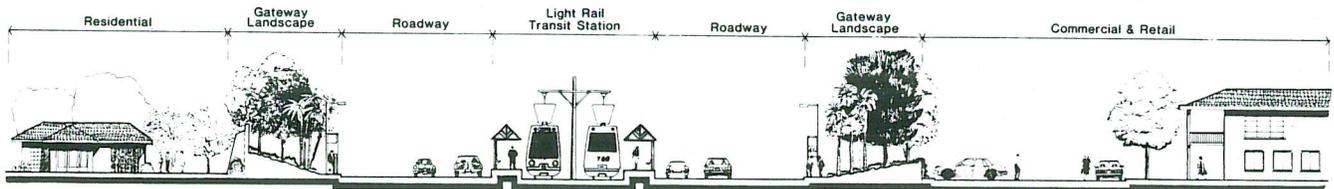


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BROADWAY CORRIDOR STUDY

Phase II Executive Summary



The City of Tucson
Department
of Transportation

May 1990

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Brinckerhoff **100**
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BROADWAY CORRIDOR STUDY - PHASE II

**Executive Summary
June 1990**

TABLE OF CONTENTS

	<u>Page</u>
SCOPE AND PURPOSE	1
Project History	1
Background of the Phase II Work Program (Transitional Corridor Analysis)	3
STUDY PROCESS	3
TRANSIT ALTERNATIVES STUDIED	5
Process	5
Alternatives	5
CONCLUSIONS	8
Ridership and Costs	8
UMTA Cost-Effectiveness Analysis	8
SUMMARY	13
FIGURE 1: Broadway Corridor Study Area	2
TABLE 1: 2010 System Summary	9
TABLE 2: Summary of Alternatives	10
TABLE 3: UMTA Total Cost-Effectiveness Index (CEI)	12

SCOPE AND PURPOSE

Project History

The Broadway Corridor (Figure 1) extends from I-10 on the west to Houghton Road on the east, a distance of twelve miles. It is one mile wide and includes the area one-half of a mile either side of Broadway Boulevard.

In 1987 a jointly sponsored (by the City of Tucson and the Urban Mass Transportation Administration) study of the Broadway Corridor, called the Phase I analysis, was completed and a Corridor Concept Plan was adopted by the Mayor and City Council. The actions listed below were adopted by the City of Tucson:

1. Approve the Corridor Concept Plan and Draft Final Report of the Broadway Corridor Transportation Study Phase I as valid, appropriate, and proper.
2. Approve the key items of the Corridor Concept Plan which are:
 - o Minimum 150 feet of right-of-way between Euclid and Camino Seco; and a minimum 120 feet of right-of-way between Camino Seco and Houghton Road.
 - o Buffering of adjacent residential areas as outlined in the Broadway Corridor Transportation Study Draft Final Report.
 - o Landscaping and urban design concepts as identified in the Broadway Corridor Transportation Study Draft Final Report.
 - o Grade separations at warranted locations as defined in Phase I of the project (cross streets will be depressed).
 - o Reaffirm Broadway Boulevard as a priority transit corridor for study of transit options.
3. Approve the recommendation that a major transit capital investment project be pursued in conjunction with the Federal Urban Mass Transportation Administration (UMTA).
4. Develop a Phase II Work Program requesting UMTA's participation and consent in the next phase of the major transit capital investment process, Alternatives Analysis and Draft Environmental Impact Statement (AA/DEIS).

5. Develop an advanced right-of-way acquisition plan for the Broadway Corridor.

Based on the above recommendations and Phase I technical analyses, an application for more detailed study of the Broadway Corridor transit alternatives was made to the UMTA. This application was submitted consistent with UMTA's guidelines and policies on Major Urban Mass Transportation Capital Investments.

