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June 7, 2022

304710

Via E-Filing

Ms. Cynthia Brown
Chief, Section of Administration
Surface Transportation Board
395 E Street SW
Washington, DC 20423

Re: Great Redwood Trail Agency (formerly North Coast Railroad Authority) — Abandonment Exemption — in Mendocino, Trinity, and Humboldt Counties, CA -- AB 1305X

Dear Ms. Brown:

Our firm respectfully submits these comments in the above referenced proceeding on behalf of the Sierra Club and Friends of the Eel River ("FOER") in support of the Great Redwood Trail Agency's ("GRTA's") (formerly North Coast Railroad Authority or NCRA) proposed abandonment and interim trail use of the rail line. Sierra Club and FOER also offer comments with respect to the Corrected Draft Environmental Assessment dated May 23, 2022, as well as the late-filed letter of intent to file an offer of financial assistance ("OFA") by the North Coast Railroad Company ("NCRCo") dated June 1, 2022.

FOER is a party to the proceeding and has previously submitted comments dated March 30, 2021, July 30, 2021, and September 15, 2021 (referred to collectively herein as "Prior FOER Comments"), which comments are incorporated herein by reference. By this letter, Sierra Club also requests to be placed on the service list as a party of record in this proceeding. The Sierra Club consents to e-mail service of pleadings. The e-mail addresses for e-service for the Sierra Club are: bricker@smwlaw.com (for Amy Bricker, attorney for Sierra Club and FOER, which e-mail already appears on the service list for this proceeding, representing FOER), and aaron.isherwood@sierraclub.org (for Aaron Isherwood, Sierra Club's Managing Attorney, which needs to be added to the service list). A copy of this request is being sent to counsel for NCRA as well as the parties identified on the service list for this docket.

Sierra Club is the nation's oldest grassroots organization. It has over 3.5 million members and supporters nationwide, including more than 167,000 members in California. Sierra Club is dedicated to the protection and preservation of the natural and human environment. Sierra Club's purpose is to explore, enjoy and protect the wild places of the earth; to practice and promote the responsible use of the earth's ecosystems and resources; and to educate and enlist humanity to protect and restore the quality of the natural and human environments.

One of Sierra Club's priority national conservation campaigns involves promoting smart energy solutions. Sierra Club is particularly interested in ensuring that coal mines and transport facilities comply fully with all applicable statutes and regulations. This campaign organizes individuals regionally and nationwide to work on coal-related issues and educates the public on these issues, including the impacts of coal on air and water quality. As discussed below, Sierra Club and FOER are concerned that the letter of intent to file an OFA by NCRCo is an attempt to begin the process of reopening the rail line for coal transport, with attendant negative environmental consequences.

Comments on Corrected Draft Environmental Assessment:

On May 23, 2022, the Board's Office of Environmental Analysis ("OEA") issued a Corrected Draft Environmental Assessment ("CDEA") for the proposed abandonment. Sierra Club and FOER concur with the CDEA's conclusion that abandonment of the rail line without any salvage activities would not result in any significant environmental impacts. Sierra Club and FOER also support the use of the rail corridor for recreational trail use and do not believe that interim trail uses would result in any significant environmental impacts that could not be mitigated.

Sierra Club and FOER are concerned, however, with the following statement in the CDEA:

> OEA has also received comments expressing concern that freight rail service could resume on the Line and that such a resumption of rail service could have environmental impacts. OEA notes that railroads have the right to route or reroute traffic on their rail lines without seeking Board authority and have the obligation to provide rail service to shippers upon reasonable request. Therefore, unlike the proposed abandonment, a potential change in rail service on the Line would not be a federal action subject to environmental review under NEPA or a federal undertaking subject to historic review under Section 106 of NHPA. Accordingly, OEA's environmental and historic review in this

> proceeding, as in all abandonment proceedings, is limited to the analysis of the potential diversion of rail traffic to other transportation modes and impacts from any salvage activities resulting from the proposed abandonment.

CDEA at p. 3.

"The National Environmental Policy Act [NEPA] has 'twin aims. First, it places upon [a federal] agency the obligation to consider every significant aspect of the environmental impact of a proposed action. Second, it ensures that the agency will inform the public that it has indeed considered environmental concerns in its decisionmaking process.'" *Kern v. U.S. Bureau of Land Management*, 284 F.3d 1062, 1066 (9th Cir. 2002) (citation omitted).

Here, given the status of the defunct and deteriorating rail line, any reopening of the rail line would flow directly from the STB's discretionary actions in approving an OFA. The STB has received one (albeit untimely) letter of intent to pursue an OFA for the entire rail line. There is sufficient evidence available (*see* Exhibits A-C), that the purpose of the reopening the rail line would be to transport coal. Thus, NEPA would require the STB to review the potential consequences of reopening the rail line for coal transport prior to approval of any such OFA.

Such environmental consequences would be grave. As discussed in the Prior FOER Comments, which Sierra Club joins, the environmental consequences of attempting to repair or reconstruct the rail line, which runs through the environmentally sensitive Eel River Canyon, would alone be devastating (not to mention, as discussed below, economically infeasible). If the rail line were to operate again for the purpose of coal transport, the environmental consequences from such transport, storage, and handling would also be severe.

A wide range of government agencies, public health organizations and experts—including the U.S. Environmental Protection Agency ("U.S. EPA"), World Health Organization ("WHO"), American Heart Association ("AHA"), Occupational Safety and Health Administration ("OSHA"), and South Coast Air Quality Management District ("SCAQMD")—have documented the adverse public health impacts from the fugitive dust generated by uncovered storage and handling of coal. *See, e.g.*, Exhibits D to G. Coal generates large volumes of dust when fractured. Such fracturing occurs during transport, loading, and unloading, including at export terminals.

Coal dust contains small particulate matter less than 10 micrometers in diameter ("PM10") and extremely small particles less than 2.5 micrometers in diameter

("PM2.5"). These particles are small enough to enter the lungs; as a result, particulate pollution is associated with a host of severe health problems. Breathing particulate matter can cause numerous harmful medical conditions, including: (1) respiratory distress, asthma, and chronic bronchitis (*see, e.g.*, American Thoracic Society report concluding that PM10 levels are associated with "acute respiratory hospital admissions in children")[1]; (2) cardiovascular disease, including heart attacks and irregular heartbeat (according to the American Heart Association, "[e]xposure to PM2.5 … can trigger cardiovascular disease-related mortality and nonfatal events; longer-term exposure … increases the risk for cardiovascular mortality to an even greater extent.");[2] and (3) adverse birth outcomes. As a result, researchers have concluded that PM10 and PM2.5 pollution prematurely kills both children and adults.

Coal dust also contains toxic heavy metals that can damage human health. Coal dust contains arsenic, mercury, lead, cadmium, chromium, and nickel. Exposure to these heavy metals is associated with increased risk of cancer, birth defects, genetic defects, endocrine disruption, and neurological damage.

In addition to their deleterious effects on human health, coal also harms natural environments. For example, coal exposure causes death and reduced growth rates in marine plants and animals, as well as on the birds and mammals that feed on them. Significant impacts could thus result from uncovered transport or storage of coal, such as at or near the Eel River or Humboldt Bay. The STB would need to study all such significant impacts described herein, and in any others, in an Environmental Impact Statement ("EIS") rather than an EA.

In sum, Sierra Club and FOER concur with the CDEA that the abandonment of the rail line would not result in any significant environmental impacts. However, the reopening of the rail line via approval on an OFA would require the STB to conduct further environmental analysis, including preparation of an EIS. The STB should coordinate such environmental review with any related federal actions necessary for the reopening of the rail line and the transport, storage, and export of coal, such as any federal permits or safety reviews, and should also conduct historic review under Section 106 of the National Historic Preservation Act. *See, e.g., Thomas v. Peterson*, 753 F.2d 754, 758-59 (9th Cir. 1985) (NEPA requires agencies to review related actions in a single environmental document), abrogated on other grounds as recognized by *Cottonwood*

[1] Available at https://www.atsjournals.org/doi/abs/10.1164/ajrccm.153.1.8542133 (last visited June 6, 2022)
[2] Available at https://pubmed.ncbi.nlm.nih.gov/20458016/ (last visited June 6, 2022)

Envtl. L. Ctr. v. U.S. Forest Serv., 789 F.3d 1075, 1092 (9th Cir. 2015); 40 C.F.R. § 1501.7.

Comments on NCRCo's Letter of Intent to File an OFA:

As a preliminary matter, the STB should reject NCRCo's letter of intent to file an OFA as untimely. As noted by the Humboldt Trails Council in its response dated June 3, 2022 and GRTRA/NCRA in its Opposition dated June 6, 2022, allowing the late filing would result in prejudice to those working to impose trail use conditions on the corridor. Further, this matter has been pending for well over a year and thus the failure to timely file a letter of intent is inexcusable. NCRCo's stated rationale of travel delays and delay in receiving information simply do not constitute good cause under the circumstances. It also does not bode well for NCRCo's ability to reconstruct and operate this defunct rail line, which no prior rail owner has been able to sustainably operate.

As noted by the CDEA, "[d]ue to its location in a geologically unstable area, the Line was exposed to numerous natural hazards during the years in which it was in operation that resulted in accidents and track failure. . . . Rail service ceased after FRA imposed an emergency embargo on the line because the track did not meet safety standards," and the rail owner at the time became bankrupt. CDEA at p. 8. Prior FOER Comments, which Sierra Club joins, also detail how the reopening of the rail line could not be economically feasible. Furthermore, the communities surrounding the rail line have already demonstrated vast opposition to the reopening of the line for coal transport.

If the STB should allow NCRCo to proceed with an OFA (although as discussed, it should not), Sierra Club and FOER intend to comment further on the OFA and subsequent environmental review, including with respect to the issues discussed herein, if and when such documents are prepared, and fully reserves their rights to object to the OFA on any and all grounds.

Thank you for your consideration of these comments.

Very truly yours,

SHUTE, MIHALY & WEINBERGER LLP

Amy J. Bricker

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Exhibits:

Exh. A: Brian Maffly, The Salt Lake Tribune, *Utah Port Authority Memos Reveal Coal Industry Ties to California Rail Controversy* (September 25, 2021)

Exh. B: Ryan Burns, Lost Coast Outpost, *Aiming to Ship Coal Out of Humboldt Bay, Shadowy Corporation Makes Bid to Take Over NCRA Line* (September 2, 2021)

Exh. C: Utah Inland Port Authority, Humboldt Bay Call Memorandum (March, 2021)

Exh. D: Zoe Chafe, *Analysis of Health Impacts and Safety Risks and Other Issues/Concerns Related to the Transport, Handling, Transloading, and Storage of Coal and/or Petroleum Coke (Petcoke) in Oakland and at the Proposed Oakland Bulk & Oversized Terminal* (June 22, 2016) (Executive Summary and Summary of Findings)

Exh. E: Jaffe, D. et al. (2015). "*Diesel particulate matter and coal dust from trains in the Columbia River Gorge, Washington State, USA*," Atmospheric Pollution Research, 946-952

Exh. F: U.S. Environmental Protection Agency, Health and Environmental Effects of Particulate Matter (PM) (2021)

Exh. G: World Health Organization, Health Effects of Particulate Matter (2013)

cc: Party Service List for AB 1305X
Charles Montange, Counsel for GRTA/NCRA
Robert Wimbish, Representative for NCRCo

1515713.2

EXHIBIT A

Brian Maffly

Brian Maffly is a reporter covering public lands for The Salt Lake Tribune.

Contact Brian Maffly at brianmaffly@gmail.com

Sep 25, 2021 Published on: The Salt Lake Tribune 2 min read

Utah port authority memos reveal coal industry ties to California rail controversy

The Utah Inland Port Authority briefly worked behind the scenes to advance a secretive proposal to rehabilitate an unused California railroad for coal.

Francisco Kjolseth | The Salt Lake Tribune Coal is piled up at the Levan transfer facility along Interstate 15--south of Nephi. Utah Community Impact Board awarding a $50 million loan to four coal-producing counties to build a deep-water port in Oakland, Calif. that would be a shipping point for Utah coal. We want to illustrate Utah's current coal industry chain and points that might have between 1 and 3 million tons of coal moving through them in the future.

Editor's note • This story is available to Salt Lake Tribune subscribers only. Thank you for supporting local journalism.

The Utah Inland Port Authority worked behind the scenes exploring a secretive proposal to rehabilitate an unused California railroad with the hope of using it to ship Western-mined coal overseas through an out-of-the-way port on the Northern California coast, according to internal documents obtained by The Salt Lake Tribune.

In March, six months before the rail project came to public attention, a Utah port authority staffer named Christopher Mitton participated in a conference call with two coal industry representatives, an administrator from a Northern California tribe and a man named Justin Wight, identified as the "project consultant." The call's purpose was to discuss taking over

the North Coast Railroad and develop an export terminal at Humboldt Bay. The project would have complete, or at least majority, tribal ownership.

According to a memo Mitton wrote summarizing the March 16 call, Wight was seeking up to $1 billion in loans from the U.S. Department of Transportation to rehabilitate the rail line, which winds through Northern California's Eel River Canyon.

"This program is not a grant program but a loan program that would need to be repaid," the memo said. "The loan is likely contingent on securing long-term contracts as a source of repayment."

The memo doesn't specify which federal loan program, but a probable option is the Railroad Rehabilitation and Improvement Financing program, overseen by the Transportation Department's Build America Bureau. The North Coast Railroad, however, does not appear on the program's list of active projects.

The industry representatives on the call were Conrad "CJ" Stewart, energy director for the Crow Nation, and Utah Mining Association president Brian Somers. The Crow of southeast Montana holds extensive coal reserves in the Powder River Basin. Joining them on the call was Michelle Vassel, tribal administrator for the Wiyot, a federally recognized tribe that is indigenous to Humboldt Bay.

The Wiyot Nation is "fully committed to this project" and the Crow Nation is "looking for any new export channel or new use for their mineral resources," according to the memo that Mitton sent to

Flygare, the port authority's chief operating officer.

