Hydrology Specialist Report

Motorized Travel Plan
Dixie National Forest

Reeds Valley, Cedar City Ranger District

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3.0 Affected Environment

3.1 Existing Conditions

3.1.1 Location

The project area lies in the southwest and southcentral portion of the State of Utah including the Pine Valley Mountains, Bull Valley Mountains, Markagunt Plateau, Paunsaugunt Plateau, Sevier Plateau, Escalante Mountains, Aquarius Plateau, and Boulder Mountain.

Elevation varies considerably within these locations with the lowest point being outside of St. George at 3,800 feet and the highest point at Bluebell Knoll south of Teasdale at 11,322 feet.

3.1.2 Watersheds

The major watersheds associated with this area are the Virgin River, Colorado River, and Great Basin watersheds. Each of these larger watersheds are further sub-divided into 5th Hydrologic Unit Code (HUC) watersheds and numerous smaller 6th HUC watersheds of about 20,000 acres in size (31 square miles). These HUCs are the basis for the hydrologic effects analysis associated with this Motorized Travel Plan. Appendix C of this document contains 11x17 inch maps delineating these watersheds by ranger district. There are 39 5th HUC watersheds and 179 6th HUC watersheds.

The 179 6th level HUCs considered for this project are listed below along with any water quality impairment associated with the watershed (UDEQ 2006). The watersheds include areas on and off National Forest System (NFS) lands.

Table 1. Hydrologic Unit Code (HUC) Watersheds.

Watershed Number	Watershed Name	Area off of NFS lands (square miles)	Area on NFS lands (square miles)	Utah's 303(d)a List or TMDL
140700030201	West Fork Cedar Peak Draw	36.12	4.48	TMDL: Organic Enrichment & DO
140700030202	Antelope Spring Draw	18.77	22.57	TMDL: Organic Enrichment & DO
140700030207	Rock Spring Draw	0.00	47.46	
140700030208	Upper Pine Creek	8.42	31.62	
140700030209	Lower Pine Creek	22.43	8.00	
140700030301	Boulder Creek-Fremont River	23.50	29.00	TMDL: Organic Enrichment & DO
140700030302	Fish Creek	4.47	24.72	TMDL: Organic Enrichment & DO
140700030303	Carcass Creek	7.31	15.40	TMDL: Organic Enrichment & DO
140700030305	Donkey Creek-Fremont River	27.81	6.84	TMDL: Organic Enrichment & DO
140700030401	Upper Pleasant Creek	3.95	59.77	
140700030402	Lower Pleasant Creek	50.93	1.48	
140700030404	Sandy Draw	20.57	1.87	
140700030406	Oak Creek	13.68	44.63	
140700030408	Middle Sandy Creek	19.69	2.40	
140700050101	Upper Valley Creek	15.00	43.37	
140700050102	Birch Creek	5.98	39.73	
140700050103	Upper North Creek	0.00	46.24	
140700050104	Lower North Creek	17.01	28.75	
140700050105	Upper Pine Creek	0.00	52.60	
140700050106	Lower Pine Creek	9.46	36.77	
140700050107	Wide Hollow Reservoir-Escalante River	23.51	1.43	
140700050201	Mamie Creek	21.45	24.84	
140700050202	Sweetwater Creek	29.19	1.24	
140700050203	Upper Sand Creek	3.12	23.82	
140700050204	Lower Sand Creek	17.73	0.01	
140700050206	Headwaters Boulder Creek	0.00	53.08	
140700050207	Deer Creek	4.76	43.27	
140700050208	Deer Creek-Boulder Creek	19.83	10.25	
140700050209	Bear Creek-Boulder Creek	20.86	24.17	
140700050210	Calf Creek-Escalante River	47.72	0.03	
140700050301	Willow Creek	23.68	13.41	
140700050302	Little Alvey Wash	57.70	3.41	
140700050401	Upper the Gulch	22.42	29.66	

Watershed Number	Watershed Name	Area off of NFS lands (square miles)	Area on NFS lands (square miles)	Utah's 303(d)a List or TMDL
140700050404	Upper Horse Canyon	44.70	0.72	
140700060801	Headwaters Wahweap Creek	40.77	0.86	
140700070101	North Creek	11.54	14.73	
140700070102	Bryce Creek	28.06	0.73	303d: TDS
140700070103	Henderson Canyon	12.61	16.64	303d: TDS
140700070104	Dry Creek	22.30	1.35	303d: TDS
140700070105	Henrieville Creek	35.90	4.08	303d: TDS
140700070108	Dry Valley Creek	55.92	1.47	303d: TDS
140700070201	Upper Sheep Creek	21.98	7.57	303d: TDS
140700070202	Willis Creek	18.42	6.79	303d: TDS
140700070203	Bull Valley Gorge	27.69	1.37	303d: TDS
140700070401	Lick Wash	24.56	1.35	
140700070402	Bullrush Gorge	32.39	1.00	
140700070403	Adams Wash	29.63	1.12	
140700070404	Upper Deer Spring Wash	22.26	6.81	
150100030101	Reservoir Canyon-Kanab Creek	20.88	4.85	
150100030102	Skull Valley Wash	20.31	2.16	
150100030103	Lower Robinson Creek-Kanab Creek	21.61	3.69	
150100030301	Thompson Creek	21.49	0.79	
150100030302	Skutumpah Creek	18.39	2.87	
150100080101	Upper Deep Creek	41.07	11.73	
150100080103	Upper North Fork Virgin River	31.80	7.46	
150100080105	Lower Deep Creek	39.59	0.27	
150100080201	Headwaters East Fork Virgin River	12.47	39.72	
150100080202	Muddy Creek	36.08	0.30	
150100080203	Lydias Canyon-East Fork Virgin River	61.87	1.77	
150100080401	Pinto Creek	4.13	30.36	
150100080403	North Ash Creek	14.75	16.67	
150100080404	Ash Creek Reservoir-Ash Creek	24.34	14.62	
150100080405	Wet Sandy-Ash Creek	18.40	31.36	
150100080601	Magotsu Creek	6.10	27.98	
150100080602	Upper Moody Wash	2.08	57.66	
150100080603	Lower Moody Wash	8.09	5.76	
150100080701	Grass Valley Creek	0.00	33.25	
150100080702	Headwaters Santa Clara River	0.00	32.87	
150100080703	Mahogany Creek-Santa Clara River	4.11	41.16	
150100080704	Baker Dam Reservoir-Santa Clara River	18.31	8.30	
150100080801	Sand Cove Wash	32.13	0.08	
150100080802	Tobin Wash-Santa Clara River	31.44	2.93	

Watershed Number	Watershed Name	Area off of NFS lands (square miles)	Area on NFS lands (square miles)	Utah's 303(d)a List or TMDL
150100080806	Halfway Wash	10.69	9.74	
150100080807	Snow Canyon	37.15	19.12	
150100080903	Grapevine Wash-Virgin River	22.03	6.13	
150100080904	Heath Wash	1.49	19.10	TDS, TMDL in Progress
150100080905	Cottonwood Creek	7.93	14.03	TDS, TMDL in Progress
150100080906	Quail Creek	9.86	25.45	
150100080908	Mill Creek	20.76	2.41	
150100080910	Middleton Wash-Virgin River	49.66	0.00	
150100100101	Pine Park Canyon	8.06	11.88	
150100100102	Headwaters Wash	12.77	9.35	
150100100103	Slaughter Creek	13.43	2.74	
150100100104	Deep Canyon-Beaver Dam Wash	42.89	0.00	
150100100106	East Fork Beaver Dam Wash	48.58	7.27	
160300010101	Midway Valley-Midway Creek	0.46	17.05	
160300010102	Deer Valley-Midway Creek	0.00	37.35	
160300010103	Strawberry Creek	0.00	27.61	
160300010104	Swains Creek	0.17	26.11	
160300010105	West Fork Asay Creek-Asay Creek	0.54	29.78	
160300010201	Upper Mammoth Creek	0.86	39.62	TMDL: Siltation & Total Phosphorus
160300010202	Tommy Creek	0.00	22.25	TMDL: Siltation & Total Phosphorus
160300010203	Middle Mammoth Creek	0.00	25.16	TMDL: Siltation & Total Phosphorus
160300010204	Lower Mammoth Creek	3.98	24.95	TMDL: Siltation & Total Phosphorus
160300010301	Castle Creek-Sevier River	24.70	10.63	TMDL: Siltation & Total Phosphorus
160300010302	Pole Canyon-Sevier River	17.14	7.08	TMDL: Siltation & Total Phosphorus
160300010303	Big Hollow-Sevier River	20.51	10.84	TMDL: Siltation & Total Phosphorus
160300010304	Proctor Canyon-Sevier River	14.18	16.83	TMDL: Siltation & Total Phosphorus
160300010305	Pass Creek	22.22	23.14	TMDL: Siltation & Total Phosphorus
160300010306	Red Canyon	1.78	17.69	TMDL: Siltation & Total Phosphorus
160300010307	Hillsdale-Sevier River	19.57	4.92	TMDL: Siltation & Total Phosphorus
160300010308	Casto Wash	3.78	18.36	TMDL: Siltation & Total Phosphorus

Watershed Number	Watershed Name	Area off of NFS lands (square miles)	Area on NFS lands (square miles)	Utah's 303(d)a List or TMDL
160300010309	Graveyard Hollow	11.93	3.32	TMDL: Siltation & Total Phosphorus
160300010310	Peterson Wash-Sevier River	17.50	5.67	TMDL: Siltation & Total Phosphorus
160300010401	Ipson Creek	0.19	25.22	
160300010402	Blue Spring Creek	0.00	19.89	
160300010403	Haycock Creek	0.00	20.16	
160300010404	Butler Creek	0.00	21.60	
160300010405	Fivemile Hollow-Panguitch Creek	2.00	23.13	
160300010406	South Canyon-Panguitch Creek	17.41	1.54	
160300010501	Threemile Creek	4.48	16.16	
160300010502	East Bench-Sevier River	19.80	2.59	
160300010503	Limekiln Creek	8.03	18.58	TMDL: Siltation & Total Phosphorus
160300010504	West Ditch-Sevier River	16.20	2.01	TMDL: Siltation & Total Phosphorus
160300010505	Sandy Creek	8.77	15.08	
160300010506	Tebbs Hollow-Sevier River	13.17	6.94	TMDL: Siltation & Total Phosphorus
160300010507	Sanford Creek	2.01	27.92	TMDL: Siltation & Total Phosphorus
160300010508	Bear Creek	30.97	21.66	
160300010509	Smith Canyon-Sevier River	21.60	12.35	TMDL: Siltation & Total Phosphorus
160300010510	Horse Valley Creek-Sevier River	29.58	17.64	TMDL: Siltation & Total Phosphorus
160300010602	Chokecherry Creek-Sevier River	30.46	0.73	TMDL: Siltation & Total Phosphorus
160300010603	Birch Creek-Sevier River	31.12	0.11	
160300010604	Lost Creek	8.66	27.29	
160300010606	Burnt Hollow-Sevier River	24.02	5.84	
160300020301	East Fork Sevier River Headwaters	3.25	44.54	
160300020302	Tropic Reservoir	2.456	33.85	
160300020303	Mud Spring Creek-East Fork Sevier River	13.38	57.12	
160300020304	Showalter Creek-East Fork Sevier River	19.03	29.57	
160300020305	Hunt Creek	3.51	49.60	
160300020306	Cameron Wash-East Fork Sevier River	13.74	23.30	
160300020401	Clay Creek	0.15	25.75	
160300020402	South Creek	17.94	15.50	
160300020403	Sweetwater Creek	26.15	5.16	
160300020404	Prospect Creek	1.10	28.29	

Watershed Number	Watershed Name	Area off of NFS lands (square miles)	Area on NFS lands (square miles)	Utah's 303(d)a List or TMDL
160300020405	Ranch Creek-Sevier River	14.48	23.44	
160300020406	Cottonwood Creek	6.77	17.87	
160300020407	Cow Creek-Sevier River	13.73	3.64	
160300020408	Deer Creek	8.14	59.52	
160300020409	North Creek	3.59	23.15	
160300020410	Deep Creek	6.19	18.63	
160300020411	Forest Creek	4.10	11.63	
160300020412	Pacer Lake	17.53	16.51	
160300020501	Coyote Hollow-Antimony Creek	0.00	59.40	
160300020502	Lost Spring Draw	0.00	17.14	
160300020503	Antimony Creek	8.85	25.29	
160300020505	Dry Wash	20.35	2.35	TMDL: Temperature & Total Phosphorus
160300020506	Antimony-East Fork Sevier River	22.38	7.11	TMDL: Temperature & Total Phosphorus
160300020507	East Fork Sevier River Outlet	53.33	28.94	TMDL: Temperature & Total Phosphorus
160300060102	Buckskin Wash	36.43	1.82	
160300060105	Cottonwood Canyon-Fremont Wash	37.98	8.76	
160300060106	Kane Spring Wash-Fremont Wash	28.02	5.86	
160300060107	Willow Creek	9.90	8.85	
160300060108	Little Creek	7.61	15.12	
160300060109	Red Creek	39.39	10.30	
160300060201	Dry Lakes Creek	17.13	5.07	
160300060202	Center Creek-Parowan Creek	2.60	23.30	
160300060203	Outlet Parowan Creek	37.85	0.47	
160300060204	Summit Creek	21.32	4.96	
160300060304	Ashdown Creek	9.07	17.72	
160300060306	Crow Creek-Coal Creek	21.29	6.32	
160300060403	Duncan Creek	10.84	4.01	
160300060501	Big Hollow Wash	43.37	2.96	
160300061002	Sheep Spring Draw	57.35	1.34	
160300061004	Devils Gap	25.62	0.70	
160300061101	Sevy Hollow	51.16	1.59	
160300061102	Headwaters Pinon Park Wash	54.69	5.87	
160300061103	Escalante Mine Canal	55.40	0.51	
160300061301	Nephi Draw	1.00	51.55	
160300061302	Little Pine Creek	1.82	42.79	
160300061303	Upper Shoal Creek	8.10	20.70	
160300061304	Calf Springs Creek	0.74	29.70	
160300061305	Holt Canyon	3.08	32.37	
160300061306	Lower Shoal Creek	34.17	20.26	
160300061307	Newcastle	53.53	8.49	
160300061401	Pinto Creek	2.32	59.87	
160300061402	The Dry Wash	23.91	5.17	

Watershed Number	Watershed Name	Area off of NFS lands (square miles)	Area on NFS lands (square miles)	Utah's 303(d)a List or TMDL
160300061403	Little Pinto Creek	6.29	32.52	
160300061407	Newcastle Reservoir	40.37	0.22	
140700030201	West Fork Cedar Peak Draw	36.12	4.48	

Source: Utah Department of Environmental Quality, Division of Water Quality 2006.
[a]303(d) List of water quality-limited water bodies pursuant to Section 303 (d) of the Clean Water Act.
DO = Dissolved Oxygen
TDS = Total Dissolved Solids
TMDL = Total Maximum Daily Load

3.1.3 Past and Present Activities Within Watersheds

Existing impacts to soil and water resources from past and present activities include livestock grazing of upland and riparian areas, timber harvest, mining, oil and gas activities, stream augmentations and impoundments, developed ski areas, developed and dispersed recreation, off-highway vehicle (OHV) and all-terrain vehicle (ATV) use, wildland fires, wildland use fires (WFUs), prescribed fires, and road and trail construction, and well as maintenance associated with many of these activities

3.1.4 Water Quality

The Utah Division of Water Quality assigns beneficial uses to all waters within the state to protect them from controllable pollution (UDEQ 2000). The beneficial uses for waters downstream of the Dixie National Forest are listed below.

Table 2. Designated Beneficial Uses for the Majority of the Dixie National Forest.

Category	Designated Beneficial Uses
2B	Protected for secondary contact recreation such as boating, wading, or similar uses.
3A	Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
4	Protected for agricultural uses including irrigation of crops and stock watering.

Table 3. Designated Beneficial Uses for the Remainder of the Dixie National Forest (Paria and Escalante Rivers).

Category	Designated Beneficial Uses
2B	Protected for secondary contact recreation such as boating, wading, or similar uses.
3C	Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.
4	Protected for agricultural uses including irrigation of crops and stock watering.

Most of the waters within the Forest boundary are considered High Quality Waters (Category I). The exceptions to this may be found in Standards of Quality for the Waters of the State (UDEQ 2006).

3.1.5 Sensitive Areas

- Wet meadows, riparian areas, and riparian wetlands are particularly sensitive to compaction, increased runoff, sedimentation, and mechanical damage. These areas are found throughout the Forest, and are usually adjacent to surface water.
- Municipal watersheds by town:
    - Enterprise: Spring Creek and Shinbone Creek
    - New Harmony: Comanche Canyon
    - Veyo: Indian Hollow
    - Leeds/Silver Reef: Leeds Creek
    - St. George: West Fork and Middle Fork of Cottonwood Creek
    - Pine Valley: Rock Canyon
    - Paragonah: Red Creek Reservoir
    - Parowan: Yankee Meadow Reservoir
    - Panguitch: Delong Creek and Indian Hollow
    - Brian Head: Upper Parowan Creek
    - Antimony: Pole Canyon
    - Antimony: Little Forest Creek (tributary to Antimony Creek)
    - Teasdale: Government Creek
    - Escalante: Pine Creek (John Allen Bottom)

3.1.6 Present Condition of Watersheds

The existing condition with regard to roads on each of the 179 watersheds on the Forest is reflected in Alternative A, the No Action Alternative, in Table A-1: Road Miles/Stream Miles Directly Influencing the Stream, and Table A-2: Miles of Road/Square Mile of Watershed. Both of these tables are found in Appendix A of this document.

4.0 Environmental Consequences

4.1 Direct and Indirect Effects

In general, access management that increases accessibility also increases the risk of impacting the soil and water resources. The potential impacts include soil disturbance in the form of soil displacement and compaction in the uplands as well as stream management zones including wetlands, streambanks, meadows, and riparian areas. This soil displacement leads to sediment inputs into the streams in addition to any other pollutant inputs that may be associated with vehicular traffic.

4.1.1 Impacts of Road Systems on Hydrologic Regimes

Geomorphic effects of roads range from chronic and long-term contributions of fine sediment into streams to catastrophic mass failures of road cuts and fills during large storms. Roads may alter channel morphology directly or may modify channel flow and extend the drainage network into previously unchanneled portions of the hillslope. The magnitude of road-related geomorphic effects differs with climate, geology, road age, construction practices, and storm history. Improvements in designing, constructing, and maintaining roads can reduce road-related erosion at the scale of individual road segments (Gucinski et al. 2001).

Roads have three primary effects on hydrologic processes:

1. They intercept rainfall directly on the road surface and road cutbanks and affect subsurface water moving down the hillslope,
2. They concentrate flow, either on the surface or in an adjacent ditch or channel, and
3. They divert or reroute water from paths it otherwise would take were the road not present.

Problems of road drainage and transport of water and debris – especially during floods – are primary reasons roads fail, often with major structural, ecologic, economic, or other social consequences. The effect of roads on peak streamflow depends strongly on the size of the watershed. For example, capture and rerouting of water can remove water from one small stream while causing major channel adjustments in another stream receiving the additional water. In large watersheds, roads constitute a small proportion of the land surface and have relatively insignificant effects on peak flow (Gucinski et al. 2001).

Roads can impact streams and aquatic systems in many ways. Roads with inadequate buffers can have higher sediment loads. Road obliteration can eliminate these impacts. User-created roads often are close to streams and have poor if any drainage features to prohibit sediment from entering the stream. ATVs can travel many trails or roads or off-road, resulting in the same impacts as from roads designed for full-size vehicles. Road systems can change watershed hydrology and increase peak flows while reducing late summer base flows. Roads can be a conduit for moving chemicals and sediment into streams. These types of impacts are discussed in detail in the following paragraphs.

4.1.2 Buffers

Roads within 100 feet of a stream channel can negatively affect sedimentation, stream shading, large woody debris contributions, and pool frequency (Spence et al. 1996). Roads within 200 feet of a channel can negatively affect sedimentation.

Non-channelized sediment flow rarely travels more than 300 feet, and 200-300 foot wide buffer strips/filter strips are generally effective at protecting streams from sediment from non-channelized flow (Belt et al. 1992, Burroughs and King 1989).

