Nos. 11-338 and 11-347

IN THE

Supreme Court of the United States

DOUG DECKER, in his official capacity as Oregon State Forester, et al.,

Petitioners,

v.

NORTHWEST ENVIRONMENTAL DEFENSE CENTER,

Respondent.

GEORGIA-PACIFIC WEST, INC., et al.,

Petitioners,

v.

NORTHWEST ENVIRONMENTAL DEFENSE CENTER,

Respondent.

On Writs of Certiorari to the United States Court of Appeals for the Ninth Circuit

BRIEF OF DR. KEVIN BOSTON AS *AMICUS CURIAE* IN SUPPORT OF RESPONDENT

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INTEREST OF THE AMICUS CURIAE[1]

Dr. Kevin Boston is an associate professor in the Forest Engineering, Resources, and Management Department at Oregon State University, where he teaches courses in Forest Road Engineering and Forest Road System Management. He is engaged in active research on the physical properties of various materials used in logging road construction, and has authored or co-authored numerous publications relating to forest road management. Dr. Boston has a Bachelor of Science in Forestry from Humboldt State University and a Masters of Forestry and a PhD in Forest Engineering from Oregon State University, and is a Registered Professional Forester in California and Professional Engineer, registered in Oregon. Prior to working at Oregon State University, Dr. Boston worked as an assistant professor at the University of Georgia and as a lecturer at the New Zealand School of Forestry at the University of Canterbury. He has spent many years working in the timber industry in New Zealand and the western United States.

Dr. Boston believes that the principles of logging road engineering and the processes of sediment generation and delivery from logging roads have not

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[1] All counsel of record have consented to the filing of this brief. Petitioners Georgia-Pacific West, Inc., et al., Petitioners Decker, et al., and Respondent have all filed blanket consents. No counsel for any party authored this brief either in whole or in part. No persons other than *amicus* or its counsel has made any monetary contribution to the preparation or submission of this brief. Dr. Boston submits this brief on his own behalf and not on behalf of his employer Oregon State University.

been adequately explained in the other briefs before the Court. A sound understanding of these concepts is necessary to inform the Court's decision about whether sediment generated from the movement of heavy machinery and the hauling of timber on logging roads and conveyed to waters of the United States via engineered drainage systems constitutes a point source discharge of industrial stormwater.

INTRODUCTION AND SUMMARY OF ARGUMENT

The main purpose of this brief is to explain relevant facts surrounding the science and engineering of logging roads and their drainage systems.[2] These facts demonstrate that the primary purpose of these roads is to facilitate industrial logging operations; that the pipes, ditches, and channels associated with these roads are designed to prevent road washout and failure that would disable logging operations; and that these drainage structures can be a significant source of water pollution. 2JA 90. In short, the sediment pollution caused by the creation and use of logging roads is not natural in origin and the choices made in the planning, design, construction, and use of logging roads can determine the volume of sedi-

[2] In accord with the usage adopted by Respondent, this brief uses the term "logging roads" to refer to forest roads that are designed and constructed for heavy vehicle traffic and used for active timber cutting and hauling operations. The distinction between active logging roads and other forest roads is a common one, recognized, for example, in the Oregon regulations' definition "active roads," which "are roads currently being used or maintained for the purpose of removing commercial forest products." Or. Admin. R. 629-600-0100(3).

ment pollution that reaches rivers and streams. As a result, when this sediment pollution is directly discharged into waters of the United States through man-made ditches, pipes, culverts, and channels, it should be subject to the National Pollutant Discharge Elimination System (NPDES) permitting program under section 402 of the Clean Water Act, 33 U.S.C. § 1342.

ARGUMENT

I. Large-Scale, Modern Forestry is an Industrial Activity.

The active logging roads that are the subject of this litigation are integral parts of large-scale, complex, industrial operations. Although these logging roads may eventually be used for other purposes—such as recreation and fire suppression—their primary purpose is to enable the harvesting and extraction of timber and other forest products. This purpose determines the decisions made at each stage of the process of planning, designing, constructing, operating, and maintaining these roads.

Logging roads are built to safely and efficiently bear the heavy vehicle traffic necessary for modern industrial forestry. This traffic involves both moving the huge machines used in cutting and processing trees into the forest and removing timber from the forest on massive logging trucks. Roads can also be the site of some of the timber processing, as tree limbs are removed and stems are cut into logs for transport to the mill.

Paradoxically, these heavy-duty logging roads—built to safely bear massive equipment—are also extremely vulnerable. Constructed of dirt and built along steep and often unstable slopes, logging roads are susceptible to washout and failure. In order to protect these roads, which are indispensible to the logging process, logging companies design and install complex networks of drainage systems. These pipes, ditches, and channels are intended to fulfill an essential job: to preserve the integrity of the road by carrying water away from its surface.

