From: Official Information
To: [redacted]
Cc: Official Information
Subject: Final response - LGOIMA [redacted] - Copy of report mentioned in ME/NPS-UD HDCA
Date: Thursday, 1 February 2024 4:10:42 pm
Attachments: image001.png
image002.jpg
image003.jpg
HCC Commercial Feasibility Model Design Document.pdf

Kia ora,

We refer to your information request below. Hamilton City Council provides the following response.

Your request:

> *Please provide a copy of this report. It is referred on page 61 of the ME/ NPS -UD Housing Development Capacity Assessment 17.11.2023.*

Our response:

Please see a copy of the report attached.

You have the right to seek an investigation and review by the Ombudsman of this decision. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

Ngaa mihi
Keeley Faulkner
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Email: officialinformation@hcc.govt.nz

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From: [redacted]
Sent: Wednesday, January 24, 2024 11:50 AM

To: Official Information <officialinformation@hcc.govt.nz>
Subject: HCC. Commercial Feasibility Model . Conceptualise Design Approach. 10 Dec 2022

Good morning, Please provide a copy of this report. It is referred on page 61 of the ME/ NPS -UD Housing Development Capacity Assessment 17.11.2023. Thanks

Kind Regards

s7(2)(a) [redacted]

Design Document

Hamilton City Council-

Commercial Feasibility Model

Conceptualise Design Approach

Document status: Final

Document version: 1.00

Date: 10/12/2022

Document Author: Yong Srun Vann/ Tamil Selvan Parasuraman

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Glossary of Terms:

Term	Description
HCC	Hamilton City Council
HBA	Housing and Business Development Capacity Assessments
LTP	Long Term Plan
CFM	Commercial Feasibility Model
RMA	Resource Management Act
NPS-UD	National Policy statement on Urban Development
SA2	Statistical Area 2
PC12	Plan Change 12
CGPI	Capital Goods Price Index
PPI	Producers Price Index
LCI	Labour Cost Index
STD	Detached/Standalone
DPL	Duplex
TNH	Townhouse
APT1-3	Apartment 1-3 Storeys
APT4-5	Apartment 4-5 Storeys
APT6+	Apartment 6+ Storeys
PECM	Plan-enabled Capacity Model

1. Background

Hamilton City Council (HCC) plays a vital role in shaping Hamilton City by planning and promoting city growth and providing infrastructures to enable that growth. The National Policy Statement on Urban Development (NPS-UD) requires local authorities to prepare Housing and Business Capacity Assessments (HBA) regularly assessing housing capacity to ensure there is at least sufficient development capacity to meet growing demand.

One of the NPS-UD evidence and monitoring policies requires high-and-medium-growth local authorities to prepare HBA to assess the Plan-Enabled Capacity (PEC - development potential enabled by existing plans) and Commercially Feasible Capacity (CFC - a subset of PEC that is considered profitable to develop at today's costs and prices). The capacities were estimated by the development of the Plan-enabled Capacity Model (PECM) and Commercial Feasible Model (CFM), and these models are an important input to HCC's Growth Model, which is a core model of the Growth Modelling Environment. Previously, a narrower and less sophisticated Excel-based modelling system was used until Growth Modelling Environment has been operating successfully in the last 2 years. It is a critical operational and strategic tool that underpins a number of key urban and infrastructure planning processes, such as Housing and Business Capacity Assessments (HBA), Long Term Plan (LTP), Three-Waters Model, Transportation Model and Development Contribution Model.

During the operation of the Growth Modelling Environment, the Analytics team has identified certain areas where further enhancement can be made and benefits can be realised, i.e., the development of four distinct data models, the setup of one regional data collection process and the development of a Power BI dashboard to disseminate outputs across the organisation. Those identified products and processes will further enhance the robustness and agility of the Growth Modelling Environment (see Appendix 1). The purpose of this project is to give stakeholders access to more transparent and extensive growth data modelling to improve strategic decision-making, save costs, reduce reliance on external providers, and gain a better understanding of regional growth and the factors that influence it. The Commercial Feasibility Model or CFM is one of those identified models.

The output of the proposed models will adhere to the organisational strategy of "Embracing Growth" and "Improving the wellbeing of Hamiltonians". It will also help the HCC's employees and elected members to have a better understanding of Hamilton's growth potential, demand, and projections in real-time. This will help local authorities make better-informed choices on infrastructure spending and urban planning. All Growth Model's components will be brought together under one roof after the HBA's PECM and CFM are established internally, allowing for the planning and delivery of better results in a coordinated manner with other council's teams (Planning, Engineering and Policy). HCC will be able to be "Best in Business" by having a Growth Modelling Environment that is significantly more agile, robust, and transparent in the interim.

2. Purpose of this document

Considering that the NPS-UD posits a broad scope of action for the council to explore the sufficiency, affordability and competitiveness of land and housing markets, the purpose of this document is to summarise the methodology and assumptions of the development of the conceptualised model — HCC's Commercial Feasibility Model (CFM). The CFM, one of the crucial deliveries feeding information into HCC's Growth Model, is a critical operational tool that supports urban planning and decision-making. The proposed model is to replace the existing CFM which has been operated and maintained by an external consultancy (Market Economics) in guidance with NPS-UD to develop a parcel-level Commercial Feasibility calculation process with the latest information on sales and costs. 'Feasible' refers to commercially viable development, considering the current estimated costs, sales, and yields of the plan-enabled development capacity (NPS-UD, 2016). The proposed model will also be used for future scenario testing, such as when there is a change in the district plan or updates to national planning provisions.

The developed model will estimate the gross profit based on the sale—costs equation, a derivative of a developer's residual value equation, which includes a wide array of variables — sale price, construction cost, land purchase cost, service connection fees, etc that are faced by developers when undertaking residential construction.

This document is to detail the data, methodology and assumption used in the model development and will be reviewed by external consultants for feedback and improvement purposes.

3. The Uses of Model Outputs

- Address HBA requirements for assessing the commercial feasibility capacity
- Enhance the Growth Model
- Support decision-making and urban planning process

4. Exclusions

- Only the residential sector is included in the modelling
- Ongoing maintenance and update of the model
- NPS-UD monitoring report delivery is not included
- Delivery of the 2024 HBA and 2024 LTP scenarios are not part of the project

5. Dependencies

- The proposed Commercial Feasibility Model will be tested using the existing plan-enabled capacity outputs from the Plan-enabled Capacity Model (PECM) under the Plan Change 12 (PC12) developed by the external consultant.
- CFM relies on the most recent, available data from both internal and external sources, including construction costs, site preparation costs, professional fees and so on.

6. Modelling Approach

The model is constructed using a combination of prepared relational data, spatial data, and a series of data transformations to process the inputs and perform a sequence of calculations using a model leveraged by the R Scripts that reproduce the requirement of NPS-UD feasibility calculation.

The model is tested at the parcel level and provides City Planners with the flexibility to perform plan evaluations with appropriate aggregation. The model estimates the number of commercially feasible dwellings per plan-allowed typology at different points in time for different development scenarios. This modelling approach does not imply that all feasible parcels will be developed, but it is a commercially feasible estimate that enables separation of plan-enabled but unfeasible development that is less likely to be realised, from plan-enabled feasible development that is relatively more likely to be realised. This distinction is also reflected in the NPSUD which also requires further estimation of “reasonably likely to be realised” development from the feasible assessment.

6.1 Feasibility Development Capacity and Outputs

The feasibility development capacity is based on the development capacity enabled by the proposed plan change, which is provided by the PECM. The outputs from CFM will be produced on a parcel level and an annual basis. The output structure consists of parcel ID, number of units per typology enabled by the plan, location, zone, earliest feasible year, and feasibility in subsequent years. Nevertheless, there is no restriction on how the output structure should be as it can be changed based on the request from the users.

The details of development capacity scenarios and feasibility calculations are illustrated as follows.

6.1.1 Tested Development Scenarios

The development scenarios are derived from the plan-enable capacity outputs that are modelled based on the district plan or plan change scenarios. For modelling purposes, the proposed PC12 is used to inform three development scenarios:

Infill Capacity refers to the number of additional dwellings added to the vacant area of the existing urban parcel without demolishing any existing dwellings on the parcel.

Redevelopment Capacity refers to the number of additional dwellings added to the entire area of the existing urban parcel after demolishing the existing dwellings on the parcel.

Greenfield Capacity refers to the large vacant parcel in the Greenfield areas.

Each development scenario has different testing approaches in terms of input variables while the testing procedure explained in Section 6.2 remains similar across the scenarios.

- Infill Capacity: the land area is the core variable that makes it different from other scenarios. The land area of the parcel in the infill subdivision scenario is divided into two parts: occupied land area and vacant subdivided area. The former refers to the land area occupied by the existing dwellings, and this will be taken away from the calculation process, while the latter refers to the land area of the additional dwellings added to the vacant subdivided area which will be used to inform the floor areas of those dwellings. However, the subdivided land area is available and provided by PECM. For the Infill scenario, only the additional dwellings are used for testing. Apart from this, the demolition cost is excluded from the calculation and the land purchase cost is estimated using the land value regression (see Section 7.7)
- Redevelopment Capacity: the land area in this development scenario equals the actual developable area per parcel ID. This means that the entire parcel will be assumed as vacant areas where the existing dwellings are demolished. Hence, the number of dwellings to be tested is the total number of dwellings (not just additional dwellings) that are added to the parcel after the redevelopment. The floor area will be calculated using redeveloped land area on a dwelling level. This scenario includes the cost of demolition, and the land purchase cost is proxied by the capital value (the sum of the land value and improvement value).
- Greenfield Capacity: the land area in this scenario is the developable land area, which will be provided by PECM. The developable land area will be used to inform the floor area and section price based on the section price per m^2. In this scenario, the number of dwellings tested is assumed to be the number of additional dwellings enabled by the plan. The land cost for Greenfield is derived from the multiplication of the average section price per m^2 and the developable land area.

Table 1 summarises the main differences in methodology across the scenarios.

Development Scenario	Number of dwellings tested	Floor area	Land area	Demolition Cost	Land Purchase Cost
Infill	Additional Dwellings	Based on the vacant subdivided land area	Vacant subdivided area	Not included	The land value of vacant subdivided area per land parcel based on the market rate
Redevelopment	Total Dwellings	Based on the entire land area per land parcel	Entire land area per land parcel	Included	Capital value per land parcel
Greenfield	Additional Dwellings	Based on the entire developable land area of the section	The developable land area of the section	Not included	Section price per Greenfield developable land parcel ($ per m2)

Table 1 – Summary of Testing Scenarios

6.1.2 Infrastructure-ready Timing Layer

Infrastructure-ready timing refers to the year that the infrastructure becomes available and ready to service the growth. In this regard, there is another layer set to control feasible year to take account of infrastructure-ready timing in the modelling; this also means that the feasibility outcome will depend on whether the infrastructure-ready timing layer is OFF or ON:

1) Infrastructure-ready timing layer is OFF: The feasible year for any parcel will depend on the outcome of their feasibility testing regardless of infrastructure-ready timing.
2) Infrastructure-ready timing layer is ON: any parcel is feasible before the infrastructure-ready timing, the feasible year will be pushed forward to the year of infrastructure-ready timing for that particular parcel. For example, Parcel A in Figure 1, having a profit margin exceeding the feasibility threshold in 2025 but before infrastructure-ready timing, will have a feasible year as 2030 the same as infrastructure-ready timing. On other hand, if the profit margin exceeds the feasibility threshold at any time after the infrastructure-ready timing, the feasible year will be based on feasibility testing, e.g., 2032 is the feasible year for Parcel B in

Figure 1.

