DEPARTMENT OF ENVIRONMENTAL CONTROL

SUFFOLK COUNTY, NEW YORK

JOHN M. FLYNN, P.E., COMMISSIONER

BASIC DATA REPORT

FOR

CARLL'S RIVER
RECHARGE RESEARCH PROJECT
PHASE I

JULY 1973

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October 24, 1973

Mr. John M. Flynn, P.E., Commissioner
Suffolk County Department of
Environmental Control
1324 Motor Parkway
Hauppauge, New York 11787

Re: Basic Data Report for the
Carll's River Recharge
Research Project

Dear Commissioner Flynn:

We transmit herewith the Basic Data Report for the Carll's River Recharge Research Project. This is in accordance with the contract for engineering services dated February 27, 1973.

This report includes recommendations for a permeameter test site and a system of observation wells to determine the soil characteristics which are required in order to evaluate the use of the Carll's River for recharging treated waste water.

We would like to express our appreciation to your Department and the U.S. Geological Survey for their wholehearted cooperation during the course of this study.

Very truly yours,

HOLZMACHER, McLENDON & MURRELL, P.C.

Robert G. Holzmacher

Robert G. Holzmacher, P.E.
President

RGH:vm

DEPARTMENT OF ENVIRONMENTAL CONTROL

SUFFOLK COUNTY, NEW YORK

JOHN M. FLYNN, P.E., COMMISSIONER

WILLIAM F. GRANER, P.E., CHIEF ENGINEER

BASIC DATA REPORT

FOR

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BASIC DATA REPORT

CARLL'S RIVER RECHARGE RESEARCH PROJECT

PHASE I

JULY 1973

SECTION 1 - INTRODUCTION

The Carll's River surface water system is one of the most important water systems in southwestern Suffolk County. This system includes Belmont Lake, which is the focal point of a major State park, plus Argyle Lake in the Village of Babylon. The Carll's River itself meanders through more than three miles of prime park land containing bridle paths and hiking trails.

The Carll's River system is important recreationally, esthetically and ecologically. In addition to the internal ecological values, the fresh water flow from this system into Great South Bay significantly contributes to the brackish conditions in the Bay. These brackish characteristics are considered vital to shellfish production and therefore are of considerable ecological importance.

Belmont Lake State Park, which is situated in the north central section of the system, covers an area of 459 acres [25]. The esthetic value of this area was recognized as far back as 1864 when August Belmont chose the location as the site for his Nursery Stud Farm. He established a country estate of 1100 acres devoted to the breeding of thoroughbred horses whose names were to become internationally famous.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

The estate was held by members of the Belmont family until 1926 when a portion was acquired by New York State for the Park. The remainder of the lands had been sold the previous year for a real estate subdivision.

In 1929, the voters of the Village of Babylon approved conveyance to the State of the corridor connecting Argyle Park on Montauk Highway with Belmont Lake. This corridor, about three and one-half miles in length, borders the Carll's River. It contains foot paths, bridle paths, benches and rustic bridges.

Ecologically, the Carll's River watershed is considered one of the most unique areas on Long Island [26, pp. 4-5]. The preservation of water levels in the stream, particularly at the headwaters north of Wyandanch Avenue, is considered vitally important to the ecology of the stream and the surrounding woodlands. Belmont Lake, Southard's Pond and Argyle Lake provide unique winter rest areas and feeding grounds for rare species of water fowl.

The extensive construction of sanitary sewers in the southern portion of the Carll's River system is presently underway in the Southwest Sewer District. Within the next ten years, a significant portion of the system will be sewered, with all of the treated effluent being discharged out to sea.

Approximately ninety-five per cent of the average stream flow in the Carll's River system is seepage from the ground

water reservoir. From this, it follows that the discharge of sewage effluent to sea, over a period of years, will lower prevailing water levels in the lakes and ponds and significantly reduce stream flow. The ponds and lakes in the system are generally quite shallow and even a modest lowering of the ground water table could dry some of them up completely.

It is to assure the future preservation of this valuable surface water system that this demonstration program is proposed to be undertaken. The need for this project was first established in the "Preliminary Feasibility Study on the Recharge of Treated Waste Water" [9], completed in 1972 for the Suffolk County Department of Environmental Control by Holzmacher, McLendon & Murrell, P.C.

SECTION 2 - STATUS OF SURFACE WATER RECHARGE TECHNOLOGY UTILIZING TREATED WASTE WATER

A prime factor dictating in favor of this present project is the prevailing lack of reliable data on the successful large scale recharging of ecologically sensitive surface water bodies with treated waste water. Specific data pertaining to the hydrogeology of the Carll's River is also lacking.

The 1972 feasibility study by Holzmacher, et al. [9], examined in some detail the work of other investigators dealing with the recharge of treated waste water. This included sections on the geohydrologic, public health, ecological, esthetic and recreational aspects of recharge in stream beds, lakes and ponds.

The reader is directed to the 1972 report [9] for the background information which was utilized to develop the scope and objectives of this present project.

