

# Working together for clean air

A carrot and a nudge:  
large scale approaches to  
residential wood smoke in  
the Tacoma (former) PM  
nonattainment area

Phil Swartzendruber, Ph.D.

Clear the Air, Paths to Attainment  
Sept 26-28, 2016  
Fairbanks, AK



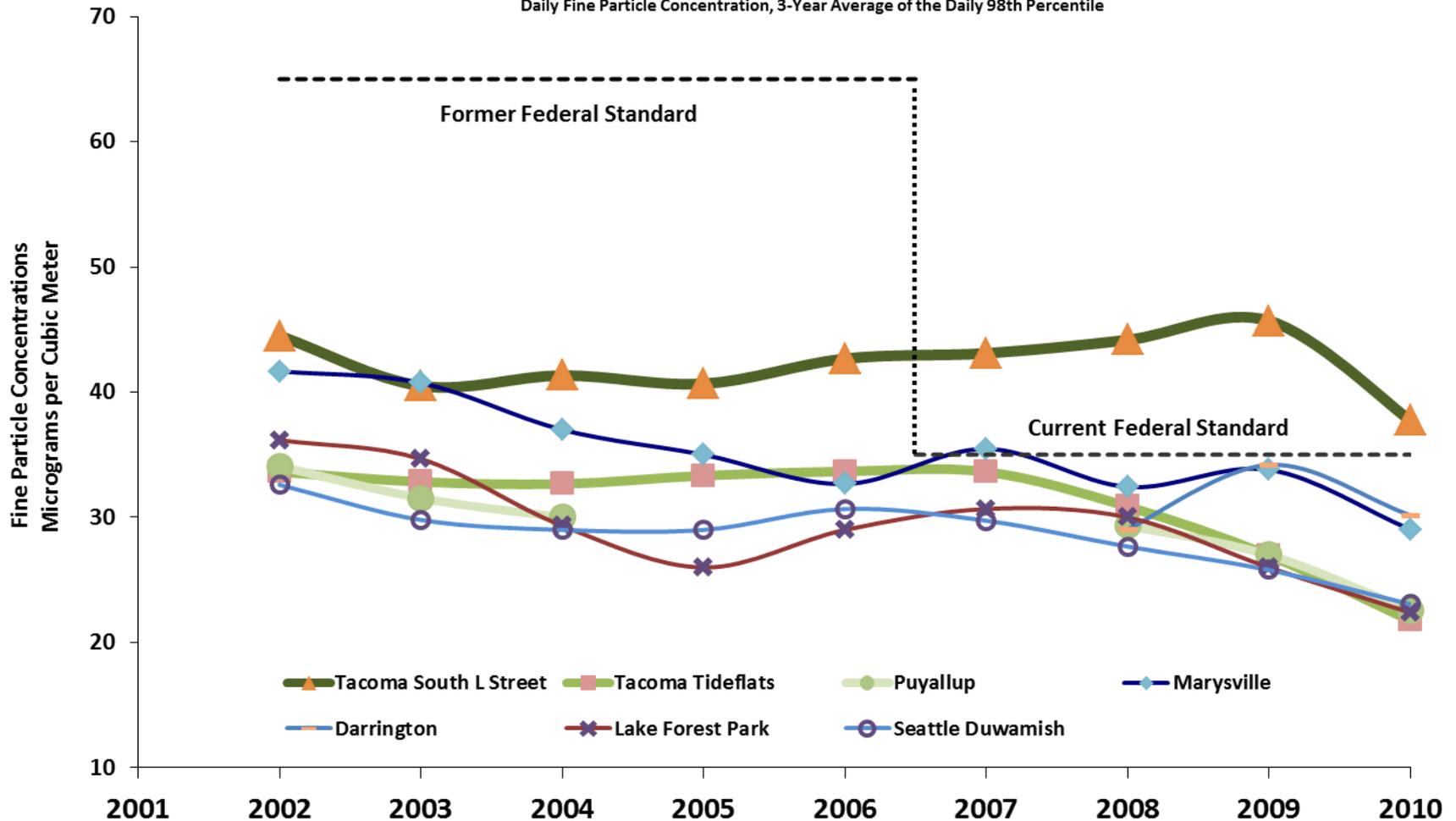
Ewe! Where is this coming from?



# 2006 revision of Daily PM2.5 standard brings area into nonattainment

## Fine Particle Concentrations at Tacoma South L and Other Puget Sound Sites

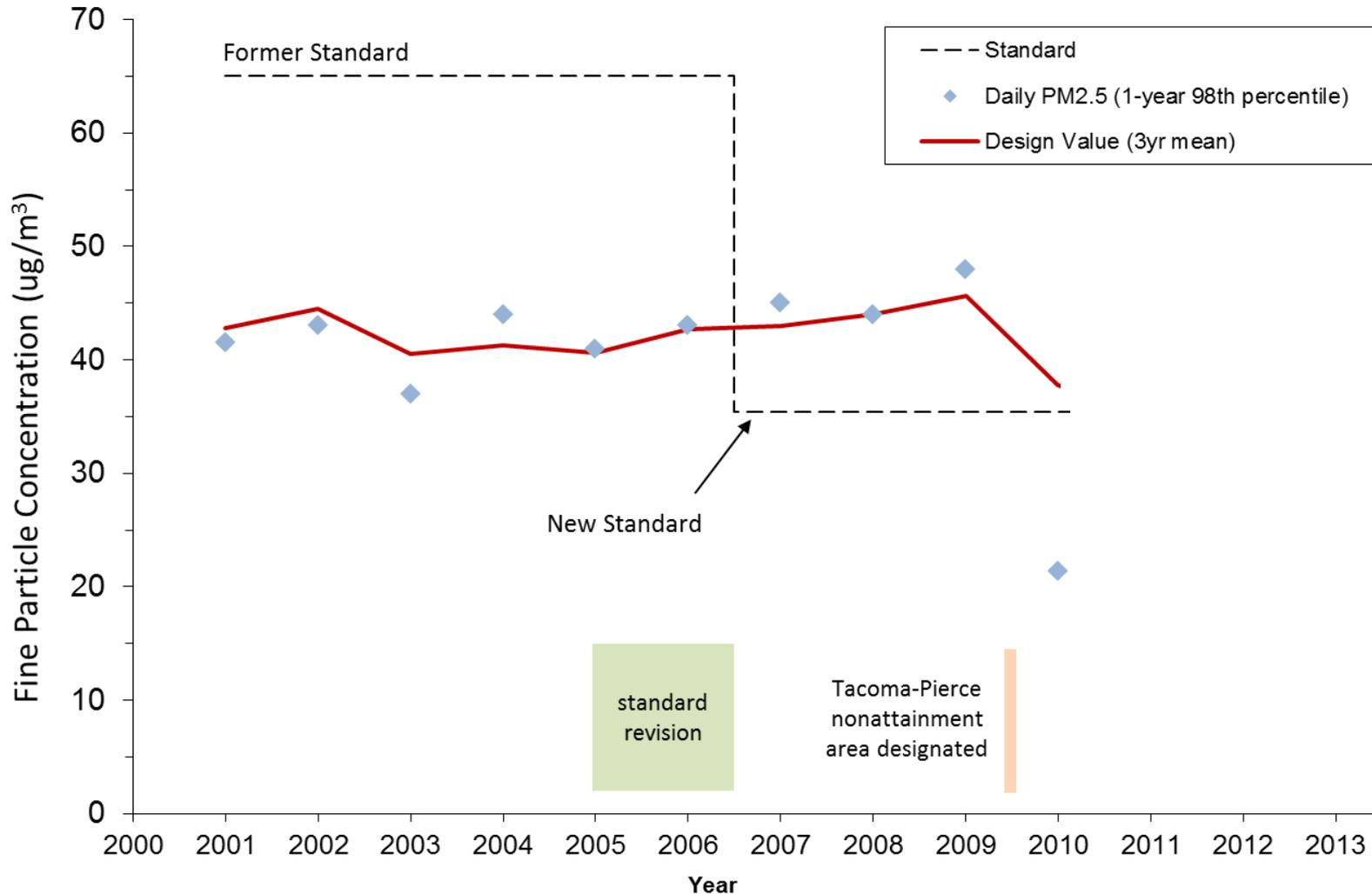
Daily Fine Particle Concentration, 3-Year Average of the Daily 98th Percentile



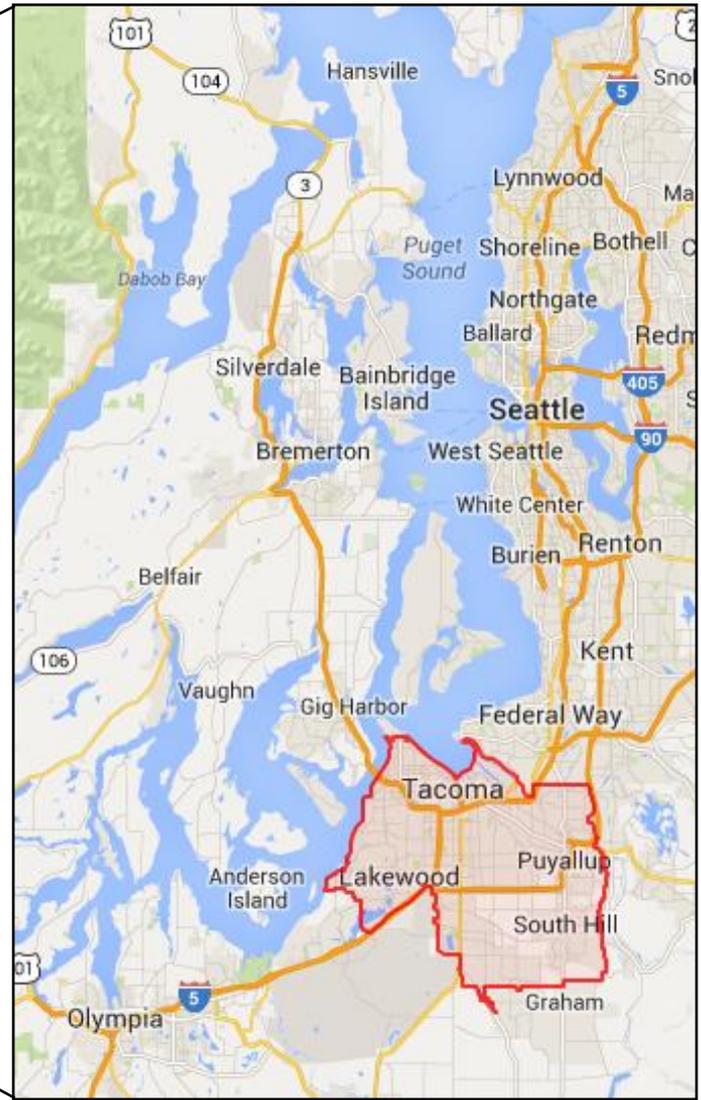
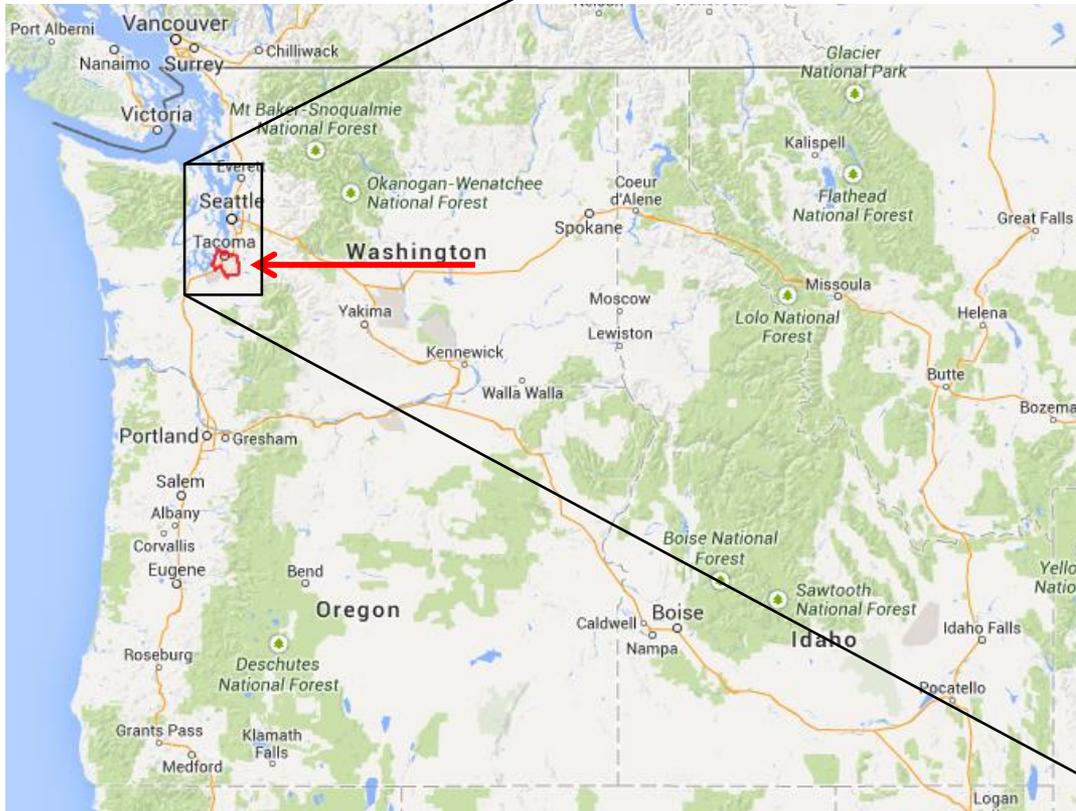
# Designation occurs in 2009

