Making Decisions from Traffic Models Workshop

Case Study: Salt Lake City, UT I-15 Reconstruction & STIP Projects (VISUM)

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Sacramento, CA

Utah Traffic Lab

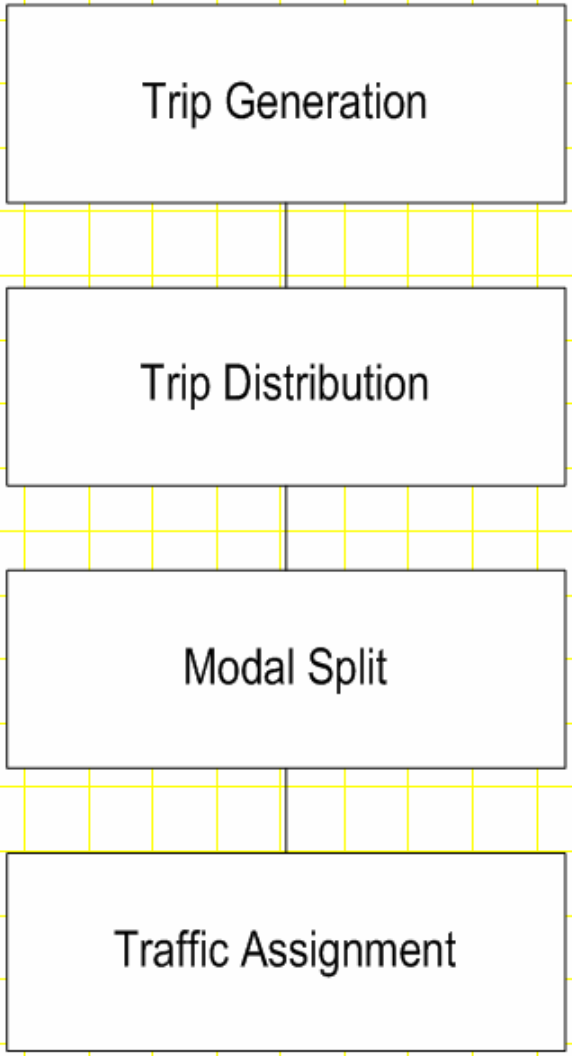
Methods for Evaluating Design-Build vs Traditional Contracting

1. Detailed Model
2. Alternative Construction Scenarios
3. Assessment of User Costs (delay)

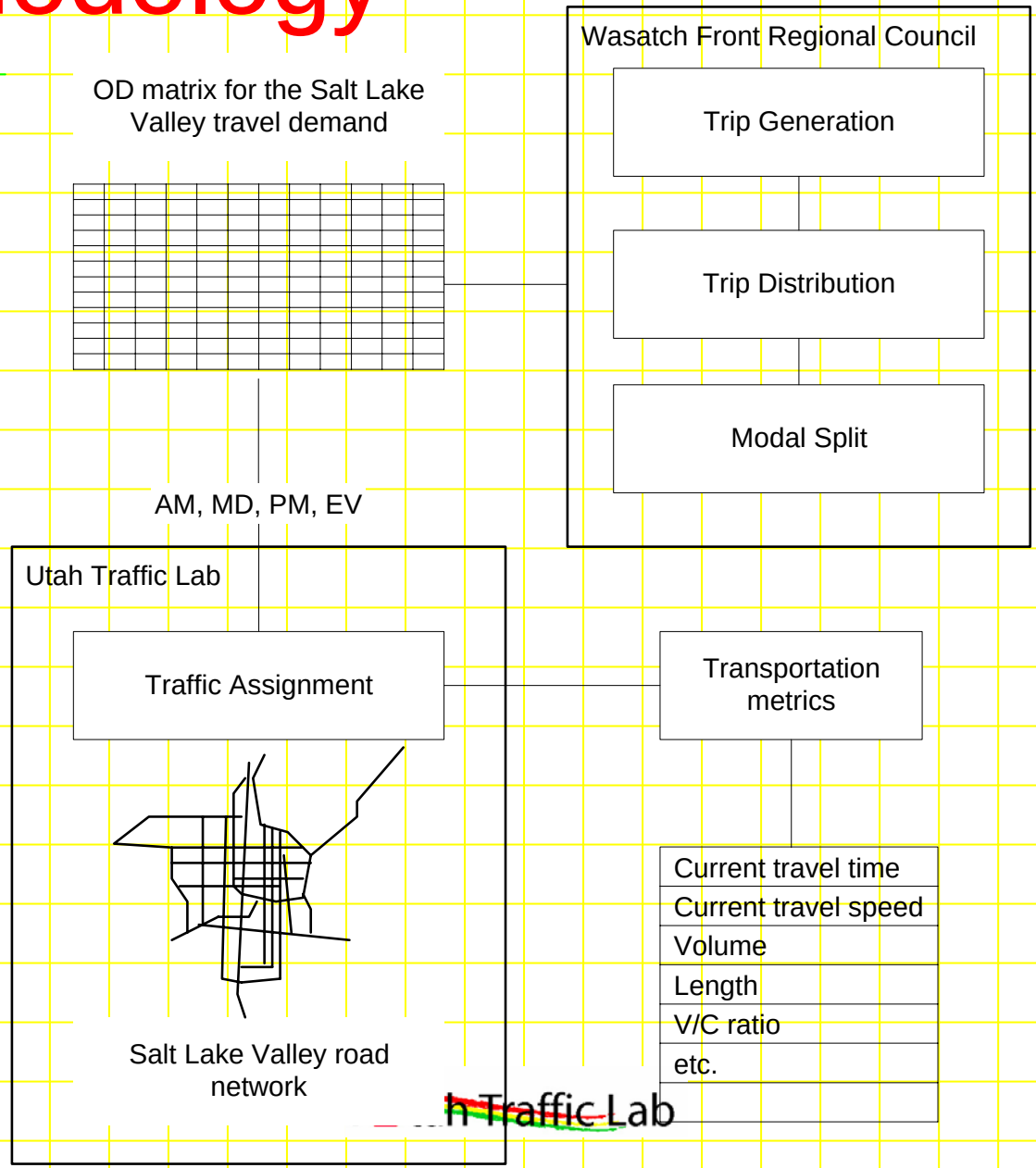
Presentation Overview

- Modeling through VISUM
- Summary of I-15 Reconstruction Evaluation
- Evaluation of 5 STIP Projects
- We could be doing so much more

Traditional Forecasting Model



Methodology



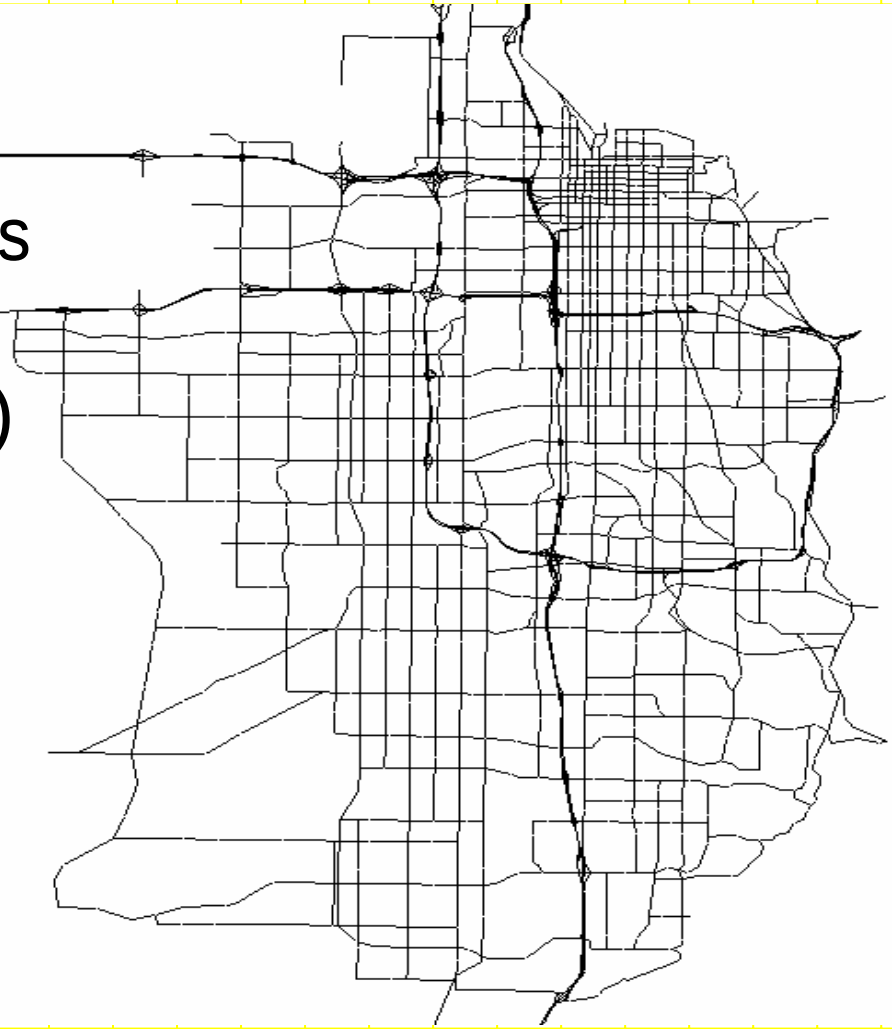
VISUM

Evaluation Possibilities

- Evaluation of user costs for various construction alternatives
  - Design-Build vs Design-Bid-Build
  - Fast-Track vs Slow-Pace (Traditional)
  - Build (Any) vs No-Build
  - Prefabricated vs On-site construction
  - Night-time vs Daytime construction
- Alternative evaluation criteria
  - User delays
  - Modeled accident rates
  - Emission levels

Original (I-15) Network – Salt Lake County, Utah

- 5,000+ links
- 4 major road types (all except local & residential streets)



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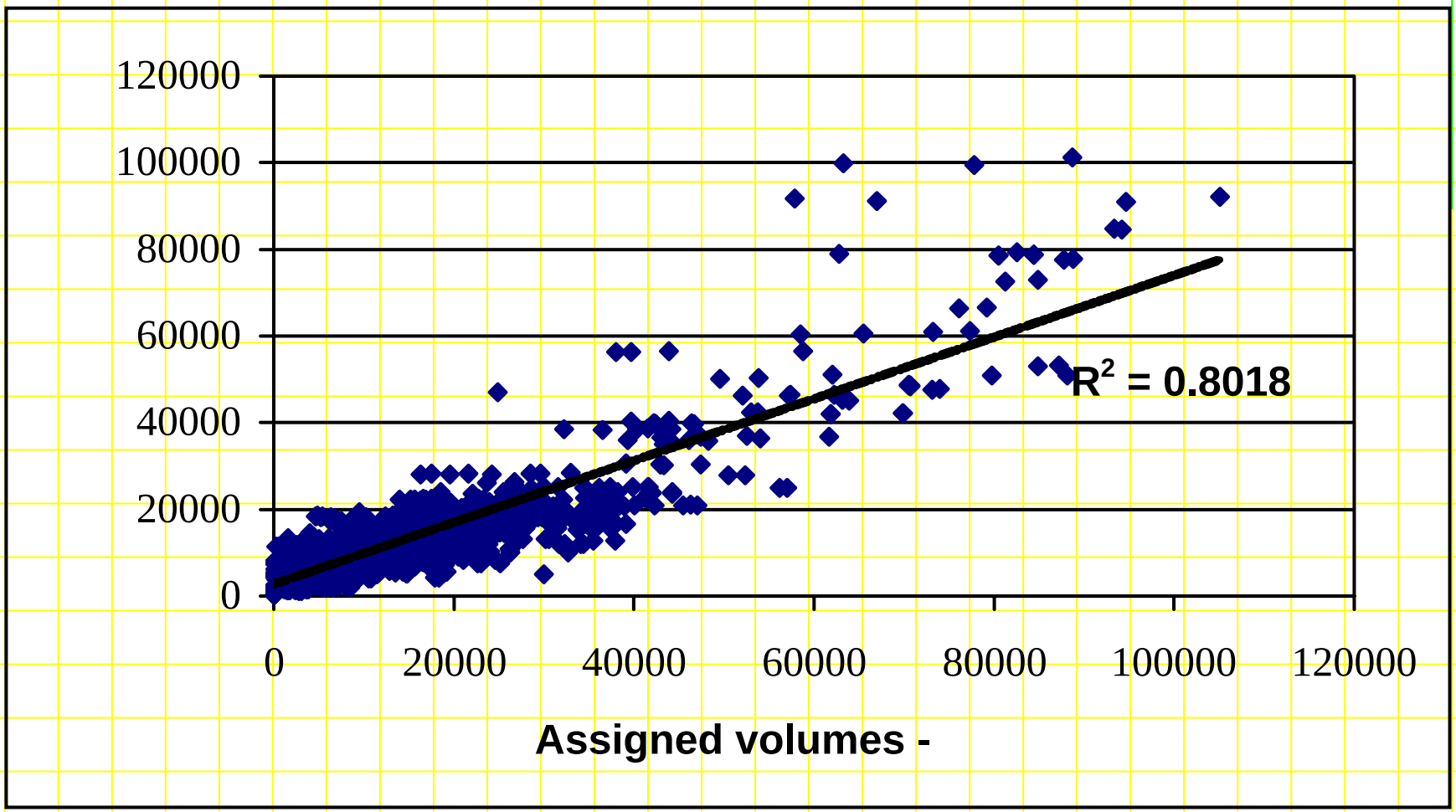
I-15 Reconstruction Project: 17 miles of Urban freeway

