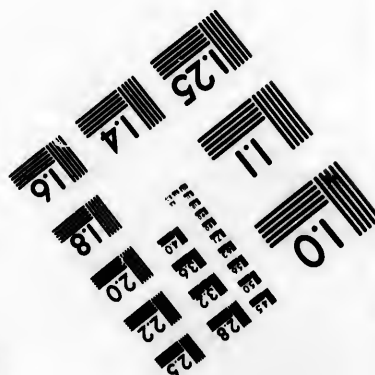
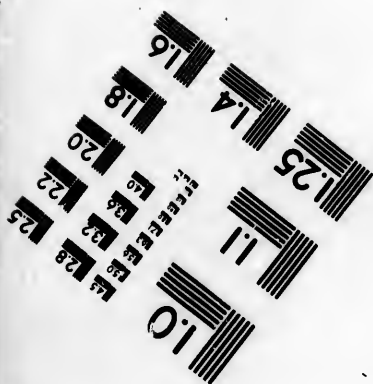
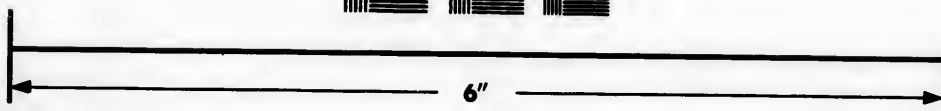
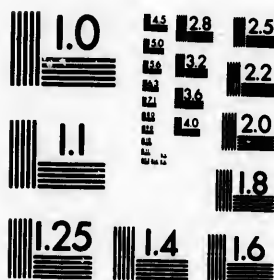


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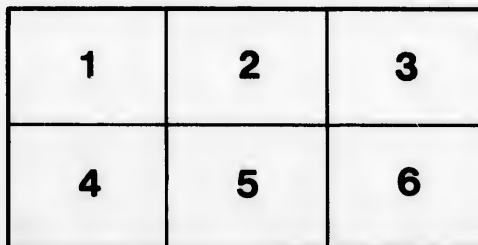
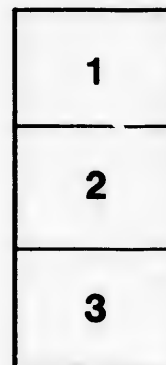
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A
PRACTICAL ESSAY

ON THE
SCIENTIFIC REPAIR AND PRESERVATION
OF
PUBLIC ROADS.

PRESENTED TO THE BOARD OF AGRICULTURE,
BY
JOHN LOUDON M^cADAM, Esq.

PRINTED AND DISTRIBUTED
*By Order of the Board of Agriculture, and Internal Improvement,
at London, 1819.*

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1819.

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THE HISTORY OF THE

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OF

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IN

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THE HISTORY OF THE
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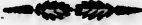
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MEMORIAL.

TO

THE RIGHT HONOURABLE THE PRESIDENT AND
THE BOARD OF AGRICULTURE.



THE duties of the Memorialist, as a Magistrate and Commissioner of the Roads in Scotland for many years, first induced him to turn his attention in a particular degree to this branch of our domestic economy. The obvious disproportion existing between the facility with which large sums are raised for the service of the roads on the one hand, and the means provided for ensuring a wise and economical expenditure on the other, excited an inclination to trace the causes of this great defect in the national system of road management; and for this object the Memorialist was induced to travel over a great part of the country, from Inverness in Scotland, to the Land's End in Cornwall, which gave him many opportunities to observe all the various modes of making and amending roads; the different kinds of materials used; and of comparing the success resulting from the several methods of constructing roads throughout the kingdom.

The ancient roads of the kingdom were paths beaten by travellers, who sought the driest ground, but without any attempt at forming an artificial surface. Modern roads have in most instances followed the same course as the old paths, which accounts for the improper lines of roads observable all over England.

When commerce became extensive, and enclosure confined travellers to one path, attention was paid to making artificial roads, and a remedy was applied to the inconveniency of sinking into a soil constantly moistened under an uncertain climate. Great quantities of stone were thrown upon the subsoil, which rendered the roads just passable. But no regular system was adopted; and

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although practice has produced considerable improvement, yet to this day no scientific principles have been applied to this most important branch of our domestic economy. Nothing has been written on the subject of the surface of roads, or the means of making them proper for the easy passage of carriages, though volumes have been published to recommend many useless, and many vexatious restrictions on the carriages themselves.

It seems never even to have been considered, what is required in constructing a public road; and it is generally deemed sufficient to collect a considerable quantity of stone or gravel, and to throw it down upon the ground.

