Fire Research Report

The Cost of Managing the Risk of Fire in New Zealand

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The actual economic cost of fire to New Zealand is determined. Distinction is made between the costs of fire risk management (including the costs of reducing the risk of fire and the costs of readiness and response to fire) and the consequential recovery costs of an actual fire. These costs are allocated between residential, commercial and public sectors. The total cost of fire to New Zealand is estimated to be about $NZ1 billion per annum.

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THE COST OF MANAGING THE RISK OF FIRE IN NEW ZEALAND

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1 Introduction and overview

The objective of this report is to quantify the scope, scale and incidence of economic costs relating to fire risk management in New Zealand, and was prepared for the New Zealand Fire Service Commission.

The term incidence identifies who bears these economic costs although this does not necessarily identify who benefits from them. Nonetheless, incidence adds a further dimension to the estimates that will serve to widen the public policy issues that this framework can address or inform.

The body of international literature in this area of research seldom refers to fire risk management *per se*, but nonetheless identifies a wide range of economic costs that should be included in the framework. The literature tends to identify three main *categories* of costs, which we have summarised as the:

1. *costs of risk reduction*: costs associated with fire prevention and fire risk reduction.
2. *costs of readiness and response*: costs associated with identifying and extinguishing fires.
3. *costs of recovery and consequence*: costs that are incurred subsequent to the fire event or incident.

The first two categories represent the *costs of fire risk management* while the costs of recovery and consequence are losses that are incurred despite this level of fire risk management. Therefore, the total of all three of these categories can be regarded as a measure of the total cost of fire.

The *incidence* of these costs tends not to be measured in an explicit manner in overseas research although the measures that are estimated can often be allocated into broad incidence groupings. In our framework, we allocate the incidence of economic costs across three main sectors:

1. *household*: people and households.
2. *commercial*: private businesses or industries.
3. *public*: central and local government organisations including the Fire Service and the Rural Fire Service.

Table 1.1 shows the total cost of fire in New Zealand according to the incidence of each cost component measured in this report. The total cost of fire in New Zealand is estimated to be about $1.0 billion dollars per annum, or about 0.79% of total Gross Domestic Product.

Table 1.1 The total annual cost of fire in New Zealand

$ Million	Household	Commercial	Public	All sectors
Risk reduction				
protection measures in buildings	$26	$212	$47	$285
safety regulations and compliance	…	$7	$19	$25
insurance services	$51	$78	$6	$136
Sub-total	**$77**	**$297**	**$72**	**$446**
Readiness and response				
reticulated water supply systems	…	…	$6	$6
fire emergency services	…	$15	$182	$197
false alarms	…	$2	$44	$46
Sub-total	**$0**	**$17**	**$232**	**$249**
Recovery and consequence				
property damage	$105	$50	$10	$164
loss of output due to damage	…	$11	…	$11
direct injury costs	…	…	$6	$6
indirect injury costs	$144	…	…	$144
Sub-total	**$248**	**$60**	**$16**	**$325**
All economic costs	**$325**	**$375**	**$320**	**$1,020**

Source: BERL

The largest cost components are fire protection measures in buildings (particularly commercial buildings); the cost of public fire emergency services; fire damage to property (particularly dwellings); and injury costs as a consequence of fire events.

Table 1.2 shows the composition of fire costs on a summarised basis using the main cost categories and incidence groups discussed above. This shows that *risk reduction* accounts for the largest proportion of these costs. Total costs are spread evenly on an *incidence* basis, although there are some notable differences including that:

- the commercial sector accounts for a high proportion of risk reduction costs because of the cost of fire protection embodied in commercial buildings.
- the public sector accounts for a high proportion of readiness and response costs as fire services are predominately delivered by public organisations.
- the household sector accounts for a high proportion of recovery and consequence costs due to damage to household dwellings, as well as injuries and fatalities.

Table 1.2 The composition of fire costs in New Zealand

	Household	Commercial	Public	All sectors
Risk reduction				
$ million	$77	$297	$72	**$446**
% of total	8%	29%	7%	**44%**
Readiness and response				
$ million	$0	$17	$232	**$249**
% of total	0%	2%	23%	**24%**
Recovery and consequence				
$ million	$248	$60	$16	**$325**
% of total	24%	6%	2%	**32%**
All economic costs				
$ million	**$325**	**$375**	**$320**	**$1,020**
% of total	**32%**	**37%**	**31%**	**100%**

Source: BERL

The annual cost of *fire risk management* does not include those costs associated with recovery and consequence. The total cost of fire risk management in New Zealand is estimated to be $690-$700 million per annum or about 0.54% of total nominal Gross Domestic Product. Table 1.3 shows the composition of fire risk management costs on a summarised basis using the relevant cost categories and incidence groups.

Table 1.3 The composition of risk management in New Zealand

	Household	Commercial	Public	All sectors
Risk reduction				
$ million	$77	$297	$72	**$446**
% of total	11%	43%	10%	**64%**
Readiness and response				
$ million	$0	$17	$232	**$249**
% of total	0%	2%	33%	**36%**
Costs of risk management				
$ million	**$77**	**$314**	**$304**	**$695**
% of total	**11%**	**45%**	**44%**	**100%**

Source: BERL

Risk reduction accounts for about 64% of the risk management costs with readiness and response accounting for the remaining 36%. The household sector accounts for a very small proportion of the fire risk management costs (but a large proportion of the recovery and consequence costs). Overall, fire risk management costs are dominated by fire protection measures in commercial buildings, and the readiness and response costs of providing emergency services in the public sector.

2 Costs of risk reduction

This Chapter describes and then quantifies the costs of risk reduction measures in New Zealand. These costs relate to measures associated with fire prevention and fire risk reduction including:

- Fire protection measures in buildings.
- Fire safety regulations and compliance.
- Insurance services.

These risk reduction measures are also quantified according to incidence groupings (i.e. household, commercial or public) as per the cost framework.

2.1 Protection measures in buildings

This cost component represents fire protection costs that are embodied in the overall cost of buildings. These costs include fire separations between properties, external surface finish requirements, internal compartmentation requirements, escape route requirements, fire safety precautions (e.g. smoke alarms or sprinklers) and structural fire protection requirements.

The cost of these measures can be uncovered either at the moment of construction when they represent an identifiable proportion of the building cost, or as forming part of the rental value of buildings.[1] Overseas research favours the first approach, and Table 2.1 presents estimates of the proportion of total construction costs that have been attributed to fire protection in a number of studies.

Table 2.1 Protection as a percent of construction costs

%	US	US	Canada	UK	ranges
Residential	2.5	2.5	4.9	0 - 2.5	0 - 5
Industrial	9.0	12.0	6.0	5.0	5 - 12
Commercial	9.0	12.0	6.0	5.0	5 - 12
Institutional	4.0	4.5	4.5	5.0	4 - 5
Other	3.0	3.0	3.0	5.0	3 - 5
report source:	*WPI*	*Meade*	*TriData*	*Weiner*	

Source: BERL

The table also presents cost ranges as implied by these four studies. These ranges could reflect a host of genuine cross-country differences such as building regulations, construction materials, and overall industrial composition. The differences could also reflect variations in the estimation procedures undertaken.

The estimates for *residential* buildings range from between negligible to five percent. TriData (1995) represents the high end of this range and was derived from additional information regarding high-rise apartments in Canada. However, TriData's estimate for single-unit homes was in the 1-2% range. Weiner (2001) represents the lower end of this range and his findings were based on earlier work indicating that the cost of building regulations in dwellings under two storeys was negligible, and that over two storeys was around 2.5%.[2]

[1] Roy D. The Cost of Fires: A Review of the Information Available. London: Home Office. 1997.

[2] Read R. Quantifying the Cost of Meeting Building Regulations Fire Safety Requirements in new buildings. BRE. 1996.

The estimates for *industrial and commercial* buildings range from five to twelve percent of total construction costs. Meade (1991) represents the higher end of this range with the estimates increased relative to the baseline WPI (1978) report after interviews with people in a number of industries. Hall (2001) notes that these estimates could be overstated as Meade's interviews were with the more "fire-safety-conscious end of American industry, whose spending patterns may provide more fire protection than is typical."

These proportions have been used as parameters in three types of cost estimation methodologies. The most common approach was to attach these proportions to the dollar value of *new* building construction. However, this approach ignores the cost of fire protection in existing building capital. The second approach adopted by Weiner incorporates protection costs in existing buildings through the use of a capital stock series. One weakness of this approach is that it assumes fire protection in buildings has remained unchanged over time, but in our opinion it is preferable because at least it includes the whole of the building stock.

Weiner also found that the capital stock series he used was not sufficiently detailed in terms of the proportion of dwellings less than two storeys high where the cost of building regulations were estimated to be negligible. Therefore, Weiner measured only the cost of fire safety equipment for dwellings, which may be a slight under-estimate as this does not include the built-in cost of fire protection measures.