Buffer widths that are adequate to protect streams from non-channelized sediment inputs should be sufficient to provide for other riparian functions, including delivery of organic matter and woody debris, stream shading, and bank stability (Belt et al. 1992).

Routes within 300 feet of stream channels, lakes, and wetlands are considered to be within the "riparian influence zone." Facilities such as roads, road fills, landings, and other encroachments in close proximity to channels have great potential to directly and indirectly modify streams (Belt et al. 1992, Gucinski 2001). In addition to being a mechanism of disturbance, encroaching and riparian roads and trails are also instrumental in providing access to and concentrating use within riparian areas and streams by livestock and humans (USDA 2006a).

Establishing a buffer zone of undisturbed forest between a corridor and a stream is helpful, but if runoff from roads or other disturbances is channeled or filter strips are too narrow, buffer zones cannot be expected to eliminate sediment movement to streams (Elliot 2000).

4.1.3 Road Obliteration

Under any of the obliteration scenarios, a large percentage of the route prisms would be disturbed. Vegetation usually becomes re-established on the disturbed soil by the end of the next growing season following obliteration. Until the vegetation does re-establish, the disturbed soil would be more susceptible to erosion. The frequent cross ditching would significantly reduce the volume of water that could entrain and transport soil from the excavated sites, and would promote re-infiltration of surface water down slope. Eroded soil would no longer be moved once the water re-infiltrated the undisturbed forest floor. Additional filtering or buffering potential is provided by down slope vegetation, downed wood, and distance from the channel network, which is typically greater than 300 feet (Ketcheson and Megahan 1996).

4.1.4 Landscapes

In mountainous watersheds, roads and trails are horizontal features that run counter to natural landscapes, which are dominated by vertical, gravity-driven forces and processes. Because roads and trails parallel slope contours, they can connect slope areas and channels that would otherwise function independently. This creates cumulative disturbances and interactions that would not exist otherwise. Higher route densities tend to lead to a greater potential for adverse watershed impacts (Gucinski et al. 2001). If poorly planned, constructed, maintained, or retired, roads can have a major impact on the forest environment (Egan 1999).

4.1.5 User-created Routes

Repeated motorized cross-country travel can lead to user-created routes that often have greater impacts than routes that have been constructed and properly engineered to reduce interactions with the water cycle. Roads and trails directly and indirectly alter normal slope hydrology in numerous ways unless the routes are properly located, designed, and maintained. The observed effects of roads and trails on the Forest include the following:

- Concentrating and re-routing overland flow and intercepted ground water.
- Increasing the potential for surface erosion by wind and water due to the disturbed cut and fill slopes, road and trail driving surface, and ditchlines.
- Adding to the density of the streams within the watershed when road and trail treads and ditchlines are drained directly into the channel network. This creates a flashier streamflow response to storms and snowmelt, and provides more direct, abundant, and

efficient sediment delivery than would occur on undisturbed, unchannelized, vegetated slopes.
- Causing downslope gullies where too much water is drained from the road and trail surface or ditchlines to a single location.
- Increasing the potential for mass erosion when water is delivered to and concentrated on naturally unstable slopes, when steep slopes are undercut or overburdened, or when channel crossings fail catastrophically (USDA 2006a).

4.1.6 Roads and Functional Watersheds

While impacts from roads and motorized trails and open use areas can be minimized, they cannot be entirely eliminated. Properly functioning watersheds and ecosystems can still be maintained, but the natural potential is usually altered to some degree by the presence of roads and motorized trails

Ripping closed roadways can increase infiltration rates, but studies show that rates do not reach undisturbed levels (Elliot 2000).

4.1.7 ATVs

These impacts may be more pronounced in the case of all-terrain vehicle (ATV) trails, where users often develop improperly located trails in addition to using designated trails. Visual turbidity observations indicate that sediment inputs differ between the ATV-affected and control streams as a result of ATV trail usage. High turbidity levels were observed in surface runoff from ATV trails entering Gap and Board Camp creeks during and after light rainstorms in the summer of 1999 on the Ouachita National Forest. Pools below ATV trail crossings were no longer clear but muddy and sediment-laden. Such observations indicate the erosive nature of the ATV trails, and they suggest that ATV trails may be significant sediment sources for streams within Gap and Board Camp creek basins (Chin et al. 2004).

Visual observations also indicate that the creeks affected by ATV trails are experiencing increased sedimentation. Measured percents confirm that sands and fines are substantially higher in stream pools within the impacted basins. Trail systems appear to have had detectable negative impacts on the structure and habitat quality of stream pools. These impacts are reflected in an increase in fine sediments in pools along with a decrease in pool depths and volumes (Chin et al. 2004).

4.1.8 Abandoned Roads

When roads or other compacted corridors are abandoned, they can continue to be sources of sediment through chronic surface erosion or mass failure (Elliot 2000). Compaction of a disturbed surface frequently restricts vegetation regrowth. Bare surfaces are susceptible to erosion, and steep areas without trees are susceptible to landslides (Elliot 2000).

On abandoned roads, culverts can fail or become blocked, causing ponding of water, embankment failure, and major offsite sedimentation (Elliot 2000). If culverts are not inspected regularly, blockages may not be detected, resulting in the culverts being blocked with woody

debris or sediment. One of the most common practices to minimize the risk of fill failure on abandoned rights-of-way is to remove the culverts (Elliot 2000).

4.1.9 Hydrologic Effects

Depending on road surface material, the roadway, the ditch, and, in some cases, the waterway below a road culvert are the main sources of detached sediment from erosion (Elliot 2000).

The presence of roads in a watershed may increase the frequency and magnitude of peak runoff discharges, particularly on small watersheds. Roads may also increase total runoff and decrease the time to peak runoff from major storms or snowmelt. Roads have a number of impacts on hydrology. They intercept precipitation and snowmelt and, because they have lower infiltration rates, divert it as surface runoff to channels. Road ditches can extend the stream network, increasing the volume of water available during the early part of a storm. The presence of roads can also shorten the time to peak flow. If a road culvert is too small or becomes blocked, water can be diverted from one subwatershed to another. Severe ditch and channel erosion may result (Elliot 2000).

Poor road drainage can also lead to saturation of road beds and mass failure. In steep terrain, abandoned roads that do not shed surface water can become saturated, increasing the likelihood of failure (Elliot 2000).

Complex combinations of interactions can occur between road segments and flows of water or sediment. Roads may act as corridors for flows of water on road surfaces or in roadside ditches and as sources of water to stream networks through culverts or gullies (Jones et al. 2000).

Networks of forest roads traverse many mountain and forested regions in the western United States. Roads impose substantial local changes to soil properties and hydrologic behavior and commonly alter sediment budgets of the basins they pass through. The net effect of the changes is to increase the supply of sediment to streams through surface erosion on the bare road surfaces and mass erosion and gullying below the road (Luce and Black 2001). In general, road systems accelerate the movement of water from hillslopes to stream systems (Kendall 1999).

Road systems can change the sub-surface and surface flow patterns of hillslopes and streams. On steeper slopes, roads can intercept groundwater (at cutslopes), making it available for concentrated overland flow on road surfaces and hillslopes. This can decrease groundwater recharge and/or storage and the amount of water that enters streams through the sub-surface system (Kendall 1999).

Road and bridges can alter the development of stream channels, floodplains, and wetlands. Because of the energy associated with moving water, physical effects often propagate long distances from the site of a direct road incursion. Alteration of hydrodynamics and sediment deposition can result in changes in channels many miles away, both downstream and upstream of the road crossing (Trombulak and Frissell 2000).

Changes in the routing of shallow groundwater and surface flow may cause unusually high concentrations of runoff on hillslopes that can trigger erosion through channel downcutting, new gully, headcutting, slumping, or debris flows (Trombulak and Frissell 2000).

Roads can affect streams directly by accelerating erosion and sediment loading, altering channel morphology, and by changing the runoff characteristics of watersheds. These processes interact to cause secondary changes in channel morphology. All of these changes affect fish habitat (Furniss et al. 1991).

Unnatural channel widths, slope, and streambed form occur upstream and downstream of stream crossings (Williams 1999); these alterations in channel morphology may persist for long periods.

Road runoff can aid in channel development (Wemple et al. 1996), and the effect of adding an impervious surface to a road may increase the efficiency and velocity of that runoff (Booth and Jackson 1997).

4.1.10 Chemicals

Most surface water contaminants enter streams at stream crossings by roads. Runoff and seepage from roads and rights-of-way can contain elevated levels of sediment, metals, and complex hydrocarbons from the highway material and traffic. Runoff and seepage may also contain traces of pesticides or other undesirable substances. Chemicals may be dissolved in the runoff water, but they frequently are attached to the eroded sediment particles (Elliot 2000).

Roads have the potential to directly contribute sediment (Grace 2002), heavy metals (Turer et al. 2001), or chemical pollutants (Trombulak and Frissell 2000) to stream systems, thereby reducing water quality. The latter effect, however, is generally associated with high volume roads and highways (Turer et al. 2001), especially where chemicals are used on the road surface or transported along the road corridor. For low volume roads the potential for this contribution is very low (Gucinski et al. 2001).

4.1.11 Sediment

On most forested watersheds, sediment is the most troublesome pollutant, with roads a major source of that sediment (Elliot 2000). Sediment can adversely impact water quality by increasing turbidity and prematurely plugging filters and other components of treatment systems. Suspended sediment can also carry undesirable chemical pollutants such as phosphates, pesticides, and other hydrocarbons into surface water and ground water (Elliot 2000).

Foltz and Burroughs concluded that the ratio of sediment production (with ruts versus without ruts) was over 2:1 for the Tin Cup site in Idaho and nearly 5:1 for Hahn’s Peak in Colorado (1990). These values are consistent with other measurements of two times the yield from a surface rutted by a heavy truck compared to a smooth surface for a silt loam soil (Foltz and Burroughs 1990).

Roads are a major contributor to erosion and stream sedimentation on forested lands. Roads alone can increase erosion rates and turbidity three orders of magnitude greater than the undisturbed forest condition. Concentrated flow, reduced infiltration, increased slopes, removal of surface cover, and interception of subsurface flow are just a few of the factors that contribute to the increased erosion potential of forest roads. Each of these factors can contribute to

increasing runoff energy to detach and transport sediment by increasing the volume and/or the velocity of storm runoff. Soil eroded from the forest road prism can be delivered directly to forest stream systems, causing adverse impacts on the nation's water quality (Grace 2002).

There is great potential for erosion and sediment production on forest roads because more water is available as surface runoff and concentrated flow (as described in the previous section). Roads, road construction, and road maintenance are considered to be the major source of sediment from upland forested watersheds. Many studies and observations indicate that as much as 90 percent of sediment from timber harvest areas originates from roads, and erosion related to forest roads usually exceed that of all other land uses within a watershed combined (Kendall 1999, Williams 1999).

Because forest roads are the major contributors of sediment, they represent the greatest concern in terms of non-point source pollution, water quality, and aquatic habitat (Kendall 1999).

On the Dixie National Forest fine sediment deposition in stream channels is the most common concern for watershed health. Excessive suspended and bedload sediment are both considered to be pollutants. Excessive amounts of suspended sediment can increase turbidity and restrict sunlight from reaching aquatic plants. Loading of fine sediments (<8 mm [<0.3 inches]) is the most common concern because it can fill interstitial spaces in gravel and cobble substrate. This limits habitat for aquatic macroinvertebrates and limits the circulation of water and oxygen between coarser sediments (Kendall 1999).

Roads contribute more sediment to streams than any other land management activity (Kendall 1999, Williams 1999). The majority of sediment from timber harvest activities is related to roads and road construction (Chamberlain et al. 1991, Dunne and Leopold 1978, Furniss et al. 1991, Megahan and King 2004, Williams 1999) and subsequent increases in erosion rates (Meehan and Bjornn 1991, Reid and Dunne 1993, Swanston and Swanson 1976, Megahan and King 2004).

The bare compacted soils on roads exposed to rainfall and runoff are a potential source of surface erosion. Roads and ditches form pathways for sediment transport to stream channels (Chamberlain et al. 1991). Roads and stream crossings can be major sources of sediment to streams from channel fill around culverts during construction (Furniss et al. 1991).

Channelized stream sections from rip rapping of roads adjacent to stream channels are directly affected by sediment from side casting, snow removal, and road grading; these activities can trigger fill slope erosion and failures.

Roads have the potential to directly contribute sediment (Grace 2002), heavy metals (Turer et al. 2001), or chemical pollutants (Trombulak and Frissell 2000) to stream systems and reduce water quality. The latter effect, however, is generally associated with high volume roads and highways (Turer et al. 2001), especially where chemicals are used on the road surface or transported along the road corridor. For low volume roads the potential for this contribution is very low (Gucinski et al. 2001).

Research consistently has shown that roads have the greatest effect of all practices associated with forest management on both surface and mass erosion (Megahan and King 2004).

4.1.12 Recovery

Erosion rates can drop rapidly as exposed slopes revegetate and stabilize. Erosion reductions of 90 percent or more are common as a road ages. Road surfaces, however, will likely continue to be a source of sediment as long as traffic or maintenance prevents the establishment of vegetation (Elliot 2000). Compaction of the road surface may be present 30 years after traffic ceases on a road (Froehlich et al. 1985).

4.1.13 Road Erosion Mitigation

Applications of high-quality gravel to unpaved roads can decrease erosion rates by up to 80 percent (Burroughs and King 1989), but reductions may be less for poorer quality aggregates (Elliot 2000).

4.1.14 Erosion and Runoff

The excess runoff from roads can overload ephemeral channels, resulting in significant downcutting of the channel.

4.1.15 Road Stream Crossing Failures

Many older roads were built with underdesigned culverts. Some culverts were made from wood that is now decaying or metal that is now corroding. In either case, most of these culverts will eventually fail unless they are removed or replaced (Elliot 2000).

4.1.16 Road Construction Vegetation Removal

The water temperature regime in stream channels can be altered when streamside vegetation is removed through harvest and/or road construction. The loss of vegetative cover results in increased solar radiation reaching the stream, which raises summertime water temperatures. Colder winter temperatures also result from vegetation removal, which in some cases causes the water to freeze. Removal of riparian vegetation generally results in adverse effects to water temperatures (Kendall 1999).

4.1.17 Aquatics

The effects of timber harvest and road construction on watershed hydrology are often expressed through changes in aquatic habitat variables such as pool frequency/quality, bank stability, and spawning habitat (Kendall 1999).

Roads can affect streams directly by accelerating erosion and sediment loading, altering channel morphology, and by changing the runoff characteristics of watersheds. These processes interact to cause secondary changes in channel morphology. All of these changes affect fish habitat (Furniss et al. 1991).

4.1.18 Time Lag Related to Road Construction Impacts

Since most of these more catastrophic responses (e.g., landslides, debris flows) are triggered by the response of roads during infrequent intense storm events, lag times of many years or decades pass before the full effects of road construction are realized (Trombulak and Frissell 2000).

4.2 Cumulative Effects

The cumulative effects watersheds chosen for this project are listed above in Table 1. Hydrologic Unit Code (HUC) Watersheds beginning on page 3.

4.2.1 Method of Analysis for Cumulative Effects

The choice of analysis for this project was to equate all past, present, and proposed road disturbances to a “detrimentally disturb soil,” which is a soil that has been displaced, compacted, or severely burned such that its hydrologic properties are impaired (Forest Service Handbook for Soil Management [FSH] 2509.18). Literature review indicates that the area of detrimentally disturbed soils should not exceed 5 percent within the 300 foot riparian influence zone adjacent to both sides of the stream and in the stream (McGurk and Fong 1995). Our assumption is that all road acreages constituted a detrimentally disturbed soil as they perform like a compacted soil and are hydrologically impaired.

The logic behind the analysis is that once a riparian influence zone exceeds the 5 percent threshold of detrimentally disturbed soils, effects to water quality will occur, as will changes to the sponge filter system. This may then cause a malfunction of the sponge filter system which may lead to detrimental changes in vegetation health, stream channel integrity, suspended sediment loads, and bedload.

To simplify analysis, the approximate 5 percent threshold used in this approach would be a 1:1 ratio of stream miles and road miles within the riparian influence zone. Use of this ratio assumes a median compacted width of 30 feet. Road density by 6th HUC watershed will also be used as a comparison parameter to track the miles of road/square mile of watershed. The logic behind using this parameter is that an increase in the miles can be considered a relative detrimental affect to the watershed and its function.

4.2.2 Assumptions Used in Effects Analysis

- Roads considered in the effect analysis include all unauthorized routes (U and G routes) and all classified roads as of 2005.
- Roads located on private land or under the jurisdiction of local counties, the State of Utah, National Park Service, and Bureau of Land Management that were located within any of the cumulative effects watersheds were considered in the analysis.
- The motorized trails proposed for construction are included in the analysis of Alternatives D and E. Alternative D includes 1.26 miles and Alternative E includes 1.26 miles of new construction (see Tables A1-A3 in Appendix A).

- The cross-country travel allowance in Alternative A will lead to an increased density of roads within each watershed and in each riparian influence zone.
- Naturally closed roads will continue to influence surface and subsurface hydrology for up to 30 years. Any reduction of road miles within a watershed from road closures will take time before negative effects are no longer realized.

4.2.3 Effects Other Than Roads Considered in the Cumulative Effects Analysis

- **Utilities:** Includes power lines, water lines/tanks, fiber optic and other telecom lines, and communication sites.
- **Oil and gas:** Also includes other minerals and mineral materials (e.g., gravel, perlite, cinders). These activities will continue to occur with a possible increase in oil and gas activity in the near future.
- **Transportation:** Motorized route designation, construction, and decommissioning. The is what will be addressed in this plan.
- **Recreation:** Includes general activities not under special use permit (sightseeing, hiking, camping) and developed recreation maintenance. Levels of use will stay the same or increase over time.
- **Vegetation treatments:** Includes timber harvest, chaining, fuel reductions, prescribed fire, fuelwood collection, and Christmas tree collection. Vegetation treatments will continue to occur with an estimated increase in chaining maintenance and prescribed fire.
- **Land exchange or easements:** Includes property disposal, highway easements, water diversions, and water augmentation. Over time these adjustment will occur at a reduced rate.
- **Special use permits:** Includes one time events (e.g., horse races, trekking) and outfitter guide activities. These will continue to occur with some increases in use.
- **Grazing:** Grazing will continue to occur at the present level.

4.2.4 Effects By Alternative

Alternative A

Direct and Indirect Effects

Compared to Alternatives B, C, and D, there is a projected increase in the road density within most of the 179 watersheds in Alternative A. Road mileage within the riparian influence zone is either greater than or equal to that in Alternatives B, C, and D. Compared to Alternative E, road density within the 179 watersheds is either greater than or equal to Alternative A. Road mileage within the riparian influence zone is either less than or equal to that in Alternative E. See Tables A-1 Road Miles/Stream Miles Directly Influencing the Stream and A-2 Miles of Road/Square Mile of Watershed in Appendix A.

Unrestricted cross-country travel (i.e., cross-country travel off the road system) would have a negative impact on watershed function as route proliferation is expected to increase over time in those watersheds where cross-country travel is allowed. An increase in road mileage would contribute to the area compacted within a watershed and would ultimately lead to increases in

erosion and runoff rates and interruption of surface and subsurface water flow. Increases in road mileage within the riparian influence zone would affect water quality, stream stability, and wetland and floodplain health.

Cumulative Effects

Since detrimental disturbance to soils from proposed road mileage does not exceed the 5 percent threshold in any of the riparian influence zones (see Table A-1 in Appendix A), none of the watersheds are expected to display cumulative impacts initially. In time this would change as the proliferation of user-created routes within the riparian influence zone, coupled with effects from other forest uses (section 4.23 on page 18), would exceed the 5 percent threshold and lead to detrimental changes in vegetation health, stream channel integrity, water quality, and bedload.

Although the detrimental disturbance within riparian influence zones does not exceed the 5 percent threshold, with time the damage from unrestricted cross-country travel and user-created routes will surpass the threshold and cumulative effects will become evident at the confluence of each watershed. These effects will likely contribute pollutants to 303d listed waters and would likely exceed Total Maximum Daily Loads mandated by the State of Utah.

Alternative B

Direct and Indirect Effects

Compared to Alternative A, there is a projected reduction in road density in 149 of the 179 watersheds and a reduction in road mileage within the riparian influence zone in 108 of the 179 watersheds. (see Tables A-1 Road Miles/Stream Miles Directly Influencing the Stream and A-2 Miles of Road/Square Mile of Watershed in Appendix A).

