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# Audit of NIAUR's Financial and Tariff Basket Model

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## **ASSUMPTIONS & LIMITING CONDITIONS**

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## 1. Introduction and Summary of Key Issues

NERA were commissioned by the Northern Ireland Authority for Utility Regulation (NIAUR) to undertake an audit of the financial and tariff basket model NIAUR will use to set prices for the next price control review (PC10).

This final report is structured as follows:

- § This Section briefly sets out the process we have undertaken to audit NIAUR's financial model, and the high-level issues that we have identified.
- § In Sections 2 and 3 we set out our detailed review of the financial model and tariff basket aspects of the model.

### 1.1. Process

To audit NIAUR's financial and tariff model, we have undertaken the following process:

1. A systematic check of the model's formulae using the Excel spreadsheet auditing software "Spreadsheet Professional". This software has enabled us to easily identify anomalies in spreadsheet formulae which could be the result of errors. We have documented all potential errors, and then checked all relevant cells manually. All errors have been logged in this report. As part of this process, we have also considered whether the model conforms to best modelling practice.
2. A review of the model's financial accounts against financial accounting standards and Ofwat's regulatory accounting guidelines (RAGs).
3. A review of the model's tariff basket worksheets for consistency with the regulatory framework. Primarily, this process has involved a check of the model's tariff basket formulae against Condition B of NIW's Licence.

### 1.2. Summary of Issues

#### Formulae Anomalies and Good Modelling Practice

We set out all the formulae anomalies that we have identified in the Tables in Section 2.5 (for the financial model worksheets) and Section 3.3 (tariff basket worksheets). We have not identified any material anomalies in the spreadsheet formulae through the application of Spreadsheet Professional.

Regarding good modelling practice, the model contains a number of checks, e.g. to check whether the value of the asset side of the balance sheet is equal to the financing side. However, as the model is currently set up, it is not possible to readily identify whether all of the checks have been satisfied. Thus, we recommend that all such checks are summarised within a single new worksheet, and the number of check failures notified in the first row of all worksheets. This will enable the user to immediately identify any model/user input errors.

## Financial Account Modelling Issues

We have identified the following material issues:

1. **Treatment of PPP Contracts:** We understand that the Alpha PPP which starts mid-2008 will be treated on-balance sheet, and if NIW were to adopt IFRS accounting rules, the PPP contracts for Kinnegar and Omega would also be treated on-balance sheet. However, the current model does not easily allow for the inclusion of the PPP contracts on-balance sheet. Therefore, we recommend additional modelling lines to the statutory accounts included in the financial model. However, we do not recommend any changes to the regulatory accounting treatment of PPP contract costs. We recommend that the contract costs associated with the PPPs are treated as though they are an operating cost item as in the current model rather than capitalised within the RCV. (See Section 2.1.)
2. **Financial Ratios:** The interest cover ratios set out in the model include movements in working capital in the numerator. By contrast, the equivalent rating agency and Ofwat ratios exclude movements in working capital. For consistency, we recommend the model's financial ratios also exclude this item. We also recommend the gearing financial ratio reflects any future pension deficits as part of net debt, as well as the extent to which the deficit is financed as an addition to the RCV. This is the approach adopted by the rating agencies. (See Section 2.2.)
3. **Regulated Revenues:** We proposed to introduce functionality to apply Ofwat's broad equivalence rule to the MEAV depreciation line. Separately, the PPP cost line appears to be net of the residual interest asset value whereas in order for NIW to recover costs this item should be gross of this value. (See Section 2.3.)
4. **Capital tax allowances:** Changes have been made to the rates associated with the capital tax allowance pools relative to the rates included in the model. For example, the industrial Buildings and Allowance Rate (IBA) is being phased out. The Chancellor has also announced in the budget an allowance of 40% for 2009-10 for capital expenditure in the main asset pool.<sup>1</sup> (See Section 2.4.)

## Tariff Basket Issues

We have identified the following two material issues with regard to the tariff basket sheets, "K-solving" and "Allocation" worksheets.

1. **Weighted Average Charge Increase (WACI):** The calculation of the weighted average charge increase (WACI) in the model does not equate precisely with the definition of the WACI as set out in Condition B of NIW's Licence. We recommend that the model is changed to conform to the Licence. (See Section 3.1.)
2. **K-solving:** There are two model errors in the model's K-solving functionality (both of which we have discussed with NIAUR during the course of this project). The errors mean that the current functionality for solving for the tariff basket

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<sup>1</sup> HMT (2009) Budget 2009, p.1.

revenues using the macro does not work correctly. We explain this in detail in Section 3.2.

## 2. Audit of Financial Accounts

This Section is structured as follows:

- § Section 2.1 discusses our proposed treatment of PPP contracts in the statutory and regulatory accounts.
- § Section 2.2 compares the model's calculation of financial ratios with the definitions adopted by Ofwat and the credit rating agencies.
- § Section 2.3 comments on two aspects of the model's regulated revenue calculation: broad equivalence and PPP allowance.
- § Section 2.4 summarises the new capital tax allowance rules.
- § Section 2.5 provides a comprehensive list of all the issues identified in our audit of the financial model, and our proposed recommendation for addressing these issues.

### 2.1. Modelling of PPP Contract Costs

#### 2.1.1. Current model approach

NIW currently has two PPP contracts, Kinnegar and Omega, with a third PPP contract, Alpha, starting in mid-2008.

The model currently treats the two existing contracts, Kinnegar and Omega as off-balance sheet. With regard to the statutory accounts, the model includes the following PPP inputs:

1. **Historic Costs Accounts (worksheet B1 - Line 3) – PPP Operating Costs:** This is equal to the cash cost or unitary payment net of the “residual interest assets”. The residual interest asset reflects the expected difference between the expected fair value of the asset on reversion and the agreed payment by NIW to the PPP operator.
2. **HCA Balance Sheet (worksheet B2 - Line 10) – PPP Assets:** This input value for this line is zero. This line could be used to record the residual interest asset. However, for AIR08 this value is recorded within the Fixed Asset line (Ref: w-sheet B2, cell G10).<sup>2</sup>

Regarding the regulatory treatment, the user sets out PPP forecasts in the w-sheet A5 - Line 3. These forecasts then feed into the allowed regulatory revenues [w-sheet P11, Line 5].

In the regulatory accounts, the PPP contract costs are treated like other operating cost items, i.e. expensed directly rather than capitalised within the regulated capital value (RCV).

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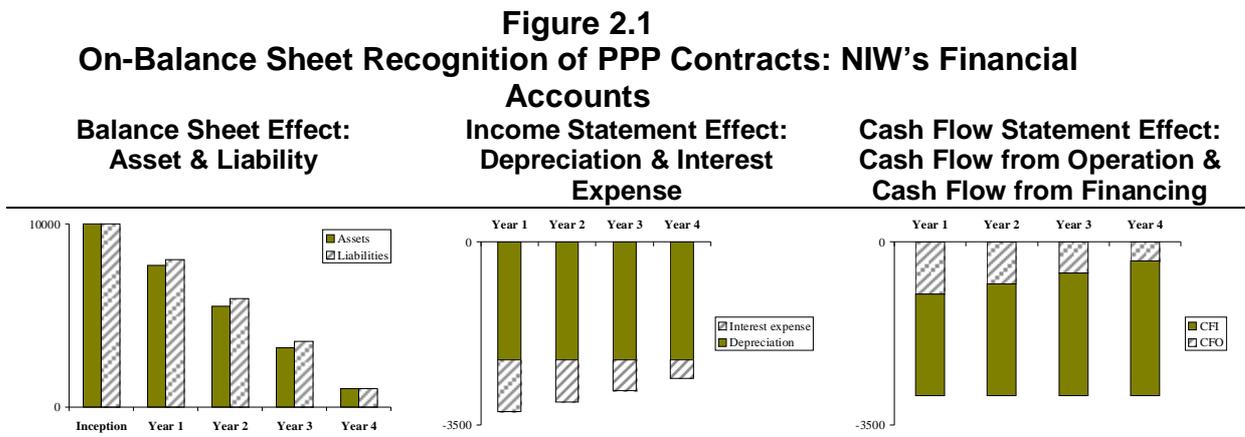
<sup>2</sup> See NIW AIR08 Commentary, Table 19 – Historical Costs Balance Sheet.

