

Prison Population Forecast 2005

Prepared for the Ministry of Justice by:

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First published in March 2006 by the
Ministry of Justice
PO Box 180
Wellington
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ISBN 0-478-29023-3

Acknowledgements

The authors would like to thank Darren Skidmore, Team Leader Data Analysis and Modelling for his assistance in writing and editing the report.

In addition, valuable technical input has been given by Dr. David Turner and Darren Skidmore, who also managed the consultation process across the Justice Sector. Thanks also to Andrew Mercer, Justice Data Warehouse Business Analyst, who is the author of Appendix 1 and who provided insight to data located in the warehouse for forecasting purposes. Finally, grateful thanks to Oscar Montes-de-Oca-Munguia and Su-Wuen Ong for peer reviewing the final report.

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Executive summary

This report presents the key points of the 2005 Ministry of Justice Annual Prison Population Forecast:

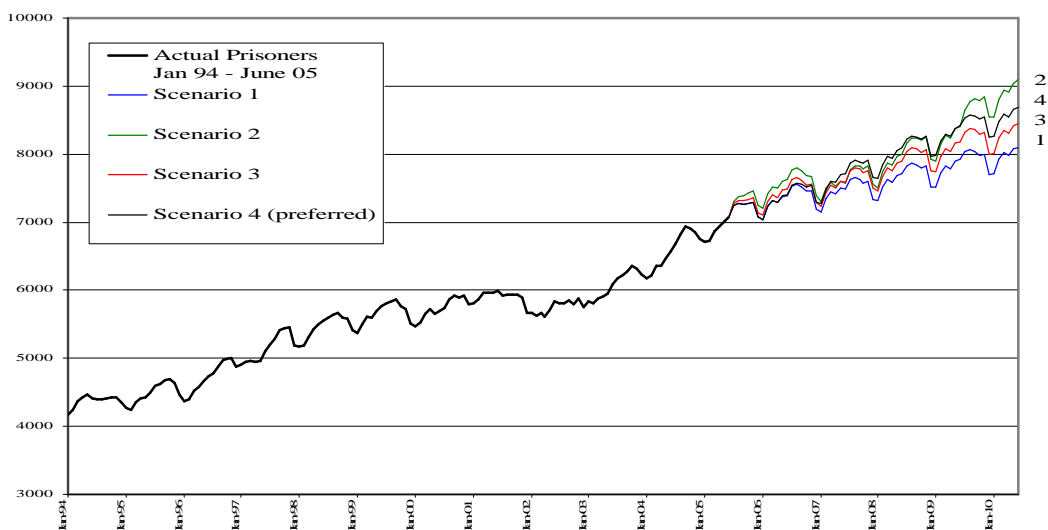
- The predicted prison population (male and female).
- Basic elements of the forecasting model.
- Issues and limitations of the 2005 forecast.

Table 1 shows the forecast prison population between 2006 and 2010. For each year, the June and the maximum monthly forecast are presented. Based on our preferred scenario, we predict an average prison population of 8685 in June 2010. Figure 1 presents the predictions graphically.

Table 1: Forecasted Size of Total Prison Population (monthly averages)

	Scenario 1 (baseline)	Scenario 2	Scenario 3	Scenario 4 (Preferred)
2006 (June)	7394	7629	7483	7399
2006 (Peak)	7553	7801	7650	7576
2007 (June)	7492	7579	7591	7712
2007 (Peak)	7655	7824	7794	7909
2008 (June)	7709	7996	7896	8092
2008 (Peak)	7866	8244	8090	8268
2009 (June)	7921	8411	8185	8413
2009 (Peak)	8069	8849	8374	8580
2010 (June)	8102	9092	8445	8685

Figure 1: 2005 Total Prison Population Forecasts



The forecast is presented as four separate scenarios. This approach was taken because we have not yet seen the full effects of the 2002 Sentencing and Parole Acts. The scenarios allow us to consider possible changes in key variables that affect the numbers of people entering prison and/or the length of time they serve. Table 2 describes the scenarios in full. We also assumed no legislative and operational policy changes over the duration of the forecast.

Table 2: The Main Elements of Each Forecast Scenario

	Scenario 1 (baseline)	Scenario 2	Scenario 3	Scenario 4 (Preferred)
Prosecutions	Separate predictions for 18 offence groups, taking into account long/short-term trends and justice sector knowledge.	Grow at rate of last 3 years, separately for all 18 offence groups.	Same as Scenario 1.	Same as Scenario 1.
Imprisonment rate	Separate predictions for 18 offence groups, taking into account long/short-term trends and justice sector knowledge.	Same as Scenario 1.	Linear trend of last 3 years, separately for all 18 offence groups.	Same as Scenario 1.
Proportion of sentence served	1. For sentences under 2 years, 50% of sentence served. 2. For life and preventive detention, fixed values used. 3. For sentences over 2 years, 2003 distribution of proportion of sentence served used.	Same as Scenario 1.	Same as Scenario 1.	1. For sentences under 2 years, life and preventive detention, as in Scenario 1. 2. For sentences over 2 years, multimodal distribution used.
Remand time	Remand time increases over 2002-2005 are considered along with remand reception times.	Same as Scenario 1.	Same as Scenario 1.	Same as Scenario 1.

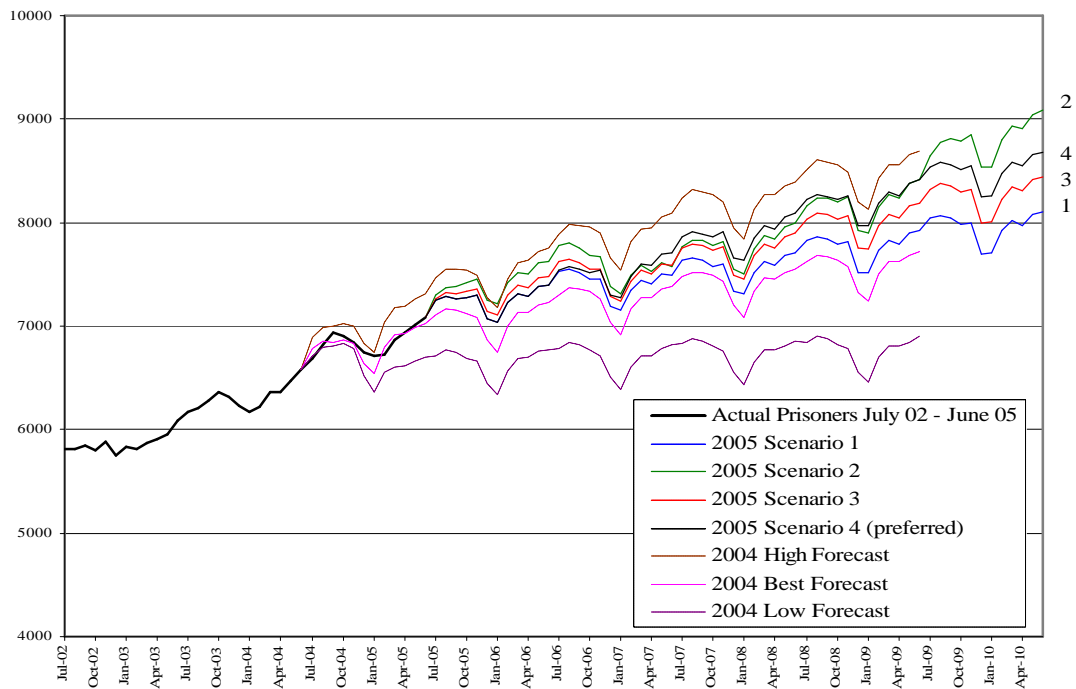
We present the 2005 forecast as four different scenarios to:

- give a comparative picture of the future prison population levels, allowing practitioners to use and extend the predictions according to their own judgements.
- stimulate and focus discussions during current and future consultations across the justice sector.
- give a “reference frame”, in terms of a baseline scenario and three variations of the baseline.

Scenario four is the preferred scenario because it represents a reasonable balance of assumptions on key variables affecting prison numbers. It appears to capture the effects of 2002 legislative changes most convincingly, and achieves the best balance between the baseline scenario and the latest actual prisoner levels.

A comparison of the 2005 and 2004 forecasts is shown in Figure 2. The 2004 forecast used a low, best, and high scenario format whilst the 2005 forecast has four scenarios based on key drivers of the prisoner population.

Figure 2: Comparison of 2005 and 2004 Prison Forecasts – Monthly average of total inmates



The forecasting method¹ takes data available at 30 June 2005, makes predictions on releases from actual prisoners, future prison receptions and releases from future receptions.

