APPENDIX 3

Economic Impacts of Junction Improvements

Introduction

This note sets out the scheme evaluation for Worcester City Centre to support the National Productivity Investment Fund.

Worcestershire County Council have identified several junctions on a main arterial route the A44 east-west axis that suffer from congestion restricting the movements of goods and people. This note outlines the identified problems, along with the proposed improvements to unlock growth in jobs and homes, the assessment methodology and the estimated benefits of the schemes.

Study Area

The area covers Worcester City centre east-west axis along the A44 corridor. These include junctions with Dolday Gyratory, Deansway and St Johns. This is the main arterial route through Worcester and the only crossing point of the River Severn. It also includes a strategic crossing on the A449 Croft Road. The OS Grid Reference is **SO 84644 54786.**

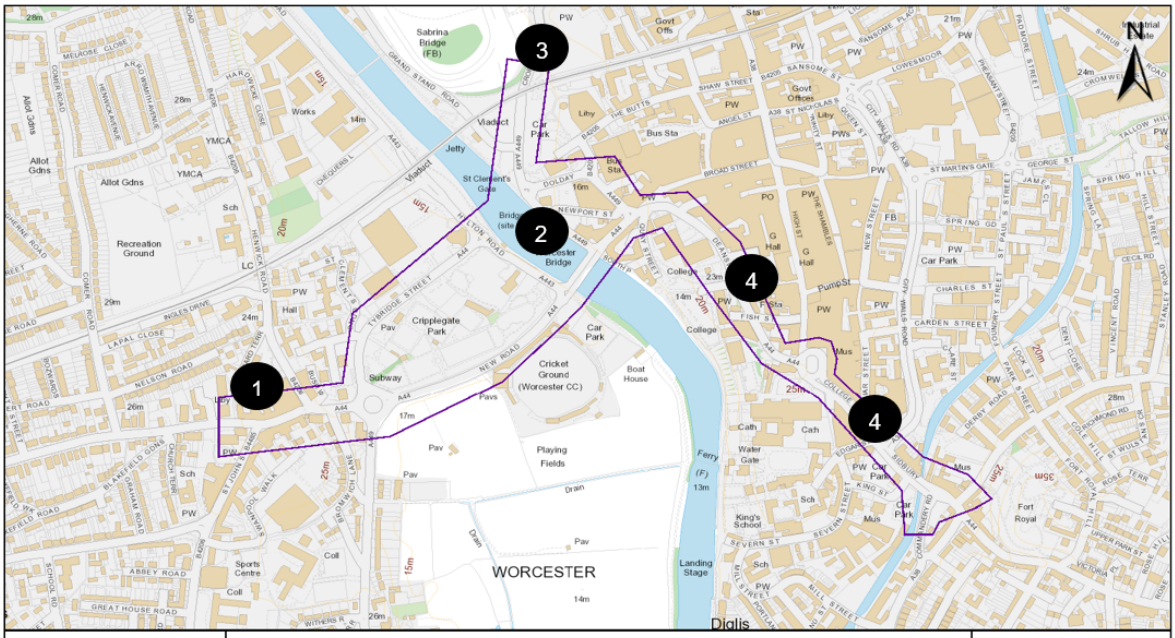
Existing Conditions and Problems Identified

The main arterial east-west A44 corridor through Worcester is essential for access, growth and vitality of the City Centre. It is constrained by one river crossing, outdated junction designs, and poor facilities for pedestrian and cyclists. The Worcester Traffic Model confirms significant delays. On the junctions along this route, there are two Air Quality Management Areas (AQMA) at St Johns (2014) and Dolday Gyratory (2009). Either side of the bridge and the A44 Deansway is expected to be an AQMA in the future. Two junctions have been identified for traffic signal upgrades through the Worcester Asset Management plan.

