Residential New Build Construction Waste Audit Summary

(Whenuapai Site)

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Auckland Council Waste Planning Team

19th September 2023:

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1.0 Project Overview:

A waste audit was carried out on a residential building site in Auckland from December 2022 till July 2023. The house being constructed was a three-bedroom standalone dwelling with a single internal garage.

The purpose of the audit was to understand in more detail the overall weight and composition of the waste created in residential construction. Auckland Council has been using an assumption of 4.5 tonnes of waste per new build which was based on figures provided by AUT in 2015 (Reference for that study yet to be found). This audit will help provide some certainty around the total volume of waste produced and help to understand in more detail the types of waste produced at various stages of the build. This more granular data will help us better understand the opportunities for diversion of waste from landfill.

The project did not intend to explore the impact of design or of site practices on waste although it has also highlighted opportunities for improvements in those areas.

2.0 The House being constructed:

2.1 House design:

155m2 floor area, pitched roof, 3 bedroom, 2 bathroom with single internal access garage.

2.2 Construction materials:

Long run steel roof, exterior cladding with cavity system - mostly cement board with some Abodo (thermally treated pine which was backed by a RAB board), fibre cement soffit, timber barge boards, pre nailed pine framing, glass wool wall and ceiling insulation, plasterboard internal wall linings with Rondo ceiling battens, main living and kitchen area floor tiled, bathrooms partially tiled. Permeable paved driveway with a concrete vehicle crossing. Fencing a combination of rough sawn timber and aluminium pool fence, stepped concrete pavers around the house with a concrete patio and front and rear lawn areas.

2.3 Building project management:

The project was managed centrally by The Developers staff based at a nearby site office. Subtrades completed each step of the build with close oversight by the project manager. Some tasks such as site clean ups were completed by staff labourers.

2.4 Timeline:

- Frames delivered 21 November 2022
- First Skip removed 20 December 2022
- Final waste collection (paver waste) July 2023
- Project completed August 2023
- Handover September 2023

3.0 Waste Audit Methodology:

3.1 Audit Process

1. Waste Containment:
   The site was fully fenced and locked after hours. A 9m3 skip bin was provided by our contractor inside the fenced area which was for the sole use of the project site. Signage was installed to ensure all waste produced on that site was deposited in the skip and to deter illegal dumping.

FIGURE 1: SITE SECURITY FENCING.

2. Monitoring:
   The site was monitored weekly by Council staff to follow the progress of the build and monitor the filling of the skip. Care was taken to observe any illegal dumping and ensure that the purpose and audit methodology were communicated regularly to new contractors working on site.

FIGURE 2: SECOND SKIP FILLING UP ON SITE DURING CLADDING STAGE.

3. Bin collection and delivery:
   When nearing full (as per monitoring by Council staff), the bin was swapped out by our collection contractor with the full bin being tracked from site to the weighbridge at the Council owned Waitakere Transfer Station. The bin was weighed over the weighbridge and recorded on a special account created for the audit (using preloaded tare weight for truck and empty bin). The waste was then tipped out of the skip on to a clear pad/ bunker ready for sorting. A tarpaulin was used to cover the pile to ensure loose material was contained.

Auckland Council
Waitakere - Auckland Council
Tax Invoice
GST # 52-211-247
Exit Ticket :859748
Printed : 02 Apr 2023 11:29:59
Customer : Auckland Council Waste Audi
t
Customer # : 1
Order # : FLETCHER's House
Vehicle ID : GBB616*

FIGURE 3: WEIGHBRIDGE DISPOSAL DOCKET EXAMPLE.

FIGURE 4: FIRST SKIP BEING TIPPED AT WAITAKERE TRANSFER STATION.

4. Waste Sorting:
   Waste sorting and weighing was completed by another contractor working in pairs. The sorting was completed in 3 stages:
   1. Pre sort to pull out and contain any loose material in wheelie bins (to avoid wind-blown litter).
   2. Bulk sorting of the largest waste streams in to piles (i.e. timber, fibre cement board etc).
   3. Detailed sorting and weighing of the individual waste streams. Timber waste was categorised by the dimension (such as 90 x 45) and then measured by total length and weight.

