

UK RP3 CAA Decision Document: Appendices

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APPENDIX A

Abbreviations

Abbreviations	
3Di	metric that incorporates flight path inefficiencies
ACP	Airspace Change Proposals
ADS-B	automatic dependent surveillance – broadcast system
AIS	aeronautical information services
AMS	Airspace Modernisation Strategy
ANS	air navigation services
ANSL	Air Navigation Solutions Ltd
ANSP	air navigation services provider
ASEPS	advanced surveillance enhanced procedural separation
ASBU	Aviation System Block Upgrades
ATC	air traffic control
ATCO	air traffic control officer
ATS	air traffic services
ATSA	air traffic services assistant
ATFCM	air traffic flow and capacity management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
BAATL	Birmingham Airport Air Traffic Ltd
C1	key performance indicator in the area of capacity - average minutes of ATFM delay
C2	performance indicator in the area of capacity - average minutes of ATFM delay attributable to NERL
C3	performance indicator in the area of capacity - delay impact score
C4	performance indicator in the area of capacity - daily excess delay score
CAAPS	CAA Pension Fund
CAPM	capital asset pricing model
CCWG	Customer Consultation Working Group
CDO	Continuous Descent Operation
CEPA	Cambridge Economic Policy Associates
CNS	Communication Navigation Surveillance

Abbreviations	
CPI	consumer price index
CSU	chargeable service unit
DB	defined benefit
DC	defined contribution
DfT	Department of Transport
DMO	Delivery Monitoring and Oversight
DUC	determined unit cost
EBITDA	earnings before interest, tax, depreciation and amortisation
EoSM	Effectiveness of Safety Management
EU	European Union
FAB	Functional Airspace Block
FAS	Future Airspace Strategy
FFO	funds from operations
FIR	flight Information Region
FMARS	future military area radar service
FTE	full time equivalent
GAD	Government Actuary's Department
GANP	Global Air Navigation Plan
GDP	Gross Domestic Product
HAL	Heathrow Airport Limited
IAG	International Airlines Group
IBP	Initial Business Plan
ICAO	International Civil Aviation Organisation
IFR	instrument flight rules
IR	independent reviewer
KEA	horizontal en route flight efficiency of the actual trajectory indicator
KEP	horizontal en route flight efficiency of the last filed flight plan
KPA	key performance area
KPI	key performance indicator
LAMP	London Airspace Management Programme
MOCCA	Met Office Civil Contingencies Aircraft
LIBOR	London Inter Bank Offered Rate
MOD	Ministry of Defence
NATS	National Air Traffic Services

Abbreviations	
NATSPG	North Atlantic System Planning Group
NERL	NATS (En Route) plc
NM	Network Manager
NOP	Network Operations Plan
NPV	net present value
NSA	National Supervisory Authority
NSL	NATS Services Ltd
OEF	Oxford Economics forecast
OFF	Opex Flexibility Fund
OTS	organised track system
PBO	Pensions Benefit Obligation
PBN	Performance Based Navigation
PI	Performance Indicator
PRB	Performance Review Body
RAB	Regulatory Asset Base
RBP	Revised Business Plan
RFR	risk free rate
RPS	Regulatory Policy Statement
RP2	Reference Period 2
RP3	Reference Period 3
RP4	Reference Period 4
RORE	return on regulated equity
RPI	retail prices index
S&P	Standard & Poor's
SARG	Safety and Airspace Regulation Group
SES	Single European Sky
SESAR	Single European Sky ATM Research
SIP	Service and Investment Plan
SSP	State Safety Programme
STATFOR	(Eurocontrol's) Statistics and Forecasts Service
TANS	terminal air navigation services
TMR	total market return
TSU	total service units
UIR	upper flight information region

Abbreviations	
UPR	user preferred routes
VAAC	Volcanic Ash Advisory Centre
WACC	weighted average cost of capital
WAFS	World Area Forecast System

Note: Unless stated otherwise, all financial figures throughout the appendices are in £2017 CPI prices.

APPENDIX B

Regulatory framework and scope

Introduction

- B1 This appendix summarises the legal and regulatory frameworks applicable to our RP3 final decisions in respect of NERL's monopoly activities and the preparation of the broader UK performance plan.

Regulatory framework

The performance and charging scheme

- B2 The SES performance and charging scheme is set out in EU legislation and is designed to improve the performance of ANS in four key performance areas (KPAs):
- Safety
 - Capacity
 - Environment
 - Cost efficiency
- B3 Detailed requirements of the performance scheme are contained in the RP3 performance and charging regulation (the 'performance regulation'),¹ the main features of which are summarised below.
- B4 Member States must adopt performance plans in respect of ANS providers covering a five-year reference period. The current regulatory cycle, Reference Period 2 (RP2), comes to an end on 31 December 2019. Reference Period 3 (RP3) will run from 1 January 2020 to 31 December 2024.
- B5 The European Commission (the Commission) must set EU-wide targets in each KPA based on Key Performance Indicators (KPIs), taking account of performance achieved in the previous reference period and inputs provided by

¹ Commission Implementing Regulation (EU) 2019/317 of 11 February 2019 laying down a performance and charging scheme in the single European sky and repealing Implementing Regulations (EU) No 390/2013 and (EU) No 391/2013

certain advisory bodies (the Performance Review Body (PRB), the SES Network Manager (NM) and NSAs).

- B6 The performance plans submitted by Member States must contain performance targets for each KPI set at national level that are consistent with EU-wide targets that are set by the Commission.
- B7 Performance targets in the KPAs of capacity, environment and cost efficiency should be subject to effective financial incentive schemes to encourage better performance. There are no financial incentives on safety due to its overriding importance.
- B8 NSAs must consult on performance plans to ensure the views of stakeholders are taken into account in establishing performance plans and targets.

Finalising the RP3 performance plan

- B9 The DfT is required to adopt and submit the draft performance plan to the Commission by 1 October 2019.
- B10 Within one month of submission, the Commission will conduct a verification process on Member States' performance plans. If no key information has been omitted, the performance plans submitted by Member States will come into effect on 1 January 2020.
- B11 Within five months of submission (1 March 2020 at the latest) the Commission will undertake a formal assessment of performance plans and targets, for consistency with the regulation and EU-wide targets. If any subsequent changes are required, they will be applied retrospectively.

The Transport Act 2000

- B12 The Transport Act gives the CAA a primary duty to exercise its functions so as to maintain a high standard of safety in the provision of air traffic services.
- B13 In exercising its functions, the CAA must do so in a manner it thinks best calculated:
- to further the interests of operators and owners of aircraft, owners and managers of aerodromes, persons travelling in aircraft and persons with rights in property carried in them;
 - to promote efficiency and economy on the part of licence holders;
 - to secure that licence holders will not find it unduly difficult to finance activities authorised by their licences;
 - to take account of any international obligations of the UK notified to the CAA by the Secretary of State (whatever the time or purpose of the notification); and

- to take account of any guidance on environmental objectives given to the CAA by the Secretary of State.

B14 The Transport Act also places duties on NERL. As the licence holder it:

- must secure that a safe system for the provision of authorised air traffic services in respect of a licensed area is provided, developed and maintained;
- must take all reasonable steps to secure that the system is also efficient and coordinated;
- must take all reasonable steps to secure that the demand for authorised air traffic services in respect of a licensed area is met;
- must have regard, in providing, developing and maintaining the system, to the demands which are likely to be placed on it in the future.

B15 Our approach to economic regulation includes price controls where we specify the maximum amounts that NERL can charge its customers for its regulated services. These amounts depend on how it performs against performance targets. These price controls are given effect through conditions in the NERL licence.

B16 If, in due course, NERL accepts our performance plan and the associated licence modifications that give effect to this, it should only do so on the basis that it is taking full responsibility and accountability for providing an appropriately high quality of service to airlines and their passengers. If NERL were not to consent to our licence modifications, we expect that we would in due course make a reference to the Competition and Markets Authority (CMA) to investigate and report on our proposed modifications.

Scope of the performance plan

B17 The performance plan covers:

- NERL's en route ANS in the Scottish and London Flight Information and Upper Information Regions (FIR/UIR);
- NERL's London Approach combined approach ANS for certain London airports;²
- the costs of the UK's contribution to Eurocontrol – referred to as DfT costs in the performance plan;
- the costs of aviation services provided by the Met Office;
- the costs of the CAA's airspace policy and regulation activities; and

² See chapter 8 on the London Approach service

- terminal ANS performance requirements.³

- B18 Under the performance regulation, Member States may decide to adopt plans at the Functional Airspace Block (FAB) or national level. Our final decisions and the performance plan have been developed on the basis of adoption at the national level. Brexit implications aside, there are material differences in terms of size, scope and complexity of UK and Irish airspace and ANS. In these circumstances, national plans provide a more transparent view of respective performance over RP3.
- B19 Furthermore, the complexity of the UK airspace and air navigation arrangements mean that it is not appropriate to apply the simplified charging scheme set out in Article 34 of the performance regulation.
- B20 The Oceanic price control covers the air traffic services NERL provides to aircraft crossing the North Atlantic. This service is not in scope of the SES performance framework and is regulated under the Transport Act. The regulatory periods are aligned and, where appropriate, we have made similar assumptions in setting the Oceanic and UK en route price controls. Chapter 11 of our main document sets out final decisions for the Oceanic price control.

³ See chapter 10 on terminal ANS

APPENDIX C

Traffic forecasts

- C1 To establish the projections of the DUC's that are central to the UK performance plan, it is necessary to adopt a traffic forecast to use alongside projections of costs and revenues. We have assessed both of the forecasts produced by NERL and Eurocontrol's Statistics and Forecasting service (STATFOR) and the latest versions of these forecasts are not significantly different from each other. In reaching our views on the best forecast to use for RP3, which are set out in chapter 1 of the main document, we have considered the advantages and disadvantages of each forecast. This appendix provides a high-level comparison between the two forecasts.

Comparison of STATFOR and NERL's traffic forecasts

- C2 NERL's (May 2019) and STATFOR (February 2019) are not significantly different, with NERL's flights forecast 1.0% above STATFOR's for the RP3 period, and NERL's TSU forecast 0.9% below that of STATFOR. We have considered the advantages and disadvantages of each forecast to identify the best forecast to use with our assumptions on costs and revenues for RP3.

