

Seismic Risk Model for a Designated Highway System

Anne Kiremidjian, Professor and Director
John A. Blume Earthquake Engineering Center
Stanford University

James Moore, Associate Professor and Director
Transportation Engineering Program
University of Southern California

Graduate Research Assistants:
Ayse Hortacsu (CE, lead, Stanford), Mark Audigier, Jeremiah LeGrue,
Dimitris Pachakis (CE, Stanford)
Yueyue Fan (CE, lead, USC), Junghoon Ki, Soojung Kim, (SPPD, USC)

Undergraduate PEER Scholar:
Kelly Burnell (CE, Stanford)

January 25, 2001

2001 PEER Annual Meeting

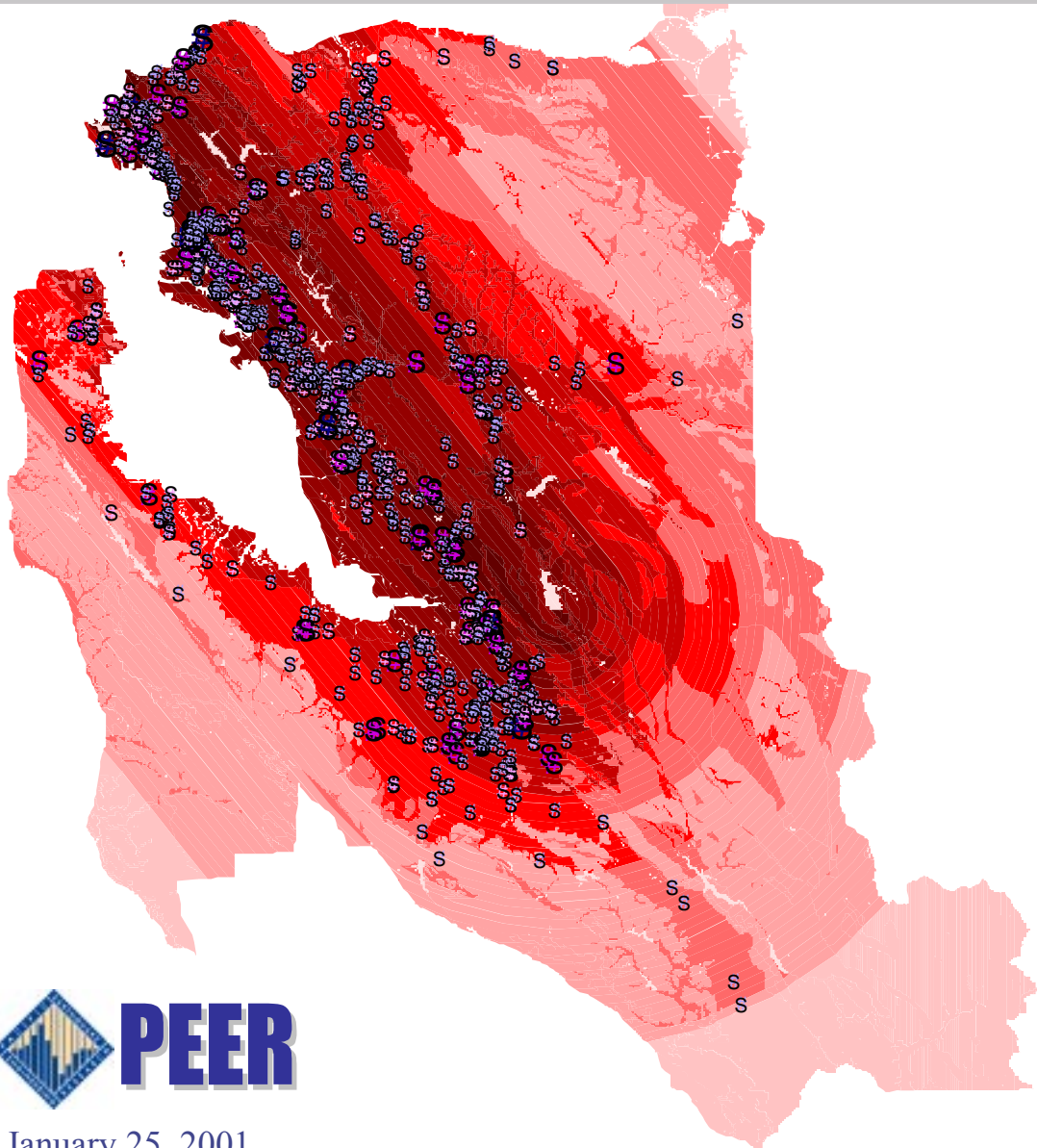


Estimated Bay Area Bridge Damage

Scenario Earthquakes:
Hayward 7.0 and 7.5
San Andreas 7.5 and 8.0

Damage State Definitions

- 1. No Damage
- 2. Slight Damage- cracking, spalling
- 3. Moderate Damage- bond, abutment backwall collapse
- 4. Extensive Damage- pier concrete failure
- 5. Complete Damage- deck unseating, pier collapse