There may be some isolated and/or localized areas where roads within the riparian influence zone would have a negative influence and/or impact to the stream channel, wetlands, floodplains, and water quality.

The elimination of unrestricted cross-country travel (travel off the road system) would lead to fewer user-created roads, which impact wetlands, floodplains, stream channel health, and water quality. Concentrating vehicular travel to a designated route designed for motorized travel would reduce and localize impacts to a more manageable level.

Cumulative Effects

Since detrimental disturbance to soils from proposed road mileage does not exceed the 5 percent threshold in any of the riparian influence zones, none of the streams are expected to display any cumulative impacts initially or over time (see Table A-1 in Appendix A). In fact, if disturbance from other past, present, and future uses (section 4.23 on page 18) were doubled, the impacts to the riparian influence zone in all 179 watersheds would still not exceed the 5 percent threshold.

Since cumulative effects are not expected to be evident initially or over time, changes to water quality down stream of each of the 6th HUC watershed is not expected to further impair any 303d listed water or add to any mandated Total Maximum Daily Load.

Alternative C

Direct and Indirect Effects

Compared to Alternative A, there is a projected reduction in road density in 149 of the 179 watersheds and a reduction in road mileage within the riparian influence zone in 108 of the 179 watersheds (see Tables A-1 Road Miles/Stream Miles Directly Influencing the Stream and A-2 Miles of Road/Square Mile of Watershed, both in Appendix A).

There may be some isolated and/or localized areas where roads within the riparian influence zone would have a negative influence and/or impact to the stream channel, wetlands, floodplains, and water quality.

The elimination of unrestricted cross-country travel would lead to fewer user-created roads, which impact wetlands, floodplains, stream channel health, and water quality. Concentrating vehicular travel to a designated route designed for motorized travel would reduce and localize impacts to a more manageable level.

Cumulative Effects

Since detrimental disturbance to soils from proposed road mileage does not exceed the 5 percent threshold in any of the riparian influence zones, none of the streams are expected to display any cumulative impacts initially or over time (see Table A-1 in Appendix A). In fact, if disturbance from other past, present, and future uses (section 4.23 on page 18) were doubled, the impacts to the riparian influence zone in all 179 watersheds would still not exceed the 5 percent threshold.

Since cumulative effects are not expected to be evident initially or over time, changes to water quality down stream of each of the 6th HUC watershed is not expected to further impair any 303d listed water or add to any mandated Total Maximum Daily Load.

Alternative D

Direct and Indirect Effects

Compared to Alternative A, there is a projected reduction in road density in 143 of the 179 watersheds and a reduction in road mileage within the riparian influence zone in 91 of the 179 watersheds (see Tables A-1 Road Miles/Stream Miles Directly Influencing the Stream and A-2 Miles of Road/Square Mile of Watershed in Appendix A).

There may be some isolated and/or localized areas where roads within the riparian influence zone would have a negative influence and/or impact to the stream channel, wetlands, floodplains, and water quality.

The elimination of unrestricted cross-country travel would lead to fewer user-created roads, which impact wetlands, floodplains, stream channel health, and water quality. Concentrating vehicular travel to a designated route designed for motorized travel would reduce and localize impacts to a more manageable level.

Cumulative Effects

Since detrimental disturbance to soils from proposed road mileage does not exceed the 5 percent threshold in any of the riparian influence zones, none of the streams are expected to display any cumulative impacts initially or over time (see Table A-1 in Appendix A). In fact, if disturbance from other past, present, and future uses (section 4.23 on page 18) were doubled, the impacts to the riparian influence zone in all 179 watersheds would still not exceed the 5 percent threshold.

Since cumulative effects are not expected to be evident initially or over time, changes to water quality down stream of each of the 6th HUC watershed is not expected to further impair any 303d listed water or add to any mandated Total Maximum Daily Load.

Alternative E

Direct and Indirect Effects

Compared to Alternative A, there is a projected increase in road density within 97 of the 179 watersheds and an increase in road mileage within the riparian influence zone in 53 of the 179 watersheds (see Tables A-1 Road Miles/Stream Miles Directly Influencing the Stream and A-2 Miles of Road/Square Mile of Watershed in Appendix A).

There may be some isolated and/or localized areas where roads within the riparian influence zone would have a negative influence and/or impact to the stream channel, wetlands, floodplains, and water quality.

The elimination of unrestricted cross-country travel would lead to fewer user-created roads, which impact wetlands, floodplains, stream channel health, and water quality. Concentrating vehicular travel to a designated route designed for motorized travel would reduce and localize impacts to a more manageable level.

Cumulative Effects

Since detrimental disturbance to soils from proposed road mileage does not exceed the 5 percent threshold in any of the riparian influence zones, none of the streams are expected to display any cumulative impacts initially or over time (see Table A-1 in Appendix A). With the exception of one watershed, if disturbance from other past, present, and future uses (section 4.23 on page 18) were doubled, the impacts to the riparian influence zone in all 179 watersheds would still not exceed the 5 percent threshold. The single watershed where the threshold would be exceeded if disturbance were doubled is Cottonwood Creek (160300020406) on the Powell Ranger District.

Since cumulative effects are not expected to be evident initially or over time, changes to water quality down stream of each of the 6th HUC watershed is not expected to further impair any 303d listed water or add to any mandated Total Maximum Daily Load.

5.0 Project Design Criteria Common to All Action Alternatives

Reconstruction and relocation of roads and ATV trails may occur and will meet the following design criteria:

- Slope less than 8 percent.
- Trail drainage will be provided at the proper spacing according to trail slope and location.
- Running surface will be provided based on traffic volume, soils, and geology.
- Stream crossings will be provided that mitigate or eliminate the effects to the stream channel, the water in the channel, and the wetland associated with the channel.
- Highly erosive soils will be avoided.
- Routes will be located outside of the riparian influence zone.

  Riparian and wetland areas of concern for each activity or project should be identified using the following guidelines (Belt et al. 1992):

  1) Site-specific identification of riparian influence zones for fish-bearing streams should include the area from the edges of the active stream channel to whichever of the following widths is most appropriate:
     - To the top of the inner gorge,
     - To the outer edges of the 100-year floodplain,
     - To the outer edges of the riparian vegetation,
     - To a distance equal to the height of two site-potential trees, or
     - To a 300 foot slope distance (600 feet, including both sides of the stream channel).
  2) Site-specific identification of riparian influence zones for permanently flowing non-fish bearing streams should include the area from the edges of the active stream channel to whichever of the following widths is most appropriate:
     - To the top of the inner gorge,
     - To the outer edges of the 100-year floodplain,
     - To the outer edges of the riparian vegetation,
     - To a distance equal to the height of one site-potential tree, or
     - To a 150 foot slope distance (300 feet, including both sides of the stream channel).
  3) Site-specific identification of riparian influence zones for wetlands, ponds, lakes, reservoirs, and seasonally-flowing or intermittent streams should include the area from the edge of the waterbody to whichever of the following widths is most appropriate:
     - To the outer edges of the riparian vegetation,
     - To the extent of the seasonally-saturated soil,
     - To the extent of moderately and highly unstable areas,
     - To a distance equal to the height of one site-potential tree,
     - To a 150 foot slope distance from the edge of the maximum pool elevation of constructed ponds and reservoirs.

Seasonal restrictions may be used to protect the road, trail, or route during saturated or near saturated soil conditions.

Natural processes of road closure, if ineffective, may be augmented with active obliteration.

Many roads were originally constructed where access was easy or traditional, such as through meadows or in riparian corridors with multiple stream crossings. Costs to soil, water, and other resources were not necessarily considered. With new timber harvest technologies, changing management emphasis, and a more developed road network, the road itself may no longer be needed and decommissioning may be a reasonable management choice. Alternatively, a different location may better fit the landscape (USDA 2006b).

6.0 Compliance with Other Laws and Regulations

6.1 Clean Water Act

The Clean Water Act (CWA) requires each state to implement its own water quality standards. The State of Utah's Water Quality Antidegradation Policy requires maintenance of water quality to protect existing instream Beneficial Uses on streams designated as Category 1 High Quality Waters. All surface waters geographically located within the outer boundaries of the Dixie National Forest, whether on private or public lands, are designated as High Quality Waters (Category 1). This means they will be maintained at existing high quality. New point sources will not be allowed, and non-point sources will be controlled to the extent feasible through implementation of Best Management Practices (BMPs) or regulatory programs (Utah Division of Water Quality 2000).

The State of Utah and the Forest Service have agreed through a 1993 Memorandum of Understanding to use the standards and guidelines in the Dixie National Forest's Forest Plan and FSH 2509.22 Soil and Water Conservation Practices (SWCPs) as the BMPs (see Appendix B: Soil and Water Conservation Practices for full text). The use of SWCPs as the BMPs meets the water quality protection elements of the Utah Nonpoint Source Management Plan; therefore, increased contributions to any 303d listed stream is not anticipated in any alternative except Alternative A, where cross-country travel would allow additional impacts to wetlands, floodplains, and stream channels.

6.2 Executive Order 11988 (Protection of Floodplains) of May 24, 1977

This order requires the Forest Service to provide leadership and to take action to (1) minimize adverse impacts associated with occupancy and modification of floodplains and reduce risks of flood loss, (2) minimize impacts of floods on human safety, health, and welfare, and (3) restore and preserve the natural and beneficial values served by floodplains.

In compliance with this order, the Forest Service is proposing to reduce or maintain the number of roads within the riparian influence zone in every alternative except Alternative A, where cross-county travel would allow for additional impacts to floodplains.

6.3 Executive Order 11990 (Protection of Wetlands) of May 24, 1977

This order requires the Forest Service to take action to minimize destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.

In compliance with this order, the Forest Service is proposing to reduce or maintain the number of roads within the riparian influence zone in Alternatives B, C, and D. In Alternatives A and E, road density in the riparian influence zones would either increase or remain the same. In Alternative A, cross-country travel would allow for additional impacts to wetlands, while in Alternative E, road density in riparian influence zones would increase.

6.4 Forest Plan Consistency

Implementation of Alternative A would not be compliant with the Travel Rule as it allows cross-country travel. All alternatives are compliant with the Forest Plan.

7.0 Best Available Science

The techniques and methodologies used in this analysis consider the best available science. The analysis includes a summary of the credible scientific evidence that is relevant to evaluating reasonably foreseeable impacts. The analysis also identifies methods used and references scientific sources relied upon. The conclusions are based on the scientific analysis that shows a thorough review of relevant scientific information.

The use of Forest Service regional SWCPs/BMPs ensure that water quality is protected during road construction and decommissioning (see Appendix B: Soil and Water Conservation Practices).

The analysis relies on identified methods and reference materials, which lends credibility and helps substantiates conclusions. The conclusions are based on intuitive thinking and logic that take into consideration responsible divergent views, the acknowledgment of incomplete or unavailable information, uncertainty, and risk.

The best available science is a composite of several elements. These elements may include, but are not limited to:

- On-site field survey, data collection, and history.
- Scientific literature (literature reviewed and cited is listed in Literature Cited at the end of this document).
- Field monitoring and research papers discussing road systems impacts to watershed resources and related to road construction and decommissioning.
- The choice of analysis for this project was to equate all past, present, and proposed road disturbances to a “detrimentally disturb soil,” which is a soil that has been displaced, compacted, or severely burned such that its hydrologic properties are impaired (USDA 1988). Literature review indicates that the area of detrimentally disturbed soils should not exceed 5 percent within the riparian influence zone adjacent to a stream or 300 feet on each side of the stream (McGurk and Fong 1995). Our assumptions are that all road acreages constituted a detrimentally disturbed soil as they perform like a compacted soil and are hydrologically impaired.
- The logic behind the analysis is that once a riparian influence zone exceeds the 5 percent threshold of detrimentally disturbed soils, effects to water quality will occur as well as changes to the sponge filter system, which may start to malfunction and lead to

detrimental changes in vegetation health, stream channel integrity, suspended sediment loads, and bedload.

- To simplify analysis, the approximate 5 percent threshold used in this approach would be a 1:1 ratio of stream miles and road miles within the riparian influence zone and assumes an average compacted width of 30 feet. Road density by 6th HUC watershed will also be used as a comparison parameter to track the miles of road/square mile of watershed. The logic behind using this parameter is that an increase in the miles can be considered a relative detrimental effect to the watershed and its function.

The determinations reached in this specialist report are based upon ground reconnaissance of the project area, previous monitoring of similar types of activities on National Forest System lands, and a review of all literature cited. Copies of all literature cited are included in the project record for this project. The potential effect of this project, the Motorized Travel Plan, on watershed resources is minor, predictable, and well-documented.

In the opinion of the authors, there are no significant scientific uncertainties or risks associated with this proposal. On the basis of the foregoing, we have determined that we have considered the best available science relevant to the effect of this project on watershed resources of the Dixie National Forest.

8.0 Conclusion

Implementation of Alternative B, C, D, or E would not exceed the estimated 5 percent threshold in any of the riparian influence zones; however, under Alternative A, the 5 percent threshold would likely be exceeded over time since cross-country travel would be permitted.

8.1 Summary Tables

Tables 4 and 5 indicate which 303d or TMDL listed streams will have a net increase or decrease in miles of road/miles of stream by alternative. All mileages of roads are based upon 2005 data. There would be a net increase in user-created routes in Alternative A because cross-country travel will continue to be allowed, which will lead to an increase in user-created routes.

Table 4. 303(d)a and TMDLb 6th HUC Watersheds: Comparison of the Alternatives by Miles of Road to Miles of Stream.

6th HUC Number	6th HUC Name	303d or TMDL Pollutant of Concern	Comparison of Net Increase or Decrease in Miles of Road to Miles of Stream by Alternative
140700070102	Bryce Creek	303d: TDS	No change in any alternative
140700070103	Henderson Canyon	303d: TDS	Decrease in Alts B, C, D; increase in Alt E
140700070104	Dry Creek	303d: TDS	No change in Alts B, C, D; increase in Alt E
140700070105	Henrieville Creek	303d: TDS	No change in any alternative
140700070108	Dry Valley Creek	303d: TDS	No change in any alternative
140700070201	Upper Sheep Creek	303d: TDS	No change in any alternative
140700070202	Willis Creek	303d: TDS	Decrease in Alts B, C, D; no change in Alt E

6th HUC Number	6th HUC Name	303d or TMDL Pollutant of Concern	Comparison of Net Increase or Decrease in Miles of Road to Miles of Stream by Alternative
140700070203	Bull Valley Gorge	303d: TDS	No change in any alternative
150100080904	Heath Wash	TDS	No change in any alternative
150100080905	Cottonwood Creek	TDS	Decrease in Alts B, C, D; increase in Alt E
150100080906	Quail Creek	TDS	Decrease in Alts B, C, D; increase in Alt E
160300010303	Big Hollow-Sevier River	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; no change in Alt E
160300010304	Proctor Canyon-Sevier River	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; no change in Alt E
160300010305	Pass Creek	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; no change in Alt E
160300010306	Red Canyon	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; no change in Alt E
160300010307	Hillsdale-Sevier River	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C; no change in Alts D, E
160300010308	Casto Wash	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; increase in Alt E
160300010309	Graveyard Hollow	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; no change in Alt E
160300010310	Peterson Wash-Sevier River	TMDL: Siltation & Total Phosphorus	Decrease in Alt B; no change in Alts C, D, E
160300010503	Limekiln Creek	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; no change in Alt E
160300010504	West Ditch-Sevier River	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; no change in Alt E
160300010506	Tebbs Hollow-Sevier River	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; no change in Alt E
160300010507	Sanford Creek	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; increase in Alt E
160300010509	Smith Canyon-Sevier River	TMDL: Siltation & Total Phosphorus	No change in Alts B, C, D; increase in Alt E
160300010510	Horse Valley Creek-Sevier River	TMDL: Siltation & Total Phosphorus	Decrease in Alts B, C, D; no change in Alt E
160300010602	Chokecherry Creek-Sevier River	TMDL: Siltation & Total Phosphorus	No change in any alternative
160300020505	Dry Wash	TMDL: Temperature & Total Phosphorus	No change in any alternative
160300020506	Antimony-East Fork Sevier River	TMDL: Temperature & Total Phosphorus	Decrease in Alt B; no change in Alts C, D; increase in Alt E
160300020507	East Fork Sevier River Outlet	TMDL: Temperature & Total Phosphorus	No change in Alts B, C, D; increase in Alt E

Source: Utah Department of Environmental Quality, Division of Water Quality 2006, as included in Appendix A, Table A-1.

[a]303(d) List of water quality limited water bodies pursuant to Section 303 (d) of the Clean Water Act.
[b]TMDL: Total Maximum Daily Load

DO – Dissolved Oxygen
TDS – Total Dissolved Solids

Table 5. 303(d)a and TMDLb 6th HUC Watersheds for TMDL Lakes: Comparison of the Alternatives by Miles of Road to Miles of Stream.

6th HUC Watershed Number	6th HUC Watershed Name	Lake	303d or TMDL for Pollutant of Concern	Change to Alternatives
160300061407	New Castle Reservoir	New Castle Reservoir[c]	TP, DO	No change in any alternative
160300010102	Deer Valley Midway Creek	Navajo Lake	DO	Decrease in Alts B, C, D; increase in Alt E
160300060109	Red Creek	Red Creek Reservoir	DO	Decrease in Alts B, C, D; no change in Alt E
160300060202	Center Creek-Parowan Creek	Yankee Meadow	DO, TP	Decrease in Alts B, C, D; increase in Alt E
140700070101	North Creek	Otter Creek	TP	Decrease in Alts B, C, D; increase in Alt E
140700030401	Upper Pleasant Creek	Lower Bowns	pH	Decrease in Alts B, C, D; increase in Alt E
160300010403	Haycock Creek	Panguitch Lake[d]	TP	Decrease in Alts B, C, D; increase in Alt E
160300010402	Blue Spring	Panguitch Lake[d]	TP	Decrease in Alts B, C, D; increase in Alt E

Source: Utah Department of Environmental Quality, Division of Water Quality 2006.
[a] 303(d) List of water quality limited water bodies pursuant to Section 303 (d) of the Clean Water Act.
[b] TMDL: Total Maximum Daily Load
[c] The majority of New Castle Reservoir is in the New Castle Reservoir 6th HUC.
[d] Panguitch Lake is divided between two 6th HUCs.

