Travel Demand Forecasting Model
&
Model Validation Project

RATS Technical Committee

September 5, 2024

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Transportation Modeler

Status Report on Travel Model Upgrade

- Why we use a Travel Model
- Review the Model and…
- Discuss the 4-Step Modeling Process
- Update on Validation Project

What is a 'Model'

- We hear about computer models in weather forecasts
- Talk about travel and air quality models

- Model, or Model Set, is a mathematical approximation of expected behavior
- Data Input, Analysis, Results

Why Model?

- Clean Air Act Amendments of 1991
  - More emphasis on mobile-sources
  - Berks County designated as non-attainment for ground-level ozone (O_3)
  - Designation required Berks to implement modeling to determine air quality impacts of future transportation projects against air quality plans (Conformity)

Berks County Travel Demand Model

- Built 1994 – 1995
- Cost roughly $500,000 to develop
- Costs included software and hardware, network development, three surveys (household, cordon, outlet), population/ employment projections, other data collection & integration, staff training

Berks County Travel Demand Model

- First used for conformity determination in 1996 (FFY 1997 – 2000 TIP)
- By using the model, projects must be shown to not have an adverse impact on air quality, specifically O_3 precursors

Ozone (O_3)?

- "Good up high; bad nearby"
- Respiratory irritant
- Not directly emitted but created; a photochemical reaction that occurs in presence of sunlight, stagnant air, and precursors:
  - Oxides of Nitrogen (NOx)
  - Volatile Organic Compounds (VOC's)

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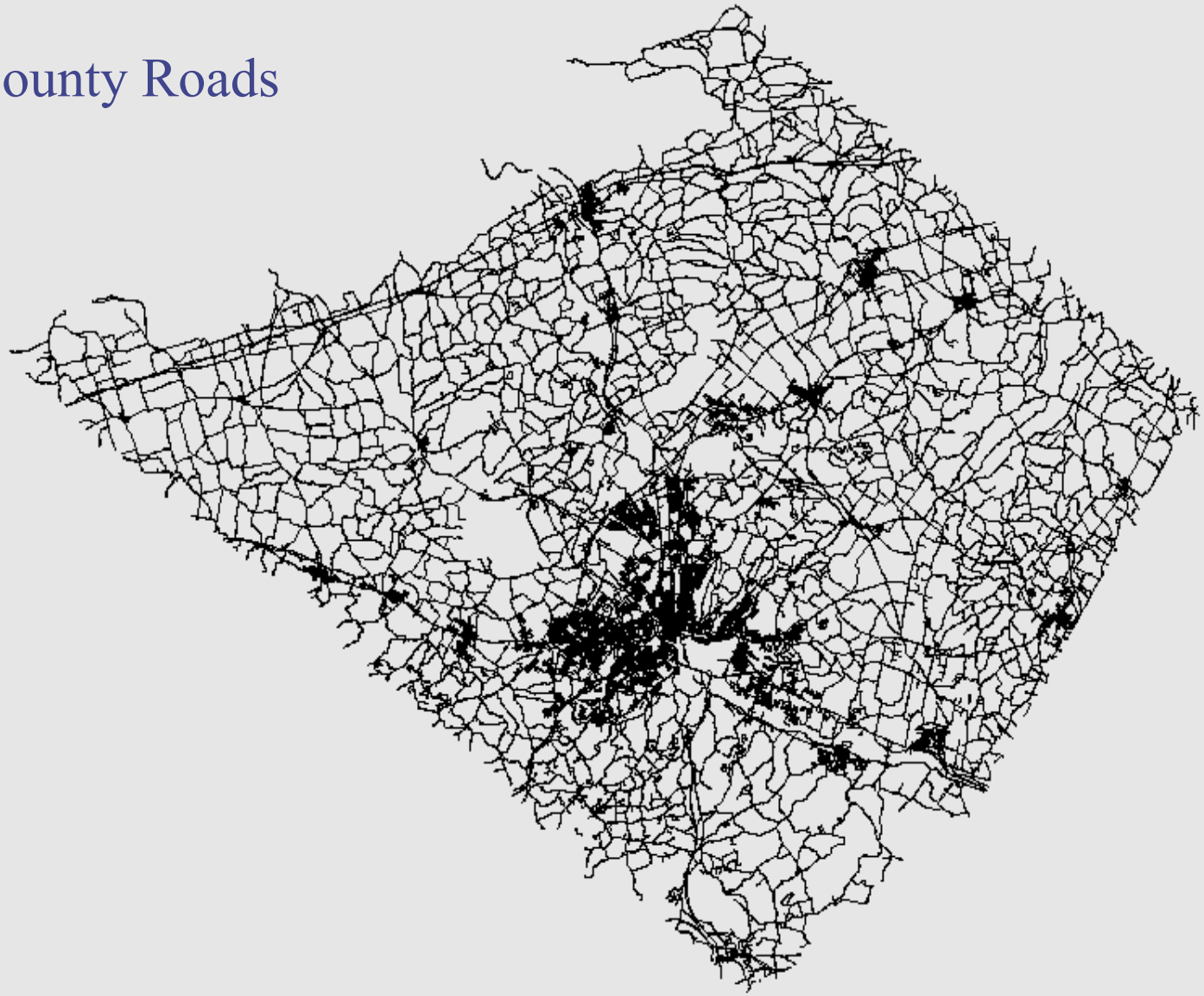
HWY:Berk20.y00

