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The Thames Barrier: climate change, shipping and the transition to a new envirotechnical regime

Matthew Kelly

The process that led the British government to build the Thames Barrier resembled the trajectory of many infrastructural projects in post-war Britain. A generally accepted need generated proposals, counter-proposals and the concomitant weakening of vested interests, until under growing public pressure the government decided to push enabling legislation through the Parliament. This decision departed from this norm, however, because the government did not seek to improve living standards or economic effectiveness, but to counter the existential threat nature posed to London, as intimated by the devastating tidal flood of 1953.[1] As this chapter will show, by the 1950s the government accepted the scientific consensus that climate change was causing glacial ablation, or melt, and rising sea levels and increased storminess threatened all North Sea coastal terrains. London was made peculiarly vulnerable by the added effect of north–south 'tilt', by which the south-east of England was gradually sinking. The Waverley Report, the official response to the 1953 flood, identified the flood not as a unique weather event, despite the unusual concatenation of factors that caused it, but as an episode in a series whose ultimate origins were geological and climatic, against which human beings could only mount a defence. In this respect, to adapt the distinction Braudel drew between the *longue durée* and the 'conspicuous' events that usually preoccupy historians, the 1953 flood was a moment when the *longue durée* became conspicuous.[2]

Whitehall accepted Waverley's recommendation that improved coastal and estuarial flood defences be augmented with a retractable barrier across the Thames, and the long policy-making process that followed left little meaningful distinction between technological and political

questions. Although the most decisive politicking occurred in private meetings between representatives of various public bodies, the public debate was periodically enlivened by the Thames barrage lobby, which hoped to transform the existing estuarial regime upstream of Gravesend or Woolwich into a slow-moving fresh water lake, 'liberating' the city from the tide. This revived a Victorian agenda but was promoted in terms of improving the river's 'amenity' value, one of the key governing concepts in post-war Britain. Although able to mobilise influential backers, the barrage lobby achieved little traction in Whitehall; the agenda seemed the stuff of outmoded visionaries, an extravagant alternative to the relatively simple technological fix represented by a retractable barrier. That this was so did not make the eventual decision to build the barrier or its location predetermined. To avoid 'naturalizing technological change', this chapter will consider the case made for the barrage and trace the fate of the different barrier schemes proposed.[3]

Moreover, the case made for a barrage threw into sharp relief how the barrier sought to protect London against a potentially devastating flood while preserving the existing estuarial regime. For much of the 1950s and 1960s, discussion concerned how the tidal energies of the Thames were harnessed by shipping, washed away the city's waste and prevented a build-up of silt. In the late 1960s, a new consideration entered the discussion. Improved sewage plants had begun to restore something of the river's pre-industrial condition and the return of migrating fish relied on levels of oxygenation and salinity partly created by tidal action. The failure of the barrage lobby should not, therefore, obscure the degree to which the River Thames was already, in William Cronon's influential formulation, 'second nature', or, to follow Thomas P. Hughes, an 'ecotechnological system', or, indeed, an example of Richard White's 'organic machine'.[4] Note, for example, how in the nineteenth century the upstream limit of the Thames tideway was lowered from Kingston-Upon-Thames by the construction of Teddington Lock, while Richmond Lock (1894), technically a half-tide lock and barrage, was necessary to maintain a navigable depth of water between the two locks following the dismantling of Old London Bridge. And this is to say nothing of the significant implications banking, flood defences and London's complex system of docks and harbours had for water flow and riverine ecology. Nonetheless, if the 'high modernist' desire of the barrage lobby to transform and control nature more closely resembles today's climate engineers than yesterday's pragmatic technocrats, the retractable barrier was contrastingly of tremendous anthropic importance but of relatively low environmental impact.

That said, in her history of the post-1945 development of the Rhône, Sara B. Pritchard argues that histories of technology tend to treat the environment as 'an unproblematic, ahistorical backdrop to studies of technological change, implying that nature and technology are entirely distinct, and that environmental and ecological process play no role in technological development'.[5] Whether this critique still holds is questionable, but certainly no meaningful history of the development of the Thames Barrier could sustain this distinction. Pritchard's argument that the Rhône is best understood as an 'envirotechnical regime' in which nature is an actant chimes with the argument made here. Given contemporary debates about climate change, it seems remarkable that during the protracted political process preceding the passage of the 1972 Act, the case made for greater flood protection attracted little opposition. Even the Port of London Authority, which contested specific proposals, did not fundamentally challenge official thinking. It can be supposed that this was because rising water levels were thought symptomatic of the interglacial cycle rather than human actions, but this explanation should not obscure how the politics of the Thames Barrier complicates the claim that 'climate change did not emerge as a *political* issue until the 1990s' and helps contextualise the responses of the British government to evidence of anthropogenic climate change in the early 1970s.[6]

It seems equally telling that the recommendations of the Waverley Report, which urged extensive improvements to downstream and coastal flood defences, including the development of an early warning system, retained authority within government over the whole period.[7] This reflected the quality of the scientific data underpinning the report and the dire prognosis that data heralded, but it also suggested much about the governing ethos of the time. A distinguished peer was given a responsibility – few were more distinguished than Sir John Anderson – and his recommendations behoved the government to respond accordingly, however ill-thought through that response proved in practice. As such, the progress of the issue was conditioned by the peculiar alchemy of deference, the authority of the Establishment – that nebulous but palpable presence in post-war Britain – and the confidence placed in state-led technological and engineering infrastructure projects. That the final decision was so delayed also makes the history of the barrier a suggestive case study in the history of post-war industrial design and engineering and, more particularly, London's historic decline as a port city. In the event, the construction of the Thames Barrier did not help sustain a threatened envirotechnical regime, but helped create a new one.

And when placed in its proper global context, the history of the Thames Barrier raises far-reaching questions about environmental justice in the context of anthropogenic climate change.