It was concluded that the discharge of high quality renovated water into streams and ponds is a feasible way of maintaining water levels and stream flows in important surface water bodies. It could also assure the continued flow of fresh water to ecologically important marine waters. The discharge of renovated water into open basins is an effective means of recharging the ground water reservoir. However, there are important water quality considerations which must be met in order to recharge without adverse effects. The successful use of injection wells requires improvements in both well design and

water quality renovation in order to be successful. The use of spray irrigation techniques, although potentially feasible in rural eastern Suffolk County, does not appear feasible in the highly developed western end of the County, because of area requirements.

From a public health standpoint, there is still a considerable amount to be learned about the effectiveness of various waste treatment techniques in the removal of certain biological and chemical contaminants before initiating large scale recharge projects. The most important of these include viruses, constituents of the nitrogen cycle, and on a longer term basis, total dissolved solids.

Recommendations were made to develop additional data on ground water levels and quality, and to study the effects of certain aspects of waste water recharge on the aquatic and marine ecology. In addition, several specific pilot scale demonstration projects were recommended to develop design criteria needed to implement any successful recharge program. These included a tertiary treatment plant for quality renovation studies, a test recharge basin program and an injection well program, all at a common site in Medford. The second project is this present one, involving recharging of treated water in the Belmont Lake - Carll's River surface water system.

SECTION 3 - PROJECT SCOPE AND OBJECTIVES

The primary purpose of the Carll's River Demonstration Project is to investigate and demonstrate the feasibility of maintaining a steady surface water profile in the Carll's River water system after the surrounding areas are sewered. This would be accomplished by maintaining continuous recharge of highly renovated waste water at different points throughout the waterway.

The project is proposed to be undertaken in five phases as follows:

1. Development of preliminary data.
2. Development of mathematical model to predict recharge rates.
3. Construction of recharge transmission system.
4. Construction of pilot treatment facility and to conduct recharge tests.
5. Construction of full scale treatment facilities and initiation of full scale recharge.

This report is designed primarily to expand in full depth the first phase which deals with the development of preliminary data.

The present "state-of-the-art" of recharging treated waste water into surface water systems will be examined in somewhat more detail than it was in the Preliminary Feasibility Study. In addition, more hydrologic and geologic data on the Carll's River flow system is necessary before a stream bed recharge system can be designed. An accurate field survey will be

undertaken to determine the stream gradient, dimensions and typical valley cross sections. Water level observation wells will be established in a number of locations. Core extractions will be made and permeameter tests conducted to develop preliminary estimates of vertical permeability. These estimates will, in turn, be used to design and construct an in-place vertical permeameter adjacent to the stream bed. Several additional stream flow gauging stations will be established. At least one or two additional continuously recording stream stage gauges will be installed. A continuously-recording precipitation station will be installed in the drainage basin at Belmont Lake State Park.

Following the installation of the monitoring and test equipment, the first of a series of tests of stream bed infiltration rates will be undertaken. As was previously mentioned, under present conditions, water infiltrates into the stream so that most stream flow is ground water seepage. As ground water levels fall, the rate of infiltration into the stream will decline as will stream flows unless augmented with reclaimed waste water. When the natural stream flow is augmented, an unknown percentage of the water will exfiltrate from the stream since the stream stage will be above the ground water level. This rate of exfiltration must be known in order to design the stream bed recharge or augmentation project. This exfiltration rate can be calculated using the infiltration rate and vertical permeability

determined from the in-place permeameter. Through the observation wells and stream gauging stations, the amount of water lost from the stream due to lowered water levels can be determined.

As ground water levels are lowered and base flow of the stream replaced by augmentation flow, the stream will change in nature from an infiltrating to an exfiltrating stream. This may change the exfiltration rate as the stream bottom becomes clogged with sediment. Therefore, it may be necessary to repeat the above test every few years until the rate stabilizes. If possible, the rate of both stream bed and lake bottom exfiltration should be determined.

In addition to the above infiltration test, data will be collected periodically from the observation wells and stream gauging stations. These data will help determine the influence of sanitary sewers as well as stream bed recharge on ground water levels and stream flows.

Included in this present report are recommendations for design of all monitoring facilities and project cost estimates.

SECTION 4 - AREA OF STUDY

The Belmont Lake - Carll's River water system and its entire drainage area, which comprises 35 square miles [4], lies within the limits of the Towns of Babylon and Huntington, Suffolk County. Plate 1 shows the boundaries of the entire drainage area.

The watershed area includes the perennial Carll's River, which is the largest river in the Town of Babylon (5.2 miles above head of tide water), and four water table lakes, Belmont Lake (.045 square miles); Southard's Pond (.040 square miles); Elda Lake (.024 square miles), and Argyle Lake (.030 square miles).