DO Dissolved Oxygen
TP Total Phosphorus

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Appendix A: Threshold Data

Table A-1. Miles of Road/Miles of Stream
Table A-2. Mile of Road/Square Miles by Watershed

Table A-1. Miles of Road/Miles of Stream

HUC Watershed Number	Watershed Name	Stream Influence Zone				
		Alt A	Alt B	Alt C	Alt D	Alt E
140700030201	West Fork Cedar Peak Draw	0.16	0.14	0.15	0.15	0.16
140700030202	Antelope Spring Draw	0.12	0.10	0.10	0.11	0.12
140700030207	Rock Spring Draw	0.05	0.04	0.04	0.04	0.05
140700030208	Upper Pine Creek	0.06	0.05	0.05	0.05	0.06
140700030209	Lower Pine Creek	0.09	0.09	0.09	0.09	0.10
140700030301	Boulder Creek-Fremont River	0.08	0.08	0.08	0.08	0.11
140700030302	Fish Creek	0.07	0.06	0.06	0.07	0.13
140700030303	Carcass Creek	0.09	0.05	0.05	0.08	0.10
140700030305	Donkey Creek-Fremont River	0.14	0.14	0.14	0.14	0.16
140700030401	Upper Pleasant Creek	0.09	0.08	0.08	0.08	0.13
140700030402	Lower Pleasant Creek	0.20	0.20	0.20	0.20	0.20
140700030404	Sandy Draw	0.06	0.05	0.05	0.05	0.06
140700030406	Oak Creek	0.13	0.09	0.09	0.10	0.14
140700030408	Middle Sandy Creek	0.03	0.03	0.03	0.03	0.03
140700050101	Upper Valley Creek	0.09	0.05	0.06	0.07	0.10
140700050102	Birch Creek	0.23	0.16	0.18	0.18	0.23
140700050103	Upper North Creek	0.10	0.07	0.07	0.09	0.11
140700050104	Lower North Creek	0.22	0.21	0.21	0.21	0.22
140700050105	Upper Pine Creek	0.05	0.03	0.03	0.04	0.08
140700050106	Lower Pine Creek	0.12	0.08	0.08	0.11	0.19
140700050107	Wide Hollow Reservoir-Escalante River	0.07	0.07	0.08	0.07	0.08
140700050201	Mamie Creek	0.00	0.00	0.00	0.00	0.00
140700050202	Sweetwater Creek	0.07	0.07	0.07	0.07	0.08
140700050203	Upper Sand Creek	0.08	0.08	0.08	0.08	0.08
140700050204	Lower Sand Creek	0.00	0.00	0.00	0.00	0.00
140700050206	Headwaters Boulder Creek	0.05	0.04	0.04	0.04	0.05
140700050207	Deer Creek	0.18	0.15	0.16	0.16	0.19
140700050208	Deer Creek-Boulder Creek	0.24	0.24	0.24	0.24	0.24
140700050209	Bear Creek-Boulder Creek	0.12	0.13	0.13	0.13	0.13
140700050210	Calf Creek-Escalante River	0.10	0.10	0.10	0.10	0.10
140700050301	Willow Creek	0.09	0.09	0.09	0.09	0.09
140700050302	Little Alvey Wash	0.24	0.23	0.24	0.24	0.24
140700050401	Upper the Gulch	0.08	0.06	0.06	0.06	0.09
140700050404	Upper Horse Canyon	0.09	0.09	0.09	0.09	0.09
140700060801	Headwaters Wahweap Creek	0.36	0.36	0.36	0.36	0.36
140700070101	North Creek	0.13	0.13	0.13	0.13	0.13
140700070102	Bryce Creek	0.12	0.12	0.12	0.12	0.12
140700070103	Henderson Canyon	0.05	0.04	0.04	0.04	0.07
140700070104	Dry Creek	0.08	0.08	0.08	0.08	0.09
140700070105	Henrieville Creek	0.13	0.13	0.13	0.13	0.13
140700070108	Dry Valley Creek	0.10	0.10	0.10	0.10	0.10
140700070201	Upper Sheep Creek	0.17	0.17	0.17	0.17	0.17
140700070202	Willis Creek	0.09	0.07	0.07	0.07	0.09
140700070203	Bull Valley Gorge	0.22	0.22	0.22	0.22	0.22
140700070401	Lick Wash	0.14	0.14	0.14	0.14	0.14
140700070402	Bullrush Gorge	0.10	0.10	0.10	0.10	0.10

HUC Watershed Number	Watershed Name	Stream Influence Zone				
		Alt A	Alt B	Alt C	Alt D	Alt E
140700070403	Adams Wash	0.15	0.14	0.14	0.14	0.15
140700070404	Upper Deer Spring Wash	0.15	0.11	0.14	0.13	0.15
150100030101	Reservoir Canyon-Kanab Creek	0.19	0.19	0.19	0.19	0.19
150100030102	Skull Valley Wash	0.12	0.10	0.12	0.12	0.12
150100030103	Lower Robinson Creek-Kanab Creek	0.09	0.06	0.07	0.07	0.09
150100030301	Thompson Creek	0.20	0.20	0.20	0.20	0.20
150100030302	Skutumpah Creek	0.34	0.34	0.34	0.34	0.34
150100080101	Upper Deep Creek	0.06	0.06	0.05	0.06	0.06
150100080103	Upper North Fork Virgin River	0.26	0.26	0.26	0.26	0.26
150100080105	Lower Deep Creek	0.08	0.08	0.08	0.08	0.08
150100080201	Headwaters East Fork Virgin River	0.16	0.16	0.16	0.16	0.16
150100080202	Muddy Creek	0.16	0.16	0.16	0.16	0.16
150100080203	Lydias Canyon-East Fork Virgin River	0.23	0.23	0.23	0.23	0.23
150100080401	Pinto Creek	0.19	0.14	0.18	0.17	0.19
150100080403	North Ash Creek	0.11	0.10	0.10	0.10	0.13
150100080404	Ash Creek Reservoir-Ash Creek	0.06	0.06	0.06	0.06	0.07
150100080405	Wet Sandy-Ash Creek	0.07	0.05	0.05	0.05	0.08
150100080601	Magotsu Creek	0.16	0.08	0.11	0.12	0.16
150100080602	Upper Moody Wash	0.17	0.09	0.10	0.11	0.18
150100080603	Lower Moody Wash	0.17	0.14	0.14	0.16	0.17
150100080701	Grass Valley Creek	0.08	0.05	0.06	0.05	0.24
150100080702	Headwaters Santa Clara River	0.07	0.07	0.07	0.07	0.17
150100080703	Mahogany Creek-Santa Clara River	0.14	0.11	0.12	0.12	0.14
150100080704	Baker Dam Reservoir-Santa Clara River	0.12	0.12	0.12	0.12	0.12
150100080801	Sand Cove Wash	0.13	0.13	0.13	0.13	0.13
150100080802	Tobin Wash-Santa Clara River	0.18	0.18	0.18	0.18	0.18
150100080806	Halfway Wash	0.05	0.04	0.04	0.05	0.05
150100080807	Snow Canyon	0.06	0.05	0.05	0.05	0.06
150100080903	Grapevine Wash-Virgin River	0.08	0.08	0.08	0.08	0.08
150100080904	Heath Wash	0.04	0.04	0.04	0.04	0.04
150100080905	Cottonwood Creek	0.15	0.14	0.14	0.14	0.16
150100080906	Quail Creek	0.11	0.10	0.10	0.11	0.12
150100080908	Mill Creek	0.04	0.04	0.04	0.04	0.04
150100080910	Middleton Wash-Virgin River	0.01	0.01	0.01	0.01	0.01
150100100101	Pine Park Canyon	0.05	0.03	0.05	0.04	0.05
150100100102	Headwaters Wash	0.30	0.30	0.30	0.30	0.30
150100100103	Slaughter Creek	0.07	0.07	0.07	0.07	0.07
150100100104	Deep Canyon-Beaver Dam Wash	0.45	0.45	0.45	0.45	0.45
150100100106	East Fork Beaver Dam Wash	0.22	0.22	0.22	0.22	0.22

HUC Watershed Number	Watershed Name	Stream Influence Zone				
		Alt A	Alt B	Alt C	Alt D	Alt E
160300010101	Midway Valley-Midway Creek	0.02	0.02	0.02	0.02	0.02
160300010102	Deer Valley-Midway Creek	0.03	0.03	0.03	0.03	0.03
160300010103	Strawberry Creek	0.03	0.03	0.03	0.03	0.03
160300010104	Swains Creek	0.07	0.07	0.07	0.07	0.07
160300010105	West Fork Asay Creek-Asay Creek	0.04	0.04	0.04	0.04	0.04
160300010201	Upper Mammoth Creek	0.09	0.07	0.08	0.08	0.10
160300010202	Tommy Creek	0.07	0.06	0.06	0.06	0.10
160300010203	Middle Mammoth Creek	0.08	0.04	0.05	0.05	0.09
160300010204	Lower Mammoth Creek	0.13	0.10	0.12	0.12	0.13
160300010301	Castle Creek-Sevier River	0.19	0.19	0.19	0.19	0.19
160300010302	Pole Canyon-Sevier River	0.26	0.26	0.26	0.26	0.26
160300010303	Big Hollow-Sevier River	0.14	0.12	0.12	0.12	0.14
160300010304	Proctor Canyon-Sevier River	0.19	0.16	0.17	0.16	0.19
160300010305	Pass Creek	0.10	0.09	0.09	0.08	0.10
160300010306	Red Canyon	0.19	0.12	0.12	0.13	0.19
160300010307	Hillsdale-Sevier River	0.18	0.17	0.17	0.18	0.18
160300010308	Casto Wash	0.18	0.15	0.15	0.15	0.21
160300010309	Graveyard Hollow	0.12	0.09	0.09	0.10	0.12
160300010310	Peterson Wash-Sevier River	0.16	0.15	0.16	0.16	0.16
160300010401	Ipson Creek	0.15	0.14	0.14	0.14	0.15
160300010402	Blue Spring Creek	0.13	0.06	0.07	0.09	0.14
160300010403	Haycock Creek	0.20	0.15	0.15	0.16	0.21
160300010404	Butler Creek	0.14	0.10	0.11	0.11	0.14
160300010405	Fivemile Hollow-Panquitch Creek	0.20	0.14	0.10	0.15	0.20
160300010406	South Canyon-Panguitch Creek	0.17	0.17	0.17	0.17	0.17
160300010501	Threemile Creek	0.37	0.28	0.30	0.36	0.37
160300010502	East Bench-Sevier River	0.12	0.10	0.10	0.10	0.12
160300010503	Limekiln Creek	0.09	0.07	0.07	0.07	0.09
160300010504	West Ditch-Sevier River	0.09	0.07	0.07	0.07	0.09
160300010505	Sandy Creek	0.27	0.25	0.25	0.25	0.27
160300010506	Tebbs Hollow-Sevier River	0.20	0.15	0.15	0.18	0.20
160300010507	Sanford Creek	0.35	0.28	0.33	0.28	0.37
160300010508	Bear Creek	0.21	0.18	0.19	0.20	0.21
160300010509	Smith Canyon-Sevier River	0.24	0.24	0.24	0.24	0.26
160300010510	Horse Valley Creek-Sevier River	0.29	0.20	0.20	0.28	0.29
160300010602	Chokecherry Creek-Sevier River	0.27	0.27	0.27	0.27	0.27
160300010603	Birch Creek-Sevier River	0.25	0.25	0.25	0.25	0.25
160300010604	Lost Creek	0.22	0.14	0.18	0.18	0.22
160300010606	Burnt Hollow-Sevier River	0.12	0.10	0.10	0.10	0.12
160300020301	East Fork Sevier River Headwaters	0.12	0.10	0.10	0.10	0.12
160300020302	Tropic Reservoir	0.18	0.09	0.12	0.12	0.18
160300020303	Mud Spring Creek-East Fork Sevier River	0.12	0.05	0.07	0.08	0.12

HUC Watershed Number	Watershed Name	Stream Influence Zone				
		Alt A	Alt B	Alt C	Alt D	Alt E
160300020304	Showalter Creek-East Fork Sevier River	0.16	0.09	0.10	0.13	0.16
160300020305	Hunt Creek	0.18	0.17	0.17	0.18	0.32
160300020306	Cameron Wash-East Fork Sevier River	0.15	0.07	0.10	0.12	0.15
160300020401	Clay Creek	0.16	0.15	0.15	0.15	0.16
160300020402	South Creek	0.09	0.09	0.09	0.09	0.09
160300020403	Sweetwater Creek	0.08	0.06	0.07	0.07	0.08
160300020404	Prospect Creek	0.15	0.08	0.06	0.10	0.44
160300020405	Ranch Creek-Sevier River	0.16	0.09	0.10	0.16	0.19
160300020406	Cottonwood Creek	0.34	0.31	0.31	0.31	0.56
160300020407	Cow Creek-Sevier River	0.16	0.16	0.16	0.16	0.23
160300020408	Deer Creek	0.18	0.10	0.10	0.10	0.47
160300020409	North Creek	0.05	0.03	0.05	0.05	0.05
160300020410	Deep Creek	0.12	0.12	0.12	0.14	0.18
160300020411	Forest Creek	0.08	0.06	0.06	0.06	0.09
160300020412	Pacer Lake	0.18	0.18	0.18	0.18	0.19
160300020501	Coyote Hollow-Antimony Creek	0.05	0.04	0.04	0.05	0.05
160300020502	Lost Spring Draw	0.10	0.05	0.05	0.06	0.10
160300020503	Antimony Creek	0.24	0.20	0.20	0.22	0.25
160300020505	Dry Wash	0.11	0.11	0.11	0.11	0.11
160300020506	Antimony-East Fork Sevier River	0.10	0.09	0.10	0.10	0.11
160300020507	East Fork Sevier River Outlet	0.20	0.20	0.20	0.20	0.23
160300060102	Buckskin Wash	0.21	0.20	0.20	0.21	0.21
160300060105	Cottonwood Canyon-Fremont Wash	0.19	0.17	0.18	0.18	0.22
160300060106	Kane Spring Wash-Fremont Wash	0.14	0.10	0.10	0.10	0.17
160300060107	Willow Creek	0.09	0.07	0.07	0.07	0.29
160300060108	Little Creek	0.25	0.23	0.23	0.23	0.25
160300060109	Red Creek	0.15	0.12	0.13	0.12	0.15
160300060201	Dry Lakes Creek	0.16	0.16	0.16	0.16	0.16
160300060202	Center Creek-Parowan Creek	0.33	0.32	0.32	0.33	0.35
160300060203	Outlet Parowan Creek	0.14	0.14	0.14	0.14	0.14
160300060204	Summit Creek	0.13	0.13	0.13	0.13	0.14
160300060304	Ashdown Creek	0.02	0.02	0.02	0.02	0.16
160300060306	Crow Creek-Coal Creek	0.27	0.26	0.26	0.27	0.27
160300060403	Duncan Creek	0.27	0.27	0.27	0.27	0.27
160300060501	Big Hollow Wash	0.04	0.04	0.04	0.04	0.04
160300061002	Sheep Spring Draw	0.31	0.31	0.31	0.31	0.31
160300061004	Devils Gap	0.13	0.12	0.13	0.13	0.13
160300061101	Sevy Hollow	0.14	0.14	0.14	0.14	0.14
160300061102	Headwaters Pinon Park Wash	0.03	0.03	0.03	0.03	0.03
160300061103	Escalante Mine Canal	0.04	0.04	0.04	0.04	0.04
160300061301	Nephi Draw	0.23	0.15	0.19	0.19	0.23
160300061302	Little Pine Creek	0.14	0.11	0.12	0.13	0.14

HUC Watershed Number	Watershed Name	Stream Influence Zone				
		Alt A	Alt B	Alt C	Alt D	Alt E
160300061303	Upper Shoal Creek	0.29	0.17	0.17	0.17	0.29
160300061304	Calf Springs Creek	0.17	0.14	0.15	0.15	0.17
160300061305	Holt Canyon	0.16	0.13	0.13	0.13	0.16
160300061306	Lower Shoal Creek	0.10	0.09	0.09	0.09	0.10
160300061307	Newcastle	0.02	0.02	0.02	0.02	0.02
160300061401	Pinto Creek	0.26	0.14	0.19	0.20	0.28
160300061402	The Dry Wash	0.09	0.07	0.07	0.09	0.09
160300061403	Little Pinto Creek	0.16	0.14	0.14	0.14	0.18
160300061407	Newcastle Reservoir	0.06	0.06	0.06	0.06	0.06

Table A-2. Miles of Road/Square Miles by Watershed

HUC Watershed Number	Watershed Name	Miles of Road/Square Miles				
		Alt A	Alt B	Alt C	Alt D	Alt E
140700030201	West Fork Cedar Peak Draw	1.36	1.21	1.21	1.24	1.36
140700030202	Antelope Spring Draw	1.88	1.25	1.25	1.56	1.88
140700030207	Rock Spring Draw	1.79	0.90	0.90	1.33	1.86
140700030208	Upper Pine Creek	1.85	1.10	1.10	1.51	2.06
140700030209	Lower Pine Creek	1.04	1.02	1.02	1.02	1.06
140700030301	Boulder Creek-Fremont River	1.58	1.48	1.48	1.53	1.98
140700030302	Fish Creek	1.03	0.66	0.66	0.96	1.60
140700030303	Carcass Creek	1.87	1.17	1.17	1.67	2.26
140700030305	Donkey Creek-Fremont River	1.66	1.63	1.63	1.65	1.77
140700030401	Upper Pleasant Creek	1.16	0.88	0.88	0.99	1.60
140700030402	Lower Pleasant Creek	0.79	0.78	0.78	0.78	0.79
140700030404	Sandy Draw	0.90	0.73	0.73	0.82	0.90
140700030406	Oak Creek	1.12	0.96	0.96	1.03	1.42
140700030408	Middle Sandy Creek	0.59	0.58	0.58	0.58	0.59
140700050101	Upper Valley Creek	2.15	1.11	1.11	1.70	2.31
140700050102	Birch Creek	1.78	1.13	1.13	1.52	1.79
140700050103	Upper North Creek	1.98	0.97	0.97	1.74	2.06
140700050104	Lower North Creek	0.73	0.39	0.39	0.45	0.73
140700050105	Upper Pine Creek	1.64	0.69	0.69	1.42	1.72
140700050106	Lower Pine Creek	1.37	0.77	0.77	1.16	1.54
140700050107	Wide Hollow Reservoir-Escalante River	1.24	1.22	1.22	1.24	1.28
140700050201	Mamie Creek	0.09	0.07	0.07	0.09	0.09
140700050202	Sweetwater Creek	1.28	1.24	1.24	1.25	1.35
140700050203	Upper Sand Creek	0.97	0.72	0.72	0.96	1.01
140700050204	Lower Sand Creek	0.10	0.10	0.10	0.10	0.10
140700050206	Headwaters Boulder Creek	0.88	0.64	0.64	0.79	0.98
140700050207	Deer Creek	0.93	0.60	0.60	0.86	1.04
140700050208	Deer Creek-Boulder Creek	0.38	0.38	0.38	0.38	0.38
140700050209	Bear Creek-Boulder Creek	0.89	0.89	0.89	0.90	0.91
140700050210	Calf Creek-Escalante River	0.44	0.44	0.44	0.44	0.44
140700050301	Willow Creek	0.76	0.59	0.59	0.70	0.95
140700050302	Little Alvey Wash	0.61	0.55	0.55	0.60	0.61
140700050401	Upper the Gulch	0.50	0.35	0.35	0.43	0.58
140700050404	Upper Horse Canyon	0.83	0.83	0.83	0.83	0.83
140700060801	Headwaters Wahweap Creek	0.46	0.46	0.46	0.46	0.46
140700070101	North Creek	0.47	0.45	0.45	0.46	0.48
140700070102	Bryce Creek	1.53	1.53	1.53	1.53	1.53
140700070103	Henderson Canyon	0.57	0.44	0.44	0.51	0.72
140700070104	Dry Creek	0.83	0.83	0.83	0.83	0.89
140700070105	Henrieville Creek	0.51	0.50	0.50	0.50	0.51
140700070108	Dry Valley Creek	0.91	0.87	0.87	0.87	0.91
140700070201	Upper Sheep Creek	1.45	1.31	1.31	1.32	1.45
140700070202	Willis Creek	1.30	1.13	1.13	1.13	1.30
140700070203	Bull Valley Gorge	0.55	0.55	0.55	0.55	0.55
140700070401	Lick Wash	1.64	1.64	1.64	1.64	1.64
140700070402	Bullrush Gorge	1.59	1.59	1.59	1.59	1.59