The Waverley Committee and climate science

The first of the Waverley committee's terms of reference was 'to examine the causes of the recent floods and the possibilities of a recurrence in Great Britain'.[8] The committee sought submissions from a range of scientific authorities, including sundry academics, the Council of the Institution of Water Engineers, the Hydraulic Research Station at Wallingford in Oxfordshire, the Observatory and Tidal Institute at Liverpool and the Royal Navy, the last a considerable source of expertise. The immediate causes were rather straightforward to establish. A relatively high tide combined with a surge, the latter caused by record-breaking northerly winds, channeled an atypically large quantity of water down the narrowing north–south axis of the North Sea to the bottleneck at the Straits of Dover. The rotation of the Earth ensured that the water was deflected to the west of the tidal currents, making the east coast of England south of Flamborough Head in Yorkshire one of the most vulnerable coastal regions in the North Sea. A significant quantity of the excess water was forced up the Thames Estuary.[9]

Expert opinion emphasised that the tide and the surge were distinct phenomena, the surge being the exceptional event. Neither was dependent on the other. Higher surges caused by fierce northerlies were on record but they had occurred in conjunction with low tides. On 1 January 1922, for example, a surge caused the sea level at Southend to rise 11 feet above the expected level, but because the peak occurred two hours after low water there were no serious consequences. By contrast, on the night of 6–7 January 1928, the surge had a height of only 5 feet at Southend but coincided with the high water of spring tides, causing serious flooding and loss of life in the Thames Estuary. To top London's flood defences, the peak of the surge had to occur within an hour or two of high water and within a day or two of spring tides.[10]

The effect of the 1953 surge could have been worse but for another factor. Rainfall had been below average, leading to low fluvial discharge into most east coast rivers; had the peak fluvial discharge of 1947 coincided with the tidal surge, the flood effect of the surge would have been greater.[11] Although the probability of a recurrence was low, the 1953 tidal surge was the greatest on record and consistent with a

trajectory of increasingly threatening and unpredictable weather events. Diagrams prepared by London County Council showed that the highest recent tidal surges – depicted in relation to London's flood defences – had in each case been up to 9 feet higher than expected; in one exceptional case – the night of 7–8 April 1943 – that figure reached 18 feet.[12] The surges of November 1897, January 1928 and February 1938 confirmed the upward trend, while water levels of 11, 12 or 13 feet above Ordnance Datum Newlyn at Sheerness or Southend were becoming increasingly frequent.[13] The general trend seemed incontrovertible. Higher tides and stronger tidal surges were to be expected. As Waverley observed, however, the scientists did not argue that this was caused by 'any appreciable change in the tides themselves', but was 'due to a steady rise of mean sea level relative to the land along the coasts of southern and south-eastern England'.[14]

How could this be explained? Several factors were thought instrumental. First, rising sea levels were a consequence of glacial ablation or melt, a symptom of climate warming. In 1939, the research of the Dutch geologist François E. Matthes into glacier regrowth in the Sierra Nevada, California, following its melting away in the Hypsithermal of the early Holocene, led him to coin the phrase the 'Little Ice Age' to describe the period 1300–1850.[15] Although the phrase was not common currency, scientists considered the climate to have 'improved' over the previous century. Second, the phenomenon of tilt: the north-west and north of England was gradually rising and, correspondingly, the south-east was gradually sinking – or downwarping – a notion that had some cultural traction at the time, particularly in East Anglia.[16] Third, and this was less well understood, a shift in wind pattern meant that southerlies and sou'westerlies were becoming marginally less predominant and northerlies marginally more common, making the North Sea stormier and tidal surges more likely.

Research conducted in the 1920s and 1930s on the extent of Norwegian glaciers by H.W. Ahlmann showed that glacier ablation had occurred at a rapid rate. These results echoed the findings of the Leningrad Arctic Institute with respect to the North-East Passage and observations of the limits of the ice edge between Denmark Strait and Novaya Zemlya made during the war by British Coastal Command. Arctic fauna had followed suit, both fish and fowl now found further north than was previously the case. This gave, as Ahlmann put it, 'proofs of climatic improvement', noting that R. Scherhag had suggested that this trend was of such significance that it could be termed 'the warming of the Arctic'.[17] A survey of the existing literature

published in 1940 confirmed that glacial ablation had occurred concurrently throughout the world since the middle of the nineteenth century, leading to an increase in sea levels of about 0.05cm per year, approximately 5cm a century. The evidence did not suggest that the interior parts of Greenland or the Antarctic were melting, though scientists recognised the danger this would pose.[18] As L.C.W. Bonacina and E.L. Hawkes observed in 1947, 'If the polar inland ice-sheet were to melt as rapidly as the glaciers, the rise in sea-level would become a far-reaching phenomenon of great practical importance.'[19] In its submission to the Waverley committee, the Hydraulics Research Station echoed these arguments, but offered more dramatic figures, suggesting that the sea level was rising 1–2mm per annum, a calculation confirmed by current thinking. They also cited an alarmist paper that suggested the rate of rise could be as much as 3.5mm per year.[20] Historical records, current measurement and predicted future trends thus informed Waverley's recommendations.

Tilt was also linked to warming. At the end of the last ice age, some 20,000 years ago, glaciation had reached as far south as the line from the Bristol Channel to the Wash. With the weight of the ice no longer acting on northern Britain, a correction – post-glacial isostatic uplift – had been long in train and this accentuated the effect of rising sea levels in the south-east. As Waverley explained, the academic evidence suggested – and he got quite exercised about this material – that in Roman times the Thames had been tidal only as far as London Bridge;[21] other evidence suggested the tide had overtopped Teddington Weir on 20 March 1874.[22] Dr Harry Godwin, University Reader on Quaternary Research at Cambridge, explained to Waverley that the evidence of the past 50 years demonstrated that in recent times the degree of tilt had been two feet per century, though that level of subsidence could not have been maintained since Roman times. Godwin thought they could probably count on between one and two feet of further subsidence in the south-east over the next 50 to 100 years. A decade or so later Dr Anthony Michaelis, prominent science journalist and friend of Dr Hermann Bondi, later significant to our story, claimed the south-east of England was sinking an inch every 10 years,[23] predictions that wildly exceed current thinking.

