REVIEW OF AIR QUALITY AND GREENHOUSE GAS EMISSION IMPACTS OF THE PROPOSED CLEAN FUEL STANDARD FOR THE PUGET SOUND REGION

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TABLE OF CONTENTS

Trinity Consultants, Inc. (Trinity) has reviewed the *Puget Sound Regional Transportation Fuels Analysis* report,[1] prepared by ICF under contract to the Puget Sound Clean Air Agency (PSCAA), focusing on the greenhouse gas (GHG) emissions, air quality, and public health impacts. The report's main findings regarding the benefits of the proposed Clean Fuel Standard (CFS) for the Puget Sound region are summarized below:

- The Puget Sound region can achieve a maximum carbon intensity (CI) reduction of 26% in the regional transportation fuel pool by 2030 relative to the 2020 baseline (Scenario D).
- Regional PM2.5 emissions will decrease as a "co-benefit" of CFS implementation.
- Reductions in PM2.5 concentrations due to the CFS will reduce air pollution-related mortality rates by 2.4 to 5.3 deaths per year resulting in cost savings of $20.3 to $45.7 million in calendar year 2030 (Scenario D).

This report presents the results of Trinity's review of ICF's analysis. Trinity believes that the impact of the CFS on both GHG and criteria pollutant emissions need to be accurately quantified, to the extent possible, with all the uncertainties discussed at least qualitatively, in order to put the potential benefits and disadvantages of CFS implementation into perspective. Unfortunately, the ICF report fails to explicitly and accurately quantify neither GHG emissions nor criteria pollutant impacts from the CFS in the Puget Sound region. In addition, the CFS analysis fails to account for several important factors, which are discussed in detail below:

- The bulk of the claimed PM2.5 emission reductions in 2030 will be realized from vehicle turnover as lower emitting new vehicles replace higher emitting older vehicles. Failure to explicitly discuss this finding obscures the fact that changes in PM2.5 emissions due to the CFS program will be negligible.
- The analysis assumes unrealistic electric vehicle penetration rates that are higher than even those forecast by the California Air Resources Board for California.
- The fact that NOx emissions are known to increase with biodiesel use was not considered nor analyzed by ICF. This is important because increases in NOx emissions will result in more indirect PM2.5 formation and increased ambient concentrations of PM2.5.
- The analysis assumes that all vehicles operating in the Puget Sound region will operate on lower-CI fuels, an assumption which fails to account for "fuel leakage" which could be a major factor if transportation fuel prices are substantially higher in the region due to the CFS compared to surrounding areas. The potential impact of fuel leakage is particularly high for the goods movement sector given the long ranges of heavy-duty diesel vehicles.
- The analysis did not quantify changes in upstream emissions associated with low-CI transportation fuel production.

[1] *https://www.pscleanair.org/DocumentCenter/View/3809/Clean-Fuel-Standard-Technical-Analysis---Final-Report?bidId=*

- The impacts of "fuel shuffling", or the transport of low-CI fuels to the Puget Sound region due to the CFS that would otherwise be used near where they are produced, were not considered in the Puget Sound transportation fuels analysis.

- The analysis failed to separate the impacts of the CFS from other biofuel programs such as the Renewable Fuel Standard (RFS) and incorrectly assumes that all low-CI fuel use was attributable to the proposed CFS.

The Puget Sound Fuels Analysis focused "solely on the air quality and public health impacts of changes in tailpipe (downstream) PM2.5 emissions resulting from each scenario." In order to estimate public health benefits, PM2.5 concentration changes were modeled for King County in 2011 and 2030, for the Baseline Scenario and Scenarios A-D. ICF states that "concentrations of directly-emitted pollutants scale linearly with emissions"; thus, a scaling factor approach was implemented. The analysis utilized EPA's MOVES2014 model supplemented with PSCAA-provided inputs for King County to come up with scaling factors that reflect changes in tailpipe PM2.5 emissions. Modeling only King County was justified by stating that the county represents about half of the population in Puget Sound and that it is "sufficiently representative of the entire region." The MOVES scaling factors were then applied to four-county PM2.5 concentration maps to quantify concentration changes, which were then used as inputs to EPA's Benefits Mapping and Analysis Program (BenMAP) model. The health exposure modeling was focused changes in mortality rates and the associated cost savings resulting from lower mortality.

