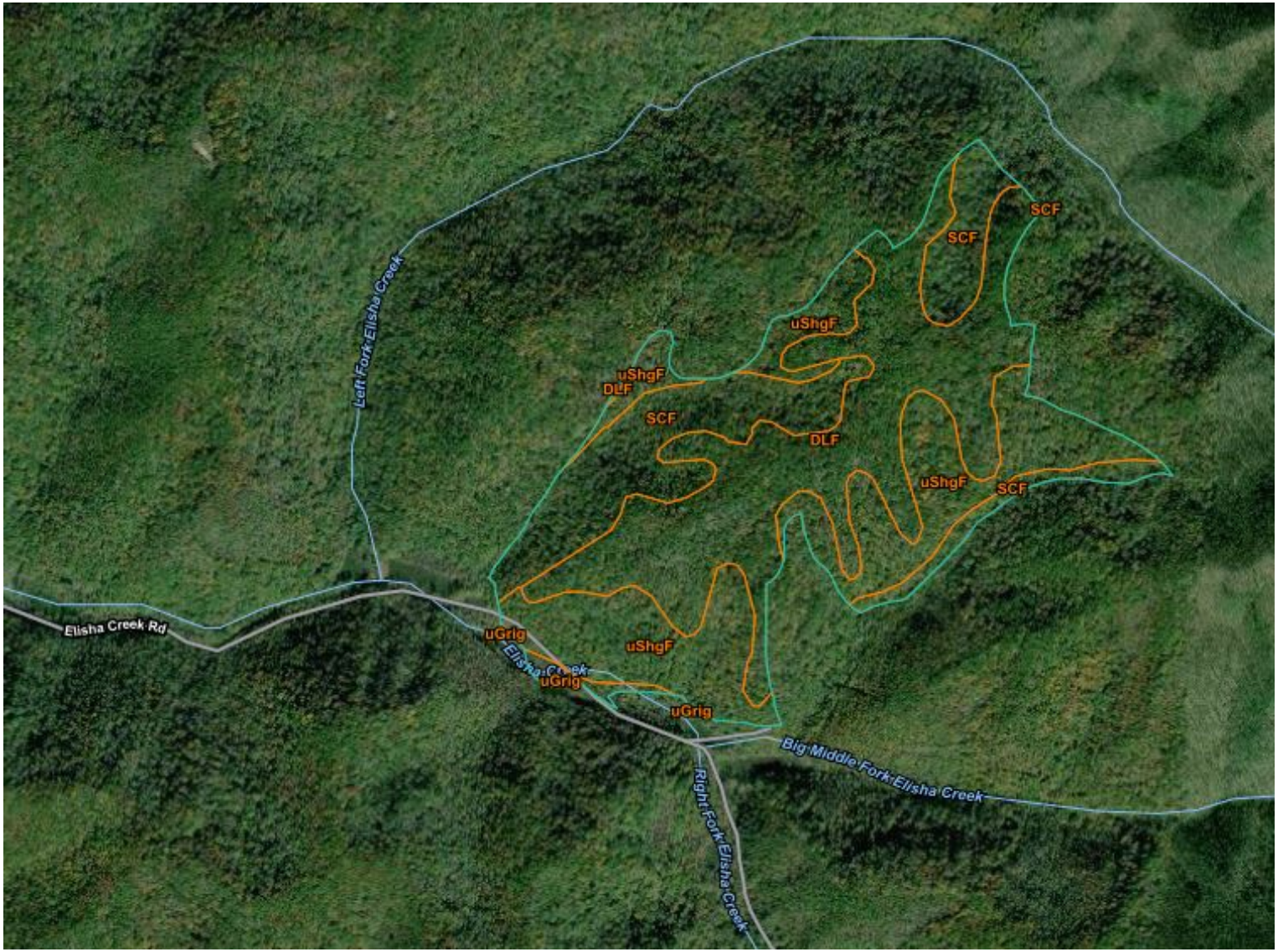


Figure 19. Soil mapping units within the harvest units in the Sawdust Pile area of the SRB Project, Redbird Ranger District, Daniel Boone National Forest.

Figure 20. Soil mapping units within the harvest units in the Paw Paw area of the SRB Project, Daniel Boone National Forest.