Scientific papers circulated in Whitehall in 1970 once Solly Zuckerman, the government's Chief Scientific Advisor, put his weight behind the barrier scheme did not offer a fundamentally different interpretation of overall geophysical trends. J.R. Rossiter of the Institute of Coastal Oceanography and Tides confirmed that sea levels were rising

and that south-east England was probably continuing to sink, causing a relative rise in sea level of about a foot a century. Although wary of making firm predictions, Rossiter hypothesised that the river's increased depth should mean a larger surface area, smaller velocities and, crucially, less bed friction. This would lead to faster propagation of the tide between Southend and Tower Pier, which had already enjoyed a mean interval decrease of about 16 minutes over the course of the previous century. The effect of this in the upper reaches of the Thames was a rise in high water levels of two feet.[24]

A radical paper by Hubert Lamb, the meteorologist and pioneering climate change scientist, was excitedly received by Rossiter. Lamb attributed the increased frequency of great wave height observed by the German Navy in the North Sea and the Norwegian Sea to the higher incidence of northerlies or nor'westerlies with a long sea fetch. These conditions, originating in the Atlantic Ocean, funnelled large quantities of water into the North Sea, and were the cause of the abnormally high frequency of slow-moving cyclonic centres in the region 50–60°N 10°W–10°E responsible for the prolonged rains and flooding seen in southern Britain in 1968 and 1969. Lamb argued that these weather patterns were part of a long-term sequence that scientists were only just beginning to understand. Data stretching back to the medieval period, although imperfect, suggested a repeated oscillation with a period length of about two hundred years in which mean frequencies of sou'westerlies over London coincided with the thicknesses of annual snow layers at the South Pole. Consequently, the increased frequency of nor'westerlies in the North Sea was likely to persist for much of the next century, continuing to generate the slow-moving weather fronts that increased the likelihood of tidal surges.

Lamb's argument then developed a distinctly sceptical discussion of theories posited by American and Soviet meteorologists – and since exploited by anthropogenic climate change deniers – that the Earth had entered a period of cooling. Short-term temperature trends did indeed suggest this, and Lamb was apparently comfortable with the idea that the increased levels of CO_2 in the atmosphere that might have accentuated warming could now offset the increase of particulates and other pollutants in the atmosphere, but evidence of long-term weather patterns saw him ultimately reject the cooling thesis. Either way, he insisted, whether the trend was towards warming or cooling, a continued increase in North Sea nor'westerlies or northerlies was likely, leading to continuing storminess.[25]

Whitehall deliberations: technocrats, civil engineers and the PLA

From the perspective of Whitehall, the scientific consensus and the broad case for a barrier was clear. The positioning of the barrier was more contentious. The more upstream the barrier's position, the greater the cost of improving downstream flood defences; the more downstream the barrier's position, the greater the engineering challenge and cost associated with the design and construction of the barrier as the river widened. These cost–benefit calculations had implications for London's spatial politics: riverine communities upstream of the barrier would be relatively privileged by the consequent need for lower-impact flood defences, whereas the possible effect of a 'reflected wave' caused by the barrier on downstream estuarial communities and infrastructure might necessitate more substantial flood defences than those already planned, an issue repeatedly raised by Kent and Essex county councils. For much of the process, however, the Port of London Authority proved the most influential voice. Since the 1908 Thames Act gave the PLA sole statutory authority for the management of the Thames tideway it had resisted any intervention that might undermine the navigational capacity of the river or the shipping interest.[26] In the 1950s and 1960s, the PLA enjoyed an Indian Summer as the weight of shipping and employment in London's docks reached historic highs, but the creation of the Greater London Council in February 1968 and the rapid decline of London as a port city in the 1970s radically transformed the play of power with respect to the governance of the Thames. Ultimately, the positioning of the barrier reflected this fundamental change in what London was.

In June 1955, the Ministry of Housing and Local Government (HLG), the lead ministry on the barrier project, published an internal report arguing that the middle of Long Reach, a section of the Thames 20 miles downstream of London Bridge, was the most suitable site for a barrier. As an easily navigable long straight stretch of river relatively free of dense industrial or residential development, landward approaches were easy and the river bottom – gravel overlying chalk – offered a hard substratum, relatively resistant to scour, with a high load-bearing capacity. Should the engineering solution require a mid-stream pier, the needs of shipping could be met by allowing clear waterways of 500 feet either side and vertical clearance of 200 feet above Newlyn Ordnance Datum. Side spans of 250 feet with vertical clearance of 50 feet would be needed to allow barges and light river craft to pass unhindered.[27] Once these

requirements were agreed in principle, the Treasury granted permission to appoint consultant engineers, though it insisted this did not constitute a commitment to finance the project and the riparian authorities were told that at best the Treasury might partner other authorities.[28]

The Institution of Civil Engineers recommended Messrs Rendel, Palmer and Tritton and Sir Bruce White, Wolfe Barry & Partners. Both firms were long established with SW1 addresses, had close contacts in government and much experience of major civil engineering projects. Brigadier Bruce White had overseen the construction of the 'Mulberry' piers used in the D-Day landings, while Rendel, Palmer and Tritton's significant works included the Royal Albert Docks (1880), the West India and Millwall Docks Improvements (1929) and the Tilbury Docks Improvements (1930), as well as similar projects elsewhere in Britain and a host of imperial projects, including major undertakings in India and several significant commissions related to the development of the oil industry in the Middle East and Britain.[29] Firms like these helped the British Empire function. The ministry intended that the two firms would work in friendly competition before coming together to produce a final plan; the Hydraulic Research Board and the Geological Survey of Great Britain would provide free advice and the PLA grudgingly agreed to hire out its large model of the Thames.[30]

Friendly competition did not see the two firms arrive at the best solution. They differed over the best time to close the barrier and the volume of water that should pass through it – controlling the level of flow rather than entirely blocking a tidal surge was the aim. Further research resolved these questions, but both firms proved obstinate with respect to their preferred engineering responses. Each proposed a structure that would lower gates into the river. Rendel et al. favoured the 'vertical lifting type', comprising steel spans raised and lowered between towers built in the river, with hinged frames attached to the underside of the spans that carried vertical lifting gates. When the barrier was open, it would constitute a huge rectangular arch over the river. By contrast, White et al. advocated the 'horizontal swing type', comprising two 670 foot piers lying longitudinally in the river mounted with long arms carrying vertical lifting gates. Closing the barrier would mean swinging the arms into place across the river and then lowering the gates. Rendel et al. maintained that their proposals were preferable because the barrier could be closed by gravity in the event of a power failure, plus the 'vertical lifting type' would be significantly more expensive to build and maintain. A retractable barrier, whereby a huge cantilever girder would be housed in dry dock on either side of the river and then launched along tracks

across the riverbed, was judged by both firms to be outside of engineering experience and, as such, too risky to pursue.[31] Still, attractive drawings of the scheme were produced, evidence of the speculative nature of the proposals at this stage.[32]