2.1.1 Building protection measures in New Zealand

Table 2.2 shows an estimate of the value of building capital stock in New Zealand, which in 2003 totalled about $238 billion.[3] Residential dwellings account for about $161 billion or 67% of the total building capital stock. This $161 billion has been allocated between the household and public sector on the basis of 2001 census data relating to the proportion of people renting from public sector organisations.

The public sector includes Housing New Zealand (HNZ) as well as a number of local councils, and combined account for 13% of residential dwellings on a population basis. The household sector includes residential buildings owned by owner-occupiers, private individuals renting out investment properties, and some commercial businesses renting out investment properties. The latter will mean that the capital stock in the household sector is over-stated to some small extent.

[3] These estimates were derived by BERL using Statistics New Zealand capital stock data, Statistics New Zealand input-output data, and previous BERL calculations.

The non-dwelling capital stock has been separated into industrial, commercial and other (including institutional) buildings. Some of this non-residential building capital stock is owned by the public sector, including government administration buildings, and public hospitals and educational institutions. The total value of non-residential public sector buildings has been estimated by apportioning a share of the total building capital stock within each sector according to the number of public and commercial enterprises operating within each industry.

Table 2.2 also shows the estimated *consumption of capital*, which in 2003 totalled $6.37 billion per annum. This represents an annual economic cost similar in concept to depreciation. For example, the consumption of building capital in the household sector dwelling stock is estimated at $2,556 million per annum, which implies a depreciation rate of 1.8% or an average economic life of 50-55 years.

Table 2.2 Summary of the costs of fire protection in buildings

Building capital stock ($Mn)	**Household** dwelling	**Commercial** industrial	commercial	other	**Public** dwelling	other	**Total**
Building capital stock	$140,570	$18,886	$35,499	$6,122	$20,527	$16,676	$238,280
Implied depreciation rates	1.8%	5.2%	4.6%	3.2%	1.8%	3.8%	2.7%
Consumption of capital	**$2,556**	**$990**	**$1,620**	**$193**	**$376**	**$636**	**$6,371**
Fire proportions (%)	0-2%	10-14%	4-5%	6-7%	0-2%	6-7%	4.3%
Fire protection costs	**$25.6**	**$121.6**	**$77.6**	**$13.2**	**$3.8**	**$42.9**	**$284.7**
Addendum:							
Sector totals	**$25.6**			**$212.5**		**$46.6**	**$284.7**

Source: BERL

BERL commissioned Beca to provide a report outlining the cost of fire protection measures for a range of buildings in New Zealand.[4] Their engineering advice was used to establish the average *fire proportions* shown in Table 2.2. For example, fire protection measures are estimated to account for 0-2% of building costs in household sector dwellings. This proportion has been multiplied by the relevant consumption of capital stock figure of $2,556 million to arrive at the annual cost of fire protection in household dwellings of $25.6 million per annum.

Section 6.1 provides additional information about fire protection in residential dwellings including that fire damage is estimated to average $18,000-$20,000 per residential dwelling.

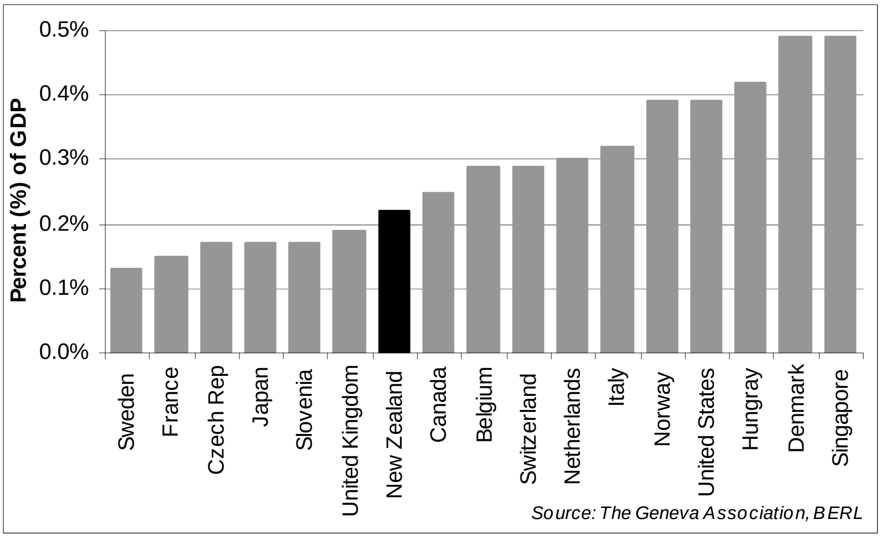
[4] The cost of Managing the Risk of Fire in New Zealand: A Review of Fire Safety in Typical Buildings, and Associated Costs. Beca. 2005.

On average, fire protection measures are estimated to account for about 10-14% of industrial building costs in the commercial sector. Note this proportion can differ by a considerable amount depending on specific circumstances, for example, with the proportion increasing to about 25-30% in densely populated industrial areas.

Overall, it is estimated that the cost of fire protection embodied in buildings totals about $284.7 million per annum with property in the commercial sector accounting for the largest share of this cost.[5]

The cost of fire protection in buildings is a significant component of the total cost of fire risk management, and is estimated to account for about 0.22% of New Zealand's total GDP. Figure 2.1 below compares BERL's estimate to independent estimates for a number of other countries published by the Geneva Association.[6]

Figure 2.1 Fire protection in buildings as a percent of GDP



The estimate for New Zealand sits between estimates for two groups of countries. The first group includes countries like the UK, Japan and France where the cost of fire protection is 0.15-0.2% of GDP. The second includes countries like Canada, Belgium and the Netherlands where the cost of fire protection is 0.25-0.3% of GDP.

[5] This figure includes annual revenue received by AFA Monitoring Ltd for monitoring and managing the Alarm Transport Service.

[6] World Fire Statistics. The Geneva Association. October. 2003.

2.2 Safety regulations and compliance

This component of the framework refers to costs borne by building owners, tenants and the NZFS through complying with fire-related safety regulations for buildings.[7] Compliance costs for building owners relate to expenditures on establishing building evacuation schemes and undertaking trial evacuations. Trial evacuations also affect building tenants and owner-occupiers through opportunity costs associated with short periods of employee down-time.

Building evacuation schemes and trial evacuations are a legislative requirement for many non-residential properties with the exception of farms and (under certain other circumstances) other business premises where less than ten people are employed. Schemes, inspections and evacuations are undertaken or managed by Independent Qualified Persons (IQPs) who receive fees from building owners for these services.

2.2.1 Safety regulations and compliance in New Zealand

NZFS data indicates that there are 19,347 registered building evacuation schemes in New Zealand, and that 20,488 evacuations were completed in 2003 with the NZFS attending 4,945 of these trial evacuations.

The fees charged by service providers (IQPs) for establishing evacuation schemes can range from between $500-5,000 per scheme but discussions with a number of IQPs indicated that an average charge would be in the order of $1,900 per scheme. This has been amortised over an average period of ten years to provide an annual average cost of $160 per scheme. Service providers have also indicated that $180 would be an appropriate average charge per trial evacuation.

Table 2.3 presents the estimated annual costs associated with the establishment of building evacuation schemes and trial evacuations. These costs are estimated to be in the order of $6.8 million per annum with trial evacuations accounting for about $3.7 million of this total cost. These costs are borne by the building owner although, presumably, they could also be passed-on through the rental value of the buildings.

[7] Specifically, the Building Act 1991 and the Fire Safety and Evacuation of Buildings Regulations 1992.

Table 2.3 Cost of schemes and trial evacuations

	Number recorded	Average cost	Total costs ($Mn)
Evacuation schemes	19,347	$160	**$3.1**
Trial evacuations	20,488	$180	**$3.7**
Total			**$6.8**

Source: BERL

The magnitude of *opportunity costs* associated with employee down-time from evacuations depends on the number of employees per non-residential building. This parameter will change according to a number of factors such as the population size and density of the area in question. Thus, major urban areas will tend to have a much higher number of employees per non-residential building than rural areas.

The average number of FTEs per non-residential building was estimated by BERL using regression equations based on a sample of local council areas (this research is discussed in more detail in Section 6.2 of this report). Table 2.4 summarises the findings of this work with local council areas summarised into three broad categories consisting of rural areas, urban areas and cities.

The regression equations confirmed a reasonable relationship between the population of a local council area and the average number of FTEs per non-residential building. On this basis, the total number of FTEs in trial evacuations was estimated for *each* local council by multiplying the number of trial evacuations by the estimated average number of FTEs per non-residential building.

