RSU 25 FIRST STUDENT (HANCOCK, LAMOINE) ORRINGTON 9/27/18 dcg LC

CLASS 7 (10) | (8) 2009 (3) 2008

Section 7: Application Scoring Matrix

CLASS 6 (1)

Score Assigned	Attachment	Attachment Description
10	A	**Mitigation Action Description:** Related to Maine's Beneficiary Mitigation Plan
10 avg = 79%	B	**NOx Emission Reduction:** NOx emission reductions estimate using EPA's Diesel Emission Quantifier
10	C	**Health Benefits:** Maximized health benefits include: reductions in particulate matter and/or greenhouse gases; net reduction of diesel fuel use; or idle reduction strategies.
10	D	**Action Location:** Within an area with a disproportionate quantity of air pollution from diesel fleets, such as ports, rail yards, terminals, school depots/yards, and freight distribution areas.
10	E	**Class 1 Areas:** Benefits a designated federal Class 1 Area, specifically Acadia National Park, Roosevelt Campobello International Park, or the Moosehorn Wilderness Area located within the Moosehorn National Wildlife Refuge Area.
10 35% $907,000 – 317,450 = $589,550 REQ	F	**Verified Funding:** Match or leveraged funding for cost sharing secured. Budget provided.
10	G	**Action Schedule:** Action implemented within two years of the award date. Schedule provided.
10	H	**Benefit Period:** Sustained emission benefits over the ten-year Trust Effective Period. Maintenance plan provided.
10	I	**Relevant Experience and Compliance Certification:** Existing administration and programmatic structure in place to implement diesel emission reduction or offset actions.

Gates, Judy

From: Dean, Joseph <Joseph.Dean@ryan.com>
Sent: Tuesday, September 18, 2018 12:24 PM
To: Gates, Judy
Cc: Sabelhaus, Patrick; Beechem, Brian; Trenkamp, Bo; Newbold, Allea; Falleroni, Michael; Madden, Jerry; Finocchi, Alyssa; Harvey, Ryan
Subject: RE: VW Mitigation Trust Application submittal

Hi Judy,

We hadn't seen any confirmation showing your receipt of our VW Mitigation Trust application, so I just wanted to follow up to see if you can reply with a quick email, verifying that you've received both the hard copy and emailed application materials sent last week for First Student?

Thanks!

Joe

Joseph Dean
Manager, Credits and Incentives Consulting
Credits and Incentives
Ryan
213.627.1719 Ext. 19-5258
818.679.3326 Mobile

From: Dean, Joseph
Sent: Friday, September 14, 2018 8:10 AM
To: 'judy.gates@maine.gov' <judy.gates@maine.gov>
Cc: Sabelhaus, Patrick <Patrick.Sabelhaus@firstgroup.com>; Beechem, Brian <brian.beechem@firstgroup.com>; Trenkamp, Bo <Bo.Trenkamp@firstgroup.com>; Newbold, Allea <Allea.Newbold@ryan.com>; Falleroni, Michael <Michael.Falleroni@ryan.com>; Madden, Jerry <Jerry.Madden@ryan.com>; Finocchi, Alyssa <Alyssa.Finocchi@ryan.com>; Harvey, Ryan <Ryan.Harvey@ryan.com>
Subject: RE: VW Mitigation Trust Application submittal

Hi Judy,

Per your email instructions, please find attached the **Maine Volkswagen Environmental Mitigation Action Round 1 Application (for Appendix D-2 Eligible Actions)**, submitted on behalf of First Student, Inc. A hard copy of this application has also been sent to your attention via Fed Ex, which per the tracking information, looks to have already arrived.

At your earliest convenience, please confirm receipt of both submittals, and feel free to reach out for clarification regarding any of the information contained within.

Thanks and best regards!

Joe

Joseph Dean
Manager, Credits and Incentives Consulting

Credits and Incentives
Ryan
213.627.1719 Ext. 19-5258
818.679.3326 Mobile

From: Dean, Joseph
Sent: Thursday, September 13, 2018 11:26 AM
To: judy.gates@maine.gov
Cc: Falleroni, Michael <Michael.Falleroni@ryan.com>
Subject: VW Mitigation Trust Application submittal

Hi Judy,

For the VW MitigationTrust grants, the application instructions state: *"Submit an electronic version of your application via web at www.maine.gov/mdot/vw."*

However, when I go to this page, I'm not seeing an upload link or any way to submit the application...should we email directly to you? Perhaps I'm missing something...please advise.

Thanks in advance!

Joe

Joseph Dean
Manager, Credits and Incentives Consulting
Credits and Incentives
Ryan
213.627.1719 Ext. 19-5258
818.679.3326 Mobile

	Percent Reduced (NOx, %)	Lifetime Baseline of Vehicles Retrofitted (NOx, short tons)	Lifetime Amount Reduced (NOx, short tons)	Lifetime Amount Emitted After Retrofit, Retrofitted Vehicles (NOx, short tons)	Capital Cost Effectiveness ($/short ton), Retrofitted Vehicles (NOx)
11	79.10%	0.3157	0.2497	0.066	214,627.53
10	79.10%	0.3392	0.2683	0.0709	199,754.12
9	79.10%	0.345	0.2729	0.0721	196,411.32
8	79.10%	0.5068	0.4009	0.1059	133,686.79
7	79.10%	0.5626	0.445	0.1176	120,427.93
6	79.10%	0.3842	0.3039	0.0803	176,375.10
5	79.10%	0.3649	0.2886	0.0763	185,679.70
4	79.10%	0.5246	0.415	0.1096	129,152.32
3	79.10%	0.4687	0.3708	0.098	144,551.38
2	79.10%	0.5009	0.3962	0.1047	135,264.63
1	79.10%	0.4317	0.3415	0.0902	156,934.78

Type	Target Fleet	Class/Equipment	Model Year	Retrofit Year	Technology Description	Fuel Type	Vehicle Miles Traveled/Year (VMT)	Annual Baseline of Vehicles (NOx, short tons)
Onroad	School Bus	School Buses	2008	2019	Vehicle Replacement - Diesel	ULSD	11352	0.03946139
Onroad	School Bus	School Buses	2008	2019	Vehicle Replacement - Diesel	ULSD	12260	0.04239963
Onroad	School Bus	School Buses	2008	2019	Vehicle Replacement - Diesel	ULSD	12483	0.043121246
Onroad	School Bus	School Buses	2009	2019	Vehicle Replacement - Diesel	ULSD	16560	0.056314054
Onroad	School Bus	School Buses	2009	2019	Vehicle Replacement - Diesel	ULSD	18476	0.06251411
Onroad	School Bus	School Buses	2009	2019	Vehicle Replacement - Diesel	ULSD	12348	0.042684286
Onroad	School Bus	School Buses	2009	2019	Vehicle Replacement - Diesel	ULSD	11687	0.040545331
Onroad	School Bus	School Buses	2009	2019	Vehicle Replacement - Diesel	ULSD	17171	0.058291212
Onroad	School Bus	School Buses	2009	2019	Vehicle Replacement - Diesel	ULSD	15252	0.052081448
Onroad	School Bus	School Buses	2009	2019	Vehicle Replacement - Diesel	ULSD	16357	0.055657159
Onroad	School Bus	School Buses	2009	2019	Vehicle Replacement - Diesel	ULSD	13982	0.047971808

HGS
Hancock Grammar School
LCS
Lamoine Consolidated School

Hancock & Lamoine School Departments

66 Main Street Suite 201 ~ Ellsworth, ME 04605
Phone: 207.664.7199 ~ Fax: 207.669.6242

September 12, 2018

Maine Department of Transportation
Environmental Office
16 State House Station
Augusta, Maine 04333-0016

Dear Maine DEP,
It is our pleasure to write this letter in support of the grant application submitted by First Student, Inc. ("First Student") for the Maine School Bus Replacement Program, as part of the Volkswagen Environmental Mitigation Settlement.

First Student is the preferred school transportation solutions provider for student transportation in Hancock and Lamoine, proudly serving our district's student population with six vehicles. Our current contract with First Student serves us for 5 years, ending on June 30, 2020.

First Student takes the health and safety of our students very seriously by continuously pursuing environmentally sustainable initiatives for their fleet, and we have formed a trusted relationship with First Student because of their overall commitment to student safety and health.

Diesel-fueled buses emit diesel particulate matter (PM), toxic air containments that adversely affect human health, including proper lung development in children. Several studies of diesel PM and children's exposure to air pollution on school buses have found that the school bus itself is a major source of diesel PM exposure for children riding the bus. Funding school bus replacements not only reduces diesel PM, but also reduces NOx, which is the focus if the VW Mitigation Trust.

We fully support the effort of First Student as they seek Maine School Bus Replacement Program grant funding to help support the reduction in diesel emissions in Hancock and County. We believe that awarding the grant to First Student will incentivize them to modernize their fleet faster than normal budgets allow, and will serve as a long-term beneficial investment in Maine's efforts to reduce harmful diesel emissions. With fewer diesel emissions, our students won't be forced to breathe toxic pollutants that aggravate or increase incidents of respiratory illness, asthma, or other health problems.

Sincerely,

Katrina Kane
Superintendent of Schools
Hancock School Department
Lamoine School Department

Regional School Unit 25

James Boothby, Superintendent

Susan Lamoreau
Director of Special Services
207.469.6642

Central Office
62 Mechanic Street
Bucksport ME 04416
207.469.7311
FAX 207.469.6640
www.rsu25.org

Evelyn Beaulieu
Director of Curriculum &
Academic Achievement
207.469.6641

September 12, 2018

To: Maine Department of Transportation

From: Regional School Unit 25

Re: Volkswagen Environmental Mitigation Settlement

It is my pleasure to write this letter in support of the grant application submitted by of First Student Inc. as part of the Volkswagens Environmental Trust Settlement. First Student has been the contracted transportation provider for RSU 25 since our inception and to our member communities for many years prior.

First Student has made a commitment to RSU 25 to update their fleet of buses and that effort, though not completed, has paid off with increased fuel efficiency and lower emissions. It is important, as a State, we attend to an aging fleet of buses and improve the transportation experience for all students and communities. With newer buses we will see improved safety features, lower emissions, and increased fuel efficiencies.

Awarding grants to First Student will assist them in upgrading their fleet of buses on an accelerated timeline and improve the transportation experience for our students and communities.

Sincerely,

James Boothby

Superintendent

Table of Contents

Letters of Support

- Hancock Lamoine - VW Settlement Letter of Support
- RSU 25 - VW Settlement Letter of Support

Maine VW Round 1 Application

(For MaineDOT Use Only)
Date Application Received 9/14/18
Beneficiary's Project ID 23901.10
Funding Request # 25

MaineDOT

Maine Volkswagen Environmental Mitigation Action Round 1 Application for Appendix D-2 Eligible Actions

- All applications for Round 1 funding are **due by September 15, 2018.**
- A fillable **application template** is available at www.maine.gov/vw/application
- Use the **list of attachments** in Section 3 to ensure that your application is complete.
- **Funding** approvals for action(s) may be whole or partial.
- A **timeline** for Maine's Round 1 application process can be found at www.maine.gov/mdot/vw/application.
- For information on Maine's Diesel Emission Reduction Act (DERA) Program, go to http://www.maine.gov/dep/air/mobile/cleandiesel.htmls.
- For information on Zero Emission Vehicle Supply Equipment (ZEVSE), go to www.efficiencymaine.com.
- Submit any **questions** through the website at www.maine.gov/mdot/vw/application/faqs.
- Information on the **current base price** for Maine school buses can be found at https://www.maine.gov/doe/transportation/programs/buspurchase.html

Section 1: General Information

Action Title: **First Student – Class 4-8 School Buses – Maine Round 1**			
Action Location: Town/Territory: **Various – Lamoine, Hancock, Orrington, RSU25**		County: **Hancock, Penobscot**	
Type of Action: Repower: ☐ Replacement: ☒			
Action Proponent: **First Student, Inc.**			
Action Proponent Mailing Address: **FirstGroup America, Inc. Corporate Headquarters 600 Vine Street, Suite 1400 Attn: Brian Beechem**			
City: **Cincinnati**	State: **Ohio**	Zip: **45202**	County: **Hamilton**
Daytime Phone: 513.419.3218	Alternate Phone: 513.256.0351	Email: brian.beechem@firstgroup.com	
Authorized Agent (if different from Action Proponent): Ryan, LLC			
Authorized Agent Mailing Address: 333 S. Grand Ave, Suite 4150			
City: Los Angeles	State:California	Zip: 90071	County: Los Angeles
Daytime Phone: 213.627.1719 . 19-5258	Alternate Phone:	Email: joseph.dean@ryan.com	

Section 2: Eligibility Criteria

The following categories are **eligible mitigation actions** pursuant to Appendix D-2 of the Environmental Mitigation Trust Agreement (https://www.maine.gov/mdot/vw/app/Maine_VW_Eligible_Mitigation_Actions_1-8.pdf) and reflect basic eligibility criteria for consideration under this program. See Maine's Beneficiary Mitigation Plan (www.maine.gov/mdot/vw/BMP_final_2-12-18.pdf) for details on eligibility. Check all that apply. Leave checkboxes blank for actions that don't apply. List individual vehicles or equipment using the table on the following page.

Check all that apply	Eligible Mitigation Actions
☐	**1992-2009 engine model year Class 8 Local Freight Trucks and Port Drayage Trucks** repowered with any new diesel or alternate fueled engine or all-electric engine, or replaced with any new diesel or alternate fueled or all-electric vehicle, with the engine model year in which the eligible large trucks mitigation action occurs or one engine model year prior.
☒	**2009 engine model year or older Class 4-8 school buses, shuttle buses, or transit buses** repowered with any new diesel or alternate fueled or all-electric engine, or replaced with any new diesel or all-electric vehicle, with the engine model year in which the eligible bus mitigation action occurs or one engine model year prior.
☐	**Pre-Tier 4 freight switcher locomotives that operate 1000 or more hours per year** repowered with any new diesel or alternate fueled or all-electric freight switcher certified to meet the applicable EPA emissions standards or other more stringent equivalent state standard.
☐	**Unregulated, Tier 1 or Tier 2 marine engines on ferries or tugs** repowered with Tier 3, Tier 4, alternate fueled, or all-electric engine, or upgraded with an EPA certified remanufacture system or an EPA verified engine upgrade.
☐	**Marine shore power systems or components of such systems** that enable a compatible vessel's main and auxiliary engines to remain off while the vessel is at berth. Components eligible for reimbursement are limited to: cables, cable management systems, shore power coupler systems, distribution control systems, and power distribution. Subject marine shore power systems comply with international shore power design standards (ISO/IEC/IEEE 80005-1-2012 high voltage shore connection systems or the IEC/PAS 80005-3:2014 low voltage shore connection systems) and are supplied with power sourced from the local utility grid.
☐	**1992-2009 engine model year Class 4-7 local freight trucks** repowered with a new diesel, alternate fueled, or all-electric engine, or replaced with any new diesel, alternate fueled, or all-electric vehicle, with the engine model year in which the eligible medium trucks mitigation action occurs or one engine model year prior.
☐	**Tier 0, Tier 1, or Tier 2 diesel powered airport ground support equipment**; and **uncertified or certified to 3 g/bhp-hr or higher emissions spark ignition engine powered airport ground support equipment** repowered with an all-electric engine, or replaced with the same airport ground support equipment in an all-electric form.
☐	**Forklifts with greater than 8000 pounds of lift capacity and port cargo handling equipment** repowered with an all-electric engine, or replaced with the same equipment in an all-electric form.

Vehicles & equipment proposed for replacement or repower under this Eligible Mitigation Action. (Leave fields blank that do not apply)							
Current Vehicle Class	**Current Tier (if applicable)**	**Current Model**	**Current Model Year**	**Mileage**	**Current Fuel Type**	**Proposed Fuel Type**	**Associated equipment**
Class 7	Tier 2	International CE SB	2009	125,838	Diesel	Diesel	N/A
Class 7	Tier 2	International CE SB	2009	147,217	Diesel	Diesel	N/A
Class 7	Tier 2	International CE SB	2009	137,269	Diesel	Diesel	N/A
Class 7	Tier 2	International CE SB	2009	154,544	Diesel	Diesel	N/A
Class 7	Tier 2	International CE SB	2009	105,188	Diesel	Diesel	N/A
Class 7	Tier 2	International CE SB	2009	111,133	Diesel	Diesel	N/A
Class 7	Tier 2	International CE SB	2009	166,285	Diesel	Diesel	N/A
Class 7	Tier 2	International CE SB	2009	149,048	Diesel	Diesel	N/A
Class 7	Tier 2	International INT	2008	124,831	Diesel	Diesel	N/A
Class 7	Tier 2	International INT	2008	122,603	Diesel	Diesel	N/A
Class 6	Tier 2	International INT	2008	113,526	Diesel	Diesel	N/A

Application Attachments

Section 3: Action Overview and Instructions

e following information provides the reviewers with background on the proposed action and will be considered as part final decisions on what actions are funded in any given year. If an attachment is not application to the proposed action, that action is not disqualified from funding; however, Action Proponents are encouraged to provide accurate and concise answers to as many questions as possible and note why an attachment is not relevant to their proposal.

Check if attached	Scoring (for MaineDOT use)	Attachment	Attachment Description
☒		A	**Mitigation Action Description:** Attach a no more than two-page narrative describing the action and how it relates to Maine's Beneficiary Mitigation Plan and label as "Attachment A".
☒		B	**NOx Emission Reduction:** Estimate the NOx emission reductions from the action in terms of dollar per ton of NOx using EPA's Diesel Emission Quantifier found at https://www.epa.gov/cleandiesel/diesel-emissions-quantifier-deq or for heavy-duty vehicles http://afleet-web.es.anl.gov/hdv-emissions-calculator/ Attach a <u>separate</u> summary calculation worksheet generated by the Quantifier for <u>each</u> vehicle or piece of equipment and label as "Attachment B".
☒		C	**Health Benefits:** Describe any health benefits <u>maximized</u> by the action <u>beyond</u> calculated NOx emission reductions as "Attachment C". Examples of maximized health benefits include: reductions in particulate matter and/or greenhouse gases; net reduction of diesel fuel use; or idle reduction strategies.
☒		D	**Action Location:** As "Attachment D", indicate whether the action will occur in an area with a disproportionate quantity of air pollution from diesel fleets, such as ports, rail yards, terminals, school depots/yards, and freight distribution areas.
☒		E	**Class 1 Areas:** Using the Maine map found at www.maine.gov/mdot/vw/application/class1, note the location of the proposed action to indicate whether it will benefit a designated federal Class 1 Area, specifically Acadia National Park, Roosevelt Campobello International Park, or the Moosehorn Wilderness Area located within the Moosehorn National Wildlife Refuge Area. Include the map as "Attachment E".
☒		F	**Verified Funding:** As "Attachment F", verify that the action has secured funding for cost sharing or leveraging by providing a commitment letter or signed agreement from a financial institution or budget committee for cost share or leveraged funding. Also, using the template in Section 4 of this application, include a general project budget indicating the amount of match to be provided by the Action Proponent.
☒		G	**Action Schedule:** The action must be implemented within two years of the award date. Using the template provided in Section 4 of this application, provide schedule and major milestones, labeled as "Attachment G".
☒		H	**Benefit Period:** The action must result in sustained emission benefits over the ten-year Trust Effective Period. Provide a concise description of how benefits will persist through 2027 and a maintenance plan for eligible vehicles/equipment funded under this program as "Attachment H".
☒		I	**Relevant Experience and Compliance Certification:** By signing provisions in "Attachment I", the Action Proponent and Authorized Agent (if applicable) verify that there is existing administration and programmatic structure in place to implement diesel emission reduction or offset actions.

Attachment A – Mitigation Action Description

Attach a no more than two-page narrative describing the action and how it relates to Maine's Beneficiary Mitigation Plan primary goal of the BMP is to improve and protect ambient air quality by implementing eligible mitigation projects that will: Achieve significant and sustained cost-effective reductions in NOx emissions from vehicles, engines and equipment in terms of annual tons of reductions.

First Student is the leading school transportation solutions provider in North America, moving more passengers per day than all U.S. airlines combined by leveraging best practices, technologies and processes to deliver quality transportation solutions. First Student serves the Maine student population with 102 buses and 95 employees across the state, and we take the health of Maine's student population very seriously by setting the highest standards for pursuing environmentally sustainable and safety initiatives for our fleet.

Diesel-fueled buses emit many toxic air contaminants that adversely affect human health, including proper lung development in children. Research published in the Journal of the Air & Waste Management Association has concluded that, "A high percentage of school buses are powered by diesel engines, and commuting children may be exposed to high concentrations of exhaust particles and gases during their commutes, at school bus stops, or at loading/unloading zones". Additionally, the Maine Department of Environmental Protection (ME DEP) website states that, "Human exposure to these pollutants can include both short-term (acute) and long-term (chronic) complications. Long-term exposures to many air toxics may result in damage to the respiratory or nervous systems, birth defects, and reproductive effects." Moreover, several studies also suggest that exposure to toxic air pollutants from diesel emissions may also facilitate development of new allergies *(please see Appendices in this application for supporting documents)*.

For this project, First Student plans on replacing eleven eligible 2009 or older diesel buses with the same number of new Class C diesel replacement vehicles. By removing these older buses off the road, First Student will be eliminating a sustained 0.364 short tons of NOx emissions annually, and 3.207 short tons of NOx emissions over the lifetime of the new vehicle, which is a **79.1% annual estimated reduction**, per the EPA's DEQ qualifier. Other harmful emissions will be reduced as well, including Particulate Matter 2.5 (PM2.5 47.4%), Hydrocarbons (HC - 55.4%), Carbon Monoxide (CO - 55.4%), Carbon Dioxide (CO_2 – 23.5%) and more. This bus replacement project will result in cleaner and healthier conditions for the students we serve, our employees, and the Maine neighborhoods in which these buses operate. Given that the primary goal of the Maine Beneficiary Mitigation Plan is to protect ambient air quality by reducing NOx emissions, awarding the VW Mitigation Trust grants to First Student will incentivize us to modernize our fleet faster than normal budgets will allow, and will serve as a long-term beneficial investment for the State of Maine's efforts to reduce harmful diesel emissions.

