REPORT

OF THE

STATE GEOLOGIST,

PROF. GEO. H. COOK,

FOR THE YEAR 1867.

TRENTON, N. J.:
PRINTED AT THE TRUE AMERICAN OFFICE.
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BOARD OF MANAGERS OF GEOLOGICAL SURVEY.

His Excellency MARCUS L. WARD, Governor, and *ex-officio* President of the Board.

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WILLIAM M. FORCE, Esq., Hon. JACOB R. WORTENDYKE,	*Fifth Congressional District.*

State Geologist—GEORGE H. COOK.
Assistant Geologist—JOHN C. SMOCK.

ANNUAL MEETING OF THE BOARD OF MANAGERS.

The annual meeting of the Board of Managers was held in the Executive Chamber, at Trenton, December 27, 1867.

The report of the State Geologist for the year 1867 was read and approved.

The Geologist reported that the funds appropriated by the Legislature for the survey were sufficient to complete the work according to the plan proposed, but that the collection of specimens and the publication of the final report could not be finished by the first of April, 1868, and would require a few months longer; whereupon Messrs. Wortendyke, Hay, Hewitt, Force and Cook were appointed a committee to ask from the Legislature the repeal of that section of the law relating to the Geological Survey which requires its completion in April, 1868.

A meeting of the Board was directed to be called when the final report should be completed, to distribute the reports and suites of specimens.

The Auditing Committee reported

The expenditures of the past year at	$5,098 55
The total expenses to the close of 1867,	17,488 03
Balance still unexpended of	2,511 97

To His Excellency, Marcus L. Ward, Governor of the State of New Jersey:

SIR—I have the honor herewith to submit my report of the operations of the State Geological Survey for the year 1867.

Yours, respectfully,

GEO. H. COOK, *State Geologist.*

REPORT.

The work of the Geological Survey has been continued throughout the year. My own time has been occupied in the business matters of the survey, in arranging and directing the various branches of the field work, in getting maps and sections drawn and engraved, and in giving such attention to the practical ends of the survey as the interests of the State seemed to me to require.

John C. Smock, the Assistant Geologist, has been in the field during the entire year, except when the weather compelled him to remain in the office. He has completed the survey of the southern portion of the State, has carefully gone over and traced on the maps the boundaries of the different limestones, slates, sandstones, &c., of the northern part of the State, and when winter drove him from the field, was engaged in making collections of characteristic specimens of the different rocks, ores, minerals, building stones, fertilizers, &c.

Edwin H. Bogardus, Chemist for the Survey, has been steadily employed during the year at his work in the laboratory. The results of his labors, as given in this and the final report, will show a useful addition to our knowledge of various iron ores, zinc ores, copper ores, limestones, peats, marls, sandstones, &c.

Francis C. Van Dyck, Chemist, has worked a part of the year analyzing well waters and minerals, and has contributed valuable material for the report.

Paul Cook has been in the field most of the summer and autumn, engaged in searching for iron ore with the miners' compass. The results are shown in the map of the iron mines and on the map of Northern New Jersey. At the close of the season he was in the field with Mr. Smock collecting specimens.

Mr. John Hance, of Port Oram, and others of much local experience in mining and searching for ore, were also engaged in the work with the miners' compass.

G. Morgan Hopkins, Civil Engineer, has been employed a part of the year. He has compiled the general maps of the survey, and has surveyed for and drawn those of the zinc mines, and of the Oxford Furnace iron mines.

Dr. C. C. Abbott has completed his list of the vertebrate animals

of the State. He has spent much time in making it full in regard to the rare, almost extra limital, or otherwise little known species, and it is as perfect as he can make it at present. This list will be of much interest to those engaged in the study of natural history.

Much time and money has been spent in preparing the colored maps, so as to exhibit to the eye at a glance, what pages of print, however carefully worded, can but imperfectly convey. This mode of presenting results is alike acceptable to the scholar and to the unlettered man. The maps which are prepared are—

First—A map of the Azoic and Paleozoic Formations, including the Iron-Ore and Limestone Districts of New Jersey. On this the boundaries of the Gneiss rocks are carefully drawn out, and the various iron mines found in them are marked. The white limestone is also traced out in its outline, colored, and the zinc mines found in it are located. The limestone valleys are also marked and colored, and the region of the slates is indicated, as well as the ridges of sandstone and conglomerate.

This rich agricultural and mineral region is a subject of study and of admiration, with its long narrow belts of limestone, its hills and valleys of slate, and its ranges of rich and productive iron mines. It includes that great portion of the great valley of the eastern United States which is in New Jersey. And famed as it is in the Lancaster Valley of Pennsylvania, the Cumberland Valley of Maryland, and the Shenandoah Valley of Virginia, this portion in our State is not behind them in picturesque or rural beauty; and, lying as it does within a few hours' ride of the great commercial centres, it presents, in addition to its substantial advantages, remarkable attractions to lovers of country life. The sections accompanying the maps show the structure of the rocks and their relation to each other.