Table 2.4 Annual number of FTEs participating in trial evacuations

	Number of trial evacuations	Average FTEs per property	FTEs in trial evacuations
Rural areas (< 30,000 popn)	2,024	9	18,438
Urban areas (30-100,000 popn)	7,103	13	90,608
Cities (> 100,000 popn)	11,361	15	169,979
Total	**20,488**	**13**	**279,025**
Addendum:			
Total hours lost			93,008
Average wage per hour			$20
Opportunity cost ($Mn)			**$1.8**

Source: BERL

The total number of FTEs in trial evacuations is estimated to be about 279,025 per annum. This total is dominated by the cities, which account for 55% of evacuations and 61% of FTEs. The addendum shows the estimated opportunity cost of these trial evacuations. Based on NZFS response times it is estimated that the average duration of an evacuation for employees is 20 minutes, which indicates that total employee down-time is about 93,000 hours per annum. These hours are converted into a monetary value based on an average FTE wage per hour.[8] The total opportunity cost of evacuations is estimated to be about $1.8 million per annum.

There are also NZFS costs associated with schemes and evacuations. These costs include a small proportion of the total NZFS operational budget and a specific budget item of $5.7 million for scheme approval and monitoring. The proportion of NZFS operational resources delivered to this area of risk management has been estimated according to the amount of total appliance hours delivered, and is discussed in more detail in Section 3.2 of this report.

Table 2.5 Annual cost of NZFS resources

	2004
Total appliance hours delivered	203,471
Value of resource delivered ($Mn)	$11.1
NZFS budget output 2.2 ($Mn)	$5.7
Total Fire Service Costs ($Mn)	**$16.9**

Source: BERL

2.2.2 Summary of regulation and compliance costs

Table 2.6 summarises the total cost of building safety regulations and compliance in New Zealand. The total cost is estimated to be about $25.5 million per annum with NZFS resources accounting for a large proportion of the overall cost.

Table 2.6 Summary of regulation and compliance costs

$Mn	Household	Commercial	Public	Total
Schemes and evacuations	…	$5.1	$1.6	$6.8
Opportunity costs	…	$1.4	$0.4	$1.8
NZFS resource costs	…	…	$16.9	$16.9
Total costs	**$0.0**	**$6.6**	**$18.9**	**$25.5**

Source: BERL

Public sector organisations can be commercial building tenants as well as building owners (and landlords) and, therefore, a proportion of some cost components have been allocated between the commercial and public sectors. The cost of evacuation

[8] Source: Statistics New Zealand's Quarterly Employment Survey (QES).

schemes was allocated between the commercial and public sectors according to each sector's share of total non-agricultural enterprise numbers. The opportunity costs of down-time were allocated between the sectors according to each sector's share of non-agricultural FTE employment.[9] Note that each of these allocation methods resulted in the public sector accounting for between 20-25% of total costs.

[9] Source: Statistics New Zealand's Business Demographics data. The number of enterprises and FTEs in commercial and public sectors is identified in this database.

2.3 Insurance services

Insurance premiums paid to insurance companies are larger than insurance claims paid to the public. The difference between premiums and claims (representing insurance company operating costs and profits) constitutes the *collective* cost of mitigating the financial impact of fire risk for *individual* households and businesses. Weiner (2001) expresses this concept in another way in that the capital and labour used by insurance companies to administer policies and insurance claims would (in the absence of fire risk) be released to increase output elsewhere.

In principle the cost of insurance services can be measured as the difference between insurance premiums and claims, but in practice this approach is complicated by the fact that most insurance policies cover multiple risks. The approach adopted in most research to overcome this issue is to treat the margin between premiums and claims as a constant for all types of risk insured against. This enables the margin between premiums to claims to act as a surrogate for the margin of fire-related premiums to claims and, therefore, to establish costs of managing the financial risk of fire.

2.3.1 Insurance services in New Zealand

The Insurance Council of New Zealand (ICNZ) publishes annual data on premiums and claims for a number of products. BERL also estimates the proportion of claims due to fire-related damage in Section 4.1 of this report. These sets of information provide the basis for estimating the collective cost of insurance services.

Table 2.7 shows the annual average value of insurance premiums and claims with the margin being the insurance sectors operating costs and profits. These total margins are estimated to total $770.8 million per annum.[10] However, as discussed, this margin relates to dual-risk policies as opposed to just fire-related risk policies.

Table 2.7 also shows the value of claims that are related to fire damage as estimated in Section 4.1 of this report. Fire-related claims are estimated to be about $147.1 million per annum or 13%-15% of total insurance claims. This proportion tends to change between sectors due to the different composition of insurance products within each sector and the significance of fire-related damages to these products.

[10] This includes domestic, motor vehicle, and commercial insurance product lines. Excludes liability, and earthquake and other (personal accident, travel livestock and other) insurance product lines.

The final row in Table 2.7 shows the value of fire-related insurance margins, which has been calculated by multiplying the total margin in each sector by the proportion of claims in each sector that is considered to be related to fire damage.

Table 2.7 Summary of annual insurance services costs

($Mn)	Household	Commercial	Public	Total
Total gross premiums	$1,259.9	$512.6	$63.5	$1,835.9
Total gross claims	$818.4	$226.4	$20.3	$1,065.1
Total margins	**$441.5**	**$286.2**	**$43.1**	**$770.8**
Fire-related claims	**$95.0**	**$47.5**	**$4.6**	**$147.1**
% of total gross claims	11.6	21.0	22.5	13.8
Fire-related margins	**$51.3**	**$60.0**	**$9.7**	**$121.0**

Source: BERL

The total fire-related cost of insurance services is estimated to be about $121 million per annum. The commercial sector accounts for the largest proportion of this total cost although the household sector also makes a significant contribution.

3 Costs of readiness and response

This Chapter describes and then quantifies the costs of readiness and response measures. These costs relate to measures associated with identifying and responding to potential and actual fire events including:

- Reticulated water supply systems.
- Fire emergency services.
- False alarms.

These measures are also quantified according to incidence groupings (i.e. household, commercial or public) as per the cost framework.

3.1 Reticulated water supply systems

Fire flow requirements are often a major factor in the sizing of water mains and pumps in communities, and the additional cost of larger pipes and pumps than is required for drinking water and sanitation can be attributed to fire risk. The cost of fire hydrants is also attributable to fire risk.

TriData (2001) note that fire-related costs are a major factor in small communities as a "large city needs large pumps and mains just to distribute water to households and businesses, and only in the outlying fingers of the network does fire flow affect sizing and costs". TriData base their calculations on expert advice that fire-related costs in Canada tend to be 10% for a large municipal water system and 30% for a small municipal water system.

Table 3.1 summarises the proportion of water system construction costs that have been allocated to fire requirements in two reports. The range of 8-25% for total water works in Canada was calculated by BERL using dollar estimates presented in the TriData report. The second report makes an estimate of fire service requirements for New Zealand's rural/urban areas based on the broad opinion of local authorities.

Table 3.1 Protection as a share of construction cost

	Canada		NZ
%	range	average	average
Water mains and hydrants	10 - 30	20	…
Pumping stations	5 - 15	10	…
Storage tanks	1	1	…
Total waterworks	8 - 25	17	30
source	*TriData*		*DIA*

Source: BERL

TriData's approach to estimating the cost of fire-related requirements is to attach the relevant proportions to an annual dollar value of *new* waterworks construction. This approach is similar to that used in other studies on fire protection costs embodied in buildings and, therefore, suffers from the same weakness in that the costs embodied in the existing capital stock are excluded.

3.1.1 Reticulated water supply systems in New Zealand

BERL commissioned a specific study by Beca and their engineering advice indicates that it is only in low-density residential areas that water reticulation is affected by fire fighting requirements. Beca has prepared concept-level designs of networks that serve local communities consisting of either 1,000 or 5,000 residents, and has estimated the proportion of costs for these networks that are broadly related to fire fighting requirements.

Thus, an estimate of the amortised cost of these two types of network configurations is also required. Statistics New Zealand's *Local Authority Statistics* indicates that in 2004 local authorities recorded $92 million in annual depreciation expenditure on water supply assets.[11] This depreciation figure covers all public owned water services, and therefore a proportion needs to be allocated to the relevant low-density areas.

BERL's methodology is to separate New Zealand's total resident population into four groups consisting of people residing in:

- Minor rural areas with populations of less than 1,500 residents.
- Rural areas with populations of between 1,500- 4,000 residents.
- Rural-urban areas with populations of between 4,000-6,000 residents.
- Other areas with populations of greater than 6,000 residents.

This grouping resulted in a total of 21% of New Zealand's population residing in the relevant low-density resident areas as shown in Table 3.2.

The dollar value of $92.1 million in annual depreciation was then allocated across the population groupings on a per capita basis, which resulted in $19.7 million per annum being attributed to the relevant population areas.[12] The largest share of this cost (about $14.4 million) was attributed to the minor rural areas representing communities of less than 1,500 residents. The rural and rural-urban areas were each attributed about $2-3 million in deprecation costs as shown in Table 3.2.

[11] As a cross-check, this depreciation figure is in good accordance with BERL's consumption of fixed capital stock figures.