Thanks for your consideration,

Brian Beechem
Sr. Director
600 Vine Street, Suite 1400, Cincinnati, Maine 45202
Office: 513.419.3218
Mobile: 513.256.0351
brian.beechem@firstgroup.com
www.firstgroupamerica.com

Attachment B – NOx Emission Reduction:

NOx Emission Reduction: *Estimate the NOx emission reductions from the action in terms of dollar per ton of NOx using EPA's Diesel Emission Quantifier found at https://www.epa.gov/cleandiesel/diesel-emissions-quantifier-deq or for heavy-duty vehicles http://afleet-web.es.anl.gov/hdv-emissions-calculator/ Attach a separate summary calculation worksheet generated by the Quantifier for each vehicle or piece of equipment and label as "Attachment B".*

1) **EPA DEQ Emissions Summary – Total Project Summary**
2) **EPA DEQ Emissions Summary – for the 11 Individual Buses**

Emission Results and Health Benefits for Project: First Student ME (combined project)

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.460	0.003	0.024	0.089	235.3	20,912
Amount Reduced After Upgrades	0.364	0.001	0.013	0.049	55.4	4,921
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	4.054	0.025	0.208	0.787	2,074.4	184,392
Amount Reduced After Upgrades	3.207	0.012	0.115	0.436	488.2	43,392
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$282,817	$75,371,068	$7,887,572	$2,080,148	$1,858	
Total Cost Effectiveness[4] (includes all project costs)	$183,831	$48,991,140	$5,126,916	$1,352,094	$1,208	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Remaining Life	**2008 Diesel Buses:** School Bus | School Buses	8 years
	2009 Diesel Buses: School Bus | School Buses	9 years

Logged in as Joseph | logout | help
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For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 1

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.056	0.000	0.003	0.011	28.8	2,563
Amount Reduced After Upgrades	0.045	0.000	0.002	0.006	6.8	603
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.507	0.003	0.026	0.098	259.5	23,067
Amount Reduced After Upgrades	0.401	0.002	0.014	0.055	61.1	5,427
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$204,371	$54,468,028	$5,700,014	$1,503,214	$1,343	
Total Cost Effectiveness[4] (includes all project costs)	$132,841	$35,404,218	$3,705,009	$977,089	$873	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Emission Results and Health Benefits for Project: First Student Maine Bus 2

Emission Results ▢

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.053	0.000	0.003	0.010	27.2	2,421
Amount Reduced After Upgrades	0.042	0.000	0.002	0.006	6.4	569
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.479	0.003	0.025	0.093	245.1	21,789
Amount Reduced After Upgrades	0.379	0.001	0.014	0.052	57.6	5,121
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$216,311	$57,638,590	$6,032,046	$1,590,857	$1,423	
Total Cost Effectiveness[4] (includes all project costs)	$140,602	$37,465,083	$3,920,830	$1,034,057	$925	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Logged in as Joseph | logout | help
Note: Your session will time out after 30 minutes of inactivity. For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 3

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.011	0.000	0.001	0.002	5.5	488
Amount Reduced After Upgrades	0.008	0.000	0.000	0.001	1.3	114
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.4%	23.4%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.097	0.001	0.005	0.019	49.4	4,392
Amount Reduced After Upgrades	0.076	0.000	0.003	0.010	11.5	1,026
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.4%	23.4%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$1,073,199	$286,292,620	$29,954,665	$7,897,830	$7,104	
Total Cost Effectiveness[4] (includes all project costs)	$697,579	$186,090,203	$19,470,532	$5,133,589	$4,618	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Logged in as Joseph | logout | help

Note: Your session will time out after 30 minutes of inactivity. For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 4

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.050	0.000	0.003	0.010	25.3	2,250
Amount Reduced After Upgrades	0.039	0.000	0.001	0.005	6.0	529
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.446	0.003	0.023	0.087	227.8	20,250
Amount Reduced After Upgrades	0.352	0.001	0.013	0.048	53.6	4,761
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$232,689	$61,984,573	$6,487,238	$1,711,032	$1,531	
Total Cost Effectiveness[4] (includes all project costs)	$151,248	$40,289,972	$4,216,705	$1,112,170	$995	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Logged in as Joseph | logout | help
Note: Your session will time out after 30 minutes of inactivity. For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 5

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.061	0.000	0.003	0.012	31.4	2,790
Amount Reduced After Upgrades	0.049	0.000	0.002	0.007	7.4	657
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.552	0.003	0.028	0.107	282.5	25,110
Amount Reduced After Upgrades	0.437	0.002	0.016	0.059	66.5	5,913
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$187,730	$50,018,699	$5,234,690	$1,380,596	$1,233	
Total Cost Effectiveness[4] (includes all project costs)	$122,025	$32,512,154	$3,402,548	$897,388	$801	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Logged in as Joseph | logout | help
Note: Your session will time out after 30 minutes of inactivity.
For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 6

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.039	0.000	0.002	0.008	19.9	1,769
Amount Reduced After Upgrades	0.031	0.000	0.001	0.004	4.7	416
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.350	0.002	0.018	0.068	179.1	15,921
Amount Reduced After Upgrades	0.277	0.001	0.010	0.038	42.1	3,744
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$295,946	$78,823,083	$8,249,788	$2,175,994	$1,947	
Total Cost Effectiveness[4] (includes all project costs)	$192,365	$51,235,004	$5,362,363	$1,414,396	$1,265	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Logged in as Joseph | logout | help
Note: Your session will time out after 30 minutes of inactivity.
For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 7

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.041	0.000	0.002	0.008	21.1	1,877
Amount Reduced After Upgrades	0.033	0.000	0.001	0.004	5.0	442
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.372	0.002	0.019	0.072	190.0	16,893
Amount Reduced After Upgrades	0.294	0.001	0.011	0.040	44.8	3,978
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$278,979	$74,308,854	$7,777,221	$2,051,315	$1,832	
Total Cost Effectiveness[4] (includes all project costs)	$181,337	$48,300,755	$5,055,194	$1,333,355	$1,191	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Logged in as Joseph | logout | help
Note: Your session will time out after 30 minutes of inactivity.
For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 8

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.065	0.000	0.003	0.013	33.0	2,935
Amount Reduced After Upgrades	0.051	0.000	0.002	0.007	7.8	690
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.581	0.004	0.030	0.113	297.2	26,415
Amount Reduced After Upgrades	0.459	0.002	0.016	0.062	69.9	6,210
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$178,456	$47,559,743	$4,977,102	$1,312,577	$1,174	
Total Cost Effectiveness[4] (includes all project costs)	$115,997	$30,913,833	$3,235,116	$853,175	$763	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Logged in as Joseph | logout | help

Note: Your session will time out after 30 minutes of inactivity. For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 9

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.038	0.000	0.002	0.007	19.4	1,725
Amount Reduced After Upgrades	0.030	0.000	0.001	0.004	4.6	406
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.303	0.002	0.016	0.059	155.3	13,800
Amount Reduced After Upgrades	0.240	0.001	0.009	0.033	36.5	3,248
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$341,623	$91,014,336	$9,525,213	$2,512,236	$2,244	
Total Cost Effectiveness[4] (includes all project costs)	$222,055	$59,159,318	$6,191,389	$1,632,953	$1,459	

[1] Emissions from the electrical grid are not included in the results.

[2] 1 short ton = 2000 lbs.

[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.

[4] Cost effectiveness estimates include only the costs which you have entered.

Logged in as Joseph | logout | help
Note: Your session will time out after 30 minutes of inactivity.
For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 10

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.031	0.000	0.002	0.006	15.9	1,409
Amount Reduced After Upgrades	0.025	0.000	0.001	0.003	3.7	331
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.248	0.002	0.013	0.048	126.8	11,272
Amount Reduced After Upgrades	0.196	0.001	0.007	0.027	29.8	2,648
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.5%	23.5%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$418,073	$111,396,658	$11,658,049	$3,074,662	$2,753	
Total Cost Effectiveness[4] (includes all project costs)	$271,748	$72,407,828	$7,577,732	$1,998,530	$1,789	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Logged in as Joseph | logout | help
Note: Your session will time out after 30 minutes of inactivity.
For best results, do not use your browser's "back" arrow.

Emission Results and Health Benefits for Project: First Student Maine Bus 11

Emission Results

Here are the combined results for all groups and upgrades entered for your project.[1]

Annual Results (short tons)[2]	NO_x	PM2.5	HC	CO	CO_2	Fuel[3]
Baseline for Upgraded Vehicles	0.015	0.000	0.001	0.003	7.7	682
Amount Reduced After Upgrades	0.012	0.000	0.000	0.002	1.8	161
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.6%	23.6%
Lifetime Results (short tons)[2]						
Baseline for Upgraded Vehicles	0.120	0.001	0.006	0.023	61.4	5,456
Amount Reduced After Upgrades	0.095	0.000	0.003	0.013	14.5	1,288
Percent Reduced After Upgrades	79.1%	47.4%	55.4%	55.4%	23.6%	23.6%
Lifetime Cost Effectiveness ($/short ton reduced)						
Capital Cost Effectiveness[4] (unit & labor costs only)	$916,494	$243,998,924	$25,539,500	$6,737,112	$6,004	
Total Cost Effectiveness[4] (includes all project costs)	$595,721	$158,599,301	$16,600,675	$4,379,123	$3,903	

[1] Emissions from the electrical grid are not included in the results.
[2] 1 short ton = 2000 lbs.
[3] In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.
[4] Cost effectiveness estimates include only the costs which you have entered.

Attachment C – Health Benefits:

Health Benefits: *Describe any health benefits maximized by the action beyond calculated NOx emission reductions as "Attachment C". Examples of maximized health benefits include: reductions in particulate matter and/or greenhouse gases; net reduction of diesel fuel use; or idle reduction strategies.*

First Student plans on replacing eleven eligible 2009 or older diesel buses, which will result in the elimination of over 0.364 short tons of NOx emissions annually, and 3.207 short tons over lifetime of the replacement vehicles. In addition, there are further emission reduction benefits associated with this project, including but not limited to: Eliminating over 0.001 short tons of diesel particulate matter (PM2.5) annually and over 0.012 short tons over the lifetime of the new replacement buses (a 47.4% reduction) and also the reduction of other harmful greenhouse gas emissions, including:

- Hydrocarbons (HC - 55.4%),
- Carbon Monoxide (CO - 55.4%),
- Carbon Dioxide (CO_2 – 23.5%)

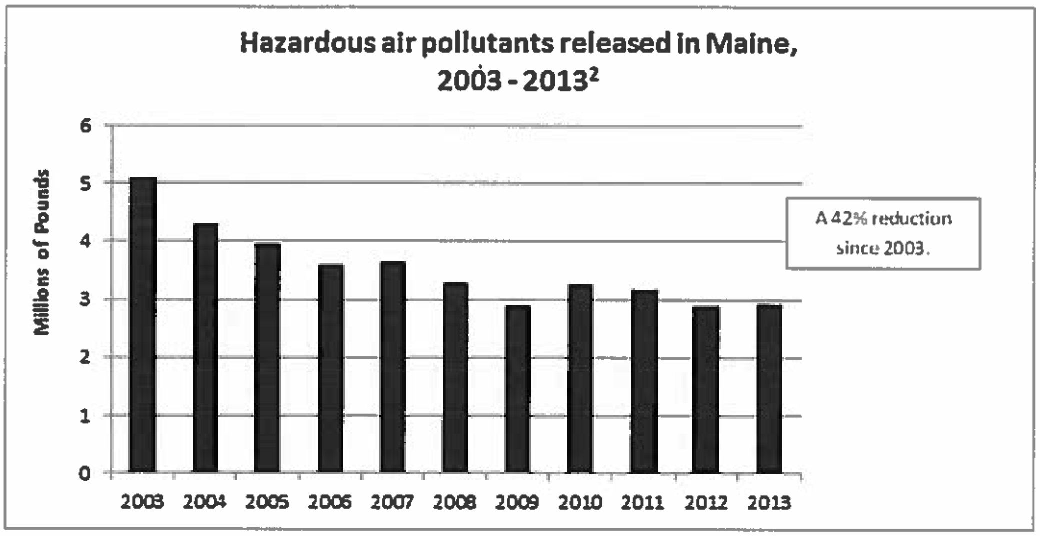
Diesel-fueled buses also emit diesel particulate matter (DPM), and other toxic air contaminants that adversely affect human health, including proper lung development in children. Research published in the Journal of the Air & Waste Management Association has concluded that, "A high percentage of school buses are powered by diesel engines and commuting children may be exposed to high concentrations of exhaust particles and gases during their commutes, at school bus stops, or at loading/unloading zones." Additionally, the Maine Department of Environmental Protection (ME DEP) website states that – "Human exposure to these pollutants can include both short-term (acute) and long-term (chronic) complications. Long-term exposures to many air toxics may result in damage to the respiratory or nervous systems, birth defects, and reproductive effects." Several studies also suggest that exposure to toxic air pollutants may also facilitate development of new allergies. Those most vulnerable to non-cancer health effects are children whose lungs are still developing and the elderly who often have chronic health problems. In fact, some of the school districts in Maine being directly serviced by this project look to already be at risk for harm, as an average of 13% of the population have asthma (20% of these are children), and 9.54% of the population has been diagnosed with Chronic Obstructive Pulmonary Disease (COPD).

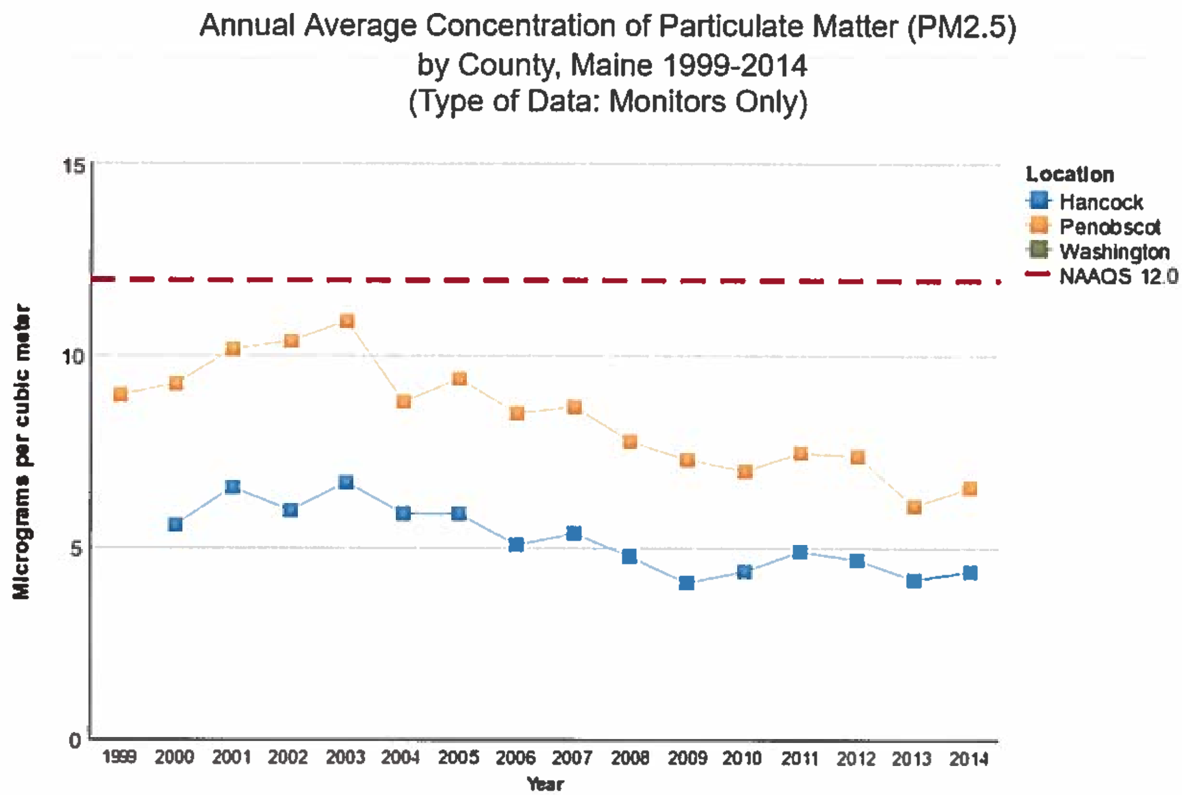
Moreover, hazardous air pollutants can have both a direct effect on the environment (i.e. climate change) and have indirect effects on human health through the leeching of air pollutants into soil or into lakes and streams, potentially affecting ecological systems and eventually human health through consumption of contaminated food.

The EPA Diesel Emissions Quantifier shows that this project will help with the health risks mentioned above, by eliminating over 0.001 short tons of diesel particulate matter (PM2.5) annually and over 0.012 short tons over the lifetime of the new replacement buses (a 47.4% reduction), and also reduce other harmful greenhouse gas emissions, including Hydrocarbons (HC - 55.4%), Carbon Monoxide (CO - 55.4%), Carbon Dioxide (CO_2 – 23.5%) and more.

Furthermore, First Student employs a companywide anti-idling policy to mitigate excessive fuel usage, reduce harmful diesel emissions, and comply with Federal, State and Provincial anti-idling laws. The policy restricts how long an engine can idle in various circumstances and implements unannounced inspections to monitor compliance. Typical school bus engines burn about half a gallon of fuel per hour of idling. Elimination of unnecessary idling helps to decrease emissions and can also save significant dollars in fuel costs each year. Their policy is designed to eliminate all unnecessary idling by school and other transport buses operated by or on First Student facilities such that idling time is minimized in every aspect of bus operations.

The data shows that emissions reduction projects like these do work. Several programs have been implemented in Maine to control the emissions of hazardous air pollutants and the EPA maintains a program for reporting releases and transfers of toxic chemicals to the environment known as the Toxic Release Inventory(TRI). Based upon reported TRI (Toxic Release Inventory) data since 2003, Maine has reduced its hazardous air pollutant emissions by over 42% (see the graphs below).





In summary, there are additional health benefits that will be maximized by this project, and it will serve as a long-term beneficial investment for the State of Maine's efforts to reduce harmful diesel emissions.

Attachment D – Action Location: *As "Attachment D", indicate whether the action will occur in an area with a disproportionate quantity of air pollution from diesel fleets, such as ports, rail yards, terminals, school depots/yards, and freight distribution areas.*

The 11 buses in this application are part of an overall fleet in Maine of 102 total buses serving several school districts throughout the state. Three of them are located at the main First Student bus depot located at 99 Front Ridge Road, Orland, ME 04472 with the rest parked offsite. For the Front Ridge Road site, the replacement of even a few buses would surely help improve the air quality for the drivers, maintenance workers, and administrative staff who work at that location, and also for the surrounding neighborhoods.

Attachment D – Action Location: *As "Attachment D", indicate whether the action will occur in an area with a disproportionate quantity of air pollution from diesel fleets, such as ports, rail yards, terminals, school depots/yards, and freight distribution areas.*

The 11 buses in this application are part of an overall fleet in Maine of 102 total buses serving several school districts throughout the state. Three of them are located at the main First Student bus depot located at 99 Front Ridge Road, Orland, ME 04472 with the rest parked offsite. For the Front Ridge Road site, the replacement of even a few buses would definitely improve the air quality for the drivers, maintenance workers, and administrative staff who work at that location, and also for the surrounding neighborhoods.

<u>Attachment E - Class 1 Areas:</u> *Using the Maine map found at www.maine.gov/mdot/vw/application/class1, note the location of the proposed action to indicate whether it will benefit a designated federal Class 1 Area, specifically Acadia National Park, Roosevelt Campobello International Park, or the Moosehorn Wilderness Area located within the Moosehorn National Wildlife Refuge Area. Include the map as "Attachment E".*

The following buses in the application are located within proximity and will benefit a Class 1 area - The Acadia National Park. Please see the distances below and the attached maps.

Main Terminal - 99 Front Ridge Road Orland, Maine — 50.3 km / 31.3 miles
4DRBUAFM38A567902
4DRBUAFN38A571778
4DRBUSKN69B133358

Offsite - 196 Blacks Woods Road Franklin, Maine - 64.5 km / 40.1 miles
4DRBUSKN89B133376

Offsite - 16 Wilbur Lane Hancock, Maine - 36.5 km / 22.7 miles
4DRBUSKN69B133361

Offsite - 12 Boulder Cove Way Lamoine, Maine - 23.6 km /14.7 miles
4DRBUSKN59B133383

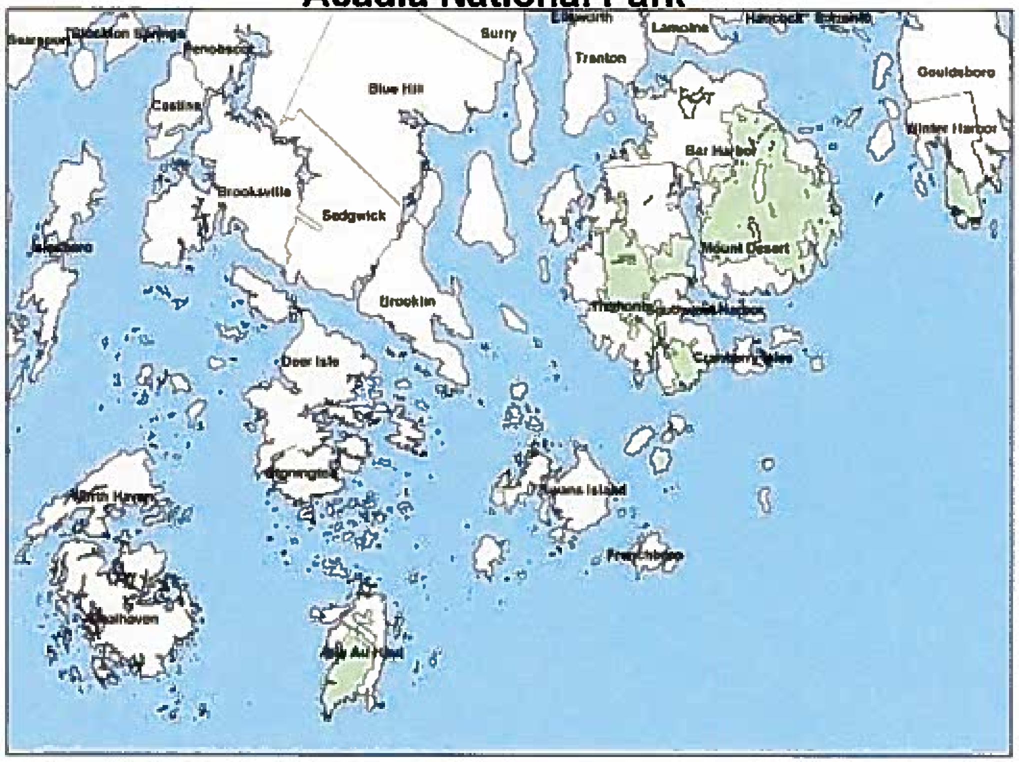
Offsite - 36 Pomroy Road Hancock, Maine - 37.1 km / 23.1 miles
4DRBUSKN69B133375

Offsite - 28 Acadia Lane Hancock, Maine – 31.9 km / 19.8 miles
4DRBUSKN89B133362

Offsite - 53 Lamoine Beach Road Lamoine, Maine - 23.0 km / 14.3 miles
4DRBUSKN59B133349

Offsite - 381 Hawes Bridge Prospect, Maine - 66.8 km / 41.5 miles
4DRBUAFN28A571285

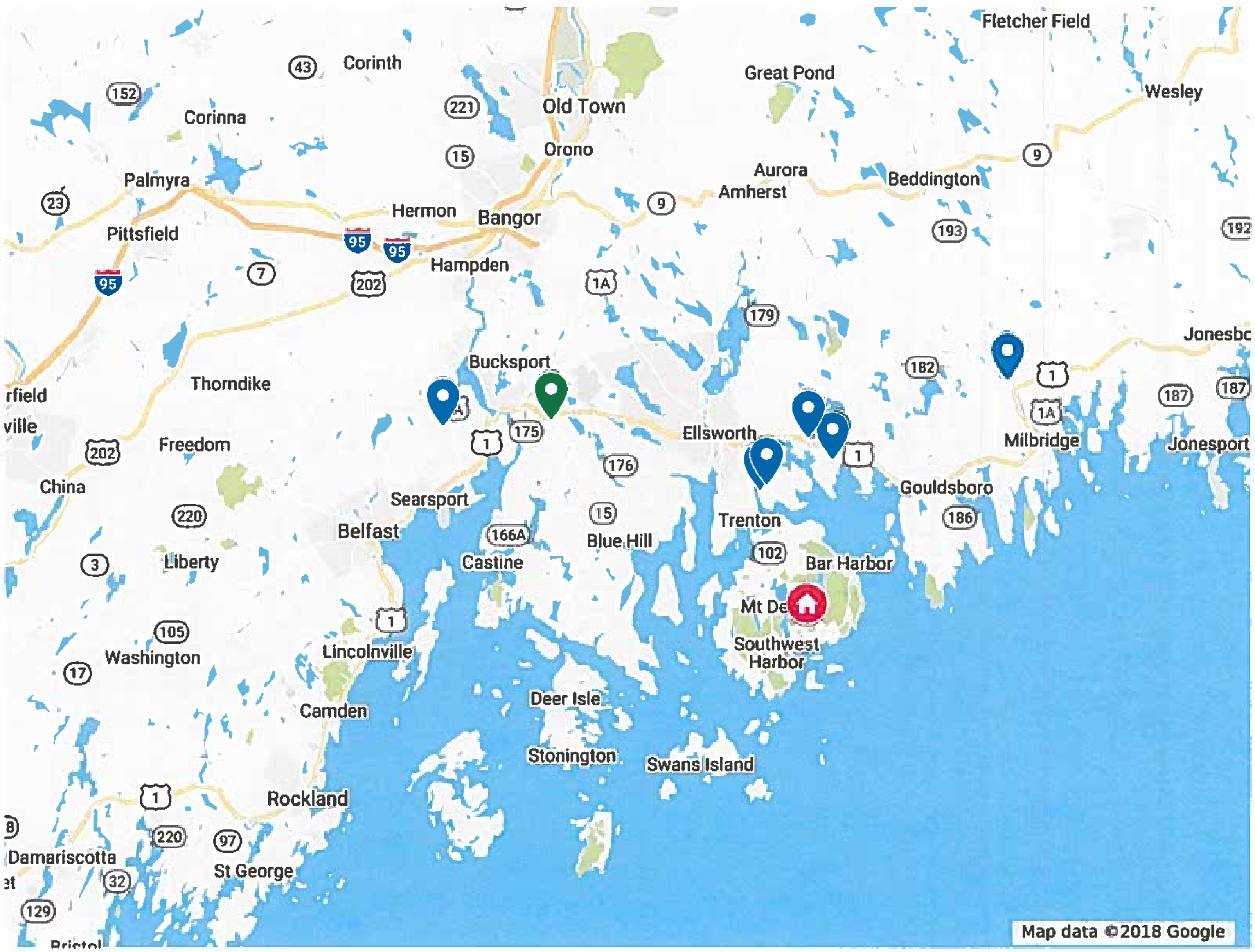
Acadia National Park



First Student - proximity to Acadia National Park

First Student bus locations

- 99 Front Ridge Rd
- 196 Blacks Woods Rd
- 16 Wilber Ln
- Acadia National Park
- Boulder Cove Way
- Pomroy Road
- Acadia Lane
- 53 Lamoine Beach Rd
- Hawes Bridge Road



Attachment F

1) Budget Summary
2) Verified Funding Letter

Attachment F - Budget Summary:

Budget Summary		
1	Total Estimated Cost of the Proposed Action	907,000.00
2	Minimum required cost share or leverage funding for this action Percentage: 20% Source: Appendix D-2 (Gov't Owned trust funding limits) and email confirmation from Judy Gates 7/12/2018 (i.e. 80% reimbursement for private bus companies under contract with public entities to provide public school transportation)	181,400
3	Actual cost share and cost overage committed by the Action Proponent (may include local funding, grants awarded, contributions, etc.) Percentage: 35%	317,450
4	Funds requested from Maine's VW Environmental Mitigation Settlement	589,550

First America

600 Vine Street
Suite 1400
Cincinnati, OH 45202
Tel: 513-241-2200
Fax: 513-268-0049

September 6, 2018

Maine DOT Environmental Office
Attn: Judy Gates, Director
16 State House Station
24 Child Street
Augusta, ME 04333-0016

RE: Verified Funding Commitment Letter (Attachment F)

Dear Maine DOT Environmental Office:

I , Brian Beechem, an "Authorized Representative" of First Student, Inc., do hereby attest that First Student, Inc. has available Cash Funds in an amount that is sufficient to fund the entire project being proposed in this Diesel Emission Mitigation Program Proposal, such project estimated to cost $907,000.00. I further attest that these Cash Funds on deposit are free of any liens or encumbrances. Said Cash Funds are immediately available and freely transferable.