Berks County Roads



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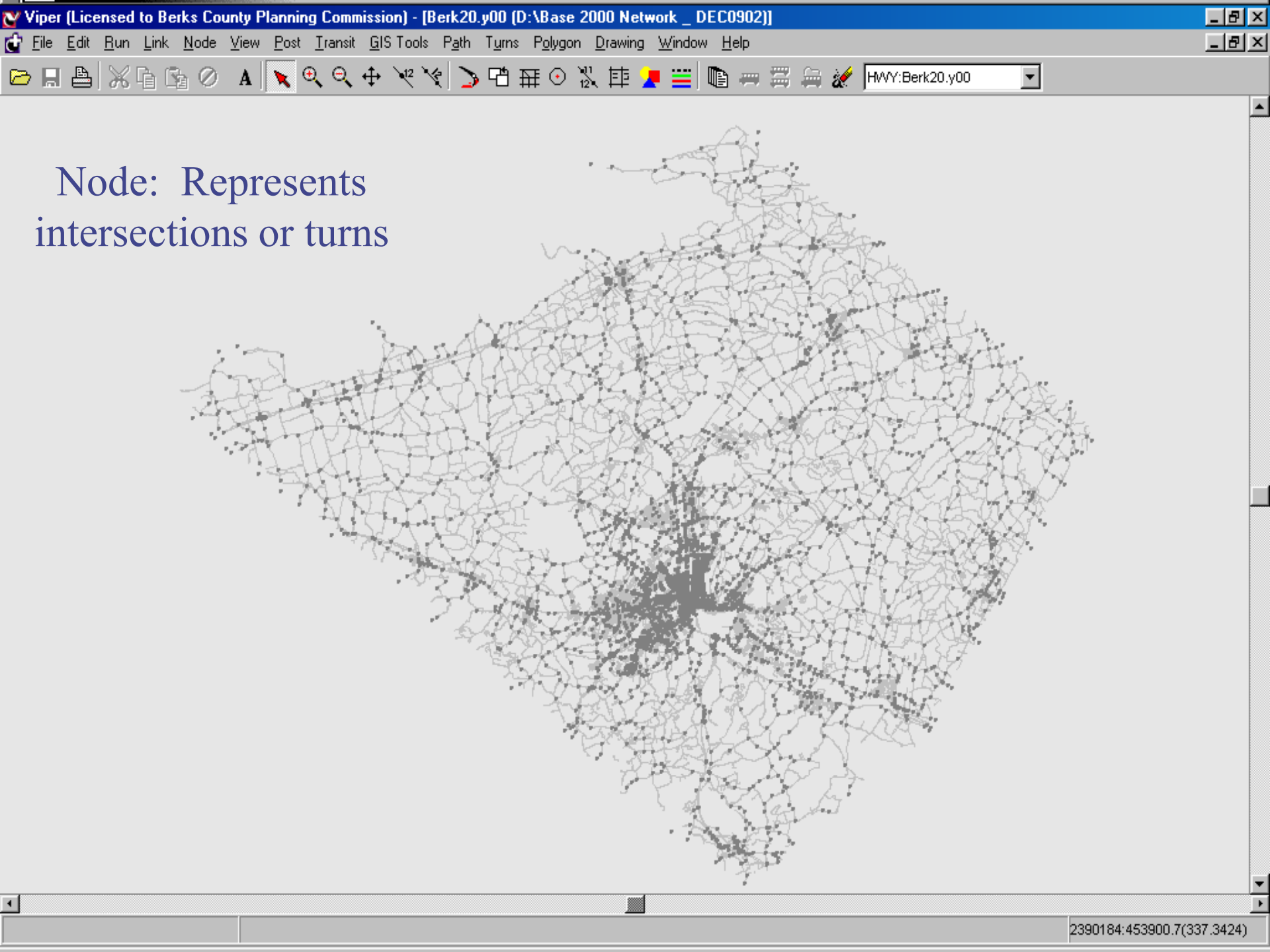
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HWY:Berk20.y00
Node: Represents intersections or turns
2390184:453900.7(337.3424)

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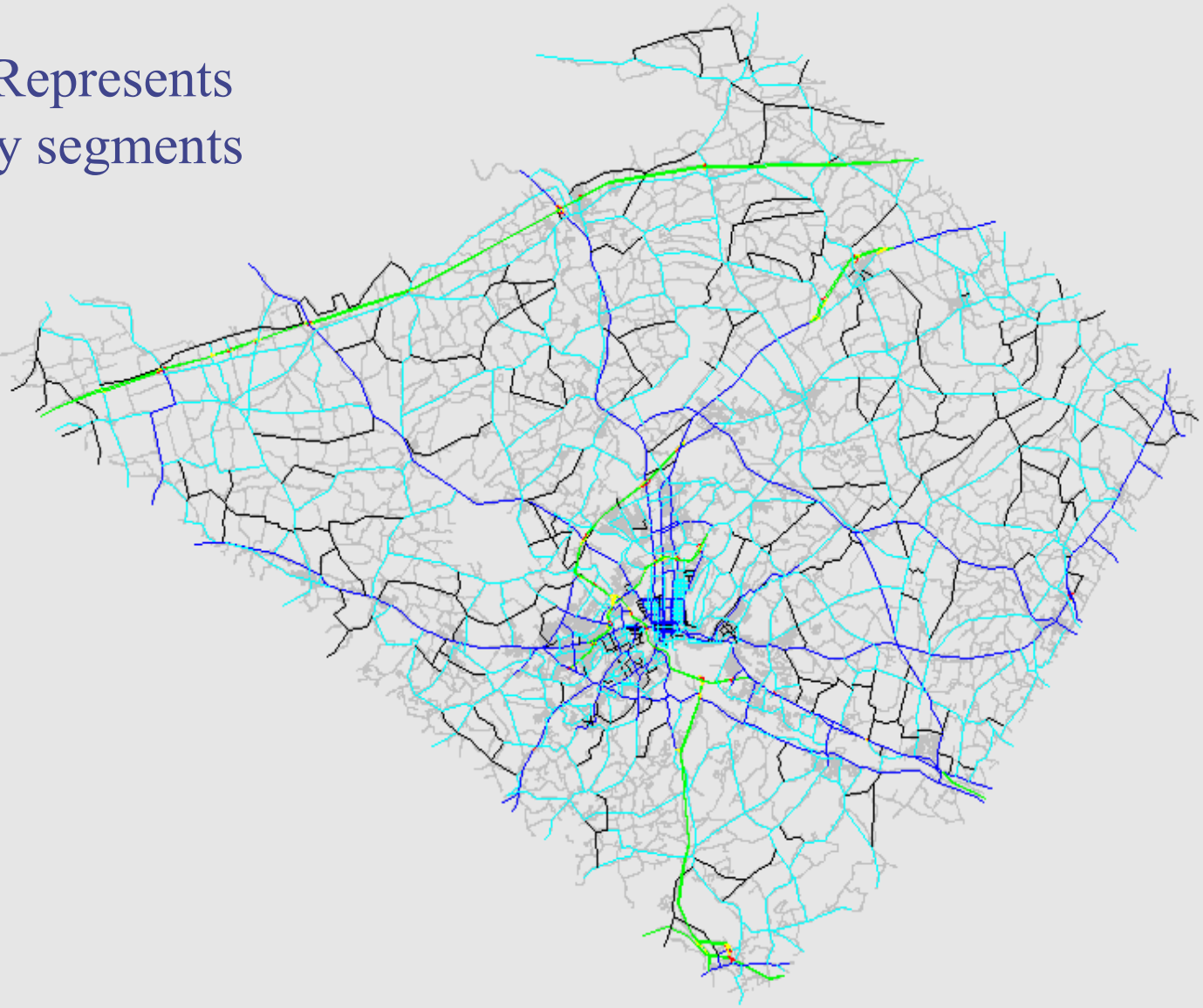
HWY:Berk20.y00

