March 14th, 2003

Pahvant Interagency Fuels Reduction Project

Soil Resource Management

♦ Introduction

Generally speaking … soil resources consist of a relatively thin, unconsolidated layer of mineral type horizons that are located upon the earth's crust. Some soils have distinct accumulations of humified organic matter occurring at the ground surface. The soil profile usually acquires its unique properties as a direct result of physical and chemical weathering along with the biological alteration of its geologic parent rocks; in addition, the actual process of soil formation includes a contribution by factors such as climate, topography along with the simple recognition – that, all soils continue to form over time. In some instances, such as the recent accumulation of alluvial sediments, eolian deposits or gravitation debris, the soil can actually inherit its distinct characteristics from the surrounding geologic source materials. Rapid progress in the knowledge of soil resources has developed during the past 70 years; initially, it started with the establishment of the USDA - Soil Erosion Service back in 1933. This federal agency changed its name to the Soil Conservation Service (SCS) in 1935 and later again to the Natural Resources Conservation Service (NRCS) in 1994 – but, still remains committed to its mission of being the leader in the taxonomic identification, accurate interpretation and responsible conservation of both wildland and urban soils. The NRCS accomplishes this important task by working in cooperation with land - grant universities, local units of government, state agencies and related federal agencies, such as the USDA - Forest Service and USDI - Bureau of Land Management, in order to manage healthy soils for healthy ecosystems.

The primary purpose and need of this proposed project is to reduce the risk of uncharacteristic wildfire(s) from occurring along the urban interface; secondly, by reducing the amount of hazardous fuels currently existing upon the landscape … any future burning disturbances should have a short residence time consisting of low to moderate intensity fires – meaning, the potential threats of post-fire flooding should be minimized for the local residents of eastern Millard County, Utah. Finally, a few small areas would actually benefit (indirectly) from the planned mechanical and prescribed fire treatments by 1) changing the diversity of vegetation existing on the site, 2) increasing forage production for both wildlife and domestic livestock and 3) improving the habitat for upland big game animals by changing their opportunities for thermal and hiding cover across the landscape.

♦ Legal and Administrative Framework

There are many laws, Executive Orders and regulations that reference the objective of protecting, and where appropriate, enhancing long-term soil productivity on our public lands. The specific authorities which direct the management of soil resources on National Forest System (NFS) lands list as follows:

Bankhead Jones Farm Tenant Act of 1937, as amended

Sustained Yield Forest Management Act of 1944

Multiple-Use, Sustained-Yield Act of 1960

Forest and Rangeland Renewable Resources Planning Act of 1974, as amended

National Forest Management Act of 1976

Public Rangeland Improvement Act of 1978

As an agency, the Forest Service has a responsibility to gather detailed information about the unique properties, current distribution, potential capability, existing suitability and apparent limitations of the contrasting soils occurring upon NFS lands. Secondly, we have the obligation to apply this knowledge during the revision of our Land and Resource Management Plans in order to optimize sustained yields of goods and services without impairing the productivity of the land. Our policy will be to manage both our forests and rangelands in a manner that will improve soil quality and its related health. Appropriate soil information systems will be used in support of all management activities affecting, or influenced by, the soil resource (FSM 2550.2).

Likewise, several statues provide the necessary authority for the Bureau of Land Management (BLM) to effectively manage soil resources within their designated areas of public land. Specifically, the Federal Land Policy and Management Act (FLPMA) of 1976 requires that lands administered by the Bureau be managed to protect 1) scientific, 2) environmental and 3) valuable water resources. It also requires that land use plans comply with existing pollution control laws -- including state and federal water policies or other known pollution standards. Finally, FLPMA requires compliance with all the following laws while planning or implementing any ground disturbing activities:

Soil Conservation and Domestic Allotment Act of 1935

Watershed Protection and Flood Control Act of 1954

National Environmental Policy Act of 1969

Federal Pollution Control Act of 1972, as amended

Colorado Basin Salinity Control Act of 1974

BLM / Manual 7000 (Soil, Water and Air Resources) and numerous Executive Orders provide specific policy and direction in terms of protecting fragile soils. Overall, the objective is to prevent the impairment of soil productivity due to accelerated rates of soil loss … or, by physical and chemical degradation of the resource. All management actions initiated by the Bureau must be consistent with the capabilities of the soil resource.

♦ FS - Intermountain Region / Soil Quality Standards and Guidelines (R4 / SQS)

Here in the Intermountain Region of the Forest Service, our Regional Forester has accepted the specific responsibility for developing Soil Quality Standards and Guidelines along with selecting the suitable methods for monitoring any site disturbance. The Forest Supervisors understand the important need to incorporate the current standards and guidelines into their Forest Monitoring Plans. Secondly, the District Rangers and their staffs have acted to ensure that management prescriptions are consistent with the R4 / SQS in both the planning and implementation of land management activities.

ULTIMATELY … THE OVERALL GOAL OF MANAGEMENT SHOULD BE TO CAUSE AS LITTLE SOIL RESOURCE DAMAGE AS POSSIBLE ON PUBLIC LANDS ADMINISTERED BY THE FOREST SERVICE -- NOT JUST KEEPING TREATMENT AREAS FROM SITE DISTURBANCES WHICH EXCEED THE R4 / SOIL QUALITY STANDARDS AND GUIDELINES.

The present concept about soil quality as it pertains to the management of public lands and the overall direction related to this important topic are effectively communicated to us in the following statements taken from the Forest Service Handbook (FSH 2509.18):

" Soil resource management must be consistent with the Forest Service goal of maintaining or improving long-term soil productivity (NFMA) and site hydrologic function. "

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" ... presently, at least 85 % of the total acreage occurring within an activity area must have soil properties that remain in satisfactory condition. Plans for projects where treatments are expected to cause resource damage, exceeding the maximum thresholds listed under the R4 / Soil Quality Standards and Guidelines, must include provisions for mitigation of the ground disturbance. "

In this particular instance, the mechanical treatments being proposed by the FS would include the thinning of invading pinyon – juniper stands on fan terraces and surrounding foothills along with the possibility of constructing hand lines to contain the flames associated with our prescribed fire treatments. All of these projects would need to meet the existing guidelines for 1) displacement, 2) puddling and 3) compaction on NFS lands. Regardless of whether the planned ignitions are started by drip torches, aerial torches or plastic spheres from a dispenser mounted in a helicopter … all prescribed fire treatments on NFS lands need to follow the current guidelines for 1) severely burned sites, 2) insufficient ground cover and 3) maintaining coarse woody debris at the ground surface.

In order to accomplish the standards and guidelines related to the soil quality direction contained in our updated Soil Management Handbook, resource specialists from the Forest Service will be conducting both pre-burn and post-burn types of monitoring activities. This action includes collecting soil samples prior to initiating prescribed fire treatments in order to calculate existing moisture conditions occurring upon different aspects and within the different vegetative communities of a particular project area; the specific purpose of this sampling effort is to identify relatively dry sites – because, these areas are the most susceptible locations to water-repellent type conditions following a moderate to high intensity burn. Implementation monitoring will continue to be conducted by the people responsible for project administration. The objective of this monitoring activity is to collect data which either supports the continued use of existing mitigation measures or suggests changes in land management prescriptions in order to protect long-term soil productivity and prevent water use impairment by either sedimentation or nutrient pollution. Up to this point, our post-burn studies have consisted of effectiveness monitoring with qualitative evaluations used to measure how adequately applied conservation practices have limited detrimental change in wildland soil properties. Eventually, validation monitoring will be addressed and managed as a function of extended research efforts; permanent study plots will be used to verify the direct relationship between applied management practices and the remaining site productivity. Validation monitoring will answer the question *" ... are the existing standards and guidelines appropriate for meeting our Forest Plan objectives with respect to maintaining long-term soil productivity here in south – central Utah? "*

The Soil Quality Monitoring supplement to the R4 / Soil Management Handbook was initially approved by the Regional Forester (Mr. Jack Blackwell) during November of 1995; and, it was recently amended and re-approved by the Regional Forester (Mr. Jack Troyer) in January of 2003.

♦ BLM - Critical Erosion Areas / Monitoring

The BLM identifies and maps Critical Erosion Areas during the process of conducting its watershed inventories. Many of these fragile areas experience surface runoff conditions that remove valuable topsoil horizons and actually truncate the landscape. These sites require special rehabilitation measures in order to control accelerated rates of soil erosion. Specifically, the erosion treatments are designed to limit the amount non-point pollution going into our streams and water bodies as sedimentation.

The land management practices used by the BLM are designed to meet particular resource objectives such as vegetative manipulation, habitat improvement and watershed restoration to name a few examples. Generally speaking … most treatments enhance vegetative cover or improve existing watershed conditions. The overall goal of these actions is to feature the least amount of surface disturbance possible. Some of the work related to improving soil conditions includes 1) upgrading or maintaining existing road surfaces, 2) rehabilitating disturbed landscapes (i.e. wildfire sites) by applying emergency stabilization measures, 3) constructing earth check-dams, 4) building erosion control structures and 5) applying broadcast seeding treatments to reduce critical erosion hazards.

Activity plans are written for specific areas having critical erosion problems or other concerns (i.e. salinity, alkali conditions etc.) where more attention is needed than is provided through normal funding and regular program planning. It should be noted, there are no Critical Erosion Areas located within the perimeter of the analysis area.

If any of the fuels reduction projects being proposed by the federal government are actually implemented on BLM lands … the Bureau will be completing their standard 3 and 5 year monitoring studies to evaluate the impacts of the treatments upon 1) the soil resource, 2) site hydrologic function as it relates to water quality issues and 3) the post-burn plant communities in terms of subsequently establishing either exotic species or noxious weeds on the site.

♦ Soil Survey Projects / Geology Maps / Vegetative Communities

All of the soil survey projects initiated by the Forest Service and Bureau of Land Management within the state of Utah have been conducted according to the exact specifications listed in a Memorandum of Understanding (MOU) approved by both the NRCS and Utah Agricultural Experiment Station. Each survey project that has been completed on public lands administered by these government agencies was managed to achieve all the technical standards of the National Cooperative Soil Survey (NCSS) program. The specific direction for the NCSS as it relates to policy, responsibility, procedures, guidelines and definitions has been outlined by the NRCS in the following list of USDA publications:

Keys to Soil Taxonomy – 2nd Edition, 1999 / AH 436

National Soil Survey Handbook, 1996 / Title 430

Soil Survey Manual, 1993 / AH 18

The NCSS program is a collaborative partnership of government agencies, academic institutions and now includes international committees that work together to investigate, inventory, document, classify and interpret soil resources for the specific purpose of disseminating, publishing and promoting the use of soil survey information within the United States and its trusted territories.

