No. 21-454

In the
Supreme Court of the United States

MICHAEL SACKETT; CHANTELL SACKETT,
Petitioners,
v.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY;
MICHAEL S. REGAN, Administrator
Respondents.

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

BRIEF OF ASSOCIATION OF AMERICAN RAILROADS IN SUPPORT OF PETITIONERS

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INTEREST OF *AMICUS CURIAE*[1]

The Association of American Railroads is an incorporated, nonprofit industry association whose membership includes freight railroads that operate 83 percent of the line haul mileage, employ 95 percent of the workers, and account for 97 percent of the freight revenues of all railroads in the United States. AAR also represents passenger railroads that operate intercity passenger trains and provide commuter rail service.

Combined, the nation's railroads operate nearly 140,000 miles of right-of-way. The tracks on most of that mileage are drained by engineered ditches that are essential to rail safety and reliability. This case could affect whether some or all of those ditches are jurisdictional "waters of the United States" under the Clean Water Act.

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[1] Pursuant to Supreme Court Rule 37.6, counsel for *amicus* represent that they authored this brief in its entirety and that none of the parties or their counsel, nor any other person or entity other than *amicus*, its members, or its counsel, made a monetary contribution intended to fund the preparation or submission of this brief. Pursuant to Rule 37.3(a), counsel for Respondents have given blanket consent to the filing of amicus briefs, while counsel for Petitioners consented via email.

INTRODUCTION AND SUMMARY OF ARGUMENT

Ditches are as much a part of the nation's rail system as tracks and trains. These ditches are designed, built, and maintained using rigorous engineering standards, solely to drain water away from rail infrastructure. Without that drainage, the tracks could lose integrity, causing service interruptions and safety risks.

Though railroad ditches are vital to rail operations, agency interpretations of the Clean Water Act have left them in a constant state of regulatory flux. As the relevant rules—and the people interpreting them—have changed, the number of railroad ditches that qualify as "waters of the United States" has changed too. But the text of the Clean Water Act has not changed. It says that ditches are point sources and that point sources are not navigable waters. As the Court considers the proper test for identifying waters of the United States, that distinction should anchor its interpretation.

ARGUMENT

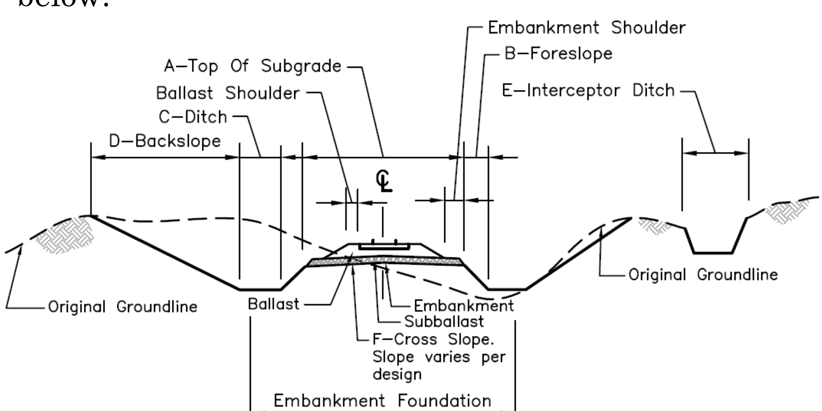
In deciding whether the wetlands here were waters of the United States, the Court of Appeals ruled that "the Sackett's wetlands were adjacent to a jurisdictional tributary." *Sackett v. U.S. Envtl. Prot. Agency*, 8 F.4th 1075, 1092 (9th Cir. 2021). That "jurisdictional tributary" was in fact a manmade, roadside ditch. Op.Br. 19-20, 50-51; Pet.App.C-3. Similar ditches run along both sides of the tracks within the nation's 140,000-mile rail network. By clarifying once and for all that those ditches are not waters of the United States, the Court can end decades of costly regulatory uncertainty.

I. The Court should clarify that railroad ditches are not waters of the United States.

Railroad ditches have one purpose: to capture and remove water from the tracks. In doing so, ditches allow trains to operate safely even when water is present. Rail safety thus demands that the hundreds of thousands of miles of railroad ditches be regularly maintained to ensure proper drainage. To fulfill that obligation and keep their tracks safe, railroads need to know that those ditches are not jurisdictional.

A. Railroads depend on engineered ditches to keep their track stable and operational.

Railroads are the most fuel-efficient way to move freight long distances over land. That efficiency is a function of engineering: steel wheels on steel rails create less resistance than rubber tires on pavement. Those rails and their supporting crossties rest on a bed of ballast and sub-ballast that helps distribute the weight of the trains to an embankment, as illustrated below.



App.3a, American Railway Engineering and Maintenance-of-Way Association, Manual for Railway Engineering at 1-1-14, Fig. 1-1-1a (2019).

With this foundation, railbeds can support axle loads far heavier than highways. But the railbed must be stable for the railroad to operate safely and efficiently. Instability disrupts service and may even lead to derailments.

