REPORT

OF A

SANITARY SURVEY

OF THE

SCHUYLKILL VALLEY

By Dana C. Barber, *Assistant Engineer.*

Philadelphia Water Department,
February 28, 1885.

Col. William Ludlow,
Chief Engineer:

Sir:—I have the honor to submit the following report of a Sanitary Survey of the Schuylkill Valley made by me, under your direction. Its basis is the special preliminary survey made by me in December, 1883 and January, 1884, from which were compiled the statistics of pollution published in your last annual report. The work of this investigation during the past year has consisted chiefly in a more thorough and complete examination of the special sources of pollution, particularly of the large towns, where much time was spent in studying the natural facilities for house-drainage—for few of the towns have any sewers, and none a complete sewerage system.

Nearly all the manufactories in the valley have been revisited and the first report verified, supplemented or corrected. Some of the mills in operation at the time of the first inspection were closed at the second visit, while some new ones had

started in the meantime and many slightly changed their rate of production. But in general there was little change either way, and the drainage arrangements remained in almost every case exactly the same.

The second (last) survey was made in the opposite direction from the first, *i. e.*, going up the valley instead of down, so that, since most of the summer and early fall was occupied in the proposed future supply watersheds and in investigations of the pollution of the Schuylkill within the city, but little was done in the portion above the city until late in the fall, and the field work was not finished till January 20; while some special investigations within the city have been made since that date.

For convenience of comparison the same method of division and other arrangement is used in this as in the first report. The whole valley is divided into seven districts each of which ends just above the the principal towns on the river, generally at a pumping station, as most of the towns draw their supply from the river and above their own pollution.

First, or Pottsville District.

Beginning at the upper end, the first and largest district comprises the whole valley above Reading, having an area of about 657 square miles and a population of about 91,000. This district (which, from its principal town, I have styled the Pottsville district) is naturally sub-divided into four parts: the Schuylkill proper above its confluence with the Little Schuylkill, the Little Schuylkill, the Schuylkill below the Little Schuylkill, and Maiden's creek. The first two are rough mountainous regions, containing but little arable land or any industry other than coal mining.

The principal river pollution comes from the mine water, which contains large amounts of sulphuric acid, and from the drainage of towns that have been built up by the mining industry. According to Mr. Edwin F. Smith, Chief Engineer of the Schuylkill Canal, the acidity of the water has been de-

creasing since the year 1868, and is, in his opinion, now only about one-third of its former strength at Pottsville, on account of the gradual transfer of mining operations to the other side of the mountain, draining into the Susquehanna, though in the last three years much acid has come from the washing of old dirt piles for the recovery of the fine coal.

The largest town in the first or upper district is Pottsville, situated on the right bank of the Schuylkill, about 100 miles above Fairmount dam by way of the river, and 600 feet above sea level. It is the seat of Schuylkill County, the centre of trade for the surrounding country, and has a population of about 15,000.

The Pottsville water-works, owned by a stock company, derive their supply from streams on Broad Mountain, in the old red sandstone overlapping the coal formation. An impounding reservoir, eight miles north of the town (in west end of Ryon township) and 800 feet above it, with earth dam 35 feet high, covers 70 acres, and has a capacity of about 300,000,000 gallons. Several small streams are taken in on the aqueduct route, so that the exact consumption is unknown. They supply an estimated population of 25,000, including Palo Alto, Port Carbon, and St. Clair, and the collieries and locomotives of the Philadelphia and Reading Railroad Company, and extensive rolling mills and shops, and estimate the total supply as high as 4,000,000 or 5,000,000 gallons per day. The distributing reservoir, of 6,000,000 gallons capacity, is not high enough to supply the whole town, and a part is therefore supplied directly from the aqueduct.

The town is favorably situated on quite steep slopes for easy and thorough drainage. Norwegian creek, flowing through the town, is arched over through the thickly-settled portion, and has numerous lateral branches. Probably three-fourths of the population has direct drainage for wash-water, either by separate sewer connection or through street gutters and inlets. Over 300 water-closets are supplied with the public water, and the Secretary and Engineer of the Water Company

(Mr. William D. Pollard) estimates that 95 per cent. of them have sewer connection. Probably many houses on the line of the sewers and creek (where it is arched over) have privies over the same, but no estimate of their number was obtained. Almost all houses not near the creek or sewers have good surface drainage, and most of the streets are thoroughly washed into the river by every heavy rain.

Besides the domestic drainage there are the following sources of pollution in Pottsville:

Coal and Iron Company's repair shops, having privies for 900 men over Norwegian creek.

Pottsville Iron and Steel Company's shops, having privies for 400 men over the same creek.

Ulmer's Packing House, on east branch of Norwegian creek, one mile from the river, employing 30 men and slaughtering 300 hogs and 10 cattle per week, discharging all waste into the creek; using 25,000 gallons of water per day.

Gas works, on Norwegian creek about seven-eighths of a mile from the river. Product from 40,000 to 70,000 cubic feet per day, from naphtha, causing considerable tarry waste.

One large brewery (Yuengling's) and one or two small ones having direct drainage to the river.

Small glue factory just above the pork-packing house, discharges small amount of waste from beef legs.

Small soap works drained by sewer to Norwegian creek.

Within four or five miles of the borough of Pottsville, there is an additional population of about 20,000. The principal towns included are the following:

Minersville, four miles west of Pottsville, on West Branch of Schuylkill. Population 5,000. Water supply; no sewers, but good surface drainage.

Cressona, on same stream, near confluence with Schuylkill, four miles south of Pottsville. Population 1,500. No public water supply.

Schuylkill Haven, east of Cressona, on Schuylkill river at head of canal-boat navigation. Population about 3,000. No

public water supply at present but water works in process of construction, to be completed next spring, from streams five miles distant, beyond Cressona, giving head of 235 feet. Small gas works (supplying Cressona also) and small rolling mill, but no other special sources of pollution discovered. Good surface drainage for greater part of the town.

Palo Alto, on Schuylkill, east of Pottsville. Population about 2,000. Water supply from Pottsville company. Situated on steep banks and has good surface drainage to river. Privies over the river for 150 men in shops.

Port Carbon, on Schuylkill at mouth of Mill creek, two miles northeast of Pottsville. Population 2,500. Water supply from Pottsville company. Situated on steep slopes and has good surface drainage to river.

St. Clair, on Mill creek, two miles above Port Carbon. Population about 4,000. Water from Pottsville company. Situated on nearly level ground, affording very little direct drainage into the stream.

The valley of the Schuylkill above Pottsville, extending about 15 miles northeast, or nearly to Tamaqua, is a mining region containing a number of other towns, smaller than those mentioned above, in which there is no special pollution except the sulphuric acid from the coal mines. The valley below Pottsville, as far as Port Clinton, where the Little Schuylkill enters, is sparsely populated except in the towns named above, though containing considerable grazing and some farming land.

The valley of the Little Schuylkill is very rugged and contains no villages of note except Tamaqua, near the head of the valley, 20 miles above Port Clinton and 800 feet above the sea level. It is a mining town of 6,500 inhabitants, with a water supply from a stream flowing through farming country in old red sandstone, overlapping coal formation. Two storage reservoirs, having combined capacity of over 50,000,000 gallons; consumption not known. The houses are scattered over a small plateau and on gentle slopes to the surrounding hills. The main street is drained by a partly-covered natural water-

course in the rear of the buildings on one side and by a private sewer on the other side. Perhaps 50 houses have complete drainage and one-third of the whole population direct drainage for wash water. The only special sources of pollution discovered were a small gas-works and two small slaughter-houses.

The Little Schuylkill apparently brings more acid water than the Schuylkill proper, for while fish are occasionally found in the river above the mouth of the latter, none are found below until it receives the Tulpehocken Creek, at Reading, 23 miles distant.

The valley of the Schuylkill between Port Clinton and Reading is a farming and grazing country, containing but few villages or manufactories near the river. Hamburg, on the left bank of the Schuylkill, 80 miles above Fairmount, is the only notable town. It has a population of about 2,500, without a public water supply or drainage facilities except an open shale soil over clay, with gentle slope towards the river. The navigation canal intercepts this drainage, as well as that from the farm lands below, and allows opportunity for subsidence before discharging into the river ten miles below Hamburg.

At Shoemakersville, 75 miles above Fairmount, a tannery, which last year used 2,000 hides, 100 bushels of lime, 60 bushels of hen manure and 360 tons of bark, draining into a small creek 20 rods from the river, will do nothing this year.

Maiden's Creek, entering from the left, about 70 miles above Fairmount, drains a large area of farming country, partly in a limestone region, but though bringing lime-water into the Schuylkill sufficient to remove considerable of the sulphuric acid (by depositing sulphate of lime), the river water still remains too acid for fish to live in it.

No special sources of pollution were found in the Maiden's Creek watershed except the following:

Rolling mill at Maiden's Creek Iron Works, three miles from the river, uses two barrels of oil on the rolls.

Tannery at Trexler Station, Albany township, near the creek, 19 miles from the river, used 1,000 hides, 50 bushels of

lime, 30 bushels of hen manure and 180 tons of bark last year, but will do very little this year. Tannery in Grimsville, Greenwich township, near branch of creek, 15 miles from the river, uses 1,750 hides, 87 bushels of lime, 52 bushels of hen manure and 315 tons of bark per year.

Tannery in Kutztown, Manatawny township, on branch of creek, 14 miles from the river, uses 1,500 hides (estimated), 75 bushels of lime, 45 bushels hen manure and 270 tons of bark per year.

Tannery in Berkeley, Ontelaunee township, near the creek, one mile from the river, uses 1,200 hides, 60 bushels of lime, 36 bushels of hen manure and 216 tons of bark per year.

The *Second* or *Reading District*, comprising the watershed from the northern boundary of Reading to (but not including) Manatawny creek—just above Pottstown—contains about 400 square miles and has a population of about 95,000. It is almost entirely a farming region containing very few other sources of pollution except from the city of Reading, the largest town in the valley above Philadelphia, situated on the left bank of the Schuylkill about 60 miles above Fairmount dam, at an elevation (foot of Penn street) of 181 feet above sea level. It is the seat of Berks County and the centre of trade for the surrounding country, has extensive iron works, numerous hat factories and various other lesser industries, with a rapidly growing population, now estimated at 53,000.

The water works are owned by the city. The sources of supply are small streams from a sandstone region above the town. The total reservoir capacity is about 150,000,000 gallons and the daily consumption about 5,000,000 gallons.

There is only one public sewer in the city, and that merely takes the place of the lower portion of a natural brook, yet on account of unusually good facilities for gutter drainage and the common practice of thus disposing of domestic wash water, probably three-fourths of all the waste water of the city passes directly to the river. And although no water-closet

connections with the one sewer or the other natural stream are allowed, it is almost certain that much fæcal matter reaches the river by the following peculiar arrangement. A regulation of the Board of Health requires all privy wells and cesspools to be dug 20 feet deep unless rock or water is encountered at a less depth, but does not require them to be water tight; they are almost invariably walled up with loose stone. Cavernous limestone underlies the city and is within 20 feet of the surface under nearly half of the built-up portion, and fissures are commonly found on or near the surface of the rock. As it has been observed that those vaults or wells which reach one of these fissures do not fill up nearly as soon as others, if at all, such natural outlets are sought in digging privy wells in order to avoid the trouble and expense of cleaning them out. It is, moreover, not unusual to find running streams of water through these fissures and these also are sought, to a less extent, for natural sewers. These streams come from the hill back of the town, soaking down through coarse sand and gravel at the foot of the hill and coming up as springs in the river bed.

Throughout the city cesspools and privy wells are seldom cleaned until they become full and new wells are sometimes dug instead of emptying the old ones, though this is forbidden by the Board of Health. Of the 9,000 privy vaults and cesspools in the city only about 520 were cleaned last year. The contents are removed to farms outside the city at a distance from streams.

The total death-rate of the city was about 18 per 1,000 during the year 1883 and about 19 per 1,000 in each of the three years previous. Nearly one-fourth (exactly one-fourth if still-births are excluded) of all the deaths in 1883 were from zymotic diseases, 41 being from scarlet fever, of which 187 cases were reported during the year. During last fall (1884) there was an unusual prevalence of diphtheria, 273 cases and 60 deaths being reported from October 1 to December 6.

The special sources of pollution at Reading comprise two gas-works, five tanneries, one soap-works, several slaughter-

houses, two paper mills, one woolen mill, nine hat factories, five breweries and two malt houses, several rolling mills and hardware works, besides many others of such a character that the pollution is very slight.

The Reading Gas Company, having works near the canal at the foot of Fifth street, produce from 60,000 to 200,000 cubic feet per day, using crude petroleum—five or six gallons to one thousand cubic feet. This was considered, at the time of my first inspection (December, 1883), one of the worst sources of pollution at Reading. Scarcely any attempt was made to utilize or destroy the great quantity of waste which went directly to the river by a pipe under the canal. This waste-pipe leaked badly under the canal, causing much annoyance to the navigation company, whose Chief Engineer (Mr. Edwin F. Smith) finally devised a method of burning the waste, which the gas company have recently adopted. An old boiler shell is fitted, in an upright position, to the mouth of the waste-pipe in the river, projecting several feet above the ordinary water-level, about 25 feet from the shore. The waste products are thus retained in the iron cylinder and set on fire every day, except when it storms or the water overflows the receptacle, as it had been doing for a week or more at the time of my last inspection (January 16, 1885). The waste then all runs off, and at other times much escapes through a leak in the pipe, so that the arrangement is at present by no means a complete abatement of the nuisance. It is designed to remedy these defects in the spring. I could get no estimate from the Superintendent of the quantity of waste which formerly was discharged into the river, but from comparison with other gas-works below I estimate it to have been over 150 gallons per day on the average—of a thick, black, pulpy matter—or over 250 gallons per day in winter.

The Philadelphia & Reading Railroad Company's gas-works on North Sixth street near Greenwich street (on a small stream, about a mile from the river) use naphtha or refined coal oil, producing about 65,000 cubic feet per week. The

waste from these works is comparatively small, but is sufficient to cause a decided tarry odor several hundred feet away.

At Winter & Goetz's tannery, on the canal, at the corner of Island and Front streets, the waste liquid from treating 120 dozen sheepskins and 25 dozen calfskins per week runs directly into the canal. The principal animal waste comes from soaking the skins in water for two or three days. More or less waste also comes from the use of ten bushels of lime, 200 lbs. of salt and 400 lbs. of alum per week, also small quantities of aniline dyes and a variable number of eggs, sometimes as many as 100 dozen per day. Forty workmen use privies over an earth pit 15 feet from the canal. As the water from the canal enters this vault considerable pollution probably results.