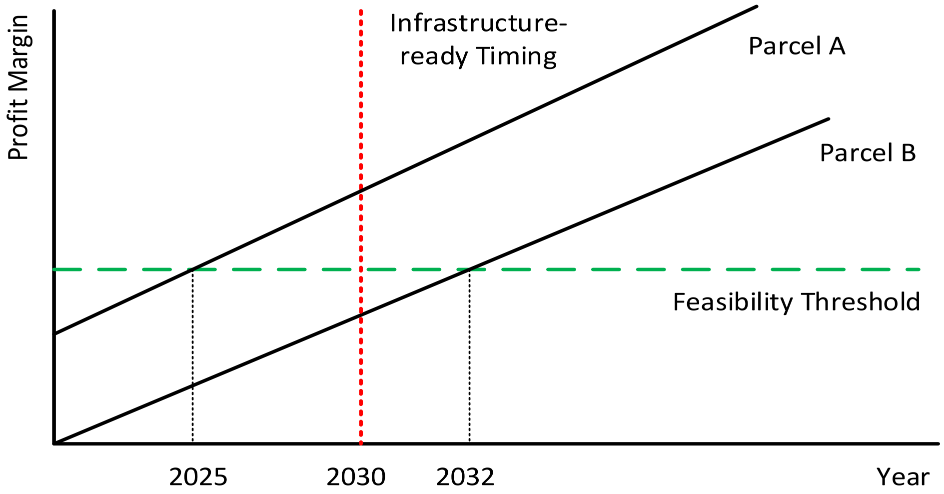

Figure 1 – Infrastructure-Ready Timing Diagram

6.2 Feasibility Calculation Formula

The proposed CFM will be used as an assessment of the ability of a typical profit-motivated developer acting within normal commercial parameters to deliver within extant planning constraints.

The approach is an attempt to simulate the process a private, profit-driven developer takes to develop and sell the completed dwellings that are in accordance with the parameters set by District Plan provisions, engineering constraints and accounting for other external costs & sales prices. However, the model can only represent a subset of the market that is driven by the profit but not the whole market that would include other non-profit-driven sectors, such as the public sector and individual homeowners. The model's output calculation focuses on the analysis of the developer's 'gross' profit, i.e., the expected total sales price of the development minus the total costs of undertaking the development. If the resulting profit margin meets or exceeds the 'feasibility threshold,' the tested dwellings are considered to be 'commercially feasible'.

For present modelling purposes, the adjustable feasibility threshold has been set at 20% for all typologies except the Apartment (25%). This threshold is generally an average margin that is likely to be adopted in the CFM studies and suggested by NPS-UD, while some development may occur at a lower or higher margin. However, the profit margin can be adjusted based on current market conditions and developers' intentions, and as indicated above, by typology. Equation (3) illustrates the details of the commercial feasibility equation:

Development Cost: $$Cost_{p,t} = n\sum_{a=1}^{j} CostI_{a,t} + \sum_{b=1}^{k} CostP_{b,t} \quad (1)$$

Sale Price: $$Sale_{p,t} = n * Sale_{i,t} \quad (2)$$

Profit Margin: $$Profit\ Margin = \frac{Sale_{p,t} - Cost_{p,t}}{Cost_{p,t}} \quad (3)$$

where p is parcel ID, t is year t, n is the number of dwelling units per parcel p, $CostI_a$ is the dwelling-level cost for variable a, $CostP_b$ is the parcel-level cost for variable b. $Sale_i$ is the sale price per dwelling unit. $Cost_{p,t}$ and $Sale_{p,t}$ are the development cost per parcel and sale price per parcel, respectively.

If $Profit\ Margin_{p,t} \geq feasibility\ threshold\ (20\%\ \ or\ 25\%)$, parcel p is considered feasible at year t. Otherwise, the feasibility calculation of a non-feasible parcel at year t will be iterated with inflation factoring to find out which year it will become feasible as explained by Equation (4):

$$Profit\ Margin_{p,t+T} = \frac{\left(1 + r_{s,t}\right)^T Sale_{p,t+T} - \sum_{m=1}^{z}\left(1 + r_{m,t}\right)^T Cost_{m,t+T}}{\sum_{m=1}^{z}(1 + r_m)^T Cost_{m,t+T}} \quad (4)$$

where T is the number of years that the parcel will be feasible given $Profit\ Margin_{p,t+T} \geq 20\%\ (25\%)$ at year $t + T$, m is the cost variable 1,…, z, $r_{s,t}$ is the inflation rate[1] for sale price at year t, r_m is the inflation rate for cost variable m (either $CostI$ or $CostP$).

The model will calculate the profit margin per parcel level on yearly basis for all typologies and identify the year that parcel becomes feasible per typology and continues calculation for the subsequent years even after the parcel becomes feasible based on the users' requirements.

6.3 Modelling structure

This diagram explains the methodology framework of CFM testing. The test is conducted per typology per parcel level, meaning that all typologies will be tested on each parcel as long as they are enabled by the plan. A high-level overview of the CFM is outlined in the flow chart in Figure 2.

[1] The model allows inflation rate to be varied across variables throughout the time. It can be adjusted based on the users. In this report, different inflation rates for each variable is proposed as can be seen in Section 7.11.

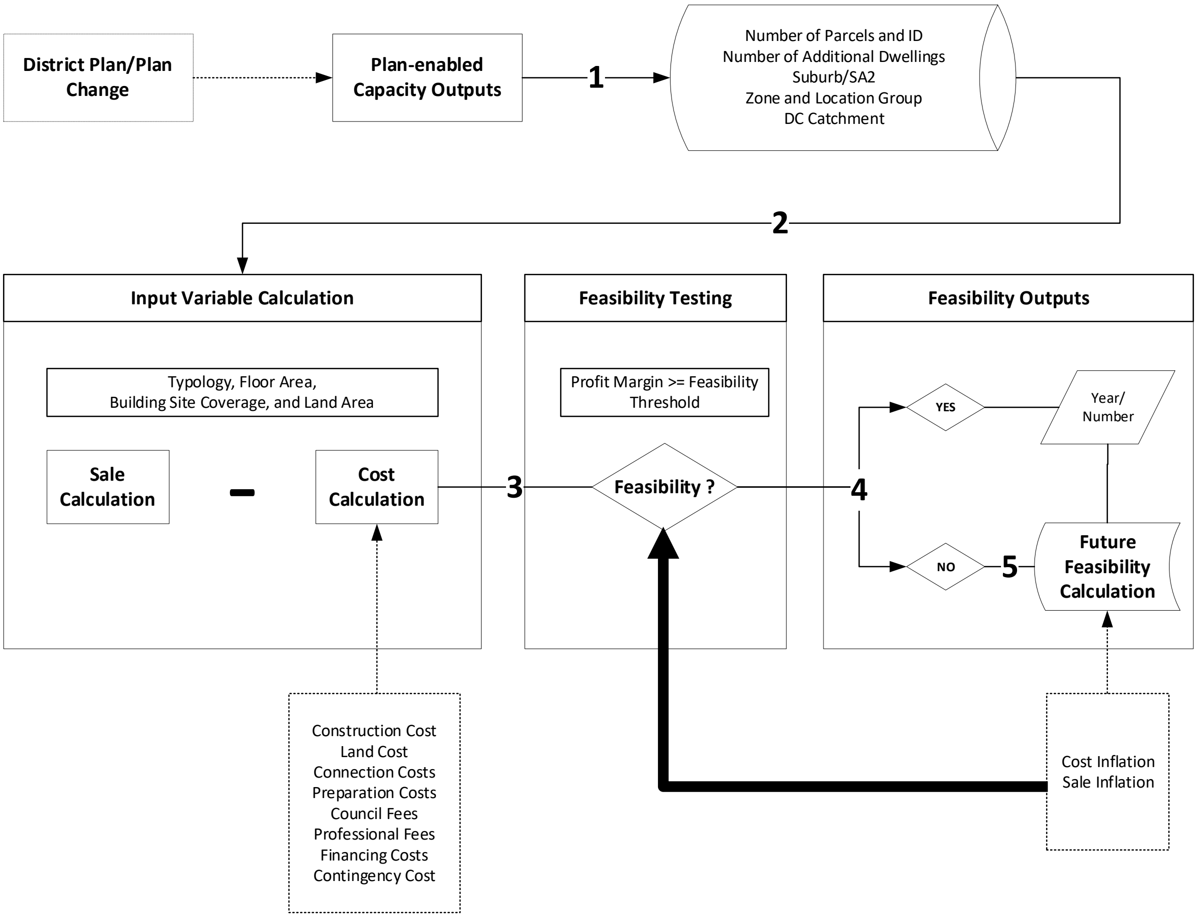

Figure 2 – Commercial Feasibility Modelling Approach Diagram

Step 1—Collecting plan-enabled capacity outputs and spatial information: the outputs from PECM are collected and used to advise the maximum number of dwellings enabled on each land parcel for feasibility testing. The outputs must contain the following information: number of parcels and ID, number of new additional dwellings, suburb or SA2 name, zone and location group, and DC catchment. The spatial information is very important in selecting the appropriate cost and sale functions for each parcel.

Step 2—Input variable calculation: the information in Step 1 will be used to calculate costs and sale price per dwelling and then multiplied by the number of units per parcel ID to get parcel-level costs and sale price. In the calculation, other global parameters are very crucial in determining the specific costs and sales apart from the spatial information; they are the typology, floor areas, building site coverage, and land area. For the cost calculation, the total cost is derived from the sum of various costs, which are Construction Costs, Land Purchase Costs, Service Connection Costs, Preparation Costs, Council Fees, Professional Fees, Financing Costs and Contingency Costs. For the sale calculation, the sale function is used to estimate the per-dwelling sale price based on location, typology, building size and land area.

Step 3—Feasibility Testing: all the costs and sale price will be calculated at the parcel level by typology, so the feasibility can be tested on parcel-level information. This step is mainly to answer whether the profit margin at the current year is equal to or larger than the feasibility threshold (20% or 25%) based on the calculation formula explained in Equation 3.

Step 4—Feasibility Output: if the testing result from Step 3 indicates that the profit margin per parcel ID in the current year is equal to or larger than the feasibility threshold, the parcel and the number of dwelling units are considered feasible for development at the current year.

Step 5—Future Feasibility Calculation: in this step, future feasibility testing is the calculation of feasibility in the subsequent year by factoring assumed inflation (this may be negative) on both the various costs and sale price equations (See Equation 4). If future feasibility testing shows that the profit margin is equal to or larger than the feasibility threshold at year $t+T$, the parcel will be considered feasible at year $t+T$. The future feasibility is tested on both feasible parcels and non-feasible at the current year; the feasible parcel per typology at year t will keep tested in the subsequent years even after the parcel becomes feasible. It is noteworthy that if the difference between the sale growth rate and cost growth rate remains constant, the parcel will remain feasible in the subsequent years.

7. Data Elements

The most crucial part of the model development is to select suitable and useful input data elements and estimates. The selection of variables is based on theoretical justifications, but not all variables will be useful and applicable due to data availability. Efforts have been made to get a list of possible variables that can improve the model output, nevertheless; there are common variables that have been fundamentally justified as important drivers of feasibility outcomes by both theoretical and statistical evidence, e.g., sale price, build costs, professional fees, council fees.

The proposed model approach will make use of all potential variables whose data are available and collected from internal and external sources at both local and national levels. This approach is beneficial on the ground that all possible data elements will be considered, and a possible statistical approach would be inoculated to enhance the model quality. There are two main types of variables: non-numerical variables and numerical variables. The former is called global parameters while the latter refers to the cost and sale variables. The list of input variables and their methodologies are detailed as follows.

7.1 Global Parameters

The global parameters refer to the fundamental information that is used to distinguish the cost and sale difference per typology and location.

7.1.1 Zone and Typology

HCC District Plan defines a number of different zones and its provisions that enable opportunities for different dwelling densities, housing typologies and intended growth outcomes. . In accordance with the HCC District Plan and input from the City Planning team, the typologies that are allowed in each residential zone based on the proposed PC12 are different. Each zone has permitted activity as well as discretionary and non-permitted activities requiring Resource Consent. The CFM testing relies on the typologies and yields enabled by the plan in each zone calculated in the PECM. If a particular typology is identified as a discretionary, non-complying or prohibited activity by the plan, the PECM's output would be zero (by definition it is not 'plan enabled'), so that typology is not needed for feasibility testing in the CFM.

