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NEW JERSEY STATE DEPARTMENT OF TRANSPORTATION

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ENVIRONMENTAL ANALYSIS AND REPORT

FOR

ROUTE 18 FREEWAY EXTENSION

CITY OF NEW BRUNSWICK AND PISCATAWAY TOWNSHIP

MIDDLESEX COUNTY, NEW JERSEY

VOLUME II - APPENDIX

SECTION 7 - ECOLOGICAL REPORTS

SOILS, WILDLIFE,

LIMNOLOGICAL AND VEGETATION

PREPARED BY

JACK MC CORMICK & ASSOCIATES

FOR

KING & GAVARIS
CONSULTING ENGINEERS

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ENVIRONMENTAL ANALYSIS AND REPORT
FOR
ROUTE 18 FREEWAY EXTENSION
CITY OF NEW BRUNSWICK AND PISCATAWAY TOWNSHIP
MIDDLESEX COUNTY, NEW JERSEY

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Dept. of Zoology, Rutgers Univ.
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Jack McCormick & Associates

VOLUME II - APPENDIX

SECTION 7 - ECOLOGICAL REPORTS - SOILS, WILDLIFE
LIMNOLOGICAL AND VEGETATION

PART 1 - SOILS

by K. P. Wilson

State Soil Scientist (Retired)

Soils

Kenneth P. Wilson
State Soil Scientist (Retired)

A soil survey prepared by the United States Bureau of Soils (Patrick, 1923) was found to lack site-specific detail and only two classes of soils were delineated in the area of the right-of-way. A new investigation there was conducted in the area designated as the right-of-way for the proposed Route 18 extension to assess the potential environmental impact of highway construction. The soils were classified into series, variants, and phases following the system of the National Cooperative Soil Survey (U. S. Department of Agriculture, 1951) on the basis of field inspection and soil borings made to depths of five feet.

Results

Bowmansville sandy loam (BSL), a very silty, floodplain soil, is mapped at two sites. One site is between Metlars Brook and Landing Lane, and the other is along River Road northeast of the racetrack. These areas are slackwater lagoons on the Raritan River floodplain, although Johnson Park has infringed upon their boundaries considerably. Similar areas within the Park occurred in long, narrow strips behind the levee next to the River, but have been ditched and filled with coarser materials. This soil also occurs along the River as low embankments which were too small to be mapped. A few areas of Bowmansville soils were included in the Rowland

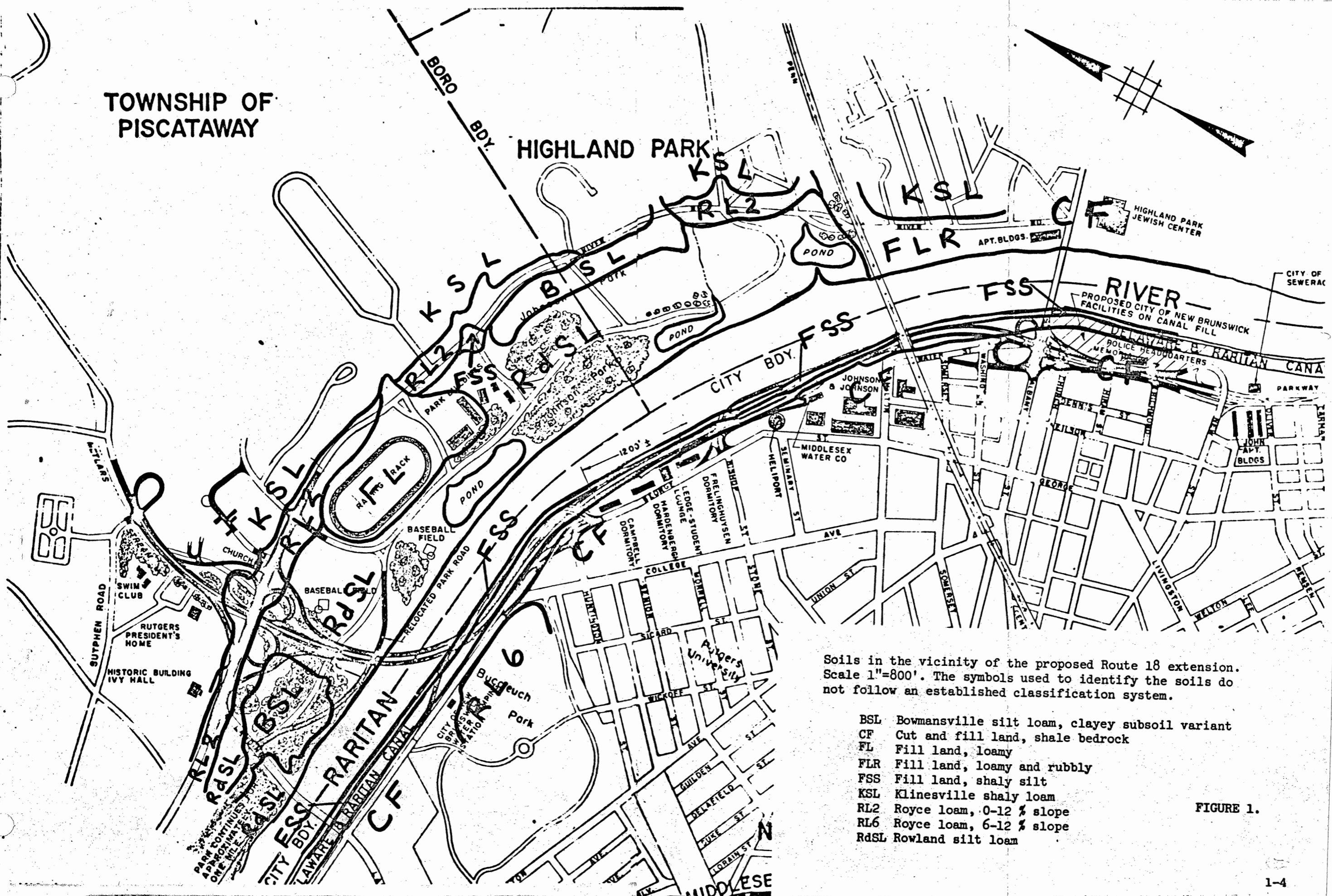
Table 1. Soils in the vicinity of the Route 18 extension

Name	Symbol	Profile	Slope	Trafficability	Stability	Erodibility	Drainage	Flooding Wetness	Moisture Capacity	pH	Vegetational Suitability
Bowmansville silt loam, clayey subsoil variant	BSL	12-36" recent gray silt 6" dark gray original silt 24-48" dark gray mottled clay or silty clay Reddish sandy silt	0-2%	Poor unless topped with coarser material	Good below 4-6 foot depth. Shallow clay layers may compressible and exhibit moderate shrink-swell.	Highly	Poorly drained	Slow permeability, wet most of year. Flooded at least 5 to 6 times each year.	Good	5.1-6.0	Only plants tolerant of high moisture over long periods can survive. Maples and ash grow well, and pin oak may do well.
Cut and fill land, shale bedrock	CF	Fractured and bedrock shale, and soil (often Royce loam).		Good		Moderately	Generally well-dr.	Generally moderately perm.			
Fill land, loamy	FL	Royce-like subsoil and clayey sand substrate mixture.		Good	Good		Normally well-dr.	Moderately perm. floods frequently to occasionally. inclined to be wet.			
Fill land, loamy and rubbly	FLR	Royce-like substrate, rocks, and clean fill.									
Fill land, shaly silt	FSS	Rock and weathered soil.		Good	Well compacted		Probably well-dr.	Probably moderately perm.			

Table 1 Continued.

Name	Symbol	Profile	Slope	Trafficability	Stability	Erodibility	Drainage	Flooding Wetness	Moisture Capacity	pH	Vegetational Suitability
Klinesville shaly loam	KSL	12" reddish brown, very shaly soil. Fractured shale bedrock	18-25%	Good		Moderately	Excessive drainage	Rapid perm.	Low	4.5-5.5	Difficult to establish vegetation because of shallow, droughty soil. Roots will penetrate shale bedrock in time.
Royce loam	RL 2 RL 6	6-12" dark brownish, loamy soil 30-40" reddish-yellow or yellowish-red, clayey sand with much water-worn quartz gravel 4-10 feet coarser, less clayey, silty sand	2-12% 6-12%	Good	Good. Narrow shrink-swell. Compacts very well.	Moderately high	Well-dr.	Moderately perm. except when compacted	Mod. good	4.5-5.5	Most upland trees and other plants do well.
Rowland silt loam	RdSL	12-30" recent silty stream deposits 6" dark gray original silt 30-40" varying strata of sandy silt and silty sand	0-2%	Poor unless topped with coarser material	Good for low buildings below original silty layers if protected from flooding	Highly	Moderately well to somewhat poorly dr.	Mod. perm. Frequently flooded. Mottling at depth of 40 to 50 " indicates that water table stands at that level at least several months of the year.	High	5.1-6.0	Well-suited for grasses and lowland trees which can withstand inundation for several days as often as 5 or 6 times each year.

TOWNSHIP OF
PISCATAWAY



Soils in the vicinity of the proposed Route 18 extension.
Scale 1"=800'. The symbols used to identify the soils do
not follow an established classification system.

- BSL Bowmansville silt loam, clayey subsoil variant
- CF Cut and fill land, shale bedrock
- FL Fill land, loamy
- FLR Fill land, loamy and rubbly
- FSS Fill land, shaly silt
- KSL Klinesville shaly loam
- RL2 Royce loam, 0-12 % slope
- RL6 Royce loam, 6-12 % slope
- RdSL Rowland silt loam

FIGURE 1.

mapping unit because of their small size and the extensive artificial covering.

Cut and fill land, shale bedrock (CF) constitutes nearly all of the project south and west of the Canal. It is an area of severely disturbed soil and bedrock that was probably covered mostly by Royce loam before being disturbed. The shale is hard when first exposed, but is rippable and will disintegrate into several inches of shaly soil after several years.

Loamy fill land (FL) is found in the vicinity of the race track in Johnson Park, and was formed from Royce-like subsoil and clayey sand substrate.

Loamy and rubbly fill land (FLR) is found on the north bank of the river between Albany Street and the railroad. As in the case of cut and fill land, this area has been severely disturbed. Filling has been the predominant activity, however, so little shale bedrock is exposed. The fill is a mixture of Royce-like substrate materials and many kinds of rock and other relatively clean fill.

Shaly silt fill land (FSS) forms the embankment of the Canal throughout its entire length. It consists of rock and weathered soil excavated from the bed of the Canal, and probably contains much stone.

Klinesville shaly loam (KSL) occurs on the steep valley walls above the floodplain and is found northeast of River Road. The soil is shallow and is underlain by shale bedrock, which has been

exposed in places by road cuts. The shale is hard when first exposed, but is rippable and will disintegrate into several inches of shaly soil after several years. Many small outcrops of thinly bedded shale along River Road were included in this mapping unit.

Royce loam (RL2, RL6) is a mixture of old extra-morainic outwash and red shale, and mantles much of the gently sloping uplands in the vicinity of New Brunswick outside the study area. In the study area it is found also as thick deposits in depressions and along the base of valley walls. It was mapped north of the River as a narrow band on 2 to 12 percent slopes (RL2) below slopes covered by Klinesville sandy loam. In most places along River Road, this soil has been scalped or removed completely, and may have been used as fill on areas of Rowland and Bowmansville soils. Some silt has been deposited by river overflows on the Royce loam in areas adjacent to Rowland soils. South of the River a single area of Royce soil on 6 to 12 percent slopes (RL6) was mapped in Buccleuch Park.

Rowland silt loam (RdSL) is a dark reddish brown soil that covers much of the floodplain north of the River. Throughout most of Johnson Park below Landing Lane and to some extent also upstream, this soil has been topped with bank-run subsoil and substrate from Royce-like soils. Included in this mapping unit are many areas of well-drained silty alluvium. They were not delineated because of their small size, and the extensive topping. They are most common immediately adjacent to the River as a low levee or berm.

