SECTION 3

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INFRASTRUCTURE ASSESSMENT

INFRASTRUCTURE ASSESSMENT

INTRODUCTION

Infrastructure is the land, hardware, or structures that are publicly owned and maintained—or privately owned and maintained for public benefit—through, from, or on which public services emerge. The infrastructure assessment is the analysis of the magnitude of future capital facilities under planned (IPLAN) versus traditional (TREND) development.

The infrastructure evaluation is performed employing five models; these include the Transportation Infrastructure (Road and Transit) Model, the Water and Sewer Demand Model, the Water Cost Model, the OSP Wastewater Cost Model, and the School Capital Facilities Model.

The CUPR Road Model uses population and vacant land estimates to derive density quotients by municipality. Varying density affects the road-lane requirements of growth. The Model evaluates the difference between TREND and IPLAN road needs according to different densities inherent in their buildouts in various locations. The Transit Model allows transit to supplant automobile use at certain thresholds of density where its use seems reasonable and can be justified.

The Water and Sewer Demand Model is driven by the household and employment projections generated by a subroutine of the Land Capacity Model. These projections, converted to different types of structures and the number of people who occupy them, form different water and sewer demand profiles. Differentials in water and sewer demand are measured according to differences in the amounts, types, and locations of residential and nonresidential structures generated by TREND or IPLAN. In general, water and sewer demand are higher in single-family detached structures than single-family attached or multifamily structures. It is also higher in suburban versus urban nonresidential structures.

The School Capital Facilities Model is driven by these same household projections. To these are added school children estimates per household as well as educational capital facilities needs per school child. These vary according to the projected user base of each facility. If the user base is large, there are less facilities and less cost per school child; if it is small, the reverse is true. TREND and IPLAN are evaluated differently to the degree that: (1) one or the other generates a larger user base in a peripheral location, or (2) one or the other develops more intensely in locations of existing infrastructure capacity.

Each of the above models contains a cost component. Thus, not only is the demand for infrastructure projected and evaluated for each alternative, the infrastructure-related costs of growth are also evaluated.

PART IA

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IMPACTS ON ROAD INFRASTRUCTURE

INFRASTRUCTURE ASSESSMENT: PART IA — IMPACTS ON ROAD INFRASTRUCTURE

BACKGROUND

The CUPR Road Model projects future road mileage needs as a function of population density. As population of a municipality or county increases, more road lane-miles are needed to accommodate the traffic generated. The curve describing the relationship is convex, which shows that the increase in lane-miles needed as population density increases is most dramatic when population density is low. The Road Model is designed to operate at two different levels—State and local. Changes in local roads are generated from new construction as well as extensions and are calculated at the municipal level. State roads, in which new construction takes the form of road widenings, are projected at the county level. Costs differentials due to the level of urbanization are applied. The Road Model differs between TREND and IPLAN on the basis of population density; IPLAN encourages density increases in relatively urban areas where the Model will predict relatively fewer roads. The Road Model is a portion of the Transportation Infrastructure Model.

CONCEPTS

How the Model Works

For the two scenarios, TREND and IPLAN, the following evaluation procedure is used:

For local road projections, 1) municipal population is projected; 2) future local road densities are calculated from population densities based on a regression of road density to population density; 3) an upper limit of 65 lane-miles per square mile of municipality is applied; 4) a lower limit of no decreases in road densities is also applied; and 5) any current unsatisfied local road demand is not included.

For State road projections, 1) county population is projected; 2) future State road densities are calculated from population densities based upon a regression of the ratio of lane-miles to center-line miles related to population density; 3) a lower limit of no decreases in road densities is applied; and 4) any current unsatisfied State road demand is not included.

The results are aggregated to the regional level; the amounts of roads built under IPLAN are then compared with the amounts of the same under TREND.

Basic Model Inputs and Outputs

The basic Model inputs for both TREND and IPLAN are the following variables: Total number of persons for each municipality, current and projected for 1995 and 2010, for both TREND and IPLAN.

- Area of each municipality
- Local center-line miles (by municipality)
- County center-line miles (by municipality)
- State center-line miles (by county)
- State lane-miles (by county)
- Costs for local and State roads (by lane-mile)
- Density designations for counties (urban/suburban/rural)

The outputs of the Model are the additional local and State lane-miles required, and the costs associated with additional local and State lane-miles.

EXPECTED DIFFERENCES BETWEEN TREND AND IPLAN

TREND may indeed generate more miles of roadway than IPLAN. This conclusion is based on nonlinearity of the Model equations, where analysis has shown that as communities become more dense, less new infrastructure is needed for additional population. State roads cost more to build in urban areas, whereas local roads do not. The overall differences between TREND and IPLAN will be apparent only after the complex trade-offs between population density, lane-miles required, and costs are worked through.

TREND FINDINGS

The CUPR Road Model is run for both State and local roads. The Model disaggregates to the county level when projecting State road needs, and operates at the municipal level for local roads. The county and State figures are then summed across the six New Jersey Council on Affordable Housing-defined regions of New Jersey[1] used in this State Plan Impact Assessment. The State road and local road models are driven by population densities. The reader is cautioned that the CUPR Road Model does not include

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1 The New Jersey Council on Affordable Housing has partitioned the State of New Jersey into six housing regions. Based on an analysis of journey-to-work patterns conducted by the Center for Urban Policy Research at Rutgers University, the State's housing regions are as follows: 1. Bergen, Passaic, and Hudson counties; 2. Essex, Morris, Union, and Sussex counties; 3. Middlesex, Somerset, Hunterdon, and Warren counties; 4. Monmouth and Ocean counties; 5. Camden, Gloucester, Burlington, and Mercer counties; and 6. Atlantic, Cape May, Cumberland, and Salem counties.

corrections for existing deficiencies in roadway infrastructure in a community. CUPR Road generates only the number of lane-miles needed to serve new population increments.

State Roads

State results are presented first (see Exhibit 1). For 1995 the CUPR Road Model projects an additional 26 lane-miles across all of New Jersey, while requiring 160 lane-miles to be added by the year 2010. The expectation is that there will be relatively little growth in terms of State highways over the next two decades. However, these State mile projections are for the additional population growth expected and do not account for current deficiencies. The reader must keep in mind that the purpose of this study is to examine differences between TREND and IPLAN, and raw numbers are less important than these differences.

There are interesting variations in projected State roadway miles by region. The Northwest region is ranked first in 1995 but drops to third among regions in the year 2010. Three regions—West Central, Southwest, and South-Southwest—are tied in second place for the additional lane-miles required by 1995. The picture shifts in the year 2010. The West Central region is ranked first in terms of additional roadway needs, followed by the Southwest region. These numbers reflect the differential growth rates for population that occur across counties within which the regions are located.

These findings indicate a relatively small need for additional State road lane-miles over the next twenty years in TREND. As pointed out earlier, the analysis here projects lane-miles to satisfy new demand only, not to rectify existing deficiencies. CUPR Road also does not include bridge replacements or special projects. The Model reflects the historical realities of the relationship between demographics and roads.

Local Roads

CUPR Road also projects local lane-miles of roadway in New Jersey for both 1995 and the year 2010 (Exhibit 3). For TREND the Model projects an additional 1,200 lane-miles of local roads for 1995, and fully 5,500 for the year 2010. The East Central region contains the largest amount of additional local lane-miles for both 1995 and 2010. While this region has 33 percent of the additional miles in 1995, it has only 25 percent of new mileage in 2010. By 2010, development pressures are growing in the West Central and Southwest regions: Each has about 22 percent of total requirements. As might be expected, the Northeast region has the lowest amount of lane-mile requirements for both 1995 and 2010. This region is heavily built-up, and there is little room for additional roadway construction.

EXHIBIT 1

STATE ROADS BY REGION
TREND CONDITIONS: 1990-2010
(in lane-miles)

	TOTAL LANE-MILES	ADDITIONAL ROAD LANE-MILES REQUIRED			
	1990	1990-1995		1990-2010	
	Number	*Number*	*Percent of Total New Roads*	*Number*	*Percent of Total New Roads*
STATEWIDE	8,950.8	25.8	100.0	159.5	100.0
NORTHEAST	1,045.5	0.5	1.9	2.1	1.3
NORTHWEST	1,665.9	7.5	29.1	26.7	16.7
WEST CENTRAL	1,673.6	5.1	19.8	51.7	32.4
EAST CENTRAL	1,354.8	1.4	5.4	14.8	9.3
SOUTHWEST	1,984.4	5.9	22.1	39.2	24.6
SOUTH-SOUTHWEST	1,226.5	5.6	21.7	25.0	15.7

Source: CUPR Road Model, 1992

EXHIBIT 2

STATE ROADS BY REGION
IPLAN CONDITIONS: 1990-2010
(in lane-miles)

	TOTAL LANE-MILES	ADDITIONAL ROAD LANE-MILES REQUIRED			
	1990	1990-1995		1990-2010	
	Number	*Number*	*Percent of Total New Roads*	*Number*	*Percent of Total New Roads*
STATEWIDE	8,950.8	20.7	100.0	132.4	100.0
NORTHEAST	1,045.5	1.0	4.8	3.7	2.8
NORTHWEST	1,665.9	4.7	22.7	17.8	13.4
WEST CENTRAL	1,673.6	5.1	24.7	44.3	33.5
EAST CENTRAL	1,354.8	1.5	7.2	14.7	11.1
SOUTHWEST	1,984.4	4.8	23.1	34.0	25.7
SOUTH-SOUTHWEST	1,226.5	3.6	17.4	17.8	13.4

Source: CUPR Road Model, 1992

EXHIBIT 3

LOCAL ROADS BY REGION
TREND CONDITIONS: 1990-2010
(in lane-miles)

	TOTAL LANE-MILES	ADDITIONAL ROAD LANE-MILES REQUIRED			
	1990	1990-1995		1990-2010	
	Number	*Number*	*Percent of Total New Roads*	*Number*	*Percent of Total New Roads*
STATEWIDE	61,771	1,177	100.0	5,493	100.0
NORTHEAST	8,817	45	3.8	272	5.0
NORTHWEST	12,298	163	13.8	732	13.3
WEST CENTRAL	10,301	208	17.7	1,184	21.6
EAST CENTRAL	9,684	388	33.0	1,390	25.3
SOUTHWEST	11,910	240	20.4	1,223	22.3
SOUTH-SOUTHWEST	8,761	134	11.4	692	12.6

Source: CUPR Road Model, 1992

IPLAN FINDINGS

State Roads

The 1995 and year 2010 state roadway projections under IPLAN are less than the TREND projections (see Exhibit 2). About 21 additional lane-miles are required for 1995, and about 132 are required for 2010. The West Central region contains the highest portion of total required miles in 1995—about 25 percent—rising to 34 percent in 2010. The Southwest region is second in required mileage for both 1995 and 2010. Again, the densely populated Northeast region has the least requirement for new roads.

Local Roads

For 1995, about 800 additional local lane-miles of roadway are required statewide (see Exhibit 4). For 2010, about 3,900 lane-miles are projected for the State. For both 1995 and 2010 the East Central region requires the most infrastructure development. This region is projected to require 27 percent of the total local mileage in 2010, a drop from the 35 percent of 1995. The next two regions—West Central and Southwest—run together for 1995 and 2010, each with 23 percent of total. The Northeast region, as usual, requires the least in new required roadways.

COMPARISON OF TREND AND IPLAN

State Roads

The overall results for both State and local roads for TREND and IPLAN are in keeping with the research findings that supported the development of the CUPR Road Model. In simple terms, already developed communities have an existing infrastructure base that requires less new transportation construction for the same population than do less densely developed areas. IPLAN requires fewer roads than TREND for new population growth. IPLAN requires 83 percent fewer lane-miles than TREND in 2010. However, the differences between dollar expenditures for 2010 for State roads—$636 million for IPLAN and $727 million for TREND—are not significant (see Exhibit 5). There is more construction in denser urban and suburban counties in IPLAN, but construction costs more in these areas. The relatively large differences between miles needed in TREND and IPLAN are not supported in terms of dollars expended.

The differences between TREND and IPLAN for State roads in 2010 vary depending upon region. The Northwest region requires one and one-half times as many miles in TREND as it does in IPLAN. In IPLAN all regions except the Northeast have fewer State lane-miles in 2010. The highly urbanized Northeast has slightly more. IPLAN

EXHIBIT 4

LOCAL ROADS BY REGION
IPLAN CONDITIONS: 1990-2010
(in lane-miles)

	TOTAL LANE-MILES	ADDITIONAL ROAD LANE-MILES REQUIRED			
	1990	1990-1995		1990-2010	
	Number	*Number*	*Percent of Total New Roads*	*Number*	*Percent of Total New Roads*
STATEWIDE	61,771	786	100.0	3,872	100.0
NORTHEAST	8,817	30	3.8	188	4.9
NORTHWEST	12,298	70	8.9	324	8.4
WEST CENTRAL	10,301	146	18.6	885	22.9
EAST CENTRAL	9,684	276	35.1	1,062	27.4
SOUTHWEST	11,910	165	21.0	880	22.7
SOUTH-SOUTHWEST	8,761	97	12.3	532	13.7

Source: CUPR Road Model, 1992

EXHIBIT 5

ANTICIPATED EXPENDITURES FOR LOCAL AND STATE ROADWAYS TREND AND IPLAN CONDITIONS, 1995-2010

	1995 (Millions of $)	2010 (Millions of $)
TREND Conditions:		
Local Roadways	$471	$2,197
State Roadways	107	727
IPLAN Conditions:		
Local Roadways	$314	$1,549
State Roadways	97	636

Source: CUPR Road Model, 1992.

is concentrating development, and encouraging roadway construction, in the more densely populated regions of the State.