Treatment of excess demand

- C3 The main difference between NERL's forecasting methodology and STATFOR's is the treatment of excess demand when airports become constrained. NERL's model re-allocates passengers to viable alternative airports when a particular airport is capacity-constrained. The STATFOR model instead assumes that excess demand is lost, implying that constrained-off passengers would not fly. The NERL approach is theoretically preferable for the UK compared to the STATFOR approach, which is more suited to continental Europe where the impact of airport constraints is significantly lower than for UK, and where rail or road travel may be a more viable alternative to flying.
- C4 There are minor differences in scope between how NERL and STATFOR count historical flight numbers, however they generally evolve at the same rate because, by and large, they almost completely overlap. The official Network Manager IFR Flight Counts, as used by STATFOR, were 0.8% higher than NERL equivalent counts. Therefore, to make like-for-like comparisons between NERL and STATFOR, we have derived the NERL forecast using NERL growth rates, but baselined to STATFOR 2018 actual data. It is noted that the NERL financial model uses NERL actual TSUs for 2018, which are about 2000 TSU's lower than shown in Table C.1.

Table C.1 compares the NERL (May 2019) and STATFOR (February 2019) forecasts. All else being equal, in a capacity-constrained environment, as expected for the UK in RP3, the NERL model would be expected to produce higher traffic forecasts. However, for RP3 as a whole, STATFOR's forecast for TSU is 0.9% higher than NERL's forecast.

Table C.1: Comparison of NERL and STATFOR traffic forecast

	Source	2018 A	2019	2020	2021	2022	2023	2024	RP3 (2020- 2024)
Overall UK flights (000)	STATFOR	2,558	2,600	2,649	2,685	2,737	2,771	2,802	13,645
	NERL	2,558	2,581	2,630	2,693	2,760	2,827	2,866	13,776
TSU (000)	STATFOR	12,194	12,408	12,648	12,891	13,183	13,406	13,615	65,743
	NERL	12,194	12,299	12,391	12,701	13,043	13,380	13,636	65,150

Source: NERL and STATFOR

2019 baseline

- C5** Both forecasts use 2019 to represent the base starting point for the 2020-2024 forecast period. Actuals available for 2019 at the time of the analysis (January – June) point to a more positive outturn than anticipated in NERL's forecast. For flights, year to date growth is 1.7% compared to STATFOR's annual growth rate assumption of 1.7% and NERL's annual assumption of 0.9%. On this basis, the STATFOR forecast appears more plausible.
- C6** For TSUs, year to date growth is 3.3% compared to STATFOR's annual growth rate assumption of 1.8% and NERL's annual assumption of 0.9%. For the STATFOR forecast to materialise, the rest of the year would be expected to grow by 0.4%, while for NERL's forecast to materialise, the rest of the year (including the peak summer months) the TSUs growth would have to decline by 1.3%. Both forecasts appear to underestimate the likely outturn for 2019 given the year to date, but NERL significantly more so than STATFOR. This reinforces the conclusions above with respect to STATFOR being a more plausible forecast.

Distance factor assumptions

- C7** The position of the jet stream over the North Atlantic significantly influences distances flown by transatlantic flights, which make up a significant (c.40%) portion of NERL's regulated revenue. NERL assume a decline in distances on the North Atlantic from a peak in 2018 to 5-year average distances by 2020. To date in 2019 this has not been apparent and TSUs continue to grow strongly relative to 2018. Based on outturn traffic to June 2019, it would take a significant

and sustained reduction in average distances on the North Atlantic for the rest of the year for NERL's 2020 forecast to materialise and, while this is possible, we consider it to be unlikely.

- C8 We understand that STATFOR shares the NERL view regarding distances on the NAT reverting to long-term averages. However, the STATFOR TSUs forecast is based on a higher flight forecast than NERL's in the early years which raises the TSU forecast above NERL's. Although outturn to June 2019 points to higher TSUs than either STATFOR or NERL, STATFOR compares more favourably with data from 2019.

Aircraft weight assumptions

- C9 Analysis of both forecasts suggests that the methodology and assumptions used for calculating the aircraft weight factor do not seem to sufficiently take account of aircraft weight growth. Heathrow and Gatwick airports are both likely to be constrained in RP3 and the NERL forecast would be expected to assume larger aircraft sizes to maximise runway utilisation at constrained airports. However, there appears to be no significant weight factor growth in NERL's TSUs calculation, with flight and TSU growth rates appearing to be almost identical. This could lead to NERL underestimating TSU's growth.
- C10 STATFOR assumes some weight growth based on historical data for the UK (not individual routes/airports), which should capture some of the effect of increased aircraft sizes at constrained airports in the UK, but not to the extent we would have expected, meaning that STATFOR's forecast could also understate TSUs. On balance, recognising that the STATFOR TSU forecast is higher than NERL's, we consider STATFOR to represent a more plausible scenario.

Economic assumptions

- C11 1.11 GDP is a key economic assumption underpinning the forecasts and has been revised down since our draft proposals (although these revisions have not been material). In May 2019, STATFOR issued a new short-term TSU forecast covering only the first year of RP3. For the UK, this represented a 0.2% reduction in TSUs when compared to the February 2019 forecast.

Distance factor methodology

- C12 For RP3 a new method for calculating the distance factor will apply for establishing TSUs. In RP2, the distance factor is based on planned distances whereas in RP3, it will be based on actual distances. Neither NERL nor STATFOR forecasts take into account this change in methodology.
- C13 In May 2019, the CRCO estimated that the change in methodology will increase the UK TSU forecast by some 0.2%. Recognising the potential limitations of

using forecasts that do not account for the RP3 change in method,⁴ taking the impact of the GDP effect together with the implied impact of the change in distance factor, the net outcome is neutral making the STATFOR February forecast still plausible.

⁴ STATFOR is expected to issue a new forecast, which will follow the new methodology set out in the performance regulation in October 2019, after the performance plans are submitted to the Commission.

APPENDIX D

Service quality – additional information

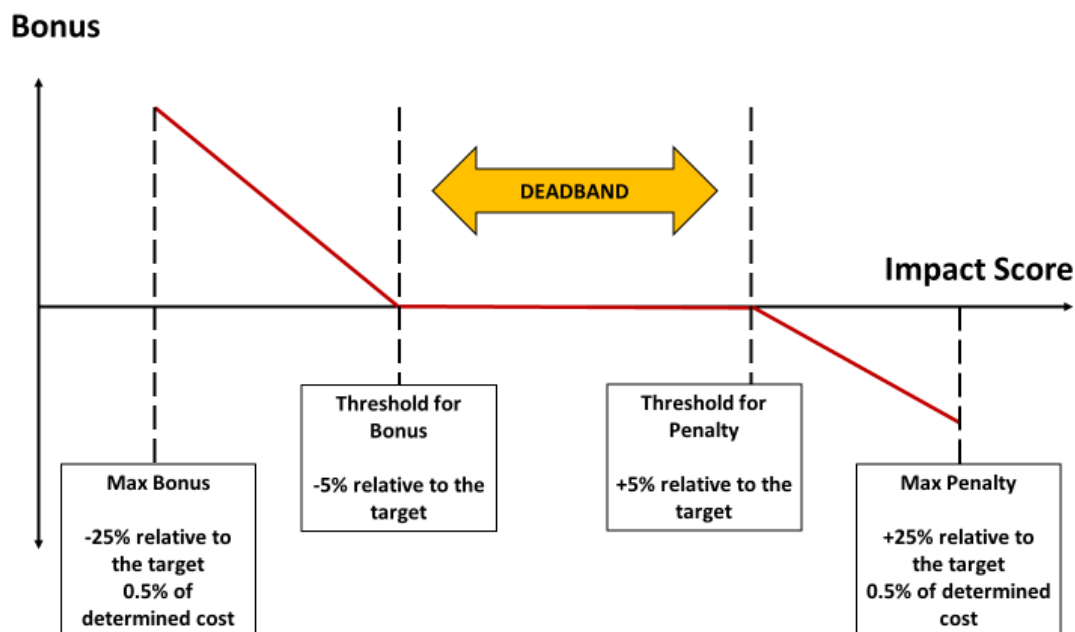
- D1 The service quality metrics and incentives for the UK for RP3 are based on the performance measures in place for RP2. This appendix provides further detail on the calculation of the service quality metrics for the Environment and Capacity KPAs.

Environment

3Di incentive scheme

- D2 The 3Di incentive scheme is established on the basis of the targets discussed in chapter 3. As in RP2, a deadband of $\pm 5\%$ is proposed for RP3 within which no bonus or penalty is triggered. Beyond the deadband, the incentive will follow a smooth sliding scale until $\pm 25\%$ of the target at which point maximum financial bonus or penalty will be reached.
- D3 The incentive rate is calculated evenly for each 3Di unit within the range $+5\%$ to $+25\%$ of the target (and correspondingly between -5% and -25% of the target).
- D4 For example, the incentive rate for 2020 is $\pm 0.091\%$ of NERL's Determined Costs for each 3Di unit beyond the deadband, up to a maximum of $\pm 0.5\%$ of Determined Costs. The incentive rate is derived by dividing the overall pot of the incentive scheme (in this case $\pm 0.5\%$ or 0.005) by the units between the $\pm 5\%$ deadband and $\pm 25\%$ maximum threshold. With the 2020 target of 27.8 the deadband for bonuses starts at 26.4 and ends at 20.9 [$26.4 - 20.9 = 5.5$; $(0.005/5.5) \times 100\% = 0.091\%$].
- D5 Figure D.1 illustrates the incentive scheme for 3Di.
- D6 As in RP2, the 3Di thresholds are not modulated for traffic.

