I have superimposed a line on the RHK chart showing the average DLC cost per line from the HAI 5.2a MA model run presented in Dr. Mercer's testimony. It can be readily observed that the HAI Model presented in this case uses a conservatively high average investment cost per DLC served line. I believe that this is compelling evidence as to the reasonableness and adequacy of the DLC costs presented by AT&T in this case.

Q. WHAT HAI MODEL INPUT ITEMS ARE IN THE STRUCTURE COSTS CATEGORY?

A. To facilitate discussion, this category will focus on the installed cost of poles, anchors and guys, pole spacing, copper and fiber manholes; distances between them; and underground and buried excavation and restoration.

Q. IS THERE SIGNIFICANT INFORMATION AVAILABLE IN THE PUBLIC RECORD REGARDING THE COST OF POLES?

A. Yes. In mid-1997 the FCC requested information from large companies regarding the installed costs of 40 foot Class 4 poles.[24] The responses included material costs that ranged from $134.00 per pole (GTE) to $402 per pole (US West). Labor costs ranged from $100.00 per pole (Sprint) $902 (Bell Atlantic-Massachusetts). In addition, the FCC relied on a review of RUS contract costs for thousands of items to help determine its cost inputs for poles.

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[24] See data available at http://www.fcc.gov/Bureaus/Common_Carrier/Comments/da971433_data_request/datareq.html

Copper Manhole Spacing (feet between manholes)		
Density (lines/sq. mi.)	HAI Model inputs	FCC
0-5	800	725
5-100	800	725
100-200	800	725
200-650	800	725
650-850	600	575
850-2,550	600	575
2,550-5,000	600	575
5,000-10,000	400	400
10,000+	400	400

Q. WHAT MANHOLES ARE REQUIRED FOR FIBER CABLE?

A. For the most part, manholes have been built in the past to accommodate underground copper feeder cable splices.[25] Underground structure, by its nature, was created primarily to allow the periodic placement of additional copper feeder cables to accommodate growth over time.

Because of the high number of [feeder route] cables involved, and the need for periodic addition of cables, most below-ground feeder plants are in underground conduit structures for ease of placement and replacement.[26]

The length of a conduit section [between manholes] is based on several factors, including the locations of intersecting conduits and manholes for ancillary

25 "In more congested areas, cables are placed in conduits. Manholes are used for splicing … [and] for ancillary equipment such as repeaters or loading coils." Telcordia Technologies, *Telecommunications Transmission Engineering*, 1990, p. 120.

26 Telcordia Technologies, *Bellcore Notes on the Networks*, Issue 3, December 1997, page 12-1.

equipment such as repeaters or loading coils, the lengths of cable reels[27], acceptable pulling tension, and physical obstructions. Pulling tension is determined by the weight of the cable, the coefficient of friction, and the geometry of the duct run. Plastic conduit has a lower coefficient of friction than concrete or fiberglass conduit, and thus allows longer cable pulls. The ability to

[27] Maximum fiber cable reel lengths on a No. 420 Reel are approximately 38,211 feet (7.2 miles) for 96-fiber cables and smaller, or 26,356 feet (5.0 miles) for 216-fiber cables and smaller. See Lucent Technologies, *AT&T Outside Plant Engineering Handbook*, August 1994, pages 14-70 and 14-87.

make long pulls [between manholes] is an important consideration in placing fiber cables because it allows the avoidance of splices. Fiber pulls of several thousand feet are routine.[28]

When the HAI Model is set to allow copper feeder cable placements, an appropriate number of copper manholes will be placed at intervals specified by the copper manhole spacing parameters. Any manholes required for fiber cables will first use any available copper feeder manholes placed by the model. If no copper manholes exist for a portion of the route, the model utilizes fiber pullboxes, at an installed cost of $500.00, with a distance of 2,000 feet assumed between adjacent pullboxes. Fiber manholes and pullboxes are essentially only required for slack cable storage, assumed to be at 2,000 foot intervals to allow slack to be pulled in case of a future fiber cable dig-up that severs the fiber[29].

[28] Telcordia Technologies, Telecommunications Transmission Engineering, 1990, p. 120.

[29] "The number of [future contingency] maintenance splices allocated is generally a local decision based on a history of maintenance problems. If no local policy exists, then one maintenance splice per kilometer (3,280 feet) can be used." Lucent Technologies, *AT&T Outside Plant Engineering Handbook*, August 1994, p. 5-19.

Fiber cable pulling distance are long enough to have splicing take place in central offices and DLC Remote Terminal cabinets, rather than in manholes.

Considering the significant amount of fiber feeder cable in a forward-looking construct, it is not surprising that few manholes are being built these days in practice, especially considering that one of the main reasons for underground copper feeder was the ability to augment cable capacities over time. This growth in a fiber environment is handled by simply putting higher bandwidth cards in the DLC Remote Terminal, rather than by placing more cable.

