Ministry of Health

Evaluation of the New Zealand Bowel Screening Pilot
Interim costing analysis - costs of the first screening round (2012-13)

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FINAL VERSION

sapere research group

About Sapere Research Group Limited

Sapere Research Group is one of the largest expert consulting firms in Australasia and a leader in provision of independent economic, forensic accounting and public policy services. Sapere provides independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies, and regulatory bodies.

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Introduction

The Bowel Screening Pilot (the 'BSP' or the 'pilot') has been running in Waitematā District Health Board ('WDHB') since commencing with a 'soft launch' in October 2011, with the start of the first full screening round in January 2012.

Sapere Research Group Ltd ('Sapere') has been commissioned to complete a full cost-effectiveness analysis (CEA) at the end of the second screening round, which concludes 31 December 2015.

This interim report details Sapere's costing analysis of the pilot on the basis of the first screening ground (completed at the end of 2013). A summary of this report is included in the Interim Evaluation Report, completed jointly with Litmus.

Objectives

In undertaking this costing analysis, we seek:

- to develop understanding of the nature and quantum of costs associated with the design, implementation and operation of the pilot to date;
- to forecast the total cost of the BSP for two full screening rounds (years 1-4); and
- to use the results to extrapolate high level estimates of:
  - the on-going cost of running a bowel screening programme in Waitematā DHB; and
  - the potential 'steady state' cost of operating a bowel screening programme on a national basis.

Key constraints

This costing analysis provides an input to, and establishes a baseline for, the full economic evaluation that will take place after the second screening round is complete. A key part of an economic analysis is to take into account the counterfactual and to identify the incremental change that has occurred over and above 'what would have happened anyway', in the absence of the pilot.

It is important to highlight that this costing analysis is *not* an incremental analysis but rather takes a 'snap-shot' perspective of costs incurred to design and run the pilot in the first two years, with some assumption-based extrapolation to inform understanding of potential future costs. As such, it does not account for counterfactuals, such as that some cancers detected as a result of pilot screening may have been detected symptomatically anyway. Further, it does not address the cumulative impacts that may be experienced over time following the introduction of a screening programme, and indeed these impacts might not be linear.

It is also important to note that the nature of a pilot is that it is continually developing and improving its activity. This means that results calculated over the lifetime of the pilot so far are to some extent based upon a moving target, and it is expected that epidemiological and cost results, in particular, will continue to evolve as the pilot continues. The final report, completed at the end of the pilot, will provide a more authoritative picture.

Approach

Our assessment of the cost of the pilot is based on a detailed bottom-up costing model that uses samples of actual cost data from the pilot during development and on-going implementation of screening.

The model developed to support our analysis involves three key analytical steps. Step one uses data relating to costs incurred over two sample periods to assess the cost of developing and running the pilot during the first two years. In step two, these costs are forecast out to estimate a total cost of developing and running the pilot for the full four years. In step three, we estimate the direct costs of running a national screening programme in a 'steady state'. Our estimates do not include development/start-up costs such as workforce development or capital purchases and are based a set of key assumptions (as described in section 3.1.3).

Costs associated with development and operation of the pilot

Costs of development and operation of the pilot during years 1 & 2

A total of **$13.742 million** was incurred in developing and operating the first two years of the Pilot (excluding the costs of treating cancers diagnosed).

The **total development cost** incurred to develop the pilot is estimated at **$3.148 million** (incorporating costs of the Waitematā DHB contract to plan and implementation of the pilot; the design and build of the pilot register; and costs of developing promotional materials).

During 2012, the **total operating cost** for the pilot was **$4,927,000** and during 2013 it was **$5,666,000** (including Ministry of Health oversight costs). This was comprised as follows:

Table: Summary of operating costs for the first screening round

	Year 1 (2012)	Year 2 (2013)
Pilot operating costs		
Fixed	$2,780,000	$2,651,000
Variable	$1,653,000	$2,520,000
Sub total	**$4,433,000**	**$5,172,000**
Additional MoH operating costs		
Ministry oversight[1]	$495,000	$495,000
Total	**$4,927,000**	**$5,666,000**

[1] This is an estimate of the proportion of Ministry of Health staff time spent per year on the bowel screening pilot, including contract management, monitoring and development of policy advice.

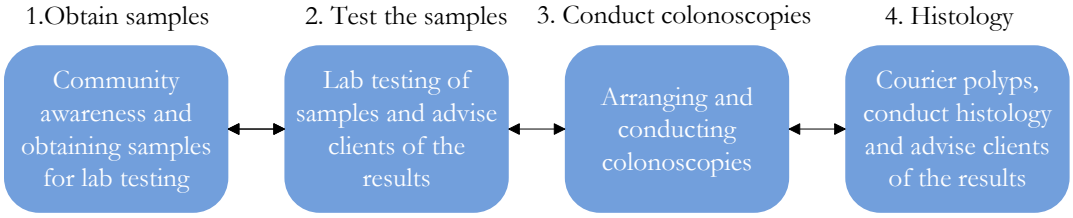
Estimated lifetime cost of treating cancer detected by the pilot in years 1 and 2

The estimated lifetime cost of treating the 129 cancers detected during years 1 and 2 of the pilot is **$6.178 million.**

Detailed findings regarding operating costs in year 1 and 2

The pilot screening pathway has four stages, as shown in the figure below.

Figure: Four high-level stages of the screening pathway



Stage three, conducting colonoscopies, absorbs the greatest proportion of resource: 43% of the annual operating cost of the pilot (note that this cost includes overheads assigned to this stage of the pathway, as well as the direct costs of conducting colonoscopies).

The unit cost for particular 'process outcomes' have been developed by dividing the annual operating cost for each stage by a key process outcome measure. These unit costs are estimated as follows:

- **Average cost per person returning a sample to the laboratory** - $64 per person, of which $28 per person relates to promotion, outreach and targeted support efforts and $36 per person to mail-outs and sample collection activities
- Laboratory **testing of iFOBT kits** (including notification of results) - $18 per sample
- **Average cost of colonoscopy** - $1,107 per person
- **Average cost of histology tests** following colonoscopy - $190 per person

We also combined the operating costs for stages one and two and divided by the number of people returning a kit for testing to derive a **cost per participant screened** of $87.21. In addition, we derived a **cost per participant receiving investigation** of $1,268.76 by combining operating costs for stages 3 & 4 and dividing by the number of colonoscopies conducted (acknowledging that most of these participants go on to have histology).

Over years 1 and 2, the average operating cost (excluding development costs) was for key screening outcomes was[2]:

- $82,100 **per cancer** detected
- $6,000 **per adenoma** detected
- $5,600 **per lesion** detected (adenomas and cancers)

Note that screening for colorectal cancer includes removing premalignant lesions (adenomas) during the colonoscopy. These adenomas thus never present as cancers, meaning that the

[2] The cost per cancer/adenoma/lesion is derived by dividing the total operating costs of the pilot by the number of cancers/adenomas/lesions detected during the pilot. It is not the sum of the direct costs of detecting a single cancer/adenoma/lesion.

incidence of colorectal cancer declines with screening. For this reason, it is important to present the cost of screening per lesion (adenoma and cancer) detected as well as per cancer.

The direct cost of providing services aimed at **improving participation of particular population groups** (that may be more likely to encounter barriers due to language or cultural reasons) was an average of $187,00 per year (over years 1-2).

The overall cost of **colonoscopy provision** was $1.042 million in year 1 and $1.550 million in year 2 (with the increase in year 2 driven by higher volumes and a more expensive temporary arrangement to increase capacity).

Primary Health Teams are contracted at a unit price of $60 to advise any of their patients of a positive iFOBT result. The total cost of this service was estimated at $119,000 in year 1 and $169,000 in year 2.

Forecast of costs of the full pilot from years 1-4

We forecast the total cost of the four year screening pathway on the basis of the cost estimates developed for the first two years.

The forecast total operating cost for each of years 3 and 4 is **$5.505 million**, including Ministry of Health oversight costs.

The forecast total cost of the pilot over years 1-4 is **$24.753 million**. This includes the cost of developing the pilot ($3.148 million) and the estimated operating cost for years 1 and 2 (total of $10.594 million), including Ministry of Health oversight costs.

The forecast cost of the pilot over years 1-4, excluding Ministry of Health oversight costs, is **$19.625 million**.

Estimates of the annual 'steady state' operating cost of a national bowel screening programme

In estimating the costs of a national bowel screening programme, we have only considered the direct costs of a national screening programme in a "steady state". Our estimates do not include development/start-up costs such as workforce development or capital purchases. We have also not included any Ministry of Health oversight and governance costs.

We have made a number of assumptions, including that the pilot model design is replicated and that all key parameters remain the same. We have assumed that the current models for laboratory services, the coordination centre and the IT register are scaled up to manage the increased volumes required for a national programme. We also assume that colonoscopy services will be provided by salaried and contracted colonoscopists, in the same proportion as services provided to the pilot in the second half of year two (July to December 2013).

National view

The **annual operating cost** of a national screening programme in steady state, excluding development costs and Ministry of Health oversight is estimated at **$39.073 million.** This is 7.8 times higher than our estimate of the annual operating cost of $5.010 million for the pilot in Year 4.

The results of sensitivity testing undertaken suggest a plausible range for the annual operating cost of a national screening programme in steady state as being between **$26.531 million** and **$50.623 million** (with the base case estimate at **$39.073 million**).

Regional view

The following table shows the variable and fixed operating costs allocated on a proportional basis (by population share) to each of the DHB regions.

Table: National model - estimated annual operating cost in steady state, by region

	Northern	Midland	Central	Southern	Total
Regional costs ($ million)					
Variable operating cost	$5.862	$3.483	$3.435	$4.568	$17.348
Fixed operating cost	$7.592	$4.311	$4.250	$5.572	$21.724
Annual operating cost	**$13.454**	**$7.794**	**$7.686**	**$10.139**	**$39.073**
Regional shares (%)					
Share of national population (50-74 years)	34.9%	19.8%	19.6%	25.6%	100.0%
Share of total operating costs	34.4%	19.9%	19.7%	25.9%	100.0%

1. Introduction

1.1 Context

1.1.1 Bowel cancer in New Zealand

Overview

Bowel cancer incidence and mortality is high in New Zealand in comparison with other countries. In 2009, 2837 people were diagnosed with bowel cancer and 1244 people died from the disease. It was the second most common cancer both in men and women, the second highest cause of cancer death for men (after lung cancer) and the third highest for women (after lung and breast).[3]

Estimates of the cost of bowel cancer

On the basis of analysis completed by the Ministry of Health[4] (using 2008 incidence data and 2008/09 national prices), the annual public price of registered cancer in 2008 was estimated at $511million. Cancers of the colo-rectum and anus made up some 14% of this total, at an estimated annual public price to New Zealand of $69.7million, second only to female breast cancer at 15%.

Further, population growth and structural ageing are dominant forces driving change in cancer registration counts, sometimes overwhelming the effect of changes in cancer risk.[5]. The Ministry of Health analysis[6] incorporated incidence projections from 2011 to 2021, leading to an estimated 23% increase in the total price of cancer to $627million by 2021. This increase incorporated a significant growth in price relating to colorectal cancer at $13million.

1.1.2 The New Zealand Bowel Screening Pilot

The Bowel Screening Pilot (the 'BSP' or the 'pilot') has been running in Waitematā District Health Board (WDHB) since commencing with a 'soft launch' in October 2011, leading to the start of the first full screening round in January 2012.

The target population for the pilot is men and women aged between 50-74 years at the time of invitation who were both resident in the Waitematā DHB area and eligible for publicly funded healthcare. The screening test used is a single immunochemical faecal occult blood test (iFOBT). Eligible people will be recalled for screening every two years.

[3] Ministry of Health, 2012a. Cancer: New Registrations and Deaths 2009. Wellington.

[4] Ministry of Health. The Price of Cancer: The public price of registered cancer in New Zealand. Wellington: Ministry of Health, 2011.

[5] Ministry of Health. 2002. Cancer in New Zealand: Trends and Projections. Wellington: Ministry of Health.

[6] Ministry of Health. The Price of Cancer: The public price of registered cancer in New Zealand. Wellington: Ministry of Health, 2011.

1.1.3 Evaluation of the BSP

Overview of the evaluation

Litmus Limited ('Litmus') and Sapere Research Group Limited ('Sapere') have been commissioned jointly by the Ministry of Health to undertake the evaluation of the BSP.

The pilot will provide essential information that will help determine whether a bowel screening programme should be rolled out nationally. It will be evaluated on the basis of two full two-year screening rounds, taking place during calendar years 2012-2013 and 2014-2015. The analysis provided in this report is completed on data collected from the first screening round.

The overall goal of the pilot and its evaluation is to determine:

> *Whether organised bowel screening could be introduced in New Zealand in a way that is effective, safe and acceptable for participants, equitable and economically efficient.*

Economic evaluation of the BSP

An economic evaluation compares the incremental costs and outcomes (effects) of different courses of action; in this case, we are comparing the introduction of a bowel screening programme with the status quo, essentially opportunistic diagnosis of colorectal cancer.

Sapere is responsible for completing the economic evaluation of the pilot, to address the following specific aim:

> *'Economic efficiency: Can a national bowel screening programme be delivered in an economically efficient manner?'*

We are due to complete a full cost-effectiveness analysis (CEA) at the end of the second screening round, with a final report due to be completed by August 2016. In terms of approach, we will be undertaking a cost utility analysis (CUA), a distinct form of CEA that measures the effects of interventions in quality-adjusted life years (QALYs) rather than trying to value the consequences of interventions in monetary terms (as would be the approach in a standard Cost Benefit Analysis). The QALY measures the number of years of healthy life gained as a result of the intervention. By calculating the cost per QALY gained through bowel screening, we will be able to draw comparisons with the relative value for money of bowel screening versus other similarly evaluated health interventions.

1.2 Purpose of this costing analysis

A first key deliverable from Sapere was a costing analysis of the pilot on the basis of the first screening ground, which finished at the end of 2013. A summary of this stand-alone report will be included in the Interim Evaluation Report, to be completed jointly with Litmus.

Overview of our scope

In undertaking this costing analysis, we seek:

- to develop understanding of the nature and quantum of costs associated with the design, implementation and operation of the pilot to date;
- to forecast the total cost of the BSP for two full screening rounds (years 1-4); and
- to use the results to extrapolate high level estimates of the potential 'steady state' cost of operating a bowel screening programme on a national basis. (It is important to

emphasise here that there are some broad brush assumptions and exclusions to costs captured within this national forecast. The approach, assumptions and exclusions are described fully in section).

What this analysis *doesn't* address

This costing analysis provides an input to and establishes a base line for the full economic evaluation that will take place after the second screening round is complete.

However, a key part of an economic analysis is to take into account the counterfactual and to identify the incremental change that has occurred over and above 'what would have happened anyway', in the absence of the pilot. It is important to highlight that this costing analysis is *not an incremental analysis* but rather takes a 'snap-shot' perspective of costs incurred to design and run the pilot in the first two years, with some assumption-based extrapolation to inform understanding of potential future costs.

As such, it does not account, for example, for the fact that some cancers detected as a result of pilot screening, may have been detected symptomatically anyway. Further, it does not address the cumulative impacts that may be experienced over time following introduction of a screening programme, whereby we might expect to see an initial hump in diagnosis of new bowel cancer cases that will plateau and potentially reduce once the screening programme has been running for some years.

