ANNUAL REPORT

OF THE

STATE GEOLOGIST

OF

NEW-JERSEY,

FOR THE YEAR 1871.

TRENTON, N. J.:
PRINTED AT THE STATE GAZETTE OFFICE.
1872.

GEOLOGICAL SURVEY OF NEW-JERSEY.

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STATE GEOLOGIST:

GEO. H. COOK, New-Brunswick.

To His Excellency, THEODORE F. RANDOLPH, *Governor of the State of New-Jersey, and ex-officio President of the Board of Managers of the State Geological Survey.*

Sir :—I have the honor herewith to submit my annual report, on the Geological Survey of the State, for the year 1871.

With much respect,

Your obedient servant,

GEO. H. COOK,

State Geologist.

RUTGERS COLLEGE.
New-Brunswick, Dec. 26, 1871.

REPORT.

THE operations of the Survey have been prosecuted during the past year, both in the field, and in the laboratory and office. The results of the work will appear, in part, in the following pages; while another part consisting of partially finished work upon the iron mines, and on the soils of the State, is reserved until it can be completed, and published in a separate report.

PERSONS EMPLOYED.

The following persons have been engaged in the work during some portion of the year.

PROF. JOHN C. SMOCK, *Assistant Geologist*, has been occupied with investigations on the rocks of the iron-ore region, in examining mines, the methods of finding and opening them, &c. He began work in June, and has been employed for about two-thirds of the time since.

EDWIN H. BOGARDUS, *Chemist*, has been at his duties in the laboratory all the year, except a few weeks, in which he was in the field collecting specimens of rocks, for examination. His work has consisted of the analysis of ores, rocks, soils, and fer-fertilizers.

PROF. EDWARD A. BOWSER, *Civil Engineer*, has been employed a portion of the year in surveying the Drowned Lands on the Wallkill in Sussex Co., and preparing his report, map and profiles of the work. He has also surveyed and mapped the lands liable to overflow on the Passaic, Whippany, and Rockaway Rivers, from Little Falls on the Passaic to Chatham

on the Passaic, to Whippany and Madison on the Whippany, and to Rockaway Neck on the Rockaway. He has also surveyed the Great Meadows in Warren County, which are liable to overflow with freshets in the Pequest. The two last mentioned surveys have been made in obedience to the "Act to provide for the Drainage of Lands, approved March 8th, 1871," which puts the direction of works of drainage under the charge of the Board of Managers of the Geological Survey, and requires them to make examinations and surveys, on the petition of owners of the wet and flowed lands. He has been employed about three months.

GEO. W. HOWELL, *Civil Engineer*, has surveyed and mapped the wet and flowed lands on the Passaic and Dead Rivers, from Chatham to Millington on the Passaic, and to Liberty Corner on Dead River. He has also made the maps and profiles for the drainage of the Great Meadows, on the Pequest. He was employed for about one month.

PROPOSED PLAN OF WORK FOR THE COMING YEAR.

The time for which provision has been made for the expenses of this survey ends next year. The special works upon drainage, on our natural fertilizers, on soils and agriculture, and on our iron ores and mining, which were proposed at the beginning, can be closed in that time. The surveys and reports upon drainage have probably been made as full as is required at the state expense, and the present report with those of 1869 and 1870 will have put upon record the facts regarding the most important of these works. The report upon iron ores and mining is well advanced—most of the mines have been re-examined, collections and studies of the rock structure of the region have been made, an account and explanation of the mode of searching for iron-ore veins has been prepared, and the work of completing the report is provided for. It is proposed to print and distribute this report separately.

The report upon soils and fertilizers is so far advanced that it can be published in the course of the year. Such a work

can never be complete, as long as agriculture is improving, and we have lands to bring into cultivation, and farming resources to develop.

The progress of the survey continually shows new fields in which the fostering care of the State can profitably be employed to aid individual effort in developing our mineral, manufacturing and agricultural wealth. A better map of our mining districts is much needed. One that would exhibit the topography of the country, show the inequalities of the surface, the mountains, hills, ridges, valleys, &c., would be of great service to the iron industry of the state. It would give direction and accuracy to studies on the geological structure of the region, to mining explorations, to manufacturing enterprises using water-power, and to agriculture. Such a map was made of some sixty or seventy square miles about Dover. It was first drawn on a scale of six inches to a mile, but was afterwards engraved on a scale of three inches. It is much liked by all who have had occasion to use it, and if a similar one could be made of the whole iron-ore region of the state it would be useful, and meet a want which is felt by many. The United States Coast Survey stations would furnish a basis upon which the triangulation could be extended so as to include any desired area in its net work, and give the required accuracy without resort to expensive measurements of a new base line, or to tedious astronomical observations to determine latitudes and longitudes. The construction of such a map involves both money and time. I would respectfully submit whether it is not expedient to inaugurate such a work the coming year, laying out the plan, ascertaining carefully the amount and kind of work to be done, and making proper estimates of its annual cost, the time required for its completion, and the expense of publication.

PUBLICATIONS OF THE SURVEY.

There is a moderate call for the "Geology of New-Jersey," and also for the maps. They have been supplied to all libraries within the state, as far as these have been ascertained. The

copies of the Annual Report have been much called for, and they have been distributed more extensively than ever before. The letters of inquiry regarding geological, mineral, agricultural, and other scientific and industrial matters, are very numerous, and occupy much time in answering. As far as possible, these have been attended to.

There have been two applications to the Board during the year for permission to use the geographic, topographic and other material collected by the Survey. The Board, considering that the interests of the state were best subserved by favoring enterprises which have for their object the publication of our resources, passed the following resolution. "That the State Geologist be authorized to allow the publishers of maps and geographical books to make such use of the material under his control, as will in his judgement tend to diffuse a knowledge of the resources of the state, provided that no exclusive privilege be granted to any publisher; and the maps and printed matter in such publications shall first be submitted to the State Geologist, and be approved by him before publication." Under this authority, Messrs. Beers, Comstock and Kline, of Newark, map publishers, have been allowed the use of material from the Survey, in preparing a new atlas of the state. And it is fair to presume that our citizens will get a better atlas for the price paid than they could have got without the use of this material.

DRAINAGE LAW.

At the last session of the Legislature, a law was passed entitled "An act to provide for the drainage of lands,"* in which "the Board of Managers of the Geological Survey, on the application of at least five owners of separate lots of land included in any tract of land in this state, which is subject to overflow from freshets, or which is usually in a low, marshy, boggy or wet condition, shall be and hereby are authorized and empowered to examine such tract, and if they shall deem it for the interest of the public, and of the land-owners to be affected

*Laws of New-Jersey, 1871; Chap. 132, p. 25.

thereby, they are further authorized, from time to time, to make surveys of any such tract or tracts of land, and to decide upon and adopt a system of drainage for draining the same, and to cause maps of the same, together with the plans of drainage by them adopted, to be made; and for this purpose they shall be authorized to call in the assistance of the State Geologist, and such other persons as they may deem expedient; and when they shall have completed their said surveys, maps and plans, they shall make a written or printed report of the same to the Supreme Court of this state; and thereupon it shall be the duty of the said Court, at the same or next stated term thereof, or as soon as can conveniently be done, upon reasonable notice given to that effect, and published in a newspaper circulating in the county where such tract of lowlands is situate, to appoint three commissioners (not interested in the lands to be drained) to superintend and carry out the drainage of any particular tract or tracts aforesaid, whose duty it shall be to carry out and execute the system of drainage which may thus have been adopted and reported by the said Board of Managers, in reference to said particular tract or tracts; provided, that if, at the time fixed for such appointment of commissioners, it shall appear to the Court by the written remonstrance of the owners of a majority of the said low and wet lands, duly authenticated by affidavit, that they are opposed to the drainage thereof at the common expense, then the said Court shall not appoint such commissioners as is directed in this section." Other sections prescribe the mode of proceeding to execute the work, to assess and collect money to pay the expense, to compensate for damages, and to perform all acts necessary to carry out the contemplated work of drainage.

Under this act the "owners of lands subject to overflow, bordering the Passaic River between Chatham and Little Falls," applied to the Board of Managers to examine said lands, determine upon a system of drainage for the same, and to take such legal steps as may be necessary to effect the object desired with the least delay. A meeting of the managers was held, a committee appointed to examine the lands, and if judged expedient to prepare maps and plans for the drainage, and report

to the Board. The committee made the examination, directed surveys, maps and plans of the proposed drainage to be prepared, and when these were done, submitted them to the Board with their report. Their report was accepted, and ordered to be presented to the Supreme Court for the appointment of commissioners. The report and maps were presented to the Supreme Court in June last, and notice of the application was published in the newspapers of Essex, Morris and Passaic counties for eight weeks preceding the November term of the Court. The commissioners have not yet been appointed.

A like application was made by the owners of wet and overflowed lands on the Passaic River, between Chatham and Millington, which was received by the Board of Managers, and acted upon in the same manner with the preceding. The maps plans and report were presented to the Supreme Court in June, and public notice of the application was given for two months preceding the November term of the Supreme Court, in the newspapers of Essex, Morris, Somerset and Union. The result of the application is not yet announced.

An application has been made to the Board by the owners of wet and boggy land in the Great Meadows, on the Pequest, in Warren County, for the examination, and if judged proper, for a plan of drainage of said meadows ; and that the necessary action be taken to carry out the plan under the Drainage Law. The map, plan and report upon the same are before the Board for their final action this day.*

The execution of these works of drainage would reclaim a large amount of rich and valuable land, would do much to drive away chills and fever, which are now quite too common, and would greatly help the attractiveness of important parts of the State. At the same time, the pecuniary benefits arising from the increased value of the lands, will be secured to the landowners. The plans presented by the Board, as well as the provisions of the law, are arranged so as to keep down the expenses as low as is consistent with the proper and thorough execu-

* The map and plan are filed in the Office of the Clerk of the Supreme Court, and the Board ordered the application to be made at the February Term.

tion of the work ; and the powers of the commissioners will enable them to carry out the work without burdensome taxation of the land-holders.