Q. WHAT MANHOLES ARE REQUIRED FOR COPPER CABLE?

A. The widespread use of fiber optic cables for significant numbers of lines dictates that small copper cable manholes will suffice. However, even the smallest standard manhole, a "Class A" manhole, is 7 feet deep by 12 feet long and 5 feet wide. These dimensions are designed to accommodate at least 10 copper cables.

Q. HOW DO THE HAI MODEL INPUTS FOR MANHOLES COMPARE WITH THE FCC'S INPUTS?

A. The following chart compares the costs by density zone between the HAI Model study inputs and the FCC's inputs. As shown, the model inputs are uniformly higher than the FCC's inputs.

Copper Manhole Costs (per Class A manhole)		
Density (lines/sq. mi.)	HAI Model inputs	FCC
0-5	$5,140.00	$4,472.47
5-100	$5,140.00	$4,472.47
100-200	$5,140.00	$4,472.47
200-650	$5,140.00	$4,472.47
650-850	$5,540.00	$4,472.47
850-2,550	$5,840.00	$4,472.47
2,550-5,000	$5,840.00	$4,472.47
5,000-10,000	$7,340.00	$4,472.47
10,000+	$7,340.00	$4,472.47

Q. WHAT ANALYSIS DID THE FCC USE TO DETERMINE COPPER MANHOLE COSTS?

A. As with other items, the FCC relied heavily on the NRRI analysis of thousands of lines of RUS contract data.

Q. HOW DID YOU VALIDATE THE STUDY'S INPUT VALUES FOR MANHOLES?

A. The following represents information obtained from several small contractors and suppliers on installed, prefabricated manholes.

Manhole Material
$1,350
$1,700
$2,340 — HAI Model Input = $2, 340
$3,100
$3,389
$3,500
$4,720
$4,720

Manhole Excavation & Backfill, Rural
$850
$1,500
$1,600
$1,600
$1,614
$1,750
$2,800 — HAI Model Input = $2,800
$3,500
$4,000

Manhole Excavation & Backfill, Suburban
$1,250
$1,830
$2,050
$2,100
$2,400
$2,400
$2,800 — HAI Model Input = $3,200
$4,200
$4,500

Manhole Excavation & Backfill, Urban
$1,700
$2,650
$3,140
$3,200
$3,500
$4,000
$4,000
$5,000 — HAI Model Input = $5,000
$8,500

Q. HOW DO THE HAI MODEL INPUTS FOR UNDERGROUND CONDUIT COSTS COMPARE WITH THE FCC'S INPUTS?

A. The following chart compares the cost inputs by density zone. The study inputs are uniformly ***higher*** than the FCC's input values.

Underground Excavation & Restoration Costs (per foot)		
Density (lines/sq. mi.)	HAI Model inputs	FCC
0-5	$10.29	$1.86
5-100	$10.29	$1.86
100-200	$10.29	$7.63
200-650	$11.35	$8.16
650-850	$11.88	$8.90
850-2,550	$16.40	$10.23
2,550-5,000	$21.60	$14.15
5,000-10,000	$50.10	$27.79
10,000+	$75.00	$42.59

Q. HOW DID YOU VALIDATE THE MODEL'S INPUT VALUES FOR UNDERGROUND CONDUIT EXCAVATION AND RESTORATION?

A. The following represents information obtained from several small contractors and suppliers on performing excavation and restoration. Placement and stabilization of conduit pipes would be additional. Consequently, this data would apply to the excavation and restoration functions that would be common to both underground conduit placement and buried trenching operations.

Normal Trenching in Dirt with Backfill – Rural 36" depth (per linear foot)

$1.50
$1.87
$2.10
$2.50
$2.75
$2.75 ← HAI Model Input = $2.81-$3.08
$3.00
$3.00
$3.15
$3.20
$3.25
$3.30
$3.30
$3.40
$3.50
$3.50
$3.75
$4.00
$4.50
$4.93
$6.00

Normal Trenching in Dirt with Backfill – Suburban 36" depth (per linear foot)

$2.00
$2.46
$2.50
$3.10 ← HAI Model Input = $2.81 - $3.88
$3.50
$3.60
$3.90
$4.00
$4.10
$4.25
$4.25
$4.50
$4.50
$4.50
$4.50
$4.75
$4.90
$6.00
$11.00
$15.00

Normal Trenching in Dirt with Backfill – Urban 36" depth (per linear foot)

$7.40
$8.50
$8.60
$8.80
$8.80
$9.10
$9.80
$9.87
$10.00

$10.50	
$14.00	
$14.25	
$15.00	
$16.00	
$17.00	
$17.00	
$17.50	← HAI Model Input = 13.58 – 47.93
$22.00	
$42.00	
$63.00	

