

Fugitive Dust from Coal Trains: Factors Effecting Emissions & Estimating PM_{2.5}

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NW-AIRQUEST 2013

Background

The main reason I looked into this topic was to address a public comment EPA received in relation to our federal register notice, which proposed approving WA Dept. of Ecology's 2008 baseline emissions inventory (EI) for Tacoma.

The comment came from the Sierra Club and suggested the Tacoma 2008 EI was deficient for not discussing or accounting for fugitive dust from coal trains in the EI.

I was asked to see what could be estimated about coal train fugitive dust impacts in Tacoma.

Background

Based on US Coal export data*, coal exports from the 'Seattle' export district (includes Tacoma up through the Canadian border) were as follows:

Year	Coal Exported (tons)
2008	30581
2009	365260
2010	3500204
2011	4854451
2012	4746960

So there was some level of coal transported in 2008 (and probably through Tacoma).

*<http://www.eia.gov/coal/>

Why is this an area of interest now generally?

- There is growing interest from Asian markets in U.S. export coal.
- Currently there are 7 proposed or existing coal export terminals along the west coast (4 U.S. & 3 Canadian).
- Coal transport could increase quickly.

Existing and proposed coal export capacity. (in millions of tons)

<u>BC Canada</u>	<u>2012</u>	<u>2017</u>	<u>2022</u>
Prince Rupert	0.0	1.5	5.0
N. Vancouver	0.0	2.0	5.0
Roberts Bank	5.0	8.0	15.0
	<u>Washington</u>		
Cherry Point	0.0	27.5	52.5
Grays Harbor	0.0	0.0	5.0
Longview	0.0	27.5	48.0
	<u>Oregon</u>		
St. Helens	0.0	5.0	21.0
Boardman	0.0	3.5	8.5
Coos Bay	0.0	0.0	10.0
<u>Totals</u>	5.0	70.0	139.0

(Source: Whiteside et al., 2012)



Coal Transport and Source Location

- The majority of export coal would come from the Powder River Basin (PRB) in MT/WY.
- Based on current pricing, BNSF would be the primary U.S. rail carrier from PRB to PNW.

Rail routes from PRB to proposed U.S. Pacific Northwest Coal Terminals



BNSF **UNION PACIFIC**

PORTLAND & WESTERN **COOS BAY RAIL LINK** **BNSF and UNION PACIFIC**

Coal Train Frequency Based on Projected Capacity

➤ The number of coal trains per day on rail routes would significantly increase if these terminals are built.

Proposed coal export capacity and number of projected loaded coal trains per day.

<u>BC Canada</u>	<u>2022 (10⁶ tons)</u>	<u>Loaded trains per day*</u>
Prince Rupert	5.0	0.9
N. Vancouver	5.0	0.9
Roberts Bank	15.0	2.8
<u>Washington</u>		
Cherry Point	52.5	9.8
Grays Harbor	5.0	0.9
Longview	48.0	8.9
<u>Oregon</u>		
St. Helens	21.0	3.9
Boardman	8.5	1.6
Coos Bay	10.0	1.9
Totals	139.0	25.8