Link: Represents roadway segments



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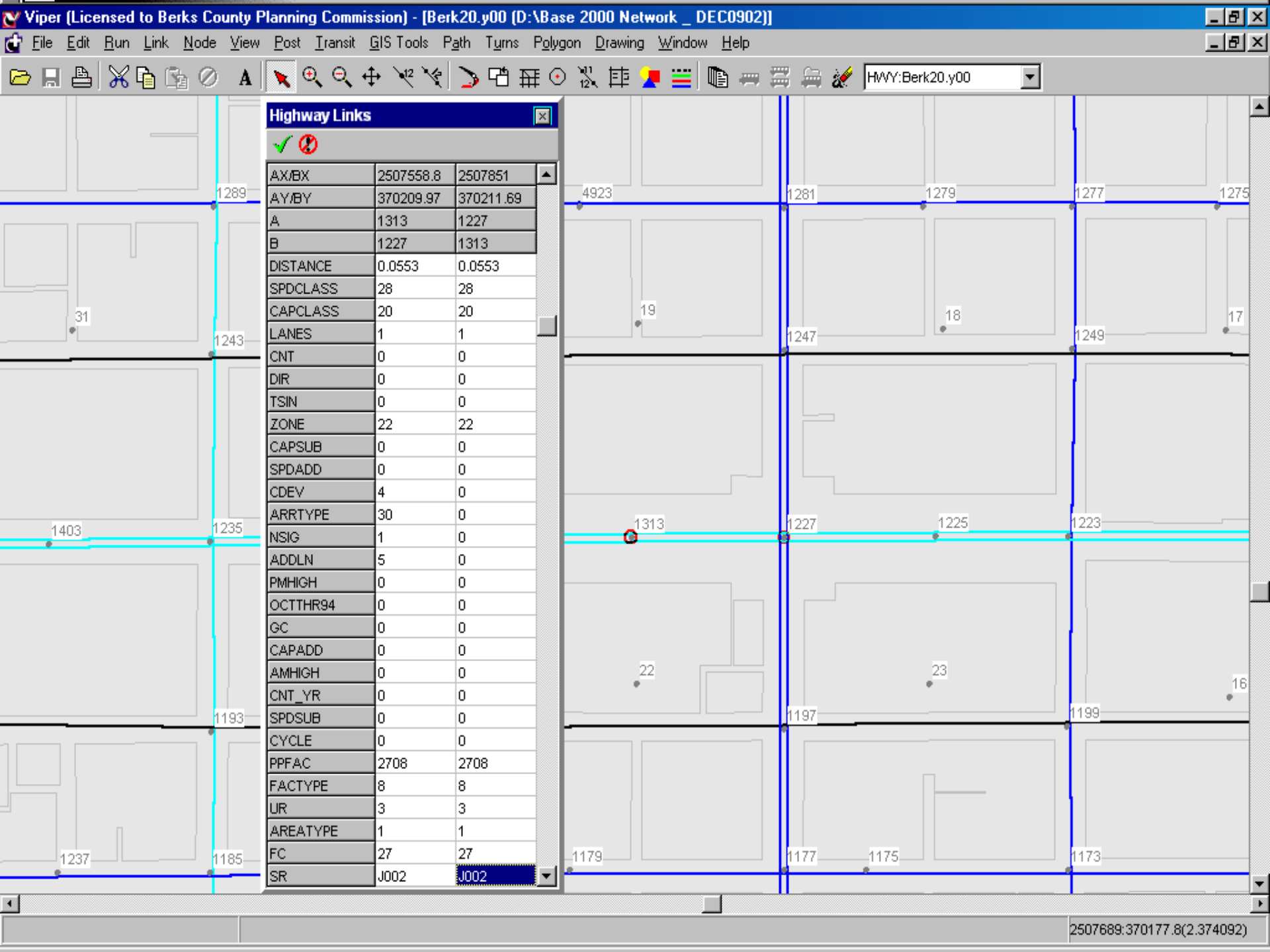
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Highway Links
AX/BX 2507558.8 2507851
AY/BY 370209.97 370211.69
A 1313 1227
B 1227 1313
DISTANCE 0.0553 0.0553
SPDCLASS 28 28
CAPCLASS 20 20
LANES 1 1
CNT 0 0
DIR 0 0
TSIN 0 0
ZONE 22 22
CAPSUB 0 0
SPDADD 0 0
CDEV 4 0
ARRTYPE 30 0
NSIG 1 0
ADDLN 5 0
PMHIGH 0 0
OCTTHR94 0 0
GC 0 0
CAPADD 0 0
AMHIGH 0 0
CNT_YR 0 0
SPDSUB 0 0
CYCLE 0 0
PPFAC 2708 2708
FACTYPE 8 8
UR 3 3
AREATYPE 1 1
FC 27 27
SR J002 J002
1289