"[T]he principal influence on soil stability in roadbed, subgrade, and slopes" is water. App.11a, American Railway Engineering and Maintenance-of-Way Association, Manual for Railway Engineering at 1-1-34. That being so, "control of surface and subsurface water is the most important factor in roadway design and maintenance." *Id.* Control is achieved mainly by installing ditches next to the railbed. *Id.* These ditches must handle both runoff and subgrade drainage. *Id.*

The vital function of railroad ditches is well known to the Federal Railroad Administration. According to FRA's track safety manual, "[o]ne of the most essential elements of track maintenance is a comprehensive drainage system." FRA, Track Safety Standards Compliance Manual at 5.22, § 213.33.[2] FRA rules thus require that railroad ditches "be maintained and kept free of obstruction to accommodate expected water flow . . . ." 49 C.F.R. § 213.33; *see id.* § 213.319. To ensure safety, FRA also mandates track inspections and tells inspectors to note right-of-way ditches. *See id.* § 213.233; FRA, Track Safety Standards Compliance Manual at 5.22.

Streets and highways are often built on similar principles, with roadside ditches used for drainage. *See* Federal Highway Administration, Maintenance of Drainage Features for Safety 1 (July 2009) ("Drainage systems that remove storm water run-off from streets

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[2] Available at https://railroads.dot.gov/sites/fra.dot.gov/files/2020-08/2008_Track_Safety_Standards%20%281%29.pdf.

and highways are an integral feature of a safe system.")[3] So the jurisdictional issues addressed in this brief are not unique to railroads or the Sacketts. How agencies interpret their jurisdiction under the Clean Water Act affects anyone who needs to maintain, modify, or fill a ditch.

B. Regulatory uncertainty over railroad ditches risks rail safety and operations.

For years, the regulation of railroad ditches has been anything but predictable. The earliest Corps of Engineers rules defining "waters of the United States" under the Clean Water Act expressly "excluded" drainage and irrigation ditches. 40 Fed. Reg. 31320, 31321 (July 25, 1975). But in 1986, the Corps announced that while it "generally [did] not consider" non-tidal drainage ditches to be jurisdictional waters, it would start deciding ditch jurisdiction case-by-case. 51 Fed. Reg. 41206, 41217 (Nov. 13, 1986). EPA soon took the same posture. *See* 53 Fed. Reg. 20764, 20765 (June 6, 1988).

These changes began a long period of vacillation that affected all regulated parties, including railroads. A rule promulgated in 2000 defined most "non-tidal drainage ditches" as waters of the United States. 65 Fed. Reg. 12818, 12823 (Mar. 9, 2000). Then, after this Court's decision in *Rapanos v. United States*, 547 U.S. 715 (2006), case-by-case judgments returned via the "significant nexus" test. *See* U.S. Envtl. Prot. Agency & U.S. Army Corps of Eng'rs, *Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in* Rapanos v. United States & Carabell v. United States

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[3] Available at https://safety.fhwa.dot.gov/local_rural/training/fhwasa09024/fhwasa09024.pdf.

(Dec. 2, 2008) (*Rapanos* Guidance).[4] This post-*Rapanos* guidance begat a new rule, which said that ditches would "in many instances" qualify as jurisdictional waters. 80 Fed. Reg. 37054, 37078 (June 29, 2015). Five years later, a now-vacated rule narrowed but retained jurisdiction over ditches. *See* 85 Fed. Reg. 22250, 22297 (April 21, 2020). And the latest proposed rule reverts to 1986 standards by broadly asserting jurisdiction over ditches. *See* 86 Fed. Reg. 69372, 69422 (Dec. 7, 2021).

Not knowing from one administration (or one project) to the next whether railroad ditches qualify as waters of the United States is a serious problem. Railroads operate tracks with ditches on both sides over nearly 140,000 miles of right-of-way. Those ditches must be maintained. Indeed, FRA rules require them to be unobstructed and able to handle expected water flow. *See* 49 C.F.R. § 213.319. Complying with that rule can mean modifying, deepening, or relocating a ditch. But if railroad ditches are jurisdictional, another set of rules applies: the rules that govern activity under section 404 of the Clean Water Act. The burdens of Clean Water Act permitting would conflict with railroads' obligations under FRA safety rules.

Even apart from that conflict, classifying ditches as jurisdictional waters could delay projects that advance rail operations and safety. Privately owned U.S. freight railroads evaluate all projects with an eye on permitting costs and risk. Costs rise when ditch work requires a Clean Water Act permit, and risks multiply when agencies change their position or use ambiguous rules. These growing costs and risks can force changes

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[4] Available at https://www.epa.gov/sites/default/files/2016-02/documents/cwa_jurisdiction_following_rapanos120208.pdf.

to project designs, plans, and budgets. Large amounts of capital may have to be reallocated; years of planning can be lost. And if one project requires more resources, it has a cascading effect on others. In short, regulatory costs and uncertainty make long-term investment harder, potentially delaying supply chain improvements that benefit everyone.