The adjoining portions of New York are very much like our State in geological structure and mineral products, and it has been found profitable to continue the study of our rocks into that State. The map is extended so as to include the country beyond the State line to the New York and Erie railway.

Second—The map of the Triassic Formation, including the Red Sandstone and Trap Rocks of Central New Jersey. The country covered by this map is the most thickly settled portion of the State. It is remarkable for the long, narrow and abrupt ranges of hills of trap rocks which traverse it in various directions, and which have given character to all its improvements. This region does not contain any mineral wealth, but it is susceptible of the highest degree of agricultural and rural improvement, and has been cultivated by farmers for two hundred years past. It is charming for its many beauties of scenery and its thousands of residences; and all of it being within an easy morning's ride of New York or Philadelphia, it is destined to be the most highly improved portion of the United States.

Third—The map of the Cretaceous Formation, including the green-

sand marl beds. The portion of the State covered by this map contains the rich deposits of fire and potters' clays which have already made the region, the seat of the largest potteries, and manufactories of fire brick in the whole country, and which still contains material enough to enlarge these branches of industry to an almost unlimited extent. It contains also those immense beds of green-sand marl which have already been the means of converting the light and impoverished soils of this region into a garden of fertility, and which, now that their value is known, are being made to perform the same friendly office for the neighboring lands. This marl is, when properly managed, by far the cheapest phosphatic fertilizer that can be bought; and every year is making it more highly and more extensively appreciated.

Fourth—The Tertiary and Recent Formations of Southern New Jersey. The portion of country covered by this map is that which has so long been known as "the pines," "barrens," and "sands," and by various other disparaging names. It has been out of the way of markets, chiefly held in large tracts by iron and glass manufacturers, for its charcoal and wood, and has mostly remained unimproved. By the opening of railroads, and other means of ready communication, these despised lands have been brought into market. They have been tilled, and everywhere have developed a most unexpected capability of improvement, and under skillful cultivation have yielded as large crops of wheat, corn, potatoes, oats, rye, &c., as any other in the State; and now that so large a portion of the market garden and small fruit supplies of New York and Philadelphia are drawn from New Jersey, these sandy and gravelly loams are proving themselves to be just what are needed for such a purpose. The clearing up and settling of new land is going on as fast here as anywhere in the West.

Vineland, in Cumberland county, would be a marvel in any country. In 1861 it was all uncleared, and less than one hundred people (wood-choppers and colliers) in it. Now it is laid out in farms and cultivated, and has more than ten thousand inhabitants, who, though in a new country, are provided with good roads, schools, churches, and all the conveniences and privileges of an old-settled community, besides being exempt from many of their disadvantages. There are a score of other towns and villages within the area covered by this map, which are also looking forward to a like prosperous future. This map has been carefully corrected, and is a valuable contribution to the geography of Southern New Jersey, and will be a useful and important means of making these valuable lands known.

These four maps, on a uniform scale of two miles to an inch, cover the whole area of the State. In addition to these, several other maps of small area have been prepared upon a larger scale, in order to exhibit more plainly some particular parts of our Geology.

Fifth—The map of a group of iron mines in Morris county covers

an area of about 75 square miles, drawn to a scale of three inches to a mile. The miners' compass has been used in tracing out the beds of ore now opened, and the indications it has given are shown upon the map. There is an immense wealth of iron ore in the district here represented, and the map will be highly suggestive to landowners, miners, and iron manufacturers, in looking for further supplies of ore.

Sixth—A map of the Ringwood Iron Mines. This map covers an area of about $1\frac{3}{4}$ square miles, and is drawn on a scale of eight inches to a mile. It exhibits the overlapping of the beds of ore, and shows with remarkable plainness this singular feature of our iron-ore beds.

Seventh—A map of the Oxford Furnace Iron-Ore Veins. This map covers an area of about $3\frac{1}{2}$ square miles, and is drawn on a scale of 8 inches to one mile. The peculiarity of the district covered by this map is that it contains the end of one of those close folded beds of limestone and sandstone, and the iron-ore beds seem to be bent around, somewhat in conformity to the limestone.

Eighth—A map of the Zinc Mines of Sussex county. This map is drawn to show the geological and topographical relations of the remarkable ores of this region. The same general structure of rocks is shown as in the other maps, and the folding of the strata in both mines is the same as at Oxford Furnace; but the minerals are peculiar to this region.

The report which is to accompany these maps will also contain explanations and illustrations of the various geological formations, and it is hoped, will make the subject so plain that every one can understand it. And these, with the descriptions, analyses, and uses of the various materials found in the State, must make up the matter of the report.

