Data on Residential Weathertightness Failures

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Executive summary

Background

The Weathertight Homes Resolution Service (WHRS) has been in operation since late 2002. In 2009 it was estimated that the number of dwellings built 1992-2008 that would have weathertightness failures within 15 years was between 22,000 and 89,000, with a consensus figure of 42,000. It was expected that the WHRS would receive claims for around three quarters of those dwellings.

As of mid-2014 however, the WHRS had only received claims for 9912 dwellings. The majority of the failures were expected to occur in dwellings built between 1992 and 2005, and most of those homes are now outside of the 10 year liability limit, so are no longer eligible to enter the WHRS as claims. It may be that weathertightness failures have been less numerous than predicted, or it may be that many dwellings with failures have not been subject to WHRS claims.

The nature of the remaining weathertightness problem has implications for the future direction of WHRS services, and for initiatives addressing New Zealand housing quality more generally. This report analyses several sources of data on the extent and nature of the remaining residential weathertightness problem in 2014. This is intended to support the WHRS to make recommendations for policy changes and decisions on the future of its service provision.

The scope of this analysis is wider than the estimation carried out in 2009. It includes dwellings built from 1985 to mid-2014, as sector experts indicated that the beginning of the weathertightness problem preceded 1992.

Dwellings subject to claims and litigation

As of mid-2014, 9912 dwellings had been the subject of WHRS claims, 28% of which were single-unit dwellings, and 72% of which were in multi-unit complexes. Most were built in the years 1997-2004, with a peak in 1999-2002.

In addition to the dwellings with WHRS claims, a further 1940 to 3640 dwellings have been subject to weathertightness litigation outside of the WHRS system. This brings the total number of dwellings with known failures (WHRS claims plus litigation) to 11,942-13,372. This is considerably lower than the 2009 estimate of the number of dwellings that would fail within 10 years.

Expert opinion and investigation of claiming behaviours in selected developments

Interviews with key informants including building surveyors and claimant representatives indicated that these professionals generally hold the opinion that the number of dwellings with weathertightness failures is much greater than the 11,942-13,372 dwellings that have undergone claims or litigation, and that there is a large ongoing problem that is hidden. Most agreed with the 'extreme view' in the 2009 report, estimating that 89,000 or more dwellings built between 1992 and 2008 were likely to fail.

An investigation of three developments in which dwellings with WHRS claims were present found that dwellings with claims only represented a proportion of those that were likely to fail. Standalone dwellings with claims accounted for only 13-20% of the dwellings that were at risk of failure. Claiming rates were higher among complexes, with 67-85% of complexes that were likely to fail associated with WHRS claims. The developments were not selected at random, so this result cannot be extrapolated to a national estimate, but it is consistent with the idea that WHRS claims cover only a fraction of the dwellings with failures.

Higher claiming rates among complexes could result from a greater chance that at least one owner in a complex will notice a weathertightness failure, the use of WHRS claims as a means to force other owners in a complex to take action, or the possibility that complexes may have failed faster or more obviously than standalone houses.

In all developments, there was evidence that the risk of failure had decreased among dwellings consented from 2003 onwards, with less risky designs and better detailing.

Failures known to owners of multi-unit dwellings

A survey of companies that provide body corporate management services allowed an estimation of the number of multi-unit dwellings with failures that are known to the owners, but which may or may not be subject to litigation or WHRS claims.

This method estimated that among the 115,714 dwellings in complexes with 5 or more dwellings, built 1985-2014, 37084 (32%) may have known weathertightness failures (95% confidence interval: 34127,39690).

This estimate is very similar to the number of dwellings in 5+ complexes that were estimated to be 'very likely to leak', using a method based on pre-purchase report data, described below.

Figure 1 compares these findings with WHRS claims and litigation, and the pre-purchase report-based estimation.

The great majority of the failed complexes identified in the survey were built during the 11 year period 1995-2005, which coincided with a peak in the number of multi-unit dwellings built, a period when untreated timber framing was allowed under some circumstances, and the period prior to the Building Act 2004 coming into force. The survey results suggest that the number of failed complexes has decreased since that time, but this should be treated with caution as these complexes have had less time for failures to become apparent.

Known and unknown failures estimated from pre-purchase report data

An analysis of pre-purchase inspection reports was used to estimate the number of likely weathertightness failures among dwellings built between 1985 and 2014. This addresses the size of the hidden weathertightness problem, including failures that homeowners may be unaware of, and including both systemic failures (that require a full re-clad to remediate) and localised failures that require only a targeted repair.

This method estimated that among the 649,593 New Zealand dwellings built 1985-2014, 27% (174,394) are 'very likely to leak' (95% confidence interval: 140,741, 213,277), and 58% (379,280) are 'likely to leak' (95% confidence interval: 340,881, 406,948). The 'very likely to leak' dwellings are a subset of the 'likely to leak' dwellings that have a higher likelihood of failure and that are more likely to be systemic failures.

This is an estimate of the widest extent of the problem, covering systemic and localised failures, and failures that are, and are not, known to the owners. It is a large number of dwellings compared to the 11,942-13,372 dwellings associated with claims or litigation, and compared to the 2009 report's consensus estimate of 22,000 to 89,000 dwellings built 1992-2008.

Figure 1 compares these findings with WHRS claims and litigation, and the multi-unit survey results.

Analysis of factors associated with differences in failure rates found that failures occurred in dwellings with all cladding types, but that monolithic claddings had highest overall proportion of failures, and were faster to fail. Timber claddings also had a high overall proportion of failures, but were much slower to fail. Failure rates among non-monolithic claddings were considerably higher than what would be expected based on WHRS claims data and the 2009 report's estimates. However the pre-purchase report data does not distinguish between systemic and localised failures, and the rate of systemic failure may differ more widely between cladding types.

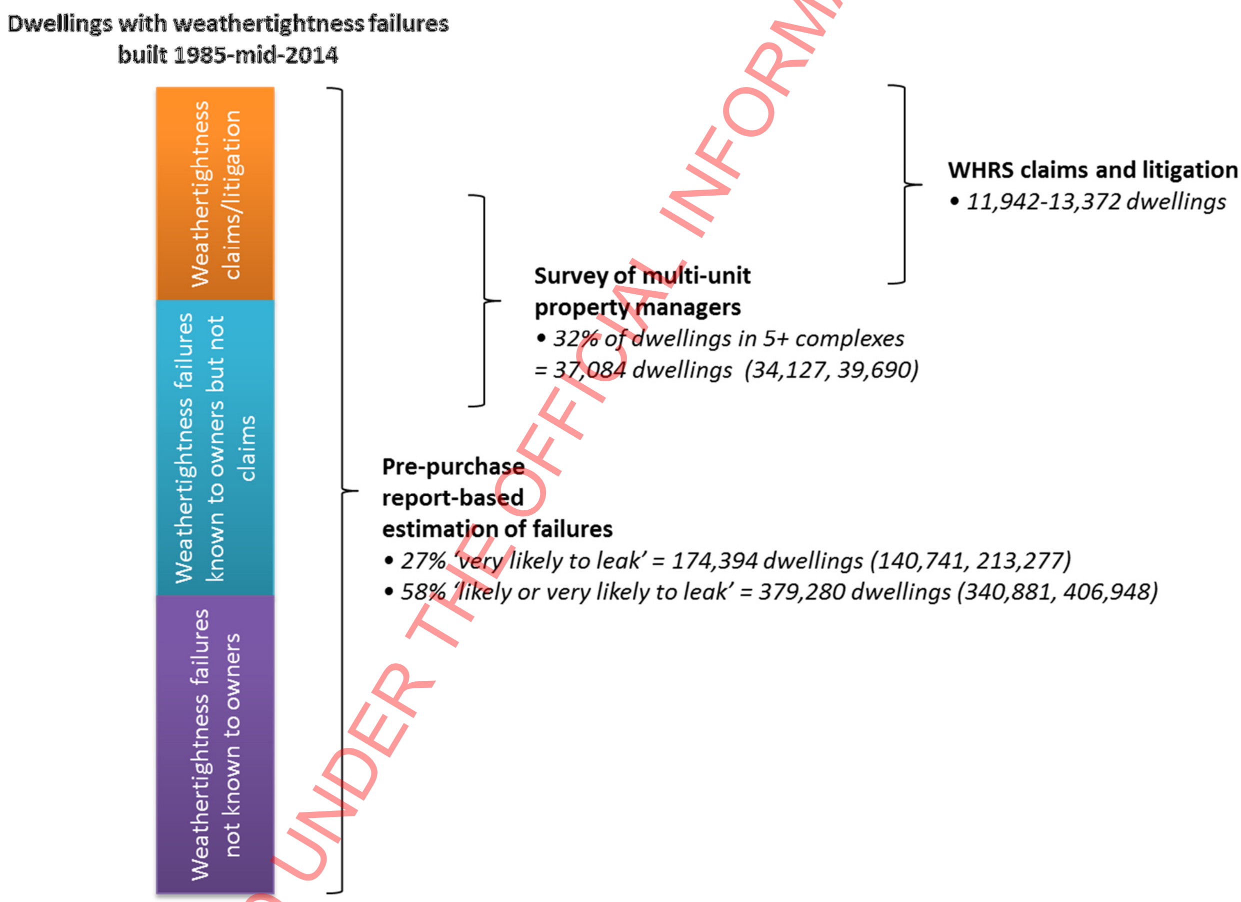

Figure 1. Comparison of the count of dwellings with WHRS claims and litigation, the estimate of multi-unit dwellings with known failures, and the pre-purchase report-based estimate of failures that are known and unknown to dwelling owners.

Comparison with the 2009 estimate

The pre-purchase report-based estimate of the number of dwellings with failures differs considerably from the 2009 estimate of the number of failures among dwellings built between 1992 and 2008 (22,000 to 89,000 with a consensus figure of 42,000). This is in part due to different failure rates, and in part due to the coverage of a much wider year range in this report and a different method for estimating the number of homes affected by failures in monolithic claddings.

A comparison of the estimates was carried out by applying the rates of failure presented in the 2009 report to the current data. Applying the 2009 report's "extreme view" failure rates to dwellings built in 1990-2014 resulted in a similar overall estimate of the overall number of failed dwellings to that generated through analysis of pre-purchase reports. However the estimates differed, in the that pre-purchase report-based analysis suggested that many more homes without monolithic claddings were likely to fail, and that the drop in weathertightness failures from 2006 onwards has not been as steep as that which was anticipated in 2009.

Remediation

An analysis of several sources of data on weathertightness remediation found that there is no complete or unambiguous source of data on remediation, and there are wide discrepancies between different data sources in the level of remediation that they predict.

A survey of closed claimants estimated that 96% of dwellings with claims had been or were to be remediated, and the survey of companies that provide body corporate management services estimated that remediation was underway or completed for 46% of the failed dwellings, and was planned for 54% (only 0.5% of dwellings had no remediation planned).

By contrast, estimating the level of remediation using WHRS Financial Assistance Package (FAP) data and building consent data suggested that 3,512-7,265 dwellings with claims may have been remediated, and 4,113-11,149 dwellings not associated with claims may have been remediated or reclad. This comprises 10% or fewer of the 174,394 dwellings estimated via pre-purchase reports to be 'very likely to leak'.

It is not known which data sources are more accurate, but expert opinion suggests that only a fraction of dwellings with weathertightness failures have been remediated.

There is a considerable amount of remediation occurring outside of the WHRS claims system. Building consents data suggests that around the same number of dwellings with and without claims have been remediated or reclad.

Reasons for non-remediation

Interviews with key informants, including building surveyors and claimant representatives, supported the idea that there is a large hidden issue where owners are not aware that their home has a weathertightness problem. Lack of awareness is a considerable barrier to the remediation of homes with failures.

In cases where owners are aware of the problem, cost is by far the biggest barrier to remediation. The cost to remediate is often much larger than they had expected, and they are not able to raise the required funds through savings or borrowing.

Deterioration of unremediated dwellings

This work attempted to estimate the rate of deterioration of homes with failures over time, asking how costs to remediate increase over time when a home is not remediated. However, the findings indicated considerable variation in the rate of deterioration due to factors that could not be statistically controlled for.

There is disagreement among building experts as to the relative importance of different factors in determining deterioration rates, but key factors include:

- whether the framing is treated
- the quality of the design and installation, including the products chosen
- the level of maintenance by the owner
- the location, which determines factors such as wind exposure, sun, salt spray, and movement of the house due to seismic, wind and thermal fluctuations
- the types of leaks (gravity-fed versus wind-induced).

Contents

1. Background

In 2009, the Department of Building and Housing commissioned a report that investigated the size of the leaky homes problem in New Zealand.[1] This report estimated that the number of homes that would have weathertightness failures within 15 years was between 22,000 and 89,000 with a consensus figure of 42,000. This was considerably higher than the previous estimate of 8,000 to 12,000 failures, developed in 2004 when the extent of the problem was only just becoming apparent.[1] The 2009 report also estimated that around 25% of the 22,000 to 89,000 failures would occur outside of the 10 year liability cap for making a claim, meaning that the Weathertight Homes Resolution Service (WHRS) might expect to receive claims for around 16,500 to 66,750 homes.

Although the WHRS has been in operation since late 2002, it has received claims for considerably fewer homes than the 16,500 minimum estimated in 2009. The great majority of the failures were predicted to occur in dwellings built between 1992 and 2005, and most of those homes are now outside of the 10 year liability limit for making a claim, so only a few further claims for those houses can be expected. This raises the question as to whether failures were overestimated in 2009, or whether WHRS claims represent only a fraction of dwellings with weathertightness failures. Anecdotal evidence from the building and construction sector suggests that the weathertightness issue is still significant and that the latter may be the case.

An evaluation of the Financial Assistance Package in 2013 highlighted the question of what has happened to the potentially large number of additional homes that might be expected to fail and whose status is unknown.[2] If these are dwellings where people cannot afford repairs, or are ignoring them, the long term quality and availability of residential housing could be impaired.

This report analyses several sources of data on the extent and nature of the remaining residential weathertightness problem in 2014. Data sources that were not available in 2009 are used, and the scope is wider, including dwellings built from 1985 onwards, as sector experts indicated that the weathertightness problem began before 1992. This work addresses the following questions.

1. How many dwellings in the domestic housing stock, built since 1985, have had or could have weathertightness failure and damage?
2. How many of these dwellings have been repaired?
3. For those that are unrepaired, why have they not been repaired?
4. How does the condition of unrepaired dwellings develop over time, and what factors affect deterioration rates?

The nature and extent of the remaining problem with weathertightness failures has implications for the future direction of WHRS services, and for initiatives addressing New Zealand housing quality more generally. This report is intended to support the WHRS to make decisions on the future of its service provision, and to make recommendations for policy changes.

It is important to note that this work estimates the size of what is essentially a hidden problem, and that no comprehensive data on this problem exists. Several data sources have been used, each subject to its own biases and rates of error. Where possible, errors and confidence intervals are

[1] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost.
[2] Ministry of Business, Innovation and Employment (2013). Evaluation of the Financial Assistance Package.

quantified, and sources of bias and missing data are described. However, it should be remembered that this work estimates the number of dwellings with weathertightness failures based on available, but imperfect data, and the findings are not an unequivocal count.

2. Known weathertightness failures: WHRS claims and legal proceedings

Key findings

As of mid-2014, 9912 dwellings had been the subject of WHRS claims, of which 28% were single-unit dwellings, 30% were in apartment complexes, and 42% were in non-apartment complexes (including duplexes, terraced developments, and complexes of standalone dwellings).

Most of the dwellings with claims were built in the years 1997-2004, with a peak in 1999-2002. The drop in the number of dwellings with claims preceded the end of the building boom by several years, but coincided with changes in building regulations and practices, including the introduction of the Building Act, 2004.

Compared to the total number of dwellings built in New Zealand, dwellings in complexes (and especially apartment complexes) are over-represented among WHRS claims. This suggests either that weathertightness failures are more prevalent in complexes, or that owners are more likely to make a claim for a weathertightness failure when the dwelling is in a complex.

Most of the dwellings with claims (70%) are in the area governed by Auckland Council. The territorial authority with the next highest number of dwellings with claims is Wellington City Council (9%), followed by Christchurch and Tauranga City Councils (5% each). Compared to new dwelling construction activity, Auckland Council and Wellington City Council account for a higher proportion of claims than would be predicted by the number of new dwellings built. This difference is partially explained by the higher prevalence of dwellings in multi-unit complexes in these territorial authorities, but this does not fully account for the difference.

Monolithic cladding systems are much more prevalent among dwellings with claims than among total dwellings built.

In addition to the dwellings with WHRS claims, a further 1940 to 3640 dwellings have been the subject of weathertightness litigation outside of the WHRS claims system. This brings the total number of dwellings with known failures (WHRS claims plus litigation) to 11,942-13,372. This is considerably lower than the 2009 estimate of the number of dwellings that would fail.

Information collated by one territorial authority suggests that there could be about half as many dwellings again, for which the owners have identified a potential weathertightness failure and have had some discussion with the Council, but have not pursued litigation or a WHRS claim.

2.1. Dwellings with WHRS claims

The Weathertight Homes Resolution Service Act 2002 came into force in November 2002. The WHRS holds data on dwellings for which claims have been made, from late November 2002 to the present.

This chapter tallies the total number of dwellings that have made WHRS claims, and summarises their characteristics with respect to property type, location, year built, and cladding type.

2.1.1. Data extraction, cleaning, and analysis

Data was extracted on all dwellings that have been subject to WHRS claims, up until 27 June, 2014. This dataset underwent extensive cleaning to eliminate duplicates, to harmonise information that had been entered inconsistently across units within a complex, and to establish a consistent measure of the year built. This process is described in Appendix A1. A review of satellite and street-view images of properties, using Google maps, was used to develop the property type classification for multi-unit complexes (more detail in Appendix A2).

Dwellings with open and closed claims were included in the analysis. Dwellings that were ineligible for WHRS assistance were included if the only reason for ineligibility was that the claim was lodged after the 10 year limitation period for legal liability (it was assumed that most of those dwellings would have had eligible weathertightness failures if their claims had been lodged within 10 years). Dwellings were excluded if they were ineligible because the house was not a leaky building, because the house had not been damaged as a result of being a leaky building, because the claimant was not the homeowner, or because the property was not a residential building.

A small number of dwellings were excluded because they had been built before 1985. The data in this section of the report only includes dwellings built from 1985-present. Note that, because of the 10 year liability period and the fact that the WHRS did not begin until late 2002, dwellings built before 1993 may be much less likely than newer dwellings to be associated with claims.

2.1.2. Total number of dwellings and property type

As of 27 June, 2014, a total 9912 dwellings were in the WHRS database and met the criteria above.

Of these 9912 dwellings, 28% (2758) were standalone properties and the remaining 72% (7154) were units in 1062 multi-unit complexes.

Of the dwellings in multi-unit complexes, 41% (2955) were in 121 apartment blocks, and the remaining 59% (4199) were in 941 non-apartment complexes: terraced units, duplexes, or complexes of standalone dwellings (Figure 2.1). Appendix A2 describes this classification of property type in more detail.

For many complexes, only some of the dwellings in the complex had made claims. In total, there were 11728 dwellings in the complexes; 4574 of which were not themselves subject to claims (Figure 2.1). It is reasonable to assume that some, but not all, of those dwellings have had, or are at risk of having a weathertightness failure, in addition to those for which claims have been received.

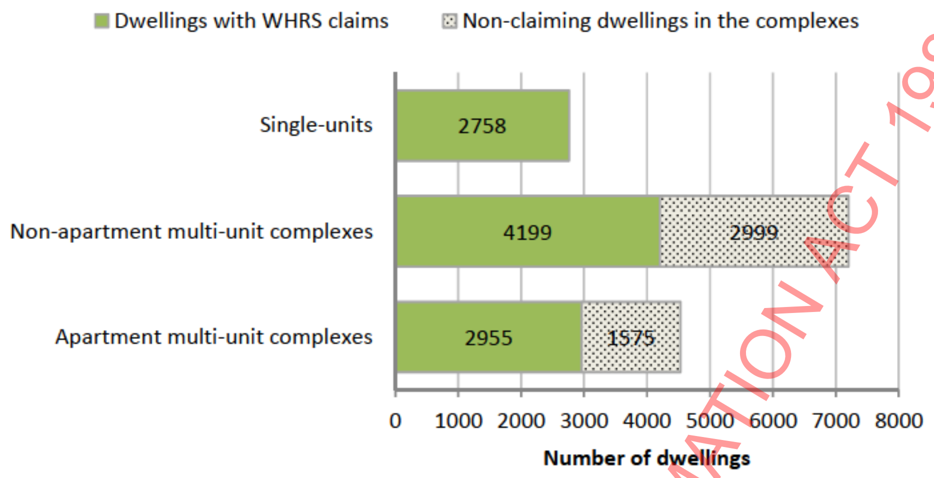

Figure 2.1. Dwellings with WHRS claims by property type.

Compared to the total number of dwellings built in the 1995-2005 period (which corresponds with when most of dwellings with claims were built, see Figure 2.3), dwellings in apartment multi-unit complexes are over-represented in WHRS claims, and single unit dwellings are under-represented (Table 2.1). Single unit dwellings accounted for 44% of the dwellings built in New Zealand between 1995 and 2004, but only 28% of the WHRS claims. Apartment multi-unit dwellings accounted for 17% of dwellings built and 30% of claims. Non-apartment multi-unit dwellings accounted for approximately the same proportion of dwellings built as claims. These differences persist when other built year ranges are used (data not shown), and suggest that either or both of the following issues may be present.

- Weathertightness failures may be more prevalent among dwellings in multi-unit complexes and especially apartment complexes, as compared to single unit dwellings.
- Owners of dwellings with weathertightness failures may be more likely to make a claim if the dwelling is part of a multi-unit complex, and especially if it is part of an apartment complex.

Table 2.1. Proportion of claims compared with the proportion of new dwellings built 1995-2004, by property type

Property type	% dwellings with claims	% New Zealand dwellings built 1995-2004*
Single-units	28%	44%
Non-apartment multi-unit complex	42%	39%
Apartment multi-unit complexes	30%	17%

* Source: District Valuation Roll-based national count of residential dwellings, supplied by Data Insight Ltd.

2.1.3. Dwellings by territorial authority

Most of the dwellings with claims (70%) are in the area governed by Auckland Council. The territorial authority with the next highest number of dwellings is Wellington City Council (9% of dwellings), followed by Christchurch and Tauranga City Councils (5% of dwellings each). Figure 2.2 shows the number of dwellings with claims by territorial authority and property type. The territorial authorities with more claims tend to have a higher proportion of multi-unit complexes among their dwellings with claims.

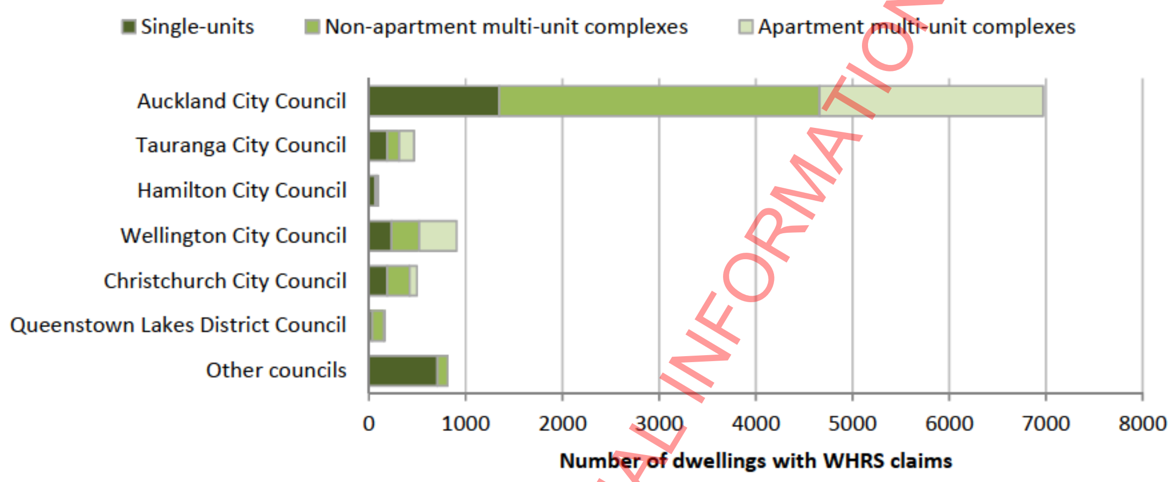

Figure 2.2. Dwellings with WHRS claims by territorial authority and property type.

Table 2.2 compares the percentages of claims by territorial authority, with the percentages of dwellings consented in the 1991-2013 period. Auckland Council and Wellington City Council account for a higher proportion of claims than new dwellings, while Hamilton City Council, Christchurch City Council, and other councils account for fewer dwellings with claims than might be expected given their construction activity during 1991-2013. Tauranga City Council and Queenstown Lakes District Council account for a proportion of claims that is roughly similar to their proportion of dwellings consented between 1991 and 2013.