Carll's River, which flows southward, has a gentle gradient that averages about 2 feet per 1,000 feet and an average, well sustained flow of 25.8 cubic feet per second (16.6 M.G.D.) [22]

The Babylon area lies within the Atlantic coastal plain physiographic province. The topographic features are mostly depositional in origin and slightly modified by stream erosion. The northern section of the area is characterized by irregular hilly topography, which corresponds to the distribution of the Ronkonkoma terminal moraine and manetto gravel. The southern part of the area is mainly composed of a broad, gentle sloping plain.

Altitude of the terminal plain and adjacent hills may vary, but it is generally about 150 feet above the outwash

plain. The outwash plain is characterized by a gently southward sloping land surface at about 20 feet per mile.

The rate of population growth in the Town of Babylon was high during the 1950's. Total population in 1950 was 45,556 and it jumped to 142,309 by 1960. The rate was somewhat slower in the following decade when total population increased to 203,570 by 1970. [18]

SECTION 5 - GEOHYDROLOGY OF THE CARLL'S RIVER WATERSHED AREA

The geohydrology of the Carll's River area is typical of the outwash plain in western Suffolk County. A detailed account can be obtained in numerous other publications and will only be summarized here. Bedrock ranges in altitude from about 1,300 feet below sea level at Belmont Lake to about 1,650 feet below sea level in the Argyle Lake area. Its surface represents the lower limit of the ground water reservoir.

The various formations above bedrock in ascending order are the Lloyd sand member of the Raritan formation, overlain in turn by the Raritan clay member. Above this is the Magothy formation which is between 700 and 1,000 feet and its basal altitude is as much as 750 feet below sea level at Belmont Lake. Its surface ranges in altitude from approximately 20 feet below sea level at Belmont Lake to about 80 feet below sea level in the Argyle Lake area.

The Magothy is the most important water-bearing formation in the Babylon area from the standpoint of public water supply. The upper surface of the clay member of the Raritan formation defines the lower boundary of the aquifer. Clayey and silty lenses in the upper part of the Magothy formation and the

Information and data presented in Section 5 are chiefly based on investigations of the geohydrology of Babylon and surrounding areas by the U.S. Geological Survey and published in references [10], [11], [16], [17], and [23].

Gardiners clay, where present, constitute the upper boundary. The average coefficient of permeability of the Magothy formation is normally estimated to be about 300-400 gallons per day per square foot.

Deposits of the Pleistocene age, belonging to one or more glacial stages, comprise the uppermost 30-100 feet of sediments in most of the area. The Jameco gravel, which is an early glacial outwash deposit of Pre-Wisconsin age, and usually found in most subsurface strata of western Long Island, is not found in the Babylon area. The Gardiners clay is a marine interglacial deposit of probable Sangamon age and has been recognized in wells along the south shore in the Babylon area.

The Gardiners clay is generally 20 to 40 feet thick and the altitude of the top of the formation ranges from about 50 to 100 feet below sea level. The formation consists of dark-colored clay, lenses of green silt and very fine sand and thin layers of fine gravel. The layers of clay and silt are generally fossiliferous.

The Gardiners clay is overlain by Upper Pleistocene deposits of Wisconsin age. These deposits chiefly consist of an outwash of stratified medium to coarse sand and gravel and terminal moraine till and ice-contact deposits of stratified sand and gravel.

The outwash is the most extensive Upper Pleistocene deposit in the area. It is underlain by the Gardiners clay

and/or Magothy formation and is partly overlain by younger Glacial and Recent deposits. The thickness of the outwash ranges from zero to more than 100 feet. In some parts of the Babylon area, poorly to well stratified ice-contact deposits may be found above the outwash.

The Upper Pleistocene formation is a highly permeable zone and constitutes the uppermost zone of the ground water reservoir. This water table aquifer is present everywhere in the Babylon area, but it is very thin in some places. In general, the depth of water ranges between 0 to 5 feet below land surface along the Great South Bay and in areas immediately adjacent to the Carll's River and the associated lakes. Further away from the surface waters, the water level becomes deeper below land surface. It ranges from 5 to 25 feet in areas adjacent to the Carll's River system.

The lower boundary of the water table aquifer is defined in most of the area by beds of low permeability in the upper part of the Magothy formation. Where the upper part of the Magothy is composed of permeable material, these beds form a part of the water table aquifer. In the extreme southern part of the area, Gardiners clay forms the lower boundary of the water table aquifer.

Deposits of Recent age are found along stream channels, in marshes and ponds, on the barrier beaches and under Great South Bay. Stream channel deposits consist of thin sheets of

discontinuous outwash deposits. Recent age beds of very fine sand, silt and clay are also deposited in marshes and ponds and under Great South Bay.

The Recent and Upper Pleistocene deposits which compose the water table aquifer beneath Great South Bay contain only salt water. Beneath the barrier beaches, fresh water in the water table aquifer occurs in small discontinuous lenses and is underlain by salt water. The thickness of the water table aquifer averages about 70 feet. The permeability of the outwash deposits was estimated to range between 800-2200 gallons per day per square foot. Because of the high permeability and shallow depth of the water table, wells drilled into this formation are both productive and economical. The water table aquifer supplied approximately 84 per cent of the total pumpage of ground water in the Babylon-Islip area in 1961. This was prior to the time when increasing contamination in this aquifer, resulted in most public pumpage being switched to the Magothy formation.