Background of the Phase II Work Program (Transitional Corridor Analysis)

During the early discussions with UMTA officials, it was decided that more technical analyses and technical tools were needed before UMTA would consider a full application for an AA/DEIS. UMTA considers the entry into the AA/DEIS as a critical decision by UMTA related to their major transit capital investment policy. UMTA stated that they would participate financially in the development of a better travel demand forecasting tool (transit ridership forecasts), a new transit user survey to support the travel forecasting tool development, a refined definition of alternatives based on the Phase I study, and an initial assessment of other possible transit corridors.

A revised scope of work was presented to UMTA that would meet the needs of UMTA in assessing their decision related to participating in future capital investment alternatives analysis. It was agreed that the tools developed in this study phase would meet the requirements of the AA/DEIS guidelines and thus would not need additional development if UMTA approved further studies. In addition, because of the concern by UMTA and the City of Tucson, a review and concurrence by UMTA of the transit conceptual alternatives and travel demand forecasting procedures was part of the study process.

STUDY PROCESS

This study was sponsored by the City of Tucson and was administered by the City of Tucson Department of Transportation. The study was financed by the City of Tucson with grant money from the Urban Mass Transportation Administration (UMTA). The study process was guided by a Technical Advisory Committee (TAC) consisting of members of the City of Tucson Department of Transportation's Transportation Planning Division, Traffic Engineering Division, Engineering Division, and SunTran. Membership also included the City of Tucson Planning Department, Pima County Department of Transportation and Flood Control District, and the Pima Association of Governments Transportation Planning Division (PAG-TPD).

One of the main components of the study process was to provide for community participation throughout the study. Therefore, a process was established to ensure close coordination with known interested and affected community interests. The program was built on the efforts of the Phase I study rather than developing a completely new and different program. The program components included the Community Coordination Forum, public meetings, and presentations on study progress in response to requests from community organizations. The role of community participation in the study process was to provide opportunities for citizen review and comment on findings of the Phase II Transitional Corridor Analysis.

The community advisory panel was organized in October 1988 following mailed invitations to seventy individuals representing forty-three known neighborhood, business and commercial, and community-wide groups in the study area. All members of the Phase I Broadway Corridor Study Forum were invited to continue their representation. Forum representatives designated by the community groups received notices of scheduled Forum meetings held throughout the study.

Minutes of the Forum meetings and full results of the comment forms are on file at the City of Tucson's Department of Transportation (TDOT) offices.

General public involvement was solicited for a major presentation and open house on October 25, 1989. The meeting was sponsored by the City of Tucson Department of Transportation, the UMTA, and Parsons Brinckerhoff. The purpose of the open house was to present the preliminary findings of the Broadway Corridor study

Extensive promotion included newspaper ads, radio and television features, posters on SunTran buses and in libraries, and postcard meeting notices mailed to over 2,000 people in the community. One hundred fifty (150) people attended one of two presentations scheduled during the open house.

During this phase, presentations about the purpose and progress of the Broadway Corridor Study were made to numerous community groups or associations such as the San Clemente Neighborhood Association, the Sam Hughes Neighborhood Association, and the Downtown Business Association. In addition to these activities, the project team responded to individuals with inquiries or requests for information by phone and in informal meetings throughout the study.

TRANSIT ALTERNATIVES STUDIED

Process

The process for developing the transit alternatives has been evolutionary and has followed UMTA's guidelines while considering local desires. Four conceptual alternatives were developed during Phase I of the Broadway Corridor Study. These four alternatives were further refined in terms of possible alignments, operating characteristics, and other considerations. Based on UMTA guidelines and policies, the City of Tucson Department of Transportation staff review, input from the TAC, and the review by the Broadway Corridor Community Coordination Forum, eleven (11) alternatives were developed for further definition and analysis.

Alternatives

A summary description of the 11 alternatives studied are given below. Even though this study is directed toward the transit or fixed guideway options, a companion highway network, consistent for all 11 alternatives except as modified by the transit elements, is assumed for each alternative in the forecast year of 2010.

