

Office of Rail Regulation and
Network Rail

**AO/027: Review of Analysis in
Network Rail's 'Freight Cap'
Consultation**

Report

223767-01

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This report takes into account the particular
instructions and requirements of our client.

It is not intended for and should not be relied
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Executive Summary

Network Rail (NR) have calculated initial cost estimates that could inform freight variable usage charges (VUC) and freight only line charges, to be applied during CP5. NR and the Office of Rail Regulation (ORR) have asked Arup, as the Part A Independent Reporter, to carry out a high level review of these calculations in particular:

- To review Network Rail's (NR's) initial analysis underpinning its consultation on freight caps¹; and
- To advise on the robustness of the cost estimates, and associated uncertainties underpinning the estimates.

There are a number of stages to the calculations and our findings for each of these are as follows.

Initial Track Variable Cost Estimate

The variable cost of wear and tear on track has been calculated using the VTISM and associated models. Different scenarios of traffic volumes have been modelled to calculate the corresponding renewal and maintenance volumes and costs. The traffic growth scenarios were found to produce very consistent results. Initially the one reduced traffic scenario produced counter-intuitive results. However, NR has advised this was due to the way that the model was set up to always expect traffic growth. They have corrected this and the results are now more intuitive.

As agreed in the mandate, we have not reviewed the VTISM model itself. However, we agree that the overall approach taken to calculate the variable costs by using VTISM and the Strategic Route Section Maintenance Model (SRSMM) is appropriate.

We have checked that the inputs to VTISM and SRSMM are consistent with those used in the Initial Industry Plan (IIP).

SERCO carried out the VTISM runs to identify the 'best fit' renewal and maintenance budgets for each of the traffic scenarios considered. NR then fed these into T-SPA to produce the estimated work volumes and costs. We have not checked or replicated these runs, but it is the same process as undertaken for the IIP.

The results from VTISM and T-SPA have been input to the SRSMM to forecast light maintenance volumes. This version of the model is different to that used in the IIP in that it uses more 'normalisers' to calculate work volumes. NR advise these additional normalisers are likely to be used for the Strategic Business Plan (SBP).

Finally, the model outputs are fed into a spreadsheet model to calculate the track element of the VUC. We checked this model and found no errors in the calculations.

Overall, then, we judge the variable track cost estimates to be calculated using a sound bottom-up approach. Data has been used consistently between the different

¹ Available at: <http://www.networkrail.co.uk/PeriodicReview2013.aspx>

models. The VUC spreadsheet contains no computational errors. The main cause of uncertainty in our view has been reduced by NR producing more credible results for a traffic reduction scenario.

Civils Structures

The variable costs to Structures are proposed in CP5 to be extended from metallic underbridges to masonry and brick underbridges and to culverts. There is evidence to suggest that these additional structures are and will continue to be affected by heavy axle loads. However, no evidence has been provided by NR on the variability impact. There is, therefore, some uncertainty on these variable costs.

Earthworks

NR proposes retaining the 6% variability percentage applied to earthworks in PR08. There are credible fatigue type mechanisms for higher plasticity Clay embankments that could be induced by railway traffic loading. However, there is insufficient data to enable a robust estimate of the variable usage charge percentage. In the absence of such information, NR has used its own engineering judgment.

Signalling

Variability for signalling maintenance is proposed to increase from 5% to 6%. In addition, minor works points renewals have been included for the first time with a variable percentage of 44%.

NR has demonstrated that it has applied a more thorough approach in calculating the proposed variable usage costs than for CP4. Whilst still based upon expert judgement, it enables each sub category to be quantified individually and enables each sub category to be seen in the context of the overall usage charge. On the specific elements:

- We agree that the signalling maintenance variability assumptions are reasonable;
- We agree that the inclusion of minor works renewals of clamplock points operating equipment and point machines are reasonable; and
- Given the approach, the 6% signalling maintenance variability is reasonable.

NR does not differentiate between levels crossings using barriers and open types in its variable cost estimates. We would expect that only types using barriers would be included and that open types would be excluded. However, we understand that safety aspirations will mean that more level crossings will be fitted with barriers. In addition, this element of the variable cost is relatively small (about 5% of the signalling maintenance) so we judge this to be no more than a minor concern.

Variable Usage Charge

The track, civils structures, earthworks and signalling costs are brought together in a final spreadsheet. They are apportioned between freight and passenger trains according to relationships derived off-line from the PR08 VUC model. We have checked the calculations in this final spreadsheet and found no errors.

Level of uncertainty of VUC

In the final spreadsheet the variable usage cost estimate is uplifted by 20% to reflect the levels of uncertainty in its calculation (including the final apportionment of costs between freight and passenger traffic). We have considered if this is appropriate by categorising each element by whether its method of calculation is sound and there is little concern on data or assumptions (**green**), there are some concerns on method, data or assumptions but nothing major (**yellow**), or there is at least one major concern (**red**). This is a high level view but a red might merit uncertainty of 20% or more.

Asset	Rating	Comment
Track	yellow	Calculations are based on VTISM which is a well developed model. Our review of the same modelling process for IPP (the Tier 1 model as part of the AO/016 and 021 mandates) graded its computational integrity a green and data inputs as a yellow.
Civils Structures	red	Based on engineering judgement with no firm evidence on the quantified impact.
Earthworks	red	Based on engineering judgement with no firm evidence on the quantified impact.
Signalling	yellow	Whilst based on engineering judgement, the impacts have been broken down into constituent parts in a logical way.

The dominant element of the VUC is track which constitutes 85% of the overall charge. We would therefore suggest that an overall rating of uncertainty of **yellow** would be reasonable. By this view, uplifting by 20% might be on the high side. Note, though, we have not included consideration of any uncertainty arising from the passenger / freight apportionment which will be considered separately by the ORR and must be taken into account in the overall confidence interval.

Freight only line charges

The freight only line charge is designed to recover a proportion of the fixed costs that NR incurs in respect of freight only lines. NR have produced a spreadsheet model which we have reviewed. The list of freight only lines is assumed to be correct.

The version of the model we reviewed has been updated since the publication of NR's consultation paper on the 29th November 2011. This produces revised caps of £5.93m for Coal ESI and £1.52m for Nuclear Fuel (including the 20% confidence interval).

The main reason for the difference is the replacement of the 24% and 14% mark ups for Coal ESI and Nuclear Fuels with a more bottom-up approach to estimating signalling related renewal costs. In our view this is a more reasonable approach.

In the model, the costs for the track renewal and maintenance, signalling maintenance and civils renewals have all been reduced by 20%. The rationale for this is that it is easier to gain access to freight only lines than for the 'average' route and so unit costs will be lower than the average. This figure was suggested by the previous Independent Reporter.

However, it is unclear why the 20% has not been applied to the signalling related renewal costs. We would recommend that NR should consider applying it, in which case the annual costs would reduce from £0.62m to £0.50m for Coal ESI and £0.07m to £0.06m for Nuclear Fuel.

We found no computational errors in the model and all the data used is consistent with the IIP. Each of the steps in the calculations are reasonable and logical, however it is our opinion that apportioning costs to specific freight only lines will involve some approximations and assumptions. In addition, the incomplete ACTRAFF data will add to the overall uncertainty. Taking all into consideration, it is our view that applying a confidence interval of $\pm 20\%$ to the calculated cost to represent the range in which the true cost will lie is reasonable.

1 Introduction

In its Periodic Review 2013 (PR13) first consultation, ORR requested views on whether it should once again place a cap on certain freight charges in advance of its final determination. In order to facilitate a possible cap on certain freight charges Network Rail (NR) calculated initial estimates of variable usage charge (VUC) and freight only line charge costs. NR set out the basis of its initial cost estimates in its recent consultation letter on 'freight caps'. Following the conclusion of NR's 'freight cap' consultation, ORR will conclude on whether it wishes to place a cap on certain freight charges in advance of its final determination.

As part of this process, NR and ORR have asked Arup as the Part A Independent Reporter to review NR's method and calculations for these initial estimates. In particular they have asked Arup:

- To review Network Rail's (NR's) initial analysis underpinning its consultation on freight caps; and
- To advise on the robustness of the cost estimates, and associated uncertainties underpinning the estimates.

The mandate for this work is presented in Appendix A. The review undertaken is subject to a resource cap of 20 person days and so is essentially high level.

