GEOLOGICAL SURVEY OF KENTUCKY.

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THE TRANSPORTATION ROUTES OF KENTUCKY,

AND THEIR RELATION TO THE

ECONOMIC RESOURCES OF THE COMMONWEALTH

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In the matter of the economic development of the resources of any area, the means whereby these resources may be approached, and their distribution to markets accomplished, is often of far greater value than the character of the resources themselves. At first sight these questions of transportation would seem to be matters for the consideration of an engineer rather than a geologist, on account of the importance of the questions concerning the ease or possibility of particular projects; but the knowledge required for these considerations is, to a great extent, that which is obtained by the geologist rather than the engineer.

I have endeavored, as far as possible, to avoid the difficult considerations which arise from the discussion of the plans of several projectors of various transportation routes. The sketch given below is an effort to show what development of the existing lines of transportation is necessary to give the State a proper hold upon the economic resources found within its borders, and to bring them into relation with the rest of the world.

The first thing that strikes the observer who considers the transportation conditions of Kentucky, is the fact that the State is singularly isolated from the great markets of this continent. Its considerable railway system leads mainly to its local markets, and its wonderful water system lies undeveloped, or, when effective, is cut off, by some slight barriers, from access to its best mineral fields. In the past, this water system has been under grave disadvantages. Its ways, too, do not lead towards the great markets of the country. On the

contrary, they turn their course to the less settled sections, where development has not gone far enough to make great markets for the natural products of the State.

In considering the relation of natural and artificial ways to the markets, I shall take up first the rivers, and pass then to those channels of trade that do not depend, to the same extent, on the natural features of the country.

It is impossible to examine the rivers of Kentucky as I have done, during my journeys through the State, without being convinced that in them the Commonwealth has a wonderful set of natural ways whereby her great stores can be taken to their markets. In those ways lie her riches quite as much as in the coal, iron, salt, stone, oil, timber, and net products which are found beneath her surface. With all the grosser products of the earth the question of carriage must always be one of the first importance, and in the present and all prospective advance of rail transportation, the cost of carriage must always be much greater than by water, even where the latter form of transportation has to be obtained by locks and dams.

As previously noticed, our river system has had the grave disadvantage that it leads towards the west rather than the east. Such a river system turned towards the Atlantic coast would have made a very different economic history for this part of the continent. It should be noticed, however, that this disadvantage is, year by year, becoming less grave. The gain is made in two ways: firstly, by the increase in population in the regions bordering the Mississippi; and secondly, by the extension of navigation on these waters. There is, at least, twenty-five thousand miles of shore line on this water system that can be made readily accessible to water navigation. With the growth of population, it is not too much to expect that, within the knowledge of living men, this shore line will be occupied by a population of nearly one hundred million of people, with the most varied industries the world has ever seen gathered into one river valley. With this system of water transportation made completely available, Kentucky will always have the best possible chance of furnishing

a large share of the products of mining and manufactures used by the valley in which it lies. As regards the products of the earth found in this valley, she must always have the first place, as determined by the elements of richness and accessibility. Her coal, taking it for all qualities, is as good as that of West Virginia, and is far nearer the regions of great demand. She has the largest area of iron-working coals as yet discovered, and in many other elements of mineral wealth she is equally well favored.

It is not only in regard to the growing numbers and ripening civilization of the Mississippi Valley that this river system is of value. The civilization of Europe has overdrawn its stock of coal, iron, and timber, and the day has come when these must be brought, in part, from afar in order to maintain her industries. The Ohio Valley would, at present prices, be able to send iron to Europe at an advantage, if there were only a proper use made of these natural channels of trade. With the growth of capital and the adjustment of our currency, giving a sound basis for our industries, we may be sure of a vast source of wealth in this export alone. There is no other region in which can be found iron-working coal or cheap charcoal, together with iron ores of such varied qualities, all in such easy relations of distance to each other, and where their products are on a water system leading to so large a native and foreign population. Looking more closely to our Ohio river system, as developed within Kentucky, we are struck by the fact that the main river has very little actual contact with the best of the coal and iron of the State, or with that of the other States bordering on the river. In most cases these materials have to be brought to the river from some distance, either through its tributaries or by the means of railways. It is not necessary to discuss the reasons for this peculiar geographical relation of the natural resources of the valley. I only wish to call attention to the fact that there is less good coal on the Ohio river front than on any one of its principal southern tributaries, and that the peculiar difficulties which beset the approach to these fields are common to the whole

river. That these difficulties of position are not at all serious, is shown by the fact that they are obviated not only in many other countries, but that the most prosperous coal mining region on the Ohio, that of the Monongahela river, is approached by means of locks and dams, there being already several of these structures, giving about one hundred miles of navigation on that river. What is especially desirable in Kentucky, is the careful prosecution of the work of improving the navigation of the rivers of the State by means of locks and dams, as has often been proposed. In the Appendix to this report, I have assembled the information which I have been able to gather concerning the results obtained by the special surveys made about forty years ago, with the view to this sort of improvement. This work was begun about fifty years too soon —before the demand for the mineral products of the State had grown to sufficient dimensions. Its advantages would have been great, however, provided that in any one of the easternmost streams of the State these improvements had been carried to completion; as it is, the half success of the experiment on Green river has counted against the work. A glance at the map will show that the mouth of this river is below all the more populous cities of the Ohio Valley, it being necessary to tow the boats, carrying coal and other similar products, up the river for a great distance, in order to find any considerable market. If this improvement had been applied to the Big Sandy, the Licking, or the Kentucky, the markets of Cincinnati and Louisville would have been opened to its products. The improvements on the Green river are gradually growing in value, and I look forward to seeing them extended so as to give access to the admirable coal and iron deposits on its tributaries—Mud river, Bear creek, and Nolin river. The markets below its mouth, though still small and suffering from the great depression arising from the late war, are slowly coming to their natural prosperity. The unhappy and utterly unnecessary blunder which was made with the first furnace in this valley, that at Airdrie, has done a great deal to frighten capital away from this region. The cause of this unfortunate piece