Alternative 1: Short Range Transit Plan (Do Nothing)

The "Do Nothing" alternative is mandated as a necessary alternative for analysis by UMTA. For study purposes, this alternative assumed implementation of the Short Range Transit Plan (SRTP) for the transit component and implementation of the "existing + committed + reasonable" highway elements of the adopted Regional Transportation Plan (RTP).

Alternative 2: Best Bus/Transportation System Management

The "Best Bus" or Transportation System Management (TSM) alternative is again required by UMTA and provides the UMTA mandated basis for comparing against the build alternatives. This alternative also forms the basis by which all the fixed guideway alternatives (i.e., busway and light rail transit) were developed. This alternative represents the best transit ridership and level of service that can be achieved without a major transit capital investment. This alternative more than doubled the service levels provided in the "Do Nothing" alternative (581 peak buses versus 285 peak buses).

Alternative 3: Busway with U of A Shuttle

Alternative 3 provides for a two-way busway in the median of Broadway between Pantano and the central business district (CBD) with express stops at Kolb, Wilmot, Craycroft, Swan, Alvernon, Tucson Boulevard, Highland-Cherry, and the downtown. The buses would enter the downtown through the proposed

Broadway Traffic Interchange and operate in mixed traffic flow in the downtown using the Ronstadt Transit Center as a major transfer point to other transit services. Pantano, Kolb, Wilmot, and Alvernon stops also have park-and-ride facilities available for the patrons. At Highland or Cherry, a separate shuttle bus (requiring a transfer) would operate between Broadway and the University of Arizona (U of A) main campus.

Alternative 4: Busway with U of A Direct Link

Alternative 4 provides for a two-way busway in the median of Broadway with a similar design and express stop concept as developed in Alternative 3. Operationally, the major express bus routes would be split thereby providing direct service to the University of Arizona campus (rather than a shuttle service from Broadway which requires a transfer) and to the CBD. The U of A connection would route the Broadway buses via Campbell, Sixth Street, and Stone to the downtown in regular mixed traffic flow operations.

Alternative 5: Light Rail Transit (LRT) with Bus Shuttle to U of A

Alternative 5 is the first of four light rail transit alternatives that were studied. This alternative provides for an at-grade, exclusive, two-way, double-tracked LRT system between Pantano and the CBD. Eleven stations would be constructed at Pantano, Kolb, Wilmot, Craycroft, Swan, Alvernon, Tucson Boulevard, Highland-Cherry, and three in the CBD. Park-and-ride facilities would also be provided at the Pantano, Kolb, Wilmot, and Alvernon light rail station areas. The bus system developed in Alternative 2 (Best Bus/TSM) was modified to optimize the feeder bus service to the LRT line and the applicable express bus services were eliminated because of the LRT line. The LRT line would operate two-car trains at five-minute headways during the peak periods (AM and PM) and at ten-minute headways in the off-peak periods. A shuttle bus on Highland or Cherry would provide service to and from the U of A main campus at similar headways as the LRT.

The LRT alternatives will require a separate maintenance and operations facility. A possible site on the south team tracks (south of 22nd Street; about 1 mile south of the CBD) was identified and included in the proposed cost of the new LRT system.

Alternative 6: LRT with a University of Arizona Spur

Alternative 6 is the same as Alternative 5 with a similar alignment and cross-section configuration, station stops, and operating headways. This alternative replaces the bus shuttle service to the U of A with a direct spur link along Highland or Cherry. An additional station (12 total) would be needed at the U of A. From an operations concept, every other train

would serve the U of A campus with the terminus at Highland or Cherry and Sixth Street.

Alternative 7: LRT to CBD via Sixth Street

This alternative as originally defined was similar to Alternative 5 east of Alvernon. The LRT line then headed north on Dodge and then west on Fifth/Sixth Streets and entered the CBD on Stone. Based on public input and review of this alternative concept, the community along Fifth/Sixth Street between Campbell and Dodge opposed the concept. This alternative could be modified to provide the transition from Broadway to Sixth Street at some to-be-determined alignment between Campbell and Highland. Twelve stations would be provided with this alternative and the operational headways would be identical to Alternative 5.