## Fine Particle Levels in Tacoma and Federal Daily Standard

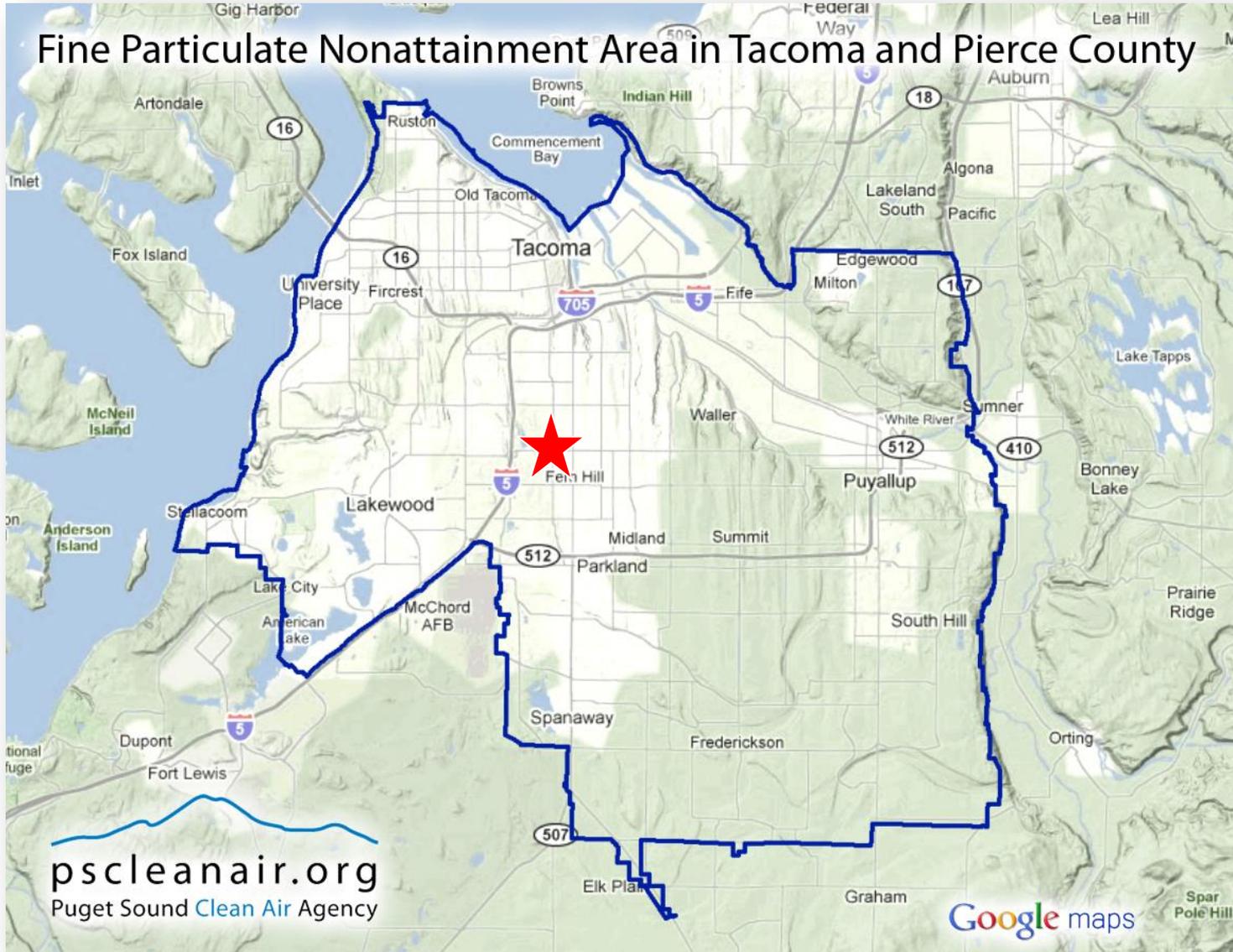
(Daily PM2.5 [1-year 98%ile] and Design Value [3-year mean of Daily])



# Where is the nonattainment (aka Smoke Reduction Zone) ?



# The Tacoma-Pierce County Non-Attainment Area



# **The solution: a collaboration**

- **Clean Air Task Force (stakeholder group) with independent facilitator**
- **Puget Sound Clean Air Agency sponsored, with major help from WA State Department of Ecology**
- **open to public, accepted comments at every meeting**
- **met 12 times over 8 months**



**Clean Air  
Task Force**

# The solution: a collaboration

Clean Air Task Force membership included representatives from:

- citizen wood burners
- business
- realtors
- Hearth/Stove retailers
- Respiratory health professional (UW)
- the Port of Tacoma
- Joint Base Lewis-McChord
- Electric and gas utilities
- regulators



Clean Air  
Task Force

# **The solution: a collaboration**

**Clean Air Task Force  
discussion progressed  
through:**

- 1. Background science on air pollution, health, and Tacoma data**
- 2. Relevant Regulations**
- 3. Brainstorming solutions**
- 4. Narrowing and revising solutions**
- 5. Making final recommendations**



**Clean Air  
Task Force**

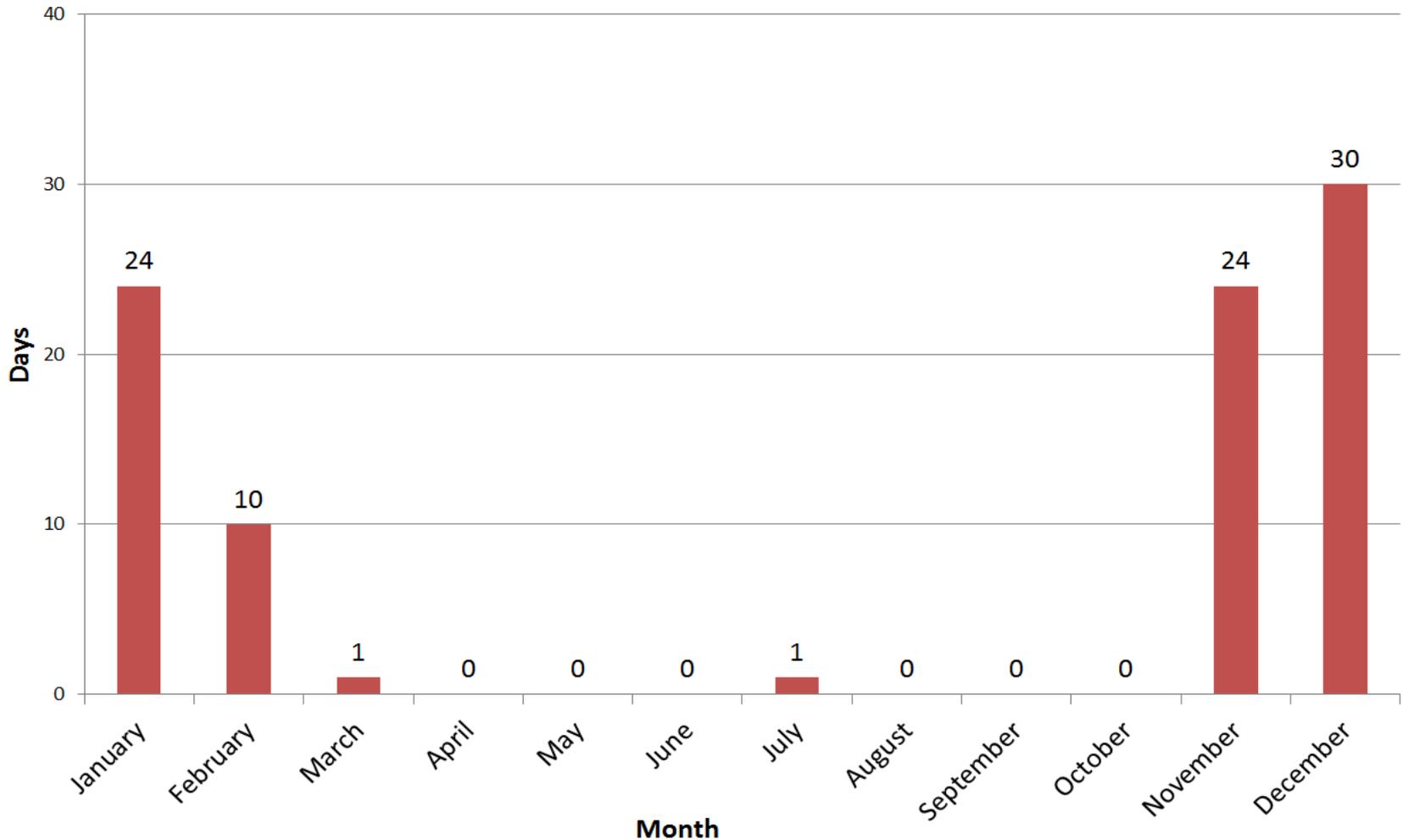
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## About the Nonattainment area (now, Smoke Reduction Zone )

- **About 200 square miles**
- **About 220,000 urban, suburban and rural households**
  - Median income = \$51,000
  - Poverty rate = 12%
  - ~25,000 households (17%) are at 150% of federal poverty level
- **10 cities and towns plus many unincorporated communities (most of the county's urban growth area)**
- **About 24,000 uncertified wood stoves (2007 inventory)**
  - ~21,000 of those are being used
  - ~3,500 wood is "Primary" source of heat (Census, 2005-2009 ACS)
  - ~600 wood is sole source of heat (Assessor records)