HUC Watershed Number	Watershed Name	Miles of Road/Square Miles				
		Alt A	Alt B	Alt C	Alt D	Alt E
140700070403	Adams Wash	1.39	1.36	1.36	1.36	1.39
140700070404	Upper Deer Spring Wash	1.78	1.35	1.35	1.63	1.78
150100030101	Reservoir Canyon-Kanab Creek	1.38	1.36	1.36	1.37	1.38
150100030102	Skull Valley Wash	1.54	1.46	1.46	1.53	1.54
150100030103	Lower Robinson Creek-Kanab Creek	1.44	1.32	1.32	1.40	1.44
150100030301	Thompson Creek	1.43	1.42	1.42	1.43	1.43
150100030302	Skutumpah Creek	1.60	1.58	1.58	1.59	1.60
150100080101	Upper Deep Creek	1.28	1.27	1.27	1.29	1.30
150100080103	Upper North Fork Virgin River	1.44	1.44	1.44	1.44	1.45
150100080105	Lower Deep Creek	1.09	1.09	1.09	1.09	1.09
150100080201	Headwaters East Fork Virgin River	2.56	2.56	2.56	2.56	2.56
150100080202	Muddy Creek	1.05	1.05	1.05	1.05	1.05
150100080203	Lydias Canyon-East Fork Virgin River	1.01	1.01	1.01	1.01	1.01
150100080401	Pinto Creek	0.84	0.61	0.61	0.66	1.00
150100080403	North Ash Creek	1.08	1.04	1.04	1.04	1.32
150100080404	Ash Creek Reservoir-Ash Creek	1.37	1.33	1.33	1.36	1.49
150100080405	Wet Sandy-Ash Creek	1.35	1.20	1.20	1.26	1.53
150100080601	Magotsu Creek	1.23	0.77	0.77	1.04	1.33
150100080602	Upper Moody Wash	0.99	0.54	0.54	0.74	1.00
150100080603	Lower Moody Wash	1.59	1.28	1.28	1.53	1.59
150100080701	Grass Valley Creek	0.62	0.44	0.44	0.49	1.32
150100080702	Headwaters Santa Clara River	0.53	0.52	0.52	0.52	1.64
150100080703	Mahogany Creek-Santa Clara River	1.93	1.56	1.56	1.62	1.95
150100080704	Baker Dam Reservoir-Santa Clara River	1.75	1.71	1.71	1.71	1.75
150100080801	Sand Cove Wash	0.73	0.73	0.73	0.73	0.73
150100080802	Tobin Wash-Santa Clara River	1.31	1.27	1.27	1.31	1.31
150100080806	Halfway Wash	1.27	1.01	1.01	1.10	1.27
150100080807	Snow Canyon	1.17	1.05	1.05	1.06	1.21
150100080903	Grapevine Wash-Virgin River	1.53	1.53	1.53	1.53	1.53
150100080904	Heath Wash	0.48	0.30	0.30	0.48	0.76
150100080905	Cottonwood Creek	0.92	0.80	0.80	0.90	1.09
150100080906	Quail Creek	1.51	1.41	1.41	1.44	1.81
150100080908	Mill Creek	1.84	1.82	1.82	1.84	1.84
150100080910	Middleton Wash-Virgin River	2.09	2.09	2.09	2.09	2.09
150100100101	Pine Park Canyon	0.49	0.41	0.41	0.45	0.49
150100100102	Headwaters Wash	0.88	0.88	0.88	0.88	0.88
150100100103	Slaughter Creek	1.15	1.15	1.15	1.15	1.15
150100100104	Deep Canyon-Beaver Dam Wash	0.43	0.43	0.43	0.43	0.43
150100100106	East Fork Beaver Dam Wash	1.08	1.03	1.03	1.07	1.11

HUC Watershed Number	Watershed Name	Miles of Road/Square Miles				
		Alt A	Alt B	Alt C	Alt D	Alt E
160300010101	Midway Valley-Midway Creek	3.12	3.12	3.12	3.13	3.13
160300010102	Deer Valley-Midway Creek	3.30	3.12	3.12	3.25	3.52
160300010103	Strawberry Creek	5.36	5.36	5.36	5.36	5.39
160300010104	Swains Creek	5.49	5.49	5.49	5.49	5.49
160300010105	West Fork Asay Creek-Asay Creek	2.00	1.95	1.95	1.98	2.05
160300010201	Upper Mammoth Creek	2.05	1.46	1.46	2.14	2.75
160300010202	Tommy Creek	0.85	0.77	0.77	1.14	1.51
160300010203	Middle Mammoth Creek	3.25	1.54	1.54	2.66	3.81
160300010204	Lower Mammoth Creek	3.25	1.93	1.93	2.51	3.56
160300010301	Castle Creek-Sevier River	1.91	1.91	1.91	1.91	1.91
160300010302	Pole Canyon-Sevier River	1.09	1.09	1.09	1.09	1.11
160300010303	Big Hollow-Sevier River	2.41	2.07	2.07	2.20	2.41
160300010304	Proctor Canyon-Sevier River	1.73	1.28	1.28	1.45	1.73
160300010305	Pass Creek	2.93	1.82	1.82	2.04	2.93
160300010306	Red Canyon	1.54	0.79	0.79	1.04	1.64
160300010307	Hillsdale-Sevier River	1.71	1.44	1.44	1.57	1.71
160300010308	Casto Wash	1.44	0.88	0.88	0.95	1.54
160300010309	Graveyard Hollow	3.44	2.29	2.29	2.15	3.44
160300010310	Peterson Wash-Sevier River	2.19	2.01	2.01	2.11	2.19
160300010401	Ipson Creek	2.03	1.61	1.61	1.67	2.04
160300010402	Blue Spring Creek	2.46	1.39	1.39	2.00	2.74
160300010403	Haycock Creek	3.18	1.98	1.98	2.26	3.43
160300010404	Butler Creek	1.80	1.37	1.37	1.53	1.80
160300010405	Fivemile Hollow-Panquitch Creek	1.94	1.32	1.32	1.50	1.97
160300010406	South Canyon-Panguitch Creek	1.93	1.69	1.69	1.71	1.93
160300010501	Threemile Creek	1.32	1.03	1.03	1.21	1.32
160300010502	East Bench-Sevier River	2.69	2.58	2.58	2.60	2.69
160300010503	Limekiln Creek	1.24	0.82	0.82	0.82	1.24
160300010504	West Ditch-Sevier River	1.19	1.14	1.14	1.14	1.19
160300010505	Sandy Creek	1.16	1.08	1.08	1.09	1.16
160300010506	Tebbs Hollow-Sevier River	1.11	1.02	1.02	1.05	1.11
160300010507	Sanford Creek	0.86	0.65	0.65	0.69	0.95
160300010508	Bear Creek	1.25	1.07	1.07	1.15	1.25
160300010509	Smith Canyon-Sevier River	1.39	1.34	1.34	1.34	1.46
160300010510	Horse Valley Creek-Sevier River	1.01	0.77	0.77	0.94	1.01
160300010602	Chokecherry Creek-Sevier River	0.98	0.97	0.97	0.97	0.98
160300010603	Birch Creek-Sevier River	1.27	1.25	1.25	1.25	1.27
160300010604	Lost Creek	1.09	0.75	0.75	0.90	1.23
160300010606	Burnt Hollow-Sevier River	1.38	1.25	1.25	1.26	1.38
160300020301	East Fork Sevier River Headwaters	4.57	2.20	2.20	3.94	4.61
160300020302	Tropic Reservoir	3.74	1.77	1.77	2.61	3.93
160300020303	Mud Spring Creek-East Fork Sevier River	4.25	1.75	1.75	2.48	4.26

HUC Watershed Number	Watershed Name	Miles of Road/Square Miles				
		Alt A	Alt B	Alt C	Alt D	Alt E
160300020304	Showalter Creek-East Fork Sevier River	2.95	1.54	1.54	2.03	3.00
160300020305	Hunt Creek	1.03	0.70	0.70	0.88	1.51
160300020306	Cameron Wash-East Fork Sevier River	2.69	1.25	1.25	2.13	2.71
160300020401	Clay Creek	2.17	1.90	1.90	2.06	2.20
160300020402	South Creek	1.80	1.71	1.71	1.71	1.83
160300020403	Sweetwater Creek	1.69	1.18	1.18	1.56	1.88
160300020404	Prospect Creek	0.58	0.39	0.39	0.47	1.20
160300020405	Ranch Creek-Sevier River	1.17	0.94	0.94	1.16	1.44
160300020406	Cottonwood Creek	0.63	0.58	0.58	0.58	1.24
160300020407	Cow Creek-Sevier River	1.27	1.24	1.24	1.27	1.43
160300020408	Deer Creek	0.19	0.16	0.16	0.16	0.33
160300020409	North Creek	1.36	1.22	1.22	1.34	1.60
160300020410	Deep Creek	0.77	0.72	0.72	0.89	1.24
160300020411	Forest Creek	1.64	1.31	1.31	1.34	1.84
160300020412	Pacer Lake	1.60	1.39	1.39	1.48	1.78
160300020501	Coyote Hollow-Antimony Creek	2.49	2.00	2.00	2.32	2.51
160300020502	Lost Spring Draw	2.48	1.16	1.16	1.40	2.48
160300020503	Antimony Creek	1.35	0.95	0.95	1.03	1.46
160300020505	Dry Wash	1.79	1.79	1.79	1.79	1.86
160300020506	Antimony-East Fork Sevier River	1.11	0.92	0.92	1.10	1.35
160300020507	East Fork Sevier River Outlet	1.20	1.03	1.03	1.08	1.55
160300060102	Buckskin Wash	1.58	1.53	1.53	1.56	1.58
160300060105	Cottonwood Canyon-Fremont Wash	1.21	1.18	1.18	1.20	1.34
160300060106	Kane Spring Wash-Fremont Wash	1.31	1.23	1.23	1.23	1.42
160300060107	Willow Creek	1.26	0.94	0.94	1.11	1.66
160300060108	Little Creek	1.68	1.37	1.37	1.50	1.68
160300060109	Red Creek	1.83	1.58	1.58	1.66	1.83
160300060201	Dry Lakes Creek	3.26	3.21	3.21	3.24	3.37
160300060202	Center Creek-Parowan Creek	1.23	1.10	1.10	1.13	1.40
160300060203	Outlet Parowan Creek	2.10	2.10	2.10	2.10	2.10
160300060204	Summit Creek	1.16	1.16	1.16	1.20	1.27
160300060304	Ashdown Creek	0.43	0.43	0.43	0.46	1.00
160300060306	Crow Creek-Coal Creek	1.31	1.29	1.29	1.38	1.38
160300060403	Duncan Creek	1.87	1.80	1.80	1.80	1.87
160300060501	Big Hollow Wash	2.19	2.14	2.14	2.14	2.19
160300061002	Sheep Spring Draw	0.91	0.89	0.89	0.89	0.91
160300061004	Devils Gap	1.23	1.18	1.18	1.20	1.23
160300061101	Sevy Hollow	1.28	1.26	1.26	1.26	1.28
160300061102	Headwaters Pinon Park Wash	1.91	1.90	1.90	1.90	1.91
160300061103	Escalante Mine Canal	2.44	2.44	2.44	2.44	2.44
160300061301	Nephi Draw	1.50	1.00	1.00	1.29	1.50
160300061302	Little Pine Creek	1.03	0.65	0.65	0.82	1.08

HUC Watershed Number	Watershed Name	Miles of Road/Square Miles				
		Alt A	Alt B	Alt C	Alt D	Alt E
160300061303	Upper Shoal Creek	1.12	0.73	0.73	0.73	1.12
160300061304	Calf Springs Creek	2.11	1.47	1.47	1.84	2.11
160300061305	Holt Canyon	1.39	1.08	1.08	1.11	1.40
160300061306	Lower Shoal Creek	1.75	1.56	1.56	1.64	1.75
160300061307	Newcastle	2.72	2.66	2.66	2.69	2.72
160300061401	Pinto Creek	1.29	0.70	0.70	0.92	1.44
160300061402	The Dry Wash	2.52	2.45	2.45	2.50	2.52
160300061403	Little Pinto Creek	1.29	1.13	1.13	1.16	1.41
160300061407	Newcastle Reservoir	1.47	1.47	1.47	1.47	1.47

Appendix B: Soil and Water Conservation Practices

Forest Service Handbook 2509.22

15 - ROADS AND TRAILS. Transportation systems are developed top serve the transportation needs of National Forest System lands and resource management programs. Transportation planning is a complex process that assures that roads and trails are planned, located, designed, constructed, and maintained to meet these long-term Forest management needs and objectives. General objectives are developed by legislation, policy, and directives and addressed in Forest Plans. Specific objectives are developed by an interdisciplinary team during the NEPA process in project planning.

Transportation planning is normally conducted on a Forest or area-wide basis with the objective of locating roads for individual timber sale areas and long range transportation needs. Alternative road corridors are mapped or flagged on the ground after consideration of management objectives and resource information. The interdisciplinary team reviews these corridors and makes recommendations for road design criteria, modifications of the corridor locations, use of existing roads, and upgrading inadequate roads.

The environmental effects, economic analysis, and recommendations from the interdisciplinary team are considered prior to selecting a preferred alternative by the Line Officer. The appropriate NEPA document resulting from the environmental analysis establishes design criteria which is used to develop design standards, erosion control measures, and the road operation and maintenance standards. Additional interdisciplinary team input may be required in the design phase to ensure meeting the management objectives.

During road construction, the Contract Officer and/or Engineering Representative shall be assigned to the project. These personnel assure that the project is constructed according to contract specifications and drawings. Interdisciplinary team members may be requested to review proposed design modifications during construction.

Subsequent to and upon road completion, periodic reviews of selected projects are made by interdisciplinary team members to evaluate the construction performance, the effectiveness of specific design features or treatments to control erosion, and the appropriateness of the level of maintenance. These reviews provide a feedback mechanism to improve future road construction and maintenance by modifying design or erosion control practices.

PRACTICE: 15.01 - General Guidelines for Transportation Planning

OBJECTIVE: To introduce soil and water resource considerations into Transportation Planning.

EXPLANATION: Transportation Planning shall be included as an integral part of the Forest Planning process. In some cases, a transportation facility may itself require an appropriate NEPA document. Transportation systems will be planned to achieve an optimum balance of minimum environmental effects at minimum, overall long-term cost, while meeting the land and resource management objectives.

Transportation Planning shall develop and evaluate alternative methods of providing needed transport services. Alternative methods may include alternative modes, routes, geometric features, materials standards, or some combination thereof. Evaluation shall include determining the social, environmental, and economic characteristics of each alternative.

Selection of a recommended alternative shall be by the responsible Line Officer and the decision shall be documented. No implementing activities shall be undertaken prior to the approval by the responsible official.

IMPLEMENTATION: An interdisciplinary team during the NEPA process will evaluate watershed characteristics and estimate the response of soil and water resources to proposed transportation alternatives and activities. The NEPA process will identify mitigating measures needed to protect soil and water resources. The subsequent contract will include provisions to meet water quality, soil, and other resource protection requirements as directed by the environmental analysis.

REFERENCES: FSM 1950, 7700, and 7710; NFMA; NEPA; individual Forest Plans; SWCP 11.01, 11.02, 11.03, 11.04, 11.05, 11.06, 11.09, and 11.14; see references in "Best Management Practice" Definition (05--2 and 3); In R-4: R-4 Technical Guide - Erosion Prevention and Control on Timber Sale Areas, May 1981.

PRACTICE: 15.02 - General Guidelines for the Location and Design of Roads and Trails

OBJECTIVE: To locate and design roads and trails with minimal soil and water resource impact while considering all design criteria.

EXPLANATION: There are several considerations which must be incorporated into the location and design of roads and trails. These factors directly affect protection of water quality, soil, and other resource values. The following coordination instructions apply to all transportation activities:

a. Area Transportation Analysis and project planning will be completed using an interdisciplinary process, and the appropriate NEPA document will be prepared and tiered to the Forest Plan. Area Transportation analysis is an extremely effective tool to reduce overall road mileages and, thus, minimize potential resource impacts.

b. Location, design, and construction activities shall utilize appropriate technical resource staffs, when needed, to evaluate effects of transportation development and operations, and recommend mitigating measures to minimize adverse impacts.

c. Roads and trails will be located and designed to facilitate completion of the transportation system, serve specific resource management needs, fit the terrain, and minimize damage to improvements and resources. Fragile, unstable, sensitive, or special areas should be avoided.

d. Roads and trails should be designed based on traffic and safety requirements of anticipated use and to meet the overall transportation plan. The design shall incorporate features to prevent or minimize soil movement and sedimentation as well as undue disruption of water flow.

e. Stream crossing structures shall be designed to provide the most efficient drainage facility consistent with resource protections, importance of the road, legal obligations, and total costs. The design may involve a hydrologic analysis to determine runoff rates and volumes, flood conditions, velocities, scour, open channel shapes, approach topography, materials-foundation condition, and fish passage, as required. An economic comparison of various flood frequencies versus structure sizes and types is also considered.

f. Locate and design roads and trails to drain naturally by appropriate use of out-sloping or in-sloping with cross drainage and grade changes, where possible. Relief culverts

and roadside ditches will be designed whenever reliance upon natural drainage would not protect the running surface, excavation, or embankment. Road and trail drainage should be channeled to effective buffer areas to maximize sediment deposition prior to entry into live water.

IMPLEMENTATION: during the environmental analysis, an interdisciplinary team will be used to insure that management needs, objectives, requirements, and controls are incorporated in the location and design of roads and trails. Mitigation measures needed to protect soil and water resources will be identified in the NEPA process. Contract provisions will be prepared that meet the soil and water resource protection requirements.

REFERENCES: FSM 7710 and 7720; NFMA; FSH 7709.56, Road Preconstruction Handbook; NEPA; SWCP 15.01; see references in "Best Management Practice" Definition (05--2 and 3); In R-4: R-4 Technical Guide - Erosion Prevention and Control on Timber Sale Areas, May 1981.

PRACTICE: 15.03 - Road and Trail Erosion Control Plan

OBJECTIVE: To prevent, limit, and mitigate erosion, sedimentation, and resulting water quality degradation prior to the initiation of construction and maintenance activities through effective contract administration during construction and timely implementation of erosion control practices.

EXPLANATION: Land disturbing activities usually result in at least short-term erosion. Poorly designed, located, constructed, and maintained roads and trails are usually responsible for the majority of stream sedimentation problems associated with forest management practices. By effectively planning for erosion control, sedimentation can be minimized.

Roads and trails require a variety of erosion control measures. Many erosion control practices will not only protect water quality but also maintain road prism integrity, reduce maintenance costs, and improve trafficability. The location of the road or trail with respect to streams, beneficial uses of that water, soil, and geologic information and other site factors govern the degree of stabilization required. Stabilization usually includes a combination of practices that promotes the reestablishment of vegetation on exposed slopes, provides physical protection to exposed surfaces, prevents and downslope movement of soil, or controls road drainage.

Since a newly constructed road is most susceptible to erosion from seasonal precipitation, the timing of erosion control practices is of primary concern. Those practices that can be accomplished concurrent with road counteractions shall be favored as a means of immediate protection of the water resource.

IMPLEMENTATION: Erosion control objectives and detailed mitigation measures are developed using an interdisciplinary approach during the environmental analysis. These measures and objectives shall be reflected in the contract specifications and provisions for the road or trail. When standard specifications do not provide the degree of mitigation required, special project specifications will be developed by the interdisciplinary team.

Prior to the start of construction, the Purchaser shall submit a schedule for proposed erosion control work as required in the Standard Specifications. The schedule shall include all erosion control items identified in the specifications. The schedule shall consider erosion control work necessary for all phases of the project. The Purchaser's construction schedule and plan of operation will be reviewed in conjunction with the erosion control plan to insure their compatibility before any schedules are approved. No work will be permitted on the project until all schedules have been approved by the Contracting Officer.

The Contracting Officer or Engineering Representative shall ensure that erosion control measures are implemented according to the approved schedule and are completed in an acceptable fashion. Field reviews and on-site inspection by the Line Officer and/or Forest Engineer will identify any additional erosion control measures required to protect the streams that were not recognized during planning or design. Necessary correction measures shall be implemented immediately through normal administrative channels.

The following items may be considered as erosion control measures when constructed in a timely manner. To maximize effectiveness, erosion control measures must be in place and functional prior to seasonal precipitation or runoff.

a. Measures to reestablish vegetation on exposed soils. This is usually accomplished by seeding suitable grass and legume species in conjunction with mulching and fertilization. In some situations, treatments may include tree seedling planting or sprigging of other woody species.

b. Measures which physically protect the soil surface from detachment or modify the topography to minimize erosion. These treatments may include the use of dust oil or gravel on the road travelway and ditches and the use of mulches, riprap, erosion mats, and terracing on cuts, fills, and ditches. Temporary waterbars in areas of uncompleted roads and trails can be effectively utilized to reduce sedimentation.

c. Measures which physically inhabit the downslope movement of sediments to streams. These may include the use of slash filter windrows on or below the fill slopes, baled straw in ditches or below fillslopes, catch basins at culvert inlets, and sediment basin slash filter windrows may be utilized in live water drainages where fish passage is not required and where peakflows are low.

d. Measures that reduce the amount of soil disturbance in or near streams. These measures may include dewatering culvert installation or other construction sites, and immediate placement of permanent culverts during road pioneering. Temporary pipes should not be allowed unless positive control of sedimentation can be accomplished during installation, use, and removal.

e. Measures that control the concentration and flow of surface and subsurface water. These may include insloping, outsloping, ditches, cross drains, under drains, trenches, and so forth.

REFERENCES: FSM 7721, 7722, and 7723; Timber Sale Contract Provisions B6.31, B6.5, B6.6, and C6.3; see references in "Best Management Practice" Definition (05--2 and 3); In R-4: R-4 Technical Guide - Erosion prevention and Control on Timber Sale Areas, May 1981; Cook, M.J. and J.G. King. 1983. Construction Cost and Erosion Control Effectiveness of Filter Windrows on Fill Slopes. USDA Forest Service Research Note, INT-335; SWCP Handbook 10.40 Feedback mechanism; FSH 7709.56b, Drainage Structures Handbook.