### 2.1.2. Modelling PPP costs in statutory accounts on-balance sheet

We understand that the Alpha PPP which starts mid-2008 will be treated on balance-sheet, and Kinnegar and Omega will also be treated on-balance sheet if NIW were to adopt IFRS. This implies the following accounting treatment:

- § **Accounting at inception:** The present value of minimum lease payments is recognised as an asset and as a liability on NIW’s balance sheet.
- § **Periodic transactions:** During the term of the lease, the leased asset is depreciated on the income statement. The leased asset is depreciated over its estimated economic life. The lease payment is separated into interest expense (the discount rate times the lease liability at the beginning of the period<sup>3</sup>) and principle payment on the lease liability (the lease payment less the interest expense). Cash flow from operations is reduced by the interest expense and cash flow from financing is reduced by the principle payment of the lease liability.

The effects of the lease on NIW’s financial accounts are illustrated below drawing on the following example: assuming a notional lease with a fair market value of 10,000 which is equal to the leasehold value at inception, an implied interest rate in the lease of 10%, a lease term of four years and a salvage value of 1,000 at the end of the lease term.



Source: NERA illustration

It is possible to use the current model without change to represent these contracts on-balance sheet. However, this would involve consolidating the PPP costs within existing statutory accounting lines. The presentation would not be transparent and we do not recommend such an approach.

A more explicit representation will require the following additional lines:

<sup>3</sup> Note the lessee uses the lower of the lessor’s implicit rate and the lessee’s incremental borrowing rate.

HCA/ CCA Profit and Loss

1. PPP operating cost (i.e. the operating cost proportion of the existing unitary payment)
2. PPP depreciation
3. PPP interest expense: calculated as the discount rate times the lease liability at the beginning of the period

HCA/ CCA Balance Sheet*Fixed Assets:*

4. PPP recognised at fair value (minimum of asset value or present value of PPP payments).

*Long-term liabilities:*

5. Obligations under PPP

HCA/CCA Cash-flow

6. PPP principal payment
7. PPP interest expense

We will need to include the additional lines listed above within the base year historic data worksheets, as well as forecasts within the relevant assumptions sheet.

**2.1.3. Modelling PPP costs in regulatory accounts under IFRS**

We recommend that for regulatory purposes, the contracts are treated as an operating expenditure item, i.e. the cash cost associated with the PPP contracts is included as an item within the regulated revenues in the year it occurs.

This approach is simpler than the alternative approach, which would involve capitalising the stream of payment liabilities within the RCV, and allowing NIW to recover the costs through a depreciation charge and a WACC based return on the RCV. As well as its relative simplicity, we note the following two comparative advantages of recognising the PPP payments as an operating cost when they occur:

- § Capitalising the assets within the RCV involves forecasting future PPP contract payments. The PPP contract payments are subject to volume and quality targets, and can therefore be variable. Future adjustments might have to be made to the amounts capitalised to reflect the changes in PPP payments, and this revision process could be complex.
- § Allowing NIW to recover the cash cost when incurred (instead of a depreciation charge and return element) will help NIW's cash-flow position and financeability (i.e. its ability to meet standard financial ratios).

## 2.2. Financial Ratios (Ref: O4)

Table 2.1 sets out the financial ratios as calculated within the model with the rating definitions used by Moody's and S&P, and Ofwat (as defined in June Returns). Following our review we recommend two changes to the way the ratios are calculated in the model:

- § **Working-capital movements:** The calculation of interest cover ratios within the model includes changes in working capital in the numerator, whereas the rating agencies and Ofwat exclude movements in working capital. We therefore recommend that the cash interest ratios exclude this item.
- § **Pensions:** The rating agencies include pension deficits within their calculations (but not surpluses). Where there is a deficit, they also include any part of the deficit which is funded within the RAV, i.e. they consider the funded component is like a regulatory asset.

The NIW pension fund is currently in surplus (=£5.6 million, reference: B2 Cell G88). Therefore, for consistency with rating agency definitions, this surplus should be excluded from the gearing ratio calculation. However, we recommend that the model formulae are amended to include any (future) deficit as part of net debt; and the RCV is adjusted to include any part of the deficit funded by NIAUR.

There is one additional noteworthy point (but where we do not recommend any changes to the model):

- § **Gross or net interest:** For the cash interest cover ratios, the model uses gross interest payments in the denominator. This is consistent with Ofwat and S&P. However, Moody's uses net interest.

Finally, the treatment of PPPs on-balance sheet will involve a change in the way PPPs are currently reflected in the financial ratios (where the PPP unitary payment is currently included within net-cash-flow from operations). Therefore, we will also change the ratios to reflect the proposed treatment of PPPs (as discussed in Section 2.1.)

## 2.3. Regulated Revenues (Ref: P11)

Our audit has identified two issues with regard to the calculation of regulated revenues: broad equivalence and PPP allowance.

### 2.3.1. MEAV Depreciation (Line 3)

At our inception meeting with NIAUR, NIAUR asked us to consider whether the model should be adjusted to accommodate Ofwat's rule on the MEAV depreciation line within regulated revenues also known as current cost depreciation (CCD).

At previous reviews, Ofwat has compared companies' forecasts of CCD to future levels of maintenance non-infrastructure expenditure (MNI). Ofwat believes that over the long-term, for a pool of assets that provides a stable service level, the CCD charge

should be comparable to the expenditure required to maintain these assets. This is Ofwat's "broad equivalence" policy.

However, in setting price limits, Ofwat does not mechanistically allow for the lower of CCD or MNI. It acknowledges that there might a number of valid reasons why CCD is not broadly the same as MNI. It also only adjusts CCD if it is more than 5% higher in present value terms than MNI.<sup>4</sup>

In undertaking the test, Ofwat use a 28-year comparison period, which for PR09 will be from 1997-98 (i.e. including 10 years of historic data). These data are not available in the current NIAUR model. NIW might not also be able to provide robust historic MNI data because they have not categorised expenditure in this way in the past.

Thus, it is not possible to mechanistically apply Ofwat's broad equivalence rule within the model (because their decision involves judgement, as well as the use of data which are lie outside the model period). However, it is straightforward to include the *functionality* to allow the user to select between CCD and an alternative (user defined) MNI figure in the regulatory revenue calculations. We will discuss this issue with NIAUR.

### **2.3.2. PPP Costs (Line 5)**

The current model version appears to include in regulated revenue [ref. w-sheet P11] the PPP unitary cost net of the residual interest asset. We recommend that the regulatory revenues should include the unitary cost or cash-payment gross of the residual interest cost. This will allow NIW to recover the full costs of the PPP contracts.

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<sup>4</sup> Ofwat (2003) Setting Price Limits for 2005-10: Framework and Approach, p.62-63.