This report covers the following areas:

- Section 2 – Initial track variable cost estimates to be included in the VUC;
- Section 3 – Civils structures and earthworks cost estimates to be included in the VUC;
- Section 4 – Signalling cost estimates to be included in the VUC
- Section 5 – Final variable usage spreadsheet
- Section 6 – Freight only line charges
- Section 7 – Recommendations

Note that the apportionment of the VUC between passenger and freight trains is currently based on the relationship between gross and equivalent tonnage in the CP4 VUC model. The final apportionment will be determined following the development of the CP5 VUC model. The uncertainty in this respect is not included in the mandate of this review and will be considered separately by ORR.

2 Initial Track Variable Cost Estimates

2.1 Introduction

This section presents our review of Network Rail's method for calculating the initial track variable costs for freight traffic. The modelled track variable cost estimates form the largest input to the 'final' variable usage charge spreadsheet.

For the purposes of this audit, we have reviewed the spreadsheet model produced by NR which derives the initial track variable cost estimates by processing the outputs from VTISM and the SRS Maintenance Model (both together used as the Track Infrastructure Cost Model for the 2011 Initial Industry Plan).

Checks were made to ensure that the approach taken is consistent with the 2011 Initial Industry Plan.

By way of context, both passenger and freight traffic is forecast to grow by about 15% during CP5, with further growth beyond. Consequently, the models have been set up to model traffic growth.

2.1.1 Overview to Network Rail's Approach

Network Rail has produced a spreadsheet model to calculate the initial track variable costs for freight and passenger traffic. The renewals and maintenance costs for Track are based on a period of 35 years (CP5 to CP11) and were modelled using the Infrastructure Cost Model (ICM).

NR has tested how the renewals and maintenance costs would change assuming the following hypothetical traffic scenarios:

- Basecase - No increase in traffic beyond the end of CP4;
- 5% traffic increase;
- 10% traffic increase;
- 20% traffic increase;
- 10% traffic decrease - in their consultation paper of 29th November 2011, NR had stated that the initial results from VTISM for the -5% and -10% traffic scenarios were counter-intuitive. They have explained that the primary reason for this is that the track asset management policies incorporated in VTISM do not consider scenarios in which traffic volumes decline because this situation is deemed to be unlikely to occur. However, following some concerns raised by the stakeholders, Network Rail have prepared an additional case study for an assumed 10% decrease in the overall traffic, which, in accordance with our mandate, has not been reviewed in this report.

A summary of the methodology used by NR to derive the initial track variable usage costs for freight and passenger traffic is set out below:

- The CP4 Baseline volumes were estimated by NR using VTISM and SRSMM models for forecast end of CP4 traffic levels.

- Serco were commissioned by NR to derive the final budgets associated with the hypothetical traffic scenarios (5, 10 and 20% traffic increments) whilst maintaining the track condition the same as the end of CP4.
- The adjusted budgets (T-SPA . mod files) supplied by Serco were input into the T-SPA model to predict track degradation and the remedial effects of heavy maintenance and renewal for the basecase and the hypothetical traffic scenarios.
- The Light Maintenance calculations were undertaken by the SRS Maintenance Model by choosing a normaliser metric for each maintenance type. These normalisers are used to calculate an “activity volume per unit of normaliser” factor which when multiplied by the normaliser volume calculates the level of maintenance activity. The SRS Maintenance Model functions by using the offline inputs (Track asset inventory) from VTISM.
- The activity volumes produced by VTISM (T-SPA) were multiplied by the relevant unit costs to obtain the cost of renewals and heavy maintenance. NR have used the same unit cost rates that informed the IIP.
- The cost differentials between the basecase and the remaining traffic scenarios were then converted to a variable usage charge.

The activity volumes are modelled over a period of 35 years (CP5 to CP11).

2.1.2 Approach to Audit

In order to get a full understanding of the calculations, underlying assumptions and input data, the following checks were undertaken:

- Audit of spreadsheet formulae and data processing;
- Checks on the consistency and appropriateness of the input data with the offline input sources. However, VTISM runs were not undertaken for this review. The input data into VTISM and the output data from the VTISM runs were supplied by NR; and
- Checks of the calculation methodology against NR's Freight Cap Consultation Document.

A series of meetings was held with the Network Rail staff responsible for the calculations and the input data in the models. The meetings are listed in Appendix B. ORR were present at several of these meetings.

2.1.3 Models and Documents Reviewed

Following the inception meeting with Network Rail, the final spreadsheet used to calculate the VUC was obtained. In addition, several documents were received supporting the calculations, and these are listed below:

Table 2. 1: Models and Documents Reviewed - Track VUC

Description	File
Track VUC model	VTAG Variable Cost Results.xls
SRS Maintenance Models	VUC Track M models.zip
Spreadsheet summarising the response from FOCs to NR's VUC and Freight Cap consultation	20120224 -BW- summary spreadsheet vTOORR.xls
Serco Report	VTISM Stage 2 Calculation Services for CP5 Summary Report.doc, October 2011

2.2 Review of Modelling Approach

There are two strategic models that Network Rail has developed and used to forecast work volumes, condition, performance and expenditure for the whole track network in CP5 in compliance with their Track Policy. These are VTISM, which has provided the costs for plain line, S&C Renewals and Heavy Maintenance and the SRS Maintenance Model, using the output from VTISM runs, to produce the costs for Light Maintenance. The off-track and non-volume costs are not sensitive to traffic volumes and are manually input within the Track VUC model.

The computed annual costs for the five hypothetical traffic scenarios produced by NR are shown below in Table 2. 2.

Table 2. 2: Total Renewals and Maintenance Costs - Track

Costs (£m per year)	Baseline	-10%	5%	10%	20%
Plain line renewals	334	321	341	346	357
S&C renewals	144	138	145	146	148
Heavy maintenance	69	66	70	71	74
Light Maintenance	294	283	298	302	312
Off-track	23	23	23	23	23
Non-volume	45	45	45	45	45
Total	910	876	922	934	958

The incremental increase in the annual renewal, heavy maintenance and light maintenance costs are shown in Table 2. 3. These are calculated for each of the scenarios by subtracting the total costs in Table 2. 2 from the baseline costs.

The average track vehicle cost per thousand gross tonne kilometres is calculated by dividing the total incremental increase in costs by the incremental increase/decrease in tonnage for the same scenario as shown in Table 2. 3.

NR forecast that total freight and passenger traffic in 2013/14 will be 180.5m kgtkm.

The total track renewal and heavy maintenance variable costs were estimated by multiplying the average vehicle cost per kgtkm by forecast end CP4 baseline traffic.

Table 2. 3: Total variable costs for the hypothetical traffic scenarios - Track VUC

	Total Cost Increase (£m per year)	Total Traffic Increase (million kgtkm)	Total £ per kgtkm rate	Total 2013/14 cost (£m per year)
Traffic Scenarios	<i>a</i>	<i>b</i>	<i>a/b</i>	
-10% traffic scenario	-33.9	-18.0	1.88	339.5
+5% traffic scenario	12.4	9.0	1.38	248.9
+10% traffic scenario	24.3	18.0	1.35	243.4
+20% traffic scenario	48.5	36.1	1.34	242.4

2.3 Comparison with IIP Tier 1 SRSMM

The ICM model uses actual traffic forecast to the end of CP4 and beyond. However, the SRSMM for the 'No traffic increase' scenario of Freight Cap assumes no increase in traffic beyond the end of CP4. Checks were undertaken to compare the costs forecast by the ICM with that in the Freight Cap baseline model and to ensure that they were lower, as expected, than the ICM Track model.

The SRSMM for the 'No traffic increase' scenario of Freight Cap was compared with the IIP Track Tier 1 model. It was observed that the Freight Cap version of the model is different to that used in the IIP in that it uses three more 'normalisers' to calculate work volumes. The normalisers are listed in Table 2. 4.

Table 2. 4: Normalisers used in SRSMM

IIP Tier 1 Normalisers	Freight Cap Normalisers
#SC	#SC
#SC.EMGTPA	#SC.emgtpa
Actionable defects per 100k.km	Actionable defects
km	km
km.emgtpa	km.emgtpa
-	Switch Used Life-units
-	Tamp-km
-	BFI-km

In the timescale, we were unable to carry out a sensitivity test by updating the VB code within the SRSMM for ICM to check the impact of the additional normalisers used in Freight Cap.

NR advise that the new normalisers facilitate further refinements in the calculations and are likely to be used for the Strategic Business Plan (SBP).