The landscapes being considered for treatments under our proposed Pahvant Interagency Fuels Reduction Project are located within an area covered by the following two soil survey reports:

Eastern Millard County, Utah, Soil Survey Area # 618, unpublished

Tushar - Pahvant - Canyon, Soil Survey Area # 649, unpublished

Both survey reports contain all of the necessary information to interpret contrasting soils with respect to making recommendations about hazardous fuels reductions using mechanical or prescribed fire treatments. When a Soil Scientist conducts a land resource investigation ... the process of making the final survey maps

actually includes tracking a history of the project area with respect to its stages of soil development and various vegetative responses under a known set of climatic conditions over a period of time. After making numerous field observations ... a Soil Scientist will have gathered enough information about the survey area in order to make RESPONSIBLE PREDICTIONS about soil behavior -- in terms of how the site will respond following a set of applied management treatments.

Back in 1980, Dr. Lehi F. Hintze of the Utah Geological and Mineral Survey (UGMS) developed a detailed map showing all the known geologic formations and surficial deposits occurring within the State of Utah; this information has been available and used by different resource specialists during the evaluation of this proposed project. In addition to the hard copy map, most information related to geology for the State of Utah can be acquired as an ArcInfo export file from the State Geographic Information Database (SGID) by contacting the Automated Geographic Reference Center (AGRC) at their office in Salt Lake City, Utah. These different themes are usually displayed at 1:250,000 scale or ¼ ” = 1 mile on the map.

In February of 1998, the Fishlake National Forest used its soil survey information to generate a GIS display of Existing Vegetative Communities for all 4 Ranger Districts on our 1.4 million acre Forest. Basically … we went back and reviewed all of the supporting documentation collected for both the Tushar-Pahvant-Canyon and Fremont-Monroe-Salina project areas; since the distribution of soils can be repetitive across the landscape, we were able to prepare a map based on the soil properties and site characteristics shown on our field descriptions. In January of 2003, I contacted the NRCS and acquired the digital files and map unit descriptions for both the Eastern Millard County, Utah and Beaver – Cover Fort, Utah / Soil Survey Projects. Following the same protocol, we were able to prepare another vegetation map for the BLM, State of Utah and private lands located within and adjacent to the perimeter of the proposed project area. The 2 maps were subsequently edge-matched together and now exist as 1 coverage in our Fishlake National Forest / GIS library.

(Note) -- The Project File will include 2 documents which list all of the soil symbols in both NRCS survey areas and how each symbol was labeled with respect to identifying its dominant vegetative community.

♦ Affected Environment

Most of the wildland soils occurring within the perimeter of the analysis area were formed in alluvium, colluvium and residuum derived from mixed sedimentary or metamorphic type parent materials. In a few specific instances, the soil resources were actually formed from intermediate igneous rocks such as latite and andesite, in deposits of the secondary mineral dolomite or from lacustrine sediments related to the historic distribution of Lake Bonneville. Some isolated areas consist of miscellaneous land types with rock outcrops, talus slopes or riverwash materials – typically, these areas (usually) support less than 10 % vegetative cover.

Contrasting land resources have been identified, mapped and documented within desert, semidesert, upland, mountain, high mountain and subalpine types of ecological sites. According to the Utah State University / Climatological Center, during the past 30 years, the mean annual precipitation for the analysis area has varied from a low of approximately 13 " / year just south of Holden, Utah to over 36 " / year near White Pine Peak -- located southeast of Fillmore, Utah. The State of Utah / Automated Geographic Reference Center has developed an information database using 5 ' contour intervals which indicate elevations vary from a low of approximately 4,760 ' on the alluvial plains surrounding the Pahvant Range to over 10,200 ' along the high peaks within this Subsection. The terrain ranges from 0 to 2 % slopes on nearly level alluvial fans up to 90 % slopes on very steep canyon walls and ridgetop areas. Soils have been sampled and studied within wetlands, riparian zones and on surrounding upland hillsides under the following types of vegetative communities:

Wyoming Big sagebrush subalpine

mountain big sagebrush	spruce / fir
black & low sagebrush	seral aspen
basin big sagebrush	stable aspen
mountain brush / Gambel oak	mixed conifer
pinyon - juniper	perennial grasses
riparian / aquatic	semidesert & desert shrub
tall forb	black greasewood / four-wing saltbush

This survey information has been manuscripted, digitized and entered into our Fishlake / GIS database; subsequently, it has been refined using the ArcInfo (7.2.1) and ArcView (3.2) software packages and plotted over 1:24,000 scale continuous tone orthophotographs for project assessment, planning, implementation and monitoring purposes.

Approximately 287,482 acres of land resources and 13 acres of streams or water developments are included inside the perimeter of the analysis area; the ownership of this ground has the BLM with 10,088 acres or 3.5 %, the FS administers 181,770 acres at 63.2 %, the State of Utah – including its Wildlife Reserves manages 16,618 acres which equals 5.7 % and the remaining 79,006 acres are privately owned and scattered within the remaining 27.6 % of the area. While the State of Utah had representatives sitting at the table during the opening discussions on this proposed fuels reduction project … they have not identified any specific areas for treatment at this time. The BLM and FS have decided to consider 7 units for mechanical thinning, broadcast seeding and prescribed fire treatments within the analysis area. All of the proposed treatment units currently support Gambel oak, pinyon – juniper, mountain big sagebrush and Wyoming big sagebrush with perennial and annual grasses. The following table displays all of the proposed treatment areas and acreage totals by land ownership:

Pahvant Interagency Fuels Reduction Project – Table # 1

Proposed Treatment Units – Land Ownership Status

Unit Names	Acreage - USFS	Acreage - BLM
Grabalt	914	1,438
Wild Goose	1,578	-0-
Holden Springs	-0-	1,943
Pioneer	1,149	454
Frampton Heights	-0-	490
Horse Hollow	1,434	-0-
Meadow	2,195	2,734
Totals	7,270	7,059

(Note) -- Included with this brief specialist report are a series of Geographic Information System (GIS) maps and attachments intended to provide the reader with additional clarification about the soils, geology and existing vegetation occurring within the proposed treatment units. Please refer to the soil survey and pre-burn vegetation maps attached to the document at this time. It should be noted, that more detailed information on these different themes is currently available from the Fishlake National Forest for the entire analysis area.

Overall, a total of 14,329 acres are being evaluated for fuels reduction treatments on public lands occurring in close proximity to the wildland urban interface. The proposal as it now stands would include approximately 3,182 to 6,378 acres of mechanical thinning, somewhere between 5,731 and 11,463 acres of prescribed fire treatments and up to 11,463 acres of broadcast seeding on the disturbed landscapes. The publication symbols and mapping unit names for all the contrasting soils identified within the proposed treatment units are listed in the following table:

Pahvant Interagency Fuels Reduction Project – Table # 2

Soil Survey Legend for the Proposed Treatment Units

Publication Symbols	Mapping Unit Names
8	Bandag loam, 2 to 5 percent slopes
19	Borvant very gravelly loam, 15 to 40 percent slopes
20	Borvant – Jardal complex, 15 to 40 percent slopes
22	Borvant – Pavant, 2 to 15 percent slopes
25	Calita – Erda complex, 0 to 2 percent slopes
26	Calita – Erda complex, 2 to 8 percent slopes
27	Cessna loam, 0 to 5 percent slopes
31	Collard gravelly loam, 2 to 5 percent slopes
33	Current Spring gravelly loam, 30 to 50 percent slopes
34	Current Spring – Maple Hollow complex, 5 to 15 percent slopes
35	Current Spring – Maple Hollow complex, 15 to 30 percent slopes
37	Donnardo very stony loam, 2 to 15 percent slopes
41	Erda silt loam, 2 to 5 percent slopes
66	Jardal – Donnardo complex, 2 to 15 percent slopes
71	Kapod – Collard complex, 2 to 15 percent slopes
86	Lodar – Kidman complex, 15 to 50 percent slopes
88	Lonjon stony loam, 30 to 60 percent slopes
119	Brinkert – Hourglass families association, 5 to 30 percent slopes
121	Broad – Dagan Families association, 8 to 30 percent slopes
155	Forsey – Forsey / Moderately Deep Phase – Agassiz families complex, 30 to 70 percent slopes

Publication Symbols	Mapping Unit Names
156	Forsey – Genoa families – Rock Outcrop complex, 30 to 80 percent slopes
160	Genoa – Irigul – Forsey families association, 30 to 70 percent slopes
170	Holmes – Pernty – Demner families association, 30 to 70 percent slopes
182	Pernty – Agassiz families – Rock Outcrop association, 40 to 80 percent slopes
183	Pernty family – Rock Outcrop complex, 30 to 70 percent slopes
188	Red Butte – Kanarra – Reywat families association, 5 to 40 percent slopes
201	Spager family, 5 to 30 percent slopes
221	Yeates Hollow – Ostler families complex, 5 to 25 percent slopes
222	Yeates Hollow – Yeates Hollow / Moderately Deep Phase families complex, 15 to 40 percent slopes

(Note) -- Publication symbols 8 through 88 were listed in the (draft) Soil Survey Report for Eastern Millard County, Utah which is being prepared by the USDA – Natural Resources Conservation Service for the USDI – Bureau of Land Management and residents of south – central Utah.

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(Note) -- Publication symbols 119 through 222 are found in the (draft) Soil Survey Report for the Tushar-Pahvant-Canyon Area of the Fishlake National Forest which is being prepared by the USDA – Forest Service.

Pahvant Interagency Fuels Reduction Project – Table # 3

Classification of Soils using the 1st Edition of Soil Taxonomy

Soil Names	Taxonomic Classifications
Agassiz	Loamy-skeletal, mixed, frigid Lithic Haploxerolls
Bandag	Fine-loamy, mixed (calcareous), mesic Xeric Torriorthents

Soil Names	Taxonomic Classifications
Borvant	Loamy-skeletal, carbonatic, mesic, shallow Petrocalcic Palexerolls
Brinkert	Fine, montmorillonitic Argic Cryoborolls
Broad	Loamy-skeletal, mixed, frigid Calcic Argixerolls
Calita	Fine-loamy, mixed, mesic Typic Calcixerolls
Cessna	Fine-loamy, mixed (calcareous), mesic Typic Xerofluvents
Collard	Loamy-skeletal, mixed, mesic Typic Argixerolls
Current Spring	Clayey-skeletal, montmorillonitic, mesic Typic Argixerolls
Dagan	Loamy-skeletal, mixed, frigid Calcic Haploxerolls
Demner	Loamy-skeletal, mixed, frigid Pachic Argixerolls
Donnardo	Loamy-skeletal, mixed, mesic Typic Calcixerolls
Erda	Fine-silty, mixed, mesic Typic Calcixerolls
Forsey	Loamy-skeletal, mixed Argic Cryoborolls
Genoa	Loamy-skeletal, mixed Argic Lithic Cryoborolls
Holmes	Loamy-skeletal, mixed, frigid Typic Argixerolls
Hourglass	Fine-loamy, mixed Argic Cryoborolls
Irigul	Loamy-skeletal, mixed Lithic Cryoborolls
Jardal	Loamy-skeletal, carbonatic, mesic Petrocalcic Palexerolls
Kanarra	Fine, montmorillonitic mesic Aridic Calcic Argixerolls
Kapod	Loamy-skeletal, mixed, mesic Calcic Argixerolls
Kidman	Coarse-loamy, mixed, mesic Calcic Haploxerolls
Lodar	Loamy-skeletal, carbonatic, mesic Lithic Calcixerolls
Lonjon	Loamy-skeletal, carbonatic, frigid Typic Calcixerolls
Maple Hollow	Fine, montmorillonitic, mesic Typic Argixerolls
Namon	Loamy-skeletal, mixed Mollic Cryoboralfs
Ostler	Fine, montmorillonitic, frigid Typic Argixerolls
Pavant	Loamy, mixed, mesic, shallow Petrocalcic Palexerolls
Pernty	Loamy-skeletal, mixed, frigid Lithic Argixerolls
Red Butte	Loamy-skeletal, mixed, mesic Aridic Calcic Argixerolls
Reywat	Loamy-skeletal, mixed, mesic Lithic Argixerolls
Spager	Loamy-skeletal, carbonatic, mesic shallow Xerollic Paleorthids
Whiteman	Clayey-skeletal, montmorillonitic Argic Cryoborolls
Yeates Hollow	Clayey-skeletal, montmorillonitic, frigid Typic Argixerolls

(Note) – Both survey areas were correlated by the SCS prior to the distribution of their current Taxonomy book.

