Exhibit RAM-15
The Impact of Model Changes Between HM 2.2.2 and HM 5.2a-MA

I. A Meaningless Comparison of HM 2.2.2 and HM 5.2a Results

Line A of Table E15-1 shows the per-foot distribution structure cost that Dr. Tardiff has reported for HM 2.2.2 and HM 5.2a in Table 1 of his testimony.[1]

Table E15-1: Average Per-Foot Structure Costs for Various Scenarios

Line	Scenario	HM 2.2.2	HM 5.2a-MA
A	Tardiff, Table 1, p. 24	$3.31	$0.82
B	HM 2.2.2 input values in HM 5.2a-MA (revised HM 2.2.2 baseline)	**$2.36**	$0.82
C	HM 2.2.2 baseline except MA-specific outside plant structure mix	**$1.35**	$0.82
D	HM 5.2a-MA inputs with top three density zones collapsed into one	$1.35	**$1.06**

Note: the bold entry on each line shows what has changed since previous line

The large difference in results shown in that line is the basis for Dr. Tardiff's claim that we have used a "convenient" or "results oriented" approach to setting input values to the model. But this comparison is meaningless, for the following reasons.

First, HM 5.2a-MA reflects the higher number of lines present in the 1999 ARMIS data compared to the number assumed in HM 2.2.2.[2] Second, Along with many other model differences, HM 5.2a-MA uses a dramatically different, and much more precise, algorithm to calculate the number of route-miles of distribution cable than does HM 5.2a-MA, as explained in detail in Dr. Mercer's Direct Testimony.[3] Thus, there is no reason to expect the relative amounts

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[1] Tardiff Testimony, at p. 24. The per-foot structure investment cost in HM 5.2a-MA does not change as a result of the model correction we have made.

[2] There are significant economies of scale associated with the local exchange network. For instance, an increase in the number of customer lines in a given area served by the network does not require an increased investment in poles or other outside plant structures; therefore, the investment per line in outside plant decreases as the number of lines served increases.

[3] For instance, HM 2.2.2 placed a fixed number of fixed-length distribution cables in each CBG; the number and length of the cables depended only on the density zone in which the CBG fell, not on the dimensions of the

of route-miles in different density zones[4] will remain the same between the two models. But distribution structure costs vary dramatically by density zone. For instance, in HM 2.2.2, the cost of placing buried plant in the most dense zone is ten times greater than in the lowest density zone; in HM 5.2a-MA, this ratio between the highest and lowest density zone is more than a factor of 20.[5] There are also very large differences between low and high density zones for placing underground cable in conduit. Therefore, the average structure cost across all density zones is highly dependent on the relative amounts of route distance in the various zones, which do not remain constant between the two versions of the model. To use a direct comparison of average structure cost between the two models as a way of assessing the effect of changing structure cost inputs to the model is therefore a meaningless exercise.

II. A Meaningful Way to Isolate the Effect of Input Changes

A meaningful way to isolate the effect of input changes is to run HM 5.2a-MA with all relevant model inputs set to their HM 2.2.2 values, thereby in effect doing an "HM 2.2.2" run of the model. In doing so, the model is run with various user "switches," or options, set to the values that best replicate the way calculations were done in HM 2.2.2. Comparing the results of this "HM 2.2.2" run to the HM 5.2a-MA results has two beneficial effects. First, it holds constant the relative mix of route miles across different density zones. Second, it holds constant

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CBG or the number of premises located in that CBG. By contrast, HM 5.2a-MA places cables to serve clusters of customers that are much more precisely defined than CBGs, and the number and lengths of cables in each cluster depend on the area and shape of the cluster and the number of customer premises served.

[4] Density refers to the number of lines per square mile. Rural areas typically have a density on the order of a few lines per square mile. Urban areas typically have a density of at least 10,000 lines per square mile, and often much higher. The model refers to density "zones," or ranges of line density.

[5] This is because the input for the per-foot cost of buried cable in the highest density zone of HM 5.2a-MA is more that double the input value used in HM 2.2.2, based on the recommendations of the outside plant engineering team that advised the developers of the HAI Model subsequent to the publication of HM 2.2.2.

the number of lines (and uses the same cluster database), thereby eliminating economy of scale effects in the outside plant results.