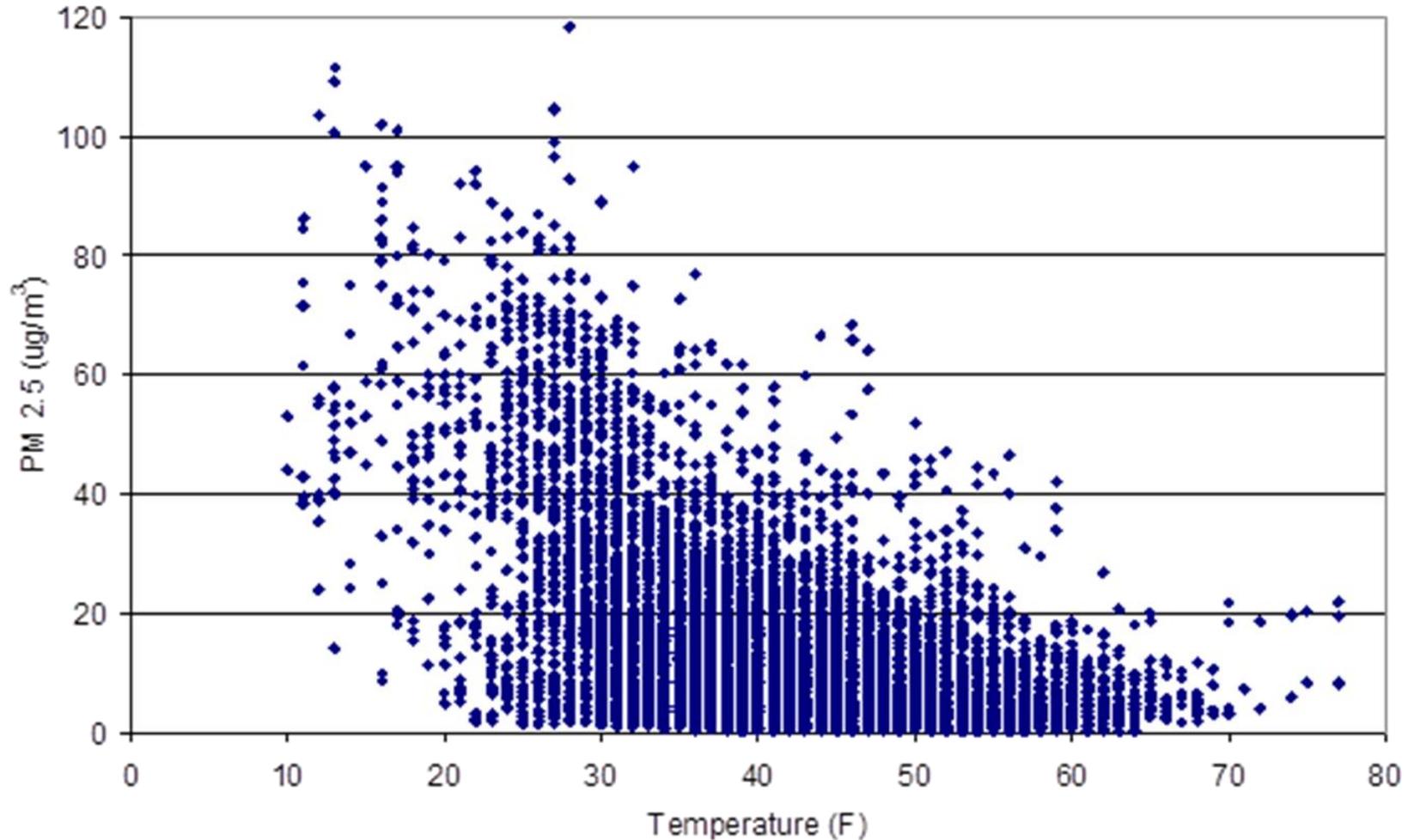
# Where, when, how, why ????? Exceedances only occur in the winter...

Number of days per month over the Federal Standard since 2002



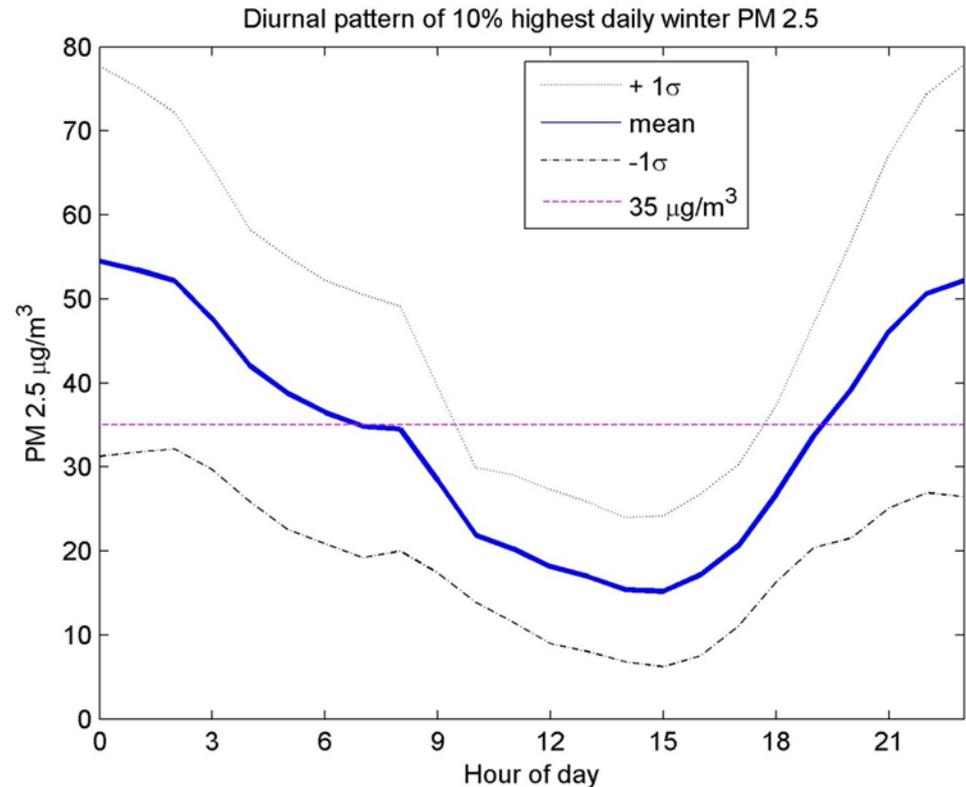
# Temperature drops, PM2.5 goes up...

Tacoma South L, fall-winter hourly PM2.5

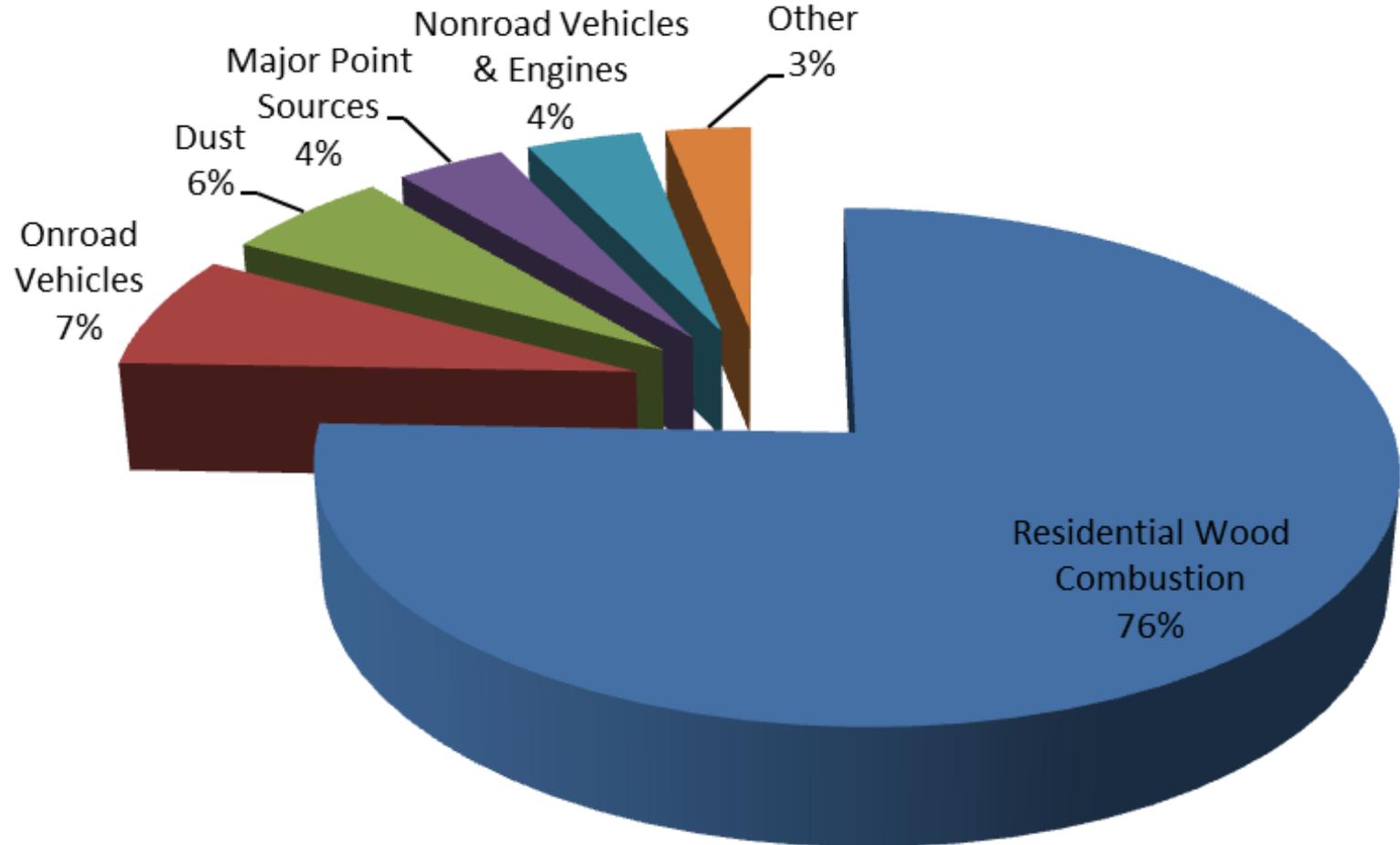


# On worst winter nights, diurnal pattern matches burning habits...

- diurnal pattern
- stagnation at *night*
- rapid increase in evening when burning occurs
- dissipates after midnight
- venting during the day
- typically clear with high pressure ridge