There are a number of zones where residential use is enabled currently tested in the CFM:

- General Residential,
- Medium Density Residential,
- High Density Residential,
- Historic Heritage Area,
- Large Lot Residential,
- Peacocke Medium Density Residential,
- Precinct 1- Downtown Precinct,
- Precinct 2- City Living Precinct, and
- Precinct 3- Ferrybank Precinct.

For the typology tested, 4 distinct typologies are enabled by the proposed PC12:

- **Detached (STD)** refers to standalone single dwellings that are not attached to other dwellings and often have their land site.
- **Duplex (DPL)** refers to attached dwellings that share a vertical party wall with another identical dwelling in one site where they are normally known as duplex pairs on each site formed. They can be multi-storey dwellings that are reflected by the size of the floor area and land area.
- **Townhouse (TNH)** refers to horizontally attached dwellings that are commonly two to three-storey walk-up terraced housing.
- **Apartment (APT)** refers to vertically attached dwellings that are formed on one site with multiple storeys with a height limit defined in each District Plan zone.

7.1.2 Location Group

The sale prices and costs to develop are spatially differentiated across Hamilton, reflecting the spatialisation of different market segments, and the incomes of households to have gravitated towards these areas. However, it is arduous (and arguably spurious) to differentiate the cost and sale values by very fine geographic detail such as parcel or SA2 levels as there are not sufficient data available for the calculation. To consider the variety of cost and price differences, the cost and price values can be grouped by a broader area based on the similarity of the dwellings' price bands (or market segments), which are termed, ‘Location Group’.

The purpose of using Location Group categorisation is to achieve the best estimates for cost and price differences based on their common features identified in previous data analysis and to serve as a parameter that classifies the outputs by location for the sake of comparison and estimation. However, the categorisation is adjustable if there is a significant spatial change or market price in a particular location, e.g., as a result of major development like a highway or school.

In this CFM, the location group is based on the spatial structure studied by M.E. in their Residential Capacity Modelling report (M.E, 2022). The spatial structure contains two layers:

- The base layer is the Location group (LG) which is formed of SA1 and consists of location groups; LG1-5 covers most of the Infill areas, while LG0 is the city centre, whose majority are commercial areas. Figure 3 shows the map of the base layer (Figure 3).
- The second layer is the Main Centre Surrounds (hereafter, Amenity) and Main Roads. Amenity refers to whether the parcel is located at or near the town and enters within assumed walkable distance. There are 7 main amenities in the dataset: Central Business District (CBD), Chartwell, Five Cross Road, Grey Street, Nawton, Rototuna 1 and Rototuna 2. Main Road refers to whether the parcel is located along the main road. There are 3 main roads in the dataset: Main Road 1, Main Road 2, and Main Road 3 (See Figure 4).

Detailed spatial information, including the second layer, can be found in M.E (2022).

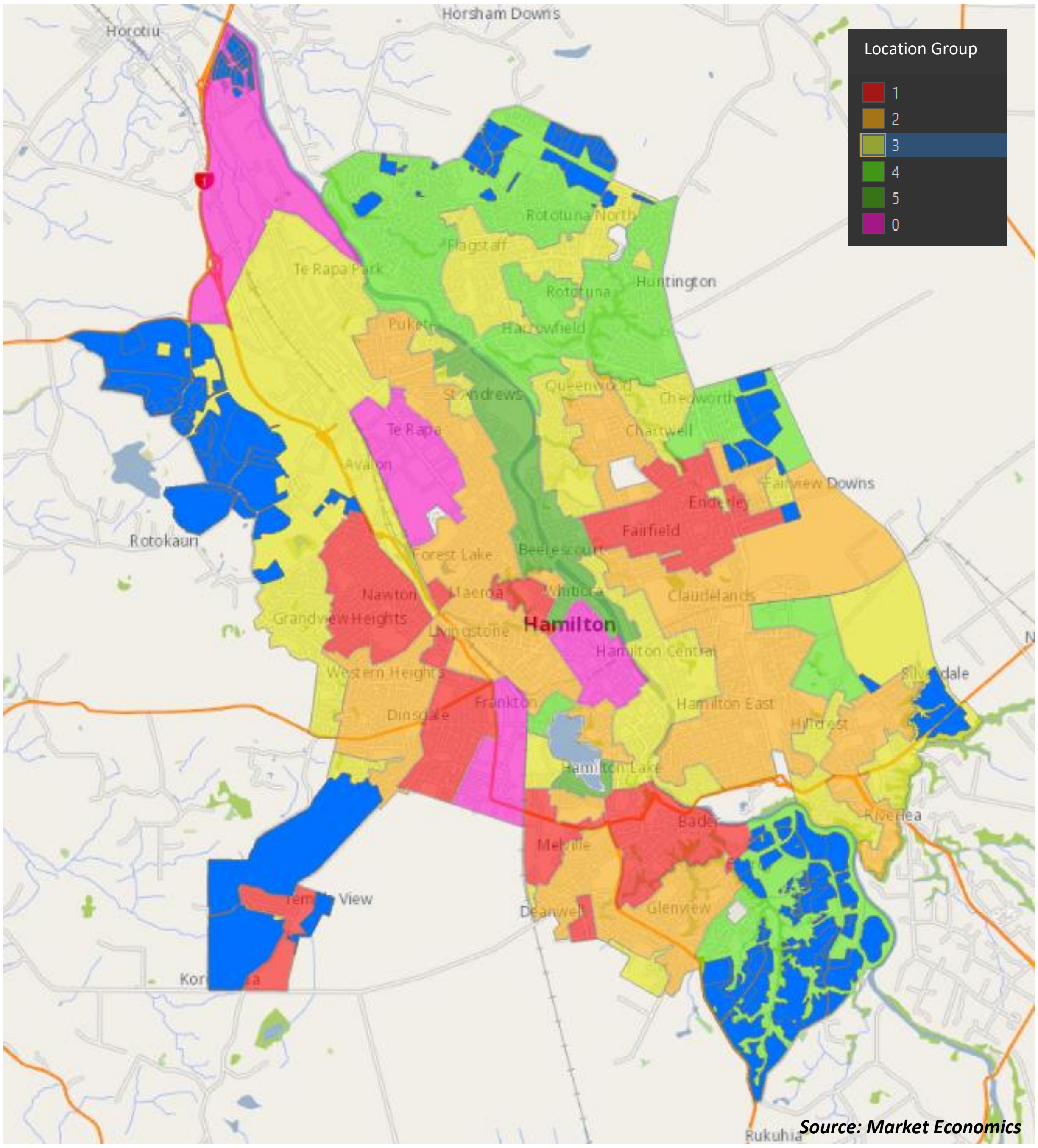

Figure 3 – Location Group Category

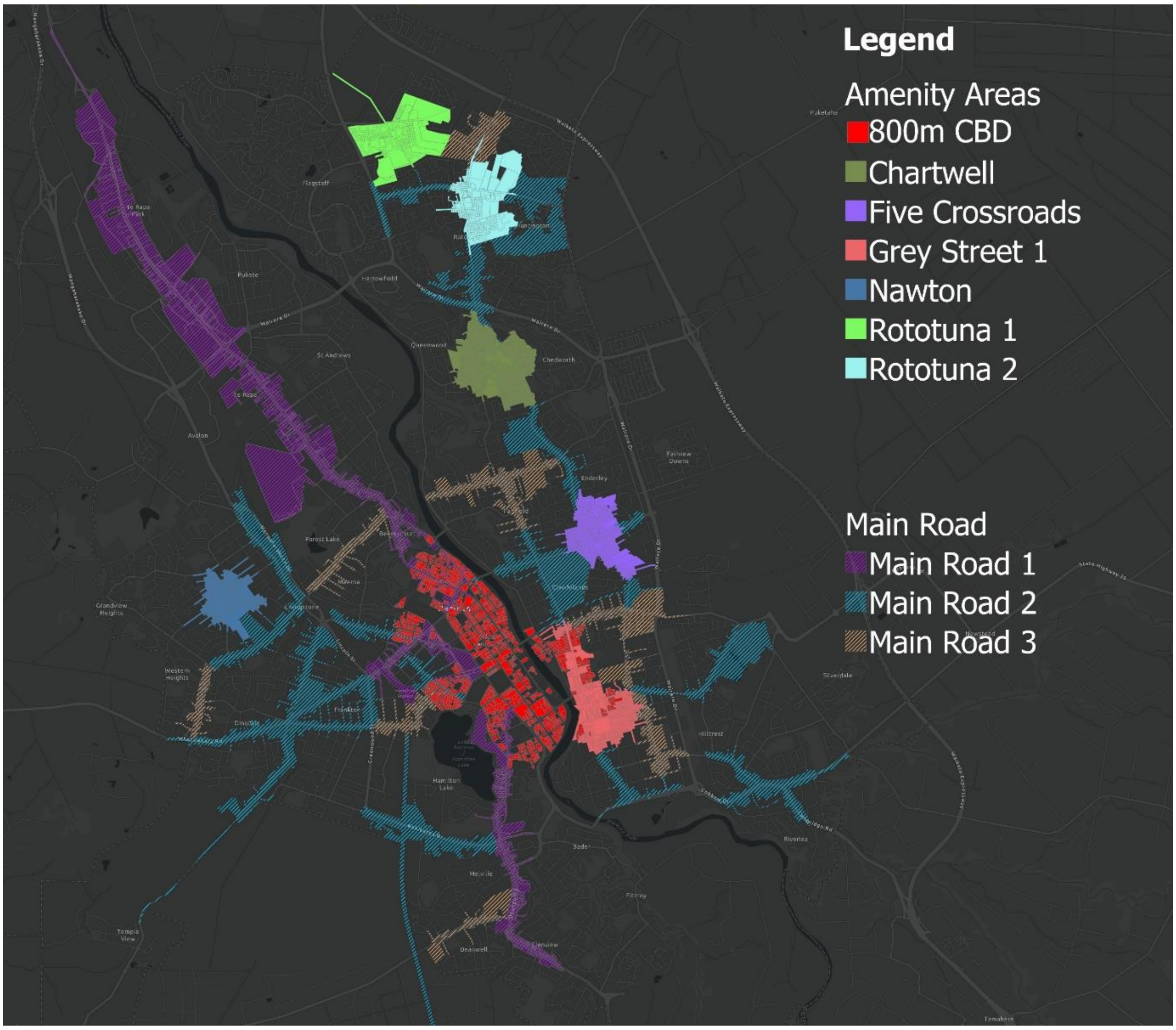

Figure 4 – Amenity and Main Road Category

7.1.3 Floor Area

The floor area (floorspace) refers to the potential dwelling size per typology on each parcel. The calculation of floor area is not straightforward as it can be related to many factors. The historic consent data is used to examine the median and average floor area per typology. It shows that different typologies tend to have different floor areas. In this case, we proposed a mixed approach that can tailor floor area based on typology. The floor area is calculated on individual dwellings per typology for each parcel, meaning each plan-enabled unit per typology on the same parcel ID will have the same dwelling size, but the dwelling size per typology across the parcel ID will be different depending on the developable land area per parcel ID.

A. Detached

Visual inspecting of the scatter relationship between floor area and parcel size can indicate whether parcel size can determine floor area. Next, linear regression is used to estimate their relationship. The Building Consent data from 2015-2022 is used to study the relationship. The data has been cleansed and filtered by removing some outliers. The results show that the relationship is only statistically significant for Detached/ Therefore, the regression approach is used to estimate the floor area for Detached. However, in the real world, the floor area does not always go larger when the parcel size increases, so a maximum value of 350 m^2 is capped on the floor area for Detached.

B. Duplex and Townhouse

A mixed approach is used to study the floor area for the Duplex and Townhouse. To reflect the PC12 which responses to the MDRS, we collected more than 100 samples of Duplex and Townhouse in Auckland and use them to study the floor area and land area relationship in Hamilton. This approach is justifiable that the samples are the newly developed high-density in Auckland, and they tend to reflect the effect of MDRS. The samples are used to structure the relationship between floor area and land area by using linear regression. The cap of 250m2 is used for Townhouse and Duplex as there are only a few samples that exist above 250 m2. Figure 5 shows the relationship between floor area and land area for the three typologies.