Vassel did not respond to a request for comment left at the Wiyot tribal offices in California. Stewart did not respond to a voicemail left on his cellphone. Somers could not be reached and contact information for White was not available.

A co-founder of the National Tribal Energy Association and former member of his tribe's Legislature, Stewart is a leading advocate of coal exports and has spoken out against

Pacific coast states' efforts to block proposed coal-loading port projects, such as the stalled Millennium Bulk Terminals in Longview, Wash., and the Oakland Bulk and Oversize Terminal on the San Francisco Bay.

"Imagine having a trillion dollars in mineral wealth under your feet and yet your people are starving and destitute before you," he told a Senate committee in 2018. "It's a cruel nightmare that could be avoided if not for the Clean Water Act being weaponized against the Crow Tribal resource economy and the Crow people and culture."

The rail proposal came to light three weeks ago after a shadowy company notified the federal Surface Transportation Board of its intentions to take over the century-old North Coast Railroad, a defunct and dilapidated line running 320 miles through northern California's coastal mountains from the Bay Area to the Port of Humboldt Bay. The company's filing said it has a "thoroughly developed" plan to rehab the line for "high-volume traffic" and has secured $1.2 billion in financing for a project that aims to export unspecified bulk minerals.

Who exactly is behind the newly formed North Coast Railroad Co. remains a mystery, but available evidence points squarely to the Western coal industry, which has long hoped to expand its seagoing export capacity. Hammered by the nation's flagging appetite for a fossil fuel closely associated with climate change, Utah coal producers hope to increase exports to Japan and economically growing Asian countries that burn coal to generate power. These ambitions have repeatedly been thwarted by local and state political leaders on the West Coast aiming to block coal shipments through their communities and discourage the use of coal elsewhere.

The mystery company's recent filing, known as an "offer of financial assistance," was ostensibly made to block a popular plan to convert the rail right of way into the Great Redwood Trail, which has upset many northern Californians, few more than state Sen. Mike McGuire, a champion of the rails-to-trails project.

This month, he introduced a bill in the California Legislature aimed at blocking the rail rehabilitation.

"This toxic coal train would run through the heart of so many thriving communities and along the Russian and Eel Rivers, which are the main source of drinking water for nearly 1 million residents," McGuire said in a statement posted Tuesday. "This dangerous proposal must be stopped."

But the coal industry's involvement has been a matter of conjecture thanks to the North Coast Railroad Co.'s complete lack of transparency in its public filings. The Inland Port documents help clarify the roles of Utah, the tribes and the coal industry, although many unanswered questions remain concerning the company: Who is Justin White working for? What is the source of the $1.2 billion in funding the company claims? Do the Crow and Wiyot tribes control the company? Does it have contracts in place with coal producers?

Another memo Mitton provided his boss in March contained contact information for various officials with the Humboldt Bay Harbor District, whom Mitton apparently reached out to around that time.

The district's deputy director, Adam Wagschal, told The Tribune that Mitton contacted him asking about the port's suitability for shipping bulk minerals. In an interview this week, Wagschal said he could not recall whether Mitton mentioned coal or any specific commodity.

The port authority declined to make an official available for an interview.

Speaking through a spokesperson, Flygare said the participation of Mitton, who worked only a few months at the port authority as its "strategic projects manager," was limited to asking some questions about the Humboldt Bay project.

The port authority was invited to the March meeting to hear about the proposal, according to Flygare. After conducting due diligence, the agency determined it was not a viable port project and it hasn't been involved since.

"In response to a Tribune reporter who is writing a story that falsely implies the Utah Inland Port Authority is pushing or has ever supported a project to ship coal from Utah to

Asia — UIPA has no current or future plans to export coal from Humboldt Bay," said executive director Jack Hedge in an emailed statement. "We looked into it and did not find it to be a project the Port Authority could be involved with."

Few people believe the North Coast Railroad has any chance of ever being restored and put back into service, given the need to rebuild it completely and the difficulty of maintaining the stretch through the slide-prone Eel River Canyon.

Additionally, the Port of Humboldt Bay would require costly upgrades before it could handle the level of freight traffic described by the proponents of the rail project. The harbor entrance itself is prone to regular closures because of river sediments forming sandbars that complicate navigation.

The Army Corps of Engineers dredges the channels every spring to remove the sediments that wash down the Eel River in winter, according to Jennifer Kalt, a local environmentalist who heads the Humboldt Baykeeper.

"There would have to be a massive increase in dredging to create the kinds of depths at the shipping channels and then also to open the entrance year-round," Kalt said. Meanwhile, the facilities on the site, all associated with Humboldt's faded timber industry, are in no shape for handling mass volumes of coal or other bulk mineral commodities.

"There isn't really something anyone calls a port here necessarily. What there is is a lot of dilapidated former mill sites that have docks. Two of them were pulp mills. Some of them were lumber mills, and they're just completely dilapidated and falling apart."

But one remains in fairly good condition and occupies the harbor's deepest water, she said. It's a privately owned facility called the Fairhaven Terminal, where the water is 38 feet deep and there are five acres of paved storage. A message left for that terminal's owner, Eureka businessman Rob Arkley, was not returned.

The Inland Port memo indicates the bay has existing federal shipping channels that would work for exporting minerals. Wight identified terminals on the north side of Humboldt Bay

that could be used for loading ships and are not close to environmentally sensitive areas.

“Both Justin [Wight] and Michelle [Vassel] stated there is strong local support for revitalizing the harbor and port operations,” the memo said. “Michelle mentioned she would expect some, but not overwhelming opposition to the project.”

Vassel could have hardly been more wrong in this assessment.

“No way, no how are we going to let this happen,” said Sen. McGuire in unveiling key additions to his SB307 on Tuesday.

The legislation would ban any state funding from being used to improve the northern half of the rail line for coal shipments north and from being used to build a coal handling terminal at Humboldt Bay.

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Ryan Burns (/author/ryan-burns) / Thursday, Sept. 2, 2021 (/2021/sep/02/) @ 4:53 p.m. / Business (/categories/business/), Environment (/categories/environment/), Transportation (/categories/transportation/)

Aiming to Ship Coal Out of Humboldt Bay, Shadowy Corporation Makes Bid to Take Over NCRA Line

A freight train carrying coal. | Photo: CSIRO via Wikimedia Commons, Creative Commons License (https://creativecommons.org/licenses/by/3.0/deed.en).

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Unidentified coal companies appear to be behind a new backdoor effort to acquire the North Coast Railroad Authority's right-of-way between Eureka and Willits and rehabilitate the defunct railroad, all so they can export coal to Asian markets via the Port of Humboldt Bay.

State Senator Mike McGuire calls this development "one of the largest environmental threats to hit the North Coast in decades."

On Aug. 16, a mysterious, newly formed corporation called North Coast Railroad Company, LLC, filed a pleading with the Surface Transportation Board. Ostensibly a proposal to submit an "Offer of Financial Assistance" to rebuild the line, the filing makes a number of surprising claims.

For one, the 14-page filing (https://lostcoastoutpost.com/loco-media/loco-media/blog/post/32258/302869.pdf), submitted by a pair of Chicago attorneys, says NCRCo. is "capitalized to the tune of $1.2 billion" and has "thoroughly-developed plans" to acquire and rehabilitate the dilapidated rail line between Humboldt Bay and Willits. Once complete, the company says, this newly reconstructed railroad will move "high-volume shipments" between the San Francisco Bay Area and Humboldt Bay.

The document does not disclose what these "high-volume shipments" might contain. Nor does it identify anyone involved with the corporation.

The pleading prompted an incredulous response from the North Coast Rail Authority (NCRA), the state agency that spent ~~30~~ 20 years trying to resuscitate that same stretch of railroad but is now, under McGuire's leadership, working to develop the Great Redwood Trail (http://www.thegreatredwoodtrail.org/), a multi-use pathway extending 320 miles along the agency's right-of-way.

NCRCo., the opaque corporate entity, appears to be trying to derail this rails-to-trail effort by submitting a last-minute "Offer of Financial Assistance" (OFA) to rebuild the line. Federal law (https://www.law.cornell.edu/uscode/text/49/10904) holds that the Surface Transportation Board must give priority to maintaining or restoring a rail line wherever possible.

The NCRA says it's just not possible on this stretch of railroad, which runs through the geologically unstable Eel River basin. In an Aug. 20 letter replying to NCRCo.'s Chicago attorneys (https://lostcoastoutpost.com/loco-media/loco-media/blog/post/32258/NCRAletAug20.pdf), NCRA counsel Charles Montagne says the company and its so-called plans appear to be "a hoax or some sort of ruse."

The company was incorporated in Wyoming on Aug. 6, just 10 days before its filing with the STB. The "organizer" was identified as InciFile.Com LLC, a Texas-based corporation whose accreditation with the Better Business Bureau has been revoked. The only address listed for NCRCo. is a Wyoming office suite that's home to some 250 LLCs, according to Montagne's research.

"In short," he says in his letter, "there is no indication in NCRCo.'s organizational filings … that NCRCo. has any assets, rail plans, personnel, or existence, other than as a legal fiction."

Reached by phone on Thursday, Montagne said no one from NCRCo. has responded to his letter.

Is this indeed all just a ruse, as Montagne suggests?

Rep. Jared Huffman doesn't think so. In a conversation with the *Outpost* on Wednesday, the congressman said he'd spent the previous 24 hours "basically nonstop on this," investigating who's behind the effort and what they're after. The answer, he said, is coal companies in league with the Crow Tribe in Montana.

McGuire said the same thing. "The people behind this toxic coal train have been operating in secret, meeting with local officials here on the North Coast," he said. "They've been operating anonymously through the LLC in Wyoming, and they are intentionally hiding behind these corporate laws that hide individuals behind these types of toxic operations."

The Crow Tribe's 2.2 million-acre reservation in Southern Montana is home to billions of tons of coal deposits in the Powder River Basin. The tribe has signed numerous agreements with coal mining companies from Wyoming, Utah and Montana.

"They've always been all about coal," Huffman said. "They are out of step with many of their fellow tribes, and it's just sort of this Faustian deal that they cut."

There were rumors that the Wiyot Tribe was involved as well, but Huffman said he'd spoken with Tribal Administrator Michelle Vassel earlier on Wednesday and gotten assurances that they're not involved.

"She told me unequivocally they are not supporting this," Huffman said. "They will not be part of it. But what I don't know is whether they were part of some initial exploration of this."

In an emailed statement to the *Outpost*, Vassel said, "We have not received a proposal or accepted a proposal related to coal. I am not sure how the Tribe's name became part of this discussion but I have had a number of phone calls about it."

First District Supervisor Rex Bohn said he met with some of the interested parties. About six months ago, he had dinner with a group of people who said they were interested in restoring the rail line. The group included Utah State Senator David Hinkins.

"They had some Native Americans they were partnering up with," Bohn said. "I know that they met with the Wiyots quite a bit. They were talking about just opening the rail line. … They thought it's usable. They had some freight ideas that they could get out of here."

Asked if they identified what type of freight they intended to ship, Bohn said, "They held it pretty close to the chest, I thought. Rightly so."

Told that McGuire and Huffman had identified the interested parties as coal companies, Bohn said, "They did talk about *clean* coal cars, you know, completely covered, completely domed and everything."

Asked what he thought of the proposal at the time, Bohn said he kept an open mind. "You want to listen to everybody because you don't want to kick anybody out," he said. "You want to see if it will have any basis to it whatsoever."

A phone message and email to Senator Hinkins were not returned. Nor was an email to the Crow Tribe.

NCRCo.'s filling with the Surface Transportation Board is defiant about the company's secrecy. "NCRCo need not disclose the precise merits of its plan or the continuing public need for rail service on the Line until tendering its [Offer of Financial Assistance]," it says.

The company disputes the NCRA's estimated costs for rehabilitating the line and says, "It would be premature to conclude that the Line could not be restored and become economically viable. Such arguments only establish that the current owners of the Line [NCRA] lack the funds and will to take an entrepreneurial risk on the Line as NCRCo would do … ."

Huffman is skeptical.

"It is hard for me to imagine anyone so naive as to think that this could ever succeed," he said. "I mean, I truly think that you will see time travel and teleporting before you will see a coal train exporting out of the Port

of Eureka. … But I'm not going to take that for granted. This is one of those do-whatever-it-takes-to-kill-it priorities and believe me, the wheels are already in motion."

McGuire said he and his colleagues in the Senate plan to introduce legislation that would ban state investments into any rail infrastructure associated with coal.

"We're going to introduce this bill here in the coming days," McGuire said. "We fully expect full-throated litigation from multiple sources to be able to block this."

Like Huffman, McGuire expressed doubts about the viability of this endeavor, but he also pointed out how serious the threat is.

"This toxic train would run along the Russian River and the Eel River, which is the main source of drinking water for just under 1 million residents," he said. "It's also home to some of the most sensitive ecosystems on Earth, along with endangered species."

California banned coal-fired power plants for good reason, he added. **"**Coal is the dirtiest and most damaging source of energy out there, and it's also the No. 1 cause of global warming. It's the No. 1 contributor to our climate crisis. And I'm here to promise you, right now, that no matter how many billions this anonymous corporation may have to throw at this project, it's not going to happen. The Great Redwood Trail is going to win the day. The Great Redwood Trail is going to continue to move forward."

Mitch Stogner, executive director of the NCRA, called NCRCo.'s ploy "absurd."

"According to our best estimates, the cost to restore the line would exceed $2.4 billion and [the line] would remain unreliable due to the regular slides and washouts, especially along the environmentally sensitive Eel River Canyon," Stogner said. "And of course that does not include whatever billions it would cost to upgrade the Humboldt Bay Harbor to transport coal. All of this is widely known, and exactly the reason the state of California has directed us to focus on the Great Redwood Trail — a mission our board is working hard on. We suggest this LLC stop the secrecy and do their homework."

McGuire agreed that the costs are prohibitive, but in the same breath he said he's not taking any chances. "It is not going to happen — and I will tell you, we are going to fight them like hell every step of the way."

Others are lining up to fight, too.