DROWNED LANDS OF THE WALLKILL.

The valley of the Wallkill, from Hamburg in Sussex County, almost to Goshen in Orange County, New York, is largely occupied by a tract of swamp and marshy grounds, known as the Drowned Lands. The obstruction which stops the flow of the stream and causes these lands to form, is in the State of New York, and the largest body of swamp and marsh is in that State ; but the portion in our state is a large one—not less than ten thousand acres* in Sussex County being subject to overflow whenever there is a freshet in the Wallkill, and the current in the stream is so sluggish that the water in a single freshet remains for many days upon these lands, effectually preventing cultivation, and rendering the natural and wild growth almost worthless. The importance of reclaiming these lands has induced me to have them surveyed, and proper levels taken so as to find out the nature of the obstructions to the flow of the stream, their location and extent.

Prof. Edward A. Bowser has made the examinations, and he finds the chief obstruction to be in a heavy deposit of drift-earth and boulders, and, perhaps some slate rock in the lower part, which fills the valley at Denton and Hampton, three miles and a half west of Goshen, in Orange County. The Wallkill found a passage over this bank, but had not the force to wear it away, and the water remained dammed up in a pond, filling the valley for twenty miles south, and in some places spreading out to a width of four miles. In passing over this bank the water had a fall of twenty-four feet in a distance of two miles. At an early period, dams were built at Hampton to utilize this fall, and two mills were erected. The property in these mills has operated as a hindrance to any efforts for lowering the bed of the stream, or carrying out any plan for

* The whole area of these lands is 25,600 acres of which 15,600 acres are in Orange County.

draining the Drowned Lands. About forty years ago a very vigorous effort was made to improve the drainage, and a ditch or *canal* was cut across from the stream at the lower end of the Drowned Lands, the location of which was about a half mile east of the old channel, and entered the original bed three miles below, shortening the distance about a half mile. The water all runs in the new channel now, and its surface at the lower end of the Drowned Lands is considerably lower than the bottom of the old bed of the stream. This has done much to improve these lands, but it is by no means all that is needed. They are still flooded after heavy rains, and the current of the stream is scarcely perceptible in thirty miles or more of its tortuous course. In the freshet on the first of September, 1871, the fall in the whole distance from Denton to Ogden's Bridge, which by the course of the stream is thirty-five miles, was only seven and a half feet.

It would be easy to deepen the canal seven or eight feet. A very moderate expense in cutting off bends in the stream would shorten its course several miles, and the removal of a few bars in the channel would give a uniform and lively current to the Wallkill through the whole length of the Drowned Lands.

New-Jersey is largely interested in having this improvement carried out. And I have no doubt that any active effort on the part of the owners of the flooded lands in Sussex, would meet a hearty response from those interested, in Orange County, and that together they could carry it to a thorough successful end.

The value of these lands where they have been successfully drained, can hardly be over estimated. In the vicinity of Chester, Orange County, a considerable tract is reclaimed and cultivated. Onions have been a specially successful crop ; a thousand dollars worth having, in many cases, been taken from a single acre of this black ground. Near Florida, in the same county, I saw a field of this kind, from which the owner assured me he had taken a hundred and fifty bushels of ears of corn per acre, for fifteen years in succession. Potatoes, also, yield enormous crops in this soil. For meadows and pasturage it is all admirably adapted. The carrying out of this work

GEOLOGICAL SURVEY OF NEW JERSEY.

MAP OF THE

DROWNED LANDS

ON THE WALLKILL AND ITS BRANCHES

THE POCHUNK AND WAWAYANDA CREEKS,

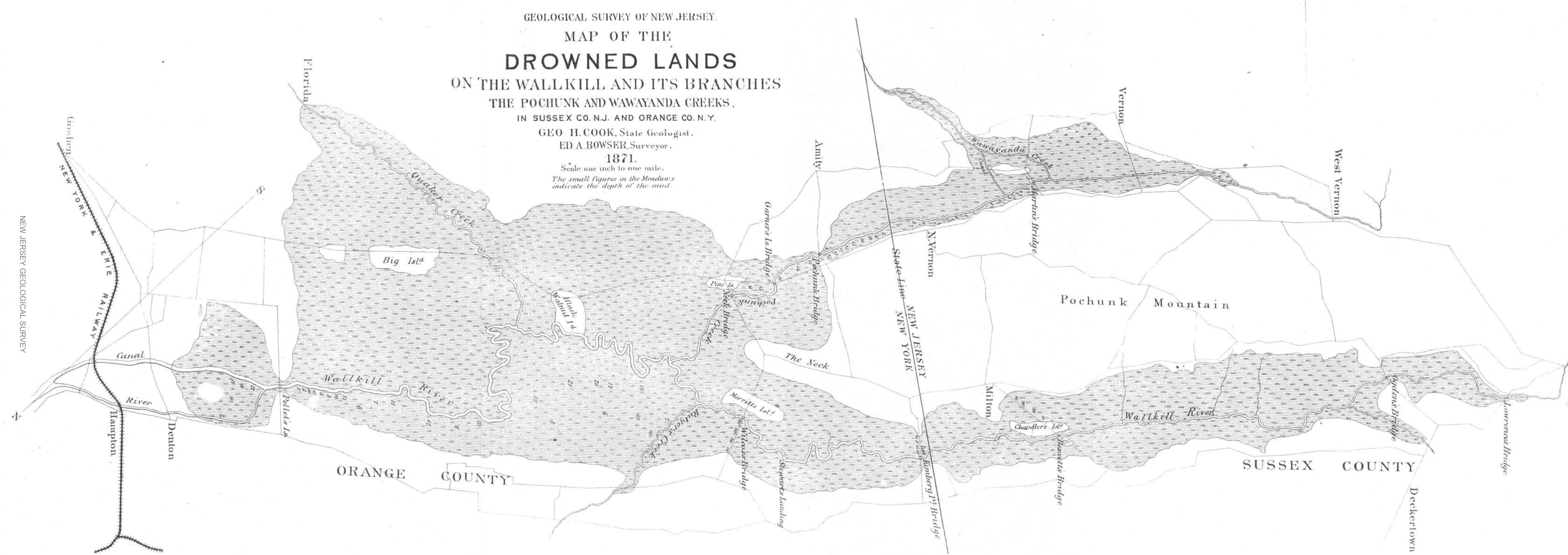
IN SUSSEX CO. N.J. AND ORANGE CO. N.Y.

GEO H. COOK, State Geologist.
ED. A. BOWSER, Surveyor.

1871.

Scale one inch to one mile.

The small figures in the Meadows indicate the depth of the mud.



would change an unsightly waste into a field of rural beauty and riches.

The report of Prof. BOWSER, with his map and profiles, is presented here.

Prof. Bowser's Report of the Levels and Soundings taken on the Wallkill River and its branches, the Pochunk and Wawayanda Creeks, in Sussex County, N. J., and Orange County, N. Y.

A bench, called "first bench," was made on a large maple tree, on the right bank of the Wallkill, and on the left bank of the "canal," at their junction, or "outlet" of the canal, about 800 yards below Hampton. The datum plane was assumed 10 feet under this bench. A line of levels was run from this bench up the Wallkill to Lawrence's Bridge, distant in a right line about 20 miles, and about 37 miles by following the channel; and also up the Pochunk Creek to the second bridge above the mouth of the Wawayanda Creek; and up the Wawayanda to the second bridge; and benches were located at all the bridges and at intermediate points. The heights along the surface of the river were determined by leveling from these benches. The heights along the bottom were determined by sounding in the channel, and subtracting the depths from the heights of the surface. The heights of the points, both along the surface and the bottom of the river, were measured from the datum plane 10 feet beneath the first bench.

By examining the profile, it will be seen that the bed of the river, from the first bench up to the lower end of the Drowned

Lands, has a rise of 24.6 feet, while the rise from the first bench to the upper end of the canal—inlet of the canal—is but 14 8-10 feet, making the bed of the river at the latter place 9 8-10 feet *lower* than it is at the lower end of the Drowned Lands in the old channel of the river.

The bed of the river at the lower dam is 10 7-10 feet, and at the upper dam, just below the railroad bridge, it is 14½ feet higher than it is at the first bench. Although the bed of the river from the second dam to the lower end of the Drowned Lands rises 10 1-10 feet, yet owing to the *fall* of 9 8-10 feet from the latter place to the inlet, the rise from the second dam to the inlet is only 8-10 of a foot, and from the first dam to the inlet it is only 4 1-10 feet. The top of the lower dam is 4-10 of a foot, and that of the second dam 6 7-10 feet higher than the bed of the river at the inlet.

The rise in the bed of the river, from the inlet to Pellett's Island bridge, is 3½ feet, while from the latter up to Willcox's bridge, distant 12½ miles by the river, the rise is only 1 2-10 feet. The bed of the river at Black Walnut Island is 3½ feet *higher* than it is at Willcox's bridge. The bed of the river at Kimberg Point bridge is 4 3-10 feet *lower* than at Willcox's bridge, and 7 8-10 feet *lower* than at Black Walnut Island, while just above the State Line, it is 3 7-10 feet higher than at Willcox's, or on a level with the bed at Black Walnut Island. The bed at Bessett's bridge, distant ten miles from Willcox's by the channel, is on a level with that at Willcox's bridge, or 3 7-10 feet *lower* than at Black Walnut Island, while from Bessett's to Ogden's bridge, distant nine miles following the channel, owing to the increased shallowness of the river, the rise is 11 7-10 feet, making a rise of 8 feet from Black Walnut Island to Ogden's bridge, or 16 1-5 feet from the inlet to Ogden's. The rise from Ogden's to Lawrence's bridge is 2 7-10 feet.

The profile of the Pochunk Creek shows that its bed at the mouth is 7 4-5 feet *lower* than the bed of the Wallkill at Black Walnut Island, and that its bed at the Neck bridge, Garner's Island bridge and the Pochunk bridge is 1 4-5 feet, 9-10 feet, and 3 1-5 feet, respectively, higher than the bed of the Wall-

GEOLOGICAL SURVEY OF NEW JERSEY.