2.1. VEHICLE TURNOVER

Following a public records act (PRA) request, Trinity obtained and reviewed MOVES2014 inputs used in the Puget Sound Fuels Analysis and then employed the same emissions model with all the input tables provided to attempt to reproduce ICF's results. While we were able to reproduce 2011 Baseline and 2030 Scenario D emission estimates for PM2.5, the inputs provided generated different emission results for the 2030 Business-As-Usual (BAU) case. Table 1 shows the scaling factors as reported by ICF and as modeled by Trinity. Instead of a 7% reduction in PM2.5 emissions for Scenario D from BAU conditions in 2030, Trinity calculated that this reduction is closer to 3% (Table 2).

Table 1. Comparison of PM2.5 Emissions Scaling Factors

Scenario	ICF PM2.5 Emissions (metric tons)	ICF Scaling Factor	Trinity PM2.5 Emissions (metric tons)	Trinity Scaling Factor
Baseline 2011	*1442*	*1.000*	*1442*	*1.000*
BAU 2030	463	0.321	444	0.308
Scenario D 2030	430	0.298	430	0.298

Table 2. Comparison of 2030 PM2.5 Emission Changes due to CFS

Modeling	BAU	Scenario D	Percent Change
ICF Report	463	430	-7%
Trinity	444	430	-3%

As shown in Table 1, 2030 PM2.5 emissions decrease from the 2011 Baseline by approximately 68% just from normal vehicle turnover. Only an additional 2% comes from CFS implementation according to ICF MOVES input files. This decrease is reduced to 1% if appropriate corrections to BAU Scenario modeling are made. The PM2.5 reduction anticipated solely from normal fleet turnover is 30 times greater than the PM2.5 reduction anticipated between the BAU Scenario and Scenario D, as modeled by ICF, and nearly 70 times greater when modeled accurately. The ICF analysis even acknowledges that "PM2.5 levels declined significantly from 2011-2030 BAU, mainly as a result of federal vehicle standards." The Puget Sound Fuels Analysis report does not explain other methods that may have been used to estimate additional PM2.5

reductions or additional post-processing for the BAU scenario. Removing additional older vehicles from the fleet would likely be far more cost-effective means of reducing PM2.5 emissions than the CFS program.

2.2. ELECTRIC VEHICLES

In order to model CFS emission benefits, ICF made changes to Alternative Vehicle and Fuels Technology (AVFT), VMT, and population input tables in MOVES2014. The user-specified AVFT inputs increase the number of full electric and plug-in hybrid vehicles while decreasing the number of conventional gasoline vehicles, as shown in Table 3 for passenger cars.

Table 3. MOVES Default and ICF Modeled Vehicle Technology Fractions for Passenger Cars

Passenger Cars	2011 Default	2030 Default	2030 Baseline	2030 Scenario D
Conventional (gas)	91%	93%	72%	55%
Moderate Hybrid (gas)	0%	0%	8%	6%
Full Hybrid (gas)	0%	0%	2%	5%
Diesel	1%	1%	3%	2%
E85	7%	5%	3%	2%
Electric	0%	0%	13%	29%

As shown, ICF modeled sales of MY 2030 full-electric vehicles as 29% of all passenger cars in 2030, compared to 0% for 2030 Default and 13% for the 2030 BAU Scenario. In contrast, the Puget Sound Fuels Analysis report stated that electric vehicles would represent 28% of new vehicle sales by 2025 and 42% by 2030 for Scenario D. Further inconsistencies in the assumptions for electric vehicles were noted upon reviewing the GHG emissions analysis spreadsheet provided by PSCAA as part of the PRA request.[2] The GHG calculations employed by ICF assumed even more aggressive electric vehicle penetration in MY 2030: 28% for full EVs, 14% for PHEVs, and 7% for fuel-cell vehicles; conventional gasoline vehicles represented only 43% of passenger cars in MY 2030.