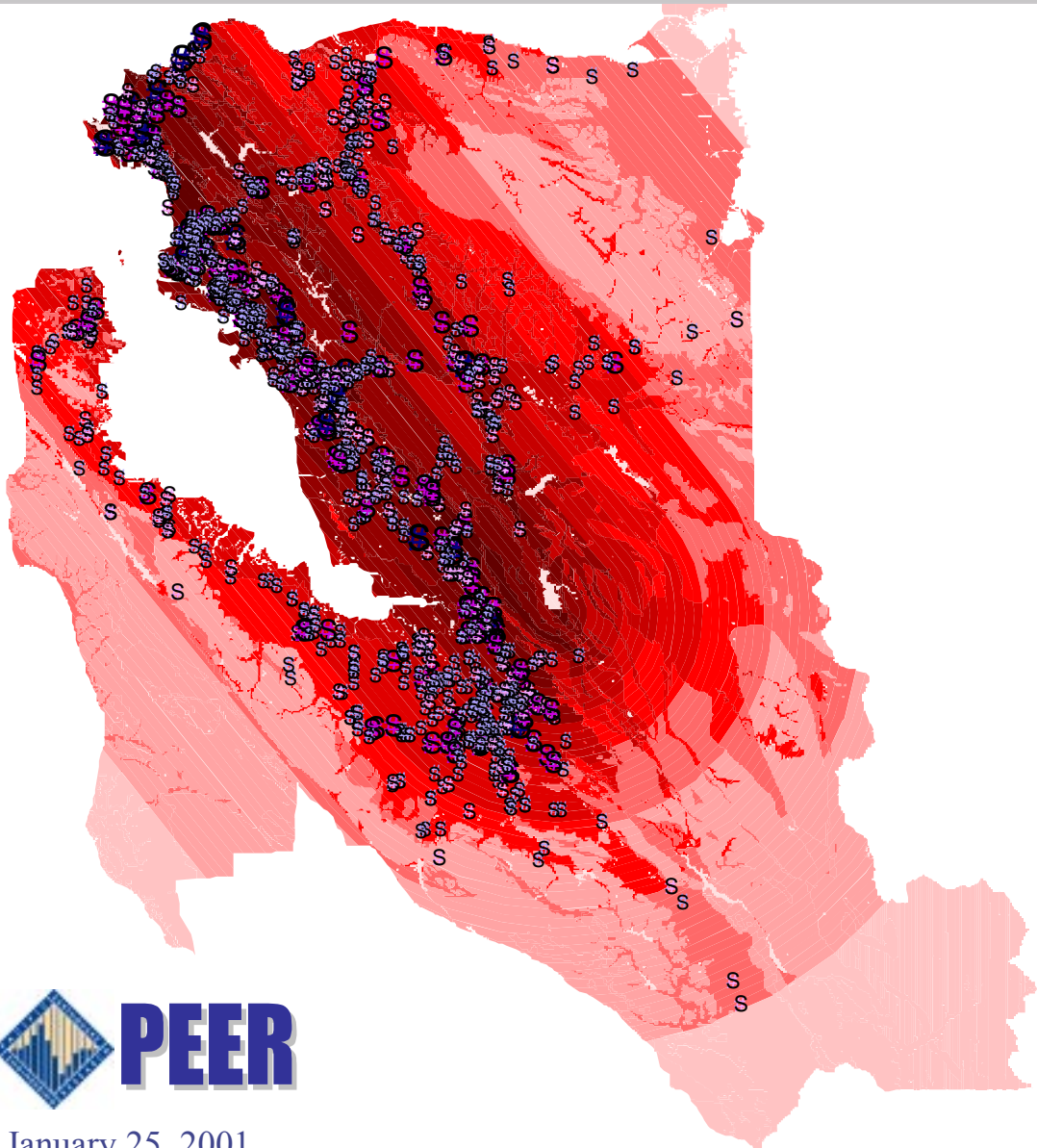
B

G



January 25, 2001

2001 PEER Annual Meeting



B

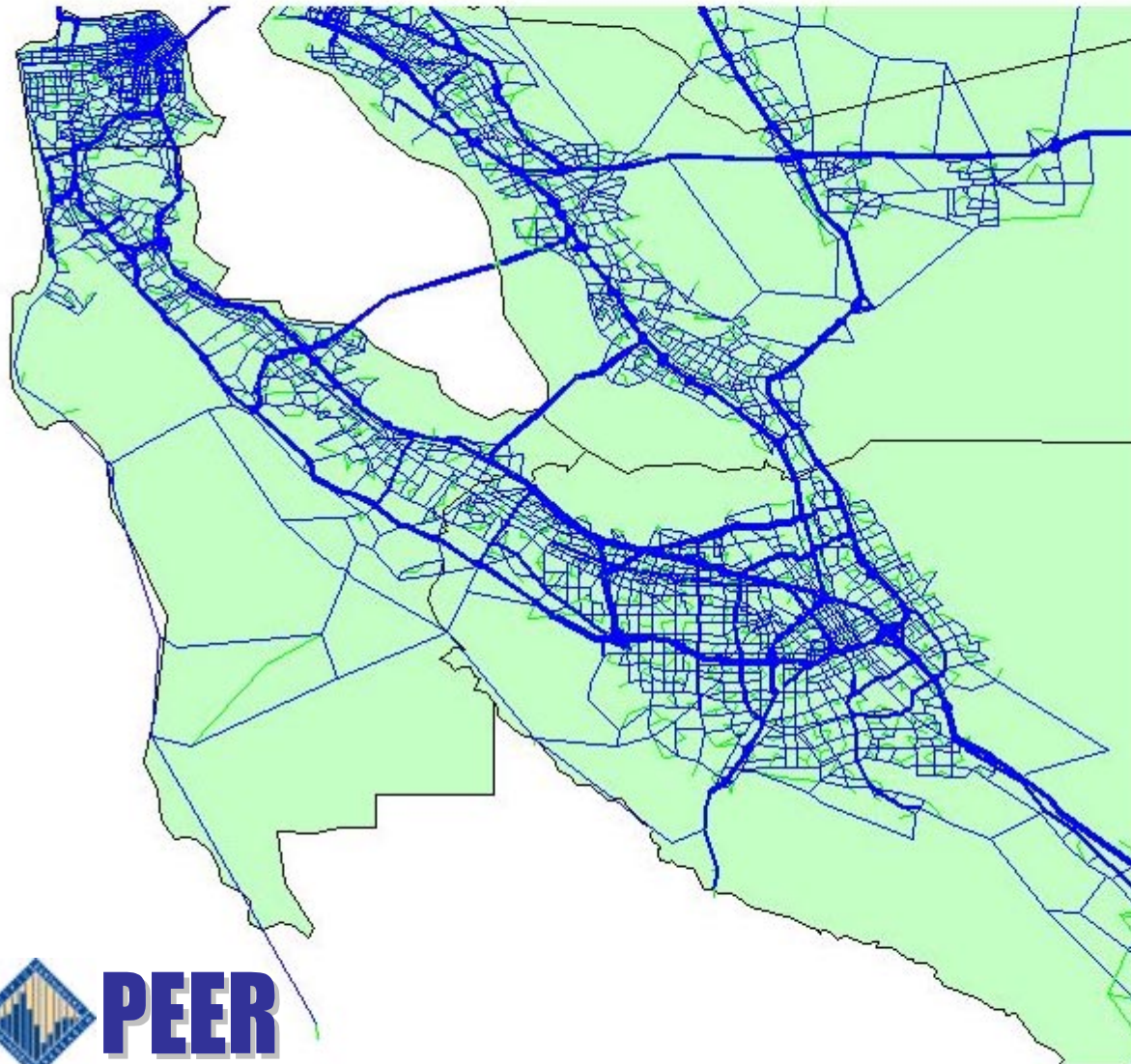
G



January 25, 2001

2001 PEER Annual Meeting

MTC Highway Network

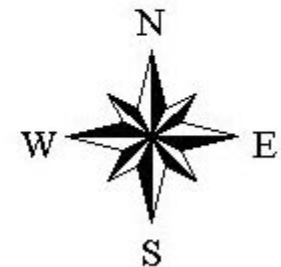


- MTC Links**
- Centroid Connectors
 - Major Roads