[12] This approach may tend to slightly overstate the total capital and depreciation costs in the relevant communities because these costs on a 'per capita' basis tend to increase, at least initially, as the resident population increases.

Table 3.2 Annual depreciation costs of water supply

	Population (number)	(%)	Depreciation ($Mn)
Minor rural (< 1,500)	582,285	16%	$14.4
Rural (1,500-4,000)	126,354	3%	$3.1
Rural-urban (4,000-6,000)	90,411	2%	$2.2
Urban (> 6,000)	2,938,227	79%	$72.4
Total	**3,737,277**	**100%**	**$92.1**

Source: BERL

Beca uses the *New Zealand Fire Fighting Water Supplies Code of Practice* (SNZ PAS 4509:2003) as the basis for estimating the additional cost of water reticulation due to fire fighting requirements. Beca's concept-level designs indicate that total costs are about 33% higher due to fire fighting requirements in configurations servicing a population of 1,000 residents. This total cost declines to about 13% for configurations servicing a population of 5,000 residents.[13]

The Beca estimates above have been adopted by BERL to reflect fire protection costs for minor rural and rural-urban population areas as shown in Table 3.3. In addition, BERL has assumed that fire protection accounts for 23% of the construction costs for water reticulation in rural areas serving 1,500-4,000 residents.

Table 3.3 Costs of fire in water supply services

	Depreciation ($Mn)	Fire protection (%)	Fire costs ($Mn)
Minor rural (< 1,500)	$14.4	33%	$4.8
Rural (1,500-4,000)	$3.1	23%	$0.7
Rural-urban (4,000-6,000)	$2.2	13%	$0.3
Total	**$19.7**	**29%**	**$5.8**

Source: BERL

Overall, it is estimated that fire protection adds a further 29% to water reticulation construction costs in these areas. This fire protection cost is equivalent to about $5.8 million per annum in amortised (depreciation) capital costs. More than 80% of this cost is attributed to water reticulation for communities of than 1,500 residents.

[13] These costs are based on global rates for new construction, and assume the pipelines are laid in the carriageway of the road. Beca have indicated an overall accuracy range of plus or minus 30-40% in each case.

3.2 Fire emergency services

Fire services represent a major cost of fire risk management and include the costs of paid and volunteer personnel, fire stations, appliances, fire suppression equipment, and other hardware.

Most fire services are provided by the public sector, and in New Zealand these services are delivered by the New Zealand Fire Service (NZFS) and the Rural Fire Authorities. There are also a number of private fire services that operate within the forest, transport, and manufacturing industries, as well as the national 111 emergency call system operated by Telecom.

Not all fire service activities are related to fire risk management because fire brigades also respond to other emergencies such as hazardous material spills, earthquakes, and floods. Thus, there is a strong argument that a proportion of fire service costs should be excluded from the overall cost of fire risk management.

This has been addressed in previous research using a number of cost allocation methods. Roy (1997) adopts the broadest approach by allocating the fire brigade costs according to the number of fire versus non-fire call-outs. Weiner (2001) makes an allowance for differences in resource usage or consumption between fire and non-fire incidents by calculating the average number of 'appliance-hours' spent attending each type of call-out. BERL (2002) also adopts this second approach in assessing the impact of industrial fires in New Zealand.

Implicit in these *incidence* based allocation methods is the assumption that the cost of operational readiness (standing costs, overheads, etc) can be apportioned between fire and non-fire risk on the same basis as the appliance time spent on response and suppression.

TriData (1995) argue that the majority of personnel, equipment and stations would still be required even if fire protection was the only service provided by fire brigades, and that the provision of non-fire services has only been made on an *incremental* cost basis. TriData recommend "deducting from the total cost of fire only the incremental costs of equipment, personnel, vehicles and capital plant that is not used for fire protection."[14] Their estimate is that this incremental cost is less than 5% of the overall costs associated with fire services.

[14] Page 3-2, Total Cost of Fire in Canada: Initial Estimate. TriData Corporation. 1995.

TriData's approach is similar to the view that the marginal cost associated with the fire service responding to non-fire related emergencies is very small because the bulk of fire service costs are *standing army* requirements associated with fire risk. The *incidence* and *incremental* approaches are different in underlying concept and cannot be easily reconciled. Generally speaking, the incidence approach will tend to yield a more conservative cost estimate.

3.2.1 Emergency services in New Zealand

Estimates of the annual cost of fire emergency services in New Zealand need to include costs associated with public and private sector fire brigades. These costs are outlined in the following section.

3.2.1.1 Public emergency services

Public fire services are delivered by the New Zealand Fire Service (NZFS) and by Rural Fire Authorities, which are funded by a range of organisations including local councils, the Department of Conservation and the New Zealand Defence Force.

As discussed, these public services respond to both fire and non-fire emergencies. The approach adopted in this report is to allocate fire service costs to either *mixed* or *fixed* costs. Mixed costs are those relating to both fire and non-fire related activities, while fixed costs are those that can be identified as being related only to fire risk management. Mixed costs are allocated between fire and non-fire activities based on the proportion of appliance hours delivered (as per the incidence approach). Fixed costs are then added-back to derive a total fire service cost in relation to fire. This method includes some aspects of both methodologies discussed above but remains more conservative than the *incremental* approach.

The NZFS 2004 budget provides the basis for estimating mixed and fixed costs for the urban fire services with this allocation process outlined in detail in Section 6.3 of this report. Discussions with the Department of Internal Affairs indicated that the costs of the Rural Fire Authorities are about $20 million per annum excluding funding delivered through the NZFS budget (and with local councils accounting for about $9.2 million of this total).[15] Most functions and activities of the Rural Fire Authorities are fire-specific, and therefore we have assumed $18 million or 90% of these costs are fixed as opposed to mixed costs.

[15] Note a very small proportion of fire fighting costs in rural areas are recovered by Rural Fire Authorities from the household and commercial sectors.

Table 3.4 shows how these public fire service costs have been allocated into either mixed or fixed costs. In addition, mixed costs include monetised estimates of the contribution of volunteer time in both the urban and rural fire services.

The contribution of $62.8 million per annum for NZFS (urban) volunteers is based on a shadow price using the average labour cost per fire incident in the paid fire brigades.[16] The same approach applied to volunteers in the rural services implies a monetised contribution of about $2.3 million per annum. However, the functions of the rural fire services are different from their urban counterparts. Rural fire services are targeted more towards the prevention and suppression of vegetation fires including the monitoring and suppression of flare-ups in vegetation areas.

In this respect, there are fewer fire incidents but the average appliance time involved is much longer. Data supplied by the NZFS indicates that the average appliance time for rural fire incidents is about 176 minutes compared to about 72 minutes for non-rural fires. The value of volunteer time in the rural services has been scaled up on the basis of this difference in appliance time to arrive at a broad estimate of $5.5 million per annum.

Table 3.4 Separation of public fire service costs

($Mn)	NZFS	Rural	Total
Operational readiness	$174.8	$2.0	$176.8
Contribution of volunteers	$62.8	$5.5	$68.4
Mixed costs	**$237.6**	**$7.5**	**$245.2**
Fixed fire costs	**$45.7**	**$18.0**	**$63.7**
Total	**$283.3**	**$25.5**	**$308.8**

Source: BERL

Total mixed costs for the public fire services are estimated to be about $245.2 million per annum with the NZFS accounting for about 97% of these costs. Total fixed costs are estimated to total about $63.7 million per annum.

Table 3.5 shows how the mixed costs of $245.2 million have been allocated across a number of incident categories based on estimates of the *incidence* of appliance hours delivered. Fires represent 48% of the total appliance hours delivered and therefore $118.3 million of the total mixed costs have been allocated to these incidents. Non-fire incidents represent about 29% of the total appliance hours delivered and so $71.0 million of the total mixed costs have been allocated to non-fire incidents.

[16] This was estimated as $3,477 in 2001 by the NZIER and was adjusted to reflect 2004 conditions.

Trial evacuations and false alarms have respectively been allocated $11.1 and $44.7 million per annum. Note that these costs are incorporated into other Sections of this report and *not* continued with in this Section to avoid double-accounting.

Table 3.5 Allocation of mixed costs based on total appliance hours

	Fire incidents	Non-fire incidents	False alarms	Trial evacuations	Total
Number of incidents	23,307	16,404	19,863	4,945	64,519
Number of appliances	51,998	32,067	49,728	12,380	146,173
Average appliances per incident	2.2	2.0	2.5	2.5	2.3
Average elapsed time per incident	41.6	40.5	16.4	16.4	30.6
Average appliance time	93	79	41	41	69
Total appliance hours delivered	**2,161,557**	**1,297,110**	**817,280**	**203,471**	**4,479,418**
Share of mixed costs (%)	48%	29%	18%	5%	100%
Share of mixed costs ($Mn)	**$118.3**	**$71.0**	**$44.7**	**$11.1**	**$245.2**

Source: BERL

The total (mixed and fixed) costs of the public fire services are estimated to be about $308.8 million per annum in Table 3.4, and on this basis non-fire incidents are estimated to account for about 23% of public fire service costs.