Impact Area Determination

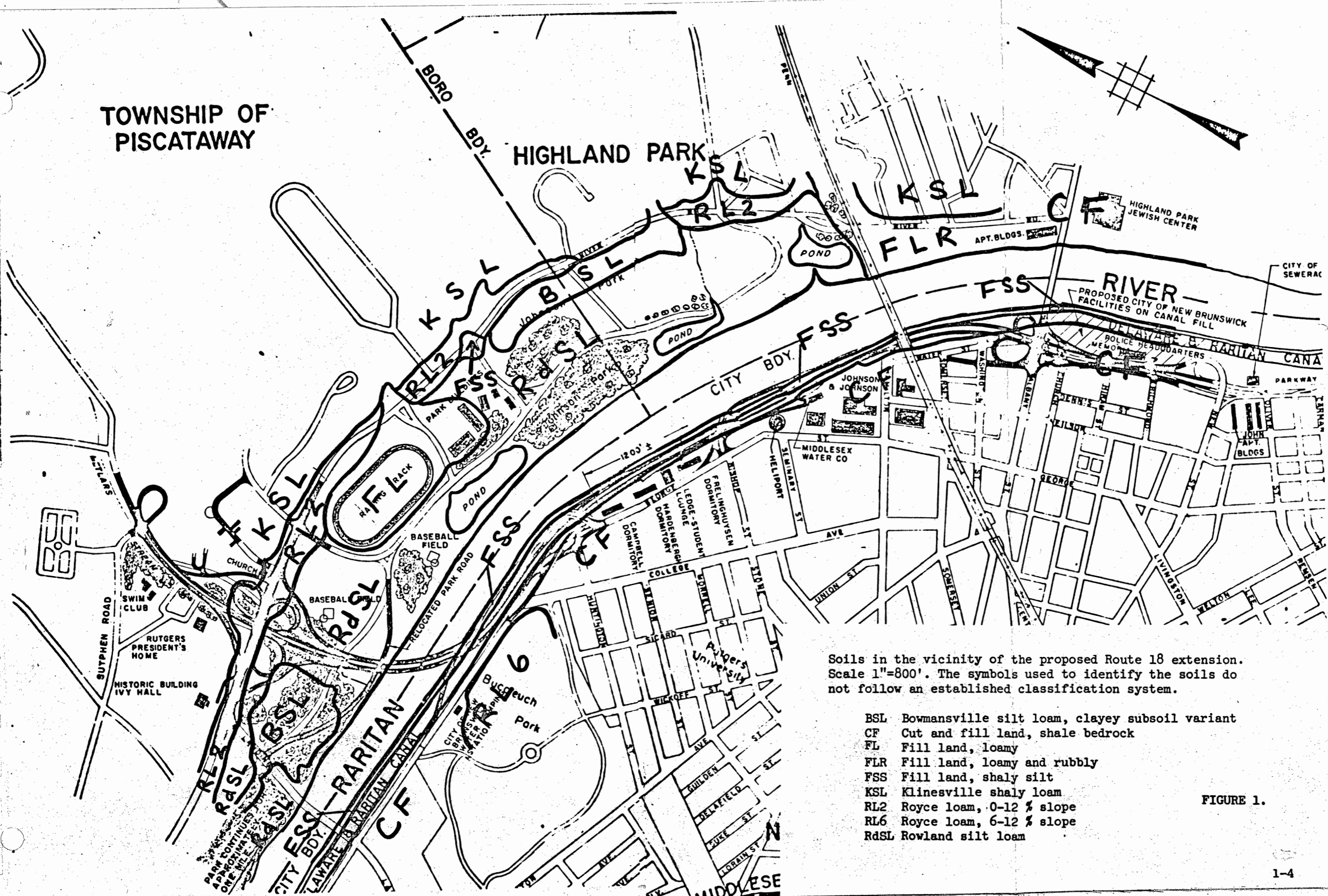
To determine the impact areas of the proposed Route 18 alignment on the soils, the boundaries of the proposed right-of-way and non-right-of-way (such as ditches and sidewalks to be constructed in conjunction with the highway) impact areas were transferred from plan sheets (1 inch = 30 feet) to a soil map (1 inch = 100 feet). The area of each soil type to be impacted was then determined by planimeter. Paved roads and buildings were not included with the measurements.

The impact area of the alternative alignment was determined from plan sheets (1 inch = 100 feet) prepared by the firm of King and Gavaris. This alignment represents an interpretation of the route proposed by the Rutgers Center for Transportation Studies (Bright, 1972). The impacted soil areas were determined by planimeter. Paved roads and buildings were not included in the measurements.

Environmental Impact of Proposed Extension

The proposed extension would impact cut and fill land (area undetermined), Royce loam (.02 acres), and shaly, silt fill land (8.99 acres) south of the Raritan River along the Canal and in Buccleuch Park. Because most of these areas have been variably disturbed in the past, their natural productivity and recreational suitability are not known and possibly are of a variable nature.

TOWNSHIP OF
PISCATAWAY



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Scale 1"=800'. The symbols used to identify the soils do
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- RL2 Royce loam, 0-12 % slope
- RL6 Royce loam, 6-12 % slope
- RdSL Rowland silt loam

FIGURE 1.

The road will be constructed on an embankment built on the Canal from large amounts of fill to be obtained from an undisclosed site. Because of the proximity of the embankment to the River, care must be exercised in the selection of fill material and in securing the surface of the embankment to prevent the erosion of large amounts of sediment into the River.

The extension would impact Royce (3.41 acres), Bowmansville (2.03 acres), and Rowland (14.98 acres) soils in the floodplain below River Road on the north side of the River in Johnson Park. All three soil types are naturally productive, although Bowmansville and Rowland soils are well suited principally for floodplain vegetation. Royce soil is better suited for intensive recreational use since it is well drained and has good trafficability. Bowmansville and Rowland soils are less suitable because of poorer drainage and poor trafficability, unless ditched and topped with coarser materials.

The roadway and interchange between the Raritan River and River Road will be built largely on a fill embankment, and Metlars Brook will be rechanneled through conduits and ditches. Fill material with low erodibility should be utilized, and the use of retention basins, vegetation planting, sodding, and/or other measures should be undertaken concurrently with the construction of the roadway to prevent erosion of fill materials onto adjoining park lands or into waterways. Existing soils should not be graded into steep slopes because all three types are highly to moderately-highly susceptible to erosion.

North of River Road the extension will largely impact Klinesville soil (11.83 acres), although a small area (3.46 acres) of Royce loam also will be affected. Klinesville soil is only moderately susceptible to erosion, but it is a shallow droughty soil that is difficult to revegetate. Construction activities should be confined to the actual site of the roadway to minimize destruction of existing vegetation and resultant erosion problems. Upon completion of construction activities, unpaved right-of-way areas along the roadway and in the interchange should be reforested with native tree and shrub species to stabilize the soils in these areas, particularly if they are on slopes.

The most serious environmental impact of this extension may result from the rechanneling of flood and normal river waters. The construction of the embankments in Johnson Park at Metlars Stream, in the Raritan River, and on the Canal will constrict the floodplain at this point, and may increase upstream flooding and rechannel river waters so as to undercut the riverbank in Johnson Park.

Environmental Impact of Alternative Alignment

The alternative plan would have Route 18 cross the Raritan River on a remodelled Albany Street bridge and then follow River Road to an interchange at Metlars Lane. This plan also would incorporate a remodelling of the Landing Lane bridge, and the construction of a new connector road from the bridge to the proposed interchange. Plans for the alternative alignment are only tentative and partially complete at this time. Thus, it was not possible to assess the impact fully in the Metlars Brook area above the interchange, or in Johnson Park where access roads may be needed to give access to the park either from or across the new roadway.

This alignment would impact 10.26 acres of Royce soil, 0.19 acre of Klinesville soil, 1.94 acres of Bowmansville soil, and 3.75 acres of Rowland soil, as well as undetermined amounts of fill land that are located principally east of the railroad. In Johnson Park a total of only 8.87 acres (Royce 2.99, Klinesville 0.19, Bowmansville 1.94, Rowland 3.75 acres) would be impacted - as compared with 20.42 acres under the proposed plan. If the connection from the Landing Lane Bridge to the alternate interchange were not built on a high embankment and if suitable culverts were provided, this alignment also would minimize potential bank erosion.

Conclusions

A comparison of the proposed and alternate alignments on the basis of soil considerations can be made by assuming either of two alternative potential land uses. If recreational use is considered, the alternate alignment has less impact because it will require only 8.87 acres of Johnson Park, whereas the proposed plan would require 20.42 acres.

The difference in impact is principally due to less Rowland soil being taken by the alternative alignment, although Rowland soil is less suitable for intensive recreational use than Royce soil because of poorer drainage and trafficability. However, Rowland soil is well suited for floodplain plants and would be desirable for extensive recreational activity or a natural open space system.

If residential development is considered as the potential land use, the proposed alignment would have less impact since it will take 6.87 acres of Royce soil, as compared with 10.26 acres under the alternative alignment. This soil is well suited for plant growth, has good trafficability, and is generally outside of the floodplain. Thus, it is a more suitable soil for residential development and the landscaped areas that accompany such development.

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SECTION 7 - ECOLOGICAL REPORTS - SOILS, WILDLIFE
LIMNOLOGICAL AND VEGETATION

PART 2 - WILDLIFE

by D. Zumeta & Jack M^CCormick

Jack M^CCormick & Associates

Part 2

Wildlife

David Zumeta and Jack McCormick
Jack McCormick & Associates
Devon, Pennsylvania 19333

To assess the probable impact of the proposed extension of Route 18 on wildlife in the project area, mammal and bird populations were inventoried. Information concerning mammals of the area was obtained from Dr. Paul Pearson, Chairman, Department of Zoology, Rutgers University, New Brunswick, New Jersey. Bird census data obtained from Dr. Charles S. Leck, a member of the Department of Zoology, was supplemented by field observations made by Jack McCormick & Associates in May 1972.

Wildlife populations of five habitats in the project area are discussed: forest, park, river, pond, and developed land. The forest habitat is composed of an overstory (canopy) of trees and a shrubby and(or) herbaceous undergrowth of native plants that has been little disturbed by residential development or recreational use. Forests principally are found along the banks of the Delaware and Raritan Canal and in the vicinity of Metlars Brook. Deciduous forests cover the embankments of the Canal, the area between Metlars Brook and Landing Lane to the south of Park Road, and much of the Metlars Brook ravine north of River Road. The southern half of the area bounded by Metlars Brook, Park Road, Landing Lane, and River Road largely is covered by swamp shrubs and deciduous trees, and is included in the definition of forest

habitat. East of Metlars Lane, in the vicinity of the proposed loop road opposite Sutphen Road, there is an extensive mixed oldfield-origin and red-cedar forest. Three stands of deciduous forest border River Road on the north between Hillcrest Road and the Penn Central Railroad. There also are several small stands of deciduous forest along the north bank of the Raritan River between the railroad and Albany Street.

Park habitat is woody and/or herbaceous vegetation that has been greatly altered by commercial, residential, or recreational activities. It includes lawns, gardens, and other landscaped areas (such as forests with a mowed grass undergrowth) primarily associated with residential areas and Johnson, Boyd, and Buccleuch Parks. Nearly all of the non-forested section of the project area supports this habitat type.

There are two aquatic habitats: river and pond. The river habitat is composed of the Raritan River, the Delaware and Raritan Canal, and associated mudflats and shoreline. The pond habitat includes Metlars Brook and ponds in Johnson Park.

The developed land habitat consists of intensively utilized residential and commercial areas with little or no vegetation cover. This habitat occurs in the vicinity of the River Road-Albany Street intersection and along the south bank of the Canal, east of Seminary Street.

Mammals

Mammal populations in the project region generally are small because of extensive residential, commercial, and recreational development. Cottontail rabbits and gray squirrels are common in forests and less common in wooded park habitats. Opossums, weasels, woodchucks, and raccoons occur occasionally in the forests, particularly in stands along Metlars Brook. Muskrats are present, but uncommon, along the Raritan River and also in forests west of Metlars Brook to the south of River Road. White-tail deer occur occasionally in the forest east of Metlars Lane near the Sutphen Road intersection and elsewhere.

Birds

In spite of extensive development, some parts of the project region support valuable bird habitats. One-hundred and thirty-five species of birds are known to occur in or near the project area, and 57 of these nest (Table 1). Forests are the most important bird habitat and support at least ninety-four species. Thirty-nine kinds of birds are known to nest in the forests and eight others are believed to nest there. All forests are good habitat for songbirds. An extensive stand east of Metlars Lane in the vicinity of Sutphen Road supports ring-necked pheasants,

Table 1. Birds of the Route 18 study area, Middlesex County, New Jersey, prepared from annotated checklist provided by Charles S. Leck, Rutgers University and field observations by Jack McCormick & Associates 9 and 25 May 1972.

*Asterisks mark species known to have nested on the study area. Asterisks followed by question marks indicate species that probably nest on the study area, but for which no nests have yet been located.

a = abundant c = common u = uncommon r = rare

F = Forest

Pd = Pond

R = River

P = Park

D = Developed

Species	Habitat	Spring Mar.-May	Summer Jun.-Aug.	Fall Sep.-Nov.	Winter Dec.-Feb.
Horned grebe	R	r		r	r
Pied-billed grebe	R	u		u	
Great blue heron	R	c	u	c	
*?Green heron	R,L	c	c	c	
Little blue heron	R	u		u	
Cattle egret	R	r			
Snowy egret	R		u	u	
Black-crowned night heron	R,F		u	u	
*Canada goose	R,Pd,P	c	u	c	
Snow goose	R	r		r	
*Mallard	Pd,R,P	c	u	c	c
Black duck	R,Pd,P	c		c	c
Green-winged teal	R	u		u	
Blue-winged teal	R	u		u	
American widgeon	R	u		u	
*?Wood duck	R,Pd,F	u	u	u	
Red-breasted mer- ganser	R	u		u	u
Turkey vulture	F,P	u	u	u	
Sharp-shinned hawk	F	r		r	
Cooper's hawk	F	r		r	
Red-tailed hawk	F	r		r	r
*?Red-shouldered hawk	F	u	u	u	
Broad-winged hawk	F	u		u	
*?Sparrow hawk	F,P	u	u	u	u
*Ring-necked pheasant	F	c	c	c	c
American coot	Pd,R	u		u	
Killdeer	P,R	c		c	
American woodcock	F	u		u	

Table 1. continued.

Species	Habitat	Spring	Summer	Fall	Winter
*Spotted sandpiper	R,Pd	c		c	
Greater yellowlegs	R,Pd	c		c	
Lesser yellowlegs	R,Pd	c		c	
Pectoral sandpiper	R	u		u	
Least sandpiper	R	c		c	
Semipalmated sand- piper	R	c		c	
Western sandpiper	R	r		u	
Great black-backed gull	R,Pd,P	u		u	u
Herring gull	R,Pd,P	c	u	c	c
Ring-billed gull	R,Pd,P	a	u	a	c
Laughing gull	R	u		u	
Common tern	R	u		u	
*Rock dove	D,P	c	c	c	c
*Mourning dove	F	c	c	c	c
Black-billed Cuckoo	F	u		r	
*Screech owl	F	u	u	u	u
Common nighthawk	D,P,F	c	c	c	
Chimney swift	D,P,F	c	c	c	
*?Ruby-throated humming bird	F	u	u	u	
Belted kingfisher	R	u	u	u	
*Yellow-shafted flicker	F,P	c	c	c	
Red-headed wood- pecker	F	r			
Yellow-bellied sapsucker	F	u		u	
*Hairy woodpecker	F	u	u	u	u
*Downy woodpecker	F	c	c	c	c
*Eastern kingbird	F	c	c	r	
*Great crested fly- catcher	F	u	u	u	
*Eastern phoebe	F,Pd,R	u	u	u	
Yellow-bellied flycatcher	F			r	
Empidonax flycatcher (Species unidentified)	F	u		u	
*Eastern wood pewee	F	c		c	
Horned lark	P	u		u	u
Tree swallow	R	c		c	
Bank swallow	R	u		u	
*Rough-winged swallow	R	u	u	u	

Table 1 continued.