Table 2.2. Proportion of claims compared with the proportion of new dwellings consented 1991-2013, by territorial authority

Territorial authority	% dwellings with claims in the territorial authority	% new dwelling consents 1991-2013 in the territorial authority*
Auckland Council	70.4%	34.0%
Tauranga City Council	4.7%	4.8%
Hamilton City Council	1.0%	3.6%
Wellington City Council	9.1%	3.7%
Christchurch City Council	5.0%	8.9%
Queenstown Lakes District Council	1.6%	2.1%
Other councils	8.2%	42.7%

* Source: Statistics New Zealand Building consents (Annual-Dec)

Some, but not all of the differences in claiming rates between territorial authorities are related to the types of dwellings that were built. Figure 2.3 shows that across all territorial authorities, dwellings in multi-unit properties have a higher likelihood of being associated with a claim than single unit dwellings. The magnitude of the difference between multi-unit and single unit dwellings varies across territorial authorities, however. For example, multi-unit dwellings with claims account for just over 9% of multi-unit dwellings consented in the Auckland Council catchment, while single unit dwellings with claims account for just over 1% of those consented. This is the most extreme difference across the territorial authorities. In the Wellington City Council catchment, multi-unit dwellings with claims account for just under 6% of multi-unit dwellings consented, while single unit dwellings with claims account for just over 3% of those consented. Wellington City Council has a higher rate of claims among single unit dwellings than any other territorial authority.

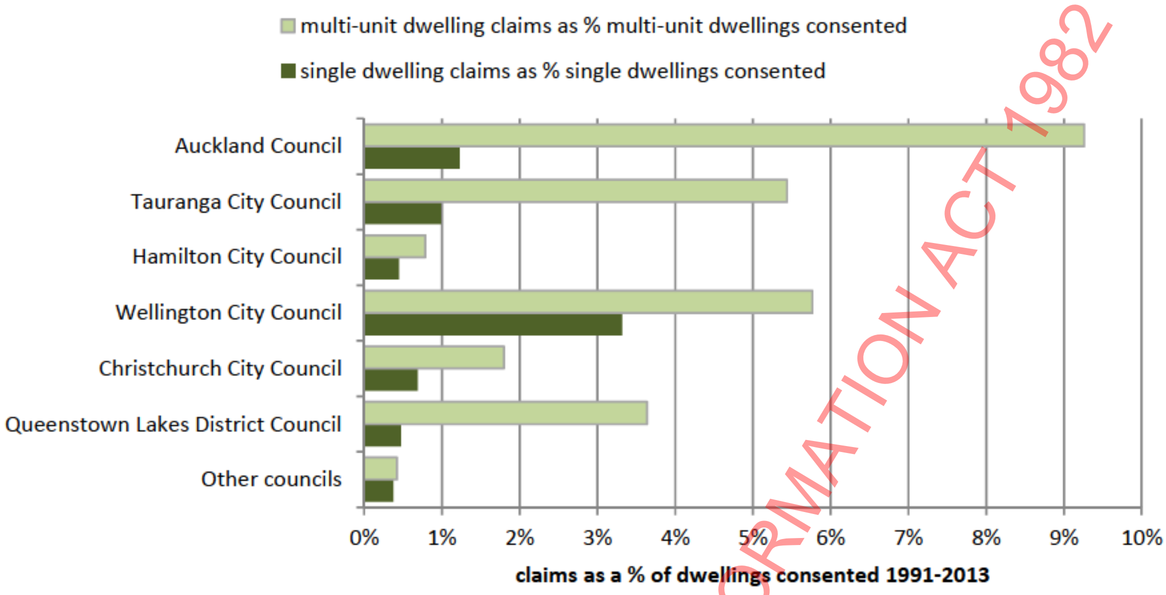

Figure 2.3. Dwellings with WHRS claims by territorial authority and property type, as a percentage of the dwellings consented from 1991 to 2013, by territorial authority and property type. Data on dwellings consented by property type is from customised Statistics New Zealand building consents data (Annual-Dec).

The differences seen in Table 2.2 and Figure 2.3 persist when the count of consented dwellings is restricted to those consented between 1994 and 2003, which corresponds to the time during which the bulk of the dwellings with claims were built (data not shown).

This suggests that differences between Territorial Authorities in the number of dwellings with claims are related to construction volumes and the types of dwellings that were built (with multi-unit dwellings more likely to be associated with WHRS claims), but that other factors also contribute to differences in claiming rates by territorial authority. This could result from differences in those dwellings rates of weathertightness failures, or it could result from differences in owners' propensities to claim, once a weathertightness failure has occurred.

2.1.4. Dwellings by built year

Analysis of the dwellings with claims by the year in which they were built shows that the number peaked between 1999 and 2002 for single unit dwellings and non-apartment multi-unit complexes, with the peak occurring slightly later for single unit dwellings. Apartment multi-unit complexes do not show a clear peak, with wide fluctuations due to claims in some years from very large multi-unit apartment complexes (Figure 2.4). Figure 2.5 shows the number of apartment and non-apartment complexes with claims by year built, and shows smoother peaks without the fluctuations due to large apartment blocks.

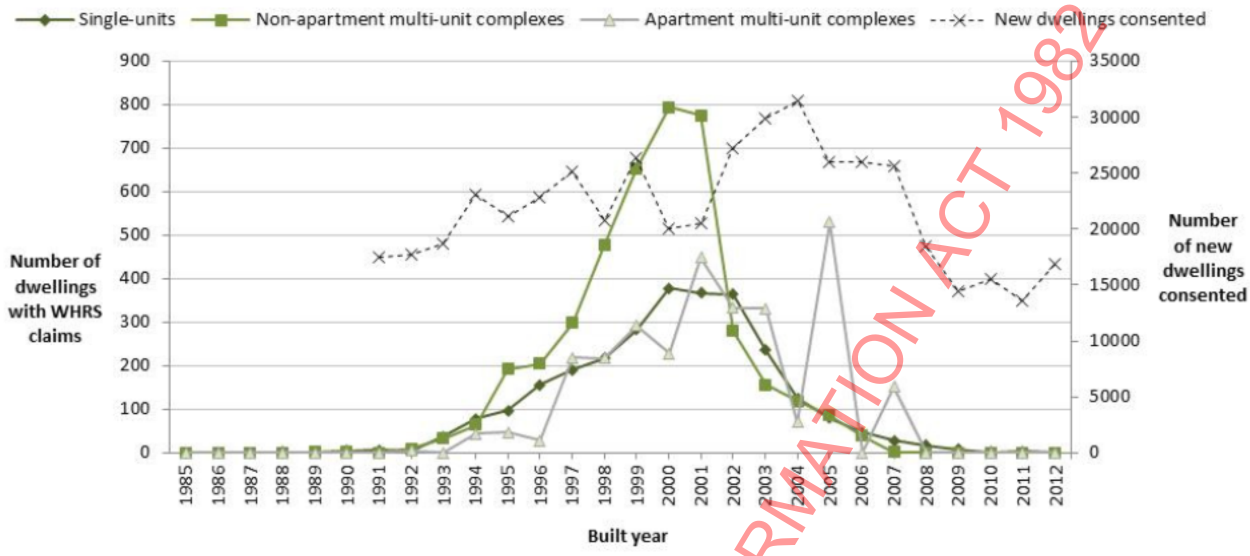

Figure 2.4. Dwellings with WHRS claims by built year and property type, with a comparison to the number of new dwellings consented by year (dashed line and right had axis). Data on new dwellings consented is from Statistics New Zealand Building consents data (Annual-Dec).

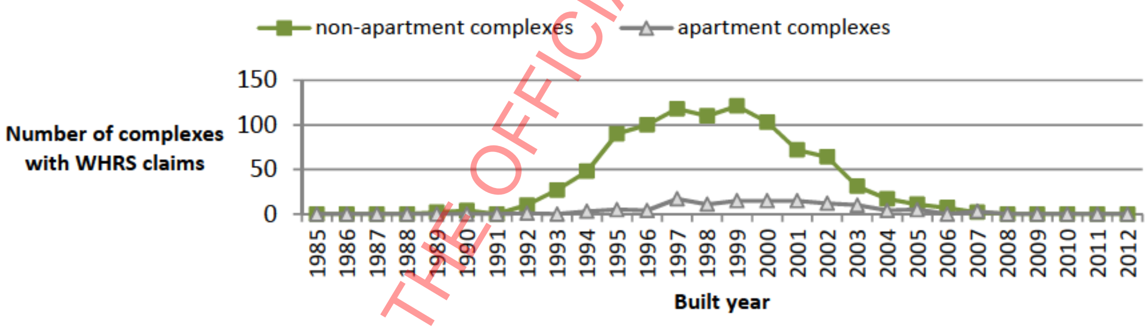

Figure 2.5. Complexes with WHRS claims by built year.

In interpreting these findings, it is important to remember that dwellings are only eligible for WHRS assistance if the claim is lodged within 10 years of the built date. The very low number of dwellings with claims built before 1993 may simply reflect the fact that the WHRS did not begin accepting claims until late 2002, by which time dwellings built before late 1992 were ineligible for assistance.

Statistics New Zealand data on new dwellings consented shows that high numbers of dwellings continued to be consented until 2008, when new dwelling consent volumes dropped. The drop in the number of claims from dwellings built in 2002 onwards therefore precedes the end of the building boom by several years.

The decreased number of dwellings with claims after 2002 may, in part, reflect the lag between built date and making a claim. Because weathertightness failures can take several years to become evident, more recently built dwellings with weathertightness failures are less likely to have made claims. Analysis of the time elapsed between built year and claim lodgement showed that the median time to claim was 8 years for single dwellings, and 7 years for complexes. These medians remained consistent, even when the analysis included only dwellings built between 1996 and 2002, whose 10 year eligibility window falls well within the 2002-2014 period of operation of the WHRS.

For single unit dwellings and non-apartment complexes, if the median number of years between built date and claim lodgement remains consistent in future years, the number of dwellings built from 2004 onwards that apply for WHRS assistance will increase, but will not reach the volume seen for dwellings built in the peak years of 1999-2002. This decrease in claims could result from fewer failures in homes built from 2003 onwards, homes built from 2003 onwards taking longer to fail, or a reduction in the proportion of owners of leaky homes who make claims (although there is no evidence to suggest the latter). It may be significant that the decrease coincided with changes to building regulations and practices, including the introduction of the Building Act, 2004 (Appendix B). Evidence from the estimation of failures in multi-unit complexes also suggests that weathertightness failures peaked among those built 1994-2005 and are considerably lower among those built later (Chapter 6).

For apartment complexes, a reduction in the number of dwellings with claims cannot be predicted with any confidence, as a small number of future claims from large complexes could greatly increase the number of dwellings with claims.

2.1.5. Dwellings by cladding type

The WHRS holds data on the cladding types used in dwellings with claims. Analysis of this data found that 89% of the dwellings had some form of monolithic cladding, either as the sole cladding type, or as one cladding in a mixed cladding property. Common monolithic cladding types included EIFS (used in 28% of dwellings), stucco (used in 20%), and textured fibre cement (used in 45%).

However, data on cladding type was missing for 43% of the dwellings in the WHRS database (these dwellings are excluded from the percentages given above), and where more than one cladding type was used, the predominant material is not identified in the WHRS database.

In 2009, risk profiling of a random sample of 857 dwellings in the WHRS database found that 85% of dwellings with claims used a monolithic cladding as the predominant material.[3] This is a much higher prevalence of monolithic claddings than among New Zealand dwellings as a whole. The Building Research Association of New Zealand (BRANZ) materials survey found that the proportion of single-unit dwellings using a monolithic system as the main cladding type peaked at 37-40% in dwellings built in 1998-2002, and dropped thereafter, reaching 14% for those built in 2007 and 2009. There were very few multi-unit dwellings in the BRANZ survey sample, but the available data suggests that roughly similar proportions of multi-unit dwellings used monolithic claddings; far fewer than the 85% in the 2009 sample of dwellings with WHRS claims.[4]

[3] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost, page 14.
[4] BRANZ (2009) New dwellings wall cladding, framing, timber treatment details. Report to the Department of Building and Housing, 1 May, 2009.

2.2. Dwellings that have undergone litigation for weathertightness failures without a WHRS claim

Two territorial authorities supplied data on the number of dwellings that, to their knowledge, have been subject to litigation in relation to weathertightness failures. The findings from analysis of this data are described below.

2.2.1. Wellington

Wellington City Council (WCC) data was matched, by address, with WHRS data, and the dwellings in the WCC data that were not WHRS claims were identified. The number of dwellings in Wellington that are known to have undergone litigation related to weathertightness, and that are not WHRS claims, is 234. Of those dwellings, 14 are single-unit dwellings and 220 are units in 9 complexes. Not all of the dwellings in the complexes are recorded as having undertaken litigation; the 9 complexes contain a total of 229 dwellings.

These dwellings can be regarded as confirmed weathertightness failures in the Wellington City Council catchment, additional to the 905 dwellings in Wellington with WHRS claims and the 670 dwellings with non-formal weathertightness notifications (section 2.3).

2.2.2. Auckland

Anonymised data on the number of dwellings and complexes associated with WHRS claims and weathertightness litigation was provided by Auckland Council (AC). Because it was anonymised, this data could not be matched with WHRS claims, meaning that the extent of overlap with the WHRS database could not be conclusively established, and the results are therefore calculated as a range.

The AC data contained 5454 dwellings that had been subject to weathertightness litigation, and that were not recorded as being associated with WHRS claims. Of these dwellings, 5087 were in 133 multi-unit complexes, and the remaining 367 were single-unit dwellings. However, the AC data only recorded that an additional 3220 dwellings were associated with WHRS claims, which is considerably fewer than the 6974 dwellings recorded in the WHRS database from the AC catchment. AC acknowledge that their dataset may not be complete; in particular older data, collated from predecessor councils before their amalgamation in 2010, is less consistent. It is therefore possible that a number of the 5484 non-claim dwellings that have been subject to litigation are also WHRS claims, but that this is not recorded in the AC data. Taking a minimal view that assumes complete overlap between the WHRS database and the AC data, but that AC data does not identify some WHRS claims, it can be calculated that 1700 dwellings (the Auckland total of 8674 minus the WHRS total of 6974) are associated with litigation, but not with WHRS claims. It is not possible to determine the distribution of these dwellings across complexes and single-unit dwellings.

It can therefore be concluded that the number of dwellings known to AC, that have been associated with weathertightness litigation but not WHRS claims, lies in the range of 1700 to 3220.

2.2.3. Judicial Decisions in other areas

Christchurch City Council and Tauranga City Council were also asked if they held any information on dwellings subject to weathertightness litigation that were not WHRS claims. Neither had any such dwellings on record.

A search of Judicial Decisions Online for residential weathertightness-related Court decisions outside of the WCC and AC areas was conducted as described in Appendix A5. Only three properties were found that were outside of Wellington and Auckland, and that were not also subject to WHRS claims. Of the three, one was a single-unit dwelling, and two were multi-unit complexes. One of the complexes contained two dwellings, and the number of dwellings in the other complex could not be determined from the information in the judgement.

This suggests that, outside of Wellington and Auckland, there are very few dwellings that are subject to litigation over weathertightness failures, and that are not also subject to a WHRS claim.

The following restrictions in the coverage of Judicial Decisions Online should be noted.

- All cases from the Supreme Court are available
- High Court cases from 2005 onwards only are available
- Court of Appeal cases from 2003 onwards only are available
- District Court cases are not available
- The following decisions are not published.
    - Decisions subject to statutory prohibitions or orders prohibiting publication
    - Decisions subject to time-limited suppression orders
    - Decisions relating to bail applications or bail appeals (unless the Court concerned determines otherwise in the particular case)

These restrictions mean that the count of one single-unit dwelling, one duplex, and one additional complex with an unknown number of units may underestimate the number of non-WHRS claim dwellings outside of Auckland and Wellington associated with litigation. However, it does suggest that litigation for weathertightness, outside of the WHRS system and outside of Auckland and Wellington, is rare.

2.3. Non-formal weathertightness notifications to a TA

In addition to records of WHRS claims and litigation (section 2.2), Wellington City Council records non-formal notifications of weathertightness issues. These are alleged weathertightness failures, where some contact has been made with the Council, but where there may or may not have been any follow-up work by the owner to confirm that a failure exists. These dwellings can be thought of as possibly having weathertightness failures, but with a lower certainty than dwellings associated with WHRS claims or litigation.

The number of dwellings in Wellington with non-formal weathertightness notifications is 670. Of them, 62 are single-unit dwellings, and 608 are units in 37 complexes. Not all of the dwellings in the complexes are recorded as having non-formal notifications; the 37 complexes contain a total of 1107 dwellings.

The Wellington non-formal notifications add 59% (670 dwellings with possible failures) to the 1139 Wellington dwellings with WHRS claims and litigation (Table 2.3).

Table 2.3. The number of Wellington dwellings associated with claims, litigation, and non-formal notifications

Dwelling type	WHRS claims	Litigation	Non-formal notifications
Single unit dwellings	233	14	62
Dwellings in multi-unit complexes	672	220	608
Multi-unit complexes	115	9	37
Total dwellings	905	234	670
Additional dwellings in the complexes*	639	9	499

* These are units in complexes with units that have been involved in claims, litigation, or non-formal notifications. These units have not themselves been involved in claims, litigation, or non-formal notifications.

2.4. Collation of known weathertightness failures

Table 2.4 (overleaf) collates the count of dwellings with weathertight claims or litigation across the data sources described in sections 2.1 to 2.3. An exact number cannot be calculated, but it is in the range of 11942 to 13372 dwellings.

In addition, a further 4583 dwellings are in complexes where other dwellings have made WHRS claims, or undergone litigation. This is an undercount as data on total units in complexes was not available from Auckland Council.

For the one territorial authority that collated information on non-formal notifications of weathertightness failures, those notifications comprised 670 dwellings, an additional 59% over and above those already known to be involved in WHRS claims or litigation (section 2.3). If this were extrapolated to an estimate covering all of New Zealand, it would add 7025 to 7866 dwellings to the total of 11942 to 13372 dwellings involved in claims and litigation, giving a total of 18967 to 21238 dwellings. While this extrapolation provides an indication of the possible number of dwellings which have weathertightness issues that are known to the owners, and where the owners have taken some action in contacting their TA, this is not a robust estimate, as it should not be assumed that the situation in Wellington is representative of the situation across New Zealand.

Relative to the 2009 estimate of the number of leaky homes,[5] dwellings that have been involved in WHRS claims and litigation as of mid-2014 number fewer than the lower limit of the range of 16,500 to 66,750 dwellings estimated to fail within 10 years. If non-formal notifications are extrapolated to a New Zealand estimate, the number of dwellings with failures falls within the lower part of this range, but this is not a robust extrapolation.

Do these known cases represent most, or only a fraction of the actual number of dwellings with weathertightness failures? Did the 2009 research overestimate the size of the problem, or are there many more dwellings with weathertightness failures that are not associated with claims or litigation? Chapters 3 and 4 investigate this question through key informant interviews and case-

[5] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost.

studies of selected developments. Then Chapters 5 and 6 use alternative data sources to develop independent estimates of the number of leaky dwellings.

Table 2.4. Collation of the count of dwellings with WHRS claims and weathertightness litigation

	WHRS claims				weathertight litigation				Total	
Territorial authority	Standalone dwellings	Dwellings in complexes	Number of complexes	*Total dwellings*	Standalone dwellings	Dwellings in complexes	Number of complexes	*Total dwellings*	Number of complexes	*Total dwellings*
WCC	233	672	115	*905*	14	220	9	*234*	124	*1139*
AC	1347	5627	711	*6974*	unknown			*1700 to 3220*	more than 711	*8764 to 10194*
Rest of NZ	1178	855	236	*2033*	1	estimate 5*	2	*10**	238	*2039**
All of NZ	***2758***	***7154***	***1062***	***9912***	***unknown***			***1940 to 3460***	***more than 1073***	***11942 to 13372***

* This figure is estimated because there was one complex associated with weathertightness litigation, for which the number of dwellings was unknown (section 2.2). The number of dwellings was estimated to be 3, based on the median number of dwellings in complexes with WHRS claims.

3. Expert opinion on the extent of weathertightness failures

Chapter 2 assesses the size of the known weathertightness issue. However, the key informants interviewed during this research commented that weathertightness is still largely a hidden issue, and that the properties with weathertightness failures that have come to public view are a minority of the overall number of failures.

Key informants whose views contributed to this chapter included 9 building surveyors and one claimant representative.

3.1. The nature of the hidden problem

In their 2009 report, PWC's expert panel estimated that, as an extreme view, 80 – 95 percent of monolithic clad houses built between 1992 and 2005 would suffer some sort of failure within 15 years.[6] By cladding type, this was estimated to be: Stucco – 95 percent, EIFS – 80%, fibre cement – 80 percent. By contrast, a 2 percent failure rate was estimated for weatherboards, brick, metal, concrete and blockwork. This extreme view estimated that 89,000 or more dwellings could fail within 15 years.

Opinion among the key informants agreed with the 'extreme' view, believing that failure rates are about 80 percent and higher among monolithic clad houses. Some even suggested that any monolithically clad house of that era will eventually leak. One assessor who has worked as a pre-purchase building surveyor since 1990 said *"In my experience, I've never found a monolithic house that hasn't leaked"*. Another building surveyor agreed that 80 percent is a fair representation of the failure rate. Another said he believed it would be more than 80 percent and that 100 percent could be right.

"In somewhere like Wellington with high wind pressures and reasonably high rainfall if you took me to a selection of houses on a random basis I think you would find it's significantly higher than 80 [percent]"

Lack of awareness, and lack of money to fix problems are two factors that have contributed to the problem remaining hidden and ongoing. Two key informants said that a number of owners of leaky homes that they had worked with had chosen not to continue to a detailed assessment once they had been given an indication of the cost to proceed.

3.2. The size of the hidden problem

Most key informants stated that they believe that we have only seen about 20 percent of cases so far. Another said he believed it was more likely to be 10 -15 percent and that only a fraction of those homes have been fixed.

Another key informant believed that the size of the problem is 10 percent of all New Zealand housing stock and that *"we haven't seen much of that [coming to the public view]"*

[6] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost, Page 17.

4. Investigation of claiming behaviours in selected developments

Key findings

This chapter describes the results of an assessment, by an expert weathertightness reviewer, of three developments in which dwellings with WHRS claims were located. The assessment asked whether the development contained additional dwellings, further to those with WHRS claims, which were also likely to have weathertightness failures.

Across all three developments, WHRS claims only represented a proportion of the dwellings that were assessed as likely to fail. The ratio of dwellings with WHRS claims to dwellings without claims that were likely to fail differed between standalone houses and dwellings in complexes. Complexes were more likely to be associated with a claim than standalone dwellings.

Only a minority of the standalone dwellings that were assessed as likely to fail were associated with WHRS claims. Typically, standalone dwellings with claims accounted for only 13-20% of the dwellings that were assessed as at risk of failing.

By contrast, most of the complexes that were assessed as likely to fail were also associated with WHRS claims, with only a minority of complexes (33% in one development and 15% in the other) assessed as likely to leak, but not associated with a WHRS claim.

The analysis could not determine whether the differences in claiming rates were due to differing owner behaviours, or differing deterioration rates between standalone dwellings and complexes.

In all three developments, the review found evidence that the risk of failure had decreased among dwellings consented from 2003 onwards, with less risky designs and better detailing evident in the plans.

4.1. Method and rationale

When this research was scoped, a number of the people who were consulted described visiting homes with weathertightness failures that were situated in developments that included many other houses built in a similar style and at the same time. They were concerned that the other houses in these developments were at risk of failing, and that only a few of them were subject to WHRS claims. This was presented as evidence that the scale of the weathertightness problem may be considerably larger than the number of dwellings with WHRS claims. This chapter investigates this concern, examining three developments, each containing several WHRS claims, and assessing the risk of failure associated with the other properties in the development.

The assessment was carried out by an expert reviewer with extensive experience in quality assurance of WHRS weathertightness assessments. The reviewer:

- examined the assessment reports for the dwellings in the development with WHRS claims, to ascertain what faults led to weathertightness failures in those dwellings
- investigated whether those faults were also likely to be present in the other (non-WHRS claim) dwellings in the development, by reviewing those dwellings':
    - building consent documents

- google streetview and satellite view images (where available)

The reviewer then made a judgement as to whether, on balance, each non-claim dwelling was likely to leak, taking into account information from building consent documents, google streetview and satellite view, topographical maps, and wind exposure.

This assessment has some limitations. It relies on expert opinion, and it does not take account of post-consent alterations that may have occurred and not been documented. It is also important to remember that this is an analysis of the pre-remediation status of each dwelling. Some of the dwellings in the developments may have been remediated, but this is not assessed here. Chapter 7 addresses remediation rates.