Water in marshes, ponds or streams in the Babylon-Islip area is nearly always hydraulically connected with the water table.

All of the water which is in the ground beneath Long Island comes from the precipitation which falls on the Island. The Town of Babylon receives an average annual precipitation of 46 inches [15]. The greatest intensity usually occurs

sustained yield (based on salt water intrusion limitations) of 75 per cent of accretion. Consequently, according to these estimates, about 25 inches, or about 1.2 M.G.D. per square mile, will be lost either directly to the atmosphere via evaporation and transpiration of plants or ground run-off overland in streams draining into the Great South Bay. The permissive sustained yield in this area would be about 16 inches or 0.76 M.G.D. per square mile. Table I lists these estimated hydrological parameters for the Carll's River drainage area.

TABLE I

HYDROLOGICAL PARAMETERS

CONDITION	EST. PERCENTAGE OF MEAN ANNUAL PRECIPITATION	MEAN IN INCHES	M.G.D.
Mean annual precipitation	100	46	76
Evapotranspiration	53	24	40
Direct runoff	2	1	1
Accretion	45	21	34
Permissive sustained yield	34	16	26

Data presented in Table I indicates that in an average year, 34 M.G.D. is recharged into the ground reservoir within the Town of Babylon. Out of this, only 26 M.G.D. may be withdrawn if excessive salt water intrusion is to be avoided.

As was previously discussed, any significant withdrawal due to sewering or other causes, will lower fresh surface water levels and decrease stream flows. The maintenance of surface water levels rather than the prevention of salt water intrusion, thus becomes the controlling factor in the development of the area's water resources.

SECTION 6 - WATER QUALITY

The Comprehensive Public Water Supply Study for Suffolk County [8], included a chemical analysis of water withdrawn from 8 Glacial and 17 Magothy wells in the Town of Babylon. Description of the general quality is shown in Table II:

TABLE II

GLACIAL AND MAGOTHY WATER QUALITY

TOWN OF BABYLON

	DESCRIPTION		
CONSTITUENT	GLACIAL	MAGOTHY	CONTENT
Hardness	Soft	Soft	<80. mg/l
pH	Corrosive	Corrosive	6.5
Iron	Marginal	Marginal	.3-1.0 mg/l
Manganese	Marginal	Acceptable	<.05 mg/l = Acceptable .05-.3 mg/l = Marginal
Chloride	Acceptable	Acceptable	<75. mg/l
MBAS (detergent)	Marginal	Acceptable	<.2 mg/l = Acceptable .2-.5 mg/l = Marginal
Nitrate	Acceptable	Acceptable	<7.5 mg/l

In general, the study described both aquifers as having a soft water, but one that is corrosive. In addition, iron and manganese concentrations are higher than the acceptable level.

The same study has listed concentrations of different chemical constituents in water discharged from 14 public water supply wells in the vicinity of Belmont Lake - Carll's River

area. Furthermore, Harr [7] tested the concentrations of phosphorus as phosphate and nitrogen in its three basic forms, ammonia, nitrite and nitrate, in water discharged from 8 of these 14 public wells. Locations of these wells are shown in Figure 1. Of these 14 wells, 6 were screened in the Glacial aquifer and 8 in the Magothy. Table III shows the chemical analysis presented in both reports.

The Comprehensive Public Water Supply Study for Suffolk County [8] also included a partial chemical analysis of water flows in Carll's River. These data are presented in Table IV. This table shows that, in general, the quality of water flowing in Carll's River is soft and mildly corrosive, but has a high concentration of both iron and manganese.

There are no data available as to the quality of individual lakes involved in this study. It is possible that their quality is less satisfactory than the Carll's River water or ground water quality, due to direct public access to these water bodies.

WELL	S-13477	S-13478
OWNE	Suffolk County Water Authority	Suffolk County Water Authority
LOCA	Smith Street	Smith Street
FORM	Glacial	Glacial
DATE	1967 -	1967 -
DEPT	34	34
RESU COND		
ALKA	8.	10.
HARD	32.	10.
pH*	5.4	5.8
IRON	.04	.33
MANG	.33	< .05
CHLO	12.5	7.5
DETE	.41	.83
NITR	- -	.02 -
PHOS	-	-
AMMO	-	-
NITR	-	-

NOTES

W	S-20635	S-21375
C	Suffolk County Water Authority	Suffolk County Water Authority
L	August Road	Smith Street
F	Magothy	Magothy
I	1967 1971	1967 1971
I	556	445
F (		
A	2.	-
K	4.	-
F	5.3	-
]	.42	.16
M	<.05	-
(	6.	-
]	-	-
I	.02 0.0	- 0.0
]	.26	3.12
	.01	0.0
	0.0	0.0