The problems identified are summarised in detail as follows:

- **St Johns Junction (St Johns/Bromyard Rd/Bull Ring)** - St Johns Junction, on the western side of the study area, is a narrow junction with evolved layout and ageing signal infrastructure that cannot served present traffic volumes. In addition, St Johns Junction offers poor quality pedestrian facilities. The inefficient nature of the junction generates significant localised congestion.
- **Dolday Gyratory (Dolday/Bridge Street/All Saints Road/North Quay/North Parade) -**The Dolday Gyratory is located immediately to the east of Worcester bridge. This Gyratory is a complex series of signalised junctions, which represents the heart of Worcester's highway network. The gyratory is heavily congested by car traffic entering the city centre in combination with buses utilising the gyratory to and from the bus station, resulting in buses become trapped in the congestion, as well as further worsening the traffic conditions. Poor pedestrian and cycling infrastructure also restricts travel by sustainable modes.
- **A449 Croft Road** – Directly links the City and St John's University Campuses via Sabrina walking and cycling bridge over River Severn. There is poor pedestrian and cycle provision for the high level of users. This uncontrolled crossing also adds to delays on the northern section in both directions
- **A44 Deansway (All Saints Signals through Copenhagan Street to Sidbury Signals) -** A network of signalised junctions on A44 Deansway, at the eastern end of the study area. This is a complex arrangement of signaled junctions consisted from A44/A449 All Saints junction, Copenhagen Street junction, Cathedral Square junction and Sidbury/City Walls Road junction at the eastern end. This ageing signaling infrastructure leading to inefficiencies, delays and poor quality pedestrian crossing facilities.

FIGURE 1: STUDY AREA AND IMPROVEMENT SCHEMES LOCATIONS



Proposed Improvements

The efficiency of the ageing signals infrastructure will be improved by replacing them with Microprocessor Optimised Vehicle Actuation (MOVA), which is a product developed to overcome some of the problems associated with traditional signal control system. MOVA traffic signals at each of the locations would enable more efficient demand management, smoothing traffic flow through this funnel and improving multimodal access and ambient air quality. The signals will also include provision for pedestrians and cyclist to cross, and public realm provision to facilitate improved pedestrian and cycling flow through the highway network. The estimated Opening Year of the these schemes is 2019.

Economic Efficiency of the Transport System

Modelling Approach

The approach used to estimate the user benefits of installing MOVA operating system at the traffic signals scheme locations is detailed below.

The performance of the existing signals arrangements was assessed using the 'Worcester Traffic Model' (WTM) against NPIF guidance, the relevant performance indicators (traffic volume, total travelled time and total travelled distance) were extracted to be used in the monetary benefit analysis. For each scheme, AM peak, PM peak and average inter-peak hour was modelled.

The WTM is a strategic variable demand SATURN/EMME traffic model built to the latest WebTAG guidance and is the preferred tool used by WCC to determine the future flows and travel times for the schemes in Worcester.

The performance indicators predicted by the WTM for the Do-minimum (without scheme scenario) of the 3 signal schemes (St Johns, Dolday Gyratory and A44 Deansway) have been used. The Do-something (with scheme scenario) assumes that traffic flows would grow by 2% and journey times would be reduced by 5%. This assumption is based on a 2016 survey where a MOVA system was installed on a series of junctions at Barbourne Corridor accessing Worcester City Centre from the North. The survey is suggesting travel time savings of 5%. Although, DfT is suggesting journey time savings of 13% (The "MOVA" signal control system, DfT, March 1997) based on MOVA trials taken place

in London; a reduction of 5% was chosen instead as a more conservative approach, reflecting better the local conditions. The key performance indicators for the 3 schemes are presented below in tables 1-3. Please note that this conservative assessment does not quantify any benefits related to the 2% additional traffic.