The zero-emission vehicle (ZEV) penetration rate assumed for Scenario D is unreasonable. Vehicle market studies in California and other states that have chosen to follow California's ZEV Action Plan have found that ZEV sales would need to reach approximately 10% by 2025.[3] Yet, Washington has not yet adopted a ZEV Mandate and ZEV sales in the state are currently much lower levels than in California. According to the Auto Alliance,[4] ZEVs represented only 4.5% of total new vehicle sales in the 12 months between July 2018 and June 2019, as compared to 8.6% in California during the same period. This is far from the 28% that ICF found plausible in the PSCAA region in the next five years and by 2025.

Analysis of Governor Brown's Executive Order calling for five million ZEVs in California by 2030 suggested that ZEV sales would have to equal 40% of all new vehicle purchases by 2030.[5] This California target—which has been deemed as aggressive by most and as unrealistic by many—is lower than the 42% ZEV sales assumed for the Puget Sound CFS Scenario D in the same year. Further, the State of Washington and

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[2] EXCEL file: *Copy of PSCAA_CFP_Final_v2(fromICF)_ALLSHEETSVIS.xlsm*

[3] *https://autoalliance.org/energy-environment/state-electric-vehicle-mandate/*

[4] *https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/*

[5] *http://business.ca.gov/Portals/0/ZEV/2018-ZEV-Action-Plan-Priorities-Update.pdf*

the Puget Sound region are not likely to provide the level of incentives required to subsidize ZEV purchases and infrastructure (e.g. similar to those in California) to generate such high ZEV penetration rates.

2.3. OTHER MODELING CONCERNS

Provided below is a short list of additional issues Trinity discovered upon our review of ICF's MOVES modeling, which was the basis for the air quality and health benefits assessment for PSCAA's CFS.

- The MOVES model is not able to estimate emissions from heavy-duty natural gas vehicles nor medium-duty electric vehicles. It is unclear from the report how or whether ICF accounted for these vehicle technology changes when estimating their impact on PM2.5 emissions for 2030.

- The MOVES model does not account for emission changes due to biofuel use (e.g., E15 and B20), and the ICF report does not provide a narrative as to how these were quantified, if at all.

- Trinity disagrees with the assumption that King County is representative of the entire Puget Sound region. King County is largely urban with specific emission modeling characteristics that would not be representative of more rural counties. In our technical experience, variables such as roadway distribution, vehicle speed, vehicle class distribution, VMT per vehicle, and vehicle age vary for counties that have lower income levels and are more dispersed with respect to jobs and housing. All these variables would impact the emissions profile for criteria pollutants, including PM2.5 emissions, which were then used to develop the scaling factors for health-based modeling in the entire Puget Sound region.

3.1. NOx EMISSIONS

Only tailpipe PM2.5 emissions were considered in the Puget Sound Fuels Analysis. While Trinity understands that ICF did not attempt to model actual criteria pollutant impacts, NOx emissions are particularly significant when mandating fuel switching to biofuels. According to the research[6] performed by the California Air Resources Board (CARB) in support of the 2018 Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) regulatory amendments, NOx emissions increase between 1.5% and 4% for B20 blends, depending on biodiesel saturation level. Given that B20 was the assumed blend level for the Puget Sound region by 2030, it is important to account for this increase when modeling Scenario D impacts. Using MOVES outputs, Trinity calculated that NOx emission benefits from diesel-fuel vehicles between BAU and Scenario D in 2030 could be reduced from 96 tpy to 25 tpy, assuming high saturation biodiesel. However, if low saturation biodiesel is used, NOx emissions could increase under Scenario D conditions by 93 tpy (Table 4). We note that long-term low saturation biodiesel presence in the state is likely given the competing low carbon fuel programs in Canada, California, and Oregon.