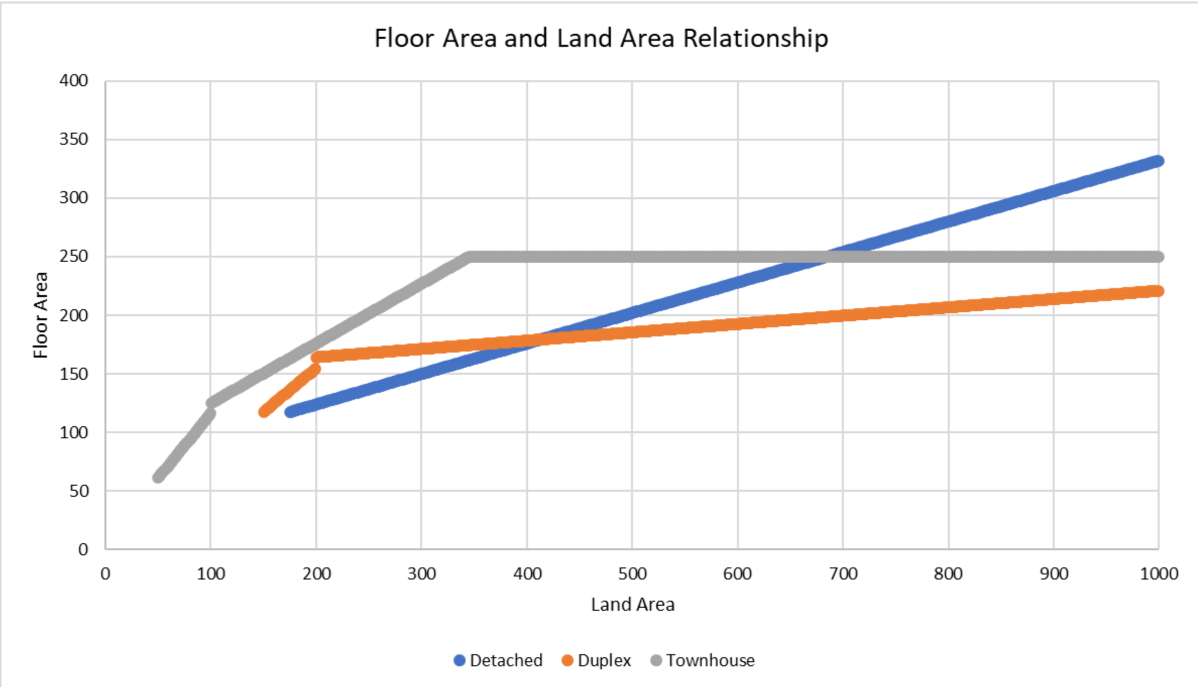

Figure 5 – Floor Area and Land Area Relationship

C. Apartment

As there is not much existing data for apartments in Hamilton City, a different approach is applied. To be consistent with the assumptions used in the PEC model, the floor area for the Apartment is fixed per zone, as shown in Table 2.

Zone	Floor area per Apartment Unit	Number of Stories
Central City	80m2	7
High Density	100m2	7
Medium Density	130m2	5
Note: this excludes the commercial ground floor.		

Table 2 – Apartment's Floor Area Assumption

D. Number of Stories

After the floor area is derived from the land area, the number of stories is calibrated based on the maximum floor area rules. The number of stories is an important factor in deciding the build cost rate because a house with multiple stories tends to have a higher average cost per square meter than a house with one story. To calibrate the number of stories, the maximum floor area per story based on PC12 requirements is used[2]. If the total floor area exceeds the maximum floor area per story allowed by PC12, it will distribute the remaining to the next floor. E.g., based on Figure 5, 250m2 of the land area will have a detached house with 137m2 floor area, but PC12 only allows building up to a maximum ground floor area of 125m2, and this means the developer needs to build a two-story detached house to accommodate 137m2 floor area. Table 3 provides a summary of the floor area relationship and the rule of number of stories by using the land area. Instead of floor area, land area is used as it is easier for modelling in the R codes; nevertheless, it should produce the same output because the floor area is determined by the land area.

Typology	Floor Area Calculation			Number of Stories Calibration	
	Land area per unit	Constant	Slope	Land area per unit	# Stories
STD	<=1070	72	0.26	>300	1
STD	>1070	Cap at 350m2		<=300	2
DPL	<200	5	0.75	>=350	1

---

[2] The maximum floor area per story is calculated using the 60° recession plane and 3-meter height, which is about a 1.73-meter reduction. $Maximum\ Floor\ Area\ per\ Story = \sum_{k=0}^{n}(\sqrt{MGFA} - (1.73 * k)) * \sqrt{MGFA})_k$ where $MGFA$ denotes the maximum ground floor enabled by the Plan (site coverage, zone and etc), the square root is the angle length of the square[2]. $k = 1, \dots, n$ is the total number of stories.

DPL	>=200, <1410	150	0.071	<349	2
DPL	>=1410	Cap at 250m2			
TNH	<100	6.2	1.1	>500	1
TNH	>=100, <=345	74	0.51	>=185, <=499	2
TNH	>345	Cap at 250m2		<185	3

Table 3 – Floor Area and Number of Stories Estimation for Detached, Duplex and Townhouse

7.1.4 Land Area

Land area refers to the total 'developable' land area that accommodates the developments per parcel. The land area is useful in calculating the floor area, related costs and sale price. The raw data on the developable land area can be obtained from the PECM output. As different development scenarios are different in terms of development assumptions, the land areas are different accordingly.

Development Scenario	**Land Area Assumption**
Infill	Subdivided Land Area
Redevelopment	Total Developable Land Area
Greenfield	Total Developable Land Area (factored infrastructure development cut-off)

Table 4 – Land Area Assumption by Development Scenario

7.2 Build Cost

Build Cost refers to the construction cost of the building. The cost is derived from QV's CostBuilder—a comprehensive subscription-based building cost platform. HCC has engaged with QV for the CostBuilder subscription to have access to their recent data.

To account for the build cost difference across the typologies and economies of scale, the build cost per m2 varies depending on the dwelling size and the number of stories. First, the dwelling size group is formed using the QV's property dwelling size ranges; the build cost per m2 for each dwelling size group varies depending on the number of stories tested. In this case, the information about the number of stories available in the QV's property type is used to match our typology classifications.

As QV's property types are not completely symmetric with our CFM's tested typologies, the matching process is based on a series of floor area assumptions and local knowledge to ensure that we can get the most appropriate build cost per m2. As QV's build cost is available in a range, the 'mean' approach is used to get the average value. Whilst most build costs will be based on the average values, some are using the lower or upper bound to reflect the economies of scale and cost differences across the typology classifications. E.g., a Duplex will take a lower bound build cost while a Detached takes the average build cost because a Duplex generally has a lower build cost than a

Detached. A summary of build cost per m2 based on the November 2022 price for each typology is shown in Table 5.

Typology	Dwelling Size Group		ZONE	Number of Stories	Build Cost Code	Build Cost ($ per m2)
	Floor Range (m2)	Size Code				
STD	0-130	STDSIZEA	Any Zone	1	STDNASTDSIZEA1	2,200
STD	131-230	STDSIZEB	Any Zone	1	STDNASTDSIZEB1	2,450
STD	>230	STDSIZEC	Any Zone	1	STDNASTDSIZEC1	2,250
STD	0-130	STDSIZEA	Any Zone	2	STDNASTDSIZEA2	2,425
STD	131-230	STDSIZEB	Any Zone	2	STDNASTDSIZEB2	2,550
STD	>230	STDSIZEC	Any Zone	2	STDNASTDSIZEC2	2,450
DPL	0-130	DPLSIZEA	Any Zone	1	DPLNADPLSIZEA1	2,200
DPL	131-230	DPLSIZEB	Any Zone	1	DPLNADPLSIZEB1	2,450
DPL	>230	DPLSIZEC	Any Zone	1	DPLNADPLSIZEC1	2,250
DPL	0-130	DPLSIZEA	Any Zone	2	DPLNADPLSIZEA2	2,425
DPL	131-230	DPLSIZEB	Any Zone	2	DPLNADPLSIZEB2	2,550
DPL	>230	DPLSIZEC	Any Zone	2	DPLNADPLSIZEC2	2,450
TNH	0-100	TNHSIZEA	Any Zone	1	TNHNATNHSIZEA1	2,600
TNH	>101	TNHSIZEB	Any Zone	1	TNHNATNHSIZEB1	2,550
TNH	0-100	TNHSIZEA	Any Zone	2	TNHNATNHSIZEA2	2,700
TNH	>101	TNHSIZEB	Any Zone	2	TNHNATNHSIZEB2	2,650
TNH	0-100	TNHSIZEA	Any Zone	3	TNHNATNHSIZEA3	2,800
TNH	>101	TNHSIZEB	Any Zone	3	TNHNATNHSIZEB3	2,700
APT	0-100	APTSIZEA	MDR	5	APTMDRAPTSIZEA5	5,010
APT	>101	APTSIZEB	MDR	5	APTMDRAPTSIZEB5	5,010
APT	0-100	APTSIZEA	HDR	7	APTHDRAPTSIZEA7	5,250
APT	>101	APTSIZEB	HDR	7	APTHDRAPTSIZEB7	5,250
APT	0-100	APTSIZEA	CBD	7	APTCBDAPTSIZEA7	5,250
APT	>101	APTSIZEB	CBD	7	APTCBDAPTSIZEB7	5,250

Table 5 – QV Construction Cost per square metre for Hamilton

From Table 5, the Build Cost Code is used to classify the build cost depending on typology, dwelling size group, zone and the number of stories, and it will be used to inform the build cost in the CFM calculation following the classification developments belong to.

7.3 Council Fees

7.3.1 Building Consent Fee

The data on Building Consent Fees is gathered from the HCC's Building Consenting Data. The fee is computed depending on the estimated construction value and the degree of building complexity. Therefore, the average proportion per typology is calculated and used as a proxy of the building consent fee variable because the building consent fee was estimated based on the value proposed in the consent application; this method allows the consenting cost to be varied according to construction cost rather than a flat rate.

We use the frequency distribution to further validate the obtained average proportion values and whether it happens frequently in the data. The histogram in Figure 6 shows that 1.5% to 2.5% of the data are the most observed proportions. This finding supports the method of using average proportion values as a proxy for building consent fee. Table 6 displays the building consent fee used in the model.

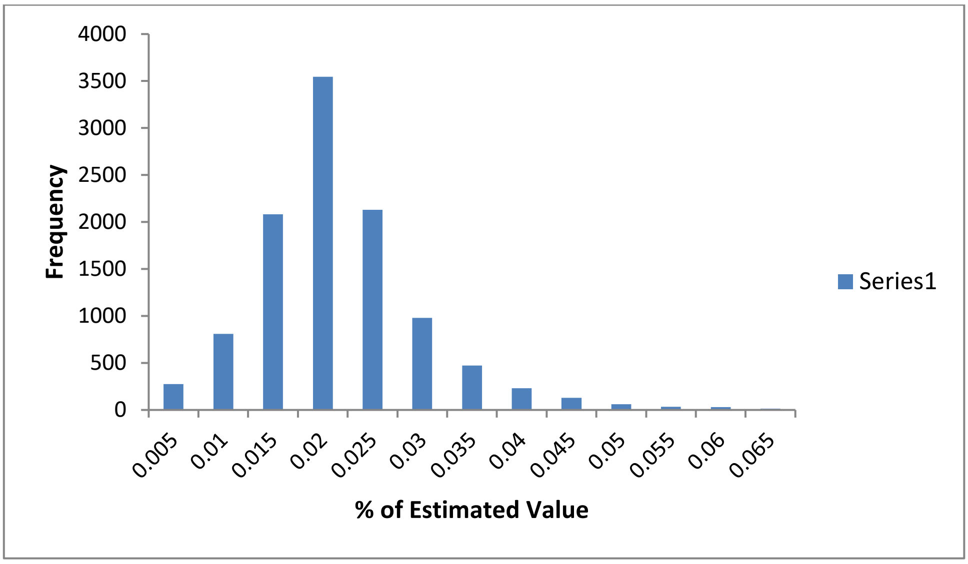

Figure 6 – Building Consent Fee Frequency Distribution

Typology	Unit	% of Total Construction Cost
STD	Per Build Cost	1.90%
DPL	Per Build Cost	2.30%
TNH	Per Build Cost	2.10%
APT1-3	Per Build Cost	1.78%
APT4-5	Per Build Cost	1.78%
APT6+	Per Build Cost	1.78%

Table 6 – Building Consent Fee as a Proportion of Construction Costs

7.3.2 Resource Consent Fee

The data on Resource Consent Fee is collected from HCC's Resource Consent Data. Although there are different types of resource consents, only Land Use Consent and Subdivision Consent are considered as they are more frequently lodged and more pertinent to this model. First, the median resource consent fees of Land Use Consent and Subdivision Consent are calculated for both Infill and Greenfield using the latest data as shown in Table 7.

