

THE DETERIORATION OF THE MERSEY.

By Joseph Boulton, Esq., F.R.I.B.A.

(READ FEBRUARY 19TH, 1874.)

THE navigable condition of the Mersey is a subject that must ever be of interest to those who dwell upon its banks, and live upon the proceeds of its waters; yet the number of those who are able to take intelligent interest in the processes by which its condition is affected is probably very limited: so limited, that those processes are usually considered due to causes recondite and technical, and only to be understood by a privileged few.

As I believe there are not many now living who have given as much attention to those causes as myself, it may be permitted to me to invite a consideration of views which are the result of many years of careful study; especially at this season, when the principal entrance is again in a critical state—passing through one of those crises which have more than once threatened to close the river against all comers, and to divert the favours of commerce from its shores.

The treatment of harbours appears to be largely empirical. Yet I believe that with due inquiry it may be made thoroughly scientific, and based upon a few definite principles, the application of which must be modified by circumstances and experience, as in the treatment of other morbid processes.

There is, perhaps, no surer indication of empiricism than the confusion of maxims with axioms. Yet surely they are very different. The maxim, like a proverb, embodies the result of shrewd, casual observation; the axiom is the result of a long series of observations, carefully conducted and then

critically compared before definition is attempted. For example, it is a maxim, frequently repeated, that the permanence of the entrances to the Mersey depends upon the careful preservation of the backwater; by which is meant that the receptacle into which the flood pours its volume shall not be reduced in capacity. The correct expression, I apprehend, is different; namely that the amount of backwater should be proportioned to the work it has to perform: this is axiomatic. Applied practically, it means that if, from any cause, there be a diminution in the rate of deposit in Liverpool Bay, the scour will be more effective, or may be reduced; but if the rate of deposit be increased, then the scour will be less effective, or must be increased, provided the condition of the channels, under each change of circumstances, is to be maintained.

In January, 1860, the Acting Conservator observes:—"It is as remarkable as fortunate, that the changes which have taken place in the sea-channels, during the last twenty years, have been for the better; every new channel being a decided improvement on the old. This desirable result," he says, "may be fairly attributed to the careful preservation of the 'tidal backwater' in the upper estuary, and, also, to the prevention of any artificial works outside the entrance of the river, which would check or divert the volume of tidal wave from rushing unimpeded up the river. As long as both these objects are properly attended to, and the 'contracted vein' shape given to the entrance, there will always be a good and safe channel into Liverpool."

In 1855, the Conservator compared the "contracted vein" to an hour-glass, with its narrowest section at Seacombe Point; and states it is "a form that admits of the greatest possible quantity of water flowing in and out of the upper estuary during each tide, and therefore the best possible shape for preserving and scouring out the sea-channels."

The "contracted vein" has been fully completed upon lines laid down, I believe, by the present Acting Conservator: the capacity of the upper estuary is believed to be greater now than it was in 1860, therefore the "tidal backwater" has been carefully preserved: and, except in Bootle Bay, "artificial works" "outside the entrance of the river" have been prevented: the works in Bootle Bay have been sanctioned by the Conservator, and therefore, it is to be presumed, are, in his opinion, innocuous: and yet,—the channels are not preserved! All the conditions laid down in 1860 are carefully observed; but the promise of 1860 that "there will always be a good and "safe channel into Liverpool" is not fulfilled. Yet in 1873, when recording that the adverse changes "in the Queen's and "Crosby channels present conditions less favourable to navigation than have been recorded for many years," he says, they show "most forcibly the importance of maintaining the "full scouring power of the backwater, by preventing encroachments on the tidal area of the upper estuary; and the "necessity of adopting the best methods available for mitigating the effects of deposits in the bed of the river and in "the sea-channels."