The jurisdictional status of railroad ditches is far from the only regulatory uncertainty created by the Clean Water Act rules. Current law treats ephemeral streams as jurisdictional, requiring permitting and mitigation in places where water rarely flows. And the opacity of the "significant nexus" test for identifying jurisdictional wetlands forces railroads to spend time and money figuring out which projects require which federal permits. As even the agencies admit, "significant nexus is not a purely scientific determination." 86 Fed. Reg. at 69390. On all these issues, AAR endorses the Sackett's arguments. But ditches present a special problem for railroads—a problem that the text of the Clean Water Act helps solve.

II. Because ditches are point sources, they cannot be waters of the United States.

The wetlands that EPA identified on the Sacketts' property were separated from traditionally navigable waters by a road and a manmade roadside ditch. *See Sackett*, 8 F.4th at 1081. Similar manmade ditches parallel railroad tracks throughout the country. Under the Clean Water Act, those ditches cannot be waters of the United States. Nor can they expand federal jurisdiction by linking otherwise isolated wetlands to traditionally navigable waters.

A. The Clean Water Act distinguishes point sources from navigable waters.

The Clean Water Act "use[s] specific definitional language" to achieve its goals. *County of Maui v. Hawaii Wildlife Fund*, -- U.S. --, 140 S.Ct. 1462, 1469 (2020). Its definition of "point source" includes ditches:

> The term "point source" means any discernable, confined and discrete conveyance, including . . . any pipe, *ditch*, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

33 U.S.C. § 1362(14) (emphasis added). Point sources are important because the Act regulates "any addition of any pollutant to navigable waters from any point source." 33 U.S.C. § 1362(12)(A) (defining "discharge of pollutants"); *see* § 1311(a) (making such discharges "unlawful"); *Nat'l Ass'n of Mfrs. v. Dep't of Def.*, -- U.S. --, 138 S.Ct. 617, 624 (2018).

The concept is simple: Point sources are "conveyances" that have the potential to discharge pollution. Navigable waters—which the Act defines as "the waters of the United States, including the territorial seas"—are vulnerable to that pollution. 33 U.S.C. § 1362(7). So the Clean Water Act generally prohibits discharges *from* point sources *to* navigable waters. *See* 33 U.S.C. § 1311(a); *Nat'l Ass'n of Mfrs.*, 138 S.Ct. at 624.

The plurality in *Rapanos* saw that this regulatory scheme "conceive[s] of 'point sources' and 'navigable waters' as separate and distinct categories." 547 U.S. at 735. It reasoned that regulating point source discharges to navigable waters "would make little sense if the two categories were significantly overlapping." *Id.* And the plurality was right. The definition of discharge crumbles if a point source can also be a navigable water. Because the Act does not prohibit adding pollutants from one navigable water to another, blurring the distinction between point sources and navigable waters opens a loophole in the Act's main rule.

The Act's main permitting program—the National Pollutant Discharge Elimination System—makes the same distinction. Under that program, regulators can issue point source discharge permits that protect water quality. *Nat'l Ass'n of Mfrs.*, 138 S.Ct. at 625. Those permits must contain "effluent limitations" that restrict the "quantities, rates, and concentrations" of pollutants "discharged *from* point sources *into* navigable waters." 33 U.S.C. § 1362(11) (emphasis added); *see Nat'l Ass'n of Mfrs.*, 138 S.Ct. at 625. If point sources and navigable waters were overlapping categories, the NPDES permitting requirements for ditches (and potentially other point sources as well) would become indecipherable.

Despite this potential for confusion, the Corps and EPA have continued to define ditches as navigable waters after *Rapanos*. Their initial effort took the form of a guidance document that asserted jurisdiction over all "tributaries" (including manmade ditches) having a "significant nexus" with traditional navigable waters. *See Rapanos* Guidance at 1. Ditches "excavated wholly in and draining only uplands" were "generally" excluded. *Id.* The agencies formalized this guidance in their 2015 rule, the preamble to which noted that "[d]itches are one important example of constructed features that in many instances can meet the definition of tributary." 80 Fed. Reg. at 37078. Their most recent proposed rule reiterates the agencies' belief that "a ditch can be both a point source and a water of the United States . . . ." 86 Fed. Reg. at 69434.

These agency interpretations should not subvert the Clean Water Act's plain language. A ditch is a point source. 33 U.S.C. § 1362(14). Point sources are not navigable waters. *Id.* §§ 1362(11), (12)(A). In claiming otherwise, the agencies are muddying the Clean Water Act's most basic rule: Discharges from point sources to navigable waters are prohibited.

B. Ditches are not tributaries.

What about the agencies' claim that ditches should be treated like navigable waters when they act as "tributaries"? Setting aside its conflict with the Clean Water Act's text, this claim ignores the ordinary meaning of the words "ditch" and "tributary." That ordinary meaning should control. *See, e.g.*, *Wooden v. United States*, -- U.S. --, 142 S.Ct. 1063, 1069 (2022).

