Growth Management and Transit Potential: Case Study in Atlantic City, New Jersey

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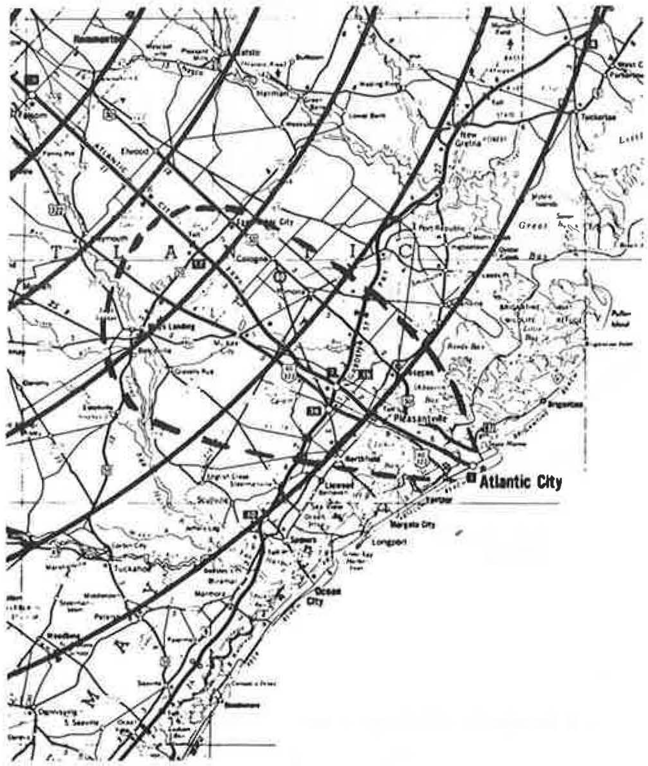
The methodology and findings of a joint development study on Atlantic City conducted by a team of graduate and undergraduate students at Princeton University are described. The objective of the study was to evaluate the feasibility of alternative rapid transit configurations in a selected corridor under various managed land development scenarios. In order to assess the effectiveness of alternative land development options together with various transit service options, the team adapted and used an interactive sketch planning model that allows rapid calculation of the results of changes in either the land use or the transit service. Such variables as ridership, vehicle miles of travel, demand for parking spaces at the stations, and also revenue-cost aspects of the transit and land consumption are quantified and trade-offs are outlined. The use of a computerized sketch planning model allows the analyst to evaluate quickly a large number of alternatives and to focus rapidly on the more promising ones.

Legalization of gambling in Atlantic City, New Jersey, has brought a surge of expectation for growth and economic development in the City and County. State and local officials are sensitive to the threat of ill-planned, haphazard development, which could both endanger the surrounding ecologically sensitive area and overstrain Atlantic City's limited street and parking facilities. The County is experiencing a population explosion due primarily to the development of casino gambling. Each casino directly employs approximately 4000 persons and is assumed to generate an equal amount of secondary employment. Population increases of up to 400 000 persons within the next 20 years were forecast by the affected planning agencies (1). The State of New Jersey, mainly represented by the Pineland Commission, the Office of Coastal Zone Management, the Casino Control Commission, and the Atlantic City and County Planning Agencies, was faced with the problem of directing and managing this expected growth. The State was concerned that ecologically sensitive lands be protected and that impacts on the existing transportation system be manageable. Local agencies wanted the jobs and urban renewal but also wanted to focus this new growth and to find a transportation solution that would provide access to casinos but would not turn Atlantic City's small island into a big parking lot. One of the areas targeted for development is a corridor along an existing railroad right-of-way that both state and local agencies felt could be a growth zone (see Figure 1).

Figure 1. Study area.



METHODOLOGY

Several research efforts have looked at possible relations between housing location and transit ridership. Most of the literature attempts to identify the impact of transit service on housing location and value (2-4) or to highlight empirical relations between transit service and housing densities (5). The objective of this work was to assess the impact of the location of housing on transit ridership and various related transportation statistics.

The technique used and described in this paper seeks to evaluate quickly a large number of alternatives, each of which consists of a housing location scheme and a transit configuration. Each transit scheme specifies a transit service that uses existing streets or a separate right-of-way. Each housing location scheme provides a specific distribution of households by zone and by type of building (i.e., apartment, duplex/single family, etc.) in the corridor. The distribution is determined by specifying total growth, the net housing density in each zone (for the developable land), and a preferred sequence of zonal development.