The basic steps involved in getting timber "from the 'stump to mill'" are roadbuilding, felling, extraction, processing, loading, and trucking.[3] Each step in this industrial process is typically carried out by a specialized piece of heavy machinery and/or by individuals with a specialized skill. As described in detail below,[4] the first step, foundational to all others, is roadbuilding, which involves clearing the road with bulldozers, smoothing the surface with graders, and installing drainage structures. Once the road is built, the "felling" (cutting down) of trees is often performed by mechanical harvesters—tracked or wheeled machines that can weigh more than 30 tons. The operator of one of these machines, who sits in a

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[3] Virginia Tech University, Dep't of Forestry, *Harvesting Process*, http://web1.cnre.vt.edu/harvestingsystems/HarvestingProcess.htm (last visited October 18, 2012). For illustrations and descriptions of the types of machinery described below, see LOREN D. KELLOGG, PETE BETTINGER & DON STUDIER, TERMINOLOGY OF GROUND-BASED MECHANIZED LOGGING IN THE PACIFIC NORTHWEST (1993), *available at* http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/7615/RC1.pdf.

[4] See *infra* Part III.

cab, uses a huge claw-like arm to grab the entire tree, cut it off from the stump, and stack it with others on the ground. On steep ground or areas with large trees, this task may be accomplished by highly-skilled timber fallers using chainsaws. Next, the tree is "extracted" (moved) to a landing or roadside. To carry out this step, the tree is either carried on a machine called a forwarder or dragged by a different machine called a skidder. On steep slopes, machines similar to cranes, called yarders, are used to haul logs on a system of cables. Typically, at the landing or roadside, another machine called a delimber or people with chainsaws are used to cut off the branches and the stem is manufactured into the preferred log lengths. A log loader is then used to lift the logs onto a truck for transport to the mill.

Given the size and sophistication of the machinery and the skill of the individuals involved at each step of this process, it is not surprising that a classic text on logging practices describes a modern industrial forestry operation as "a loose grouping of mobile factories. The manufacturing process taking place in those factories is not unlike the process taking place in other extractive industries such as coal mining and oil production."[5]

All of this massive machinery is delivered into the heart of a forest by means of logging roads. The logging trucks—with a total weight between approximately 80,000 and 105,000 pounds depending on state regulations—then use the roads to carry the

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[5] STEVE CONWAY, LOGGING PRACTICES: PRINCIPLES OF TIMBER HARVESTING SYSTEMS 48 (1976).

timber to the mill for processing. As described in the following section, the cumulative impacts of this intensive use of the forest in support of industrial logging operations is significant water pollution.

II. Active Logging Roads Have Significant Impacts on Water Quality.

Logging roads are significant sources of pollution—the most important source of forestry-related sediment pollution. 2JA 119, 128. In particular, the Environmental Protection Agency (EPA) has concluded that "up to 90% of the total sediment production from forestry operations" comes from logging roads.[6] Furthermore, a report commissioned by EPA concluded that "forestry-related sediment is a leading source of water quality impairment to rivers and streams nationwide."[7] The magnitude of these impacts is directly related to the decisions that are made at each stage of the development and use of logging roads.[8] As a result, these impacts are also the direct result of logging roads' function in the overall industrial logging operation.

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[6] EPA, *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* 27 (1993).

[7] GREAT LAKES ENVTL. CTR., NATIONAL LEVEL ASSESSMENT OF WATER QUALITY IMPAIRMENTS RELATED TO FOREST ROADS AND THEIR PREVENTION BY BEST MANAGEMENT PRACTICES 2 (2008) [hereinafter NATIONAL LEVEL ASSESSMENT] (citing EPA's 2000 and 2002 National Water Quality Inventories).

[8] Or. Dep't of Forestry, Technical Report # 17, *Wet Season Road Use Monitoring Project: Final Report* 24 (2003), *available at* http://www.oregon.gov/odf/privateforests/docs/roaduse.pdf.

Not all of the sediment generated by logging roads enters streams. Indeed, in a properly planned, designed, constructed, and maintained logging road, virtually all of the sediment will be discharged overland. 2JA 78. As a practical matter, however, the amount of sedimentation actually delivered to streams from logging roads can be staggering.

An imaginative exercise based on the actual results of removing abandoned logging roads from the landscape may help sharpen the problem. In 2008, in recognition of the impact of logging roads on water quality, Congress created the Legacy Roads and Trails Remediation Program. Recently, the U.S. Forest Service's Rocky Mountain Research Station completed research measuring the benefits of this program.[9] The research group chose a notably large measurement unit: metric tons per year. The research revealed that rehabilitating just 42 miles of abandoned roads prevented delivery of 200 metric tons per year of sediment into streams—the equivalent of a 1-ton pickup truck dumping a full load of dirt and aggregate into a stream, 200 times.

Active logging roads contribute to water pollution through several mechanisms. Specifically, whether a logging road causes stream sedimentation depends on three factors: generation, mobility, and connectivity. That is, whether and how much sediment is delivered from logging roads to streams depends on

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[9] U.S. FOREST SERVICE, ROCKY MOUNTAIN RESEARCH STATION, LEGACY ROADS AND TRAILS MONITORING PROJECT UPDATE 2012, *available at* http://www.fs.fed.us/GRAIP/downloads/case_studies/2012LegacyRoadsMonitoringProjectUpdate.pdf.

