

E LOGIT MODEL

South Stirling Park & Ride
Stirling Council and Tactran
STAG Report



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TACTRAN

Stirling Park & Ride

Demand Forecasting Briefing Note

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|--------------------|-----------------------|-------------------------|---------------------------|
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1 INTRODUCTION

1.1 Introduction

- 1.1.1 This document provides supporting information for the assessment of Park & Ride to the south of Stirling.
- 1.1.2 The Briefing Note describes the approach used in forecasting future travel demand and presents the results of the modelling and forecasting work. This has been done making best use of available data and in accordance with the methodology contained in WebTAG 3.10.3.
- 1.1.3 The modelling used to assess the viability and performance of the proposed packages was a Stirling S-Paramics model, derived outputs from LATIS and a desktop Logit model. Descriptions of these models are provided later.

1.2 Forecast Years

- 1.2.1 The appraisal of the preferred proposal for the south Stirling Park & Ride has been compared with an appropriate baseline Do-Minimum case.
- 1.2.2 S-Paramics Transport models were available for the following years and agreed with the client steering group as suitable for the assessment:
- Weekday AM and PM 2008 Base Year to which the models have been calibrated and validated in accordance with DMRB
 - Weekday AM and PM 2012 forecast year – assumed to be the opening year
 - Weekday AM and PM 2017 forecast year – assumed to be five years after the full scheme opening
- 1.2.3 The S-Paramics modelling has been used to derive vehicle journey times, speeds and travel distances for input to the generalized cost equations forming the Logit model.
- 1.2.4 Logit Modelling has been undertaken in the following stages:
- 2008/09 Base model calibration of Park & Ride demand for existing sites
 - 2012 Forecast for Park & Ride usage in Stirling



- 2017 Forecast for Park & Ride usage in Stirling

1.2.5 LATIS modelling has been undertaken and the following information has been used as input for this study:

- Growth

1.3 Time Periods

1.3.1 Due to limitations of data and off-the-shelf modelling, within the available timescale the S-Paramics modelling has been undertaken for the weekday AM peak period (07:00 – 10:00) only. The remaining weekday period demand forecast has been factored using local data from this AM base point.

1.3.2 The Saturday forecast has also been factored using local data from the weekday AM peak period forecast.

2 LOGIT MODEL

2.1 Introduction

2.1.1 A Logit model was used for forecasting purposes in the South Stirling Park & Ride Feasibility Study. This Note reports the technical content of this exercise.

2.2 Generalised Cost

2.2.1 The generalized cost (measured in minutes) for private cars was calculated in accordance with WebTAG. Calculations for VOT are based on Transport Analysis Guidance as issued December 2008.

2.2.2 **Car Travel:** $G = 2*A + 60*D/V + D*VOC/(occ*VOT) + PC/(occ*VOT)$

- where A is the access time at both ends of the trip: since this will generally be walked, it is weighted by 2
- D is the mean journey distance in kms
- V is the mean traffic speed in kph
- occ is the mean car occupancy
- VOC is the mean car operating cost in pence per km
- VOT is the value of time per person in pence per minute
- PC is half the mean car parking cost in pence

2.2.3 **Bus Travel:** $G = 2*Walk + 2*Wait + 60*D/V + Fare/VOT + I$

- Where Walk is the sum of the time spent walking to the stop or station at the origin end of the journey and the time spent from the destination stop or station to the actual destination
- Wait is the mean time spent waiting for the service, which will be half the service interval for frequencies of 2 per hour or better, rising to a nominal 15 (minutes for less frequent services)
- Walk and Wait are weighted by 2 since this time is costed highly
- V is the mean journey speed, including stopping



- I is the interchange value in minutes

2.2.4 The mean fare appropriate to those travellers likely to choose between car and public transport (i.e. probably not concessions) should be for a single journey divided by the mode-specific value of time as for car. If access is by Park & Ride it will be necessary to add in the car access generalised cost, including half of any parking fee, and if access at either end of a rail journey is by bus the extra generalised cost should be calculated added. If the journey requires interchange between services the extra wait time (and walk time if relevant) should be included and an interchange penalty per interchange added.

2.2.5 In the case of the Stirling Park & Ride trips, this also includes the cost for the car trip to access the Park & Ride.

