Appendix A
Traffic Analysis

APPENDIX A

Traffic Analysis

Introduction

The purpose of this report is to summarize traffic forecast updates and operational analysis for the Hoover Dam Bypass Environmental Impact Statement (EIS). The work is being administered by the Central Federal Lands Highway Division (CFLHD) of the Federal Highway Administration (FHWA).

The study includes two traffic elements. The first element is an update of current forecasts and development of more comprehensive traffic operational data for the three relatively close new Colorado River Crossings. The updated information is used for impact definition and mitigation planning. The second element is the evaluation of a Laughlin-Bullhead City Alternative (LBA) (see FEIS Appendix B).

Traffic Forecast Update

Traffic forecast updates have been completed using historic traffic count information available from Arizona Department of Transportation (ADOT) and Nevada Department of Transportation (NDOT). Additional traffic counts or surveys were not included in the scope of this work. Key assumptions for traffic forecast updates are:

- Average annual daily traffic (AADT) data from NDOT and ADOT are the most current references to update traffic forecasts.
- The two sets of data showing different growth rates and forecasts on the east (NDOT Sta 03-222 and ADOT MP 20.50) and west side (NDOT Sta 03-221) of the Colorado River should be used to develop different traffic growth rates for those locations. This is consistent with the fact that traffic west of the Colorado River is influenced by regional development in Las Vegas and associated tourism, and traffic east of the Colorado River is influenced more by interstate trade and tourism.
- Long-range traffic forecasts will have the strongest correlation to the last 15 years of growth. Using this long of a study period will help identify and average out high and low years. It will also allow us to evaluate long-term and interim conditions that help prevent a "radical" forecast.
- Traffic on Hoover Dam should reflect a volume that is between the western and eastern forecasts.

Further details and calculations showing traffic growth and traffic diversion for the LBA Alternative are presented in Appendix B.

Traffic Forecast Calculations

Based on the above scope and assumptions, unconstrained AADT forecasts have been developed as follows.

AADT West of Colorado River. Traffic growth is forecasted at an uncompounded (straight line) rate of 5.0 percent per year.

The last 15 years of traffic data at NDOT Station 3-0222, U.S. 93, 0.6 mile south of Lake Shore Road show a 5.79 percent average annual rate (straight line) of traffic growth as compared to our '92 forecasted average annual rate of 4.14 percent. While 5.79 percent average growth per year might seem high, it has been sustained over a significant period of time. Based on this more current data, the previous '92 forecasted growth is low. For the purposes of this study, the approximate average, or 5.0 percent from the year 1996 is used to forecast future traffic growth.

Traffic forecasts west of the Colorado River reflect a location prior to eastbound traffic having a choice of using the existing dam crossing or a new Bridge. It can be assumed that the majority of this traffic is originating from locations near or northwest of Las Vegas and is destined for the Hoover Dam or locations east of Kingman. As shown in Figure A-1, forecasts are:

- Year 1997 forecast = 12,600 (1+0.05) = 13,230, use 13,200
- Year 2017 forecast = 12,600 (1+0.05*21) = 25,830, use 25,800
- Year 2027 forecast = 12,600 (1+0.05*31) = 32,130, use 32,100

AADT East of Colorado River. Traffic growth is forecasted at an uncompounded (straight line) rate of 4.0 percent per year

The last 15 years show a 7.46 percent average annual (straight line) rate of traffic growth as compared to our '92 forecasted average annual rate of 3.6 percent. This rate is high due to a recent 5-year traffic growth explosion over 9.4 percent average per year. During this period the highest single year was 36 percent. The last 5 years also included a reduction of traffic by 27.9 percent from 1995 to 1996. Using NDOT data that exclude the last 5 years, growth is 4.35 percent.

Given the volatile nature of traffic growth over the last 5 years at this location, counts from ADOT east of the dam were reviewed. These data show traffic growth of 3.7 percent for the last 10 years. Data from 1981 through 1986 were not included because the total volume was too low to reflect sustainable growth rates.

Based on both NDOT and ADOT data, a 4 percent average annual growth rate for growth east of the Colorado River is projected.