(1) the amount of sediment that is generated and thus made available for delivery; (2) the mobility of the sediment (in other words, the degree to which it is able to be transported by the available water); and (3) the hydrological connection between roads and streams that allows the sediment generated and mobilized to enter the streams.

A. Sediment Generation.

Sediment is generated at the road site in a number of ways. First, a massive amount of soil is made available during the excavation of a road.[10] This soil is loosened by being torn from its anchor of vegetation. The cut-slopes are thus exposed to potentially damaging rainfall, often without any of the vegetative protection remaining. This excavated material, already loose, is made more vulnerable to erosion when it is used to make fillslopes (on the slope below a road), which can be placed at a steeper angle than native hillslopes and thus are prone to mass wasting events (landslides).[11] Such landslides frequently produce sedimentation when they reach streams, either through road-surface flows and obstruction of drainage (likely outcomes for mass wasting on cut-slopes, which are upslope from roads and thus frequently land on the road surface), or through debris flows (a likely outcome for fillslopes, which are

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[10] *See* KEITH MILLS, OR. DEP'T OF FORESTRY, FOREST ROADS, DRAINAGE AND SEDIMENT DELIVERY IN THE KILCHIS RIVER WATERSHED 2 (1997), *available at* www.oregon.gov/ODF/privateforests/docs/kilchis.pdf [hereinafter MILLS REPORT].

[11] *Id.*

downslope of roads and can be carried wholesale to a stream during a storm).[12]

Second, sediment can be generated from the rock and dirt, or "aggregate," used to surface the road. Although aggregate is used to allow for year-round use of a forest road, it also reduces the erosive potential when compared to dirt roads. Additionally, when logging trucks pass over aggregate, they can crush it into even more fine sediment.[13] Studies have found that tire crushing alone may yield from 10 to up to 500 tons of sediment per kilometer of road.[14]

Third, the creation of ruts in the surface of the roads from repeated use can disable the road's ability to shed water as it becomes concentrated in the road's surface. This water can accelerate the erosion of the road surface that can lead to an increase in sedimentation of forest roads. As a result, a rutted road can produce two to four times as much sediment as a freshly graded road.[15]

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[12] *Id.* at 5.

[13] Randy B. Foltz & Mark Truebe, *Locally Available Aggregate and Sediment Production*, 1819B TRANSP. RESEARCH RECORD 185, 190 (2003).

[14] Robert E. Bilby, Kathleen Sullivan & Stanley H. Duncan, *The Generation and Fate of Road-Surface Sediment in Forested Watersheds in Southwestern Washington*, 35 FOREST SCI. 453, 459 (1989); Leslie M. Reid & Thomas Dunne, *Sediment Production from Forest Road Surfaces*, 20 WATER RESOURCES RES. 1753, 1759 (1984).

[15] Randy B. Foltz & William J. Elliot, *Effect of Lowered Tire Pressures on Road Erosion*, 1589 TRANSP. RESEARCH RECORD 19, 19 (1997).

Finally, additional sediment is generated from ditches, which are generally surfaced not with aggregate but with more erodible native dirt. 2JA 77.

B. Sediment Transport.

The movement of water over the road transports the sediment loosened by road building and road use. For example, even a light rain falling on roads can mobilize fine sediment, direct it into the road-side ditch, and ultimately carry the sediment to streams. Rain can also saturate cut and fill slopes, causing landslides that results in materials entering streams. Stormwater rushing across a roaded landscape increases the likelihood of these sources of pollution entering streams.

Streamwater can also carry away sediment from logging roads. When a logging road crosses a stream, a pipe or "culvert" is commonly installed to carry the water under the road.[16] However, during a storm, flows may be heavier than the culvert can bear.[17] The flow may be diverted from the stream channel and into the roadside ditch or may create new channels near stream banks, where the soil is more erodible than in the established channel.[18] Or the flow may carry off soil that has been loosened as part of roadbuilding, such as that on fillslopes that eventually reaches the stream.[19]

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[16] MILLS REPORT, *supra* note 10, at 2.

[17] *Id.*

[18] *Id.*

[19] *Id.*

C. Connectivity.

Sediment may be produced by roadbuilding and use and may be transported across the landscape by water, but it only damages stream life if it reaches streams—a question of connectivity. Unfortunately, there are numerous possible points of connectivity between roads and streams. Not surprisingly, mass movement events like landslides often have momentum sufficient to deliver sediment directly to streams. More significant to this litigation, many logging roads discharge directly to rivers and streams through purposefully-designed systems of ditches. Studies in the Pacific Northwest have found that between 25% and 75% of road drainage points discharge directly to streams.[20] 2JA 122, 128.

