The Art and Science of Firefighting
CAMA May 2014

An Interdisciplinary Approach

Presented by

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&

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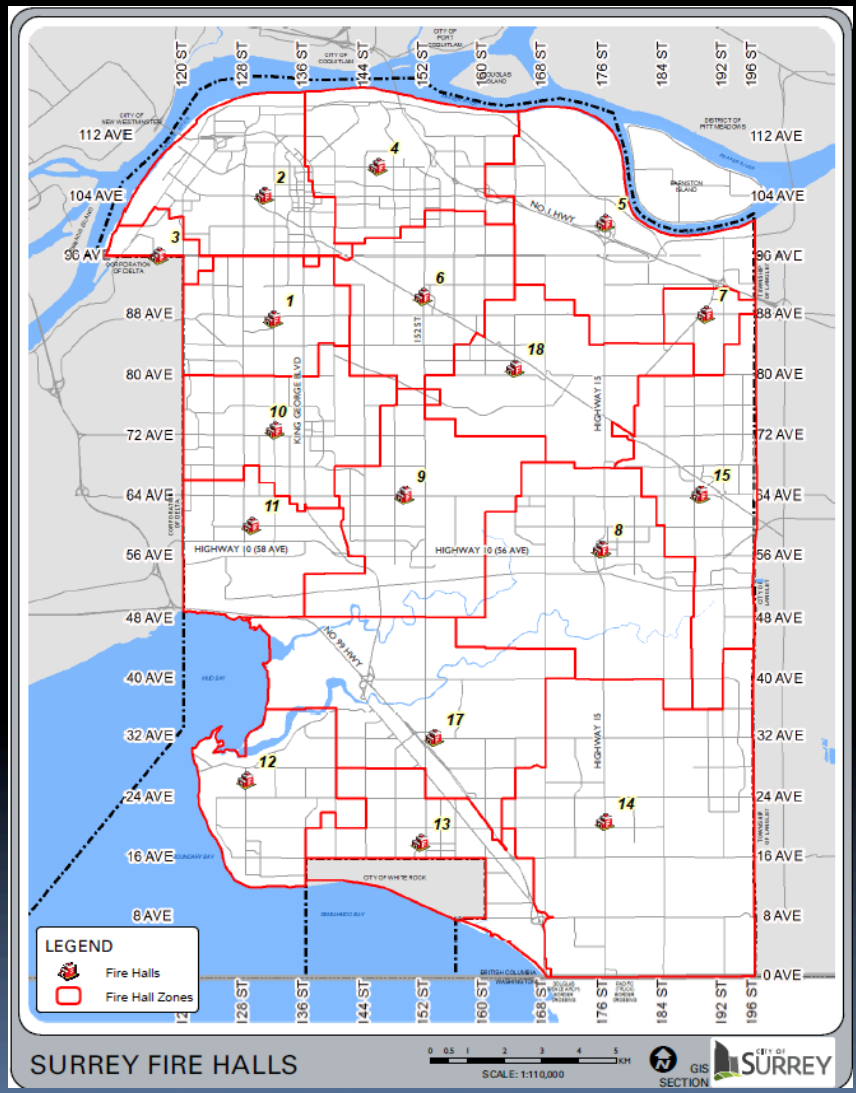
RUSSIA
Arctic Ocean
Greenland
(DENMARK)
ICELAND
0 500 1000 km
0 500 1000 mi
Beaufort Sea
Baffin Bay
UNITED STATES
(Alaska)
Davis Strait
Dawson
Mackenzie
Whitehorse
Labrador Sea
Hudson Bay
peace
Churchill
St. John's
North Pacific Ocean
Edmonton
Surrey
Lake Winnipeg
Calgary
Vancouver
Québec
Regina
Winnipeg
Halifax
OTTAWA
Montréal
Lake Superior
Toronto
UNITED STATES
North Atlantic Ocean

Surrey BC

- 12th largest City in Canada
- Fastest growing City in Canada
- 17 Fire Halls
- 317.4 km^2 coverage
- 502,000 residents



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Beginning with the End in Mind

Fire Service - Key Issues Identified:

- There is no apparent fact-base view of trends , issues or best practices in Fire Services
- No quantitative risk-evaluation model exists

Source : Transforming BC Fire Services: FSLG Sept 2009

Beginning with the End in Mind

- Canadian residential home fires can be reduced in half, by simply be making sure there is a working smoke alarm in homes, evidence elsewhere indicates we can do better. Seniors most at risk ,32% of the deaths in BC , In the UK smoke alarms are working 88% of the time.
- Fires and Crimes are predictable , they occupy the same place and effect the same people.
- Construction material type has no influence on death / injury or fire spread.
- NFPA – response times can they be more or less?
- Facing the Future – the UK experience.
- NFPA Total Cost of Fire .
- Business tools that make good predictions.
- Selecting the best people / measures of success.
- Predicting risk for fire safety inspections

Serious Business

Every Day Heroes … Right ?

What Drives US ?

- Public Expectations
- City Manger Expectations
- Council Expectations
- Employee Expectations / Union
- Insurance (IAO) Expectations

Problems that Drive Fire Services Expressed by the Following:

- Consolidation Issues
- Budget Cuts
- Station Location / Relocation / Closure
- Apparatus Deployment
- Live move ups
- Staff / Management Cuts
- Dispatch Optimization
- Mutual Aid Interoperability
- Accreditation / Standards
- Standards - NFPA 1710
- UK standards of Cover
- Optimize After Budget Cuts
- Disaster Response Solutions
- Staffing Strengths / Weakness
- Pros / Cons Automatic aid
- Reform

Because We Have Always Done It This Way !

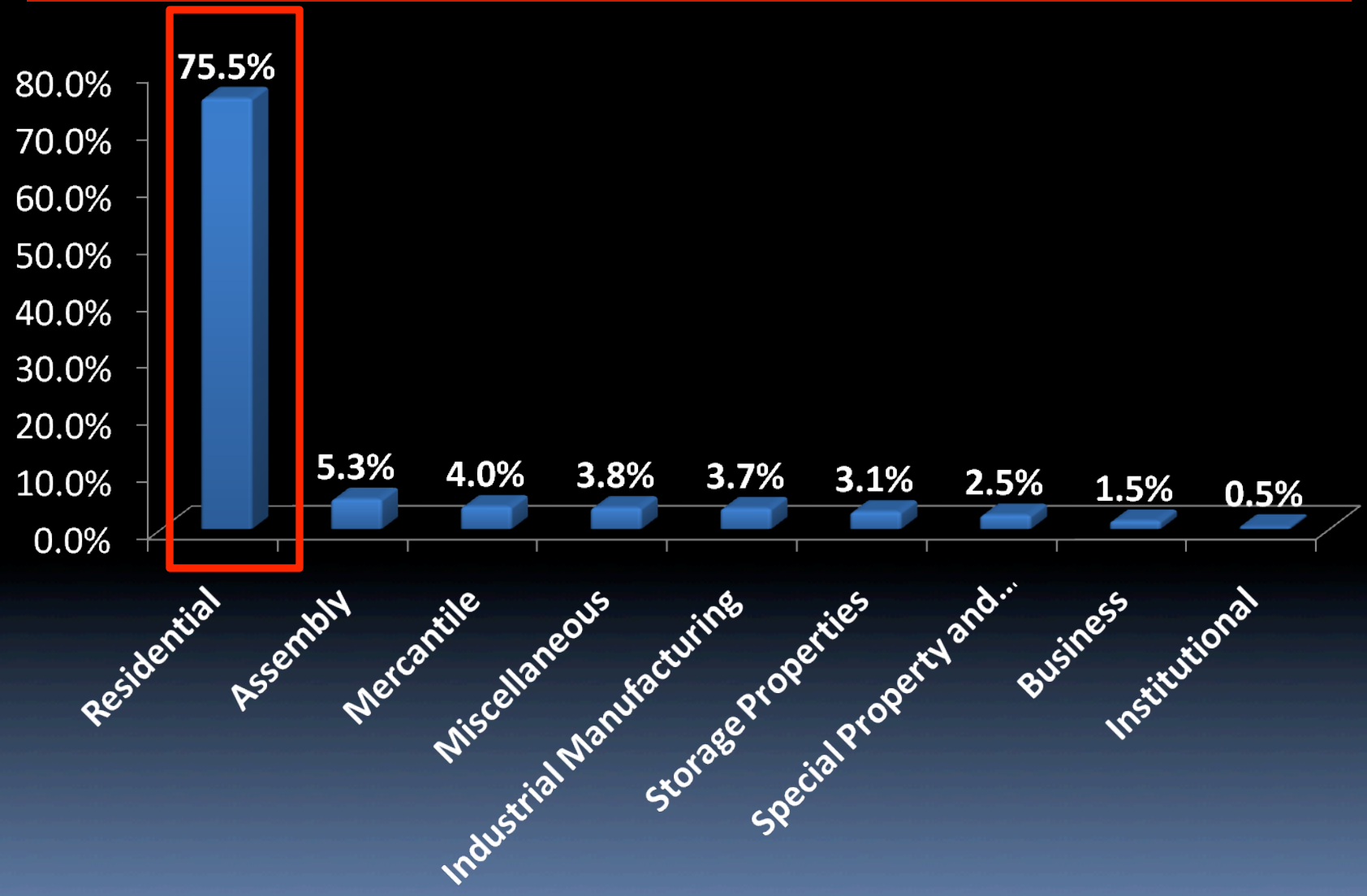
Home Safe:

Why we did what we did, how it worked, and what we're doing next

Where did Home Safe come from?

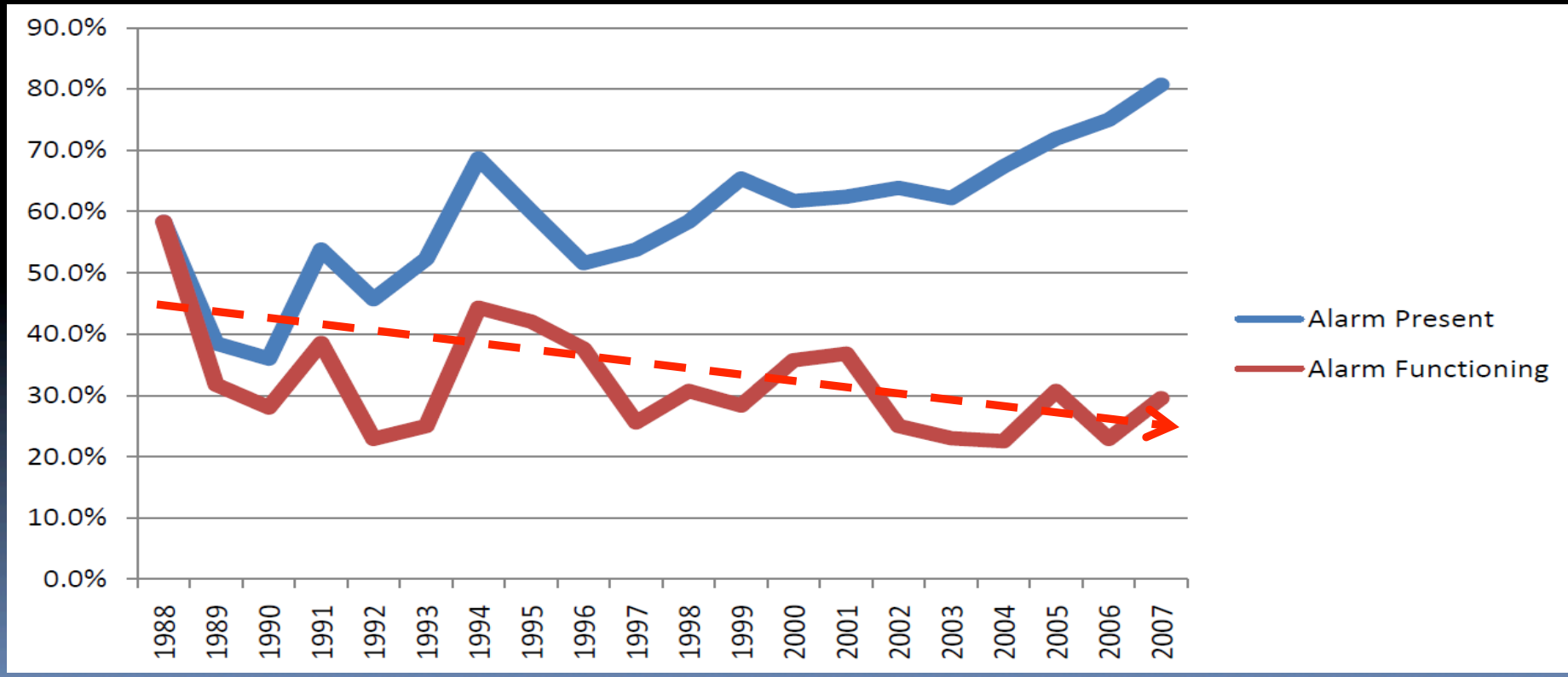
- 2008: McCormick (UFV) completed a 20-year independent review of fires in Surrey
- Key findings:
  - Where fires were occurring and their causes.
  - Smoke Alarms were present more often.
  - Smoke Alarms were not functioning over time.
  - The impact of smoke alarms on fire spread

Fires by property type (88-07)

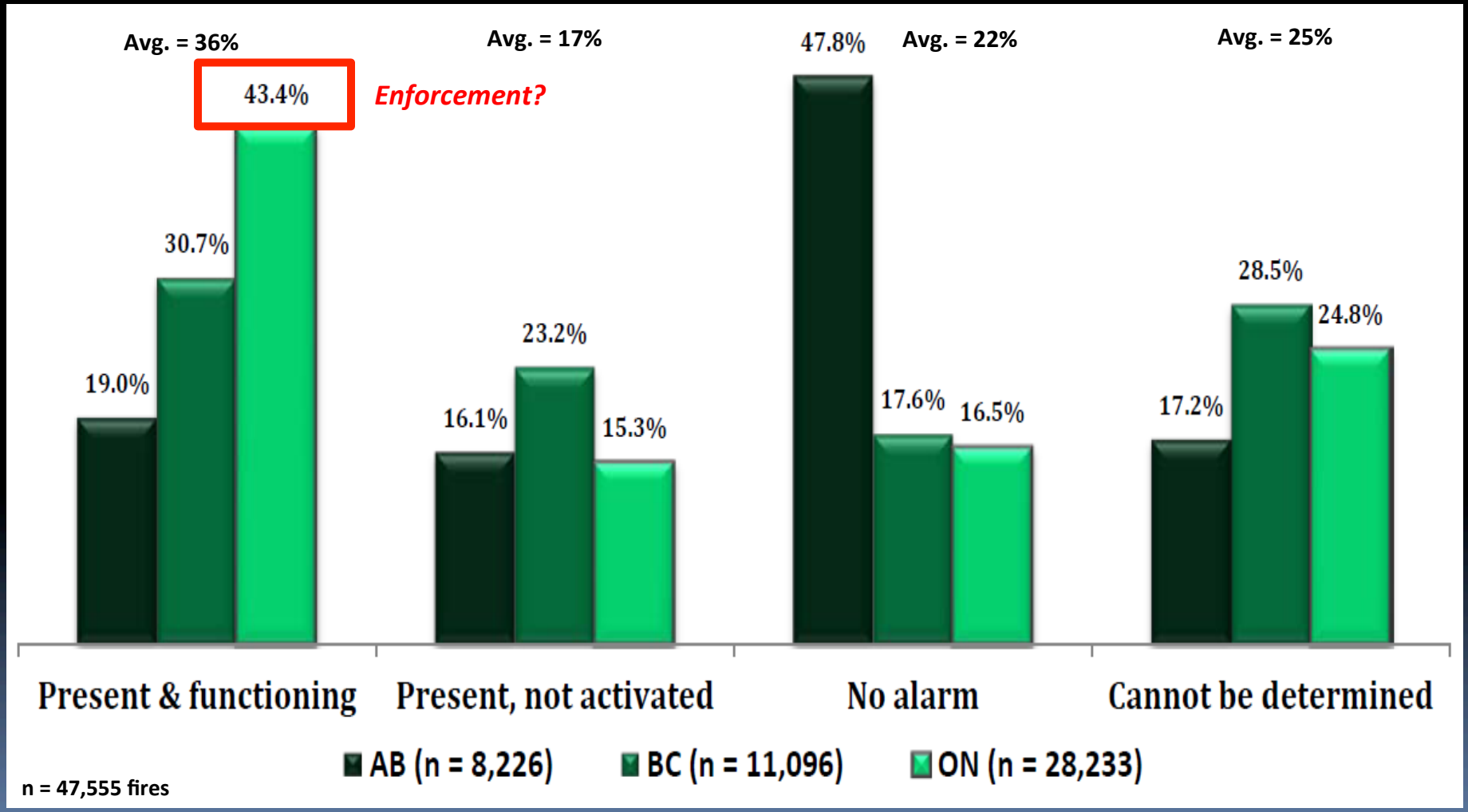


Smoke alarm status (88-07)

- **For 2007 fires, 80.7% had a smoke alarm**
  - **However, NOT Activated 63% of the time**
- **Overall proportion of 2007 fires with <u>Functioning</u> Smoke Alarm - 30.0%**



The National Score Card is Very Poor…



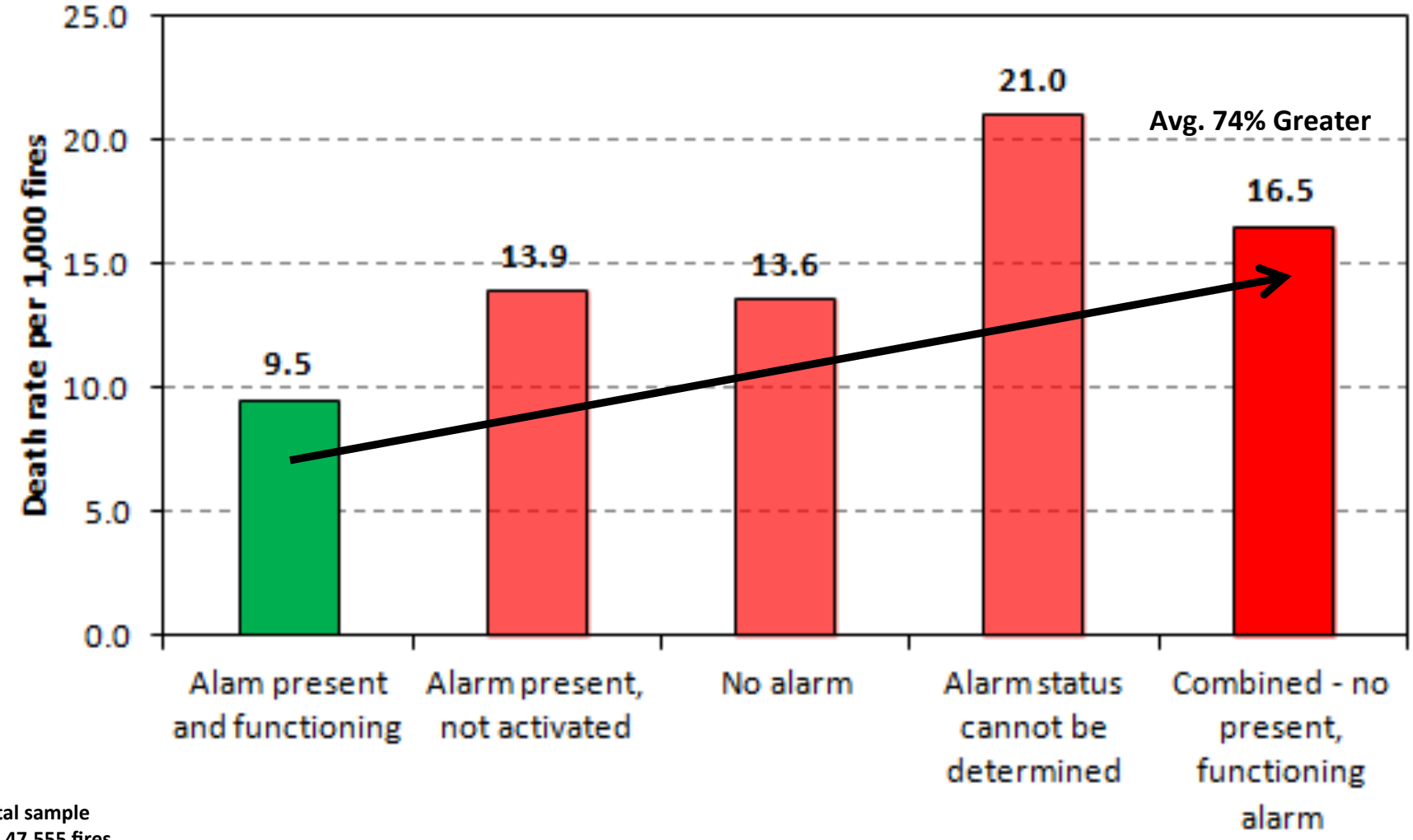
Research findings from elsewhere

- Smoke alarms save lives
- Fire risk is non-random
  - High-risk people
  - High-risk areas
  - High-risk dwelling types
- Fire prevention education does make a difference
- Fire safety home visits do make a difference

Building on what's worked elsewhere

- Home safety visits undertaken in the UK, Australia, New Zealand, and some isolated examples from the US
- Home safety visits, with a range of styles, focusing on:
  - Fire prevention education
  - Smoke alarm presence and function
  - Development of fire escape plans
  - Focus on high-risk households/individuals