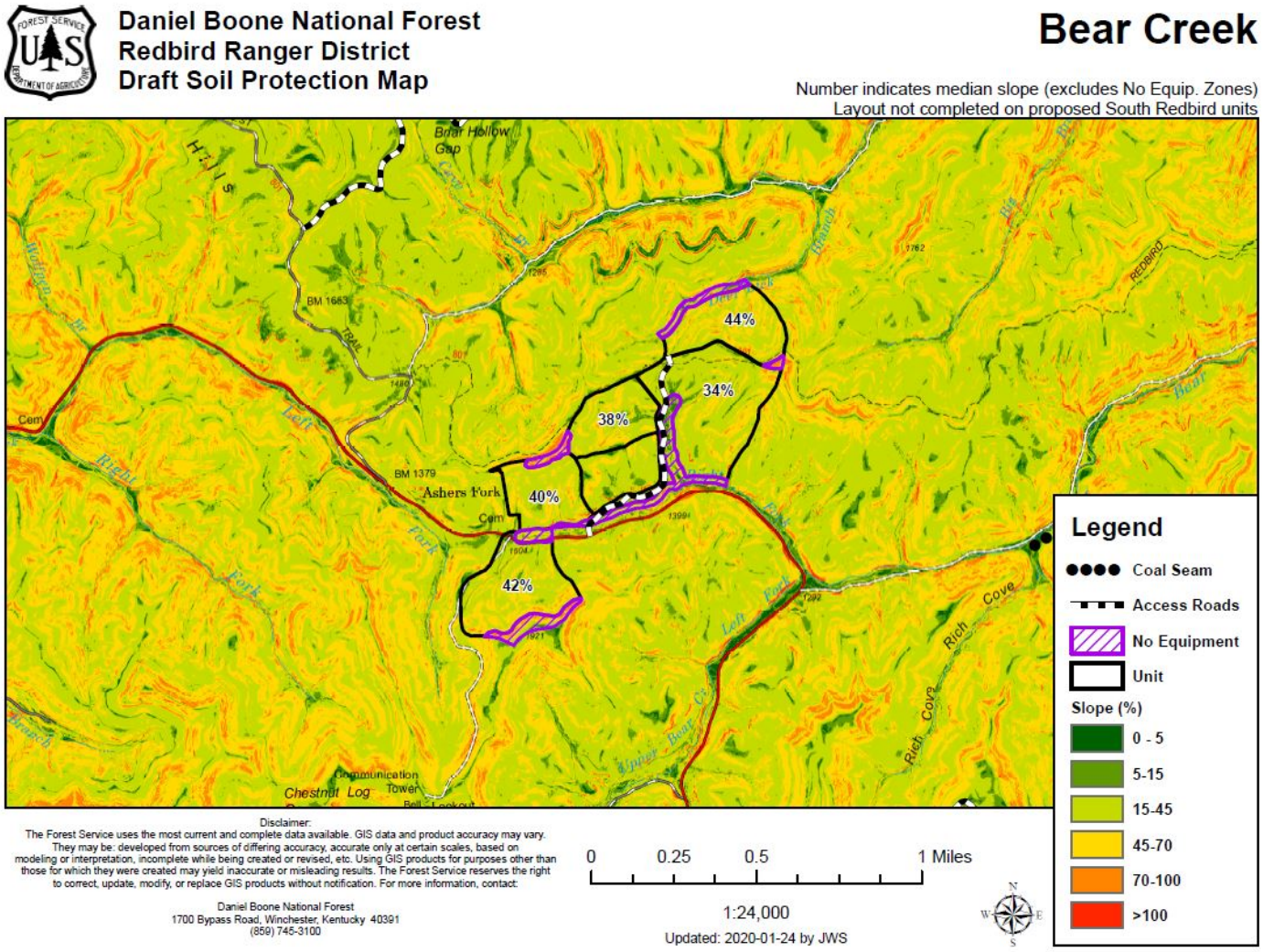
Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
FbF	Fairpoint and Bethesda soils, 20 to 70 percent slopes, stony	0.5	0.0%
GlE2	Gilpin-Shelocta complex, 20 to 35 percent slopes	52.1	1.7%
GsF	Gilpin-Rayne-Sequoia complex, 25 to 55 percent slopes, very stony	470.8	15.1%
SkF	Shelocta-Kimper-Cloverlick complex, 20 to 80 percent slopes, very stony	470.1	15.0%
SlF	Shelocta-Highsplint-Gilpin complex, 20 to 70 percent slopes, very stony	380.1	12.2%
Subtotals for Soil Survey Area		**1,373.6**	**44.0%**
Totals for Area of Interest		**3,123.4**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
DLF	Matewan-Marrowbone-Latham complex, 20 to 80 percent slopes, very rocky	758.1	24.3%
FaB	Fairpoint soils, undulating	12.3	0.4%
FaF	Fairpoint and Bethesda soils, 2 to 70 percent slopes, benched, stony	24.9	0.8%
SCF	Shelocta-Cutshin-Gilpin complex, 20 to 75 percent slopes, very stony	555.3	17.8%
uGrig	Grigsby fine sandy loam, 0 to 3 percent slopes, frequently flooded	2.4	0.1%
uShgF	Shelocta-Highsplint-Gilpin complex, 20 to 70 percent slopes, very stony	396.8	12.7%
Subtotals for Soil Survey Area		**1,749.8**	**56.0%**
Totals for Area of Interest		**3,123.4**	**100.0%**

Figure 21. Key to soil mapping units for Figures 5-16.

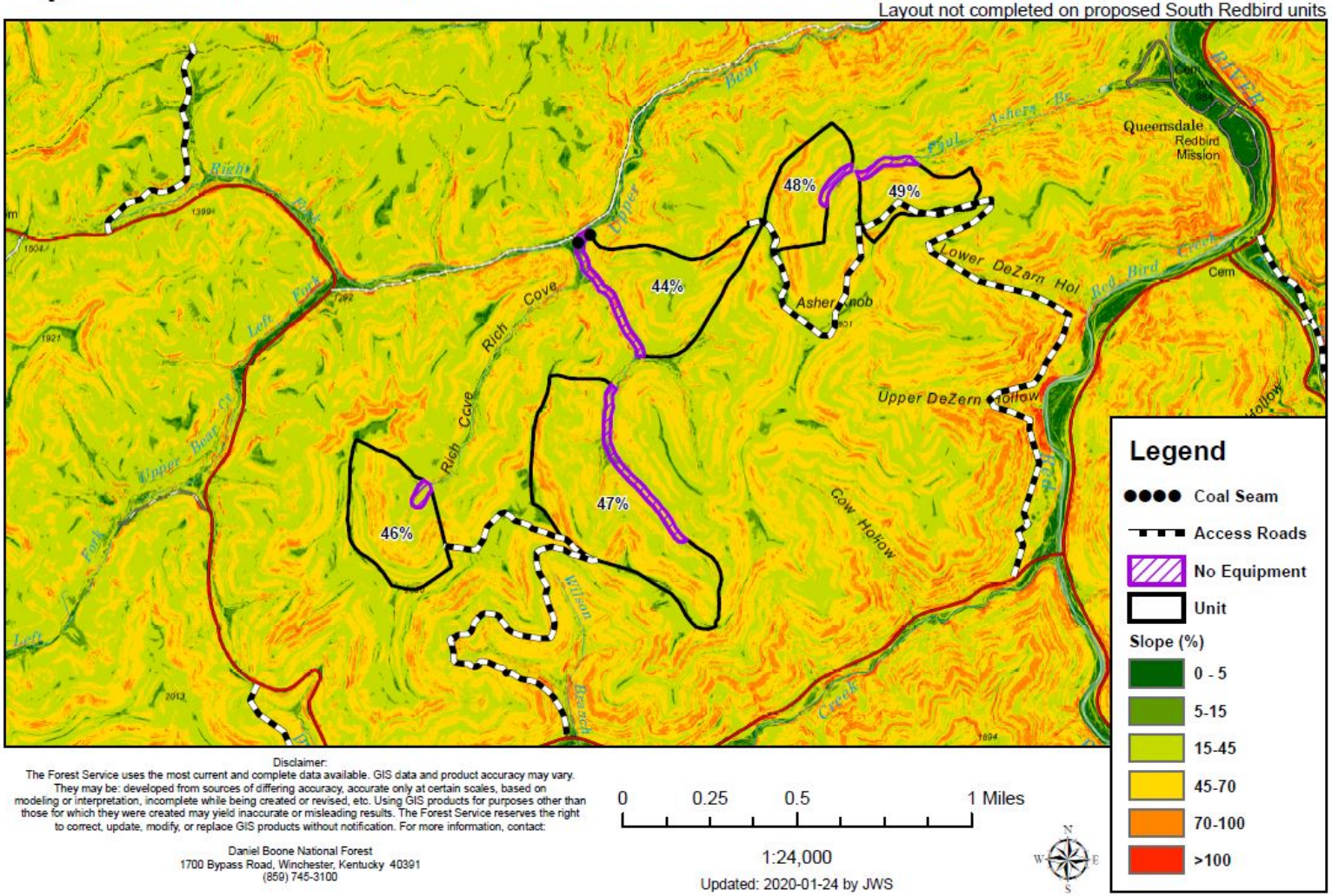
Appendix 2: Mapped harvest units for the SRB Project depicting soil protection areas (no equipment), median slope percent of operating area, and Fireclay and Fireclay Rider coal seams.