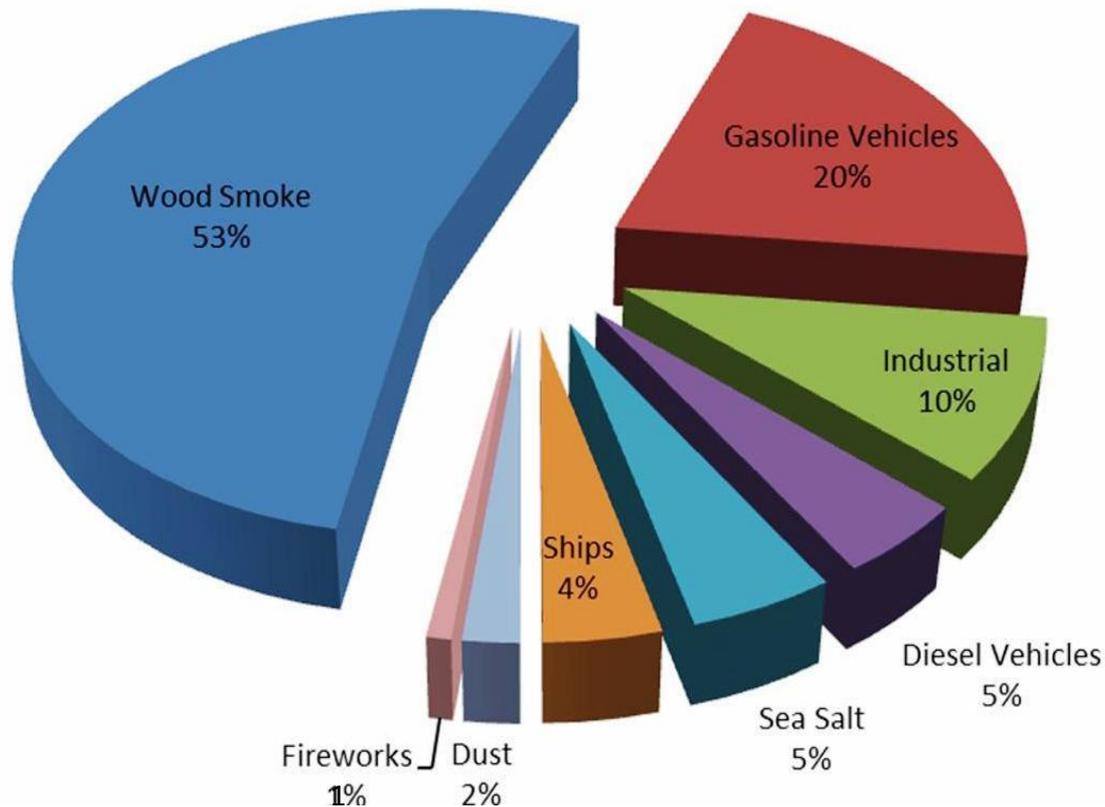


# Emissions Inventory highlights residential wood burning as largest PM2.5 source...



# PMF (fingerprint) results of chemical composition analysis...

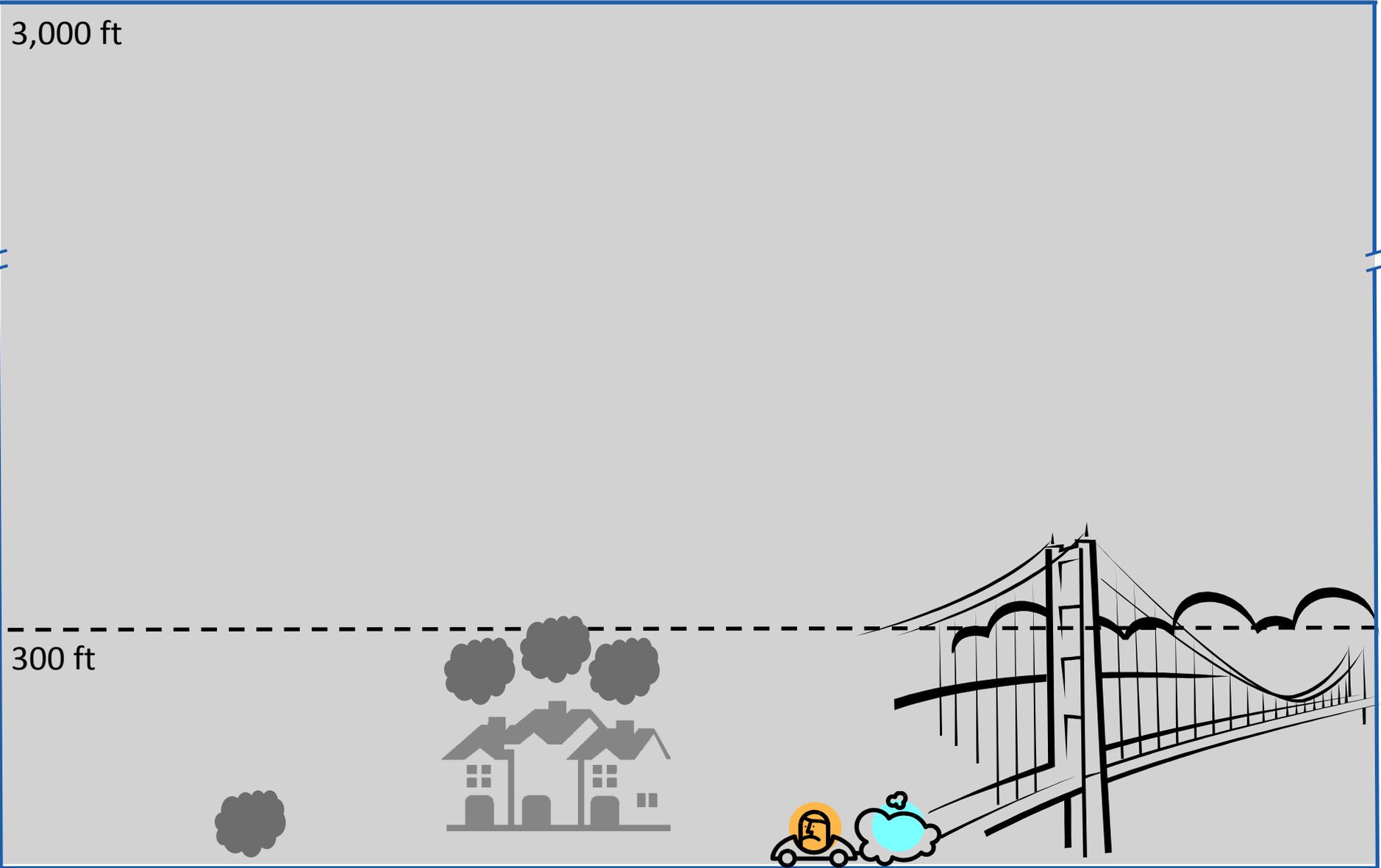
## Sources of wintertime fine particle pollution in South End Tacoma/Pierce County



# When highest? Normal ventilation – most days

3,000 ft

300 ft



# When highest? Ventilation during an inversion

3,000 ft

300 ft inversion "lid"



# The solution: a collaboration

Clean Air Task Force discussion progressed through:

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Clean Air  
Task Force

# Recommended Strategies :

1. **Improve Efficacy of Burn Bans (but have exemptions)**
2. **Remove uncertified wood stoves (by 2015)**
3. **Continue and enhance changeout program with incentives**



# Recommended Strategy #1

- **Improve Effectiveness of Burn Bans**
  - **Beef up enforcement: people and coverage**
  - **Lower the threshold for calling burn bans (triggers dropped from 35 to 30 ug/m<sup>3</sup>)**
  - **Expand communication and outreach**





# Outreach Campaign

- New Burn Ban website
- Paid advertising
  - **Print** – Ads 2x weekly, major pubs
  - **Digital** – The News Tribune online
  - **Outdoor** – 5 at a time, 8-week/set
- **Earned media**
  - Print, TV, radio news, editorial
  - Government access
- **Direct mail postcard**
  - Targeted 80,000 pieces
- **Community outreach**
  - 60+ local presentations
  - 40 local publications
  - 28,000 flyers distributed locally
- **Engaged partners**
- **Social media, text and email alerts**



**LEAVE YOUR OLD FLAME BEHIND.**

Take a chance in our Nov. 30<sup>th</sup> drawing to win up to \$1,500 for a new, cleaner home heating device. 10 lucky winners will receive a free cleaner heating system in exchange for their old wood stove. Visit [airsafepiercecounty.org](http://airsafepiercecounty.org) for more details.

[airsafepiercecounty.org](http://airsafepiercecounty.org) AIR. ON THE SAFESIDE 



**BURN BAN ENFORCEMENT HAS BEGUN.**

**SIGN UP FOR ALERTS.**  
Pierce County doesn't meet federal health standards for certain kinds of air quality. During winter, wood smoke is responsible for much of the problem. Burning during a burn ban can result in fines. Text "pierceburn" to 313131 to know when it's ok to burn.

[airsafepiercecounty.org](http://airsafepiercecounty.org) AIR. ON THE SAFESIDE 



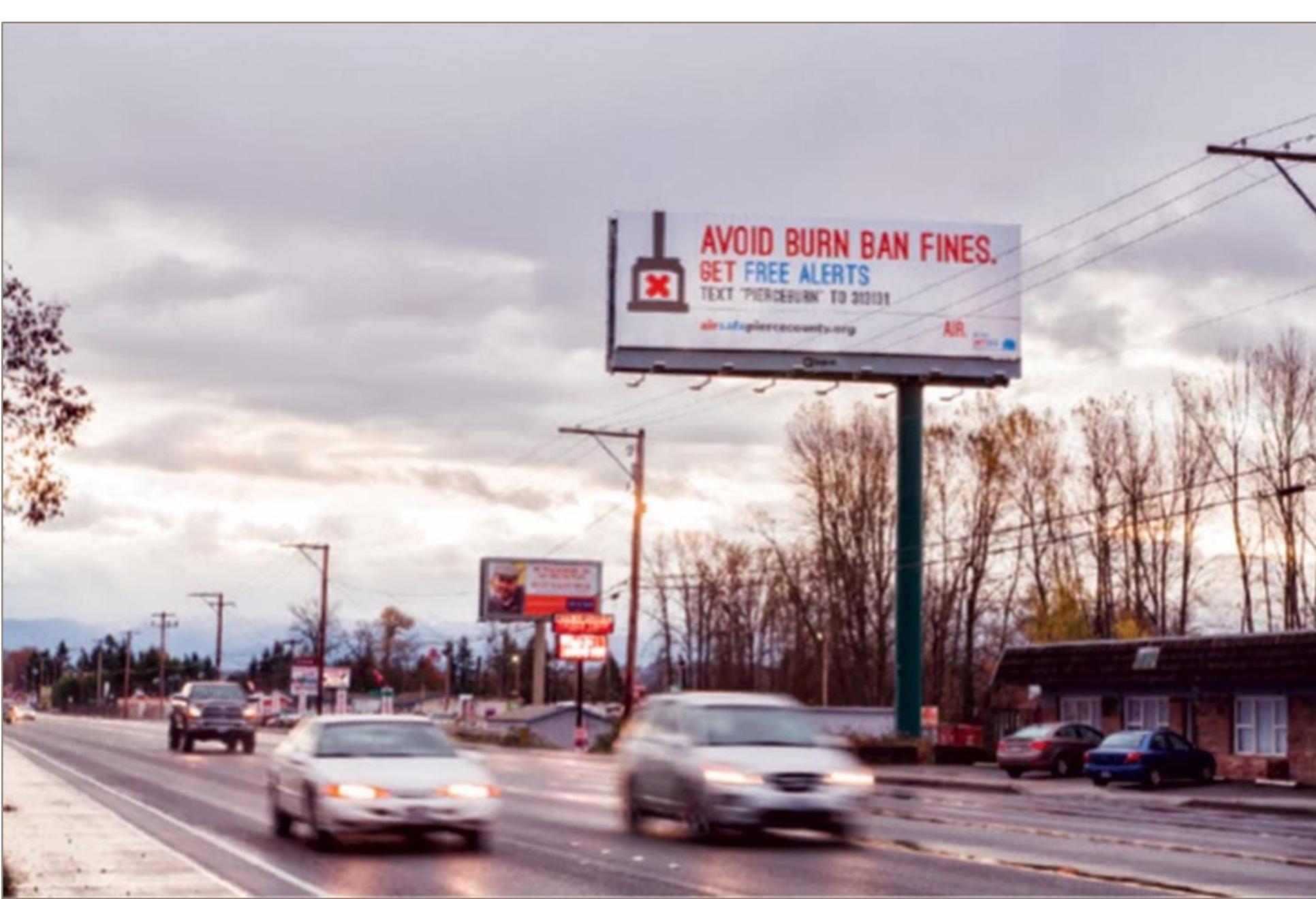
**AVOID BURN BAN FINES.**  
**GET FREE ALERTS**  
TEXT "PIERCEBURN" TO 313131

[airsafepiercecounty.org](http://airsafepiercecounty.org) AIR. ON THE SAFESIDE 



**AVOID BURN BAN FINES.**  
**GET FREE ALERTS.**

AIR. ON THE SAFESIDE 



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# Enforcement Improvements

- **Use staff of local gov. partners in on-call basis**
- **More patrols, was 2 or 3 teams, maxed at ~ 40 teams**
- **Lower thresholds for calling burn bans**
- **Patrol more hours at common burning times (nights and weekends)**
- **Developed nighttime capability (most burning is at night, day has inequality issue)**
- **Create “no other adequate source of heat” program (NOASH)**

# “No Other Adequate Source of Heat” exemption program

- Houses were designed with wood as primary heat
- Houses with heating systems too small for “adequate” warmth
- about 1-2% of all houses
- had to submit information about heating system and insulation
- compared to county records

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# How did we get 40 teams???

- **“Rented” other local agency staff during burn bans**
- **Four cities and the county**
- **Developed agreements/contracts**
- **Required significant training on observations and documentation**
- **Paid them for their time**

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# Results from 2012/13 and 2013/14 Winters

- **burn bans for ~30 days total**
- **~2,700 potential violations documented with photographs (even after dark)**
- **~1700 NOVs (Notice of Violations) issued**
- **~1000 civil penalties issued**

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**You might ask “How did you document smoke at night?”**