- Reconstruction alternatives:
  1. Design-Build ("Fast Track")
  2. Traditional-Build (lower capital cost, protracted congestion)
  3. No-Build (no works but extensive congestion in future) : "Do Nothing"
- Evaluation based on:
  - User delay costs
  - I-15 corridor travel times
  - Network congestion

Modeling Procedure

1. Build VISUM model
   - Base Network, alternative construction scenarios
   - Travel demand
2. Calibrate model
3. Model traffic assignments
4. Derive
   - user delay costs
   - travel times
   - network congestion

Calibration Results



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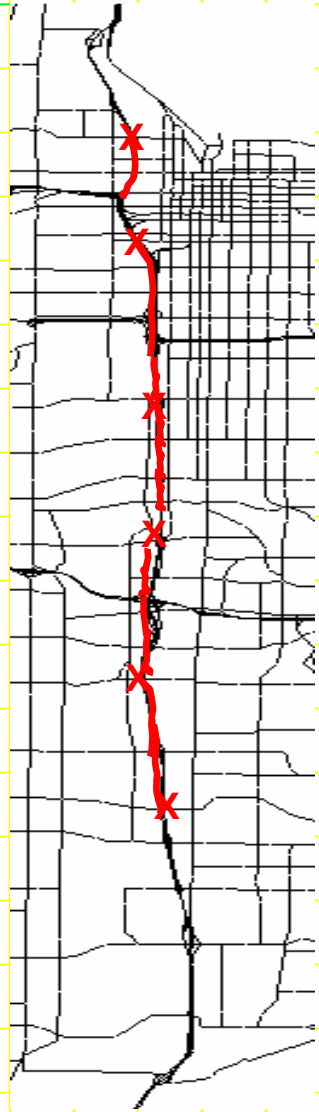
Traffic Assignments

- Network configurations based on:
  - Network updates from Transportation Improvement Plans (TIP) – Bangerter Hwy
  - Traffic mitigation measures for I-15 reconstruction (eg I-215 re-striping)
  - Road work closures
- DB work schedule – actual data (UDOT)
- TB work schedule – assumptions
- NB work schedule - none

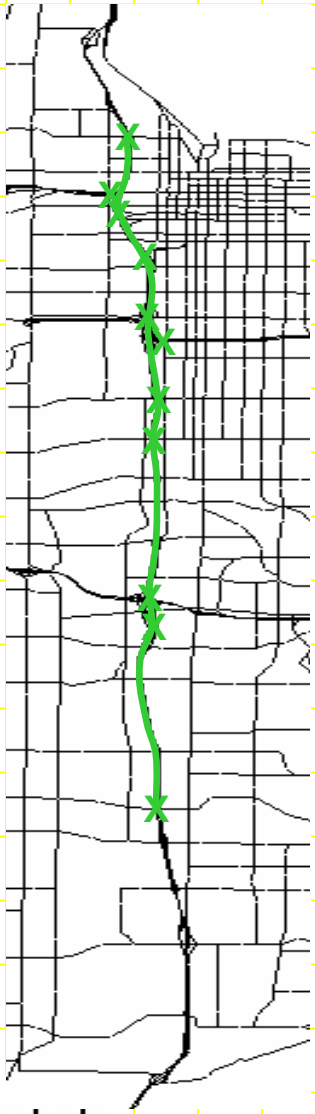
Traditional Build Work Schedule Assumptions

1. Utah Traffic Lab <u>makes up</u> its own construction contract schedule
2. Delivered to UDOT
3. Schedule modified

Traditional Build (TB) and Design Build (DB) Scenarios



Traditional-Build Contracts



Design-Build Contract

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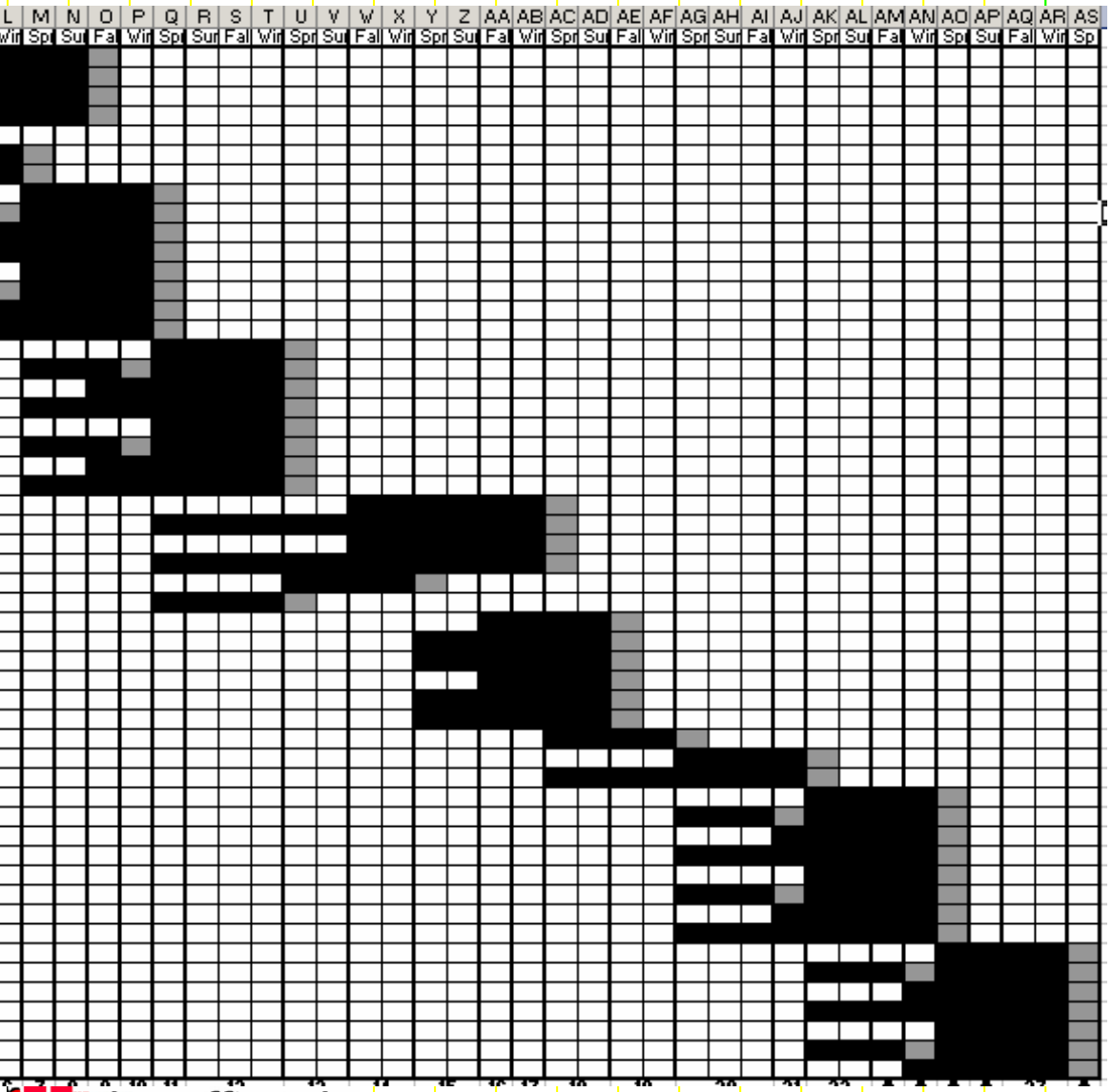
Assumed Road Closures - TB

	A	B	C	D
1	Activity	Activity Description	Close	Open
2	600 N	Arterial closed	Fall-98	Fall-99
3	600 N	NB On&Off	Spring-97	Fall-99
4	600 N	SB On&Off	Winter-97	Fall-99
5	600 N	Fwy sect 600N to I-80	Fall-97	Fall-99
6	900 S	SB ramp	Spring-97	Spring-98
7	900 S	NB ramp	Spring-98	Spring-99
8	900 S	Fwy sct 900S to 2100S	Spring-97	Spring-99
9	3300 S	Arterial	Spring-99	Spring-00
10	3300 S	NB On&Off	Spring-98	Spring-00
11	3300 S	SB On&Off	Fall-98	Spring-00
12	3300 S	Fwy sct 2100S to 33S	Spring-98	Spring-00
13	10600S	Arterial	Spring-99	Spring-00
14	10600S	NB On&Off	Spring-98	Spring-00
15	10600S	SB On&Off	Fall-98	Spring-00
16	10600S	Fwy sct 9000S to 106S	Spring-98	Spring-00
17	5300 S	Arterial	Spring-00	Spring-01
18	5300 S	NB On&Off	Spring-99	Spring-01
19	5300 S	SB On&Off	Fall-99	Spring-01
20	5300 S	Fwy sct 4500S to 53S	Spring-99	Spring-01
21	7200 S	Arterial	Spring-00	Spring-01
22	7200 S	NB On&Off	Spring-99	Spring-01
23	7200 S	SB On&Off	Fall-99	Spring-01
24	7200 S	Fwy sct I-15/I-215 to 72S	Spring-99	Spring-01
25	2100 S	Arterial	Fall-01	Spring-03
26	2100 S	NB On&Off	Spring-00	Spring-03
27	2100 S	SB On&Off	Fall-01	Spring-03
28	2100 S	Fwy sct 2100S to I-80S	Spring-00	Spring-03
29	I-15/I-80	NB On&Off	Spring-01	Spring-02
30	I-15/I-80	SB On&Off	Spring-00	Spring-01
31	500 S	Arterial	Fall-02	Fall-03
32	500 S	NB On&Off	Spring-02	Fall-03
33	500 S	SB On&Off	Spring-02	Fall-03
34	600 S	Arterial	Fall-02	Fall-03
35	600 S	NB On&Off	Spring-02	Fall-03
36	600 S	SB On&Off	Spring-02	Fall-03
37	I-15/215	NB On&Off	Spring-03	Spring-04
38	I-15/215	SB On&Off	Spring-04	Spring-05
39	I-15/215	Fwy sct 5300S to I-15/215	Spring-03	Spring-05
40	4500 S	Arterial	Spring-05	Spring-06
41	4500 S	NB On&Off	Spring-04	Spring-06
42	4500 S	SB On&Off	Winter-04	Spring-06
43	4500 S	Fwy sct 3300S to 45S	Spring-04	Spring-06
44	9000 S	Arterial	Spring-05	Spring-06
45	9000 S	NB On&Off	Spring-04	Spring-06
46	9000 S	SB On&Off	Winter-04	Spring-06
47	9000 S	Fwy sct 7200S to 90S	Spring-04	Spring-06
48	400 S	Arterial	Spring-06	Spring-07
49	400 S	NB On&Off	Spring-05	Spring-07
50	400 S	SB On&Off	Winter-05	Spring-07
51	400 S	Fwy sct I-80/I-15 to 900S	Spring-05	Spring-07
52	1300 S	Arterial	Spring-06	Spring-07
53	1300 S	NB On&Off	Spring-05	Spring-07
54	1300 S	SB On&Off	Winter-05	Spring-07