Table 4. NOx Emission Increase[a] Due to Biodiesel (tpy)

Blend	BAU	Scenario D	Emissions Impact (BAU-Scen D)
MOVES Baseline	*4,821*	*4,725*	*-96*
B20 High Saturation	4,821	4,796	-25
B20 Low Saturation	4,821	4,914	+93

a. Calculations use NOx emissions output from MOVES for diesel vehicles only.

The CFS analysis also failed to account for NOx emission reductions that may result from the use of renewable diesel in R20 blends. While it is not clear whether PSCAA would be able to achieve R20 average blend levels as assumed by ICF, it would be prudent to analyze the NOx emission impacts of both biodiesel and renewable diesel in the fuels analysis for the PSCAA region. Table 5 shows potential NOx emissions outcomes for various blends and saturation levels.

Table 5. NOx Emissions Decrease[a] Due to Renewable Diesel (tpy)

Blend	BAU	Scenario D	Emissions Impact (BAU-Scen D)
MOVES Baseline	*4,821*	*4,725*	*-96*
R20 (no BD)	4,821	4,588	-233
R20 B20 High Saturation	4,821	4,659	-162
R20 B20 Low Saturation	4,821	4,777	-44

a. Calculations use NOx emission output from MOVES for diesel vehicles only.

Excluding a discussion on NOx emission impacts due to increased biofuel use speaks to additional inaccuracies when modeling PM2.5 emissions that are later used for health exposure modeling. In addition, the Puget Sound Fuels Analysis does not account for the formation of PM2.5 as a secondary pollutant from NOx or other constituents. NOx is a well-known precursor to indirect PM2.5 formation and is typically included in State Implementation Plans (SIPs) that are developed to meet the annual and 24-hour PM2.5 NAAQS. Trinity has

[6] *https://ww3.arb.ca.gov/regact/2018/lcfs18/appg.pdf?_ga=2.15556534.12723633.1573939466-2076536111.1571945704*

reviewed a number of SIPs that account for NOx to PM2.5 formation through the use of a trading mechanism in regional conformity demonstrations. The San Joaquin Valley and South Coast nonattainment areas in California currently utilize a ratio of 6.5:1 and 10:1 for NOx to PM2.5 conversion, respectively.[7] While EPA's initial guidance[8] states that secondary PM2.5 formation is specific to regional photochemistry, it suggests a 100:1 ratio as a default assumption for the Western United States. Using NOx emissions modeled with MOVES in a manner similar to PM2.5 and a 100:1 EPA-recommended ratio, Trinity calculated additional PM2.5 emissions of 81 tpy for the Baseline Scenario and 79 tpy for Scenario D in 2030. While this estimate is not likely to be accurate without understanding the actual photochemistry in Puget Sound, it demonstrates the importance of including NOx emissions when using PM2.5 emission concentrations in health-based modeling.

3.2. FUEL SHUFFLING

Fuel shuffling is a phenomenon that results in emission increases due to transport of low-CI fuels to markets with low carbon fuel mandates and high-CI fuels to markets without such programs in place. The same concept applies to biofuel feedstock transport. While fuel shuffling is typically discussed in the context of global GHG emissions, it is important to consider its global impacts on criteria pollutants as well. The Puget Sound shuffling impact is further complicated due to competing low carbon fuel programs in place in California and Oregon that have stronger price signals to attract low-CI fuels.

