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# Engineering Field Notes

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## Engineering Technical Information System

# Vision of Opportunity: Changes on the Horizon

***Vaughn Stokes***
***Director of Engineering***
***Washington Office***

This is a time of opportunity for the Forest Service. I was recently at a Deferred Maintenance meeting in Albuquerque, New Mexico, and was impressed with the esprit de corps and the teamwork among the Infra coordinators, program managers, and development team. Certainly, all agreed that we have come a long way in a short time and have accomplished much.

With that in mind, I wanted to be sure that all levels of the organization receive a big thanks for jobs well done. A special thanks goes to the folks in the field at the district and forest levels that gathered data; the managers, rangers, and supervisors that provided leadership and oversight; the local, regional, and national Infra teams that provided staff work; and finally, the WO Infra development team that developed and deployed three major releases this year. Thanks also goes to Vincette Goerl and her Operations staff for their support in working out the bugs with the Inspector General's office.

When the urgent call for action went out, all parts of the organization stepped up and performed. This is a can-do outfit!

Our motivation was a clean bill of health: the ability to demonstrate the validity of the Forest Service infrastructure, its value, and its short-term annual and long-term deferred needs. Equally important, Infra will serve as a tool to integrate inventory, identify program shortfalls or priorities, develop and allocate budgets, and analyze trends and accomplishments. This will make Government Performance and Results Act (GPRA) trends meaningful and much easier to track.

Is it over? Has the journey been completed? No. As meeting participants discussed what's happened, it is clear that there is still much to do. This year, we need to validate data, improve consistency, and, yes, visit and inventory many recreation facilities, roads, range improvements, and so on. But I am confident that we are going to do it and do it well.

Changes are on the horizon for Engineering. We will be using this publication to help keep you informed about road analysis, forest planning regulations, transportation policy, and other significant issues and to provide some technical insights into these issues. In this edition, Tom Pettigrew, the Regional Engineer in Region 1, Missoula, has outlined the road analysis process with information on what it is, where it came from, and how it should be used.

I encourage you to read that article and understand the road analysis process. Because road analysis will help drive our future decisions, we must use it wisely. It is easy to come up with new ideas and tools; it is hard to let go of what has worked for years but is now out of step with the values and priorities of today's society.

Change is relentless. There is no way to stop it, to avoid it, or to turn back the clock. I encourage you to embrace change and to be innovative in its application. This next year will be much brighter for us if we give change a chance and focus on the opportunities at hand.

As I look at the accomplishments of the past year, I am pleased with the progress that we've made. We've focused our attention on fiscal issues and four Infra areas:

- Infra-fiscal health
- Buildings and facilities
- Geospatial data
- Watershed restoration
- Roads.

In each of these areas, we've made substantial gains. To continue and surpass this level of accomplishment in our varied and ambitious goals, we must work smarter.

# 1998 *Engineering Field Notes* Award Winners

To all who took the time to vote for their favorite *Engineering Field Notes* articles published during 1998—thanks! We appreciate your efforts to let our authors know that their articles are read and valued.

Because putting your thoughts and experiences on paper takes time, energy, and dedication, we especially appreciate our authors' willingness to submit articles. For us to remain a valuable resource to our field personnel, we rely on people who are willing to share their time, knowledge, experiences, successes, and even their failures. According to our readers, your articles continue to save the Forest Service time and resources.

And now, here are the winners of the cash awards for the winning *Engineering Field Notes* articles for 1998!

- Rocky Hildebrand for "Cadastral Boundary Survey Using Global Positioning System Equipment"
- Frank Sutton for "GIS Data Collection Project"
- Bill Renison for "Risky Business."

Congratulations to all of our winners and to all of the authors who make this publication possible. Keep those articles coming, and next year *you* could be one of our winners.

# Road Analysis

***Tom Pettigrew***
***Director of Engineering, Northern Region***
***Member of the Roads Analysis Team***
***Liaison to the Transportation Policy Revision Team***

## Where Did Road Analysis Come From?

As the Natural Resource Agenda: Watershed Health and Restoration, Sustainable Forest Management, National Forest Roads and Recreation was being forged, the transportation system and its relationship to the other elements of the Natural Resource Agenda was clear. Roads were a part of the Agenda from the beginning. Within the Natural Resource Agenda, a New Forest Road Agenda was articulated:

1. Determine the best way to provide all Americans with access to the National Forests.

2. Accelerate the pace of decommissioning unneeded substandard roads that damage the environment.

3. Selectively upgrade Forest roads.

4. Seek additional funding sources for the transportation system.

As a part of efforts to "... provide all Americans with access to the National Forests," on January 28, 1998, the Forest Service proposed a rule in the Federal Register to suspend road construction in certain unroaded areas. A part of that proposed rule indicated that it was necessary to prepare a 'New Science-Based Road Analysis Process' to assist National Forest Managers in re-evaluating the transportation system. The re-evaluation must assure that the Road Analysis Process is responsive to a new focus on ecosystem restoration, the public's need for access to the National Forests, and the maintenance and operation of the transportation system within existing and expected funding limits. The Road Analysis Process was prepared by a team of senior scientists and managers to meet the requirements of the final rule.