2022 Resource Consent Fee	Greenfield	Infill
Land Use Consent	$ 2,350	$ 2,760

Subdivision Consent	$ 2,760	$ 2,499

Table 7 – Resource Consent Fee for Land Use and Subdivision

The statistical test of the difference between the resource consent fees for Greenfield and Infill is investigated. There is no statistically significant difference between the two of them. For this reason, one uniform value is used as a proxy of the resource consent fee for both Greenfield and Infill, i.e., $2,760 (See Table 8). To validate this result, the histogram is used to inspect if this value frequently happens in the dataset. Figure 7 indicates that $2,760 is the most happening value, thus suggesting it is a suitable value.

Resource Consent Type	Unit	Greenfield	Infill
STD	Per Project (Parcel)	$ 2,760	$ 2,760
DPL	Per Project (Parcel)	$ 2,760	$ 2,760
TNH	Per Project (Parcel)	$ 2,760	$ 2,760
APT1-3	Per Project (Parcel)	$ 2,760	$ 2,760
APT4-5	Per Project (Parcel)	$ 2,760	$ 2,760
APT6+	Per Project (Parcel)	$ 2,760	$ 2,760

Table 8 – Resource Consent Fee based on Typology

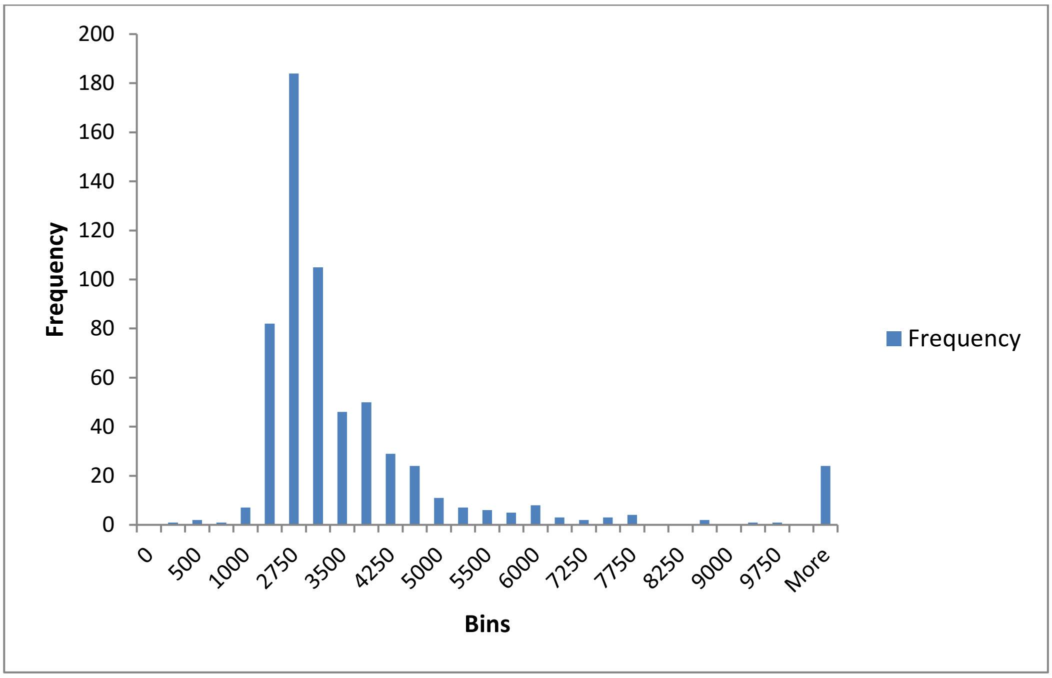

Figure 7 – Resource Consent Fee Histogram

7.3.3 Financial Contribution Fee

As Hamilton becomes increasingly intensified and urbanised, the infrastructure capacity must keep up with the demand growth. At the time of writing this report, to identify and fund infrastructures, HCC proposes to utilise Financial Contributions to ensure that a sense of place is maintained, urban convenience is enhanced, and the adverse effects of increased built form are mitigated. The three general purposes of Financial Contribution are: (1) Improving streetscape amenities and access to open green space; (2) Ensuring the objectives of Te Ture Whaimana o Te Awa o Waikato/The Vision and Strategy for the Waikato River are met; (3) Local network infrastructure renewals. The details of the Financial Contribution can be found in the Financial Contribution Provision (Thresher, 2022). The Financial Contribution charge depends on the number of bedrooms for residential developments or GFA (per 100 m^2) for non-residential developments. Table 9 summarises the Financial Contribution fee charged per three-bedroom 'residential' dwelling.

Typology	Units	Fees
STD	Per three-bedroom dwellings	$ 4,850
DPL	Per three-bedroom dwellings	$ 4,850
TNH	Per three-bedroom dwellings	$ 4,850
APT1-3	Per three-bedroom dwellings	$ 4,850
APT4-5	Per three-bedroom dwellings	$ 4,850
APT6+	Per three-bedroom dwellings	$ 4,850

Table 9 – Financial Contribution Fee per Three-bedroom Residential Dwelling

7.3.4 Development Contribution Fee

The current and previous Development Contribution (DC) policies were used to calculate the DC charge per HUE (Household Unit Equivalent). The base charge is the sum of all DC charges for water, wastewater, stormwater, reserves, community infrastructure, and transport activities. HCC must find a fair and appropriate balance in the way the costs of growth are shared between Greenfield and Infill development. DC's main purpose is to recover a fair and equitable portion of the capital expenditure for the growth of the city; thus HCC's approach is to create a DC policy that considers the resident of the city's overall well-being as well as financial factors.

The conversion factor, cap factor and sector factor are not included in the model to maintain the base rate for the residential sector. The average DC charge per HUE for three bedrooms is calculated using the latest year as provided in Table 10.

Development Contribution Catchment	2022 Fees
GField / Peacocke 1 / SW - Mangakotukutuku / WW - West	$ 45,827
GField / Peacocke 2 / SW - Mangakotukutuku / WW - East	$ 51,585
GField / Peacocke 2 / SW - Peacocke / WW - East	$ 46,832
GField / Rotokauri / SW - Lake Rotokauri / WW - West	$ 83,952
GField / Rotokauri / SW - Mangaheka / WW - West	$ 38,140
GField / Rotokauri / SW - Ohote / WW - West	$ 31,129
GField / Rotokauri / SW - Rotokauri West / WW - West	$ 31,033

GField / Rototuna / SW - Kirikiriroa / WW - East	$ 31,952
GField / Rototuna / SW - Otama-ngenge / WW - East	$ 29,618
GField / Rototuna / SW - River North / WW - East	$ 29,909
GField / Rototuna / SW - Te Awa o Katapaki / WW - East	$ 39,287
GField / Ruakura / SW - Hamilton East / WW - East	$ 24,272
GField / Ruakura / SW - Kirikiriroa / WW - East	$ 26,210
GField / Ruakura / SW - Mangaonua / WW - East	$ 25,756
GField / Te Rapa North / SW - Mangaheka / WW - West	$ 30,027
GField / Te Rapa North / SW - St Andrews / WW - West	$ 23,197
GField / Te Rapa North / SW - Te Rapa Stream / WW - West	$ 24,410
GField / Temple View / SW - Temple View / WW - West	$ 28,604
GField / Temple View / SW - Waitawhiriwhiri / WW - West	$ 28,628
Infill / Infill East / SW - Chartwell / WW - East	$ 18,023
Infill / Infill East / SW - City Centre / WW - East	$ 17,867
Infill / Infill West / SW - City Centre / WW - West	$ 21,275
Infill / Infill East / SW - Hamilton East / WW - East	$ 18,028
Infill / Infill East / SW - Kirikiriroa / WW - East	$ 20,249
Infill / Infill West / SW - Lake Rotokauri / WW - West	$ 79,831
Infill / Infill West / SW - Mangakotukutuku / WW - West	$ 28,758
Infill / Infill East / SW - Mangaonua / WW - East	$ 19,686
Infill / Infill West / SW - St Andrews / WW - West	$ 20,572
Infill / Infill West / SW - Te Rapa Stream / WW - West	$ 21,785
Infill / Infill East / SW - Waitawhiriwhiri / WW - East	$ 18,243
Infill / Infill West / SW - Waitawhiriwhiri / WW - West	$ 21,652
Infill / Infill West / SW - Western Heights / WW - West	$ 21,003

Table 10 – Development Contribution Fee per Household Unit Equivalent Dwelling

7.3.5 Rates

Rates are considered in the model as the builder or owner normally prefers to have all costs considered against the sale price which includes the rates that are being paid to the council during the development process. Rates are collected to fund the day-to-day operational cost as well as a portion of the capital cost of the city. Rates are proxied based on the rating valuation of each rating unit (property) which includes land value and improvement value. Rates are varied for each land parcel in this model, so unfortunately this document is unable to display all the data to keep this document short. On average, Rates are about $3,000 per residential dwelling in Hamilton; therefore, this figure has been assumed for the parcels that are currently waiting to be rated due to the real-world development happening at the moment.

7.4 Service Connection Costs

Service Connection Costs refer to the infrastructure service connection costs, including the water connection, sewerage connection, stormwater connection, electricity connection and telecommunication connection.

The Three-Water Connection Costs (Sewerage, Stormwater, and Water) are as advised by the HCC's City Water team. Aggregate data are grouped by construction projects and the application date of projects to determine the frequency distribution. The median method is also used to find the 50^{th} percentile of the total cost, which is then examined with frequency distribution whether that cost appears frequently in the sample. However, the examination is never straightforward; utilizing expert judgement combined with statistical approaches is appropriate in calculating the Three-Water Connection costs. The result is shown in Table 11.

Electrical Connection Costs are based on a recent evaluation of electrical service rates collected from QV's CostBuilder. Charges per dwelling vary depending on typology as outlined in Table 11.

Telecommunication Connection Costs were inferred from publicly available information released by BigPipe Company. The expansion of the current Ultra Fibre operating area for connection fees is unknown, but it is assumed that it will eventually be introduced to all residential areas as well as future urban areas. For this model, standard telecommunication charges incorporating connection modem and associated charges are considered, but they could be varied in the future if required. Table 11 summarises the service connection costs used as input variables in CFM. However, these costs will be reviewed when the model is re-run and more data become available. Although Telecom cost is really small and makes a very insignificant impact on the model calculation, however, the reason we consider this is to increase the flexibility of the model so that simulation or pressure test can be done if required.

Service Connection Cost	Three-Water Connection (Per Project)	Electricity Connection (Per Dwelling)	Telecoms Connection (Per Dwelling)
STD	$ 10,444	$ 96	$ 99
DPL	$ 10,444	$ 131	$ 99
TNH	$ 10,444	$ 131	$ 99
APT 1-3	$ 10,444	$ 455	$ 99
APT 4-5	$ 10,444	$ 455	$ 99
APT 6+	$ 10,444	$ 455	$ 99

Table 11 – Service Connection Costs

7.5 Preparation Costs

Preparation Costs are another cost group that accounts for the demolition cost, site preparation, crossing/driveway, fencing, and landscaping. These costs are used as input variables whose values were predominately provided by the CostBuilder with a thorough discussion with QV experts on the selection of costs.