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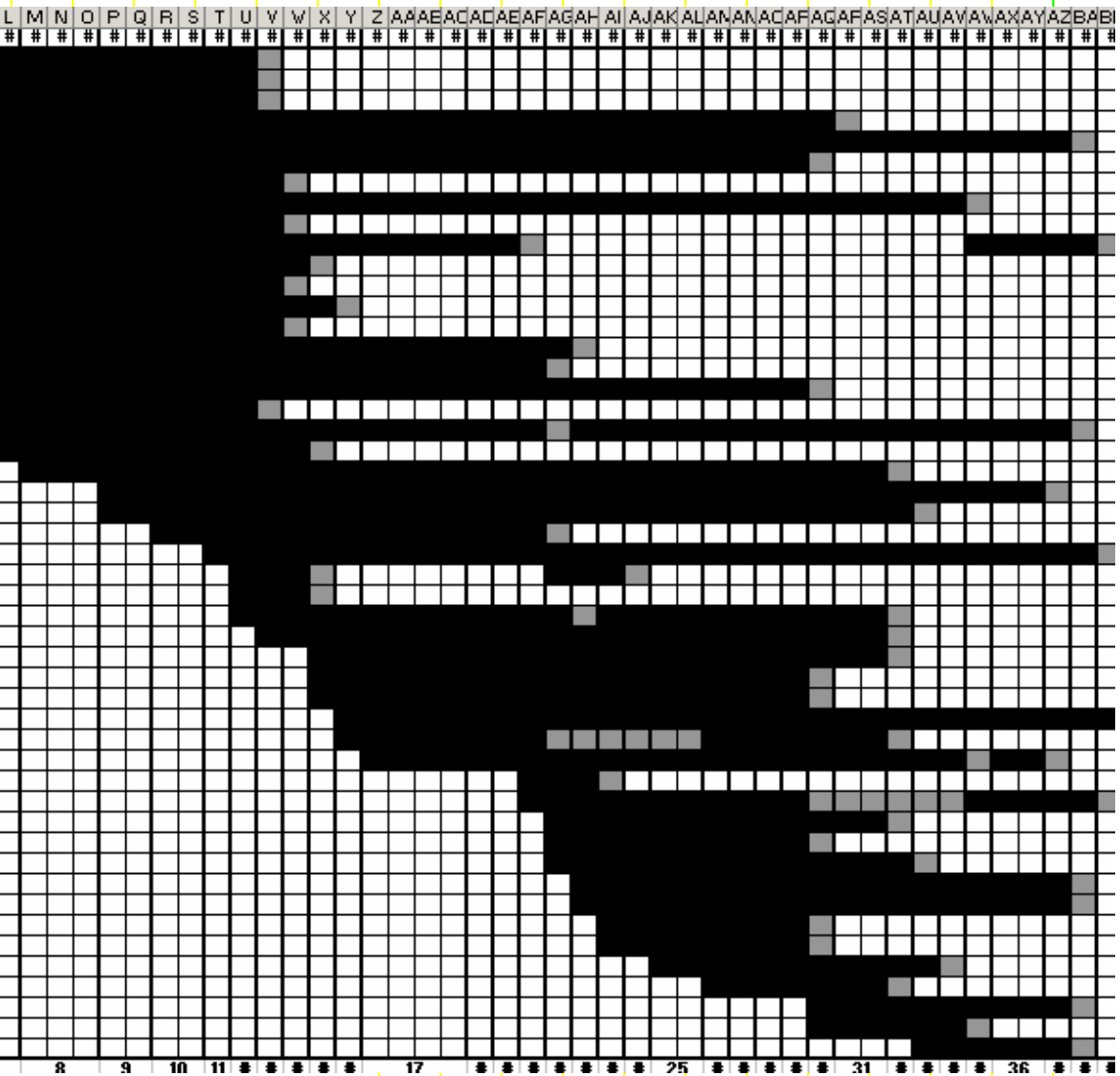
Actual Road Closures - DB

	A	B	C	D
1	Activity	Activity Description	Close	Open
2	600 N	Traffic Close 600 N Off & On Ramp	May-97	Oct-98
3	600 N	Traffic Close 600 N @ 300 & 900 W	May-97	Oct-98
4	600 N	Traffic Close 400 W @ 500 & 700 N	Jun-97	Oct-98
5	I-15/80	Traffic Close I-80 E to NB I-15	Jul-97	Aug-00
6	I-15/215	Strategic Closure I-215 W to 15N	Jul-97	May-01
7	1300 S	Traffic Close Ramp 1300S-A	Jul-97	Jul-00
8	7200 S	Traffic Close 7200 to I-15 S Ramp A	Jul-97	Nov-98
9	500 S	Traffic Close 500 S to WB I-80	Jul-97	Jan-01
10	7200 S	Traffic Close I-15S to 7200 Ramp C	Aug-97	Nov-98
11	3300 S	Traffic Close Ramp 33B, 33D	Aug-97	Jun-01
12	4500 S	Traffic Close Ramp 45A & 45C	Aug-97	Dec-98
13	7200 S	Traffic Close Ramp I-215 E to 7200	Aug-97	Nov-98
14	7200 S	Traffic Close Ramp 7200 to I-15 N	Aug-97	Jan-99
15	I-15/215	Traffic Close I-15N to I-215E	Sep-97	Nov-98
16	I-15/80	Traffic Close 80W15S / 80W15NC	Sep-97	Oct-99
17	2100 S	Traffic Close 2100S Ramp/temp	Sep-97	Sep-99
18	1300 S	Traffic Close Ramp 1300S-D	Sep-97	Jul-00
19	10600 S	Traffic Close 106th SB On-Ramp (A	Oct-97	Oct-98
20	400 S	Traffic Close 400 S	Nov-97	May-01
21	10600 S	Traffic Close 106th SB Off-Ramp (D	Nov-97	Dec-98
22	1300 S	Traffic Close Ramp 1300S-C	Jan-98	Oct-00
23	I-15/80	Traffic Close I-80E to SB I-15	Apr-98	Apr-01
24	I-15/80	Traffic Close I-80 W from NB I-15	Apr-98	Nov-00
25	7200 S	Traffic Close Ramp I-15 N to 7200	Jun-98	Sep-99
26	I-15/80	Traffic Close I-80 W from SB I-15	Aug-98	Jun-01
27	10600 S	Traffic Close 106th NB On-Ramp (D	Sep-98	Dec-99
28	10600 S	Traffic Close 106th NB Off-Ramp (B	Sep-98	Dec-98
29	600 S	Traffic Close 600 South	Sep-98	Oct-00
30	9000 S	Traffic Close Ramp 90-A	Oct-98	Oct-00
31	9000 S	Traffic Close Ramp 90-C	Dec-98	Oct-00
32	5300 S	Traffic Close Ramp 53-C	Dec-98	Jul-00
33	5300 S	Traffic Close Ramp 53-A	Dec-98	Jul-00
34	500 S	Traffic Close 500 S to NB I-15	Jan-99	Jan-99
35	9000 S	Traffic Close Ramp 90-D	Jan-99	Oct-00
36	500 S	Traffic Close 500 S to SB I-15	Feb-99	Apr-01
37	4500 S	Traff Close Ramps 45B&D	Aug-99	Nov-99
38	3300 S	Traffic Close Ramp 33A, 33C	Aug-99	Jun-01
39	9000 S	Traffic Close Ramp 90-B	Sep-99	Oct-00
40	I-15/215	Traffic Close Ramp I-215 E to I-15 N	Sep-99	Jul-00
41	2100 S	Traffic Close 2100s B,D Ramps	Sep-99	Nov-00
42	900 S	Traffic Close 900S-A (NB to 900S)	Oct-99	May-01
43	900 S	Traffic Close Ramp 900S-B	Oct-99	May-01
44	5300 S	Traffic Close Ramp 53-B1	Nov-99	Jul-00
45	5300 S	Traffic Close Ramp 53-D	Nov-99	Jul-00
46	1300 S	Traffic Close Ramp 1300S-B	Jan-00	Dec-00
47	9000 S	Traffic Close 90th Arterial	Mar-00	Oct-00
48	2100 S	Traffic Close 21 S 600W to 1050W	Jul-00	May-01
49	4500 S	Traffic Close 45A,B,C,D & Arterial	Jul-00	Jan-01
50	2100 S	Traffic Close 2100 S All	Nov-00	May-01
51				



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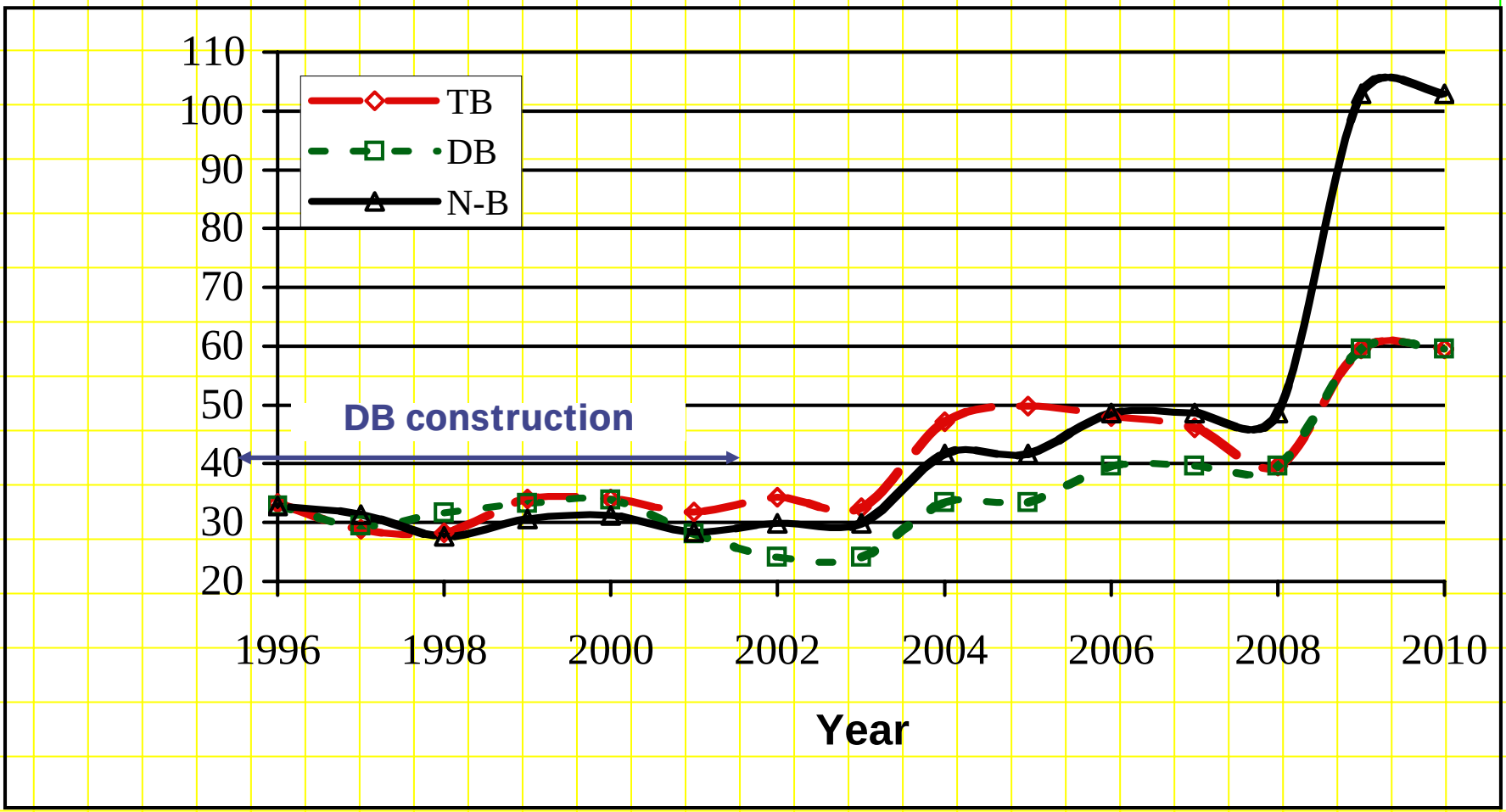
Evaluation Metrics

- User Delay
- Travel Time
- Congestion
  - % links congested
  - v/c > 1 PM peak
- Accidents
- Emissions