The following findings provide some information on the validity of the expert opinion on which this analysis is based.

- Five of the non-claim dwellings in Development A were assessed by two reviewers. The reviewers agreed that three were almost certain to leak, but differed in their assessment of the remaining two. The first reviewer thought that both were likely to leak (although one with less certainty), while the second reviewer thought that, on balance neither were likely to leak. The results described below use the assessments of the second reviewer and therefore may be a relatively conservative estimate of the number of properties that are likely to leak.
- Three of the non-claim dwellings in one of the developments were known by the territorial authority to have had weathertightness failures. This was unknown to the reviewer, but in all three cases the reviewer correctly categorised the dwelling as 'almost certain to leak'.

During the course of the assessments, the reviewer developed a list of typical faults that contribute to weathertightness failures that were found in the developments. These are listed in Appendix C.

4.2. Development A findings

This development consisted of 105 standalone dwellings, consented in the years 1996-2006, co-located in a 'greenfields' subdivision and all built by the same company, which offered design and build packages. While none of the houses had identical designs, there were similarities between them. The typical house was a two storey Harditex clad home, with face fixed windows, metal tile roof, two valleys in the roof, three bedrooms, and a double garage, on a site slightly falling to the south.

In this development, 12 houses were associated with (open or closed) WHRS claims, and building consent documentation was reviewed for another 93 houses that were not associated with claims.

Of the 93 reviewed houses, 42 were assessed as 'almost certain to leak', 22 as 'not likely to leak', and 29 as 'unsure'. The 'unsure' rating was applied to houses where the reviewer found:

- a mix of features that raised and lowered the risk, meaning that the house had the potential to leak, but the certainty was low
- that there was insufficient detail in the consent documentation to be sure of the assessment, but enough detail to indicate a level of risk between 'almost certain to leak' and 'not likely to leak'

- that the home would not be likely to leak if it was carefully built, but the reviewer did not have confidence in the quality of the build, or there was no information on build quality available.

The 'unsure' rating therefore indicates that the house has the potential to have a weathertightness failure, but that the probability of this happening is lower than for those that received the rating 'almost certain to leak'. The 'unsure' rating was sometimes accompanied by a comment from the reviewer that if leaking occurred, it would be likely to be minor or localised.

The results of the review suggest that, in development A, for every dwelling that is associated with a WHRS claim, a further 3.5 are almost certain to leak if they are not remediated, and 2.4 are also at risk if not remediated, although their risk is lower. So, for every home with a WHRS claim, a further 3.5 to 5.9 are estimated to be at risk of failing unless they are remediated. WHRS claims only account for 14-22% of the homes in this development that are likely to have weathertightness failures.

During the 1996-2006 period in which these houses were consented, a number of changes to building practices and regulations occurred (see Appendix B for a summary). Analysis of the reviewer ratings by building consent year showed that, in houses consented from 2002 onwards, there may have been a slight drop in the proportion rated as 'almost certain to leak', but that even some of the later homes were likely to have weathertightness failures (data not shown). The sample size is too small for this to be a robust finding, but the reviewer did observe that:

- from late 2001 to early 2002 the designs improved and showed more information, including Hardies details which show alternative window details featuring sill flashings and semi-recessed windows
- from late 2002/early 2003 the designs show improved window flashings and cavities.

4.3. Development B findings

Development B was less homogenous than development A, with a wider range of building types, styles, complexity and scope. All of the dwellings were built by one company, within one city, but on infill subdivisions distributed across several locations. All dwellings were consented in the years 1992-2003. The development consisted of:

- two standalone houses and 6 terraced complexes (each containing 4-6 dwellings), which were associated with WHRS claims.
- 22 standalone houses, 2 duplexes, and 1 terraced complex (containing 7 dwellings) that were not associated with claims.

Of the 25 properties (standalone houses, duplexes and complexes) that were not claims, 12 properties (comprising 20 dwellings) were assessed as 'almost certain to leak', 8 (all standalone houses) were assessed as 'not likely to leak', and 5 (all standalone houses) were assessed as 'unsure'. The 'unsure' rating is described in section 4.2, and indicates that the property has the potential to have a weathertightness failure, but the probability is lower than for properties that received the rating 'almost certain to leak'.

The ratio of properties with claims, to properties that are likely to leak but that are not associated with claims, differed between standalone houses and complexes.

- For every standalone house that was associated with a WHRS claim, a further 4.5 are almost certain to leak if they are not remediated, and 2.5 are also at risk.
- By contrast, 6 out of the 9 complexes were associated with WHRS claims. All of the remaining 3 complexes were assessed as 'almost certain to leak', so for every 2 complexes that were associated with a WHRS claim, a further 1 complex was almost certain to leak if not remediated.
- Therefore, WHRS claims in this development account for 13-18% of the standalone houses that are likely to have weathertightness failures, and 67% of the complexes that are likely to have weathertightness failures.

Four properties in this development had been granted consents for weathertightness remediation work: 2 were complexes (both associated with WHRS claims), and 2 were standalone houses (neither of which were associated with WHRS claims, but both of which were assessed as 'almost certain to leak').

There are several factors that could contribute to a lower rate of claiming among standalone houses, relative to complexes.

- With more households in a complex, the chance that at least one household will identify a weathertightness failure and decide to lodge a claim may increase.
- Making a WHRS claim may benefit owners in complexes who want to remediate, by initiating a formal process that helps to force other owners in the complex to take action. Owners of standalone houses may be more likely to feel that the disadvantages of making a claim outweigh the advantages, and prefer to remediate without claiming. On the other hand, making a WHRS claim may disadvantage owners in complexes, if other owners remain resistant to remediation, even after a claim is lodged. In addition, owners in complexes may pressure their neighbours to hide problems, so as to protect their investment.
- The complexes in this development may be more likely than the standalone houses to show obvious weathertightness failures within the 10 year liability period, leading to a higher rate of detection of failures among complexes. The assessor did not feel that it was possible to predict the rate of failure of the complexes, as compared to the standalone houses, but commented that, with a few exceptions, the standalone houses were of simpler construction, with a more conservative design approach and materials choice. The defects in the standalone houses were generally limited to the use of Harditex in conjunction with membrane decks, while the complexes had additional defects.
- The standalone houses that were likely to leak were mostly consented in the period 1994-1998, while the complexes were mostly consented later, between 1999 and 2003. If owners of older dwellings are less likely to claim, this could contribute to the lower claim rates among standalone houses, but given that the WHRS has been operating since late 2002, almost all of the standalone houses that were likely to leak would have been able to claim within the 10 year liability period.

During the 1992-2003 period in which these houses were consented, a number of changes to building practices and regulations occurred. However, analysis of the reviewer ratings by building consent year showed no detectable pattern of differing risk by build year (data not shown), although, as mentioned above, the standalone houses that were likely to leak were mostly consented in the period 1994-1998, while the complexes were mostly consented later. The reviewer did note a shift over time, in complex design.

- It appears that the same designs among the complexes were repeated, with the same risk features and defects, until 2002, when there was a shift in design approach which lowered the basic risk, but introduced new risk features. In 2003 the approach fundamentally changed, with a much simpler style used, lowering, but not eliminating the risk of leaking. These changes may have been driven by an awareness of weathertightness risks, but an equally, or more likely explanation is that there were changes in market perceptions of style, plus it was a lower value development in 2003, necessitating cost containment and a simpler design.

4.4. Development C findings

Development C consisted of 22 standalone dwellings and 31 dwellings in 13 complexes (most of the complexes were duplexes). Dwellings were consented in the years 1997-2004, were co-located in a 'greenfields' subdivision and were all built by the same company. All but one used the EIFS cladding system. Five of the standalone dwellings were 'one-off' designs, while the remaining 48 dwellings were built to one of 7 standard designs. There was a considerable similarity among the dwellings of each standard design.

In this development, 21 dwellings were associated with (open or closed) WHRS claims. Building consent documentation was reviewed for the remaining 32 dwellings that were not associated with claims.

Of the 32 reviewed dwellings, 20 were assessed as 'almost certain to leak', 8 as 'not likely to leak', and 4 as 'unsure'. The 'unsure' rating is described in section 4.2, and indicates that the property has the potential to have a weathertightness failure, but the probability is lower than for than properties that received the rating 'almost certain to leak'.

The ratio of properties with claims, to properties that are likely to fail but that are not associated with claims, differed between standalone houses and complexes in a way that is consistent with the findings from Development B.

- For every standalone house that was associated with a WHRS claim, a further 4.0 are almost certain to fail if they are not remediated, and 2.0 are also at risk.
- By contrast, all 13 of the complexes were assessed as 'almost certain to leak'. Of the 13 complexes, 11 contained at least one dwelling with a claim, so for every 5.5 complexes associated with a WHRS claim, a further 1 complex was almost certain to leak if not remediated.
- Therefore, WHRS claims in this development account for 14-20% of the standalone houses that are likely to have weathertightness failures, and 85% of the complexes that are likely to have weathertightness failures.

As discussed in section 4.3, the reason for the higher claiming rates among complexes is unknown, but several factors that could contribute, including a greater chance that at least one owner in a complex will identify a weathertightness failure, use of the WHRS claims process as a means to force other owners in a complex to take action, and the possibility that complexes have failed faster or more obviously than the standalone houses.

Analysis of the standard designs and risk of failure by building year suggested that change has occurred over time. Several of the 7 standard designs had been consented in mid-2003, in a period that the reviewer described as "transitional", when the problems with EIFS were becoming apparent but were not widely recognised. All of those dwellings were either WHRS claims or assessed as 'almost certain to leak'. Some other standard designs were built in 1997-98, and while they avoided some of the problems found in the mid-2003 designs, around half were assessed as 'almost certain to leak'. A later design, consented in late-2003 exhibited a "step-up" in the design, detailing, and site construction, and none were found to be likely to fail.

5. Estimation of failures known to the owners of multi-unit dwellings

Key findings

A survey of companies that provide body corporate management services gathered anonymised data about weathertightness failures among the complexes they managed. This method estimates the number of multi-unit dwellings with failures that are known to owners, but that may or may not be subject to weathertightness litigation or WHRS claims. This method does not capture failures that are unknown to owners and it does not cover single unit dwellings.

This method estimates that among the 115714 dwellings in complexes with 5 or more dwellings, built 1985-2014, 37084 (32%) may have known weathertightness failures, with a 95% confidence interval of (34127,39690).

This estimate is very similar to the number of dwellings in 5+ complexes that were estimated to be 'very likely to leak', using the pre-purchase report method described in Chapter 6, which estimated that 34890 were 'very likely to leak', with a 95% confidence interval of (31637,38402).

Complexes with known weathertightness failures were, on average, bigger than those without failures. It is not known if this relates to a greater probability of failures among larger complexes, or a greater probability that failures in larger complexes will be detected by owners. The probability that at least one homeowner will detect a weathertightness failure and bring it to the attention of the body corporate may increase as the number of homeowners in a complex increases.

The great majority of the failed complexes identified in the survey were built during the 11 year period: 1995-2005, which coincides with a peak in the number of multi-unit dwellings built, a period when untreated timber framing was allowed under some circumstances, and the period prior to the Building Act 2004 coming into force. The results suggest that the number of failed complexes has decreased since that time, but this finding should be treated with caution as these complexes have had less time for failures to become apparent, if they are leaking.

This chapter describes the results of a survey that asked about weathertightness failures among multi-unit complexes whose body corporates were managed by specialist companies. It estimates the number of multi-unit dwellings with failures that are known to the owners. Those dwellings may or may not be subject to weathertightness litigation or WHRS claims. Unlike Chapter 6, it does not estimate failures that are unknown to the owners and it does not cover single unit dwellings.

5.1. Method

Companies that provide body corporate management services for residential multi-unit complexes were identified by consulting with MBIE staff and searching in the yellow pages and on google. A total of 21 were identified, and all were contacted to request their participation in a survey asking for non-identifying information on the number and proportion of units they manage with known weathertightness failures. The companies that agreed to participate were emailed a spreadsheet template, and non-responders were followed up over a period of 8 weeks. Data from the companies did not include any identifying information about the complexes. Details of the statistical modelling of the estimate of the number of dwellings in complexes with known weathertightness failures are provided in Appendix A10.

5.1.2. Response rate

Responses were received from 9 of the 21 companies, comprising a response rate of 43%. Collectively, these companies managed a total of 1580 residential complexes, containing 36657 dwelling units. The survey attempted to get national coverage, but not all Territorial Authorities were covered. The survey results included complexes in the following territorial authority areas.

- Auckland Council
- Christchurch City Council
- Dunedin City Council
- Far North District Council
- Hamilton City Council
- Kaipara District Council
- Kapiti Coast District Council
- Lower Hutt City Council
- Marlborough District Council
- Napier City Council
- Nelson City Council
- New Plymouth District Council
- Palmerston North City Council
- Porirua City Council
- Queenstown-Lakes District Council
- Ruapehu District Council
- Taupo District Council
- Tauranga City Council
- Thames-Coromandel District Council
- Upper Hutt City Council
- Wellington City Council
- Western Bay of Plenty District Council
- Whangarei District Council

5.1.3. Definitions

The data described in sections 5.2 and 5.3 splits complexes and dwellings into two categories:

- those with known weathertightness failures, that were built within the year range 1985-present
- those with no known weathertightness failures, that were built at any time

Complexes without weathertightness failures could not be assigned to a built year as most companies did not hold this data for complexes that did not have problems.

This means that when a proportion of complexes or units with weathertightness failures is stated, it is the number of complexes or units with failures built 1985-2014, divided by the total number of complexes or units from all built years.

A complex was classified as having a weathertightness failure if it contained at least one failed dwelling. In most cases, either all, or none of the dwellings in a complex had failed, but in 14 of the 141 failed complexes, only some units had weathertightness failures.

The complexes and units categorised as 'failed' were those that were known to the surveyed companies. We cannot exclude the possibility that more will fail, but are not yet failing detectably, or are not yet known to the companies. Chapter 6 uses a method that estimates weathertightness failures that are both known and unknown to the dwellings' owners.

5.2. Characteristics of the complexes with weathertightness failures

Size

The complexes with weathertightness failures were, on average, bigger than those without failures. The average number of units for failed complexes was 43, nearly twice the average of 21 units per non-failed complex. Figure 5.1 shows the distribution of complexes with failures by the number of dwellings in the complexes. It is not known if this difference in size results from a greater probability of failures among larger complexes, or a greater probability that failures in larger complexes will be detected by owners. The probability that at least one homeowner will detect a weathertightness failure and bring it to the attention of the body corporate may increase as the number of homeowners in the complex increases.

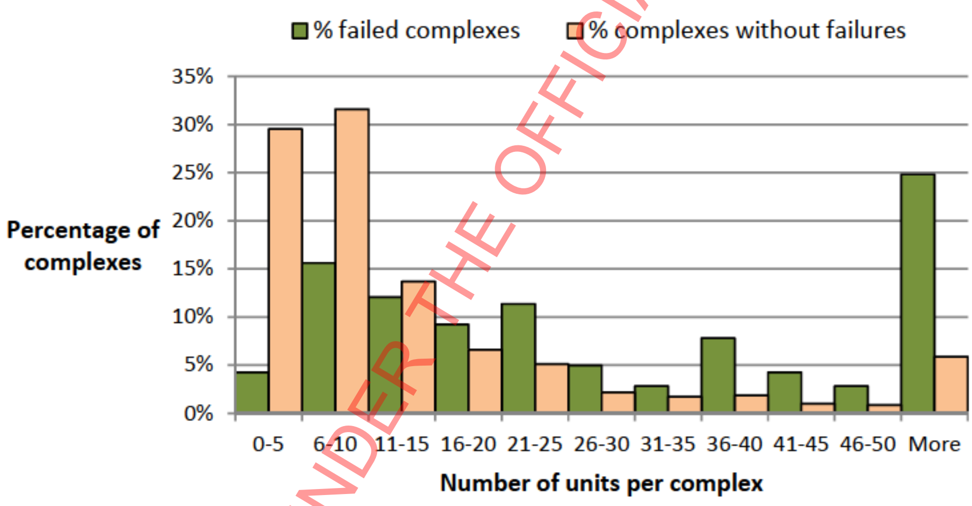

Figure 5.1. Comparison of complexes with failures (n=141) and complexes without failures (n=921) by size. The distribution of complexes with failures is skewed towards those with more units, as compared to those without failures. Note that the data on complexes without failures was restricted to those managed by two of the surveyed companies, as a breakdown of units per complex was not available from the other companies. These two companies accounted for 63% of the complexes and 56% of the units in the sample, and the distribution of their failed complexes across size bands was almost identical to the distribution in the overall sample of failed complexes.

5.2.1. Property type

Companies were asked to provide information on whether the complexes were apartment blocks, terraced housing blocks, duplexes, or complexes of standalone dwellings. None were able to provide this information consistently across all the complexes they managed, but it was provided for around half (49%) of the failed complexes in the sample.

Of the 69 failed complexes whose property type was known, 68% were apartment blocks, 29% were terraced complexes or duplexes, and 3% were classified as 'other' or mixed property type developments.

Apartment blocks tended to be bigger, with an average of 54 dwellings per complex (and accounting for 81% of the failed dwellings in the sample), while terraced complexes and duplexes had an average of 24 dwellings per complex (and accounted for 16% of the failed dwellings).

5.2.2. Year built

All of the failed complexes in the survey sample were built from 1985 onwards. Some companies were able to provide a further breakdown by year built. This further breakdown was available for 103 of the 141 complexes.

Figure 5.2 shows that the great majority of the failed complexes were built during the 11 year period of 1995-2005, which coincides with a period when untreated timber framing was allowed under some circumstances, and the period prior to the Building Act 2004 coming into force (Appendix B). It also coincides with a peak in the building of dwellings in multi-unit complexes, and this may in part account for the result.

Only 11 of the failed complexes were built before 1995, and further information on those complexes showed that half were built in 1994, and the remainder between 1988 and 1993. This suggests that weathertightness failures in complexes may be much more prevalent among complexes built from 1994/5 onwards than among those built earlier. There is also a 12-fold decrease in the number of leaky complexes built from 2006 onwards, as compared to those built in 1995-2005 (Figure 5.2). This is a sizeable decrease, although it should be treated with some caution as it is only an eight and a half year period, and these complexes will have had less time for any failures to become apparent, if they are leaking.

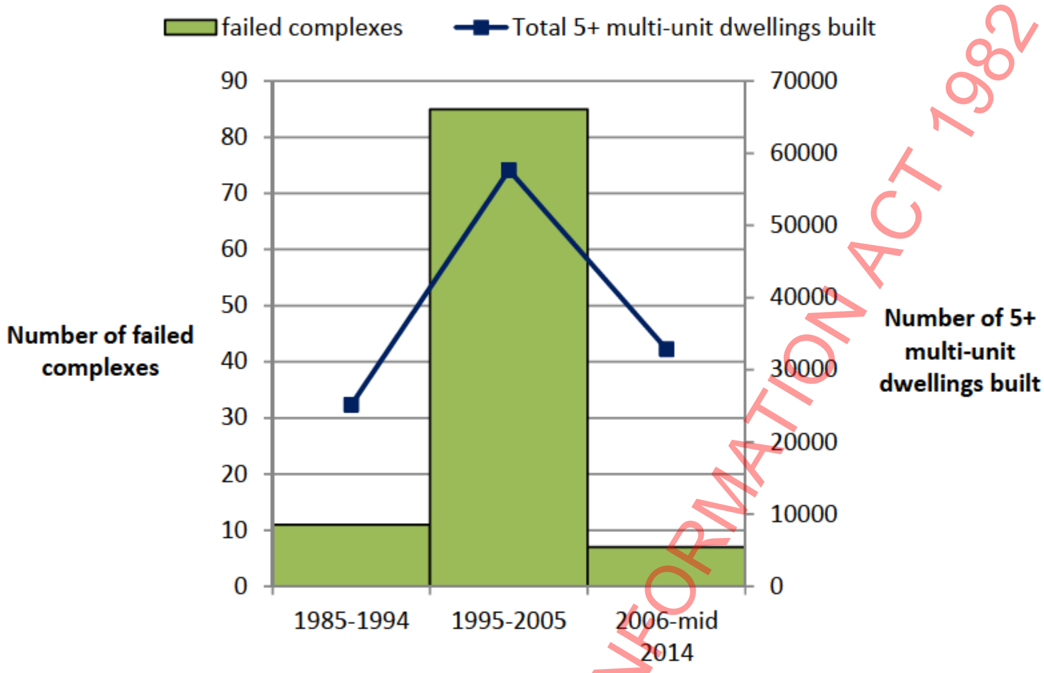

Figure 5.2. Year built for the 103 failed complexes for which this survey data was available (bars and left hand axis), and the total number of dwellings built in multi-unit complexes containing 5 or more dwellings (line and right hand axis). Year ranges were chosen to coincide with key changes in building and construction legislation and practices (Appendix B), so 1985-1994 is a 10 year period, 1995-2005 is an 11 year period, and 2006-mid 2014 is an eight and a half year period. The number of failed complexes is sourced from the multi-unit survey data and the number of 5+ multi-unit dwellings built is sourced from the modelled count of New Zealand dwellings and their characteristics (Appendix A6).

5.3. Remediation of the failed complexes

Companies were asked about the remediation status of the failed complexes that they managed. Data on remediation was provided for 140 of the 141 complexes. Figure 5.3 shows that remediation had been completed for 29% of the complexes, and was underway for a further 20%. Remediation was planned, but had not yet begun for 49% of the complexes, and no remediation was planned for 1%.

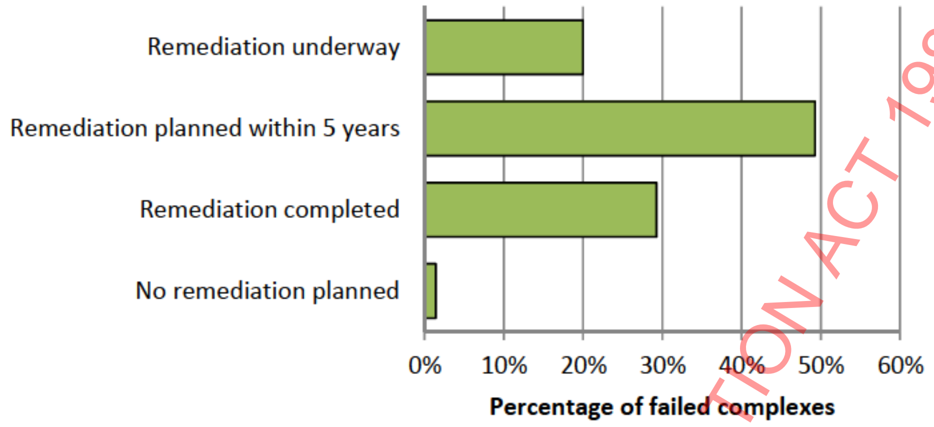

Figure 5.3. Remediation status for the failed complexes in the survey sample (n=140).

Further analysis showed no association between remediation status and complex size, with small and large complexes similarly distributed across the remediation status categories (data not shown).

Some companies chose to comment on remediation progress for specific complexes. Key points included the following.

- Of the two complexes for which no remediation was planned, one was hampered by disagreement among the owners about process, and the other had only just identified a problem and the owners had not yet met to discuss options.
- Complexes with planned remediation were at the stages where the owners were:
    - awaiting completion of weathertightness investigations
    - awaiting WHRS claim approval or a court trial
    - developing remediation plans
    - awaiting approval of the remediation plan by either the WHRS or the territorial authority
    - tendering and contracting for the work.
- Where remediation was underway, there was often mention of staged processes, where some units had been repaired and others were about to begin.
- Among the 5 comments on complexes with completed remediation, 4 had completed remediation quite recently, between 2012 and 2013, and one had completed before 2010.
- Two of the comments about remediation mentioned problems with owners arguing.
- Three comments mentioned that the remedial work that was now planned or underway was not the first attempt to fix the problem.

5.4. Estimation of the number of dwellings in complexes with weathertightness failures

The estimation of the number of New Zealand dwellings in complexes with known weathertightness failures took account of the bias in failures towards larger complexes (section 5.2), and extrapolated an estimate based on the size and number of complexes built in the 1985-2014 period, by territorial authority. The extrapolation was restricted to complexes that contained 5 or more dwellings, as smaller complexes were not well represented in the survey data on weathertightness failures. This method is described in more detail in Appendix A10.

The extrapolation from the survey data estimated that among the 115714 dwellings in 5+ complexes built 1985-2014:

- 37084 (32%) may have known weathertightness failures, with a 95% confidence interval of (34127,39690).

This estimate is actually very similar to the number of dwellings in 5+ complexes that were estimated to be 'very likely to leak', using the pre-purchase report method described in Chapter 6. This method estimated that among the 115714 dwellings in 5+ complexes built 1985-2014:

- 34890 are 'very likely to leak', with a 95% confidence interval of (31637,38402).

