



Southern Cancer Network Modelling of Linear Accelerator Requirements for the South Island – 2012 to 2026

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Executive Summary

The purpose of the model is to investigate future linear accelerator requirements to meet projected demand for Radiation Oncology treatment in the South Island

Using 2011 as base year, the model runs to 2026

There is a current configuration of four machines at Christchurch Hospital, one of which is a new and additional machine, two machines at St George's private clinic in Christchurch, and three machines at Dunedin Hospital. One machine at Dunedin is also recently commissioned, as a replacement machine. Dunedin currently caps capacity to 2½ machines by staffing to that level, but will operate three full linacs by the start of 2013. A "full" linac is based on being available to operate 8 hours per day. The base situation is a total of nine current available machines in the South Island.

The model looks at the total number of machines required. It does not take into account replacement of old machines. Nor does it try to take into account the possible impacts of technology in newer machines, which may impact the range of cancers able to be treated on a machine or speed of treatment

There is a national target that no patient requiring radiation treatment should wait longer than four weeks from assessment to commencement of treatment, except where it is clinically necessary they do so.

Prior to the installation of the additional machine in Christchurch and the replacement machine in Dunedin, the South Island was meeting that target, with the exception of some quite small disruption caused by the Christchurch earthquakes (even this disruption was minimised by effective staff and management responses) However, the target was being achieved by redirecting some demand to the North Island

In addition to natural demand growth, there is also the opportunity to further enhance treatment in two areas – the provision across the South Island of more complex treatments, such as Intensity Modulated Radiation Therapy (IMRT), and the achievement of an increased radiation oncology intervention rate across the South Island. This would particularly benefit provincial areas

The model assumes the use of more complex procedures, which are enabled by the technology available on the new linacs and by the time made available. This is reflected in the average treatment times per patient modelled.

Based on current trends, the use of more complex and longer treatments is likely to increase

Key to the capacity requirements is the intervention rate modelled. This is the percentage of patients registered with malignant tumours that receive radiation treatment.

The model has been run examining three possible Intervention Rate scenarios:

1. Southern DHB region reaching a 50% Intervention Rate by 2015, with the rest of the South Island achieving 45% by 2015, and all of the South Island achieving 52% by 2020
2. Achieving a 52% Intervention Rate across the South Island by 2015

3. Achieving a 45% Intervention Rate across the South Island by 2015, and retaining that level

Conclusions

Most Aggressive Scenario

The “**most aggressive**” scenario – 52% IR across the South Island by 2015, would require the commissioning of an additional linac by 2015

The additional linac in 2015 would allow some redistribution of current public / private volume back to public, and allow the target to be achieved with one additional machine for the South Island.

Going forward further, growth would require a further new linac in the South Island by 2025.

This would see approximately 11% available capacity going forward from 2026

Least Aggressive Scenario

The “**least aggressive**” scenario (45% IR for the South Island) would require an additional linac in the South Island around 2023. This would facilitate natural growth over that time, plus an increase from current intervention rates and the growth of IMRT treatment.

The total South Island capacity would see 10% available going forward from 2026

Preferred Scenario

A “**middle scenario**” models a gradual increase in Intervention Rates, achieving 50% in Southern DHB by 2015, 45% for the other DHBs by 2015 and 52% across the South Island by 2020

Achieving a 52% intervention rate by 2020 still requires a total of an additional 2 linacs by 2025

However, the more gradual increase means that the first of those linacs is not required until 2019. A further linac would be required in 2025.

This is based on 46% to 47% of Nelson Marlborough patients being treated at Capital and Coast throughout the period. In the aftermath of the Canterbury earthquakes, 53% were treated there in 2011.

Also under this scenario South Canterbury patients may be redirected between Christchurch and Dunedin at different periods depending on capacity and location of additional linacs.