Each month the predicted number of inmates, males and females sentenced and on remand, is obtained using the formula:

$$\text{current prisoners} = \text{previous month's prisoners} + \text{current month's prisoner receptions} - \text{current month's prisoner releases}$$

¹ The forecasting method was developed by Dr. Sue Triggs.

1 The forecast model

1.1 Current Ministry of Justice prison population forecast model

Each year the Ministry of Justice updates its forecasts of the size of the prison population. The forecasts are intended to assist planning and policy making. To achieve this, we consider four scenarios of the future prison population. We also indicate our preferred scenario.

This is a spreadsheet-based model using data from the Justice Data Warehouse². SAS³ programs were used to process data from 1992 to June 2005. In addition, the aforementioned programs were used to build a multivariate empirical distribution function of cases. From this, we made quasi-random simulations to obtain future prison receptions and releases.

The programs' results were then fed into a set of inter-linked spreadsheets. These spreadsheets were used for analysing the outputs and for choosing the values of key drivers used in the prediction scenarios.

The spreadsheets were also used to describe prison population features, such as male/female prisoner numbers by months/years, offence groups and sentence groups. Furthermore they were used to predict the future numbers of prisoners using the following formula:

$$\text{current prisoners} = \text{previous month's prisoners} + \text{current month's prisoner receptions} - \text{current month's prisoner releases}$$

The current forecast model produced separate forecasts for male and female, sentenced and on custodial remand prisoners.

1.2 Purpose and approach of the 2005 forecast

The purposes of the 2005 forecast are to:

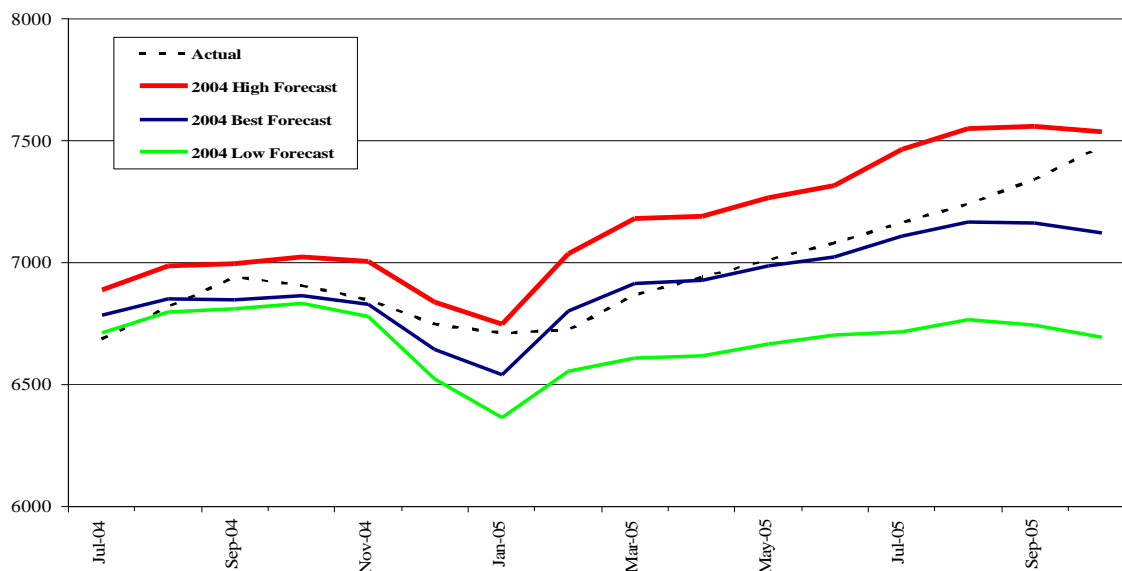
- estimate future prison populations, making use of all information available.
- identify the main drivers that determine the changes in prison population and to consider the most likely scenarios to occur.

² The Justice Data Warehouse (JDW) is a Ministry of Justice database for statistical and research purposes.

³ SAS is the main analytical software used to query, analyse and report data from the JDW. Historical information related to the **key drivers** defined in this document were analysed using SAS.

The 2004 forecast produced the predictions for 2005 shown in Figure 3. Actual prison numbers were within the 2004 forecast range⁴.

Figure 3: Prison Population Forecasts 2004 Against Actual Data July 2004 - Oct 2005



The 2005 forecast used fundamentally the same approach as the 2004 forecast. It consisted of examining and forecasting trends in key drivers of the prison population separately. Thus, trends in the following were all examined by offence type, gender and other factors:

- prosecutions,
- imprisonment rates,
- prison receptions (admissions),
- imposed sentence length, and
- the proportion of sentence served.

The key drivers were then used to create several scenarios. The scenarios were fed into a specifically made simulation model to predict future receptions and releases, and hence prison levels.

This approach allowed the identification of specific factors leading to changes in the prison population. These changes could be forecasted with regard to known causes.

⁴ The 2004 forecast predictions tracked closely to the “best” estimate scenario until September 2005. From September 2005 the actual population approached the 2004 “high level scenario”. The difference between actual and predicted was within the limits of 2004 forecast variability. However, it was unclear if a new driving factor had evolved, or was only stochastic variability. This issue can only be resolved when more data becomes available.

The 2005 forecast was focused on predicting medium term trends, and should be used as a tool for supporting strategic decision making. The forecasts are not intended to support daily or weekly operational decisions.

Note that no forecast method is able to provide perfectly accurate results in predicting the future. Furthermore, there is no universal forecast method which can be perfectly adapted to any circumstances. Moreover, the forecast itself can be a driver of future change. Based on modelled predictions, decision makers can alter current policy and thereby affect the future.

The approach of analysing key drivers is not necessarily more accurate than other methods, such as time-series forecasting. Increased accuracy could, however, result from deeper understanding of key factors behind short-term effects and longer-term trends.

1.3 Data sources

The 2005 forecast used data from:

- the Ministry of Justice Case Management System (CMS); and
- the Department of Corrections' Corrections Analysis and Reporting System (CARS).

These datasets were available through the Justice Data Warehouse. A brief history of the prison forecast data sources is shown in Appendix 1.

1.4 Main assumptions and drivers of the 2005 forecast

The principal assumption of the 2005 forecast was that no major legislative or operational policy changes would occur over the forecasting period 1 July 2005 – 30 June 2010.

There were many factors that could be taken into account to determine the future number of prisoners. Attempting to make separate assumptions on each of those factors would result in a very complex model. Thus, the four most important factors were selected as the 2005 forecast key drivers. The most likely combinations of values for the four drivers were chosen as the 2005 forecast scenarios.

The key drivers of the 2005 forecast are:

- number of prosecutions,
- imprisonment rate, defined as the proportion of prosecutions resulting in a prison sentence,
- proportion of sentence served, and
- remand time served.

Predicted values of the key drivers were based on:

- historical data on offending, sentencing and sentence served (from 1988 or later to June 2005);
- latest trends, if significantly different from the long-term trends forecast;
- latest information concerning historic legislative changes such as the 2002 Sentencing and Parole Acts and the Sentencing Amendment Act 2004;
- justice sector expert judgements on offences and key drivers unlikely to follow historical trends.

Four scenarios were defined for the 2005 forecast, by assuming different values of three key drivers: numbers of prosecutions, imprisonment rate and proportion of sentences served. The remand time assumption was kept constant across the four scenarios.

Another factor taken into consideration was the length of the imposed sentence. This driver was considered by including it as one of the variables of the multivariate empirical distribution. The distribution was derived from the reception dataset, which was used for stochastic simulation of future prison cases⁵.

It was assumed that the length of imposed sentence would not change significantly over the next five years. This assumption was derived from histogram analysis of historic sentence lengths, and consultation with stakeholders. Therefore, no variations of this parameter were considered for defining the 2005 forecast scenarios.

In order to increase confidence in the 2005 forecast, individual assumptions about the key drivers were validated via consultation with experts. These experts were from the Ministry of Justice, other Justice Sector agencies, and external forecasting specialists.

1.5 Brief description of the current forecast method

Separate forecasts were produced for sentenced and remand prisoners and for males and females (four combinations). Many prisoners serve a period of custodial remand before being sentenced. That is, for each sentence given, the total time served is the sum of time served as a custodial remand prisoner and time served as a sentenced prisoner.

Separate forecasts for remand and sentenced prisoners were produced because the factors that affected the two prison populations differ. These separate forecasts were summed to obtain the total prison forecast.

⁵ See below steps 5 and 6 of the forecasting method for sentenced prisoner population.