The word "tributary" does not appear in the relevant parts of the Act. The Corps seems instead to have introduced jurisdiction over tributaries in its 1975 rules. 40 Fed. Reg. at 31324. But those rules expressly disclaimed jurisdiction over "[d]rainage and irrigation ditches." *Id.* at 31321. It took another 25 years before ditches and tributaries were conflated. *See* 65 Fed. Reg. 12818, 12823-24 (March 9, 2000) ("Drainage ditches constructed in uplands that connect two waters of the United States may be considered waters of the United States if those ditches constitute a surface water connection . . . ."). Now, after 25 more years, the agencies appear wedded to the idea of "assess[ing] a ditch's jurisdictional status based on whether it could be considered a tributary." 86 Fed. Reg. at 69433.

The agencies' approach creates problems because ditches and tributaries are two different things. Since the Clean Water Act does not define the word "ditch," its ordinary, dictionary meaning governs: "[A] long narrow trench or furrow dug in the ground, as for irrigation, drainage, or a boundary line." Am. Heritage Dictionary of the English Language 384 (1st ed. 1969); *see also* Webster's New Int'l Dictionary 661 (3d ed. 1961) (defining ditch as "a trench for conveying water for drainage or irrigation"). A tributary, by contrast, is a natural feature—"[a] stream or river flowing into a larger stream or river." Am. Heritage Dictionary 1370; *see also* Webster's New Int'l Dictionary 2441 (defining tributary as "a stream feeding a larger stream or lake").

Agencies cannot change a statute's meaning years later by adopting rules that introduce new terms and use them in unnatural ways. *See Kisor v. Wilkie*, -- U.S. --, 139 S.Ct. 2400, 2416 (2019) ("[T]he agency's reading must fall within the bounds of reasonable interpretation.") (internal citation and quotation marks omitted). The Clean Water Act says that ditches are point sources. That the agencies today call them tributaries instead cannot transform them into navigable waters.[5]

C. If ditches are not navigable waters, they cannot extend federal jurisdiction.

Treating ditches like tributaries, as EPA and the Ninth Circuit did here, is the first domino in a jurisdiction-expanding chain reaction. EPA's exercise of jurisdiction over the Sacketts' wetlands rested on its

[5] Similar definitional distinctions separate ditches from canals. *See* Am. Heritage Dictionary 194 (defining canal as "[a] man-made waterway or artificially improved river used for irrigation, shipping, or travel"). Even the permanent presence of water would not change a ditch into a canal. *See Rapanos*, 547 U.S. at 736 n.7. Ditches are for drainage, not travel.

finding that those wetlands were "adjacent to a jurisdictional tributary." *Sackett*, 8 F.4th at 1092. That tributary—really a roadside ditch, *see* Op.Br. 19-20; Pet.App.C-3—was declared jurisdictional because it was connected to Kalispell Creek, which in turn "flow[ed] into Priest Lake, a traditional navigable water." *Sackett*, 8 F.4th at 1092 (citing 33 C.F.R. § 328.3(a)(5) for the proposition that "tributaries to jurisdictional waters are themselves jurisdictional"). The same conclusion, the Court held, was supported by the agencies' post-*Rapanos* guidance, which asserted jurisdiction over "all wetlands adjacent to the same tributary." *Id.* at 1092-93 (quoting *Rapanos* Guidance). Since the roadside ditch "tributary" here was adjacent to the Sacketts' wetlands and the Kalispell Bay Fen, the guidance counseled federal jurisdiction over both. *See id.* at 1093.

So, according to the Ninth Circuit, any ditch that qualifies as a jurisdictional tributary can expand federal jurisdiction in at least two ways: (1) by linking a traditionally navigable water to otherwise unconnected upstream wetlands, or (2) by linking all wetlands to which the ditch is adjacent. Applying these principles to the hundreds of thousands of miles of railroad ditches in the United States would dramatically expand federal jurisdiction. A single railroad ditch linked to a traditionally navigable water could—absurdly—create jurisdiction over a wetland hundreds of miles away.

If the agencies instead applied the Act's distinction between point sources (including ditches) and navigable waters, several problems would be solved. To start, railroads would not have to wonder whether their ditches would be subject to slow, expensive Clean Water Act permitting. This confidence would reduce delays, facilitate growth, and, given the role of railroad ditches, promote safety. Beyond that, ditches would stop being part of larger fights over wetland jurisdiction like the one in this case. Indeed, whenever jurisdiction hinges on treating ditches like tributaries, those fights would shrink or vanish.

III. Ditches are regulated in other ways.

Treating ditches like tributaries is not the only way to regulate them. Nor is doing so essential to protecting navigable waters and water quality. Both goals can be accomplished while applying the Clean Water Act's plain meaning.