2.2.6 The notional modal split is calculated as:

$$PPT = \frac{\exp(-\lambda_{modeGPT})}{\{\exp(-\lambda_{modeGPT}) + \exp(-\lambda_{modeGcar})\}}$$

2.3 Calibration

2.3.1 As only weekday AM and PM peak S-Paramics models are available, only the AM peak has been calibrated. The Inter peak and Saturday forecasts will be based on factored values derived from the observed data for both Castleview and Springkerse.

2.3.2 The survey data collected in 2010 for the existing Castleview and Springkerse Park & Ride sites was used to calibrate the terms in order to forecast demand for the Stirling South Park & Ride.

2.3.3 Analysis of the 2010 passenger survey information provided origin data which enabled the catchment for existing sites to be identified and the number of Park & Ride trips occurring. The catchment was then associated with the S-Paramics route zones to determine the approximate number of trips by approach.

2.3.4 The observed/interviewed passengers from the 2010 survey provided only a sample of the total boarding and a factor has been applied using the passenger boarding information.

2.3.5 Table 2.1 provides summary information for passengers between 07:30 – 10:00.

Table 2.1 : Existing Demand

| | Commuter | Other | Total | Boarding | Sample | Factor | Commuter | Other | Total |
|--------------------------|----------|-------|-------|----------|--------|--------|----------|-------|-------|
| Site Interviews | | | | | | | | | |
| Castleview | 12 | 4 | 16 | 76 | 21% | 4.75 | 57 | 19 | 76 |
| Springkerse | 31 | 2 | 33 | 88 | 38% | 2.67 | 83 | 5 | 88 |
| Total | 43 | 6 | 49 | | | | 140 | 24 | 164 |
| Trip Purpose %age | | | | | | | | | |
| Castleview | 75% | 25% | 100% | | | | 75% | 25% | 100% |
| Springkerse | 94% | 6% | 100% | | | | 94% | 6% | 100% |
| Total | 88% | 12% | 100% | | | | 85% | 15% | 100% |

2.3.6 Table 2.1 indicates that the most reliable data set was collected for Springkerse with a sample rate of 38% with 33 interviews compared to only 21% at Castleview for 16 interviews.

2.3.7 The average trip purpose split over the period was 88% for commuters and 12% for other. Based on the more reliable data set for Springkerse, the split is 94% for commuter and 6% for other. Due to the limited observations, for the purpose of increasing the sample for the Logit



model, all data has been assumed to be commuter. No Logit modelling has been completed for ‘other’ trip purposes.

2.3.8 Table 2.2 shows the origin distribution for each existing site derived from the full S-Paramics model demands prior to final cleaning.

Table 2.2 : Origin Distribution Summary

| Castleview | | Springkerse | |
|--------------|-------------------|-------------|-------------------|
| Origin | Percentage of P&R | Origin | Percentage of P&R |
| Stirling | 17% | A905 | 4% |
| A9 North | 42% | Stirling | 13% |
| A811 | 17% | A91 | 30% |
| A84 | 25% | M80 | 17% |
| | | A907 | 35% |
| Total | 100% | | 100% |

2.3.9 Table 2.2 demonstrates that the majority of trips for Castleview originate from the A9 north and for Springkerse the majority originate from the east though some trips from the south do use Springkerse.

2.3.10 Park & Ride destinations have been assumed as being within the controlled parking area of Stirling City Centre. This enabled walk times to be calculated using S-Paramics zone centroids and known bus stop locations. The distribution of P&R trips in the CPZ was undertaken according to the proportional demand within each S-Paramics zone within the CPZ area.

2.3.11 Table 2.3 illustrates the source for the various input data to the generalized cost equations.

Table 2.3 : Logit Model Component Source

| Car Trip Component | Component Source | P&R Trip Component | Component Source |
|--------------------|---|----------------------|--|
| Journey Time | O/D Journey Time from S-Paramics models | Car JT | Time from S-Paramics |
| Journey Distance | O/D Journey Distance from S-Paramics models | Car Journey Distance | Distance from S-Paramics |
| Parking Cost | Average Long Stay CPZ Regions D & E (£2.90) | Parking Cost | Assumed as zero |
| Access Time | Assumed as 3min | Bus Freq | From existing AM Peak |
| | | Bus Journey Time | S-Paramics model Based on Existing (100 pence) |
| | | Bus Fare | Calculated from zone centroid to bus stop |
| | | Walk & Transfer Time | Assumed as 4min |
| | | Interchange Time | |

2.3.12 Table 2.3 shows that the S-Paramics model has been used wherever possible in informing key values for the generalized cost equations for both the private car trips and Park & Ride trips.