Daniel Boone National Forest
Redbird Ranger District
Draft Soil Protection Map

Blue Hole

Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units



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0 0.25 0.5 1 Miles

1:24,000

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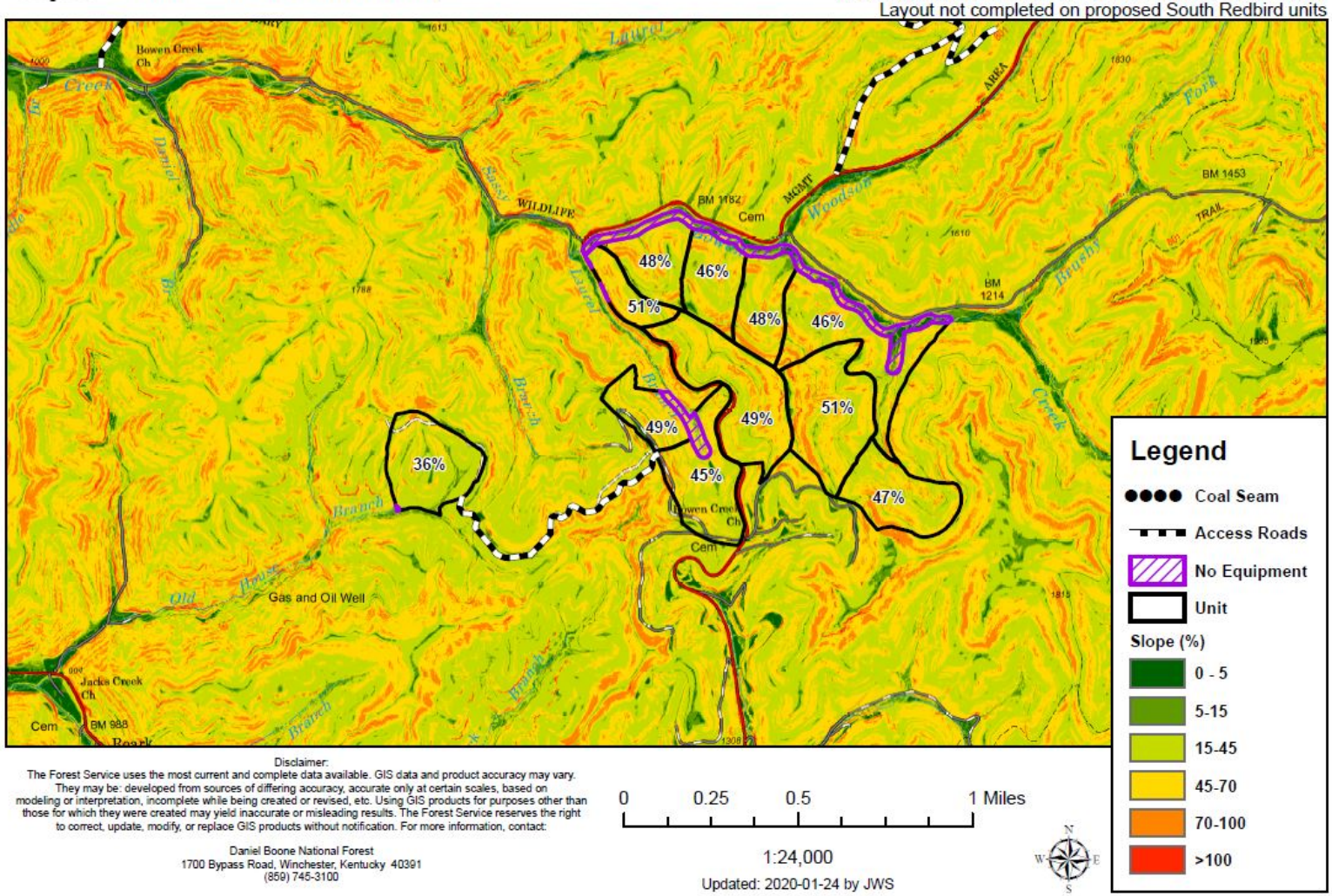
Redbird Ranger District
Draft Soil Protection Map