WELL N	S-28503	S-33005
OWNER	uffolk County ater Authority	Suffolk County Water Authority
LOCATI	rospect Ave.	Prospect Ave.
FORMAT	Magothy	Magothy
DATE O	1968 1971	1968 1971
DEPTH	599	600
RESULT CONDUC		
ALKALI	6.	8.
HARDNE	2.	-
pH*	4.9	5.3
IRON (	.26	.18
MANGAN	.05	.05
CHLORI	4.	2.5
DETERG	.02	-
NITRAT	.02 0.0	- .06
PHOSPH	2.5	.03
AMMONI	.01	0.0
NITRI	0.0	0.0

NOTES

I RKWAY S	WYANDANCH AVENUE DATE	mg/l
ALI (C	4/69	--
	3/72	22.0
HAF (C	4/69	--
	3/72	48.0
pH	4/69	--
	3/72	6.4
IRC	4/69	--
	3/72	0.21
MAI	4/69	--
	3/72	--
TOT SC	4/69	--
	3/72	163.0
CHI	4/69	16.5
	3/72	39.0
DET (N	4/69	0.16
	3/72	0.20
AMI FI	4/69	1.59
	3/72	1.50
AMI AI	4/69	0.19
	3/72	0.015
NI	4/69	1.08
	3/72	2.70

*

** Month

SECTION 7 - STREAM FLOW

Stream flow of the Carll's River has been gauged on a continuous basis since October 1944 at a single continuous gauging station. This station is located 130 feet downstream from the outlet of Southard's Pond and 0.9 miles upstream from the mouth.

The average discharge for the 27-year period through October 1971 was 25.8 c.f.s. (cubic feet per second). This is equivalent to 16.7 m.g.d. (million gallons per day), or 11,600 g.p.m. (gallons per minute).

Extreme flows for the period of record through October 1971 include a maximum discharge rate of 193 c.f.s. on June 23, 1967 and a minimum daily discharge of 4.5 c.f.s. on July 6, 1966 [24, p. 45].

Partial gauging stations have reportedly been established from time to time at different locations in the stream, but consistent records have not been maintained at locations other than the continuous gauging station.

The stream was gauged at a point just south of Wyandanch Avenue, in the vicinity of the proposed permeameter test site, on July 10, 1973. On that particular day, the base flow of the stream at that location was measured at 9.27 c.f.s., equivalent to 4150 g.p.m.

Monthly variation of average stream flow for the water year October 1970 to September 1971 and for the period 1945 - 1959 water years, is summarized in Table V.

The minimum, average, and maximum stream flows in Carll's River for the years 1960 through 1966 are presented in Table VI.

TABLE V

AVERAGE STREAM FLOW BY MONTH - CARLL'S RIVER

MONTH	WATER YEARS 1971 C.F.S.	WATER YEARS AVG. 1945-59 C.F.S.
October	12.9	21.1
November	17.6	26.3
December	16.9	28.5
January	17.7	30.2
February	26.4	31.7
March	25.8	35.9
April	22.4	36.4
May	20.1	32.7
June	14.5	27.8
July	13.1	23.6
August	13.3	23.8
September	17.3	21.0

NOTES: 1. 1971 Data from [24, p. 45]
2. 1945-59 Data from [17, p. 98]
3. Flow measured at U.S.G.S. Gauging Station at outlet of Southard's Pond

TABLE VI

STREAM FLOW DATA - CARLL'S RIVER

CALENDAR YEARS 1960-1966

YEAR	FLOW IN CUBIC FEET PER SECOND MAXIMUM	MINIMUM	AVERAGE
1960	48.98	7.11	14.47
1961	41.02	7.95	15.92
1962	52.33	7.54	15.37
1963	28.47	2.30	12.56
1964	29.30	4.19	11.65
1965	34.75	3.27	8.44
1966	27.21	1.89	7.54
1960-66 Average			12.28
Long Term Average			13.47

NOTES: 1. Data from [8, Vol. III, App. V]
2. Flow measured at U.S.G.S. Gauging Station at outlet of Southard's Pond
3. Data converted from M.G.D. to C.F.S.

From the preceding data, it may be seen that the average monthly flows for water year 1971 (the most recent year of published data), are substantially below the averages for the period 1945-1959. This is not unanticipated considering that in 1971 ground water levels were still below average, reflecting the record drought of the mid-1960's. When data for 1972 and 1973 becomes available, reflecting the record precipitation during those two years, monthly average stream flows will almost surely equal or exceed those of the 1945-1959 period.

SECTION 8 - PHASE I - RECOMMENDED TESTING AND MONITORING FACILITIES AND PROCEDURES

General

Complete sewering of the Babylon area will cause continuous lowering of ground water level and a decrease in the storage capacity of the water table aquifer. This is mainly because of the loss of that portion of accretion due to artificial recharge through septic tanks and cesspools. This loss will also cause depletion of underground seepage to surface water bodies, causing a lesser stream base flow, as well as lower surface water levels in lakes. A decline of the water table will also be reflected in decreased levels in the underlying Magothy aquifer.