Demolition Cost is based on residential typology with 40% clean fill and 60% mixed debris per square meter, where the existing site coverage per parcel is used to determine the size of the demolition area. Site Preparation is the cost used to prepare earthwork on the construction site assumed to be the total land area. Driveways, Fencing and Landscaping are parts of a building or a development that, irrespective of the typology design or method of construction, tend to perform the same function. These are available on CostBuilder and the selection of appropriate cost categories is done with the support of QV's expert.

The Slope Cost is another critical cost when building dwellings– which varies depending on the severity of the slope and its aspect. These factors have a significant impact on the cost of the project. However, there is no available parcel-level data on the slope and cost at the time this document is conducted, so it will be factored into the model in the future once data become available, especially when the information is available from the PEC model. Table 12 provides per unit cost for Preparation Cost.

Preparation Cost	Site Preparation ($/m²)	Demolition ($/m²)	Driveway/ Crossing ($/m)	Fencing ($/m)	Landscaping ($/m²)
STD	$ 29	$ 76	$ 133	$ 120	$ 66
DPL	$ 29	$ 97	$ 133	$ 120	$ 66
TNH	$ 29	$ 97	$ 133	$ 120	$ 66
APT1-3	$ 29	$ 174	$ 133	$ 120	$ 66
APT4-5	$ 29	$ 174	$ 133	$ 120	$ 66
APT6+	$ 29	$ 174	$ 133	$ 120	$ 66

Table 12 – Preparation Cost per land parcel

To produce the most realistic outcome, the Preparation Cost group is a calculation based on 'approximate' land area per parcel ID, meaning there is an assumption on the size or perimeter of land area that is incurred for a particular cost as explained in Table 13.

Preparation Cost	The assumption on Land Area
Site Preparation	100% of land area per parcel ID
Demolition	100% of existing structures' floor area, varied by typology
Driveway/Crossing	20% of the perimeter per parcel ID
Fencing	50% of the perimeter of land area per parcel ID
Landscaping	20% of land area per parcel ID[3]

Table 13 – Preparation Cost Assumption

7.6 Professional Fees

Professional Fees refer to the charges for hiring specialists and professionals to work on the following services: engineering and consultancy, project management, sale or marketing, and legal works. Engineering and Consultancy Fee and Project Management Fee information are collected from QV's CostBuilder. The important factors to consider when identifying these fees are the building type and dwelling yield because it determines the scope of the service required. More complex and/or larger projects require more professional services.

We calculated the average value from the QV-suggested range. For Engineering and Consultancy Fee, the ranges are 4% to 6% for Detached, and Duplex, and 9% to 11.5% for other typologies, giving an average of 5% and 10%, respectively. Depending on the size of the construction, the Project

[3] A cap of 250m is applied to avoid overestimating the landscaping cost as recommended by M.E.

Management Fee ranges from 2% to 5%, giving an average of 3.5%. QV recommended Site Management Fee can be excluded for Detached and Duplex as they are less complicated projects.

According to the Agent Finder website, the Sale Commission and Marketing Fee mostly range from 2.5% to 3.95% of the sale price, giving an average of 3.2%. For Legal Fee, most firms charge a set price for the sale or purchase of a standard residential property as a package. As a result, a single amount has been allocated to each typology. Table 14 summarises the Professional Fees.

Professional Fees	Engineering and Consultancy (% of Build Cost)	Site/Project Management (% of Build Cost)	Sales Commission and Marketing (% of Build Cost)	Legal Fees (Per Dwelling)
STD	5.0%	0%	3.2%	$ 1,500
DPL	5.0%	0%	3.2%	$ 1,500
TNH	7.0%	3.5%	3.2%	$ 1,500
APT1-3	7.0%	3.5%	3.2%	$ 1,500
APT4-5	9.5%	3.5%	3.2%	$ 1,500
APT6+	9.5%	3.5%	3.2%	$ 1,500

Table 14 – Professional Fees

7.7 Land Purchase Cost

We use the latest HCC Rating Valuation data (in this case the effective valuation date is June 2021) to determine the site purchase cost. Rating valuation is derived from the recent property sale price. It consists of three different sub-costs: land value (LV), improvement value (IV) and, a sum of both, capital value (CV=LV+IV).

Developers must compete with non-developers for sites and must also purchase the existing improvements even if they are not required for their development. For this model, the cost of redevelopment land is therefore the Capital Value of the site, adjusted for changes in the market since the valuation date. Existing Improvement value is a sunk cost that must be recovered through the sale price of future improvements. This limitation means that a true residual value approach cannot be taken, as site prices are 'fixed' exogenously and the inclusion of DCs as a cost to developers (rather than a lowering of the price of land) is required, which may underreport feasibility.

Only market index sales which reflect the true cost of the property purchase are qualified to be used to inform the valuation. Therefore, using the latest rating valuation as the land purchase cost is a good approach. The values will be inflated to reflect any change within the local market since the rating valuation date. However, the quality check on Rating Valuation data is needed to ensure that feasibility is not mistakenly estimated. In case of any inaccurate values, the average land value per m2 parcel size within the same location is used.

Development Scenario	Land Area per Dwelling	The Purchase Cost of the Existing Dwelling	Land Purchase Cost
Infill	Subdivided area	Not included	The land value of the vacant subdivided area is based on the regression of land area as shown in Appendix 7.
Redevelopment	Entire land area (total parcel size)	Included	The capital value of (land value and improvement value)[4]
Greenfield	Entire vacant land area per parcel	N/A	The average section price per m^2 of the recently sold section multiplies the developable area per Greenfield parcel ID

Table 15 – Land Purchase Cost

Table 15 displays the land purchase for each development scenario. The same land parcel could have different site purchase costs depending on the development scenarios tested. Details of development scenarios are illustrated in Section 6.1.1. The land purchase costs for the Infill subdivision scenario are estimated using the land value regression and subdivided land area. This method is used to account for the spatial structure component and to reflect the market price of same-size parcel rather than relying on the percentage of total land area. The land purchase cost for Redevelopment scenarios is proxied by the actual capital value per parcel ID from the Rating Valuation data, while the land purchase cost for Greenfield is obtained from the median section price per m^2 at the current year collected from the existing section sale price multiplied by the land area per Greenfield developable parcel.

7.8 Financing Cost

Financing Cost is the interest cost of the monetary loan to build or purchase assets. To make it close to real-world practice, Financing Cost is divided into two types: Property loan and Construction loan.

[4] Concerning the quality of CV data, data cleansing and manipulation is used to remove data outliers and for those parcels with missing CV and no existing dwellings, their CV will based on the LV regression used for Infill Scenario.

A property loan equates to a financial loan for purchasing the land, while a Construction loan is associated with the loan for financing the building activities (the sum of build costs, council fees, service connection costs, preparation costs, and professional fees). Using the historic monthly bank mortgage data (2012-2022) from the Reserve Bank of New Zealand[5] (RBNZ), the average interest rates are obtained: the average floating (5.63%) and two-year fixed (5.09%), which will be used as interest rates for Financing Cost for Property Purchase and Financing Cost for Construction, respectively. Also, the period of the property loan may take about 24 months while the construction loan takes about 12 months based on the data on HCC's Construction Completion Period. In the calculation process, the calculated mortgage payments for both land purchase and construction are added to the total development cost.

The financing cost is calculated using the commonly adopted mortgage formula given as follows:

$$M_c = P\frac{\mathrm{i}(1+i)^n}{(1+i)^n - 1} \tag{5}$$

where M denotes the mortgage payment, c denotes the cost type (either land purchase cost or construction cost), P denoted the principal loan amount acquired to finance the land purchase or construction cost, i denotes the monthly interest rate, and n denotes the number of months.

7.9 Contingency Fund

To limit the overall financial risk, developers tend to allocate up-front funds to cover any unforeseen, unexpected and unplanned change during the construction development. For example, changes associated with Council inspection, delay of materials, accidental damages caused by humans or nature etc. Therefore, the contingency fund is very important for developers to secure the smoothness of the development process. The contingency refers to the additional cost that could arise depending on the complexity of the project or due to unforeseeable events. The Contingency Rate is measured as a percentage of the total project development cost. Following the recommendation of the QV expert, we set a 10% of Contingency Rate for all typologies except 30% for Apartments because the construction of an Apartment tends to be more complicated and costly.

7.10 Sale Price

The sale price is the 'estimated' property sale that is used to determine the profit after taking out all the costs. The selection of sale price methodology can be restricted by the availability of the data and the nature of the research. The approach using the average sale price per m2 could be naïve and suffers from overestimates. That is, the sale price will continue rising as the floor areas expand,

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[5] RBNZ Bank Mortgage: https://www.rbnz.govt.nz/statistics/key-statistics/housing

while, in fact, at one point the sale price per m2 should drop as the floor area goes larger, and this contradicts how the house price evaluation should be formulated. In general, the value of a property could depend on many factors other than floor area, including location, land area, age of the building, neighbourhood and many more. Therefore, a good estimation approach should be able to control for those factors.

To address the heterogeneity nature of sale price formulation, the Hedonic Regression is regarded as one of the most suitable methods to estimate the property sale price. This model is widely adopted in various property studies. Therefore, the Hedonic Regression is used to estimate the property sale price in Hamilton City. The regression consists of various important variables that are identified to be correlated with the sale price, and, most importantly, available in the dataset.

The sale data are extracted from valuation data, which contains various information related to the property. The data is collected from newly built dwellings from the 2000s and sold between 2016-2022. Data cleansing was performed to remove some missing information, noisy data and outliers, including data entry errors, unusual big parcel size, floor size and sale price. Table 16 provides the total number of observations used in the regression:

Typology	Number of Observations
Detached	5203
Duplex	
Townhouse	
Apartment	322

Table 16 – Number of Observations Used in Regressions

The regression takes the following form:

$$Sale\ Price = Year + Typology + Location\ Group + Floor\ Area + Land\ Area$$

where *Sale Price*: the sale price of the dwelling per typology at year t in NZD. *Year:* sale year. *Location Group*: dummy variable of the location group. *Typology*: dummy variable of typology whether the property is Detached, Duplex or Townhouse. in the amenity group. *Floor Area*: the total gross floor area per unit per typology. *Land Area*: the total land area per unit per typology

For Apartment typologies, a separate regression is used as Apartment mostly exists in LG0 where there were not Standalone, Duplex, and Townhouse existing, so it is more appropriate not to pool the data in one regression. However, the Apartment regression takes the same equation as provided above. The details of estimation outputs for all typologies can be seen in Appendix 8. The summary of estimation outputs using the 2022 sale price (sale price in other years can be also extracted from the year dummy estimates) is provided in Table 17.

Location Group	Typologies	Constant	Floor Area	Land Area
LG0	STD	-	-	-

LG1	STD	492,746	2,406	63
LG2	STD	508,008	2,406	63
LG3	STD	519,822	2,406	63
LG4	STD	575,294	2,406	63
LG5	STD	658,747	2,406	63
LG0	DPL	-	-	-
LG1	DPL	452,297	2,406	63
LG2	DPL	467,559	2,406	63
LG3	DPL	479,373	2,406	63
LG4	DPL	534,845	2,406	63
LG5	DPL	618,298	2,406	63
LG0	TNH	-	-	-
LG1	TNH	480,203	2,406	63
LG2	TNH	495,466	2,406	63
LG3	TNH	507,280	2,406	63
LG4	TNH	562,752	2,406	63
LG5	TNH	646,205	2,406	63
LG0	APT	463,029	2,861	-
LG1	APT	366,120	2,861	-
LG2	APT	381,382	2,861	-
LG3	APT	417,007	2,861	-
LG4	APT	447,933	2,861	-
LG5	APT	455,522	2,861	-
Note: this is for any observation that does NOT appear in Amenity and Main Road				

Table 17 – Sale Price Estimation Outputs

Furthermore, Amenity and Main Road are removed from regression as there are not sufficient data to estimate their impacts on sale price. Some typologies have not existed in some amenities nor main roads thus yet in the sale data, so estimation output does not produce any estimates of those. To overcome missing information, this study relies on the data provided by M.E on the weighting schemes used in their PC12's CFM run and the expertise input from discussion with their expert, i.e., Townhouse tends to be developed more around amenity and main road in the future and Apartment is expected to appear in the CBD amenity, so their weighting schemes are set to be higher than the rest. Table 18 explains the weighting schemes used in calculating price differentials across amenities and main roads.