The Ministry of Transport was concerned that the plans suggested the horizontal clearances proposed for the centre and side spans were narrower than the terms of reference had stipulated and it objected to the placement of 'an obstruction in tidal waters in the main navigable channel of the greatest port in the world and of vital economic importance to the country'.[33] Despite this, HLG published 'Technical Possibilities of a Thames Barrier' as a Blue Book in March 1960 (Cmnd. 956). Local authorities downstream of the proposed barrier immediately raised some concerns. They asked about the effect massive piers would have on river flow, the risk of an oil spillage should a tanker strike a pier and whether a reflected wave caused by the barrier might worsen the downstream effect of a tidal surge, threatening civilian populations and industry alike. As Essex River Authority observed, there was 'no exact community of interest between those above and below the proposed barrier' and the downstream consensus was that the consequential costs of improving flood defence downstream of the barrier should be met by those upstream.[34] Still, a conference of the Thames estuary authorities that December approved the plans on the assumption that substantial funding would be forthcoming from central government. The only significant objection was made by a PLA engineer who explained that the plans raised fundamental questions about how the Thames was navigated. Ships sailed in on the flood tide and out on the ebb tide, but the piers would create turbulence and narrow the river, increasing the speed of the tide. Necessary speed restrictions during the construction period – and possibly thereafter – would be impossible to meet without reversing the pattern of navigation, so that 'ships were brought up against the stream'.[35]

In February, alarmed officials were reassured by Sir Leslie Ford of the PLA that the authority's position was not as hostile as the engineer had suggested, but it was troubled by estimates that during construction the tideway would be reduced to a 500-foot gap and the tidal speed increased from 3.5 to 6 knots. That April, Commander Parminter made the PLA's difficulty plain:

> the principal difficulty was that of taking a big ship through the gap between the piers and the difficulties in handling a big ship at slow speed would be enhanced by the effects of the eddies which were to be expected near the piers. Big ships always went up river on a

> flood tide but if the barrier were constructed it would be necessary for them to proceed up the River on Ebb tide and down on the Flood tide with consequent delay which would result in missing favourable tides elsewhere.[36]

Moreover, when the barrier was closed advance warning would be needed so anchorages could be found for ships, while placing the barrier in the middle of Long Reach would not only bisect an industrial area of growing importance but also halve the last significant stretch of safe deep water anchorage for inward-bound ships. HLG acceded to PLA demands: it accepted there could be no permanent structure in the navigable channel, that a minimum gap of 1,400 feet was required when the barrier was open, and that it should be located at the western end of Long Reach. Cutting back the bank (and dredging) would be necessary to improve alignment and visibility. This meant a recourse to a retractable barrier housed in dry docks, costed at £20m.[37]

HLG's report to the Home Affairs Committee in July 1962 reiterated Waverley's assessment of the threat, placed the likely cost of a barrier at £30m, and requested £50,000 to finance further investigations. With its usual ritualised display of reluctance, the Treasury released £56,000, having sanctioned an additional £6,000 for on-site borehole testing; the original engineers began fresh hydraulic investigations and a complete redesign. What had been considered outside the realm of engineering possibility in the 1950s was now the basis for the new designs. Rendel proposed a 'high-level' type, in which the arms would be cantilevered out from dry docks and the gates lowered into the river; White went with a 'low-level' design, whereby the arms would be launched along a sill constructed across the river bed. Rendel argued silting might have an adverse effect on the 'low-level' design, and at £30m, it was some £9m more than the estimated cost of the 'high-level' design; the construction time for both was estimated to be six or seven years, a factor that would grow in importance as the process lengthened.[38]

In the meantime, consultations by HLG on the land requirements unearthed a difficulty peculiar to the time. The War Office intended to put Purfleet Camp and Magazine, a portion of which overlapped with the proposed barrier's northern site, up for auction in March 1963. The War Office insisted the process could not be reversed, for undertakings had been made to an Italian oil company that the land was available for purchase; although the War Office allowed that the PLA could also bid, it suggested the barrier be shifted 200 feet westward, allowing the two installations to exist side by side. This was a characteristic move by

a ministry still struggling to come to terms with the reality of civilian power and priorities.[39] Notwithstanding the ill-advised observation by a War Office official that the negotiations on behalf of the Italians had been handled by the stepson of Peter Thorneycroft, former Chancellor of the Exchequer, HLG made it clear that the wants of a private company would not be placed above the public interest. War Office pressure on London County Council to buy the land also went unheeded. In 1964–5, stroppy queries from the War Office and the Ministry of Defence were brushed off by HLG: they would just have to wait, though the land could be offered for sale to the newly formed Greater London Council.[40]

Orthodoxies challenged: the case for a barrage and the weakening of the Port of London Authority

In the mid-1960s, ministerial attention was roused by the revival of the old question of whether the Thames needed not a barrier but a barrage. Tom Driberg, Labour MP, raised the question in response to the award of the President's Prize of the Royal Institution of Chartered Surveyors to Michael Wand, a constituent, for his paper 'A Town in the Thames – the New South-East Centre?' Characteristic of the futurism that could capture the public's imagination in the 1960s, it was but the latest attempt to imagine a re-engineered Thames, which, as Richard Crossman admitted, had never had a full public airing.[41] Herbert Spencer had promoted the agenda in the mid-nineteenth century and it was revived in 1903 when a group of parliamentarians were inspired by the decision to barrage the Charles River in Boston. Frustrated by the refusal of the Royal Commission on the Port of London to hear evidence in favour of a barrage, they formed an informal parliamentary committee, commissioned a series of expert studies and promoted three bills to draw attention to the question. The case was made in *The Port of London and the Thames Barrage: A Series of Expert Studies and Reports* (1907), which scrutinised the conversion of 'the river from a highway into a dock' and criticised legislative attempts to render the Thames more commercially efficient for giving the Port Authority monopolistic control over the estuary. Among the technical factors assessed were the suitability of the geological strata and the vexed question of silting and pollution, but the fundamental case was made in terms of improving the navigable capacity of the Thames and enhancing its 'popular use'. To maintain upstream water permanently at high tide with a barrage and eight locks at Gravesend would provide sufficient depth for ships of increased tonnage, end hazardous tide-waiting, and

reduce the dues paid at dock entrances and the cost of barging, pilotage and labour. To make the full width of the river always available would ease congestion and allow obstructive floating piers to be dismantled and landing places to be built closer to the shores. To slow the water flow would allow reliable passenger services to be developed and more use by pleasure boats. Aesthetic improvements would follow too: supposedly ugly mudflats would not be exposed twice a day, fresh water would make for a more pleasant environment and the sewage system would be re-engineered so effluent was pumped out below Gravesend, making for a more fragrant river.[42]