Local Roads

IPLAN requires fewer lane-miles than TREND for local roads as well—more than 5,400 miles for TREND and about 3,900 miles for IPLAN. The dollar expenditures also are different: about $2.2 billion for TREND and $1.5 billion for IPLAN (Exhibit 5). There are also some variations within the regions between IPLAN and TREND for local roads in 2010. The East Central region requires the most construction for both IPLAN and TREND. Also, the West Central and Southwest regions in both IPLAN and TREND are tied for second in ranking, and, in fact, are approximately equal in number. There is a significant difference in the Northeast region. TREND has one and one-half times as much local road construction as does IPLAN for 2010. On the other hand, the Northeast region has minimal construction needs for both TREND and IPLAN.

IMPLICATIONS OF THE FINDINGS

Under what conditions would the TREND and IPLAN projections diverge even further? The answer, using the Model as the basis for the analysis, is in the projected distribution of future population growth in New Jersey. Should population become even more dispersed than is estimated under TREND, the Model would necessarily reflect that difference. Correspondingly, if there was an increased emphasis on higher-density development in already existing communities, then running the Model might show even a further reduction in roadway requirements.

There are also conditions under which the TREND and IPLAN numbers might come together. First, State roads are not necessarily built in response to population density. The analysis and Model developed here do not take into account the proposals for new construction that are on the books or that may occur over the next few years. Rather, the Model represents an idealized version of what should happen if population distributions locate according to TREND and IPLAN.

There could be reduced differences in local roads construction as well. Funding restrictions, developer contributions, and the implications of the federal Clean Air Act planning efforts could all foster a reduced focus on roadway construction in suburban and rural areas. Correspondingly, there could be increased roadway construction under IPLAN if certain of the current funding mechanisms available in the State are used widely. For example, transportation development districts set up mechanisms to foster contributions to an enhanced infrastructure within the area.

Overall, CUPR Road represents a simplified view of expected highway needs over the next twenty years. There is a nonlinear relationship between roadway needs and population density in the Model. This suggests that existing higher-density areas with currently adequate roadway capacity could accommodate additional population with relatively few additional lane-miles of construction. Of course, there may be higher levels of congestion in built-up areas as a result of increased growth, and this factor should be considered. However, many local roads are not congested, so entering congestion in the analysis requires detailed information beyond the scope of this project.

CUPR Road yields a picture of the roadway impacts of two alternate futures for New Jersey. The Model is useful at pointing out the differences that may occur in roadway infrastructure with shifts in population distribution. However, the Model is a generalized view of a highly complex system, and the results must be viewed with caution.

PART IB

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IMPACTS ON TRANSIT INFRASTRUCTURE

INFRASTRUCTURE ASSESSMENT: PART IB — IMPACTS ON TRANSIT INFRASTRUCTURE

BACKGROUND

The CUPR Transit Model utilizes net residential density, i.e., the number of dwelling units per residential acre, to predict transit ridership. It projects propensities for four different modes of transit at the municipal level. The Model suggests that any municipality with a certain threshold residential density will show a propensity for public transit. This Model does not address current conditions, e.g., why a municipality with the requisite density needed for commuter rail does not have a train station. Nor does it address why a community with an extremely low dwelling-unit density currently supports frequent express bus service. The Model differentiates between TREND and IPLAN on the basis of population change and residential or housing-unit density change. It is part of the assessment of infrastructure demand.

CONCEPTS

How the Model Works

For TREND and IPLAN, the current net residential density is calculated for each municipality utilizing municipal residential acreage and the number of dwelling units within the municipality. Output from the Land Capacity Model, used in conjunction with projected number of households, determines 1995 and 2010 net residential densities. Since TREND and IPLAN generate different numbers of households at different development intensities for municipalities, the scenarios will induce different municipal net residential densities.

After the densities are generated, the transit propensity thresholds of each transit type are compared to net residential densities. For those communities meeting or exceeding the thresholds, transit will be produced. For commuter rail, however, a municipality must not only satisfy the propensity threshold but must also be within a seven-mile corridor surrounding the rail line (within three and one-half miles from the rail line) with employee destinations to large cities such as New York City or Philadelphia. It is important to remember that each transit threshold implies a particular level of service (LOS). Therefore, if transit is indicated for a community, it will be presumed present at a given LOS.

Results from TREND and IPLAN are then compared and contrasted.

Basic Model Inputs and Outputs

Current and projected transit propensities for both TREND and IPLAN are calculated from:

- Current and projected (1995 and 2010) residential acreage by municipality for each scenario
- Current and projected (1995 and 2010) number of dwelling units by municipality
- Transit threshold dwelling-unit densities

The outputs of the Model are municipal transit propensities for each of the transit categories for both scenarios and a cost for additional bus operations. Municipalities that satisfy propensities for transit modes serving higher densities are also identified as satisfying transit modes serving lower densities, with the exception of municipalities outside commuter rail corridors.

EXPECTED DIFFERENCES BETWEEN TREND AND IPLAN

The Transit Model differentiates between TREND and IPLAN on the basis of population change and residential or housing-unit density change. Greater population increases will be placed in already built-up areas, so the likely effect is that IPLAN will generate more transit. The Model is spatially driven, so as land is consumed by increasing residential density, the propensity for transit increases. Clustering is assumed to be reflected in the IPLAN net residential density numbers. Since the propensity for transit is driven by the density of residential land, clustering may add to the chances for transit in IPLAN.

TREND FINDINGS

The CUPR Transit Model operates at the municipal level for four different modes of transit. It is then aggregated for regional analysis. Exhibit 1 shows the TREND results as well as the base year.

Transit Propensity—Statewide

State results are presented first. The most notable result is that the express bus mode generates the greatest number of municipalities. This is not surprising, considering it has the next to lowest net residential density requirements and, unlike the lowest density mode of commuter rail, is not restricted by being in a specific corridor. Commuter rail follows; low-level bus service (at 20 buses per day) is third. High-level bus service (at 40 buses per day), with its high-density requirements, has the lowest number of municipalities

EXHIBIT 1

NUMBER OF MUNICIPALITIES WITH TRANSIT PROPENSITY FOR EACH TRANSIT MODE UNDER TREND SCENARIO

(Comparison of 1990 Base to 1995–2010 TREND)

	Local Bus 40 Buses per Day (7 Dwelling Units per Acre)	Local Bus 20 Buses Per Day (4 Dwelling Units per Acre)	Express Bus Park-and-Ride (3 Dwelling Units per Acre)	Commuter Rail (2 Dwelling Units per Acre)
BASE 1990				
Statewide	84	208	269	247
Northeast	36	58	69	76
Northwest	13	40	50	60
West Central	16	30	36	32
East Central	5	29	40	34
Southwest	13	45	56	38
South-Southwest	1	6	18	7
TREND 1995				
Statewide	84	209	272	249
Northeast	36	59	69	76
Northwest	13	40	50	61
West Central	16	30	36	32
East Central	5	29	42	34
Southwest	13	45	57	39
South-Southwest	1	6	18	7
TREND 2010				
Statewide	88	216	284	270
Northeast	38	60	73	84
Northwest	13	41	52	63
West Central	17	32	36	35
East Central	6	28	46	40
Southwest	13	47	57	41
South-Southwest	1	8	20	7

Source: CUPR Transit Model, 1992

supporting transit.[1] In 1995 the Transit Model projects 249 communities supporting commuter rail service. It generates 272 municipalities amenable to express bus/park-and-ride facilities, 209 communities supporting low-level bus service, and 84 with high-level bus service. When compared to the base numbers derived from 1990 densities, there are two more commuter rail municipalities, three more for express bus, only one for low bus service, and no change for high-level bus service. The greatest change—two additional commuter rail municipalities—accounts for an increase of less than 1 percent of those that current support service. The obvious finding is that the 1990 to 1995 TREND change is insignificant. When considering these numbers, one must keep in mind that: a. they reflect a presumed level of service, and b. they suggest only municipalities with *propensities* for transit.

In 2010 the Transit Model projects 270 communities that support commuter rail. For buses, 284 communities can support express bus/park-and-ride, 216 support local buses at 20 buses per day, and 88 municipalities have sufficient density to support the high-level bus service (40 buses per day). Compared to 1990, this represents 9 percent additional commuter rail municipalities (+23), 6 percent more communities supporting express bus service, 4 percent additional for low-level bus service, and 5 percent more for high-level bus service. Overall, these numbers represent small but definable percentage increases in transit for TREND.[2]

Transit Propensity—by Region

CUPR Transit generates predictable rankings among the transit modes by region. Between 1990 and 2010, the relative rankings remain constant: the Northeast is the leader, with the most municipalities supporting transit in both years; the South-Southwest region has the fewest communities with transit propensities. After the Northeast region, the Northwest has the highest number of municipalities supporting commuter rail; in other words, the next highest number of communities with densities of two dwelling units per acre that are along rail lines. The Northwest drops to third for the other modes. The West Central region, with its large quantity of small cities, makes this region a rich area for intense local bus service. It, however, contains fewer areas with the requisite densities for

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1 For the purpose of analysis, 20 buses per day is considered to be a *low* level of bus service and 40 buses per day a *high* level of bus service. A higher level bus service indicator, at 120 buses per day and 15 dwelling units per acre, was not measured in this assessment. As indicated in ***Report I: Research Strategy—Research Design, Model Descriptions, Case Study Profiles, Variable Selection*** at Section 3, Part IB, only four of the nine different levels of service and transit modes were chosen.

2 The authors do not wish to diminish the cost of providing service to these new communities, even though costs are not predicted as part of CUPR Transit. The TREND scenario projects 23 new municipalities supporting commuter rail. If each of these were to receive both train stations and regular service this would represent a substantial cost burden to the State.

other modes than most other regions. The East Central region, next to the South-Southwest, has the sparsest concentration of housing in the State. All these numbers reflect the differential household densities that occur across counties within which the regions are located.

These findings indicate relatively small additions of new communities to the State's transit system. However, they do not show the new services—additions of routes or increases in levels of service—required within the regions. They also do not indicate the effects of TREND upon communities that are already *transit-rich*, i.e., are well above the minimum density requirements. Since transit propensity is a measure of housing units per residential acre, the next part of the analysis examines the transit effect on households. The number of households served within these communities and changes from base year to TREND 2010 provide an indication of the change in transit-richness of the area.

Households Served by Transit—Statewide and by Region

Exhibit 2 shows the households served for each of the municipalities passing the transit propensity threshold in each mode. Unlike the first part of the analysis, in which the express bus mode generates the highest municipal use of transit, commuter rail serves the most households. This occurs despite the restriction that eligible municipalities must be located within the rail corridor. In the base year, the regions showed much the same rankings as in Exhibit 1. The Northeast led the way in the number of households served by transit; the South-Southwest region—with the exception of high-level bus service—contained the least number of households served. There are slight variations in the rankings in the middle range. In TREND 2010, development continues as it has in 1990; increases in households produce nearly identical rankings. The exception is for local bus service at 40 buses per day: the East Central region incurs many more households than the South-Southwest, meaning municipalities in Monmouth and Ocean receive more households in TREND 2010 than municipalities in the counties of the South-Southwest.

The bottom portion of Exhibit 2 shows the changes in households from base to 2010 TREND. Comparison of statewide numbers across modes shows the greatest growth (almost 14 percent) in commuter rail. This demonstrates that TREND favors development in moderately low-density communities. The percentages in growth decline as one moves up the density threshold. Intense bus service grows at a small 2 percent. The regional numbers amplify the differential growth rates. These patterns are much less neat. The East Central region shows the greatest numerical growth in the lowest two density modes and, remarkably, also the greatest percentage growth in 40-bus-per-day service (nearly 86 percent). The drop in the number of households being served by the East Central region's

EXHIBIT 2

NUMBER OF HOUSEHOLDS SERVED UNDER TREND SCENARIO

(Comparison of 1990 Base to 2010 TREND)

	Local Bus 40 Buses per Day (7 Dwelling Units per Acre)	Local Bus 20 Buses Per Day (4 Dwelling Units per Acre)	Express Bus Park-and-Ride (3 Dwelling Units per Acre)	Commuter Rail (2 Dwelling Units per Acre)
BASE 1990				
Statewide	894,306	1,601,035	1,863,039	2,190,713
Northeast	404,613	536,931	577,953	634,865
Northwest	250,243	434,519	473,634	538,218
West Central	120,823	201,524	262,013	293,392
East Central	15,341	119,013	173,021	255,012
Southwest	87,555	274,778	311,519	386,336
South-Southwest	15,731	34,270	64,899	82,890
TREND 2010				
Statewide	914,091	1,734,469	2,078,571	2,494,336
Northeast	437,549	582,638	628,652	685,748
Northwest	210,952	408,648	465,448	540,334
West Central	135,482	273,529	313,913	373,576
East Central	28,495	110,317	243,919	354,427
Southwest	86,451	322,968	348,793	446,641
South-Southwest	15,162	36,369	77,846	93,609
DIFFERENCE BETWEEN TREND 2010 AND BASE 1990				
Statewide	19,785	133,434	215,532	303,623
Northeast	32,936	45,707	50,699	50,883
Northwest	-39,291*	-25,871*	-8,186*	2,116
West Central	14,659	72,005	51,900	80,184
East Central	13,154	-8,696**	70,898	99,415
Southwest	-1,104*	48,190	37,274	60,305
South-Southwest	-569*	2,099	12,947	10,719

* While communities in this region maintain sufficient densities to support this transit mode, the communities' number of households has declined from base to 2010.

** This decline reflects the loss of one community.

Source: CUPR Transit Model, 1992

20-bus-per-day service represents the loss of one community; i.e., the community falls below the requisite density threshold. The Northeast shows the largest numerical growth in the high-level local bus mode and substantial growth in the other categories, although these are only relatively small percentage increases (approximately 8 percent). The West Central region of Middlesex, Somerset, Hunterdon, and Warren shows the greatest increase in households accessible to low-level local bus service and places second in the other categories. Percentage changes range from 12 to 36 percent (in the low-level bus mode). The positive increases in the Southwest and South-Southwest region represent modest increases in households (from 6 to 20 percent).

