Civil Infrastructure Cost Estimates Summary Briefing

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Bechtel

NAHSC Workshop #3

September 19, 1996

(slides 7-1 to 7-10)

Contents

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Cost Estimating Premises

- Hypothetical application scenarios for urban, inter-city, and rural environments
- Superimposition of and addition of one hypothetical dedicated AHS lane on existing freeway configuration
- Assumptions reflecting moderately complex application environment
- Extensive use of our cost estimating experience and judgment

7-3

Cost Estimating Premises

- Acquired cost estimating and modeling software package
- Unit costs for individual items; these are grouped as blocks; blocks are combined to create cost estimating modules or scenarios
- Unit rates can be adjusted up or down to reflect varying local productivity, material prices or site-specific condition

7-4

General Cost Estimating Assumptions

- **Limited ROW availability in urban areas**
- **Urban area:**
  - *replacement of one manual lane with an AHS dedicated lane*
  - *addition of one AHS dedicated lane*
- **Inter-city and rural areas: addition of one AHS dedicated lane**
- **Barrier separation between manual and dedicated AHS lanes**
- **Existing geometric and structural design standards**

7-5

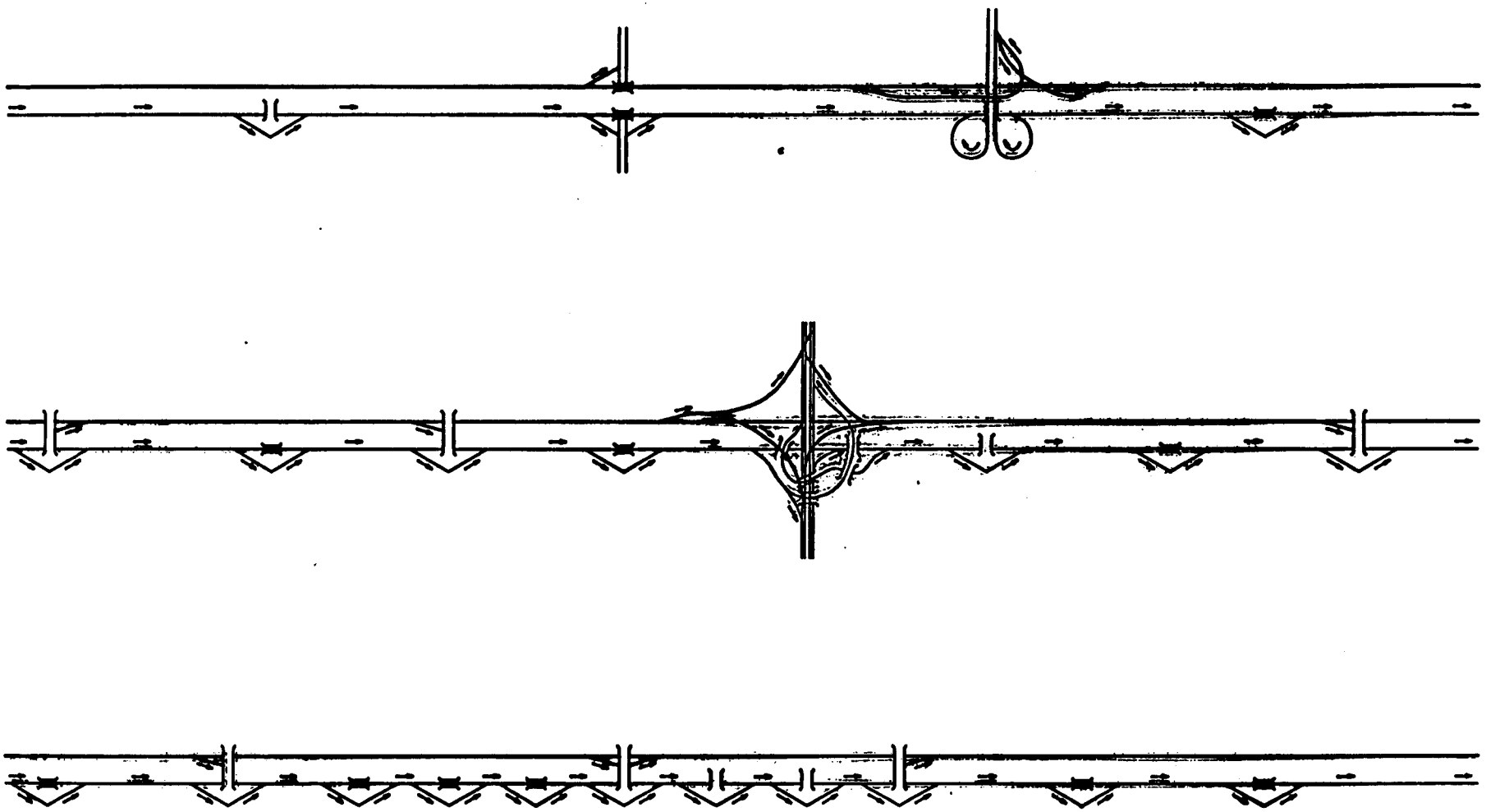
Sample of Unit Costs

(1996 dollars)

- **Pavement: $4 per sq. ft.**
- **Retaining Wall: $60 per sq. ft.**
- **Earthwork: $10 per cu. yd.**
- **Bridge Structures: $80 per sq. ft.**
- **ROW: $7.5 to $25 per sq. ft.**
- **4-level dedicated AHS Interchange: lump sum of $350 million**

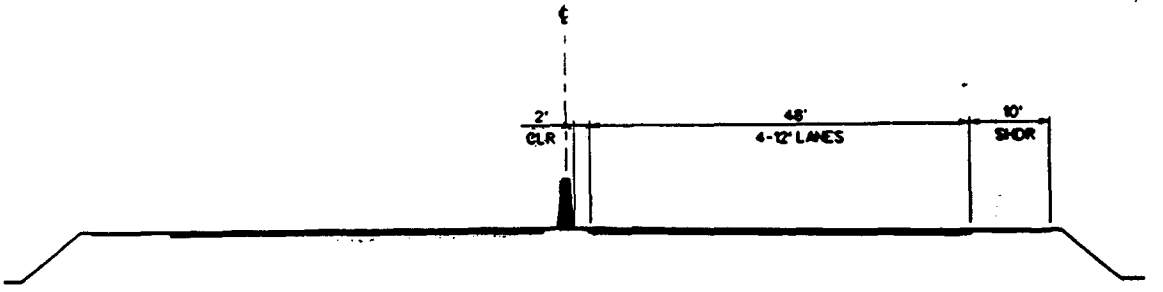
7-6

(half-picture (mirror vertically for full picture)



AHS URBAN SCENERIO CASE I

7-5a



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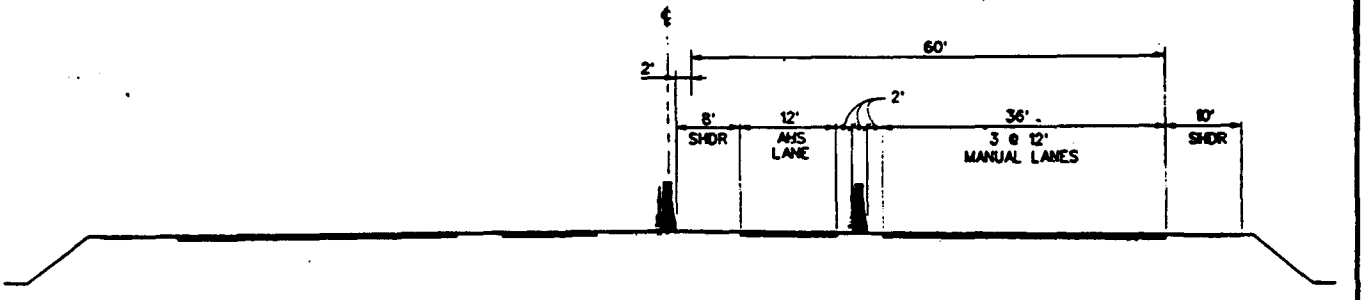