Many ditches, including railroad ditches, are for managing stormwater. Certain industrial stormwater discharges from point sources to navigable waters are subject to EPA's NPDES stormwater program. *See* 40 C.F.R. § 122.26; *see also* U.S. EPA, National Pollutant Discharge Elimination System Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity (2021). Those rules do not require—indeed, they are undermined by—a reading of the Clean Water Act that counts ditches as navigable waters.

When ditches convey non-stormwater pollutant discharges to navigable waters, the discharger may have to acquire an NPDES permit from the EPA or its state designee. *See* 33 U.S.C. § 1342. Such permits must meet various standards designed to protect against pollution. *See, e.g.*, *id.* § 1312(a) (requiring effluent limitations for specific point sources); *id.* § 1316 (addressing standards of performance). Here too, treating ditches as navigable waters is counterproductive.

Complying with rules is the foundation of railroads' safety culture. As they move essential commodities around the continent every day, railroads must comply with all manner of rules. But an agency-made rule that may or may not assert jurisdiction over railroad ditches makes no sense, either as a practical matter or on a plain reading of the Act's definitions. Railroad ditches are manmade safety features, not navigable waters.

CONCLUSION

The judgment of the Court of Appeals should be reversed.

Respectfully submitted,

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April 18, 2022

Appendix

AREMA
American Railway Engineering and Maintenance-of-Way Association
Manual for Railway Engineering
[Excerpts]

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Part 1
Roadbed
– 2019 –

FOREWORD

Since the development of soil and foundation engineering as an important branch of civil engineering, earth and rock have come to be treated as construction materials. They have properties which can be evaluated and are subject to strains and failures in the same way as other building materials.

Earth and rock are different, however, from materials such as steel and concrete in that each soil and rock deposit is extremely variable and has its own characteristics which reflect its origin and future performance (if used). As a result, investigation and testing are uniquely important if soils and rock are to be utilized economically and safely in engineering work.

Part 1 of the AREMA Manual is prepared with recognition of the importance of geotechnical knowledge in the design, construction, and maintenance of track. The subgrade is considered to be as important to track performance as rail and ballast. Keeping this balanced point of view in mind, an engineered approach is presented for many roadbed problems rather than reference to standard practice.

The choice of available investigation methods is given with an evaluation of the judgment factors involved in many of the questions relating to the design and construction of the new roadbed and the upgrading and maintenance of existing roadbed. Considerations such as drainage and slope stability, which affect the roadbed directly but are outside its physical limits, are included.

Due to the fact that there are a variety of foundation conditions and associated problems that occur, a number of references are given. Details of methods are presented only when adequate information is hard to find elsewhere. Specialized help is advisable when a detailed appraisal of the suitability and performance of particular deposits is required.

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1.2.2 CUTS (EXCAVATIONS) (2013) R(2016)

1.2.2.1 General

a. Definition: Cuts are made when excavations are required to provide roadbed grades and to acquire materials for use when constructing fill sections. Materials encountered in cuts can consist of cohesive soils, cohesionless soils, rock or combinations thereof. The general components of a cut (and fill) section consist of the back slope(s), benches (if required), foreslope(s), ditches, and the top of subgrade (track roadbed) as presented in Figures 1-1-1a and 1-1-1b. The "cut" width is the total of the backslope(s), ditches, foreslope(s) top of subgrade widths, and interceptor ditches for the section(s). The purpose of each of these segments are defined in Table 1-1-6.

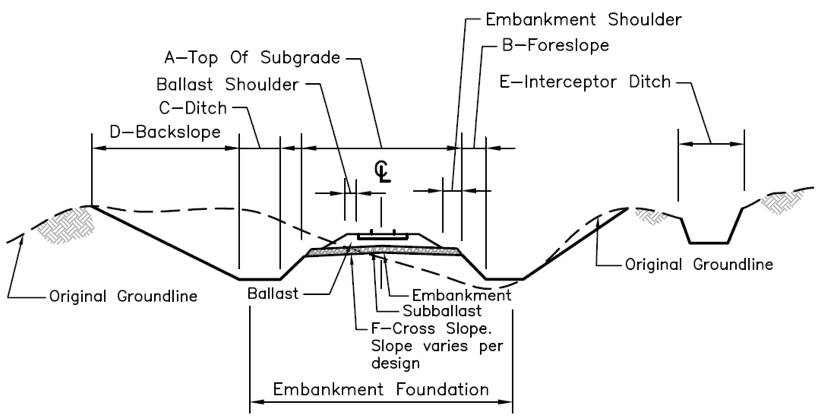

Figure 1-1-1a. Cut and Fill Section Components without Service Road (NTS)