3.2.1.2 Private emergency services

A small number of commercial businesses in New Zealand maintain industrial fire brigades. The largest of these industrial fire brigades are associated with international airport facilities in Auckland, Wellington and Christchurch. These brigades include dedicated or full-time fire fighting personnel.

There are also a number of industrial fire brigades in other sectors, predominantly in forestry and manufacturing. However, these fire brigades tend to rely on employees as volunteer fire fighters. The main costs of these brigades relate to expenditures on maintaining appliances and equipment although there are also personnel costs in relation to training.

The New Zealand Forest Owners Association has completed a survey of fire brigade costs for its members. This data indicates that commercial fire service costs in the forest sector totals about $8 million per annum.[17] BERL also canvassed the other industrial brigades, and estimate that costs in these brigades totals about $6.5 million per annum with airports accounting for a large share of this total. Therefore, the total costs of the private fire brigades are estimated to be about $14.5 million per annum.

[17] NZFOA submission to the Department of Internal Affairs.

The national 111 emergency call system is also funded and operated by a commercial entity (i.e. Telecom) and the costs associated with this system should be included as a commercial sector cost of emergency services.

Telecom has indicated that its cost of providing this service is between $2-3 million per annum.[18] Telecom has also indicated that about 12% of the total 111 calls it dispatches are dispatched to the NZFS. This proportion implies that about $0.3 million per annum of Telecom's total annual costs can be apportioned to fire.

Overall, it is estimated that private fire-related emergency services cost about $14.8 million per annum.

3.2.1.3 Summary of public and commercial fire services

Table 3.6 summarises the annual costs associated with the provision of fire services in New Zealand. Total fire service costs are estimated to be in the order of $196.8 million per annum. This includes about $14.8 million within the commercial sector and about $182 million per annum within the public sector.

Table 3.6 Summary of fire emergency service costs

($Mn)	Commercial	Public	Total
Operational readiness	$14.8	$85.3	$100.1
Contribution of volunteers	…	$33.0	$33.0
Fire mixed cost allocation	**$14.8**	**$118.3**	**$133.1**
Fire fixed costs	**…**	**$63.7**	**$63.7**
Total	**$14.8**	**$182.0**	**$196.8**

Source: BERL

[18] Page 30, Fire Management in New Zealand: A Background Paper Prepared by Officials from Central Government and Local Government New Zealand. Department of Internal Affairs. 2003.

3.3 False alarms

False alarm incidents impose a range of costs including opportunity costs associated with avoidable employee down-time. However, the largest costs are incurred by the NZFS in terms of responding to these false alarms. These NZFS resource costs are off-set to a very small degree by false alarm charges.

3.3.1 False alarms in New Zealand

Table 3.7 summarises the costs of false alarms, which are estimated to total about $46.2 million per annum. This includes NZFS false alarm revenue of $1.5 million, which has also been subtracted from the cost of NZFS resources to avoid double-accounting.

Table 3.7 Annual costs of false alarms

($Mn)	Household	Commercial	Public	Total
False alarm revenue	…	$1.2	$0.4	$1.5
Opportunity costs	…	$0.7	$0.2	$0.9
NZFS resources	…	…	$43.8	$43.8
Total	**$0.0**	**$1.9**	**$44.4**	**$46.2**

Source: BERL

NZFS data indicates that are an average of about 19,800 false alarms per annum and about 50% or 9,900 of these in are non-residential buildings. The opportunity cost of these false alarms are estimated to be about $0.9 million per annum based on the calculations of building occupancies discussed in Section 2.2.

False alarms are estimated to account for about 18% of total NZFS appliance hours delivered representing about $44.7 million per annum in terms of NZFS operational resources (refer to Table 3.5). In addition, there is a separate NZFS budget allocation of $0.6 million for fire alarm systems monitoring and reduction of false alarms. False alarm revenues of $1.5 million are subtracted to arrive at about $43.8 million in false alarm costs to the NZFS.

4 Costs of recovery and consequence

This Chapter describes and then quantifies the costs of recovery and consequence in New Zealand. These costs are those that are incurred as a consequence of fire events including:

- Property damage.
- Loss of output.
- Direct injury costs.
- Indirect injury costs.

These costs are quantified according to incidence groupings (household, commercial or public) as per the cost framework.

4.1 Property damage

Property damage is one of the most high profile costs of fire and includes damage to structures, household contents, business stocks, and equipment. However, fire can also cause damage to areas valued by society for their environmental or heritage value. This section focuses on fire damage to structures, household contents, stocks, and equipment.

Overseas research either uses data on insurance claims or fire incident reports to quantify the dollar cost of these damages. However, not all property is insured and thus there remains a proportion of property damage that is not included using insurance data sources. To include the cost of damage to non-insured property, a correction factor is typically adopted based on estimates of the proportion of property that is non-insured.[19] Table 4.1 presents BERL's interpretation of the correction factors used in Roy (1997) and TriData (1995) and shows some similar estimates from the Household Economic Survey (HES).

Table 4.1 Percent property non-insured

%	UK	UK	Canada	NZ
structures	39			10 - 15
Contents	27			25 - 30
households		**11-28**	**5**	
private		**25**	**10 -14**	
source	*BCS*	*Roy*	*TriData*	*HES*

Source: BERL

The 1994 British Crime Survey (BCS) records that 39% of households do not have building insurance and 27% of households do not have contents insurance. These figures may, however, overstate the true proportions because rental properties may be insured by the owner as opposed to the tenant.

Roy (1997) bases part of his estimate for dwellings on the BCS data and arrives at an overall correction of between 11-28% depending on the assumptions he adopts. The TriData (1995) estimate is much lower at about 5% but is not clear if this estimate is just for fires in insured dwellings that are *not* reported to insurance companies, or is meant as an estimate for *all* dwellings that are non-insured.

[19] We use the term non-insured to include property owners who are not insured (i.e. are not managing their fire risk) or are self-insured.

BERL has used the 2001 Household Economic Survey (HES) to undertake similar calculations. On the assumption that all rental-property owners have taken out building insurance on their rental properties, the calculations using the HES suggest that between 10-15% of dwellings are non-insured. Assuming that 15-25% of contents in rented dwellings are insured by the property owner suggests that about 25-30% of dwelling contents are non-insured.

The proportion of *commercial* and *public* sector properties that are non-insured is a difficult matter to calculate because many organisations (particularly in the public sector) are thought to be self-insured. Roy assumes that 100% of public sector is self-insured; that 100% of commercial institutions are insured; and that 25% of owner-operators are non-insured. These assumptions result in the overall estimate that 25% of all non-dwelling properties in the UK are non-insured. Using the same assumptions the TriData estimates for Canada suggest that this proportion ranges between 10-14%.

4.1.1 Property damage in New Zealand

The Insurance Council of New Zealand (ICNZ) publishes annual data on premiums and claims for a number of products[20]. However, the ICNZ data for each product was not detailed enough for the purposes of this report. BERL has therefore made some alterations to generate the required level of detail.

The alterations to the data are based on survey responses from a number of insurance companies, previous research in this field, and related parameters such as BERL's capital stock series. The key assumptions are:

- that the household sector accounts for 80% of motor vehicle premium/claims;
- that material damages account for 85% of total material damage and business interruption premium/claims; and
- the commercial sector accounts for 80% of material damage premium/claims.

Table 4.2 shows the distribution of insurance premiums and claims based on the ICNZ data and these assumptions. The household sector is estimated to account for $818 million in claims per annum representing 77% of the total. The commercial

[20] ICNZ data for 2002 and 2003 were used to calculate an annual average profile of premiums and claims for domestic, motor vehicle and commercial insurance.

sector is the next most significant in terms of claims and includes a wider range of insurance products such as material damage and business interruption.

Table 4.2 Insurance premiums and claims by product line

($Mn)	Household	Commercial	Public	Total
Building and contents	$527	…	…	$527
Motor vehicle	$733	$183	…	$916
Material damage	…	$271	$63	$334
Business interruption	…	$59	…	$59
Gross Premiums	**$1,260**	**$513**	**$63**	**$1,836**
Building and contents	$335	…	…	$335
Motor vehicle	$484	$121	…	$605
Material damage	…	$87	$20	$107
Business interruption	…	$19	…	$19
Gross Claims	**$818**	**$226**	**$20**	**$1,065**

Source: BERL

Gross insurance claims include those for both fire and non-fire related damages. The proportion of claims due to fire has been estimated on the basis of responses from a number of insurance companies and previous research in this area. The proportions are shown in Table 4.3 together with the resulting estimates of the annual value of fire-related claims. Overall, it is estimated that fire-related damages cause:

- 25-30% of building and contents claims in the household sector representing $92 million per annum.