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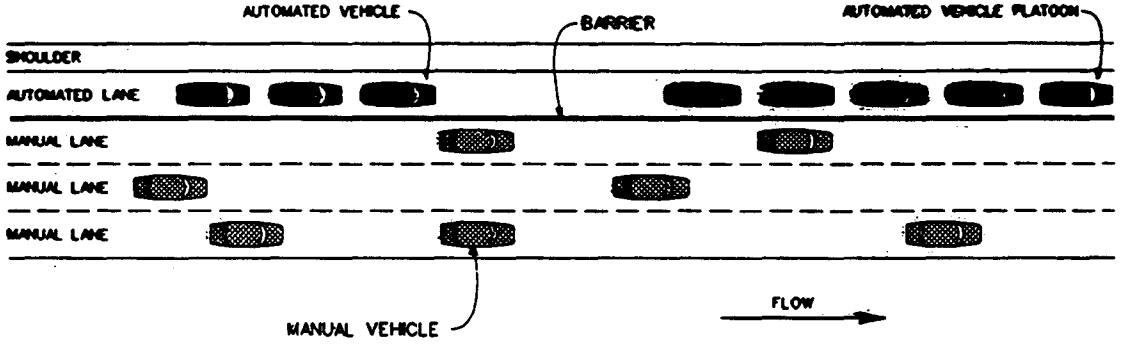
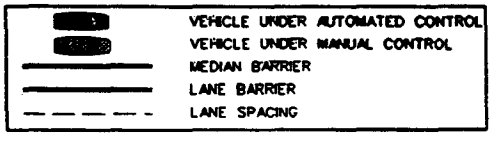
DEDICATED LANE -
DEDICATED ENTRY / EXIT RAMPS





URBAN
CASE 1

Preliminary Cost Results

Total estimated cost of accommodating one dedicated AHS lane onto an existing roadway:

	cost/lane mile	cost/lane kilometer
Urban	**~~$10~~ million to ~~$18.5~~ million**	**~~$7.5~~ million to ~~$11.5~~ million**
Inter-City	**~~$3.25~~ million**	**$2 million**
Rural	**~~$1.5~~ million**	**$1 million**

7-7

Recent Cost Experience (California)

- Santa Clara Freeway widening (39 miles, 29 interchanges): $14 million/lane-mile
- Cypress Freeway: $71 million/mile (includes complex interchanges)
- Los Angeles (I-110)Freeway: $8.75 million/ lane-mile, ROW not included
- L.A. Elevated viaduct: $6.25 million/ lane-mile
- I-80 Freeway: $11 million/lane-mile, no ROW
- Orange County I-5 Fwy: $13 million/lane-mile to construct; $16 million/mile for ROW

7-8

Conclusions

- Dedicated AHS lane construction will cost about the same for all concept attributes, except operations in mixed traffic
- Highway configuration is independent of most concept attributes and is mostly dependent on characteristics of site-specific application
- Super-imposition of dedicated AHS operations on existing freeway system is a costly and time consuming proposition, especially in congested urban areas.

7-9

Discussion Issues

- Unit and lump sum cost assumptions
- Highway geometric design assumptions
- Methods of separation: AHS and manual lanes
- Provision of dedicated breakdown/refuge areas
- Automated operational impacts on lateral clearances and other geometric elements
- Noise, pollution, and other environmental mitigation measures

7-10

Civil Infrastructure Cost Estimates

Ron Hearne / Greta Huang

NASHC Workshop #3

September 19, 1996

(slides 7-11 to 7-34)

CIVIL INFRASTRUCTURE COST ESTIMATES

- Application scenarios:
  - 4 Urban cases
  - 1 Inter-City case
  - 1 Rural case
- Recent highway construction cost experience
- Questions and issues for discussion

Urban Application - Base Case and Cost Assumptions

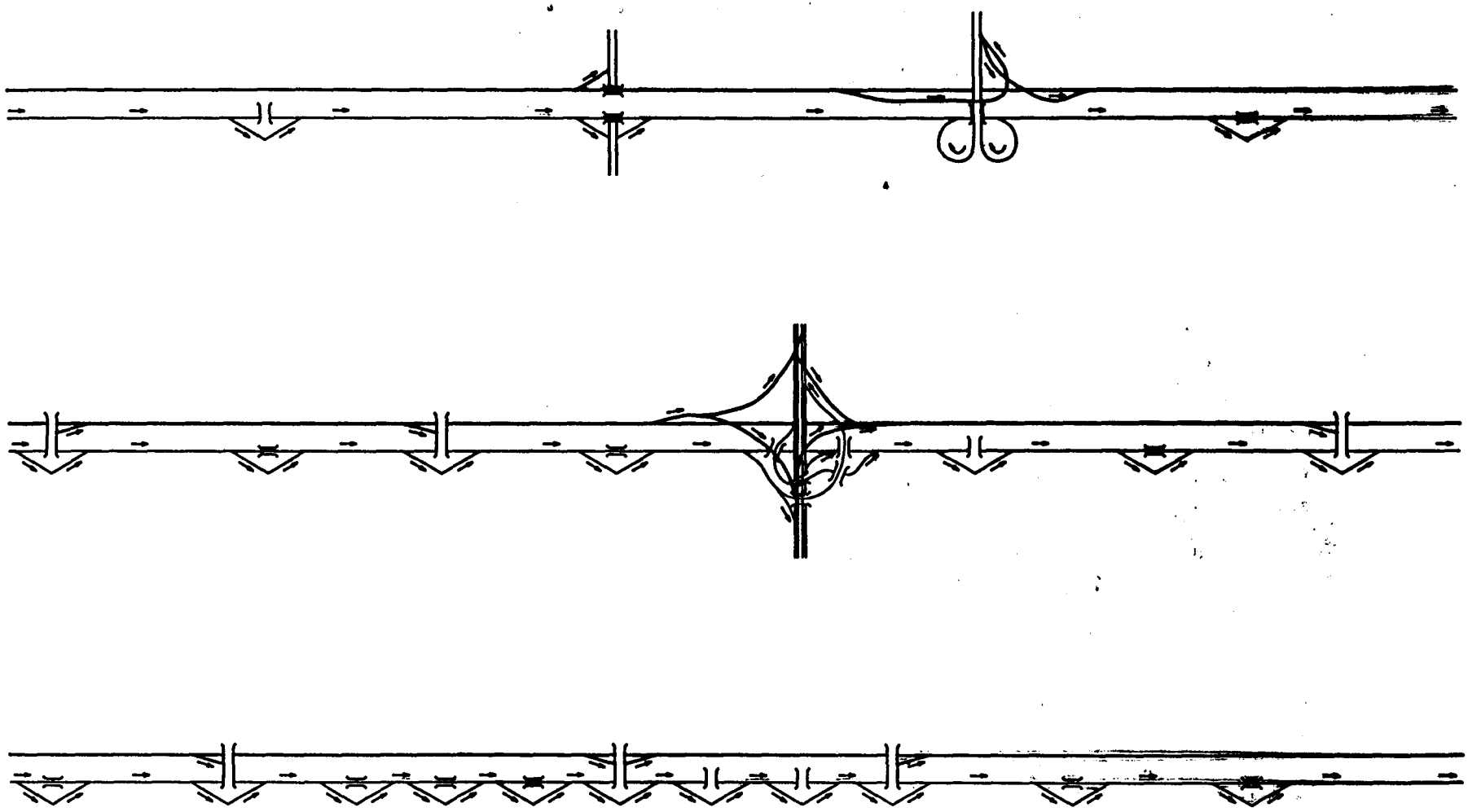
- 40 Km corridor (25 miles), 4 lanes each direction, 21 arterial interchanges, one 4-legged and one 3-legged regional interchanges. Medium complex urban environment.
- Two ROW acquisition assumptions : at 100% and 50%
- Two ROW cost bases: at $15/sq ft and $25/sq ft (as assumed in PSR studies)

7-13

Urban Application (Continued)

- Average unit costs commensurate with complexity of construction.
- Unit lump sum cost assumed for utility relocation, drainage, signing and striping, signalization and lighting, traffic mitigation, and landscaping.
- Normally-accepted markups at this stage of conceptual engineering : mobilization (10%); engineering and management (38%); and contingency (35%).