PROFILES OF THE WALLKILL RIVER,

FROM LAWRENCE'S BRIDGE, IN SUSSEX CO. N.J. TO THE MOUTH OF THE CANAL, NEAR HAMPTON, IN ORANGE CO. N.Y.

with its branches

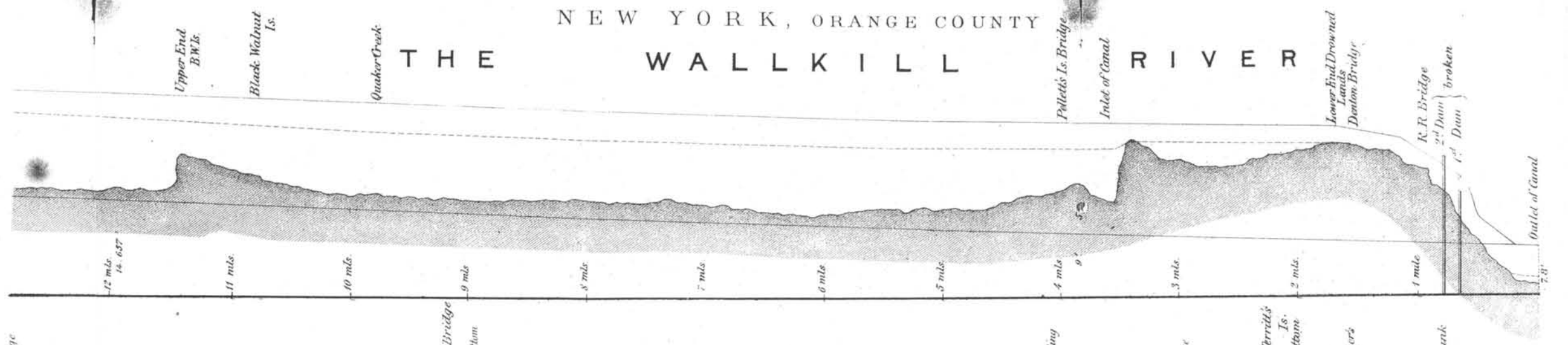
THE POCHUNK AND WAWAYANDA CREEKS.

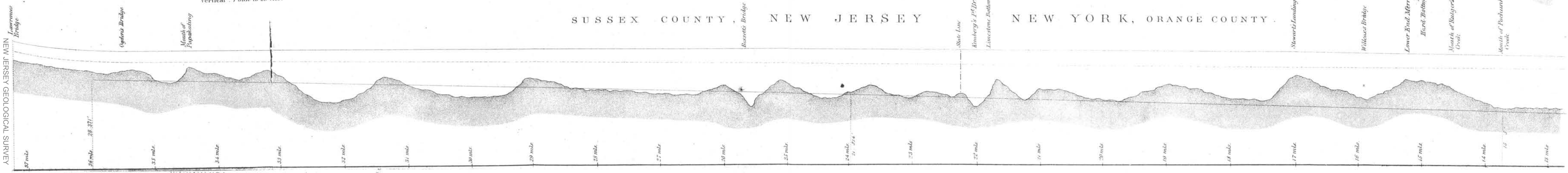
GEO. H. COOK, State Geologist.
ED. A. BOWSER, Surveyor.

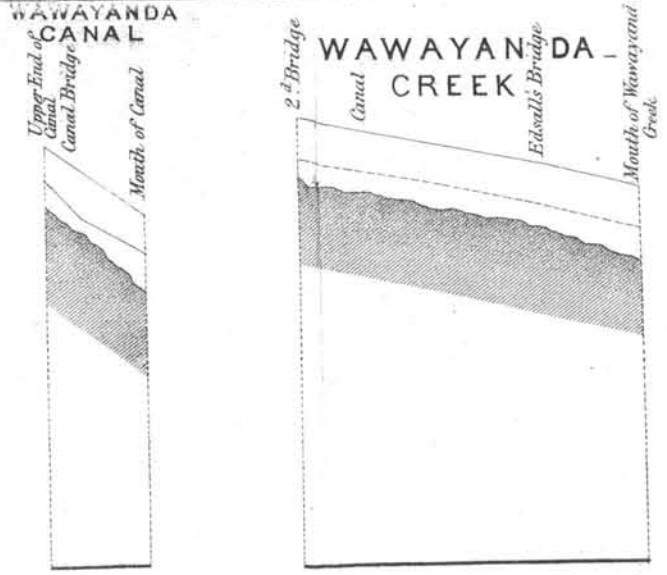
Scale:
Horizontal: 1 inch to 1 mile.
Vertical: 1 inch to 20 feet.

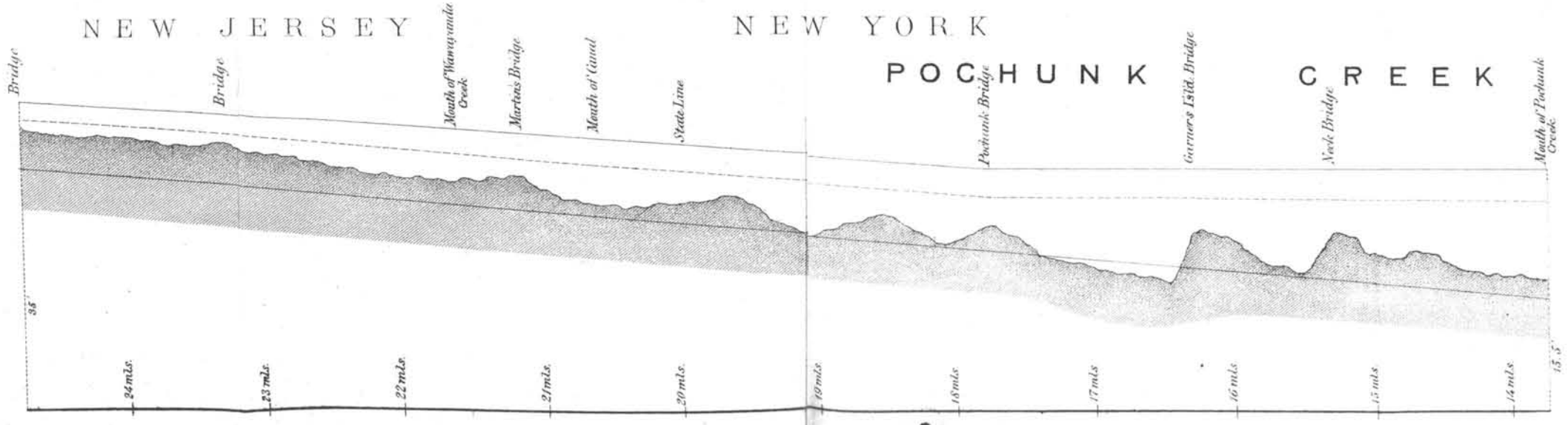
Explanation of lines on the profiles in the order of their succession.

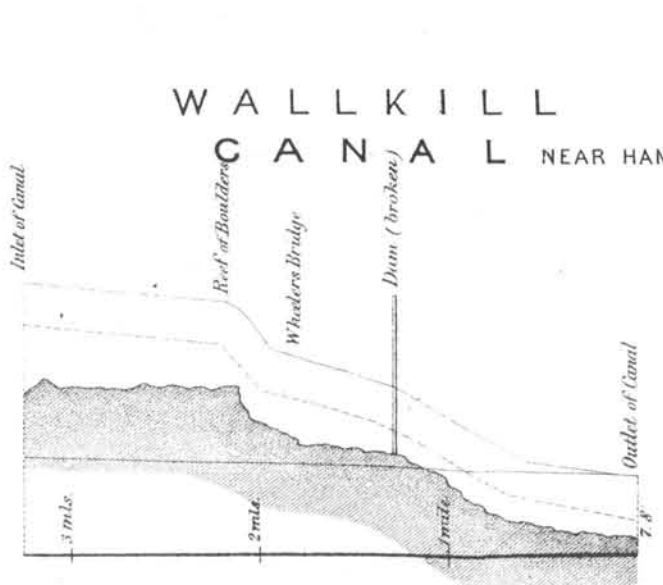
- High water Sept. 1st 1871.
- High water Aug. 16th 1871.
- Bed of the River.
- Grade line 6.7 inches per mile.
- Datum plane 10 feet under 1st Bench.











kill at Black Walnut Island. The rise in the bed, from the Pochunk bridge to Martin's bridge, is 6 7-10 feet, from Martin's to the first bridge above the mouth of the Wawayanda Creek it is 4 1-5 feet, and from the latter bridge to the second bridge above the mouth of the Wawayanda the rise is 2 9-10 feet.

The rise of the bed on the Wawayanda Creek, from the mouth to Edsall's bridge is 3 3-10 feet, and from Edsall's to the second bridge the rise is 5 7-10 feet.

The profile of the Canal shows that the rise of its bed is much more uniform than the rise of the bed in the old channel. The rise in the bed from thfirst bench to the railroad bridge is 2 1-5 feet; from the railroad bridge to Wheeler's bridge it is 8 3-10 feet; and from Wheeler's bridge to the inlet the rise is 4 3-10 feet, and very uniform, excepting a reef about 600 yards above Wheeler's bridge, which is 2 7-10 feet *higher* than the bed at the inlet. The top of the old dam, 800 yards below Wheeler's bridge, is 28 3-10 feet above the bed of the river at the first bench, or 3 7-10 feet higher than the bed of the old channel at the lower end of the Drowned Lands.

