**Supplemental Material for:**

**An Assessment of VOCs Emissions from Bulk Wood Pellet Storage**

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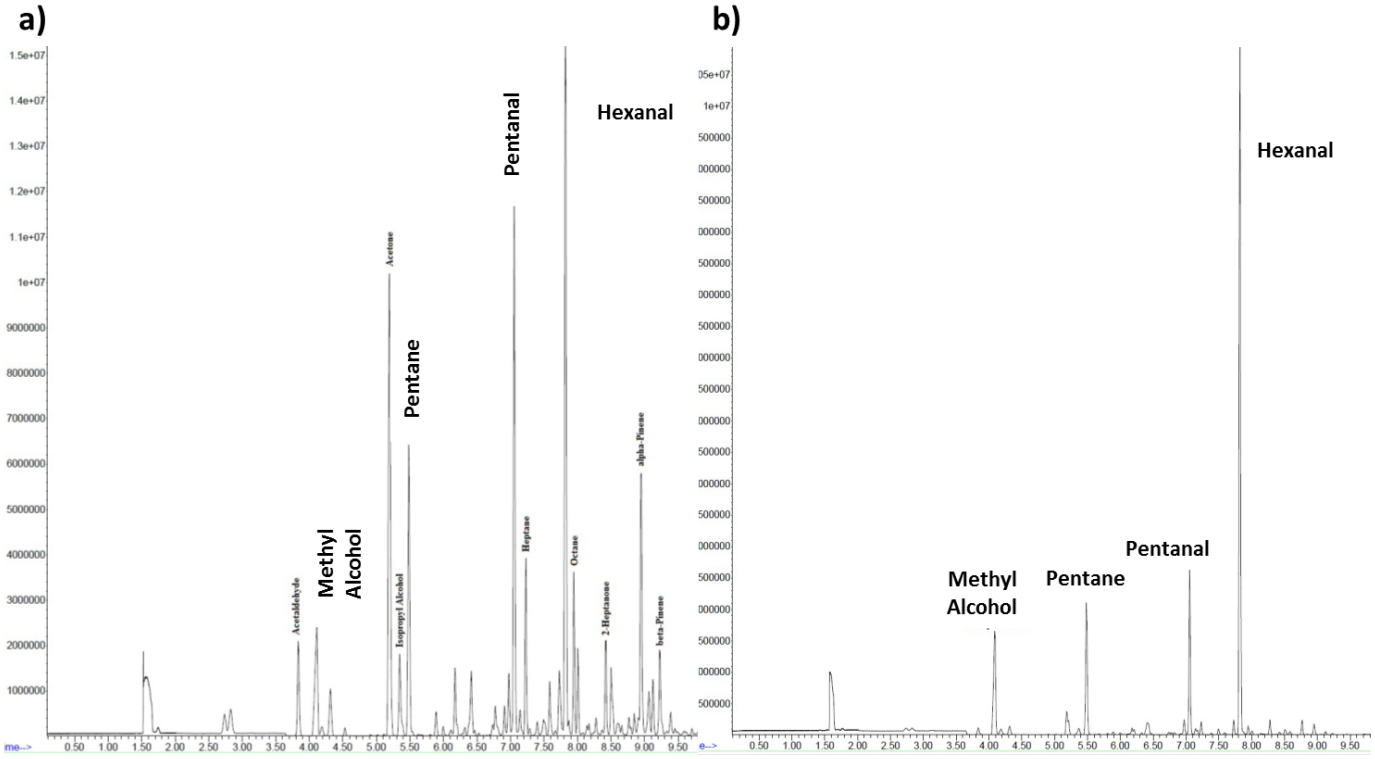
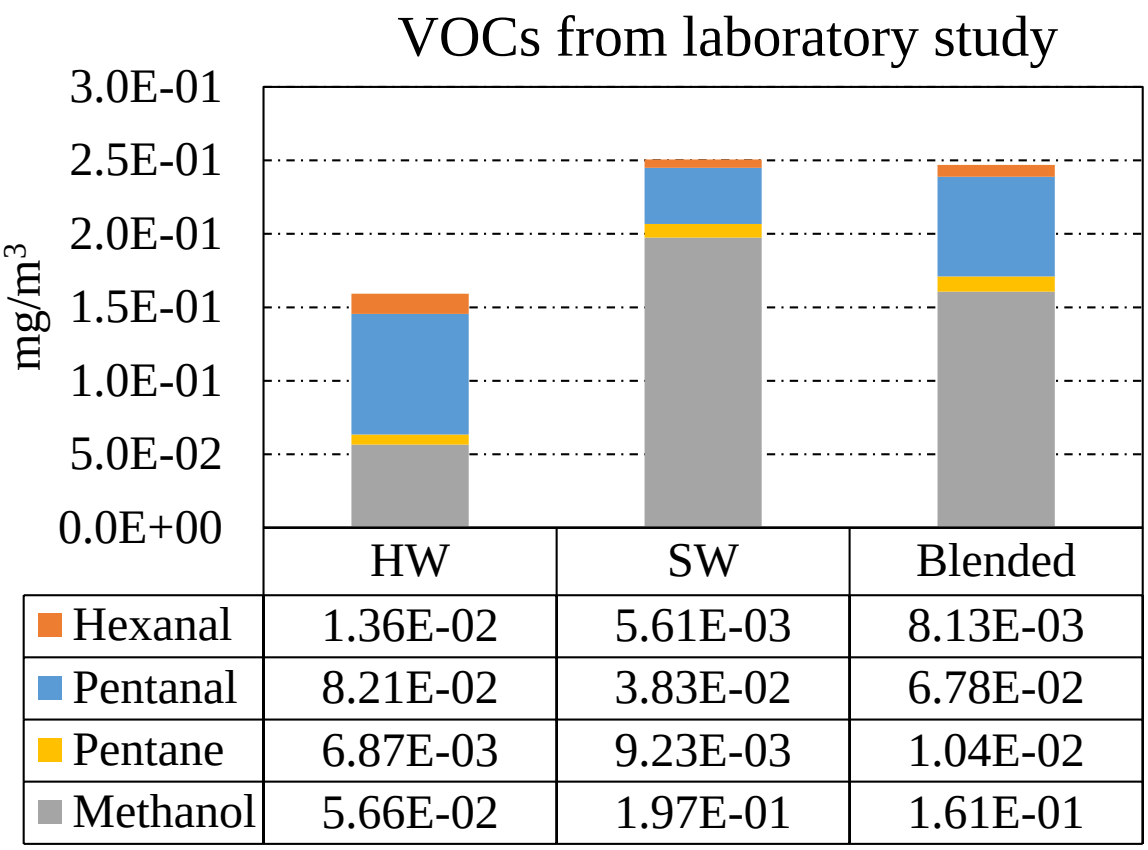