The method for forecasting sentenced prisoner population consists of the following steps:

Step 1: Analyse historical prosecution and sentencing trends by offence groups⁶. The offence groups were obtained by aggregation of cases using the 'offence code' information in the CARS and CMS databases. There were eighteen offence groups used in the forecast, as shown in Table 3.

Step 2: Analyse historical proportions of sentence served by offence groups, with and without remand time included.

Step 3: Forecast annual total number of receptions for each financial year from 2005/2006 to 2009/2010.

Step 4: Forecast the proportions of sentence served for each category of sentence (see Appendix 2).

Step 5: Create a "reception dataset" for a historical period. A "reception dataset" is a multivariate empirical distribution of random variables associated with any prosecuted case, e.g. offence group, sentence lengths, sentence commencement date.

Step 6: Simulate monthly receptions and the associated sentences from the "receptions dataset". Monthly receptions are scaled so that their annual totals equal the yearly predictions derived in Step 3⁷.

Step 7: Calculate release date of prisoners incarcerated as at 30 June 2005, by using known details of sentences and the predicted proportion of sentence served.

Step 8: Simulate release dates corresponding to new simulated receptions, which were generated at Step 6.

Step 9: Compute monthly prediction of prisoners by:

- a) adding the simulated new receptions,
- b) subtracting the releases of inmates that were in prison at 30 June 2005, and
- c) subtracting the predicted releases corresponding to simulated receptions after 30 June 2005.

The method for forecasting remand prisoner population consists of the following steps:

Step 1: Analyse historical data of prosecutions and custodial remand periods by groups of offences⁸.

⁶ These trends were assessed with data from 1990 onwards with particular emphasis on the last three years when new legislation took effect.

⁷ This process means that the average historic seasonal patterns are maintained for future receptions. No analytical evidence was found of reception seasonal patterns changing over time.

⁸ Data since 1992 were used to assess these trends, with particular emphasis on the last three years.

Step 2: Analyse historical proportions of all prosecuted cases that had a remand period, by groups of offences.

Step 3: Forecast the number of total custodial remand cases for each financial year from 2005/2006 to 2009/2010.

Step 4: Forecast the average time spent in custodial remand, as a linear trend of historical average times.

Step 5: Forecast the yearly average number of remand prisoners, calculated as the number of total yearly custodial remand cases multiplied by the average time spent⁹.

Step 6: Forecast monthly average number of remand prisoners, using monthly coefficients derived from the average seasonal levels.

⁹ Queuing theory and Little's law were applied here. This assumes that the custodial remand system is a stable system. See section 2.2.8 for further detail.

2 Data and key drivers of the forecast

2.1 Data availability and data quality

This section discusses the availability and quality of the data used in the 2005 forecast. These issues did not affect the 2004 or previous forecasts.

The Department of Corrections (hereafter called “Corrections”) data provided information about the sentence actually served by prisoners. Ministry of Justice data provided information about their prosecution, the sentences imposed and different stages of court proceeding.

2.1.1 Corrections data

Previous forecasts used the Corrections Custody Supervision Subsystem (CUSSUP) dataset. In 2005 a new Justice Data Warehouse dataset called Corrections Analysis and Reporting System (CARS) replaced CUSSUP.

In order to use the existing SAS programs, an equivalent dataset was created from the CARS database. The 2005 forecast used this equivalent CARS-CUSSUP dataset to analyse and make predictions on the proportion of actual sentence served. See Appendix 3 for more details.

To ensure that the replication was robust, we ran the 2004 SAS software programs on the CARS-CUSSUP dataset. Similar results were obtained to those derived from the 2004 CUSSUP dataset. We concluded that the 2005 CARS-CUSSUP equivalent dataset was sufficiently compatible with the CUSSUP dataset used in 2004.

Some differences between the datasets were found. They were, however, sufficiently minor for us to assume that they do not adversely affect the 2005 forecast.

Regular consultation was carried out with Corrections and Ministry of Justice analysts on data issues¹⁰. For example, inconsistent elements and duplicate records were detected in the CARS dataset¹¹.

¹⁰ David Harpham from Department of Corrections and Andrew Mercer from Justice Data Warehouse.

¹¹ Especially concerning the records of remand time after July 2002 and the maximum sentence length.

2.1.2 Ministry of Justice data

The Ministry of Justice database contains data on charges brought against people at criminal courts. It also has charge data that has been merged into cases. In 2005, the Ministry of Justice decommissioned its previous database, the Law Enforcement System (LES), and the new one – the Case Management System (CMS) – came online. CMS contains all the data found in LES although they are structured differently.

The groupings, variables and formats of 2005 CMS data were converted into versions compatible with 2004 data. The steps for obtaining the compatible datasets were:

- 1) Identifying the variables required by the 2004 forecast method and SAS codes.
- 2) Changing the variable names and/or SAS permanent¹² formats¹³.
- 3) Running the SAS programs and validating the consistency of 2005 results against previous years' results.

The 2005 forecast used Ministry of Justice data for:

- analysing and predicting prosecution trends and sentencing rate,
- building the “reception dataset”, which is the multivariate empirical distribution function associated with the prosecuted cases,
- predicting releases of current prisoners, and
- simulating future receptions and associated releases.

2.2 Trend analyses and forecasting assumptions of key drivers

Criminal experts in the Ministry of Justice, other Justice Sector agencies, and external forecasting specialists were consulted to validate the assumptions made about the key drivers. The key drivers are:

- number of prosecutions,
- imprisonment rate,
- proportion of sentence served, and
- remand time served.

From the key drivers, 4 scenarios were derived (see Table 2 for the summary version). Scenario 1 used the baseline trends of all the key drivers. The remaining scenarios varied one key driver whilst holding the other three at their baseline values. Only the remand time key driver did not change in all four scenarios.

¹² See any SAS documentation about SAS permanent formats, such as that available at www.sas.com.

¹³ Andrew Mercer from Justice Data Warehouse built two additional formats for these operations.

2.2.1 Prosecution trend analysis

Prosecutions were analysed based on 18 groups of offences (Table 3). The analysis focused on parameters such as the direction, magnitude and frequency of changes, long/short-term trends and patterns.

Table 3: Groups of offences used in the 2005 forecast

1	Homicide	10	Motor vehicle conversion
2	Sexual violation	11	Fraud
3	Robbery	12	Theft
4	Grievous assault	13	Use cannabis
5	Serious assault	14	Deal cannabis
6	Other violence/person	15	Non-cannabis drugs
7	Other sexual offences	16	Against justice
8	Burglary	17	Damage, order and misconduct
9	Receiving stolen goods	18	Traffic

The trend in the number of prosecutions for males has been increasing sharply over the last three years for most of the 18 offence types. The total numbers increased from 79,470 prosecutions in 2002 to 94,511 in 2005, an 18.9 % increase in 3 years. The exceptions were fraud, using cannabis, and dealing cannabis, which decreased 14.5%, 12.7% and 20.6% respectively. However, these offence groups represent only a relatively small proportion of prosecutions, so the overall trend was still increasing.

The trend in the number of prosecutions for females was similar. The general increase was 21.7%. The exceptions were homicide, fraud, using cannabis and dealing in cannabis, which showed a downward trend of 61.5%, 9.5%, 7.5% and 13.7% respectively. However, the number of prosecutions under these categories was too small to have a significant effect on the overall forecast.

2.2.2 Assumptions for prosecution trends

Future projections of prosecution trends were by offence groups, using results from the analysis above. This method of projection is common to the two approaches used to forecast prosecutions.

The first approach (baseline) took into consideration all known factors – historical data and justice sector knowledge – by groups of offences. This is the “standard” approach of the 2004 prison population forecast method. Depending on the particular characteristics of each group of offence, long-term or short-term trends were chosen. In some special cases, trends were adjusted using justice sector knowledge.

The second approach only took into account the trend of the last three years. This variation to the baseline long-term trend was modelled as Scenario 2. Other reduced approaches were trialled but did not lead to realistic results and were discarded.

Other elements were also considered in assessing the likelihood of the predicted number of prosecutions. The 2005 forecast incorporated them as additional judgements and trend adjustments within different types of offences, rather than direct computations. An example would be the effect of a changing demographic mix of the “at risk” population. The 21-25 year age group was identified as having a higher risk of offending. If the population in this age group increased, then one might expect more prosecutions. Indeed, one explanation for the increased number of prosecutions recently may be the increase in the 21-25 year age group population¹⁴. If so, then the impact was indirectly included in a scenario which allowed for increasing prosecutions within this age group.