7-14



AHS URBAN SCENERIO CASE I

Urban Application - Dedicated AHS (Cases 1 and 2)

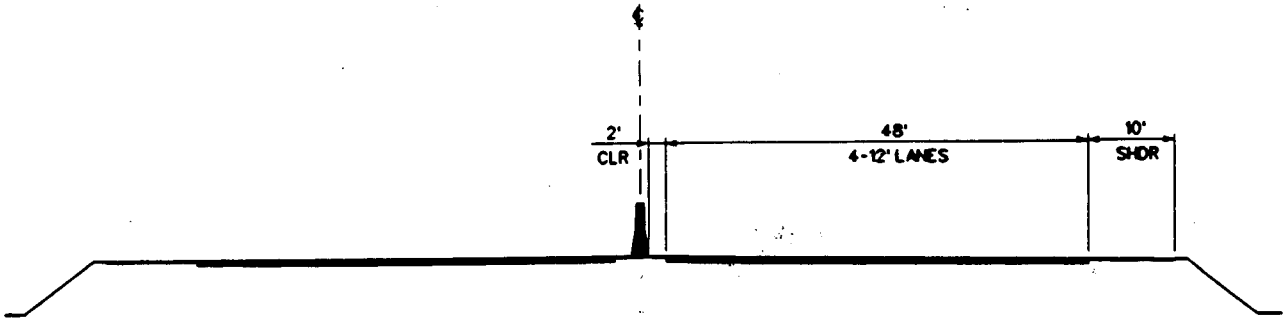
- Replace one manual lane with one dedicated AHS lane, fed by 7 dedicated interchanges at 3.6 miles (5.7 km) average spacing
- Separate breakdown lane per direction.
- Length of merge lane assumed at 1,400 ft (425 m), exit lane at 500 ft (150m)
- Carry AHS lanes over dedicated ramps through regional interchanges

7-15

Urban Case 1 and 2 (Continued)

- Lump sum cost assumption for regional interchanges: $350 million for 4-leg and $125 million for 3-leg
- Case 2 assumes a shared breakdown lane (modified variable barrier) for two opposing AHS directions
- Minor cost difference between cases 1 and 2

7-16



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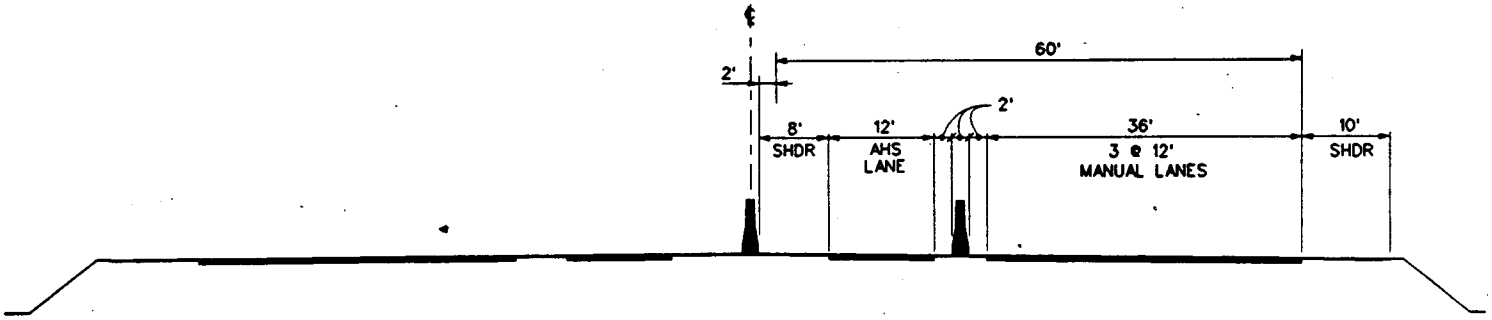

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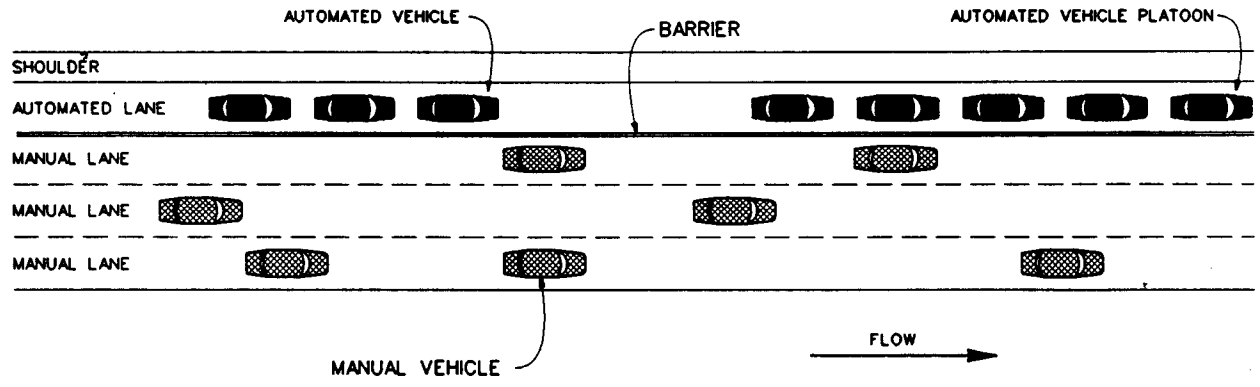
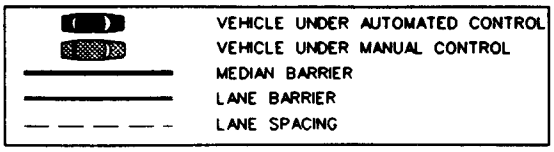
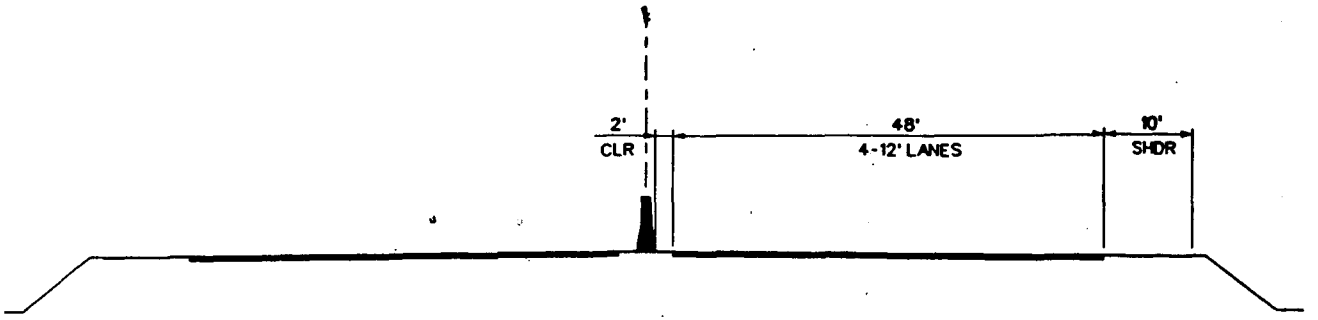
DEDICATED LANE -
DEDICATED ENTRY / EXIT RAMPS