of mismanagement is well set forth in the report of Assistant P. N. Moore, in the second volume of this series of reports. After a careful personal study of the conditions in this valley, I am satisfied that, with the revival of industry, which all reasonable men await, this section is sure of a prosperous industry in iron manufacturing. I am convinced that, reckoning the cost of getting the product to a great market as part of the cost of manufacture, there is no region in the world where iron can, at the present time, be made any cheaper than it can here.

To complete the navigation of the Green there is needed an extension of the slack-water to Nolin river, and up that river and up Bear creek for about twenty miles on each. One dam will answer every purpose on the main river, and one on each of these tributaries. Or it may be, that, by making the dam on the main river rather high, it would back up those streams for a sufficient distance for all the present needs of access to their ores. The navigation on Pond river should be extended by one more dam, to give access to the admirable ores on that stream, which, with this improvement, could be shipped, at a good profit, even as far as Cincinnati, whenever the manufacture of pig iron becomes again active. With these additions, which could all be made for less than two hundred thousand dollars, I should regard this stream as having all its known resources sufficiently opened to industry.

The Cumberland and the Tennessee are so far within other States that the plans for the bettering of their navigation should be accomplished by the General Government. The resources which will be brought out through their improved channels are really enormous, and though not in the main from beneath Kentucky soil, would still serve to build up the interests of the Ohio Valley, in which Kentucky has the largest share of any State. The Cumberland is more the property of Kentucky than the Tennessee, for the larger part of its course is in our State. The region drained by its upper waters has a great store of coal, and is especially rich in the

heavy lubricating coal oils, which are sure to have a large and constantly increasing market.

The small, narrow, and crooked stream bearing the name of the Tradewater river, has not yet been sufficiently explored. Its banks are very richly stored with timber, and there is, doubtless, much coal accessible on its waters. A preliminary study of its drainage goes to show that one or two dams will develop a great deal of navigable water. These dams would be low and of small cost. Probably, with sufficient accommodation for boats of a size fitted to pass the narrow and tortuous windings of the stream, thirty thousand dollars each would be a sufficient estimate. I base this reckoning on similar works in other districts.

Above the Green, there is no river which demands improvement, in the interests of the mineral resources of the State, until we come to the finest of our purely Kentucky rivers, the noble stream of that name. In the old work of improvement of the rivers, this stream had four locks and dams, of good workmanship, built along its course. Of these, the uppermost was just sufficient to carry the navigation to Hickman Landing, above Frankfort—still about one hundred miles below the lowest coal and iron on its waters—practically not in the least bettering the mineral interests of that valley, though it has well paid for itself by its incidental effects on the prosperity of the Commonwealth. To complete this system, there should be about twelve more dams on the main stream, carrying the navigation about one hundred and fifty miles further up than it extends at present. Then a system of smaller dams on the tributaries—giving about three to Red river and four each to the North and Middle Forks—would make an effective outlet for the resources of a large area. At the time of the surveys for these improvements, it was proposed to make a water route to Cumberland Gap, by building a dam at Cumberland Ford, taking the water thence, by canal, to Richland creek, entering the same at a point about six miles above Barbourville; thence, by a cut about a mile in length, and not over forty feet deep at any one point, to Colline Fork of

Goose creek; thence down Goose creek to the Kentucky river, a total descent of two hundred and twenty-five feet, requiring about thirty locks for the connection between the Cumberland and main Kentucky. Yellow Creek, above the Cumberland Ford, would give, with two locks, an easy passage up to the foot of the Cumberland Gap, within about a mile of the summit of the pass over the mountain. This would make a total of about forty locks between the Cumberland Mountain and the Ohio river. The cost of the work would require reëstimation for modern prices. A careful consideration of the Kentucky river has satisfied me that the lockage could be finished to the Three Forks for about two million of dollars. On the tributaries the locks and dams would cost about fifty thousand dollars apiece, so that Red river, and the North and Middle Forks, would, for the locks we have proposed, cost about five hundred thousand dollars. If it was ever desired to carry out the project of a canal to the upper Cumberland, the cost would be about three million dollars for that work alone—a cost that makes it inexpedient to consider it at present. I must say, however, that this last named channel offers certain great advantages. It will be seen, by reference to the preceding reports in this volume, that the iron ores at the Cumberland Mountain are the cheapest and best of any within our limits or near our borders. It is exceedingly desirable that they should be brought into close relation with our iron ores and iron-working coals. I believe in time our industries will warrant the investment of the money necessary to make this line of cheap water transportation; for it will serve to bring the question of carriage of ores in this great ore and coal district to a most satisfactory solution.