What Do We Know About Smoke Alarms? First, They Definitely Save Lives…



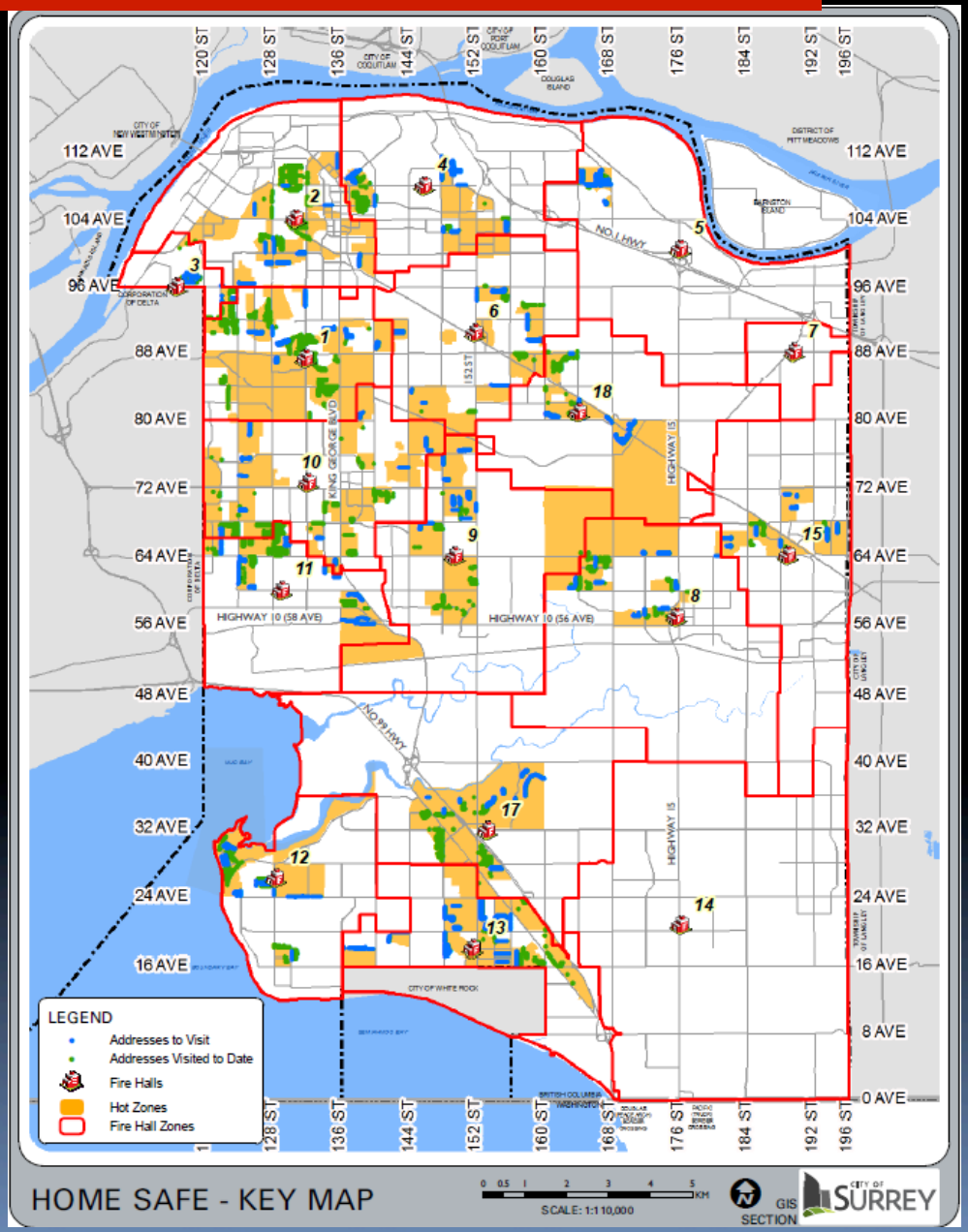
Total sample
n = 47,555 fires
from AB, BC & ON

Estimate 69 preventable deaths per year across Canada

Finding new high-risk locations

Identify high-risk areas – top 10% for the following:

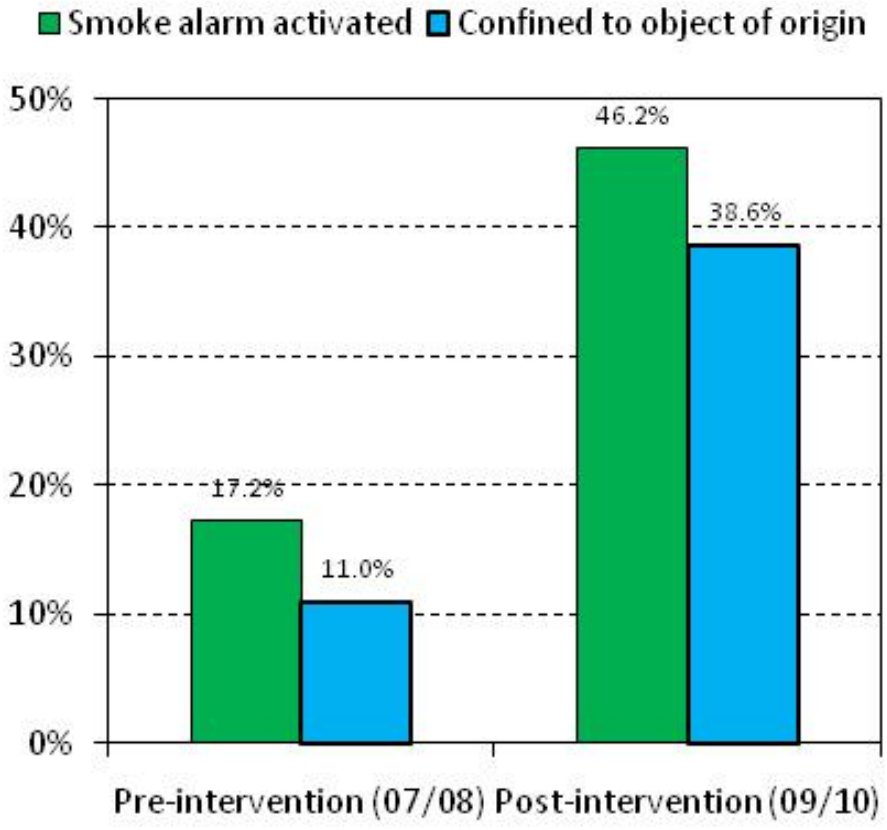
- High proportion of elderly citizens (over 64 yrs)
- High proportion of young children (under 6 yrs)
- Disadvantaged
  - Unemployed
  - Single-parent families
- High residential mobility
- Combined with *hot-spots* for recent fire incidents

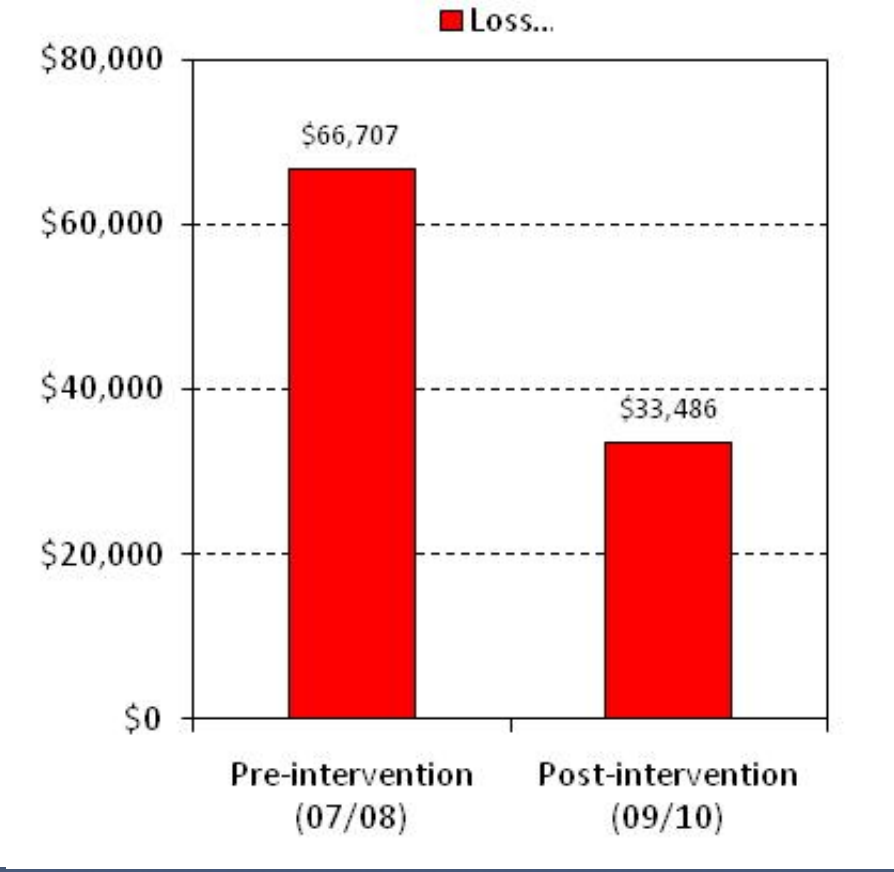


Moving forward

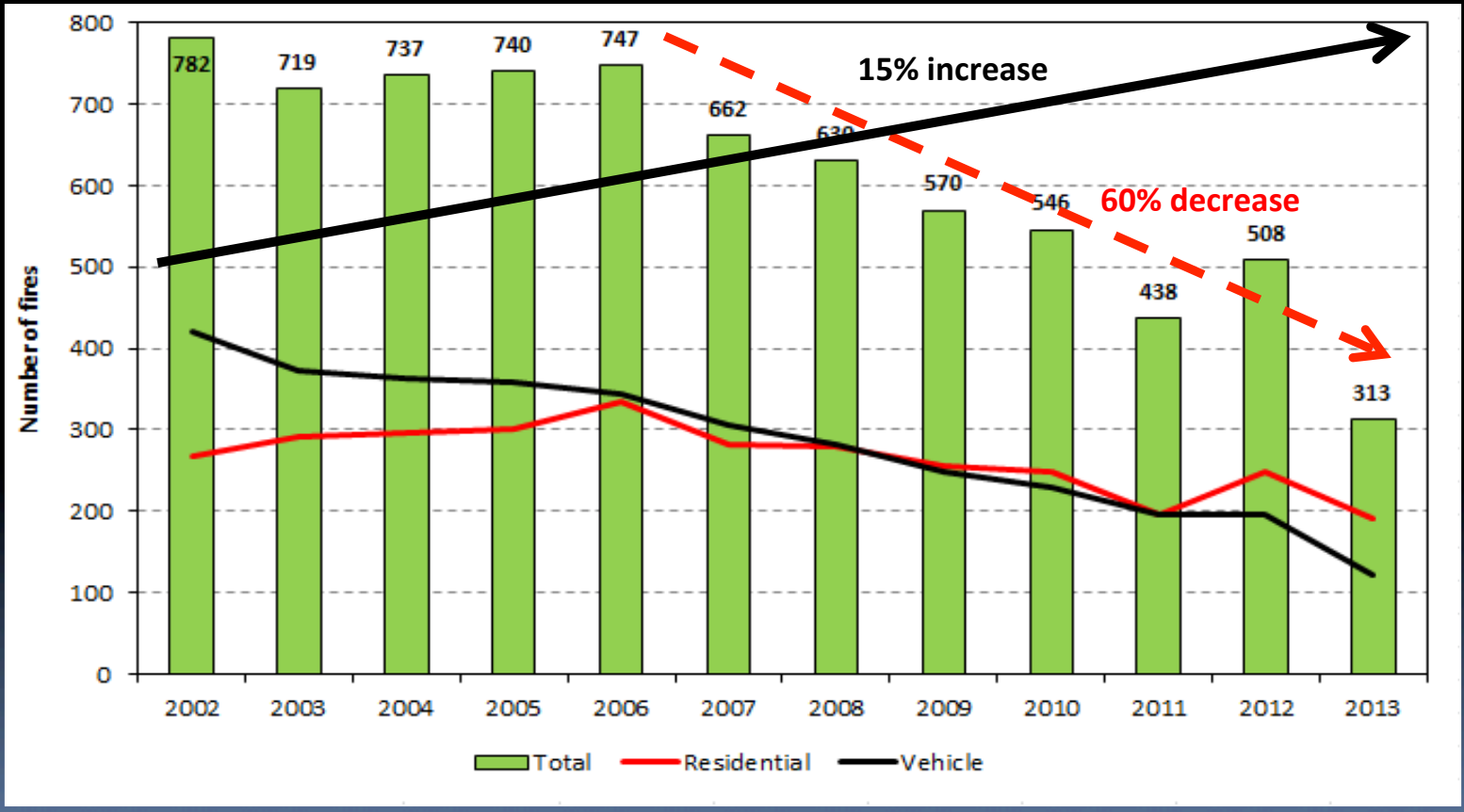
- We visited 40,000 dwellings identified as high-risk in the city.
- We continue to monitor the heath of these areas through our records management system.
- This is one of our performance measures.
- Because we know over time the benefits of these 40,000 visits will lose effect.
- We need to look at how to maintain.

What impact has *Home Safe* had?

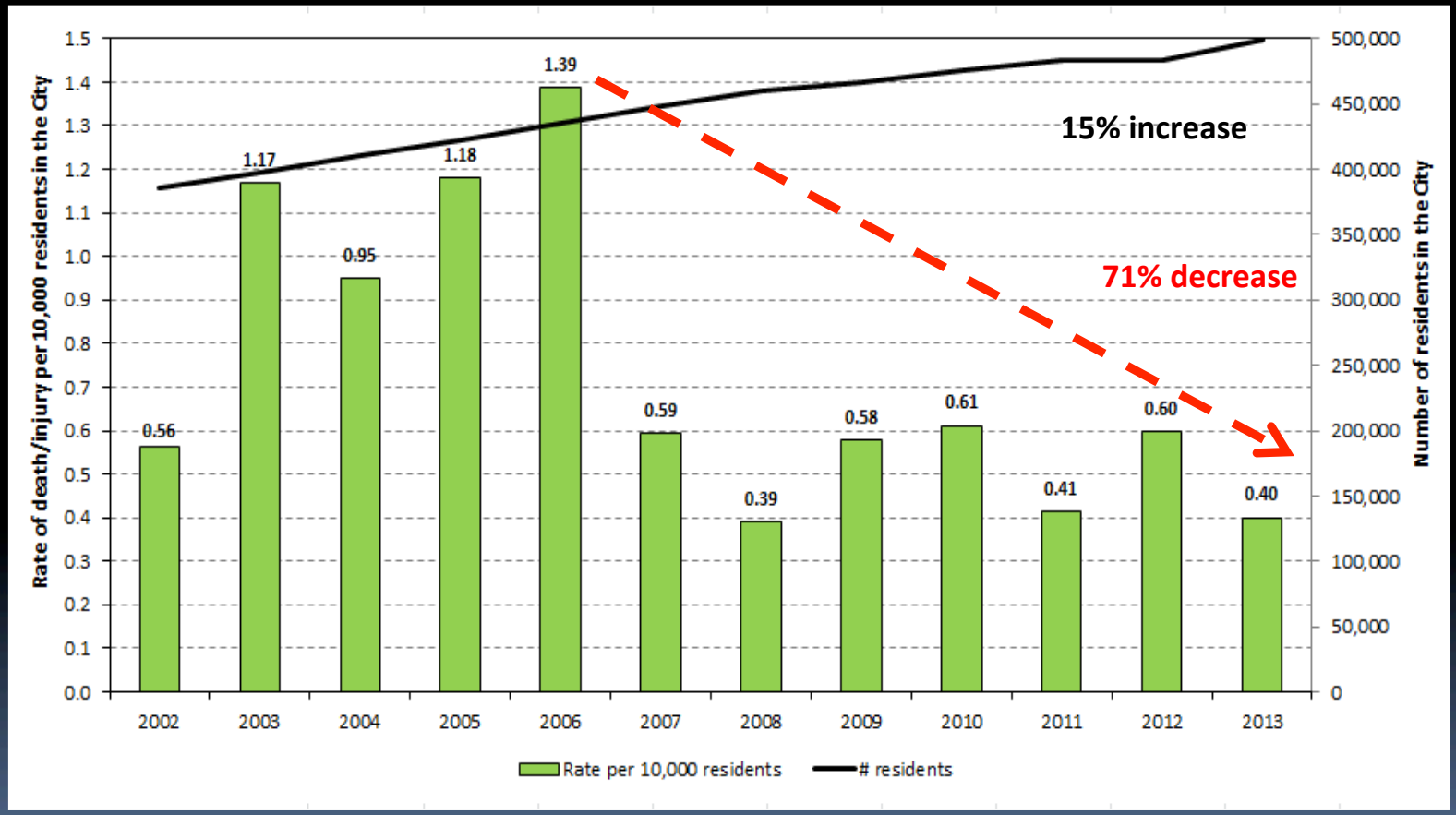




Fitting this into the Bigger Picture?



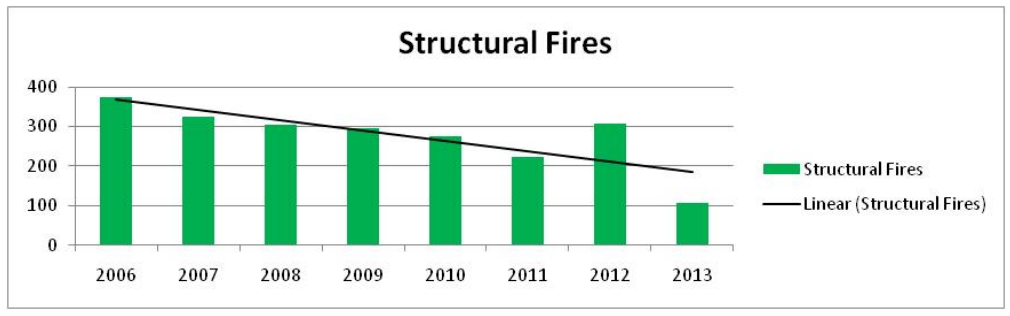
Also Fewer Fire-Related Deaths/Injuries

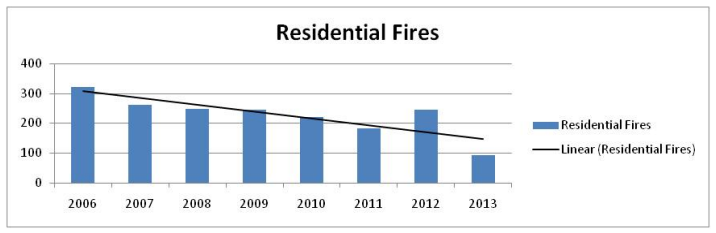


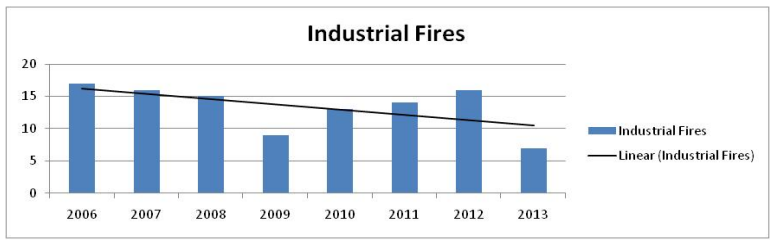
Overall results of evaluation

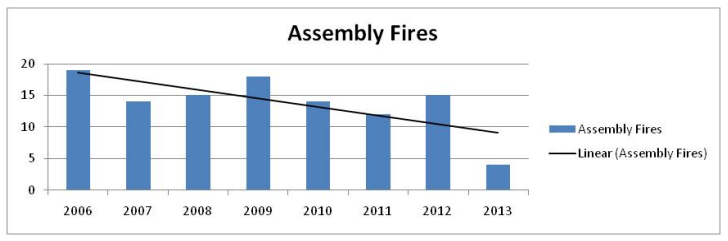
- Fewer fires than expected without Home Safe
- When fires did occur
  - More fires confined to object of origin
  - More smoke alarms activated
  - Lower $ damage
- Estimated savings of 13 house fires and $1.3Million dollars in damages
- Likely implications for death and injury

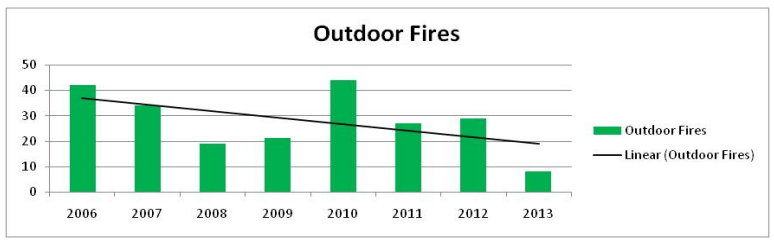
Fewer Fires

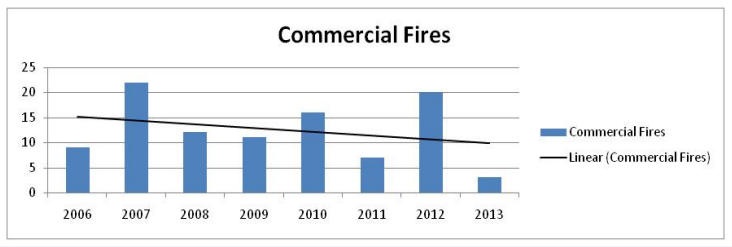

Structural Fires
400
300
200
100
0
2006
2007
2008
2009
2010
2011
2012
2013
Structural Fires
Linear (Structural Fires)