It might be supposed from this last quotation, that the gallant admiral had been treated as Cassandra was at the siege of Troy: that he had correctly predicted the evil results of a given policy, if it were adopted; that, notwithstanding all he could say, that policy was adopted; and that all the evils predicted naturally followed. But I have carefully examined all his reports for thirty years, from 1844 to 1873, both included; *—years during which many works have been constructed on the Mersey, calculated to have momentous influence on its future history;—and I do not find that his remonstrances and suggestions have been in any case neglected,

* *Mersey Papers*, Part I. London, 1874.

except in the disposal of the mud and sand daily dredged out of the Liverpool docks. In 1843-4 the dredgings amounted to 213,000 tons for the whole year: they are now estimated to be equal to 600,000 tons. Doubtless these figures are very large, and, taken by themselves, look rather serious; but, if the largest amount be divided by the number of working days in the year, the amount daily is less than 2000 tons, or than 1000 for each tide, the average for each hour being 80 tons; an almost imperceptible addition to the silt which the Mersey habitually holds in solution. The materials for comparison are, fortunately, available. In a communication to the British Association, in 1837, Admiral (then Captain) Denham, at that time Marine Surveyor, stated that he had analysed the tide in its passage from the ocean and back again. Taking the average of springs and neaps, he found the quantity of matter held in solution to be 330,989 cubic yards upon each *flood*, and 379,054 yards upon each *ebb*, or an average of 60,200 cubic yards per hour. If it be assumed that each ton of dredgings contains $1\frac{1}{4}$ cubic yard,* then 80 tons would be equal to 100 cubic yards, as against 60,200 yards; or $\frac{1}{602}$ per cent. If it be assumed that the whole of the dredgings are carried away by the ebb, the per-centage would be not quite double, or $\frac{1}{301}$. Thus, it appears that to lay so much stress upon the injury done by the dredgings, whilst the water is so burdened from other sources, is a veritable straining at a gnat, whilst the camel passes, not only without impediment, but almost without notice. When Admiral Denham explained the large amount of silt which the Mersey water contained, Professor Sedgewick remarked, it was evident that "the quality of *Mersey* is not strain'd."

The source whence this enormous quantity of silt is derived

* A cubic ton of sand is said to contain 23·5 or 24 feet; a ton of clay, 17 feet; of earth, 18 feet; of water, 37·5 feet. As the silt, a mixture of sand and earth, contains much water, I have assumed that a ton may contain $1\frac{1}{4}$ cubic yard. The detritus from abrasion of the river's bed must not be overlooked.

invites inquiry ; for, as, according to Admiral Denham, the amount in suspension on the ebb is much greater than on the flood, (in the proportion of 33 to 29,) it is by the ebb that the banks are nourished and the channels silted up and changed.

If the streams which supply the fresh water of the Mersey be examined, it will be found that the quantity of silt held in their waters is quite inadequate to supply the enormous quantity ascertained by Admiral Denham. Those streams, besides others of less note, are, the Gowy, the Weaver, the Mersey above the tidal range, with its feeders, the Bollin, Irwell, and Tame. As the quantity of silt is so small, some persons have supposed that the large amount deposited must be derived from the sea coast, and be carried in by the flood and by the prevailing winds. But Admiral Denham's figures entirely preclude that source, for the ebb tide contains much more silt than the flood ; the proportion being 33 cubic inches in every yard of the ebb, against 29 inches in each yard of the flood. The difference between 29 and 33 must therefore be obtained by the ebb tide in its transit to the sea ; a conclusion which derives confirmation from the state of the ebb during neap tides in dry seasons, when the water is usually very clear. Now, during the last thirty years, the policy which has governed the conservancy of the Mersey has been embodied in the maxim, "The backwater cannot be too great, therefore increase it in every available way." There being a certain analogy between tidal action and that of a pump, the removal of impediments, and the perfecting of the contracted vein, have enabled the tidal pump to send more water into the upper estuary, which serves as the principal receptacle ; and so may be used as representing the whole. But thirty years ago the receptacle then existing was filled by the spring tides, and more than filled, as shown by the fretting away of its shores—and consequently all the additional quantity, which

has been pumped into that receptacle, has not only required, but has produced, an enlargement of the receiver. This has been accomplished by washing away the enclosure; land has been absorbed by the flood tide and carried away by the ebb. Thus every additional cubic yard of tidal "backwater" which has been stored in the reservoir has occasioned the displacement of a cubic yard from the enclosure. Consequently, the supply of silt has been unfailing; and it is not impossible that a repetition of Admiral Denham's experiment, which is very desirable, would show that the ebb is even more saturated with silt than it was in his day, now nearly forty years ago.