**Table 2.1**  
**Comparison of NIAUR Model Ratios, Ofwat (JR06 Definition) and Rating Agencies**

Model Ref	Ratio calculation	Model Definition	Moody's Definition	S&P Definition	Ofwat June Returns 2006 Definition
O4: Line 7	<b>Cash interest cover</b>	=+("Net cash flow from operating activities"+"Taxation paid"+"Interest received")/-"Interest paid"	(FFO + (Interest expense - Interest income)) / (Interest expense - Interest income)	(FFO (= Operating cash flow + Changes in working capital) + Interest paid - Lease adjustment to depreciation) / Interest expense	(Net cash flow from operating activities + interest received + tax (paid)/ received - increase in debtors & prepaid expenses - increase in creditors & accrued expenses) / (interest paid + interest in finance lease rentals)
O4: Line 9	<b>Adjusted cash interest cover I (maintenance charges)</b>	=+("Net cash flow from operating activities"- "Current Cost depreciation"- "Infrastructure renewals charge"+"Taxation paid"+"Interest received")/-"Interest paid"	(FFO - IRC - CCD + (Interest expense - Interest income)) / (Interest expense - Interest income)		(Net cash flow from operating activities + interest received + tax (paid)/ received - increase in debtors & prepaid expenses - decrease in creditors & accrued expenses - CCD - IRC) / (interest paid + interest in finance lease rentals)
O4: Line 11	<b>Adjusted cash interest cover II (maintenance expenditure)</b>	=+("Net cash flow from operating activities"- "Total - Maintenance Infrastructure"- "Total - Maintenance Non-Infrastructure"+"Taxation paid"+"Interest received")/-"Interest paid"			(Net cash flow from operating activities + interest received + tax (paid)/ received - increase in debtors & prepaid expenses - decrease in creditors & accrued expenses - IRE (net of grants and contributions) - MNI (net of grants and contributions)) / (interest paid + interest in finance lease rentals)
O4: Line 13	<b>Funds from operations:debt</b>	=+("Net cash flow from operating activities"+"Taxation paid"+"Net cash flow from returns on Investment & servicing of finance")/"Net debt (closing) **"	FFO / (Debt - Cash & Cash equivalents)	FFO / Net debt	(Net cash flow from operating activities + interest received + tax (paid)/ received - increase in debtors & prepaid expenses - decrease in creditors & accrued expenses + interest paid (negative input) + interest in finance lease rentals (negative input)) / net debt
O4: Line 15	<b>Retained cashflow:debt</b>	=+("Net cash flow from operating activities"+"Taxation paid"+"Net cash flow from returns on Investment & servicing of finance"+"Retained earnings paid")/"Net debt (closing) **"	(FFO - dividends paid) / (Debt - cash & cash Equivalents)		(Net cash flow from operating activities + interest received + interest paid (negative input) + interest on finance lease rentals (negative input) + tax (paid)/received + total dividends paid (negative input)) / net debt
O4: Line 17	<b>Gearing *</b>	= "Net debt (closing) **" / "Closing RCV"	Net debt/ RCV		

## 2.4. Capital Tax Allowances (Ref: P6)

Changes have been made to the capital tax allowance pools relative to the rates included in the model. For example, the industrial Buildings and Allowance Rate (IBA) is being phased out. The Chancellor has also announced in the budget an allowance of 40% for 2009-10 for capital expenditure in the main asset pool.<sup>5</sup>

The following Table sets out the new capital tax allowance pools.

**Table 2.2**  
**Capital Tax Allowance Pools**

Pool	Model Rates	Current Rates (at 24 April 2009)
Plant and Machinery Short life - < 25 years - allowance rate (reducing balance)	<b>20%</b>	40%: New expenditure incurred - 2009-10 20%: Unrelieved balances – 2009/10 20% all other years.
Plant and Machinery Long life - > 25 years - allowance rate (reducing balance)	<b>6%</b>	10% - from 2008/09
Industrial Buildings Allowance rate (straight line)	<b>4%</b>	3% - 2008/09 2% - 2009/10 1% - 2010/11 0% thereafter

Sources: NERA review of Aquarius; HMT (2009) Budget 2009, p.1; available at: [http://www.rothman-pantall.co.uk/content/taxcentre\\_taxcard/allow.html](http://www.rothman-pantall.co.uk/content/taxcentre_taxcard/allow.html)

## 2.5. List of All Issues: Financial Model

This section sets out all of the issues that we have identified following our audit of the financial accounts worksheets, i.e. Base Historic Data, Assumptions, Processes and Outputs worksheets.

### 2.5.1. Base Historic Data worksheets

We have not identified any problems with the Base Historic Data worksheets.

### 2.5.2. Assumptions worksheets

In the Assumption worksheets we identified the following inconsistency in worksheet A1 (line 1):

§ 2008-09, 2009-10 entries are hard-coded, which is inconsistent with the corresponding definition for COPI (line 3).

We recommend that the two hard-coded figures are derived within the worksheet as it is the case for COPI (line 3).

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<sup>5</sup> HMT (2009) Budget 2009, p.1.

### 2.5.3. Process worksheets

Table 2.3 sets out our audit log and recommended changes for the Process w-sheets.

In Appendix A, we set out our audit of the iterative tax and interest calculations although we do not propose any model changes.

**Table 2.3**  
**Process Worksheets Audit Log**

Sheet	Line	Name	NERA Comment	Action
P1	25-37	Asset Life	Figures in base year prices; not inflated by COPI.	Inflate figures by COPI. To discuss with NIAUR.
P1'	48-53	Asset Life	Includes "Non infra c/f" in base year prices and "Non infra" figures inflated by COPI.	As above.
P1	56	Total	Totals shown in Line 10 do not equal to totals shown in Line 56 because totals in Line 10 are inflated by COPI and totals in Line 56 include "Non infra c/f" in base year prices	As above.
P4	6	Non-Infrastructure Assets	"Non-Infra c/f" is not inflated by COPI (see P1_51)	As above.
P5	65	Notional inflation	Hard-coded input; should be consistent with inflation assumption in WACC calc.	Set equal to inflation assumption in WACC calc.
P5	66	Real weighted average interest rate on embedded debt	Fisher Equation is appropriate to convert into real terms	Introduce Fisher Equation
P6	1-34	Capital Allowances for tax purposes	Capital tax allowances out of date.	Update allowances. See Section 2.4.

### 2.5.4. Output worksheets

Table 2.4 sets out our audit log and recommended changes for the Output worksheets.

**Table 2.4  
Output Worksheets Audit Log**

<b>W-sheet</b>	<b>Line</b>	<b>Name</b>	<b>Comment</b>	<b>Recommendation</b>
O4	7	Cash interest cover	Includes WC movements	Exclude for consistency with Rating Agencies' definitions
O4	9	Adjusted cash interest cover I (maintenance charges)		
O4	11	Adjusted cash interest cover II (maintenance expenditure)		
O4	13	Funds from operations:debt		
O4	15	Retained cashflow:debt		
O4	17	Gearing *	Excludes pension liabilities.	Include any deficit for consistency with Rating Agencies' definitions

In addition to the issues set out above, worksheet "O6", which summarises the charging caps, will need to be changed to account for the issues we have identified in the audit of the tariff basket model, as set out in Section 3 below.

### 3. Audit of Tariff Basket Model

This section is structured as follows:

- § Section 3.1 sets out our audit of the weighted average charge increase calculation (WACI).
- § Section 3.2 sets out our audit of the model’s K-solving functionality.
- § Section 3.3 provides a comprehensive list of all the issues identified in our model audit, and our proposed recommendation for addressing these issues.

#### 3.1. Audit of the Weighted Average Charge Increase (WACI) Calculation

We have audited the model’s calculation of the weighted average charge increase (WACI), comparing this to the definition of the WACI included in condition B of NIW’s Licence. The specific worksheet that sets out the WACI is TA23, line 40, although all of the tariff worksheets from TA3 – TA21 include data/calculations that are used in the derivation of the WACI.

We provide a detailed derivation of the WACI in Appendix B. This Section summarises our results.

In the Licence, the WACI is defined as follows:

*“Weighted Average Charges Increase means the sum calculated as follows:*

$$W_t = \sum_i \left[ \frac{A_t(i)}{A_{t-1}(i)} * r(i) \right] + \sum_j \left[ \frac{B_t(j)}{B_{t-1}(j)} r(j) \right] - 1$$

*Where:*

*W<sub>t</sub> is the Weighted Average Charges Increase for the Charging Year;*

*i is an index identifying the two Unmeasured Basket Items;*

*j is an index identifying the three Measured Basket Items;*

*A<sub>t</sub>(i) is the Average Charge Per Chargeable Supply in respect of Unmeasured Basket Item i for the Charging Year*

*A<sub>t-1</sub>(i) is the Average Charge Per Chargeable Supply in respect of Unmeasured Basket Item i for the Prior Year*

*B<sub>t</sub>(j) is the Weighting Year Revenue in respect of Measured Basket Item j for the Charging Year;*

*B<sub>t-1</sub>(j) is the Weighting Year Revenue in respect of Measured Basket Item j for the Prior Year*

*r(i) or r(j) is the revenue (exclusive of VAT) which accrued to the Appointee in the Weighting Year from all Standard Charges other than Excluded Charges (including, in the case of Measured Basket Items, any Non-volumetric charge) in respect of Unmeasured Basket Item (i) or Measured Basket Item j (as the case may be), divided by the aggregate of such revenues for all five Basket Items.”*

Drawing on the definition above, and other defined terms in the Licence, Table 3.1 compares the formulae for the constituent elements of the WACI derived from the Licence with the formulae in the model. This shows that for consistency with the Licence we need to make a number of changes to the model. The main issue is that although the WACI formula in the model is correct in terms of its structure, frequently it does not use the correct precedent year with regard to Chargeable Supplies (e.g. it generally it draws on Chargeable Supplies in t-1, whereas the Licence stipulates t-2.)