Scenario	Input Data / Key Performance Indicators	Unit	AM Peak Hr Weekday	PM Peak Hr Weekday	Inter-Peak Hr Weekday
Do-Minimum	Number of highway trips affected	vehicles	2,076	2,185	1,679
	Total vehicle travelled time	vehicle-hours	51	57	33
	Total vehicle travelled distance	vehicle-km	729	175	270
	Highway peak period conversion factor	-	2.59	2.77	6.00
	Number of PT passenger trips on affected routes	passenger trips	64	41	38
	Total PT travelled time	passenger-hrs	1.17	1.08	0.83
	PT peak period conversion factor	-			
Do-Something	Number of highway trips affected	vehicles	2,107	2,217	1,704
	Total vehicle travelled time	vehicle-hours	49	54	31
	Total vehicle travelled distance	vehicle-km	729	175	270
	Highway peak period conversion factor	-			
	Number of PT passenger trips on affected routes	passenger trips	64	41	38
	Total PT travelled time	passenger-hrs	1.11	1.03	0.79
	PT peak period conversion factor	-			

TABLE 1: SCHEME 1, ST JOHNS JUNCTION KEY PERFORMANCE INDICATORS

Scenario	Input Data / Key Performance Indicators	Unit	AM Peak Hr Weekday	PM Peak Hr Weekday	Inter-Peak Hr Weekday
Do-Minimum	Number of highway trips affected	vehicles	3,619	3,111	2,849
	Total vehicle travelled time	vehicle-hours	127	117	84
	Total vehicle travelled distance	vehicle-km	1,675	2,507	1,862
	Highway peak period conversion factor	-	2.59	2.77	6.00
	Number of PT passenger trips on affected routes	passenger trips	112	84	122
	Total PT travelled time	passenger-hrs	5.51	4.37	6.56
	PT peak period conversion factor	-			
Do-Something	Number of highway trips affected	vehicles	3,673	3,157	2,891
	Total vehicle travelled time	vehicle-hours	121	111	80
	Total vehicle travelled distance	vehicle-km	1,675	2,507	1,862
	Highway peak period conversion factor	-			
	Number of PT passenger trips on affected routes	passenger trips	112	84	122
	Total PT travelled time	passenger-hrs	5.24	4.15	6.23
	PT peak period conversion factor	-			

TABLE 2: SCHEME 2, DOLDAY GYRATORY KEY PERFORMANCE INDICATORS

Scenario	Input Data / Key Performance Indicators	Unit	AM Peak Hr Weekday	PM Peak Hr Weekday	Inter-Peak Hr Weekday
Do-Minimum	Number of highway trips affected	vehicles	3,431	3,302	2,826
	Total vehicle travelled time	vehicle-hours	282	313	153
	Total vehicle travelled distance	vehicle-km	2,375	1,620	1,603
	Highway peak period conversion factor	-	2.59	2.77	6.00
	Number of PT passenger trips on affected routes	passenger trips	83	88	150
	Total PT travelled time	passenger-hrs	5.92	7.16	10.27
	PT peak period conversion factor	-			
Do-Something	Number of highway trips affected	vehicles	3,482	3,352	2,869
	Total vehicle travelled time	vehicle-hours	267	297	145
	Total vehicle travelled distance	vehicle-km	2,375	1,620	1,603
	Highway peak period conversion factor	-			
	Number of PT passenger trips on affected routes	passenger trips	83	88	150
	Total PT travelled time	passenger-hrs	5.63	6.80	9.76
	PT peak period conversion factor	-			

TABLE 3: SCHEME 4, A44 DEANSWAY KEY PERFORMANCE INDICATORS

The hourly travel time savings from Do-minimum to Do-something were used to monetise the travel time benefits using WebTag Table A 1.3.5. Per WebTag guidance, the total time savings were categorised by identified vehicle type and journey purpose. After the time benefits were categorized, WebTag Table 1.3.5 was used to monetise the user benefits. The travel time benefits were monetised based on 2010 prices and 2010 values. The identified user groups and their predicted hourly savings for scheme 1 are presented below.

Vehicle type/ Journey Purpose	Hourly travel time savings (£)		
	AM Peak Hr	PM Peak Hr	Inter-Peak Hr
Car - Work	5.02	5.72	2.60
Car - Commuting	10.42	11.61	5.30
Car – Other	15.01	18.23	13.03
LGV - Business Use	0.47	0.52	0.30
HGV - Work	0.22	0.25	0.14

Table 4: Hourly travel time savings by vehicle type and journey purpose for Scheme 1

Then the two vehicle groups assessed were combined by journey purpose, resulting to combined hourly benefits for each user group as presented in the table below.