PRACTICE: 15.04 - Timing of Construction Activities

OBJECTIVE: To minimize erosion by conducting operations during minimal runoff periods.

EXPLANATION: Erosion and sedimentation are directly related to runoff. Scheduling operations during periods when the probabilities for rain and runoff are low is an essential element of effective erosion control. Purchasers shall schedule and conduct operations to prevent erosion and sedimentation. Equipment shall not be operated when ground conditions are such that excessive impacts will result. Such conditions are identified by the Contracting Officer or Engineering Representative with assistance from technical resource staffs as needed.

Temporary erosion control measures may be required to prevent, control, and mitigate erosion and sedimentation.

In addition, it is important to keep permanent erosion control work as current as practicable with ongoing operations. Construction of drainage facilities and performance of other contract work which will contribute to the control of erosion and sedimentation shall be carried out concurrent with earthwork operations or as soon thereafter as practicable. Limitation of the amount of area being graded at a site at any one time, and minimization of the time that an area is laid bare should be a consideration in contract preparation. Erosion control work must be kept current when road construction occurs outside of the normal operating season.

IMPLEMENTATION: Detailed erosion control measures are developed by an interdisciplinary team during the environmental analysis and are incorporated into the contract specifications. Compliance with plans, specifications, and the operating plan is assured by the Contracting Officer and/or Engineering Representative.

REFERENCES: FAR 52.236-15; Timber Sale Contract Provisions C6.3, C6.36, and B6.31; SWCP 15.03; see references in "Best Management Practice" Definition (05--2 and 3).

PRACTICES: 15.05 - Slope Stabilization and Prevention of Mass Failures

OBJECTIVES: To reduce sedimentation by minimizing the chances for road-related mass failures, including landslides and embankment slumps.

EXPLANATION: Road construction in mountainous terrain requires cutting and loading natural slopes which may lead to landslides and/or embankment failures depending on the soil strength, geology, vegetation, aspect, and groundwater regime. Landslides and embankment failures are undesirable because they interrupt traffic, are costly to repair, visually unacceptable, and generate large quantities of erosion and sedimentation.

Roadways may drastically change the subsurface drainage characteristics of a slope. Since the angle and height of cut and fill slopes increase the risk of instability, it is often necessary to provide subsurface drainage to avoid moisture saturation and subsequent slope failure. Where it is necessary, horizontal drains, drainage trenches, or drainage blankets may be used to lower the subsurface water levels and to prevent groundwater from entering embankments.

In areas with high landslide potential, the composition and characteristics of embankments may be controlled since they are essentially engineered structures. Care must be taken to prevent the incorporation of construction slash or other organic material and the embankment material should be placed by one of the following methods.

a. Layer placement.
b. Controlled compaction.
c. Controlled compaction using density controlled strips.
d. Compaction controlled with a special project specification.

IMPLEMENTATION: In areas with intrinsic slope stability problems, appropriate technical resource staffs must be involved in an interdisciplinary approach to route location. Sufficient subsurface investigation and laboratory testing must be performed to general design parameters and mitigating features which will meet the constraints and requirements developed through the NEPA process.

In contracted projects, compliance with environmental analysis requirements and controls which

have been provided for in the specifications is assured by enforcement of the Timber Sale Contract Provisions by the Contracting Officer and/or Engineering Representative.

REFERENCES: FSM 7706.11, 7706.12, 7710, and 7720; Standard Specifications 203, 212, 605, 613, 619, 630, and 631; Timber Sale Contract Provisions B6.31, B6.62, C5.2, C5.4, and C6.36; FSH 7709.11, Transportation Engineering Handbook and FSH 7709.56b, Drainage Structures Handbook; see references in "Best Management Practice" Definition (05--2 and 3); In R-4: R-4 Technical Guide - Erosion prevention and Control on Timber Sale Areas, May 1981.

PRACTICE: 15.06 - Mitigation of Surface Erosion and Stabilization of Slopes

OBJECTIVE: To minimize soil erosion from road cutslopes, fillslopes, and travelway.

EXPLANATION: Road construction exposes fresh, loose soil to the erosive force of wind, water, and traffic. Surface erosion from roads is greatest during the first year following construction. If is desirable to minimize erosion due to the adverse impacts on water quality, vehicle maintenance, road maintenance, and safety. Erosion can occur on cutslopes, fillslopes, and/or travelway. Each of the three surfaces has unique erosion consideration which are outlined below:

Surface	General Characteristics	Stabilization-Mitigation Measures
Cutslope	Steeper, undisturbed, and more sterile soil	Vegetative and mechanical stabilization
Fillslope	Flatter, loose, and more fertile soil	Vegetative and mechanical stabilization
Travelway	Flattest, compact (due to traffic)	Surface Stabilization

Vegetative measures include seeding herbaceous species (grass, legumes, or browse species) or the planting of brush or trees.

Fertilization, mulching, watering, and/or erosion netting and fabrics may be required to insure success.

Mechanical measures include construction of slash windrows, straw bale dams, erosion netting and fabrics, terraces, or benching, riprapping, tackifiers, and gunnite.

Surface stabilization includes watering, dust oiling, dust pallatives, aggregate layer, bituminous surface treatment, or asphalt paving depending on traffic, soils, and climatic factors.

An integrated system of collection control, and dispersion of concentrated surface water is very important in order to prevent erosion on fillslopes, travelways, and natural slopes below cross drains and culverts.

IMPLEMENTATION: During the NEPA process, detailed mitigation measures and slope stabilization techniques are incorporated into the design package by the interdisciplinary team. Compliance with environmental analysis controls and requirements is obtained by the Contracting Officer and/or Engineering Representative through the Standard Specifications and/or Timber Sale Contract Provisions.

REFERENCES: FSM 7706.11, 7706.12, 7706.13, and 7720; Standard Specifications 50.4, 203,

204, 206A, 210, 212, 412, 619, 625, 626, 629, and 630; Timber Sale Contract Provisions B6.31, B6.6, B6.62, B6.65, B6.66, C5.2, C5.23, C5.4, C5.441, C5.46, R-1 C6.36, C6.52, C6.6, C6.601, and C6.622; SWCP 15.03 and 15.04; see references in "Best Management Practice" Definition (05--2 and 3); In R-4: R-4 Technical Guide - Erosion prevention and Control on Timber Sale Areas, May 1981.

PRACTICE: 15.07 - Control of Permanent Road Drainage

OBJECTIVE: To minimize the erosive effects of concentrated water and the degradation of water quality by proper design and construction of road drainage systems and drainage control structures.

EXPLANATION: Degradation of water quality by sediment and the erosive effects of surface runoff can be minimized by stabilizing the road prism and adjacent disturbed areas from erosion. Velocities in the road drainage system can be dissipated before entry into the natural system by design and construction of control structures.

A number of measures can be used alone or in combination to control the detrimental effects of road drainage. Methods used to control water and reduce erosion may include: properly spaced culverts, cross drains, water bars, rolling dips, energy dissipaters, aprons, gabions, and armoring of ditches and drain inlets and outlets. Dispersal of runoff can also be accomplished by rolling the grade, insloping, outsloping crowning, contour trenching, installation of water spreading ditches, and so forth.

IMPLEMENTATION: Project location, design criteria, drainage control features, and detailed mitigation measures are determined during the NEPA process by an interdisciplinary approach. Compliance with plans, specifications, and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: SWCP 15.02, 15.03, 15.06; Timber Sale Contract Provisions B6.6, B6.66, C6.3, C6.6, and C6.601; FSM 7721, 7723, 7706.11, and 7706.12; FSH 7709.56b, Drainage Structures Handbook; see references in "Best Management Practice" Definition (05--2 and 3); In R-4: R-4 Technical Guide - Erosion prevention and Control on Timber Sale Areas, May 1981.

PRACTICE: 15.08 - Pioneer Road Construction

OBJECTIVE: To minimize sediment production and mass wasting associated with pioneer road construction.

EXPLANATION: Pioneer roads are built to allow equipment access for construction of planned roadways. Pioneering is usually done within the corridor of the planned road. To meet the objective of minimizing sediment, the following constraints should be followed:

a. Construction of pioneer roads shall be confined to the roadway construction limits unless otherwise approved by the Contracting Officer.

b. Pioneering shall be conducted so as to prevent undercutting of the designated final cut slope, prevent avoidable deposition of materials outside the designated roadway limits, and accommodate drainage with temporary culverts or log crossings unless approved otherwise.

c. Erosion control work will be completed concurrent with construction activity or prior to the wet season.

d. Live streams crossed by pioneer roads will be dewatered by diversion devices.

IMPLEMENTATION: The Contracting Officer or Engineering Representative are responsible for enforcing contract specifications, drawings, and plans. The Purchaser is responsible for submitting for approval an operating plan that includes erosion control measures.

REFERENCES: SWCP 15.02, 15.03, 15.04, 15.05, and 15.06; Standard Specification 201, 203; FSM 7721; Timber Sale Contract Provisions B6.6, B6.65, C6.3; see references in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.09 - Timely Erosion Control Measures on Incomplete Roads and Streamcrossing Projects

OBJECTIVE: To minimize erosion of and sedimentation from disturbed ground on incomplete projects.

EXPLANATION: The best drainage design and erosion control measure can be useless if projects are incomplete at the end of the normal operating season. Affected areas can include roads, fills, tractor trails, skid trails, landings, streamcrossings, bridge excavations, and firelines. Preventive measures include:

a. The removal of temporary culverts, culvert plugs, diversion dams, or elevated streamcrossing causeways.
b. The installation of temporary culverts, side drains, flumes, cross drains, diversion ditches, energy dissipaters, dips, sediment basins, berms, debris racks, or other facilities needed to control erosion.
c. The removal of debris, obstructions, and spoil material from channels and floodplains.
d. Grass seeding, planting deep rooted vegetation, and/or mulching.

IMPLEMENTATION: Protective measures must be applied to all areas of disturbed, erosion-prone, unprotected ground that is not to be further disturbed in the present year. When conditions permit operations outside the Normal Operating Season, erosion control measures must be kept current with ground disturbance, to the extent that the affected area can be rapidly closed, if the weather conditions deteriorate. Areas must not be abandoned for the winter with remedial measures incomplete.

Project location and mitigative measures are developed in the NEPA process using an interdisciplinary approach. Compliance with environmental analysis controls and requirements, contract specifications, and operating plans are assured by the Contracting Officer or Engineering Representative.

REFERENCES: FSM 7721; Standard Specification 206; Timber Sale Contract Provisions B6.31, B6.6, C6.6; FAR 52.213-3, 52.236-15, and 4G-52.235-107; SWCP 15.03 and 15.04; see reference in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.10 - Control of Road Construction Excavation and Sidecast Material

OBJECTIVE: To reduce sedimentation from unconsolidated excavated and sidecast material caused by road construction, reconstruction, or maintenance.

EXPLANATION: Unconsolidated material from road construction is frequently exposed on cut and fillslopes, can be difficult to stabilize, and represents a major sediment source. The area of exposed material is often reduced when the cut and fillslopes and roadbed are constructed to the lines, grades, and dimensions shown on the drawings or designated on the ground. The Contracting Officer and/or Engineering Representative insures that construction is within

tolerances, particularly on sections of high erosion or stability hazards. In some cases layer placement and/or benching may be necessary for stabilization and to obtain the proper dimensions and fill slope ratios. End hauling and retaining structure may be necessary to prevent thin layers of consolidated material from being sidecast on steep slopes where compaction is impractical. Prior to commencing construction, reconstruction, or maintenance activities, waste areas should be located where excess material can be deposited and stabilized. If waste areas are located on steep slopes, sidecast materials should be consolidated and stabilized. Disposal of slide debris should be in areas where it can be stabilized. The purchaser may be required to remove excess material not placed according to the contract and/or restore damaged areas.

Normal erosion control such as seeding should be supplemented with special mitigation measures such as jute netting, erosion cloth, mulching, slash windrows, sediment ponds, hay bale dams, and rock gabions, when such measures are determined necessary for local conditions.

IMPLEMENTATION: Project location, selected disposal areas, and mitigative measures are developed through the NEPA process, using an interdisciplinary approach. Forest Service supervisors are responsible for insuring that In-Service projects meet design standards and project requirements. For contracted projects, compliance with specifications and operating plans is assured by the Contracting Officer and/or Engineering Representative.

REFERENCES: FSM 7720.3. 7706.11, and 7721; Standard Specification 203; SWCP 15.03, 15.05, 15.06, and 15.09; Timber Sale Contract Provisions C6.221 and C5.4; see reference in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.11 - Servicing and Refueling of Equipment

OBJECTIVE: To prevent contamination of waters from accidental spills of fuels, lubricants, bitumens, raw sewage, wash water, and other harmful materials.

EXPLANATION: During servicing or refueling, pollutants from logging or road construction equipment may enter a watercourse. This threat is minimized by selecting service and refueling areas well away from wet areas and surface watercourses and by using berms around such sites to contain spills.

IMPLEMENTATION: The Contracting Officer, Engineering Representative, or certified Sale Administrator will designate the location, size and allowable uses of service and refueling areas. They will also be aware of actions to be taken in cause of a hazardous spill, as outlined in the Forest Hazardous Substance Spill Contingency Plan (SWCP 11.07).

REFERENCES: SWCP 11.07; Timber Sale Contract Provisions B6.34, C6.341, and C6.34; Standard Specifications 204.42; FSH 2409.15, Timber Sale Administration Handbook; see reference in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.12 - Control of Construction in Riparian Areas

OBJECTIVE: To minimize the adverse effects on Riparian Areas from roads and trails.

EXPLANATION: Except at designated stream crossings, road and trail construction will avoid placing fill materials or structures in Riparian Areas that will directly affect the ecological values of the stream. Occasionally exceptions may occur. These instances should be identified by the interdisciplinary team in the NEPA process and the final location designed to create the minimum impact possible. Factors such as stream class, channel stability, sideslope

steepness, slope stability, resources dependent on these areas and standards, guidelines, and direction from Forest Plans are considered in determining the management of activities and width of Riparian Areas. Mitigation measures should be used to the optimum to insure minimum impact.

IMPLEMENTATION: Riparian Area requirements are identified during the environmental analysis by the interdisciplinary team. The road or trail project is designed to include site specific recommendations for the prevention of sedimentation and other stream damage from road/trail activities. As appropriated, monitoring and evaluation will be identified in the NEPA documentation. Forest Service supervisors are responsible for insuring that In-Service projects meet design standards and project requirements. On contracted projects, compliance with project requirements, contract specifications and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: SWCP 11.02, 14.03, and 14.06 FSM 7706.11 7706.12, 7706.14 and 7710; Timber Sale Contract Provisions B6.5, B6.61, C6.51, and C6.52; see reference in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.13 - Controlling In-Channel Excavation

OBJECTIVE: To minimize stream channel disturbances and related sediment production.

EXPLANATION: During the construction of roads and the installation of stream crossing structures, it may be necessary for construction equipment to cross, operate in, or operate near streamcourses. However, this will be allowed only at crossings designated by the Forest Service or as necessary in the construction or removal of culverts and bridges. Close coordination is needed with the Purchaser to minimize damage to the stream and aquatic resources.

Also, excavation during the installation of streamside structures should be accomplished in the following manner in order to protect water quality. Unless otherwise approved, no excavation shall be made outside of caissons, cribs, cofferdams, or sheet piling, and the natural stream bed adjacent to the structure shall not be disturbed without approval of the Engineering Representative or Contracting Officer. If any excavation or dredging is made at the site of the structure before caissons, cribs, or cofferdams are sunk in place, all such excavations will be restored to the original ground surface or the stream bed will be protected with suitable stable material. Material deposited within the stream area from foundation or other excavation shall not be discharged directly into live streams but shall be pumped to settling areas shown on the drawings or approved by the Engineering Representative or Contracting Officer. If the channel is damaged during construction, it should be restored as nearly as possible to its original configuration without causing additional damage to the channel. Excavations for stream crossings should be started early enough in the summer so that the installation is complete before winter.

IMPLEMENTATION: Project location and mitigation measures are developed by the interdisciplinary team during the NEPA process and are inserted into the contract. Compliance with the management requirements, contract specifications, and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: FAR 52.213-3, 52.236-15, and 4G-52.236-107; FSM 7721 and 2502.1; Standard Specifications 206; Timber Sale Contract Provisions C6.36, C6.52, and B6.5; EO 11988, Flood Plain Management; SWCP 11.04, 11.05, 14.03, 14.06, and 15.12; see reference in "Best Management Practice" Definition (05--2 and 3); In R-4: R-4 Technical Guide - Erosion

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PRACTICE: 15.14 - Diversion of Flows Around Construction Sites

OBJECTIVE: To minimize downstream sedimentation by insuring that all stream diversions are carefully planned.

EXPLANATION: Flow must sometimes be guided or piped around project sites. Typical examples are bridge and dam construction. Flow in streamcourses will be diverted if the Forest Service deems it necessary for the Purchaser to do the job. Such a diverted flow shall be restored to the natural streamcourse as soon as practicable and, in any event, prior to the major storm season or fish migration season. Stream channels impacted by construction activity will be restored to their natural grade, conditions, and alignment as soon as possible.

IMPLEMENTATION: The interdisciplinary team during the environmental analysis will identify where diversions are required and the project design will include mitigative measures to protect fishery values and other downstream uses. The NEPA process may require project review by other Federal, State, and/or local agencies and private parties, to insure that all factors are considered. For In-Service projects, Forest Service supervisors are responsible for implementing design standards and management requirements. On contracted projects, compliance with contract specifications and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: Timber Sale Contract Provisions B6.5, C6.3, C6.51, C6.52, and C6.6; FSM 2505.1 and 7721; FAR 52.213-3, 52.236-15, and 4G-52.236-107; FSH 7709.56b, Drainage Structures Handbook; EO 11988, Flood plain Management; SWCP 11.04, 11.05, 14.03, 14.06, 15.12, and 15.13; see reference in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.15 - Streamcrossings on Temporary Roads

OBJECTIVE: To keep temporary roads from unduly damaging streams, disturbing channels, or obstructing fish passage.

EXPLANATION: Culverts, temporary bridges, low water crossings, or fords will be required on temporary roads at all locations where it is necessary to cross streamcourses. Such facilities shall be designed and installed to provide unobstructed stream flow and fish passage, and to minimize damage to streamcourses.

The number of crossings shall be kept to the minimum needed for access. Channel crossings should generally be as perpendicular to streamcourses as possible. Streambank excavation shall be kept to the minimum needed for use of the crossings.

Crossing facilities shall be removed when the facility has served its purpose and is no longer needed. Fills associated with these facilities shall also be removed.

IMPLEMENTATION: Project location and protective measures are developed by the interdisciplinary team during the NEPA process. Those developed by the Purchaser will be reviewed and approved by the certified Sale Administrator or Contracting Officer. Forest Service supervisors are responsible for insuring that In-Service projects meet management objectives and requirements. For contracted projects, compliance with specifications and operating plans is assured by the Contracting Officer, certified Sale Administrator, or Engineering Representative.

REFERENCES: Timber Sale Contract Provisions B6.5, B6.62, B6.65, C6.3, C6.51, C6.52, C6.6, and C6.753; FSH 2409.15, Timber Sale Administration Handbook, FSM 2505.1 and 7721; FAR

4G-52.236-107; SWCP 11.04, 11.05, 14.03 14.06, 14.17, 15.12, 15.13, and 15.14; see reference in "Best Management Practice" Definition (05--2 and 3); In R-4: R-4 Technical Guide-Erosion Prevention and Control on Timber Sale Areas, May 1981.

PRACTICE: 15.16 - Bridge and Culvert Installation (Disposition of Surplus Material and Protection of Fisheries)

OBJECTIVE: To minimize sedimentation and turbidity resulting from excavation for in-channel structures.