"When I heard that this was a credible thing, I obviously wanted to activate every possible avenue of opposition," Huffman said. The congressman reached out to the board of SMART, the Sonoma Marin Area Rail Transit, which owns the southern section of rail line running from San Francisco Bay north to the Sonoma-Mendocino County border.

"I think you can absolutely guarantee vigorous opposition from the SMART board," Huffman said.

Local environmental groups are also up in arms. Alicia Hamann, executive director of Friends of the Eel River, said, "Coal trains running through the Eel River canyon to Humboldt Bay would poison the river, the bay, and the entire region. It would devastate the progress that FOER and so many others have made in restoring Eel River salmon and steelhead." Noting the environmental cost of fossil fuels, she added, "Humboldt County should have no part in that."

"Regardless of who is behind this, we'll fight at every turn to keep coal trains from coming to Humboldt Bay," said Jennifer Kalt, executive director of Humboldt Baykeeper. "The pollution from mile-long trains coming through Eureka and Arcata would be horrendous. And burning coal will worsen the climate crisis and add to the mercury contaminating our fish."

Tom Wheeler, executive director of EPIC, was more blunt. "Fuck coal trains," he said. "We are going to fight this with everything we've got."

If NCRCo. ends up submitting an Offer of Financial Assistance, as the company has indicated it will, the Surface Transportation Board is charged with performing due diligence on the financial plans. If the company clears that hurdle, it will still face bureaucratic and legal obstacles, such access to SMART's portion of the rail line and the legislation being prepared by McGuire and others.

But public opposition may play a key role, too.

"This community is going to have to rally," McGuire said.

He noted that the North Coast has been the center of some of the largest environmental battles in the nation, from Redwood Summer to a rally against Big Oil to protect the coast from offshore oil drilling.

"And now is the time to be able to put the nail in the coffin of coal once and for all … ," he said. "We know that we're going to be successful but it's going to take all of us working together here in the weeks and months to come."

###

DOCUMENTS:

- NCRCo's filing in opposition to the NCRA's exemption request (https://lostcoastoutpost.com/loco-media/loco-media/blog/post/32258/302869.pdf)
- The NCRA's response letter to NCRCo's attorneys, with supporting documents (https://lostcoastoutpost.com/loco-media/loco-media/blog/post/32258/NCRAletAug20.pdf)

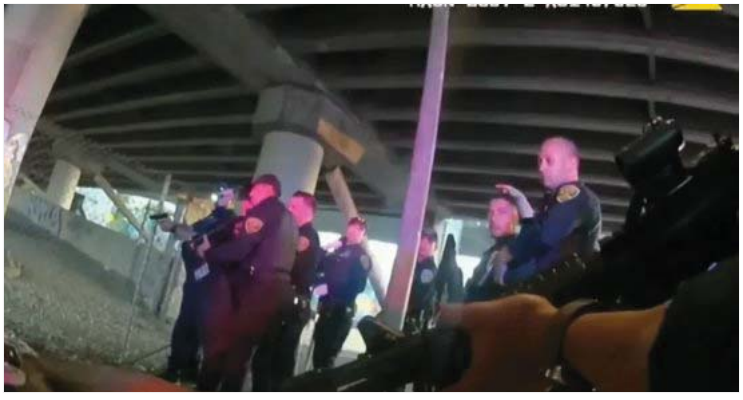
PREVIOUSLY:

- It's Official: Sen. Mike McGuire Introduces 'Great Redwood Trail Act' (https://lostcoastoutpost.com/2018/mar/15/its-official-sen-mike-mcguire-introduces-great-red/)
- 'Great Redwood Trail Act' Passes State Senate Unanimously; Assembly Left to Wrestle With All the Details (https://lostcoastoutpost.com/2018/may/31/great-redwood-trail-act-passes-state-senate-unanim/)
- Will the Great Redwood Trail Act Pass Before the NCRA Goes Off the Fiscal Cliff? (https://lostcoastoutpost.com/2018/jul/19/can-debt-laden-ncra-survive-long-enough-preserve-g/)
- Up Against Legislative Deadline, McGuire Scales Back 'Great Redwood Trail' Plans in Hopes of Getting Bill Past Assembly, Governor (https://lostcoastoutpost.com/2018/aug/21/against-legislative-deadline-mcguire-scales-back-g/)
- The Bill Formerly Known as 'The Great Redwood Trail Act' Has Passed the Assembly (https://lostcoastoutpost.com/2018/aug/30/bill-formerly-known-great-redwood-trail-act-has-pa/)
- END OF THE LINE: Gov. Brown Signs McGuire Bill to Eviscerate the North Coast Railroad Authority, Start Trail Planning

(https://lostcoastoutpost.com/2018/sep/29/end-line-gov-brown-signs-mcguire-bill-eviscerate-n/)

- In Key Step for the Great Redwood Trail, NCRA Board Votes To Railbank the Line from Willits to Samoa (https://lostcoastoutpost.com/2021/feb/19/key-step-great-redwood-trail-ncra-board-votes-rail/)
- 'A Transformational Day': McGuire Announces That $16.5 Million for the Great Redwood Trail Has Been Added to the State Budget (https://lostcoastoutpost.com/2021/jul/2/transformational-day-mcguire-announces-145-million/)

Lately on LoCO



Attorney General Candidates Divided on New Police Shootings Law

(/2022/jun/6/attorney-general-candidates-divided-on-new-police/)

EXHIBIT C

Jill Flygare <jflygare@utah.gov>

Re: Humboldt Bay

1 message

Jill Flygare <jflygare@utah.gov> Wed, Mar 17, 2021 at 8:54 AM
To: Chris Mitton <cmitton@utah.gov>
Cc: Jack Hedge <jackhedge@utah.gov>, Ginger Chinn <gchinn@utah.gov>

Thanks Chris

On Tue, Mar 16, 2021 at 3:41 PM Chris Mitton <cmitton@utah.gov> wrote:

> All,
>
> Quick wrap-up from the Humboldt Bay call UIPA was asked to participate in this morning:
> ***Attendees***:
> Brian Somers (Utah Mining Association)
> Michelle Vassel (Tribal Administrator - Wiyot Tribe)
> CJ Stewart (Energy Director - Crow Nation)
> Justin Wight - (Project Consultant)
>
> ***Key Highlights***:
> 1) The Wiyot Nation is "fully committed to this project..."
> 2) The Crow tribe is looking for any new export channel or new use for their mineral resources.
> 3) The terminal at Humboldt Bay and the RR would be Tribal owned, or would have small, non-tribal minority owners.
> 4) Northwestern Pacific Railroad is considered an "open-active" railroad, which makes the rehabilitation of this rail line much easier from a permit perspective. This has not been independently verified at this time (I am looking into it).
> a) A southern portion of this line has been a freight and passenger service in serving a small area north of San Francisco.
> 5) Justin Wight (project consultant) stated he has had conversations with USDOT regarding funding for the rail rehabilitation, up to $1 billion. This program is not a grant program but a loan program that would need to be repaid. The loan is likely contingent on securing long-term contracts as a source of repayment.
> 6) There are existing federal navigation channels that can be utilized for the export of minerals and Justin is not concerned about that piece for exporting.
> a) The terminals identified for use are on the north side of the bay and are “well away from the environmentally sensitive areas.”
> b) Justin did not view this as an area of concern
> 7) Both Justin and Michelle stated there is strong local support for revitalizing the harbor and port operations. Michelle mentioned she would expect some, but not overwhelming opposition to the project.
> The in-person meeting will move ahead next week between the tribal officials, local officials, Brian Somers and others.
>
> Please let me know if you have any questions.
>
> **Chris Mitton**
> Utah Inland Port Authority | Strategic Projects Manager
> 385-977-3451 - Mobile
> www.utahinlandport.org

--

Jill Flygare
Utah Inland Port Authority | Chief Operating Officer
801.577-7253 m
https://inlandportauthority.utah.gov/

EXHIBIT D

Analysis of Health Impacts and Safety Risks and Other Issues/Concerns Related to the Transport, Handling, Transloading, and Storage of Coal and/or Petroleum Coke (Petcoke) in Oakland and at the Proposed Oakland Bulk & Oversized Terminal

Prepared by **Zoë Chafe**, PhD, MPH
For Councilmember Dan Kalb

June 22, 2016

CONTENTS

EXECUTIVE SUMMARY

There is substantial evidence that the proposed transport, handling, transloading, storage, and export of coal through the bulk and oversized terminal proposed at the site of the decommissioned Oakland Army Base would endanger the health and safety of people working at or visiting the project site, as well as those living in, recreating in or visiting adjacent communities.

It is very likely that coal dust in the form of fine particulate air pollution ($PM_{2.5}$) from this project would harm human health. Coal dust is generated when coal is fractured during loading and unloading activities, in addition to during transport. Coal dust contains fine particles that become suspended in air and create dangerous air pollution ($PM_{2.5}$).

Due to their proximity to heavily used freeways, truck transport routes, and the Port of Oakland, communities surrounding the proposed terminal site already suffer from exposure to elevated levels of pollution, including $PM_{2.5}$, and the associated chronic and severe health effects. These communities are particularly vulnerable to adverse health effects of pollution due to high rates of poverty and chronic disease.

The $PM_{2.5}$ generated as a result of the proposed project's daily coal transport, transloading and handling is expected to exacerbate existing environmental pollution problems. There is no evidence of a safe level of exposure to $PM_{2.5}$, so any additional increase in the $PM_{2.5}$ to which communities are exposed is expected to lead to additional ill-health in the form of morbidity and/or mortality.

Workers at the terminal will be in closest contact to the coal dust, as it is generated when the coal is transferred between railcars and terminal equipment and eventually into docked ships. In the event of enclosed port facilities as suggested by the project sponsors, concentrations of coal dust within the facilities would be expected to be high. There is evidence that current workplace safety standards, including those for combustible dust, are inadequate to protect the safety of workers, implying that terminal workers (and adjacent communities) will be at risk even if current occupational standards are met.

There is no evidence for a threshold effect for pulmonary effects from respirable coal mine dust exposures, and due to the blending and potentially enclosed handling of coal at the terminal, work conditions may be considered similar to mining conditions.

There are difficult trade-offs for health and safety between enclosing terminal facilities (to attempt to reduce coal dust from contaminating nearby communities) and increasing the risk of devastating explosions or fire due to accumulated combustible dust.

Coal and coal dust from Utah are considered highly volatile. In an emergency situation, such as spontaneous combustion of coal in stationary railcars, spontaneous combustion of coal dust in the facility, explosion of coal gases or coal dust, or a fire at the facility, workers,

adjacent communities, and visitors in the Oakland area will be exposed to coal combustion emissions (coal smoke), which are known to be carcinogenic.

It is likely that hundreds of thousands of people would be exposed to airborne gases and particles, including heavy metals. Coal fires must be controlled in specific ways, so emergency responders must undergo training specific to the facility and the commodity.

There is currently no evidence of relevant regulation that would require coal cars to be covered. There is also no evidence that covered rail cars designed to safely transport coal are in use in the United States, let alone evidence that this technology has been thoroughly tested or approved for use. It has been suggested that transport-related coal dust suppression techniques could include application of chemical surfactants. Other chemicals (freeze conditioning agents) appear likely to be applied during the transport process. Compounds used in both surfactants and freeze conditioning agents present health concerns.

There is no such thing as "clean" coal. Coal from Utah is sometimes referred to as "EPA-compliant" because it has lower sulfur content than other coals. However, it contains high levels of silica and emits high amounts of carbon dioxide and other short-lived climate pollutants, some in the form of health-harming fine particulate matter ($PM_{2.5}$), when combusted.

Coal exported from the proposed terminal would likely be burned in Asia. Emissions from coal burning in Asia negatively affect air quality in the San Francisco Bay Area, contributing to unhealthy levels of $PM_{2.5}$ and ozone. Poor air quality is a cause of ill-health in Oakland and other parts of the Bay Area, particularly among vulnerable populations.

When burned, coal releases large amounts of carbon dioxide, a powerful greenhouse gas. Incomplete combustion of coal also releases other greenhouse gases and short-lived climate pollutants, such as black carbon (or soot) which also is damaging to human health. Continued coal burning will exacerbate climate change and contribute to sea level rise, a well-documented hazard that Oakland will confront this century. There is increasing evidence that climate change contributes to droughts, heat waves, and other extreme weather in California and beyond. Vulnerable populations in the Bay Area are particularly susceptible to the effects of heat waves and other extreme weather events. Climate change also affects infectious disease vectors, increasing the potential for ill-health.

Oakland and the State of California have made significant strides in combatting global warming and have positioned themselves as leaders in environmental protection. The greenhouse gas emissions released when coal that is exported through Oakland is eventually burned will counteract the work done by Oakland, through its Energy and Climate Action Plan, and by California, through the Global Warming Solutions Act of 2006 (AB 32) and related legislation, to mitigate climate change.

SUMMARY OF FINDINGS

1. It is inevitable that the transport, transloading, handling, storage and export of coal through the proposed terminal will cause workers, adjacent communities, commuters and/or nearby visitors to be exposed to coal dust in the form of fine particulate matter ($PM_{2.5}$). There is no evidence that coal dust in Oakland can or will be fully contained.

2. There is no safe level of exposure to $PM_{2.5}$. Particulate matter in outdoor air pollution causes cancer in humans. There is new evidence that even existing air quality guidelines may not sufficiently protect human health. Any additional $PM_{2.5}$ released as a result of the proposed terminal should be expected to negatively affect the health of workers at the proposed terminal, residents of adjacent communities, and visitors, commuters, and people recreating near the terminal and former Army Base site.

3. Coal and related dust contain substances that are known by the State of California and the World Health Organization to cause cancer or birth defects or other reproductive harm. These substances include respirable crystalline silica (quartz), lead, mercury, arsenic, cadmium, and nickel.

4. Coal dust and other air pollutants emitted at or near the terminal will add to already harmful levels of environmental pollution in West Oakland, East Oakland and Emeryville. The San Francisco Bay Area is currently in non-attainment status for $PM_{2.5}$ and ozone.