FIGURE 5: PRE-SORT IN TO WASTE TYPES.

FIGURE 6: SORTED LENGTHS OF FIBRE CEMENT BOARD.

FIGURE 7: WASTE SORTING BINS AND PLATFORM SCALES SETUP.

5. Data aggregation:
   Once the waste was sorted and weighed, the data was then aggregated on a spreadsheet with the weight, volume/ length and a photograph of each individual waste item recorded. There were over 1000 rows to that spreadsheet so too many to easily summarise here.

				
Ferrous metals	Steel roofing/ screws/strapping/galvanised.	Metal ties		
Ferrous metals	Steel roofing/ screws/strapping/galvanised.	Reinforcing rod off cuts		

FIGURE 8: EXAMPLE OF THE WASTE MATERIAL CATALOGUE.

6. Waste disposal:
   On completion of the audit, the waste was recovered, recycled or disposed to landfill. Items of value were first offered to community groups to sell, recycled where possible (i.e. timber, plasterboard, cardboard, metal) or disposed to landfill. Where materials were sold by community groups, the value was recorded.

3.2 Health and Safety:

One of the reasons often cited for the lack of data around construction waste is the risk involved in entering skip bins. Health and safety was of paramount importance in this audit. We worked with our audit contractor to develop a detailed Health and Safety plan that identified key risks and mitigations in this project.

We were able to mitigate many of these risks by virtue of the space made available at the Waitakere Transfer Station. This allowed us to safely tip the bins out of the way of other traffic and ensured that we had plenty of room to separate the waste carefully and safely.

While we had a good idea of the types of materials that might be placed in the skip at each stage of the build, we did not initially factor in the risks associated with fly tipping. This led us to put in place two additional procedures:

1. A summary of the expected waste materials in each skip (which would help sorting staff to identify any fly tipped or potentially hazardous waste).
2. A process to deal with potentially hazardous materials encountered in the skip.

These processes helped to identify potential asbestos contamination in one of the skips and we were able to act quickly to isolate and test the material with an ‘asbestos gun’ on site.

3.3 Staff and subcontractor engagement:

We were fortunate to have the full support of The Developers staff who were very engaged with the project and its purpose. While we specifically asked them not to change any of their usual processes for this build, we found that they were already very focussed on waste minimisation and had good practices embedded in their systems. Normally in a development like this they would utilise shared bins (front load for mixed waste to be sorted via a C&D MRF plus source separated plasterboard bags and hardfill gantry bins as required) which are emptied on a fixed schedule. The main change for this build was to require waste be captured in the 9m3 gantry bin on site. In many ways, this bin was more convenient to use as it was located closer to the building than all the other bins so this change was relatively easy to implement.

The Developers project managers were responsible for communicating the audit process to the sub trades. Council staff also engaged directly with the subtrades on site who were also highly engaged and cooperative. We found that there was a lot of interest from all the trades who interacted with the audit and intend to work with The Developer to present the results/ data with them in future.

By having good lines of communication, we were able to collect some waste streams source separated which enabled streamlined capture of weights (saving sorting time and reducing the audit cost). Examples of source separated streams: Insulation, Plasterboard, Tile offcuts, cardboard, concrete, spoil.

4.0 Audit Results:

4.1 Timeline of collections:

Date:	Collection Detail:	Weight:	Build Stage:
21/12/22	Skip 1 – 9m3	400kg	Framing/ Roofing.
20/03/23	Skip 2 – 9m3	1480kg	Exterior cladding.
25/03/23	11* bags of insulation (1.5m3 total)	38kg	Pre-line
02/04/23	2* plasterboard bags (4m3 total)	740kg	Internal wall lining.
10/05/23	Skip 3 – 9m3	720kg	
30/05/23	2* bulk bags (2m3 total – one for cardboard, one for tile waste)	380kg	Fit off.
	TOTAL WEIGHT:	**3679 kg**	

Total weight at 13/06/23: 3679kg

(Note: driveway and landscaping waste was additional to this)

4.2 Summary of key data:

FIGURE 9: TOTAL WEIGHT AND VOLUME OF WASTE PRODUCED DURING THE BUILD (EXCLUDES SPOIL AND CONCRETE).