Traffic forecasts east of the Colorado River reflect a location prior to westbound traffic having a choice of using the existing dam crossing or a new bridge. It can be assumed that the majority of this traffic is originating from locations east of Kingman and destined for locations near or northwest of Las Vegas. As shown in Figure A-2, forecasts for this location are:

- Year 1997 forecast = 8,900(1+0.04) = 9,256, use 9,300.
- Year 2017 forecast = 8,900(1+0.04*21) = 16,376, use 16,400.
- Year 2027 forecast = 8,900(1+0.04*31) = 19,936, use 19,900.

AADT on Hoover Dam. Traffic on Hoover Dam is more directly proportional to traffic west of the dam than traffic east of the dam. Traffic east will be lower than the total traffic west of the dam because all Hoover Dam-destined trips are not expected to drive over the dam itself. The reason for this change from previous conditions is that the new visitor center parking garage is located west of the dam.

It is assumed that half the current traffic parks at the new parking garage. This is a reasonable estimate because the new garage represents over half the parking available in the area. Given this assumption, traffic (AADT volumes) on the dam would be (13,200-9,300)/2+9300=11,450. Forecasts for the years 2017 and 2027 are 21,100 and 26,000, respectively. NDOT's most recent AADT projections southeast of the dam are 17,800 and 22,100 for the years 2017 and 2027, respectively. Since the NDOT forecasts are consistent with our forecasts east of the river and on the dam, the following volumes are used as AADT forecasts at Hoover Dam:

- Year 1997 forecast = 11,500
- Year 2017 forecast = 21,100
- Year 2027 forecast = 26,000

Build Alternative Traffic Assignment

Unconstrained AADT forecasts for build alternatives have been developed on the following assumptions.

- Truck traffic will be prohibited from using the dam crossing.
- Since they are relatively close to each other, the three new crossings closest to Hoover Dam should not have significant differences in traffic demands. Therefore, forecasts for those alternatives are the same.
- The Laughlin Alternative will not significantly attract private auto trips from Hoover Dam until traffic congestion on the existing U.S. 93 Colorado River crossing on the dam consistently creates delays that are equal to the additional driving time. This delay time due to traffic congestion on the dam is estimated at 30 minutes. Operating conditions will need to be at LOS F for at least one-half hour for the delay to approach 30 minutes.
- Traffic Origins and Destinations have not changed significantly since the Traffic Study at Hoover Dam, 1991, or since the update for the Traffic and Revenue Study, 1992. Key items from those studies show that all trips using the dam are to and from the Las Vegas area and to and from southeast and east of Kingman.
- The crossings closest to Hoover Dam will provide an opportunity for trips from Las Vegas to Hoover Dam to circulate locally on a new Colorado River bridge. This could reduce the total number of tourist trips on the dam originating during times of traffic congestion.

Given these assumptions, unconstrained AADT forecasts for build alternatives have been developed as follows.

Key Locations. Key locations for AADT forecasts of these alternatives also include a new Colorado River crossing. The approach for making these forecasts is to distribute all traffic east of the river to the new crossing and to distribute the remaining traffic to the existing dam crossing. This approach may seem simplistic because it assumes all traffic currently east of the dam is through traffic that does not stop at the dam, but is the most accurate given available data. It is noted that this approach is also consistent with current Hoover Dam visitor travel characteristics.

AADT West of Colorado River

- Year 1997 forecast = 13,200
- Year 2017 forecast = 25,800
- Year 2027 forecast = 32,100

AADT on Hoover Dam

- Year 1997 forecast = 2,200
- Year 2017 forecast = 4,700
- Year 2027 forecast = 6,100

AADT East of Colorado River

- Year 1997 forecast = 9,300
- Year 2017 forecast = 16,400
- Year 2027 forecast = 19,900

AADT on New Bridge

- Year 1997 forecast = 9,300
- Year 2017 forecast = 16,400
- Year 2027 forecast = 19,900

Traffic Analysis

Analysis of traffic operations for existing conditions, build alternatives based on Highway Capacity Software (HCS) methods and procedures. Key factors for the analysis include:

Peak Hour of AADT = 9%
Percentage of Trucks = 18%
Percentage of Buses = 2%
Percentage of RVs = 4%
Peak Hour Factor = 95%
Directional Distribution = 53/47
All new alignments will have four lanes.

Further details and HCS calculations forms are attached to the end of this report.