2.2.3 Imprisonment rate analysis

The imprisonment rate determines the proportion of prosecuted cases resulting in a prison sentence. As not all sentenced people go to prison, the imprisonment rate has direct effects on the prison population.

This forecast used the predicted imprisonment rate to obtain the expected numbers of future receptions. Some adjustments were made, based on justice sector knowledge.

Imprisonment rates were analysed by offence groups (Table 3) and by gender using historical data. However, in contrast to prosecution rates, imprisonment rates by offence groups over the last three years did not follow a common trend.

For males, the imprisonment rate increased in about of the half of the offence types. In the other half, the rate decreased or was steady. The overall imprisonment rate for males increased from 0.09 to 0.095 (5.5 %) in the last three years.

For females, 11 out of the 18 offence groups showed a rising trend. The overall increase in the last three years was from 0.030 to 0.046 (53 %).

2.2.4 Assumptions for imprisonment rate

The forecasts for imprisonment rates were calculated using two methods. The first method was the one used for the 2004 forecast. It considered the 18 groups of offences individually.

The formula applied to each offence group differed, depending on particular circumstances. In some cases, the long-term trend was adopted. In others, it was the short-term trend. Some used a pure average. And others had expert-derived formulae, based on the knowledge of our Justice Sector experts. In practice, the baseline assumption is not based on a single method. Instead there are a few, selected to suit each offence type.

¹⁴ See <http://www.stats.govt.nz/tables/nat-pop-est-tables.htm>.

The second method considered the trends of the last three years for all groups of offences. This second method was used to define the third scenario. Other assumptions on imprisonment rate trends were also considered. Eventually, only the latest three-year trend was presented as a scenario for the 2005 forecast.

2.2.5 Sentence length – analysis and assumptions

Sentence length (length of imposed sentence) was not used to define separate scenarios. Instead it was considered for the 2005 forecast only as one of the variables of the multivariate empirical distribution function.

The sentence length analysis considered not only the groups of sentences but also the groups of offences (Table 3). Histograms of sentence length by years (1999-2005) and by groups of sentences (see Appendix 2) were developed and analysed.

The 2005 forecast assumed that sentence length would not significantly increase or decrease over the next five years. In 2002 and 2003 lengths increased slightly but decreased in 2004. In 2005 they were observed to be the average of the period 1999-2004. This suggests that the effects of the 2002 Sentencing and Parole Acts have worked through. A new equilibrium has been established for all groups of sentences. Therefore, no different scenarios based on the variation of this parameter were considered.

2.2.6 Proportion of sentence served analysis

The proportion of the sentence served was analysed not only by sentence groups (see Appendix 2), but also by offence groups (Table 3). The most important issue considered for this key driver was the effect of changes in the 2002 Sentencing and Parole Acts. These effects differed by sentence group.

The data analysis showed that:

- For sentences “2 years and under”, prisoners were most likely to serve half their sentence.
- For sentences “over 2 years”, there was some evidence prisoners were most likely to serve more than two thirds of their sentence. However, not enough data was available to say whether this proportion was increasing or becoming stable.
- A significant percentage of longer-term prisoners have yet to complete their sentences. Therefore estimating changes in the proportion of sentence served would not be reliable, whatever method was used.
- Analysis of sentences “over 2 years” between 1999 and 2005 showed significant variability in the proportion of sentence served. This made the estimation of future trends challenging with large uncertainty attached to the estimates.

2.2.7 Assumptions for proportion of sentence served

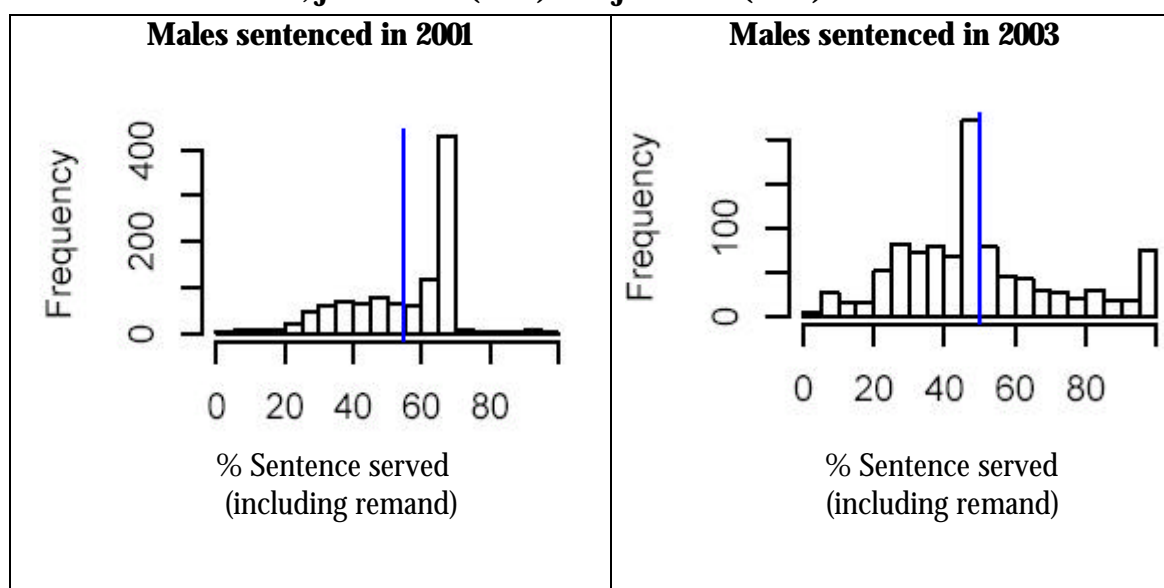
This section describes the main modelling assumptions made for the proportion of time served, by groups of sentences. All assumptions had to be consistent with the legislation described in Appendix 2.

For sentences of less than two years, convicted offenders were assumed to serve only 50% of their sentence. This is consistent with the legislation which states that prisoners must complete at least half of their imposed sentence (Appendix 2). Life and preventive detention offenders are treated as fixed terms of 12.5 and 14 years respectively.

For sentences of more than two years, new parole regulations and historical data show contrasting patterns. For offenders that were sentenced before the 2002 Parole Act, those not paroled generally served two thirds of the sentence. Figure 4 shows an example histogram of males sentenced in 2001 with a very clear mode.

After the 2002 Parole Act, the shape of the histograms suggests a three-modal distribution. The histogram of males sentenced in 2003 (Figure 4) shows that the modes were roughly at one third, half and at the end of sentence.

Figure 4: Examples of histograms of proportions of time served: sentences > 2 years for males, just before (2001) and just after (2003) the 2002 Acts



Note: The solid line is the mean sentence served and it is similar in both histograms.

Based on the complex reasons given above, we have adopted the assumptions shown in Table 4 for our forecast model. For the baseline, 1/4 of male prisoners serve 33% of their sentence, 5/8 serve 50% and 1/8 serve the full term. For 'baseline' female prisoners, 5/8 serve 33% of their sentence, 1/4 serve 50% and 1/8 serve 67%.

Our alternate scenario is to have even longer sentences. This is modelled as a greater percentage of prisoners serving higher proportions of their sentences. For male prisoners, only 1/8 serve 33% of their sentence, whilst 1/4 now serve their whole sentence. For females, only 1/2 get released after 33% of their sentence, and 1/4 after 67% of their sentence.

Table 4: Modelled Percentage of Prisoners Serving fixed Sentence Proportions for Imprisonment > 2years (excludes indeterminate sentences)*

Males	Proportion Served	33%	50%	100%
	Baseline	1/4	5/8	1/8
	Alternate	1/8	5/8	1/4
Females	Proportion Served	33%	50%	67%
	Baseline	5/8	1/4	1/8
	Alternate	1/2	1/4	1/4

* Example: for 'baseline' female prisoners, 5/8 serve 33% of their sentence, 1/4 serve 50% and 1/8 serve 67%.

2.2.8 Remand time analysis and assumptions

The most important issue analysed was data quality and availability. The 2005 forecast did not consider as many factors as in the case of sentenced prisoners.

The remand forecast was calculated by using a method similar to a queuing model. The expected number of remand prisoners is based on the average time spent in the system and prisoners' arrival rate (prisoners remanded per year).

Analysis was undertaken using Corrections data (CARS) and Ministry of Justice data (CMS). We noted some discrepancies in remand time data in both data sources. Corrections staff assisted with the selection of the most reliable datasets to use. We did not evaluate the effect of the discrepancies on the 2005 forecast.

We found that since 2002, remand times have significantly increased for both male and female prisoners. The average remand time for males has increased from about 1.33 months in 2002 to 1.50 months in 2005. For females it has increased from 0.85 months in 2002 to 1.12 months in 2005.