FIGURE 10: THE FOUR LARGEST WASTE STREAMS FROM THE BUILD BY WEIGHT.

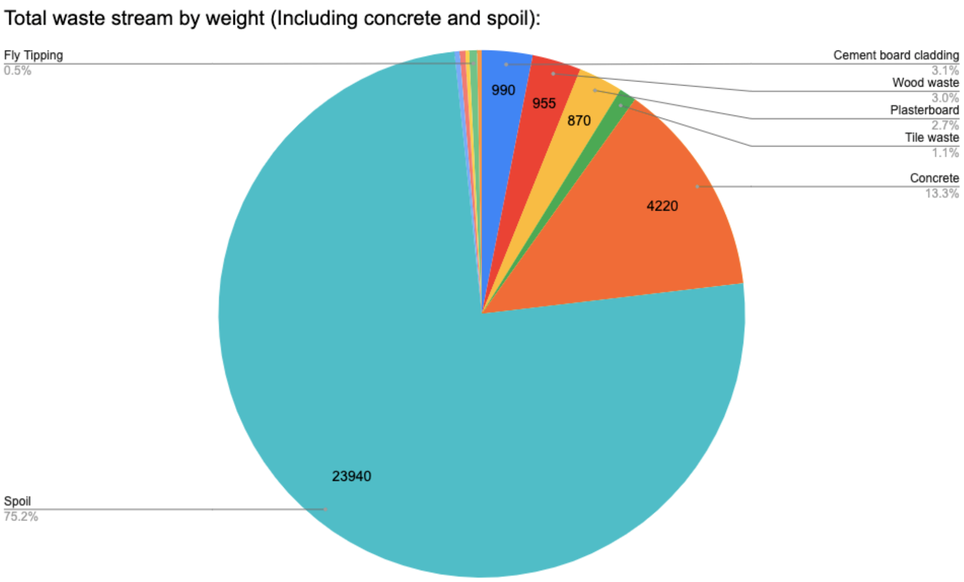


FIGURE 11: PIE CHART SHOWING BREAKDOWN OF THE COMPLETE WASTE STREAM - INCLUDING CONCRETE AND SPOIL.

Wood waste breakdown:

Timber category:	Total weight (kg):
Lengths and pieces	604
Pallets and crates	43
Sheets	26
Pieces under 600mm and sweepings	282
TOTAL	955 kg

Ferrous Metals Breakdown:

Metal Category:	Total weight (kg):
Steel can	0.28
Hardware / strapping	25
Roofing sheet	17.7
Roofing Flashings	18.9
TOTAL	**61.63 kg**

Non-ferrous metals breakdown:

Metal Category:	Total weight (kg):
Electrical cable	11.8
Aluminium cans and food packaging	1.45
Aluminium hardware	2.47
Other	0.02
TOTAL	**15.74 kg**

Paper/ Cardboard breakdown:

Category:	Weight (kg):
Corrugated Cardboard	87.16
Printed paper (instructions etc, food packaging, newspaper	19.5
TOTAL	**106.66 kg**

Plastics breakdown:

Plastics category:	Weight (kg):
HDPE	28.65
LDPE	16.77
Uncertain (7)	6.36
PET	15.78
PP	12.69
PS	3.83
PVC	16.08
TOTAL	**100.16 kg**

4.3 Insights From the build process:

4.3.1 Illegal Dumping/ Fly Tipping:

Fly tipping has been highlighted as a significant issue on building sites and this study has most certainly backed that up that claim with 155kg of non-site waste recorded. The development where the building site was located contained many easily accessible front load bins, yet we were still finding household waste being dumped in the audit skip. Increasing signage seemed to reduce the problem but it continued to occur throughout the build. Where possible any fly tipping was identified quickly and removed from the bin so as not to influence the results of the study.