4923
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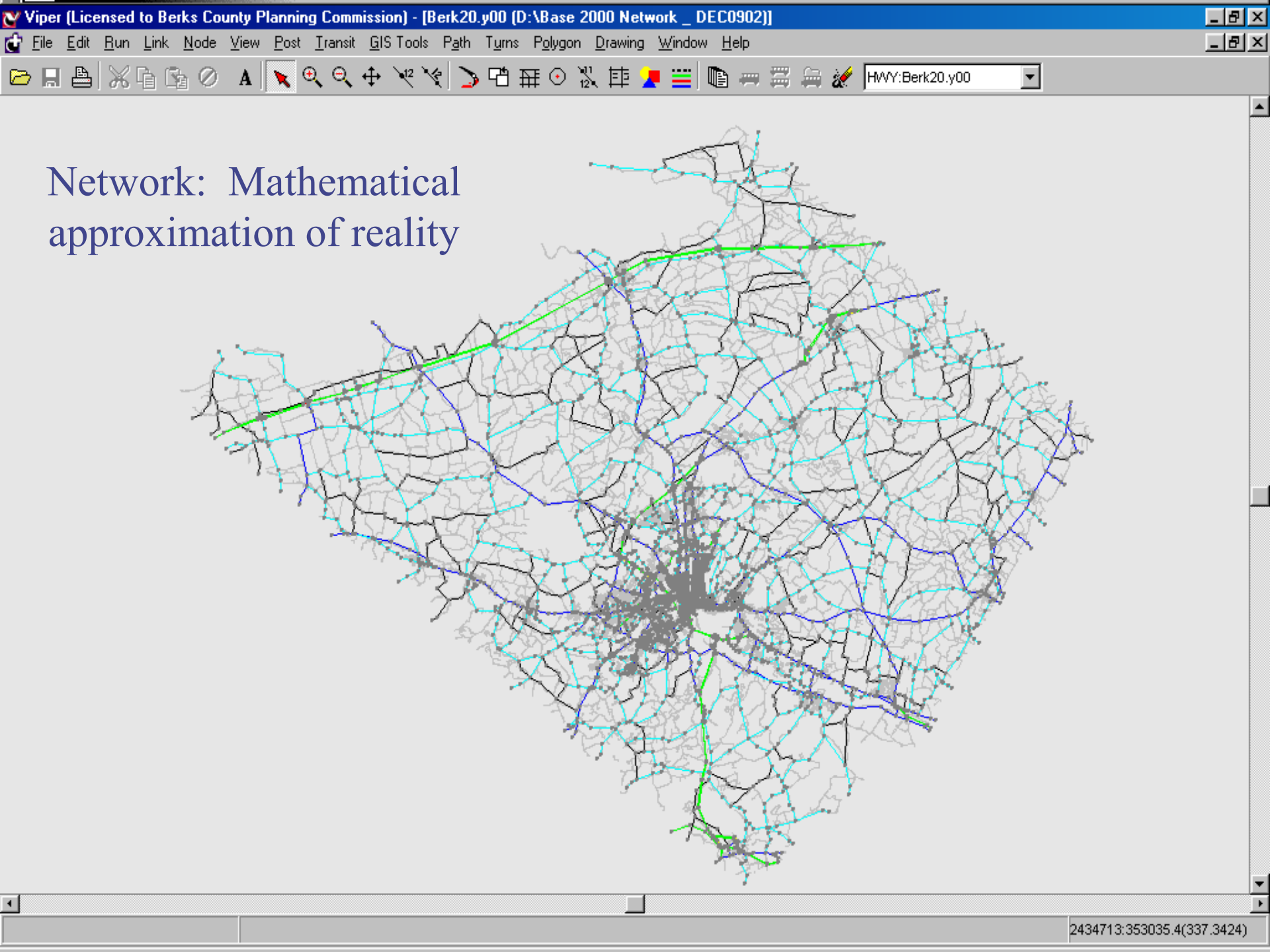
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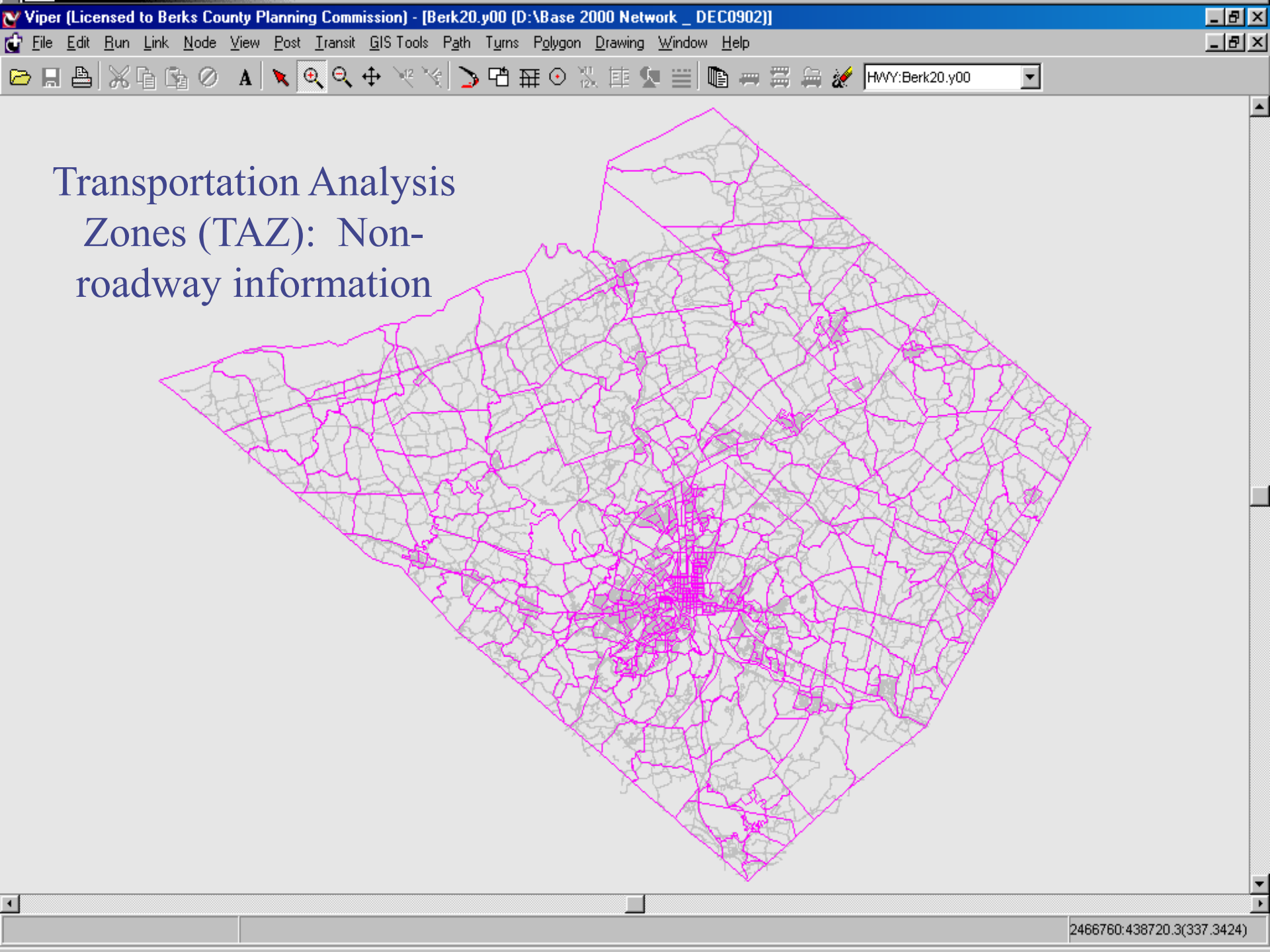
Network: Mathematical approximation of reality
2434713:353035.4(337.3424)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File Edit Run Link Node View Post Transit GIS Tools Path Turns Polygon Drawing Window Help
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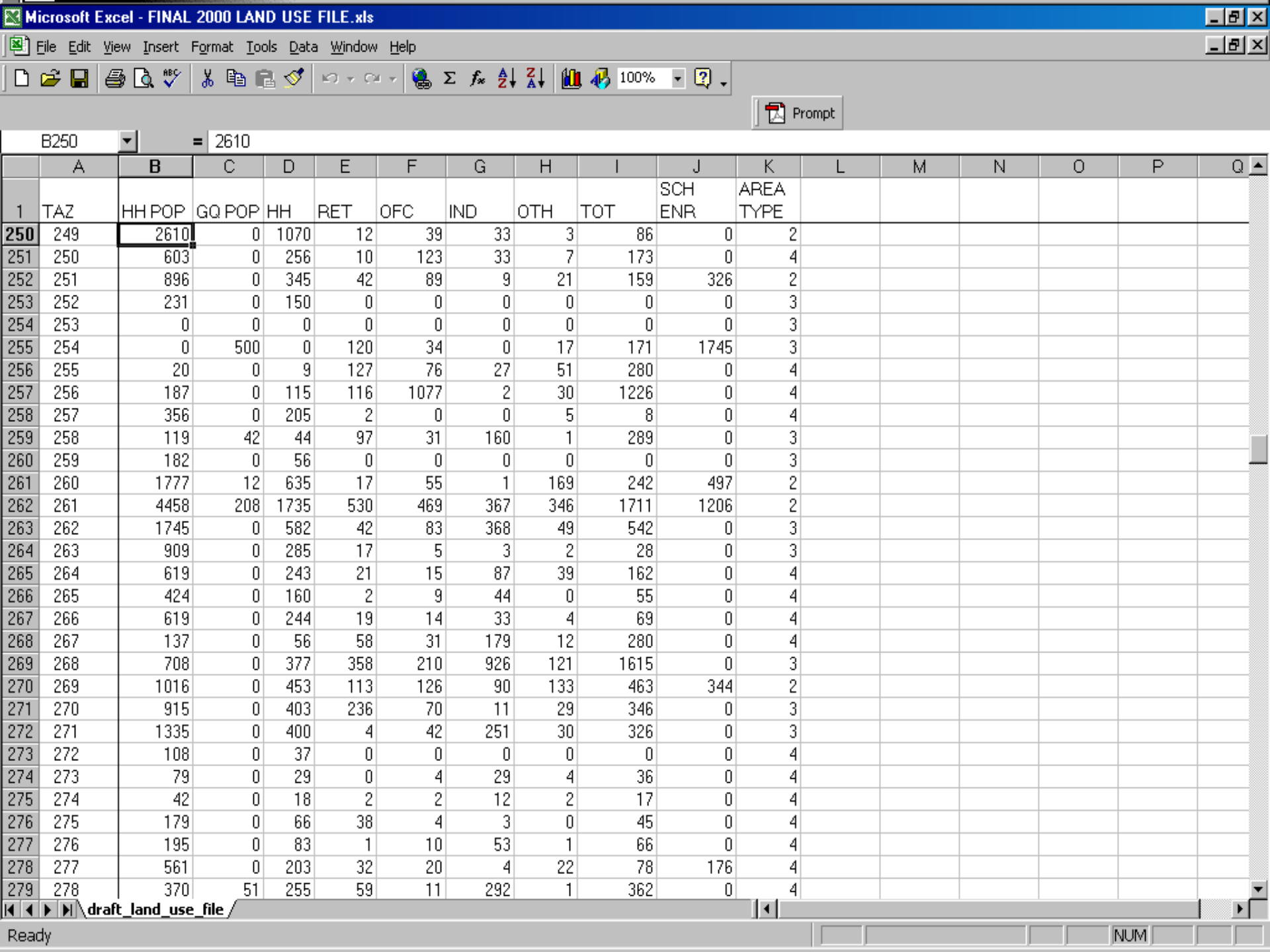
Transportation Analysis Zones (TAZ): Non-roadway information
2466760:438720.3(337.3424)