I am satisfied, that if the slack-water navigation of the Kentucky river was carried up to the Three Forks, it would be rapidly extended up the smaller tributaries. The cost of the locks and dams in the smaller tributaries is much less than in the large streams. Sufficient locks and dams on the Three Forks of the Kentucky will cost only about one half what would be required on the main stream, and the rate of

fall would give something like three fourths of the navigation to each lock that it would in the main stream. As will be shown hereafter, the expense would be but little more per mile of navigable water than the cost of the turnpikes, and not over one third the first cost of cheap railways. When the navigation of the Kentucky is fully developed, it will afford about six hundred miles of navigable water bordered by coal, iron, salt, and timber lands. Every dam will be a possible source of water-power; for the flow is much in excess of the probable needs for lockage. The cost of this navigation will probably be not far from five thousand dollars per mile, unless done by convict labor, when it can be reduced to about three thousand dollars per mile; in the one case the total would be three millions, in the other, twelve hundred thousand dollars.

The next stream, the Licking, has not quite half the possible mileage that we find on the Kentucky, and the cost of getting to the point where the coal field begins would be about twice as great. At least twenty dams would be required to take the navigation to that point where the supply of iron ore becomes great. If we had them now, there is no doubt that there would be a great tide of trade poured over this way. It gives access to some admirable iron ores, which, by slack-water navigation, could be put at the furnaces in Newport so as to cost, for the ore required to make a ton of pig metal, not more than five dollars. Its admirable cannel and bituminous coals should find a great market in the Cincinnati centre, where the stream debouches. This stream, with the safe harborage for vessels, and its ready access to the greatest city of the Ohio Valley, would become a great manufacturing centre. Four of these locks and dams were begun, but only one, the lock No. 3 from the mouth, has been kept uninjured; the others have been destroyed to the foundations for their stone. The dams in this river would be less costly than on the Kentucky, especially if the plan of beginning the dams at the head waters and working down was adopted. Some time would be lost, but admirable building

stone would be secured at low cost. Reckoning from the contract prices of dams on the Monongahela, we may estimate the cost of locks and dams on the Licking sufficient to carry the navigation to West Liberty, at about two million five hundred thousand dollars, with ordinary labor. Many of the lateral streams are worthy of improvement by one or two dams—Slate creek, in order to give access to the Preston ore banks, and the coal nearest to the lower river, and other streams to give more coal frontage. The total possible navigation in the coal and iron district on this river is about one hundred and eighty to two hundred miles. Owing to the smaller water supply, the water-powers would be less valuable than on the Kentucky river.

Still further up the Ohio river we have Tygert's creek and Little Sandy. Both these streams are capable of this form of improvement; but the Little Sandy is sufficiently improved by the railway which traverses its valley, which was built for the purpose of furnishing an outlet for the mineral wealth of the district. Tygert's creek, though a smaller stream, is quite capable of being locked and dammed at relatively small cost. It would open a considerable territory for coal and iron production. The Lambert ore bank, and other ores found along its waters, would furnish cheap shipping ores. To carry this navigation to the Iron Hills Furnace would require about six dams, costing about two hundred thousand dollars, if made with locks for sixty-foot boats, which are large enough for this rather crooked and small stream. This stream would furnish the most westerly coal on the main Ohio above its principal cities.

The Chatterawha or Big Sandy river is admirably suited for this form of improvement. On its waters we have a great series of coal seams; in fact, the most westerly development of the beds certainly identifiable as the West Virginia and Pennsylvania seams, is found on its eastern branch, the Tug Fork. Six dams on the main stream and two on Tug Fork would cost less than a million dollars, and would give about one hundred miles of navigation in a good coal country. Ex-

cept the recently discovered "black band ore," the only valuable iron ores known to this Survey on its waters are on the tributaries of Big Blaine creek, which it would be possible to lock and dam by making storage reservoirs. Every mile of the possibly navigable waters of this stream abounds in coal of varied qualities. The stream is strong-flowing in the greatest droughts, and would afford excellent water-powers at all the main dams. The navigation could be extended up the smaller streams at many points. Big Blaine, Rockcastle, John's creek, Beaver creek, are all suited for such improvements, and on the main stream the system would be possible quite up to the State line. The possible water transportation on this river, which would be regarded as within the mineral belt, amounts to quite four hundred miles.

I am glad to say that there is a chance of action on the part of the Federal Government looking to the improvement of this stream. In 1875 I furnished, at the request of the United States engineers, a report on the mineral resources of this district, with special reference to this matter of slack-water navigation in the Chatterawha or Big Sandy Valley. As a good part of the waters of the river lies within the boundaries of another State, the Federal Government has a warrant for an effort at its betterment, and our Representatives should urge action on this point with all possible energy. With the same number of locks and dams on this river that has been built on the Youghiogheny, it would be possible to put equally as good qualities of coal into the Ohio below all the most serious dangers of navigation that menace the coals moving from Pittsburg to the lower Ohio, thus bringing the eastern coal beds of the Commonwealth at least one half nearer the market than the present sources of supply. The Peach Orchard coal brings the highest price paid for bituminous coal, and regularly sells at better prices than the Pittsburg coal, whenever it manages to struggle past the obstacles which block it from the market.

The upper Cumberland, within the limits of Kentucky, affords over three hundred miles of waters which could readily

be made navigable by slack-water but for the eighty feet of fall and some distance of cascades, where it passes the conglomerate of the coal measures. The fifty miles of this stream below the falls only afford a precarious navigation to small steamboats—a navigation which is so little to be trusted, that it cannot be thought of much value. Excepting at the falls and rapids above described, the Cumberland is a stream of very gradual fall, and is, therefore, well fitted for improvements of this description. Engineering skill would doubtless succeed in contriving a canal past these obstructions without great difficulty. The tributaries of the Cumberland, on account of their gradual fall, are peculiarly suited for the ready creation of a great canal system. Big South Fork, Laurel river, Clear Fork, Big Yellow creek, Straight creek, and the uppermost head waters, Poor Fork, Clear Fork, and Martin's creek, are capable of transformation into cheap canals.