The negative values in Exhibit 2 indicate regions in which communities have lost households from 1990 to 2010. This can result in a municipality falling below the density threshold for a particular mode (as with the East Central region's low-level bus service). Many other communities with net decreases in households will continue to maintain sufficient residential densities to support transit in that mode. The TREND scenario produces a larger number of cities and towns shrinking in number of households. The most dramatic example occurs in the Northwest, where municipalities that qualify for local and express buses have actually *decreased* in transit-richness. The southern regions are also losing households in their high-level bus municipalities. Households are shifting from high-density areas to low-density locations or areas that cannot support transit. In terms of supporting households, transit is being diffused by TREND.

CUPR Transit shows, not surprisingly, that transit is heaviest in the Northeast and lightest in the South-Southwest. Increases in the number of municipalities served by transit are fairly negligible in the TREND scenario from base year 1990 to 2010. Household changes show a different picture. The largest number of households served exist in the two northern regions. The next two largest areas are in the central and western parts of the State: West Central and Southwest. TREND to the year 2010 shows the least use of transit in the East Central and South-Southwest regions. However, household growth shows that TREND favors the East Central region. It favors communities with the low-density modes of express bus and commuter rail potential. In the TREND scenario, households shift from high-density areas to low-density locations or areas that cannot support transit.

IPLAN FINDINGS

Transit Propensity—Statewide

Exhibit 3 shows the IPLAN municipal results for each transit mode. Slight changes in the percentage of municipalities supporting transit exist for IPLAN as they did for

EXHIBIT 3

NUMBER OF MUNICIPALITIES WITH TRANSIT PROPENSITY FOR EACH TRANSIT MODE UNDER IPLAN SCENARIO

(Comparison of 1990 Base to 1995–2010 IPLAN)

	Local Bus 40 Buses per Day (7 Dwelling Units per Acre)	Local Bus 20 Buses Per Day (4 Dwelling Units per Acre)	Express Bus Park-and-Ride (3 Dwelling Units per Acre)	Commuter Rail (2 Dwelling Units per Acre)
BASE 1990				
Statewide	84	208	269	247
Northeast	36	58	69	76
Northwest	13	40	50	60
West Central	16	30	36	32
East Central	5	29	40	34
Southwest	13	45	56	38
South-Southwest	1	6	18	7
IPLAN 1995				
Statewide	82	208	270	247
Northeast	36	57	70	76
Northwest	13	40	50	60
West Central	15	30	35	31
East Central	6	30	42	35
Southwest	11	45	56	38
South-Southwest	1	6	17	7
IPLAN 2010				
Statewide	96	217	280	262
Northeast	38	58	71	82
Northwest	14	42	52	60
West Central	17	31	38	34
East Central	12	30	45	39
Southwest	13	47	56	40
South-Southwest	2	9	18	7

Source: CUPR Transit Model, 1992

TREND. Like TREND, 1995 State results for IPLAN show that express bus is the favored "municipal" mode of transit travel, followed by commuter rail. From 1990 to 1995, of the four modes of transit, only the express bus shows a gain (less than one-half of 1 percent). The Model actually generates a loss for high-level bus service (although it represents a loss of only 2 percent). Regional comparisons show insignificant changes. IPLAN 1995 generates minor shifts—gains or losses of one to two—in the number of municipalities supporting transit. Regional differences will be discussed in greater depth in subsequent paragraphs.

In 2010 under the IPLAN scenario, the largest category remains express bus, with 280 municipalities. Commuter rail is a close second, followed by low-level bus service. High-level bus service, with its high-density requirement, is now at 96. Comparing 1990 and 2010, commuter rail shows a gain of fifteen, or 6 percent additional, municipalities. Express bus and low-level local bus each produce a small increase of 4 percent. High-level bus service generates a large increase of 14 percent. IPLAN clearly favors the transit mode with the highest requisite net residential density.

Transit Propensity—by Region

Regional rankings from 1990 to 2010 are virtually identical in TREND and IPLAN. The Northeast, with its dense development, once again has the highest portion of municipalities served by transit. The South-Southwest has the least. The Northwest has the second highest number supporting commuter rail. The West Central region is notable as it is the second largest supporter of high-level bus service. The Southwest region has many medium-size municipalities supporting low-level bus service and express bus.

While relative rankings remain the same from 1990 to 2010, the regions increase at differential rates. The East Central region shows the largest overall growth in the number of municipalities supporting transit. Five new communities can support express bus and commuter rail; an additional seven can support the highest density local bus service. Seven new municipalities represent the largest increase in this category and more than double the base number. The Northeast, with its dense development, has the highest increase in commuter rail municipalities. The South-Southwest increases its low-level bus service with 50 percent more communities.

Households Served by Transit—Statewide and by Region

Exhibit 4 shows the IPLAN household numbers in the base year 1990 and in 2010. As in TREND, the highest number of households occur in the commuter rail mode. This is followed by express bus and the two local buses, inversely related to the modes' density

EXHIBIT 4

NUMBER OF HOUSEHOLDS SERVED UNDER IPLAN SCENARIO

(1990 Base to 2010)

	Local Bus 40 Buses per Day (7 Dwelling Units per Acre)	Local Bus 20 Buses Per Day (4 Dwelling Units per Acre)	Express Bus Park-and-Ride (3 Dwelling Units per Acre)	Commuter Rail (2 Dwelling Units per Acre)
BASE 1990				
Statewide	894,306	1,601,035	1,863,039	2,190,713
Northeast	404,613	536,931	577,953	634,865
Northwest	250,243	434,519	473,634	538,218
West Central	120,823	201,524	262,013	293,392
East Central	15,341	119,013	173,021	255,012
Southwest	87,555	274,778	311,519	386,336
South-Southwest	15,731	34,270	64,899	82,890
IPLAN 2010				
Statewide	1,097,179	1,824,677	2,108,765	2,541,381
Northeast	443,018	582,951	644,199	688,273
Northwest	242,008	434,137	476,687	539,207
West Central	159,250	253,655	310,739	388,030
East Central	108,131	181,901	232,893	350,299
Southwest	116,497	325,567	365,623	450,218
South-Southwest	28,275	46,466	78,624	125,354
DIFFERENCE BETWEEN IPLAN 2010 and BASE 1990				
Statewide	202,873	223,642	245,726	350,668
Northeast	38,405	46,020	66,246	53,408
Northwest	-8,235*	-382*	3,053	989
West Central	38,427	52,131	48,726	94,638
East Central	92,790	62,888	59,872	95,287
Southwest	28,942	50,789	54,104	63,882
South-Southwest	12,544	12,196	13,725	42,464

* While communities in this region maintain sufficient densities to support this transit mode, the communities' number of households has declined from base to 2010.

Source: CUPR Transit Model, 1992

requirements. The Northeast region, as usual, generates the most households that can access transit. Many of the rankings change position from the municipal to the household analysis. The Northwest becomes the second-highest supporter of high-level bus service; West Central is third. It also ranks second for low-intensity buses, supplanting the Southwest. The greatest change is in the express bus mode. Once again, the Northwest is second. West Central and Southwest are third and fourth in all categories. The South-Southwest always generates the least number of households supporting transit.

The latter portion of Exhibit 4 compares IPLAN 2010 to the base year. Examining the 1990 statewide changes in households, IPLAN produces similar increases across most transit modes. They are in the 200,000 range and, in the case of commuter rail, the 300,000 household range. Household growth and those supporting transit are rampant in the East Central region. This region gains nearly 100,000 households in the high-level local bus mode, which is six times its original number. The East Central region shows considerable gains in all other modes (ranging from 30 to 50 percent). The Northeast produces the largest increment in commuter rail, although this is only 8 percent greater than the base year. The Northwest actually shows a net loss in households: declines of 400 and 8,000 households. These, however, represent drops of only one-tenth of one percent and 3 percent. The Model generates the second largest number of households served by commuter rail in the West Central region. The South-Southwest, normally a poor showing in transit, witnesses substantial gains, from 21 percent in express bus and 36 percent in low-level local bus, to 51 percent in rail and 80 percent in high density local bus service. Clearly, IPLAN produces a larger percentage of households in the South-Southwest, a region which historically, has had too little residential density to support much transit.

CUPR Transit demonstrates that IPLAN concentrates development—increasing densities in existing municipalities—across the State. Express bus is the favored "municipal" mode of transit travel, followed by commuter rail—although the latter generates the most households. High-level local buses, the mode with the highest requisite net residential density, shows the greatest municipal increase. The densely developed Northeast has the highest portion of municipalities and households served by transit. The East Central region shows the largest overall growth in the number of municipalities supporting transit. It shows the largest household growth as well. The South-Southwest always generates the least number of households supporting transit. In the IPLAN scenario, however, it begins to show reasonable relative growth.

COMPARISON OF TREND AND IPLAN

Transit Propensity—Statewide

A comparison of TREND and IPLAN reveal that both scenarios produce similar results in the first portion of the analysis, i.e., municipalities passing the transit propensity threshold for the four transit modes. The two scenarios generate identical statewide rankings in the transit mode support among municipalities from base year 1990 through 1995 to 2010. Results indicate that the greatest propensity is for express bus service, followed by commuter rail, then low-level local buses, and finally, high-level local buses. The number of communities supporting transit grows from two to 23 in the four modes. Overall, TREND adds 48 municipalities supporting transit; IPLAN increases transit propensity above thresholds in 47 municipalities. This part of the analysis yields results that are essentially transit-neutral for two growth scenarios.

Changes from the base to 2010 represent relatively small percentage additions. With the exception of one case (IPLAN high-level bus service), all increase less than 10 percent. In TREND the largest growth is in commuter rail; the scenario generates 9 percent additional municipalities (+23) in this mode. Thus, TREND favors the lowest density transit mode. IPLAN favors high-level local bus service (an increase of 14 percent or 15 communities), the mode with the highest requisite net residential density. In contrast to TREND, IPLAN produces a modest 6-percent gain for commuter rail.

Transit Propensity—by Region

Regional rankings from 1990 to 2010 are virtually identical TREND to IPLAN. The heavily built-up Northeast contains the highest portion of municipalities served by transit. The South-Southwest has the least. The Model generates the second highest number supporting commuter rail in the Northwest region. The Southwest has many medium-size municipalities with sufficient density for low-level bus service and express bus. CUPR Transit produces identical results for both scenarios in 2010.

Households Served by Transit—Statewide and by Region

The consideration of households on the basis of transit propensities produces different results. Unlike the first part of the analysis, in which the express bus mode supports the highest municipal use of transit, statewide, commuter rail is the mode serving the most households. This occurs despite the Model's condition that eligible municipalities must be located within the rail corridor. Household analysis produces an inverse relationship of numbers of households served to residential density requirements.

The regional household rankings are identical from TREND to IPLAN; neither radically alters the transit pattern in the State. The Northeast, being the densest region, has the most households served by transit. This region is followed by the Northwest, Southwest, West Central, East Central, and, finally, the South-Southwest.

Exhibit 5 highlights the dramatic distinctions between TREND and IPLAN revealed when examining the incremental changes in households served. Statewide, TREND produces gains ranging from 20,000 to 300,000 by mode. In contrast to TREND, IPLAN produces even gains across most transit modes. The three bus service modes generate approximately 200,000 new households; commuter rail adds 300,000 households. Regional differences are quite different under the two scenarios. Under TREND, the South-Southwest gains nearly 90 percent new households for high-level bus service but lose 7 percent for low-level bus service. Under IPLAN it gains from between 30 percent and 600 percent of the base figures. IPLAN generates large percentage gains in many of the regions. Even the South-Southwest, a sparsely developed region, shows gains of 20 to 80 percent. TREND produces considerable net losses in households for some transit modes. The Northwest incurs losses of nearly 40,000 households. The losses are less severe under IPLAN. In the Northwest, losses for high-density bus service are nearly five times greater in the TREND scenario, and even worse for low-level bus service.

In TREND, households shift from high-density areas to low-density locations or areas that cannot support transit. TREND tends to decrease the transit-richness of a region. The "0.00" indicates ratios that cannot be calculated since IPLAN adds households to the region and mode, while TREND subtracts households. IPLAN concentrates and enriches already developed areas, supporting transit. The Northeast shows incremental growth of 1.05 to 1.31 times TREND. Similar findings occur for the other regions. There are some modes supported by TREND, most noticeably the West Central and East Central regions. TREND development will encourage transit growth in certain regions at the low to moderate densities.

One must be careful with comparisons of TREND and IPLAN and within modes. The Model does not consider changes in levels of service. Additions of households to these regions' modes will have significant impacts upon transit service demands. Modes have differential impacts on riders. Commuter rail, favoring the lower-density municipalities and regions, is often serving the choice rider. The Model cannot address the societal costs of not locating services for those lacking other transportation options. High-level local buses support less than half the households as commuter rail, yet these are more likely to be non-choice riders.

IMPLICATIONS OF THE FINDINGS

The overall results for transit modes for TREND and IPLAN differ somewhat from the original picture that influenced development of the CUPR Transit Model. The analysis of municipalities with transit propensity should have produced more divergent results. The Model assumed distinct differences in residential growth and density from TREND to IPLAN. Already-developed communities have existing residential density to support transit. Small towns and cities have residential development approaching transit service for the next dense mode. Growth would be targeted in such a way as to boost those municipalities close to supporting a particular mode above the threshold. There would be major growth in transit under IPLAN. Under TREND, dispersion of households to low-density areas would cause many municipalities to lose their transit propensity. Yet the actual transit propensity effect is not too different between the two scenarios. This is a consequence of the existing level of development in New Jersey. While there are development differences between TREND and IPLAN, New Jersey in many areas is a developed State with established and linked transit patterns. An incremental influence on this system under any scenario is difficult.

Household access to transit is significantly improved under IPLAN, however, which directs household growth to developed areas. This is a critical finding, particularly considering the potential loss of transit-richness in regions under TREND. IPLAN enhances transit; TREND dilutes it.