This is the preferred scenario because it provides a realistic timeframe for some areas to grow from current to future intervention rates, and will therefore reduce the risk of underutilising existing capacity

Current Christchurch supply is made up of four linacs at the public CDHB Cancer Centre and two at the private St Georges Cancer Centre

Future modelled supply assumes that additional linacs will be available to all patients

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There is evidence that private medical insurance cover in New Zealand is dropping. Additionally, techniques such as IMRT are becoming equally accessible in public and private centres and waiting times for assessment and treatment in public facilities continues to fall. It is therefore likely that insurance funded private demand will reduce

If private linac capacity is not fully used, or if patients from DHBs without a Cancer Centre are not redirected towards available public capacity, earlier investment in additional linacs may be required

Proposed Capacity Plan, based on the Preferred Scenario

Number of Linacs Required in the South Island 2012 to 2026

	2013	2015	2017	2019	2121	2023	2025	2026					
Christchurch													
CDHB - Public	4	4	4										
St Georges - Private	2	2	2										
Dunedin													
SDHB	3	3	3										
Total South Island	9	9	9	10	10	10	11	11					

Projected Demand

The formula used for projected demand was: ((Projected Cancer Registrations x Intervention Rates) + Retirements + Peak Demand Factor)

Projected Registrations & Growth Rates

Cancer Registrations have been projected using the 2009 Cancer Registrations as a base.

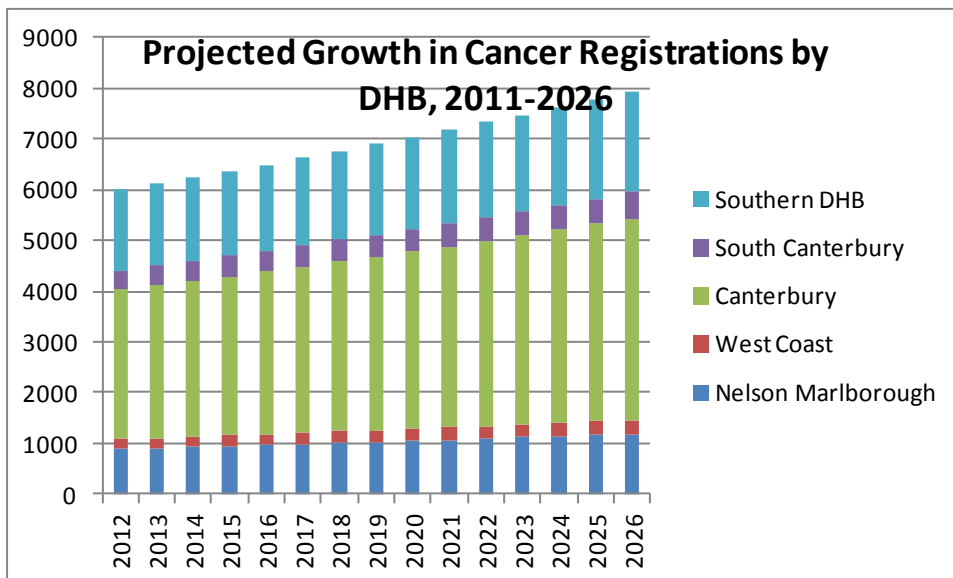
These are sourced from *Cancer Registrations, malignant sites, number, 2009** *Provisional as at 11/07/2011 (NZCR, Ministry of Health)

The 2011 base and projections from 2011 to 2026 have used growth rates from the report, **New Models of Care for Medical Oncology**, Cranleigh Health, October 2011

The Cranleigh Report excluded haematological cancers and childhood cancers and used 2006 Cancer Registrations as a base. Hence there are differences in the projected registrations, despite using identical growth rates. These growth rates are also consistent with those used in previous Ministry of Health Cancer Projections (Cancer Projections Incidence 2004–2008 to 2014-2018, Ministry of Health 2010), and are hence considered credible.