The upper Cumberland, within Kentucky, can readily furnish six hundred miles of very important navigable waters. Thus we see that, including Green river and its tributaries, the Tradewater, the Kentucky, the Licking, Tygert's creek, the Chatterawha or Big Sandy, and the Upper Cumberland, the State can readily secure enduring water navigation having a length,within the mineral districts,of about twenty-four hundred miles. Estimating the average length of the pools at ten miles, would give a total of two hundred and fifty dams; and these, at a cost of say fifty thousand dollars each, which, inasmuch as the small tributary dams are small and not costly, is, it seems to me, a sufficient average price, we have a total of about twelve million dollars for the total cost. When we compare this sum with the cost of creating other practicable ways for the transportation of heavy materials, it is seen to be by no means excessive. The cheapest railways, fitted for heavy traffic in coal and iron, cost nearly ten times as much per mile. Indeed, the cost of this form of canal is not much over the cost of good ordinary turnpikes. The cost of operating is not to be compared with that of railways, nor even with turnpikes of the first class. The cost of the force of propulsion,

and the consequent impost on the materials, is exceedingly small compared with railways. This, with coal and iron, in a region where the transportation makes all the difference between profit and loss, is a most important matter.

The cost of creating this system of water navigation may be materially reduced by using convict labor, and protracting the work long enough to accomplish it in this fashion. Supposing the labor of seven hundred and fifty convicts is given to the work, and supposing that two thirds of the cost of construction is in the labor, it would require about forty years to complete this system, which is not too long a time for the execution of a great system of public works of this kind. If undertaken at once and steadfastly prosecuted, by the expiration of that time our State would have a system for the production and cheap transportation of iron and its products which would be without rival in the world. It would not require more than two hundred thousand dollars per annum, with the convict labor, to bring this scheme to completion; so that eight million of dollars, spread over nearly half a century, and giving, as one of its benefits, the incalculable amelioration of our penitentiary system, is the small price we would have to pay for this noble system of ways to our wealth.

In any contemplated extension of this slack-water system in our State, I would suggest a careful inquiry into the several methods of making dams now used in Europe. One of these methods, the system adopted to some extent in France, uses a dam that can be lowered down in high water and lifted in low water, with great ease, and possesses many advantages, inasmuch as it does not obstruct navigation in high water, permitting vessels to run out in floods without the delay of lockage, and yet providing locks when they are needed.

Another plan, which will be found very useful on the small creeks, tributary to the Ohio and to the Kentucky streams, where there is already slack-water, or where it may be hereafter built, has for its characteristic feature a contrivance whereby the lock is entirely dispensed with, and only a few hundred gallons of water is necessary to pass a vessel one hundred

feet long and twenty feet wide. An inclined plane, made of wood, leads from below the dam to its crest, rising at the rate of about two feet in a hundred. This can be made slippery by allowing a little water to flow over it, and then the boat mounting is dragged up by oxen. In descending, the vessel runs down the slope unaided, like a launching ship. The advantage is not only in the saving of water, but in the less cost of the inclined way as compared with the lock, it being readily seen that, in a country where timber abounds, the cost of the way need not be over five thousand dollars, even when built in the most solid fashion. The only place where I have seen these dams is in the Saltzkammer-gut, or the crown salt lands of Austria, where it is extensively used for the transportation of salt to market, the return loads being very small. The increased cost of return loads comes from the need of oxen to drag the boats over the dam. It would be easy, where there was a reasonable supply of water, to make a small water-wheel do this work. A wheel costing only a few hundred dollars would furnish ample power for the needs of this work. From what I have seen and heard of this method, I am inclined to think that it might work as well on the main streams as it does on the smaller rivers of Austria, where it has been adopted on account of the saving of water. If this should appear, on careful inquiry, to be the case, it would be immensely to the advantage of the general plan; for it would greatly reduce the expense of construction and management. On the main streams, where most of the transportation would be done by means of steamers towing flats, the steam power of the tug-boats could be made to drag their barges over the dam. The most considerable advantage of this system would be found in the fewer dams required, and the saving of all the trouble incident to the maintenance of locks. In order to carry vessels of large burden, there must be at least four feet of water on the gate-sills of the locks. This amount of water can often be readily had in mid-stream, five hundred feet below the lock, when it is hard to get it on the lock floor, and the water-way leading thereto. Some damage

would naturally be apprehended from the straining of vessels in passing over such ways. I believe that this fear is groundless; or, if it should prove an obstacle, it would be easy to meet the difficulty by the use of sheet-iron boats, which are pronounced to be the cheapest for long-continued usage. If this plan can be adopted for streams of all sizes, it would probably reduce the cost of giving our rivers the advantages of a system of locks and dams to not more than two thirds the cost of the ordinary method; possibly even less, for it is the locks, rather than the dams, that will make the expense of this form of navigation on our narrow rivers.

Inasmuch as this question is one of national importance, the Federal Government might be memorialized to have the whole question adequately examined, and determinative experiments made. By some such means the Ohio river could have its completely navigable waters extended to over six thousand miles of length. The problem of cheap transportation can be more easily solved in this way than any other.