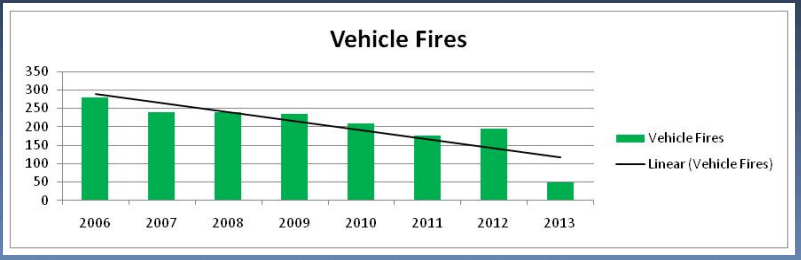

Residential Fires
400
300
200
100
0
2006
2007
2008
2009
2010
2011
2012
2013
Residential Fires
Linear (Residential Fires)


Industrial Fires
20
15
10
5
0
2006
2007
2008
2009
2010
2011
2012
2013
Industrial Fires
Linear (Industrial Fires)

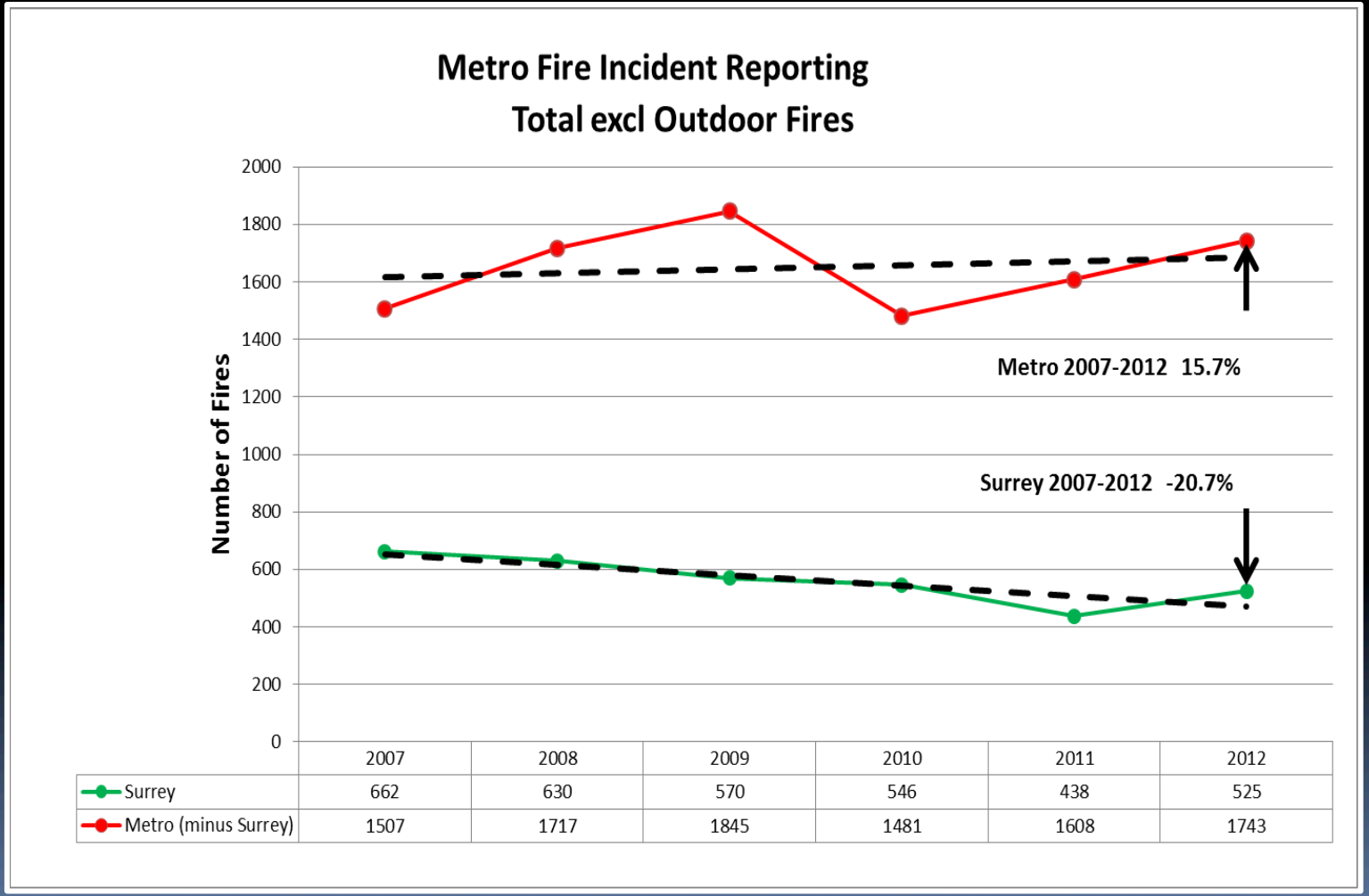

Assembly Fires
20
15
10
5
0
2006
2007
2008
2009
2010
2011
2012
2013
Assembly Fires
Linear (Assembly Fires)


Outdoor Fires
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
Outdoor Fires
Linear (Outdoor Fires)

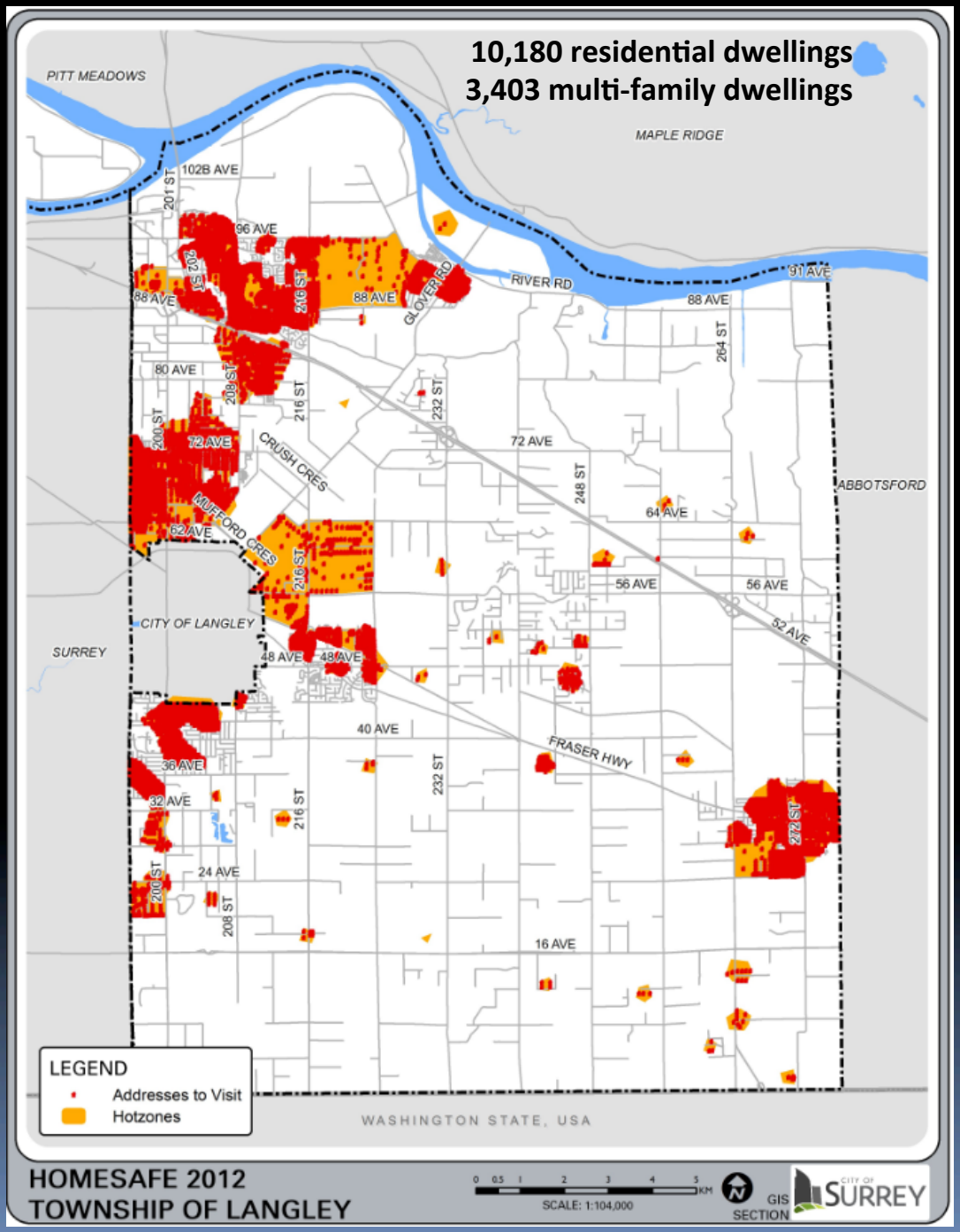

Commercial Fires
25
20
15
10
5
0
2006
2007
2008
2009
2010
2011
2012
2013
Commercial Fires
Linear (Commercial Fires)

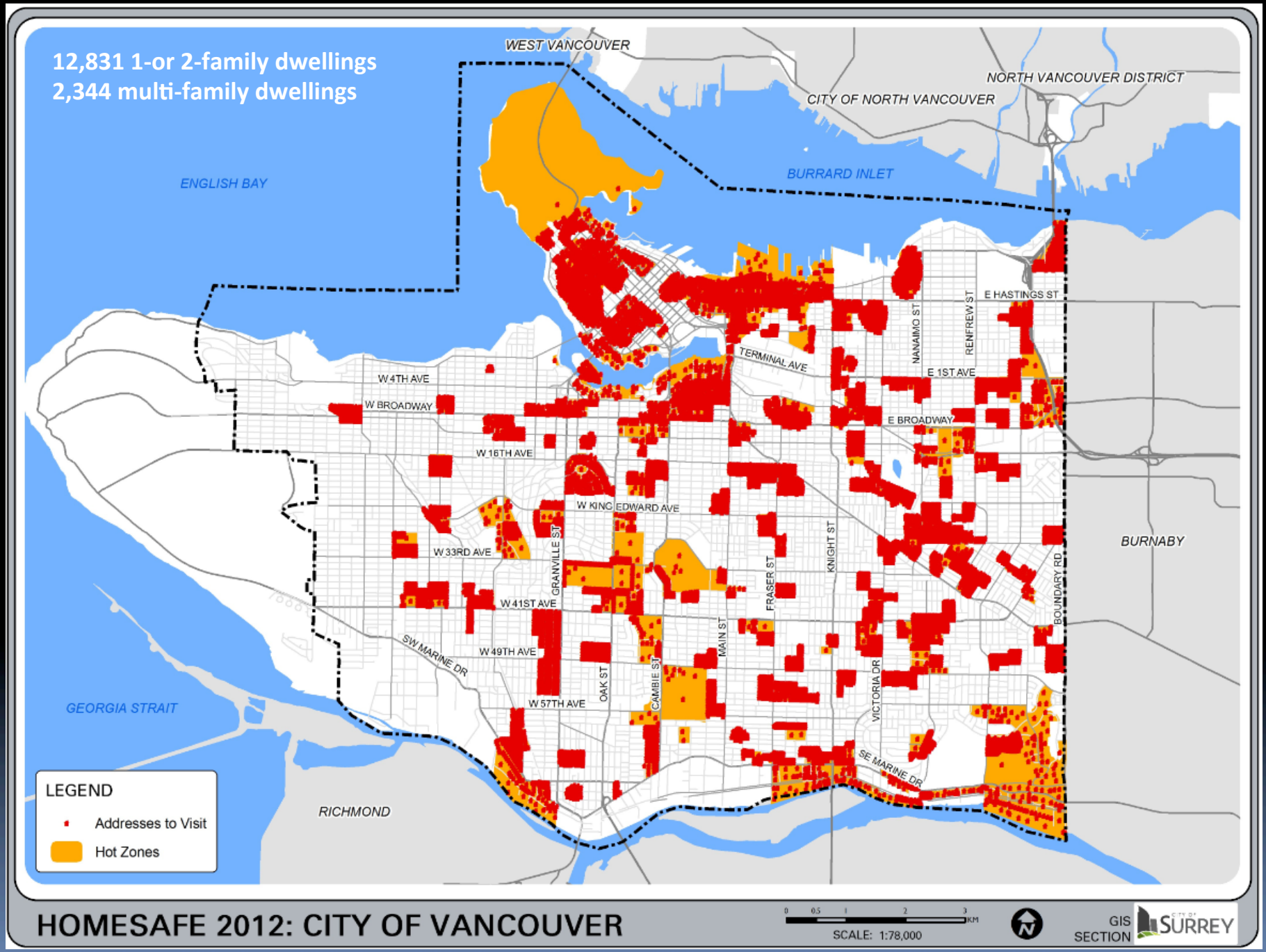

Vehicle Fires
350
300
250
200
150
100
50
0
2006
2007
2008
2009
2010
2011
2012
2013
Vehicle Fires
Linear (Vehicle Fires)

Our Nearest Neighbors Have Not Observed an Equivalent Decline in Residential Fires



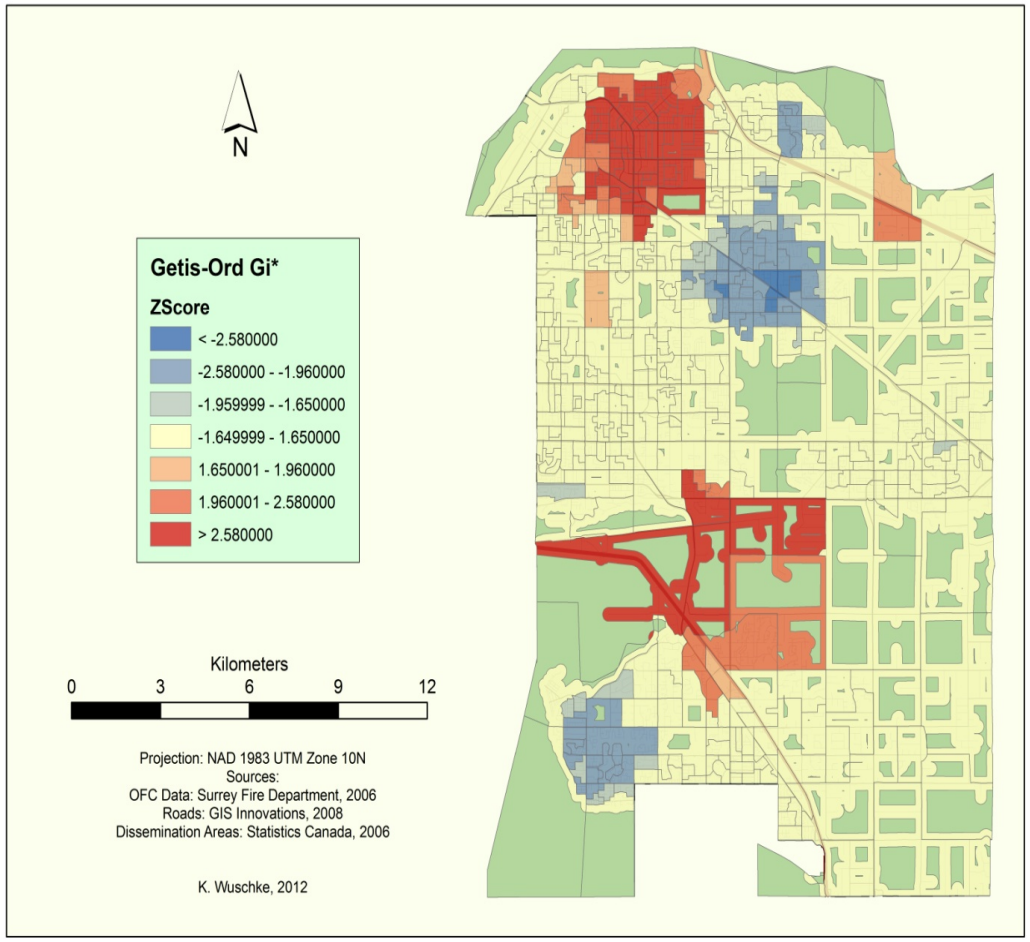
	2007	2008	2009	2010	2011	2012
Surrey	662	630	570	546	438	525
Metro (minus Surrey)	1507	1717	1845	1481	1608	1743

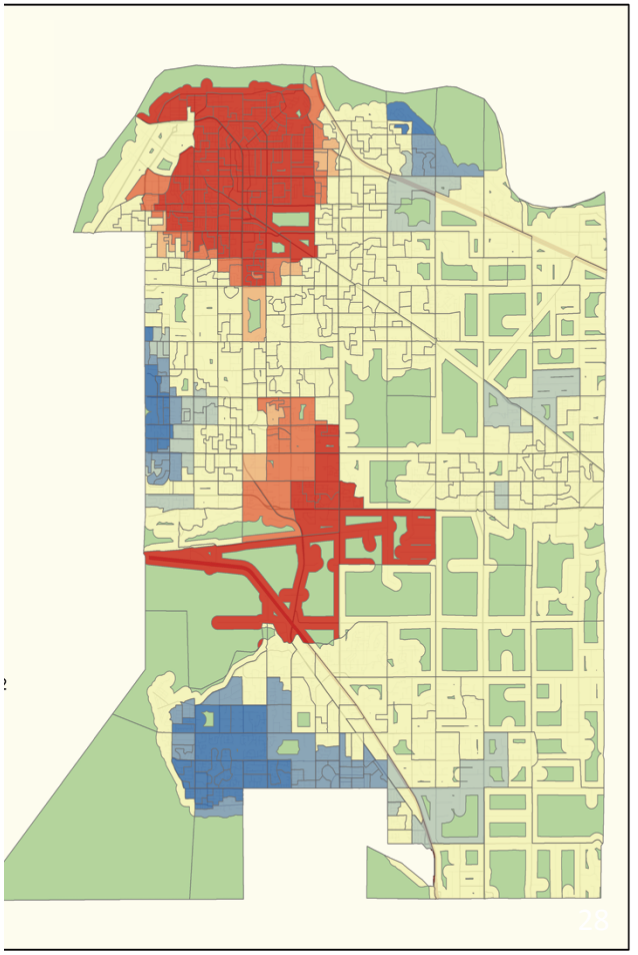

10,180 residential dwellings
3,403 multi-family dwellings
PITT MEADOWS
MAPLE RIDGE
ABBOTSFORD
CITY OF LANGLEY
SURREY
WASHINGTON STATE, USA
102B AVE
96 AVE
91 AVE
88 AVE
80 AVE
72 AVE
64 AVE
62 AVE
56 AVE
52 AVE
48 AVE
40 AVE
36 AVE
32 AVE
24 AVE
16 AVE
201 ST
202 ST
208 ST
216 ST
200 ST
232 ST
248 ST
264 ST
272 ST
RIVER RD
GLOVER RD
CRUSH CRES
MUFFORD CRES
FRASER HWY
LEGEND
Addresses to Visit
Hotzones
HOMESAFE 2012
TOWNSHIP OF LANGLEY
SCALE: 1:104,000
GIS SECTION
CITY OF SURREY


12,831 1-or 2-family dwellings
2,344 multi-family dwellings
WEST VANCOUVER
NORTH VANCOUVER DISTRICT
CITY OF NORTH VANCOUVER
ENGLISH BAY
BURRARD INLET
E HASTINGS ST
NANAIMO ST
RENFREW ST
TERMINAL AVE
E 1ST AVE
W 4TH AVE
W BROADWAY
E BROADWAY
W 16TH AVE
W KING EDWARD AVE
BURNABY
W 33RD AVE
GRANVILLE ST
FRASER ST
KNIGHT ST
BOUNDARY RD
W 41ST AVE
SW MARINE DR
W 49TH AVE
MAIN ST
OAK ST
CAMBIE ST
VICTORIA DR
W 57TH AVE
SE MARINE DR
GEORGIA STRAIT
RICHMOND
LEGEND
Addresses to Visit
Hot Zones
HOMESAFE 2012: CITY OF VANCOUVER
0 0.5 1 2 3 KM
SCALE: 1:78,000
GIS SECTION
CITY OF SURREY

This has Predictability…
Fire is Just Like Crime…

- Residential Structure Fires (2006) / B&Es (2006)





Predictability…
Fire / Crime share similar time

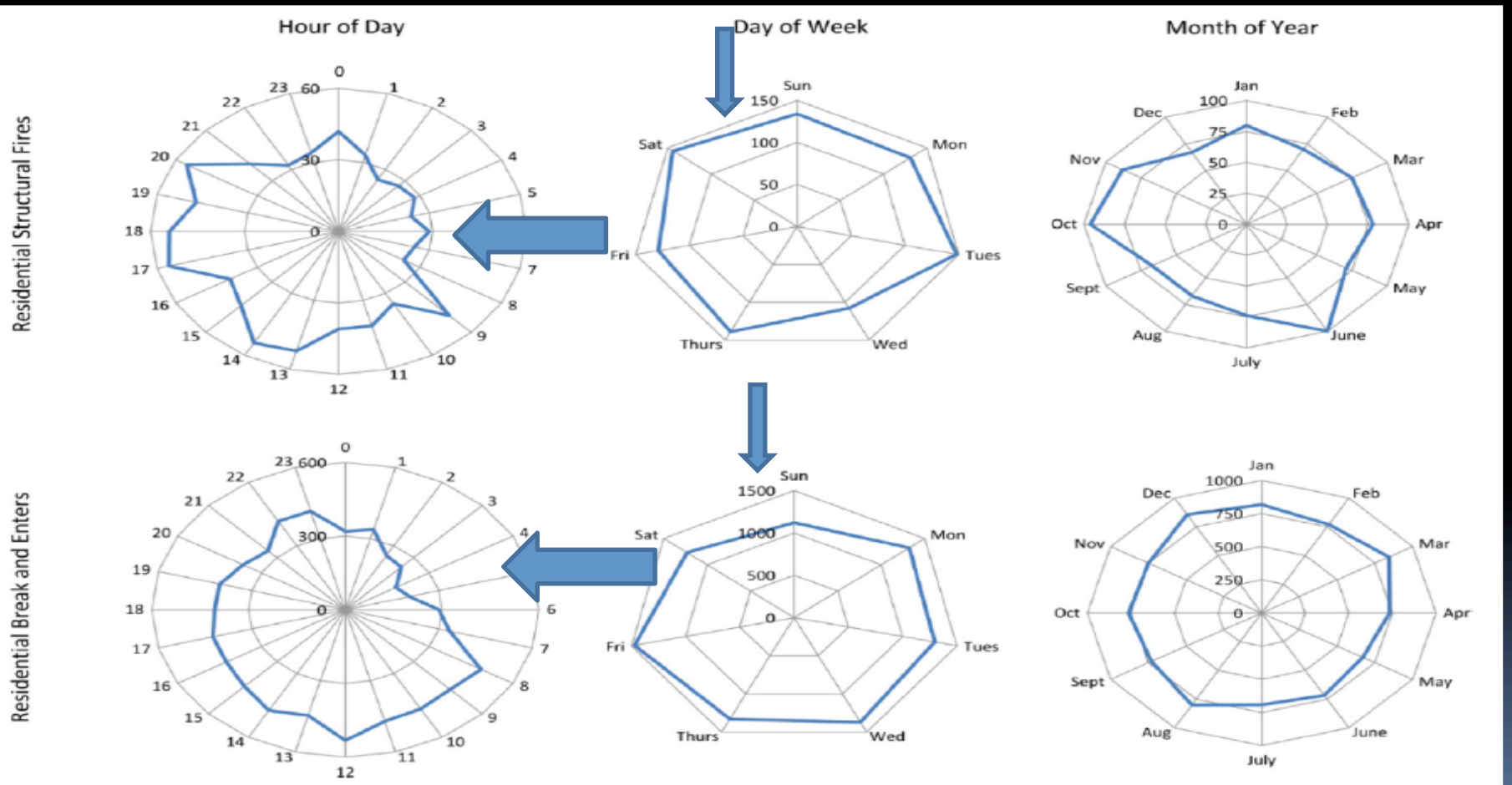


Fig. 6. Temporal patterns of fires and burglaries.