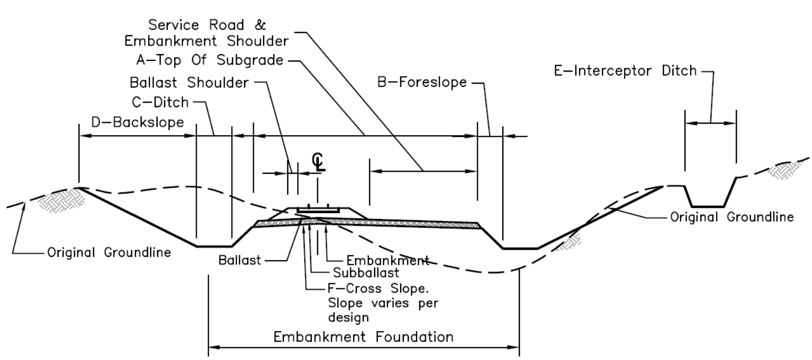

Figure 1-1-1b. Cut and Fill Section Components with Service Road (NTS)

Begin page 1-1-15

Table 1-1-6. Factors Affecting Width of Cut

SEGMENT	PURPOSE	WHERE PROVIDED	WIDTH & PROFILE
A. Top of Subgrade	To provide a base for subballast, ties, rails and service roads.	Throughout cut and fill sections.	Standard width.
B. Foreslope	To safely support track and road subgrade. To place subgrade at safe height above maximum design drainage levels.	Throughout cut and fill sections.	Standard width.
C. Ditch	To carry runoff from watershed served and intercept any groundwater entering cut, while preventing development of unstable track subgrade conditions.	In all cuts.	Width as required to accommodate hydraulics. Profile may need to be different than track profile in long level cuts. Refer to Article 1.2.2.1.b.
D. Backslope	To provide a resultant excavation face located between outer ditch line and natural ground line.	In all cuts.	Variable width depending on slope, height of cut face, soil stability, maintenance and erodibility.

E. Interceptor Ditches	To carry runoff from the watershed served and prevent surface runoff from entering the cut.	Above cut slope.	Width as required to accommodate hydraulics.
F. Cross Slope	To provide positive surface drainage transverse to the track alignment.	Atop finished track subgrade and subballast.	Cross width as required to get off grade.

b. Cut Section Design Requirements: The track roadbed (top of subgrade) portion of a cut should remain stable during the excavation and track laying operations, and once the railroad line has been placed into operation. Cut section design issues include providing safe backslopes and foreslopes. Drainage ditches need to be sized to accommodate surface runoff and subsurface water which may seep from the backslope face. Ditches made within rock cuts may need to be designed having additional width for catchment of rock materials which may fall from the backslope face. Primary consideration when designing this catchment width is to position the toe of slope at a point that will minimize falling rock fragments bouncing onto the track. The working width required by ditch cleaning machines is important. The materials that will be encountered in the cut must be evaluated for excavatability. Cuts may need to be designed with flat slopes to facilitate self-cleaning by prevailing winds and minimize snow storage. Benching of the backslope may be required to accommodate drainage and to catch falling rocks.

1.2.2.2 Backslopes in Cuts

Slope stability analysis should be performed to aid in selecting the appropriate safe backslope section. Cross-sections should then be drawn transverse to the proposed track alignment to determine if safe cuts can be made within the right-of-way lines or if additional right-of-way or soil slope reinforcement will be required for the project. Soils and rock materials having varying strengths may necessitate that the backslope be cut at varying slopes. Subsurface water that seeps from the face of the backslopes can facilitate slope instability. Vertical interceptor drains and horizontal drains may need to be designed to intercept subsurface groundwater flow and reduce hydrostatic pressures which could cause instability.

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1.2.2.3 Drainage Ditches in Cuts

Ditches designed for drainage and catchment (as shown in Figure 1-1-2) should be designed to have the capacity to handle regional surface water runoff, snow storage and to control debris and talus buildup. The capacity is influenced by the width, depth and gradient of the ditch. Reference should be made to Article 1.2.4 which provides specific ditch design guidelines.

1.2.2.4 Track Bed Performance in Cuts

Track performance is enhanced by providing uniform stable subgrade conditions through-out a given cut. Providing drainage of the immediate subgrade materials generally improves subgrade stability by increasing the materials strength while reducing the detrimental effects of frost action. Longitudinal and transverse drains can be designed to facilitate subgrade drainage.

1.2.2.5 Cuts in Soil

1.2.2.5.1 General

a. Considerations such as the proposed slope angle, drainage conditions, and moisture conditions and strength of the soils encountered in a cut are the most significant factors that influence the stability of earth slopes. All sloping soils have a tendency to move under the influence of gravity. Slope stability evaluations should generally be made to select the cross-section for cuts over 15 feet deep. Observations of nearby cuts in similar soils and natural slopes in the project locale can aid in slope design and may necessitate slope stability evaluations be made in cuts much less than 15 feet deep.

b. It is important that the cut cross-section be wide enough to provide side ditches for interception of surface water. Where it is not practical to collect surface drainage with adequate ditches, buried drainage pipes can be provided. It is important to evaluate the need for relief of subsurface water pressure in sloping ground to avoid slope failures. The subsurface water pressure may be reduced by installing interceptor ditches or drains above the slope, or horizontal buried drainage pipes at critical depths within the slope either longitudinal or transverse to the cut face. In rare cases, vertical wells may be required.

c. For every soil type it is necessary to maintain a safe and stable cut section. This could include incorporating berms, drainage, erosion protection, filter layers and vegetation. Additionally, proper selection of the finished cut slope angle should be used as a means of achieving this end. Discussion is provided in Article 1.4.3 and Article 1.4.5. Cribs or retaining walls may be used in troublesome sections where berms and other less costly means of providing a stable cut slope are unable to be installed. Details for the design of crib and retaining walls are given in Chapter 8, Concrete Structures and Foundations. While slope control structures and techniques add to costs, they will pay dividends in reduced requirements for slope restoration and ditch cleaning.