Table 5.1 presents estimates disaggregated by territorial authority. Differences in the proportion of estimated failures between territorial authorities relate to the differences in the size distribution of their multi-unit complexes; those with predominantly smaller complexes have a lower estimated proportion of failures.

Table 5.1. Number of dwellings in 5+ multi-unit complexes that are estimated to have known weathertightness failures, based on the survey of body corporate management companies

Territorial authority	Total number dwellings in 5+ multi-units*	Estimated number dwellings with failures	95% confidence interval
Ashburton District	245	section 9(2)(b)(ii)	
Auckland	57434		
Buller District	147		
Carterton District	53		
Central Hawke's Bay District	211		
Central Otago District	186		
Christchurch City	10406		
Clutha District	132		
Dunedin City	2220		
Far North District	1686		
Gisborne District	690		
Gore District	79		
Grey District	77		
Hamilton City	3784		
Hastings District	733		
Hauraki District	235		
Horowhenua District	341		
Hurunui District	210		

Invercargill City	405	section 9(2)(b)(ii)
Kaikoura District	37	
Kaipara District	168	
Kapiti Coast District	721	
Kawerau District	55	
Lower Hutt City	748	
Mackenzie District	81	
Manawatu District	464	
Marlborough District	896	
Masterton District	512	
Matamata-Piako District	511	
Napier City	783	
Nelson City	1042	
New Plymouth District	1787	
Opotiki District	96	
Otorohanga District	121	
Palmerston North City	945	
Porirua City	561	
Queenstown-Lakes District	1681	
Rangitikei District	26	
Rotorua District	921	
Ruapehu District	159	
Selwyn District	756	
South Taranaki District	163	
South Waikato District	200	
South Wairarapa District	49	
Southland District	65	
Stratford District	111	
Tararua District	67	
Tasman District	448	
Taupo District	868	
Tauranga City	2427	
Thames-Coromandel District	887	
Timaru District	413	
Upper Hutt City	535	
Waikato District	956	
Waimakariri District	611	
Waimate District	31	
Waipa District	939	
Wairoa District	32	
Waitaki District	250	
Waitomo District	72	
Wanganui District	577	
Wellington City	10862	
Western Bay of Plenty District	730	
Westland District	18	

Whakatane District	390	section 9(2)(b)(ii) [redacted]
Whangarei District	1669	

*Restricted to those built 1985-mid-2014. Source: modelled count of New Zealand dwellings and their characteristics (Appendix A6)

6. Estimation of failures using pre-purchase inspection reports

Key findings

An analysis of pre-purchase inspection reports was used to estimate the number of likely weathertightness failures among dwellings built between 1985 and 2014. This addresses the size of the hidden weathertightness problem, including failures that homeowners may not be aware of.

This method identifies considerably more failures than other methods because it does not rely on home owner awareness, and because it captures both systemic failures (that require a full re-clad to remediate) and localised failures that require only targeted repairs.

This method estimates that among the 649593 New Zealand dwellings built 1985-2014, almost 60% (379280) are 'likely to leak', with a 95% confidence interval of (340881,406948). Just under half of those dwellings (174394) are estimated to be 'very likely to leak', meaning that they have a higher likelihood of failure and they are more likely to be systemic failures (95% confidence interval: 140741,213277).

This is an estimate of the widest extent of the weathertight homes problem, covering systemic and localised failures, and failures that are and are not known to the owners. It is a large number of dwellings compared to the 9912 WHRS claims received, and compared to the consensus estimate of 42000, generated in 2009 (which covered dwellings built 1992-2008).

The difference between the pre-purchase report-based estimate and the estimate generated in 2009 results in part from the different methods used and the wider range of built years covered. Both estimates agree that there are likely to be many more dwellings with weathertightness failures than those are associated with WHRS claims. However the pre-purchase report-based estimate suggests that many more homes without monolithic claddings are likely to fail, and that the drop in weathertightness failures from 2006 onwards has not been as steep as that which was anticipated in 2009.

An analysis of factors associated with differences in failure rates found that failures occurred in dwellings with all cladding types, but that monolithic claddings had the highest overall proportion of failures, and were faster to fail. Timber claddings also had a high overall proportion of failures, but were much slower to fail. Failure rates among monolithic claddings were similar to the "extreme view" predicted in 2009 which estimated that 80-95% of dwellings with monolithic claddings built 1992-2005 would fail. Failure rates among non-monolithic claddings were considerably higher than what was estimated in 2009.

The speed of monolithic cladding failure may in part account for the much higher rate of WHRS claims among monolithically-clad dwellings. However the pre-purchase reports do not distinguish between systemic and localised failures, and it is also possible that the rate of systemic failures may differ more widely between cladding types.

The proportion of dwellings estimated to be 'very likely to leak' decreases among more recently built homes, but the decrease is more gradual than the sharp drop after 2004 that was anticipated in 2009. It is also more gradual than what would be expected based on the decrease in the number of

WHRS claims since the early 2000s. Again, it is possible that the number of systemic failures has decreased more sharply, and this may affect WHRS claim numbers.

The greatest number of failed dwellings are estimated to be located in the Auckland Council area, reflecting the large number of dwellings that were built there between 1985 and 2014. This is also somewhat affected by a slightly higher estimated rate of failure in Auckland, once other factors are accounted for.

This chapter describes the results of an analysis of weathertightness failures among dwellings that have undergone pre-purchase inspections. This method estimates size of the hidden weathertightness problem, including failures that homeowners may be unaware of, and including both systemic failures and less severe localised failures.

6.1. Rationale

Getting a true picture of the extent of weathertightness failures in the New Zealand housing stock would require invasive inspections of a representative sample of homes by specialist weathertightness inspectors, and this is unfeasible due to the imposition on home-owners. An analysis of pre-purchase inspection reports was carried out as a next-best option. While pre-purchase inspections may not be 100% accurate in identifying weathertightness failures, they are likely to be as accurate as non-invasive testing can be, when carried out by appropriately skilled building surveyors.

This method identifies considerably more weathertightness failures than other methods, because:

- it does not rely on home owners identifying weathertightness failures and therefore avoids the underestimate that results from their lack of knowledge of, or their unwillingness to acknowledge failures
- it identifies systemic weathertightness failures (that require a full re-clad to remediate) and localised weathertightness failures that require only a targeted repair. There is not enough evidence in the pre-purchase reports to distinguish between the two, so both are counted.

6.2. Method

6.2.1. Sample characteristics

2978 anonymised pre-purchase inspection reports for houses that had been built between 1985 and 2014 were obtained from Realsure. All inspections had been carried out between January 2009 and August 2014. The reports covered a range of areas, including urban, sub-urban and rural locations, across several Territorial Authorities, including some with high, and some with low numbers of WHRS claims relative to building activity (Chapter 2). Not all territorial authorities were represented in the sample (most notably the South Island was not represented). The data included dwellings in the following territorial authority areas.

- Auckland Council
- Wellington City Council
- Hamilton City Council
- Hutt City Council

- Upper Hutt City Council
- Porirua City Council
- Kapiti Coast District Council
- South Waikato District Council
- Carterton District Council
- Masterton District Council
- South Wairarapa District Council
- Tauranga City Council
- Palmerston North City Council
- Horowhenua District Council
- Manawatu District Council
- Rotorua District Council
- Western Bay of Plenty District Council

As well as data on weathertightness-related factors, the following variables were collected and used to control for bias in the sample (section 6.2.3).

- cladding type/s
- year built
- year of inspection (for calculation of the elapsed years between the built date and the inspection)
- city
- dwelling size (floor area)

The extracted data contained limited information on dwelling type, but most (85-90%) were standalone dwellings.

Automated data extraction was carried out by Dragonfly Science.

6.2.2. Testing the assessments

This analysis uses data from one building survey company, Realsure, to develop an estimate of the number of dwellings with weathertightness failures. The feasibility of obtaining data from other companies was investigated, but no other companies were found that could provide sufficient geographic coverage. Two methods were used to test the reliability of Realsure data in identifying weathertightness failures, as follows.

- A review of a random sample of 49 Realsure inspection reports was carried out by WHRS technical assessment staff. Overall, the evidence on weathertightness failures was light, but the reviewers felt that in most cases it was sufficient to support a judgement as to whether a dwelling was likely to fail. This review also identified phrases in the reports that correlated well with reviewers' assessments of the likelihood of a dwelling having a weathertightness failure (Section 6.2.3).
- A random sample of 48 pre-purchase reports were obtained from the Wellington company, BUILD Consultancy Services. Appendix A8 presents the findings from a comparison of the

likely weathertightness failures identified in BUILD Consultancy reports and in Realsure reports from Wellington. The two sources gave very similar estimates, suggesting that the Realsure findings are not anomalous.

6.2.3. Developing weathertightness indicators

Reports from Realsure use a standardised format, in which the surveyor selects from stock phrases to describe the findings from the inspection. While there is sometimes modification of the phrases, a review of a sample of reports found considerable consistency in wording, and found that searches for phrases could be used to identify homes with likely weathertightness failures. The search terms are described in Appendix A7. The indicators that are used in sections 6.3 and 6.4 are as follows.

- *Very likely to leak:* these dwellings showed high moisture readings in non-plumbing-related locations, and also:
    - either rot was found in exterior timbers, or
    - the inspector had recommended that a full weathertightness survey be undertaken.

  Most of those assessed as likely to leak had high moisture readings plus a weathertightness survey recommendation (70%), while 13% had high moisture readings and rot, and 17% had all three. These dwellings can be considered to be at high risk of having a weathertightness failure, although the certainty that this is so is not absolute. Failures may be systemic, or they may be localised within the dwelling, but failures are more likely to be systemic than those detected in dwellings assigned to the *'likely to leak'* category.
- *Likely to leak:* these dwellings had any one of the following:
    - high moisture readings in non-plumbing-related locations
    - rot found in exterior timbers
    - an inspector recommendation that a full weathertightness survey be undertaken

  This is a broader category that captures the dwellings assessed as *'very likely to leak'* as well as an additional group of dwellings that are at risk of leaking, but with a lower certainty that this is the case. While the number of dwellings in this category is very high, this indicator matched well with the findings of a WHRS technical review of the likelihood of leaking across a sample of reports (Appendix A7).

6.2.4. Estimating weathertightness failures and extrapolating a national estimate

The data was analysed to investigate which factors had statistically significant associations with weathertightness failures. Results of this analysis are described in section 6.3.

The extrapolation of a national estimate took account of these factors, estimating the total number of failures while controlling statistically for differences in the rate of failure associated with:

- built year
- the elapsed time between the dwelling's built date and the inspection
- cladding type
- location (by territorial authority)

A detailed description of the statistical modelling and estimation is provided in Appendix A9.

A modelled count of New Zealand dwellings and their characteristics with respect to built year, cladding type, dwelling type, and location was generated using data from Statistics New Zealand Census 2013, Statistics New Zealand new dwelling consents, and the District Valuation Roll provided by Data Insight Ltd. This was necessary because no one of these data sources provided all of the information needed to generate a national count of dwellings built 1985-2014, disaggregated by location, cladding type, and built year. Appendix A6 describes this model.

6.3. Factors that influence the weathertightness failure rate

Analysis of the factors that are statistically associated with differences in failure rates found that there were significant associations between the likelihood of failure and:

- cladding type
- built year
- location

There was no significant association found between house size (floor area) and failure rates. The relationships with each of the factors above are described in sections 6.3.1 to 6.3.3. The estimation of the number of dwellings with weathertightness failures, described in section 6.4, takes account of these factors.

6.3.1. The effect of cladding type

The statistical modelling found that failures were evident in dwellings with all cladding types, but that different cladding types had different rates of failure, some failing more frequently, and at a faster rate than others. Figure 6.1 shows the modelled failure rates for different cladding types over time, using the 'likely to leak' indicator (Section 6.2.3). The highest ultimate rate of failure was found among monolithic claddings, and those claddings were also the fastest to fail, reaching their maximum failure rate within 5 years. Timber claddings also had a high maximum rate of failure, but were much slower to reach that failure rate. Concrete claddings had a relatively low failure rate, but failed very quickly when they did fail.

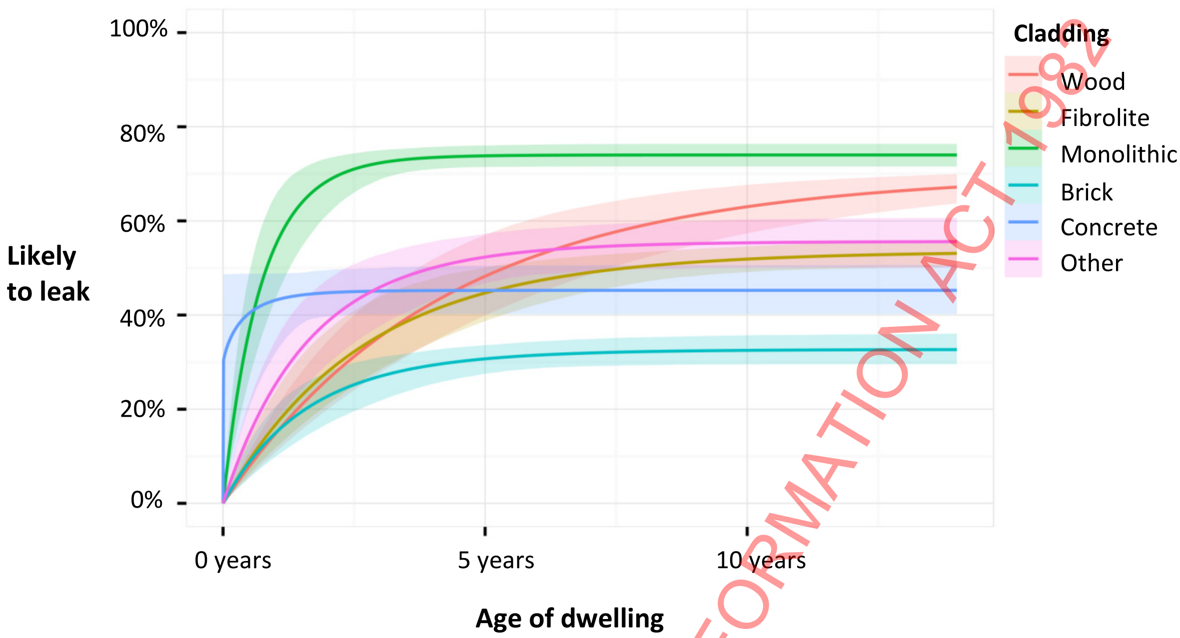

Figure 6.1. The average probability of a dwelling being 'likely to leak' by age and cladding type. These rates can be applied to dwellings with one type of cladding; dwellings with multiple cladding types had failure rates determined by their combination of claddings. Solid lines indicate mean failure rates while shaded areas indicate 95% confidence intervals. Cladding types were derived from pre-purchase report data and were simplified to match the cladding types listed in District Valuation Roll data from Data Insight. The wood category includes predominantly timber weatherboard and plywood. The fibrolite category includes fibre cement weatherboard and unplastered fibre cement sheet. The monolithic category includes predominantly plastered fibre cement sheet, EIFS, solid plaster, and stucco plaster. The brick category includes brick and brick veneer. The concrete category includes concrete and concrete block. The 'other' category includes metal, plastic, masonry, tiles, and miscellaneous other claddings.

Source: statistical modelling of pre-purchase report data, Dragonfly Science.

Compared to the failure rates by cladding type predicted in the 2009 report, these findings are closer to the "extreme view" which estimated that 80-95% of dwellings with monolithic claddings built 1992-2005 would fail.[7] Figure 6.1 also suggests that the failure rate among non-monolithic claddings is considerably higher than that estimated in 2009. The speed of failure among monolithic claddings, relative to other claddings may in part account for the much higher rate of WHRS claims among these dwellings, but it should also be remembered that these findings do not distinguish between systemic and localised failures, and the rate of systemic failure may differ more widely between cladding types than is indicated in figure 6.1.

[7] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost

6.3.2. The effect of location

The statistical modelling found that there was an association between territorial authority and the 'likely to leak' indicator, once cladding type was accounted for. Figure 6.2 shows these effects for the territorial authorities that were present in the pre-purchase report data. Auckland Council was the only territorial authority with an effect size significantly greater than 1.0, meaning that it has more dwellings that are 'likely to leak' than would be estimated from the dwellings' cladding types alone. The territorial authorities with an effect size significantly below 1.0 were: Upper Hutt City Council, the three combined Wairarapa councils, South Waikato District Council, and Hamilton City Council.

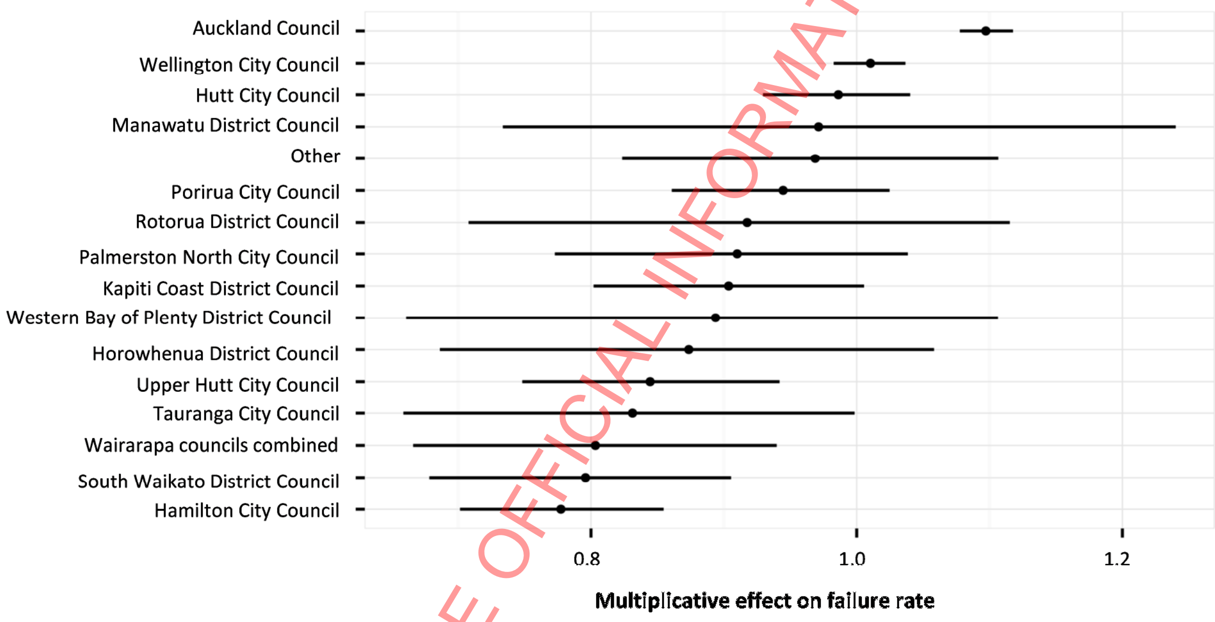

Figure 6.2. The effect of territorial authority on the 'likely to leak' indicator. These effects were multiplicative, that is, the proportion of dwellings in each territorial authority that was estimated to be 'likely to leak' was multiplied by the number shown. Round markers indicate the mean multiplicative effect and horizontal lines indicate the 95% confidence interval. Territorial Authorities that were not represented in the pre-purchase data were assigned a mean of 1.0 and a 95% confidence interval spanning the entire range shown in this chart.

Source: statistical modelling of pre-purchase report data, Dragonfly Science.

6.3.3. The effect of built year

The statistical model found that there was an association between built year and the 'very likely to leak' indicator, once differences were accounted for in cladding type, territorial authority, and the elapsed time between the built date and the pre-purchase inspection. Figure 6.3 shows the modelled effect of built year on the 'very likely to leak' indicator. Failure rates peaked in dwellings built 1990-1999 and dropped gradually thereafter. The lowest failure rate is found in dwellings built in the 2010-2014 period.

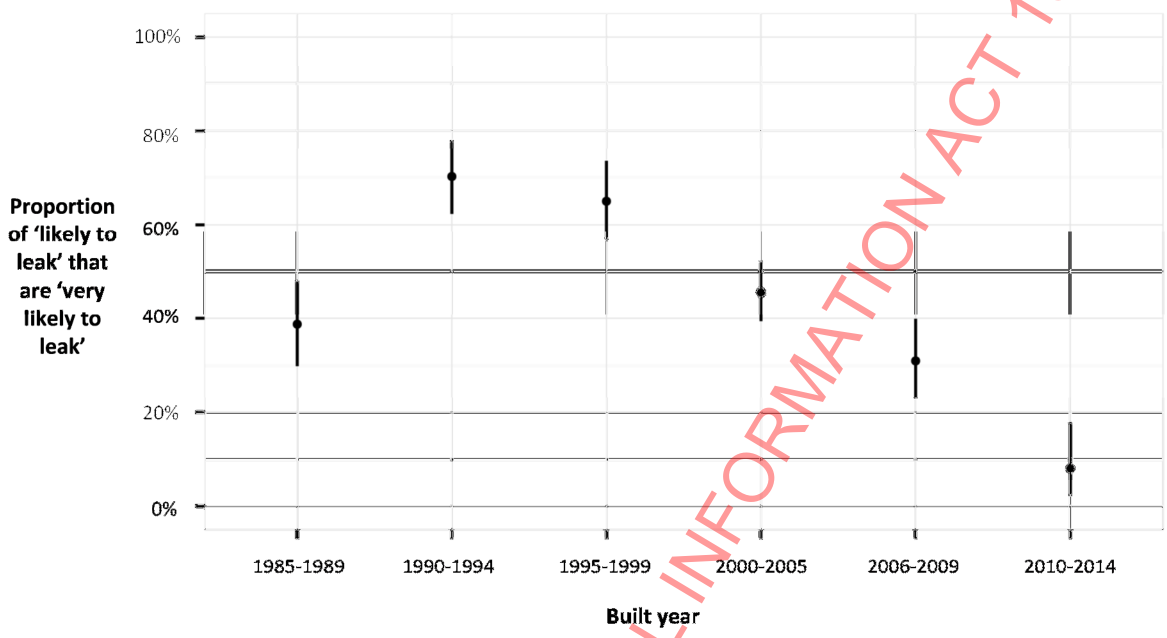

Figure 6.3. The proportion of the 'likely to leak' dwellings that are 'very likely to leak', by built year. Means are indicated by the round markers, and vertical lines indicate 95% confidence intervals.

Source: statistical modelling of pre-purchase report data, Dragonfly Science.

The estimated decrease in the rate of failure among dwellings built from 2000 onwards is more gradual than what might be expected, given the changes in the regulatory environment in 2004-05 (Appendix B), and the decrease in the number of WHRS claims received from post-2001 dwellings (Chapter 2). However, this decrease in the failure rate has occurred in combination with a decrease in the proportion of dwellings with higher risk monolithic claddings, so the actual decrease in failures is greater than Figure 6.3 alone would suggest (section 6.4.1). In addition, this data does not distinguish between systemic and localised failures, and it is possible that there has been a steeper decrease in the more severe systemic failures.

6.4. Estimation of the number of dwellings with weathertightness failures

The extrapolation of weathertightness failure rates took account of the factors described in section 6.3. The 'likely to leak' probability is the product of an effect for each territorial authority (Figure 6.2), and a failure rate depending on dwelling age and cladding types (Figure 6.1), and the 'very likely to leak' probability is derived from the 'likely to leak' probability by multiplying those rates by a built year effect (Figure 6.3). The modelled count of New Zealand dwellings and their characteristics (Appendix A6) contained data on built year, cladding type, and location, and the estimates below take account of the number of dwellings built with different cladding types, in different locations and at different times.

The extrapolation estimated that among New Zealand dwellings built 1985-2014:

- 379280 are 'likely to leak' (95% confidence interval: 340881,406948)
- Among those dwellings, 174394 have a higher likelihood of failure and are more likely to be systemic failures, thus are estimated to be 'very likely to leak' (95% confidence interval: 140741,213277).

This is an estimate of the widest extent of the weathertight homes problem, covering systemic and localised failures, and failures that are and are not known to the owners. It covers the 649593 dwellings built in the 29.5 year period from 1985 to 2014.

This is a large number of dwellings compared to the 9912 WHRS claims received, and compared to the 2009 consensus estimate of 42,000 (which covered dwellings built between 1992 and 2008).[8] The following sections provide further insights into the characteristics of this estimate, considering cladding type, built year, and location.