2.4 Review of Serco Documentation

NR had commissioned Serco to derive the final budgets associated with the hypothetical traffic scenarios (5, 10 and 20% traffic increments) whilst maintaining the track condition at the same level as the end of CP4.

The methodology used by Serco to calculate the 'Best Fit Budget Factors' for the three traffic scenarios and the associated results are reported in 'VTISM Stage 2 Calculation Services for CP5 Summary Report' dated October 2011.

Serco also adjusted the renewal and refurbishment budgets within the T-SPA mod files, for each criticality band, to replicate the basecase track condition at the end of each control period using the Alpha (Plain Line budget) and Beta (S&C budget) factors identified in the calculation of Best Fit Budget Factors' spreadsheet.

T-SPA is Network Rail's Track Strategic Planning Application model. It is a decision support tool designed to provide a detailed analysis of a broad range of renewal and maintenance options. In particular the volumes and cost of the work are linked to the condition and performance outputs that would be obtained.

The 'Best Fit Budget Factors' derived by Serco using VTISM are shown in Table 2. 5.

Table 2. 5: Best Fit Budget Factors - Serco Report

Band	5% Traffic Increase		10% Traffic Increase		20% Traffic Increase	
	Plain Line	S&C	Plain Line	S&C	Plain Line	S&C
1	7.6%	11.4%	7.1%	9.5%	8%	7.8%
2	4.3%	3.4%	5.8%	4.2%	10.4%	6.7%
3	3.0%	3.7%	4.1%	2.7%	8.2%	6.8%
4	1.6%	2.7%	4.2%	5.3%	7.7%	7.6%
5	7.9%	4.8%	12.0%	5.6%	21.0%	7.1%

Checks were made to ensure that the above factors match those in the 'Budget Fit Adjustment Factors' spreadsheets supplied by Serco to NR.

NR then used the updated T-SPA .Mod files prepared by Serco to calculate the total renewal, refurbishment and maintenance volumes shown in Table 2. 2.

2.5 Review of Output Spreadsheets and Resulting Track Variable Usage Costs

As part of the review, we have checked the resulting output spreadsheets from VTISM and SRSMM and how they feed into the 'final' track variable usage charge spreadsheet. The methodology used is discussed in this section.

Track - Heavy Maintenance and Renewals

The VTAG spreadsheet supplied to Arup comprised of an extract of the outputs from the T-SPA model runs, carried out by NR, using the T-SPA .Mod files

(supplied by Serco) for the hypothetical traffic scenarios for each of the five criticality bands.

The outputs from the T-SPA runs were supplied to Arup in a spreadsheet – 'VTAG Variable Cost Results.xls'. Adjustment factors were used to convert the sample of track modelled in T-SPA to represent the whole network. Our checks showed that NR has used the same adjustment factors as that in the ICM.

Track - Light Maintenance

The SRS Maintenance model functions by using the offline inputs (Track asset inventory) from VTISM.

Checks were carried out to ensure that the annual 'Light Maintenance' cost in the VTAG spreadsheet matched with the outputs from the SRS Maintenance models for all the traffic scenarios tested.

It was observed that the formula for calculating the S&C renewals and heavy maintenance volumes were adjusted such that if the final volumes for the +5, +10 and +20% traffic scenarios were lower than the baseline scenario, then the model selects the volumes from the baseline scenario instead to ensure volumes of work do not reduce. However, our checks have indicated that this change in the formulae has negligible impact on the results for +5 and +10% scenarios and has no effect on the result for +20% traffic scenario.

2.6 Conclusions

The key findings from our review of the Track variable cost model are summarised as below:

- No errors have been identified in the computations within the Track VUC model.
- The key inputs into the Track VUC model are the renewals and maintenance costs from the previously audited Infrastructure Cost Model.
- The SRS Maintenance Model has been adjusted to include three additional normalisers. This is in line with the expected development for NR's Strategic Business Plan.
- Results from the three traffic increase scenarios modelled using VTISM are consistent.
- As per the mandate, we have not reviewed VTISM.
- The new traffic decrease scenario (-10%) modelled has a more intuitive result than previously reported.
- The unit costs used in the Track VUC model are identical to the costs used in ICM.

3 Civil Structures and Earthworks

3.1 Introduction

This section reviews the Civils Structures and Earthworks elements of the VUC.

A meeting was held with NR on 6th March 2012 at which the NR's approach to estimating the Variable Usage Cost percentages for Civils assets was presented by NR. Subsequently various documents have been provided by NR.

The approaches adopted by NR are described below. We have considered the approaches, commented and given our opinion as to the uncertainty rating to be assigned.

In preparing our opinion we have considered the following questions:

- *How was the VUC percentage calculated for CP4?*
- *What evidence is there that railway traffic damages the asset?*
- *What is the relationship between railway traffic and damage to the asset?*
- *What costs have been incurred by NR due to damage caused by railway traffic?*
- *Is there evidence of increasing asset failures due to railway traffic?*

The opinion set out below is a 'high level' opinion has been subject to a resource cap as requested by ORR and NR. A resource of 1 man day of a Geotechnical Engineer and 3 man days of a Structural Engineer was agreed. This has limited the breadth and depth of our review and in this time we have primarily relied upon documents provided to us by NR, as well as our knowledge from work on the Buildings and Civils Asset Management Transformation Programme (Independent Reporter mandate AO/019) and reviewing NR's CP5 asset policies (mandate AO/017).

3.2 Civil Structures Renewals

3.2.1 Approach Adopted by NR

The initial estimates of the Variable Usage Cost percentages (Percentage variability) proposed by NR for CP5 Civils assets are set out in Figure 3.1 below. The variability percentage assigned to brick and masonry bridge renewals is 20%, which is the same variability percentage applied to metallic underbridge renewals, and a figure of 5% has been applied to culverts. Of the structures assets, in CP4 only metallic underbridges were included in the VUC. The reason for including these two additional structure types is the effect of 4-axle 100T freight wagons on multi-span structures particularly on routes new to freight. This is discussed further in Section 3.2.4 below.

Table 3: Non track variable usage cost estimates (2011/12 prices end CP4 efficiency)

Asset type	Annual average (£m)	Percentage variability	Variable usage cost (£m)
Civils:			
Embankment renewals	32.4	6%	1.9
Metallic underbridge renewals	48.7	20%	9.7
Brick and Masonry underbridge renewals	92.7	20%	18.5
Culverts renewals	9.2	5%	0.5
Signalling:			
Maintenance	137.2	6%	8.2
Minor works points renewals	12.2	44%	5.4
Total variable usage cost			44.3

Figure 3.1 Extract from NR (2011a²) – NR Proposed Variable Usage Charges

The Variable Usage Cost percentages adopted for Civils assets in CP4 are set out in Figure 3.2 below.

Table 1: CP4 annual variable usage costs (2011/12 prices at end CP4 efficiency)

Asset	Variable usage cost (£m)	'top down' variability assumption
Track	221	N/A
Metallic underbridge renewals	19	20%
Embankments renewals	2	6%
Signalling maintenance	6	5%
Brick and Masonry underbridge renewals	0	0%
Culverts renewals	0	0%
Minor works points renewals	0	0%
Total	248	

Figure 3.2 Extract from NR (2011a³) – NR CP4 Variable Usage Charges

Comparing these two figures, it is not immediately clear why the VUC for metallic bridges in CP5 is approximately 50% of the CP4 figure.

In the NR letter dated 13th September, NR state that *'For other assets (e.g. civils and signalling) we propose estimating total (passenger and freight) variable usage costs by applying 'top down' estimates of cost variability based on expert judgement. This methodology is consistent with the approach we adopted in PR08. We comment on this further in 3.2.2 below.*

3.2.2 Comment and Opinion

For the proposed CP5 Freight Cap for Civils Structures, specifically bridges, Network Rail has initially proposed adopting the approach used in CP4, with two significant additions to the metallic bridge category. The first relates to damage to brick and masonry underbridges, and the second to culverts and short span bridges with shallow cover. These are discussed in the paragraphs which follow.

Planned expenditure

² NR (2011a) Freight Cap Consultation Note dated 29 November 2011

³ NR (2011a) Freight Cap Consultation Note dated 29 November 2011

The planned CP5 Civils expenditure is shown in the following Table, which is taken from the Structures IIP Asset Policy.