5. There is no evidence that covered rail cars are available to safely transport coal to or through Oakland, including at the proposed terminal. Any use of covered rail cars to transport coal would be experimental and should be accompanied by grave concern about health and safety effects on workers, adjacent communities, and any individuals spending time near the rail yards that will serve the terminal.

6. There is no known state or federal law that requires covered containers for coal transport.

7. Bituminous coal is highly volatile and prone to spontaneous combustion. Any fires occurring in rail cars filled with coal, in stockpiles at the terminal, during transloading, handling, or blending, or in docked ships loaded with coal, will release "emissions from combustion of coal," which are substances known by the State of California to cause cancer or birth defects or other reproductive harm.

8. When coal is burned, either because of spontaneous coal combustion or fires at the terminal or intentionally by an end user overseas, mercury will be released in the resulting emissions. Both mercury and methyl mercury, a chemical formed when mercury enters the environment, are substances known by the State of California to cause cancer or birth defects or other reproductive harm.

9. Certain people are at even more risk than others for health problems when exposed to PM2.5 and other components of coal because of their age, current health status, or socioeconomic conditions. Susceptible groups include people with health problems (such as asthma and other pre-existing lung conditions, heart disease, or other chronic and acute diseases), people who are very young or very old (infants, children, and elderly people) and people with suppressed immune systems. Pregnant women are also at particular risk because fetuses' lungs are sensitive to pollution while rapidly developing. Studies suggest that women of color and low income women suffer disproportionately from the adverse birth outcome effects of PM exposure.

10. A portion of PM2.5 is classified as "ultrafine" particulate matter, characterized by having aerodynamic diameter of <0.1 μm. There is mounting evidence that this specific fraction of PM2.5 is even more dangerous to health than generalized PM2.5. Exposure to ultrafine particles may compound the effects of chronic or underlying health conditions, especially those linked to inflammation, such as Type 2 diabetes.

11. BNSF, one of the railroad companies that would service the terminal, has published studies indicating that 500-2000 lbs (one ton) of coal can escape from a single loaded coal car, and perhaps as much as 3% of the load (3600 lbs on a standard car).

12. The World Health Organization (WHO) cites coal dust, along with silica and asbestos, as being responsible for the most occupational lung disease due to any airborne particulate.

13. Given the substantial danger posed by combustible dust known to be produced by handling of coal, it is of concern that the industrial hygiene section of the preliminary operating plan submitted by project sponsors does not mention combustible dust prevention, detection, or emergency protocols.

14. After reviewing information presented by parties from both sides related to air quality impacts of coal transport via rail, the Alameda County Public Health Department found it reasonable to conclude that there will be increased emissions, particularly for those living and working nearby, from fugitive coal dust, resulting in increased health concerns.

15. A study of children living near a coal bulk handling port found increased prevalence of respiratory symptoms in primary schoolchildren exposed to coal dust. This port handled less than 2 million tonnes at its peak, less than a quarter of the proposed capacity of the terminal in Oakland.

16. Coal dust may travel approximately 500 m to 2km (1/3 to 1 ¼ miles) from the train tracks, depending on weather conditions and train speed.

17. If coal were the only commodity to be handled at the terminal, and virtually all of the coal were to be eventually burned in power plants overseas, this burning would generate approximately 23 million metric tons of CO2 per year. This is more than 8 times all of the greenhouse gases emitted in the City of Oakland in 2013, the last year for which data are available.

18. Over just 10 years of full operation (at 9 MMTPA coal), combustion of coal exported through this terminal would likely result in the release of GHGs equivalent to approximately half of California's entire annual carbon budget at current levels. It is also equivalent to all of the greenhouse gas emissions that will need to occur in California between 2020 and 2025 to ensure that California transitions from the 2020 Target (set in The Global Warming Solutions Act of 2006, AB 32) to the 2030 Goal established in Executive Order B-30-15.

19. With the lower estimate of 5 MMTPA of coal handled through the proposed terminal, burning of the commodity shipped through Oakland would still result in annual GHG emissions in excess of 4 times all of those currently emitted in Oakland. (See Figure 25.) The emissions that would result from burning a single year's worth of exported coal (5 million metric tons of coal, a conservative scenario), would be 179 times the amount by which Oakland must reduce its emissions each year to meet its 2020 greenhouse gas emissions target.

20. There is no such thing as "clean" coal. Coal from Utah is sometimes referred to as "EPA-compliant." This simply means that it has lower sulfur content than some other coals, allowing users of the coal to more easily comply with U.S. sulfur dioxide standards without additional air pollution mitigation technology; however it does not mean that emissions from the coal will meet emission standards for any other pollutants.

21. The Alameda County Public Health Department finds that working conditions at the terminal will be dangerous: "…workers at the Terminal, the larger Development Area, and the Port of Oakland are another population that will be impacted and continuously exposed to working conditions dangerous to their health and safety." Despite occupational health regulations and vetted infrastructure designs, buildup of coal dust within industrial settings is a documented problem.

22. Bituminous coal, such as the coal proposed to be handled through this project, is highly volatile.

23. Coal is explosive when in dust or powder form. It does not take much coal dust to cause an explosion, and in fact, the dust may be virtually hardly invisible but still sufficient to cause an explosion.

24. City workers (emergency responders) will be at high risk when responding to coal fires or explosions in large part due to the hidden dangers associated with coal and coal dust fires, which requiring special training and experience to put them out.

25. The National Academy of Sciences, in a review of relevant literature concluded that "air pollution is no longer a local issue. If and when the coal that is exported through this terminal is burned in Asia, some portion of the emissions from the burning of that coal will come back to impact human health in the Bay Area."

26. Measured ozone levels in the Bay Area are above the standards set by the US EPA and the California EPA to protect human health. Ozone in the Bay Area is worsened by pollution coming from distant sources, including coal-burning in China.

27. Climate Change has been called the biggest global health threat of the 21st century. Climate change produces a wide range of mild to devastating effects on human health. In general the most vulnerable people will be most severely affected. The EPA states that, "Our most vulnerable citizens, including children, older adults, people with heart or lung disease and people living in poverty are most at risk to the health impacts of climate change."

28. Emissions from end use of the coal exported through the proposed terminal are an indirect source of greenhouse gas emissions from the project that would have a significant impact on the environment.

29. The health and safety of Bay Area residents, and specifically those in Alameda County, is expected to be affected by climate change over the next few decades. Climate change threatens Oakland specifically, with impacts that are felt as both discrete shocks (coastal floods, increased wildfire risks) and continual or periodic stress (rising seas and droughts). As the climate warms, droughts, extreme heat days, large rainstorms and other abnormal weather patterns are expected to occur more frequently and intensely.

30. Sea level is already rising as a result of human activities. In a recent report on sea level rise and its impact on coastal flooding in the San Francisco Bay Area, Climate Central found that human-caused global sea level rise has caused the number of flood days in San Francisco to increase by 118% over the past 30 years. Sea level has risen at least 4 inches since 1950, and 3.5 inches can be linked to human-caused global sea level rise. Between 1950-2014, 329 flood days (69%) were attributable to anthropogenic global sea level rise in San Francisco. Over the past 10 years alone, 81 flood days (82% of all flood days in that period) were attributable to anthropogenic sea level rise in San Francisco.

EXHIBIT E

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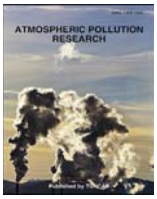

Original article

Diesel particulate matter and coal dust from trains in the Columbia River Gorge, Washington State, USA

Daniel Jaffe [a, b, *], Justin Putz [a], Greg Hof [a], Gordon Hof [c], Jonathan Hee [a], Dee Ann Lommers-Johnson [a], Francisco Gabela [a], Juliane L. Fry [d], Benjamin Ayres [d], Makoto Kelp [d], Madison Minsk [e]

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ABSTRACT

We examined the emissions of diesel particulate matter (DPM) and coal dust from trains in the Columbia River Gorge (CRG) in Washington State by measuring PM_1, $PM_{2.5}$, CO_2, and black carbon (BC) during the summer of 2014. We also used video cameras to identify the train type and speed.

During the two-month period, we identified 293 freight trains and 74 coal trains that gave a $PM_{2.5}$ enhancement of more than 3.0 μg/m^3. We found an average $PM_{2.5}$ enhancements of 8.8 and 16.7 μg/m^3, respectively, for freight and coal trains. For most freight trains (52%), and a smaller fraction of coal trains (11%), we found a good correlation between $PM_{2.5}$ and CO_2. Using this correlation, we calculated a mean DPM emission factor (EF) of 1.2 gm/kg fuel consumed, with an uncertainty of 20%.

For four coal trains, the videos revealed large plumes of coal dust emanating from the uncovered coal cars. These trains also had the highest peak $PM_{2.5}$ concentrations recorded during our study (53–232 μg/m^3). Trains with visible coal dust were observed for 5.4% of all coal trains, but 10.3% when the effective wind speed was greater than 90 km/h. We also found that nearly all coal trains emit coal dust based on (1) statistically higher $PM_{2.5}$ enhancements from coal trains compared to freight trains; (2) the fact that most coal trains showed a weak correlation between $PM_{2.5}$ and CO_2, whereas most freight trains showed a strong relationship; (3) a statistically lower BC/$PM_{2.5}$ enhancement ratio for coal trains compared to freight trains; and (4) a statistically lower PM_1/$PM_{2.5}$ enhancement ratio for coal trains compared to freight trains. Our results demonstrate that, on average, passage of a diesel powered open-top coal train result in nearly twice as much respirable $PM_{2.5}$ compared to passage of a diesel-powered freight train.

1. Introduction

Rail locomotives powered by diesel fuel travel through the Columbia River Gorge National Scenic Area as well as many urban areas in Washington State. Evaluating the air quality impacts from rail traffic for people living near rail lines is hampered by a lack of data. Several plans that would expand coal shipments by rail through Washington and Oregon to coastal ports for export to Asia have been proposed. New export facilities have been proposed for Longview and Bellingham, Washington. One proposed port near Bellingham would have the capacity to ship up to 54 million metric tons of coal annually (WA DOE, 2013).

The U.S. Department of Health and Human Services states that diesel particulate matter (DPM) is "reasonably anticipated to be a human carcinogen" (U.S. DHHS, 2014). The World Health Organization also categorizes DPM as "carcinogenic to humans" (WHO, 2012). In urban areas, including Seattle, the most significant "air toxic" is DPM, contributing over 80% of the cancer risk for air toxics

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(Keill and Maykut, 2003; PSCAA, 2005). DPM sources consist of rail locomotives, ships and diesel trucks, both on road and off road. Average DPM concentrations for the Seattle area are 1.4–1.9 μg/m^3, based on monitoring and a chemical mass balance model (Keill and Maykut, 2003; Maykut et al., 2003). These DPM concentrations make up 15–20% of the mass of total particulate matter with diameters less than 2.5 μm ($PM_{2.5}$).

Emission standards for new and remanufactured locomotives, developed by the U.S. Environmental Protection Agency (EPA) (40 CFR part 1033) have decreased steadily over the past several decades. For diesel locomotives various standards apply based on the date of manufacture: Tier 0, 1973–2001; Tier 1, 2002–2004; Tier 2, 2005–2010; Tier 3, 2011–2014; and Tier 4, after 2015 (U.S. EPA, 2013). Tier 4 locomotives must comply with a PM_{10} standard of 0.03 g/bhp-h, which is about 0.19 g of PM_{10} per kg of fuel consumed (U.S. EPA, 2009).

Previous studies looked at rail yards as air pollutant sources. They determined that the primary source of $PM_{2.5}$ at these sites was diesel fuel combustion. One study investigated the impact of DPM emissions on $PM_{2.5}$ concentrations at an Atlanta area rail yard (Galvis et al., 2013). Using measurements collected upwind and downwind of the rail yard, they found the average "neighborhood" contribution to $PM_{2.5}$ was 1.7 μg/m^3. The emission factors (EFs) per kg of diesel fuel burned were calculated to be 0.4–2.3 g DPM. The EFs were not determined from individual train measurements but were calculated using three different methods, each based on differing assumptions. Two studies of a Roseville, California, rail yard also found significant enhancements in $PM_{2.5}$ from the yard. Using measurements from upwind and downwind, Cahill et al. (2011) found an average $PM_{2.5}$ enhancement of 4.6 μg/m^3, and Campbell and Fujita (2006) found even larger contributions (7.2–12.2 μg/m^3). Cahill et al. (2011) also demonstrated that particles with diameters below 1 μm are the major contributor to $PM_{2.5}$ aerosol mass from diesel exhaust. Abbasi et al. (2013) studied concentrations in the interior of trains and close to rail lines and found significantly elevated $PM_{2.5}$ and PM_{10} concentrations, particularly in stations that were underground. Gehrig et al. (2007) looked at electric trains in Switzerland and examined the influence of dust from these trains on PM_{10} concentrations. Several studies investigated the EFs of on-road diesel trucks and buses (Jamriska et al., 2004; Zhu et al., 2005; Cheng et al., 2006; Park et al., 2011; Dallmann et al., 2012), but we have found no similar studies on diesel rail.

Trains that carry coal in uncovered rail cars may also release coal dust, in addition to DPM, into the atmosphere. The BNSF railway requires that a surfactant be applied over the top of coal being transported by rail (see BNSF Railway, 2013). However, we are unaware of any studies reported in the scientific literature that evaluate the efficacy of this or the impact of coal dust on air quality. By examining the PM by train type, we can examine whether there is respirable coal dust ($PM_{2.5}$) as part of the emissions from coal trains. We will also examine the particle size distribution because combustion-related particles and coal dust, which is mechanically generated, are associated with particles of different sizes (Seinfeld, 1986).