## What Is the Need for Road Analysis?

An optimum road system supports land management objectives; for the Forest Service, those objectives have markedly changed in recent years. How roads are managed must be reassessed in light of those changes. Expanding road networks have created many opportunities for new uses and activities in National Forests, but they have also dramatically altered the character of the landscape. Recreation traffic now exceeds 90 percent of all traffic on Forest Service roads. The Forest Service must find an appropriate balance between the benefits of access to the National Forests and the costs of road-associated effects to ecosystem values. Providing road systems that are safe to the public, responsive to public needs, environmentally sound, affordable, and efficient to manage is among the agency's top priorities. Completing an assessment of road systems for all National Forests is a key step in meeting this objective.

## What Is Road Analysis?

Road Analysis is an integrated ecological, social, and economic approach to transportation planning, addressing both existing and future roads—including those planned for unroaded areas. Road Analysis is intended to be based on science. Analysts should locate, correctly interpret, and use all relevant existing scientific literature in the analysis, disclose any assumptions made during the analysis, and reveal the limitations of the information on which the analysis is based. Finally, the analysis report should be subjected to critical technical review.

## How Should Road Analysis Be Used?

The Analysis is designed to be applied at multiple scales, flexible, and driven by road-related issues important to the public and to managers. It uses a multi-scale approach to ensure that these issues are examined in context, and it provides a set of analytical questions to be used in fitting analysis techniques to individual situations. The Road Analysis is intended to complement and integrate existing laws, policy, guidance, and practice into the analysis and management of roads on the National Forests. While the Road Analysis Process is presented as a stand-alone procedure, it is strongly recommended that the analysis be completed in conjunction with other ecosystem assessments whenever possible.

The level of detail of the Analysis must be appropriate to the intensity of the issues addressed. Where ecosystem analyses or assessments are completed, Road Analysis will use that information rather than duplicating these efforts. Road Analysis may be integrated as a component of watershed analyses, landscape assessments, and other analyses supporting existing decision processes.

Road Analysis neither makes decisions nor allocates lands for specific purposes. Technical analysts conduct analyses that inform the decision-making role about effects, consequences, options, priorities, and so on. Line officers, with public participation, make decisions through the National Environmental Protection Act process (NEPA). Road Analysis provides information for decision making by examining important ecological, social, and economic issues. Road Analysis helps managers implement Forest plans by identifying potential opportunities for initiating site-specific projects. It may also identify the need for amendments or revisions to the Forest plan.

By completing Road Analysis, National Forests will generate maps and narratives that display and describe management opportunities for changing current road systems to better address future needs, budgets, and environmental concerns. A report from the Analysis will provide details of potential changes and other information relevant to managing National Forest programs and projects. At the appropriate scales, the Analysis will include inventories and maps of all classified and unclassified roads.

## What Are the Six Steps?

Road Analysis comprises six steps aimed at producing needed information and maps. Line-officer participation is essential to the process. Although the Analysis consists of six sequential steps, the process may require feedback and iteration among steps over time as the Analysis matures.

The amount of time and effort spent on each step will differ, based on specific situations and available information. The process provides a set of possible road-related issues and analysis questions. Their answers can inform the choices made about future road systems. Line officers and interdisciplinary teams can determine the relevance of each question, incorporating public participation as deemed appropriate by line officers.

**Step 1 — Setting Up the Analysis**

The Analysis must be designed to produce an overview of the road system. Line officers will establish appropriate interdisciplinary teams and identify the proper analytic scales. The interdisciplinary team will develop a process plan for conducting the Analysis. The output from this step will include assignment of interdisciplinary team members, a list of information needs, and a plan for the Analysis.

**Step 2 — Describing the Situation**

The interdisciplinary team will describe the existing road system in relation to current Forest plan direction. Products from this step include a map of the existing road system, descriptions of access needs, and information about physical, biological, social, cultural, economic, and political conditions associated with the road system.

**Step 3 — Identifying Issues**

The interdisciplinary team, in conjunction with line officers and the public, will identify important road-related issues and the information needed to address these concerns. The interdisciplinary team will also determine data needs associated with analyzing the road system in the context of the important issues, for both existing and future roads. The output from this step includes a summary of key road-related issues, a list of screening questions to evaluate them, a description of status of relevant available data, and whatever additional data will be needed to conduct the analysis.

**Step 4 — Assessing Benefits, Problems, and Risks**

After identifying the important issues and associated analytical questions, the interdisciplinary team will systematically examine the major uses and effects of the road system, including the environmental, social, and economic effects, and the values and sensitivities associated with unroaded areas. The output from this step is a synthesis of the benefits, problems, and risks of the current road system and the risks and benefits of constructing roads into unroaded areas.

**Step 5 — Describing Opportunities and Setting Priorities**

The interdisciplinary team and line officers will identify management opportunities, establish priorities, and formulate technical recommendations that respond to the issues and effects. The output from this step includes a map and descriptive ranking of management options and technical recommendations.

**Step 6 — Reporting**

The interdisciplinary team will produce a report and maps that portray management opportunities and supporting information important for making decisions about the future characteristics of the road system. This information sets the context for developing proposed actions to improve the road system and for future amendments and revisions of Forest plans.