The specific model lines that will need changing are noted in Table 3.4.

In addition, in calculating the “Real Tariff Baskets” (ref: K-solving, Lines 6-10), the model should use the RPI value for the preceding November as stated in the Licence. The model currently uses an RPI figure for the actual charging year (beginning April 1<sup>st</sup>) to calculate the real charging caps. However, we believe that this is an acceptable approximation as a November based RPI forecast series is unlikely to be materially different from an April based RPI forecast series.

**Table 3.1**  
**Comparison of NERA Derived WACI from NIW’s Licence**  
**and Model WACI**

Term	NERA/ Licence	Model	Model Differences
<b>Unmeasured Basket</b>			
A <sub>t</sub> (i) (Charing Year)	$\frac{\sum_n StCh_{it}^n * ChSup_{i,t-1(Dec)}^n}{TotalChSup_{i,t-1(Dec)}}$	$\sum_n StCh_{it}^n * ChSup_{i,t-1}^n$	(i) Model uses Chargeable Supplies in t-1 as proxy for charges in December t-1.  (ii) No denominator. (Assumed to cancel with A <sub>t-1</sub> .)
A <sub>t-1</sub> (i) (Prior Year)	$\frac{\sum_n StCh_{i,t-1}^n * ChSup_{i,t-2(Dec)}^n}{TotalChSup_{i,t-2(Dec)}}$	$\sum_n StCh_{i,t-1}^n * ChSup_{i,t-1(Dec)}^n$	(i) Model uses Chargeable Supplies in t-1.  (ii) No denominator. (Assumed to cancel with A <sub>t</sub> .)
R <sub>t</sub> (i)	Tariff basket share of revenue in t-2.	Tariff basket share of revenue in t-1.	Model uses weights from Prior Year and not Weighting Year.
<b>Measured Basket</b>			
B <sub>t</sub> (j)	$\sum_n StCh_{jt}^n * ChSup_{j,t-2}^n$	$\sum_n StCh_{jt}^n * ChSup_{j,t-1}^n$	Model uses Chargeable Supplies from Prior Year not Weighting Year.
B <sub>t-1</sub> (j)	$\sum_n StCh_{j,t-1}^n * ChSup_{j,t-2}^n$	$\sum_n StCh_{j,t-1}^n * ChSup_{j,t-1}^n$	Model uses Chargeable Supplies from Prior Year not Weighting Year.
R <sub>t-1</sub> (j)	Tariff basket share of revenue in t-2	Tariff basket share of revenue in t-1.	Model uses weights from Prior Year and not Weighting Year.

Notes: (1) See Appendix B for detailed derivation. (2) StCh denotes the list of n charges that apply within each Unmeasured Basket item (e.g. the schedule of standing charges; sundry charges etc.); ChSup denotes the corresponding list of chargeable supplies for each n; TotalChSup denotes the number of Chargeable Supplies for tariff basket i; t denotes the Charging Year; t-1(Dec) denotes December 1<sup>st</sup> of the preceding year.

### 3.2. Audit of K-Solving Macro

This Section is structured as follows:

- § Section 3.2.1 describes how the “K-solving” works according to the model’s User Guide.
- § Section 3.2.2 provides a test of the K-solving macro, and identifies any errors/inconsistencies with respect to the User Guide description.

Appendix C sets out in detail the macro code and our translation of the code that we have undertaken as part of our audit.

### 3.2.1. Overview of model functionality

According to the User Guide, the model incorporates the following functionality with regard to K-solving:

- § *“The model uses the K-solving macro to exactly match the calculated revenue with the revenue from the tariff basket worksheets.”*
- § *“The calculated revenue will be from either the building blocks revenue or manually inputted revenue.”*
- § *“The macro applies goal seeking by iterating the increase in tariffs by revenue group from sheet TAI, so they match the desired revenue proportion target from the allocation worksheet [...]. This calculation is undertaken for the period 2010 to 2013.”*
- § *“After this, the macro seeks a single charge cap, applied to all groups, that will match the entire tariff basket revenue with the calculated financial revenue.”*
- § *“The charge caps are shown as the outputs in the K solving sheet.”*
- § *“Once the macro has been run, these charge caps then feed back to sheet TAI as the percentage change in tariffs per revenue groups.”*
- § *“The user may smooth the macro calculated charge caps from above manually. Changes to tariffs per revenue groups are in sheet TAI. (Refer to sheet O6 to see the current tariffs by revenue group as calculated by running the macro with either the building blocks or entered revenue.) The user should select option 3 in cell K9 of the K solving sheet.”*

### 3.2.2. Testing K-solving Macro

We have undertaken an analysis of whether the K-solving macro works correctly. There are two tests:

1. Does the macro result in an allocation of allowed revenues to different revenue groups identical to the “revenue proportion allocation” rules selected by the user for the period 2010-13?<sup>6</sup>
2. Does the overall allowed revenue from the financial model equal tariff basket revenue for the period 2010-2017?<sup>7</sup>

We present below the results of these two tests from running the K-solving macro under all possible scenarios.

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<sup>6</sup> In terms of model lines the test is: “revenue target selected alternative” [Ref: w-sheet Allocation, Cells J17:L24] = “% revenue allocated to revenue groups (net of non-primary revenues)”: [Ref: w-sheet Allocation, Cells J94:L101]

<sup>7</sup> In terms of model lines the test is: “Primary revenue (from financial model)” - “Primary Revenue (from customer base)” = 0. [Ref. Allocation: Cells J12:Q12.]

**Table 3.2**  
**Does the Functionality of the K-solving Macro Satisfy the Two Tests?**

Revenue Proportion Allocation	Option 1: Fixed Revenue	Option 2: Revenue Calculation Formula
1 = Straight Line	No	No
2 = Input on year one, straight-line thereafter	Yes	Yes
3 = All inputs	Yes	Yes

As set out in Table 3.2, the macro does not satisfy the two tests where the selected “revenue proportion allocation” is “1 – Straight Line”. This is because in worksheet “Allocation”, the formulae in cells J31:L39 are incorrect. These cells have been copied across from cells I31:39 erroneously.

We have also identified a second error: the model functionality which allows the user to input target revenue allocations for 2013-14 is incorrect. As described in the User Guide and Section 3.2.1 above, the macro does not solve for the tariff increases that satisfy each individual revenue group allocation in 2013-14 but applies a uniform tariff increase to all revenue groups to satisfy overall revenue. Hence, the model should be changed such that the user enters target allocations for 2012/13 (the last year of the price review). That is,

- § For “Revenue target: Alternatives 1” and 2 and 3, w-sheet Allocation, Cells M30:40; 45:55; 60:70 should be deleted.
- § Change: “Revenue target: Alternatives 1”, and “Revenue target: Alternatives 2” such that the user inputs values for 2012-13.

Table 3.3 sets out the proposed corrections to the formulae in the worksheet “Allocations” – to correct for the two identified errors in K-solving.