The opinion having once unfortunately prevailed, that all exertion of science was unnecessary in the forming and preservation of the public roads, the profession of road-making became contemptible in the greatest degree; and it is at present believed to be perfectly adapted to the capacity of the most ignorant day-labourer.

This misapprehension has occasioned the fatal error of intrusting the care of the Turnpike Roads, and the actual expenditure of the immense sums annually raised for their maintenance, to the hands of Surveyors, selected from the lowest and most illiterate class of the community. Experience has shown, that the control exercised over these men by Commissioners, is very inefficient. The number of Gentlemen constituting a Trust; the universal ignorance of the principles of road-making; and the private occupation of the Commissioners, render them totally unfit to enter into the detail of the business, or to exercise that constant and vigilant control, requisite to preserve integrity and economy throughout an expenditure so complicated and so extensive.

From these two causes, the want of all scientific principles in the construction of roads, and the want of education, rank and character in the officers under whose inspection the money passes to its destination, have proceeded the proverbially bad state of the roads of Great Britain;—the enormous amount of the expenditure;—and the consequent creation of a debt, which threatens in a few years to absorb the whole road funds for payment of interest.

The turnpike roads of England and Wales amount to about 25,000 miles in extent, and cost annually about a million and a quarter to maintain them, in their present defective state. The debt over the whole cannot well be estimated at less than seven millions; probably it even exceeds that sum; whilst the numerous petitions yearly presented to Parliament for increase of tolls, show, that this enormous debt is accumulating with alarming rapidity.

Many years necessarily elapsed, before the efforts of a private individual could obtain sufficient information, to enable him to form any comprehensive maxims respecting a branch of the public service so widely extended; and where the ignorance of the executive officers rendered their communications of small value, whilst that little was often deceitfully, always unwillingly bestowed.

The following plans for the construction and repair of the roads of Great Britain, and the protection of the funds from mismanagement and speculation, were the result of the reflections of thirty years.

A road ought to be considered as an artificial flooring laid upon the naturally moist and soft soil of this island: this artificial flooring requires considerable skill and ingenuity in the choice and preparation of the materials, and in distributing them, so as to form what is required, namely, a strong, smooth, solid surface, over which carriages may pass without danger of sinking into the sub-soil, or finding any impediment to prevent their being drawn with the smallest possible effort of animal labour.

The first of these objects, strength, is obtained by the quantity of materials; in this respect, all the old roads of the kingdom have been overdone; and the Memorialist has generally found a sufficient supply in a road for several years use.

The second, smoothness and solidity, can only be obtained by a proper selection, preparation and distribution of the materials. None but firm and solid bodies can be made smooth. It seems, therefore, an obvious proposition, that the materials of which a road is to be composed, should be reduced to such a size as shall enable carriages to pass over, without striking against them, so that they may be consolidated by a perpendicular pressure. The size of the stones must be proportioned to that part of the wheel, which will form the point of contact upon a smooth, level surface; and this will be found to be about an inch square. When the stones of a road exceed the size of this bearing, the wheels of carriages will keep them in constant motion, and prevent their consolidating: because, when a wheel rests only on one part of a stone, the other part rises; or, if the stone be so large that the wheel does not pass over, but strikes against it, besides the impediment presented to the carriage, a great damage is done to the road. From this it appears, that every stone above a specified size, is a positive disadvantage in road-making. Upon a road made of well-ordered materials, wheel carriages will pass over without any jolt or shake; and consequently without that action and re-action between the wheels and the stones, which is the real cause of the present bad state of the roads of Great Britain. A rough road can only be a road made of large stones; and as neither use, nor change of weather, can produce them, this defect must be entirely the work of the road-maker.

It has been urged in favour of the practice of using large materials, that carriage wheels very soon break them. Supposing this assertion well founded, it would not be difficult to prove, that carriage wheels are the most expensive breaking hammers which can be employed by the public. But is not true, that the work is effectually performed; for wheels passing over and amongst large stones, grind them to powder, instead of breaking them into proper sizes. The same argument also applies to an opinion very commonly entertained, that breaking the stones small, anticipates the

ON MAKING AND REPAIRING OF ROADS.

friction, and consequently the wear of the road: There is much more friction upon a rough road, than on one perfectly level and smooth.

In making a road, the practice of mixing the stone with sand or earth, is to be carefully avoided. Earth retains the moisture, is strongly affected by frost, and changes with every variation of the weather. Clean unmixed stone cannot be acted upon by any change of the weather; and a road properly made, will be equally good in all seasons.