- less than 1% of vehicle claims in the household sector and about 5% of vehicle claims in the commercial sector representing $9.1 million per annum.

- 35-40% of material damage claims in the commercial sector and 20-25% of material damage claims in the public sector representing $37.0 million per annum.[21]

- 45-50% of business interruption claims in the commercial sector representing $9.0 million per annum.[18]

Overall, it is estimated that fire-related damages account for 13-15% of the insurance claims included in this report, or about $147.1 million per annum. Note that when motor vehicles are excluded, the proportion of claims that are estimated to be due to fire increases to about 30%.

[21] As a cross-check, these estimates are of a similar magnitude to those estimated in An Economic Impact Assessment of Industrial Fires in New Zealand. BERL. 2002.

Table 4.3 Insurance claims for fire-related damages

	Household	Commercial	Public	Total
% of all claims fire-related	(%)	(%)	(%)	(%)
Building and contents	27.5	…	…	27.5
Motor vehicle	0.6	5.0	…	1.5
Material damage	…	37.5	22.5	34.7
Business interruption	…	47.5	…	47.5
Sector averages	**11.6**	**21.0**	**22.5**	**13.8**
Fire-related claims ($Mn)	($Mn)	($Mn)	($Mn)	($Mn)
Building and contents	$92.0	…	…	$92.0
Motor vehicle	$3.0	$6.0	…	$9.1
Material damage	…	$32.5	$4.6	$37.0
Business interruption	…	$9.0	….	$9.0
Total fire-related claims	**$95.0**	**$47.5**	**$4.6**	**$147.1**

Source: BERL

As discussed, insurance claims do not account for all fire-related damage because a certain proportion of property is not insured. Table 4.4 summarises the total annual costs of fire-related damage based on conservative parameters for the proportion of property that is not non-insured.

It is assumed that 10% of the household sector is non-insured based on estimates from the Household Economic Survey (Table 4.1) and discussions with relevant experts. Also, on the assumption that 20% of sole proprietors are non-insured, it is estimated that 5% of commercial property is non-insured.[22]

No correction has been made to insurance claims on *non-residential* public sector property as our understanding is that a high proportion of these properties are insured particularly in industries such as health and education.

A number of public sector organisations such as Housing New Zealand also provide *residential* properties to households. Our understanding is that these organisations tend to manage their own financial risk in relation to these properties, and so the cost of fire damage will not be included in the insurance claims data.

The annual cost of fire-related damage to the stock of public sector dwellings is estimated to be about $5-$6 million per annum. This cost mostly reflects damage to the structure of the building (as opposed to building contents) as discussed in Section 6.1 of this report.

[22] This is more conservative than Roy (1997) who assumes 25% of sole proprietors are non-insured.

Table 4.4 Summary of annual fire-related damages

($Mn)	Household	Commercial	Public	Total
Fire related claims	**$95.0**	**$47.5**	**$4.6**	**$147.1**
Assumed % non-insured	10.0	5.0	…	…
Non-insured losses	**$9.5**	**$2.4**	**$5.5**	**$17.4**
Total property damage	**$104.5**	**$49.9**	**$10.1**	**$164.5**

Source: BERL

These estimates indicate that the total cost of fire-related damages in New Zealand is about $164.5 million per annum. The household sector accounts for about $104.5 million or 64% of these annual costs.

4.2 Loss of output

Business output can be temporarily or permanently reduced as a consequence of fire damage, and can be regarded as an indirect cost of fire. There is much debate in the international literature about whether or not these output losses should be included in a national framework, because the loss in output of one firm may result in a gain in output for another firm.

The middle-ground appears to be that output losses should be included if the good or service being produced is 'tradeable' internationally and thus the affected firm faces foreign competition; the good or service is unique to the firm; or where natural resources are concerned (e.g. loss of commercial forest areas due to fire damage).

BERL's review of the literature has identified a number of approaches to measuring these indirect losses. Meade (1991) uses NFPA data from the United States on 109 fire incidents, and establishes the following parameters:[23]

- indirect losses for manufacturing and industrial properties are 65% of direct property damages; and
- indirect losses for public assembly, educational, institutional, store and office properties are 25% of direct property losses.

Hall (2001) applies the above parameters and arrives at an overall estimate of 20% for the United States.

An alternative approach uses information on business interruption insurance claims. This insurance product enables the business to claim for some of the costs of being unable to operate on a temporary basis. Business interruption policies can differ but generally include losses relating to wages and profits foregone as a result of damage. Business interruption claims are thus similar in concept to Value Added or GDP.

TriData (1995) note that business interruption losses are a 'lower bound' of the total indirect loss because it does not include impacts on suppliers to the affected business. TriData quote a member of the Canadian Insurance Adjusters Association who states that the costs to other businesses are often of the same order of magnitude as the interruption loss in the business itself. This finding led TriData to increase their estimate of business interruption claims (as a measure of indirect loss) by 50-100%.

[23] Based on the 109 incidents it was estimated that 2% of these businesses closed. We understand that the impact of these closures was estimated and included in the parameters shown.

A similar outcome was reported by BERL in assessing the cost of industrial fires in New Zealand.[24] In this report, the value of business interruption claims was taken to be the loss suffered by the business. However, estimates of the indirect impact on supplying businesses were made using an Input-Output table of the whole economy.

This approach is similar in concept to Tridata's conclusion that the impact on other businesses is often in the same order of magnitude as the business interruption loss to the business itself. Overall, BERL's estimate was that the total indirect loss for industrial fires was 45% of the total direct loss, with business interruption claims and supplier losses each accounting for about 20-25% of the total indirect loss.

4.2.1 Loss of output in New Zealand

Fire-related business interruption costs in New Zealand will tend to vary from year to year depending on overall climate conditions, and the occurrence or otherwise of a significant fire event. Nonetheless, we consider that the estimate of $9.0 million per annum (as per Table 4.3) provides a reasonable average of these costs.

These business interruption costs have been allocated across three broad sectors in Table 4.5 on the basis of previous research and information gained from a number of local insurance companies. The primary production (agriculture, forestry, fishing & mining) and manufacturing sectors are each estimated to account for $2-$2.5 million of these costs, with the latter being dominated by costs incurred within textile and apparels manufacturing. The trade and services sector accounts for $4.5 million per annum or about 50% of the total fire-related business interruption costs. These costs are dominated by the costs incurred in trade and distribution.

Business interruption policies can differ but generally include insurance payments for company losses relating to wages and profits foregone. Business interruption claims are thus similar to the economic concept of Value Added (GDP). However, the *indirect* impact on *businesses that supply* to the fire-affected business should be measured in terms of foregone revenue, which is similar to the economic concept of Gross Output.

The broad relationship between the loss of *direct* Value Added (GDP) in a businesses affected by fire and the loss in *indirect* Gross Output for supplier businesses can be measured using a national Input-Output table. This relationship has been shown as sector average *supply multipliers* in Table 4.5.

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[24] An Economic Assessment of Industrial Fires in New Zealand. BERL. 2002.

The last column in Table 4.5 below shows the *indirect* losses that are incurred by supplier businesses. Overall, these indirect costs of fire are estimated to average about $10.6 million per annum in Gross Output (i.e. sales or revenue).

Table 4.5 Indirect output losses to suppliers

($Mn)	Business interruption	Supply multipliers	Supplier losses
Primary production	$2.0	1.10	$2.2
Manufacturing	$2.4	1.60	$3.9
Trade and services	$4.5	1.00	$4.5
All industries	**$9.0**	**1.19**	**$10.6**

Source: BERL

Total supplier losses are estimated to be of a similar order of magnitude as the direct business interruption costs. The supplier losses are estimated to account for 20-25% of total material damage and business interruption insurance claims.[25]

[25] $10.6 million divided by material damage and business interruption claims of $46 million.

4.3 Direct injury costs

Direct injury costs are expenditures on the care of persons injured in fire incidents, and are borne mostly by the Government through hospital care and compensation payments made by the Accident Compensation Corporation (ACC).

4.3.1 Direct injury costs in New Zealand

Data from the NZFS and the Health Information Service (HIS) has been used to calculate the annual average number of fire-related injuries between 1999 and 2003. The HIS data records that there was an annual average of 398 people with 'exposure to fire and smoke injuries', which compares to an average of 311 injuries in the NZFS data.

NZFS data excludes injuries that do not involve a Fire Service call-out or injuries sustained by fire fighters. The HIS data, therefore, provides a better measure for the total number of relevant injuries. Note these comparisons imply a correction factor of 1.28 is required to match the NZFS data with the HIS total.

However, the NZFS data includes the number of 'other apparent injuries' that have occurred during fire incidents, while the HIS data focuses on diagnosis as opposed to incident. Thus, fires that cause injuries other than burns and smoke inhalation (e.g. fractures) will not be identifiable in the HIS database.