Model Results

User Delay



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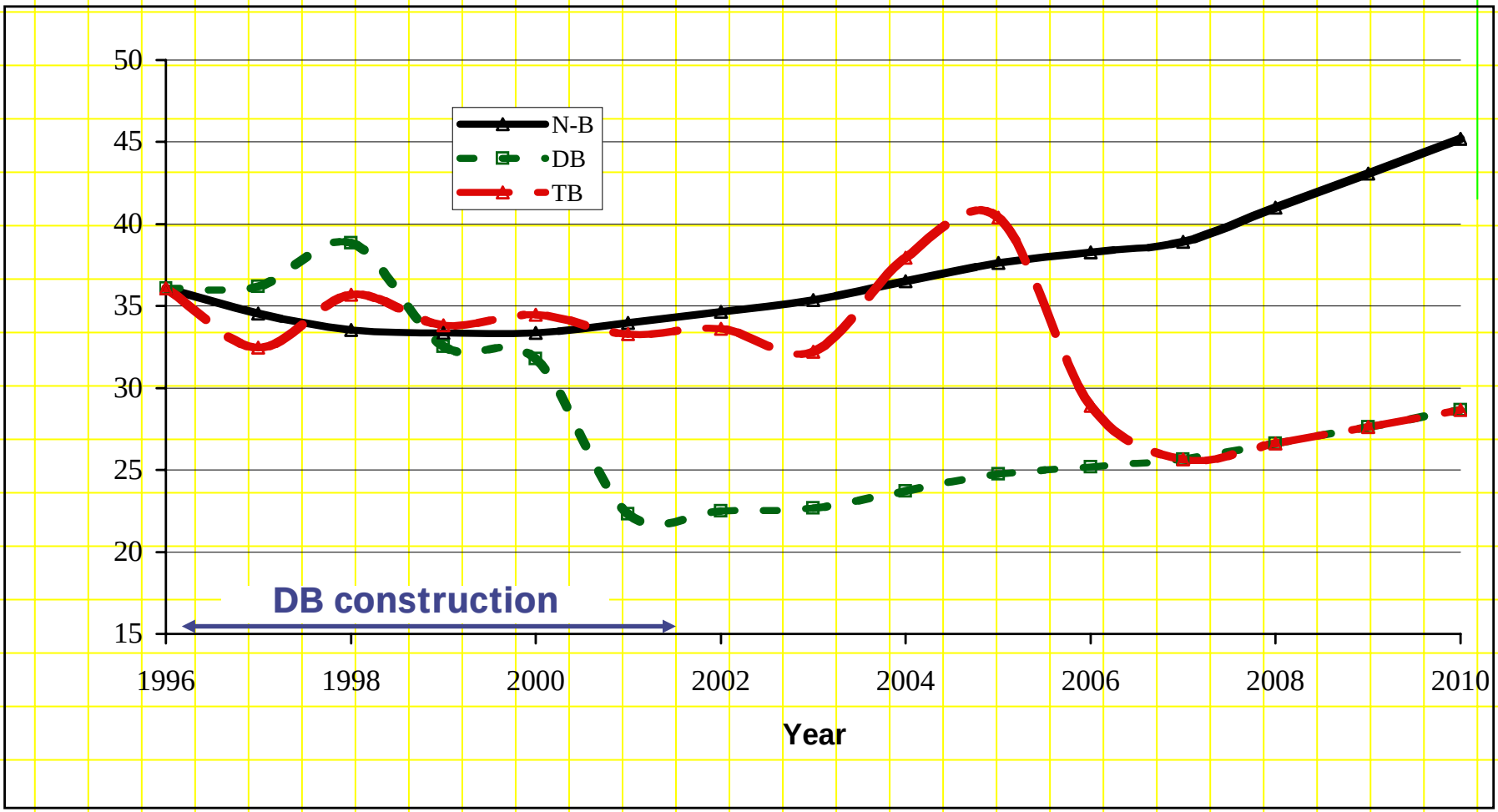
Travel Time



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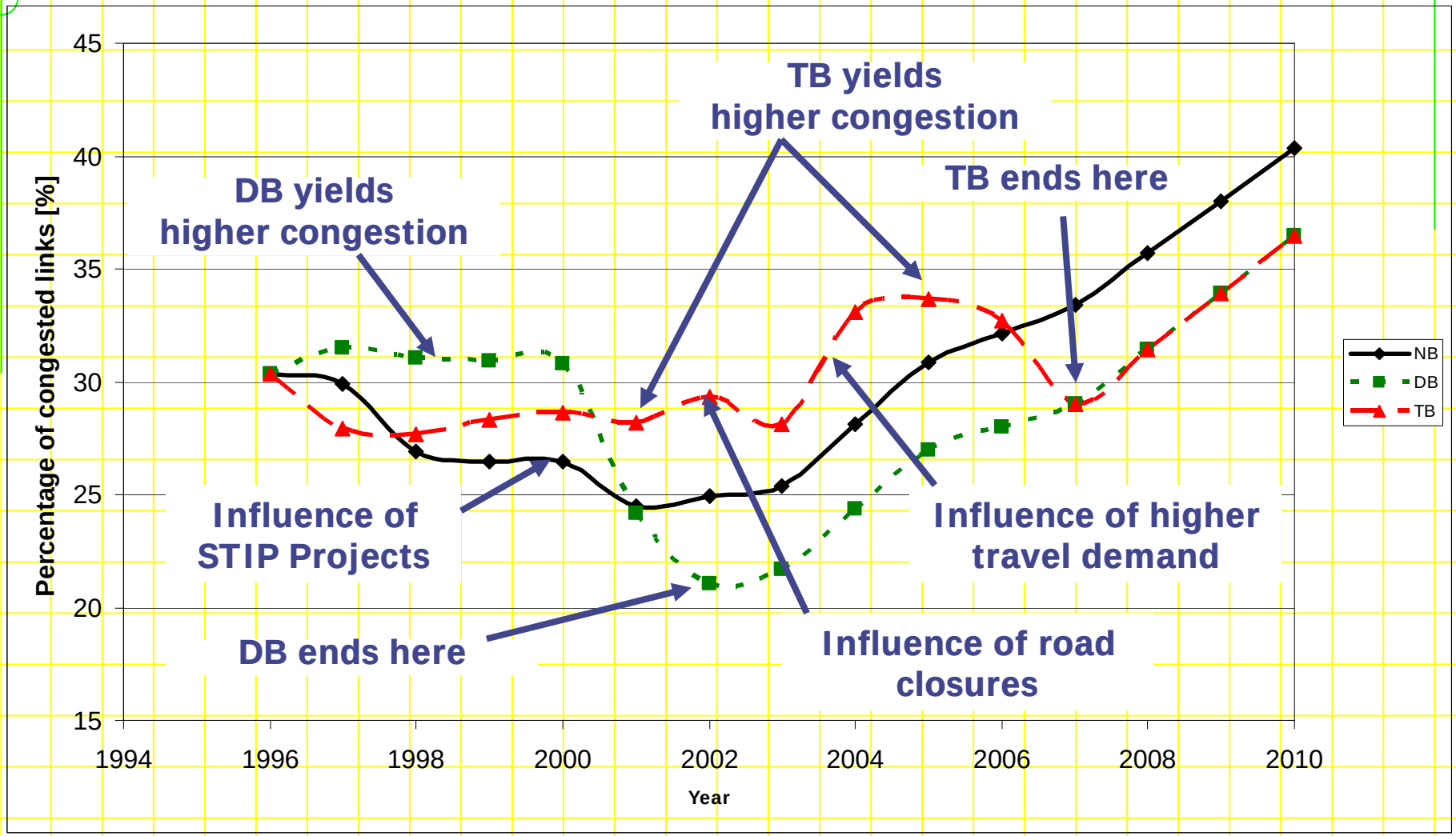
Congestion



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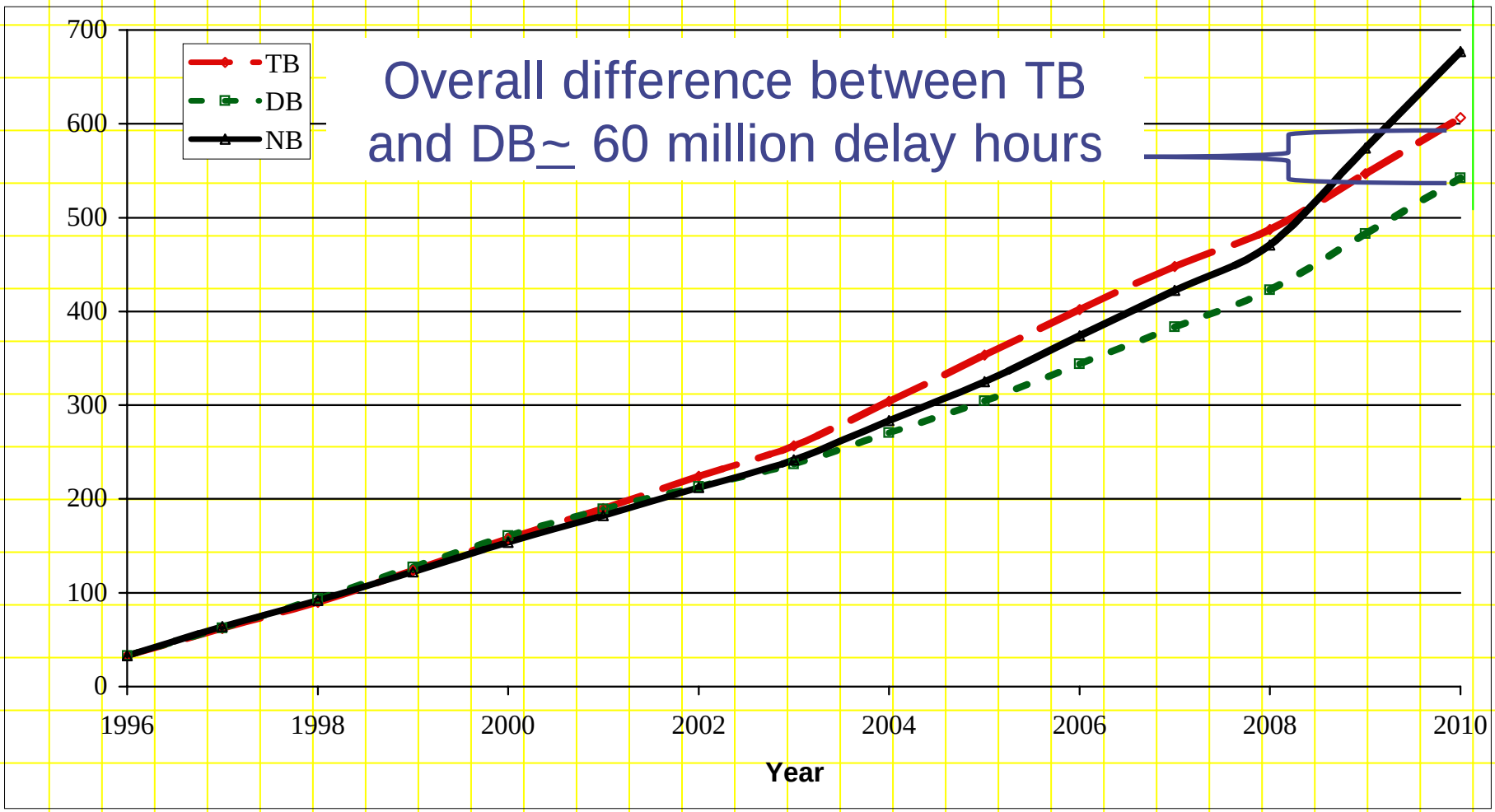
Cumulative Delay Savings



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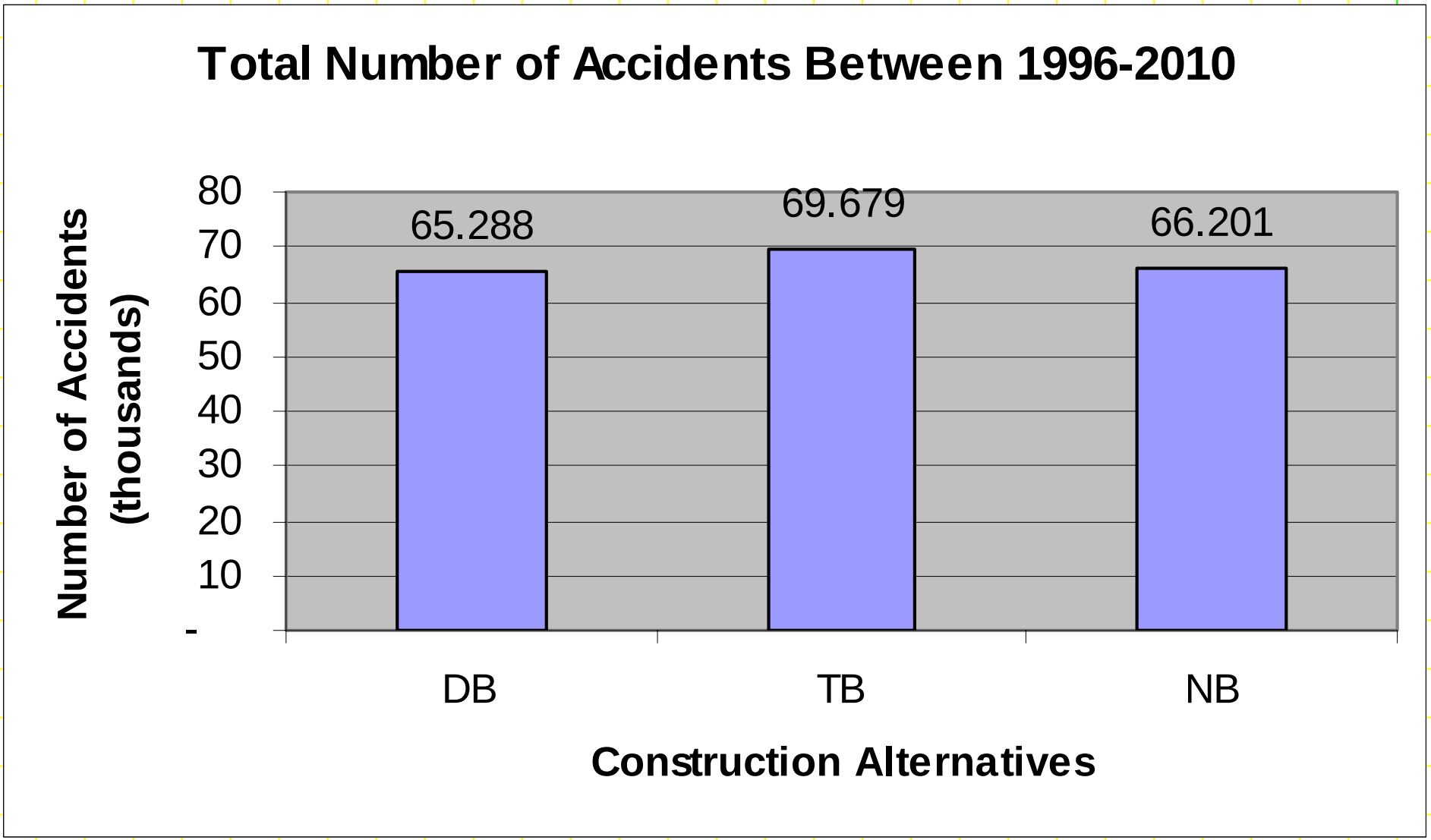