Regional Cancer Centre	Growth from 2011 + 15 Years	Compound Annual Growth Rate
Christchurch	38%	2.17%
Dunedin	28%	1.66%

Figure 2 shows projected growth in cancer registrations by DHB



Retreatment Rate

A retreatment rate of 35% has been applied to all the projected demand volumes

Retreatment is defined as “any patient seen for any second or subsequent course for the same primary pathology”

There is a risk that in using a 35% retreatment rate we have underestimated the current number of new cancers treated from some DHBs and as a result we have underestimated the current intervention rates. Retreatment rates for each cancer centre have been reported to the Radiation Oncology Working Group since September 2011. Monthly retreatment rates for public radiotherapy services in Dunedin and Christchurch have ranged from SDHB and CDHB radiotherapy services have ranged from 29% to 48%, with a mean of 38.6%, so we feel that the risk of overestimating current intervention rates is small.

Meeting Peak Demand

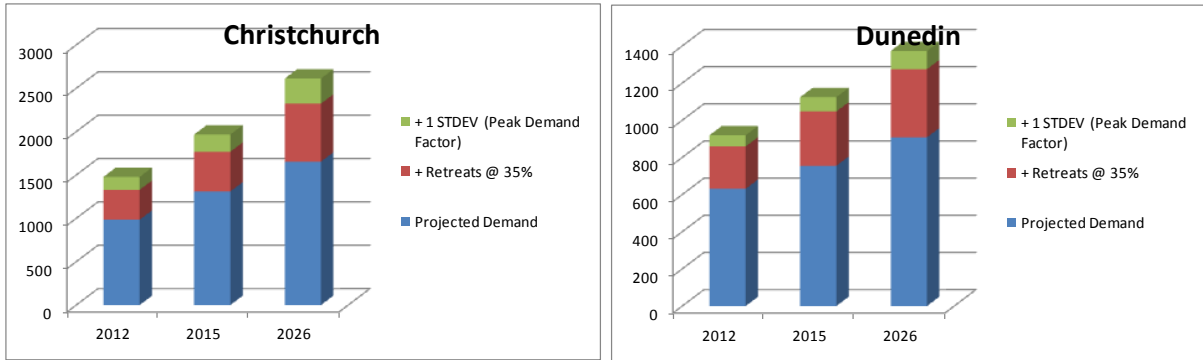
Capacity measurement in the model is based on the capacity required to meet the four week wait target from FSA to commencement of treatment for all patients.

The model projects capacity by:

- Taking the annual volume projection
- Applying the Intervention Rate
- Adding a retreatment rate of 35%
- Distributing that volume by month, according to historical distribution from the 2010 / 2011 ROWG data set
- One standard deviation is added to the monthly average for modelling, to ensure patients seen in peak monthly volume periods will still be treated in four weeks

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Figure 3 shows the three segments making up the total modelled demand: Projected Demand (cancer registrations x intervention rates); Retreats; Peak Demand Factor



Intervention Rates

Appropriate intervention rates are a source of considerable discussion in New Zealand as Centres look to plan to deliver world class treatments.

We have calculated current 2011 South Island intervention rates as:

	2009 Registrations	CAGR	2011 Projection	Total Patient Courses Commencing Linac 2011 (ROWGdata)	Retreatments @ 35%	New Treatments Commencing (Total less Retreatments)	Calculated 2011 Intervention Rate
Nelson Marlborough DHB	861	2.17%	899	299	105	194	22%
Canterbury DHB	2877	2.17%	3003	1350	472	877	29%
West Coast DHB	200	2.17%	209	88	31	57	27%
South Canterbury DHB	374	2.17%	390	181	63	118	30%
Southern DHB - Otago	1014	1.66%	1048	651	228	423	40%
Southern DHB - Southland	545	1.66%	563	258	90	168	30%
Southern DHB	1559	1.66%	1611	909	318	591	37%
Christchurch Cancer Centre	3968	2.17%	4142	1798	629	1169	28%
South Island	5527		5753	2707	947	1759	31%

Note: Takes 60% Nelson Marlborough Patients being treated at Canterbury and the remainder in Wellington
 Nelson Marlborough Calculation is for all NM registrations
 South Island total includes 60% of those registrations

Our approach to calculating intervention rates uses 2009 cancer registrations with a Compound Annual Growth Rate (CAGR) applied to extrapolate to 2011.