 - Frwy&Expwy
 - Bay Area

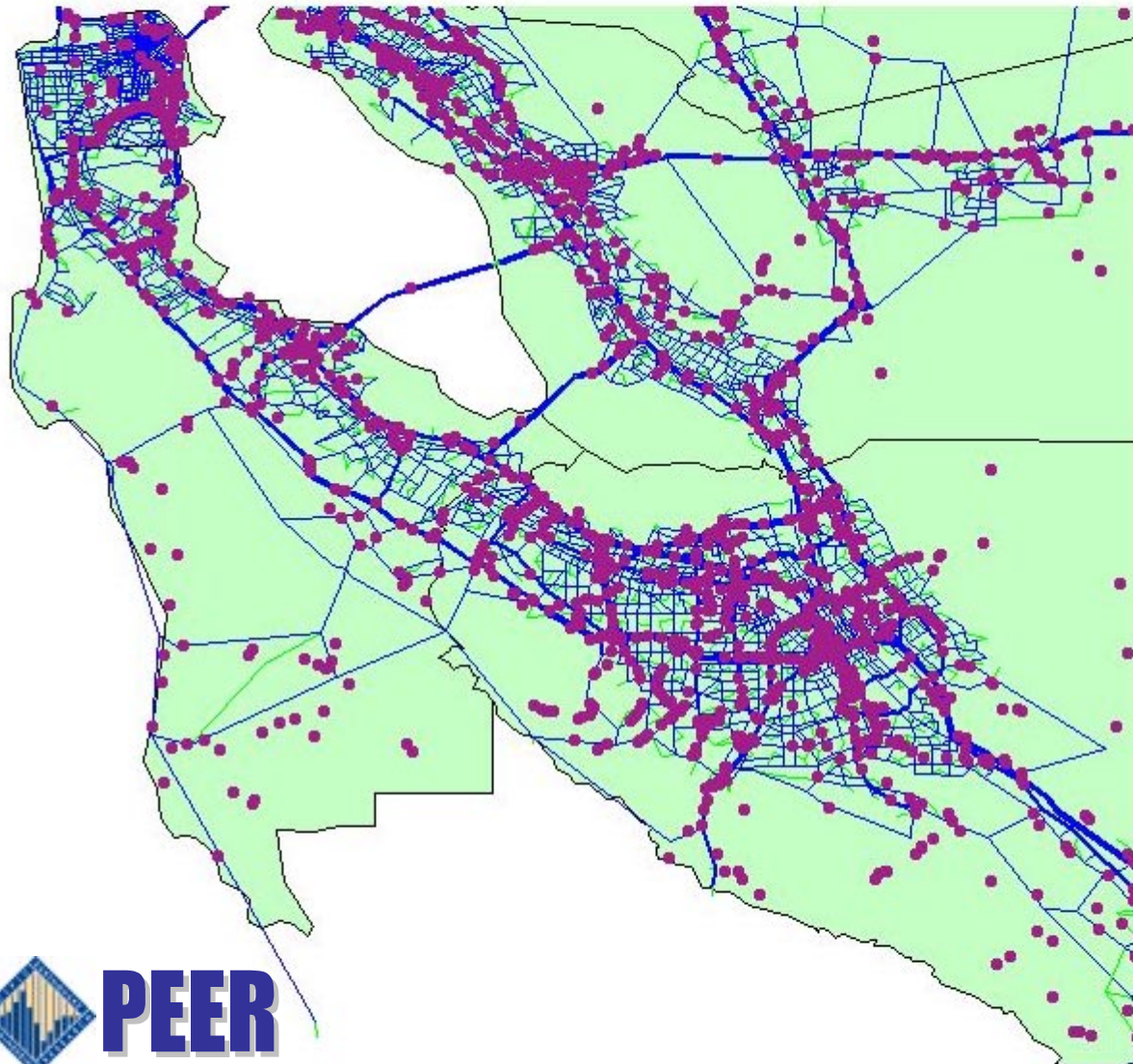


January 25, 2001

2001 PEER Annual Meeting



Caltrans District 4 Bridges

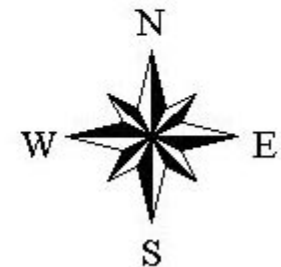


- Caltrans District 4 Bridge
- MTC Links
- Centroid Connectors
- Major Roads
- Frwy&Expwy
- Bay Area