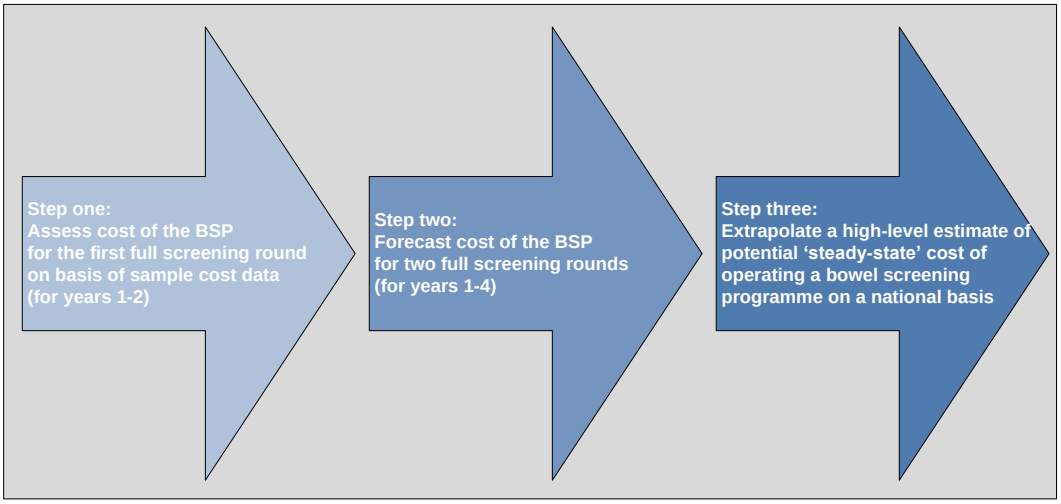
Note also that the nature of the pilot is that it is continually developing and improving its activity. This means that results calculated over the lifetime of the pilot so far are to some extent based upon a moving target, and it is expected that epidemiological and cost results, in particular, will continue to evolve over the remaining life of the pilot.

2. Analytical framework

2.1 Brief overview

Our approach to this costing analysis involved three key steps, as outlined in Figure 1 below. Step one uses data relating to actual costs incurred over two sample periods to assess the cost of developing and running the pilot during the first two years. In step two, these costs are forecast out to estimate a total cost of developing and running the pilot for the full four years. In step three, on the basis of some key assumptions (as outlined in section 3.1 below) we extrapolate results from step two to develop a high-level estimate of the potential 'steady-state' cost of operating a bowel screening programme on a national basis.

Figure 1: Key steps in the costing analysis



2.2 Key parameters

2.2.1 Perspective

The perspective for this costing analysis is that of Vote: Health or the health funder. We address the total direct health-system costs of the resources used.

This is the approach we will use for the full CEA. It is consistent with the approach promoted for CEAs in New Zealand by PHARMAC (the New Zealand Pharmaceutical Management Agency) and as such will facilitate comparisons across other health sector investments in New Zealand.

In line with this perspective, our analysis does not capture costs to patients, for example travel costs, or those relating to services that are partially subsidised, such as patient co-payments for GP and pharmacy services.

Further, our work does not incorporate a wider concept of economic cost to society, for example, in relation to lost productivity through absence from work due to sickness.

2.2.2 Overview of costing data and approaches

Cost categories

Our analysis covers two key categories of costs, as identified in Table 1 below.

Table 1: Broad categories of costs included in scope

Category	Definition
1. **Bowel screening pilot costs**	Costs related to the development and implementation of the BSP including: • pilot start-up costs; and • screening pathway costs (for all steps along the pathway to the point of diagnosis of bowel cancer). (This group of costs is used as the primary input into step 3 where we develop a high-level estimate of the 'steady state' cost of running a bowel screening pilot nationally.)
2. **Treatment costs**	Lifetime cost of treating bowel cancers diagnosed via the BSP (calculated on the basis of average lifetime cost of treating bowel cancer in NZ accounting for factors such as age, gender and stage of cancer).

Costing approaches

We employ two broad costing approaches in this analysis.

- Our assessment of the **cost of the pilot** is based on a detailed bottom-up costing model that uses samples of actual cost data from the pilot during development and on-going implementation of screening. (This
- **Costs associated with treatment of bowel cancers** diagnosed as a result of the pilot are based on estimates of average NZ lifetime costs of treating bowel cancer diagnosed at different stages, sourced through national data collections.

2.2.3 Definition of key terms

Types of cost

Our approach to modelling of costs differentiates between various types of costs that have been incurred in the development and running of the pilot. We have provided below an explanation of how we have used key terms:

- **Operating costs** are the on-going operational expenses of running the pilot. They may be variable or fixed (as outlined below).
  - **Variable costs** are those that are sensitive to changes in activity, such as service volumes. Examples include the cost of FOBT test kits (which is driven by how many are mailed out to eligible people) and the cost of colonoscopy (driven by the number of returned tests that provide a positive result).
  - **Fixed costs** are those that remain constant over a period of time, irrespective of any changes in the volume or intensity of activity. These typically relate to ongoing capacity at a pre-agreed level, for example, the salaried staff members employed at

Waitematā DHB to work on the pilot, such as those in the coordination centre and the endoscopy unit.

- **Overhead costs** are a particular type of fixed expense associated with operating a programme, such as rent and utilities costs. In this case, we use the term in the context of services that support the pilot as a whole, rather than those that can be attributed any single stage, such as corporate services at Waitematā DHB, which support the pilot employed staff with core functions such as recruitment, training, payroll, and legal/financial advice.

- **Development costs** relate to the start-up of the pilot and are typically one-off costs incurred before the pilot commenced. Some examples of these development costs include the design and build of the pilot register, the production of promotional resources, and the preparatory work undertaken by the Ministry of Health and Waitematā DHB.
  - **One-off costs** are essentially development costs paid once and not repeated.

Our use of the term 'cost' versus 'price'

In economics, the term 'cost' is used to describe what it takes (in dollars or resources) for a supplier to produce a particular product or service. 'Price' relates to what someone is willing to pay for that product or service, and as such comes from more of a demand perspective. In economic analysis of health care, we need to measure or value inputs and impacts of particular interventions – given the nature of health care this can be challenging. It is relatively common for 'price' to be used as a proxy for 'cost' as we are sometimes limited in our ability to understand the true cost of delivering services.

For our analysis of screening pathway costs, the majority of inputs to the model are valued at the direct financial cost paid by the pilot (i.e. Waitemata DHB). In some cases, the costs incurred by the DHB are the prices paid for an input from an external source (for example, where they relate to the contract/sticker price charged by an external provider for a transaction, e.g. cost of test kits, courier trips, or the fee-for-service amount in the contracts with colonoscopist contractors working onsite in a private capacity). In this case, the price paid by the pilot equates to cost. In other cases, the costs used in the model are estimates derived from items in the pilot budget or DHB cost centres e.g. working out the unit cost of colonoscopies delivered by in-house salaried staff or the share of corporate overheads allocated to the pilot by the DHB.

When we are estimating costs of treatment for bowel cancer, our analysis uses the standard national prices charged within New Zealand for particular items of service. For example, for hospital services we use the cost-weighted discharge value for services which are then applied to the national inter-district flow (IDF) price for secondary services. While these are actually 'prices' it is common practice within health economics to use these as a proxy for value or 'cost'.

2.2.4 Time horizon and discounting

In terms of time horizon, as shown in Figure 1 above, our focus for steps 1 and 2 is a snapshot of the four year duration of the pilot. Our positioning point for analysis in step 3 is notionally 'year 5', when the pilot has concluded and all pilot development costs have been absorbed.

In economic analysis, it is standard practice to discount, or to adjust costs and benefits for differential timing, recognising that future benefits achieved and costs incurred are not as valuable as those occurring now. In the full CEA of the BSP we intend to apply a discount rate to both costs and benefits measured.

However, the stance for the costing analysis is different in that we are looking at the data from a financial perspective, using snap-shot samples of actual costs incurred. The time period of four years is fairly short and we have determined that it is not necessary to adjust for time effects for this piece of work.

3. Methodology

This section summarises the key assumptions driving our work and then for each of the key steps of analysis, outlines the detailed methodology that has been employed.

We have separated the first step into two components - Step 1a describes the method for determining costs of the pilot in year 1 and 2, while Step 1b outlines how we estimated costs of treating patients diagnosed with cancer by the pilot.

3.1 Summary of assumptions and constraints

3.1.1 Step 1a: Costs of the pilot in year 1 and 2

The model captures the resources required to develop and plan for the pilot and then identifies/estimates costs for all inputs along the screening pathway. Variable costs are determined on the basis of actual volumes of patients receiving services at different points along the pathway. Overhead costs are allocated proportionally along the pathway.

Assumptions

Variable costs

- The screening pathway was defined as series of resource units.
- 'Unit costs' for the resource units were determined on the basis of two six-month samples of data relating to actual costs incurred by the pilot:
  - For year 1, unit costs were based on expenses incurred during July-December 2012.
  - For year 2, unit costs were based on expenses incurred during January -June 2013.

Fixed costs

- Overhead costs (such as the cost of running the pilot co-ordination centre and Ministry of Health costs for oversight and governance) were allocated proportionally across four discrete stages of the pathway according to their relative value of operating expenditure (determined by variable unit costs applied to volumes).
- However, WDHB corporate overheads were allocated to the four stages by their proportionate value once outsourced services. The rationale is that these outsourced services (e.g. general practitioners advising of a positive result) are not likely to be supported by DHB corporate functions.

Development costs

- Development costs were incurred during the business case development phase led by the Ministry of Health and in the pilot planning period from February 2011 to January 2012.
- Where available, actual costs incurred were collected from the Ministry of Health and the pilot. However, some items had to be estimated, particularly during the start-up phase, where salaried staff time at the Ministry of Health for the pilot development ebbed and flowed over time.
- The full quantum of development costs of the pilot was included in our assessment of the total pilot cost for year 1 and 2.

Constraints and limitations

- Some costs (particularly overheads) are based on estimates and unit costs are based on two sample sets of data relating to expenses incurred. However, while there may be some variation, there are limited constraints in interpreting our assessment of costs of the pilot to date, given that the findings are based on analysis of real pilot data.

3.1.2 Step 1b: Costs of treating diagnosed cancers

We develop an estimate of the average lifetime cost in NZ of treating bowel cancers diagnosed at different stages. This average cost is applied to cancers detected through the screening pilot, in order to estimate the total treatment cost incurred as a result of cancers diagnosed.

Assumptions

- Our estimates are based on an 'excess difference' approach which is based on the assumption that additional health system cost for people with bowel cancer is attributable to their cancer diagnosis.
- As a start point, we took an estimated excess health system cost for bowel cancer in 2009 developed by the BODE[3] programme (Burden of Disease Epidemiology, Equity & Cost-Effectiveness). This figure includes the costs of cancer for people diagnosed in 2009 but also the cost of treating people diagnosed in the four years preceding 2009. Therefore, we use the cost incurred prior to 2009 as a proxy for the future costs that will be incurred by those diagnosed in 2009, to determine a total average excess cost of treating bower cancer for a patient.
- We had to estimate the relative proportion of bowel cancers diagnosed at each stage in NZ prior to the introduction of the bowel screening pilot, as there is incomplete staging information in the New Zealand Cancer Registry. We obtained an extract of this data from 2011 restricted to bowel cancers and undertook analysis of available TNM7 and Dukes staging8 data to estimate proportions across the whole dataset.
- We reviewed international literature for information about the ratio of costs incurred by stage and applied the ratio determined to the estimated treatment costs for.

Constraints and limitations

- It is important to note that this is not an incremental analysis, in that some of the cancers diagnosed via the pilot may have been diagnosed symptomatically during the course of the first screening round.
- Further, given the top-down costing approach based on analysis of national activity data, along with the assumptions and approach to determining estimates noted above, we recognise that this component of the costing analysis is indicative only.

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7 TNM Classification of Malignant Tumours (TNM) is a cancer staging notation system that gives codes to describe the stage of a person's cancer.

8 Dukes classification classifies colorectal cancer into stages.

3.1.3 Step 2: Forecast cost of the pilot years 1-4

Our estimate of the full cost of the pilot (years 1-4) uses the results of the bottom-up costing of the pilot during years 1 and 2. On the basis of some assumptions noted below, we forecast out to year 4.

Assumptions

We forecast the total cost of the four year screening pathway on the basis of the cost estimates developed for the first two years. In doing this, we have made the following key assumptions:

- there will be no further changes to the fixed cost base (e.g. we assume that current IT infrastructure will be sufficient to last until the end of the Pilot). The annual fixed cost estimate determined for year 2, is applied to years 3 and 4.
- the trend in service volumes is likely to stabilise. Variable costs are forecast using unit costs (estimated on the basis of costs incurred in January to June 2013). Future volumes at each stage in the pathway are based on the average from July 2012 to December 2013.
- no further development costs will be incurred. Development costs are spread over the four years of the pilot.

Constraints and limitations

- Estimated treatment costs associated with treating cancers diagnosed are not included due to data constraints; it would not be advisable to forecast the number of cancers by stage diagnosed, due to limited outcomes data available from the first screening round at this point in time.

3.1.4 Step 3: High-level national estimates

Our brief required us to develop a simplistic high-level estimate of the 'steady state' cost of operating a bowel screening programme on a national basis, with results presented also from a regional perspective. We were advised against undertaking analysis of different service configurations (e.g. the number of coordination centres) and to utilise results obtained from the first two years of screening, applied at a national level. To do this, we replicate the Waitematā pilot model, scaled up to a national level and assume that national coverage of the screening programme is achieved immediately (i.e. at the beginning of year 5, following conclusion of the pilot).

Assumptions

The national model follows the same approach as the model developed to assess the actual costs of screening incurred during year 1 and 2, applying the following principles:

Variable costs

- Participation volumes are determined by taking the age-ethnic group rates for the pilot (for five-year age groups among each of the four ethnic groups of Māori, Pacific, Asian and Other). These rates are applied to the equivalent groups among the national population to determine the volume of people that would enter and move along the screening pathway. These results drive the variable cost components of the national model, with the unit costs from year 2 of the pilot being applied to the volumes along the steps of the pathway.
- We assume there is no variation in the cost per participant according to differences age or ethnic group.

Fixed costs

- The fixed cost components of year 2 of the pilot are scaled up by a factor of 8.0, as the national population aged 50-74 years is approximately 8 times larger than the equivalent population at Waitemata DHB.
- The potential impact of economies of scale on fixed costs components, such as the coordination centre, is explored in the sensitivity testing.

Design

Screening pathway design	➢ The pilot model design is replicated. ➢ We assume that all key parameters would be the same e.g. no change to target population; the iFOBT test produces the same results; equivalent participation rates are achieved etc.
Laboratory services	➢ The current model for provision of laboratory services (iFOBT tests and histology) is replicated and scaled up to manage the increased volumes required to cover all DHBs.
Coordination centres	➢ Staffing for the current coordination centre model is scaled up to manage the increased volumes required to cover all DHBs.
Colonoscopy services	➢ The same level of colonoscopy services will be provided, with the same mix of volumes provided by salaried/contracted colonoscopists as by the pilot in the second half of Year 2 (i.e. July-December 2013).
IT register	➢ It will be feasible to scale up the coverage of the existing IT register to support a national programme.

Exclusions

The following costs are not captured in the national model because a full understanding would require more involved consideration, including for example, assessment of colonoscopy capacity on a DHB-by-DHB basis, confirmation of key policy decisions about the configuration of the service delivery model and a more detailed set of data than we have available from the pilot alone.