Under what conditions in CUPR Transit would the TREND and IPLAN projections diverge even further? The primary answer is in the projected distribution of future household growth and density of development in New Jersey; households could move to areas that are currently even lower-density or more sparsely occupied. In contrast, an even greater emphasis on higher-density developments in already existing communities might show enhanced additions in transit access. Altering modal density thresholds to reflect area-specific levels of service could change the reaction of the two growth scenarios. Including more municipalities in the rail corridor would create additional opportunities for commuter rail transit.

There are also conditions under which the TREND and IPLAN numbers might converge. The Model represents an idealized version of what should happen if households locate in certain densities. While public transit is suited to high-density development, it is not necessarily built in response to net residential density. The analysis and Model developed here do not take into account the complex system that influences public transit. It cannot consider the proposals or limitations for new construction and changes in service that may occur over the next few years. The historical uses and placement of transit present unique cases that are difficult to model. Most significantly, the Model does not include the prohibitive costs of adding services for one mode of transit versus another.

Further, the population and employment increases on which the Model operates may be less influential than other factors. Funding reductions, further private-public partnerships, gasoline costs, and the implications of the federal Clean Air Act could all foster a different focus on transit in urban, suburban and rural areas. For example, corporate shuttle-bus service or transit service with suburban origins and suburban destinations could be instituted to comply with the Clean Air Act. Solutions such as these could be enacted under either growth scenario.

Obviously, CUPR Transit is a simplified approach, emphasizing transit propensity rather than transit demand. There are extensive opportunities to refine the Model. A spatial model could be designed to examine transit corridors and transit zones. The Model, as constructed, cannot track individual municipalities adjacent to transit-rich neighbors or located between well-used origins and destinations. The Model could be enriched by including transit destinations, i.e., projecting employee workplaces. Data inputs would require restructuring to produce true transit analysis. Other factors could be projected, such as frequencies of use and fare structures, producing an enhanced prediction of transit demand.

CUPR Transit yields a statewide picture of the transit impacts of two alternate futures for municipalities in New Jersey. The Model is useful at pointing out the differences that may occur in public transit with shifts in households and residential density at the municipal level. However, the Model is a generalized view of a highly complex system. The results must be viewed as the first step in predicting transit use and growth.

PART IIA

—

IMPACTS ON WATER AND SEWER INFRASTRUCTURE DEMAND

INFRASTRUCTURE ASSESSMENT: PART IIA — IMPACTS ON WATER AND SEWER INFRASTRUCTURE DEMAND

BACKGROUND

This section of the infrastructure Impact Assessment compares the impacts of growth on water and sewer usage under two development scenarios—TREND and IPLAN. Water and sewer infrastructure, along with schools and transportation infrastructure, are among the components of infrastructure that must be provided to accommodate growth. One of the goals of IPLAN is to provide at reasonable cost adequate public facilities that will serve all projected growth. This analysis will determine the effect on water and sewer *demand* when development occurs at different locations and in different arrangements throughout the State. It will be followed by an evaluation of the effect of differing development locations and land-use patterns on water and sewer infrastructure *costs*. The result of this analysis will enable a comparison of water and sewer infrastructure usage and costs depending on development scenario. It will thus provide an answer to the question of whether development under TREND or under IPLAN will promote the infrastructure efficiencies and cost savings established as a Policy Goal of the Interim State Development and Redevelopment Plan.

CONCEPTS

The Water and Sewer Demand Model can be classified as a multiple-coefficient model in which two or more explanatory variables are used that are based on observed correlation with past water use. The variables selected for use in the Water and Sewer Demand Model are ones that show the variation in water and sewer demand related to land-use development patterns. The Model forecasts water and sewer demand as a function of future population and employment multiplied by use rates combined with selected variables shown to affect usage. The Model looks at residential and employee water and sewer demand separately, then combines them to arrive at total demand.

Residential water demand varies depending on total population and type of dwelling units. The Model first calculates population-driven water demand. This represents indoor water use. It then calculates the water demand by different housing-unit types. This represents outdoor water use. As part of its evaluation of the State Plan, CUPR has projected housing-unit type for each municipality. Water use rates by housing-unit type and by type of municipality (urban, suburban, rural) have been derived from water companies in the State. Type of municipality is important because outdoor water demand has been found to be higher in suburban areas where lot sizes are larger.

The approach to estimating residential sewer demand and employee water and sewer demand is similar. Residential sewer demand is calculated by applying a per capita sewer rate to population estimates. Employee water demand and employee sewer demand are calculated by applying water and sewer use rates to employee estimates. Residential and employee water demand per municipality are combined to arrive at a total water demand estimate. The same is done to estimate total sewer demand. Water and sewer demand estimates can then be compared for growth under TREND and IPLAN.

The inputs for the TREND analysis consist of the following:

- Projected population by municipality
- Projected number of households by municipality by dwelling-unit type
- Per capita water demand rate
- Per dwelling unit water demand rate by dwelling unit type by type of municipality
- Per capita sewer demand rate
- Employee projections by municipality
- Per employee water demand rate
- Per employee sewer demand rate

Outputs consist of total water and sewer demand by region and for the State as a whole.

Inputs for the IPLAN analysis include those listed above for the TREND analysis. While both growth scenarios limit the extension of water and sewer infrastructure in environmentally sensitive areas, the IPLAN scenario assumes less extension of infrastructure. In addition, the IPLAN analysis assumes that a greater proportion of multifamily units will be built, lowering water demand for these units. Outputs for the IPLAN analysis are the same as for TREND, namely, total water and sewer demand by region and for the State as a whole.

EXPECTED DIFFERENCES BETWEEN TREND AND IPLAN

A reasonable assumption is that under TREND residential development patterns will continue to be characterized by relatively low-density development comprised predominantly of single-family homes. Density is particularly important in water demand, because large lots consume more water than small lots. The larger the lot size, the more water necessary to serve the same number of housing units. By reducing outdoor space, by increasing development intensities, and/or by changing landscaping practices, a larger number of housing units can be served by the same amount of water. Clustered multifamily units, for example, is a residential pattern that produces lower water demand. If IPLAN directs new residential development to existing developed areas with smaller lot sizes, to multifamily units, and/or to clustered single-family units, water demand will be less under IPLAN than under TREND. The Model measures these differences by taking into consideration dwelling-unit type and the area where development is occurring under TREND compared to IPLAN.

ASSUMPTIONS AND DATA PARAMETERS

A major assumption in the analysis is that residential development under TREND will be characterized by larger lot sizes and more single-family units than under IPLAN. CUPR projections assume that, while there will be some movement towards a greater share of single-family attached and multifamily units and towards clustered development under TREND, more will occur under IPLAN. Another assumption is that development will be encouraged in more urban areas of the State. Therefore, outdoor water use should be less under IPLAN. The daily water use rates used in the Model to estimate outdoor water use were derived from the Hackensack Water Company and verified with other experts on water use. The rates represent actual usage posted by different types of housing units in different types of municipalities in various parts of the State. These values are as follows:

AVERAGE OUTDOOR WATER USE
BY DWELLING-UNIT TYPE BY AREA
(gallons of water per day)

Dwelling-unit Type	AREA: Urban	AREA: Suburban/Rural
SFU Detached	30	50
SFU Attached	5	25
2–4 MFU	5	25
5+ MFU	5	15

A further assumption is that a greater proportion of single-family units will be clustered under IPLAN than under TREND. The IPLAN analysis assumes that 15 percent of single-family units are clustered, thus lowering the amount of water needed for outdoor purposes.

Per capita indoor water use for both TREND and IPLAN is estimated at 75 gallons per day, a value that is commonly found in the literature and used for design purposes. The same rate was estimated for per capita sewer use on the assumption that all, or virtually all, indoor water use would be returned to the sewers. It was assumed that water used outdoors would not return to the sewers. Also, for both TREND and IPLAN, employees were assumed to use 25 gallons of water per day, with sewer demand identical to water demand. These figures were derived from the New Jersey Department of Environmental Protection and Energy.

To capture the assumption that the extension of water and sewer infrastructure will be limited in environmentally sensitive areas, both the TREND and IPLAN analyses assume a 0-percent increase in water and sewer demand in rural communities in Atlantic, Burlington, and Ocean counties. In addition, no increase in water and sewer infrastructure is foreseen for rural communities in the State under IPLAN, compared to a 35-percent extension in these communities under TREND. These assumptions underestimate water and sewer demand associated with new and expanded Centers in rural areas that may subsequently be identified in IPLAN as a result of negotiations with counties and municipalities through the Cross-acceptance process.

It is important to stress that the purpose of this analysis is to compare relative differences in water and sewer demand under different land-use growth scenarios. The purpose is not to arrive at absolute demand numbers. The demand estimates are not intended to demonstrate actual needs, but rather, serve as a basis on which comparisons can be made.

TREND FINDINGS

Water Demand

Changes in water demand from 1990 to 1995 and from 1990 to 2010 for development under TREND are shown in Exhibit 1. Under TREND, between 1990 and 1995, the State will experience an increase in water demand of 7.89 million gallons a day. Between 1990 and 2010, the increase in water demand under TREND will be 60.13 million gallons a day. The regional figures show variation, with water demand diminishing between 1990 and 1995 in the Northeast and the Northwest regions. Water demand in the Northwest region continues to diminish between 1990 and 2010 as well. These findings reflect the population losses projected for the two regions during these time periods. Because there are fewer people, water demand is reduced.

Sewer Demand

Changes in sewer demand from 1990 to 1995 and from 1990 to 2010 for development under TREND are shown in Exhibit 1. Under TREND, between 1990 and 1995, the State will experience an increase in sewer demand of 4.89 million gallons a day. Between 1990 and 2010, the increase in sewer demand under TREND will be 46.10 million gallons a day. As for water demand, the regional figures show variation, with

EXHIBIT 1

WATER AND SEWER DEMAND
(in millions of gallons per day)

	Change 1990-1995			Change 1990-2010		
	TREND	IPLAN	TREND as a Percent of IPLAN	TREND	IPLAN	TREND as a Percent of IPLAN
Water Demand						
State Total	7.89	7.54	104.0	60.13	57.52	104.5
Northeast	-0.16	-0.17	106.3	6.13	6.02	101.8
Northwest	-2.73	-2.78	101.8	-4.84	-5.08	105.0
West Central	2.60	2.62	99.2	18.58	18.40	101.0
East Central	4.59	4.61	99.6	18.17	18.20	99.8
Southwest	2.85	2.55	111.8	18.35	16.90	108.6
South-Southwest	0.74	0.72	102.8	3.74	3.07	121.8
Sewer Demand						
State Total	4.89	5.18	94.4	46.10	46.69	98.7
Northeast	-0.37	-0.37	100.0	4.98	4.98	100.0
Northwest	-3.04	-2.93	96.4	-6.32	-5.87	92.7
West Cental	2.04	2.14	95.8	15.70	16.03	97.9
East Central	3.53	3.68	95.9	14.14	14.70	96.2
Southwest	2.17	2.07	104.8	14.89	14.42	103.3
South-Southwest	0.55	0.59	93.2	2.80	2.43	115.2

Note: In some regions, water demand and sewer demand diminish under both TREND and IPLAN growth scenarios. In these cases, the higher value indicates a greater reduction in demand. For these regions, the TREND projections have been divided by IPLAN projections in order to express the relationship appropriately.

Source: CUPR Water and Sewer Demand Model, 1992.

sewer demand diminishing between 1990 and 1995 in the Northeast and the Northwest regions and in the Northwest region between 1990 and 2010. The findings for sewer demand also reflect the population losses during the two time periods in these regions.

IPLAN FINDINGS

Water Demand

Changes in water demand from 1990 to 1995 and from 1990 to 2010 for development under IPLAN are also shown in Exhibit 1. Under IPLAN, between 1990 and 1995, the State will experience an increase in water demand of 7.54 million gallons a day. Between 1990 and 2010, the increase in water demand under TREND will be 57.52 million gallons a day. As under TREND, the regional figures show variation, with water demand diminishing between 1990 and 1995 in the Northeast and the Northwest regions. Water demand in the Northwest region continues to diminish between 1990 and 2010 as well. Water demand is reduced due to the population losses projected for the two regions during these time periods under IPLAN.

Sewer Demand

Changes in sewer demand from 1990 to 1995 and from 1990 to 2010 for development under IPLAN are also shown in Exhibit 1. Under IPLAN, between 1990 and 1995, the State will experience an increase in sewer demand of 5.18 million gallons a day. Between 1990 and 2010, the increase in sewer demand under TREND will be 46.69 million gallons a day. As under TREND, the regional figures show variation, with sewer demand diminishing between 1990 and 1995 in the Northeast and the Northwest regions and in the Northwest region between 1990 and 2010. Sewer demand under IPLAN, as under TREND, is declining in these regions due to projected population losses.

COMPARISON OF TREND AND IPLAN

Water Demand

A comparison of the findings in water demand for TREND and IPLAN is shown in Exhibit 1. Changes in the amount of water demand are indicated for the time periods 1990 to 1995 and 1990 to 2010. The change in water demand under TREND conditions will be 60 million gallons a day from 1990-2010; the comparable figure for IPLAN is 57.5 million gallons a day, thus reflecting a savings of 2.5 million gallons of water a day for the entire State if development follows the IPLAN scenario. The amount saved represents indoor water use for 33,000 additional persons.

The final column in the Exhibit for each time period gives percentages of demand under TREND compared to IPLAN. A finding of 100 percent would indicate that demand is the same under TREND and IPLAN, a finding of more than 100 percent indicates that demand under TREND is higher than under IPLAN, and a finding of less than 100 percent indicates that demand is higher under IPLAN. If demand is declining, as, for example, in the Northeast and the Northwest regions, the development scenario associated with higher water decline obviously indicates less water usage.