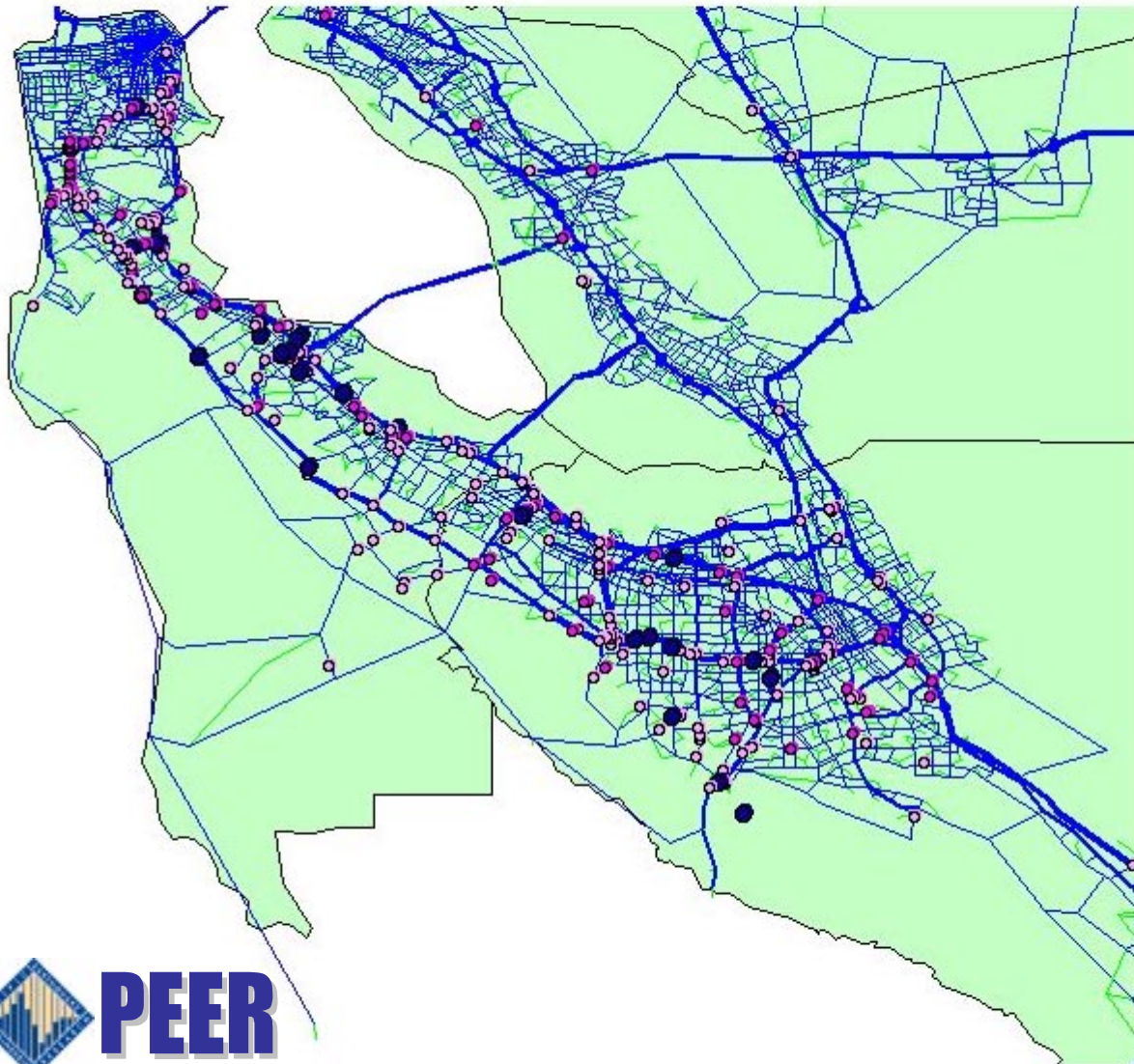


January 25, 2001

2001 PEER Annual Meeting



San Andreas 7.5 Scenario



Damaged Bridges

- 3
- 4
- 5

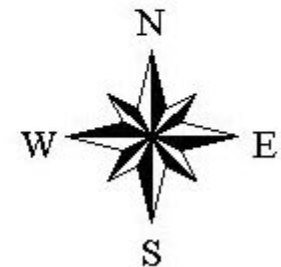
MTC Links

- Centroid Connectors
- Major Roads
- Frwy&Expwy
- Bay Area

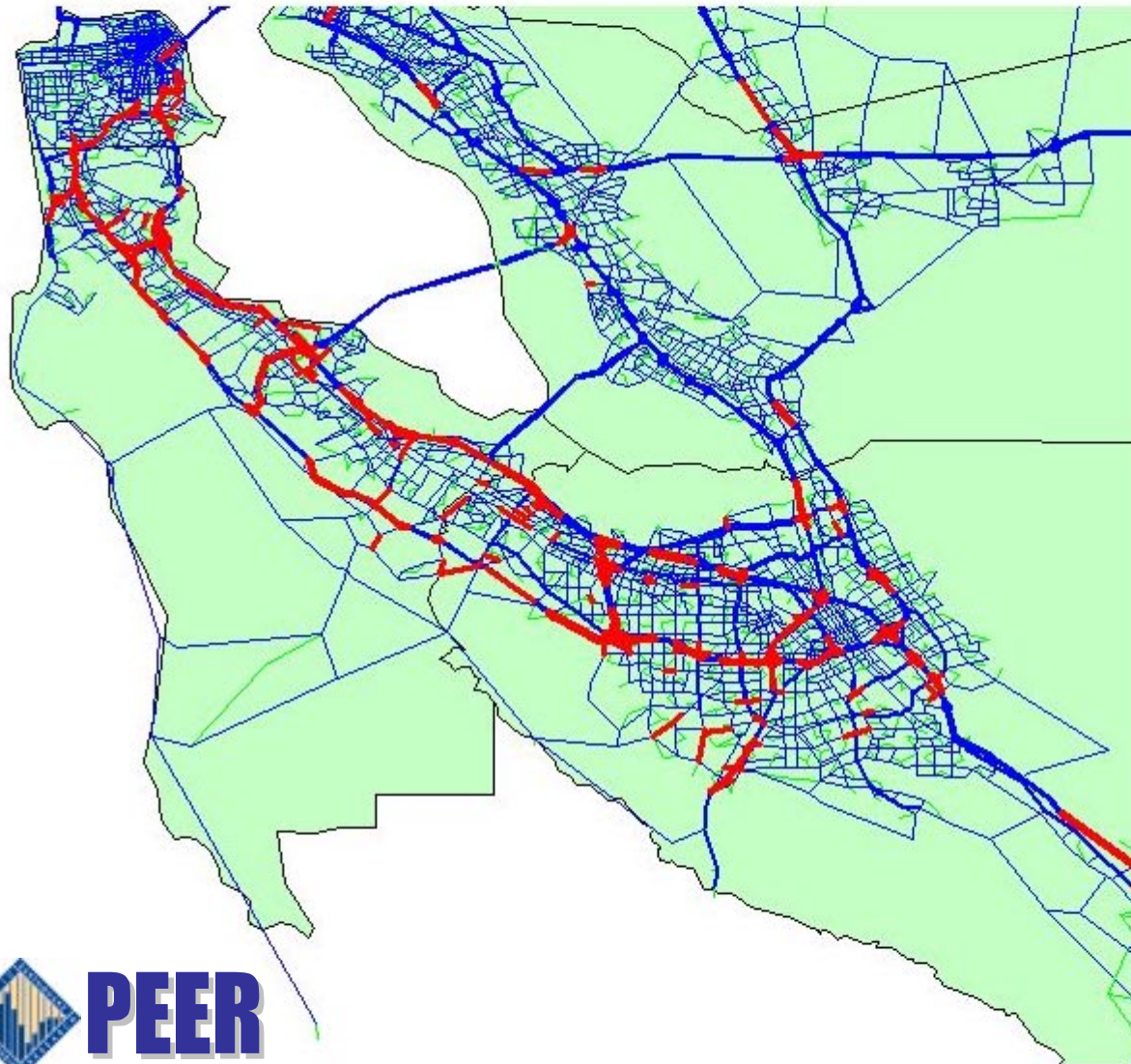


January 25, 2001

2001 PEER Annual Meeting



San Andreas 7.5 Scenario

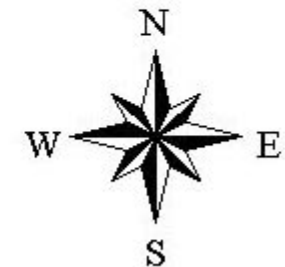


-  Closed Links
-  MTC Links
-  Centroid Connectors
-  Major Roads
-  Frwy&Expwy
-  Bay Area