User Group	Hourly travel time savings (£)		
	AM Peak Hr	PM Peak Hr	Inter-Peak Hr
Business Users	5.71	6.48	3.03
Non-Business Commuters	10.42	11.61	5.30
Non-Business Others	15.01	18.23	13.03
Total Hourly Savings (£)	**31.14**	**36.32**	**21.37**

Table 5: Hourly travel time savings by user for Scheme 1

Afterwards, the daily user benefits were computed based on the 3 appraised time periods. The assumption that the daily benefits include AM peak, PM peak and 8 inter-peak hours in between was

made. The approach followed is considered to be a conservative approach, making the assumption that both peaks are limited to an hour. The annual benefits were calculated using an annualisation factor of 253 (working days in a year).

The estimated annual benefits, based on 2010 prices, were inflated from 2010 to the estimated opening year (2019) and onwards for each year of the 60 years' appraisal period. Then the inflated benefits were discounted by 3.5% for the first 30 years and by 3% for the remaining years of the appraisal period, as per WebTag guidance.

Key Assumptions

The key assumptions adopted for this assessment are detailed below and listed in table 9.

The assumption that modal spit would be constant throughout the overall flow was made for all 3 time periods assessed. The modal split used in the calculation is based on 2016 AADT values of a DfT traffic count (CP16443) on A44, west of Worcester Bridge. The traffic count location is illustrated below.

Figure 2: CP 16443 Traffic Count location.

In addition, it was assumed that the journey purpose of car users is following the national trend based on Table NTS0409 of National Travel Survey (2015) and the journey purpose of heavy vehicle users in only work.

The assumption that the travel purpose of LGVs and HGVs is only work was made for all 3 time periods assessed. The assumption that HGV journey purpose is limited to work was made since WebTag Table 1.3.5 only provides only a work purpose price for HGV. It was assumed that LGV travel purpose would also be only work related due to the lack of more information and the insignificant price difference in WebTag Table 1.3.5 between average LGV and LGV for work.

The journey purpose proportion for car users is based on the car/van driver trips per person per year for England (2015) as presented in Table NTS0409 of National Travel Survey, Department of Transport Statistics. The percentages vary over peak and off peak hours. It was assumed that non-business other use in the peak hour is mostly Education/Escort education, other escort and personal business; whereas in off peak is mostly shopping and leisure. The car/van driver values from National Travel Survey Table NTS0409 are presented in table 6 and the proportions used in the analysis in Table 7.

Trips per person per year	
Purpose	Car / van driver
Commuting	79
Business	22
Education / escort education	24
Shopping	81
Other escort	47
Personal business	39
Leisure	89
Other including just walk	-
All purposes	381

TABLE 6: NATIONAL TRAVEL SURVEY TABLE NTS0409 (2015) FOR CAR/VAN DRIVER

% car trips by purpose	AM Peak Hr	PM Peak Hr	Inter-Peak Hr
Business Use	10.2%	10.2%	8.0%
Non-Business Commuting	37.7%	37.7%	29.3%
Non-Business Other	52.1%	52.1%	62.8%

TABLE 7: PROPORTION OF CAR USE BY PURPOSE

In addition, in order for the travel time benefits to reflect both car drivers and car passengers as per WebTag guidance; WebTag Table A 1.3.3 was used. The car occupancy per vehicle kilometer travelled used in the benefits calculations is presented in the table below.

Car occupancy	AM Peak Hr	PM Peak Hr	Inter-Peak Hr
Business Use	1.13	1.15	1.16
Non-Business Commuting	1.13	1.14	1.15
Non-Business Other	1.71	1.79	1.82

TABLE 8: CAR OCCUPANCY

All key Assumptions used in the travel time benefits calculation are listed in Table 9 below.