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Conclusions for I-15 Analysis

- DB - best alternative in every aspect
- NB - worst alternative in every aspect
- Travel demand growth is more important than the way TB project boundaries are defined
- Congestion associated with only 2 to 3 (TB) Contracts is as bad as the entire project as one work zone (DB)

I-15 Reconstruction DB Benefits

- DB saved 60 million hours of delay over TB - ($600 million 2002 dollars)
- DB modeled fewer annual accidents:
  - 287 crashes
  - 110 injuries
  - 1 fatality

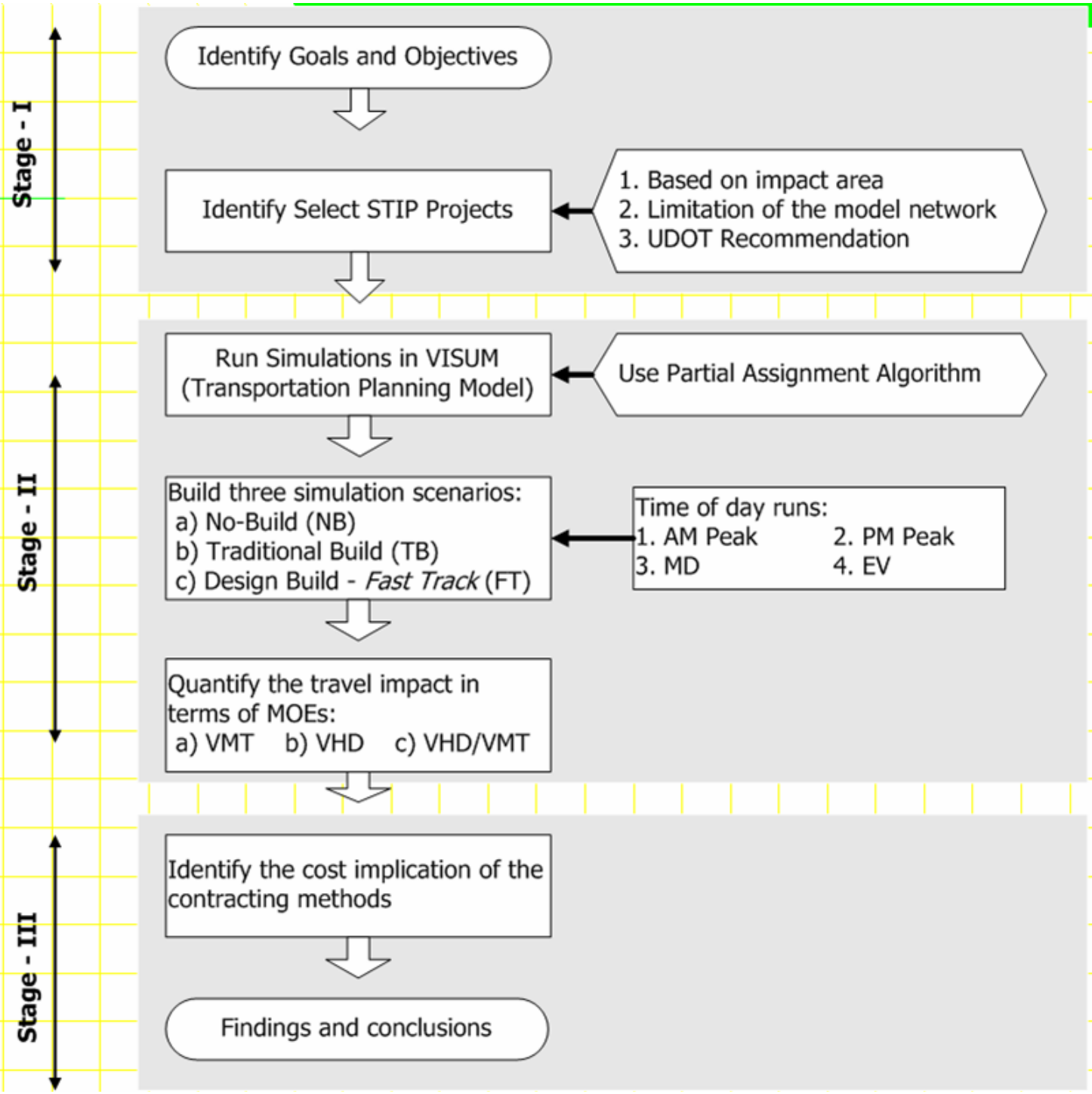
($120 million saving 2002 dollars)

I-15: 17 miles Urban Freeway

↓

STIP Projects

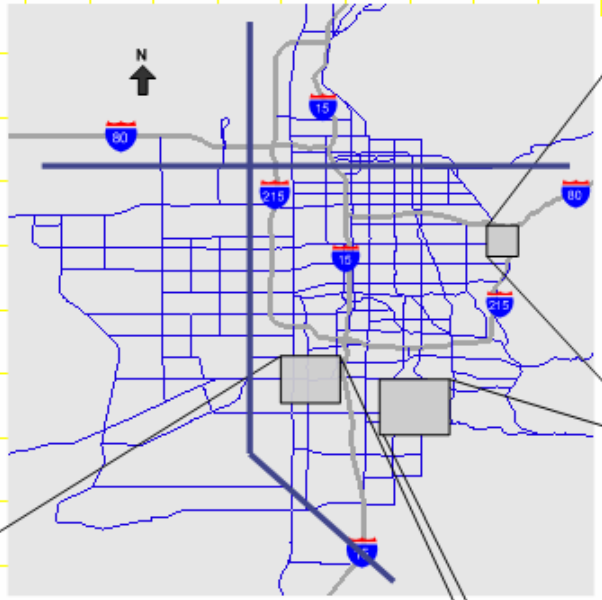
STIP Projects - Methodology

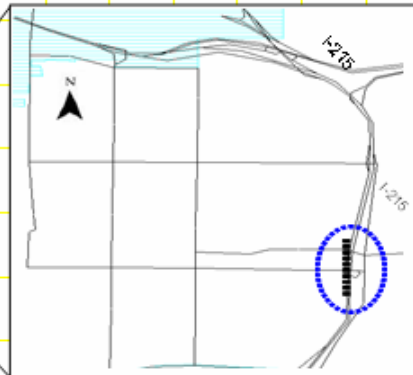


STIP Reconstruction Scenarios

- Fast-Track: One year
- Traditional-Build: 4 years
- No-Build: No reconstruction works

STIP Projects



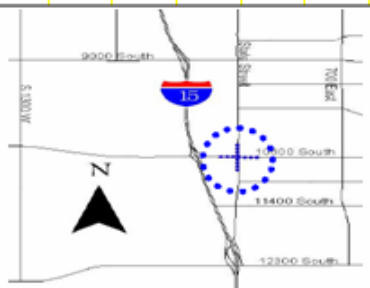


Project #5 : I-215 Bridge

- Bridge re-construction
- Pre-fab technique - *'Lego Bridges' first in Utah*
- User impact on I-125
- Total estimated cost: $4.35 Million

Project #2 : 7800 South

- Widening from 2 to 4 lanes
- Redwood and Bangerter major arterials
- Significant east-west corridor
- Total STIP estimated cost : $22 million



Project #1,3&4 : 700 E, 106th S & State St.

- 700 E - widening from 2 to 4 lanes
- 700 E major arterial
- 106th S - widening & State St. is major arterial
- 106th S is a major intersection that feeds into I-15
- Total STIP estimated cost : $33 million