The work of collecting cabinet specimens to illustrate the geology of the State, was purposely delayed until the other field work should be done. It is not possible for a geologist, who is pursuing his work on foot, to make progress in his investigations if loaded down with specimens—neither can he tell where the best specimens are to be found until he has looked over the whole field. For these reasons only small fragments of rocks and minerals have been collected for examination during the progress of the survey. Since the examinations for the maps was completed, the collection of cabinet specimens has been carried forward. Six sets of rocks and mineral specimens, to illustrate the geology and mineralogy of the country along sections 1 and 2 of the northern map, have been collected, and about half of those to illustrate section 3 of the same map. Suites of specimens to illustrate the cretaceous formation are also nearly completed. Those to illustrate the red sandstone, especially its quarries of freestone, are still to be made.

There is, however, an abundance of material for the winter's examination and study, and a few weeks in the open weather of spring will bt sufficient to make these collections as complete as they need

to be made for the work we are doing. They are designed to comprise specimens of our various formations in their varieties—building stones, slates, limestones, marls, peats, soils, ores, minerals, clays, glass sands, moulding sand, &c.

The specimens will be marked and packed in separate sets as fast as they can be examined and described.

The Geological Survey was undertaken for economical purposes. Its special object was to benefit the agricultural, mining and manufacturing interests of the State. Its work was to study out our different rock formations, our soils, our mines and minerals, our fertilizers, and other useful substances, and then to classify, describe and publish the results so that our citizens may understand them, and so that all may have full and free opportunity to avail themselves of our natural resources.

These objects have been kept steadily in view during the progress of the work, and every endeavor has been made to direct it in such channels as to make it useful. The liveliest interest has been exhibited by our people in the progress of the work, and questions on soils, fertilizers, marls, ores, rocks, peats, building stones, artesian wells, &c., are being asked every day; and with the publication of our work, it is hoped that a still greater interest will be aroused for turning our resources to the best account.

The transportation of marl on our railroads is rapidly increasing. The Raritan and Delaware Bay Railroad, the Freehold and Jamesburg Railroad, the Pemberton and Burlington, the Mount Holly and Camden, the Camden and Atlantic, the West Jersey, and its connecting roads to Salem, Bridgeton, Millville and Cape Island, are all employed in carrying this useful article, greatly to the benefit of the State and its agriculture. A road from Pemberton to Hightstown is in process of construction, and others from Swedesboro' to Woodbury, from Vineland to Atsion, and from Squankum to Freehold, are soon to be built, all of which will furnish new markets for the marl, and extend its benefits over new areas.

Every mile of new railroad adds to the value of our farms; it gives cheaper and quicker access to markets, and makes it possible to bring in fertilizers to enrich the soils and increase the crops. Already we have 855 miles completed, and 68 more being built. Several new lines are projected. It is hoped that they will continue to be built until every farm in the State can enjoy their benefits.

With the completion of the maps we have been enabled to make a new measurement of the area of the State, and we find it to contain 7,576 square miles. The areas heretofore published have been quite discordant. (Morse has it 8,320 square miles, Gordon 7,276, and Darby 6,851 square miles.) The area of the State in acres is therefore 4,848,640. The statistics of the United States census for 1860 give the estimated area of New Jersey farm lands as 2,983,525 acres. Of this, 1,944,441 acres was called improved lands, and 1,039,084

unimproved lands. There is then left an area of 1,865,115 acres which is not included in farms. There are large tracts of good land in different parts of the State—especially in the southern counties—which have never been cleared up on account of their remoteness from market, and other causes. But there are also large tracts which are naturally wet and cold, and so hard to bring into cultivation that they are left among the farm lands, unimproved or else in unoccupied wilds. There are within our borders 295,476 acres of tide meadows, and 31,750 of other wet meadows, which are at present yielding but a tithe of what they are capable.

With the rapid advances in the agricultural improvement of the State there is felt to be a more urgent need for reclaiming these tide marshes, both salt and fresh, and for draining our flowed lands, as well as for calling out a more thorough system of draining and improving the lands scattered through all parts of the State, which, though enclosed in farms, are still wild, poor and unproductive. The interests of the State demand that such improvements should be made. Our rapidly increasing population can well occupy them, and the great cities on our borders are in want of just such produce as these lands can supply every day. Much of this land is owned by persons of small means, who cannot at once pay the expenses of their improvement, and who are yet unwilling to part with them. Such owners are keeping back works which, in the end will be to their benefit. And still the desire to hold land is so praiseworthy and so useful, that it must always be respected, and only the most pressing public wants will justify an invasion of the rights of freeholders. It was from strong sympathy with these worthy owners of the soil, that inquiry was made in other countries as to the means of protecting them, and still pressing forward the needed works of reclamation or drainage. Difficulties of like nature have presented themselves in Great Britain and in France. The English Inclosure Commissioners who have charge of such matters, sent out several documents and papers explaining their mode of proceeding and its results.

