Getting the Water off the Road!

Road into the Nielson family's Bluewater Heritage Ranch near Grants, NM (see previous story on page 15).

By Steve Carson

Noted wildlife biologist and surface hydrologist, Bill Zeedyk, has observed that, "Roads are the biggest impediment on our watersheds. They concentrate and divert water, dewatering one area and causing erosion in another. Plant vigor suffers, soils are washed away and sediment fouls our water courses." Aldo Leopold made the same observations in his survey of New Mexico and Arizona in the early 1900s.

In conducting numerous watershed condition assessments over the years, primarily using the criteria set forth in Watershed Assessment of River Stability and Sediment Supply (WARSSS), II Edition Rosgen 2009, roads generally come out on top of the list of situations within the watershed that are contributing to watershed instability and an increase in sediment supply into our river systems. The damage created by roads to our watersheds and their surface hydrology is unprecedented to any other anthropogenic activity in the arid Southwest. Couple the effects of roads with the impacts of poorly managed grazing and livestock trailing in past years, and we now have a landscape that is completely changed from what it was 200 years ago.

Since the negative effect of roads on watershed stability has been well documented, it is a forgone conclusion that the condition of many miles of low-standard roads in the Southwest needs to be addressed. Since road drainage is very cost-effective per mile treated and per problem solved, it should then be one of the first treatments conducted in the pursuit of restoring watersheds.

Losing water to the road . . .

Over the years I have personally installed over 7,000 drainage structures across more than 700 miles of roads from West Texas, across New Mexico and all over Arizona. The problem is the same in all locations, as is the solution: to reengage the water back onto the watershed. My working motto is: "It's not a road problem—it's a water management problem."

Roads collect, concentrate and divert the original natural surface flow-patterns within our watershed. This concentration and diversion of flows takes water out of one micro watershed and diverts it into another. The first micro watershed is de-watered and the plant vigor and species diversity is reduced. The second micro watershed is overloaded with the additional flows causing erosion, down-cutting and accelerating sediment contribution into the mainstem system.

Sediment has been identified as the number one water pollutant in our western river systems. It creates geomorphic channel evolution by increasing deposition on point bars, transverse bars and mid-channel bars that accelerates stream bank erosion, which, in turn, contributes more sediment into the system. This sets up an insidious chain reaction that overloads the entire system with sediment and creates mass erosion. This overload of sediment plugs up irrigation works and costs millions of dollars a year to filter out of the water supply so it can be used in municipal water systems. Also, new road construction and the subsequent land disturbance allows noxious weeds to colonize, and the asphalt emulsion and other toxic materials such as the oils used to reduce dust get into our waterways after a rain or snow runoff event.

Slope or No Slope, Drainage is key

When planning solutions to restore and stabilize watersheds, the proper drainage of the road systems will make a significant contribution toward reversing the downward watershed trends and restoring the natural surface hydrological patterns. Road drainage systems are also one of the most cost-effective ways to restore watershed function and decrease erosion and sediment contribution into the overall system.

Two main factors drive the erosion process on roads: 1) the amount of water that is discharged on the road surface (length and width of road) coupled with the amount of time the water is allowed to run down the road surface, and 2) the slope of the road. The first factor, discharge, we can effectively address by aggressively draining the road surface. The second factor, slope, we are generally less able to change due to the topography and/or the cost to reroute the road.

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If the volume of water on the road surface (discharge) remains the same but the slope is doubled (from, say, 2% to 4%), the ability for the water to move surface materials is four times greater and the size of particles the water can move is increased by eight. Hence, the need for more and better drainage features, especially, as the road slope increases.

By the Numbers

Why is harvesting water off roads important? Let's do the math: a 10 foot-wide ranch road, one mile long, will collect 31,200 gallons of water in a 1-inch rain event. Reduce this amount of water for infiltration and evaporation by 20% and now there are 25,200 gallons of water being discharged on each mile of road per one inch of rain. With 14 inches of annual precipitation, each mile of road will collect and discharge 352,800 gallons (1.08 acre feet) of water per mile in one year. Using 20 miles of road (+/- the average miles on a 10,000 acre ranch in NM) = 7,056,000 gallons (21.65 acre feet) that is being discharge off the road surface only in one year. If the water that runs onto the road from the adjoining landform is included, this number can be multiplied by five, which equals 35,280,000 gallons or 108 acre-feet per year of water to be managed off the road. This is an astonishing amount of water that if property redirected off the road can be put to beneficial use. This, in many cases, exceeds the legal number of water rights a ranch may own.

In the practice of road drainage systems in the Southwest, the design and installation of road drainage features needs to be aggressive to be effective, meaning, it's better to err on installing too many drainage features than not enough. Many practitioners after completing a road drainage project and monitoring it for a year have come back with the conclusion, "I wish I would have read the landscape better and installed more drainage. I still have problems that need to be addressed." Also, you need to ensure that a good amount of materials are used in each drainage feature. This will guarantee that the drainage feature will stand the test of time and need very little or no maintenance in the future. The drainage features also need to be constructed so that they drain properly, and do not create a mud puddle or scour out.