**Good question!**

**A: standard low-light photography:**

- high ISO
- “fast” lens (open aperture)
- long exposure → tripod

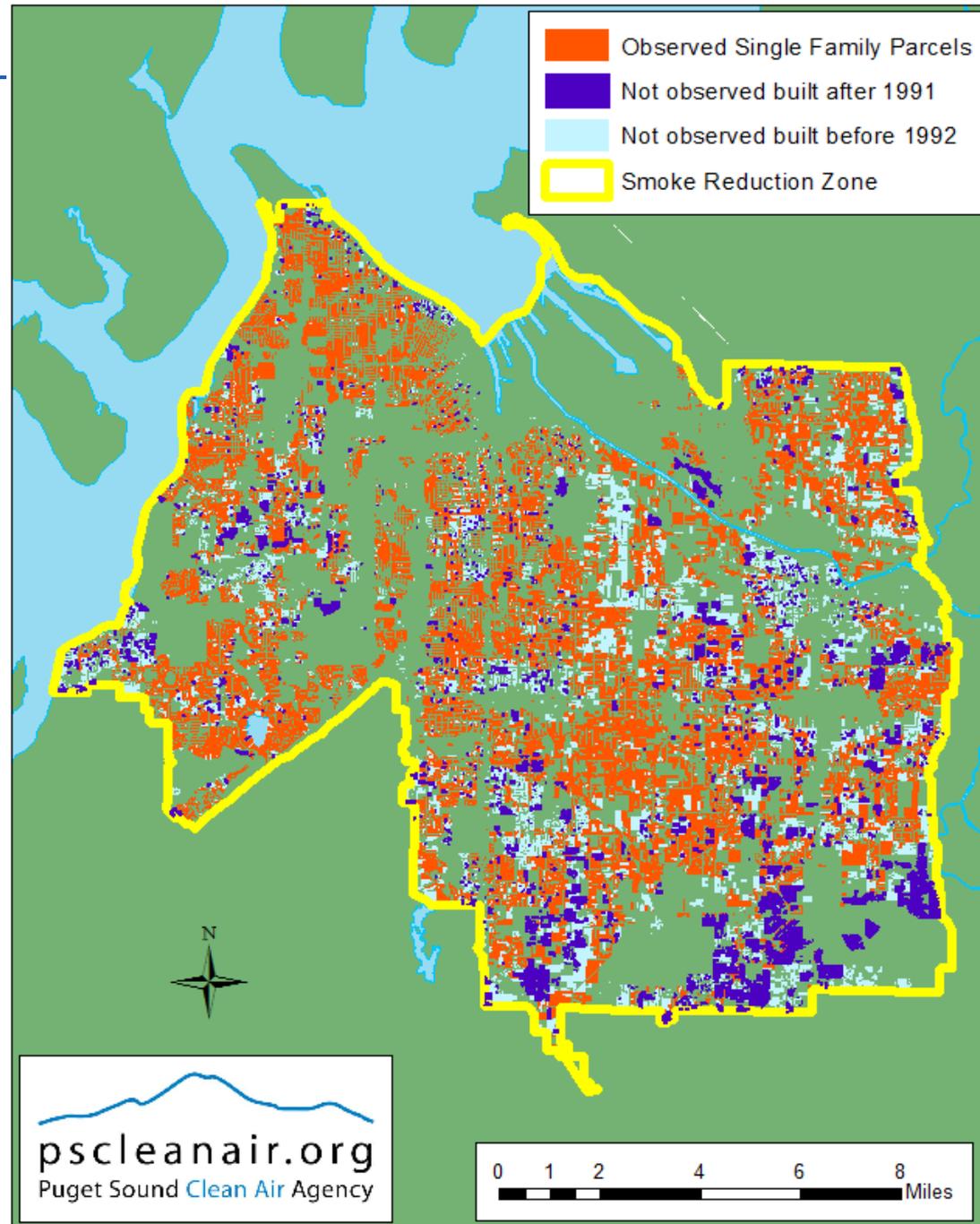
## Camera specs

- “off the shelf” Nikon D5100 DSLR with f/1.8 85mm lens
- is only visible light
- GPS tagger adds location to .jpg file
- ISO 3200 at f/6.3, typically 1-10 seconds exposure
- tripod or window-pod
- requires training and practice for those not familiar with DSLR
- biggest problem is correct focus (auto focus doesn't work)



## 2013/14 Enforcement Coverage

- Used GPS to track vehicles
- 130,000 single family parcels in SRZ
- 65,000 covered (~50%) at least once
- Better coverage in fewer patrol days
- Fewer re-citation in same burn ban



# Strategy #2: Removing uncertified stoves

- New rule banning uncertified woodstoves as of September 2015 (along with incentives)
- Only in the nonattainment area



- Can be rendered inoperable...We prefer old stoves taken to recycler and crushed

# Strategy #3: Incentives for removal or replacement of uncertified stoves

- Wood Stove Replacement Program (WSRP)
- Replace (with cleaner heating device)
  - Income-Qualified households = FREE
  - \$1500 discount for others
  - fireplace pilot program



# WSRP: Full cost to income qualified, \$1500 to others

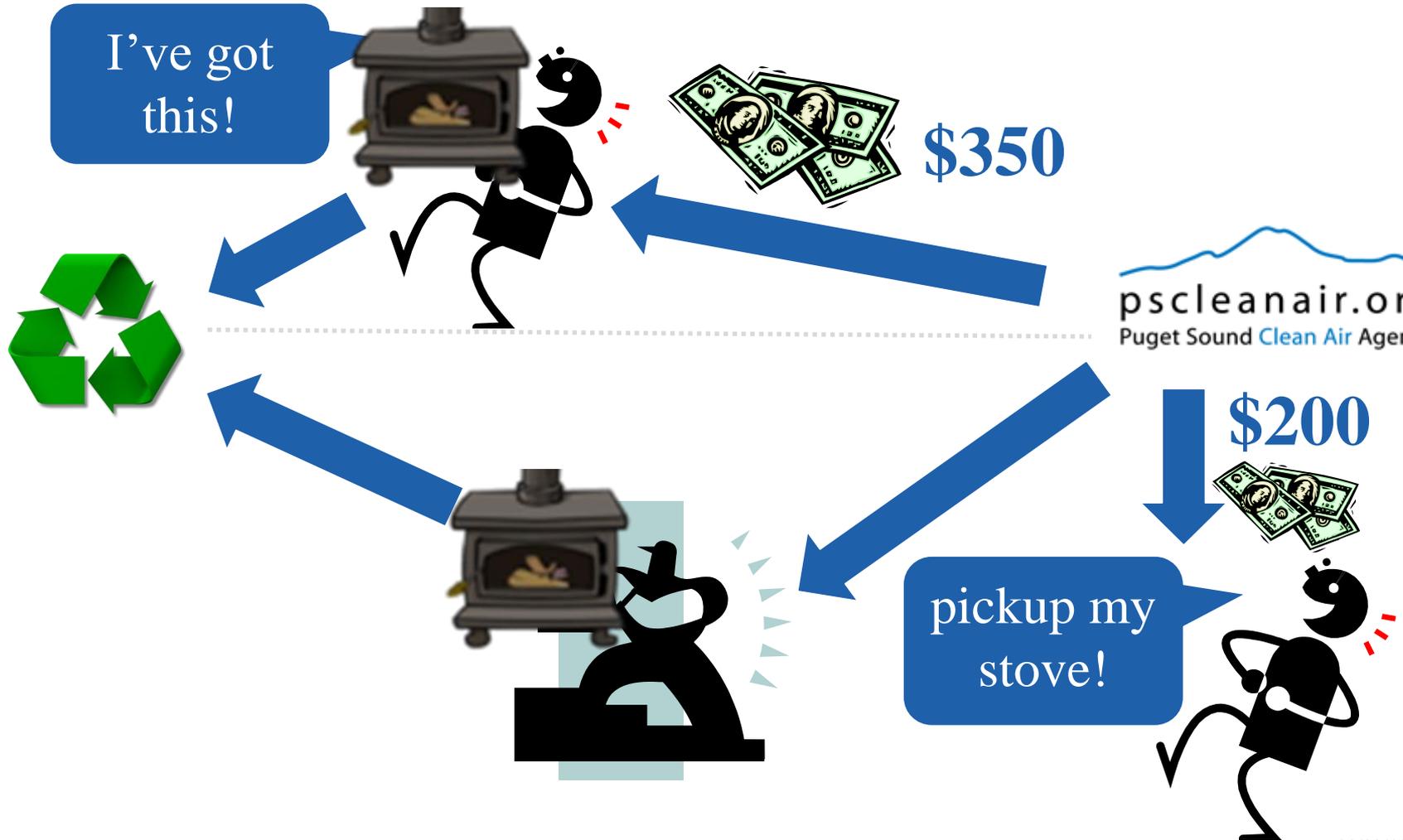


## In 2012 added a Bounty Program...

- **uncertified stoves recycled for a reward**
- **Just scrap it!**
- **Don't have to replace it**
- **\$200 reward if our contractor picks up**
- **\$350 reward if you do heavy lifting and take to designated recycle yard**



# Removal (Recycling): \$350 drop off, or \$200 we pick up



# What kinds of OLD devices are we talking about?

**Wood stoves**



**Free-standing, manufactured fireplaces**



**Wood-burning fireplace inserts**



**Wood-burning furnaces**



**Coal stoves/inserts**



**Fireplace retrofit (case-by-case)**



# Results to date...

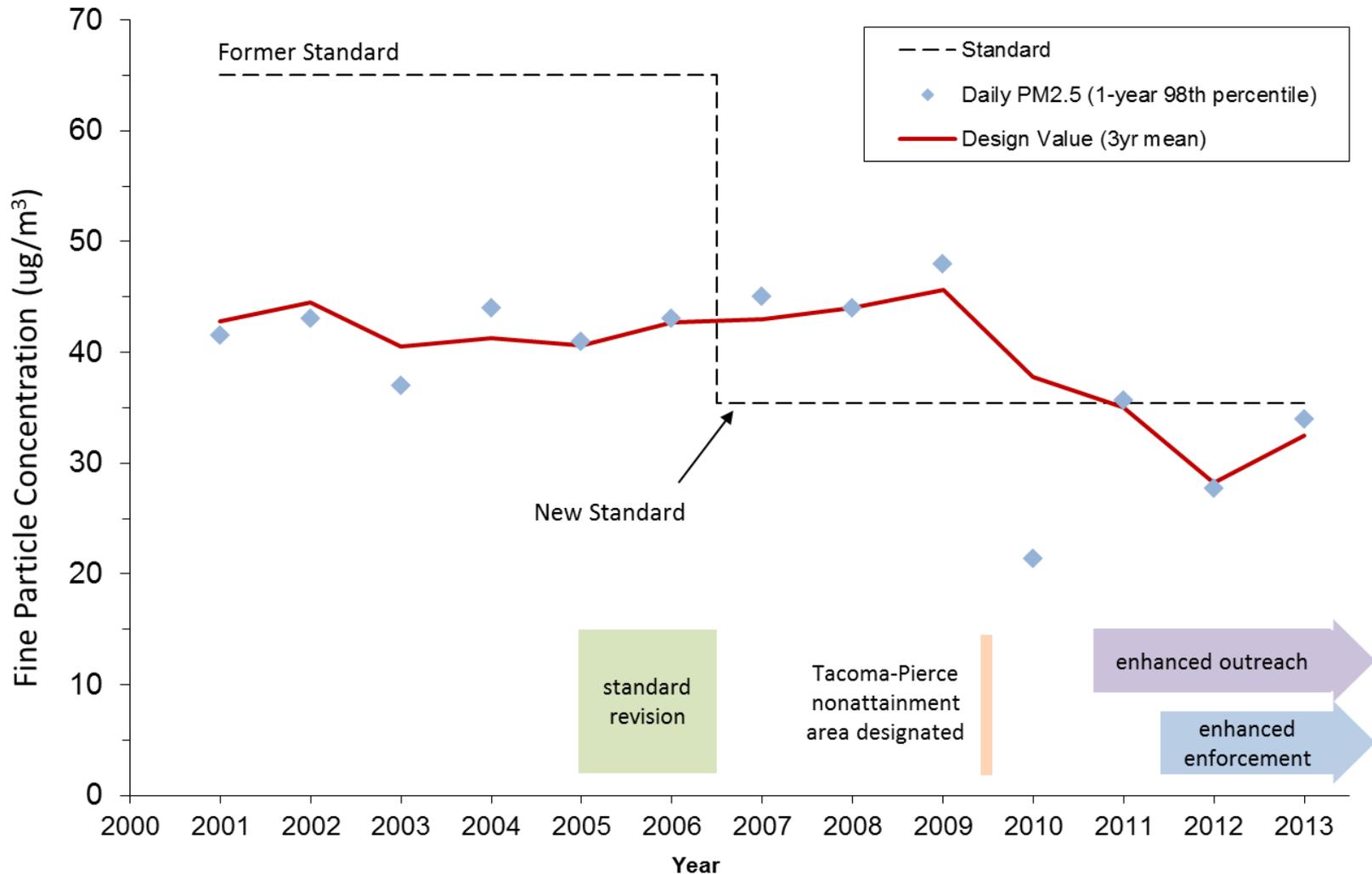
- Over 3,000 old stoves/inserts removed!