Until some powerful hand shall form one uniform system of making and repairing roads upon a scientific plan, and of preventing different Trusts being competitors for the purchase of materials, as is the case at present in the neighbourhood of London, all the little palliatives of regulating acts will be nugatory: the hydra evil, of Commissioners expending immense sums in marring the roads with large stones, blended with earth, and other mischievous materials, will continue. Whatever carriages the law may compel men to draw through such roads (for at present they do not travel over them), must continue to act as ploughs.

When the necessity of adopting one scientific system for the management of roads throughout the kingdom shall be felt by the Legislature, in order to insure its success, another great public act will remain to be performed.

The Legislature has intrusted the care of local road affairs, to Commissioners selected from that class of the community least liable to abuse the confidence reposed in them; and as far as their duties extend, it is impossible to commit this great trust into better hands. But it appears, that these Commissioners are, from various causes, incompetent to the unremitting vigilance requisite in executive officers; and thus, while every other branch of the public service, requiring the expenditure of large sums, is placed under the constant control of men of rank and character, the road revenue remains without any efficient protection against the united depredations of dishonesty and ignorance.

The remedy proposed is, to commit the scientific direction of the work into the hands of responsible officers of the rank of Gentlemen; to place the Sub-surveyors under the orders of those officers, upon whose report the Commissioners may safely rely, in selecting deserving and trust-worthy persons as Sub-surveyors; and by whose skill these Surveyors may be first instructed, as well as directed in their proper discharge of their duties.

The system of road management hitherto practised, has had the effect of repressing every effort for acquiring skill, and every exertion of science, as connected with this branch of service. Men of education, of character, and of rank in society, must now be induced to accept the situation of General-Surveyors of Counties or Districts, by due encouragement from the country; by the profession being made properly respectable, and reasonably lucrative.

As the care and management of the roads of the kingdom can never, with advantage to the public, be taken from the Commissioners, and consequently the nomination of the General-Surveyors, and other officers, must remain with them, it will be necessary, in order to obviate the danger of the abuse of patronage, to commit a general inspection of roads to some department of the Government. The department most obviously and naturally connected with the roads, is the Post-Office, and the public voice has already decided, that to this authority the superintendance should be committed by a special commission to the Post-Masters General:

This additional department must be invested with a discretionary power, to suspend officers in cases of neglect or misconduct; and a report of the condition of the roads in every district, their extent, alterations made, &c. &c. with a copy of the accounts, and an exact statement of the finances, must be transmitted yearly, by the Surveyor-General to the Post-Office, which must lay the whole before Parliament.

A laudable ambition to excel being thus excited by the prospect of farther promotion, gentlemen's sons will be induced to acquire the necessary skill and information, to follow this profession. Although from local circumstances, some appointments will be less liable than others, the confidence reposed must in all cases be so great, that it will be impossible to consider the public interest safe, in any other than the hands of a gentleman.

The expence of such an establishment will appear as nothing when the immense sums annually lost to the public, through misapplication and fraud, are properly considered. Whenever the Memorialist has been called upon to examine into the affairs of a Trust, and to attempt an amendment of its Roads, it has been proved incontestibly; that at least one-third of the funds has been unprofitably, if not mischievously expended. A tythe of the money thus squandered would liberally provide for an establishment which would effect a general reformation of roads throughout the kingdom.

The heavy expence to the public, in the consumption of horses and carriages, occasioned by the present deplorable state of the roads, although it falls so gradually on all ranks of people, as to be little thought of, is a subject deserving the serious attention of the Legislature. The sum so lost by the nation has been estimated, by a Committee of the House of Commons, in 1811, at five millions per annum.

The Contractors for expediting the Mails, find considerable difficulty in fulfilling their contracts, from the same cause. Notwithstanding the destruction of horses, painful to humanity, in drawing the mail coaches, it is nearly impossible, on some roads to perform the distance within the given time.

Although the necessity of some public control over all the roads of the kingdom can hardly be questioned, yet the hints, respecting the manner in which that control should be exercised, are offered with great diffidence. It is generally hoped, that the importance

of the subject will call forth the attention of much abler men. Of that part of the system which relates to the construction of the roads, and the appointment of General-Surveyors of Districts, the Memorialist speaks with that confidence which is the result of actual experience.

When years left the Memorialist at liberty to devote his time entirely to the public service, the Commissioners for care of the Turnpike Roads of the Bristol District were induced, by an acquaintance of many years, during which the Memorialist had acted as Commissioner in that Trust, to place their roads under his direction as General-Surveyor. The public spirit of the Commissioners having empowered the Memorialist to begin the work of reformation, their zealous and unwearied support enabled him to extend it to the most minute details in the management of the roads.