- **Development costs:** The national model does not examine the upfront development costs of rolling out bowel screening. For example, we have not considered the costs of developing colonoscopy capacity within each region to absorb the additional workload generated from screening.
- **Treatment costs:** Given concerns about the relatively small numbers of cancers detected at each stage so far and our inability at present to fully understand the incremental impact of the programme, we decided not to include an estimate of cancers that would be likely to be detected through a national programme.
- **Other exclusions:** Several elements are excluded, where there is little information at this point, namely the:
  - oversight and governance development costs incurred by the Ministry of Health;
  - start-up costs of a national programme, (e.g. capital purchases, development of materials); and
  - work-force development and training costs.

- For the regional view, there is no consideration of patients transferring across DHB or regional boundaries. We assume that the resident population of each DHB is screened within their home location.

Constraints and limitations

- The national model is more speculative and entails higher number of assumptions than the pilot costing model which is, for the most part, based on research and driven by actual volumes and unit/fixed costs.
- We acknowledge that the results presented here present a simplistic and partial analysis of the potential cost of rolling out a national programme. In reality, the implementation programme would need to take into account the complexities of constrained available resources, local situations with respect to development of colonoscopy and treatment capacity, and is likely to involve some type of phased implementation arrangement.
- This is not a dynamic population forecast. It does not factor in forecasts of any future changes in population structure (such as an ageing population) but uses a static 2013 population estimate to estimate the annual 'steady state' cost of operating a national programme.
- Given these constraints, it is important that the results presented are always quoted in full, with description of inclusions and exclusions, to acknowledge the constraints and to ensure that they are not taken out of context.

3.2 Detailed methodology

3.2.1 Step 1a: Costs of the pilot in year 1 and 2

Overview

The purpose of this component of analysis was to understanding the cost of the pilot in years 1 and 2, based on a detailed bottom-up costing model.

Bottom up costing involves determining the number of units of a particular resource that has been used, then multiplying those volumes by the unit cost for that item, and aggregating up results to determine overall costs. It allows analysis of the key drivers of cost within a complex programme and enables us to predict the potential impact of changes in price of key inputs or in levels of service delivery. For this project, our modelling has involved defining a series of 'resource units' from start to finish of the screening pathway, capturing costs of all inputs required for their delivery to determine unit costs, and then applying the unit costs to volumes provided by the BSP.

A high-level schedule of costs incurred by the pilot was agreed at the outset with the pilot Programme Manager. The schedule differentiates between the one-off development (i.e. start-up) costs and the ongoing operating costs of running the pilot (fixed and variable). (Appendix 1 provides full schedules of fixed and variable cost components.)

A detailed costing model was then built up, by mapping samples of actual costs and service volumes against the agreed cost schedule. The division of development costs and operating (fixed and variable) costs allows for flexibility in modelling the current and future costs of the various stages of the screening pathway.

The costing model also distinguishes between the direct operating costs of the pilot and the ongoing oversight and monitoring costs incurred by the Ministry of Health.

Data sources

Volumes data

The volumes of activities undertaken at different stages of the screening pathway determine the variable costs. Some indicators comprise a composite of a number of items costed on individual basis: for example, 'iFOBT kit sent' comprises a sample bottle, a sample collection sheet, a zip-lock bag, accompanying information and a specially designed envelope for returning the sample to the laboratory. Where a key activity has a range of differing costs, for example, variation in price paid for different arrangements for provision of colonoscopy, we separate the volumes and cost them accordingly.

The primary source of data is the BSP Biannual reports submitted to the Ministry of Health, supplemented with a small number of more detailed items provided directly from the pilot. For volumes of cancers detected and stage distribution, we use the published monitoring indicator reports developed by the Ministry of Health.

The costing model draws on actual volumes from the first four six-month periods: January to June 2012; July to December 2012; January to June 2013; and July to December 2013.[9]

Cost data

The approach has been to identify the upfront development costs of the pilot and to sample the operating costs from two six-month periods of the pilot.

The development costs relate to the pilot planning period from February 2011 to January 2012, immediately before the pilot officially got underway, as well as to the earlier business case development phase led by the Ministry of Health.

The two samples of operating costs relate to: July to December 2012 (the second half of the first year of the pilot); and January to June 2013 (the first half of the second year of the pilot). These two separate snapshots of operating costs enables analysis into how processes and associated costs have changed or settled down since the pilot began.

The cost data has been sourced from the pilot Programme Manager and the Manager of the Ministry of Health's Bowel and Prostate Cancer Programmes. Much of the data is held at the pilot coordination centre or the Finance Team at Waitematā DHB. Some expenditure had to be estimated, particularly during the start-up phase, where salaried staff time at the Ministry of Health for the pilot development ebbed and flowed over time.

Key steps in data modelling

Treatment of pilot costs

As illustrated in Figure 2, our preliminary analysis is based on a two-year view in which we assess costs that have been incurred to date, including fixed and variable costs in years 1 and 2, in addition to the full development cost for the pilot.

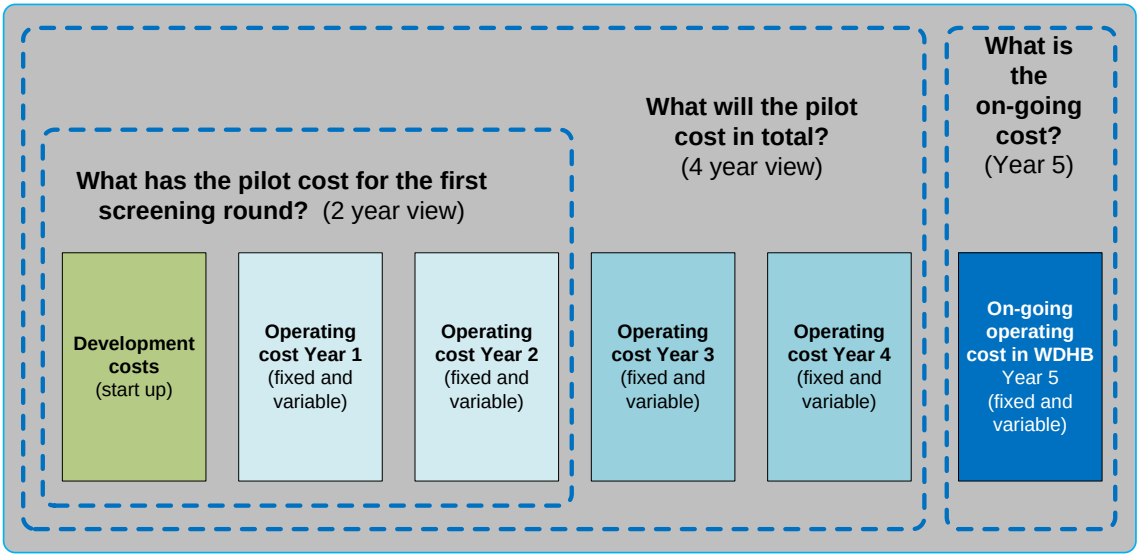
[9] This costing report uses the figure of 129 cancers detected by the pilot during the period 1 January 2012 – 31 December 2013. This number differs from the number of cancers reported in the epidemiological section of the combined interim report produced with Litmus ltd, which only covers the first 22 months of the screening programme.

The development costs relate to the pilot planning period from February 2011 to January 2012, immediately before the pilot officially got underway, as well as to the earlier business case development phase led by the Ministry of Health. We had to make some assumptions about how to spread these development costs over the time of the pilot.

We have taken a stance that recognises that the development costs are sunk or retrospective costs that have already been incurred and cannot be recovered. At the end of year 4, the pilot study is due to conclude and we do not know whether a decision will be made to extend the life of the pilot or to broaden coverage of bowel screening to other areas. Hence, we use the end of the pilot as being an artificial 'cut-off point', assuming that development costs will have been absorbed completely by the end of year 4. Arguably, if the bowel screening programme were to be continued, there is further value that can be secured from the previous investment in development costs and they could legitimately be spread into the future, thus reducing the cost of the programme now. However, given the lack of certainty about the future, we decided to take the approach of fully absorbing these costs during the life of the pilot.

This approach allows us to develop a high level estimate of the marginal operating cost of any future continuation of bowel screening in Waitematā DHB, which can be extrapolated to estimate the cost of wider coverage for a screening programme within NZ.

Figure 2: Treatment of pilot costs



Allocation of overhead costs

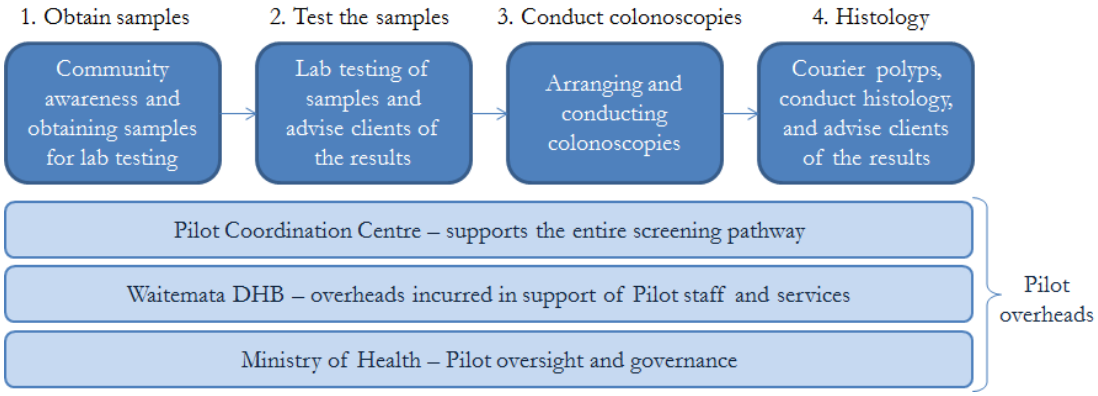
Broadly, the pilot screening pathway can be viewed as having four discrete phases as illustrated in Figure 3 below. While it is relatively straightforward to allocate the fixed and variable operating costs to these four phases, several steps are needed to allocate the overhead costs associated with the pilot. These 'overheads' relate to the services that support the pilot as a whole, rather than any one stage, and are grouped into three categories:

- the pilot Coordination Centre, which manages and monitors the screening pathway;
- corporate services at Waitematā DHB, which support the employed staff with core functions such as training, IT systems, payroll, and legal and financial advice etc.; and
- Ministry of Health costs for oversight and governance of the pilot.

The costing model allocates these overheads to the four stages of the screening pathway according to their value by operating expenditure.

The exception is the treatment of the Waitematā DHB corporate overheads; these are allocated to the four stages by their proportionate value following an adjustment to exclude outsourced services. The rationale is that these outsourced services (e.g. laboratory reading of kit samples, general practitioners advising of a positive result) are not likely to be supported by DHB corporate functions.

Figure 3: Four high-level stages of the screening pathway and associated overheads

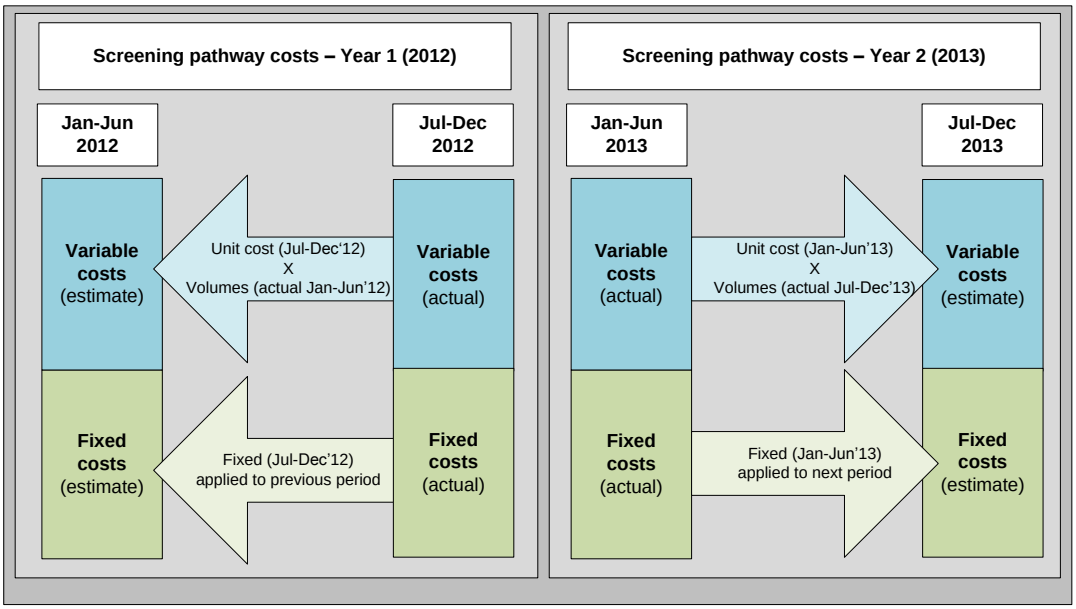


Treatment of fixed and variable costs

The estimates for these full-year costs are based on the following steps (illustrated in Figure 4 below):

- the sample of fixed costs for July to December 2012 is applied to the prior six-month period of January to June 2012, under the assumption that it is a fair proxy for the fixed costs incurred during that period;
- similarly, the sample of fixed costs for January to June 2013 is applied to the subsequent six-month period of July to December 2013, under the assumption that fixed costs will continue at the, slightly lower, level observed over the period January-June 2013; and
- the unit costs for the variable cost elements sampled in July to December 2012 and January to June 2013 are applied to the actual service volumes recorded for January to June 2012 and July to December 2013.

Figure 4: Assessment of fixed and variable costs for years 1 and 2



3.2.2 Step 1b: Costs of treating diagnosed cancers

Overview

The purpose of this component of analysis is to develop an estimate of the average lifetime cost of treating bowel cancer diagnosed at different stages. This average cost is applied to cancers detected through the screening pilot, in order to estimate the total treatment cost incurred as a result of cancers diagnosed.

As a start point for this analysis, we have used recent work undertaken by the University of Otago Health Research Council-funded BODE^3 programme (Burden of Disease Epidemiology, Equity & Cost-Effectiveness Programme). This adopts an 'excess difference' approach, which essentially estimates the difference in average costs over a specified time period for a patient with and without bowel cancer, after adjusting out for socio-demographic confounding. The 'excess difference' or the additional cost for people with bowel cancer is assumed to be attributable to their cancer diagnosis. This is an internationally accepted approach to estimating the cost of cancers.[10]

Data sources and key steps in data modelling

Estimated average excess health system cost for treatment of bowel cancer in NZ

The data used by BODE^3 is gathered from a number of national data-sets as outlined in Table 2 below[11]. Using a method developed by the Ministry of Health[12], records were linked via the National Health Index (NHI) identifier, to develop a data-extract identifying all publically funded health care activity for each New Zealander occurring in July 2006 - June 2011 with pricing applied as indicated (GST exclusive).

This analysis led to an estimated excess health system cost for bowel cancer in 2009 (in $NZ2011 prices) of $58,000 excluding GST. This figure includes the costs of cancer for people diagnosed in 2009 but also the cost of treating people diagnosed in the four years preceding 2009. Therefore, we use the cost incurred prior to 2009 as a proxy for the future costs that will be incurred by those diagnosed in 2009, to determine a total average excess cost of treating bower cancer for a patient.