The potential increase in criteria pollutants due to shuffling is not discussed in the CFS report and is hard to quantify. Regional and global NOx and PM2.5 emissions could increase from trucking and railing low-CI ethanol, biodiesel, and renewable diesel from the Midwest, Oregon, and Canada to Washington. Higher-CI fuels that are produced on the West Coast would, in turn, be transported to other states without a clean fuels program. A good example of fuel shuffling today is the REG Grays Harbor facility that primarily processes virgin vegetable oils as a feedstock and is currently targeting the California market for its biodiesel sales. Even with the PSCAA CFS in place, it is unlikely that REG would divert its biodiesel volumes from California to Puget Sound without a significant financial incentive in a form of high CFS credit prices. In addition, in order to meet the demand for low-CI biodiesel in line with Scenario D assumptions, the facility would have to switch to used cooking oil or tallow as its feedstock, shipping it from Canada or other countries, which would further add to criteria pollutant impacts even on a regional scale.

Another example is the expected reliance on low-CI sugarcane ethanol from Brazil in order to achieve the desired average ethanol CI in the region. Ocean-going vessel emissions associated with ethanol transport would dwarf any local criteria pollutant benefits claimed by PSCAA due to CFS. In contrast, should higher-CI corn ethanol be railed from the Midwest, NOx and PM2.5 emissions would be significantly lower due to differences in transport mode and transportation distance. Table 6 compares NOx and PM2.5 emissions resulting from transporting sugarcane ethanol from Brazil to Washington by ocean vessel and corn ethanol transported from Minnesota to Washington by rail. To inform this comparison, Trinity utilized emission factors for ethanol transport from the CA-GREET3.0 model and applied these to transportation distances for import/export locations chosen for this scenario. As shown, criteria pollutant emissions per barrel of ethanol delivered to Washington are approximately 93% higher for lower-CI sugarcane ethanol when compared to corn ethanol, largely due to the longer distances ocean vessels would travel.

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7 *https://www.govinfo.gov/content/pkg/FR-2011-11-09/pdf/2011-27620.pdf#page=2 and https://ww3.arb.ca.gov/planning/sip/sjvpm25/2018plan/20180828_transportation_conformity.pdf*

8 *https://www.federalregister.gov/documents/2008/05/16/E8-10768/implementation-of-the-new-source-review-nsr-program-for-particulate-matter-less-than-25-micrometers; http://www.4cleanair.org/sites/default/files/01072011-NACAAPM2.5ModelingWorkgroupReport-FINAL_3.pdf.*

Table 6. Ethanol Fuel Shuffling Scenario – NOx and PM2.5 Emissions

Mode	Route	Distance	NOx Emissions (g/bbl.)	PM2.5 Emissions (g/bbl)
Corn Ethanol by Rail	Mankato, MN to Seattle, WA	1,635	63	2
Sugarcane Ethanol by Vessel	Santos, Brazil to Seattle, WA	11,493	898	71

An increase in petroleum fuel exports from Washington refineries due to CFS implementation would constitute another example of fuel shuffling. While Trinity agrees that the CFS could reduce the overall regional demand for petroleum fuels by 2030, it is unlikely that Washington State refineries would reduce their production volumes. Consistent with CARB assumptions for the LCFS environmental analysis, regional refineries are more likely to continue to operate at capacity to maximize their economics. Instead, higher volumes of diesel and gasoline will be exported to Canada and Latin America, as well as potential new markets, resulting in increases in criteria pollutant emissions in the region. Utilizing the same approach as for the ethanol shuffling scenario, Trinity calculated the potential increase in NOx and PM2.5 emissions due to additional diesel exports from Washington to Mexico, as an example (see Table 7). It is important to note that air quality impacts due to additional biofuel transportation and distribution in California were included in the original environmental analysis for the 2009 LCFS regulation by CARB.[9]

Table 7. Diesel Export Fuel Shuffling Scenario – NOx and PM2.5 Emissions

Mode	Route	Distance	NOx Emissions (g/bbl)	PM2.5 Emissions (g/bbl)
Diesel by Vessel	Seattle, WI to Manzanilla, Mexico	3,186	78	6

For each additional barrel of diesel exported, global NOx and PM2.5 emissions would increase by 78 grams and 6 grams, respectively, specific to the scenario analyzed. If Washington exports to Mexico increase by just 10%, or 150 bpd,[10] the overall impact would equal 4.3 tpy for NOx and 0.33 tpy for PM2.5. Even longer export routes may be undertaken with proper economic incentives resulting on global emissions increases.