# **DID WE REALLY SOLVE THE PROBLEM?**

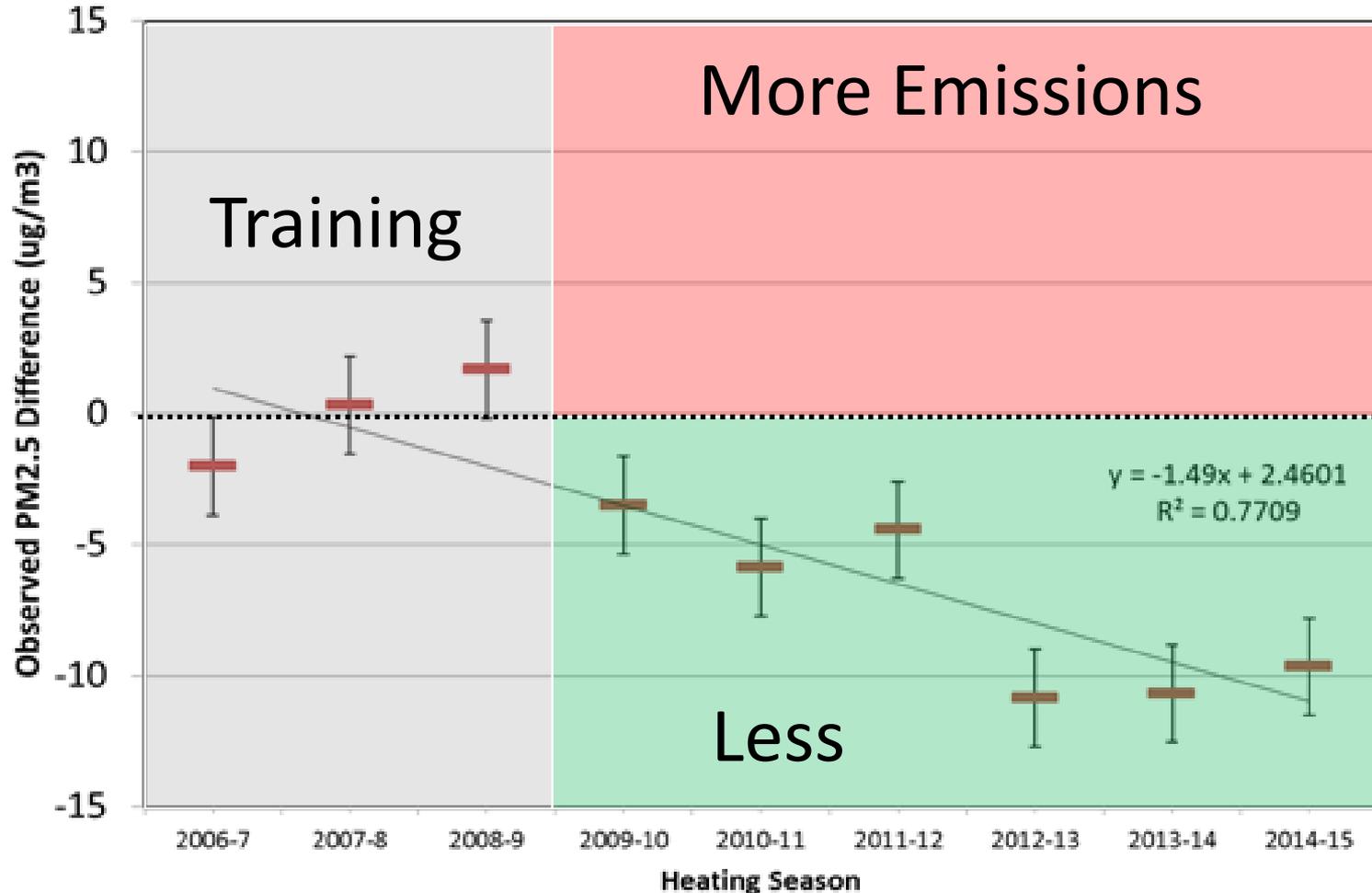
# Fine Particle Levels in Tacoma and Federal Daily Standard

(Daily PM2.5 [1-year 98%ile] and Design Value [3-year mean of Daily])



# Weather corrected PM2.5 trend:

## Observed Tacoma South L Seasonal PM2.5 Compared to Historic Norm

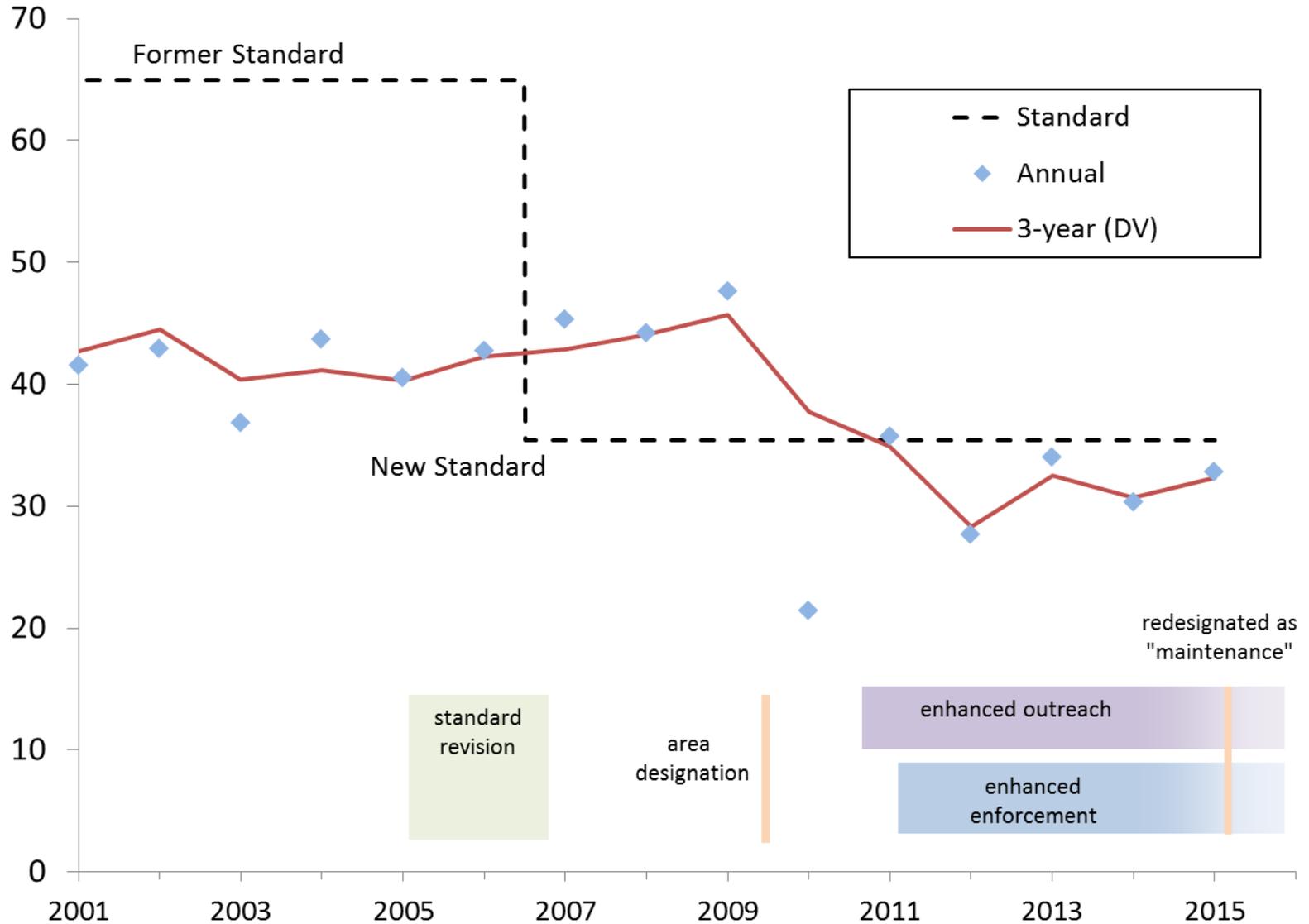


## The end of the story (almost):

- Feb 2015, was re-designated as “maintenance area”!



# 2016 update to Tacoma PM2.5

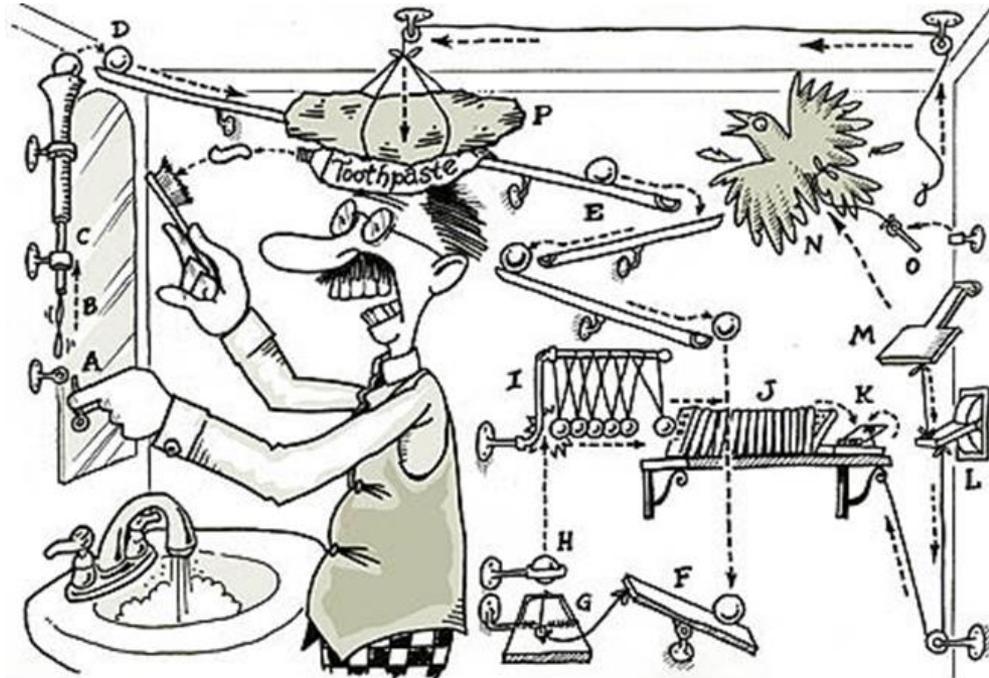


# Other strategies and long-term: What about retrofits?

- **replacement of wood stoves is ~\$2,000-5,000 (w options & installation)**
- **retrofits start as low as \$600**
- **could retrofits give similar result for lower cost?**
- **would also provide another option for NOASH or others who really like existing stove**
- **Well after Tacoma, we received a grant to seek and test emerging retrofit technologies**

# The Technical Challenge of our Challenge

- All retrofits we were previously aware of have one or more of the following limitations:
- too expensive and complicated
- require significant care and maintenance
- have significant technical limitations that render them ineffective, unreliable, or hazardous



- **With help from WA Dept. of Ecology (R.Tinnemore) obtained NEP grant to:**
- **Fund an open search for retrofits to reduce PAHs and fine PM**
- **Funded testing for finalists**
- **InnoCentives was contracted to promote the challenge and the open search**
- **It is difficult to provide financial motivation and protect intellectual property**
- **It is difficult to create a meaningful test protocol**

- **Contracted with OMNI-Test in Portland, OR**
- **Two uncertified stoves, good representatives of existing stock**
- **Three test conditions:**
  - high burn rate, high wood moisture
  - low burn rate, low wood moisture
  - low burn rate, high wood moisture
- **Testing was done in two rounds, only three devices advanced to the second round**
- **Operated similar to official certification test method**
- **Also measured PAHs, CO, and temperature**