Figure D.1: 3Di incentive scheme



Source: CAA

Capacity - C2

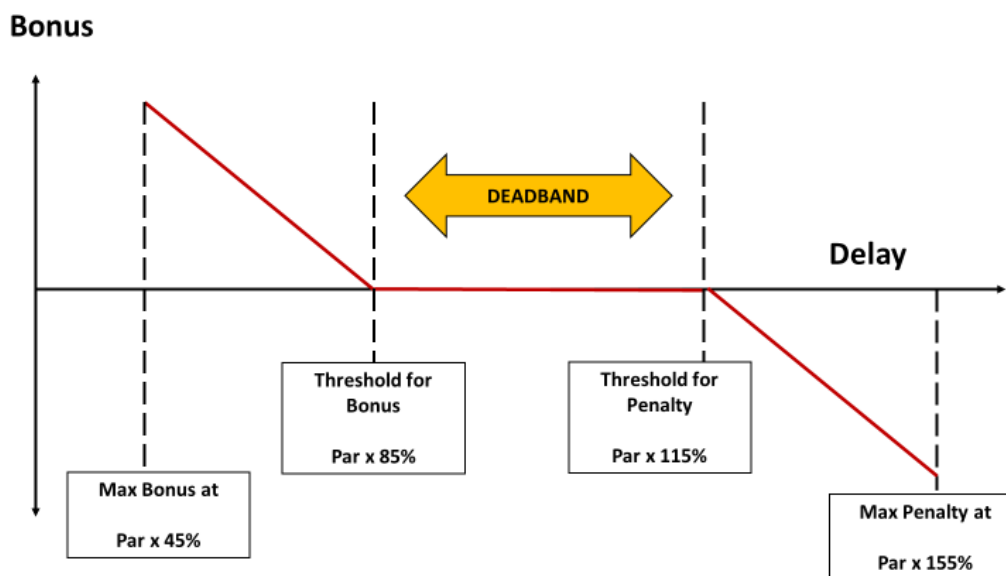
C2 incentive scheme

- D7 The C2 is an adjusted metric that is used for the purpose of the mandatory incentive scheme in the capacity KPA. It is referred to as 'pivot value' in the performance regulation.
- D8 As indicated in chapter 4, we intend to maintain the proportions of non-ANSP-attributable delay for the calculation of this target vs. the C1 target at levels targeted currently in RP2. Based on past performance, the C2 targets for RP2 represented 78% of the C1 target (meaning 22% of the C1 delay was considered non-ANSP attributable). This proportion was maintained in NERL's business plan and agreed with airlines during NERL's consultation. The RP3 target for C2 is therefore also calculated on the basis of the same proportions. For example, the C2 target for 2020 is the C1 target of 0.26 multiplied by 78% ($0.26 \times 0.78 = 0.20$).
- D9 The performance regulation requires a symmetric 'deadband' range be applied around the C2 target, so that minor variations in ATFM delay do not lead to bonuses or penalties.
- D10 As discussed in chapter 4, the targets seek to balance good past performance, with ensuring appropriate flexibility to support the major transitions planned in RP3. To prevent NERL from gaining undue bonuses if the transitions are delayed (or do not cause the extent of delay anticipated by NERL) as well as strong opposition from airspace users to pay for additional capacity if targets are outperformed, we decided to minimise the potential for bonuses by reducing the

strength of the incentive scheme. With uncertainties related to the transitions, an adjustment was also made to the strength of the penalty for this metric, to align it with RP2 levels. As per our draft proposals, we propose that the deadband is set at $\pm 15\%$. NERL considered that this would mean penalties will be incurred sooner but the asymmetric deadband in RP2 meant that NERL would start incurring penalties if it deviated from the target value by 10%, rather than 15% proposed for RP3.

- D11 This means that NERL would be subject to a penalty should its performance in any year be more than 15% worse than the targets set out in chapter 4 (i.e. for 2020 this would mean ATFM delay of 0.23 minutes/flight or higher). NERL will earn a bonus should its performance in any year be more than 15% better than the targets set out in chapter 4 (i.e. for 2020 this would mean ATFM delay of 0.17 minutes/flight⁵ or lower).
- D12 As in RP2, maximum allowed bonuses or penalties would be reached if NERL's performance is outside the deadbands by an additional $\pm 40\%$. The incentive will follow a sliding scale as illustrated in Figure D.2 below.

Figure D.2: C2 deadband and incentives



Source: CAA

Capacity - C3

Calculation of C3

- D13 The C3 metric is an impact score, which places greater weight on long delays and delays in the morning and the evening peaks. The targeted levels of the C3

⁵ Rounded to two decimal places

impact score are set out in chapter 4. The annual impact score is calculated by weighting ATFM delays in accordance with Table D.1.

Table D.1: Weights for impact score

	Morning peak period	Evening peak period	Other times
Delay > 0 and ≤ 15 minutes	3	2	1
Delay > 15 and ≤ 30 minutes	6	3	2
Delay > 30 and ≤ 60 minutes	9	6	3
Delay > 60 minutes	18	9	6

Source: CAA. Notes: "Morning peak" means flights with an off-block estimated time between 0400 and 0800 UTC in Summer (April –October inclusive) and between 0500 and 0900 UTC in Winter (January – March inclusive and November-December inclusive). "Evening Peak" means flights with an off-block estimated time between 1500 and 1900 UTC in Summer (April –October inclusive) and between 1600 and 2000 UTC in Winter (January-March inclusive and November-December inclusive).

D14 The weights in Table E.1 were developed through consultation between NERL and users for a previous control period (CP3) before the performance regulation applied. It will continue to apply in RP3.

C3 incentive scheme

D15 The thresholds beyond which NERL can earn a bonus or penalty for the C3 metric are determined with reference to C2. That is:

- the (upper) threshold above which NERL is penalised be equal to the C3 score derived from the level of the C2 target; and
- to maintain consistency with RP2, the (lower) threshold below which NERL would earn a reward be set at two-thirds of the upper threshold.⁶

D16 In RP2 a ratio of 2.2 was used to convert C2 value to C3 thresholds. However, NERL's performance so far in RP2 (including its projection for 2018) point to an average ratio of 1.89. We have therefore used a ratio of 2.0 in this determination.

D17 In order to arrive at the C3 value, the C2 target is first converted from minutes/flight to seconds/flight by multiplying the target by 60. It is then multiplied by the conversion factor of 2.0 to reach the upper threshold of C3. For example, for 2020 the calculation is as follows: $0.20 \times 60 \times 2.0 = 24$.

D18 The lower threshold of C3 is then derived by multiplying the upper thresholds by two-thirds. For example, for 2020 the calculation is as follows: $25 \times (2/3) = 16$.

D19 Following the increase of C3 targets as discussed in chapter 4 and given the availability of transitional allowance for this measure (see below), we reviewed

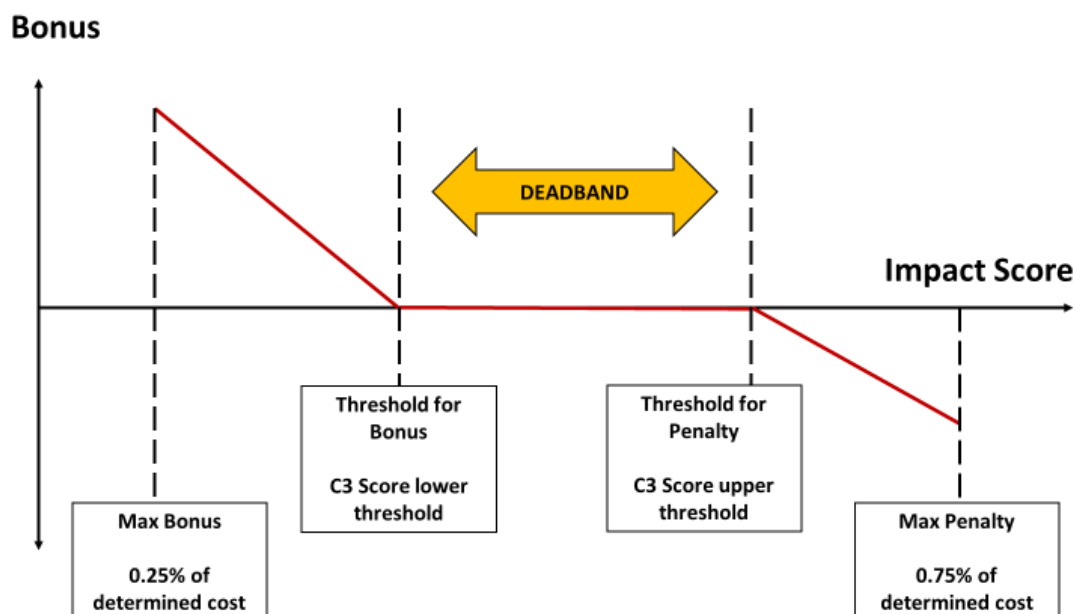
⁶ In RP2 the lower threshold was based on delay forecasts in NERL's business plan

and reduced the strength of the incentive scheme. The rate at which NERL's performance would affect any bonus or penalty it earns has been set such that the maximum reward of 0.25% of Determined Costs would be earned if the impact score is zero and the traffic is as forecast for 2020.⁷ That rate is £0.038 in 2017 prices. The penalty rate is £0.075 in 2017 prices up to a cap of -0.75% of Determined Costs. The bonus and penalty rate will be indexed to CPI during RP3.

D20 The rates are calculated based on total pot for the incentive (for 2020, based on a Determined Cost of £637.390m in 2017 prices, this is £1.593m for bonuses given the 0.25% maximum cap and £4.780m for penalties given the 0.75% maximum cap) divided by: the C3 score (for 2020, this is a lower threshold of 16 or upper threshold of 24) multiplied by the traffic forecast for that year (for 2020, this is 2.649). The bonus rate for 2020 is calculated as follows:
 $1.593 / (16 * 2.649) = 0.038$.

D21 Figure D.3 illustrates the application of the incentive.

Figure D.3: C3 incentive scheme



Source: CAA

Modulation of C3

D22 The same approach to modulating C3 for traffic volumes that was used in RP2 will be maintained for RP3. If traffic is more than $\pm 4\%$ different from the level forecast for that year, the bonus/penalty thresholds will be adjusted. The

⁷ The rate is fixed in real terms for every year of RP3 but is calibrated based on 2020 traffic

thresholds will be modulated by the net change in traffic beyond the $\pm 4\%$ threshold, multiplied by an “elasticity factor” of 5.