No Build Alternative

Current (1997) level of service (LOS) for key No Build Alternative locations are:

- U.S. 93, west of the dam/LOS E
- U.S. 93, at the dam/LOS F
- U.S. 93, east of the dam/LOS E

These LOS calculations have been verified with field observations and correspondence from NDOT. As would be expected given current physical conditions, analysis of year 2017 and year 2027 traffic volumes shows that operations will deteriorate to LOS F for the three study locations. At this level of congestion, the dam crossing may not be able to serve the forecasted traffic volumes due to long delays caused by traffic backups approaching the crossing.

Build Alternatives

Traffic operations for the three build alternatives will be relatively the same. The following summarizes the operations at the key locations for those alternatives.

- U.S. 93, west of the dam/ year 2017- LOS B/ year 2027- LOS C
- U.S. 93, at the dam/ year 2017- LOS E/ year 2027- LOS E
- U.S. 93, east of the dam/ year 2017- LOS A/ year 2027- LOS B

At the new River Crossing/ year 2017- LOS A/ year 2027- LOS B

Key Findings and Conclusions

No Build Conditions

Current traffic operations at Hoover Dam are poor and expected to further deteriorate without significant capacity improvements. Existing traffic demands on the dam will increase due to growth in through trips and tourist activities related to both Las Vegas activities and Hoover Dam itself. LOS at the dam is currently F, indicating stop-and-go conditions with significant delays. These conditions will only be exacerbated with additional demands.

U.S. 93 approaches to the dam are currently at LOS E. This means full operating speeds are not maintained due to insufficient passing opportunities combined with a high percentage of trucks. LOS will deteriorate from E to F by year 2017. Traffic will experience significant congestion and delays for the length of the study area.

Build Alternatives

The three build alternatives will provide the needed capacity to adequately accommodate future traffic demands at key locations in the study area. This is evident from the level of traffic operations expected after the construction of additional lanes and a new Colorado River Crossing. Even in year 2027 after the project has been constructed for 20 years, traffic on the dam approaches will operate at LOS C or better; and operations on the dam will not fail.

It is noted that traffic operations on the dam are calculated at LOS E. This may seem poor, but the primary reason for the poor rating is the mountainous terrain, steep grades, and sharp curves. Speeds will be low, but capacity of the roadway is well above demand. The volume-to-capacity (V/C) ratio will be 0.57 in year 2017 and 0.74 in year 2027. Given these relatively good V/C ratios, traffic should not experience significant delays on the dam.

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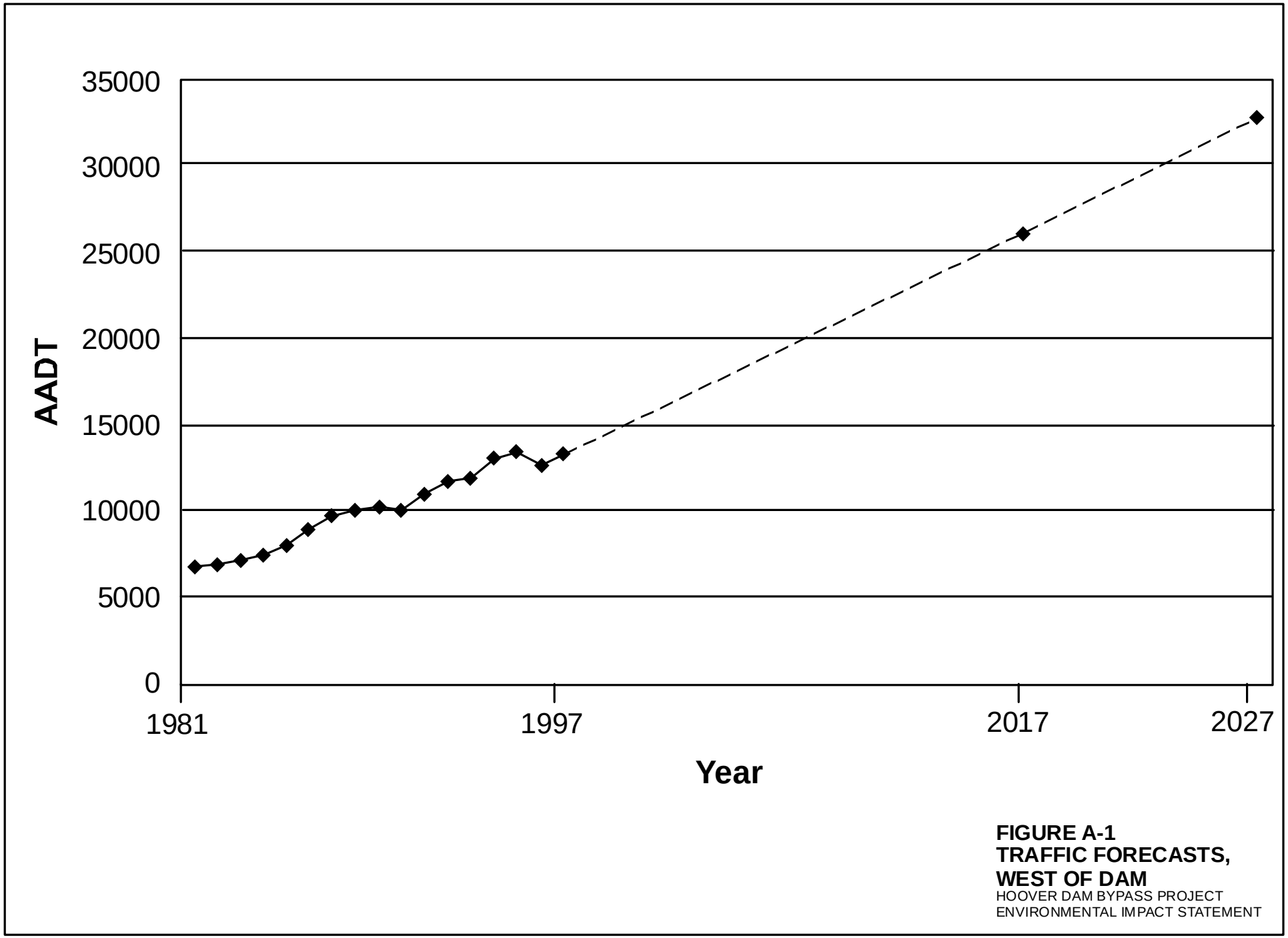