These papers are of much interest. They give not only the forms of proceeding, but also the effects of drainage on the value and productiveness of land in England, the best methods of drainage, and the conditions on which $20,000,000 have been loaned by the Government to encourage such improvements. Extracts from them are inserted in the appendix, and they will well repay perusal.

Nearly 20,000 acres of tide marshes have been reclaimed in Salem, Cumberland and Gloucester counties, by banking out the tides and draining by sluices, and the lands thus regained from the water are the most productive and the most profitable in the State.

The Iron Dike and Land Reclamation Company has undertaken to bank in some 6,000 acres of marsh which constitutes the tongue of land between the Passaic and Hackensack rivers at the head of Newark Bay. The marsh is already enclosed by a bank some six miles

long, and to prevent the damages from muskrats, boring crabs, &c., which pierce the banks and let in the water, they have put an iron core in the centre of the bank. This core is made of thin cast iron plates which are fitted together at their edges so as to make a continuous shield of iron standing on edge and extending about a foot and a half above the level of the marsh, and three and a half feet below that level. It is expected that this plate protected by a proper weight of earth in the bank over it, will withstand the pressure of the water and the attacks of the borers. The plan contemplates draining the water to a level considerably below low-water mark. The undertaking is one of great public importance, in view of the extension of such improvements to all our tide marshes; and it is of much pecuniary interest, on account of the richness of the land, and its location so near to New York market.

The Drowned Lands on the Walkill have suffered very much the past season for want of drainage. Nearly all the hay grown upon 15,000 acres of land has been spoiled, and the losses in a single year have been much more than enough to pay for removing all the obstructions in the river and draining it thoroughly. The great obstacle to be overcome is a mill dam at Hampton, where the Walkill leaves the Drowned Lands. Considering the interests involved there should be no difficulty in getting some joint action with the State of New York, by which to effect this much needed improvement.

The southeastern half of Morris county is one of the most charming valleys to look upon in all our country. It is a vast amphitheatre, having the highland range of mountains on the northwest, and on the other sides being enclosed by the long ridges of trap which curve around from near Pluckamin, by Boundbrook, Plainfield, Springfield, Orange, Bloomfield, Paterson, and around to Pompton. The Passaic and its tributaries supply it with an abundance of water in every part. But it is not well drained—the streams are sluggish, and there are large tracts of wet meadows which are liable to overflow, and which in rainy seasons like the last summer are spoiled by the excess of water. Fever and ague is so prevalent in some years as to give much of the valley a bad reputation. It needs some well-planned and thoroughly-carried out system of drainage to make it what it ought to be. The area to be benefitted is large, being full twenty-five miles long, and, on an average, five miles wide. This is one hundred and twenty-five square miles, or 80,000 acres, and I have no doubt that if this improvement were thoroughly done, every acre of land in this large area would be worth $20 an acre more than it is now, and much of it would be worth $50 an acre more. The smaller increase would make $1,600,000, a sum in comparison with which the cost of improvement is not worth mentioning.

The Great Meadows in Warren county are also lying comparatively unproductive for the want of drainage. They contain five thousand acres of first quality meadow land on the Pequest, and would be

easily brought to their highest productiveness if the water that now fills them were drawn off to some lower level, as it is said that it could be at a very moderate expense.

There are many other topics which have been subjects of examination during the survey, and might well claim a place here but for the short time before the final report will be issued. The results of the examinations into the structure of the iron-ore beds, and the gneiss rocks which contain them, together with the indications of the miners' compass, cannot but be useful. They will relieve some of the uncertainties of mining, and may save much useless expenditure of money.

The analyses of fertilizers must possess a curious and important interest for farmers. A number have been made during the last year, and they give new importance and value to some of those which are most easily obtained.

Statistics of Mining.—According to the tables of the Morris Canal and Banking Company, furnished by William H. Talcott, Esq., there has been transported on that canal during the year 1867, 250,064 tons of iron ore, and 22,456 tons of zinc ore, the products of our mines. There has also been carried 2,000 tons of zinc ore, and perhaps 25,000 of iron ore by railroad, which would make the products of our mines for the past year to be:

Iron ore,	275,064 tons.
Zinc ore,	24,456 tons.

Statistics of Marl.—The amount of marl which has been carried on railroads and mostly beyond the marl region, as far as ascertained, is as follows:

	Bushels.	Tons.
By the Squankum Marl Company,	400,000	20,000
" Freehold and Jamesburg Ag. R. R.,	366,805	18,340
" Pemberton Marl Company,	500,000	25,000
" Camden and Atlantic Railroad,	220,000	11,000
" West Jersey Marl Company,	1,048,000	52,400

Prices of Marl.—The Squankum Marl Company deliver marl on the line of the Delaware and Raritan Bay Railroad between Eatontown and Manchester for 7½ cents a bushel, or $1.50 a ton, and at all other points on that road, as well as on board boats at Port Monmouth, for 8 cents a bushel, or $1.60 a ton. William E. Barrett, Farmingdale, Agent.