2.3.13 The generalized costs for the Springkerse and Castleview catchments were combined and calculated by “ij” pair with the results cleaned to ensure no unrealistic values, i.e. zero car trips or where trips to the Park & Ride were greater than the total trips between the “ij” pair.



Following cleaning there were a total of 76 Park & Ride trips remaining for the regression analysis.

2.3.14 Figure 2.1 shows the resultant regression analysis for the observed data.

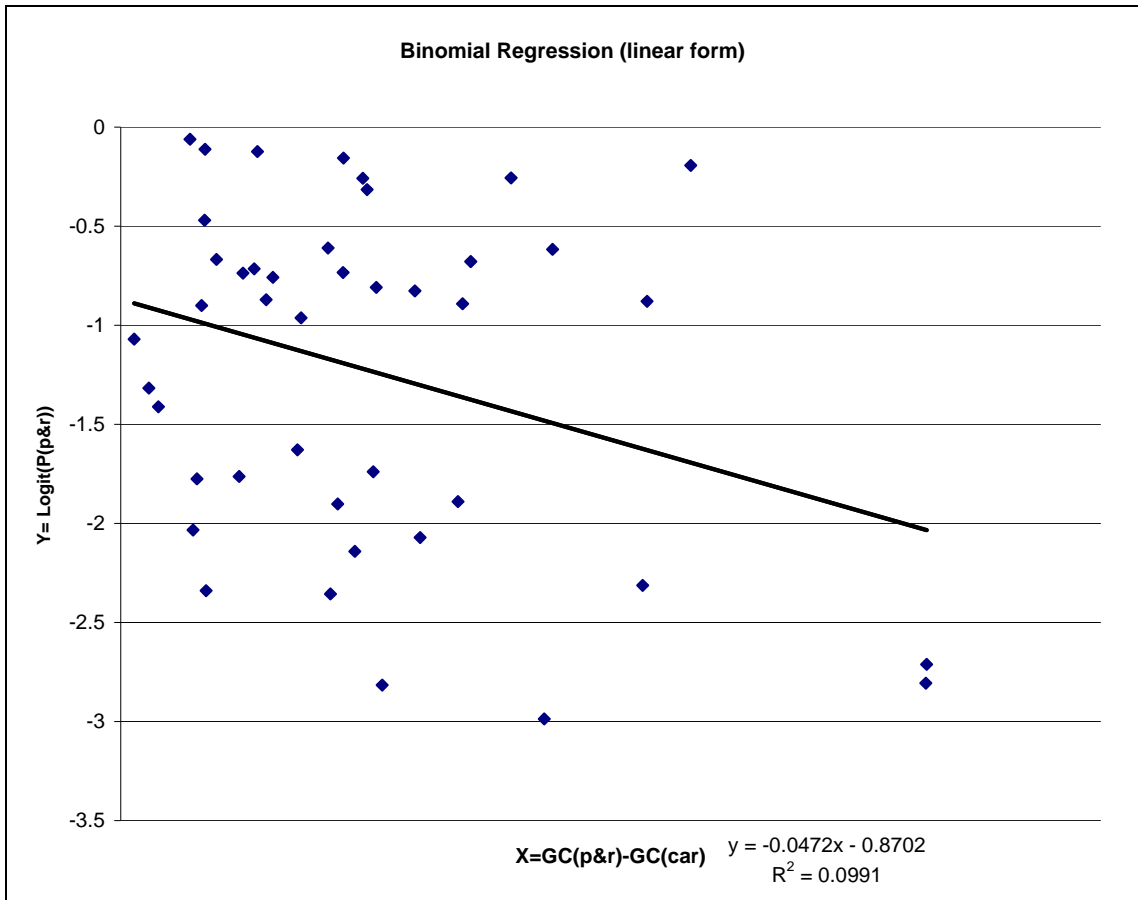


Figure 2.1 : Binomial Regression

2.3.15 Figure 2.1 demonstrates that there is a large scatter and variation in the observed values resulting in a low R^2 value. It does, however, result in reasonable values for lambda and the mode specific intercept of 0.0472 and 0.8702 respectively.