This statistic offers both good news and bad news for stream health. The bad news is that direct drainage of sediment-laden runoff from logging roads to streams is real—and widespread. 2JA 129 (concluding that, despite "forest practices rules, which require filtering of muddy runoff through the forest floor," in practice "roads are designed and maintained for efficient delivery of water to channels"). The good news is such direct drainage is not inevitable. After all, when viewed in reverse, the statistic reveals that 25% to 75% of road drainage points *do not* discharge directly to streams. Sediment-laden water from these drains is reincorporated into the landscape before reaching streams—usually through dispersion onto the forest floor where it infiltrates into the soil matrix. Stream-friendly drains that

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[20] *Id.*; NATIONAL LEVEL ASSESSMENT, *supra* note 7, at 43-44.

avoid direct discharges into streams are thus possible, even common.

There is further good news for streams: intensive analyses of watersheds in Oregon and Idaho by the U.S. Forest Service's Rocky Mountain Research Station has revealed that 90% of the sediment that reaches streams is deposited by a mere 7% of drain points.[21] The implication is clear: stream health can be dramatically improved by regulating the small fraction of drains that act as problematic point sources.

III. Creating a Logging Road is a Complex, Multi-step Undertaking, with Implications for Sediment Pollution at Each Step.

The planning, design, construction, use, and maintenance of logging roads is a complicated process, requiring significant expertise and study. The presence of a road represents a significant manipulation of the forested landscape; the road is engineered to achieve a particular purpose. Key issues in this process include the selection of a road surface shape and the design and placement of drainage structures to transport water away from the surface of the road as efficiently as possible. By moving the water in this way, the goal of forest road engineers is to maintain the usefulness of the road as a conduit for logging equipment and timber extraction, as well

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[21] Wildlands CPR, *Road Reclamation: Measuring Success* 6 (2012) (summarizing Forest Service results), *available at* http://www.wildlandscpr.org/files/GRAIP%20Report%20Wildlands%20CPR_0.pdf.

as to reduce the impact of the road on the environment.

Successful road design requires an understanding of forest hydrology and forest erosion processes in addition to knowledge of civil, mechanical, and industrial engineering. Scientists and engineers in the discipline of forest engineering produce many papers each year, reporting research on topics such as the ability of surface aggregates to sustain mechanical and chemical breakdown, the causes of fillslope failures, the efficiency of travel routes taken by graders, and the choice and distribution of logging machinery. Even this listing—necessarily only a tiny sample of forest engineering literature—helps illuminate the complexity of the decision making involved in creating a logging road.

A. Road System Planning.

Before logging can begin, the necessary road network must be in place. Depending on the location, this process can involve the construction of new roads, the rehabilitation of old roads, or some of each. To arrive at the appropriate road network design, the landscape must be evaluated, and location alternatives must be generated and contrasted.

The feasibility of any particular logging project is dependent on the possibility of designing the necessary road network. Forest landowners will frequently plan access routes when designing timber sales, even mandating in contracts that contractors or subcontractors use specified roads and/or provide notice of their proposed hauling routes. C.A. ER 47 at 98-99.

It is essential that location decisions be made carefully: even the best design and construction decisions are often not enough to overcome a poor location. The challenge here is the same that runs through most decisions about forest roads—it lies in reconciling the need for safe, efficient roads on the one hand with the unpredictability and variability of a natural place on the other.

As a basic matter, sediment delivery to waters of the United States can be reduced by simply locating roads away from streams.[22] In fact, where the topography allows it, the link between logging roads and streams can be nearly severed by locating roads on ridgetops, which allows road runoff to be dispersed and reenter the soil.[23] Thus, an effective method is the severing of the connection between roads and streams. There are numerous other ways, however, to reduce sedimentation at the road system planning stage. For example, avoiding unstable, landslide-prone slopes not only improves safety but also reduces sedimentation.[24]

Although engineered fills (i.e. material with a known set of properties that will perform in well-

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[22] *See* NATIONAL COUNCIL FOR AIR AND STREAM IMPROVEMENT, FOREST ROADS AND AQUATIC ECOSYSTEMS: A REVIEW OF CAUSES, EFFECTS, AND MANAGEMENT PRACTICES 9 (2003) [hereinafter NCASI WHITE PAPER].

[23] *See* Jacky Croke & Simon Mockler, *Gully Initiation and Road-to-Stream Linkage in a Forested Catchment, Southeastern Australia*, 26 EARTH SURFACE PROCESSES & LANDFORMS 205, 216 (2000).

[24] *See* NCASI WHITE PAPER, supra note 22, at 9.

understood manner) are used in highway constructions, logging roads are constructed from the materials found in place. Thus there is a high variability in the engineering soil properties that are encountered during the construction of logging roads. Some may be wet or weak soils while others will be much stronger. The location of the road has the goal to place the road to avoid the weaker soils or locate on the stronger soils. However, limitations on grade and road alignment may result in the road located on less desirable construction materials.[25]

B. Road Design.

Once the location for a logging road has been selected, the road must be designed. The basic elements of a logging road, and the terminology used to describe them, are illustrated in Figure 1.

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[25] *See* Kevin Boston, Marvin Pyles & Andrea Bord, *Compaction of Forest Roads in Northwestern Oregon—Room for Improvement*, 19 INT'L J. OF FOREST ENGINEERING 24 (2008).