In order to develop the design criteria for the proposed recharge of renovated waste water into the Carll's River flow system, additional hydrological and geological information on the area is required. Information required includes: (a) stream bed infiltration and exfiltration rates; (b) rates of sedimentation and clogging of stream and lake beds, and (c) change of surface and ground water levels as a function of time.

To achieve this goal, it is recommended that a two-phase scheme be executed consisting of the following:

(a) Surveying and Installation of Facilities

(b) Monitoring and Testing

SURVEYING AND INSTALLATION OF FACILITIES

This phase includes the following:

1. A complete field survey of the Carll's River surface water system from Grand Avenue, Wyandanch, to south of Montauk Highway, Babylon. This will include a topographical survey of the stream bed and flow gradients.

2. Installation of the following facilities at or in the immediate vicinity of a test site on the north side of Wyandanch Avenue at the intersection of the Carll's River:

(a) A constructed in-place permeameter to measure vertical exfiltration. The permeameter will be constructed in the stream bed by driving tongue and groove marine wood sheeting to form an open top and bottom box 10 feet by 10 feet and extending approximately 10 feet into the stream bed. The top of the box will be approximately 6 feet above the water level in the stream. The sides of the permeameter will be of watertight construction. Stream water will be pumped into the permeameter with a small gasoline driven pump and the inlet will be baffled to avoid disturbing the soil in the permeameter. A water metering device with remote readout will record the flow of water into the permeameter. Two or more outlets, each at a different elevation above the stream level, will be provided. The outlets will be piped to a common water metering device with remote readout which will record the flow of water from the outlet. Each outlet will have a shut-off valve.

1. ... River surface

... Montana, ...

... of the ... River.

... elevation above the ...

will be piped to a common ...

out which will record the flow of water from ... Each

outlet will have a shut-off valve.

Pressure transducers will be installed inside the permeameter to accurately measure the piezometric head at various depths below the stream surface. Transducers will be installed at the following depths below stream bed:

UNIT NO.	DEPTH BELOW STREAM BOTTOM
1	3 inches
2	25% of box depth below stream bottom
3	50% of box depth below stream bottom
4	75% of box depth below stream bottom
5	90% of box depth below stream bottom
6	100% of box depth below stream bottom

Transducers will be equipped with remote readout.

(b) One pumping well adjacent to the permeameter. This well will be for the dual purposes of determining the horizontal permeability of the sediments, plus inducing a downward infiltration through the permeameter. The well will be installed on the west bank of the stream, adjacent to the permeameter. The well will have a capacity of approximately 750 gallons per minute and will have 20 to 30 feet of 12-inch diameter screen, with top of screen placed at approximately the elevation of the bottom of the stream.

The well will be equipped for the duration of the tests with a pump driven by an internal combustion engine. The discharge will be piped some distance downstream to ensure against recycling of pumped water back into the well. The discharge pipe will be equipped with a metering device to permit flow measurement.

(c) A stream stage recorder adjacent to the permeameter.

(d) Nine (9) observation wells. Six (6) of the wells will be 1-1/2-inch diameter by 20 feet deep with 3-foot long well points.

The remaining three (3) wells will be 3-inch diameter by 25-feet deep with 3-foot long well points. One line of observation wells will be installed westward from the pumping well at right angles to the line of the stream at distances of 5, 15, 50, 200 and 500 feet from the pumping well. A second line of four (4) observation wells will be installed to the northwest at 45 degrees to the first line, at distances of 5, 15, 50 and 200 feet from the pumping well. The 200 and 500 feet distant wells will be 3-inch diameter and all others will be 1-1/2-inch diameter. Three (3) inch diameter observation wells will be constructed with steel casings and stainless steel screens. One and one-half inch diameter wells will be constructed with steel or PVC casings and stainless steel or PVC screens. All wells will be terminated below ground level in access pits with removable, lockable steel covers installed flush with the ground surface.

(e) A core boring 50-feet deep in the immediate vicinity of the pumping well. Spoon samples will be obtained at 10-foot intervals.

3. Installation of a system of observation wells throughout the Carll's River system, as indicated on Plate No. 1.

A total of 17 wells will be installed, six (6) 3-inch diameter by 25 feet deep and eleven (11) 3-inch diameter by 20 feet deep. All wells will be equipped with 3-foot long well points. Well construction will conform to the description in Paragraph 2 (d) preceding.

4. Installation of a continuously-recording meteorological station at Belmont Lake State Park. This should be installed as soon as possible in order to develop an adequate period of meteorological records prior to the operational date set for the Southwest Sewer District treatment plant. Instrumentation would include a rain gauge, temperature, humidity and wind speed and direction recorders.

5. Installation of one lake level recorder at Belmont Lake. Recording should be continuous to detect changes in surface water levels as a result of precipitation, recharge and seepage into or from ground water. A water temperature recorder would also be provided at the same site.