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10 Mariotto AB, Yabroff KR, Shao Y, et al. Projections of the cost of cancer care in the United States: 2010-2020.[Erratum appears in J Natl Cancer Inst. 2011 Apr 20;103(8):699]. Journal of the National Cancer Institute 2011;103(2):117-28, and, Barlow WE. Overview of methods to estimate the medical costs of cancer. Med Care 2009; **47**(7 Suppl 1):S33-6.

11 Results were provided by Professor Tony Blakely from as yet unpublished work from the BODE^3 programme.

12 Ministry of Health. The Price of Cancer: The public price of registered cancer in New Zealand. Wellington: Ministry of Health, 2011.

Table 2: National data sets

National data-sets	Events	Pricing
National Minimum Data Set (NMDS)	Public hospital discharges, including palliative care and ED admissions. (Also includes a small number of private hospitalisations viewed to have a marginal impact on overall cost.)	Cost-weighted discharge value is calculated when the data is submitted by DHBs. Cost weights are then applied to the national inter-district flow (IDF) price for secondary services.
National Non-admitted patient Collection (NNAPC)	ED and outpatient attendances.	DHB contracted prices applied.
PHARMHOUSE	Subsidised community pharmaceutical dispensing and inpatient pharmaceuticals.	Drug costs applied to the date of dispensing.
LABS (the laboratory claims collection)	Laboratory tests (including community and inpatient).	Either the actual price of the claim made for the test or if bulk contracted, the contracted price divided by the contracted volume.
General Medical Subsidy Data Warehouse (GMS)	General practice consultations (only non-enrolled patient visiting a capitated practice).	GMS fee-for-service claim price.

Estimate of the staging of bowel cancer diagnosed in NZ

For the purposes of the treatment cost estimate for this analysis, we sought to incorporate the impact of any differential cost for treating bowel cancers diagnosed at different stages.

However, due to incomplete staging information in the data, we had to estimate the relative proportion of bowel cancers diagnosed at each stage in New Zealand, prior to the introduction of the bowel screening pilot.

The New Zealand Cancer Registry (NZCR) is a population-based tumour registry held by the Ministry of Health. The primary function of the registry is to collect and store cancer incidence and mortality data to provide a basis for cancer survival studies and research programmes. We obtained an extract of this data from 2011 restricted to bowel cancers[13] and undertook analysis of available TNM[14] and Dukes staging[15] data to estimate proportions across the whole dataset.

Then, we reviewed international literature for information about the ratio of costs by stage and applied the ratio determined to the estimated treatment costs for 2009 generated by the BODE analysis.

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13 We identified bowel cancers using International Statistical Classification of Diseases (ICD 10) codes.

14 TNM Classification of Malignant Tumours (TNM) is a cancer staging notation system that gives codes to describe the stage of a person's cancer.

15 Dukes classification classifies colorectal cancer into stages.

3.2.3 Step 2: Forecast cost of the pilot years 1-4

Overview

This step of analysis is used to forecast the full cost of developing and running the pilot during years 1-4. It uses the results of the bottom-up costing of the pilot during years 1 and 2.

Estimated treatment costs associated with treating cancers diagnosed are not included due to data constraints; it would not be advisable to forecast the number of cancers by stage diagnosed, due to limited outcomes data available from the first screening round at this point in time.

Data sources and key steps in data modelling

Data sources

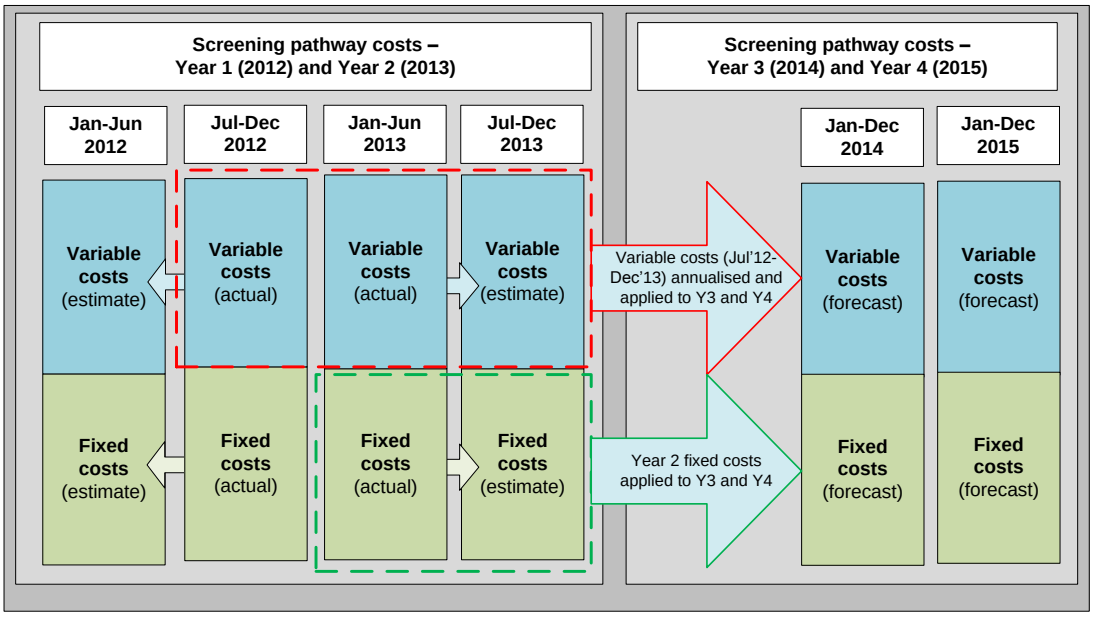
This analytical step uses the same cost and volume inputs as for Step 1a, analysis of costs of the pilot in years 1 and 2.

Forecasting fixed and variable costs for the second screening round

The total cost of the pilot over four years is based upon the following steps (as illustrated in Figure 5):

- extrapolate the fixed cost estimate established for January to June 2013;
- forecast variable costs using volumes that are based on an average of the three six-month periods from July to December 2012 through to July to December 2013, along with the unit costs that were used to cost the two periods of July to December 2012 and January to June 2013;; and
- extrapolate the high-level annual estimate of Ministry oversight and governance costs.

Figure 5: Forecast of fixed and variable costs for years 3 and 4



Allocation of development costs

As illustrated in Figure 2 on page 19, for our estimate of the total cost of the pilot to the end of the second screening round, we spread the development cost over four years.

3.2.4 Step 3: High-level national estimates

Overview

Purpose

The output for this step is to develop a high-level estimate of the 'steady state' cost of operating a bowel screening programme on a national basis.

Our brief – important limitations of this analysis

For this costing analysis, Sapere was requested to develop a high-level estimate of the cost of operating a bowel screening programme nationally within New Zealand, based on a replication of the Waitematā pilot model, scaled up to a national level. To do this, the model assumes that national coverage of the screening programme is achieved immediately (i.e. at the beginning of year 5, following conclusion of the pilot).

While we appreciate that this scenario is unrealistic for a range of reasons (e.g. availability of funding and extreme pressure resulting on colonoscopy services) this was viewed by the Ministry to be the most appropriate approach at this point in time. It recognises that there are a number of key policy decisions yet to be confirmed around how national roll-out would be approached and phased (for example, whether screening would be implemented region-by-region, or if there would be any change in the target age).

We acknowledge that the results presented here present a simplistic and partial analysis of the potential cost of rolling out a national programme. In reality, the implementation programme would need to take into account the complexities of constrained available resources, local situations with respect to development of colonoscopy and treatment capacity, and is likely to involve some type of phased implementation arrangement.

As such, it is important that the results presented are always quoted in full, with description of inclusions and exclusions, to acknowledge the constraints and to ensure that the results are not taken out of context.

Approach

We have developed a high-level model of the annual operating costs of a national screening programme. It is important to note that the model assumes a 'steady-state' for the annual operating costs following an immediate roll-out of the national programme.

Data sources and key steps in data modelling

Data sources

The national estimate builds on the costing model of the pilot, drawing on the same unit costs.

We use the Statistics New Zealand 2013 DHB population projection series for the 2014/15 financial year, by five-year age groups (50-54 55-59, 60-4, 65-69, 70-74 years) and by ethnic group (Māori, Pacific, Asian and Other). This population data is also viewed on a regional basis, using the four historic district health board regions – Northern, Midland, Central and Southern.

Volume estimates for participation along the pathway are developed on the basis of these demographic groupings.

Key steps in data modelling

National model

Essentially, the national model follows the same approach as the model developed to assess the actual costs of screening incurred during year 1 and 2.

However, for the national model the participation volumes are determined by taking the age-ethnic group rates for the pilot and applying them to the national population. This involves calculating participation rates within the pilot for five-year age groups among each of the four ethnic groups of Māori, Pacific, Asian and Other.

These age-ethnic group rates are applied to the equivalent groups among the national population to determine the volume of people that would enter and move along the screening pathway. These results drive the variable cost components of the national model, with the unit costs from year 2 of the pilot being applied to the volumes along the steps of the pathway.

The fixed cost components of year 2 of the pilot are scaled up by a factor of 8.0. This simple approach reflects the fact that the national population aged 50-74 years is approximately 8 times larger than the equivalent population at Waitemata DHB. It also reflects the fact that the model does not make any assumptions about programme infrastructure and administration and how this might be arranged on the ground. The potential impact of economies of scale on fixed costs components, such as the coordination centre, is explored in the sensitivity testing.

Sensitivity testing

The results of the national programme are tested for sensitivity by varying assumptions separately in three main areas:

- fixed costs – coordination centre costs are tested under low (4.0) and high (10.0) scaling assumptions, with the intuition being that the larger volumes of a national programme may lead to economies of scale being realised or some additional coordination costs;
- variable costs – the participation rate is varied from the base case (56.0%) with the addition of low (46.0%) and high scenarios (62.0%). Similarly, the positivity rate is varied from the base case (5.0%) with low (4.0%) and high scenarios (7.5%) being tested. These parameters were agreed as being plausible in discussions with the Ministry of Health.

These sensitivity tests are then combined into overall "low" and "high" scenarios for consideration alongside the base case for the national programme.

Regional view

The national costing model is also examined on a regional basis, using the four district health board regions – Northern, Midland, Central and Southern. The variable and fixed operating costs of the base case of the national model are allocated using simple methods that provide insights into how costs might be incurred across the regions. This high-level approach does not factor in differences in population distribution, such as the mix of rural and urban areas.

In terms of variable costs, the regional approach factors in differences in participation rates for each five-year age group and four ethnic groups of Māori, Pacific, Asian and Other – using the approach outlined for the national modelling work. This means that the variable costs incurred in each region will be determined by population size and the balance of age and ethnic groups among those aged 50-74 years.

The fixed operating costs of the national model are allocated among the regions on a simple population share basis (i.e. 50-74 years). Again, no assumptions have been made about the underlying programme infrastructure and administration.

4. Assessing costs of the BSP

4.1 Results for key input parameters

4.1.1 Volumes data – services provided and key outcomes

Summary of BSP activity

The majority of the volumes indicators that drive the modelling are sourced from biannual reports from the BSP to the Ministry, with some supplementary items (as indicated in Table 3 below) provided directly from the pilot.

It is important to emphasise the dynamic nature of this data. It provides a snapshot of activity undertaken and recorded within specified periods. At the start of each six-month time period, participants will have reached different stages of the pathway. It is not possible to trace the flow of volumes from the start-point (i.e. pre-notification letters sent) to the end of the pathway.

Further, we recognise that there will have been many adjustments made to processes, systems, the register and to data capture practice – as the pilot has evolved.

Colonoscopy volumes

The pilot has made use of three forms of colonoscopy provision during its first two years, contracted under different terms as outlined below:

1. **Provision at Waitakere Hospital by salaried Waitematā DHB colonoscopists:** The pilot reimburses the Gastroenterology and Surgery Departments for the full costs of the colonoscopists that deliver each session (e.g. including annual leave and continuing medical education). The pilot has employed a team of endoscopy nurses (6 FTEs) to support the delivery of these volumes.

2. **Provision at Waitakere Hospital by contracted colonoscopists:** These volumes are led by colonoscopists (who tend to be those who work in the private sector or at the DHB on a part-time basis) contracted to the DHB on a fee-for-service basis ($350 per colonoscopy procedure).

3. **'Temporary increased capacity' within Waitematā DHB:** The Gastroenterology Department agreed to free up additional colonoscopy capacity to provide volumes to the pilot as a temporary measure, until the pilot's salaried and fee-for-service capacity reached a sufficient level. To achieve this, a number of symptomatic cases were referred to the private sector at $1,000 per colonoscopy procedure. The cost was covered through implementation funding that that been allocated but not used for start-up costs.

Table 3: Summary of Pilot activity data, 2012/13 [16]

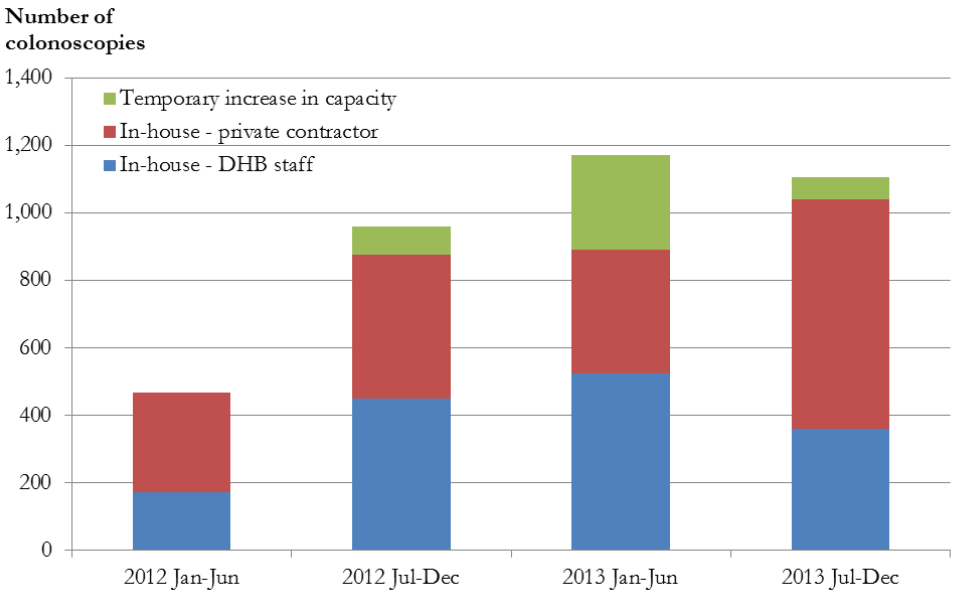
Stage of pathway	Volume indicator	2012 Jan-June	2012 July-Dec	2013 Jan-June	2013 July-Dec
Obtain the samples	Number of pre-notification letters sent	31,843	32,248	41,332	31,152
	Number of iFOBT kits sent (includes resends)	28,286	34,792	40,844	39,715
	Number of reminder letters sent at 4 weeks*	14,251	20,531	24,435	24,281
Test the samples	Number of samples received at laboratory	13,462	17,984	22,900	20,499
	Number of positive results	765	1,187	1,395	1,423
	Letters sent to patients with a negative result	9,931	14,397	18,355	16,253
Conduct colonoscopies[17]	Number of pre-assessments completed	712	1,176	1,337	1,438
	Colonoscopies completed - WDHB salaried colonoscopists	172	450	523	359
	Colonoscopies completed - WDHB contracted colonoscopists	297	425	368	682
	Colonoscopies completed ('temporary increased capacity')	0	86	279	64
	Colonoscopy under general anaesthetic*	*3 Estimate*	4	2	*3 Estimate*
	CT colonography instead of colonoscopy	*7 Estimate*	11	23	12
Histology	Histology conducted as a result of colonoscopy	368	763	855	949

16 Data sourced from: Waitematā DHB, Bowel Screening Pilot Biannual Reports to Ministry of Health. (Items annotated with * are supplementary data provided to Sapere directly from the pilot.)