Species	Habitat	Spring	Summer	Fall	Winter
*Barn swallow	R,P	a	c	a	
Purple martin	R,P	u	u		
*Blue jay	F	c	c	c	c
*Common crow	F,P	c	c	c	c
Fish crow	F,R	u		u	u
*Black-capped chickadee	F	c	c	c	c
Carolina chickadee	F	r			
*Tufted titmouse	F	c	c	c	c
*?White-breasted nuthatch	F	c	c	c	c
Red-breasted nuthatch	F	u		u	
Brown creeper	F	u		u	u
*House wren	F	c	c	c	
*Mockingbird	F	u	u	u	u
*Catbird	F	c	c	c	
*Brown thrasher	F	u	u	u	
*Robin	F,P	a	a	a	u
*Wood thrush	F	c	c	c	
Hermit thrush	F	c		c	
Swainson's thrush	F	u		u	
Gray-checked thrush	F	r		r	
*Veery	F	c	c	c	
*Blue-gray Gnatcatcher	F	u	u	u	
Golden-crowned kinglet	F	c		c	r
Ruby-crowned kinglet	F	c		c	
Cedar waxwing	F	u	r	u	u
*Starling	D,P,F	a	a	a	a
Solitary vireo	F	u		u	
*Red-eyed vireo	F	u	u	u	
*?Warbling vireo	F,R	c	c	r	
*Black and white warbler	F	c	c	u	
*?Blue-winged warbler	F	u	u		
Nashville warbler	F	u		u	
Parula warbler	F	c		c	
*Yellow warbler	F,R	c	c	r	
Magnolia warbler	F	c		c	
Cape May warbler	F	r		u	

Table 1 continued.

Species	Habitat	Spring	Summer	Fall	Winter
Black-throated blue warbler	F	u		u	
Myrtle warbler	F	a		a	
Black-throated green warbler	F	c		c	
*Chestnut-sided warbler	F	u	u	u	
Bay-breasted warbler	F	u		u	
Blackpoll warbler	F	c		c	
Pine warbler	F	u		r	
Palm warbler	F,P	c		u	
*Ovenbird	F	c	u	c	
Northern water-thrush	F,Pd	u			
*Yellowthroat	F	c	c	c	
Wilson's warbler	F	u		r	
Canada warbler	F	u		u	
*American redstart	F	c	c	u	
*House sparrow	D,F,P	c	c	c	c
*Red-winged blackbird	F	a	c	a	
*Baltimore oriole	F	c	c		
*Common grackle	F,P	a	c	a	
*Brown-headed cowbird	F,P	c	c	c	
*?Scarlet tanager	F	u	u	r	
*Cardinal	F	c	c	c	c
*?Rose-breasted grosbeak	F	c	u	r	
*?Indigo bunting	F	c	c	u	
Purple finch	F	c		c	
House finch	F,D	r		r	r
Pine siskin	F	u		u	u
*?American goldfinch	F,P	a	c	a	u
*Rufous-sided towhee	F	c	c	c	r
Savannah sparrow	P	u		u	
Vesper sparrow	P	u		u	
Slate-colored junco	F,P	a		a	a
Tree sparrow	F	u		u	c
*Chipping sparrow	P	c	c	c	
White-throated sparrow	F	a		a	a
Fox sparrow	F	u		u	
*Song sparrow	F	a	a	a	u

several kinds of migrating hawks, and screech owls. The lowland forest and shrubby areas west of Metlars Brook and south of River Road form excellent habitats for songbirds, pheasants, and red-winged blackbirds. More kinds of birds were observed in this area during field investigations (33 species, including 11 types of warblers) than in any other place in the project area. Large flocks of goldfinches and purple finches were observed feeding in the canopy of the lowland forest. This stand is of particular value because it is the last relatively undisturbed floodplain forest between Landing Lane and Albany Street.

The river-canal complex is the second most important area for birds and the river-edge constitutes the scarcest ecotone of the entire region. Forty-one species are known to utilize this area, eight of which have been observed to nest and two others are believed to nest. The open water and shoreline ecotones of the canal and river are attractive to migrating grebes, herons, Canada geese, ducks, shorebirds (mostly sandpipers), migrating swallows, and large numbers of gulls.

The park habitat is of lesser importance to birds, although 25 species occur, of which 12 are known to nest and one species is assumed to nest. Starlings, crows, robins, cowbirds, common grackles and several species of sparrows are common inhabitants of park areas.

Fourteen kinds of birds are known to use the pond habitat. Five species nest here and another is assumed to nest. Mallards feed and rest on Metlars Brook. One pair of Canada geese has been observed to nest on the pond nearest the railroad. Gulls, black ducks, wood ducks, and shorebirds also occur in this habitat.

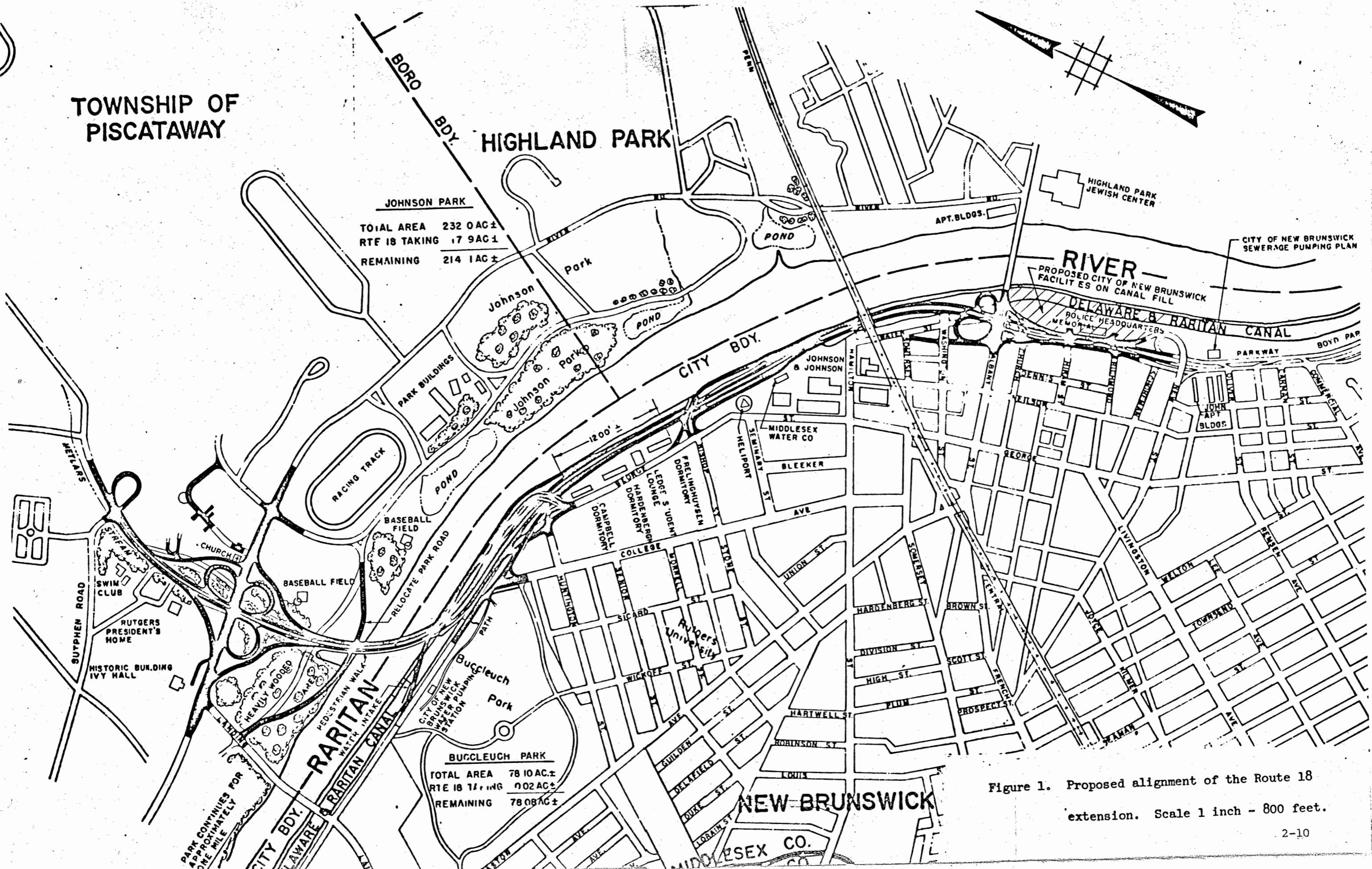
Only six species are known to occur in the developed land habitat, half of which are known to nest there. Rock doves (pigeons) and starlings are the most common birds.

Impact of the Proposed Alignment

The proposed alignment of the Route 18 extension would cover the Delaware and Raritan Canal from Albany Street to Buccleuch Park, where it would cross the Raritan River (Figure 1). After crossing the River, it would cover parts of Metlars Brook through Johnson Park to an interchange that is to be constructed in the vicinity of the present River Road-Metlars Lane intersection. The alignment then would cover Metlars Brook north to Sutphen Road.

This alignment would destroy the valuable wildlife areas formed by the forest and river habitats in the vicinity of the Delaware and Raritan Canal and Metlars Brook and would usurp more than 9000 feet of river-edge ecotone. The proposed Metlars interchange and the realignment of the Park Road also would

**TOWNSHIP OF
PISCATAWAY**



JOHNSON PARK
 TOTAL AREA 232.0 AC ±
 RTE 18 TAKING 17.9 AC ±
 REMAINING 214.1 AC ±

BUCCLEUGH PARK
 TOTAL AREA 78.10 AC ±
 RTE 18 TAKING 0.02 AC ±
 REMAINING 78.08 AC ±

Figure 1. Proposed alignment of the Route 18 extension. Scale 1 inch - 800 feet.

eliminate a large part, and might result in substantial noise, light, and motion impact on the remainder of the shrub swamp and floodplain forest between Metlars Brook and Landing Lane. The proposed interchange loop east of Metlars Lane in the vicinity of Sutphen Road would eliminate sections of the upland forests, mixed oldfield-origin forests, and redcedar forests located east of Metlars Lane in this area.

Impact of the Alternative Alignment

The alternative alignment would cross the Raritan River on a remodelled Albany Street bridge, and then follow River Road to Metlars Lane. River Road would be widened to four-lanes; this widening largely would be on the north side of the existing roadway. An interchange smaller than that for the proposed alignment would be installed near the present Metlars Lane-River Road intersection. The existing Landing Lane bridge would be remodelled and a new four-lane roadway would be constructed between the bridge and the interchange. The existing Landing Lane between the bridge and River Road would be abandoned and restored for park use. Metlars Lane would be widened to four lanes north of the proposed interchange for a distance of approximately 300 feet. No plans exist at this time that show the

alternate alignment farther north along Metlars Laen to Sutphen Road. Therefore, any impact of the alternate alignment in that area cannot be assessed.

The impact of the alternate alignment on wildlife in the area principally would result from the destruction of forest habitat near Metlars Brook. Although the alternate Metlars interchange would take less forest habitat than the proposed interchange in the vicinity of Metlars Brook and would not cover the stream, the connecting road between the Landing Lane bridge and the interchange would pass through the center of the shrub swamp west of Metlars Brook and north of Park Road. The impact on the forest habitat along Metlars Brook north of the interchange cannot be determined.

The alternate alignment also would destroy areas of forest habitat on the north side of River Road between Metlars Lane and the Penn-Central Railroad in the two places where forests presently border River Road.

Conclusions and Recommendations

The alternate alignment would be less destructive to wildlife than the proposed alignment because it impacts less forest habitat. None of the forest habitat along the Delaware and

Raritan Canal would be destroyed by the alternate alignment and none of the river-edge ecotone would be usurped. Approximately one-third of the forest and shrub swamp habitat west of Metlars Brook and south of River Road, however, would be destroyed by the alternate alignment as presently envisioned. This alignment also would destroy forest habitat in two areas north of River Road between Metlars Lane and the railroad. The impact of the alternate alignment on the area near Metlars Brook north of the proposed interchange at River Road cannot be determined because plans are lacking at this time.

The proposed alignment would destroy the forest habitat along the Delaware and Raritan Canal and along Metlars Brook from the Raritan River to Sutphen Road. More than 9000 feet of scarce river-edge ecotone would be usurped. The interchange at River Road and the relocation of Park Road also would impact much of the forest habitat west of Metlars Brook by encircling it completely with roadways and dividing it in half by a relocated road.

On the basis of wildlife, therefore, construction of the alternate alignment should minimize adverse environmental impact of the project. Care should be taken during construction to minimize the disturbance of existing forest habitats and to avoid unnecessary clearing or other disturbances. A slight alteration in

the plans for a connector road to the Landing Lane bridge might avoid or minimize the impact on valuable floodplain habitats.

VOLUME II - APPENDIX

SECTION 7 - ECOLOGICAL REPORTS - SOILS, WILDLIFE,
LIMNOLOGICAL AND VEGETATION

PART 3 - LIMNOLOGICAL

by F. B. Trama, Ph.D.

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Part 3

An Assessment of the Limnological Impact
of the Proposed Route 18 Extension
and of an Alternative Alignment.