Authorized Representative: [signature], Asst. Secretary

Authorized Representative Name (printed): Brian Beechem

Date of Signature: 9/10/2018

Attachment G – Action Schedule:

Projected Action Schedule	
Milestone	**Estimated Date**
MaineDOT Requests Round 1 Proposals for Actions to be funded by VW Environmental Mitigation Settlement	July 9, 2018
Action Proponent or Agent Submits Proposal to MaineDOT	September 14, 2018
MaineDOT Provides Written Approval of Action Proponent's Proposal	October 31, 2018
Action Proponent Enters Contract with MaineDOT	November 30, 2018
MaineDOT verifies funding approval by incorporating Action into Maine Beneficiary Mitigation Plan	November-December, 2018
Trustee Acknowledges Receipt of Project Certification and Funding Direction	January–March, 2019
Action Proponent Obtains Cost Share, Notifies or Certifies to MaineDOT	March 31, 2019
Action Installation(s)/Delivery	June-September, 2019
Submit Proof of Delivery or Work Completed to MaineDOT by providing copies of the vehicle title and receipt for vehicle, equipment, or service.	June-September, 2019
Submit Proof of Scrapping of Replaced Vehicle or Engine to MaineDOT	June-September, 2019
MaineDOT Remits Committed Funding to Action Proponent	September-October, 2019
Due date of first Status Report and Maintenance Record to MaineDOT (six months after funding award)	June-September, 2019
MaineDOT Reports Action Completion to Trustee	September-October, 2019

Attachment H – Benefit Period: *The action must result in sustained emission benefits over the ten-year Trust Effective Period. Provide a concise description of how benefits will persist through 2027 and a maintenance plan for eligible vehicles/equipment funded under this program as "Attachment H".*

For the eleven buses in this application, the emissions benefits will last much longer than 2027, as the estimated useful life of the school buses in the First Student fleet is usually around 15 years, give or take a few, depending on business conditions and budgets. First Student also has long standing contracts with several different public school districts in Maine. Although a few of these contracts are up for renewal over the next few years, some have been in place for over *25 years*, and there is a reasonable expectation (if not certainty) that these contracts will be renewed for multiple 3 or 5-year options that will last well past 2027. However, should one (or more) of the contracts relating to the buses in this application not be renewed, First Student has the luxury of relocating the grant awarded buses within Maine to various school districts as necessary, due to the fact that First Student has multiple contracts with several school districts at any given time. This ensures that the newer, lower emission grant awarded replacement buses will always be operated within the State of Maine, in order to remain in compliance with the 2027 Volkswagen Mitigation Trust Settlement requirement.

Preventive Maintenance Plan

Preventive Maintenance is a vitally important function to the operation of the First Student fleet. Their facilities perform Preventive Maintenance Inspections (PMI's) at specified intervals, fully maintaining manufacturer requirements, to ensure customers are provided with safe reliable vehicles. The goal is to prevent failures, and the successful completion of PMI's and related tasks ensures safety. All PMI Defect Repairs must be completed in accordance with internal policy prior to a vehicle being released for service. The vehicles eligible for funding under this program will be subject to First Student's Preventive Maintenance Policy to keep the vehicles running as expected and up to manufacturer specifications.

PMI Standards

Shop Management personnel must review PMI reports daily to make sure inspections are thoroughly completed and on time. Past inspection sheets must also be pulled to review the vehicles defect repair history. PM's are scheduled at minimum every 90 days, and/or triggered at required time intervals and mileage limits.

PMI Items checked (or replaced if found worn or defective)

- Belts
- Batteries
- Push Rod travel
- Brakes (hydraulic and air)
- Fluids (Oil, Hydraulic)
- Fault Codes
- Wiper Blades
- Filters
- King Pin / Ball Joint play
- Wheel bearing play
- Tires
- General Interior/Exterior visual checks

PMI's must be performed in a manner consistent with company policies and standards and must be completed by First Student personnel. The Regional Maintenance Manager must approve any exceptions.

PMI's must "meet or exceed" OSHA, Federal, Government, State, and/or Municipal regulations and standards.

All vehicles not passing the PMI are rescheduled into the workshop as soon as possible for any outstanding repairs to be completed.

ATTACHMENT I

Authorized Agent Certification

The Authorized Agent certifies that they have been authorized by the Project Proponent to submit this application, that the Project Proponent agrees to all the program requirements, and that the information provided is an accurate representation of the project.

Action Proponent's Signature: [signature]

Date: 9/10/2018

Authorized Agent's Signature: RYAN LLC [signature]
(if different from Action Proponent)
Date: 9/10/2018 JOSEPH DOAN

Action Proponent Signature

The Action Proponent certifies that the action(s) is/are accurately described in this application. Signature indicates that the action(s) comply with all requirements of the Volkswagen Environmental Mitigation Settlement, provides the designated level of cost share funds, and a willingness to enter an agreement with the Maine Department of Transportation requiring the Action Proponent to administer the project abiding to federal, State, and local requirements. The Action Proponent also accepts responsibility for submitting progress reports during the term of the project and providing future maintenance of the completed action through 2027.

Action Proponent(s): Brian Beechem

Title: Asst. Secretary/Corporate Officer

Phone#: (513) 419-3218

Email: brian.beechem@firstgroup.com

[signature]
Signature(s)

9/10/2018
Date

Exhibits

Program: Maine VW Mitigation Trust Application - Round 1
Applicant: First Student

VIN	Current Vehicle Class	Current Tier (If Applicable)	Current Model	Current Make	Current Model Year	Mileage @ 7/29/2018	Current Fuel Type	Associated Equipment	Annual Miles Travelled	Annual Idling Hours	Estimated Fuel Gallons per Year	Replacement Year	Replacement Make	Replacement Model	Replacement Cost	Proposed Fuel Type
4DRBUSKN79B133384	Class 7	Tier 2	2009 INT: CESB	IC	2009	125838	Diesel	N/A	16661	96	2563	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUSKN89B133376	Class 7	Tier 2	2009 INT: CESB	IC	2009	147217	Diesel	N/A	15739	91	2421	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUSKN69B133361	Class 7	Tier 2	2009 INT: CESB	IC	2009	137269	Diesel	N/A	3175	18	488	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUSKN59B133383	Class 7	Tier 2	2009 INT: CESB	IC	2009	154544	Diesel	N/A	14628	85	2250	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUSKN69B133375	Class 7	Tier 2	2009 INT: CESB	IC	2009	105188	Diesel	N/A	18134	105	2790	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUSKN69B133358	Class 7	Tier 2	2009 INT: CESB	IC	2009	111133	Diesel	N/A	11500	67	1769	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUSKN89B133362	Class 7	Tier 2	2009 INT: CESB	IC	2009	166285	Diesel	N/A	12200	71	1877	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUSKN59B133349	Class 7	Tier 2	2009 INT: CESB	IC	2009	149048	Diesel	N/A	19080	110	2935	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUAFN38A571778	Class 7	Tier 2	2008 INT INT	IC	2008	124831	Diesel	N/A	11210	65	1725	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUAFN28A571285	Class 7	Tier 2	2008 INT INT	IC	2008	122603	Diesel	N/A	9161	53	1409	2019	ThomasBuiltBuses	Type C Conventional	$ 82,000.00	Type C Diesel
4DRBUAFM38A567902	Class 6	Tier 2	2008 INT INT	IC	2008	113526	Diesel	N/A	4431	26	682	2019	ThomasBuiltBuses	Type C Conventional	$ 87,000.00	Type C Diesel
														Total Project Cost	$ 907,000.00	
														Grantee Cost Share	$ 317,450.00	
														Grant Request	$ 589,550.00	

Total Eligible Vehicles: 11

First Student

Anti-Idling Policy Summary: First Student's employs a company-wide anti-idling policy that ensures compliance with Federal, State and Provincial anti-idling laws. The policy restricts how long an engine can idle in various circumstances and implements unannounced inspections to monitor compliance. Typical school bus engines burn about half a gallon of fuel per hour of idling. Elimination of unnecessary idling helps to decrease emissions and can also save significant dollars in fuel costs each year. Their policy is designed to eliminate all unnecessary idling by school and other transport buses operated by or on First Student facilities such that idling time is minimized in every aspect of bus operations.

Locally, First Student Location Managers are responsible for

- ensuring inspections are conducted,
- posting anti-idling signs at all applicable locations (garages, maintenance facilities, employee break rooms, etc)
- provide anti-idling training as directed, and
- ensuring the inspection results are input into an internal database for analysis and record keeping.

The First Student anti-idling policy is as follows:

No bus will idle in excess of 3 minutes while not in transit unless certain exceptions exist (shown below). When bus drivers arrive at loading or unloading areas to drop off or pick up passengers, they should turn off their buses as soon as possible to eliminate idling time and reduce emissions. The bus should not be restarted until it is ready to depart and there is a clear path to exit.

In colder weather, schools are requested to provide a space inside the school where bus drivers who arrive early can wait. Also, if the warmth of the bus is an issue, idling is to be kept to a very minimum and occur outside the school zone. The "warmed" bus is to enter the school zone as close to pick-up time as possible to maintain warmth and then shut down.

Buses should not idle while waiting for students during field trips, extracurricular activities, or other events where students are transported off school grounds. Additionally, Operations staff are directed to revise bus schedules so that school bus caravanning can be avoided and buses with the lowest emissions assigned to the longest urban intensive routes.

First Source also follows all manufacturer suggested engine maintenance recommendations to minimize exhaust emissions, diesel emissions in particular.

Exceptions would include:

- conditions that would compromise passenger safety, such as extreme weather conditions

- Idling while in traffic, and
- Repairs or maintenance that requires the engine to be running.

If states permit maximum idling times in excess of three (3) minutes, or do not restrict idling at all, company policy prevails. Even where exceptions exist, best efforts should be made to limit engine idling at all times.

Inspections: Bus idling inspections are conducted six (6) times per month, with no more than three (3) inspections on a particular day of the week during a given month. Inspections alternate between AM, mid-day, and PM. If any buses exceed the maximum idling time limit, the bus number, operator's name, idling time is recorded, and corrective action is taken to prevent the operator from exceeding the idling time limit in the future. Progressive training is followed for all violations that occur.

When performing Driver Vehicle Inspections, every attempt to limit idling time by grouping the items on the DVIR that require the engine to be running will be made.

Training: All drivers shall be retrained on the FGA anti-idling policy at the beginning of every school year. A record of retraining will be kept in each employee's personnel file.

Maine Demographic info

All info based on 2011-2015 Census data - Policy Map.com

	1	2	3	4	Average	Total
City/School District	Hancock SD	Lamoine SD	Orrington SD	RDU 25 SD		
Census Tract qualification (Severely Distressed)	Not Eligible	Severe Distress	Not Eligible	Not Eligible		
Percent of People in Poverty	26.64%	12.09%	17.12%	15.69%	17.89%	N/A
Tract Income as % of AMI (Area Median Income)	84.42%	79.78%	128.51%	97.24%	97.49%	N/A
Population	925	13,555	3,689	5,425	5,899	23,594
Median Family Income	$44,415	$64,347	$71,750	$53,413	$58,481	N/A
Area Median Income	$53,700	$64,300	$72,700	$64,300	$63,750	N/A
Percent Population under 18	20.11%	18.98%	19.98%	23.76%	20.71%	N/A
Percent Population over 65	15.78%	19.91%	18.35%	18.56%	18.15%	N/A
Percent of Adults Reporting to Have Asthma	13.32%	12.48%	11.81%	13.13%	12.69%	N/A
Percent of People of Color (Asian/Pacific Islander, Black, Hispanic, two or more races)	2.05%	3.81%	3.77%	0.43%	2.52%	N/A
Percent of People with Chronic Obstructive Pulmonary Disease	11.07%	9.63%	8.01%	9.45%	9.54%	

*Source – Policymap.com

Exhibit 4 – Contracts with public schools

received
7-17-15

TRANSPORTATION CONTRACT
HANCOCK SCHOOL DEPARTMENT
66 Maine Street, Suite 2A Ellsworth, Maine 04605
Phone 207.664.7199 ~ fax 207.669.6242

First Student agrees to transport and convey on every school day for the 2015/2016, 2016/2017, 2017/2018, 2018/2019, & 2019/2020 school years all HANCOCK pupils, grades PK-12, attending the Ellsworth High School, Sumner Memorial High School, Hancock County Technical Center and Hancock Grammar School. Other schools may come into existence during the terms of the contract, said transportation and conveyance will be to and from these schools. First Student also agrees to transport HANCOCK pupils to all extracurricular activities, co-curricular activities, inter-scholastic activities, field trips, after school programs, special school activities and functions, recreational activities, and other activities approved by the Superintendent of Schools. First Student further agrees to furnish vehicles that will comply with the requirements of State law including the rules, regulations, and specifications governing school bus construction, equipment and operation as promulgated by the Commissioner and the Department of Education, and meet the developmental and physical needs of all students.

1. **Routes and Mileage.**

First Student must recommend the routes to be followed but said routes may be subject to approval by the HANCOCK School Committee / Designee which retains its statutory authority to determine routes and to designate stops. It is expected First Student will work cooperatively with HANCOCK to design a transportation system that will meet both programming needs and maximize efficiencies. HANCOCK will maintain existing turnaround locations and First Student will obtain any necessary permission for the access to and use of the turnarounds.

The 2013/2014 mileage, inclusive of daily runs, extracurricular runs, after school, and secondary students was 65,000 miles. First Student should anticipate annual mileage variances from 63,000 to 67,000 not inclusive of miles due to factors such as location of unknown kindergarten children, new children who may move into areas not presently covered, breakdown mileage, variances in extracurricular mileage, etc. If the annual total mileage including regular pupil and extracurricular should exceed 67,000 in any one of the contract years, then there shall be a per mile additional compensation to First Student for the actual mileage above 67,000. Conversely, if the annual total mileage, including regular pupil and extracurricular should be less than 63,000 miles in any of the contract years, then there shall be a per mile adjustment in favor of the School Committee in the compensation to First Student for the actual mileage below 63,000 miles.

2. **Buses.**

First Student will provide a minimum of **5** diesel buses for regular runs and provide evidence of availability of a sufficient number of spare buses to cover breakdowns and to provide for extracurricular trips that may occur during the school day or at the time normal bus runs are being made. The buses may range in size between 84 and 72 passenger buses depending of the need within the confines of HANCOCK. First Student will provide handicapped accessible busses for the transportation of students with special needs or in wheelchairs, including use during the summer school session. First Student will also show proof of the ability to provide a sufficient number of spare buses to cover breakdowns and to provide for extra-curricular and field trips which may occur during the school day or during the time of normal bus runs.

First Student shall provide all vehicles to be used and shall bear all the operational, maintenance, and insurance costs. The school department shall pay the fuel costs of such vehicles when transporting HANCOCK children. All vehicles provided must meet Maine licensing requirements for operation as a school bus and all Maine Bus Safety Standards as now exist or may hereafter be amended. All vehicles must be inspected in accordance with State law pertaining to school buses. In addition, First Student shall be required to provide evidence that regular safety inspections are being done as requested. This may be in the form of driver inspection sheets that will be subject to HANCOCK Superintendent review. First Student shall also provide the HANCOCK Superintendent with monthly vehicle maintenance charts if requested. Buses must be repaired and serviced by First Student in a workmanlike manner. The buses must be mechanically safe and sound at all times.

No bus shall be more than eight years old or exceed an odometer reading exceeding 150,000 miles at the time of its use for regular runs. Exceptions may be granted by the HANCOCK School Committee upon presentation of a full maintenance/condition report on the vehicle to be used. The HANCOCK School Committee reserves the right to accept or reject any buses to be used, or a replacement vehicle, should such buses fail to meet minimum safety standards.

All buses used shall be equipped with cell phones, or 2-way radios to be provided by First Student, to allow adequate communication between the HANCOCK schools and the buses should contact be necessary. Additionally, First Student shall provide video equipment in all buses deemed necessary to assist in maintaining a safe transportation environment for all students. Whenever practical, buses will be housed as close as possible to each individual driver's route.

Should there be the ability to reduce the number of buses required to meet the needs of the daily runs, First Student will reduce the annual contract by the negotiated amount. Should there be a need to increase the number of buses to meet the needs of the daily runs HANCOCK will compensate First Student an additional negotiated amount per year of the contract. These figures will be prorated if for less than a full year. Additionally, the negotiated figure includes driver, insurance, and all other cost associated with the bus. Compensation may occur in the next school year.

HANCOCK shall make the arrangements for the purchase of the necessary fuel for the buses needed for the execution of this contract. Should it be necessary for First Student to purchase fuel outside of HANCOCK in the execution of this contract, HANCOCK shall reimburse First Student the full purchase price of the fuel with the presentation of evidence of such purchase.

3. **Days.**

First Student shall be required to transport students pursuant to this Contract for a period of one hundred seventy-five (175) days minimum to one hundred eighty five (185) days maximum each school year. In the event, due to a change in State law, local Committee decision, or Individual Educational Plan decision the school year for any pupil(s) is extended to exceed one hundred eighty five (185) days, First Student agrees to provide transportation at the contracted amount provided the total annual mileage does not exceed 67,000 miles. If the annual total mileage, including pupil and extracurricular miles, should exceed 67,000 compensation to First Student shall be adjusted at the negotiated per mile rate. Compensation may occur in the next school year.

First Student shall provide input relative to driving conditions regarding operation during inclement weather but the decision to close school on any given day shall rest solely with the HANCOCK Superintendent of Schools (hereinafter referred to as the "Superintendent").

In the event school is closed early due to weather conditions or otherwise, First Student shall be required to provide sufficient vehicles and drivers to ensure safe and timely transportation of pupils without exceeding loading factors.

4. Times.

First Student shall provide sufficient vehicles and drivers to maintain pupil transportation times compatible with existing schedules. In the event the HANCOCK School Committee changes the school starting and ending times during the term of the Contract, First Student shall make the necessary adjustments to comply with the changed times. If the changes in the school starting and ending times cause the annual total mileage including pupil and extracurricular miles to exceed 67,000; then compensation to First Student shall be equitably adjusted.

This section of the Contract is subject to annual review depending on any possible changes in the starting or ending times of the school day.

5. Insurance.

First Student shall obtain and at all times during the term of the Agreement shall keep in full force a minimum of $5,000,000 property damage/bodily injury insurance. Such coverage shall apply to any and all accidents in which buses might be involved. State policy requirements for insurance may be higher if the vehicles are also to be used as a public carrier. First Student shall also carry Worker's Compensation insurance in such an amount as is required by law.

Proof of insurance in the amount referred to above to cover carrying of passengers must be provided annually, in advance, to HANCOCK in the form of an insurance certificate. First Student shall also be required to list HANCOCK, its School Committee, and its agents and employees as additional insureds.

Should State law change to require increased insurance coverage beyond what is stated, First Student shall comply.

6. Drivers.

First Student shall provide drivers trained in the operation of school buses in general and in the operation of the specific vehicles to which they are assigned. Such drivers shall be exclusively employees of First Student and shall not be considered to be agents, employees or representatives of the HANCOCK School Committee for any purpose whatsoever. Such drivers will be of good reputation, good overall character and shall be courteous and considerate of the welfare of the students. Such drivers shall be fully qualified as school bus drivers and shall have satisfied and shall comply with all applicable Federal, State and local laws relating to driving of school buses. Such drivers shall be responsible for maintaining order among the pupils on their buses at all times in accordance with regulations for pupil conduct on such buses as promulgated by the School Committee. The Superintendent reserves the right to determine whether First Student has complied with the requirements of this section and to require the replacement of any driver who he/she determines is not performing satisfactorily or who is not maintaining order among the pupils on the buses, and First Student agrees to remove and replace such driver forthwith.

First Student shall pay all expenses and wages related to the employment of drivers for the school buses, and First Student shall be fully responsible for hiring and firing all drivers, for procuring worker's compensation insurance protection for them, and for paying all unemployment compensation and payroll taxes regarding them.

First Student shall submit to HANCOCK copies of valid Maine school bus operator's licenses and State police check for any prior convictions. First Student shall submit to HANCOCK a list of regular and substitute bus drivers who may be employed by First Student. This list shall be submitted prior to the beginning of each school year and updated during the school year as necessary. First Student shall, at his/her expense, have each bus driver have a physical examination annually prior to driving any bus. The results of said exam shall be made available to HANCOCK.

7. Pupils.
First Student shall be responsible for the care and supervision and conduct of pupils while being transported and enforce such rules of conduct as required to ensure the safe orderly transportation of pupils. Rules of conduct should reference and be in compliance with the State of Maine guidelines for transportation of pupils. First Student, based on disciplinary rules approved by the School Principal and/or school policy, shall be expected to handle student disciplinary problems, and shall have the right to withhold transportation service to any student who fails to conduct himself or herself in accordance with the rules of conduct or whose behavior endangers the safe operation of the contractor's buses. First Student and its drivers shall not administer bodily punishment to any student and shall not discharge any student from a bus other than at the student's designated stops, or deprive any student of transportation except as authorized in writing by the HANCOCK School Committee.

Upon request, First Student will meet with the Superintendent of Schools or designee for the purpose of reviewing any concerns by either party regarding student conduct, disciplinary procedures, or operational procedures. Other meetings may be scheduled on an as-needed basis dependent upon the circumstances.

First Student will not transport on any bus while transporting the students any passengers other than students and persons authorized by the Superintendent or the School Committee to be transported.

8. Pupil Training/Orientation.
First Student shall conduct training sessions for pupils in such areas as safety, conduct, good riding habits, emergency procedures, etc., as required by Maine Law. Classroom space and time will be made available for this activity.

9. Extracurricular Activities.
First Student shall provide vehicles and drivers sufficient to transport HANCOCK students to and from extracurricular activities such as field trips, athletic events, etc., at the request of the School District. The costs for these activities have been included in the statement of anticipated mileage.

Extra-Curricular trips outside the State of Maine may be scheduled from time to time and are not included in the mileage statement. Each trip will be negotiated as an extra with First Student on an individual trip basis.

10. Surveillance
First Student shall be prepared to provide video equipment in any bus if deemed necessary to assist in maintaining a safe transportation environment for all students.

11. Length of Contract.
The term of this contract shall be for five (5) years from July 1, 2015 through June 30, 2020.

12. Observer/Monitor
It is expected First Student will periodically place a supervisor on buses to observe and evaluate overall bus operations. Should a monitor be requested to ride the bus for an extended period of time, it shall be at the expense of HANCOCK.

13. Payment.
Payment for each year of the contract will be made monthly in twelve (12) equal installments starting in July of 2015.

14. Reports.
First Student shall be responsible for the preparation of and timely filing of all reports required by the State of Maine, including but not limited to the Uniform School Bus Accident Report, Pupil Transportation Safety Program, EF-T-21, and Survey of Privately Owned Buses for School Purposes, EF-T-19.

15. Arbitration
In the event that any dispute shall arise between parties hereto relative to the obligations of on another under the terms of this agreement, the parties agree to submit such dispute to binding arbitration in Bangor, Maine according to the Rules and Regulations of the American Arbitration Association.

16. Termination of Agreement.
First Student agrees with the HANCOCK School Committee that this Agreement can be terminated or amended upon any of the following conditions:

(A) Mutual agreement of the parties;
(B) Breach of the Agreement by either First Student or the HANCOCK School Committee;
(C) Failure of First Student to provide the services set forth herein in a prompt and effective manner to the satisfaction of the HANCOCK School Committee.

17. Hold Harmless
First Student shall agree to obey all laws, rules and regulations pertaining to the transportation of pupils including, but not limited to, State and municipal motor vehicle laws.

First Student shall, at its own expense, defend, indemnify, and hold harmless the District, its officers, agents, and employees from and against any and all claims, causes of action, suits, losses, damages, expenses, including attorney's fees, which arise out of, or result from the error, omission, negligence, or fault of First Student or any of its agents, contractors or employees in the performance of this agreement, except to the extent such loss or claim results from error, omission, negligence, or fault of the District, its officers or employees.

18. Assignment.
First Student will not subcontract or assign any portion of rights or obligations under this Agreement without prior written approval of the HANCOCK School Committee.

HANCOCK School Department
CONTRACTED SERVICES FOR TRANSPORTATION
WITH FIRST STUDENT
2015 TO 2020

School Year July to June	Annual Price	Per Mile Adjustment Rate	Per Bus Adjustment
2015/2016			
2016/2017			
2017/2018			
2018/2019			
2019/2020			

Confidential

TOTAL 5 YEAR COST : Confidential

First Student certifies that the requirements and stipulations outlined in the specifications are understood and that all the requirements of insurance, bus provisions and maintenance, drivers, pupil conduct, and training will be met.

Hold Harmless Clause

First Student shall agree to obey all state laws, rules, and regulations pertaining to the transportation of pupils. In addition, First Student shall agree to absolve, indemnify, and hold harmless the HANCOCK SCHOOL DEPARTMENT and its agents from any or all claims now and in the future that may be brought against First Student as a result of fulfilling the terms of this contract.

SIGNATURE OF FIRST STUDENT Howard Anderson DATE 7/17/15

PRINTED NAME & TITLE Howard Anderson, Area General Manager

BUSINESS NAME First Student

ADDRESS 51 Lowell Road, Salem NH 03079

TELEPHONE NUMBER 603-893-5722

SIGNATURE OF SCHOOL SUPERINTENDENT Katie H. King DATE 9/4/15

TRANSPORTATION SERVICES AGREEMENT BETWEEN ORRINGTON SCHOOL DEPARTMENT AND FIRST STUDENT, INC.