**Table 3.3**  
**Proposed Formulae Corrections: “Revenue Target Alternative 1 - 3”: Ref Allocation, Rows 28-70**

Revenue target: Alternative 1 - straight line

	% Revenue allocated to Revenue groups (net of non-pr	Units	Field Type	ditional	=+Basemir	=+Baseyear	=+Baseplus1	=+Baseplus2	=+Baseplus3	=+Baseplus4	=+Baseplus5
1	Revenue Group 1: domestic measured water	%	I/C			=+T2!G19/(T2!G\$29-T2!G\$28)	=+T2!H19/(T2!H\$29-T2!H\$28)	=+T2!I19/(T2!I\$29-T2!I\$28)	=+(\$L31-\$I31)/3+J31	=+(\$L31-\$I31)/3+J31	0
2	Revenue Group 2: domestic measured sewerage	%	I/C			=+T2!G20/(T2!G\$29-T2!G\$28)	=+T2!H20/(T2!H\$29-T2!H\$28)	=+T2!I20/(T2!I\$29-T2!I\$28)	=+(\$L32-\$I32)/3+J32	=+(\$L32-\$I32)/3+J32	0
3	Revenue Group 3: domestic unmeasured water	%	I/C			=+T2!G21/(T2!G\$29-T2!G\$28)	=+T2!H21/(T2!H\$29-T2!H\$28)	=+T2!I21/(T2!I\$29-T2!I\$28)	=+(\$L33-\$I33)/3+J33	=+(\$L33-\$I33)/3+J33	0.4
4	Revenue Group 4: domestic unmeasured sewerage	%	I/C			=+T2!G22/(T2!G\$29-T2!G\$28)	=+T2!H22/(T2!H\$29-T2!H\$28)	=+T2!I22/(T2!I\$29-T2!I\$28)	=+(\$L34-\$I34)/3+J34	=+(\$L34-\$I34)/3+J34	0.25
5	Revenue Group 5: non-domestic measured water	%	I/C			=+T2!G23/(T2!G\$29-T2!G\$28)	=+T2!H23/(T2!H\$29-T2!H\$28)	=+T2!I23/(T2!I\$29-T2!I\$28)	=+(\$L35-\$I35)/3+J35	=+(\$L35-\$I35)/3+J35	0.1
6	Revenue Group 6: non-domestic measured sewerage	%	I/C			=+T2!G24/(T2!G\$29-T2!G\$28)	=+T2!H24/(T2!H\$29-T2!H\$28)	=+T2!I24/(T2!I\$29-T2!I\$28)	=+(\$L36-\$I36)/3+J36	=+(\$L36-\$I36)/3+J36	0.05
7	Revenue Group 7: non-domestic unmeasured water	%	I/C			=+T2!G25/(T2!G\$29-T2!G\$28)	=+T2!H25/(T2!H\$29-T2!H\$28)	=+T2!I25/(T2!I\$29-T2!I\$28)	=+(\$L37-\$I37)/3+J37	=+(\$L37-\$I37)/3+J37	0.05
8	Revenue Group 8: non-domestic unmeasured sewerage	%	I/C			=+T2!G26/(T2!G\$29-T2!G\$28)	=+T2!H26/(T2!H\$29-T2!H\$28)	=+T2!I26/(T2!I\$29-T2!I\$28)	=+(\$L38-\$I38)/3+J38	=+(\$L38-\$I38)/3+J38	0.05
9	Revenue Group 9: trade effluent	%	I/C			=+T2!G27/(T2!G\$29-T2!G\$28)	=+T2!H27/(T2!H\$29-T2!H\$28)	=+T2!I27/(T2!I\$29-T2!I\$28)	=+(\$L39-\$I39)/3+J39	=+(\$L39-\$I39)/3+J39	0.1
10	Total revenue	%	C			=SUM(G31:G39)	=SUM(H31:H39)	=SUM(I31:I39)	=SUM(J31:J39)	=SUM(K31:K39)	=SUM(L31:L39)

Revenue target: Alternative 2 - Input 1st year,

	% Revenue allocated to Revenue groups (net of non-pr	Units	Field Type	ditional	=+Basemir	=+Baseyear	=+Baseplus1	=+Baseplus2	=+Baseplus3	=+Baseplus4	=+Baseplus5
1	Revenue Group 1: domestic measured water	%	I/C			=+T2!G19/(T2!G\$29-T2!G\$28)	=+T2!H19/(T2!H\$29-T2!H\$28)	=+T2!I19/(T2!I\$29-T2!I\$28)	0	=+(\$L46-\$J46)/2+J46	0
2	Revenue Group 2: domestic measured sewerage	%	I/C			=+T2!G20/(T2!G\$29-T2!G\$28)	=+T2!H20/(T2!H\$29-T2!H\$28)	=+T2!I20/(T2!I\$29-T2!I\$28)	0	=+(\$L47-\$J47)/2+J47	0
3	Revenue Group 3: domestic unmeasured water	%	I/C			=+T2!G21/(T2!G\$29-T2!G\$28)	=+T2!H21/(T2!H\$29-T2!H\$28)	=+T2!I21/(T2!I\$29-T2!I\$28)	0.25	=+(\$L48-\$J48)/2+J48	0.4
4	Revenue Group 4: domestic unmeasured sewerage	%	I/C			=+T2!G22/(T2!G\$29-T2!G\$28)	=+T2!H22/(T2!H\$29-T2!H\$28)	=+T2!I22/(T2!I\$29-T2!I\$28)	0.35	=+(\$L49-\$J49)/2+J49	0.25
5	Revenue Group 5: non-domestic measured water	%	I/C			=+T2!G23/(T2!G\$29-T2!G\$28)	=+T2!H23/(T2!H\$29-T2!H\$28)	=+T2!I23/(T2!I\$29-T2!I\$28)	0.2	=+(\$L50-\$J50)/2+J50	0.1
6	Revenue Group 6: non-domestic measured sewerage	%	I/C			=+T2!G24/(T2!G\$29-T2!G\$28)	=+T2!H24/(T2!H\$29-T2!H\$28)	=+T2!I24/(T2!I\$29-T2!I\$28)	0.1	=+(\$L51-\$J51)/2+J51	0.05
7	Revenue Group 7: non-domestic unmeasured water	%	I/C			=+T2!G25/(T2!G\$29-T2!G\$28)	=+T2!H25/(T2!H\$29-T2!H\$28)	=+T2!I25/(T2!I\$29-T2!I\$28)	0.01	=+(\$L52-\$J52)/2+J52	0.05
8	Revenue Group 8: non-domestic unmeasured sewerage	%	I/C			=+T2!G26/(T2!G\$29-T2!G\$28)	=+T2!H26/(T2!H\$29-T2!H\$28)	=+T2!I26/(T2!I\$29-T2!I\$28)	0.01	=+(\$L53-\$J53)/2+J53	0.05
9	Revenue Group 9: trade effluent	%	I/C			=+T2!G27/(T2!G\$29-T2!G\$28)	=+T2!H27/(T2!H\$29-T2!H\$28)	=+T2!I27/(T2!I\$29-T2!I\$28)	0.08	=+(\$L54-\$J54)/2+J54	0.1
10	Total revenue	%	C			=SUM(G46:G54)	=SUM(H46:H54)	=SUM(I46:I54)	=SUM(J46:J54)	=SUM(K46:K54)	=SUM(L46:L54)