The Mersey Conservancy Act was passed 30th July, 1842; and Admiral (then Captain) Fitzroy was the first Acting Conservator under its provisions. In January, 1843, he presented to the Conservators his annual report: unfortunately the only report he prepared. In it he draws attention to the many thousand tons of alluvial land which are displaced annually by the action of the river and its feeders. The following description is very instructive, and merits grave consideration:—

"The falling of these earthy cliffs, now going on quite unchecked, is a subject deserving the attention of all who are interested in the navigation of the Mersey. Dry weather, rain, frost, and the undermining action of the water, combine to wear away these low cliffs of friable earth in a surprisingly rapid manner, and all their detritus is swept into the river. One dry season alone, if followed by much rain, and then frost, as is so frequently the case, will cause the fall of thousands of tons of valuable earth, all of which is speedily washed away. I measured some places on the shore (now bare sandstone, but formerly covered by a layer of earth several yards in thickness), from which a mass of good soil, about twenty feet in depth and

“thirty in width, had been carried away during the last ten years only. About Dungeon Point, the destruction I witnessed in December last (*i.e.* 1842) was still more remarkable. Along the whole length of the cliffs (on which there had been woods, now nearly gone), yards of surface, with trees standing, and all the soil beneath their roots, to a depth of twenty or thirty feet, had recently slid down to the stony beach below, and would soon be washed away. Trees stood upright on the flat shore, within the reach of high tides; and seemed to be left there unnoticed, except by passing boatmen who wanted fuel.

“Some of the most fertile fields are thus dwindling away. A farmer on the spot told me that a field adjoining the cliff, for which he pays rent as so many acres, is not near that size now, having lost much by the fall of the cliff since he took his lease. The wood just mentioned as being almost gone, now indeed only a narrow slip along the edge of the cliff, this farmer remembered of considerable width when he was a boy, and used to go bird’s-nesting there. In another place, not far distant, an intelligent couple, about seventy years of age, showed me a spot on the bare beach, now washed by every high tide, where, in their recollection, stood a gate across a road to a limekiln, built well above high water mark; but since then entirely carried away with the adjoining cliffs.”

He adds, “It is much to be regretted that such a waste so prejudicial to the farmer as well as to the landlord, and so detrimental to the navigation of the Mersey, should be suffered to continue without an effort being made for its diminution.”

Admiral Fitzroy’s wise counsel was anticipated by Admiral Denham; and has been repeatedly enforced by Admiral Evans, the present well-known Acting Conservator; and also by Captain Graham H. Hills, Marine Surveyor: but as yet,

after forty years of warning and remonstrance, has been unavailing!

The waste is not confined to the cliffs of friable clay; but the rocky cliffs at the Dingle, and above and below Eastham Ferry, are undermined by the tides, split by the frost, shaken by the winds, abraded by the rains, and ultimately fall in masses on the shores, sometimes carrying trees with them; and then the ruin is consummated, and the rock becomes indistinguishable silt. In 1870, the acting Conservator refers to the washing away of the land between Eastham Ferry and Port Ellesmere; and states in illustration, that a mark was made on the cliff at Hooton in the month of April last (1869), and at the end of the year it was found that nearly four feet of the edge of the cliff had fallen into the river in the interval. As clay is composed of about two-thirds of sand and gravel, with one-third argillaceous matter, the material for sandbanks and sandhills is abundant. The abrasion of the rocky shores and of the sandbanks in the upper estuary furnish further contributions.

Some fifteen years ago the late Mr. Macfarlane, the steward of the Speke Hall Estate, informed me that for the preceding twenty-five years that estate had lost annually a yard in breadth for the whole length of its river frontage. During the interval, I believe the waste has continued at the same rate. It may be observed in other places, as between Dingle Point and Garston, and at Bromborough, between the Pool and New Ferry.