THIS AGREEMENT is made by and between ORRINGTON SCHOOL DEPARTMENT with Superintendent's Office at 19 School Street, Orrington Maine, 04474 hereinafter called "DISTRICT" and FIRST STUDENT, INC. with its headquarters and or business offices at 3 Ricom Way, Providence, Rhode Island, 02909 hereinafter called "CONTRACTOR" and collectively called "Parties".

WHEREAS, DISTRICT has selected CONTRACTOR to provide the pupil transportation services described herein; and

WHEREAS, CONTRACTOR desires to provide such transportation services,

NOW, THEREFORE, the parties enter into this Transportation Service Agreement dated 14 day of June, 2017 and mutually agree as follows:

1. **TERM** The term of the Agreement shall extend for three (3) years beginning July 1, 2017 and ending June 30, 2020; thereafter this agreement may be extended by mutual written agreement of the parties.

2. **SCOPE OF SERVICES** CONTRACTOR shall, during the term of this Agreement, supply and maintain such buses and personnel as are required to fulfill DISTRICT'S needs for transportation services as described in the NOTICE TO BID and CONTRACTOR'S Proposal. In the event of a conflict between this Agreement and those two documents, this Agreement will control.

3. **COMPENSATION** Compensation is based on approved bid in Exhibit "A"

4. **INDEMNIFICATION** CONTRACTOR agrees to indemnify, hold harmless and defend DISTRICT, its governing board, officers, employees and agents from and against every claim or demand which may be made by any person, firm, or corporation, or any other entity arising from or caused by any act of neglect, default or omission of CONTRACTOR in the performance of this Agreement, except to the extent that such claim or demand arises from or is caused by the negligence or willful misconduct of DISTRICT, its agents or employees.

5. **PERSONNEL** All drivers used in performance of this Agreement shall be CONTRACTOR employees. CONTRACTOR shall be responsible for hiring and discharging personnel employed by CONTRACTOR to perform its obligations hereunder. However, DISTRICT shall have the right to request CONTRACTOR to remove from service to the DISTRICT any employee who, in DISTRICT's sole discretion, is deemed unsuitable for the performance of transportation services for DISTRICT; provided that DISTRICT shall make such request in writing, state the reasons therefore and include any supporting documentation, and provide further that such request does not violate applicable local, state or federal laws, rules or regulations.

6. **EQUIPMENT** In the event that the DISTRICT or any governmental agency imposes equipment requirements other than those set forth on CONTRACTOR'S vehicles during the term of this Agreement, which are specific requirements for the operation of this Agreement, or immediate installation is required for continuing operation of vehicles, CONTRACTOR and DISTRICT in good faith shall negotiate price increases applicable to such equipment requirement. If the parties do not reach agreement regarding applicable price increases, either party may terminate this Agreement upon not less than 60 days prior written notice to the other party.

7. **<u>TERMINATION</u>** Either party may terminate this Agreement for convenience upon not less than one hundred eighty (180) days prior written notice to the other party. Also, if either party violates any of the covenants or duties imposed upon it by this Agreement, such violation shall entitle the other party to terminate this Agreement in accordance with the following procedure: The non-defaulting party shall give the offending party thirty (30) days' written notice of default and the opportunity to remedy the violation or take steps to remedy the violation. If at the end of such 30-day default notice period, the party notified has not remedied the purported violation or taken steps to do so, the non-defaulting party may terminate this Agreement upon a ten (10) days' notice of termination.

8. **<u>ASSIGNMENT</u>** The CONTRACTOR may assign the Agreement if the assignment is made to a parent, subsidiary, related or affiliated company.

9. **<u>FORCE MAJEURE</u>** In the event CONTRACTOR is unable to provide the transportation services as specified in this Agreement because of any act of God, civil disturbance, fire, riot, war, terrorism, picketing, strike, labor dispute, labor shortages, governmental action or any other condition or cause beyond CONTRACTOR's control or any other force of majeure clause as defined by state law, DISTRICT shall excuse CONTRACTOR from performance under this Agreement.

10. **<u>NOTICE TO PARTIES</u>** All notices to be given by the parties to this Agreement shall be in writing and serviced by depositing same in the United States Mail, certified mail.

Notices to DISTRICT shall be addressed to:
Orrington School Department
19 School Street
Orrington, ME 04474
Attention: Superintendent of Schools
Notices to CONTRACTOR shall be addressed to:
First Student, Inc.
51 Lowell Road
Salem, NH 03079
Attention: Area General Manager
With a Copy to:
First Student, Inc.
99 Front Ridge Rd
Orland, ME 04472
Attention: Sue Flewelling

IN WITNESS WHEREOF, this Agreement has been signed and executed in duplicate on behalf of the parties hereto by persons duly authorized on the day and year first written above.

Orrington School Department **FIRST STUDENT, INC.**

By: ______________	By: ______________
Title: Business Manager	Title: Area General Manager
ATTEST:	ATTEST:
By: ______________	By: ______________

ORRINGTON SCHOOL DEPARTMENT
BUS BID FORM

Contracted Services

School Year July to June	Gross Bid
2017/2018	Confidential
2018/2019	
2019/2020	

TOTAL THREE (3) YEAR BID Confidential

The bidder certifies that the requirements and stipulations outlined in the Bid Document are understood and that all the requirements, including without limitation, those pertaining to insurance, bus provisions and maintenance, drivers, pupil conduct and training will be met; and that if the bid is accepted, the bidder will enter into a Contract with the Orrington School Committee containing the terms of the bid Document through and including Article XVI thereof.

Mail bids to: AOS #47 Orrington School Department
Superintendent of
Schools 19 School Street
Orrington, ME 04474

received
7-17-15

TRANSPORTATION CONTRACT

LAMOINE SCHOOL DEPARTMENT

66 Maine Street, Suite 2A Ellsworth, Maine 04605
Phone 207.664.7199 ~ fax 207-669-6242

First Student agrees to transport and convey on every school day for the 2015/2016, 2016/2017, 2017/2018, 2018/2019, & 2019/2020 school years all LAMOINE pupils, grades PK-12, attending the Ellsworth High School, Hancock County Technical Center, MDI High School and LAMOINE Consolidated School. Other schools may come into existence during the terms of the contract, said transportation and conveyance will be to and from these schools. First Student also agrees to transport LAMOINE pupils to all extracurricular activities, co-curricular activities, inter-scholastic activities, field trips, after school programs, special school activities and functions, recreational activities, and other activities approved by the Superintendent of Schools. First Student further agrees to furnish vehicles that will comply with the requirements of State law including the rules, regulations, and specifications governing school bus construction, equipment and operation as promulgated by the Commissioner and the Department of Education, and meet the developmental and physical needs of all students.

1. Routes and Mileage.

First Student must recommend the routes to be followed but said routes may be subject to approval by the LAMOINE School Committee / Designee which retains its statutory authority to determine routes and to designate stops. It is expected First Student will work cooperatively with LAMOINE to design a transportation system that will meet both programming needs and maximize efficiencies. LAMOINE will maintain existing turnaround locations and First Student will obtain any necessary permission for the access to and use of the turnarounds.

The 2013/2014 mileage, inclusive of daily runs, extracurricular runs, after school, and secondary students was 29,000 miles. First Student should anticipate annual mileage variances from 27,000 to 31,000 not inclusive of miles due to factors such as location of unknown kindergarten children, new children who may move into areas not presently covered, breakdown mileage, variances in extracurricular mileage, etc. If the annual total mileage including regular pupil and extracurricular should exceed 31,000 in any one of the contract years, then there shall be a per mile additional compensation to First Student for the actual mileage above 31,000. Conversely, if the annual total mileage, including regular pupil and extracurricular should be less than 27,000 miles in any of the contract years, then there shall be a per mile adjustment in favor of the School Committee in the compensation to First Student for the actual mileage below 27,000 miles.

2. Buses.

First Student will provide a minimum of 2 diesel buses for regular runs and provide evidence of availability of a sufficient number of spare buses to cover breakdowns and to provide for extracurricular trips that may occur during the school day or at the time normal bus runs are being made. The buses may range in size between 84 and 72 passenger buses depending of the need within the confines of LAMOINE. First Student will provide handicapped accessible busses for the transportation of students with special needs or in wheelchairs, including use during the summer school session. First Student will also show proof of the ability to provide a sufficient number of spare buses to cover breakdowns and to provide for extra-curricular and field trips which may occur during the school day or during the time of normal bus runs.

First Student shall provide all vehicles to be used and shall bear all the operational, maintenance, and insurance costs. The school department shall pay the fuel costs of such vehicles when transporting LAMOINE children. All vehicles provided must meet Maine licensing requirements for operation as a school bus and all Maine Bus Safety Standards as now exist or may hereafter be amended. All vehicles must be inspected in accordance with State law pertaining to school buses. In addition, First Student shall be required to provide evidence that regular safety inspections are being done as requested. This may be in the form of driver inspection sheets that will be subject to LAMOINE Superintendent review. First Student shall also provide the LAMOINE Superintendent with monthly vehicle maintenance charts if requested. Buses must be repaired and serviced by First Student in a workmanlike manner. The buses must be mechanically safe and sound at all times.

No bus shall be more than eight years old or exceed an odometer reading exceeding 150,000 miles at the time of its use for regular runs. Exceptions may be granted by the LAMOINE School Committee upon presentation of a full maintenance/condition report on the vehicle to be used. The LAMOINE School Committee reserves the right to accept or reject any buses to be used, or a replacement vehicle, should such buses fail to meet minimum safety standards.

All buses used shall be equipped with cell phones, or 2-way radios to be provided by First Student, to allow adequate communication between the LAMOINE schools and the buses should contact be necessary. Additionally, First Student shall provide video equipment in all buses to assist in maintaining a safe transportation environment for all students. Whenever practical, buses will be housed as close as possible to each individual driver's route.

Should there be the ability to reduce the number of buses required to meet the needs of the daily runs, First Student will reduce the annual contract by a negotiate amount. Should there be a need to increase the number of buses to meet the needs of the daily runs LAMOINE will compensate First Student an additional negotiated amount per year of the contract. These figures will be prorated if for less than a full year. Additionally, the negotiated figure includes driver, insurance, and all other cost associated with the bus. Compensation may occur in the next school year.

LAMOINE shall make the arrangements for the purchase of the necessary fuel for the buses needed for the execution of this contract. Should it be necessary for First Student to purchase fuel outside of LAMOINE in the execution of this contract, LAMOINE shall reimburse First Student the full purchase price of the fuel with the presentation of evidence of such purchase.

3. **Days.**

First Student shall be required to transport students pursuant to this Contract for a period of one hundred seventy-five (175) days minimum to one hundred eighty five (185) days maximum each school year. In the event, due to a change in State law, local Committee decision, or Individual Educational Plan decision the school year for any pupil(s) is extended to exceed one hundred eighty five (185) days, First Student agrees to provide transportation at the contracted amount provided the total annual mileage does not exceed 31,000 miles. If the annual total mileage, including pupil and extracurricular miles, should exceed 31,000 compensation to First Student shall be adjusted at the negotiated per mile rate. Compensation may occur in the next school year.

First Student shall provide input relative to driving conditions regarding operation during inclement weather but the decision to close school on any given day shall rest solely with the LAMOINE Superintendent of Schools (hereinafter referred to as the "Superintendent").

In the event school is closed early due to weather conditions or otherwise, First Student shall be required to provide sufficient vehicles and drivers to ensure safe and timely transportation of pupils without exceeding loading factors.

4. Times.

First Student shall provide sufficient vehicles and drivers to maintain pupil transportation times compatible with existing schedules. In the event the LAMOINE School Committee changes the school starting and ending times during the term of the Contract, First Student shall make the necessary adjustments to comply with the changed times. If the changes in the school starting and ending times cause the annual total mileage including pupil and extracurricular miles to exceed 31,000; then compensation to First Student shall be equitably adjusted.

This section of the Contract is subject to annual review depending on any possible changes in the starting or ending times of the school day.

5. Insurance.

First Student shall obtain and at all times during the term of the Agreement shall keep in full force a minimum of $5,000,000 property damage/bodily injury insurance. Such coverage shall apply to any and all accidents in which buses might be involved. State policy requirements for insurance may be higher if the vehicles are also to be used as a public carrier. First Student shall also carry Worker's Compensation insurance in such an amount as is required by law.

Proof of insurance in the amount referred to above to cover carrying of passengers must be provided annually, in advance, to LAMOINE in the form of an insurance certificate. First Student shall also be required to list LAMOINE, its School Committee, and its agents and employees as additional insured.

Should State law change to require increased insurance coverage beyond what is stated, First Student shall comply.

6. Drivers.

First Student shall provide drivers trained in the operation of school buses in general and in the operation of the specific vehicles to which they are assigned. Such drivers shall be exclusively employees of First Student and shall not be considered to be agents, employees or representatives of the LAMOINE School Committee for any purpose whatsoever. Such drivers will be of good reputation, good overall character and shall be courteous and considerate of the welfare of the students. Such drivers shall be fully qualified as school bus drivers and shall have satisfied and shall comply with all applicable Federal, State and local laws relating to driving of school buses. Such drivers shall be responsible for maintaining order among the pupils on their buses at all times in accordance with regulations for pupil conduct on such buses as promulgated by the School Committee. The Superintendent reserves the right to determine whether First Student has complied with the requirements of this section and to require the replacement of any driver who he/she determines is not performing satisfactorily or who is not maintaining order among the pupils on the buses, and First Student agrees to remove and replace such driver forthwith.

First Student shall pay all expenses and wages related to the employment of drivers for the school buses, and First Student shall be fully responsible for hiring and firing all drivers, for procuring worker's compensation insurance protection for them, and for paying all unemployment compensation and payroll taxes regarding them.

First Student shall submit to LAMOINE copies of valid Maine school bus operator's licenses and State police check for any prior convictions. First Student shall submit to LAMOINE a list of regular and substitute bus drivers who may be employed by First Student. This list shall be submitted prior to the beginning of each school year and updated during the school year as necessary. First Student shall, at his/her expense, have each bus driver have a physical examination annually prior to driving any bus. The results of said exam shall be made available to LAMOINE.

7. Pupils.

First Student shall be responsible for the care and supervision and conduct of pupils while being transported and enforce such rules of conduct as required to ensure the safe orderly transportation of pupils. Rules of conduct should reference and be in compliance with the State of Maine guidelines for transportation of pupils. First Student, based on disciplinary rules approved by the School Principal and/or school policy, shall be expected to handle student disciplinary problems, and shall have the right to withhold transportation service to any student who fails to conduct himself or herself in accordance with the rules of conduct or whose behavior endangers the safe operation of the contractor's buses. First Student and its drivers shall not administer bodily punishment to any student and shall not discharge any student from a bus other than at the student's designated stops, or deprive any student of transportation except as authorized in writing by the LAMOINE School Committee.

Upon request, First Student will meet with the Superintendent of Schools or designee for the purpose of reviewing any concerns by either party regarding student conduct, disciplinary procedures, and operational procedures. Other meetings may be scheduled on an as-needed basis dependent upon the circumstances.

First Student will not transport on any bus while transporting the students any passengers other than students and persons authorized by the Superintendent or the School Committee to be transported.

8. Pupil Training/Orientation.

First Student shall conduct training sessions for pupils in such areas as safety, conduct, good riding habits, emergency procedures, etc., as required by Maine Law. Classroom space and time will be made available for this activity.

9. Extracurricular Activities.

First Student shall provide vehicles and drivers sufficient to transport LAMOINE students to and from extracurricular activities such as field trips, athletic events, etc., at the request of the School District. The costs for these activities have been included in the statement of anticipated mileage.

Extra-Curricular trips outside the State of Maine may be scheduled from time to time and are not included in the mileage statement. Each trip will be negotiated as an extra with First Student on an individual trip basis.

10. Surveillance

First Student shall be prepared to provide video equipment in any bus if deemed necessary to assist in maintaining a safe transportation environment for all students.

11. Length of Contract.

The term of this contract shall be for five (5) years from July 1, 2015 through June 30, 2020.

12. Observer/Monitor

It is expected First Student will periodically place a supervisor on buses to observe and evaluate overall bus operations. Should a monitor be requested to ride the bus for an extended period of time, it shall be at the expense of LAMOINE.

13. Payment.

Payment for each year of the contract will be made monthly in twelve (12) equal installments starting in July of 2015.

14. Reports.

First Student shall be responsible for the preparation of and timely filing of all reports required by the State of Maine, including but not limited to the Uniform School Bus Accident Report, Pupil Transportation Safety Program, EF-T-21, and Survey of Privately Owned Buses for School Purposes, EF-T-19.

15. Arbitration

In the event that any dispute shall arise between parties hereto relative to the obligations of on another under the terms of this agreement, the parties agree to submit such dispute to binding arbitration in Bangor, Maine according to the Rules and Regulations of the American Arbitration Association.

16. Termination of Agreement.

First Student agrees with the LAMOINE School Committee that this Agreement can be terminated or amended upon any of the following conditions:

(A) Mutual agreement of the parties;
(B) Breach of the Agreement by either First Student or the LAMOINE School Committee;
(C) Failure of First Student to provide the services set forth herein in a prompt and effective manner to the satisfaction of the LAMOINE School Committee.

17. Hold Harmless

First Student shall agree to obey all laws, rules and regulations pertaining to the transportation of pupils including, but not limited to, State and municipal motor vehicle laws.

First Student shall, at its own expense, defend, indemnify, and hold harmless the District, its officers, agents, and employees from and against any and all claims, causes of action, suits, losses, damages, expenses, including attorney's fees, which arise out of, or result from the error, omission, negligence, or fault of First Student or any of its agents, contractors or employees in the performance of this agreement, except to the extent such loss or claim results from error, omission, negligence, or fault of the District, its officers or employees.

18. Assignment.

First Student will not subcontract or assign any portion of rights or obligations under this Agreement without prior written approval of the LAMOINE School Committee.

LAMOINE SCHOOL DEPARTMENT
CONTRACTED SERVICES FOR TRANSPORTATION
WITH FIRST STUDENT
2015 TO 2020

School Year July to June	Annual Price	Per Mile Adjustment Rate	Per Bus Adjustment
2015/2016	Confidential		
2016/2017			
2017/2018			
2018/2019			
2019/2020			

TOTAL 5 YEAR COST: Confidential

First Student certifies that the requirements and stipulations outlined in the specifications are understood and that all the requirements of insurance, bus provisions and maintenance, drivers, pupil conduct, and training will be met.

Hold Harmless Clause

First Student shall agree to obey all state laws, rules, and regulations pertaining to the transportation of pupils. In addition, First Student shall agree to absolve, indemnify, and hold harmless the LAMOINE SCHOOL DEAPRTMENT and its agents from any or all claims now and in the future that may be brought against First Student as a result of fulfilling the terms of this contract.

SIGNATURE OF FIRST STUDENT *Howard Anderson* DATE *7/17/15*

PRINTED NAME & TITLE *Howard Anderson, Area General Manager*

BUSINESS NAME *First Student*

ADDRESS *51 Lowell Rd, Salem NH 03079*

TELEPHONE NUMBER *603 893-5722*

SIGNATURE OF SCHOOL SUPERINTENDENT *Katrina H. Kane* DATE *6/4/15*

Regional School Unit 25
TRANSPORTATION AGREEMENT

JULY 1, 2015 – JUNE 30, 2020

This agreement shall confirm the arrangement and understandings between First Student (the "Contractor") and Regional School Unit No. 25 ("RSU 25") for transportation services (the "Contract") that incorporates the specifications and requirements set forth herein.

The Contractor agrees to transport and convey on every school day for the 2015/2016, 2016/2017, 2017/2018, 2018/2019, & 2019/2020 school years all RSU 25 pupils, grades EK-12, attending the Bucksport High School, Bucksport Middle School, Miles Lane School. Jewett School, Hancock County Technical Center, Reach School, and other schools that may come into existence during the terms of the Contract, said transportation and conveyance to be to and from these schools. The Contractor also agrees to transport RSU 25 pupils on all extracurricular activities, co-curricular activities, inter-scholastic activities, field trips, after school programs, special school activities and functions, recreational activities, and other activities approved by the Superintendent of Schools (the "Superintendent"). The Contractor further agrees to furnish vehicles that will comply with the requirements of State law including the rules, regulations, and specifications governing school bus construction, equipment and operation as promulgated by the Commissioner and the Department of Education, and meet the developmental and physical needs of all students.

I. Routes and Mileage.

The Contractor is encouraged and expected to recommend the bus routes to be followed that will provide safe and efficient transportation of RSU 25 students. Said routes must be approved by the RSU 25 School Board / Designee which retains its statutory authority to determine routes and to designate stops. It is expected the Contractor will work cooperatively with RSU 25 to design a transportation system that will meet both programming needs and maximize efficiencies. RSU 25 will maintain existing turnaround locations and the Superintendent will obtain any necessary permission for the access to the turnarounds for the use of the Contractor.

The Contractor should anticipate that annual mileage variances under the Contract will range from 248,000 to 270,000 inclusive of early kindergarten transportation for Bucksport, Orland, Prospect, and VeronaIsland and miles due to factors such as location of kindergarten children, new children who may move into areas not presently covered, breakdown mileage, variances in extracurricular mileage, etc. If the annual total mileage including regular pupil and extracurricular should exceed 270,000 in any one of the Contract years, then there shall be a .70 cent per mile additional compensation to the Contractor for the actual mileage above 270,000. Conversely, if the annual total mileage, including regular pupil and extracurricular should be less than 248,000 miles in any of the Contract years, then there shall be a .70 cent per mile adjustment in favor of the School Board in the compensation to the Contractor for the actual mileage below 248,000.

II. Buses.

The Contractor will provide properly equipped buses necessary to transport the students of RSU 25. Currently, on a daily basis, sixteen (16) full size (72-84) passenger diesel buses are being used for regular runs within the confines of RSU 25 and two (2) 24 passenger diesel, handicapped accessible buses for the transportation of students with special needs. The Contractor will provide evidence of availability of a sufficient number of spare buses to cover breakdowns and to provide for extracurricular trips that may occur during the school day or at the time normal bus runs are being made.

The Contractor shall provide all vehicles to be used and shall bear all the operational, maintenance, and insurance costs. RSU 25 shall pay the fuel costs of such vehicles when transporting RSU 25 children. All vehicles provided must meet Maine licensing requirements for operation as a school bus and all Maine Bus Safety Standards as now exist or may hereafter be amended. All vehicles must be inspected in accordance with State law pertaining to school buses. In addition, the Contractor shall be required to provide, on a monthly basis, evidence that regular safety inspections are being done. This may be in the form of driver inspection sheets that will be subject to RSU 25 review. The Contractor shall also provide the RSU 25 School with monthly vehicle maintenance charts. The buses must be mechanically safe and sound at all times.

Buses must be repaired and serviced by the Contractor in a workmanlike manner and in a facility within the confines of the RSU 25. It is expected the fleet of buses provided to RSU 25 will be a range of ages, but no bus shall be more than eight (8) years old. Exceptions may be granted by the RSU 25 upon presentation of a full maintenance/condition report on the vehicle to be used. The RSU 25 reserves the right to accept or reject any buses to be used, or a replacement vehicle, should such buses fail to meet minimum safety standards.

All buses used shall be equipped with cell phones, or 2-way radios to be provided by the Contractor, to allow adequate communication between the RSU 25 schools and the buses should contact be necessary. Additionally, the Contractor shall provide video equipment in all buses to assist in maintaining a safe transportation environment for all students and drivers. Whenever practical, buses will be housed as close as possible to each individual driver's route.

Should there be the ability to reduce the number of buses required to meet the needs of the daily runs, the Contractor will reduce the annual Contract price by [redacted] per bus per year of the Contract. Should there be a need to increase the number of buses to meet the needs of the daily runs RSU 25 will compensate the Contractor an additional [redacted] per bus per year of the Contract. These figures will be prorated if for less than a full year. Additionally, the [redacted] figure includes driver, insurance, and all other cost associated with the bus.

RSU 25 shall make the arrangements for the purchase of the necessary fuel for the buses needed for the execution of this Contract. Should it be necessary for the Contractor to purchase fuel outside of RSU 25 in the execution of this Contract, RSU 25 shall reimburse the Contractor the full purchase price of the fuel with the presentation of evidence of such purchase.

<u>III. Days.</u>

The Contractor shall be required to transport students pursuant to this Contract for a period of one hundred seventy-five (175) days minimum to one hundred eighty five (185) days maximum each school year. In the event, due to a change in State law or school board decision, the school year for pupils is extended to exceed one hundred eighty five (185) days, the Contractor agrees to provide transportation at the contracted amount provided the total annual mileage does not exceed 270,000 miles. If the annual total mileage, including pupil and extracurricular miles, should exceed 270,000, then compensation to the Contractor shall be adjusted at a rate of 70 cents per mile.

The Contractor shall provide input relative to driving conditions regarding operation during inclement weather but the decision to close school on any given day shall rest solely with the RSU 25 Superintendent of Schools (hereinafter referred to as the "Superintendent").

In the event school is closed early due to weather conditions or otherwise, the Contractor shall be required to provide sufficient vehicles and drivers to ensure safe and timely transportation of pupils without exceeding loading factors. It is expected the Contractor will work with the RSU 25 administration to develop plans for transportation in the event of an emergency, and will be willing to practice the evacuation plans on an annual basis if needed.