Table 4.6 presents our estimates of the annual average number of fire-related injuries and fatalities. The number of fatalities is taken direct from the NZFS data. The composition of injuries (including other injuries) is taken direct from the NZFS data but has been multiplied by the correction factor of 1.28 discussed above.

Table 4.6 Average number of injuries and fatalities

(Number)	Burns & smoke inhalation	Other apparent injuries	**All apparent injuries**
Slight & moderate	375	56	430
Life threatening	23	13	37
Total injuries	**398**	**69**	**467**
Total fatalities	**29**	**7**	**36**

Source: BERL

On average, fire incidents are estimated to cause 467 injuries and 36 deaths per annum[26]. The majority of injuries and deaths are due to burns and smoke inhalation, and most injuries are slight or moderate injuries.

The public sector meets most of the direct costs of fire-related injuries through the funding of District Health Boards (DHBs) and the ACC. Table 4.7 summarises our estimate of the average annual cost of these public expenditures. Total public sector costs are estimated to be about $5.9 million per annum.

Table 4.7 Costs of hospital care and ACC compensation

	Burns & smoke inhalation	Other apparent injuries	**All apparent injuries**
Number of injuries	398	69	467
Average DHB revenue	$4,988	$3,886	$4,825
Hospital costs ($Mn)	**$2.0**	**$0.3**	**$2.3**
ACC costs ($Mn)	**$3.2**	**$0.4**	**$3.7**
Total costs ($Mn)	**$5.2**	**$0.7**	**$5.9**

Source: BERL

The estimates of hospital costs are based on the estimated annual number of fire-related injuries, and estimates of the average DHB revenue received for treating these injuries. ACC costs include new and on-going compensation payments to patients. Compensation payments for burn injuries averaged $3.2 million per annum between 1999 and 2003 with 95% of this cost being for on-going claimants. ACC costs for other apparent injuries are not available, and in this case were assumed to be proportional to hospital costs.

[26] There are likely to be a number of minor fire injuries that involve self-treatment or treatment by a GP as opposed to hospital care. These injuries are not included in the above estimate. However, costs associated with the latter should be included in the ACC estimates.

4.4 Indirect injury costs

Indirect injury costs are losses associated the loss of life or life quality as a result of fire-related injuries. These indirect costs are mostly attributable to individuals although they can also include 'friction' costs for businesses due to the temporary or long-term absence of injured employees.[27]

There are a wide range of techniques used to measure the costs associated with deaths and reduced life quality but not all of these provide a monetary estimate.[28] The most common approach to providing a monetary estimate is to use Contingent Valuation to establish a Value of Statistical Life (VoSL). This approach has been used in a large number of domestic and overseas studies.

4.4.1 Indirect injury costs in New Zealand

The New Zealand Land Transport Safety Authority (LTSA) has undertaken estimates of peoples' willingness to pay to avoid the risk of road fatalities and has arrived at several estimates of the VoSL. These estimates range from $2.6 million to about $4 million based on different valuation methods. The LTSA also places a cost on serious and minor injuries with indicative monetary values of $0.25 and $0.1 million.

There is an on-going debate regarding the extent to which a VoSL derived from peoples' willingness to pay to avoid road accidents can be applied to other risks such as fires. For example, the literature indicates that people are willing to pay more to avoid the risk of multiple-fatality or 'dread' incidents, which implies a higher VoSL than the LTSA's may be more appropriate for some types of fire incidents.

Nonetheless, the VoSL as estimated by the LTSA provides a clear benchmark for estimating indirect costs associated with injuries and fatalities in New Zealand, and these benchmarks have been adopted in Table 4.8. Note that slight and moderate fire-related injuries from the NZFS database are assumed to be equivalent to a LTSA minor injury. Similarly, a life threatening fire-related injury in the NFS database is assumed to be equivalent to a LTSA serious injury.

[27] Friction costs can include those associated with the recruitment and training of replacement employees. Such costs are difficult to measure and will vary considerably depending on the extent of the injury and the nature of the work undertaken. Friction costs are not assessed in this report.

[28] BERL's report 'Measuring the Total Cost of Injury in New Zealand' (2002) provides a discussion of these various measures.

Table 4.8 Average indirect injury costs

	VoSL value ($)	All injuries	**Costs ($Mn)**
Slight & moderate	$102,000	430	$43.9
Life threatening	$255,000	37	$9.4
Mortality	$2,550,000	36	$90.5
Total	**$286,107**	**503**	**$143.8**

Source: BERL

The estimates suggest that indirect losses from fire-related injuries and fatalities are in the order of $144 million per annum. Fatalities account for about $91 million or 63% of these losses.

5 Other costs of fire risk management

There are a number of other cost measures that have *not* been quantified in this report for a number of reasons including that:

- it was not possible to separate fire costs where the measures in question are for dual safety purposes (e.g. preventing electrical shocks as well as fires);
- in our opinion the estimation procedures were not sufficiently robust to apply to the New Zealand context;
- the estimates would range over a very wide and uncertain band (or be highly volatile between years); or
- the data required was lacking in New Zealand and was too time or resource intensive to collect within the context of this research.

The following provides an overview of several measures that were not estimated in this report, and which may offer areas for fire research in New Zealand in the future.

5.1 Protection measures in products

Fire safety protection measures are embodied in a wide range of products including vehicles, equipment, household appliances, furnishings and other consumer products. The development and testing of these fire protection measures also represents a large outlay to manufacturers, which will be passed on to consumers.

Unfortunately the body of overseas research relating to protection costs embodied in products is very scarce. Meade (1991) appears to be the only researcher in this field that attempts to quantify these costs. His approach was to estimate the costs of meeting 'fire grade' standards in the United States for the manufacture of industrial and information processing equipment. Meade's estimates of the additional cost of making such equipment to a fire grade standard ranged substantially with an overall increase of +30%.

TriData (1995) note that Meade's calculations include costs that can be attributable to protection from electrical shock and, therefore, that the calculations could be overstated quite significantly. TriData appears not to express much confidence in Meade's findings but note that no satisfactory alternative has emerged. TriData incorporates Meade's findings by scaling Meade's results to Canadian dollars on a per capita basis, and discounting by half to provide a lower bound estimate.

5.2 Corridors for the prevention and containment of fire

There are a number of fire risk management measures under this broad heading including:

- land in agriculture and forestry set aside for fire breaks;
- land in agriculture and forestry set aside to protect electricity transmission lines and to avoid arcing;
- expenditures on maintaining the above corridors; and
- local government and Transit expenditures on maintaining strips alongside rural roads and state highways.

These measures entail opportunity costs (land unavailable for production) as well as actual expenditures. However, not all of the costs can be attributed solely to fire risk. For example, fire breaks are also used as road access while transmission corridors also protect the power lines and maintain the security of electricity supply. Similarly, the maintenance of road-side strips is necessary for the purposes of visibility.

5.3 Damage to natural resources and heritage sites

Fire causes damage to areas or sites that are valued by society either for their strong environmental or heritage value. These losses are difficult to value in monetary terms and, depending on severity, can range across a wide band on a year-by-year basis.

The costs associated with the loss of vegetation (particularly non-commercial forest and other vegetation) from wildfires have not been assessed in this report due to the reasons cited above. However, previous work in this area has assumed a cost $1,500/ha plus environmental costs associated with carbon emissions, and further research in this area could build on this work.[29]

Natural or historical areas can also generate income based on recreational use and tourism, and the loss of this income leads to indirect losses to businesses in the area. For example, the impacts of the Yellowstone National Park fires were based on this analytical approach.[30] However, these impacts are only relevant for significant fires in major tourism spots, and extrapolation for all fires is impractical.

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[29] Pearce. G. Protecting New Zealand from Rural Wildfire (8876-NPHZ-FRI).

[30] Page 40-41, Yellowstone in the Afterglow. Franke, M. Yellowstone Centre for Resources. 2000.

6 Appendices

6.1 Fire-related costs in residential dwellings

Table 6.1 provides a more detailed breakdown of fire protection costs in residential dwellings. The 2001 census indicates that houses and other single-storey dwellings account for about 85% of the total stock of residential dwellings. This proportion has been applied to the capital stock series for both the household and public sectors.