The most realistic forecasting assumption was a continuation of the 'high level' trend of remand rates. Therefore, the projected trend increases of the 2002 to 2005 remand times were used as the modelled remand reception times in all scenarios.

2.3 Timing and other restrictions

A considerable amount of time was required to undertake the shift from CUSSUP to CARS and LES to CMS transitions as described in 3.1 above. This reduced the time available developing the overall method and investigating methodological improvements. These issues will be addressed by the Ministry for subsequent forecasts.

3 Definition of scenarios used in the forecast

3.1 Overview of scenario definitions

The principal assumption of the 2005 forecast was that no major legislative or operational policy changes would occur over the forecasting period 1 July 2005 – 30 June 2010.

Based on this assumption, the modelling and justice sector consultation agreed that the prison population (sentenced and remand) would continue to increase. The difficulty in fully accounting for the 2002 Acts and other unknown factors increased the uncertainty in the forecasts.

We therefore created four scenarios to mitigate this uncertainty. Policy makers are encouraged to consider all four scenarios in order to make more informed policy decisions. Table 5 shows in detail how the scenarios differ from one another.

The scenarios were validated via extensive consultations with experts of the Ministry of Justice and other Justice Sector stakeholders. The consultation process showed that the users of the forecast also have their own opinions, judgements, and objectives. The forecast will be used for different purposes, many of them involving decisions as a result of a risk assessment process. Thus, they need more than one scenario.

The consultation process was iterative. The first results of the analysis were forwarded to our experts. Based on their feedback, we performed another round of analysis. Feedback was once again sought. Eventually, a final version of the baseline scenario was established along with the other three scenarios.

3.2 Scenario 1

Scenario 1 evolved through considering the long term trends in the key drivers of the prison population. Trend data over a five to ten year period was considered and a basic linear extrapolation approach applied. Some adjustments were made to the trend data, based on expert opinion and sector knowledge.

This approach assumes a continuation of moderate prisoner number growth seen in long term trends. Therefore, the short term effects of historical policy changes are disregarded. This scenario may be less useful to policy staff interested in policy effects over the short to medium term.

Scenario 1 is our “baseline” for the 2005 forecasts. It is essentially the 2004 “best” scenario adapted by considering the latest evolution of the main drivers.

Once scenario 1 was developed it was possible to create new scenarios by varying certain key drivers.

3.3 Scenario 2

Scenario 2 varies the prosecution trend assumption whilst keeping the others similar to the baseline. It assumes a higher rate of increase in prosecutions, as seen in the latest years. The short term trend of the past three years was used, instead of the baseline long-term trend.

3.4 Scenario 3

Scenario 3 alters the imprisonment rate assumption only, keeping the other baseline assumptions constant. It strictly uses the short-term trend of the past three years only for all 18 offence groups. This is to reflect the effects of the 2002 Sentencing Act. In contrast, the baseline scenario used a mixture of trends, averages and expert-derived formulae which varied between the 18 groups.

3.5 Scenario 4

For Scenario 4, we varied the sentence proportion served but kept everything else at the baseline. The variation made is shown on Table 4 above. The changes are meant to take account of the 2002 Parole Act.

Only the sentences of over two years were varied. Those of two years and under and the indeterminate sentences remain similar to the baseline.

In this scenario, the average male sentenced to more than 2 years serves 60% of their sentence. This is an ‘increase’ over the baseline proportion of 52%. For the average female, the proportion served rises from 42% to 46%.

Table 5: Overall View of the Assumptions for all Scenarios

Scenario	Remand	Served Time	Imprisonment Rate	Prosecution
<p>Scenario 1 (Baseline of the method)</p>	<p>Using sector knowledge, long term or short term linear trends of the 18 offence groups were individually chosen.</p> <p>Monthly remand receptions were assumed to follow the average seasonal patterns for the 2002-2005 years.</p> <p>Linear trends since 2002 were used for remand time.</p>	<ul style="list-style-type: none"> ▪ Inmates sentenced to “2 year and under” serve 50% of their sentence including remand time. ▪ Life and preventive detention sentences were assumed to have imprisonment periods of 12.5 years and 14 years respectively. ▪ “Over 2 year” sentences follow the pattern of the 2003 receptions. This is modelled as: <ul style="list-style-type: none"> ➢ Males – 1/4 serve 33% sentence, 5/8 serve 50% and 1/8 serve the full term. Average proportion served is 52%. ➢ Females – 5/8 serve 33% sentence, 1/4 serve 50% and 1/8 serve 67%. Average proportion served is 42%. 	<p>Using sector knowledge, long term or short term trends of the 18 offence groups were individually chosen.</p>	<p>Using sector knowledge, long term or short term linear trends of the 18 offence groups were individually chosen.</p> <p>The monthly arrival times were assumed to follow the seasonal patterns for the 2002-2005 years.</p>
Scenario 2	As in Scenario 1	As in Scenario 1	As in Scenario 1	Linear short term trend over the last 3 years was used.
Scenario 3	As in Scenario 1	As in Scenario 1	Linear short term trend over the last 3 years was used.	As in Scenario 1
Scenario 4 (preferred)	As in Scenario 1	<ul style="list-style-type: none"> ▪ No change to sentences of life, preventive detention and “2 years and under” ▪ “Over 2 year” sentences modelled as: <ul style="list-style-type: none"> ➢ Males – 1/8 serve 33% sentence, 5/8 serve 50% and 1/4 serve the full term. Average proportion served is 60%. ➢ Females – 1/2 serve 33% sentence, 1/4 serve 50% and 1/4 serve 67%. Average proportion served is 46%. 	As in Scenario 1	As in Scenario 1

4 Results and recommendations

4.1 Comments on the detailed results and scenarios

The forecast results of the four scenarios are presented here. Table 6 shows the forecasted prison population between 2006 and 2010. For each year, the June and the maximum monthly forecast are presented. Based on our preferred scenario, we predict an average prison population of 8685 in June 2010. Figure 5 presents the predictions graphically.

Table 6: Forecasted Size of Total Prison Population (monthly averages)

	Scenario 1 (baseline)	Scenario 2	Scenario 3	Scenario 4 (preferred)
2006 (June)	7394	7629	7483	7399
2006 (Peak)	7553	7801	7650	7576
2007 (June)	7492	7579	7591	7712
2007 (Peak)	7655	7824	7794	7909
2008 (June)	7709	7996	7896	8092
2008 (Peak)	7866	8244	8090	8268
2009 (June)	7921	8411	8185	8413
2009 (Peak)	8069	8849	8374	8580
2010 (June)	8102	9092	8445	8685

Figure 5: 2005 Total Prison Population Forecasts

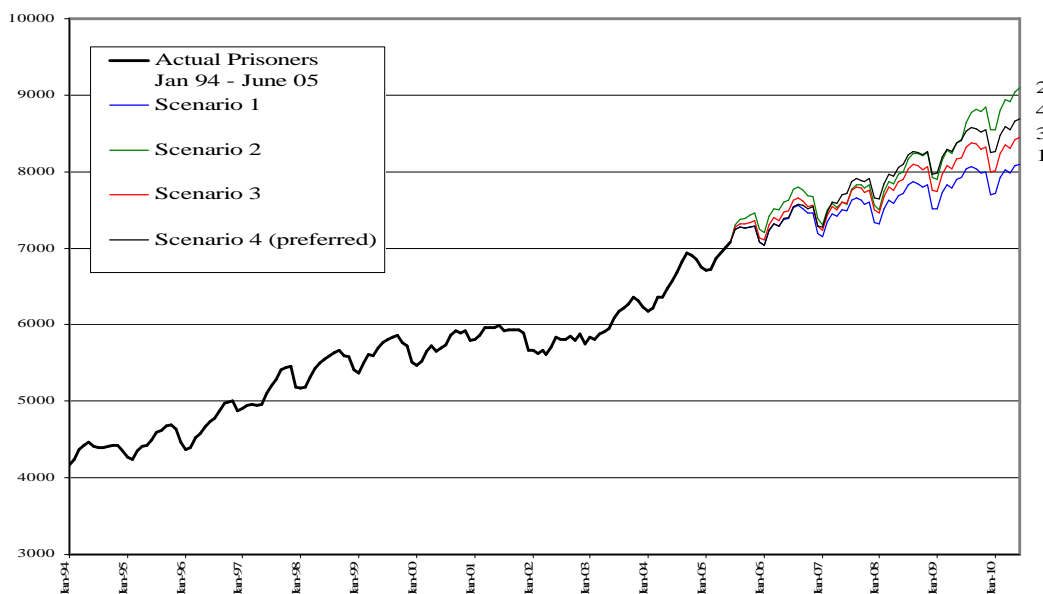


Figure 6 and Figure 7 show the breakdown by male and female prisoners respectively. The corresponding data is tabulated in Appendix 4.