The price of Squankum Marl on board of cars at Freehold is 12 cents a bushel, or $2.40 a ton, and the Freehold and Jamesburg Agricultural Railroad Company deliver it at Bordentown, Trenton, and Millstone, at 5 cents a bushel advance, at New Brunswick, 4½ cents, Rocky Hill and South Amboy at 4¼ cents, and at all intermediate points along the railroads for lower prices, corresponding with the distances. I. S. Buckalew, Jamesburg, Superintendent.

The Pemberton Marl Company sells marl from the Middle Marl

Bed, digging it near Birmingham, Burlington county. Their advertised prices delivered by railroad are: At Birmingham 80 cents a ton, of twenty bushels; at Mount Holly 95 cents; at Burlington $1.25; at Camden $1.70; Bordentown $1.90; South Amboy $3.00; Trenton $2.10; New Brunswick $2.90; Flemington $2.95; and at Belvidere $3.95 a ton. John S. Cook, Mount Holly, General Agent.

The White Horse marl is delivered along the line of the Camden and Atlantic Railroad for prices varying from about four cents a bushel upwards, according to distance. This marl is dug near White Horse Post Office, Camden county.

The West Jersey Marl Company deliver marl by railroad at South Amboy for $3.50 a ton, of 20 bushels; New Brunswick $3.40; Trenton $2.65; Bordentown $2.45; Camden $1.70; Marlboro' 90 cents; Bridgeton $1.85; Salem $2.00, and for corresponding prices at intermediate points, and on the road to Cape May. On the Delaware and Raritan Canal the freights are less than by railroad, and the prices are lower by from 30 to 50 cents a ton. I. C. Voorhees, of Woodbury, Agent.

The work of describing minerals, rocks, &c., and writing the Final Report, will occupy the time this winter, and some time will be needed after the season opens to complete the collection of specimens, and to attend to the printing of the work. The money appropriated will probably be sufficient for these expenses, but as the time for making the survey closes with the month of March, 1868, some legislation may be needed to authorize the continuance of the work, and I would respectfully suggest that a committee of this Board be authorized to procure the passage of such a law as they may deem necessary.

By the terms of the law this Board is constituted with powers to publish and distribute the reports of the survey, and to designate the places where suites of specimens shall be sent. As the time for this distribution is near, it may be desirable to consider how the reports shall be distributed, and how the results of the survey can be best made known to all our citizens.

It will probably be necessary to have a meeting next spring, in order to hear the Final Report, and to complete the arrangements for its distribution.

APPENDIX.

APPENDIX.

EXTRACTS FROM THE PAPERS SENT BY THE INCLOSURE COMMISSIONERS OF GREAT BRITAIN.

Memorandum No. 1.—Commission of Sewers are issued under the provisions of 24 and 25, Vic. cap. 133. Under this act the Inclosure Commissioners for England and Wales, after due inquiries, can recommend to the Sovereign that a Commission of Sewers should issue for a certain area defined by them, and thereupon a Commission of Sewers is issued under letters patent, sealed with the great seal of England. The persons named therein as the first Commissioners are recommended by the Inclosure Commissioners. A Drainage Board is formed under the provisions of this same statute (24 and 25 Vic. cap. 133). Upon application made to the Inclosure Commissioners they, after inquiry, issue a provisional order. To this provisional order is attached a map, on which is defined the limits of the area within which the Drainage Board may exercise jurisdiction. The first members, and the number of the members of the board, with their qualifications, are also stated in the provisional order. This provisional order is afterwards confirmed by act of Parliament, and this act is deemed a public, general act of Parliament.

The members of the board are, after the first board has officiated a certain time, elected by the proprietors of land within their district, according to a scale laid down in the act of Parliament.

To form a Commission of Sewers under this last named act, the consent of proprietors of one-tenth part in acreage of the land within the proposed boundary is required for the petition to form it. If one-third afterwards dissent, the Commission is not formed.

To form a Drainage Board under that act, the petition to form it must be signed by one-tenth in acreage, and must afterwards be assented to by two-thirds in acreage.

A Commission of Sewers once established is deemed to continue until superceded.

A Drainage Board is a body corporate, with perpetual succession and a common seal, having a capacity to hold lands for all purposes of their constitution.