The rise of the water surface on August 16, 1871, from the inlet to Willcox's bridge, 12½ miles, was 6½ feet, and from Willcox's bridge to Ogden's bridge, 9 miles, it was 3 3-10 feet, making a rise of 9 4-5 feet from the inlet to Ogden's bridge, distant 21½ miles. Though it was a very dry time, the water from Black Walnut Island up to Ogden's was on a level with the top of the ground. On September 1st, when there had been considerable rain, the rise of the water surface from the inlet to Willcox's bridge was 7 1-5 feet. Much of this rise was owing to the obstruction at Black Walnut Island, where the water runs over a point of the upland. The surface rise from Willcox's to Ogden's was 1½ feet, and from Ogden's to Lawrence's it was 3 7-10 feet. The water during this week was from 2 to 5 feet deep on the "Drowned Lands." The rise of the water surface, on the Pochunk, during this time, from its mouth to the Pochunk bridge, was 1 foot; from the Pochunk bridge to Martin's bridge it was 3 7-10 feet; and from Martin's to the second bridge above the mouth of the Waway-

anda it was 5 1-10 feet, the water standing 3 and 4 feet deep on the meadow. The rise of the water surface, on the Wawayanda, during the same time, from its mouth to Edsall's bridge was 3 3-10 feet, and from Edsall's to the second bridge on the Wawayanda it was 5 7-10 feet. The country from the lower end of the Drowned Lands to Lawrence's bridge, and on the Pochunk to the second bridge above the mouth of the Wawayanda, was covered with water, in many places 5 feet deep. This water remained upon the land over two weeks.

A fall of 8 inches per mile would give the Wallkill a velocity of about 1½ feet per second. If the river from Ogden's bridge down to the first bench be shortened to 30 miles, which can very easily be done by cutting off some bends, 8 inches per mile would give a fall of 20 feet from Ogden's down to the first bench. Had this been the fall of the Wallkill in the first week of September, and the grade at Ogden's bridge 4 feet below its present bed, which is now entirely too shallow, the water could scarcely have remained above its banks for more than two days.

The grade line on the profile represents this new bed. It begins at Ogden's bridge, 4 feet below the present bed, and falls 6 9-10 inches per mile, following the present channel as it is represented in the profile; or, if the channel from Ogden's bridge to the first bench be reduced to 30 miles, the grade will be 8 inches per mile, giving in either case a fall of 20 feet from Ogden's bridge down to the first bench.

By examining the profile, it will be seen where the grade runs *below* the present bed, and where it runs *above* it. At Bessett's bridge it runs *above* the bed, while 400 yards below the bridge it runs *under* it 6 feet. At Kimberg's Point bridge the grade is again above the bed, while 500 yards below, it is 8 feet beneath it. At Stewart's landing the grade is 10 feet beneath the bed. At Willcox's bridge it is 3½ feet beneath the bed. At lower end of Willcox's Island it is 10½ feet beneath the bed. At the mouth of the Pochunk it is 2½ feet beneath the bed. At the upper end of Black Walnut Island it is 9½ feet beneath the bed. At the lower end, 7 feet beneath. It reaches Pellett's Island bridge 9 feet under the bed, and the inlet of the canal 6 feet under the bed. Following down

the old channel we see that the grade reaches the lower end of the Drowned Lands 16½ feet beneath the present bed, the railroad bridge 11½ feet, the second dam 7 feet, and the first dam 3½ feet beneath the present bed. It reaches the first bench 7 4-5 feet above the present bed. Following the canal, whose bed is much more uniform, the grade reaches the reef 9 feet, Wheeler's bridge 3 feet, and the dam below Wheeler's bridge 1 foot below the present bed of the canal. The cutting in the old channel, the profile shows, greatly exceeds the cutting in the canal.

The Pochunk Creek, being a smaller stream, requires a greater fall. At the second bridge above the mouth of the Wawayanda Creek, the Pochunk at present is entirely too shallow. Its bed here should be cut down 6 feet, leaving a fall of 19½ feet from this bridge to the mouth of the Pochunk, distant 11 miles, or 1 4-5 feet per mile. This grade, as the profile shows, reaches the first bridge above the mouth of the Wawayanda 5½ feet, Martin's bridge 4 feet, the Pochunk bridge 4½ feet, Garner's Island bridge 5 feet, and the Neck bridge 7 feet below the present bed of the channel. It reaches the mouth of the Pochunk 2½ feet beneath the present bed, or on a level with the grade on the Wallkill River.

The Map accompanying this report shows the extent of the Drowned Lands, the exceedingly crooked channel of the Wallkill and the Pochunk, and the nature of the surface material, whether black muck alone or mixed with mud (blue clay). The figures on the map denote the depth in feet of the surface material down to the hard bottom, which is sand or gravel. The material for drawing the map of that part of the Drowned Lands which lies in Orange County, was obtained from A. S. Murray, Esq., of Goshen, who very kindly lent me a map of these lands, that was made several years ago, when there was an attempt made to drain them. The material for making the map of that portion of the Drowned Lands that lies in Sussex County was obtained by traversing the shore line during high water. The depth of the surface material was ascertained by running an iron rod down to the solid bottom. Wherever it was muck alone, the ground was very soft, the rod running

down easily. Where there was considerable clay—which was generally near the banks of the Wallkill and the Pochunk, and especially near streams running into these channels—the ground was very firm, the rod running down with difficulty. The nature of the surface material in Sussex County, and also of that portion of the land in Orange County that produces only wild grass, is similar to that in Orange County that is under cultivation, and that produces as fine crops as are to be seen anywhere in the country. There is this difference, however: the surface material in Sussex County, above Bessett's bridge, is not so deep as it is lower down in Orange County. The number of acres of Drowned Lands in Orange County, (by Murray's Map), 15,579; the number of acres in Sussex, 10,000; total number of acres of the Drowned Lands in Orange County and in Sussex, on the Wallkill River, and the Pochunk and Wawayanda Creek, 25,579.

As the amount of cutting in the canal will be far less than in the old channel, it will be economy to carry the water down the canal, where it is running at present. If one of the mills below Hampton could be saved, it would be very desirable to carry the water down the old channel. But as the grade runs 3½ feet *beneath* the bed of the river at the lower dam, there will be no possibility of saving a mill. It seems, therefore, that there can be no object in carrying the water down the old channel, when it can be taken down the canal with *far less expense*.

AGRICULTURE AND POPULATION.

The United States census of 1870, though only partially published as yet, gives some information of much interest to Jerseymen. The population of the United States and of the State of New-Jersey is given in the following table, for every ten years, beginning with 1790. The table also shows the percentage of increase for each ten years:

	Population of United States.	Percentage of increase.	Population of N. Jersey.	Percentage of increase.
1790.....	3,929,827		184,193	
1800.....	5,305,937	35.02	211,949	15.10
1810.....	7,239,814	36.45	245,555	15.86
1820.....	9,638,191	33.13	277,426	13.04
1830.....	12,866,020	33.49	320,823	15.58
1840.....	17,069,453	32.67	373,306	16.36
1850.....	23,191,876	35.87	489,555	31.14
1860.....	31,443,321	35.58	672,035	37.27
1870.....	38,998,753	24.03	906,096	34.83

It will be seen that there has been a very uniform increase in the population of the United States up to the last ten years, when the destructive civil war interfered to check our rapid growth, and diminished the aggregate by probably three million persons.

Our own state has had a much more irregular growth. For fifty years after 1790, the percentage of increase was less than half that of the whole country, owing probably to the large emigration to the newer States. Since then, however, the growth has been much more rapid—for twenty years about equal to that of the whole country, and for the last ten years considerably greater. Our growth was checked by the war, the state census of 1865 showing a population of 773,700, and an increase of 15.14 per cent. in five years, while the percentage of increase for the last five years is 19.70, a more rapid growth than it has ever had before.

The increase of population is not uniform throughout all parts of the state, as appears in the following list of counties with the population of each for every ten years from 1790 to 1870, with the ratio of increase for the last ten years. The arrangement of counties is geographical, so as to bring those counties which have been set off since 1790 next those from which they were taken :

POPULATION OF NEW-JERSEY AT DIFFERENT PERIODS.

COUNTIES.	1790.	1800.	1810.	1820.	1830.	1840.	1850.	1860.	1870.	Pr cent. increase past 10 years.
Bergen	12,601	15,956	16,603	18,178	22,412	13,223	14,725	21,618	30,122	39.34
Passaic	-------	-------	-------	-------	-------	16,734	22,569	29,013	46,416	59.98
Hudson	-------	-------	-------	-------	-------	9,483	21,822	62,717	129,067	105.79
Essex	17,785	22,269	25,984	30,793	41,911	44,621	73,950	98,877	143,839	45.47
Union	-------	-------	-------	-------	-------	-------	-------	27,780	41,859	50.68
Morris	16,216	17,750	21,828	21,368	23,666	25,844	30,158	34,677	43,137	24.40
Sussex	19.500	22,534	25,549	32,752	20,346	21,770	22,989	23,846	23,168	—2.84
Warren	-------	-------	-------	-------	18,627	20,366	22,358	28,433	34,336	20.76
Hunterdon	20,153	21,261	24,556	28,604	31,060	24,787	28,990	33,654	36,963	9.83
Mercer	-------	-------	-------	-------	-------	21,502	27,992	37,419	46,386	23.96
Somerset	12,296	12,815	14,725	16,506	17,689	17,455	19,692	22,057	23,510	6.58
Middlesex	15,956	17,890	20,381	21,470	23,157	21,893	28,635	34,812	45,029	29.35
Monmouth	16,918	19,872	22,150	25,038	29,233	32,909	30,313	39,346	46,195	17.41
Ocean	-------	-------	-------	-------	-------	-------	10,032	11,176	13,628	21.94
Burlington	18,095	21,524	24,972	28,882	31,107	32,831	43,203	49,730	53,639	7.86
Camden	-------	-------	-------	-------	-------	-------	25,422	34,457	46,193	34.06
Gloucester	13,363	16,115	19,744	23,089	28,431	25,438	14,655	18,444	21,562	16.90
Atlantic	-------	-------	-------	-------	-------	8,726	8,961	11,786	14,093	19.58
Salem	10,437	11,371	12,761	14,022	14,155	16,024	19,467	22,458	23,940	6.60
Cumberland	8,248	9,529	12,670	12,668	14,093	14,374	17,189	22,605	34,665	53.35
Cape May	2,571	3,066	3,632	4,265	4,936	5,324	6,433	7,130	8,349	17.09
Total	184,193	211,949	245,555	277,426	320,823	373,306	489,555	672,035	906,096	34.83

The chief increase in population has been in the cities and towns near New York, and consists largely of manufacturers, artisans, and persons doing business in that city. There is, however, a large addition of persons in easy circumstances who have come here to get the climatic, social and educational advantages of New-Jersey. It is worthy of remark that the counties which are purely agricultural, and are well improved throughout, have increased very little in the last ten years. Sussex, our best dairy county, has lost more than two per cent. Salem and Somerset, models of thrifty and productive farming districts, have gained but little more than six per cent.; Burlington and Hunterdon, our largest and wealthiest farming counties, only about eight and ten per cent. respectively. And of several others the increase is in the towns and not in the country. In fact, wherever the land is cleared and in good cultivation, it needs, with the modern implements, fewer hands to till the soil than it did forty years ago In many sections this loss of population is very evident, at the same time that the farms are made to produce double, and in many cases four times as much as they formerly did.