Ruth & Co., 547 South Fourth street, manufacture glove kid, using 40 dozen sheepskins per week. It is claimed that the only waste discharged into the canal (by separate sewer) is the water in which the skins have been soaked. This is a new factory, started last August.

De Long Bros., Ninth and Muhlenburg streets, tan 5,000 cattle hides and 1,250 calfskins per year, using 1,000 tons of oak and chestnut bark, 200 bushels of lime and 100 bushels of hen manure. The hides are kept in pits filled with water for eight months, the water being changed every day for the first few days, then at gradually increasing intervals,—ten, twenty and thirty days. All waste water (about 4,000 gallons per day) passes directly into a brook, half a mile from the river.

Henry Kerper tans 2,000 hides per year at Second and Chestnut streets, using 100 bushels lime, 60 bushels hen manure and 360 tons bark. Waste water by sewer to canal.

George F. Winter, at Second and Front streets, tans 1,250 hides per year, but claims to discharge no waste into the sewer. Probably the usual proportion of animal matter reaches the canal by the sewer from Kerper's tannery.

The slaughter-houses of Reading are mostly at a distance from the river or water-courses and drain liquid waste into

wells in the earth, so that, unless these have outlets through the cavernous limestone before mentioned, there can be but little pollution from this source. The blood is generally caught and removed with the offal for fertilizer. The principal slaughter-house draining into the river is that of Rader & Thompson, Second and Court streets, on the line of the public sewer. They claim to discharge no waste into the sewer except wash water. A small hog-slaughtering house on Maple street drains blood as well as waste water into the creek close by. The manure pile, which also receives the solid waste, drains into the creek.

In December, 1883, the Reading Soap and Candle Works, W. K. Leman, proprietor, Second and Washington streets, were using 75,000 to 100,000 lbs. of grease per year, 27,000 lbs. caustic soda, 20,000 lbs. sal soda, 350 lbs. of rosin, 100 lbs. oil of sassafras, and 5 lbs. of citronella, producing 150,000 lbs. hard soap and 20,000 lbs. of candles per year, and discharging about 7,000 gallons of spent lye (alkali strength 3° to 5°) into the sewer, or 19 gallons per day. At the last inspection (January 16) the workmen in charge said they were not doing more than half as much then.

The lower mill of the Bushong Paper Company, limited, on the canal at Bingaman and Canal streets, use about 5,000 lbs. of domestic rags per day, with 15 bushels of lime, 550 lbs. chloride of lime, and 1,000 lbs. of wood pulp. All waste matters, including sewage from 60 operatives, discharged into canal; 400,000 gallons water used per day.

Another mill of the same company, on the canal at the foot of Court street, uses 4,000 lbs. of rags, 800 lbs. of lime and 450 lbs. of chloride of lime. Water closets used by 35 operatives in this mill discharge into the canal, as well as all other waste.

J. G. Leinbach & Company's woolen mill, on North Fourth street, near Buttonwood, scours 500 lbs. of wool per day, and uses 24 lbs. soda ash, 31 lbs. of rosin soap, 30 lbs. extract of logwood (liquid), 3 lbs. chrome, 3 lbs. oil of vitriol, 2½ lbs.

cutch and 1½ lbs. blue vitriol per day; also trifling amounts of aniline and other dyes.

Hendel, Bro., Sons & Co., Fifth street, below Laurel street, are the largest manufacturers of wool hats in Reading, producing 1,000 dozen a week, or about 1,700 per day. They use about 90 lbs. of hard soap, 10 to 15 lbs. of blue vitriol, 3 barrels of logwood and smaller amounts of other dye stuffs and chemicals per day; also scour a little wool—from 50 to 100 lbs. a day. The waste water runs 700 feet in street gutter to canal.

It was found so difficult to obtain reliable statistics from the eight other hat factories in Reading that time was taken only to obtain the products, which aggregate (including the one above mentioned) about 10,000 hats per day [average for every day in the year]. The relative quantities of soap and dye stuffs used in the other factories probably do not vary much from the figures given above. Most of them are situated near a creek flowing through the lower portion of the city and the waste water runs to the creek in the street gutters. When not colored by dye stuffs, the waste water (which I have estimated to be about 300,000 gallons per day) from fulling the hats, is slightly soapy and is turbid from short wool fibres.

Peter Barbey's lager beer brewery, Hockley lane and River road, produces about 25,000 barrels of beer per year. Waste water from rinsing barrels and vats, and cleaning generally, runs in gutter to canal, two or three hundred feet distant.

The Lauer Brewing Company, limited, produce about 30,000 barrels of lager beer annually at Third and Walnut streets. Waste water runs through box culvert 500 feet to public sewer. A porter and ale brewery, with malt-house connected, at Third and Chestnut streets, owned by the same company, produce 10,000 barrels per year. Waste runs by special sewer (draining also two tanneries mentioned above) to canal.

W. P. Deppen's Spring Garden Brewery, Chestnut street, near Tenth, produces 15,000 barrels of beer, porter and ale per year. A malt-house in the rear, belonging to the same

man, produces 25,000 bushels per year. Waste water from both places runs in street gutter a quarter of a mile to a creek entering the river at the foot of South street.

Keller & Schäffer's Keystone Brewery, between Fourth and Ash streets, below Elm street, produces about 8,000 barrels of lager beer per year. Waste water by special connection to public sewer.

M. K. Graeff's malt-house, west of Ninth street, below Muhlenburg street, produces 35,000 to 40,000 bushels a year. Water in which grain has been soaked runs to creek near by.

The Reading City Passenger Railway Company's stables, on Miner street above Willow, occupied by 40 or more horses, have stall drainage by terra cotta pipe to street gutter, 600 feet from creek near river. No other stables in the city have direct drainage.

William McIlvaine & Sons' rolling mill, on Laurel street east of Seventh, use 25 barrels of suet and petroleum per year on rolls; drainage into creek flowing through the yard where much of the waste oil is caught and retained till heavy rains. Privies for 150 men over the same creek; only 75 men employed at time of last inspection (January 16, 1885). Several other iron works and rolling mills cause slight pollution, from the rolls and laborers' baths.

The Penn Hardware Works, on the canal between Spruce and Pine streets, formerly had privy for 200 operatives close to the canal wall from which most of the fæcal matter entered the river. This was abandoned just before last inspection (Dec. 12) and a new one constructed 120 feet back, over a pit reached by the canal water; hence probably some pollution by filtration.

The Reading Stove Works, Orr, Painter & Co., on the canal between Spruce and Chestnut streets, have privies over earth vaults near the canal; water passes through the intervening earth and removes more or less of the polluting matters; those most used require cleaning every year. Bath water (from 250 men) discharged into canal.

H. S. Getz & Co's marble mills, on the Canal, near foot of Second street, have water-closets for 13 men connected with sewer from Lauer's brewery and Kerper's and Winter's tanneries.

Eckert & Co's fire-brick works, on canal just below preceding, have privies over canal wall for perhaps 20 men. [Works closed at time of inspection.]

McHose & Co's fire-brick works, on canal near foot of Fourth street, have privy for 50 men over leaching well ten feet from canal; requires cleaning every two years, but probably causes considerable river pollution.

Besides the above, situated so near the canal or creeks as to permit more or less direct pollution by fæcal matter, the following large establishments have partial privy drainage through the limestone fissures previously referred to. At the Philadelphia and Reading Railroad Company's machine-shops, Seventh street, between Spruce and Franklin, so much of the privy waste escapes from the vaults that one requires cleaning only once in five years, and the other only once in ten years, though the two are used by 1,000 men. At the car-shops of the same company, Sixth and Centre streets, the privies formerly were self-cleaning, but now are not entirely so; about 850 men are employed here. The spectacle works of T. A. Wilson & Co., Second and Washington streets, are in the cavernous limestone district and the privies will probably never require cleaning. Two hundred operatives are employed here where the wash (bath) water goes directly to the public sewers or culvert, with which the privies were at first connected, but afterward cut off to comply with Board of Health regulation forbidding water-closet connections. The cesspool receiving the drainage of the water-closets at the Philadelphia and Reading Railroad depot has a clear outlet to the river, as was shown at the time of its construction, when the full head of a fire hydrant was turned into it for twenty-four hours without filling it.

Tulpehocken creek, entering the Schuylkill opposite Reading, drains a large area of farming country in a limestone region

and brings down enough limestone water to complete the reduction of the acid, in part effected by Maiden's creek, so that the water below Reading is generally good (so far as acidity is concerned). Above the Tulpehocken the Schuylkill water is too acid to be used in boilers. The only special sources of pollution discovered in the Tulpehocken watershed are the following:

Paper-mill of the Bushong Paper Company (limited), near the mouth of the Tulpehocken; uses 5,000 lbs. jute per day, with about 800 lbs. of lime and 450 lbs. of chloride of lime.

Van Reed's paper-mill, five miles from the Schuylkill, uses about 2,000 lbs. of paper rags and some wood pulp.

Tannery in Bernville, on branch of North Kill creek, 15 miles from the Schuylkill, tans 2,000 hides and uses 100 bushels of lime, 60 bushels hen manure, and 360 tons bark.

Tannery in Jefferson township above Bernville, 18 miles from the Schuylkill, tans 1,200 hides and uses 60 bushels of lime, 36 bushels hen manure, and 215 tons of bark.

Another in Womelsdorf, Heidelberg township, near the Tulpehocken, about 24 miles from the Schuylkill, does the same amount as the preceding. Both the latter are on very small brooks and probably no pollution reaches the river.

Small woolen mill in Wernersville, Lower Heidelberg township, on Spring creek, about 18 miles from the Schuylkill, scours perhaps 12 lbs. of wool per day.

The following establishments contributing to river pollution are in the immediate vicinity of Reading:

Cyrus Erence's neats foot oil and tallow factory, in Exeter township, four miles east of Reading, receives all the dead animals from that city. During the year 1883 there were 72 horses, 7 cattle, 16 sheep, 104 cats, 85 dogs, 54 pigs, besides numerous chickens, geese, etc. The carcasses are boiled to obtain the oil and all the liquid waste runs to a creek nearly seven miles from the river. Bones and butcher's offal are received from other sources, over 100 tons of dry bones being shipped from this place during a year.

Next door to the above is Joseph Levan & Co.'s glue factory. During the winter and early spring about 150 tons of beef legs are treated with oil of vitrol (100 lbs. a day), and during the late fall and late spring 200 tons of scraps of hides are used, with one or two bushels of lime to each ton. The establishment is a local nuisance, but comparatively little animal matter reaches the water course. The proprietor estimated about 400 gallons per day of waste liquid from washing the beef legs and 1,000 gallons of lime water per day from the hide stock. Most of this runs by a small brook to the creek above mentioned.

A mile above on the same creek, Louis Kraemer & Co.'s woolen mill scours 27 lbs. of wool per day, and uses 5 lbs. soda ash, 3 lbs. bichromate of potash, 40 lbs. extract of logwood, 10 lbs. chipped logwood and smaller amounts of various other dye stuffs.

A short distance below the glue factory above mentioned, on Antietam creek is A. J. Brumbach's cotton and woolen mill, scouring nearly 300 lbs. of wool per day and using over 200 lbs. of extract of logwood and smaller quantities of fustic, hyperric, etc. Fifty operatives use privies over the stream.

Opposite Reading, near the river, is G. W. Alexander & Co.'s hat factory producing about 700 hats per day and using a great variety of dye stuffs, generally in small quantities; and in Mohnsville, Cumru township, about six miles from the Schuylkill, by a small creek, are six or seven more hat factories producing perhaps 3,000 hats per day.

Between Reading and Pottstown (about 20 miles) there are almost no sources of pollution except from agriculture. The greatest is at Birdsboro, half way between the two towns, where about 20 houses have indirect washwater drainage into Hay creek, over which E. & G. Brook's nail works have privies for 400 men. Though having a public water supply (by 12-inch pipe from a small stream one or two miles distant and 170 feet above the town) and a population of perhaps 2,000 this

town has no other sources of direct pollution, most of the houses being situated at a distance from the river or any tributary. In the extreme lower end of the second district, just above the mouth of the Manatawny creek, the Warwick Furnace and Rolling Mill has privies for 60 men over the stream, though the manager thought that not more than 30 or 40 used them.

The *Third*, or *Pottstown District*, comprising the valley from just above Manatawny creek to the pumping station of the Phœnixville water works, an area of about 150 square miles, has a population of about 25,000. The river valley is narrow between these points and consists principally of good farming land.

Manatawny creek, the principal tributary in this district, drains a rougher country with poorer soil and sparse population. Boyertown, partly in this (Manatawny) and partly in the Perkiomen watershed, has a population of 1,200 or 1,300. It has a water supply (used by about two-thirds of the population) from Ironstone creek, half a mile from the town, half by gravity and half by pumping; consumption not known. The town has but little direct drainage except into the iron mines which underlie a part of it, whence the filtered water is pumped into Ironstone creek. The following small manufactories of a polluting character are in the Manatawny watershed:

Small woolen mill at Friedensburg, Oley township, about 18 miles from the river; custom work—perhaps 2,000 pounds of wool per year.

Wren's cotton and woolen mill, in Colebrookdale township, between Boyertown and Colebrookdale station, on Ironstone creek, eight miles from the river; mixed shirtings and blankets, mostly from cotton; uses 15 lbs. soap, 1 lb. oil of vitriol and 1 lb. cochineal per day besides small quantity of concentrated black dyes.

G. B. Conrad's "Oley" paper mill, Oley township, 14 miles from the river, uses about 2,500 pounds of paper rags per day.

Brewery, producing 5,000 barrels a year, on the creek, two miles from the river.

Glasgow Iron Co.'s rolling mill and puddling furnace, a short distance above the preceding; uncertain quantity of oil from the rolls passes directly into the stream; privies for 140 men on the bank.

The greatest pollution from this district is from the borough of Pottstown, situated on the left bank of the Schuylkill just below the mouth of Manatawny creek, 40 miles above Fairmount dam and 150 feet above sea level. Population about 5,000 or, including suburbs, 9,000. Seat of several large iron works and centre of trade for surrounding country. The water works, owned by a private company, draw their supply from the river near the lower end of the town. The water is generally considered bad, especially in summer, when most people resort to wells for drinking water. An association of physicians recently urged the water company to take the supply from above the town, but at last accounts this had not been favorably considered. Probably on account of the unsatisfactory quality the amount supplied is quite small for the population—less than 200,000 gallons per day.

Three natural water courses through the town drain wash water from about two-fifths of the entire population, mostly through the street gutters; and, according to a recent inspection by two resident physicians (Drs. Kellar and Saylor) water-closet drainage from over one hundred houses is discharged into two of these streams, one of which is culverted through the built-up portion of its course. The Philadelphia and Reading Railroad station water-closets also drain to the river. Moreover, the night soil is taken to steep slopes just outside the town whence much fæcal matter is probably washed into the streams.