Not Just Talking About Smoke Alarms

- US Fire Administration research (2008)
  - Fire sprinklers alone – chances of dying in a fire decrease by 69% (compared to no sprinklers)
  - Smoke alarms alone – chances decrease by 63% (compared to no alarm)
  - Sprinklers AND smoke alarms – chances decrease by 82%
- Fire risk is non-random
- Not advocating for blanket approaches – more thoughtful and risk driven

L

Does Construction Type make a difference ?

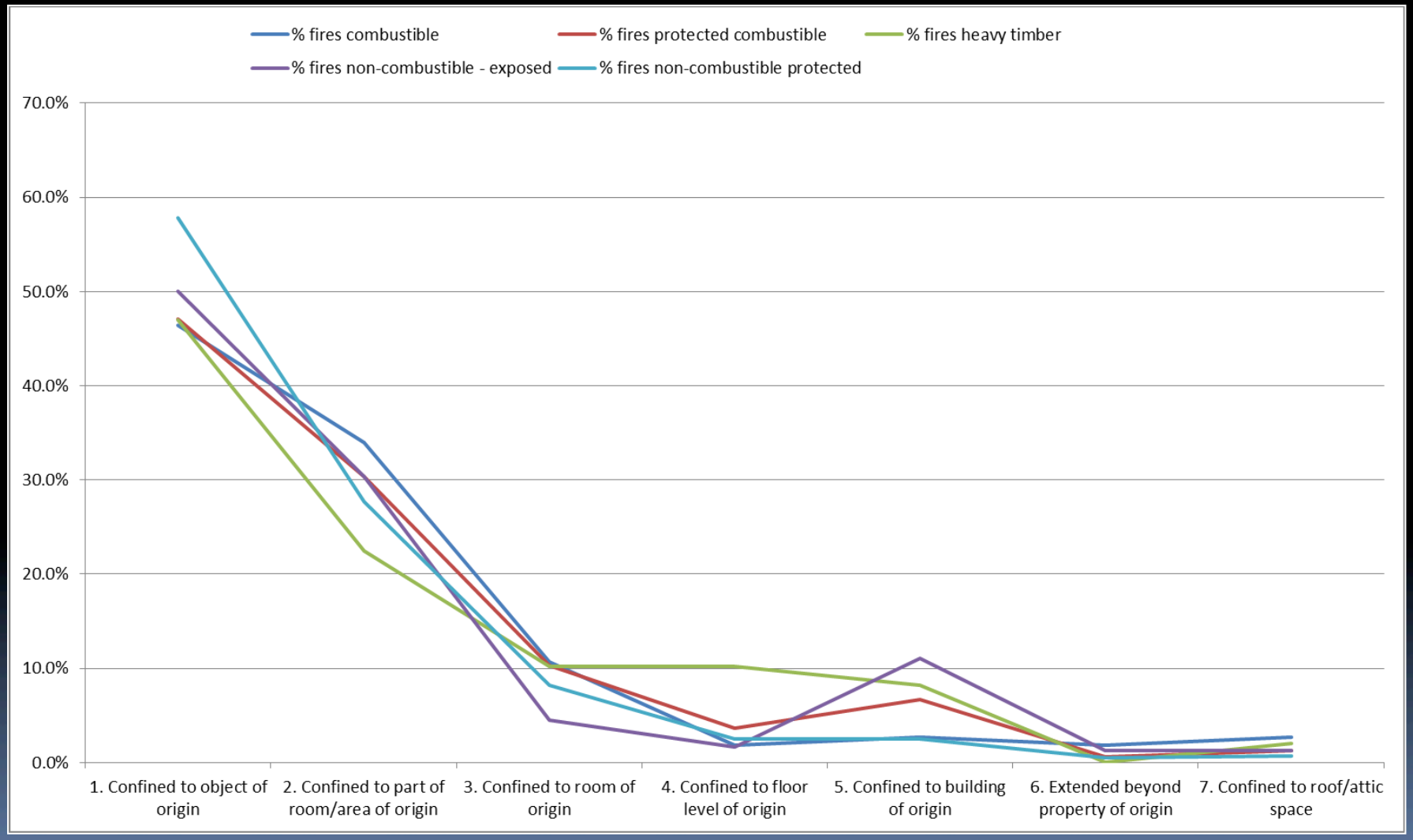
- Looking at (n = 11,875)
  - Frequency of fires , deaths and injuries by general construction type
  - Extent of fire spread by general construction type
  - Frequencies of fires, sprinkler protection, smoke alarm activation and injury rate general construction type
  - Extent of fire spread by general construction type and protection type

J

Does Construction Type make a difference ?

J

Does Construction Type make a difference ?



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Does Construction Type make a difference ?

No Deaths

	Sprinkler AND Smoke alarm protected fires					
General construction type	# fires	% fires	# injured	Injury rate	# death	Death rate
Combustible construction - open wood joist	54	6.2%	0	0.0	0	0.0
Protected combustible construction - wood protected by plaster/gyproc	413	47.7%	26	63.0	0	0.0
Heavy timber construction	15	1.7%	0	0.0	0	0.0
Non-combustible construction - exposed steel	75	8.7%	1	13.3	0	0.0
Protected non-combustible construction - protected steel or concrete	308	35.6%	16	51.9	0	0.0
Grand Total	**865**	**100.0%**	**43**	**49.7**	**0**	**0.0**

Protected Combustible Injury Rate 63 / 1,000
Non - Combustible Injury Rate 52 / 1,000

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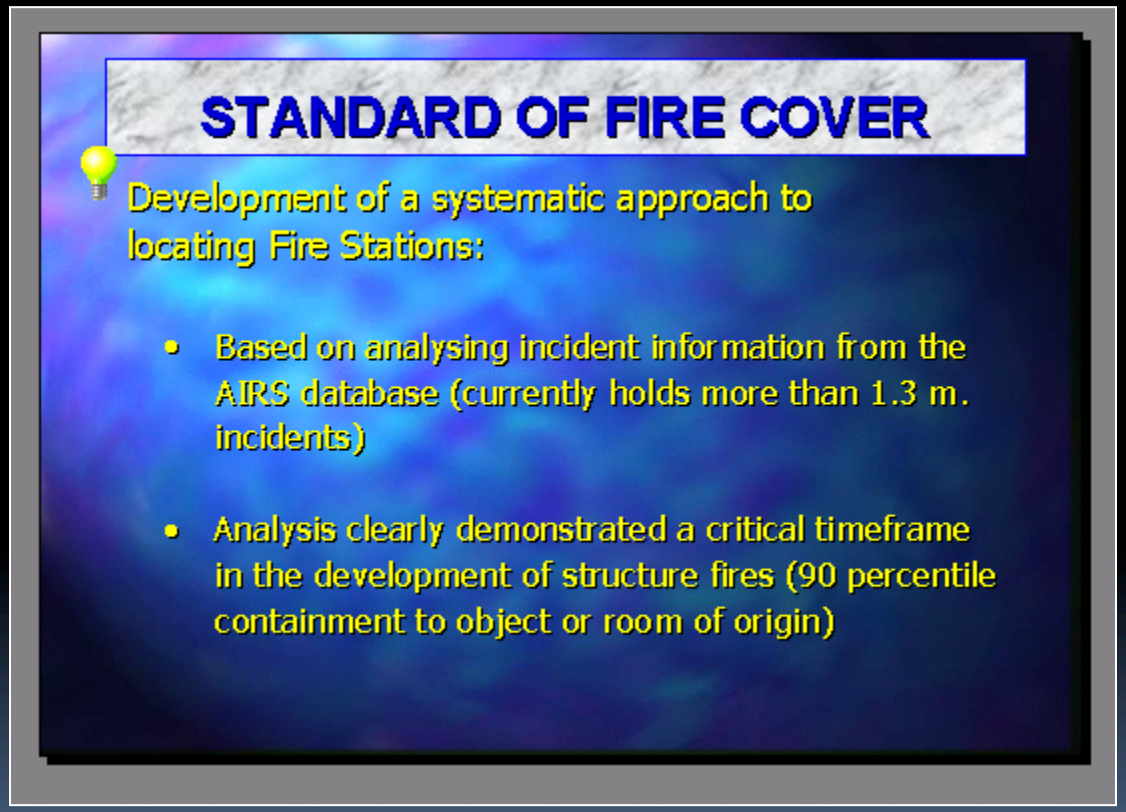
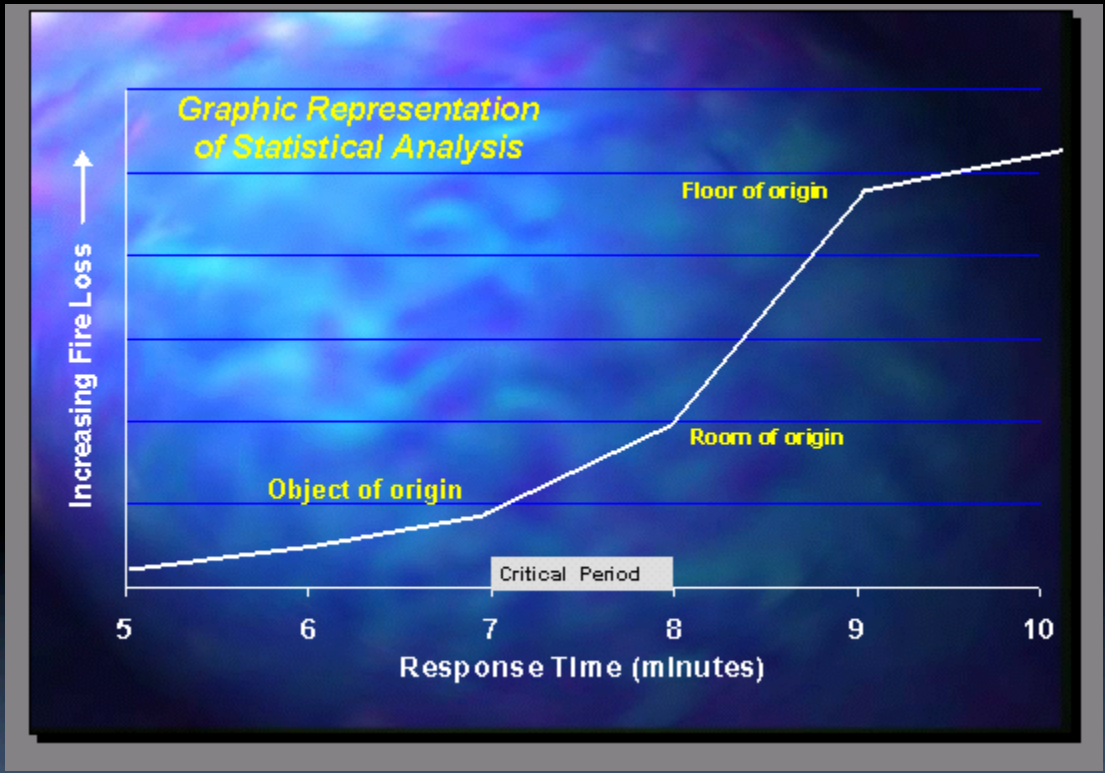
Some of the Drivers are Standards

- NFPA Response Times
- Prescription 6 minutes
- Equivalency = Evidence ???

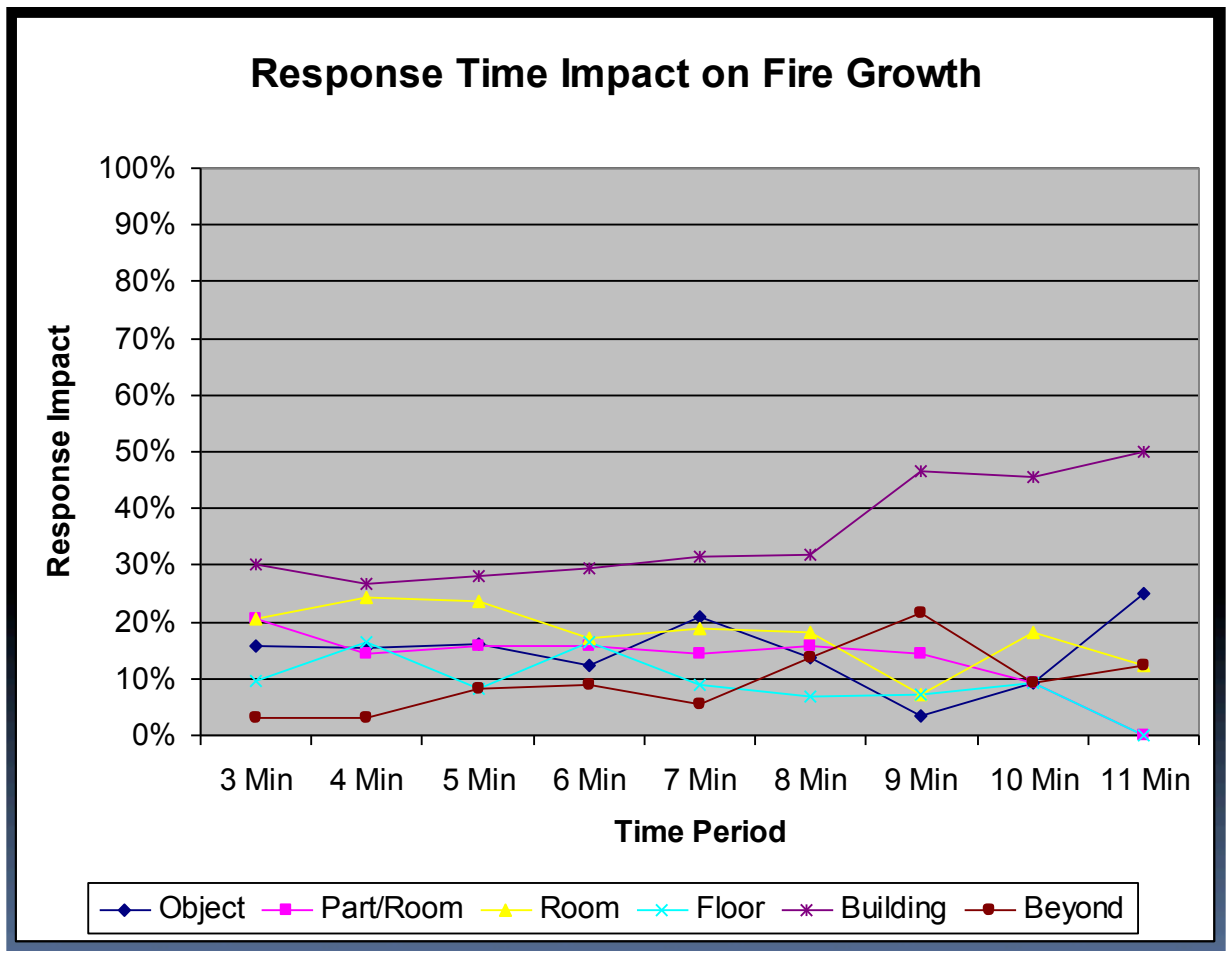
Standards of Cover
Australia Fire Engineers



Standards of Cover
Australia Fire Engineers



Surrey Experience 1000 Fires (1988 – 2001)



United Kingdom Reforms Fire Services 2002 Sir Edward Bain

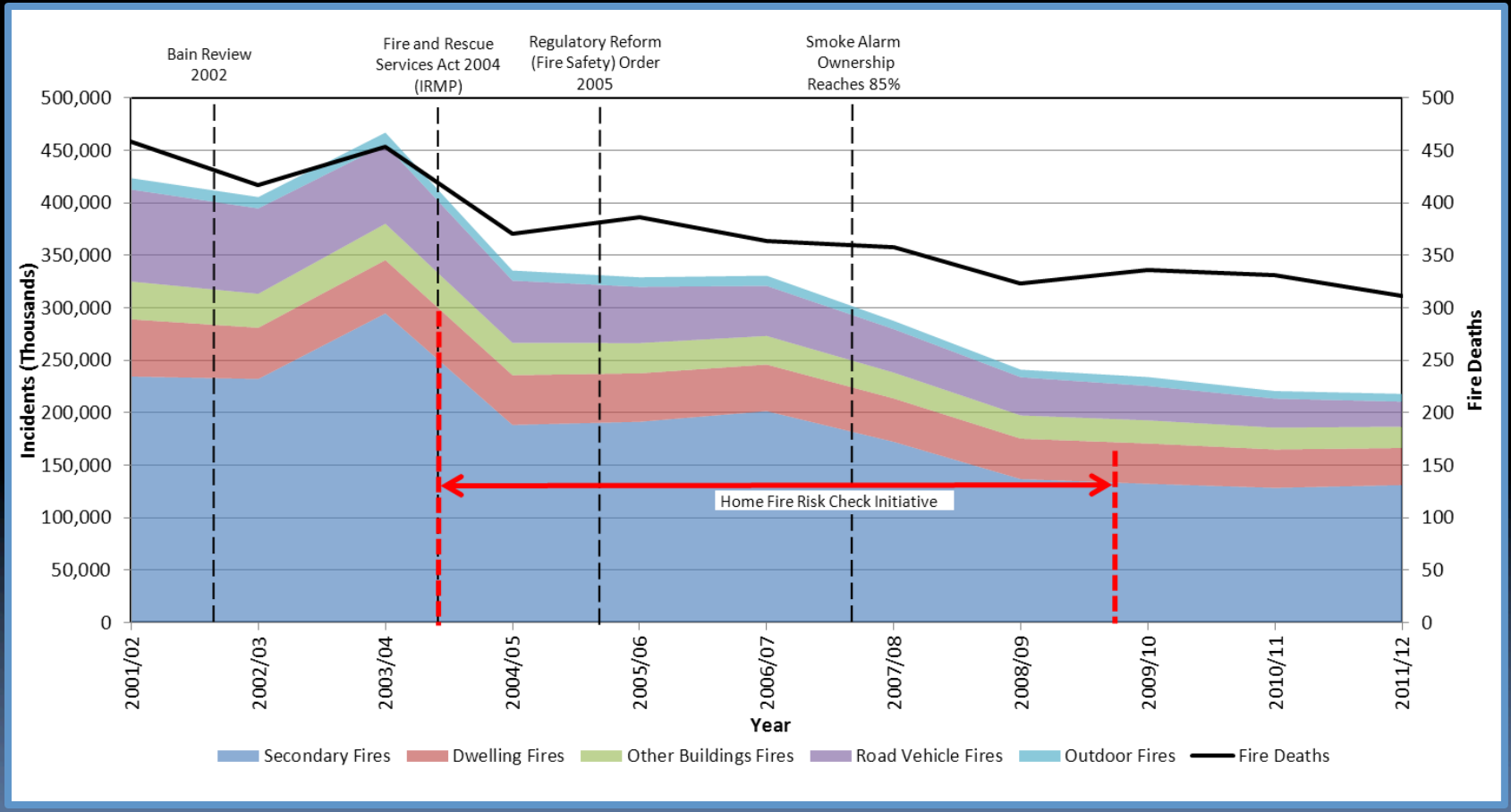
- Shift stations based on demand on social economic probabilities and call occurrences
- Staff stations Deployment to calls change
- Fire Services Act – Changes
- Regulatory Reform – Fire Safety Order
- Smoke Alarm Ownership
- Attendance Management