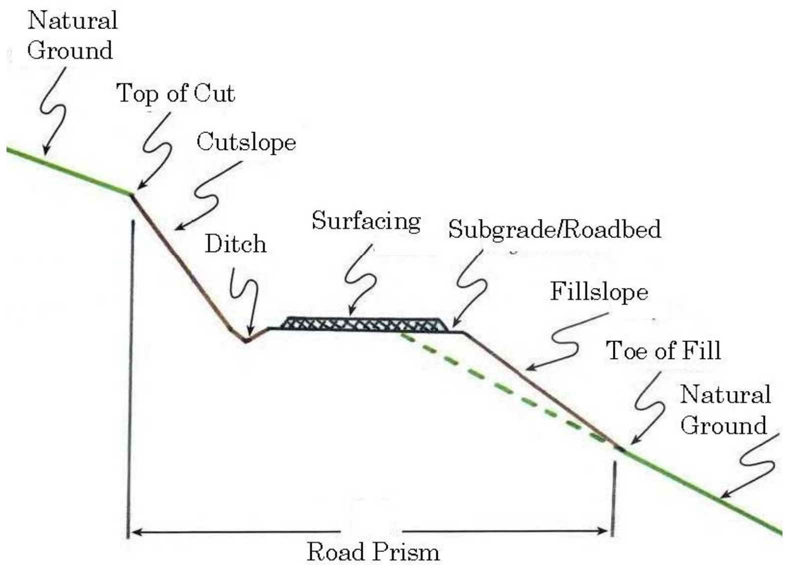

Figure 1: Logging Road Terminology [adapted from Or. Dep't of Forestry, *State Forests Program, Forest Roads Manual* (2000)].

The main adversary here is water. Water that is not quickly dispersed can cause surface erosion and rutting. These conditions hinder the safe passage of logging trucks and other heavy equipment. Landslides can also lead to road failures.[26] Thus road engineers must design roads that shed water before it can erode the road and disable the drainage system. 2JA 81, 97.

[26] NCASI WHITE PAPER, supra note 22, at 5, 17. As Industry Petitioners acknowledge, "[a]s a practical matter, forest roads cannot be built or maintained without stormwater drainage systems: without them, the roads would wash out." Industry Br. at 34.

They accomplish this task through several means. The first is choice of road shape. A perfectly flat road will retain too much water, so the road engineer will generally design the road to be in-sloped, out-sloped, or crowned (see Figure 2).

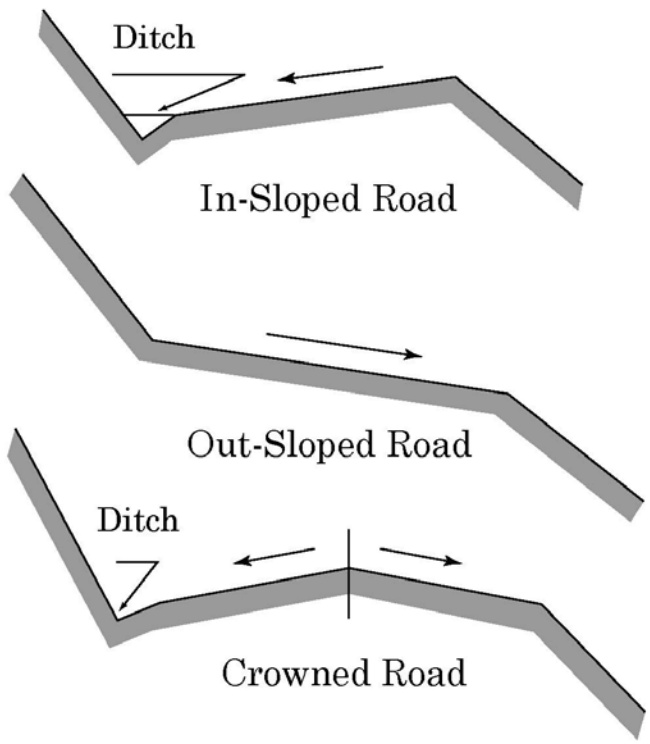

Figure 2: Logging Road Surface Shapes [adapted from Jeffry Moll, Ronald Copstead & David Kim Johansen, U.S. Forest Service, *Traveled Way Surface Shape* (1997)].

These surface shapes are designed to "encourage shedding of water from the surface before it [can] cause unacceptable surface erosion" or ruts.[27] On in-sloped roads the surface is angled so that surface runoff is diverted toward the cutbank (the uphill side), where it can be collected in a purposely-designed drainage ditch. When rain falls, water flows off the road and into the ditch, then downslope in the ditch until it is emptied either onto the forest floor via a ditch-relief culvert or cross-drain, or emptied directly into a stream at a road-stream crossing. Currently, the best practice is to disconnect these ditches and culverts from the streams, but that is not physically possible in all circumstances. While an in-sloped surface is commonly used, it likely provides the least protection of the three road surface shapes against chronic sediment pollution discharges to waterways, as it collects the largest portion of the water from the road surface.

Out-sloped roads divert surface runoff down the hill toward the exposed edge of the roadway, thereby avoiding the concentration and channelization of runoff. Because of safety concerns, out-sloped roads are generally appropriate only for roads with gentler road grades. 2JA 81, 97.