IV. Times.

The Contractor shall provide sufficient vehicles and drivers to maintain pupil transportation times compatible with existing schedules.

In the event the RSU 25 School Board changes the school starting and ending times during the term of the Contract, the Contractor shall make the necessary adjustments to comply with the changed times. If the changes in the school starting and ending times cause the annual total mileage including pupil and extracurricular miles to exceed 270,000; then compensation to the Contractor shall be equitably adjusted.

This section of the Contract is subject to annual review depending on any possible changes in the starting or ending times of the school day.

V. Insurance/Bonds/Indemnification.

The Contractor shall obtain and maintain at all times during the term of the Agreement shall keep in full force a minimum of $10,000,000 property damage/bodily injury insurance. Such coverage shall apply to any and all accidents in which buses might be involved. State policy requirements for insurance may be higher if the vehicles are also to be used as a public carrier. The Contractor shall also carry Worker's Compensation insurance in such an amount as is required by law.

Proof of insurance in the amount referred to above to cover carrying of passengers must be provided annually, in advance, to RSU 25 in the form of an insurance certificate. The Contractor shall also be required to list RSU 25, its School Board, and its agents and employees as additional insureds.Should State law change to require increased insurance coverage beyond what is stated, the Contractor shall comply.

The Contractor shall procure and maintain in force a performance bond from an insurance company or surety company licensed to do business in the State of Maine for the benefit of RSU 25 conditioned upon the faithful performance of the terms of the Contract for each school year of the ontract.

The Contractor agrees to indemnify and hold harmless RSU 25 and its School Board members, officers, agents, and employees in their individual and official capacities (collectively, the "Indemnities") from any and all claims, costs, expenses, injuries, liabilities, losses, and damages of every kind and description, including without limitation claims for property damage or bodily injury (including death), resulting from or arising out of the performance of the Contract by the Contractor, its employees, agents, or subcontractors. Claims to which this provision applies include, without limitation, the following: (i) Claims made or asserted by any driver, contractor, subcontractor, laborer and any other person, firm, corporation or other legal entity (hereinafter in this paragraph referred to as "person") providing work, services, materials, equipment or supplies in connection with the performance of the Contract; (ii) Claims made or asserted by any other person who may be injured or damaged by the performance of Contractor under the Contract; (iii) all legal costs and other expenses incurred by Indemnities in connection with any asserted claims to which this provision applies; and (iv) legal costs and expenses incurred by Indemnities in enforcing this provision. This provision shall apply, without limitation, to all claims made by employees of the Contractor or of any supplier or subcontractor, in contractual privities with the Contractor regardless of any provisions of the applicable Workers' Compensation laws, and in particular regardless of the exclusive remedy and/or employer immunity provisions of those laws, all of which are expressly waived. Nothing in this Contract is intended, or shall be construed, to constitute a waiver of any defense, immunity, or liability that may be available to RSU 25, or any of its officers, agents, or employees available at common law or by statute, including the Maine Tort Claims Act.

VI. Drivers.

The Contractor shall provide drivers trained in the operation of school buses in general and in the operation of the specific vehicles to which they are assigned. Such drivers shall be exclusively employees of the Contractor and shall not be considered to be agents, employees or representatives of RSU 25 or its School Board for any purpose whatsoever. Such drivers will be of good reputation , to the extent not prohibited by law, and good overall character, shall be courteous and considerate of the welfare of the students. Such drivers shall be fully qualified as school bus drivers and shall have satisfied and shall comply with all applicable Federal, State and local laws relating to driving of school buses. Such drivers shall be responsible for maintaining order among the pupils on their buses at all times in accordance with regulations for pupil conduct on such buses as promulgated by the School Board. The Superintendent reserves the right to determine whether the Contractor has complied with the requirements of this section and to require the replacement of any driver who he/she determines is not performing satisfactorily or who is not maintaining order among the pupils on the buses, and the Contractor agrees to remove and replace such driver forthwith.

The Contractor shall pay all expenses and wages related to the employment of drivers for the school buses, and the Contractor shall be fully responsible for hiring and firing all drivers, for procuring worker's compensation insurance protection for them, and for paying all unemployment compensation and payroll taxes regarding them.

The Contractor shall submit to RSU 25 copies of valid Maine school bus operator's licenses and State police check for any prior convictions. The Contractor shall submit to the RSU 25 a list of regular and substitute bus drivers who may be employed by the Contractor. This list shall be submitted prior to the beginning of each school year and updated during the school year as necessary. The Contractor shall, at his/her expense, have each bus driver have a physical examination annually prior to driving any bus. The results of said exam shall be made available to RSU 25.

VII. Pupils.

The Contractor shall be responsible for the care and supervision and conduct of pupils while being transported and enforce such rules of conduct as required to ensure the safe orderly transportation of pupils. Rules of conduct should reference and be in compliance with the State of Maine guidelines for transportation of pupils. The Contractor, based on disciplinary rules approved by the School Board, shall be expected to handle student disciplinary problems, and shall have the right to withhold transportation service to any student who fails to conduct himself or herself in accordance with the rules of conduct or whose behavior endangers the safe operation of the Contractor's buses. The Contractor and its drivers shall not administer bodily punishment to any student and shall not discharge any student from a bus other than at the student's designated stops, or deprive any student of transportation except as authorized in writing by the RSU 25 School Board.

The Contractor will meet at least semi-annually with the Superintendent of Schools for the purpose of reviewing any concerns by either party regarding student conduct, disciplinary procedures, and operational procedures. Other meetings may be scheduled on an as-needed basis dependent upon the circumstances.

While transporting students, the Contractor will not transport on any bus while transporting the students any passengers other than students and persons authorized by the Superintendent or the School Board to be transported.

VIII. Pupil Training/Orientation.

The Contractor shall conduct training sessions for pupils in such areas as safety, conduct, good riding habits, emergency procedures, etc., as required by Maine Law. Classroom space and time will be made available for this activity.

IX. Extracurricular Activities.

The Contractor shall provide vehicles and drivers sufficient to transport RSU 25 students to and from extracurricular activities such as field trips, athletic events, etc., at the request of the School District. The costs for these activities have been included in the statement of anticipated mileage.

Extra-Curricular trips outside the State of Maine may be scheduled from time to time and are not included in the mileage statement. Each trip will be negotiated as an extra with the Contractor on an individual trip basis.

X. Surveillance

Contractor shall provide surveillance system for use on the school buses provided under this agreement. Each bus shall have boxes constructed as required for safe use, wired with the capacity to contain a video camera. Contractor shall retain ownership of the video monitoring equipment and will be responsible for supplying all video recording equipment, repair and replacement of equipment. In addition, Contractor and District will develop and update as necessary guidelines and procedures for handling, reviewing and disclosure of video tapes and the information they may contain.

Any vehicle that records audio on a bus under this agreement shall post a notice indicating that the bus is recording audio; such notice shall be affixed by Contractor at the time of delivery of the vehicle to the District. Within 30 days of this agreement, the District and Contractor will also establish reasonable procedures for the review and maintenance of recordings.

XI. Length of Contract.

The term of the Contract shall be negotiable for a term of up to five (5) years from July 1, 2015 through June 30, 2020.

XII. Observer/Monitor

It is expected the Contractor will periodically place a supervisor on buses to observe and evaluate overall bus operations. Should a monitor be requested to ride the bus for an extended period of time, it shall be at the expense of RSU 25.

XIII. Payment.

Payment for each year of the Contract will be made monthly in twelve (12) equal installments starting July 1, 2015.

XIV. Reports.

The Contractor shall be responsible to collaborate with the Superintendent of RSU 25 in the preparation and ensure the timely filing of all reports and information required by the State of Maine, including but not limited to the Uniform School Bus Accident Report, Pupil Transportation Safety Program, EF-T-21, and Survey of Privately Owned Buses for School Purposes, EF-T-19.

XV. Dispute Resolution

Any dispute arising out of or relating to the Contract shall be resolved in accordance with this paragraph. Either Party may give written notice of a dispute arising out of or related to the Contract to the other Party by certified mail, return receipt requested. The Parties shall attempt to resolve the matter through informal communication or negotiation for a period of thirty (30) days from the date of receipt of notice by the noticed Party. If the dispute has not been resolved within thirty (30) days, either Party may serve written notice on the other Party of a request for mediation. The mediation shall be conducted in Maine by a mediator mutually agreeable to the Parties, shall not exceed one full day or two half days in length, and shall be completed within sixty (60) days from the date of receipt of notice of a request for mediation by the noticed Party. If the Parties are unable to agree on a mediator within thirty (30) days, or to resolve the dispute through mediation within sixty (60) days. In the event that any dispute shall arise between parties hereto relative to the obligations of on another under the terms of this agreement, the parties agree to submit such dispute to binding arbitration in Bangor, Maine according to the Rules and Regulations of the American Arbitration Association.

XVI. Termination of Agreement.

The Contractor agrees with the RSU 25 School Board that this Agreement can be terminated upon any of the following conditions:

(A) Mutual agreement of the parties; or

(B) If either Party commits a material breach in the performance of its obligations under the contract, including failure of the contractor to provide the services set forth herein in a prompt and effective manner to the satisfaction of the RSU 25 School Board, and such breach continues for a period of 30 days after delivery by the non-breaching Party of written notice reasonably detailing such breach, then the non-breaching Party shall have the right to terminate this contract, with immediate effect, by written notice to the breaching Party.

(C) The occurrence of an event of non-appropriation as described in Section XIX below.

XVII. Assignment.

The Contractor will not subcontract or assign any portion of rights or obligations under this Agreement without prior written approval of the RSU 25 School Board. The provisions of Section V and XVI shall survive termination of this contract.

XIX. Nonappropriation.

If local or State funding is insufficient in any year of the Contract due to voter disapproval of RSU 25's operating budget or a change in the state school funding laws, the Contract may be terminated at the end of the Contract year without penalty to RSU 25. In the event that sufficient funding is not appropriated by local voters or by the State, the School Board shall notify the Contractor promptly after occurrence of such non-appropriation, and may terminate the Contract effective at the end of the period for which appropriation exists.

XX. Force Majeure

Failure to perform under this Contract shall be good and sufficient reason for excuse from contractual liability when such failure is due to strike, acts of war or terrorism, fire, earthquake, flood or other acts of God beyond the control of the Contractor or the District; provided, however, that such excuse for performance shall be limited to the period during which the party(ies) are prevent from performing. The party that is affected by such cause(s) shall give the other party prompt written notice of the event and take all reasonable steps necessary to mitigate the effects of such events.

XXI. Service Level Adjustments

This Contract may be amended only by a written instrument signed by the parties.

XXII. Financial Consideration

School Year July - June	Annual Total
2015/2016	
2016/2017	Confidential
2017/2018	
2018/2019	
2019/2020	

TOTAL 5 YEAR COST Confidential

The undersigned certifies that the requirements and stipulations outlined in the Transportation Agreement Document are understood and satisfactory to both First Student and RSU 25.

SIGNATURE FOR FIRST STUDENT: [signature]

PRINTED NAME & TITLE: Howard Anderson / Area General Manager

DATE: 9/3/05

SIGNATURE FOR RSU 25: [signature]

PRINTED NAME & TITLE: Superintendent

DATE: 9/3/15

RegionalSchool Unit 25

James Boothby, Superintendent

SusanLamoreauCentral OfficeEvelyn Beaulieu
Director of Special Services62 Mechanic Street Director of Curriculum &
207.469.6642Bucksport ME 04416 Academic Achievement
207.469.7311 207.469.6641
FAX 207.469.6640
www.rsu25.org

March 18, 2015

Mr. Howard Anderson

Area General Manager, First Student

51 Lowell Road

Salem, N.H. 03079

Dear Mr. Anderson,

I am pleased to inform you the RSU 25 School Board took action last evening and approved my recommendation to engage First Student as our transportation contractor. The motion the Board took accepted your proposal to provide transportation services for the Daily Runs and the HCTC runs, up to 270,000 miles per year, at the prices shown in the table below:

School Year	Daily Runs	HCTC Runs	Total
2015-2016	[illegible]	[illegible]	[illegible]
2016-2017	[illegible]	[illegible]	[illegible]
2017-2018	[illegible]	[illegible]	[illegible]
2018-2019	[illegible]	[illegible]	[illegible]
2019-2020	[illegible]	[illegible]	[illegible]

Confidential

Please contact me so we can finalize the agreement. I want to thank you for the service First Student has provided RSU 25 and look forward to continuing that relationship.

Sincerely,

James Boothby

Superintendent

Appendices

Adopting Clean Fuels and Technologies on School Buses

Pollution and Health Impacts in Children

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Abstract

Rationale: More than 25 million American children breathe polluted air on diesel school buses. Emission reduction policies exist, but the health impacts to individual children have not been evaluated.

Methods: Using a natural experiment, we characterized the exposures and health of 275 school bus riders before, during, and after the adoption of clean technologies and fuels between 2005 and 2009. Air pollution was measured during 597 trips on 188 school buses. Repeated measures of exhaled nitric oxide ($F_{E_{NO}}$), lung function (FEV_1, FVC), and absenteeism were also collected monthly (1,768 visits). Mixed-effects models longitudinally related the adoption of diesel oxidation catalysts (DOCs), closed crankcase ventilation systems (CCVs), ultralow-sulfur diesel (ULSD), or biodiesel with exposures and health.

Measurements and Main Results: Fine and ultrafine particle concentrations were 10–50% lower on buses using ULSD, DOCs, and/or CCVs. ULSD adoption was also associated with reduced $F_{E_{NO}}$ (−16% [95% confidence interval (CI), −21 to −10%]), greater changes in FVC and FEV_1 (0.02 [95% CI, 0.003 to 0.05] and 0.01 [95% CI, −0.006 to 0.03] L/yr, respectively), and lower absenteeism (−8% [95% CI, −16.0 to −0.7%]), with stronger associations among patients with asthma. DOCs, and to a lesser extent CCVs, also were associated with improved $F_{E_{NO}}$, FVC growth, and absenteeism, but these findings were primarily restricted to patients with persistent asthma and were often sensitive to control for ULSD. No health benefits were noted for biodiesel. Extrapolating to the U.S. population, changed fuel/technologies likely reduced absenteeism by more than 14 million/yr.

Conclusions: National and local diesel policies appear to have reduced children's exposures and improved health.

Keywords: particulate matter; air pollution; asthma; absenteeism; lung function

Traffic-related air pollution may adversely affect children's respiratory health (1–11). Little is known, however, about the health effects of commuting to school, especially aboard diesel-powered school buses. As more than 25 million American children commute via school bus (12) and experience elevated pollution levels on these buses (13–19), commuting is a major contributor to children's exposures to traffic-related air pollutants (14, 20–22).

To limit exposures to diesel exhaust and to protect health, the U.S. Environmental Protection Agency (USEPA) created a voluntary retrofit initiative to help states install clean air technologies on vehicles. Clean air technologies such as

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At a Glance Commentary

Scientific Knowledge on the Subject: Exposures to traffic-related air pollution at home and school have been repeatedly linked to adverse respiratory health in children. Children also experience elevated pollution levels on diesel-powered school buses, yet little is known about the resultant health effects or the level of protection offered by clean air technologies and fuels on school buses.

What This Study Adds to the Field: The findings from this natural experiment suggest that when children ride buses with clean air technologies and/or fuels, they experience lower exposures to air pollution, less pulmonary inflammation, more rapid lung growth over time, and reduced absenteeism than when they are on buses without these technologies and fuels. These improvements were often strongest among children with asthma, suggesting that cleaner buses may be especially important to protecting the health of our most vulnerable students. Given that more than 25 million American children commute to school each day via school bus, these findings have clear policy implications for protecting the health of school children.

diesel oxidation catalysts (DOCs) and crankcase ventilation systems (CCVs) are used to reduce tailpipe and engine emissions, respectively. These technologies, which can be adopted on older buses and are commonly installed on newer buses, are estimated to reduce particulate emissions and onboard concentrations by 20 to 50% (23–28). The USEPA also required that refineries produce ultralow-sulfur diesel (ULSD) starting in 2006 under the Highway Diesel Fuel Sulfur Control Requirements. ULSD and biodiesel are projected to reduce particle generation by approximately 10–30% and to enhance the operation of clean air technologies (23, 29). Although these initiatives have been estimated to prevent approximately 20,000 hospitalizations and 3.3 million days of lost productivity (30), no study has directly assessed the health impacts of these policies on individual children.

We investigated the impacts of clean air technologies and fuels on air pollution levels in school buses and on pulmonary health in a cohort of elementary school children. Associations were explored using a natural experiment in which we monitored in-bus air pollution concentrations and markers of health before, during, and after the staggered adoption of clean air technologies and fuels. Early results of this study have been previously reported as abstracts (31–33), and one published article (16).

Methods

Population and Design

We sampled 307 school bus riders (6–12 yr) attending a public elementary school in the Seattle and Tahoma, Washington, school districts (*see* Figure E1 in the online supplement). Children were monitored monthly (2005–2009) while the Puget Sound Clean Air Agency (PSCAA) incentivized clean air technology installation and a fuel change occurred under USEPA rules. Children were unaware of the technology and fuel of their buses, resulting in a blinded natural experiment with the collection of exposure and health measurements before, during, and after the staggered implementation of interventions. Children with asthma were preferentially recruited for power and as a sensitive subpopulation (34). Children in smoking households, on buses with fewer than 50 seats, taking oral corticosteroids, or missing information were excluded, resulting in a sample of 275. All protocols were approved by our institutional review board and written guardian consent and child assent were obtained.

Bus Characteristics

Children's buses were identified on the basis of information from the district transportation departments and later confirmed by school administrators and study technicians. When children rode more than one bus, we used their primary bus for our analyses. Bus characteristics, including age, mileage, technologies, and fuels, were compiled from the PSCAA, school transportation departments, and annual inspection. Adoption of clean air technologies and fuels was also tracked continuously with a focus on DOCs, CCVs, ULSD, and a biodiesel mixture (approximately 20%). Although we had also been interested in diesel particulate filters (DPFs), these were used only temporarily on five buses, so we had insufficient information for our models.

Air Pollution

We collected measurements inside 188 buses ("in cabin") during 597 regular commutes greater than 10 minutes. Fine ($PM_{2.5}$) and ultrafine (UFP) particulate matter were measured with a *p*DR-1200 equipped with a cyclone preseparator (Thermo Scientific, Waltham, MA) and P-TRAK 8525 (TSI, Shoreview, MN), respectively. A PAS2000CE (EcoChem Analytics, League City, TX) was also used to capture particle-bound polycyclic aromatic hydrocarbons (pb-PAHs) as well as the black carbon content of the particles. During most trips, pollution was also measured inside a gasoline hybrid electric car traveling before the bus with open windows ("on road"). Differences between the bus and road reflect the pollution from the bus itself ("self-pollution") as has been validated by chemical tracer research (35). Ambient pollution measurements were also obtained from the PSCAA.

Pulmonary Health

Lung function and exhaled nitric oxide (Fe_{NO}) were measured monthly at school by technicians unaware of the children's bus characteristics. Measurements were collected at fixed times on school day mornings and afternoons, in accordance with standard procedures (36). Fe_{NO} and room nitric oxide were collected with an offline collection kit (Sievers, Boulder, CO). Children exhaled into 1.5-liter aluminized Mylar balloons at a constant pressure of 12 cm H_2O to prevent contamination by nasal nitric oxide and to normalize expiratory flow rates. Fe_{NO} samples were collected in triplicate and analyzed within 4 hours with an NOA 280i (Sievers), using the median value for our analysis. FEV_1 and FVC were measured with a MicroDL spirometer (Micro Medical, Lewiston, ME). Self-reported absenteeism in the previous month was supplemented with technician-collected records on absenteeism on the day of health testing.

General health, including asthma symptoms and recent illness, was ascertained by technician-administered questionnaires. Asthma status was assessed annually by doctor diagnosis or symptoms of wheezing or whistling in chest, wheezing after exercise, or a dry cough at night over the previous year based on validated questions from the International Study of Asthma and Allergies in Childhood (ISAAC) survey (37). Asthma severity was defined as persistent asthma (on controller medication), intermittent asthma (not on controller medication), and nonasthmatic.

Covariates

Self-reported demographics (race, sex, parental education) and medical history were collected at an annual health screening. Height and weight were obtained during monthly examinations, concurrent with collection of pulmonary health endpoints. Meteorology (relative humidity and temperature) and flu prevalence data were obtained from the University of Washington Atmospheric Sciences Department and the U.S. Influenza-Like Illness Surveillance Network, respectively. School and home locations were classified as near a major roadway, using ArcGIS (ESRI, Redlands, CA), if they were within 100 m of an interstate or U.S. highway or within 50 m of a state or county highway.

Statistical Analysis

Descriptive statistics were generated using repeated-measures analysis of variance models. Exploratory analyses then compared pollution and health between buses that never or always had certain technologies/fuels as well as within buses before and after a switch. Pollutant and $F_{E_{NO}}$ levels were log-transformed due to right-skewed distributions and investigated using multivariable mixed-effects models to account for correlation between repeated measures. Two-stage growth models with random intercepts and slopes were used for spirometry measures (38, 39). Risk differences for being absent within the past month were modeled with a mixed-effects log binomial regression. In-bus pollution models adjusted for ambient $PM_{2.5}$, weather (wind speed, temperature, relative humidity), bus characteristics (manufacturer, mileage, year, engine position, make, and model, bus base), and trip covariates (stops, duration, window usage, time of day, on-road pollution events). Health models were adjusted for age, race, sex, asthma, temperature, relative humidity, ambient $PM_{2.5}$, district flu prevalence, and seasonality. For $F_{E_{NO}}$ and spirometry, height, weight, and cold/flu were also included. School air nitric oxide and day of week were included in $F_{E_{NO}}$ models. Nonlinear relationships were assessed in R version 3.02 (www.r-project.org) and modeled with splines (flu prevalence) whereas other analyses used SAS version 9.3 (SAS Institute, Cary, NC). Models were run first with individual technologies and fuels and then with all technologies and fuels to separate the independent associations with pollutants and health. We further explored the impacts of DOC, CCV, and biodiesel among buses after the national switch to ULSD to assess the added benefit of nonrequired clean air interventions.

We tested for effect modification by asthma status and confirmed the robustness of our results to control for parental education, school/home roadway proximity, district, and additional time trends. We also explored sensitivity to classifying asthma on the basis of doctor diagnosis, restricting to children riding the same bus at least 75% of the time, control for or exclusion of buses with a DPF, and using fixed-effects models. Finally, we estimated preventable absences if all American school bus riders exclusively rode buses with clean air technologies and fuels. These calculations assumed that 54.6% of 54,876,000 school children ride buses (12), that 9.3% of these children have asthma (40), and that, of the children with asthma, 25% have persistent asthma (41).

Results

Study Participants

A total of 275 bus riders provided 3,223 observations with an average of 6 (range, 1–19) repeat visits over 4 years. These children were predominantly white and from college-educated families (Table 1). The mean age was 9.5 years. More than half (54%) were asthmatic, and the majority (85%) were not taking controller medication. Higher $F_{E_{NO}}$ levels, more frequent absenteeism, and lower baseline lung function were observed among children with asthma compared with healthy children.

Buses Serving Study Population

During our 4-year study the adoption of clean air technologies and fuels increased over time (Figure 1). Across all buses serving our study population, approximately half had DOCs and ULSD and 35% had CCVs in the first year whereas greater than 90% had these technologies and fuels in the final year. This resulted in the majority of students always riding buses with DOCs (69%) and ULSD (81%) and fewer always riding buses with CCV (34%) and biodiesel (7%). Between 15 and 37% of students rode buses with and without clean air technologies and/or fuels, allowing for within-subject comparisons (Table 1 and Table E1). In general, there was little correlation between the various technologies and fuels, with the exception of DOC and ULSD, which had a correlation of approximately 0.5.

Measured Pollution Levels on Monitored Buses

Among the 597 trips on 188 buses with air pollution monitoring, the average mileage was 65,100 (SD, 58,700) and bus body year was 2002 (SD, 5) (Table 2). The average trip had a duration of 40 minutes (SD, 17 min) with 27 riders (SD, 14). Mean (±SD) in-cabin $PM_{2.5}$ concentrations (20 ± 18 $\mu g/m^3$) were approximately three times higher than ambient levels (7 ± 5 $\mu g/m^3$) and 1.5 times higher than roadway levels (13 ± 12 $\mu g/m^3$). Mean in-cabin UFP levels (21 ± 12 thousand/cm^3) were lower than on the surrounding roadways (29 ± 20 thousand/cm^3). Average pb-PAH concentrations were also lower inside bus cabins (101 ± 70 ng/m^3) than on surrounding roadways (125 ± 88 ng/m^3).

In multivariable models, we found strong evidence of lower in-cabin $PM_{2.5}$ concentrations with clean air technology use but weaker evidence for fuel types (Figure 2). DOCs and CCVs were associated with 26% (95% CI, −42 to −6%) and 40% (95% CI, −48 to −30%) lower in-cabin $PM_{2.5}$ concentrations, respectively. In contrast, UFPs were lowest with DOCs (−43%; 95% CI, −53 to −31%) and ULSD (−47%; 95% CI, −58 to −34%) with weaker reductions for CCVs and no associations with biodiesel. For pb-PAH concentrations, there were consistent increases with DOCs, CCVs, and ULSD. Only biodiesel was associated with lower in-cabin pb-PAH concentrations (−40%; 95% CI, −49 to −28%). Findings were similar for self-pollution concentrations and models adjusted for other technologies and fuels (results not shown).