The advice from Beca is that protection costs in houses and single-storey apartments are negligible at 0.1% of construction costs. Beca also estimates that this proportion increases to 5-9% for low and high rise apartments. This is consistent with previous research in Canada in the United Kingdom.[31]

Table 6.1 fire protection costs in residential dwellings

Dwellings	Household	Public	Total
Houses and single-storey apartments	$120,890	$17,653	$138,543
multiple-storey apartments	$19,680	$2,874	$22,554
Dwelling capital stock ($Mn)	**$140,570**	**$20,527**	**$161,097**
Houses and single-storey apartments	$2,198	$323	$2,522
multiple-storey apartments	$358	$53	$410
Consumption of capital ($Mn)	**$2,556**	**$376**	**$2,932**
Houses and single-storey apartments	0.1%	0.1%	0.1%
multiple-storey apartments	6.5%	6.5%	6.5%
Fire proportions (%)	**1.0%**	**1.0%**	**1.0%**
Houses and single-storey apartments	$2.2	$0.3	$2.5
multiple-storey apartments	$23.4	$3.4	$26.8
Fire protection costs ($Mn)	**$25.6**	**$3.8**	**$29.3**

Source: BERL

Overall, fire protection costs are estimated to be about $2-$3 million per annum for houses and other single-storey apartments, and about $26-$27 million per annum for multiple-storey apartments.

The large difference in fire protection costs between these two dwelling categories is due to a large number of additional requirements in multiple-storey dwellings such as fire hydrants, emergency lighting, smoke doors, and fire resistance requirements for the structure of the building.

[31] Refer to Section 2.1 for more information on these studies.

Table 6.2 provides an overview of buildings and contents damage as a result of fires in residential dwellings. Fire damage in the household sector is estimated to be $101 million per annum, or about 0.07% of the building capital stock in this sector.

Housing New Zealand (HNZ) accounts for the vast majority of residential dwellings provided by the public sector, and this organisation manages its own financial risk in relation to these properties. Thus, damage to the structure of these dwellings will not be included in insurance claims although some damage to tenant household contents may be.

The cost of fire-related damage to the stock of public sector dwellings is estimated to be about $5-$6 million per annum. This estimate mostly reflects fire damage to the structure of the dwelling, and is estimated to account for about 0.03% of the building capital stock. This estimate of 0.03% compares to 0.07% of the building capital stock in the household sector, which includes fire damage to household contents as well as the structure of the dwelling.[32]

Table 6.2 Summary of fire costs in residential dwellings

Residential dwellings	Household	Public	Total
Dwelling capital stock	$140,570	$20,527	$161,097
Annual consumption of capital	$2,556	$376	$2,932
Annual fire protection costs	$26	$4	$29
Annual fire-related damage	$101	$5.5	$107
% of dwelling capital stock	0.07%	0.03%	0.07%
Addendum:			
Average number of dwelling fires			5,650
Average cost per dwelling fire ($)			$18,890

Source: BERL

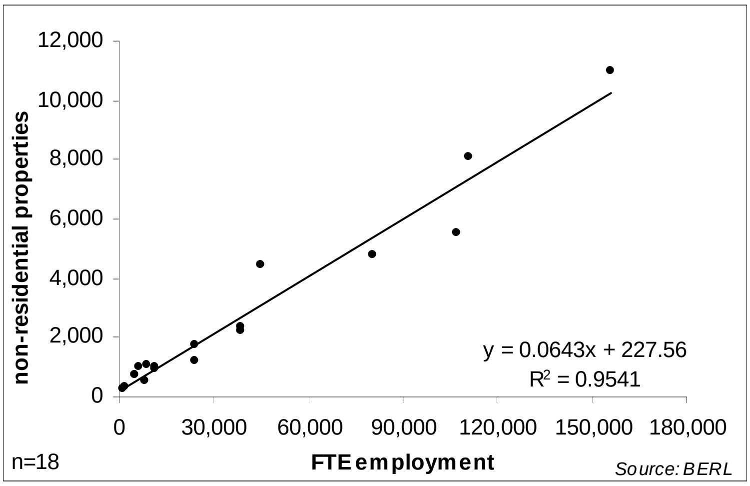
The total cost of fire in residential buildings is estimated to be about $107 million per annum in terms of building and contents damage. NZFS data records that there are about 5,650 residential fires per annum, which indicates that the average cost per residential dwelling fire is about $18,000-$20,000.

[32] This is broadly consistent with ICNZ claims data in which buildings account for about 50% of total building and contents claims.

6.2 Trial evacuations and false alarms

Eighteen local councils (representing 25% of all local councils) were canvassed to establish a relationship between non-agricultural FTE employment and the number of non-residential properties by council area. This relationship is presented in Figure 6.1 indicating that a strong relationship exists.

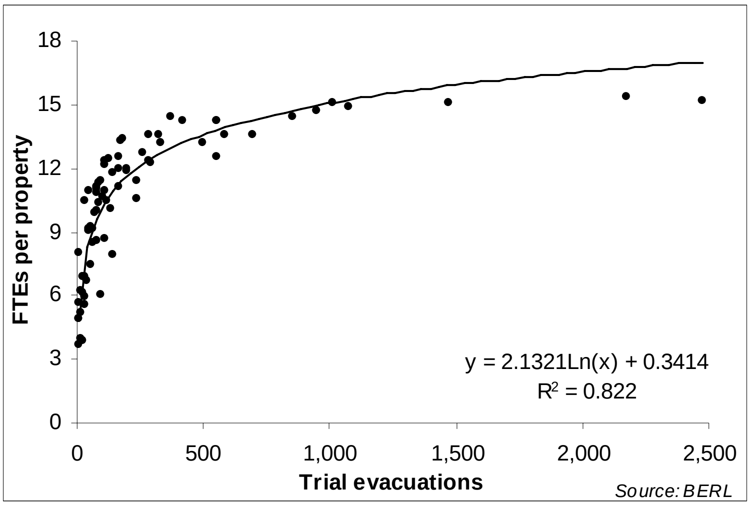
Figure 6.1 Relationship between the number of FTEs and non-residential properties by local council area



The number of non-residential properties in each of the total 73 local councils was estimated using FTE numbers in each local council area and the regression equation derived from the sample of 18 councils. These estimates were then compared against NZFS data on the annual number of trial evacuations per local council area.

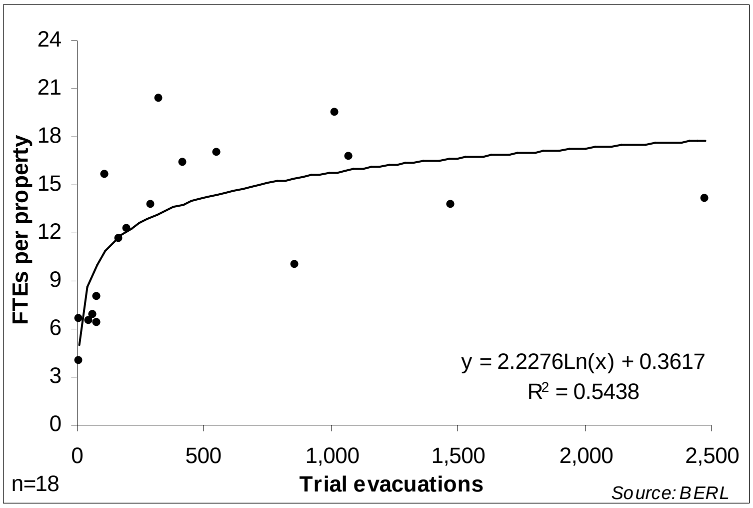
Figure 6.2 shows the implied relationship between the average number of FTEs per non-residential building in each local council and the number of trial evacuations in each local council.

Figure 6.2 Average FTEs per non-residential property and trial evacuations by local council area



These estimates were cross-checked with the eighteen councils in the sample. The relationship between the average number of FTEs per non-residential building and the number of trial evacuations from this sample is presented in Figure 6.3. This relationship is similar to Figure 6.2 providing supporting evidence for the method used to calculate the average number of FTEs per non-residential building by local council area.

Figure 6.3 Actual FTEs per non-residential property and trial evacuations from sample of local councils



6.3 Allocation of the NZFS 2004 budget

Table 6.3 shows how the NZFS 2004 budget components have been allocated prior to additional analysis in Section 3.2. A total of $220.5 million has been allocated either to mixed costs or fixed costs. Mixed costs are those that cover both fire and non-fire related activities. A number of separate budget components totalling $13.2 million have also been allocated to other cost areas in this report.

Table 6.3 Allocation of NZFS 2004 budget

NZFSC 2004 budget ($Mn)	Mixed	Fixed	Total
Output class 1 fire prevention & other forms of fire safety		$38.7	$38.7
Output 2.1 fire fighting and other operations	$149.3		$149.3
Output 2.5 operational planning		$0.6	$0.6
Output 2.6 operational responses to fire & other emegencies	$25.5		$25.5
Output class 3 National Rural Fire Authroity Administration		$2.9	$2.9
Funds expenditure		$3.4	$3.4
Sub-total for allocation	**$174.8**	**$45.7**	**$220.5**
Output 2.2 evacuation scheme approval & monitoring			$5.7
Output 2.3 Municipal water supply & building supply monitoring			$6.9
Output 2.4 Fire alarm systems monitoring & reduction in false alarms			$0.6
Sub-total allocated elsewhere			**$13.2**
Total NZFSC 2004 budget			**$233.7**

Source: BERL

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