The special sources of pollution within the town are few. The gas-works (owned by private company—same owning water-works) produce from 15,000 to 30,000 cubic feet per day from coal; tar sold, and but little waste to river, except

ammonia water. The Philadelphia Bridge Works, below the intake of the water-works, have privies for 400 men over cesspools in made ground; probably some river pollution by percolation after high water.

J. Trinley's fertilizer factory, below Limerick station (about 34 miles above Fairmount), on small creek one-fourth mile from river, grinds 500 tons of bones per year, and mixes the dust with prepared manure; process mostly dry, causing no river pollution; some waste, however, from boiling fresh bones before grinding, and from dead animals from the surrounding country. Complaint is made that animals having died of contagious diseases are used there, and the liquid waste drained into the stream, but the proprietor's representative claimed that they were very careful not to take such material. The proprietor sold in 1883 one thousand tons of fertilizers, mostly in the Schuylkill valley, including 150 to 200 tons of other makes.

At Royer's Ford, a village of 700 or 800 inhabitants, situated on the left bank of the Schuylkill, in Limerick township, 32 miles above Fairmount, a stone culvert under a row of houses on the main street drains wash-water from perhaps 20 houses and a dozen water-closets, including that of the hotel. The Spring City Gas Company's works at the same place, near the river, produce about 8,000 cubic feet per day, for the supply of both Royer's Ford and Spring City (on the other side of the river). The gas is made from naphtha, with considerable waste of heavy hydrocarbons. Buckwalter & Co.'s stove foundry, near the river, above the bridge, has one privy over a small stream, used by a dozen men. Bath-tubs, used every day by 70 sweaty men (60 moulders), discharge into the same stream.

Spring City, a village of 1,500 to 1,800 inhabitants, opposite Royer's Ford, contributes but little direct pollution, except from the manufactories named below, the houses being scattered and generally distant from streams. Perhaps one-half the population have fairly good surface drainage.

The American Wood-Paper Company's mill, on the canal above the bridge, produces about seven tons of wood pulp per day, using 80 bushels of lime, 2,000 lbs. soda ash, 2,000 lbs. chloride of lime, 100 lbs. alum, and a little coloring matter. Seventy-five workmen use water-closets draining into the canal.

Yeager & Hunter's stove foundry, near the canal in the lower part of the village, has privies for about fifteen men over the water.

The Fourth or Phœnixville District, embracing an area of about 520 square miles, with 65,000 inhabitants, extends from the Phœnixville pumping station to the upper boundary of Norristown. The main river valley is narrow between these points and by far the larger portion of the area is drained by the Perkiomen, entering the Schuylkill from the north, about 25 miles above Fairmount. The source of greatest pollution is the borough of Phœnixville, on the right bank of the Schuylkill, 28 miles above Fairmount and 110 feet above sea level. The population is estimated at 7,500, mostly living back from the river, on both sides of French Creek, which thus receives most of the drainage. The water supply (works owned by the borough) is pumped from the Schuylkill above the town and is generally considered to be of good quality, except sometimes in winter, when, owing to the peculiar formation of the river just above the pumping station, broken ice accumulates under the surface ice and collects a great quantity of organic impurities, more or less of which are drawn in by the pumps in certain conditions of the river. The consumption is about 500,000 gallons per day. The upper portion of the town, north of French Creek, has one arched culvert taking wash water only from perhaps 800 people. The main part of the town, south of the creek, has two natural watercourses, one of which is arched over for a quarter of a mile or more and the other for a short distance. Both receive gutter drainage from a population of perhaps 1,500, besides complete drainage from some 15 houses. A few privies are also placed

over the upper culvert near the canal, so that perhaps 150 people have water closet drainage into the two streams, including the 25 operatives of Griffin, Smith & Co.'s pottery works on the lower culvert.

The death-rate of the borough, as calculated by a local physician, ranges from 19 to 23 per 1,000, the principal diseases being, in summer, diarrhœa and malaria, and in winter pneumonia, scarlet fever, diphtheria and a peculiar affection of the bowels known there as "winter cholera," which may have some connection with the foul condition of the water supply referred to above.

The most serious special pollution in the town is the privy drainage of the Phœnix Iron Company, which has extensive works along the creek entirely through the town. Eight hundred men use privies over race ways or other arrangements providing direct water carriage to the creek, and 800 more use privies over leaching wells which high water enters by percolation.

The Phoenixville Gas Works producing about 12,000 cubic feet in winter, from crude petroleum, wastes a large quantity of thick, pulpy matter (said by the Superintendent to be eighteen gallons a day) to the river by a special pipe. At the mouth of this water pipe was a large accumulation of viscid tarry matter which had not been carried away by the water at the time of the last inspection (Nov. 20, 1884.)

No other special sources of pollution were discovered in Phoenixville except two or three small slaughter-houses in the extreme upper part of the town, one of which drains all blood and casts much offal into a small branch of French creek. French creek drains a farming country in which no special pollution was discovered besides a small paper mill—J. Frederick Sheeder's—near the southern boundary of East Vincent township, eight miles from the river, producing three tons of binders', trunk, album, and box board, from old paper rags.

Pickering creek, entering the Schuylkill a short distance

below Phoenixville, from the right, also drains a farming country containing a few small manufactories, as follows:

J. W. P. Ingraham's woolen mill, in Charlestown village, five miles from the river, uses about 2,000 pounds of fulling soap per year in fulling blankets, and about the same quantity of scouring soap; no wool scouring or dyeing.

John Rees, Jr.'s paper-mill, near the above, uses about 1,000 lbs. of old paper per day during ten months of the year, to make binders' board. Near the above are two lead mines which have not been worked lately.

B. F. Williams' paper-mill, on small branch of Pickering creek, about three miles from the river, in Schuylkill township, makes about one ton per day of binders' board from old paper.

On the creek, just below the entrance of the above brook, is a small creamery, which evidently gives little or no pollution; waste liquid (cheese whey) taken by the farmers bringing milk to feed to hogs.

Only that portion of the Perkiomen valley below Schwenksville is included in the present report, the portion above that point being comprised in the proposed future supply watersheds on which I have submitted a special report, including also the Skippack creek, above Evansburg. There are but few manufactories in this lower portion, and little pollution, except from the farming land which occupies most of the territory.

At Schwenksville, the largest village in this lower portion, about eleven miles from the Schuylkill, a few houses have very imperfect surface drainage to the creek. The only manufactory having any drainage of a foul character is a creamery, from which the amount of waste reaching the creek is very small, most of it being taken by farmers.

At Grater's Ford, nine miles from the Schuylkill, about a dozen houses on top of a steep bank of the creek cast rubbish of various sorts down the bank and about half of them have privies on the bank. Just below the above a small brook enters the creek, which receives, four or five miles above, the drainage of a small tannery near Limerick Square. It uses

about 400 hides and 1,200 calfskins, 300 bushels lime, 18 bushels hen manure and 100 tons bark.

At Rahn's Station, eight miles from the Schuylkill, a small fur hat factory, using per day 50 lbs. chipped logwood, 3 lbs. fustic, 2 lbs. oil of vitriol and trifling amounts of cudbear, hyperinc and other dyes, drains into the Perkiomen, about 800 feet distant, by a small stream which also receives the privy waste from the operatives, perhaps twenty in number.

Casselberry's tannery, at Evansburg, on a small tributary, one mile from the Perkiomen and seven miles from the Schuylkill, tans 500 hides and 2,200 calfskins per year, using 44 bushels lime, 27 bushels hen manure and 150 tons of bark.

In the valley of the main river below the Perkiomen are the following sources of pollution:—

Palm Paper Co.'s mill, at Valley Forge, 23 miles above Fairmount, formerly used rags, but now use jute bagging (old sacks), 2,700 lbs. per day, with 270 lbs. wood pulp, 10 bushels lime, 300 lbs. chloride of lime and 75 lbs. alum. Water closets for 14 operatives discharge directly into the stream.

At Port Kennedy station, Upper Merion township, 21 miles above Fairmount, the hotel has privies beside a creek entering at that point, which also receives considerable pollution from the general surface drainage of a population of nearly 500.

Abraham's paper mill, at Merion station, 19 miles above Fairmount, on Crow Creek, near the river, uses 2,000 lbs. of old paper per day in making cardboard. No chemicals are used in making cardboard or binders' board, except copperas, about 12 quarts to the ton.

The Fifth, or Norristown District, extending from the upper boundary of Norristown to the pumping station of the Conshohocken water works, is the smallest of the seven, having an area of only 30 square miles and a population of 20,000. There is no pollution in this district other than from agriculture, except from the towns of Norristown and Bridgeport,

situated opposite each other on the Schuylkill, about 16 miles above Fairmount dam.

The borough of Norristown, on the left bank, has a population of about 14,500. It is the seat of Montgomery county, is a trading centre for the farmers for several miles around, especially from the north and northwest, and has considerable manufacturing.

The water works, owned by a private company, draw their supply from the Schuylkill, pumping continuously for six days in the week from that division of the river flowing to the right or on the farther side of Barbadoes island, opposite the town, in order to avoid the pollution entering that part of the river adjacent to the town above the pumping station. The reservoir, two miles from the river and 211 feet above it, has a capacity of 12,000,000 gallons. The daily consumption is from 800,000 to 1,000,000 gallons. The quality of the water is generally considered satisfactory.

Two natural streams, Stony Creek through the upper part and Saw Mill Run through the lower, afford good surface drainage for the greater portion of the town. There are also several sewers, as follows: Four-feet brick sewer in Marshall street, from George street to Stony Creek, about 1,300 feet, takes only surface water from street gutters and possibly waste water direct from a few houses (50 on the line), probably no water closets connected. Three-feet sewer in Main street, from Swede street (summit of grade) to Stony Creek, about 2,000 feet; perhaps 35 houses connected, a few having water closets. Also, in same street, from same point, 1,550 feet in opposite direction, to river, receiving water closet drainage of Mill street station, Philadelphia & Reading Railroad, and a few cesspools; about 90 houses on the line, most of them connected for wash water only. Three-feet sewer in De Kalb street, from below Main street, about 750 feet to mill race, 400 feet from river; about 20 houses, including two or three hotels and some cesspools connected, also water closets of Pennsylvania Railroad station.

Saw Mill Run receives gutter drainage from at least 150 houses, in addition to many beside it which drain into it more or less wash water through their backyards, which also contain privies near the banks. An old race from this creek to a flour mill on the river receives considerable backyard drainage, wash water, stable washings, etc. Besides the houses on the lines of the sewers to Stony Creek about 200 have gutter drainage to it directly.

I regret having been unable, on account of the absence of any Health Board or official registration, to procure full and definite statistics of disease and death in this town. According to a local physician the undertakers report 390 deaths during the past year. If there were as many deaths the rate per 1,000 would be 27 (assuming a population of 14,500), but the number probably includes some bodies of persons dying elsewhere. Still I judge the death-rate to be very high, especially from zymotic and infantile diseases. One physician reports having attended 50 cases of typhoid fever in 1884.

In addition to the extensive domestic drainage, the following establishments in Norristown drain foul waste matter into the river or its tributaries:

Slemmer Bros.' Montgomery Oil Works (for refining petroleum), in lower end of town, about 1,000 feet from the river, formerly caused much pollution, but in rebuilding, after destruction by fire, in November, 1883, greater pains were taken to prevent this. The works were again partially burned in September, 1884. At both times considerable oil escaped into the river. The waste liquid is now intercepted by six successive traps (large settling tanks), from which accumulations are removed to pits, six feet deep or more, 200 feet from the river, and covered with ashes. Beyond the settling tanks the waste flows a quarter of a mile through ditches and meadows, so that but little oil ordinarily reaches the river. Probably considerable is washed in by heavy rains, which clean out the channels. About 2,500 gallons of crude oil is used per day,

of which the proprietor thinks not more than one per cent. goes to waste.

Another small oil refinery some distance below the preceding had been idle for a long period at both times of inspection.

More oily waste was running into the river from the Norristown Gas Works (supplying also Bridgeport) than from the oil works at the time of my last inspection (September 22, 1884). About 30,000 cubic feet per day was then being produced from coal. In the preceding winter the product was from 75,000 to 80,000 cubic feet per day and they were then using benzine.

Beener's slaughter house, between Cherry and Barbadoes streets, has a sewer to Stony Creek for liquid waste from slaughtering two or three cattle and ten hogs per week. Two or three other slaughter houses of about equal capacity on Carson alley have a sewer to Saw Mill Run, which also drains surface water from an area containing about 50 houses.

Samuel J. Long, hide and tallow dealer, Markley and Lafayette streets, handles 80–100 hides, 280 sheepskins and 75–120 calfskins per week. The cellar where these are packed in salt, drains by separate sewer into Stony Creek, which also receives much animal matter from the rendering of 25 barrels of tallow per week at the same place.

The county prison, usually containing about 60 inmates, has a special sewer for all liquid waste to Saw Mill Run at Arch and Penn streets.

Bullock's woolen mill, on Saw Mill Run, about one-eighth of a mile from the river, when running to its full capacity, scours 875 lbs. of wool per day and uses 66 lbs. hard soap, 70 lbs. nitrate of iron, 7 lbs. iron liquor, 40 lbs. extract of sumac, 10 lbs. alum, 4 lbs. oxalic acid, 86 lbs. chipped fustic and 2 gallons of ammonia, also irregular and variable quantities of salt, blue vitriol, oil of vitriol, hyperinc, Lima wood, madder, chrome and barwood; sewage from 450 operatives has water carriage to river. At the time of last inspection the average consumption of wool was said to be only about 215 lbs. a day, or one-fourth the full capacity, and at that

time only eight workmen used water closets draining into the creek.

J. & J. Shaw & Co.'s woolen and cotton mill, on Saw Mill Run, one and a half miles from the river, uses 67 lbs. extract logwood, 17 lbs. soda ash, 10 lbs. oil of vitriol and 5 lbs. cutch per day. The dye water flows several hundred feet through a meadow before entering the stream and is thereby slightly purified.

J. Morton Brown & Co.'s woolen and cotton mill, on Barbadoes street near Airy street, when using wool, scours about 860 lbs. a day, with 43 lbs. soda ash and 17 lbs. dyers' bar soap. Also uses regularly, on the average, 43 lbs. extract logwood, besides an unknown quantity of chipped logwood and some aniline dyes. Waste water runs in ditch 500–600 feet to Stony Creek.

The Washington Woolen Mill, near the river, in the upper part of the town, scours 430 lbs. of wool per day and uses 4 lbs. potash, 4½ lbs. soda ash, 8½ lbs. bichromate of potash, 21 lbs. blue vitriol and 75 lbs. extract logwood. Waste water runs to river by pipe. Privies for 85 operatives beside a small brook flowing past the mills. Contents said to be removed to farm, but probably some pollution.