URBAN
CASE 1



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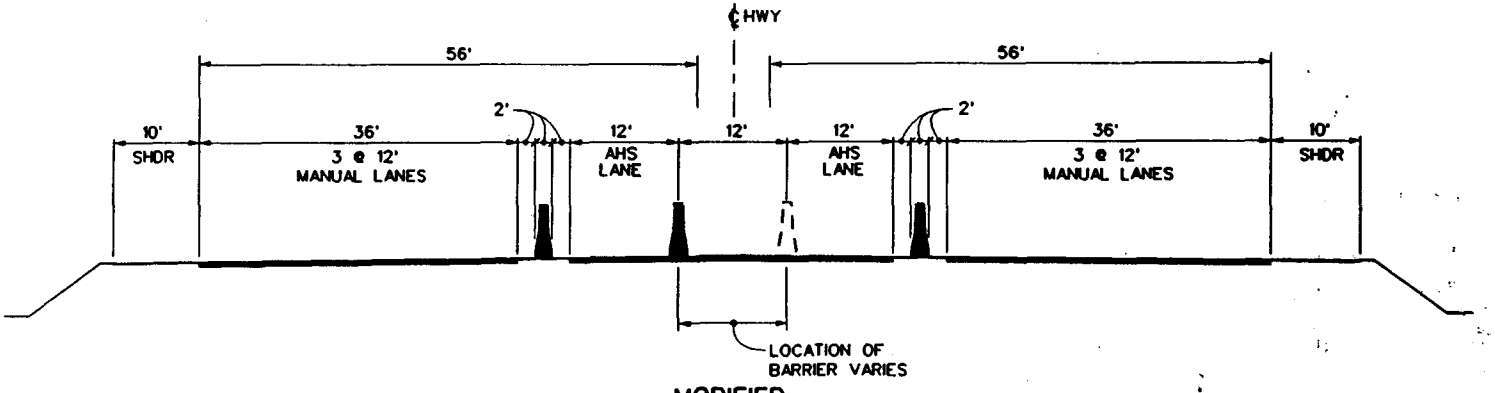

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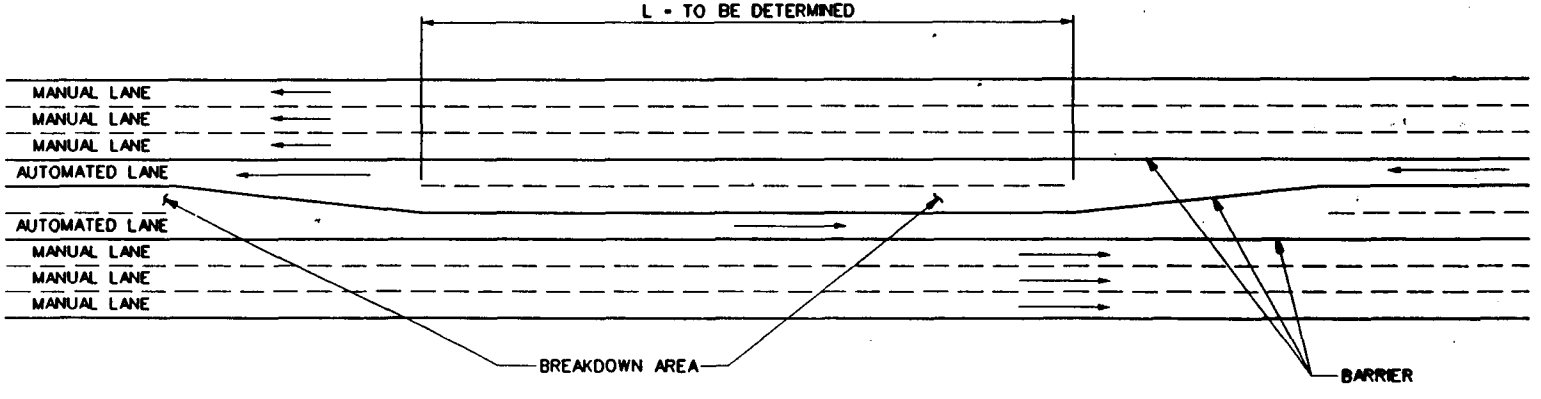
VARIABLE BARRIER



URBAN
CASE 2

Urban Application - Case 1

–Total Cost Breakdown

	$M/mi	$M/km	%
Construction	18.20	11.38	48.27
ROW	3.81	2.38	10.10
Eng..... & Mgt	6.92	4.32	18.34
Contingencies	8.78	5.49	23.29
Total	37.71	23.57	100.00

note: ROW - 100% req'd @ $15 per sq.ft.

7-17

Urban Application - Case 2

Total Cost Breakdown

	$M/mi	$M/km	%
Construction	18.20	11.38	50.22
ROW	2.34	1.46	6.46
Eng..... & Mgt	6.92	4.32	19.08
Contingencies	8.78	5.49	24.24
Total	36.24	22.65	100.00

note: ROW - 100% req'd @ $15 per sq.ft.

7-18

Urban Application - Case 3

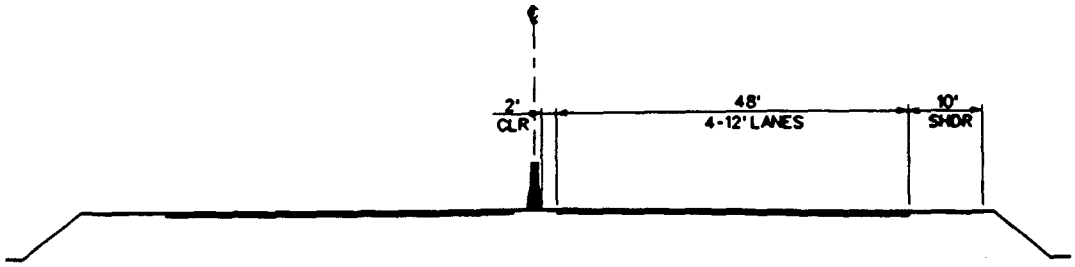
- Replace one manual lane with one dedicated AHS lane fed by common entry/exit ramps and a dedicated continuous transition lane.
- Barriers with gaps assumed between manual and transition lanes and between transition and AHS lanes
- Flexible placement of entrance / exit gaps for transition and AHS lanes on basis of local conditions.

7-19

Urban Application - Case 3

- Special by-pass ramp arrangement at freeway-to-freeway interchanges.
- Need for local widening of manual lanes to accommodate weaving traffic.

7-20



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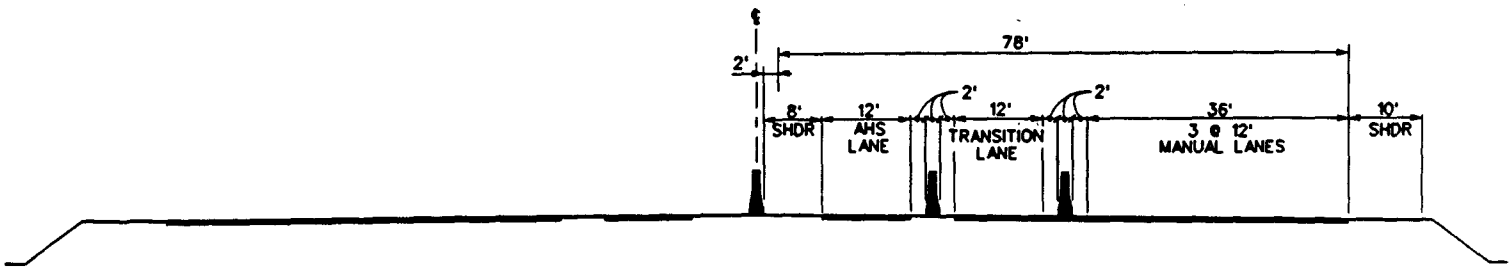