Population Demographics

- United Kingdom – 62.74 Million
- United States - 313.9 Million
- Germany - 81.8 Million
- Canada - 34.48 Million
- Australia – 22.32 Million
- **British Columbia – 4.6 Million**

Facing the Future

Findings from the review of efficiencies and operations in fire and rescue authorities in England ***May 2013***



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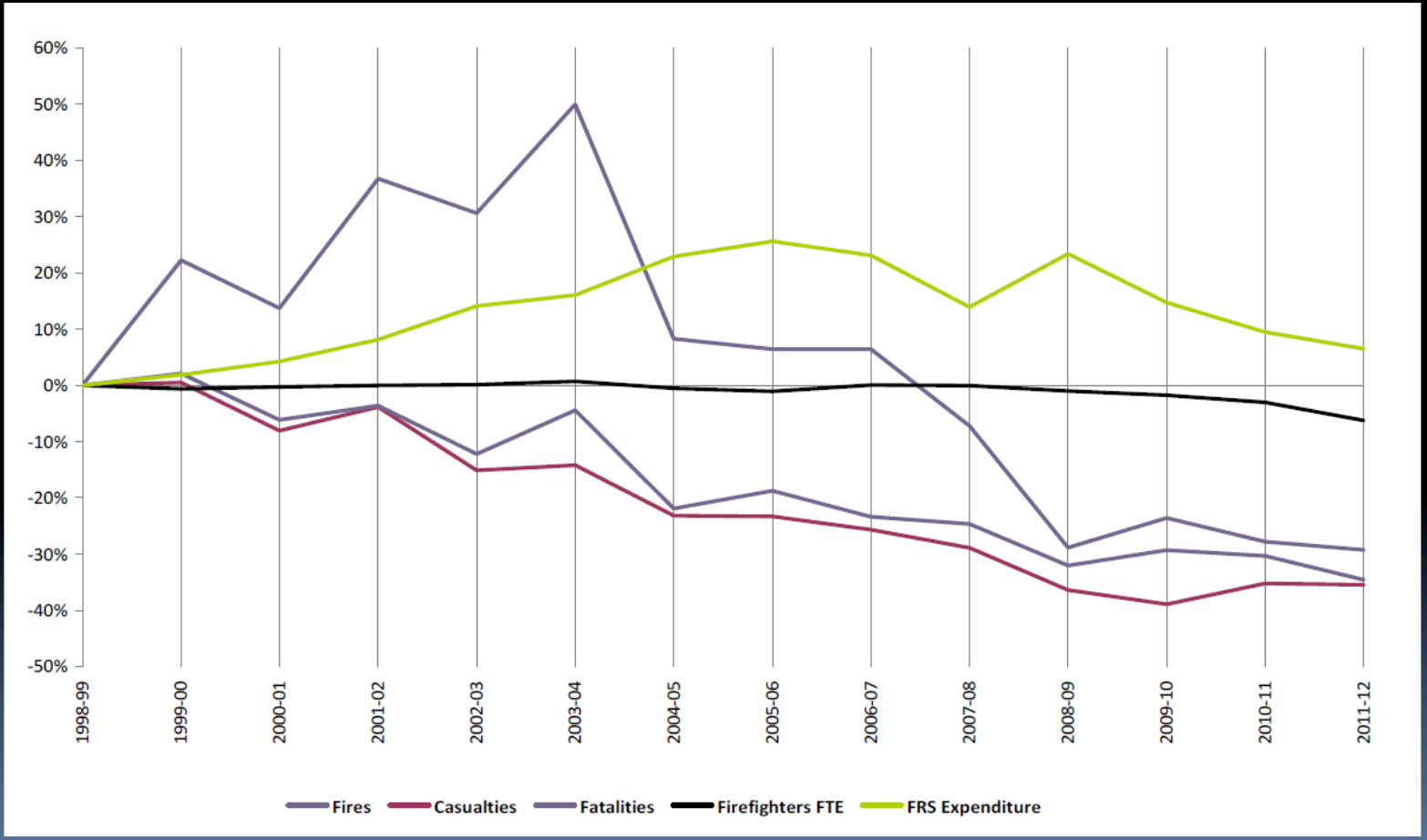
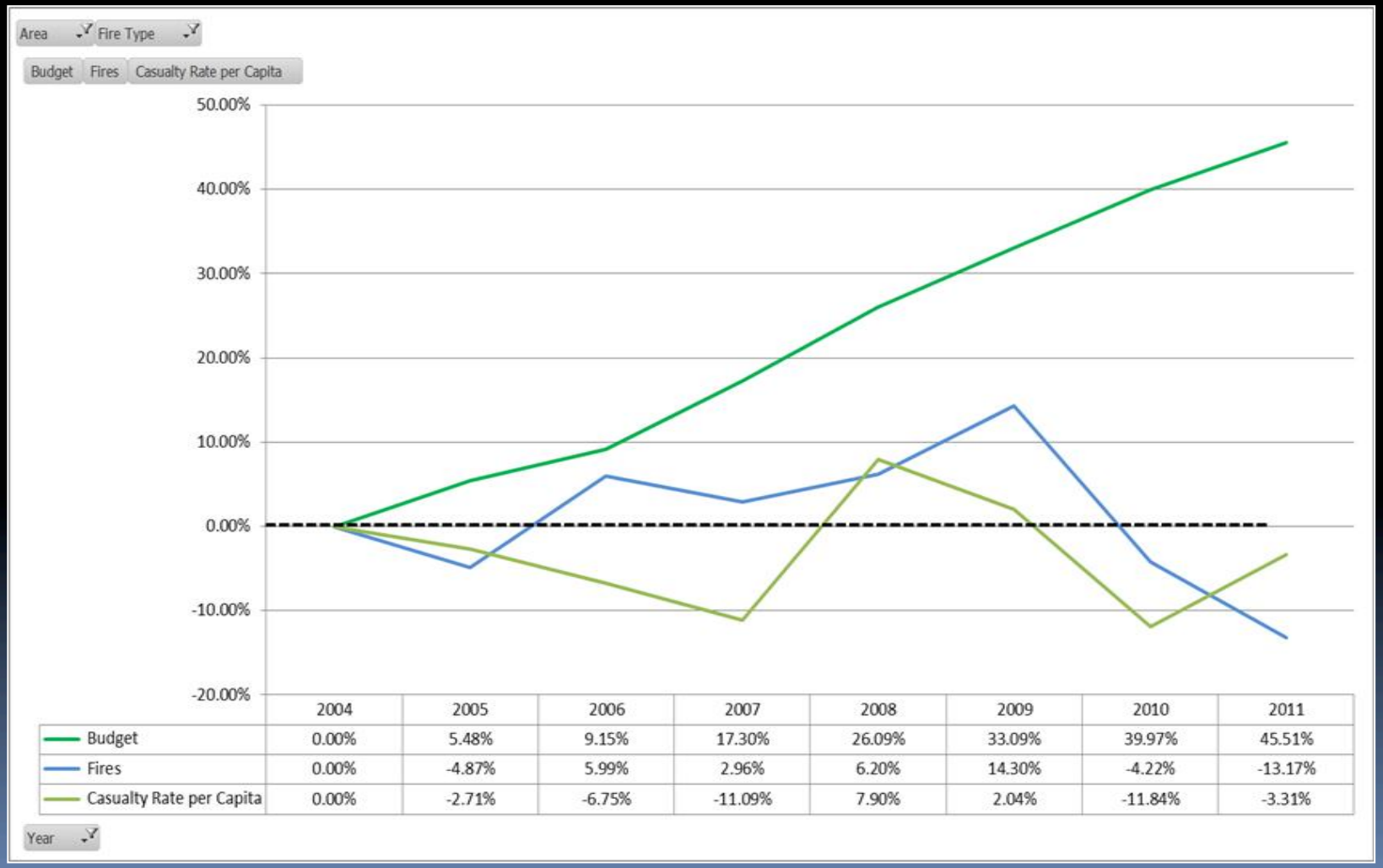


Facing the Future

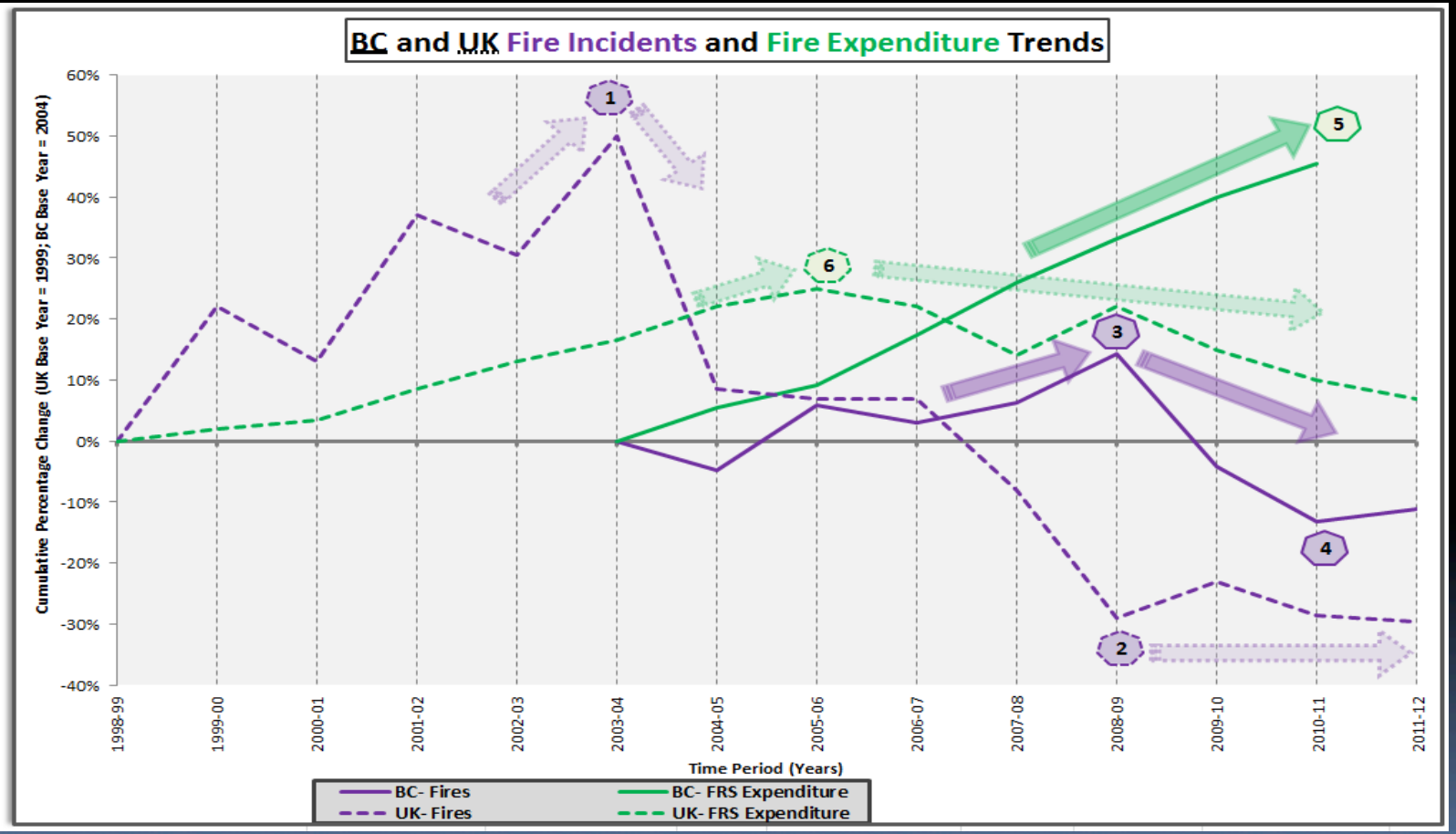
Findings from the review in BC



	2004	2005	2006	2007	2008	2009	2010	2011
Budget	0.00%	5.48%	9.15%	17.30%	26.09%	33.09%	39.97%	45.51%
Fires	0.00%	-4.87%	5.99%	2.96%	6.20%	14.30%	-4.22%	-13.17%
Casualty Rate per Capita	0.00%	-2.71%	-6.75%	-11.09%	7.90%	2.04%	-11.84%	-3.31%

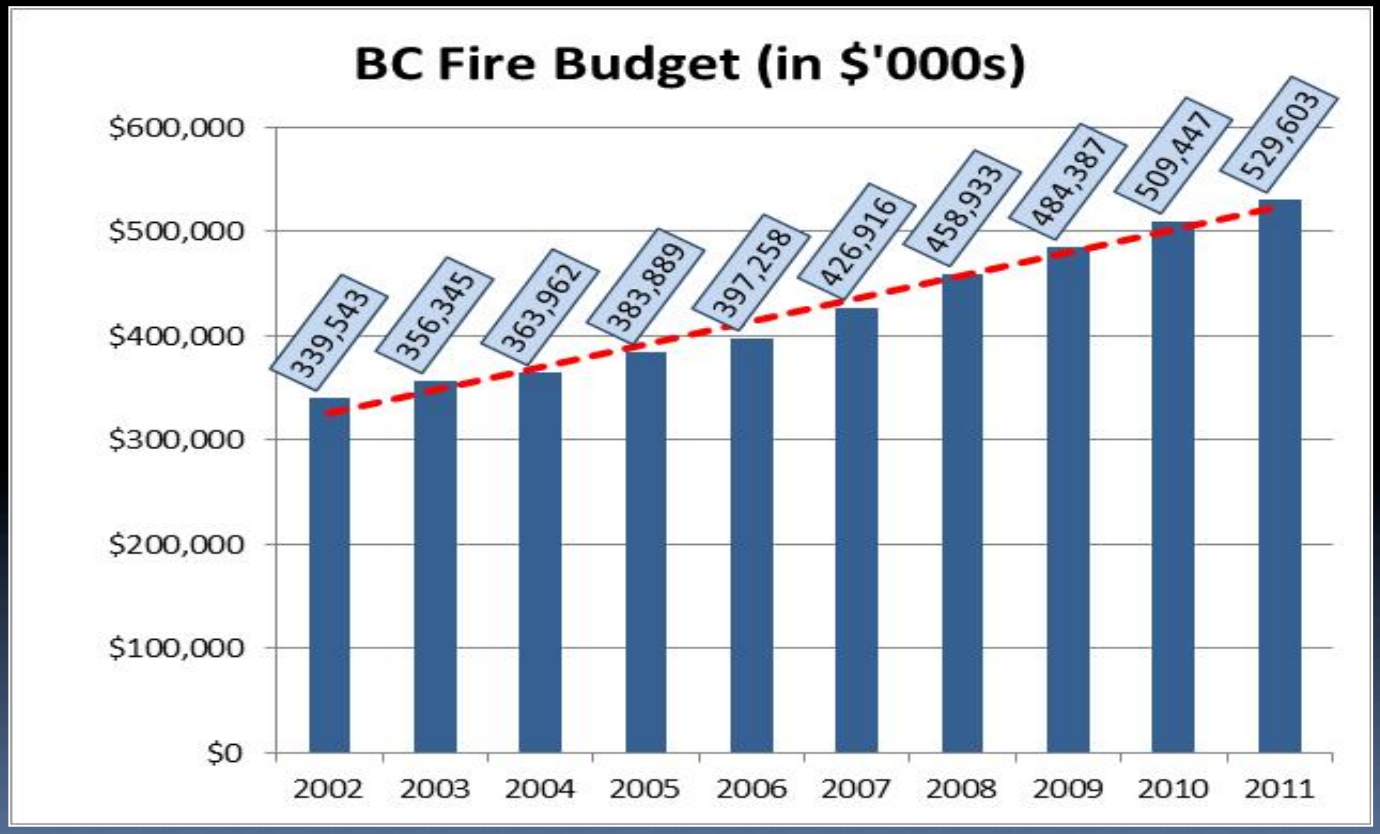
Facing the Future

Findings from the review in BC

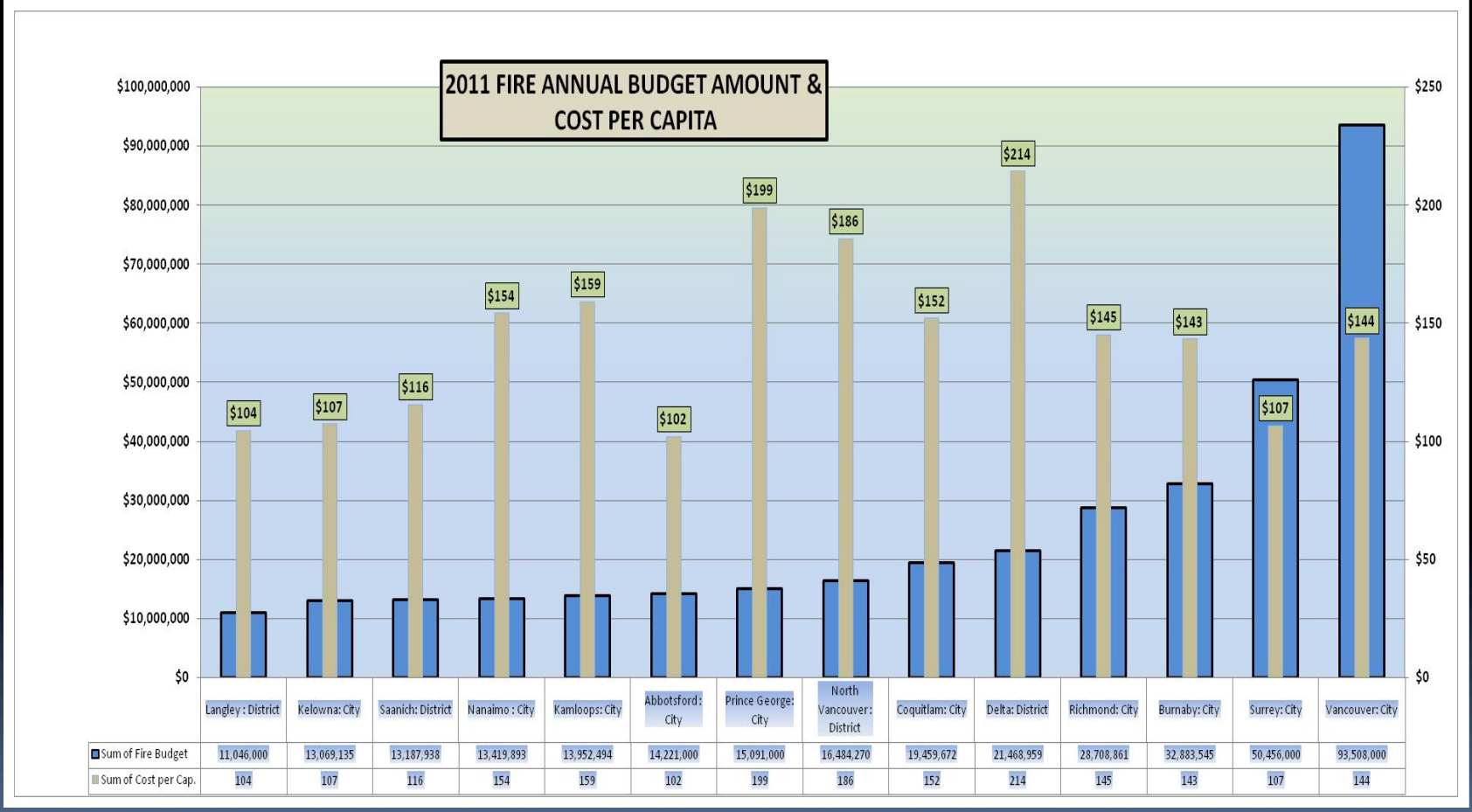


Facing the Future

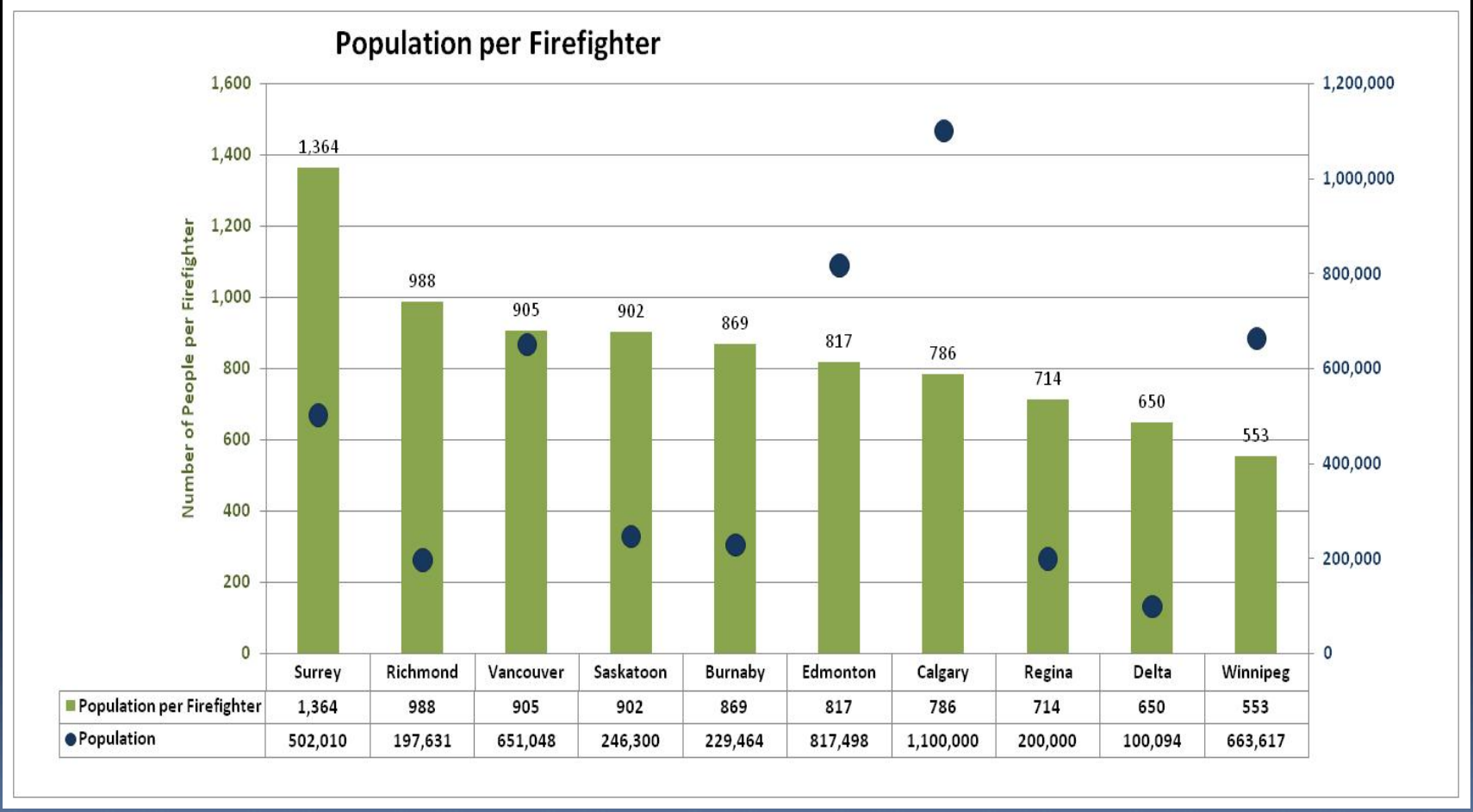
Findings from the review in BC



Population Cost



Population Firefighter Trends



How Much does Protection Fire Cost?