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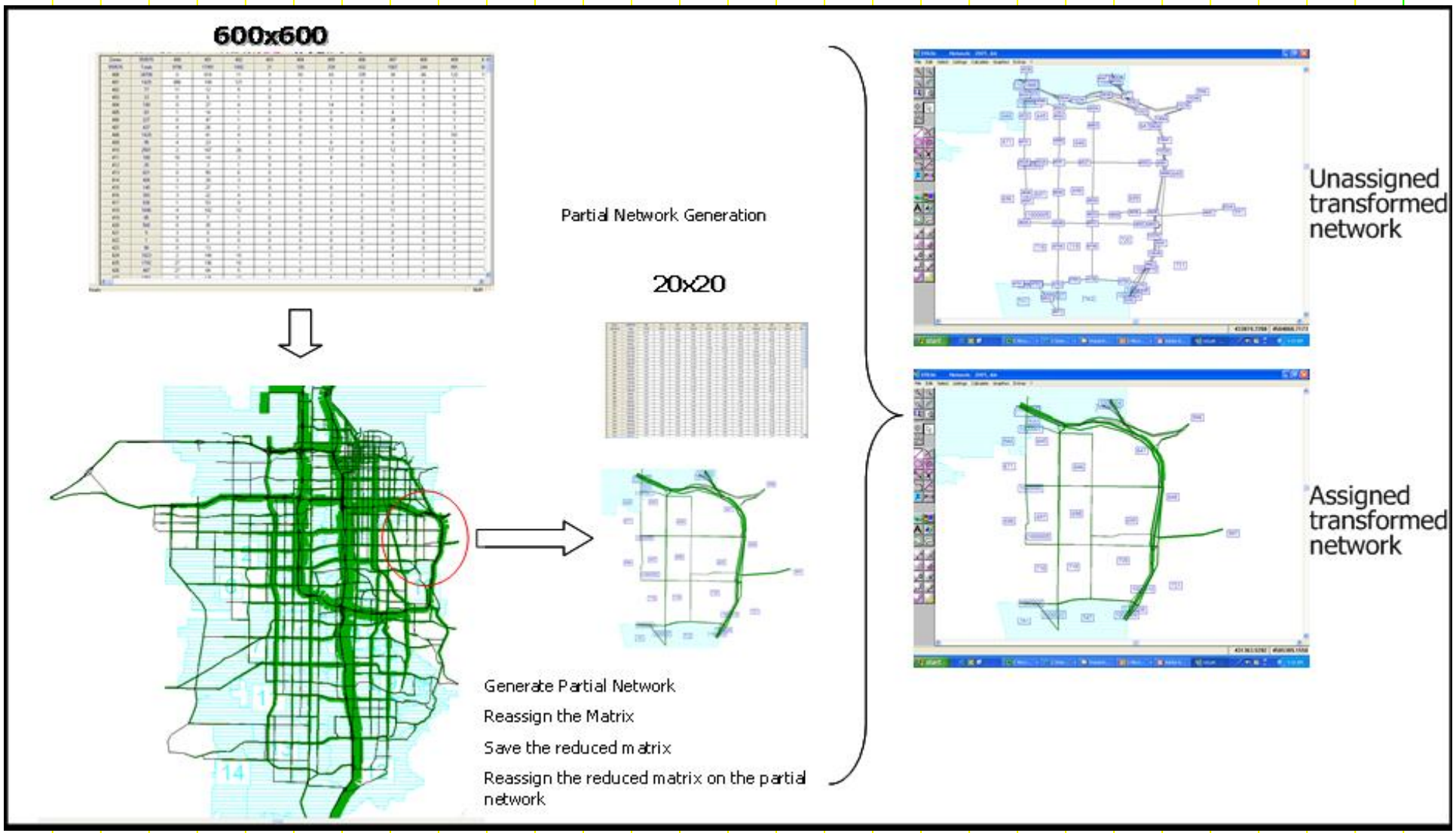
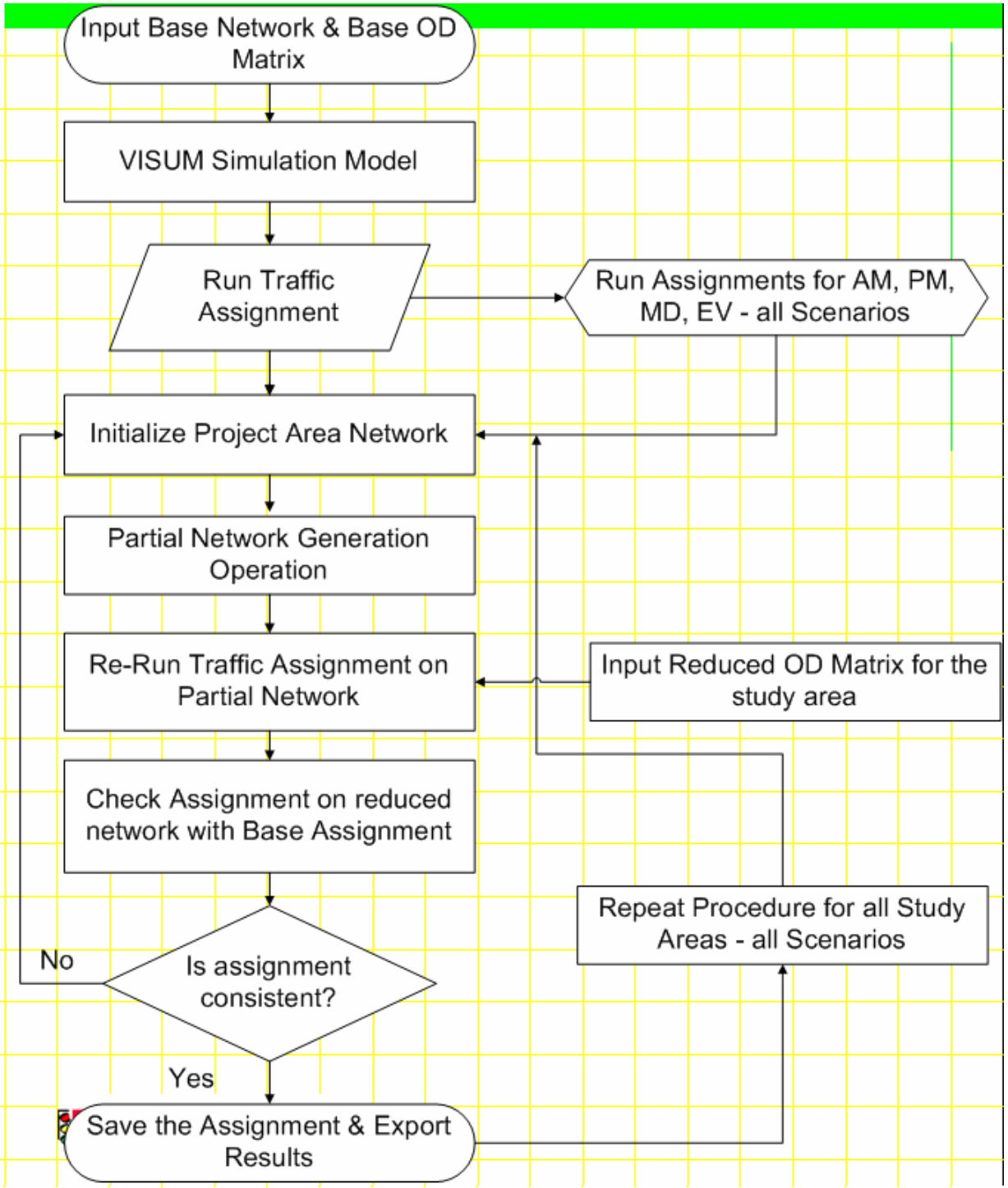
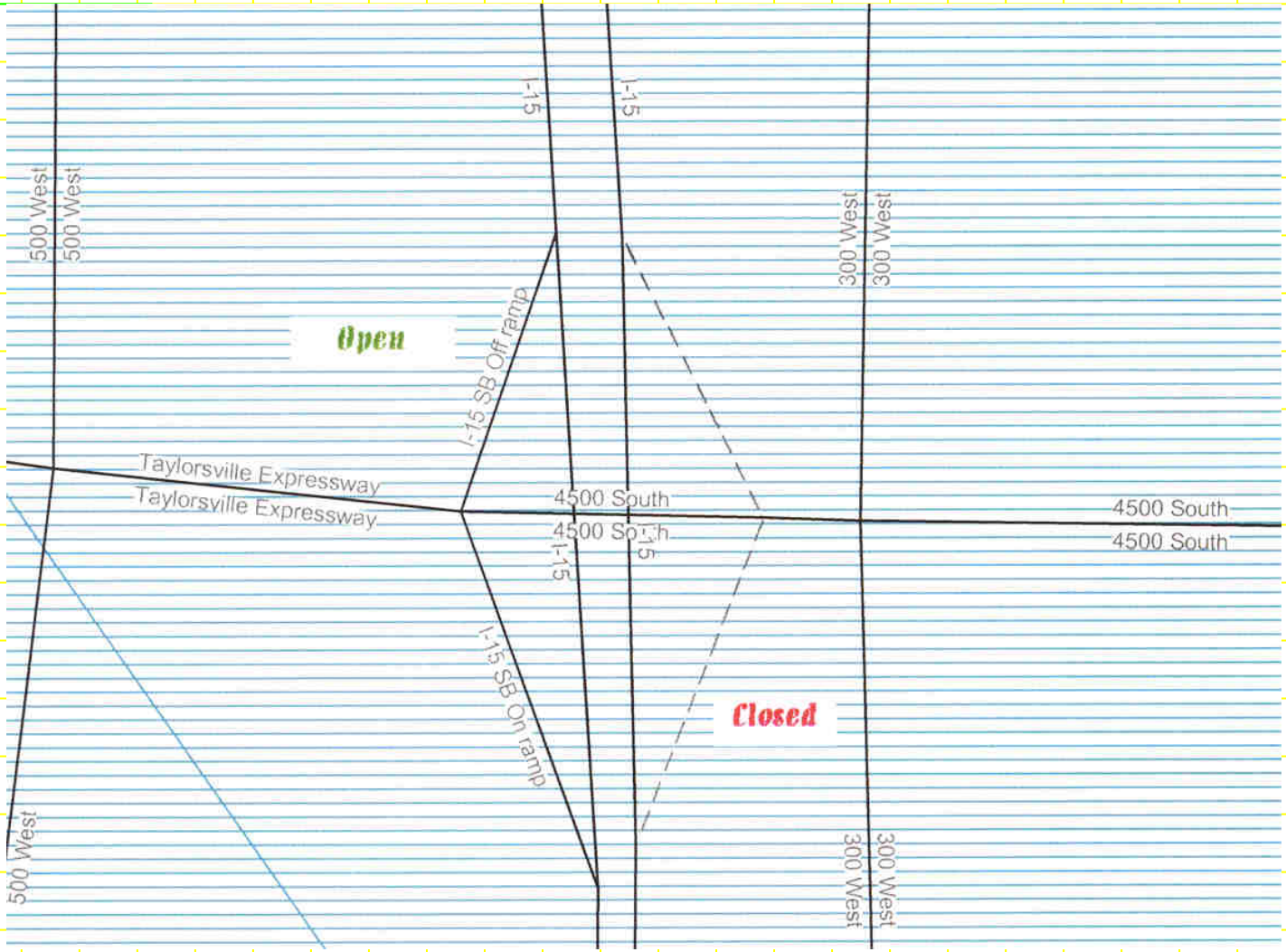
Partial Network Generation



Partial Network Model Procedure



Modeling A Road Closure



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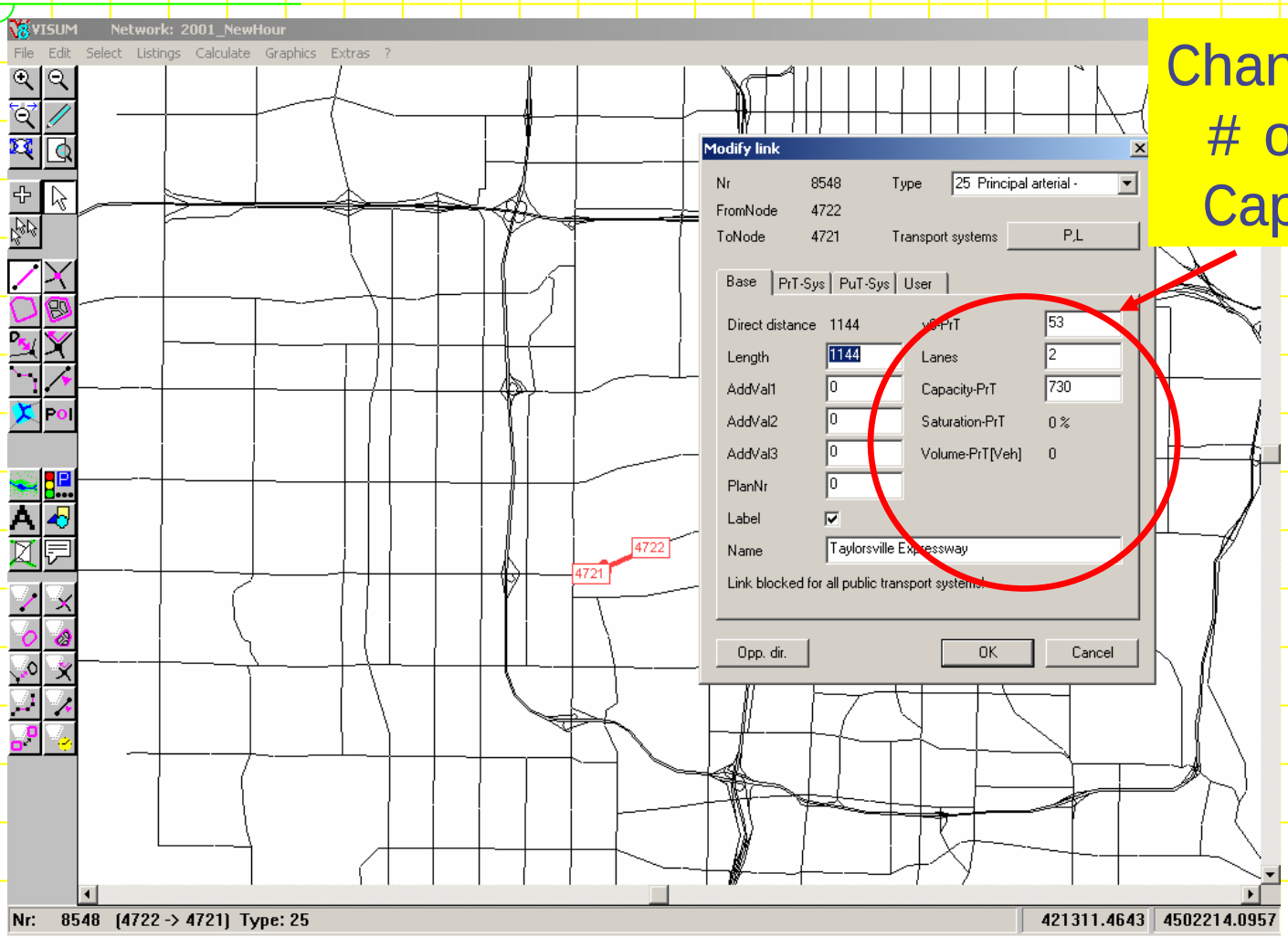
Modeling Capacity Reduction



Change:
# of lanes
Capacity (vphpl)