There has been a considerable increase in the population of those counties which contain a large area of uncleared land. The wants of our first settlers required that they should clear and till land that would produce crops at once, and without manure; and such were the only lands cultivated in the early settlement of our State. All lands which did not possess this degree of available fertility were considered to be barren and valueless. A large area in New-Jersey especially in the southeast parts, came under this condemnation, and were held in disrepute till very recently. In the counties of Cape May, Cumberland, Salem, Gloucester, Camden, Atlantic, Burlington, Ocean, Monmouth and Middlesex there were in 1860, 734,561 acres of land of this class, and still covered with a forest of oak and yellow pine. It is one of the discoveries of modern farming that such lands can be profitably tilled. And there has been a considerable addition to our population in the new settlements in various parts of these counties; Cumberland and Atlantic in particular have increased largely in this way.

There is a continued advance in the Agriculture of the State. The area of improved land is growing larger, the land is better cultivated, more fertilizers are used, and larger and better paying crops are raised. This improvement is chiefly due to our location near New-York and Philadelphia, the best markets on our continent, and to our large manufacturing and mining population, which makes a ready home market for our products. But it is partly due to the real capabilities of the soil for raising crops ; which heretofore, and under an exhausting system of tillage, have been greatly underrated, but which, with an improved system of tillage, the judicious use of manures, and restorative crops, are proving their real worth. The statistics of farm lands and their value in our state will be more plainly exhibited by a comparison with those in the states of Connecticut, New-York, Pennsylvania and Delaware ; these states being nearest to us and to the great markets.

	Area in Acres.	Per centage of Land in Farms.
Connecticut	2,991,360	79
New-York	30,080,000	74
New-Jersey	4,848,832	62
Pennsylvania	29,440,000	61
Delaware	1,356,800	78

The prices of the farm lands per acre for the years 1850, 1860 and 1870, are given in the following table :

	1850.	1860.	1870
Connecticut	$30.50	$36.00	$52.54
New-York	29.00	38.00	57.36
New-Jersey	43.67	60.40	86.14
Pennsylvania	27.33	39.00	58.00
Delaware	19.75	31.00	44.39

From this, it appears that the value of our farm lands, by the acre, is much greater than in the neighboring states, and that it is still increasing as rapidly as ever.

In farm products, the comparison is equally favorable, as appears by the following table, which is also compiled from the census returns.

	Connecticut.	New-York.	New-Jersey.	Pennsylvania.	Delaware.
Bushels of Grain and Corn.....	3,206,773	77,751,088	15,985,688	97,992,934	4,473,625
" Potatoes.....	2,790,761	28,558,199	6,256,223	13,020,939	448,033
Value of Orchard Products.....	$535,954	8,347,417	1,295,282	4,208,094	1,226,893
" Market Garden Products....	$599,718	3,432,354	2,978,250	1,810,016	198,075
" Slaughtered Animals.....	$4,881,858	28,225,720	6,982,162	28,412,903	997,403
Est'ed value of all Farm Products..	$26,482,150	253,526,153	42,725,198	189,946,027	8,171,667
Value of all Live Stock.....	$17,545,038	175,882,712	21,443,463	115,647,075	4,257,223

The comparison between these different states can easily be made when it is considered that the land in farms in Connecticut is five-sixth as much as in New-Jersey ; in New-York, seven times as much ; in Pennsylvania. six times; and in Delaware, one-third as much.

A Comparison of the Agricultural Statistics of New-Jersey for Thirty Years.

FROM THE U. S. CENSUS REPORTS.

		1840.	1850.	1860.	1870.
Acres of Land — Improved	Acres	.....	1,767,991	1,944,441	1,976,474
Acres of Land — Woodland and other unimproved	"	.....	984,955	1,039,084	1,013,037
Present Cash Value — Of Farms	Dollars	.....	120,237,511	180,250,838	257,523,376
Present Cash Value — Of farming impl'nts & machin'y	"	.....	4,425,503	5,746,567	7,887,991
Orchard Products	"	464,006	667,268	429,402	1,295,282
Produce of Market Gardens	"	249,613	475,242	1,541,995	2,978,250
Value of Animals Slaughtered or sold for Slaughter	"	.....	2,638,555	4,120,276	6,982,162
Wool	Pounds	387,207	375,396	349,250	336,609
Butter	"	$1,328,052	9,478,210	10,714,447	8,266,023
Cheese	"	.....	365,726	182,172	38,229
Milk Sold	Gallons	.....	.....	.....	5,373,323
Value of all Live Stock	Dollars	.....	10,669,291	16,134,693	21,443,463
Horses	Number	.....	63,955	79,707	79,708
Mules and Asses	"	70,502	4,089	6,362	8,853
Milch Cows	"	.....	118,736	138,818	133,531
Working Oxen	"	220,202	12,070	10,067	3,830
Other Cattle	"	.....	80,455	89,909	60,327
Sheep	"	219,285	160,483	135,228	120,067
Swine	"	261,443	250,370	236,089	142,563
Wheat — Spring	Bushels	.....	.....	.....	2,099
Wheat — Winter	"	774,203	1,601,190	1,763 218	2,299,334
Rye	"	1,665,620	1,255,578	1,439,497	566,775
Indian Corn	"	4,361,975	8,759,704	9,723,336	8,745,384
Oats	"	3,083,524	3,378.063	4,539,132	4,009,830
Barley	"	12,501	6,492	24,915	8,283
Buckwheat	"	856,117	878,934	877,386	353,983
Seed — Clover	"	.....	28,280	39,205	26,306
Seed — Grass	"	.....	63,051	85,408	72,401
Hay	Tons	334,861	435,950	508,726	521,975
Peas and Beans	Bushels	.....	14,174	27,674	56,221
Irish Potatoes	"	2,072,069	3,207,236	4,171,690	4,705,439
Sweet Potatoes	"	.....	508,015	1,034,832	1,550,784
Hops	Pounds	4,531	2,133	3,722	19,033
Flax	"	.....	182.965	48,651	234.061
Flax Seed	Bushels	.....	16,525,	3,241	6,095
Sorghum Molasses	Gallons	.....	.....	396	17,424
Tobacco	Pounds	1,922	810	149,485	40,871

A comparison of the census statistics of New-Jersey of 1840, 1850, 1860, and 1870, shows the direction in which its agriculture has developed. The area of cleared lands has increased but little. The value of farm lands has doubled.

The increased sales of farm produce, have been in orchard and market garden products, and in the value of animals slaughtered or sold for slaughter, There is a large increase in the quantity of potatoes raised. No statistics of other root crops have yet been collected, though turnips, in particular, are raised in large quantities for feeding stock.

More wheat is raised, and less rye than there was thirty years ago. The amount of Indian corn raised is double what it was in 1840.

In live stock it is remarkable that there is no increase in number, though there is a very large increase in value. Nothing shows this better than the sheep, which only number about half what they did in 1840, while the amount of wool has fallen off but little. There is a diminution in the number of working oxen, and an increase in the number of mules.

The changes are such as are called for by the peculiarities and advantages of our location. This will be more clearly seen, when the great development of our railroad system, and the consequent increase in marketing facilities, are considered.

According to the United States census of 1850 there were at that time 206 miles of railroad in operation in New-Jersey. In 1860 the number of miles was 560. The returns for 1870 are not at hand, but at the end of 1871 there were 1,110 miles in running order, an increase at the rate of 100 per cent. in eleven years.

At the beginning of the Geological Survey in 1854, and before the new settlements and improvements in the southern part of the state began, the total length of the railroad lines was 408 miles. Of this 78 miles only were in that half of the state south and southeast of the Camden and Amboy Railroad. In 1864, the date of the revival of the Survey, the length of railroad had increased to 704 miles, and that of the southern portion of the state to 305 miles. At the close of 1871 this length had still further increased to 405 miles. The

ratio of railroad length to area is 1:6.82, *i. e.*, one mile of road to each 6.82 square miles of territory, so that if uniformly distributed no person in the state would be two miles from a railroad. And as it is, there are very few people in the state who cannot go to New-York or Philadelphia, transact business and return the same day.

In this condition of the agricultural resources of New-Jersey and its advantages for profitable development, there is a sufficient reason for the increased attention which is given to farming in all parts of the state.

The improvement so far has been mainly by enriching the land already cleared, and tilling and cultivating it more thoroughly. The marked success which has attended this is a warrant for bringing the still uncleared lands into cultivation. There are now almost a million acres of such lands in southern New-Jersey, which can be successfully brought into farms. Vineland, with its 10,000 inhabitants, Hammonton, Egg Harbor City, Bricksburg, Manchester and many smaller settlements, are on ground, that only ten or fifteen years ago were uncleared—and now they have become self-supporting—raising good crops of corn, wheat, clover, potatoes and other staple crops, and fruits in abundance, both for family and for market purposes.

Experience shows that this light land can be cheaply and easily cleared. It needs fertilizing for the first crop, but this is compensated by the cheaper tillage, warmer soil and fewer delays from either extremely wet or dry weather. The mildness and salubrity of the climate, too, are attractive to those who have experienced the rigors of a northern winter.