17 See previous section for explanation of different contracting practice for colonoscopy.

Figure 6 shows how the mix of the three providers has varied over the four six-month periods. The period January to June 2013 recorded the highest total colonoscopy volumes and also the highest volumes of colonoscopies provided through the mechanism of 'temporary increased capacity' (at 279 cases, compared with 86 cases in the previous period and 64 in the subsequent period).

Figure 6: Colonoscopy volumes by provider, 2012-13



Cancers detected

Table 4: Cancers diagnosed as a result of the pilot

Stage of diagnosis	Stage distribution (Jan 2012 -Dec 2013)	Estimate of cancers detected by stage[18]
I	44.4%	57
II	24.1%	31
III	22.3%	29
IV	9.3%	12
	Total (actuals)	**129**

[18] The Ministry of Health information provides the stage distribution of the cancers detected by the pilot in percentages. We have used this information to estimate the actual number of cancers at each stage detected by the pilot.

4.1.2 Cost data

BSP costs for two sample periods

On the basis of cost data obtained from the BSP, the cost of running the pilot increased slightly across the two six-month periods for which detailed costs were sampled.

The operating cost of the screening pathway for July to December 2012 is **$2.656 million** whereas the cost for January to June 2013 is **$2.924 million** – equating to an increase of $268,000 or 10.1% (see Table 5 below).

Each sample incudes a high-level estimate of $248,000 for the oversight and ongoing development costs incurred by Ministry of Health during the six-month period. The total operating cost for this twelve-month period (financial year 2012/13) is estimated at **$5.580 million**.

Table 5: Estimated operating cost of the Pilot – two six-month samples

Type of cost	Sample (July-Dec 2012)	Sample (Jan-Jun 2013)	Change
Fixed costs	$1,390,000	$1,326,000	-$64,000 (-4.6%)
Variable costs	$1,018,000	$1,351,000	$333,000 (+32.7%)
MoH oversight	$247,000	$247,000	*(No change – annual estimate)*
Total operating cost (exc. development $)	**$2,656,000**	**$2,924,000**	**$268,000 (+10.1%)**

The increase in costs between the two six-month samples is driven by higher variable costs (which increased by 32.7%). This increase is partly due to more test kits being sent out in January to June 2013 (+17%) with flow on-effects of higher volumes along the screening pathway. Colonoscopy costs were another driver of this increase in variable costs (as outlined in section 4.1.1 above) because the additional colonoscopy volumes were purchased at a higher price as an interim measure until additional capacity was arranged. This relatively expensive option was wound down in the subsequent six-month period.

The increase in variable costs was partly offset by lower fixed costs (which reduced by $64,000 or -4.6%) due, for example, to some rationalisation of staff at the coordination centre. Changes in the fixed cost base are to be expected due to ongoing refinements in pilot systems and processes.

Estimate of treatment costs

Estimated average lifetime costs of treating colorectal cancer in New Zealand

The BODE³ analysis led to an estimated total excess health system cost for colorectal and anal cancer in 2009 (estimated in $NZ2011 prices) at a total of $163.60 million, representing 17.5% of all excess health system cost attributed to cancer through this methodology.

The average cost per bowel cancer treated in 2009 (at $NZ2011 prices) was calculated to be $58,000.[19]

Table 6: Estimated excess health system costs by cancer in 2009, in $NZ2011

Cancer	Excess cost in millions	Proportion of 'total' excess cost of cancer ($977 million)	Approximate cost per diagnosed case
Colorectal & anus	**$163.6**	**17.5%**	**$58,000**
Colon	$97.1	10.4%	$53,000
Rectosigmoid	$12.2	1.3%	$51,000
Rectum	$52.8	5.6%	$77,000
Anus & anus canal	$4.2	0.4%	$81,000

Source: BODE³

Our bottom-up costing analysis for the screening pathway includes diagnostic costs. Hence, when using the BODE³ data-set we have excluded any costs incurred pre-diagnosis to avoid double-counting, resulting in an average estimated lifetime cost in NZ per bowel cancer diagnosed of **$56,000**.

Estimated variance in cost by stage of diagnosis

We estimated the relative proportion of bowel cancers diagnosed at each stage in NZ using TNM fields matched with Dukes staging information. Then, we reviewed relevant published international literature to inform the distribution of costs by stage. The only relevant research that provided the appropriate ratios for the spread of costs was a 2011 study about the cost of care for colorectal cancer in Ireland.[20] We applied the same ratios to the NZ data to develop the estimates provided in Table 7 below.

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19 As described in section 3.2.2 we use this as a proxy for average lifetime costs, given that the figure includes the cost of treating people diagnosed in the four years preceding 2009. We use this component of excess cost as a proxy for the future costs that will be incurred by those diagnosed in 2009, to determine a total excess cost of treating bower cancer for an average patient.

20 Tilson L, Sharp L, Usher C, Walsh C, S W, O'Ceilleachair A, Stuart C, Mehigan B, John Kennedy M, Tappenden P, Chilcott J, Staines A, Comber H, Barry M. Cost of care for colorectal cancer in Ireland: a health care payer perspective. Eur J Health Econ. 2012 Aug;13(4):511-24. doi: 10.1007/s10198-011-0325-z. Epub 2011 Jun 3. PubMed PMID: 21638069

Table 7: Estimated average lifetime cost of bowel cancer treatment by stage

Stage of diagnosis	Estimate - average lifetime cost of colorectal cancer, by stage in Ireland (2008)		Proportion of bowel cancers diagnosed by stage for NZ (2011)	Estimate for NZ average lifetime cost of bowel cancer by stage ($NZ2011)
	(€s)	Weight		
I	€29,000	0.60	18%	$33,000
II	€47,000	0.95	39%	$53,000
III	€62,000	1.24	39%	$70,000
IV	€46,000	0.93	4%	$52,000
	€50,000			**$56,000**

4.2 Total cost of the first screening round[21]

4.2.1 Pilot development costs

The costs incurred to develop the pilot are estimated at **$3.148 million**. The main elements of this estimate are: the contract with Waitematā DHB to plan for the implementation of the pilot during 2011 ($1.346 million); and the design and build of the pilot register ($1.608 million). The estimate of development costs also includes expenditure incurred by the Ministry of Health in the development of promotional materials ($164,000). It does not include the cost of Ministry of Health staff time to produce the business case for the pilot.

4.2.2 Pilot operating costs

As noted in section 4.1.2, from the sample cost data we estimated that the total operating cost for the twelve-month period financial year 2012/13 was **$5.580 million**. Following the method described in section 3.2 the total annual operating costs were extrapolated for the preceding and following six months, as illustrated in Figure 7.

[21] Note: $ figures presented in this analysis are rounded to the nearest $1000.

Figure 7: Estimated operating cost of the pilot – four six-month periods

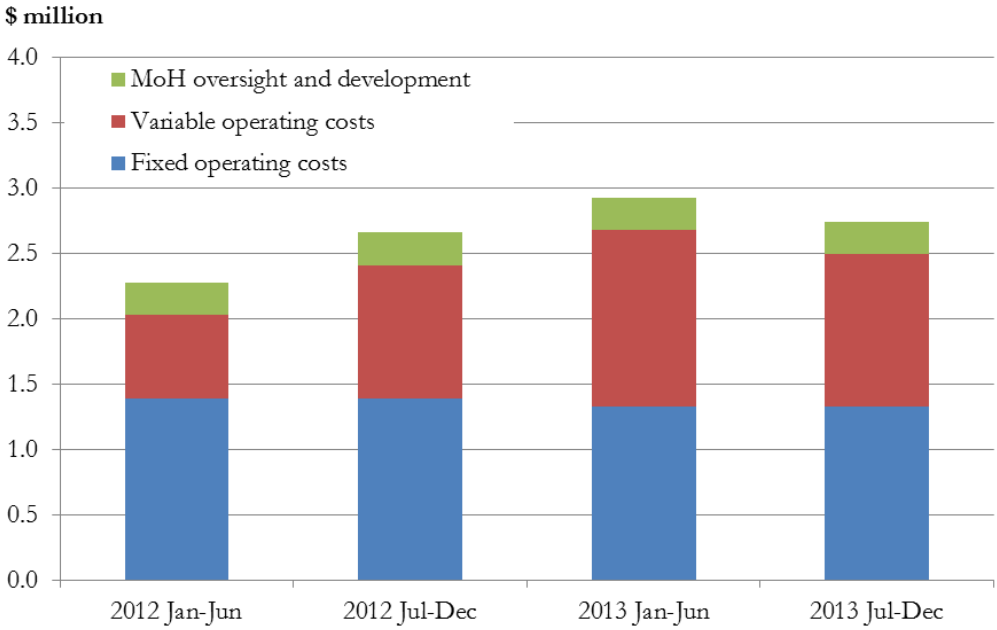


Table **8** below provides a summary of all costs for the development and implementation of the first screening round, during 2012 and 2013. This excludes treatment costs.

Table 8: Summary of costs for the first screening round

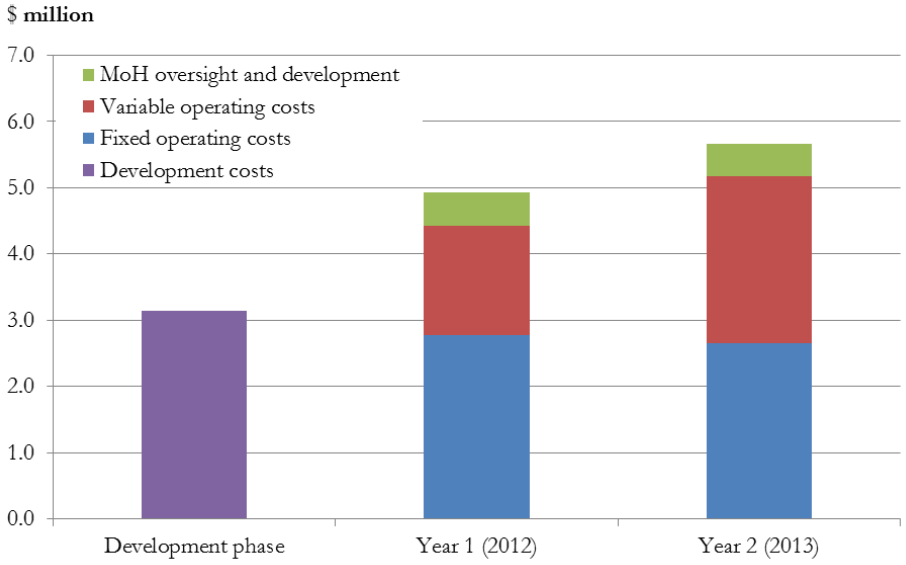
	Development phase	Year 1 (2012)	Year 2 (2013)
Development costs	**$3,148,000**		
Operating costs			
Fixed		$2,780,000	$2,651,000
Variable		$1,653,000	$2,520,000
Sub total		**$4,433,000**	**$5,172,000**
Additional MoH operating costs			
Ministry oversight [22]		$495,000	$495,000
Total		**$4,927,000**	**$5,666,000**

In Figure 8, below, the estimated development cost of **$3.148 million** is presented alongside operating costs of **$10.594 million**. The combination of all these costs gives a total of

[22] This is an estimate of the proportion of Ministry of Health staff time spent per year on the bowel screening pilot, including contract management, monitoring and development of policy advice.

$13.742 million incurred in developing and operating the first two years of the Pilot (excluding the costs of treating cancers diagnosed, as outlined in section 4.2.3, below).

Figure 8: Estimated cost of Pilot – development phase and Year 1 and Year 2



4.2.3 Cost of treating cancers detected through the BSP

Table 9 below provides an estimate of the lifetime cost of treating cancers that have been detected through the screening programme. It is important again to emphasise that this estimate of treatment costs is not a fully developed incremental analysis. If the pilot had not been in place, some of the early stage cancers may not have been detected during this time period and thus the cost of treatment is higher than may otherwise have been incurred. However, the whole point of screening is to change the stage distribution of cancer; without a full incremental analysis, we are not able to fully understand the financial off-set of detecting these cancers earlier (rather than diagnosing them symptomatically at stage III later in the person's life). On the basis of current information from the pilot, we do not have the ability to fully understand and adjust for this impact.

Table 9: Estimated lifetime cost of treating bowel cancer detected in first screening round

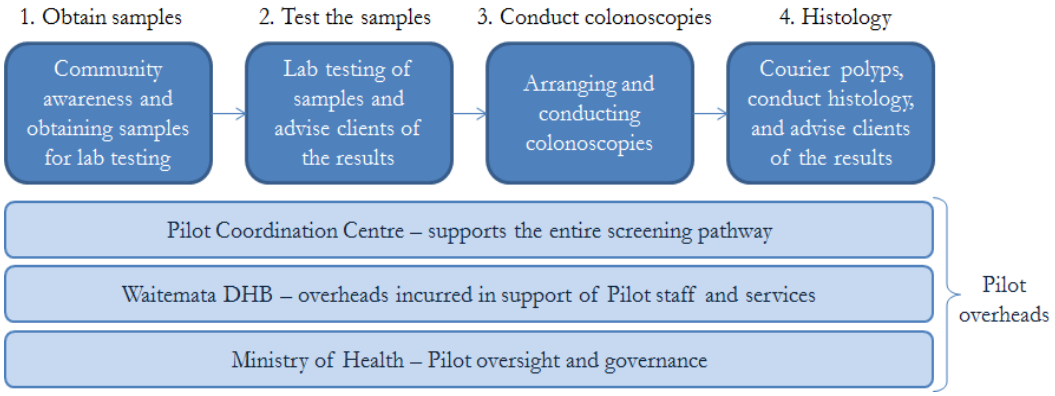
Stage of diagnosis	Stage distribution (Jan 2012-Dec 2013)	Estimate of cancers detected by stage	Estimate NZ ave. lifetime cost of bowel cancer by stage ($NZ2011)	Total cost ($NZ2011, millions)
I	44.4%	57	$33,000	$1,881,000
II	24.1%	31	$53,000	$1,643,000
III	22.3%	29	$70,000	$2,030,000
IV	9.3%	12	$52,000	$624,000
Total (actuals)		**129**		**$6,178,000**

4.3 Drilling down into the data (years 1-2)

4.3.1 Relative cost of screening pathway stages

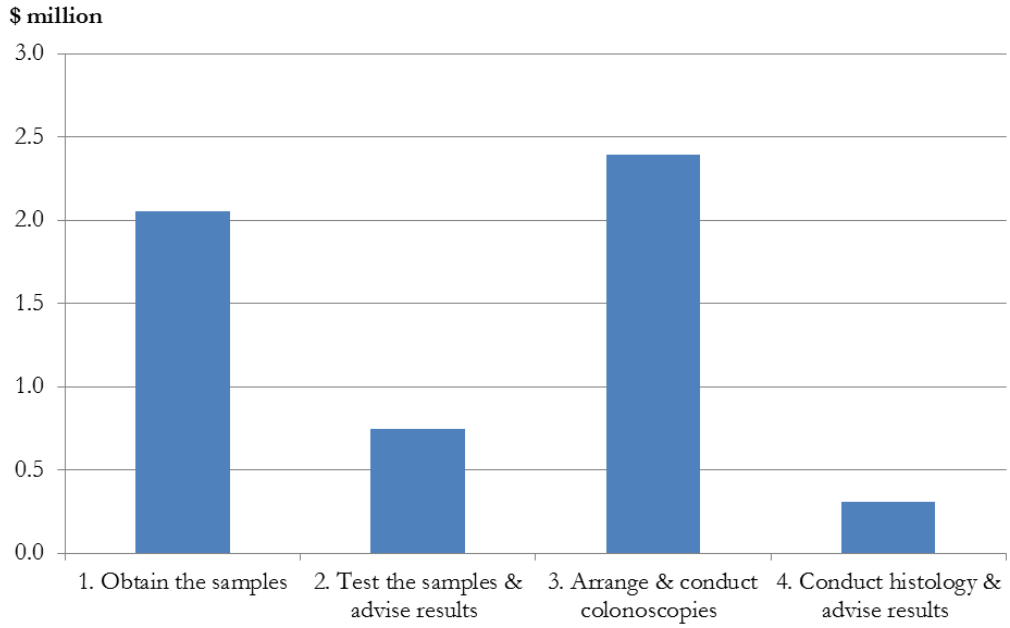
As shown in Figure 9 below, the screening pathway can be viewed as having four discrete phases. Looking at the pilot operating costs through this lens can help to determine where the bulk of the costs are incurred and where the costs-per-outcome are highest.