Alternative 8: LRT to U of A and CBD via Tunnel

Alternative 8 provides the same physical concept and operating characteristics as Alternative 5 east of Campbell. At approximately Campbell Avenue, the LRT would enter an exclusive below-grade tunnel which travels northwest and directly penetrates the U of A campus. The LRT remains in tunnel and then turns southwest where it crosses Fourth Avenue, the Southern Pacific Railroad (SPRR), and enters the CBD along Pennington Street. The benefit of testing this alternative (even though more costly) related to the increased operating speed of the LRT in the tunnel section. Stations (11 total) would remain identical east of Campbell and also include the U of A campus, Fourth Avenue, and the CBD.

Alternative 9: LRT on North Side of Broadway with Tunnel to CBD

Alternative 9 is a variation of Alternative 5 in the section of Broadway between Country Club and the CBD. West of Country Club, the LRT moves out of the median operation of Broadway to an exclusive configuration along the north side of, and parallel to Broadway Boulevard. The LRT crosses the SPRR via a tunnel and enters the CBD on Pennington Street. This alternative has similar station stops, headways, and Broadway median designs as described in Alternative 5. The transit ridership will be the same as Alternative 5, since this is a design variation. This alternative would also require the closure of all non half-mile streets west of Country Club and gate controls for all half-mile streets along the north side of Broadway.

Alternative 10: Busway with Electric Buses

Alternative 10 is configured physically similar to Alternative 3 along with the provision of electric trolley buses and overhead electric supply in the corridor and the inclusion of

a shuttle bus along Highland or Cherry to serve the U of A campus. Because of a change of mode to access the electric trolley buses operating on Broadway (diesel feeder buses to electric trolley buses), the operating characteristics and transit ridership will be very similar to the LRT alternative described in Alternative 5. The advantage of the electric trolley buses would be cleaner operating engines and longer life for the buses. The disadvantage is the higher initial capital costs, transfer penalty (affecting ridership), and similar operating costs to a standard transit bus.

Alternative 11: Busway with U of A Direct Link and use of Electric Buses

Alternative 11 is physically configured similar to Alternative 4 along with provision of electric trolley buses and overhead electric supply in the corridor and along Highland/Cherry and Sixth Street. The operating characteristics and transit ridership would be similar to the LRT Alternative 6 because of the mode change needed and the use of the alternating electric trolley buses serving the CBD and the U of A campus.

CONCLUSIONS

Ridership and Costs

For each alternative, the transit service levels (vehicles, hours and miles of service, speeds) were defined and an estimate of transit ridership was forecast for the year 2010. The ridership forecasts used the new travel forecasting tool developed for this study which estimates a person's choice between using one mode of travel over another. The key factors which affect this choice are the future roadway systems, the community's socioeconomic characteristics, future highway and transit speeds, future transit fares, parking costs, and transit service levels. In comparing the transit alternatives, all of these factors except the transit service levels were held constant. Consequently, changes in transit ridership, as shown in Table 1, reflect only changes in transit service levels.

The total capital cost and annual operating and maintenance cost for each transit alternative are based on engineering concepts and operating (transit service levels) and ridership estimates for each alternative. Costs, computed in 1989 dollars, are summarized in Table 2. The capital costs range from \$66 million and \$400 million, while the annual operating and maintenance costs range from \$36 million to \$90 million.