A substantial amount (44–60%) of the diesel engine $PM_{2.5}$ mass is black carbon (BC) (Bond et al., 2004; Kirchstetter and Novakov, 2007; Ramanathan and Carmichael, 2008). Because radiative forcing due to BC is the major light-absorbing species in atmospheric aerosol, it is significant both globally and regionally (Jacobson, 2001; Ramanathan and Carmichael, 2008). In addition, because of BC's surface properties, it is possible for polyaromatic hydrocarbons (PAHs) and other semi-volatile compounds to be adsorbed and transported by BC (Dachs and Eisenreich, 2000). Health organizations are also taking a hard look at BC because of its contribution to the harmful effects caused by $PM_{2.5}$, including cardiopulmonary and respiratory disease (Jansen et al., 2005; Janssen et al., 2011; U.S. EPA, 2012).

Because of the lack of information on $PM_{2.5}$ concentrations and the exposure to humans from diesel trains, the debate over coal dust and the scarcity of information on diesel train EFs, we sought to measure these air quality effects by answering the following questions:

1. What are the DPM emission factors for locomotives in Washington State and how do these compare with published values?
2. Do open-top coal-carrying trains emit respirable coal dust ($PM_{2.5}$) into the air? If so, can we quantify the emissions?

To address these questions we measured PM_1, $PM_{2.5}$, CO_2, black carbon and meteorology at a location in the Columbia River Gorge next to the rail line. Because we wanted to quantify DPM and coal dust exposure and quantify the EFs from each train, we collected measurements every 10 s in order to identify the air quality impacts of individual trains. In a previous study, we measured a similar suite of parameters in 2013 at a site in Seattle, Washington, and (very briefly) at a site in the Columbia River Gorge (Jaffe et al., 2014). In the previous study, we quantified DPM emission factors from diesel trains, evaluated the neighborhood scale exposure to $PM_{2.5}$ from trains and found evidence that suggested emissions of coal dust, based on particle size. In the present analysis, we report new data taken in 2014 that more clearly identifies and quantifies the emissions of DPM and coal dust from coal-carrying trains.

2. Experimental

Measurements were made at a site between the towns of Lyle and Dallesport, Washington, in the Columbia River Gorge (approximately 45.7°N, 121.2°W) between June 7–August 10, 2014. The instruments were housed in a weather-proof enclosure, located about 10 m above and 20 m northeast of the rail line. Two video cameras were used; one took video of the trains at a 90° angle to the rail line, and one viewed the trains arriving/departing to the northwest. The rail line travels along the north side of the Columbia River. There were no roads between our site and the river. Our measurement site was approximately 200 m southwest of Washington Route 14, a state highway with light traffic. The measurement location used in 2014 was in the same general location, but about 300 m away, from the site we used for our 2013 measurements (Jaffe et al., 2014). At this site the rail line is almost completely flat; there is a maximum grade of 1 m per km in the next few km in either direction.

We used a DustTrak DRX Aerosol Monitor (Model #8533, TSI, Inc., Shoreview, MN) to measure size-segregated PM. The DustTrak reports 4 size fractions of PM mass concentrations: PM_1, $PM_{2.5}$, PM_{10} and TSP. The instrument uses aerosol scattering to calculate its measurements. Therefore, its measurements are not the same as mass-based measurements (Wang et al., 2009). The DustTrak is calibrated against Arizona road dust (ISO 12103-1) by the manufacturer and so will not correctly reflect the mass concentration for other types of aerosol. This is specifically the case for diesel PM because of the particle size (Park et al., 2011). Obtaining accurate measurements with the DustTrak requires comparing its measurements with a mass-based measurement (Moosmuller et al., 2001). The DustTrak has been used to quickly measure several PM size fractions and determine EFs of individual vehicles in several previous studies (e.g., Park et al., 2011; Dallmann et al., 2012), but usually after using a mass-based method to calibrate the response factor (Jamriska et al., 2004; Zhu et al., 2005; Cheng et al., 2006; Jaffe et al 2014). In our study, the DustTrak was

calibrated against two mass-based measurements—a Tapered Element Oscillating Microbalance (TEOM) and the EPA Federal Reference Method at a routine air quality monitoring station in Seattle, Washington (details below).

The DustTrak inlet was stainless steel tubing (4.8 mm i.d.) facing downward from a height of approximately 2 m above ground level. The flow rate through the inlet was 3.0 L per minute. With these conditions, the flow was laminar. To estimate the particle sampling efficiency, we used the methodology and program provided by von der Weiden et al. (2009). The wind speeds during train sampling in the CRG varied between 1 and 11 m per second (mps), with an average of 4.5 mps during the sampling period. For particles less than 2.5 μm aerodynamic diameter, we calculated greater than 90% particle transmissions at all wind speeds up to 15 mps. For particles between 3 and 10 μm aerodynamic diameter, the inlet sampling efficiency would be much less than 1.0 and vary with wind speed (von der Weiden et al., 2009). For this reason, we used only the $PM_{2.5}$ and PM_1 data in this analysis.

We measured CO_2 using a Licor-820 (Licor, Inc., Lincoln, NE) with a small vacuum pump for sampling. The inlet was a 4.8 mm i.d. stainless steel tube (38 mm long) connected to PFA tubing. We zeroed the instrument using CO_2-free air and calibrated it with a 395 ppmv standard from Airgas, Inc. We calibrated the instrument both before and after the deployment; the instrument response varied by less than 1 ppmv between these calibrations. We used DAQFactory on a PC to record data from the DustTrak, the Licor-820 (CO_2, cell temperature and pressure) and the meteorological station. We recorded 10-s averages for PM and CO_2 data.

To identify trains and quantify their speeds, we used two Night Owl cameras (Model CAM-MZ420-425M) that were equipped with infrared (IR) night vision. The cameras were motion activated and operated with iSpy open source camera security software. However, even with the IR capability of the cameras, we were unable to identify the type of trains at night. We considered using an auxiliary light to view the trains at night; however, this was rejected as the Columbia River Gorge is classified as a National Scenic Area, which limits lighting options. Only trains that could positively be identified as freight or coal were used in this analysis, so this excluded all trains passing our site in full darkness.

BC was measured using an aethalometer (Magee Scientific model AE22). BC data were collected at one-minute time resolution at 370 nm and 880 nm. BC loading was determined using infrared attenuation data at 880 nm alone, because at 370 nm, other organic compounds may contribute interference (Wang et al., 2011). The aethalometer determines raw BC concentration (BC_0, ng/m^3) from measured attenuation values (ATN, m^{-1}) via

$$BC_0 = 10^9 \times ATN/\sigma \quad (1)$$

where σ is the calibrated cross-section (16.6 m^2/g at 880 nm). As in our previous study (Jaffe et al., 2014), we applied a correction to the BC_0 concentrations to account for diminishing transmission as a function of BC loading. Transmission (Tr) is calculated from each attenuation value:

$$Tr = e^{-ATN/100} \quad (2)$$

Following Kirchstetter and Novakov (2007), we calculated the corrected BC mass loading (BC_{corr}, ng/m^3) as:

$$BC_{corr} = BC_0/(0.88 \times Tr + 0.12) \quad (3)$$

The DPM EFs are calculated for each passing train in units of DPM emitted per kg of diesel fuel burned using:

$$EF\ (PM_{2.5}) = \frac{\Delta PM_{2.5}}{\Delta CO_2} \times CF \times W_c \quad (4)$$

where the $\Delta PM_{2.5}/\Delta CO_2$ or "enhancement ratio" is calculated from the Reduced Major Axis (RMA) regression slopes of the 10-s CO_2 and $PM_{2.5}$ data for each passing train, in units of μg/m^3 per ppmv. CF is a conversion factor to convert CO_2 concentrations in ppm to μg C/m^3 units using the ideal gas law at 1 atm and 25 °C (1 ppmv CO_2 = 490.7 ugC/m^3). W_C is the mass fraction of carbon in diesel fuel (870 g C/kg fuel) (Lloyd's Register, 1995; Cooper, 2003), which yields overall units on the EF of g $PM_{2.5}$/kg fuel consumed. Yanowitz et al. (2000) showed that over 95% of diesel fuel carbon is released as CO_2.

Enhancement ratios ($\Delta PM_{2.5}/\Delta CO_2$ and $\Delta PM_1/\Delta PM_{2.5}$) were calculated from the 10-s data using the RMA regression method, which considers errors in both the x and y variables (Ayers, 2001; Cantrell, 2008). Absolute enhancements were calculated by subtracting out the PM, BC and CO_2 maximums during train passage from the background concentration measured prior to each trains passage. The RMA regression parameters were calculated for each train passage using a program written in Java utilizing Apache Commons Mathematics Library 3.3. The program first looked for a $PM_{2.5}$ enhancement of at least 3 μg/m^3 over the median value from the past 17 min (100, 10-s data points). The accuracy of the Java program to calculate PM and CO_2 enhancements and the RMA regression parameters were manually verified for approximately 20% of the peaks. All times in this manuscript are given in Pacific Daylight Time (PDT).

3. Results

3.1. Calibration of the DustTrak

We compared the DustTrak $PM_{2.5}$ concentrations with a TEOM and the filter-based Federal Reference Method (FRM) at a routine air quality monitoring site in Seattle, Washington (Beacon Hill), operated by the Puget Sound Clean Air Agency (PSCAA). Comparison data were obtained between April 30–May 20, 2014. TEOM data were continuous and reported on an hourly basis, the filter-based FRM measurements were for 24 h and conducted every third day only. At this site, the TEOM is a Thermo Fisher Scientific Model 1400AB with 8500C Filter Dynamic Measurement System (FDMS) with the Very Sharp Cut Cyclone (VSCC™) modification (U.S. EPA, 2014). This configuration is designated by the EPA as a Federally Equivalent Method (FEM) for $PM_{2.5}$. The inlet and flow configuration used for the DustTrak at the Beacon Hill site were identical to the configuration used in the Columbia River Gorge.

We found a very good correlations between the TEOM $PM_{2.5}$, the FRM and the DustTrak's reported $PM_{2.5}$. Table 1 shows the regression parameters.

The 95% confidence interval in the slope for the DustTrak-TEOM comparison is ±4.5%, whereas it is ±32% for the DustTrak-FRM comparison due to the very small sample size. In both cases, the intercepts are insignificantly different from zero (95% confidence interval overlaps zero). Because of this, we corrected all of the DustTrak PM data using the TEOM slope of 0.5577. This slope is 22% greater than the one reported by Jamriska et al. (2004), who reported a slope of 0.458. It also is approximately 14% greater than our earlier DustTrak comparison at a different site, where we reported a slope of 0.491 (Jaffe et al., 2014). These differences may be attributable to different aerosol types at these sites. Given these differences, we estimated the uncertainty in the corrected DustTrak PM_1 and $PM_{2.5}$ values to be ±20%.

Table 1
Regression parameters for the comparisons between the DustTrak data, the TEOM data and the FRM method at the PSCAA site at Beacon Hill, Seattle, Washington.

Comparison equation (using reduced major axis regression)	R^2	N
TEOM $PM_{2.5}$ ($\mu g/m^3$) = DustTrak × 0.5577 − 0.6977	0.74	485 (h averages)
FRM $PM_{2.5}$ = DustTrak × 0.5524 − 0.8433	0.92	7 (24-h samples)
FRM $PM_{2.5}$ = TEOM × 1.05 − 0.4326	0.96	7 (24-h samples)

3.2. Overview of observations on train emissions in the Columbia River Gorge

As each train passed our observation site, we may detect a peak in PM and CO_2, but this depended on the wind direction and wind speed. If the winds were from the north to northeast directions, our sensors recorded minor peaks only, or no peaks at all, in PM and CO_2. We found that small PM events had a lower correlation between the various parameters. For this reason, we screened out small peaks where the maximum $\Delta PM_{2.5}$ (enhancement above background) was <3 $\mu g/m^3$. If a peak larger than this value was detected and the video confirmed a simultaneous train passage, then we included this peak in our analysis. We included only freight and coal-carrying trains, since these were the dominant types that we observed in the Columbia River Gorge. Trains that carried mixed loads (e.g., freight plus coal), sand or other unidentifiable or uncovered cargo were not included in this analysis. We also observed very few passenger trains during the daytime hours, in contrast to our previous study in Seattle (Jaffe et al., 2014).

During this study, we observed 367 events with $\Delta PM_{2.5}$ >3 $\mu g/m^3$ that were identified by the video cameras as either freight or coal. We refer to each train passage with a detectable PM peak and verified by the video as a "train event." Table 2 shows a summary of the 367 train events, including number and average peak PM_1 and $PM_{2.5}$ enhancement values (over background). The peak PM_1 and $PM_{2.5}$ enhancements (10-s) from coal trains are about double the enhancements seen from freight trains. In addition, there are three extreme events with $PM_{2.5}$ enhancements greater than 75 $\mu g/m^3$ that were seen only for the coal trains. The differences between the peak PM enhancements for coal and freight trains are statistically significant ($P < .001$). The statistically significant difference remains even if these extreme events are excluded from the analysis. For all train events, there is an excellent relationship between the PM_1 and $PM_{2.5}$ data, although the fraction of $PM_1/PM_{2.5}$ varies by train type. This is discussed in Section 3.5 below.