FIGURE A-1
TRAFFIC FORECASTS, WEST OF DAM
HOOVER DAM BYPASS PROJECT
ENVIRONMENTAL IMPACT STATEMENT

SCO142883.12.PM traffic 9/98

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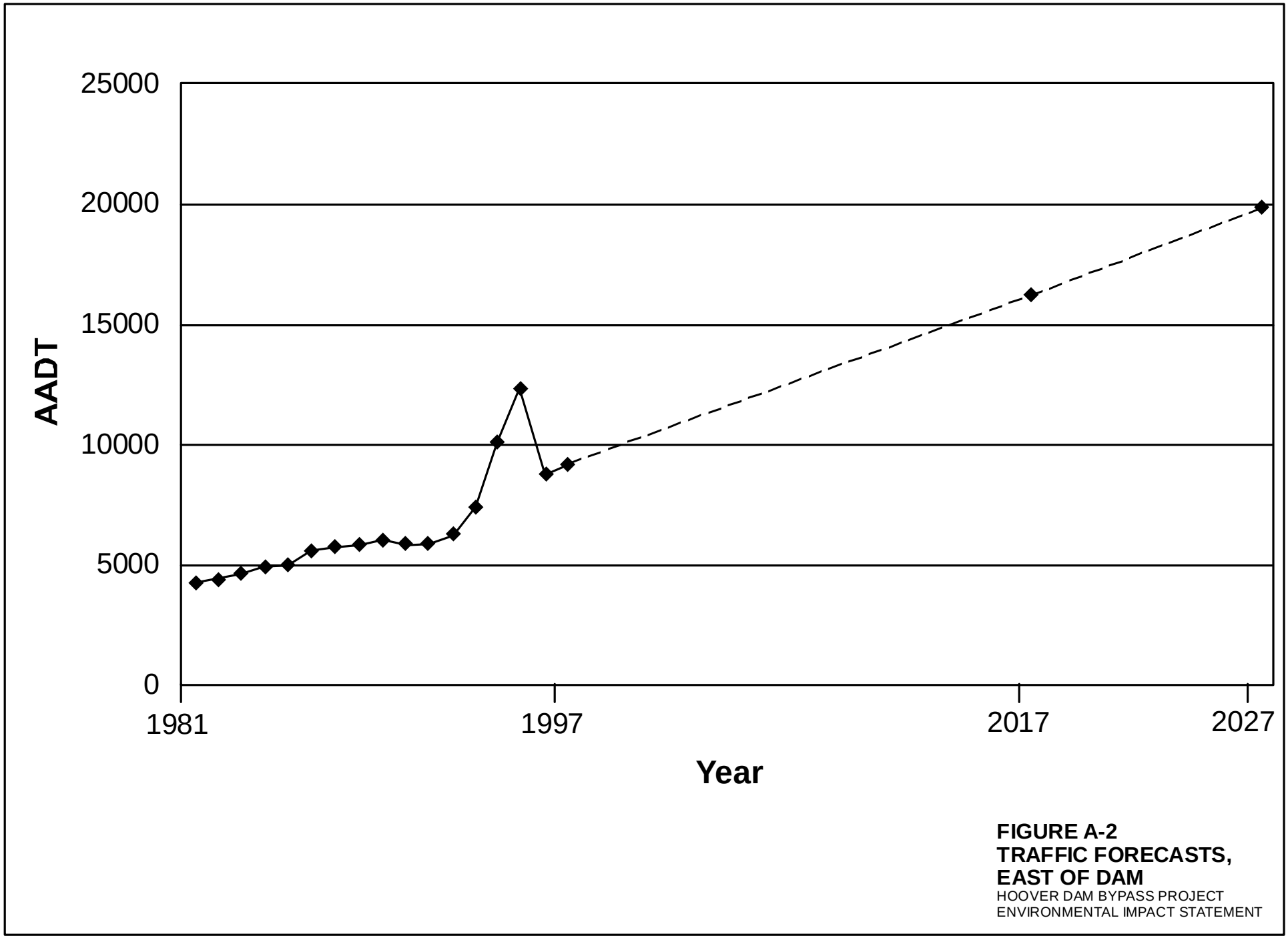