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The Delaware and Raritan Canal was used as an inland shipping channel between the Atlantic Seaboard and the Delaware River from 1834 to 1932 (Cawley 1971). Today it is under jurisdiction of the State of New Jersey which maintains the canal as a water resource and recreational area for its citizens. As in the past, the canal's water is derived from the Delaware River via a 22-mile feeder canal that originates at Raven Rock and ends in the vicinity of Trenton. The canal then flows some 44 miles from the Trenton area to its terminus south of the Albany Street Bridge in New Brunswick.

Originally the canal was 80 feet wide and 8 feet deep, but in the area of concern in this study its morphometry has been significantly altered. Just north of the Landing Lane Bridge a spillway through the towpath has existed for many years. This was recently reconstructed by the State, presumably to facilitate diversion of excess canal flows from the canal channel to the Raritan River. Many large trees and shrubs were removed, the spillway was enlarged and the entire spill area generally was fortified with rubble and concrete. The canal is now about 60 feet wide and 6 feet deep in the area of Landing Lane Bridge (Renlund 1953).

The towpath narrows considerably in the section immediately north of the Penn Central Railroad bridge, and it is in this area that the canal has broken through to the river level. At its lower end, the canal has been narrowed with fill and water seems to stagnate in this stretch.

Because of the present spillway at Landing Lane, the existing breach near the Railroad, and a moderate withdrawal of water by the Water Department of the City of New Brunswick and the Middlesex Water Company, the canal is essentially a pond-like aquatic habitat. There is only a very slow movement of water downstream in the area of concern in this study.

The river bed of the Raritan River is below mean sea level in the impact area. The river bottom does not reach sea level for approximately one-half mile upstream from Landing Lane Bridge, and the relatively broad and shallow river is tidal in this region. Although there is no increased salinity from the tides, the water surface fluctuates from 2 to 3 feet during normal tides. Consequently, this part of the Raritan alternately takes on the appearance of a river freely flowing to sea or one that is stilled or impounded. Whenever there is a high-high tide combined with strong landward winds, waves with white-caps and the translocation of water upstream have been observed.

This stretch of river is typical of the many streams and rivers emptying into their estuaries. Tidal fluctuations and frequently

flooded floodplains from a heavy runoff and/or tidal flow are the rule rather than the exception. At average flow and lowtide, the Raritan exposes an extensive mud bank or flat along its eastern shoreline.

Raritan River water in this area is highly colored and has an odor that varies in its composition and strength. Water quality, however, is not so bad as to exclude all biota. A viable and productive assemblage of hardy plants and animals reside in this region of the Raritan. In places where the river bed is swept clean of fine sediment, large populations of snails, leeches, attached algae, and some fish are found.

This river, as it flows past Johnson Park in Piscataway and the City of New Brunswick could be--as it once was--one of their greatest assets. Today, unfortunately, it is not.

Methods

It was not always possible to obtain pertinent data for the impact area itself and data from regions in close proximity to the study area were drawn upon freely. All available published documents and construction plans provided were studied and evaluated solely by me.

Numerous individuals, agencies, and company personnel gave freely of their time and available information in regard to this study with one exception. I was unable to obtain even the most elementary information from the Public Relations Department of Johnson and Johnson Company, New Brunswick.

Some unpublished data in the form of field collections made by my students and colleagues were used in documenting my findings. Although no specific surveys or analyses were made in conjunction with this study, my long-term familiarity during more than ten years in this area was frequently drawn upon.

Impact on the
Delaware and Raritan Canal

Hydrologic Background Summary

Excellent data are available from U.S.G.S. records on canal discharge at Kingston, New Jersey dating from 1947 to the current year. Maximum and minimum daily discharges for 1955 to 1965 are given in Table 1. Recent flow records (U.S.G.S. 1969, 1970) do not significantly differ from those presented in Table 1. Because it is--to a degree--a regulated flow there is little seasonal variation in monthly mean flows which ranged from 92.1 to 109 cfs from October 1969 to September 1970 (U.S.G.S. 1970).

Renlund (1953) conducted the only known study on the plankton and physico-chemical characteristics of the canal over a two-year span. His research effort was concentrated on an analysis of the plankton, especially in the vicinity of the Landing Lane Bridge.

Surface water velocity and water depth were determined weekly by Renlund in the vicinity of Landing Lane. He did not tabulate these data but does give canal flow (= discharge?) for May 1950 to May 1951. Apparently these flows were taken from U.S.G.S. records at Kingston. Renlund does cite an unreferenced source in claiming that surface water velocities of the canal are approximately 0.1 ft/s at times of normal flow and 0.25 ft/s under conditions of high discharge and strong winds. These values are reasonable if one considers that

the canal cross-sectional area could be at a maximum 360 ft^2 (60 ft. wide x 6 ft. deep) and high discharges are in the order of 100 cfs, the mean velocity through the cross-section would be roughly 0.28 ft/s ($100 \text{ cfs}/360 \text{ ft}^2$).

Effect of Conduit on Water Quality

The Route 18 Freeway plan proposes to conduct canal water through a 90-inch pipe which will be buried in the present canal bed as a consequence of filling in the canal to accommodate the roadway and interchange in the George Street area. The City of New Brunswick on an average day pumps roughly 8 mgd from the canal; this amounts to only 12.5% of the total canal flow (1970 monthly mean = 92.1 to 109 cfs). At this diversion rate the remaining canal water would have to move along the 90-inch pipe (= 44 ft^2 x.s. area) at approximately 2 ft/s, if no overflow were permitted. Middlesex Water Company's demand of 2 mgd could be satisfied by an in-pipe water velocity of only 0.07 ft/s which is not an unreasonable flow rate. Since the distance from the projected pipe inlet to outlet is estimated to be 6000 feet, travel time from inlet to outlet at an average velocity of 0.07 ft/s is estimated at almost 24 hrs., and this should have little or no influence on water quality.

Background Data--Water Quality

Physical

Renlund (1953) regularly recorded surface water temperature, secchi disc transparency, and turbidity in the Landing Lane region of the canal. As expected, temperatures ranged from the freezing point to about 30°C. Transparency of the canal water varied seasonally and was lowest in December and March. Secchi disc depths were greater (i.e. transparency high) during the summer and autumn months when plankton populations also were relatively great. Secchi disc readings were, however, generally between 1.0 and 1.5 meters. This is indicative of a high turbidity possibly due to (1) suspended sediment, (2) phytoplankton, and/or (3) color. Data for 1971 to 1972 provided by the City of New Brunswick Water Department also indicate that raw canal water often is quite turbid and highly colored (Table 2).

Chemical

Data on the chemical characteristics of raw canal water are rare. Renlund (1953) gives a somewhat detailed analysis for water sampled on 20 March 1950 (Table 3). The City of New Brunswick Water Department routinely analyzes raw canal water for iron, pH, and total alkalinity (Table 2). The Department, of course, has very complete analyses of the finished water, but this has little semblance to raw canal water.

There is no question about the necessity and suitability of canal water as a drinking water supply for the several communities in the region. New Brunswick's water intake in the canal must be moved upstream at least 200 feet from its present location to safeguard the quality of this water supply. The Middlesex Water Company's supply should be protected from highway pollutants and chemicals which could find their way into the canal water at the pipe inlet. This can be accomplished by careful attention to the design of storm-water drains and suitable location of the pipe inlet.

Biological

Renlund (1953) reported a total of 92 phytoplankton genera from the Canal: 40 Chlorophyta, 5 Euglenophyta, 9 Chrysophyta, 25 Bacillariophyceae, 10 Cyanophyta, and 3 Pyrrophyta. Of the 92 Genera, 15 were found throughout the year and 8 of these were diatoms (Bacillariophyceae).

During the summer months of 1950 to 1952 Renlund observed dense growths of flowering plants (Myriophyllum exalbescens, Elodea canadensis, Potamogeton crispus and Valisneria americana) in a 10 to 15 feet wide band along the canal banks. In the past, the canal surface has been literally blanketed with a freshwater fern (Azolla; Cohn and Renlund, 1953), but in recent years the canal has become covered by Lemna, a minute flowering plant commonly called duckweed. High water quality and slow velocity facilitate this surface growth. While it may be unpleasing to some in an esthetic sense, it does serve to shade

out excessive phytoplankton growths and thereby assists in maintaining a water supply of high quality.

No study of the benthos or the littoral faunal of the canal in the impact area is available. No fish survey has been made, but brown bullheads, various sunfishes, and smallmouth bass are known to inhabit this region of the canal.

Impact on Recreational Uses of the Canal

Because of its high water quality and biological richness the canal and its banks, including the towpath, attract many aquatic and terrestrial forms of wildlife. For example, many species of ducks, various song birds, muskrats, raccoons and rabbits, to name a few, are observed. This in turn is appealing to many people who walk along the towpath or fish from its banks. Even in the absence of hard data it can be safely assumed that the canal is biologically diverse and productive. In comparison to the Raritan River, the Canal has a much higher potential for recreational use.

No human-use figures are available but the Landing Lane area is a very popular fishing site, especially for the youngsters from New Brunswick and Somerset. The towpath now is covered by deciduous trees and shrubs and is a popular hiking and birdwatching trail. The canal itself often is used for leisurely canoe trips. In the vicinity of the Johnson and Johnson Company, north of the railroad bridge, the towpath is very narrow and has been breached.

It is difficult to assess the recreational loss due to the elimination of roughly 6000 feet of open canal and towpath. If the freeway can be built in a manner which does not obliterate this habitat, it would be a resource to the many young people and others of the surrounding areas who use it for some form of recreation. The loss of this habitat and its associated organisms, however, could not conceivably have measurable deleterious effect on wildlife outside of the impact area.

Impact on the Raritan River

A separate assessment is being made of the effect on river hydrology of the presence of bridge piers and a highway embankment required by the proposed plans. Should this assessment indicate that the velocity of the current in the River will be increased to 3 feet per second or more, the proposed alignment is expected to result in scouring of benthic organisms from streambed rocks. This condition would disrupt the aquatic biota at least to the distance upstream and downstream (in the tidal system) to which such velocities are projected.

Background Data on Water Quality

Prior to 1966 only occasional U.S.G.S. records exist on the physical and chemical characteristics of the Raritan River in the region below Bound Brook. Since 1966, however, good records are available for this general area of the river (Table 6). Partial records are available since May 1969 from the U.S.G.S. continuous water quality recorder below South Bound Brook; temperature, dissolved oxygen, pH, and specific conductance are continuously monitored.

Physical

River water in the impact area is highly colored (Table 6) and frequently has a strong chemical odor (personal observation).

Turbidity measurements are not available but at times would be quite high judging from personal observations of river flows and available suspended sediment analyses made by U.S.G.S.

According to U.S.G.S. records for 1968 to 1970 the suspended sediments in river water below Calco Dam near Bound Brook were highly variable from day to day and even from hour to hour. For example, a range of 86 to 590 mg/liter was reported for a total of 7 samples taken between the hours of 07:25 and 20:45 on 13 March 1968. When the accompanying discharges are considered, these reported sediment concentrations imply sediment discharge rates ranging from 2,440 to 17,000 tons per day. On 28 July 1969 at 14:10 the suspended sediment amounted to 796 mg/l and with a river discharge of 12,400 cfs would mean a sediment discharge rate equal to 26,600 tons/day. Therefore, large quantities of sediment are at times transported or deposited in or out of the impact area. Size of sediment particles and water velocity determine the export or sedimentation of particulate matter (Table 4). Particle size of these sediments according to U.S.G.S. analyses generally were less than 0.5 mm with about 50% of the sediments smaller than 0.004 mm in diameter.

Water temperatures, as expected, range from an upper limit of about 30 C to lows near the freezing point. The river frequently freezes and thaws during the colder months of winter. Late January or early February thaws are of common occurrence; freezing conditions frequently recur.

Chemical

On the basis of reported chemical analyses (Tables 6 and 7) and Public Health Standards (1962), water from this region of the Raritan River must be judged undesirable as a potential supply for drinking water. The concentrations of manganese and iron usually exceed the acceptable limit of 0.05 and 0.3 mg/liter, respectively. An acceptable sulfate limit of 250 mg/liter also is frequently exceeded and on rare occasions the chloride limit of 250 mg/liter is surpassed. It should be pointed out that these specific limits are not based on a health hazard but on esthetic and economic considerations.

Phenolic compounds have been detected both by odor and chemical analysis at various points and times in river regions below the Calco Dam near Bound Brook. Recent records at the Technicon Site No. 3 at South Bound Brook (U.S.G.S. 1970) give phenol levels of 12 to 26 $\mu\text{g/liter}$ and 30 $\mu\text{g/liter}$ on 12 May and 1 July 1970, respectively. The maximum allowable phenol level in drinking water is 1 $\mu\text{g/liter}$.

Biological

Coliform counts (number of colonies per 100 ml) in water taken below Calco Dam near Bound Brook ranged from 1,100 to 100,000 between 29 April and 19 September 1968 (U.S.G.S. 1968) and from 1,200 to 89,000 between 22 November 1968 and 19 June 1969 (U.S.G.S. 1969). In the water year October 1969 to September 1970 the coliform counts in water taken near South Bound Brook ranged from 3,800 to 57,000 colonies

per 100 ml (U.S.G.S. 1970). No records are available for the impact area per se, but it can be assumed that comparable coliform populations exist in the water passing through. Public Health Standards limit coliform counts to 2400 per 100 ml for human bathing and swimming.

Very little biological information is available for the Raritan River in or adjacent to the impact area. Edgar (1968) in a study of benthic algae of the Raritan River basin included the Landing Lane Bridge area as his final downstream station. He found that the algal flora at the Landing Lane Station differed significantly from those located upstream:

"The flora of the river system as a whole was fairly homogeneous with the exception of those areas immediately below large bodies of standing water and at Landing Lane (Station DD)...At Landing Lane Stigeoclonium lubricum was abundant year-round. In that Cladophora glomerata was characteristic of most stations in the watershed, its complete absence and replacement by S.(tidgeoclonium) lubricum throughout the entire year at this station was considered significantly different from the pattern established in the rest of the watershed."