Each alternative is simulated and evaluated by using an interactive sketch planning model developed at Princeton University (6). The rapid (1-min) evaluation of each alternative allows the analyst to explore a wide range of possible solutions. After a first round the analyst can quickly focus on ranges of alternatives and refine them to what he or she considers optimal. In order to limit the scope of the research, the study focused on the rail mode, which appeared to offer the greatest potential for delivering workers to the boardwalk casinos and to eliminate much of the parking that would otherwise be required.

MODEL DESCRIPTION

The interactive model used in this research was partly developed under a contract from the Program of University Research, U.S. Department of Transportation. It is composed of a set of programs written in VSAPL. The model uses an array of computer graphics for both input and output (see Figures 2 and 3) and is implemented on Princeton University's IBM 3033. Within the overall package, a disaggregate modal-split model (logit), which uses U.S. Census data, predicts ridership for the transit line based on discrete combinations of mode and access mode, including walk-and-ride, park-and-ride, kiss-and-ride, and feeder bus. The program allows the ana-

Figure 2. Sample of model computer graphics output: percentage transit ridership.

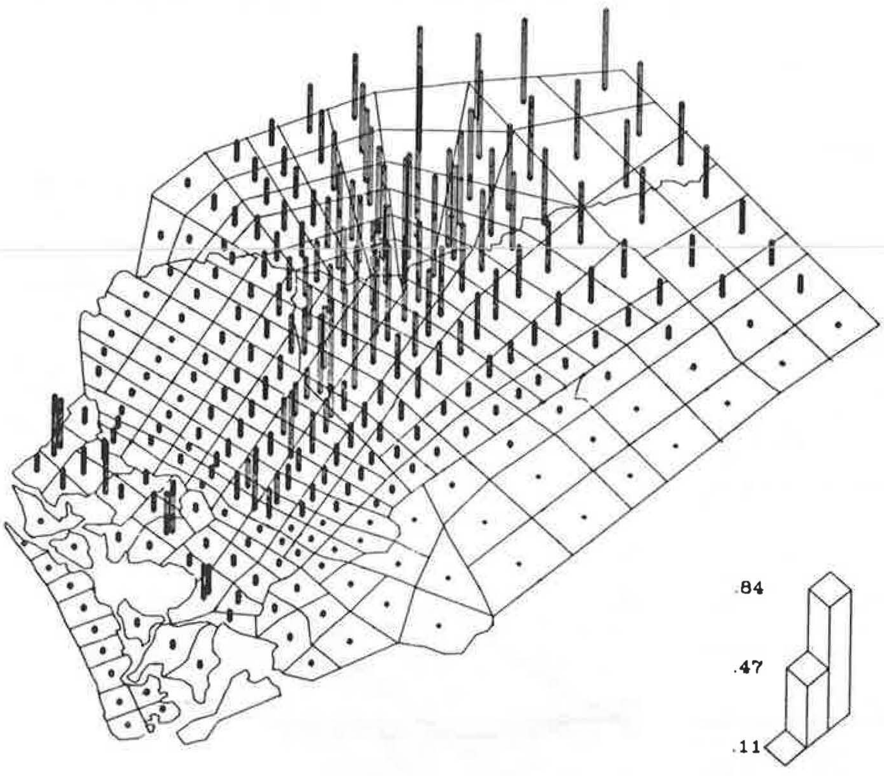
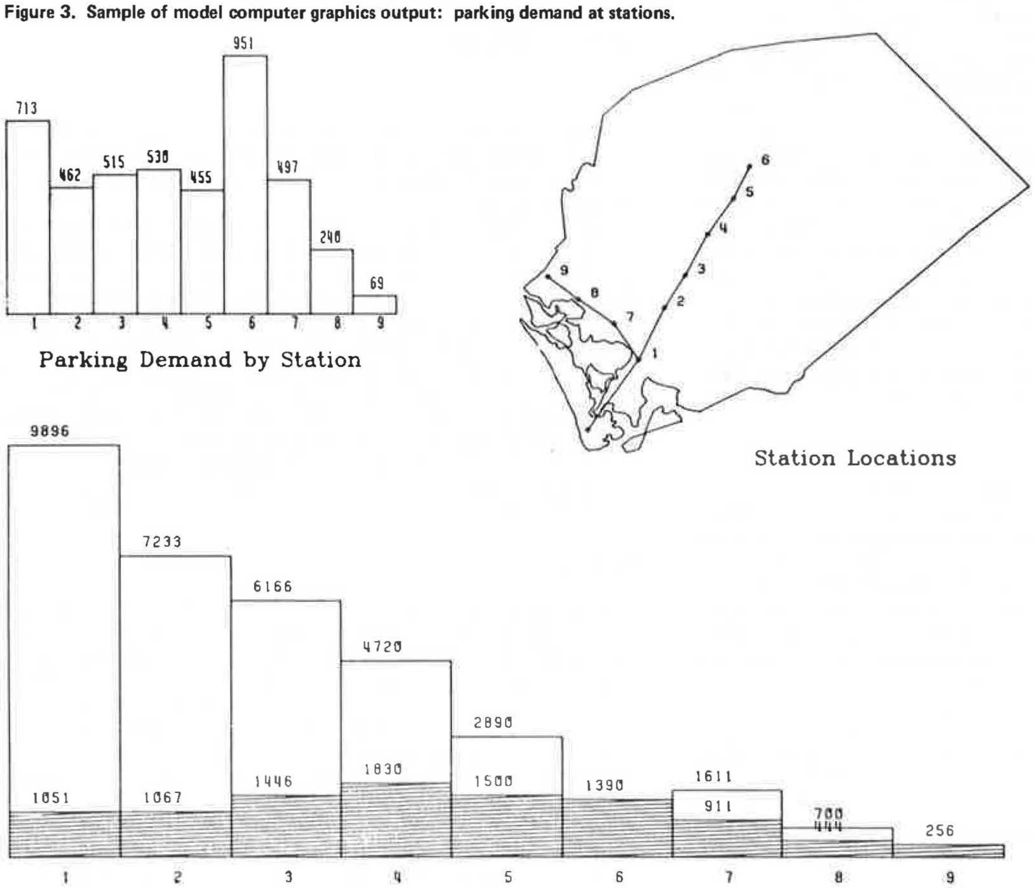