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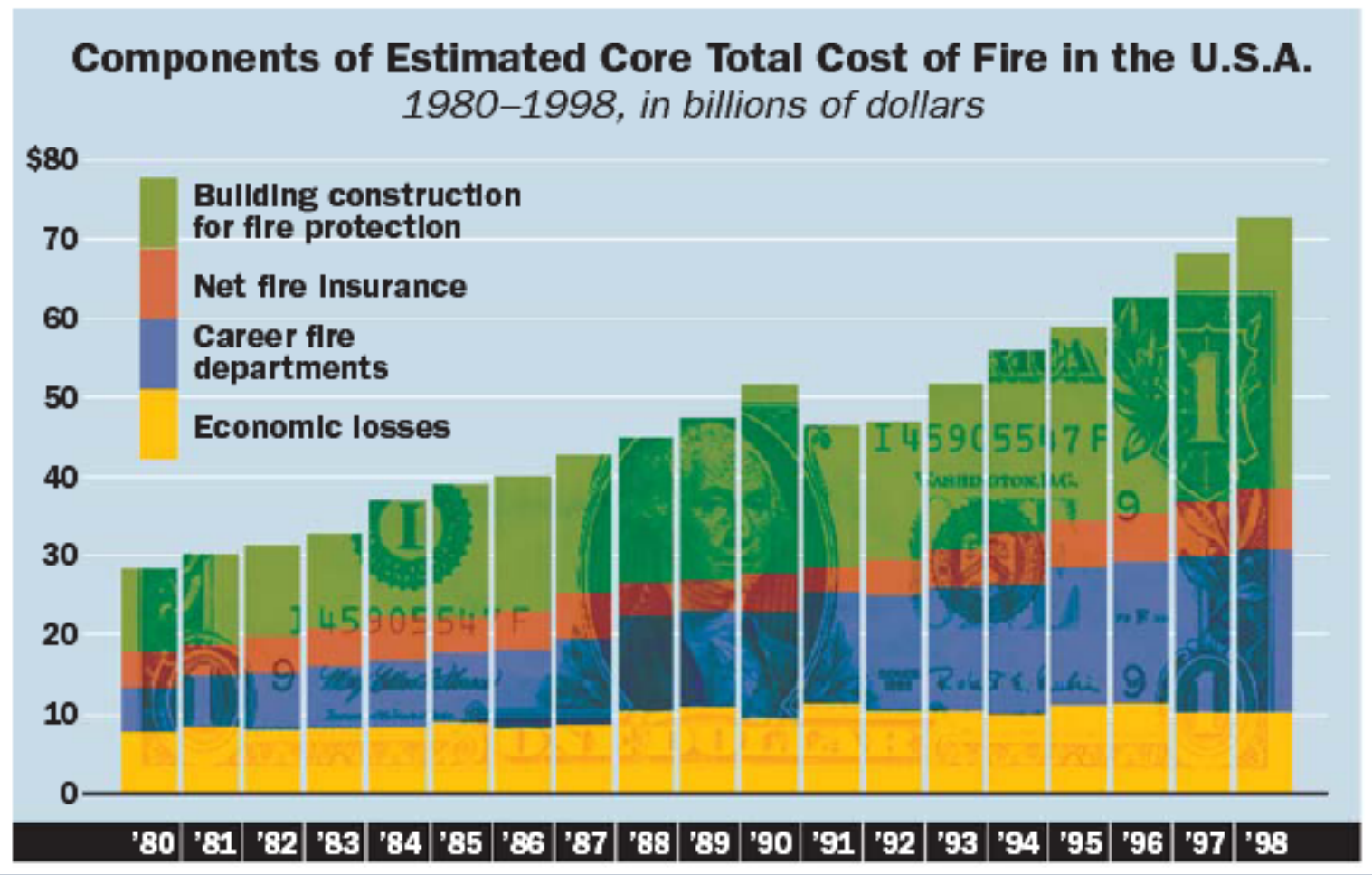
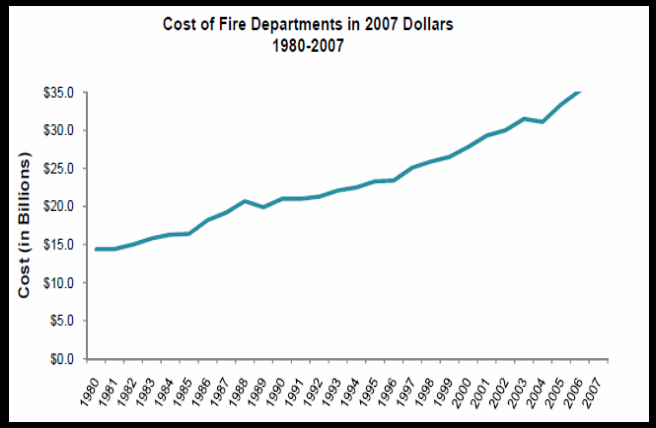
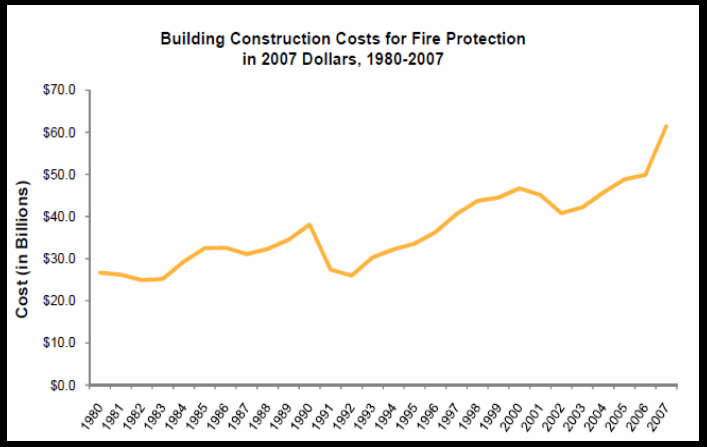
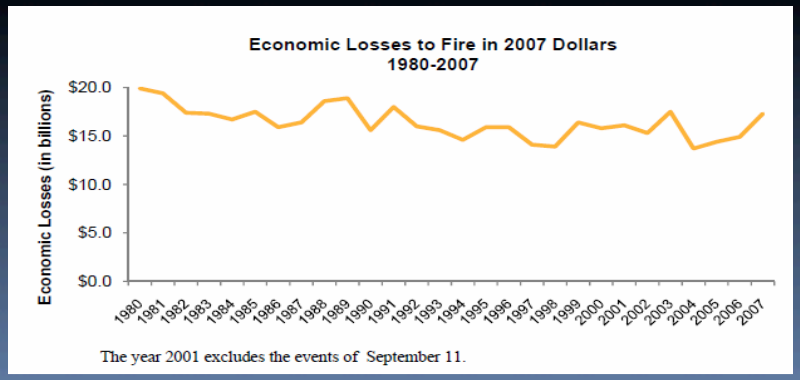
NFPA Report on Cost of Fire



NFPA Report on Cost of Fire / 2007







Hall (2012) / NFPA Challenges

- 156% - increase in Fire Department Costs
- 130 % - increase Building Costs for Fire Protection
- 67 % - increase in Net Insurance Premiums after Insured Loss Paid
- 13% - decrease in Economic loss

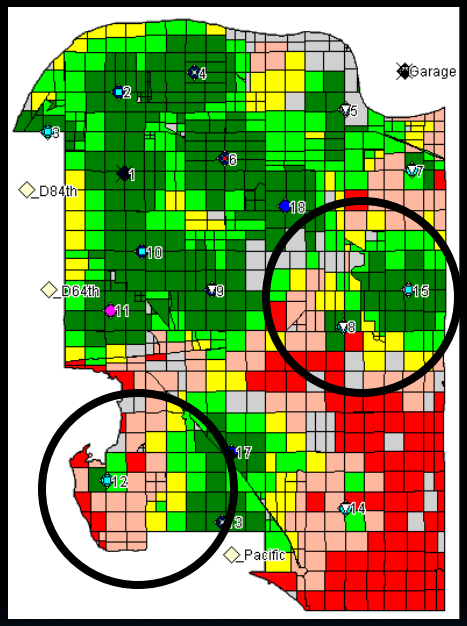
Challenges

- Research Evidence Based Policy
- Select Policies and Priorities that show promise
- Create Performance Measures
- Collect data
- Conduct Event Simulation / predictions with positive outcomes
- Evidence of success has to be apparent

Business Tools

- Deccan Modeling Software
- Event Simulations of Actual Data
- Move or Add Resources
- Forecasts Outcomes 90% Confidence

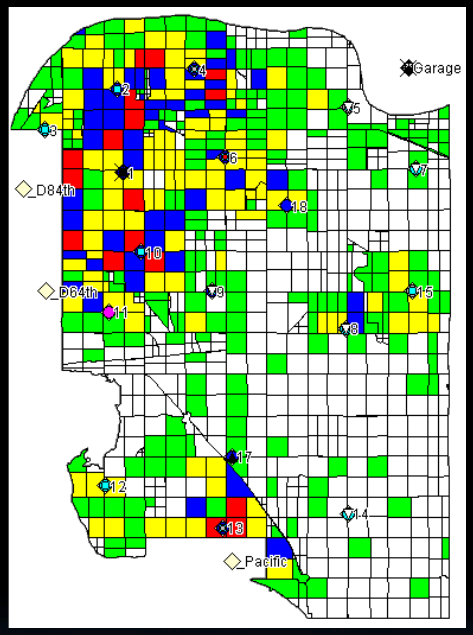
Current



TRspFUntM Graduated Percentage Performance

Over 90%	(234)
80% To 90%	(190)
70% To 80%	(99)
50% To 70%	(115)
Under 50%	(88)
No Access	(94)

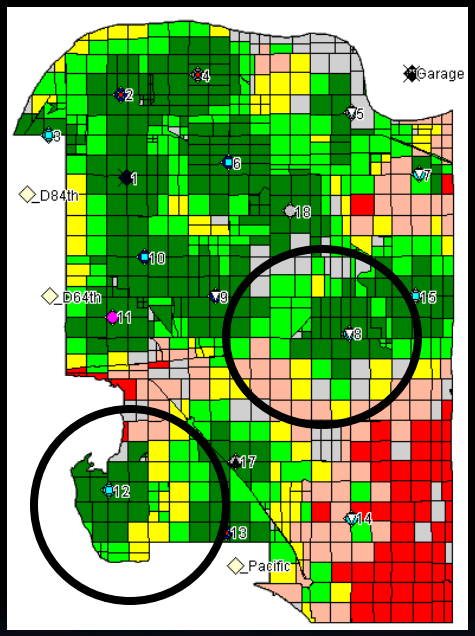
Workload



Total Workloads Distribution

143 to 335	(17)
62 to 143	(49)
27 to 62	(110)
7 to 27	(206)
0 to 7	(438)

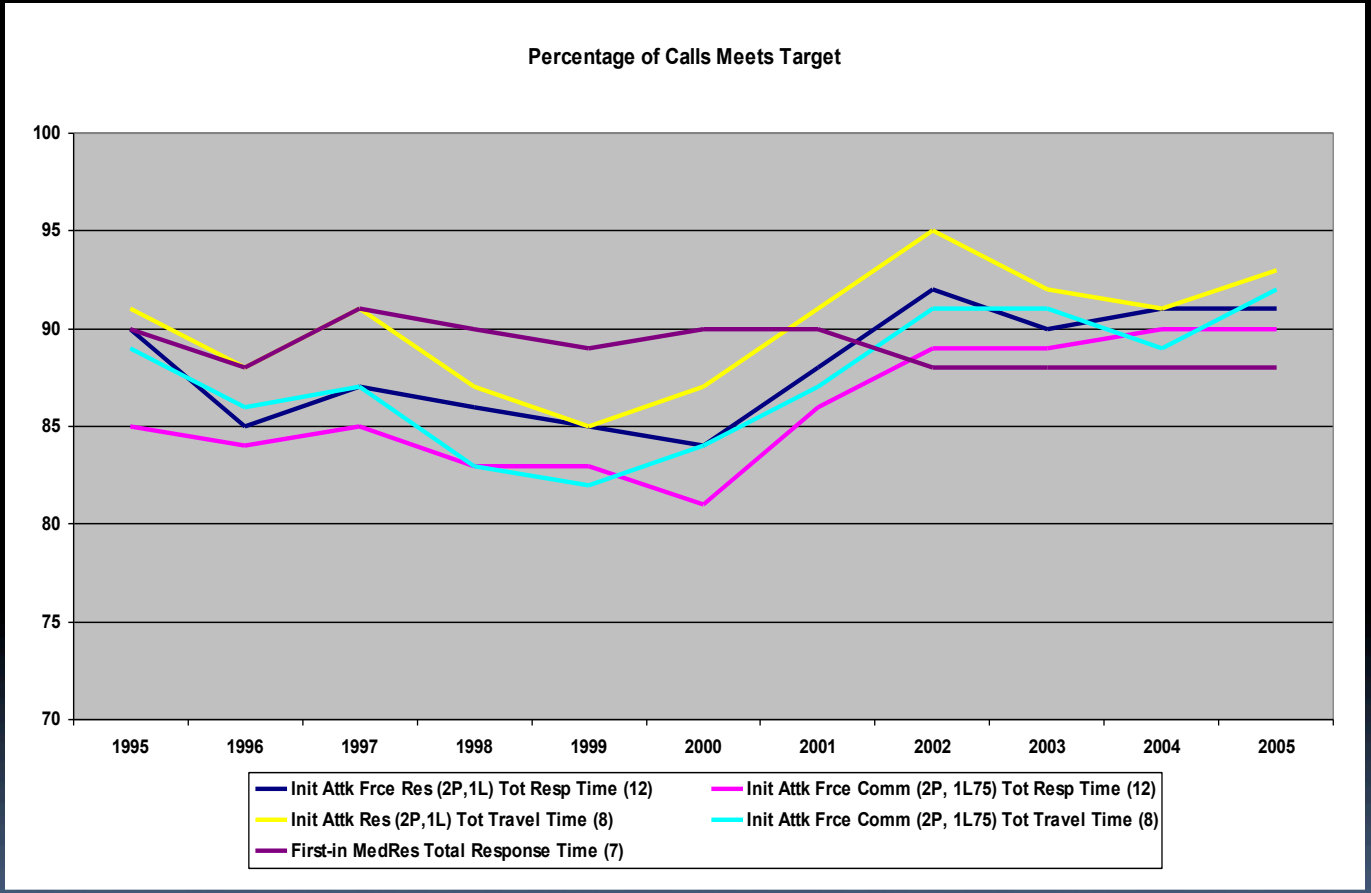
Future



TRspFUntM Graduated Percentage Performance

Over 90%	(265)
80% To 90%	(219)
70% To 80%	(97)
50% To 70%	(87)
Under 50%	(58)
No Access	(94)

Performance To-Day



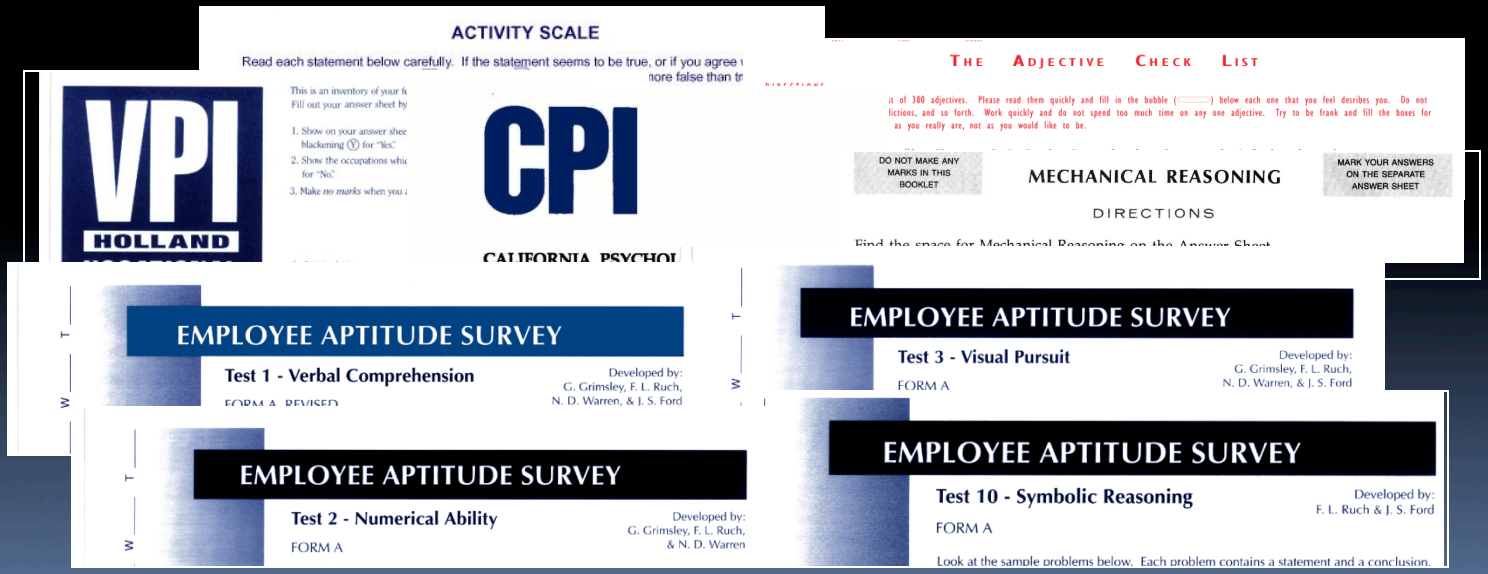
A. W. FRASER & ASSOCIATES

INDUSTRIAL PSYCHOLOGISTS MANAGEMENT CONSULTANTS

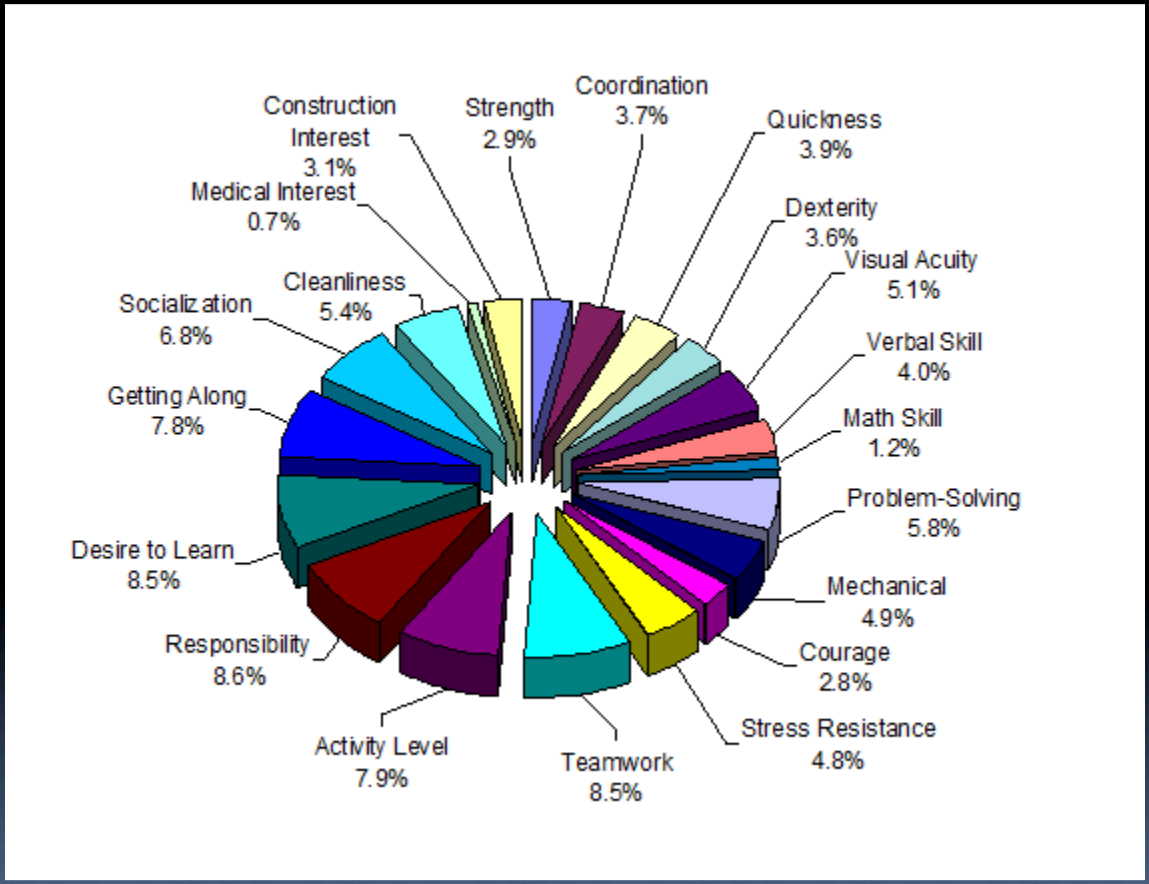
Municipal Firefighter Competency Profiling System Started 12 Years Ago