2.3.16 Figure 2.2 demonstrates the calibrated intercept value for the Stirling Park & Rides.



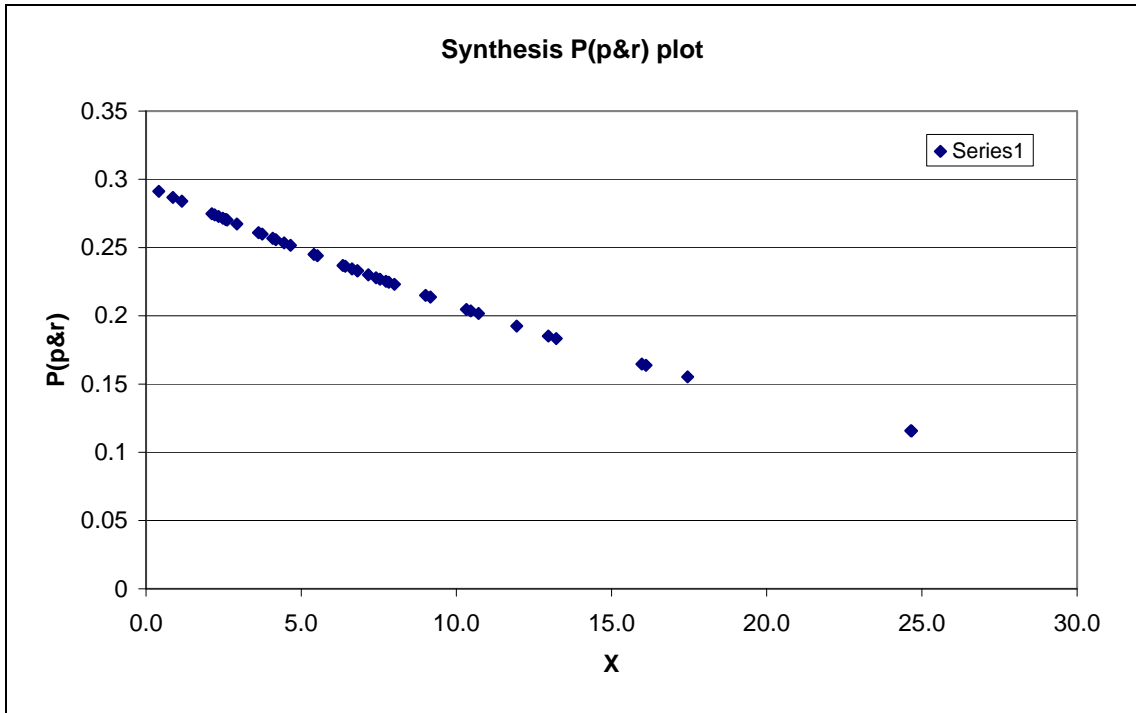


Figure 2.2 : Synthesis P(p&r) Plot

2.3.17 Figure 2.2 demonstrates that if the costs of private car journeys or Park & Ride journeys were equal there would be a 30% probability of trips within the catchment that would use the Park & Ride, as cost of Park & Ride (X) increases the probability decreases.