Immense deposits of peat are found in all parts, and the railroads give ready access to the marl beds. No better fertilizers than these can be found for supplementing the stores of the barn-yard, and there is no cheaper or more lasting fertilizer than the green-sand marl, which exists in inexhaustible quantities.

These uncleared lands constitute the largest body of undeveloped wealth in the state, and they offer a most inviting field for those who wish to get cheap farms and homes for

themselves, and at the same time to retain the advantages which come from proximity to the great business centres of the country. Wild land can be got at from $5 to $25 an acre, according to its nearness to roads, railroads and settlements. The wood upon it is in many cases worth all the land costs. This is cut off, in the early summer, if possible, the brush is left scattered all over the ground, except a strip 10 or 15 feet wide all around the field. From this strip the brush and leaves are raked off and several furrows are plowed in it, so as to stop fire from getting into the adjoining lands. When dry the brush is fired on the windward side, and in a few minutes the fire sweeps over the whole ground, burning leaves, brush and everything, except some of the larger sticks. This costs not more than a dollar an acre. The ground is then plowed and harrowed, at a cost of $6, and dressed with 40 or 50 bushels of slaked lime per acre, at a cost of $5. The ground may then be sown with rye, and in the following spring with clover seed. The crop of rye will amount to 10 or 12 bushels an acre, and the clover will grow for two years, giving a crop of perhaps a ton an acre, each year.

Some farmers after plowing and liming the ground prefer to plant to potatoes in the spring, dressing them with 400 pounds of super-phosphate of lime, or 5 tons of marl, to the acre. An average crop of potatoes raised in this way is 50 bushels an acre. A crop of wheat or rye follows the potatoes. It is dressed with barn-yard manure, compost, or any good fertilizer that can be got. The quantity of wheat or rye will not be more than 10 or 12 bushels an acre. The clover sown in the wheat is a light crop, but it grows, and is the beginning of the improvement of the land.

After the land has been in clover two years, it is plowed up and planted to corn, of which it will yield a crop of 40 bushels an acre, without other fertilizer than the sod. Most of the stumps will plow out by this time. The corn may then be followed by oats or potatoes, and that crop by wheat, using such fertilizers as the farm will afford, and buying marl, super-phosphates, other purchased fertilizers, or gathering muck, marsh-mud, fish, sea-weed, &c., for composts, as the location will permit.

By the third rotation in this way, wheat may be brought to an average of 20 bushels an acre, corn to 70 bushels, and hay to 3 tons, while the cost of tillage is but little more than half what it is on heavy soils.

Iron Ores and Mining.

MAGNETIC IRON ORE.

In the Final Report, made in 1868, the "*list of mines of magnetic iron ore*" included 115 separate mines and groups of mines. The list as corrected in the autumn of 1871, contains 161 mines and localities, at which mining operations have been undertaken in their examination or further development—an increase of 46 during the past three years. This additional number is mainly due to quite recent explorations in Warren and Sussex Counties. In Morris County there has been little discovery outside of the large mines already in operation. Within the limits of these there is, of course, much change and discovery as they are more and more extensively opened. But the number of localities at which ore is mined is less than it was a few years ago. The product is considerably greater, showing that the mines are more vigorously worked than at any previous period, and also that their capacity is not lessened as they get deeper. Several comparatively new openings have been given up, and some of the older mines appear to be worked out. The greater portion of the ore comes from about thirty mines and groups of mines. And these furnished nearly the same relative proportion of it three years ago. The remaining 131 localities consist of new openings, mines that are idle, and those that are yielding small amounts of ore. Many of them must be regarded as still in the nature of explor-

ations—*undeveloped*. Of the mines not working, many are narrow *veins* and strings of ore ; in some there is too much rock, rendering the extraction of the ore unprofitable ; others are too far from easy and cheap communication, lines of railroad or canal ; a few are held by owners not in need of an additional supply of ore ; and a very few are idle for reasons known only to the business management.

In Hunterdon County nearly all of the iron ore mined comes from the Bethlehem and High Bridge mines. Some work in prospecting has been done near Lebanon and at various points on the Musconetcong Mountain, but the product of these discoveries has been inconsiderable.

In Warren County there have been several new openings made on the mountain range running northeast from Washington to the Sussex County line. Ore has been discovered in workable quantities at several points on the subordinate ridges of Jenny Jump Mountain. The most extensively worked of these new mines is that of the Pequest Mining Company, about two miles northeast of Oxford Furnace.

On Schooley's mountain, in Morris County, there are a few quite recent discoveries of ore, but they are not yet sufficiently explored to determine their probable value. Near Chester, three mines have been opened since 1868. Northeast of these, the mining operations, with few exceptions, are confined to the older localities.

In Sussex and Passaic counties the construction of the Midland Railroad has given a fresh impetus to searches for ore, and brought to light some outcrops that are quite encouraging. The completion of this road will no doubt lead to other discoveries, and to the further development of ore beds now known. Hitherto these have been almost valueless, in consequence of the cost of carting the ore several miles over rough roads to railroad and canal lines.

During the past year there have been some interesting discoveries of iron ore in the north eastern part of Somerset County—from two to three miles west of Bernardsville, but the diggings are still too limited in extent to speak with much certainty concerning them.

The detailed description of these localities is reserved for the final report on the iron ores of the state, to be published during the current year.

The product of the iron mines of the State for the year ending December 31st, 1871, may be approximately set down at 450,000 tons. The data for this estimate are as follows: the ore tonnage of the Delaware, Lackawanna and Western Railroad, Central Railroad of New-Jersey, Morris Canal; the statements of the managers at Ringwood, Oxford Furnace, Franklin Furnace, and the estimate for amounts mined at new openings, and mines whence the ore has not been shipped. The aggregate of the amounts carried from stations in New Jersey on the above mentioned lines is 411,661 tons. This latter sum includes some hematite, but the amount is scarcely large enough to warrant a deduction from the above estimated product. In the annual report for 1867, the product of the iron mines was estimated at 275,000 tons. In 1864, the estimate was 226,000 tons, so that there has been an increase of 100 per cent in the product of our iron mines since that date. Dr. Kitchell said, in 1855, that the mines might yield 100,000 tons for that year, or not one quarter of their present working.

Of this total, (450,000 tons,) more than four-fifths, or about 370,000 tons, come from Morris County, leaving but 80,000 tons for Sussex, Warren, Passaic and Hunterdon counties.

HEMATITE.

The mining of this ore of iron in New Jersey is limited to a few localities, of which the Pochuck and Edsall mines northeast of Hamburg, the Beattyestown mine, and that near Carpentersville, on the Delaware, are the most important. These have not been steadily worked since they were opened, so that the total product of hematite in the state is very small in com-

parison with that of the magnetic ore. It is occasionally found in small masses on or near the surface, but so far no very large deposits have been discovered outside of the above-mentioned mines. Small quantities have been obtained in pits dug in our limestone valleys. A recent discovery of interest was brought to the notice of the Survey by E. P. Potter, of Pottersville, Somerset County. The specimens sent by him came from German Valley, near the Hunterdon County line. The percentage of metallic iron in these was determined to be as follows :

No. 1.	No. 2.	No. 3.	No. 4.
54.88.	56.89.	40.45.	56.12.

The geological character of this valley is very similar to that of the Musconetcong Valley, and to that of the brown hematite localities of Eastern Pennsylvania. The probabilities in favor of the occurrence of workable deposits of such ore in this valley are strong enough to justify a careful and thorough examination of its whole surface, and its superficial beds. As ore is most generally found near the borders of the limestone outcrop, either between the gneiss (or grey rock) of the bounding ridges and the limestone, or between the latter rock and the overlying slate, searches should be confined more particularly to such lines of outcrop. Explorations should, however, extend over the whole breadth of these valleys, as it is sometimes found resting upon the limestone strata, covered by quite thick beds of ferruginous loam, clay or other earthy matter.

The total product of these mines for 1871, has been estimated by good authorities at 15,000 tons. But this is below their capacity, even as at present opened and worked.

Another interesting specimen sent to the Survey laboratory came from the bottom of the Beattystown mine. It was at first supposed to be an altered limestone belonging to the underlying rock strata, but a more careful examination showed it to be a carbonate of iron, mixed with some silicious matter. On analysis, it was found to contain 82.23 per cent. of carbonate of iron. The extent of this *ore* has not been ascertained, as it was first uncovered the day of the visit to this mine.

The increasing demand for hematites and the erection of new

furnaces near some of these mines, will greatly enlarge their operations, and stimulate to discoveries in other localities.

ZINC ORE.

The zinc mines of the state have yielded about 22,000 tons of ore during the past year.

ARSENICAL ORE.

During the past season specimens of so-called silver ore have been extensively circulated at Hackettstown, and in the neighboring villages of Warren and Sussex counties, the localities whence they came being kept secret. A single lump of what was said to be the same as the "silver ore," was obtained from the ridges on the east side of the Jenny Jump Mountain, and was analyzed and found to be an ore of arsenic. The specimen yielded 15.60 per cent. of sulphur, and 29.80 per cent. of arsenic. Mineralogically, it is arsenopyrite or mispickel, with probably some lölingite, but the specimen was too small to determine the latter with certainty. In the report on the Mineralogy of New York, Dr. L. C. Beck mentions this arsenical ore as occurring in crystalline limestone near Edenville, Orange County. The geological character of the latter locality is very similar to that of these subordinate ridges of the Jenny Jump Mountain range. The analysis of the New-Jersey specimen indicated traces of cobalt and nickel, but no silver could be detected. It is probable that the traditions of silver ore on this mountain are based upon this arsenical pyrites. This ore associated with other combinations of arsenic, nickel, cobalt, iron and sulphur is worked in Saxony, and extensively at Reichenstein, in Silesia, as a source of metallic arsenic, arsenious acid, or white arsenic, the pigments realgar and orpiment, and for other arsenical compounds used in the arts. The extent of the occurrence, and the character of this ore, are matters to be more fully studied, before deciding upon its probable value.