Much more information upon the loss of land on the margin of the Mersey will be found on reference to Mr. Eyes' *Littoral Survey of the Port of Liverpool*, "Trans. Hist. Soc.," vol. xxii (New Series x), Sess. 1869-70, p. 171.

Lieut. Murray Parkes and Captain Graham Hills, in their joint *Report and Memoir of the Survey of the River Mersey during the years 1860-61*, p. 7, state the loss between

Garston Salt Works and Dungeon Mills to be at the rate of as "nearly as possible 1 foot per annum;" but there would appear to be some fallacy in this statement, as the result is so different from the information obtained by Admiral Fitzroy and others; partly the result of actual measurement.

From the foregoing facts, it is clear that a grievous mistake has been committed through an inconsiderate adoption of the maxims—that the tidal backwater must be preserved, and that in no case can there be too much backwater: * a juster appreciation of the axiom, that the backwater must be proportioned to the work it has to perform, would have drawn attention to the fallacy of supposing there was any advantage in augmenting a backwater in which the quantity of silt was augmented in the same, if not greater, ratio. It would have been seen that, inasmuch as the construction of new docks in the lower Mersey augmented the rush of water into the upper estuary, those extensions, if not suspended, must be accompanied by such works in the upper estuary as would prevent any addition to the silt. Then the augmentation of the water would have caused a dilution of the silt; that is, the ratio of silt to water would have been reduced; and a beginning made towards its practical elimination. But, under the policy pursued, the candle has been burnt at both ends; and the process adopted for improving the navigation of the Mersey resembled the task imposed upon the Devil, of filling a sieve with water.

The principal reason why the shores of the upper estuary have not been protected as required, is financial. The question naturally arises, By whom are the funds to be provided? To solve this, it is necessary to determine under what circumstances the necessity for expenditure arises. This is clearly due to the demands of commerce; and thus it

* Report of Messrs. John and George Wilkin on "Mersey Conservancy," (Printed by order of the House of Commons, 4th August, 1840,) p. 2.

is, by those who thrive on the commerce of the Mersey that the funds should be provided. They may be roughly assumed to be the various towns and townships which border the Mersey, and other interests; and from them the funds may be raised upon their rateable value. Clearly the land-owners, as such, should not bear the burden: they have been grievously injured already, for they have lost irrecoverably thousands of acres. It is questionable whether they should not be compensated; especially, when the Acting Conservator Fitzroy suggested that the tidal backwater would be increased by the aggressive action of the flood tide, if the narrow passage at Runcorn were enlarged; "because it would admit more flood to eat away the yielding soil," and, "would allow the ebb to escape more quickly; carrying off, therefore, in suspension much matter that, under the existing state of the channel, would be deposited above the narrow passage." It may be urged that other places, which do not border on the Mersey, benefit through their proximity; but many of those will be found to have their special burdens resulting therefrom; and, taken as a whole, the basis proposed seems to be reasonable, and as fair as any which can be adopted.

This, however, is a branch of the subject somewhat foreign to the proper treatment of the river to secure its immunity from further deterioration, and its general improvement.

Another fallacy, which has been productive of much confusion respecting the scour of the sea-channels, is concealed in the maxim—that water ebbing from the higher parts of the Mersey is infinitely more valuable than that from the lower parts.

If correctly expressed, this means, that the water from Woolston Weir—the limit of the tidal range, and four miles above Warrington Bridge—is more valuable for the purpose of effecting a scour on the bar than from any other part of the

tide's course. The bar of the Queen's Channel is about ten miles below the Rock lighthouse, and Woolston Weir is about thirty miles above the Rock: thus the extreme range from the bar to the Weir is forty miles. Admiral Denham ascertained that the water of the flood and ebb moved respectively at the following maximum velocities, that is, in the straits, narrows, contracted vein, or bottle neck:—

	THE FLOOD.			THE EBB.		
1st hour	4 miles	...	...	4½ miles.
2nd "	6¼ "	...	...	7¼ "
3rd "	7 "	...	...	7 "
4th "	6 "	...	...	5¾ "
5th "	3 "	...	...	4½ "
6th "	1 "	...	...	2½ "