Exhaled Nitric Oxide

Strong and statistically significant associations were identified between $F_{E_{NO}}$ and ULSD use in fully adjusted models (Figure 3). Among the whole cohort, ULSD was associated with 16% (95% CI, −21 to −10%) lower $F_{E_{NO}}$ levels. These

Table 1. Characteristics of Bus-Riding Elementary School Children Monitored between 2005 and 2009 during the Adoption of Clean Air Technologies and Fuels

	All	No Asthma	Intermittent Asthma	Persistent Asthma
Number of children	275 (100%)	126 (46%)	126 (46%)	23 (8%)
Number of samples	3,223 (100%)	1,590 (49%)	1,326 (41%)	307 (10%)
Baseline age, yr				
6–8	90 (33%)	34 (27%)	47 (37%)	9 (39%)
9–10	127 (46%)	65 (52%)	52 (41%)	10 (43%)
11–12	58 (21%)	27 (21%)	27 (21%)	4 (17%)
Female	124 (45%)	57 (45%)	58 (46%)	9 (39%)
Race				
Asian	25 (9%)	11 (9%)	13 (10%)	1 (4%)
Black	23 (8%)	4 (3%)	18 (14%)	1 (4%)
Other	19 (7%)	5 (4%)	9 (7%)	5 (22%)
White	203 (74%)	105 (83%)	83 (66%)	15 (65%)
Parental education				
College	33 (12%)	8 (6%)	22 (17%)	3 (13%)
Some college	35 (13%)	16 (13%)	16 (13%)	3 (13%)
College	88 (32%)	45 (36%)	32 (25%)	11 (48%)
College	105 (38%)	54 (43%)	45 (36%)	6 (26%)
School district				
Tahoma	89 (32%)	39 (31%)	39 (31%)	11 (48%)
Seattle	186 (68%)	87 (69%)	87 (69%)	12 (52%)
Height, m	1.4 (0.1)	1.4 (0.1)	1.4 (0.1)	1.4 (0.2)
Weight, kg	35.2 (11.0)	34.2 (9.1)	36.2 (12.1)	34.6 (14.1)
Outcomes				
Fe_{NO}, ppb	12.1 (1.9)	10.0 (1.6)	14.2 (2.0)	14.3 (2.3)
FEV_1, L				
Baseline	1.73 (0.4)	1.78 (0.36)	1.69 (0.42)	1.67 (0.47)
Δ per year	0.13 (0.49)	0.15 (0.4)	0.14 (0.51)	0.01 (0.77)
FVC, L				
Baseline	2.09 (0.48)	2.13 (0.45)	2.06 (0.49)	2.09 (0.54)
Δ per year	0.17 (0.54)	0.2 (0.38)	0.2 (0.57)	−0.06 (0.94)
MMEF, cl/s				
Baseline	167.0 (56.1)	176.2 (52.5)	160.5 (58.2)	152.3 (58.2)
Δ per year	14.5 (121.1)	14.4 (113.5)	14.8 (125.7)	12.9 (141.4)
Missed school days per month	0.35 (0.25)	0.32 (0.25)	0.35 (0.26)	0.40 (0.24)
Interventions				
DOC				
Never	36 (13%)	19 (15%)	15 (15%)	2 (9%)
Sometimes	48 (17%)	23 (18%)	18 (18%)	7 (30%)
Always	191 (69%)	84 (67%)	93 (67%)	14 (61%)
CCV				
Never	81 (29%)	37 (29%)	36 (29%)	8 (35%)
Sometimes	101 (37%)	52 (41%)	41 (33%)	8 (35%)
Always	93 (34%)	37 (29%)	49 (39%)	7 (30%)
ULSD				
Never	13 (5%)	8 (6%)	5 (4%)	0 (0%)
Sometimes	40 (15%)	18 (14%)	15 (12%)	7 (30%)
Always	222 (81%)	100 (79%)	106 (84%)	16 (70%)
Biodiesel				
Never	183 (67%)	90 (71%)	77 (61%)	16 (70%)
Sometimes	72 (26%)	32 (25%)	38 (30%)	2 (9%)
Always	20 (7%)	4 (3%)	11 (9%)	5 (22%)

Definition of abbreviations: CCV = crankcase ventilation system; DOC = diesel oxidation catalyst; Fe_{NO} = fraction of exhaled nitric oxide; MMEF = maximal midexpiratory flow; ULSD = ultralow-sulfur diesel.
Data are given as n (%) or mean (SD).

associations were strongest among children with asthma: 31% (95% CI, −39 to −21%), 20% (95% CI, −28 to −12%), and 6% (95% CI, −14 to 2%) lower levels among children with persistent asthma, intermittent asthma, and no asthma, respectively. These associations were robust to control for other technologies and fuels (results not shown).

For children with persistent asthma, lower Fe_{NO} levels were observed for children riding buses with DOCs (−12%; 95% CI, −23 to −0.4%) or CCVs (−14%; 95% CI, −24 to −4%) compared with buses without these technologies. Associations with CCVs, but not DOCs, were robust to control for other technologies and fuels but they were not

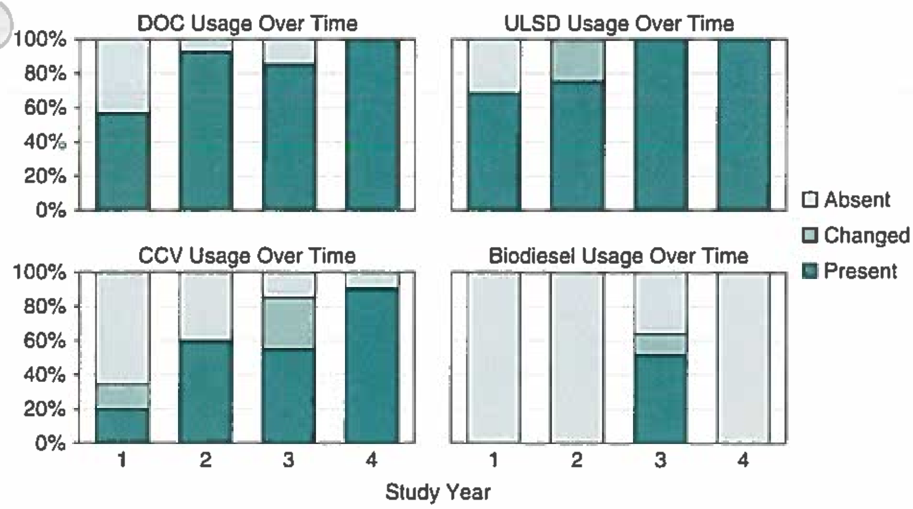

Figure 1. Clean air technologies and fuels over the 4-year study (defined as absent all year, changed during the year, or present all year). CCV = crankcase ventilation system; DOC = diesel oxidation catalyst; ULSD = ultralow-sulfur diesel.

found among other children. Biodiesel was unassociated with $F_{E_{NO}}$.

Pulmonary Function

Among all children, rates of change were 0.17 L/yr for FVC and 0.13 L/yr for FEV_1. After control for other factors, we observed 0.02 (95% CI, 0.003–0.05) and 0.02 (95% CI, 0.001–0.04) L/yr faster rates of change in FVC among children riding buses with ULSD and DOCs, respectively (Figure 4). These associations with FVC were generally robust to control for other technologies and fuels as well as stratification by school year among children without asthma (results not shown). Suggestive increases in FEV_1 over time were also found among all children for ULSD (0.01 L/yr; 95% CI, −0.006 to 0.03) and DOC (0.01 L/yr; 95% CI, −0.008 to 0.03) use, due primarily to associations with children without asthma and those with mild asthma. Lower changes in FEV_1 were observed with DOCs, ULSD, and biodiesel among those with persistent asthma. Although these associations were generally robust to control for multiple interventions, they had wide confidence intervals and could not be distinguished from no association.

Table 2. Characteristics of Monitored School Buses and Trips

	All Buses		Buses That Switched Technologies/Fuels	
	Buses	Trips	Buses	Trips
n	188	597	62	292
Clean air technologies*				
Diesel oxidative catalyst	165 (88%)	510 (85%)	18 (29%)	93 (32%)
Crankcase ventilation	134 (71%)	376 (63%)	36 (58%)	177 (61%)
Diesel particulate filter	5 (3%)	10 (2%)	0 (0%)	0 (0%)
Clean air fuels*				
Ultralow-sulfur diesel	183 (97%)	549 (92%)	18 (29%)	93 (32%)
Biodiesel	59 (31%)	152 (25%)	28 (45%)	138 (47%)
Mileage, in thousands	65.7 (57.4)	65.1 (58.7)	70.1 (54.5)	71.3 (58.9)
Body year	2002 (5.2)	2002 (5.0)	2002 (4.7)	2002 (4.7)
Seating capacity	72 (4.4)	72 (4.5)	73 (4.0)	73 (4.1)
Opacity, %	4 (7.3)	5 (9.8)	5 (7.9)	5 (9.6)

Data are given as n (%) or mean (SD).
*Bus results reported if bus ever had the technology or fuel. Trip data reflect the conditions during the monitoring event.

Absenteeism

Children missed an average of 3.1 school days over 9 months (2.9 for children without asthma, 3.6 for children with persistent asthma). Among all children, there was an 8% (95% CI, −16 to −1%) lower risk of being absent in the previous month when riding a bus with ULSD as compared with other buses (Figure 5). Similar findings were observed for DOC use: a 6% (95% CI, −11 to −0.2%) reduction in the risk of absenteeism over the past month. These associations were largest among children with asthma, especially those receiving controller therapy. Although associations with ULSD were robust to control for other technologies and fuels, associations with DOCs were diminished by control for ULSD (results not shown). On the basis of these findings, we estimate that the switch to ULSD resulted in 14 million fewer absences per year across the United States.

Sensitivity of Results

Associations between clean air technologies and fuels with each of the health endpoints were qualitatively robust to further adjustment for parental education, school/home proximity to major roads, district, and additional time trends. Our findings were also insensitive to use of doctor-diagnosed asthma, restricting to children riding the same bus at least 75% of the time, excluding or controlling for buses with a DPF, and modeling using fixed effects. Restriction to only those buses using ULSD suggested independent improvements with DOCs for absenteeism among children with severe asthma and changes in FVC over time, although little change was observed with FEV_1 or $F_{E_{NO}}$ after this restriction (results not shown).

Discussion

In this natural experiment, we documented lower in-vehicle exposures and improved pulmonary health of children with the adoption of clean air technologies and fuels on school buses. $PM_{2.5}$ concentrations were 25–40% lower on buses with DOCs and CCVs, and UFP levels were 40–50% lower on buses with DOCs and ULSD. In health analyses, we found that ULSD was most consistently associated with beneficial effects with evidence of less pulmonary inflammation, faster lung growth, and lower risks of school absenteeism. These

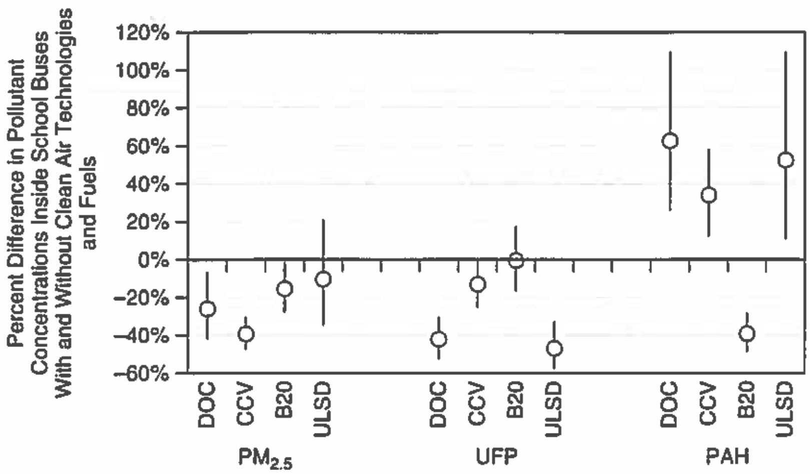

Figure 2. Associations of clean air technologies and fuels with air pollution concentrations inside school buses after control for ambient weather and pollutants, bus characteristics, and trip features. Models were adjusted for ambient wind speed, temperature, relative humidity, ambient $PM_{2.5}$, noted pollution events, trip duration, number of stops, open windows, time of day, bus base, year bus was built, mileage, engine make and model, body make, and random intercept for each bus. These contrasts include data from different buses and those that switched technologies. B20 = biodiesel; CCV = crankcase ventilation system; DOC = diesel oxidative catalyst; PAH = polycyclic aromatic hydrocarbons; $PM_{2.5}$ = fine particulate matter, ≤2.5-μm diameter; UFP = ultrafine particulate matter; ULSD = ultralow-sulfur diesel.

results were robust to control for other technologies and fuels and were often largest among children with asthma, especially those with persistent asthma. DOCs, and to a lesser extent CCVs, also were associated with better health, but these findings were primarily restricted to those with persistent asthma and were often sensitive to control for ULSD. Overall, we found that adopting certain clean air technologies and fuels reduced in-vehicle particulate exposures and likely improved respiratory health.

To our knowledge, no prior studies have examined the individual-level health impacts of clean air technologies and fuels, although one school district–level analysis suggested that a school bus emission reduction program was associated with decreased incidence of bronchitis, asthma, and pneumonia (42). Our findings suggest that the benefits of school bus emission reductions are also experienced at the child level. We identified sizeable improvements in absenteeism for children riding buses with ULSD that are comparable to 50–70% of the reductions observed for children living in nonsmoking homes as compared with homes with smokers (43). With 25 million children riding buses to school (12), we estimate that switching to ULSD resulted in 14 million fewer absences per year in the United States. Such reductions in absenteeism may translate to improved grades and health for the students (15, 16) as well as less missed work and lost productivity for their caregivers. Although results were strongest with ULSD, we also found evidence of reduced absenteeism among children with severe asthma and increased FVC over time with DOC usage even when restricted to buses using ULSD. This suggests that there may be additional benefit to clean air technologies independent of any changes in fuel.

Clean air technologies and fuels were not only associated with health benefits but also with reductions in on-board pollution. Both DOC and CCVs showed significant reductions in $PM_{2.5}$ and UFPs. This is generally consistent with previous in-vehicle studies, which found reductions of 25–60% for $PM_{2.5}$ and 5–70% for UFPs (17, 25, 27, 28). Reductions in UFPs, and to a lesser extent $PM_{2.5}$, with ULSD are also consistent with an earlier in-cabin study using ULSD in combination with DPF (17). Interestingly, our findings of comparatively larger reductions in $PM_{2.5}$ with CCVs and larger reductions in UFPs with DOCs are supported by previous research demonstrating that in-cabin $PM_{2.5}$ concentrations are primarily due to crankcase emissions and that UFPs primarily originate from the tailpipe (35, 44). Although we have previously demonstrated distinct patterning of pb-PAHs from $PM_{2.5}$ and UFPs in school buses (45), the observed increase in pb-PAHs with DOCs, CCVs, and ULSD is unexpected given that past research has generally shown reductions with clean air technologies and fuels (17, 46–48). Unfortunately, we have little explanation for these findings. One hypothesis is that a shift in the distribution of PAHs between the gaseous and particle phase may have led to measurement artifact because enhanced

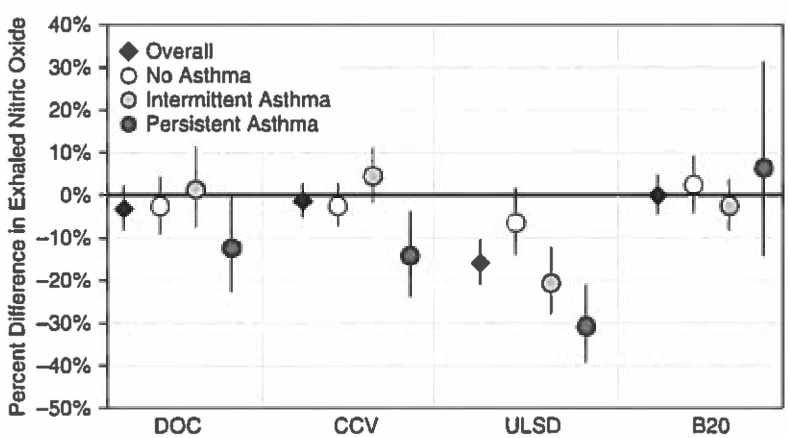

Figure 3. Adjusted associations (percent difference, 95% confidence interval) between levels of exhaled nitric oxide and clean air technologies and fuels among all students and by asthma status. Models were adjusted for age, sex, race/ethnicity, height, asthma status, ambient temperature, relative humidity, fine particulate matter (≤2.5-μm diameter), room nitric oxide, district flu prevalence, individual report of a cold or flu, within–school year time trend, time of day, and random subject effect. B20 = biodiesel; CCV = crankcase ventilation system; DOC = diesel oxidative catalyst; ULSD = ultralow-sulfur diesel.

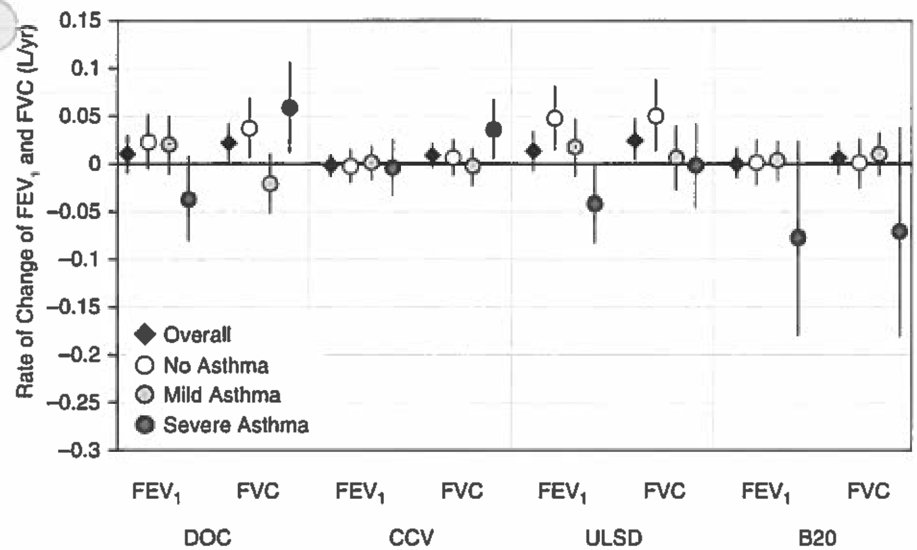

Figure 4. Adjusted associations (percent difference, 95% confidence interval) between rate of change in lung function over time and clean air technologies and fuels among all students and by asthma status. Models were adjusted for age, sex, race/ethnicity, height, weight, asthma status, ambient temperature, relative humidity, fine particulate matter (≤2.5-μm diameter), district flu prevalence, individual report of a cold or flu, within–school year time trend, and random subject effect. B20 = biodiesel; CCV = crankcase ventilation system; DOC = diesel oxidative catalyst; ULSD = ultralow-sulfur diesel.

nitro-PAH formation and nucleation can occur with clean air technologies (46, 49, 50).

The finding that ULSD and DOCs were most strongly and consistently associated with health suggests that UFPs may be a critical exposure on school buses. This is not surprising because UFPs are hypothesized to be especially toxic because of their high deposition in the lower airways, large surface areas to absorb chemicals/free radicals, lower removal by alveolar macrophages, and ability to initiate inflammation (51). Associations with Fe_{NO}, a marker of cytokine activity in the airways and alveoli (52), also suggest that lowered inflammation is a likely mechanism through which decreased exposures may lead to improved health. Furthermore, our finding of greater health improvements among children with asthma is also consistent with UFPs because airway narrowing increases the deposition efficiency of UFP in the lungs (53).

The cohesiveness of our findings across several endpoints further supports the hypothesized benefits of clean air technologies and fuels on respiratory health. Our results are consistent with controlled exposure studies in animals and humans, which have reported increased inflammation after the inhalation of diesel exhaust (54–58). Given that ULSD, DOCs, and CCVs were associated with lower particulate concentrations, our results are further supported by population-based studies of children that have linked higher particulate concentrations with higher Fe_{NO} (59, 60), slower lung growth (61, 62), asthma exacerbation (63), and school absenteeism (61, 64–66). Although all of our results were on the same order of magnitude as past research, our lung growth findings were somewhat larger than expected (61, 64–67). This may be partially attributable to the young age of this population or the high asthma prevalence because some, although not all, research has reported enhanced associations among this group (34).

This study has numerous strengths including its large size and repeated, individual-level health and in-vehicle air pollution measurements surrounding the adoption of clean air technologies and fuels. It is not, however, without limitations. One key limitation is the possibility for residual confounding by time because some technologies/fuels, like ULSD, were used only in the later years of the study. If our statistical models inadequately captured any temporal trends in health, then we could incorrectly attribute some of the observed changes in health to the bus technologies/fuels. Sensitivity analyses indicated that this was unlikely for Fe_{NO} and absenteeism as our models were robust to additional adjustment for time and there were no significant time trends among children who rode buses that did not change technologies or fuels. In contrast, FVC is more closely linked to time in this population. We allowed for different growth curves by age and age-adjusted height after accounting for differences between the sexes, ages, and asthma status. Within this age range, linear trends are expected and observed. If, however, accelerated growth due to puberty occurred among a small fraction of children, then the true associations with lung growth could be overestimated. Another limitation is that our absenteeism information was not verified by school records. Any misclassification would not likely be differential, however, because children were unaware of their bus characteristics. In addition, we supplemented self-reported absenteeism data with technician-recorded absenteeism of children during their monthly examinations to account for the inherent problem that absent children cannot report their absenteeism. Finally, although we

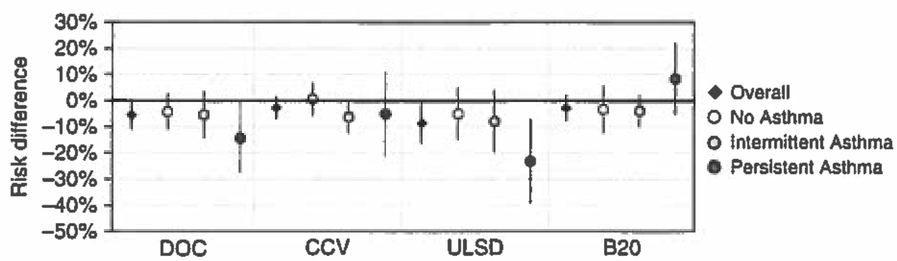

Figure 5. Adjusted associations (risk difference, 95% confidence interval) for any absenteeism in the past month as a function of clean air technologies and fuels among all students and by asthma status. Models were adjusted for age, sex, race/ethnicity, asthma status, ambient temperature, relative humidity, fine particulate matter (≤2.5-μm diameter), district flu prevalence, within–school year time trend, and random subject effect. B20 = biodiesel; CCV = crankcase ventilation system; DOC = diesel oxidative catalyst; ULSD = ultralow-sulfur diesel.

a priori anticipated that children with asthma would be more sensitive to exposures, we cannot exclude the possibility that our findings of enhanced associations among those with persistent asthma were due to chance given the small sample size (23 children, 307 samples).

In summary, we used a natural experiment to examine associations between clear air technologies and fuels in school buses and children's health. Our results show that the national switch to ULSD fuel may have had a measureable positive public health impact on children riding diesel school buses. This benefit was likely especially important for children with asthma. Our results further suggest that children with asthma may also have benefited from the nationwide voluntary school bus retrofit initiative and the adoption of DOCs and CCVs. Although the exact results varied by outcome, ULSD and DOCs were most consistently associated with both reduced pollutant concentrations and improved health, suggesting a role for UFPs in the health effects of diesel-powered school buses. ■

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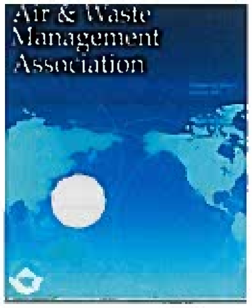

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Relative Importance of School Bus-Related Microenvironments to Children's Pollutant Exposure

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Relative Importance of School Bus-Related Microenvironments to Children's Pollutant Exposure

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ABSTRACT

Real-time concentrations of black carbon, particle-bound polycyclic aromatic hydrocarbons, nitrogen dioxide, and fine particulate counts, as well as integrated and real-time fine particulate matter ($PM_{2.5}$) mass concentrations were measured inside school buses during long commutes on Los Angeles Unified School District bus routes, at bus stops along the routes, at the bus loading/unloading zone in front of the selected school, and at nearby urban "background" sites. Across all of the pollutants, mean concentrations during bus commutes were higher than in any other microenvironment. Mean exposures (mean concentration times time spent in a particular microenvironment) in bus commutes were between 50 and 200 times greater than those for the loading/unloading microenvironment, and 20–40 times higher than those for the bus stops, depending on the pollutant. Although the analyzed school bus commutes represented only 10% of a child's day, on average they contributed one-third of a child's 24-hr overall black carbon exposure during a school day. For species closely related to vehicle exhaust, the within-cabin exposures were generally dominated by the effect of surrounding traffic when windows were open and by the bus's own exhaust when windows were closed. Low-emitting buses generally exhibited high concentrations only when traveling behind a diesel vehicle, whereas high-emitting buses exhibited high concentrations both when following other diesel vehicles and when idling without another diesel vehicle in front of the bus. To reduce school bus commute exposures, we recommend minimizing commute times, avoiding caravanning with other school buses, using the cleanest buses for the longest bus routes, maintaining conventional diesel buses to eliminate visible emissions, and transitioning to cleaner fuels and advanced particulate control technologies as soon as possible.