- D23 For example, if the traffic growth in a particular year is 7% higher than forecast, the thresholds will be adjusted upwards by $(7\% - 4\% = 3\%) * 5 = 15\%$. For example, should this be the case in 2020, the lower threshold would increase from 16 to 18.4 (i.e. $16 * 1.15 = 18.4$) and the upper threshold would increase from 24 to 27.6 (i.e. $24 * 1.15 = 27.6$).

Capacity - C4

Calculation of C4

- D24 The C4 metric (Daily Excess Delay Score) is based on weighted delays exceeding pre-determined thresholds on a daily basis. The targeted levels of C4 are discussed in chapter 4.
- D25 C4 is calculated by weighting ATFM delay in accordance with Table D.3. Delay below the lower threshold is weighted as zero.

Table D.3: Weighting of delay to derive excess delay score – weightings

Season	Daily delay thresholds (average delay per flight)		Weighting
Winter	Lower threshold	40 seconds	1
	Upper threshold	80 seconds	2
Summer	Lower threshold	60 seconds	1
	Upper threshold	110 seconds	2

Source: CAA. Note: Summer is April –October inclusive. Winter is January – March inclusive and November-December inclusive.

C4 incentive scheme

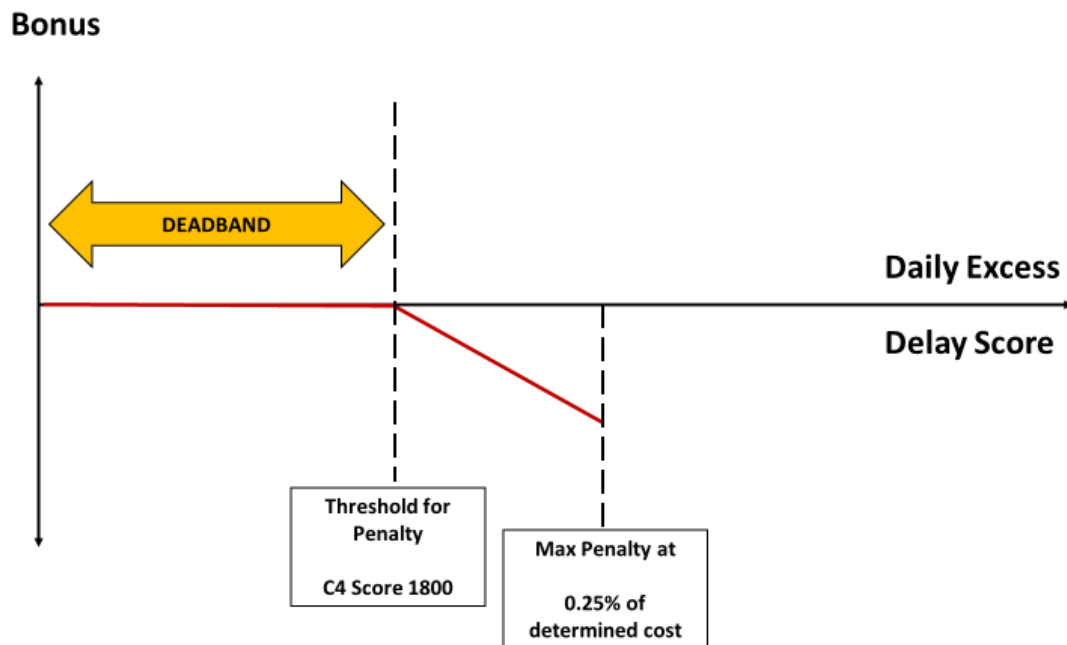
- D26 C4 is a penalty-only incentive scheme. For RP3 we initially proposed to increase the maximum penalty to 0.5% of Determined Costs but given the overall importance of the AMS and the fact the target level is tightened for RP3, we have reverted to the RP2 strength of the penalty, capped at 0.25% of Determined Costs. The maximum penalty would be incurred if traffic is as forecast for 2020 and NERL's C4 score is 20% higher than the threshold. That rate is - £0.00167094 in 2017 prices.
- D27 The rate is calculated based on total pot for the penalty (for 2020, based on a Determined Cost of £637.390m in 2017 prices, this is £1.593m given the 0.25% maximum cap) divided by: the C4 score at which maximum penalty will be incurred (for 2020, based on the 20% mentioned above this is $1800 * 20\% = 360$)

multiplied by the traffic forecast for that year (for 2020, this is 2.649). The rate for 2020 is calculated as follows: $1.593/(360 \times 2.649) = 0.00167094$.⁸

D28 The penalty rate will be indexed to CPI during RP3. Figure D.4 illustrates the C4 incentives.

D29 As in RP2, the C4 threshold is not modulated for traffic volume.

Figure D.4: C4 incentive scheme



Source: CAA

Exemption days

D30 Principles for the application and use of exemption days:

- the mechanism allows NERL to exclude up to 100 days from counting against the C3 and C4 incentives when major new systems or airspace changes are being implemented and transitions are made;
- the exemption days apply only to the C3 and C4 measures;
- on days when C4 is triggered, the implied penalty applied for that day for C3 and C4 in aggregate will be the higher of either individual penalties for the day;
- the amount of days NERL will be allowed to use towards its transitions is capped at 100 days for the entire five-year period of RP3;

⁸ Note the numbers may not add up fully due to rounding of the penalty pot to illustrate the example

- NERL will consult airspace users on the exemption days in advance under currently existing consultation mechanisms (eg. SIP) or targeted consultation;
- the length of any given transition should be limited to three weeks (unless otherwise agreed with users) and will be agreed in advance as well as the amount of days from the overall cap that NERL wishes to use towards this transition;
- the number of days agreed during the consultation will be fixed (unless subsequently revised with the agreement of users) but the particular exempt days within the agreed transition period would not need to be specified as part of the consultation;
- NERL will carry out the transition by means of the detailed steps and timing that are most operationally practical and ex-post nominate the exempt days (up to the pre-agreed maximum) for the transitional period (length of which is also pre-agreed).
- if at the end of the transition period NERL does not need/wish to use the pre-agreed amount of exempt days, these will still count against the overall 100 day cap (i.e. no roll over of unused exclusions).

APPENDIX E

Cost of capital

Introduction

- E1 In its RP3 business plan, NERL proposed a pre-tax weighted average cost of capital (WACC) of 5.07%, deflated by the retail prices index (RPI) for the UK en route and Oceanic price controls.⁹ This was made up of a vanilla WACC of 4.51% and a tax uplift of 12.7%.¹⁰ NERL's proposed vanilla WACC was higher than we set at RP2 (4.25%), but the pre-tax WACC was lower than at RP2 (5.86%) given the reduction in the corporation tax uplift (37%). NERL commissioned NERA Economic Consulting to advise on the appropriate WACC for RP3. NERL adopted NERA's point estimate, which reflected the mid-point of its low-high range.
- E2 In our draft proposals we used a vanilla WACC of 2.57% and a pre-tax WACC of 2.84%, deflated by the retail prices index (RPI) for the UK en route and Oceanic price controls.¹¹ This was significantly below NERL's proposed pre-tax WACC of 5.07%, particularly reflecting our view that NERL has significantly overestimated the required cost of equity.
- E3 In its response to our draft proposals, NERL has made a number of points around our draft proposals for cost of equity, cost of debt and overall WACC.¹² NERL commissioned NERA Economic Consulting (NERA) to advise on the cost of equity and Professor Zalewska to advise on debt betas used to estimate the cost of equity.¹³ In its response, NERL proposed a revised vanilla WACC of 4.21% in RPI-deflated terms, a 30bps reduction on 4.51% proposed in its RP3 business plan.

⁹ This is consistent with the Regulatory Asset Base (RAB), which is inflated each year to current cost terms using RPI

¹⁰ The 'vanilla' WACC uses a pre-tax cost of debt and post-tax cost of equity. The pre-tax WACC includes a tax uplift to the cost of equity, which provides a tax allowance for NERL. Other UK regulators typically use a vanilla WACC to determine an allowed return on the regulatory asset base and then make a separate allowance for corporation tax.

¹¹ [CAP 1758](#) – Draft UK Reference Period 3 Performance Plan proposals, February 2019

¹² NERL, NERL's response to CAP 1758: Draft UK reference period 3 performance plan proposals, April 2019

¹³ NERA, Cost of equity for RP3, April 2019; Professor Zalewska, Estimation of the debt beta of the bond issued by Nats (En-Route) plc, April 2019

- E4 In this appendix, we set out our approach to estimating NERL's pre-tax WACC for our final decision, including updates to our draft proposals. We have consulted a wide range of market, regulatory and academic sources to inform our final decision, including the following:
- For our draft proposals, we commissioned Europe Economics to provide advice on areas of the WACC specific to NERL – betas, gearing and cost of new debt.¹⁴ For our final decision, we commissioned Europe Economics to provide updates on these areas and its report is published alongside this final decision.¹⁵
 - We have published a report from PwC that provides responses to issues raised by stakeholders on total market return and debt beta for CAA price controls for NERL for RP3 and for Heathrow Airport Limited (HAL) for the next price control (H7).¹⁶ We have considered the recommendations on market-wide factors – total market return and debt betas – in determining NERL's RP3 WACC. For the avoidance of doubt, the final decision in this appendix is specific to NERL for RP3 and should not be read as a CAA position for H7. We set out further details on the links between the WACC in RP3 and H7 in a separate working paper with our draft proposals.¹⁷
 - We have considered the responses and consultant adviser reports provided by NERL (reports from NERA and Professor Zalewska), HAL (a report from NERA) and International Airlines Group (IAG) (a report from Cambridge Economic Policy Associates (CEPA)),¹⁸ as well as other stakeholder responses.
 - We have reviewed recent consultations and determinations from other UK regulators – Ofwat, Ofcom and Ofgem – and the Competition and Markets Authority (CMA).
 - We reviewed recent academic reports, including the cost of equity study by Professor Wright et al for the UK Regulators Network (we refer to this report as the UKRN cost of equity report).¹⁹

¹⁴ Europe Economics, Components of the Cost of Capital for NERL (December 2018)

¹⁵ Europe Economics, Comments on NERA/NERL critiques of Europe Economics' WACC analysis, June 2019

¹⁶ PwC, Estimating the cost of capital for H7 and RP3 – Response to stakeholder views on total market return and debt beta, August 2019

¹⁷ Published at www.caa.co.uk/natslicence

¹⁸ NERA, Cost of equity for RP3, April 2019; Professor Zalewska, Estimation of the debt beta of the bond issued by Nats (En-Route) plc, April 2019; NERA, Cost of equity for HAL at H7, April 2019; NERA, Cost of debt for HAL in H7, April 2019; CEPA, Response to CAA consultations on RP3 and H7 WACC, April 2019

¹⁹ Professor Stephen Wright et al, Estimating the cost of capital for implementation of price controls by UK

- E5 The rest of this appendix provides further details on the CAA's approach to estimating the cost of capital for NERL for RP3. This appendix is structured by topic as follows:
- CAA's overall approach to estimating the cost of capital;
 - inflation;
 - total market return;
 - risk-free rate;
 - gearing;
 - equity beta;
 - overall cost of equity;
 - cost and proportion of embedded debt;
 - cost of new debt;
 - overall cost of debt;
 - tax uplift; and
 - overall weighted average cost of capital.
- E6 Unless otherwise stated, the figures in this appendix are presented in retail prices index (RPI) deflated terms, consistent with indexation of the regulatory asset base (RAB). The difference between the consumer prices index (CPI) and RPI forecasts shown in this appendix, are used to express the allowed WACC components in nominal and CPI-deflated terms for comparison where relevant.
- E7 The WACC in this chapter refers to both the expected and allowed rates of return for NERL in RP3, as we have not forecast expected outperformance or underperformance for our final decision.