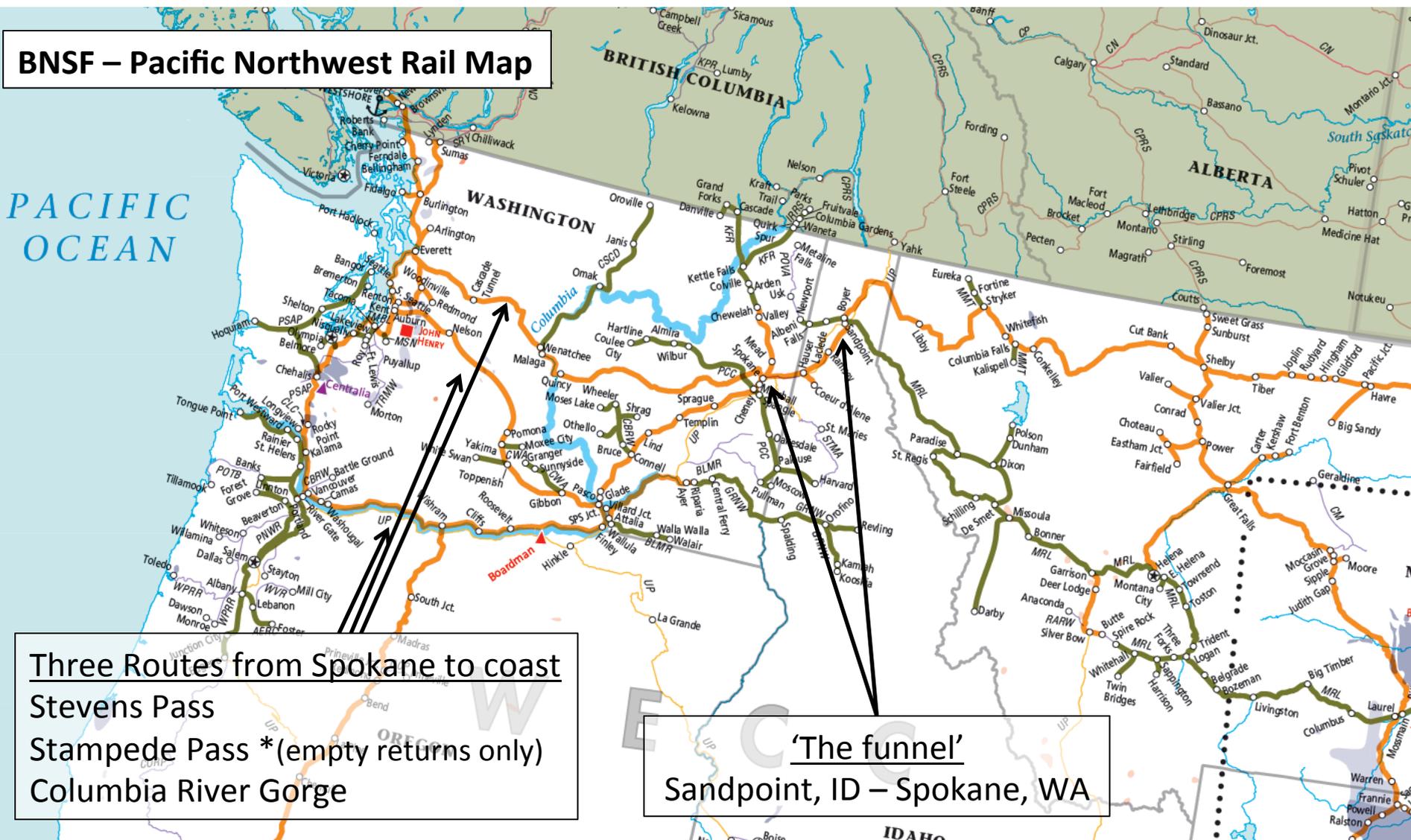
MARK FRIESEN/THE OREGONIAN

(*assumes 14,750 tons per train, 125 cars per trains; there will be an equal number of empty trains returning to the PRB)

Some Communities will be Impacted More than Others

- Some transit portions have multiple route options, some only one.
- **Every** BNSF coal train from the PRB to PNW would go through 'the funnel' (Sandpoint – Spokane)
- Three BNSF routes from Spokane to pacific terminals (all would be utilized).

BNSF – Pacific Northwest Rail Map



Three Routes from Spokane to coast
Stevens Pass
Stampede Pass *(empty returns only)
Columbia River Gorge

'The funnel'
Sandpoint, ID – Spokane, WA

Community Concerns

There are a range of community concerns related to increased coal train traffic, some of these are:

- Air quality impacts from fugitive coal dust & increased diesel emissions
- Ecological impacts of coal dust



➤ Derailments



- Longer rail crossing wait times
- Rail infrastructure improvement cost burden on local communities
- ‘Nuisance dusting’ of coal dust on cars/homes

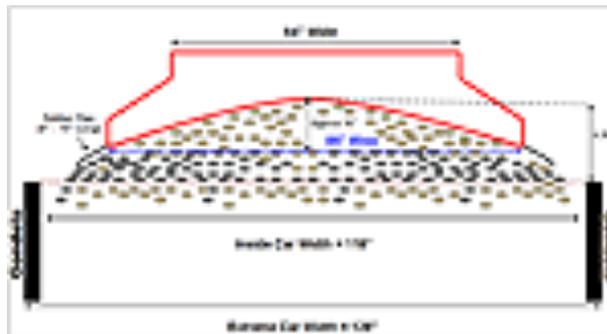


- Rail congestion adverse impacts on current rail customers (e.g., container ports, ag shipments)
- Long term climate impacts

Factors Effecting the Amount of Fugitive Coal Dust from Coal Trains.

Car and load geometry

rail car dimensions
coal load profile
total exposed surface area of coal



Coal physical properties

coal moisture content
coal size distribution

Trip specifics

train speeds throughout route
load jostling in route
total journey length
weather: wind, precipitation, temp



Dust controls

control measure effectiveness and
percent remaining at end of journey



Dust control measures

Rail lines have an economic incentive to reduce fugitive coal dust ... coal dust in track ballast increases the frequency and cost of track maintenance and can lead to derailments.