The exhibit shows that, overall, development under the IPLAN growth scenario is associated with reduced water demand. Between 1990 and 1995, an additional 4 percent of water is required to service development under TREND, and the figure increases to 4.5 percent between 1990 and 2010. Thus, the amount of water to be saved under the IPLAN development scenario can be expected to increase as time goes on. In terms of regional differences between TREND and IPLAN, only in the West Central and East Central regions between 1990 and 1995 is water demand higher under the IPLAN scenario, and by 1990 to 2010, just the East Central region remains with a higher water demand. The higher demand for water in the East Central region under IPLAN reflects the greater concentration of population. Under TREND, the population is more dispersed, resulting in a reduced demand on the public water system.

These findings reflect the fact that although water demand for indoor use remains the same for TREND and IPLAN, outdoor use varies between the two growth scenarios. Outdoor water use, it will be recalled, is calculated according to dwelling-unit type and area, with more water used by single-family units and in suburban and rural municipalities. In IPLAN, the greater number of multifamily units and single-family attached units, and the clustering of some single-family detached units to achieve a higher intensity of land use, result in lower water demand for outdoor water use. In addition, the shifting of a greater share of development from suburban and rural areas to urban municipalities, where lot sizes tend to be smaller, also lowers water demand.

An even greater reduction of water demand could be achieved under a number of conditions. These include clustering a greater proportion of single-family units, thus increasing the intensity of land use, building more multifamily or single-family attached units, or shifting more residential development to urban areas. The opposite patterns would increase water demand, namely, spreading out single-family units, increasing the proportion of single-family over multifamily units, and shifting more residential development to suburban and rural areas.

To the extent that water is an inexhaustible resource, the amount of water demand under different development scenarios is merely an interesting exercise. Experience with water shortages in various parts of the State over the last ten years shows that this is not the case. A development scenario that reduces the amount of water demand is preferable over one that does not, as the future points to more and more water supply problems.

Sewer Demand

A comparison of the findings in sewer demand for TREND and IPLAN can also be obtained from Exhibit 1. Changes in the amount of sewer demand are indicated for the time periods 1990 to 1995 and 1990 to 2010. The change in sewer demand under TREND conditions totals 46.1 million gallons a day between 1990 and 2010; the comparable figure for IPLAN is 46.69 million gallons a day. Thus, development under IPLAN is associated with slightly more sewer demand than under TREND. The gap appears to be closing, however. Between 1990 and 1995, development under TREND has 5.6 percent less sewer demand than development under IPLAN. Between 1990 and 2010, development under TREND has only 1.3 percent less sewer demand.

In terms of regional differences between TREND and IPLAN, the findings for sewer demand mirror those for water demand, with regions expected to experience population decreases exhibiting a reduction in sewer demand. Like water demand, sewer demand is higher in the West Central and East Central regions between 1990 and 1995 under the IPLAN scenario, to which must be added the South-Southwest region. From 1990 to 2010, however, only West Central and East Central regions remain with a higher sewer demand. These higher sewer demands under IPLAN reflect the greater concentration of population. Under TREND, the population is more dispersed. While demand exists, it is more likely to be satisfied by on-site private systems.

These findings reflect the fact that sewer demand is measured in terms of indoor water use which does not vary between TREND and IPLAN. This is in contrast to outdoor water use, which does vary between the two growth scenarios, with more water used by single-family units and in suburban and rural municipalities. Water used outdoors does not contribute to sewer demand. Differences in values between TREND and IPLAN for sewer demand, therefore, can be attributed to differences in population concentrations under the two growth scenarios. TREND, because population is spread out more, would be expected to have a lower sewer demand.

It should be added that other factors, such as infiltration and inflow, contribute to sewer demand. There are geographic dimensions to sewer demand from this source, because infiltration and inflow tend to be more prevalent in older, urban sewer systems. However, infiltration and inflow will not vary depending on development scenario. It was therefore assumed that sewer demand from this source would be identical under TREND and IPLAN and was not included as part of the calculations of total sewer demand. The impact of infiltration and inflow on sewer costs, however, will be addressed in the next section, which covers both water and sewer infrastructure costs.

PART IIB

—

IMPACTS ON WATER AND SEWER INFRASTRUCTURE COSTS

INFRASTRUCTURE ASSESSMENT: PART IIB — IMPACTS ON WATER AND SEWER INFRASTRUCTURE COSTS

WATER INFRASTRUCTURE

BACKGROUND

The preceding analysis has focused on differences in water and sewer demand under the TREND and IPLAN growth scenarios. This section compares the impacts of different growth patterns on water infrastructure costs. It will be followed by an evaluation of the effect of differing development locations and land-use patterns on sewer infrastructure costs. As a result of the analysis, water and sewer infrastructure costs of development under the different growth scenarios are compared, thus providing an answer to the question of whether development under TREND or IPLAN will promote the infrastructure efficiencies and cost savings established as a Policy Goal of the Interim State Development and Redevelopment Plan.

CONCEPTS

The Water Cost Model is a needs-based model. It estimates residential water infrastructure costs by disaggregating infrastructure needs based on the type of community where development is occurring. Water infrastructure needs differ depending on the community experiencing growth. In rural areas, access to infrastructure is difficult or nonexistent; where individual wells are not able to serve new development, new water infrastructure is required. In urban and suburban areas, units can generally be hooked up to existing service. The Water Cost Model therefore bases water infrastructure needs and costs on community type.

Once a determination of community type has been made, the number of hookups required to service the projected development must be calculated. When water treatment plants and distribution systems are designed, their size is determined by the number of houses or buildings they will serve, with costs calculated on the number of hookups required. As part of its analysis of the State Plan, CUPR has estimated net changes in the housing supply by unit type for every municipality in New Jersey. The Model assumes that each single-family unit will require a hookup to the water supply. One hookup for every four multifamily units is calculated, although in actual practice fewer hookups will probably be necessary. By overstating the number of hookups, the proper size water treatment plant required to service the new population is estimated.

In rural communities, the Model assumes that new developments containing fewer than 50 units (or hookups) will be served by private wells and that new developments containing 50 units (hookups) or more will require construction of central treatment facilities. Private wells and associated distribution system and hookup costs amount to $2,500 per hookup in southern New Jersey rural areas and $3,500 per hookup in northern New Jersey rural areas, with the cost differential reflecting the type of soil found in each area. The following per-hookup breakdown gives the costs of water treatment facilities and distribution system costs:

Number of Hookups	*Cost*
50-149	$ 500,000
150-499	750,000
500+	1,250,000

In suburban and urban communities, the Model assumes that new development will be served by current water treatment facilities. The cost per hookup, therefore, becomes a function of the cost of the distribution system. The distribution system cost is calculated by the Model at $2,000 times the number of hookups per municipality. Total water infrastructure costs will be the sum of all rural, suburban, and urban water infrastructure costs. (All cost estimates have been supplied by the New Jersey Department of Environmental Protection and Energy [NJDEPE].)

For the TREND analysis, the basic concepts are as described above. For the IPLAN analysis, it is assumed that a portion of the single-family units are clustered. Cost savings from clustering can be estimated at 15 to 20 percent of distribution system costs, and distribution system costs comprise 42 percent of total water infrastructure costs. Thus, in rural areas, it is possible that 42 percent of costs can be reduced for those units that are clustered. In suburban and urban communities, cost reductions from clustering affect total water infrastructure costs since the costs incurred in suburban and urban areas are for distribution systems. Of course, not all single-family units are clustered in IPLAN.

Inputs for the TREND analysis consist of the following:

- Assignment of municipalities into rural, suburban, and urban categories
- Assignment of municipalities into northern and southern New Jersey
- Projected net change in housing supply by municipality by housing-unit type
- Well and hookup costs per dwelling unit
- Water facility costs

Outputs consist of water infrastructure costs. Cost estimates are calculated by region and for the State.

The inputs for the IPLAN analysis include those listed above for the TREND analysis. In addition, the IPLAN analysis assumes that a portion of the projected single-family component of the housing supply will be clustered, lowering water distribution costs for these units. Water distribution system rates for clustered units are calculated as well as for non-clustered units. Outputs for the IPLAN analysis are the same as for TREND, namely water infrastructure costs. Cost estimates are calculated by region and for the State as a whole.

EXPECTED DIFFERENCES BETWEEN TREND AND IPLAN

Water supply infrastructure costs for development under TREND are expected to differ from IPLAN in several ways. First, the development scenario favoring more clustering will experience lower distribution system costs. Where there is more clustering of housing units, shorter pipe lengths are needed to serve the development resulting in cost savings. Second, to the extent that new development occurs in rural municipalities rather than suburban and urban municipalities, water infrastructure costs will be higher due to the construction of water treatment plants, except as the number of units increases and per-unit costs are reduced. Costs will be lower when development occurs in rural areas on a large scale. The Model is able to calculate these differences because it takes into consideration land-use patterns, which affect distribution system costs, and the location of new development, which affects the need for water treatment facilities.

ASSUMPTIONS AND DATA PARAMETERS

The major assumption underlying the Water Cost Model is that residential water infrastructure needs can be estimated according to the type of community where development is occurring. The Model assumes that if new growth is occurring in rural communities, access to infrastructure is nonexistent or difficult. Individual wells will serve small scattered development, but new water infrastructure will be required to serve larger developments in rural areas. In urban and suburban communities, the Model assumes that units can generally be hooked up to existing service. Municipalities have been assigned in the Model to rural, suburban, and urban categories depending on the presence of an existing water supply system. The same assignment is assumed for both projected time periods and for both TREND and IPLAN development scenarios. Municipal assignment was verified with NJDEPE.

Cost assumptions for water infrastructure components—wells, distribution systems, water treatment facilities—for both TREND and IPLAN have been described above. In addition, the Model assumes that 15 percent of the new single-family housing supply in the IPLAN growth scenario will be clustered. Cost savings from clustering is estimated at 15 percent of distribution system costs, with distribution system costs comprising 42 percent of total water infrastructure costs. Thus, in rural communities, 42 percent of costs are reduced by 15 percent for clustered units. However, if development in rural areas consists of fewer than 50 units, the Model assumes that each housing unit will be served by a private well and no savings in distribution system costs is calculated. In suburban and urban communities, cost reductions achieved from clustering affect total water infrastructure costs for those single-family homes that are clustered, since the costs incurred in suburban and urban areas are for distribution systems.

For the IPLAN analysis, clustering of 15 percent of single-family detached housing in rural areas results in the following water infrastructure cost estimates:

Number of Hookups	*Cost of New Distribution Systems*
50–149	$ 495,275
150–499	742,912
500+	1,238,187

In suburban and urban areas, the distribution system cost is calculated by the Model at $2,000 times the number of hookups per municipality. For the 15 percent of single-family units assumed clustered under IPLAN, water infrastructure costs are estimated at $1,700 for these units, reflecting savings in distribution system costs.

TREND FINDINGS

Residential water infrastructure costs for development under TREND are shown in Exhibit 1. It is important to note when reviewing these costs that the purpose of this evaluation is to examine differences between TREND and IPLAN. TREND and IPLAN outputs per se are therefore less important than the differences. Rural, suburban, and urban water infrastructure costs have been combined in the exhibit to arrive at total costs. Total water infrastructure cost to service residential development under TREND from 1990 to 1995 is estimated at $147 million and from 1990 to 2010 at $634 million. Regional cost figures for the latter time period are as follows: Northeast region—$70 million; Northwest region—$72 million; West Central region—$118 million; East Central region—$162 million; Southwest region—$154 million; and South-Southwest region—$58 million.

EXHIBIT 1

RESIDENTIAL WATER INFRASTRUCTURE COST
(in millions of dollars)

	TREND		IPLAN		Difference Between TREND and IPLAN	
	1990–1995	1990–2010	1990–1995	1990–2010	1990–1995	1990–2010
State Total	$146.7	$634.3	$136.3	$573.3	$10.4	$61.0
Northeast	14.0	70.1	14.9	68.1	-0.9	2.0
Northwest	20.5	72.4	14.2	48.6	6.3	23.8
West Central	26.9	117.5	25.3	117.0	1.6	0.5
East Central	31.9	162.0	35.3	152.6	-3.4	9.4
Southwest	36.6	154.3	33.5	134.0	3.1	20.3
South-Southwest	16.9	58.0	13.2	53.1	3.7	4.9

Source: CUPR Water Cost Model, 1992.

Residential water infrastructure costs under TREND conditions for the time period 1990-2010 thus range from a low of $58 million in the South-Southwest region to a high of $162 million in the East Central region. These differences reflect regional variations in changes in the housing supply. Higher water infrastructure costs are observed for regions undergoing the greatest population increases and increases in the housing supply. The more sparsely populated areas have lower costs when water is supplied by private wells.

IPLAN FINDINGS

Residential water infrastructure costs for development under IPLAN are also shown in Exhibit 1. The 1990-1995 and 1990-2010 water cost projections under IPLAN are less than under TREND. The total cost of water infrastructure required to service residential development under IPLAN from 1990 to 1995 is estimated at $136 million and from 1990 to 2010 at $573 million. Regional cost figures are as follows: Northeast region—$68 million; Northwest region—$49 million; West Central region—$117 million; East Central region—$153 million; Southwest region—$134 million; and South-Southwest region—$53 million.

Water infrastructure costs under IPLAN conditions thus range from a low of $49 million in the Northwest region to a high of $153 million in the East Central region. As under the TREND development scenario, the areas of highest water infrastructure costs are in the parts of the State where the greatest amount of development is expected to occur, with differences reflecting regional variations in net changes in the housing supply. As under TREND, higher water infrastructure costs are observed for regions undergoing the greatest population increases and increases in the housing supply. The more sparsely populated areas have lower costs, especially when water is supplied by private wells.

COMPARISON OF TREND AND IPLAN

Water infrastructure costs for TREND and IPLAN are compared in Exhibit 1. It is evident that development under the IPLAN growth scenario is associated with reduced water infrastructure costs. Use of existing infrastructure, greater clustering, and more attached and multifamily units produce savings of $61 million between 1990 and 2010 in IPLAN- versus TREND-directed growth, or approximately 10 percent. For the regions, the following savings are produced: Northeast region—$2 million; Northwest region—$24 million; West Central region—$1 million; East Central region—$9 million; Southwest region—$20 million; and South-Southwest region—$5 million.