In practice there is always a component of illicit waste in bins with the cost of that waste disposal either being passed through to the homeowner or covered by the builder/developer. It is easy to see why builders often site fly tipping as the main reason why they do not keep skip bins on building sites.

As identified in the Health and Safety section of this document, fly tipping also creates additional risks for staff at transfer station facilities due to potentially hazardous waste being hidden in bins.

4.3.2 Foundations:

Due to timing constraints, this project was already at the foundation stage when we began the audit. This meant that we did not monitor the slab being poured however we were able to observe the floors being poured at neighbouring sites and interviewed the contractors about their processes. Very little waste is produced at foundation stage with the formwork being reused and moved from house to house in the development. Reinforcing rod and ties were left on site and were captured in the audit. The floor slab contractor also had very good systems to bag any polystyrene offcuts which are collected by the manufacturer for recycling.

4.3.3 Drainage/ plumbing:

The drainage work was completed at foundation stage so there is a likelihood that some PVC pipe waste was created prior to the skip being on site. We did however capture the PVC pipe waste created during the build (water and drainage plus telecom and power) which was a total of 16kg of PVC.

4.3.4 Framing:

There is a common assumption that pre nail framing does not produce any site waste. This audit has highlighted that this is not the case – with a total of 15.3 lineal metres of 90 x 45 framing timber ending up in the skip (only pieces over 600mm included in that total).

The framing timber waste came from the cutouts of the bottom plate for doorways and some of the joinery. Due to the fact that the frames were fully made there is no opportunity to utilise that timber for nogging so it typically ends up in the bin. The other component of the framing waste comes from the props used to brace the frames as they are stood. The source of this is typically random lengths that come with the frame order. We intend to cross check the frame and truss order to compare the quantity of random lengths ordered against the waste output.

4.3.5 Roofing:

Steel roofing offcuts came to 17.7 kg and flashings were 18.93 kg this comprised over half of the ferrous metal waste produced in the build (61.6 kg) which was in line with expectations and hard to avoid.

4.3.6 Cladding:

The largest waste stream by weight was the cement board cladding (Hardiplank) at 990kg. This stream was particularly high which was likely a combination of the density of the boards as well as the pitched roof design with the boards being laid vertically (meaning a large proportion of offcuts). Cement board is not typically able to be recycled in New Zealand although overseas it is commonly able to be crushed and used as a base course blend.

We were expecting to see more Abodo cladding waste in the skip due to its use on one side of the house with the pitch and full 4m lengths needing to be cut down. There is a possibility that some of that waste material was 'recovered before reaching the skip' or potentially the order had been factory cut to suit.

A delay with the supply of the Abodo cladding supply meant that RAB (Rigid Air Barrier) board was required over that section of framing which created additional waste. The James Hardie RAB board product is unable to be recycled so those offcuts plus the PVC plastic cavity battens used would become landfill. Total weight of the offcuts was 5kg so relatively insignificant. Worth noting that the GIB Weatherside RAB board has a gypsum core which is able to be recovered although that was not used on this project.

FIGURE 12: RAB BOARD WITH HORIZONTAL PVC CAVITY BATTEN (PRIOR TO ABODO VERTICAL CLADDING).

Timber cavity battens formed a small component of the overall timber waste but there was over 12 lineal metres of that waste which may well have been able to be reused. Cavity battens are likely viewed as a low value item and easier to dispose rather than store.

4.3.7 Insulation:

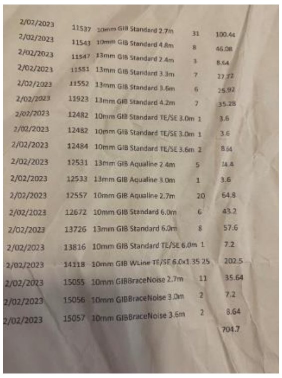
Project managers on site had made the assumption that the leftover insulation was being recycled as it was bagged up and removed by the installers. In practice though it was just the plastic bags that were recycled as the insulation waste is not recyclable. Normally this waste would just end up in a skip bin on site or back at the installers/ distribution site.