Revenue target: Alternative 3 - Custom inputs

	% Revenue allocated to Revenue groups (net of non-pr	Units	Field Type	ditional	=+Basemir	=+Baseyear	=+Baseplus1	=+Baseplus2	=+Baseplus3	=+Baseplus4	=+Baseplus5
1	Revenue Group 1: domestic measured water	%	I/C			=+T2!G19/(T2!G\$29-T2!G\$28)	=+T2!H19/(T2!H\$29-T2!H\$28)	=+T2!I19/(T2!I\$29-T2!I\$28)	0	0	0
2	Revenue Group 2: domestic measured sewerage	%	I/C			=+T2!G20/(T2!G\$29-T2!G\$28)	=+T2!H20/(T2!H\$29-T2!H\$28)	=+T2!I20/(T2!I\$29-T2!I\$28)	0	0	0
3	Revenue Group 3: domestic unmeasured water	%	I/C			=+T2!G21/(T2!G\$29-T2!G\$28)	=+T2!H21/(T2!H\$29-T2!H\$28)	=+T2!I21/(T2!I\$29-T2!I\$28)	0.25	0.3	0.3
4	Revenue Group 4: domestic unmeasured sewerage	%	I/C			=+T2!G22/(T2!G\$29-T2!G\$28)	=+T2!H22/(T2!H\$29-T2!H\$28)	=+T2!I22/(T2!I\$29-T2!I\$28)	0.35	0.3	0.3
5	Revenue Group 5: non-domestic measured water	%	I/C			=+T2!G23/(T2!G\$29-T2!G\$28)	=+T2!H23/(T2!H\$29-T2!H\$28)	=+T2!I23/(T2!I\$29-T2!I\$28)	0.2	0.2	0.2
6	Revenue Group 6: non-domestic measured sewerage	%	I/C			=+T2!G24/(T2!G\$29-T2!G\$28)	=+T2!H24/(T2!H\$29-T2!H\$28)	=+T2!I24/(T2!I\$29-T2!I\$28)	0.1	0.1	0.1
7	Revenue Group 7: non-domestic unmeasured water	%	I/C			=+T2!G25/(T2!G\$29-T2!G\$28)	=+T2!H25/(T2!H\$29-T2!H\$28)	=+T2!I25/(T2!I\$29-T2!I\$28)	0.01	0.01	0.01
8	Revenue Group 8: non-domestic unmeasured sewerage	%	I/C			=+T2!G26/(T2!G\$29-T2!G\$28)	=+T2!H26/(T2!H\$29-T2!H\$28)	=+T2!I26/(T2!I\$29-T2!I\$28)	0.01	0.01	0.01
9	Revenue Group 9: trade effluent	%	I/C			=+T2!G27/(T2!G\$29-T2!G\$28)	=+T2!H27/(T2!H\$29-T2!H\$28)	=+T2!I27/(T2!I\$29-T2!I\$28)	0.08	0.08	0.08
10	Total revenue	%	C			=SUM(G61:G69)	=SUM(H61:H69)	=SUM(I61:I69)	=SUM(J61:J69)	=SUM(K61:K69)	=SUM(L61:L69)

### 3.3. List of All Issues: Tariff Basket Model

Table 3.4 sets out a log of all the issues (with the two noted exceptions below) we have identified from our audit of the tariff basket elements of the financial model. The Table does not show:

- § Required changes to the worksheet TA23 – which comprises the WACI calculation. All lines within this worksheet will need to be changed for consistency with the Licence.
- § Required changes to the “Allocation” worksheet. The required changes are set out in detail in Table 3.3 above.

**Table 3.4**  
**Tariff Basket Worksheets Audit Log**

Worksheet	Line	Name	NERA Comment	Action
TA1	26	Flat rate charge	Cells have no dependents.	Link to T21, L22.
TA1	33	Flat rate charge	Cells have no dependents.	Link to T21, L55.
TA1	71	Other revenue flat rate charge	Calc has no dependents	Link to T21, L25.
T3	55-57	Domestic Allowance Volume	Should not form part of revenue calc.	Move to separate section on w-sheet.
T3	61	Total non-domestic measured water revenue	Includes Domestic Allowance revenue.	Delete reference to Domestic Allowance revenue.
T3	62-65	Standing charge	Calc used in WACI - inconsistent with Licence.	Change for consistency with WACI Licence definition.
T4	19-24	Standing Charge	Calc used in WACI - inconsistent with Licence.	Change for consistency with WACI Licence definition.
T6	19-24	Standing Charge	Calc used in WACI - inconsistent with Licence.	Change for consistency with WACI Licence definition.
T7	55-57	Domestic Allowance Volume	Should not form part of revenue calc.	Move to separate section on w-sheet.
T7	62-65	Standing Charge	Calc used in WACI - inconsistent with Licence.	Change for consistency with WACI Licence definition.
T9	13-16	Standard charge revenue	Calc used in WACI - inconsistent with Licence.	Change for consistency with WACI Licence definition.
T10	28-31	Total Standard Customer Revenue	Calc used in WACI - inconsistent with Licence.	Change for consistency with WACI Licence definition.
T14	28-31	Total Standard Customer Revenue	Calc used in WACI - inconsistent with Licence.	Change for consistency with WACI Licence definition.
T15	13-16	Standing charge revenue	Calc used in WACI - inconsistent with Licence.	Change for consistency with WACI Licence definition.
T17	22	Total Revenue	Calc used in WACI - inconsistent with Licence.	Change for consistency with WACI Licence definition.

## Appendix A. Derivation of Additional Tax and Interest Adjustment Due to Circularities

The model derives in a closed formula the adjustment to corporation tax and interest, which is due to their circular nature. The worksheet P7 (line 65) derives the “Additional Tax and interest adjustment to infinity (due to circularities)” as follows:

$$(1) \quad L = P * t / (1 - t - i)$$

Where:

L = Loan equal to the “additional tax and interest adjustment to infinity (due to circularities)”

P = Profit before iteration

t = Corporate tax rate

T = Allowed corporation tax

i = Interest rate (nominal)/2

Below, we show that this formula is not correct as it ignores an additional factor in the denominator. To this end we define two simultaneous equations:

$$(2) \quad T + L * i = L$$

$$(3) \quad (P - L * i + T) * t = T$$

The first equation states that the Loan equal to the tax and interest adjustment to infinity (due to circularities) is equal to the allowed corporation tax and the additional interest incurred on the loan. The second sets out the relationship between the allowed corporation tax (T) and the profit before iteration (P), accounting for the fact that the interest on the Loan (L) is tax deductible.

From (3), it can be shown that

$$(4) \quad T = (P * t - L * i * t) / (1 - t)$$

Inserting T from (4) in (2) gives the following expression:

$$(5) \quad L = P * t / (1 - t - i + 2 * i * t)$$

Comparing (5) with (1), it is apparent that the correct formula (5) to express the “Additional Tax and interest adjustment to infinity (due to circularities)” includes the additional factor “ $2 * i * t$ ” in the denominator. This factor is however small (but strictly positive) and hence has only a marginal impact on the overall result. We consider that the current model provides a good approximation of the interest and tax arising from the iterative process and we do not propose to modify the current model’s approach.

## Appendix B. Derivation of the WACI

We have audited the model's calculation of the weighted average charge increase (WACI), comparing this to the definition of the WACI included in condition B of NIW's Licence. The specific worksheet that sets out the WACI is TA23, line 40, although all of the tariff worksheets from TA3 – TA21 include data/calculations that are used in the derivation of the WACI.

This Section is structured as follows:

- § Section B.1.1 sets out the relevant licence conditions with regard to the WACI/ K-setting.
- § Section B.1.2 sets out our derivation of the WACI formula.
- § Section B.1.3 compares our derivation to the formulae in worksheet TA23.

### B.1.1. Relevant Licence Conditions

The relevant licence conditions with regard to K-setting at the Periodic Review are as follows:

Article 1.1 of Condition B states:

*“1.1. [...] to limit increases in Standard Charges for the supply of water, the provision of sewerage services and the reception, treatment and disposal of trade effluent in the fourth charging year (commencing on the 1<sup>st</sup> April) and in subsequent Charging Years.*

*The weighted average charge increase in the fourth Charging Year and subsequent Charging Years is limited to the sum of the movement in the Retail Prices Index, and Adjustment Factor called K, and a Subsidy Factor, called S.*

*The Subsidy Factor is intended to compensate the Appointee for any revenue shortfall that results from non-payment of any subsidy in respect of customers for whom special provision is made and the payment of which has been taken into account by the Authority in determining the Adjustment Factor.*

*Changes in metered charges are calculated by reference to actual consumption in respect of a Weighting Year (a financial year of the Appointee). Changes in unmetered charges are calculated by reference to changes in average revenue per chargeable supply calculated on the customer base as at the preceding 1<sup>st</sup> December.”*

Article 2 states:

*“2. Average Charge per Chargeable Supply means in respect of a specified Unmeasured Basket Item for a specified year, the amount  $R/N$  where:*

