Johnson, Steve, 1995

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R To: 2500 Date: Feb 6, 1995

Subject: Factors Supporting Road Removal and/or Obliteration

To: Fire Recovery Hydrologists

Hilaire asked me recently to put some thoughts down as to why we, as hydrologists on the fire-recovery teams, were recommending road removal and/or obliteration. It was a question that is coming up frequently now among IDTs so I spent a some time thinking about the subject and offer the following for you to use as you see fit when questions about roads, road problems, and road obliteration objectives come up:

NOTE: The articles mentioned herein are by no means complete as to the amount of available information on the subject. However, I believe they provide enough information to explain why I believe road removal and/or obliteration should be emphasized, on a case by case basis, for the fire salvage analyses.

ROADS AND FOREST HYDROLOGY- Roads have been identified as the major impact on the forest environment. Literally hundreds of publications in the last 10-20 years have brought this out. California analyzes cumulative watershed effects in NEPA documents using the Equivalent Roaded Area concept, much the same as we u[illegible]e Equivalent Clearcut Area concept. They do this because they realize ro[illegible] are the phenomenon of change in their environment, so they relate all activities to that one.

These impacts from roads basically fall into three areas: introduced sediment into streams; snowmelt re-direction and concentration; and surface flow production. Each is briefly documented in this paper.

INTRODUCED SEDIMENT- This one is pretty obvious so I won't spend a lot of time on it (entire books have been written on the subject, including one by the EPA several years ago). However, I need to mention that road surface drainage, and the sagging of road ditches into channels and creeks, continues to be the most common BMP violation we have on this forest. Roads designed in the past, the very ones we are trying to obliterate now, were designed without current BMP philosophy in mind so it is not surprising. For the roads we no longer actively use, our dwindling road maintenance budget will make it difficult to maintain the culvert crossings. When these fail during storm and runoff events, tremendous amounts of sediment can be delivered directly to the channel and from there down into lower streams with significant beneficial uses such as sensitive fish habitat. **It is important to note that culverts can fail if not maintained even on roads that have become so brushed in that travel is difficult.** Even on roads that appear to be so thick with alder that a sediment production concern seems ludicrous, we often find that the road tracks are still actively functioning as erosion sources. True, it is not the magnitude it was when the road was constructed, but it is still an erosion source that comes into play during events when we also have plenty of flow to take the erosion on into a channel.

<u>SNOWMELT RE-DIRECTION AND CONCENTRATION</u> Roads are basically a horizontal feature in a landscape driven by vertical, gravity driven processes. Spring snowmelt and runoff from our frequent mid-winter melt and rain-on-snow events that would normally travel in a downhill direction, usually as shallow sub-surface flow, is intercepted by the compacted roads and their ditches and becomes surface flow. By doing this they are, in effect, dramatically increasing the drainage efficiency of a watershed. Increasing the drainage efficiency of a watershed concentrates flow so that peaks are higher. A recent Oregon State University Thesis by Wemple under the direction of Gordon Grant, focused on the hydrologic interaction of forest roads with stream networks. In this document they clearly point out the contributions of the road and ditch network to peak flows. They suggest that the roads in their study might have extended the stream network by as much as 40% during storm events. Couple this fact with information from a USGS study by Carlston that found that the mean annual flood varies with stream density in the form of $Q/mi^2 = 1.3\ D^2$, where Q is flow and D is drainage density. Using Wemple and Grants' finding of a 40% increase in drainage density and applying it to this equation, we find that the flow would almost double (1.96 times) using an average figure from their work. They found these results in two watersheds where the road density was only **1.61** **$mi/mi^2$**. In many of our watersheds, and particularly in ones where we are trying to remove or obliterate older roads, we have densities of roads, jammer-logging trails, and major skid-trails that **exceed <u>20 mi/mi²</u>**. The average watershed on this forest is probably double their average, and the heavily harvested ones probably triple or more. Thus our efficiency increase would be expected to be even higher.

In another study which documents this phenomenon, Hollis examined the effect of basin urbanization on flood recurrence intervals. While this may sound like it does not apply, I believe it does because he found that the development of a **storm water drainage system which increased the <u>drainage efficiency</u> of the basin** was involved. In his analysis he also used information from Leopold relating floods to the percentage of the area that was impervious.

Hollis found dramatic increases in the size of floods: small floods may be increased 10 times; and the 100-year flood may be doubled in size when drainage is basin-wide and 30% has been paved (left with impervious surfaces). In our basins on this forest, we are talking about a road network that functions as the efficiency improvement, and harvest units and road surfaces that function as impervious or reduced infiltration areas, so I believe their work is very applicable.