Figure 9: Four high-level stages of the screening pathway and associated overheads



The high-level results of this stage-by-stage cost analysis (estimates of annual cost based on the 2012 and 2013 samples of cost data) are shown in Figure 10. It illustrates that stages 1 and 3 of the pathway consume the largest relative proportion of resources by far (37% and 43%, respectively). This may not be surprising when it is considered that the initial laboratory testing is largely automated and that the histology component deals with relatively small volumes (i.e. the positivity rate is from initial testing is generally 7-8% and around 75% of those who receive a colonoscopy as a result then have samples being sent for histology).

Figure 10: Stages of the screening pathway – relative costs



4.3.2 Average cost per 'process outcome' for each stage

The cost of the four stages of the pathway can also be examined on a cost-per-outcome basis. These unit costs have been developed by dividing the annual operating cost for each stage by a key process outcome measure, as shown in Table 10:

- The cost incurred for each person who returns a sample to the laboratory is relatively low ($64 per person) due to high volumes at this stage of the pathway (based on a figure of 32,129 people between July 2012 and June 2013). Stage one can also be subdivided into two categories – promotion, outreach and targeted support to potential participants (44% of stage one costs) and mail-outs and sample collection activities (56%). Using this split, $28 per person of the stage one unit cost relates to promotion, outreach and targeted support efforts and $36 per person to mail-outs and sample collection activities.
- Similarly, the laboratory testing of the samples and the advising of the results has a relatively low unit cost ($18) due to a combination of high volumes (based on a figure of 40,884 kit tests being conducted between July 2012 and June 2013) and the role that automation plays in the testing process.
- In contrast, the cost of a colonoscopy per person is relatively more costly ($1,107 per person on average). This high unit cost not unexpected given that the procedure is carried out in a clinical environment and involves skilled labour.
- Histology being conducted as a result of a colonoscopy has the second highest unit costs ($190 per person), likely due to the cost of the trained and skilled labour inputs involved even though the volumes are smaller at this stage of the screening pathway (based on a figure of 1,618 tests being conducted between July 2012 and June 2013).

Table 10: Unit cost for process outcomes at each stage of the screening pathway

	1. Obtain the samples	2. Test the samples	3. Conduct colonoscopies	4. Histology
Total cost (A)	$2,054,000	$748,000	$2,397,000	$307,000
Process outcome measure	Person returning a sample	Samples tested at laboratory	Person receiving a colonoscopy	Histology conducted
Volume of units of outcome (B)	32,129	40,884	2,165	1,618
Cost per unit of outcome (A/B)	$63.92	$18.30	$1,107.03	$189.75

We combined the operating costs for stages one and two and divide by the number of people returning a kit for testing to derive a **cost per participant screened** of $87.21.

We also derive a **cost per participant receiving investigation** of $1,268.76 by combining the operating costs for stages 3 & 4 and dividing by the number of colonoscopies conducted (acknowledging that most of these participants go on to have histology).

The unit costs used for the variable cost components are shown in Table 11 below.

Table 11: Unit cost of variable cost components, by stage of pathway

Process step	Components	Unit cost
Stage 1: Obtain samples		
Pre-invitation letter sent	Letterhead, Letter printing, Brochure "All About Bowel Screening", DLE envelope, Postage	$1.20
FOBT kit sent (includes re-sends)	Sample bottles, Sample collection sheet, Plastic zip lock bags, Collation and packaging of test kits, Letterhead, Overprinting of letterhead, Letter printing, C5 envelope, C5 envelope postage, Pamphlet "Quick Reference Guide"	$5.62
Standard follow-up at four weeks (reminder letter)	Letterhead, Letter printing, DLE envelope, Postage	$1.13
FOBT kit returned to NZ Post mail centre	Sample return envelope (production), Sample return postage	$2.33
FOBT kit couriered to LabPlus	Courier trips of FOBT kits from Mail Centre to LabPlus; return of consent forms to Coordination Centre	$41.68
Stage 2: Test the samples		
FOBT kit read at laboratory	LabPlus processing cost, Lab orders of reagents	$7.07
Negative result	Letterhead, Letter printing, Pamphlet "All Clear", DLE envelope, Postage	$1.20
GP informs patient of positive result	GP payment for managing positive iFOBT	$60.00
Stage 3: Conduct colonoscopies		
Colonoscopy preparation (following telephone assessment)	Letter printing, Pamphlet "Further Investigation", Bowel preparation instruction sheet, Colonoscopy Information Sheet, Glycoprep, Bisercodyl, Bisercodyl bottling/labelling, Courier pack	$19.66
Colonoscopy - under local anaesthetic	In-house salaried colonoscopists	$123.08
	In-house - private contractor	$350.00
	"Temporary increase" capacity	$1,000.00
	Clinical supplies for in-house procedure	$117.85
Colonoscopy - under general anaesthetic	In-house service	$1,001.50
Colonoscopy - ProVation reports	Report (paper), Report (printing - colour), DLE Envelope, Postage	$0.68
Alternative investigation	Participant receives CT colonoscopy	$427.75
Stage 4: Histology		
Histology	Analysis per participant, Laboratory handling fee, Specimen courier, Histology results letter (paper), Histology results letter (printing), Envelope, Postage	$151.38

4.3.3 Average cost for key screening outcomes

The cost per cancer and per lesion detected is a useful measure of the cost of the pilot in terms of key screening outcomes, given that at this stage in the evaluation full cost effectiveness analysis is not yet feasible.

Screening for colorectal cancer includes removing premalignant lesions (adenomas) during the colonoscopy. These adenomas thus never present as cancers, meaning that the incidence of colorectal cancer declines with screening. For this reason, it is important to present the cost of screening per lesion (adenoma and cancer) detected as well as per cancer.

Cost per cancer detected

Table 12 below presents the numbers cancers detected during the first two years of the pilot (129) alongside the operating cost over the same period ($10,593,900). This gives an operating cost per cancer detected of $82,100.

Table 12: Estimated operating cost per cancer detected during first two years

Indicator	Total
Number of cancers detected	129
Operating costs	$10,593,900
Operating cost per cancer detected	$82,100

1. Figures rounded to nearest $100.

Cost per lesion detected

Table 13, below, presents the number of lesions (cancers or adenomas) detected during the first two years of the pilot (1,896) alongside the operating cost (as before). The cost per lesion detected is $5,600.

Table 13: Estimated operating cost per lesion detected

Indicator	Total
Number of lesions detected	1,896
Operating costs	$10,593,900
Operating cost per lesion detected	$5,600

2. Figures rounded to nearest $100.

4.3.4 Costs of specific types of activity

Further analysis was completed to drill down into the cost of specific types of activity that takes place within the four phases of the screening pathway, to enable us to build our understanding of key cost drivers.

Improving participation of under-screened populations

The pilot undertakes a number of activities aimed at improving the participation of population groups that may be more likely to encounter barriers to access due to language or cultural reasons. Four sizeable populations receive additional focus aimed at improving their rates of participation – Māori and Pacific peoples, as the well as the relatively large Chinese and Korean-speaking populations that reside within Waitematā DHB.

The pilot has employed coordinators with relevant language and cultural expertise to undertake community outreach activities, such as presentations about the pilot to a range of ethnic specific community groups and churches (for example, there were than 100 such presentations in 2012/13 year). The coordinators also assist in the development of information resources (i.e. posters, translations of resources) and by recording radio advertisements and appearing on community radio and television shows. The team also takes responsibility for follow-up calls to people within these populations who have not responded to the pre-invitation letter and to people who have returned a test kit which cannot be tested (e.g. due to errors in the accompanying documentation) in order to explain the error and to send out a second kit.

Some of the direct costs involved in the provision of these services are straightforward to measure. The pilot employs a Māori coordinator, a Samoan coordinator, a Chinese coordinator and a Korean coordinator with bilingual language abilities and cultural knowledge. The coordinators are contracted to work between 0.4 and 0.6 of a full-time equivalent. In addition, there are two contracts with community providers that work with Pacific peoples.

The direct cost of all of these services is estimated at an average of **$187,000 per year** in Year 1 and Year 2. As a proportion of the direct annual operating cost of the pilot for those years, these costs equate to an average of 3.5%.

As well as the potential limitation of this analysis (in that all costs may not be captured) it is not straightforward to calculate the unit cost of these outreach activities in the absence of detailed activity and outcome data. Within the course of day, a coordinator may need to search out contact numbers and make a variety of approaches to a particular individual; ultimately, the outcome may result in agreement to provide a sample, a decline or no response. For the period of time under consideration for this analysis, the pilot did not hold information on outcomes to this level, though subsequently systems have been established to collect this.

Cost of colonoscopy

As noted earlier, the pilot has purchased colonoscopies in different ways, although all pilot volumes are delivered at Waitakere Hospital. Table 14 below presents a breakdown of the estimated unit prices for each type of lead colonoscopist arrangement, along with the volumes delivered in Year 1 (2012) and Year 2 (2013) and the associated cost in those years.

The overall cost of colonoscopies – including the nursing team, clinical supplies, equipment, and facility costs – is estimated at $1,042 million in Year 1 and $1,550 million in Year 2. This increase is driven by the higher volumes being delivered in Year 2 and by the more expensive cost of volumes provided through the temporary arrangement described above.

Table 14: Colonoscopy volumes and colonoscopist costs in year 1 and 2

	WDHB salaried colonoscopist	WDHB contracted colonoscopist	Temporary increased capacity
Unit price for lead colonoscopist (estimate)	$123	$350	$1,000
Volumes - Year 1	622	722	86
Volumes - Year 2	882	1,050	343
Colonoscopist expenditure - Year 1	$105,600	$252,700	$86,000
Colonoscopist expenditure - Year 2	$132,400	$367,500	$343,000

Note: these costs do not include a range of other costs associated with colonoscopy delivery, including patient preparation, nursing team, clinical supplies and the equipment and clinical space at the endoscopy unity at Waitakere Hospital.

Mix of colonoscopy providers

Colonoscopies are a relatively expensive stage in the screening pathway and the cost per output has been dependent on the provider used. We therefore examine the pilot's colonoscopy volumes to test the extent to which they determine the differences in the direct annual operating cost incurred in Year 1 (2012) and Year 2 (2013). We hold the volume of colonoscopies conducted in Year 1 constant, while scaling the mix of providers to that used in Year 2. This means that the share of colonoscopy volumes decreases for salaried DHB staff (44% to 39%) and private contractors (50% to 46%) while 'temporary increased capacity' increases (6% to 15%).

Under this scenario, the direct annual operating cost of the Pilot in Year 1 (2012) would be $4.552 million – $119,000 or 2.7% higher the base case of $4.433. This accounts for approximately 16% of the difference in the direct annual operating cost between Year 1 (2012) and Year 2 (2013). This suggests that the difference in volumes – e.g. the number kits returned for testing was 28% higher in Year 2 – is the more important factor in explaining the difference between the annual operating cost in Year 1 and Year 2 than the mix of colonoscopy providers.

4.3.5 Cost of involving Primary Health Teams

General practitioners are contracted to inform and advise their patients who have submitted a kit that is found to have a positive result. The payment for advising of a positive kit is made on a fee-for service basis and was set at $60 for each referral.

The total amount for this service is estimated at **$119,000** in Year 1 (based on 1,952 positive results) and **$169,000** in Year 2 (2,818 positive results). These estimates may be slightly above the actual costs incurred, given anecdotal evidence that a small number of general practices were, initially, not claiming this fee. Furthermore, some patients did not have a general practitioner. These caveats are not considered to be substantial enough to warrant an adjustment to these estimated figures.

4.3.6 Cost of spoiled kits

Spoiled kits accounted for 14% of all kits returned by participants to the laboratory for testing on average in Year 1 and Year 2. The average cost per year of testing spoiled kits is estimated at $78,000 in direct costs which equates to 1.6%, on average, of the direct annual operating cost of the pilot.

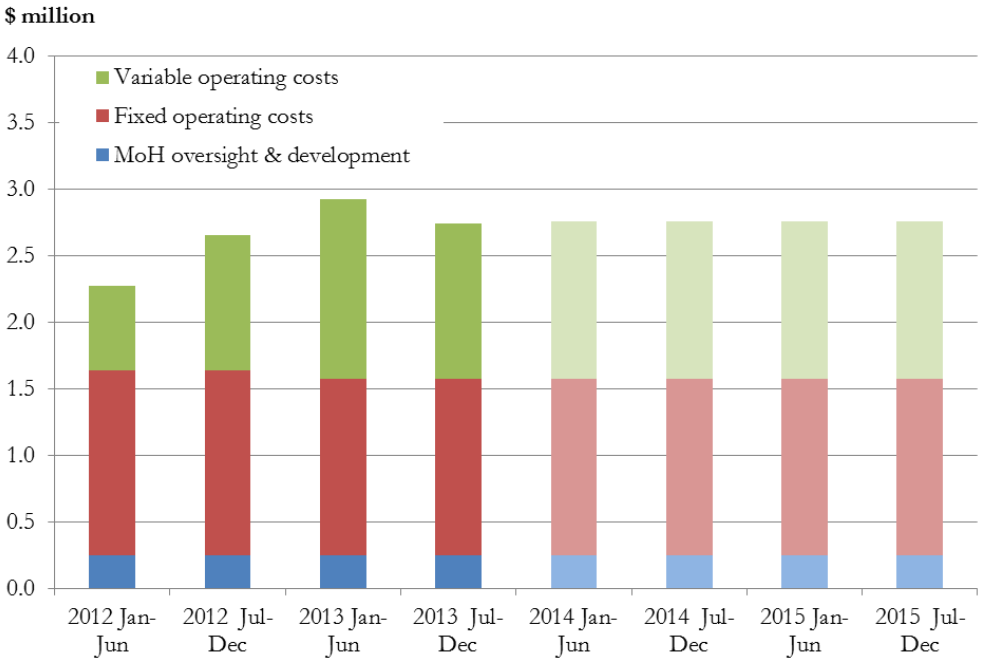
This estimate includes the cost of the spoiled kit itself, the initial postage and packaging, the postage for the sample being returned, and the testing of the sample at the laboratory. It does not include the pre-invitation letter and the follow-up letter at four weeks, as these items form part of the initial contact that would be incurred only once. Also excluded are cost items that are relatively fixed and insensitive to the volume of spoiled kits, such as the follow up with priority populations, daily courier trips of the kits from the mail centre to the laboratory, and Waitematā DHB corporate overheads.