*R is the annual revenue (exclusive of VAT) which would accrue to the Appointee in respect of the specified Unmeasured Basket Item if all Standard Charges (other than Excluded Charges) made or to be made in respect of the Unmeasured Basket Item in the specified year were applied to all Chargeable Supplies of the Appointee which would have been subject to those Standard Charges as at 1 December preceding the specified year.*

*N is the number of Chargeable Supplies as at such 1 December for which the Appointee would have been entitled to make those Standard Charges provided that, where the specified year is a Prior Year,*

*(a) there shall be included in N the number of any additional Chargeable Supplies which the Appointee would have made as at such 1<sup>st</sup> December if the Standard Charges to be made in respect of the Unmeasured Basket Item in the relevant Charging Year had applied.*

*(b) there shall be excluded from N the number of any Chargeable Supplies which the Appointee would not have been entitled to make as at such 1<sup>st</sup> December if the Standard Charges to be made in respect of the Unmeasured Basket Item in the relevant Charging Year had applied;*

**Basket Items are:**

- (1) unmeasured water supply;*
- (2) unmeasured sewerage services;*
- (3) measured water supply;*
- (4) measured sewerage services; and,*
- (5) reception, treatment, and disposal of trade effluent.*

**Ministerial Policy Limit** means in relation to any Charging Year, the maximum amount of Domestic Total Controlled Revenue that is consistent with ensuring that the Appointee's average charges for the supply of water and the provision of sewerage services to domestic customers (taking into account for this purpose any subsidy payable by the DRD under Article 213 of the Order) do not exceed the average charges for the supply of water and the provision of sewerage services to domestic customers in England and Wales or such other maximum amount of Domestic Total Controlled Revenues as is determined [...]

**Weighted Average Charges Increase** means the sum calculated as follows:

$$W_t = \sum_i \left[ \frac{A_t(i)}{A_{t-1}(i)} * r(i) \right] + \sum_j \left[ \frac{B_t(j)}{B_{t-1}(j)} r(j) \right] - 1$$

Where:

*W<sub>t</sub> is the Weighted Average Charges Increase for the Charging Year;*

*i is an index identifying the two Unmeasured Basket Items;*

*j is an index identifying the three Measured Basket Items;*

*At(i) is the Average Charge Per Chargeable Supply in respect of Unmeasured Basket Item i for the Charging Year*

*At-1 (i) is the Average Charge Per Chargeable Supply in respect of Unmeasured Basket Item i for the Prior Year*

*Bt(j) is the Weighting Year Revenue in respect of Measured Basket Item j for the Charging Year;*

*Bt-1 (j) is the Weighting Year Revenue in respect of Measured Basket Item j for the Prior Year*

*r(i) or r(j) is the revenue (exclusive of VAT) which accrued to the Appointee in the Weighting Year from all Standard Charges other than Excluded Charges (including, in the case of Measured Basket Items, any Non-volumetric charge) in respect of Unmeasured Basket Item i or Measured Basket Item j (as the case may be), divided by the aggregate of such revenues for all five Basket Items;*

**Weighting Year** means the financial year of the Appointee ended last before 7 October in the Prior Year; and,

**Weighting Year Revenue** means the revenue (exclusive of VAT) which would have accrued to the Appointee in the Weighting Year in respect of the specified Measured Basket Item, if all Standard Charges other than Excluded Charges (including any Non-volumetric Charge) made or to be made in respect of that Measured Basket Item in the Charging Year or, as the case may be, the Prior Year had applied.”

Article 5 states:

“5. *The Charges Limit*

5.1 *The Appointee shall ensure that the Weighted Average Charges Increase in any Charging Year (beginning with the Charging Year commencing on 1<sup>st</sup> April 2010) when expressed as a percentage does not exceed the Charges Limit:*

5.2 *The Charges Limit is the percentage calculated as  $RPI+K - S$ , where:*

*RPI is the percentage change [...] in the Retail Prices Index between that published for the month of November in the immediately preceding Charging Year and that published for the immediately preceding November;*

*K is the adjustment factor*

*S is the subsidy factor*

5.3 *The Adjustment Factor is, for each of the successive Charging Years commencing on 1<sup>st</sup> April 2010, such number [...] as shall have been determined under this Condition [...].*

### **B.1.2. NERA Derivation of WACI**

In this Section, we expand the weighted average charge increase (WACI) formula for comparison with the formula used in NIAUR’s financial model (worksheet TA23).

As set out in the Licence, the WACI formula is as follows:

$$1. W_i = \sum_i \left[ \frac{A_t(i)}{A_t - 1(i)} * r(i) \right] + \sum_i \left[ \frac{B_t(j)}{B_{t-1}(j)} r(j) \right] - 1$$

Drawing on definitions in the Licence, we expand the first term of the WACI formula. First, we define the Average Charge Per Chargeable Supply as follows:

$$2. A_t(i) = \frac{R}{N} (ChargingYear) = \frac{\sum StCh_{it}^n * ChSup_{i,t-1(Dec)}^n}{TotalChSup_{i,t-1(Dec)}}$$

Where: StCh denotes the list of n charges that apply within each Unmeasured Basket item (e.g. the schedule of standing charges; sundry charges etc.); ChSup denotes the corresponding list of chargeable supplies for each n; TotalChSup denotes the number of Chargeable Supplies for tariff basket i; t denotes the Charging Year; t-1(Dec) denotes December 1<sup>st</sup> of the preceding year.

The equation above states that the Average Charge Per Chargeable Supply is equal to the Standard Charges for basket i multiplied by the chargeable supplies associated with each charge in time t-1, divided by the Chargeable Supplies in time t-1.

We define the denominator in the first term of Equation 1 as follows:

$$3. A_{t-1}(i) = \frac{R}{N} (PriorYear) = \frac{\sum StCh_{i,t-1}^n * ChSup_{i,t-2(Dec)}^n}{TotalChSup_{i,t-2(Dec)}}$$

Equation 3 has the same meaning as equation 2 but in relation to the Prior Year.

Finally, r<sub>t</sub>(i) is defined as the *accrued revenue* shares for tariff basket i in the Weighting Year. For the purposes of calculating these no.s in the model, we define r<sub>t</sub>(i) as follows:

$$4. r_t(i) = \frac{\sum StCh_{i,t-2}^n * ChSup_{i,t-2}^n}{\sum_i \sum_n StCh_{i,t-2}^n * ChSup_{i,t-2}^n}$$

Note, the revenue weights correspond to revenues in period t-2. We can show this by example. Assuming the Charging Year = 1<sup>st</sup> April 2010, then the Weighting Year, which means the “*financial year ended last before 7 October in the Prior Year*”, is equal to financial year ended last before 7 October 2009. The financial year for NIW commences April 1<sup>st</sup>. That is, the Weighting Year is equal to the financial year ending March 31<sup>st</sup> 2009 or commencing April 1<sup>st</sup> 2008. In the equation above, this is denoted by the subscript t-2.

Using these terms above, we can now expand the first term of the WACI.

5. Unmeasured Tariff Basket revenue: =

$$= \sum_i \left[ \frac{A_t(i)}{A_{t-1}(i)} * r(i) \right]$$

Substituting in equations 2 and 3, we have:

$$= \sum_i \left[ \frac{\frac{\sum_n StCh_{i,t}^n * ChSup_{i,t-1(Dec)}^n}{TotChSup_{t-1(Dec)}}}{\frac{\sum_n StCh_{i,t-1}^n * ChSup_{i,t-2(Dec)}^n}{TotChSup_{t-2(Dec)}}} * r(i) \right]$$

Substituting in equation 4, we have:

$$= \sum_i \left[ \frac{\frac{\sum_n StCh_{i,t}^n * ChSup_{i,t-1(Dec)}^n}{TotChSup_{t-1(Dec)}}}{\frac{\sum_n StCh_{i,t-1}^n * ChSup_{i,t-2(Dec)}^n}{TotChSup_{t-2(Dec)}}} \right] * \left[ \frac{\sum_n StCh_{i,t-2}^n * ChSup_{i,t-2}^n}{\sum_i \sum_n StCh_{i,t-2}^n * ChSup_{i,t-2}^n} \right]$$

This equation states that the WACI in relation to the Unmeasured Basket items is calculated as: the Average Charge Per Chargeable Supply in the Charging Year divided by the Average Charge Per Chargeable Supply in the Prior Year, then multiplied by the tariff basket i's share of accrued revenues in time t-2.