Figure 3. Sample of model computer graphics output: parking demand at stations.



lyst to input alternative residential policies by defining density and preferred location. The model allocates to the highest-priority zones as much housing as can be accommodated in the existing developable land before moving to a lower-priority order. A modal-split model, driven by more than 40 changeable parameters, evaluates the effects of the different housing patterns on projected ridership and various other transportation statistics.

Transit cost equations were developed by using the work of Pushkarev and Zupan (5) and a report on studies done for the Delaware River Port Authority (7). A more detailed description of the model and its capabilities is presented elsewhere (6,8).

CORRIDOR DESCRIPTION

The existing rail corridor (Figure 1) runs approximately 17 miles from downtown Atlantic City to the outskirts of May's Landing, the County seat. According to the 1970 Census, most of the 218 000 County residents lived in the coastal area east of the Garden State Parkway. About 40 percent of the County population lived in the remainder, which is largely composed of pinelands and wetlands marked for preservation. The study area has been divided into 269 zones based on U.S. Census tracts, on which the transportation and housing analysis was conducted. In each of these zones, the percentage of vacant land suitable for residential development has been assessed based on land use maps and aerial photographs.

RAIL TRANSIT/HOUSING SCENARIOS

A number of rail transit/housing scenarios were constructed, including a "do-nothing" alternative. These scenarios are characterized by four main features: (a) projected demand for homes (three cases), (b) rail transit configuration (three cases), (c) housing density and location (three cases), and (d) rail technology (light rail and rapid rail). The combinations of these features plus a 1980 base case amount to 55 alternatives to be analyzed and evaluated.