6.4.1. Estimated failures by cladding type and built year

The modelled count of New Zealand dwellings and their characteristics (Appendix A6) used data from rating valuations and Realsure pre-purchase reports to estimate the number of dwellings that used a monolithic system as at least one of their cladding types. Figure 6.4 indicates that the use of monolithic claddings peaked in 1994-2005. This is consistent with findings from the BRANZ materials survey, which found that the proportion of single-unit dwellings using a monolithic system as the main cladding type peaked at 37-40% in dwellings built in 1998-2002, and dropped thereafter.[9]

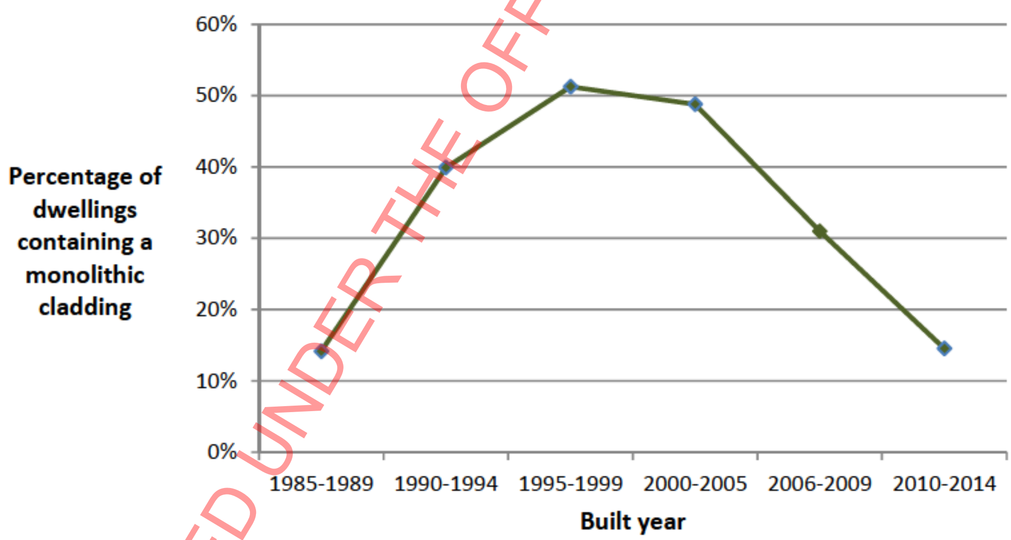

Figure 6.4. Dwellings using a monolithic system as at least one of the cladding types, as a percentage of all dwellings built, by time period. Source: modelled count of New Zealand dwellings and their characteristics, described in Appendix A6.

[8] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost.
[9] BRANZ (2009) New dwellings wall cladding, framing, timber treatment details. Report to the Department of Building and Housing, 1 May, 2009.

Table 6.1 provides the counts of dwellings that are estimated to be 'likely to leak' or 'very likely to leak', by built year and by whether or not they use a monolithic system as at least one of the cladding types.

Table 6.1. Number of dwellings that are 'likely' and 'very likely' to leak, by cladding and built year

Built year	Total number dwellings	Number dwellings 'likely to leak'	'Likely to leak' 95% CI	Number dwellings 'very likely to leak'	'Very likely to leak' 95% CI
Dwellings with a monolithic cladding system					
1985-1989	14839	10965	(9400,11950)	4381	(3259,5575)
1990-1994	39189	26979	(23214,29271)	19248	(16068,22751)
1995-1999	57849	41160	(36914,43855)	27195	(22979,31948)
2000-2005	76003	55468	(50230,58947)	25618	(21630,30107)
2006-2009	29613	21476	(18461,23306)	6855	(4898,9077)
2010-2014	11882	8841	(6835,9837)	757	(209,1670)
Dwellings without a monolithic cladding system					
1985-1989	90052	48742	(43499,53908)	18949	(14347,23895)
1990-1994	59166	32307	(28260,36323)	22703	(19051,26841)
1995-1999	55051	28339	(254147,31244)	18479	(15583,21782)
2000-2005	79533	38253	(34431,42087)	17449	(14650,20722)
2006-2009	66400	32166	(28529,35863)	9929	(7100,13079)
2010-2014	70016	34583	(30578,38708)	2831	(774,6200)

Figure 6.5 shows the trend over built years in the proportion of dwellings that are 'likely' and 'very likely' to leak, by whether or not they use a monolithic system as at least one of the cladding types. This data suggests the following.

- While dwellings with monolithic claddings are more likely to fail, there is still a high proportion of failures among dwellings that don't use monolithic claddings.
- Among dwellings estimated to be 'likely to leak', there is no change in the percentage of failures across built years, while a peak in failures for those built between 1990 and 2005 is detectable for those estimated to be 'very likely to leak'. This may relate to the greater likelihood that the 'very likely to leak' indicator has selected dwellings with systemic weathertightness failures.
- The change in the proportion of failures across built years does not differ much between dwellings with and without monolithic claddings, with a 1990-2005 peak visible in those estimated to be 'very likely to leak' among both those with, and those without, monolithic claddings.

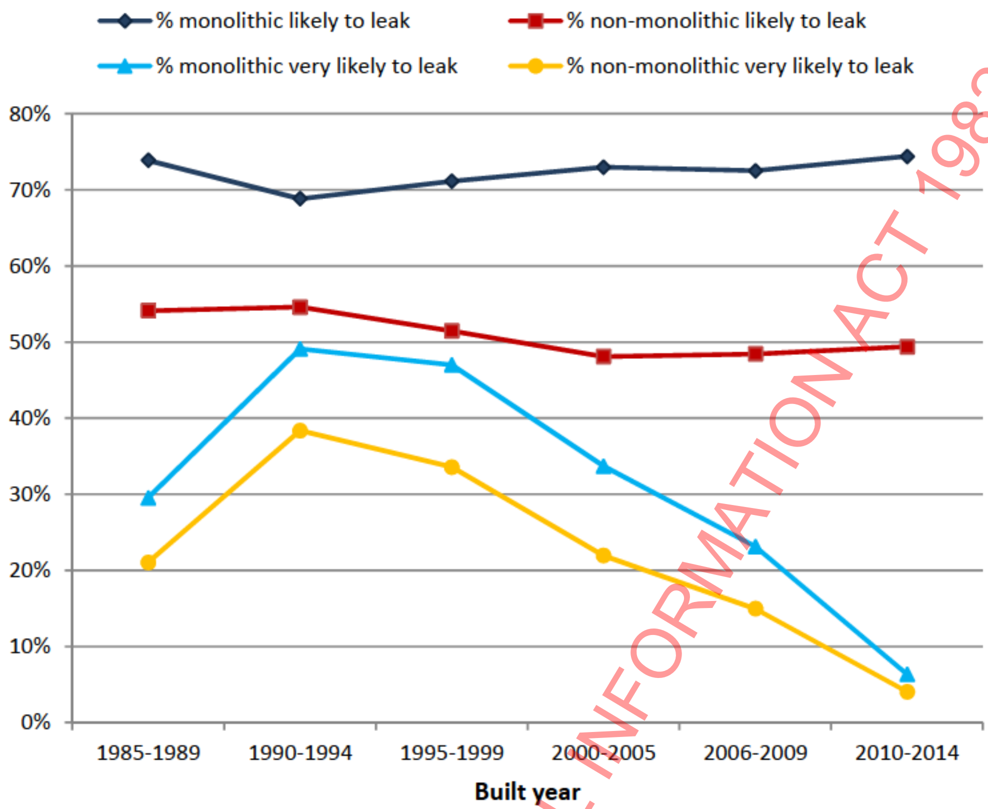

Figure 6.5. Estimated failure rates by built year, comparing dwellings that do, and do not, use a monolithic system as at least one of the cladding types.

The high proportion of failures among dwellings without monolithic claddings is somewhat surprising given that around 90% of the dwellings with WHRS claims use a monolithic cladding as one of their cladding types (Chapter 2). It is possible the failures among those without monolithic claddings are more likely to be localised than systemic, and are therefore less likely to lead to a WHRS claim.

6.4.2. Estimated number of failures by territorial authority

Table 6.2 provides the counts of dwellings that are estimated to be 'likely to fail' or 'very likely to fail', by territorial authority. Auckland Council has more than any other territorial authority, predominantly reflecting the large number of dwellings that were built there between 1985 and 2014, but also somewhat affected by the factors described in section 6.3, including the slightly higher estimated rate of failure in Auckland (Section 6.3.2).

Table 6.2. Number of dwellings that are 'likely' and 'very likely' to fail, by territorial authority

Territorial authority	Total number dwellings	Number dwellings 'likely to leak'	'Likely to leak' 95% CI	Number dwellings 'very likely to leak'	'Very likely to leak' 95% CI
Ashburton District	5175	3133	(2238,3683)	1691	(1200,2258)
Auckland	215736	142491	(138277,146652)	70679	(65645,76012)
Buller District	1713	971	(695,1178)	592	(402,793)
Carterton District	1382	793	(564,977)	430	(293,583)
Central Hawke's Bay District	1334	778	(567,932)	460	(320,618)
Central Otago District	3549	2078	(1490,2412)	964	(678,1282)
Christchurch City	60304	32752	(24132,38379)	16523	(11831,22003)
Clutha District	1514	874	(639,1025)	441	(308,590)
Dunedin City	12297	7033	(5141,8162)	3528	(2522,4676)
Far North District	11639	6966	(5023,8162)	4304	(3030,5743)
Gisborne District	3514	1980	(1452,2343)	956	(671,1268)
Gore District	845	451	(325,548)	231	(157,311)
Grey District	1445	781	(569,921)	394	(276,532)
Hamilton City	22430	9630	(8574,10642)	4524	(3971,5091)
Hastings District	7734	4626	(3296,5367)	2165	(1530,2889)
Hauraki District	3099	1712	(1251,2029)	880	(620,1176)
Horowhenua District	4133	2074	(1614,2532)	985	(761,1227)
Hurunui District	2730	1515	(1120,1759)	716	(507,955)
Invercargill City	3958	2109	(1522,2561)	1218	(850,1634)
Kaikoura District	922	507	(363,603)	233	(159,316)
Kaipara District	3791	2288	(1641,2672)	1374	(962,1827)
Kapiti Coast District	10682	5649	(4978,6321)	3182	(2725,3653)
Kawerau District	99	54	(35,72)	25	(13,40)
Lower Hutt City	5820	3511	(3273,3732)	1736	(1560,1921)
Mackenzie District	1056	641	(448,777)	411	(270,575)
Manawatu District	3715	2020	(1533,2405)	933	(694,1210)
Marlborough District	9861	5424	(3992,6350)	2778	(1971,3701)
Masterton District	3091	1770	(1294,2141)	1031	(723,1381)
Matamata-Piako District	4109	2126	(1548,2556)	1005	(715,1338)
Napier City	7441	4503	(3169,5227)	2185	(1559,2921)
Nelson City	9636	5720	(4128,6803)	3529	(2496,4698)
New Plymouth District	9256	5094	(3724,5988)	2371	(1685,3167)
Opotiki District	1076	621	(455,737)	311	(216,418)
Otorohanga District	916	530	(383,624)	255	(175,342)
Palmerston North City	9429	4931	(4168,5646)	2426	(2018,2826)
Porirua City	4673	2823	(2553,3085)	1297	(1136,1463)
Queenstown-Lakes District	11827	7401	(5151,8602)	3622	(2575,4812)
Rangitikei District	874	486	(353,588)	248	(172,334)

Rotorua District	7000	3667	(2834,4439)	1745	(1336,2171)
Ruapehu District	1106	669	(475,783)	319	(218,435)
Selwyn District	11866	5838	(4286,6956)	2323	(1642,3125)
South Taranaki District	1707	900	(651,1072)	393	(275,533)
South Waikato District	1056	474	(380,564)	213	(158,271)
South Wairarapa District	1540	758	(611,904)	423	(325,525)
Southland District	2737	1534	(1131,1786)	669	(473,895)
Stratford District	824	425	(307,517)	191	(131,259)
Tararua District	1339	730	(526,875)	361	(249,485)
Tasman District	10291	6192	(4443,7207)	3892	(2741,5177)
Taupo District	7418	4439	(3197,5157)	2284	(1616,3018)
Tauranga City	30394	14608	(11548,17460)	7435	(5845,9014)
Thames-Coromandel District	11759	6864	(4970,7966)	3522	(2502,4693)
Timaru District	4896	2716	(2001,3161)	1360	(965,1814)
Upper Hutt City	3803	1805	(1576,2045)	790	(668,920)
Waikato District	7628	3347	(2830,3865)	1361	(1132,1620)
Waimakariri District	13884	7306	(5325,8887)	4656	(3291,6212)
Waimate District	647	386	(273,461)	179	(122,245)
Waipa District	7959	4161	(3052,4968)	1961	(1395,2607)
Wairoa District	483	291	(205,357)	140	(91,195)
Waitaki District	2384	1327	(969,1555)	645	(452,866)
Waitomo District	634	363	(263,430)	173	(118,235)
Wanganui District	3789	2161	(1585,2534)	1085	(766,1453)
Wellington City	22085	14279	(13771,14791)	6796	(6265,7335)
Western Bay of Plenty District	9190	4718	(3489,5790)	2269	(1659,2853)
Westland District	1258	700	(510,822)	342	(241,460)
Whakatane District	3911	2191	(1603,2571)	1123	(794,1502)
Whangarei District	15196	8571	(6286,10063)	4238	(2997,5626)

Dwelling counts do not tally exactly with Table 6.1 due to the necessity of using different correction factors for the estimates disaggregated by Territorial Authorities and by built year (Appendix A6)

6.5. Comparison with the 2009 estimate

The 2009 report estimated that the number of homes built between 1992 and 2008 that would have weathertightness failures within 15 years, was between 22,000 and 89,000 with a consensus figure of 42,000.[10] The estimate described in this chapter differs considerably from this for several reasons. Two of those reasons relate to the different data sources used in this report, as follows.

- This report covers a much wider year range: 1985-mid-2014. This report estimates failure rates among the 649593 dwellings built during that period, whereas the 2009 report estimated failures among 400951 dwellings.

[10] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost.

- Both reports apply different failure rates to monolithically and non-monolithically-clad dwellings, but they use different estimations of the number of monolithically-clad dwellings. While the 2009 report estimated the number of dwellings that were predominantly monolithically clad (28-31% of dwellings built 1992-2008), this report estimates the number of dwellings that contain a monolithic cladding as at least one of the cladding types (44% built 1990-2009). For this reason, this report estimates a larger proportion of dwellings with monolithic cladding.

To compare estimates between the two reports, the rates of failure presented in the 2009 report were applied to the data sources in this report. The 1992-2005 failure rates in the 2009 report were applied to the 1990-2005 data in this report, and the 2006-onwards failure rates in the 2009 report were applied to the 2006-2014 data in this report. These rates are shown in Table 6.3.

Table 6.3. Failure rates from the 2009 report by year range and cladding type

	monolithic cladding	No monolithic cladding
'extreme view'		
1990-2005 failure rate	80.0%	2.0%
2006-2014 failure rate	0.2%	0.2%
'consensus view'		
1990-2005 failure rate	34.9%	0.39%
2006-2014 failure rate	0.2%	0.05%

* The 2009 report presented different failure rates for dwellings with high, medium and low risk designs. The risk ratings cannot be applied to the new data, so the failure rates given here cover dwellings across all three risk rating categories. This calculation has taken account of the number of dwellings in each risk rating category as well as the different failure rates for each category.

Source: PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost. Figures 12, 21, 42, 43.

Table 6.4 applies the 2009 'extreme' and 'consensus' failure rates to the data in this report on dwellings built 1990-2014, with and without monolithic claddings.

As shown in Table 6.4, the 2009 'extreme view' for dwellings built 1990-2005 produces a fairly similar overall estimate to the number of dwellings estimated to be 'very likely to leak' using pre-purchase report data. However there are two key differences.

- In comparison to the 2009 estimates, the 'very likely to leak' indicator estimates that many more dwellings without monolithic claddings are likely to have weathertightness failures.
- The 2009 report anticipated that there would be a sharp reduction in the number of failed dwellings with monolithic claddings built from 2006 onwards. While the 'very likely to leak indicator' supports the idea that there has been a reduction, it is not as steep as that which was estimated in 2009.

Table 6.4. Application of 2009 'extreme' and 'consensus' estimates and comparison with the 'very likely to leak' indicator

Built year	monolithic cladding	no monolithic cladding	*All cladding types*
Estimated number of dwellings 'very likely to leak' (this report)			
1990-2005	72061	58631	*130692*
2006-2014	7611	12760	*20371*
Estimated failures using 2009 report "extreme view" failure rates			
1990-2005	138433	3875	*142308*
2006-2014	83	273	*356*
Estimated failures using 2009 report "consensus view" failure rates			
1990-2005	60421	748	*61169*
2006-2014	83	62	*145*

The difference between the current estimate and the estimate generated in 2009 is unsurprising, given the different methodologies used. However, both estimates agree that there are likely to be many more dwellings with weathertightness failures than those that have made WHRS claims. The pre-purchase report-based estimate covers systemic and localised weathertightness failures, and may include dwellings that have failures, but that are not likely to result in WHRS claims as the damage is not severe. This may to some extent account for its higher estimate of the number of non-monolithically-clad dwellings with failures. Alternatively, there may be a sizeable weathertightness problem among non-monolithically clad homes, that is unrecognised, and was not anticipated in 2009.

7. Remediation and re-clad activity

Key findings

There is no complete or unambiguous data source on weathertightness remediation, and there are wide discrepancies between different data sources in the level of remediation that they predict.

A survey of closed claimants estimated that 96% of dwellings with claims had been or were to be remediated, and a survey of body corporate management companies that asked about failures in their multi-unit dwellings estimated that remediation was underway or completed for 46% of the failed dwellings, and was planned for another 54% (0.5% of dwellings had no remediation planned).

By contrast, estimating the level of remediation using WHRS FAP data and building consent data suggested that 3512-7265 dwellings with claims may have been remediated, and 4113-11149 dwellings not associated with claims may have been remediated or reclad. This comprises 10% or less of the 174394 dwellings estimated to be 'very likely to leak' (Chapter 6), suggesting a remediation rate much lower than that reported by home owners and body corporate management companies, in relation to their dwellings with claims and known failures.

It is not known which data sources are more accurate, but expert opinion suggests that only a fraction of dwellings with weathertightness failures have been remediated (Chapter 3).

Data sources are consistent in suggesting that there is a considerable amount of remediation occurring outside of the WHRS claims system. Building consents data suggests that around the same number of dwellings with and without claims have been remediated or re-clad.

This chapter describes analysis of the available data on remediation and re-cladding of homes that have had, or that may have had, weathertightness failures. There is no complete or unambiguous dataset on weathertightness remediation, so the figures presented in this chapter should be viewed only as a broad indication of the amount of remediation that may have occurred.

7.1. Data sources

7.1.1. Weathertight claimant and respondent survey

In 2009, a survey of WHRS claimants with closed claims was carried out by PS... Services', commissioned by the Department of Building and Housing. This survey obtained responses from 32% of the claimants contacted (n=213).

7.1.2. WHRS data on dwellings accessing the Financial Assistance Package

The Financial Assistance Package (FAP) was introduced in 2011 and provides an alternative path for WHRS assistance. The FAP provides financial contributions towards the cost of repair, and a process via which the WHRS can track the progress of the remediation of homes in the scheme. Unlike non-FAP WHRS claims, the remediation status of homes in the FAP scheme is known.

7.1.3. Building consents for re-cladding and weathertightness remediation

A dataset containing summary-level data on residential building consents for recladding and weathertightness remediation was supplied by Data Insight Ltd. This data was extracted by searching the description field of building consents for terms such as 'weathertight', 'clad', and 'leaky'. Further details on the characteristics of this dataset are in Appendix A11.

The Data Insight dataset provides New Zealand-wide coverage, but it is incomplete, especially for some territorial authorities. It has been supplemented with building consent data sourced directly from Tauranga City Council, in which the building consent description fields were searched for the terms 'remediation' and 'reclad'. Further details on the characteristics of this dataset are in Appendix A12.

Building consent data provides some indication of the number of dwellings that have been remediated, but it is likely to under-estimate remediation activity due to missing consents, and non-capture of consents for remediation when the search terms are not in the description field.

7.1.4. Auckland Council count of consents for re-cladding

Auckland Council provided anonymised data on the number of consents that they have received for re-cladding work. This data covers consents granted between 2001 and mid-2014, but the Council note that their data has improved over time, and there is likely to be more missing data in the earlier years of this time period. This dataset may therefore underestimate re-cladding and remediation, but on the other hand it may overestimate due to inclusion of some commercial buildings (which could not be excluded from the dataset), and inclusion of dwellings built prior to 1985.

7.1.5. Remediation data from the survey of body corporate management companies

The survey of body corporate management companies collected data on the remediation status of multi-unit complexes with known weathertightness failures. This data and its method of collection is described in Chapter 5.

7.2. Remediation of dwellings with WHRS claims

7.2.1. Survey of claimants with closed claims

In 2009, a survey of 213 WHRS claimants with closed claims found that close to two thirds (62 percent) said that they had fully repaired their homes.[11] Nearly one fifth (19 percent) reported that they had partially completed repairs and a further 19 percent reported that they had not completed repairs (Figure 7.1).

[11] PS…Services (2009). Weathertight Claimant and Respondent Survey.

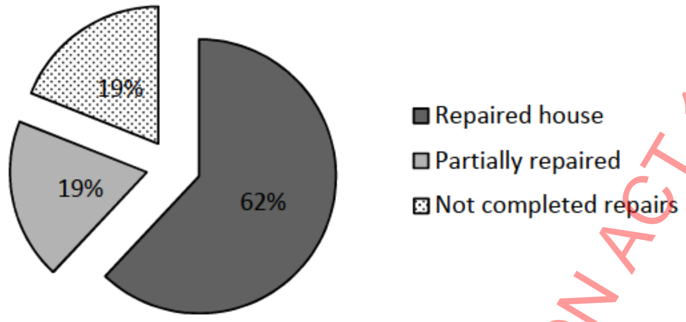

Figure 7.1. Progress towards repairs among closed claimant survey respondents (n=213).

Of the 38 respondents who had partially completed repairs, one had sold the home, and 32 intended to fully complete repairs. One did not intend to complete repairs, and four did not state what their future plans were (Figure 7.2).

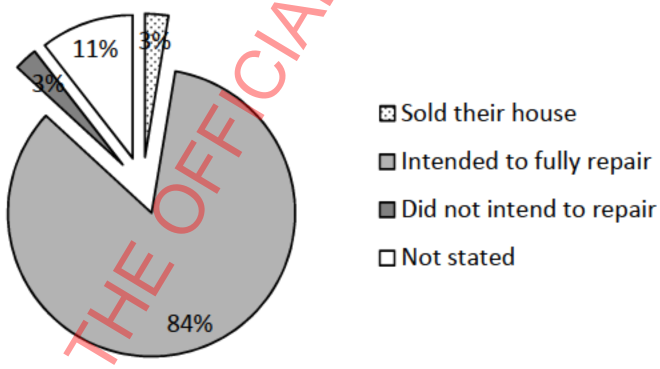

Figure 7.2. House ownership status and future intentions of closed claimant survey respondents who had partially remediated their houses (n=38).

Of the 39 who had not completed repairs, 10 had sold their homes without repairing, and 29 still owned their homes. Of the 29, 20 intended to repair, and 9 did not (Figure 7.3).

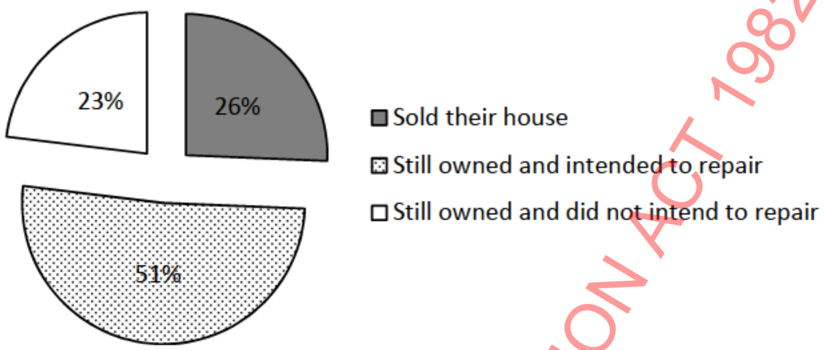

Figure 7.3. House ownership status and future intentions of closed claimant survey respondents who had not remediated their houses (n=39).

These survey results suggest that among past WHRS claimants, around 96% do remediate their homes. Only 9 out of 213 had not remediated and did not intend to. If 96% of the 9912 dwellings with WHRS claims have been remediated, this would bring the total number of remediated dwellings to 9516. However, there may have been bias in this survey. The survey response rate was 32%, and it is not known whether the 446 who did not respond differed in their remediation progress. Past claimants may have been less motivated to respond to the survey if their remediation efforts had gone badly.

7.2.2. Dwellings accessing the FAP

The FAP was introduced in 2011 and provides financial assistance for, and a process for tracking remediation of dwellings with WHRS claims.

Of the 2758 single unit dwellings with WHRS claims, 18% (506) have accessed the FAP. Dwellings accessing the FAP are committed to completing remediation once owners have submitted a home owner agreement. As of mid-2014, 322 of the 506 had passed this milestone and were either remediating or had completed remediation. WHRS Claims Advisors state that, in their experience, the great majority of participants in the FAP complete remediation eventually, although it can take some time. So while the remaining 184 single unit dwellings in the FAP have not yet committed to remediation, the owners have shown a motivation to remediate, and will most likely do so given time.