CAA's views on cost of capital for RP3

Overall approach

- E8 Our business plan guidance for NERL set out that NERL should assume a cost of capital that is *"no more than the efficient level necessary to compensate NERL for the business and regulatory risks it faces."*²⁰
- E9 In general, we consider that there is compelling evidence that the efficient level of the cost of capital has reduced between the RP2 performance plan and this

Regulators, An update on Mason, Miles and Wright (2003) (March 2018)

²⁰ [CAP 1625](#) - Guidance for NERL in preparing its business plan for Reference Period 3 (January 2018)

RP3 final decision, even before considering the impact of corporate taxation. This reduction in the estimated cost of capital since RP2 is supported by a review of a range of historical and forward-looking market evidence for investors' required rates of return. Other UK regulators have reflected this in their recent proposals for the allowed WACC.

- E10 In our draft proposals, we were concerned that by proposing an increase in the vanilla WACC between RP2 and RP3, NERL's proposals were inconsistent with the broad range of evidence available and significantly overstated the efficient WACC necessary to compensate NERL during RP3. In its response, NERL reduced the vanilla WACC by 30bps to 4.21%. This is similar to the vanilla WACC at RP2 of 4.25% and so is still inconsistent with the expected reduction in the estimated cost of capital since RP2 and significantly overstates the efficient WACC necessary to compensate NERL during RP3. We have therefore provided our own estimate of the pre-tax WACC for this final decision.
- E11 In developing our final decision, we have estimated the allowed WACC based on the weighted average of the estimated cost of debt and equity finance, and using the capital asset pricing model (CAPM) to estimate the cost of equity. These approaches are commonly used across UK regulated sectors and are consistent with recommendations in the UKRN cost of equity study and NERA's advice to NERL.
- E12 For our final decision, we have considered the points raised on our draft proposals by stakeholders and in supporting consultant reports. For a number of the points raised, we have sought views from our advisers, Europe Economics and PwC, and have published their updated analysis alongside our final decision.
- E13 We have considered how the allowed WACC for NERL compares with recent UK regulatory precedent and considered the reasons for differences. We recognise that judgement is required in estimating an efficient WACC and seek to balance the benefits to consumers from using a lower allowed WACC with the significant downside risks for NERL's financeability and incentives to invest if the allowed WACC is set too low.
- E14 We discuss below the approach and analysis that has informed our considerations of the different components of the WACC. It is important to note that while we have considered these individual elements, we have also made an overall judgement about the appropriate WACC. In making this judgement, we have considered stakeholder views on the WACC and cross-checked the overall cost of equity and WACC with recent consultations and decisions from other UK regulators, while recognising the differences in the risks that NERL faces. This overall judgement is important to avoid placing undue reliance on individual parameters that require judgement.

Inflation

- E15 NERA, in its September 2018 report for NERL, assumed an RPI forecast of 3.2% p.a. to estimate the RPI-deflated WACC. Separately, NERL's RP3 business plan included an RPI forecast that increased from 2.88% in 2020 to 3.54% p.a. by 2024, or about 3.3% p.a. on average. Over the same period, CPI increased from 1.57% to 1.96%, or about 1.8% p.a. on average.
- E16 For our draft proposals, we reviewed recent inflation forecasts published by the HM Treasury,²¹ the Office for Budget Responsibility (OBR),²² Bank of England²³ and International Monetary Fund (IMF).²⁴ We concluded that the inflation forecasts from these sources were broadly aligned and supported an inflation assumption for RP3 of **2.0% p.a. for CPI** and **3.0% p.a. for RPI** (an RPI-CPI wedge of 1.0%), which we used to estimate the WACC in RPI-deflated terms in our draft proposals. RPI forecasts are typically higher than CPI (particularly due to the 'formula effect') and these inflation forecasts were consistent with a wedge between RPI and CPI of 1.0% p.a., which matches the estimate of the long-run difference between RPI and CPI estimated by the OBR in March 2015.²⁵
- E17 In its response, NERL states that it considers our RPI-CPI wedge of 1.0% to be underestimated based on Oxford Economics forecasts, and recommends a higher RPI-CPI wedge of 1.3% in the last two years of RP3. We note that NERL does not appear to have applied this higher RPI-CPI wedge to its analysis of the RPI-deflated WACC and underlying parameters, in a consistent manner.
- E18 We have reviewed recent inflation forecasts from Oxford Economics,²⁶ the HM Treasury (which includes Oxford Economics within its consensus forecasts),²⁷ the Office for Budget Responsibility (OBR),²⁸ Bank of England²⁹ and International Monetary Fund (IMF).³⁰ These are summarised in Figure E.1.

²¹ HM Treasury, Forecasts for the UK economy: a comparison of independent forecasts (November 2018)

²² Office for Budget Responsibility, Economic and fiscal outlook (October 2018)

²³ Bank of England, Inflation Report (November 2018)

²⁴ IMF, World Economic Outlook (October 2018)

²⁵ Office for Budget Responsibility, Economic and fiscal outlook (March 2015)

²⁶ Provided by NERL in May 2019 relating to Oxford Economics' March 2019 forecast, published in April 2019

²⁷ HM Treasury, Forecasts for the UK economy: a comparison of independent forecasts (May 2019)

²⁸ Office for Budget Responsibility, Economic and fiscal outlook (March 2019)

²⁹ Bank of England, Inflation Report (May 2019)

³⁰ IMF, World Economic Outlook (April 2019)

Figure E.1: Summary of recent inflation forecasts

Source	CPI (% p.a.)						RPI (% p.a.)						Implied RPI-CPI wedge (% p.a.)
	2019	2020	2021	2022	2023	2024	2019	2020	2021	2022	2023	2024	RP3 average
Oxford Economics (April 2019) – proposed by NATS	1.8	1.8	1.6	1.6	1.8	1.9	2.5	3.2	3.1	3.1	3.3	3.3	1.4 (1.3 in NATS response)
HM Treasury independent average forecasts (May 2019)	1.9	2.0	1.9	1.9	2.0	-	2.6	2.7	3.0	3.1	3.0	-	1.0
OBR Economic and Fiscal Outlook (March 2019)	2.1	1.9	2.0	2.0	2.0	-	2.9	2.8	3.0	3.1	3.1	-	1.0
Bank of England Inflation report (May 2019)	2.1 (Q2)	1.7 (Q2) 1.9 (avg)	2.1 (Q2) 2.1 (avg)	2.2 (Q2)	-	-	-	-	-	-	-	-	-
IMF World Economic Outlook (April 2019)	1.8	2.0	2.0	2.0	2.0	2.0	-	-	-	-	-	-	-

Source: CAA analysis of various sources

E19 Most of the inflation forecasts from these sources are broadly aligned and continue to support an average inflation assumption for RP3 of **2.0% p.a. for CPI** and **3.0% p.a. for RPI**, which we use to estimate the WACC in RPI-deflated terms in our final decision. This is similar to the inflation forecasts we use in the financial modelling. The main difference is the forecasts from Oxford Economics, which show much lower CPI over RP3 than the other sources, and therefore a higher RPI-CPI wedge. We note that the EU charging regulations require the use of CPI forecasts from the IMF. These broadly align with forecasts from HM Treasury, OBR and Bank of England, so we do not place any weight on the forecasts from Oxford Economics.

E20 For our final decision we are proposing a mechanism within the RP3 RAB rules that will true-up allowed returns and depreciation for differences between the expected and outturn RPI-CPI wedge during RP3. Further details are provided in chapter 7. This mechanism will reduce the inflation risk that NERL faces.

