



# Prioritizing Road Restoration using the Geomorphic Road Analysis and Inventory Package (GRAIP) to Improve Watershed Conditions in the Wall Creek Watershed, Oregon

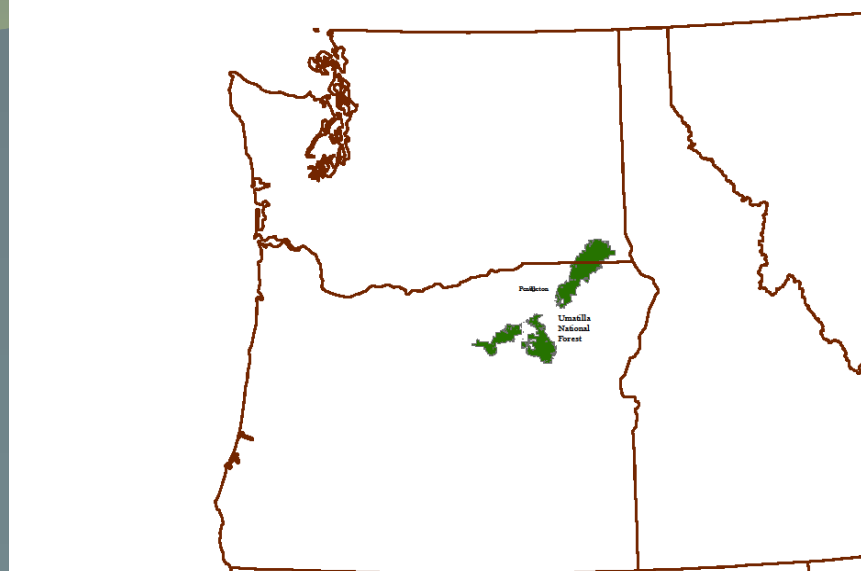


## #H43D-1272

Kate T Day<sup>1</sup>, Nathan Nelson<sup>2</sup>, Catherine Clifton<sup>1</sup>, Tom Black<sup>2</sup>, Charles Luce<sup>2</sup>, and Sara McCune<sup>3</sup>

kateday@fs.fed.us

Affiliations: <sup>1</sup>Umatilla National Forest, Pendleton, OR, <sup>2</sup>US Forest Service Rocky Mountain Research Station, Boise, ID, <sup>3</sup>Whitman College, Walla Walla, WA

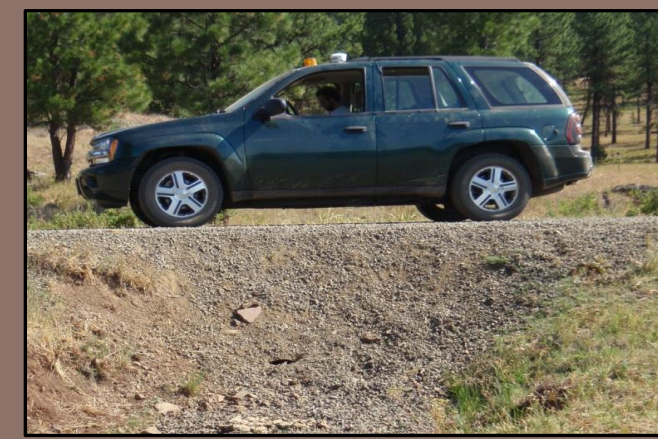


### The Geomorphic Road Analysis and Inventory Package (GRAIP)

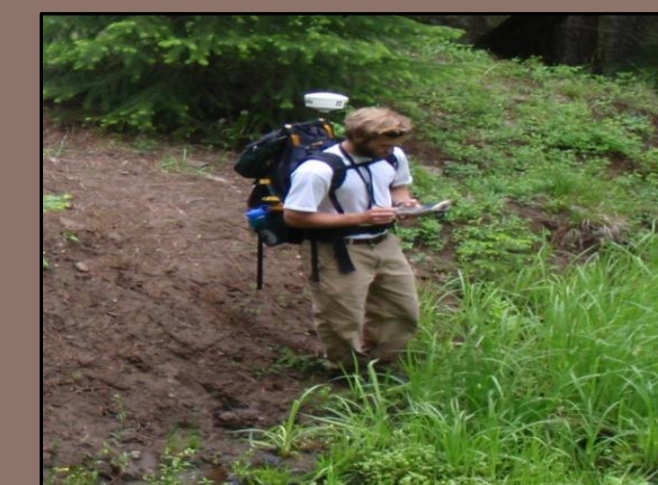
- GRAIP is a set of tools that quantifies road surface sediment production and delivery, assesses mass wasting and gully risk, and stream crossing failure potential.
- Developed by the Forest Service Rocky Mountain Research Station and Utah State University: <http://www.fs.fed.us/GRAIP/index.shtml>

Two primary steps in the process:

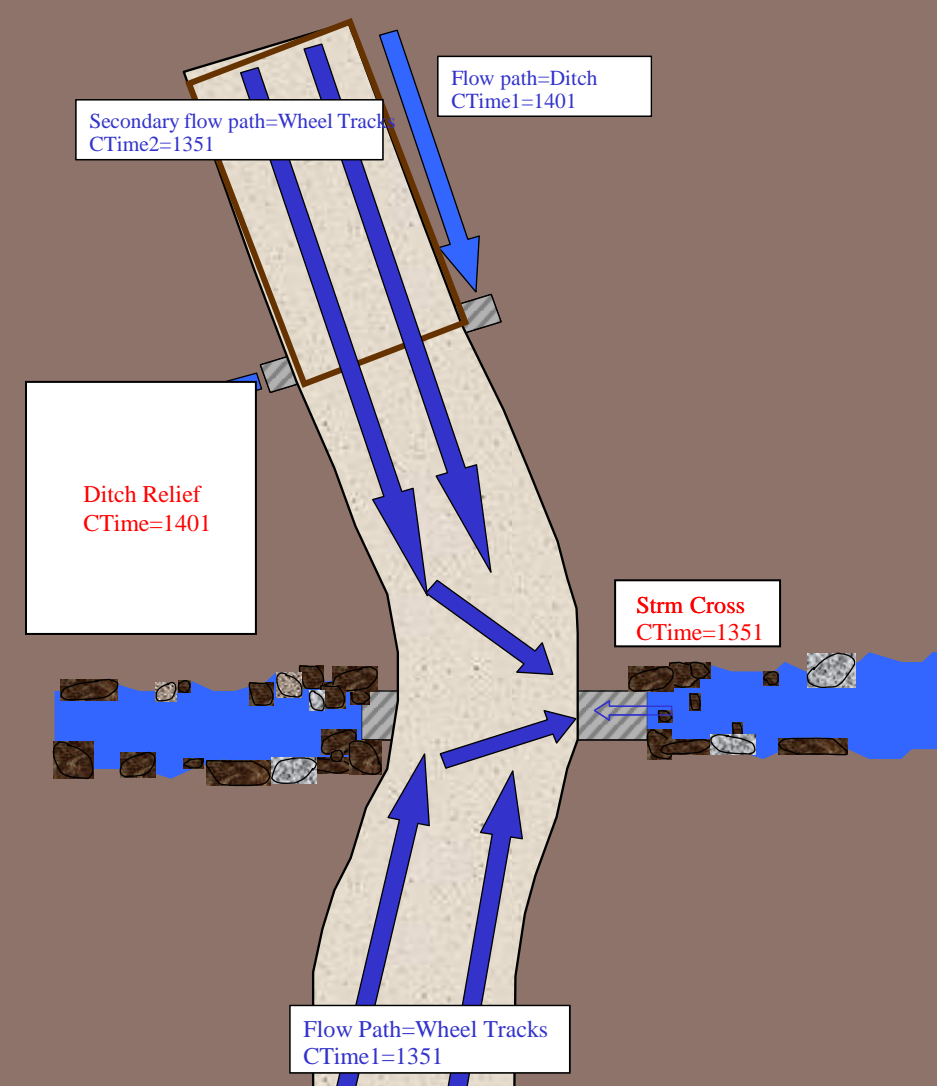
1. Detailed quantitative field inventory of water and sediment routing and hydrologic connectivity on road segments and drain points using GPS and TerraSync™ data dictionary.



Data collection on an open road.



Data collection on a closed road using backpack GPS unit.

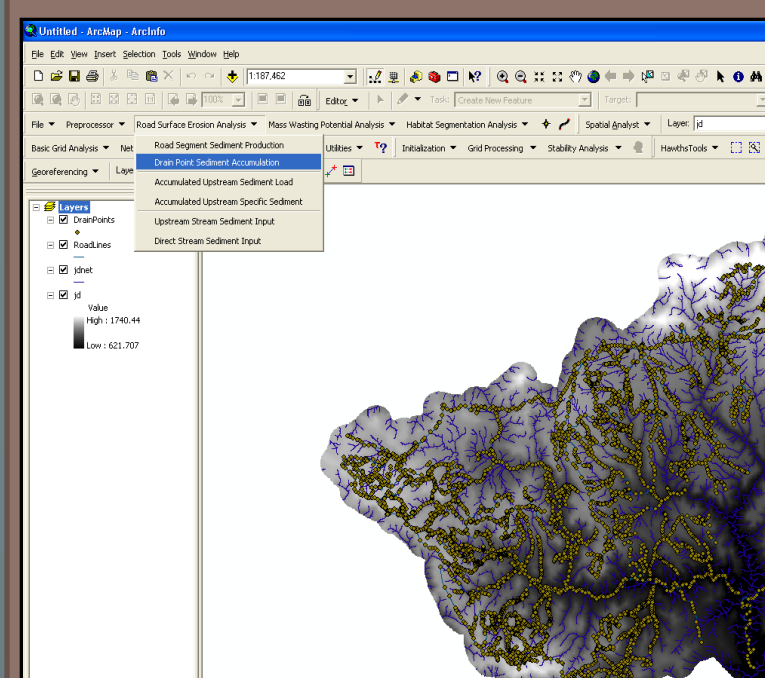


Schematic of road segment and drain point data collection method.

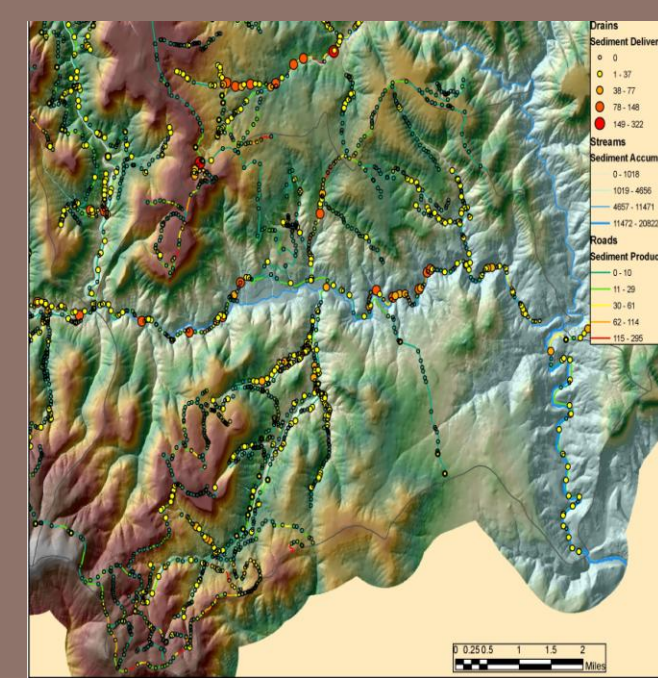
Sediment production is calculated using the following equation and empirical data collected in the road inventory<sup>4</sup>:

$$\text{Sediment Production (kg)} = B \times L \times S \times V \times R$$

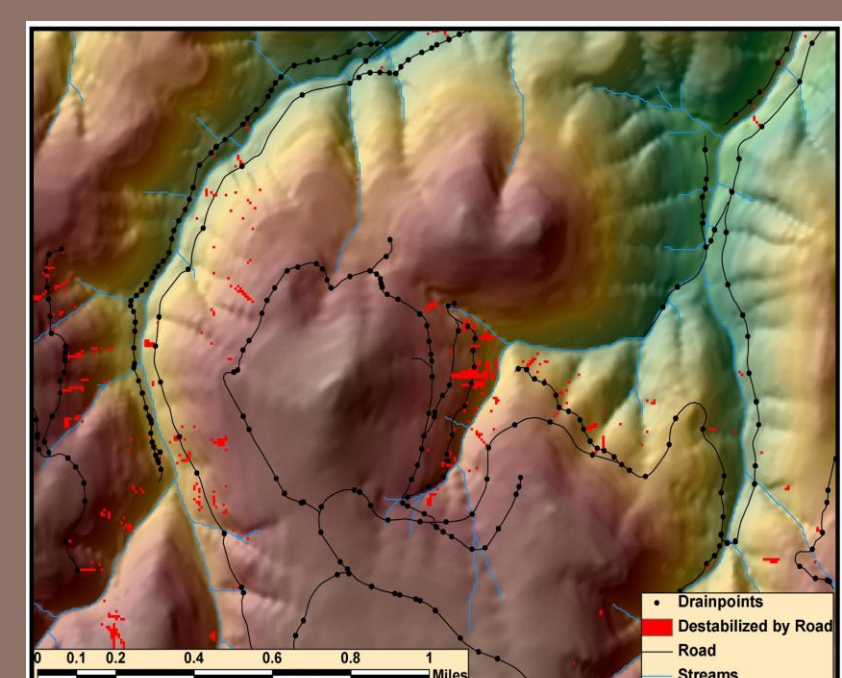
B = Base erosion rate (kg/m of elevation change)  
 L = Flow path length (m)  
 S = Flow path slope (m/m)  
 V = Vegetation factor  
 R = Road surface factor



Screen capture of ArcMap™ during modeling process.



Model output showing road and drain sediment production and delivery.