Barrage enthusiasts like Lord Desborough, for 32 years the Chair of Thames Conservancy, were frustrated by what they took to be the PLA's failure to make an objective assessment of the case. As J.H.O. Bunge explained in *Tideless Thames in Future London* (1944), the 1928 flooding put the idea back on to the agenda among those who recognised that the 'only radical solution' was to keep the tides 'out of London altogether' by locating 'a barrage well below the floodable area'. The decision of a public enquiry in July 1934 that the tide made river buses unworkable on the Thames prompted the formation of the Thames Barrier Association in 1935.[43] When the barrage question was debated in the House of Lords in May 1937, Lord Dudley directed his fire at the 'complete dictatorship' the 1908 Act had given the 'pig-headed' Port of London Authority over the whole estuary below Teddington Lock. Under more enlightened direction, the Thames could become 'a slow-moving lake' and 'the playground and the pathway of London's citizens', becoming, according to Lord Jessel, like the Charles River, where 'there is a full river, which provides many amenities for the citizens – yachting clubs and every sort of thing of that kind'.[44] Lord Richie, Chair of the PLA, emphasised the negative effect a barrage would have on sewage and shipping and insisted the PLA had considered the idea, just as it had the less transformative and the more fantastical schemes that came its way. Ritchie cannily suggested a barrage would be vulnerable to bombing in the event of war.[45] Leslie Burgin, the Minister of Transport, when asked if he intended to establish a committee of inquiry, responded that this was a question for the PLA.[46] Under considerable political pressure, the PLA conceded an enquiry, but on its eve, 28 March 1938, Burgin urgently requested that the PLA halt its proceedings because the Committee of Imperial Defence feared that to publicly air these issues would compromise national security.[47] Bunge lamented the preparation done and remained convinced the PLA, knowing it would lose the argument, had made its influence felt in Whitehall.[48]

When the idea resurfaced in the post-war decades it was often considered in conjunction with the plan to link Britain and France with an underwater tunnel between Dover and Calais. A channel tunnel seemed imminently realisable and visionary planners re-imagined Britain's north–south transport links as a new road and rail network firmly to the east of London and integrated into a barrage. Despite lobbying activity, the view in Whitehall remained resolutely sceptical. In 1955, when the consulting engineers were contracted for the first time, the Ministry of Transport made it clear to HLG that they should not be asked to investigate a barrage. It was simply too expensive and its implications were too significant. To remove the 'scouring action of the tides' would completely alter 'the regime of the river', leading to greater siltation and more pollution, while a permanent rise in ground water level risked flooding basements in low-lying riverside areas and interfering with drainage and underground services, including London's underground railway. Engineering solutions could be found, of course, but at greater cost than the barrage itself.[49]

The barrage also got an outing in Professor Hermann Bondi's catalysing report on the need for a barrier, though the report was mainly significant for questioning the underlying assumptions that had steered discussion so far. On Zuckerman's recommendation, Bondi had been commissioned by Richard Crossman and Lord Kennet who, given the threatening water levels of 10 December 1965 and the engineering problems raised by the latest designs, agreed that a fresh look at the problem was needed by a scientist of 'Nobel quality'. Bondi, then professor at King's College London, clearly relished his task. He shared Waverley's assessment of the risk and wrote in melodramatic terms of the threat a major tidal surge posed London and, particularly, the underground railway system, which he thought could be put out of action for a year. Bondi did not attempt to calculate the probability of a major flood, but simply argued that it was foreseeable and so the government must act.[50] Although he was keen on a barrage, suggesting that at high tide the north bank of the Thames made London aesthetically superior to Paris and the equal of Leningrad, he was convinced a barrage would lead to greater siltation, making increased dredging a permanent charge of the PLA. Ultimately, Bondi believed a barrage should be pursued only as part of a fundamental rethink of the south-east, which must include a willingness to diminish the utility of the docks in the upper part of the river, but the apparent absence of any enthusiasm for the idea among the public made the cause a dead letter.[51]

Bondi found it absurd that the mariners had been allowed to dictate the barrier's requirements, and no attempt had been made to quantify the cost of different approaches. If the 1400-foot requirement was determined by the location, asked Bondi, would not a change of location make for more cost-effective or technologically viable solutions? How would the problem be approached if, for example, questions of cost meant the opening was limited to 800 feet? The wide opening needed at Long Reach reflected the large swing big ships needed to come alongside various jetties and wharfs, but to position the barrier upstream of the Royal Docks at the Isle of Dogs where big ships did not go would make a smaller opening serviceable without disrupting shipping. The money saved could be spent on improving downstream flood defences. Alternatively, placing the barrier at Woolwich was possible, though it would be necessary to 'sterilise' the banks by buying up existing berths used by large ships needing big swings, which would then allow openings as small as 350 feet. Protecting Plumstead Marshes, site of the new Thamesmead residential development (first stage due to begin on 1 March 1967), would mean additional costs. Other possible locations were just below either the Ford Motor Works or Dagenham Dock, where Bondi thought a minimum opening of 750 feet was needed.[52]