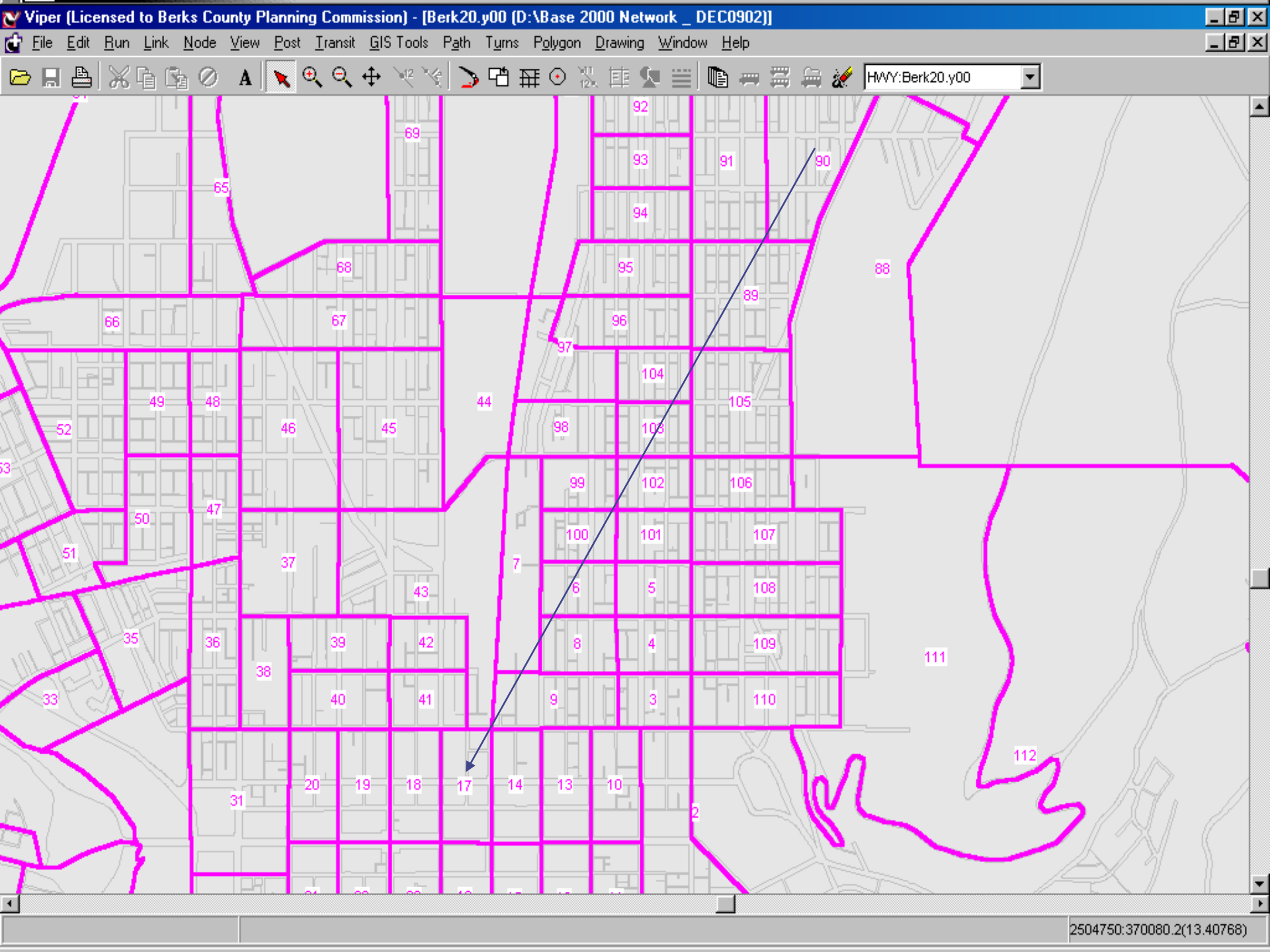
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	TAZ	HH POP	GQ POP	HH	RET	OFC	IND	OTH	TOT	SCH ENR	AREA TYPE						
250	249	2610	0	1070	12	39	33	3	86	0	2						
251	250	603	0	256	10	123	33	7	173	0	4						
252	251	896	0	345	42	89	9	21	159	326	2						
253	252	231	0	150	0	0	0	0	0	0	3						
254	253	0	0	0	0	0	0	0	0	0	3						
255	254	0	500	0	120	34	0	17	171	1745	3						
256	255	20	0	9	127	76	27	51	280	0	4						
257	256	187	0	115	116	1077	2	30	1226	0	4						
258	257	356	0	205	2	0	0	5	8	0	4						
259	258	119	42	44	97	31	160	1	289	0	3						
260	259	182	0	56	0	0	0	0	0	0	3						
261	260	1777	12	635	17	55	1	169	242	497	2						
262	261	4458	208	1735	530	469	367	346	1711	1206	2						
263	262	1745	0	582	42	83	368	49	542	0	3						
264	263	909	0	285	17	5	3	2	28	0	3						
265	264	619	0	243	21	15	87	39	162	0	4						
266	265	424	0	160	2	9	44	0	55	0	4						
267	266	619	0	244	19	14	33	4	69	0	4						
268	267	137	0	56	58	31	179	12	280	0	4						
269	268	708	0	377	358	210	926	121	1615	0	3						
270	269	1016	0	453	113	126	90	133	463	344	2						
271	270	915	0	403	236	70	11	29	346	0	3						
272	271	1335	0	400	4	42	251	30	326	0	3						
273	272	108	0	37	0	0	0	0	0	0	4						
274	273	79	0	29	0	4	29	4	36	0	4						
275	274	42	0	18	2	2	12	2	17	0	4						
276	275	179	0	66	38	4	3	0	45	0	4						
277	276	195	0	83	1	10	53	1	66	0	4						
278	277	561	0	203	32	20	4	22	78	176	4						
279	278	370	51	255	59	11	292	1	362	0	4						