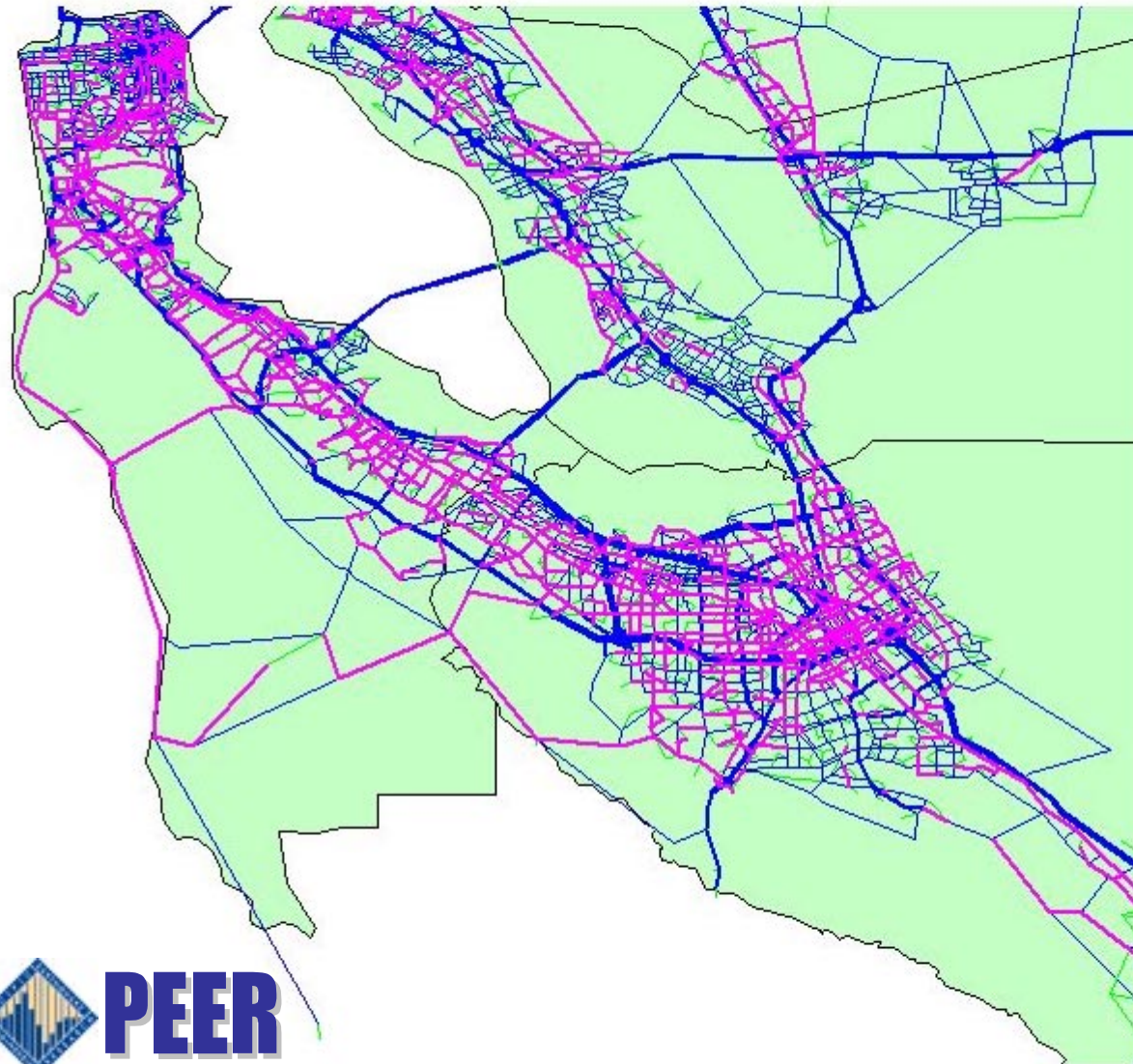


January 25, 2001

2001 PEER Annual Meeting



San Andreas 7.5 Scenario

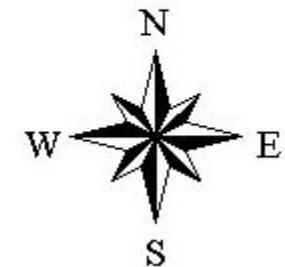


- Significant Increase in Vol. MTC Links
- Centroid Connectors
- Major Roads
- Frwy&Expwy
- Bay Area



January 25, 2001

2001 PEER Annual Meeting



1990 Base & San Andreas 7.5 Scenario Comparison

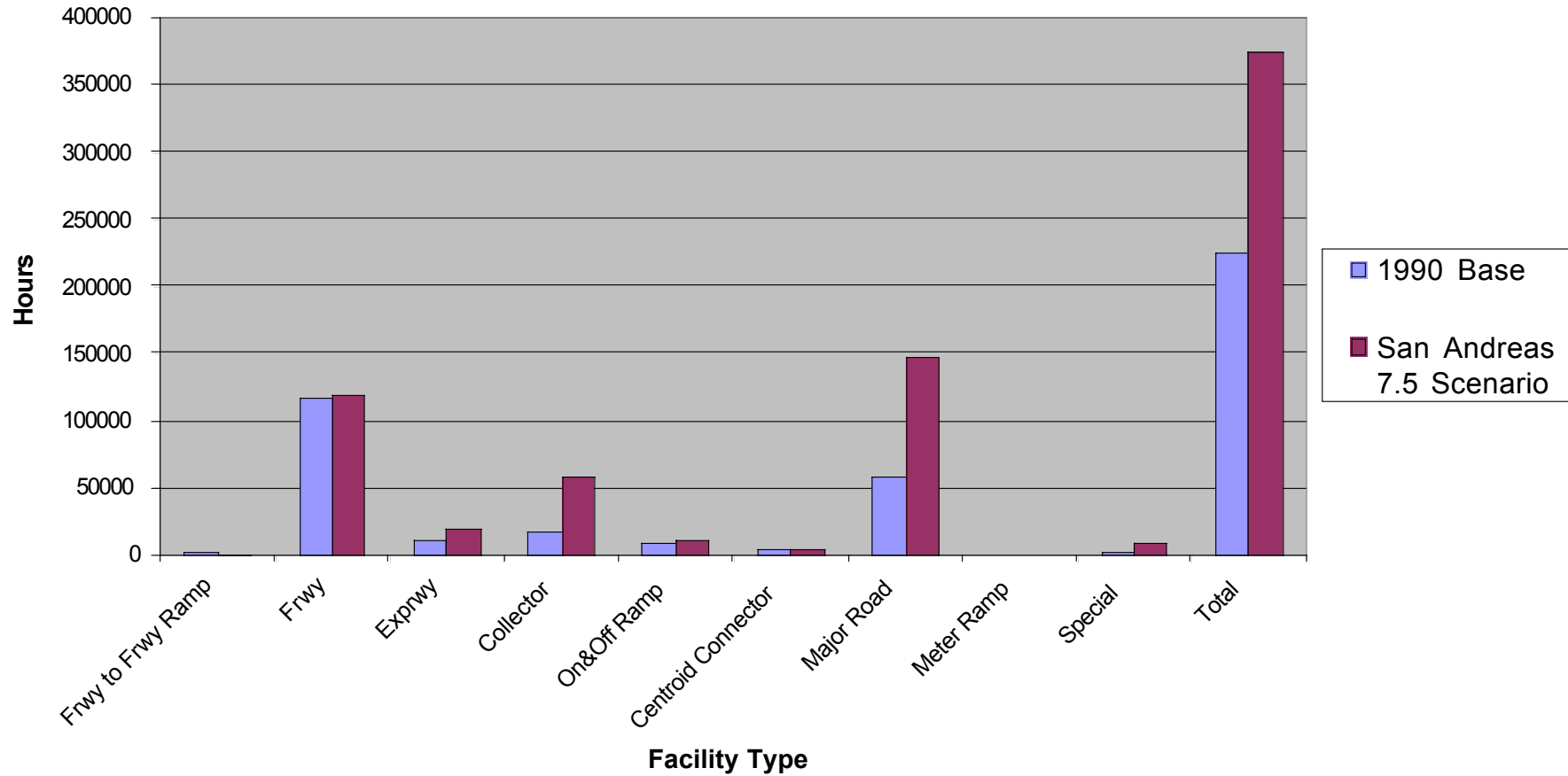
Link Type	No. of Links		Link Length(mi)		Lane Length		Vehicle Hours	
	Base	SA 7.5	Base	SA 7.5	Base	SA 7.5	Base	SA 7.5
1	178	92	87.09	42.44	140.95	64.84	2,420	1,490
2	2013	1495	1327.39	1025.35	3592.97	2771.98	116,589	119,347
3	829	709	432.15	391.64	862.36	785.79	11,951	19,820
4	6931	6857	4426.28	4385.49	5304.06	5250.76	17,156	59,094
5	1852	1489	528.13	415.67	567	442.64	8,632	11,353
6	4892	4892	1921.57	1921.57	5764.65	5764.65	5,385	5,385
7	9741	9595	4680.06	4613.54	8113.71	7983.87	59,894	147,671
8	78	47	29.89	18.24	31.09	19.44	485	419
9	8	8	3.99	3.99	11.97	11.97	3,389	9,195
Total	26522	25184	13436.5	12817.9	24388.8	23095.9	225,901	373,774