This is compared to total patient courses commencing during 2011, from the Radiation Oncology Working Group (ROWG) data set, less a 35% retreatment rate.

Views on Optimal Intervention Rates

International Benchmarks:

Australian evidence-based radiation utilisation model

Radiotherapy in Cancer Care: estimating the Optimal Utilisation from a review of evidence-based clinical guidelines (CCore October 2003)

The Australians have developed an evidence-based benchmark for radiotherapy intervention for different cancer types. This work involved a systematic review of treatment guidelines, construction

of decision trees and review of epidemiological data to calculate the proportion of patients with cancer in whom radiotherapy would be recommended **according to best available evidence**.

The recommended overall optimal radiation treatment intervention rate, based on best available evidence, was estimated to be 52.3%.

All states in Australia use this radiation treatment utilisation rate as a benchmark in planning future radiation oncology services. It has also been used in WHO recommendations (World Health Organisation. 2008. *World Cancer Report*. Boyle,P and Levin, B, eds. Lyon: International Agency for Research on Cancer)

English (NRAG – National Radiotherapy Advisory Group)

Radiotherapy: Developing a world class service for England (Department of Health, May 2007)

In developing the NRAG model, information from previous work in Canada, Australia and Scotland was used to derive appropriate rate of radiation treatment for each cancer site, including consideration of disease stage, performance status and patient choice.

Appropriate Rates of Radiotherapy are deduced from treatment trees that are largely based on the Scottish report but have been adjusted for English practice.

New Zealand Views

Based on the Regional Strategic Plan for the Sustainable Delivery of Radiation Treatment in the Northern Region – 2019, published June 2010, capacity planning in the Northern region has been based on the English model.

The Northern project group recommended a stepped approach to achieving 46% radiation treatment intervention rate which is the rate achieved when English model is applied to New Zealand cancer registrations. This was a target of 40% for 2009 /10, increasing to 46% by 2015

The Midland Region is currently considering appropriate intervention rates to model their future demand.

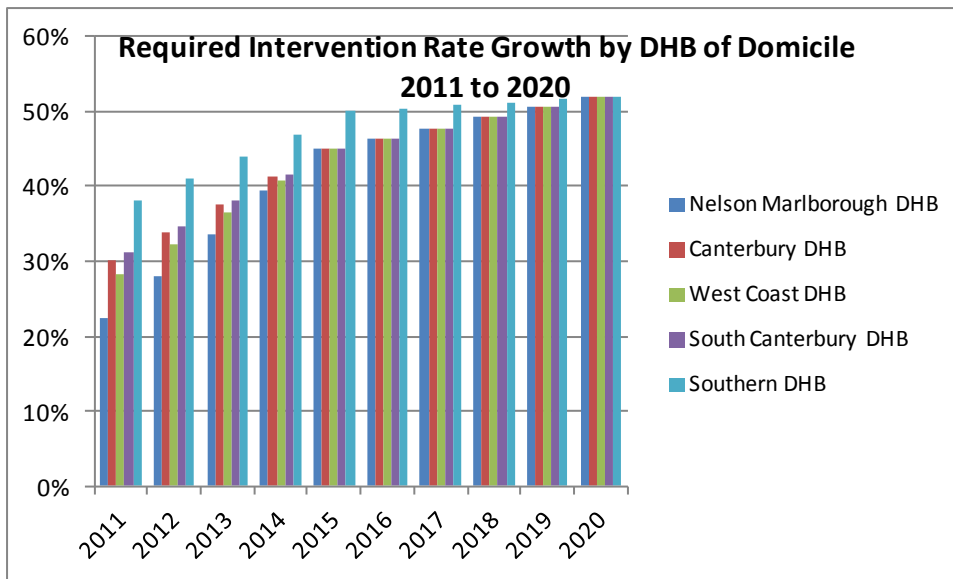
The New Zealand Ministry of Health view suggested to Midland by John Childs, National Clinical Director, Cancer Programme, Sector Capability and Implementation, is that: *“An intervention rate of 45% is accepted as reasonable. However it is for each region to determine the time frame over which it would/could support capacity growth to achieve this intervention rate from the current regional baseline rate” (personal correspondence, January 2012)*

Based on this range of information, we have looked at the three scenarios outlined above.