♦ Environmental Consequences -- Fire on the Landscape

Energy in the form of heat is generated during the ignition of a fire; subsequently, this heat release is transferred into the surrounding environment and continues to intensify with the combustion of fuels during flaming. Soil is an important component of the ecosystem that is affected by the transfer of heat into the duff layer and underlying mineral horizons. The actual impacts of fire upon the soil resource are quite variable and remain highly dependent upon fire intensity, fire residence times, presence or absence of organic horizons, ambient moisture occurring within the ground and type of fuels being burned. Some of the important factors affecting fire intensities are microrelief, wind speed and direction, soil and fuel moisture content, both the kind and spatial distribution of fuels -- especially duff, surface litter and accumulations of coarse woody debris.

" Fire is a tool that has been used to manage a wide range of natural ecosystems. As such, it has affected soil, water, vegetation, riparian zones, wetlands, air and the cultural components of these related ecosystems. "
(Debano, Neary and Ffolliott, 1998)

As the general relationship between fire and its function on ecosystem processes was studied and better understood ... prescribed fire was finally utilized, and has since become re-introduced, as a disturbance event that will assist federal land managers with moving forest, shrubland and grassland ecosystems along towards the concept of properly functioning condition. The specific purpose and need of using prescribed fire in ecosystem restoration type projects has been to move our public lands back towards historic and sustainable conditions of ecological structure and function. Now that our resource managers and decision-makers understand the need to evaluate the effects of fire in relation to the many components of the landscape; the Forest Service and Bureau of Land Management will be able to achieve continued success in the arena of 1) hazardous fuels reduction and 2) ecosystem management by balancing the overall benefits of using fire as a tool versus the costs associated with implementing this type of management action.

Soils are considered to be RENEWABLE RESOURCES when the site includes favorable topsoil properties, subsoil horizons or exposed substratum layers that can be renewed by tillage, fertilizer amendments, applications of organic matter and other land management practices. However, the soil resource is viewed as a NON-RENEWABLE type of site when its acquired properties and inherited characteristics simply can't be sustained or improved by economical means using soil & water conservation practices or applied mitigation measures. An example of a non-renewable soil would be a shallow site having less than 20 inches of soil material occurring directly over a bedrock contact or an indurated hardpan layer. Prescribed fire treatments should be designed to <u>minimize</u> impacts on fragile soils located upon shallow or highly erodible sites.

Fire-related changes produce a wide array of impacts to the soil resource and modifications to the surrounding environment. The initial response of the biological components is quite rapid due to the consumption of existing vegetative communities and possible combustion of both surface litter and coarse woody debris at the ground surface. Large populations of soil microorganisms, roots with mycorrhizae, invertebrates and burrowing animals can be destroyed during a burn. The availability of macronutrients and micronutrients, along with the process of cycling these reserves, are directly linked with the intensity and residence time of a fire. In some instances, the burned-area will actually benefit from the fire event by increasing the overall availability of both nitrogen and phosphorus along with the cations of calcium, magnesium and potassium and may include minor amounts of the element sulfur; sites impacted by severe burns will exhibit the destruction of humus -- resulting in a reduction of their cation exchange capacity and overall buffering capacity of the organic component in the soil. In addition, the combustion of organic matter by fire destroys soil structure along with reducing bulk density and overall porosity -- which limits infiltration and increases surface runoff and accelerated erosion. Hydrophobic or water-repellent type conditions may persist at the ground surface and within the topsoil horizon for a period of 1 to 5 years after the fire.

Low to Moderate Fire Intensity Zones

Generally speaking ... many areas affected by low to moderate intensity fires will actually benefit from the burning activity by increased nutrient availability, increased forage production for both livestock and upland big game animals along with changing the amount and diversity of vegetation existing at the site. Soil productivity is still maintained in these specific situations; secondly, there is no threat to human life and property, no alteration of site hydrologic function or deterioration of water quality following most low to moderate type burns occurring on nearly level to moderately steep terrain. While the landscape may exhibit a charred looking appearance, the underlying mineral soil is not visibly altered by the burn. Lethal temperatures for soil organisms only occur down to the depth of about 1 to 2 inches in the ground. Sufficient ground cover in the form of vegetation, litter and rock fragments - larger than ¾ " along with perennial canopy cover within 3 ' of the ground remains in place to protect the soil surface from accelerated rates of erosion.

Accelerated Rates of Erosion for Fire Disturbances

→ This erosion model was taken from the R1 / R4 - Guide for Predicting Sediment Yields from Forested Watersheds.

→ **BASIC EROSION RATES (BER)** for fire disturbances were originally listed in units of tons/mile²/year … these figures were subsequently divided by 640 in order to calculate erosion in tons/acre/year for this document. The BERs for prescribed fire treatments are listed as follows:

Pahvant Interagency Fuels Reduction Project – Table # 4

Basic Erosion Rates for Fire Disturbances

Year Number	Prescribed Fire (tons/mile²/year)	Prescribed Fire (tons/acre/year)
1	550	.86
2	120	.19
3	25	.04
4	5	.008
5	-0-	-0-

→ The **GEOLOGIC EROSION FACTOR (GEF)** for soft fluvial sediments = 1.05 (i.e. soils derived from mixed alluvium) … for weakly consolidated sedimentary rocks, it's = 0.66 (i.e. soils derived from sandstone and shale formations) … the corresponding geologic factor for hard sedimentary rocks – including secondary mineral deposits = 0.52 (i.e. soils derived from conglomerate, limestone or dolomite) while the **GEF** for all basic igneous rocks = 0.42 (i.e. latite, andesite etc.)

→ The **LAND UNIT SLOPE FACTOR** (**LUSF**) is included with the R1 / R4 Erosion Model for site disturbances related to prescribed fire activities; in this document, the slope factor was set-up in increments of ten percent slopes (i.e. 10 %, 20 %, 30 % etc.) with 10 % = 0.543, 20 % = 0.633, 30 % = 0.800, 40 % = 0.959, 50 % = 1.19 and 60 % = 1.48

→ The **FIRE INTENSITY FACTOR** (**FIF**) was added to acknowledge the size of the burned-area, its potential for water repellent conditions, remaining amounts of protective ground cover, potential flood source sites etc.; the factor for low intensity burns is 0.2; the factor for moderate intensity burns = 0.5 and the factor for high intensity fires = 1.0; this erosion model runs for a period of approximately 4 years

The natural erosion rate for most of the wildland soils located within the analysis area ranges from approximately 0.2 up to 0.6 tons/acre/year. The calculation used to estimate erosion losses after a natural or management-induced fire disturbance is as follows:

(BER) x (GEF) x (LUSF) x (FIF) = Accelerated Erosion Rates in Tons / Acre / Year

Pahvant Interagency Fuels Reduction Project – Table # 5

Soil Erosion Rates for MODERATE Intensity Burns

(This table approximates soil erosion on strongly sloping terrain having 10 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
mixed alluvium	.245	.053	.011	.002
sandstone or shale	.154	.033	.007	.001
latite or andesite	.098	.021	.004	***
limestone, dolomite or conglomerate	.123	.026	.005	.001

(This table approximates soil erosion on moderately steep terrain having 20 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
mixed alluvium	.285	.062	.013	.002
sandstone or shale	.179	.039	.008	.001
latite or andesite	.113	.024	.005	***
limestone, dolomite or conglomerate	.141	.030	.006	.001

(This table approximates soil erosion on steep terrain having 30 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
Mixed alluvium	.361	.078	.016	.003
sandstone or shale	.227	.049	.010	.002
latite or andesite	.144	.031	.006	.001
limestone, dolomite or conglomerate	.178	.038	.008	.001

(This table approximates soil erosion on steep to very steep terrain having 40 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
Mixed alluvium	***	***	***	***
sandstone or shale	.269	.058	.012	.002
latite or andesite	.171	.037	.007	.001
limestone, dolomite or conglomerate	.212	.046	.009	.001

(This table approximates soil erosion on very steep terrain having 50 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
Mixed alluvium	***	***	***	***
sandstone or shale	.337	.073	.015	.003
latite or andesite	.214	.046	.009	.001
limestone, dolomite or conglomerate	.266	.058	.012	.002

(This table approximates soil erosion on very steep terrain having 60 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
mixed alluvium	***	***	***	***
sandstone or shale	.420	.091	.019	.003
latite or andesite	.267	.058	.012	.002
limestone, dolomite or conglomerate	.331	.072	.015	.003

(Note) – There are no areas within the seven proposed treatment units where mixed alluvium actually occurs on fan terraces measuring > 30 % slopes.

What these tables show is … in most cases, the potential for accelerated erosion, with respect to soil movement exceeding the maximum thresholds established by the R4 / Soil Quality Standards and Guidelines, is really not a significant factor when low to moderate intensity burns are applied to the landscape. Secondly, most areas of medium textured -- moderately deep, deep and very deep soils that are impacted by fires, usually don't have many problems associated with surface flow in the form of sheet erosion or channelized flows consisting of rills and gullies.

High Fire Intensity Zones / Severely Burned Sites

A zone of high fire intensity will have detrimental impacts to the soil resource and in many instances … should be designated as a potential flood source area. Under these particular circumstances, unwanted wildland fire, wildland fire use and prescribed fire will adversely affect long-term site productivity by impacting the physical, chemical and biological properties of the soil resource. The physical effects of fire upon the soil resource will include the loss of structure, reduction in porosity and alteration of color. Hydrophobic or water repellent conditions will exist at the ground surface and may occur within the upper 6 inches of the topsoil horizon -- resulting in accelerated rates of soil erosion. The 5 factors having the most pronounced affect on the temporary development of water repellent conditions within the ground include the following soil properties and site characteristics:

Texture of the topsoil

Intensity and duration of the burn

Water content in the soil at the time of the fire event

Type and amount of organic matter originally present at the burned-area site

Temperature gradients developed within the upper mineral soil -- especially between 176 and 204° C

The consumption of organic matter at the ground surface affects the chemical properties related to nutrient availability, soil pH and cation exchange capacity. Substantial amounts of nitrogen, phosphorous and sulfur can be lost to the atmosphere by volatilization during the combustion of large woody debris, surface litter and

humified organic matter. Cations such as calcium, magnesium and potassium can be lost from the site if ash is removed by wind or water erosion. The biological response to fire includes a reduction in the populations of soil microbes -- needed for nutrient cycling, along with the destruction of cryptogamic crusts in both arid and semiarid rangeland areas. Ground cover may be insufficient to protect these fire-damaged areas from the dynamic splash associated with raindrop impact.