As the installers had bagged this as a separate waste stream, we were able to weigh easily and then sold the off cuts via Trade Me on $1 reserve. The offcuts sold for $11.50 but saved 49 kg or 1.5m3 of waste to landfill. Prior to listing on Trade Me these were offered to the Community Recycling Centre at the transfer station who declined them as they did not think they would sell.

FIGURE 13: BAGGED INSULATION OFFCUTS READY FOR COLLECTION.

4.3.8 Wall Lining:

The plasterboard waste largely lined up with the expected quantity of waste based on the order (see below). The slightly higher than expected weight of 869kg is likely due to the pitched roof design. Plasterboard waste was around 25 % of the total build waste so a very significant component. There were several full sheets left over also but they were not included in the audit total as they were moved along to the next house in the development. The Developers process is to keep moving the leftover sheets along each build in the street and then to adjust the order to suit for the final house. Again this is an example of some of the efficiencies able to be achieved by developers building at scale.



2/02/2023	11537	10mm GIB Standard 2.7m	31	100.44
2/02/2023	11543	10mm GIB Standard 4.8m	8	46.08
2/02/2023	11547	13mm GIB Standard 2.4m	3	8.64
2/02/2023	11551	13mm GIB Standard 3.3m	7	27.72
2/02/2023	11552	13mm GIB Standard 3.6m	6	25.92
2/02/2023	11923	13mm GIB Standard 4.2m	7	35.28
2/02/2023	12482	10mm GIB Standard TE/SE 3.0m	1	3.6
2/02/2023	12482	10mm GIB Standard TE/SE 3.0m	1	3.6
2/02/2023	12484	10mm GIB Standard TE/SE 3.6m	2	8.64
2/02/2023	12531	13mm GIB Aqualine 2.4m	5	14.4
2/02/2023	12533	13mm GIB Aqualine 3.0m	1	3.6
2/02/2023	12557	10mm GIB Aqualine 2.7m	20	64.8
2/02/2023	12672	10mm GIB Standard 6.0m	6	43.2
2/02/2023	13726	13mm GIB Standard 6.0m	8	57.6
2/02/2023	13816	10mm GIB Standard TE/SE 6.0m	1	7.2
2/02/2023	14118	10mm GIB WLine TE/SE 6.0x1.35	25	202.5
2/02/2023	15055	10mm GIBBraceNoise 2.7m	11	35.64
2/02/2023	15056	10mm GIBBraceNoise 3.0m	2	7.2
2/02/2023	15057	10mm GIBBraceNoise 3.6m	2	8.64
				704.7

FIGURE 14: COPY OF THE PLASTERBOARD ORDER FOR THE BUILD WITH PROJECTED WASTAGE CALCULATED.

FIGURE 15: FULL SHEETS OF PLASTERBOARD LEFT OVER TO BE TRANSFERRED TO THE NEXT HOUSE IN THE DEVELOPMENT.

FIGURE 16: 2M3 PLASTERBOARD WASTE BAG READY FOR COLLECTION.

4.3.9 Flooring:

Tile waste was an unexpected yet significant proportion of the total waste from the build (9%). The high level of waste was purely due to the size of the area being tiled which included the living areas. Although the weight was significant, the volume was not (less than 1m3) so a typical smaller build site would not have a separate hardfill bin for collection. Ordinarily The Developer would utilise hardfill bins shared across the development for this waste stream. This also highlights the impact of design decisions on the waste output.

There was no carpet waste captured so it is assumed that the carpet installers removed any waste from site. We did not manage to speak with the carpet installers, so this is a knowledge gap at this stage.

4.3.10 Driveway and Landscaping:

While not typically captured as part of the build waste, this was a very interesting part of the build process with some surprising data.

The process followed in this subdivision (and most new build sites across the country) is to build the house first then cut through the footpath (often newly laid if new subdivision) to install the vehicle crossing and driveway as the final stage.

For this site there was 4200 kg of concrete from the footpath cut and then 23940 kg of spoil removed for the driveway cut. Most of the spoil removed was actually Gap65 metal that had been brought on to the site in preparation for the build. Once the driveway/ vehicle crossing are down to correct level then new metal is brought in for the base course.