## How Does Road Analysis Relate to the Revision of Transportation Policy?

On January 28,1998, the Forest Service also published an Advanced Notice of Proposed Rulemaking to revise the Forest Service Road Policy. The team that prepared the Road Analysis Process anticipated that the revision of the road policy would establish the agency policy related to the Road Analysis Process. The team that has been preparing the revised Transportation Policy has addressed the application of the Road Analysis Process and it will see significant application in the future. The draft Transportation Policy is posted on the Forest Service web site at: *http://www.fs.fed.us/news/roads/*.

Until the draft Transportation Policy becomes final, the Associate Chief's 1900/7700 letter of October 18, 1999, and Interim Directive 7710-99-1 point out the value of implementing the Road Analysis Process for better informing road management decisions, and encourage units to use the process as appropriate.

## Where Can I Get More Information?

Several copies of the Road Analysis Process are being distributed to each Ranger District, Supervisors Office, Regional and Station Offices, and the Area Office. The Road Analysis Process is posted on the Forest Service Web Site at: *http://www.fs.fed.us/news/roads/*. Copies of the references cited in the Road Analysis Process are available through the Librarian at the Rocky Mountain Research Station at *http://fsweb.rsl.psw.fs.fed.us/roads/request.html*. There may be a charge for copies of the reference material depending upon whether or not your Region or Station participates in their exchange process. The Ecosystem Management Staff in the Washington Office is the custodian of the Road Analysis Process and the Engineering Staff in the Washington Office will be providing technical support for the Road Analysis Process. Much of the material for this article was taken from the Road Analysis Process publication.

# Water/Road Interaction Training Project

***Jeffry Moll, P.E.***
***Senior Project Leader***
***San Dimas Technology and Development Center***

The Water/Road Interaction Training Project entered its second year on October 1, 1999. Goals established at the beginning of the project included the following:

- Function with existing information to aid investigation of water/road interaction problems and potential fixes
- Facilitate communication on the subject among personnel from diverse backgrounds and disciplines
- Inform line officer decisions
- Encourage use of the Water/Road Interaction Technology Series documents.

## Project Description and Action Items

The following description and action items are from the project planning process, prepared at the project's inception.

*This project will develop and conduct regional level training sessions on transportation system activities with a water/road interaction emphasis. Activities include location, design, construction, maintenance, closure, and obliteration, and will be presented from general as well as regionally specific standpoints.*

*The Water/Road Core Team will work with SDTDC to oversee preparation of lesson plans and training materials, and will participate with regional personnel in conducting training sessions. The objective of the training is to increase expertise on transportation system activities at regional and forest levels in support of Chief Dombeck's new roads policy. The training will be based on the Water/Road Interaction Technology Series.*

*Training materials will cover traditional methods and newly emerging techniques, and will stress development of new concepts in treating site specific problems on the ground. Existing as well as new and innovative construction equipment and materials will also receive treatment. Training will consist of a combination of practice, theory, and hands-on experience, and will involve classroom and field work as appropriate. Training duration will range from 1/2 to 4 days depending on the needs of individual regions. Sessions will be incorporated into current workshops and regional training or will stand alone, also depending on regional needs.*

*Action—Assemble a training cadre made up of core team members and regional/field unit personnel.*

*Action—Prepare training materials, with core team, of a general nature for use at all sessions.*

*Action—Prepare region-specific materials with core team and regional personnel.*

*Action—Conduct training sessions. Four regions will receive training in FY 99 and the remaining five in FY 00.*

## FY 99 Training Sessions

The following training sessions were held during FY99 in support of the above action items.

### Region 8/9 University

This session occurred in February 1999. Included were presentations on surface and subsurface drainage and drainage crossing topics from the Water/Road Interaction Technology Series and a demonstration of the X-DRAIN model. Approximately 25 people attended, representing a variety of disciplines;

### Presentations at BLM Oregon/Washington Engineers Workshop

The Bureau of Land Management (BLM) Oregon/Washington Engineers Workshop took place in March 1999. Presentations included surface drainage topics, an update on WEPP model applications, and a session on road closure and obliteration. Approximately 115 BLM employees representing a variety of disciplines attended;

### Region 1 Regional Training Academy

This meeting, also in March 1999, included talks on hydrologic modification due to road prisms, surface and subsurface drainage topics, WEPP model applications and supporting research, and drainage crossing topics along with diversion potential. Approximately 110 people attended, representing a variety of disciplines;

### Stand-Alone Workshops

Two 3-day stand-alone workshops dedicated to the Water/Road Interaction project were held in September 1999. The first workshop was held in Nashville and the second was held in Reno. The purpose of these workshops was to further the goals listed at the beginning of this article.

Ninety-six people attended the Nashville workshop and 150 people attended the Reno workshop. An approximate breakout by discipline is as follows: hydrologists, 51; biologists, 29; foresters, 5; geologists, 6; soil scientists, 4; landscape architects, 3; engineers, 130; and others. Employees representing five agencies attended the two sessions. Critique forms completed at each session as well as verbal feedback from attendees were used to improve the session on the following day.

On the first day of each workshop, personnel from the Washington Office and Regional offices spoke on general topics including the following:

- National Natural Resource Agenda Update
- Regional Perspectives and Issues
- Clean Water Action Plan and 404 Permits
- Road Analysis, Pilot Forests

- Road Policy Team
- Water/Road Interaction Fundamentals.