Attachment 1 to this exhibit shows the User Adjustable Inputs worksheet from running HM 5.2a-MA with HM 2.2.2 inputs. The inputs values that specifically impact the distribution structure cost are highlighted in bold font in the Current Scenario Value columns. The inputs used can be seen in the columns labeled “Current Scenario Value.” Note that two “switches,” or options, available in the model – the “Buried Fraction Available for Shift” and the “Strand Adjustment Switch” – have been turned off to better replicate the HM 2.2.2 model operation. Note also that, as discussed later, the input values in the upper three zones of the model are the same, since those three zones formed a single density zone in HM 2.2.2. A few other inputs have also been “force fit” to make them compatible with HM 2.2.2. For instance, HM 2.2.2 assumed a fixed drop cost of $40 irrespective of drop length, with no differentiation between aerial and buried drops and no sharing of structures with other utilities. This has been replicated in the run by assuming 100% buried drops of a fixed 50 foot length, an investment of $0.80 per foot, and no structure sharing.

Row B of Table E15-1 shows the average distribution structure cost based on the HM 2.2.2 run of the model. It will henceforth be referred to as the revised HM 2.2.2 baseline, signifying that it results from running HM 5.2a-MA with HM 2.2.2 inputs and assumptions to put the model results on a more consistent footing. The average per-foot structure cost for the new HM 2.2.2 baseline is notably less than the value from the actual HM 2.2.2 model run shown in Row A -- $2.36, versus the $2.59 Dr. Tardiff reports from running HM 2.2.2.

III. The Effect of Assuming the Massachusetts-Specific Structure Mix in HM 2.2.2

HM 2.2.2 model assumes a different mix of structure types – that is, the relative proportions of aerial, buried, and underground cable – than does HM 5.2a-MA. HM 2.2.2 uses nationwide average structure percentages. By contrast, the HM 5.2a-MA structure percentages are based on Verizon's own ARMIS data on various types of structure. This is described in John Donovan's Direct Testimony.[6] Note that in a sense, Dr. Tardiff is right- -- the structure percentage input values have changed between the two models. But the change is due to substituting Massachusetts-specific input values for the nationwide values formerly used in HM 2.2.2, not due to some deviousness on the part of the HAI Model developers. Substituting the MA-specific structure percentages into the HM 2.2.2 run of the model leads to the results shown in Line C of Table E15-1. The average per foot cost of structure for the HM 2.2.2 run is now $1.35, versus the HM 5.2a-MA value of $0.82.

IV. The effect of Assuming the HM 2.2.2 Density Zone structure in HM 5.2a

HM 2.2.2 and HM 5.2a-MA assume different density zones. Since the effect of this difference on the average structure cost is somewhat complicated to explain, consider the following simple analogy. Suppose a man goes into a bakery shop to pick up a morning treat for his office. He purchases 10 bagels at $0.60 apiece and 10 sweet rolls for $1.20 apiece. As the left part of Table 12-2 shows, on the average he pays $0.90 for each of the 20 items. At the office that morning, he makes two observations. First, he notices his health-conscious office consumes all of the bagels, but few of the sweet rolls. Second, even though sweet rolls are going

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[6] Donovan Direct Testimony, at p. XX.

to waste, a couple of people complain they did not get a treat. Two weeks later, he again stops by the bakery. He notices that both the bagels and sweet rolls have increased in price, to $0.65 and $1.30, respectively. Remembering his previous experience, he buys 18 bagels and six sweet rolls -- that is, more total items and a different mix of bagels and sweet rolls. As the right side of the table shows, even though the price per item for both bagels and sweet rolls has increased (by more than 8%), and even though his total price has increased, from $18.00 to $19.50,[7] the price per item has markedly decreased to $0.81, a drop of 10%.

Table 12-2: Model Analogy: Cost per Bakery Item

	First Bakery Visit			**Second Bakery Visit**		
Bakery Item	Price per Item	Number Items	Total Price	Price per Item	Number Items	Total Price
Bagels	$0.60	10	$6.00	$0.65	18	$11.70
Sweet Rolls	$1.20	10	$12.00	$1.30	6	$7.80
Total Items/Price		20	$18.00		24	$19.50
Average Price per Item			**$0.90**			**$0.81**

In the subsequent discussion of density zones in the HAI Model, the difference between bagels and sweet rolls corresponds to different line density ranges, the number of each item purchased corresponds to the route miles in different density zones, and the average cost per item corresponds to the overall average structure cost per foot.