While there are short-term savings under TREND in the Northwest and East Central regions, differences between 1990 and 2010 show savings if development follows IPLAN land-use patterns. Under TREND development, greater concentrations of population are expected in undeveloped areas, thus achieving economies of scale in infrastructure costs in these regions. Under IPLAN, growth is redirected from undeveloped areas to areas with existing infrastructure. By 2010, clustering of single-family units, a greater proportion of multifamily units, and use of existing infrastructure have resulted in greater savings in these regions as well as in the rest of the State.

An even greater reduction of water infrastructure costs could be achieved under a number of conditions. These include clustering a greater proportion of single-family units, thus increasing the intensity of land use; building more multifamily or single-family attached units; and shifting more residential development to areas where infrastructure already exists. The opposite patterns would increase water infrastructure costs, namely, spreading out single-family units, thus reducing development intensity; increasing the proportion of single-family over multifamily units; and shifting more residential development to rural areas where new infrastructure must be built. The clustering factor, for example, used in the Model to estimate the amount of clustering of single-family dwelling units under IPLAN was 15 percent. This rather conservative estimate was selected because while compact patterns of development under IPLAN are encouraged, the municipalities are responsible for delineating their own form. It seems likely, however, that clustering will occur at higher levels than that estimated in the Model, which would have the effect of further reducing water infrastructure costs.

The cost of water infrastructure under different development scenarios is an important ingredient in overall housing and development costs. Thus, the development scenario that reduces the cost of water infrastructure is preferable over one that does not. As development costs are reduced, housing costs can also be reduced, an important consideration given the housing affordability crisis.

SEWER INFRASTRUCTURE

BACKGROUND

This section compares sewer infrastructure costs under two development scenarios—TREND and IPLAN. Sewer infrastructure, along with water treatment facilities, transportation infrastructure, and schools, are among the components of infrastructure that must be provided to accommodate growth. As has been discussed, one of the goals of IPLAN is to provide at reasonable cost adequate public facilities that will serve all projected growth. This analysis will determine the effect on sewer infrastructure costs when development occurs at different locations and in different arrangements. The result of this analysis will enable a comparison to be made of sewer infrastructure costs depending on development scenario. It will thus provide an answer to the question of whether development under TREND or under IPLAN will promote the infrastructure efficiencies and cost savings established as a Policy Goal of the Interim State Development and Redevelopment Plan.

The costs derived in this section for sewer infrastructure differ from the costs derived for other infrastructure in that they include *all* sewer infrastructure costs, not just the costs associated with new growth. This difference is due to the data source used to estimate needs—the Needs Assessment, a survey conducted by the New Jersey Department of Environmental Protection and Energy on a biennial basis for the U.S. Environmental Protection Agency. The Needs Assessment collects information from public wastewater facilities on present and future service levels, infrastructure needs, and capital costs. Thus, the costs derived include the costs of bringing existing treatment facilities up to meet public health and water quality standards, not just the costs of providing additional service to meet new demand.

CONCEPTS

CUPR used the Office of State Planning's Draft Wastewater Cost Model on which to base sewer infrastructure cost estimates. The strength of OSP's Model lies in its usage of data collected in the Needs Assessment to calculate identified wastewater infrastructure needs. The Needs Assessment is a biennial survey conducted by the New Jersey Department of Environmental Protection and Energy for the U.S. Environmental Protection Agency containing detailed information on all publicly owned wastewater treatment facilities. The data show that wastewater infrastructure needs vary considerably throughout the State. Some treatment facilities are virtually at capacity, while others have ample capacity. Some need upgrading to meet Clean Water standards. The Model, which is a needs-based model, reflects these specific differences in infrastructure needs statewide.

In the first step, the Model takes municipal population and employment projections, assigns them to the sewer agency providing service to the municipality, and calculates the number of people and jobs receiving treatment in each public system. Next, the service forecasts are converted into sewer flows. The third step estimates the total capital costs for each sewer facility to provide the required service. Where specific cost information has not been provided by the facility, the Model calculates estimated costs, following EPA's cost-estimating procedures. The final step of the Model assigns facility capital costs to the municipalities served by the facilities.

The inputs for the sewer cost analysis consist of the following:

- Population and employment projections
- Sewer demand multipliers
- Facility, interceptor, and collector cost estimates
- Regional cost adjustment values and inflation factors
- Number of persons per dwelling unit by county
- Net residential density by municipality
- Assignment of counties into regions

Outputs consist of sewer infrastructure costs. Cost estimates are calculated for regions and for the State.

EXPECTED DIFFERENCES BETWEEN TREND AND IPLAN

Sewer infrastructure costs are expected to be the lowest for two kinds of development scenarios: small scattered developments in rural areas where no extension of sewer service is predicted, and clustered development in areas where there are ample existing capacity and low backlog needs. In the former case, this pattern of development is served by individual septic systems, which are the least costly form of sewer service. In the latter case, as a general rule clustered development reduces collector system costs. It seems unlikely that development under TREND will be so scattered that individual systems will suffice to service units. It seems more likely that increased cost savings will be realized under the more clustered development patterns expected for IPLAN. However, cost savings will depend on where development is occurring. As discussed, sewer infrastructure needs are highly site-specific. Wherever systems are operating at or near capacity, new development may trigger much higher infrastructure costs if construction of new treatment facilities is required. Furthermore, if development occurs at sufficiently high densities, infrastructure costs may increase because high-density development requires larger pipes, which are more expensive. The Model is able to account for these differences by calculating the costs associated with development in specific municipalities depending on the location of growth projected for TREND versus IPLAN.

ASSUMPTIONS AND DATA PARAMETERS

The major assumption underlying the OSP Wastewater Cost Model is that the data collected in the Needs Survey accurately reflect sewer usage and infrastructure needs throughout the State. A second important assumption is that facility-specific data have been accurately converted to municipal data.

In terms of data parameters, the OSP Wastewater Cost Model requires input of various projections and service multipliers. In all cases where possible, CUPR modified the Model by using its own multipliers and municipal population and employment projections. For projections of wastewater flows the sewer demand multipliers recommended by NJDEPE are used, namely, 75 gallons per capita per day (gpcd) and 25 gallons per employee per day (gped). It was assumed that conservation policies would be the same under TREND and IPLAN. The CUPR projections of net residential density prepared for the State Plan analysis, as well as number of people per dwelling unit, were used instead of OSP's estimates. The "regional cost adjustment" values, which reflect cost variations in the State, and the inflation factors used to express costs in 1990 dollars (adjusted from 1988 dollars) are as follows:

REGIONAL COST ADJUSTMENT
WASTEWATER TREATMENT PLANT CONSTRUCTION

Counties with:	Cost Adjustment
High construction costs	1.53
Moderate construction costs	1.28
Low construction costs	1.19

REGIONAL COST ADJUSTMENT
SEWER CONSTRUCTION

Counties with:	Cost Adjustment
High construction costs	1.52
Moderate construction costs	1.21
Low construction costs	1.09

INFLATION FACTORS

For wastewater treatment plant construction	1.315
For sewer construction	1.176

The U.S. Environmental Protection Agency is the source for these values and multipliers.

TREND FINDINGS

Wastewater infrastructure costs for development under the TREND development scenario are shown in Exhibit 2. It is important to note that these costs measure *total* infrastructure costs, not just those associated with new development. This is because the Needs Survey on which the infrastructure costs are based includes costs for bringing existing facilities up to federal standards as well as costs arising from extension of service. Total sewer infrastructure cost to service new development under TREND from 1990 to 1995 is estimated at $4,296 million and from 1990 to 2010 at $6,790 million. Regional wastewater infrastructure costs for the latter time period are as follows: Northeast region—$836 million; Northwest region—$1,373 million; West Central region—$1,382 million; East Central region—$733 million; Southwest region—$1,649 million; and South-Southwest region—$817 million.

Total sewer infrastructure costs under TREND conditions over the 20-year period thus range from a low of $733 million in the East Central region to a high of $1,649 in the Southwest region.

IPLAN FINDINGS

Wastewater infrastructure cost figures for development under the IPLAN development scenario are also shown in Exhibit 2. Again, these represent total infrastructure costs, not just those arising from new development. The statewide total cost for development to serve IPLAN development from 1990 to 1995 is estimated at $4,217

EXHIBIT 2

SEWER INFRASTRUCTURE COST
(in millions of dollars)

	TREND		IPLAN		Difference Between TREND and IPLAN	
	1990–1995	1990–2010	1990–1995	1990–2010	1990–1995	1990–2010
State Total	$4,296.2	$6,790.4	$4,216.9	$6,411.1	$79.3	$379.3
Northeast	746.9	836.0	750.9	832.4	-4.0	3.6
Northwest	1,028.1	1,372.6	992.6	1,292.4	35.5	80.2
West Central	822.2	1,382.3	813.3	1,304.1	8.9	78.2
East Central	417.0	733.2	415.9	695.5	1.1	37.7
Southwest	919.9	1,649.2	885.2	1,533.0	34.7	116.2
South-Southwest	362.0	817.2	359.0	753.8	3.0	63.4

Source: CUPR application of OSP Wastewater Cost Model, 1992.

million and from 1990 to 2010 at $6,411 million. Regional cost figures for the latter time period are as follows: Northeast region—$832 million; Northwest region—$1,292 million; West Central region—$1,304 million; East Central region—$696 million; Southwest region—$1,533 million; and South-Southwest region—$754 million.

Total sewer infrastructure costs under IPLAN conditions for the 20-year time period thus range from a low of $696 million in the East Central region to a high of $1,533 million in the Southwest region.

COMPARISON OF TREND AND IPLAN

Sewer infrastructure cost estimates for development under TREND and IPLAN are compared in Exhibit 2. On a statewide basis, development from 1990 to 2010 under IPLAN results in sewer infrastructure cost savings of $379 million, or approximately 5.6 percent. Cost savings are realized for development under IPLAN from 1990 to 2010 in each of the regions as follows: Northeast region—$4 million; Northwest region—$80 million; West Central region—$78 million; East Central region—$38 million; Southwest region—$116 million; and South-Southwest region—$63 million.

It is evident that development under the IPLAN growth scenario is associated with reduced infrastructure costs. An even greater reduction of sewer infrastructure costs could be achieved under a number of conditions. These include shifting more residential development to areas with ample wastewater treatment plant capacity or by clustering a greater proportion of dwelling units. Increased intensity of land use reduces collector capital costs. However, development at very high densities can have the opposite effect of increasing collector costs because more expensive large pipes are required to service the development. The opposite patterns would increase water demand, namely, reducing residential densities and shifting development to areas where the treatment plant is near or at capacity.

Since sewer infrastructure is a costly component of development, its cost under different development scenarios is very important. As with water supply infrastructure, to the extent that sewer infrastructure costs can be reduced, savings can be introduced in housing costs, increasing their affordability. Especially since the State is facing enormous costs from an aging infrastructure, a development scenario that reduces the sewer infrastructure is certainly preferable over one that does not.

PART III

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IMPACTS ON SCHOOL CAPITAL FACILITIES

INFRASTRUCTURE ASSESSMENT: PART III — IMPACTS ON SCHOOL CAPITAL FACILITIES

BACKGROUND

The school capital facilities analysis projects the need for and cost of future elementary and secondary schools in New Jersey under TREND versus IPLAN. It first identifies the additional pupil spaces and square footage of school facilities that will be required by grade grouping—elementary, middle, and high school. In parallel, capital costs are developed, again by grade level. The needs and costs projection is determined to the local level for every school district in New Jersey.

This projection is part of an overall infrastructure assessment of TREND and IPLAN. In addition to schools, the other facilities that are considered include roads, transit, and water and sewerage. These comprise the major capital improvements that New Jersey will have to provide in the future.

In addition to being a component of the overall infrastructure assessment, the school capital facilities analysis is linked to the Fiscal Impact Model with respect to educational costs. The Fiscal Impact Model first calculates the school operating expenses that New Jersey will have to provide for into the future. It then adds educational capital expenditures to derive the full cost implications. This increment of school infrastructure that is factored in the Fiscal Impact Model is based on the school capital facilities analysis described below.

CONCEPTS

The School Capital Facilities Model employed for determining the school infrastructure proceeds in a step-by-step fashion of first determining the future student enrollment, next identifying the ensuing capital needs to accommodate this population, and finally translating the need into a cost assessment. The Model is effected through a series of inputs and outputs.

The first series of inputs and outputs identify the future number of public school children by grade level for each school district in New Jersey under TREND and IPLAN. This analysis starts with the total population by municipality for TREND and IPLAN. From the overall population change, first the increment of school-age children is derived and then refined to the number of public school children. This information is first shown on a municipal basis and then translated to a school district level by factoring the interrelationships between these units of government (i.e., is the municipality served by a coterminous school district, or does it send some pupils to a regional high school?).

The next stage of the analysis translates the number of public school children by school district under TREND and IPLAN first as an assessment of need, and then cost. The calculations are again effected through a series of inputs and outputs. The first input is the existing school enrollment-to-capacity relationship. This indicates the presence of any excess school capital capacity (current school capacity exceeds current enrollment), or conversely, deficient capacity (current enrollment exceeds current capacity). The bringing together of the school enrollment by school district and the district's existing capital situation yields the net capital need in terms of students to be accommodated by each school district for TREND and IPLAN.

The remaining inputs and outputs are directed for translating the school infrastructure net need to costs. This is done by first factoring the square feet of school space needed per student by grade level. The product of the net students to be accommodated multiplied by the space-per-pupil standards yields the square footage of school space needs under TREND and IPLAN. An expense is then identified by factoring costs per square foot differentiated by grade level and school district location in the State (i.e., construction and land acquisition costs are higher in certain locations than others). Applying this matrix of square foot costs to the previously determined projection of square footage needs under TREND and IPLAN yields the total school capital expenses for each school district in New Jersey under the two development scenarios.