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Evaluation Metrics

- Vehicle Miles Traveled
- Vehicle Hours of Delay
- Delay per Vehicle

$$VHD_t = \sum_{i=1}^{n} \left[(t_c - t_f)_t \times vol_t \right]_i$$

$$VHD / VMT = \sum \frac{VHD_t}{VMT_t}$$

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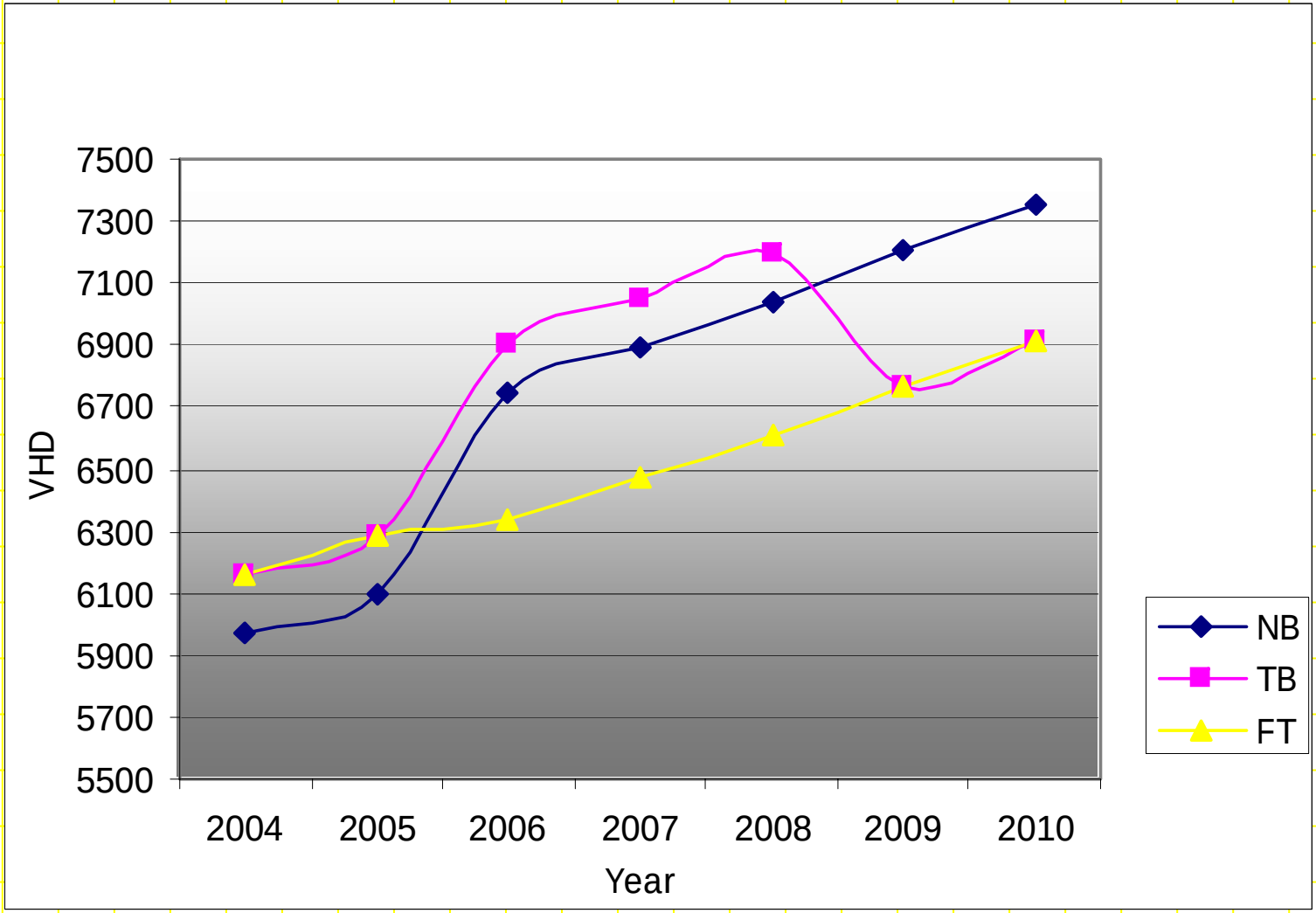
#1 State Street 10600 S



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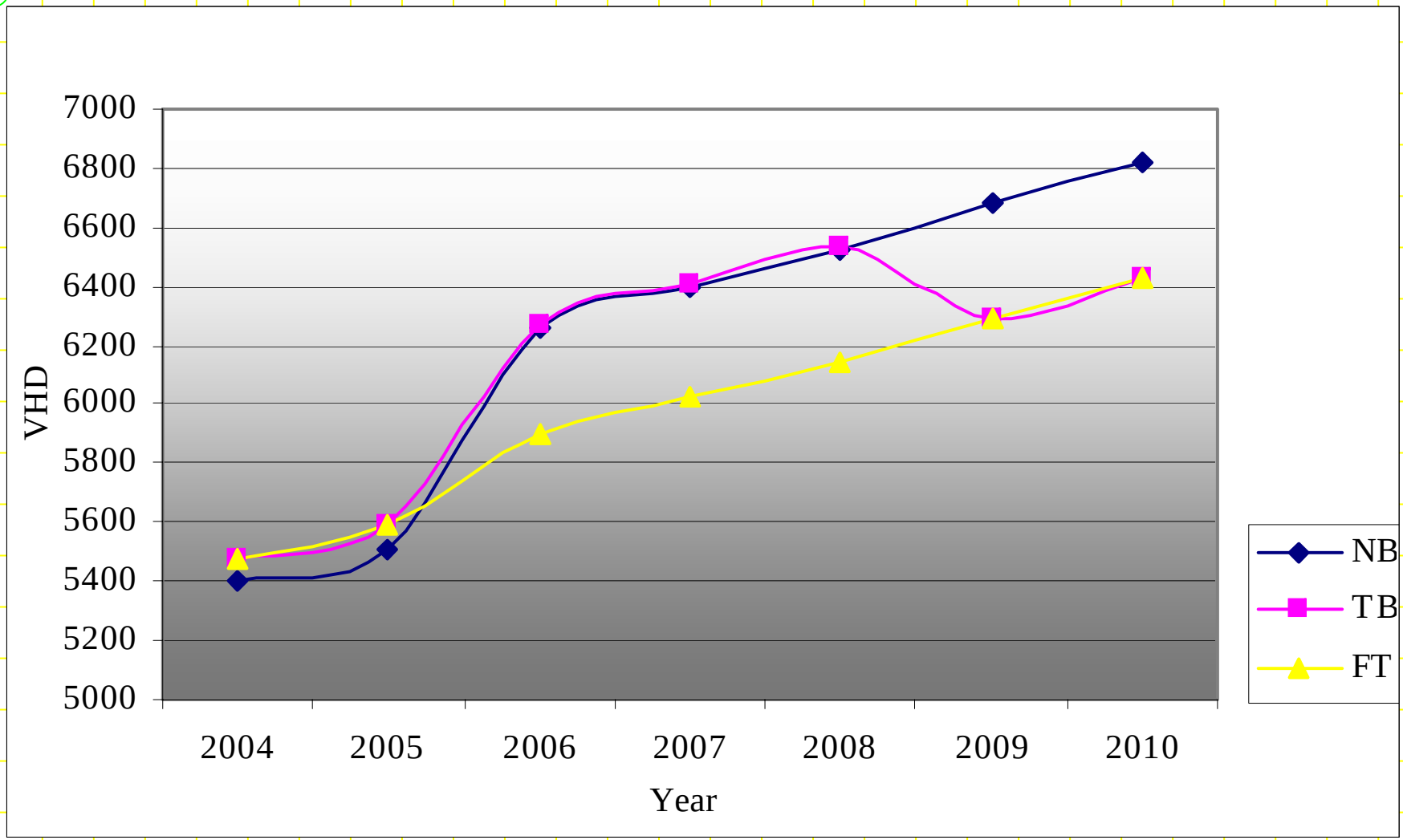
#2 7800 S Redwood Rd.



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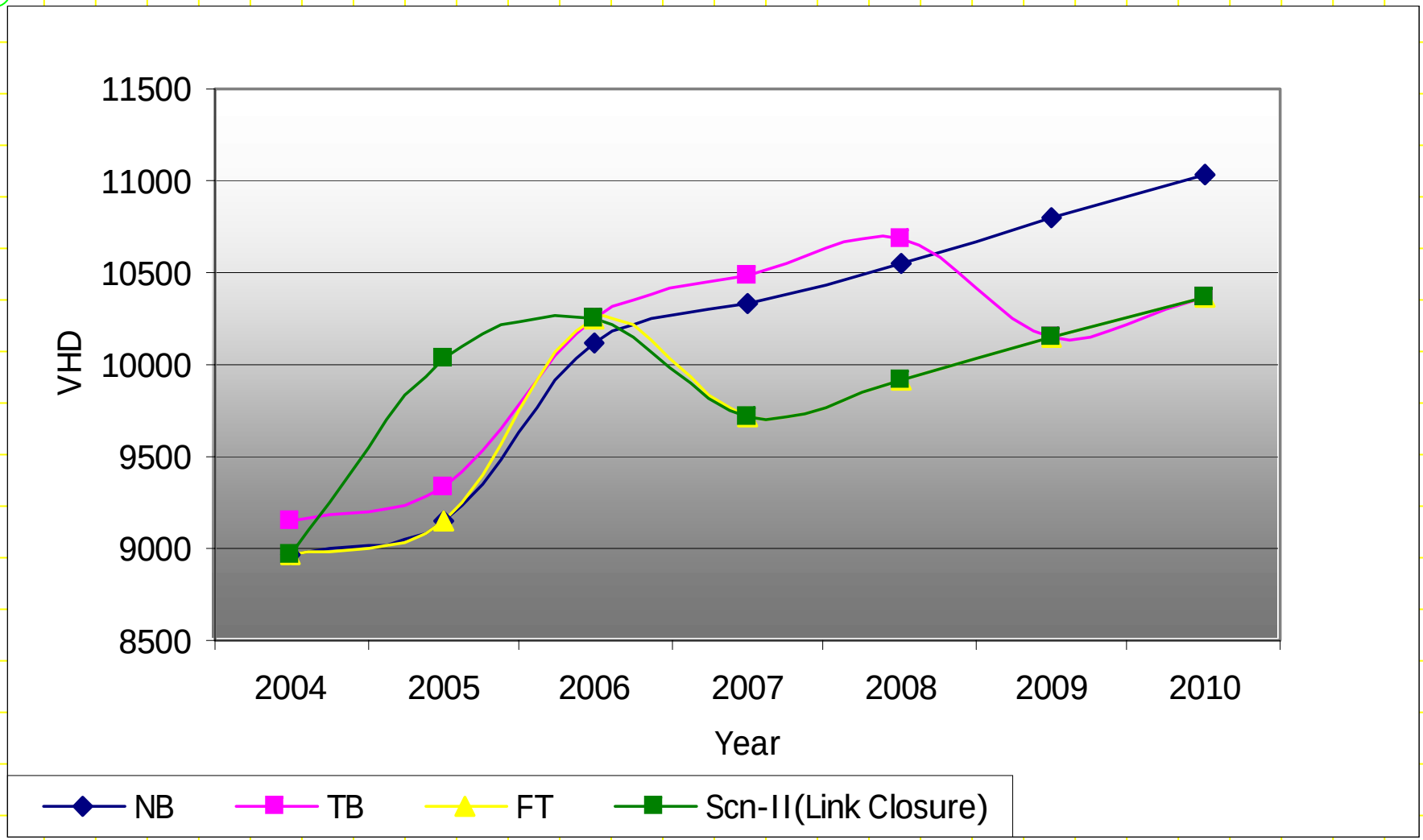
#3 700 E 9400 S



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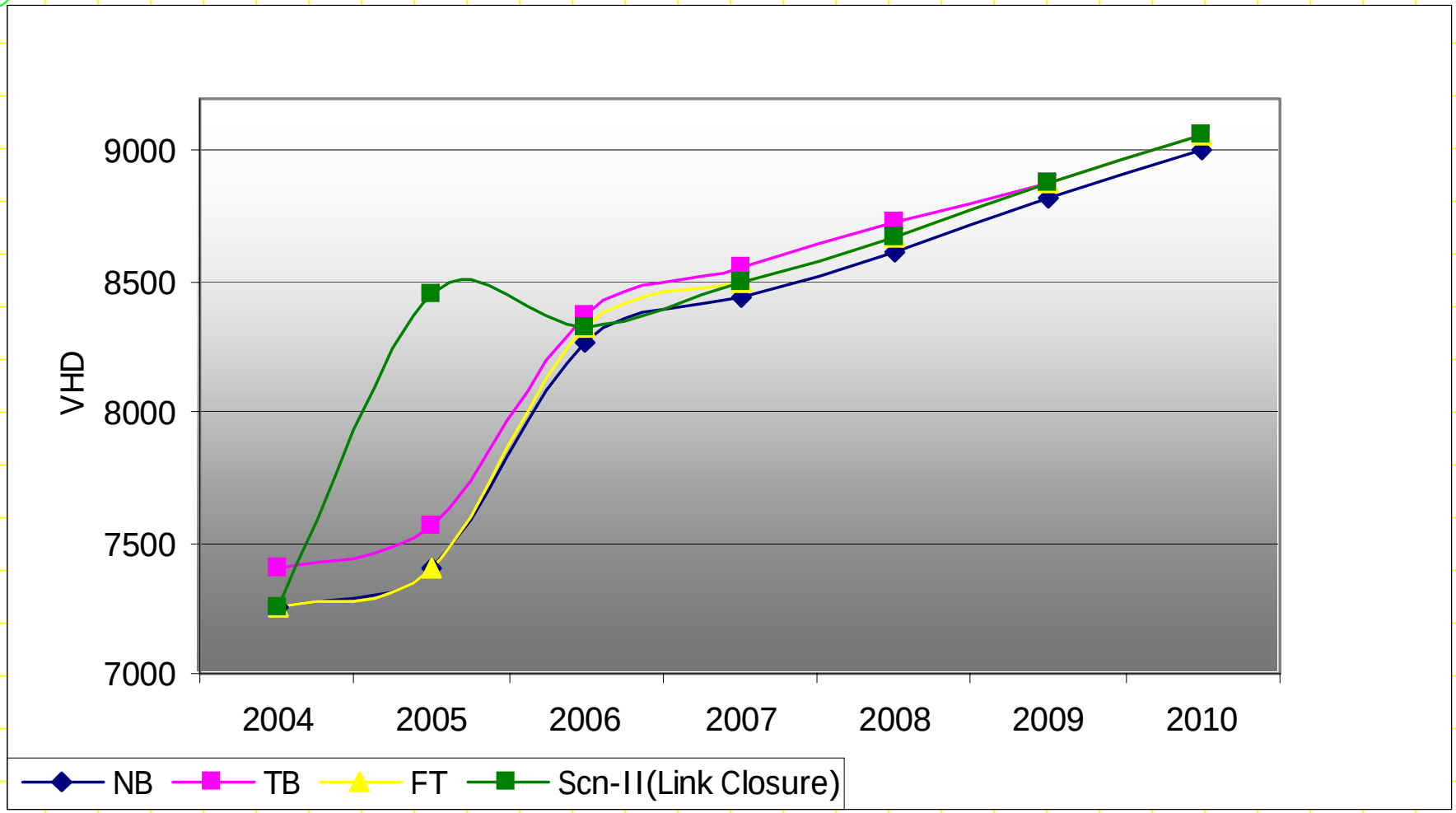
#4 State Street TRAX (7800 S)