Attendees could select two of three options on the second and third days of the workshop. Sessions within these options included the following:

- ***Option 1***
  Wetland and Road Ecology and Management
  Wetland and Road Engineering and Design.
- ***Option 2***
  Soil Science and Soils Engineering
  Deferred Maintenance
  Road Surface Drainage, X-Drain Model
  Environmental Considerations for Road/Stream Crossings
  Road Closure and Obliteration.
- ***Option 3***
  River Morphology
  Water/Road Interaction Field Guide
  Subsurface Drainage
  Fish Passage Software and Issues (FishXing 1.0).

Various training methods were employed at these workshops. The first-day speakers delivered presentations to the entire group. During the three concurrently running options of the second and third days, some sessions were conducted by presentation, while others used interactive techniques including group breakouts and attendee participation. One session in Nashville on environmental considerations for road stream crossings was held outside at a major drainage structure installation.

## FY 2000 Workshops

In fiscal year 2000, individual Forest Service regions or groups of regions may request Water/Road Interaction workshops. The content, duration, and location can be tailored to regional needs; we ask that the regions organize and provide the required facilities. Additionally, the regions should prepare a list of topics. SDTDC will coordinate with regional personnel to organize and conduct desired sessions and provide for the travel and per diem needs of outside presenters, if necessary.

Thus far, three regions have requested Water/Road Interaction workshops for fiscal year 2000. A draft session schedule for a 2-day presentation at the R8-R9 University appears on the following page:

***Water/Road Interaction Workshop***
***R8-R9 University***
***Cincinnati, OH***
***February 28-March 3, 2000***

***Session Schedule***

| ***Session*** | | ***Presenter*** |
|---|---|---|
| **Day 1** | | |
| 8:00 | Regional Perspective and Issues | Regional or WO Staff |
| 10:00 | Water/Road Interaction Primer | Mike Furniss, Regional Staff |
| 12:00 | Lunch | |
| 13:00 | Surface Drainage and X-DRAIN | Ron Copstead,<br>Kim Johansen, Susan Graves |
| 16:00 | Soils and Erosion | Regional Staff |
| 17:00 | Adjourn | |
| **Day 2** | | |
| 8:00 | Fish Passage | Rich Standage, Regional Staff |
| 9:00 | River Morphology | Lorena Corzatt, Janice Staats |
| 12:00 | Lunch | |
| 13:00 | Road Closure and Obliteration | Jim Kozik, Regional Staff |
| 15:00 | Water/Road Interaction Field Guide | Jeff Moll, Regional Staff |

Region 6 has requested a workshop for the week of March 6 through March 10, possibly in Portland or Eugene, Oregon. One hundred and twenty people are expected to attend the workshop, which will cover a range of topics including wet meadow restoration, fish passage, habitat restoration, surface drainage, and drainage crossings.

To request a Water/Road Interaction workshop in your region, contact the Water/Road Interaction Project Leader at (909) 599-1267, x246.

# Economic Fish Passage: An Innovative Alternative

***Charles G. Showers***
***Assistant Forest Engineer***
***Payette National Forest***

## Introduction

Many national forests are confronted with the need to improve critical habitat for endangered species. Restoring fish passage at stream crossings in critical habitat for Snake River chinook salmon and steelhead trout is a high priority on the Payette National Forest. The Payette Forest has been making efforts to restore fish passage in a cost-efficient and innovative manner.

The New Meadows Ranger District of the Payette National Forest processed a "Ditch Bill" easement in an anadromous drainage in 1996. Consultation with National Marine Fisheries Service (NMFS) on the action was required as the area has steelhead trout and Snake River chinook salmon habitat. A NMFS Biological Opinion gave the Payette direction to "... remove the fish passage barrier on Boulder creek by August 1999 ..." Failure to do so would require that the Payette reconsult on the action.

Boulder Creek is a major tributary of the Little Salmon River. Boulder Creek is also habitat to three endangered species, Snake River chinook salmon, steelhead trout, and bull trout.

The barrier, a multiplate arch pipe (3.8 meters x 2.7 meters x 15 meters [8 feet x 12 feet x 50 feet]) with concrete headwalls, constrained the stream channel and caused water velocities through the barrel in excess of 4.57 meters per second (15 feet per second) during high flows. The high velocities occurred during the steelhead trout spawning migration.

The Forest originally intended to replace the culvert (which was more than 30 years old) with a clear span structure, returning the crossing to a more natural channel configuration. Preliminary cost estimates for removing the culvert and replacing it with a bridge was $80,000. However, as funding was limited other less costly alternatives were explored. The proposal to modify the culvert in lieu of replacement was made following a detailed site survey and additional field review by engineering staff.

This article documents the design, construction, and problems encountered during construction.

## Design

The existing culvert was on a 1 percent gradient and above the natural stream bottom. Upstream of the culvert appeared to be a deposition bed of cobbles 100 to 200 millimeters thick interspersed with larger stones. Immediately downstream of the culvert, the stream cascades over a tightly fractured basalt ridge and basalt boulders 1 meter in diameter and larger.

*Original installation*

The conceptual design was to remove the invert of the existing multiplate arch and provide the crossing with a natural bottom.