Of the 1062 multi-unit complexes with WHRS claims, 9% (96) have accessed the FAP. Of the 96, 49 have submitted a home owner agreement and were either remediating or had completed remediation. As discussed above, most of the remaining 47 complexes are also expected to follow through with remediation given time. The 96 complexes in the FAP account for 1340 dwellings with claims, and contain 1493 dwellings in total (not every dwelling in a complex is associated with a WHRS claim). This accounts for 19% of the multi-unit dwellings with claims.

Overall, 1846 dwellings with WHRS claims (single unit dwellings and dwellings in complexes) have accessed the FAP. This comprises 19% of the total number of dwellings with WHRS claims. These dwellings have either been remediated or are very likely to be remediated in future.

7.2.3. Re-cladding and remediation consents for dwellings associated with WHRS claims

The WHRS does not track remediation of dwellings when they have not accessed the FAP. Once a claim has been resolved via WHRS processes, owners may choose to remediate or not, and the WHRS is no longer involved.

Data on building consents issued for re-cladding and remediation (described in section 7.1.3) was matched by address to WHRS claims. This revealed that, further to the dwellings in the FAP scheme:

- another 622 single unit dwellings with claims had consents issued for remediation or re-cladding
- another 293 multi-unit complexes with claims had consents issued for remediation or re-cladding
- The 293 complexes accounted for 1044 dwellings with claims and contained a total of 1723 dwellings (not every dwelling in a complex is associated with a WHRS claim).

These 1666 single unit dwellings and dwellings in complexes comprise 17% of the total dwellings with WHRS claims. These dwellings are very likely to have been remediated, but the following caveats mean that this is likely to be an underestimate.

- The building consent data is only available for a limited year range: from 1999 onwards for Tauranga City Council data, and from 1996 onwards for the Data Insight data. Re-cladding and remediation consents issued before this time have not been captured, and the coverage of consents in the earlier years within this period may also be patchy, as territorial authority data capture processes have improved over time.
- Building consent data may be incomplete for some territorial authorities. Comparison with data sourced directly from Tauranga City Council shows that the New Zealand data supplied by Data Insight captured only 29% of the WHRS claim-associated consents that were in the data sourced directly from Tauranga City Council. Tauranga City Council data was therefore used to supplement the national dataset. It is possible that missing data is an issue for other territorial authorities too, and an adjusted estimate is also discussed below.
- Consents for remediation that do not mention any of the keywords that were searched for have not been captured. A list of the keywords is in Appendix A11.
- Remediation work that did not trigger a consent application has not been captured. This may particularly result in an underestimate of remediation completed before 2008, as an amendment to the Building Act on 14 March, 2008 reinstated the 1993 provision requiring durability failures to be repaired under a building consent.

7.2.4. Overall estimate of remediation rates among dwellings with WHRS claims

The following estimate is expressed as a broad range only. This is because several limitations with the available data mean that only a very broad indication of the level of remediation can be determined.

Table 7.1 summarises the data on remediation of dwellings with claims gathered from WHRS records on the FAP scheme, and building consent data on re-cladding and remediation.

Table 7.1. Number of dwellings with claims by their known remediation status*

	Participating in the FAP	Non-FAP but with consented remediation	*Total with known remediation*	*Total with no known remediation*
Multi-unit complexes	96	293	*389*	*673*
Dwellings with claims in complexes	1340	1044	*2384*	*4770*
Single unit dwellings	506	622	*1128*	*1630*
Total dwellings with claims	1846	1666	*3512*	*6400*

* Dwellings are assigned to the known remediation category if they are in the FAP scheme or have a re-cladding or remediation building consent in the Data Insight or Tauranga City Council consents dataset. For reasons outlined in the body of this report, this is likely to under-count remediation.

As summarised in Table 7.1, 3512 of the 9912 dwellings with WHRS claims are known to be pursuing remediation through the FAP scheme, or are known to have had consents issued for remediation or re-cladding. This comprises 35% of the dwellings with WHRS claims, and is well below the estimate, based on the 2009 survey of claimants with closed claims, that 96% of dwellings with claims are remediated.[12] As discussed above, there are reasons to believe that data on building consents underestimates the number of dwellings remediated. The New Zealand data undercounts consents, capturing only 29% of those with WHRS claims, that are in the data sourced directly from Tauranga City Council. If this is assumed to be representative of the undercount across New Zealand, an adjustment can be made that estimates that 5419 dwellings with non-FAP claims may have consented remediation.[13] If this adjustment is valid, the number of dwellings pursuing remediation, including via FAP, comes to 7265, comprising 73% of claims. This is much closer to, but still less than the total of (96%) suggested by the survey findings. As discussed, there may have been response bias in the survey, with claimants that were managing to remediate more likely to respond.

The number of dwellings with WHRS claims that have been, or that will be remediated is therefore likely to lie between 3512 and 9416, but is probably at the upper end of this range, given that New Zealand consents data appears to undercount consented remediation, and that unconsented remediation is not possible to detect.

7.3. Remediation of dwellings without WHRS claims

7.3.1. Re-cladding and remediation consents for dwellings not associated with WHRS claims

The following estimates use data sourced from Data Insight Ltd and Tauranga City Council on building consents for re-cladding and weathertightness remediation (described in section 7.1.3). This data is incomplete as there is missing data from some territorial authorities, as only consents issued

[12] PS ... Services (2009). Weathertight Claimant and Respondent Survey.
[13] This adjustment multiplies the 1533 dwellings with consented remediation and non-FAP claims that are outside of Tauranga by 1/0.29. This comes to a total of 5286 and is added to the 133 from Tauranga.

from 1996 onwards are covered, as the search terms may not have captured all remediation or re-cladding consents, and remediation work that did not trigger a consent application is not included. For these reasons, the numbers below are likely to underestimate the amount of remediation and re-cladding that has occurred, although there may also be some overestimation due to re-cladding for non-weathertightness reasons (however, this is somewhat minimised by the exclusion of consents that mentioned fire damage, earthquake damage, and/or house relocation).

Data on building consents issued for re-cladding and remediation contained 4113 consents for dwellings that were not associated with WHRS claims. The data did not have sufficient information to allow a precise determination of the number of dwellings covered by these consents, but most appeared to refer to one dwelling only and in some cases there were several consents for a complex, each referring to a separate dwelling. However, this data may still underestimate the number of dwellings in multi-unit complexes with remediation or re-cladding consents, as a few consents covered more than one dwelling. The Data Insight information on property type suggested that just over half (51%) of the consents were for dwellings in multi-unit complexes, and that 8% were for dwellings in multi-unit complexes of 5 or more dwellings.

As described in section 7.1.3, a comparison with data sourced directly from Tauranga City Council showed that the New Zealand data undercounts consents, capturing only 34% of those without WHRS claims, that are in the data sourced directly from Tauranga City Council. If this is assumed to be representative of the undercount across New Zealand, an adjustment can be made that estimates that 11149 dwellings that are not associated with WHRS claims may have consented remediation or re-cladding.[14]

It is therefore estimated that at 4113 to 11149 dwellings that are not associated with WHRS claims may have undergone consented re-cladding or weathertightness remediation. This is subject to considerable uncertainty however. Caveats with the data mean that, on balance, this may be an under-estimate.

7.4. Multi-unit survey remediation data

Chapter 5, Section 5.6 reports on the remediation status of the multi-unit complexes managed by the surveyed body corporate management companies. Table 7.2 summarises these results. Remediation had been completed for 27% of the dwellings, and was underway for a further 19%. Remediation was planned, but had not yet begun for 54% of the dwellings, and no remediation was planned for 0.5%.

[14] This adjustment multiplies the 3628 non-WHRS claim dwellings with consented remediation or re-cladding that are outside of Tauranga by 1/0.34. This comes to a total of 10664 and is added to the 485 from Tauranga.

Table 7.2. Percentage of dwellings and complexes in the multi-unit survey by remediation status, and estimated total numbers of dwellings in 5+ multi-unit complexes*

Remediation status	% of failed complexes	% of failed dwellings	Estimated mean no. dwellings	Estimated range†
No remediation planned	1%	0.5%	185	171-198
Remediation completed	29%	27%	10013	9214-10716
Remediation planned within 5 years	49%	54%	20025	18429-21433
Remediation underway	20%	19%	7046	6484-7541

* Further information on the multi-unit survey is provided in Chapter 5.

† Based on the 95% confidence interval of the estimated number of multi-unit dwellings with failures, section 5.7.

Extrapolating the remediation proportions up to the estimated number of dwellings in 5+ multi-unit complexes with failures (section 5.7), an estimated 15698 to 18257 dwellings have remediation completed or underway, and 18429 to 21423 have remediation planned within 5 years (Table 7.2). This estimate is restricted to dwellings in multi-unit complexes of 5 or more dwellings only, and it is greater than what would be expected based on consents and WHRS data (sections 7.2 and 7.3).

7.5. Re-cladding and remediation relative to the estimated number of weathertightness failures

The analysis of pre-purchase report data (Chapter 6) estimated that among New Zealand dwellings built 1985-2014:

- 379280 are 'likely to fail' (95% confidence interval: 340881,406948)
- Among those dwellings, 174394 have a higher likelihood of failure and are more likely to be systemic failures, thus are estimated to be 'very likely to fail' (95% confidence interval: 140741,213277).

With regards to remediation of dwellings with weathertightness failures, different methods of estimating the number of dwellings that have been remediated give different results. Methods that ask owners about remediation of known failures give much higher estimates:

- The survey of closed claimants estimated that 96% of dwellings with claims had been or were to be remediated (section 7.2.1)
- The survey of known failures among body corporate management companies estimated that remediation was underway or completed for 46% of dwellings in complexes, and planned for another 54% (section 7.4)

By contrast, methods that count the number of dwellings that have been, or are to be remediated via the FAP scheme, and estimate the number of additional remediations and reclads using building consent data suggest that:

- 3512-7265 dwellings with claims may have been remediated (section 7.2.4)

- 4113-11149 dwellings not associated with claims may have been remediated or reclad (section 7.3.1)

The sum of the upper limit of these ranges (18414) only comprises 10% of the estimated 174394 dwellings with a higher likelihood of failure, suggesting a remediation rate much lower than that reported by owners and managers of dwellings with claims and known failures.

It is not known which rates are more accurate, but expert opinion gathered via key informant interviews suggests that only a fraction of dwellings with weathertightness failures have been remediated (Chapter 3)

One factor that is evident from the analysis of building consent data is that there does appear to be a considerable amount of remediation happening outside of the WHRS claims system. Data from building consents suggests that at least the same number of dwellings with and without claims have been remediated or reclad.

The building consent and FAP data does not capture remediation that has not been consented (while the survey of closed claimants and body corporate management companies may capture some sub-consent level remediation. Anecdotally, there is a considerable amount of remediation occurring at the sub-consent level, although its effectiveness is unknown, and during the analysis of claiming behaviours in selected developments (Chapter 4), the reviewer found evidence that some homes had undergone remedial work that may not have triggered consent requirements, but that may have been effective in improving weathertightness. For example, google streetview images showed some homes had cap flashings that had not been specified in their original consents.

8. Homeowner reasons for non-remediation

Key findings

There is a large hidden problem where people are not aware they have a home with a weathertightness issue.
- This means that we are not in a position to fully remedy the problem.
- This also creates limitations when exploring why houses aren't remediated.

Cost is by far the biggest barrier to remediation in cases where people are aware of the problem.

The cost to remediate is generally much larger than people expect and often they don't have the money and can't borrow it.

Other barriers are more transitory in nature and include emotional issues associated with the grieving process, and delaying factors such as the complexity of multi-unit claims.

People who can afford to remediate are able to find the positives in the situation and use those factors to encourage themselves to fix their houses (for example, 'we caught it early', 'our house is cheaper to fix than some others', 'at least there aren't any toxic moulds in our house').

8.1. Method and rationale

This chapter builds on the work done in 2009[15] and explores why some houses with weathertightness issues have not been remediated. The objectives are to explore:

- factors that might contribute to a lack of awareness amongst home owners,
- barriers and enablers that affect whether homeowners remediate when they are aware that their house has a problem.

The findings are qualitative, based on a review of relevant literature and interviews with key industry informants.

8.1.1. Assumptions and limitations

The weathertightness issue is in many ways a hidden problem – through lack of awareness, or through owners taking private remedies. While a qualitative approach can canvas opinion about the experiences of all homeowner behaviour, there is likely to be a bias towards the attitudes and behaviours of owners who come into the public eye in some way.

8.1.2. Literature Review

The reports reviewed for this chapter are:

MBIE's evaluation of the Financial Assistance Package (FAP) in 2013, which provides some insights into homeowner behaviours when making WHRS claims, with case studies of ten homeowners who participated in the FAP. Available: http://www.dbh.govt.nz/UserFiles/File/Building/Reports/pdf/fap-full-evaluation-report.pdf

[15] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost.

PS... Services' weathertight claimant and respondent survey (2009), commissioned by the Department of Building and Housing, which reports on the results of a survey of claimants with closed claims, and provides some insights into the processes that claimants go through before making a claim, and the remediation strategies that were (or were not) followed once claims were closed.

PricewaterhouseCoopers' report 'Weathertightness – estimating the cost' (2009), which included a brief collation of expert opinion on factors that prevented homeowners from recognising weathertightness failures, and factors that discouraged them from taking action once a leak was recognised. Available: http://www.dbh.govt.nz/userfiles/file/news/whrs/pdf/pwc-weathertightness-estimating-cost-full-report.pdf

8.1.3. Semi-structured interviews

Interviews were undertaken with thirteen key informants. The types of key informants are listed in Table 8.1.

Table 8.1. Interviewees by type

Participant	Number of interviews
Weathertightness Assessors/Property surveyors	6
MBIE claims advisors	3
Claimant representative	1
Banks	2
Local Government	1

8.2. Findings

This chapter discusses the factors that could mean that an owner is not aware that their house has a weathertightness issue. It then explores the various ways that homeowners become aware of the problem, and their pathways to action once awareness is established. Common factors that hinder the likelihood of the house being remediated (barriers) and factors that increase the likelihood of remediation (enablers) are then identified and discussed.

8.2.1. Pathways to awareness

Several factors influence whether a house with a weathertightness failure has issues that are detectable by the owner.

Key informants stated that some areas of New Zealand are more likely to have problems earlier. These include areas exposed to salt spray, wind exposed areas, and wet parts of the country. Also, houses that are not well maintained will have problems earlier (however good maintenance only mitigates and delays problems with their root in design, workmanship and product issues). A property surveyor gave an example where he estimated that a very well maintained textured fibre cement board cladding on one house he inspected would last 25 years, while others in the neighbourhood had failed much earlier.

Key informants and the published reports suggested various avenues by which owners can be alerted to the possibility of a weathertightness failure in their homes. These avenues are as follows.

- Most common is that the owner decides to sell their house, and is alerted to the problem through a potential buyer's building inspection.
- Another common avenue is when an owner tries to get a code of compliance certificate (CCC), in preparation for selling the house, or to a complete the paperwork after the house is built. One building surveyor stated that there was a lot of confusion in the 1990s and early 2000s as to who (the owner or the builder) should obtain the CCC, meaning that in many cases, no one got it. His understanding was that "up to 50 percent of houses in the 1990s didn't get a code of compliance".
- Another common event prompting awareness is when a painter is hired, and the painter notifies the owner that cracks in the cladding could be a sign of a bigger problem.
- Some other examples of awareness triggers mentioned in case studies of FAP recipents were:
    - a builder came in to do another repair and suggested that there may be a weathertightness problem
    - the owner discovered small isolated leaks and realised the problem was more widespread
    - the owner did some small repairs to cladding and discovered more extensive problems.[16]

8.2.2. Pathways to action

Homeowners who identify that their houses have weathertightness problems have a number of options open to them. If they are within ten years of their built date, they can decide to litigate and/or to lodge a claim with the Weathertight Homes Resolution Service (WHRS). Outside of the ten year limit these options are closed, but they can still decide to pay for the remediation work themselves, or they may be able to come to a private arrangement with the liable parties. Another option is to not remediate and sell the house, rent it out, or continue to live in it.

Even when people are aware that their house may have an issue, there are the complexities of the human psyche to navigate. Key informants agreed that there is no one path for people who do not remediate their houses; "each story is different". Homeowners may have to go through a grieving process before they can take action, and people are unique in how they approach that. Homeowners need to come to terms with the fact that the value of their property has dropped, often significantly, and "behaviour at that time is often driven by what people can afford".

Therefore, some common themes at this time are cost, perceived time and hassle, delay, confusion, denial, and disagreement (where one member of the household wants to remediate and the other doesn't). One property surveyor said that sometimes he has reason to believe the owners "might be trying to do something dodgy". That is, trying to sell their house and claim no knowledge of the issues. However, another property inspector stated that most people he has come across are honest and don't want to "pass their problems onto someone else".

[16] Ministry of Business, Innovation and Employment (2013). Evaluation of the Financial Assistance Package.

The findings from the WHRS closed claims survey[17] has limitations in that it only covers a subset of the 'aware' homeowners (WHRS claimants). These people may differ in attitudes and behaviours to other types of homeowners with houses with weathertightness failures who are not claimants. The findings on remediation rates among closed claims are described in Chapter 7. In summary, these results suggest that among past WHRS claimants, the great majority do remediate their homes, while the proportion who do not remediate appears to be less than 5% (9 out of 213). However, there may be bias in this data. Past claimants may not be representative of all owners of leaky homes, and those who responded to the survey may not be representative of all past claimants.

Among survey respondents, reasons for not repairing usually related to cost, with seven saying that they could not raise the required funds, or that the resale value of their home did not justify the cost. Six decided that selling their home without repairing was a better option, one person could not find tradespeople to do the repairs, and one could not repair because they could not determine the source of the leak.

A report compiled by MBIE in October 2013 presents nine case studies of homeowners who participated in the Financial Assistance Package (FAP) process.[18] The proportions in the case studies roughly matched the findings above. Six of the nine (67 percent) had completed repairs and three (33 percent) had not started repairs. Of the three who had not started repairs, one couple were not going to repair, one said they were going to make a decision soon and the other was doing "smaller fixes" and "maintenance" to stop further deterioration (a full reclad had been recommended). Affordability was a factor for all three. Again, these are homeowners with 'visibility' in the public system, so they may not be representative of all homeowners.

8.2.3. Investment properties

This chapter has largely focussed on owner occupiers, although people who own property as an investment are also affected by ownership of houses with weathertightness issues. Key informants suggested that their attitudes differ from those of owner occupiers.

The Auckland Property Investors Association conducted an informal, small-scale survey of members regarding weathertightness issues, and provided the results to MBIE.[19] Out of the six who responded, four property investors believed that weathertightness failures had a detrimental effect on property values, while one did not, and one was "not sure".

Three had properties in their portfolios that were experiencing weathertightness failures. Each of them owned between 1 and 5 properties in this category; two were remediating, the third was not. The property investor who was not remediating stated that "My 'leaky' property only leaks a little, and has treated timber so it does not rot. It gives me a much higher rental yield than a comparable building since I bought it cheap. So the only issue arises is when it comes time to sell, and the stigma when selling".

Consistent with this, three of the remaining five property managers said that they would consider buying a property that had a weathertightness failure and three considered that they were no harder to rent out than other properties.

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[17] PS…Services (2009). Weathertight Claimant and Respondent Survey.
[18] Ministry of Business, Innovation and Employment (2013). Evaluation of the Financial Assistance Package.
[19] Email correspondence between MBIE and the Auckland Property Investment Association (APIA), April 2014.

8.2.4. Summary of Barriers to remediating homes from literature and interviews

In their 2009 report, PWC suggested that some of the reasons that houses have not been remediated included:

- problems that have yet to visibly manifest (and, of which, home owners are therefore, ignorant)
- slower manifestation of problems in drier areas of the country
- denial behaviour by home owners of the existence and/or potential severity of problems and hence urgency of need to address them
- inability of some home owners to finance any form of major repair
- the transaction costs of pursuing a claim
- procedural obstructions to bringing claims on behalf of all owners within a multi-unit complex.[20]

The following factors could mean that a house is never remediated (at least by its current owners).

Lack of awareness

The most common barrier to remediation is lack of awareness. This has the potential to have the largest unknowable impact on the future housing market and people's financial, physical and emotional health.

The results presented in Chapter 6 suggest that the number of homes with weathertightness failures unknown to the owners may be very large. This is consistent with opinion among key informants, all of whom agreed that there is a large "hidden" problem. One believed that the size of the problem is 10 percent of all New Zealand housing stock and "we haven't seen much of that [coming to the public view]". Another stated that we have only seen about 20 percent of cases so far. Another said he believed it was more likely to be 10 -15 percent and only a fraction of those have been fixed.

Repair costs are unaffordable

Cost was identified as the most significant barrier to remediation once homeowners are aware that they have a problem (both by key informants and in the literature). Most commonly, people cannot afford it, but in some cases they can afford remediation but have calculated that it isn't worth the money (discussed in the next section).

MBIE Claims Advisers stated that out of the 'stalled' claims in their caseload, roughly 85 percent are believed to be affordability issues, while the rest are either clients who are not motivated to fix their houses, clients facing emotional issues such as the property being part of a divorce settlement, or multi-unit claims experiencing problems where one or more owners can't or won't pay or can't be contacted.

In order to be eligible for the Financial Assistance Package (FAP), a homeowner must show they have the finance available to fund the repairs. In some cases, this is a substantial amount of money. There are some mitigating factors built into the FAP process such as working with banks on behalf of homeowners and offering guarantees for loans, and the banks attempt to utilise the 10 percent

[20] PricewaterhouseCoopers (2009). Weathertightness – estimating the cost, page 2.

available to them for low loan to value ratio (LVR) lending. Even so, affordability is a barrier for many of these homeowners.

Claims Advisers report that among stalled claims, obtaining finance is often an issue. Repair costs can be much higher than the owners anticipated and owners cannot obtain finance from banks because:

- they do not have enough equity in their homes (sometimes they have 100 percent mortgages)
- they don't earn enough to cover their mortgages as well as the repair costs.

Claims advisers state that when they follow up with this group of claimants, they usually indicate that they are still saving for repairs.

Litigation is also a resolution pathway with high up-front costs that are unaffordable for many homeowners. Or homeowners may not have any parties to pursue.

One key informant suggested that working with territorial authorities to institute stepped repair plans that can be added to the LIM would stop the 'deer in the headlights' phenomenon caused by large upfront repair costs.

Cost benefit analysis is not favourable

Another factor that can be a barrier to remediation is when people weigh up their options the calculation favours non-remediation.

Some examples given in interviews and reports include:

- a retired couple in their 80s stating that "the house will outlast them"
- an owner stating that the sale price of their house doesn't justify remediation
- landlords who are getting good rental return for their properties as is and don't want to spend money.

Indecision and inaction can also result from weighing up the pros and cons of the situation when there is not a clear benefit for the owner. In one example, the cost of re-cladding the home was more than the house was worth. The owner could not, at the time of publication, decide what to do. He stated that the house was "almost worthless" without remediation, but that he was getting a good rental return for it. Getting it fixed would be costly and the FAP process would take time and energy and only pay for 25 percent of the costs. Even if he did get it fixed it would still have the stigma of being a leaky home as this was recorded on the LIM report.[21]

8.2.5. Factors that add delay

The following factors delay remediation.

Multi-unit claims

Some examples of issues that delay remediation in multi-unit complexes are:

[21] Ministry of Business, Innovation and Employment (2013). Evaluation of the Financial Assistance Package, page 47.

- overseas landlords who cannot be reached
- landlords for whom it is an investment property only
- owners for whom English is a second language
- owners who are in denial
- owners who cannot afford repairs.[22]

These owners can be difficult to contact and difficult to convince to get involved in a claim process. The interviewed key informants reinforced this view. One property surveyor had been refused access to an apartment in a housing complex because the owner denied there were any issues with his apartment.

Pre-purchase inspections

Some of the key informants stated that there are housing inspectors who are failing to give accurate reports on homes with weathertightness issues, and as a result, buyers are unaware that they are buying a leaky home. This has the effect of delaying awareness, and the new owners may not become aware of the problem until the home is beyond the 10 year liability period. There may be an opportunity to tighten up requirements on house inspectors.

Emotional factors as barriers

The next biggest delaying issues were emotional factors, with many owners struggling to come to terms with the idea that they need to pay to fix something that "is not their fault". Unwillingness to pay can be a bigger barrier than ability to pay, although a claims advisor stated people usually move through this stage eventually.