UMTA Cost-Effectiveness Analysis

A cost-effectiveness analysis provides a means for comparing the benefits of each alternative with its costs. The cost-effectiveness analysis also provides a measure for comparing

BROADWAY CORRIDOR STUDY

Table 1

2010 SYSTEM SUMMARY

<u>Alternative</u>	<u>Auto</u>		<u>Transit</u>		<u>Total</u>	
	<u>Person Trips</u>	<u>Mode Share</u>	<u>Person Trips</u>	<u>Mode Share</u>	<u>Person Trips</u>	<u>Mode Share</u>
1 SRTP	3,562,100	98.3%	60,600	1.7%	3,622,700	100%
2 Best Bus/ TSM	3,530,600	97.5%	92,100	2.5%	3,622,700	100%
3 Busway, U of A Shuttle	3,525,900	97.3%	96,800	2.7%	3,622,700	100%
4 Busway, U of A Direct	3,527,100	97.4%	95,600	2.6%	3,622,700	100%
5 LRT, U of A Shuttle	3,530,000	97.4%	92,700	2.6%	3,622,700	100%
6 LRT, U of A Spur	3,531,700	97.5%	91,000	2.5%	3,622,700	100%
7 LRT via Sixth St.	3,530,900	97.5%	91,800	2.5%	3,622,700	100%
8 LRT, U of A Tunnel	3,527,900	97.4%	94,800	2.6%	3,622,700	100%
9 LRT, Northside	3,530,000	97.4%	92,700	2.6%	3,622,700	100%
10 Busway, Electric Trolley Buses; U of A Shuttle	3,530,000	97.4%	92,700	2.6%	3,622,700	100%
11 Busway Electric Trolley Buses; U of A Direct	3,531,700	97.5%	91,000	2.5%	3,622,700	100%

BROADWAY CORRIDOR STUDY

Table 2

SUMMARY OF ALTERNATIVES

Alternative	Transit Service Levels (2010)				Daily Transit Trips (2010)	Capital Costs (1989 \$, millions)	Annual Operating & Maintenance Costs (1989 \$, millions)
	Number of Transit Vehicles						
	Regular Buses	Electric Trolley Buses	LRT Vehicles				
1 SRTP	342	--	--	--	60,600	\$ 66.4	\$ 36.4
2 Best Bus/TSM	697	--	--	--	92,100	\$184.1	\$ 73.4
3 Busway, Uofa Shuttle	816	--	--	--	96,800	\$238.6	\$ 88.7
4 Busway, Uofa Direct	824	--	--	--	95,600	\$240.6	\$ 89.4
5 LRT, Uofa Shuttle	665	--	20	20	92,700	\$331.9	\$ 76.9
6 LRT, Uofa Spur	661	--	20	20	91,000	\$335.1	\$ 74.9
7 LRT via Sixth Street	661	--	26	26	91,800	\$348.4	\$ 75.8
8 LRT, Uofa Tunnel	661	--	20	20	94,800	\$397.3	\$ 75.5
9 LRT, Northside	665	--	20	20	92,700	\$346.7	\$ 76.9
10 Busway, Electric Trolley Buses; Uofa Shuttle	736	80	--	--	92,700	\$305.1	\$ 89.0
11 Busway, Electric Trolley Buses; Uofa Direct	734	90	--	--	91,000	\$313.9	\$ 89.8

alternatives to aid in the selection of a recommended alternative. The cost-effectiveness analysis has become an important part of the UMTA procedures for review of major transit projects. UMTA has established uniform procedures for calculation of a cost-effectiveness index for major projects. UMTA uses the index as an input to its rating system, which compares projects from throughout the nation and identifies those most worthy of Federal funding. UMTA also uses the index to measure projects against thresholds established as minimum criteria for advancing projects into the alternatives analysis, preliminary engineering, design, and construction phases.