1990 Base & San Andreas 7.5 Scenario Comparison

(Continued)

Link Type	Vehicle Miles		Average Speed		Average Volumes		Max Volumes	
	Base	SA 7.5	Base	SA 7.5	Base	SA 7.5	Base	SA 7.5
1	103,774	56,683	43	38	1192	1336	7719	9923
2	4,740,782	3,043,641	41	26	3572	2968	11266	14542
3	538,111	722,303	45	36	1245	1844	4555	7192
4	458,204	1,032,831	27	17	104	236	3438	4173
5	234,930	201,356	27	18	445	484	4362	6199
6	537,591	537,163	100	100	280	280	6897	9463
7	1,779,913	3,229,454	30	22	380	700	4344	6577
8	11,718	6,758	24	16	392	370	1869	1806
9	44,576	56,282	13	6	11172	14106	11174	14433
Total	8,449,598	8,886,470	37	24	629	693	11266	14542

Vehicle Hours Comparison

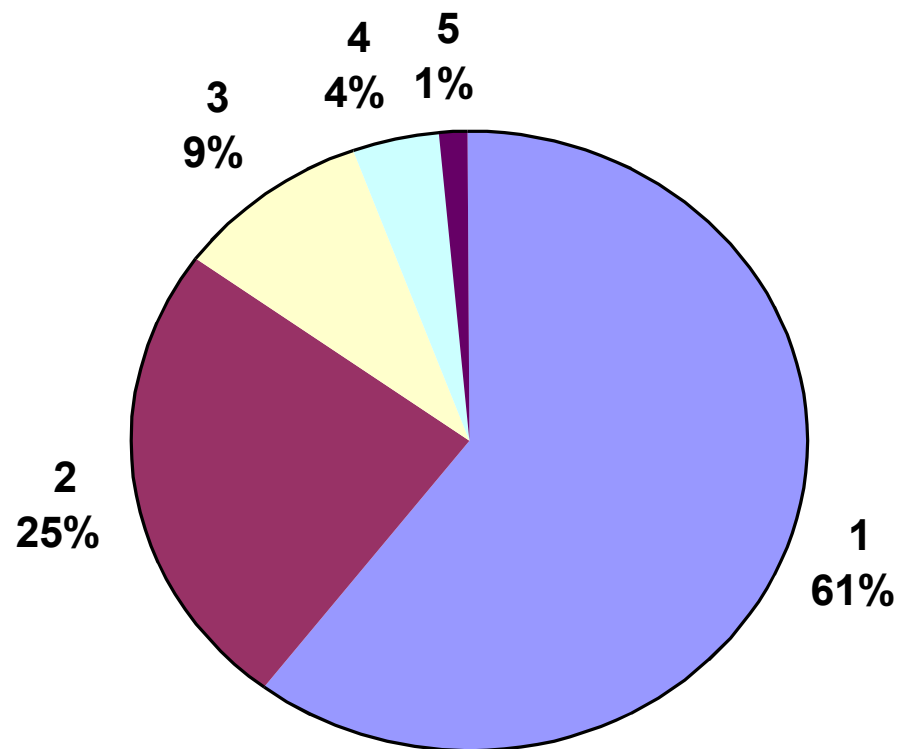


Januray 25, 2001

2001 PEER Annual Meeting



San Andreas 7.5 Bridge Damage States



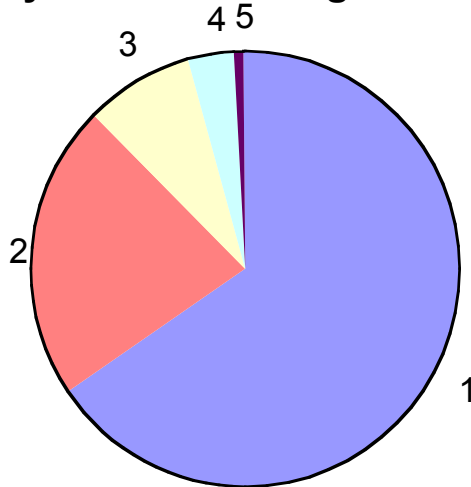