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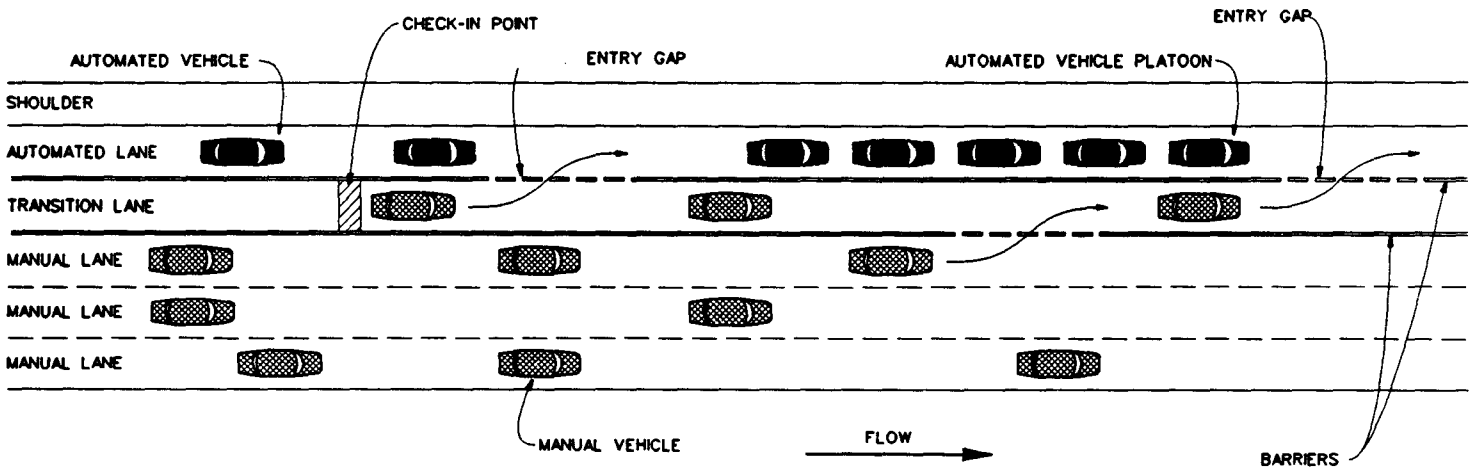
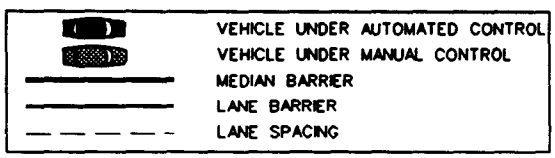
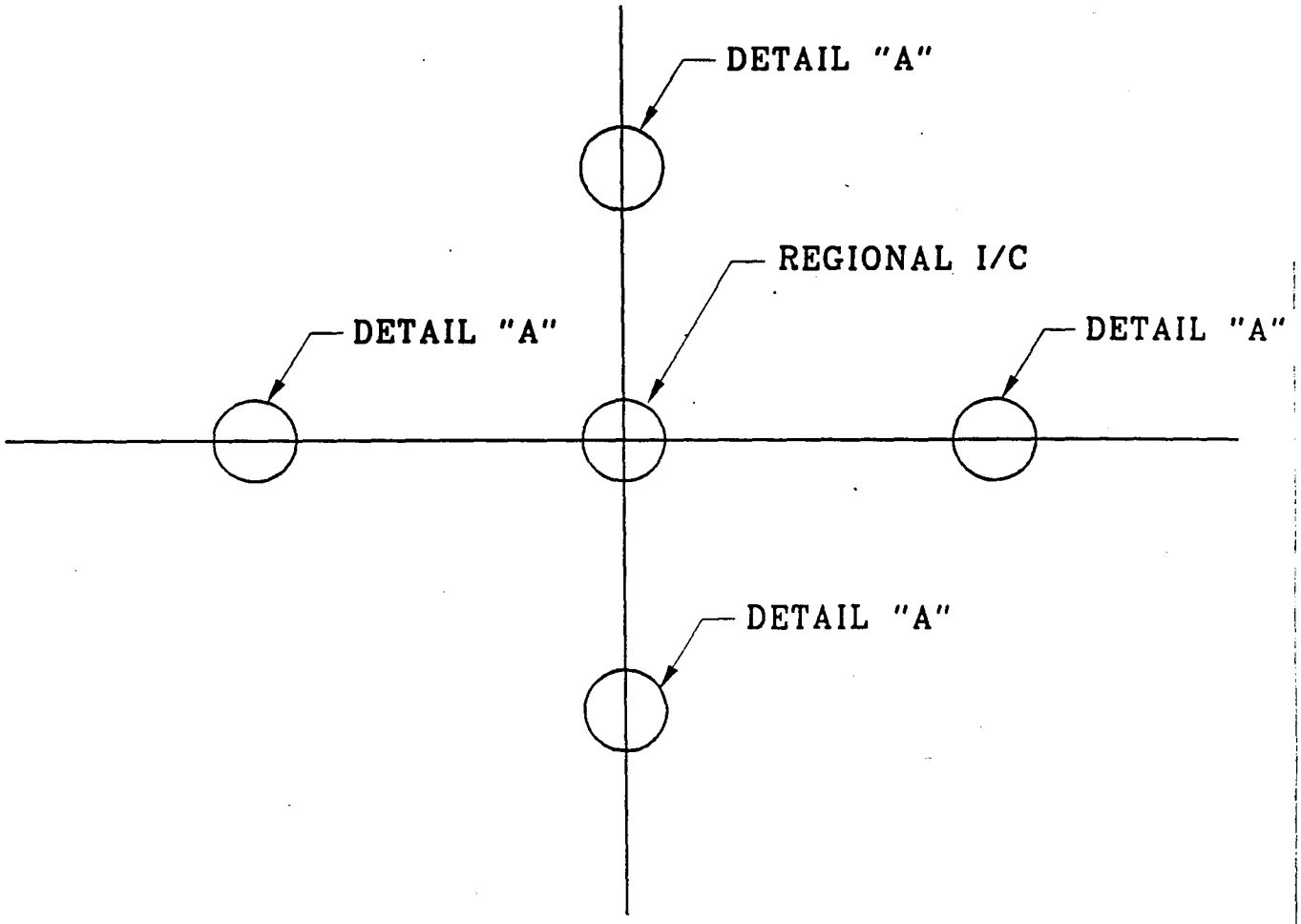
DEDICATED LANE WITH TRANSITION LANE
COMMON ENTRY / EXIT RAMPS

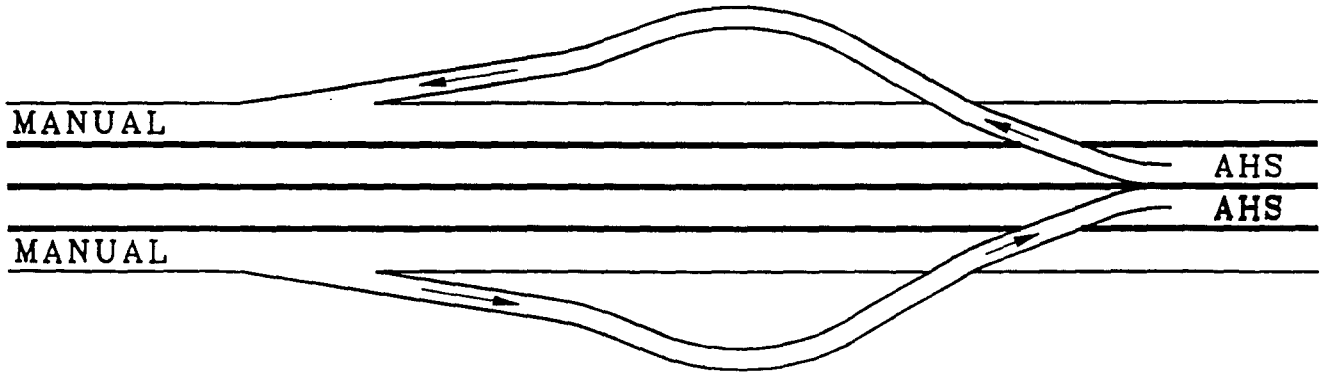




URBAN
CASE 3

URBAN CASE





DETAIL A

7-20a

AHS VEHICLES CHANGING HIGHWAYS MERGE WITH MANUAL VEHICLES

Urban Application - Case 3

Total Cost Breakdown

	$M/mi	$M/km	%
Construction	13.28	8.30	42.37
ROW	6.61	4.13	21.10
Eng..... & Mgt	5.05	3.15	16.10
Contingencies	6.41	4.00	20.44
Total	31.35	19.59	100.00