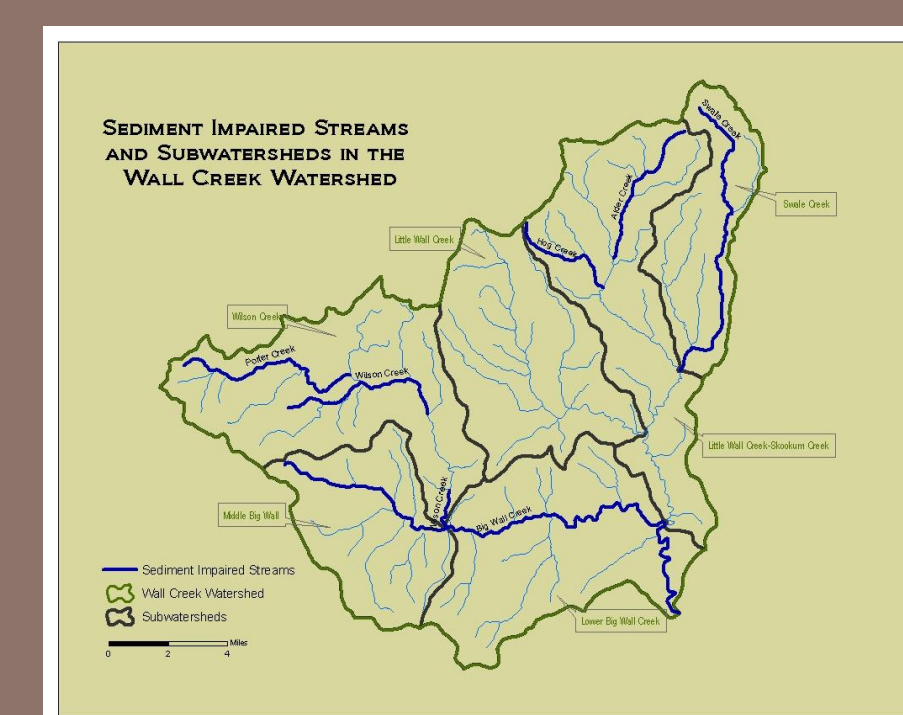
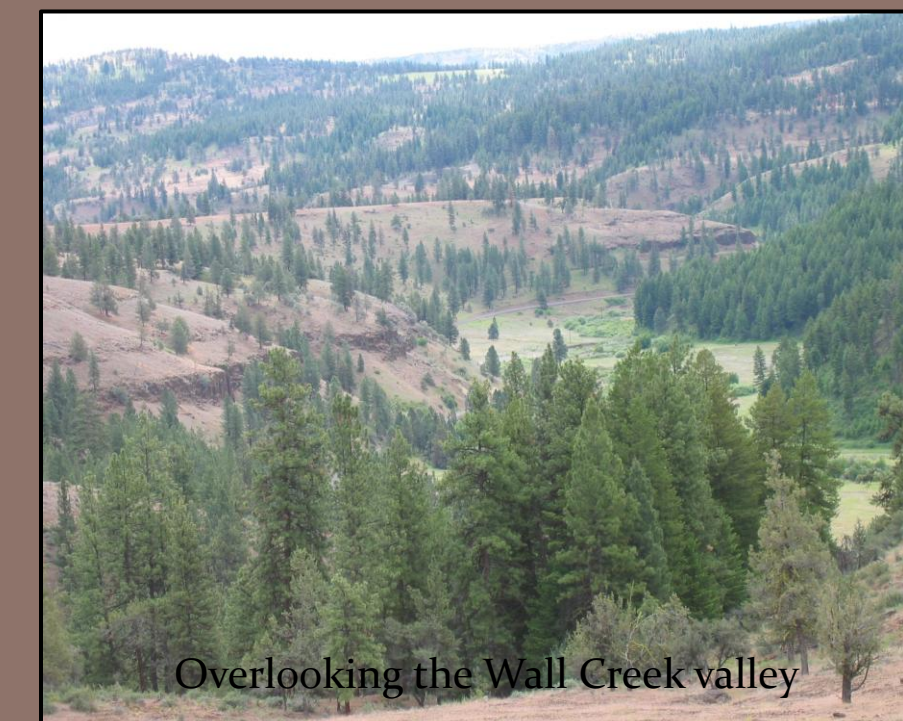
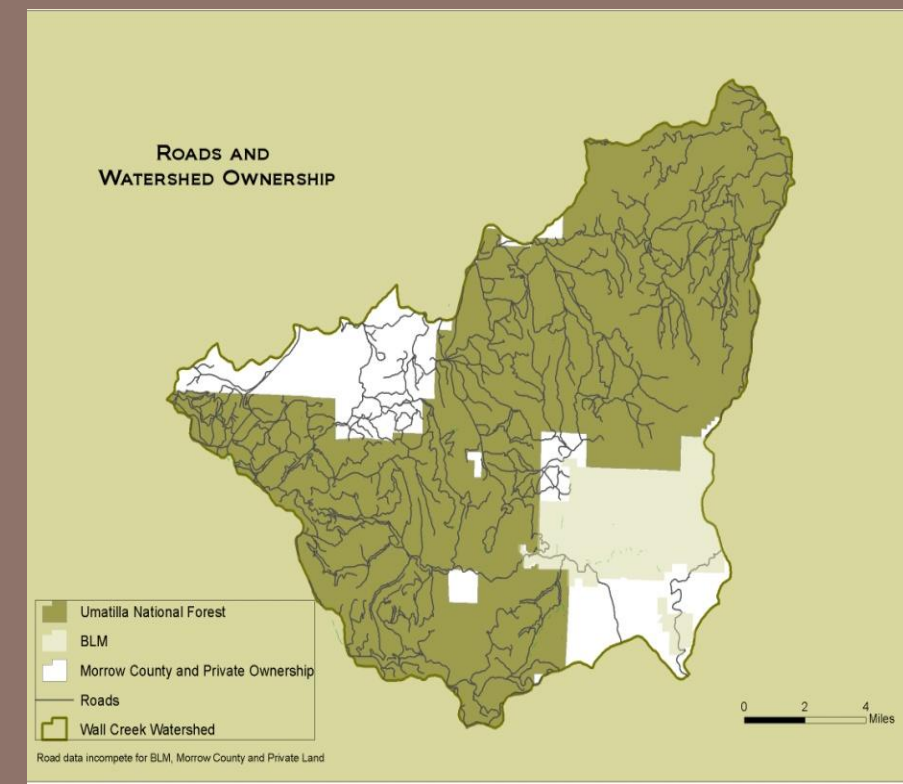
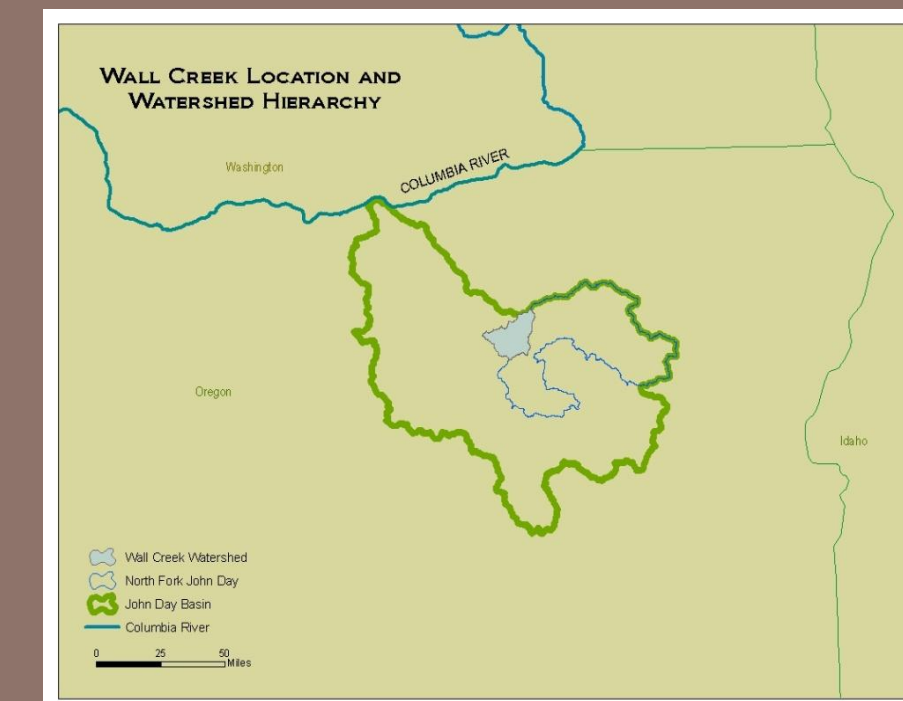


SINMAP Model output showing road-related landslide risk

- GRAIP produces a georeferenced inventory of road and drain point sediment production and delivery, location of stream crossings with high blockage potential, gully location and cause, and mass wasting potential.