In sum, the analysis of school capital facilities need and cost for TREND and IPLAN is determined through the following inputs:

Inputs

1. Future total population by municipality
2. School-age children as percentage of total population
3. Public school children as percentage of total school-age children
4. Municipal–school district interrelationships
5. Existing school enrollment-to-capacity relationships
6. School capital need factors—square feet of school space per student by grade level
7. School capital facility cost factors—costs per square foot of school space differentiated by grade level and location

These inputs are the basis for the following intermediate and final outputs:

	Outputs	Basis
1.	Future number of public school children, by municipality, and then by school district	Inputs 1-4
2.	Future need for additional pupil spaces and square footage of improvements	Output 1 and Inputs 5-6
3.	Future school capital costs by school district	Output 2 and Input 7

TREND and IPLAN are both evaluated through the same serial input-to-output approach. Differences may occur however, because some of the input values will differ under TREND versus IPLAN as discussed below.

EXPECTED DIFFERENCES BETWEEN TREND AND IPLAN

The need for future school facilities is influenced first by the total population figures for New Jersey. To the extent that TREND and IPLAN differ in this regard, the number of public school children to be accommodated will also vary, as will their respective school capital facilities needs and costs.

The outcome may also differ even if there are no differences in statewide population between TREND and IPLAN. This reflects differences in the locations in which development takes place. As described earlier, the School Capital Facilities Model incorporates the existing school enrollment-to-capacity relationships—noting situations of excess or deficient capacity. It is possible that development under IPLAN, as opposed to TREND, will occur in locations where school infrastructure is in place and where excess capacity exists. To the extent that IPLAN can draw down on this reserve capacity, while TREND cannot to the same extent because it distributes growth differently, then school infrastructure costs will be lower for IPLAN. Some of this savings, however may be countered by the fact that land costs for new schools are higher in urban areas where IPLAN will distribute a larger share of the population relative to TREND. Furthermore, it remains to be seen whether IPLAN, as opposed to TREND, can better capitalize on New Jersey's excess school capacity. In short, it is far from clear whether IPLAN will differ from TREND in terms of school capital facilities and if there is a difference, whether it will be a significant one.

CRITICAL ASSUMPTIONS AND DATA PARAMETERS FOR TREND AND IPLAN ANALYSIS

The critical assumptions and data calibration for the School Capital Facilities Model as effected for TREND and IPLAN are listed below:

1. *Future School Enrollment*. It is assumed that the future school population can be projected by factoring both (a) future total population, population of school-age children, and public school children attendance ratios—the population based approach, and (b) State of New Jersey Department of Education (NJDOE) pupil forecasts. For methodological reasons the former results in "lower end" numbers, the latter "higher end." To derive a consensus pupil projection, the results from the pure population-based approach were adjusted upward by referring to the NJDOE projections. This was accomplished as follows:

   a. The total public school children from the population-based method were identified.
   b. This result was compared to the NJDOE projections which, as noted, were higher than from the population-based technique.
   c. From comparing the results from a. and b., an upward adjustment factor to the population-based figures was determined.
   d. The upward adjustment factor (result c.) was applied only to the public school children population-based projections for municipalities and school districts projected to *gain* in population.
   e. Since IPLAN and TREND vary in the populations accommodated in individual municipalities and school districts (i.e., a municipality and school district may lose population under TREND while they gain population under IPLAN), the application of procedure d. above results in slightly different public school children projections to individual municipalities and school districts. However, these differences are slight, and the same total statewide public school children counts are maintained for both TREND and IPLAN.

2. *Measure of School Capacity*. Existing school physical capacity was derived from 1990 surveys and data from the New Jersey Office of State Planning (OSP) and Department of Education (DOE). "Capacity" is inherently difficult to measure precisely; it differs depending on whether "physical" capacity is meant versus "programmatic" capacity, the latter reflecting the local district's curriculum and staffing ratios. In addition, capacity diminishes over time due to aging of the physical plant. Thus, the data from OSP and DOE are a *rough* gauge of school capacity but they comprise the only statewide data available on this measure.

3. *Enrollment–Capacity Relationship*. The full measure of excess capacity (physical capacity in excess of enrollment) at any given point in time is credited to the school district in question subject to a pairing by grade level (i.e., excess high school capacity cannot be applied against elementary student need). Conversely, the full measure of deficient capacity (capacity by grade level is less than

enrollment by grade grouping) is debited to the school district. If there is a debit it is assumed that the school district will provide the necessary facilities according to the following parameters.

4. *Space Per Student Infrastructure Needs*. This factor specifies the square footage of school space for elementary, middle, and high school students. In practice, the determination of the level of physical improvements is a local decision that reflects such considerations as school curriculum, affluence, state aid, local taxpayer receptivity to spending, and so on. The infrastructure parameters incorporated in the State Plan analysis, shown below, were suggested by the State Department of Education as being "typical" for the State of New Jersey.

SCHOOL LEVEL/GRADES		*SCHOOL BUILDING SQUARE FOOTAGE PER PUPIL*
Elementary	(K–6)	120 Square Feet
Middle	(7–8)	150 Square Feet
High School	(9–12)	180 Square Feet

5. *School Construction Costs Per Pupil*. As with the square footage parameters, school construction costs were based on "average" figures for the State of New Jersey. They are differentiated by grade level and area of the State, as follows:

SCHOOL LEVEL GRADES		*CONSTRUCTION COSTS PER SQUARE FOOT BY REGION OF THE STATE*	
		NORTH	SOUTH
Elementary	(K–6)	$110	$100
Middle	(7–8)	$120	$110
High School	(9–12)	$135	$120

6. *Land Costs*. This figure is even more variable than the "bricks and mortar" expenditures. If a school district owns land for a site, there will be no, or negligible, land costs. If sites are not held or not suitable, and/or if land has to be acquired where there is little remaining acreage, then site acquisition can be quite costly.

   While difficult to specify, broad parameters for land costs can be developed as follows:

SCHOOL LAND COSTS AS AN ADDITION TO
SCHOOL CONSTRUCTION COSTS

AREA	*PERCENTAGE INCREASE*
Rural	10%
Suburban	15%
Urban	12%

The logic for the gradation by area factors, in a gross manner, differences in land costs and school-site availability. Thus, land generally costs more in urban and suburban areas relative to rural locations. The land-cost increment is somewhat less in urban versus suburban areas, however, because in practice more urban school districts own or can more readily acquire sites (i.e., from tax foreclosures) relative to their suburban counterparts.

In all of the above factors the same approach is applied for TREND and IPLAN. Thus, the future school enrollment is projected identically for both scenarios and the same school infrastructure and cost standards are applied. What differs, however, is the population distributions for TREND and IPLAN.

7. *Capital Facilities Need/Cost Coverage.* A final note concerns the scope of the School Capital Facilities Model. The Model covers one aspect of need—the accommodation of students in "standard" elementary, junior high, and high schools. There are many capital costs that are *not* encompassed in the Model. They include: 1. school facilities designed at higher than "typical" standards (in terms of square footage and amenities); 2. specialized school facilities for vocational training and the handicapped; 3. spending for environmental reasons such as the removal of asbestos and underground tanks; 4. spending for building systems replacement and deferred maintenance (i.e., roofs, windows, heating/ventilation/air conditioning, and so on). Spending for building systems replacement and deferred maintenance is an especially costly category.

   In short, the School Capital Facilities Model covers an important component, but surely only one element, of the total educational infrastructure and improvements that will have to be provided by New Jersey school districts in the future. On the category that is encompassed by the Model, however—the relationship of local school capacity to student enrollment, and the need to provide additional school spaces—the Model provides useful *relative* results for comparing TREND to IPLAN.

TREND FINDINGS

Addition of Public School Children

The starting point of any projection of educational capital facilities is the determination of the future school population. Exhibit 1 identifies the public school enrollment in New Jersey as of 1990 and then projects the public school population to 1995 and then 2010. The school enrollment counts are shown for the State as a whole and for the six housing regions delineated by the New Jersey Council on Affordable Housing.[1]

As of 1990, the State of New Jersey contains about 1,100,000 public school children. Of the State's total pupil population, the Northeast, Northwest, and Southwest each contain about 250,000 students, followed by the West Central and East Central regions with about 150,000 pupils each, and finally the Southwest region with under 100,000 students. The differences roughly reflect the regions' proportional population distributions. Thus, the Northeast, Northwest, and Southwest areas have the highest public school children tallies because with 1.5 to 2 million total population each they are larger than the West Central and East Central regions, which contain about 1 million population each. The South-Southwest is last in terms of number of public school children because with .5 million population it is considerably smaller than the other regions.

From 1990 to 2010 the State's total public school children count is projected to increase from 1,090,000 to 1,421,000—a gain of 331,000 or just shy of one-third from the 1990 base. There are difference, however, by region. The largest numerical increases, of some 60,000 to 80,000 students each, is anticipated for the West Central, East Central, and Southwest regions. These changes represent a jump of some 40 to 50 percent from these three areas' 1990 student levels. The West Central, East Central, and Southwest regions have the most vigorous gains in students because they grow the most rapidly in terms of overall population. By contrast, other areas of the State, anticipated to change in total population at a lesser pace, in parallel have far less robust increases in public school children.

Public School Capital Facilities Need

The 1990 to 2010 increment in public school enrollment just described comprises the largest component of gross need to be provided for in terms of school infrastructure. To this figure, the School Capital Facilities Model adds the existing 1990 school deficiency.

1 The New Jersey Council on Affordable Housing has partitioned the State of New Jersey into six housing regions. Based on an analysis of journey-to-work patterns conducted by the Center for Urban Policy Research at Rutgers University, the State's housing regions are as follows: 1. Bergen, Passaic, and Hudson counties; 2. Essex, Morris, Union, and Sussex counties; 3. Middlesex, Somerset, Hunterdon, and Warren counties; 4. Monmouth and Ocean counties; 5. Camden, Gloucester, Burlington, and Mercer counties; and 6. Atlantic, Cape May, Cumberland, and Salem counties.

EXHIBIT 1

PUBLIC SCHOOL CHILDREN BY REGION TREND CONDITIONS: 1990-2010

	Enrollment (Pupils in 000s)			Change in Enrollment (Pupils in 000s)			
	1990	1995	2010	1990-1995		1990-2010	
				Number	Percent	Number	Percent
Statewide Total Public School Children	1,090.0	1,160.0	1,420.7	70.0	6.4	330.7	30.3
Northeast Total Public School Children	228.2	238.6	282.8	10.4	4.6	54.6	23.9
Northwest Total Public School Children	265.6	266.9	281.3	1.3	0.5	15.7	5.9
West Central Total Public School Children	147.3	158.8	219.8	11.5	7.8	72.5	49.2
East Central Total Public School Children	143.4	160.3	209.6	16.9	11.8	66.2	46.2
Southwest Total Public School Children	223.6	244.5	307.4	20.9	9.3	83.8	37.5
South-Southwest Total Public School Children	81.9	91.0	119.7	9.1	11.1	37.8	46.2

Note: Items may not add to indicated totals because of rounding.

Source: CUPR School Capital Facilities Model, 1992.

The latter is a need driven from situations where the 1990 public school enrollment exceeds the indicated 1990 school capacity—a situation of capital shortfall.

These two elements of gross public school capital need are indicated in Exhibit 2. Thus as of 1990, there is an existing school deficiency of 34,000 student spaces[2] in the State of New Jersey. The largest component of this amount—10,000 pupil spaces—is found in the Southwest Region with the remaining areas each having a shortfall of roughly 5,000 pupil spaces each.

The second and larger element of gross school need is the housing of new students, that is, the accommodation of the gain in enrollment over the projection period. As described in the previous section, from 1990 to 2010, New Jersey's public school population is anticipated to grow by 331,000 (Exhibit 1). Adding that figure to the starting 1990 deficiency of 34,000 student spaces results in a total 1990 to 2010 school capital need for 365,000 pupil spaces (Exhibit 2).

The above figure represents a gross need, that is, need before there is a reduction due to drawing down upon excess infrastructure capacity. Before considering how this is done, some background information is in order.

New Jersey, like many other states, has excess physical capacity in its schools because of a long term drop in enrollment. For instance, over just the last decade New Jersey's total public school population has fallen from roughly 1.5 to 1.1 million. This does not mean that there are .4 million excess school spaces to be drawn on because:

1. there has been an increase in space-intensive educational programs such as computer instruction;

2. the growing emphasis on mainstreaming special students, that is, accommodating them in local schools, has added to new space demands;

3. the desire of many school districts to lower average class sizes in order to improve instructional quality is a further draw on school space; and

4. aging and obsolescence have reduced the usefulness and the inventory of New Jersey's educational infrastructure from its historical levels.

Despite the countervailing forces described above, many school districts in New Jersey have excess physical capacity. It provides a pool to be drawn upon that would

2 This is not the total school infrastructure used as of 1990. As discussed earlier, the School Capital Facilities Model does not incorporate spending for pent-up repairs, improvements, special facilities, environmental improvements (i.e., asbestos removal), and the like.

EXHIBIT 2

PUBLIC SCHOOL CAPITAL FACILITIES NEED (PUPIL SPACES) BY REGION TREND CONDITIONS: 1990-2010

	Existing 1990 School Capital Deficiency[1] (pupil spaces)*	1990-1995 Increase in Enrollment[2] (pupil spaces)*	Total 1990-1995 Gross School Capital Need[3] (pupil spaces)*	Total 1990-1995 Net School Capital Need[4] (pupil spaces)*	1990-2010 Increase in Enrollment[2] (pupil spaces)*	Total 1990-2010 Gross School Capital Need[3] (pupil spaces)*	Total 1990-2010 Net School Capital Need[4] (pupil spaces)*
Statewide							
Total Public School Children	34.1	70.0	104.3	82.1	330.7	364.8	287.9
Northeast							
Total Public School Children	5.8	10.4	16.2	11.3	54.6	60.4	38.8
Northwest							
Total Public School Children	4.9	1.3	6.2	6.7	15.7	20.6	26.5
West Central							
Total Public School Children	4.1	11.5	15.6	10.0	72.5	76.6	47.6
East Central							
Total Public School Children	5.1	16.9	22.0	18.9	66.2	71.3	62.3
Southwest							
Total Public School Children	10.0	20.9	30.9	26.6	83.8	93.8	82.0
South-Southwest							
Total Public School Children	4.3	9.1	13.4	8.6	37.8	42.1	30.8

* Pupil spaces in 000s.