However, only some train events showed a good correlation between $PM_{2.5}$ and CO_2. Fig. 1 shows an example of a freight train that passed our site on July 10, 2014. In this case, the $PM_{2.5}$ enhancement is 24 $\mu g/m^3$, the CO_2 enhancement is 39 ppmv and the two are very well correlated, indicating that the dominant source of PM is diesel exhaust. Fig. 2 shows an example of a coal-carrying train that passed by on July 18, 2014. For this example, the peak $PM_{2.5}$ concentration is more than 6 times the peak shown

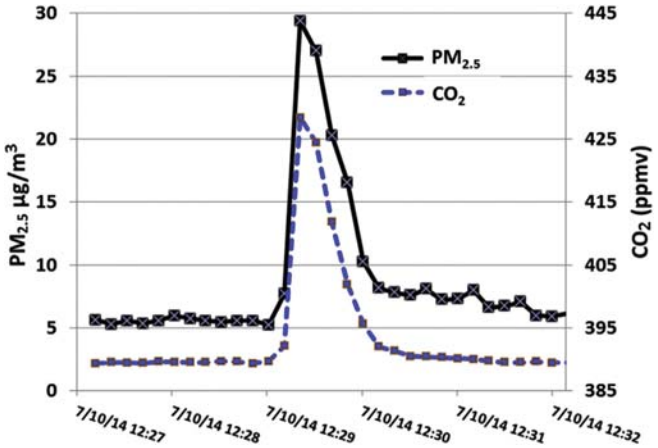

Fig. 1. $PM_{2.5}$ and CO_2 during passage of a freight train on 7/10/2014 at 12:29 PDT. The two values show a good correlation with an R^2 of 0.98 and a slope of 0.61 $\mu g/m^3$ per ppmv.

previously for the freight train, while the CO_2 enhancement is much smaller. In addition, the CO_2 peaks occurred at the start and end of the train passage due to locomotives at the beginning and end of this train, which is typical of the very long coal trains. The height of the CO_2 peak shows no obvious relationship with train type and likely varies mainly with meteorology, which influences the degree to which the combustion exhaust gases reach the measurement site. For the coal train (Fig. 2), the dominant source of PM is not diesel exhaust but coal dust. This was confirmed by the video (discussed below). It should be noted that DPM was probably present but is not apparent in the data due to the much larger coal dust peak. In this case, because the PM concentrations were not correlated to CO_2, we were not able to calculate a DPM emission factor. For this reason, we did not include train events in the DPM EF calculation if the $PM_{2.5}$–CO_2 R^2 is less than 0.5. We also excluded train events that had very small CO_2 enhancements (ΔCO_2 <2 ppmv), as these had erratic behavior.

Supplementary data related to this article can be found online at http://dx.doi.org/10.1016/j.apr.2015.04.004

3.3. DPM emission factors

The $\Delta PM_{2.5}/\Delta CO_2$ was used to derive the DPM emission factors. The average $\Delta PM_{2.5}/\Delta CO_2$ slope for all train events was found to be 6.56 $\mu g/m^3$ per ppmv, but this included many trains with a very poor correlation between $PM_{2.5}$ and CO_2. For the DPM emission factor calculation, we restricted our analysis to only those cases with an R^2 for the $PM_{2.5} - CO_2$ relationship of 0.5 or greater and a CO_2 enhancement of at least 2 ppmv. Table 2 shows the number of each train type that was used for the DPM analysis and statistics on the $PM_{2.5} - CO_2$ slope.

Table 2
PM and CO_2 data for freight and coal trains. Slopes for $\Delta PM_{2.5}/\Delta CO_2$ relationship is reported only for those train events with R^2 >0.5 and ΔCO_2 >2 ppmv.[a]

	Freight	Coal	All trains
Number	293	74	367
Average peak ΔPM_1 ($\mu g/m^3$)	11.0	19.7	12.5
Average peak $\Delta PM_{2.5}$ ($\mu g/m^3$)	10.7	20.9	13.0
Maximum $\Delta PM_{2.5}$ ($\mu g/m^3$)	57.2	232.3	232.3
Number with $PM_{2.5} - CO_2$ R^2 > 0.5 and ΔCO_2 > 2 ppm	152 (52%)	11 (15%)	163 (44%)
Mean/median $\Delta PM_{2.5}/\Delta CO_2$ slope ($\mu g/m^3$/ppmv)	0.70/0.56	0.71/0.56	0.70/.56
Max/Min slope	3.88/0.10	1.64/0.20	3.88/0.10

[a] In addition to the criteria given in the text above, we excluded one additional case with visible coal dust and an extremely high $PM_{2.5}$–CO_2 slope (12.0).

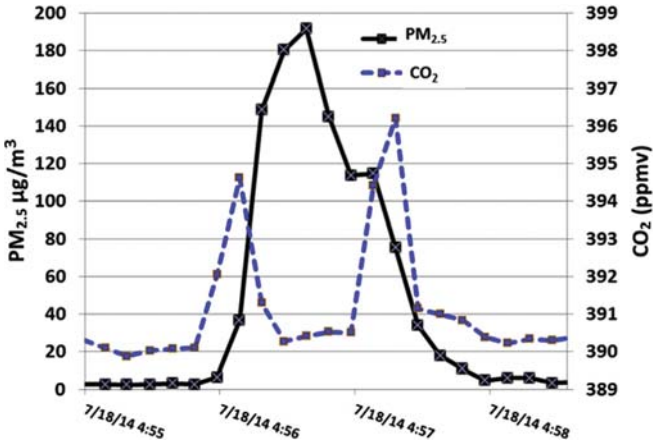

Fig. 2. $PM_{2.5}$ and CO_2 during passage of a coal train on 7/18/2014 at 4:56 PDT. The two parameters show no correlation during this time period. The train was observed to have locomotives in the front and rear, giving rise to the CO_2 peaks at the beginning and end of this time period.

The data in Table 2 show that while most freight trains were included in this analysis, the majority of coal trains were not included. This is due to the fact that most of the coal train events show a poor correlation between $PM_{2.5}$ and CO_2 (see Fig. 2). One coal train that would otherwise have been included in the DPM calculation had a $PM_{2.5} - CO_2$ slope of 12.0, more than 10× the mean value, and had visible coal dust in the video. Thus the large amount of $PM_{2.5}$ in this case cannot be attributed solely to DPM. This train event was not included in the DPM analysis. With this exclusion, the mean and median slopes for freight and coal trains are rather similar. Using equation (4), we find that the mean and median DPM EFs from our study are 1.2 and 0.99 g/kg fuel consumed, with an overall uncertainty of 20%. Our previous observations in the Pacific Northwest (Jaffe et al., 2014) found an average EF for diesel locomotives of 0.94 g/kg.

Diesel EFs for locomotives have been previously reported from several measurement campaigns. Kean et al. (2000) reported locomotive emission factors of between 1.8 and 2.1 g/kg using the EPA "NONROAD" model. A 2009 report (U.S. EPA, 2009) estimated that average locomotives EFs are declining about 5% per year, with a 2014 value of 0.98 g/kg. A study by Sierra Research in 2004 (Sierra Research, 2004) forecast a much slower decrease in the EFs of diesel locomotives, compared to U.S. EPA (2009), and for 2014 projected 1.4 g/kg. Our average measured EF is consistent with those cited in the above literature for the 2014 time frame, within the respective uncertainties.

3.4. Black carbon

We obtained simultaneous BC and $PM_{2.5}$ data on 294 of the trains. Table 3 reports the observed $BC/PM_{2.5}$ and $PM_1/PM_{2.5}$ enhancement ratios (discussed in Section 3.5).

These data show that, on average, 43% of the $PM_{2.5}$ was BC for all trains. In our previous study using similar data from 2013 (Jaffe et al., 2014), we found that the BC/PM_1 fraction was 52%, with most of those observations on freight trains. Our new data in 2014 indicates a significant difference ($P < .001$) in the average $BC/PM_{2.5}$ fraction for freight (0.47) and coal trains (0.29). Previous studies have found values that are similar to our freight train values for the BC/PM fraction. A study by Hildemann et al. (1991) found that 55% of diesel emissions were BC, and Watson et al. (1994) reported 45%. An Atlanta study (Galvis et al., 2013) found that diesel trains had BC to $PM_{2.5}$ ratios of 47–52%. The significant difference in the $BC/PM_{2.5}$ between coal and freight trains, shown in Table 3, indicates a significant coal dust component in the PM from the coal trains.

Table 3
$BC/PM_{2.5}$ and $PM_1/PM_{2.5}$ enhancement ratios for freight and coal trains.

	Freight	Coal	All trains
N (for $BC/PM_{2.5}$ analysis)	233	61	294
Mean/median $BC/PM_{2.5}$ (unitless)	0.47/0.40	0.29/0.20	0.43/0.35/0.27
Standard deviation on $BC/PM_{2.5}$	0.27	0.23	0.27
N (for $PM_1/PM_{2.5}$ analysis)	293	74	367
Mean/median $PM_1/PM_{2.5}$ (unitless)	0.93/0.93	0.96/0.96	0.96/0.96
Standard deviation on $PM_1/PM_{2.5}$	0.03	0.03	0.03

We assume that the coal dust has the same composition as the coal being shipped. This coal, from the Powder River Basin of Wyoming and Montana, has a relatively low carbon content compared to other coal types (ca 50% C), with the remainder of the mass made up of moisture and minerals, such as silicates, iron oxides and calcium oxide (NETL, 2012). While the low carbon content is partly responsible for the low $BC/PM_{2.5}$ fraction, shown in Table 3, our data suggest that other factors may also be involved. This could include a change in the mass absorption cross section for coal dust, as compared to diesel exhaust, which might reflect the impact of the coal mineral content, the organic matter composition or the size distribution of the particles.

3.5. $PM_1/PM_{2.5}$ fraction

The DustTrak calculates concentrations of PM in four size ranges, but due to the inlet sampling efficiency (discussed in Section 2) we considered only data for PM_1 and $PM_{2.5}$. Table 3 gives the statistical parameters on the $PM_1/PM_{2.5}$ enhancement ratio. Coal trains showed a larger mass fraction of particles above 1 µm aerodynamic diameter, and this difference is statistically significant. This reflects the significant contribution of coal dust to the $PM_{2.5}$ concentrations during the passage of the coal trains.

3.6. Influence of coal dust on $PM_{2.5}$ concentrations

In four cases, the videos revealed visible coal dust from the open-top coal trains. These visible coal dust plumes were seen in the four train events with the highest peak $PM_{2.5}$ concentrations (Table 4). We call these four train events with the highest $PM_{2.5}$ and visible coal dust "super-dusters." Two of the "super-duster" videos have been archived as part of the supplemental materials for this paper (8/7/2014 and 7/27/2014). Fig. 3 shows still images obtained from the video before and after train passage for the "super duster" on 8/7/2014, along with the measured $PM_{2.5}$ concentrations. We found that 4 out of 74 coal trains, or 5.4%, were classified as "super dusters" during our study.

A number of factors could be important in explaining the coal dust emissions of $PM_{2.5}$ from coal trains. These include quality of the surfactant application or factors that may disturb the coal/surfactant surface, such as high train speeds, exposure to high winds or rough handling during transport. While we have no information on

Table 4
The four train events with the highest peak $PM_{2.5}$ concentrations. In each case, a coal train with a visible coal dust plume was confirmed in the video recording.

Date/time (PDT)	Peak $PM_{2.5}$ conc. µg/m^3	Peak BC µg/m^3	$BC/PM_{2.5}$ ratio
8/7/14 17:28	232.3	53.5	0.23
7/18/14 4:57	188.8	88.9	0.47
7/20/14 14:07	77.6	8.86	0.11
7/27/14 21:16	53.1	9.13	0.17

Fig. 3. Images captured from the video camera before and after coal train passage on 8/7/2014 at 17:28 PDT. The full video of this train passage is archived as part of the supplemental materials for this paper. The camera looks to the west, downriver in the Columbia River Gorge. The coal train is visible in the right image and was moving from left to right.

upstream conditions, our data do allow us to examine the influence that train and local wind speed may have played on dust emissions. To do this, we calculated train speeds for each coal train from the videos. We also calculated the vector component of the winds in the direction opposite to the trains' travel. The sum of train speed plus vector wind speed represents the true wind speed across the open-top coal trains. We refer to this as the effective wind speed. During our study, the average train speed was 71.3 km/h and the average vector wind speed was 14.9 km/h.

Fig. 4 shows the effective wind speed versus peak $PM_{2.5}$ for each coal train event. The four "super dusters" are shown as large red squares. While no simple relationship emerges from this analysis, the data do suggest that "super dusters" are more likely to occur when the effective wind speed is greater than 80–90 km/h. Above 90 km/h, the fraction of "super dusters" is 10.3% (3 out of 29 trains), compared to 5.4% at all wind speeds. Thus we can view wind speed as one factor that increases the risk of high-level coal dust exposure. However, the fact that many coal trains with effective wind speeds greater than 90 km/h are not "super dusters" indicates that other factors, such as quality of the surfactant applied to the coal surface, must also be important.

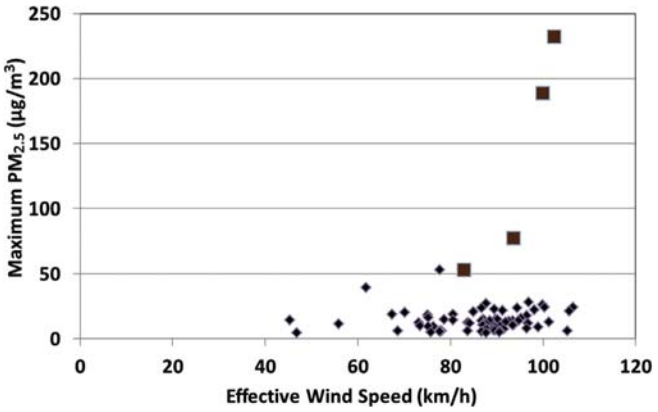

Fig. 4. Peak $PM_{2.5}$ enhancement for each coal train passage versus effective wind speed over the top of the train. The effective wind speed is calculated as the train speed plus the vector component of the wind at 180° to the train's movement. The four "super dusters" are shown as large red squares.

4. Conclusions

We measured PM_1, $PM_{2.5}$, BC and CO_2 during 367 train passages (train events) in the Columbia River Gorge. From the data, we calculated a DPM EF average of 1.2 g/kg fuel consumed (±20%) on 163 of those train events that show a good correlation between $PM_{2.5}$ and CO_2 (mostly freight trains). Our data indicate that nearly all open-top coal trains release coal dust, which contributes to enhanced $PM_{2.5}$ in the Columbia River Gorge. In four train events, that we call "super-dusters," the coal dust emissions led to visible dust plumes and the highest $PM_{2.5}$ concentrations observed in our study. But nearly all coal trains generate some degree of coal dust ($PM_{2.5}$) based on the following evidence:

1. Statistically higher peak $PM_{2.5}$ concentrations during passage of coal trains compared to freight trains. The peak $PM_{2.5}$ enhancements during a coal train passage are nearly double, on average, compared to the value during a freight train passage (Table 2);
2. The fact that most freight trains (52%) show a good correlation between $PM_{2.5}$ and CO_2, whereas very few coal trains (15%) show this relationship (Table 2);
3. The BC/$PM_{2.5}$ enhancement ratio is statistically higher for freight trains compared to coal trains (Table 3);
4. The $PM_1/PM_{2.5}$ enhancement ratio is statistically higher during passage of freight trains compared to coal trains (Table 3).