Bowens Creek

Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units



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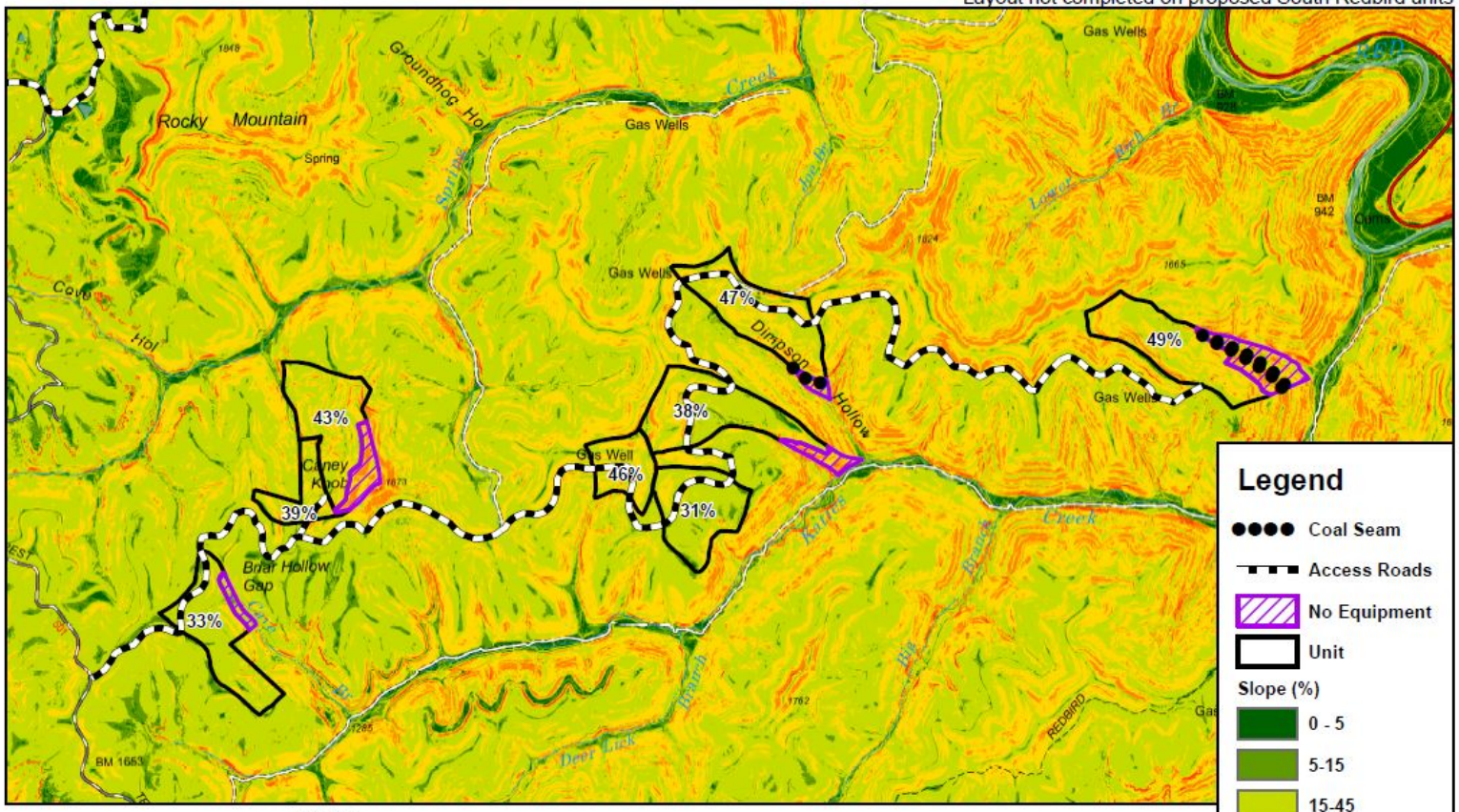
Caney Knob

Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units



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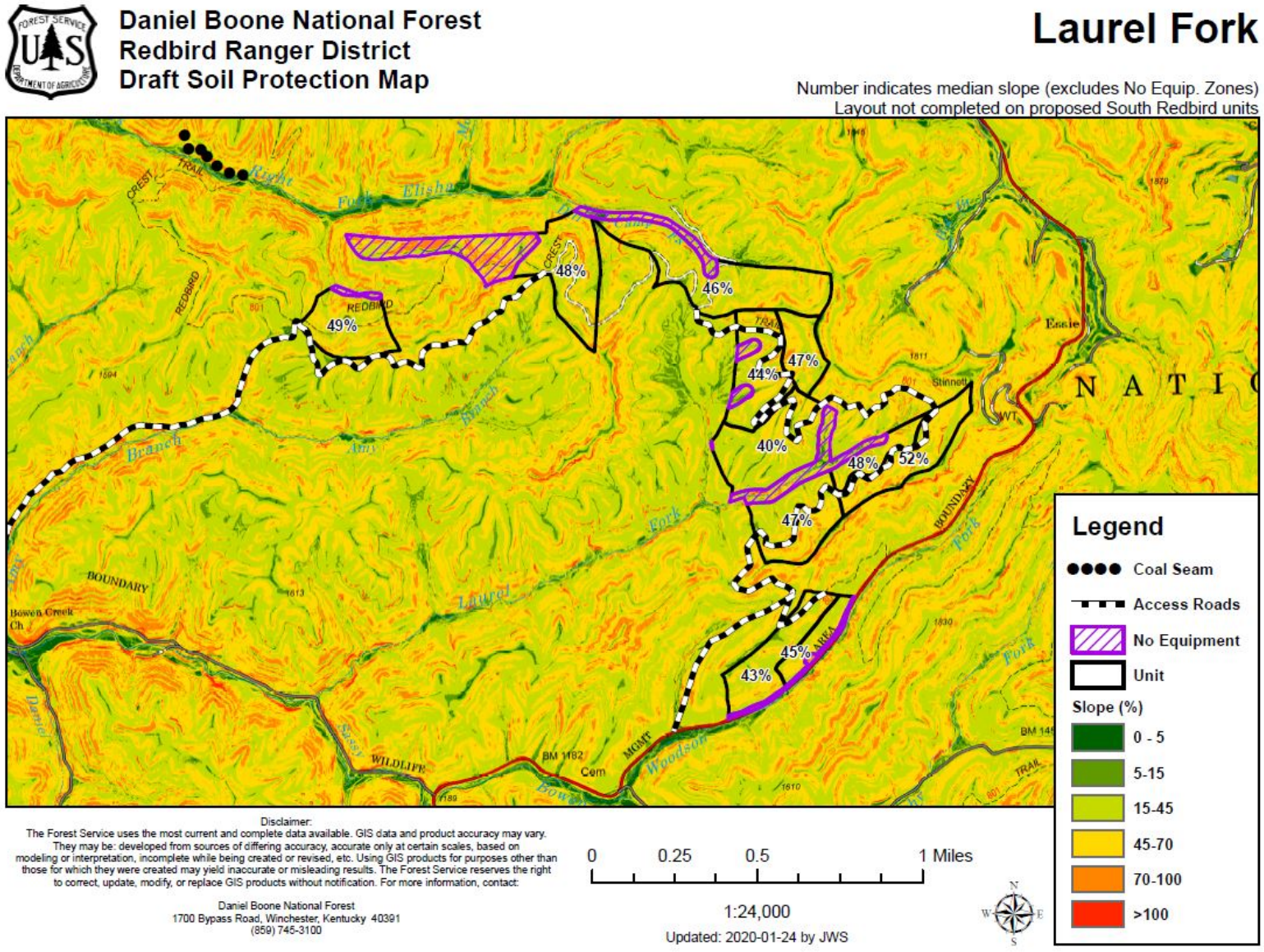
Daniel Boone National Forest
Redbird Ranger District
Draft Soil Protection Map
Laurel Fork
Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units
48%
46%
49%
47%
44%
40%
48%
52%
47%
45%
43%
Legend
Coal Seam
Access Roads
No Equipment
Unit
Slope (%)
0 - 5
5-15
15-45
45-70
70-100
>100
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0 0.25 0.5 1 Miles
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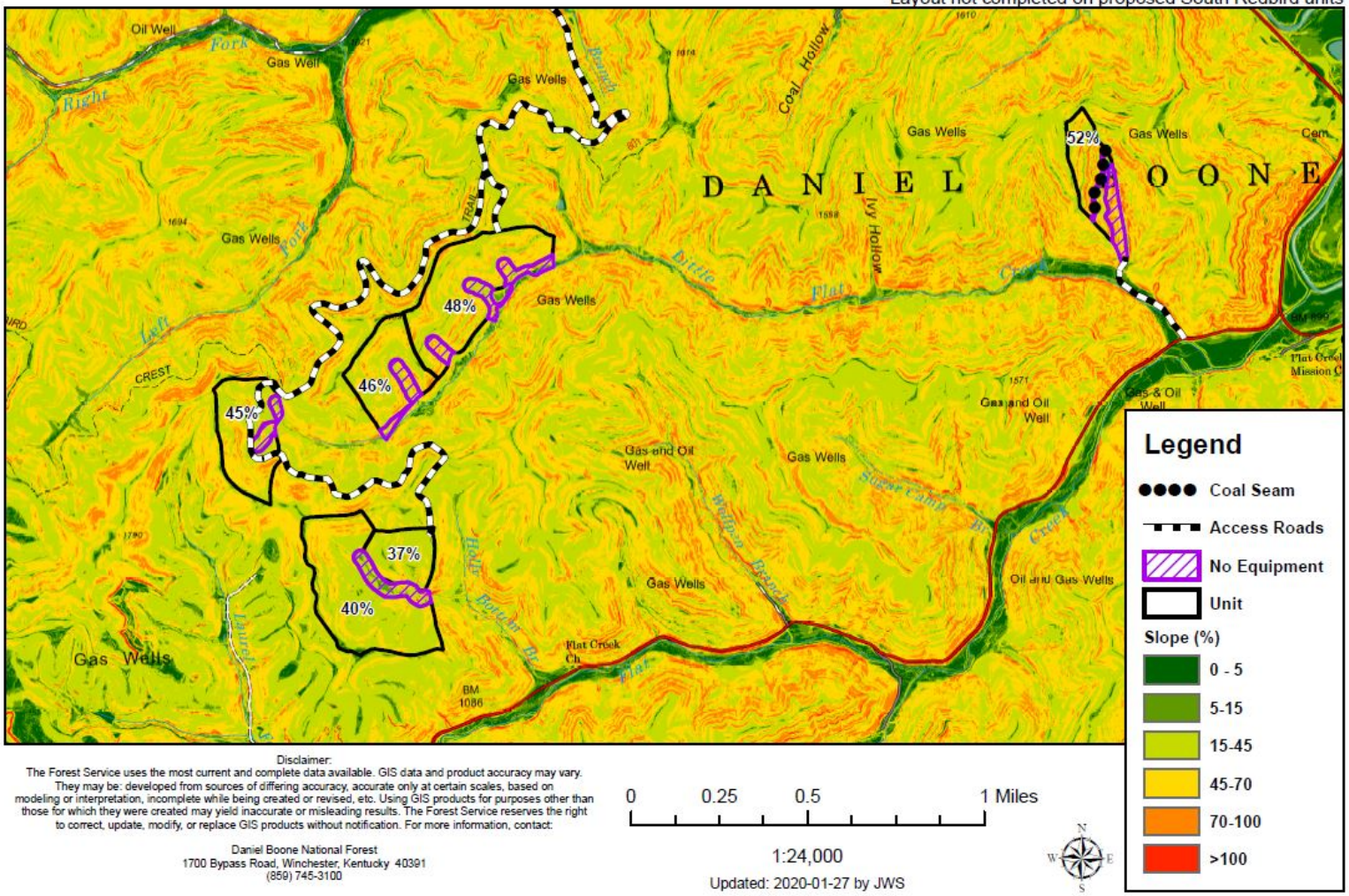
Draft Soil Protection Map

Little Flat Creek

Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units



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Redbird Ranger District
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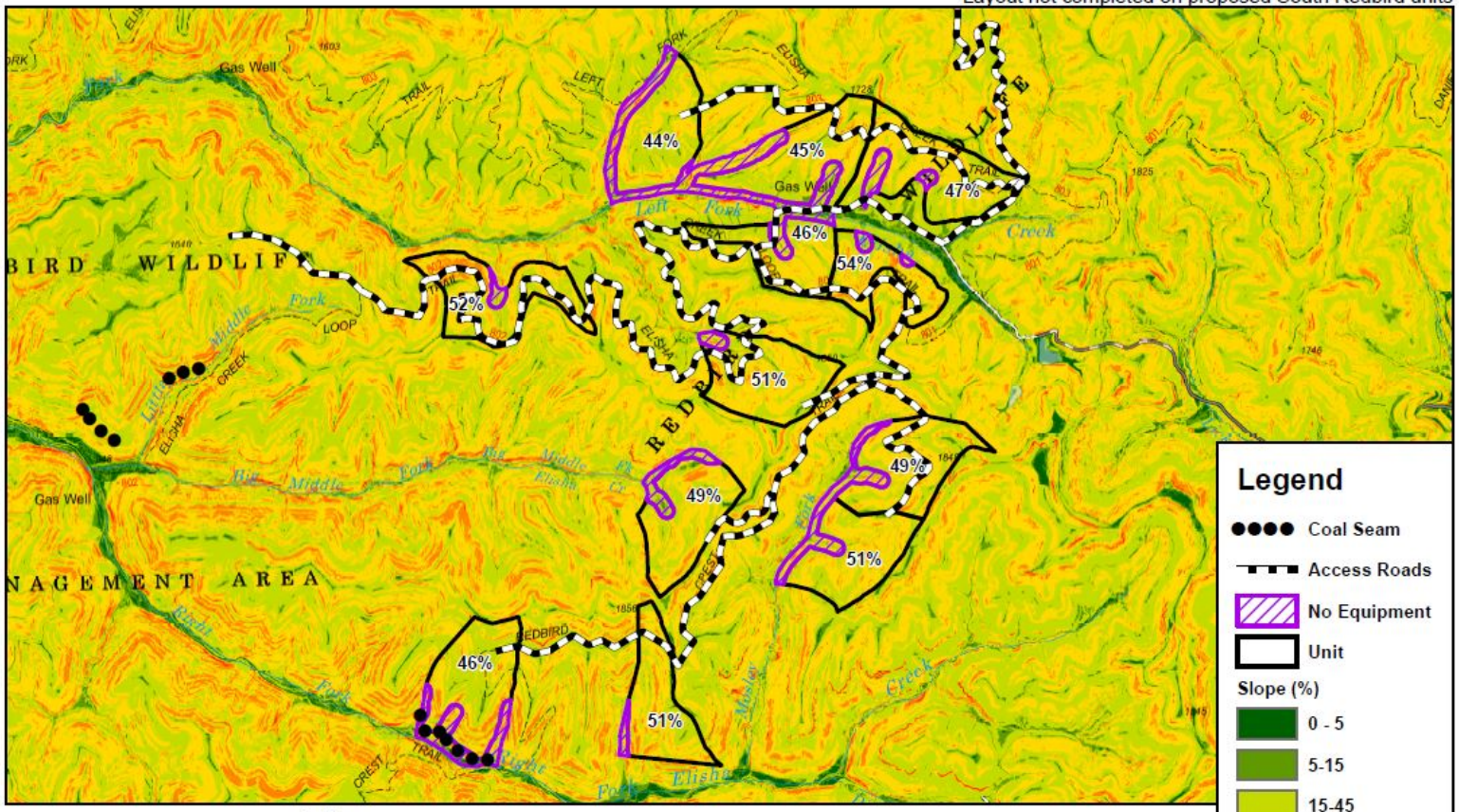
Mosely Fork

Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units



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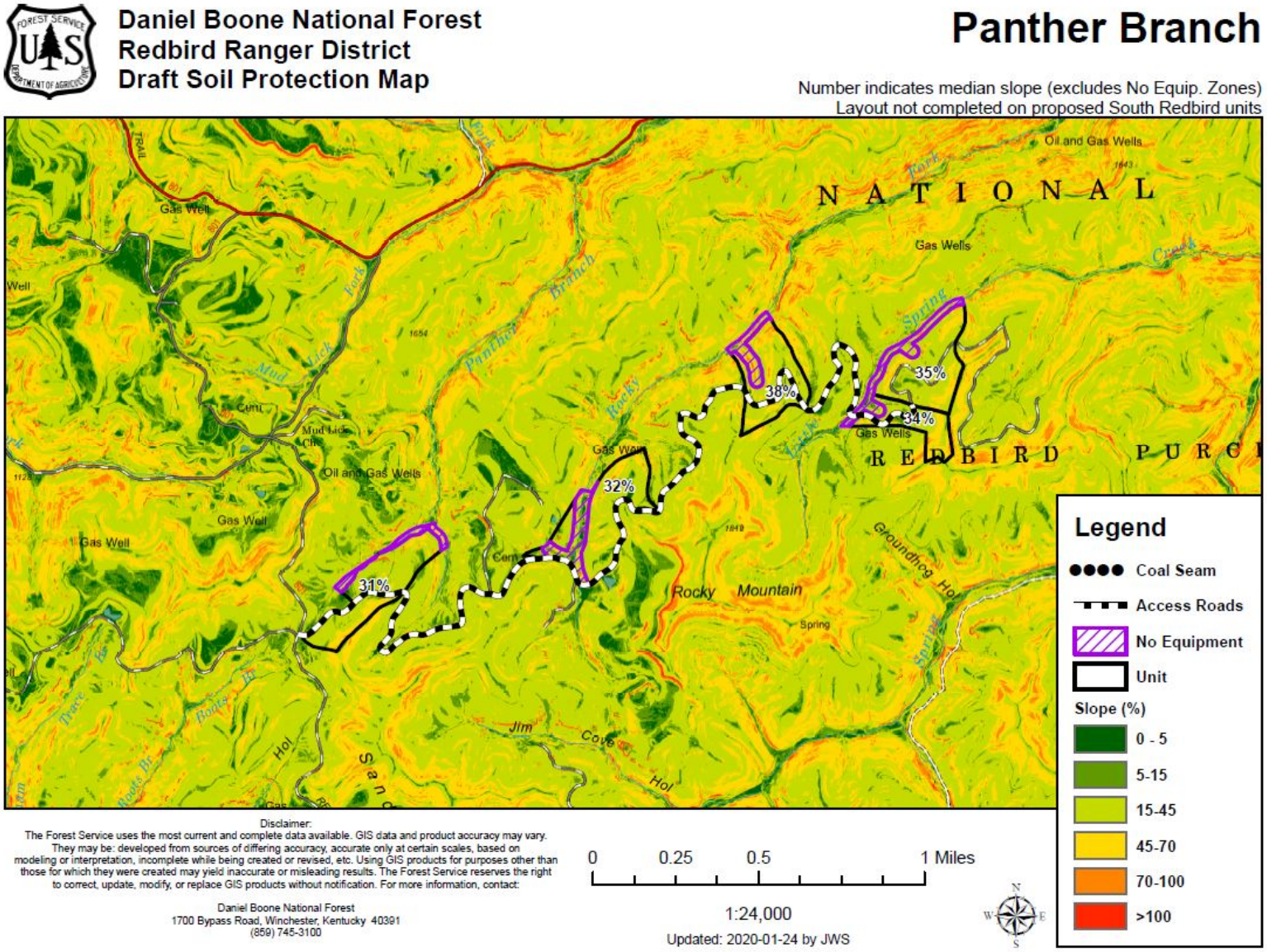
Daniel Boone National Forest
Redbird Ranger District
Draft Soil Protection Map
Panther Branch
Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units
Oil and Gas Wells
Gas Wells
Gas Well
Mud Lick Cem
Rocky Mountain
Spring
38%
35%
34%
32%
31%
Legend
Coal Seam
Access Roads
No Equipment
Unit
Slope (%)
0 - 5
5-15
15-45
45-70
70-100
>100
Disclaimer:
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0 0.25 0.5 1 Miles
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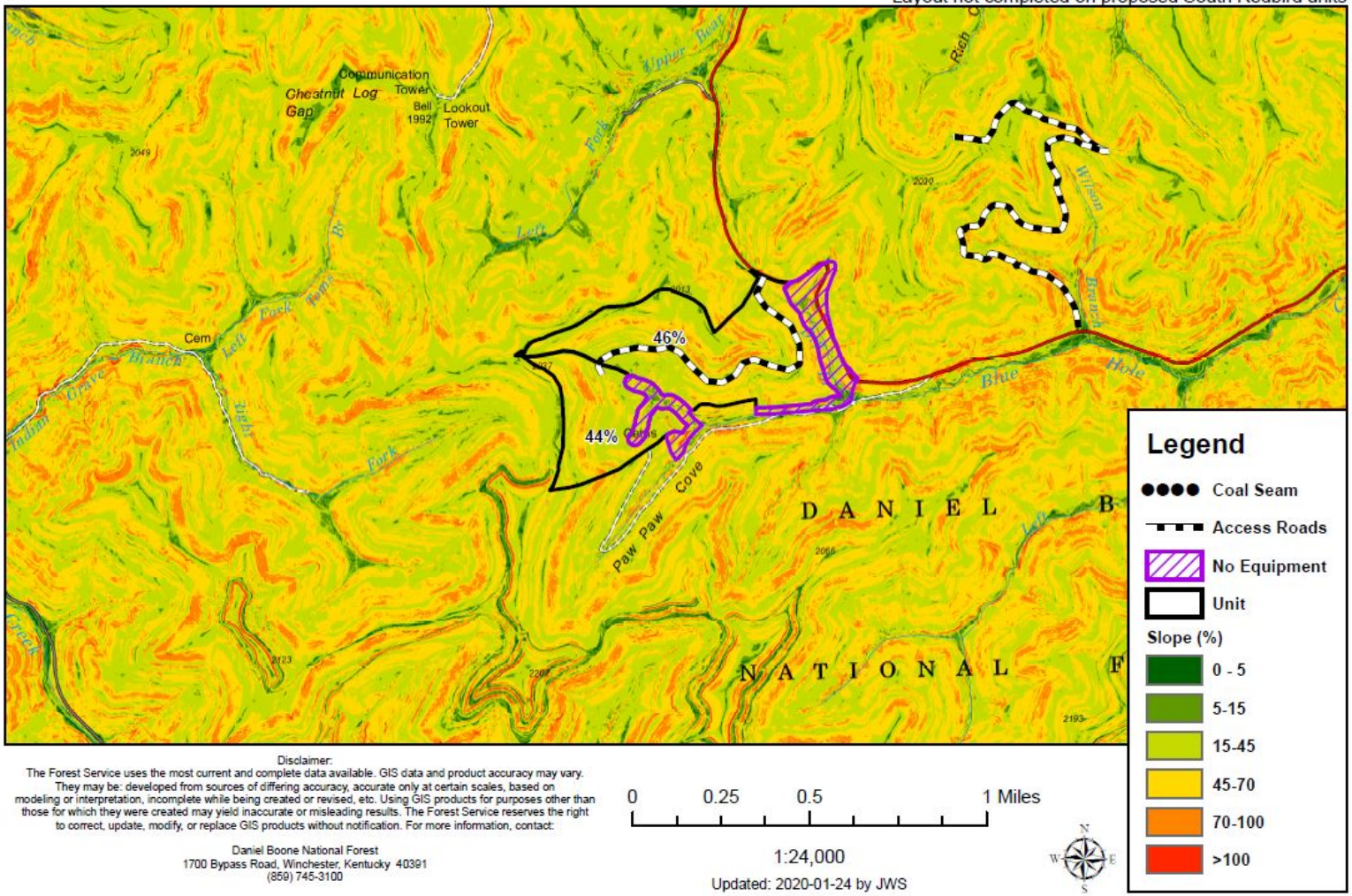
Redbird Ranger District
Draft Soil Protection Map