	Annual averages					TOTAL
	14/15	15/16	16/17	17/18	18/19	
Maintenance	44	44	44	44	44	220
Renewals	341	341	341	341	341	1,705
Underbridges	205	205	205	205	205	1,025
Overbridges	30	30	30	30	30	150
Major structures	29	29	29	29	29	145
Tunnels	21	21	21	21	21	105
Minor assets	40	40	40	40	40	200
Structures - other	15	15	15	15	15	75
TOTAL	385	385	385	385	385	1,925

Figure 3.3 Extract from Structures IIP Asset Policy – Planned CP5 expenditure on Structures (£m)

The £205m per annum planned to be spent on underbridges is broken down in the IIP Tier 1 models for Structures to include £78m for metallic underbridges, £90m for masonry underbridges and £9m on culverts. For CP5, NR is planning for a significant increase in expenditure on metallic, masonry and underbridges primarily because of the condition of these structure types.

However, the VUC uses the annual expenditure averaged over CP5 to CP11, and these figures are consistent with corresponding figures from the IIP Tier 1 model. This method is also consistent with the approach taken in the VUC to use long term costs and seeks to smooth out the impact of periodic peaks in workload to maintain a sustainable renewals and maintenance strategy.

The Policy document, issued in September 2011, makes reference to the issues of fatigue and masonry crushing in the context of increased axle loading (para 2.3.1), and potential damage to culverts from increased axle loading is referred to in para 9.4.6.

3.2.3 Metallic Underbridges

Metallic bridges are prone to fatigue, in which cracks form in regions of high stress concentrations under repeated loading. Fatigue damage is cumulative and in particular structural detail, function of the stress range and the number of stress cycles. Given the age of some of NR's metallic bridge stock, it is reasonable to expect fatigue to be an issue, and NR have provided evidence of fatigue cracking which has been found during examinations. However, we have not been provided with data which shows the number of fatigue repairs carried out annually, or relates greater fatigue damage to routes which are heavily used by freight traffic.

3.2.4 Brick and Masonry Underbridges

Damage to masonry structures, viaducts in particular, has become apparent in recent years following the damage to the spandrel walls at Enterkin Viaduct and other similar structures in Scotland. Network Rail has shown us results of analyses which demonstrate that the effect on masonry viaducts of a 4-axle 100T loaded freight wagon can be very significantly greater (up to seven times) than a 2-axle 50T wagon, even though the axle loads are the same. It would appear that

this was not something which was checked when such wagons were first proposed for use on the network.

NR believe that there is more likelihood of damage to viaducts on new freight routes than on routes that have regular freight traffic, but have not provided any evidence to support this.

We have not been provided with any evidence to support the figure of 20% for the VUC. However, if 20% is accepted as a reasonable figure for metallic structures, we are not aware of any strong evidence which suggests that a different figure for masonry underbridges would be more appropriate.

3.2.5 Culverts

NR has provided us with information about damage to abutments of short span bridges and culverts. These show a consistent pattern of vertical cracking, which is attributed by NR to the effects of heavy axle loading, and which has led in some cases to replacement of the bridge on grounds of cost-effectiveness. If the routes on which these defects are starting to appear carry heavy freight loads, it is reasonable to infer that this would be the cause. We have not been provided with actual or expected numbers of bridges found with this type of defect and therefore cannot comment on the appropriateness or otherwise of the proposed VUC.

3.2.6 Conclusions - Structures

Network Rail has proposed to widen the scope of the freight cap for Structures to include masonry underbridges and culverts, in addition to metallic underbridges. There is evidence which supports the view that some structures in these asset sub-groups are and will continue to be affected by heavy axle weight loads.

Network Rail has not provided data which supports the variability assumption; this should be provided for all three types of structure. The values proposed are consistent with those used for CP4 and therefore appear to be a reasonable starting point for Masonry underbridges. We are unable to comment on the appropriateness or otherwise of the proposed VUC for culverts.

3.3 Embankment Renewals

3.3.1 Approach Adopted by NR

NR propose adopting a variable usage charge of 6% of Annual Average Renewals Expenditure for embankments (£32.4m) which equates to £1.9m. This compares to a 6% charge in CP4 and a variable usage cost of £2m.

In summary the approach adopted by NR in calculating the variable usage charge percentage for CP5 was as follows (NR⁴ 2011b):

1. *Traffic loading effects contribute towards the number of embankment failures*
2. *Proportion of track length nationally on high or very high plasticity clays is 11.1% (approx 12%)*
3. *Approximately half of this track length is on embankment (50% of 12%)*
4. *These embankments are vulnerable to increased plastic strain due to increased tonnage or increased frequency of heavy axle loads*
5. *Therefore reasonable to take variability of earthwork costs of 6% due to variable usage*

3.3.2 Comment and Opinion

How was the VUC percentage calculated for CP4 ?

Based on the meeting with NR on 6th March 2012, we understand that the 6% variability assumption applied in CP4 was based on expert judgement but there is not a detailed explanation available in relation to its origin (see Figure 3.2 above).

What evidence is there that Railway Traffic damages the asset ?

NR are of the opinion that railway traffic loading on earthworks primarily affects the embankments asset. Research is ongoing by the Railway Safety and Standards Board (RSSB) into the effects of railway traffic on embankment stability. RSSB⁵ (2012a) succinctly summarises the current 'state of the art':

“Deterioration of railway embankments occurs naturally over time. However, there has been a marked increase in embankment damage on the railway network in Great Britain over the past ten years. Sometimes this has resulted in failure; for example the embankment at Mottingham in Kent, in 2001.

The increase in damage can be related to an increase in railway traffic loading, due to higher axle loads and increased train speeds. Currently, there is no means of assessing the potential damage to embankments where an increase in railway traffic loading is anticipated.”

⁴ NR (2011b) 'Earthwork Variable Usage Charge Cost Estimates' presentation by Eifion Evans 06.03.12

⁵ RSSB (2012a) Research Brief 'The effects of railway traffic on embankment stability T679 – February 2012'

We have been provided with one of the RSSB research reports (Mott MacDonald⁶ 2011a). This states that three principal factors are associated with railway embankment serviceability limit state type damage, namely:

- Train axle load;
- Embankment Clay Fill Plasticity,(higher plasticity Clays are more susceptible to irrecoverable plastic deformation under loading)
- Trackbed configuration. (i.e. type and thickness of ash/ballast – ability to attenuate loading)

The Mott MacDonald Report notes that based on their RSSB research:

“... Although the evidence of embankment failures around the UK railway network does not provide a link with failure due to increased railway traffic loading, the project has highlighted the potential mechanisms for failure. It is likely that the development of embankment failures induced by railway traffic loading will be a slow progressive process which will initially become evident through increasing frequency of track maintenance.”

We are in agreement with Mott MacDonald and NR that there are credible fatigue type failure mechanisms for higher plasticity Clay embankments that could be induced by increased railway traffic loading.

What is the relationship between Railway Traffic and damage to the asset ?

NR typically experience between 6 and 42 embankment failures per annum (see Figure below from NR⁷ 2011b).

These failures are caused by a range of site-specific factors that influence maintenance and asset life, including vegetation cover, geology, ground and surface water conditions, local climate and other variables.⁸

⁶ Mott MacDonald (2011) ‘RSSB 1386 (Revised) The effects of railway traffic on embankment stability Final Report’ March 2011 RSSB

⁷ NR (2011b) ‘Earthwork Variable Usage Charge Cost Estimates’ presentation by Eifion Evans 06.03.12

⁸ Network Rail ‘Earthworks Asset Policy’ version 1 dated September 2011 Section 2

Embankment Failure Rates	
Year	Embankment Failures (national) CIV/28 Reports
2004/5	15
2005/6	13
2006/7	26
2007/8	42
2008/9	19
2009/10	14
2010/11	6

Figure 3.3 Embankment Failure Rates

There are many different types of potential failure mechanism for embankments and the likely influence of train loading on these different failure modes varies.

The Mott MacDonald Report concludes that based on their RSSB research:

... The review concluded that there is no correlation evident between the incidence of large scale catastrophic embankment failure, and a change in railway traffic loading, on the basis of the data reviewed. This corroborates the conclusions of the Embankment Failure Review, that the failures recorded under current NR reporting procedures, are predominantly classical geotechnical ‘slip circle’ type failures, rather than the fatigue type failure mechanism, which would be induced by train loading. Fatigue failure would manifest itself by increased maintenance and poor trackbed performance...