EXPLANATION: Excavation in or near streamcourse is a common requirement for the installation of bridges, culverts, and other streamside structures such as weirs, check dams, riprapping, or fish passage structures. Surplus material should not obstruct the streamcourse including the floodplain nor the efficiency of the associated structure. Preventive measures include:

a. Diverting stream flow around project sites during construction in order to minimize erosion and downstream sedimentation.
b. Easily erodible material shall not be deposited into live streams.
c. Any material stockpiled on floodplains shall be removed before rising waters reach the stockpiled material.
d. During excavation in or near the streamcourse, it may be necessary to use suitable coffer dams, caissions, cribs or sheet piling. This will usually be the case where groundwater is contributing a significant amount of water to the immediate excavation area. If any of the aforementioned devices are used, they will be practically watertight and no excavation will be immediately outside of them. If water from subsurface strata is not significant, pumping may be used, provided the sediment from the pumped water can be disposed of where it will not re-enter the stream during high flows.
e. Water pumped from foundation excavation shall not be discharged directly into live streams, but shall be pumped into settling ponds.
f. When needed, bypass roads should be located to have the minimal disturbance on the streamcourse.
g. The construction activity in or adjacent to the stream will be limited to specific times to protect beneficial water uses (such as fisheries).

IMPLEMENTATION: Project location and detailed mitigative measures are developed in the environmental analysis and are detailed in the appropriate NEPA document using an interdisciplinary team approach. Forest Service supervisors are responsible for insuring that In-Service projects meet the design standards. For contracted projects, compliance with contract specifications and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: FAR 52.213-3, 52.236-15, and 4G-52.235-107; Standard Specifications 206 and 206A; Timber Sale Contract Provision C6.5; FSM 2505.1; see reference in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.17 - Regulation of Borrow Pits, Gravel Sources and Quarries

OBJECTIVES: To minimize sediment production from borrow pits, gravel sources, and quarries, and limit channel disturbance in those gravel sources suitable for development in floodplains.

EXPLANATION: Borrow pits, gravel sources, and quarries are often susceptible to erosion due to steep side slopes, lack of vegetation, and/or their proximity to water courses. Whenever possible, the top soil should be removed and stockpiled for use as surface dressing during the reclamation phases, prior to excavation of the site.

Drainage design for the excavation should consider temporary erosion control measures during the life of the material source and permanent drainage control measures after the site has been rehabilitated. When excavation of the site has been completed on all or part of the area, and the site will not be used again, the sides will be sloped, graded, or scaled and the general pit are smoothed and stabilized. Oversized material, if planned for future use as riprap or derrick rock, should be stockpiled. If not, it should be scattered or buried. Finer material, if available, should be spread over the bottom of the pit prior to spreading stockpiled or imported topsoil. Seeding, mulching, and/or planting should be carried out. If the site will be used again, the above requirements will be limited to those essential to resource protection between uses. Access roads to the site should also have temporary or permanent drainage design for erosion control depending on the life of the pit or the roads should be ripped, drained, blocked to traffic, and seeded, mulched, and/or planted unless other uses are planned.

Borrow pits and gravel sources located in floodplains require special attention. Material deposited in floodplains or along channel sections during storm runoff often provide excellent and inexpensive sand and gravel. Because of easy access, these deposits are often in demand. With careful planning and design, these deposits can be removed with minimal impact on water resources. Under some circumstances, sand and/or gravel removal may alter stream flow characteristics and consequently affect stream channel stability and create a new sediment source. Excavation of these deposits within stream channels should be limited to those above the waterline which is normal for the period of the excavation. If the borrow area is subject to periodic flooding, leveling, shaping, or other special drainage features shall be provided.

Excavation in flood plains should not take place below the water table unless sediment basins are built to contain or catch the resulting sediment. Sediment basins should not be subject to washouts. If excess sediment accumulates in basins, it should be excavated to clean the basin and the sediment removed to an approved site.

Wash water or waste from concrete batching or aggregate operations shall not be allowed to enter streams prior to treatment by filtration, flocculations, settling and/or other means. The potential pollution of adjacent water resources by blasting agent in quarry operations shall be addressed in the pit operation plan.

IMPLEMENTATION: Project feasibility, location, suitability, and the limits for disturbance and sediment production will be identified through the NEPA process using an interdisciplinary approach. Detailed mitigative measures are developed by the design engineer using criteria from the environmental analysis and through consultation with technical resource staffs when needed. Development of borrow pits or gravel sources in the floodplain will be coordinated with State and local agencies.

Special-use permits issued for borrow pits, gravel sources, and quarries will include the above requirements and District Rangers or their representatives are responsible for insuring compliance. Forest Service supervisors are responsible for implementing In-Service projects to design standards. For contracted projects, compliance with management requirements, specifications, and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: FSM 2511, 2502.1, 7706.11, 7706.12, 7721; FSH 7709.11, Transportation

Engineering Handbook, and FSH 7709.56, Road Preconstruction Handbook; FAR 52.236-09; Standard Specifications 203, 210, 611, 624, 625, 626, and 629; Timber Sale Contract Provision B6.31, B6.6, B6.62, B6.65, and B6.66, C5.2, C5.23, C5.4, C6.36, C6.52, C6.6, C6.601, C6.622; Water Pollution Control Act, 33 USC 466; NEPA; Montana Water Quality Act and Hardrock Act; Idaho Dredge and Placer Mining Act, Title 47, Ch. 13; SWCP 11.04, 11.05, 15.03; see reference in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.18 - Disposal of Right-of-Way and Roadside Debris

OBJECTIVE: To insure that debris generated during road construction is kept out of streams and to prevent slash and debris from subsequently obstructing channels.

EXPLANATION: As a preventive measure, counteractions debris and other newly generated slash developed along roads near streams shall be disposed of by the following means as applicable:

a. On-Site.
    (1) Windrowing (SWCP 15.03).
    (2) Scattering
    (3) Burying
    (4) Chipping
    (5) Disposal in Cutting Units
    (6) Piling and Burning
b. Removal to agreed upon locations.
c. A combination of the above.
d. Large limbs and cull logs may be bucked into manageable lengths and piled alongside the road for fuelwood.

IMPLEMENTATION: Criteria for the disposal of Right-of-Way and roadside debris are established in the environmental analysis by an interdisciplinary team. Project location and detailed mitigative measures are also developed. Forest Service supervisors are responsible for insuring that In-Service projects meet design standards. For contracted projects, compliance with plans, specifications, and operating plans is assured by the Contracting Officer, Engineering Representative, or certified Sale Administrator.

REFERENCES: Timber Sale Contract; SWCP 13.05, 14.20, and 15.03; see reference in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.19 - Streambank Protection

OBJECTIVE: To minimize sediment production from streambanks and structural abutments in natural waterways.

EXPLANATION: The stabilization of stream embankments disturbed by the construction of a water crossing or a roadway fill parallel to a streamcourse, is necessary to prevent erosion of the material during natural stream flow. To reduce sediment and channel bank degradation, it is necessary to incorporate "armoring" in the design of a structure to allow the water course to stabilize after construction. Riprap, gabion structures, and other measures are commonly used to armor stream banks and drainage ways from the erosive forces of flowing water. These measures must be sized and installed in such a way that they effectively resist erosive water

velocities. Stone used for riprap should be free from weakly structured rock, soil, organic material and materials of insufficient size, all of which are not resistant to stream flow and would only serve as sediment sources. Outlets for drainage facilities in erodible soils commonly require riprapping for energy dissipation.'

IMPLEMENTATION: Project location and detailed mitigative measures are developed through the NEPA process to meet the objectives and requirements of the management. Forest Service supervisors are responsible for implementing In-Service projects to design standards and management requirements. For contracted projects, compliance with contract specifications and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: SWCP 15.03; see references in "Best Management Practice" Definition (05--2 and 3); In R-4: R-4 Technical Guide-Erosion Prevention and Control on Timber Sale Areas, May 1981.

PRACTICE: 15.20 - Water Source Development Consistent With Water Quality Protection

OBJECTIVE: To supply water for road construction and maintenance and fire protection while maintaining water quality.

EXPLANATION: Water source development is normally needed to supply water for road construction, dust control, mixing surface, compaction, planting and for fire control requirements of the timber Purchaser. Water source development should aim toward the construction of durable, long term water sources rather than the construction of hasty, expedient developments. Permanently designed sources, such as tanks, will result in the lowest, long term impact to the affected streams.

Other considerations in the development of water sources should be:

a. Downstream flow should not be reduced so as to detrimentally affect aquatic resources, fish passage, or other uses.
b. Temporary cofferdams should be constructed of sandbags containing sand or clean gravel, or of other materials and means which will not induce sediment in the stream.
c. Overflow should go directly back into the stream.
d. All temporary facilities for gathering water will be removed prior to causing any resource damage.

IMPLEMENTATION: Certified Sale Administrators and Engineering Representatives in conjunction with technical resource staffs should evaluate streams in which water developments may be constructed. Project location and detailed mitigative measures are developed by the interdisciplinary approach during the environmental analysis. Forest Service supervisors are responsible for insuring that In-Service projects meet design standards and management requirements. For contracted projects, compliance with contract specifications and the operating plan is assured by the Contracting Officer and/or engineering Representative.

Any damage to resources caused by Purchaser's operations or fire suppression activities shall be retired by purchaser or fire suppression crews in a timely and agreed manner to the extent practical to restore and prevent further resource damage.

REFERENCES: Standard Specification 207; Timber Sale Contract Provisions; SWCP 14.03; Timber Sale Administration Handbook (FSH 2409.150; see references in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.21 - Maintenance of Roads

OBJECTIVE: To maintain all roads in a manner which provides for soil and water resource protection by minimizing rutting, failures, sidecasting, and blockage of drainage facilities.

EXPLANATION: Roads normally deteriorate because of use and weather impacts. This deterioration can be minimized through proper and timely maintenance and/or restriction of use (SWCP 11.09). All system roads will be maintained to at lease the following level: Provide the basic custodial care required to protect the road investment and to insure that damage to adjacent land and resources is held to minimum. This level of maintenance often requires an annual inspection to determine what work, if any, is needed to keep drainage functional and the road stable. This level is the normal prescription for roads that are closed to traffic. As a minimum measure, maintenance must protect drainage facilities and runoff patterns. Higher levels of maintenance may be chosen to reflect greater use or resource administrative needs. Additional maintenance measures could include resurfacing, outsloping, clearing debris from dips and cross drains, armoring of ditches, spot rocking, and drainage improvement.

Maintenance needs will be reflected in an annual road maintenance plan developed to include all roads under Forest Service control. Individual maintenance plans will be developed annually for each timber sale and for each cost share area outlining performance standards, responsibilities, and timing.

For maintenance of roads on active timber sales, the Forest Service and the Purchaser shall annually agree at the beginning of the operating season on an Annual Road Maintenance Plan outlining responsibilities and timing. If the road is subjected to commercial use, the Forest Service may collect deposits to facilitate road maintenance and to equitably assess maintenance cost of each user.

In addition to timely performance of regular maintenance, each Forest should have an emergency action plan which identifies procedures to be used during periods of high runoff to protect facilities and reduce resource damage.

IMPLEMENTATION: The work is controlled through the Forest Engineer who is responsible for the development of the annual road maintenance plan based on condition surveys. Maintenance levels are established for each road and maintenance performed in accordance with standards. On timber sales, maintenance is a Purchaser responsibility and compliance with standards is assured by the Contracting Officer, Engineering Representative, or certified Sale Administrator. On system roads outside of active timber sales, road maintenance is insured by the Engineering Representative or Contracting Officer.

REFERENCES: FSM 7730.2, 7732, and 7735; FSH 2409.15, Timber Sale Administration Handbook and FSH 7709.15, Transportation System Maintenance Handbook; Timber Sale Contract provision C5.4; SWP 11.09; see references in "Best management Practice" Definition (05--2 and 3).

PRACTICE: 15.22 - Road Surface Treatment to Prevent Loss of Materials

OBJECTIVE: To minimize the erosion of road surface materials and consequently reduce the likelihood of sediment production.

EXPLANATION: Unconsolidated road surface material is susceptible to erosion during precipitation events. Likewise, dust derived from road use may settle onto adjacent water bodies. On timber sale roads, the Purchaser shall undertake measures to prevent excessive loss of road material if the need for such action has been identified. Road surface treatments

may include: water, dust, oiling, penetration oiling, sealing aggregate surfacing, chip-sealing, or paving.

IMPLEMENTATION: Project location and detailed mitigative measures are developed by an interdisciplinary approach to meet environmental analysis criteria. Forest Service supervisors are responsible for insuring that In-Service projects meet design standards and management requirements. On contracted projects, compliance with contract specifications, and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: Timber Sale Contract; FSH 2409.15, Timber Sale Administration Handbook.

PRACTICE: 15.23 - Traffic Control During Wet Periods

OBJECTIVES: To reduce the potential for road surface disturbance during wet weather and to reduce sedimentation probability.

EXPLANATION: The unrestricted use of many National Forest roads during wet weather often results in rutting and churning of the road surfaces. Runoff from such disturbed road surfaces often carries a high sediment load. The damage/maintenance cycle for roads that are frequently used during wet periods can create a disturbed road surface and sediment source.

Roads that must be used during wet periods should have stable surface and sufficient drainage to allow such use with a minimum of resource impact. Rocking, oiling, paving, and armoring are measures that may be necessary to protect the road surface and reduce erosion potential. Roads not constructed for all weather use should be closed during the wet season. Where winter field operations are planned, roads may need to be upgraded and maintenance intensified to handle the traffic without creating excessive erosion and damage to the road surfaces.

IMPLEMENTATION: Road closures (SWCP 11.09) and traffic control measures should be implemented on all roads when damage would occur as a result of use during wet weather. Project-associated implementation procedures can be enforced by District personnel. Hauling activity can be controlled by the certified Sale Administrator within active timber sales. The decision for closure is made when the responsible Line Office determines that a particular resource or facility needs protection from use.

Detailed mitigative measures are developed by an interdisciplinary approach as necessary. Forest Service supervisors are responsible for implementing In-Service projects according to design standards. For contracted projects, compliance with plans, specifications, and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: FSM 7731.4, SWCP 11.09, 13.06, and 14.04; Timber Sale Contract provisions B5.12, B5.22, and C5.12; FSH 2409.15, Timber Sale Administration Handbook; see references in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.25 - Obliteration of Temporary Roads

OBJECTIVE: To reduce sediment generated from temporary roads by obliterating them at the completion of their intended use.

EXPLANATION: Temporary roads are constructed for a specific short-term purpose, such as, ski area development roads, logging spurs on a timber sale, and so forth. In order to prevent continued low level casual use, such roads are obliterated at the completion of their intended use. Due to short-term nature of temporary roads, continued maintenance funds can not be used for work on temporary roads. Temporary roads that are allowed to remain in use beyond

their prescribed time are subject to continued, uncorrected damage, and they can become chronic sediment sources.

Effective obliteration is generally achieved through a combination of the following measures:

a. Road effectively drained and blocked.
b. Temporary culverts and bridges removed and natural drainage on figuration re-established.
c. Road returned to resource production through revegetation (grass, browse, or trees).
d. Sideslopes reshaped and stabilized.

IMPLEMENTATION: For timber sales, temporary road closure, stabilization and removal of temporary structures are accomplished by the Timber Purchaser. Compliance with plans and the Timber Sale Contract is assured by the certified Sale Administrator. Forest Service supervisors are responsible for insuring that other temporary roads developed by the Forest Service met design standards and management requirements. Temporary road development on Forest Service lands that are allowed through special use permits and/or easements are subject to the same obliteration requirements as temporary roads on timber sales. District Rangers or their representatives are responsible for assuring the obliteration of such roads is accomplished.

REFERENCES: Timber Sale Contract provisions B6.62, B6.5, C6.6, and C6.601; FSM 2522; SWCP 11.03, 11.08, 11.09, 13.04, 14.12 - 14, 14.19, and 15.03; NFMA; FSH 2409.15, Timber Sale Administration Handbook; see references in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.26 - Surface Erosion Control at Facility Sites

OBJECTIVE: To minimize the amount of erosion and sedimentation at developed sites.

EXPLANATION: On lands developed for administrative sites, ski areas, campgrounds, parking areas, or waste disposal sites much ground is cleared of vegetation. Erosion control methods need to be implemented to stabilize the soil and to reduce the amount of stream sedimentation. Some examples of erosion control methods that could be applied: grass seen, jute mesh, tackifiers, hydromulch, paving or rocking of roads, water bars, cross drains, or retaining walls.

To control erosion and sedimentation, the natural drainage pattern of the area should not be changed. Sediment basins and sediment filters should be established to filter surface runoff. Diversion ditches and berms should be built to divert surface runoff around bare areas. Construction activities should be scheduled to avoid periods of heavy precipitation or runoff.

IMPLEMENTATION: Mitigative measures are developed by the interdisciplinary team during the NEPA process and incorporated in the project by the design engineer. Forest Service supervisors are responsible for implementing In-Service projects to design standards and management requirements. For contracted projects, compliance with plans, specifications, and operating plans is assured by the Contracting Officer or Engineering Representative.

REFERENCES: SWCP 11.08, and 11.12; FSM 2522; see references in "Best Management Practice" Definition (05--2 and 3).

PRACTICE: 15.27 - Trail Maintenance and Rehabilitation

OBJECTIVE: to minimize soil erosion and water quality problems resulting from trail erosion.

EXPLANATION: Trails often have erosion problems due to poor location, improper maintenance, and the amount or type of use. This deterioration can often be minimized by proper maintenance, restriction of certain types of use, and/or relocation.

Mainline and heavy use trails should have a functional drainage systems (waterbars, culverts at small stream crossings, corduroy, puncheon or boardwalks in boggy areas). Additional measures (lateral ditching, trail relocation, reconstruction, and so forth) may be required in heavy sue or problem areas.

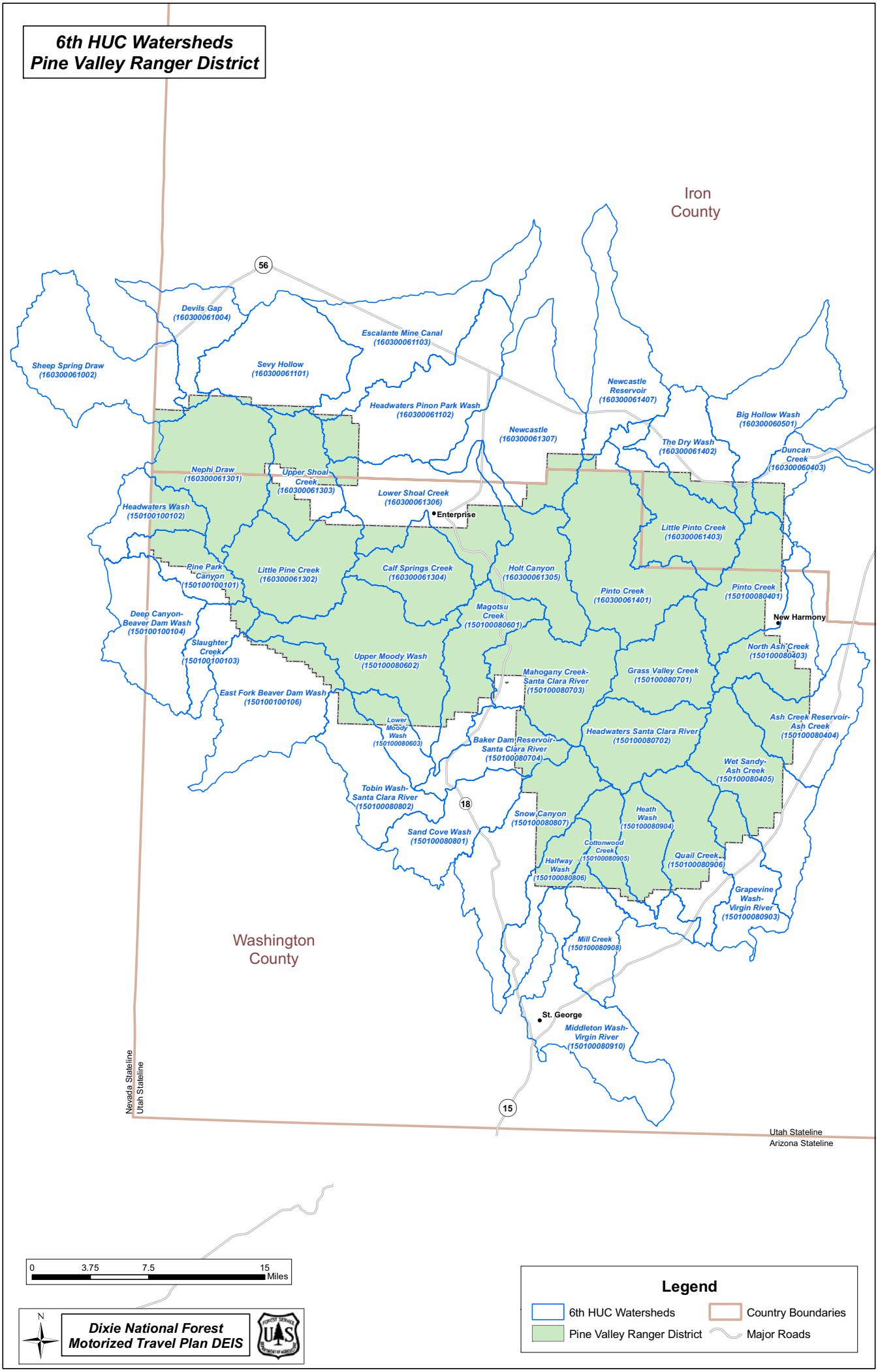
IMPLEMENTATION: Each District will develop a trail maintenance plan which determines level, timing and frequency of maintenance. The need for closures will be identified through Forest Transportation Planning. Closure is done by authority of the Forest Supervisor (SWCP 11.09).