Steps In The Process

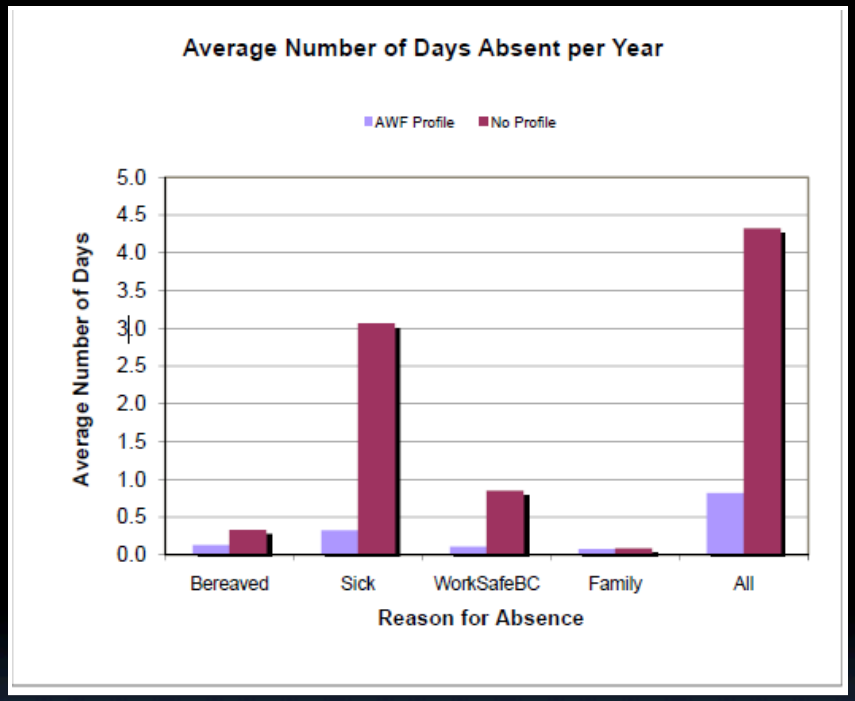
1. Profile department on 16 duty clusters
2. Establish departmental weights for 20 competencies needed to do the job
3. Applicants complete a test battery

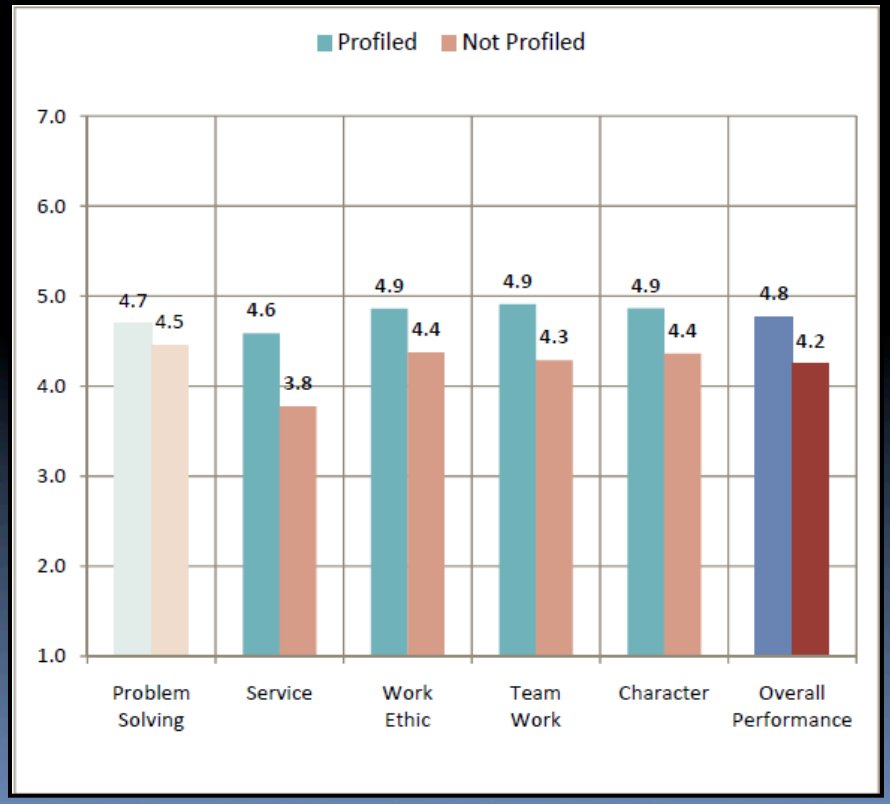


Municipal Firefighter Competency Profiling System



Surrey Fire Fighter Evaluation Results





Case Study Staffing Issues

- Attendance Management
- Staffing Issues
- Management of Resources

Attendance Management / Staff Absences

FIGURE 1. SURREY ATTENDANCE MANAGEMENT RESULTS: GROUPED YEARS 2000-2012

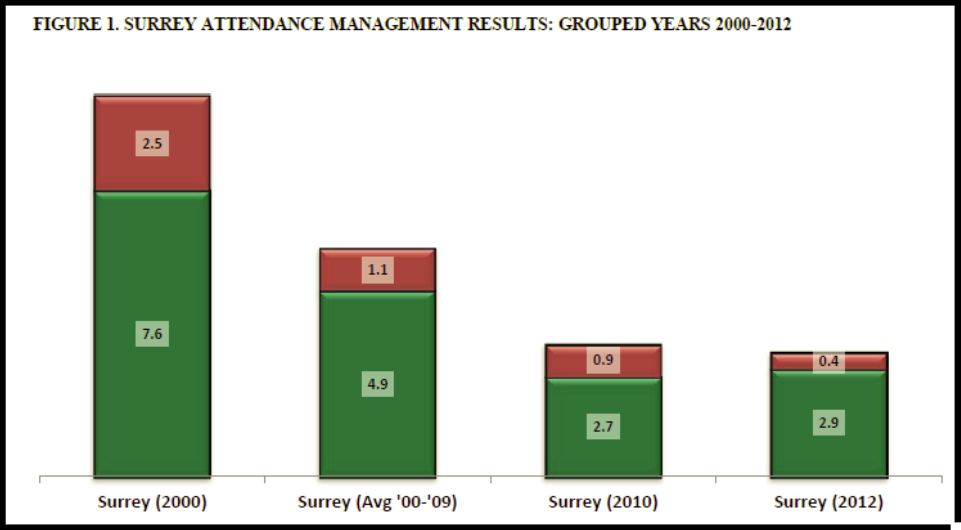
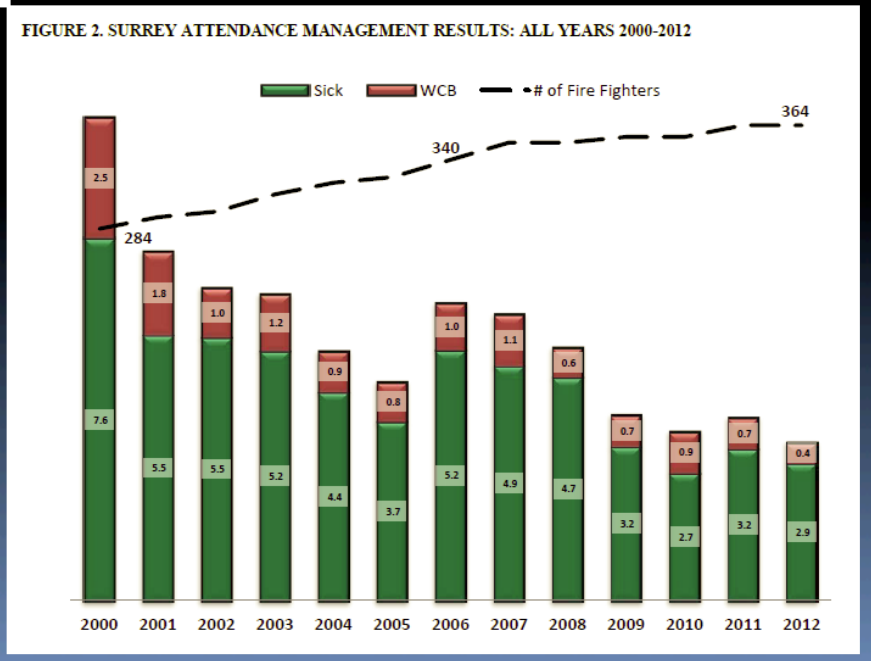


FIGURE 2. SURREY ATTENDANCE MANAGEMENT RESULTS: ALL YEARS 2000-2012



Attendance Management / Staff Absences

FIGURE 3. SURREY ATTENDANCE MANAGEMENT RESULTS, SAVINGS ALL YEARS 2000-2012

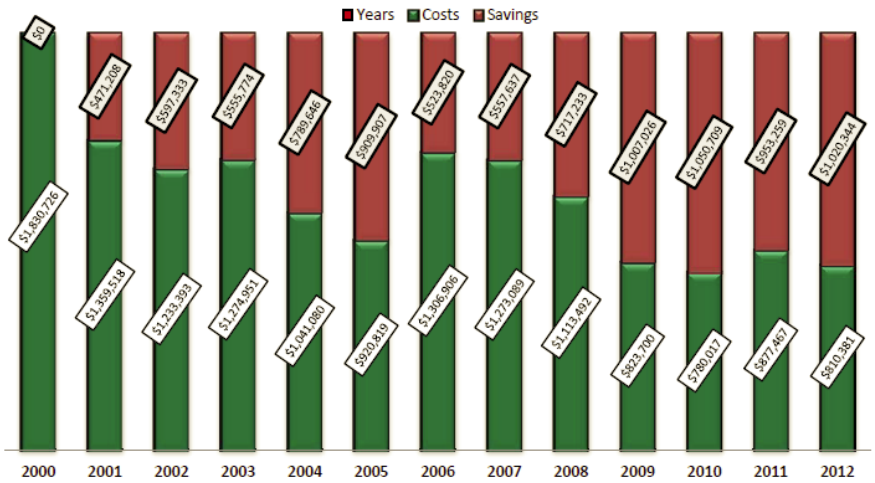
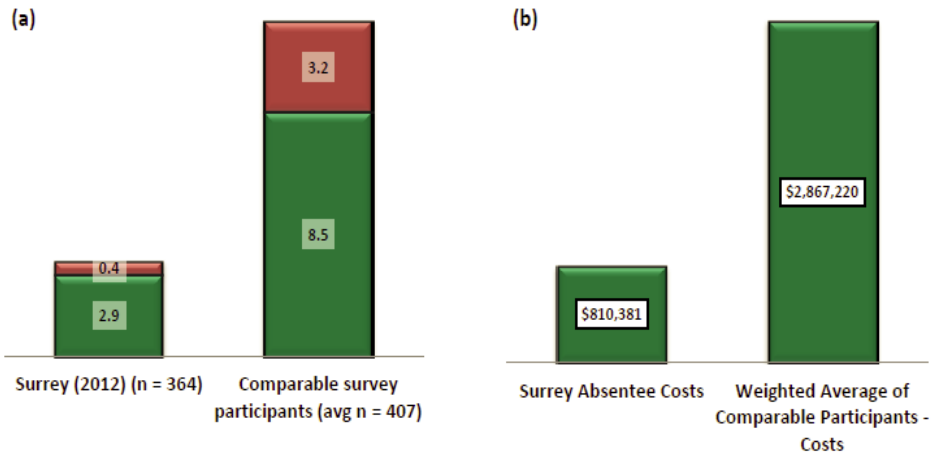


FIGURE 4. (A) ABSENTEES PER FIRE FIGHTER AND (B) COSTS FOR ABSENTEE HOURS, SURREY VS. COMPARABLE SURVEY PARTICIPANTS, 2012



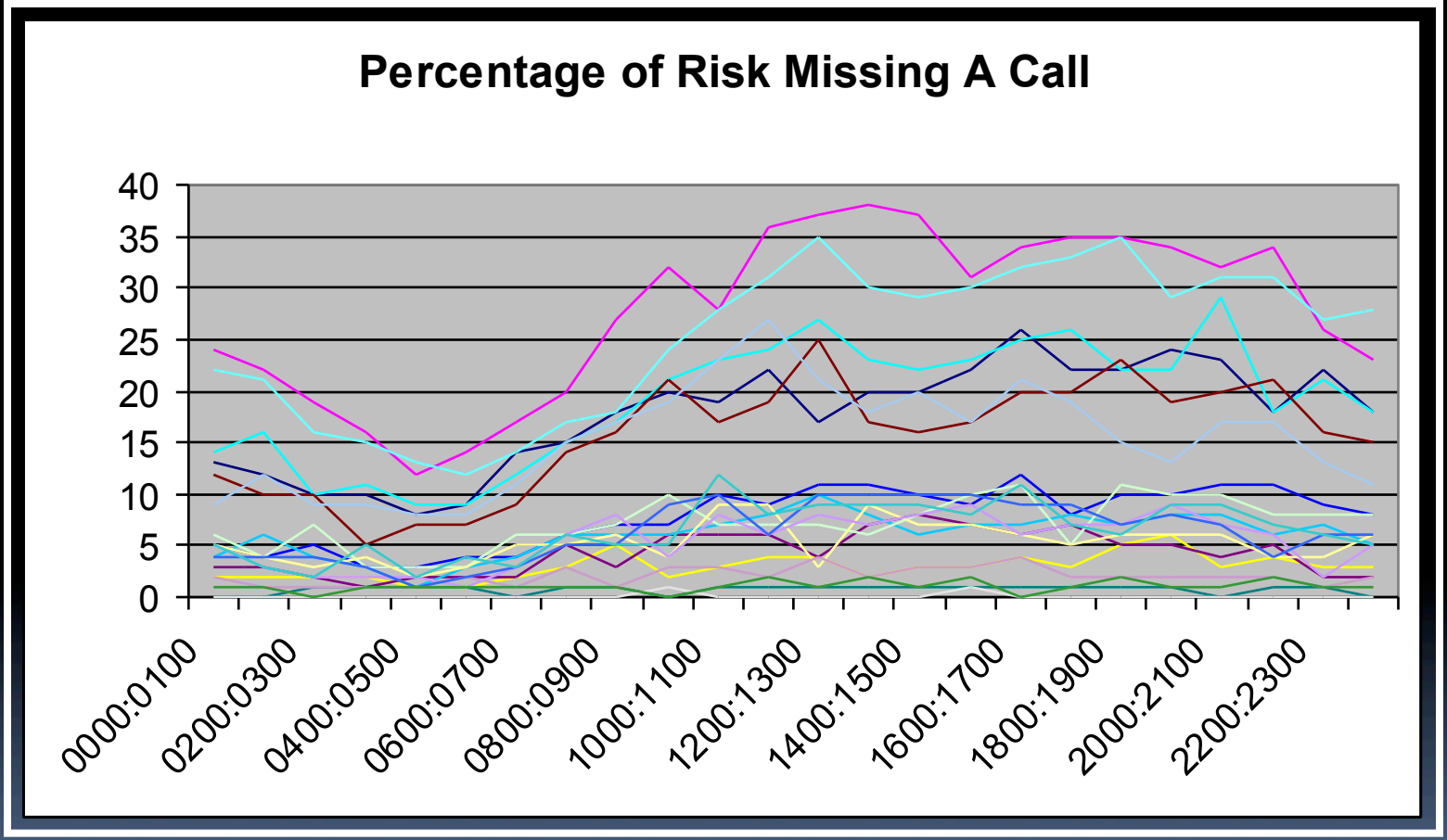
Dynamic Staffing

- Move up or Cover
- Nearest Neighbour
- Leap Frog
- Bump and Cover
- Probability

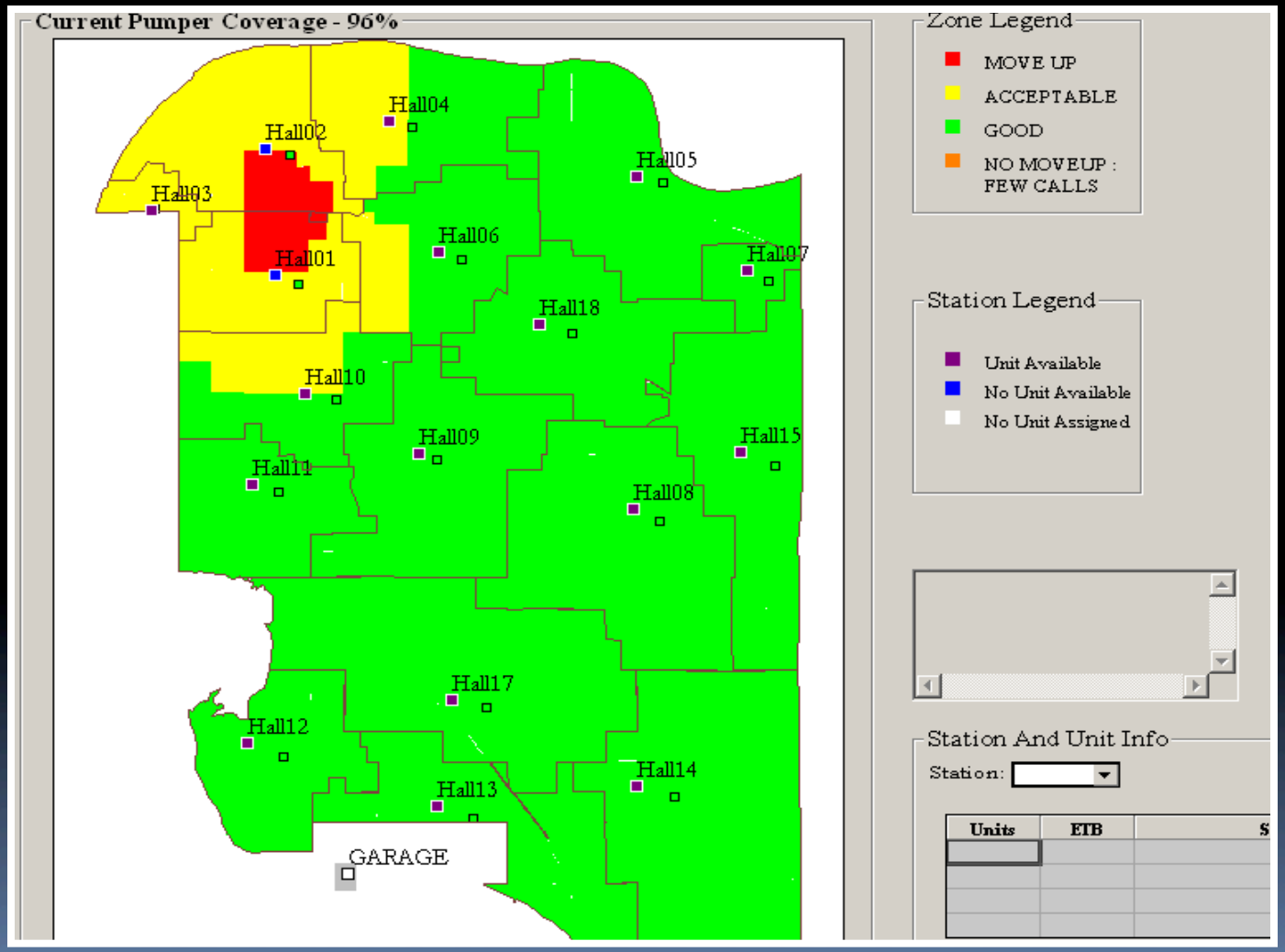
Probability

- The system employs what is known as the Bayesian approach to probability – a simple mathematical formula that determines the probability of an event occurring based on past incidences of the event.