1.2.2.5.2 Cuts in Cohesionless Soils (Sands and Gravels)

a. Sands and gravels that are located above the groundwater level generally will stand safely at a slope 2(H):1(V) or flatter. Steeper slopes may be able to be excavated and stand for short periods of time, but will eventually try to assume a flatter slope. Finished slopes in sand-gravel materials that are exposed to groundwater flow from the backslope face will routinely have to be cut flatter than would be required for the same cohesionless soil cut in a non-saturated state. In areas of loose saturated cohesionless soils, special provisions may be required to avoid liquefaction.

b. The stability of slopes in sand is generally improved as the density of the cohesionless soil increases.

1.2.2.5.3 Cuts in Cohesive Soils (Silts and Clays)

a. Cuts in cohesive soils need to be designed with caution. Previously stable slopes have been known to fail. Cuts in cohesive soils should be designed using slope stability analysis. Local long-term experience may prove to be an indicator of a stable slope for a particular soil profile. A slope of 2(H):1(V) or flatter generally proves stable in cohesive soils. Generally, clay slopes over 10 feet in height should be designed on the basis of laboratory tests and

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slope stability analysis. Typically, the higher the cut section becomes, the flatter the slope will have to be to remain stable. Highly plastic soils require flatter slopes than those discussed above.

b. The stability of clay slopes can be increased by the installation of drains and by flattening the cut slope. Other means such as soil nailing and ground anchors may deem useful in particular situations.

c. Cut slopes in areas where it is known that slides are inevitable may be designed to allow for slope movement (failure) without interference to traffic.

1.2.2.5.4 Cuts in Non-Uniform Soils

Cuts in soils which are layered or contain seams of varied soil types should be designed on the basis of a slope stability analysis. The seams that contain cohesionless (granular) soils are often water bearing during some part of the year and drainage of these seams should be provided. Effective drainage may stabilize an otherwise unstable slope if the soil properties of the unsaturated (drained) backslope soils are adequate.

1.2.2.5.5 Cuts in Loess

In site specific cases cuts in loess can be designed with near-vertical or flatter slopes based upon the engineering properties of the soils and the findings of slope stability analysis. Cuts in loess that are designed to have a near-vertical face should be carefully drained at the foot and top of the face. Loess soils possess a natural cementation that is soluble, a uniform grading, and a vertical root hole structure. Deep cuts can be made with near vertical faces and berms, but it is critical to the stability of the backslope that drainage be carefully designed and maintained so that water does not accumulate atop the benches.

1.2.2.6 Cuts in Rock

1.2.2.6.1 General

The design of a rock cut is predicated on obtaining the lowest balanced construction and maintenance cost consistent with safety. The ratio between construction and maintenance costs will vary with individual situations and should be developed for each project.

1.2.2.6.2 Assembly of Design Information

a. Factors which should be evaluated when designing rock cuts are the 3-dimensional competence of the rock and overburden, the depth and length of the cut, and the potential for rock fall.

b. The first steps in design include preparing profiles and cross sections that incorporate data obtained by reviewing existing topographic maps and geologic maps; data obtained from field reconnaissance, test boring, groundwater surveys; and laboratory test data which is discussed in great detail in Section 1.1.

c. In layered formations, where dip or strike of the bedding planes is not normal to the center of the cut, it may be desirable to evaluate sections on the dip of the bedding planes to aid in examining the stability of the cut slope.

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1.2.4 DRAINAGE (2013) R(2016)

1.2.4.1 General

a. This section deals with the surface and subsurface drainage of the roadway as distinguished from drainage of the ground surface by natural waterways. The latter subject is dealt with in Part 3 Natural Waterways, and Part 4 Culverts.

b. Since water is the principal influence on soil stability in roadbed, subgrade and slopes, control of surface and subsurface water is the most important factor in roadway design and maintenance.