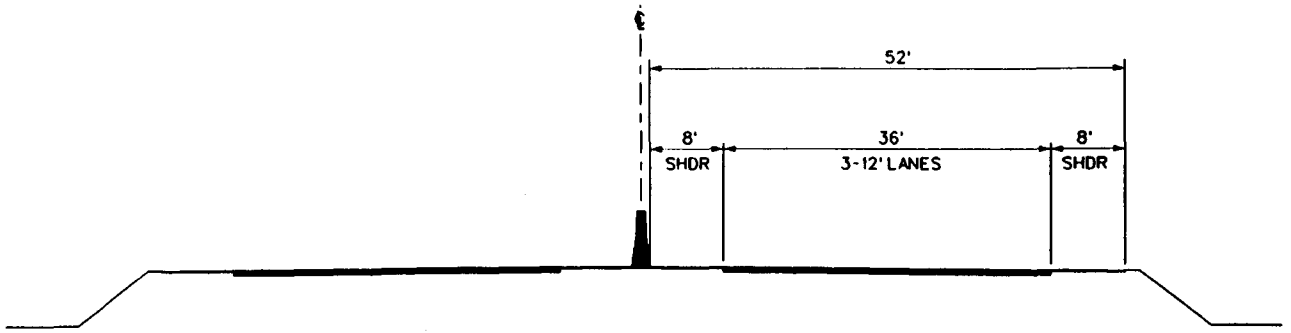
note: ROW - 100% req'd @ $15 per sq.ft.

7-21

Urban Application - Case 4

- Add one dedicated AHS lane(without taking away a lane), fed by 7 dedicated interchanges at 3.6 miles (5.7 km) average spacing.
- Separate breakdown lane per direction.
- Length of merge lane assumed at 1,400 ft (425 m), exit lane at 500 ft (150m) .
- Carry AHS lanes over dedicated ramps through regional interchanges

7-22



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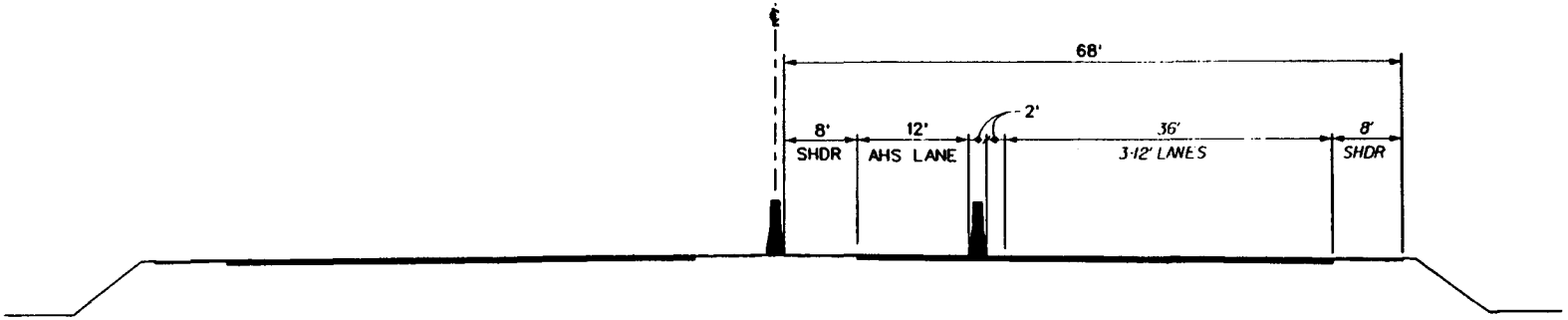

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ADD / AHS LANE
AND BARRIER SEPARATION

URBAN

CASE 4

7-22a

Urban Application - Case 4

Total Cost Breakdown

	$M/mi	$M/km	%
Construction	21.12	13.20	46.41
ROW	6.15	3.84	13.51
Eng..... & Mgt	8.03	5.02	17.64
Contingencies	10.21	6.38	22.44
Total	45.51	28.44	100.00

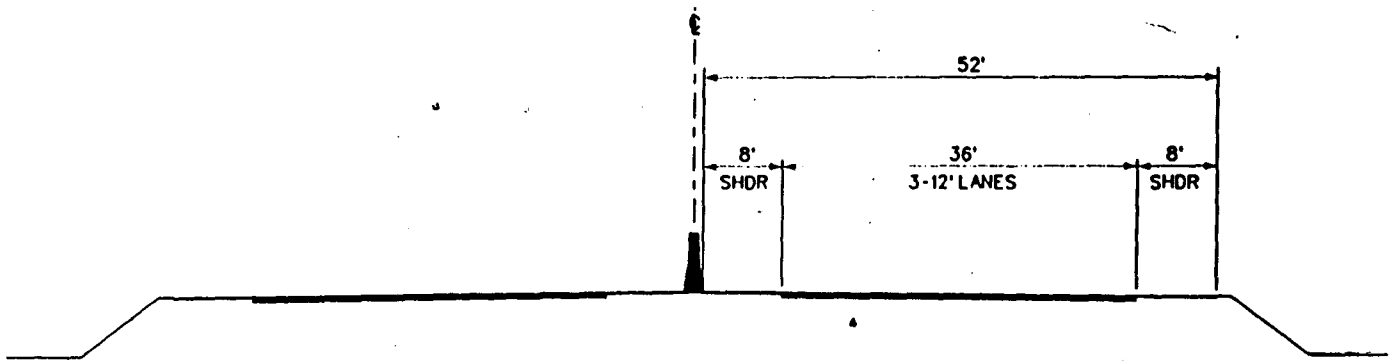
note: ROW - 100% req'd @ $15 per sq.ft

7-23

Inter-City Application

- 74 miles (119 km) Inter-City freeway, 3 lanes each direction, 20 normal interchanges, and 2 freeway-to-freeway interchanges.
- Add one dedicated AHS lane fed through common ramps via a localized transition lane.
- Assume 50% new ROW acquisition at $7.5 per sq ft.

7-24



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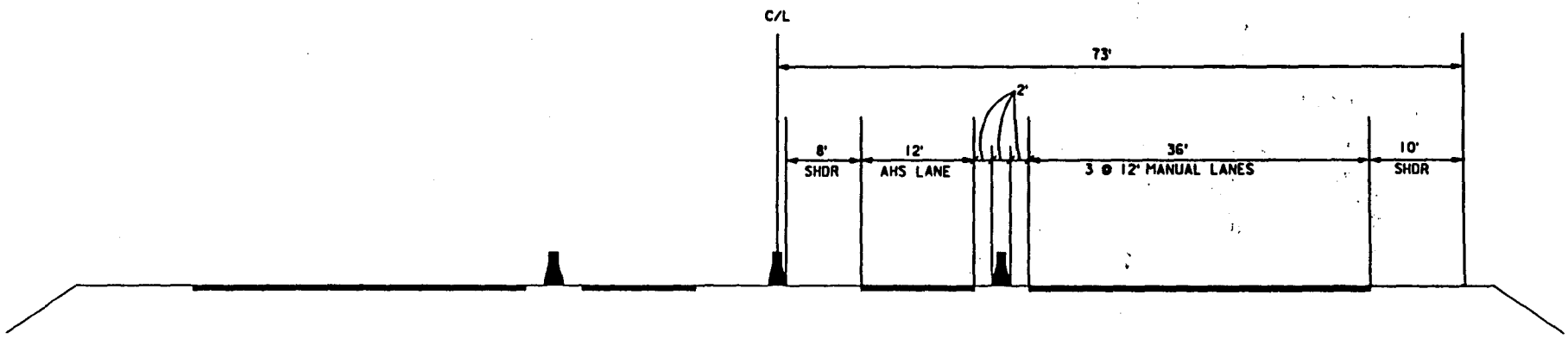