M. L. Cresson & Co.'s Ford street mill, near lower end of town, 300 feet from river, uses 10 lbs. soda ash, 24 lbs. extract logwood, 8 lbs. bichromate of potash and 25 lbs. copperas per day. Dye water enters stream from the oil works and runs one-fourth mile in ditch to river.

John & James Hunter's cotton mill, on the river at De Kalb street, has water closets for 130 operatives discharging into the river, and William Simpson & Son's Wyoming Mills, at the foot of Swede street, have the same arrangement for 150 operatives.

A shirt factory, 600 feet from Stony Creek, half-mile from the river, uses 1½ barrels of soap and 1 barrel of starch per day, in washing and starching new cloth. Waste water runs over surface of ground and in small ditch to creek.

The Eagle Iron Works, on the river, in the lower part of town, have privies for 60 men on the river bank. Excrements reached only by high water, but washed in by heavy rains.

James Hooven & Sons' rolling mill, near the river above the bridge, uses 3,000 lbs. tallow and some other grease on the rolls in a year. Sewer to the river for waste water and grease.

Stony Creek Rolling Mill, at mouth of Stony Creek, uses 1,000 lbs. of grease per month, also 30 lbs. of cylinder and engine oil per day. Privies for 150 men on bank of creek. Excrement falls near low water line and is partially washed in by the stream from the rolls, which flows into the creek under the privies.

Scheidt's brewery, Marshall and Barbadoes street, produces 3,000–4,000 barrels of lager beer per year. Waste water by sewer to Stony Creek.

The Pennsylvania tack works, on Stony Creek, one-third mile from river, use 1 gallon oil of vitriol per day, most of which runs into the creek.

The Star Glass Works, near the river, in the extreme lower end of town, have privies for 75 men on the top of the river bank, 75 feet from the water. Pollution only at times of heavy rain-fall.

In the outskirts of the town, one mile north of the centre of population, is the State Hospital for the Insane (southeast district of Pennsylvania), containing a population of about 1,200. Heretofore the water closet sewage, amounting to 60,000 gallons per day, has been treated (by precipitation and filtration) for the recovery of the solid fertilizing constituents, which were removed, in the form of sludge, by pumping and gravity, to a distant part of the farm, while the partially purified liquid was discharged into a small branch of Stony Creek, together with the remaining 140,000 gallons of waste water (including all kitchen-sink grease), to which no purification process was applied. The decomposing organic matter adhering to the sides of the brook as it flowed past the Hospital station of the Stony Creek Railroad caused an almost intolerable

stench at the time of my last inspection (September 23, 1884). Arrangements are now being made to utilize the sewage by sub-surface irrigation.

Stony Creek, after receiving the hospital drainage and the Norristown sewage from the various sources indicated above, was the most grossly polluted tributary of the Schuylkill in the whole valley, above Dobson's Run.

In Bridgeport, opposite Norristown, a borough of about 2,000 inhabitants, the houses are scattered, there is no water supply and comparatively little domestic waste water reaches the river. About 20 houses along the canal, below the bridge, drain into the canal more or less directly, and most of them have privies near the canal bank. The principal pollution from the town is from the following manufactories:

Lee's woolen mill, in the extreme lower end of town, scours about 10,700 lbs. of wool per day and uses 2,830 lbs. of soft soap, 50 lbs. extract logwood, 14 lbs. alum, 8 lbs. copperas, 8 lbs. blue vitriol, 14 lbs. chrome, 360 lbs. soda ash, 145 lbs. sal soda, 3 lbs. aniline dyes and 14 lbs. oil of vitriol per day. Seven hundred operatives use water closets discharging into a stream to the canal.

Worral & Ratcliff's cotton and woolen mill, on canal nearly opposite railroad station, scours 100 lbs. wool per day and uses 50 lbs. extract of logwood, 6 lbs. blue vitriol and a small quantity of catechu. Seventy operatives use privies over the canal.

A yarn mill, opposite the above, was scouring 214 lbs. wool per day on January 2, 1884. At the time of last visit (October 2, 1884) it had been closed for several weeks. The waste water ran through gutter and ditch, 150 to 200 feet, to canal.

Smith's Cloth Factory, near the canal, in the upper end of town, contemplated starting a dye-house; no pollution at time of last visit (October 1, 1884).

H. McInnes' Paper Mill, on the canal, opposite the railroad station, uses 6,000 lbs. of jute butts and bags (cotton bales,

etc., mostly imported), 850 lbs. chloride of lime, the same quantity of lime, and 21 lbs. soda ash per day. Five operatives use water-closets discharging into the stream, and 23 use a privy over a leaching vault beside the canal wall.

Dager & Cox's Paper Mill, near canal, above De Kalb street bridge, was using 3,430 lbs. of jute bagging, 8,000 lbs. jute butts, 3,000 lbs. chloride of lime, 550 lbs. lime, and 34 lbs. soda ash per day on January 2, 1884. At time of last inspection (September 29, 1884) the works were being re-built (having been destroyed by fire), with one-third greater capacity; jute butts to be used chiefly hereafter.

At J. B. Horn's Packing House, on the canal, below the De Kalb street bridge, 7 cattle per week in summer and 100 hogs per week in cold weather (October to May) are slaughtered, and all liquid waste discharged into the canal.

The Sixth, or Conshohocken District, though a little larger than the Norristown (38.5 square miles), has a smaller population (about 16,000). It extends from the Conshohocken Water Works Pumping Station to the Roxborough Pumping Station of this Department. The principal pollution is from Conshohocken and its tributaries,—Gulf Creek and Mill Creek.

The borough of Conshohocken, population 5,000 to 6,000, is situated on the left bank of the Schuylkill, 12 miles above Fairmount dam, and 60 feet above sea level. The water works, owned by a private company, draw their supply from the river, opposite the upper end of the town, near the entrance to the upper canal lock, the mouth of the intake being eight feet from the tow-path, and half-way between the surface and bottom at ordinary low-water. The reservoir is about 200 feet above the river, and has a capacity of 1,300,000 gallons, which is so large in proportion to the daily consumption (65,000 to 100,000 gallons), that the pump is run only 40 to 60 hours per week, at any time when the water is clearest, except Monday. The pumping-engine boilers are cleaned of scale every three months.

The town contains no sewers, and on account of the houses being scattered but little house drainage reaches the river. About 150 houses have more or less direct gutter drainage to the canal, and the Philadelphia and Reading Railroad Station has water-closets discharging into the same. There is little other pollution, except from the following manufactories:

The Albion Print Works, below the bridge, between the river and canal, use the following materials in bleaching, dyeing, and printing 40,000 yards of cloth per day: 85 lbs. aqua fortis, 200 lbs. muriatic acid, 300 lbs. oil of vitriol, 280 lbs. extract log wood, 390 lbs. bar wood, 9 lbs. alum, 33 lbs. extract citron bark, 4 lbs. bar tin, 3 lbs. antimony, 195 lbs. bichromate potash, 16 lbs. blue vitriol, 13 lbs. sulphate of copper, 6 lbs. catechu, 57 lbs. extract sumac, 281 lbs. gambier, 128 lbs. indigo, 95 lbs. indigo auxiliary (zinc powder), 42 lbs. brown sugar of lead, 4 bushels lime, 4 lbs. litharge, 2 gallons iron liquor, 3 lbs. aniline dyes, 6 lbs. white soap, 483 lbs. soda ash, 83 lbs. sal soda, 105 lbs. sumac, ¾ lb. tin crystals, 1 lb. yellow prussiate of potash, 240 lbs. oxalic acid, 1 lb. tartaric acid, 14 lbs. aniline oil, 3 lbs. chlorate of potash, 72 lbs. chloride of lime, and 185 lbs. sulphur. Two hundred operatives use privies over the stream or on the bank.

Samuel Fulton's Furnace, near the mouth of Plymouth Creek, has privies for 200 men over the bank of the creek; excrement reached by ordinary high water. At a small cinder-crushing works, just above the preceding, and owned by the same man, about a dozen men use a privy on the bank of the creek.

J. Wood & Bros.' Iron Works (smaller shop), between the river and canal, just above the bridge, have a privy over a raceway direct to the river, used by 20 men.

Alan Wood & Co.'s Schuylkill Iron Works, near the canal in the lower portion of the town, waste considerable tar into the canal from their private gas works which make 2,000 cubic ft. of gas per day, from rosin and coal. These iron works

also use 150 lbs. of sulphuric acid per day for one-third of the time and waste some oil from the rolling mill.

The Conshohocken Cottonade Mill, just above the preceding, uses 120 lbs. extract of logwood, 15 lbs. of bluestone and 16 lbs. soda ash per day besides small quantities of other dyes. Waste water flows through an earth ditch several hundred feet to the canal.

The Schuylkill Woolen Mills, near the preceding, use 50 lbs. extract of logwood, 10 lbs. soda ash, 10 lbs. bluestone, 12 lbs. cutch and 8 lbs. extract of bark per day. Waste water runs through box-culvert 200 ft., then over the ground 400 ft. or more to the canal, being entirely absorbed and evaporated in dry weather.

At West Conshohocken the houses are scattered and very little domestic drainage reaches the river. The principal pollution from this point is the drainage of the two following mills:

Bullock's worsted mill, on the river just above the bridge, scours nearly 5,000 lbs. of wool and 500 yds. of cloth per day, using 400 lbs. best suet and tallow soap; also, in the dye-house, 43 lbs. sumac, 30 lbs. chipped logwood, 14 lbs. copperas and 29 lbs. of all other dye stuffs per day. Privies over leaching vaults near the river bank for 366 operatives.

James Hall's carpet factory, on a small stream, near its mouth, in the lower end of the village, uses 100 lbs. chipped logwood, 21 lbs. copperas, 14 lbs. scouring soap and 14 lbs. soda ash per day. About 3,000 gals. of water from spring on hill used per day in dyeing and scouring. Privies on bank of stream—partly over it—for 43 operatives.

Gulf creek, entering the river just above West Conshohocken, drains the following mills:

Bullock's woolen mill, about one-fourth mile from the river, scours 2,000 lbs. of wool per day and uses 820 lbs. chipped logwood; also 55 lbs. of other dye stuffs of which I could not obtain estimate in detail. Privies for 300 operatives partly over pits in the earth and partly over streams—perhaps two-

thirds directly to the river. Seven tenement houses below the mill have privies over the stream, which had a filthy appearance at the time of my last inspection (Sept. 19, 1884).

McFarland's mill, 1½ miles from the river, uses 100 lbs. extract of logwood per day, besides smaller quantities of other dye stuffs. Privies for 125 operatives over raceway, direct to the creek.

About three-fourths of a mile from the river a dozen houses have privies on the banks—six being near enough to the creek to be reached by high water.

At Spring Mill Station, one mile below Conshohocken, seven houses have privies on the banks of a small stream, and about 20 houses drain in wash water more or less directly.

Mill creek, entering from the right, just below Rose Glen Station, eight miles above Fairmount, drains the following mills:

Stelwagon's paper mill, about one-eighth mile from the river, uses 1,700 lbs. jute butts, 8½ bushels lime, 86 lbs. chloride of lime, 130 lbs. alum, and 21 lbs. rosin per day, when running, and has privies for 14 men over the stream. When last inspected (September 9, 1884,) it had been idle for some time.

A woolen carpet yarn factory three-eighths of a mile from the river; 15 operatives use a privy on the bank of the stream, reached by high water.

Another mill just above the preceding, which had been idle for a long time, has privies over the race-way, used by 60 operatives when in operation.

At a carpet yarn factory, one mile from the river, 50–60 operatives use privies over the stream.

W. C. Hamilton & Sons' Riverside paper mill, on a creek near the river, at Lafayette Station (Norristown Branch of P. & R. R. R.), nine miles above Fairmount dam, uses about 9,000 lbs. of cloth rags per day—cotton and linen worn-out garments, one-fifth foreign and four-fifths domestic. The foreign rags were from Germany at the time of last inspection

(September 6, 1884.) The rags are boiled under a pressure of from 40 to 50 lbs. for ten hours, with 2,200 lbs. caustic lime; then washed and bleached with 440 lbs. chloride of lime. About one-half million gallons of water are used per day. Privies for 100 operatives discharge into the stream. Above the mill, one house has its privy over the stream, two on the bank, and several others near it. This mill is only one-and-a-half miles above the Roxborough Pumping Station, of this Department, and is the worst case of pollution between Manayunk and Conshohocken.

In the upper portion of Philadelphia, on streams entering the river near Shawmont and Princeton Stations, several houses drain wash water and cast garbage into the stream, and two or three privies also discharge into them.

The Seventh, or Manayunk District, comprising all the territory draining into the Schuylkill, between Flat Rock and Fairmount dams, or between the highest and lowest pumping stations of the department, has an area of about 75 square miles, and a population of 50,000, of which 20 square miles and 40,000 population are within the city limits. The valley of Wissahickon creek contains almost the whole of the remaining 55 square miles; this is a farming region with no large villages. The greater portion of the district, even of that part within the city limits, is rural and sparsely inhabited; the bulk of the population occupies a comparatively small territory, chiefly on the steep slopes of Manayunk, and the house drainage of this part of the city, with the manufactory refuse from the extensive mills along the river and canal at that place, and on a small tributary stream at the Falls, constitute the principal pollution. Three special reports on the pollution within this district were made by me during the past year, and published in the Appendix to the Journal of Councils, as follows: On June 21, 1884, a "Report on the quantity and kind of solid refuse along the banks of the Schuylkill river, between Flat Rock Dam and the Wissa-

hickon creek" (Appendix No. 204 to the Journal of the Common Council); on July 3, 1884, a "Report of an investigation of the sources of pollution of Wissahickon creek" (Appendix No. 210 to the Journal of the Common Council); and on September 4, 1884, a "Report on the pollution of the Schuylkill river, between Flat Rock and Fairmount dams" (Appendix No. 120 to the Journal of the Select Council).

The present report combines these three reports with additional information obtained from subsequent investigations.

There are three public sewers in Manayunk, as follows: Through Baker street (from just above Belmont avenue, or Green lane) to Gay street, to Levering street, to Main street, to the river just below Levering street, with branches up Main and Gay streets, down Cresson street, and down Main and up Grape streets—about 2,600 feet in all; through Lyceum avenue (from Pechin street) to Wood street, to Cotton street to the river, with branch up Mechanic to Cresson—about 3,500 feet; and through Main street, from Robeson to Shurs' lane—about 1,330 feet. Besides these a private sewer on the course of a natural brook enters the Baker street sewer just above Oak street, and a natural stream along the upper side of Shurs' lane is used as a sewer by several mills, making in all nearly two miles of sewers which discharge into the Schuylkill at Manayunk. These sewers receive not only the street washings and surface drainage from the greater portion of the most densely populated part of this district, but domestic waste water from more than 1,000 houses (occupied, probably, by over 5,000 persons), either by direct connection or through the street gutters and inlets (beside many others at such a distance from regular channels that most of the water is absorbed or evaporated), and water-closet drainage from about 65 houses, including the city police station, with 25 officers and an average of 7 or 8 lodgers, and many liquor saloons, representing a population of probably over 500 persons who have water-closet drainage into the river through the sewers of Manayunk.