He also reported other differences in the algal species found at Landing Lane relative to upstream stations but offered no explanation or possible causal factors.

In her 1967 study on the diatoms of the Raritan River basin the late Dr. Joan Hellerman found that up to 99% of the diatoms collected at Landing Lane in a #25 plankton net were Nitzschia palea.

Students in the Limnology course at Rutgers University qualitatively sampled the biota in the riffle area north of the Landing Lane Bridge on 15 April 1971 and again on 28 March 1972 (Table 8).

Contrary to the reports of Edgar (1968) and Hellerman (personal communication) the phytoplankton retained by a #25 net contained a large number of genera at both times of sampling. The zooplankton was more restricted in its composition and appeared more diverse in the 1972 survey. It must be noted, however, that river plankton generally is classed as tychoplankton ("accidental") because they either are routed from the river bottom and attached surfaces by the current or they are washed into the main river from upstream pools. Thus, the more recent class data may reflect either a transient state or a general improvement in river conditions.

Benthos organisms, unlike the plankton, are indicative of in situ conditions because they maintain a relatively long residence time in or on the river bottom. All of the benthic forms reported in Table 8 are very tolerant of a wide range of environmental conditions and no so-called "clean-water forms" are present. The faunal composition found during both surveys is indicative of poor quality water with some evidence of a moderate level of chemical pollution.

In a study on benthic repopulation in the Raritan River estuary Dean and Haskin (1964) reported a total of four species on 23 March 1959 in their uppermost river station a, which had a salinity of 1%. Station a was located at New Brunswick and is downstream from the impact study area. Macro-benthic fauna identified were two species of Limnodrilus, one unidentified oligochaete, and Helisoma trivolvis. At station B (just downstream from station a) on 10 August 1960 they found a large population of oligochaetes (possible as many as 4 species),

Erpobdella, Helisoma, Lymnaea, Physa, Sphaerium, Amphipoda (unidentified), diptera larvae, and Cyathura polita (a marine isopod). Most of these have also been reported by students in the limnology class surveys conducted in the spring of 1971 and 1972 at Landing Lane (Table 8).

Recreational Use

By order of 15 April 1965, the main stem of the Raritan River from Raritan Bay to the Fieldsville Dam (upstream from the project site) was designated as a Class TW-1 stream. The order conditioned the classification, however, to the following extent:

These waters are not a source of public potable water supply and, therefore, standards of quality and criteria referring exclusively to water supplies are not applicable. The standards of quality and bacterial criteria for shellfish growing areas are applicable only in areas where shellfish harvesting is permitted by the Department [of Environmental Protection].

As established by orders of 30 June 1971 (Rules and regulations establishing surface water quality criteria), the Department of Environment Protection has declared that Class TW-1 streams shall "be suitable for the maintenance, migration and propagation of the natural and established biota; and for primary contact recreation ...". Regardless of the present condition of the River, therefore, any impact analysis must consider its future potential for fisheries and for all water-related recreational uses.

Except when viewed from a distance and an upwind vantage point this region of the Raritan River currently has little esthetic attraction. Over the past 10 years river conditions have greatly improved, but the water quality still is too poor for the establishment of any direct form of recreational use. Coliform counts exceed swimming water quality standard of 2400 colonies per 100 ml.

The odor emanating at times from the river has repelled people from the picnic areas along the banks in Johnson Park. Construction of the bridge and highway would not have any adverse influence on the recreational value of the river in this area under its present condition. Such construction, however, will preclude recreational use in the future when conditions will be improved as required by law. Any impact from the runoff of chemicals generated by the use and maintenance of the bridge and elevated highway is beyond the scope of this study.

Metlars Brook

Edgar (1970) in an experimental study on eutrophication used Metlars Brook. He described it as a freshwater tributary of the

Raritan River on the Piedmont of New Jersey. He found the stream to have a mean depth of only a few centimeters and an approximate width of one meter throughout its length. Keller (1954) described Metlars Brook (Hillside Stream) as a small stream originating in an open unused field, flowing one-half mile to the Raritan River. No hydrographic data are available for this small stream which constantly flows through open fields and wooded areas adjacent to Metlars Lane.

According to the topographic map of the Plainfield Quadrangle, this stream arises at an elevation of about 75 feet in a wooded section east of Metlars Lane at a point about midway between the intersection of Bevier Road and Davidson Road with Metlars Lane. The stream drops to an elevation of 20 feet north of River Road at a point approximately 1500 feet from its mouth; this is roughly one-third of its course. The stream passes rapidly through a relatively deep ravine through most of its course until it reaches the elevation of 20 feet at which point the stream banks are fairly low. As it passes through Johnson Park the stream tends to meander. Consequently, the banks are severely undercut at times of flooding.

No published information is available on the fauna of this stream. Edgar (1970) listed (in an Appendix to his Ph.D. thesis) 148 species and varieties of diatoms identified in Metlars Brook from 30 June to 19 July 1968. This is approximately the maximum number predicted for many streams in the United States. Keller (1954)

reported the following number of species in the various algae groups from Metlars Brook (Hillside Stream):

Greens	29
Euglenoids	4
Diatoms	40
Yellowgreens	3
Blue-greens	<u>5</u>
Total	81

Diatoms, while fewer in number than reported by Edgar (1970), are the dominant algal species.

The only chemical and physical data found on this stream were reported by Keller (1954). He measured a temperature range of 28°C in July to 1°C in January and a rather constant pH between 6.7 and 7.6 over the two year period of study.

Apparently only one chemical analysis was performed on the water of Metlars Brook (Hillside Stream) by Keller (Table 9). Dissolved oxygen on 23 December 1953 was 9.75 cc/liter at 5C (= 107% saturation).

Too little is known about this small stream to evaluate its ecological uniqueness or importance. It seems to serve mainly as a vital waterway for land drainage. In its present state, however, it is a very pleasant landscape feature and constitutes no economic or health problems.

Summary of Findings

1. Construction and operation of the Route 18 Freeway as proposed would have little or no effect on the supply or quality of Delaware and Raritan Canal water currently available to the City of New Brunswick and Middlesex Water Company nor would there be any deleterious effects on the quality of Raritan River water at this point.
2. Flooding regularly occurs in this section of the river and these waters proceed rapidly downstream within the floodway area. Any impediment to this flow, such as the construction of the elevated highway in the park on fill, will result in a back up of flood water. This impounding or stilling of flood water would result in the sediment load, carried by otherwise fast-flowing flood waters, being deposited in the floodway instead of being carried downstream into the estuary. Such placement of fill would be contrary to the recommendations of the State of New Jersey's Flood Hazard Report No. 2: Raritan River (March 1972).
3. Accelerated water velocities in the restricted floodway at times of flooding most likely will cause excessive scouring of the river bed in the main channel and erosion along the eastern bank.
4. Transporting the canal water via conduits and filling the canal bed will destroy an aquatic and semi-aquatic habitat and the biota now associated with this waterway. Organisms residing in the

region to be filled are not rare or unique with respect to their assemblage or behavior. Their demise would have no measureable influence on the wildlife in regions outside of the impact area. There would be a substantial degradation, however, of the existing and potential recreational values associated with this aquatic and semi-aquatic biota.

5. An alternative plan to construct the Route 18 Freeway by widening the Albany Street Bridge and River Road would have minimal influence on the environmental factors associated with the canal and river system.

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Part 1 Stream Flow Records.

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Quality Records.

Table 1: Discharge for the Delaware and Raritan Canal
at Kingston, New Jersey. 1955-1965.

Water Year	Date	Daily Discharges (cfs)		
		Yearly Maximum	Date	Yearly Minimum
55-56	July 1, 1956	94	October 16, 1955	12
56-57	April 6, 1957	174	December 15, 1956	50
57-58	March 26, 1958	108	March 1, 1958	57
58-59	October 8, 1958	98	November 18, 1958	10
59-60	July 15, 1960	96	December 14, 1959	44
60-61	November 3, 1960	102	October 29, 1960	53
61-62	September 14, 1962	129	September 23, 1962	20
62-63	July 2, 1963	132	April 23 to 28, 1963	62
63-64	July 14, 1964	129	October 2 to 4, 1963	75
64-65	June 9, 1965	121	July 8, 1965	63

Data Source: Surface Water Supply of New Jersey. Stream Flow Records. Special Reports Nos. 20 and 31. Prepared by the U.S. Geological Survey in cooperation with the State of New Jersey.

Table 2: Physico-Chemical Analyses of Raw Delaware and Raritan Canal water (1971-72)
 Data provided by The Water Department, City of New Brunswick.

	<u>Date</u>	<u>Color</u>	<u>Turbidity</u>	<u>Iron</u>	<u>pH</u>	<u>Alk</u>
Jan.	5 1971	25	15	0.4	7.2	44
	12	20	10	0.4	7.0	38
	19	25	15	0.3	6.9	40
	26	25	15	0.4	7.1	44
Feb	2	50	15	0.1	7.2	35
	9	225	60	0.4	6.9	22
	17	160	50	0.1	6.8	12
	23	130	30	0.1	6.8	20
Mar	2	110	45	0.2	6.8	24
	9	120	40	0.2	6.8	24
	16	100	25	0.17	6.8	22
	23	90	25	0.15	7.1	28
	30	100	20	0.25	7.1	22
Apr	6	40	10	0.2	7.3	38
	13	80	30	0.2	7.1	28
	20	50	15	0.1	8.2	23
	27	70	20	0.15	8.2	30
May	4	30	15	0.2	8.2	36
	11	60	30	0.1	7.8	32
	17	40	30	0.2	7.9	32
	21	80	25	0.15	7.6	34
	27	60	25	0.2	7.8	32
June	1	50	20	0.1	7.8	36
	8	60	15	0.2	7.9	42
	15	50	15	0.1	8.0	46
	22	80	15	0.15	7.9	48
	29	50	10	0.5	8.0	54

Table 2 continued.

	<u>Date</u>	<u>Color</u>	<u>Turbidity</u>	<u>Iron</u>	<u>pH</u>	<u>Alk</u>
July	6	50	15	0.15	8.4	56
	13	50	10	0.1	7.8	52
	20	40	10	0.1	7.5	50
	27	40	10	0.05	7.0	52
Aug	3	80	10	0.1	7.1	40
	10	50	12	0.07	7.5	42
	17	30	10	0.1	7.5	30
	24	20	7	0.05	7.4	48
	31	190	60	0.35	6.7	22
Sept	7	90	30	0.15	7.3	26
	14	110	25	0.15	6.3	20
	21	90	30	0.2	6.8	32
	28	100	25	0.1	7.1	43
Oct	5	50	20	0.15	7.1	28
	12	50	20	0.1	7.3	40
	19	50	20	0.1	7.2	44
	26	60	20	0.1	6.9	40
Nov	1	90	15	0.1	7.0	40
	8	50	30	0.1	7.1	44
	16	70	20	0.2	7.0	40
	22	70	20	0.15	7.3	50
	30	260	110	0.05	6.9	20
Dec	7	210	70	0.1	6.8	22
	14	65	25	0.1	6.8	32
	21	60	10	0.1	6.9	26
	28	45	10	0.05	6.9	26
Jan	4 1972	40	20	0.15	7.0	32
	11	80	35	0.2	6.6	20
	18	80	35	0.15	6.9	16
	25	70	15	0.15	7.2	30
Feb*	1	40	15	0.1	7.1	30
	8	40	20	0.1	7.1	24
	15	100	35	0.2	6.8	10
	22	90	40	0.15	6.9	20
	29	60	30	0.15	7.0	18
Mar	7+	100	30	0.15	7.1	22
	14	120	60	0.1	7.0	14
	21	100	30	0.15	6.9	24
	28	130	40	0.2	7.1	28

+ Strong musty odor on raw canal water sample reported.

* On Feb. 6 Phenols was incurred in canal supply and all canal raw samples for Feb. reported to have a musty odor.

Table 3. Analysis of Water taken from Delaware and Raritan Canal on March 20, 1950.

<u>Measurement</u>	<u>*Reported Value</u>
Turbidity	23
Color	30
pH	8.6
Total Solids	165
N-NH ₃	0.05
N-NO ₂	0.004
N-NO ₃	1.8
Si (as SiO ₂)	10
Na & K (as Na ₂ O)	0.79
Mn	0.1
Fe (as Fe ₂ O ₃)	0.4
Al (as Al ₂ O ₃)	2.0
Total Hardness (as CaCO ₃)	64

* All values reported in units of milligrams per liter except for turbidity, color and pH which are expressed in terms of standard units.

Data Source: Unpublished data of C. Henderson, Rutgers University, as reported by R.N. Renlund (1953) in his Ph.D. thesis.

Table 4. Relation of Current Velocity to Substrate

Velocity (ft/sec)	Approx. Diam. Particles Transp. (mm)	Habitat classification	Nature of Substrate
Greater than 4	40	torrential	rock
Greater than 3	20	torrential	heavy shingle
Greater than 2	11	non-silted	light shingle
Greater than 1	5	partly silted	gravel
Greater than 0.7	1.3	partly silted	sand
Greater than 0.4	0.5	silted	silt
Less than 0.4	0.2	pond-like	mud

Table 5.

Peak Discharges for Raritan River at
Bound Brook, New Jersey. 1955-1965.

Water Year	Date	Discharge (cfs)	
		Peak	Daily Mean
55-56	October 15, 1955	26,700	22,600
56-57	April 6, 1957	15,400	14,400
57-58	February 28, 1958	21,500	16,500
58-59	October 26, 1958	12,300	8,900
59-60	September 13, 1960	19,200	15,000
60-61	March 24, 1961	15,600	12,100
61-62	March 13, 1962	19,500	14,600
62-63	March 7, 1963	15,300	10,300
63-64	January 10, 1964	16,000	12,100
64-65	February 8, 1965	16,900	12,700

Data Source: Surface Water Supply of New Jersey. Stream
Flow Records. Special Reports Nos. 20 and 31.
Prepared by the U.S. Geological Survey in
cooperation with the State of New Jersey.