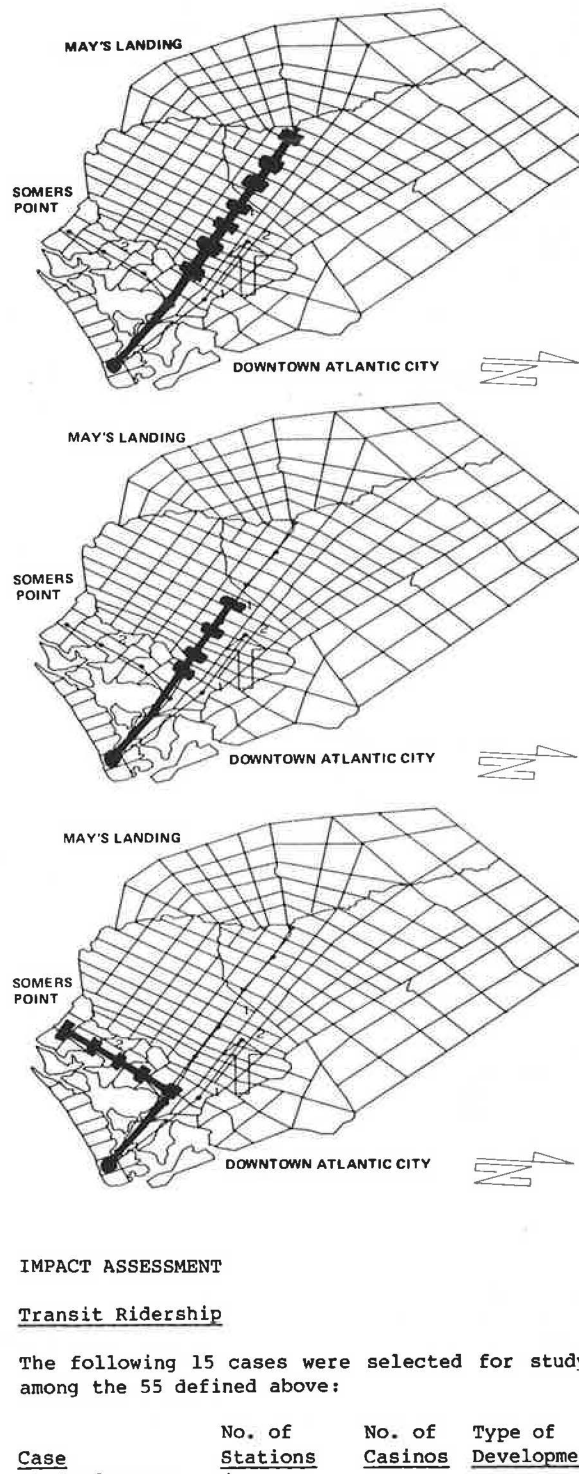
The extent of future casino construction is uncertain. Rather than attempting to project the number of casinos that will be present in any specific time period, this analysis simply isolates for examination the three scenarios of 9, 18, and 27 casinos. Based on a preliminary housing study, the demand for new homes is found to be, respectively, 16 000, 32 000, and 48 000 for the three scenarios. The rail transit configurations (see Figure 4) consist of (a) a line from downtown Atlantic City to May's Landing (seven stations), (b) a line from Atlantic City on the active portion of the right-of-way only (four stations), and (c) a line along the Pleasantville corridor toward Somers Point.

Three housing policies that prioritize development in the vicinity of the rail line were defined (station zone = 0.25 mile from a station):

Policy	Net Density (dwelling units/acre)
Sprawl development	2
Medium density	10
Mix of medium and high density	50

Light rail and rapid rail alternatives were also analyzed to compare the impacts of the two options in terms of service provided and cost of the system.

Figure 4. Transit options: (top) four-station line to May's Landing, (middle) seven-station line to May's Landing, and (bottom) line to Somers Point.



IMPACT ASSESSMENT

Transit Ridership

The following 15 cases were selected for study from among the 55 defined above:

Case	No. of Stations	No. of Casinos	Type of Development
1 (reference 1980)	4		
2	4	9	Sprawl
3	4	9	Medium density
4	4	18	Sprawl
5	4	18	Medium density
6	4	18	High density
7	4	27	High density
8	7	18	Sprawl
9	7	18	Medium density
10	7	18	High density
11	7	27	High density

Case	No. of Stations	No. of Casinos	Type of Development
12 (light rail)	4	9	Medium density
13 (light rail)	4	18	Medium density
14 (light rail)	7	18	Medium density
15 (Somers Point)	4	18	Medium density

Tables 1-3 summarize the results for these cases.

Six of these cases were further evaluated in terms of transit costs and revenues. The model shows that, if the transit line had been operating in 1980, there would only be 3347 riders/day inbound in the morning. This was considered too few to sustain operation of a rail rapid transit line. For case 2 (nine casinos, sprawl development, four stations), the model shows a ridership of 6601 riders, which constitutes a feasibility threshold in terms of

Table 1. Model output summary: ridership.