**The exact location of all road-related sediment inputs is known for all surveyed roads making GRAIP an effective tool for managers to quickly prioritize road treatments at the watershed scale.**

### Wall Creek Watershed



<b>Drainage area</b>	128,050 acres 518 km <sup>2</sup> 200 mi <sup>2</sup>
<b>Watershed hierarchy</b>	Tributary to the North Fork John Day River in the John Day Basin
<b>Major geologic units</b>	Columbia River basalts, Picture Gorge basalts, John Day formation (tuffs), exotic terrains (metamorphic and sedimentary), Mazama ash
<b>Elevation range</b>	1739 m (5707') at Madison Butte 629 m (2060') at confluence with North Fork John Day River
<b>Precipitation</b>	23" Annual average Ranges from 13" at the confluence, to 30" at Madison Butte Intensity (10-Yr-6 Hour) = 1.2"
<b>Stream discharge at mouth</b>	Low flow from 0 to 0.14 cms (0-5 cfs) Average ~ 2.2 cms (80 cfs or 0.4 cfs) 2-YR flood ~ 24 cms (865 cfs or 4.3 cfs) 50-Yr flood ~ 69 cms (2453 cfs or 12.3 cfs)
<b>Land ownership</b>	74% Forest Service 10% BLM 16% Private & County
<b>Roads</b>	Total = 1030 km (640 mi) FS and BLM = 837 km (520 mi) Miles of closed road = 446 km (277 mi) <i>Forest Service data only</i> Average road density = 3.2 mi/mi <sup>2</sup>
<b>Air temperatures</b>	Maximum = 32°C (90 °F) July Minimum = -6 °C (21° F) January
<b>Forest vegetation types</b>	Mixed dry pine plant communities in lower elevations Cool-moist grand fir/Douglas-fir in higher elevations (watershed about 70% forested)
<b>Streams</b>	Total = 1175 km (730 mi) Perennial = 296 km (184 mi) Fish-bearing = 172 km (107 mi) Mid Columbia River steelhead = 154 km (96 mi) Most streams are designated critical habitat for steelhead 303(d) streams (6) listed for sedimentation = 96.7 km (60.1 mi)
<b>Watershed sediment yield</b>	Estimated at 158,000 kg per year at mouth of Wall Creek <sup>1</sup>