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ADD / AHS LANE
WITH BARRIER

INTERCITY

7-24a

Inter-City Application

Total Cost Breakdown

	$M/mi	$M/km	%
Construction	3.18	1.97	47.96
ROW	0.71	0.44	10.71
Eng..... & Mgt	1.21	0.75	18.22
Contingencies	1.53	0.95	23.11
Total	6.63	4.11	100.00

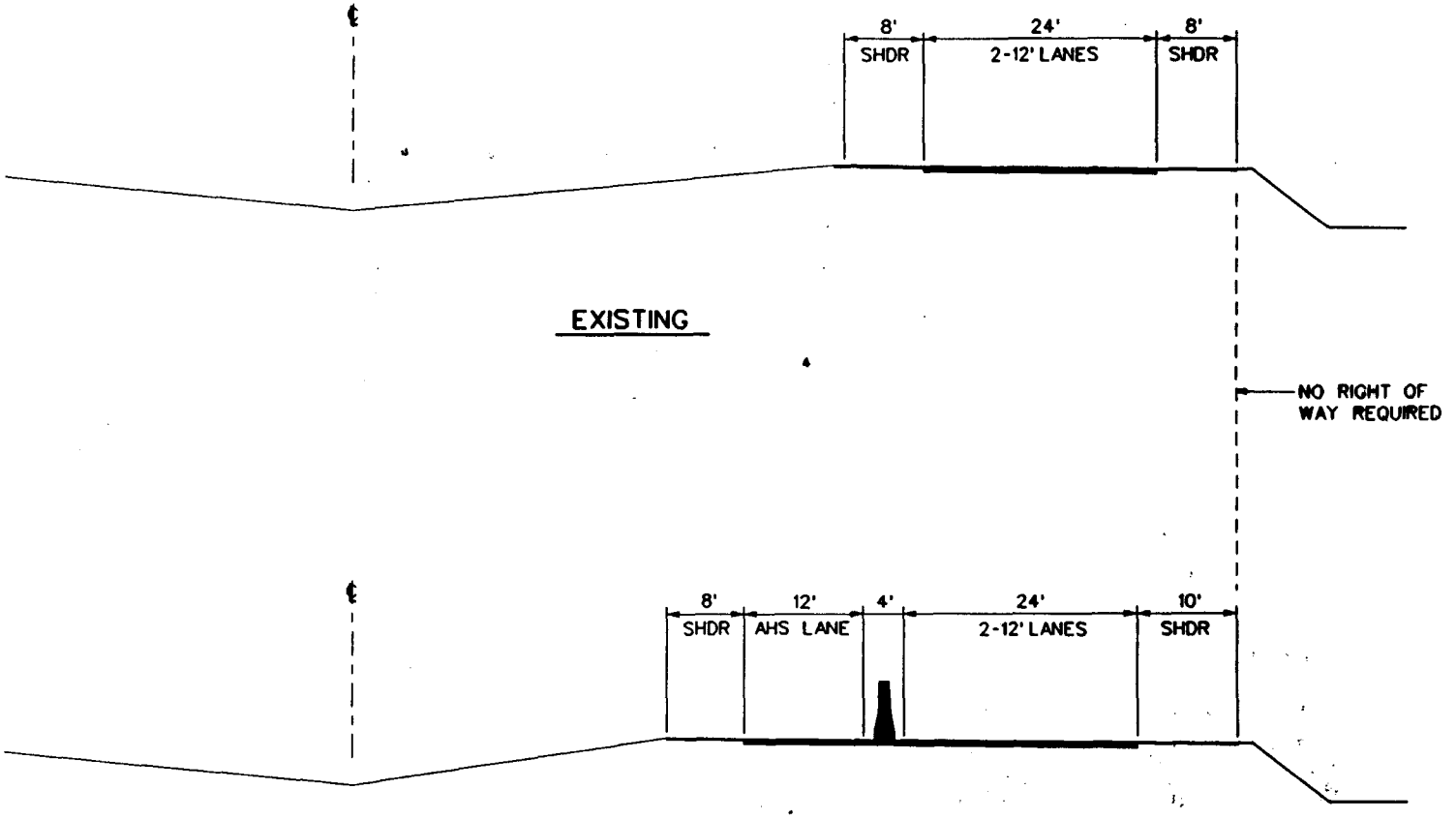
note: ROW - 50% req'd @ $7.50 per sq.ft

7-25

Rural Application

- 296 miles (476 km) rural freeway, 2 lanes each direction, 20 normal interchanges and 2 freeway-to-freeway interchanges.
- Add a dedicated AHS lane fed through common ramps via localized transition lanes.
- No ROW acquisition cost.

7-26



RURAL
CASE 1

7-26a

Rural Application Cost

Total Cost Breakdown

	$M/mi	$M/km	%
Construction	1.77	1.10	53.68
ROW	0.00	0.00	00.00
Eng..... & Mgt	0.67	0.42	20.40
Contingencies	0.85	0.53	25.92
Total	3.29	2.05	100.00

7-27

Recent Highway Cost Experience (California)

Santa Clara County Traffic Authority

- 18 miles of new freeway, 39 miles of widened freeway, 29 interchanges.
- Total cost $1,119 million: 51.1% constr, 30.5% ROW, and 18.4% Eng. & Mgt.
- $14 million/lane-mile of widened freeway

Cypress Freeway - I-880

- 19 miles costing $1.35 billion or $71 million per mile (includes complex interchanges)

7-28

Recent Highway Cost Experience (California)

I-110 Freeway / Transitway - Los Angeles

- Construction cost only
- 10.3 miles exclusive at-grade transitway
  - $35 million/mile, or $8.75 million/lane-mile, ROW not included
- 1.0 mile elevated viaduct
  - $25 million/mil, or $6.25 million/lane-mile

7-29

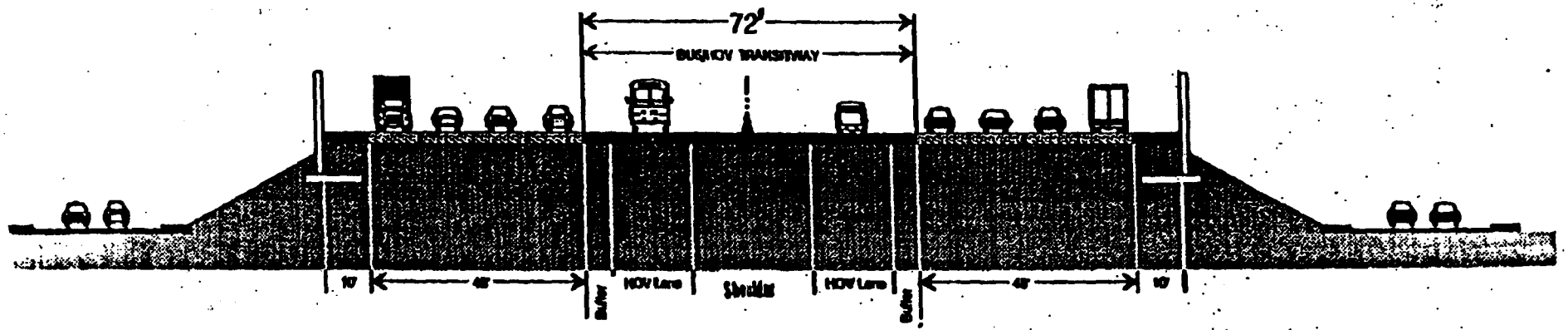
Recent Highway Cost Experience (California)