Januray 25, 2001

2001 PEER Annual Meeting

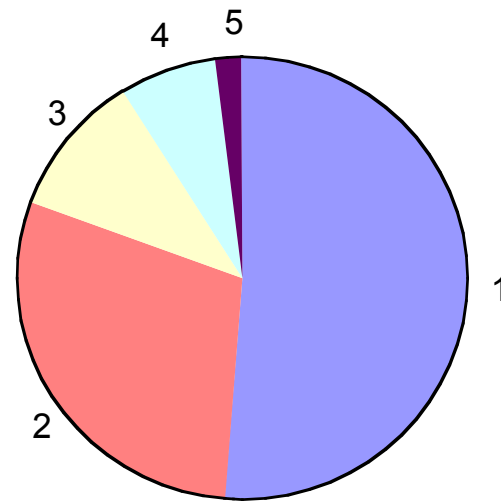


Proportion of 2,640 Bridges in each Damage State by Scenario

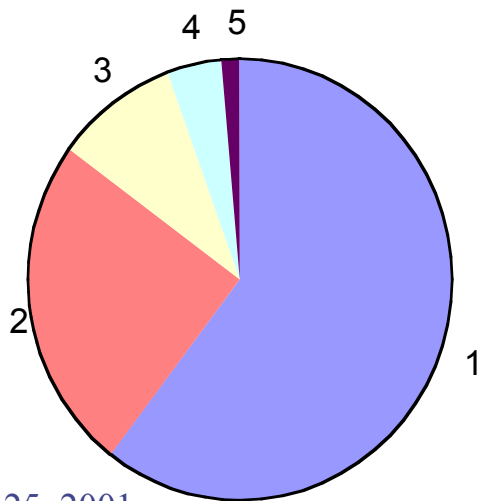
Hayward 7.0 Damage Distribution



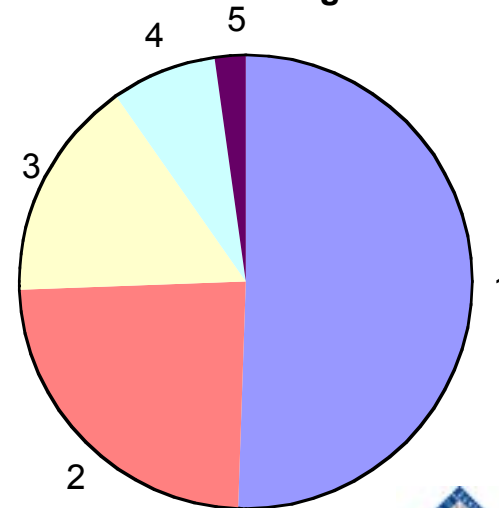
Hayward 7.5 Damage Distribution



San Andreas 7.5 Damage Distribution



San Andreas 8.0 Damage Distribution



Januray 25, 2001

2001 PEER Annual Meeting



Damage Summary

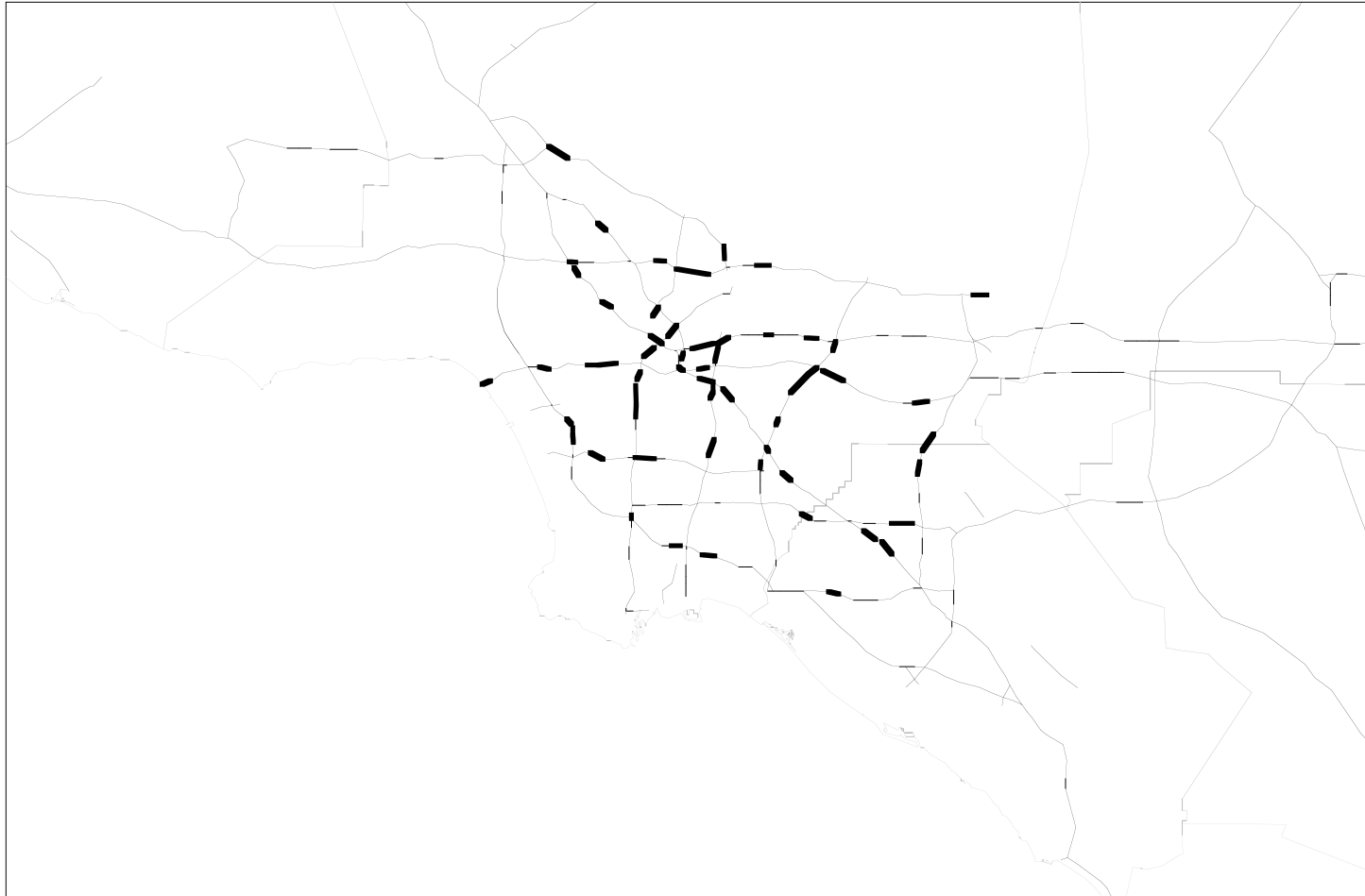
<u>Damage State</u>	<u>Hayward 7.0</u> <u># of bridges</u>	<u>Hayward 7.5</u> <u># of bridges</u>	<u>San Andreas 7.5</u> <u># of bridges</u>	<u>San Andreas 8.0</u> <u># of bridges</u>
<u>1</u>	1732	1350	1589	1334
<u>2</u>	585	778	658	634
<u>3</u> <u>closed</u>	221	280	249	413
<u>4</u> <u>closed</u>	91	182	110	201
<u>5</u> <u>closed</u>	21	50	35	59