FIGURE A-2
TRAFFIC FORECASTS, EAST OF DAM
HOOVER DAM BYPASS PROJECT
ENVIRONMENTAL IMPACT STATEMENT

SCO142883.12.PM traffic fh 9/98

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1985 HCM:TWO-LANE HIGHWAYS
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FACILITY LOCATION.... US 93 on Dam
ANALYST..... TKR
TIME OF ANALYSIS..... All
DATE OF ANALYSIS..... 05-21-1998
OTHER INFORMATION.... Build

A) ADJUSTMENT FACTORS

PERCENTAGE OF TRUCKS	0
PERCENTAGE OF BUSES	2
PERCENTAGE OF RECREATIONAL VEHICLES	4
DESIGN SPEED (MPH)	50
PEAK HOUR FACTOR	.95
DIRECTIONAL DISTRIBUTION (UP/DOWN)	53 / 47
LANE WIDTH (FT)	11
USABLE SHOULDER WIDTH (AVG. WIDTH IN FT.)	2
PERCENT NO PASSING ZONES	100

B) CORRECTION FACTORS

MOUNTAINOUS TERRAIN

LOS	E T	E B	E R	f w	f d	f HV
A	7	5.7	5	.75	.98	.8
B	10	6	5.2	.75	.98	.79
C	10	6	5.2	.75	.98	.79
D	12	6.5	5.2	.75	.98	.78
E	12	6.5	5.2	.88	.98	.78

C) LEVEL OF SERVICE RESULTS

INPUT VOLUME(vph): 1000
ACTUAL FLOW RATE: 1053

LOS	SERVICE FLOW RATE	V/C
A	16	.01
B	163	.1
C	260	.16
D	532	.33
E	1477	.78

LOS FOR GIVEN CONDITIONS: E

1985 HCM:TWO-LANE HIGHWAYS

****

FACILITY LOCATION.... US 93 on Dam
ANALYST..... TKR
TIME OF ANALYSIS..... All
DATE OF ANALYSIS..... 05-19-1998
OTHER INFORMATION.... No Build

A) ADJUSTMENT FACTORS

PERCENTAGE OF TRUCKS	18
PERCENTAGE OF BUSES	2
PERCENTAGE OF RECREATIONAL VEHICLES	4
DESIGN SPEED (MPH)	50
PEAK HOUR FACTOR	.95
DIRECTIONAL DISTRIBUTION (UP/DOWN)	53 / 47
LANE WIDTH (FT)	12
USABLE SHOULDER WIDTH (AVG. WIDTH IN FT.)	2
PERCENT NO PASSING ZONES	100