Release 2.2.2 of the HAI Model (HM 2.2.2) defined six line density zones. Many of the model's parameters are set on a per-density-zone basis, reflecting construction cost and other significant differences between rural areas of low density, urban areas of high density, and in-between semi-rural and suburban areas of moderate density. At the time HM 2.2.2 was developed, the HAI model developers had relatively little experience with density zones, which

[7] Note that if he bought the same total number of items as before -- say, 15 bagels and five sweet rolls -- his total price would be $16.25, 10% less than the previous total he paid.

was a new concept in local exchange cost modeling at the time. Thus, In HM 2.2.2, the developers specified six density zones, the densest of which was defined to consist of areas with line densities of greater than 2,550 lines per square mile (to facilitate reading, the "lines per square mile" will be omitted in the remainder of the discussion). Since that was the highest density zone, it was assumed to correspond to an urban setting, and model parameters such as the cost per foot for buried and underground structure were set to the high values that would be appropriate for an urban area.

Subsequent to HM 2.2.2, the model developers, advised by a newly-formed team of subject matter experts that had been assembled to provide guidance on outside plant design and input values to the developers, reexamined the proper way to define line densities. They found that areas with line densities of 2,550 were decidedly not urban areas. For instance, Dr. Mercer lives in a residential area of Boulder, Colorado. The entire city had a population of only about 90,000 people at the time HM 2.2.2 was released. His neighborhood, which is well away from the light-urban downtown area of Boulder, consisted (and still consists) solely of single-family detached homes on individual lots, with generous utility easements. Yet this neighborhood, which is manifestly not an urban area, has a line density of approximately 3,500.

After examining this and other cases, the HAI model developers subdivided the existing six density zones of HM 2.2.2 into nine zones for later versions of the model. The uppermost zone of HM 2.2.2 was broken into three parts, defined by line densities of 2,550-5,000, 5,000-

10,000, and >10,000, respectively.[8] The model developers, informed by the outside plant team, found these densities roughly corresponded to what one might think of as suburban, dense suburban (or light urban), and dense urban areas, respectively. They developed specifications for outside plant input parameters accordingly. Parameters such as the per foot cost of buried and underground trenching in the 2,550-5,000 and 5.000-10,000 zones were appropriately assigned values lower than their counterpart values in the >10,000 urban zone. One change "conveniently" ignored by Dr. Tardiff, however, is that the per-foot costs of buried and underground placement in the >10,000 urban zone of later model versions were set significantly higher than in the >2,550 urban zone of HM 2.2.2 -- $45 versus $20 per foot (more than twice as much) for buried cable placement, and $75 versus $70 for underground cable placement. This was again done because the then-new team of outside plant engineers advised the model developers that the existing urban costs were set too low.

It turns out that a substantial majority of the distribution route miles in the >2,550 density zone of HM 2.2.2 falls in the 2,550-5,000 and 5,000-10,000 zones of HM 5.2a-MA, where placement costs are appropriately lower. In Massachusetts, there are approximately 21.8 million distribution route feet in the three upper zones, and they break down as follows:

- ?? 2,550-5,000: 13.9 million feet
- ?? 5,000-10,000: 8.3 million feet
- ?? >10,000: 4.5 million feet

Thus, more than 83% of the total route distance in what was the single "urban" zone of HM 2.2.2 is located in the suburban and dense suburban zones of HM 5.2a-MA, and only 20% in the urban zone of HM 5.2a-MA.

[8] One of the lower zones of HM 2.2.2, previously defined as the range 5-200, was subdivided into two zones of density 5-100 and 100-200 to allow a greater granularity in the treatment of rural versus semi-rural areas. This change has no significant impact on the issue in question, and will not be discussed further.

This is analogous to the man buying a different mix of bagels and sweet rolls during his second visit to the bakery, and seeing a drop in the per-item average cost. Just as in the bakery example, the per-foot cost decreases even though the buried and underground structure costs of the uppermost zone in HM 5.2a-MA are actually substantially higher than their counterparts in HM 2.2.2 – it has nothing to do with what Dr. Tardiff describes as an “inconceivable” decrease in the structure cost inputs to the model.[9] The calculations are somewhat more involved than the bakery analogy, because there are many factors that influence the overall cost per foot of structure. But the gist of the explanation is the same.

To appropriately compare results of the two models, therefore, it is necessary to use a consistent definition of density zones. Since HM 2.2.2 defined all densities greater than 2,550 as belonging to a single zone, there is no available breakdown of the HM 2.2.2 inputs for the three upper density zones. Instead, the effect of assigning all densities >2,550 to a single urban zone has been replicated by using the structure input values normally associated with the highest density zone in HM 5.2a-MA for all of the three highest zones in the model. From a cost point of view, this is equivalent to collapsing the top three zones into a single zone as they are in HM 2.2.2. The results are shown in Line D of Table 2. The average per foot structure cost in HM 5.2a-MA in this case is now $1.06, versus $1.35 for HM 2.2.2, a difference of approximately 21%.

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[9] Tardiff, at p. 24.