These four results demonstrate statistically significant differences between freight and coal trains, even if the four super-dusters are excluded from the statistical analysis.

Because our focus was on air quality, we measured the respirable size fractions of PM. Thus it is not possible to relate our observations to any data on bulk loss of coal during transport, since most of this loss will occur as much larger size particles. Because most coal train events show a poor correlation between $PM_{2.5}$ and CO_2, it is not possible to rigorously derive a fuel-based emission factor for the coal dust. Nonetheless, our data provide some guidance to anyone wishing to calculate total $PM_{2.5}$ emissions from the railway sector. Since the peak $PM_{2.5}$ values for coal trains are nearly double those for freight trains, it is reasonable to conclude that the total $PM_{2.5}$ emissions from coal trains are approximately double

those of freight trains. This would imply that the coal train $PM_{2.5}$ emissions consist of approximately half DPM and half coal dust.

Though all coal trains appear to generate some degree of dust, the "super-dusters" generate visible plumes and the highest concentrations of $PM_{2.5}$. "Super-dusters" represent 5.4% of all coal trains but 10.3% when the effective wind speed is greater than 90 km/h. This indicates that wind is one factor contributing to the coal dust emissions, but it is not the only explanatory factor.

Conflict of interest

The authors have no conflicts of interest to report.

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EXHIBIT F

Particulate Matter (PM) Pollution

CONTACT US <https://epa.gov/pm-pollution/forms/contact-us-about-particulate-matter-pm-pollution>

Health and Environmental Effects of Particulate Matter (PM)

Health Effects

The size of particles is directly linked to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into your lungs, and some may even get into your bloodstream.

Exposure to such particles can affect both your lungs and your heart. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including:

- premature death in people with heart or lung disease
- nonfatal heart attacks
- irregular heartbeat
- aggravated asthma <https://epa.gov/asthma>
- decreased lung function
- increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

People with heart or lung diseases, children, and older adults are the most likely to be affected by particle pollution exposure.

- AirNow EXIT <https://airnow.gov/> can help you monitor air quality near you, and protect yourself and your family from elevated PM levels.

Environmental Effects

Visibility impairment

Fine particles ($PM_{2.5}$) are the main cause of reduced visibility (haze) in parts of the United States, including many of our treasured national parks and wilderness areas. Learn more about visibility and haze <https://epa.gov/visibility>

Environmental damage

Particles can be carried over long distances by wind and then settle on ground or water. Depending on their chemical composition, the effects of this settling may include:

- making lakes and streams acidic
- changing the nutrient balance in coastal waters and large river basins
- depleting the nutrients in soil
- damaging sensitive forests and farm crops
- affecting the diversity of ecosystems
- contributing to acid rain effects <https://epa.gov/acidrain/effects-acid-rain>.

Materials damage

PM can stain and damage stone and other materials, including culturally important objects such as statues and monuments. Some of these effects are related to acid rain effects on materials <https://epa.gov/acidrain/effects-acid-rain#materials>.

Further Reading

Particle Pollution and Your Health (PDF)(2 pp, 320 K, About PDF <https://epa.gov/home/pdf-files>): Learn who is at risk from exposure to particle pollution, what health effects you may experience as a result of particle exposure, and simple measures you can take to reduce your risk.

How Smoke From Fires Can Affect Your Health EXIT <https://www.airnow.gov/air-quality-and-health/how-smoke-from-fires-can-affect-your-health/>: It is important to limit your exposure to smoke -- especially if you may be susceptible.

EPA research on airborne particulate matter <https://epa.gov/air-research>: EPA supports research that provides the critical science on PM and other air pollutants to develop and implement Clean Air Act regulations that protect the quality of the air we breathe.

PM Home <https://epa.gov/pm-pollution>

Particulate Matter (PM) Basics <https://epa.gov/pm-pollution/particulate-matter-pm-basics>

Health and Environmental Effects

Setting and Reviewing PM Standards <https://epa.gov/pm-pollution/setting-and-reviewing-standards-control-particulate-matter-pm-pollution>

PM Standards Regulatory Actions <https://epa.gov/pm-pollution/national-ambient-air-quality-standards-naaqs-pm>

Implementing PM Standards <https://epa.gov/pm-pollution/applying-or-implementing-particulate-matter-pm-standards>

PM Implementation Regulatory Actions <https://epa.gov/pm-pollution/particulate-matter-pm-implementation-regulatory-actions>

SIP Checklist Guide <https://epa.gov/pm-pollution/pm-state-implementation-plan-sip-checklist-guide>

PM SIP Training Presentations <https://epa.gov/pm-pollution/pm-naaqs-implementation-training-and-assistance-state-and-local-air-agencies>

PM Data and SIP Status Reports <https://epa.gov/pm-pollution/technical-data-and-reports-particulate-matter-pm-measurements-and-sip-status>

Other Criteria Air Pollutants <https://epa.gov/criteria-air-pollutants>

Contact Us <https://epa.gov/pm-pollution/forms/contact-us-about-particulate-matter-pm-pollution> to ask a question, provide feedback, or report a problem.

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LAST UPDATED ON MAY 26, 2021

EXHIBIT G

World Health Organization
REGIONAL OFFICE FOR Europe

HEALTH EFFECTS OF PARTICULATE MATTER

Policy implications for countries in eastern Europe, Caucasus and central Asia

Abstract

This paper summarizes the evidence about the health effects of air pollution from particulate matter and their implications for policy-makers, with the aim of stimulating the development of more effective strategies to reduce air pollution and its health effects in the countries of eastern Europe, the Caucasus and central Asia.

Keywords
AIR POLLUTION - adverse effects
ENVIRONMENT AND PUBLIC HEALTH
ENVIRONMENTAL POLLUTANTS
HEALTH POLICY
PARTICULATE MATTER - analysis
POLICY MAKING

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Contents

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Convention on Long-Range Transboundary Air Pollution

Abbreviations

AQG	air quality guidelines
EECCA	eastern Europe, the Caucasus and central Asia
PAH	polycyclic aromatic hydrocarbon
PM	particulate matter
UNECE	United Nations Economic Commission for Europe

Introduction and context

In most countries in the region covered by the United Nations Economic Commission for Europe (UNECE), ambient air quality has improved considerably in the last few decades. This has been achieved by a range of measures to reduce harmful air emissions, including those stipulated by the various protocols under the Convention on Long-range Transboundary Air Pollution *(1)*. There is, however, convincing evidence that current levels of air pollution still pose a considerable risk to the environment and to human health.

Recently, the Executive Body of the Convention has adopted amendments to the Convention's 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone. Following years of negotiations, the approved revised text of the Protocol now specifies national emission reduction commitments for main air pollutants to be achieved by the UNECE Parties by 2020 and beyond. The revised Protocol includes, for the first time, commitments to reduce the emission of fine particulate matter ($PM_{2.5}$). Furthermore, black carbon or soot is now included in the revision as an important component of $PM_{2.5}$. Black carbon is an air pollutant which both affects health and contributes to climate change *(2)*.

What is particulate matter?

PM is a widespread air pollutant, consisting of a mixture of solid and liquid particles suspended in the air.

Commonly used indicators describing PM that are relevant to health refer to the mass concentration of particles with a diameter of less than 10 µm (PM_{10}) and of particles with a diameter of less than 2.5 µm ($PM_{2.5}$). $PM_{2.5}$, often called fine PM, also comprises ultrafine particles having a diameter of less than 0.1 µm. In most locations in Europe, $PM_{2.5}$ constitutes 50–70% of PM_{10}.

PM between 0.1 µm and 1 µm in diameter can remain in the atmosphere for days or weeks and thus be subject to long-range transboundary transport in the air.

PM is a mixture with physical and chemical characteristics varying by location. Common chemical constituents of PM include sulfates, nitrates, ammonium, other inorganic ions such as ions of sodium, potassium, calcium, magnesium and chloride, organic and elemental carbon, crustal material, particle-bound water, metals (including cadmium, copper, nickel, vanadium and zinc) and polycyclic aromatic hydrocarbons (PAH). In addition, biological components such as allergens and microbial compounds are found in PM.

Where does PM come from?

Particles can either be directly emitted into the air (primary PM) or be formed in the atmosphere from gaseous precursors such as sulfur dioxide, oxides of nitrogen, ammonia and non-methane volatile organic compounds (secondary particles).

Primary PM and the precursor gases can have both man-made (anthropogenic) and natural (non-anthropogenic) sources.

Anthropogenic sources include combustion engines (both diesel and petrol), solid-fuel (coal, lignite, heavy oil and biomass) combustion for energy production in households and industry, other industrial activities (building, mining, manufacture of cement, ceramic and bricks, and smelting), and erosion of the pavement by road traffic and abrasion of brakes and tyres. Agriculture is the main source of ammonium.

Secondary particles are formed in the air through chemical reactions of gaseous pollutants. They are products of atmospheric transformation of nitrogen oxides (mainly emitted by traffic and some industrial processes) and sulfur dioxide resulting from the combustion of sulfur-containing fuels. Secondary particles are mostly found in fine PM.

Soil and dust re-suspension is also a contributing source of PM, particularly in arid areas or during episodes of long-range transport of dust, for example from the Sahara to southern Europe.

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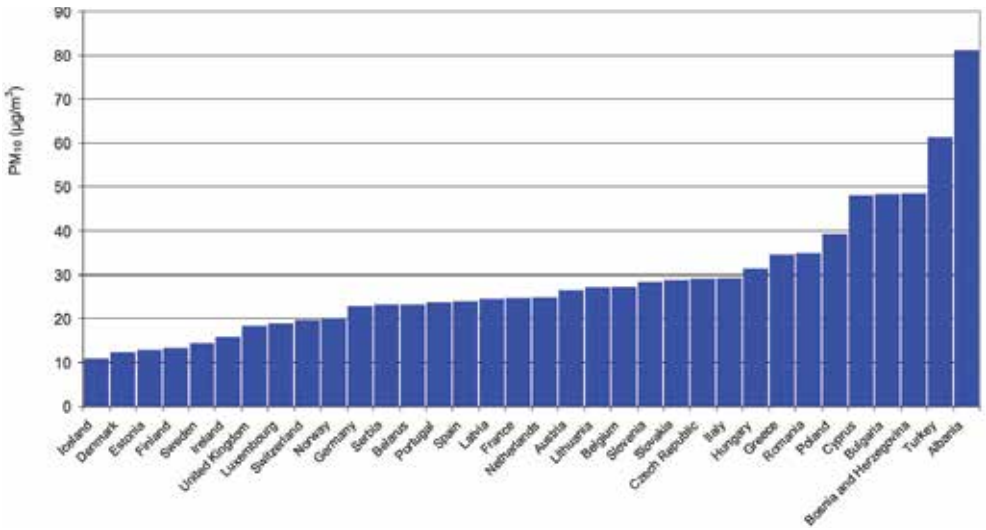
What are the levels of and trends in PM in the WHO European Region[1] ?

The WHO Environment and Health Information System (ENHIS), which is based to a large extent on data submitted by European Union (EU) member states to the European Environment Agency AirBase *(3)*, includes PM_{10} monitoring data from urban and suburban background locations. Fig. 1 presents the population exposure, expressed as annual mean concentration of PM_{10}, weighted by the population in cities with data, in 403 cities in 34 WHO European Member States for 2010. In only 9 of these 34 Member States, PM_{10} levels in at least some cities are below the annual WHO air quality guideline (AQG) level of 20 $\mu g/m^3$. Almost 83% of the population of the cities for which PM data exist is exposed to, PM_{10} levels exceeding the AQG levels. Although this proportion remains high, it is an improvement compared to previous years, with average PM_{10} levels slowly decreasing in most countries in the last decade.

Fig. 1.
Population-weighted annual mean PM_{10} in cities by WHO European Member State, 2010



Source: WHO Regional Office for Europe *(4)*.

On the other hand, monitoring of PM_{10} and $PM_{2.5}$ is very limited in countries in eastern Europe, the Caucasus and central Asia (EECCA), with only a small number of monitoring

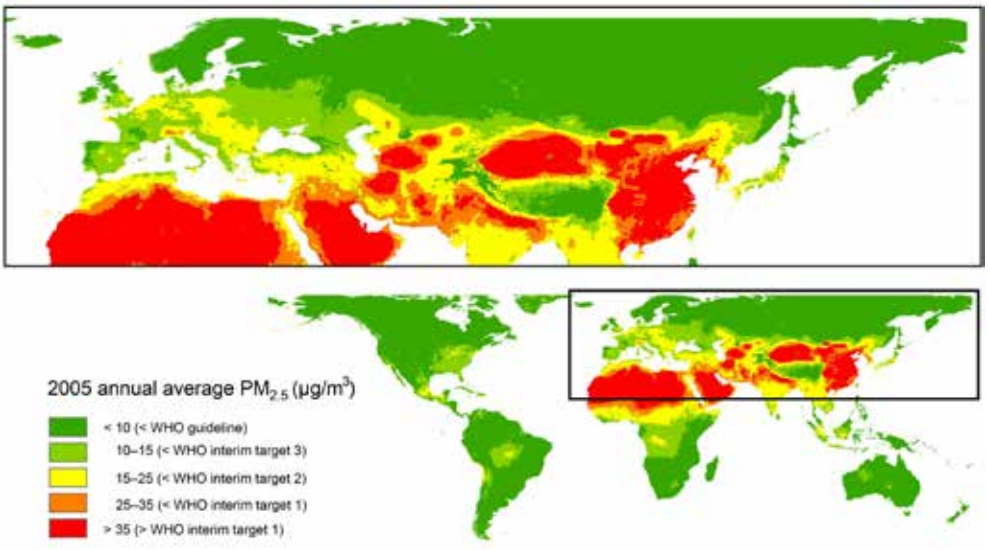
1 The WHO European Region includes 53 countries stretching from the Atlantic Ocean to the Pacific Ocean, with a population of almost 900 million people.

stations in Belarus, the Russian Federation (Moscow) and Uzbekistan (one in Tashkent and one in Nukus). Initial data from the two Uzbek cities indicate that PM_{10} and $PM_{2.5}$ levels are high in comparison with most of the other cities with PM monitoring in the Region. While the levels in Nukus may be affected by dust storms (which are frequent in that area), various combustion sources may be predominant in Tashkent.