In 2010 BNSF and Union Pacific conducted a field evaluation of coal dust suppressant technologies.

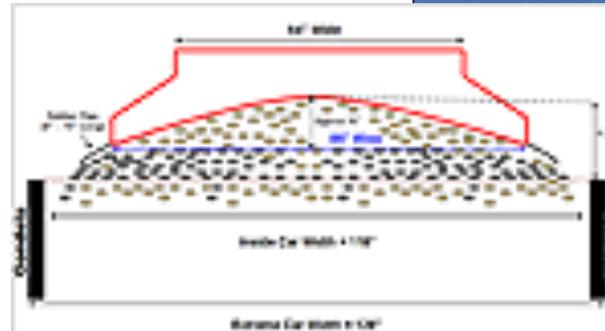
- Trackside and train-board aerosol monitors were used.
- 1633 coal trains treated with various dust suppressant technologies.

>85% dust suppression was achieved with:

Specific load profile guidelines

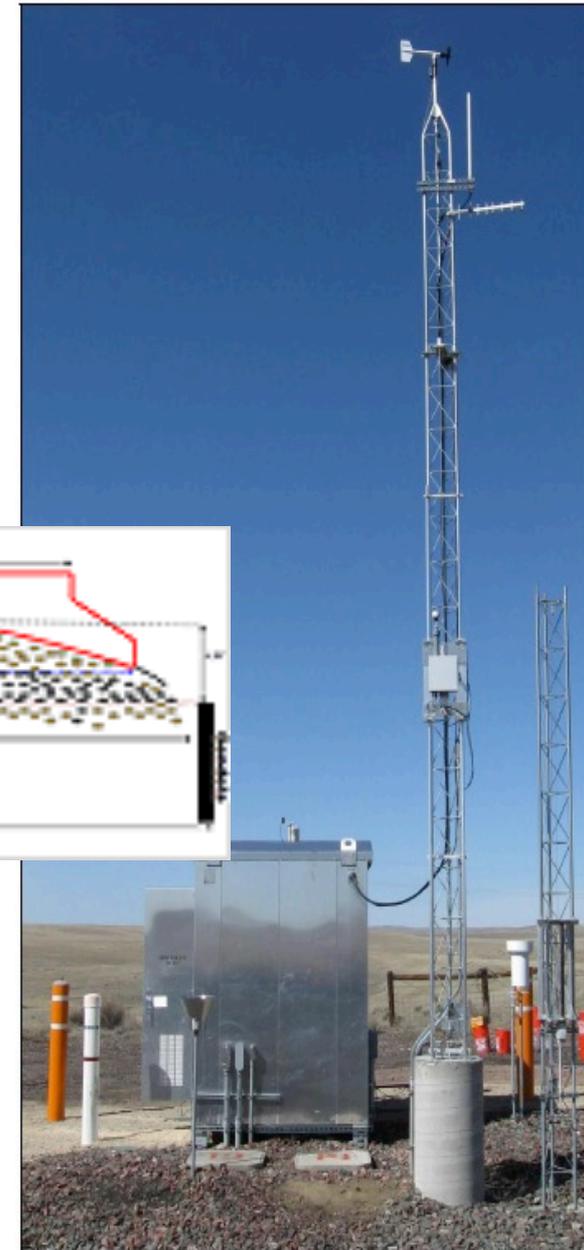
and

applying a topper agent to loaded coal



As of October 2011 BNSF's Coal Loading Rule requires coal shippers to use measures achieving > 85% dust suppression.

TrackSide Monitoring System



Estimating Fugitive Coal Dust Emissions from Coal Trains.

No clear information about how much coal is lost through fugitive dust in transit.

Various sources give a range of 0.5% to 3% of total coal transported is lost through fugitive dust when there are no dust control measures.

Wind tunnel experiments (1983) have estimated losses on the order of 0.9 to 1.8% for a 1100 km journey.



Canadian EI Example

Canadians EI's have been using a distance based equation based on a report titled "A Study of Fugitive Coal Dust Emissions in Canada" (Cope and Bhattacharyya, 2001).

The base equation is (for total suspended particulate, TSP):

$$\text{Emissions Factor (kg/tonne)} = 0.1 * (0.62 * D)^{0.6}$$

Where

D = total distance travelled by rail cars (km)

This equation gives 0.5% coal loss over a 1100 km transit, so on the low end of the 0.5 – 3.0% uncontrolled coal fugitive dust losses.