The significance of Bondi's intervention stemmed from both his proposals, which proved influential, and his approach to the problem. When Anthony Greenwood, Crossman's successor at HLG, took the report to the Cabinet's Home Affairs Committee, it was clear that Bondi had galvanised ministers. The Treasury, irritated by the suggestion it would meet two-thirds of the eventual cost, conceded that Bondi had raised questions needing answers and it took HLG to task for not recognising that a barrage would have to be looked at again.[53] Kennet, junior minister at HLG, Chair of the Flood Protection Policy Committee and barrage enthusiast, became increasingly vocal on the question.[54] More significant was the shift in responsibility away from HLG, which retained ultimate oversight for the project, to the newly constituted Greater London Council (the GLC) in February 1968. The Treasury agreed HLG should increase its share of these research costs from a third to a half and it allowed the overall cost to reach £539,000 by 1970.[55]

The transfer of responsibility affected the balance of power. It was less that London County Council had simply deferred to the PLA, than that it simply did not have the GLC's broad responsibilities or its broad perspective on how the Thames might serve London's citizens. A GLC working party examined the possibility of a barrage at Limehouse Reach, commissioning the Hydraulics Research Station to investigate

silting; with respect to a barrier, it examined the dangers of a reflected wave. Initially, the prospect of improving amenity loomed large in the GLC's thinking, though this was tempered by its consciousness of how Battersea and Bankside power stations were dependent, respectively, on coal and oil supplied by coastal shipping.[56] The PLA's plaintive response to Bondi was that it had not been asked to consider sites other than Long Reach and it accepted that an 800-feet opening could be sufficient at the two Dagenham sites, though it considered Woolwich already too built-up. The authority privately admitted that Tilbury Docks, which had been adapted to containerisation, a development that loomed large in Bondi's projections, would in time take an increasing proportion of shipping, relieving pressure on the Royal Docks, though there was not yet much talk about their future, despite the closure of Surrey Docks in 1969.[57]

In the event, the GLC came down against a barrage. Its report of January 1970 confirmed the risk to London identified by Waverley, duly recognised the advantages a barrage would confer on London, but equally recognised the challenge it would pose to shipping, the problem of increased siltation, the ecological effect of lower levels of oxygen saturation caused by impounding the water, and the potential problem caused by the location of London's sewages outlets. Much would be determined by where the barrage was positioned and the GLC feared it could take another 10 years to make that decision: 'It is scarcely likely therefore that a decision now to build a barrage would result in London being protected against a surge tide before the 1980s.'[58] The irony of the statement cannot be missed. As for the alternative of raising the walls along the Thames to the six feet needed, the cost would be little different to a barrier but obscuring pedestrian views of the Thames would significantly damage the river's amenity value.[59] Moreover, the Hydraulic Research Centre had established that if the barrier was closed for six hours, it was hard to conceive of the circumstances when the fresh water flow would cause the water level to rise more than three feet; as for the risk of a reflected wave to land downstream of the barrier, tests demonstrated that if the barrier was closed at low tide and the sluices closed gradually, allowing some water through, the reflected wave could be reduced to no more than a few inches at Canvey Island or Southend.[60] A barrier, then, it had to be, and the GLC expressed its preference for the low-level type, arguing that research showed it to be within the bounds of current engineering capability, a claim that could not be confidently made of the more complicated high-level type.[61]

This, then, seemed clear enough, but that April Kennet felt bound to write to the prime minister, short circuiting 'all proper channels', to

express his concern at government inaction. 'I have tried all I can think of', he wrote, 'and have now concluded it is only right to let you know personally and directly that this situation is now extremely grave.' In a somewhat humiliating letter, Harold Wilson replied that a HLG paper was due to be discussed at the highest levels of government, though the general election that June meant responsibility passed to the incoming Conservative government under Edward Heath.[62] By July, the government had accepted the GLC's recommendation that the barrier be located at Silvertown in Woolwich and was prepared to take on the vested interests of the PLA, which it had come to consider opposed a barrier *tout court*. Tasked to prepare a chair's brief ahead of the crucial meeting, S.K. Gilbert at HLG was determined that discussion would not be dominated by the PLA's 'hobby horses' of siltation and pollution or its increasingly dubious insistence that London's docklands would remain in full use for another 20 years: a push must be made towards the consideration of strictly practical questions.[63]

That dismissive reference to pollution is striking, for any tendency to dismiss the PLA as a purely reactionary force needs to be tempered by an awareness of its growing responsibility for managing pollution levels in the tideway and how these concerns were becoming part of the political mainstream. In an account presenting a largely positive picture of the PLA, Leslie Wood explained how since the 1940s it engaged in an extensive programme of research into the extent and causes of riverine pollution, which led to a major report in 1964 and the passage in 1968 of an Act giving the PLA the responsibility for pollution control in the Thames enjoyed by the other river authorities since 1951. If higher levels of oxygen saturation were achieved by treating sewage effluent more effectively and aerating the heated effluents released into the river from power stations and other industrial plant, migratory fish like salmon and trout would return to the Thames. A significant upgrade of the storm sewage tanks and the sewage treatment works meant that by 1980 the river's pollution load had been reduced by 90 per cent.[64]

In the event, the GLC's case against the barrage did indeed reflect the likely effect impounding the Thames would have on oxygen saturation and water temperature upstream. In October 1970, Zuckerman wrote to the prime minister advising that a barrier be built at Silvertown, financed at 50 per cent by central government, and investigations into all other sites be halted; in early November, the GLC was informed that Peter Walker, the first Secretary of State for the newly established Department of the Environment, agreed that a movable barrier was necessary and should cross the Thames at Silvertown.[65] With this the

settled policy of both the government and the GLC, the type of barrier and the width of the openings once again became a source of contention. New solutions were prepared by the engineers, including a drum gate scheme which would involve deep excavation, until the idea of a 'rising gate type' was hit upon by Charles Draper. In this ingenious solution, the gates are attached to large wheel-like structures and sit on the bed of the river when open. Rotating the wheels lifts the gates into the closed position between the piers.[66]