## Schrader (#1)



## Princess (#2)





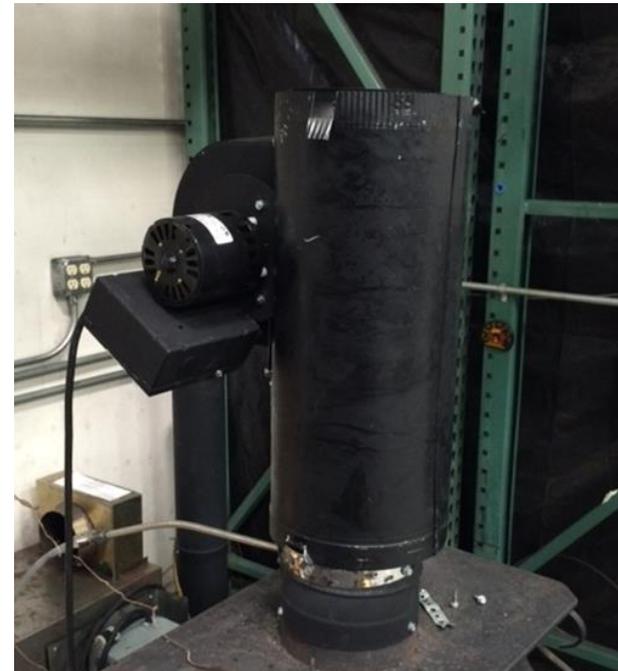
Grahn  
Afterburner



GraceFire  
StoveCAT

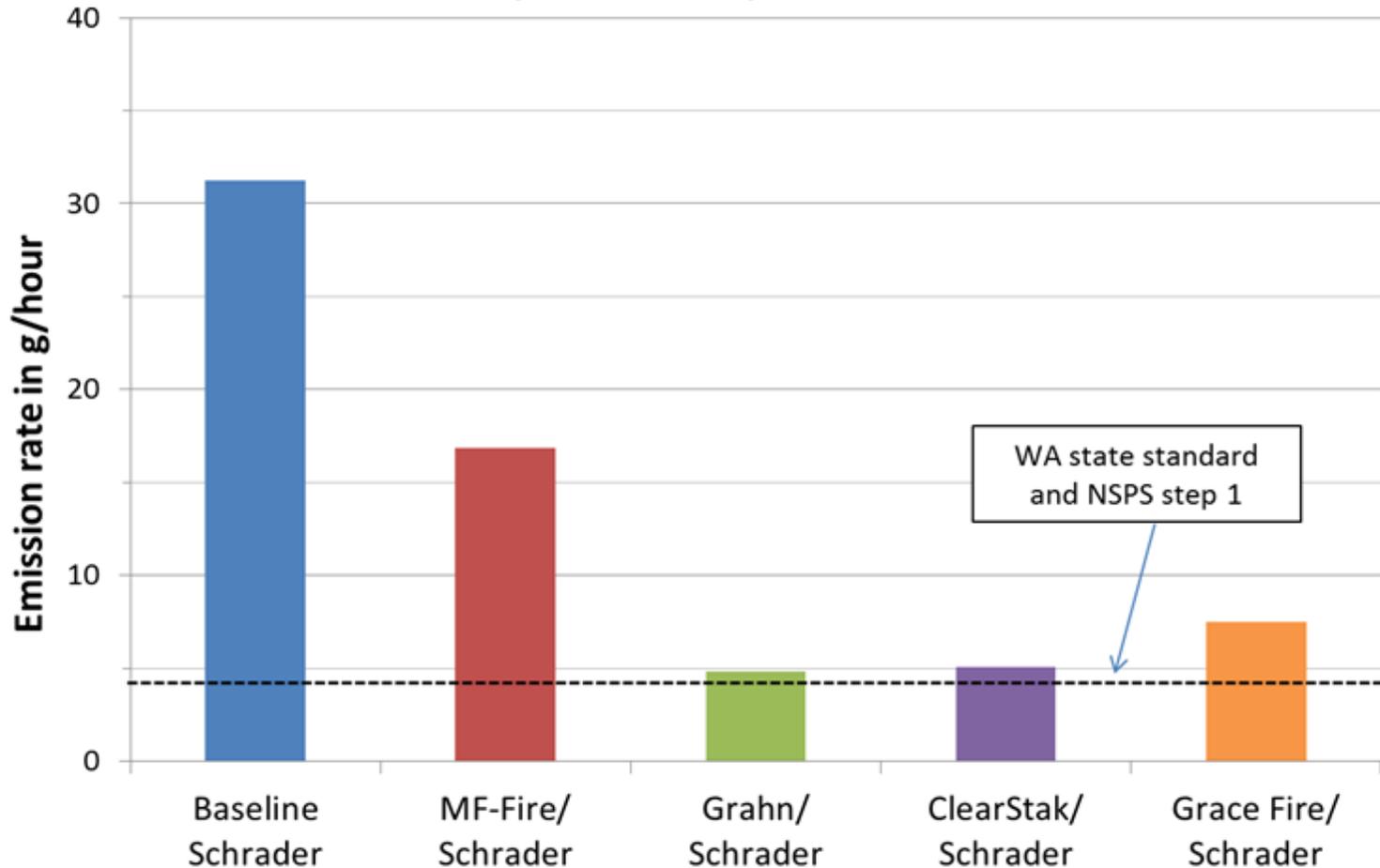


ClearStak

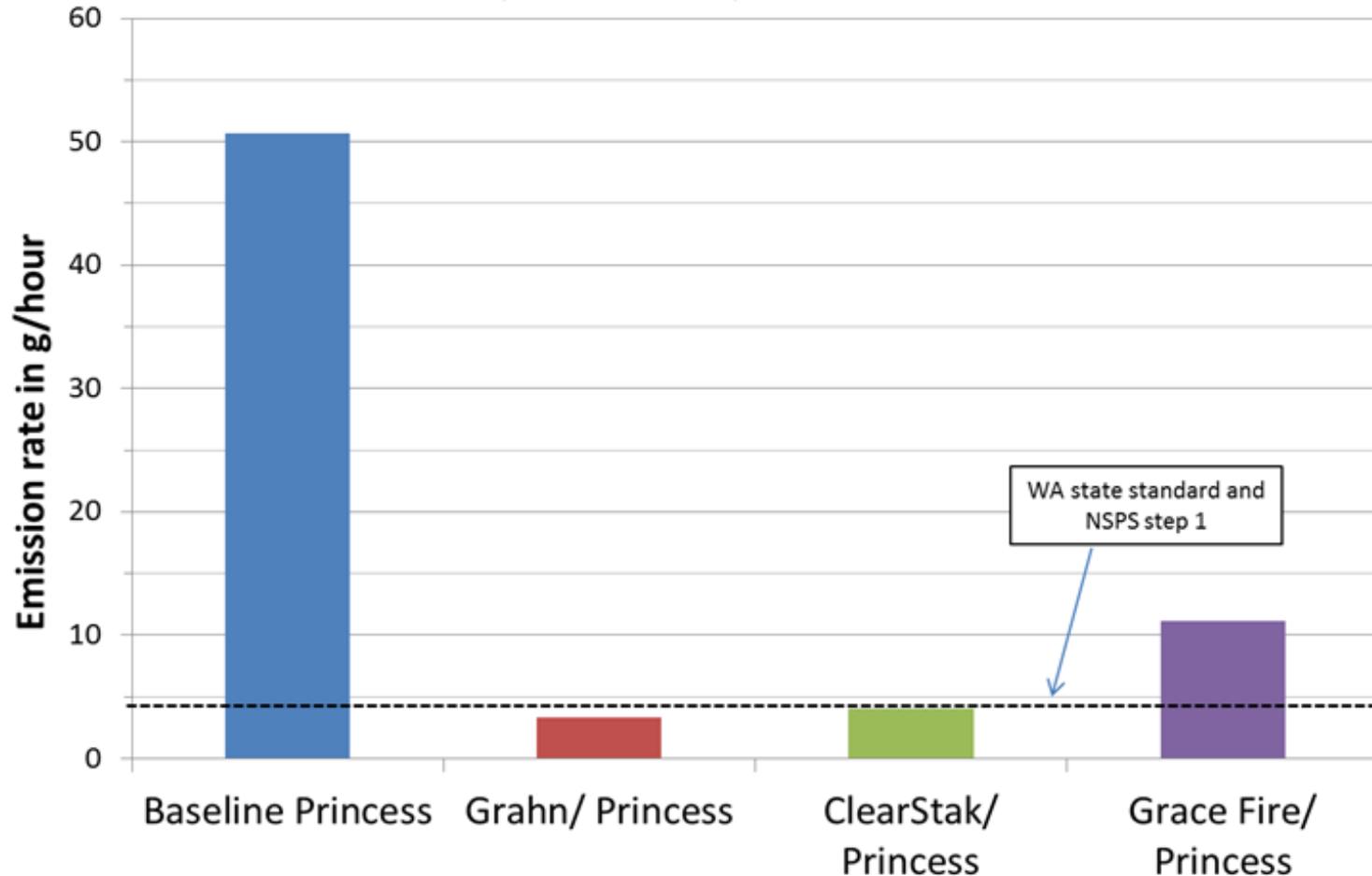


MF Fire

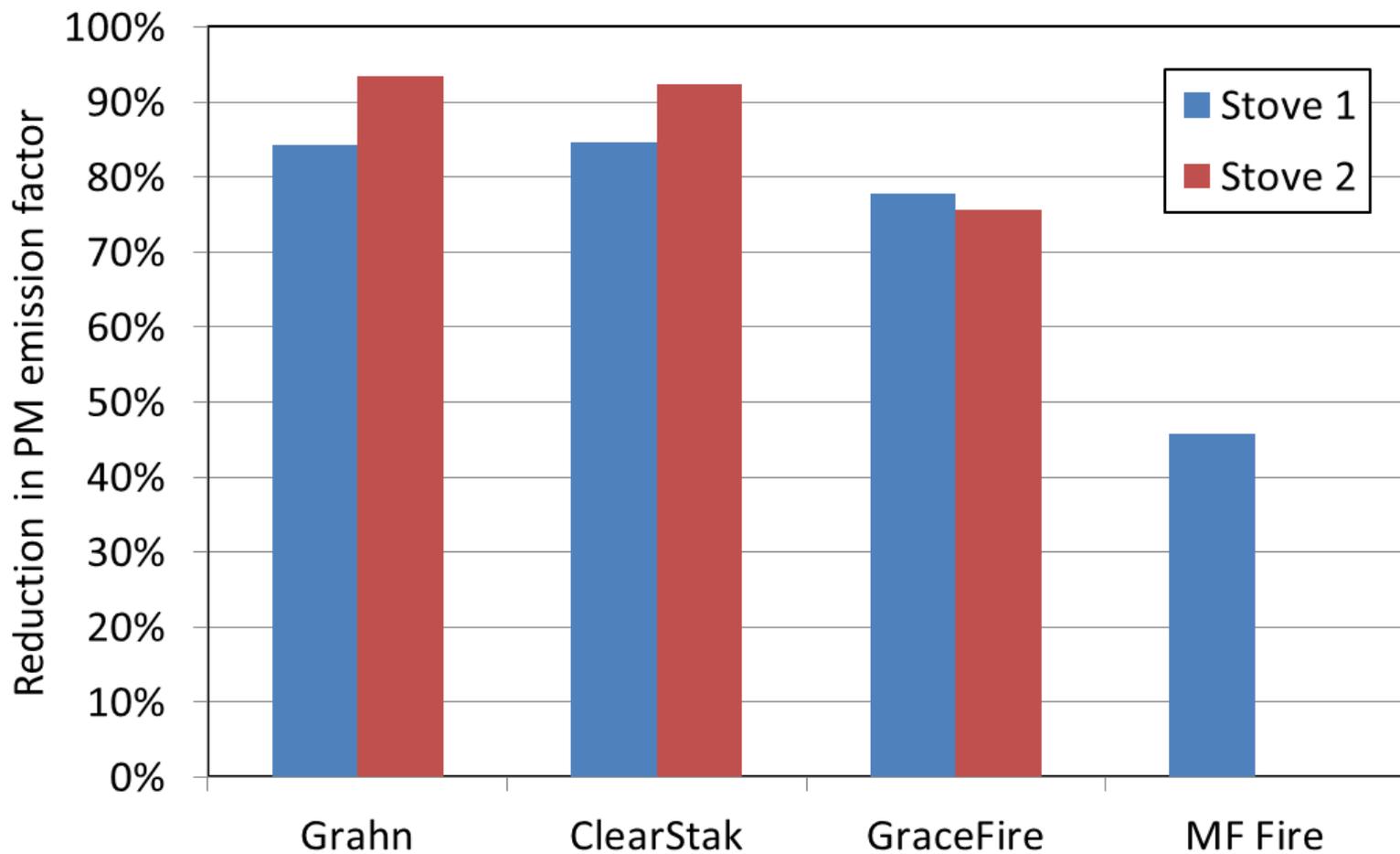
## Fine PM emission rate for uncertified stove #1 without, and with, four retrofits



## Fine PM emission rate for uncertified stove #2 without, and with, three retrofits



Retrofit mean reduction in PM emission factor with respect to baseline, on two uncertified stoves



- In the end the three devices all met the Challenge criteria and were declared a 3-way tie.
- Each had unique characteristics and may work better in some situations than others and have various advantages
- We are encouraged and urge continued development and testing, hopefully some field testing...