**Figure S1**. Major VOC's components of the a) soft and b) hard wood pellets identified by the GC/MS.




| | HW | SW | Blended |
|---|---|---|---|
| Hexanal | 1.36E-02 | 5.61E-03 | 8.13E-03 |
| Pentanal | 8.21E-02 | 3.83E-02 | 6.78E-02 |
| Pentane | 6.87E-03 | 9.23E-03 | 1.04E-02 |
| Methanol | 5.66E-02 | 1.97E-01 | 1.61E-01 |

**Figure S2.** VOCs concentration sum from three different type of stored wood pellets (Hardwood-HW, Softwood-SW, and Blended). Pellets were stored for a month (31 days) in sealed 20 gallon drums containing ~18 kg of pellets.

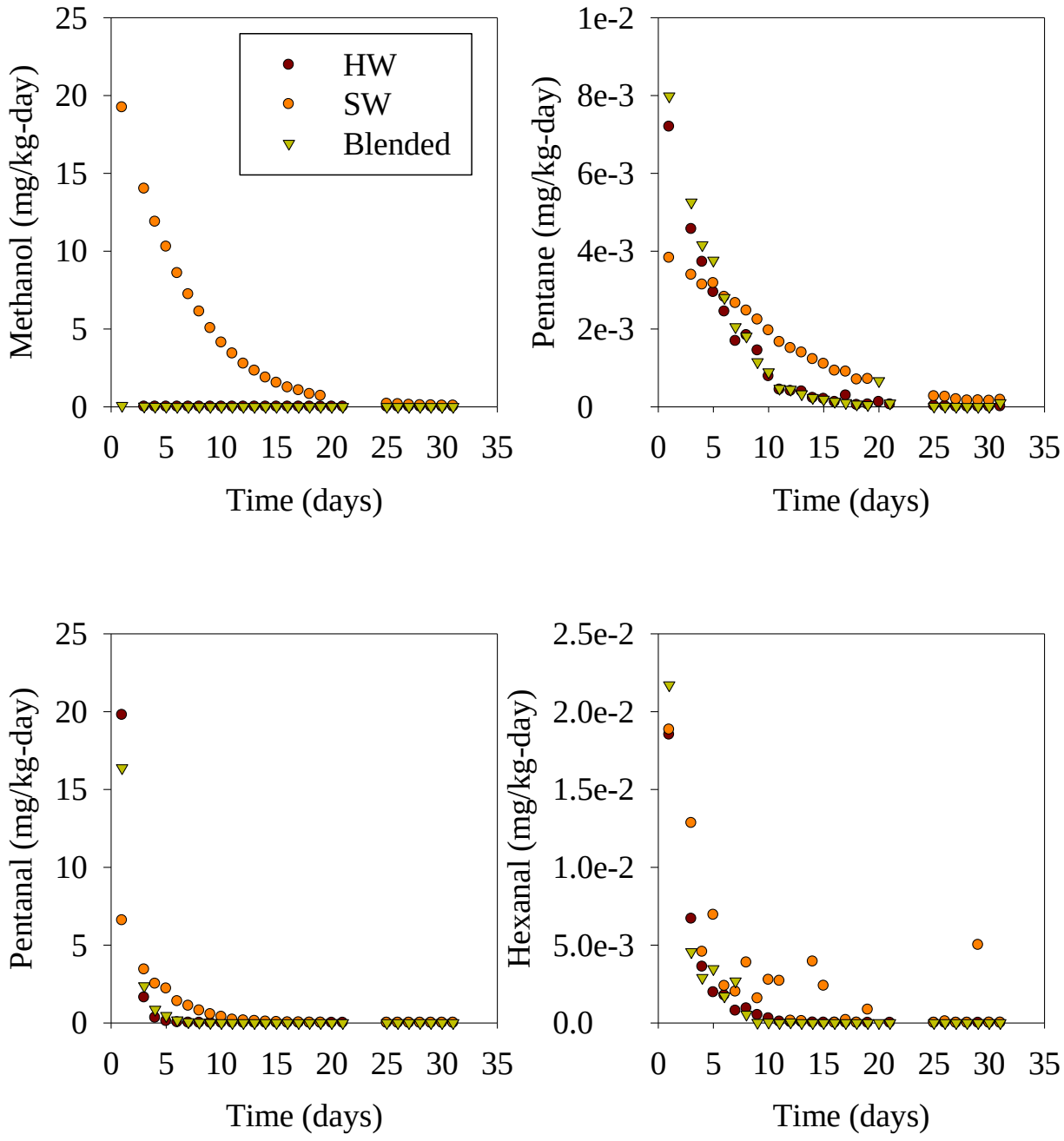



**Figure S3**. Emission Rates (mg/kg-day) per day of the four common VOCs in the hardwood (HW), softwood (SW) and blended pellets.

**Table S1.** Major VOCs components of soft wood and hard wood pellets identified by the GC/MS.

| Soft Wood Pellets | Hard Wood Pellets |
|---|---|
| Acetaldehyde | |
| Methanol | Methanol |
| Acetone | |
| Isopropyl Alcohol | |
| Pentane | Pentane |
| Pentanal | Pentanal |
| Heptane | |
| Hexanal | Hexanal |
| Octane | |
| 2-Heptanone | |
| Alfa-Pinene | |
| Beta-Pinene | |

**Table S2**. VOCs concentration in homes and occupational locations in Northern New York State. Samples were collected during the heating season (November 2014- April 2015).

| n | Site ID | Volume (ton) | Short Site Name | Type of Storage | Age | T (max, average, min)°C | Average (ppb) | | | | Standard Deviation (±) ppb | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Methanol | Pentane | Pentanal | Hexanal | Methanol | Pentane | Pentanal | Hexanal |