Transitu 27¼ miles. 31½ miles.*

Giving a total transit by the flood of 27¼ miles in 5 hours 20 minutes; and by the ebb of 31½ miles in 6 hours 30 minutes. Thus it follows that, even if this maximum velocity were maintained throughout the range of tide, the water of the ebb from Woolston Weir, if unobstructed, could not reach the bar, but would descend only to a line a little below the Rock Point, which is about ten miles short of the bar. The ebb, however, would be obstructed by the young flood; for the tide does not attain its full height at Woolston until 2½ hours after it has been high water on the bar: consequently the tide has turned on the bar; and the flood is 2½ hours old when the ebb begins at Woolston.

Being of that age, the flood would of course be advanced up the Channel; and, according to Denham's table, have run some 13 or 14 miles: on the other hand, the ebb from Woolston would have run only 3 hours, or 18 or 19 miles downwards; that is, abreast of Speke and Hooton. So that the meeting of the last ebb and the next flood would be somewhere between that line and the Rock Point.

It will be seen that the above is a theoretical comparison

* Denham's *Mersey and Dee Navigation*, 1840, p. 134.

of two sections only of the tide, which are supposed to be unaffected by the intermediate sections. Not only is the period of high water at Woolston $2\frac{1}{2}$ hours later than on the bar, there is also a difference of 12 feet in the surface level of the two places, due to the heaping up of the tide in the upper reaches, and to the fall through the ebb on the bar.

Were it possible to restrict the influence of the scour of any tide to one section, namely, to that which begins to ebb as soon as it attains its utmost altitude on the bar, then the utmost distance from which the water of the ebb would reach the bar—still at the maximum velocity—would be a little higher than Halton Point. As, however, the series of sections, the velocities, and the periods of change are practically infinite, it is impossible accurately to determine the utmost verge from which the ebb reaches the bar; and further complication arises from the like variation in the succeeding tide which has attained nearly half its growth before the ebb at Woolston. From these considerations, I think it must be obvious that the value of water ebbing from the higher parts of the Mersey is very much over-rated, for the ebb which merely reaches the bar will not produce any useful effect; if it is to act as a scour, it must run over the bar, and carry the silt therefrom into deep water. Thus it will appear that the water from Wallasey Pool was more effective than the same quantity from a more distant station; and that the abstraction of Bootle Bay is a very serious loss. The deprivation of Wallasey Pool may, possibly, be compensated by the improved form which has been given to the “contracted vein;” though it is questionable whether the velocity given to the stream of tide is not excessive. Though it maintains a maximum depth of 80 feet low water in that part of the river, it would be difficult to name any parties to whom that great depth is advantageous; while the objections to the *race* are obvious.

An equalization of the force of the current over the whole area will probably be deemed necessary whenever the due relation between tidal power and the removal of silt is recognized, and when all excludable silt is prevented from entering the river.

The water in Bootle Bay was conveniently at hand for passing to sea after the banks were uncovered; for, being ten miles from the bar, its ebb did not commence until about forty minutes later, and thus it operated to some extent in the channels, instead of being lost, as generally assumed, over the banks. Because the water in Bootle Bay did not undergo any apparent diminution of bulk, it was hastily assumed that it was not of service as scour; but the comparison of periods and places suggested above appears to show, that the efflux from Bootle was probably much more valuable than the same quantity from Woolston, or any other of the higher reaches of the Mersey. It had the further advantage of being more free from silt, inasmuch as there were not any margins of friable material to be eaten away, as above Runcorn Gap. It is true, some years ago there was a great waste of the clay cliffs north of Egremont; and it is equally true, that Mr. James Walker, the eminent civil engineer, after a careful investigation, stated that the material washed down was of a clayey nature, and did not remain on the rocky bottom or the bar, which was sand—adding, “I hardly think that even the words *tending to injure the navigation*, can be applied to the “washing down of the soil,” &c.* Mr. Walker, who is at issue with the authorities previously quoted, appears to have overlooked the fact, that clay contains a large proportion of sand, and on being rapidly dissolved in troubled water, the light argillaceous matter and the gravel would be separated from the sand, and each material reach its ordinary destination. It is noticeable, that the enclosure of Bootle Bay was not com-