Table 6. Chemical Analyses for Raritan River at or below Gaging Station near Bound Brook, N.J.
From U.S. Geological Survey records; chemical analyses in milligrams per liter.

Date of collection	Mean discharge (cfs)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Carbonate (CO ₃)	Sulfate (SO ₄)
Jan. 18, '66	152	--	--	--	--	--	A201	--	73	0	356
Feb. 28	1000	--	--	--	--	--	A27	--	12	0	76
Mar. 29	350	6.2	0.30	0.10	19	7.2	16	2.9	25	0	57
Apr. 29	1540	--	--	--	--	--	A16	--	22	0	55
May 23	1120	--	--	--	--	--	A15	--	10	0	59
June 30	138	6.7	.70	.15	28	11	67	6.0	14	0	147
Aug 30	70	--	--	--	--	--	A327	--	41	0	583
Sept. 30	279	13	.64	.20	25	8.2	24	4.9	10	0	82
Oct. 27	560	--	--	--	--	--	A33	--	11	0	99
Nov. 23	211	--	--	--	--	--	A127	--	10	0	244
Dec. 13	432	11	0.56	0.22	24	8.5	32	4.0	13	0	89
Jan. 26, '67	1430	--	--	--	--	--	A16	--	24	0	54
Feb. 28	671	--	--	--	--	--	A22	--	29	0	58
Mar. 15	2170	--	--	--	--	--	A17	--	23	0	53
Apr. 12	683	6.9	.58	.00	15	5.8	18	2.5	18	0	54
May 5	737	--	--	--	--	--	A13	--	24	0	47
May 24	689	--	--	--	--	--	A18	--	26	0	55
June 27	329	--	--	--	--	--	A72	--	25	0	97
July 21	464	9.5	.45	.08	23	7.7	16	3.3	48	0	48
Aug. 24	374	--	--	--	--	--	A55	--	23	0	120
Sept. 28	234	--	--	--	--	--	A77	--	12	0	167

Date of collection	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Phosphate (PO ₄)	Dissolved solids (residue at 180°C)	Hardness as CaCO ₃		Specific conductance (micromhos at 25°C)	pH	Color
						Calcium, magnesium	Non-carbonate			
Table 6 continued.										
Jan. 18 '66	200	--	4.2	--	--	280	220	1500	7.8	5
Feb. 28	36	--	13	--	--	92	82	357	6.3	5
Mar. 29	22	0.2	9.5	0.72	168	77	57	264	6.5	5
Apr. 29	16	--	8.3	--	--	70	52	231	6.8	25
May 23	16	--	8.4	--	--	66	58	230	6.1	25
June 30	70	.0	20	.78	416	115	104	622	5.8	100
Aug. 30	285	--	.4	--	--	332	299	2160	6.2	100
Sept. 30	32	.4	21	.26	228	96	88	335	6.0	7
Oct. 27	37	--	17	--	--	105	96	390	5.7	5
Nov. 23	118	--	29	--	--	175	167	959	5.4	100
Dec. 13	36	0.2	31	0.58	241	95	85	371	6.2	7
Jan. 26, '67	18	--	11	--	--	76	57	240	6.7	2
Feb. 28	27	--	8.2	--	--	82	58	286	6.5	1
Mar. 15	18	--	7.6	--	--	69	50	231	6.5	2
Apr. 12	22	.2	9.5	.54	167	62	47	243	6.9	10
May 5	20	--	7.6	--	--	74	55	241	6.6	20
May 24	21	--	8.3	--	--	76	55	258	7.0	20
June 27	36	--	12	--	--	112	92	407	6.2	27
July 21	22	.1	9.9	.60	171	89	52	276	7.2	16
Aug. 24	60	--	18	--	--	124	105	547	6.0	30
Sept. 28	83	--	20	--	--	149	139	700	5.6	16

A Calculated Na plus K, reported as Na.

Chemical Analyses for Raritan River at or below Gaging Station near Bound Brook, N.J.
From U.S. Geological Survey records; chemical analyses in milligrams per liter.

Table 6.
(Continued)

Date of collection	Mean discharge (cfs)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Carbonate (CO ₃)	Sulfate (SO ₄)
Oct.23, 1967	277	8.3	.93	.72	69	23	150	7.2	3	0	351
Nov.21	332	-	-	-	38	14	A55	-	45	0	120
Jan.25, '68	1090	-	-	-	20	8.2	A26	-	22	0	68
Feb.20	526	-	-	-	29	11	A36	-	55	0	86
Mar.20	4160	8.1	.45	.16	11	4.7	7.8	2.9	11	0	34
Apr.29	693	-	-	-	21	8.5	A29	-	36	0	73
June 12	4430	-	-	-	25	8.2	A33	-	42	0	75
June 26	734	-	-	-	18	6.1	A17	-	40	0	43
July 16	208	-	-	-	34	6.0	A40	-	58	30	53
Aug. 13	152	-	-	-	49	15	A99	-	27	0	207
Sept. 19	131	-	-	-	64	22	A173	-	5	0	339
Oct. 25	228	6.8	.75	.60	68	18	142	13	3	0	320
Nov. 22	661	-	-	-	23	7.9	A65	-	23	0	72
Dec. 30	713	-	-	-	19	7.8	A29	-	16	0	62
Jan.28, '69	683	9.8	.52	.17	22	6.5	16	3.2	14	0	58
Feb. 19	368	-	-	-	27	9.9	A67	-	53	0	110
Mar. 20	1570	8.3	.12	.04	17	5.4	10	2.4	16	0	40
Apr. 30	560	-	-	-	17	6.8	A19	-	30	0	51
May 29	249	-	-	-	24	7.4	A26	-	40	0	61
June 19	331	-	-	-	49	11	A126	-	7	0	230
Oct. 29	187	-	-	-	5.8	11	-	-	4	0	179
Nov. 18	410	-	.84	.49	32	10	-	-	18	0	108
Dec. 29	1170	11	-	-	17	6.3	11	1.2	27	0	40
Jan.20, '70	646	-	-	-	20	8.0	A23	-	19	0	51
Feb. 27	604	5.8	.14	.24	33	10	35	3.4	8	0	104
Mar. 23	2990	-	-	-	18	6.5	A 9.7	-	24	0	40
May 05	700	6.1	.11	.12	20	8.0	14	3.5	38	0	52
May 21	927	-	-	-	16	5.5	A18	-	40	0	34
June 26	335	-	-	-	17	5.0	A49	-	23	0	81
July 23	140	-	-	-	37	9.5	A34	-	34	0	81
Sept. 03	120	7.3	.19	.70	70	18	145	8.8	2	0	325
Sept. 28	263	-	-	-	36	9.7	A71	-	15	0	145

Date of collection	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Phosphate (PO ₄)	Dissolved solids (residue at 180°C)	Hardness as CaCO ₃		Specific conduct- ance (mi- cromhos at 25°C)	pH	Col- or
						Cal- cium, mag- nesium	Non- car- bon- ate			
Table 6 continued										
Oct. 23, '67	151	.1	28	.83	854	267	264	1310	5.4	80
Nov. 21	60	-	19	-	-	153	116	610	6.3	25
Jan. 25, '68	31	-	10	-	-	84	66	325	6.2	9
Feb. 20	36	-	12	-	-	118	73	450	6.5	5
Mar. 20	10	.1	6.9	.23	107	47	38	159	6.8	5
Apr. 29	28	-	7.8	-	-	88	58	328	6.6	5
June 12	32	-	12	-	-	96	62	377	6.6	10
June 26	18	-	5.7	-	-	70	37	234	6.9	5
July 16	29	-	2.5	-	-	110	62	376	9.2	4
Aug. 13	114	-	2.1	-	-	184	162	907	6.0	4
Sept. 19	183	-	18	-	-	250	246	1460	5.7	85
Oct. 25	160	.2	44	.83	783	244	241	1240	5.1	50
Nov. 22	89	-	15	.53	-	90	71	319	7.6	25
Dec. 30	36	-	15	.51	-	78	65	304	6.2	8
Jan. 28, '69	22	.3	18	.42	171	82	70	256	7.2	10
Feb. 19	67	-	.5	.37	-	108	65	539	6.8	12
Mar. 20	15	.3	9.2	.38	131	65	52	184	7.1	8
Apr. 30	19	-	10	.44	-	71	46	241	7.6	7
May 29	29	-	18	.56	199	91	58	323	7.6	12
June 19	115	-	42	.90	-	168	162	927	6.0	75
Oct. 29	102	-	45	1.6	-	190	186	816	4.9	40
Nov. 18	57	-	29	1.1	-	121	106	496	6.8	20
Dec. 29	19	.2	10	.36	144	69	47	222	7.7	10
Jan. 20, '70	37	-	17	.91	-	83	68	320	7.3	5
Feb. 27	49	.2	23	.28	298	124	117	455	6.6	20
Mar. 23	17	-	9.5	.35	-	72	52	212	6.9	5
May 05	22	.3	8.5	.44	154	83	52	265	7.0	8
May 21	18	-	8.6	.56	-	63	30	229	7.2	4
June 26	38	-	16	.87	-	63	44	400	6.5	20
July 23	52	-	25	1.7	-	132	104	448	6.2	12
Sept. 03	160	.2	37	1.0	808	249	247	1250	5.0	75
Sept. 28	66	-	34	1.3	-	130	118	619	6.5	35

Table 7. Spectrographic analysis, Raritan River below Bound Brook, micrograms per liter

Date of collection	Mean Discharge (cfs)	Aluminum (Al)	Barium (Ba)	Beryllium (Be)	Boron (B)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)
Apr. 12, 1967	-	70	50	<0.3	70	-	2	<1
Oct. 24, 1968	150	25	50	<3.0	110	<140	<25	<15
Sept. 29, 1969	748	40	31	<0.7	73	<35	<4	<2
Sept. 03, 1970	120	50	62	<2.0	170	<150	<12	<15

Date of Collection	Copper (Cu)	Iron (Fe)	Lead (Pb)	Lithium (Li)	Maganese (Mn)	Molybdenum (Mo)	Nickel (Ni)
Apr. 12, 1967	5	120	2	4	150	3	8
Oct. 24, 1968	3	55	<15	8	440	10	13
Sept. 29, 1969	6	55	3	3	110	2	7
Sept. 03, 1970	8	160	<7	8	660	12	13

Date of Collection	Rubidium (Rb)	Silver (Ag)	Strontium (Sr)	Tin (Sn)	Titanium (Ti)	Vanadium (V)	Zinc (Zn)
Apr. 12, 1967	5	<0.2	140	<2	1	1	<75
Oct. 24, 1968	13	<2.0	310	<30	<6	<9	<430
Sept. 29, 1969	7	<0.4	130	<4	<4	<2	<140
Sept. 03, 1970	7	<0.6	360	<12	7	<7	<620

< Less than figure shown.

Table 8: Biological Survey of Raritan River in Vicinity of Landing Lane Bridge. Collections and analyses performed by students enrolled in Limnology Course. Rutgers University. Presence of organism indicated by an X.

Community	Taxon	Date of Survey	
		April 15, 1971	March 28, 1972
Phytoplankton	Cymbella	X	X
	Fragillaria	X	X
	Pinnularia		X
	Nitzschia	X	X
	Diatoma	X	X
	Navicula	X	X
	Meridron	x	X
	Suriella	X	
	Synedra	X	X
	Asterionella	X	X
	Melosira	X	X
	Eudorina	X	X
	Stigeoclonium	X	X
	Mougeotia	X	
	Ulothrix	X	X
	Cladophora	X	X
	Spirogyra		x
	Chaetophora	X	X
	Pediastrum		X
	Coelastrum	X	
Closterium		X	
Tribonema		X	
Oscillatoria	X	X	
Zooplankton	Keratella		X
	Polyarthra	X	X
	Notholca		X
	Copepoda (nauplii)	x	X
	Ciliata		X
	Nematoda		X
	Tendipedidae (pupa)		X
	Tardigrada		X
Ostracoda		X	
Benthos	Tendipedidae (larva)		X
	Physa	X	X
	Lymnaea	X	X
	Helisoma		X
	Placobdella	X	X
	Erpobdella	X	X
	Garmmarus	X	X
	Asellus		X
Nekton	Fundulus (killifish)	X	X
	Anguilla (eel)	X	
	Gasterosteus (three-spine stickleback)		X

Table 9: Chemical Analysis of Metlars Stream (Hillside Stream, Keller 1954) for March 19, 1954.

<u>Constituent</u>	<u>mg/liter</u>	<u>Constituent</u>	<u>mg/liter</u>
NH ₃ -N	.02	Calcium (as CaO)	18.3
NO ₂ -N	.008	Mg (as MgO)	7.3
NO ₃ -N	1.4	Sulfur (as SO ₄)	39.6
Silica (as SoO ₂)	7.5	Manganese (Mn)	0.9
Aluminum (as Al ₂ O ₃)	2.86	Phosphorus (as PO ₄)	0.4
Iron (as Fe ₂ O ₃)	0.14	Chloride (Cl)	7.0

VOLUME II - APPENDIX

SECTION 7 - ECOLOGICAL REPORTS - SOILS, WILDLIFE,
LIMNOLOGICAL AND VEGETATION

PART 4 - VEGETATION

by H. A. Somes Jr, & Jack M^CCormick

Jack M^CCormick & Associates

Part 4

Vegetation

Horace A. Somes, Jr. and Jack McCormick
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To describe the vegetation on and near the proposed and alternative rights-of-way, a map was prepared from aerial photographs and site inspections.