Stability of the structure was our first concern. Would the culvert without the invert support the fill and the traffic on the collector road?

Scour, behind and below the walls of the culvert, was our next concern. What would happen to the material under the culvert invert when exposed to flowing water?

## Scour

We planned to use the standard rule for bridge design of placing footings 1 meter below scour depth.

All reviews of the site concluded that the culvert was installed on a rock ledge or that there was a rock ledge at the outlet that would limit down cutting of the channel. A rock ledge at the outlet could also cause turbulence or force the water under and around the walls of the culvert.

A projected flow line through the crossing to anticipate scour was estimated by taking an elevation approximately 10 meters upstream and 10 meters downstream of the culvert inlet and outlet. A flow line of 5.24 percent was projected (figure 1). The points upstream and downstream were chosen because the surveyed profile of the creek showed that the grade upstream became steeper at that point and the grade downstream flattened out. The designed depth of footings was determined from the projected flow line. Depth of bedrock under the culvert was unknown. Excavating a footing 1 meter into bedrock would be unnessary to prevent channel scour. In the event the stem wall excavation became limited by bedrock, the contractor would be required to drill at least 150 millimeters into the bedrock and pin the vertical reinforcing steel into the bedrock (figure 2). This situation was expected to occur in most locations.

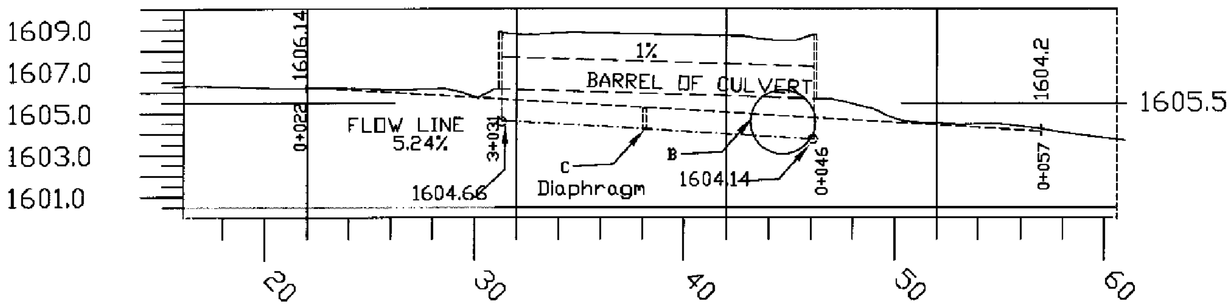


***Figure 1.***

Footings

Excavation inside the culvert for the designed footings, while difficult, could be done by using small excavators. Due to the limited working space inside the culvert, the designer decided that a wide stem wall to support the culvert wall would be easier and faster to construct than a stem wall on top of a footing. The extra cost of concrete would be offset by reducing the amount of forming and time the project would take.

This raised another question: Would the culvert collapse during construction, with the invert removed?

Analysis:

- The culvert was installed in the late 1960's, using a dozer and pushing fill over the culvert.

- There are numerous exposures of bedrock in the immediate area with a Forest Service–owned quarry less than 300 meters away.

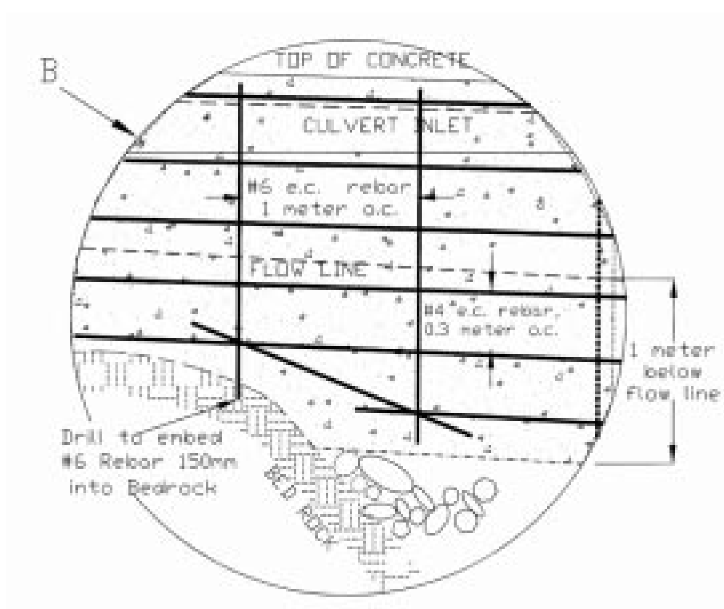


***Figure 2.***

- The predominant soils are sandy clays interspersed with first-sized stones and boulders. These soils are heavy and compact well, with a unit weight of approximately 2,082 kilograms per meter (130 pounds per cubic foot).

- The bearing capacity of the soil was calculated and a footing width determined, based upon the dead load of the 0.66 meters of soil over the culvert and a live load of 355.86 kilonewtons (kN) (80,000 pounds) such as a loaded log truck.

Based upon this information, the soils at this crossing are supporting (bridging) the site and as long as the soils remain dry and no heavy loads cross the culvert, the culvert should not subside during the removal of the invert.[1]

The concrete footings solved the third problem of scour behind the pipe wall. The wide footings became stem walls that sealed off the wall of the pipe. Tying the footings directly to the concrete headwalls on the inlet and outlet sealed water from moving around the culvert barrel.