The proper assessment of levels of and trends in PM in EECCA countries requires PM_{10} and/or $PM_{2.5}$ monitoring in more locations in those countries. The assessment of PM concentrations requires continuous monitoring conducted for 24 hours daily for 365 days a year, with standardized methods or methods equivalent to the standard. Quantitative knowledge about sources and levels of and trends in emissions of primary particles and precursor gases plays an important role in finding the best control strategy for reducing risks.

In view of the scarcity of ground-level data for PM, remote (satellite) sensing combined with modelling and existing surface measurements has recently been used for the assessment of population exposure at country level. Recent estimates have been published for $PM_{2.5}$ concentrations using this technology as part of the Global Burden of Diseases, Injuries and Risk Factors Project *(5)* (see Fig. 2). Further development of these methods and their precision depends to a large extent on the availability of surface measurements in all regions of the world.

Fig. 2.
Estimated 2005 annual average $PM_{2.5}$ concentrations (μg/m^3), presented according to the WHO AQG and interim target values



Source: Michael Brauer, personal communication based on *(5)*.

What are the health effects of PM?

PM_{10} and $PM_{2.5}$ include inhalable particles that are small enough to penetrate the thoracic region of the respiratory system. The health effects of inhalable PM are well documented. They are due to exposure over both the short term (hours, days) and long term (months, years) and include:

- respiratory and cardiovascular morbidity, such as aggravation of asthma, respiratory symptoms and an increase in hospital admissions;
- mortality from cardiovascular and respiratory diseases and from lung cancer.

There is good evidence of the effects of short-term exposure to PM_{10} on respiratory health, but for mortality, and especially as a consequence of long-term exposure, $PM_{2.5}$ is a stronger risk factor than the coarse part of PM_{10} (particles in the 2.5–10 µm range). All-cause daily mortality is estimated to increase by 0.2–0.6% per 10 µg/m^3 of PM_{10} *(6,7)*. Long-term exposure to $PM_{2.5}$ is associated with an increase in the long-term risk of cardiopulmonary mortality by 6–13% per 10 µg/m^3 of $PM_{2.5}$ *(8–10)*.

Susceptible groups with pre-existing lung or heart disease, as well as elderly people and children, are particularly vulnerable. For example, exposure to PM affects lung development in children, including reversible deficits in lung function as well as chronically reduced lung growth rate and a deficit in long-term lung function *(4)*. There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur. The exposure is ubiquitous and involuntary, increasing the significance of this determinant of health.

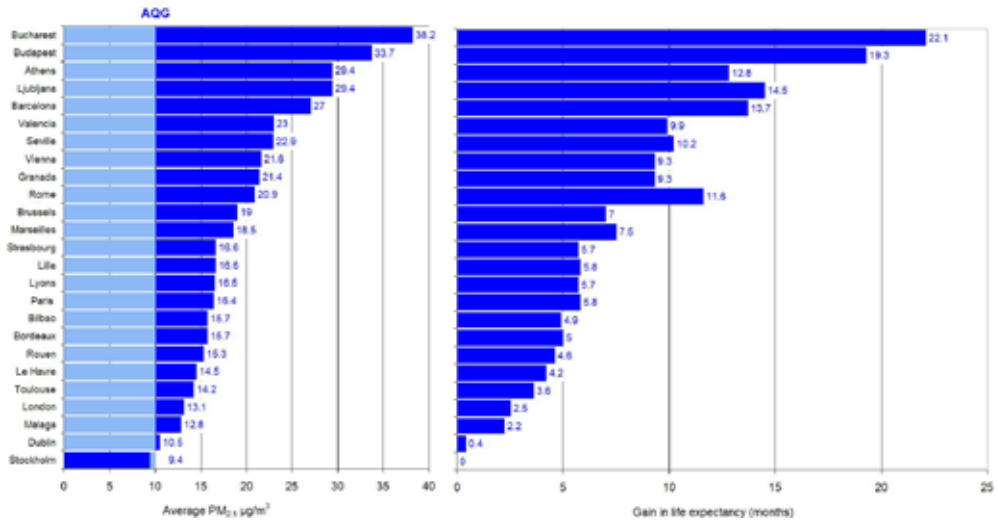
At present, at the population level, there is not enough evidence to identify differences in the effects of particles with different chemical compositions or emanating from various sources *(11)*. It should be noted, however, that the evidence for the hazardous nature of combustion-related PM (from both mobile and stationary sources) is more consistent than that for PM from other sources *(12)*. The black carbon part of $PM_{2.5}$, which results from incomplete combustion, has attracted the attention of the air quality community owing to the evidence for its contribution to detrimental effects on health as well as on climate. Many components of PM attached to black carbon are currently seen as responsible for health effects, for instance organics such as PAHs that are known carcinogens and directly toxic to the cells, as well as metals and inorganic salts. Recently, the exhaust from diesel engines (consisting mostly of particles) was classified by the International Agency for Research on Cancer as carcinogenic (Group 1) to humans *(13)*. This list also includes some PAHs and related exposures, as well as the household use of solid fuels *(14,15)*.

What is the burden of disease related to exposure to PM?

It is estimated that approximately 3% of cardiopulmonary and 5% of lung cancer deaths are attributable to PM globally. In the European Region, this proportion is 1–3% and 2–5%, respectively, in various subregions *(16)*. Results emerging from a recent study indicate that the burden of disease related to ambient air pollution may be even higher. This study estimates that in 2010, ambient air pollution, as annual $PM_{2.5}$, accounted for 3.1 million deaths and around 3.1% of global disability-adjusted life years *(17)*.

Exposure to $PM_{2.5}$ reduces the life expectancy of the population of the Region by about 8.6 months on average. Results from the scientific project Improving Knowledge and Communication for Decision-making on Air Pollution and Health in Europe (Aphekom), which uses traditional health impact assessment methods, indicate that average life expectancy in the most polluted cities could be increased by approximately 20 months if the long-term $PM_{2.5}$ concentration was reduced to the WHO (AQG) annual level (Fig. 3).

Fig. 3.
Predicted average gain in life expectancy (months) for people aged 30 years for a reduction in average annual levels of $PM_{2.5}$ down to the WHO AQG annual mean level of 10µg/m^3 in 25 European cities participating in the Aphekom project



Source: based on Medina *(18)*.

WHO AQGs

WHO last revised its AQG values for PM in 2005, as follows:

- for $PM_{2.5}$: 10 µg/m^3 for the annual average and 25 µg/m^3 for the 24-hour mean (not to be exceeded for more than 3 days/year);
- for PM_{10}: 20 µg/m^3 for the annual average and 50 µg/m^3 for the 24-hour mean.

In addition to these guideline values, the AQGs provide interim targets for each air pollutant, aimed at promoting a gradual shift to lower concentrations in highly polluted locations. If these targets were to be achieved, significant reductions in risks for acute and chronic health effects from air pollution could be expected. Progress towards the guideline values should, however, be the ultimate objective. As no threshold for PM has been identified below which no damage to health is observed, the recommended values should be regarded as representing acceptable and achievable objectives to minimize health effects in the context of local constraints, capabilities and public health priorities.

WHO is currently developing indoor air guidelines for household combustion of fuels for cooking, heating and lighting. These will provide recommendations for household fuels and technologies that will enable progress towards the AQGs.

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Evidence on effects of air quality improvements

There is consistent evidence that lower air pollution levels following a sustained, long-term intervention result in health benefits for the population, with improvements in population health occurring soon (a few years) after the reduction in pollution. Several successful interventions and accountability studies have been evaluated *(19,20)*. A few examples are summarized below.

Follow-up to the Harvard Six Cities Study, United States

A group of adults living in six cities in the United States was followed from 1974 to 2009 in order to estimate the effects of air pollution on mortality. Overall, $PM_{2.5}$ concentrations had decreased to below 15 µg/m^3 by 2000 (except in one city where levels were below 18 µg/m^3). The main finding was that a 2.5 µg/m^3 decrease in the annual average level of $PM_{2.5}$ was associated with a 3.5% reduction in all-cause mortality *(21–23)*. Results show associations between chronic exposure to $PM_{2.5}$ and all-cause, cardiovascular and lung cancer mortality, with health effects seen at any PM concentration. Results suggest that the critical period of exposure to $PM_{2.5}$ for the associated health effects is one year for all-cause mortality, implying that health improvements can be expected to start almost immediately after a reduction in air pollution. In a related study, but using different data, it was demonstrated that the reduction in fine particulate air pollution in the United States in the 1980s and 1990s accounted for as much as 15% of the 2.7-year overall increase in life expectancy that had occurred in that period *(24)*.

Short-term decrease in industrial emissions, United States

A copper smelter strike in 1967–1968 in four states, and the closure and reopening of a steel mill in Utah Valley in 1986–1987, are two examples of unplanned events which had a positive impact on health by decreasing air pollution concentrations in specific areas. The copper smelter strike led to a 60% drop in regional sulfur dioxide concentrations over eight months and was associated with a 2.5% decrease in mortality *(25)*. In the Utah Valley, the closure of the steel mill, which was the primary source of PM_{10} in the area, lasted for 13 months and led to a decrease in PM_{10} levels of approximately 50% during the closure in winter compared to the previous winter when the mill was operating. Hospital admissions for children were approximately three times lower and bronchitis and asthma admissions were halved when the mill was closed *(26)*. Furthermore, the reported 3.2% drop in daily numbers of deaths was associated with a simultaneous fall in PM_{10} levels of approximately 15 µg/m^3 while the steel mill was closed, the strongest association being with respiratory deaths *(27)*.

Respiratory health studies and air pollution abatement measures, Switzerland

The Swiss Study on Air Pollution and Lung Diseases in Adults assessed lung diseases in adults from eight Swiss communities in 1991 and again in 2002. Overall exposure to outdoor PM_{10} estimated at each individual's residence fell by an average of 6.2 $\mu g/m^3$ over the study period, to reach a range of approximately 5 $\mu g/m^3$ to 35 $\mu g/m^3$ in 2002, depending on the community. This reduction in particle levels was associated with attenuated age-related annual declines in various lung function parameters. The falling PM_{10} levels were also associated with fewer reports of respiratory symptoms such as regular cough, chronic cough or phlegm, and wheezing and breathlessness *(28,29)*. As part of a separate investigation, children from nine Swiss communities were followed between 1992 and 2001 as part of the Swiss Study on Childhood Allergy and Respiratory Symptoms with respect to Air Pollution, Climate and Pollen. Falling levels of regional PM_{10} were associated with a declining prevalence of various respiratory symptoms, including chronic cough, bronchitis, common cold, nocturnal dry cough and conjunctivitis symptoms *(30)*. These findings suggest that modest as well as drastic improvements in ambient air quality are beneficial for respiratory health in both children and adults.

These examples of successful interventions show that decreased levels of particulate air pollution can substantially diminish total, respiratory and cardiovascular death rates. Benefits can be expected at almost any reduction in levels of air pollution, which suggests that further policy efforts that reduce fine PM air pollution are likely to have continuing favourable effects on public health.

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Air quality management and policy

Up to 80% of particulate air pollution in EECCA countries can be reduced with currently available technologies *(31)*. The reduction of outdoor air pollutants in general, and PM in particular, requires concerted action by public authorities, industry and individuals at national, regional and even international levels. Responsible authorities with a vested interest in air pollution management include the environment, transport, land planning, public health, housing and energy sectors. Since the burden of air pollution on health is significant at even relatively low concentrations, the effective management of air quality is necessary to reduce health risks to a minimum.

The development and exchange of information on policies, strategies and technical measures to reduce emissions are part of the fundamental principles of the Convention on Long-range Transboundary Air Pollution. The Working Group on Strategies and Reviews of the Convention, and in particular its Expert Group on Techno-economic Issues *(32)*, maintains the database of information on control technologies for air pollution abatement and their costs. An example of its work is provided by the Group's 2010 report summarizing progress in work to reduce dust emissions from small combustion installations *(33)*.

There are co-benefits to addressing particulate air pollution that go beyond just the positive impact on health. For example, reductions in black carbon emissions from the strategic mitigation of combustion sources will also simultaneously reduce global warming *(34)*.

Finally, integrated policies on urban planning and transport can encourage the use of cleaner modes of transport and lead to changes in individual behaviour by promoting walking, cycling and increased commuting by public transport. These policies contribute to cleaner air while promoting physical activity and largely benefiting public health.

Conclusions

PM is a widespread air pollutant, present wherever people live.

The health effects of PM_{10} and $PM_{2.5}$ are well documented. There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur.

Since even at relatively low concentrations the burden of air pollution on health is significant, effective management of air quality aiming to achieve WHO AQG levels is necessary to reduce health risks to a minimum.

Monitoring of PM_{10} and/or $PM_{2.5}$ needs to be improved in many countries to assess population exposure and to assist local authorities in establishing plans for improving air quality.

There is evidence that decreased levels of particulate air pollution following a sustained intervention result in health benefits for the population assessed. These benefits can be seen with almost any decrease in level of PM. The health and economic impacts of inaction should be assessed.

Particulate air pollution can be reduced using current technologies.

Interventions resulting in a reduction in the health effects of air pollution range from regulatory measures (stricter air quality standards, limits for emissions from various sources), structural changes (such as reducing energy consumption, especially that based on combustion sources, changing modes of transport, land use planning) as well as behavioural changes by individuals by, for example, using cleaner modes of transport or household energy sources.

There are important potential co-benefits of integrating climate change and air pollution management strategies, as evidenced by the importance of the PM indicator and climate change contributor black carbon.

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