Studies by Dennis Harr have consistently pointed out the effects of the compacted surfaces (roads, skid trails, landings, and firelines) on peak flows. In the watersheds he has studied, he has found significant peak flow increases when only 6% of the watershed was compacted, and numerous authors have used Harr's data to claim that a 12% threshold exists (believing that keeping compacted surfaces below 12% will protect channels from the effects of peak flows). While pointing out the fallacy of the "12% threshold", Harr does emphasize that building and locating roads so as to not intercept and re-direct water is very important.

Burroughs et al in the Bitterroot Mountains (Volume of Snowmelt Intercepted by Lo g Roads); and King and Tennison at Horse Creek (Alteration of Streamflow C .teristics Following Road Construction in North Central Idaho) have all documented the effects of roads on the normal drainage phenomenon on forested slopes.

<u>SURFACE FLOW PRODUCTION</u> Roads in our glacially-modified environment actually produce water: Infiltration rates in glacial soils are not high, particularly more than a few feet below the loess/till interface. Road cuts that exceed a few feet in height take shallow subsurface water and convert it to surface flow, adding it to a ditch where it becomes part of a peak flow event. Publications by Megahan (Subsurface Flow Interception by a Logging Road in Mountains of Central Idaho), and the King/Tennison article mentioned above all relate to the surface flow developed by roads. Based on the observations of Hydrologists and the Soil Scientist, the KNF used a factor of 1.3 in the old Kootenai Water Yield Model to indicate that we believed roads produced 1.3 times the flow of a normal clear-cut unit. We did not have the hard data to back this number up, but it looked reasonable.

A few years ago the Flathead NF developed data to substantiate this number. They investigated a large harvest area that had very few channels but which was having a problem keeping pipes in place: they were being consistently over-topped and blowing out. They discovered that the road cuts were intercepting shallow sub-surface flow and converting it to surface flow that was then being routed to channels and culverts at road crossings. They sent a crew out to actually gage the flow in the ditches being produced by the i ception. They found that amounts varied by soil material, as expected, b .so found that the flow volumes, in $FT^3$/second, were amazing. The Flathead data is summarized below:

| SOIL MATERIAL | CFS PER MILE OF ROAD AVERAGE | RANGE |
|---|---|---|
| Fine sandy till | 3.7 | 1.1 - 8.4 |
| Lacustrine till | 1.6 | 0.5 - 15.3 |
| Residual Upland | 1.6 | 0.5 - 5.8 |

Interpretation: In basins with average road densities, on the order of 4+ $mi/mi^2$; and the **average** flow production rates listed in the table, we can have between 6 and 15 cfs of water added to the natural amount **for every square mile in the basin**. Based on the upper end of the measured ranges of surface flow generation, we could have <u>up to 61 cfs per square mile of drainage basin</u>. It is easy to see why the Flathead was blowing out their crossings.

In portions of our forest, where we have the road densities mentioned above (10-20 $mi/mi^2$) and substantially more precipitation than this area of the Flathead, we have had similar problems with crossings. To our credit we have consistently sized our culverts larger than would the Flathead, but the discussion still points out the volumes possible and the hazards involved with road interception of shallow sub-surface flows. Removing or obliterating roads s at the flow would remain sub-surface is a major benefit of the proposals w e suggesting.

**THE BOTTOM LINE** We have many watersheds on this forest, including most within the fire salvage analysis areas, where water yields from past events are already stressing or damaging the aquatic system. Roads, through their interception and re-direction of sub-surface runoff, have had a major contributing emphasis. Restoration of the normal drainage phenomenon can be achieved through the use of road removal and obliteration. In fact, Wemple concludes that modifying road segments is the **most effective way** to approach watershed restoration.

Also, in the Purpose and Need Statements for Salvage Projects in these areas, we need to explain why salvage activities will lead to an improvement in watershed condition. For streams listed on the Montana TMDL (water quality limited) list; for watersheds we have identified as being in degraded conditions even before the fire; and in watersheds that we know were in experiencing problems, it is absolutely critical that we be able to show that our activities are a plus. In the case of the TMDL-listed streams, the State Water Quality Division has told us we cannot cause any increases in listed problem parameters, which usually include sediment. Showing a decrease in sediment while we salvage log will require us to show a decrease elsewhere in the watershed so the **net** change is in the positive direction. A reduction in total road mileage through obliteration will enable us to show this improvement. If we cannot show an improvement, we stand little if any chance of having regulatory agency approval for salvage activities, regardless of our assertion that we will use generated funds for watershed rehabilitation.

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attachments: references used

REFE[illegible]ES (copies of all but Wemple attached [provided earlier])

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