Previous Studies

The vegetation of the Raritan River flood plain was studied by Buell and Wistendahl (1955) and Wistendahl (1958). On the north bank from Landing Lane upstream for approximately one mile, the River is bordered by a natural levee, behind which was a marshland (Wistendahl, 1958). The better drained sections of the levee and the more elevated lands north of the marsh area were cleared during the Colonial Period for farms, mills, and warehouses. Much of this land had been abandoned by late nineteenth century, however, and once again is becoming forested. The margin of the levee nearest the River was least disturbed by clearing, and now is covered with trees of various sizes and species. The marshland is covered by grasses, sedges, and other herbaceous plants.

On fields disturbed most recently, woody plants were represented principally by shrubs and vines, such as silky dogwood, bayberry, and poison ivy. The first trees to appear were redcedar,

wild cherry, red ash, and white ash. Ash forests, with occasional elm, basswood, pin oak, hackberry, and box elder, were characteristic of the oldest fields.

The levee at Raritan Landing had not been cleared for many years, and was covered by a strip of forest no wider than 90 feet. The most common tree species on the levee were black willow, river birch, silver maple, sycamore, and box elder. American elm, ash, hackberry, basswood, honey locust, and swamp white oak were less abundant. In some places poison ivy, Japanese honeysuckle, bladder-nut, and grape were common as an understory.

A rather extensive marsh existed behind the levee at the Landing. Grasses and sedges generally were the most common plants, and included broad-leaved cattail, rice cutgrass, sweetflag, bur-reed, and sedge (*Carex stricta*). Goldenrod, knotweed, tickseed sunflower, Joe Pye weed, ironweed, and New England aster were abundant locally, and duckweed covered the surface of standing water during the summer. Silky dogwood was the most common shrub; marsh mallow and poison ivy were abundant in places. Small ash, elm, pin oak, swamp white oak, and honey locust trees were scattered in the area.

Landscape Types

Fifteen landscape types were distinguished during field inspections. Eleven of these describe areas covered by natural,

semi-natural, or cultivated vegetation. The four other landscape types include water, water-related areas, and intensive cultural-use areas.

Vegetation Types

Upland Forests in the study area are composed largely of ash, but American elm, slippery elm, sycamore, wild cherry, tree-of-heaven, Norway maple, basswood, sugar maple, honey locust, mulberry, American beech, white oak, red oak, shagbark hickory, and black locust are frequent associates. White pine, tulip poplar, and bur oak also were observed. The undergrowth, which is more or less continuous, includes hackberry saplings, maple-leaved viburnum, nannyberry, blackberry, rose, Japanese honeysuckle, and grape. These forests grow on upper terraces and on slopes which are infrequently or never flooded.

Riverbank Forests are well developed on the flood plain of the Raritan River. Red ash and white ash are the most abundant tree species. River birch, box elder, red maple, silver maple, black willow, swamp white oak, and slippery elm are common associates. The sparse undergrowth is composed of silky dogwood, barberry, blackberry, and grape.

In Parkland Forests the tree canopy overspreads more than 50

percent of the soil surface, the ground layer usually is a mowed grassland, and the understory is absent or is composed of occasional cultivated shrubs (forsythia, privet, and various evergreens). The canopy of parkland forests is variable, but in the public parks it generally is composed of trees of upland or riverbank forests (pin oak, red oak, red ash, white ash, American elm, black willow, sycamore, red maple, silver maple, honey locust, and others). Near homes, mulberry, Norway maple, Norway spruce, white pine, black walnut, and other planted trees are common.

Evergreen Plantations are composed of exotic conifers, particularly pines and spruces, or native redcedars.

Mixed Oldfield Forests occupy land formerly used for agriculture or otherwise disturbed and allowed to revegetate. Common oldfield tree species noted were tree-of-heaven, wild black cherry, hackberry, black locust, crabapple, white ash, mulberry, and redcedar. Blackberry, rose, maple-leaved viburnum, bayberry, sassafras, and nannyberry are abundant in the shrub layer with Japanese honeysuckle, poison ivy, grape, catbrier, and other woody vines. Broom-sedge is the characteristic herbaceous component, but goldenrods, Queen Anne's-lace, and other broad-leaved herbs are conspicuous locally.

Redcedar Oldfield Forests are nearly pure stands of redcedar with various shrubs and herbs. Similar stands in the New Brunswick region were described by Bard (1952).

Oldfields are shrubby and herbaceous growths on lands formerly cultivated or otherwise disturbed. Blackberry, bayberry, winged sumac, smooth sumac, Japanese knotweed, broomsedge, poison ivy, sassafras, Japanese honeysuckle, bush honeysuckle, and rose are common. Because trees are absent or scattered, these areas probably have been cultivated more recently than oldfield forests or they are mowed or burned periodically.

A Shrubland area in Johnson Park east of Landing Lane is covered primarily by silky dogwood. Occasional pin oaks, hawthornes, rushes, sedges, and grasses also occur. It borders a large stand of riverbank forest north of the Raritan River.

Marshland is lowland covered by grasses, sedges, and rushes. Common reed is the most conspicuous species.

Grasslands are mowed grass areas with ornamental shrubs and few or no trees. If trees are present, their crowns overspread less than 50 percent of the ground.

Areas Without Vegetation

Open Water includes the normal channels of the Raritan River, Delaware and Raritan Canal and of smaller streams, and ponds.

Mudflats are alluvial deposits of sand, gravel, and/or silt associated with the Raritan River. These areas are flooded frequently and are barren of rooted plants.

Bare Areas have been denuded or kept free of vegetation by scraping, intensive use (trampling), or surficial filling (railroad ballast, gravel).

Description of Existing Landscape Conditions

South of the Raritan River

The embankment of the Delaware and Raritan Canal east of the Johnson and Johnson facilities generally is about 30 feet wide, although it is 70 feet wide in the vicinity of the Pennsylvania Railroad bridge. The top of the embankment is no more than 5 feet above the high tide level. The principal vegetation cover is a riverbank forest in which ashes as great as 8 inches in diameter are common.

Upland forests predominate on much of the remainder of the vegetated portion of the project area. West of the Johnson and Johnson facilities the Canal embankment generally is 60 to 70 feet

wide and more than 15 feet above the high tide level. The towpath is a barren strip 6 to 10 feet wide along the crest of the embankment. Most of the embankment is covered by upland forest in which Norway maple and ash ranging to 10 inches in diameter are common. A few black willow (maximum diameter 24 inches) and silver maple (16 inches) trees were observed along the lower slopes of the embankment. Upland forests also occupy a 30 to 80 foot wide bank along the steep south bank of the Canal from Landing Lane to a point 150 feet north of Seminary Street. From Landing Lane to Huntington Street, the forest is bounded on its upland edge by George Street. Parkland forests composed principally of Norway maple (8 to 16 inches in diameter) occur in Buccleuch Park along the opposite (south) side of George Street from Landing Lane to College Avenue. Between College Avenue and Huntington Street parkland forests associated with residences line the south side of George Street. Beyond Huntington Street, however, the upland forest is separated from George Street by a strip of developed land on which three dormitories of Rutgers University are located.

Southeast of Seminary Street the south bank of the Canal largely is occupied by buildings, pavement, and bare areas to Hiram Street. From Hiram Street to the limit of work, public and private buildings and paved parking areas near the proposed right-of-way are separated from the Canal by bare areas, oldfield forests, riverbank

forests, oldfields, and a narrow strip of grassland.

Tidal mudflats 5 to 10 feet wide occupy the area immediately north of the Canal embankment and primarily west of the Johnson and Johnson facility. A narrow band of shrubland, marsh, and mudflats occurs along the south bank of the Canal and was mapped as mudflat.

North of the Raritan River, and South of River Road

Johnson Park, an intensively managed public recreational open space on the level flood plain, lies between the alternative alignment and the Raritan River from the Penn-Central Railroad westward beyond Landing Lane. A mudflat that borders the Raritan River throughout the length of the park generally is 10 to 20 feet wide, although in places near Metlars Brook it is 120 feet wide.

West of Metlars Brook and south of River Road, the land is covered primarily by riverbank forests and shrubland. Between Park Road and the Raritan River, the riverbank forest is composed largely of silver maples (to 10 inches in diameter). Other species of trees and some shrubs occur along the edges of this stand. Box elders and ashes to 8 inches in diameter are common. Mulberry (6 inches), swamp white oak (30 inches), and river birch (10 inches) also occur. Common elderberry, grape, silky dogwood and, at places along the

River, reed canary grass also grow in the understory. The central third of this stand, however, contains only multiple-stemmed silver maple (individual stems to 10 inches in diameter), with a dense groundcover of jewelweed.

West of Metlars Brook, the southern half of the tract between Park Road and River Road contains shrubland and riverbank forest. The forest is composed of a variety of riverbank species and has a thick undergrowth of shrubland species. Most of the northern half of this tract is covered by a grassland interspersed with several parkland forests composed principally of ash (to 10 inches in diameter).

Johnson Park east of Metlars Brook is characterized by grasslands, although scattered stands of parkland forests occur particularly in the central section near the deer pen. Between Hillcrest Road and Metlars Brook, the principal components of the parkland forest are ash (generally 6 to 10 inches in diameter), pin oak (8 to 10 inches), and silver maple (10 to 15 inches). Black walnut, honey locust, and swamp white oak are less common associates. A smaller stand of parkland forest that is located near River Road northeast of the racetrack contains several ash trees (to 28 inches in diameter) and honey locusts (12 inches). An evergreen plantation of redcedar is located near the River Road-Hillcrest Road intersection. Sycamores (8 to 10 inches in diameter) have been planted along River Road and Hillcrest Road and are mapped with the grassland because they are spaced widely.

Parkland forests are the predominant cover from the deer pen to the tennis courts. Grasslands are scattered in the area and a marshland was mapped inside the deer pen. Ash (generally 8 to 15 inches in diameter) is the most common tree species. Principal associates are swamp white oak, honey locust, red oak, pin oak, and hackberry. Crabapple and dogwood have been planted in several areas, most of which are within grasslands.

Grasslands are predominant from the tennis courts to the Penn-Central Railroad. Trees occur along River Road, but in only a few places were they dense enough to be mapped as parkland forest. Ashes (8 to 12 inches in diameter) are most common, but there also are numerous individuals of gray birch (maximum diameter 5 inches), river birch (8 inches), hackberry (12 inches), honey locust (8 inches), and sycamore (10 inches). Crabapple, forsythia, winged euonymus, and small dogwood have been planted along the edge of River Road.

Between the Penn-Central Railroad and Albany Street, parkland forests and grasslands associated with residences and the Devonshire Arms Apartments are the principal vegetation types. Several small areas of oldfields, mixed oldfield forest, and riverbank forest also occur. High embankments on both sides of the railroad are covered by a mixed oldfield forest.

The area east of Albany Street is covered by parkland forest associated with the Highland Park Jewish Center. A narrow band of riverbank forest separates the parkland forest from the Raritan River.

North of River Road and East of Metlars Lane

The north side of River Road is marked by a sharp rise in topography. The vegetation is composed largely of grassland, upland forest, and parkland forest on residential lots and the property of the Cenacle Retreat and Kaplan and Sons (Old Queens Gallery).

An upland forest borders River Road for approximately 800 feet opposite the Johnson Park racetrack. Pin oak up to 10 inches in diameter and ash are common, but hackberry (to 7 inches) is especially abundant along River Road. Cherry, shagbark hickory, black walnut, honey locust, red oak, and redcedar are less common components of the forest. Japanese honeysuckle and poison ivy form a thick ground cover in many places. A red pine stand (8 to 10 inches in diameter) within the upland forest (approximately 150 feet from River Road) was mapped as an evergreen plantation.

A second upland forest borders River Road for 1100 feet opposite the Johnson Park tennis courts. Ash (to 15 inches in diameter) is the most common tree species, but tree-of-heaven, hackberry, honey locust, pin oak, red oak, dogwood, Norway maple, and slippery elm also are present.

A parkland forest on the property of Kaplan and Sons (Old Queens Gallery) borders River Road for approximately 1000 feet to the east of the aforementioned upland parkland. Many native and introduced tree species compose this stand. Norway maple, red oak,

white pine, beech, witch hazel, Norway spruce, and red pine are common.

An upland forest borders River Road east of the Kaplan property to Cedar Lane. Ash, hackberry, and Norway maple are common, although Scotch pine and horse chestnut were also observed near Cedar Lane.

Parkland forest associated with the Cenacle Retreat borders River Road for 800 feet east of Cedar Lane. Redcedar, Norway spruce, European beech, dogwood, Norway maple, red pine, and white pine occur in this area.

The western two-thirds of the area between the Cenacle Retreat and the Penn-Central Railroad has been cleared and is mapped as bare ground. The remaining portion is covered by oldfield mixed forests.

Between the Railroad and Albany Street, the north edge of River Road is bordered principally by parkland forests and grasslands associated with residences and a church (St. Mary of Zirovicy). Two small areas of upland forest also occur near the Railroad. These forests contain ash, Norway maple, pin oak, red oak, tulip poplar (to 20 inches in diameter), and bur oak (to 24 inches).

North of River Road, and West of Metlars Lane

An upland forest of red oak (to 15 inches in diameter), beech (13 inches), ash, Norway maple, and honey locust occupies much of the area between Metlars Lane and the landscaped land associated with the residence of the President of Rutgers University, north to

Sutphen Road. Grassland, parkland forest, and an evergreen plantation are associated with the University-owned residence.

In the first 8600 feet along the east side of Metlars Lane, parkland forest, grassland, and some upland forest are associated with three house lots (only two presently have houses on them) and the Church of Jesus Christ of Latter Day Saints, Metuchen Branch (now vacant). Ash, Norway spruce, red oak, and a variety of ornamental shrubs are common woody species. North of this section, Metlars Lane is bordered by a strip of upland forest 130 to 160 feet wide. Ashes to 10 inches in diameter are common, and several red oak trees (to 5 inches) were observed. East of the upland forest is a redcedar oldfield forest. Redcedars 4 to 8 inches in diameter and ranging to 40 feet in height are common. Ash (to 8 inches), red oak (6 inches), and gray birch (3 inches) are scattered among the cedars.