2.3.18 Figure 2.3 plots the actual and synthesized Park & Ride demands.

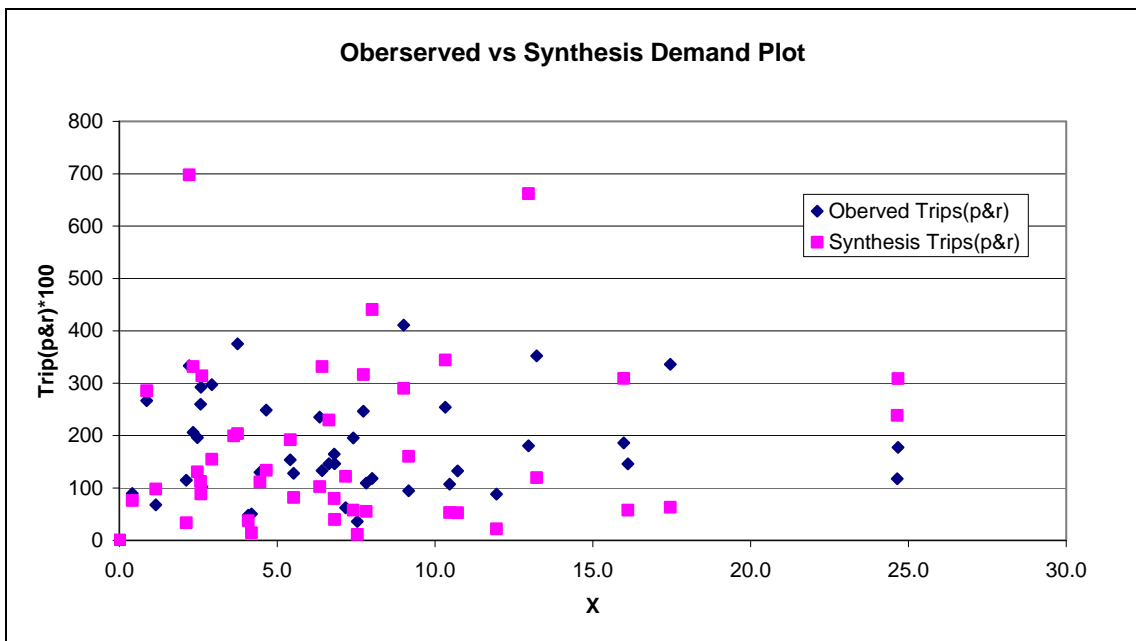


Figure 2.3 : Observed vs Synthesis Demand Plot

2.3.19 Figure 2.3 demonstrates that, while not an exact match, the synthesized trips do bear a close relation to the observed values. The final total for synthesized trips works out at **78** which compares well with the **76** actual trips used in the regression analysis.



2.4 Forecasting

2.4.1 The potential catchment area for a Park & Ride site to the south of Stirling was identified and the S-Paramics model output used to derive the components for the generalized cost equations. A total of six sites were coded and assessed in S-Paramics for the AM peak.

2.4.2 In the initial forecast for the new sites, Park & Ride frequency has been assumed at 12min and the fare has been assumed to remain at 100 pence. A further four scenarios have been considered and these are indicated in Table 2.4, scenarios 2 to 5.

Table 2.4 : 2012 Forecast Scenarios

| Ref | Scenario | Parking Charge (pence) | Bus Frequency (min) | Bus Fare (pence) | Bus Priority (s) |
|-----|-----------------------------------|---------------------------|------------------------|---------------------|---------------------|
| 1 | 2012 Base | 290 | 12 | 100 | 0 |
| 2 | 2012 Proposed Parking Charge | 250 | 12 | 100 | 0 |
| 3 | 2012 Parking Increase | 500 | 12 | 100 | 0 |
| 4 | 2012 15 min Frequency at New Site | 250 | 15 | 100 | 0 |
| 5 | 2012 2 min saving Bus Priority | 250 | 12 | 100 | 120 |

2.4.3 Table 2.4 highlights that the Logit model has been used to provide some indication of the potential impact of changes to parking charges in Stirling, Park & Ride service frequency and any bus priority on the new Park & Ride service route.

2.4.4 Only the 2012 results are reported within this document. Due to the growth assumptions for future years, the results for 2017 forecasts are reported in the economics sub section of the main Park & Ride Assessment Report.

2.4.5 Using the observed data it was possible to derive factors, based on the relative proportion of journeys occurring in the AM, Inter peak and Saturday period. This has enabled the AM Logit model output to be factored to provide forecasts for the remaining weekday and Saturday periods.

2.4.6 Any trips using Springkerse from the south were discounted on the assumption that they will use any new site in the south. While this proportion of abstraction will vary with changes to key generalized cost components for Springkerse, it is not dependant on the new site location and is tied into the Southern demand catchment as defined in the S-Paramics model. Tables 2.5a) to 2.5e) provides initial summary results. The following paragraphs provide a brief description of the scenarios.