The current guideline for severely burned sites applies to both prescribed fire treatments and natural fires that are managed for either 1) resource benefiting function or 2) eliminating hazardous fuel accumulations (R4 / SQS, 01/2003). Burned-areas are identified by qualitative ratings associated with fire severity (i.e. unburned, low, moderate or high) and overall impacts to the soil resource. As expected, a severely burned site is generally a soil occurring within a high fire severity area as defined by the Forest Service / Burned-Area Emergency Rehabilitation Handbook (FSH 2509.13) and by Dr. Leonard DeBano et al. in his publication *" Fire's Effects on Ecosystems. "* Losses in soil humus, structural changes, the development of hydrophobic conditions and site sterilization are all indicators of severely burned sites.

If this Interagency project becomes authorized and implemented … the FS and BLM need to conduct implementation and effectiveness monitoring within all the different activity areas inside the project perimeter. Both agencies should identify high fire severity areas for each of the different vegetative communities present on the landscape. An example of high fire severity would be 1) when deep ground char occurs, 2) when the duff layer is completely consumed or 3) when the top of the mineral soil is visibly reddish or orange in color. The char layer can extend to a depth of 4 inches or more into the ground. Soil textures within the surface layer can be changed due to extreme heat – which may result in the fusion of soil material forming clinkers at the ground surface. All shrub stems are consumed during severe burning disturbances. Soil temperatures can reach 250 ºC at a depth of ½ inch below the ground surface; under these conditions, microbial activities in the soil are eliminated and nutrient cycling does not occur on the fire-damaged site.

Pahvant Interagency Fuels Reduction Project – Table # 6

Soil Erosion Rates for HIGH Intensity - Severe Burns

(This table approximates soil erosion on strongly sloping terrain having 10 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
mixed alluvium	.490	.106	.022	.004
sandstone or shale	.308	.067	.014	.002
latite or andesite	.196	.042	.008	.001
limestone, dolomite or conglomerate	.242	.052	.011	.002

(This table approximates soil erosion on moderately steep terrain having 20 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
mixed alluvium	.570	.124	.025	.005
sandstone or shale	.358	.078	.016	.003
latite or andesite	.226	.049	.010	.002
limestone, dolomite or conglomerate	.282	.061	.012	.002

(This table approximates soil erosion on steep terrain having 30 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
mixed alluvium	.722	.157	.032	.006
sandstone or shale	.454	.099	.020	.004
latite or andesite	.288	.062	.013	.002
limestone, dolomite or conglomerate	.356	.077	.016	.003

(This table approximates soil erosion on steep to very steep terrain having 40 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
mixed alluvium	***	***	***	***
sandstone or shale	.538	.117	.024	.004
latite or andesite	.342	.074	.015	.003
limestone, dolomite or conglomerate	.424	.092	.019	.003

(This table approximates soil erosion on very steep terrain having 50 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
mixed alluvium	***	***	***	***
sandstone or shale	.674	.146	.030	.006
latite or andesite	.428	.093	.019	.003
limestone, dolomite or conglomerate	.532	.116	.024	.004

(This table approximates soil erosion on very steep terrain having 60 % slopes)

Geologic Types	Accelerated Erosion Rates in Tons / Acre / Year			
	Year # 1	Year # 2	Year # 3	Year # 4
mixed alluvium	***	***	***	***
sandstone or shale	.840	.183	.038	.007
latite or andesite	.534	.116	.024	.004
limestone, dolomite or conglomerate	.662	.144	.030	.006

The R1 / R4 model suggests that most problems, if any, related to erosion by water would occur during the 1st year, become less significant throughout the 2nd year and virtually become a non-factor during both the 3rd and 4th years following a burn. Simply stated … most of the actual effects of burning are usually related to the consumption of existing vegetation, combustion of organic matter and impacts to microbial populations occurring within the soil.

Burned-Area Emergency Rehabilitation (BAER)

Disturbances associated with escaped fire situations or unwanted wildland fire within the analysis area can be treated with emergency rehabilitation work within the burned-area in an effort to minimize threats to human life and property, maintain soil productivity and limit the deterioration of water quality. The specific authority, objectives, policy, responsibility and definitions for the BAER program are listed in the Burned-Area Emergency Rehabilitation Handbook -- recently amended during CY 2000. In the event of unwanted wildland fire – or, if prescribed fire should become escaped based upon an updated situation analysis, the Fishlake National Forest will assemble a team of resource specialists to evaluate the detrimental impacts of the fire following the containment and subsequent control of the burn.

Pahvant Interagency Fuels Reduction Project – Table # 7

BAER Treatments for Severely Burned Sites

Mitigation Measures	Brief Description of the Treatments
Broadcast Seeding	This treatment may consist of spreading native and introduced grasses along with non-persistent cereal grains on the damaged site at a rate of about 60 seeds / ft². The seed mix may include forbs or shrubs for erosion control. The mix is applied to the ground using a Type III helicopter, fixed-wing aircraft or rangeland drill. Seeding often occurs during the late fall and early winter season. The seed mix must be certified to be free of noxious weeds. The mixes are specifically designed for a variety of locations depending upon soil type, climate, aspect, elevation and temperature. The cost of this treatment can range from about $ 35 to 185 / acre depending upon the type of seed mix, method of implementation (aircraft vs. drill) and the amount of ground support needed to complete the project. Under ideal conditions, project accomplishments will be about 600 to 850 acres / day if using aircraft to apply the seed mix – it depends on the terrain and overall distance from the Helispot or Landing Strip to the burned-areas.
Aerial Mulching	This treatment is commonly used to protect communities from flooding, mud slides and debris flows … effects commonly associated with severely burned sites. In order to justify using this type of treatment … the values-at-risk must be SIGNIFICANT and involve either threats to human life and property or genuine concerns about transportation surfaces, irrigated croplands, municipal water supplies, domestic water supplies, recreational developments, abandoned mine sites, power lines, utility lines etc. Aerial mulching with weed-free straw should be applied to problem landscapes at a rate of 1 to 1½ tons / acre using a Type III helicopter. This mulching treatment provides for a protective layer of ground cover to become established on a fire-damaged site; it should be noted, mulching is still considered as the " most effective " land treatment in controlling soil erosion. As expected, this treatment is quite useful on steep to very steep terrain. The cost of this expensive treatment varies from about $ 875 to 2500 / acre -- depending on the availability of straw, the contract price on the aircraft, any transportation costs that might be incurred to acquire the straw bales along with daily expenditures for the supporting helitack personnel. When 2 helicopters are involved with rehabilitating the same severely burned-area, the crews can drop straw at a rate of about 50 to 60 tons / day on the site.

Mitigation Measures	Brief Description of the Treatments
Mulching by Hand	Mulching by hand can be easily accomplished on most gently sloping to moderately steep terrain at a cost of about $ 750 to 1250 / acre – but, the process is much slower when compared with the previously described aerial mulching methods. Normal accomplishments for a Type II / Fire Crew would be treating about 8 to 10 acres / day when the application rate is at 1 ton / acre.
Straw Wattles	Straw wattles are artificial barriers used to trap sediment on erosive hillsides. The barriers are about 9 inches in outside diameter, filled with weed-free straw and clipped into wattles having lengths of about 10 to 25 feet. The wattles are anchored to the burned-areas using 24 inch wood stakes positioned every 4 feet along the wattle. The wattles are placed along the contour in parallel rows spaced about 10 to 40 feet apart – depends on the slope of the landscape. The wattles usually decompose in place about 24 to 48 months after their initial installation – depending upon the climate. The barriers must be flush with the surface of the ground to be effective. Forest Service / BAER Teams have commonly recommended straw wattles in order to protect fragile riparian areas and wetlands from the detrimental impacts of fire. The cost of this particular treatment ranges from about $ 2.65 to 4.25 / linear foot – depending upon how much time and work it takes to mobilize the wattles prior to usage. Accomplishments can range from about 3,000 to 5,000 linear feet / day – more if volunteers are involved with the project.
Log Erosion Barriers	Similar to the straw wattles, the log erosion barriers (LEBs) are physical structures actually built upon fire-damaged hillsides for the specific purpose of trapping sediment and slowing the overland flow of surface runoff waters. The logs are usually 6 to 10 inches in outside diameter and measure about 15 to 20 feet in length. The LEBs can be anchored to the site using 24 inch wood stakes … 30 inch stakes are necessary if the terrain is steep or very steep. Once again, the logs must be flush with the ground surface and back-filled with soil material to be effective as sediment traps. The LEBs can remain useful structures on-the-ground for a period of up to 10 years. Like the wattles, spacing between the log barriers ranges from about 10 to 40 feet – depending upon the terrain. If logs are placed on the hillsides in a more discontinuous manner … the treatment is known as contour felling. If trees are simply cut and left unanchored as protective ground cover on very steep slopes … the treatment is called slashing. The advantages of using straw wattles vs. LEBs is the availability of the product and safety factor for the crews

Mitigation Measures	Brief Description of the Treatments
	working at the site. The cost of this land treatment usually runs about $ 375 to 650 / acre – depending upon the location of the burned-area. Under ideal conditions, a Type II / Fire Crew can build log barriers on about 12 to 16 acres / day.
Contour Raking	This treatment involves mixing the top 6 inches of the mineral soil using a McLeod (hand tool) in order to break-up water repellent ground conditions caused by a severe burning disturbance. The action is intended to promote the infiltration and percolation of water and snowmelt into the ground and minimize surface runoff conditions. The raking is not effective on sites having 1) very steep terrain, 2) a high percentage of rock fragments or 3) much coarse woody debris located at the ground surface; in addition, it is not considered practical in remote locations. The cost of a McLeod is currently about $ 65 / each. The cost of implementing this emergency treatment usually ranges from about $ 175 to 350 / acre for labor. Project accomplishments can be expected to be about 18 to 22 acres / day using a Type II / Fire Crew.
Silt Fences	These barriers are made with a geotextile fabric that can be un-rolled and hung over a re-enforced metal fence supported by steel posts; silt fences are commonly solidified at the ground surface by placing straw bales along the length of the barrier. Typically … they are constructed on nearly level to gently sloping terrain (0 to 8 % slopes) in order to minimize any potential " blowouts " from occurring under the fabric. It should be noted, silt fences are specifically designed to trap suspended sediment in swale areas – not, control accelerated rates of soil erosion from occurring upon surrounding hillsides. It is necessary to use either a backhoe or trencher while building the fence in order to place the fabric in a folded position below the ground surface; this action allows for the effective trapping of sediment during storm events. The cost associated with building a silt fence is quite variable – just depends on the method of construction and how many rock fragments (cobbles and stones) are located within the topsoil; actual expenditures can range from about $ 1.50 to 4.75 / linear foot. Frequently, silt fences are constructed in discontinuous segments on alluvial plains or fan terraces … or, are placed in parallel rows if heavy runoff conditions are expected from a fire-damaged landscape. Accomplishments will be variable … as a general rule of thumb, a Type II / Fire Crew can build about ¼ mile or 1,320 feet of silt fence / day.