Paw Paw

Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units



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0 0.25 0.5 1 Miles

1:24,000

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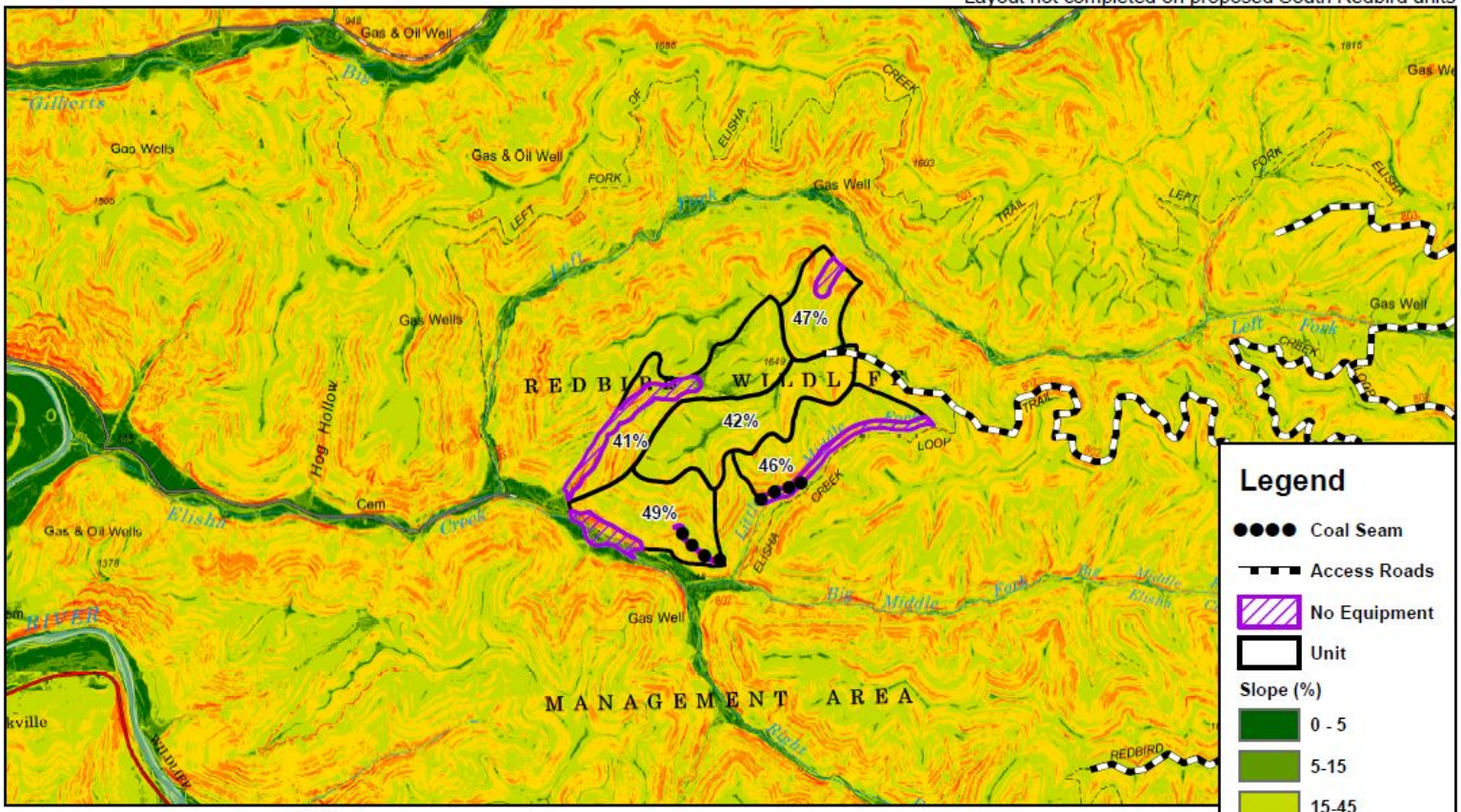
Redbird Ranger District
Draft Soil Protection Map