- Table 2.5a – 2012 results using base values for town centre parking charge (weighted average), bus fare and bus frequency
- Table 2.5b – 2012 results using base values, but changing the town centre parking charge (weighted average) to reflect current reduced parking charge proposals
- Table 2.5c – 2012 results using base values, but doubling the proposed parking charge (weighted average)
- Table 2.5d – 2012 results using base values, but adopting the proposed town centre parking charge and changing the Park & Ride frequency for Castlevie and the new site from 12min to 15min. Springkerse remains as a 12min frequency.
- Table 2.5e – 2012 results using base values, but adopting the proposed town centre parking charges and assuming a 120s saving in Park & Ride bus journey time for the new site as a result of bus priority measures



Table 2.5 : 2012 Logit Model Test Scenario Summary Results

a) 2012 Forecast - Base Components

| Person Trips 2012 | AM | | | IP | | | SAT | | | Total |
|----------------------|----|----|----|-----|-----|-----|-----|-----|-----|-------|
| | CV | SK | Sx | CV | SK | Sx | CV | SK | Sx | |
| CV + SK | 57 | 90 | 0 | 111 | 175 | 0 | 147 | 481 | 0 | 1,061 |
| CV + SK + S1 | 57 | 74 | 56 | 111 | 145 | 109 | 147 | 396 | 239 | 1,333 |
| CV + SK + S3 | 57 | 74 | 57 | 111 | 145 | 111 | 147 | 396 | 243 | 1,341 |
| CV + SK + S4 | 57 | 74 | 60 | 111 | 145 | 117 | 147 | 396 | 256 | 1,362 |
| CV + SK + S5 | 57 | 74 | 59 | 111 | 145 | 115 | 147 | 396 | 251 | 1,355 |
| CV + SK + S7 | 57 | 74 | 55 | 111 | 145 | 107 | 147 | 396 | 234 | 1,326 |
| CV + SK + S8 | 57 | 74 | 59 | 111 | 145 | 115 | 147 | 396 | 251 | 1,355 |
| SK Abstraction | | | | | | | | | | |
| CV + SK + Sx | | 16 | | | 31 | | | 84 | | |

b) 2012 Forecast - Current Proposed Parking

| Person Trips 2012 | AM | | | IP | | | SAT | | | Total |
|----------------------|----|----|----|-----|-----|-----|-----|-----|-----|-------|
| | CV | SK | Sx | CV | SK | Sx | CV | SK | Sx | |
| CV + SK | 51 | 81 | 0 | 100 | 159 | 0 | 133 | 436 | 0 | 960 |
| CV + SK + S1 | 51 | 66 | 51 | 100 | 129 | 100 | 133 | 353 | 217 | 1,200 |
| CV + SK + S3 | 51 | 66 | 52 | 100 | 129 | 101 | 133 | 353 | 222 | 1,208 |
| CV + SK + S4 | 51 | 66 | 55 | 100 | 129 | 107 | 133 | 353 | 234 | 1,229 |
| CV + SK + S5 | 51 | 66 | 53 | 100 | 129 | 103 | 133 | 353 | 226 | 1,215 |
| CV + SK + S7 | 51 | 66 | 50 | 100 | 129 | 98 | 133 | 353 | 213 | 1,193 |
| CV + SK + S8 | 51 | 66 | 53 | 100 | 129 | 103 | 133 | 353 | 226 | 1,215 |
| SK Abstraction | | | | | | | | | | |
| CV + SK + Sx | | 15 | | | 30 | | | 82 | | |

c) 2012 Forecast - Parking Doubled from Current Proposals

| Person Trips 2012 | AM | | | IP | | | SAT | | | Total |
|----------------------|----|-----|----|-----|-----|-----|-----|-----|-----|-------|
| | CV | SK | Sx | CV | SK | Sx | CV | SK | Sx | |
| CV + SK | 93 | 143 | 0 | 181 | 279 | 0 | 240 | 764 | 0 | 1,700 |
| CV + SK + S1 | 93 | 117 | 90 | 181 | 229 | 176 | 240 | 626 | 384 | 2,135 |
| CV + SK + S3 | 93 | 117 | 92 | 181 | 229 | 180 | 240 | 626 | 392 | 2,150 |
| CV + SK + S4 | 93 | 117 | 96 | 181 | 229 | 187 | 240 | 626 | 409 | 2,178 |
| CV + SK + S5 | 93 | 117 | 94 | 181 | 229 | 183 | 240 | 626 | 401 | 2,164 |
| CV + SK + S7 | 93 | 117 | 89 | 181 | 229 | 174 | 240 | 626 | 379 | 2,128 |
| CV + SK + S8 | 93 | 117 | 93 | 181 | 229 | 182 | 240 | 626 | 396 | 2,157 |
| SK Abstraction | | | | | | | | | | |
| CV + SK + Sx | | 26 | | | 50 | | | 138 | | |