Even where it is not deemed advisable to improve the whole of a river, it will sometimes prove important to make this form of navigation connect with a railway system. When the Chesapeake and Ohio Railway is extended to Lexington, Kentucky, as it must be in time, the Licking, from the crossing of the railway to its head waters should be provided with these locks and dams, or locks and slides. At a cost of something like five or ten thousand dollars per mile, this river could be made an admirable branch line of transportation for the railway. For this end, if desired, cars could be taken directly on to the boats and loaded at the mines, and taken from the boats, by an inclined way, to the main railway. The upper Cumberland, when it is crossed by a railway, either at the ford or at the falls, could be treated in a similar manner. My opinion is, however, clearly to the effect that the State should start with the determination to make, in time, every bit of possibly navigable water within its mineral districts the seat of actual navigation, so that its great natural sources of wealth may suffer no hindrance from the evils which so gener-

ally cramp the development of such resources. In the great race which is before our Ohio Valley States it will secure her the victory.

RAILWAY TRANSPORTATION.

The advantages of our natural water-ways have been considered in some detail. It will be seen that the possibly navigable waters intersect the State so completely that there is no point more than twenty-five miles from water which could be made passable for boats carrying one hundred and fifty tons of coal or other equal burden. But, as before remarked, all this system turns its current towards the west; and it is only through the Mississippi river, or the eastward-running canals, that water-ways can be had towards the great markets of the world. Year by year, with the marvelous growth of the Ohio Valley, makes the products of its tributary streams more valuable. But it is, in a high degree, important that in this growth our State should have its full share of the increasing markets. That it has failed to get this share in the past cannot be questioned. The first State of the Ohio Valley, in order of time and in order of resources, she has been the last in order of growth. The reason for this is plain. The other States, from the Gulf to Canada, have had their ways leading to the east, whence has come the tide of immigrating capital and labor—ways of water and of iron—the best that art could build. Kentucky has had the Wilderness Turnpike, a way where the tolls are about the only evidence of the existence of a road. It is easier for the immigrant to find his way to Kansas than it is to Kentucky; and it is not surprising if he concludes that the region must have little to offer where there are so many obstacles in the way of access. We have permitted the great store of coal and iron, which forms the so-called mountains of the State, to serve as an unbroken barrier between us and the outer world, cutting us off from the great cities of the Atlantic seaboard, from the Southern and Eastern States, and from the European markets.

It should be the especial object of our railroads to open the east to our markets, as our improved rivers will open the west. I shall not consider the existing railroads of Kentucky, nor those required for other than mineral purposes, but shall limit myself to the main lines necessary for the fullest development of our industries which have a geological aspect.

The so-called mountains of Kentucky, so far from being a barrier to the passage of railways, is, on the whole, a region more fitted for their passage than the Blue Grass country. The valleys are more traversable, and the great obstacles more easily turned. The cost of trunk roads to the sea should be less than an equal mileage in Central Kentucky, constructed with the same thoroughness. In this I am expressing the opinion of competent engineers, who have examined the country with preliminary surveys, whose judgments my own observations have abundantly confirmed. In the present condition of capital in Kentucky, and with the limitation of our Constitution, it is absolutely necessary that the greater part of means of construction of these roads should come from other States. In this regard the position of Kentucky, with respect to the bordering States, is, on some accounts, fortunate, and in others unfortunate. The mother State on the east, Virginia, ravaged by war, worn by time, and robbed of her richest lands, can give us little but good will as aid. The West Virginia section is helpless from several causes, as well as from the doubt that rests on the legality of its organization. The States of North and South Carolina are also in grievous financial trouble. All these States, however, have a material interest in getting highways through Kentucky, and whatever can be done by them will doubtless be done in aid of this work. It is, however, to ourselves, and to the States to the north and west, that we must look for the execution of these great works. The need of coöperation, and the chance of obtaining it, will necessarily greatly influence our plans of breaking through our eastern barriers. The same causes which led to the creation of the Cincinnati Southern Railway will, in time, force other lines through the State. My

aim is simply to show the points at which this barrier can best be broken by railways, both as regards the physical and mineral conditions of the routes.

Beginning at the Ohio river, the first of these routes is that which has been projected, and a small part actually built, along the Ohio river, following the meanders of the stream, from the mouth of the Chatterawha or Big Sandy to the city of Newport. This road, while promising many eminent advantages, would not serve as a main eastern outlet for the body of the Commonwealth. Its principal mineral value would be the certain market for the products of the mines and furnaces approached by the Eastern Kentucky Railway—already one of the considerable roads of the State. Coal that has once been placed on rail cars should not be transferred to boats on account of damage of transfer. As these coals, or, at least, that of the most worked seam, have peculiar properties of great value as coals for smelting iron and for locomotive boilers, they would command an extensive market. The iron ores of this region have also some peculiar properties, which may well bring about their shipment to other iron-producing districts in the Ohio Valley. The shipment of coal to the Cincinnati centre from these Eastern Kentucky mines would, doubtless, make this region one of the sources of supply for that great market. I do not believe it could compete with the supply from the Big Sandy, when that river has been provided with proper locks and dams for the lower one hundred miles of its course. When that is done, shipments by rail to the towns as distant as Cincinnati will, for the ordinary uses of house and steam coal, have to be limited to those seasons when the main river is unnavigable, and the price of coal consequently much enhanced. Probably the greatest advantage that could be gained by this road is in the better chance it would afford of marketing our Kentucky iron products in the middle Atlantic States. This, however, will be substantially gained by any connection between the Eastern Kentucky Railway and the Chesapeake and Ohio Railway. There is no question that this railroad will be required by the com-

merce of the Ohio river. At first sight it might seem a matter of indifference to the commerce of the valley whether it should be built on the north or the south side of the river. It should, however, be well understood, that the supply of coal that can be obtained from the line of the Eastern Kentucky Railway is larger in amount and better in quality than that to be had by taking the northern side of the river. Any road down the valley should be laid so as to secure this connection.