	Transit			Park-and-Ride		Kiss-and-Ride		Feeder Bus		Walk-and-Ride	
Case	Percent	Ridership	Index/ Base	Ridership	Index/ Base	Ridership	Index/ Base	Ridership	Index/ Base	Ridership	Index/ Base
1	16	3 347	100	2 716	100	308	100	270	0	32	100
2	22	6 601	197	4 394	162	1067	346	797	259	225	703
3	25	7 527	225	4 494	165	1281	416	912	296	640	2 000
4	21	8 276	247	5 584	206	1327	431	1014	329	225	703
5	29	11 541	345	6 356	234	2274	738	1572	510	975	3 047
6	31	12 201	365	6 019	222	2194	712	1498	486	2063	6 363
7	33	16 216	484	7 882	290	3187	1035	2157	700	2398	7 494
8	32	12 687	379	7 978	294	2350	763	1756	570	381	1 191
9	45	17 574	525	9 219	339	3688	1197	2533	822	1537	4 803
10	44	17 157	513	7 815	288	3115	1011	2115	687	3469	10 841
11	50	24 352	728	12 383	456	5388	1749	3661	1189	2045	6 391
12	16	4 819	144	2 158	79	834	271	592	219	437	1 366
13	19	7 369	220	4 006	147	1464	475	1011	374	652	2 038
14	30	11 886	355	6 049	223	2534	823	1725	639	1149	3 591
15	20	7 830	234	4 028	148	1467	476	1009	374	1066	3 331

Table 2. Model output summary: VMT.

	Automobile		Carpool		Park-and-Ride		Kiss-and-Ride		Total	
Case	VMT	Index/ Base	VMT	Index/ Base	VMT	Index/ Base	VMT	Index/ Base	VMT	Index/ Base
1	150 324	100	68 341	100	19 354	100	1 653	100	239 672	100
2	199 331	133	86 841	125	21 526	111	3 404	206	311 101	130
3	194 527	129	85 368	127	20 784	107	3 147	190	303 825	127
4	262 161	174	110 536	162	25 547	132	4 725	286	402 969	168
5	240 778	160	103 285	151	22 383	116	4 802	291	371 248	155
6	232 584	155	99 723	146	21 709	112	4 157	251	358 173	149
7	278 836	185	117 641	172	28 307	120	5 812	352	425 596	178
8	231 023	154	99 354	145	25 628	132	7 774	470	363 952	152
9	197 286	131	89 085	130	23 234	120	7 546	457	317 151	132
10	193 948	129	85 278	125	21 373	110	5 671	343	306 271	128
11	226 526	151	103 567	152	25 876	134	10 340	626	355 428	148
12	220 367	147	97 347	142	12 388	64	2 029	123	332 129	139
13	279 647	186	120 376	176	13 399	69	3 076	186	416 498	174
14	263 253	75	122 582	179	14 058	73	4 878	296	404 771	169
15	234 767	156	97 902	143	15 915	82	3 006	182	351 590	147

Table 3. Model output summary: trip length.

	Automobile		Carpool		Park-and-Ride		Kiss-and-Ride		Total		Transit-On-Line	
Case	Miles	Index/ Base	Miles	Index/ Base	Miles	Index/ Base	Miles	Index/ Base	Miles	Index/ Base	Miles	Index/ Base
1	12.3	100	13.9	100	7.1	100	5.4	100	11.9	100	8.6	100
2	12.0	98	13.2	95	4.9	69	3.2	59	10.8	91	9.3	109
3	12.2	99	13.4	96	4.6	65	2.5	46	10.8	91	9.6	112
4	11.8	96	12.8	92	4.6	65	3.6	67	10.7	90	9.3	108
5	12.2	99	13.2	95	3.5	49	2.1	39	10.2	86	9.95	116
6	12.0	98	13.1	94	3.6	51	1.9	35	10.2	86	9.9	115
7	12.2	99	13.0	94	2.9	41	2.0	37	9.9	83	10.0	117
8	12.2	99	13.2	95	3.2	45	3.3	61	9.9	83	12.2	142
9	12.9	105	14.1	101	2.5	35	2.0	37	9.2	77	14.0	163
10	12.3	100	13.5	97	2.7	38	1.8	33	9.3	78	13.2	153
11	12.8	104	14.0	101	2.2	31	1.8	33	8.8	74	13.7	160
12	12.4	101	13.6	98	4.4	62	2.4	44	11.2	94	9.5	110
13	12.3	100	13.3	96	3.3	46	2.1	39	11.2	94	9.9	115
14	13.6	111	14.9	107	2.3	32	1.9	35	11.2	94	14.3	166
15	10.2	83	11.7	84	3.9	55	2.0	37	9.5	80	7.6	88