Table 8.2. Summary of the barriers to remediation

Barrier	
Awareness	Problems yet to visibly manifest
	House inspector says house is OK when purchased
Financial	Cost of remediation
	Cost of litigation
	Cost/benefit analysis in favour of 'doing nothing'
	No parties to pursue
	Banks won't take on new lending for disclosed 'leaky' houses (i.e. if a builder wanted to buy the house cheaply and remediate, they would find it difficult to get a loan for that)
Emotional	Unwillingness to pay
	Denial about the extent of the problem e.g. no visible signs inside
	Unwillingness to go through the time and effort of a claim
	Indecision
	Stress of litigation
	Stigma (on LIM, stigma remains even if the home is fixed, fear of further remediation work)
Practical	Inability to get owners to agree (in cases of multi-unit dwellings)

[22] Ministry of Business, Innovation and Employment (2013). Evaluation of the Financial Assistance Package, page 47.

8.2.6. Factors that enable remediation

As well as factors that act as barriers or delays to remediation, there are some factors that enable people to remediate.

These factors were outlined in the case studies in the FAP Evaluation[23] and by key informants.

Affordability

As described in the barriers section, the single biggest barrier to remediation is that it is unaffordable for some people. Conversely, for those who can afford it this is a significant enabler.

One couple described in a FAP evaluation case study stated that they felt fortunate that they could afford repairs and that their house was not as bad as some others (e.g there were no toxic moulds found). Another couple from the same study felt they "were one of the lucky ones" in terms of the extent of the issue -their house only needed a partial reclad. Both sets of claimants were pleased to be able to recoup part of the costs from the FAP.

One key informant added that those who could afford to remediate sometimes saw it as an opportunity to upgrade/remodel their houses (e.g. put in double glazing, new kitchens etc.)

Banks are also very motivated to lend to borrowers who can afford the repayments as they are then assured that the value (which the bank has a stake in) remains in the house.

Multi-unit claims

There are provisions under the Unit Titles Act to force individual owners to pay for remediation work through levies. Although it is a very lengthy process, motivated body corporates can be more successful in convincing reluctant owners to remediate. These owners would possibly not remediate if they owned a stand-alone property. One bank representative also suggested that he believes the number of multi-unit apartments undertaking remediation will start "ranking up" with an escrow deed being signed between banks which will make the process for owners in multi-unit complexes and their banks more straight forward.

Table 8.3. Summary of enablers to remediating homes from literature and interviews

Enablers
They can afford to remediate
Feeling fortunate as their situation could have been worse (e.g. Discovering there were no toxic moulds, discovering issues earlier rather than later)
They can afford to make the repairs and see it as an opportunity to remodel/upgrade their house e.g. an opportunity to upgrade to double glazing
Pressure from other owners (in cases of multi-unit dwellings)
Body corporates having powers under Unit titles Act
Having FAP to reimburse some of the costs
Banks will try to lend to remediate (existing loans only) – drawing on 10 percent of low LVR lending allowed to them

[23] Ministry of Business, Innovation and Employment (2013). Evaluation of the Financial Assistance Package.

Selling disclosed leaky houses

There is some evidence that owner occupier purchasers who are desperate to get into the Auckland housing market are buying homes that are openly being sold as 'leaky" with the intention of "fixing a wall this year, a wall next year" and that vendors are getting more money for them than previously expected.[24]

"You'd expect them to sell for somewhere between land value and CV but they're getting closer to CV." [25]

One key informant said he also believed vendors were "getting too much" for disclosed leaky properties as purchasers were in denial about the extent of the issues and the impact on their lives and health.

New Zealanders have a culture where of relying heavily on home ownership for wealth creation. Several key informants noted the detrimental impact of weathertightness issues on the future wealth of New Zealanders, and flow on effects on health and wellbeing.

[24] http://www.landlords.co.nz/article/4672/desperate-buyers-turn-to-leaky-homes (2013).
[25] Ibid.

9. Deterioration of unremediated dwellings

Key findings

While houses with weathertightness failures are observed to deteriorate over time, there is considerable variation in the rate of deterioration. Among houses that have had multiple WHRS assessments, time between assessments only accounts for 6 percent of the variation in costs to repair.

Building experts suggest that the higher the number of risk features, the quicker houses will fail – all other things held equal. However, other things (such as climate, level of workmanship and other factors) are not equal for each house so the complexity of working out the deterioration rate needs to encompass these other factors.

There continues to be disagreement among building experts as to the relative importance of different factors in determining deterioration rates, but key factors, where there was a consensus that they have an effect include:
- whether the framing is treated
- the quality of the original design and installation, including the products chosen
- the level of maintenance by the owner
- the location, with factors such as wind exposure, sun, salt spray, and movement of the house due to seismic, wind and thermal fluctuations
- the types of leaks (gravity-fed versus wind-induced).

This chapter looks at the rate and nature of deterioration for houses with weathertightness failures. The material in this chapter is derived from a quantitative analysis of repeat assessments, a review of selected literature, and semi-structured interviews with key informants. The quantitative component of this chapter analyses the deterioration rates for houses that have had more than one assessment by an MBIE contracted weathertightness assessor and looks for a pattern that could describe the overall level of deterioration. The qualitative component builds on the quantitative findings by looking at how high risk features interact with other factors such as climate and workmanship to contribute to the different deterioration rates for houses.

9.1. Deterioration between WHRS assessments

This section describes an analysis of the changes in the estimated cost to repair, and the nature of repairs needed for dwellings that have had repeat WHRS weathertightness assessments.

9.1.1. Changes in cost to repair over time

Appendix A13 describes an analysis of the relationship between the assessed cost to remediate and time between assessments, for dwellings with WHRS claims that have had two or more assessments. The analysis found that while there was a statistically significant positive correlation between time and cost to repair, there was considerable variability between houses, and time between assessments only accounted for 6 percent of this variability. Therefore there is only a very weak relationship between time and cost to repair.

9.1.2. Changes in the nature of the recommended repair over time

A second analysis tested for a relationship between elapsed time and the type of recommended repair. This assessed whether, as time between assessments increased, there was also an increase in the proportion of dwellings that went from having a targeted repair recommended at the first assessment, to having a full reclad recommended at the second assessment. The analysis found no significant relationship between time between assessments and change in the repairs recommended (Appendix A13).

9.1.3. Summary of quantitative results

The very weak relationship between time and cost to repair, and the lack of a significant relationship between time and recommended repair suggests that factors other than time play an important part in determining the rates of deterioration of dwellings with weathertightness failures. The remainder of this chapter describes a qualitative investigation of these factors, via key informant interviews.

9.2. Other factors that affect deterioration rates

Qualitative data on deterioration of leaky homes was gathered from semi-structured interviews with eight key informants from the building industry. Table 9.1 shows the distribution of interviews by the type of interviewee.

Table 9.1. Interviewees by type

Participant	Number of interviews
Building surveyor	7
Territorial authority	1

The very weak relationship between time and deterioration, as measured by cost to repair, suggests that time alone only explains a small amount of the difference in deterioration rates (section 9.1). While it may seem that there should be a stronger relationship, key informants noted that every house deteriorates at a different rate depending on a number of factors. These factors are:

- whether the framing is treated
- the quality of the original design and installation, including the products chosen
- the level of maintenance by the owner
- location, with factors such as wind exposure, sun, salt spray, and movement of the house due to seismic, wind and thermal fluctuations
- the types of leaks (gravity-fed versus wind-induced).

The following sections describe these factors in more detail. It is important to note that key informant opinion can differ. In these cases, a majority opinion is presented as a conclusion in each subsection.

9.2.1. Treated versus untreated timber

Once water has penetrated the house, deterioration has begun, and as the leaks get established they fan out and find more 'food' and deterioration continues. Different rots, fungi and moulds like different 'foods', and will attack different building components. If the house has untreated timber framing and cellulose in the cladding, this a ready source of food for rots and moulds, and deterioration will happen more quickly. One key informant said that untreated timber can rot in as little as 6 months. In houses that have treated timber the deterioration is likely to be slower at first (5 to 6 years for boric treated timber – key informant). However, if enough water penetrates the cladding, over time this will wash treatments out of timber.

9.2.2. Design and installation

There was a general belief among key informants that failure starts from the beginning, when the house is built.

These initial risks as identified by building experts include:

- poor design (including inappropriate design relative to the dwelling's location, its ease of maintenance, and the materials used)
- poor workmanship, with the contributing factors:
  - a building boom leading to rushed jobs and inadequate supervision
  - inadequate apprenticeship training
  - private certifiers allowing substandard work to be certified.

"Poor workmanship meant that they were failing from day one".

"Risks in design and mistakes in construction".

Key informants differed in the relative attribution of failures to design or workmanship faults, but overall both were thought to be contributors.

9.2.3. Cladding products

Some key informants believed that monolithic cladding products were inherently failure-prone and that knowledge when houses with weathertightness issues were being built allowed systems to be used that only had a limited life. One said that fibre cement is not a cladding product that should be used even though it is still being used today.

Others stated that they believed the main issue with the products wasn't the products themselves but that they were used incorrectly, or to do jobs they were not designed for. This was a key point of disagreement among key informants. This is consistent with the 2009 findings where professionals had divergent views about failure rates among cladding types with some believing that all or almost all houses with monolithic claddings would fail while others thought that only those with high risk designs would fail.[26]

"the products were used in ways that shouldn't have been"

"lack of following manufacturer's instructions"

9.2.4. Maintenance

Most key informants agreed that good maintenance slows the rate of failure and reduces the extent of damage. There is however, a high level of maintenance required for monolithic claddings.

[26] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost.

According to one key informant, the cladding needs to be cleaned every three months, any cracks that appear should be sealed and and painted, and the whole cladding should be re-painted every five years. This informant noted that most people do not think that level of maintenance should be required and many people bought houses with monolithic claddings because they were considered to be low maintenance.

Another building surveyor said that it was important not to overstate the impact of maintenance for the following reasons.

- When houses fail, in some cases within ten years, there is insufficient time for maintenance to have an effect. In his experience, people were often doing maintenance, including re-painting, in cases where the problem was already well advanced, and he believed this to be a waste of money as the cladding would need to be replaced anyway. *"Maintenance doesn't get a chance to kick in"*
- He considered that the problem always went back to the original design, and that a lack of maintenance had only rarely hugely exacerbated problems.

A Department of Building and Housing publication on E2/AS1, on describing how to prevent weathertightness issues over the lifetime of the home, states that:

"…there is little point in providing a junction that relies on a coating being regularly maintained if the junction is, for example, impossible to access by a homeowner or if the homeowner does not understand the importance of regular "normal" maintenance"[27]

Key informants generally agreed that good maintenance means houses may deteriorate more slowly. One suggested that a combination of fewer risk features (e.g. Lower scores on the E2/AS1 risk matrix) and good maintenance may help slow deterioration. However, it was generally thought that homes with original design and installation faults, even if well maintained, would not last the 50 years required under the NZBC.

9.2.5. Location

Location-based exacerbations include:

- salt spray
- sunny sites
  - claddings deteriorate faster (especially darker claddings)
  - causes thermal movement
- high rainfall
- high wind speeds
  - wind-driven rain
  - causes movement

Not all key informants agreed that the above factors affected deterioration rates. However, it was generally agreed that an exposed house (due to design or placement on site) on an exposed site with a high rainfall would deteriorate faster than a more protected house in a sheltered, dry area.

[27] Department of Building and Housing (2006) External moisture – An introduction to weathertightness design principles, page 7.

9.2.6. Types of leaks

One key informant stated that gravity-fed leaks are more consistent and cause more damage if they get established. There was some contention amongst the other key informants as to whether gravity-fed leaks were worse than other types of leaks (e.g. capillary or wind driven leaks) with most building experts believing “a leak is a leak” and that water causes damage no matter it gets in. However, one key informant added that gravity-fed leaks are likely to cause problems all the way through a building, culminating in a lot of damage at the ‘bottom’ of the leak as the water spreads out.

The DBH publication on external moisture offers this interpretation.

> *“For low-rise buildings, gravity leaks are usually more of a problem than wind-induced leaks, in contrast to high-rise buildings where wind pressures tend to dominate”*[28]

[28] Department of Building and Housing (2006) External moisture – An introduction to weathertightness design principles, page 12.

Appendix A. Data sources and methods

A1. WHRS data extraction and cleaning

Data was extracted for the WHRS claims received as of 27 June, 2014.

Inclusions and exclusions

Data included open and closed claims. Claims that were ineligible *only* because they had exceeded the 10 year period since the built date were included, but claims that were ineligible for other reasons were excluded. Excluded claims included those that were ineligible because:

- the house was not a leaky building
- the house had not been damaged as a result of being a leaky building
- the claimant was not the homeowner
- the property was not a residential building.

For units in complexes, only those that were dwellings were counted. Common property units were excluded from the analysis.

The few dwellings in the WHRS database that were built before 1985 were excluded from the analysis. Dwellings with unknown built dates were included, except in the analyses by built year.

Eliminating duplicates

Some properties had more than one associated WHRS claim, resulting in duplicate records in the WHRS database. Reasons for multiple claims include changes of ownership, changes in claiming practices for complexes (with the Weathertight Homes Resolution Services Act 2006 enabling class actions for multi-unit properties), and second generation claims in which properties returned to the WHRS for further remediation. Duplicates were eliminated through a review of dwelling addresses. Where duplicate claims were found, the record that was retained was the one with the most recent assessment date.

Further data cleaning

Further data cleaning involved the following steps.

- Reviewing complex names and rationalising those names where inconsistencies were found. Some complexes had been assigned more than one name, and these were re-grouped under just one name, so that the number of complexes would not be over-counted.
- Reviewing data on the total number of units in complexes and, where inconsistencies were found, checking this data with claims advisors.
- Cleaning and harmonisation of data on the total number of dwellings with claims within each complex.
- Development of a harmonised built year field, which primarily used the built date stated on the claim application form, because this was the most complete data field. For 55 records where the built date on claim application was missing, the following data was used instead, in order of preference:
    - year construction completed
    - year building consent issued + 1 year

- year final inspection
- year Code Compliance Certificate issued

For 17 dwellings there was no data and built date could not be determined.

A2. Satellite and street-view-based assignment of multi-unit property type among WHRS claims

For multi-unit complexes with a total of 5 or more residential units, satellite and street-view images (maps.google.co.nz) were used to determine the property type.

The property type was assigned as an 'apartment multi-unit complex' if:

- dwellings shared a common entrance, such as a lobby or stairwell, and
- dwellings were configured as strata dwellings; above and below each other.

Other multi-unit property types that were grouped into the category 'non-apartment multi-unit complex' included:

- multi-unit complexes with 4 or fewer residential units
- terraced complexes, where dwellings were side by side, and may share common property such as driveways, but do not have common entrances
- side-by-side duplexes
- standalone dwellings in a complex
- mixed developments including any of the above, but no apartment buildings.

For a few complexes, satellite and street-view images did not allow unambiguous identification of the property type. In these cases, the researcher made a best guess, based on the available information. While this may have created a small amount of inaccuracy, there is no reason to believe that this is biased in either direction.

A3. Statistics New Zealand new dwelling consents 1991-2013

Customised building consents data (Annual-Dec) was obtained from Statistics New Zealand. This dataset counts building consents for new dwellings built by territorial authority and meshblock, for the period 1991-2013. The data is also disaggregated by:

- whether the consent was for a single unit dwelling or a complex of dwellings
- size band of the complex (2-4 units; 5-9 units, 10-29 units, 30+ units)
- floor area bands (1-119 sq m; 120-200 sq m, 201 or more sq m).

Some limitations with this data are as follows.

- The data does not allow a good classification of multi-unit complex types into apartment or non-apartment complexes. It distinguishes consents for multiple dwellings from others, and classifies dwellings as 'apartments' if 10 or more dwellings were specified in the consent.
- Data broken down by territorial authority is not available prior to 1991 due to the major reorganisation of local government boundaries that occurred in 1989-1990.
- There is no data on the cladding types used.

This data has been used to:

- calculate the number of dwellings with WHRS claims as a proportion of new dwellings built, so as to compare claiming rates over time across territorial authorities
- correct for the undercount of dwellings built 1985-2014 in the Data Insight national count of dwellings (Appendix A6).

In line with the practice in the previous estimate of weathertightness failures,[29] it was assumed that the built date of a new dwelling was one year after its consent date. For example, dwellings with WHRS claims that were built between 1992 and 2014 are most validly compared to Statistics New Zealand data on new dwelling consents in 1991-2013.

A4. Data Insight national count of dwellings

Data on the number and characteristics of dwellings in New Zealand was supplied by Data Insight Ltd. This dataset uses the District Valuation Roll as its primary source, but it also contains some data sourced from building consents and land title information.

This data has been used to:

- compare the volume of dwellings with WHRS claims to the total number of dwellings built in New Zealand by territorial authority and property type
- input into the modelled count of New Zealand dwellings and their characteristics (Appendix A6).

Some limitations with this data are as follows.

- There is no definitive source of information on the year that the property was built, and this has been modelled by Data Insight using a combination of territorial authority ratings data, Land Information New Zealand data, building consents, and sales data. There may be some error introduced by the modelling, and this data is expressed as broad year ranges only. It undercounts dwellings built 1985-2014, relative to Statistics New Zealand building consents data (Appendix A3), especially for some territorial authorities.
- Relative to 2013 census data on the number of dwellings, this dataset slightly undercounts the number of dwellings. The 2013 census counted 1,736,226 occupied and unoccupied private dwellings, while the Data Insight national count of dwellings counted 1,475,755, and in particular undercounts dwellings from some of the smaller more rural territorial authorities.
- Data on cladding type relies on valuer judgement, and has little detail. For example, the data does not distinguish between different types of roughcast cladding, or between cladding that is over a cavity, or is direct-fixed to the framing. Reliance on the judgement of the valuer means that the cladding on the street-facing elevation is more likely to influence the categorisation than cladding on other elevations, and that the data is not 100% accurate. It

[29] PricewaterhouseCoopers (2009). Weathertightness – Estimating the Cost.

is, however, reasonably consistent with cladding data from the BRANZ materials survey (data not shown).[30]

A5. Collection and analysis of data from Judicial Decisions Online

A search of Judicial Decisions Online (https://forms.justice.govt.nz/jdo/Search.jsp) for weathertightness-related Court decisions outside of the WCC and AC areas was gathered by searching with the term: *weathertight*. This search retrieved 331 results. The content of each decision document was reviewed to determine whether it involved a residential property, and whether the property was located outside of Auckland and Wellington. A few properties were subject to more than one judicial decision, and these properties were only counted once.

For the 33 properties that fitted these criteria, a second stage review used WHRS data and the content of the decision document to determine whether the properties were also subject to WHRS claims. Only 3 of the 33 were not claims.

The following restrictions on the coverage of Judicial Decisions Online should be noted.

- All cases from the Supreme Court are available
- High Court cases from 2005 onwards only are available
- Court of Appeal cases from 2003 onwards only are available
- District Court cases are not available
- The following decisions are not published.
    - Decisions subject to statutory prohibitions or orders prohibiting publication
    - Decisions subject to time-limited suppression orders
    - Decisions relating to bail applications or bail appeals (unless the Court concerned determines otherwise in the particular case)

A6. Modelled count of New Zealand dwellings and their characteristics

Due to the limitations with the available data sources on New Zealand dwellings (Appendices A3 and A4), a modelled count of New Zealand dwellings and their characteristics was generated by Dragonfly Science. This modelled data included a record for each dwelling and its location, and imputed values for each dwelling's built year, cladding types, property type (single unit or complex), and complex size. The data set was built from the Data Insight national count of dwellings, and scaled at the meshblock level to match the 2013 Census reported dwelling numbers. Estimates generated using this data set were later subject to a second scaling step, which used Statistics New Zealand consents data to correct for the underestimation of dwellings built 1985-2014 in the Data Insight count of dwellings.

The Data Insight data, based on valuation reports, counted the number of dwellings by meshblock, year range (with the categories pre-1985, 1985-1989, 1990-1994, 1995-1999, 2000-2005, 2006-2009, 2010-2104), main cladding type, site type (multi-unit complex or single unit dwelling), and estimated floor area. This provided the only source of national-level information on cladding types, but only at the level of a single "main" cladding. By contrast, pre-purchase report data (Appendix A9) indicated that many dwellings have multiple cladding types. To account for this in the modelled

[30] BRANZ (2009) New dwellings wall cladding, framing, timber treatment details. Report to the Department of Building and Housing, 1 May, 2009.

count of New Zealand dwellings, an imputation step was performed, sampling the cladding types seen based on their proportions in the pre-purchase reports. In addition, the age of the dwellings was derived from the year ranges in the Data Insight data, imputing the age structure, by built year, seen in the pre-purchase reports. The cladding type and built year imputations impose the structure seen in the prepurchase reports on the final prediction data set. This has the effect of not introducing any addition signal other than that provided by the year range and main cladding type aggregates in the Data Insight valuation data.

The Data Insight data also included a complex identifier to reflect the structure of the multi-unit complexes, which was used in the modelling of the number of dwellings in complexes with known failures (Appendix A10).

The 2013 Census provides a count of the number of dwellings in each meshblock, and this count was found to be considerably different from the Data Insight data in a number of areas. There are a number of expected discrepancies such as unoccupied holiday homes or recently built dwellings. However there were also some differences that could not be explained. In addition, the total number of dwellings in the Data Insight data set is much lower than the Census data in a number of territorial authorities. To compensate for the differences in the number of dwellings, the imputation was done at the level of each meshblock, and forced to reflect the totals in the 2013 Census

A7. Pre-purchase report key phrases

The key phrases in the inspection reports from Realsure that were used to indicate weathertightness risk are listed in the following table. These terms were searched for only in the 'house exterior' section, and in the 'weathertightness' section when it was present. This restriction was made to eliminate false positives from leaks associated with interior plumbing, such as bathroom leaks.

Weathertightness risk category	**Report contained the terms**
Very likely to leak*	In the 'House Exterior' OR 'Weathertightness section of the report. CONTAINS: 'did indicate high moisture readings'† AND EITHER ONE OF: 'rot' (and variations like rotten, rotting, rotted) A recommendation for further investigation by a specialist weathertightness surveyor
Likely to leak	In the 'House Exterior' OR 'Weathertightness section of the report. CONTAINS: 'did indicate high moisture readings'† OR 'rot' (and variations like rotten, rotting, rotted) OR A recommendation for further investigation by a specialist weathertightness surveyor
Unlikely to leak	Does not contain any of the search terms above

* Note that the dwellings assessed as 'Very likely to leak' are a subset of those assessed as 'likely to leak'

†Unless the house was brick-clad only. With porous brick claddings, high moisture readings do not necessarily indicate a weathertightness failure, so those with high moisture readings but only brick cladding were ignored.

The following points should be noted.

- A review of 49 randomly selected reports was carried out by the WHRS technical team. Based on the evidence presented in the 'House exterior' and 'Weathertightness' sections of the reports, the team assessed 12 as showing evidence of a current leak, and a further 19 as likely to leak. Only 18 were assessed as unlikely to leak. When checked against possible search terms, the closest match to this assessment was found to be the scheme presented in the table above. Tested against the same random sample of reports, this scheme identified 14 that were very likely to leak, a further 12 that were likely to leak, and 23 that were unlikely to leak. For 32 of the 49 houses the categories matched across the two assessments. Among those that didn't match:
    - Six houses assessed as very likely to leak using search terms were assessed as likely to leak by the technical team
    - Two houses assessed as likely to leak using search terms were assessed as showing evidence of a current leak by the technical team
    - The search terms failed to capture 2 houses assessed as showing evidence of leaking, and 5 assessed as likely to leak by the technical team, instead classifying them as unlikely to leak.
    - The search terms only over-estimated leaking for two houses, categorising them as 'likely to leak', when the technical team categorised them as unlikely to leak.

  The search terms and the technical assessment showed similar patterns when the results were analysed by built year and cladding types (data not shown). The search terms may slightly underestimate the likelihood of leaking, compared to the technical assessment, but the difference is not large, and there were also uncertainties in the technical assessment. In particular, the technical team noted that the distinction between 'likely to leak' and 'evidence of leaking' was difficult to make using the available evidence.

- Moisture readings were gathered by Realsure using non-invasive moisture meters. While these are not 100% reliable, if the meter is calibrated and the definitions are used consistently it is potentially a more reliable method of detecting failures than inspector observations. This method may occasionally result in a false positive from a plumbing leak, if it results in high readings on the external wall of a bathroom. The search returned a positive only if high or very high moisture readings were indicated in the report. Realsure provides the following definitions:
    - "Normal" generally indicates moisture readings up to approximately 16%
    - "Slightly high" generally indicates moisture readings between 17% to 22%
    - "High" generally indicates moisture readings between 23% to 30%
    - "Very high" generally indicates moisture readings 30% and above.
- Where a house has a mixture of brick and other cladding types, moisture readings may in some cases indicate a leak where there was none, as high moisture readings associated with brick cladding do not necessarily indicate a failure. With these houses there was no way to determine, from the extracted data, whether the high moisture reading was associated with the brick cladding or the other cladding type, and this may have resulted in some over-estimation.