Mitigation Measures	Brief Description of the Treatments
Straw Bale Check Dams	These structures are used in ephemeral and small intermittent stream channels to prevent sediment from entering perennial streams during the first winter following a fire event. Straw bale dams work very well in areas that do not have native rocks or logs to make natural type dams. Most often … the straw bale dams are built on gently sloping to strong sloping terrain (3 to 15 % slopes) – but, closely spaced structures can be somewhat effective on moderately steep landscapes measuring 15 to 25 % slopes too. The purpose of the dams is to initially trap and slowly meter sediment through a drainage system – minimizing impacts to the fisheries. As expected, the cost associated with building the dams varies between $ 150 to 400 / each – depending upon how much time and work it takes to mobilize the bales prior to usage. Under normal conditions, a Type II / Fire Crew can construct about 40 to 50 straw bale check dams / day.
Erosion Blankets	These mats are used when immediate ground cover and maximum protection is needed to shelter a sensitive (i.e. archeological) or high value site like a developed spring location. Simply stated … the cost of using either fiber or jute-netting mats is the highest of all the erosion control treatments at about $ 8500 to 10000 / acre. The purpose of these mats is to prevent the detachment and transport of soil material from the dynamic splash associated with raindrop impact. The blankets come in different sizes, thickness, flexibility, tear resistance and absorptive capacities. Most of the erosion mats are 100 % biodegradable in a period of about 2 to 5 years after installation. If the terrain is not too steep … a Type II / Fire Crew can use 6 inch metal stakes to anchor about 5 acres of blanket / day.
Hydromulching & Seeding	The purpose of this treatment is to protect the soil from surface erosion; it provides both a temporary ground cover along with establishing a root mass to bind the soil particles together. For the most part, this treatment is limited to areas that have existing road access. Overall, this treatment is very effective … because, even if the weather does not cooperate to germinate the seed as expected – the mulch will continue to protect the soil for a year until the vegetation grows and provides its new cover. Generally speaking … hydromulching is used to protect transportation surfaces from potential damages associated with severely burned sites. The cost of this particular treatment can range from about $ 750 to 1500 / acre – depending on the seed mix, type of terrain, contract price on the spraying equipment

Mitigation Measures	Brief Description of the Treatments
Hydromulching & Seeding *(continued)*	and the amount of ground support necessary to complete the seeding project. Accomplishments are commonly about 4 to 6 acres of spraying / day; usually, a strip about 100 to 200 feet in width is mulched on both sides of the road surface.

(Note) – the information presented in the Mitigation Measures / Brief Descriptions table on treatment costs and project accomplishments was taken from the Burned-Area Emergency Rehabilitation Handbook - Techniques (R5, 1998) along with Initial and Interim BAER Reports from the Fishlake National Forest (Swains, Oldroyd and Mourning Dove Fires of 2000; Cottonwood and Johnson Fires of 2002), Uinta National Forest (Oak Hills Fire of 2000; Mollie, Nebo Creek, Birch and Y-Mountain Fires of 2001) and Ashley National Forest (Mustang Fire of 2002) … all located within the Intermountain Region of the Forest Service.

In addition to the land, channel and road treatments listed in the previous discussion … other mitigation measures that might be considered in the event our prescribed fire treatments become an escaped fire event with severe burning disturbances would be as follows:

Strip Mulching	Hand Seeding	Sand Bags
Contour Trenching	Disking / Subsoiling	Temporary Fencing
Rock / Log Check Dams	Channel Clearing	Debris Basins
Upgrading Culverts	Road Rocking (2 to 3 ” gravels)	Storm Patrols (etc.)

Geologic Hazards

Some of the areas known to be problem landscapes when it comes to either natural or management-induced site disturbances are soils derived from clayey sediments of the North Horn Geologic Formation; these locations are subject to soil creep, slumping and landslides during spring snowmelt conditions and summer thunderstorm events – especially, when protective vegetative cover has been removed from the site. Once the existing vegetation is gone from a North Horn type soil, the process of de-watering the affected landscape is slowed until new vegetation in the form of Gambel oak and perhaps aspen become re-established following a burn. While the site remains moist or wet, water actually acts as a lubricant -- which minimizes the coefficient of friction between the mineral soil separates and adds weight to the burned-area … making it prone to minor slumps and even larger landslides. In addition, soils formed in calcareous deposits of limestone or dolomite located on very steep terrain and all soils having properties inherited from sandstone parent materials are subject to water-repellent ground conditions, mudslides and debris flows following severe burning disturbances.

After explaining the fragile and unpredictable nature of North Horn dominated landscapes to the members of our Interagency ID Team … it was decided to eliminate all areas of North Horn soils from any consideration in the current analysis for hazardous fuels reduction. Everyone on the ID Team understands the importance of minimizing severe burning disturbances on our public lands. The treatment methods being discussed for the

application of prescribed fire (hand burning, aerial torches and plastic spheres) allow for better control of the ignitions in order to achieve a mosaic of low to moderate intensity burns across the landscape. With the type of fuels observed in the Wild Goose Unit, scattered pinyon – juniper with small diameter oakbrush, it is unlikely that a severe burn would occur on its calcareous soils. A larger concern would be the sandstone soils of both the Horse Hollow and Meadow Units. Still … if these areas are burned during the spring season with a low to moderate intensity fire while the ground conditions have at least 12 to 15 % water by weight in the upper topsoil horizons – very little, if any, resource damage would occur on the site.

(Note) -- Please refer to the geology maps attached to the document at this time; a more detailed explanation of potential impacts to coarse-textured (sandy) soils is provided in the discussion of Alternative # 2.

♦ Environmental Consequences – Mechanical Treatments

Some of the mechanical treatments being considered for this proposed hazardous fuels reduction project include the removal of pinyon – juniper type vegetation using chainsaws and subsequently piling the slash into scattered piles for burning treatments. In addition, a few non-stony, nearly level to gently sloping areas would be re-seeded using a rangeland drill. A limited amount of discussion was given to the possible use of double chaining and seeding on BLM administered lands … but, this proposed action was later dismissed from any serious consideration. It should be noted, some of the thinning in pinyon – juniper plant communities has already been analyzed by the BLM as part of the Holden Environmental Assessment (EA) of 1991, the Frampton EA of 1996 and the Meadow EA of 1997; all 3 EA documents were updated in June of 1999. Currently, the mechanical thinning is about completed on the BLM portion of the Meadow unit – and, some of the thinning work has been started on both the Frampton Heights unit and BLM lands within the Pioneer unit.

At this time … I'm simply going to list the type of potential disturbances that could occur on public lands if mechanical thinning is used to reduce hazardous fuel accumulations. Simply stated … displacement is actually a type of nonpoint pollution in the form of wind or water erosion. While puddling and compaction are both considered as IN-SITU type ground disturbances ... ones that occur in place -- resulting in the deformation of soil structure within the top 12 inches of the ground. If the proposed treatments are actually implemented on BLM and FS administered lands … theoretically, any, or all of these disturbances could be caused by the crews working on the sites or by vehicular traffic – especially during inclement weather conditions. In reality … only a very small likelihood exists that damages will occur to the soil resource from the proposed thinning activities.

Displacement

Erosion is defined as the detachment, transport and deposition of soil particles by a natural force of energy such as water, wind or gravity; in addition, highly erosive ground conditions can be the direct result of management - induced site disturbances. For example, topsoil horizons can become scalped by the continued action of dragging shrubs and trees over the ground surface to make a burn pile. The displacement of soil material can leave a treatment area with insufficient amounts of ground cover … making the site susceptible to erosional events by the influences of wind and water. Detrimental conditions occur on NFS lands when displacement amounts to the loss of either 2 inches or ½ of the humus enriched topsoil -- whichever is less. Quite often, eroded sediment is the richest past of the soil profile – usually its surface horizon containing most of the site fertility in the form of plant nutrients and organic matter. Soil erosion rates are dependent on the inherent erodibility of the land resource; overall, the erosivity of a site is based upon rainfall factors such as intensity and duration, wind velocity along with topographical position – including slope length and its gradient.

- Wind erosion is a basic geomorphological process; it is responsible for creating an assortment of shapes including dunes, blowouts, desert pavements and rock pedestals. While the overall transport capacity of the wind is much less than that of flowing water … the process of wind erosion is capable of removing nutrient rich soil material from disturbed sites – including road, trail and unprotected ground surfaces. The resulting dust clouds may contaminate the atmosphere within the immediate transport area and occasionally impact residents living within its depositional locations.

- Water erosion is a series of processes leading to the depletion of soil material from upland hillside locations; simply stated, topsoil is detached and transported as sediment into surrounding streams and bodies of water. These processes include 1) diffuse surface erosion (e.g. the dynamic splash associated with raindrop impact), 2) linear erosion in the form of rills and gullies, 3) subsurface erosion … seen as piping and 4) shallow mass movements.

MITIGATION MEASURES … establish a quick vegetative cover on upland hillsides by applying broadcast seeding treatments on landscapes exhibiting signs of soil displacement; in some instances, plant residues -- such as coarse woody debris or straw mulch can be utilized to protect the ground surface from accelerated rates of erosion; windbreaks can be planted and tillage equipment is commonly used on nearly level to gently sloping terrain to promote surface roughness -- which limits the detachment and transport of soil particles.

(Note) – Any soil can be susceptible to displacement; coarse woody debris is considered to be any organic materials measuring > 3 inches in diameter. Retaining nutrient-rich organic matter within disturbed areas limits erosion by protecting the ground surface from the dynamic splash associated with raindrop impact.

After the Swains Fire of CY 2000, the BLM and FS used the following plant species in their seed mixes to stabilize severely burned sites located within the Pahvant Range on alluvial fan terraces, upland foothills and the surrounding mountainsides:

Tall Wheatgrass	Smooth Brome	Crested Wheatgrass	Alfalfa	Orchardgrass
Small Burnet	Intermediate Wheatgrass	Cliffrose	Bitterbrush	Wyoming Big Sagebrush
Mountain Brome	Slender Wheatgrass	Hard Fescue	Sheep Fescue	Timothy

(Note) -- It should be noted, the Swains Fire occurred immediately southeast of the proposed Holden Springs treatment unit. Overall, 7,809 acres were damaged by this incident of unwanted wildland fire; severe burning disturbances occurred on 2,185 acres – which was about 28 % of the entire area. The community of Holden, UT was affected by 2 dramatic episodes of flooding. The Maple Hollow and Johnson Canyon areas on NFS lands have experienced floods on 6 different occasions over past 2 years. The FS segment of the Maple Hollow Road has accumulated 10 to 12 feet of assorted debris as a result of the flooding – and, remains closed at this time.