Additional questions arose as to the direction of the resultant forces that would act upon the stem walls and footings and whether rotation would become a problem. Reviewing *Culvert Inspection Manual* (U.S. Department of Transportation, Federal Highway Administration, FHWA-IP-86-2, July 1986), the principal type of stress in a pipe arch is a result of inadequate soil support at the haunches where the pressure is relatively high. Arch culverts with completely deteriorated inverts function as an arch structurally, but are highly susceptible to failure due to erosion of bedding support at the haunches. Embedding the culvert wall in the stem wall and filling any voids behind the haunches with concrete removes the concern of inadequate bedding and loss of support.

Another concern was that bedrock would not be encountered before the stem wall excavation was one meter below the “flow line” and that the ratio of the depth of the stem wall to the width would be such that rotation from the outside-in might become a problem. Normally, wide footings would solve this problem. In this instance, a contingency was made to construct a diaphragm midway in the barrel of the culvert that in conjunction with the concrete headwalls would provide the support necessary to oppose rotational forces (figure 3).

## Other Considerations

### Concrete Protection

The design called for installation of angle iron at the corners of all exposed concrete to protect the concrete from rock impact during high flows.

### Temperature Protection

The work was performed in October and November. Ice was forming in the creek and starting to sheet all surfaces. Insulating blankets were used during the cure period to reduce the risk of freezing.

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[1] As each site is different, designers recommend that no more than half of a side of footing or stem wall be constructed before the other side is constructed.

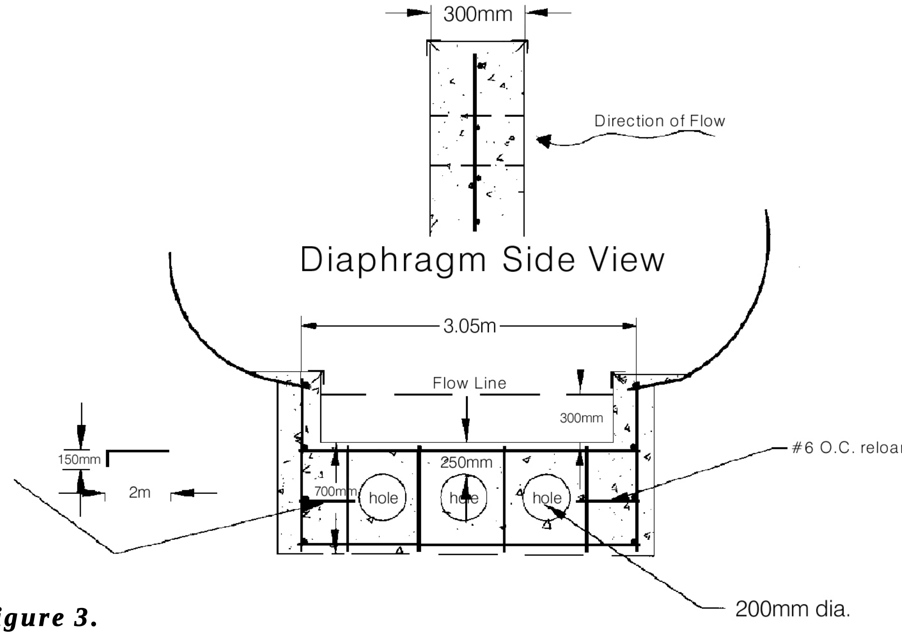



***Figure 3.***

## Erosion Control

Control of all water in a live stream culvert of this size is difficult. Bull trout, which was present and spawning downstream, was of particular concern at the time of the Boulder Creek culvert modification. Every effort was made to halt the movement of fines that could plug and smother bull trout redds.

## Contract Specifications

The Forest used F*orest Service Specifications for Construction of Roads and Bridges (*EM-7720-100, August 1996), modifying only two specifications as described below.

*Constructing the stem wall/footing*

Section 220 – Rock Blasting

**Subsection .04, Blasting Plan.** Delete "14 days" and insert "1 working day." During excavation, large rock (floaters) that would require blasting to remove could be encountered. Leaving the excavation open for 14 days could cause serious resource damage as well as instability to the invertless culvert.

Section 602 – Minor Concrete Structures

**Subsection .01, Work.** Add the following:

*Modify existing structures, including but not limited to: removing material, excavating foundations/stem walls, blasting, constructing foundations, de-watering, compacting fill, erosion control, steel reinforcement, concrete, concrete forming.*

**Subsection .03, Concrete Composition. (b) Method B.** Add the following:

*Three cylinders shall be taken from each load of concrete, from three different portions of the load, and tested for 28-day compressive strength.*