Two of those are based on ultimately achieving a 52% intervention rate by, at latest, 2020

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Figure 1 Shows the required increase for each South Island DHB to achieve this between 2011 and 2020, based on the base calculation we have used:



Supply

South Island Linear Accelerators

Current:

	Christchurch	St Georges	Dunedin	Total	Total Based on 8 Hour Day
Number of Linacs	4	2	3	9	8.5
Number of Available Daily Hours at 100%	32	16	20	68	68.0
Number of Available Annual Hours at 100%	7968	3984	4980	16932	16,932
Number of Available Annual Hours at 87%	6932	3466	4333	14731	14,731

Annual hours are based on 8 hours operation per linac per day for 249 days per year

Available hours are based on an available eight hours per linac per day at 100% utilisation. It is important to note that other factors than number of linacs influence available hours, in particular established staffing levels. This model assumes that each linac is fully staffed.

The annual hours takes a 249 day available year, at 100%. $((52 \times 5) - 11)$

An 87% utilisation factor is used in the model. This is designed to allow for planned and unplanned downtime, such as service, breakdowns, checks, staff shortages, etc.

Current Christchurch supply is made up of four linacs at the public CDHB Cancer Centre and two at the private St Georges Cancer Centre

Future modelled supply assumes that any additional linacs will be available to all patients

Treatment Times

There is currently a wide discrepancy in average treatment time per patient between New Zealand Cancer Centres. This has been particularly pronounced between Christchurch and Dunedin Centres.

The different treatment times are most likely explained by a combination of complexity of treatments used, patient ages and individual centre practices.

The most significant of these factors from the South Island point of view is the complexity of treatments.

While Dunedin has used more complex IMRT treatment for some major cancer types for some time, this practice is only just being introduced in Christchurch. This has led to Dunedin historically using longer treatment times, occupying more booked linac “treatment slots” (by South Island and National standards), and Christchurch historically using shorter treatment times

New linacs and the ability to utilise Volumetric Modulated Arc Therapy (V Mat) technology means that complex treatments should be utilised in the future using treatment times that are faster than traditionally so for IMRT (such as Dunedin current), but still longer than traditional non IMRT (Christchurch current)

On that basis, we considered three scenarios: “Longest” (current Dunedin); “Shortest” (current Christchurch); “Medium” (Mid Central Cancer Centre was selected)

Treatment Slots Required		Short	Medium	Long
Single - 10 minutes		75%	59%	27%
15 minutes		0%	24%	0%
20 minutes		22%	11%	59%
25 minutes		0%	0%	0%
30 minutes		3%	6%	14%
		100%	100%	100%

The model has used the medium time

Refinement of current radiotherapy technology and corresponding investment may see these treatment times reduce. However, introduction of new techniques may also increase average treatment times

We consider the medium times used to be a “best estimate”. It allows for the fact that Christchurch will increase IMRT treatment. It also allows for the fact that a new linac and V Mat technology will aid Dunedin in reducing average treatment times while maintaining complexity levels

Regional Volume Distribution

The distribution of patients for treatment, DHB of Domicile to Cancer Centre for the 2011 calendar year, based on Ministry of Health Wait Time Reporting, was:

	Canterbury	Otago	Capital & Coast	St Georges
Nelson Marlborough DHB	45%	0%	53%	2%
Canterbury DHB	83%	0%	0%	17%
West Coast DHB	93%	0%	0%	7%
South Canterbury DHB	71%	26%	0%	2%
Southern DHB Dunedin	0%	99%	0%	1%
Southern DHB Southland	0%	100%	0%	0%

The Christchurch earthquakes will have influenced the distribution of patients during 2011 to some extent.