Puddling

Puddling is usually evaluated at the surface of a mineral soil; it is defined as *" … the act of artificially destroying the natural structure of a soil when the ground is wet or saturated "* (R4 / SQS, 2003) Visual indicators of detrimental puddling include clearly identifiable tire ruts with berms left in the topsoil. Fine - textured soils are the most susceptible sites to receiving puddling type disturbances; these locations have a high to very high potential for developing plastic conditions due to their appreciable amounts of clay. When a puddled site becomes dry, the soil material is hard, dense and exists in a cloddy type of structureless condition.

Puddled areas are almost impervious to the movement of air and water within the soil profile due to a reduction in overall pore space. This type of condition commonly results in accelerated erosion losses. Frequently … puddling occurs in conjunction with detrimental compaction disturbances.

MITIGATION MEASURES … surface tillage with mechanical equipment will improve aeration, water movement and root penetration within the soil profile; in addition, it can be used to shape the ground surface for the purpose of erosion control. In some instances, Dixie Harrow treatments could be used to manipulate the site, allowing for increased infiltration, followed by broadcast seeding to accomplish both erosion control and forage production.

The following publication symbols have loamy or fine textured soils which can be puddled during moist or wet ground conditions: (please see attachment # 19)

8, 25, 26, 27, 34, 35 and 41 (East Millard County, Utah / Soil Survey Area)

119, 188 and 221 (Tushar – Pahvant – Canyon / Soil Survey Area)

Compaction

Compaction is generally evaluated just below the ground surface … between the depth of 2 and 12 inches in a mineral soil. A common cause of compacted layers in the soil is operating motorized vehicles and heavy equipment over the ground during moist or wet conditions – this action results in a subsurface or subsoil condition known as a *" traffic pan. "* On NFS lands, detrimental conditions occur … when porosity is reduced by 10 percent on loamy or clayey sites and by 12 percent on sandy textured soils (R4 / SQS, 2003). The persistence of soil compaction is determined by climate, the shrink – swell potential of the soil along with the overall depth to the massive condition. Freeze / thaw cycles can help to offset soil compaction occurring near the ground surface.

MITIGATION MEASURES … deep chiseling or subsoiling of a relatively dry site with tillage equipment will shatter compacted layers and subsequently loosen soil materials allowing for the downward percolation of water into the lower subsoil horizons and underlying substratum layers.

The following publication symbols have loamy of fine textured soils which can be compacted during moist or wet ground conditions: (see attachment # 19)

8, 25, 26, 27, 34, 35 and 41 (East Millard County, Utah / Soil Survey Area)

119, 188 and 221 (Tushar – Pahvant – Canyon / Soil Survey Area)

SPECIAL CONSIDERATIONS

Biological Soil Crusts and Potential Impacts from Mechanical Treatments and Prescribed Fire Disturbances

Soil texture and pH have a pronounced influence on the species composition of any biological crust (USDI – BLM and USGS, Technical Reference 1730-2, 2001) occurring at the ground surface. For instance … a fine textured soil located on a stable site will support a greater abundance and more varied population of cyanobacteria, lichens and mosses compared to a less stable -- coarse-textured type soil. Calcareous and gypsiferous soils usually support a very high coverage of species rich crust – with some taxa being excellent

indicators of soil chemistry. Embedded rocks at the soil surface can increase the percentage of crust cover by perching water and armoring the surface from the impacts of physical disturbances. Shallow sites often support a wide variety of crusts … especially within the Ustic Moisture Regime because the sites are frequently recharged with water; in addition, shallow soils can be re-moistened by the capillary rise of water during the spring, summer and fall seasons.

Mechanical disturbances and impacts to soil crust can result from a variety of activities such as vehicular traffic, trampling by wildlife and livestock and land-clearing activities -- such as the thinning of pinyon – juniper in semidesert environments. Most of these mechanical disturbances will puddle and compact the upper soil profile (top 12 inches) during moist or wet ground conditions. The deformation of soil structure influences soil – plant water relationships and can accelerate rates of erosion by wind and overland flows. Cyanobacteria are the most resistant crusts to disturbances because the organism is highly mobile and can re-colonize disturbed soils quite rapidly.

Biological crusts are generally killed by the impacts of hot ground fires. However, if the fire occurs in a mosaic pattern over the landscape … lichens and mosses can be found under vascular plants – where some protection from sediment burial is provided. The recovery of biological crusts after a fire disturbance is faster on fine-textured soils. Sites having coarse sandy loam, very coarse sandy loam or loamy sand type textures may take up to 10 years to recover following a high severity burn. With all that being said … prescribed fire treatments that are implemented to reduce hazardous fuel accumulations can be a useful tool in managing soil crust populations when low to moderate intensity burns are applied to the landscape. This proactive style of land management should limit the occurrence of large, uncharacteristic wildfires – especially, along the urban interface. Simply stated … more frequent fires of smaller extent, having less residence time and burn severity will have fewer detrimental impacts to the crust populations. Under no circumstances should semiarid sites be burned if the action will result in the conversion of perennial grasses and shrubs to annual grasses, annual weeds or noxious weeds – unless, post-fire restoration treatments are immediately planned for the area. Some of the necessary post-fire management may include using the following treatments and strategies to stabilize the burned-areas:

- Aerial seeding using a fixed-wing aircraft,
- Broadcast seeding using a no-till type drill to limit puddling and compaction disturbances,
- Restrictions in seasonal recreation uses (ATVs, hunting, dispersed camping etc.),
- and, closing the area to domestic livestock grazing for a period of about 2 to 3 years – until the site has stabilized from the burning disturbance, vegetation is re-established and biological soil crusts have recovered at the ground surface.

Overall, we need to manage our populations of biological soil crust in order to provide for soil stabilization, improved water retention properties and nitrogen fixation within semiarid ecosystems. Currently the BLM and FS have proposed to combine the pile burning of slash on public lands with seeding treatments and temporary restrictions on grazing in order to maintain or improve soil crust communities located in the Grabalt, Holden Springs, Frampton Heights, Pioneer and Meadow units.

The following publication symbols have sandy textured soils which can be disturbed by either mechanical or prescribed fire treatments resulting in damage or elimination of biological crusts (see attachment # 20):

20, 25, 26, 66 and 86 (East Millard County, Utah / Soil Survey Area)

156 and 201 (Tushar – Pahvant – Canyon / Soil Survey Area)

These fragile areas need to be monitored following all ground disturbing activities to determine if the soil resource has adequate cover to protect the sites from accelerated erosion losses.

Evaluation of Impacts to Soils within Inventoried Roadless Areas

One of the characteristics commonly associated with Inventoried Roadless Areas (IRAs) is that these locations often include high quality or undisturbed soil, water and air resources. The FS has identified several IRAs occurring within the Pahvant Range of the Fillmore Ranger District. A significant portion of these Roadless Areas -- measuring about 1,135 acres, actually extend into the 1) Wild Goose, 2) Pioneer, 3) Horse Hollow and 4) Meadow treatment units. Our current proposal for reducing hazardous fuels on NFS lands includes the use of mechanical treatments with low to moderate intensity prescribed fire to limit or prevent uncharacteristic wildfires from occurring along the urban interface. If implemented, these fires would cause a (temporary) charred-look upon the landscape … however, the soil resource would become enriched by plant nutrients suddenly made available in the ash layer deposited at the ground surface. As previously discussed, there would be little, if any, change to site hydrologic function from these (light) burning disturbances on nearly level to moderately steep terrain – meaning, these areas will continue to have healthy watersheds that provide clean water for both domestic and agricultural uses. At this time, let's take a brief moment to review a prescribed fire treatment from 1996 that was implemented by the Fishlake National Forest within and adjacent to the Oak Creek / Inventoried Roadless Area of the Canyon Mountains.

Several years ago, the Fillmore Ranger District treated approximately 1,000 acres of upland hillsides within the Whiskey Creek / Grazing Allotment with low to moderate intensity prescribed fire treatments; this action was used to 1) reduce hazardous fuels, 2) accomplish vegetative manipulation objectives and 3) increase the diversity of plant species in an area located south of Mud Springs. These sites were burned during April of 1996 … the two photographs shown in this presentation were taken during July of 1996. Both the Gambel oak and perennial grasses quickly re-sprouted once adequate moisture was available in the topsoil. Mean annual precipitation in this region of the Canyon Mountains is about 15 " / year.

Some of the new grasses observed in the treatment area included intermediate wheatgrass, western wheatgrass, thickspike wheatgrass and crested wheatgrass. Most of the perennial grasses did not have their plant root crowns consumed or heavily damaged by the low to moderate intensity burns.

This fire disturbance did not adversely affect the high quality soils located within or directly adjacent to the Oak Creek / Roadless Area.

The only mechanical treatments that would take place on NFS lands are in the Grabalt treatment unit; this particular area is located outside the IRAs. Simply stated … there are no issues or concerns currently surrounding the use of prescribed fire within the Inventoried Roadless Areas of the Forest Service. The soil resource will continue to provide for healthy fish and wildlife populations along with being the basis for many types of outdoor recreation activities.

♦ Alternatives … the Direct and Indirect Effects

Alternative # 1 … No Action

Under this alternative, both the FS and BLM will continue to maintain the long-term productivity and site hydrologic function for all contrasting soil resources occurring on federal lands within the analysis area; taking this approach would be consistent with meeting the staff responsibilities listed in the R4 / Soil Quality Standards and Guidelines and in harmony with the BLM direction for Critical Erosion Areas. In the event of unwanted wildland fire, the FS / Fillmore Ranger District or BLM / Fillmore Resource Area Office could assemble or request a BAER Team or Emergency Stabilization & Rehabilitation (ESR) Team to evaluate the impacts of the burn.

Now … the indirect effect of selecting this particular alternative is that taking the NO ACTION approach towards land resource management could very well result in a large event of unwanted wildland fire -- having the same environmental consequences as the previously described high fire intensity zone / severely burned site! In addition, the landscape would be affected by the related fire suppression activities … such as chemical retardant drops and the construction of dozer lines to contain the burn. Currently, the overall fire hazard, which includes factors such as aspect, slope, fire density and a fuels model, strongly suggests a moderate to high potential exists for another large incident of wildfire in the Pahvant Range – especially on upland terrain measuring between 20 to 60 % slopes. **If a large, high intensity burn actually occurred on fragile soils derived from unstable geologic formations, on steep to very steep terrain or upon non-renewable type sites ... a genuine potential would exist for detrimental impacts to the soil resource.** Accelerated rates of erosion, along with the risk of flooding, slumping and landslides would continue until vegetative cover was re-established and hydrologic function became restored within the burned-areas.