*The minimum 28-day compressive strength shall be 25 MPa.*

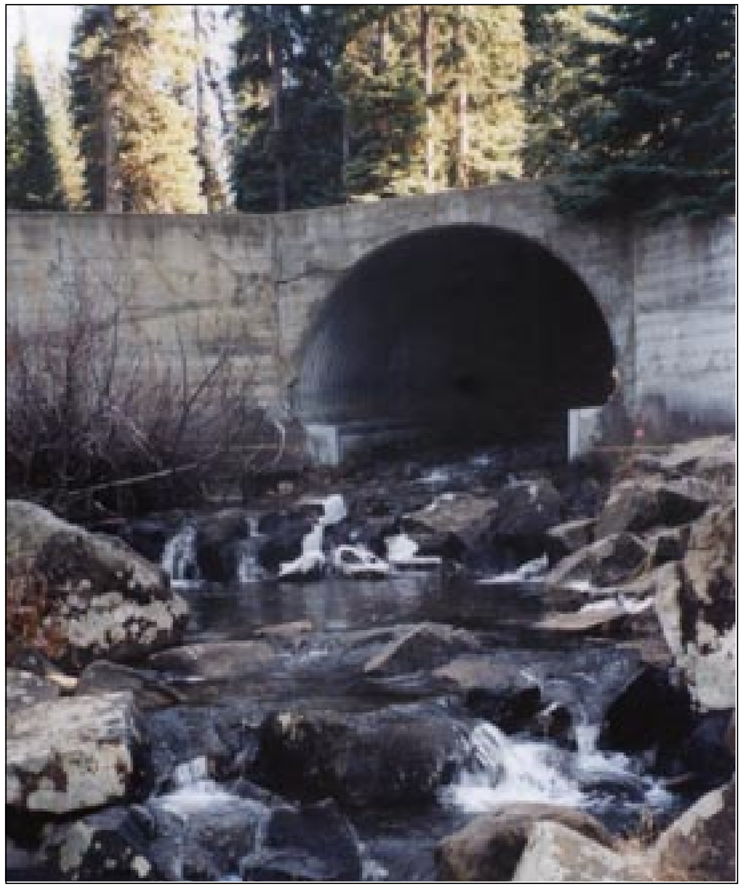
**Subsection .10, Basis.** Add the following:

*602(03) Remove Invert . . . . . . . . . . . . . . . . . . . . Lump Sum*
*602(04) Concrete Stem Wall, method B . . . . . . . Cubic Meter*
*602(05) Concrete Diaphragm, method B . . . . . . Cubic Meter*

## Construction

The contract was awarded to Yelton Excavation of New Meadows, Idaho, for $22,000. Yelton presented the Forest Service with an aggressive schedule that anticipated completion in 30 days, half the time allowed in the contract. Work began on September 15, 1998, with installation of erosion control and removal of the invert.

*Modified barrel viewing from inlet*



*Boulder Creek with modified outlet*

The stream was diverted from the sides of the culvert using sandbags and plastic sheeting to line the channel. A silt fence was installed in the channel downstream of the work in a herringbone configuration to filter out the bedding that would wash out from below the invert after it was removed. The captured sediments and the silt fence would be removed upon completion of the project.

The invert was detached by using a cutoff saw and metal blades. Where the water had been successfully diverted from the cutting area, cutting was efficient. Where water was present, cutting was slow and the blades were worn out quickly.

The invert was removed by dragging it out with a cable attached to a D-6 CAT dozer. Cutting the invert loose took approximately 1 day and pulling it out took approximately 5 hours.

The stream was once again diverted along one side of the culvert, using sandbags and plastic sheeting to line the diversion. Excavation utilizing a small excavator and hand shovels began, quickly followed by concrete forms.

Forest Service inspectors reviewed the excavated area and confirmed the presence of bedrock and the specified reinforcing steel placement. A profile of the bedrock beneath the stem wall was made for future monitoring.

Concrete was placed after the Project Engineer approved the forms. Three concrete cylinders were made from each truckload of concrete for 28-day compressive strengths. Insulating blankets were placed over the concrete prior to nightfall and the contractor's departure from the site. The concrete was covered with plastic and insulated blankets throughout the curing period. The forms were stripped 7 days later.

The stream was diverted against the new stem wall after stripping the forms. The process was repeated for the other stem wall.[2]

## Conclusion

Final inspection was made on November 3, 1998. Two forest fish biologists reviewed the modification to the fish passage and were very pleased.

The final cost of the contract was $21,123, a considerable savings over the estimated cost of at least $80,000 for removing the culvert and fill and constructing a bridge.

The Project Engineer recommended minor specification changes for future projects of this type—(1) completely bypass the stream out of the work area where possible and (2) construct only one-half of one side's stem wall and footing before the other side has been constructed when complete stream bypass is not possible.

The Engineering and Fisheries departments monitored performance of the project during 1999. The first monitoring visit to the site took place in early June during peak high water. The Forest Engineer and the Assistant Forest Engineer took velocity measurements. The average velocity at the surface and the middle of the stream was 2.27 meters per second (7.46 fps). This velocity was well within the capability of steelhead trout that were migrating at that time.

The second monitoring visit was in mid-July. The Assistant Forest Engineer and the Forest Maintenance Engineer observed that the flows had scoured the channel to bedrock in the downstream end of the crossing and the stream bottom had the expected common variations. No fish were observed moving through the crossing but the depth of flow and the velocity were no different than those in the stream above and below the crossing.

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[2]The contractor and Project Engineer noted some subsidence of the culvert invert at the center of the second stem wall. They believed that diverting the stream over against that side during construction of the first stem wall caused the subsidence. The soil behind the culvert became saturated and was unable to support the culvert as before. For this reason, the author recommends constructing only one-half of one side's stem wall prior to completing the second side.