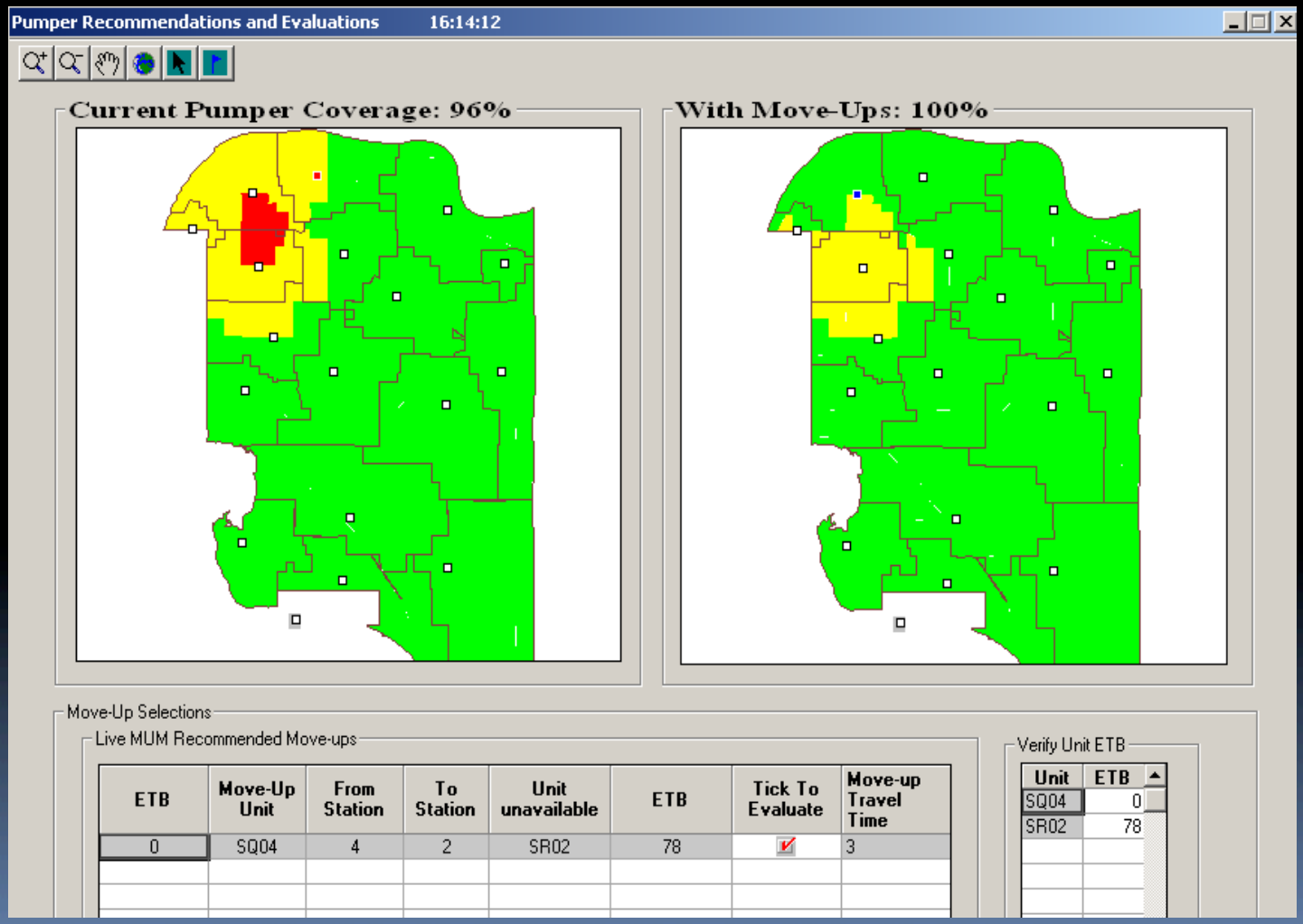
Probability



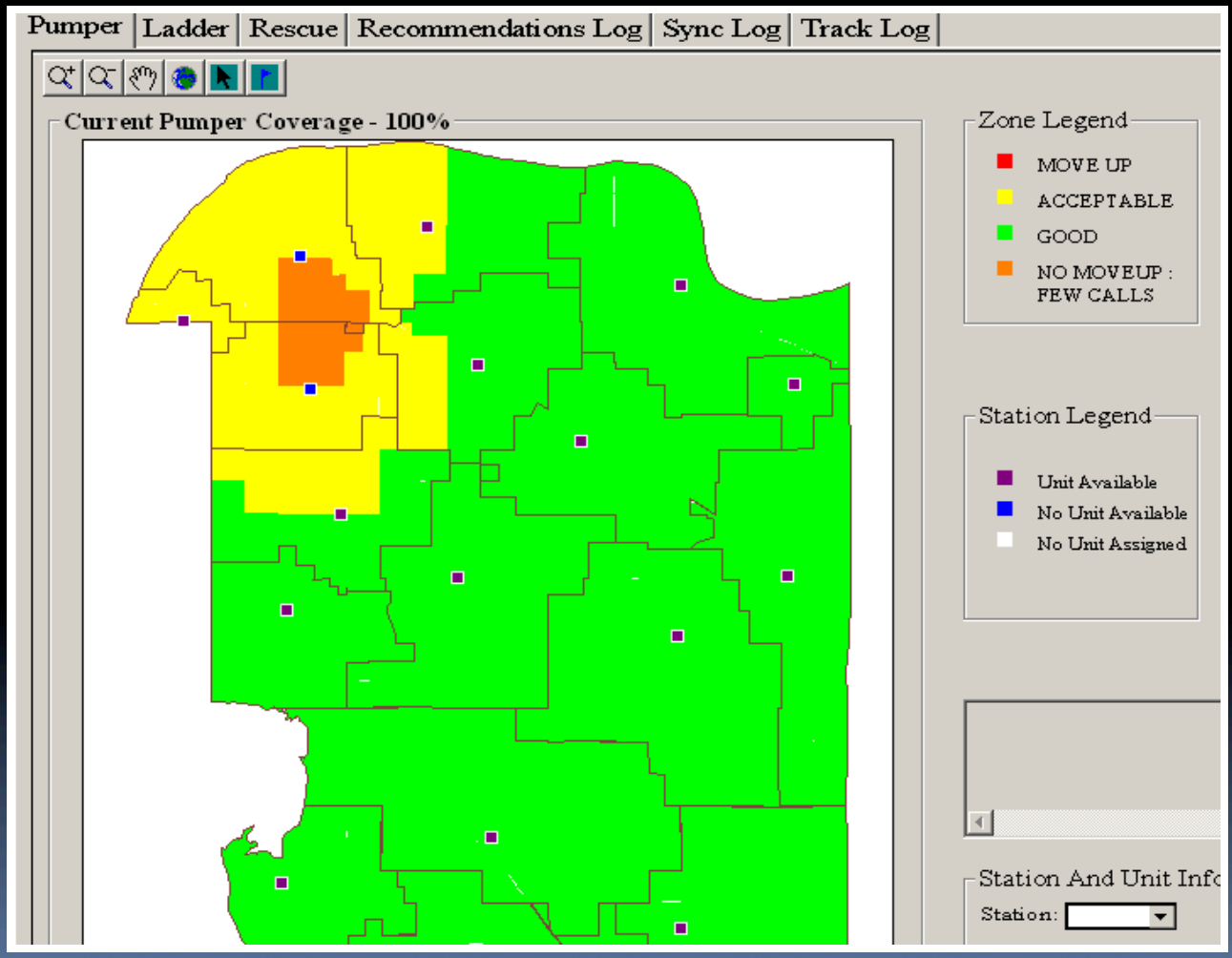
Simulate Structure Fire Sun 16:00 hrs



Probability of an other event greater than 25%



Simulate Structure Fire
Monday 02:00 hrs

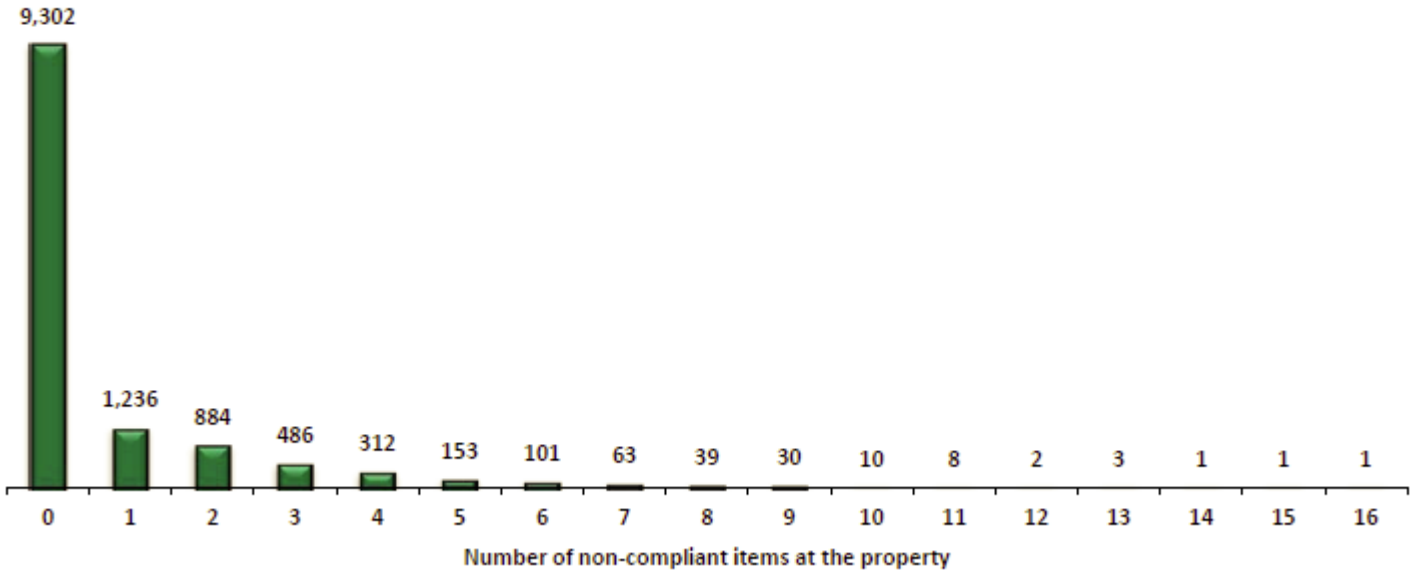


Fire Prevention Policy

- Local Government will provide a system of regular safety inspection
- Frequency of Inspection is influenced by : History, NFPA , Stakeholders – More is better
- Usually once a year, every 18 months or once every two years

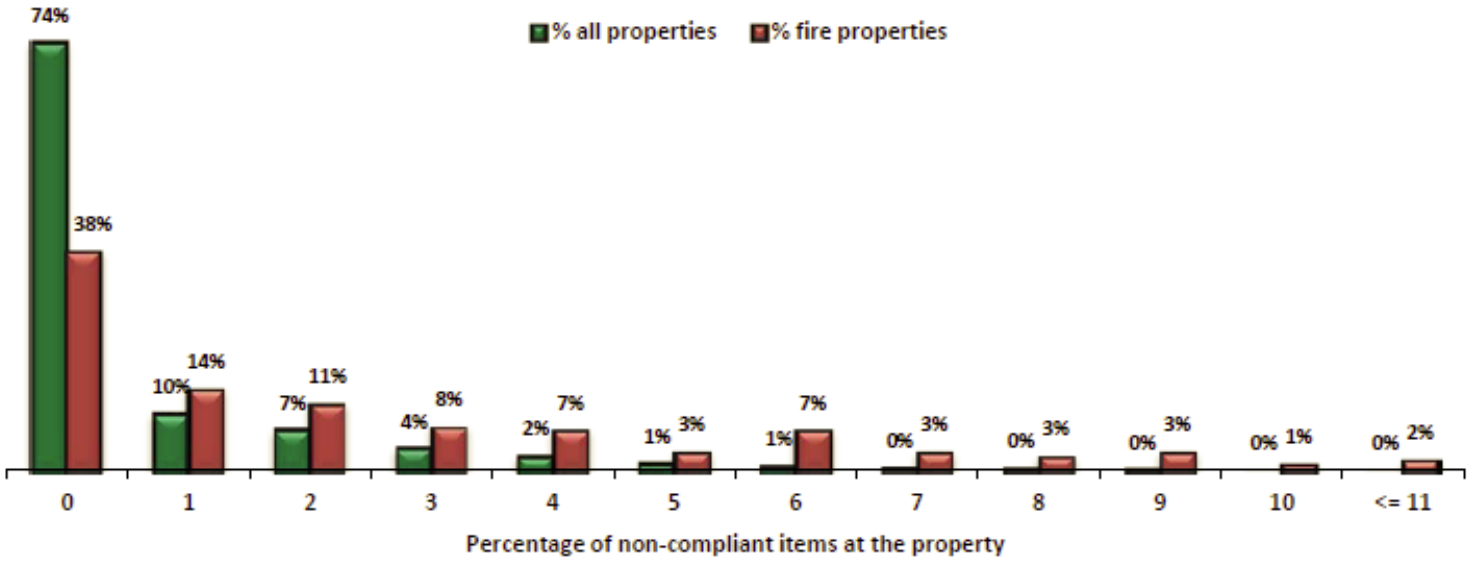
73 % 0f our 12,632 Inspecatble Properties are Compliant

FIGURE 1. FREQUENCY OF NON-COMPLIANT ITEMS PER INSPECTION FOR THE MOST RECENT INSPECTION PER PROPERTY (N = 12,632 PROPERTIES)



63 % of the 157 Inspecatble Properties that had a fire were non-compliant

FIGURE 2. RELATIVE PERCENTAGES OF NON-COMPLIANT ITEMS PER INSPECTION FOR ALL MOST RECENT INSPECTIONS (N = 12,362 PROPERTIES) AND FOR INSPECTIONS PRIOR TO FIRES (*N* = 157 PROPERTIES)

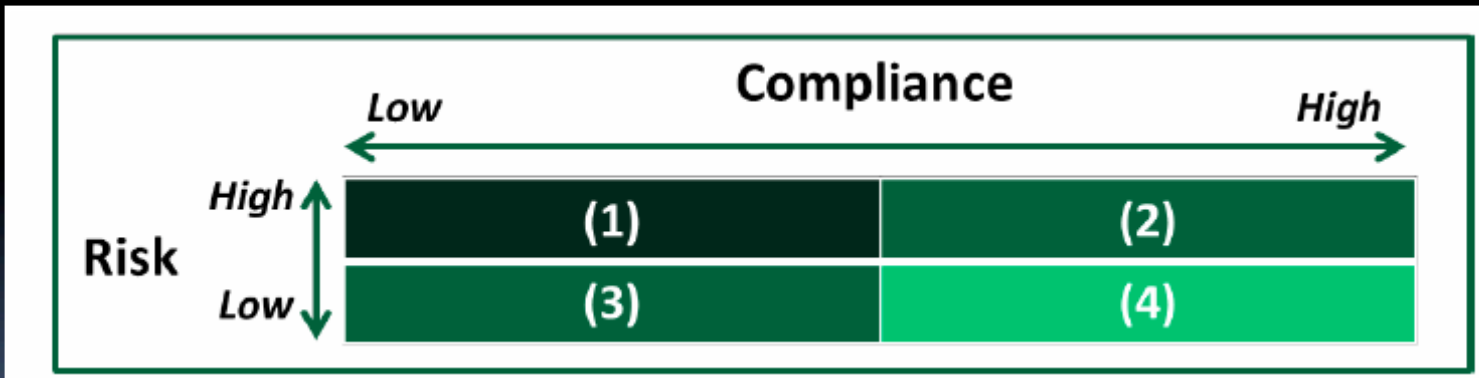


7 years
157 Fires
63 % / 98 were non – compliant

Predicting Risk

The Non-Random Nature of Fire Safety Inspection Compliance

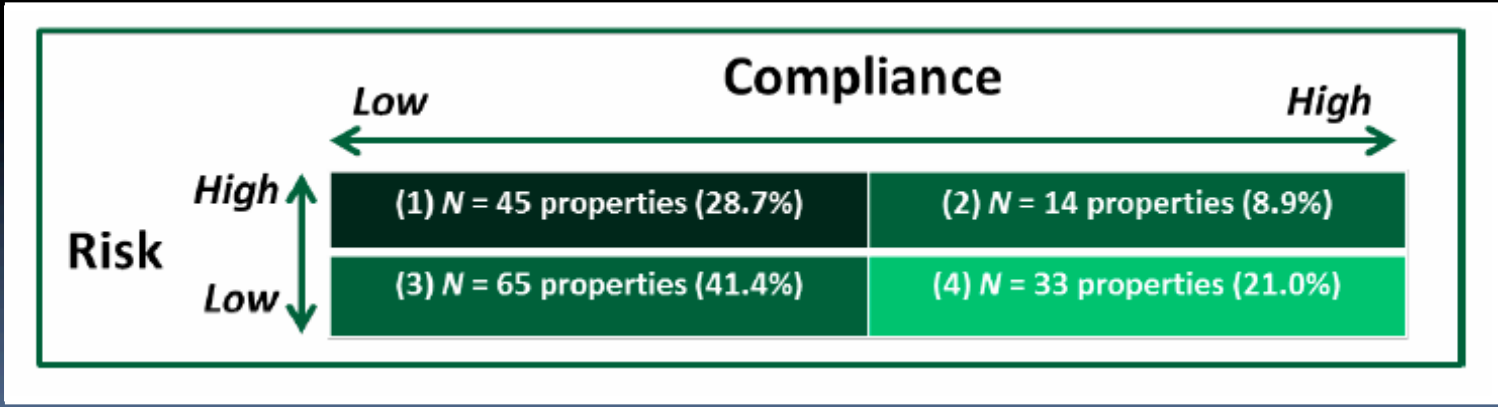
A Platform for Predicting Fire Risk



Predicting Risk / Low Compliance

The Non-Random Nature of Fire Safety Inspection Compliance

A Platform for Predicting Fire Risk



Property Risk Assessment Rating

TABLE 1. AN EXAMPLE OF THE INSPECTABLE PROPERTY RISK ASSESSMENT RATING PROVIDED IN APPENDIX A OF THE SERVICE DELIVERY STANDARDS OF THE MUNICIPAL RISK BASED FIRE QMP

Inspectable property risk assessment rating example	Score if 'Yes'
Does the premises have an automatic sprinkler system?	5
Does the premises have a fire alarm system?	3
Does the alarm system automatically contact the emergency services?	2
Does the premises have on-site maintenance staff?	1
Is the owner/operator of the premises a government body?	1
Is the premises staffed 24 hours a day?	2
Are occupants under the care of staff 24 hours a day?	3
Is the staff/resident (patient) ratio at night 1:12 or better?	4
Is the staff/resident (patient) ratio at night 1:6 or better?	5
Does the premises provide self-inspections every 6 months?	4
Does the premises provide self-inspections every 12 months?	2
Are fire drills conducted every two months on average?	1
Was the premises built since 1974?	1
Was the premises built since 1985?	2
Was the premises built since 1990?	3
Was the premises built since 1997?	4
Is there 3m from this structure to the next on one side?	1
Is there 3m from this structure to the next on both sides?	1
Is there 3m from this structure to the one behind?	1
Is there one fire hydrant within 90m of this structure?	1
Are there two fire hydrants within 90m of this structure?	2
Is the premises within 5 miles of the nearest fire hall?	3
Does the owner/manager life on site?	2
Do occupants regularly sleep on the premises?	−5
Do occupants have mobility problems?	−5
Is this a licensed premises?	−5
Is smoking allowed on the premises?	−5
Were there any deficiencies noted on the last inspection report?	−5
Is the structure(s) within 10m of treed/brush area?	−5
Does the structure have wooded shakes/shingles for roofing/siding?	−5
Has the structure followed FireSmart guidelines?	−5

Re-thinking Approach to Fire Safety Inspections

- Marjory of Properties inspected are Compliant
- Majority of Items inspected are Compliant
- Properties that Experience Fires Have a greater Incidence of Non-Compliance

Finally The Future

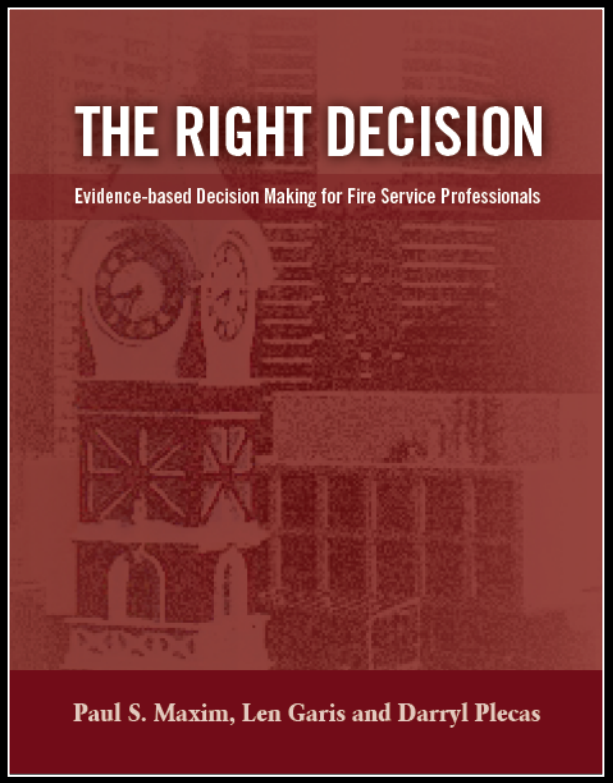
- NFPA / UK standards of cover
- Performance measures are inevitable
- Evidence lead decisions that can provide better outcomes:
- The inevitable path into the future for Fire Service delivery

Transforming the Fire/Rescue Service

Solution seek a new organization that will be tasked with

Research:
- Fire
- Emergency & rescue trends
- Issues & best practices

Develop:
- Fact-base effective decision-making
- Systematic process to share best practices



Questions ?

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Canadian Safety and Security Program

This project was supported by the Canadian Safety and Security Program (CSSP) [CSSP-2013-CD-1109, Establishing Evidence-based Policy (Fire Community of Practice)] which is led by Defence Research and Development Canada's Centre for Security Science, in partnership with Public Safety Canada.

Partners in the project include the CSSP, the City of Surrey (Surrey Fire Department) and the University of the Fraser Valley. The CSSP is a federally-funded program to strengthen Canada's ability to anticipate, prevent/mitigate, prepare for, respond to, and recover from natural disasters, serious accidents, crime and terrorism through the convergence of science and technology with policy, operations and intelligence.