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Alternative # 2 … Treating seven selected areas occurring outside the known extent of the North Horn Geologic Formation which have few, if any, soil limitations towards using either mechanical treatments or prescribed fire to accomplish hazardous fuels reduction along the urban interface. (~ 14,329 acres)

This alternative would result in site disturbances expected to be quite similar in their overall impact to the environmental consequences represented by a low to moderate fire intensity zone. In most instances, the implementation of prescribed fire could be utilized as an effective management tool to accomplish both hazardous fuel reductions and ecosystem restoration projects on nearly level to moderately steep terrain. If this alternative is selected … prescribed fire treatments would be applied to the ground starting as early as the summer of CY 2003 and continue for about a 5-year period of time. Keep in mind, the different areas being proposed for burning treatments would be limited in size and scope – with most management actions restricted to approximately 2,500 acres / treatment / year. It should be noted, the selection of this action alternative should result in more acres of public lands being burned ... not necessarily, more fires getting ignited on the ground. The following areas of the Pahvant Subsection have few soil limitations with respect to conducting prescribed fire treatments during the early spring or late fall seasons:

Wild Goose

Holden Springs

Frampton Heights

Pioneer

Generally speaking … most of these upland landscapes support existing vegetative communities of Gambel oak, mountain big sagebrush along with scattered pinyon – juniper trees. Many of the burning treatments being considered for the Grabalt, Wild Goose, Pioneer and upper Horse Hollow will return existing PJ stands back into an early seral stage – which suggests, these areas will eventually include a component of oakbrush and mixed sagebrush with perennial grasses. If we use the Adelaide Fire of 1996 as an indicator of soil behavior for the Pahvant Subsection … the Fishlake / BAER Team made the following comments about the impacts to Woolsey Ridge following a large burn within the Corn Creek watershed:

" … most of the burn in the Woolsey Ridge area of the Fillmore Ranger District was of low to moderate fire intensity. The vegetation in this photograph includes Gambel oak, pinyon – juniper, mountain big sagebrush along with scattered perennial grasses. If anything … the Adelaide Fire was considered to have a beneficial effect on these upland sites! The Woolsey Ridge landscape was exactly the type of unit being considered by the Fishlake Forest for prescribed fire treatment because … there is no threat to human life and property, no deterioration of water quality and soil productivity is maintained after the burn. Secondly, its response to fire meets the objectives of ecosystem management by improving wildlife habitat, increasing forage production for domestic livestock and by changing the diversity of vegetation existing at the site. "

At this time, I want to emphasize the need for conducting both pre-burn and post-burn type monitoring activities – especially within the **Grabalt, Meadow** and **Horse Hollow** units … because soils derived from sandstone parent rocks are very susceptible to hydrophobic conditions if the site is burned during dry ground conditions. IN ORDER TO LIMIT OR PREVENT THE DEVELOPMENT OF WATER REPELLENT CONDITIONS IN THESE SPECIFIC LOCATIONS, THE SOIL MOISTURE CONTENT SHOULD BE AT LEAST 12 TO 15 % WATER BY WEIGHT IN ORDER TO PROTECT THE FRAGILE NATURE OF THE RESOURCE. Soil material should be collected at the sampling depths of both 0 to 3 inches and 3 to 6 inches, placed in a drying oven at 105° C for 24 hours and re-weighed in order to determine its moisture content using the following calculation:

$$\frac{(\text{moist field weight}) - (\text{oven dry weight})}{\text{oven dry weight}} (100\,\%) = \%\ \text{water by weight}$$

Once again, the Fishlake National Forest would continue to maintain the long-term productivity and site hydrologic function for most or all of the contrasting soil resources occurring within the Pahvant Subsection by selecting this action alternative; taking this management approach would be consistent with meeting the staff responsibilities listed in the R4 / Soil Quality Standards and Guidelines. As a reminder, the R4 / SQS allow for UP TO 15 % resource damages to occur within the perimeter of a given project area -- before measures are required to mitigate the disturbances on-the-ground. Under Alternative # 2 … the Fishlake National Forest would be required to continue with following its goals, objectives, management requirements

and general direction listed in our existing Land and Resource Management Plan in order to *" ... maintain soil productivity, minimize man-caused soil erosion and sustain the integrity of associated ecosystems. "*

Pahvant Interagency Fuels Reduction Project – Table # 8

Comparison of Alternatives – Estimated Soil Erosion Rates in Tons/Acre/Year

Resource / Year	Alternative # 1 (No Action)	Alternative # 2 (Proposed Actions)	Unwanted Wildfires
Soils – Year # 1	0.2 – 0.6	0.3 – 1.0	0.4 – 1.4 +
Soils – Year # 2	0.2 – 0.6	0.2 – 0.7	0.4 – 1.4 +
Soils – Year # 3	0.2 – 0.6	0.2 – 0.7	0.4 – 1.4 +
Soils – Year # 4	0.2 – 0.6	0.2 – 0.6	0.4 – 1.4 +
Soils – Year # 5	0.2 – 0.6	0.2 – 0.6	0.4 – 1.4 +

(treatments are being proposed for upland terrain measuring between 0 to 45 % slopes)

(Note) -- It should be stated, the R1 / R4 Model does not factor in climate as one of its variables when calculating the estimated rates of erosion following a burning disturbance. Usually, a BAER Team will recommend a continuum of land, channel and road treatments to quickly stabilize a burned-area based upon the runoff numbers indicated by either a 10 or 25 Year - Storm Event. Using the Disturbed WEPP Model, it was determined that soil erosion losses could approach as much as 64 tons / acre / year in the first year for the Mollie Fire near Santaquin, Utah. The same model suggested erosion losses could measure about 29 tons / acre / year in the first year for the Mustang Fire in the Flaming Gorge National Recreation Area. Both models were run under the assumption that climatic conditions would resemble a 25 Year - Storm Event.

Pahvant Interagency Fuels Reduction Project – Table # 9

Potential for Direct and Indirect Effects to the Soil Resource using Mechanical Treatments and Prescribed Fire to Reduce Hazardous Fuel Accumulations, Limit Uncharacteristic Wildfires and Prevent Flooding Occurrences along the Urban Interface

Direct Effects	Indirect Effects
consumption of existing vegetation	accelerated rates of erosion
combustion of organic matter accumulations	risk of flood source sites
severely burned soils	impacts to hydrologic function
water-repellent conditions	changes in plant nutrient reserves
insufficient protection at the ground surface	detrimental puddling and compaction
impacts to microbial populations	displacement / mass movement

As long as the Forest Service conducts low to moderate intensity prescribed fires having short residence times ... these types of management actions will remain consistent with the goals and direction contained in the various Forest Plans and supported by the R4 / SQS. Simply stated ... the Land and Resource Management Plan of the Fishlake National Forest contains specific passages that indicate priority will be given to 1) protecting the renewable and non-renewable soil resources, 2) rehabilitating disturbed areas and 3) sites damaged by fire will be stabilized in order to protect deteriorated watersheds.

It should be noted, if implemented, none of the treatments intended to reduce hazardous fuels would occur within fragile riparian zones associated with the Meadow, Holden Springs, Pioneer or Horse Hollow units. Secondly, on this proposed project … broadcast seeding is a design feature that would be implemented only if post-treatment monitoring indicates potential problems with erosion, soil productivity or site hydrologic function.

Included with this specialist report is a final GIS map (see attachment # 21) that identifies areas that may contain shallow, non-renewable type soils in the proposed project area. It must be noted, not all of the shaded polygons are composed entirely of shallow soils. For instance, only 15 % of the total acreage occurring within FS polygons labeled with publication map symbol # 155 actually have shallow soils (Agassiz family) on the landscape. Likewise … all of the BLM units with the Borvant Series (map symbols 19, 20 and 22) probably have a situation which exhibits a wavy contact to the top of the indurated hardpan – meaning, lots of these areas are actually moderately deep sites (20 to 40 ” to the pan) on alluvial terraces. The purpose of including GIS plots #’s 19, 20 and 21 with this report is simply to make sure we **KNOW WHERE TO MONITOR** fragile soils that are subject to 1) hydrophobic ground conditions, 2) losses of biological crusts, 3) detrimental puddling, 4) detrimental compaction and 5) accelerated erosion losses on non-renewable type sites. Most of the shallow soils associated with this proposed project are located within the Grabalt, Horse Hollow and Meadow treatment units.

♦ Cumulative Effects

Cumulative effects consider the combined impacts of past, present, reasonably foreseeable and proposed management actions. Well … over the past 100 to 150 years, the exclusion of prescribed burning treatments, our increased efficiency in fire suppression tactics, the historical grazing practices combined with changes in climatic conditions have resulted in the accumulation of hazardous fuels along with a lack of structural diversity in most vegetative communities occurring within the Pahvant Range. Specifically, there is a serious potential for uncharacteristic wildfires to occur in close proximity to the residents of eastern Millard County – communities such as Fillmore, Meadow, Scipio, Kanosh and Holden, Utah. Associated with these fires would be the genuine potential for flooding, mudslides and debris flows if a significant portion of the Pahvant Range is damaged by a severe burning disturbance. In addition, many of the mixed sagebrush communities with perennial grasses have been converted into seral pinyon – juniper stands. Natural or management induced disturbances will be necessary to move these landscapes along towards historic and sustainable conditions of ecological structure and function.

The use of mechanical thinning along with low to moderate intensity prescribed fire would have few, if any, adverse impacts to the soil resource. However, fire cannot be restored to each and every ecosystem without acknowledging the risk of potential consequences to the environment. If the soil resource is damaged by a prescribed fire treatment, the site will need to receive emergency rehabilitation treatments in order to protect its long-term productivity. Escaped fire or large incidents of unwanted wildland fire would be evaluated by a BAER Team and emergency rehabilitation treatments would be applied, as deemed necessary, to minimize threats to human life and property, maintain soil productivity and limit the deterioration of water quality.

In this next section, I want to evaluate each of the 7 proposed treatment areas with respect to the past and present management practices applied to each particular area. My analysis will include the reasonable foreseeable management actions along with our proposed actions related to this project too; the units list as follows:

- Grabalt … included with this unit are two communication sites established by both the FS and BLM. Secondly, the area has a major power line located along the southern edge of the proposed thinning / burn unit. To a certain extent, these developments represent a small – but, irreversible commitment of the soil resources on our public lands. Since very little water actually exists within this unit … the actual impacts by domestic livestock and wildlife have been quite minimal over time. The region has been open to the activity of hunting during the late summer and early fall seasons; a few areas have been utilized for dispersed camping activities during the different hunts. Some parts of the Grabalt area have been defoliated by Mormon crickets over the past several years – but, not to the point of causing erosion because of droughty climatic conditions. The roads leading into the unit from Scipio or the I-15 transportation corridor have been maintained to allow for frequent access into the communication sites and along the utility lines. A small tract of private land exists within the perimeter of this unit. In this particular instance, the proposed action includes mechanical thinning … and broadcasting the slash across the landscape prior to burning – not, piling the woody debris upon steep to very steep terrain. Some areas would not be treated due to safety concerns for the Fire Crew members and seasonal employees. The areas not being treated for hazardous fuels reduction … are also the same areas with non-renewable type soils located on north facing slopes. Overall, the cumulative effect of implementing the proposed fuels reduction treatments on this unit would be to 1) have some temporary development of water-repellent ground conditions occurring on the coarse-textured located along the west side of this area and 2) a few shallow areas may actually have accelerated erosion rates that exceed 1 ton/acre/year during the first year following the planned treatments – but, impacts will amount to less than 15 % of the total acreage within the area. If implemented … most of the unit will eventually resemble the Eightmile Fire of 1996, located ¼ mile due west of the Grabalt polygon, with few hazardous fuels observed on-the-ground, excellent recovery of perennial grasses and upland shrubs – especially on the hardpan soils and no potential for flooding hazards to either I-15 or the community of Scipio, Utah. Some of the area may experience increased ATV use following the vegetative treatments, as folks are curious to see what's going on near the community of Scipio – but, normal road maintenance will minimize any impacts related to puddling or compaction on the transportation surfaces.