Figure 6: Prison Population Forecasts – total Males

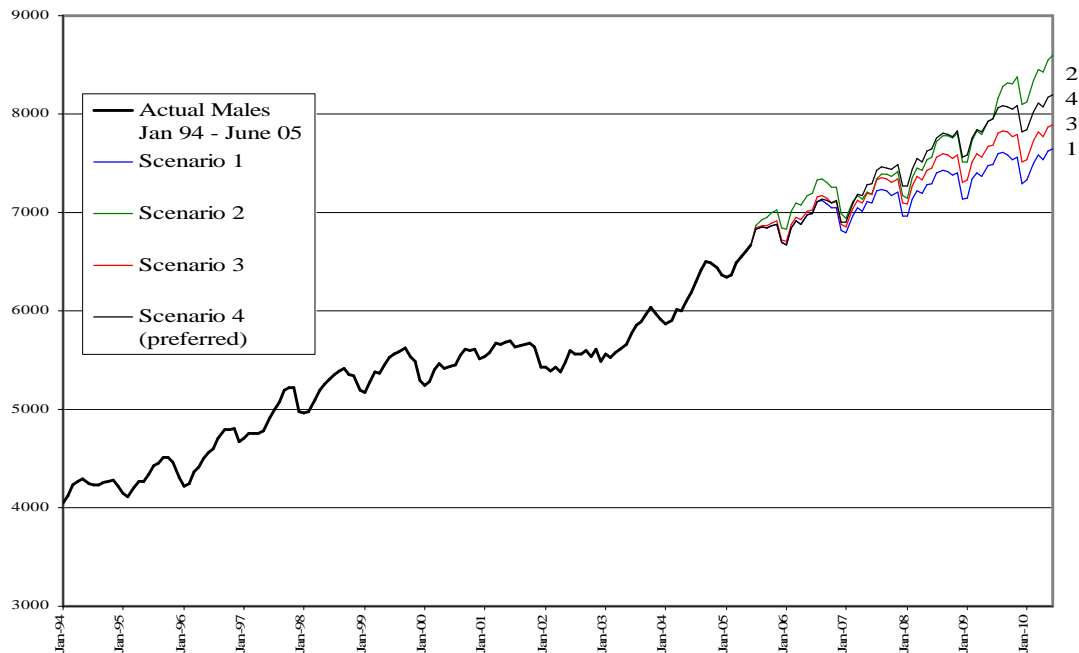
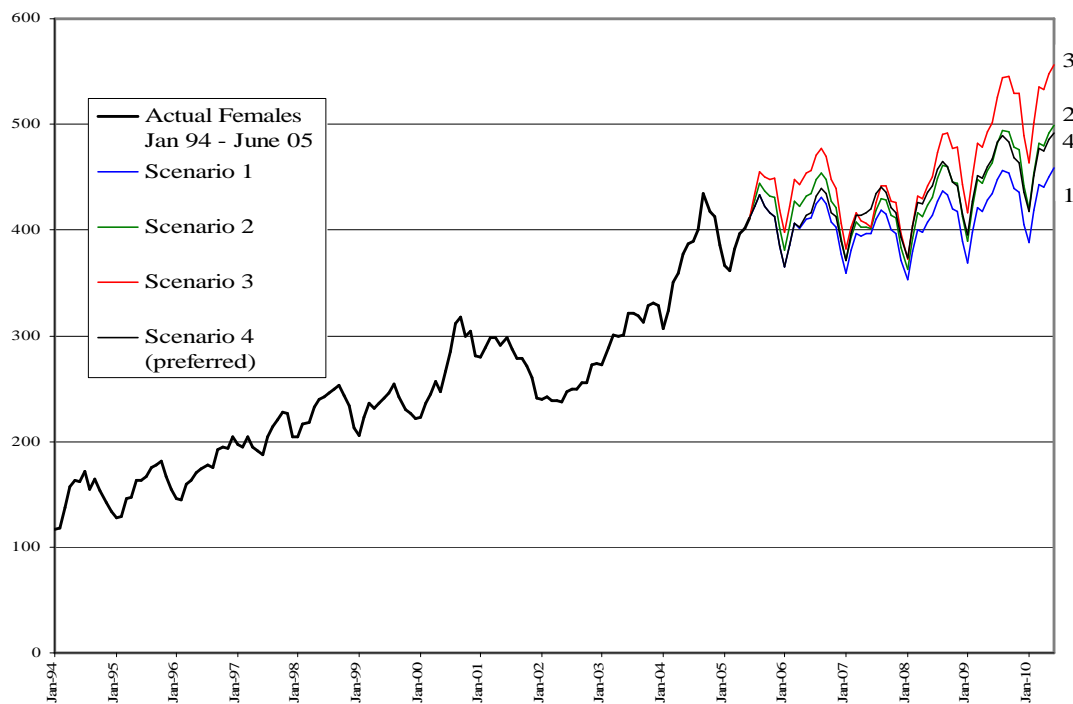


Figure 7: Prison Population Forecasts – total Females



4.1.1 Scenario 1

Scenario 1 predicts a total prison population in June 2010 of 8102 prisoners: 7645 males and 457 females. This forecast is the lowest of all scenarios at June 2010 – it is 10.9% lower than the highest scenario (scenario 2). Scenario 1 is closely aligned with scenario 4 until the middle of 2006. Thereafter scenario 4 starts to climb above scenario 1.

This scenario was not chosen as the preferred one because:

- It is similar to the 2004 'best' forecast. This 2004 forecast deviated below actual prison levels in 2005 from September onwards.
- The opinions expressed in the consultation process did not give too much credit to the idea of a "quiet" evolution of prison population size. Those consulted also expected the short-term trends of high increases in prosecution, imprisonment rates and sentence proportion served to continue.
- The yearly increments are quite unequally distributed over the five years. The predicted increase in 2006 is 313 prisoners, whereas in 2007 the increase is only 98 prisoners.
- The effects of 2002 Sentencing and Parole Acts on the long-term sentences have yet to be fully felt. Many convicted people have yet to complete their sentences and the effective time served in these cases is unknown. Hence such cases could not be used in assessing the proportion of sentence served.

Nevertheless scenario 1 is the "baseline" approach of the forecasts.

4.1.2 Scenario 2

Scenario 2 varies considerably from the stable approach exemplified by Scenario 1. Its forecast of 9092 total prisoners at June 2010 (8593 males and 499 females) is the highest prediction. It also gives unequally distributed yearly increments. The short-term trend of prosecution rates has a larger effect on prison numbers than the short-term trends of the other three drivers. During the consultation process, experts considered there was a low likelihood of such large forecasts and they did not expect prosecutions to increase at the current rate.

Scenario 2 should, however, be considered as a possible and plausible scenario. It highlights the effect on prisoner numbers of current high prosecution rates combined with the existing sentencing environment. Because of that, it should be included in any further discussion on prison population issues.

4.1.3 Scenario 3

Scenario 3 also gives higher predicted numbers of prisoners than Scenario 1 – 8445 total inmates at June 2010 (7889 males and 556 females). It was, however, less than both scenario 2 and scenario 4. The yearly increment was quite steady, but not equally balanced between 2006 and 2007.

These results show that the short-term trend in imprisonment rates has relatively less impact on the prison population than the other two short-term trends. The experts consulted gave credence to increasing imprisonment rates, although not to the extent of recent trends. They considered, however, that prosecution numbers and sentence proportion served are more likely to increase than imprisonment rates. Consequently, Scenario 3 was not the preferred one.

Nevertheless, Scenario 3 also has a high likelihood of occurring and it should be considered together with the others.

4.1.4 Scenario 4

Scenario 4 was preferred to the other 3 scenarios of 2005 forecast and to the 2004 forecast predictions. It predicts 8685 total inmates in 2010, comprising 8193 males and 492 females. The yearly increments are well balanced over the forecasting period, largest in 2006 and progressively decreasing till 2010. It is recommended for the following reasons:

- This scenario better captures the features of both the latest evolution of prison population and the presumed long-term effects of 2002 Sentencing and Parole Acts.
- It achieves the best balance between the more stable key drivers and the more dynamic factors. The projections on proportion of lengthy sentences served are consistent with available data.
- The justice sector experts agreed that the assumptions in this scenario were consistent with the 2002 legislative changes.
- The forecasted prison population levels seemed the most likely of all the scenarios. Its forecast is at not as extreme as Scenarios 2 or 3 in 2010. For the middle three years of the forecast, the trend is similar to Scenario 2.