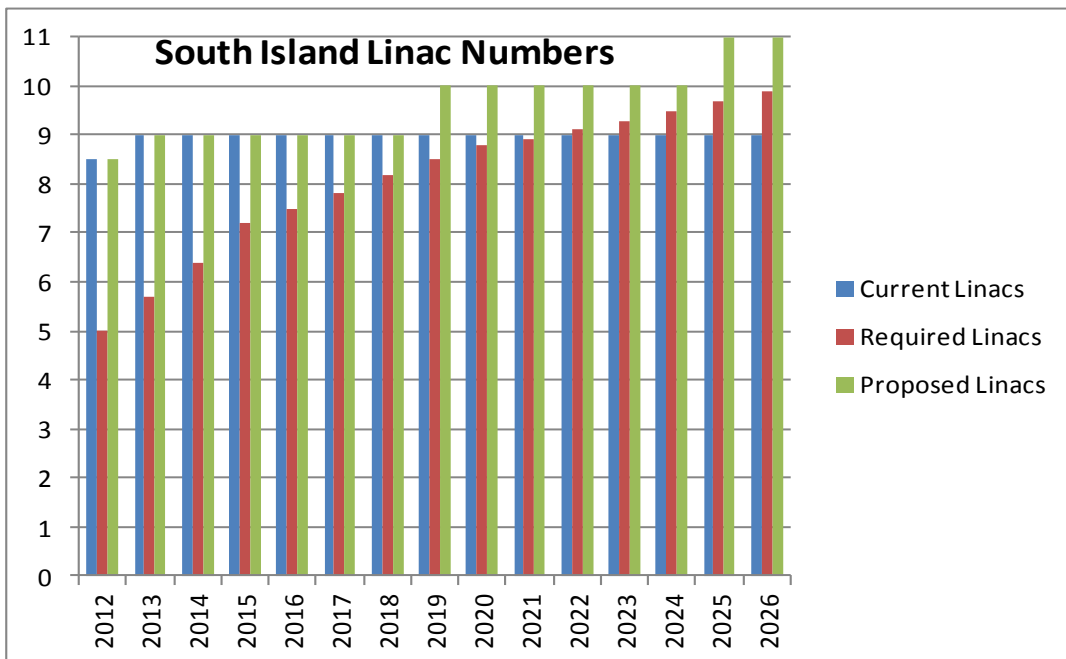
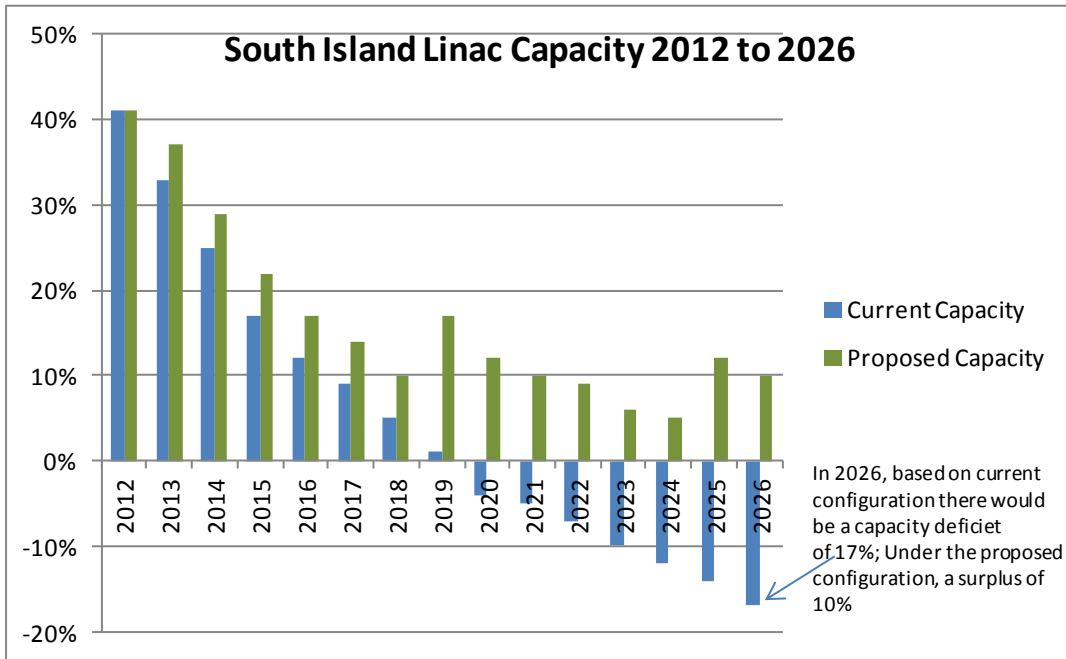
The model allocates 46% of Nelson Marlborough patients to be treated in Wellington. This was 53% in 2011