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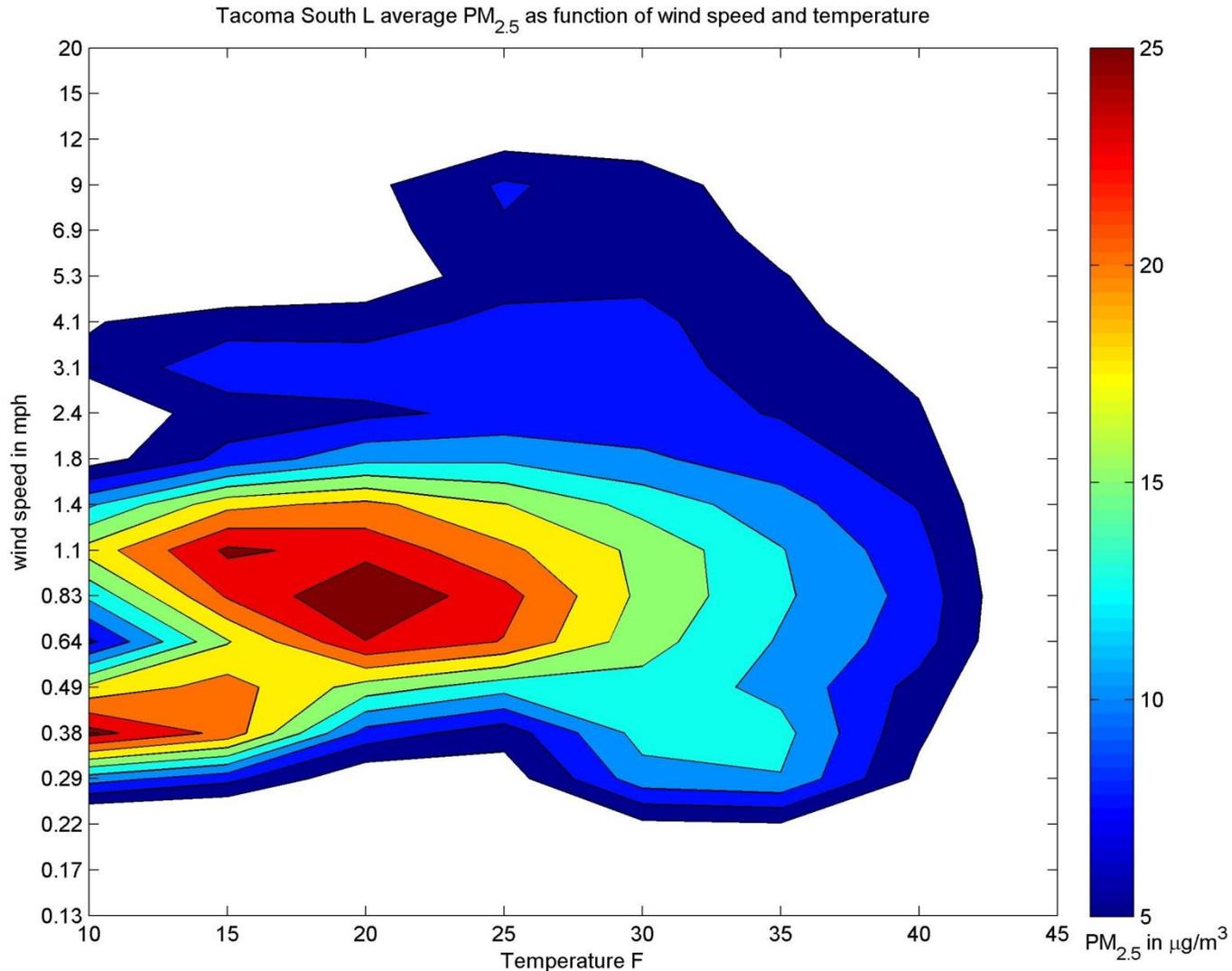
# extra slides



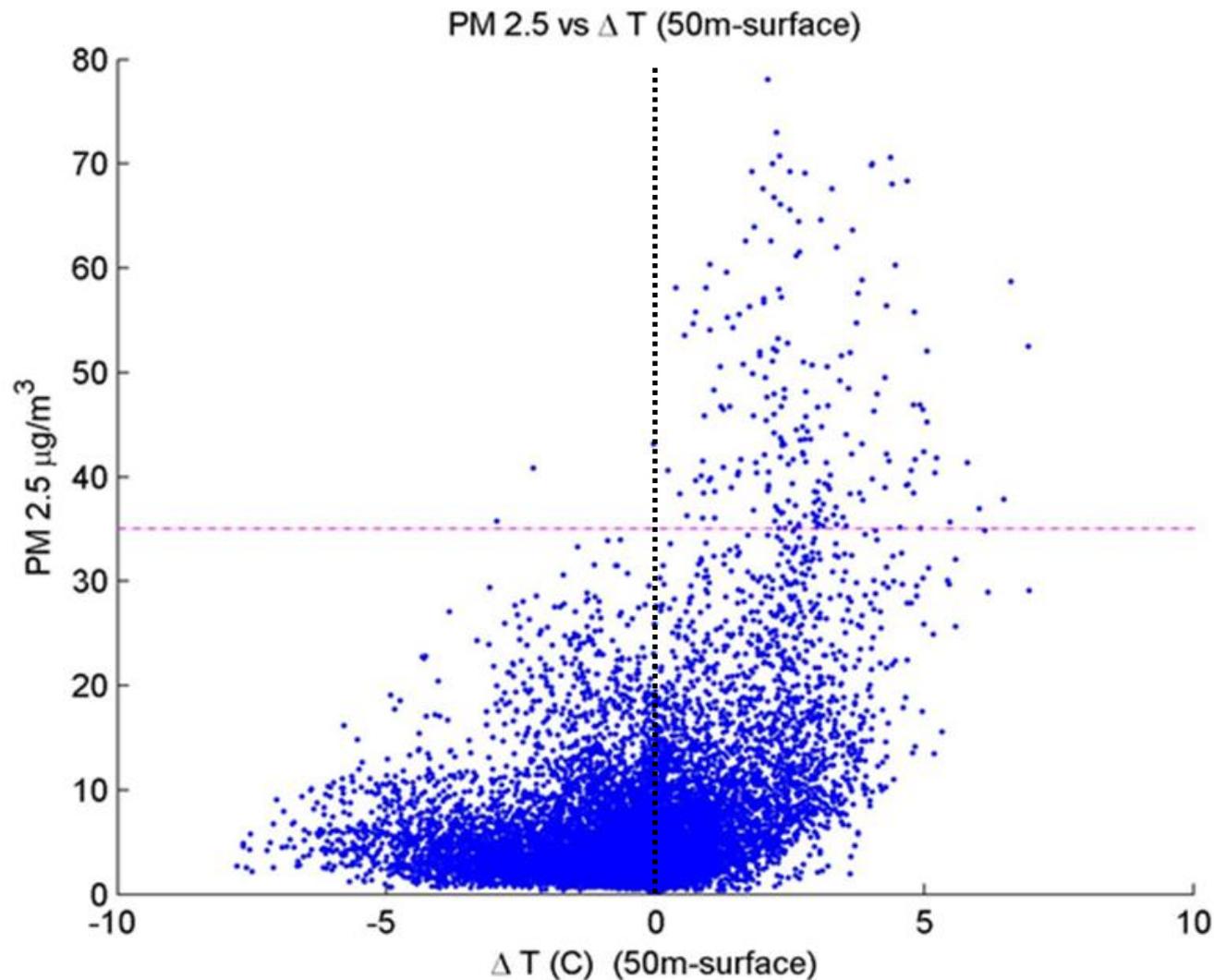
## Metrics (2014 Burn Ban Ad Season)

- 10,710 Unique Visits to Webpage, 72 percent new visits
- 1100 Email Alert Sign Ups
- 1407 Text Alert Sign ups (Just over 3000 total for Pierce Co)
- 520 new Facebook followers added during burn ban season
- 665 woodstove applications completed, 363 redeemed

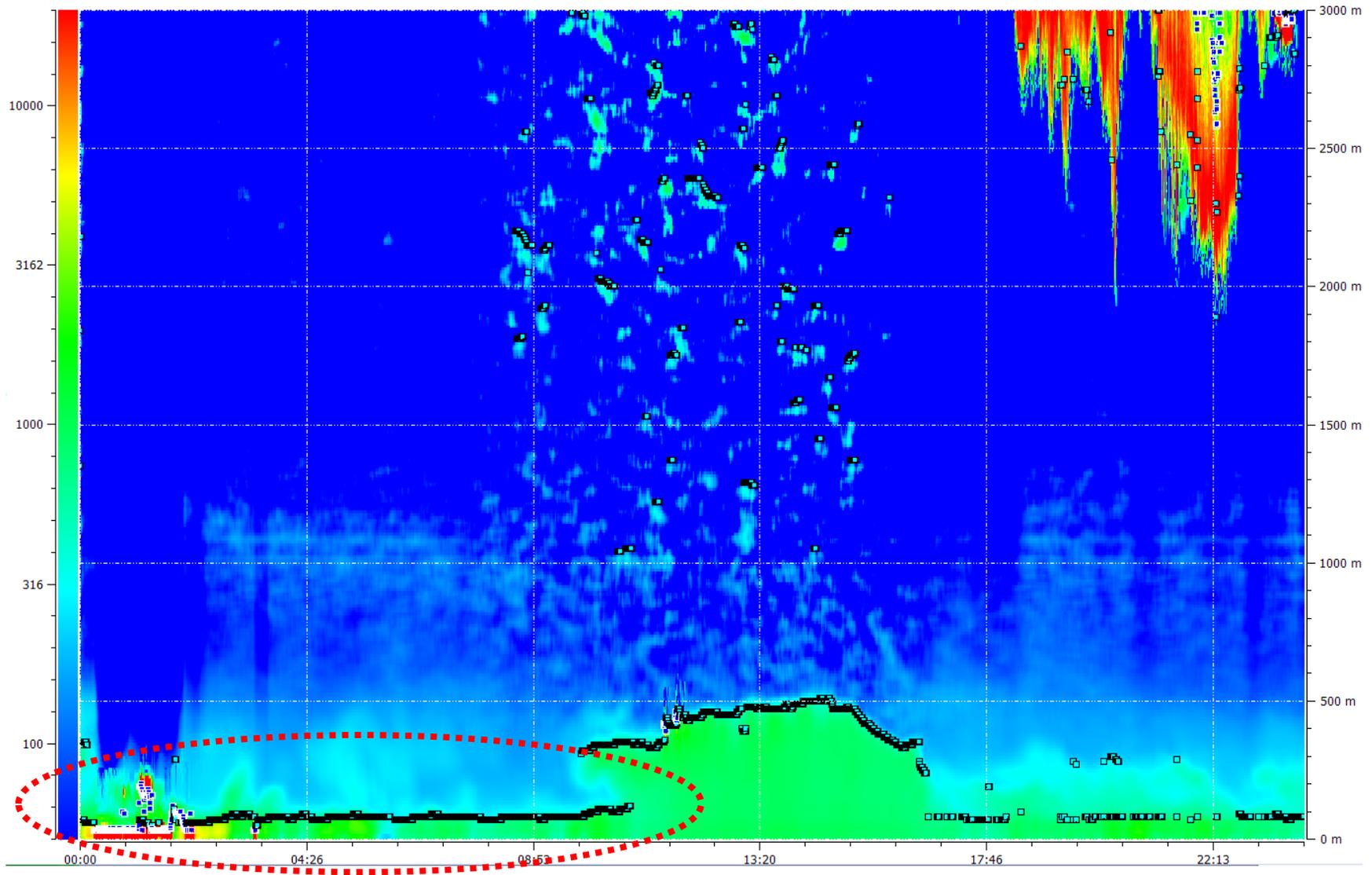
# Burn Ban Forecasting: **Cold** and **Calm** need winds $< \sim 1$ mph, temps $< 35$ F



# Burn Ban Forecasting: **Calm** and **Clear** need 50m inversion > 0.5 C



# Ceilometer (shown) and temp profiles helps diagnose shallow nocturnal PBL



**8:45 PM Dec 7 (13 sec f/6.3 ISO 3200)**



2013.12.07 20:45

**9:20 Dec 8 (0.6 sec f/1.8 ISO 3200)**



**8:53 pm Nov 27 (3 sec f/2.2 ISO 800)**