If Commissioners of Sewers and Drainage Boards require to purchase lands for new works otherwise than by agreement with the owners thereof, they must apply to the Inclosure Commissioners, who, after inquiry, can issue a provisional order; but this order to be of any validity must be confirmed by Parliament. Commissions having the same objects and powers as mentioned above, have also been formed under private acts of Parliament; but these are too numerous and special in their circumstances, objects and powers to be mentioned in detail in this memorandum.

There are upwards of three hundred of such private acts of Parliament; some of them apply to drainage only, some to drainage and embankments, some to drainage and navigation of the tidal rivers and canals which pervade the districts to which they relate. But they will all, more or less, partake of the character and comprise the duties and powers of the Commissioners of Sewers.

Commissioners of Sewers, under the act of Henry VIII., have within the area of their jurisdiction power to survey and repair existing sea walls, and other defences against inroads of the sea, or of fresh water descending over marsh or other lands. They can correct, remove or put down annoyances caused by mills, mill-dams, floodgates, locks, weirs, and other impediments.

For maintenance and improvement of existing works, Commissioners of Sewers may be said to be "facultatif." They can do the works and assess persons for the costs thereof. If they desire to make new walls, banks, sewers, cuts, &c., where none have heretofore been, they must have a majority in value to bind the minority, and must obtain the consent in writing of the owners of three-fourths at least in *value* of lands proposed to be charged with the costs. Where such work will cost more than £1,000 sterling, the proprietors of one-half of the *area* to be taxed can negative such works by expressing their dissent.

Drainage Boards may be said to be under the same legislative provisions in the above mentioned respects as Commissioners of Sewers.

In Commissions of Sewers the administration of its duties and powers is carried on by those named in the commission. In Drainage Boards by those named as members of the first board by the Inclosure Commissioners, and afterwards by those who are elected by the proprietors, according to a scale of voting laid down in the act of Parliament.

Contributions are assessed upon the proprietors of lands within the area of jurisdiction of the Commissioners of Sewers and Drainage Boards. These have power to appoint surveyors, valuers, collectors and other officers to assess and collect from each district or parish contributions in proportion to the benefit or advantage received, or capable of being received by them, and to apportion the sum so assessed among the occupiers of the lands of each parish or district within their jurisdiction, according as they ought to pay.

If any complaint is made against the amount of the sum to be raised, or against the assessment of that sum, it is heard by the Court of Sewers, whose decision is final.

There is also a liability to do works of repair, or be rated for the same where the obligation arises from tenure. This, however, may now be commuted.

The rates may be mortgaged, and the money so raised is repaid, principal and interest, in a term of years not exceeding thirty. The consent of the Inclosure Commissioners is required in order to affect such mortgage.

The establishment of Commissioners of Sewers is undoubtedly of very long standing in England. Probably the laws relating to Romney Marsh, in the county of Kent, are the oldest. These date from the reign of Henry III., A. D. 1216–1272, and extend over a district computed at 20,000 acres. There have also been established Commissioners of Sewers for draining and protecting marsh lands in the counties of Cambridge, Lincoln, Norfolk, Nottingham, Oxford, Essex, Gloucester, Monmouth, Huntingdon, and Hatfield Chase, in the county of York. The "Bedford Level Corporation" is the largest and most important, and undoubtedly it is owing to the large powers with which these Commissioners were from early times invested for the public benefit that the reclamation from the sea, and the rendering productive of such immense tracts of level marsh and other lands have taken place. It is computed that the "Great Bedford Level" extends over an area of 680,000 acres of the richest land in England, converted from a dreary waste into a fruitful plain. This conversion has been brought about by the successful application of art as much as in the Kingdom of Holland, opposite to which this great district lies. Among other large districts under the jurisdiction of Commissioners of Sewers, or of Commissioners acting under private acts of Parliament, may be mentioned "The Commissioners of Sewers for the county of Somerset," "The Nene Valley Drainage Commissioners," "The Rye and Derwent Drainage Commissioners," and the "River Witham Drainage Acts."

Memorandum No. 2.—1. Does the State interpose in works of drainage undertaken by private invididuals?

It does in this way: It advances money necessary to defray the expenses after the execution of the works.

2. What are the guarantees which it requires?

The gurantee it requires is a charge on the lands drained.

3. Does any administration, any rules exist to determine the conditions on which the State makes advances to individuals?

The Inclosure Commissioners for England and Wales are charged with the administration of the affairs connected with the drainage of land.

4. What is the course of proceeding prior to the grant of a loan?

The course of proceeding prior to granting the loan will be found in the appendix.

5. What are the powers put in motion for the control of the works and to make sure that a loan is really applied to the drainage works?

* * * * An inspection of the works by those employed under the Inclosure Commissioners.

6. What measures are taken in case of a loan, if the works should be abandoned by the proprietor before their completion?

7. How does the government proceed to recover its first advances?

There are no advances to recover, because they are not made until after the execution of the works of drainage. The government reduces the sum which it has advanced by an annual payment of 6½ per cent. on the outlay, which, at the end of twenty-two years, discharges principal and interest.