Things moved swiftly at a succession of meetings in December. The choice put by the GLC was between a 'drop gate type' with a main opening of 450 feet and auxiliary openings of 150 feet or a 'rising gate type' with three 200-feet openings, which would give an estimated cost saving of £9–10 million. The PLA rejected the latter, explaining that tidal speeds and the angle of approach made it likely that large ships would hit the piers, but the response by the GLC's consulting engineers was that the drop gate type was not practical and, in any case, fewer than two ships of over 10,000 tons per day now passed Silvertown for upriver berths and their navigational difficulties could be resolved if Voight Schnieder tugs were introduced.[67] Allies of the PLA now gave way. The Department of Trade and Industry conceded that 450 feet was ideal, but 200 feet might work; the Chamber of Shipping and Trinity House insisted 450 feet was preferable, but an appropriate system of tugs would make 200 feet possible. Increasingly isolated, the PLA made a stand against a rising sector gate, insisting the risk of collision was high, but its offer to accept a 350-foot drop gate and two 200-foot rising gates was politely rejected by the Department of Environment. In a press release of 22 December, Peter Walker accepted the GLC's recommendation of a rising sector type and expressed his hope that construction would begin in 1973. According to a scribbled note on a draft letter, the 'clinching' moment came when Trinity House broke ranks with the PLA.[68]

Although the River Thames (Barrier and Flood Prevention) Bill 1972 had the backing of the Department of the Environment, the Ministry of Agriculture and the Department of Trade and Industry, it was, as befitted its statutory responsibility, a private bill promoted jointly by the GLC and the Kent and Essex river authorities. It was not, as such, a government bill, although in the end the Treasury footed most of the bill. In the months preceding the first reading, Whitehall was irritated by the PLA's continuing attempt to undermine the decision and the failure of the GLC to deal effectively with the political fallout, which seemed of a piece with its earlier assumption that the Department of Environment would make the difficult decisions on

their behalf and force the PLA into submission.[69] Nigel Spearing, Labour MP for Acton, proved particularly awkward. During the parliamentary debate on the second reading he made it clear he did not wish to see the bill fail, but he questioned proceedings that had seen the navigational interest bullied into accepting the 200-foot opening at a 'murky' meeting in the Department of the Environment in late 1970.[70] There was some truth to this, but only the most partisan of observers could suggest that the PLA had been the victim of a process outlined by one Whitehall civil servant in 1968 as the 'History of the Thames Barrier Project. "The years the locusts ate."'[71]

A new envirotechnical regime

Waverley had urged the construction of a retractable barrier across the River Thames not simply as a response to the catastrophic events of 31 January 1953 but as a necessary defence against a set of geophysical and climatic developments that could not be controlled or overcome any other way. Of all the official documentation generated by the question, it was perhaps a note by the Treasury that best captured the meaning of this intervention. When the PLA claimed that the state should cover the costs of pilotage, comparing passage through the barrier to passage through Tower Bridge, the Treasury responded:

> It seems to us, however, to be dangerous to imply that the Barrier is in the same category as Tower Bridge. The Barrier is not simply an inconvenience: it is something which changed physical characteristics of the river itself have made necessary. In these circumstances our general line on compensation etc. should surely be negotiating the Barrier will become part of the true cost of using the Thames for shipping purposes in much the same way as natural reefs and obstructions.[72]

Foregrounding the need to respond to the 'changed characteristics of the river' identified a distinct category of state activity. The solution chosen, and the navigable costs associated with it, should not obscure the singularity of the problem: there was nothing whimsical about the proposed barrier. Consequently, it was plausible for the government to categorise its technological response to climate change as equivalent to 'natural reefs and obstructions': the specificity of the barrier made it no less inevitable. And by dissolving the distinction between technology and the

natural world, the Treasury effectively categorised the Thames Estuary as 'second nature'.

But that 'second nature' had already been subject to change, as Leslie Wood's account of the PLA's successful attempt to restore the Thames tideway as a habitat for fishes made clear. This is part of a larger story that challenges the declensionist narrative that once dominated environmental history. De-industrialisation and improved sewage technologies have improved riverine habitats throughout the post-industrial world. To take one example, this is part of the story Leona Skelton tells in her history of the River Tyne.[73] Writing on the eve of the barrier's completion, Wood noted its environmental effects 'are likely to be insignificant' but he warned that if it were used as a half-tide barrier, as opportunistic barrage enthusiasts had proposed, it would create a localised thermal barrier that would interrupt fish migration and keep mudflats covered, thereby impeding wildfowl access to tubificid worms, which in turn would be affected by the size of particulate matter in the substrate caused by silting.[74] The ecological implications of the half-tide use of the barrier were understood in the early 1970s and the view in Whitehall appears to have been that this possible use of the barrier represented such a significant alteration to their intentions that it would need separate consideration by government and therefore need not be resolved in order for the primary legislation to go ahead.[75]

Although the Thames Barrier has not been used as a half-tide barrage, its meaning would nonetheless change, undermining the claim that its high-tech stainless steel structures were in some ontological sense 'natural'. Originally intended to protect London against the cyclical consequences of interglacial weather patterns, it is now regarded as the city's first defence against the threat posed by anthropogenic climate change, a shift in historical sensibility as significant as any that has gone before. A second Thames Barrier, much larger and further downstream, has been proposed, but the Environment Agency says there is no need before 2070: the existing barrier is used more frequently than was anticipated, but remains fit for purpose. Jon Agar asks if there is a British equivalent to the 'technological sublime' identified by David Nye with respect to the awe generated by the human-built component of the territories of the United States.[76] Does the Thames Barrier qualify? Its iconic design, particularly when the gates are raised, has inspired some magnificent photographs, but to visit its decaying visitor centre under more ordinary circumstances delivers a milder thrill. As a large-scale state project conceived at the height of post-war dirigisme but opened when under sustained ideological assault, the potential of the Thames

Barrier as spectacle has perhaps never been fully realised. The contrast with the highly commercialised redevelopment of London's docklands in the 1980s and 1990s, a symbol first of Thatcherite hubris and now of Britain's embrace of a post-industrial and neo-liberal economy, is striking. Aesthetically, the barrier is of a piece with docklands; politically, it is of a piece with Thamesmead. Either way, it was foundational to the transformation of an envirotechnical regime in a period of significant political change. In this respect, the barrier is comparable to the equally iconic *Intercity 125* locomotive (British Rail Class 43) of 1976, another engineering product of the mixed economy, which helped renew an equally significant envirotechnical regime and whose working life has also exceeded expectations: Class 43 was later privatised, a fate yet to befall the barrier.[77]

To observe that the barrier's existence, and more particularly its possible supplement, helps protect private as well as public interests raises profound questions about environmental justice. Londoners are safe from the potentially catastrophic consequences of climate change not because they are blessed by geographical good fortune but because they live in a wealthy state capable of mobilising sufficient resources to mount an effective defence. People facing periodic coastal flooding elsewhere, whether it is in peripheral parts of the developed world, which include the north or south-west of England, or on a more catastrophic scale in the developing world, do so not because they are peculiarly geographically vulnerable but because they are of low national priority or live in states incapable of developing the necessary defensive infrastructure. Historians of climate change, and particularly historians of the technological solutions intended to mitigate its effect, should not lose sight of the global inequalities that give structures like the Thames Barrier meaning. Faced with the global consequences of the carbon economy's long history, in no meaningful sense can it be said that the polluter pays.