6. Establishment of six (6) partial recording stream flow gauging stations in proposed locations, as shown in Plate 1.

MONITORING AND TESTING

This phase includes the following:

1. Monitoring of stream flow and gradients, as well as ground water levels at the different proposed stream gauging stations and observation wells. Partial measurements should be made for all stations on the same day, not sooner than two

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days after a period of precipitation. Partial measurements should be made on a quarter annual basis. Hydrograph analysis at each station will be of considerable aid in estimating stream bed infiltration rates prior to sewerage. Through observation wells and stream gauging stations, the amount of water lost from the stream due to lowered water levels, resulting from installation of sewers, will also be determinable in the future. It is recommended that additional stream gauging points be established and read by the Suffolk County Department of Environmental Control. This should be done in close cooperation with the U. S. Geological Survey in order to assure a properly coordinated extension of stream gauging in the Carll's River system.

2. Testing vertical infiltration rates. This will be accomplished by pumping water into the permeameter to maintain a higher level inside the box than in the stream, thus inducing a downward flow of water through the soil contained in the permeameter. The water level inside the permeameter will be maintained constant during any particular test run, however, the water level will be varied between successive runs by use of the outlet pipes previously described. Measurements of the water flow into and out of the permeameter box, piezometric heads in the permeameter, stream water levels, and water levels in the adjoining system of observation wells, will be made. From these data, the vertical infiltration can be determined.

In conjunction with the vertical permeability values determined from the permeameter box, relatively undisturbed samples of soil should be tested in a laboratory permeameter. The purpose of this would be to establish a correlation, if one exists, between the vertical permeabilities determined in the permeameter box and the indicated values from the laboratory unit. Hopefully, this would produce a "correction factor" to be applied to laboratory permeameter results and could thus make possible the development of approximate field permeability data for a large number of locations without the accompanying substantial expense of a large permeameter box.

Horizontal permeability will be measured at the test location by pumping the well and recording the flow and the water level in the adjoining system of observation wells. From these data, the horizontal permeability can be determined.

The permeameter results will reflect present stream bed clogging plus vertical permeability of the underlying sediments within the permeameter. The results will not necessarily be indicative of a possible future increase in the stream bed clogging rate as a result of introducing highly treated sewage into the stream.

In order to put the uncertainty of the future clogging rate in its proper context, it should be realized that an increase in clogging will tend to decrease the amount of recharge

required per unit of stream length at the same time that continued lowering of prevailing levels will tend to increase the length of stream requiring recharge.

Data obtained from the recommended monitoring and testing program will provide the required information for development of a mathematic simulation model of the surface water - ground water system, under a second-phase program. Such a model could then be utilized to develop the design criteria necessary for a future system for the recharge of waste water. Data from the monitoring system would also permit evaluation of the influence of sanitary sewers, as well as any future recharge system, on the hydrogeological system.

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SECTION 9 - ESTIMATED CAPITAL COSTS

The estimated capital costs for the Carll's River Recharge Study as presented in Table VII, are $60,000.

Because of the exploratory nature of the permeameter installation, the cost of this item may not prove very reliable. However, the estimated costs for the remaining items, consisting mainly of well construction, are considered reliable and no serious variations in overall project cost are foreseen.

The operating cost of the main test well pump for a two week test period is included in the estimate, primarily because this item will be included in the test well contract. The costs of engineering services for protracted monitoring of the observation wells, stream gauges, meteorological station, and prolonged permeameter testing are not included.

TABLE VII

COST ESTIMATE

ITEM	COST
Permeameter, including sheeting, flow meters, recorders, pressure transducers, stream stage recorder, and installation	$ 12,000.
Pumping well, 750 G.P.M., 10-inch diameter, 20-foot screen length, two-weeks operation, and 50-foot core boring	10,000.
Lake level recorder and installation	1,000.

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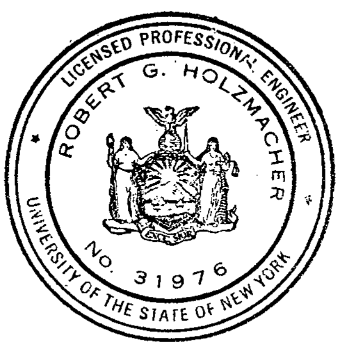
TABLE VII - (CONT'D.)

ITEM	COST
Observation Wells-	$ 22,500.
6 - 1-1/2" diameter, 20' deep 3 - 3" diameter, 25' deep 11 - 3" diameter, 20' deep 6 - 3" diameter, 25' deep	
Meteorological equipment, including hydro-thermograph, shelter, rain gauge, anemometer and installation	2,500.
SUB-TOTAL	$ 48,000.
25% Contingencies & Engineering Fees	12,000.
TOTAL.	$ 60,000.

Respectfully submitted,

HOLZMACHER, McLENDON & MURRELL, P.C.