| 4 | Home1/Basement | 10 | Home1 | Fabric Bag | new | 18-23 | 5181 | 64 | 44 | 136 | 3142 | 25 | 11 | 85 |
| 2 | | | | | old | | 362 | 2 | 4 | 4 | 362 | 2 | 4 | 17 |
| 3 | Home2/Basement | 0.02 | Home2 | Bags | new | 18-23 | 256 | 9 | 14 | 41 | 256 | 9 | 14 | 41 |
| 4 | | | | | old | | 40 | 25 | 24 | 33 | 40 | 25 | 24 | 33 |
| 2 | Occupational/CC | 10 | WP1/CC | Fabric Bag | new | 18-23 | 77 | 39.6 | 100 | 409 | 3 | 0.4 | 5 | 8 |
| 3 | | | | | old | | 47 | 22 | 42 | 386 | 47 | 9 | 7 | 92 |
| 1 | Occupational/WC | 30 | WP2/WC | Trailer Bin | old | (3, -1, 5) | 0.00 | 0.00 | 0.00 | 0.00 | | | | |
| | | | | Boiler Room | old | | 472.86 | 1.47 | 3.40 | 6.13 | | | | |
| 2 | Occupational/WAC | 10 | WP3/WAC | Storage Bin | new | (38,26,17) | 89 | 14 | 6 | 37 | 89 | 14 | 6 | 37 |
| 1 | | | | | old | | 103.64 | 19.06 | 22.27 | 249.33 | | | | |
| 1 | | | | Boiler Room | new | | 18.75 | 98.14 | 54.24 | 30.14 | | | | |
| 2 | | | | | old | | 22 | 26.81 | 3.5 | 15 | 2 | | 0.1 | 6 |
| 1 | Clarkson University/EC | 3 | CU/EC | Storage Bin | new | (7,1,-5) | 70.12 | 55.17 | 225.76 | 1327.21 | | | | |
| 1 | | | | | old | | 70.44 | 13.78 | 159.11 | 33.93 | | | | |
| 1 | | | | Boiler Room | new | | 31.39 | 4.45 | 2.23 | 10.16 | | | | |
| 2 | | | | | old | | 107 | 30 | 64 | 291 | 2 | 14 | 9 | 7 |