#### Why use GRAIP in Wall Creek?

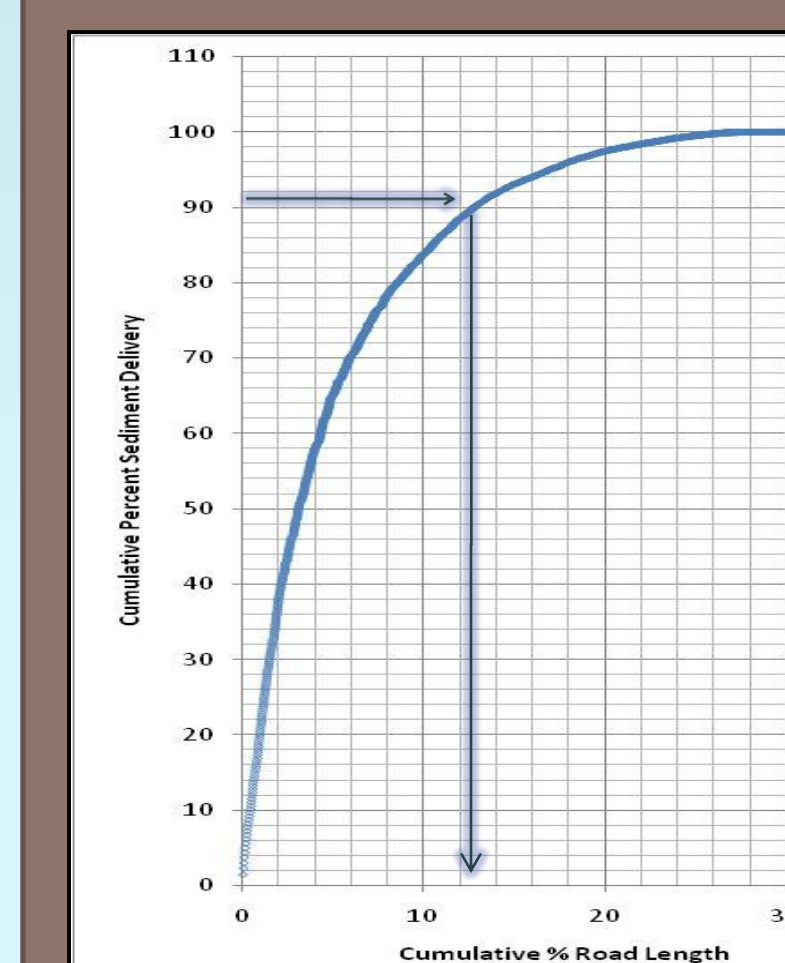
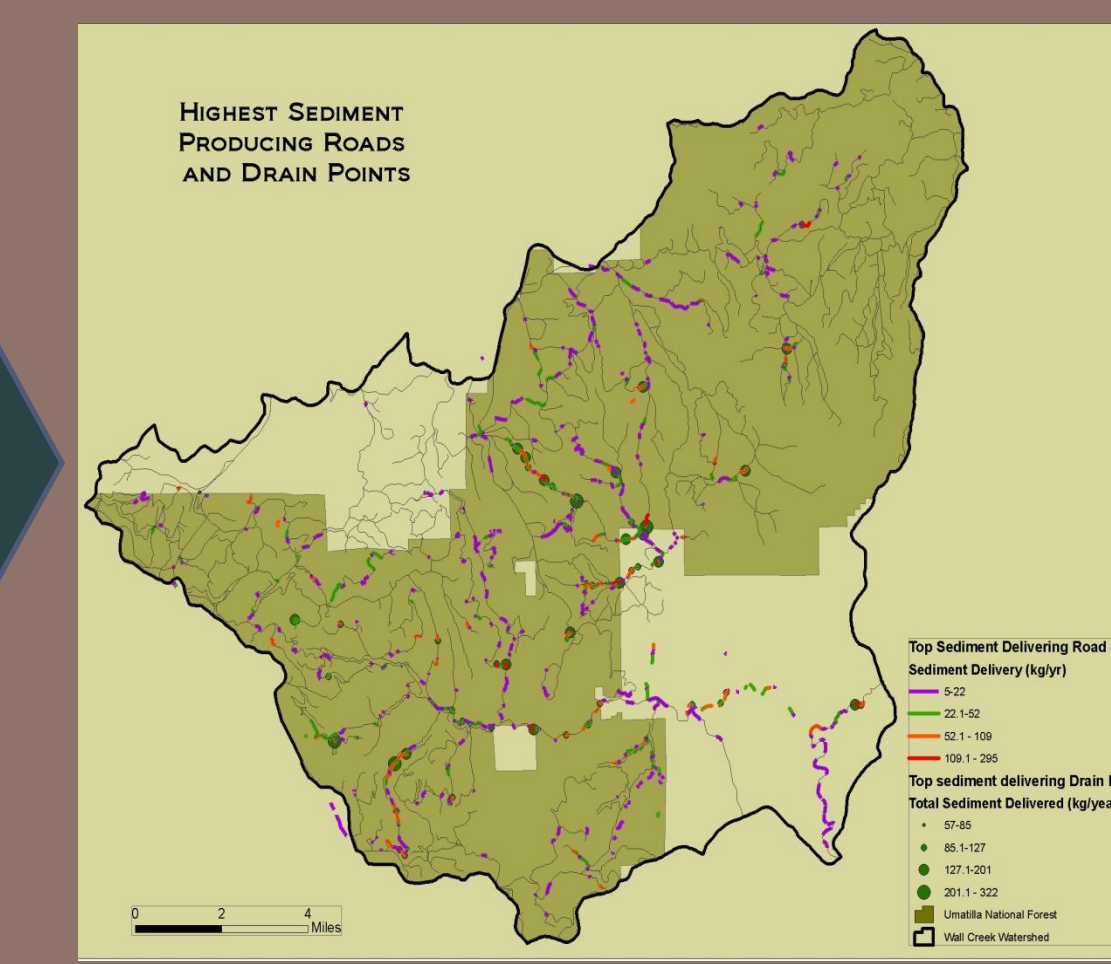
- US Forest Service Region 6 focus watershed for restoration activities.
- Roads were identified in a 1995 watershed analysis as the major factor affecting watershed conditions, and resources for managing these roads are limited.
- Sediment impairment listings and future TMDL development warrant the use of a tool that can quantify sediment production and potential sediment reduction so that numeric criteria can be developed and met.

### Application of GRAIP in the Wall Creek Watershed

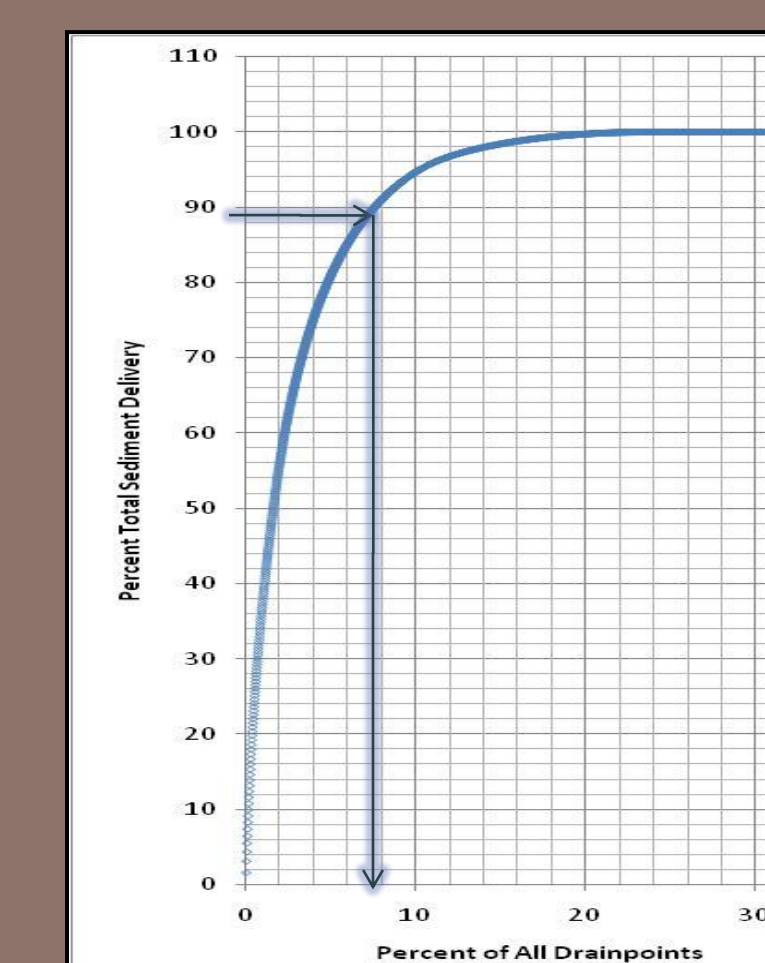
- Data collected on 726 km (450 miles) of road (90% of federal road miles) in the watershed in the summer of 2009.
- Work was funded by a grant from the US Environmental Protection Agency (EPA), and the Umatilla National Forest, BLM, and the Forest Service Rocky Mountain Research Station.