Sawdust Pile

Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units



Disclaimer:
The Forest Service uses the most current and complete data available. GIS data and product accuracy may vary. They may be: developed from sources of differing accuracy, accurate only at certain scales, based on modeling or interpretation, incomplete while being created or revised, etc. Using GIS products for purposes other than those for which they were created may yield inaccurate or misleading results. The Forest Service reserves the right to correct, update, modify, or replace GIS products without notification. For more information, contact:

Daniel Boone National Forest
1700 Bypass Road, Winchester, Kentucky 40391
(859) 745-3100

0 0.25 0.5 1 Miles

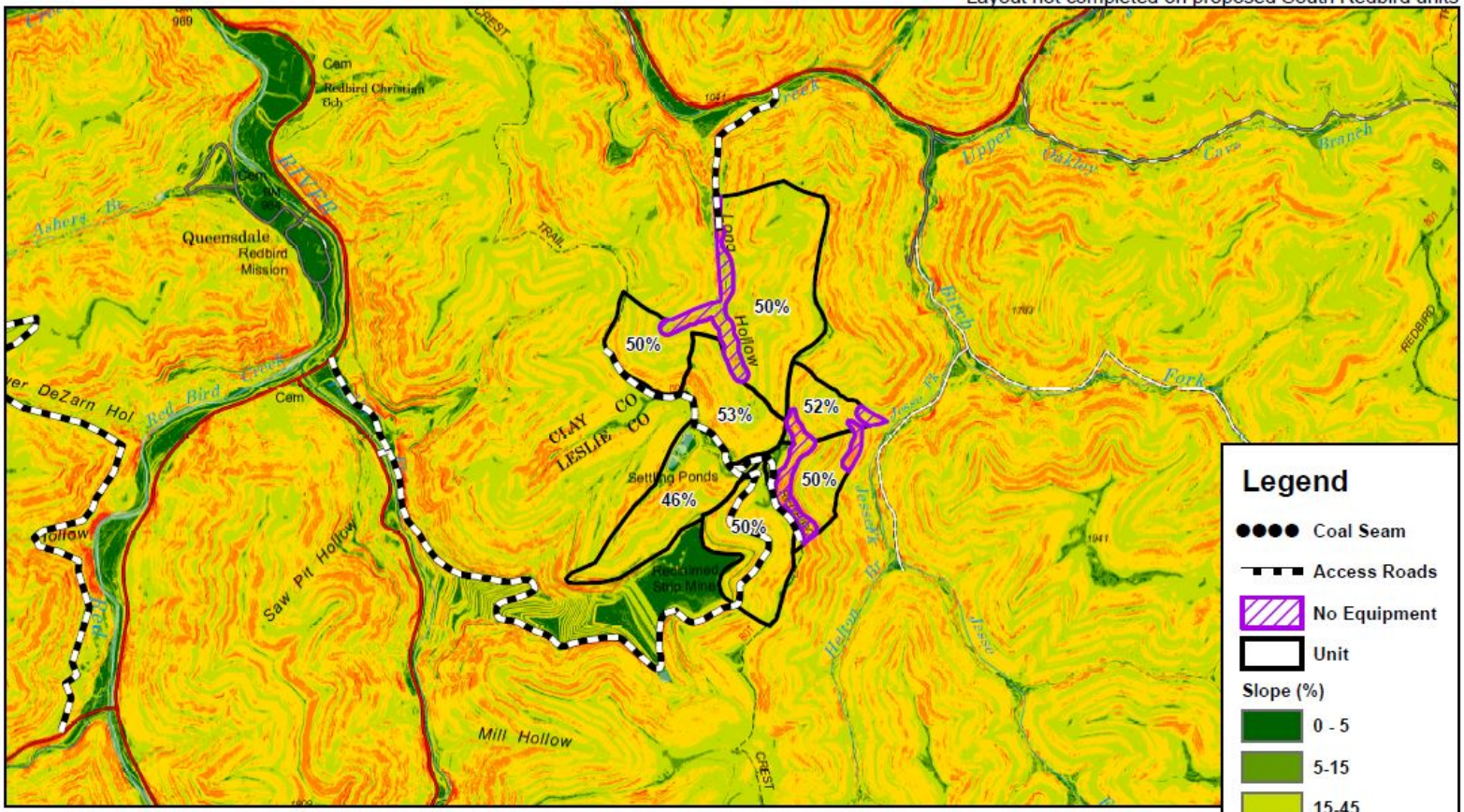
1:24,000

Updated: 2020-01-27 by JWS

Daniel Boone National Forest
Redbird Ranger District
Draft Soil Protection Map

Steel Trap

Number indicates median slope (excludes No Equip. Zones)
Layout not completed on proposed South Redbird units



Legend

- Coal Seam
- Access Roads
- No Equipment
- Unit

Slope (%)

- 0 - 5
- 5-15
- 15-45
- 45-70
- 70-100
- >100

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