Nevertheless the other scenarios are also possible and could happen. For this reason, we have not discarded the other scenarios. Also, intermediate results could be of interest to other stakeholders.

The results of the 2005 forecast can be used as a tool for monitoring the prison population evolution.

4.2 Recommendations for improving future forecasts

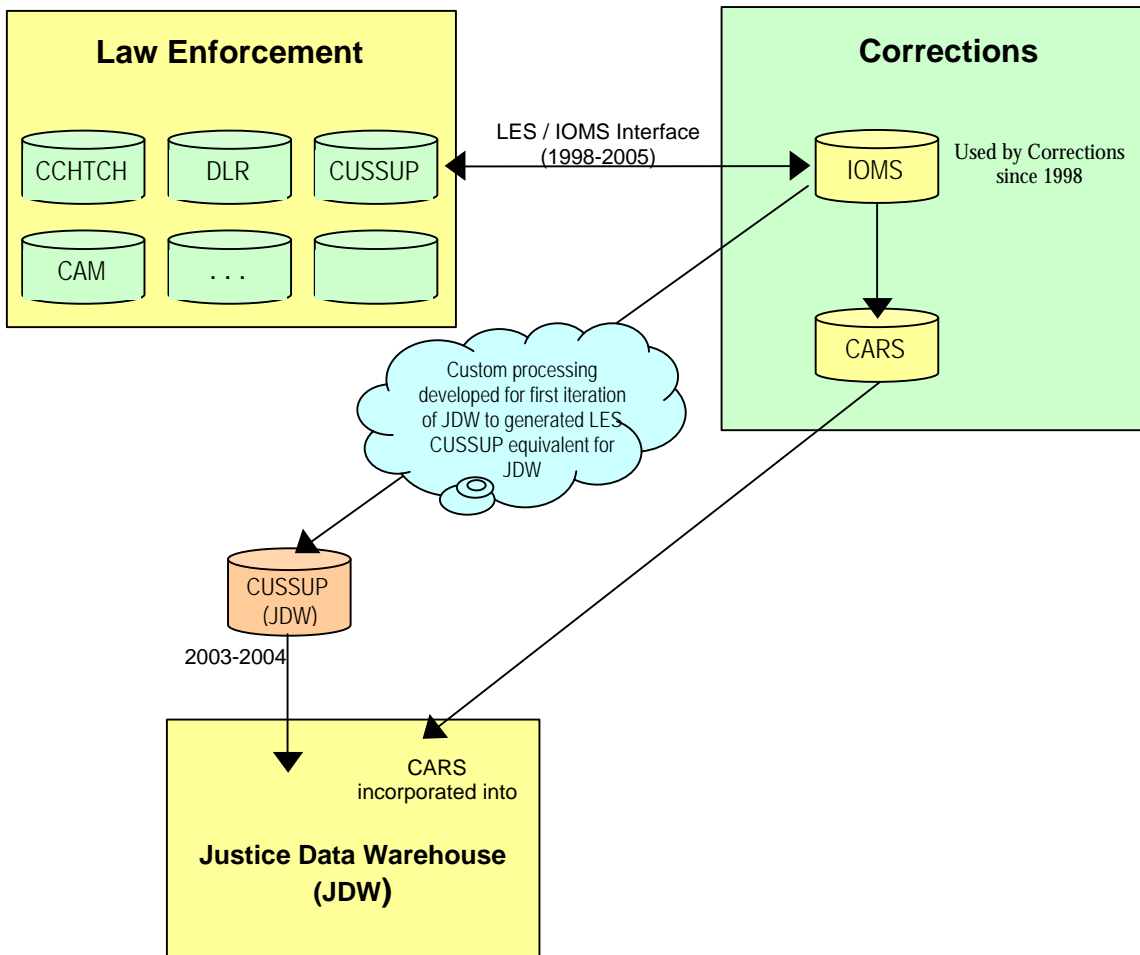
The Ministry of Justice continually explores enhanced and new approaches to forecasting and modelling activities. This capability has been further expanded in 2006 with the formation of a new specific forecasting and modelling team, based in the Research Evaluation and Modelling Unit.

The additional capacity and indeed skills provided by this new team extends the opportunity to improve, in particular, the annual MOJ prisoner forecast. With respect to improving the prisoner forecast some future potential areas of focus for the forecasting and modelling team are:

- 1) Improving the quality of data used to build and present the forecast, such as:
 - Work more closely with Corrections to enhance data quality, such as remand data, that is included in the Justice Data Warehouse.
 - Investigate the opportunity to provide regional prisoner forecasts.

- 2) Exploring alternative forecasting methods
 - An additional method of analysis that could be explored is the use of time series analysis. This approach would potentially enable a more responsive and timely forecast to be generated.
 - The Ministry of Justice is developing a model of the justice sector. The name given to the current model is the Pipeline model. The model has the potential ability to provide a range of justice forecasts including prisoner forecasts.

Appendix 1: A brief history of prison forecasting data sources¹⁵



Some significant changes have recently occurred in the data sources used for prison forecasting. Data was originally sourced from the Law Enforcement System (LES) shared by all justice sector agencies. This contained a flat file, the Corrections Custody Supervision Subsystem (CUSSUP), which was able to be extracted and analysed as the basis for the forecasts. Other points to note:

- Department of Corrections was the first of the justice sector agencies to migrate away from LES in 1998, with the introduction of the Integrated Offender Management System (IOMS).

¹⁵ The author of the document is Andrew Mercer, Justice Data Warehouse Business Analyst.

- Nonetheless, there was an interface back to LES to accept incoming data from other justice sector agencies – and to write back Corrections-entered or updated records where required. This meant that the CUSSUP database on LES was still able to be used as a source for statistical reporting and analysis.
- A separate reporting database, Corrections Analysis and Reporting System (CARS), was developed with Department of Corrections for internal reporting and analysis needs. This is now the basis for Corrections' own forecasting.
- The Justice Data Warehouse (JDW) was developed to provide capability for ongoing sector-wide analysis and reporting subsequent to LES decommissioning. This system was originally rolled out in 2003. In its initial incarnation it included a CUSSUP dataset derived from the Corrections' operational data (in IOMS). The format of this dataset was intended to be identical to that of the old LES-sourced CUSSUP dataset. However, there were data quality issues identified.
- The JDW CUSSUP dataset was discontinued in late 2004, with the CARS data being imported into the JDW instead. This data was able to be verified, and had the advantage that analysts in both Justice and Corrections would be working from the same source. This would hopefully promote consistency, and facilitate greater sharing of knowledge between analytical staff.

Appendix 2: Legislative conditions for proportion of sentence served

In what follows, some legislative details related to the length of sentenced actually served are given.

- **Sentences of one year or less:** generally, the proportion of sentence effectively served should be 50%. This is because, according to the Criminal Justice Act 1995, a person sentenced to a term of imprisonment of one year or less should automatically be released, not on parole, after serving half their sentence. This is the same under the Parole Act 2002. This period is often actually split up in a part served as a custodial remand inmate and a part served as a sentenced inmate, which are subjects of the separate forecasts of sentenced and on remand prisoners. This half of sentenced actually served can be reduced only by home detention. However, the numbers of those who have been granted home detention decreased compared to the period 2002/03. This change can be attributed to the Sentencing Amendment Act 2004 and numbers are likely to remain at a low level.
- **Sentences of more than one year and up to two years for not serious violent offences:** under the Sentencing Act 2002, offenders convicted to these types of sentences should serve half of their imposed sentence and after that are automatically released, as in the case of those sentenced to one year or less. Previously, under the Criminal Justice Act 1995, they had to serve one third of their sentence to be eligible for parole. Those not released on parole had to complete two thirds of their sentence before being automatically set free. Historical data show that before 2002, the average time served was around half of that sentenced. This means that the 2002 Act did not significantly change the proportion of time served.
- **Sentences of more than two years, except those for serious violent offences:** the Parole Act 2002 mainly changed the regulations related to this group of sentences. According to the 2002 Parole Act changes, a convicted person can initially apply for parole after serving one third of the imposed sentence. If they are not granted parole, the convicted person can be held in prison for their entire imposed sentence. In some cases, the court can impose a minimum non-parole period, which can be up to two thirds of the imposed sentence. This is a big change compared to the previous Criminal Justice Act 1995, when they had to be automatically released, not on parole, after serving two thirds of the sentence. The new regulations have the effect of increasing the proportion of time actually served for this group of sentences. The 2005 forecast could not take into account all the effects of these changes, as not all the information is available. This is because prisoners sentenced to more than four years have yet to complete their sentences, except for those who have been paroled. The new legislation creates the possibility of differential treatment concerning release on parole, according to individual circumstances. Those of good behaviour and not considered a risk to the community can be released after serving only one third of their sentence. Those with aggravating circumstances and

deemed a significant risk to society could be required to complete their whole sentence. The analysis of available data led to the use of a multimodal distribution of proportion of sentence effectively served. That is, in assessing the most likely expected value of time served, the distribution is considered tri-modal. The male distribution has modes at one third of sentence, one half and 100% of the sentence. For females the modes are at one third, half and two thirds of the sentence.