- Wild Goose … the Holden Irrigation Company has a water development and pipeline project established in this unit. Unimproved dirt roads exist in both Dry Canyon and upper Wild Goose Canyon – neither transportation surface is maintained on a regular basis. Once again, the area is utilized by domestic livestock and managed using a 4-unit rest rotation grazing system; secondly, the canyon has limited pressure from hunting and dispersed camping activities during the late summer and early fall seasons. Currently, the range is considered to be in good condition. The area located along the toeslopes of lower Wild Goose Canyon may be susceptible to puddling and compaction problems associated with the mechanical treatments – this area needs to be avoided during moist or wet ground conditions. To be honest, most of these lower elevation landscapes currently support Gambel oak and mountain big sagebrush – so, most of the disturbance planned in these areas would be related to prescribed fire. With only 40 to 80 % of this area being considered for treatment, and much of the clonal vegetation capable of re-sprouting following a burning disturbance … there would be few, if any, adverse affects to the Wild Goose landscape. In fact, most of the fire would be beneficial to the NFS lands and have no impact to the surrounding State of Utah and private lands located within the immediate area.

- Holden Springs … the Swains Fire occurred in close proximity to this proposed treatment unit; it burned approximately 7,800 acres during CY 2000 and damaged the hillsides of upper Maple Hollow and Johnson Canyon. The FS, BLM and State of Utah were all involved with 1) requesting funds, 2) planning treatments and 3) implementing emergency stabilization measures following this unwanted wildland fire to control

accelerated erosion losses on the surrounding fan terraces, foothills and mountainsides. **Today, about 2½ years after the disturbance, the alluvial fan terraces of lower Maple Hollow have fully recovered from that incident of wildfire.** Both the BLM and State of Utah are to be commended for their actions of removing dead PJ trees by chaining, re-seeding the western portion of the burned-area and repairing damages to the established road system caused by surface runoff waters. Currently, the fan terraces support perennial grasses, re-sprouting shrubs such as Gambel oak and maple along with new shrubs (established from seed) in the form of bitterbrush, cliffrose and Wyoming big sagebrush. If the Holden Springs Unit becomes treated as planned … I would expect the response of the landscape to be very similar to that of the lower fan terraces that were quickly rehabilitated as part of the recent Swains Fire. One concern I do have in relation to the Swains Fire is that … the steep to very steep mountainsides of upper Maple Hollow on NFS lands remain a fire-damaged landscape at this time. During the next 1 to 2 years, a genuine potential exists that additional episodes of flooding could impact the community of Holden, Utah along with the surrounding Holden Springs area with another deposit of sediment and debris. This does not preclude us from planning and perhaps implementing the proposed treatments – however, it suggests we need to be aware of the hazard and plan the timing of the treatments accordingly to achieve success on-the-ground. The FS / Maple Hollow Recreational Facility remains closed at this time – so, few individuals and families are staying overnight and camping in the immediate area; not many vehicles are traveling on the Maple Hollow Road which remains closed to the public in upper Maple Hollow due to potential debris flows. Most of the Holden Springs area is not susceptible to damage from ATVs in the form of puddling or compaction. The most common form of recreation is hunting which includes the pursuit of turkeys in the spring season and mule deer later in September and October. Since most of the proposed project would occur on gently sloping to strongly sloping terrain (3 to 15 % slopes) … I see no adverse impacts potentially occurring to the surrounding State of Utah or private lands.

- Pioneer … the BLM has completed some mechanical thinning of pinyon – juniper at the lower elevations along the western edge of this unit; this work is scheduled to continue during the summer of 2003. This part of the Pioneer Grazing Allotment produces very little palatable forage -- so, it is not used much by domestic livestock or upland big game animals. This allotment is managed under a 3-unit rest rotation grazing system … only 2 units are utilized each year – so, an opportunity exists to rest the proposed treatment area for a period of 2 or more years. Unimproved dirt roads exist on both the BLM and FS located south of Pioneer Creek. Overall, the cumulative effect of implementing the proposed fuels reduction treatments on this unit would be a few shallow areas may actually have accelerated erosion rates that exceed 1 ton/acre/year during the first year following the planned treatments – but, impacts will amount to less than 15 % of the total acreage within the area. Some areas of this unit may require broadcast seeding in an effort to maintain or improve long-term soil productivity. If our treatments consist of low to moderate intensity burns on 40 to 80 % of the unit … there will be no detrimental effects to the State of Utah and private lands surrounding this polygon.

- Frampton Heights … once again, the BLM has completed some mechanical thinning of pinyon – juniper at the lower elevations along the northern edge of this unit. In this particular instance, PJ has been felled and stacked in scattered burn piles across the unit as coarse woody debris. Several homes exist in close proximity to this tract of BLM land. Unimproved roads exist in both North Canyon and surrounding Red Cedar Hill. The BLM has indicated that no changes would be necessary in managing the existing grazing system following any of the proposed fuels treatments. Local residents use this area during the fall hunts and for dispersed camping opportunities. ATVs commonly use this area -- because it is located about 3½ miles NE of Fillmore, Utah. A culinary water development exists in the area for the purpose of providing seasonal flows over to nearby residents. If this project is implemented … the eastern and southern parts of the unit is prone to puddling and compaction problems due to loamy and fine textured soils. As it turns out, most of these areas currently support mountain big sagebrush with perennial grasses – so, very little, if any, mechanical treatments would occur to reduce hazardous fuels in the form of pinyon – juniper trees. If soil deformation occurs … and runoff conditions become a problem for the North Canyon Road – surface tillage of the problem areas would

allow for normal infiltration of water back into the soil profile. Once again, if our land treatments consist of scattered thinning followed by low to moderate intensity burns … there will be no detrimental effects to the State of Utah and private lands surrounding this polygon.

- Horse Hollow … this area is located in close proximity (2 miles) to the city of Fillmore, Utah in the Chalk Creek drainage. Included in the area are dirt roads and trails going into Mountain Sheep Canyon and Horse Hollow along with a gravel transportation surface treated with Magnesium Chloride located along the South Fork of Chalk Creek. The local permittees do not graze their livestock in this area … because it's difficult to remove the animals from the densely growing PJ and mountain brush. A few small riparian zones exist within the perimeter of this treatment unit – but, would not be treated to reduce hazardous fuels. As might be expected, this unit receives heavy use from ATVs – especially during the Jamboree events on Chalk Creek Canyon Trail and along the Sand Rock Ridge Road. Several picnic areas are located about ¾ of a mile east of the proposed treatment area. The Fillmore Irrigation Company has a water diversion in the Chalk Creek drainage and the community of Fillmore, Utah has a developed water system for its residents. Overall, the cumulative effect of implementing the proposed fuels reduction treatments on this unit would be to 1) have some temporary development of water-repellent ground conditions occurring on the coarse-textured located along the northern edge of this area and 2) a few shallow areas may actually have accelerated erosion rates that exceed 1 ton/acre/year during the first year following the planned treatments – but, impacts will amount to less than 15 % of the total acreage within the area. Most of the landscapes considered as being susceptible to either puddling or compaction (western ⅓ of the polygon) currently support Gambel oak with mountain big sagebrush – vegetative types that would not being treated with mechanical thinning. Some areas of this unit may require broadcast seeding in an effort to maintain or improve long-term soil productivity. If our treatments consist of low to moderate intensity burns on 40 to 80 % of the unit … there will be no detrimental effects to the State of Utah and private lands surrounding this polygon.

- Meadow … generally speaking, most of the mechanical thinning of PJ on BLM lands has already been completed on this treatment unit. The region has been open to the activity of hunting during the late summer and early fall seasons; a few areas have been utilized for dispersed camping activities during the different game hunts. Some parts of the Meadow area have been defoliated by Mormon crickets over the past several years – but, not to the point of causing erosion because of droughty climatic conditions. This part of the Meadow Creek Allotment is managed for livestock using a 2-unit alternate year grazing system. The proposed treatment area receives limited use from either wildlife or livestock due to the lack of available water combined with little palatable forage. If this project is authorized … the range will require 2 or more years of rest to allow for the establishment of seeded vegetation. The fragile riparian zones located along Meadow Creek would not be treated as part of this project. The road located along Meadow Creek has been graveled for about 1½ miles before it turns into a dirt surface once again; the remaining roads on Meadow Bench and within Walker Creek are unimproved transportation surfaces which allow for access on public lands. Several trails for ATVs and horses exist within and surrounding the proposed treatment area. The FS / Meadow Bench Campground gets some use by local residents during the summer season – mostly on weekends. The nearby community of Meadow gets its culinary water from the Meadow Creek basin. In addition, a diversion has been built to allow for excess flows to be used for irrigated croplands. To my understanding, a flood control structure (small debris basin) has been constructed to protect the residents of Meadow during spring snowmelt conditions and summer thunderstorm events. Most of the talus slopes associated with Chief Walker's Grave Site (located ~ ⅛ mile SE of this polygon) support < 10 % vegetative cover … so, the likelihood that a fire would carry into that area is relatively small. If implemented … most of the unit will eventually resemble the Adelaide Fire of 1996, located about 5 to 7 miles SE of the Meadow polygon, with few hazardous fuels observed on-the-ground, excellent recovery of perennial grasses and upland shrubs – especially on the hardpan soils and no potential for flooding hazards to either I-15 or the community of Meadow, Utah.

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If left untreated … all of these units will remain quite susceptible to large incidents of catastrophic wildfire because of the existing build-up of hazardous fuels. Simply stated … the Fillmore Ranger District (Canyon Mountains and Pahvant Range) gets more lightning strikes than any other part of the Fishlake National Forest. If a large burn occurs across the landscape causing severely burned sites … the small communities located in eastern Millard County will be at-risk of flooding hazards.

Under the present conditions, the productivity of the soil resource is being maintained throughout most of the Pahvant Subsection. Some of the riparian areas are currently at risk because these fragile sites are not in properly functioning condition. A few upland locations may have small areas of compaction and puddling type disturbances related to grazing by both livestock and upland big game animals. It remains reasonably foreseeable that another large incident of wildfire could impact the Pahvant Range – much like 1996 and 2000. In the event of a large scale, uncontrolled fire -- having a long residence time, detrimental conditions would exist on the ground after the burn. By implementing the action alternative, the Forest would be addressing the issue of hazardous fuel accumulations; another indirect benefit would be achieving ecosystem restoration treatments in decadent vegetative communities. The proposed management action has a certain degree of risk associated with its implementation … but, if prescribed fire treatments are conducted with a genuine regard for the fragile nature of the soil resource, most, perhaps all, of the low to moderate intensity burns will be beneficial to our public lands.

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