Given that air quality impacts are typically discussed in a regional setting, the NOx and PM2.5 emission increases are expected to be significantly less for the Puget Sound region itself, but proportionally related to the transport distances within the counties' under PSCAA jurisdiction and directionally producing the same negative impact on air quality.

3.3. UPSTREAM EMISSIONS

As mentioned earlier, the Puget Sound Fuels Analysis focuses solely on changes to tailpipe (downstream) PM2.5 emissions. The report notes that no "upstream" emissions were included, because assuming new biofuel facilities in the area due to the CFS was "speculative." However, in order to realize the low-CI fuel volumes called for by the proposed program and due to existing competing California and Oregon fuel markets, it would be

[9] *https://ww3.arb.ca.gov/regact/2009/lcfs09/lcfsisor1.pdf*
[10] ICF, Puget Sound Regional Transportation Fuels Analysis, Table 3; outbound foreign export volumes.

logical to assume that new biofuel facilities would come online or existing biofuel facilities would expand production in the region or elsewhere. This assumption would be consistent with CARB's original environmental impact analysis for the 2009 LCFS regulation, which assumed construction of 18 new cellulosic ethanol and 6 biodiesel/renewable diesel facilities in California as a result of LCFS implementation.[11] Table 8 summarizes CARB-reported NOx and PM2.5 emission increases for the new biofuel production facilities expected to come online by 2020. While the emissions impacts would obviously be different for the Puget Sound region, simply ignoring these in the CFS analysis is misleading.

Table 8. NOx and PM2.5 Emissions for New Biofuel Facilities in California, 2020

Mode	NOx Emissions (tpd)	PM2.5 Emissions (tpd)
Cellulosic Ethanol	4.76	0.65
Biodiesel	0.95	0.25

[11] 2009 LCFS ISOR. *https://ww3.arb.ca.gov/regact/2009/lcfs09/lcfsisor1.pdf.* And Appendix F5.

Another issue with the Puget Sound Fuels Analysis is that it fails to frame GHG emission impacts attributable to the proposed CFS program in the context of other existing regulatory requirements and incentives. For instance, the report fails to mention the federal Renewable Fuel Standard that mandates biofuel production in the U.S. with higher incentives granted for lower-CI fuels in the form of RIN types. As an example, CARB has considered such impacts in its environmental analysis of most recent LCFS amendments and specifically distinguished between impacts of federal and state programs in reducing GHG emissions by fuel type (Table 9).

Table 9. CARB's Attribution of GHG Reductions due to LCFS and Other Programs in California

Fuel or Project Type	Action	Primary Attribution
Electricity	Switch to EVs that are charged with electricity at the grid average CI	Light-duty / heavy-duty / off-road ZEV regulations and other vehicle incentive / rebate programs
	Use of renewables to reduce the CI for charging below the grid average	LCFS
Hydrogen	Switch to FCEVs using hydrogen produced with 33 percent renewable content	Light-duty / heavy-duty / off-road ZEV regulations and other vehicle incentive / rebate programs. SB 1505 requiring 33 percent renewables
	Use of greater than 33 percent renewables to reduce the CI of hydrogen used in FCEVs	LCFS
Natural Gas	Switch to NG vehicles operating with fossil NG	Vehicle incentive / rebate programs and low NG prices relative to diesel
	Switch from fossil NG to landfill RNG	RFS – cellulosic RIN value
	Switch from landfill to dairy digester RNG	LCFS
Propane	Switch from fossil propane to renewable propane	LCFS
Starch Ethanol	Use of starch ethanol with an average CI of 80 g/MJ	RFS – 20 percent CI reduction to qualify as renewable fuel
	Reduction in CI of ethanol below 80 g/MJ	LCFS
Sugar Ethanol	Use of sugar ethanol with an average CI of 50 g/MJ	RFS – 50 percent CI reduction to qualify as advanced biofuel
	Reduction in CI of sugar ethanol below 50 g/MJ	LCFS
Cellulosic Ethanol	Use of cellulosic ethanol with an average CI of 40 g/MJ	RFS – 60 percent CI reduction to qualify as cellulosic biofuel
	Reduction in CI of cellulosic ethanol below 40 g/MJ	LCFS