...It is considered that the ‘failures’ which are directly attributable to train loading (a fatigue type of mechanism) would not be reported in the current NR reporting system, where the emphasis is on the recording of classical ULS⁹ embankment failures. Furthermore, a prolonged time period would need to elapse before obvious signs of deterioration become apparent. Such SLS failures would typically manifest themselves as local track settlement and generally lead to the need for increased track maintenance.

...

In summary, there does not appear to be any record held by NR as to the proportion of embankment failures that can be attributed to railway traffic loading.

What costs have been incurred by NR due to damage caused by Railway Traffic ?

⁹ The potential failure of a railway embankment can be classified as either an Ultimate or a Serviceability Limit State. The Ultimate Limit State (ULS) would involve the collapse of the embankment whereas the Serviceability Limit State (SLS) involves excessive deformation.

NR's maintenance and renewal expenditure (actual and planned) during CP4 is summarised in the following table below (NR¹⁰ 2011c).

	Expenditure (£ m)					
	09/10	10/11	11/12	12/13	13/14	CP4
Embankments	31.351	33.439	22.930	32.162	21.641	141.523
Soil Cuttings						
Rock Cuttings						
Cuttings	16.810	18.824	22.458	18.081	15.559	91.732
Drainage	7.298	6.417	6.899	5.404	3.872	29.890
Unplanned	18.102	7.187	0.000	0.000	0.000	25.289
Minor Works	5.892	5.713	5.456	5.872	6.365	29.298
Other	11.015	21.930	31.932	25.498	29.431	119.806
Total	90.468	93.510	89.675	87.017	76.868	437.538

Table 3.1 Earthworks Asset – CP4 Actual and Planned M&R Expenditure

The following table, derived from NR Initial Industry Plan Earthworks Tier 1 Model¹¹, summarises the proposed maintenance and renewal expenditure on the earthworks asset in CP5 to CP11.

	Annual Average Expenditure (£ m)				
	CP5	CP6	CP7	CP8-CP11	CP5
Embankments	30.231	30.231	33.231	33.231	151.154
Soil Cuttings	19.242	25.242	25.242	15.242	96.209
Rock Cuttings	20.204	20.204	20.204	20.204	101.018
Drainage	3.303	3.704	3.704	3.704	16.517
Unplanned	Included in Other				
Minor Works	Included in Other				
Other	15.337	15.337	15.337	15.337	76.686
Examinations & Climate Change	2.601	4.521	4.521	4.521	13.007
Total	90.918	99.239	102.239	92.239	454.591

Table 3.2 Earthworks Asset – CP5-CP11 Planned Expenditure

Tables 3.1 and 3.2 suggest that annual average expenditure (Actual and Planned) is in the range £21.6m to £33.4m.

The annual average figure of £32.4m used by NR in their VUC calculation is consistent with the annual average expenditure detailed in the NR IIP financial model¹² for the period CP5 to CP11.

As noted above, NR do not hold details of the proportion of historical expenditure on embankment remedial works that has been directly associated with railway traffic loading.

¹⁰ Network Rail (2011c) Earthworks Asset Policy Version 1 dated Sept 2011

¹¹ Network Rail - Earthworks IIP Tier 1 Model - Version 6.xls

¹² Network Rail - Earthworks IIP Tier 1 Model - Version 6.xls

NR have supplied outline details of the remedial works required at Mottingham embankment in Kent in 2001¹³ – the embankment referenced by RSSB¹⁴ (2012a). The issue was ‘catastrophic failure of embankment’ and cause is noted as ‘gradual loss of integrity’. An anticipated final cost for the long-term solution of £150,000 is quoted for the 120m long repair.

Is there evidence of increasing asset failures due to railway traffic ?

The Mott MacDonald Report concludes that based on their RSSB research:

“...The number of annual failures was also investigated, to assess whether there is evidence of an increasing failure rate; the data remains inconclusive with regard to an overall trend of increasing failure rate with time. In general embankment failures occur predominantly within medium to high plasticity ground conditions...”

As noted above, there are no details as to the number of embankment failures primarily due to railway traffic.

3.3.3 Conclusions

Based on the above consideration, in the time available for this review (1 person day of a Geotechnical Engineer) we have concluded:

- We are in agreement with Mott MacDonald and NR that there are credible fatigue type failure mechanisms for higher plasticity Clay embankments that could be induced by railway traffic loading.
- It is likely that a proportion of the planned embankment remedial works in CP5 –CP11 will address failure mechanisms induced by railway traffic loading.
- There is insufficient data to enable a robust estimate of the variable usage charge percentage. In the absence of such information, NR have used their own engineering judgement.

¹³ Network Rail – ‘39 Emergency Response at Mottingham – 27th March 2001’

¹⁴ RSSB (2012a) Research Brief ‘The effects of railway traffic on embankment stability T679 – February 2012’

4 Signalling

4.1 Introduction

4.1.1 Overview to Network Rail's Approach

NR propose adopting a variable usage charge of 6% of annual average maintenance expenditure for Signalling Maintenance (£137.2m) which equates to £8.2m. This compares to a 5% charge in CP4 and a variable usage cost of £6m.

NR also propose including an additional variable usage cost of 44% of annual average Minor Works Points Renewals expenditure (£12.2m) which equates to £5.4m. This is an additional variability assumption that was not previously applied in CP4.

In summary the approach NR have taken in calculating the annual variable usage charge percentage for CP5 was as follows (NR¹⁵):

- Sub categories of Train Detection, Points, Level Crossings & Rapid response separately assessed for maintenance impact.
- Each sub category's percentage variability subjected to engineering judgement using a forecast traffic increase of 100% as a start point. A linear relationship was assumed between traffic levels and maintenance impact.
- Percentage variability applied to official IIP maintenance cost figures (CP5-CP11) for each sub category,
- Previous variable usage charge percentage for CP4 not considered.

4.1.2 Approach to Audit

A meeting was held with NR on 9th March 2012 at which NR's approach to estimating the Variable Usage Costs percentages for Signalling was presented by NR.

4.1.3 Models and Documents Reviewed

The Variable Usage Cost percentages (Percentage variability) proposed by NR for Signalling assets are set out in Figure 3.1, section 3.1.3 above. The Variable Usage Cost percentages adopted for Signalling assets in CP4 are set out in Figure 3.2.

A spreadsheet was tabled by NR in the meeting of 9th March 2012, demonstrating the breakdown of planned signalling maintenance activities (both cyclical and reactive) and the proportion of IIP costs attributed to each, the engineering judgement in justifying the percentage maintenance increase, and the percentage increase in cost for each sub category per 100% increase in traffic.

¹⁵ NR Signalling Variable Usage Costs Estimates Meeting 9th March 2012

4.2 Review of Signalling Maintenance Variability Assumptions

NR have assumed a 100% increase in traffic levels (i.e. traffic doubles) as a basis for applying engineering judgement on the increase to alarms/alerts this additional traffic would bring. Through discussion with NR, NR recognise that whilst there is not a linear relationship between additional fault reporting and increase in traffic, it is a reasonable proxy for the purposes of estimating variable costs.

We agree that assuming a 100% traffic increase provides a meaningful scenario around which engineering judgement can be applied and variable costs estimated.

For points maintenance, as well as assuming that there will be an increase in maintenance in response to remote condition monitoring alarms/alerts, NR have assumed that there will also be a change in cyclical maintenance periods, resulting in increases in planned work.

We are in agreement that increases in cyclical maintenance periods will alter and should therefore be captured.

With regard to level crossings, NR's basis for justification of maintenance increases focuses on the following:

- an increase in remote condition monitoring alerts
- an increase in reactive work
- an increase in the number of barrier machines requiring quarterly service

We agree that the reactive element of maintenance currently includes a proportion caused by level crossing abuse. We also recognise that it is likely to make up a small proportion of reactive costs. We therefore consider it reasonable to assume that changes in traffic levels affect level crossing abuse and should therefore be included in the engineering judgment.

Through discussion with Network Rail it is noted that other costs associated with increased level crossing usage such as additional risk assessments are outwith the Variable Usage Charges.

4.3 Review of 44% variability to Minor Points Renewals

NR have applied engineering judgement assuming that the clamplock points operating equipment renewal rate will double for a 100% increase in traffic, whilst renewals of point machines increase by 25%. This assumption is reasonable given that the clamplock mechanism is integral to the permanent way and is therefore subject to far greater wear and vibration imposed by rail forces.