In addition to the above number of houses (1,000) having

wash-water drainage into the river through the sewers, about 300 drain into a brook entering the canal at the foot of Leverington street, and 100 more into other brooks in the upper and lower portions of Manayunk, and into the river and canal directly.

More than thirty mills or other manufacturing establishments in Manayunk drain into the river, more or less completely. About half of them are located on the river-bank, and the remainder quite near it or on small tributary streams. The most common, as well as the most dangerous pollution from these manufactories is the privy or water-closet waste, which, in more than half of the whole number (at the time of my last inspection, in August), discharged directly into the stream. The establishments having such arrangements last summer employ, when running at full capacity, over 2,300 persons. The largest, however, has not been in operation for about a year, and the next largest for six months, while the third largest was ordered by the Court to stop the practice (and is reported by the Board of Health to have done so), so that the number of mill-operatives having water-closet drainage into the river at the beginning of the year was reduced to something less than 800.

After excrementitious matter, the most common pollution is from dyeing yarn and cloth, and scouring wool and woolen goods.

The following is a list of the several establishments having foul drainage into the river at Manayunk, with a brief account of each:

The uppermost is the American Wood Paper Company's mill, situated between the river and canal, about six miles above Fairmount dam. Wood pulp only is made, the following quantities of raw materials being used per day:* 34 cords of wood (mostly poplar), 21,000 lbs. of lime, 12,000 lbs. of soda ash, 4,300 lbs. of chloride of lime, and 70,000 gals. of water. The liquid waste—weak solutions of lime, chlorine

* Average for every day (including Sundays), when running at full capacity.

and soda, with the juice of the wood—is discharged directly into the river, and the solid refuse, chiefly waste lime, is dumped on the river bank above the mill, whence much is washed away by high water. The privies are over vaults (said to be tight), 75 ft. from the canal.

Just below the preceding are Nixon's Flat Rock Paper Mills, using 10,000 lbs. of domestic cotton rags, 16 cords of wood, 10,000 lbs. of lime, 1,700 lbs. of soda ash, 2,140 lbs. of chloride of lime and 2,000,000 gals. of water per day. All the liquid waste runs directly into the river with no purification. Formerly the solid waste also was dumped into the river, together with the ashes from 20,000 tons of coal per year, near the evaporating house, some distance below the mills, but since the first of last summer this solid refuse has been taken to waste land above the mills, between the river and canal, which is reached only by the highest water. The water-closets discharge into leaching brick vaults, about 100 ft. from the river. As there is a constant, though slow, passage of water through the ground from the canal to the river, probably some river pollution results.

Next below is a woolen mill belonging to James M. Preston. The principal pollution is from the dye-house, using 137 lbs. of extract of logwood, 34 lbs. of soda ash and 34 lbs. of blue vitriol per day. Privies for 250 operatives are over leaching vaults within 75 ft. of either the river or canal (some within 15 ft.) so that some pollution of this character is probable.

A. Bacher & Co.'s cotton mill is just below the preceding. In dyeing cotton yarn the following materials are used, the waste from which discharges into the river after running a short distance over the earth: ⅔ lb. of anilines, 3 lbs. of bluestone, 47 lbs. of catechu, 8 lbs. of chrome, 3 lbs. of copperas, 7 lbs. of indigo, 10 lbs. of extract of logwood, 1⅔ lbs. of madder, 10 lbs. of soda ash, and 3 lbs. of sumac per day, besides smaller amounts of other stuffs. Until last fall the privies used by about one hundred and forty operatives were on the river bank, down which the excrements drained and were

washed by rains, causing considerable dangerous pollution. The arrangement was then slightly improved by a vault (not tight) under the privies, and it was agreed to have the contents removed. The ash heaps back of the mill contained much vegetable waste matters, dye stuff sacks and casings, paper rags, etc., until washed away by the winter freshets.

The new mill of John and James Dobson, beside the canal, a short distance below the preceding, was claimed to cause no pollution last summer. During the winter of 1883–4 it did the dyeing for the "Rock Hill Mill" of the same firm in West Manayunk, using the following quantities of materials per day: 1 lb. of anilines, 2 lbs. oxalic acid, 3 lbs. ammonia, 21 lbs. alum, 7 lbs. black dye, 77 lbs. chloride of lime, 7 lbs. bluestone, 11 lbs. bi chromate of potash, 10 lbs. copperas, 2 lbs. crystals of tin, 8 lbs. camwood, 1 lb. extract of quercitron bark, 60 lbs. extract of logwood (solid), 8 lbs. extract of fustic, 4 lbs. extract of sumac, 22 lbs. extract of indigo, 18 lbs. Glauber's salts, 153 lbs. chipped logwood, 16 lbs. limewood, 22 lbs. madder, 2 lbs. oil of vitriol, 36 lbs. sal soda, and 82 lbs soda ash. The dyeing is now done on the other side of the river (outside the city), as will be noted again below.

Just below the preceding is a private corporation gas works (producing during the winter from 50,000 to 60,000 cubic ft. per day for the supply of the mills on the island) which is the source of some, but apparently not very great pollution. The gas is made from benzine by Prof. Low's process, and the superintendent claims that there is no waste. From an inspection of the outlet to the river it appears to be very small in amount.

Another mill belonging to James M. Preston, situated beside the canal just below the preceding, has privies for 100 operatives over leaching vaults six or eight feet from the raceway, which causes, without doubt, considerable pollution.

The "Pekin Mills," just below the preceding and the first on the island above the bridge at the foot of Leverington street, are claimed to cause no pollution, the operations consist-

ing simply of weaving, and the privy vaults being 50 ft. or more from the canal and cleaned two or three times a year.

Several mills are located on a natural stream entering the canal just below Leverington street, as follows:

Stafford & Co., Church and Wood streets, manufacturers of blankets and carpet yarns, had until last summer, privies for 40 operatives over the stream. They have since been removed to stone-lined vaults, at a distance from the stream, but some solid waste—wool dust, etc.—still drains into the brook above the mill.

Andrew Wilson's packing box factory had a privy over the same stream, a short distance below, at the time of my last general inspection, in August.

At Fitzpatrick & Holt's "Canton Mills" (cotton and woolen yarns), over the same brook, at High and Leverington streets, the dye-house waste from 267 lbs. extract logwood, 47 lbs. soda ash, 33 lbs. blue vitriol, 17 lbs. catechu, 3 lbs. chrome and ½ lb. aniline per day, discharges directly into the stream, and previous to last fall the privies for 300 employés were over chutes leading to the same, but since the Court ordered this nuisance abated the Board of Health Inspector reports that tight cesspools have been provided.

Beside the canal, but draining into the river, nearly opposite the mouth of the above stream, is Stelwagon's paper mill, another establishment which was charged in court last fall with polluting the water supply. Formerly all waste from this mill, solid as well as liquid, was discharged directly into the river or thrown down the bank, whence it was washed away. This filth was of the worst character, since the product is coarse wrapping and roofing paper, in making which the rags are not boiled, and much coarser, dirtier stock is used than in the other mills above. The raw material consists of three tons of cloth rags (colored), nearly two tons of shoddy waste and over one ton of paper rags. The solid waste dumped on the bank consisted of materials too coarse to be used, as hats, shoes, corsets, mats, &c., shoddy dust too fine to use and the heavy solids

which fall to the bottom of the machines in which the rags are reduced to pulp. The water closet drainage of 24 men was also allowed to run into the river.

Some time after the order of the Court to abate this nuisance the following changes were made: A dusting machine was introduced, through which all the cloth rags were said to be passed, thus removing much of the dirt which adhered to them only loosely, catch basins were placed in the bottom of the machines to intercept the heavy solid wastes, the waste shoddy-dust and other material unsuitable for use was said to be burned in a furnace provided with a blower, and privies were built over a tight vault. Nevertheless, but little change was noticeable in the character of the effluent stream, of which I collected a sample on January 24 and forwarded to Dr. A. R. Leeds, analyst.

Carlyle Greaves' dye house, a small custom place, just below the preceding, uses about 50 lbs. chipped logwood per day on the average, 10 lbs. Glauber's salts and unknown amounts of other dyes very irregularly, the waste from which goes directly to the river.

The "Crompton Mills," beside the canal, next below, are occupied by J. A. Campbell & Bro. (formerly by Morris & Ott), cotton and woolen yarn spinners, having 12 operatives, and using 43 lbs. extract logwood, 9 lbs. soda ash and 9 lbs. blue stone per day, also other dyes in small quantities and irregularly; Shaw, Ferguson & Bowen, using same materials, but one-third more, and having about 18 operatives; Ripley & Co., weavers, having 53 operatives, but no dye-house; and Watson, weaver, having five operatives. One or two of these firms have dye-houses on the river bank; but the waste water is partially settled and filtered before entering the river, by first flowing into a small basin, enclosed by a stone wall and having an overflow. The water-closet drainage of all the above operatives (88) is discharged into the river. A considerable quantity of shoddy dust, and waste material is dumped on the river bank, just below the dye-houses, probably from these mills.

George Grebe's Blanket Mill, opposite the preceding, on the river bank, scours 137 blankets per day, using 34 lbs. of soap and 9 lbs. soda ash. All waste, including water-closet discharges from 16 operatives, goes directly into the river.

The "Wabash Mill," of James M. Preston, at the lower end of the river road on the island between the river and canal, usually employs about 180 hands in the manufacture of flannels and blankets. When in full operation between 150 and 200 blankets are scoured per day with 43 lbs. of fulling soap and 7 lbs. of soda ash, all waste going directly to the river. Small quantities of mill waste were dumped on the bank, or into the river, back of the mill, and the operatives' privies were over the raceway, from the canal to the river, at the time of my last inspection (August 15, 1884.) Since then the Court ordered the cessation of this pollution, and at about the same time the mill was stopped and has ever since been idle. The Medical Inspector of the Board of Health reports that no change has been made in the drainage arrangements.

The mills of the Winpenny estate, a short distance below the preceding, have been idle for a long time.

A small quantity of refuse has been deposited on the bank from the "Eagle Mill" of Sevill Schofield, Son & Co., between the river and canal, just above the West Manayunk bridge; but there appears to be no regular pollution of note from this place.

The "Ripka Mills" (owned by the estate of R. Patterson), situated on the island between the river and canal, below the bridge to West Manayunk, have been idle since early last fall. It is not known when they will start up. When in full operation they employ about 500 persons, all of whom use water-closets discharging directly into the river. In the manufacture of ginghams and dress goods they dye 1,370 lbs. of cotton yarn per day, and use for coloring 1 lb. aniline dyes, 5 lbs. muriate of antimony, 52 lbs. catechu, 62 lbs. chloride of lime, 7 lbs. chrome, 1 lb. copperas, 1 lb. fustic, 13 lbs. indigo, 3 lbs. indigo auxiliary, 19 lbs. iron liquor, 19 lbs. extract of logwood,

6 lbs. madder, 40 lbs. oil of vitriol, 19 lbs. soda ash, 75 lbs. extract of sumac, 21 lbs. muriate of tin, and 1 lb. turmeric—the waste of all which goes directly into the river.

The river bank in the rear of these mills presents a neater appearance than at any other place at Manayunk. Only ashes are deposited there, and these are leveled, covered with earth, and sodded, year by year.

The City Fire Department Station on the north side of Main street, a short distance above the West Manayunk bridge, had water closet drainage to the canal for 12 men until last fall, when a tight well was substituted.

William McMaster's livery stables, on Main street, below Belmont avenue, have partial indirect drainage into the Main street gutter, and thence to the sewer; also a public urinal near the stable office.

Serwazi & Co., bottlers of weiss beer, porter, ginger ale, and mineral waters, at 131 Grape street, wash between 60 and 80 dozen bottles per day, and discharge all waste-water into the sewer.

At Taylor Spink's shoddy works, on Cresson street below Gay street, the operatives' water closets drain into the street sewer, as also small quantities of dye water. On January 10, 1884, about 20 workmen were employed.

Liebert & Obert's brewery, on Oak street, above Baker street, producing from 35,000 to 40,000 bbls. of beer per year, drains into a culvert back of the brewery. A privy for six workmen is placed directly over the culvert. Sixteen dwellings on the same street have privies over the same culvert.

The water closets at the Philadelphia and Reading (Norristown branch) Railroad Station at Manayunk drain into the river by sewer, and also the City Police Station House, between Cotton and Mechanic, Cresson and Main streets. The latter is occupied by 25 officers and men and had on February 6, 1885, an average of seven or eight lodgers. The same branch of the street sewer running to the Police Station House

receives water closet drainage from several private dwellings on Main street.

The next manufactory below the Ripka Mills, above mentioned, is the Schuylkill Paper Mill, owned by George McDougal, between the canal and river near the foot of Levering street. On January 12, 1884, the foreman stated that the following quantities of materials were used per day, on the average: 1,700 lbs. cotton rags, 3,430 lbs. wood pulp, 366 lbs. chloride of lime, and 43 lbs. soda ash. During the past summer the mill was not in operation and the upper part underwent reconstruction. Back of this part, on June 19, 1884, was a pile of old sackings and mattings, rotten rags, etc.,—foul in appearance—containing about 80 cubic yards, and about 250 yards of waste lime, within reach of high water. Back of the lower portion was about 80 yards of waste lime and a large pile (10,000 yds.) of ashes. At present the reconstructed portion is operated by W. J. Elliot, for the manufacture of manilla wrapping paper. Only jute is used and this is boiled with lime, so that the river pollution is much less serious than formerly. The following is a list of the average quantities of materials used per day: 6,000 lbs. jute, 20 bushels lime, 500 lbs. chloride of lime and 200 lbs. of alum. The privy drainage which formerly discharged into the river is now retained in dry wells.