- The presence of the term "rot" in the exterior section of the reports was associated with instances of inspectors finding rot damage. While it is not a definitive indicator of a weathertightness failure, it does indicate that a failure may be present, and in combination with high moisture readings it raises the likelihood that a weathertightness failure has occurred and is causing damage to the home. Some typical phrases containing "rot" include:
    - *There is some rot damage to the timber scribers of the home*
    - *There is some rot damage to the fascia*
    - *There is moderate rot damage to some joinery*
    - *The Garage door facings appear to have been finished in direct contact with the concrete blocks which is causing rot damage*
    - *The Garage door facings have been finished in contact with the concrete which may cause rot damage*
    - *Rot to floor joists was found*
    - *Some of the inter-cladding scribers are rotting*
    - *There is some rot damage in the timber cladding due to poor cladding clearance*
- A recommendation for an inspection by a specialist surveyor is generated by Realsure when a house is deemed to be at a higher risk in relation to weathertightness, based on design and location, and also has a large volume of risks and defects (especially inadequate ground clearances, no kick outs, a lack of flashings, or cracks on the cladding). The presence of this recommendation is often, but not always, accompanied by high moisture meter readings.

A8. Pre-purchase report comparison between Realsure and BUILD Consultancy

Weathertightness results from a random sample of 48 pre-purchase reports completed by the Wellington company, BUILD Consultancy Services were compared with the results from Realsure reports on houses in Wellington. BUILD consultancy provided data on cladding types, year built, and their assessment of whether each house had leaks present, or was at risk of leaking in the future. The comparison between Realsure and BUILD Consultancy results is shown in the table below.

	BUILD Consultancy			Realsure Wellington		
Built year	**No. houses in sample**	**% with leaks found***	**% with leaks found and at risk of future leaks**	**No. houses in sample**	**% very likely to leak†**	**% likely to leak**
1985-1994	11	64%	64%	55	25%	71%
1995-2005	30	70%	87%	278	35%	72%
2006-2014	7	43%	72%	93	8%	33%
All years	*48*	*65%*	*80%*	*426*	*28%*	*63%*

* these are a subset of the dwellings assessed as having leaks found or being at risk of future leaks

† these are a subset of the dwellings assessed as 'likely to leak'

Both samples show that more than half of the houses were assessed as leaking or likely to leak, and they display a similar pattern across year ranges.

The Realsure category 'Likely to leak' is a similar proportion of the total houses in the sample as the BUILD Consultancy category 'Leaks found'.

The proportion of houses containing a monolithic cladding was similar between the samples, with 41% of the BUILD Consultancy houses containing a monolithic cladding, as compared to 47% of the

Realsure Wellington houses. In the BUILD consultancy sample, 95% of the houses with monolithic claddings were assessed as having leaks found, as compared to 43% of those without monolithic cladding. In the Realsure Wellington sample, 80% of the houses with monolithic claddings were assessed as 'likely to leak', compared to 49% of those without monolithic cladding.

These results support the idea that the Realsure findings are not anomalous. Both samples resulted in an assessment that almost two thirds of dwellings were leaking or likely to leak, and the results remain consistent when year built and cladding type is taken into account.

A9. Pre-purchase report data analysis

The predictive model for weathertightness failures based on pre-purchase report data was developed by Dragonfly Science. A range of models were compared, considering how well they predicted the 'likely to leak' and 'very likely to leak' classifications, based on dwelling age at the time of inspection, cladding types, built year, and territorial authority. The models were compared by predicting back on the pre-purchase report data set, and then comparing the deviance information criteria (DIC).

The estimation model predicted the probability that a dwelling, indexed by *i*, was considered to be 'likely to leak' r_i or, 'very likely to leak' l_i. The proportion of 'likely to leak' dwellings that were considered to be 'very likely to leak' in vintage (built year range) *v*, denoted σ_v, associates the two classifications as follows:

$$l_i = r_i \sigma_{v[i]}$$

The σ_v effects were drawn from a uniform prior independently for each vintage:

$$\sigma_v \sim \mathcal{U}(0, 1)$$

The probability r_i is assumed to depend on the cladding types of the dwelling, the age of the dwelling when it was inspected, and the territorial authority. The raw data indicated that the failure rate depended on the age of the dwelling, with older dwellings more likely to have failed. The 'likely to leak' probability r_i is therefore assumed to have a two parameter age dependent structure. The long term failure rate p_i indicates the chance that the dwelling will eventually be 'likely to leak', while the age dependence is encoded as a parameter λ_i that describes the instantaneous risk of failure, or how quickly the dwelling will become 'likely to leak'. These two parameters are used to derive r_i as:

$$r_i(t) = \gamma_{a[i]} p_i (1 - \exp(-\lambda_i * t))$$

The parameters p_i and λ_i are assumed to depend on the cladding types, indexed by *c*, that are present on the dwelling. We code this as C^c_i, indicating that dwelling *i* includes cladding *c*. The long run proportion p_i comes from the logistic combination of the risks associated to each of the cladding types, *c*, while the rate λ_i is combined on a log scale:

$$\text{logit}(p_i) = \sum_c C^c_i b_c$$

$$\log(\lambda_i) = \sum C^c_i \beta_c$$

The cladding type factors b_c and β_c are estimated from a uninformative, normally distributed prior:

$$p_c \sim \mathcal{N}(0, 100)$$
$$\lambda_c \sim \mathcal{N}(0, 100)$$

To account for variability between the different territorial authorities, a random effect, a, is introduced, that acts multiplicatively on the 'likely to leak' rate r_i. They are drawn from a gamma distribution with mean 1, and variance given by the non-informative Jefferys prior:

$$\gamma_a \sim \Gamma(\nu, \nu)$$
$$\nu \sim \text{Jefferys}(0, 1)$$

In summary, the model estimates the 'likely to leak' probability as the product of a random effect for each territorial authority, times a failure rate that depends on the age and cladding types on the building. The 'very likely to leak' probability is derived from the 'likely to leak' probability by multiplying by a fixed vintage effect.

The model was fit to the groomed pre-purchase report data using Gibbs sampling and Monte-Carlo Markov chains (MCMC) with the JAGS program. The parameter estimates were derived from four independent chains, each with 8000 iterations, discarding a burn-in of 2000 iterations, and a thinning rate of 1 in 5. Convergence was checked using the standard tools provided in the R statistical programming environment.

Various other models were also tested. Variations included dropping the fixed and random effects, and changing the parameterisation of the cladding effects. The final model was selected over the others because it had the lowest DIC.

A10. Multi-unit survey data analysis

The multi-unit survey statistical modelling was carried out by Dragonfly Science, using the results from the survey of property management companies (Chapter 5) and the modelled count of New Zealand dwellings and their characteristics (Appendix A6). The survey data included the total number of complexes in each territorial authority managed by each respondent company, the number of units in each complex, and the number of complexes (and their size in number of dwellings) that had been built after 1985 and had developed a weathertightness failure. The data set included 111 records, most of which included multiple complexes as the respondents had grouped their data by territorial authority to preserve dwelling anonymity.

The statistical modelling predicts for each record, i, the number of complexes, c_i, with weathertightness failures, L_i, and built since 1985. The probability of failure, p_i, was derived as the sum, on the logistic scale, of a base rate, r, and an effect β associated to the number of units in each complex, u_i. The two rates β and r were both drawn from a non-informative normal prior.

The proportion of multi-unit complexes with 5 or more dwellings that were built in New Zealand since 1985, R_a, was calculated from the modelled count of New Zealand dwellings and their characteristics (Appendix A6) for each territorial authority, a. This allowed the rates r and β to compensate for the fact that the total number of complexes under management included many that were built earlier than 1985, while allowing for the different age structures in each of the territorial authorities.

The model was structured as:

$$L_i \sim \text{Binomial}(p_i * R_{a[i]}, c_i)$$

$$\text{logit}(p_i) = r + \beta \log(u_i)$$

$$r \sim \mathcal{N}(0, 100)$$

$$\beta \sim \mathcal{N}(0, 100)$$

A11. Building consents for weathertightness remediation and recladding

National data on residential building consents for recladding and weathertightness remediation was supplied by Data Insight Ltd. This dataset uses a collation of data on Building consents as its primary source, but it also contains data sourced from the District Valuation Roll and land title information.

The relevant consents were extracted by searching the consent description field for the following keywords.

Definitive terms	
FAP	Financial Assistance Package
WHR	Weathertight Homes Resolution Service
WEATHER*RESOL	Weathertightness Resolution
CLAIM 0123 or CLAIM NUMBER 0123 OR CLAIM NO 0123	Has a CLAIM number, which is
WEATHERTIGHT or WEATHER TIGHT	Weather tightness related (might not mention FAP, WHR or a CLAIM)
Recladding	
CLAD	Consent involves cladding or recladding. May be weathertightness if done to a home built after 1990
Leaky	
LEAKY	Not definitive, but if not identified from terms above almost always a leaky home. LEAKING, LEAKS not used as usually plumbing or roofing

This search extracted records for 5249 consents. A review of the description field of the consents then excluded from the analysis those that:

- described only work on non-dwelling structures such as sheds and separate garages
- mentioned earthquake damage, fire damage, or dwelling relocation, as these events often triggered re-cladding but were not weathertightness-related.

After these exclusions, 4885 consents remained, and these were matched, by address, with data on WHRS claims, and data on remediation and re-cladding consents sourced from Tauranga City Council (Appendix A12).

This dataset is likely to underestimate the amount of re-cladding and weathertightness remediation, for the following reasons.

- Data is only available for consents issued from 1996 onwards; re-cladding and remediation consents issued before this time have not been captured. It is also possible that the coverage of consents in the earlier years within this period is patchy as territorial authority data capture processes have improved over time.
- Building consent data may be incomplete from some territorial authorities. Comparison with data sourced directly from Tauranga City Council shows that the New Zealand data captured only one third of the consents that were in the data sourced directly from Tauranga City Council. Tauranga City Council data was therefore used to supplement the national dataset.
- Consents for remediation that do not mention any of the keywords above will not have been captured.
- Remediation work that did not trigger a consent application has not been captured.

On the other hand, this dataset may overestimate the amount of weathertightness-associated remediation for the following reasons.

- Re-cladding is sometimes done for cosmetic reasons, or to improve the value of houses with monolithic claddings. While recladding consents that were noted as associated with earthquake damage, fire damage or dwelling relocation were excluded, there may still be some consents in the dataset with non-weathertightness-related re-cladding.
- It is difficult to determine the original built year of the dwellings associated with the consents. The year built was modelled by Data Insight Ltd, as described in Appendix A4. The great majority of the dwellings in the dataset have built years of 1985-onwards. Some have unknown built dates, and a review of these showed that it was likely that most were also built from 1985-onwards, so they were included in the analysis. A small number of dwellings in this analysis may therefore have been built before the 1985-2014 time period that is within scope for this report.

A12. Remediation and re-cladding consents from Tauranga City Council

Tauranga City Council (TCC) supplied a list of remediation and re-cladding consents extracted from their database by searching the description field for the keywords *remediat* and *reclad*. In addition to this, a staff member familiar with weathertightness issues in the TCC catchment had excluded the consents that were known not to be weathertightness-related.

This data was further reviewed to:

- exclude duplicates from the dataset
- exclude consents that mentioned fire damage or dwelling relocation
- exclude consents that described only work on non-dwelling structures such as sheds and separate garages
- exclude a small number of consents for school and commercial buildings

The reviewed dataset contained 510 consents. These were matched, by address, with data on WHRS claims, and data on remediation and re-cladding consents sourced from Data Insight Ltd (Appendix A11).

This dataset is likely to underestimate the amount of re-cladding and weathertightness remediation that has occurred in Tauranga, for the following reasons.

- Data is only available for consents issued from 1999 onwards; re-cladding and remediation consents issued before this time have not been captured. It is also possible that the coverage of consents in the earlier years within this period is patchy as territorial authority data capture processes have improved over time.
- Consents for remediation that do not mention the keywords have not been captured.
- Remediation work that did not trigger a consent application has not been captured.

On the other hand, this dataset may overestimate the amount of weathertightness-associated remediation for the following reasons.

- Re-cladding is sometimes done for cosmetic reasons, or to improve the value of houses with monolithic claddings. While recladding consents that were noted as associated with earthquake damage, fire damage or dwelling relocation were excluded, there may still be some consents in the dataset with non-weathertightness-related re-cladding.
- It does not provide data on the original build year of the dwellings associated with the consents, and the dataset may therefore include some dwellings built before the 1985-2014 time period that is within scope for this report.

A13. Deterioration of unremediated dwellings

Repeat assessment data extraction

Data on properties with WHRS claims that had been subject to more than one assessment was extracted from the WHRS database, to assess whether the recommended remediation type, or cost to repair had changed between assessments.

Each case was reviewed, and dwellings were excluded from the sample if any of the following circumstances applied.

- The first assessment was prior to the Weathertight Homes Resolution Services Act 2006 coming into force (1 May 2007) which allowed for the calculation of future likely damage. Estimated costs to repair before that date did not include future likely damage and were therefore consistently lower.
- The second assessment was a cost update and not a full re-assessment of the damage to the dwelling.
- The second assessment was an addendum produced because of a difference in opinion between assessors.
- The second assessment was an addendum that increased the scope of the original assessment (for example, due to earthquake damage).
- The property was a multi-unit complex. These assessments often differed in the number of units within the complex that were assessed, and costs were not comparable across assessments as a result.

With these cases removed, 97 standalone dwellings remained in the sample.

Data analysis

As a proxy for deterioration, the cost difference between assessments, as a proportion of the total assessed cost at the first assessment was calculated. All costs were adjusted to March 2014 dollars, using index figures for residential building from The Capital Good Price Index.[31] In addition, the percentage that moved from having a targeted repair recommended at the first assessment, to a full re-clad recommended at the last assessment was calculated.

Linear regression was used to assess whether there was a significant relationship between time between assessments and the change in costs between assessments. Logistic regression was used to test for a relationship between elapsed time and progression from a targeted repair to a full reclad.

Relationship between time and assessed cost to repair

Figure A13.1 shows the results of a linear regression that examines the relationship between the assessed cost to remediate and time between assessments. If deterioration over time is occurring in these houses, this analysis should show a positive correlation, and be able to predict a rate of deterioration. Figure A13.1 shows that, while there is a statistically significant positive correlation between time and cost to repair (p-value 0.017), it is also evident that factors other than time contribute to the change in assessed cost. The R^2 value of 0.0585 indicates that only 6 percent of the variation in the assessed cost to repair is accounted for by the number of months between assessments, and the scatterplot demonstrates the considerable variability between houses. The analysis predicts that for each year that it remains unremediated, a dwelling's cost to repair increases by 7 percent (0.59% x 12). However, given that most of the variability is not accounted for by elapsed time, this should not be used to predict changes in costs for individual dwellings.

[31] http://www.stats.govt.nz/browse_for_stats/economic_indicators/prices_indexes/capital-good-price-index-info-releases.aspx

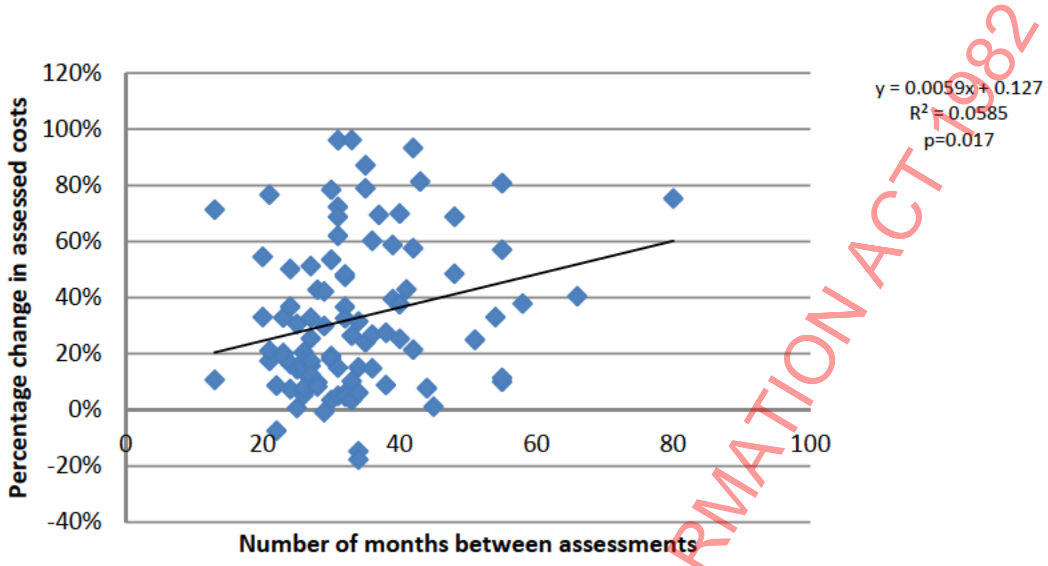

Figure A13.1. Deterioration over time among houses with repeat WHRS assessments, measured by percentage change in the assessor's estimated cost to repair, relative to the first assessment. This analysis includes standalone dwellings only, and all costs were adjusted to March 2014 dollars.

Testing linear regression assumptions

For the linear regression, jackknife residuals were computed, and analysed to determine whether the data fitted the assumptions of linear regression. A QQ-plot showed that there was some departure from the assumption of a normal distribution, but this was not severe. Plots of residuals over fitted values and residuals over the predictor showed that the assumptions of linearity and constant variance were met. While there were several leverage points, Cook's Distance and DFBETAS plots showed that none were overly influential on the fitted values or regression coefficients.

In conclusion, while the regression assumptions are mostly satisfied, there is some doubt about the normality of the distribution of the data. The model used in this analysis only accounts for just under 6% of the variation in the data, so the correlation is very weak.

Relationship between time and changes in the recommended repair

A second analysis used logistic regression to test for a relationship between time between assessments, and the type of recommended repair. This assessed whether, as time between assessments increased, there was also an increase in the proportion of dwellings that went from having a targeted repair recommended at the first assessment, to having a full reclad recommended at the second assessment. There was no significant relationship between time between assessments and change in the repairs recommended (p-value 0.625). Of the 97 dwellings in the analysis, 22 went from needing targeted repairs to requiring a full re-clad. (23 percent).

Appendix B. Key events impacting New Zealand building standards from 1985-2014

Date	Event
1985	Shift from asbestos to fibre cement cladding - James Hardie ceased production of asbestos based cladding in 1985. New fibre cladding was less weathertight, relying on paint and sealants to protect wood fibres within from moisture, and was less malleable, making it more difficult to apply in a weathertight fashion.
1988	Building Industry Commission report released which provided the foundation for a new building control regime, established by the Building Act 1991, and a performance-based building code (contained in a schedule of the Building Regulations 1992), which came into force on 1 January 1993. A shift towards a performance-based building code moved away from strict prescriptive requirements for building, in favour of performance standards.
1990	NZS 3602 required radiata pine to be treated if it was exposed to moisture.
1992	NZ Building Code Acceptable Solution clause H1/AS1 adopts NZS 4218P 1977 as acceptable solution for minimum insulation suggested for building consent.
1 July 1992	Building Act 1991 came into force alongside the new national Building Code (under Building Regulations 1992). Under the Code monolithic cladding (without a cavity) could be used as an alternative solution. First edition of B2/AS1 Approved Document provided for NZS 3602:1990 to be an acceptable solution to the Code requirements for timber framing. In-wall insulation required by law. Before the 1991 Building Act, territorial authorities had control over the BC process with N.Z.S. 1900 as the standard.
1 January 1993	Formal transitional period under Building Act 1991 ended, all new building work required a building consent under the 1991 Act from this date.
15 September 1993	Schedule 1 of Building Act 1991 amended to clarify that any repair or replacement of a component or assembly that has failed the durability provisions of the Code (clause B2) must be done under a building consent.
17 June 1995	NZS 3602 revised to allow use of untreated timber in certain circumstances. The use of untreated timber was an alternative solution for Code compliance.
28 February 1998	Second edition of B2/AS1 Approved Document provided for NZS 3602:1995 to be an acceptable solution to the Code requirements for timber framing. Second edition of E2/AS1 Approved Document provided for plaster cladding on a rigid backing without a cavity to be an acceptable solution to the Code requirements for external moisture protection. (plaster cladding on a non-rigid backing required a cavity to be an acceptable solution).
2000	NZ Building Code Clause H1/AS1 amended to increase minimum insulation standard.
31 August 2002	Hunn Report on weathertightness published.
26 November 2002	Weathertight Homes Resolution Services Act 2002 came into force. First WHRS claims lodged late November.
March 2003	Government Administration Select Committee report on weathertightness released.
December 2003	NZS 3602 revised to no longer allow untreated timber to be used in framing for exterior walls.

Date	Event
June 2004	Third edition of E2/AS1 Approved Document published but did not come into effect. This edition provided, among other things, changes to approved solutions for flashings, joins and roofing, and a risk matrix against which homes could be assessed to determine the appropriate approved cladding system, whether it was able to be directly fixed or whether it should be installed over a cavity. Regardless of risk factor, all Stucco cladding must have a cavity to comply with the acceptable solutions standard.
31 March 2005	Building Act 2004 came into force. Schedule 1 of the Act inadvertently omitted the 1993 provision requiring durability failures to be repaired under a building consent. Approved Documents now called Compliance Documents. B2/AS1 Compliance Document amended to refer to NZS 3602:2003 as the acceptable solution to the Code requirements for timber framing.
1 July 2005	Amended version of third edition of E2/AS1 Compliance Document came into effect.
2007	NZBC Clause H1/AS1 amended to increase minimum insulation standard.
1 May 2007	Weathertight Homes Resolution Services Act 2006 came into force. Key new provisions: future damage and general damages able to be claimed; easier for owners of multi-unit buildings to make claims, Weathertight Homes Tribunal established to adjudicate claims.
14 March 2008	Schedule 1 of Building Act 2004 amended to reinstate 1993 provision requiring durability failures to be repaired under a building consent.
4 April 2011	Acceptable solution B2/AS1 was altered to include only a single class of timber treatment, H1.2, for enclosed radiata pine and Douglas fir framing. There were previously four different classes of timber, including untreated timber, which could be used to frame a building.
August 2011	Acceptable solution E2/AS1 was altered so that dwellings in extra high wind zones require rigid underlays and drained cavities to comply.
July 2014	Fire protection boundary rules under C1-7 and F7 came into force, AS1 required dwelling's walls to comply with higher fire safety standards when built closer to boundary. This could affect how remediation is undertaken and possibly increase costs.

Appendix C. Typical faults found in the developments

Chapter 4 describes a technical assessment of dwellings co-located in developments with dwellings that are subject to WHRS claims. The reviewer who carried out the assessment developed a list of typical faults found in the dwellings, and noted the extent to which they influenced the assessed risk of weathertightness failure. A weighting system based on this list was then used to score the assessed houses for their risk of failure, and the reviewer found that the scores correlated well with the overall assessments. This system was used by the reviewer to cross-check the assessments.

The typical faults and their influence on risk were as follows.

- Exposure: the exposure of the site increased the risk considerably.
- Built post-2002: if a dwelling was built in the latter half of 2002 or later, this decreased the risk considerably. This was assigned when consent documentation showed post-2002 detailing at the windows.
- Window design: windows with sloping, stepped or circular heads or sills, large windows in proportion to the wall area, and conservatory or bay windows increased the risk slightly.
- Cavity: the presence of a cavity in consent documentation decreased the risk considerably.
- Cladding: weatherboard cladding decreased the risk considerably. EIFs or Monotek cladding decreased the risk moderately relative to HardiTex.
- Plantons: the use of plantons at interstorey junctions, gables, or as mock stone corbels at corners increased the risk slightly.
- Roof complexity: this increased the risk - the more complex the roof, the higher the risk.
- Gutters: box gutters or concealed gutters increased the risk moderately. Klass or similar gutters increased the risk slightly.
- Parapets and balustrades: parapets and/or solid balustrades increased the risk moderately.
- Drainage: roof/deck dependent on downpipes through wall and/or to rainwater head increased the risk slightly.
- Decks: a membrane deck or flat roof over rooms below increased the risk moderately. Decks with top-fixed metal balustrades or metal balustrades fixed to boxed piers, or timber decks fixed to the wall at the upper level increased the risk slightly.
- Footprint: a highly irregular ground floor footprint increased the risk slightly.
- Boxed columns: boxed up columns increased the risk slightly, although less risk was associated with boxed columns on plinths.
- Orientation: a gable end square on to wind exposure increased risk slightly.
- Roof to wall junctions: curved roof to wall junctions increased the risk slightly.
- Ground clearance and protection from dampness: evidence that ground clearances may not be adequate, for example, the ground levels not clearly falling away from the building, increased the risk slightly. Protection from ground dampness for the walls beside the garage door decreased the risk slightly
- Construction standard: sophistication, expense and/or extreme exposure suggesting that better than average construction standard can be expected decreased the risk considerably.
- Maintenance: evidence that better than average maintenance has occurred, for example, well developed grounds, decreased the risk moderately.