This increase in renewals is then calculated over the population ratio of clamplocks to point machines (25:75). We agree that population ratio of clamplocks to point machines is reasonable, again based upon NR's expert judgement.

4.4 **Review of 6% Signalling Maintenance Variability**

Based on the meeting with NR on 9th March 2012, we understand that the 5% percentage variability assumption applied in CP4 was based on expert judgement and we do not believe that it has been documented in detail. (see Figure 3.2 above). It is our assumption that this figure was based around broad expert judgement.

In light of this, we consider that the proposed increase in variable usage cost for CP5 to 6% is reasonable, given that NR's costings have been derived by considering each sub category separately.

We can confirm that the sum total of the sub category variable costs equates to 6% of the IIP signalling maintenance costs of £137.25m.

4.5 **Level Crossings**

In discussion with NR in the meeting of 9th March 2012, level crossing type is not differentiated within the justification of increased maintenance requirements, and therefore based upon IIP costs for both open and barrier/gated crossings.

However, we believe this to be a reasonable approach considering the industry's level crossing safety aspirations are likely to increase the number of barrier crossings on the Network.

We also note that Level Crossings is a relatively small element of the Signalling Maintenance variable costs, totalling £0.4m out of £8.2m.

4.6 **Conclusions**

Network Rail has demonstrated that it applied a more thorough approach in calculating the proposed variable usage costs. Whilst still based upon expert judgement, it enables each sub category to be quantified individually and enables each sub category to be seen in the context of the overall usage charge.

5 Final Variable Usage Spreadsheet

5.1 Introduction

The Variable Usage Charge (VUC) is designed to recover Network Rail's operating, maintenance and renewal costs that are likely to vary with traffic.

This section summarises the findings from the review of NR's methodology to estimate the total variable usage costs. NR has adopted a 'bottom up' approach for estimating the track variable usage costs, and a 'top down' approach to estimating non-track (such as civils and signalling) variable usage costs. The track and non-track VUCs are then added together to estimate the total variable usage costs.

In addition to checking the overall methodology, computational checks of the final spreadsheet used to calculate the total VUC were carried out to identify any errors in calculations.

5.1.1 Models and Documents Reviewed

Following the inception meeting with Network Rail, the final spreadsheet used to calculate the VUC was obtained. In addition, several documents were received supporting the calculations, and these are listed below:

Table 5. 1: Model and Documents Reviewed - Total VUC

Description	File
Final spreadsheet summarising the estimate initial track variable usage costs for freight and passenger traffic	VTAG Summary and Charts v0.7 (ARUP consultation version).xls
Responses from Consultees	GBRf response to Network Rail consultation on VUC and freight line charges.doc
	img-127144344 (DBS).pdf
	John McGuinness - NWR Review of VTAC+VUC Jan 12 (DRS).doc
	NR Freight Caps Response (FTA).doc
	VTAC Consultation Response 270112 Confidential Removed.pdf
	Freight Caps Consultation on Variable Usage Charge FINAL Jan 12 (RFG).docx

5.2 Data Inputs

The key inputs to the model are as listed below:

- Activity volumes estimated by Infrastructure Cost Models (ICM)

- Period 8 tonnage data from PR08 VUC model
- CP4 Baseline (2013/14) tonnage data
- CP4 track horizontal damage percentage – 30%

5.2.1 Overview to Network Rail's Approach

The activity volumes estimated by the Infrastructure Cost Model (ICM) for the various asset types was used by NR to calculate the annual average costs presented in Table 5. 2. The costs were modelled over a period of 35 years (CP5 to CP11) in order to smooth out the impact of periodic peaks in workload to maintain a sustainable renewals and maintenance strategy.

Total variable usage costs as shown in Table 5. 2 comprise the sum of track and non-track variable usage costs. All of these costs have been reviewed and commented on in the previous chapters of this report.

The VUC model currently assumes that telecoms and buildings maintenance and renewal costs do not vary with traffic and, therefore, are excluded from the total VUC estimate.

Table 5. 2: Annual variable usage costs (2011/12 prices at end CP4 efficiency)

Asset type	CP5
Track:	242.4
Track maintenance and renewals	242.4
Civils:	30.7
Embankments renewals	1.9
Metallic underbridge renewals	9.7
Brick and Masonry underbridge renewals	18.5
Culverts renewals	0.5
Signalling:	13.6
Maintenance	8.2
Minor works points renewals	5.4
Total	286.7

NR have apportioned the costs presented in Table 5. 2, based on the relationship between gross and equivalent tonnage in the CP4 VUC model. This methodology classified the costs as follows:

- Track (includes Signalling excludes rail surface damage);
- Structures (Civils); and
- Track surface damage (30% of total track variable usage costs).

The total variable usage costs for the above three categories are then apportioned between freight and passenger traffic, based on the relationship between gross and equivalent tonnage in the CP4 VUC model which, in accordance with our

mandate, has not been reviewed in this report. We have instead checked that the model's relationships have been applied correctly.

The relationship between gross and equivalent tonnage in the PR08 VUC model is shown in Table 5. 3..

Table 5. 3: PR08 Tonnage data – CP4

Sector	Gross Tonnage	EGTM (M)		EVM (M)
		Track (excluding rail surface damage)	Structures (Civils)	Track Surface Damage
Passenger	71,296	181,561	154,764	121
Freight	33,191	81,284	180,397	27
Total	104,487	262,845	335,162	148
Passenger (%)	68%	69%	46%	82%
Freight (%)	32%	31%	54%	18%
Total	100%	100%	100%	100%

The relationship between gross and equivalent tonnage for CP5 (see Table 5. 4), is then calculated by dividing the equivalent tonnages by the corresponding gross tonnage from the above table. For example, the Structures (Civils) relationship for freight is 180,397 divided by 33,191 which is 5.44.

Table 5. 4: Relationship between gross and equivalent tonnage

Type	Track (excluding rail surface damage)	Structures (Civils)	Track Surface Damage
Passenger	2.55	2.17	0.0017
Freight	2.45	5.44	0.0008

The equivalent tonnage for CP5, derived by applying these factors to the Baseline 2013/14 gross tonnages is summarised in Table 5. 5 below.

Table 5. 5: Equivalent Tonnage splits for CP5

Traffic Type	Baseline (2013/14) tonnage - million tonne km	Track (excluding rail surface damage)	Structures (Civils)	Track Surface Damage
Passenger	129,642	330,145	281,419	221
Freight	50,851	124,530	276,376	41
Total	180,493	454,675	557,795	262
Passenger (%)	72%	73%	50%	84%
Freight (%)	28%	27%	50%	16%
Total	100%	100%	100%	100%

The initial variable usage costs estimated by ICM are apportioned between freight and passenger traffic based on the above percentage splits. The resulting costs are presented in Table 5. 6.

Table 5. 6: CP5 costs apportioned based on CP4 ratios

Traffic Type	Track Cost (excluding rail surface damage)	Structures Costs (Civils)	Track Surface Damage Cost	Total
Passenger	133.1	15.5	61.3	209.8
Freight	50.2	15.2	11.5	76.9
Total	183.3	30.7	72.7	286.7

The average vehicle cost for freight and passenger traffic of £1.59 per kgtkm as shown in Table 5. 7 was derived by dividing the initial estimate of total variable usage costs (£286.7m) from Table 5. 2 by forecast end of CP4 traffic levels (180.5m kgtkm) from Table 5. 5.

Table 5. 7: Average Rates (2011/12 prices end CP4 efficiency)

Traffic Type	CP5 (£/kgtkm)	CP4 (£/kgtkm)	% change	Confidence interval (20%)
Passenger	1.62	1.52	6%	1.94
Freight	1.51	1.36	11%	1.81
Total	1.59	1.47	8%	1.91

Variable usage charge cap - NR have proposed to apply the upper limit of 20% confidence interval to the VUCs rate of £1.59 per kgtkm shown in Table 5. 7, resulting in a proposed charge of £1.81 per kgtkm for freight traffic.

5.3 Conclusions

The Final Variable Usage Cost spreadsheet model is used to collate the variable usage costs for the Track and non-track assets and applies the apportionment for freight and passenger traffic based on methodology in the PR08 VUC model. The total variable usage charge for freight and passenger traffic is then uplifted by 20%. Our checks have indicated that there are no computational errors within the final VUC model.

6 Freight Only Charges

6.1 Introduction

This section reviews NR's method for calculating the fixed costs that it incurs on freight only lines which can be levied on those segments of the freight market that are deemed able to bear the cost by the ORR.