A crowned road combines some elements of each of the other two designs, including the use of a cut-bank drainage ditch. Crowned roads are the most common road shape in the areas at issue in this case. 2JA 81. Since the distance the water travels is reduced in a crowned road, this road type has the abili-

[27] Jeffry Moll, Ronald Copstead & David Kim Johansen, U.S. Forest Service, *Traveled Way Surface Shape* 1 (1997).

ty to shed water the fastest and is often used in areas with significant rainfall.

After settling on the road surface shape, a road engineer must next decide on the drainage system to use. As indicated above, these two decisions are interrelated—the choice of an in-sloped or crowned road generally necessitates the use of a drainage ditch located on the cutbank side of the road. Ditches are built during road construction. They are typically 3-5 feet wide and 1-3 feet deep. Other drainage devices used in connection with logging roads include culverts, waterbars (diagonal berms made by cutting and filling across the road and usually associated with roads that are temporarily or seasonally closed), and dips (gentle grade reversals of the road surface). 2JA 83.

The entire purpose of these structures is to convey water from the road surface. The design objective of these drainage systems is to collect surface runoff (and intercepted subsurface flow from the cutbank) and then divert it via cross-drain structures to the forest floor. The majority of logging road drainage systems do just that. 2JA 122, 128. Sometimes, however, the water is discharged into a river or stream—those discharges, and only those discharges, are at issue in this case.

As with road system planning, many aspects of the road design decision affect sedimentation. First, poor drainage choices can be a major cause of slope failures and subsequent delivery of sediment to streams through mass wasting events (landslides).[28]

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[28] *See* Bradley T. Piehl, Robert L. Beschta & Marvin R. Pyles,

As a basic precaution, the risk of landslides, and the sedimentation that follows, can be reduced by taking care not to direct drainage onto landslide-prone slopes. 2JA 75. Even if the road has been constructed across an extended area of high landslide risk, cross-drains can still be used to redirect water to gentler slopes where water is more likely to be dispersed safely. 2JA 77.

Second, the ditches and other aspects of the drainage networks themselves also produce sediment. 2JA 77. Ditches generally have finer, more erodible soil material than stream beds.[29] 2JA 77.

However, the sedimentation impact of drainage networks can be reduced, for example by carefully designing the spacing between the ditch-relief culverts to manage water velocity.[30] 2JA 123. Logging companies can reduce sedimentation by creating a network that slows water by, for example, frequently discharging the ditches into the forest to reduce the volume and velocity of the water in ditch. Slower-moving water detaches less soil matrix and results in less sediment production.[31]

Ditch-Relief Culverts and Low-Volume Forest Roads in the Oregon Coast Range, 62 NORTHWEST SCI. 91, 91 (1988).

[29] Charles H. Luce & Thomas A. Black, *Spatial and Temporal Patterns in Erosion from Forest Roads*, *in* LAND USE AND WATERSHEDS: HUMAN INFLUENCE ON HYDROLOGY AND GEOMORPHOLOGY IN URBAN AND FOREST AREAS 165, (Mark S. Wigmosta & Stephen J. Burges eds., 2001).

[30] *See* NCASI WHITE PAPER, supra note 22, at 9.

[31] *See id.*

C. Road Construction.

At the construction stage, logging companies implement the design parameters chosen above and create a road that will support the logging project. In general, construction involves clearing the roadbed of brush, timber, and stumps; filling holes or dips; compacting the subgrades; and choosing and placing aggregate.[32]

As in the other stages of creating a logging road, the choice of construction practices strongly affects the generation of sediment pollution. As a foundational matter, construction itself can be a significant source of sedimentation. In fact, studies have shown that the highest rates of sediment production occur in the years immediately following road construction.[33] Sources of sedimentation from construction include sidecast materials—uncompacted material from excavation that is disposed on the fill side of the road. This material has low strength and is subject to gully formation or landslides when it becomes saturated.[34]

Choices made at the construction stage affect not only the amount of sedimentation that is immediately created, but also the amount of sediment that will

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[32] *See id.* at 7.

[33] Beverley C. Wemple, Frederick J. Swanson & Julia A. Jones, *Forest Roads and Geomorphic Process Interactions, Cascade Region, Oregon*, 26 EARTH SURFACE PROCESSES AND LANDFORMS 191, 191 (2001).

[34] Mary Ann Madej, *Erosion and Sediment Delivery Following Removal of Forest Roads*, 26 EARTH SURFACE PROCESSES AND LANDFORMS 175, 175 (2001).

be generated over the life of a road. For example, one method to improve forest road performance is to compact the subgrade. The subgrade is the native, base soil of a road, to which aggregate and other types of surfacing are added.[35] Compaction of the subgrade increases the strength of the road.[36] A well-compacted road can better resist catastrophic road failures, but its primary purpose is that is can resist rut formation. If the subsurface is not adequately compacted—particularly if it is composed of fine, loose soil—a portion of the aggregate can sink into the subsurface, leading to the creation of ruts.[37]

Additionally, the quality of the aggregate (crushed rock) used to surface the road significantly influences the quantity of fine sediment that is subsequently generated by the road. Native-surfaced (dirt) roads are generally the most erosive, meaning that they produce the most sediment pollution. Logging roads are usually surfaced with aggregate to allow year-round hauling. This process involves trucking in many tons of rock from a quarry. These materials are placed on the road surface and then compacted and smoothed by road building machinery.