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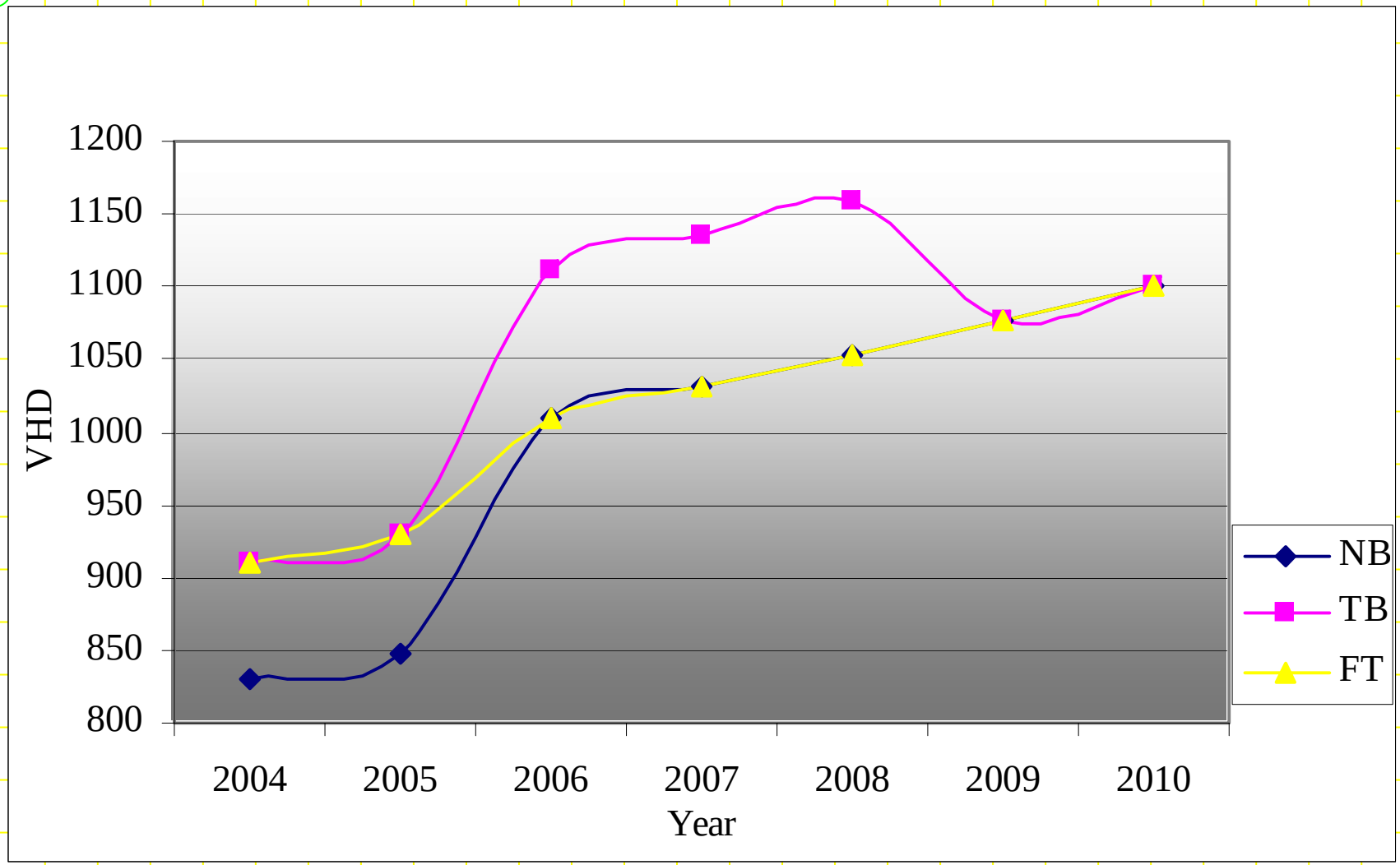
#5 I-215 3900 S (Prefab Bridge)



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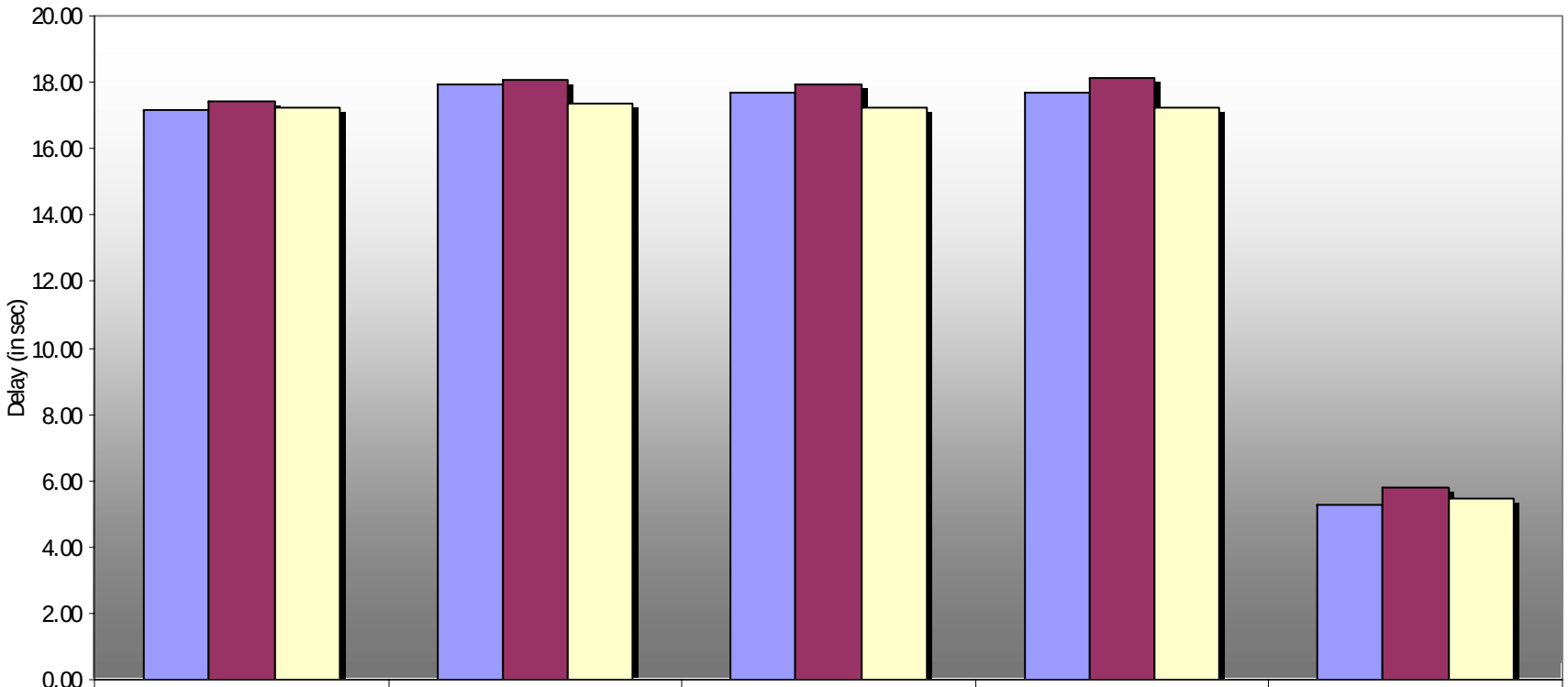
Mean Delay per VMT (sec)



	State St. TRAX	7800 S	700 E	Sate St. 106th S	I-215 Bridge Re-Cosnt.
NB	17.15	17.94	17.66	17.66	5.26
TB	17.44	18.07	17.94	18.11	5.79
FT	17.22	17.37	17.20	17.20	5.44

VHD(in sec)/VMT

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Delay Savings (Assuming User Costs $ 13/h)

Selected STIP Projects	Estimated Project Cost (millions)	Modeled Delay Savings (millions)
#1 State Street 10600 S	$3.3	$4.2
#2 7800S - Redwood Rd	$21.7	$5.4
#3 700 E 9400 S	$19.9	$7.2
#4 StateSt-TRAX(7800 S)	$10	$0.8
#5 I-215 Prefab Bridge	$4.35	$2

STIP Modeling Conclusions 1/3

- State Street 10600 S
  - Benefits are very high comparing with other projects
  - Estimated savings are significant ($4.2 Million)
  - Small projects can cause serious congestion in areas with high traffic
- 700 E 9400 S
  - Benefits are the highest ($7.2 Million) among the projects
  - PM peak period is critical

STIP Modeling Conclusions 2/3

- 7800 S Redwood Rd
  - Capacity augmentation needed in the long run due to increasing travel demand
  - PM peak construction should be avoided due to high VHD and VMT values
  - $5.4 million savings if FT is used over TB construction

STIP Modeling Conclusions 3/3

- State Street Trax (7800 S)
  - The savings ($0.8 Million) - least significant due to small impact area
- I-215 Prefab Bridge
  - The VHD is the lowest in absolute number compared to the other projects
  - Least impact anticipated due to construction - yet off peak construction is desirable
  - There is a saving of $2 million

UDOT Recommendations

- Fast Track for all projects
  - Justified by delay savings
- No PM peak period construction
  - PM peak period construction brings highest delays

So many success stories

A Few Reflections:

"We could be doing so much more!"

Challenges

- Model building - calibration & validation
- Scenario identification
- Timing - long range planning

Modeling is Expensive

Model building & Model maintenance

- Labor Intensive
- High Caliber People
  - Detail oriented
  - Big Picture awareness
  - People skills

Great Potential for Waste

Modeling Costs

- so small compared to
  - Construction costs
  - User delays
- Eg I-15
  - Construction costs: $2+billion
  - User delay savings: $600million
  - Modeling Cost: $120,000

Modeling Costs

- so small compared to
  - Construction costs
  - User delays
- Eg I-15
  - Construction costs: $2+billion **(0.005%)**
  - User delay savings: $600million **(0.02%)**
  - Modeling Cost: $120,000

Overall Recommendations

1. Set up system level teams
2. Set up modeling teams
3. Staff with trained specialists
4. Continually update models
5. Initiate modeling very early
6. Develop regional macro simulation (VISUM)
7. Build local microsimulation models (VISSIM)
8. Integrate regional models with local models

System Level Team

- Innovative Contracting Engineer
- Region Materials Engineer
- Urban Planning Engineer
- STIP Coordinator
- Engineer for Programming
- MPO Representatives
- Model Team (In-house, University, Consultant)

Modeling Team

- Principal Investigator / Consultant Project Manager
  - Manage
  - Report
  - Communicate
- Two trained modelers
  - Micro/micro simulation specialists
  - Grad students / EIT
- Two modelers in training
- Maintenance
  - Software management
  - Calibration / Validation

New Studies

- Incentives/disincentives
- Lane rental
- Time-of-day restricted construction
- Model Alternative Traffic Control Plans
- Assess Permutations and Combinations

Project Permutations & Combinations

order	Comb A	Comb B	Comb C
first	*1*	*5*	*1,3,4*
second	*2*	*1,2,3,4*	*2*
third	*3*		*5*
fourth	*4*		
fifth	*5*		

There is so much more we could be doing…