#### Results:

- 27% (198km, 123 miles) of inventoried road are hydrologically connected (deliver water and sediment directly to the stream system).
- 81,445 kg/year of sediment produced by the road system
- 20,976 kg/year of sediment delivered to the stream network
- 12% of inventoried road length (93km, 58 miles) delivers 90% of sediment to streams.
- 9% of inventoried drain points (approximately 100) deliver 90% of sediment to streams.



12% of inventoried road length delivers 90% of road-related sediment.



9% of inventoried drain points deliver 90% of road-related sediment.

**A small percentage of the road system and drain points deliver the majority of road-related sediment and the location of these roads is known in the Wall Creek Watershed.**

#### Other Findings:

- 55 Stream crossings have a high blocking potential during storm events.
- 59 gullies recorded; 14 receive runoff from a road drain point.
- Landslides are uncommon in the watershed; 19 were recorded, 16 are road-related. The excavated volume of these features totals 3,922,000kg; 175 years of fine sediment delivery at the current rate.
- Sediment from the road system makes a relatively small (<5%) contribution to the estimated natural background watershed sediment yield of 518,000 kg/year.

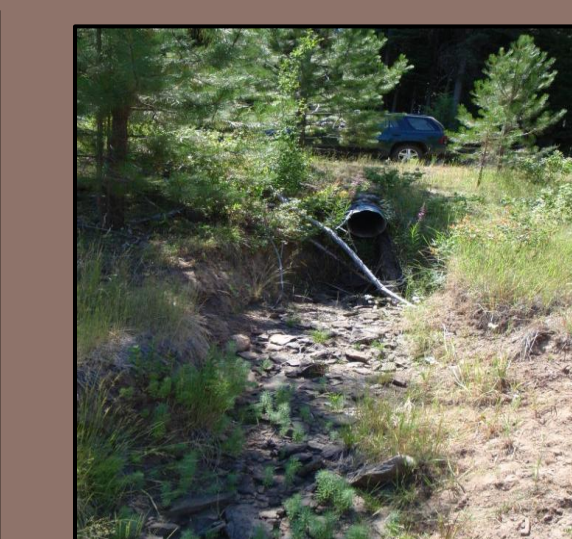
### Using GRAIP Data to Prioritize Road Work and Improve Watershed Conditions

- Based on the key finding that a small number of roads and drain points produce the majority of road-generated sediment in the watershed, these features were revisited in the summer of '10 to prioritize road work. Location of roads and drain points revisited are shown the "Highest Sediment Producing Roads and Drain Points" Map.