Table E.1: Inflation for estimating RP3 WACC

	NERL business plan	CAA draft proposal	CAA final decision	Notes
RPI inflation	3.2% p.a. (from NERA report on cost of capital)	3.0% p.a.	3.0% p.a.	Same as draft proposals, to reflect recent external forecasts
CPI inflation	Not in NERA report (c.1.8% in financial model)	2.0% p.a.	2.0% p.a.	Same as draft proposals, to reflect recent external forecasts

Source: CAA analysis

Total market return

- E21 We have used a ‘decompositional’ approach to estimate cost of equity under CAPM, where the total market return (TMR) and risk-free rate (RFR) are estimated separately to derive the equity risk premium (ERP). The TMR is an estimate of the expected return by investors for the market as a whole. This approach to estimating TMR and RFR separately is broadly consistent with the approaches adopted by NERL and other UK regulators, as the TMR is typically shown to be more stable than the ERP.
- E22 In its RP3 business plan, NERL proposed a TMR range of 6.5%-7.1% and a point estimate of 6.8% (in RPI-deflated terms), based on a report by NERA. NERA’s range is based on a review of long-run historical estimates from Dimson, Marsh and Staunton (DMS)³¹ for different holding periods and averaging approaches, with the bottom end of the range reduced by 0.3% reflecting the ONS’ estimate for the increase in the RPI ‘formula effect’ arising from the 2010 change to the method for collecting clothing prices.
- E23 The TMR has been subject to a wide-ranging debate in different regulated sectors during 2018 and 2019, and a range of new information has been published around estimates of TMR using different historical and forward-looking methods. As different methods can lead to very different estimates of TMR, we consider it is appropriate to consider the wide range of evidence and cross-checks available in forming our judgement on the appropriate TMR.
- E24 In our draft proposals, we used the wide range of evidence to propose a TMR range of 5.0% to 6.25% and a point estimate of 5.4%. This was based, primarily, on available evidence and TMR ranges from the UKRN cost of equity report, PwC’s advice to the CAA for the H7 price review and recent publications from other UK regulators.
- E25 In its response, NERL has proposed an updated TMR of 6.25%, reduced from 6.8% in its RP3 business plan. This is based on the intersection between the revised range from NERA (6.2% to 6.8%) based on a new method for adjusting long-run historical UK returns for inflation and the CAA’s range in its draft proposals. NERL and NERA have raised a number of issues around the approach in the CAA’s draft proposals, which they consider is downward biased. Similar points have also been raised by Heathrow Airport Limited (HAL) and in NERA’s report for HAL. We consider the points raised below.
- E26 CEPA, in its updated report for IAG, supports the CAA’s TMR estimate but raises issues with the top end of the CAA’s range of 6.25%, which it considers is not supported by most sources of evidence.

³¹ Credit Suisse, Global Investment Returns Yearbook 2017

Evidence of lower expected returns since RP2

- E27 In our draft proposals, we used a range of evidence to inform our TMR of 5.4% in RP3 that was significantly lower than the TMR of 6.25% set for RP2.
- E28 NERA, in its updated reports for NERL and HAL, considers that there is no evidence that expected returns have fallen since RP2 and that recent market evidence is consistent with broadly constant TMR over time. In summary, this is based on analysis showing:
- upward trends in historical realised equity returns in the US, Germany and Japan and broadly constant returns in France and the UK, which therefore do not support a reduction in expected returns across global equity markets;
 - DMS evidence from cross-country data showing an apparent positive relationship between real interest rates and equity returns is driven by a negative relationship between both variables and inflation and the relationship between equity and bond returns during high inflation periods are not relevant in the current low risk-free rate environment;
 - forward-looking dividend growth models (DGM) from Bank of England and PwC shows the TMR is relatively stable over the current period and do not show a trend decline since RP2;
 - forward-looking survey evidence from Fernandez et al does not show any systematic reduction in TMR in recent periods; and
 - the approved return on equity in the US for electricity and gas has remained relatively stable over recent periods, which is contrary to the view that lower interest rates are consistent with lower equity returns.
- E29 We have asked PwC to review the issues raised by NERA.³² This includes the following points in response:
- focusing on the UK, PwC has considered the 10-year trailing average of UK market returns, which it considers is more appropriate than the 30-year trailing average used by NERA. PwC finds that there was a noticeable decline in returns during the 2008-09 financial crisis and then from 2012 onwards, implying a downward trend in realised returns in recent years;
 - the DMS analysis does show a clear relationship between real asset returns and interest rates, even when take account of the impact of inflation on real rates;

³² PwC, Estimating the cost of capital for H7 and RP3 – Response to stakeholder views on total market return and debt beta, August 2019

- TMR estimates from DDM models are important estimates to use in conjunction with other approaches to form a view on TMR. However, instead of focusing on monthly TMR estimates, PwC believes it is better to consider the 5-year moving average as this smooths out monthly fluctuations;
- focusing on the UK survey data from Fernandez et al, this provides a useful cross-check on outputs of TMR analysis. However, PwC cautions against assigning too much weight to survey outputs from one particular year or period; and
- from its review of US electricity and gas returns, PwC finds that the decline in approved return on equity – particularly before 2006 – was more comparable to the decline experienced in the US risk free rate. PwC is also cautious about assigning too much weight to the US example applied to returns in the UK.

E30 In summary, PwC considers that its additional analysis indicates that there has been a decline in realised equity returns in the UK in recent years, contrary to NERA's findings.

E31 Ofcom, in its recent Statement for the business connectivity market review (BCMR),³³ did not accept BT's arguments that the TMR is stable with no relationship to lower real risk-free rate. Ofcom sets out evidence from Europe Economics, which found a statistically significant relationship between the real TMR and real RFR in CPI-deflated terms, and the 2019 DMS Yearbook, which concluded that future returns on all risky assets are lower when real interest rates are low.

E32 We conclude from the response from PwC and Ofcom, as well as further evidence on investor expectations presented below, that there is some evidence to suggest that the TMR expectations will have fallen since RP2. This is still consistent with the TMR being relatively more stable than the equity risk premium and the reduction is not one-for-one with the reduction in real interest rates. This is consistent with a lower TMR at RP3 than we set at RP2, in contrast to the proposal from NERL for the same or higher TMR than at RP2.

UKRN cost of equity study, use of inflation measures and predictability of returns

E33 In our draft proposals, we considered the cost of equity study by Professor Wright et al for the UK Regulators Network (UKRN),³⁴ which recommended that the TMR is based on long-run historical averages taking into account both UK and international evidence. Based on their analysis of long-run historical returns

³³ Ofcom, 2019 PIMR and BCMR Statement: Annex 21, June 2019

³⁴ Professor Stephen Wright et al, Estimating the cost of capital for implementation of price controls by UK Regulators (March 2018)

in the UK and other markets, the authors propose a TMR range of 6-7%. This is based on long-run historical geometric average returns of not more than 5%, increased by 1-2% to account for serial correlation of returns. The authors note that the case for an adjustment to geometric average returns as large as 2% is weakened if regulators are setting returns on a consistent basis at a relatively long (e.g. 10-year) horizon.

- E34 We understand that the 6-7% range for the TMR in the UKRN cost of equity study was estimated in real-CPI terms, using the long-run historical CPI series estimated by the Bank of England.³⁵ To obtain an equivalent estimate in RPI-deflated terms, we reduced the TMR for the RPI-CPI wedge estimated above (1%) to 5-6% in RPI-deflated terms. This is consistent with the approaches recently taken by other UK regulators.³⁶
- E35 NERA, in its report to NERL, stated that the CPI measure used by the UKRN report authors is unreliable and that the historical real TMR should be estimated using RPI inflation. We disagreed with this in our draft proposals, as the back-cast CPI series from the Bank of England appears to be a reasonably consistent time series, in contrast to historical RPI where there have been structural changes, meaning historical RPI series will not be an accurate indicator of future RPI-deflated returns. We considered evidence provided by NERA and PwC in our draft proposals and concluded that the CPI series from the Bank of England, while not perfect in terms of providing a consistent time-series from a single underlying source, represents a reasonable basis for deflating historical nominal returns.
- E36 NERA considers that the historical TMR in the UKRN report is understated due to the authors incorrectly interpreting a historical inflation series as CPI and applying an excessive adjustment for long holding periods and alleged predictability of returns. Correcting for these, NERA estimates a TMR range of 6.2% to 6.8% in RPI-deflated terms, by:

³⁵ Bank of England, A millennium of macroeconomic data for the UK, Research datasets (2018)

³⁶ For example, Ofgem (RIIO-2 Sector Specific Methodology Annex: Finance, December 2018) confirmed with study author Professor Wright that it is fair to interpret the TMR range of 6-7% in CPI-terms as 5-6% in RPI terms; and Ofcom and Ofwat both express the 6-7% TMR range as CPI-deflated (Business connectivity market review, Annex 21 Cost of capital (June 2019) and PR19 draft determinations (July 2019))

- concluding that average holding periods of 1 to 5 years is supported by market evidence, below the estimates from the UKRN report and PwC, and this supports historical TMR of 6.8% to 7.1% in RPI-deflated terms using historical RPI. NERA has used the arithmetic average of long-run historical returns to estimate the TMR. NERA states that established methods developed by Blume or Jacquier, Kane and Marcus (JKM) to provide unbiased estimators of the TMR for long investment horizons with serial dependence would support downward adjustments of 10 to 40 bps, substantially below the 100bps assumed by the UKRN report for a 10-year holding period;
- adjusting the result for the estimate of the historical RPI-CPI wedge to estimate CPI-deflated returns. NERA uses a range for the historical RPI-CPI wedge based on historical RPI and back-cast CPI between 1950 onwards (47bps) to the RPI-CPI wedge from 1989 onwards (72bps);
- then adjusting the CPI-deflated returns for the forward-looking RPI-CPI wedge of 100bps to calculate the return in RPI-deflated terms, thus correcting for structural changes in RPI data over time.

- E37 NERA states that the change in its TMR range since its September 2018 report for NERL is based on new evidence on different inflation indices raised in the UKRN cost of equity report.
- E38 PwC has reviewed NERA's new approach and does not consider this to be a robust way of accurately capturing the differences between RPI and CPI. In its view, this approach does not accurately capture the differences between RPI and CPI back to 1899 when the DMS dataset, which is used to calculate TMR, begins. In creating the historical CPI series, the Bank of England has maximised use of consumer price indices and minimised use of the implied consumption deflator. As some parts of the series are neither CPI nor RPI, but have no evidence to adjust either way and there is evidence to suggest the historical RPI-CPI wedge is small, then PwC prefers the Bank of England CPI series to calibrate forward-looking real returns.
- E39 Ofwat has reviewed the approach to deflating historical average returns for its PR19 draft determinations.³⁷ Ofwat compares the inflation series in the 2019 DMS Yearbook and two CPI series in the Bank of England Millennium dataset and concludes that the two Bank of England series are preferred as reasonable estimates of long-term CPI inflation.
- E40 In its recent BCMR Statement,³⁸ Ofcom found that the difference between UK CPI and RPI has been relatively modest on a historical basis, but more significant in recent years, at 0.7% on average since 2000. Ofcom concludes that

³⁷ Ofwat, PR19 draft determinations, Cost of capital technical appendix, July 2019

³⁸ Ofcom, 2019 PIMR and BCMR Statement, Annex 21, June 2019

the UKRN cost of equity report and deflated returns from the DMS dataset can be used to provide reasonable estimates of ex post CPI-based returns to inform future expectations. Ofcom concludes that ex post evidence would support a TMR of 6.0-7.3% in CPI-deflated terms (about 5.0-6.3% in RPI-deflated terms).