4.4 Forecast total cost of the pilot (Years 1-4)

4.4.1 Operating costs

The forecast operating cost estimates for Year 3 (2014) and Year 4 (2015) of the pilot are shown below in Figure 11. The forecast operating cost is $2.753 million for each of the six-month periods, which combined give a forecast operating cost of **$5.505 million** per year for year 3 and year 4 of the Pilot (excluding development costs but including Ministry of Health oversight). These forecasts are slightly lower than the estimated operating cost for Year 2 ($5.666 million), which was relatively high due to the temporary increased capacity for colonoscopy procedures.

Figure 11: Pilot operating cost – forecasting years 3 and 4



4.4.2 Summary of total cost for delivery of the pilot

As shown in Table 15, the total cost for delivery of the pilot over the four years (including full absorption of all pilot development costs) is forecast to be **$24.753 million.**

Table 15: Summary Pilot cost – estimates and forecast

		Year 1 (2012)	Year 2 (2013)	Year 3 (2014)	Year 4 (2015)	Total
Development cost	$3.148m					$3.148m
Operating cost (including MoH oversight costs)		$4.927m	$5.666m	$5.505m	$5.505m	$21.604m
					Total cost	**$24.753 million**

5. Estimating the 'steady state' cost of a national programme

5.1 Estimated annual 'steady state' operating cost for base case

5.1.1 National view

The main result metric is the **annual operating cost** of a national screening programme in steady state – this excludes development costs and Ministry of Health oversight. The annual operating cost of a national programme is estimated at **$39.073 million** – or 7.8 times higher than our estimate of the annual operating cost of **$5.010 million** for the pilot in Year 4.

To a large extent, this result reflects a scaling up for the national population aged 50-74 years, which is approximately 8 times larger than the equivalent population at Waitemata DHB. Whereas the fixed costs for national programme are assumed to be 8.0 times those of the pilot, differences in the age profile and ethnic groups within the national population contribute to the variable costs being slightly less than 8 times those incurred in the pilot.

5.1.2 Regional view

The national programme is also considered on a regional basis and the results are shown alongside the national view in Table 16. The results for each region largely reflect their population share but slight differences in participation rates matter too. As noted earlier, the regional approach also factors in differences in participation rates for each five-year age group and four ethnic groups of Māori, Pacific, Asian and Other, which are applied to the mix of age and ethnic groups among the four regional populations.

As a result, the Northern Region, which has higher proportions of groups that tend to have lower participation rates (i.e. Māori, Pacific and younger age groups), has a slightly lower participation rate (54%) than the Southern Region (58%), which has an older age profile. The rates for the Midland and Central Regions match that derived for the national model (56%).

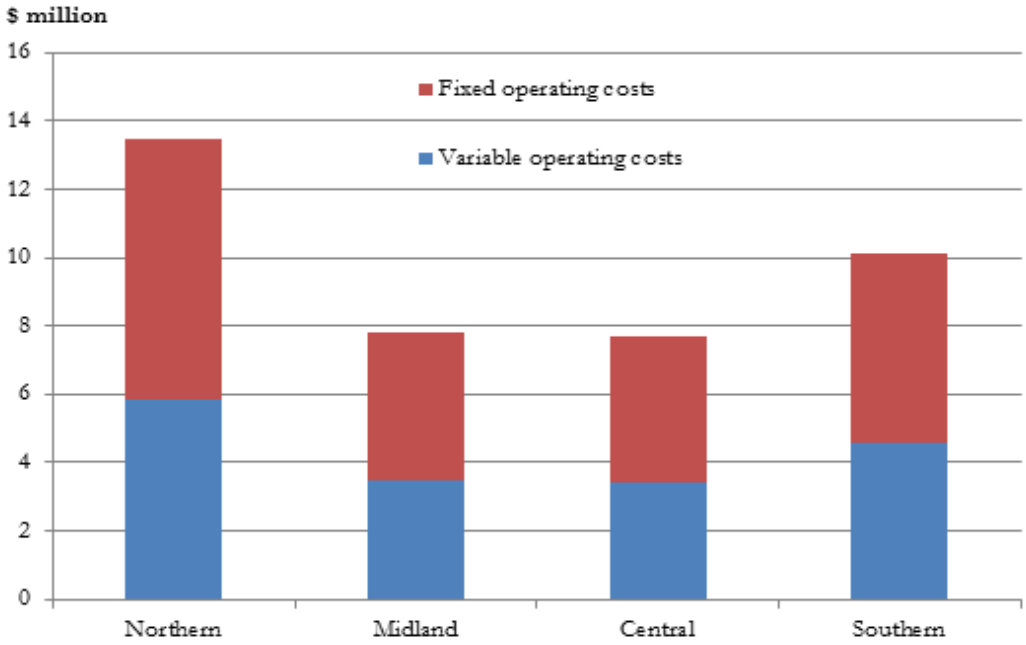
Table 16: National model - estimated annual operating cost in steady state, by region

	Northern	Midland	Central	Southern	Total
Regional costs ($ million)					
Variable operating cost	$5.862	$3.483	$3.435	$4.568	$17.348
Fixed operating cost	$7.592	$4.311	$4.250	$5.572	$21.724
Annual operating cost	**$13.454**	**$7.794**	**$7.686**	**$10.139**	**$39.073**
Regional shares (%)					
Share of national population (50-74 years)	34.9%	19.8%	19.6%	25.6%	100.0%
Share of total operating costs	34.4%	19.9%	19.7%	25.9%	100.0%

Figure 12 shows that the Northern Region is modelled as having the highest share of total annual operating costs, at $13.454 million or 34.4% of national model costs. This is consistent with the region having the largest share of the national population aged 50-74 years (34.9%).

Whereas the variable costs are determined by the size of each region's population, adjusted for age and ethnic group differences in participation rates, the fixed costs are those derived for the national model and allocated on a population share basis.

Figure 12: Annual operating costs under the national model by region



5.2 High and low estimates from sensitivity analysis

The results of sensitivity testing undertaken suggest a plausible range for the annual operating cost of a national screening programme in steady state as being between **$26.531 million** and **$50.623 million** (with the base case estimate at **$39.073 million**).

These low and high estimates are scenarios that have been constructed by combining the results of separate sensitivity tests of key elements among the fixed and variable costs, namely:

- varying the scale-up factor for the fixed costs of the coordination centre to explore the potential impact of economies of scale;
- varying the participation rate, which has a flow-on impact to the rest of the screening pathway and associated variable costs; and
- varying the positivity rate, which also has a flow-on impact to later stages of the screening pathway, namely the variable costs of colonoscopies and histology.

The individual results of these sensitivity tests are reported below.

5.2.1 Fixed costs and potential economies of scale

Varying the scale-up factors use for the fixed cost components provides a plausible range for the annual operating cost of a national screening programme of between **$29.736 million** and **$44.504 million**.

The results in Table 17, below, show how we have varied these scaling assumptions for these fixed cost elements to produce these 'low' and 'high' scenarios.

Departing from the base case scaling assumption of 8.0 – which is based on the eligible national population being approximately eight times larger than the Waitemata population – we test the assumption of community awareness activities and the coordination centre functions being four times as large as the pilot. This scalar of 4.0 allows for an increase in outreach activities on a national scale while also implying that there will be some economies of scale in that the larger volumes will not increase workload by an equivalent amount (e.g. programme management, clinical oversight, quality management, data management and analysis). This assumption reduces the annual fixed costs in the base case by $9.337 million.

The high scenario tests a scaling factor of 10.0 as an upper bound. The rationale for this is that the larger national programme may involve an extra level of complexity that outweighs any economies of scale from higher volumes, for example additional layers programme management and coordination, quality control for national standards and auditing etc. This assumption increases the annual fixed costs in the base case by $5.431 million.

Table 17: National model - estimated annual operating cost in steady state

	Low scenario	Base case	High scenario
Scaling assumptions			
Community awareness and outreach	4.0	8.0	10.0
Coordination Centre functions	4.0	8.0	10.0
Results			
Annual variable costs	$17.348	$17.348	$17.348
Annual fixed costs	$12.387	$21.724	$27.156
Annual operating cost	**$29.736**	**$39.073**	**$44.504**

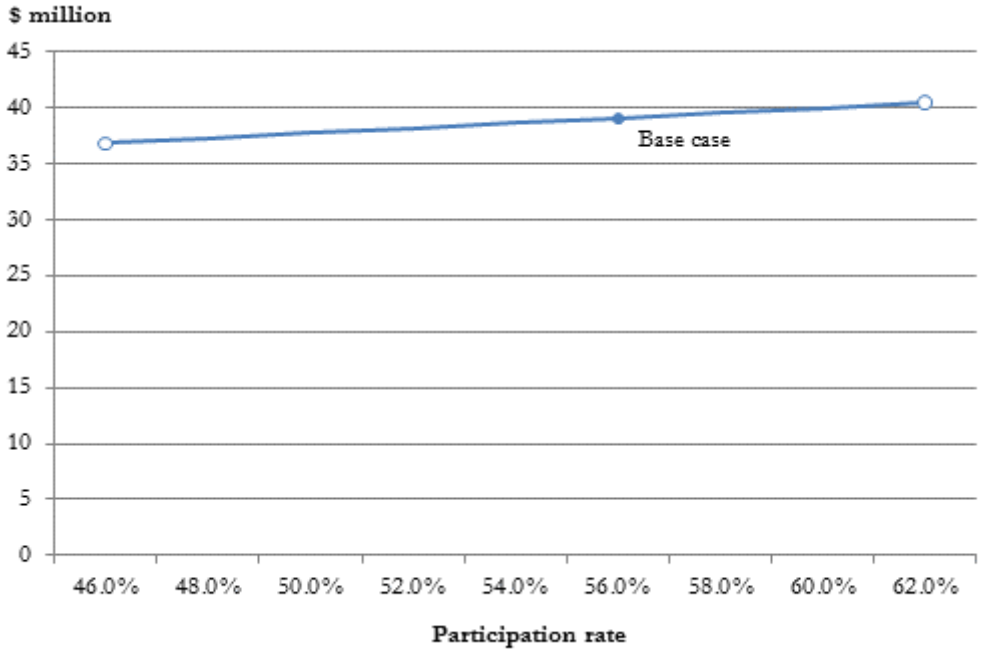
5.2.2 Varying the participation rate

The operating costs are sensitive to the participation rate – i.e. the proportion of clients who were sent a kit and then return it to the laboratory for testing. In our base case, the participation rate of 56% was determined by applying age/ethnic group-specific rates from the pilot to the national population.

Figure 13 shows how different assumptions about the participation rate impact on the estimated annual operating cost of a national screening programme in steady state. If the participation rate is assumed to be 46% – approximately 10 percentage points lower than the base case assumption of 56% – then the annual operating cost would be **$36.820 million**, or $2.252 million lower (-5.8%) than the base case of $39.073 million. Under the "high" scenario,

where the participation rate is 62%, the annual operating cost would be $1.352 (+3.5%) million higher than the base case, at **$40.425 million**.

Figure 13: Sensitivity of the annual operating cost (steady state) to changes in the participation rate

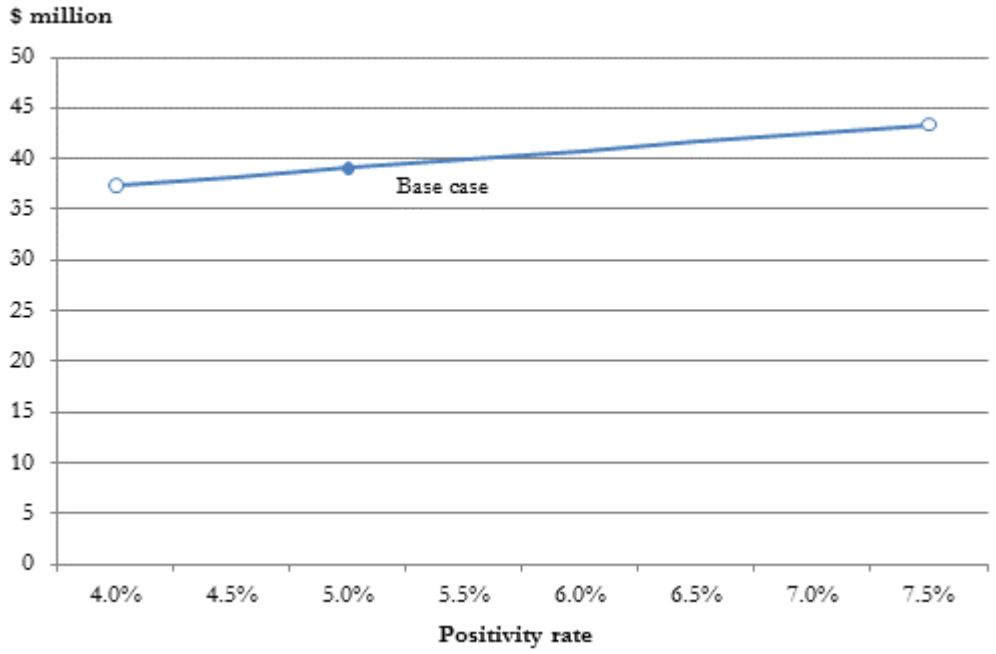


5.2.3 Varying the positivity rate of iFOBT

The annual operating costs are fairly sensitive to small changes in the positivity rate (i.e. the proportion of positive results among clients who return a kit), as shown by adjustments of our base case assumption of 5.0%. It should be noted that this base case assumption is somewhat lower than the average of the positivity rates for the first two years of the pilot, as reported in the Biannual Reports (i.e. approximately 7.5% across 2012 and 2013), as it was determined to be a more appropriate 'steady state' figure, following consultation with the Ministry of Health.

Figure 14 shows that the impact of varying the positivity rate assumption at intervals of half a percentage point. If the positivity rate is assumed to be 4.0%, rather than the base case assumption of 5.0%, then the annual operating cost falls by $1.723 million (or -4.4%) to **$37.350 million**. Conversely, if the positivity rate is assumed to be higher, at 7.5%, the annual operating cost is $4.307 million higher (or +11.0) at **$43.380 million**.

Figure 14: Sensitivity of the annual operating cost in steady state to changes in the positivity rate



5.2.4 Combined impact of sensitivity testing

The next step is to combine the sensitivity tests conducted on the fixed cost and variable cost components. **Error! Reference source not found.** combines the low and high assumptions from the three tests into low and high scenarios. The combined impact of varying the both the scaling factors for the fixed costs, and values for participation and positivity rates is to provide a range of **$26.531 million** to **$50.623 million**.

5.3 Exploring the impact of variation in colonoscopy provision

The model of the national bowel screening programme was tested for sensitivity to changes in the mix of colonoscopy provision. The mix of lead colonoscopists used in the base case reflects the average mix observed across the first two years of the pilot, namely, in-house DHB staff providing 40%, contractors providing 50%, and a level of 'temporary increased capacity' accounting for 10% of colonoscopy volumes delivered.