Although the concrete is being crushed for reuse and spoil is cleanfilled, it is far from ideal use of resources and warrants further exploration due to the sheer scale in comparison to the build waste (28160 kg of concrete/ spoil vs 3679 kg of building waste).

Aside from 35 kg of paver off cuts, there was very little landscaping waste (no deck).

FIGURE 17: CONCRETE FOOTPATH CUT AND STACKED READY FOR DISPOSAL PRIOR TO VEHICLE CROSSING INSTALLATION.

5.0 Project Summary:

5.1 Areas for improvement in the audit process:

One of the challenges we faced was communicating the name and utility of each of the building products to the audit contractors. This created some problems with data collection as some of the waste types had been named incorrectly. The photos helped but in hindsight we should have had more input in to the audit process and setting up of the categories in the first stage of the audit. There was a focus on reuse diversion opportunity for timber which meant that all unusable lengths (under 600mm) were grouped together as a waste type so we lost some detail on the source for those shorter lengths.

We also perhaps had undue focus on the MfE SWAP (Solid Waste Analysis Protocol) categories which were unsuitable for this type of audit. The SWAP categories are unable to cater for the level of granularity required for an audit such as this (construction waste).

5.2 Key takeaways:

On the basis of this audit, the estimate of 4.5 tonnes of waste per new house build seems to be accurate but high. This house at 155m2 was close to the current average size (158m2 in 2019) but included architectural features such as the pitched roof which increased the wall area and material wastage. The choice of materials also had a large impact on the weight of the waste – in this case fibre cement board cladding and tile waste were a large proportion of the total waste.

Plastic waste across the entire build totalled 100kg (HDPE, PVC, LDPE, PP, PET and indeterminate). While a large proportion of this waste could be recycled, it was a relatively small proportion of the total waste. Because this waste stream was created throughout the build, it would be challenging to identify and recover as it was in many different forms. It is likely that the highest return would come from a focus on avoiding this waste where possible rather than looking to sort/ divert.

A surprising component of the skip waste was the amount of brand new and unused building products that ended up in the skip. Some examples included full rolls of building paper, unopened tubes of silicone and several boxes of unused nail plates. The hypothesis is that this material was simply cleared in to the skip as part of a site clean-up potentially because it was easier than finding/ moving somewhere for the materials to be reused. There seems to be an opportunity for a small business or Community Recycling Centres to be more active in helping recover materials from sites before they reach the skip.

The most significant volume of waste on this site was the concrete and spoil waste from the vehicle crossing and driveway. Ordinarily (aside from possibly HAIL sites) this waste stream would not be deposited in landfill but it does account for for a significant chunk of cleanfill waste (still a linear rather than circular extraction/disposal model). This is a resource that may not necessarily need to be extracted in the first place so it would be worthwhile to explore alternative site processes.

Based on this audit, it seems that the simplest and most effective way for building sites to maximise their diversion is to ensure they have a recovery pathway for timber waste and plasterboard waste. Those components alone account for over half of the building waste stream and simple diversion solutions are available.

5.3 Opportunities for further analysis:

There is a huge amount of data available to us now and it can be analysed in many ways. As time and resources allow, it would be good to explore further:

- **Quantification of the value of discarded materials.**
- **Cross check frame and truss order to confirm quantity of random lengths included.**
- **Check process for carpet installation, also consider wool vs nylon and recycling options.**
- **Explore in more detail what materials could be recovered/ sold via a CRC (Community Recycling Centre)**
- **Cross check tonnages from this build with other sites and extrapolate across all building consents to compare against our estimates across Auckland.**
- **How much waste could have been designed out of the build?**
- **Estimates on tile waste across Auckland? Survey of tilers to understand where they are currently disposing of waste. Possibly a significant waste stream which has diversion potential.**
- **Estimates on concrete waste produced with each new vehicle crossing built in Auckland (utilise VCA data from Auckland Transport).**
- **Explore alternative ground surface coverings to reduce metal (gravel) requirement and spoil waste during the build process.**