[1]Existing 1990 school capital deficiency results when 1990 enrollment exceeds 1990 school capacity.
[2]See Exhibit 1.
[3]Gross school capital need is equal to the sum of the 1990 school capital deficiency plus the indicated increment in school enrollment.
[4]Net school capital need is equal to the gross school capital need by grade level less surplus school capacity by grade grouping.

Note: Items may not add to indicated total because of rounding.

Source: CUPR School Capital Facilities Model, 1992.

reduce the gross school need described earlier to a net figure, that is, the number of new spaces that must be provided. Consequently, the gross school demand for each district in New Jersey by grade level (elementary, junior high, and high school) was matched against that district's available surplus space, again by grade level.

The results, aggregated from the individual school district level to regions and then the State, are reported in Exhibit 2. Statewide, from 1990 to 2010, there is a gross school capital need of 365,000 pupil spaces. Since excess capacity can be drawn upon, the net statewide need is reduced by about one-fifth to 288,000 student spaces. There are considerable variations by region. The Southwest has the largest need—more than 80,000 pupil spaces—from 1990 to 2010. Its figure is high because: 1. it begins with the largest starting (1990) school capital deficiency (10,000 spaces); 2. it experiences by far the most significant increase in enrollment; and 3. of all the regions it is least able to capitalize on excess capacity; all the other areas have a much larger drop from gross to net school need. This differentiation results from the fact that the Southwest's pool of excess capacity is not that large relative to the other areas and that again, relatively, the excess capacity that the Southwest has is not as fortuitously located in terms of accommodating growth.

After the Southwest, the East Central region has the highest 1990-2010 pupil space need—62,300. This figure mainly reflects a large enrollment increase over the two-decade period. The other areas have considerably lower net needs—ranging from the 25,000 to 50,000 level. In each case individual area dynamics are at work. For instance, the Northwest's need is low because of minimal enrollment increase; the Northeast gains many more students but its gross need is reduced by about 40 percent because it can tap considerable regional excess capacity (Exhibit 2).

Once the net school spaces are determined, it is a simple matter to first calculate the attendant school square footage needs—assuming that a given amount of space is provided for elementary/secondary pupils—and then school capital facility costs—assuming construction cost parameters per square foot. The results for TREND for 1990–2010 are shown in Exhibit 3. In brief, over the two-decade period it is anticipated that about 41 million square feet of school space will be needed at a cost of some $5.3 billion. The largest shares of these amounts are in the areas with the highest net pupil space need. Thus the Southwest will have to provide some 12 million square feet of schools at a cost exceeding $1.5 billion. By contrast, the Northeast's capital liability is half that of the Southwest's while the Northwest and South-Southwest are at a one-third level.

EXHIBIT 3

PUBLIC SCHOOL CAPITAL FACILITIES NEED ($FT.^2$) AND COST ($) BY REGION TREND CONDITIONS: 1990-2010

	Total 1990-1995 Net School Capital Need (000s $Ft.^2$)[1]	Total 1990-1995 School Capital Cost ($ millions)[2]	Total 1990-2010 Net School Capital Need (000s $Ft.^2$)[1]	Total 1990-2010 School Capital Cost ($ millions)[2]
Statewide	11,815	$1,543	40,659	$5,296
Northeast	1,700	230	5,614	749
Northwest	1,020	143	3,780	518
West Central	1,423	194	6,762	926
East Central	2,483	307	8,474	1,067
Southwest	4,048	535	11,897	1,542
South-Southwest	1,142	135	4,132	493

[1] Equals net school capital need in pupil spaces by grade level multiplied by the square footage standard per pupil by grade grouping.

[2] Equals net school capital need in square footage by grade level and school district location multiplied by the capital cost per square foot by grade grouping and district location.

Note: Items may not add to indicated totals because of rounding.

Source: CUPR School Capital Facilities Model, 1992.

IPLAN FINDINGS AND COMPARISON OF TREND AND IPLAN

A parallel capital facilities analysis was conducted for IPLAN. The overall underlying total gross demand is the same as with TREND. There is the same starting (1990) count of deficient pupil spaces (34,000). To this figure is added the 1990 to 2010 enrollment increase Statewide of 331,000 students for a total statewide need of 365,000 pupil spaces. There is a similar distribution of gross need to the different regions (Exhibits 2, 4, and 5). Thus, the Northeast's 1990–2010 gross need is 60,000 under TREND and 57,000 under IPLAN; for the West Central area the two figures are 77,000 and 74,000, respectively. (The reason why there are these slight differences by region for TREND versus IPLAN is a function of how the population-based enrollment projections were adjusted by the NJDOE projections; see "Critical Assumptions and Data Parameters. . . .)

As before, the final step in the needs calculation is to match gross demand at the individual school district and grade level against the availability of usable excess capacity, again by school district and grade grouping. If the State's excess capacity is found only in caches, that is among only certain communities as opposed to others, then the different community population emphases of TREND versus IPLAN would affect the ability to capitalize on the excess capacity. For instance, if the overage capacity was concentrated in New Jersey's urban areas, then IPLAN, favoring a shift of population to just such communities, would be in a better position to draw down on the available pupil spaces.

When one observes the distribution of slack school capital capacity in New Jersey the pattern is dispersed: Slack capacity is scattered among many communities—cities, close-in suburbs, newer suburbs, and many rural areas—as opposed to being clustered in any particular category of jurisdiction. Given this, the differing population distributions of TREND versus IPLAN should not have a significant consequence in terms of any heightened or lessened ability to capitalize on excess capacity.

The findings lend support to this view. For both TREND and IPLAN the total gross school capital facility need for 1990 to 2010 is 365,000 student spaces. TREND can draw down on 77,000 excess spaces to a net of 288,000 (Exhibit 2). IPLAN can draw down on a slightly higher count of excess capacity of 87,000 student spaces—10,000 more than for TREND. IPLAN's net 1990-2010 school capital need is therefore 10,000 lower than for TREND—278,000 compared to 288,000 pupil spaces (Exhibits 2 and 4). Thus the future total statewide need for schools is very similar for both TREND and IPLAN. There is also an equivalency in the tallies by region. The 1990-2010 net need for the Northwest is 27,000 and 24,000 pupil spaces for TREND and IPLAN, respectively. For the West Central region, the figures are 48,000 (TREND) and 43,000 (IPLAN). Thus, both

EXHIBIT 4

PUBLIC SCHOOL CHILDREN BY REGION
IPLAN CONDITIONS: 1990-2010

	Enrollment (Pupils in 000s)			Change in Enrollment (Pupils in 000s)			
	1990	1995	2010	1990-1995 Number	1990-1995 Percent	1990-2010 Number	1990-2010 Percent
Statewide							
Total Public School Children	1,090.0	1,160.0	1,420.7	70.0	6.4	330.7	30.3
Northeast							
Total Public School Children	228.2	239.7	279.0	11.5	5.0	50.8	22.3
Northwest							
Total Public School Children	265.6	266.7	279.4	1.1	0.4	13.8	5.2
West Central							
Total Public School Children	147.3	159.1	217.5	11.8	8.0	70.2	47.7
East Central							
Total Public School Children	143.4	159.5	208.2	16.1	11.2	64.8	45.2
Southwest							
Total Public School Children	223.6	243.9	317.4	20.3	9.1	93.8	41.9
South-Southwest							
Total Public School Children	81.9	91.1	119.1	9.2	11.2	37.2	45.4

Note: Items may not add to indicated totals because of rounding.

Source: CUPR School Capital Facilities Model, 1992.

EXHIBIT 5

PUBLIC SCHOOL CAPITAL FACILITIES NEED (PUPIL SPACES) BY REGION IPLAN CONDITIONS: 1990-2010

	Existing 1990 School Capital Deficiency[1] (pupil spaces)*	1990-1995 Increase in Enrollment[2] (pupil spaces)*	Total 1990-1995 Gross School Capital Need[3] (pupil spaces)*	Total 1990-1995 Net School Capital Need[4] pupil spaces)*	1990-2010 Increase in Enrollment[2] (pupil spaces)*	Total 1990-2010 Gross School Capital Need[3] (pupil spaces)*	Total 1990-2010 Net School Capital Need[4] (pupil spaces)*
Statewide Total Public School Children	34.1	70.0	104.3	76.8	330.7	364.8	278.2
Northeast Total Public School Children	5.8	11.5	17.3	11.9	50.8	56.6	39.4
Northwest Total Public School Children	4.9	1.1	6.0	7.5	13.8	18.7	23.9
West Central Total Public School Children	4.1	11.8	15.9	8.5	70.2	74.3	42.8
East Central Total Public School Children	5.0	16.1	21.2	16.6	64.8	69.9	58.5
Southwest Total Public School Children	10.0	20.3	30.3	24.2	93.8	103.8	85.2
South-Southwest Total Public School Children	4.3	9.2	13.5	8.0	37.2	41.5	28.6

*Pupil spaces in 000s.

1 Existing 1990 school capital deficiency results when 1990 enrollment exceeds 1990 school capacity.

2 See Exhibit 4.

3 Gross school capital need is equal to the sum of the 1990 school capital deficiency plus the indicated increment in school enrollment.

4 Net school capital needs is equal to the gross school capital need by grade level less surplus school capacity by grade grouping.

Note: Items may not add to indicated totals because of rounding.

Source: CUPR School Capital Facilities Model, 1992.

statewide and at the regional levels, the net school capital need is similar for TREND and IPLAN.

There is a direct flow from this finding to attendant demand for square footage for new school capital facilities and the cost of that construction. From 1990 to 2010, under TREND New Jersey will need to add roughly 11.8 million square feet of school space; for IPLAN, the sum is a somewhat lower 11.3 million square feet (see Exhibit 6). In parallel, the future school construction cost is estimated statewide at $5.3 billion for TREND versus $5.1 billion for IPLAN—a difference of some $200 million, or 3 percent.

In sum, the implications for school capital facilities, whether measured in student spaces, square footage, or costs, are equivalent for TREND and IPLAN. This follows from the similarity of the two scenarios in terms of population growth and the fact that pupil capacity is distributed among many communities as opposed to being clustered in any one area or type of jurisdiction.

Under alternate conditions or assumptions the findings could differ. For instance, regionalization of school districts can provide scale economies (i.e., it is less expensive per pupil for two districts to build a joint 1,200-student-capacity elementary school than the two districts separately constructing 600-student facilities). By encouraging cooperation among governments, IPLAN could foster regionalization. Another consideration is that by clustering population in Centers under IPLAN it would be possible to construct larger, and thus typically more cost-efficient, school buildings on a per pupil basis.[3]

In the present analysis, these factors were not incorporated because they are deemed more a matter of educational rather than land-use policy. For instance, the State of New Jersey is currently studying regionalization. Some change in this direction may very well take place under TREND for pedagogical, cost reduction, racial integration, and other reasons. It would be conjectural to formulate a varying matrix of the extent to which regionalization would occur under IPLAN versus TREND, and where there was such joining of districts, the level of savings that would be realized.

These are similar considerations with respect to IPLAN's possible fostering of more cost-efficient schools because of its massing of population in Centers. This characteristic is influenced more by educational as opposed to land-use policy. For instance a school district servicing a Center could very well opt for smaller, neighborhood-based elementary schools of, say, 300 to 500 students each as opposed to larger facilities, despite the fact that the larger schools could service Centers and would be relatively less costly.

3 For instance, common core facilities, such as kitchens and gymnasiums, are amortized over a larger pupil base in a bigger school as opposed to a smaller one; hence, total costs per student are lower in the former case.

EXHIBIT 6

PUBLIC SCHOOL CAPITAL FACILITIES NEED ($FT.^2$) AND COST ($) BY REGION IPLAN CONDITIONS: 1990-2010

	Total 1990-1995 Net School Capital Need (000s $Ft.^2$)[1]	Total 1990-1995 School Capital Cost ($ millions)[2]	Total 1990-2010 Net School Capital Need (000s $Ft.^2$)[1]	Total 1990-2010 School Capital Cost ($ millions)[2]
Statewide	11,268	$1,482	39,489	$5,115
Northeast	1,811	247	5,703	761
Northwest	1,157	161	3,422	464
West Central	1,265	175	6,175	847
East Central	2,206	273	8,002	1,003
Southwest	3,747	497	12,323	1,579
South-Southwest	1,082	129	3,863	462

1 Equals net school capital need in pupil spaces by grade level multiplied by the square footage standard per pupil by grade grouping.

2 Equals net school capital need in square footage by grade level and school district location multiplied by the capital cost per square foot by grade grouping and district location.

Note: Items may not add to indicated totals because of rounding.

Source: CUPR School Capital Facilities Model, 1992.

For the reasons described above, the delivery of school capital facilities in terms of pattern and costs was not altered for IPLAN versus TREND. Had they been (i.e., under the assumption that a slightly higher level of regionalization would occur under IPLAN) then the State Plan could have realized greater savings in school capital needs relative to TREND than reported here.

Another variation concerns the identification of excess capacity. This was measured from data on school capacity and enrollment assembled from New Jersey Department of Education and Office of State Planning sources. As noted, the information on capacity, while the only statewide source available, is a very rough gauge. Development of an alternative measure of capacity might affect the findings on school capital need under TREND versus IPLAN, but it is unlikely that the conclusions would change dramatically.

In short, unlike other substantive areas considered in the State Plan Impact Assessment, with respect to school infrastructure TREND and IPLAN are more alike than dissimilar. While some difference is found, the variation is inconsequential.