Notes

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10 K.F. Bowden, 'Storm Surges in the North Sea', *Weather* 8, no. 3 (March 1953): 82.
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12 The diagrams can be found at HLG 50/2502, 1953–4, TNA.
13 Ordnance Datum Newlym is the mean sea level at Newlyn in Cornwall, 1915–21, and is used by the Ordnance Survey as the basis for deriving altitude on maps; Waverley, 6.
14 Waverley, 6.
15 John A. Matthews and K.R. Briffa, 'The "Little Ice Age": Re-Evaluation of an Evolving Concept', *Geografiska Annaler: Series A, Physical Geography* 87, no. 1 (2005): 17.
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19 L.C.W. Bonacina and E.C. Hawkes, *Climatic Change and the Retreat of Glaciers* (Royal Meteorological Society, 1947), 190.
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21 Waverley, 46.
22 *The Port of London and the Thames Barrage: A Series of Expert Studies and Reports* (London: S. Sonnenschein & Co., 1907), 29.
23 *The Times* (November 1967) HLG 52/2020, TNA.
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27 Thames Technical Panel Report and Chairman's Confidential Minute, 27 June 1955, HLG 50/2495, TNA.
28 Treasury to HLG, 25 January 1956, HLG 50/2495, TNA.
29 Rendel, Palmer and Tritton, *Yare Basin Flood Control Study* (London: Rendel, Palmer & Tritton, 1978).
30 See Minute by McNaughton, 15 May 1956, HLG 50/2495, TNA; Letter from Sir Claude Inglis of the Hydraulic Research Station, 29 May 1956, HLG 50/2495, TNA; Letter from W. J. Pugh of the Geological Survey of Great Britain, 28 May 1956, HLG 50/2495, TNA; the Treasury

approved the cost of hire at £50 per day for both firms, taking the overall cost of the consultation to £24,750, though this soon jumped another £1,000 by 25 June 1957, HLG 50/2496, TNA.

31 Rendel et al. to HLG, 15 August 1958, HLG 50/2497, TNA; White et al. to HLG, 19 August 1958, HLG 50/2497, TNA; Rendel et al. to Henry Brook, 24 September 1958, HLG 50/2497, TNA; Note on the Reports, 6 October 1958, HLG 50/2497, TNA.

32 Reproductions of these and later proposals can be found in Stuart Gilbert and Ray Horner, *The Thames Barrier* (London: Thomas Telford, 1984), although these are no match for the originals, which can be found in the above cited files of the National Archive, Kew.

33 O.F. Ginger, Ministry of Transport, to Pearce, HLG, 29 October 1959, HLG 50/2497, TNA.

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35 Account of the meeting by W. O. Hart, clerk of LLC, to Evelyn Sharp, HLG, 19 December 1960, HLG 120/344, TNA.

36 Notes on meeting between HLG and PLA, 22 February 1961 and 11 April 1961, HLG 120/344, TNA.

37 Report of the Navigational Working Party under Capt. H. Menzies, RN, 25 January 1962, HLG 120/380, TNA; Report of Meeting of Interested Parties including the PLA, HLG & MAFF, 27 September 1962, HLG 120/380, TNA; Statement by Chamber of Shipping, 16 November 1962, HLG 120/380, TNA.

38 Thames Flood Barrier. Report of Steering Committee on Consulting Engineers' Reports, 6 July 1964, HLG 120/528, TNA; for correspondence on the boreholes investigation, see HLG 120/642, TNA.

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41 Crossman to Tom Fraser, Ministry of Transport, 5 July 1965, JH 7/16, TNA.

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43 J.H.O. Bunge, *Tideless Thames in Future London* (London: Thames Barrage Assn., 1944), 31, 45–6.

44 HL Deb., 26 May 1937, vol. 105, c235–7, 240, Hansard.

45 HL Deb., 26 May 1937, vol. 105, c243–8, Hansard.

46 HC Deb., 02 June 1937, vol. 324, c1012, Hansard.

47 *Daily Mail*, 29 March 1938.

48 Bunge, *Tideless Thames in Future London*, 48–50.

49 Watkinson, MT, to Sandys, HLG, 28 February 1956, HLG 50/2495, TNA. This exchange was promoted by the TBA's lobbying. Lord Brabazon, R.A. Allen, MP, A.W.J. Lewis, MP, and Bunge were fobbed off with a letter signed by the minister.

50 Bondi Report, 1966, HLG 145/105, TNA, 3–10.

51 Bondi Report, 1966, HLG 145/105, TNA, 11–17.

52 Bondi Report, 1966, HLG 145/105, TNA, 22–30.

53 P.F. Clifton, Treasury, to Lloyd-Davies, HLG, 13 June 1967, HLG 52/2020, TNA; Cousins, Treasury, to John Crocker, HLG, 15 September 1967, HLG 52/2020, TNA; Cousins to J. H. Street, HLG, 28 December 1967 and 4 January 1968, HLG 120/1381, TNA.

54 For example, see note by Kennet on Bondi, 14 November 1967, HLG 120/1381, TNA.

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58 GLC Report, 1970, HLG 120/1377, TNA, 10–13, quotation at 13.
59 GLC Report, 1970, HLG 120/1377, TNA, 14.
60 GLC Report, 1970, HLG 120/1377, TNA, 14–16.
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70 HC Deb., 5 June 1972, vol. 838, c121–6, Hansard.
71 Note by S.K. Gilbert, 29 April 1968, HLG 120/1380, TNA.
72 Walley, Treasury, to Adams, DoE, 2 July 1971, HLG 120/1380, TNA.
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76 Jon Agar, 'Historiography and Intersections', Chapter 1 this volume.
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