When Roads Cross the Water

Road stream-crossing locations can be very problematic and a source of ongoing maintenance cost especially during the monsoon season. The scouring out of the channel-crossing that leaves an elevated drop-off can be easily rectified by placing a boulder grade-control structure on the downstream side of the road crossing. This structure can be in the form of a One Rock Dam, Rock Arch Dam or a Rock Cross Vane. A channel-crossing road should always cross the channel at a right angle.

In some cases, the road runs in a down-valley direction once it crosses the channel and is on the first-terrace elevation (flood plain). A road on the flood plain can lead to what is called "capturing of the flood water." This occurs at high flows and the floodwaters get caught or "captured" in the roadway. This results in the road being washed out and, in some cases, the primary streamflows are rerouted down the roadway. There are a couple of solutions to remedy this situation. The road could be realigned so it crosses the channel at a right angle and immediately climbs up to an elevation that is above the active flood plain. Another remedy is to plug the road at the terrace elevation with a drive-over plug/dike, much like a Rolling Dip. This will divert the floodwaters back into the channel and keep it from being "captured in the road."

Photo of a classic legacy road erosional disaster in Cebolla Canyon south of Grants, NM. The road most likely started in the 1920s, when homesteaders moved to the area. The road crossed a small ephemeral stream channel up a valley and the stream was captured in the road—a very common scenario. Since the road went straight down the valley its gradient/slope was steeper than the stream channel, causing the water to run faster, down-cutting the channel. There is no fix for this other than, if possible, to plug the upper end and put the water back into the original channel.

Other Considerations. . .

Other considerations are the amount and classification of roads within any given management area. Questions the land manager can pose are: Do we really need all the roads that we currently have? Can some of them be left in place, but classified and only used for fire control or big game retrieval, etc.? Can some of the roads be permanently closed, such as double access to the same location? By reducing the number of roads within any land management area we can reduce the cost of road maintenance, erosion and increase the amount of vegetation and forage.

Landowners today must think of themselves as water managers as well as land managers. Road redesign and maintenance are long-term investments landowners can make to maximize the benefits of the precious water they do receive each year. As a side note, conservation easements such as those held by NMLC help protect that investment and support watershed resilience by preventing future subdivision and development and all the associated, additional road work. And, for conservation purposes, easements strictly limit the amount of new roads that can be constructed, even after a property has changed hands.

Same Problem, Same Solution

This type of road drainage and water harvesting can be applied to any dirt, gravel road. We have successfully installed these systems on everything from a simple two-track ranch road to a 30-foot-wide county road with traffic running at 45 miles per hour. This practice has also been used on driveways and rural residential driveways/roads that may be a quarter-mile or more to access the residence.

There are many lifetimes of problematic roads to be drained across the West, so our work is just getting started. At 71 years of age, I am still getting on the bulldozer and fixing roads, but my days are numbered. My focus now is to train others to effectively get the work done.

My simplistic conclusion about the effects of roads on watersheds is this: "Different location, same problem, and same solution—get the water off the road ASAP!" #

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The history of modern roads in the arid Southwest started

with the first Spanish carts with their crude wooden wheels that cut ruts across the arid landscape. The next set of wheels to follow had steel rims and were introduced via the Santa Fe Trail. The ruts cut by the pioneers' wagons can still be seen today and many of them are now arroyos, 20-foot deep. The steel-wheeled wagons traversed every corner of the West that could be driven over or where a primitive road could be constructed. In many cases the arroyos and gullies we now see are a legacy of these old wagon roads and trails, especially in the valley bottoms where it was the easiest place to travel in a horse-drawn wagon. The ruts in the valley bottom converted the original [water] sheet-flow to a concentrated flow. Once the water was trapped in the ruts the velocity was increased enough to down-cut the ruts to the point that there are gullies today that are 20 to 30 feet deep.

The advent of the automobile exacerbated the scenario. Many of the original auto routes followed the same path as the wagon roads. When a road washed out or gullied out to the point it could not be traversed, the road/wheel ruts were just moved over a bit, and another route was carved out. This scenario can be observed at many locations where there are parallel gullies and/or parallel washed-out roads.

The post World War II era brought us a barrage of heavy earth-moving equipment. The bulldozer was the tool of choice for building all road systems, but especially useful in building low-standard county, ranch, logging and mining roads. Between 1945 and today there have been tens of thousands of miles of low-standard roads carved into the watersheds in the Southwest. Many of these roads are now abandoned and have created miles of eroding gullies and scars across the western landscape.

Although we cannot reclaim all that we have lost in soils and vegetation diversity, we can make the appropriate adjustments in our current road systems to reestablish the original surface hydrological flow patterns that have been disrupted by roads. Using the appropriate road drainage systems, we can then curtail erosion and further loss of soils, harvest road water to reinvigorate vegetation and stitch the natural surface hydrological flow-pattern back together. #

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