NR has produced an updated version of their model since publication of their consultation paper of 29th November 2011. This new model addresses some of the concerns raised by stakeholders. It is this updated model which we have reviewed in this report.

As agreed with NR and ORR, we have not reviewed the initial list of freight only lines and have therefore assumed it is a complete and accurate list. We understand that this list will be reviewed by stakeholders as part of NR's freight caps consultation.

6.1.1 Overview to Network Rail's Approach

NR has produced a spreadsheet model that calculates the renewals and maintenance costs for each of the designated freight only lines. These costs are based on the costs produced by NR for the IIP from CP5 to CP11, and have been apportioned according to the number of assets (bridges, signals, track km etc.) on these lines.

Specific maintenance and renewals costs have been calculated for track, civils and signalling. A small additional allowance is made for other assets not specifically modelled. These costs are then apportioned to the different freight markets according to the relative numbers of freight trains as recorded in the ACTRAFF system.

The model currently assumes that coal ESI and nuclear fuel are the two segments of the freight market that can bear the fixed costs (these were the two segments of the market deemed by ORR able to bear the cost in PR08). Based on the freight traffic on these lines, it calculates the variable charges that would be levied on them using the VUC rate of £1.51 per kgtkm (i.e. before the 20% uplift is applied). Removing these variable charges results in the fixed cost element. Finally an uplift factor of 20% is applied to account for uncertainties to produce the final cap figures.

This new version of the model produces different caps to those presented in the 29th November 2011 consultation paper. These are shown below with all prices at 2011/12 end CP4 efficiency.

Table 6.1: Freight only line caps

Commodity	29 th November 2011 Consultation Paper (including 20% confidence interval)	Revised Model (including 20% confidence interval)
Coal ESI	£8.15m	£5.93m
Nuclear Fuel	£1.85m	£1.52m

6.1.2 Approach to Audit

NR demonstrated the November consultation model at our initial inception meeting on the 24th February. They then sent us the revised version for review.

We checked the model for computational integrity by working through example routes and comparing results against manually calculated figures. We also checked the data inputs from the Infrastructure Cost Model (ICM) for the IIP to ensure they were consistent.

6.1.3 Models and Documents Reviewed

We reviewed the model:

- Freight Only Master Mar 2012 - v13 – update.xls.

This included the following updates made by NR in response to feedback from the November consultation paper:

- An updated list of lines and mileages based on NR's review of DB Schenker's review of the list in the November consultation;
- Actual traffic data to replace estimates for two lines; and
- A more robust estimate of related renewals based on the IIP bottom up signalling renewals forecast.

6.2 Computational Checks

The specific costs calculated by the models for the freight only lines are:

- Track renewal and maintenance;
- Signalling maintenance; and
- Civils renewals (including embankments).

Signalling renewal costs are covered by the 'related renewals' described in section 7.4 below.

It is unclear why maintenance costs have not been included in the Civils calculations. In CP5 the total Civils maintenance costs for the whole network are forecast to be £235m compared with the renewal costs of £2,144m. This suggests that the calculated Civil costs for the freight only lines would be 11% higher if maintenance costs were included.

That said, the model applies a 5% uplift to the total of the above list of costs to account for other asset costs not directly calculated by the model. They refer to electrical and plant and telecoms assets, but will also include the missing Civils maintenance costs. This is likely to make the 5% uplift to be on the low side.

In calculating the Civils renewal costs, the model calculates the cost per track km and applies this to the freight only lines. This cost rate is calculated separately for each of the 305 Strategic Route Sections (SRS) that make up the national network by apportioning the costs according to the number of assets on each SRS. However, for calculating the costs on the freight only lines, the model uses the cost per track km averaged over all SRSs, including both freight and passenger routes. This equates to £0.0145m per track km. This would appear to be a conservative value because the average cost for freight SRS's is approximately double at £0.030m per track km.

No errors have been identified in any of the model calculations.

6.3 Data Inputs

The asset maintenance and renewal costs in the model have been correctly input from the ICM. Note that they refer to the 'Current Railway with Investment' scenario in the IIP.

The freight traffic data is from ACTRAFF for 2010/11. This is used to determine the proportion of traffic by commodity on each freight only line in order to calculate the proportion of costs to be covered by each commodity. In addition it is used to calculate the income from the variable charges.

As noted in the consultation letter, not all freight only lines have ACTRAFF data. In the updated version of the model, coal ESI freight traffic has been added for two further routes (Ayr Harbour to Newton Junction and Uskmouth to East Usk Junction). For routes with no data, a view has been taken on the proportion of traffic that is coal ESI or nuclear fuel, and in all but one case it is set at 100%. This suggests that there it is fairly clear that these lines are all coal ESI or nuclear fuel traffic (although we have not checked this). For calculating the income from the variable charges on the lines with missing traffic data, the model assumes that the variable charges will cover 15% of the total costs of the line, this is an average rate based on the lines for which there is actual traffic data.

6.4 Renewals Mark ups

In the consultation paper, NR applied a 24% mark up to the coal ESI costs and 14% to the nuclear fuels costs to cover signalling and points costs for connecting to/from the mainlines. This has now been replaced by a new method that calculates the signalling renewal costs and which involves the following steps.

- Input the signalling renewal costs by SRS from the ICM. These have been derived from workbanks for renewing the signal interlocking and cover the period from CP5 to CP11.
- For each SRS, calculate the proportion of Signalling Equivalent Units (SEUs) on the freight only line. This is assumed to equate to the percentage of route interlockings on the freight only line.
- Apply the interlocking percentage to the SRS signalling renewal costs to calculate the freight only costs.

In our opinion this is a reasonable approach and an improvement to the previous mark ups. It results in lower costs than the previous method (reductions of 63% and 50% for coal ESI and nuclear fuels respectively).

6.5 Unit Renewal Costs

The costs for the track renewal and maintenance, signalling maintenance and civils renewals have all been reduced by 20%. The rationale for this is that it is easier to gain access to freight only lines than for the 'average' route. This figure was suggested by the previous Independent Reporter.

It is unclear why the 20% has not been applied to the related (signalling) renewal costs. If this was applied, the annual costs would reduce from £0.62m to £0.50m for coal ESI and £0.07m to £0.06m for nuclear fuel.

6.6 The Proposed 20% Confidence Interval

NR propose to add 20% to the calculated costs to take account of uncertainties in the method and data used.

Although each of the steps in the calculations are reasonable and logical, it is our opinion that apportioning costs to specific freight only lines will involve some approximations and assumptions. In addition, the incomplete ACTRAFF data will add to the overall uncertainty. Taking all into consideration, it is our view that applying a confidence interval of $\pm 20\%$ to the calculated cost to represent the range in which the true cost will lie is reasonable.

6.7 Conclusions

The updated model is an improvement to the previous version and results in lower costs. No computational errors have been found in the calculations and the input cost data is consistent with the ICM.

We have noted that Civils maintenance costs have not been specifically modelled, but are assumed to be covered by the 5% uplift applied for unmodelled assets.

It is unclear why the related renewal costs have not been reduced by 20% to reflect lower unit costs on these lines. It would be worth considering if this factor should be applied.

7 Recommendations

We make one specific recommendation from this review which is shown below.

No	Recommendation to NR	Section in Report	NR Champion	Date
2012.CAP.01	Consider reducing related renewal unit costs by 20%	7.5	NR Modeller	Apr 12

Appendix A

Mandate

Mandate for Independent Reporter Part A – Review of analysis in Network Rail’s ‘Freight Cap’ consultation

Audit Title:	Review of analysis in Network Rail’s ‘Freight Cap’ consultation
Mandate Ref:	AO/027
Document version:	Draft
Date:	10 February 2012
Draft prepared by:	Emily Bulman, Joe Quill
Remit prepared by:	Emily Bulman, Joe Quill
Network Rail reviewer:	Ben Worley

Authorisation to proceed

ORR	Chris Fieldsend	
Network Rail	Bill Davidson	

Purpose

- To review Network Rail’s (NR’s) initial analysis underpinning its consultation on freight caps
- To advise on the robustness of the cost estimates, and associated uncertainties underpinning the estimates.

This work should supplement the work already conducted reviewing cost estimates included in the Initial Industry Plan, including the IIP tier 0&1 model audits and the work conducted by reporter AMCL, in order to avoid any unnecessary duplication.