Their recommended equation for TSP estimates yearly emissions including terms for precipitation (P), emissions controls (CE), and estimating emissions for only a segment (SD) of the total rail trip.

$$\text{Emissions Factor (kg/tonne)} = 0.1 * (0.62 * D)^{0.6} * (365 - P) / 365 * (SD / D) * (100 - CE) / 100$$

Where

D = total distance travelled by rail cars (km)

SD = rail segment estimation emissions for (km)

P = number of days in the year with measureable precipitation (rain and snow)

CE = Control efficiency of any applied dust control measures (%).

Example: Applying Canadian Method to Tacoma

WRAP and AP-42 recommended a PM_{2.5} / TSP ratio of 0.15

(Cope and Bhattacharyya used 0.2, from US EPA AP-42 c. 2000)

PM_{2.5} Emissions Factor = 0.15 * TSP Emissions Factor (kg/tonne)

Example for Tacoma WA using Cope and Bhattacharyya (2001) formula.

(Emissions Factor (kg/tonne) = 0.1*(0.62*D)^{0.6} * (365-P)/365 * (SD/D) * (100-CE)/100)

Assumptions: SD = 40 km, D = 2414 km (1500 mi), PM_{2.5}/TSP EF = 0.15

all Seattle export district coal exported through Tacoma

all projected Cherry Point coal exported through Tacoma

Tacoma nonattainment area estimated coal train fugitive PM_{2.5} (tons per year)

Year	Control Efficiency (%)	# Precipitation days	Coal Exported (tons)	Tacoma NAA PM _{2.5} (TPY)
2008	0	161	30581	0.3
2009	0	146	365260	4.4
2010	0	190	3500204	33.5
2011	85 (3 months)	166	4854451	44.4
2012	85	177	4746960	7.3
2017*	85	168	27500000	44.5
2022*	85	168	52500000	84.9
*projected				

For comparison, the Ecology Tacoma 2008 SIP EI lists yearly emissions of PM_{2.5} of:

1199 TPY for Residential wood combustion & 411 TPY for onroad sources

Uncertainties with Canadian method: *Many*, but it does give us an estimation method.

Questions / unknowns / simplifications

- Some evidence for nonlinear dust loss over journey (more earlier on), but this equation assumes linear
- Majority of dust lost may be through 'dusting events'. Some sections of track may be more prone to dusting events based on topography, typical winds, typical train speed, etc.
- Effectiveness of controls may wear off throughout journey, leading to more dust later in the journey.
- Does not account for emissions from 'empty' return trains (coal residue can emit fugitive dust)
- Fugitive dust is directly related to train speed, train speeds make be slower through cities(?)
- How variable is the coal size distribution?
- How variable is coal moisture content?
- How important are seasonal effects (winter/summer – temperature / humidity / winds)
- Effects of precipitation are simplified.

However, for estimating annual emissions the importance of some of the above variability may be reduced.

Other activity around coal train fugitive dust?

For the Gateway Pacific Terminal at Cherry Point WA

An environmental impact statement (EIS) is being developed under guidelines from the National Environmental Policy Act (NEPA) and the State Environmental Policy Act (SEPA).

Air quality is one of many environmental impacts under review.

Uncertain if this will lead to measurements and/or improved fugitive dust estimates.

The agencies coordinating the EIS are

U.S. Army Corps of Engineers,

WA State Department of Ecology, and

Whatcom County

EIS Timeline:

9/2012 – 1/2013 Public input on scope of EIS

3/2013 EIS scoping summary report issued (summary of comments)

~2014 Issue draft EIS

~2014/2015 Issue final EIS

Other activity around coal train fugitive dust?

Dan Jaffe (UW Prof.) will conduct a short trackside study based on 'crowdsource' funding.

Duration: 4-6 weeks

Location: North of Seattle (?)

Time: Summer/Fall 2013

Currently proposing to measure

PM1,
PM2.5,
PM10,
TSP, and
Met. variables

The image shows a screenshot of a crowdfunding page on the microryza platform. The page features a background image of a coal train in an urban setting. The main text on the page asks, "Do coal and diesel trains make for unhealthy air?" and is attributed to Dan Jaffe. A progress bar indicates that \$20,204 has been pledged towards a \$18,000 goal, with 112% funded and 33 days left. The page includes navigation links for "HOW IT WORKS", "DISCOVER", "START A PROJECT", and "LOGIN / SIGN UP". At the bottom, there are three sections: "What are the goals of this project?", "Why is this research important?", and "How will the funds be used?".

microryza HOW IT WORKS DISCOVER START A PROJECT LOGIN / SIGN UP

Do coal and diesel trains make for unhealthy air?
DAN JAFFE

\$20,204 Pledged

\$18,000 GOAL	112% FUNDED	33 DAYS LEFT
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OVERVIEW LAB NOTES 3

What are the goals of this project? Why is this research important? How will the funds be used? Contact us!

Selected References:

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**Thank you for
your attention!**