initial capital investment. The model output shows that transit ridership does increase with increasing densities of development. However, the increase of transit ridership is more significant between sprawl and medium density than between medium and mixed medium-high density. For 18 casinos and a short line (four stations), the percentage of transit riders increases from 21 (sprawl) to 29 (medium) to 31 (high); for 18 casinos and a long line (seven stations), the ridership percentage increases from 32 (sprawl) to 45 (medium) and declines slightly to 44 (high). Other statistics, including vehicle miles of travel (VMT), exhibit the same trend. Figure 5 compares total VMT and transit ridership for the three housing scenarios.

Four- Versus Seven-Station Line

The seven-station line extending to May's Landing showed a drastic increase in ridership (from 29 to 45 percent) over the four-station line. This increase in ridership yields reductions of 30 percent in drive-alone VMT and 17 percent in total automobile VMT. A 45 percent increase in the demand for parking space indicates that one-half of the increase in transit ridership is attributable to the park-and-ride mode. In addition, there is a large increase in walk-and-ride from the four-station line to the seven-station line. A major impact of the seven-station line over the four-station line is a 40 percent increase in the average on-line transit trip length, which has a large effect on operating costs. The revenue/cost ratio drops from 1.22 for the four-station line to 0.72 for the seven-station configuration. Capital costs for the long line are found to be 80 percent greater than for the shorter alternative ($324 million versus $178 million).

The table below summarizes the long-line versus short-line data (projected growth with 18 casinos and medium density):

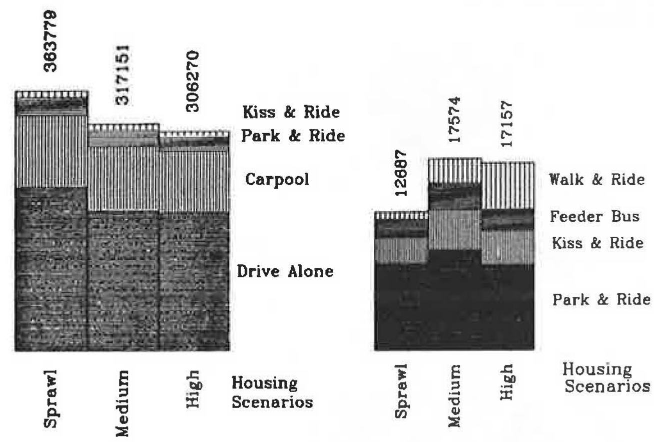
Item	Four Stations	Seven Stations
Ridership		
No. of passengers	11 541	17 574
Percent	29	45
VMT		
Drive alone	240 778	197 286
Total automobile	371 248	317 151
Avg on-line travel distance (miles)	9.95	14.0
Revenue/cost ratio	1.22	0.72
Estimated capital cost ($000 000s)	178	324

Light Rail Versus Rapid Rail

Light rail and rail rapid systems (for 18 casinos, seven stations, medium density) are compared below:

Item	Light Rail Transit	Rail Rapid Transit
Avg speed (mph)	30	40
Ridership		
No. of passengers	11 886	17 574
Percent	30	45
Farebox revenue ($000 000s)	5.8	8.6
Estimated operating expenses ($000 000s)	5.1	11.8
Avg on-line travel distance (miles)	14.3	14.0
Revenue/cost ratio	1.14	0.72
Estimated capital cost ($000 000s)	176.8	324.1

Figure 5. Comparison of three housing scenarios for 18-casino projected growth and seven-station line: (left) total VMT by automobile mode and (right) transit ridership by access mode.



A 25 percent reduction in speed (from 40 to 30 mph) from rail rapid transit to light rail results in a 35 percent drop in transit ridership. This indicates that the user is highly service oriented. With the same fare structure, the cost analysis shows that light rail exhibits a much healthier revenue/cost ratio. Further research should examine the combined impact of a reduction of the fare for light rail on ridership and revenue/cost ratio.