The next road to be considered is one of the most important that could be undertaken in the interests of the development of Kentucky. The Lexington and Big Sandy, though necessarily, from the way in which it has to cross the drainage, a very costly road, is destined to afford a series of very great advantages to the development of the geological industries of our State.

The valley of the Kentucky river, on a line from the city of Lexington to Pound Gap, affords the next practicable and desirable line. A road has, it is true, been projected and surveyed from Portsmouth to Pound Gap by way of Tygert's creek; but the interests leading to its creation are too small, and the physical obstacles in its way are too great, to be readily overcome. This Kentucky river line, for all of its path within the State, must lie in the basin of this stream. From the point of view of our industries, this road must have very great value. Traversing the Appalachian coal field at nearly right-angles, it comes in contact with all the important beds of coal that exist in this section. There are reasons to believe that the Clinton iron ores may be found on the Virginia side of the coal field, a little beyond the State line. If this should prove to be the case, we should secure a market for our iron-smelting coals in the working of these ores in that section. These coals of the Kentucky field ought to find a considerable market in the valley of Virginia, and might pay for transportation to the seaboard.

The timber resources of this section are admirable, and, in the existing state of the market, would alone warrant the

extension of the road for a great distance into the coal field. I have already expressed my opinion concerning the importance of this road to Central Kentucky in a letter to the President of the Mount Sterling Coal Road. It is only necessary to add thereto that, this road being complete to Abingdon, Virginia, would constitute another of those main lines of entrance into the State, on the creation of which absolutely depends the chance of future greatness of the Commonwealth in point of wealth and numbers.

From Pound Gap south to Cumberland Gap there are grave obstacles to any projected railway. The Pine Mountain is a formidable and unbroken barrier, and the country on either side of it presents considerable difficulties. It was not without reason that for nearly a century the road to Cumberland Gap was the highway over which a large part of the commerce of Kentucky found its way. Nature has marked it for a way by the comparatively easy grades; and the generally good agricultural conditions of the country traversed gave the other advantages required for such a highway. There are two possible lines by which the passage can be made from the central region of Kentucky to Cumberland Gap, and beyond to the seacoast, via the great road to Charleston and Savannah, which will soon require only this link for its completion. One of these lines may be considered as starting from Paris, Winchester, or Mount Sterling, and passing by way of the Kentucky Red river, crossing the Kentucky at some point near the mouth of Station Camp creek, or even higher; and thence by way of Manchester, in Clay county, to Cumberland Ford; and thence by the valley of Big Yellow creek to the Gap. There are no serious engineering difficulties on this line that have been seen in the reconnoissances of the Survey. I am very anxious to see a road built from the central belt, by way of Red river and Manchester, to the Gap, for the reason that I believe it to be one of the most important roads for the mineral interests of Kentucky that can possibly be built. In the first place, it will bring the furnaces of the Red River district into close connection with the admirable ores of the Clinton beds, just at the

Gap. These ores can be put at the Red River furnaces for about two dollars per ton; so that four dollars' worth of ore will make a ton of pig iron. It will, at the same time, give an outlet for the product of these furnaces. One and a half million dollars have been invested in these furnaces, but they are now lying idle for lack of sufficient transportation to furnish them with ores and take away their product. These furnaces could be operated to-day at a profit if this railway were in existence. The Manchester Salt-works are apparently capable of indefinite extension in their production, provided they were supplied with cheap transportation. At present, their product struggles out over almost impassable roads into East Tennessee and Central Kentucky. The iron ores of the neighborhood of Cumberland Gap have already been described in the preceding section of this report, and in the more detailed report of Mr. P. N. Moore. To give a chance for this interest to develop itself—to build in our borders, as we certainly should, one of the most extensive iron industries in this country—would be of itself a sufficient result of this road to pay for its building many times over. The variety of coals accessible on the line of this road, or any similar line, is great. Details on this point will be found in the special report* concerning the line from Livingston to the Gap. In this report will be found a discussion of these cannel coals, and the other geological features of this line.

The great importance of this line cannot be presented without considering its relations beyond the limits of the State of Kentucky. It is as a through line from the northwest to the southeast that it most deserves our attention. The proposed Chicago and Southeastern road would most satisfactorily establish the relations which would give this line from Central Kentucky its true character. Passing through Kentucky, on the shortest line, this road would come by Livingston Station, or some line near there. But this line would not serve the purpose of continuing the Kentucky

*On the line from Livingston to Cumberland Gap, by C. J. Norwood, volume II, second series.

Central Railway which is one of the improvements the near future must bring into existence; nor of furnishing connection to the Red River furnaces with their markets, on the one hand, and new supplies of ore on the other. It seems to me, that the best plan would be to carry separate roads from Livingston and from Red river to some point near Cumberland Ford, and make them joint roads from that point eastward to the Morristown (Tennessee) connection with the southern and eastern railroads. With this set of roads from the Gap, westward and eastward, we would develop a very extensive coal and timber country, opening at either end to good markets. On the west, they would ship coal through Kentucky to the Ohio river; on the east, the whole of the market of the Carolinas and East Tennessee would be within the range of competition. It will be seen, by a glance at the maps which accompany this report, that the three eastward connections provided by the roads which are advocated here would, in fact, be the through routes to the sea-board, each terminating at one or more of the first-class harbors of our coast: the Lexington and Big Sandy connecting advantageously with New York, Philadelphia, Baltimore, Washington, Alexandria, and Richmond; the Pound Gap road would give direct connection with Norfolk and Wilmington, North Carolina, by a nearly air-line route; the Cumberland Gap affords a direct connection with Charleston, South Carolina, and Savannah, so that our principal mineral belt would be brought into the most immediate contact with all the shore-belt cities of the Atlantic for a hundred miles of coast. The coaling of the ocean navigation steamers, which, in fifty years, will go forth from these cities, between Washington and Florida, would of itself develop the mining interests of Eastern Kentucky. These Kentucky mines can put coal in Norfolk cheaper than it can be had from any other region, owing to the fact that they can be worked without pumping, and deliver their coal directly on the tracks of the railways.