Amenity/Main Road	**STD**	**DPL**	**TNH**	**APT**
CBD	1.1	1.1	1.3	1.3
CWT	1.08	1.08	1.2	1.08
FCR	1.05	1.05	1.1	1.05
GST	1.05	1.05	1.1	1.05
NWT	1.05	1.05	1.1	1.05

ROT	1.05	1.05	1.1	1.05
RTN	1.05	1.05	1.1	1.05
MR1	1.1	1.1	1.2	1.1
MR2	1.07	1.07	1.17	1.07
MR3	1.03	1.03	1.13	1.03

Table 18 – Amenity and Main Road Weighting Schemes

7.11 Inflation Variables

Inflation variables refer to the inflation rates that are used to calculate the future cost and sale price as the cost and sale price tend to increase over time. If the parcel is not feasible in the current year, inflation rates are used to account for price inflation in both cost and sale components, so that future feasibility can be tested — answering which year the parcel will become feasible. To achieve a comprehensive feasibility study, the inflation rates on each cost and sale variable should be derived from their individual information and data. In other words, it is suggested to have inflation rates for each variable rather than using one value applied to all even though it can be justified by the user's requirement. For modelling purposes, we assume all variables will have a constant inflation rate although real-world inflation tends to fluctuate. However, the inflation rate can be adjusted at any time of running the CFM tests when we have a better projection about it. The followings explain the inflation rate calculation and methodology for each related variable.

7.11.1 Build Cost Inflation

The Stats NZ's Capital Goods Price Index (CGPI), as suggested by QV experts, can be used as the inflation rate for the Build Cost variable. The Capital Goods Price Index (CGPI) is a measure of the price level changes for physical assets purchased by producers of goods and services throughout the economy. The quarterly change is used to calculate the quarterly growth rate. To align the inflation data with the information we have on Construction Costs, we only estimated the quarterly growth from 2005. The annual average growth rate (4.89%) is calculated by multiplying the quarterly average (1.22%) by the number of quarters (4).

7.11.2 Connection Cost & Preparation Cost Inflation

Rising costs of Connection Costs are difficult to calculate due to the short data timespan and lack of concrete information. Hence, we assume that its inflation rate follows the CGPI as the cost of most types of service connections is based on material costs that tend to influence the CGPI. Likewise, the Preparation Cost Inflation is assumed to follow the CGPI, as suggested by QV experts and is applied to all typologies. Therefore, the Connection Cost Inflation and Preparation Cost Inflation are proxied by the CGPI, but for ease of modelling purposes, the percentage of Build Cost (% of Build Cost) will be used as their inflation rate instead.

7.11.3 Council Fees Inflation

7.11.3.1 Building Consent Fee Inflation

The estimated construction value and level of building complexity are used to calculate Building Consent Fees at the time of lodging the Building Consent Application. Building Consent Fee tends to increase in line with the trend of Construction Cost, meaning the inflation rate of Building Consent Fee could be the same as that of the Build Cost. Therefore, CGPI or percentage of Build Cost are considered the inflation rate of the Building Consent Fee.

7.11.3.2 Financial Contribution Fee Inflation

To maintain the data consistent with the HCC's Financial Contribution (FC) Model, FC Inflation data are collected from Capital Inflation data provided by HCC's Finance Department. We utilise these rates as the inflation rate, therefore the rate will be varied over time in accordance with the model that is currently available internally.

7.11.3.3 Resource Consent Fee and Rates Inflation

When estimating the future costs for Resource Consent Fees, we consider cost inflation separately from other council-related fees as historic data demonstrates a pattern over time. While examining the graphical representation of historical data (Figure 8), the growth rates for both Infill and Greenfield are rather comparable and experience the same rate of cost inflation over time. As a result, the average growth rate of 4.84% is used as cost inflation of the Resource Consent Fee for Infill land Greenfield.

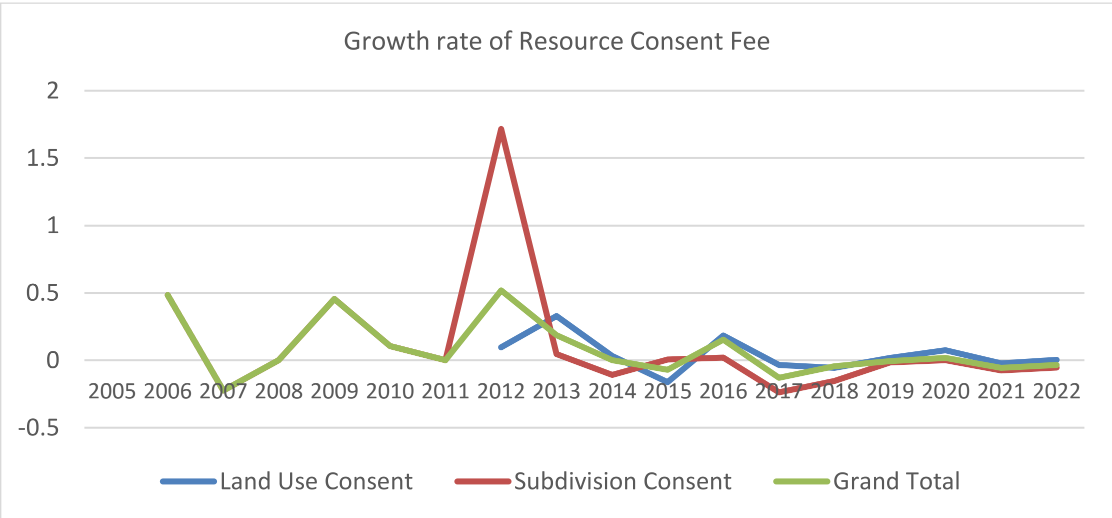

Figure 8 – The growth rate of Resource Consent Fee

On the other hand, it is difficult to find the actual inflation rate of Rates as the values are varied by parcel and there is no sufficient information about it. For the modelling purpose, it is therefore assumed to have the same inflation rate as Resource Consent. However, once the information becomes sufficient in the future, its inflation rate can be adjusted accordingly.

7.11.3.4 Development Contribution Fees Inflation

A comparison of two approaches was applied to determine the cost inflation for Development Contribution (DC) Fee. The DC data are from 2011-2022, whilst for 2013-2016, the stormwater and wastewater charges are added to the base charge by aligning the stormwater catchment and wastewater catchment with the latest/current catchments. Approach 1 calculates the average annual growth rate for each catchment from 2011 to 2022, while Approach 2 calculates the growth rate between 2011 and 2022 and averages it by the number of years, giving 5.8% and 5.7% respectively. Due to the 0.01 percentage point difference, a more conservative rate — 5.7% is used as the long-term growth rate of the Development Contribution Fee.

7.11.4 Professional Fees Inflation

We choose the annual growth rate of Construction Cost (% of Build Cost) as the inflation rate of both Consultancy Fee and Project Management Fee as we anticipate that both will rise by the values of the Construction Cost. For the Sale Commission and Marketing Fee and Legal Fee, their inflation rates are measured by the annual growth rate of labour cost, which is calculated from the Labour Cost Inflation (LCI) collected from Stats NZ. This is because these fees are more responsive to the change in overall labour cost or wage growth. The inflation rate is about 2.23% based on historic data over the last decade.

7.11.5 Land Purchase Cost Inflation

The inflation rate of Land Purchase Cost is assumed to have the same as that of Property Sale Price because purchasing the land would have gone into the property marketing listing which is normally evaluated based on the market price. Although the land value could rise faster as the urban grow, how fast the land value will grow is not predicted within CFM, so for the modelling purpose and not to overstate the cost-sale ratio, the growth rate of land value remains consistent with the growth of the sale price.

The calculation of the inflation rate is explained in Section 7.11.7.

7.11.6 Financing Cost Inflation

As the amount for Property Financing will vary depending on the cost of the property purchase, we hypothesise that the Property Financing Cost grows proportionately to the increase in land acquisition. Thus, the inflation rate of Financing Cost for land purchase can be measured as a percentage of the Land Purchase Cost per parcel. Similarly, the inflation for Construction Financing Costs rises proportionately to the growth in the project cost. Thus, its inflation rate will be proxied as a percentage of the total development cost (excluding site purchase and contingency fund).

7.11.7 Property Sale Inflation

Due to the house price's high volatility and the change in the macro environment, it is challenging to project the Property Sale Price Inflation dynamically; thus, a constant growth rate is preferred in this case. To this end, the Sale Price Inflation is measured by the long-term average sale growth calculated from the historic sale data. The calculation finds that the Sale Price Inflation is about 6.54%. As mentioned in Section 7.11.5, the growth of Land Purchases over time will be comparable to the inflation in real estate sale prices. Consequently, a 6.54% annual growth rate is assigned to both Land Purchase and Property Sale Price growth rates. If there is a significant change in the housing market, the rate will be adjusted accordingly.

8. Sensitivity Testing

There are multiple ways to test the sensitivity of the feasibility results. One of the most effective ways is to test how sensitive the results are when there is a change in the variable setting. A number of key variables play major influences on feasibility outcomes as they share a larger weight in the total cost. The variables that take up a large proportion of total cost tend to have a large impact on the feasibility outcome, so the feasibility outcome will be more sensitive to the change in the values of those variables. In addition, it is important to note that the results could be sensitive to the relationship between dwelling size and land area per typology and the planning provision, which affects the plan-enabled capacity yield and thus leads to the changes in feasibility capacity output.

Table 19 explains the sensitivity level of the variables and how they impact feasibility outcomes.

Variables	Sensitivity Level	Impacts on feasibility
Sale price	High	Determine feasibility
Inflation rate	High	The speed of the growth
Construction cost	High	Take up approximately 40% of the total cost
Land cost	High	Take up a big proportion of the total cost
Floor area	Medium	Determine both cost and sale
Parcel size	Medium	Determine land purchase cost and floor area
Connection Cost	Low	Share a smaller weight in the total cost

Council Fees		
Professional Cost		
Preparation Cost		
Financing Cost		
Contingency Cost		

Table 19 – Summary of Sensitivity Testing

9. Expansion of Urbanisation

The growth of urbanisation is the effect of population growth that creates more demand for homes and other infrastructure. With the expansion of urbanization, there would be a change in spatial structure (amenity, main road, urban area, etc) and sale-cost function. In particular, as the urban grows, the demand for houses rises and hence affects the property sale price and the land value.

However, it is difficult to identify how and when the urban will grow and how big the impacts are on sales and cost prices. Although this is an important factor to consider, it is not the input that can be predicted within CFM. Therefore, the expansion of urbanisation cannot be achieved within the CFM calculation process.

Even though we can use walkable distance as a proxy of expansion, this could be very subjective and groundless as we do not have good historic data to support it and it may require extensive research to indicate the growth behaviour of urbanization. In addition, we can work with planners to get their input, but it will not provide a complete picture, in particular, when it is going to happen. We can still look at other cities, in particular Auckland' spatial structure, but we have limited knowledge and data about other cities, so it seems not achievable for us to understand how and when the spatial structure will evolve.

Instead of making subjective assumptions on where and when the urban will grow, which potentially could create an unnecessary bias to the CFM's output, a more appropriate prediction needs to be studied within other growth models, e.g., the Growth Model that shows when and where the population will grow that relies on inputs from various models, including CFM.

For the modelling purpose and not to add any complexity and biases to the model, the future spatial change of urbanization will not be considered in the CFM calculation process, and that means the spatial structure will stay the same over the period of study. However, this will remain a limitation that will be addressed regularly in the future when CFM is re-run and there is more supporting information or data available.

Disclaimers

This report presents a model that has been internally developed and externally peer-reviewed by appropriately qualified third-party consultants. It’s crucial to understand that a model, by its very nature, is a simplification of a complex system, designed to enhance our understanding and predictability of the system.