* *Vide* Report ordered to be printed by the House of Commons, 23rd June, 1856.

pleted until 1872, a short length of the northern boundary, 240 yards, not then being built. The wall next to the river, however, was constructed some years previously, having been "completed to the point where it will form a junction with" Seaforth Battery, in 1866; and for all practical purposes affecting the channels, Bootle Bay may be regarded as to a large extent abstracted in that year. The enclosure, however, was completed as above mentioned, in 1872; and the same report in which that fact is recorded states, that the depth of water on the bar of the Queen's Channel was only eight feet at low water springs, instead of eleven to twelve feet, with a more direct course "than has been known for several years past," as was reported to be its condition in the preceding year. During that preceding year, the Victoria Channel, after undergoing deteriorations of one kind or another, had silted up and entirely closed; the water which had passed by that channel was doubtless diverted, at any rate in part, to the Queen's Channel, thence the improvement—the spurt—in 1871; but the abstraction of Bootle Bay being completed, the Queen's Bar all at once silted up three to four feet! It is also to be observed, that the deterioration year by year of the Victoria Channel, and in other approaches from the sea, appears to have proceeded *pari passu* with the works of the North Docks. Until some other more satisfactory explanation is adduced, this conclusion is likely to appear probable; and it confirms the preceding observations upon the slight influences which can be exercised on the bar by water from remote parts of the estuary.

The dynamic phenomena of tides are so complex as to render difficult the comprehension of their effects. During the flood, the water under the influence of tidal impulse, is, as it were, pumped up into the river; but though the transit of the *impulse* is rapid, that of the *water* is comparatively tedious. The impulse travels forty miles in $2\frac{1}{2}$ hours, equal

to sixteen miles in the hour; the water during the 5 hours 20 minutes of flood travels twenty-seven and a quarter miles, or at the rate of less than five miles (4·81) in the hour. And this is the very highest average, namely in the contracted vein; in other places, and for the greater part of the whole distance of forty miles, the average velocity will not exceed one half of that maximum. Thus, a drop of water on the bar, travelling at the utmost rate, will require 16 hours for its passage to Woolston; whilst the duration of the flood is only 5 hours 20 minutes: to this add 2 hours 30 minutes for the difference between high water at the two stations, and it will be found that 7 hours 50 minutes is the utmost time allowed by the duration of a tide; that is, one half of the time actually requisite. It is clear then that the alternations of high water in the upper parts of the river are due to the damming up of water already in the river basin, by the sea water which follows the tidal impulse upwards from the bar. Consequently the water which flows seaward, towards the close of the ebb, is fresh water mixed with a quantity of sea water, that has been detained in the basin ever since it assumed its present general form and condition. On a former occasion I attempted to show that, in early days, a portion of the upper estuary was occupied by a fresh water lake or mere: and that the upland waters on the Cheshire side passed to the sea by Wallasey Pool and the Leasowes; its embouchure being now occupied by the township of Hoose, a name very suggestive of such an origin; and that on the Lancashire side those waters passed by the Alt, entering the sea at Crossens near the mouth of the Ribble.*

It is well known that before the close of the 13th century, there was an important abbey at Stanlaw; and that the brethren were expelled at that time by irruptions of the sea. The extent of land on which stand the ruins of that abbey,

* *Pro. Lit. and Phil. Soc.*, 1872-3, xxvii, 249.

or rather of the cell to which it dwindled, is totally inadequate for the stately abbey and church of which descriptions exist; and such buildings could not be erected now without extending a considerable distance below high water of spring tides. For these and other reasons, I have conjectured that the surface of the lake was not higher than that of a tide rising 18 feet upon the Old Dock Sill. If those speculations are well founded—and what other explanations will accord with historic data?—a large part of the water which now occupies the upper estuary must have been supplied from the sea, when the mere or lake was absorbed, and the abbey overthrown. On the same assumption the complaints which have been made against those who have enclosed the marshes with embankments are unfounded; for the tide never had any legitimate right to flow over those marshes. It is not improbable that the embankments were formed long before the destruction of the mere for the purpose of protecting the marshes from freshets; and afterwards strengthened to resist the more powerful aggression of the sea-robber, or pirate, who destroyed the lake and the monastery, and drove the monks to Whalley. That same sea, with remorseless maw, has ever since been “eating away the yielding soil,” just as Admiral Fitzroy suggested it should be provided with additional facilities for doing, above Runcorn Gap.