During three years that the Memorialist has held the Office of General-Surveyor, an extensive field of observation has presented itself to his view. Above all, having now felt the difficulties of a profession, requiring the union of much statistical information and practical knowledge of country work, with the regular habits of business, the estimation of his own abilities as a road-maker has been much lowered; and consequently, the opinion of the urgent necessity of employing officers of education and character, in the executive department of the roads, has daily acquired strength in his mind. Many things, which appeared in theory, were found unprofitable in practice; and others of obvious utility, have been rendered difficult of execution, from the obstacles of prejudice and ignorance, which nothing but time and talent, exerted under the fostering care of the Legislature, can effectually overcome.

J. LOUDON M'ADAM.

Directions for Repair of an old Road; being the Substance of a Communication made to the Committee of the Honourable House of Commons in 1811, and published with the Report, by Order of the House, with additions and alterations, deduced from actual practice during the last three years.

1st February, 1819.

No addition of materials is to be brought upon the road, unless in any part it be found that there is not a quantity of clean stone equal to ten inches in thickness.

The stone already in the road is to be loosed up and broken, so as no piece shall exceed more than six ounces in weight.

The road is then to be laid as flat as possible; a rise of three inches from the centre to the side, is sufficient for a road thirty feet wide.

The stones, when loosened in the road, are to be gathered off by means of a strong heavy rake, with teeth two and a half inches in length, to the side of the road, and there broken; and on no account are stones to be broken on the road.

When the great stones have been removed, and none left in the road exceeding six ounces, the road is to be put in shape, and a rake employed to smooth the surface, which will at the same time bring to the surface the remaining stone, and will allow the dirt to go down.

When the road is so prepared, the stone that has been broken by the side of the road, is then to be carefully spread on it; this is rather a nice operation, and the future quality of the road will greatly depend on the manner in which it is performed. The stone must not be laid on in shovels full, but scattered over the surface, one shovel-full following another, and spreading over a considerable space.

Only a small space of road should be lifted at once: five men in a gang should be set to lift it *all across*; two men should continue to pick up and rake off the large stones, and to form the road for receiving the broken stone, the other three should break stones; the broken stone to be laid on as soon as the piece of road is prepared to receive it, and then break up another piece—two or three yards at one lift is enough.

The proportioning the work among the five men, must of course be regulated by the nature of the road: when there are many very large stones, the three breakers may not be able to keep pace with the two men employed in lifting and forming, and when there are few large stones, the contrary may be the case: of all this the Surveyor must judge and direct.

But while it is recommended to lift and relay roads which have been made with large stone, or with large stone mixed with clay, chalk, or other mischievous materials, there are many cases in which it would be highly unprofitable to lift and relay a road, even if the materials should have been originally too large.

The road between Cirencester and Bath is made of stone, too large in size, but it is of so friable a nature, that in lifting it becomes sand: in this case I recommend cutting down the high places, keeping the surface smooth, and gradually wearing out the materials now in the road, and then replacing them with stone of a better quality, properly prepared.

In like manner a part of the road in the Bath District is made of freestone, which it would be unprofitable to lift.

At Egham, in Surrey, it was necessary to remove the whole road, to separate the small portion of valuable materials from the mass of soft matter, of which it was principally composed, which was removed at considerable expence, before a road could be again made upon the site.

Other cases of several kinds have occurred, where a different method must be adopted, but which, it is impossible to specify, and must be met by the practical skill of the officer, whose duty it may be to superintend the repair of a road, and who must constantly recur to the general principles laid down in this Memorial, (p. 272). These principles are uniform, however much circumstances may differ, and they must form the guide by which his judgment must be always directed.

When additional stone is wanted on a road that has consolidated by use, the old hardened surface of the road is to be loosened with a pick, in order to make the fresh materials unite with the old.

Carriages, whatever be the construction of their wheels, will make ruts in a new-made road, until it consolidates, however well the materials may be prepared, or however judiciously applied; therefore, a careful person must attend for some time after the road is opened for use, to rake in the track made by wheels.

The only proper method of breaking stones, both for effect and economy, is by persons *sitting*: the stones are to be placed in small heaps, and women, boys, or old men past hard labour, must sit down with small hammers and break them, so as none shall exceed six ounces in weight.

The Tools to be used are,

Strong picks, but short from the handle to the point, for lifting the road.

Small hammers of about one pound weight in the head, the face the size of a new shilling, well steeled, with a short handle.

Rakes with wooden heads, ten inches in length, and iron teeth

about two and half inches in length, very strong, for raking out the large stones when the road is broken up, and for keeping the road smooth after being relaid, and while it is consolidating.

Very light broad-mouthed shovels, to spread the broken stone, and to form the road.