# Bibliography of Washington Office Engineering and Detached Units' Publications

This bibliography contains information on publications produced by the Washington Office Engineering staff and its detached units. Arranged by series, the list includes the title, author or source, document number, and date of publication.

This issue lists material published since our last bibliography (*Engineering Field Notes*, Volume 30, September-December 1998). Copies of *Engineering Field Notes* and most Engineering Management Series documents can be obtained from the Washington Office Engineering staff. Copies of project reports, Tech Tips, and special and other reports can be obtained from the technology and development center listed as the source.

Forest Service—USDA
Engineering Staff
201 14th Street, SW
Washington, DC 20024
(202) 205-0922

Forest Service—USDA
San Dimas Technology and Development Center
444 E. Bonita Avenue
San Dimas, CA 91773
(909) 599-1267

Forest Service—USDA
Missoula Technology and Development Center
Building #1, Fort Missoula
Missoula, MT 59801
(406) 329-3978

## Engineering Field Notes (EFN)

This publication, which is published every 6 months, provides a forum for the exchange of information among Forest Service personnel. It contains the latest technical and administrative engineering information and ideas related to forestry.

### EFN by Title (Volume 31)

## EFN by Author (Volume 31)

| | |
|---|---|
| Monlux, Steve. (January-June 1999): 43 | Reducing Aggregate Surfacing Maintenance |
| Pettigrew, Tom. (July-December 1999): 5-8 | Road Analysis |
| Showers, Charles G. (July-December 1999): 13-20 | Economic Fish Passage: An Innovative Alternative |
| Stokes, Vaughn. (January-June 1999): 1-4 | Vision of Opportunity |
| Stokes, Vaughn. (July-December 1999): 1-3 | Vision of Opportunity: Changes on the Horizon |

## Engineering Management Series and Other Publications

The Engineering Management (EM) Series contains publications serving a purpose or reader and publications involving several disciplines that are applied to a specific problem.

| Title | Number |
|---|---|
| Forest Service Desk Guide to Fleet Management (December 1999) | EM 7130-4 |
| Forest Service Guide to Land Transactions (September 1999) | EM 2160-2 |
| Technology and Development for the 21st Century (May 1999) | EM 7100-18 |
| Implementation of Remote Sensing for Ecosystem Management (Revised March 1999) | EM 7140-28 |
| History of the Architecture of the USDA Forest Service (A) (July 1999) | EM 7310-8 |

## Reports

### Project Reports

| Title | Number | Source | Date |
|---|---|---|---|
| Asphalt Seal Coat Treatments | 9977-1201 | SDTDC | 4/99 |
| Comprehensive Waste Management | 9923-1206 | SDTDC | 9/99 |
| Dust Palliative Selection and Application Guide | 9977-1207 | SDTDC | 11/99 |
| Field Data Collection Equipment Guide | 9977-1203 | SDTDC | 4/99 |
| Fire Retardant Standard Mixing System | 9951-1204 | SDTDC | 6/99 |

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| Hearing Safety at Airtanker Bases | 9957-1205 | SDTDC | 9/99 |
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| Trigger Pull Force Evaluation of Three Manual Tree Marking Paint Guns | 9924-1202 | SDTDC | 4/99 |

## Tech Tips

| **Title** | **Number** | **Source** | **Date** |
|---|---|---|---|
| Asbestos Allowed in Some Roofing Materials | 9971-2302 | MTDC | 1/99 |
| Backing Up on Forest Roads: Take Your Time | 9967-2336 | MTDC | 8/99 |
| Cryoprobe: A Unique Tool for Archaeologists | 9923-1307 | SDTDC | 8/99 |
| Double 32 Gallon Bear-Proof Refuse Container | 9923-1306 | SDTDC | 8/99 |
| Electric Fence Systems: Requirements for Meeting the NCDE Food Storage Special Order Implications on Risk Compensation, Final Report | 9923-2321 | MTDC | 3/99 |
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| Evaluation of the Trimble ProXRS GPS Receiver Using Satellite Real-Time DGPS Corrections | 9971-2318 | MTDC | 5/99 |
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| Sustainable Building: What Are Green Building Products and Where Do I Find Them? | 9971-2307 | MTDC | 4/99 |
| Using Computers Without Hurting Yourself: Ergonomics Training Resources | 9967-2343 | MTDC | 9/99 |

## Special Reports

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| Collocation of PM 2.5 Particulate Monitors and Nephelometers: Experimental Design | 9925-2825 | MTDC | 5/99 |
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| Ground Pattern Performance of the Sims 2000-Gallon Helibucket | 9957-2850 | MTDC | 10/99 |
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| Laboratory Evaluation of Two Optical Instruments for Real-Time Particulate Monitoring of Smoke | 9925-2806 | MTDC | 2/99 |
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| Standard Test Procedure for General Purpose Spark Arresters | 9951-1805 | SDTDC | 08/99 |
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| Tree Girdling Tools | 9924-2809 | MTDC | 5/99 |
| Two Decades of Tailoring GPS Technology for Natural Resource Applications: Missoula Technology and Development Center | 9971-2826 | MTDC | 12/99 |
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