It would appear, then, that the policy hitherto adopted for the conservation of the Mersey, should be almost entirely reversed. That, instead of aiding the tide to force more water into the river basin, and thus destroy more land and create more silt, the land should be protected wherever it is now exposed, and the strength of the impulse be left as it is, until experience shows the effect of reducing the quantity of silt. When the water is less charged with silt, it will then be able to take up some of that which is so detrimental in the upper estuary, and will work out deeper channels for its passage to

and fro. That, with respect to sand banks and other deposits in all parts between the bar and Woolston, they should not be considered as having any vested right to remain where they are. That something of the same vigorous policy which has been so beneficial on the Tyne and the Clyde, should be adopted, *mutatis mutandis*, on the Mersey; not only in the upper estuary, but in Liverpool Bay also. That the nettle which has been so much dreaded hitherto, should be firmly grasped; and, seeing how deep a channel has been scoured and maintained in the contracted vein, some effort should be made to secure an approximation to that depth, in all the approaches through the bay. The strength of the current in those channels appears never to exceed two miles in an hour, and the banks, being of sand only, yield to almost every capricious influence. Who can expect stability amid free sand? Yet it has been in attempting to obtain that impossibility that valuable sums have been expended, valuable time lost; and in consequence, it is to be feared, valuable ships with lives and treasure have become castaways. The casing of the sand need not rise higher than the tops of the banks, until experience shows that it is desirable to raise it. Mr. George Rennie proposed to use wattled hurdles, and to employ natural agents to do most of the work; the cost would thus be moderate, and should any work appear injurious it can be readily destroyed and removed.

But here, we are met with another maxim—There always has been a channel, and if one outlet is closed, Nature will form another. When people vaunt their reliance upon Nature or Providence, it is usually that they may conceal their ignorance and inability, and to justify their censure of those who venture to think that for every ill some remedy may be found.

Perhaps, however, in the face of all the strong prejudice which exists, it will be more prudent to try experiments in the upper estuary, care being taken to preserve just as much

backwater as may be found needful, and diminishing the occasion for any scour to the utmost. If there were never any silt, scour would not be necessary; but as there will always be some silt, there must always be as much scour as will prevent the deposition of that silt.

The formation of the upper estuary closely resembles that of the lower, including a "contracted vein" at Runcorn Gap; the form and proportions of which, may be improved *secundum artem*.

Last August, when the steamer "City of Richmond" came to her station from the Clyde, she reached the bar at 7-15 a.m., but in consequence of the insufficiency of water, was unable to cross it until 11-30 a.m., suffering a detention of more than four hours. Being only in ballast, her draft would be light, and the detention being in August there was abundance of daylight. But the same vessel may have very different experience; heavily laden, and drawing much water, she may arrive on a dark, stormy winter's night, just when the ebb renders it imprudent to attempt to cross, and may have to lie on and off for much longer than four hours. It may well be doubted if this is the proper condition for the main entrance to such a port in the 19th century; and whether it is creditable to engineering science or to commercial intelligence.

The approaches appear almost as if they were returning to conditions similar to those which existed for about twenty years, 1813 to 1833, from which they emerged under Denham's supervision. That admiral is honourably distinguished by zealous efforts to collect facts upon which to base scientific treatment; unfortunately he was discouraged by those who then claimed to be the conservators of the Mersey: so the correct diagnosis, and consequently the sound regimen, have been indefinitely postponed.

There are other branches of the subject which invite attention, but they must be deferred to a future occasion.