Every road is to be made of broken stone, without mixture of earth, clay, chalk, or any other matter that will imbibe water and be affected with frost: nothing is to be laid on the clean stone on pretence of *binding*; broken stone will combine by its own angles into a smooth solid surface, that cannot be affected by vicissitudes of weather, or displaced by the action of wheels, which will pass over it without a jolt, and consequently without injury.

Prices.

The price of lifting a rough road, breaking the stones, forming the road, smoothing the surface, cleaning out the watercourses, and replacing the stone, leaving the road in a finished state, has been found in practice, to be from one penny to two pence per superficial yard, lifted four inches deep; the variation of price depends on the greater or lesser quantity of stone to be broken.

At two pence per yard, a road of six yards wide will cost, therefore, one shilling per running yard, or 88*l.* per mile.

Any rough road may be rendered smooth and solid at this price unless it be weak, and require an addition of stone, or require some very material alteration of shape.

Breaking stone has been reduced in price, by the use of more proper hammers and the sitting posture.

The Commissioners at Bristol used to pay fifteen pence per ton for limestone from Durdham Down, for the use of their roads, and broken to a size above twenty ounces: stone is now procured from the same place, broken so as none exceed six ounces, for ten pence per ton, and the workmen are very desirous of contracts at that rate, because the heavy work is done by the men, the light work with small hammers by the wives and children, so that whole families are employed.

In Sussex, the proportion is greater between former and present prices: the breaking of flint cost at one time two shillings per ton; and is now done, by introducing a better method and fitter tools, at about one shilling per ton.

By a more judicious preparation and application of materials, the quantity of stone consumed in roads is decreased, by which a great saving of expence is made, and with this great advantage, that the saving is in horse labour of cartage, while the labour price is given to men, and in such a manner as includes boys from the age of ten upwards, women, and old men past the age of being able to labour hard. The proportion of men and horse labour in the Bristol District, under former management, was one-fourth,

to men's labour, three-fourths to horse labour. Under a better system of management, the proportion has been exactly reversed—during half a year that an exact account was kept, there was paid

For men, women, and children's labour,.....£3088
For horses' labour,..... 1033

This immense advantage is presented in every part of the country, as roads are confined to no particular place, and are universally in want of repair; ample funds are already provided for every useful and proper purpose, although at present misapplied in almost every part of the kingdom, while the labourers are in want of that employment which it ought to afford them.

The following curious Details relative to the Roads near London, have been published by a Committee on the Highways of the Kingdom.

NAME OF TRUST.	Length of Road.	Amount of Tolls, 1818.	Expences 1818.
	m. yards		
Surrey New-road.....	6 440	£ 9,210	£ 9,210
City-road.....	1 440	1,645	1,661
Ste. Mary-le-Bone.....	4 1,584	3,960	3,808
Kensington	17	14,600	12,933
Canon-street.....	1 747	1,167	962
New Cross.....	39 660	11,853	11,660
Whitechapel.....	34 220	12,450	13,086
Surrey and Sussex.....	57 798	14,606	14,758
Highgate and Hampstead....	20	11,536	14,183
Hackney.....	6 880	4,355	3,942
Old-street.....	1 880	1,520	1,255
Stamford-hill.....	20 880	10,540	10,393
	210 489	97,482	98,856
		—	—
		464. p. mile.	470. p. mile.

After considering the propriety of various plans of altering the general constitution of the laws affecting the management of turnpike-roads, the Committee give the preference to that of empowering the magistrates of every county, assembled in Quarter Sessions, to appoint one or more surveyors-general, who shall have the superintendance and management of the turnpike-roads within the county, under the authority and direction of the commissioners of the different trusts. They also are of opinion, that the most eligible mode of paying the salary of this officer, would be by a uniform rate per mile upon all the roads within the county, to be fixed by the magistrates at Quarter Sessions, and paid from the funds of the respective trusts.

ROADS.

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 1033

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 ace, and are univer-
 already provided for
 present misapplied
 the labourers are in
 ford them.

*Roads near London,
 the Highways of the*

Amount of Tolls, 1818.	Expences 1818.
£ 9,210	£ 9,210
1,645	1,661
3,960	3,808
14,600	12,933
1,167	962
11,833	11,660
12,450	13,086
14,606	14,758
11,536	14,183
4,355	3,942
1,520	1,255
10,540	10,393
97,482	98,856
—	—
64 p. mile.	47 p. mile.

plans of altering the
 management of turn-
 pike to that of em-
 plemented in Quarter
 Sessions-general, who shall
 of the turnpike-roads
 direction of the com-
 missioners are of opinion, that
 of this officer, would
 roads within the coun-
 ty Quarter Sessions, and paid