Abbreviations: n refers to the amount of sample; WP refers to work place; CC-Chamber of Commerce; WC-Wild Center; WAC-Walker Center; CU-Clarkson University; EC-Energy Cabin. *Note: New is used for samples collected after pellets delivery with 2-5 days old. Old refers to four week to 3 months old and it is depending on the site: Home 1(2-3 months), Home 2 (4 weeks), Occupational/ CC (2 months), Occupational/ WC (2-3 months), Occupational/ WAC (3-4 weeks), CU/EC (4-5 weeks old).

**Table S3.** Occupational exposure limits and health effect of major VOCs off-gassed from wood pellets measured from Northeastern, US.

| Chemical | ACGIH-TLV (ppm) | Target Organs | Symptoms | Odor | Air odor threshold |
|---|---|---|---|---|---|
| Hexanal | N/A* | eyes, skin, respiratory system, CNS | Vapor: irritating to eyes, nose & throat. Liquid: irritating to skin and eyes. | Powerful fatty-green odor. Can emit acrid smoke and fumes when heated. | 4.5-5 ppb** |
| Pentane | 1000*** | Eyes, skin, respiratory system, CNS | Irritation eyes, skin, nose, dermatitis, chemical pneumonitis | Gasoline like | 119-1147 ppm*** |
| Pentanal | 50 (175 mg/m$^3$) | Eyes, skin, respiratory system | Irritation eyes, skin, nose and throat | Strong, acrid, pungent | 0.028-0.060 ppm |
| Methanol | 200 | Eyes, skin, respiratory system, CNS | Irritation eyes, skin, upper respiratory system; headache; drowsiness, dizziness, nausea, vomiting, visual disturbances, optic nerve damage (blindness), dermatitis. | Pungent | 100 ppm |

ACGIH-TLV - American Conference of Governmental Industrial Hygienists- Threshold Limit Value (*Hexanal: 50 ppm (197 mg/m$^3$) is recommended in general by NIOSH for certain alkyl aldehyde, but hexanal is not included here. However," Volunteers exposed to 0, 2, and 10 ppm n-hexanal for 2 hours at rest in a balanced order. ... Ratings of discomfort in the eyes and nose, solvent smell, and headache increased significantly with the level of exposure. Frequency of blinking was significantly increased at 10 ppm. No effects on pulmonary function and nasal swelling were detected, except a not-significant tendency to increased nasal obstruction at 10 ppm. No clear effects on plasma inflammatory markers were observed. It was concluded that ***two hours of exposure to n-hexanal results in mild irritation at 10 ppm, with no apparent adversity at 2 ppm***. Ernstgard L et al; J Occup Environ Med 48 (6): 573-80 (2006)"
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+560
**Hexanal odor threshold
http://www.leffingwell.com/odorthre.htm
*** http://hazmap.nlm.nih.gov/category-details?table=copytblagents&id=107
Pentane- Sources/Uses: Used as a chemical raw material and in lighter fluids, blowtorch fuels, laboratory solvents, blowing agents for plastics, gasoline additives, and aerosol propellants; [HSDB] Used as foaming agent for expanded polystyrene (EPS) and polyurethane, process diluent/carrier for polymerizations, formulation solvent in adhesives, and for other minor uses (pharmaceuticals, degreasing agents, lubricants, stain removers, and cleaning agents); [ExPub: CPS&Q: RARs - Final Risk Assessment Report].