- **Sentences of more than two years for serious violent offences:** this group of offences is no longer considered by the new Parole Act 2002. It has been defined under the previous legislation including specified violent and sexual offences. The inmates serving this type of sentence received it under the previous legislation. They nevertheless appear in the forecast as they have to complete the sentence.

Appendix 3: Steps for building the CARS-CUSSUP equivalent table

The SAS programs used in 2004 processed one table in CUSSUP. The corresponding information used in 2005 is stored in several tables of CARS. Moreover, variables that have the same meaning also have, generally, different names.

The steps for obtaining the CARS-CUSSUP datasets were as follows:

Step 1: Identify all CUSSUP variables and the SAS software formats used by the SAS programs.

Step 2: Consider the links between the variables included in the CARS dataset.

Step 3: Assess the meaning of the variables, their associated formats and recognise those that can be used in replicating the required information according to CUSSUP structure.

Step 4: Assess the availability and the validity of the formats associated to CARS variables.

Step 5: Build the equivalent CARS-CUSSUP dataset and the SAS software formats.

Step 6: Run the 2004 SAS programmes using the equivalent 2005 CARS-CUSSUP data.

Step 7: Check the consistency of the results obtained from the equivalent 2005 CARS-CUSSUP data against the results obtained from 2004 CUSSUP data.

Appendix 4: Monthly averages of prisoner numbers

The yearly predicted numbers of prisoners are given in Table A.1, total and by gender. The monthly averages are given in Table A.2.

Table A.1: Predicted Size of Prison Population – Yearly average values

		2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
Scenario 1	Males	6851	7021	7176	7365	7534
	Females	406	399	397	416	436
	Total	7257	7420	7573	7780	7970
Scenario 2	Males	7001	7185	7381	7756	8336
	Females	423	414	410	441	474
	Total	7424	7599	7791	8198	8810
Scenario 3	Males	6882	7088	7307	7545	7760
	Females	440	428	424	473	525
	Total	7322	7516	7731	8018	8285
Scenario 4	Males	6851	7118	7466	7781	8048
	Females	407	413	421	445	468
	Total	7258	7531	7887	8226	8516

Table A.2: 5 Years Prison Population Forecast 2005 (sentenced and remand)

	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Jul-05	6826	422	7248	6872	428	7300	6835	434	7269	6826	422	7248
Aug-05	6849	433	7282	6933	444	7377	6866	455	7321	6849	433	7282
Sep-05	6839	423	7262	6950	437	7387	6862	451	7313	6839	423	7262
Oct-05	6862	416	7278	6994	432	7426	6890	448	7337	6862	416	7278
Nov-05	6881	413	7294	7030	431	7461	6912	449	7361	6881	413	7294
Dec-05	6690	384	7074	6846	401	7248	6723	419	7142	6690	384	7074
Jan-06	6676	365	7041	6830	381	7212	6708	398	7106	6676	365	7041
Feb-06	6843	386	7229	7014	404	7418	6879	423	7302	6843	386	7229
Mar-06	6910	407	7317	7095	427	7522	6949	448	7396	6910	407	7317
Apr-06	6884	402	7286	7076	422	7499	6924	443	7367	6884	403	7287
May-06	6971	410	7381	7175	432	7607	7013	454	7467	6971	413	7384
Jun-06	6982	412	7394	7195	434	7629	7026	457	7483	6982	417	7399
Jul-06	7106	425	7531	7328	448	7776	7153	471	7624	7111	432	7543
Aug-06	7123	431	7553	7347	454	7801	7173	478	7650	7137	439	7576
Sep-06	7089	425	7514	7309	448	7757	7142	470	7612	7121	434	7555

Prison Population Forecast 2005

Oct-06	7046	407	7454	7256	427	7684	7104	447	7551	7098	417	7515
Nov-06	7055	402	7457	7252	421	7673	7116	440	7555	7127	413	7540
Dec-06	6814	377	7192	6990	392	7382	6879	407	7285	6908	389	7297
Jan-07	6791	359	7150	6939	371	7310	6857	382	7239	6900	371	7271
Feb-07	6964	381	7345	7105	393	7497	7035	402	7437	7083	396	7480
Mar-07	7045	397	7442	7175	408	7583	7122	417	7539	7181	414	7595
Apr-07	7016	395	7411	7130	403	7533	7098	409	7508	7173	414	7587
May-07	7104	396	7500	7205	403	7608	7192	407	7599	7280	416	7696
Jun-07	7095	397	7492	7178	402	7579	7188	403	7591	7292	419	7712
Jul-07	7222	411	7633	7347	419	7766	7328	426	7754	7432	434	7867
Aug-07	7237	418	7655	7394	430	7824	7353	442	7794	7467	441	7908
Sep-07	7216	415	7630	7396	428	7824	7339	442	7780	7455	435	7890
Oct-07	7175	400	7575	7369	413	7783	7303	427	7730	7441	421	7862
Nov-07	7204	396	7601	7411	411	7822	7336	426	7762	7493	416	7909
Dec-07	6967	371	7339	7171	384	7554	7099	397	7495	7270	393	7663
Jan-08	6959	353	7312	7144	362	7506	7086	373	7459	7265	374	7639
Feb-08	7140	380	7519	7349	391	7741	7274	404	7678	7443	404	7846
Mar-08	7225	401	7626	7456	416	7871	7365	432	7797	7543	426	7969
Apr-08	7189	398	7587	7429	413	7841	7331	429	7760	7517	425	7942
May-08	7280	407	7688	7538	424	7962	7428	441	7869	7620	435	8055
Jun-08	7296	414	7709	7565	431	7996	7446	450	7896	7649	442	8092
Jul-08	7402	428	7830	7714	449	8163	7563	473	8036	7762	458	8220
Aug-08	7430	436	7866	7778	461	8239	7599	491	8090	7803	465	8268
Sep-08	7409	434	7843	7781	460	8241	7584	492	8076	7790	460	8250
Oct-08	7372	420	7792	7757	445	8202	7551	477	8028	7773	446	8219
Nov-08	7403	417	7820	7800	444	8244	7584	478	8062	7824	442	8266
Dec-08	7129	389	7518	7514	413	7927	7308	443	7750	7559	415	7974
Jan-09	7152	368	7520	7514	389	7903	7324	416	7740	7581	395	7976
Feb-09	7337	397	7735	7729	421	8149	7517	451	7968	7761	427	8187
Mar-09	7408	421	7829	7824	448	8272	7594	482	8076	7844	452	8296
Apr-09	7371	418	7789	7796	445	8241	7560	479	8038	7812	449	8261
May-09	7474	429	7903	7922	457	8379	7668	493	8161	7922	460	8383
Jun-09	7486	434	7921	7947	464	8411	7684	502	8185	7946	467	8413
Jul-09	7592	448	8040	8163	482	8644	7800	526	8326	8056	483	8539
Aug-09	7613	456	8069	8276	494	8770	7830	544	8374	8091	489	8580
Sep-09	7590	453	8043	8317	493	8810	7813	545	8358	8073	483	8556
Oct-09	7540	440	7979	8310	478	8788	7765	530	8295	8043	469	8512
Nov-09	7565	436	8001	8373	476	8849	7794	530	8323	8086	464	8550
Dec-09	7288	406	7694	8099	441	8540	7512	490	8002	7813	435	8248
Jan-10	7325	388	7713	8120	420	8539	7542	464	8005	7847	418	8265
Feb-10	7503	419	7922	8341	454	8795	7728	502	8230	8021	451	8472
Mar-10	7580	443	8023	8456	482	8938	7812	536	8348	8110	476	8587
Apr-10	7537	441	7978	8431	480	8910	7771	533	8304	8072	475	8547
May-10	7626	451	8077	8552	491	9044	7867	547	8414	8168	485	8653