In 2011 71% of South Canterbury patients are treated by CDHB. The modelling moves up to 75% of those patients to Dunedin in the last two years of the current configuration, leading up to the implementation of a new linac in 2019.

Appendix 1: Output of Model

Summary															
	Intervention Rate	50% by 2015 for Southern													
		45% by 2015 for rest of SI				52% by 2020 for all SI									
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Raw SI Linac Demand	5.0	5.7	6.4	7.2	7.5	7.8	8.2	8.5	8.8	8.9	9.1	9.3	9.5	9.7	9.9
Current	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
CDHB	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
SDHB	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
St Georges	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
% of Available Linac Hours Required - Current															
CDHB	66%	73%	80%	86%	91%	97%	100%	105%	111%	113%	116%	117%	120%	122%	127%
SDHB	65%	73%	80%	85%	90%	90%	93%	95%	98%	98%	100%	103%	103%	105%	105%
St Georges	41%	53%	69%	81%	88%	91%	97%	100%	103%	106%	106%	113%	113%	116%	119%
South Island	59%	67%	75%	83%	88%	91%	95%	99%	104%	105%	107%	110%	112%	114%	117%
% of Available Linac Hours Required - Future															
						Add 1 Ch			Rest St Ggs		Add .5 Dun		Add 1 Ch		
CDHB	66%	73%	80%	86%	89%	91%	94%	89%	89%	90%	91%	94%	95%	85%	88%
SDHB	65%	60%	67%	71%	77%	81%	83%	79%	88%	90%	90%	94%	96%	88%	88%
St Georges	41%	53%	69%	81%	88%	91%	97%	81%	88%	91%	91%	94%	94%	97%	100%
South Island	59%	63%	71%	78%	83%	86%	90%	83%	88%	90%	91%	94%	95%	88%	90%

Appendix 2 – Capacity Graphs



Appendix 3: Acknowledgements

The South Island modelling has been completed by Murray Prior of LSI Consulting Limited for, and in close consultation with:

- **Annie Bermingham**, Network Manager, Southern Cancer Network
- **Shaun Costello**, Radiation Oncologist, Southern Blood and Cancer Service, Clinical Director Medicine and Emergency Service, Clinical Director Southern Cancer Network, Dunedin Hospital
- **Iain Ward**, Clinical Director Radiation Oncology, Canterbury Regional Cancer and Blood Service, Canterbury District Health Board

We have drawn on a number of sources of data and information, including:

- Cancer Registrations, malignant sites, number, 2009* *Provisional as at 11/07/2011 (NZCR, Ministry of Health)
- Report *New Models of Care for Medical Oncology, Cranleigh Health, October 2011*
- Sustainable Delivery of Radiation Therapy in the Northern Region – 2019, published June 2010
- Paper on Radiotherapy Utilisation Rates, Loryn Scanlan, Midland cancer Network, January 2012
- Midland Cancer Network modelling (currently in progress)
- Radiation Oncology Working Group data set, Ministry of Health

We have also drawn on input and observation from Christchurch and Dunedin Cancer Centres