Background

In its Periodic Review 2013 (PR13) first consultation¹⁶ ORR requested views on whether it should once again place a cap on certain freight charges in advance of its final determination. In order to facilitate a possible cap on certain freight charges NR calculated initial estimates of variable usage charge (VUC) and freight only line charge costs. NR set out the basis of its initial cost estimates in its recent consultation letter on ‘freight caps’¹⁷. Following the conclusion of NR’s ‘freight cap’ consultation, ORR will conclude on whether it wishes to place a cap on certain freight charges in advance of its final determination.

Scope / Methodology

Network Rail’s ‘final’ spreadsheets of its variable usage and freight only line charge initial cost estimates

The independent reporter is required to critically review the two Network Rail ‘final’ spreadsheets, used to calculate the variable usage and freight only line charge initial cost estimates included in the freight cap consultation. This review should identify any computational errors in the spreadsheets and consider the uncertainty of the inputs;

¹⁶ Available at: [PR13 First consultation - Office of Rail Regulation](#)

¹⁷ Available at: [Periodic review 2013 -NR](#)

The reporter is then required to advise on the uncertainty in respect of Network Rail's variable usage and freight only line charge initial cost estimates. Specifically, the independent reporter should assess the basis of Network Rail's proposed 20% confidence interval on its initial cost estimates included in the freight cap consultation and advise on uncertainties associated with different elements of the cost estimates, in quantitative terms where feasible, and hence on whether 20% is an appropriate upper bound for the cost estimate. Please note that the 20% confidence interval incorporates uncertainty in relation to the apportionment of variable usage charge costs between passenger and freight traffic. ORR is reviewing the extent of the uncertainty in this respect.

The following sections provide sections provide more details of the scope of this review.

Initial track variable cost estimates

The output of this analysis feeds into Network Rail's 'final' variable usage charge spreadsheet.

This aspect of the work should, where appropriate, take account of the findings of the IIP tier 0&1 model audits.

Network Rail will talk Arup through the end-to-end process that it went through in order to estimate track variable usage costs. Following this initial discussion Arup should:

- Review and comment on the overall principle of Network Rail's approach to modelling track variable usage costs using the Vehicle Track Interaction Strategic Model (VTISM) and the Strategic Route Section Maintenance Model (SRSMM).
- Review the inputs used in the VTISM and SRSMM modelling and compare to those used for the IIP.
- Review and comment on the process documented in the note prepared by Serco setting out how it estimates variations in track maintenance and renewal costs in response to hypothetical traffic scenarios.
- Review and comment on the output spreadsheets resulting from the VTISM analysis and how Network Rail transposed these outputs into initial track variable usage costs.

For the avoidance of doubt, a model audit of VTISM and Network Rail's track asset management policies is beyond the scope of this remit separate audits for these elements have already been commissioned from Arup, and reports from Arup have been issued:

- The review of the track asset management policy (Initial Industry Plan 2011 Review Final Report) was issued to ORR on 29 November 2011 and concluded that the track policy (including associated volume and expenditure estimates for CP5) fully met ORR's criterion for robustness.
- The review of the track models (VTISM and the SRS Maintenance Model) was issued on 6 February 2012. It found that the computational integrity was sound, apart from a minor post-processing error which had no significant impact on the results, with a

proviso that the complexity of the model made it difficult to cover all the model functionality in the audit

Civil structures and earthworks initial variable cost estimates

Review / assess NR's 'top down' (expert judgement) variability assumptions for civil structures and earthworks assets currently included in the VUC.

Assess NR's rationale for extending the variability assumption to masonry and brick under bridges/culvert renewals and minor point works and subsequent the level of variability for each additional category. With respect to masonry and brick underbridges, to confirm whether the variability cost assessment is based on long viaducts/multi-span bridges or includes also single span bridges.

Review the basis for the VUC cost estimates in Table 3 of the Freight Caps consultation and specifically an explanation for the differences in annual average cost for CP5 (Table 3) compared with CP4 costs (Table 1) for Metallic underbridge renewals.

This review should consider and avoid duplication of Arup's previous reviews of civil structures and earthworks asset management. These reviews include the Initial Industry Plan (IIP) 2011 Review and the review of asset policy, stewardship and management of structures (March 2011).

Signalling initial variable cost estimates

Review / assess NR's 'top down' (expert judgement) variability assumptions for signalling assets currently included in the VUC.

Signalling variability:

- Review NR's signalling maintenance variability assumptions and the extent to which these are properly related to variability in rail traffic levels – (eg. Whether road traffic damage to level crossing barriers should be included in VUC)
- Review of the basis for the 44% variability applied to minor points renewals in Table 3.
- Review of the basis of the 'expert judgement' for increasing signalling variability from 5% to 6%, including confirmation that the signalling maintenance variability sub categories in Table 2 of the Consultation document tally to the 6% total signalling maintenance variability.

Review of level crossing types underpinning the level crossing categories variability cost estimate in Table 2 to ensure the count of level crossings types on which the variability cost is based includes only level crossing types that use barriers.

The Part B independent reporter (AMCL), has completed an assessment of NR's non-track infrastructure 2011 asset policies (Signalling and Electrical Power). AMCL's findings should be considered and, if required, discussed. The AMCL report is published on the ORR website at: <http://www.rail-reg.gov.uk/pr13/PDF/amcl-iip-2011-review.pdf>.

Apportioning variable costs between freight and passenger traffic

Review how NR apportions costs between freight and passenger traffic. NR has done this based on the relationship between gross tonnage and equivalent gross tonnage in the PR08 VUC model (which ORR is familiar with).

ORR will review the extent to which there is uncertainty in respect of the final allocation of costs between freight and passenger traffic due to the current absence of a VUC model for CP5.

Freight only line costs

As part of its review of Network Rail's 'final' freight only line spreadsheet the independent reporter should:

- Review of related renewals mark-up to cover costs of signalling / points for connecting to /from FOL to mainline, (currently NR apply 24% mark up to total coal ESI costs, 14 % to spent Nuclear fuels).
- Review the lower unit renewal costs applied by NR (80% of the network average) and whether these are still valid? (eg take account of changes in access cost to maintain FOL etc)

Deliverables

The Reporter should provide a publishable report, including findings, conclusions and recommendations, expressed in quantitative terms where meaningful to do so. The report should be prepared in draft form and sent electronically to Network Rail and ORR, at the same time. The Reporter should facilitate and provide a revised report with track changes. This should be followed by a final report for publication on ORR's website.

Timescales / Resources

A fully costed proposal for this work is required by 15 February 2012. The response should also confirm whether there are any conflicts of interest and if so how they will be handled.

Work is expected to commence shortly after, following approval by NR and ORR.

The deliverables are to be phased as follows:

- Draft report setting out whether the Reporter is satisfied with NR's initial analysis, any concerns it has, and the scale of uncertainty associated with different estimates by no later than close of business **16 March 2012**
- Final report setting out whether the Reporter is satisfied with NR's initial analysis, any concerns it has, and the scale of uncertainty associated with different estimates by no later than close of business **30 March 2012**

ORR and NR will aim to provide comments on the draft report by no later than close on business on **23 March 2012** (assuming the draft report is received on **16 March 2012**).

The breadth and depth of this review is subject to a resource cap of 20 man days.

Independent Reporter remit proposal

The Independent Reporter shall prepare a fully costed proposal for review and approval by NR and ORR on the basis of this mandate. The approved remit will form part of the mandate and shall be attached to this document. The proposal will detail methodology, tasks, programme, deliverables, resources and costs.

Confidence grades

Confidence grades are not required for this mandate.

Appendix B

Meetings with NR/ORR

Date/Time/Venue	Attendees	Agenda
24 th Feb 2012 14:00 – 16:30 NR's offices at Kings Place	NR, ORR and Arup	Inception Meeting High level walkthrough of the final VUC and FOL spreadsheets
29 th Feb 2012 15:00 – 17:00 40 Melton Street	NR, ORR and Arup	Review of assumptions in track VUC spreadsheet model
14 th March 2012 12:00 – 13:00 Ryedale House	NR and Arup	Walkthrough of the calculations relating to the Track Variable Cost Estimates
6 th March 2012 13:00 – 15:00 40 Melton Street	NR, ORR & Arup	NR approach to estimating the Variable Usage Cost percentages for Civils assets
9 th March 2012 13:00 – 14:30 40 Melton Street	NR, ORR & Arup	NR's approach to estimating the Variable Usage Costs percentages for Signalling