IMPLICATIONS

A high percentage of school buses in California and elsewhere are powered by diesel engines and commuting children may be exposed to high concentrations of exhaust particles and gases during their commutes, at school bus stops, or at loading/unloading zones. This research showed bus commutes were much more important than bus stops or loading/unloading zones for children's exposure because more time was spent commuting and concentrations were higher in bus cabins. Self-pollution and the type of vehicle being followed were the main drivers for within-cabin exposure during bus commutes; however, the effect of these factors was influenced by window position, pollutant type, and other variables. Based on our findings we make recommendations for reducing children's overall bus commute-related exposures.

INTRODUCTION

Out of the 6 million school children in California, 1 million are transported by public school buses, and ~70% of the 26,000 school buses operating in California are powered by diesel engines.[1,2] Because of their high-volumetric inhalation rates relative to body mass, narrower lung airways, immature immune systems, and rapid growth, children are more susceptible than adults to the health effects of various air pollutants.[3–6]

A number of studies have reported increased personal exposure and risk associated with bus commutes and traffic congestion.[7–15] A recent study of in-vehicle concentrations, conducted in Sacramento and Los Angeles using a passenger vehicle as a chase car, found that proximity to diesel vehicles caused high concentrations of in-vehicle fine particles and black carbon (BC).[16] Moreover, children may be exposed to high concentrations of diesel particulate matter (DPM) and other associated vehicle emissions while waiting at school bus stops, riding on buses (particularly when buses are caravanning), or during the time they are assembled at a school for loading or unloading near buses that are idling.

However, to date, no comprehensive studies of children's exposure while traveling to and from school in general, and on diesel school buses in California in particular, have been published in the peer-reviewed literature. This is true despite the fact that roadways and sidewalks have been shown to have the highest outdoor concentrations for many air pollutants, and in-vehicle concentrations have been shown to be higher than those measured at fixed site monitors and in some cases higher than measured along roadways.[14–22]

The overall objective of this study was to characterize the relative importance of exposures experienced by children during time spent in three school bus-related microenvironments: school bus cabins, school bus stops, and the school loading/unloading zone.

In addition, we estimated the contribution of the most relevant of these microenvironments to overall 24-hr exposure.

METHODS

We measured the concentrations of BC, particle-bound polycyclic aromatic hydrocarbons (PB-PAHs), nitrogen dioxide (NO_2), fine particulate matter ($PM_{2.5}$), and fine particulate counts in the size range between 0.3 and 0.5 μm (PC) inside six school buses (at the rear of the cabin) to capture the dynamic behavior of vehicle-related pollutants and to determine the most important factors governing children's exposure associated with commuting on school buses.[23,24] A total of 22 morning and afternoon runs, in Spring 2002, were conducted in Los Angeles on two urban school bus routes. Although no children were on board during the measurements, the bus routes followed in-use time and route patterns of the Los Angeles Unified School District. We also conducted six measurement periods at two bus stops along the primary route, and three measurement periods in front of the school where the children congregated briefly after exiting or before boarding the buses. To simulate typical bus operation, windows were closed during morning runs and partially opened (every other window down 10–15 cm) during afternoon runs. Six different buses were used, including two older high-emitting diesel buses, two diesel buses more representative of current fleets, one particle trap-outfitted diesel bus, and one compressed natural gas (CNG) powered bus. Table 1 lists the buses selected for testing.

In addition, we recorded traffic conditions and other exposure-related events using a high-resolution video camera mounted at the front of the test bus. Using the videotaped record of an exposure run, which showed the view of the road in front of the test bus, we systematically identified the events and characteristics that occurred in the area surrounding the test bus (i.e., presence of any diesel-powered vehicle, exhaust location of the vehicle being followed, presence of visible emissions, level of traffic congestion, and roadway type). This information was later correlated with the pollutants' real-time concentration data.[23] We also metered a tracer gas into the buses' exhaust system to determine the degree of self-pollution (the fraction of a bus's own exhaust that can be found inside its cabin) for the tested buses.[25]

The purpose of collecting videotape records and self-pollution data was to establish the relative importance of two potential significant sources of children's exposure inside school buses: the bus's own exhaust and the exhaust from other nearby vehicles.

Another objective of this study was to identify a school with a diverse student population drawn from various parts of Los Angeles, which offered a broad range of travel distance, roadway type, and traffic congestion

Table 1. Characteristics of school buses selected for testing.

Bus Type[a]	Year	Make	Model	Rows	Engine	Mileage	Displacement (liters)
HE1	1975	Crown	Supercoach	15	Cummins 290	316,000	6
HE2	1985	Crown	Supercoach	15	Detroit Diesel 671	315,000	6
RE1	1993	Thomas	Saf-T-Liner	13	Cat 3116	177,000	6.6
RE2	1998	Thomas	Saf-T-Liner	14	Cummins 250 HP 8.3	111,000	8.3
TO	1998	Thomas	Saf-T-Liner	14	Cummins 250 HP 8.3	78,000	8.3
CNG	2002	Thomas	Saf-T-Liner	14	John Deere 8.1	1000	8.1

Notes: [a]HE1, HE2 = high-emitter diesel school buses; RE1, RE2 = representative diesel school buses; TO = particle-trap outfitted diesel school bus; CNG = compressed natural gas school bus.

scenarios associated with bus commutes. The schoolselected was the Brentwood Science Magnet School (BSMS) in West Los Angeles (Figure 1), a K-5 facility in the Los Angeles Unified School District. Nineteen bus routes from diverse areas of Los Angeles County served this magnet school with a total enrollment of 1,209 students in the 1999–2000 school year.

Characterization of Microenvironments

Three microenvironments were investigated: "bus commutes" refers to measurements made inside buses during travel on a typical route to or from the BSMS; "bus stops" refers to sampling at two of the stops along one of the selected routes; and "loading/unloading" zone refers to measurements made in front of the BSMS. In addition, we measured "background" concentrations with the test buses parked with the engine off and the windows fully opened at different locations around Los Angeles.

Bus Commutes. Two different in-use bus routes that traveled from south central Los Angeles to west Los Angeles were used: a primary urban route (U1) with significant driving time on freeways, used for most of the runs; and for comparison, a second urban route (U2) with no time on freeways (Figure 1). Route U1 involved a wide variety of traffic conditions and roadway types, ranging from single-lane residential streets with little or no traffic, to heavily congested, multi-lane freeways. Approximately 40% of this route traveled on two of the most heavily congested freeways in the United States (I-405 and I-10) during peak (morning) and near-peak (mid-afternoon) traffic periods. The vehicle mix on these freeways included a substantial percentage of medium and heavy-duty diesel vehicles, including school buses. In general, as documented by our videotapes, vehicle types ranged from predominantly newer passenger vehicles and light-duty trucks close to the BSMS, to a high proportion of older cars and transit and school buses in south central Los Angeles.

Measurements were made on Route U1 during 18 bus runs in April, May, and June 2002, consisting of 9 morning and 9 afternoon commutes. The original route was 27 miles long and required a total commute time of ~100 min. We used a shortened version of this route during our sampling, because the average commute time for all BSMS bus routes was significantly shorter (75 min). Each morning run started at ~6:30 a.m. at the farthest pick-up location (of the truncated route) and ended at ~7:40 a.m. at BSMS. During the afternoon runs, the bus left BSMS at ~3:05 p.m. and reached the final drop-off location at ~4:10 p.m. At each stop, the bus pulled up to the curb, opened the doors, and waited for 1 min before driving away, to simulate the conditions of children loading or unloading from the bus.

As mentioned above, Route U2 traveled only on surface streets and covered a different geographic area than Route U1. In the morning, this route started in Carson, south of the BSMS, and traveled north through industrial areas with a substantial percentage of heavy-duty diesel traffic (Figure 1). Four exposure runs were conducted on U2, two in the morning and two in the afternoon, in May 2002. The morning runs started at ~6:15 a.m. at the first stop in Carson and finished at ~7:30 a.m. at the final stop of the truncated route we used to keep the commute time not much longer than 1 hr. In the afternoon, we drove the route in reverse, leaving from the first stop at ~3:35 p.m. and arriving at the final bus stop on U2 at ~5:00 p.m.

Bus Stops. These measurements were conducted at two bus stops along U1 (Figure 1). The first stop, in front of the Vermont Elementary School (on the northeast corner of 27th Street and Vermont Avenue) was characterized by increased traffic congestion during peak periods and served as a bus stop for several other school bus routes. Diesel school buses arrived to pick up or drop off children frequently during the period just before

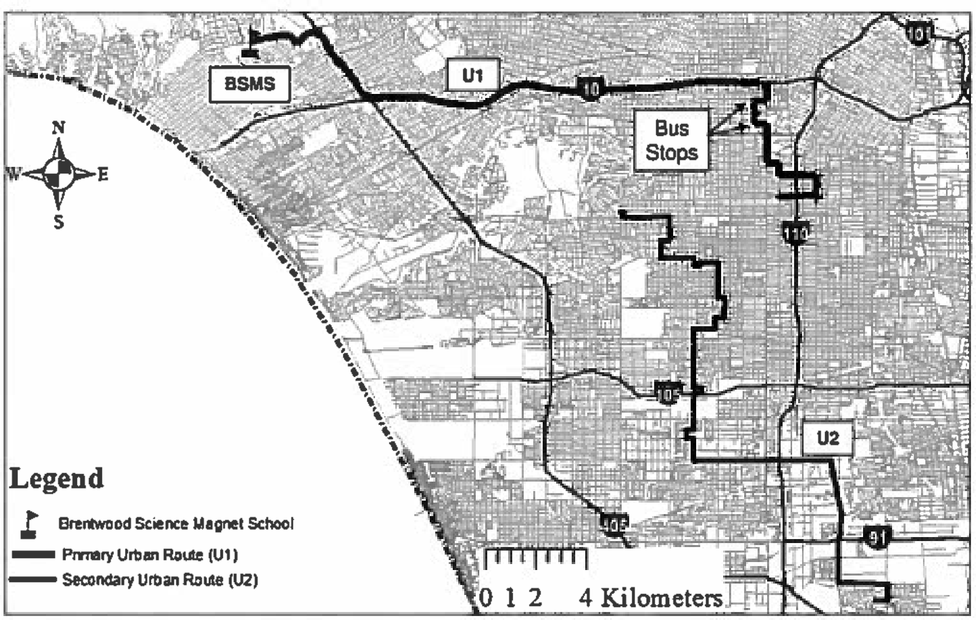

Figure 1. Location of BSMS, commute routes, and bus stops.

school started and after it let out. Measurements were conducted at this bus stop during two mornings and two afternoons in November 2001.

The second bus stop selected was the Weemes Elementary School (on 36th Place, three blocks west of Vermont Avenue) and was also characterized by increased traffic congestion during peak periods and also served as a bus stop for several other school bus routes. Measurements were made during one morning and afternoon in May 2002. The average time spent by a bus at these two stops was ~1 min, with the engine of the bus remaining on after the bus pulled up to the curb and children loaded/unloaded. Occasionally, a bus would idle at these stops for up to 5 min.

Each measurement period at the bus stops started at least 30 min before the arrival of the BSMS bus and continued for at least 30 min after the bus departed. Our fully instrumented bus was parked (engine off) next to the sidewalk on the street, and other buses and passenger vehicles pulled in front of or behind our instrumented bus to drop off/pick up children at the bus stops. Air samples from outside the bus, between the street and the sidewalk, were continuously drawn to the analyzers (located inside the cabin) through sampling lines that hung down from a window to a height of ~1.5 m.

Loading/Unloading Zone. Loading/unloading zone measurements were made during one morning and two afternoons in November 2001, using an instrumented van parked next to the sidewalk of the BSMS, in a portion of the staff parking lot, ~0.5 m from the sidewalk where children congregated briefly when leaving or boarding the buses. The sampling lines connected to the analyzers collected air from outside the van between the sidewalk and the street at a height of ~1.5 m.

Each morning 19 school buses typically arrived and parked one behind the other along the sidewalk in front of the school, between 7:40 a.m. and 8:00 a.m. to unload children. Generally, each bus turned off its engine as soon as it parked, in compliance with Los Angeles Unified School District regulations. Children quickly unloaded from the buses onto the sidewalk in front of the school, then walked as a group into the school. Buses arrived at different times, so often children were present on the sidewalk when another bus pulled up to the curb.

In the afternoon, buses arrived and parked along the sidewalk in front of the school, between 2:00 p.m. and 2:30 p.m. During our observations, each bus turned off its engine as soon as it parked. School ended at 2:45 p.m., and children quickly boarded the 19 buses. Typically, children were on the sidewalk no more than 5 min before they boarded.

Because the duration of our measurements in the loading/unloading zone was not long enough (40–70 min) for integrated mass sampling in the relatively clean air of west Los Angeles, we did not collect ambient $PM_{2.5}$ data during these sampling periods. In addition, we do not report PC data for this microenvironment, because the PC instrument used during loading/unlading measurements was different from the PC instrument used throughout the rest of the study. More details and discussion about this data set can be found elsewhere.[23]

Background Measurements. Because of the lack of noncriteria pollutant measurements at nearby air quality stations operated by the South Coast Air Quality Management District, and the desire to use the same instruments and methods used in the microenvironment measurements, we obtained our own ambient air background measurements for comparisons with the microenvironment data (with the exception of background $PM_{2.5}$ mass integrated data, again because of the relatively short sampling periods).

Eighteen sets of background measurements were conducted with the test bus parked with the engine off and the windows fully opened to allow ambient air throughout the cabin. The duration of these measurements was as long as practical (from 10 min to 2 hr) and longer than the minimum time needed (except for $PM_{2.5}$) to establish stable and detectable background concentrations. Measurements were conducted at several locations in Los Angeles: close to the intersection of two congested streets and in proximity to the I-405 freeway (duration ~30 min); in a University of California, Los Angeles parking lot away from traffic (~2 hr); in front of the BSMS after morning commutes were completed or before afternoon commutes started (~15 min); and in front of several of the schools that served as bus stops on the routes used during our study, either before morning commutes started or after afternoon commutes were completed (10–25 min).

Measurement Methods

A Climet (Redlands, CA) Spectro 0.3 Optical Particle Counter, operating at a flow rate of 1.0 l min^{-1} was used for particulate count concentration measurements in 16 size bins from 0.3 to 10 μm. The size range between 0.3 and 0.5 μm was used for our data analysis, because the highest number concentrations were found in this size bin. This size range, as part of the accumulation mode, was expected to reflect particle mass from secondary particle formation, a significant source of $PM_{2.5}$ mass in the Los Angeles basin. Detecting a portion of the largest particles generated by diesel vehicles was also likely, because diesel vehicles produce more mass in the accumulation mode than gasoline-powered vehicles.[26,27]

BC concentrations were measured using a Magee Scientific Aethalometer (Berkeley, CA), which drew sample air through a 0.5-cm^2 spot on a quartz fiber filter tape. Infrared light at 880 nm was transmitted through the quartz tape and detected using photodetectors, with the response to the change in light transmittance reported as BC.

An EcoChem Model PAS 2000 analyzer (West Hills, CA) was used to measure the concentrations of particle-bound PAHs based on photoionization of only the PB-PAH absorbed on aerosols. The lower detection threshold of this method was close to 3 ng m^{-3} total PB-PAH.

Nitrogen dioxide concentrations were measured by gas chromatographic separation of NO_2 and peroxyacetyl nitrate, followed by reaction with luminol and detection of emitted photons.[28] We also collected data for NO (using a chemiluminescence technique); however, we only report NO_2 concentration data, because this pollutant is the one of more interest from a health effects perspective.

Filter samples for particulate matter were collected using custom sampling systems designed for portable use. The inlets were of the Harvard design, which have been shown to have effective cuts at 2.5 μm while sampling at 20 l min^{-1}.[29] The flow rates were controlled by a needle valve and measured with a rotameter and calibrated against a volumetric flow rate sensor. The samples were collected on 37-mm Gelman "Teflo" filters (Pall Corp., East Hills, NY) with a 2-μm pore size. A Cahn Model 34 microbalance (ThermoCahn, Madison, WI) was used to determine the weight of the filters to within ±2 μg before and after sampling. All of the filters were equilibrated at 23 °C and 40% relative humidity for at least 24 hr before weighing. Filters were weighed a minimum of three times before and after sample collection.

Real-time $PM_{2.5}$ measurements were made using a DustTrak Aerosol Monitor Model 8520 (TSI Inc., Shoreview, MN). In this instrument, an impactor is used to perform the necessary size cuts, and the PM concentration is determined by measuring the intensity of 90 ° scattering of light from a laser diode. The instrument sample flow rate was 1.7 l min^{-1}.

Using a mass flow controller, we metered sulfur hexafluoride (SF_6), into the bus's exhaust system from cylinders containing 0.5% and 1% SF_6. The injection probe extended ~15 cm into the bus's exhaust pipe (located in the right-hand side of the rear bumper in all of the tested buses and in the great majority of the school buses we observed during the field study) to provide reasonable mixing of the SF_6 without attempting to snake the probe around the bends in the exhaust system.[25]

The SF_6 concentrations were measured inside the bus cabins using an AeroVironment Model CTA 1000 analyzer (Monrovia, CA) based on electron capture detection after water and oxygen were removed from the sampled air. The instrument was developed for operation on a moving platform and had a sensitivity of ~10 ppt with a response time of 3 sec.

As noted earlier, an 8-mm high-resolution video camera was mounted at the front of the test buses to record traffic conditions and other exposure-related events occurring in front of and adjacent to the test bus during the measurement periods. All of the video camera records were digitized into MPEG format.

Additional details about measurement methods, data analysis, and quality control procedures are given elsewhere.[23–25]

RESULTS AND DISCUSSION

School Bus Commute-Related Microenvironments

The mean concentrations observed for each of five pollutants in each microenvironment are given in Table 2. Mean concentrations observed for the loading/unloading microenvironment in front of the BSMS were low compared with those for the bus commute, or the bus stops in south central Los Angeles, and comparable with the background values we measured in west Los Angeles.

Mean concentrations at the bus stop microenvironment (means from the two bus stops) were between 1.5 and 3 times higher than mean concentrations at the loading/unloading zone microenvironment, depending on the pollutant. The highest ratio was observed for PB-PAH, whereas the lowest ratios occurred for NO_2. These results are explained by the substantial difference in air quality, at street level, between west Los Angeles

Table 2. Mean pollutant concentrations in the three school bus commute-related microenvironments and background ambient air.

	Mean concentrations			
	Background[a]	Loading/ Unloading Zone	Bus Stops	Bus Commutes[b,c]
BC (μg m^{-3})	2 ± 0.1	2 ± 0.3	4 ± 0.4	3–19 (8)
PB-PAH (ng m^{-3})	27 ± 1.5	15 ± 0.3	44 ± 4.5	64–400 (134)
NO_2 (ppb)	49 ± 1.0	35 ± 0.2	54 ± 1.9	34–110 (73)
PC (count cm^{-3})[d]	83 ± 3.1	N/C	62 ± 1.8	77–236 (130)
$PM_{2.5}$ (μg m^{-3})[e]	20 ± 2.4e	N/C	25[f]	21–62 (43)

Notes: N/C = Concentration data were not collected; [a]These values were measured around Los Angeles with the bus parked, engine off, and with the windows fully open and represent urban ambient air background concentrations during the study; [b]The ranges are associated with the different bus types and window position (open and closed); [c]The values within parentheses are the means for all runs; [d]In 0.3–0.5 μm size range; [e]From published data for Los Angeles basin;[31] [f]Not enough data to establish a confidence interval.

(upwind of major freeways and close to the ocean) and south central Los Angeles (heavily impacted by a wide range of emission sources) and also by the influence of other school buses that were dropping or collecting children while we measured the concentrations at the bus stops.

Mean concentrations, across all runs, inside buses were between 2 and 9 times higher than those at the loading/unloading zone for the corresponding pollutant. Again, the highest ratio was observed for PB-PAH, whereas the lowest ratio was for NO_2. Mean concentrations inside buses were 1.5, 2, and 3 times higher than the mean concentrations at the bus stops for NO_2, BC, and PB-PAH, respectively. However, the highest individual commute concentrations inside bus cabins were factors up to 9 times (for PB-PAH) higher than the mean concentrations at bus stops. Mean concentrations inside buses were 1.5 and 2 times higher than the mean concentrations at bus stops for $PM_{2.5}$ and PC, respectively.

The mean in-cabin pollutant concentrations reported in Table 2 are consistent with previous comparable studies,[7,16,21] as shown in Figure 2. We did not include PB-PAH as part of these comparisons because of the limited exposure data available to date for this pollutant.

Comparison of Microenvironment Exposures

To provide a measure of the relative importance of a given microenvironment we calculated pollutant-specific mean exposures, defined as the mean concentration of a specific pollutant in a given microenvironment multiplied by the time spent by children in that microenvironment. These results are presented in Table 3.

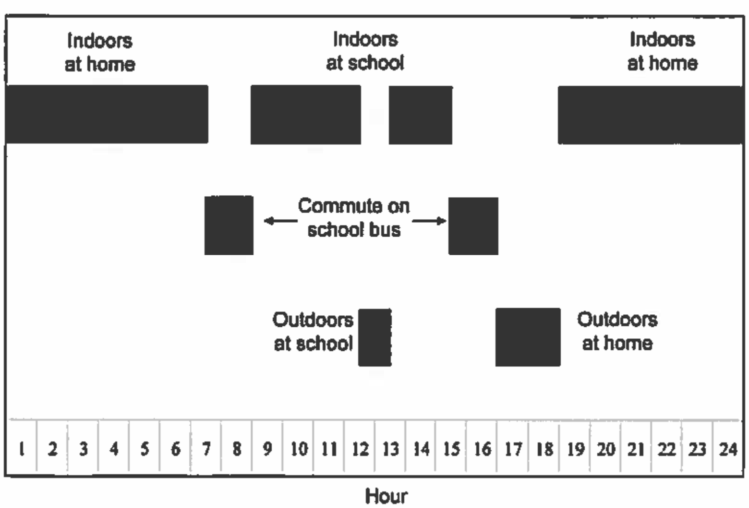

Figure 2. Time-activity pattern for a child on school day. Short periods (of several minutes) not reflected in this diagram include walking from home to the bus stop and from the bus stop to home, waiting at the bus stop, and loading and unloading the school bus.

Because our objective was to characterize the range of exposures experienced by children during school bus commutes, especially under high exposure conditions, mean exposures were estimated based on the travel time from the first bus stop to the school in the morning and the travel time from the school to the last bus stop in the afternoon, corresponding to the child with the maximum commute time. The times children spent at the loading/unloading zone and the bus stops were estimated from our observations in the field and are consistent with results from previous research.[30] In our study, the maximum time spent commuting on the bus was 15 and 25 times greater than the mean time spent at bus stops and the loading/unloading zone, respectively (Table 3).

Mean exposures for the bus stops were between 2.5 and 5 times higher than for the loading/unloading zone. The highest of these ratios was observed for PB-PAH, whereas the lowest was for NO_2. Across all pollutants the exposures during bus commutes were much higher than for the other two microenvironments. The mean exposures for the urban commutes that were part of this study were between 50 (NO_2) and 200 (PB-PAH) times higher than for the loading/unloading zone and between 20 (NO_2) and 40 (PB-PAH) times higher than for the bus stops. The mean exposures for the bus commutes for both PC and $PM_{2.5}$ were 30 times higher than for the bus stops.

These results indicate the loading/unloading zone was the least important microenvironment in terms of school bus-related exposure, both because children generally spent a short time on the sidewalk (5 min or less) before entering the school in the morning or boarding the buses in the afternoon and because bus drivers were required by school district policy to turn off their engines as soon as they arrived in the morning, before the children left the buses. Similarly, in the afternoon, drivers were instructed not to turn on their engines before all children were aboard the buses and the entire fleet was prepared to depart.

In contrast to the absence of idling buses at the BSMS loading/unloading zone, during our monitoring periods at both the Vermont Avenue School and the Weemes Elementary School bus stops, as many as half a dozen buses would pull up in front of the school and wait with the engine idling until children boarded. In several cases, buses were early and waited with their engines idling for several minutes, while children waiting for other buses stood nearby. Buses would then accelerate away from the curb, often releasing an exhaust cloud of black smoke (approximately one-third of the 19 diesel buses serving the BSMS emitted visible smoke on acceleration).

Table 3. Mean exposures for three school bus commute-related microenvironments.

	Mean Exposures[a]		
	Loading/ Unloading Zone	Bus Stops	Bus Commutes
BC (μg m^{-3} hr)	0.1	0.3	10
PB-PAH (ng m^{-3} hr)	0.8	4	170
NO_2 (ppb hr)	2	5	90
PC (counts cm^{-3} hr)[b]	N/A	5	160
$PM_{2.5}$ (μg m^{-3} hr)	N/A	2	55
Average time spent in this microenvironment (min)	3	5	75[c]

Notes: N/A = Not available; [a]Defined as the mean concentration of a specific pollutant in a given microenvironment multiplied by the time (hr) typically spent by children in that microenvironment; [b]In 0.3–0.5 μm size range; [c]Average commute time (one way) for BSMS bus routes.