Four-step Modeling Process

- Traditionally accepted method used in travel modeling
- Four major 'steps'
  - Ninety (90) individual processes
  - Post processing for air quality is added-on at the end of the travel modeling

STEP 1: Trip Generation

- Defines the relationship between trip making and land use & households
- Helps explain why trips are made
- Trip 'ends' are:
  - Defined by either origin or destination
  - Estimated based on the characteristics of the activity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92 93 91 90 94 69 65 68 95 88 89 66 67 96 97 104 49 48 44 105 52 46 45 98 103 99 102 106 50 47 100 101 107 51 37 7 43 6 5 108 35 36 39 42 8 4 109 111 38 33 40 41 9 3 110 112 31 20 19 18 17 14 13 10 2
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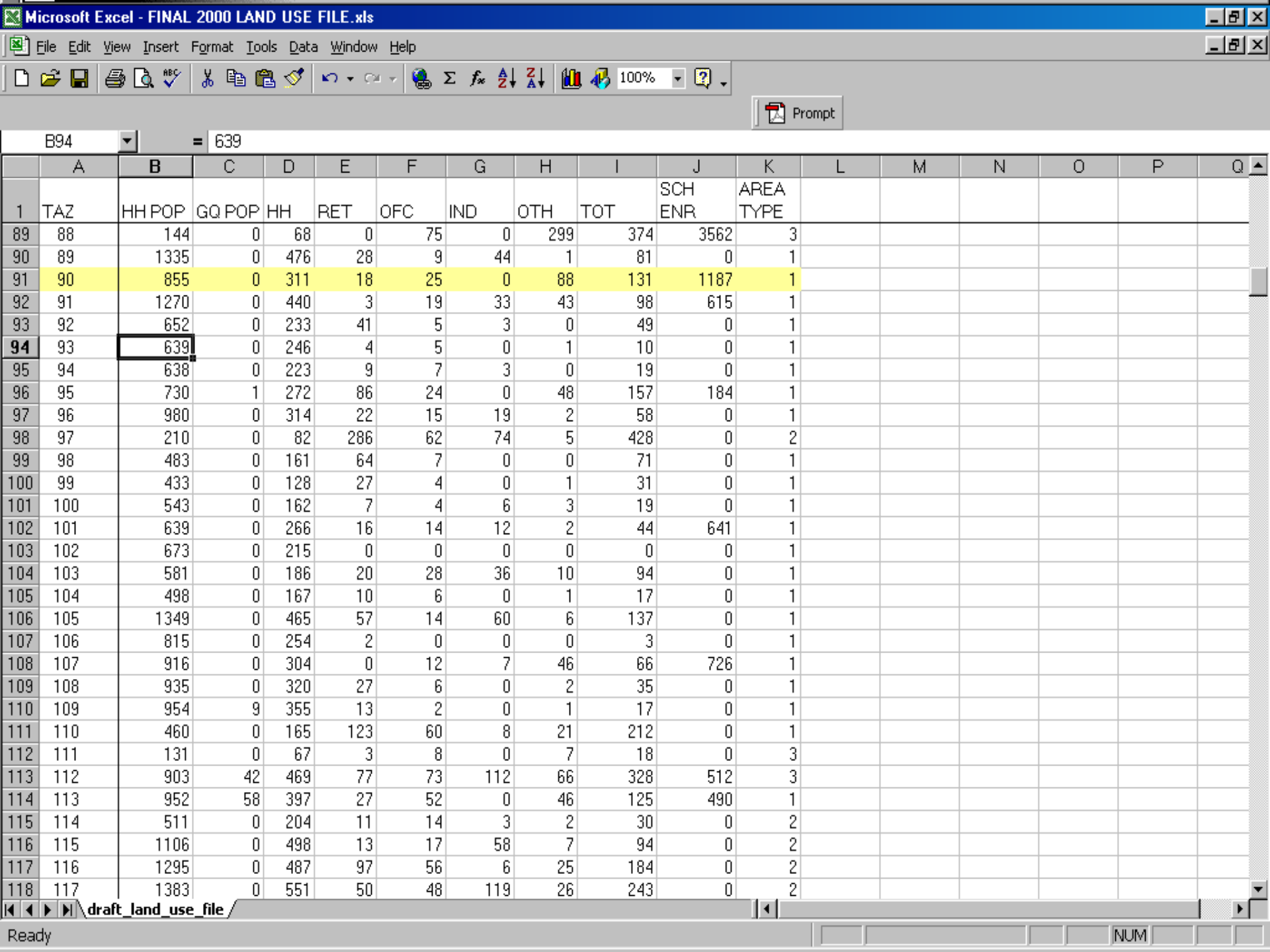
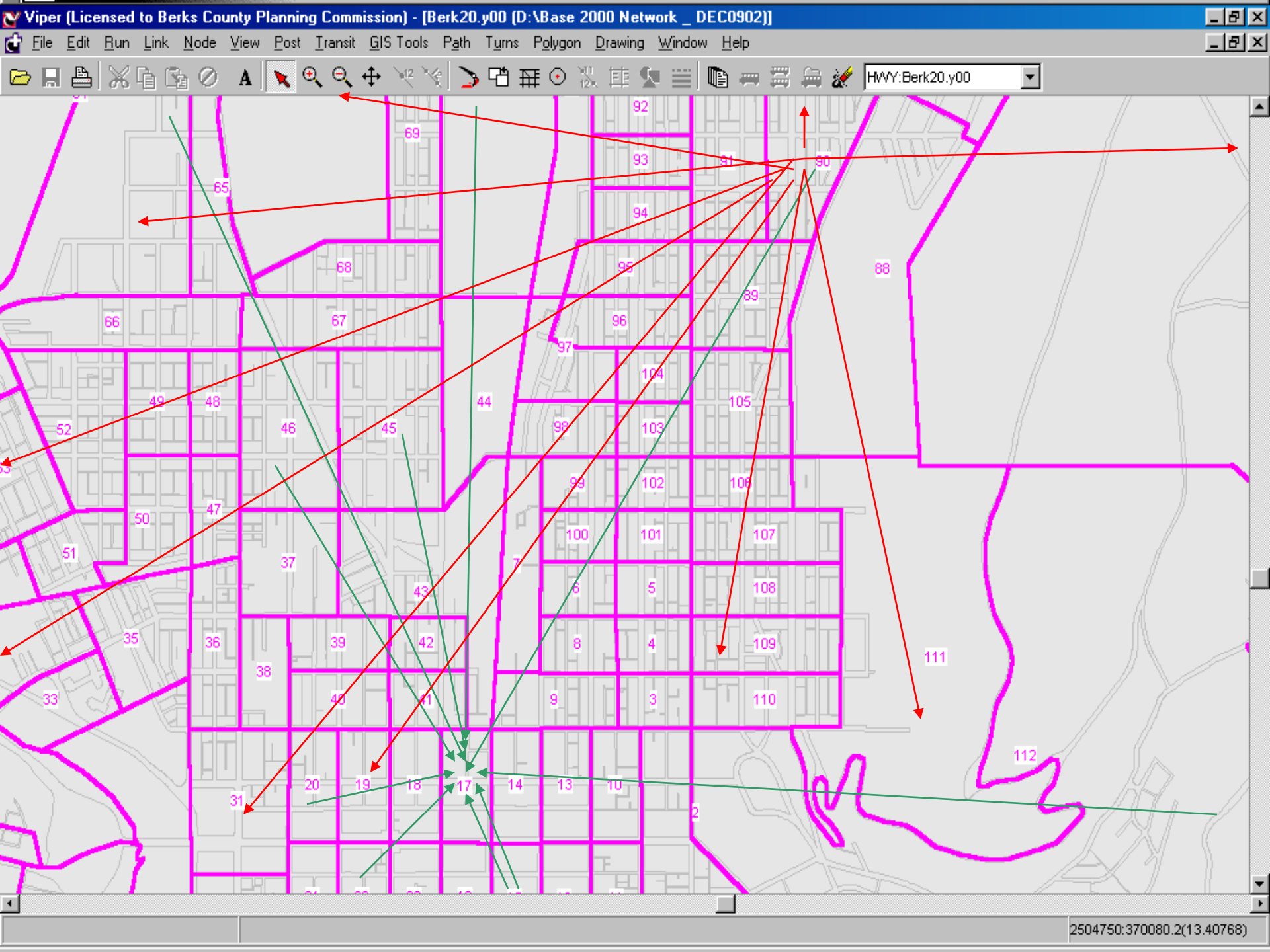


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	TAZ	HH POP	GQ POP	HH	RET	OFC	IND	OTH	TOT	SCH ENR	AREA TYPE						
89	88	144	0	68	0	75	0	299	374	3562	3						
90	89	1335	0	476	28	9	44	1	81	0	1						
91	90	855	0	311	18	25	0	88	131	1187	1						