B) CORRECTION FACTORS

MOUNTAINOUS TERRAIN

LOS	E T	E B	E R	f w	f d	f HV
A	7	5.7	5	.81	.98	.43
B	10	6	5.2	.81	.98	.35
C	10	6	5.2	.81	.98	.35
D	12	6.5	5.2	.81	.98	.31
E	12	6.5	5.2	.93	.98	.31

C) LEVEL OF SERVICE RESULTS

INPUT VOLUME(vph): 1000
ACTUAL FLOW RATE: 1053

LOS	SERVICE FLOW RATE	V/C
A	10	.01
B	77	.1
C	123	.16
D	226	.33
E	612	.78

LOS FOR GIVEN CONDITIONS: F

1985 HCM:TWO-LANE HIGHWAYS
****

FACILITY LOCATION.... S 93 East and west of Dam
ANALYST..... TKR
TIME OF ANALYSIS..... All
DATE OF ANALYSIS..... 05-19-1998
OTHER INFORMATION.... No Build

A) ADJUSTMENT FACTORS

PERCENTAGE OF TRUCKS	18
PERCENTAGE OF BUSES	2
PERCENTAGE OF RECREATIONAL VEHICLES	4
DESIGN SPEED (MPH)	60
PEAK HOUR FACTOR	.95
DIRECTIONAL DISTRIBUTION (UP/DOWN)	53 / 47
LANE WIDTH (FT)	12
USABLE SHOULDER WIDTH (AVG. WIDTH IN FT.)	6
PERCENT NO PASSING ZONES	50

B) CORRECTION FACTORS

ROLLING TERRAIN

LOS	E T	E B	E R	f w	f d	f HV
A	4	3	3.2	1	.98	.6
B	5	3.4	3.9	1	.98	.53
C	5	3.4	3.9	1	.98	.53
D	5	2.9	3.3	1	.98	.54
E	5	2.9	3.3	1	.98	.54

C) LEVEL OF SERVICE RESULTS

INPUT VOLUME(vph): 1000
ACTUAL FLOW RATE: 1053

LOS	SERVICE FLOW RATE	V/C
A	115	.07
B	277	.19
C	511	.35
D	773	.52
E	1367	.92

LOS FOR GIVEN CONDITIONS: E

1985 HCM:TWO-LANE HIGHWAYS

****

FACILITY LOCATION.... S 93 East and West of Dam
ANALYST..... TKR
TIME OF ANALYSIS..... All
DATE OF ANALYSIS..... 05-19-1998
OTHER INFORMATION.... LCA Alt

A) ADJUSTMENT FACTORS

PERCENTAGE OF TRUCKS	0
PERCENTAGE OF BUSES	2
PERCENTAGE OF RECREATIONAL VEHICLES	4
DESIGN SPEED (MPH)	60
PEAK HOUR FACTOR	.95
DIRECTIONAL DISTRIBUTION (UP/DOWN)	53 / 47
LANE WIDTH (FT)	12
USABLE SHOULDER WIDTH (AVG. WIDTH IN FT.)	6
PERCENT NO PASSING ZONES	50

B) CORRECTION FACTORS

ROLLING TERRAIN

LOS	E T	E B	E R	f w	f d	f HV
A	4	3	3.2	1	.98	.89
B	5	3.4	3.9	1	.98	.86
C	5	3.4	3.9	1	.98	.86
D	5	2.9	3.3	1	.98	.88
E	5	2.9	3.3	1	.98	.88

C) LEVEL OF SERVICE RESULTS

INPUT VOLUME(vph): 1000
ACTUAL FLOW RATE: 1053

LOS	SERVICE FLOW RATE	V/C
A	171	.07
B	449	.19
C	827	.35
D	1265	.52
E	2239	.92

LOS FOR GIVEN CONDITIONS: D

HCS: Multilane Highways Release 2.1

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File Name .....

Facility Section.....
US 93 West of Dam
From/To.....