Vicinity of Proposed Logan Lane Connector Road

The area within the proposed location of the Logan Lane connector road (from the north end of Logan Lane eastward to Hillcrest Road) largely is covered by upland forest, redcedar oldfield forest, mixed oldfield forest, and oldfields. Logan Lane is bordered by grasslands and parkland forests associated with homes. The west side of Hillcrest Road in this area is edged by residential lawns (mapped as grasslands) and parkland forests.

Impact Area Determination

Proposed Alignment

The boundaries of the proposed right-of-way (including areas for the installation of ditches and walkways), as shown on plan sheets supplied by King and Gavaris (1 inch equals 30 feet), were plotted on the vegetation map. The area of each vegetation type within these boundaries was determined by planimeter (Table 1). For segments of the alignment located north of River Road, areas not included on the vegetation base map were determined on the plan sheets.

Alternative Alignment

No detailed plans for the alternative alignment have been prepared to date. The firm of King and Gavaris prepared a set of right-of-way maps (1 inch = 100 feet) interpreted from an alternative alignment proposal made by the Rutgers Center for Transportation Studies (Bright, 1972). These maps were used to assess the potential impact of the alternative alignment. The plans, however, do not include the Metlars Brook area north of the proposed interchange at River Road, and no allowances have been made for any service roads that may be needed to provide access to Johnson Park. The areas determined by planimeter, therefore, may be less than would actually be impacted if the alternative route were utilized (Table 1).

Figure 1. Vegetated impact areas (acres) of proposed and alternate alignments.

		Forest										Total			
		Riverbank	Park	Evergreen Park	Upland	Oldfield Origin	Redcedar	Forest	Shrub	Oldfield	Grass	Marsh	Mudflat	Proposed	Alternate
South of Raritan River	Proposed	1.66	1.00	0	5.51	0	0		0	.31	1.48	0	3.06	13.02	0
	Alternate	0	0	0	0	0	0		0	0	0	0	0		
Raritan River to River Road west of Hillcrest Road	Proposed	3.24	3.59	.01	0	0	0		1.29	0	12.13	.02	.11	20.39	
	Alternate	1.55	1.72	0	0	0	0		.45		3.04	.07	.00		6.83
Raritan River to River Road east of Hillcrest Road	Proposed	0	0	0	0	0	0		0	0	.28	0	0	0.28	
	Alternate	.13	1.52	0	0	.14	0		0	.13	1.33	0	.05		3.30
North of River Road	Proposed	0	2.67	0	6.74	.11	1.59		0	.17	3.64	.37	0	15.29	
	Alternate	0	6.85	.07	7.69	2.24	0		0	.07	3.08	.07	0		20.07
Total	Proposed	4.90	7.26	.01	12.25	.11	1.59		1.29	.48	17.53	.39	3.17	48.98	
	Alternate*	1.68	10.09	.07	7.69	2.38	0.00		.45	.20	7.45	.14	.05		30.20

*Alternate impact areas are minimum estimates because of incomplete plans for alternate alignment at this time, particularly north of River Road in the vicinity of Metlars Brook.

Environmental Impact

A quantifiable appraisal can be made of the relative values of different vegetation types on the basis of productivity. However, no productivity studies are known to have been performed within the impact area. Therefore, the impact of the proposed and alternative alignments cannot be compared on the basis of productivity of the impacted vegetation. Consequently, an alternative method of impact assessment had to be used. The method utilized is based on the relationship of land use to vegetation cover.

From this standpoint, the overall environmental impact of the Route 18 extension can be considered in two ways. In both considerations it is assumed that the existing vegetation within the rights-of-way will be destroyed because the road will be constructed largely on fill regardless of which alignment is selected.

If the vegetation of the impact area is considered from an existing intensive recreational-use viewpoint, the proposed alignment will be more physically destructive. The proposed alignment would take 15.73 acres of grassland and park forest in Johnson Park and 0.82 acre of park forest in Buccleuch Park (Figure 1). Both park forests and grasslands are used for intensive recreational activities (such as picnicking and sports). The alternative alignment would require 4.76 acres of park forest and grassland of Johnson Park in the interchange area west of Hillcrest Road, as well as a

TOWNSHIP OF
PISCATAWAY

HIGHLAND PARK

JOHNSON PARK

TOTAL AREA 232.0 AC ±
 RTE IS TAKING 17.9 AC ±
 REMAINING 214.1 AC ±

BUGCLEUCH PARK

TOTAL AREA 78.10 AC ±
 RTE IS TAKING 0.02 AC ±
 REMAINING 78.08 AC ±

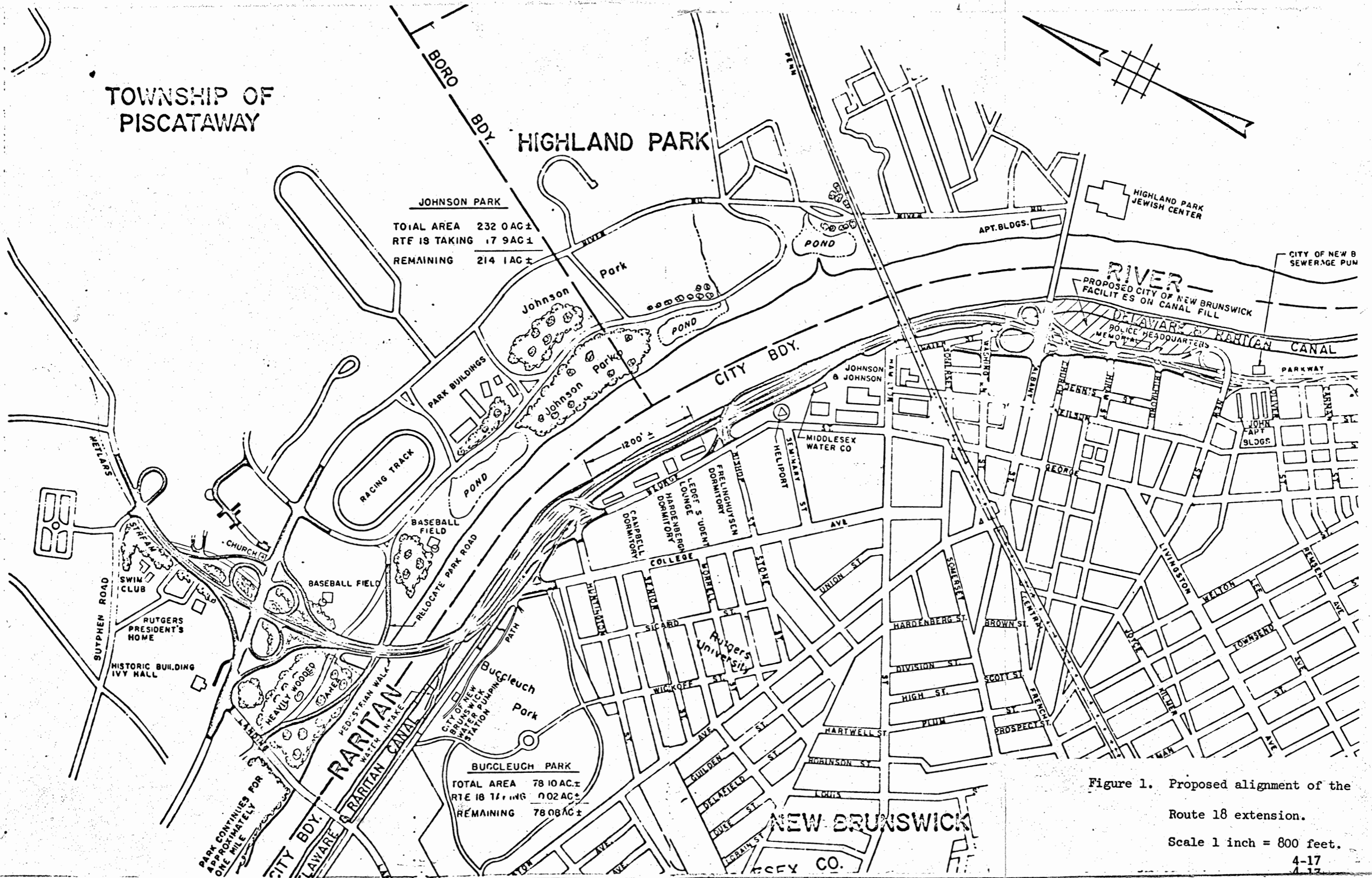


Figure 1. Proposed alignment of the
Route 18 extension.

Scale 1 inch = 800 feet.

minimum additional 1.75 acres along River Road east of Hillcrest Road.

The other consideration that the vegetation can be given is from an open space and extensive recreational-use viewpoint. In this case the alternative alignment would be less destructive to the floral environment since it would leave intact those areas of natural vegetation that have open space and extensive recreational (such as hiking and bicycling) value--that is upland and riverbank forests, marshes, and shrubby areas. The alternative alignment would impact 7.69 acres of upland forest, 1.68 acres of riverbank forest, 0.45 acre of shrubby area, and 0.14 acre of marsh, most of which is located in the interchange area at Metlars Lane. The proposed alignment would impact 6.74 acres of upland forest, 3.24 acres of riverbank forest, 1.29 acres of shrubby area, and 0.39 acre of marsh in the Metlars Brook area, as well as 5.51 acres of upland forest, and 1.66 acres of riverbank forest south of the Raritan River. Furthermore, it would destroy the lower 2800 feet of Metlars Brook by filling and rechanneling through conduit, as well as the length of the Delaware and Raritan Canal between Buccleuch Park and Albany Street. The riverbank forests and shrubby areas north of the River are unique in that they are among the few remaining areas of natural floodplain forest within Johnson Park that have not been altered for intensive recreational use through ditching, filling,

tree removal, and the establishment of a mowed-grass groundcover. Although the forested lands along the Canal were impacted heavily in the past when the Canal was built and in operation, today they are forested predominantly with floodplain species and form an open space band through the city of New Brunswick. Furthermore, the waterway and forested banks of the Canal appear to have a high potential recreational value.

The impact of highway construction on either alignment can be minimized by restricting construction activities to those areas that must be filled, graded, or excavated. All other land within the right-of-way should not be disturbed.

Common and scientific names of plants cited in the text. (Nomenclature follows Gray's Manual of Botany, Eighth Edition).

Ash, Red	<i>Fraxinus pennsylvanica</i>
Ash, White	<i>Fraxinus americana</i>
Aster, New England	<i>Aster novae-angliae</i>
Basswood	<i>Tilia americana</i>
Bayberry	<i>Myrica Pensylvanica</i>
Beech, American	<i>Fagus grandifolia</i>
Birch, Gray	<i>Betula populifolia</i>
Birch, River	<i>Betula nigra</i>
Blackberry	<i>Rubus allegheniensis</i>
Bladdernut	<i>Staphylea trifolia</i>
Box-elder	<i>Acer negundo</i>
Brier	<i>Smilax</i> spp.
Broomsedge	<i>Andropogon virginicus</i>
Bur-reed	<i>Sparganium americanum</i>
Cattail, Broad-leaved	<i>Typha latifolia</i>
Cherry, Wild	<i>Prunus serotina</i>
Chestnut, Horse	<i>Aesculus hippocastanum</i>
Crabapple	<i>Pyrus</i> spp.
Cutgrass, Rice	<i>Leersia oryzoides</i>
Dogwood, Silky	<i>Cornus racemosa</i>
Duckweed	<i>Lemna minor</i>

Elderberry, Common	<i>Sambucus canadensis</i>
Elm, American	<i>Ulmus americana</i>
Elm, Slippery	<i>Ulmus rubra</i>
Euonymus, Winged	<i>Euonymus alatus</i>
Garlic, Wild	<i>Allium</i> spp.
Goldenrod	<i>Solidago</i> spp.
Grape	<i>Vitis</i> spp.
Grass, Reed Canary	<i>Phalaris arundinacea</i>
Grasses	Family Gramineae
Hackberry	<i>Celtis occidentalis</i>
Hickory, Shagbark	<i>Carya ovata</i>
Honeysuckle, Japanese	<i>Lonicera japonica</i>
Ironweed	<i>Vernonia noveboracensis</i>
Ivy, Poison	<i>Rhus radicans</i>
Joe-Pye weed	<i>Eupatorium purpureum</i>
Knotweed	<i>Polygonum</i> spp.
Locust, Black	<i>Robinia pseudo-acacia</i>
Locust, Honey	<i>Gleditsia triacanthos</i>
Maple, Norway	<i>Acer platanoides</i>
Maple, Red	<i>Acer rubrum</i>
Maple, Silver	<i>Acer saccharinum</i>
Maple, Sugar	<i>Acer saccharum</i>
Marsh-mallow	<i>Hibiscus palustris</i>
Mulberry	<i>Morus</i> spp.
Nannyberry	<i>Viburnum lentago</i>

Oak, Mossy-cup	<i>Quercus macrocarpa</i>
Oak, Northern Red	<i>Quercus rubra</i>
Oak, Pin	<i>Quercus palustris</i>
Oak, Swamp White	<i>Quercus bicolor</i>
Oak, White	<i>Quercus alba</i>
Pine, Scotch	<i>Pinus sylvestris</i>
Pine, White	<i>Pinus strobus</i>
Poplar, Tulip	<i>Liriodendron tulipifera</i>
Queen Anne's-lace	<i>Daucus carota</i>
Redcedar	<i>Juniperus virginiana</i>
Reed, Common	<i>Phragmites communis</i>
Sassafras	<i>Sassafras albidum</i>
Sedges	Family Cyperaceae
Spruce, Norway	<i>Picea abies</i>
Sunflower, Tickseed	<i>Bidens coronata</i>
Sweetflag	<i>Acorus calamus</i>
Sycamore	<i>Platanus occidentalis</i>
Walnut, Black	<i>Juglans nigra</i>
Willow, Black	<i>Salix nigra</i>

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