8. Does the government cause the official work to be stopped in certain cases to preserve the security?

It is not necessary that the government stop official works because the security in the case supposed cannot exist.

9. In the principal works of drainage which have been executed, has the cost of drainage been always covered by the increased value of the land?

The act of Parliament does not allow the Commissioners to make any advance for drainage if they are not satisfied that increased value of the land will cover the advance.

10. Is the increase of production of the land immediate? Is there a continuing increase, or is there a sensible decrease in it after some years?

The increase of production is in general immediate, and it continues to increase for some years. It never decreases unless the flow of water is arrested by the imperfection of the works, or from causes hereafter pointed out. In very strong land, nevertheless, in order to secure immediate benefit, it is important to make use of the subsoil plough, which stirs the land, without turning it over, to the depth of eighteen inches from the surface, after the common plough has done its work.

11. Has the presence of vegetation been observed in the pipes which has stopped the flow of water?

12. What are the measures taken in this case?

Three sorts of vegetation have been observed which have stopped the flow of water—the roots of trees and bushes, roots of underground plants, and those of mangold wurzel and rape. It is not possible to take any measures against the roots of trees and bushes, except to root them up, which is better done a couple of years before the drainage. There has been no remedy discovered as regards the roots of underground plants; but obstructions from these are rarely met with, as they generally die away as the ground becomes dry from the water being carried off. In the meantime it is necessary to raise the tiles

and clear them of the roots if occasion require. As to the roots of plants, as mangold wurzel or rape, it is a good plan not to sow the seed over the drains for a couple of years after drainage, to give time for the ground to settle down. In case one has to drain land impregnated with iron, it is very difficult to prevent the tiles from being choked, because the water, which is clear as long as it is not exposed to the action of the atmospheric air, oxydizes as soon as the exposure to it takes place, and leaves a considerable deposit. One should, therefore, endeavor to prevent a greater admission of atmospheric air into the pipes than is necessary to facilitate the flow of water through them, which may be accomplished in the following manner: As a general rule the furrow drains ought to follow the fall of the ground, and empty themselves in a larger drain running across them. The orifice of the larger drain is secured by a dry stone wall, to keep the pipe in its place; but in land impregnated with iron, the last pipe forming the orifice ought to be turned down, so that the mouth is under water contained in a tank constructed for that purpose. It becomes absolutely necessary, nevertheless, to empty the tank from time to time, and if this be not done it will be filled with an accumulation of the oxide of iron.

13. How much does it cost to drain a hectare (2.47 acres) of ordinary land?

The drainage of a hectare (2.47 acres) of ordinary land will come to £11 5*s*. 0*d*., or £12 10*s*. 0*d*.

14. Give the difference of price between the drainage of ordinary land, stony and clay lands and loam.

The difference must depend on the sort of lands you propose to drain. All lands are costly to drain where there are stones requiring the use of the pick-axe, as well as the draining spade; or which, from any special cause, or from the very close and impervious nature of the subsoil, require the drains to be placed near each other. The drainage in such difficult cases will reach £15, £18, £20, and even £22 per hectare.

15. Give some estimate of the difference of the produce of a hectare before and after drainage.

The best proof there is of the increased value of land, as regards the facility of finding a tenant, is that the farmers of their own account pay the 6½ per cent. on the outlay for drainage. In certain cases where the land rent per hectare was not 2*s*. 6*d*., after drainage it has become worth £2 10*s*. 0*d*. The additional value given by drainage to land does not consist alone in the increase of the corn crops, but in the rendering it fit for root crops, such as turnips and mangold wurzel, which are of the greatest importance to the proper cultivation of land, which would not grow thereon unless drained. Drainage often produces an increase in the wheat crop of 7.25 hectolitres the hectare (8 bushels the English acre.)

16. Give the different modes of drainage, which are the most favorable and least costly with respect to land difficult to drain.

No mode of drainage is allowed because it is a cheap one, if it be not also permanent. But it may be safely said that only circular pipes are made use of when they can be procured. These pipes should not only be closely fitted together, but in light lands—in order to prevent the sand getting into the pipes—a collar of three inches in length should be made use of, so as to cover the joints of the pipes. In some places where it is impossible to procure pipes, stones, broken to a size to pass through a ring three inches in diameter, are placed at the bottom of the cutting, and covered with a turf to prevent the earth getting into the drain. The experience we have acquired demonstrates in the most satisfactory manner that drains to produce the improvements of which we have spoken, ought not to be less than four feet deep. A less depth does not render the ground sufficiently dry by getting rid of the evaporation to secure the necessary warmth for the roots of agricultural plants—a warmth which alone renders their growth certain, an earlier maturity, and an abundant crop.