Lower quality aggregates, which are weaker, create substantially more sedimentation because

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[35] Or. Dep't of Forestry, Forest Practices Technical Note No. 9, *Wet Weather Road Use* 8 (2003), *available at* http://www.oregon.gov/odf/privateforests/docs/wetseasonroadusefptechnote9.pdf [hereinafter *Wet Weather Road Use*].

[36] *Id.*; Boston, Pyles & Bord, *supra* note 25, at 24.

[37] *See* Boston, Pyles & Bord, *supra* note 25, at 24.

they are more vulnerable to mechanical breakdown from truck tires or to chemical breakdown from weather. Studies indicate that roads surfaced with high quality aggregate can produce one-quarter to one-twentieth the fine sediment produced by roads surfaced with poor quality aggregate.[38]

In addition, it is important to use an aggregate with the right mix, or distribution, of coarse and fine material: although some amount of fine sediment in the aggregate mix is desirable to facilitate compaction and road stability, too much is undesirable as it is easily washed off the road surface during rain events.[39]

D. Road Operation.

The use of a logging road for logging is, of course, its purpose. To sustain the road for the duration of a project, a logging company must balance considerations of traffic volume and truck weight—which can damage the road—with the need to timely transport heavy equipment into—and logs out of—the forest.

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[38] *See Wet Weather Road Use*, *supra* note 35, at 2; Randy B. Foltz, *Traffic and No-Traffic on an Aggregate Surfaced Road: Sediment Production Differences* (1996) (paper presented at the FAO Seminar on Environmentally Sound Forest Roads), *available at* http://forest.moscowfsl.wsu.edu/engr/library/Foltz/Foltz1996f/1996f.pdf.

[39] Foltz & Truebe, *supra* note 13, at 188; Randy B. Foltz, Gary L. Evans & Mark Truebe, *Relationship of Forest Road Aggregate Test Properties to Sediment Production*, *in* WATERSHED MANAGEMENT & OPERATIONS MANAGEMENT 2000 (Marshal Flug et al. eds. 2000).

Perhaps most significantly, a vast amount of sedimentation is caused by the movement of logging trucks and other heavy equipment over the road. The heavy truck traffic associated with industrial forestry increases sediment pollution in two specific ways. First, the weight of the tires passing over the road crushes the aggregate into fine sediment. Second, "vibrations from heavy traffic can move fine material up through the aggregate to the top of the road."[40] The fine sediment generated by these two mechanisms remains at the surface of the road until it is washed away by the next significant rainfall.

In one study, truck traffic levels alone explained 97% of the variation in annual sediment yield.[41] Another study demonstrated that twenty passes of a truck can produce as much sediment as is generated in a year by the road surface alone.[42] The Oregon Department of Forestry has itself concluded that "[w]et season road use can be the most significant forest practice-associated source of chronic turbidity and fine sediment in streams."[43]

This level of sediment pollution is not inevitable, however. One method of decreasing sediment production is to decrease the tire pressure of the logging

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[40] *Wet Weather Road Use*, *supra* note 35, at 4.

[41] Gary J. Sheridan & Philip J. Noske, *A Quantitative Study of Sediment Delivery and Stream Pollution from Different Forest Road Types*, 21 HYDROLOGICAL PROCESSES 387, 394 (2006).

[42] *See* Pieter J.B. Fransen, Chris J. Phillips & Barry D. Fahey, *Forest Road Erosion in New Zealand: Overview*, 26 EARTH SURFACE PROCESSES AND LANDFORMS 165, 169 (2001).

[43] *Wet Weather Road Use*, *supra* note 35, at 2.

trucks and other heavy vehicles as they pass over the logging road. Some logging trucks are manufactured with "central tire inflation," an in-cab system for adjusting tire pressures. The use of such a system to reduce tire pressures on heavy-haul vehicles when traveling over vulnerable aggregate has been shown to reduce road surface sediment production an average of 80% over a three-year study.[44] Even manually reducing the tire pressure in unmodified trucks resulted in a 45% reduction in sediment production.[45]

Lowering logging truck tire pressures decreases sedimentation in two ways. Not only does it reduce the mechanical breakdown of the aggregate, but it also minimizes the creation of ruts.[46] A rutted road produces twice to four times as much sediment as a freshly graded road.[47]

E. Road Maintenance.

After construction, the road must be periodically maintained to allow for continued use, with special care given to the smoothness of its surface, maintenance of the road shape, and the functionality of its drainage structures. Maintenance activities include surface grading and gravel supplementation; ditch cleaning; cleaning and replacement of damaged relief

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[44] Randy B. Foltz, *Sediment Reduction from the Use of Lowered Tire Pressures*, *in* CENTRAL TIRE INFLATION SYSTEMS: MANAGING THE VEHICLE TO SURFACE 47-52 (Soc'y of Automotive Eng'rs 1995).