These three trunk lines, with their connections, giving three new channels to the east, can be made by building four hund-

red and ten miles of road, which, at the average of thirty-five thousand dollars per mile, aggregates thirteen millions of dollars. Taking only the Big Sandy and the Cumberland Gap lines, which are the most important to the State, from the point of view of its mineral resources, the expense need not exceed six million dollars to secure connections with Huntingdon and Morristown from the Mount Sterling and Livingston termini.

For the present, I should feel that it was safe to trust the development of the Kentucky River Valley to its slack-water navigation, if that should be improved, waiting until the future for other communications; but in the case of the roads from Livingston to the Gap, from Winchester or Mount Sterling to the Gap, and from Mount Sterling to Huntingdon, I feel that they are the most pressing of all the imminent needs of our State, and the very first condition of her future prosperity. The cost of their building will not begin to equal the expenditure of money incurred in making any other of the great east and west routes of this country. It seems to me that they cannot fail to pay a sufficient return on the capital expended in their construction. I do not know of an instance where a road, passing for its whole distance through a valuable coal, iron, and timber district, and at the same time a district of fair agricultural qualities, connecting at either end with a far-extending ramification of routes with first-rate regions, rich in other resources, but wanting in mineral and timber products, has failed to pay.

In the three lines indicated in the foregoing discussion of the important eastward routes north of Cumberland Gap, I have desired to do nothing more than refer to the facts which are discussed in an elaborate manner in the special reports of the officers of the Survey concerning these lines of possible railway. The last part of this discussion I will give to the consideration of a line which has not yet been fully explored, but which deserves to be regarded as one of the most important ways for the development of the State. A glance at the map will show that none of these ways provide access to the

region immediately bordering the Tennessee line. It will at the same time be seen that a line passing in the most direct fashion from the great geographical centre of the Mississippi Valley, the junction of the Ohio and Mississippi, in the most direct way, to the southeastern seaboard, is a matter of great importance, not only to the State of Kentucky, but also to the whole Mississippi Valley. Taking the line of the Elizabethtown and Paducah road, from Paducah to a point near Caneyville; thence by the most direct line, past the Mammoth Cave to Glasgow Junction, on the Louisville and Nashville Railway; thence, by way of Monticello to Barbourville, we find that a total additional iron way of about one hundred and eighty miles would bring this road into connection with the other proposed roads to Cumberland Gap and the eastward. This line would give a connection between St. Louis and the sea about one hundred miles shorter than any existing route. But it is not the shortness of the line alone, and the consequent easier passage between the heart of the Mississippi Valley and the sea-board that commends it. It is the fact that it traverses, at their greatest breadth, the two principal coal and iron fields of our State. More than three hundred miles of this line would lie within the coal and iron belt, not over one third of its length within our borders being destitute of these advantages. No other road to the eastward from the Mississippi will have anything like the same amount of coal and iron on its line.

In the section east of the Cumberland there is a great area of beds, affording lubricating oil of the most admirable quality, and which, at present, struggles to a market over thirty miles of bad roads and one hundred miles of difficult river navigation. I see no reason to limit these coal oil-bearing beds to narrow bounds; and the conditions favor shipment to the eastern ports.

At the crossing with the Louisville and Nashville, the Cumberland and Ohio, and the Cincinnati Southern, this road would find a great market for the coal that is found along its line. To the Nashville line it would afford a pas-

sage to the Mammoth Cave, and thereby obtain the large passenger trade that now passes to that point. At its crossing over the Big South Fork of the Cumberland it would come upon about the best water-power in Kentucky. This crossing point could not fail to grow to be a seat of a great manufacturing industry. Rich and varied as is the timber supply of the rest of the State, this line would command the richest and most varied resources of that kind known to me in America. Along the whole line the hard-wood timbers abound. The whole western coal field is one nearly unbroken area of hard-wood forests of the finest quality. East of the Louisville and Nashville Railroad there is a great amount of fine cedar timber. At the crossing of the Big South Fork we get a water-way reaching far up into the Central Tennessee table-land, rich in the several varieties of soft wood or coniferous timber which belongs in this valley. The agricultural capacity of this line will be, on the average, greater than on any other line of equal length known to me in this country, when we take the variety and value of its crops into consideration. The whole of the line is an admirable fruit region. Damage by frost is exceedingly rare—fruits ripening earlier by some weeks than on the line of the Ohio river, near Louisville or Cincinnati. At least one half of the line is fit for tobacco culture—a crop of great value to a railway, inasmuch as it furnishes a freight that can stand heavy charges for transportation, and leads to the importation of large quantities of artificial manures. In short, the assemblage of conditions is peculiarly favorable for the development of industries in the region adjacent to the line of this proposed road.

The difficulties of a passage through this section are by no means great. In the autumn of 1875 I rode the general course a railway line will be compelled to follow, and could perceive no material obstacle. The valleys of the streams are sufficiently gradual in their slopes to admit of a passage across the drainage without very heavy grades. At about the line of the Kentucky border with Tennessee, there begins to be decided indications of the rise to the Tennessee table-

land. This extensive elevated region affords a formidable barrier to the passage of a railway from the northern line of Tennessee down to the river of that name; so that the line from Glasgow Junction to the Gap, by way of Barbourville, is about the only east and west road that is likely to be built through this part of the South for many years to come.