Appendix to Memorandum No. 2.—By the 9th and 10th Vic., cap. 101, and the 13th and 14th Vic., cap. 31, the treasury is authorized to make advances, not exceeding £4,000,000, from the consolidated fund for the drainage of lands in Great Britain.

The Inclosure Commissioners for England and Wales are the persons appointed to carry out these acts.

The words "proprietors of lands" embrace a larger class of persons than absolute owners "called owners in fee," namely, tenants for life, &c. Minors and persons under legal disabilites can also by the substitution of other parties make application. The proprietors of lands as such can make an application to the Inclosure Commissioners according to the form No. 1, and this application should give a designation of the land to be drained, the system on which it is proposed to drain it, the estimated expense, the increased value, the estate of applicant in the land, and, if the advance is intended to cover the whole, and if not, what proportion of the expense. The application is advertised twice in a local paper, and in the London *Gazette* for two successive weeks.

A provisional certificate cannot be issued until two months after the last advertisement, so that any one having any interest whatsoever in the land may object if he has any grounds. The objection must be made to the Court of Chancery. As yet there has been no case opposed.

By an amendment (act 10, Vic., cap. 11) other expenses have been included in works of drainage: Outfalls over the lands of other owners, open water courses and drains, where security is given for their maintenance; inclosing and trenching waste or pasture lands for the purpose of converting them into arable.

The land in respect of which a loan is applied for is inspected by a competent person appointed for the purpose by the Commissioners. This person makes his report, and gives his opinion whether the drainage, inclosing, &c., will be durable and effect an improvement in the land which will exceed the annual charge of 6½ per cent. on the outlay. If, after the report, the Commissioners entertain the opinion that the whole or a part of the expenses ought to be advanced, they apply to the Lords of the Treasury to obtain their sanction to grant a provisional certificate, in which the description of the land in question is specifically set forth.

The sanction of the treasury having been obtained, the provisional certificate is issued and forwarded to the applicant, who can, under the provisions of the act of 10 Vic., cap. 11, assign it to a banker, or to any one who will advance the necessary amount to carry on the works, who has the right, if the works be approved of, to receive the amount of the certificate of advance.

The inspector, in pursuance of his instructions from time to time, visits the works which are in progess and makes his report, and certifies, at the request of the proprietors, the completion of such works as are complete in themselves. If he be satisfied with the works, the Commissioners apply to the Comptroller of the Exchequer to pay to the account of the Inclosure Commissioners, at the Bank of England, a sum sufficient to meet the advances of the ensuing month, namely, £25,000. Out of this sum, if the Commissioners be satisfied with the report of the inspector, they issue a certificate of advance, and forward to the person entitled to it a check on the Bank of England, signed and sealed with the official seal.

The certificates of advance are issued from time to time in consideration of the provisional certificate, until the whole sum applied for has been received, the cost of inspection and advertisement having been retained by the Commissioners. The certificates of advance form a first charge on the land.

The Commissioners have the power of requiring a security for the cost of inspection and advertising, but they have never done so, and no inconvenience has resulted.

The 6½ per cent. on the outlay is collected by the tax collectors, and the loan—principal and interest—is cleared off at the end of twenty-two years. If the Commissioners are not satisfied with the proposed manner of executing the works, whether as regards the system or cost, they require an explanation, or perhaps, alteration. If they are dissatisfied with a report of works executed they call for an explanation, or may disallow a portion or the whole of the cost, but from the precaution taken, it seldom happens that even a portion is disallowed.

In consequence of these advances made by the government, applications have been made for more money than is at the disposal of the

Commissioners. In these cases the different applications are placed in order of their dates.

As it is an acknowledged fact, and universally admitted that the drainage of wet land is essential to agricultural operations, according to the improved system, as well as to the growth of the crops incident to it, it is impossible to give more than an outline of the result.

One can nevertheless affirm that the strong lands when drained can be worked at a much less cost, in every sense have become very fertile, and that which produced absolutely nothing now produces good crops; that in Scottish districts, which are cold and wet, the temperature of the soil, which has been improved by drainage, has so overcome the climate that corn which never formerly ripened actually now does ripen there, and generally that the harvest on drained land is earlier than it was before drainage; that turnips, vecthes, and other crops of a like nature, so necessary to maintain a sufficient quantity of beasts and sheep to carry on farming in a profitable manner, and which wet land will not produce, grow readily when the land has been drained; and in some parts of the country where industry did not prevail, as in other districts, the day laborers are become much better conditioned, and are sensible of the advantages of constant and regular work. The best proof of the good resulting in general from the drainage is the number of applications which exceed what can now be met by the four millions granted by the acts of Parliament, and the demand of parties who have already benefitted by loans for further advances, which are now made under other acts of Parliament—the amount available as a loan from government being now nearly exhausted.