The method for determining the cost-effectiveness measure is a formula described in "Procedures and Technical Methods for Transit Project Planning" published by UMTA, September 1986, and as updated by current UMTA practice. The formula is shown below:

$$\text{Total Cost-Effectiveness Index} = \frac{\Delta \$\text{CAP} + \Delta \$\text{O\&M} - \Delta \$\text{TT}}{\Delta \text{RIDERS}}$$

where the Δ 's represent changes in costs and benefits compared to the Best Bus/TSM Alternative, and

- $\Delta \$\text{CAP}$ = change in equivalent annual capital costs (build vs. TSM)
- $\Delta \$\text{O\&M}$ = change in annual operating and maintenance costs (build vs. TSM)
- $\Delta \$\text{TT}$ = value of travel time savings for existing riders carried on the TSM Alternative; and
- ΔRIDERS = annual changes in transit ridership, measured in "linked" trips (build vs TSM)

The output of the formula is an alternative's cost per new passenger attracted relative to the TSM or Best Bus Alternative. The Best Bus/TSM Alternative is used as the baseline since it is designed to represent the most effective solution to transportation problems in the corridor, short of construction of major new facilities. Thus, the TSM Alternative provides a baseline against which it is possible to isolate the added costs and added benefits resulting from a proposed major investment.

Applying this index to the alternatives in this study yields the results shown in Table 3. The current threshold by UMTA for entry into the alternatives analysis phase is \$10 per new rider. This threshold is currently under review and may be changed in the future. Based on the study results, none of the build alternatives would pass the current threshold used by UMTA. Alternative 3, busway with the U of A shuttle, however, does have the highest ridership and has a \$13 per new rider CEI.

BROADWAY CORRIDOR STUDY

Table 3

UMTA TOTAL COST-EFFECTIVENESS INDEX (CEI)
(Ridership Forecast Year - 2010)

Alternative	Annualized Capital Costs (1989 \$, Millions)	Annual Operating & Maintenance Costs (1989 \$ Millions)	Annual Travel Time Savings to the TSM Riders (1984 \$ Millions)	2010 Annual Riders (Millions)	UMTA Total CEI (1) (\$/New Rider)
1 SRTP	\$ 8.8	\$36.4	N.A.	18.5	N.A.
2 Best Bus/TSM	\$24.3	\$73.4	\$0.0	27.7	Baseline
3 Busway, UofA Shuttle	\$31.3	\$88.7	\$1.4	29.3	\$ 13.06
4 Busway, UofA Direct	\$31.6	\$89.4	\$1.3	28.7	\$ 22.00
5 LRT, UofA Shuttle	\$39.8	\$76.9	\$1.7	27.8	\$173.00
6 LRT, UofA Spur	\$40.1	\$74.9	\$1.1	27.2	Less Riders
7 LRT via Sixth Street	\$41.6	\$75.8	\$0.9	27.6	Less Riders
8 LRT, UofA Tunnel	\$46.7	\$75.5	\$2.4	28.4	\$ 31.57
9 LRT, Northside	\$41.4	\$76.9	\$1.7	27.8	\$189.00
10 Busway, Electric Trolley Buses; UofA Shuttle	\$38.0	\$89.0	\$1.7	27.8	\$276.00
11 Busway, Electric Trolley Buses; UofA Direct	\$38.9	\$89.8	\$1.1	27.2	Less Riders

(1) Compared to Alternative 2, Best Bus/TSM

SUMMARY

This phase of the Broadway Corridor Study (Transitional Corridor Analysis) was undertaken with the assistance of UMTA to more critically analyze the findings of the Phase I study related to the cost-effectiveness of implementing a major transit capital investment, as defined by UMTA, within the study area.

The study results reveal that in the Broadway Corridor, when the major build alternatives (3 to 11) are compared to the Best Bus/TSM alternative (2), none of them pass the UMTA thresholds of cost-effectiveness. In addition, Broadway has the highest transit patronage of other corridors in the City, therefore, UMTA does not foresee any federal investments in Tucson in the near future. The busway alternatives (3 and 4) perform the best but still do not pass the UMTA threshold of \$10 per new rider. Based on the analyses conducted in this study, an expanded bus system concentrating on a high quality, expedited bus service (as defined in Alternative 2) directed at the major travel corridors would be the most cost-effective program based on the existing and future community demographics.