R. G. Holzmacher, P.E.
President

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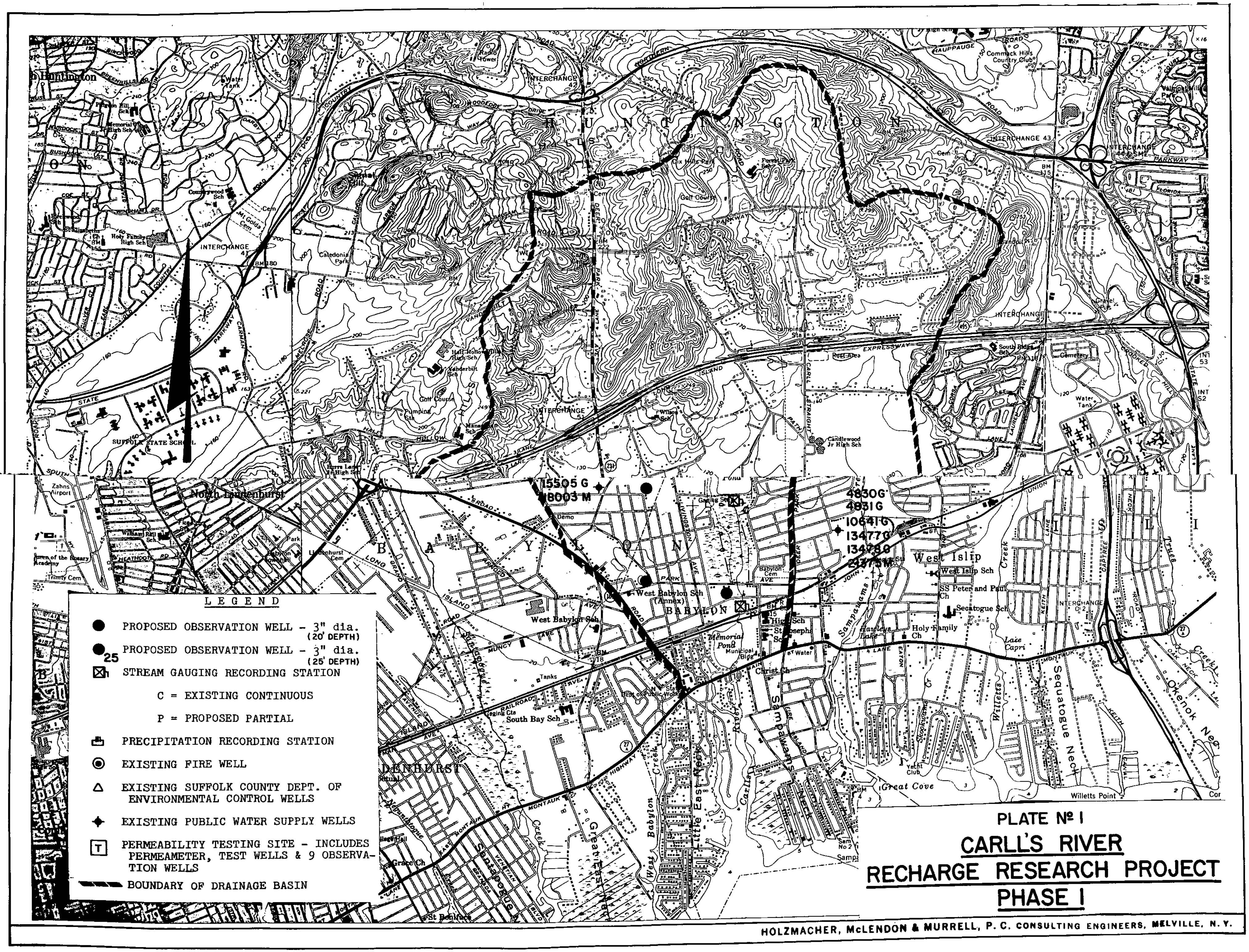

LEGEND
PROPOSED OBSERVATION WELL - 3" dia. (20' DEPTH)
25 PROPOSED OBSERVATION WELL - 3" dia. (25' DEPTH)
STREAM GAUGING RECORDING STATION
C = EXISTING CONTINUOUS
P = PROPOSED PARTIAL
PRECIPITATION RECORDING STATION
EXISTING FIRE WELL
EXISTING SUFFOLK COUNTY DEPT. OF ENVIRONMENTAL CONTROL WELLS
EXISTING PUBLIC WATER SUPPLY WELLS
T PERMEABILITY TESTING SITE - INCLUDES PERMEAMETER, TEST WELLS & 9 OBSERVATION WELLS
BOUNDARY OF DRAINAGE BASIN
15505 G
18003 M
4830G
4831G
10641G
13477G
13478G
2437SM
HUNTINGTON
BABYLON
North Lindenhurst
West Babylon Sch
West Islip
Suffolk State School
Interchange 41
Interchange 42
Interchange 43
Interchange 51
Interchange 52
Sampawams Creek
Sequatogue Neck
Great Cove
Willetts Point
PLATE Nº I
CARLL'S RIVER
RECHARGE RESEARCH PROJECT
PHASE I
HOLZMACHER, McLENDON & MURRELL, P. C. CONSULTING ENGINEERS, MELVILLE, N. Y.