#### Road problems found in Wall Creek:



Road initiated gully



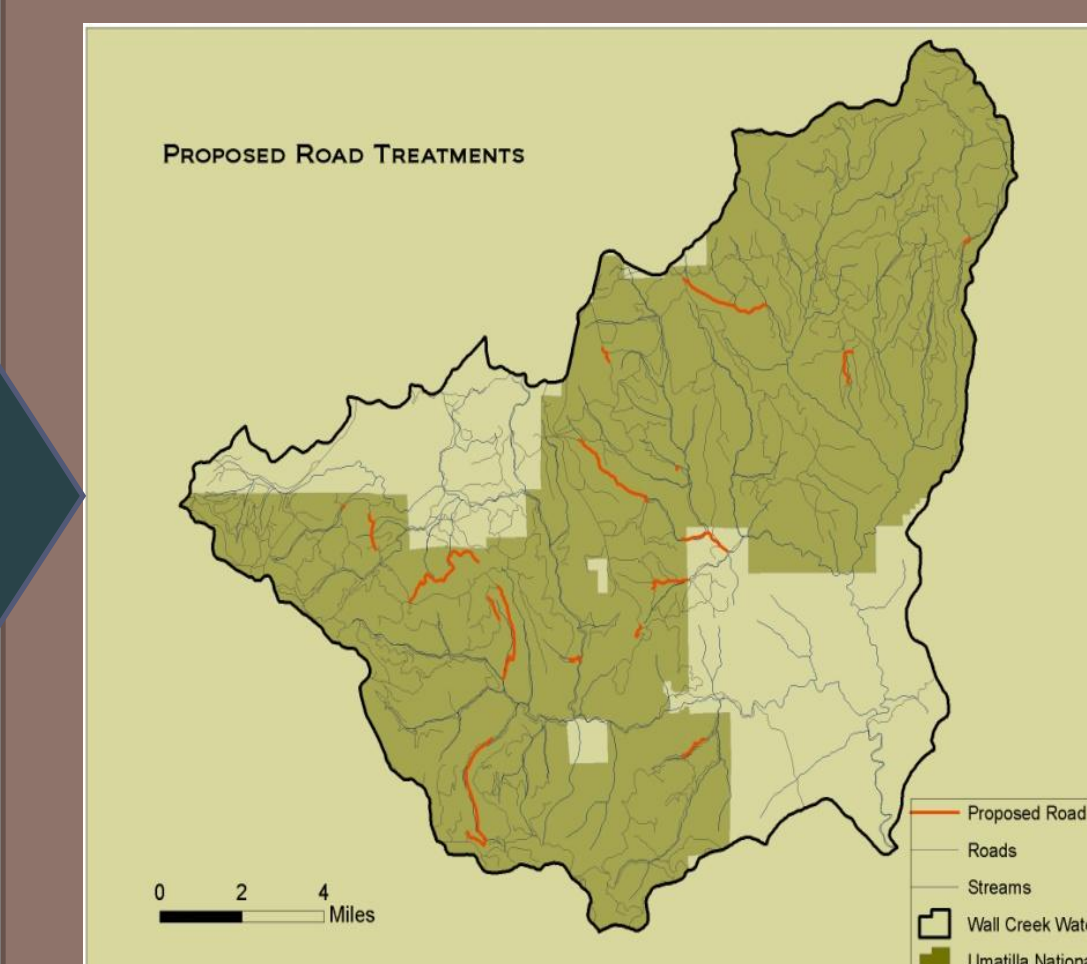
Headcut below culvert



Diverted stream on road



Road rilling



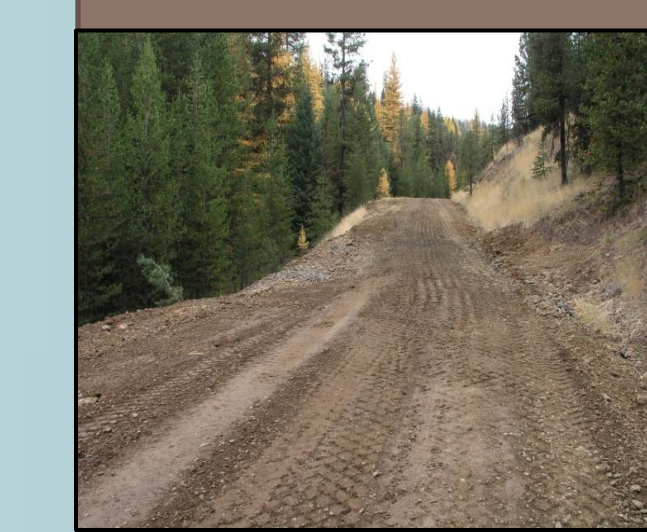
Highest sediment producing roads, drain points, and crossing with high blocking potential were revisited and treatments were developed (shown in orange).

Road Treatment	Proposed Treatment Length (miles)	Potential Sediment Delivery Reduction (kg/year)
Decommission	2.2	1,440
Maintenance (May include installation of waterbars and rolling dips, gravel, blade, stabilize, clean ditches and culverts)	5.5	3,162
Storm damage risk reduction (Pull culverts, install waterbars)	1.8	571
Stormproof and Close	1.6	592
<b>Totals</b>	<b>11.1</b>	<b>5,765</b>

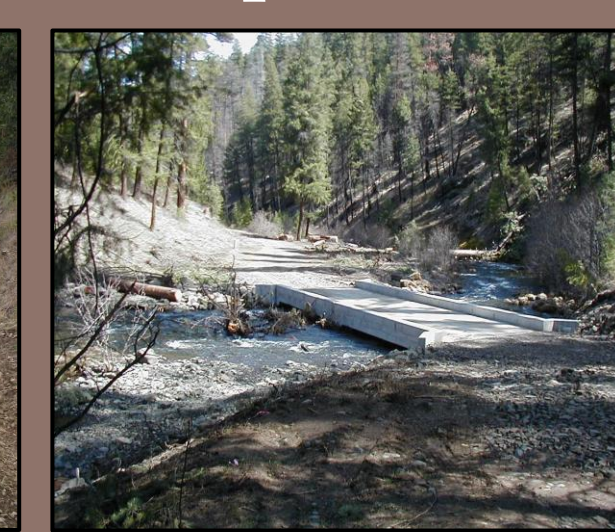
#### Future Work:

- Work is currently in the planning stage—treatments will begin in 2012.
- Data are also being used to guide economic analysis of a sustainable road system in the watershed.
- Data being used to help develop sediment TMDLs in the John Day Basin in partnership with Oregon Department of Environmental Quality and EPA.
- Sediment from the current road system may not be the primary source of water quality impairment in Wall Creek. Data and findings will be used to guide investigation of other sources of impairment including legacy landslides and gullies, and road hydrologic connectivity related to stream channel and riparian function.

#### Road treatment examples:



Armored dip



Low water vented ford



Decommission before



Decommission after

References: <sup>1</sup>Harris, R. M., Clifton, C. F., and S. M. Wondzell. 2007. Hillslope erosion rates in areas with volcanic parent materials and the effects of prescribed fires in the Blue Mountains of Eastern Oregon and Washington, USA. In: Furniss, M.J., Clifton, C.F., and K.L. Ronnenberg, eds., 2007. Advancing the fundamental sciences: proceedings of the forest service national earth sciences conference, San Diego, CA, 18-22 Oct. PNW GTR-689. Portland, Oregon. pp. 7-19.  
<sup>2</sup>Nelson, N., Clifton, C., and Black T. 2010. An Analysis of Road-related sediment in the Wall Creek Watershed using the Geomorphic Road Analysis and Inventory Package (GRAIP). Presentation at April 2010 BLM Conference.  
<sup>3</sup>Nelson, N., Clifton, C., Black, T., Luce, C., and McCune, S. 2010. Wall Creek Watershed GRAIP Roads Assessment. Final report to EPA agreement #1324-08-1A-213, September 2010, on file Umatilla National Forest, 2517 SW Hailey Ave, Pendleton, OR, 71 p.  
<sup>4</sup>Prasad, A. 2006. A tool to analyze environmental impacts of road on forest watersheds. MS Thesis. Utah State University, USA.  
<sup>5</sup>Umatilla National Forest. 2009. Wall Creek Watershed Action Plan. Report on file Umatilla National Forest Supervisor's Office, Pendleton, OR.