REFERENCES: SWCP 11.03, 11.09, 15.01, 15.02, and 15.03; FSH 7709.56b, Drainage Structures Handbook; see references in "Best Management Practice" Definition (05--2 and 3).

Appendix C: Maps

Map 1: 6th HUC Watersheds – Pine Valley Ranger District
Map 2: 6th HUC Watersheds – Cedar City Ranger District
Map 3: 6th HUC Watersheds – Powell Ranger District
Map 4: 6th HUC Watersheds – Escalante/Fremont River Ranger Districts

6th HUC Watersheds
Pine Valley Ranger District



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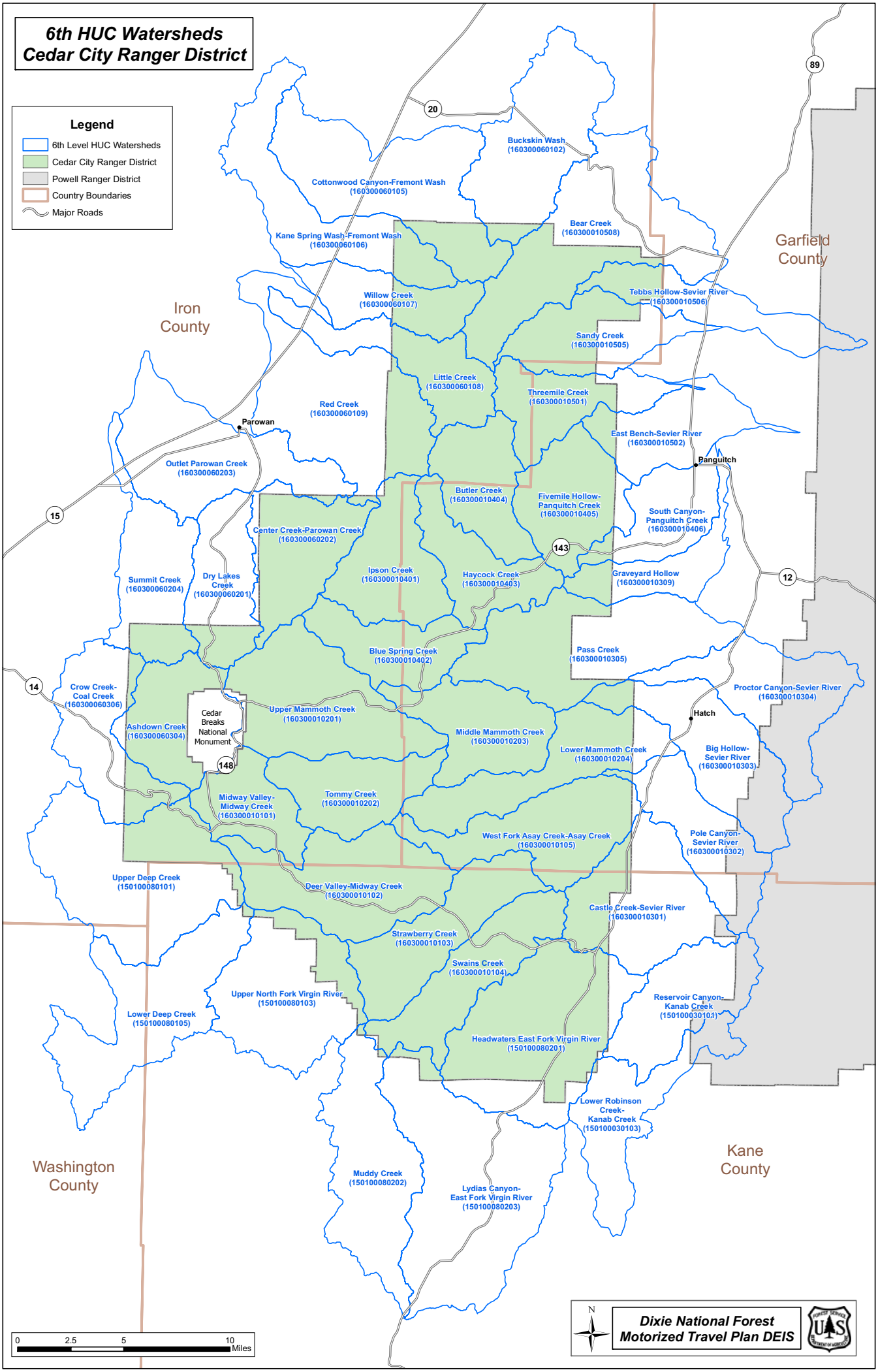
6th HUC Watersheds
Cedar City Ranger District
Legend
6th Level HUC Watersheds
Cedar City Ranger District
Powell Ranger District
Country Boundaries
Major Roads
Iron County
Garfield County
Washington County
Kane County
Parowan
Panguitch
Hatch
Cedar Breaks National Monument
20
89
15
143
12
14
148
Buckskin Wash (160300060102)
Cottonwood Canyon-Fremont Wash (160300060105)
Bear Creek (160300010508)
Kane Spring Wash-Fremont Wash (160300060106)
Willow Creek (160300060107)
Tebbs Hollow-Sevier River (160300010506)
Sandy Creek (160300010505)
Little Creek (160300060108)
Threemile Creek (160300010501)
Red Creek (160300060109)
East Bench-Sevier River (160300010502)
Outlet Parowan Creek (160300060203)
Butler Creek (160300010404)
Fivemile Hollow-Panquitch Creek (160300010405)
South Canyon-Panguitch Creek (160300010406)
Center Creek-Parowan Creek (160300060202)
Ipson Creek (160300010401)
Haycock Creek (160300010403)
Graveyard Hollow (160300010309)
Summit Creek (160300060204)
Dry Lakes Creek (160300060201)
Blue Spring Creek (160300010402)
Pass Creek (160300010305)
Crow Creek-Coal Creek (160300060306)
Proctor Canyon-Sevier River (160300010304)
Upper Mammoth Creek (160300010201)
Ashdown Creek (160300060304)
Middle Mammoth Creek (160300010203)
Lower Mammoth Creek (160300010204)
Big Hollow-Sevier River (160300010303)
Tommy Creek (160300010202)
Midway Valley-Midway Creek (160300010101)
West Fork Asay Creek-Asay Creek (160300010105)
Pole Canyon-Sevier River (160300010302)
Upper Deep Creek (150100080101)
Deer Valley-Midway Creek (160300010102)
Castle Creek-Sevier River (160300010301)
Strawberry Creek (160300010103)
Swains Creek (160300010104)
Upper North Fork Virgin River (150100080103)
Reservoir Canyon-Kanab Creek (150100030101)
Lower Deep Creek (150100080105)
Headwaters East Fork Virgin River (150100080201)
Lower Robinson Creek-Kanab Creek (150100030103)
Muddy Creek (150100080202)
Lydias Canyon-East Fork Virgin River (150100080203)
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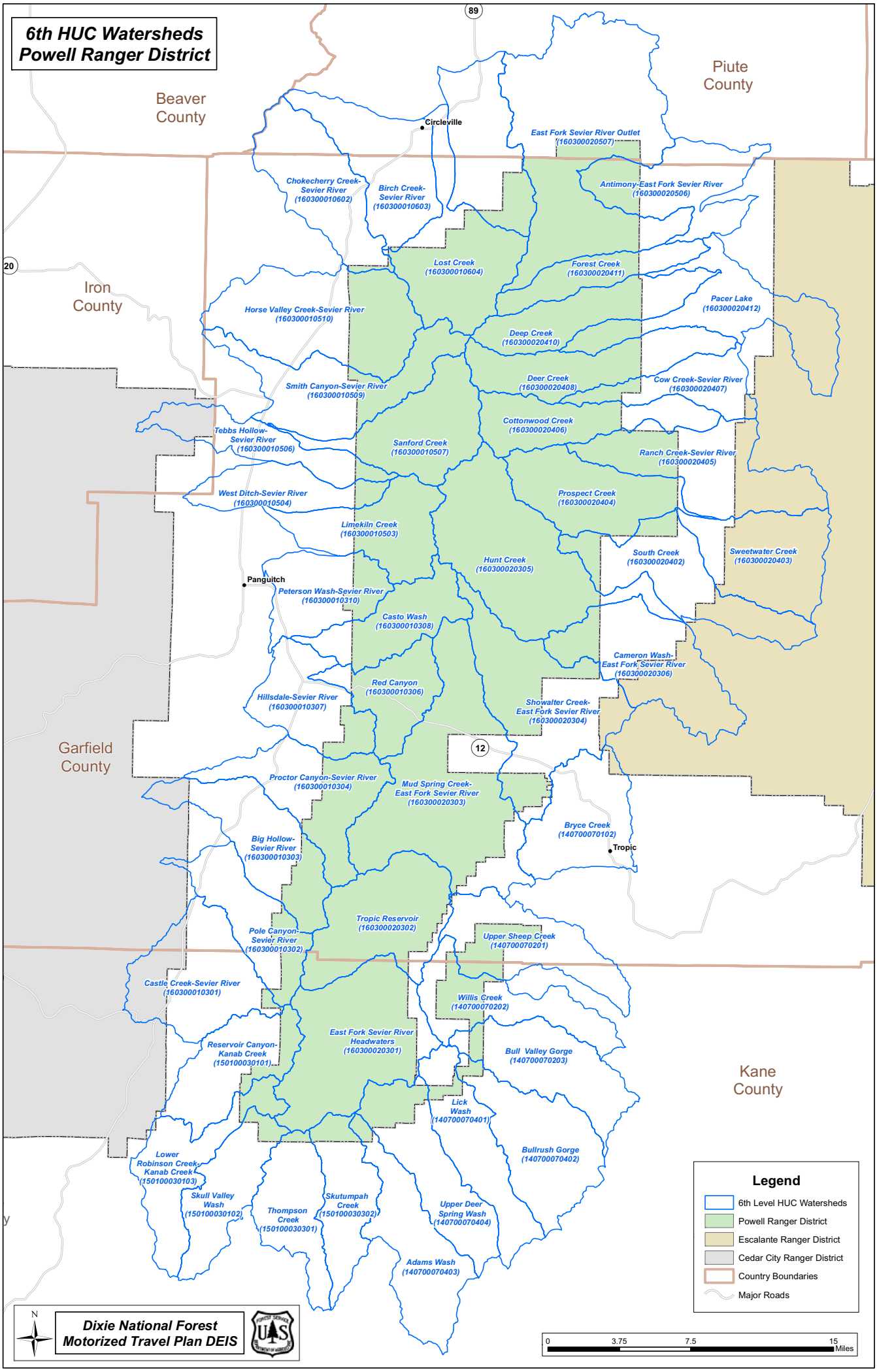
6th HUC Watersheds
Powell Ranger District
Beaver County
Piute County
Iron County
Garfield County
Kane County
Circleville
Panguitch
Tropic
89
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East Fork Sevier River Outlet (160300020507)
Antimony-East Fork Sevier River (160300020506)
Chokecherry Creek-Sevier River (160300010602)
Birch Creek-Sevier River (160300010603)
Lost Creek (160300010604)
Forest Creek (160300020411)
Pacer Lake (160300020412)
Horse Valley Creek-Sevier River (160300010510)
Deep Creek (160300020410)
Deer Creek (160300020408)
Cow Creek-Sevier River (160300020407)
Smith Canyon-Sevier River (160300010509)
Cottonwood Creek (160300020406)
Tebbs Hollow-Sevier River (160300010506)
Sanford Creek (160300010507)
Ranch Creek-Sevier River (160300020405)
West Ditch-Sevier River (160300010504)
Prospect Creek (160300020404)
Limekiln Creek (160300010503)
South Creek (160300020402)
Sweetwater Creek (160300020403)
Hunt Creek (160300020305)
Peterson Wash-Sevier River (160300010310)
Casto Wash (160300010308)
Cameron Wash-East Fork Sevier River (160300020306)
Red Canyon (160300010306)
Hillsdale-Sevier River (160300010307)
Showalter Creek-East Fork Sevier River (160300020304)
Proctor Canyon-Sevier River (160300010304)
Mud Spring Creek-East Fork Sevier River (160300020303)
Bryce Creek (140700070102)
Big Hollow-Sevier River (160300010303)
Tropic Reservoir (160300020302)
Pole Canyon-Sevier River (160300010302)
Upper Sheep Creek (140700070201)
Castle Creek-Sevier River (160300010301)
Willis Creek (140700070202)
East Fork Sevier River Headwaters (160300020301)
Reservoir Canyon-Kanab Creek (150100030101)
Bull Valley Gorge (140700070203)
Lick Wash (140700070401)
Bullrush Gorge (140700070402)
Lower Robinson Creek-Kanab Creek (150100030103)
Skull Valley Wash (150100030102)
Thompson Creek (150100030301)
Skutumpah Creek (150100030302)
Upper Deer Spring Wash (140700070404)
Adams Wash (140700070403)
Legend
6th Level HUC Watersheds
Powell Ranger District
Escalante Ranger District
Cedar City Ranger District
Country Boundaries
Major Roads
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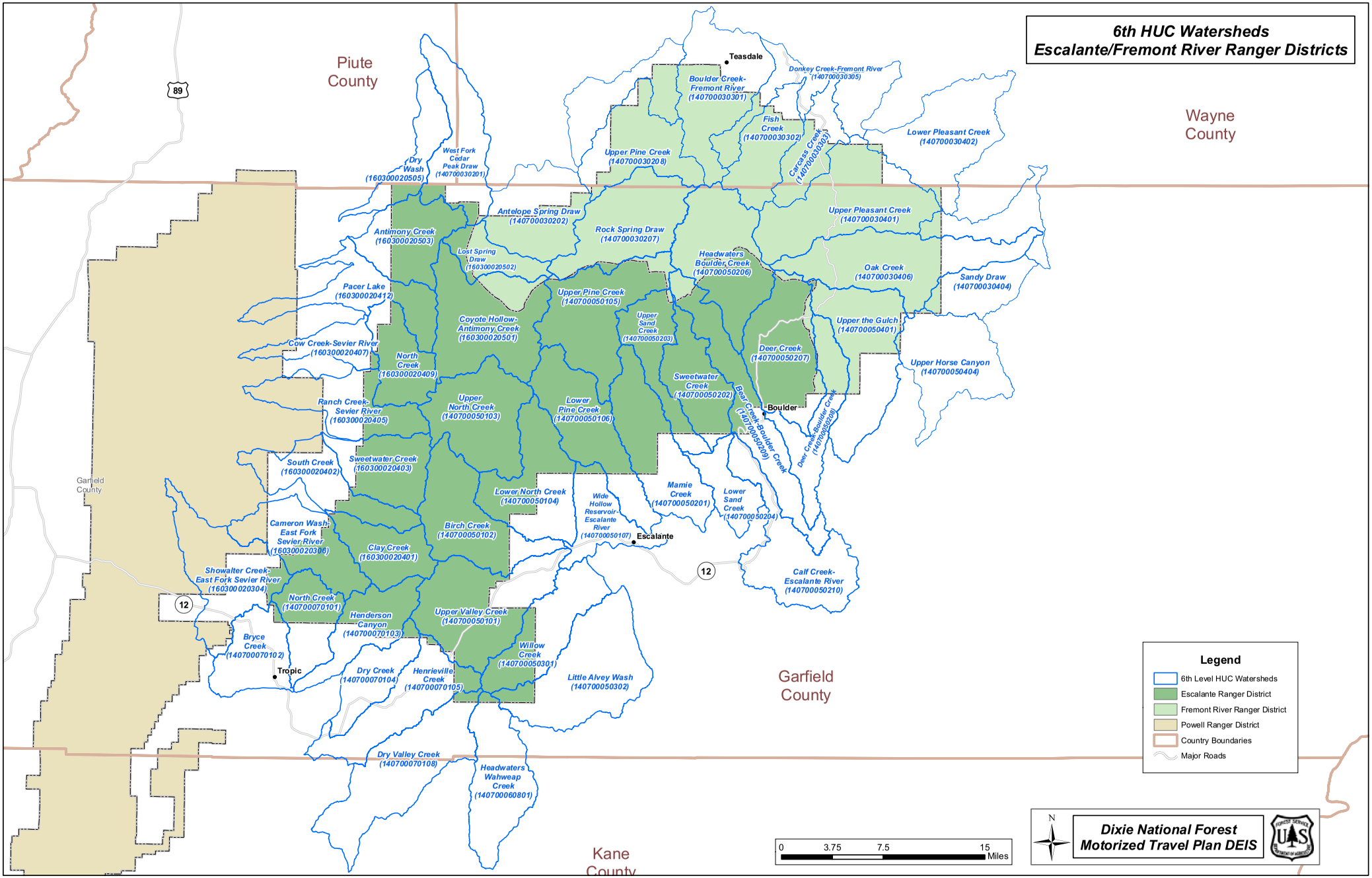
6th HUC Watersheds
Escalante/Fremont River Ranger Districts
Piute County
Wayne County
Garfield County
Kane County
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Dry Wash (160300020505)
West Fork Cedar Peak Draw (140700030201)
Antimony Creek (160300020503)
Lost Spring Draw (160300020502)
Pacer Lake (160300020412)
Cow Creek-Sevier River (160300020407)
Ranch Creek-Sevier River (160300020405)
South Creek (160300020402)
Sweetwater Creek (160300020403)
Cameron Wash-East Fork Sevier River (160300020306)
Showalter Creek-East Fork Sevier River (160300020304)
Bryce Creek (140700070102)
North Creek (140700070101)
Henderson Canyon (140700070103)
Dry Creek (140700070104)
Henrieville Creek (140700070105)
Dry Valley Creek (140700070108)
Headwaters Wahweap Creek (140700060801)
Coyote Hollow-Antimony Creek (160300020501)
North Creek (160300020409)
Upper North Creek (140700050103)
Clay Creek (160300020401)
Birch Creek (140700050102)
Upper Valley Creek (140700050101)
Willow Creek (140700050301)
Little Alvey Wash (140700050302)
Antelope Spring Draw (140700030202)
Rock Spring Draw (140700030207)
Upper Pine Creek (140700030208)
Boulder Creek-Fremont River (140700030301)
Fish Creek (140700030302)
Carcass Creek (140700030303)
Donkey Creek-Fremont River (140700030305)
Lower Pleasant Creek (140700030402)
Upper Pleasant Creek (140700030401)
Oak Creek (140700030406)
Sandy Draw (140700030404)
Upper Pine Creek (140700050105)
Upper Sand Creek (140700050203)
Headwaters Boulder Creek (140700050206)
Upper the Gulch (140700050401)
Deer Creek (140700050207)
Upper Horse Canyon (140700050404)
Sweetwater Creek (140700050202)
Bear Creek-Boulder Creek (140700050209)
Deer Creek-Boulder Creek (140700050208)
Lower Pine Creek (140700050106)
Lower North Creek (140700050104)
Wide Hollow Reservoir-Escalante River (140700050107)
Mamie Creek (140700050201)
Lower Sand Creek (140700050204)
Calf Creek-Escalante River (140700050210)
Legend
6th Level HUC Watersheds
Escalante Ranger District
Fremont River Ranger District
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Country Boundaries
Major Roads
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