Next below is the large cotton mill of the A. Campbell estate, which has been idle for a year past. When in operation it employs 700 operatives. The most serious pollution is from the water-closet wells or cesspools, which have an overflow directly to the river. The dye-house waste is more or less filtered by passing through the ash bank behind the mill. The principal pollution from this source is at times of freshet, when the water enters the cellars under the dye-houses and probably removes much of the accumulated deposit. The following list of the principal materials used per day was obtained from the Superintendent on January 10, 1884: 7 lbs. alum, 2 gallons oxy-muriate of antimony, 10 lbs. blue vitriol, 68 lbs. catechu,

66 lbs. chloride of lime, 9 lbs. chrome, 11 lbs. copperas, 6 lbs. fustic (extract), 41 lbs. indigo, 22 lbs. indigo auxiliary, 2 gallons black iron liquor, 52 lbs. lime, 7 lbs. chipped logwood, 55 lbs. extract logwood, 8 lbs. oil of vitriol, 12 lbs. soap, 6 lbs. soda ash, 81 lbs. sumac (bag), 34 lbs. sumac (extract), 15 lbs. tallow and 222 lbs. starch. Back of the mill is a long regular bank of ashes, reached by high water, but hardly in the river channel, and above the mill, near the canal, reached only by very high water if at all, is a deposit of some 70 or 80 cubic yards of chipped logwood.

Sevill Schofield, Son & Co. are the largest woolen manufacturers draining into the Schuylkill above Dobson's Mills at the Falls. At their "Economy Mills," between the river and canal, just above the lower end of the latter and on the river side of the canal, and at the "Blantyre Mills," between Main street and the canal below Cotton street, about 25,000 lbs. of wool were scoured daily; in August, 1884, with 50 lbs. of soap and an equal quantity of soda ash, and all the waste from this process goes directly into the river or canal.

In scouring cloth the following process of recovering the waste products and keeping them out of the river is employed: The scouring machines are emptied into wooden gutters, through which the waste is washed into wooden tanks in an adjoining room and below the level of the floor of the scouring room. In these tanks it is treated with oil of vitriol, causing the oils to separate from the pulp (woolen fibres), and then put in coarse filtering bags of matting for removing the water, which comes out quite clear and tasteless. The oily pulp is next placed under presses and the oil extracted, to be used over again in making soap. The mats (waste solids) are taken away to farms for manure. Thirty barrels of oil per week are thus saved and 6,000 lbs. of manure. The rinsings of the scouring machines are discharged into the river directly, and this, the proprietor claims, is the only pollution from the process. The solid waste from privies is removed to farms, but the urine is caught in barrels and used in wool scouring. In

the dye houses, which discharge directly into the river or canal, the following were average quantities of materials used per day, on January 10, 1884, besides smaller amounts of many others: 143 lbs. chipped logwood, 85 lbs. of extract of logwood, 43 lbs. extract of sumac, 40 lbs. hypernic, 8 lbs. fustic, 11 lbs. blue vitriol, 23 lbs. oil of vitriol, 12 lbs. catechu, 7 lbs. chrome, 13 lbs. copperas, 2 lbs. anilines, 86 lbs. soda ash and 7 lbs. scouring soap.

Back of the "Economy Mills" was, in June, 1884, an extensive (artificial) bank of ashes mixed with small quantities of various sorts of mill waste—principally chipped logwood and other solid waste from the dye houses, and teasels (burrs used in dressing woolen cloth) with wool clinging to them, also small quantities of wool-dust and rags. But these were washed away, apparently by the winter freshets, and the bank at this date is nearly free from organic refuse, except some old lumber, which is to be burned. A small quantity of tin scraps, old oil cloth, old hats, shavings, etc., was found in June beside the abutment of the tow-path bridge, just below the "Economy Mills," but probably dumped there by others than the mill owners. They were removed during the winter, probably by high water.

A small cemetery above Cresson and Penn streets is favorably situated for drainage into the river through the street gutters, being on a side hill and having its lower sides cut down for street and railroad, and unprotected by sod.

Below the lower canal locks, on the river bank, is J. D. Heft & Son's Yarn Mills. A little scouring is done, but the principal pollution is the sewage from 60 operatives, and the dye-house waste from 177 lbs. of extract of logwood, 67 lbs. of soda ash, 50 lbs. catechu, 43 lbs. indigo, 26 lbs. anilines (principally scarlet), 17 lbs. blue stone, and between 100 and 200 lbs. per day of other dye stuffs. [Average quantity per day in January, 1884.]

The mill of David Wallace & Son, just below the preceding, when visited on January 12, 1884, was said to scour a little wool—33 lbs. a day—and do some dyeing, using 35 lbs. of

extract of logwood, 17 lbs. blue vitriol, and small amounts of other dye stuffs. The waste from both of these processes goes directly to the river.

The four following mills on Shur's lane drain into the river through the street gutter, or natural streams, which are covered in the lower portion :

Rice & Bean, manufacturers of woolen spun yarns, on the northwest side of Shur's lane, above the railroad, dye about 1,000 lbs. per day, using 96 lbs. of extract of logwood, 14 lbs. soda ash, 14 lbs. blue vitriol, 1 lb. chrome, and small quantities of anilines. All sewage, including excrements from 30 operatives, goes to the river (about 800 feet) by a culvert having a steep grade. (Last inspection in August, 1884.)

Morris & Ott have recently started a new mill just above the preceding, but it is not yet fully in operation. Privies for 19 operatives are over the same brook, above mentioned; but it is designed to dig a vault as soon as the spring opens and abolish the old arrangement.

J. Leach & Bro., manufacturers of cotton and woolen goods, on the northwest side of Shur's lane, about one-third mile from the river, dye 600 lbs. of cotton per day, using 70 lbs. of extract of logwood and a little chipped logwood, 18 lbs. vitriol, and 17 lbs. soda ash; also 7 lbs. catechu per day for three months in the year. About 100 operatives are employed, all of whom use privies over a well receiving roof water, and having an overflow to a small brook. The dye-house waste runs in the street gutter most of the way to the river. (Last inspection in August, 1884.)

T. Kinworthy & Bro., just above the preceding, scour 1,540 lbs. of wool per day, using 46 lbs. of soap and 13 lbs. of soda ash. The waste water from this process runs in the street gutter most of the way to the river. Privies for 80 operatives are over the same stream as the preceding.

Flanigan's ("Freeland") Mills, (spinning), above the preceding, give employment to about 40 operatives, who use privies over the same brook referred to above. Just above the mill

considerable quantities of waste material—short fibres and dust—partly rotten, have been deposited on the banks of the brook, into which more or less of the foul matter is washed by every rain. (Last inspection in August, 1884.)

The "Albion Dye Works" (G. J. Littlewood & Co.), on Main street below Shur's lane, is a large custom dye-house, coloring about 5,000 lbs. of cotton and some wool, and using 600 lbs. of liquid extract of logwood, 200 lbs. of catechu, and 2 lbs. of aniline dyes per day, liquid waste from which goes directly to the river. The dye-tub sediment—said to be about only one cubic yard per year—is dumped on the bank; also an unknown quantity of dye stuff casings, mats, and sacks. About 7 cubic yards of the latter, which had been dumped over the river wall, opposite the works, remained above high water on June 19. Probably much had been washed away by high water.

The Superintendent of the City Gas Works, just below the preceding, claimed, on June 20, 1884, that no waste entered the river from the works when in operation. (At that time the gas was pumped from the city.) Nevertheless, after the works were started again in the fall, a considerable quantity of tarry matter was found to be running into the river under the corner of Hey's mill, opposite, which undoubtedly came from the gas works. In the summer a large pile of waste lime remained on the river bank, opposite the works, more or less of which was washed in by heavy rains, which also wash out old deposits of coarse waste products of a tarry nature which have been buried in the bank.

Below the Gas Works, on the same (N. E.) side of Main street, is A. Platt & Bro's cotton and woolen yarn mill. Liquid waste from dye house (using 130 lbs. logwood, 60 lbs. catechu, and 3 lbs. aniline dyes per day) runs in the street gutter a short distance to the sewer inlet.

Opposite the above (on the river side of Main street) is Richard Hey's "Progress Mills"—woolen yarns. The waste from scouring 257 lbs. of wool per day, with 4 lbs. of soda

ash and 21 lbs. of soap, goes directly to the river. The dye house waste water (from 17 lbs. chipped logwood, 2 lbs. aniline dyes and a little catechu) is partially filtered by flowing through the cellar wall. The privies for 90 employés are on the river banks, and are reached by high water.

Just below Platt's mill is J. P. Holt's cotton yarn mill, having a sewer direct to the river, taking water-closet drainage (50 operatives) and liquid waste from a dye house, which was using, on January 12, 1884, an average of 17 lbs. chipped logwood, 17 lbs. soda ash, 17 lbs. blue vitriol, $3\frac{1}{2}$ lbs. aniline dyes and 7 lbs. catechu per day.

The following, in reference to heaps of refuse on the river bank near this point, is from my report of June 21, 1884:

"A short distance below Richard Hey's Yarn Factory is a large and rapidly increasing pile of ashes and other refuse, extending more than sixty feet into the river bed. This is open to the street, and is a common dumping ground for those manufacturers who have not a convenient place adjacent to their own premises, and for oyster dealers and the street cleaning contractor for that district. The largest pile contains, approximately, 7,000 cubic yards, principally coal ashes, but with large quantities of oyster shells, wool and cotton dust and waste, and many other kinds of refuse. Below this is a long and narrow pile, beside the street, containing about 350 cubic yards of oyster shells, wool and cotton waste, etc. All this refuse has been deposited within five years. Near the upper end of the large pile are two or three small wooden buildings where Coates, Mills & Co. manufacture cotton and woolen waste (for cleaning machinery and for packing boxes) from refuse cotton and wool from the mills. From this process results about one-half cubic yard per day of short cotton and wool fibres and dust, which is dumped down the ash bank toward the river. This establishment has been in operation only fifteen months. J. P. Holt (cotton mill, just above) dumps ashes here—about one-half cubic yard per day—about four cubic yards of sediment from dye-tubs during a year, and an

indefinite (small) quantity of mill waste of various sorts. One of the employés of John Anderson, Street Cleaning Contractor for the Twenty-first District, stated that about fifteen cart-loads, per day, of street sweepings were dumped here regularly. A part of the ashes from the Albion Dye Works (G. J. Littlewood & Co.), amounting in all to about two cubic yards per day, are dumped here, and about one cubic yard per year of dye-tub sediment; also, during the winter, one cubic yard of ashes per day from A. Platt & Bro's Mill, and small quantities of shoddy waste."

Shortly after the publication of the above, notices were posted at this point forbidding the deposit of refuse along the highway, and the street cleaning contractor stopped dumping here. But deposits of mill waste and other refuse continued to be made on the great dump below Coates, Mills & Co.'s works, and are apparently still made at this date.

"A heap of refuse dumped over the river wall opposite the Albion Dye Works, contains about 17 cubic yards of dye-stuff, sacks, and matting, together with small refuse,—sweepings, etc. Probably the greater portion of this will be washed away by the next high water.

"Just below Richard H. Patton's Machine Shop, at the foot of Shur's lane, is another common dumping ground for ashes and refuse from the neighboring mills, oyster shells, etc. The pile here contains about 650 cubic yards, mostly ashes, with a few yards of cotton and woolen mill waste, oyster shells, etc." (Report of June 21, 1884.)

On Main street (the river road), a short distance above Wissahickon, are the "Enterprise Mills" of Hutchinson & Ogden, manufacturers of woolen yarns. One thousand pounds of raw wool are scoured here per day, with about 45 lbs. of soap. All the waste from this process goes direct to the river by drain under the street. This is claimed to be the only pollution. The privies are over dry wells not connected with the river. On the river bank was (in June) a small pile of refuse—teasels, yarn, sheet iron, etc.

A small brook entering the river a little way above this mill drains a small slaughter-house (two or three cattle a week) situated near it, about eight hundred feet back from the river. The liquid waste runs through small piles of manure, one close to the stream.

At West Manayunk (Montgomery County), the principal pollution is from the four following mills:

Dobson's "Rock Hill Mill" is the highest, on Gully Run. The principal waste here is from cloth scouring or fulling, and this is treated with chemicals, precipitated and partly filtered, before being turned into the stream, in order not to render the water unfit for the use of the paper mill below. The manager claimed on January 7, 1884, that all the privies were over wells, the contents of which were removed to farms, but I saw one over the stream, in use on August 11.

A short distance below, or a quarter of a mile from the river, on the same stream, are the "West Manayunk Worsted and Woolen Mills," of Schofield, Mason & Co., having one hundred and ten operatives, all of whom were using privies over the stream on August 11. The waste from scouring 857 lbs. of wool per day, with $8\frac{1}{2}$ lbs. of soap and a little soda ash is carried by pipe to below the dam of the paper mill. Above the mill is a large heap of rotting wool or cotton waste on the bank of the stream, and below it ten houses drain in wash water, and six have privies over the stream.

The "Ashland Paper Mill" is near the mouth of the same stream, into which it drains all liquid waste from the usual treatment of 4 cords of poplar wood and 430 lbs. of old newspapers with 1,666 lbs. of soda ash, 733 lbs. of chloride of lime, and 3,000 lbs. of lime. There are eighty operatives, one-half of whom use privies over the stream. The waste lime is dumped on the bank at the mouth of the brook and much is washed away. The pile remaining in June contained about 1,600 yds. which was being increased at the rate of more than 2 yds. per day.

A short distance below is an old mill, now used by the

Messrs. Dobson as a dye house. The quantity of materials used is probably at least twice as great as the list given above as having been used in January, 1884, at the mill in Manayunk, since the latter mill has been started in the meantime. The appearance of the stream from this place as it flows down the river bank is very filthy—much resembling that at the Falls, though not so extensive. Opposite the above is a small cotton waste factory belonging to H. Dougherty, from which small quantities of shoddy dust and some coarser material are dumped on the bank close to the water.

A short distance above the paper mill was a hog-yard, containing in June about 25 swine, on the river bank; but this had been abandoned before the August inspection.

Two houses near the railroad just above West Manayunk Station have privies over a small brook to the river. A few other houses above here drain wash-water and cast considerable refuse down the river bank.

Along the bank below here there are only small piles of ashes from the houses on the river road, and a little other house refuse. The presence of the canal tow-path on this side prevents any considerable deposit directly on the river bank.

A considerable portion of West Laurel Hill Cemetery is favorably situated for drainage into the river, by reason of the stream that flows along its lower side. At the foot of this stream are the Pencoyd Iron Works, from which the pollution is very slight, but about twenty tenement houses back of the works, beside the stream, discharge all waste water and small garbage directly into it; the privies are also near it, and probably give considerable pollution by filtration.

On a stream entering above the cemetery, and draining the upper side, is a small mill having a dye house, but the pollution from it seems very slight.

Above the iron works, about one hundred houses on or near the river bank—most of them on the opposite side of the road running along the river—discharge more or less waste water and garbage into the river or on the bank. About half a dozen

have privies on the bank, but all are so high as to be reached, if at all, only by the highest freshets. There are about the same number of small stables, with manure heaps draining down the bank.