Medium Versus High Density

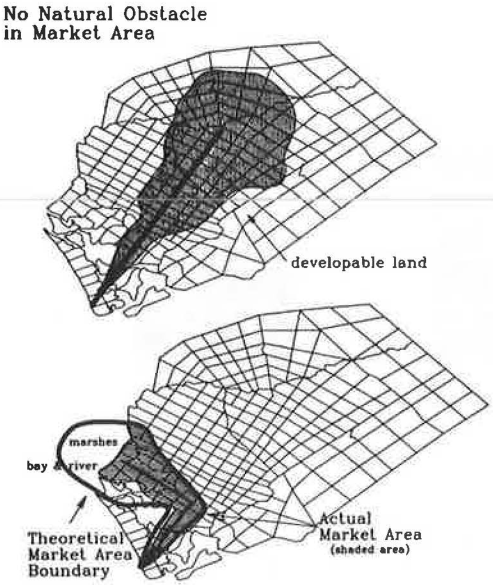
The medium-density and mixed medium- and high-density housing scenarios are compared below (projected growth with 18 casinos and a seven-station line):

Item	Mixed Density	Medium Density
Ridership		
No. of passengers	17 157	17 574
Percent	44	45
VMT		
Drive alone	193 948	197 286
Total automobile	306 271	317 151
Avg on-line travel distance (miles)	13.2	14.0
No. of park-and-riders	7815	9219
No. of walk-and-riders	3469	1537

The table indicates that total ridership for the mixed-density scheme is lower than that for the medium-density scheme. This unexpected result is explained by the fact that more high-density dwellers than medium-density dwellers can be located close to the city, which results in a slightly higher propensity to commute by car. However, other statistics show improvements from the medium-density to mixed-density schemes. The demand for parking space is relatively lower for the mixed-density scheme. In addition, the high-density policy achieves further reductions in VMT of 3 percent as well as an 0.8-mile (or 10 percent) reduction in the average on-line transit travel distance.

This reduction in passenger miles in turn reduces operating expenses. Although high-rise development in station zones does not seem justified by transit performance, as growth increases it may be critical to achieve higher-density development rates in order to conserve land. In the case of the seven-station line, for instance, high density in the station zone requires 1300 fewer acres of land than medium den-

Figure 6. Theoretical and actual market areas for two transit options: (top) line to May's Landing and (bottom) line to Somers Point.



sity and 25 000 fewer acres than the sprawl housing options.

GEOGRAPHY AND MARKET AREA

For comparative purposes, an analysis is performed on transit ridership on a line toward Somers Point on an existing right-of-way. The data exhibited in the preceding table on light rail versus rail rapid transit indicate that the ridership on this line for the 18-casino scenario is poor. The 20 percent ridership for 18 casinos (7830 riders) is less than the ridership on the May's Landing line with a medium-density scheme and a 9-casino scenario (7527 riders). However, the existing high density of development along this right-of-way creates a high percentage of walk-and-riders (1066 riders) or more than four times the level on the May's Landing line with a comparable ridership figure. This is explained by the fact that the Somers Point line is unable to capture its entire theoretical market area, since a large part of it is situated over the Great Egg Harbor and Scull's Bay (see Figure 6). In addition, since the Somers Point corridor is already developed, there is less opportunity to concentrate new growth around stations as in the May's Landing corridor.

CONCLUSIONS

The analysis reported in this paper highlights several relations and trade-offs between many aspects of a transit plan. In this particular case study, the model showed that alternative housing clustering scenarios had a substantial effect on transit ridership, cost/revenue ratios, and VMT.

The results of the model showed that medium-density development would be capable of sustaining a significant transit ridership. A preliminary housing study showed that medium-density development had the greatest potential to provide affordable housing to a cross section of the anticipated population. Therefore, medium-density development (10 dwelling units/acre) along a four-station, 11.2-mile rail rapid transit line was recommended. An additional 5.7-mile, three-station portion should be added to the existing line as a market share of 32 000 dwelling units can be achieved along the corridor. Ultimately, high-rise development in the nearby proximity of the stations should be encouraged as growth approaches 48 000 dwelling units.

The model does not lead to a single optimal solution for the following two reasons: (a) It deals with nonlinear relations (logit) and therefore cannot be defined as a standard linear programming optimization problem, and (b) the multiple objective functions consist of too many implicit or unknown relations in the transportation, social, environmental, economic, and time domains to be explicitly stated.

However, the speed and interactive nature of the model enable one to test a vast number of alternatives and possible futures in a short period of time. The model allows professionals, elected officials, or public interest groups to design, evaluate, and compare their "own" plans directly on the "screen". This would greatly facilitate the communication of results between the consultants and the decisionmaking bodies and ultimately lead to better and sounder decisions.

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