We define the terms in the second term in Equation 1 (in respect of the Unmeasured Tariff Basket Items) as follows:

$$6. Bt(j) = \sum_n StCh_{j,t}^n * ChSup_{j,t-2}^n$$

That is, standard charges applying in the Charging Year multiplied by the Chargeable Supplies in time t-2.

$$7. Bt-1(j) = \sum_n StCh_{j,t-1}^n * ChSup_{j,t-2}^n$$

That is, standard charges applying in the Prior Year multiplied by the Chargeable Supplies in time t-2.

$$8. r_i(j) = \frac{\sum_n StCh_{j,t-2}^n * ChSup_{j,t-2(Dec)}^n}{\sum_j \sum_n StCh_{j,t-2}^n * ChSup_{j,t-2(Dec)}^n}$$

That is, the revenues for time t-2 for basket j divided by total revenues for time t-2.

Substituting these terms into Equation 6, we have:

9. WACI in relation to the Measured Tariff Basket revenue is equal to:

$$\begin{aligned}
 &= \sum_j \left[ \frac{B_t(j)}{B_{t-1}(j)} r(j) \right] \\
 &= \sum_j \left[ \frac{\sum_n StCh_{jt}^n * ChSup_{j,t-2}^n}{\sum_n StCh_{jt-1}^n * ChSup_{j,t-2}^n} * r_t(j) \right] \\
 &= \sum_j \left[ \frac{\sum_n StCh_{jt}^n * ChSup_{j,t-2}^n}{\sum_n StCh_{jt-1}^n * ChSup_{j,t-2}^n} * \frac{\sum_n StCh_{j,t-2}^n * ChSup_{j,t-2}^n}{\sum_j \sum_n StCh_{j,t-2}^n * ChSup_{j,t-2}^n} \right]
 \end{aligned}$$

This formula states that the WACI for the Measured Basket Items is calculated as the sum of: the Standard Charges for each tariff basket j that will apply in the Charging Year multiplied by the Chargeable Supplies in year t-2 for basket j divided by the Standard Charges that apply in the Prior Year multiplied by the Chargeable Supplies in year t-2, multiplied by the accrued revenue share of tariff basket j in time t-2.

**B.1.3. Comparison of Licence with the Model**

Table 3.1 compares the formulae for WACI derived from the Licence with the formulae in the model. This shows that for consistency with the Licence we need to make a number of changes to the model.

The main issue is that although the WACI formula in the model is correct in terms of its structure, frequently it does not use the correct precedent year with regard to Chargeable Supplies (e.g. it generally calculates changes with respect to Chargeable Supplies in t-1, whereas the Licence stipulates t-2.)

The specific model lines that will need changing are noted in Table 3.4.

**Table B.1**  
**Comparison of Licence Conditions and Model WACI**

Term	NERA/ Licence	Model	Model Differences
<b>Unmeasured Basket</b>			
A <sub>t</sub> (i) (Charing Year)	$\frac{\sum_n StCh_{it}^n * ChSup_{i,t-1(Dec)}^n}{TotalChSup_{i,t-1(Dec)}}$	$\sum_n StCh_{it}^n * ChSup_{i,t-1}^n$	(i) Model uses Chargeable Supplies in t-1 as proxy for charges in December t-1.  (ii) No denominator. (Assumed to cancel with A <sub>t-1</sub> .)
A <sub>t-1</sub> (i) (Prior Year)	$\frac{\sum_n StCh_{i,t-1}^n * ChSup_{i,t-2(Dec)}^n}{TotalChSup_{i,t-2(Dec)}}$	$\sum_n StCh_{i,t-1}^n * ChSup_{i,t-1(Dec)}^n$	(i) Model uses Chargeable Supplies in t-1.  (ii) No denominator. (Assumed to cancel with A <sub>t</sub> .)
R <sub>t</sub> (i)	Tariff basket share of revenue in t-2.	Tariff basket share of revenue in t-1.	Model uses weights from Prior Year and not Weighting Year.
<b>Measured Basket</b>			
B <sub>t</sub> (j)	$\sum_n StCh_{j,t}^n * ChSup_{j,t-2}^n$	$\sum_n StCh_{j,t}^n * ChSup_{j,t-1}^n$	Model uses Chargeable Supplies from Prior Year not Weighting Year.
B <sub>t-1</sub> (j)	$\sum_n StCh_{j,t-1}^n * ChSup_{j,t-2}^n$	$\sum_n StCh_{j,t-1}^n * ChSup_{j,t-1}^n$	Model uses Chargeable Supplies from Prior Year not Weighting Year.
R <sub>t-1</sub> (j)	Tariff basket share of revenue in t-2	Tariff basket share of revenue in t-1.	Model uses weights from Prior Year and not Weighting Year.

## Appendix C. K-Solving Macro Code

The process for K-solving uses a macro. To use the macro, the user has to first select:

The revenue approach, where there are three options:

- § Option 1 – Fixed Revenue
- § Option 2 – Revenue Formula
- § Option 3 – Tariff Basket Revenue

The user also needs to determine how the calculated revenue will be distributed among revenue groups for the period 2010-14. There are three alternatives:

- § Input of 2013-14 targets with the model assuming a straight-line apportionment between this breakdown and that calculated for 2009-10.
- § Input of percentage targets in year 2010-2011, with the model calculating a straight-line until the 2013-14 target.
- § Input of custom revenue allocation for all years 2010-14.

We set out the macro coding below and an interpretation in words of the code in a text box:

### C.1. Macro code and interpretation

```
Private Sub CommandButton1_Click()

For numcol = 1 To 3

For numrow = 1 To 7

Sheets("TA1").Cells(8 + numrow, 9 + numcol) = 0

Next numrow

Next numcol
```

The above code refers to w-sheet TA1, Cells J9:L31. These cells relate to the % p.a. change in revenue groups 3 to 9 for the period 2010/11 to 2013/14.

```
For x = 1 To 5

Sheets("TA1").Cells(9, 12 + x) = 0

Next x
```

The above code refers to w-sheet TA1, Cells M9:Q9. These cells relate to the % p.a. change in revenue groups 3 for the years 2013-14 to 2017-18.

```
For numcol = 1 To 3
```

For numrow = 1 To 7

If Sheets("Allocation").Cells(16 + numrow, 9 + numcol) <> 0 Then

Sheets("Allocation").Cells(16 + numrow, 9 + numcol).GoalSeek Goal:=Sheets("Allocation").Cells(77 + numrow, 9 + numcol), ChangingCell:=Sheets("TA1").Cells(8 + numrow, 9 + numcol)

End If

Next numrow

Next numcol

The above code performs the following process: For each revenue group 3 to 9 for the years 2011/12 to 2013/14:

Set: “% revenue allocated to Revenue Groups (net of non-primary revenue)” (Ref w-sheet Allocation, CellsJ17:L23)

= “Revenue target: selective alternative” (Ref. w-sheet: Allocation, Cells J78:L84)

By changing cells: “Percentage change in tariff per revenue group” TA1 Cells J9:L15).]

For x = 1 To 5

Sheets("Allocation").Cells(11, 12 + x).GoalSeek Goal:=Sheets("Allocation").Cells(10, 12 + x), ChangingCell:=Sheets("TA1").Cells(9, 12 + x)

Next x

End Sub

The above code performs the following process: for each revenue group 3 to 9:

Set: “Primary revenue (from customer base)” [Ref w-sheet Allocation, Cells M:Q11]

= “Primary revenue (from financial model)” [Ref w-sheet Allocation, Cells M:Q10]

By changing cells: “Revenue Group 3: domestic unmeasured water” [Ref w-sheet TA1, Cells M:Q9

The process work by iterating the required change in tariffs for revenue group 3; but effectively all revenue groups’ tariffs are changed by the same amount There is no targeting of different cost allocations beyond the PC10 control period.]

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