The following in regard to "Riverside Mansion"—a day resort and stopping-place for teams passing from the East Park to Wissahickon drive, having grounds bordering the river just above the mouth of Wissahickon creek, and containing the upper landing of the Fairmount and Wissahickon steamers—is from my report of September 4:

"This resort is extensively patronized on hot summer days, sometimes by more than six hundred people in one day. Not only does all wash and waste water from this place go directly to the river by pipe, but also the waste from the men's urinals and water-closets. This place is only about two and one-half miles above the Belmont Pumping Station, supplying West Philadelphia, and three and one-half miles above the Spring Garden Station, supplying the largest portion of the city proper. In view of these facts, and of the probable manner of life and habits of the people frequenting this resort, the home surroundings of many of whom are probably very insanitary, thus impelling them to such a place, especially in the first stages of illness, and the facility with which the germs of zymotic diseases are transmitted by drinking water, it seems to me one of the most dangerous sources of pollution within the limits of this investigation."

The proprietors of this place, Messrs. G. & C. Soulas, were afterward convicted of maintaining a nuisance, since which the Medical Inspector of the Board of Health reports that a well or cesspool for water-closet drainage has been made.

The investigation of the sources of pollution of Wissahickon creek was made chiefly between June 24 and July 3. The information was obtained by a personal inspection of the creek from very near its source to its mouth,—following the main stream, on the banks or by the nearest road, noting the appearance and taste of the water in most of the tributaries, how-

ever small, and going up such as showed evidences of pollution or on which it could be learned that there were any special sources of contamination.

Above Ambler Station (North Penn. R. R.), in the west end of Upper Dublin township—about ten miles from the source, and twelve from the Schuylkill—no special sources of pollution were discovered except two creameries, one at North Wales and one at Spring House. The former is quite small and at a distance from the creek, and probably most, if not all the organic matters in the small amount of waste liquid are oxidized by flowing through the meadows. That at Spring House (Gwynedd township) is beside a small stream flowing into the Wissahickon, one-and-a-half miles below. This does a large business (8,000 to 9,000 lbs. of milk per day), but the proportion of waste is unusually small since the cheese whey is run into a tight well and thence pumped out and removed by farmers. About the only waste entering the stream is the rinse and wash water, and this contains so small an amount of milk and cream as to give little or no offense in the brook a few rods below the point where it enters.

Farm lands border the creek and its tributaries throughout most of its length above the city, but near the sources the soil is not so highly cultivated, so that there appears to be little pollution from fertilizers in that portion.

Considerable grazing land appears in the upper portion of the water shed, and trees and bushes are allowed to grow along the stream more than in the lower portions. The earth consists largely of "red shale," causing a very muddy condition of the water after heavy rains. Even after long absence of rain the water is not clear, having a clouded, milky appearance when seen in a glass. The course is quite winding, and the bed broad, making a shallow and somewhat sluggish stream in summer. Brown *algæ* cover the rocks which appeared to a greater or less extent in the bed at most of the points examined. Still, the taste of the water continued quite pleasant

as far down as the eastern corner of Whitpain township, where a small branch draining the vicinity of Ambler Station enters.

This stream receives the drainage of a tannery, a hotel stable, and the hotel and railway station water closets. The tannery, owned by A. D. Faust & Sons, is located about three-quarters of a mile above Ambler Station, and a little over a mile from the creek. About one hundred hides per week for the most of the year are tanned here; also about two hundred dozen calf skins during the year. The hides are mostly from Philadelphia—from Western cattle slaughtered here. Animal matter from the hides are deposited on the bank all the way to the village (three-quarters of a mile), causing an unpleasant odor (noticeable only a few feet from the stream) in hot, dry weather. The bed of the stream is also blackened by the action of the bark liquor in combination with the lime used in the process of tanning.

Between the tannery and the railway station one private residence drains into a loose rock-lined cesspool on the bank of the stream, and two or three other houses drain wash water into it more or less directly—generally over the ground for several rods.

The hotel stable (Godfrey's) and privies are built over this brook, and drain into it directly. The proprietor claims that there is not usually more than one horse in the stable, and that the summer population of the house does not exceed fifteen. The North Penn. Station Ambler also has its privies over the stream.

The chemical works of Keasby & Mattison, situated near Ambler Station, are the sources of the most extensive pollution of the Wissahickon above the city. Their principal products are sulphate of quinia and carbonate of magnesia; also, a few iron salts, bromide of quinia, etc., and the waste principally sulphate of soda (average 350 lbs. a day), and a smaller quantity (10 to 25 lbs.) of carbonate of soda, carried away by water, of which about 150,000 gals. per day are used, on the average. Carbonate of lime (3,000 lbs. a day), another waste

product, is dumped in out-of-the-way places, frequently beside the streams; but as this is nearly or quite insoluble, it does not affect the water. The waste water containing the sulphate and carbonate of soda runs in an open ditch about eight hundred feet to a small meadow brook, from which it overflows considerable pasture land on the way to the Wissahickon, about two thousand feet farther, the vegetation in its course being largely destroyed by the carbonate of lime.

At the mouth of the brook, a rough gauging showed an approximate flow at the time of the inspection of 100 gals. per minute. At this point the Wissahickon is divided into several channels, into the smallest of which the brook from the chemical works empties and flows for half a mile, very sluggishly, in a muddy bed obstructed by weeds, before entering the main stream. Yet the peculiar taste is quite perceptible in the main stream some distance below, even at times of quite high water.

Below Ambler the farms are more highly cultivated; large herds of cows and horses are occasionally seen in pastures beside the streams, a few farm houses are situated quite near the creek, causing some pollution from the washing of yards by heavy rains, and one or two privies were seen on the bank; but no serious pollution was discovered above the city limits. Limestone is quite common through Whitemarsh township, and kilns are frequent near the creek.

The most offensive and apparently most serious pollution comes from within the city limits, and considerable even from the Park. Near the right bank of the stream just within the city limits is a Catholic seminary for young ladies, called "Mt. St. Joseph's Academy," which had the following drainage arrangement as late as October 31: All water-closets and baths for a population of about 130 drain into a tight cesspool having no ventilation except through an overflow to the creek—about 1,000 ft. distant. This cesspool was built two years before and had never been cleaned. The drain from the kitchen sinks entered the cesspool overflow pipe. The bedroom basins

discharge into a separate pipe running to within 50 ft. of the creek, beyond which point the water runs in an open ditch. Thus all liquid waste entered the Wissahickon.

Four hotels on the Park drive along the creek, viz.: Indian Rock Hotel, Valley Green Hotel, Maple Spring Hotel, and Nippin's Wissahickon Hall drain all wash and waste water directly into the creek, and two—the Valley Green and Maple Spring—have privy drainage. The particulars of the pollution from these houses are as follows:

"Indian Rock Hotel." Pipe drain to creek takes all liquid waste, including that from urinals; much refuse dumped on bank—old shoes, oyster shells, matting, broken bottles, brooms, paper, tin, etc.; chicken coops, dog kennels, and hog yards (five swine) on bank; also, large manure pile, unprotected; feathers from picking fowls scattered over bank.

"Valley Green Hotel." Privies over a little brook, nearly dry most of the time, but excrements thoroughly washed into the creek by heavy rains; hog pen and chicken house near the above brook; all sink and waste water directly to the creek, washed in by overflow from watering trough; oyster shells and other garbage on bank of creek; unprotected manure pile and chicken coops near top of bank.

"Maple Spring Hotel." All wash and waste water direct to creek by small brook running under privies and washing in all excrementitious matter.

"Wissahickon Hall." All wash water direct to creek; much kitchen and restaurant garbage—lemon skins, oyster shells, etc.—on bank of brook, entering the creek above the house.

"High Bridge Mansion," on Ridge avenue near the mouth of the Wissahickon, was said to drain all liquid waste, including that from urinals, into the creek through a 15-inch pipe sewer; this discharges some distance above ordinary low water level and causes noisome odors in hot weather.

"The Wissahickon," a very large new hotel near the Chestnut Hill branch of the Pennsylvania Railroad and Springfield

avenue, has a complete drainage system connected with the creek. The sewage is first received by settling-basins, from which the liquid portion runs through about 2,000 feet of tile pipe to a small tributary of the Wissahickon creek. Although this house has been open only a short time, the discharge at the mouth of the sewer was quite offensive; the sewage probably contains much organic matter. [Since the above was written, work has been commenced on a sub-surface distribution system which will probably mitigate the evil.]

After the above, the worst pollution within the city limits is on Cresheim creek (tributary of the Wissahickon). Near its source it receives considerable pollution from several houses on Germantown avenue, just above the crossing of that street, chiefly the washing of filthy back yards. One privy with loose stone vault is directly on the bank of the stream, and two others have open ditches (about 60 feet long) running to the brook to drain off the excess of liquid matter. Clark's Mermaid Hotel, Germantown and Mermaid avenues, discharges wash and waste water into this brook.

On Cresheim Creek, below Germantown avenue, is a shoddy mill, owned by David Hey. The process is a dry one, tearing up carpet rags and spinning carpet yarn; but large quantities, 200 to 300 lbs. a day, of light dust and short wool and cotton fibres, very dirty, are dumped back of the mill beside the creek, on a pile now amounting to about 40 cubic yards. The grounds about this mill are very filthy, and several houses contribute much pollution to the stream, three having privies with shallow loose stone vaults close to a small tributary of the creek, and throwing kitchen waste near the banks. A privy for the mill operatives is also situated on the bank of the creek, the vault being of loose stone and probably reached by high water; many geese and ducks swim in the pools near the mill. The same man is about building another mill (to tear up carpet rags) below the preceding, under the Chestnut Hill branch of the Pennsylvania Railroad. Two houses near old mill ruins below Thirty-fifth street, on Cresheim Creek, have

privies directly over the water in the pool, and three or four others on the banks, very near the water.

On a small creek entering the Wissahickon, at Gorgas lane, are 2 small dye-houses, that of Carmany & Boone, situated just outside the park boundary, being the largest. About 1,800 lbs. of cotton per day is dyed here (mostly brown and black) by logwood and catechu; about 85 lbs. of the former and 100 lbs. of the latter are used per day. They also dye some blue and violet.

A. M. Haley & Bro., a short distance above on the same stream, dye about 1,000 lbs. of cotton per week. But little information was obtained from the latter, but they appeared to use a larger proportion of bright color than the firm below. Both places discharge their waste water directly into the stream; this colors the stones and bottom of the bed, producing the appearance of colored water even when it is quite clear.

Some pollution comes from dwellings near Rittenhouse Creek and its smaller tributaries, the most serious being from 5 hog pens near the bank below Wissahickon avenue. A large quantity of green water that had apparently been stagnant a long time was being pumped from a quarry near the same place at the time of the inspection.

Along the bridle path on the lower Wissahickon much kitchen refuse is scattered by picnic parties, and most of it probably goes into the creek; also the washings from the drive and much other foul refuse not apparent in an inspection covering so short a time. Probably dead animals are sometimes thrown into the stream, but none were discovered. A considerable portion of Ridge avenue, on either side of the Wissahickon has gutter drainage into the creek, but the amount of house waste water discharged into the gutters is not sufficient to keep up a constant stream; however, much solid matter is deposited and washed in by the first heavy rain.

Below the mouth of the Wissahickon the park borders the river on both sides, all the way to Fairmount dam, and the

polluting matters entering this lower portion are for the most part brought in by small tributary streams.

Powers & Weightman's chemical works, near Ridge avenue, above the Falls bridge, have an independent sewer to the river which carries, along with considerable condensed steam, small quantities of chemicals. The principal products of the works are alum, oil of vitriol, green vitriol (copperas), and tartaric and citric acids. The Superintendent claimed that the only waste was from the rinsing of carboys, and an occasional breakage of a carboy. This information being unsatisfactory, I collected a series of six samples, on July 21 and 22, from the mouth of the sewer, and forwarded them to Dr. A. R. Leeds, of the Stevens Institute of Technology, for analysis. Three or four dwelling houses, on the lane leading to the upper works, drain waste water into the stream flowing to the river. The new quinine works above the preceding, near School lane and the Norristown Railroad, were found to have practically no drainage to the river.

At the foot of Mifflin street, Falls of Schuylkill, a small natural water course enters, bringing the wash water drainage from about 155 houses below the Norristown Railroad quite directly—generally over the sidewalk to stone gutters, or through wooden drains—and many others less directly, where water runs over the ground for some distance in no regular channel, as, for example, from ten houses on the east side of James street, just below the Norristown Railroad, from the rear of which the ground has a steep slope to one branch of the brook about 100 feet distant, the privies of these houses being situated on the extreme edge of the bank, down which is thrown much garbage and waste water. Such conditions permit river pollution only during and shortly after heavy rains. An ice pond just above the railroad on the same branch, serves as a swimming bath for many small boys in summer, and just above it are two stables and a hog-yard, near the stream and draining into it more or less completely.

One brewery (J. Stein's), having a yearly product of 2,500

barrels, drains into this brook, and another when in operation, but not now running. From just above the railroad, a short distance above these breweries, to Ridge avenue, this brook runs underground through a culvert or sewer. Stein's brewery had a privy over this culvert, also one dwelling; and ten dwellings near the railroad on Wiehle street drained water-closet waste into it as late as February 6, 1885. Above the railroad, about sixty houses drain wash-water into the same brook—mostly through wooden culverts and sandy street gutters. One house on the Park drive drains all wash-water into the same stream; and a stable, for three horses, is situated nearly over it.

Odd Fellows Hall, containing on the first floor the City Police Station of that district (occupied by six men all the time), and one or two shops, is located beside the same stream on the southwest side of Main street, and has a privy well in the back yard, separated from the culvert only by a loose stone wall. Into this well the police station water-closets drain, and from it into the river through the culvert. The other tenants of the building have the same arrangement, and on the occasion of fairs in the hall many people use the privies in the yard over the same cesspool.

The Park here consists of little more than a roadway beside the river bank, and consequently is no protection against the drainage of liquid wastes into the river. Several small "hotels," (beer saloons) viz.: "Wm. Stehle's," "Leon, Jr.," "L. Tissot's Fountain Park," and "Seitz's Falls Hotel," also, a boat club house and seven dwelling houses, between the Park drive and Ridge avenue, above Dobson's run, drain all waste-water into the river, either directly by pipe sewer, or through the gutters to the storm-water culverts under the roadway.

The principal sources of contamination at the Falls are the extensive carpet, blanket, and cloth mills of John & James Dobson, situated a short distance back from the river, on a natural water course commonly called "Dobson's run," which furnishes water for the mills, and carries the waste matter to the river. The principal pollution is evidently from dyeing

and wool scouring; whether there is any other I cannot with certainty say, having been denied permission to inspect the mills. The proprietors claim to remove all water-closet waste to farms for manure, and to use a process for recovering the oil employed in scouring cloth. How carefully and fully this is done I am unable to state, but the appearance of the stream at its mouth beside the Park drive is certainly very repulsive, often attracting the attention of parties driving past, and indicates a striking if not serious case of pollution.