4.1. CI REDUCTION GOALS

The GHG reduction goals for all four scenarios analyzed appear to be too aggressive when compared to other low carbon programs. For example, Scenario A or the scenario with the most "modest changes to the transportation fuel supply" evaluates a decrease in the region's CI by 10% over 10 years primarily through biofuel blending. In comparison, California's LCFS aimed to achieve only a 6.25% reduction in CI over an eight-year period (2011 to 2019), while Oregon's Clean Fuel Standard (CFS) mandates a 1.5% CI reduction over a three-year period (2016 to 2019). The stringency of the CI standards has a direct impact on credit and fuel prices; achieving a very aggressive reduction in a short period of time would significantly impact the Puget Sound and adjacent transportation fuel markets.

4.2. FUEL SHUFFLING

Similar to criteria pollutant impacts due to fuel shuffling discussed in Section 3, global GHG emissions tend to increase as low-CI fuels are delivered to markets with a low carbon fuel program in place, instead of being sold locally. Listed below are scenarios that would increase GHG emissions on a global scale due to Puget Sound CFS.

1. Transporting tallow feedstock from Asia into Washington to produce low-CI biodiesel for Puget Sound. Send local virgin vegetable oil to the Midwest or Canada for higher-CI fuel production.
2. Transport higher-CI biodiesel from Washington to Canada provinces that have only a blend limit requirement in place. In place, transporting low-CI biodiesel from the Midwest to Washington via rail.
3. Transporting low-CI renewable diesel from Cherry Point co-processing plant to California due to better incentives. In place, transporting low-CI renewable diesel from Singapore to Washington via vessel.
4. Transporting ethanol from Brazil and higher-CI ethanol to Brazil to satisfy existing blend mandates.
5. Exporting diesel and gasoline to Canada and Latin America due to excess in Washington refinery products.

To gauge the magnitude of potential impacts, Trinity analyzed the last two scenarios using CA-GREET3.0 emission factors for ethanol and diesel transport, as documented in Section 3. Table 10 shows that GHG emissions associated with ethanol transport would increase nearly seven-fold when Midwest corn ethanol is replaced by low-CI ethanol from Brazil.

Table 10. Ethanol Fuel Shuffling Scenario – GHG Emissions

Mode	Route	Distance	CO2eq Emissions (g/bbl)
Corn Ethanol by Rail	Mankato, MN to Seattle, WA	1,635	6,122
Sugarcane Ethanol by Vessel	Santos, Brazil to Seattle, WA	11,493	42,661

Trinity also calculated that global GHG emissions due to additional exports from Washington to Mexico could increase by 204 metric tons per year as a result of CFS implementation (Table 11).