Analyst.....
TKR
Time of Analysis.....
2017
Date of Analysis.....
05/19/98
Other Information.... Build close in

A. Adjustment Data	Direction 1	Direction 2
Volume	1230	1090
Percentage of Trucks and Buses	20.0	20.0
Percentage of Recreational Vehicles	4.0	4.0
Ideal Free-Flow Speed	60.0	60.0
Peak-Hour Factor or Peak 15 Minutes	0.95	0.95
Lane Width	12.0	12.0
Access Points per Mile	4.0	4.0
Distance from Roadway Edge	6.0	6.0
Type of Median	U	U

B. Adjustment Factors

Terrain Type	E T	E R	F HV	F M	F LW	F LC	F A
ROLLING	3.00	2.00	0.69	1.60	0.00	0.00	1.00
	3.00	2.00	0.69	1.60	0.00	0.00	1.00

C. Level of Service Results	Direction 1	Direction 2
Service Flow Rate (Vp)	932	826
Average Passenger Car Speed (mph)	57	57
Free Flow Speed (mph)	57	57
Density (pcpmpl)	16	14
Level of Service (LOS)	B	B

HCS: Multilane Highways Release 2.1
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File Name .....

Facility Section.....
. US 93 West of Dam
From/To.....

Analyst.....
TKR
Time of Analysis.....
2027
Date of Analysis.....
05/19/98
Other Information.... Build close in

A. Adjustment Data	Direction 1	Direction 2
Volume	1530	1360
Percentage of Trucks and Buses	20.0	20.0
Percentage of Recreational Vehicles	4.0	4.0
Ideal Free-Flow Speed	60.0	60.0
Peak-Hour Factor or Peak 15 Minutes	0.95	0.95
Lane Width	12.0	12.0
Access Points per Mile	4.0	4.0
Distance from Roadway Edge	6.0	6.0
Type of Median	U	U

B. Adjustment Factors

Terrain Type	E T	E R	F HV	F M	F LW	F LC	F A
ROLLING	3.00	2.00	0.69	1.60	0.00	0.00	1.00
	3.00	2.00	0.69	1.60	0.00	0.00	1.00

C. Level of Service Results	Direction 1	Direction 2
Service Flow Rate (Vp)	1160	1031
Average Passenger Car Speed (mph)	57	57
Free Flow Speed (mph)	57	57
Density (pcpmpl)	20	18
Level of Service (LOS)	C	B

HCS: Multilane Highways Release 2.1
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File Name .....

Facility Section.....
US 93 East of Dam
From/To.....

Analyst.....
TKR
Time of Analysis.....
2017
Date of Analysis.....
05/19/98
Other Information.... Build close in

A. Adjustment Data	Direction 1	Direction 2
Volume	780	695
Percentage of Trucks and Buses	20.0	20.0
Percentage of Recreational Vehicles	4.0	4.0
Ideal Free-Flow Speed	60.0	60.0
Peak-Hour Factor or Peak 15 Minutes	0.95	0.95
Lane Width	12.0	12.0
Access Points per Mile	4.0	4.0
Distance from Roadway Edge	6.0	6.0
Type of Median	U	U

B. Adjustment Factors

Terrain Type	E T	E R	F HV	F M	F LW	F LC	F A
ROLLING	3.00	2.00	0.69	1.60	0.00	0.00	1.00
	3.00	2.00	0.69	1.60	0.00	0.00	1.00

C. Level of Service Results	Direction 1	Direction 2
Service Flow Rate (Vp)	591	527
Average Passenger Car Speed (mph)	57	57
Free Flow Speed (mph)	57	57
Density (pcpmpl)	10	9
Level of Service (LOS)	A	A

HCS: Multilane Highways Release 2.1
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File Name .....

Facility Section.....
US 93 East of Dam
From/To.....

Analyst.....
TKR
Time of Analysis.....
2027
Date of Analysis.....
05/19/98
Other Information.... Build close in

A. Adjustment Data	Direction 1	Direction 2
Volume	950	840
Percentage of Trucks and Buses	20.0	20.0
Percentage of Recreational Vehicles	4.0	4.0
Ideal Free-Flow Speed	60.0	60.0
Peak-Hour Factor or Peak 15 Minutes	0.95	0.95
Lane Width	12.0	12.0
Access Points per Mile	4.0	4.0
Distance from Roadway Edge	6.0	6.0
Type of Median	U	U

B. Adjustment Factors

Terrain Type	E T	E R	F HV	F M	F LW	F LC	F A
ROLLING	3.00	2.00	0.69	1.60	0.00	0.00	1.00
	3.00	2.00	0.69	1.60	0.00	0.00	1.00

C. Level of Service Results	Direction 1	Direction 2
Service Flow Rate (Vp)	720	637
Average Passenger Car Speed (mph)	57	57
Free Flow Speed (mph)	57	57
Density (pcpmpl)	13	11
Level of Service (LOS)	B	A