CANFIELD'S PHOSPHATE OF LIME AND IRON-ORE BED.

This new and extraordinary bed of apatite and magnetite

was discovered the past season. It is at Ferro-Mont, on the Dickerson Mining Company's property, a few rods northeast of the store and by the side of the public road. The line of attraction passing through it can be traced for 1000 feet, running east of the company's farm house. The bed has been uncovered at two points, by E. Canfield, and the deepest shaft is about forty feet down—measured on the slope, of which thirty-five feet was in this mixed ore. Near this, there is a fault of thirty-five feet, towards the foot wall, *throwing* the bed to the west side of the road. The bed is eight feet wide, and has regular walls of gneiss rock, in which there is little, if any, apatite. The dip is about 65° towards the southeast. The mass of the bed is a hard and firm mixture of magnetic iron ore, and greyish white apatite. Some portions of the bed show a parallelism in the arrangement of its minerals, consisting of alternate layers, or lamellar masses, of magnetite and apatite. The proportion of this latter mineral by weight may average in the whole bed, thirty-five per cent. The two are nearly of equal bulk, the phosphate being to the iron ore, in weight, as three to five, their respective specific gravities. A portion of the phosphorus is probably in combination with the iron, as the lime is not sufficient in amount to saturate the phosphoric acid, and also as the acid solution of the separated magnetite holds some phosphoric acid but no lime. A little quartz, orthoclase, and occasionally small spangles of brown mica are seen in the ore mass. The following results were obtained in the chemical examinations of an average sample, and of a specimen rich in apatite.

	AVERAGE ORE.
Matters insoluble in hydrochloric acid	11.30
Proto-sesquioxide of iron or magnetite	54.01
Lime	17.21
Magnesia	1.65
Sulphuric acid	0.07
Phosphoric acid	14.91
Total (of matters estimated)	99.15

The specimen rich in apatite gave 53.85 per cent. of phosphate of lime. The average sample contained 31.90 per cent.

Some experiments on the solubility of this ore and its phosphate were made, the results of which were as follows :

Experiment No. 1—Five grammes of the ore, heated one-half hour in twenty c. c. of dilute sulphuric acid, containing 1.27 grammes of anhydrous acid, yielded 0.27 grammes of phosphoric acid in solution. About 38 per cent. of the phosphate of lime was dissolved in this experiment.

Experiment No. 2—Two grammes of ore digested in ten cubic centimeters of dilute sulphuric acid (of same strength as in Ex. No. 1) gave 0.127 grammes of phosphoric acid in solution.

Experiment No. 3—Two grammes of the ore, treated with the same quantity of acid as in No. 2, in a vacuum, yielded 0.161 grammes of phosphoric acid in the solution.

Experiment No. 4—In this, a specimen containing about 50 per cent. of apatite was used. The iron ore was removed by means of a magnet. Of this residue, one gramme was digested in 0 73 grammes of commercial sulphuric acid, containing 0.55 grammes of anhydrous acid, over a water bath. The resulting solution contained 0.216 grammes of phosphoric acid, equivalent to 0.47 grammes of phosphate of lime.

Experiment No. 5—One gramme of the same residue as was used in No. 4, was heated in 25 cubic centimeters of dilute sulphuric acid, containing 0.55 grammes of anhydrous acid, over a water bath, and the mass evaporated to dryness; 0.237 grammes of phosphoric acid, equivalent to 0.517 grammes of phosphate of lime, were found in the solution.

Experiment No. 6—One gramme of the same residue as in Nos. 4 and 5, was treated with 0.73 grammes of commercial sulphuric acid without heat. At the end of thirty-six hours the solution yielded 0.185 grammes of phosphoric acid, or 0.405 grammes of phosphate of lime.

The residue, after the removal of the iron ore by a magnet, and which was used in Exs. Nos. 3, 4, 5 and 6, contains an average percentage of 34.5 of phosphoric acid.

From these experiments, it will be seen that the best results were obtained by the removal of the magnetic iron ore, and the digestion of the remaining mass in acid, until it was evaporated

quite to dryness. The experiment without heat did well. The previous removal of the magnetite is necessary, as can be seen by comparing experiments Nos. 2 and 3 with 5 and 6. Its removal on a large scale would give a rich ore tolerably free from phosphorus, and at the same time avoid an unnecessary waste of the sulphuric acid in the subsequent digestion. The solution from this digestion would, on evaporation, yield a superphosphate containing more soluble phosphoric acid than the average of those in the market. The separation of the magnetite and apatite could be effected by water, in consequence of the greater specific gravity of the former, or by the use of magnetic machines. The purification of the iron sands of New Zealand, of those of Moisie, in Canada, and of other localities depends upon this difference of specific gravities, and is successfully done by washing. Magnetic machines have also been used in Canada, Northern New York, and at some European mines. For either mode of separation, a previous crushing of the ore would be necessary. The economical working on a large scale must be determined by the cost of buildings, apparatus, fuel, labor, &c. In the laboratory the profit is evident when it is understood that sulphuric acid costs from two to three cents per pound, while the soluble phosphoric acid is worth at least fourteen cents a pound. Taking the figures of experiment, No. 5, we get 73 lbs. of acid, at 2½ cents=$1.79. Soluble phosphoric acid, 23.7 lbs., at 14 cents per lb.=$3,32. And 3.32—1.79= $1.53 per cwt. of separated apatite, equal to $30.60 per ton. Whether or not this margin be broad enough to cover the expenses of the necessary manipulation is for practice to decide.

Phosphate of lime is so valued in England, that in Cambridgeshire beds of coprolites from nine to sixteen inches thick, are uncovered and profitably worked, when the overlying earth, clay &c., is fourteen feet thick. And this, too, where the first cost of the land is large. The *vein* mass or material from these beds is washed, and then made into superphosphate, in the same manner as bones and some native guanos. The washed coprolites contain on an average 56 to 60 per cent. of phosphate of lime, and sell at fifty shillings, or about $13.50 per ton. In Nassau, Germany, the mining of native

phosphate of lime as a source of superphosphate has attained large dimensions. In 1867, the product of the Lahn and Dill districts, in that province, amounted to 62,500 tons. The average price of this native phosphate was about $9 per ton—*i. e.*, for such as contained from 60 to 70 per cent. of phosphate of lime. In our own country the phosphatic deposits of South Carolina yield a large amount of raw material for the manufacture of superphosphates.

As an additional source for such material, this new and extraordinary mine appears to be worthy the attention of those interested in and conversant with the business of manufacturing superphosphates.

MICA MINES.

The first to be described is located about three miles north of Stewartsville, and on the west bank of Merrill Creek, Harmony Township, Warren County. The valley is narrow, and in places ledges of rock crop out so that much of the surface is too stony for cultivation. At several points the soil contains a considerable proportion of mica, indicating the existence of this mineral in the underlying rocks of the valley. In the disintegration of the rock, this has been left unchanged, as one of the constituents of the resulting rock covering.

The openings in the exploration of the company are a few feet above the stream, and just below a shoulder or rib of the sidehill. The most northerly of these is a drift running twenty feet into this shoulder. At the further end it is about fifteen feet deep, and its average width is 2½ feet. The heading of this drift is in gneiss, as are the side walls. The whole mass of the vein is mica, the cleavage planes lying in all directions. South of this drift there is a broader excavation in the hill side, it being about twenty-five feet long, and eighteen feet deep. Here the mica appears to be in veins one to two feet thick, traversing the gneiss of the hill. This latter rock is micaceous, with some beds of a granitoid character. Associated with the mica, occur quartz, feldspar and asbestus. Some portions appear to be mixtures of whitish pyroxene and mica. Between

these two openings, and south of the last described, there are several excavations of lesser depth, but all showing the same general character—veins of mica traversing the gneissic beds of the country. The mica may be considered as constituting the mass of granitic dikes, which lie in, and cut the bedded rocks of the district, differing from ordinary granitic and syenitic dikes of our azoic formation in the larger proportion of mica, amounting, as it occasionally does to an entire exclusion of the minerals usually accompanying it, and forming the mineral aggregate of such masses. The mica of this locality is a brown potash variety. known as muscovite. In thin plates it is transparent and almost colorless. The present company made these openings the past summer, under the superintendence of their agent, R. J. Rymer, of Stewartsville. The explorations already made show that the masses of mica are quite irregular in their extent, and from the known character of such dikes nothing can be predicated of them with certainty, beyond what is in sight.

Another, so-called, *mica mine* has been opened during the year past by Clarkson Bird, of Broadway, on Scott's Mountain, about one mile north of that village. The property was leased from J. Fritts. The *mine* is on the southeast slope of the ridge, near the road to Springville. It consists of two small excavations, about twenty feet apart, one being about fifteen feet (vertically) higher up on the hillside. The covering was about four feet thick of rotten gneiss and earth. The mica is free from impurities or admixture of other minerals, but the cleavage planes are much bent and not very large—not generally exceeding a few inches square. The upper portions of the micaceous mass are quite loose, so that the plates are easily split out. Deeper, the mass is more solid, and the plates appear larger. The surface of the vein or dike dips or descends westerly into the face of the hill. The rock on top of the vein is a crumbling gneiss, consisting of orthoclase, brown muscovite, and a small per centage of vitreous quartz. Some of the mica from the bottom will measure 8x10 inches. Thus far the work has been for exploration alone.

The mineral here is the same as at the mine of the last de-

scribed locality, muscovite, excepting that it is darker colored, being a deep brown, to amber color. The surface indications of the same ridge, further to the south, are favorable to the existence of the same mica dikes beneath.

ROAD MATERIALS AND ROADS.

Good roads are essential to any community that would thrive. The losses in time, wear of teams and carriages, and diminished amount of work done, are enough to take off a large share of the profits of ordinary business. Up to a very recent date bad roads have been the rule, and good ones the exception in New-Jersey. Heavy sand in the southern part, and mud and stones in the northern and middle portions of the state have too often been the road materials.