	Modelling Criteria	Value	Commentary
Scheme Details	Opening year	2019	
	Last year of initial funding	2019	
	Appraisal Period	60 years	
Road users' benefits	Traffic flow increase from Do-Nothing to Do-Something	2%	Based on DfT National Statistics for Non-Metropolitan West Midlands Urban A roads. Impacts related to additional users have not been monetised as part of this conservative assessment.
	Journey time reduction from Do-Nothing to Do-Something	5%	Based on surveys of existing SCOOT and MOVA systems on traffic lights north of Worcester City (Barbourne Rd)
	Modal split: Car LGV HGV Bus	 84.1% 1.2% 1.2% 12.5%	The modal split used in the user benefits calculation is based on AADTs from DfT Traffic Count CP16443 (2016) that is located at A44, west of Worcester Bridge.
	Car journey purpose: Work Commuting Other	Varies over time	The journey purpose percentages for car users are based on the car/van driver trips per person per year for England (2015) as presented in Table NTS0409 of National Travel Survey, Department of Transport Statistics. The percentages vary over peak and off peak hours, because it was assumed that non-business other use in the peak hour is mostly Education/Escort education, other escort and personal business; whereas in off peak is mostly shopping and leisure.
	HGV and LGV journey purpose: Work	100%	According to WebTag Databook Table A 1.3.5 (March 2017 version) the only journey purpose for Heavy Vehicles is work. The assumption that LGV journeys are also only work related was made due to lack of more information.
	Market Price of time per vehicle based on distance travelled for: car - work car- commuting car - other LGV - work OGV1/OGV2 - work	Varies over time	The AM peak, PM peak and inter-peak value of time for each vehicle/travel purposed used in the time saving benefits calculations are based on Table A 1.3.5 for the WebTag Databook (March 2017 version)
	Car occupancy	Varies over time	The car occupancy rate for each time period is based on WebTag Table A 1.3.3
	Daily journey time savings (hours)		AM peak hour + PM peak hour + 8 times the average inter peak hour
	Annualisation factor of hourly savings	253	Standard workings days / year (excluding weekends and bank holidays)

TABLE 9: KEY ASSUMPTIONS

Travel Time Saving Economic Benefits

The benefits for each one of the three schemes assessed are presented in tables 10-12 and the total benefits of the three schemes in Table 13. Even though the uplift value used for the travel time savings and the modelling assumptions are considered to be conservative, the user benefits for all schemes are high.

Economic Efficiency of the Transport System (TEE)	£ [000]
Non-business: Commuting Travel time benefits	613
Non-business: Other Travel time benefits	1,307
Business Travel time benefits	347
NET BUSINESS IMPACT	347
Present Value of Transport Economic Efficiency Benefits (TEE)	2,267

TABLE 10: SCHEME 1 TEE

Economic Efficiency of the Transport System (TEE)	£ [000]
Non-business: Commuting Travel time benefits	1,508
Non-business: Other Travel time benefits	3,258
Business Travel time benefits	854
NET BUSINESS IMPACT	854
Present Value of Transport Economic Efficiency Benefits (TEE)	5,620

TABLE 11: SCHEME 2 TEE

Economic Efficiency of the Transport System (TEE)	£ [000]
Non-business: Commuting Travel time benefits	3,033
Non-business: Other Travel time benefits	6,369
Business Travel time benefits	1,714
NET BUSINESS IMPACT	1,714
Present Value of Transport Economic Efficiency Benefits (TEE)	11,116

TABLE 12: SCHEME 4 TEE

Economic Efficiency of the Transport System (TEE)	£ [000]
Non-business: Commuting Travel time benefits	5,154
Non-business: Other Travel time benefits	10,934
Business Travel time benefits	2,915
NET BUSINESS IMPACT	2,915
Present Value of Transport Economic Efficiency Benefits (TEE)	19,003

TABLE 13: COMBINED TEE FOR SCHEMES 1, 2 AND 4