However, this document does not bear any legal liability for inaccuracies or misuse of the information contained herein. The information used was the best available information available to Council at the time of the study.

The CFM is subject to future modifications for enhancement, reflecting the inherent uncertainty and evolving nature of the system it represents. The model will undergo regular reviews and improvements, which means there is a high likelihood of updates and changes to the data and model structure, reflecting the most current and available information.

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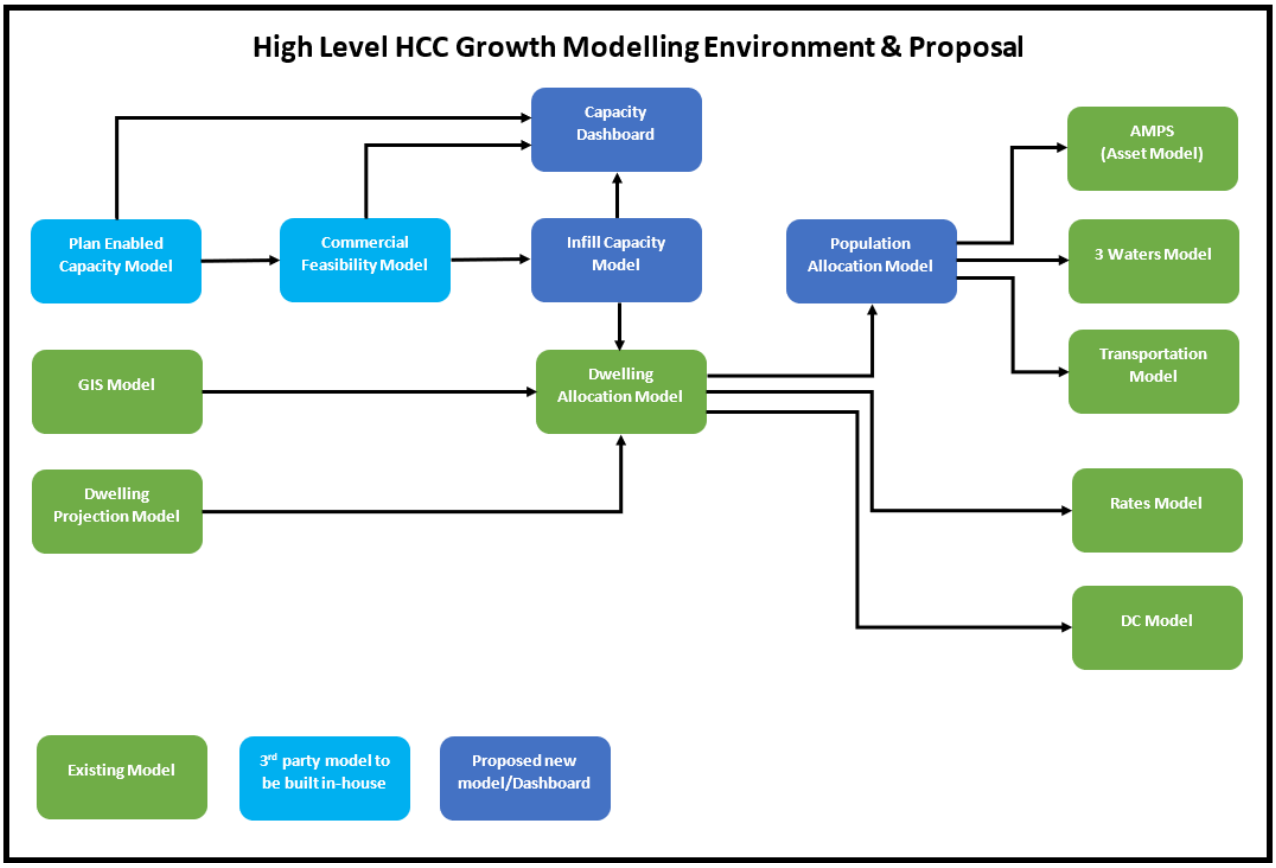
Appendix 1: Proposed High Level Growth Modelling



Appendix 2: Summary of Cost and Sale Inflation

Table below summarises the inflation rate of each variable. However, it is noteworthy that the inflation rate obtained in the table is based on the dataset and methods that are used to calculate it, so it is subject to change if a different dataset or approach is used. For most variables, the rates are constant over time except for Financial Contribution.

Cost Group	Variable	Inflation	Data Source	Data Range
Property Sale	Property Sale Price	6.54%	HCC Property Sale Data	2005-2022
	Land Purchase			
Construction	Construction Cost	4.89%	Stats NZ CGPI	2005Q1-2022Q2
Service Connection	Electricity Connection	% of Build Cost		
	Telecoms Connection			
	3 Waters Connection			
Council Fees & Charges	Building Consent			
	Financial Contribution	Varied	HCC Finance	2023-2051
	Resource Consent	4.84%	HCC Resource Consent	2012-2022
	Development Contribution	5.70%	HCC DC Charges	2011-2022
	Rates	5%	HCC Rating Valuation	2012-2022
Financing	Property Financing	% of Sale Price	RBNZ's Bank Mortgage	2012M1-2022M8
	Construction Financing	% of Project Cost		
Site Preparation	Crossing/Driveway	% of Build Cost	Stats NZ CGPI	2005-2022
	Demolition Cost			
	Fencing			
	Landscaping			
	Site Preparation			
Professional Service	Engineering and Consultancy			
	Project Management			
	Legal Fees	2.23%	Stats NZ Labour Cost Inflation	2002M6-2022M6
	Sale Commission and Marketing			

Appendix 3: Summary of Variables and Data

No	Cost Type	Variable	Per Project/ Per Dwelling	Unit	Data Source
1	Global Variable	Location Group	N/A	N/A	HCC Valuation Data
2	Global Variable	Typology	N/A	N/A	HCC's District Plan (PC12)
3	Global Variable	Floor Area	Per Dwelling	m^2	HCC Building Consent Data
4	Global Variable	Land Area	Per Dwelling	m^2	HCC Building Consent Data
5	Global Variable	Existing Site Coverage	Per Dwelling	m^2	HCC Building Consent Data
6	Construction Cost	Build Cost	Per Dwelling	\$ per m^2 of floor area	QV Cost Builder Data
7	Connection Cost	Electricity Connection	Per Dwelling	\$ per dwelling	QV Cost Builder- Electrical Service
8	Connection Cost	Telecoms Connnection	Per Dwelling	\$ per dwelling	BigPipe Webpage
9	Connection Cost	Three-water Connectoin	Per Project (Parcel)	\$ per parcel	HCC's City Waters Unit
10	Council Fees	Rates	Per Project (Parcel)	\$ per dwelling	HCC Valuation Data
11	Council Fees	Financial Contribution Fees	Per Dwelling	\$ per dwelling	HCC FC Policy Document
12	Council Fees	Building Consent Fees	Per Project (Parcel)	% of build cost per parcel	HCC Building Consent Data
13	Council Fees	Resource Consent Fees	Per Project (Parcel)	\$ per parcel	HCC Resource Consent Data
14	Council Fees	DC Fees	Per Project (Parcel)	\$ per parcel	HCC DC Policy Document
15	Preparation Cost	Crossing/Driveway	Per Project (Parcel)	\$ per meter of parcel	QV Cost Builder Data
16	Preparation Cost	Demolition Cost	Per Project (Parcel)	\$ per m^2 of parcel	QV Cost Builder Data
17	Preparation Cost	Fencing	Per Project (Parcel)	\$ per meter of parcel	QV Cost Builder Data
18	Preparation Cost	Landscaping	Per Project (Parcel)	\$ per m^2 of parcel	QV Cost Builder Data
19	Preparation Cost	Site Preparation	Per Project (Parcel)	\$ per m^2 of parcel	QV Cost Builder Data
20	Preparation Cost	Slope	Per Project (Parcel)	\$ per m^2 of parcel	HCC's PEC output
21	Professional Fees	Legal Fees	Per Dwelling	\$ per dwelling	Expert Opinon from Law Firm
22	Professional Fees	Sale Commission Fees	Per Dwelling	% of sale price	Real Estate Blog

23	Professional Fees	Site/Project Management Fee	Per Project (Parcel)	% of build cost	QV Cost Builder Data
24	Professional Fees	Engineering and Consultancy Fees	Per Project (Parcel)	% of build cost	QV Cost Builder Data
25	Other Costs	Financing Cost-Land Purchase	Per Project (Parcel)	$ per parcel	ANZ, RBNZ and Rating Data
26	Other Costs	Financing Cost-Construction	Per Project (Parcel)	$ per parcel	ANZ, RBNZ and HCC's CCC data
27	Other Costs	Contingency	Per Project (Parcel)	% of project cost	HCC's Assumption (10-30%)
28	Land Cost	Land Purchase	Per Project (Parcel)	$ per m^2 pf parcel	HCC Valuation Data
29	Property Sale	Property Sale Price	Per Dwelling	$ per m^2 of floor area	HCC Valuation Data
30	Global Variable	Sale Inflation	N/A	%	HCC Valuation Data
31	Global Variable	Cost Inflation-Connection Fees	N/A	% of build cost	Stats NZ CGPI
32	Global Variable	Cost Inflation- Build Cost	N/A	%	Stats NZ CGPI
33	Global Variable	Cost Inflation-Preparation Cost	N/A	% of build cost	Stats NZ CGPI
34	Global Variable	Cost Inflation-Professional Fees	N/A	% of build cost & fixed rate	Stats NZ CGPI,Stats NZ Labour Cost Inflation
35	Global Variable	Cost Inflation- Council Fees	N/A	Varied	Stats NZ CGPI, Valuation Data, HCC DC Charges,HCC Resource Consent, HCC Finance (Capital Growth)
36	Global Variable	Cost Inflation-Financing Cost-Land Purchase	N/A	% of project cost	ANZ, RBNZ and Rating Data
37	Global Variable	Cost Inflation-Financing Cost-Construction	N/A	% of sale price	ANZ, RBNZ and HCC's CCC data

Appendix 4: Estimation Output of Land Value

Variable	Estimate	Std.error	Statistic	P.value
Constant	447,239	8,358	53.51	0.0000
LG1	-254,830	8,091	-31.49	0.0000
LG2	-164,901	8,036	-20.52	0.0000
LG3	-122,941	8,055	-15.26	0.0000
LG4	-77,679	8,057	-9.64	0.0000
LG5	-30,395	8,875	-3.42	0.0006
Parcel Size	-254,830	8,091	-31.49	0.0000

Appendix 5: Estimation Outputs of Sale Price

Estimation Output for Detached:

Variable	Estimate	Std.error	Statistic	P.value
Constant	49,085	8,339	5.89	0.0000
Year2017	48,378	5,362	9.02	0.0000
Year2018	84,642	5,138	16.47	0.0000
Year2019	122,950	4,928	24.95	0.0000
Year2021	357,876	5,079	70.46	0.0000
Year2022	403,212	5,376	75.00	0.0000
LGLG2	15,262	6,456	2.36	0.0181
LGLG3	27,077	6,774	4.00	0.0001
LGLG4	82,548	6,859	12.04	0.0000
LGLG5	166,001	13,569	12.23	0.0000
STD	40,449	5,829	6.94	0.0000
TNH	27,907	9,617	2.90	0.0037
Floor area	2,406	47	51.61	0.0000
Parcel size	63	13	5.00	0.0000

Estimation output for Apartment:

Variable	Estimate	Std.error	Statistic	P.value
Constant	229,284	31,641	7.25	0.0000
Year2017	41,737	22,813	1.83	0.0683
Year2018	24,044	18,943	1.27	0.2053
Year2019	-4,301	26,316	-0.16	0.8703
Year2020	61,806	29,984	2.06	0.0401
Year2021	156,878	32,468	4.83	0.0000
Year2022	233,745	32,698	7.15	0.0000
Age Old	-100,032	18,765	-5.33	0.0000
LG2	-81,647	17,018	-4.80	0.0000
Floor area	2,861	281	10.18	0.0000