d) 2012 Forecast - Bus Frequency 15min for New Site and Castle View

| Person Trips 2012 | AM | | | IP | | | SAT | | | Total |
|----------------------|----|----|----|----|-----|----|-----|-----|-----|-------|
| | CV | SK | Sx | CV | SK | Sx | CV | SK | Sx | |
| CV + SK | 46 | 81 | 0 | 90 | 159 | 0 | 119 | 436 | 0 | 931 |
| CV + SK + S1 | 46 | 68 | 46 | 90 | 133 | 90 | 119 | 364 | 196 | 1,152 |
| CV + SK + S3 | 46 | 68 | 47 | 90 | 133 | 92 | 119 | 364 | 200 | 1,159 |
| CV + SK + S4 | 46 | 68 | 49 | 90 | 133 | 96 | 119 | 364 | 209 | 1,173 |
| CV + SK + S5 | 46 | 68 | 48 | 90 | 133 | 94 | 119 | 364 | 205 | 1,166 |
| CV + SK + S7 | 46 | 68 | 45 | 90 | 133 | 88 | 119 | 364 | 192 | 1,145 |
| CV + SK + S8 | 46 | 68 | 48 | 90 | 133 | 94 | 119 | 364 | 205 | 1,166 |
| SK Abstraction | | | | | | | | | | |
| CV + SK + Sx | | 13 | | | 26 | | | 72 | | |



e) 2012 Forecast - Bus Priority - 2min Time Saving on New Park and Ride Route

| Person Trips 2012 | AM | | | IP | | | SAT | | | Total |
|----------------------|----|----|----|-----|-----|-----|-----|-----|-----|-------|
| | CV | SK | Sx | CV | SK | Sx | CV | SK | Sx | |
| CV + SK | 51 | 81 | 0 | 100 | 159 | 0 | 133 | 436 | 0 | 960 |
| CV + SK + S1 | 51 | 66 | 54 | 100 | 129 | 105 | 133 | 353 | 230 | 1,222 |
| CV + SK + S3 | 51 | 66 | 56 | 100 | 129 | 109 | 133 | 353 | 239 | 1,236 |
| CV + SK + S4 | 51 | 66 | 59 | 100 | 129 | 115 | 133 | 353 | 251 | 1,258 |
| CV + SK + S5 | 51 | 66 | 57 | 100 | 129 | 111 | 133 | 353 | 243 | 1,244 |
| CV + SK + S7 | 51 | 66 | 54 | 100 | 129 | 105 | 133 | 353 | 230 | 1,222 |
| CV + SK + S8 | 51 | 66 | 57 | 100 | 129 | 111 | 133 | 353 | 243 | 1,244 |
| SK Abstraction | | | | | | | | | | |
| CV + SK + Sx | | 15 | | | 30 | | | 82 | | |

2.4.7 Tables 2.5 indicates that the new Park & Ride, were it to be located at any of the proposed sites from 1 to 8 will attract patronage at a similar level to Castleview. Some of the patronage will be as a result of abstraction from the existing Springkerse site.

2.4.8 A comparison of Tables 2.5a to 2.5e indicates the following:

- With a reduction in town centre parking charges there could be a drop in Park & Ride patronage for all sites (Table 2.5b)
- Doubling of town centre proposed parking charges results in a forecast increase in Park & Ride patronage for all sites (Table 2.5c)
- A reduction in town centre parking charges and a reduced service frequency for Castleview and the new site indicates further drops in Park & Ride patronage (Table 2.5d)
- Bus priority journey time savings of 120s for the new site will attract slightly more passengers (Table 2.5b and Table 2.5e)

2.4.9 The results of the sensitivity tests appear logical and in general indicate that, depending on placement and subject to other variables, a new site to the South of Stirling could operate at a level between the current operation of Castleview and Springkerse.

2.5 Limitations

2.5.1 Due to the limited observed data set as a result of the survey of existing sites, the Logit modelling is based on AM peak only and commuter costs only.

2.5.2 The existing Park & Ride journey times are short at around 6 – 7min from site to city centre. This suggests that existing use may not necessarily be based on decisions only on time savings and that other factors, which are difficult to capture in a simple Logit model, dictate the patronage levels, e.g. parking availability, ease of parking, etc.