92	91	1270	0	440	3	19	33	43	98	615	1						
93	92	652	0	233	41	5	3	0	49	0	1						
94	93	639	0	246	4	5	0	1	10	0	1						
95	94	638	0	223	9	7	3	0	19	0	1						
96	95	730	1	272	86	24	0	48	157	184	1						
97	96	980	0	314	22	15	19	2	58	0	1						
98	97	210	0	82	286	62	74	5	428	0	2						
99	98	483	0	161	64	7	0	0	71	0	1						
100	99	433	0	128	27	4	0	1	31	0	1						
101	100	543	0	162	7	4	6	3	19	0	1						
102	101	639	0	266	16	14	12	2	44	641	1						
103	102	673	0	215	0	0	0	0	0	0	1						
104	103	581	0	186	20	28	36	10	94	0	1						
105	104	498	0	167	10	6	0	1	17	0	1						
106	105	1349	0	465	57	14	60	6	137	0	1						
107	106	815	0	254	2	0	0	0	3	0	1						
108	107	916	0	304	0	12	7	46	66	726	1						
109	108	935	0	320	27	6	0	2	35	0	1						
110	109	954	9	355	13	2	0	1	17	0	1						
111	110	460	0	165	123	60	8	21	212	0	1						
112	111	131	0	67	3	8	0	7	18	0	3						
113	112	903	42	469	77	73	112	66	328	512	3						
114	113	952	58	397	27	52	0	46	125	490	1						
115	114	511	0	204	11	14	3	2	30	0	2						
116	115	1106	0	498	13	17	58	7	94	0	2						
117	116	1295	0	487	97	56	6	25	184	0	2						
118	117	1383	0	551	50	48	119	26	243	0	2						