Q. HOW DO THE HAI MODEL INPUTS FOR BURIED EXCAVATION AND RESTORATION COSTS COMPARE WITH THE FCC'S INPUTS?

A. The following chart compares the cost inputs by density zone.

Buried Excavation & Restoration Costs (per foot)		
Density (lines/sq. mi.)	HAI Model inputs	FCC
0-5	$1.77	$0.77
5-100	$1.77	$1.54
100-200	$1.77	$3.24
200-650	$1.93	$4.26
650-850	$2.17	$5.20
850-2,550	$3.54	$5.51
2,550-5,000	$4.27	$7.34
5,000-10,000	$13.00	$9.02
10,000+	$45.00	$11.93

In my opinion, the FCC failed to give adequate weighting to the opportunity for plowing cables. This is a very cost-effective way to place multiple cables, with the least amount of disruption to the ground surface. Although this is impractical in higher density zones, it is the most often used method in rural and rural-suburban areas.

Q. HOW DID YOU VALIDATE THE MODEL'S INPUT COSTS FOR PLOWING CABLES?

A. The following represents information obtained from several small contractors and suppliers on performing excavation and restoration. This method would not be appropriate for underground conduit placement, but would apply to buried cable placement where pavement is not a factor.

Plow Cable – Rural 36" depth (per linear foot)

$0.50
$0.60
$0.80 ← HAI Model Input = $0.80
$0.90
$0.90
$0.90
$0.92
$0.95
$0.95
$1.15
$1.25
$1.35
$1.35
$1.75
$2.00

Plow Cable – Suburban 36" depth (per linear foot)

$0.90
$0.95
$1.05
$1.20 ← HAI Model Input = $1.20
$1.25
$1.30
$1.30
$1.35
$1.35
$1.57
$1.65
$1.90
$2.00
$2.95
$4.00

Q. WHAT ARE THE HAI MODEL INPUT VALUES FOR BURIED STRUCTURE SHARING PERCENTAGES?

A. The HAI Model assigns 33% of the structure cost to telephone for buried distribution plant and 40 % in feeder plant. With the strong messages by state public utility commissions and from the general public at large to utilities requesting placement of out-of-site plant, the percentages of buried plant structure shared among utilities will only improve in the future. It is also important that utilities continue to cooperate on joint placement of facilities to reduce costs and to prevent frequent disruptions that will occur as more competitors enter the telecommunications facilities market. In addition to other facts and opinions presented to this Department, there is new information that has not previously been considered. In a recent Universal Service Fund case in Kansas, the Kansas Corporate Commission's consultant, Dr. Ben Johnson "examined the placement of feeder and distribution cable for 14 selected wire centers. In every case, at least 40 percent of the feeder routes also included distribution cable. In some wire centers, the percentage was much higher."[30] The Kansas Commission has found that study to be persuasive, and has adopted a 40% reduction in feeder structure and placement costs.[31]

30 Kansas State Corporation Commission, Docket No. 99-GIMT-326-GIT, Order 16, at 52.

31 Ibid. at 54.

Whereas the Kansas Commission chose to reduce feeder structure cost directly, the logic applies directly to the issue of structure sharing percentages, and we ask that this Department take notice of what we believe is a common finding and expectation that feeder cable in Massachusetts will frequently ride jointly with distribution and power company facilities in or on a number of structures.

Q. WHAT INPUT VALUES ARE USED IN THE HAI MODEL FOR UNDERGROUND STRUCTURE SHARING PERCENTAGES?

A. The HAI Model varies the percentage of underground structure sharing cost depending upon the density zone and whether the structure is for feeder facilities or for distribution facilities. In feeder routes the percentage assigned to telephone range from 50% in the lowest density to 33% in the highest density zones. In distribution plant the percentages assigned to telephone range from 100% in the lowest density zone to 33 % in the highest density zones. In large cities it is well known that there are many occupants in the conduit network. As more service providers continue to enter the marketplace, the sharing of underground structure facilities will grow in most metropolitan areas of the country.

Q. WHAT ARE THE HAI MODEL INPUT VALUES FOR AERIAL STRUCTURE SHARING PERCENTAGES?

A. The HAI Model input value for aerial structure sharing for feeder and distribution plant is 50 % in density zone 0-5, 33 % in density zone 5-100, and 25 % in the remaining higher density zones. These input values are very reasonable since pole structure is normally divided between high voltage users (electric companies) and low voltage users (telephone and other communications companies). In the lower density zones there is less possibility of CATV being available and therefore less sharing opportunities. However as population densities increase so do the opportunities for increased sharing of pole space. (See Appendix B of the Inputs Portfolio).

Q. DOES THIS CONCLUDE YOUR TESTIMONY AT THIS TIME?

A. Yes.