In our southern counties there is an abundance of gravel and gravelly loam, and nearly all of the ground is naturally well drained. In such case, it is easy to make good roads. It is only necessary to shape its surface to the proper form, to make ditches and drains to carry off all the water, so that none shall stand upon the road or on the sides near its level, and then to cover its surface from six inches to a foot in thickness with gravel, containing loam enough to make it pack, and the road is done. Most excellent roads are made in this way. And there are hundreds of miles of them in the different counties of Southern New Jersey, over which it is a delight to drive. There is no reason why all the roads should not be of this character. Their cost varies from $1,000 to $1,500 per mile, according to the greater or less distance that the gravel has to be carted. In a few instances, this turnpiking has been done by the townships, but much more has been the work of private corporations acting under charters from the state.

In the northern half of the state there is much more difficulty in making good common roads, gravel is not so abundant and the soil is not so well underdrained. Roads that remain in good order throughout the year are not common. Those about Madison, Morris County, possess this excellence, and they make it one of the most attractive and desirable places of residence in the whole state. Roads generally, wherever the

soil is not dry enough, must first be drained by tile or stone underdrains, and then made of the proper form and graveled. In Orange, Essex County, trap rock has come into use for making roads, with the most satisfactory results. The material is hard and tough, and the roads made of it are solid, smooth and durable, and for their excellence of moderate expense. They are so well liked that their use is extending rapidly. Several miles are already built. This has been done by property owners, by townships, and by street commissioners. High street, in Newark, and South Orange Avenue, are both in process of paving with it. It is known as the Telford pavement, and I copy a description of it from the specifications for that in High street, which were sent me by Francis H. Dawes, Esq., of Newark:

"The roadway to be excavated, graded and properly leveled to a depth of sixteen inches below the top of the gutter-stone; the form of the cross-section to be in every respect the same as that to be given to the surface of the pavement. The road bed is then to be rolled with the steam roller until approved by the Street Commissioner. On the road bed thus formed, a bottom course or layer of stones of an average depth of eight inches is to be set by hand in the form of a close firm pavement, the stones to be placed on their broadest edges, lengthwise across the street, and so as to break joints as much as possible; the breadth of the upper edges not to exceed eight inches. The interstices are then to be filled with stone chips, firmly wedged by hand with hammers, and projecting points broken off. The whole surface of this pavement to be subjected to a thorough setting or ramming with heavy sledge hammers. The intermediate layer of broken stone is then put on to the depth of six inches, the stones to be broken to a size not exceeding three inches diameter, and thoroughly rolled down with the steam roller, after which the surface layer of broken stone, of a size not exceeding two inches in diameter, is to be put on and evenly spread to such depth as may be required to bring the surface when thoroughly compacted with the steam roller, to the proper grade and cross section; making the total depth of broken stone eight inches, and the entire thickness of the pavement,

when completed, sixteen inches. Any irregularities appearing during the rolling are to be carefully filled with additional material, so as to produce an even surface. When the surface is thoroughly rolled, a binding, composed of the screening and detritus of the broken stones with sand, is to be spread thereon, sprinkled, and thoroughly and repeatedly rolled with the steam roller until the surface becomes firm, compact and smooth. Any binding material remaining on the surface is then to be swept off and removed. For the foundation, any stone not liable to be affected by the action of the frost may be used after having been approved by the Street Commissioner. The broken stone in the intermediate and surface layers to be exclusively of trap rocks !"

When the traffic is lighter over the road the broken stone may be thinner—down to twelve or even ten inches, and the breadth may be less—sixteen or twenty-four feet. The cost of these roads varies with the distance to which the broken stone has to be hauled. That in Main street, Orange, which is sixteen inches deep, cost $1.90 a square yard. Centre street, which is paved thirty feet wide and a foot deep, cost $2.50 a running foot. The road going up the mountain is twenty feet width of pavement, and from eight to twelve inches depth of stone, and was built for one dollar a square yard. The road from the stone-breakers, on the Northfield road, for a mile down, waa graded and paved for a dollar per running foot. The contract for paving High street, Newark, was let for $1.90 per square yard, which was probably too low. Other contracts for like work have been taken at $2.25 to $2.50 a square yard. The stone is broken in a Blake's rock crusher, and when driven by a ten or twelve horse engine, ninety tons or sixty cubic yards can be broken in a day. Daniel Brennan, jr., of Orange, has done a large part of the work there, and his arrangements for doing it are very complete. He quarries the stone near the top of the First Mountain, and the breakers are so located that the carts dump the stone close to them, and the broken stone are elevated, sorted and deposited in proper shoots by machinery, and wagons are driven directly under the shoots and the stone falls into them, thus needing no handling. The excel-

lence and economy of these roads is such that I am sure it will be a great public benefit to have them more thoroughly known. I do not think that better stone roads can be found anywhere in the world than these in Orange; and it will be worth while for any who are considering the subject to go and see them.

Trap rock is abundant in all the middle portion of the state. Bergen Hill, and its extension to the Palisades, is of this rock, so are the First, Second and Third Mountains west of Newark extending from Pluckemin and Somerville to Paterson and almost to the state line. Rocky Hill, Mt Rose, Sourland Mountain, Goat Hill, Pickle's Mountain, and many smaller outcrops in the red sandstone region are of this same rock. The gneiss and gray rocks of the Highlands furnish a good material for stone roads, but not equal to the trap. The stone is not so tough, and it wears into dust much faster. Limestone is a still softer rock, and, of course, is not so well adapted for this purpose.

Those who are curious in regard to the literature of this important subject, will find in the Reports of the United States, Commissioners, on the Paris Exposition, a capital one by Arthur Beckwith, C. E., "On Macadamized Streets and Roads." The Legislature of Massachusetts, for 1869, offered prizes for the best essays on roads and road-making, and a valuable document is published containing interesting and instructive essays, to which the prizes were awarded. The annual reports upon the New York Central Park also contain accounts of its excellent roads.

LIMESTONES AND LIME.

The limestones of the northern part of the state continue to furnish a large amount of lime for agricultural purposes. The yearly product of our kilns has not, however, greatly changed within the past three or four years, and the business has not moved from the localities mentioned in the "Geology of New Jersey," in 1868. In that report the superiority of the non-magnesian limes to the ordinary dolomitic or magnesian limes and the localities where such pure or non-magnesian limestones occur, were indicated, (see pages 388, 396—399,

400—404, and 410—413 of "The Geology of New Jersey, Newark, 1868."

During the past season, some crystalline limestones from the valley of the Wallkill, Sussex County have been analyzed, and three of the analyses are here presented :

	No. 1.	No. 2.	No. 3.
Lime	51.06	53.53	51.96
Magnesia	3.02	1.73	2.92
Oxide of Iron and Alumina	0.80	0.50	0.20
Carbonic Acid	43.44	43.97	44.03
Graphite and matters insoluble in acids	1.40	0.55	0.20
	99.72	100.28	99.31

No. 1 is a surface specimen, from near a new kiln on lands of J. B. Titman, northwest of Sparta. No. 2 is the ordinary white or crystalline limestone, which is burned at Franklin Furnace. No. 3 is from West Vernon, and was sent to the Survey laboratory by J. H. Brown, of Franklin. None of these specimens are dolomitic or true magnesian. The practical value of these as a source of lime is yet a matter of experiment, and the results to be obtained are looked forward to with interest and hope. And the opening of the Midland Railway which passes directly across these beds of limestone will make them available for a large district of country.

The officers of the Survey will take pleasure in analyzing specimens of ores, minerals, fertilizers, &c., which are found within the state, and promise to be of public interest. They may be sent to Prof. George H. Cook, State Geologist, New Brunswick, N. J.

APPENDIX.

Publications of the New Jersey Geological Survey.

Geology of New Jersey, 899 pages large octavo, illustrated by 108 photolithographic engravings and woodcuts, and six mine maps ; and accompanied by a portfolio containing the following maps, in sheets :

1. Azoic and Paleozoic Formations, including the iron-ore and limestone districts ; colored ; scale 2 miles to an inch :

2. Triassic Formation, including the Red Sandstone and Trap-rocks of Central New Jersey ; colored ; scale, 2 miles to an inch :

3. Cretaceous Formation, including the Greensand Marl Beds ; colored ; scale, 2 miles to an inch :

4. Tertiary and Recent Formations of Southern New Jersey; colored ; scale, 2 miles to an inch :

5. Map of a Group of Iron Mines in Morris County ; printed in two colors ; scale, 3 inches to 1 mile :

6. Map of the Ringwood Iron Mines ; printed in two colors; scale, 8 inches to 1 mile :

7. Map of the Oxford Furnace Iron-ore Veins; colored ; scale, 8 inches to 1 mile :

8. Map of the Zinc Mines, Sussex county ; colored ; scale, 8 inches to 1 mile :

Price of the book and portfolio of maps, $6.50.

Geology of New Jersey, as above, without portfolio of maps, but containing a folded and colored map of the State, on a scale of 5 miles to 1 inch. Price, $4.00.

Geological Map of New Jersey, on a scale of 2 miles to 1 inch ; colored and mounted on rollers. It gives the Geology of the State the same as Maps 1, 2, 3. 4. in the portfolio, and is essentially these combined in one map. Size $5\frac{1}{2}$ by $7\frac{1}{2}$ feet. Price $8.00 per copy.

The prices are fixed to merely cover the cost of paper, printing and binding; the expenses of the Survey and preparing book and engravings being paid by the State.

These publications can be had from Prof. George H. Cook, State Geologist, New-Brunswick, on remitting the price, or through the booksellers.

The books are also kept for sale at these prices by William T. Nicholson, of Trenton; Morgan & Shivler, of New-Brunswick; M. R. Dennis & Co., Newark, and D. Van Nostrand, of New York City.

The work is in the following public libraries, where it can be consulted:

In all the State Libraries; in some other of the large public libraries in different parts of the United States, and in all the public libraries in New Jersey, and in the adjacent cities of New York and Philadelphia. It is also in the offices of most of the County Clerks.

The Annual Reports for 1869, 1870 and 1871, can be had on application to the State Geologist.