I-80 Reconstruction Project

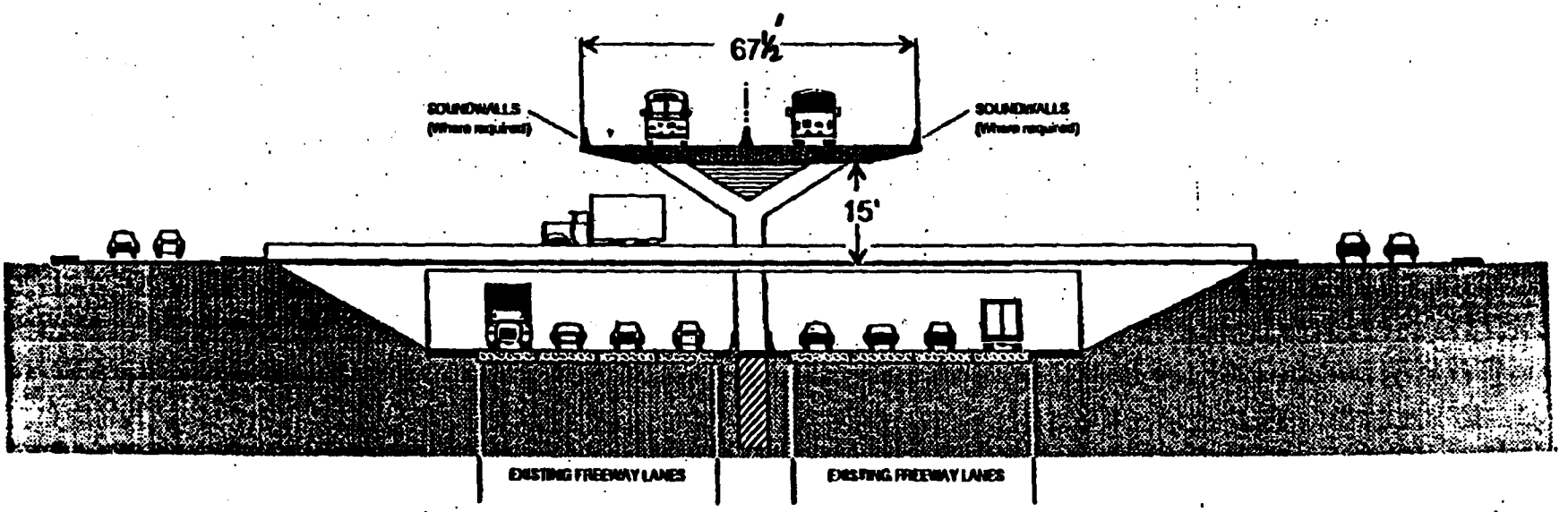
- 16.5 miles of widening, HOV lanes, I/C improvements, seismic upgrade, traffic operation improvements, other
- $355 million construction cost including Minimal ROW acquisition cost
- $11 million/lane-mile, no ROW

7-30

I-110 Freeway Transitway



AT GRADE SECTION



ELEVATED SECTION 7-29a

Recent Highway Cost Experience (California)

I-5 (Orange County) Improvement Project

- 9.5 miles widened from 6 to 10 lanes, includes one new HOV lane in each direction, and reconfiguring of I-5/SR-91 interchange
- Estimated construction cost $500 million; $13 million/lane-mile
- Estimated ROW acquisition cost $600 million; $16 million/lane-mile
- Construction in progress. Estimated completion in year 2000

7-31

Recent Highway Cost Experience (California)

Rout 24 / I-680 Interchange in Walnut Creek

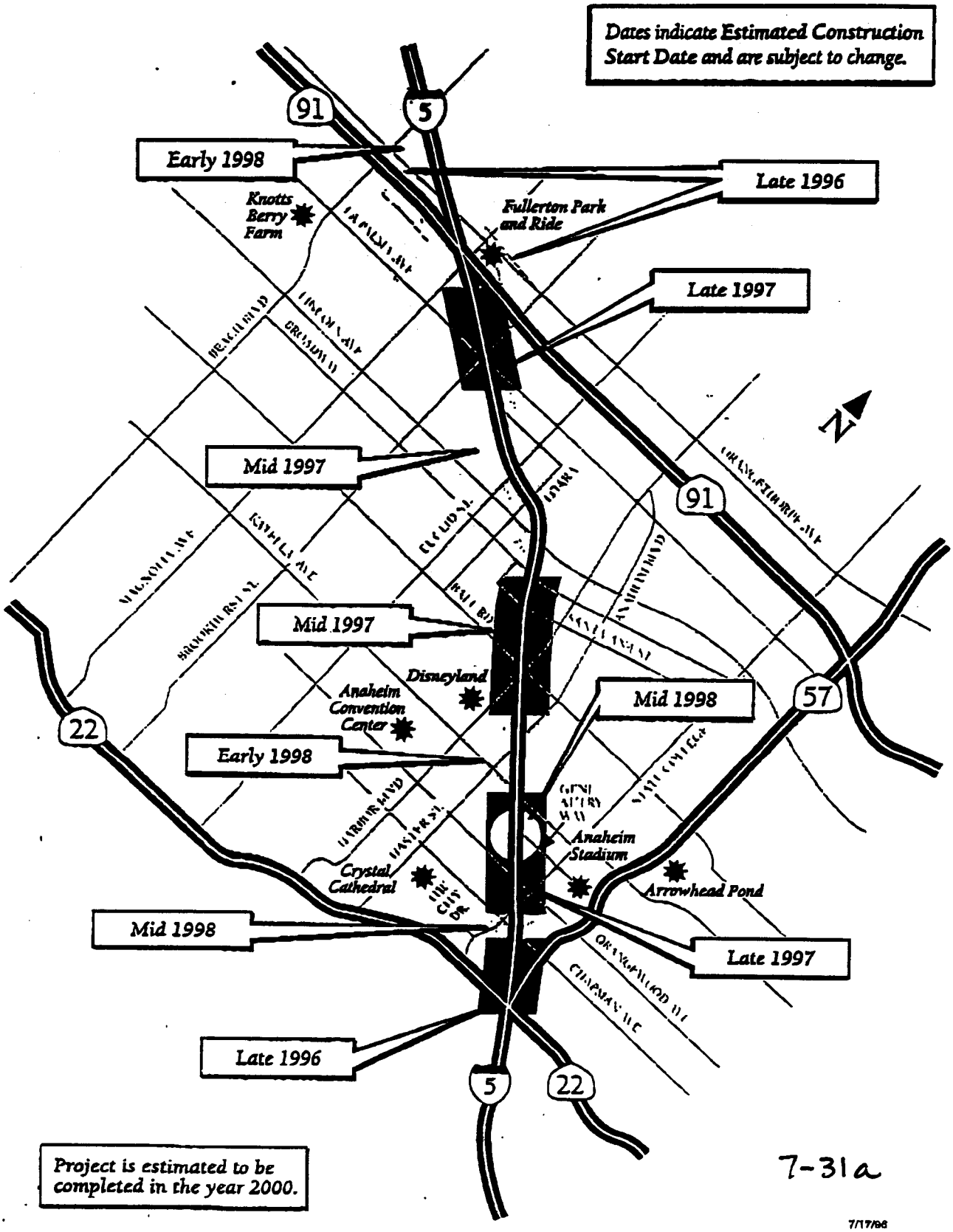
- Construction cost $275 million, including $14 million for traffic management
- ROW acquisition cost $60 million
- Total cost $355 million

I-105 / I110 interchange, Los Angeles

- Construction cost $82 million. No details are available

7-32

I-5 NORTH IMPROVEMENT PROJECT



Conclusions

- Dedicated AHS lane construction will cost about the same for all concept attributes, except operations in mixed traffic.
- Highway configuration is independent of most concept attributes and is mostly dependent on characteristics of site-specific application.
- Super-imposition of dedicated AHS operations on existing freeway system is a costly and time consuming proposition, especially in congested urban areas.

7-33

Issues to Explore

- Widths of lanes, ramps, shoulders, breakdown areas, etc.
- Methods of separation: concrete barriers, virtual barriers, buffer lanes, etc.
- Continuous vs. shared breakdown shoulders
- Impacts of automated operation on lateral clearances and other geometric elements
- Noise, pollution, and other environmental mitigation measures

7-34