- E41 Ofgem, in its RIIO-2 methodology decision,³⁹ is not persuaded by evidence from regulated companies that the Bank of England CPI inflation data cannot be relied on to provide a reasonable estimate of long-term CPI inflation. In Ofgem's view, the Bank of England series overcomes problems in the DMS approach up to its 2017 publication of using out-of-date expenditure weights, and structural changes in RPI since 2010.
- E42 For our final decision, based on the information presented above from PwC and other UK regulators, we continue to consider that the Bank of England CPI series provides a suitable estimate of ex-post real returns as the basis for calibrating forward-looking real returns for use with CPI inflation. These estimates need to be adjusted using the forward-looking RPI-CPI wedge to estimate returns in RPI-deflated terms, which we estimate to be around 1% based on information above.
- E43 On holding period and adjustment for serial correlation, the UKRN cost of equity report suggests that UK regulators estimate TMR starting from the long-run geometric averages, adjusted upwards by 1-2% depending on the extent to which regulators wish to take account of serial correlation of returns, rather than calculating arithmetic averages directly. The reports' authors are concerned that arithmetic averages can generate spurious differences, especially when returns are affected by exchange rate fluctuations.
- E44 In analysis published with the CAA's draft proposals, PwC examined the variance in returns, including reviewing the UKRN cost of equity study from 2003 and performed additional econometric analysis on the UK equities market. PwC concluded that there is evidence of predictability of returns at longer horizons (e.g. 10 years), which points to a smaller adjustment to the geometric mean for a longer-term holding period. PwC's analysis would support an upward adjustment to the geometric mean of around 0.4-1.3% for a 10-year holding period, or 0.7-1.5% for a shorter 5-year holding period, towards the lower end of the 1-2% range in the UKRN cost of equity report. Applying a volatility adjustment of 1-1.5% to the average historical UK CPI returns in the UKRN cost of equity study gives an RPI-deflated TMR range of 5.2%-5.7%. This analysis suggested that NERA's approach to using arithmetic returns may overstate the measure of expected returns.
- E45 NERA criticises analysis on predictability of returns at long horizons and dividend discount models. NERA has used the arithmetic average of long-run historical

³⁹ Ofgem, RIIO-2 Sector Specific Methodology Decision – Finance, May 2019

returns to estimate the TMR. NERA states that established methods developed by Blume or JKM to provide unbiased estimators of the TMR for long investment horizons with serial dependence would support downward adjustments of 10 to 40 bps, substantially below the 100bps assumed by the UKRN report for a 10-year holding period.

- E46 PwC, in its updated report for CAA, recommends that the CAA should use a longer-term perspective to estimate the TMR and should adjust for the predictability of returns at long horizons, consistent with the recommendation in the UKRN cost of equity report.
- E47 Ofwat, for its PR19 draft determinations, finds that it is appropriate to focus on holding periods of longer than one year given evidence that infrastructure investors focus on holding periods longer than 10 years and investment advice that longer holding periods help to manage the risk of volatility in returns. Ofwat estimates the JKM optimal estimator (a weighted average of geometric and arithmetic returns) and assumes a holding period of 5-10 years to estimate a real TMR range of 6.5-6.7% in CPIH terms (about 5.5-5.7% in RPI terms).
- E48 Given the recommendation in the UKRN cost of equity report to start from geometric average returns and adjust upwards for serial correlation of returns, Ofwat also cites PwC analysis on the impact of serial correlation with holding periods of 5-10 years, which leads to a TMR range of about 5.5-6.6% in CPIH terms (about 4.5-5.6% in RPI-deflated terms).
- E49 Ofgem, in its RIIO-2 methodology decision, considers that it is appropriate to follow the approach from the UKRN cost of equity study of uplifting geometric average returns.
- E50 For our final decision, based on the information presented above from PwC and other UK regulators, we continue to consider that the approach and TMR range in the UKRN cost of equity report remain appropriate for informing the TMR for RP3. We have considered NERA's and NERL's views on the average historical TMR. However, based on our review of the further evidence above on the treatment of inflation and predictability of returns, we consider that the historical average returns in the UKRN cost of equity report provide a reasonable basis for estimating average historical returns in CPI-deflated terms.
- E51 The resulting range of 5-6% in RPI-deflated terms, when taking into account the OBR's forecast for the future RPI-CPI wedge, is further supported by recent reviews from other UK regulators (Ofwat, Ofcom and Ofgem) and a range of advisors (UKRN cost of equity report authors, Europe Economics, PwC and CEPA). Many of these sources draw on the same underlying DMS dataset of historical average returns, but may vary slightly in terms of treatment of inflation (e.g. using the DMS' series or CPI from the Bank of England), method of averaging (e.g. geometric or arithmetic averages), and adjustments (e.g. for

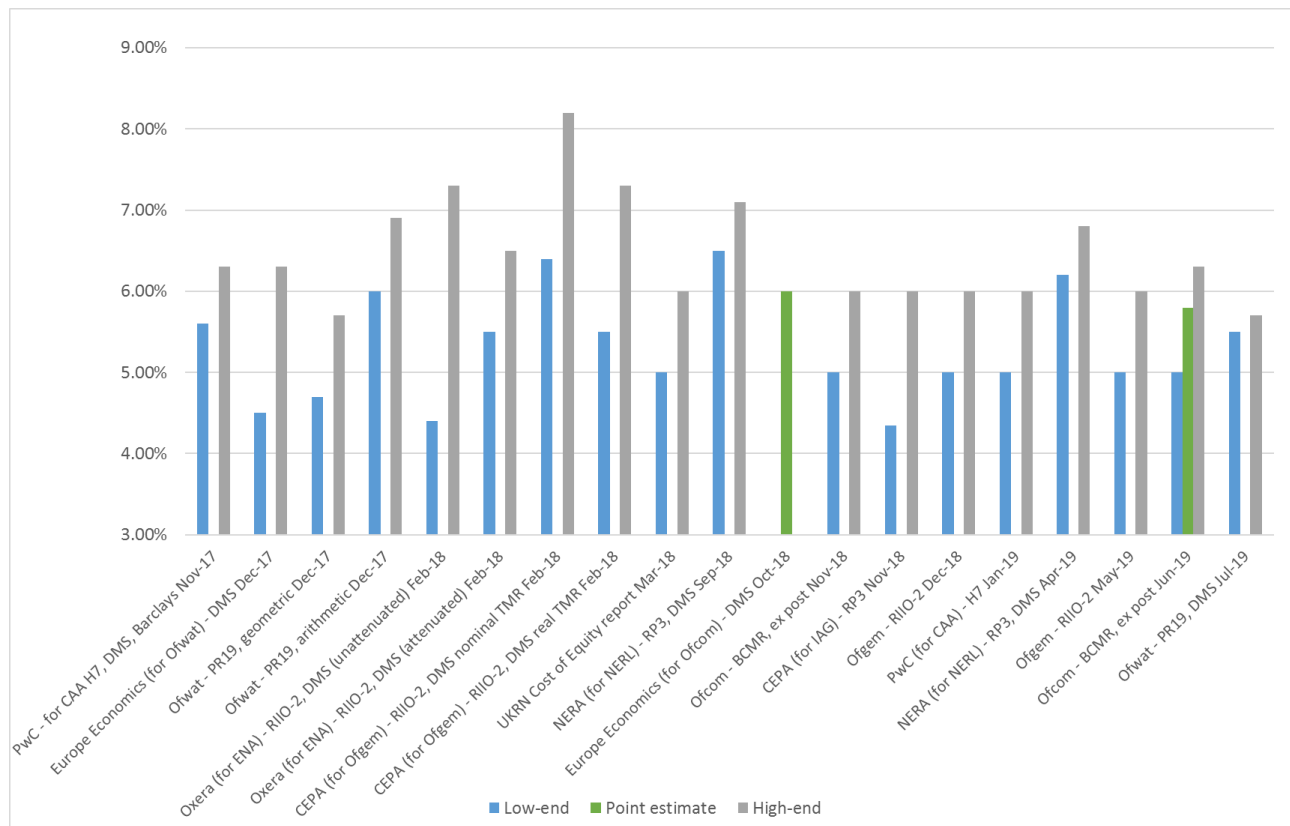
serial correlation). In general, most sources showed TMR estimates varying between 5-6% (in RPI-deflated terms), depending on the method applied. This supports a TMR of 5.0-6.0% in RPI-deflated terms and potentially a point estimate towards the lower end of this range based on PwC's analysis on the serial correlation of returns.

Estimates of average historical returns

- E52 In our draft proposals, we presented our review of the long-run historical average returns from a range of published sources. Where necessary, we adjusted published estimates for the expected 1% RPI-CPI wedge and used our expected RPI inflation forecast of 3%. This is summarised in Figure E.2 below.
- E53 In addition to the historical average approaches from the DMS dataset, other recent sources include:
- PwC, in its work for the CAA, reviewed the long-run historical average returns from Jorda et al.⁴⁰ This provides an arithmetic average of historical TMR of 7.2% in CPI-deflated terms, or 6.2% in RPI-deflated terms (assuming a 1% RPI-CPI wedge). However, PwC states that the Jorda study does not provide a comparable expected TMR, e.g. adjusting for serial correlation. Taking into account the new evidence available on long-run returns from the UKRN cost of equity report and Jorda et al, PwC considers a range of 5-6% is appropriate and that evidence of predictability at longer horizons supports a point estimate towards the lower end of this range.
 - CEPA, in its report for IAG, estimated historical ex ante returns using the historical average returns from DMS dataset, adjusted for one-off factors and inflation. CEPA estimates a range of 5.5-6.0% on an arithmetic average basis and 4.35-4.8% on a geometric average basis, in RPI-deflated terms. NERL has responded that CEPA's estimates are flawed as they do not apply the established methodologies, misinterpret historical DMS data and do not use a reliable measure of inflation.
 - In its PR19 draft determinations, Ofwat reviewed international evidence on historical average realised returns from the 2019 DMS Yearbook. Ofwat finds that international TMR has been somewhat lower than in the UK historically at around 6.0-6.5% in CPI-deflated terms (or about 5.0-5.5% in UK RPI deflated terms).