Notwithstanding these results for the bus stop microenvironment, it is clear from our data that bus commutes, both because of the much longer exposure times and the more elevated pollutant concentrations, are by far the largest contributor to school bus-related exposure for a child's time-activity pattern associated with long duration school bus commutes.

Contribution of School Bus Commutes to Overall Daily Exposure

In addition to the microenvironment measurements, we estimated the approximate contribution of the bus-commute microenvironment to a typical BSMS student's overall 24-hr exposure during a school day. We performed these calculations only for BC, $PM_{2.5}$, and NO_2, because microenvironment data for these pollutants were readily available, whereas microenvironmental concentration data for PB-PAH and PC were difficult to obtain. However, because PB-PAH and PC concentrations inside school buses were highly correlated with those of BC and $PM_{2.5}$, respectively,[23,24] our results could be extrapolated for PB-PAH and PC concentrations.

Equation 1 was used to estimate the relative contribution of the school bus commute (SBC) microenvironment (R_{SBCj}) to the 24-hr overall exposure for a particular pollutant:

$$R_{SBCj} = \frac{C_{SBCj} \cdot T_{SBC}}{\Sigma_i (C_{ij} \cdot T_i)}, \qquad (1)$$

where C_{SBCj} is the mean concentration (μg m^{-3}) of pollutant j during bus commutes, T_{SBC} is the average commute time for BSMS bus routes (hr), C_{ij} is the mean concentration of pollutant j in microenvironment i (μg m^{-3}), and T_i is the time spent (hr) in microenvironment i during a school day.

Figure 3 shows the time-activity pattern used for our calculations. The times shown spent in each microenvironment are consistent with previous research[5] and were deemed representative for a child who commutes on a school bus from south central Los Angeles to BSMS. In this case the child spends about one half of a school day (~12 hr) indoors at home, 2.5 hr commuting on a diesel school bus, approximately 7 hr inside school buildings, and the balance (2.5 hr) outdoors.

For BC and NO_2, the mean concentrations for the outdoors-at-school microenvironment were assumed to be the same as those measured at the loading/unloading zone. For the outdoors-at-home microenvironment, we assumed the mean BC and NO_2 concentrations to be the same as those measured during our background experiments. As mentioned before, we did not collect $PM_{2.5}$ data at the loading/unloading zone nor during our background measurements. Because for this pollutant, ambient air concentrations on the western side of the Los Angeles basin (where our bus study took place) exhibit a

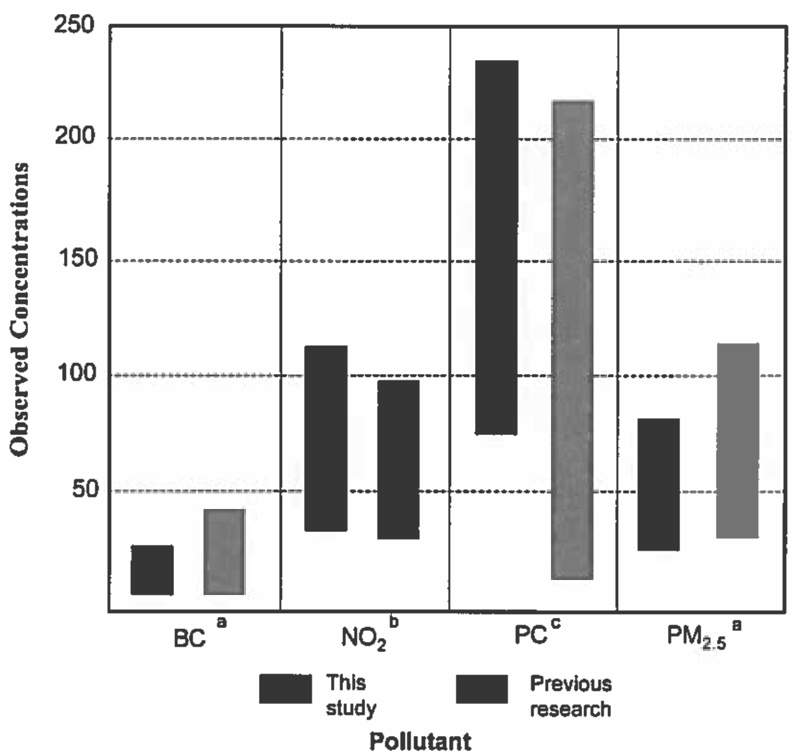

Figure 3. Ranges of concentrations observed in present and previous in-vehicle studies (commute averages). (a) Rodes et al., 1998 (μg m^{-3});[16] (b) Chan et al., 1993 (ppb);[7] and (c) Alm et al., 1999 (counts cm^{-3}).[21]

relatively low variability,[31] we used the same concentrations for both the outdoors-at-school and outdoors-at-home microenvironments. These concentrations were obtained from data recently published for this area.[31]

Infiltration of outdoor air into homes has been estimated to contribute 70% to the PM levels in naturally ventilated homes and 30% in air-conditioned homes,[32,33] and despite the strong effect of indoor sources such as smoking and cooking, the contribution of outdoor air to indoor PM levels remains significant.[33,34] Indoor exposure to BC is even more heavily influenced by outdoor concentrations.[35] Although housing characteristics, such as the presence of a gas range, are associated with indoor levels of NO_2, indoor NO_2 concentrations are significantly correlated with outdoor NO_2 concentrations.[33,36]

Based on these indoor/outdoor relationships, we estimated the mean concentrations for the indoor microenvironments (home and school) using published indoor/outdoor concentration (I:O) ratios in conjunction with our outdoor concentration data, rather than using average concentrations measured in comparable microenvironments during previous studies. According to recent research, typical BC I:O ratios are ~0.75 when no indoor sources are present.[35,37] Because we would not expect the presence of significant sources (e.g., smoking, cooking, and candle burning) in the school at times when children are in attendance, we used this value in combination with the mean concentration for the outdoors-at-school microenvironment to estimate the mean BC concentration for the school indoor microenvironment.

BC mean indoor concentrations could be up to two times higher when indoor sources are present compared with when no indoor sources are present.[35,37] We assumed activity involving BC sources for at least several hours while the child spends time indoors at home and, therefore, used an I:O ratio of 1.25 and the mean concentration for the outdoors-at-home microenvironment to estimate the mean BC concentration for the home indoor microenvironment.

Typical average I:O ratios for NO_2 for urban centers in southern California vary between 1.1 and 3.2 with a mean of 2.1 ± 1.7.[36,38] To estimate the mean concentration for the school indoor microenvironment we used the lowest of these values (1.1; i.e., no significant sources). For the home indoor microenvironment we used the mean I:O ratio of 2.1. To estimate $PM_{2.5}$ mean concentrations at home and inside the school, we used I:O ratios of 1.5 and 0.8, respectively, based on reported values[31,39,40] and similar considerations as above.

Table 4 summarizes our results for the contribution of school bus commutes to overall daily exposure by pollutant and microenvironment. This table shows that for BC, although the time spent in the school bus microenvironment only represents 10% of a child's day, on average the school bus commute contributes up to one-third to the overall 24-hr exposure of a child during a school day. These results are consistent with previous research in California, in which the in-vehicle contribution to overall DPM exposure was estimated to range between 30% and 55% of total DPM exposure on a statewide population basis[41] (taking into account the relatively high fraction of elemental carbon in DPM[27] and the strong association between elemental carbon and BC as measured with an Aethalometer).[42,43] In contrast, Table 4 also shows that for $PM_{2.5}$ the exposures in the different microenvironments were, on average, matched with the relative times spent in each one.

Finally, for all pollutants, while the outdoors microenvironment contributed only a small fraction (8% or less) to the 24-hr exposure, because of the small amount of time spent outdoors, the indoors-at-home microenvironment dominated the overall exposure (45–70% depending on the pollutant), although closely followed by the bus commute microenvironment in the case of BC.

Table 4. Contribution to overall exposures (24 hr) by pollutant and microenvironment.

		Mean Concentration			Exposure[a]			Contribution to Overall Exposure[b,c]		
Microenvironment	Time spent, hr (%)	BC (μg m^{-3})	NO_2 (ppb)	$PM_{2.5}$ (μg m^{-3})	BC (μg m^{-3} hr)	NO_2 (ppb hr)	PM2.5 (μg m^{-3} hr)	BC (%)	NO_2 (%)	$PM_{2.5}$ (%)
Indoors at home	12 (50)	3d	100[d]	30[d]	30	1200	360	45	70	55
Indoors at school	7 (30)	2d	35[d]	15[d]	10	260	110	15	15	20
Outdoor at home	1.2 (5)	2	50	20[e]	3	60	25	4	3	4
Outdoors at school	1.2 (5)	2	35	20[e]	3	45	25	4	2	4
Bus commutes	2.5 (10)	8	75	45	20	180	110	30	10	15
Total	24 (100)				65	1800	630			

Notes: All values rounded based on significant figures. [a]Mean concentration times time spent in each microenvironment; [b]From eq 1; [c]Totals do not add 100% because rounding errors through several steps of the calculations; [d]Estimated based on published I:O ratios[29–33] and outdoor concentrations measured during this study; [e]From published data for Los Angeles basin.[31]

Factors Affecting Commute Exposures

Bus commute exposure, the most important in terms of school bus use and also a significant contributor to overall exposure for pollutants such as BC, exhibited high variability under the conditions we studied. This variability is explained by the complex interactions of numerous factors that may affect pollutant concentrations inside the bus cabin, including window position, self-pollution, influence of surrounding traffic, route type, and bus type.

Window Position. Figures 4 and 5 show the differential effect of window position on the two types of pollutants considered in this study: species closely related to fresh diesel exhaust and not influenced by secondary formation (BC and PB-PAH) and species substantially affected by regional sources, secondary formation, and meteorological conditions ($PM_{2.5}$ and PC).[14,15] NO_2 is associated with fresh vehicle emissions and is also a secondary pollutant for which high background concentrations are possible. The dual characteristics of this pollutant demonstrate that our differentiation between "directly emitted" and "background" pollutants, although valid for the analyses presented here, must be approached with caution and may not work in all scenarios. The data presented in Figures 4 and 5 were collected during the same day (morning and afternoon) using the trap-outfitted bus on Route U1.

For BC (Figure 4), a directly emitted pollutant, the real-time concentrations with windows closed (morning) exhibit a relatively uniform pattern along the run with a slight upward trend that can be attributed to a combination of self-pollution (see below), accumulation because of limited ventilation, build-up of roadway concentrations, and the transition (during the morning commute) from relatively light residential street traffic near bus stop areas to heavy freeway traffic. No pronounced transient peaks are observed during this run with windows closed. For the same pollutant, the run with windows open (afternoon) exhibits a lower baseline (the mean concentration is about half the morning run mean concentration) with noticeable transient peaks that were correlated with the presence of diesel vehicles around the test bus.[23,24] These peak concentrations reach as high as 15 times the baseline concentrations.

For $PM_{2.5}$ (Figure 5), a background pollutant, the real-time concentrations (for the same runs as above) with windows closed are again relatively uniform. However, there is no upward trend for this case, which suggests that for background pollutants the effect of self-pollution is not as important for within-cabin exposure as for directly emitted pollutants. Similar to the case for BC (Figure 4), there are no significant transient peaks during this run, demonstrating that, as expected, the effect of surrounding traffic (see below) is not as important with windows closed compared with windows open. Figure 5 also shows that for $PM_{2.5}$ the run with windows open exhibits a slightly lower baseline (~25% less as opposed to ~75% less in the case of BC) with several transient peaks. However, in contrast to the observations for BC, these peak concentrations are only about twice as high as the baseline concentrations. These results demonstrate the effect of surrounding traffic is far more important for directly emitted pollutants than for background pollutants.

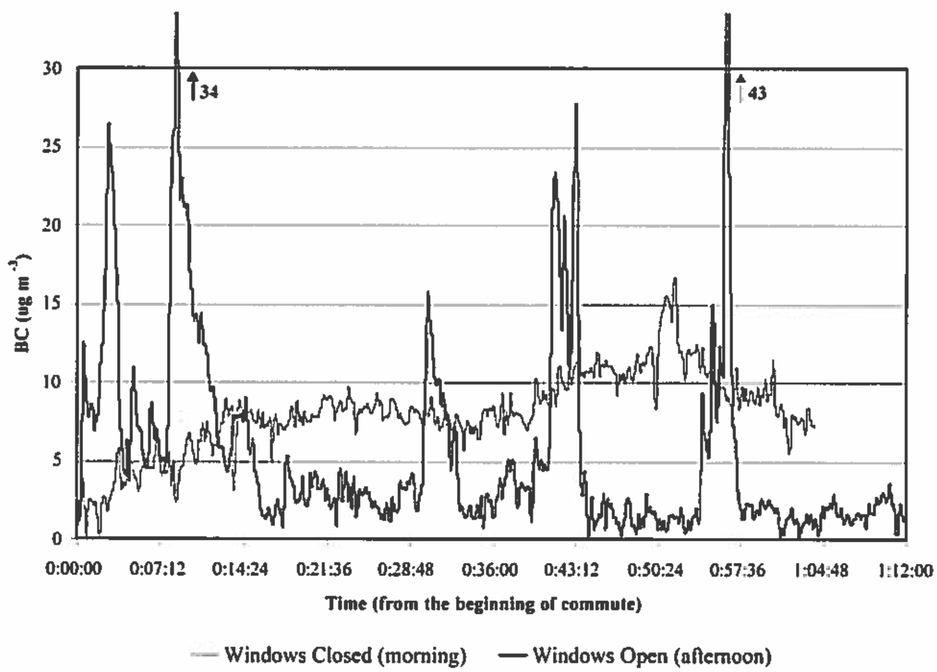

Figure 4. Real-time BC concentrations during a commute with windows open and a commute with windows closed. The great majority of the transient peaks observed for directly emitted pollutants during runs with windows open were correlated with events occurring around the test bus (e.g., following another diesel school bus).

Self-Pollution. The amount of a bus's own exhaust that can be found inside its cabin varied significantly between buses and also depended on window position. For all of the buses tested, self-pollution (measured with the tracer gas experiments) was substantially higher with all of the windows closed compared with the windows partially open. Moreover, older buses showed a larger percentage of their own exhaust entering into the cabin compared with newer buses.[25]

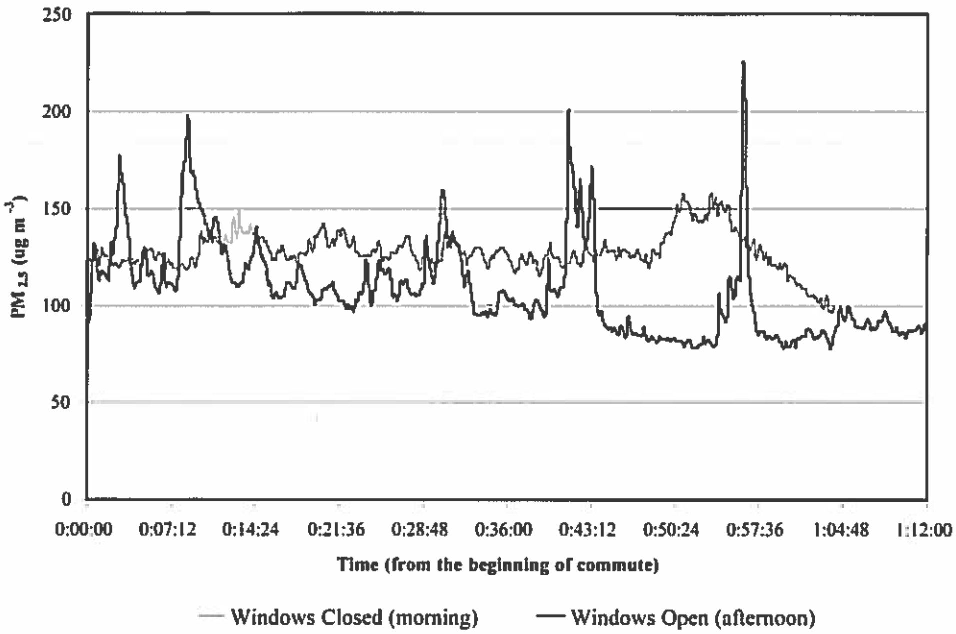

Figure 5. Real-time $PM_{2.5}$ concentrations during a commute with windows open and a commute with windows closed.

Different bus models and ages corresponded to different construction and cabin designs, and the results of our SF_6 tracer analyses suggested these differences may result in a wide range of pollutant exposures across bus types (see below). More detailed analyses about self-pollution in the tested buses are presented elsewhere.[25]

Influence of Surrounding Traffic. Using the videotapes collected during runs with windows open we were able to correlate the great majority of the transient peaks observed for BC and PB-PAH (see Figure 4) with events occurring around the test bus (e.g., following another diesel school bus).[24] For runs with windows open, we found BC and PB-PAH concentrations inside the test buses were highest when following a diesel school bus that emitted visible exhaust and lowest when following a gasoline vehicle or when no vehicles were in front of the test bus (no target).[23]

On average in the afternoon runs (windows open), another diesel vehicle was within three car lengths in front of or adjacent to our bus, during more than one-quarter of the commute, with diesel school buses responsible for >60% of these encounters. This high incidence of following other diesel school buses was in part because of caravanning behind other buses after leaving the BSMS.

The trap-outfitted diesel bus and CNG bus generally exhibited high peak concentrations only while traveling behind a diesel vehicle, whereas the conventional diesel buses exhibited high peaks both when following other diesel vehicles and while idling without another diesel vehicle in front of the bus. When following a smoky diesel school bus during runs with windows open, concentrations inside the cabin were on average 8 and 12 times higher for BC and PB-PAH, respectively, compared with following a gasoline vehicle or no target. When following a diesel school bus that was not emitting visible exhaust, BC and PB-PAH concentrations inside the test buses were on average 4 and 6 times higher, respectively, compared with following a gasoline vehicle or no target.[23]

Route Type. The overall mean concentrations of BC and PB-PAH (for commutes with windows open) were not significantly different between the two routes used in this study, although U1 spent ~40% of the time on the freeway, whereas U2 was entirely on surface streets. This is explained by the fact that characteristics that were similar between routes, such as encounters with other diesel vehicles (particularly diesel school buses), dominated the highest peak concentrations of BC and PB-PAH and resulted in comparable mean concentrations on both routes.

Bus Type. Table 5 provides a summary of the mean exposures inside buses during commutes on Route U1. For runs with windows closed, we observed the lowest exposure inside the CNG bus and the highest exposure inside the conventional diesel buses (for these analyses we pooled the high emitter and representative buses into one category). Compared with the CNG bus, exposures to BC and PB-PAH (with windows closed) were 3 times higher inside the trap-outfitted diesel bus, and 3 to 5 times higher inside the conventional diesel buses (high-emitting and representative). Results for the trap-outfitted bus were generally in between the conventional diesel buses and the CNG bus. However, exposure to diesel-related pollutants on-board our specific trap-outfitted bus appeared to be higher than expected, based on emission data reported for other trap-equipped diesel vehicles.[44]

As explained above, for commutes with windows open, the concentrations inside the buses were dominated by outside sources, thus reducing the influence of bus type on exposures in the bus commute microenvironment (see Table 5).

Table 5. Mean exposures during commutes (one way) by bus type.

	Windows Closed (Morning)			Windows Open (Afternoon)[a]		
	CNG Bus	Trap-Outfitted Diesel Bus	Conventional Diesel Buses	CNG Bus	Trap-Outfitted Diesel Bus	Conventional Diesel Buses
BC ($\mu g\ m^{-3}$ hr)	3	10	15	4	5	7
PB-PAH (ng m^{-3} hr)	80	250	270	150	130	110
NO_2 (ppb hr)	45	55	100	50	110	95

Notes: All values rounded based on significant figures. Includes bus commutes on U1 only. Values correspond to mean exposures: mean concentration times time spent commuting on school buses. One run using the CNG bus with windows open and one run using the CNG bus with windows closed; two runs with trap-outfitted bus (TO)/windows open and two runs with TO/windows closed; six runs with conventional diesel buses/windows open and six runs with conventional diesel buses/windows closed; The number of buses tested in each category included: one CNG bus; one particle trap-outfitted diesel bus; and four conventional diesel buses; [a]With windows open, concentrations inside the buses were dominated by outside sources, thus reducing the influence of the bus type.

For particulate counts (in the size range from 0.3 to 0.5 μm) and $PM_{2.5}$ mass, differences observed between bus types were not easily explained, because, as discussed earlier, these pollutants are subject to significant background influences. Similarly, these pollutants are less useful in determining the effect of the other variables studied here (self-pollution, surrounding traffic, and route type). More details about these results are given elsewhere.[23]

UNCERTAINTY AND REPRESENTATIVENESS

The uncertainty in our concentration measurements was determined by the precision of each of the analyzers used during the study. In most cases, the signal-to-noise ratios observed in our measurements were adequate and did not affect our conclusions. In addition, the baseline concentrations we observed were well above the limit of detection of all of the instruments the great majority of the time.

The uncertainty in our calculations of the contribution of the bus-commute microenvironment to a child's 24-hr exposure during a school day was dominated by the uncertainties related to each of our assumptions about the magnitude of pollutant I:O ratios (and the relative paucity of appropriate microenvironment measurement data). We estimate these individual uncertainties to be between 30% and 50%. However, because we used these data on a relative basis in a first-order approximation model, these uncertainties are not expected to affect our overall conclusions.

Concentration data for one of the bus stops and all of the bus commutes were collected during the spring season in the Los Angeles basin, with onshore flow conditions typical of the area and time of year. In general, we observed consistent conditions (low wind speeds, relatively clear skies, and a local temperature inversion) throughout the 8 weeks of the spring sampling period. Measurements at the second bus stop and at the loading/unloading zone were conducted during a winter period, when wind speeds and ventilation of the basin were more variable, and average pollutant concentrations were expected to be somewhat lower in the loading/unloading zone and bus stop microenvironments, especially for background pollutants.

However, given the relative unimportance of the loading/unloading zone microenvironment in terms of overall exposure, we considered it appropriate to compare all three of the microenvironments across the winter and spring seasons. Similarly, because conditions during the winter bus stop measurements were not greatly different from the spring bus stop measurement conditions, we considered it appropriate to pool the bus stop data and concluded that seasonal differences did not significantly affect our analyses or our conclusion that the bus stop microenvironment was also of minor importance compared with the bus commute microenvironment.

Because of resource constraints common to any vehicle-related field project, the present study was unable to test a full range of possible commutes, traffic and meteorological conditions, bus manufacturers, model years, school districts, or geographic locations in California. Our results are representative only to the extent that the commutes, buses, conditions, and areas we studied were similar to school bus conditions in other locations.

Notwithstanding the issues discussed above, the combination of small sample size, small number of runs, and relatively high variability of the results obtained for the different buses and experimental setups dominated the uncertainty during our project. Additional field studies could be conducted to broaden the range of conditions investigated, although substantial resources are required to conduct studies of this magnitude.

CONCLUSIONS

Measurements made on-board school buses in Los Angeles indicated higher exposures occurred during children's commutes than ambient air concentrations from central site monitors would indicate. These exposures resulted primarily from the commute itself and not from loading/unloading or waiting at bus stops.

The overall mean bus commute concentrations for vehicle-related pollutants, such as BC and PB-PAH, were ~2 to 3 times higher than mean concentrations at the bus stops. For the same set of pollutants, the highest mean concentrations for an individual (~1 hr) bus commute were factors of 5 to 9 times higher than the mean concentrations at bus stops. Exposures (mean concentrations times time spent) were highest for the urban bus commutes, between 20 and 40 times higher than at bus stops and between 50 and 200 times greater than for the loading/unloading zone microenvironment, depending on the specific pollutant.

Although the 24-hr exposure for a child during a school day is dominated by indoor microenvironments, for vehicle-related pollutants (BC and PB-PAH) the contribution of school bus commutes could be as high as one-third of overall 24-hr exposure.

For "directly emitted" pollutants, the dominant variable associated with high concentrations inside the bus cabin when the windows were open was the presence of another diesel vehicle in the proximity of our test bus. For the same set of pollutants, when windows were closed the dominant factor determining in-cabin exposure was the degree of self-pollution. These two factors were sufficiently important that although we used two urban routes with different characteristics, we did not observe significant differences between the mean concentrations for the two routes. For "background" pollutants (e.g., $PM_{2.5}$) window position and surrounding traffic were less important, because these pollutants are heavily influenced by other factors, including regional sources, meteorology, and secondary formation.

During commutes when the windows of the bus were closed, we found substantial differences in concentrations measured inside the bus cabin depending on the fuel type, after-treatment technology, and levels of self-pollution of the test bus, whereas the impact of outside sources was less important.

Our results demonstrate that the type of school bus a child rides on is not the only determinant of exposure and that conventional diesel school buses can have a double exposure impact on commuting children: first, the influence of the bus's own exhaust on concentrations inside the cabin and second, exposures to the exhaust from other nearby conventional diesel school buses.

This study involved long commutes, often in congested conditions and with significant self-pollution for several buses; therefore, our findings cannot be viewed as typical for all buses under all commute scenarios. Moreover, a relatively small proportion of children attend magnet schools, and children attending neighborhood schools generally have shorter commutes than those studied here.

Under the conditions we studied, effective ways to reduce on-board exposures during the commute itself include minimizing commute times, avoiding caravanning with other school buses, using the cleanest buses for the longest bus routes, maintaining school buses to minimize or eliminate visible exhaust, and phasing in alternative fuels and advanced particulate emissions control technologies.

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