Table 11. Diesel Export Fuel Shuffling Scenario – GHG Emissions

Mode	Route	Distance	CO2eq Emissions (g/bbl)	CO2eq Emissions (tpy)
Diesel by Vessel	Seattle, WI to Manzanilla, Mexico	3,186	3,720	204

4.3. FUEL LEAKAGE

Another issue not discussed in the Puget Sound Regional Fuels Analysis is fuel leakage. It is important to note that Puget Sound residents, particularly those living close to the four-county region borders, will have a choice of where to fuel their vehicles. Higher fuel pricing, which is inevitable in Puget Sound should PSCAA adopt the CI reduction targets, may push some consumers to fuel outside of the region if its economical to do so. In California, fuel retail stations located near state borders experienced a quantifiable drop in fuel sales with the passage of the California "gas tax" (SB1), for instance.[12] The ambitious CI reductions called for by the PSCAA proposed CFS are expected to increase fuel prices faster than experienced in California and Oregon. The sudden spike in regional fuel prices would resemble the California gas tax more than a regulatory program and would push consumers living within a reasonable distance of non-Puget Sound counties to drive the "extra mile" in order to save money on fuel costs. With a price differential of 0.71 cpg for gasoline and 0.79 cpg for diesel by 2030,[13] this assumption is common-sense.

Trinity expects that some of the claimed GHG emission reductions in Puget Sound due to the CFS would be offset by emissions from additional travel for refueling purposes and the use of non-CFS fuels and lower fuel blends. Furthermore, the overall fuel sales will drop within the region, resulting in economic impacts that are outside the scope of our analysis.

Fuel leakage would be even more pronounced for the heavy-duty and goods movement sectors. Tractor-trailers delivering goods are equipped with fuel tanks that can hold up to 300 gallons of diesel fuel and would be able to make deliveries in and out of the region without refueling. Given that the heavy-duty sector constitutes nearly 40% of fuel demand in the region (according to Trinity's MOVES2014 modeling), the full life-cycle GHG emission reductions may not be realized in Puget Sound if the heavy-duty sector does not experience fuel switching to biofuels and alternative fuel technologies prescribed by CFS. It is also important to note that tailpipe GHG emissions represent approximately 75% of total CI value for petroleum fuels; therefore, actual fuel use in the region is a critical factor in the program's success in reducing GHG emissions.

[12] California Energy Commission, Retail Fuel Outlet Annual Report. *https://ww2.energy.ca.gov/piira/a15/*

[13] See Stillwater Associates' comments on the Puget Sound Fuels Analysis report.

5. HEALTH IMPACTS

Given all the uncertainties and inaccuracies associated with PM2.5 emissions modeling and scaling factor methodology implemented for the Puget Sound Fuels Analysis, Trinity believes that the health impacts are not properly analyzed. One of the major concerns is that Trinity was not able to reproduce the 2030 BAU Scenario scaling factor, which was used as the basis for quantifying health impacts due to Scenario D implementation. Given our MOVES modeling results shown in Table 1 of this report, PM2.5 emissions would be reduced by only 2% as calculated for Scenario D, compared to 7% as calculated in the Puget Sound analysis. Taking this difference into consideration, the mortality rates reported by ICF (with high uncertainty) could be further reduced by about 60% to account for this difference. The 2.4 to 5.3 avoided mortality incidences reported for Scenario D would be reduced to only 1.4 to 3.2 incidences. The same would apply for the associated costs that were developed by ICF using the EPA's value for a statistical life of $8.7 million, in $2015 USD. The maximum avoided cost due to CFS health benefits of $45.7 million should be reduced to $27.4 million, assuming a linear relationship between PM2.5 concentrations, heath, and cost impacts, a very crude assumption.

This is further emphasized in the ICF report:

> *…according to Centers for Disease Control (CDC) mortality rates, there were 4,182 all-cause mortality cases for adults ages 25-99 in the four-county Puget Sound region in 2017 (CDC, 2019). The avoided mortality cases under Scenario D make up about 0.13% of all deaths in the region in 2017. Similarly, there were 513 mortality cases for adults ages 25-99 attributed to diseases of the circulatory system in the four-county Puget Sound region in 2017 (CDC, 2019). The avoided mortality cases under scenario D make up about 1% of these deaths.*