While this line must naturally look to the people of the district it traverses for much assistance in its construction, it should be undertaken in the interest of the great transportation interests that centre near St. Louis and about the junction of the Ohio and Mississippi rivers. The northern roads to the sea have been built in the interest of the populations which fill the country north of the 40th parallel of north latitude, and naturally serve the interests of those sections for European shipment. The waters of Chesapeake Bay—the great harbor of Norfolk especially—furnish the best outlet for the commerce of the region south of that line. Year by year it will be better and better understood that the transportation of the heavy freights of the West can be more cheaply accomplished from Norfolk than from New York, on account of the difference in the distance of land carriage. Moreover, roads can be constructed and operated in this almost snowless and nearly winterless belt far more cheaply than they can be in the latitude of New York and Pennsylvania. Add to this, the greater length of line within the region abounding in coal and iron, and we perceive the conditions which will, in time, determine a large share of the commerce of the country to lines which will traverse this section. But the roads will not build themselves; and it will be quite possible for Kentucky to remain as she is—the most inaccessible State in America, a State whereto capital and labor cannot penetrate, and out of which its wealth can find no suitable way—if its people do not determine it shall be otherwise.

Situated as we are, with a people essentially agricultural, and therefore without the large capital which comes from massed industries, with our wealth of resources without value, until we can give them the results of millions of expenditure,

the question comes as to the possible plan of development. While this is a question quite outside of geology, I venture, as one who has watched with great care the methods taken in different countries for developing such works, to say a word, by way of suggestion. Our Constitution denies the right to the General Assembly to contract debt. Some may regret this provision, though I confess I am not of their number. I believe, however, it is quite within the province of the Legislature to impose taxes, and, with the money well in hand, to undertake those improvements which the advance of the State seems to demand. It also has the right to employ its convicts in the way it may seem best. If fifty years ago the men who have owed service to the State for offenses against its laws had been put on public works and kept steadily engaged, say one half upon slack-water navigation and one half on railways, we could have had at this moment, as the result of their labor, at least six hundred miles of slack-water navigation, and every railway here designated as necessary could have been completely graded, bridged, and made ready for the rails. Companies could doubtless be found to take roads at this stage of their construction, which would, for leases of say fifty years, at nominal rates, complete the work of equipping them for travel. Within a relatively short time they would fall into the hands of the State, to be released at a considerable direct gain to its revenues, to say nothing of the gain from increase of taxable property. By leasing these works, the State would avoid the great dangers of administration, which would come from direct management by her own officials.

Fifty years, with their possibilities, are in the life of our Commonwealth, let us hope, but as a day. With the yearly increasing population and the unhappy growth in the number of prisoners sentenced to labor, the work can be done in a far shorter time, beginning now, than it could have been done beginning fifty years ago. The annual cost to the State for these improvements would be the provisioning, clothing, guarding, and directing of say six hundred convicts, the purchase of

tools, &c., all amounting to about one hundred and fifty thousand dollars per annum. Who is there who knows the life of a convict in our penitentiaries who does not believe that the moral gain of breaking up our convicts into small bands, and employing them in healthy occupations, which are of account to the future of the State, would be worth this relatively trifling sum?

But the gain to the State is manifold, and to be reckoned in something more tangible than morals. The whole central region of the State is languishing for want of a direct road to the great commercial centres of the East. If the State would take, say three hundred convicts, on to the Lexington and Big Sandy road, it would be ready for the rails within five years. There is an abundance of capital that would be glad to lease it for fifty years on condition of ironing the way, and at the end of that time returning the property to the State. The Commonwealth would then have in its possession a property which, judged by the value of other east and west roads, could be reckoned as worth at least sixty thousand dollars per mile, or about five million of dollars, besides having had the profit of the gain to its citizens, which would be sure to accrue from the building of the road. At the present rate of growth of our population, the average number of prisoners fit for service on public works, during the coming thirty years, may be safely set at one thousand five hundred. This gives a total of about thirteen million five hundred thousand days' labor that can be realized in this work of public improvements. Calling this work equal to labor at two dollars per diem—a low valuation, considering that there are skillful carpenters and masons in the work, and other men trained to their trades—we would have a total of thirty-seven million dollars in our public improvements. Allowing that our railroads amount to five hundred miles, costing for grading and bridging thirty thousand dollars per mile, and that our slack-water is extended to two thousand miles, at six thousand dollars per mile, we still fall within the limits of our estimates. Granting that no dollar of profit was ever received from this form of improvement, it

is clear that the State would be repaid many fold for the cost of the works. But when we see that every mile of these improvements connects itself with the great enriching industries, it is easy to believe that the State will, after fifty years of this system of improvements, find itself in possession of a really imperial revenue from her own commercial avenues.

How advantageous it is for a State to hold possession of its commercial channels, is well shown in the little kingdom of Belgium. In that little State, less than a third of the area of Kentucky, and with far less in the way of mineral wealth, there is a rich population of more than four million souls. A large part of the success of this State has been due to the fact that the control of the channels of trade has been kept in the hands of a well-administered government. The State owns the railways, and makes them the cheapest lines in Europe, and still gains some profit from them. It will be possible for our Commonwealth to get the same control of the east and west lines, which are destined to become the great trade lines from the Mississippi Valley to the sea.