STEP 2: Trip Distribution

- Trip ends from one area are connected with trip ends from another area
- Determines where trips from each zone go to, and where trips to each zone come from
  - Origin/Destination
  - Production/Attraction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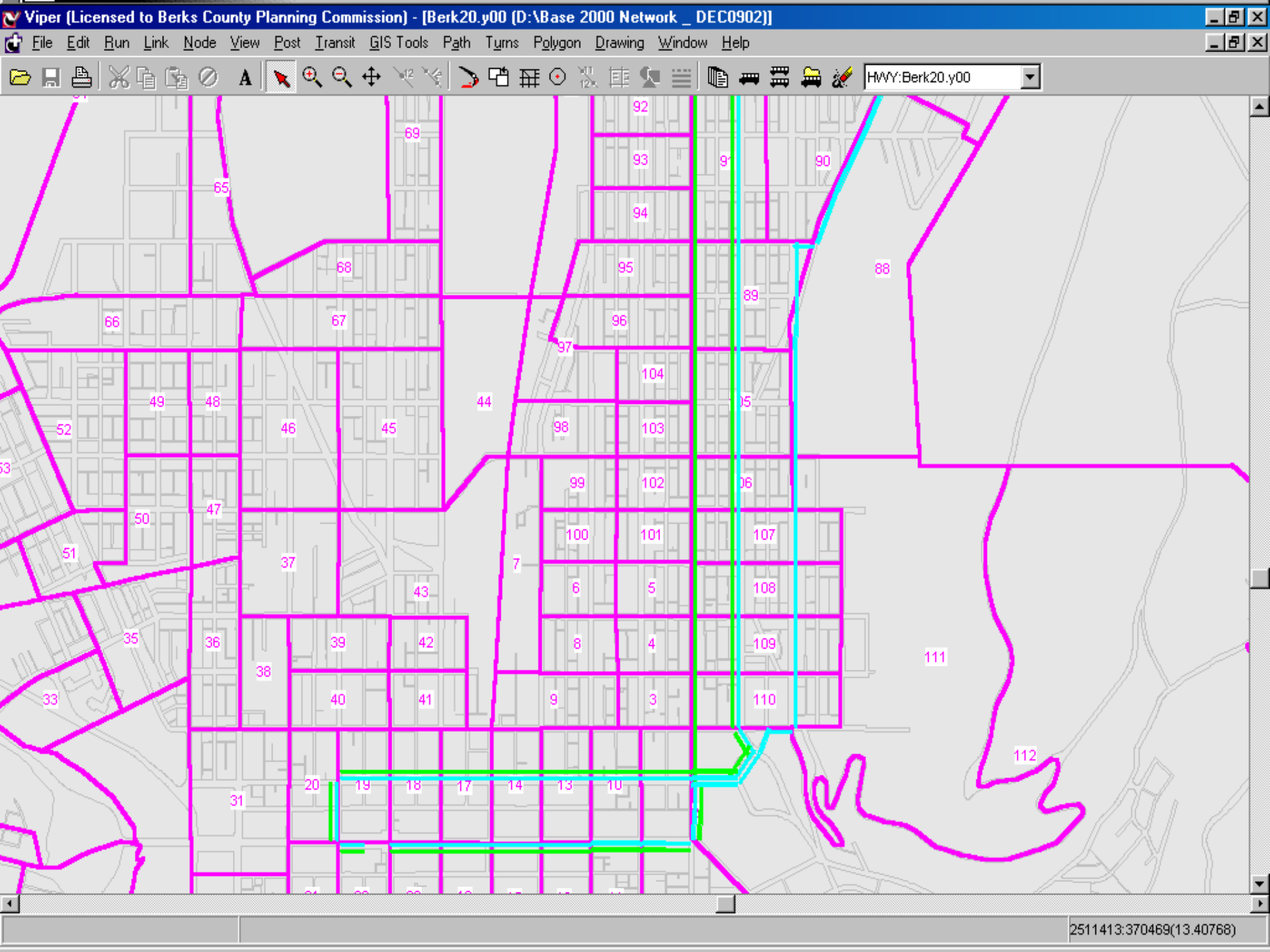
HWY:Berk20.y00
2504750:370080.2(13.40768)

STEP 3: Mode Choice & Time of Day

- Determines how and when we get there
  - SOV
  - HOV
  - Transit
  - Bike / Walk
  - Combination(s) of the above
  - Peak / off-peak periods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HWY:Berk20.y00
2511413:370469(13.40768)

STEP 4: Trip Assignment

- Determines the route ("gravity model")
- Process takes three (3) iterations
- Final output includes 'loaded' network
  - Vehicles by Facility Type and Area Type
  - Vehicles on links for each time period
- Final loaded network data used for Air Quality Conformity Determination

Why Validate?

- To ensure the model is producing valid, sound data for future years
- Based on replicating data from an existing ‘base’ year with known data

Model Validation Project

- FHWA Guidance calls for validation every ten (10) years
- Last completed 2015
- Starting September 2024
- ~Six (6) month project
  - Completed February 2025
- $75,000 - $85,000

Model Validation Project

THANK YOU, PENNDOT!

- Through an additional Work Order as part of their existing Air Quality contract, PennDOT's AQ consultant will perform this work for us at no charge to Berks County or RATS

Model Validation Project

- Review outputs against ‘base’ year data
- Modify TAZ System
- Assemble data
- Update various submodels and routines
- Review revised outputs and adjust inputs accordingly
- Install, Test, Train, Document

Model Validation Project

- Need to ensure reliable data being produced by the Travel Model
- Final loaded network data are fed into USEPA's MOVES4 Air Quality Model…
  - …whose output is then used to make a final Air Quality Conformity Determination

Model Validation Project

EXHIBIT 10: OZONE EMISSION ANALYSIS RESULTS AND CONFORMITY TEST
(Summer Weekday)

Pollutant	*2018 BUDGET (tons/day)*	*2025 (tons/day)*	*2035 (tons/day)*	*2045 (tons/day)*
VOC	**7.5**	*2.8*	*2.0*	*1.7*
NO_X	**14.9**	*6.4*	*4.1*	*4.5*
Conformity Result		**Pass**	**Pass**	**Pass**

Model Validation Project

- Newly-validated Travel Demand Model will be used to perform Air Quality Conformity determination
  - 2050 LRTP
  - FFY 2027-2030 TIP (May 2026)

Model Validation Project

QUESTIONS?

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