Arguably, a national programme in steady state might have more capacity in-house and rely less on contracted and temporary increased capacity. Such a scenario might offer greater certainty around capacity and at a lower cost. To that end, we model a "low" scenario where two-thirds (67%) of the volumes are delivered in-house by salaried DHB staff and one-third (33%) is delivered by private contractors working in-house. Under this scenario, the annual operating cost of the national programme would be $37.345 million – $1.728 million or 4.4% lower than the base case of $39.073 million.

We also model a "high" scenario where approximately one-third (34%) of the volumes are delivered in-house by salaried DHB staff, one-third (33%) by private contractors working in-house, and one-third (33%) via temporary increased capacity. Under this scenario, the annual operating cost of the national programme would be $41.392 million – $2.319 million or 5.9% higher than the base case.

6. Discussion

6.1 Reflections on our approach

6.1.1 Constraints of scope

Limitations of this costing analysis

As we have indicated throughout this report, this costing analysis is not an incremental economic analysis but rather takes a 'snap-shot' perspective of costs incurred to design and run the pilot, accompanied by estimates of the cost of treating cancers detected as a result of the bowel screening programme. We have emphasised that results must not be taken out of this context.

The results of this analysis will be updated following the conclusion of the second screening round at the end of 2015 and the results (such as unit costs for key screening inputs) will be applied to modelling undertaken to support our full economic analysis.

What will the final CEA address?

Our full CEA will focus on the incremental change that has occurred over and above 'what would have happened anyway' in the absence of the pilot.

This analysis will be supported by the application of a micro-simulation model, the MoDCONZ model (Modelling Disease and Cancer Outcomes in NZ) developed by a team of researchers from the University of Otago). In summary, MoDCONZ has at its core a natural history of colorectal cancer, which captures the adenoma-carcinoma sequence, with assumptions (developed from extensive review of the clinical literature) based on the probabilities of initiation, progression and response to treatment of colorectal cancers. Essentially, the model simulates the progression of individuals through the clinical sequence. Adenoma risk and growth are modelled as a random process with systematic variation across age, gender, race and other risk factors measured at the individual level.

In order to understand the expected pattern of health outcomes in the absence of screening, we will run the model with the hypothetical sample of people matched to the age-sex-ethnicity structure of the Waitematā population. The model will forecast the cancer incidence (counts and rates) by cancer stage and cancer site and cancer related mortality (that would eventuate in the absence of the screening programme). We will then apply a screening module that enables us to assess the incremental impact on health outcomes. Essentially, any individuals who are screened and receive a positive diagnosis of cancer have their survival pattern altered, adjusted relative to demographic parameters.

In addition, we will undertake further costing analysis to inform understanding of the following items:

- key start-up costs to roll out the bowel screening programme on a national basis, and drivers of variation in start-up costs across particular regions and/or districts;
- primary drivers of potential variation in operational costs between regions and/or districts;
- scenario analysis to support the assessment of key policy decisions on the impact of:
  - operational costs relating to service configuration approaches (e.g. the number of coordination centres); and

- cost effectiveness of potential changes to key parameters of the screening programme (e.g. the age range of the target population).

6.1.2 Data quality

As described within our methodology, this study has used a range of data from different sources, the quality of which has been reasonable, with some variability.

Data from the pilot

Detailed costing data was made available by the pilot and our analysts received significant guidance from pilot staff to ensure we developed a strong understanding of the nature of contracting mechanisms and the unit cost of key inputs. As the pilot progresses, further samples of costing data will enable us to enrich our understanding of the likely future track of costs and will inform our estimates of the 'steady-state' operational cost of bowel screening.

However, the epidemiology analysis team has significant issues in relation to the quality and reliability of data from the BSP register. This presents a significant risk for the costing analysis also, given that activity volumes recorded at different stages along the pathway are a key driver of the costing analysis. Any data inconsistencies and errors in volumes reported may have a significant impact on the reliability of costing forecasts.

Other data sourced from national data-sets

By international standards, the data-set used by BODE[3] as a basis for the estimates of the costs of treating bowel cancer in New Zealand is incredibly rich. However, we acknowledge that the analysis is constrained to some extent by the data.

In particular, for the purposes of developing this analysis, a key constraint was the lack of ability to breakdown the full data-set by stage of diagnosis of cancer, due to incomplete staging information in the cancer registry. Further, completeness and quality of NHI information is an acknowledged concern - not all patient records have an NHI, some patients have multiple NHIs that are not correctly matched and some records will have the incorrect NHI.

6.1.3 Other limitations

The excess difference approach

The approach we used to estimate treatment costs of bowel cancer – the excess difference approach based on analysis of national datasets – offers some key benefits, in that it captures most of the resource utilisation that has been used in the past and that it also accommodates the wide variation of health care use between patients.

However, we acknowledge that there are some constraints. The excess difference approach does not attempt to identify those costs wholly attributable to cancer. It works on the assumption that any additional costs for patients diagnosed with cancer over and above what an 'average' patient may expect to incur are attributable to the treatment of bowel cancer. This may result in an overestimation of costs for some services, though it is not expected this bias would have a major impact on the final results.

Use of national prices

We acknowledge that the use of case weights/national prices rather than detailed bottom-up analysis of marginal treatment costs incurred by Waitematā DHB does not account for local variation in costs incurred.

However, the application of national prices is a fairly standard and accepted way of costing services for analyses in NZ (and indeed in other international assessments of screening programmes) and given that our intent is to develop a simple estimate of treatment costs (that does not attempt at this stage to account for the 'incremental' difference achieved by the screening programme) we believe this was an appropriate choice of approach.

For the full CEA, we will undertake an additional bottom-up validation exercise to test the validity of the use of national prices in the final study and to develop a better understanding of the possible range of the costs. This alternative approach will involve identifying the additional health services that patients with a diagnosis of bowel cancer are likely to receive (for example, including: specialist clinics; general practice visits; diagnostic investigations, surgeries; and chemotherapy pharmaceuticals and cost of infusions), completing an estimate of cost inputs and reviewing results with a small number of NZ clinicians.

Sensitivity analysis

The principal source of uncertainty in the costing of the Pilot lies in the volumes – the proportions of people progressing through the stages of the screening programme. This is where we have focused the sensitivity analysis for the modelled national results. At this stage we have no information on the variance of prices used in the costings. The final report will have a full stochastic sensitivity analysis arising from the micro simulation, which will produce detailed confidence intervals for all results – the ex-post costing of the Pilot and the national modelling work.

6.2 Reflections on our results

If we step back from the detail of this report, we can reflect that this costing exercise has confirmed several features of the pilot screening pathway. Although somewhat intuitive in nature, these evidence-based conclusions are nevertheless worth documenting here.

The volume of clients involved steadily decreases as the pathway stages progress – from initial contact via letter to the testing of the kits, through to the colonoscopies and histology being undertaken. Accordingly, the costs in the early stages of the pathway tend to be driven by higher volumes at relatively low unit costs, whereas the latter stages, which are more investigative and diagnostic in nature, are characterised by lower volumes and high unit costs.

The arranging and conducting of colonoscopies, which we have defined as 'stage 3' of the screening pathway, is the most expensive phase – on a per-unit basis and in terms of aggregate costs. Our modelling suggests that small movements in either the volume (i.e. the combination of client participation and positivity rates) or the unit cost of colonoscopies has the potential to materially affect the cost of the pilot. This stage probably represents the key risk in terms of annual operating costs of the screening pathway, both for the next two years of the pilot, and for any future national roll-out.

It is also worth noting that the pilot has managed an increase in volumes as it has ramped up activity during Round 1. While these higher volumes have added to variable costs, the fixed costs have remained constant, or in some cases, declined, as internal systems have matured. The fixed costs generally relate to community awareness and sending out kits to clients as well as to general planning and oversight, clinical governance, and analysis and reporting. Many of these fixed cost elements offer scope for economies of scale if screening volumes increase.

Appendix 1 - Cost components in the screening pathway model

Variable cost components

Process step	Components	Unit of measurement	Unit cost
Pre-invitation letter sent	Letterhead	Unit cost of pre-printed letterhead per bulk contract	$0.39
	Letter printing	Unit cost of production (marginal re-print)	$0.01
	Brochure "All About Bowel Screening"	Unit cost of production	$0.15
	DLE envelope	Unit cost	$0.04
	Postage	Unit cost of postage	$0.61
FOBT kit sent (includes re-sends)	Sample bottles	Unit cost	$2.45
	Sample collection sheet	Unit cost	$0.68
	Plastic zip lock bags	Unit cost	$0.27
	Collation and packaging of test kits	Unit cost of packaging as per contract	$0.41
	Letterhead	Unit cost of pre-printed letterhead	$0.39
	Overprinting of letterhead	Unit cost of production (marginal re-print)	$0.34
	Letter printing	Unit cost of production (marginal re-print)	$0.01
	C5 envelope	Unit cost	$0.06
	C5 envelope postage	Unit cost	$0.92
	Pamphlet "Quick Reference Guide"	Unit cost of production	$0.09
Standard follow-up at four weeks (reminder letter)	Letterhead	Unit cost of pre-printed letterhead	$0.39
	Letter printing	Unit cost of production (marginal re-print)	$0.01
	DLE envelope	Unit cost	$0.04
	Postage	Unit cost of postage	$0.69
FOBT kit returned to NZ Post mail centre	Sample return envelope (production)	Unit cost of return packaging	$0.53
	Sample return postage	Unit cost of return postage	$1.80
FOBT kit couriered to LabPlus	Courier trips of FOBT kits from Mail Centre to LabPlus; return of consent forms to Coordination Centre	Unit cost of one round trip each working day	$41.68
FOBT kit read at laboratory	LabPlus processing cost	Total cost of contract per six months / number of tests processed	$5.50
	Lab orders of reagents	Monthly invoices, allocated to six-month periods	$1.57
Negative result	Letterhead	Unit cost of paper	$0.39
	Letter printing	Unit cost of production	$0.01
	Pamphlet "All Clear"	Unit cost of production	$0.07

Process step	Components	Unit of measurement	Unit cost
	DLE envelope	Unit cost	$0.04
	Postage	Unit cost of postage - letter only	$0.69
GP informs patient of positive result	GP payment for managing positive iFOBT	Standard payment per patient	$60.00
Colonoscopy preparation (following telephone assessment)	Letter printing	Unit of printing	$0.01
	Pamphlet "Further Investigation"	Marginal cost of printing only	$0.37
	Bowel preparation instruction sheet	Unit cost of paper	$0.04
	Colonoscopy Information Sheet	Unit cost of paper	$0.13
	Glycoprep	3 x units per patient	$12.72
	Bisercodyl	2x tablets per patient	$0.05
	Bisercodyl bottling/labelling	1x bottle per patient	$2.50
	Courier pack	Unit cost	$3.84
Colonoscopy - under local anaesthetic	"Temporary increased" capacity	Fee for service	$1,000.00
	Clinical supplies for in-house procedures	Average cost of clinical supplies	$117.85
	In-house - private contractor	Fee for service	$350.00
	In-house salaried colonoscopists	Unit cost for pilot volumes	$123.08
Colonoscopy - under general anaesthetic	In-house service	Unit cost for pilot volumes (national price used)	$1,001.50
Colonoscopy - ProVation reports	Report (paper)	Unit cost	$0.02
	Report (printing - colour)	Unit cost	$0.01
	DLE Envelope	Unit cost	$0.04
	Postage	Unit costs	$0.61
Alternative investigation	Participant receives CT colonoscopy	Unit cost (national price)	$427.75
Histology	Analysis per participant	Based on average pots per participant	$100.00
	Laboratory handling fee	Per specimen pot until end Jan 2013	$10.00
	Specimen courier	Per working day - as from February 2013	$40.01
	Histology results letter (paper)	Unit cost (x2 – participant and GP)	$0.02
	Histology results letter (printing)	Unit cost (x2 – participant and GP)	$0.06
	Envelope	Unit cost (x2 – participant and GP)	$0.07
	Postage	Unit cost (x2 – participant and GP)	$1.22

Fixed cost components

Stage of process	Components	Form of fixed cost	Unit of measurement
Community awareness raising	Practice liaison services (a)	Contracted service	Cost of contract
	Practice liaison services (b)	Contracted service	Cost of contract
	Primary Care CD Services	Contracted service	Cost of contract
	Pacific Health Providers (a)	Contracted service	Cost of contract
	Pacific Health Providers (b)	Contracted service	Cost of contract
Materials development	Contract with GSL to design programme material	Contracted service	Total of WDHB contract with GSL
	Other programme material development costs (poster etc.)	Contracted service	Total development costs
Coordination Centre staff costs	Programme Manager	Salary	Total cost of salary
	Clinical Director	Salary	Total cost of salary
	Lead Colonoscopist	Salary	Total cost of salary
	Quality Lead	Salary	Total cost of salary
	Data Manager	Salary	Total cost of salary
	Communications Advisor	Salary	Total cost of salary
	Team leader (Community Awareness)	Salary	Total cost of salary
	Māori Coordinator	Salary	Total cost of salary
	Chinese Coordinator	Salary	Total cost of salary
	Korean Coordinator	Salary	Total cost of salary
	Information line	Salary	Total cost of salary
	Data Administrators	Salary	Total cost of salary
	Office Manager	Salary	Total cost of salary
	Administrator time	Salary	Total cost of salary
	Training and development of staff	Inter-departmental charge rate	Total charge
	Purchase of dedicated office equipment	Cap-ex	Total capital costs
Waitematā DHB overheads (Finance team allocation)	Accommodation costs (dedicated endoscopy room)	Overhead cost	Standard allocation methodology
	PCs and printers	Overhead cost	Standard allocation methodology
	Other stationery (including print cartridges)	Overhead cost	Standard allocation methodology
	DHB overhead allocation - WDHB finance department	Overhead cost	Standard allocation methodology
Endoscopy unit	Lead colonoscopist	Salary	Total cost of salary
	Lead colonoscopist - contracted part-timer resource	Contracted service	Total cost of contract
	Lead colonoscopist – 'increased temporary capacity'	Contracted service	Total cost of contract
	Endoscopy nurses	Salary	Total cost of salary
	IT hardware for each colonoscopy unit	Cap-ex	Total cost of hardware

Stage of process	Components	Form of fixed cost	Unit of measurement
	Purchase of dedicated equipment (e.g. chairs, phones, desks)	Cap-ex	Total cost of equipment
	Theatre and equipment lease/rent	Lease	Total cost of lease
Pilot register	Cost of development/build of the register	Contracted service	Value of contract
	Additional capex to refine the register	Variation	Value of contract
	Cost of running/supporting the register	Contracted service	Value of contract
MoH development costs	Pilot promotional resources - start-up costs	Contracted service	Value of contract
Pilot start-up costs	Total expenditure Feb 2011 - Jan 2012	Contracted service	Value of contract
Screening Unit - other fixed costs	Student labour (letter 'stuffing')	Contracted service	Value of contract
	Health Promotion Costs	Contracted service	Value of contract
	Advertising	Contracted service	Value of contract
	Interpreting	Contracted service	Value of contract
	Corporate training	Contracted service	Value of contract
	Office expenses/sundries	Miscellaneous	Actual cost incurred
	Equipment rental	Lease agreement	Lease cost
	Equipment repairs	Contracted service	Value of contract
	Other/minor equipment	Miscellaneous	Actual cost incurred
	Phoenix Research	Contracted service	Value of contract
Ministry of Health costs	Monitoring, governance, policy work related to Pilot (& national development)	Estimate of proportion of salaries	Proportion of salary and overhead costs