Januray 25, 2001

2001 PEER Annual Meeting



Closed Freeway Segments, $BDI \geq 0.75$, Maximum of 200 Simulations

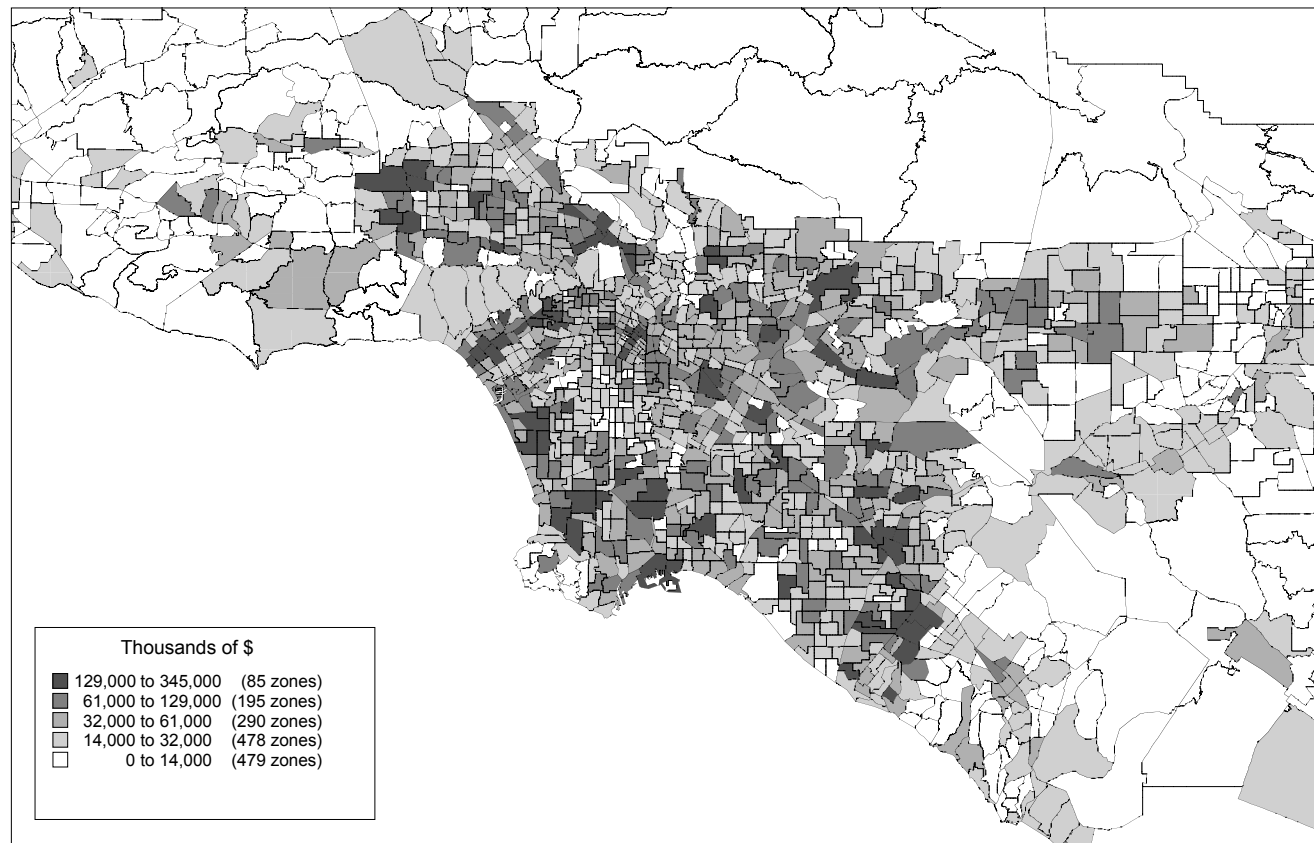


Januray 25, 2001

2001 PEER Annual Meeting



NONSTRUCTURAL(DIRECT, INDIRECT, INDUCED) ECONOMIC LOSSES AND CHANGES IN TRANS- PORTATION COST, BRIDGE CLOSURE CRITERIA OF BDI > 0.75, MAXIMUM OF 200 SIMULATIONS

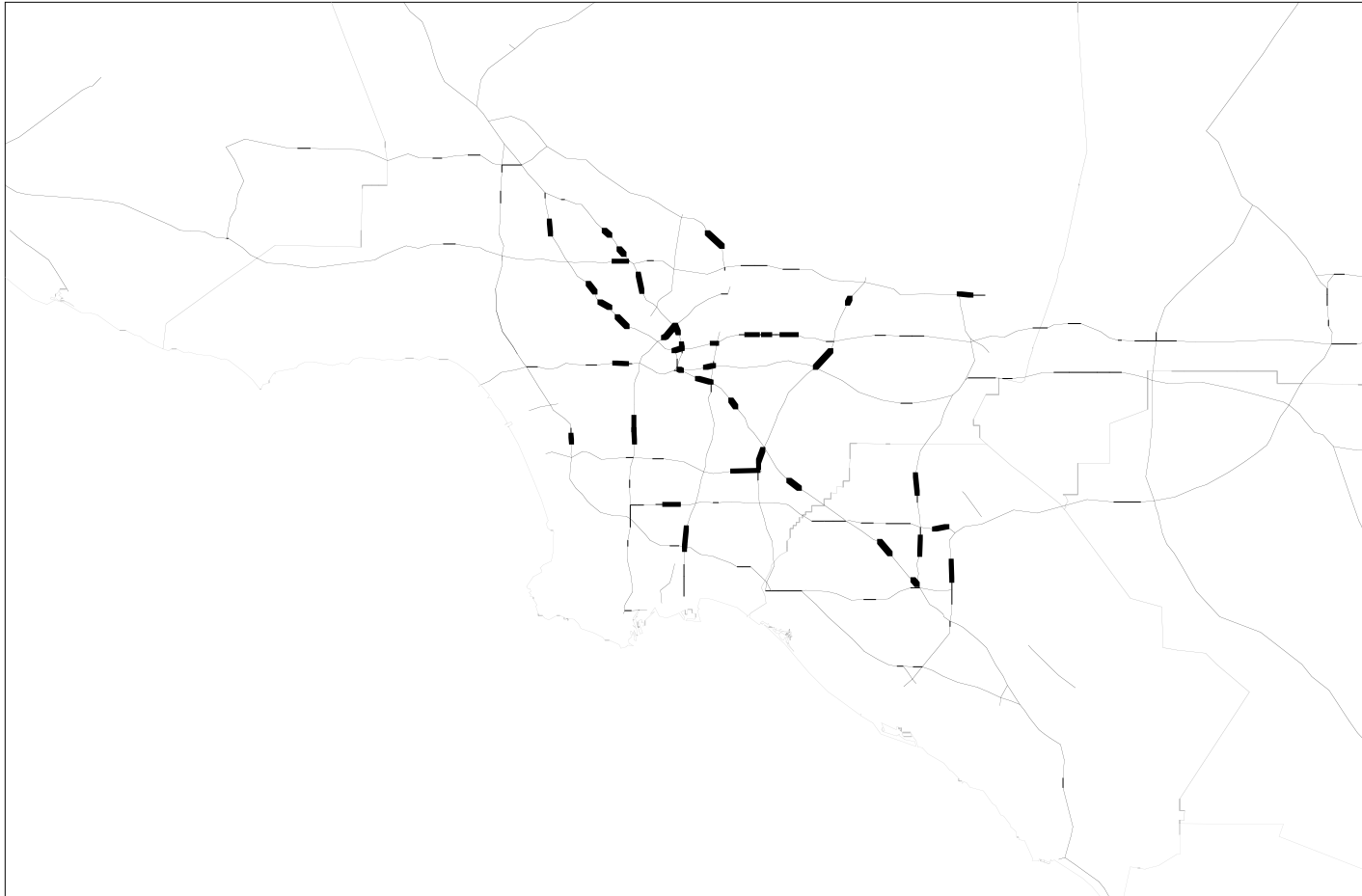


Januray 25, 2001

2001 PEER Annual Meeting



Closed Freeway Segments, $BDI \geq 0.75$, Median of 200 Simulations



Januray 25, 2001

2001 PEER Annual Meeting