1.2.4.2 Surface Drainage

a. Surface water from the roadway area, and sometimes surrounding topography, is usually handled by a system of ditches (commonly referred to as track or railroad ditches) parallel to the roadbed with offtake ditches where necessary. The roadbed cross section, slopes of cuts and fills, ditches, catch basins, underdrains and culverts should all form a balanced system to dispose of the water without accumulation or excessive saturation which would produce damaging effects. Track ditch design should generally be limited to handling non-concentrated natural drainage.

b. The design capacity of any part of the system can be calculated if the quantity of water to be carried, the distance and grade to outfall, and the infiltration factor of the soil are known. Ditches should be deep enough and sized for handling the design runoff anticipated while allowing the subgrade to drain. Track ditches should be sized for the anticipated runoff and the flow velocity calculated using the Manning equation.

c. The ditch grade may be governed by the track grade, particularly in long cuts or offtake drainage points. However, more often than not, ditch grades will be governed by existing drainage patterns and points of discharge. When the ditch is constructed in earth materials, the minimum recommended grade should not be less than 0.25% to minimize sedimentation. However, exceptions to this may be dictated by local topography such as in low-lying or flat terrain. Likewise, to prevent erosion, the maximum unlined ditch grade and/or ditch configuration should be such that it will produce a velocity less than or equal to the limiting velocity shown in Table 1-1-11. Erosion may also be prevented or reduced by paving, riprapping, sodding, or constructing check dams depending on velocity, type of soil, and depth of flow (Refer to Part 3 Natural Waterways). Liners for ditches are typically classified as either rigid or flexible. Asphaltic concrete and Portland cement concrete liners are examples of rigid liners. Riprap, sod, and grass liners are examples of flexible linings. Rigid liners are better at limiting erosion and they often result in higher water velocities since they are smoother than flexible liners.

Table 1-1-11. Guidelines for Limiting Velocities to Prevent Erosion

Material	**Velocity (Ft per Sec)**
Sand	Up to 2
Loam	2-3
Grass	2-3
Clay	3-5
Clay and gravel	4-5
Good sod, coarse gravel, cobbles, soft shale	4-6

d. Characteristics of flow and their effects on erosion need to be considered. Generally speaking, flow in track ditches may be classified as steady uniform flow provided the ditch section is relatively constant. Open channel flow is uniform when the depth of flow is the same at every section of the channel, i.e. the surface of the water is parallel to the channel. Flow in trackside ditches can be further classified as either subcritical or supercritical. Flow down gentle slopes will most likely be subcritical. Flow down steep slopes would most likely be supercritical. That is to say, when

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the depth of water is greater than the critical depth, it is subcritical flow, and when the depth is less than critical, it is supercritical flow. Critical flow, or flow near critical depth, tends to be unstable and exhibits turbulence and water surface undulations. Therefore, the slope of the channel bed that would maintain critical flow should be avoided. Critical flow is that state of flow at which the specific energy is at a minimum for a given discharge. A hydraulic jump occurs when a transition is made from subcritical to supercritical flow. Supercritical flow should be avoided in the trackside ditch design because the higher velocity can cause scour/erosion at the downstream outlet. To limit the effects of erosion at the outlet, a form of energy dissipation may be applied in the channel. Types of energy dissipaters include drop structures, roughness elements such as blocks and sills, ditch checks, etc. These decrease the chance of a hydraulic jump occurring while also decreasing the chance of erosion/scour.

e. Ditches are commonly trapezoidal or V-shaped in section. In most cases, from a constructability standpoint, it is not economical to vary the size/shape of the ditch. Although each ditch should be designed considering soil type, hydraulics and method of construction, the minimum recommended depth is 2 feet below finished top of subgrade at the shoulder of the roadbed. The minimum recommended depth is expected to provide freeboard and prevent saturation and infiltration of storm water into the subballast and ballast section.

Additionally, the minimum recommended bottom width for trapezoidal ditches in earth materials is 3 feet realizing that wider ditches may be easier to construct if right of way is available. Track ditches should be located so that the stability of adjacent cuts and fills will be maintained. Generally the top surface of a berm, if constructed or required between the toe of a fill and the ditch, should be sloped toward the ditch for good drainage.

f. Modifications of the standard ditch design may be required to address issues such as sloughing materials, sedimentation, erosion, etc. Such ditches also provide working space for equipment and subsequently allow for periodic cleaning of debris and sloughed material.

g. Interceptor ditches at the top of cut slopes, and benches on cut backslopes intended to intercept runoff water from uphill sources are often useful in reducing slope erosion, sloughing, and/or in preventing the deterioration of a rock slope due to ice formation within rock fractures/cracks. Benches should be considered for design and construction on cut backslopes when it is necessary to intercept seeping groundwater from the cut that is impacting the safety and stability of the slope. Interceptor ditches and benches may reduce the quantity of water to be handled by track ditches. Care should be taken when designing, constructing and maintaining interceptor ditches and sidehill benches so that they do not create serious erosion problems. Benches should be designed and constructed having a positive downward gradient that allows gravity flow laterally along and down the slope. Benches should be lined if necessary to prevent infiltration that will impact the slopes stability and/or to prevent erosion on the slope.

h. In low-lying or flat terrain, it may be necessary to dig offtake or adjacent ditches away from the roadway for a considerable distance to provide sufficient difference in elevation to produce drainage. In such locations, sedimentation may occur requiring periodic cleaning of ditches. An alternate would be to provide catchment areas outside the embankment area for accumulation and evaporation of runoff if right of way is available.

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