In order to measure the amount of this filth, and to determine its composition, I built a weir near the mouth of the run, on the Park property (by consent of the Superintendent), and collected samples of the water to be analyzed by Dr. A. R. Leeds, of Stevens' Institute.

While it is impossible to determine the actual pollution by this means except an infinite number of samples be taken, on account of the great variety and constant changes in the character of the waste, I believe that those samples fairly represent the average flow during the daytime, especially Nos. 1 and 2. No. 3 was taken just after the midday recess, and seemed to consist principally of dye-house water with little or no wool scouring waste.

When sample No. 1 was taken about 70,000 gallons per hour of this filth were flowing into the river, or 700,000 gallons in the ten hours per day during which the mills are in operation. This I have found to be about the average dry weather flow during working hours. During the first part of the night, while the storage reservoir above the mills is filling up, the flow falls to less than half that quantity. The stream below the mills does not then assume the same purity as above, as some might suppose, but continues very foul even till the mills start up again in the morning, on account of the long bed of semi-liquid filth through which it flows. Observations in the early morning, after the reservoir is full, and before the mills start, show that the corresponding natural flow of the stream is about 38,000 gallons per hour,

or 912,000 gallons per day. The natural character of the stream above the mill is shown by the analysis of the sample taken (at about the same time as No. 1, at the weir) from above the reservoir. Over 60,000 gallons per hour of the liquid represented by No. 2 was flowing into the river when that was taken, and about 27,000 gallons of No. 3.

Some idea of the great extent of the pollution from these mills may also be obtained from the following list of the quantities of material used per day, as obtained from the office of the proprietors in January, 1884. The quantity of dye-stuffs and chemicals given are, approximately, one three hundred and sixty-fifth of the amount actually used during one year.

45,000	pounds of	wool scoured.
500	"	tallow (used in soap for scouring.)
11	"	acetic acid.
19	"	muriatic acid.
31	"	oxalic acid.
3	"	tartaric acid.
88	"	alum.
64	"	aniline dyes.
27	"	butter of antimony.
235	"	aqua ammonia.
42	"	aqua fortis.
674	"	archil liquor.
24	"	barwood.
90	"	bi-chromate of potash.
33	"	black dye.
12	"	blue stone (blue vitriol).
3	"	borax.
245	"	brimstone.
9	"	camwood.
124	"	caustic soda.
17	"	cochineal.
7	"	copperas.
16	"	cream of tartar.
27	"	crystals of tin.
8	"	cud-bear.
24	"	cutch (catechu).
247	"	extract of bark (quercitron).
80	"	extract of fustic.
19	"	extract of indigo (acid).
165	"	extract of indigo (neutral).

22	pounds of	extract of logwood.
11	"	extract of logwood (liquid).
192	"	extract of sumac.
4	"	flavine.
7	"	fuller's earth.
47	"	chipped fustic.
2	"	gambier.
715	"	Glauber's salts.
60	"	gum substitute.
69	"	hypernic.
32	"	indigo.
3	gallons of	iron liquor.
1	pound of	litharge.
2,351	pounds of	chipped logwood.
26	"	madder.
3	"	muriate of copper.
3	"	muriate of iron.
3	"	muriate of tin (double).
16	"	muriate of tin (single).
3	"	nutgalls.
505	"	oil of vitriol.
82	"	Paris white.
36	"	pipe clay.
3	gallons of	red liquor.
2	pounds of	red sanders wood.
344	"	sal soda.
349	"	soda ash.
66	"	sumac.
4	"	turmeric.
10	"	yellow prussiate of potash.

The same stream also receives wash water and other liquid refuse from about twenty houses on the north side of Ridge avenue, under the back yards of which the run flows in a culvert, and water closet drainage from three of them (having 15 occupants); wash water, kitchen and other garbage from three houses beside the uncovered portion between the mills and the river, and privy drainage from one of them (having six occupants); the liquid waste from a slaughter house, between Ridge avenue and the Park drive (slaughtering four cattle and one calf per week), as well as the drainage of a manure pile at the same place, on which is thrown some of the offal; the

drainage of a hog pen, adjacent to the slaughter house, containing, at time of inspection, four swine; some wash water from about twenty houses east of Ridge avenue, near the railroad, draining into the run, opposite the mills, through shallow channels on the surface of the ground from which the liquid is largely absorbed or evaporated leaving the solid organic matters to be washed in by the first heavy rain; and more or less house waste water from an indefinite number of dwellings on Ridge avenue, flowing in at the intersection of the stream with that street, together with the street washings from about half a mile of Ridge avenue at the time of rains.

Above the mills, Dobson's run appears to be quite a pure stream, receiving no pollution of note, except the drainage of a large pile of rotting wool waste from the mills. It drains a considerable territory, mostly grass and wood lands, with few houses near its course.

Between the Falls and Girard avenue, there is no special source of pollution on the left hand side, except from the Park buildings—Woodford House, and Strawberry Mansion—which have cesspools with overflows to the river—about to be cut off however—and the extensive cemeteries occupying the steep slopes below the Falls. No special investigation was made to determine the extent of the pollution from the latter source.

Just below Girard avenue bridge and the Spring Garden Pumping Station is the mouth of a public sewer, built many years ago on or near the line of a natural water-course from above Thirty-first and Master streets. It formerly drained entirely the extensive breweries of that vicinity, but after the extension of the Pennsylvania avenue sewer to a point near Thirty-third street, all foul waste connections with the old sewer were ordered to be cut off; but repeated efforts to enforce this order had not been wholly successful, as was evident from the vile appearance of the outflow. By your instructions, I explored this sewer from the mouth to its source, on August 23, 1884, under the guidance of Mr. J. K. Little, of the Survey Department, Engineer in charge of the construction of sewers. At that time the lower portion consisted of a 6 ft.

and 5 ft. circular brick tunnel (except opposite the forebay of the pumping station, where a plank culvert had been temporarily placed), and owing to imperfect grade there was a deposit of gravel and silt, saturated with filth from the breweries, two feet in depth in some places, and averaging more than a foot in depth. A small stream, entering opposite the upper end of the old pumping station, was clear at that time, and the Engineer of Sewers stated that it was from springs, and received no brewery waste. Three foul discharges were found. The first was under or opposite the brewery of J. & P. Baltz. The flow at the time was small (six or eight gallons per minute), and not very foul, apparently the rinsing of kegs or vats. Much more filthy in appearance was a larger stream (perhaps fifteen gallons per minute) under or near the grounds of G. F. Rothacker & Sons, brewers. The third discharge was just above this, and probably from Rothacker's brewery also, consisting apparently of condensed steam mixed with a small quantity of brewery waste. The source of the small stream flowing through a stone and plank culvert into the upper end of the sewer was not determined, since, from lack of ventilation, the amount of oxygen was too small to support combustion in lamps, or to sustain life long enough for a thorough examination; but it is my belief that the most, if not all, comes from springs or by filtration from a natural water-course, which has been diverted just above this point into a branch of Pennsylvania avenue sewer.

A second examination of this sewer was made on February 26, when more brewery drainage was found coming in than before. There seemed to have been an attempt made to close three inlets in the crown of the sewer, by inserting thin wooden disks (like valves), fitted in with coarse cloth; but none were tight, as was shown by small quantities of water flowing in at each, and one disk (or valve) had been opened, evidently by a heavy fall of water on one side. The same inlet was discharging a large volume on my return (down the sewer), so great as to be heard several hundred feet away. Hastening to it as rapidly as possible, I measured the flow (by means of a

bucket brought in for the purpose), and found it to be about 60 gallons a minute. It soon decreased in volume, and this flow may not have been the maximum. The character of this discharge was very foul, sour to the taste and smelling strongly of spoiled beer. The smaller flow, observed on going up, was less offensive. All of these three large inlets in the crown of the sewer were under or opposite the J. & P. Baltz brewery.

The other discharges discovered in this second inspection (February 26) were as follows: About five gallons per minute of milky water, slightly sour, opposite Bergner & Engle's brewery; a small flow of nearly clear water from a very foul looking inlet opposite Arnholt & Schaffer's brewery, and two inlets evidently from George F. Rothacker & Sons' brewery—one flowing about one gallon per minute of very foul water and the other warm water (condensed steam), slightly sour.

Since the first inspection the lower portion of the sewer from the old pumping station to a point past the new intercepting (Manayunk) sewer had been rebuilt with three feet section having sufficient and regular grade, so that there was no longer the collection of filthy mud above referred to, though some remained in the old part a short distance above the new.

A gauging of the flow at the outlet of the sewer on February 28, 1885 gave a volume of about 200 gallons per minute or 288,000 gallons per day, of which considerable is underdrainage through the sides of the sewer, which are not water tight. This condition favors additional pollution, other than the direct admission of foul waste liquid. The walls of the sewer opposite the breweries were thickly covered with slime, showing the passage along the outside of the tunnel through the earth of much foulliquid. This is also the case under Bergner & Engel's stables which are thus indirectly drained into the sewer.

[Supplementary.—March 13, 1885. In accordance with your instructions I have made to-day a third inspection of the Girard avenue sewer to ascertain the result of the work of the Board of Health in cutting off the foul drainage into the river from this sewer. Just above the manhole at Thirty-second street and Pennsylvania avenue a bulkhead of brick and cement had

been built in the tunnel, stopping entirely the flow through the sewer at that point. But water was flowing in through the walls just below in quantity apparently nearly as great as before. The water, having been filtered in passing through the earth around the bulkhead, was much clearer than before, but still had a decided odor of brewery waste. All inlets to the sewer above this point having been closed according to the specifications of the Board of Health, I could make no inspection of the work above—other bulkheads and closed inlets.

March 16. In a fourth inspection of the Girard avenue sewer to-day I discovered that the branch sewer entering opposite the old pumping station, and said by the Engineer of Sewers to have no connection with any breweries, was discharging water having a decided odor and taste of brewery waste. I am informed by Inspector William May, of the Survey Department, that this has direct connection with breweries on Thirty-third street. In his inspections of last fall he had often found it discharging brewery waste. The discharge from these breweries is not constant, and the sewer is so smooth and well graded that little or no sediment is retained long after the foul flow stops, which accounts for the clear water without suspicion of foul drainage in my first inspection. A public sewer, connecting with Pennsylvania avenue sewer, is about to be built up Thirty-third street, with which, I understand, these breweries will have to connect.]

No further pollution from the left hand side was discovered, except some drainage from the boat-houses just above the Fairmount Pumping Station. The Fairmount Rowing Association (having 10 active members) had urinals draining into the river last summer, but all the others claimed to drain all water-closet waste into tight cess-pools.

From the right hand side, within the city limits (West Philadelphia), the following foul drainage is received:

In the ravine back of Horticultural Hall (Fairmoount Park) was (on August 8, 1884) a public urinal draining into the

brook beside which it stands, and on the top of the bank, some 200 feet distant from and 30 feet above the stream, a large heap of manure, decaying leaves, plants, etc.

At the Belmont steamer landing more or less waste water (from washing milk glasses and ice cream dishes) runs in over the ground from a small restaurant.

The repair shops of the Pullman Palace Car Company at Forty-first and Poplar streets had privies (as late as February 21, 1885) for 250 men over a brook entering the park east of Fortieth street, above Girard avenue. The same stream receives considerable foul waste as it flows past the block of houses on the south side of Girard avenue, between Fortieth and Forty-first streets.

The Zoological Garden, on the right bank, below Girard avenue bridge, has partial drainage into a small brook flowing from the garden to a swamp beside the river, viz.: from the yards containing the alligators, beavers, llamas, and deer; also the pelicans and other water fowl. The flow of this stream is quite small in dry weather, and appears to have no regular course through the swamp, which is separated from the river by the tow-path of the Navigation Company; hence but little pollution from this is indicated in dry weather.

The total population having water-closet drainage in the summer into the Schuylkill River, between Flat Rock and Fairmount dams, when all the mills are in full operation and the drainage arrangements the same as last summer, aggregates about 4,150, divided as follows: Manayunk mills, 2,300; dwellings, stations, offices, etc., at Manayunk, 500; Wissahickon and the Park hotels (including Riverside Mansion), 1,000; Falls of Schuylkill, 100; West Philadelphia, 250.

The number of persons using water-closets on boats (excursion steamers, and canal boats) is not included in the above and I have made no estimate of their number.

Very respectfully,

DANA C. BARBER,

Assistant Engineer.

Summary of Pollution of the River Schuylkill by Domestic Sewage.

FROM INVESTIGATIONS MADE IN THE YEAR 1884.

(*Population estimated for January 1, 1885.*)

ITEMS.	DISTRICTS.						
	FIRST. (Whole Valley above Reading.)	SECOND. (From Upper Boundary of Reading to mouth of Manatawny Creek.	THIRD. (From above Manatawny Creek to intake of Phœnixville Water Works.)	FOURTH. (From Phœnixville Water Works to Norristown Water Works.)	FIFTH. (From Norristown Water Works to Conshohocken Water Works.)	SIXTH. (From Conshohocken Water Works to Roxboro' Pumping Station.)	SEVENTH. (From Roxboro' Pumping Station to Fairmount Pumping Station.)
Drainage area	656.9 sq. mls.	398.0 sq. mls. 1,054.9* "	149.4 sq. mls. 1,204.3* "	517.6 sq. mls. 1,721.9* "	29.5 sq. mls. 1,751.4* "	38.5 sq. mls. 1,789.9* "	74.0 sq. mls. 1,863.9* "
Population	91,000	95,000 186,000*	28,000 214,000*	66,000 280,000*	22,000 302,000*	18,000 320,000*	52,000 372,000*
DOMESTIC SEWAGE.				†			
Daily water supply,* representing domestic waste water	2,600,000 gals.	4,500,000 gals. 7,100,000* "	200,000 gals. 7,300,000* "	500,000 gals. 7,800,000* "	1,000,000 gals. 8,800,000* "	80,000 gals. 8,880,000* "	
Population having water-closet drainage into the river	5,000	12,000 17,000*	750 17,750*	1,100 18,850*	2,800 21,650*	1,100 22,750*	4,150 26,900*
Population having wash-water drainage into the river	22,000	40,000 62,000*	5,000 67,000*	3,000 70,000*	4,500 74,500*	1,500 76,000*	9,000 85,000*

☞ Figures in RED INK indicate totals down to the lower end of the district represented by the column in which they occur.
(In this black and white version of the chart, red numbers are marked with * asterisks.)

* From public supply only.

† Perkiomen water-shed above Schwenksville not included in the remainder of this column.