⁴⁰ Jorda et al, Rate of return on everything, 1870-2015 (2017)

Figure E.2: CAA review of recent analysis on average historical returns (in RPI-deflated terms)



Source: CAA analysis of range of published sources.

Forward-looking estimates of TMR

- E54** In our draft proposals, we presented a range of evidence from UK regulators and advisers on forward-looking methods, such as dividend-discount models (DDM) or dividend growth models (DGM) and market-to-asset ratios, that had been used to inform or cross-check estimates of TMR. We showed that recent DDM/DGM analysis by Ofwat, Ofcom, Europe Economics, CEPA and PwC suggested forward-looking estimates of TMR around 4.0-6.3% (in RPI-deflated terms). In its January 2019 report, PwC estimated a TMR range of 5.3-6.2%, with the upper end of the range driven by the current DDM estimate, which tends to be more volatile, and considered that its proposed TMR of 5.1-5.6%, based primarily on forward-looking methods, remains appropriate. PwC considered that Bank of England models, being focused on movements in analyst expectations of equity returns rather than levels of returns, made them unsuitable for informing views on the forward-looking TMR.
- E55** Based on this analysis, we considered that estimates from forward-looking methods provided relevant evidence to inform the appropriate estimate of the TMR, in addition to the TMR estimates from historical average returns. We noted that there is a degree of overlap between some estimates of TMR from long-run

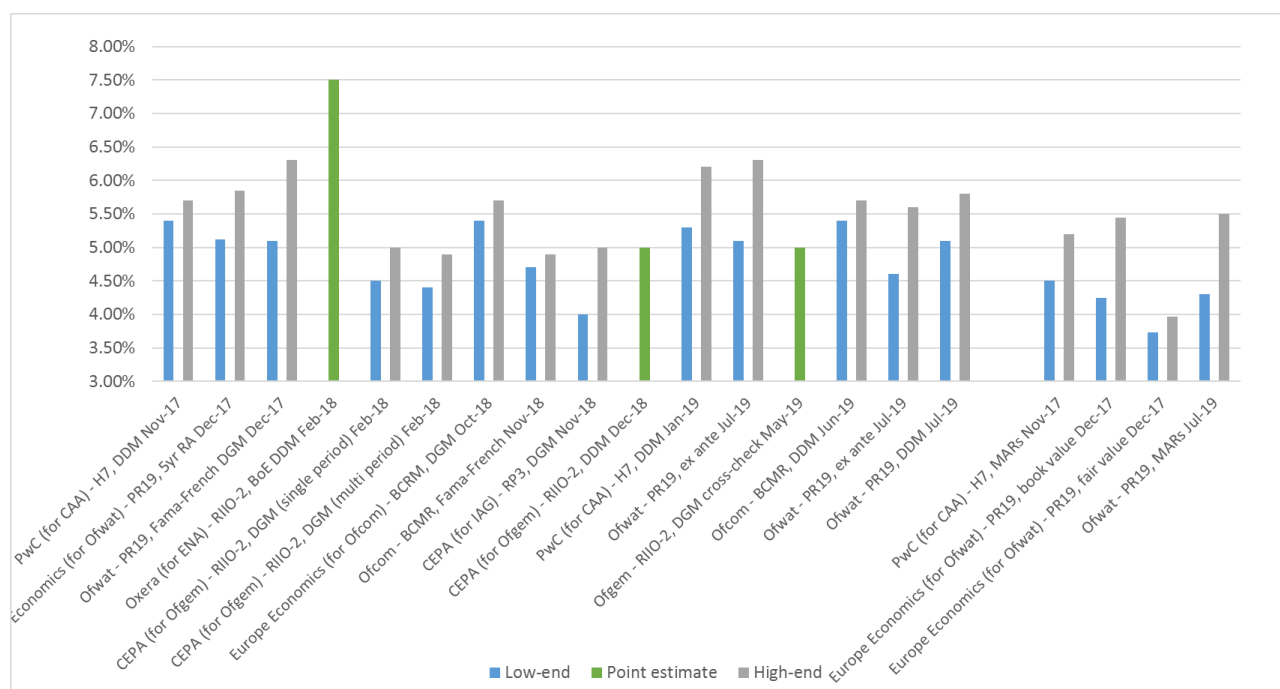
historical averages and forward-looking methods, with a range of 5-6% in RPI-deflated terms.

- E56 NERA, in its report for NERL, recommends treating estimates of TMR from DGM with caution given the relative sensitivity of results. NERA recommends relying on historical returns as primary evidence with forward-looking evidence as a cross-check.
- E57 NERA considers that PwC and other consultants have understated returns from dividend growth models (DGMs) by:
- using UK GDP growth to estimate future dividend growth which ignores UK companies' exposure to international markets with higher growth; and
 - ignoring analyst forecasts of dividend growth, which is higher than GDP growth and is used by others, such as by the Bank of England.
- E58 NERA recommends using analyst forecasts as basis of short-term dividend growth forecasts and using GDP growth from countries where FTSE companies derive their earnings for longer-term growth. NERA cites Bank of England analysis of DGM using this approach, which produces a forward-looking TMR of 7.2% to 8.1% in RPI-deflated terms, above the evidence from historical returns.
- E59 For its updated report, PwC has reviewed NERA's response. PwC considers the use of analyst forecasts is not appropriate for regulatory purposes as they have been found to be both biased and inefficient, and regulators are concerned with setting longer-term parameters that are suitable for the price control period. PwC also considers that adjustments would be required to convert global assumptions to a UK cost of capital (e.g. differential real yields or forecast inflation), so prefers to use UK based parameters, and proxies, wherever possible to avoid the need for further adjustments.
- E60 In its PR19 draft determinations, Ofwat presents evidence from four different ex ante approaches on the basis that averages of historical returns may provide an upward-biased guide to current return expectations. Ofwat estimates a wider prospective TMR range of 5.0-6.9% in CPI-deflated terms, or a narrower range of 5.6-6.6% based on Fama-French and DMS approaches. This is broadly equivalent to 4.6-5.6% in RPI-deflated terms.
- E61 Ofwat commissioned PwC and Europe Economics to provide updated estimates of forward-looking TMR from Dividend Discount Models (DDMs). This included two different Europe Economics models based on GDP and dividend yield growth assumptions. The PwC DDM estimate produces a TMR range of 5.7-7.2% in RPI-deflated terms, though concluded that some of the rise since previous estimates may not persist over the medium-term so recommended a 5-year trailing average estimate closer to 5.1-5.8% in RPI-deflated terms. The Europe Economics DDM estimates were 5.1-5.2% for the GDP-based approach

and 5.5-6.4% for the historical dividend-based approach, in RPI-deflated terms. Ofwat puts the most weight on 5-year rolling average estimates to estimate an overall TMR range of 5.1-5.8% in RPI-deflated terms.

- E62 Ofwat also considers its earlier analysis on market-to-asset ratios (MARs), which imply a TMR of around 5.3-6.5% in CPIH-deflated terms (about 4.3-5.5% in RPI-deflated terms). Ofwat considers that the MARs analysis and investor survey evidence (see details below) justify a small downwards adjustment to the lower end of the DDM range to 6.0-6.8% in CPIH-deflated terms (or 5.0-5.8% in RPI-deflated terms).
- E63 In its recent BCMR Statement, Ofcom estimates TMR using two historical ex ante approaches: (i) the Fama-French approach of estimating returns from average dividend yields and dividend growth rates, which leads to a TMR of 5.7% or lower in CPI-deflated terms; and (ii) the DMS approach to separating historical equity risk premiums into elements that correspond to investor expectations from those that relate to good or bad luck that are non-repeatable. This leads to a TMR of 5.9% or lower in CPI-deflated terms. Therefore, these approaches both suggest TMR below 5.0% in RPI-deflated terms.
- E64 Ofcom references Europe Economics DGM analysis from October 2018, which found a TMR of 6.4-6.7% in CPI-deflated terms (about 5.4-5.7% in RPI-deflated terms). Ofcom considers comments from BT that it should put weight on alternative DGM analysis from the Bank of England and Bloomberg, but concludes these are not as robust as the analysis from Europe Economics and will give results that are upwardly biased.
- E65 In its RIIO-2 methodology decision, Ofgem also prefers to use the DDM analysis from CEPA as a cross-check rather than analysis from the Bank of England, which provides a TMR of around 5% in RPI-deflated terms.
- E66 For our final decision, we have considered the full range of evidence available from UK regulators and various advisors. We agree with other views expressed above that the Bank of England DDM analysis may not be a good indicator of expected TMR for RP3. Other recent DDM analysis and historical ex ante analysis supports a TMR range of 4.6-6.3%, with most estimates in the range 5.0-5.8% in RPI-deflated terms.

Figure E.3: CAA review of recent analysis on historical ex ante and forward-looking returns (in RPI-deflated terms)



Source: CAA analysis of range of published sources.

Recent regulatory precedent

- E67** In our draft proposals, we reviewed the recent UK regulatory precedent for TMR, converted to RPI-deflated terms, finding a range of 5.2% to 5.7% from Ofwat, Ofcom and Ofgem. This showed that TMR estimates from other UK regulators have reduced significantly since previous price reviews and there is broad consistency in the estimated TMR.
- E68** We also presented TMR ranges published by a range of specialist advisors to regulators and companies, which showed that NERA appeared to be an outlier in proposing an RPI-deflated TMR above 6.5%.
- E69** NERA stated that these UK regulator decisions were affected by the same problems as CAA's estimates and are significantly below the recent precedent from the CMA from its 2014 NIE and 2015 Bristol Water determinations, which support a TMR of 6.5%.
- E70** For its PR19 draft determinations, Ofwat has estimated a TMR of 6.5% in CPIH-deflated terms, or 5.47% in RPI-deflated terms, based on the overlap between the ranges from ex-post, ex-ante and forward-looking approaches. Ofwat has not placed more weight on one type of approach than another and it is broadly the mid-point of ranges recommended by both Europe Economics and UKRN cost of equity reports. This is supported by a report from Europe Economics, which recommends a range of 6.0-7.0% in CPI-deflated terms.