[45] *Id.*

[46] *Id.*

[47] Foltz & Elliot, *supra* note 15, at 19.

culverts and stream crossing culverts; and grading of rolling dips.[48]

Maintenance choices, like choices at other steps in the process of building a logging road, can significantly reduce the rate of sedimentation. For example, overly frequent grading of the road surface can increase sediment generation.[49] Meanwhile, failure to clean plugged ditches contributes significantly to road failures.[50] In one study, blocked culverts accounted for 45 per cent of landslides caused by logging roads.[51] Blocked ditches and culverts can also cause water to travel on the landscape in other unnatural and uncontrolled ways—for example, by creating gullies along virgin slopes.[52] Erosion treatments such as spreading grass seed on the slope below roads can also be an effective way to reduce sedimentation.[53]

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[48] *See* NCASI WHITE PAPER, supra note 22, at 10.

[49] S*ee* Matthew Thompson et al., *Intelligent Deployment of Forest Road Graders*, 18 INT'L J. OF FOREST ENGINEERING 15, 15 (2007).

[50] *See* Piehl, Beschta & Pyles, *supra* note 28.

[51] *See* Fransen, Phillips & Fahey, *supra* note 42, at 170.

[52] Charles H. Luce & Beverley C. Wemple, *Introduction to Special Issue on Hydrologic and Geomorphic Effects of Forest Roads*, 26 EARTH SURFACE PROCESSES AND LANDFORMS 111, 112-13 (2001).

[53] *See* Walter F. Megahan, Monte Wilson & Stephen B. Monsen, *Sediment Production from Granitic Cutslopes on Forest Roads in Idaho, USA*, 26 EARTH SURFACE PROCESSES & LANDFORMS 153, 161 (2001).

In sum, the runoff that flows from logging roads into streams is not natural runoff—it is runoff whose timing, pathways, and sediment content has been modified by the presence, composition, and use of logging roads. Indeed, much of the sediment from logging roads is not soil from natural hill slopes—instead, it is material that has been exposed by the road construction process or aggregate that has been placed on the road surface to aid the logging operations and has then been ground up into fine particles by the repeated passage back and forth of heavy trucks and other equipment used in logging operations. Under these circumstances, when sediment-laden water from logging roads is carried by ditches and other man-made drainage structures and discharged into rivers or streams, it is best understood to be a discharge from a point source, generated by industrial activity, and not mere natural runoff.

CONCLUSION

The discipline of forest engineering teaches that discharges of water pollution to streams from logging roads is not inevitable. Indeed, scientists and engineers have demonstrated that discrete choices in the planning, design, construction, and use of logging roads can provide substantial protection to streams. These choices, detailed above, are both limited in number and achievable. They include locating roads on strong soils and away from streams; designing road shape and drainage networks to promote shedding of water from the road; compacting the subsurface to reduce rutting; selecting quality aggregates that resist weathering and crushing; using vehicles and tire adjustment systems that reduce pressure on the road; and maintaining the road by, for example, clearing drainage structures to prevent clogging and seeding slopes to reduce erosion.

The function of the NPDES permitting program in this context is to stimulate sources to adopt these important practices.[54] NPDES permitting need not be burdensome. As explained by Respondent, the EPA Administrator has a variety of mechanisms, including general permitting and variances in response to economic hardship, to minimize the administrative burden of the permitting requirement. Respondent Br. at 54-56. For example, individual sources may opt in to a general permit that sets out conditions applicable to a particular geographic area merely by providing notice to the agency. Such gen-

[54] *Amici* supporting Petitioners suggest that the impacts of stormwater runoff from logging roads are best dealt with by Best Management Practices (BMPs). *See generally* Amicus Br. of the Soc'y of Am. Foresters. While there are some benefits to BMPs, this argument misses the point that the only legal difference between a point source and a non-point source is the manner in which pollution enters waters of the United States. There can be no question that the discharges from ditches and other human-created drainage structures at issue in this case are point-source discharges. Indeed, petitioners and their *amici* do not dispute that logging roads use pipes, ditches, and channels to collect and discharge stormwater. *See, e.g.*, Industry Br. at 1, 34; State Br. at 2, 44; Amicus Br. of the Soc'y of Am. Foresters at 20; Amicus Br. of Ass'n of Or. Counties at 19-32 (discussing the numbers of culverts and ditches associated with logging roads in Oregon). Additionally, in many states BMPs are voluntary and do not provide the certainty of protection that would be accorded by conditions included in an enforceable permit. *See generally* Amicus Br. of Northwest Envtl. Advocates.

eral permitting minimizes both the burden on the agency and on sources.

In short, permitting of direct discharges from logging roads is compelled by the CWA, is necessary to achieve the goals of the Act, and—thanks to general permitting—places no unacceptable burdens on EPA or sources. The judgment below should be affirmed.

Respectfully submitted,

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